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Bin Set 1 Calcine Retrieval Feasibility Study

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ABSTRACT

At the Department of Energy's Idaho Nuclear Technology and Engineering Center, as an interim waste management measure, both mixed high-level liquid waste and sodium bearing waste have been solidified by a calcination process and are stored in the Calcine Solids Storage Facilities. This calcined product will eventually be treated to allow final disposal in a national geologic repository. The Calcine Solids Storage Facilities comprise seven "bin sets." Bin Set 1, the first to be constructed, was completed in 1959, and has been in service since 1963. It is the only bin set that does not meet current safe-shutdown earthquake seismic criteria. In addition, it is the only bin set that lacks built-in features to aid in calcine retrieval. One option to alleviate the seismic compliance issue is to transport the calcine from Bin Set 1 to another bin set which has the required capacity and which is seismically qualified. This report studies the feasibility of retrieving the calcine from Bin Set 1 and transporting it into Bin Set 6 which is located approximately 650 feet away. Because Bin Set 1 was not designed for calcine retrieval, and because of the high radiation levels and potential contamination spread from the calcined material, this is a challenging engineering task. This report presents preconceptual design studies for remotely-operated, low-density, pneumatic vacuum retrieval and transport systems and equipment that are based on past work performed by the Raytheon Engineers and Constructors architectural engineering firm. The designs presented are considered feasible; however, future development work will be needed in several areas during the subsequent conceptual design phase.

EXECUTIVE SUMMARY

Nuclear fuel processing at the Idaho National Engineering and Environmental Laboratory (INEEL) has resulted in production of a solid radioactive granular calcine material that is being stored, for the interim, in the Calcine Solids Storage Facilities. The facility consists of seven bin sets. The eventual removal of calcine from the bin sets is necessary in order to treat the waste and place it in a form that is suitable to be shipped out of Idaho for disposal by 2035. This is mandated under a Settlement Agreement between the U.S. Department of Energy and the State of Idaho. In addition, it is desirable to remove the calcine from Bin Set 1 (the first bin set built), because it is the only bin set that does not meet current Safe Shutdown Earthquake Standards.

Several options have been studied by Raytheon Engineers and Constructors for solving the structural deficiency of Bin Set 1. Among them is gaining access to the bins and vacuum-transferring the calcine into the seismically-qualified Bin Set 6. This report builds on, and further develops the information in the previous study.

The objective of this study was to prepare preconceptual designs, determine feasibility, and form the basis for future documentation for proceeding with the conceptual design phase. This Study is organized into a main body and attached Appendices. The body is primarily a summary of the more detailed work documented in the attached engineering design files (Appendix D).

Bin Set 1 does not have built in features for removing the highly radioactive calcine material and therefore, gaining access to the calcine presents a complex design problem. This project will be done in several phases. First, the existing Bin Set 1 structures located on top of the concrete vault that house the bins will be demolished. Next, a concrete cap slab will be fitted to the existing vault roof to provide added shielding and vault reinforcement. A weather enclosure will be built over the vault to house the equipment that will be used to gain access to the bins and allow the calcine to be vacuumed out. A shielded retrieval vacuum building will be built adjacent to the environmental enclosure and will contain the retrieval vacuum system and air filtration equipment. A second vacuum system, the calcine transport facility, will be built at Bin Set 6. This facility consists of a shielded building on top of bin set 6 that contains separation and filtration equipment, and a shielded retrieval building at the base of Bin Set 6 that contains vacuum and air filtration equipment. The retrieval system will include a 650-ft long shielded trench containing calcine transport piping from the retrieval building at Bin Set 1 to the transfer facility at Bin Set 6. Due to the high calcine radiation levels and potential for contamination spread, all calcine transfer equipment or facilities must be remotely operable, shielded, and doubly confined. Some of the confinements will have separate ventilation systems. This study identifies areas of uncertainty that require further study and development.

The discounted life-cycle cost total for this project was estimated at \$73,408,000. The schedule ranges from conceptual design starting in January 2000 through calcine removal at the end of 2011. Decontamination and

decommissioning activities for the calcine transfer facilities and equipment start in January 2036 and end in January 2037 report.

It is concluded that no insurmountable problems exist with the design and methods presented. The low-density pneumatic transfer systems are similar to existing systems used to transfer calcine at the INEEL and elsewhere. The use of two separate vacuum systems, one for retrieval from the Bin Set 1 and one for the lengthy transport to Bin Set 6, would provide the most reliable calcine transfer and minimize the chance for vacuum pipe clogging. The major design and development tasks will be associated with equipment necessary to gain access to the Bin Set 1 bins, and with the remote mechanisms required to access the calcine and allow it to be vacuumed from the bins. Significant development work during conceptual design will be required to ensure proper design and operation of these items. It is recommended that a conceptual design plan, short form data sheet, and a request for proposal be prepared so that conceptual design can proceed.

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ACRONYMS

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
APAD	air permit applicability determination
ASME	American Society of Mechanical Engineers
CAM	continuous air monitor
CCTV	closed circuit television
CD	critical decision
CDR	conceptual design report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPP	Chemical Processing Plant
CRN	calcine retrieval nozzle
CSSF	Calcine Solids Storage Facilities
D&D	decontamination and decommissioning
DNFSB	Defense Nuclear Facility Safety Board
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
EDF	Engineering Design File
EIS	environmental impact statement
EMM	electromechanical manipulator
EPA	Environmental Protection Agency
ERO	emergency response organization
GFE	government-furnished equipment
HAZWOPER	Hazardous Waste Operations
HEPA	high efficiency particulate air

HLLW	high-level liquid waste
HLW	high-level waste
HVAC	heating, ventilating, and air conditioning
HWMA	Idaho Hazardous Waste Management Act of 1983
HWPB	Hazardous Waste Permitting Bureau
IDAPA	Idaho Administrative Procedures Act
IDHW	Idaho Department of Health and Welfare
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IWTS	Integrated Waste Tracking System
LCC	life-cycle cost
LDR	Land Disposal Restriction
LMITCO	Lockheed Martin Idaho Technologies Company
MCP	Management Control Plan
NESHAP	National Emission Standards for Hazardous Air Pollution
NFPA	National Fire Protection Agency
NRC	Nuclear Regulatory Commission
NWCF	New Waste Calcining Facility
OPC	other project cost
PDS	project data sheet
PFP	pneumatic flex pipe
PTC	Permit to Construct
STP	Site Treatment Plan
SWPPP	storm water pollution prevention plan
TSD	treatment, storage, and disposal
RAM	remote area monitor

RCRA	Resource Conservation and Recovery Act
RDP	remote drilling platform
RFP	request for proposal
RFR	Raytheon feasibility report
ROD	Record of Decision
SNF	spent nuclear fuel
SSE	safe shutdown earthquake
TEC	total estimated cost
TPC	total project cost
UBC	Uniform Building Code
USQ	unreviewed safety question
VDA	vertical deployment apparatus
WAG	Waste Area Group
WCF	Waste Calcining Facility
WDDF	Waste Determination and Disposition Form
WGS	Waste Generator Services

Bin Set 1 Retrieval Feasibility Study

1. INTRODUCTION

1.1 Overview

The Calcine Solids Storage Facility (CSSF) at Idaho Nuclear Technology and Engineering Center (INTEC) consists of seven structures that contain bins in which radioactive calcine is stored. The radioactive calcine is produced by the liquid solidification operations that result from nuclear fuel reprocessing and decontamination. The CSSF storage structures have come to be commonly called "bin sets," since each structure contains a set of storage bins. A 1989 seismic analysis of Bin Set 1 indicated that a Safe Shutdown Earthquake (SSE) at the INEEL might overstress the vault and critical bin support components. The calculated overstress was of such magnitude that a loss of bin integrity would be expected if a SSE occurred. Similar analyses of Bin Sets 2 through 7 have shown that they are adequate to survive a SSE and are therefore suitable storage facilities for calcine.

This feasibility study proposes that the method for remedying the problems associated with the SSE structural deficiency in Bin Set 1 is to transfer the calcine to one of the six bin sets that is seismically qualified. This study proposes a method of retrieving the stored radioactive calcine from Bin Set 1 and transporting it to Bin Set 6 which is qualified for interim storage. This retrieval method combines methods previously studied¹ with input from recent calcine retrieval development work at Idaho National Engineering and Environmental Laboratory (INEEL) and current codes and standards.

This report provides data that will enable the Management and Operations (M&O) Contractor for the Department of Energy Idaho Operations Office (DOE-ID) to prepare a conceptual design plan, short form data sheet, and request for proposal (RFP) that will then be used to obtain funding and A/E services in order to begin conceptual design. This information includes:

- Feasibility design descriptions and sketches for retrieving calcine from Bin Set 1 and transporting it to Bin Set 6
- Feasibility design descriptions and sketches for demolishing the Bin Set 1 superstructure and actions required to prepare to retrieve the calcine
- Project cost estimate
- Project schedule.

Section 2 provides The design basis and assumptions. Section 3 contains the retrieval project technical description. Section 4 contains the method of construction performance. Sections 5 and 6 describe the life-cycle cost (LCC) cost estimate and project schedule respectively. Section 7 describes the requirements and assessments. Section 8 discusses the uncertainties and recommended resolutions, and section 9 gives the references. The attached appendices contain backup information for the report.

1.2 Background

INTEC has reprocessed spent nuclear fuel (SNF) to recover fissile uranium from 1953 to 1992. The resultant high-level liquid radioactive waste (HLLW), composed of dissolved fission products and fuel cladding material from the waste streams of the reprocessing operations, was stored in underground tanks at INTEC. Subsequently, waste treatment activities were developed at INTEC to calcine (process

the liquid waste into a dry granular solid) the HLLW material. The initial facilities built to produce and store the calcine was the Waste Calcining Facility (WCF) known as Chemical Processing Plant (CPP)-633, and the CSSF—the first calcine storage unit, that has come to be called Bin Set 1 (see Section 4 for a detailed description). Both of these facilities were constructed and placed into operation between 1958 and 1963. The calcine was, and still is pneumatically transferred to the CSSF.

The CSSF consists of seven concrete structures, numbered sequentially one through seven in the order of their past or intended usage, that contain sets of steel bins in which the calcine is stored. Thus, each CSSF structure is called a bin set. Each bin set consists of a reinforced concrete vault containing from three to seven stainless steel storage bins. The vaults also contain piping and ancillary equipment that support filling and retrieval (except for Bin Set 1) of calcine from the bins, and instruments which monitor and control the condition of the calcine material. The stainless steel bins and concrete vaults are intended to provide primary and secondary containment, respectively, for the stored calcined solids.

Bin Set 1 was constructed in 1959, and from 1963 to 1964, was filled with approximately 227 m³ (8,000 ft³) of alumina calcine. No other type of calcine is in this bin set. Bin Sets 1, 2, and 3 store calcine produced by the WCF, building CPP-633. These solid storage units have been filled to near design capacity and isolated from all processes. The WCF has been shut down and calcining operations have been moved to the New Waste Calcining Facility (NWCF), building CPP-659. About 3,600 m³ (127,200 ft³) of calcine exists in the current INTEC inventory.

In 1989, a seismic analysis of Bin Set 1 was conducted to assess whether or not the vaults and bins would survive the applicable Safe Shutdown Earthquake (SSE) at the INEEL. That analysis indicated that a SSE might overstress the Bin Set 1 vault and critical bin support components. The calculated overstress was of such magnitude that a loss of bin integrity would be expected due to the SSE. Similar analyses have shown that Bin Set 2 through Bin Set 7 are adequate to survive the SSE and are therefore suitable storage facilities for calcine.

Several alternatives for dealing with the calcine in Bin Set 1 have been studied. One alternative involves leaving the calcine in Bin Set 1 and modifying or reinforcing the bins so that they would survive the SSE event they are required to withstand. A second alternative, in situ immobilization of the calcine, has been considered but will not place the waste in a form that will be ready to be shipped out of Idaho for disposal by 2035 as required in the "Settlement Agreement" between DOE and the State of Idaho, which mandates that all radioactive high-level waste (HLW) now stored at INTEC be treated so that it is ready to be moved out of Idaho for disposal by a target date of 2035. HLW treatment facilities, requiring transport of calcine from the bin sets to those facilities, are being described in the High-Level Waste and Facilities Disposition Environmental Impact Statement (to be released).

In 1995, a study was conducted by Raytheon Engineers and Constructors, Inc., that considered several options for dealing with the calcine in Bin Set 1.¹ Alternate 3, "Calcine Retrieval and Transport from Bin Set 1 to Bin Set 6" was the most promising alternative, and the one chosen for this study. This study assumes that the associated Record of Decision (ROD) may not select a treatment facility, or that it will be desirable to transport the calcine out of seismically unqualified Bin Set 1 to a qualified bin set before the treatment facility begins operations.

1.3 Feasibility Study Goal and Justification

In consideration of the potential breach of Bin Set 1 integrity due to a SSE, and the resultant studies conducted to this point, especially Reference 1, the goal of this study is to describe a method for transporting as much of the calcine as possible from Bin Set 1 to the other Bin Sets. Both Bin Sets 6 and 7 could be used to receive the calcine, in that the technical issues (i.e., seismically qualified and have

enough residual capacity to hold all 227 m³ [8,000 ft³] of the calcine currently stored in Bin Set 1), costs, and schedule would be virtually identical for each.¹ However, Bin Set 6 has been selected to receive the calcine.

Project conceptual design funding should be approved because Bin Set 1 is not seismically qualified and a SSE could lead to a release of calcine directly into the concrete vault surrounding the bins. If that were to happen, the calcine double-confinement requirement would not be met because only a single confinement barrier (the vault) would exist between the calcine and the environment. In addition, the calcine and bin sets would not exist in a well-known geometry and this would increase the difficulty of any subsequent retrieval and transport effort.

1.4 Project Objectives

1.4.1 Technical Objective

The technical objective of this project is to place the HLW calcine into a seismically qualified bin set (in this case Bin Set 6). This action will eliminate any potential problems associated with failure of the Bin Set 1 vault or bins during a SSE. This action also involves safely retrieving the calcine from Bin Set 1 and transporting it to Bin Set 6.

1.4.2 Cost Objective

A feasibility study LCC developed for Bin Set 1 Retrieval and Transport (see Appendix A) contains the construction cost estimate, which includes the cost to prepare the conceptual design, the conceptual design report, and related documentation required for Critical Decision (CD)-1, "Approval of New Start." The cost estimate resulting from the conceptual design will be prepared at the end of the conceptual design phase, which, according to the project schedule in Appendix B, is at the end of 2002.

1.4.3 Schedule Objective

As stated above, the Bin Set 1 calcine transport schedule estimated in this feasibility study is included Appendix B. Conceptual design starts at the beginning of 2000, and the completion of the conceptual design report (CDR) and CD-1, "Approval of New Start," will be at the end of 2002.

1.5 Project Description

This Study describes the project that will be conducted to accomplish the goal and objectives of this study. That project is based on the development of a HLW and Facilities Disposition Environmental Impact Statement (EIS)—currently in progress—in order to determine a path forward for the INEEL HLW Program. After the EIS is developed, a Record of Decision (ROD) will be issued. The Alternative P1E in the EIS is "Transporting Calcine from Bin Set 1 to Bin Set 7." An Engineering Design File (EDF) Project Data Sheet (PDS) EDF-PDS-C-026, completed in September 1998, contains the PDS, draft project summary, construction cost estimate, and LCC estimate for Alternative P1E. The project in this study is based on Reference 1 and EDF-PDS-C-026, and will support the feasibility study goals by transporting the calcine from Bin Set 1 to Bin Set 6 by the end of 2012. Post-operations decontamination and decommissioning (D&D) of Bin Set 1 will be handled as EIS Alternative P1F, which is outside the scope and mission of this study.

1.5.1 Project Organization

The DOE-ID field office has overall control of the project. The LMITCO HLW Program reports to DOE-ID and provides project direction to LMITCO Project/Construction Management. LMITCO

Project/Construction Management has the responsibility for issuing the Feasibility Study Report that occurs at just before CD-0. Once CD-0 is approved, LMITCO Project/Construction Management will issue a RFP for an architectural engineering (A/E) firm to conduct the conceptual design. These organizations will maintain these lines of authority and reporting throughout the period from CD-0 through CD-1.

1.6 Risk Assessment

During the course of this study, several important uncertainties arose that will need additional work during conceptual design. These issues are associated with the drilling rig vertical deployment apparatus (VDA) design, riser-to-bin welding, bin lid cutting (inside riser), the calcine vacuum/airjet VDA design, dolomite introduction system, and development of proper sintered metal filter operation (to reduce the number of spent high-efficiency particulate air (HEPA) filters requiring disposal and change-out.

2. DESIGN BASIS AND ASSUMPTIONS

2.1 Design Requirements

This subsection lists the design requirements that have been established as the basis for developing and selecting the recommended vault access, retrieval, and transport system:

2.1.1 General

- Transport system should be designed for a 20-year life at a calcine transfer rate of approximately 260 m³ per year.
- Provide a design that will empty each bin 4 Bin Set 1 bins in 2.5 months.
- Select a reliable vault entry, retrieval, and transport method. These methods must be tested in a mock-up facility.
- Use a pneumatic transport system concept. Incorporate transport system enhancements based on new technologies and current safety requirements.
- A closed loop transport air system should be developed if practical.
- If conveying air temperatures are excessive, heat exchangers should be required to control the conveying air temperature and to protect the blowers and HEPA filters.
- The systems should be designed to withstand any credible fire or other applicable accident and still serve as a confinement barrier.
- The facility should be designed to withstand appropriate natural phenomena hazards.
- Establish a transport system that can be readily maintained.
- Provide for future tie-in capability to Bin Sets 2 and 3.
- Design the retrieval system so that the calcine will be retrieved to Bin Set 6 within one year.
- Provide primary and secondary confinement at all times and minimize confinement volumes.
- Design the retrieval system such that it can be assembled, dismantled and transported from one Bin Set to the next, and from one bin to another bin for calcine retrieval.
- Provide cleanouts in the transport line.
- Provide adequate heating, ventilating, and cooling in all areas of the enclosures that will be occupied by personnel.
- Provide instrumentation and control for operation and data acquisition.

2.1.2 Environmental and Permitting

- Minimize generation of secondary hazardous and radioactive waste streams.
- Minimize the release of hazardous and radioactive waste to the environment.

2.1.3 Radiation Protection

- Design should minimize worker radiation exposure to as low as reasonably achievable (ALARA), and minimize the spread of contamination."

2.1.4 Remote Operations and Maintenance

- Minimize the amount of remote electro-mechanical equipment that would will be placed in the bins to minimize the potential for equipment breakdowns.
- Provide a remote viewing system for both the vault and bin interiors during access and retrieval operations.
- Facility equipment and calcine retrieval and transport systems must be capable of being decontaminated and/or replaced safely and easily.

2.2 Initial Assumptions

This subsection lists the key assumptions that apply to the Calcine Retrieval and Transport Concept.

2.2.1 Hazard Class

- The facility is classified as a moderate hazard facility because it falls within the following guidelines specified in LMITCO MPC-2451:

"Classify a facility as having a moderate hazard classification if the hazard analysis shows the potential for considerable on-site impacts to people or the environment, but at most only minor off-site impact. Classify a facility as having a moderate hazard classification if it has at least one hazard that exceeds the low-hazard, upper threshold criteria and which meets all the following moderate-hazard, upper threshold criteria for those hazards that exceed the low-hazard criteria:

- Could not result in injuries to more than ten (10) people and/or more than five fatalities on site from a single event.
- Could not potentially result in injuries to more than five people and/or fatalities off site from a single event.
- Could not potentially result in off-site hazardous material effluents that could expose the public to conditions immediately dangerous to life and health.
- Could not potentially result in any substantially irreversible environmental degradation by either catastrophic or long-term cumulative physical disruptions or releases of regulated materials."

2.2.2 Quality Level

- The facility will be Quality Level 2 in accordance with Appendix B of LMITCO Management Control Procedure (MCP) MCP-540.

2.2.3 Mechanical and Remote

- The system will transfer calcine from Bin Set 1 to Bin Set 6.
- The system will be based on the preferred alternatives from Phase I and II of the Raytheon Feasibility Report (RFR).¹
- This feasibility study will be based on the 20-riser design used in Phase II of the RFR.¹ In the annular bins, this includes one VDA for airjet impingement and one VDA for vacuum transfer of calcine. Only a vacuum VDA will be used in the center (cylindrical) bin.
- The facilities will not fall under Nuclear Regulatory Commission (NRC) over-site and regulation. The design will be in accordance with DOE Orders with maintenance of status-quo interfaces with other regulatory and oversight agencies such as the Environmental Protection Agency (EPA), State of Idaho, and the Defense Nuclear Facilities Safety Board (DNFSB). No additional costs will be considered for NRC oversight.
- Calcine bulk density is 1.1 gm/cm³ (68.67 lbm/ft³).
- The particle density of cold alumina calcine was tested by INTEC in an independent testing laboratory and found to be 2.61 gm/cm³ (163 lbm/ft³).
- Calcine inlet velocity was set at 20.33 m/s (4,000 ft/min, 66.7 ft/s). This information is based on zirconia-type calcine that was pneumatically conveyed at a velocity ranging from 6 m/s (19.7 ft/s) to 20 m/s (65.6 ft/s) as described in Reference 2.
- The transport-system flow rate must be equal to or greater than the retrieval rate.
- The bin pressure must remain slightly more negative than the surrounding vault space during retrieval, with controls as required to maintain confinement.
- The volume of calcine stored in Bin Set 1 is 212 to 227 m³ (7,500 to 8,000 ft³).
- Present calcine temperature in the vault is approximately 27°C (80°F) that is maintained in an approximate steady state by free convection only.
- Calcine material will be retrieved from one bin at a time.
- The size of the retrieval system and retrieval rate will be dictated by the size of the line that can penetrate the vault and the conveying distance.
- The existing Bin Set 1 ventilation system is not operational.
- As close to 100% of the calcine will be retrieved as practical.
- The mean particle size used for alumina calcine is from 0.3 to 0.7 mm.

- The calcine contained within Bin Set 1 has basically remained unchanged, and has not become agglomerated during the storage period. Therefore, the calcine can be easily reclaimed pneumatically.

2.2.4 Radiological

- A dose rate of less than 0.1 mrem/h is required for routinely occupied areas.
- There will be no possibility for a nuclear critically excursion in the system design.
- The existing cyclone at Bin Set 1 has remained intact and no calcine is expected to be found within the cyclone room.
- Minimize, to the extent practical, the amount of radioactive material released to the environment as a result of the transfer operations.

2.2.5 Piping

- The transport pipe will be schedule-40, stainless steel.
- Nitronic[®] reinforced blind tees and laterals will be installed at all changes in direction.⁴
- Rodout ports will be required along all straight pipe runs.
- Double containment must be maintained through the entire transport process including the retrieval, transport, and return lines.
- All aboveground piping will be shielded.
- A 6-in. (minimum diameter) schedule-80 pipe riser was assumed.
- The pneumatic transport system design need not include a third line for a spare.
- No steam tracing will be required inside the secondary confinement pipe to provide freeze protection to the transport line. Operations could be suspended under the most extreme conditions if necessary.
- Transport and return line piping can be placed in a concrete enclosure at grade as long as 0.1 mrem/h is not exceeded. Thus, below-grade installation will be unnecessary.
- All piping shall be in accordance with American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME) B31.3 Fluid Category "M" with 100% radiograph qualification of joints.

2.2.6 Structural

- Bin Set 1 is classified as a Moderate Hazard Facility.

2.2.7 Heating and Ventilation

- The existing vault ventilation system is not operational and should not be used.

- All ventilation Zone I and Zone II confinement exhausts will be HEPA filtered and exhausted to the environment via new stacks at Bin Set 1 and Bin Set 6.
- The control system for the new heating and ventilation equipment will be the electronic type.
- Enclosure heating will utilize electric coils.

2.2.8 Architectural

- The retrieval enclosures will be designed to moderate hazard and National Fire Protection Agency (NFPA) 101 Life-Safety Code.

3. RETRIEVAL PROJECT TECHNICAL DESCRIPTION

3.1 Description of Bin Set 1

At INTEC, liquid radioactive waste from plant operations and other INEEL sources is fed to a calciner and converted to a solid granular material referred to as "calcine" in a bed of fluidized, solid particles. The granular calcine is then transported pneumatically through a double walled, stainless steel transport line to the CSSF. The CSSF consists of seven separate, self-contained units referred to as bin sets. Each bin set consists of several stainless steel bins enclosed in a concrete vault. In the vault, the transport air and offgases are separated from the calcine by a cyclone unit and the calcine is fed into the bins through the bin fill lines. The transport air and offgases are returned to the calcining facility for treatment and/or recycling.

The CSSF system components are included on the INEEL's Resource Conservation and Recovery Act (RCRA) Part A permit application, and the facility is currently operated as an interim status waste management unit subject to the requirements of 40 Code of Federal Regulation (CFR) 265, Subpart J.

The CSSF is a component of the INTEC complex at the INEEL. The INTEC is located in the south-central portion of the INEEL in Butte County, about 39 miles west of Idaho Falls. The INTEC occupies an enclosed and secured area of approximately 988 acres.

Bin Set 1, constructed from 1959 to 1963 and placed in service in 1963, was the prototype facility for calcine storage at INTEC and differs significantly in design features from other bin sets. Bin Set 1 was designed as a permanent storage facility and does not contain provisions for retrieval of the stored calcine, unlike the other bin sets.

Bin Set 1 contains four calcine storage bins constructed of type 405 stainless steel with a total capacity of about 221 m³ (7,800 ft³). These bins each contain a central cylinder surrounded by two progressively larger concentric cylinders with annular spaces between (i.e. like a triple walled vessel) to allow convective cooling. Three of the bins measure 7.44 m (24 ft-5 in.) tall and the fourth is 8.15 m (26 ft-9 in.) tall. The bins are installed in a rectangular reinforced concrete vault 7.77m (25 ft-6 in.) x 7.77 m (25 ft-6 in.) x 12.19-m (40-ft) deep. The vault structure is completely below grade.

A ventilation system that provides air circulation throughout the Bin Set 1 vault is installed to remove the decay heat from the highly radioactive calcine material, but is not operational since there is no air-filtration of the ventilation outlet. A monitoring system consisting of thermocouples built into the vaults and bins, continuous air monitors (CAMs), and remote area monitors (RAMs) is installed to detect leakage of radioactive material that might result in case of accidents.

Bin Set 1 contains a liquid sump system that consists of a sump to collect liquid that might leak into the vault and liquid level instrumentation to monitor the quantity of any liquid collected. Piping also extends into the sump for sampling and removal of any liquid collected. Bin Set 1 has experienced water inflow; in 1979, an underground water line not associated with the bin set ruptured and some water seeped into the vault through the concrete walls or floor. Rather than pump the water out through the sump system, it was monitored until the water evaporated.

The concrete vault of Bin Set 1 is supported on basalt bedrock. Soil was backfilled around the vault in order to prevent water from accumulating around the exterior. The vault penetrations are not placed below the projected elevation of the 100-yr-flood level.

3.2 Description of Calcined Waste

This description of calcined waste is from Reference 1. Calcined waste is composed of dried granular solids that are produced during the heating of HLW, and mixed HLW liquids in the presence of granular dolomite, alumina or some other fixing agents. Calcine made in the WCF and the NWCF was heated to either 400°C (752°F) or 500°C (932°F). Current experiments use heating up to about 600°C (1,112°F). When HLLW undergoes calcination, water evaporates; acids decompose; and the fission products, transuranics, and other dissolved solids convert to oxides and salts. The result is a dry, stable, spherical solid with an approximate average volume reduction of 75% to 90%.

The HLLW sent through the calcining process results mainly from fuel processing activities at INTEC. Despite the knowledge of process components, a complete chemical and physical description is not available for wastes treated at the WCF or the calcine, which is stored at the CSSF. Because RCRA rules did not exist at the time, analysis of the waste material stored at the facility was not performed in accordance with these requirements. Analysis of treatment feed stock was conducted only for constituents considered necessary for process and product considerations, and due to the high level of radioactivity, complete chemical and physical descriptions of the calcined waste is not available.

Calcine contained in the bin sets is considered very stable and remains in a free flowing, retrievable form as long as it is kept dry and the temperature is maintained within prescribed guidelines. Extremely high temperatures within the bin sets could cause caking of the stored calcine and complicate future retrieval efforts. The caking temperature of the stored calcine varies according to the type of waste calcined. For example, because of its high alkali content, sodium waste poses caking problems if a bin set temperature exceed 600°C (1,112°F). Both alumina and zirconia calcine cake at temperatures greater than 700°C (1,292°F). Additionally, residual nitrates in the calcine become volatile at temperatures above 450°C (842°F) and ruthenium compounds start volatilizing at about 800°C (1,472°F). Cesium volatilizes at 669°C (1236°F). Other chemical components in the calcine begin volatilizing at temperatures greater than 800°C (1,472°F). To avoid caking in all types of calcine, the calcine storage bin temperatures are maintained below 600°C (1,112°F).

Exposure of the calcine to water would cause certain chemical elements (i.e., heavy metals) and long-lived fission products to become soluble and leach out of the calcine and into the water. The solubility and leachability of the stored calcine depends on the type of waste calcined. Leachable elements include cesium, strontium, boron, mercury, chromium, residual nitrates, and alkalis such as sodium.

The calcine in Bin Set 1 is assumed to be, and has been demonstrated to be, free flowing.³ However, as indicated in Section 2 of EDF-1105, the calcine solids are hygroscopic, and therefore if exposed to moisture by a breach of containment, will turn from a particulate to a cement-like substance making it difficult to manage or remove.

Generally, throughout the CSSF, the calcine is deposited in distinctive layers, within the storage bins. These layers are of different chemical composition, depending on the composition of the HLLW being processed. However, calcine that is deposited in Bin Set 1 took place from December 1963 through October 1964, and is completely composed of alumina calcine.

3.3 Method Analysis

Of all the alternatives assessed in the March 1995 report issued by Raytheon Engineers and Constructors,¹ Alternate 3, "Calcine Retrieval and Transport from Bin Set 1 to Bin Set 6" was the most promising alternative and had the most favorable cost benefit ratio. This is because (a) development of methods for retrieval of calcine from the bin sets will eventually be necessary anyway, (b) adequate storage space exists on site for the contents of Bin Set 1, and (c) reasonable methods of retrieval have been identified. In all cases, the calcine was envisioned as a free flowing bulk material which was suitable for pneumatic transport.

The study of the possibilities for retrieval of calcine from Bin Set 1 included evaluation of two distinct aspects of the work, namely access to the calcine in the bins in the below-grade vault, and retrieval of all of the calcine in the bins once access is gained. Retrieval methods were conceptualized to make use of the transport methods that were discussed. Furthermore, applicability of the retrieval schemes were considered with the possibility of their implementation in the other bin sets as well as in Bin Set 1, although only, retrieval from Bin Set 1 was considered in detail. Several retrieval schemes were studied but the most promising one was the pneumatic flex-pipe (PFP) concept which makes use of steel pipe that can be remotely flexed to gain access part of the floor area of the bins for bulk retrieval of the total amount of calcine in the bins and cleanout of remaining fines. However, the PFP system requires that five risers be attached to each annular bin. Further calcine transfer development work done at INEEL subsequent to the Reference 1 report, indicate that a combination of an airjet to move the calcine from one side of an annular bin to another, in combination with a vacuuming nozzle, provide more thorough and efficient clean up of the calcine from the annular bins. Also, this design will require only two risers on each annular bin. This concept has been incorporated into this report and thus this is a change from the PFP system proposed in Reference 1.

Typical to most retrieval schemes, the recommended vault access method requires penetrations of the vault roof for risers attached to the bins for insertion of the retrieval piping. This access method is a core drilling and remote riser installation technique that has been used in similar applications at the West Valley site. To facilitate vault penetration and installation of the risers, it is recommended that the gravel soil above the vault roof, and the existing equipment room and equipment, be removed. To lower vault roof radiation fields that will exist following the excavation of the fill, a 17-in. thick cap slab will be placed on the vault roof. The top of the cap slab will be at the (-)3 ft-6 in. level which is the same as the top of the existing precast concrete roof support beams. The new cap slab will provide a level work platform with features that anticipate and facilitate core drilling, riser installation, mounting of the retrieval rig, and installation of secondary confinement features related to various aspects of project operations. To further supplement project progress, the retrieval site, which includes the area over the vault and a control room and ventilation equipment room, will be enclosed in a weather enclosure that can be erected in the field. An overhead bridge crane will be located within the weather enclosure for moving equipment.

Alternate 3¹ uses a "combine loop" calcine transport system that uses one set of pneumatic transport equipment located on and at the base of Bin Set 6. The calcine would be vacuumed from the bins and directly transported 650 ft to Bin Set 6. This study adopts the "closed loop" system in which there will be two separate pneumatic transport systems. A retrieval system will be located adjacent to the weather enclosure at Bin Set 1 and a transport system will be located on, and adjacent to, Bin Set 6. The transport system will be similar to that proposed in Alternate 3. The new retrieval system will be designed to shorten the calcine piping run from the bins. This will eliminate the possibility of slug flow in a 650-ft piping run required by the combined loop system. The retrieval system will carefully meter measured quantities of calcine into the 650-ft transport pipe to maintain a dilute phase flow. The calcine transport line forms a part of the transport system and is located at grade level. It spans between the

weather enclosure and the retrieval system at Bin Set 1, and the transport equipment at Bin Set 6. It ties into the weather enclosure at the east side of the Bin Set 1 vault. The calcine retrieval equipment within the weather enclosure will be moved from riser to riser (20 in all) and will be anchored to the floor at each riser. The vertical airjet and retrieval lines must extend more than 40 ft below the cap slab to reach the floor of the bins, and then travel 25 ft above the floor to accommodate the VDA. The VDAs will be connected to the transport line by means of reconfigurable, shielded jumpers. The retrieval equipment has removable shielding, will be remotely-operated, and will deploy the airjet and vacuum nozzle and their extension tubes in 10-ft lengths into the riser. When the nozzle and extension tubes are removed, a separate closed circuit television (CCTV) system can be lowered through the risers for viewing the progress of calcine removal. Operators in the control room have unlimited stay times, however, there will be no personnel present above the vault during calcine retrieval and transport operations. Alternate 3, as modified by this report, consists of the following:

- Bin Set 1 gravel soil removal
- Decontamination and removal of the Bin Set 1 superstructure down to (-)4 ft-11 in. elevation: structures (concrete and metal), equipment, piping and ductwork, and wiring and conduit
- Installation of a roof cap slab for shielding and equipment support
- Core drilling equipment and core drilling of 24, 9-in.-diameter penetrations in the vault roof
- Erection of an equipment weather enclosure including heating, ventilating, and air conditioning (HVAC) room and shielded control room
- Installation of 20 risers spanning from the top of the bins to the top of the cap slab
- Retrieval equipment and shielded support structures
- Construction of a the closed loop pneumatic transport process system—a retrieval system near Bin Set 1 and a transport system at Bin Set 6, including equipment (blowers, cyclone, sintered metal filter, HEPA's, piping, encasement, insulation and steam line, wiring, conduit and controls
- Buildings and ventilation equipment at Bin Sets 1 and 6
- Power, control wiring and controls for Bin Sets 1 and 6
- Riser shielding plugs
- Earth work
- Construction labor
- Construction debris boxes
- All indirects.

Alternate 3 Excludes:

- Further decontamination of materials at other locations
- Transport of materials from site
- Readiness reviews
- SO test, start-up and operations.

3.4 Calcine Transfer

3.4.1 Demolition

Currently, Bin Set 1 has equipment and structures that must be demolished before the new calcine transport facilities and equipment are constructed. Demolition is part of Alternate 4 in Reference 1, and is described in detail in the text and drawings of that document. Applicable sections of the Reference 1 report describing this demolition are included in Appendix C. For purposes of this report demolition is defined as installation of sheet piling near Bin Set 1 and demolition of Bin Set 1 superstructure to the top of the concrete vault at the (-)4 ft-11 in. level.

3.4.2 Site preparation

Excavation at Bin Set 1 will be necessary for demolition and to construct facilities on and near Bin Set 1. This includes removal of the gravel fill, presently at elevation (+)4 ft-10 in., and which was placed over the Bin Set 1 vault as shown on drawing SK-T-02 in EDF-1203 in Appendix D. A fill embankment for the adjacent bin sets 2 and 3 also affects requirements for site excavation. This material must be removed, and shoring erected both to maintain the shielding thickness required for these other bin sets and to obtain the required level space for the retrieval operations. The whole area must be cleared and leveled for construction of the vault cap slab as well as erection of the new weather and retrieval enclosures. The weather enclosure extends completely over the vault and over the control and ventilation rooms that abut the vault at the north wall. Adjustment of site drainage to the new configuration will require gentle sloping of the site from approximate elevation of (+) 4 ft-0 in. for gravity runoff of precipitation, a drainage swale, and installation of a culvert. Removal of potentially contaminated soils may also be necessary. Although there will be an attempt to balance cut and fill, it is anticipated that there will be a net excess of fill, which must be removed and stockpiled. The stockpile should be located nearby, beyond and to the east of the existing Bin Set 6 site. Removal of the gravel fill, installation of shoring, and burial of the transport line will require use of heavy equipment. Access to the site for construction personnel and equipment, which may include front end loaders, back hoes, dump trucks and other construction vehicles, will require an inclined access ramp from Olive Avenue level to the top of the vault. Finally, it will be necessary to relocate any utility lines that will be encountered at the site that are still in use, and the existing footings for an outdoor personnel access stairway will interfere with shoring installation and must be replaced to provide personnel access to the other bin set areas. Near the conclusion of the construction phase of the project, temporary construction site fencing will be removed and a more permanent fence will be installed control personnel access during calcine transport operations.

3.4.3 Facilities

Once the demolition described in the previous section is completed, new facilities will be constructed for transferring the calcine from Bin Set 1 to Bin Set 6. The buildings will consist of a weather enclosure on top of the Bin Set 1 vault, a calcine retrieval building to the north of the weather

enclosure over Bin Set 1 vault, a new shielded cyclone room on top of Bin Set 6, and a calcine transport building to the west of Bin Set 6. In addition, the at-grade calcine transfer piping system will be constructed between the Bin Set 1 weather enclosure and the calcine retrieval building, between the calcine retrieval building and the calcine transport facility, and between the calcine transport building and the cyclone building at the top of Bin Set 6. The new facilities include all modifications to Bin Set 1 that will be necessary to start the retrieval process. These include placement of the 17-in.-thick cap slab on top of the Bin Set 1 vault roof, 24 cored holes in the roof, installation of 20 risers through the cored holes, attachment of the risers to the bin tops, cutting of the holes in the bin tops inside the risers, and the installation of 24 shield plugs in the cored-holes.

3.4.4 Bin Set 1 Weather enclosure

Before making penetrations into the vault, an enclosure will be erected to provide weather protection for the work area on top of the vault. This structure will cover the entire roof of the vault as well as contain a new vault ventilation room and control room. The structure will be sized to accommodate a remote drilling platform (RDP), two vacuum nozzle/airjet VDAs (approximately 24 ft. high), and will support the bridge crane to be used in moving and positioning the RDPs and VDAs.

The weather enclosure will consist of a metal building system supported on the cap slab over the existing vault walls and that portion of the structure which overhangs the vault to provide area for the ventilation and control equipment. This portion will rest on a new foundation and floor slab. The weather enclosure plans and section are shown on SK-A-01 and SK-G-07 in EDF 1109 in Appendix D. The enclosure will be approximately 30 × 41 × 30-ft high. It will be a metal building system suitable for secondary confinement operation at 0.1 in. H₂O of vacuum. An overhead roll-up door will be access, and all joints will be sealed so the negative pressure can be maintained in the space. Heating and cooling requirements will be minimal so no insulation will be required. No shielding will be required because the VDAs will provide shielding when the shield plugs are removed from the cored holes, and when calcine is being retrieved. The vault weather enclosure need only provide weather protection and secondary confinement for the work operations. The enclosure will be equipped with the 10-ton bridge crane.

A second enclosure will be located within the weather enclosure but outside the vault top work area. This enclosure will serve as secondary confinement for the new vault and weather enclosure ventilation equipment, and the ventilation equipment serving this enclosure. This equipment will consist of blowers and HEPA filter trains for the exhaust air. The exhaust air will be monitored by an isokinetic sampler and released via a new stack. The vault ventilation enclosure will consist of a room, approximately 10 × 14 × 10-ft high, constructed of light gauge steel framing and metal wall panels and overhead decking. The joints will require sealing so that negative pressure can be maintained in the space. No radioactive shielding is required in this enclosure. Entry will be made through an airlock at the exterior of the enclosure.

A control room will be located adjacent to the ventilation equipment enclosure. A shield window in the control room wall provides a view of the equipment and operations inside the weather enclosure work area on top of the vault. This 10 × 10 × 10-ft room will be shielded to allow unlimited occupancy even during calcine retrieval operations within the weather enclosure. The control room will be separately ventilated and held as a slightly positive pressure by a small air handling unit located on its roof. The room will be insulated and lined with gypsum board. Maintenance access for control room ventilation equipment will be provided via a fixed ladder and catwalk. All remote operations, during core drilling, calcine retrieval, CCTV inspection, etc., will be monitored and controlled from this room.

3.4.5 Calcine Vacuuming Equipment and Facilities

Section 4.3.6 in the RFR¹ discusses various technologies of transporting the calcine from Bin Set 1 to Bin Set 6. Among these are a "combined loop" and a "closed loop" vacuum transport system. The combined loop system, which retrieves the calcine from Bin Set 1 and transports it to Bin Set 6 using a single pneumatic vacuum system, was selected as the preferred method in the RFR. However, this report recommends that a the closed loop system be adopted. The closed loop system uses one relatively short (about 80 ft of calcine pipe run length) pneumatic vacuum system to lift the calcine from the bins and deposit it in a weigh tank adjacent to the Bin Set 1. It uses a separate pneumatic vacuum system to transport the calcine from the weigh tank, approximately 650 ft, to Bin Set 6. This system is considered the most reliable because it reduces the possibility of slug flow in the vacuum transport piping. Slug flow can be a problem with pneumatic vacuum systems because the low differential pressure available for moving the solids may not be enough to resuspend the material into the dilute flow phase that is required for its transport. Sketch SK-BS1-01 in EDF-1203 in Appendix D is the flow diagram for the closed loop system recommended in this report. This is judged the most reliable method for moving the calcine from Bin Set 1 to Bin Set 6. In addition, its cost will bound that of the other options investigated. The closed loop pneumatic transport system consists a calcine retrieval facility at Bin Set 1, and a calcine transport facility which is mainly located at Bin Set 6, but includes the 650 ft calcine transport piping located in a trench running between the bin sets.

3.4.5.1 Bin Set 1 Calcine Retrieval Facility

The new retrieval facility was added to increase the reliability, and reduce the possibility of calcine transfer pipe clogging when transferring calcine from Bin Set 1 to Bin Set 6. The calcine retrieval facility piping has a very short run and will thus minimize clogging and slug flow. The Retrieval Facility is similar in design to the Transport Facility presented in the RFR, with additional space in the cell for a calcine retrieval cyclone separator, sintered metal filter, and calcine weigh tank on load cells.

The retrieval facility will be located in the area of the existing earth berm and just north of Bin Set 1. More excavation and shoring than indicated in the RFR study will be required around Bin Set 1 for the addition of the new retrieval facility. A new access roadway for personnel, and for removal of used and drummed HEPA filters, will be added from Olive Avenue approximately 20 ft away.

The retrieval facility will be a new single-story building that extends approximately 22 ft above grade, and has a footprint occupying an area measuring 52 × 32 ft. Floor plan and cross sections are shown on sketch S-3 of EDF 1109 in Appendix D. It will house the equipment and operations for retrieval of calcine from Bin Set 1, and provide essential features for safe and efficient operation and maintenance.

The retrieval facility houses a process HEPA-filtered and a valved balancing air blower that discharges to a monitored exhaust stack. In addition, building HVAC will be provided by a primary confinement HEPA filter and blower for cell ventilation, and a secondary confinement HEPA filter and blower for the operating corridor. Personnel entry into the facility is through one of two air-locks.

The building will be constructed with concrete foundations and floors, concrete shielding cell walls and ceiling, concrete enclosure walls and roof, and a single waterproofed roof with a single-ply roofing membrane. The exterior surfaces of this building will receive an acrylic sealer and all interior surfaces will be finished with an epoxy coating that can be decontaminated.

The facility is classified as a Uniform Building Code (UBC) group h division 7 occupancy. The H-7 occupancy applies to buildings or portions thereof containing materials that constitute a high health

hazard. It will have a construction type classification of UBC type II-F.P. Allowable area for H-7 occupancy type II-F.P. is 39,900 ft². The transport facility has 1,248 ft² of building area, well below the allowable area. The retrieval facility has 1,664 ft² of building area, well below the allowable area. Occupancy H-7 Type II-F.P. construction requires exterior bearing walls to be four hour fire rated, interior bearing walls to be two hour, permanent partition to be one hour, and structural frame, floors, and ceilings to be one hour. Because of the nature of the facility, all walls will be concrete and will meet the required fire rating. All doors, shielding doors, cells, and shielding windows, will need to be fire rated.

The underground utilities will be limited to power, steam, and plant air. No new permanent fencing will be required, but construction fencing will provide a safe work environment for INTEC personnel during this project's construction.

3.4.5.2 *Bin Set 6 Calcine Transport Facility*

3.4.5.2.1 *Bin Set 6 Cyclone Separator Building*

An enclosure will be required on top of Bin Set 6 to provide secondary confinement and radioactive shielding for the new cyclone and sintered metal filters that will be located there. The enclosure will be a concrete room constructed on the existing concrete roof of Bin Set 6. This unoccupied, enclosure will be approximately 17 × 19 × 10-ft high with walls and roof constructed of 2-ft-thick reinforced concrete. The exterior wall surfaces will receive an acrylic sealer, and the roof will be waterproofed with a single-ply roofing membrane. All interior surfaces will be finished with a decontaminable epoxy coating.

Ventilation air for this enclosure will be supplied by an air handler unit mounted on the vault roof adjacent to the enclosure. Exhaust air will be ducted through HEPA filters, monitored, and released through a roof-mounted stack.

The existing metal building structure (CPP-673) that presently occupies the location required for this enclosure and contains a small jib crane and rodding access ports will be relocated to set atop the new shielded enclosure. The existing rodding tubes will be extended through the new enclosure so they can be accessed from the relocated structure. Refer to SK-A-02 in EDF-1203 for proposed plan and elevation views of portion of the retrieval facility.

3.4.5.2.2 *Bin Set 6 Calcine Transport building*

The transport facility is described in the closed loop facility case in the RFR. That facility comprises a single vacuum system to both retrieve and transport calcine from Bin Set 1 to Bin Set 6. The function of the new design presented in this study is to transport calcine from the weigh tank of the new retrieval facility to Bin Set 6. This relieves it of the burden of retrieving calcine from the most unreliable piping section, i.e., from the bins through the vertical VDA calcine retrieval nozzle (CRN) and extension tubes. The transport building has been modified from the design described in the RFR by placing the transport blower, HEPA filter, heat exchanger, and filter change-out equipment in a centralized primary confinement cell, with an operating corridor surrounding it. The RFR design indicated that this equipment would be placed in a glovebox-type confinement. However, this would not provide required biological shielding from calcine particulate in the facility.

Due to the high calcine radiation and contamination potential, remote change-out of HEPA filters and equipment will be aided by an overhead bridge crane and an overhead electro-mechanical manipulator (EMM) in the cell. Filters are designed to be changed out remotely, and the HEPA filters

will be placed into drums that are will be removed through an air-lock. An operating corridor with shielding windows and remote control console is included.

The transport building will be located just to the north of bin set 6. A new access roadway for personnel and for removal of used HEPA filters in drums will extended from Hemlock Street, approximately 100 ft away.

The transport building will be a single-story building that extends approximately 22 ft above grade, and has a footprint occupying an area measuring 39×32 ft. The floor plan and cross sections are shown on sketches S-1 and S-2 in EDF-1109 in Appendix D. It will be designed to house the equipment and operations for transport of calcine from the weigh tank at Bin Set 1, and to providing essential features for safe and efficient operation and maintenance.

The remainder of the building houses a final HEPA filter and a valved balancing air blower that discharges to a monitored exhaust stack. Building HVAC will be provided by a primary confinement HEPA filter and blower for cell ventilation, and a secondary confinement HEPA filter and blower for the operating corridor. Personnel entry into the building is through one of two air-locks.

The building will be constructed with concrete foundations and floors, concrete shielding cell walls and ceiling, concrete enclosure walls, and roof waterproofed with a single-ply roofing membrane. The exterior surfaces of this building will receive an acrylic sealer and all interior surfaces will be finished with an epoxy coating that can be decontaminated. The transport building is classified as a UBC group H division 7 occupancy. The H-7 occupancy applies to buildings or portions thereof containing materials that constitute a high health hazard.

The modified transport building will have a construction type classification of UBC type II-F.P. Allowable area for H-7 occupancy type II-F.P. is $39,900 \text{ ft}^2$. If auto sprinkled throughout, twice the area is allowed or $79,800 \text{ ft}^2$ per section 505.3. The transport building has $1,248 \text{ ft}^2$ of building area, well below the allowable area. The retrieval facility has $1,664 \text{ ft}^2$ of building area, well below the allowable area. Occupancy H-7 type II-F.P. construction requires exterior bearing walls to be 4-hour fire rated, interior bearing walls to be 2-hour, permanent partition to be 1-hour, and structural frame, floors, and ceilings to be 1-hour. Because of the nature of the building, all walls will be concrete and will meet the required fire rating. All doors, shielding doors, cells, and shielding windows will be fire rated.

The underground utilities will be limited to power, steam, and plant air. No new permanent fencing will be required, but construction fencing will provide a safe work environment for INTEC personnel during this project's construction.

The calcine transport lines spanning from the Bin Set 1 weigh tank to Bin Set 6 will be contained in a shielded pipe trench that will pass directly beneath the first room containing the in-line blower, heat exchanger, and HEPA filtration equipment.

3.4.5.3 Calcine transport piping system

Trench excavation will be required for the new calcine transport lines. The trench will require temporary shoring during construction. Furthermore, the transport line routing passes through an environmentally controlled area south of Olive Avenue, and this material must be removed and segregated in accordance with site procedures.

Calcine transport piping will be required from Bin Set 1 (where retrieval equipment will be set up), to Bin Set 6 where the transported calcine will be deposited. The calcine transport piping size is based on

pressure drop calculations in EDF-1146 in Appendix D, and takes into consideration a 5-in.-diameter transport pipe and a 6-in.-diameter return air line. Both the transport and the return air lines will be schedule 40 stainless-steel pipe, and will be enclosed in a 22-in.-diameter schedule 10 stainless-steel secondary confinement pipe which will be completely seal welded to insure environmental isolation. The calcine transport pipe will have reinforced fittings at all changes in direction, and the return air line will be designed with long radius elbows. The secondary confinement annular space will be heated by means of a steam trace line and will have internal pipe supports every 8 ft. In order to provide adequate seismic support, as well as provide shielding from the radioactive calcine being transported, the secondary confinement pipe and all internal piping will be enclosed inside a precast system of concrete sections. These precast concrete sections will be approximately $51 \times 51 \times 108$ -in. long. A typical detail showing a section of the secondary confinement piping and precast concrete shielding sections is shown on drawing SK-P-03 in EDF-1203. Precast concrete sections will be used in order to facilitate construction, minimize cost, and allow for easier and more cost effective removal of the system after the calcine has been transported.

The routing selected for the piping from Bin Set 1 to Bin Set 6 was established taking into consideration (a) keeping the routing as short as possible, with minimum change in direction in order to minimize piping pressure drops; (b) selecting a route that considers the existing services, constructability, and future demolition characteristics in order to minimize time required during construction; and (c) minimizing construction/demolition costs where possible.

The criteria listed above resulted in a routing that is shown on SK-P-02 in EDF-1203. The calcine transport piping starts at the Bin Set 1 retrieval enclosure where the rotary airlock of the retrieval system meters calcine into the 5-in. calcine transport retrieval pipe, and exits the retrieval enclosure approximately at grade. Here the piping will drop into the transport trench which will be at the approximate elevation of 4,909 ft-6 in. This will locate the top of the precast concrete shielding at approximately 4,912 ft-0 in. which is grade elevation in this area of the plant site. Where the piping exits the transport enclosure it connects into the main trunk line which has a future connection for the calcine removal from Bin Set 2. From this intersection the transport line turns north for about 100 ft to just south of Olive Avenue. This section of piping also contains a future connection for calcine removal from Bin Set 3. At the south side of Olive Avenue the piping turns east for approximately 180 ft to a point just south-west of the intersection of Olive Avenue and Hemlock Street. At this position it will be necessary to relocate a fire station hose house to make room for the direct routing of the transport line. Here the line turns 45 degrees to the north-east and drops under Hemlock Street. This line continues for about 120 ft and heads due north paralleling Hemlock Street for another 150 ft. Here it swings to the north-east for 70 ft where it turns directly east and passes under the calcine retrieval enclosure. At the base of the Bin Set 6 vault the transport piping, which will be encased in a reinforced concrete shielding, will rise up the outside and to the top of the bin set where it will enter the cyclone separator building on top of bin set 6. The piping exits the sintered metal filter on top of Bin Set 6 where it becomes 6-in. diameter pipe. It then continues down the concrete encased riser along Bin Set 6, and then enters the calcine transport building where the return air will be filtered prior to returning the approximately 650 ft to Bin Set 1.

3.5 Portable Equipment

3.5.1 Core Bore apparatus

An RDP will be used to drill 20 penetrations through the 21-in.-thick concrete vault roof and four penetrations through the 48-in.-thick precast concrete vault roof support beams. The proposed RDP is similar to that shown in Figure 4-24 of the RFR,¹ except that the hole can be cored using a single drill bit and extension tube setup. Therefore the drill bit extension tube and magazine, loader, and indexer are not required. This modification of the RDP is shown in Figure 2 of EDF-1203. This mechanism is a

completely engineered component. However, during conceptual design consideration should be given to using a commercial electric or hydraulic core drill drive such as a Hoffman or Longyear model. The RDP will core 9-in.-diameter holes. It will be located in a field-erectable tent inside the environmental enclosure. The tent will be connected to a portable blower and HEPA filter unit. The tent will control the spread of contamination that may be associated with the vault penetration operation. The RDP will be attached to the cap slab with anchor bolts. It will use a 1-in.-diameter pilot bit to drill through the floor, capturing dust by a HEPA-filtered vacuum system as the hole is plunged through the reinforced concrete. When the pilot hole breaks through, a toggle-type tong at the end of a post, and central to the 9-in.-diameter core drill bit, will capture the concrete core. In this way, as the core penetration is completed, the core will be retained in the bit and prevented from falling into the vault.

3.5.2 Triangulation CCTV

The RDP will first core four holes through the roof near the corners of the vault. CCTV cameras will be lowered through these penetrations for accurately triangulating the future positions of the RDP over the remaining 20 core hole locations above the bin sets. The radiation field emitted through the cored holes from the calcine in the bins will prevent operators from passing near the open penetrations. The RDP will be equipped with suitable safety barriers and warning signs to prevent personnel exposure. As soon as a core is removed, the tent and core drill will be removed using the environmental enclosure's 10-ton crane.

3.5.3 Calcine Retrieval/Airjet VDA

The feasibility design of the VDA is shown in Figure 5 of EDF-1203. Its primary function is to help remove calcine from the bins; a secondary function is to lower a CCTV camera inside the bins to determine the progress of calcine removal. The VDA includes equipment that remotely handles and joins the CRN and extension tubes that will actually remove the calcine from the bins. The VDA joins the 10-ft tube sections in a continuous string up to a height of 50 ft as it lowers the string into the bins. The VDA equipment also functions as an interface between the pipe assembly and the stationary vacuum and air return lines at the east wall of the weather enclosure. Individual VDA components are described next.

3.5.3.1 Structure

The VDA is a portable tower that can be relocated from riser to riser as retrieval operations progress. It is a rectangular structural steel tower, approximately 5 × 5 ft at its base and approximately 25-ft tall. A stainless-steel sheet metal skin is seal welded and attached to the interior of the structure. It has radiused corners to facilitate decontamination. The sheet metal skin includes a catch pan at the bottom of the VDA to capture radioactive dust or to contain decontamination solution used to clean the VDA interior. The catch pan seal lid will be opened allowing access to the shield plug and the riser.

The VDA is lifted and moved by the 10-ton bridge crane inside the weather enclosure. An external caged ladder, with gate and handrail-equipped platforms at the various levels allow personnel access for service to the externally mounted equipment items along the full height of the tower. The tower contains various drive gear motors that are mounted externally to facilitate maintenance access. The VDA has external connections for ventilation ductwork, controls, electric power, video signal output, compressed air, and decontamination solution. The decontamination liquid used to flush the inside of the VDA will be prevented from entering the riser by a seal door mounted on a vertical tube built into the catch pan at the bottom of the VDA. Decontamination solution from the catch pan will be pumped to a wastewater storage container.

3.5.3.2 Shielding Panels

Removable, 2-1/2-in.-thick carbon steel panels cover the bottom half of the VDA exterior during calcine retrieval operations. Their function is to attenuate radiation fields incurred during retrieval so that the grade-level control room adjacent to the vault, and the exterior next to the weather enclosure are suitable for full time occupancy. The panels are mounted on all four sides of the lower portion of the VDA tower. The shielding spans from the floor to the elevation equal to the end of the telescoping tube (about 15 ft).

As an alternative to the steel shield panels, a 'hybrid' design can be produced. This hybrid puts part of the shielding on the wall separating the control room from the area over the vault, and places the remainder of the shielding on the VDA. The intent of this design would be to reduce the shield weight on the VDAs which must be moved from penetration to penetration (at least 20 times during the retrieval process). Removal, relocation, and reattachment of the shield panels may prove cumbersome, time consuming, and a safety intensive effort. The effort may also be reduced by placing exterior shielding around the walls of the weather enclosure adjacent to the manned control room. The design basis for the shielding (less than 0.1 mrem/h) allows full time occupancy in the control room and outside the weather enclosure. This field will also be required at external areas surrounding the site (on Olive Ave. etc.) which may be occupied by site personnel not associated with the project. Beyond the site perimeter fencing (which may be protected by administrative controls during transfer operations), the dose rate must be low. There is a tradeoff between the shielding thickness, calcine jumper shielding thickness, overhead crane load capacity, and weather enclosure construction (which may be made with a reinforced overlapping tip-up concrete wall panel system for the bottom 10 ft of wall rather than metal siding). The required trade-off should be considered during conceptual design.

3.5.3.3 Ventilation system

The VDA inner skin forms a ventilation confinement space within the tower. The VDA interior is maintained at a pressure slightly below that in the weather enclosure. The interior VDA space will be a primary confinement space when the VDA is in place and the shield plug is removed from the top of the riser that it covers. The interior airspace is ventilated by a portable fan and HEPA filter. The duct connection must be broken and reconnected each time the VDA is relocated. The ventilation system must operate when the shield plug is removed from the riser, and when used pipe spools are being stored, removed, or replaced, in the vestibule.

3.5.3.4 Quill

The top half of the VDA contains a 10-ft-long telescoping tube quill. The quill consists of a set of two stationary and two sliding concentric tubes, a rotation gear drive, a threaded nose, shielding, and seals. The quill is externally shielded by a 2-1/2-in.-thick carbon steel cylinder. The two sliding tubes are nested within the two stationary tubes (See Figure 5 of EDF-1203). Seals at the bottom ends of the stationary tubes maintain two separate airflow paths. The inner cylindrical path is for calcine vacuum air and the outer annular path is for returning air that has been removed from the bin during vacuuming. The two airflow paths diverge into two individual stationary pipes near the top of the VDA. The nose of the quill is threaded to couple to the CRN and extensions tubes.

3.5.3.5 Quill Elevator Mechanism

The VDA is equipped with a quill elevator mechanism that raises or lowers the sliding quill tubes. The mechanism consists of a drive gearmotor, chain drive, and slide. The gearmotor is located on the side of the VDA outside the inner sheet metal skin. A drive shaft connects the gearmotor to the chain

drive sprocket inside the VDA. The chain raises or lowers a dovetail slide carriage that is connected to the movable nose of the quill. The elevator mechanism lowers and raises the CRN and extension tube sections into and out of the bins.

3.5.3.6 Quill Rotation Mechanism

A set of gears located at the bottom of the quill allows the sliding tube assembly to be rotated about its vertical centerline. The gearmotor for the quill rotation is located at the top and outside of the VDA's sheet metal skin. The gearmotor turns a vertical splined shaft that rotates the drive gear in the quill head. As the quill is raised or lowered, the internally-splined drive gear traverses the length of the shaft to maintain constant drive engagement with the spline. Rotation is necessary to make and break the threaded connections at the ends of the CRN and extension tubes that will be lowered into the bins for calcine removal. It also allows the CRN airjet nozzle to be rotated to the proper various azimuth orientations inside the annular bins to blow calcine from one side of the bin to the other side where it will be vacuumed out.

3.5.3.7 Vestibule

An external sheet-metal-enclosed vestibule is located on the side of the VDA. It is an integral part of the tower structure and houses a carousel that holds the CRN, the extension tubes, and can be used to lower a CCTV mast inside the bins. The vestibule, like the tower, has an external structure with an internal sheet metal skin. Its floor is sloped to drain into the tower confinement. The carousel is driven by an external gearmotor and indexing mechanism mounted on top of the vestibule. The motor turns the central shaft of the carousel which normally holds the CRN and four extension tubes. The carousel indexes and stages one of these tubes at a time so it can be moved into position beneath the retracted quill by the tube trolley discussed below. A CRN, extension tubes, and the CCTV camera sections can be inserted and removed from the vestibule. There is a tube slot in the common wall between the vestibule and the tower that can be closed off with a sliding knife gate. There is also a sliding knife gate at the outer side of the vestibule. Under normal retrieval operations, the inner gate is open and the outer gate is closed. With the gates in these positions, the vestibule confinement shares the same air space as the interior of the tower. The inner gate is closed and the outer gate is opened during maintenance and when new CRN, extension tubes, or CCTV sections are being added or removed from the vestibule. The vestibule is thereby isolated from the tower. The used CRN, extension tube sections, or CCTV sections are bagged out through the open gate. The radiation field from this gate is controlled by a shadow shield on the back wall of the vestibule. The knife gates are manually opened and closed using external handles.

3.5.3.8 Tube Trolley

A pneumatically actuated trolley is located just below the raised quill. It rides on rails, which run horizontally across the interior of the VDA tower. The trolley has pneumatically actuated gripper jaw for grasping the upper end of the CRN and extension tubes. The function of the trolley is to advance to the vestibule, grasp a tube section that has been moved into position by the carousel, and transfer the tube to a station just below the quill end thread.

3.5.3.9 Pipe Clamps

The VDA contains an upper and lower set of pneumatically-actuated pipe clamps. The upper clamp is located just below the trolley while the lower clamp is located near the bottom of the VDA. The upper clamp holds CRN or extension tube while it is being threaded onto, or unthreaded from, the quill or another pipe section. The upper clamp is actuated to grasp the tube before the trolley jaws release.

The lower clamp holds the section of pipe that is held by the quill at its lowest position. After the lower clamp grips the pipe section, the quill is rotated to unscrew this pipe section. With the pipe section (and all the pipe string below it) hanging from the lower clamp, the quill is free to raise and acquire another pipe section. After the new pipe section is attached to the quill using the trolley and the upper clamp, it is lowered slightly and screwed onto the pipe string that is hanging from the lower clamp. The lower clamp is then released, and the pipe string can be lowered by the quill. This procedure is repeated to make up the pipe string, and reversed to break the pipe string down and return the pipe sections to the vestibule carousal.

3.5.3.10 Jumper

The externally shielded calcine jumper pipe connects to the calcine transfer vacuum pipe at the top of the VDA and terminates at the bottom of the VDA. In addition, a unshielded air return line is also routed down the outside of the VDA, and, by means of interchangeable spools, is connected to the transfer line at the east wall of the weather enclosure. The inside of the environmental enclosure acts as the secondary confinement for the calcine jumper pipes.

3.5.3.11 Plug Removal Hoist

The plug removal jib hoist is located inside the VDA on the wall opposite the vestibule. The function of the hoist is to remotely remove the shield plug from its location in the riser, and stow it out of the way of CRN and extension tubes as they are lowered through the riser and into the bins. The hoist can be swiveled from above the bin penetration by operators outside of the VDA. Once the shield plug has been removed, the radiation field emitted from the calcine in the bins prevents operators from passing near the open penetration. When the shield plug is removed, the confinement zone inside the VDA becomes Zone 1 because it is directly connected to the interior of the bin. If the ventilation system requires shutdown, or otherwise is non-operational, the shield plug must be replaced on the riser by the plug removal hoist.

3.5.3.12 Ventilation Ductwork Connection

The VDA tower interior is operated at a pressure slightly below the pressure in the environmental enclosure. The interior space serves as part of the primary confinement when the riser shield plug is removed. The interior airspace is connected via temporary ductwork to the its own ventilation system in the environmental enclosure's HVAC room. The duct connection must be broken and reconnected when the VDA is relocated.

3.5.4 VDA Spool Pieces

Shielded spool pieces are used to connect the discharge of the VDA jumper pipe and the airjet return pipe at the bottom of the VDA. These pipes are connected to the calcine transfer line and airjet return line at the transfer line trench in the east wall of the environmental enclosure. Regardless of the particular riser position at which the VDA is stationed, the spool piece configurations will be such that these two ends can be connected. These spool pieces are fabricated in 4-5-ft. lengths for ease of handling. Each spool piece will be equipped with lifting eyes for handling by the overhead crane. When the spool pieces are in operation, the environmental enclosure acts as the secondary confinement for the calcine inside the spool piece pipes. Each spool piece contains two pipes. One pipe will be dedicated to retrieving calcine from the bin and the other will be dedicated to returning the cleaned air back to the bin. The return air will be HEPA filtered and under pressure. The spool pieces will be shielded as required for reducing the radiation field within the environmental enclosure when calcine is being transferred. Blind tees with shielded caps will be located at all 90-degree elbows in the spool pieces. The spool pieces will

be laid out and configured in flanged sections as necessary to tie together the end points. Similarly, the shielding will be arranged to correspond to the configuration of the spools. The inside of the calcine spool and jumper pipes will be cleaned by a dolomite scouring system discussed below.

3.5.5 Bin CCTV System

A bin will be considered empty when the CRN(s) has reached the bin's bottom, no more calcine is being retrieved, and visual confirmation is made with a CCTV system. After vacuuming, the CRN and extension tube string will be retracted from the bin, broken down, scoured with dolomite, returned to the VDA vestibule, and the shield plug replaced in the riser. The used CRN and extension tubes can be bagged out of the vestibule sliding knife gate. The CCTV boom and its extension pieces will then be bagged into the vestibule. After evacuating the environmental enclosure, the shield plug will be removed and the CCTV camera will be deployed down the riser in a manner similar to that used to install the CRN and extension tubes. Once in the bin, the camera will be used to determine if the calcine has been sufficiently removed or if more vacuuming is required. If there is an unacceptable amount of calcine remaining in the bin, the CCTV equipment will be bagged out of the VDA and the CRN and extension tubes can be bagged back in for further vacuuming and airjetting.

3.5.6 Dolomite Back Scouring System

After calcine has been retrieved, residual calcine and dust may cling to the interior walls of the CRN, extension tubes, VDA jumper, and spool pieces. Because the residual calcine is less than that present when material is being retrieved, the fields will not be as high. However, small amounts of calcine can still be highly radioactive; therefore, a dolomite back-scouring system will be used to clean the dust from inside the piping.

Reference 1 recommends that, at the point where the spools are connected to the lines in the transfer line trench at the east side of the environmental enclosure, the lines be equipped with a double valve and tee arrangement to serve as a point for high velocity injection of dolomite. Back-scouring the line with dolomite from this point back to the bin, would scour the interior of the transfer lines before remake of the jumpers, spools, and retrieval pipe connections. This would limit the amount of material present in the line and decrease the potential for spread of contamination. However, this implies the injection point would be pressurized, and thus place the spool pieces, jumpers, and possibly the bin at a positive pressure with respect to the environmental enclosure secondary confinement. This is not advisable because it can be considered a flow reversal from an area of higher contamination potential (the piping and bin) to an area of lower contamination potential (the inside of the environmental enclosure).

Dolomite could be vacuumed (using the same system as used for calcine vacuuming) through the CRN or extension tubes near the bottom of the VDA as the sections are separated. This would keep the piping and bins at a negative internal pressure while cleaning the extension tubes, CRN, and jumpers. This would require a method for delivering dolomite into the VDA at a location close to the bottom clamp where the CRN and extension tubes are separated. The dolomite would be vacuumed to the cyclone retrieval cyclone and then be transported into Bin Set 6 by the calcine transport system. Details of this system need to be studied and developed during conceptual design.

3.6 HVAC/Confinement Systems

The subsection describes the HVAC confinements systems as given in EDF-1109 in Appendix D. Refer to EDF-1109 for detailed HVAC flow sheets and confinement zone drawings.

Each facility containing calcine materials is complete with confinement pressure boundaries (or confinement zones). Each confinement zone is kept at a negative pressure with respect to atmosphere, with the most negative being the calcine containment boundary. Each of the confinement zones is described below.

3.6.1 Primary Confinement

Primary confinement zones consist of the calcine bin sets, transport lines, and associated piping and equipment constituting the calcine storage and transport system. This system will be maintained at a negative pressure of at least 1.0 in. water gage with respect to the outside environment. However, operating pressures within this system will be much more negative during calcine transporting functions. The primary confinement zone is described in the calcine storage, retrieval, and transport sections of this project.

3.6.2 Secondary Confinement

Secondary confinement zones exist around primary confinement zones where it may be reasonably expected that a breach in the primary confinement may exist at some point in time. Examples of such breaches are at the bin-set tie-in points, filters, blowers, separators, etc. Secondary confinement zones include the existing bin-set vaults, vault exhaust ventilation systems up to the exhaust HEPA filters, vault supply ventilation from the inlet HEPA filters, enclosures around the bin-set tie-in equipment, and calcine transport system blower/separator vaults and associated inlet and exhaust ventilation systems up to the HEPA filters. Secondary confinement zones may become primary confinement during operations when the normal primary confinement is opened or breached. Secondary confinement zones will be maintained at negative pressures of at least 0.3 in. water gage with respect to the outside environment, and 0.7 in. water gage positive with respect to primary confinement zones.

3.6.3 Tertiary Confinement

Tertiary confinement zones exist around secondary confinement zones where it may be reasonably expected that the secondary confinement may have to exist as a primary confinement for any reason. Examples of such events are filter primary zone filter change-out, pump replacement, etc... During these events, the secondary zone will act as a temporary primary confinement boundary, and the tertiary confinement becomes a temporary secondary confinement boundary. Tertiary confinement zones will be maintained at negative pressures of 0.1 in. water gage with respect to the outside environment, and 0.2 in. positive with respect to the secondary confinement zones.

3.6.4 Nonconfinement

Administrative areas and control rooms are nonconfinement areas of the facilities. These areas will be maintained at positive pressures of approximately 0.1 in. water gage (exact pressure not regulated) with respect to the outside environment, or approximately 0.2 in. positive with respect to tertiary confinement areas. These areas are expected to be clean at all times.

3.7 Preoperations

Preoperations are defined as those operations in the environmental enclosure necessary to reach a condition where the calcine can be vacuumed and transported to Bin Set 6. This includes the core drilling of 24 holes in the vault roof, installing and affixing the 20 risers to the Bin Set 1 bins, and setting up the VDAs for calcine retrieval.

3.7.1 Core boring

The RDP described above will be used to drill the 20 penetrations through the 21-in.-thick concrete vault roof and four penetrations through the 48-in.-thick precast concrete roof support beams. The RDP will be set up by the 10-ton environmental enclosure crane and bolted to the cap slab. A HEPA-filtered vacuum will be placed near drilling area and a portable tent structure will be erected over the drilling platform and HEPA-filtered vacuum. A portable HEPA filtered blower will be attached to the tent to confine contamination from core drilling operation. The RDP will be equipped with suitable safety barriers and warning signs to prevent personnel exposure. After drilling the first core hole at one of the vault corners, a shield plug will be inserted into the hole to prevent radiation streaming, the tent will be disassembled, and the RDP and HEPA-filtered vacuum will be positioned at another corner of the vault roof. The above operations will be repeated until one hold has been cored at each of the four vault roof corners. Visual data from cameras, remotely lowered through the four corners holes, will be used to triangulate the positions of the 20 riser-pipe locations that will be subsequently cored over the bins by the RDP. Once the 20 riser-pipe locations have been determined, the above process will be repeated until all 20 riser holes have been cored.

3.7.2 Riser installation

EDF-1203 describes the riser installation. The shield plug will be removed from a cored riser hole and special tooling will be lowered to attach a weld stud to the top of the bin. An abrasive tool head will then be lowered through the cored hole to remotely grind the top of the bin in preparation for riser welding. The grinder will use the weld stud as a central guide. The environmental enclosure's 10-ton crane will then lower the 21-ft riser through the cored hole and onto the bin, while centering the lower end of the riser on the weld stud. The riser will then be remotely welded to the bin using a specially designed welding head that will also be lowered down the riser to the top of the bin. The weld head tooling will be reconfigured, and lowered down the riser to remotely trepan a hole in the top of the bin. The trepanning head will engage the weld stud so that the circular section cut from the bin lid will be removed with the head. After the installation, the shield plug will be inserted into the riser to reduce the radiation field through the hole.

3.7.3 VDA Setup

The VDA and its equipment are described in EDF-1203. Preoperations include set up of a VDA (and associated equipment and structures) over each of two risers located on one of the eight annular bins in Bin set 1, or one riser located on the four circular bins. All VDA setup operations will be accomplished in a hands-on manner by personnel located inside the environmental enclosure.

An annular bin to be vacuumed will first be selected. The 10-ton crane will be used to lift one of the two VDAs and place it on the cap slab over the four bolt holes located at one of the selected riser locations. Four bolts will be installed to anchor the VDA in position. The 10-ton crane will then be used to hang the four, 2-1/2-in. thick shield panels on the VDA exterior. The other VDA will be similarly installed over the other annular bin riser. The VDA shielded jumper sections, containing the calcine vacuum and air return lines, will then be lifted by the crane and attached to the outside of the VDA. After the jumpers are installed, appropriate spool piece sections will be selected and installed on top of the cap slab to connect the bottom of the jumper to the calcine transfer line trench at the east wall of the environmental enclosure. Portable shield covers will then be installed over the spool pieces to limit the radiation field from the calcine traveling through the spool piece pipes. During operations, this set up must be repeated seven more times for the remaining seven annular bins. The four center circular bins have only one riser each and therefore require only four set ups of a single VDA and associated equipment.

Operations described in Subsection 3.8 may proceed when the above set-up is complete. Operations include riser plug removal, make-up and deployment of the vacuum/airjet nozzles and extension pieces, vacuum retrieval of calcine from Bin Set 1, and vacuum transfer of the calcine to Bin Set 6.

3.8 Operations (Calcine Retrieval and Transport)

EDF-1203 contains a detailed operations description. After the VDA and its ancillary equipment are set up as described in the previous subsections, the environmental enclosure will be vacated and the remaining operations will be performed remotely from the environmental enclosure's control room. Refer to Figures 5 and 6 from EDF-1203 for the following VDA operation description.

The following operations are identical for both VDAs located above an annular bin (see description above for setup of the VDAs). The VDA plug hoist removes and stows the riser shield plug. The CRN and extension tube sections are next joined in succession to make up a long enough vacuum tube string to reach the calcine in the bin. The identical operations are performed for the other VDA until the CRN nozzle contacts the calcine on the other side of the bin. The spool pieces and retrieval pipe selection valves are set to allow one VDA to vacuum calcine, and the other to return the vacuumed air through its airjet nozzle.

EDF-1146 in Appendix D is a study of the components and equipment selected for the calcine pneumatic vacuum transfer systems. The calcine retrieval and bypass blowers are located in the retrieval equipment building that is north of the environmental enclosure. When the blowers are started, calcine retrieval is initiated. While calcine vacuuming is in progress, the interior of the bin set is held at a vacuum of approximately 1-in. H₂O with respect to the vault. Calcine is blown to the vacuum nozzle by the blower exhaust air as it expands across the airjet nozzle with a differential pressure drop of approximately 20 psid. The air is jetted in the horizontal plane and its azimuth direction can be varied from the control room by rotating the VDA quill. This will cause the calcine to be blown away from the airjet nozzle and toward the vacuum nozzle on the other side of the annular bin.

Most of the calcine in the bin should be able to be removed with one setup of the VDAs and with a single selection valve alignment. As the calcine level drops in the bins, more sections of pipe are added to the strings in the VDAs until the CRNs reach the bottom of the bins at a distance of approximately 40 ft below the vault roof. When the CRN nears the bottom of the bin, a mound of calcine will have formed at both sides of the vacuum nozzle. These mounds will not be able to be retrieved by the nozzle. The blowers will be stopped and the selection valves will be reset so that the vacuum VDA will become the air return VDA, and visa versa. With this new configuration, the two calcine mounds will be located at the sides of what will now be the airjet nozzle. When the blowers are started, the airjet VDA quill will be rotated as necessary to blow the calcine mounds to the other side of the bin for vacuuming by the other VDA. The selection valve settings will be reset as necessary, until no more calcine is being removed from the bin. At this point it is expected that the calcine level will be within 1 or 2 in. of the bottom of the bin.

When the bin is deemed to be empty, as indicated by the pipes reaching the bottom of the bin and no more calcine being received in the weight tank after a number of selection valve realignments, a dolomite scouring system will be used to clean calcine dust from the pipe string as it is retracted and disassembled in the VDA. Tube sections will be stored in the VDA vestibule, and the shield plug will be replaced in the riser. Tube string pieces will be manually bagged out of the vestibule and the CCTV boom and its extension pieces will be bagged in. After evacuating the environmental enclosure, the shield plug will be removed and the CCTV camera will be lowered down the riser in an operation similar to that used to install the vacuum tube string. Once in the bin, the camera will be used to determine if the calcine

has been sufficiently removed. If not, the CCTV equipment will be removed and bagged out of the VDA, and the vacuum tube string will be bagged back in for further vacuuming/airjetting. When the calcine has been sufficiently removed, the shield plugs will be replaced. All spool pieces, jumpers, and VDA shielding panels will then be removed and the VDAs will be lifted by the 10-ton crane, as described above, and placed in position to vacuum the next bin. The remainder of the calcine in the bin will be removed during D&D operations which are outside the scope of the retrieval and transport task.

So far, this description has been for vacuuming an annular bin having two risers. Each of the four central cylindrical bins, however, will have only one riser and thus the calcine will be retrieved by only one VDA and one set of jumpers and spool pieces. The VDA will be setup over the single cylindrical bin riser and the vacuum nozzle and extension tubes will be deployed as described above. All other VDA and retrieval operations are as described above for the annular bins. The only exception is that the selection valve positions for the transfer pipes will not need to be reset because a single VDA does not need to be switched between a vacuuming and airjetting operations. The tubing string will function as the airjet nozzle and the vacuum nozzle simultaneously. The CCTV camera system will also be used to determine the extent of calcine retrieval from the cylindrical bin. It will be deployed as described above for the annular bin operations.

The calcine retrieval facility and equipment have been previously described. The system will provide enough airflow for retrieval at the rate of 500 lb/hr of calcine. It also provides air filtration, and returns the exhaust air to the bin being vacuumed. The equipment in the retrieval facility will now be discussed (refer to flow sheet SK-BSI-01 EDF-1203). The retrieval blower suction pulls air and calcine up through the vacuum tube string and into a cyclone separator that removes the calcine particulate from calcine fines and the blower air. Some calcine fines will be entrained with the air the exits the top of the cyclone. These fines will be captured by the sintered metal filter and a two-stage HEPA filter train before they enter the blower inlet. The sintered metal filter will be automatically backflushed with compressed air when its pressure drop reaches a preset value. The backflushed fines will gravity feed to the bottom of the cyclone separator. After exiting the HEPA filters, the air enters the retrieval blower. Compression in the blower causes the air temperature to rise, and if unabated, would eventually cause the blower to overheat. Therefore, a shell and tube heat exchanger is located immediately downstream of the blower to cool the exhaust air. The blower exhaust is then divided into two separate streams. One stream contains approximately 90% of the air leaving the heat exchange and it is piped back into the bin to the airjet nozzle. This provides energy for airjetting, minimizes the amount of air released to the atmosphere, and keeps the pressure of the bin slightly below the atmospheric ambient pressure. The other stream comprises approximately 10% of the air exiting the heat exchanger and is expelled to the atmosphere through a balancing air blower system. This expelled air will compensate for air ingress into the retrieval system from the rotary valve, the sintered metal filter blowback air, and any instrument air used in the system controls. The balancing air first enters the two-stage balancing HEPA filter plenum for final cleaning and then passes through the automatic control valve that will maintain the vacuum inside the bin at a set-point value throughout the calcine transfer. The balancing air then passes through the balancing air blower and is exhausted to the atmosphere through a isokinetically-monitored exhaust stack.

The calcine and recovered fines in the bottom of the cyclone separator are gravity fed into the calcine weigh tank that is equipped with a rotary airlock at its discharge. A signal from the weigh tank load cells initiates the retrieval operation when the tank is empty or partially filled, and terminates retrieval when the tank is full. Calcine is metered through the rotary airlock at a controlled rate, and is fed into the transport system piping that forms part of the calcine transport system. The HVAC for the retrieval facility is described above, and is detailed in EDF-1109.

The calcine transport system consists of transport piping running from the retrieval facility to Bin set 6 and the calcine transport buildings located at Bin Set 6. The system will provide airflow and calcine

handling for transferring 500 lb/hr of calcine from the retrieval facility at Bin Set 1 to Bin Set 6. It also provides air filtration and transfer air return to the retrieval facility.

The calcine is delivered by the transport piping to the new cyclone separator located on top of Bin Set 6. There, it will be separated from the air and fines, and will gravity feed into the top of the existing Bin Set 6 cyclone and into the Bin Set 6 bins. The air is then cleaned of most of the fines by the sintered metal filter located adjacent to the new cyclone on top of Bin Set 6. The air piping exits the sintered filter, returns down the concrete encased riser, and then enters the shielded calcine transport building at the base of Bin Set 6. The function of the equipment in the transport building is identical to corresponding components in the retrieval building discussed above. Before the air enters the transport blower, it is cleaned by a two-stage HEPA filter and the heat exchanger located at the discharge of the blower, cools the air to maintain the blower within proper operating temperature limits. A balancing air blower is installed downstream of the heat exchanger to maintain and control the vacuum in the calcine transport line. In addition, it will expel the excess air ingress into the system from the rotary valves, the sintered metal filter blowback air system, and any instrument air used in the system controls.

4. METHOD OF CONSTRUCTION PERFORMANCE

4.1 Design, Procurement, and Construction

LMITCO Engineering personnel will most likely develop the conceptual design, but title design might be subcontracted to an Architectural Engineering firm. Any long-lead components will be provided as government-furnished equipment (GFE). Procurement contracts for these items will be placed during the Title Design phase, if necessary, to ensure the equipment is available during the construction window identified in the facility schedule. Equipment fabrication and installation will be accomplished by competitively bid, fixed-priced construction contracts. Standard components will be procured during the construction work period by the Subcontractor. Force account workers might perform demonstration and installation/modification work inside the NWCF.

4.2 Work Breakdown Structure

Figure 1 shows the work breakdown structure for the facility feasibility study.

Figure 1. Work breakdown structure for the Bin Set 1 transfer feasibility study.

4.3 Facility Decommissioning

A D&D plan will be written and in place before start of operations. The estimated cost to perform the D&D work is included in Section 11. Detailed and LCC estimates are contained in Appendix A.

5. ESTIMATED COST

The capital cost, also called total project cost (TPC), was estimated for the Bin Set 1 facility. This estimate is divided into total estimated costs (TECs) and other project costs (OPCs). TEC includes the title designs, project management (during title design and construction periods), construction and construction management, inspection, general and administrative costs, procurement, GFE, and all applicable escalation and contingency for the title design and construction periods. OPCs include conceptual designs, project management (during the conceptual and startup periods), environmental documentation, operations, support, final testing, and startup. To reflect the expected impact of inflation, the estimates are escalated to the future at a rate prescribed by the January 1998 update of "The Departmental Price Change Index Fiscal Year 2000 Guidance—Anticipated Economic Escalation Rates, DOE Construction Projects and Operating Expenses."

An LCC analysis was also performed. The LCC analysis estimates costs for preoperation, operation, and postoperation activities. LCC postoperation activities comprise D&D. The LCC analysis assume a 37-year period (2000 through 2036) because this is the estimated time required to complete all anticipated Bin Set 1 project and remediation activities. A discounted LCC analysis assumes a constant-dollar basis, discounted at 5.0% per the Office of Management and Budget Circular A-94. For the preoperations portion of the cost analyses, the TPC estimates were used. Details of the LCC analysis is included in Appendix A and summarized in Table 1 below.

Table 1. Cost estimates for the Bin Set 1 Calcine Transfer Project.

Cost category	Cost (K\$)
Preoperations	
Total Estimated Cost (TEC)	\$50,600
Other Project Cost (OPC)	\$22,000
Total Project Cost (TPC=TEC+OPC)	\$72,600
Discounted TPC	\$52,674
Operations (with escalation and contingency)	\$34,655
Discounted Operations	\$19,686
Post Operations (D&D)	\$6,069
Discounted Post Operations	\$1,048
Total Cost (unescalated, not discounted)	\$65,254
Total Cost (escalated, not discounted)	\$113,324
Discounted Total Cost	\$73,408

6. PROJECT SCHEDULE

The project design, construction, operation, and D&D schedule is illustrated in Appendix B. The schedule starts at the beginning of 2000 with conceptual design and ends the last day of 2036 with D&D. The 5 year construction schedule starts at the beginning of 2005 and ends the last day of 2009. Testing and start up occurs for 1.5 years from mid 2009 through 2010, with operations starting at the beginning of 2011. The operation period lasts for one year and ends at the end of 2011. D&D activities for the Bin Set 1 transfer facilities and equipment starts at the beginning of 2036 and ends the last day of 2036.

7. REQUIREMENTS AND ASSESSMENTS

7.1 Radiological

Radionuclides in the calcine pose radiological hazards. The calcine contains both transuranics and fission products. The radiation hazards consist of ionizing radiation exposure and contamination exposure. Protection against these exposures requires the use of significant biological shielding in all areas where the calcine is handled or transferred, and at least a double ventilation confinement system to control contamination.

EDF-1213 in Appendix D is a review and update of the RFR 1 radiological calculations. The conclusion of the EDF is that with the proposed changes/modification, the Bin Set 1 calcine can be transferred to Bin Set 6 in a safe manner and in compliance with the radiological provisions of the INEEL Radiological Control Manual.

A double confinement structure is defined as a series of physical barriers that, together with the ventilation system, minimizes the potential for release of radioactive material into work areas and the environment under normal and abnormal conditions. Radioactive materials are separated from the ambient environment by at least two barriers, and from an operator by at least one barrier.

The ventilation system is designed to ensure airflow is from less contaminated areas to higher contaminated areas. The primary confinement is maintained at a negative pressure relative to the secondary confinement, and the secondary confinement is maintained at a negative pressure relative to the environment. The ventilation exhaust of both the primary and secondary confinement areas is filtered by aerosol-testable, two stage, HEPA filters.

The radiological contamination will be contained within the primary and secondary confinement areas. This will be accomplished by use of radiological control work practices. These radiological work practices will maintain the radiological contamination in the secondary confinement within established limits by periodic decontamination using a centralized decontamination solution dispensing system, stainless steel-lined primary confinement areas, and the use of airlocks for the ingress and egress of equipment and personnel in any confinement areas that may be entered.

7.2 Environmental and Permitting Requirements

This section contains a summary of the detailed study of environmental and permitting requirements contained in EDF-1105 (see Appendix D). Currently the CSSF (comprised of the seven Bin Sets) is operating as an interim status waste management unit in the INEEL Part A Permit Application and is subject to the requirements of 40 CFR 265: Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart J, Tank Systems. The State of Idaho regulates the hazardous components stored at the CSSF through the Idaho Department of Health and Welfare (IDHW) Rules, Regulations, and Standards for Hazardous Waste, adopted pursuant to the Idaho Hazardous Waste Management Act of 1983 (HWMA). The IDHW Division of Environmental Quality's Hazardous Waste Permitting Bureau (HWPB) is the state organization with oversight of HWMA-regulated facilities. The HWMA incorporates the federal regulations RCRA.

Modifications to the CSSF under interim status will require an INEEL document action request submitted to the INTEC facility for revising the facility documentation, including drawings. A revised Part A permit application with State of Idaho approval may be necessary prior to the modification. An Engineering Change Form, INEEL Form 431.37, will also be required. This form addresses the process

for facility modifications and addresses affected documentation, including environmental documentation. Sections 6, 7, and 19 of this form specifically address affected environmental documentation. Form 435.29, RCRA Permit Modification Review is also necessary to complete. If the CSSF Part B Permit is acquired prior to the Bin Set 1 calcine transfer, then 40 CFR 264: Treatment, Storage, and Disposal (TSD) Facility Standards, Subpart J, Tank Systems, requirements will apply. In this case, it is anticipated that Class 2 or possibly a Class 3 permit modification request in accordance with 40 CFR 270.42 would be required for State of Idaho review and approval.

There are two primary DOE Orders that govern the storage, treatment, and disposal of high-level solid wastes. These DOE Orders are 5820.2A, Chapter 1, "High-Level Waste" and 6430.1A, "Section 1324, "Radioactive Solid Waste Facilities." The DOE Orders outlined in the 5400 series establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable federal, state, and local environmental protection laws and regulations, executive orders, and internal department policies. In addition, the project should meet requirements of DOE Order 435.1, "Radioactive Waste Management."

DOE Order 5820.2A, Chapter 1, "High-Level Waste," establishes the policies and guidelines for managing the DOE's HLW. All HLW generated by DOE operations shall be safely stored, treated, and disposed of according to requirements set forth in this Order. Designs for new storage (including new processing or waste handling systems) shall also meet the requirements of DOE 6430.1, applicable EM Orders and 40 CFR 264.

The criteria in DOE Order 6430.1A, Section 1300, "General Requirements" applies to all nonreactor nuclear facilities. This order provides the general guidance and design requirements associated with nonreactor nuclear facilities. It provides the directives to protect the public and facility personnel from hazards associated with the use of radioactive and other hazardous materials as a result of normal operations, anticipated operational occurrences, and Design Based Accident conditions, including the effects of natural phenomena pertinent to the site, and maintain these effects ALARA.

DOE Order 6430.1A, Section 1324, "Radioactive Solid Waste Facilities" outlines the specific requirements for radioactive solid waste facilities which store, treat, and dispose of the range of solid waste generated by DOE nuclear facilities and reactor facilities. The environmental, safety, and health concerns to be addressed to fulfill the design requirements for these facilities vary significantly according to the nature of the waste, the waste management techniques that are implemented, and the characteristics of the facility site. Special design features such as off-gas treatment systems, confinement systems, effluent control and monitoring are addressed in DOE Order 6430.1A, Section 1324. The CSSF is currently not regulated by the NRC. If the CSSF were to become regulated by the NRC, the requirements specified in 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geological Repositories," and 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," shall take precedence if a conflict arises between those regulations and these criteria.

DOE Order 5400.1, "General Environmental Protection Program," establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable federal, state, and local environmental protection laws and regulations, executive orders, and internal department policies. This DOE Order provides Environmental Protection Standards, Notification and Reports, Environmental Protection Program Plans, and Environmental Monitoring Requirements.

DOE Order 5820.2A and 6430.1A both reference DOE Order 5481.1B as the applicable order for the preparation of safety analysis reports for high-level waste operations. This, however, is no longer the case. DOE 5481.1B is obsolete for HLW activities. DOE Order 5480.23, "Nuclear Safety Analysis

Reports," provides the guidance for safety analysis reports. DOE Order 5480.21, "Unreviewed Safety Questions (USQ)," describes the process for completing the USQ determinations. A USQ determination for the proposed Bin Set 1 calcine transfer project will be necessary. The USQ screen may determine that a safety analysis report revision and a readiness assessment are necessary. DOE Order 5480.23, has a primary role of preserving the DOE authorization basis for each nuclear facility while allowing for "operational" flexibility. The USQ process was established to allow contractors to make physical and procedural changes and to conduct tests and experiments without prior DOE approval, as long as these changes do not explicitly or implicitly affect the authorization basis of the facility or result in a Technical Safety Requirement (DOE Order 5480.22) change.

The requirements set forth in RCRA 40 CFR 265, "Interim Status standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" apply to the CSSF. The 40 CFR 265 contains specific design and operating requirements and standards for owners and operators of hazardous interim status TSD facilities, and is the primary governing RCRA regulation for the CSSF. Subparts A through G of 40 CFR 265 provides the general interim status TSD requirements and management practices. Subpart J of 40 CFR 265, Tank Systems, specifically addresses the regulations for interim status tank systems for which the CSSF has been defined. If the Part B Permit is obtained for the CSSF, then 40 CFR 264 applies.

The requirements in RCRA 40 CFR 268, "Land Disposal Restrictions," apply to the calcine waste in the CSSF prior to final disposal. The 40 CFR 268 restricts the land disposal of most hazardous/mixed waste and specifies strict treatment standards that must be met before hazardous wastes can be land disposed, unless other Land Disposal Restriction (LDR) treatment standards are agreed to by the agencies through the petitioning process in 40 CFR 268.42 (b) or a variance is pursued per 40 CFR 268.44. For the Bin Set 1 calcine transfer activity, the LDRs outlined in this regulation do not specifically apply since the waste is simply being moved from Bin Set 1 to Bin Set 6 of the CSSF. For final treatment and calcine waste disposition, the requirements set forth in 40 CFR 268 will apply. Subpart D of 40 CFR 268 provides the specific treatment standards and applicable treatment technologies for hazardous wastes.

The INEEL Environmental Checklist (Forms 451.01 and 451.02) identifies the potential impacts of the proposed activities on existing regulatory policies and permits and assists in identifying if additional permits or approvals are necessary prior to commencing the proposed activities. The INEEL Environmental Checklist will need to be completed prior to starting any construction activity associated with the calcine transfer from Bin Set 1 to Bin Set 6.

The INEEL Waste Generator Services (WGS) organization provides management of the characterization, storage, treatment, and disposal of generated wastes at the INEEL facilities. The waste generator is required to contact the INTEC WGS facility representative as early as possible in the planning stages of the Bin Set 1 calcine transfer project in order to initiate the WGS services waste planning process. The generator brings a waste stream to the attention of WGS and provides the process knowledge information to the WGS facility representative. Where subcontractors are performing work at the INEEL, the facility person who requested the work assumes the responsibilities of a waste generator, assuming ownership of all waste generated by the subcontractor as a result of the work.

The waste generator and the INTEC WGS facility representative initiate the waste management process by collaborating to complete the initial process knowledge determination of INEEL Form 435.39, "Waste Determination and Disposition Form (WDDF)." A hazardous waste determination includes the completed WDDF, related attachments, and INEEL Integrated Waste Tracking System (IWTS) material and container profiles. The INEEL Site Treatment Plan (STP) may require updating. The generator, in conjunction with the subcontractor and INTEC WGS facility representative, will be required to notify the INEEL Site Treatment Plan Office and to estimate the volume of waste to be generated from the proposed

Bin Set 1 calcine transfer activities. If the volume of waste generated exceeds the current revision STP volumes, then the STP will need to be updated.

An environmental checklist and an air permit applicability determination (APAD) will be required to assess the potential air and radionuclide emissions from the proposed calcine transfer from Bin Set 1 to Bin Set 6 project. The governing regulations for the control of air pollution are found in the Idaho Administrative Procedures Act (IDAPA) 16.01.01, "Rules for the Control of Air Pollution in Idaho," Title 01, Chapter 01. It is anticipated that the Bin Set 1 calcine transfer will require a Category 1 Exemption or a Permit to Construct (PTC) from the State of Idaho as identified in 16.01.01.201.

Potential radionuclide emissions are also regulated through the National Emission Standards for Hazardous Air Pollution (NESHAP) regulations. To determine NESHAPs compliance, modeling associated with the calcine transfer from Bin Set 1 to Bin Set 6 would be necessary to determine the dose to the maximally exposed individual at the INEEL boundary. If the modeled unmitigated potential emissions would exceed 0.1 mrem/yr, a continuous emissions monitor would be required for each emission source. If the radionuclide emissions exceed 0.1 mrem/yr using 40 CFR 61 Appendix D criteria, an application to construct would be required.

The CSSF is potentially eligible for listing in the national register of historic places. Activities associated with the calcine transfer from Bin Set 1 to Bin Set 6 would require consultation with Idaho State Historic Preservation Officer and compliance with any substantive requirements identified. This consultation, required by Section 106 of the National Historic Preservation Act, would be conducted prior to the initiation of any demolition activities associated with the Bin Set 1 calcine transfer.

Within the INTEC facility, projects that involve soil disturbance by subcontractors must have a project specific storm water pollution prevention plan (SWPPP) for construction, (INEEL Form 450.16). The project manager or designated alternate is responsible for preparing the plan. Such requirements are identified during the preparation of the Environmental Checklist.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) coordination will be required. CERCLA sites in Waste Area Group (WAG) 3, the INTEC facility, may be impacted due to ground-disturbing activities at CSSF, specifically Bin Set 1. Wastes and residue left in place would also require evaluation to determine the impact on the CERCLA Record of Decision (ROD). Soil disturbing activities for the construction of the Bin Set 1 calcine transfer system may impact Environmentally Controlled Areas at the INTEC. As a minimum, the requirements for working in Environmentally Controlled Areas are: personnel must be Hazardous Waste Operations (HAZWOPER) and Radiation Worker trained, a Health and Safety Plan is needed, and a waste management plan is needed in the event soil disturbance does affect contaminated areas.

Transfer of calcine from Bin Set 1 to Bin Set 6 will trigger closure within 180 days [40 CFR 265.113(2)], or as negotiated with the State of Idaho. The intent of the project is to transfer as much calcine from Bin Set 1 as technically feasible in order to support potential future closure activities. During closure of the CSSF, residue remaining in the bins will be assessed to determine its classification as either being HLW or incidental waste. It is preferred that residues remaining in bins would be processed and managed so as to meet the Incidental Waste Criteria specified by the NRC, in 58 FR 12345, "Incidental Waste Criteria."

Under the Federal Facilities Compliance Act, DOE is required to comply with RCRA and various other environmental regulations, such as the Clean Air Act IDAPA Rules for the Control of Air Pollution in Idaho), SWPPP, NESHAPS, etc. DOE has committed to comply with environmental regulations, safety requirements, and agreements with the State of Idaho. Failure to operate acceptable waste storage

and processing facilities will place DOE in violation of RCRA, the Settlement Agreement, and the Federal Facilities Compliance Act.

The applicable commitments for high-level waste and calcine waste associated with the Settlement Agreement between the State of Idaho (under Governor Batt), the Department of Energy, and the Department of Navy, October 16, 1995 are provided below:

- DOE shall treat all high-level waste currently at INEEL so that it is ready to be moved out of Idaho for disposal by a target date of 2035.
- DOE shall accelerate efforts to evaluate alternatives for the treatment of calcined waste so as to put it into a form suitable for transport to a permanent repository or interim storage facility outside Idaho. By December 31, 1999, DOE shall commence negotiating a plan and schedule with the State of Idaho for calcined waste treatment. The plan and schedule shall provide for completion of the treatment of all calcined waste located at INEEL by a date established by the Record of Decision for the Environmental Impact Statement that analyzes the alternatives for treatment of such waste. Such Record of Decision shall be issued not later than December 31, 2009. It is presently contemplated by DOE that the plan and schedule shall provide for the completion of the treatment of all calcined waste located at INEEL by a target date of December 31, 2035. In support of the effort to treat such waste, DOE shall submit its application for a RCRA (or statutory equivalent) Part B permit to the State of Idaho by December 1, 2012.

7.3 Quality

Appropriate quality program documentation will be generated and followed as necessary to confirm proper design, construction, and operation of the Bin Set 1 transfer facility. It is assumed that DOE-ID will continue to implement the quality assurance program described in DOE/RW-0333P, *Quality Assurance Requirements and Description*, and that this will apply to the Bin Set 1 transfer project.

7.4 Safety

9.2.1 Facility Hazard Category and Performance Category

The facility is classified as UBC Group H, Division 7. The H-7 occupancy applies to buildings or portions thereof containing materials that constitute a high health hazard (the inside of the bins and VDAs, and the structures containing the process cyclone separators, sintered metal filters, primary HEPA filters, calcine weigh tank, and the grade-level calcine transport piping between Bin Sets 1 and 6).

9.2.2 Industrial Safety

The basic approach to worker safety for the Bin Set 1 transfer facilities is the incorporation of standard engineering and administrative controls to separate the worker from physical, chemical, and radiation hazards. The LMITCO Health and Safety Program includes aggressive goals with respect to ALARA for radiation hazards and lost time worker injury rates for industrial workers. These goals are most effectively attained by physical separation of workers from the hazards associated with the processes contained within the project buildings.

7.4.1.1 Construction Hazards

Construction hazards for this project are typical for most construction sites. For example, heavy equipment produces physical hazards of striking objects, excavation cave-ins, crushing of hands or feet, and head injuries. In addition, radiation fields and calcine contamination will be encountered during demolition at Bin Set 1, and construction at Bin Set 1 and Bin Set 6. Bin Set 1 Construction Subcontractors shall be required to comply with 10 CFR 1926, "Occupational Safety and Health for Construction," and monitored to ensure compliance and the INEEL Radiological Control Manual.

7.4.1.2 Systems Safety

Manual and remote modes of system operation will allow standard physical lockout of either mode to ensure that operators do not initiate actions that could injure workers performing maintenance, repair, or troubleshooting tasks inside hazardous areas. Equipment and procedures to ensure safe shutdown of the different process systems will be provided as required by the hazards associated with the system. Systems that may have high radiation fields will have remote repair or maintenance capabilities. The remote operations and maintenance descriptions are contained in EDF-1137 in Appendix D.

7.4.1.3 Equipment Safety

Equipment will comply with 10 CFR 1910, "Occupational Safety and Health Standards for General Industry." For example, equipment will be provided with guards, lockout/tagout features, operation and maintenance documentation, and any other items necessary to ensure safe operation of the equipment. To lengthen the life of the calcine piping, blind-tees will be used on all 90-degree elbows, long radius elbows will be used, and Nitronic[®] pipe or ware surfaces will be used for all bends less than 90 degrees.

7.4.1.4 Personnel Safety

In general, workers will be physically separated from the primary confinement areas. These areas are kept at a negative pressure with respect to the areas that surround them so air will always flow from areas of lower contamination to areas of higher contamination. The primary process HEPA filters will be located in shielded rooms and will be remotely changed using remote cranes and manipulators. All equipment pass-out and pass-in areas are controlled by vestibules or areas of lesser contamination. All primary zone areas are surrounded by secondary zones that are normally noncontaminated but may become contaminated. The secondary zone areas are held at a negative pressure with respect to the ambient. All operations within the environmental enclosure will be conducted remotely from the a shielded control room when transferring calcine.

Administrative procedures will allow workers access to some systems for maintenance or repair of equipment. Entries to shielded cells is viewed as hazardous and nonroutine, and will require the use of safety permits. A radiation work permit will be used to address radiological hazards. Personnel safety will be maintained by:

- Following administrative and procedural controls for entry into confinement areas
- Incorporating engineering controls into the design for systems and equipment
- Using personnel monitoring equipment
- Using video monitoring inside confinement areas

- Using lockout/tagout of remote controls and manual controls when working on equipment or systems
- Using emergency procedures to initiate worker response to chemical spills/reactions, fires, and other emergencies
- Using the buddy system when working inside confinement structures or other hazardous areas.

7.4.1.5 *Emergency Preparedness*

Operations for this project will coordinate emergency preparedness planning with the INTEC Emergency Response Organization (ERO). The INTEC ERO will handle site emergencies. Access for emergency vehicles and personnel will be provided as part of the project design.

8. UNCERTAINTIES AND RECOMMENDED RESOLUTIONS

During the course of this study, several important areas of uncertainty arose. Additional work is needed during conceptual design of these uncertainties. These topics are discussed in this section.

- RDP: The remote drilling platform needs further development to insure it will provide reliable remote performance. Investigations of using a commercial drilling head for the main drive should be conducted.
- Riser attachment equipment: EDF-1203 contains a letter and quote from a vendor that claims that the remote weld prep, welding, and bin cutting equipment can be developed to extend 20 ft down through the 9-in. cored hole and perform the operations remotely. However, none of this equipment has been designed or developed. This development will be required during conceptual design.
- Spool pieces: More than 60 different shielded spool pieces may be necessary to connect the calcine and return piping between the 20 VDA positions and the transport pipe trench at the east wall of the environmental enclosure. There is limited space in the environmental enclosure to store these items and they may be contaminated. Design work should be carried out to minimize the number of pieces and simplify their routings.
- VDA shielding: There is a tradeoff between the shielding thickness, calcine jumper shielding thickness, overhead crane load capacity, and weather enclosure construction (which may be made with a reinforced overlapping tip-up concrete wall panel system for the bottom 10 ft of wall rather than metal siding). The required trade-off should be considered during conceptual design.
- CCTV deployment: Further development is needed on the CCTV masts and connections to be remotely lowered into the bins.
- Dolomite injection system: A dolomite injection system is needed to clean calcine dust from the CRN and extension tubes, the VDA jumpers, and the spool pieces. This system, which needs to be completely developed, should employ the existing retrieval and transport vacuum systems so that the primary confinement systems are not positively pressurized. The dolomite can be transferred to Bin Set 6.
- Remote maintenance of VDA: The equipment associated with the VDA pose very unique and potentially difficult tasks for remotely maintaining this hardware. Due to highly radioactive nature of the calcine material and the potential for contamination of both the internal and external surfaces of much of this equipment, direct hands-on contact maintenance may not be practical. Therefore, remote maintenance activities may be required to prevent breakdown of equipment (or repair equipment that has failed) and maintain operations continuity for the retrieval of calcine from Bin Set 1 for pneumatic transport to Bin Set 6. Further evaluations concerning remote maintenance activities on the VDA equipment should be carried out to determine feasibility using the "weather enclosure" approach with the use of temporary shielding specifically around the VDA equipment versus the "shielded hot cell" approach. The required trade-offs should be considered during conceptual design along with the required remotely operated equipment to effectively and safely carry out maintenance activities.

- This study has provided a design for transferring alumina calcine. A future study should investigate the transfer of other types of calcine from other bin sets so that the equipment can be reused for other bin sets.
- Nitronic piping - Nitronic piping may not be available for use in the transport system piping runs as indicated in this study. The use of other types of erosion resistant materials should be investigated.
- Long run for vacuum transport - There are uncertainties with the pneumatic vacuum transfer retrieval and transport systems. The 600 ft span for calcine transfer is longer than normally found in vacuum transfer systems. This should be studied further. Two vacuum transfer loops were included to try to increase reliability but this should be verified for effectiveness.
- Remote maintenance and handling - The design for remote maintenance and remote handling in the retrieval building at Bin Set 1 and in the transport building at Bin Set 6 may be too complicated for this one-year operating facility. During conceptual design, the complexity should be investigated to determine if a simpler remote handling and maintenance methods can be successfully used.
- Use of eductor jets for calcine transport - The system may be able to be simplified by using eductor jets and tying into the NWCF off-gas system via the Bin Set 6 return line. In addition, the amount of new exhaust stack and isokinetic monitors to be installed may be able to be reduced. If the pneumatic process gas were vented to NWCF, the balance may be able to be exhausted by the local CSSF stacks with just leak detection monitors, and not the more complicated isokinetic monitors. This may simplify the project, and reduce cost.
- Interference with existing structure - The pneumatic transfer system line between the NWCF and the Remote Analytical Laboratory is located above Bin Set 1. The new 30-ft high environmental enclosure building that will be built atop Bin Set 1 may interfere with this line so it may have to be rerouted. This issue should be addressed during conceptual design.

9. REFERENCES

1. Raytheon Engineers and Constructors, Inc., *Idaho Chemical Processing Plant: Phase I and II Special Studies Calcine Recovery Bin Set #1 Project*, March 1995.
2. Hendrix, J. A., Westra, A. G., *A Prototype Facility to Demonstrate Retrieval of Simulated ICPP Calcined Waste*, ENICO 1093, September 1981
3. Staples, B. A., G. S. Pomiak, E. L. Wade, *Properties of Radioactive Calcine Retrieved from the Second Calcined Solids Storage Facility at ICPP*, ICPP-1189, March 1979
4. Bodner, S. S., *Effects of Bend Configuration on Dilute-Phase Pneumatic Transport*, ENI-129, March 1980.

Appendix A

Life Cycle Cost Estimates

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: September 14, 1999

To: D. A. Lopez MS3765 6-9020

From: R. D. Adams *RDA* MS3655 6-2963

Subject: BIN SET #1 RETRIEVAL AND TRANSFER FEASIBILITY STUDY -
RDA-30-99

Cost Estimating has prepared a Planning cost estimate for the subject project. This estimate was based on information received on September 8, 1999.

The Total Estimated Cost (TEC) for this project is \$50,600,000. This cost includes direct and indirect construction costs, G&A, PIF, procurement fee, Engineering costs, Inspection costs, Project Management costs, Construction Management costs, Conduct of Operation/Conduct of Maintenance adjustments, escalation and contingency. The estimated costs have been escalated to the midpoint of the latest schedule from the HLW program. For more detailed information, please refer to the Cost Estimate Support Data Recapitulation form.

Attached for your review are the Summary Estimate sheet, the Cost Estimate Support Data Recapitulation form, detailed estimate sheets, Contingency Analysis sheet, and G&A/PIF Calculation Sheet.

Also included is an Other Project Cost (OPC) estimate for \$22,000,000.

If you have any questions regarding this estimate, please contact me at 526-2963.

RDA

Attachments:

cc: Estimate File #2535 *RDA*
R. J. Turk MS3875
R. D. Adams File

COST ESTIMATE SUPPORT DATA RECAPITULATION

Project Title: BIN SET #1 RETRIEVAL AND TRANSFER FEASIBILITY STUDY
Estimator: R. D. Adams
Date: September 14, 1999
Estimate Type: Planning
File: 2535
Approved By:

I. **SCOPE OF WORK:** *Brief description of the proposed project.*

This project would demolish the upper levels of Bin Set 1 to gain access to the bin set vault roof. A new enclosure would be erected. Transfer lines and equipment would be erected allowing recovery and transport of bin set 1 calcine to bin set 6. A retrieval building and a transfer building will be built. Each building will have remote HEPA filter change-out capabilities, booster blowers, and filter load-out.

II. **BASIS OF THE ESTIMATE:** *Drawings, Design Report, Engineers Notes and/or other documentation upon which the estimate is originated.*

The basis for the estimates was information provided by the requester, and "Phase I & II Special Studies, Calcine Recovery Bin Set #1 Project", Alternate 4, prepared by Raytheon Engineers and Constructors. Information was used from the other HLW-EIS studies.

III. **ASSUMPTIONS:** *Conditions statements accepted or supposed true without proof of demonstration. An assumption has a direct impact on total estimated cost.*

1. All comments included with the "Phase I & II Special Studies, Calcine Recovery Bin Set #1 Project", Alternate 4, prepared by Raytheon Engineers and Constructors estimate also apply here, except as follows.
2. Allowances, adders and markups are in line with other HLW estimates completed recently, except as noted below.
3. Other Project Costs (OPC) are included as a separate estimate.
4. Contaminated earth will be boxed and processed by an outside source such as Envirocare.

COST ESTIMATE SUPPORT DATA RECAPITULATION

- Continued -

Project Title: BIN SET #1 RETRIEVAL AND TRANSFER FEASIBILITY STUDY
File: 2535

Page 2 of 3

5. Radiation levels assumed for the Raytheon study, alternate 4, were used for this estimate. These rad levels are substantially lower than those used in other alternates.
6. Rad box loading and waste processing were not included in the Raytheon estimate. An allowance is included in this estimate.
7. Radcon Tech hours were added in this estimate.
8. G&A/PIF factors were applied to construction and GFE.
9. Estimated Conceptual Design, process development and startup costs are higher than normally seen on a project of this size. Three factors enter into these numbers: 1) substantial work in high rad areas, 2) calcine retrieval, and 3) calcine transport. These factors will require much more time to design and demonstrate than normal, proven technologies.
10. This effort is a follow-on to the study used for the HLW EIS (2443as). The main area of change occurred with the addition of the retrieval building and equipment. Both retrieval and transfer buildings will be constructed of reinforce concrete with remote accessible HEPA filter cells and spent filter load out capabilities. Most of the equipment previously estimated as GFE has been moved to the construction portion of this estimate. Conduct of Operation/Conduct of Maintenance adjustments have been added to reflect the latest allowances for these activities.

IV. **CONTINGENCY GUIDELINE IMPLEMENTATION:** *The percentage used for contingency as determined by the contingency allowance guidelines can be altered to reflect the type of construction and conditions that may impact the total estimated cost.*

This project contains high rad areas, unproven recovery methods, and first-of-a-kind equipment. For these reasons, contingency at the high end of the recommended range for a planning estimate would appear to be justified.

V. **OTHER COMMENTS/CONCERNS SPECIFIC TO THE ESTIMATE**

Procurement Fee is applied against construction and GFE costs at a rate of 1%. (Procurement Fee is normally applied at 3%, however, for a project of this size, it was felt that a negotiated Fee of 1% was more appropriate.)

COST ESTIMATE SUPPORT DATA RECAPITULATION

- Continued -

Project Title: BIN SET #1 RETRIEVAL AND TRANSFER FEASIBILITY STUDY
File: 2535

Page 3 of 3

G&A is applied against construction cost, GFE, and Procurement Fee at a rate of 27% with a ceiling of \$500,000 per year. PIF is applied against construction cost, GFE, Procurement Fee, and G&A at a rate of 4.5%.

The estimating program used to do this cost estimate has the following hierarchy when costs are rolled up to the summary sheet.

- The detailed cost estimate sheets show raw costs without subcontractor/prime contractor markups or sales taxes.
- Sales tax is applied at 5% of material costs (included in the Contractor Markup Report).
- Subcontractor/prime contractor markups are applied next. The details are shown in the Contractor Markup Distribution Report.
- The appropriate escalation and contingency are calculated and the details are shown in the Contingency Analysis sheet.
- All of these costs and factors roll up to the Cost Estimate Summary.

COST ESTIMATE SUMMARY

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY
LOCATION 1: INEEL/INTEC
REQUESTOR: D. A. LOPEZ

TYPE OF ESTIMATE: Planning
PROJECT NO: 2535
PREPARED BY: R. D. ADAMS
REPORT NAME: Cost Estimate Summary

DATE: 13-Sep-1999
TIME: 12:20:47
CHECKED BY:
APPRD BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	<u>ENGINEERING, DESIGN AND INSPECTION</u>			>> <u>\$6,637,538</u>
1.1.1	DESIGN ENGINEERING TITLE I & II	4,844,900	581,388	5,426,288
1.1.2	QUALITY ASSURANCE	969,000	242,250	1,211,250
1.2	<u>MANAGEMENT COSTS</u>			>> <u>\$6,595,624</u>
1.2.1	PROJECT MANAGEMENT	3,397,195	713,411	4,110,606
1.2.2	CONSTRUCTION MANAGEMENT	1,988,014	497,004	2,485,018
1.3	<u>CONSTRUCTION</u>			>> <u>\$20,187,107</u>
1.3.1	GENERAL CONDITIONS	4,499,755	1,124,939	5,624,694
1.3.2	SITWORK	1,003,455	250,864	1,254,319
1.3.3	CONCRETE	1,134,634	283,658	1,418,292
1.3.5	METALS	7,819	1,955	9,774
1.3.7	THERMAL & MOISTURE PROTECTION	83,190	20,798	103,988
1.3.8	DOORS & WINDOWS	187,692	46,923	234,615
1.3.9	FINISHES	45,565	11,391	56,956
1.3.11	EQUIPMENT	6,272,021	1,568,005	7,840,026
1.3.13	SPECIAL CONSTRUCTION	268,913	67,228	336,141
1.3.15	MECHANICAL	2,275,222	568,805	2,844,027
1.3.16	ELECTRICAL	371,420	92,855	464,275
1.4	<u>GOVERNMENT FURNISHED EQUIP.</u>			>> <u>\$1,482,463</u>
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,185,970	296,493	1,482,463
1.5	<u>G&A/PIF</u>			>> <u>\$2,346,018</u>
1.5.1	G&A/PIF ADDER	1,876,814	469,204	2,346,018
1.5.2	PROCUREMENT FEES	173,357	43,339	>> <u>\$216,696</u>
	SUBTOTAL INCLUDING ESCALATION	30,584,936	6,880,510	>> \$37,465,446
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> \$2,423,228
	CONTINGENCY			>> \$10,711,326
	TOTAL ESTIMATED COST			>> \$50,600,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= 31.00%

CONTINGENCY= 35.06%

REV. 6/96

LOCATION 1: INEEL/INTEC

REQUESTOR: **D. A. LOPEZ**

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

PAGE # 1

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: **Detail Cost Estimate Sheet**

[illegible]

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

DETAILED COST ESTIMATE SHEET

PAGE # 2

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MAT'L UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.2.1.3	<u>RADIOLOGICAL CONTROL TECHNICIANS</u> Radiological Control Technicians	260	Wks		Z-7132 LIMITCO	60.000	15,600	697,632				697,632
	Radiation Control - Management Support - 10% OF RCT Total	1	Lot		Z-7131 LIMITCO	0.000						
	<u>RADIOLOGICAL CONTROL TECHNICIANS S/T</u>						15,600	\$697,632				\$697,632
1.2.1.4	<u>ENVIRONMENTAL SAFETY & HEALTH</u> Environmental Safety & Health	260	Wks		Z-7120 LIMITCO	20.000	5,200	320,788				320,788
	ES&H Management Support - 10% Of ES&H Total	1	Lot		LIMITCO	0.000		32,080				32,080
	<u>ENVIRONMENTAL SAFETY & HEALTH S/T</u>						5,200	\$352,868				\$352,868
1.2.1.5	<u>PM - CONDUCT OF OPERATIONS / CONDUCT OF MAINTENANCE</u> Assemble Planning Team	1	Lot		Z-6310 LIMITCO	10.000	10	740				740
	ORIGINATE WCF	1	LOT		Z-6310	4.000	4	296				296
	UPDATE WCF	156	WK		Z-6310	4.000	624	46,157				46,157
	INITIATE HAZARDS ANALYSIS PROCESS	1	LOT		Z-6310	40.000	40	2,959				2,959
	PREPARE SUPPORTING HAZARDS PROJECT DOCUMENTATION	1	LOT		Z-6310	25.000	25	1,849				1,849
	POST JOB REVIEW	1	LOT		Z-6310	10.000	10	740				740
	Project Management - Management Support - 20% Of P.M. Total	1	Lot		LIMITCO	0.000		10,548				10,548
	<u>PM - CONDUCT OF OPERATIONS / CONDUCT OF MAINTENANCE S/T</u>						713	\$63,289				\$63,289

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER

FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 3

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MAT'L UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.2.1.5	PM - CONDUCT OF OPERATIONS/ CONDUCT OF MAINTENANCE											
1.2.2	CONSTRUCTION MANAGEMENT											
11000000.00	CONSTRUCTION MANAGEMENT @ 10% OF CONSTRUCTION	1	LOT			0.000		1,439,400				1,439,400
	CONSTRUCTION MANAGEMENT S/T						0	\$1,439,400				\$1,439,400
1.2.2.1	CM - CONDUCT OF OPERATIONS/ CONDUCT OF MAINTENANCE											
	Initiate Hazards Analysis Process	1	Lot		Z-6340 LIMITCO	10.000	10	740				740
	Assemble Planning Team	1	Lot		Z-6340 LIMITCO	50.000	50	3,699				3,699
	PREPARE SUPPORTING HAZARDS PROJECT DOCUMENTATION	1	LOT		Z-6340	25.000	25	1,849				1,849
	DEVELOP WORK ORDER	1	LOT		Z-6340	40.000	40	2,959				2,959
	Develop Initial JSA & Input To Work Plans	1	Lot		Z-6340 LIMITCO	35.000	35	2,589				2,589
	APPROVE WORK ORDER	1	LOT		Z-6340	30.000	30	2,219				2,219
	SCHEDULE WORK ON POD	260	WKS		Z-6340	4.000	1,040	76,929				76,929
	Project Continuous Surveillance (2 Hours / Day)	260	Wks		Z-6340 LIMITCO	8.000	2,080	153,858				153,858
	OUTAGES	6	EA		Z-6340	20.000	120	8,876				8,876
	SUBSURFACE INVESTIGATION	4	LOT		Z-6340	20.000	80	5,918				5,918
	POST JOB REVIEW	1	LOT		Z-6340	10.000	10	740				740

TYPE OF ESTIMATE: **Planning**
PROJECT NO.: **2535**
PREPARED BY: **R. D. ADAMS**

[illegible]

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2535
PREPARED BY: R. D. ADAMS

DATE: 13-Sep-1999
TIME: 11:29:48
REPORT NAME: Detail Cost Estimate Sheet

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DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: **Planning**
PROJECT NO.: **2535**
PREPARED BY: **R. D. ADAMS**

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REPORT NAME: Detail Cost Estimate Sheet

[illegible]

Rev. 6/98

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER

FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: **D. A. LOPEZ**

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: **R. D. ADAMS**

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

[illegible]

**PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY**

TYPE OF ESTIMATE: **Planning**
PROJECT NO.: **2535**
PREPARED BY: **R. D. ADAMS**

DATE: 13-Sep-1999
TIME: 11:29:48
REPORT NAME: Detail Cost Estimate Sheet

LOCATION 1: INEEL/INTEC
REQUESTOR: D. A. LOPEZ

[illegible]

REQUESTOR: **D. A. LOPEZ**

[illegible]

DATE: 13-Sep-1999
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REPORT NAME: Detail Cost Estimate Sheet

[illegible]

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

PAGE # 11

DATE 13-Sep-1999

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REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
<u>1.3.3.2</u>	BIN SET #6 ENCLOSURE											
	NEW ENCLOSURE CURB ON TOP OF BIN SET #6	1	CY	229.00	SKWK CONC	13.640	15	518		252		770
	NEW ENCLOSURE WALLS @ BASE OF BIN SET #6	101	CY	159.00	SKWK CONC	5.310	535	18,477		16,027		34,504
	NEW ENCLOSURE CEILING @ BASE OF BIN SET #6	40	CY	264.00	SKWK CONC	12.950	517	17,837		10,534		28,370
	NEW ENCLOSURE SOG @ BASE OF BIN SET #6	35	CY	137.00	SKWK CONC	4.290	149	5,139		4,754		9,893
	NEW ENCLOSURE FTG. @ BASE OF BIN SET #6	25	CY	145.00	SKWK CONC	6.230	157	5,420		3,654		9,074
	MISC. @ 5%	0	%	50,942.00	SKWK CONC	2014.00	101	3,476		2,547		6,023
	BIN SET #6 ENCLOSURE S/T						2,114	\$72,991		\$53,489		\$126,480
<u>1.3.3.3</u>	RETRIEVAL FACILITY											
	FOOTINGS & FOUNDATIONS	47	CY	150.00	SKWK GEN	8.000	376	12,980	235	7,050		20,265
	SLAB-ON-GRADE	62	CY	120.00	SKWK GEN	6.000	372	12,841	434	7,440		20,715
	WALLS	260	CY	200.00	SKWK GEN	11.000	2,860	98,727	2,600	52,000		153,327
	ELEVATED SLABS	106	CY	300.00	SKWK GEN	12.000	1,272	43,909	1,060	31,800		76,769
	RETRIEVAL FACILITY S/T						4,880	\$168,458	\$4,329	\$98,290		\$271,077
<u>1.3.3.4</u>	TRANSFER FACILITY											
	FOOTINGS & FOUNDATIONS	38	CY	150.00	SKWK GEN	8.000	304	10,494	190	5,700		16,384
	SLAB-ON-GRADE	46	CY	120.00	SKWK GEN	6.000	276	9,528	322	5,520		15,370
	WALLS	214	CY	200.00	SKWK GEN	11.000	2,354	81,260	2,140	42,800		126,200

[illegible]

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 13

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REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MAT'L UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.3.7.1	RETRIEVAL FACILITY SIDING	3,696	SF		SHEE GEN	0.000					18,480	18,480
	RETRIEVAL FACILITY S/T						25	\$748		\$3,328	\$29,477	\$33,552
1.3.7.2	TRANSFER FACILITY ROOFING	1,248	SF	2.00	ROFC ROOF	0.015	19	561		2,496		3,057
	ROOFING INSULATION	1,248	SF		ASBE /INSUL	0.000					1,872	1,872
	RIGID EXTERIOR WALL INSULATION Includes "Z" bars.	3,124	SF		ASBE /INSUL	0.000					7,185	7,185
	SIDING	3,124	SF		SHEE GEN	0.000					15,620	15,620
	TRANSFER FACILITY S/T						19	\$561		\$2,496	\$24,677	\$27,734
1.3.8	DOORS & WINDOWS											
	DOORS & WINDOWS S/T						0					
1.3.7.1	RETRIEVAL FACILITY DOUBLE DOORS	2	EA	600.00	CARP GEN	5.000	10	346		1,200		1,546
	SINGLE DOORS	2	EA	1,600.00	CARP GEN	10.000	20	693		3,200	3	3,896
	ROLL-UP DOORS	2	EA	1,000.00	CARP GEN	16.000	32	1,108		2,000		3,108
	SHIELD DOORS	2	EA	25,000.00	SKWK GEN	160.000	320	11,046		50,000		61,046
	RETRIEVAL FACILITY S/T						382	\$13,194		\$56,400	\$3	\$69,597

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: **Planning**
PROJECT NO.: **2535**
PREPARED BY: **R. D. ADAMS**

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REPORT NAME: **Detail Cost Estimate Sheet**

[illegible]

DATE: 13-Sep-1999
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REPORT NAME: Detail Cost Estimate Sheet

[illegible]

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: **R. D. ADAMS**

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DATE 13-Sep-1999

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REPORT NAME: **Detail Cost Estimate Sheet**

[illegible]

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

DETAILED COST ESTIMATE SHEET

PAGE # 17

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.3.11.2	RETRIEVAL FACILITY O. H. PAR & CRANE	1	LOT	450,000.00	SKWK GEN	400.000	400	13,808		450,000		463,808
	RETRIEVAL FACILITY S/T						1,984	\$72,615		\$1,196,034		\$1,268,650
1.3.11.3	TRANSFER FACILITY TRANSPORT AIR BLOWER	1	EA	33,130.00	SHEE HVAC	100.000	100	3,548		33,130		36,678
	BALANCING AIR BLOWER	1	EA	1,730.00	SHEE HVAC	40.000	40	1,419		1,730		3,149
	SINTERED METAL FILTER	1	EA	275,000.00	PIPE PIPE	400.000	400	15,032		275,000		290,032
	CYCLONE	1	EA	2,600.00	PIPE PIPE	40.000	40	1,503		2,600		4,103
	HEAT EXCHANGER	1	EA	11,600.00	PIPE PIPE	40.000	40	1,503		11,600		13,103
	HEPA FILTER, 1012 ACFM	1	EA	16,825.00	SHEE HVAC	20.000	20	710		16,825		17,535
	HEPA FILTER, 720 ACFM	1	EA	6,340.00	SHEE HVAC	12.000	12	426		6,340		6,766
	ROTARY VALVE	1	EA	5,500.00	PIPE PIPE	12.000	12	451		5,500		5,951
	HEPA FILTER TRANSFER PORTS	2	EA	33,000.00	PIPE PIPE	100.000	200	7,516		66,000		73,516
	SHIELDED WINDOWS	2	EA	110,000.00	IRON GEN	96.000	192	7,711		220,000		227,711
	AIR HANDLING UNIT, 2130 CFM	1	EA	5,020.00	SHEE HVAC	60.000	60	2,129		5,020		7,149
	HEPA CANNISTER W/ PREFILTER 120 CFM	1	EA	1,870.00	SHEE HVAC	12.000	12	426		1,870		2,296
	HEPA FILTER, SINGLE STAGE W/ PREFILTER, 530 CFM	1	EA	11,000.00	SHEE HVAC	20.000	20	710		11,000		11,710
	HEPA FILTER, SINGLE STAGE W/ PREFILTER, 1600 CFM	1	EA	22,000.00	SHEE HVAC	40.000	40	1,419		22,000		23,419
	HEPA CANNISTER W/ PREFILTER 230 CFM	2	EA	2,475.00	SHEE HVAC	12.000	24	852		4,950		5,802
	EXHAUST FAN 530 CFM	1	EA	1,100.00	SHEE HVAC	12.000	12	426		1,100		1,526

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

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DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
<u>1.3.11.3</u>	<u>WEATHER ENCLOSURE</u> BRIDGE CRANE 25 TON, 30' SPAN	1	EA	300,000.00	IRON GEN	500.000	500	20,080		300,000		320,080
	WEATHER ENCLOSURE S/T						1,084	\$40,793		\$376,871		\$417,664
<u>1.3.13</u>	<u>SPECIAL CONSTRUCTION</u>											
	SPECIAL CONSTRUCTION S/T						0					
<u>1.3.13.1</u>	<u>BIN SET #1 WEATHER ENCLOSURE</u> PRE-ENGINEERED BLDG.	1,232	SF		IRON GEN	0.000					60,984	60,984
	WINDOWS	10	SF		CARP GEN	0.000					273	273
	SINGLE DOORS	4	EA		CARP GEN	0.000					3,525	3,525
	OH DOOR	150	SF		GEN	0.000					2,292	2,292
	ROOFING	208	SF		GEN	0.000					285	285
	PARTITIONS	8,040	SF		GEN	0.000					16,884	16,884
	SIDING	960	SF		GEN	0.000					3,312	3,312
	FIRE PROTECTION	300	SF		GEN	0.000					3,960	3,960
	MISC. @ 20%	0	%		GEN	0.000					18,303	18,303
	BIN SET #1 WEATHER ENCLOSURE S/T						0				\$109,818	\$109,818
<u>1.3.13.2</u>	<u>BIN SET #6 RELOCATION OF EXISTING</u> <u>BLDG. ON TOP</u> CRANE/MANLIFT ALLOWANCE	1	LOT		GEN	0.000			55,000			55,000
	REMOVE EXISTING 288SF BLDG.	1	LOT		IRON GEN	256.000	256	10,281				10,281

DATE: 13-Sep-1999
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REPORT NAME: Detail Cost Estimate Sheet

[illegible]

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DETAILED COST ESTIMATE SHEET

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REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MAT'L UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
<u>1.3.15.1</u>	PIPING											
	RETURN AIR @ GRADE - EAST OF BIN SET	140	LF	27.98	PIPE	4.660	652	24,517		3,917		28,434
	STEAM @ GRADE - SOUTH OF OLIVE AVE.	620	LF	3.88	PIPE	0.450	279	10,485		2,406		12,890
	HIGH STEAM LINE - SOUTH OF OLIVE AVE.	60	LF	3.70	PIPE	1.380	83	3,112		222		3,334
	CONTAINMENT PIPE @ GRADE - ALONG HEMLOCK ST.	620	LF	208.76	PIPE	9.920	6,150	231,132		129,431		360,563
	HIGH CONTAINMENT PIPING - SOUTH OF OLIVE AVE.	60	LF	212.06	PIPE	40.940	2,456	92,312		12,724		105,035
	TRANSPORT AIR @ GRADE - SOUTH OF OLIVE AVE.	650	LF	23.00	PIPE	1.200	780	29,312		14,950		44,262
	HIGH TRANSPORT AIR - SOUTH OF OLIVE AVE.	60	LF	11.62	PIPE	2.120	127	4,780		697		5,477
	RETURN AIR @ GRADE - SOUTH OF OLIVE AVE.	650	LF	26.00	PIPE	1.380	897	33,709		16,900		50,609
	HIGH RETURN AIR - SOUTH OF OLIVE AVE.	60	LF	23.80	PIPE	3.970	238	8,952		1,428		10,380
	PIPING REQ'D FOR PENETRATIONS INTO BIN SET #1	880	LF	136.25	PIPE	14.030	12,346	463,978		119,900		583,878
	ALLOWANCE FOR UTILITY PIPING	800	LF	9.22	PIPE	2.830	2,264	85,081		7,376		92,457
	PIPING S/T						31,149	\$1,170,591		\$346,460		\$1,517,050
<u>1.3.15.2</u>	RETRIEVAL FACILITY											
	FIRE SPRINKLER SYSTEM	2,295	SF		SPRI	0.000					6,885	6,885
	MISC. BLDG. PIPING SYSTEMS	2,295	SF		PIPE	0.000					16,065	16,065

DATE: 13-Sep-1999
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REPORT NAME: Detail Cost Estimate Sheet

[illegible]

Rev. 6/96

BIN SET #1 RETRIEVED

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

PAGE # 23

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2535
PREPARED BY: R. D. ADA

ESTIMATE. Planning

PREPARED BY: R. D. ADAMS

DATE 13-Sep-1999

TIME: 11:29:48

REPORT NAME: Detail Cost Estimate Sheet

[illegible]

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 2535

PREPARED BY: R. D. ADAMS

DATE 13-Sep-1999

TIME: 12:19:33

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.4.1.2	PROCESS WASTE BOXES RAD BOXES	348	EA	550.00		0.000				191,400		191,400
	PROCESS WASTE BOXES S/T						0			\$191,400	\$985,000	\$1,176,400
1.5.1 00701000	G&A/PIF ADDER G&A - 27%	1	LOT			0.000					1,042,018	1,042,018
	PIF - 4.5%	1	LOT			0.000					834,796	834,796
	G&A/PIF ADDER S/T						0				\$1,876,814	\$1,876,814
	PROJECT SUBTOTAL						159,409	\$15,892,218	\$420,675	\$6,513,336	\$3,245,212	\$26,071,441

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

 PROJECT NAME: **BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY**

 LOCATION 1: **INEEL/INTEC**
 REQUESTOR: **D. A. LOPEZ**
CONTINGENCY ANALYSIS

 TYPE OF ESTIMATE: **Planning**
 PROJECT NO: **2535**
 PREPARED BY: **R. D. ADAMS**

 DATE: **13-Sep-1999**
 TIME: **12:20:41**

 REPORT NAME: **Contingency Analysis**

PROBABLE % VARIATION									PROJECT CONTINGENCY		SUMMARY
WBS Element	Cost Estimate Element	Total Cost w/o Contingency	% Total Cost	Prob. % Var. From Est.		Wt. % of Prob.		Contingency	%	Cost	Total Cost by Element
				-	+	-	+				
1.1.1	DESIGN ENGINEERING TITLE I & II	4,844,900	12.93	15	35	1.94	4.53	3.879%	11.08%	1,455,163	6,300,063
1.1.2	QUALITY ASSURANCE	969,000	2.59	10	35	0.26	0.91	0.789%	2.25%	295,889	1,264,889
1.2.1	PROJECT MANAGEMENT	3,397,195	9.07	10	35	0.91	3.17	2.766%	7.90%	1,037,351	4,434,546
1.2.2	CONSTRUCTION MANAGEMENT	1,988,014	5.31	5	50	0.27	2.65	2.361%	6.74%	885,697	2,873,711
1.3.1	GENERAL CONDITIONS	4,499,755	12.01	10	35	1.20	4.20	3.663%	10.46%	1,374,024	5,873,779
1.3.2	SITWORK	1,003,455	2.68	10	**	0.27	2.68	2.384%	6.81%	894,115	1,897,570
1.3.3	CONCRETE	1,134,634	3.03	15	30	0.45	0.91	0.772%	2.21%	289,669	1,424,303
1.3.5	METALS	7,819	0.02	10	35	0.00	0.01	0.006%	0.02%	2,388	10,207
1.3.7	THERMAL & MOISTURE PROTECTION	83,190	0.22	5	35	0.01	0.08	0.069%	0.20%	25,819	109,009
1.3.8	DOORS & WINDOWS	187,692	0.50	10	40	0.05	0.20	0.175%	0.50%	65,769	253,461
1.3.9	FINISHES	45,565	0.12	10	40	0.01	0.05	0.043%	0.12%	15,966	61,531
1.3.11	EQUIPMENT	6,272,021	16.74	15	50	2.51	8.37	7.282%	20.80%	2,731,507	9,003,528
1.3.13	SPECIAL CONSTRUCTION	268,913	0.72	10	30	0.07	0.22	0.187%	0.53%	69,999	338,912
1.3.15	MECHANICAL	2,275,222	6.07	10	40	0.61	2.43	2.125%	6.07%	797,255	3,072,477
1.3.16	ELECTRICAL	371,420	0.99	10	45	0.10	0.45	0.392%	1.12%	146,882	518,302
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,185,970	3.17	15	30	0.47	0.95	0.807%	2.31%	302,775	1,488,745
1.5.1	G&A/PIF ADDER	1,876,814	5.01	10	35	0.50	1.75	1.528%	4.36%	573,095	2,449,909
1.5.2	PROCUREMENT FEES	173,357	0.46	0	45	0.00	0.21	0.187%	0.54%	70,291	243,648
	ESCALATION	6,880,510	18.36	10	35	1.84	6.43	5.601%	16.00%	2,100,900	8,981,410
SUBTOTAL		37,465,446	100.00					35.017%			
CALCULATED CONTINGENCY		13,119,372									
RESULTANT TEC		50,584,818									
ROUNDED TEC		50,600,000									
PROJECT CONTINGENCY		13,134,554						35.06%			
MANAGEMENT RESERVE		2,423,228									
CONTINGENCY		10,711,326									
TOTAL ESTIMATED COST		50,600,000								13,134,554	50,600,000

CONFIDENCE LEVEL AND ASSUMED RISKS:

The Lockheed Idaho Technologies Co. Cost Estimate Contingency Analysis Model is based on the applied contingency and the assumptions upon which the estimate was predicated. The model is applied with a suggested risk level of 18% and a level of confidence of 90% the estimate will fall within the bid range. The Contingency Analysis is based on a weighted average to provide a 90 % probability of underrun and a 10% probability of overrun.

CONTINGENCY ANALYSIS GUIDE BY TYPE OF ESTIMATE

Guidelines established by DOE/FM 50, Cost Estimating Guide, Vol. 6, Cost Guide, and as presented in the INEL Cost Estimating Guide.

PLANNING	20% - 30%
Experimental/Special Conditions.....	Up to 50%
Conceptual	15% - 25%
Experimental/Special Conditions.....	Up to 40%
TITLE I	10% - 20%
TITLE II	5% - 15%
TITLE II/AFC	Market Conditions

Lockheed Martin Idaho Technologies Co.
CONTRACTOR MARKUP DISTRIBUTION REPORT

PROJECT: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY
LOCATION: INEEL/INTEC
ESTIMATOR: R. D. ADAMS
CLIENT: D. A. LOPEZ

DATE: September 13, 1999
ESTTYPE: Planning

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
PRIME CONTRACTOR		\$0	\$0	\$0	\$0	\$0		0.00%	0.00%
TOTAL FOR PRIME CONTRACTOR	0	\$0	\$0	\$0	\$0	\$0	***.***%		
CONCRETE CONTRACTOR - CONC		\$216,935	\$131,156	\$0	\$0	\$348,092		2.87%	2.16%
PROFITS	10.00%	\$21,694	\$13,116	\$0	\$0	\$34,809	10.00%		
OVERHEADS	15.00%	\$35,794	\$21,641	\$0	\$0	\$57,435	16.50%		
TOTAL FOR CONCRETE CONTRACTOR - CONC	6,284	\$274,423	\$165,913	\$0	\$0	\$440,336	26.50%		
EARTHWORK CONTRACTOR - DIRT		\$199,089	\$2,138	\$66,665	\$0	\$267,892		2.21%	1.66%
PROFIT	10.00%	\$19,909	\$214	\$6,666	\$0	\$26,789	10.00%		
OVERHEADS	15.00%	\$32,850	\$353	\$11,000	\$0	\$44,202	16.50%		
TOTAL FOR EARTHWORK CONTRACTOR - DIRT	6,025	\$251,848	\$2,704	\$84,331	\$0	\$338,883	26.50%		
ELECTRICAL CONTRACTOR - ELEC		\$312,983	\$285,527	\$0	\$24,558	\$623,067		5.13%	3.86%
PROFIT	10.00%	\$31,298	\$28,553	\$0	\$2,456	\$62,307	10.00%		
OVERHEADS	15.00%	\$51,642	\$47,112	\$0	\$4,052	\$102,806	16.50%		
TOTAL FOR ELECTRICAL CONTRACTOR - ELEC	9,173	\$395,923	\$361,191	\$0	\$31,066	\$788,180	26.50%		
FIRE PROTECTION CONTRACTOR - FIRE		\$0	\$0	\$0	\$12,189	\$12,189		0.10%	0.08%
PROFIT	10.00%	\$0	\$0	\$0	\$1,219	\$1,219	10.00%		
OVERHEADS	18.00%	\$0	\$0	\$0	\$2,413	\$2,413	19.80%		
TOTAL FOR FIRE PROTECTION CONTRACTOR - FIRE	0	\$0	\$0	\$0	\$15,821	\$15,821	29.80%		
GENERAL CONTRACTOR - GEN		\$2,335,090	\$4,583,198	\$352,486	\$166,053	\$7,436,827		61.28%	46.05%
PROFIT	10.00%	\$233,509	\$458,320	\$35,249	\$16,605	\$743,683	10.00%		
OVERHEADS	5.00%	\$128,430	\$252,076	\$19,387	\$9,133	\$409,025	5.50%		
TOTAL FOR GENERAL CONTRACTOR - GEN	65,425	\$2,697,029	\$5,293,593	\$407,121	\$191,791	\$8,589,535	15.50%		
HVAC CONTRACTOR - HVAC		\$112,445	\$403,751	\$0	\$0	\$516,196		4.25%	3.20%
PROFIT	10.00%	\$11,244	\$40,375	\$0	\$0	\$51,620	10.00%		
OVERHEADS	18.00%	\$22,264	\$79,943	\$0	\$0	\$102,207	19.80%		
TOTAL FOR HVAC CONTRACTOR - HVAC	3,169	\$145,954	\$524,069	\$0	\$0	\$670,023	29.80%		

Lockheed Martin Idaho Technologies Co.
PROJECT: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY
LOCATION: INEEL/INTEC
ESTIMATOR: R. D. ADAMS
CLIENT: D. A. LOPEZ

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: September 13, 1999
ESTTYPE: Planning

CONTRACTOR		LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
=====										
INSULATION CONTRACTOR - INSUL			\$0	\$0	\$0	\$20,054	\$20,054		0.17%	0.12%
PROFIT	10.00%		\$0	\$0	\$0	\$2,005	\$2,005	10.00%		
OVERHEADS	15.00%		\$0	\$0	\$0	\$3,309	\$3,309	16.50%		
TOTAL FOR INSULATION CONTRACTOR - INSUL		0	\$0	\$0	\$0	\$25,368	\$25,368	26.50%		
PAINTING CONTRACTOR - PAINT			\$15,438	\$0	\$0	\$32,103	\$47,541		0.39%	0.29%
PROFIT	10.00%		\$1,544	\$0	\$0	\$3,210	\$4,754	10.00%		
OVERHEADS	15.00%		\$2,547	\$0	\$0	\$5,297	\$7,844	16.50%		
TOTAL FOR PAINTING CONTRACTOR - PAINT		508	\$19,529	\$0	\$0	\$40,610	\$60,140	26.50%		
PIPING CONTRACTOR - PIPE			\$1,498,251	\$1,223,733	\$0	\$128,441	\$2,850,425		23.49%	17.65%
PROFIT	10.00%		\$149,825	\$122,373	\$0	\$12,844	\$285,042	10.00%		
OVERHEADS	10.00%		\$164,808	\$134,611	\$0	\$14,129	\$313,547	11.00%		
TOTAL FOR PIPING CONTRACTOR - PIPE		39,868	\$1,812,883	\$1,480,717	\$0	\$155,414	\$3,449,014	21.00%		
ROOFING CONTRACTOR - ROOF			\$1,308	\$6,115	\$0	\$0	\$7,423		0.06%	0.05%
PROFIT	10.00%		\$131	\$612	\$0	\$0	\$742	10.00%		
OVERHEAD	15.00%		\$216	\$1,009	\$0	\$0	\$1,225	16.50%		
TOTAL FOR ROOFING CONTRACTOR - ROOF		44	\$1,655	\$7,736	\$0	\$0	\$9,391	26.50%		
STRUCTURAL STEEL CONTRACTOR - STEEL			\$1,569	\$2,415	\$1,524	\$0	\$5,509		0.05%	0.03%
PROFIT	10.00%		\$157	\$242	\$152	\$0	\$551	10.00%		
OVERHEADS	15.00%		\$259	\$399	\$252	\$0	\$909	16.50%		
TOTAL FOR STRUCTURAL STEEL CONTRACTOR - STEEL		39	\$1,985	\$3,055	\$1,928	\$0	\$6,969	26.50%		

Lockheed Martin Idaho Technologies Co.
CONTRACTOR MARKUP DISTRIBUTION REPORT

PROJECT: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY
LOCATION: INEEL/INTEC
ESTIMATOR: R. D. ADAMS
CLIENT: D. A. LOPEZ

DATE: September 13, 1999
ESTTYPE: Planning

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
TOTAL DIRECT COST	130,636	\$4,693,109	\$6,638,033	\$420,676	\$383,398	\$12,135,214		100.00%	
TOTAL SUBCONTRACTOR MARKUPS		\$908,121	\$1,200,946	\$72,705	\$76,673	\$2,258,444			13.98%
TOTAL COST TO PRIME		\$5,601,230	\$7,838,978	\$493,380	\$460,070	\$14,393,659			
PRIME CONTRACTOR MARKUP 12.20%		\$683,350	\$956,355	\$60,192	\$56,129	\$1,756,026			10.87%
TOTAL PROJECT COST		\$6,284,580	\$8,795,334	\$553,573	\$516,199	\$16,149,685			

G&A/PIF ADDER CALCULATION SHEET

BIN SET #1 RETRIEVAL AND TRANSFER

FEASIBILITY STUDY

PROJECT:

DATE: 9/13/99

PROCUREMENT FEE:

CONSTRUCTION =	\$16,149,685	
GFE =	\$1,185,970	
Subtotal	<u>\$17,335,655</u>	
FEE @ 1.0% =	\$17,335,655 * 0.01 =	\$173,356.55

G&A @ 27% (with a ceiling of \$500,000 imposed per year)

CONSTRUCTION \$ OR CEILING * # OF YEARS

YEARS OF CONST. = 5	\$2,500,000	
GFE =	\$1,185,970	
PROCUREMENT FEE =	\$173,357	
Subtotal	<u>\$3,859,327</u>	
FEE @ 27% =	\$3,859,327 * 0.27 =	\$1,042,018.17

PIF @ 4.5%

CONSTRUCTION =	\$16,149,685	
GFE =	\$1,185,970	
PROCUREMENT FEE =	\$173,357	
G&A =	\$1,042,018	
Subtotal	<u>\$18,551,030</u>	
FEE @ 4.5% =	\$18,551,030 * 0.045 =	\$834,796.34

TOTAL PROCUREMENT FEE: \$173,357

TOTAL G&A FEE: \$1,042,018

TOTAL PIF: \$834,796

COST ESTIMATE SUMMARY

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER
FEASIBILITY STUDY - OPC
LOCATION 1: INEEL/INTEC
REQUESTOR: D. A. LOPEZ

TYPE OF ESTIMATE: Planning
PROJECT NO: 25350
PREPARED BY: R. D. ADAMS
REPORT NAME: Cost Estimate Summary

DATE: 13-Sep-1999
TIME: 15:06:25
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	CONCEPTUAL DESIGN			>> \$1,679,600
1.1.1	CONCEPTUAL DESIGN	1,615,000	64,600	1,679,600
1.2	MANAGEMENT COSTS			>> \$6,097,875
1.2.1	PROJECT MANAGEMENT & PROCESS	5,807,500	290,375	6,097,875
1.3	PERMITTING			>> \$2,206,517
1.3.1	PERMITTING	2,062,165	144,352	2,206,517
1.4	SO TEST & STARTUP			>> \$5,529,320
1.4.1	SO TEST & STARTUP	4,036,000	1,493,320	5,529,320
1.5.2	PROCUREMENT FEES	0	0	>> \$0
SUBTOTAL INCLUDING ESCALATION		13,520,665	1,992,647	>> \$15,513,312
PROJECT CONTINGENCY				
MANAGEMENT RESERVE				>> \$0
CONTINGENCY				>> \$6,486,688
TOTAL ESTIMATED COST				>> \$22,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= 22.00%

CONTINGENCY= 41.81%

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 25350

PREPARED BY: R. D. ADAMS

DATE 13-Sep-1999

TIME: 15:05:21

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.1.1	CONCEPTUAL DESIGN											
	DESIGN @ 10% OF TCC	1	LOT		LMITCO	0.000		1,615,000				1,615,000
	CONCEPTUAL DESIGN S/T						0	\$1,615,000				\$1,615,000
1.2.1	PROJECT MANAGEMENT & PROCESS DEVELOPMENT											
	ACDC/SOW, CPDS, PEP, DC/SOW & REVIEWS @ 5% OF TCC	1	LOT		LMITCO	0.000		807,500				807,500
	PSAR & SAR	1	LOT		LMITCO	0.000		2,000,000				2,000,000
	PILOT PLANT & PROCESS DEVELOPMENT	1	LOT			0.000		3,000,000				3,000,000
	PROJECT MANAGEMENT & PROCESS DEVELOPMENT S/T						0	\$5,807,500				\$5,807,500
1.3.1	PERMITTING											
	HWMA/RCRA PERMIT	1	LOT		Z-4170	5000.00	5,000	364,800				364,800
	PERMIT TO CONSTRUCT	1	LOT		Z-4170	500.000	500	36,480				36,480
	CWA, STORM WATER, HISTORICAL, OTHER REG. COMPLIANCE	1	LOT		Z-4170	100.000	100	7,296				7,296
	P.E. CERTIFICATION	1	LOT			0.000					10,000	10,000
	HEALTH & SAFETY ISSUES	1	LOT			0.000					500,000	500,000
	QUALITY REVIEWS	1	LOT			0.000					300,000	300,000
	AIR PERMITTING	1	LOT		LMITCO	0.000					30,000	30,000

PROJECT NAME: BIN SET #1 RETRIEVAL AND TRANSFER

FEASIBILITY STUDY - OPC

LOCATION 1: INEEL/INTEC

REQUESTOR: D. A. LOPEZ

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning

PROJECT NO.: 25350

PREPARED BY: R. D. ADAMS

PAGE # 2

DATE 13-Sep-1999

TIME: 15:05:21

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MAT'L	S/C (OTHER 1)	TOTAL COST
1.3.1	PERMITTING AIR MONITORS	6	EA			0.000					720,000	720,000
	AIR MONITORING ACTIVITIES	60	MO		Z-1732	2.000	120	5,221				5,221
	AIR MONITORING LAB FEES	20	EA			0.000					40,000	40,000
	REGULATORY AFFAIRS OVERSITE	5	YR		Z-1700 LIMITCO	150.000	750	48,368				48,368
	PERMITTING S/T						6,470	\$462,165			\$1,600,000	\$2,062,165
1.4.1	SO TEST & STARTUP											
	ORR	1	LOT			0.000		1,000,000				1,000,000
	SO TEST & TRAINING @ 3% OF TEC	1	LOT		LIMITCO	0.000		1,518,000				1,518,000
	SO TEST & STARTUP S/T						0	\$2,518,000				\$2,518,000
1.4.1.1	PROJECT SUPPORT SUPPORT DURING DESIGN, CONSTRUCTION & STARTUP @ 3% OF TEC	1	LOT		LIMITCO	0.000		1,518,000				1,518,000
	PROJECT SUPPORT S/T						0	\$1,518,000				\$1,518,000
	PROJECT SUBTOTAL						6,470	\$11,920,665	\$0	\$0	\$1,600,000	\$13,520,665

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

 PROJECT NAME: **BIN SET #1 RETRIEVAL AND TRANSFER**
FEASIBILITY STUDY - OPC

 LOCATION 1: **INEEL/INTEC**

 REQUESTOR: **D. A. LOPEZ**
CONTINGENCY ANALYSIS

 TYPE OF ESTIMATE: **Planning**
 PROJECT NO: **25350**
 PREPARED BY: **R. D. ADAMS**

 DATE: **13-Sep-1999**
 TIME: **15:06:17**

 REPORT NAME: **Contingency Analysis**

PROBABLE % VARIATION									PROJECT CONTINGENCY		SUMMARY
WBS Element	Cost Estimate Element	Total Cost w/o Contingency	% Total Cost	Prob. % Var. From Est.		Wt. % of Prob.		Contingency	%	Cost	Total Cost by Element
				-	+	-	+				
1.1.1	CONCEPTUAL DESIGN	1,615,000	10.41	10	40	1.04	4.16	3.644%	8.69%	563,991	2,178,991
1.2.1	PROJECT MANAGEMENT & PROCESS	5,807,500	37.44	10	50	3.74	18.72	16.472%	39.31%	2,549,610	8,357,110
1.3.1	PERMITTING	2,062,165	13.29	10	50	1.33	6.65	5.849%	13.96%	905,332	2,967,497
1.4.1	SO TEST & STARTUP	4,036,000	26.02	10	50	2.60	13.01	11.447%	27.32%	1,771,886	5,807,886
1.5.2	PROCUREMENT FEES	0	0.00	10	40	0.00	0.00	0.000%	0.00%	0	0
	ESCALATION	1,992,647	12.84	10	40	1.28	5.14	4.496%	10.73%	695,869	2,688,516
SUBTOTAL		15,513,312	100.00					41.907%			
CALCULATED CONTINGENCY		6,501,169									
RESULTANT TEC		22,014,481									
ROUNDED TEC		22,000,000									
PROJECT CONTINGENCY		6,486,688						41.81%			
MANAGEMENT RESERVE		0									
CONTINGENCY		6,486,688									
TOTAL ESTIMATED COST		22,000,000								6,486,688	22,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:

The Lockheed Idaho Technologies Co. Cost Estimate Contingency Analysis Model is based on the applied contingency and the assumptions upon which the estimate was predicated. The model is applied with a suggested risk level of 18% and a level of confidence of 90% the estimate will fall within the bid range. The Contingency Analysis is based on a weighted average to provide a 90 % probability of underrun and a 10% probability of overrun.

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PLANNING 20% - 30%
 Experimental/Special Conditions.....Up to 50%
 Conceptual 15% - 25%
 Experimental/Special Conditions.....Up to 40%

TITLE I 10% - 20%
 TITLE II 5% - 15%
 TITLE II/AFC Market Conditions

Lockheed Martin Idaho Technologies Company
INTERDEPARTMENTAL COMMUNICATION

Date: September 22, 1999

To: D. A. Lopez MS 3765 6-9020

From: R. J. Turk *RJ Turk* MS 3875 6-3611

Subject: ECONOMIC AND LIFE CYCLE ANALYSIS CONDUCTED for Calcine
Transfer from Bin Set 1 To Bin Set 6- RJT-17-99 Rev1

Purpose:

As requested an Economic and Life-Cycle Cost (LCC) has been conducted to evaluate the proposed Calcine Transfer from Bin Set 1 To Bin Set 6 at ICPP.

This economic analysis is based on information provided by D. A. Lopez and based on a previous study with input by J. J. Quigley, and T. G. McDonald. Cost estimate provided by R. D. Adams

Methodology:

The Economic Evaluation assumed a maximum 35-year period, (2001-2035) since this is the estimated time required to complete all of the anticipated calcine transfer from Bin Set 1 To Bin Set 6. The LCC is identified by evaluating the initial development, construction, operating and post operating costs over the life-cycle. A discounted LCC analysis assumes a current dollar basis, discounted to 1999 using a 5.0% annual discount rate per the Office of Management and Budget (OMB) Circular A-94. All costs are conservatively discounted assuming the end-of-year convention.

Assumptions:

The scope of work and requirements of all related activities are vague at this time. Facility and processing costs are taken from reference cost estimates of similar scope; All costs are assumed to be reasonable for the purpose of the estimate and reflect historical experience associated with work at the INEEL.

D. A. Lopez
September 22, 1999
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The LCC analysis has been generated to match the division provided by cost estimating. These costs include Permitting, Direct and Indirect Construction, G&A, Performance Incentive Fee (PIF), Procurement fee, Engineering, Inspection, Project Management, Construction Management, Escalation and Contingency costs. DD&D costs reflect only the new capital closure and the final bin set closure is captured by another study.

Monitoring will be required after closure, the analysis assumed CERCLA would provide this service at no cost.

Results:

The discounted LCC for Calcine Transfer from Bin Set 1 To Bin Set 6 is \$ 73.4 million

(LCC reported in 1999 discounted dollars)

Attachments:

cc: R. J. Turk File

Bin Set #1 Retrieval and Transfer Feasibility Study
Calcine transfer from Bin Set 1 To Bin Set 8

fiscal year
counting year
Escalation Factor

			1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
			0	1	2	3	4	5	6	7	8	9
			1.000	1.024	1.053	1.082	1.112	1.144	1.176	1.209	1.242	1.277
(ALL COST \$1000)												
Other Project Cost (OPC)												
OPC unescalated												
Conceptual Design, Project Mgt, & Permitting												
Testing and Start-up												
Total OPC (unescalated)			0	0	2,371	2,371	2,371	2,371	0	0	0	0
plus escalation of			0	0	349	349	349	349	0	0	0	0
plus management reserve of			0	0	0	0	0	0	0	0	0	0
plus contingency of			0	0	1,138	1,138	1,138	1,138	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency			0	0	3,858	3,858	3,858	3,858	0	0	0	0
Total Estimated Cost (TEC)												
TEC unescalated												
Title Design, Inspection							2,907	2,907		0	0	0
Project mgt							485	485	485	485	485	485
Construction Mgt									396	396	396	396
Construction, Equip, GSA & Procurement									3,877	3,877	3,877	3,877
Total TEC (unescalated)			0	0	0	0	3,392	3,392	4,760	4,760	4,760	4,760
plus escalation of			0	0	0	0	753	753	1,071	1,071	1,071	1,071
plus management reserve of			0	0	0	0	259	259	377	377	377	377
plus contingency of			0	0	0	0	1,188	1,188	1,647	1,647	1,647	1,647
Total TEC including escalation, mgt reserve, contingency			0	0	0	0	5,612	5,612	7,876	7,876	7,876	7,876
Total Project Cost (TPC)												
TPC unescalated			0	0	2,371	2,371	5,763	5,763	4,760	4,760	4,760	4,760
plus escalation of			0	0	349	349	1,113	1,113	1,071	1,071	1,071	1,071
plus management reserve of			0	0	0	0	259	259	377	377	377	377
plus contingency of			0	0	1,138	1,138	2,328	2,328	1,647	1,647	1,647	1,647
Total TPC including esc, mgt res, contingency			0	0	3,858	3,858	9,470	9,470	7,876	7,876	7,876	7,876
discount factor @ OMB discount rate of 5.00% for escalated costs			1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407	1.477	1.551
Discounted Annual Cost			\$0	\$0	\$3,600	\$3,333	\$7,781	\$7,420	\$5,877	\$5,597	\$5,330	\$5,076
Operations												
2000 hr-sh/yr.												
Facility/Administration												
Managers			0 FTE @	\$125 /hr.	0	0	0	0	0	0	0	0
Engineers			0 FTE @	\$100 /hr.	0	0	0	0	0	0	0	0
Other Tech.			2 FTE @	\$85 /hr.	0	0	0	0	0	0	0	0
Administration/Support			0 FTE @	\$65 /hr.	0	0	0	0	0	0	0	0
Operations/Process Facility			0		0	0	0	0	0	0	0	0
Managers			0.5 FTE @	\$125 /hr.	0	0	0	0	0	0	0	0
Engineers			2 FTE @	\$100 /hr.	0	0	0	0	0	0	0	0
Other Tech.			2 FTE @	\$85 /hr.	0	0	0	0	0	0	0	0
Supervisors			4 FTE @	\$85 /hr.	0	0	0	0	0	0	0	0
Administration/Support			2 FTE @	\$65 /hr.	0	0	0	0	0	0	0	0
Operations			8 FTE @	\$65 /hr.	0	0	0	0	0	0	0	0
Maintenance			8 FTE @	\$65 /hr.	0	0	0	0	0	0	0	0
Maintenance			0.00% unescalated const.		0	0	0	0	0	0	0	0
Stored Liquid Waste Project Management			32.99%	\$384 \$/yr	0	0	0	0	0	0	0	0
Waste Transfer			67.01%	\$780 \$/yr	0	0	0	0	0	0	0	0
Utilities			6,450,000 kWh/yr	\$0.08 \$/kWh	0	0	0	0	0	0	0	0
STREAM			13,250,000 b/yr	\$0.02 \$/b	0	0	0	0	0	0	0	0
Analytical Lab			\$4,000 K\$/yr		0	0	0	0	0	0	0	0
Consumables					0	0	0	0	0	0	0	0
Monitoring			\$10 K\$/yr		0	0	0	0	0	0	0	0
Operations subtotal (unescalated)					0	0	0	0	0	0	0	0
plus Escalation					0	0	0	0	0	0	0	0
plus Operations Contingency @ 30.0%					0	0	0	0	0	0	0	0
Total Operations (w/ escalation & contingency)					0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of 5.00% for escalated costs					1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407
Discounted Annual Cost					\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Post Operations												
Decommission			10.00% of unescalated const.		0	0	0	0	0	0	0	0
Decontamination			2.50% of unescalated const.		0	0	0	0	0	0	0	0
Demolition			4.00% of unescalated const.		0	0	0	0	0	0	0	0
Post-Operations Subtotal (unescalated)					0	0	0	0	0	0	0	0
plus Escalation					0	0	0	0	0	0	0	0
plus Post-Operations Contingency @ 30.0%					0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)					0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of 5.00% for escalated costs					1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407
Discounted Annual Cost					\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Cost (unescalated)												
Cumulative Total LCC (unescalated)					0	0	2,371	2,371	5,763	4,760	4,760	4,760
Total Cost (w/ escalation, mgt reserve, & contingency)					0	0	2,371	4,742	10,506	16,249	21,029	25,789
Cumulative Total LCC (escalated)					0	0	3,858	3,858	9,470	7,876	7,876	7,876
discount factor @ OMB discount rate of 5.00% for escalated costs					1.000	1.050	1.103	1.158	1.216	1.276	1.340	1.407
Discounted Annual Cost					\$0	\$0	\$3,600	\$3,333	\$7,781	\$7,420	\$5,877	\$5,597
Cumulative Discounted LCC					0	0	3,600	\$6,32	15,824	22,044	27,921	33,517

Bin Set #1 Retrieval and Transfer Feasibility Study				iscal year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Calcine transfer from Bin Set 1 To Bin Set 6				counting year	10	11	12	13	14	15	16	17	18	19
(ALL COST \$1000)				Escalation Factor	1.313	1.350	1.387	1.426	1.466	1.507	1.550	1.593	1.630	1.683
Other Project Cost (OPC)														
OPC unescalated														
Conceptual Design, Project Mgt, & Permitting														
Testing and Start-up					1,605	2,431								
Total OPC (unescalated)					1,605	2,431	0	0	0	0	0	0	0	0
plus escalation of					234	358	0	0	0	0	0	0	0	0
plus management reserve of					0	0	0	0	0	0	0	0	0	0
plus contingency of					770	1,164	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency					2,611	3,955	0	0	0	0	0	0	0	0
Total Estimated Cost (TEC)														
TEC unescalated					0									
TRC Design, Inspection														
Project mgt					485									
Construction Mgt					398									
Construction, Equip, GSA & Procurement					3,977									
Total TEC (unescalated)					4,760	0	0	0	0	0	0	0	0	0
plus escalation of					1,071	0	0	0	0	0	0	0	0	0
plus management reserve of					377	0	0	0	0	0	0	0	0	0
plus contingency of					1,667	0	0	0	0	0	0	0	0	0
Total TEC including escalation, mgt reserve, contingency					7,875	0	0	0	0	0	0	0	0	0
Total Project Cost (TPC)														
TPC unescalated					6,365	2,431	0	0	0	0	0	0	0	0
plus escalation of					1,307	358	0	0	0	0	0	0	0	0
plus management reserve of					377	0	0	0	0	0	0	0	0	0
plus contingency of					2,437	1,164	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency					10,486	3,955	0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of				5.00%	1.629	1.710	1.796	1.886	1.980	2.079	2.183	2.292	2.407	2.527
Discounted Annual Cost					\$6,435	\$2,313	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Operations				2000 hr-ship/yr.										
Facility/Administration				2										
Managers				0 FTE @ \$125 /hr.	0	0	0	0	0	0	0	0	0	0
Engineers				0 FTE @ \$106 /hr.	0	0	0	0	0	0	0	0	0	0
Other Tech.				2 FTE @ \$85 /hr.	88	177	354	0	0	0	0	0	0	0
Administration/Support				0 FTE @ \$65 /hr.	0	0	0	0	0	0	0	0	0	0
Operations/Process Facility				27	0	0	0	0	0	0	0	0	0	0
Managers				0.5 FTE @ \$125 /hr.	33	65	130	0	0	0	0	0	0	0
Engineers				2 FTE @ \$106 /hr.	112	225	449	0	0	0	0	0	0	0
Other Tech.				2 FTE @ \$85 /hr.	88	177	354	0	0	0	0	0	0	0
Supervisors				4 FTE @ \$65 /hr.	177	354	707	0	0	0	0	0	0	0
Administration/Support				2 FTE @ \$65 /hr.	68	135	270	0	0	0	0	0	0	0
Operators				8 FTE @ \$65 /hr.	270	541	1,082	0	0	0	0	0	0	0
Maintenance				8 FTE @ \$65 /hr.	270	541	1,082	0	0	0	0	0	0	0
Maintenance				8.00% unescalated const.	210	420	841	0	0	0	0	0	0	0
Stored Liquid Waste Project Management				32.99% \$184 \$/yr	32	63	127	0	0	0	0	0	0	0
Waste Transfer				87.01% \$780 \$/yr	131	261	523	0	0	0	0	0	0	0
Utilities				6,450,000 kWh/yr \$0.08 \$/kWh	134	267	535	0	0	0	0	0	0	0
STEAM				13,260,000 Btu/yr \$0.02 \$/Btu	50	99	199	0	0	0	0	0	0	0
Analytical Lab				\$4,000 \$/yr	1,000	2,000	4,000	0	0	0	0	0	0	0
Consumables					75	150	300	0	0	0	0	0	0	0
Monitoring				\$10 \$/yr	0	10	10	10	10	10	10	10	10	10
Operations subtotal (unescalated)					2,739	6,485	10,961	10	10	10	10	10	10	10
plus Escalation					857	1,910	4,247	4	5	5	5	5	5	5
plus Operations Contingency @ 30.0%					1,078	2,221	4,562	4	5	5	5	5	5	5
Total Operations (w/ escalation & contingency)					4,673	9,625	19,770	19	19	20	20	21	21	22
discount factor @ OMB discount rate of				5.00%	1.629	1.710	1.796	1.886	1.980	2.079	2.183	2.292	2.407	2.527
Discounted Annual Cost					\$2,869	\$5,627	\$11,009	\$10	\$10	\$9	\$9	\$9	\$9	\$9
Post Operations														
Decommission				10.00% of unescalated const.										
Decontamination				2.50% of unescalated const.										
Demolition				4.00% of unescalated const.										
Post-Operations Subtotal (unescalated)					0	0	0	0	0	0	0	0	0	0
plus Escalation					0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @ 30.0%					0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)					0	0	0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of				5.00%	1.629	1.710	1.796	1.886	1.980	2.079	2.183	2.292	2.407	2.527
Discounted Annual Cost					\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Cost (unescalated)					9,102	7,917	10,961	10	10	10	10	10	10	10
Cumulative Total LCC (unescalated)					44,412	52,329	63,290	63,300	63,310	63,320	63,330	63,340	63,350	63,360
Total Cost (w/ escalation, mgt reserve, & contingency)					15,159	13,581	19,770	19	19	20	20	21	21	22
Cumulative Total LCC (escalated)					73,317	86,897	106,659	106,656	106,705	106,725	106,745	106,765	106,787	106,809
discount factor @ OMB discount rate of				5.00%	1.629	1.710	1.796	1.886	1.980	2.079	2.183	2.292	2.407	2.527
Discounted Annual Cost					\$5,306	\$7,940	\$11,009	\$10	\$10	\$9	\$9	\$9	\$9	\$9
Cumulative Discounted LCC					\$5,230	\$1,170	\$2,179	\$2,189	\$2,199	\$2,208	\$2,217	\$2,227	\$2,235	\$2,244

Bin Set #1 Retrieval and Transfer Feasibility Study
Calcine transfer from Bin Set 1 To Bin Set 6

fiscal year
counting year
Escalation Factor

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
	20	21	22	23	24	25	26	27	28	29
(ALL COST X1000)	1.730	1.779	1.829	1.880	1.933	1.987	2.042	2.100	2.158	2.219
Other Project Cost (OPC)										
OPC unescalated										
Conceptual Design, Project Mgt, & Permitting										
Testing and Start-Up										
Total OPC (unescalated)	0	0	0	0	0	0	0	0	0	0
plus escalation of	0	0	0	0	0	0	0	0	0	0
plus management reserve of	0	0	0	0	0	0	0	0	0	0
plus contingency of	0	0	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency	0	0	0	0	0	0	0	0	0	0
Total Estimated Cost (TEC)										
TEC unescalated										
Title Design, Inspection										
Project mgt										
Construction Mgt										
Construction, Equip, O&A & Procurement										
Total TEC (unescalated)	0	0	0	0	0	0	0	0	0	0
plus escalation of	0	0	0	0	0	0	0	0	0	0
plus management reserve of	0	0	0	0	0	0	0	0	0	0
plus contingency of	0	0	0	0	0	0	0	0	0	0
Total TEC including escalation, mgt reserve, contingency	0	0	0	0	0	0	0	0	0	0
Total Project Cost (TPC)										
TPC unescalated	0	0	0	0	0	0	0	0	0	0
plus escalation of	0	0	0	0	0	0	0	0	0	0
plus management reserve of	0	0	0	0	0	0	0	0	0	0
plus contingency of	0	0	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency	0	0	0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of	5.00%	for escalated costs								
Discounted Annual Cost	2,653	2,786	2,926	3,072	3,225	3,386	3,556	3,733	3,920	4,116
	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Operations 2080 hr-shr/yr.										
Facility/Administration										
Managers	0 FTE @ \$120 /hr.	0	0	0	0	0	0	0	0	0
Engineers	0 FTE @ \$108 /hr.	0	0	0	0	0	0	0	0	0
Other Tech.	2 FTE @ \$85 /hr.	0	0	0	0	0	0	0	0	0
Administration/Support	0 FTE @ \$65 /hr.	0	0	0	0	0	0	0	0	0
Operations/Process Facility										
Managers	0.5 FTE @ \$120 /hr.	0	0	0	0	0	0	0	0	0
Engineers	2 FTE @ \$108 /hr.	0	0	0	0	0	0	0	0	0
Other Tech.	2 FTE @ \$85 /hr.	0	0	0	0	0	0	0	0	0
Supervisors	4 FTE @ \$85 /hr.	0	0	0	0	0	0	0	0	0
Administration/Support	2 FTE @ \$65 /hr.	0	0	0	0	0	0	0	0	0
Operators	8 FTE @ \$65 /hr.	0	0	0	0	0	0	0	0	0
Maintenance	8 FTE @ \$65 /hr.	0	0	0	0	0	0	0	0	0
Maintenance	8.00% unescalated const.	0	0	0	0	0	0	0	0	0
Stored Liquid Waste Project Management	32.99% \$384 /yr	0	0	0	0	0	0	0	0	0
Waste Transfer	67.01% \$780 /yr	0	0	0	0	0	0	0	0	0
Utilities	6,450,000 kWh/yr \$0.08 \$480 /yr	0	0	0	0	0	0	0	0	0
STEAM	13,250,000 kWh/yr \$0.02 \$265 /yr	0	0	0	0	0	0	0	0	0
Analytical Lab	\$4,000 /yr	0	0	0	0	0	0	0	0	0
Consumables	\$10 /yr	0	0	0	0	0	0	0	0	0
Monitoring	\$10 /yr	10	10	10	10	10	10	10	10	10
Operations subtotal (unescalated)		10	10	10	10	10	10	10	10	10
plus Escalation		7	8	9	9	10	10	11	12	12
plus Operations Contingency @ 30.0%		6	6	6	6	6	6	6	6	7
Total Operations (w/ escalation & contingency)		23	24	25	26	26	27	27	28	29
discount factor @ OMB discount rate of	5.00%	for escalated costs								
Discounted Annual Cost	2,653	2,786	2,926	3,072	3,225	3,386	3,556	3,733	3,920	4,116
	\$0	\$0	\$0	\$0	\$0	\$0	\$7	\$7	\$7	\$7
Post Operations										
Decommission	10.00% of unescalated const.									
Decontamination	2.50% of unescalated const.									
Demo/Relocation	4.00% of unescalated const.									
Post-Operations Subtotal (unescalated)		0	0	0	0	0	0	0	0	0
plus Escalation		0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @ 30.0%		0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)		0	0	0	0	0	0	0	0	0
discount factor @ OMB discount rate of	5.00%	for escalated costs								
Discounted Annual Cost	2,653	2,786	2,926	3,072	3,225	3,386	3,556	3,733	3,920	4,116
	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Cost (unescalated)	10	10	10	10	10	10	10	10	10	10
Cumulative Total LCC (unescalated)	63,370	63,390	63,390	63,400	63,410	63,420	63,430	63,440	63,450	63,460
Total Cost (w/ escalation, mgt reserve, & contingency)	22	23	24	24	25	26	27	27	28	29
Cumulative Total LCC (escalated)	106,831	106,856	106,878	106,903	106,928	106,954	106,980	107,008	107,036	107,065
discount factor @ OMB discount rate of	5.00%	for escalated costs								
Discounted Annual Cost	2,653	2,786	2,926	3,072	3,225	3,386	3,556	3,733	3,920	4,116
	\$0	\$0	\$0	\$0	\$0	\$0	\$7	\$7	\$7	\$7
Cumulative Discounted LCC	72,292	72,261	72,269	72,277	72,285	72,292	72,300	72,307	72,314	72,321

Blk Bid #1 Retrieval and Transfer Feasibility Study

Cash transfer from Blk bid 1 to Blk bid 4

	2020	2030	2031	2032	2033	2034	2035	Total
Blk Bid #1 Retrieval and Transfer Feasibility Study	2,281	2,345	2,410	2,418	2,547	2,610	2,682	
Cash transfer from Blk bid 1 to Blk bid 4								
Other Project Cost (OPC)								
Conceptual Design, Project Mgt, & Permitting								9,455
Construction Escalation								4,010
Total OPC Unescalated								13,321
plus escalation of								1,993
plus management reserve of								0
plus contingency of								0
Total OPC including escalation, mgt reserve, & contingency								21,000
Total Estimated Cost (TEC)								
TEC Unescalated								5,614
plus escalation of								3,307
plus management reserve of								1,988
plus contingency of								10,386
Total TEC including escalation, mgt reserve, & contingency								30,985
Total Project Cost (TPC)								
TPC Unescalated								2,631
plus escalation of								2,423
plus management reserve of								10,711
plus contingency of								50,000
Total TPC including escalation, mgt reserve, & contingency								44,105
Total TPC Including Escalation, Mgt Reserve, & Contingency								
Discount factor @ 5.00% discount rate of	4,332	4,538	4,765	5,003	5,253	5,510	5,782	17,198
Discounted Annual Cost								72,800
Operations								
Facility Administration								
Engineers								
Other Tech.								
Administration/Support								
Operational/Process Facility								
Managers								
Other Tech.								
Supervisors								
Administration/Support								
Operators								
Maintenance								
Waste Transfer								
Utilities								
Available Lab								
Consumables								
Monitoring								
Operations Subtotal (Unescalated)								
plus escalation of								
plus management reserve of								
plus contingency of								
Total Operations including escalation, mgt reserve, & contingency								
Discount factor @ 5.00% discount rate of	4,332	4,538	4,765	5,003	5,253	5,510	5,782	17,198
Discounted Annual Cost								
Post Operations								
Decommission								
Demolition								
Post-Operations Subtotal (Unescalated)								
plus escalation of								
plus management reserve of								
plus contingency of								
Total Post Operations including escalation, mgt reserve, & contingency								
Discount factor @ 5.00% discount rate of	4,332	4,538	4,765	5,003	5,253	5,510	5,782	17,198
Discounted Annual Cost								
Total Cost (Unescalated)								
Cumulative Total LCC (Unescalated)								
Total Cost (including escalation, mgt reserve, & contingency)								
Cumulative Total LCC (including escalation, mgt reserve, & contingency)								
Discount factor @ 5.00% discount rate of	4,332	4,538	4,765	5,003	5,253	5,510	5,782	17,198
Discounted Annual Cost								
Cumulative Discounted LCC								

Appendix B

Project Schedule

BIN SET #1 RETRIEVAL AND TRANSFER

Default

Complete

Complete Milestone

Remaining

Remaining Milestone

Free Float

Total Float (+)

Total Float (-)

Delay

Non-Resource

Baseline 1

Critical

Remaining

Remaining Milestone

Parent

Remaining

Remaining Milestone

Appendix C

Bin Set 1 Demolition to the (-)4 Ft-11 in. Level

1 General Description

This section is taken relatively verbatim from Section 4 of Reference 1. Demolition sketches from the Appendix in Reference 1 are also included. This section constitutes the work activities required demolish Bin Set 1 to the (-) 4 ft-11 in. level.

2 Design Requirements

The following design requirements were established as the basis for the developing this alternative:

- The demolition will facilitate interface with the (future) pneumatic transport system.
- The demolition shall minimize worker radiation exposure, and minimize spread of contamination.
- Results LMITCO development described in "Retrieval of ICPP Calcine, Status of Development Work" for calcine retrieval (use 20 riser penetrations) shall be incorporated in the design.
- The existing instrumentation for monitoring the bin set for temperature and emissions release must remain operational except for short periods during demolition (i.e.; CAMS and thermocouples).
- The VGA line shall remain operational except during short periods during demolition. HEPA filters installed in the line for Bin Sets 1,2 and 3 shall allow the bins to equalize pressure with ambient conditions. The vented lines do not have to be tied back into the plant stack system.
- The existing sump shall remain operational except during short periods during demolition.
- Generation of hazardous and radioactive waste shall be minimized.
- Installed equipment shall be decontaminable and/or capable of being replaced safely and easily.
- The condition of the cyclone vault room shall be as presented on the July 1994 remote cyclone room entry video along with the radiation level readings. The visual observations indicated minor dusting, no major contamination is present in the cyclone room.

3 Key Assumptions

The following key assumptions are applicable to this alternative.

- All of the fill to be removed down to (-) 4 ft-11 in. is considered to be contaminated.
- The soil density required to determine the weight of the removed soil and gravel is 135 lb/ft³.
- The inlet air vent foundations do not require removal because: the foundations do not appear to interfere with core drilling, potential personnel exposure is minimized, the vent pipes can be integrated with the HEPA ventilation system to maintain a negative pressure on the vault during retrieval.

- The stack foundation does not interfere with the core drilling operation, and does not require removal.
- Remote or shielded mobile equipment will be required to remove soil and gravel.
- A HEPA filter will be mounted in the ventilation exhaust room and probably contains asbestos.
- All ductwork downstream of the HEPA filter in the ventilation exhaust room is clean.
- The 2 x 4 x 8-ft plywood boxes to be used to package waste costs \$400 each and can hold a maximum of 4,500 pounds (Note: the Waste Acceptance Criteria allows maximum of 12,000 pounds in the box).
- The retaining wall location is based on information obtained from the utility drawings regarding the locations of the VGA line, ductbanks, and calcine transport and retrieval lines.
- The cyclone is relatively clean of any calcine.
- The calcine transport piping has radiation levels of 5 R gamma and 30 R beta.
- The existing corrugated metal building siding is asbestos cement sheathing.
- The instrumentation used to monitor the bin set is presently operational and will only require panel relocation and rewiring during construction.
- The internal surfaces of the lead brick is contaminated.
- Temporary shielding will be required in areas of the cyclone room where streaming is occurring around the penetrations into the vault roof. Shielding will also required when removing the calcine transport and return piping.
- Equipment to cut piping remotely, or manually with appropriate shielding, will be developed and available for use before construction begins.
- Existing remote technology will be used to vacuum debris on the cyclone and ventilation Room floors and remove large objects which can not be picked up by the vacuum system.
- The condensate receiver can be temporarily rigged up to the overhead piping to allow for the placement of a 15-in.-thick concrete slab in the cyclone vault room.
- The bins or piping in the vault is not breached, and the ventilation exhaust room is not contaminated.
- Core drilling equipment and riser penetrations do not interfere with the following:
 - Cooling air inlet foundations
 - Stack foundation
 - Hatch plugs

- Pipe connections and plugs
- Calcine distribution piping and downcomers
- Conduit and thermocouples
- Manways at the top of bins
- Vent offgas lines.

4 Demolition and Decontamination Work Activities

A feasible demolition and decontamination plan with sequence of work activities was conceived. The plan emphasizes safe cost effective construction methods, minimizes the generation of waste and remote operations, reduces radiation exposure to personnel to ALARA and minimizes negative impact to the environment. The work activities have been numbered and are used throughout this section of the report to describe the different aspects of each activity. Drawings have been prepared to show major steps grouped together in the demolition process. These drawings are included in this appendix.

The demolition and decontamination plan is divided into major work activities. The plan recognizes the importance of removing as much of the static earth load acting on the vault walls as soon as possible. Consequently, the first activity is the installation of retaining walls. The walls also serve to provide level working surfaces for the installation of a confinement enclosure and the demolition and decontamination activities identified herein. The plan is designed to systematically remove materials and equipment from the corrugated metal building to the top of the vault roof. The following is an itemized list of the activities to be performed to demolish the Bin Set 1 superstructure to the (-)4 ft-11 in. level.

- 101 Install the retaining walls (east and south of Bin Set 1)—The retaining walls relieve some of the static earth pressure loading on the vault walls. Earth removal will be accomplished in two steps: work activity 102 and 143.
- 102 Remove the earth in front of the installed retaining walls down to approximately (+)4 ft-4 in. elevation 4920 ft—This activity will be performed to relieve some of the stress on the vault walls and establish a level working surface for the installation of the confinement enclosure. The earth will be removed with the use of shielded mobile equipment or remote mobile equipment.
- 103 Remove the Cooling Air Stack (CPP-732)—The removal of the stack allows for the installation of the confinement enclosure. The stack will be installed on a new foundation when the weather enclosure is erected. A crane will be used to move the stack from its present foundation to a laydown area for installation on a new foundation as part of work activity 153.9.
- 104 Set up a confinement enclosure, approximately 50 × 50-ft, over both corrugated metal buildings, HEPA filter access hatch, Cyclone Vault Room hatch and ductwork from the Ventilation Exhaust Room to the large Corrugated Metal Building—The large confinement enclosure will be used to maintain confinement during activities 105 through 141.
- 105 Remove the small corrugated metal building over the HEPA filter access hatch (Note: Building is constructed of corrugated asbestos cement sheathing)—The building will be dismantled manually to gain access to the HEPA filter hatch cover.
- 106 Remove the ductwork from the Cooling Air Stack to the Solids Cooling Air Blower.

- 107 Remove the instrumentation and panel, exposed piping, and electrical terminal box in and around the large Corrugated Metal Building.
- 108 Remove the large corrugated metal building.
- 109 Remove the solids cooling air blower (WC-G-2901).
- 110 Remove the ductwork from the blower to the Ventilation Exhaust Room.
- 111 Install a plug over the ductwork penetration into the Ventilation Exhaust Room—The ventilation opening will be plugged to minimize the potential contamination and exposure to personnel within the confinement enclosure.
- 112 Remove the lead brick around the valve stems—All the potential obstructions near the shielding bricks will have been removed in the prior steps to provide easy access to them.
- 113 Remove the instrumentation, conduit, and piping behind the lead brick.
- 114 Plug penetrations into the Cyclone Vault Room roof and VGA line out of the corrugated metal building.
- 115 Remove the lead brick around the relief valves.
- 116 Remove the instrumentation, conduit, and piping behind the lead brick.
- 117 Plug penetrations into the Cyclone Vault Room.
- 118 Pull out the HEPA filter access hatch.
- 119 Remove the existing in-line solids cooling air outlet filter (F-2720-WC) (HEPA filter) in the ventilation exhaust room—It is assumed that the filter has not been contaminated. However, it will require special packaging and/or size reduction due to its overall dimensions, 5 ft-3 in. × 6 ft-9 in. × 2 ft-6 in.
- 120 Remotely vacuum the ventilation exhaust room floor—It is likely that the HEPA filter has deteriorated since its installation. The vacuuming of the floor will pick up any loose contamination that may be present. The concept for vacuuming will be the same as described in work activity 125.
- 121 Remotely install a concrete plug in the ventilation exhaust opening at (-)4 ft-11 in. elevation 4911.62 (The 21-in. thick plug, will also serve as the top of the finished floor elevation for riser installation)—Three methods for plugging the opening have been identified. In the first method, a concrete plug would be installed with the help of a jib crane and will be slid down a rail through the existing hatch that enables access to the HEPA filter, from floor elevation (+)4 ft-10 in. Since the opening for the ventilation exhaust and the hatch are slightly offset, and the hatch minimum opening, (1 ft-9 in. × 3 ft-5 in.), is smaller than the plug overall dimensions, (2 ft-8 in. × 5 ft-0 in.), the plug must be made in two parts. The second method is to install a steel form into the opening and then pump concrete into the form. The third method is to install a steel plug which may fit through the hatch opening due to the reduced thickness required for shielding. For this study, the first method of installing the concrete plug was selected.

- 122 Install a medium quality latex paint to the floor, walls, and ceiling of the ventilation exhaust room—The installation of a this latex coating will hold any loose contamination to the surfaces and keep it from being released when the roof and walls of the ventilation exhaust room are demolished.
- 123 Replace the HEPA filter access hatch.
- 124 Remove the cyclone vault room hatch.
- 125 Remotely vacuum the cyclone vault room floor—A video of the vault entry was conducted by WINCO on June 23, 1994. A very low amount of contamination was detected. However, there was debris in the form of dead mice and what appeared to be small pieces of spilled concrete. Although the fine particulate can be readily picked up with a remote controlled mobile robot with an attached vacuum hose, the larger objects will require the assistance of an articulated arm mounted on the robot to pick up the larger debris. The robot will be lowered into the room by a jib crane. A dry type vacuuming machine equipped with a HEPA filter system will be used for this operation. The cleaning operation will be monitored through the camera mounted on the robot and the remote control panel located above the cyclone room.
- 126 Remotely pour a concrete shielding floor in the cyclone Vault Room (6 -in. thick)—The addition of the concrete for shielding will reduce the radiation level within the room to perform work activities 127 and 128 at a dose rate of approximately 34 mrem/h.
- 127 Install temporary shielding and cut out and cap piping near floor (3/4-in. PSA-3081 and 3-in. PSA-3079)—Even though the dose rate will be reduced, piping penetrations through the cyclone room floor (vault roof) will allow streaming which in turn will require temporary shielding to work around. In addition, the calcine transport line and the lines that will be cut may require shielding. Remote techniques may be required to cut both PSA lines if the radiation levels are found to be excessive.
- 128 Cut out the Solid Storage Condensate Receiver (WC-121) and temporarily rig up to the overhead Piping—The receiver is mounted near the floor. To allow for the pour of an additional 15 in. of concrete in work activity 129, the receiver support base must be cut and the receiver raised up higher than the required concrete finished elevation. Even though the receiver inside diameter is only 24 in., versus the minimum hatch opening of 2 ft-6 in. × 4 ft-0 in., it was decided to remove the vessel as part of work activity 133. This decision was made based on the time and effort that would be required to remove the vessel due to the relative position of the vessel; approximately 13 ft away from the hatch, the weight of the vessel at over 200 lb and the tripping and head clearance hazards in between. It was assumed that existing piping would adequately support the vessel until activity 133 is completed.
- 129 Remove temporary shielding and pour a second concrete shielding floor in the cyclone vault room (15-in. thick)—The second pour of concrete will reduce the dose rate to 0.1 mrem/h through the floor. Dose rates higher than 0.1 mrem/h are likely from the calcine transport piping within the cyclone room.
- 130 Install a medium quality latex coating to the cyclone vault room walls, floor and ceiling—After the concrete has dried, a latex coating will be sprayed on the surfaces to hold any loose contamination to the surfaces and prevent additional releases from pipe and equipment during work activity 133 from contaminating the floor, walls, and ceiling.

- 131 Install temporary shielding and cut out the piping which penetrates the cyclone vault room floor and install ducts—Once the room has been prepared with temporary shielding, the pipes which penetrate the room floor (vault ceiling), will be remotely cut and plugged. This activity was positioned prior to the removal of the cyclone room roof so that any potential release would be contained within the room itself.
- 131.5 Install a temporary HEPA filter with shielding on top of the 3-in. VGA-3036 line just above the finished floor—One of the lines that penetrates the floor is the offgas line from all of the bins. The pipe is presently routed to the offgas scrubbing system and then to the stack at INTEC. To allow the bins to equalize pressure with the environment, a temporary HEPA filter will be installed. Once demolition has been completed, the permanent HEPA filter will be installed in work activity 153.7.
- 132 Remove the roof of the cyclone vault room—Some of the conduit that is mounted within the room is mounted on the roof. Also, piping penetrates the roof. Both must be disconnected prior to roof removal. The roof will be cut into sections that can be placed into the 2 × 4 × 8-ft plywood boxes.
- 133 Remove temporary shielding, piping, conduit, vessels, and structural support steel in the cyclone vault room and plug wall penetrations—The temporary shielding used to shield against streaming can be easily removed once the roof is removed. Shielding will most likely remain on the calcine transport line until it can be removed. The condenser (WC-121) that was hoisted off the floor prior to the pouring of the 15 in. concrete slab can now be removed and packaged. The remaining piping, conduit, in-line HEPA filter (F-2721-WC), Cyclone (WC-915), and offgas trap (WC-116) can now be removed. The offgas trap must be reduced in size since its inside diameter is 48 in. The condenser's inside diameter is 24 in. Depending on the availability of other container sizes, the condenser may also require size reduction.
- 135 Install a second coat of latex paint to the walls and floor of the cyclone vault room—The latex coating will be sprayed again on the surface within the cyclone room to hold any loose contamination to the surfaces and keep it from being released when the walls of the room are demolished.
- 136 Remove the roof of the ventilation exhaust room—The roof will be cut into pieces, such that it can be packaged into plywood boxes.
- 137 Remove the solids sample disposal valve box, valves, and soil around the box—The valve box is located near elevation (+)4 ft–10 in. The concrete enclosure is merely supported by the fill below it. The enclosure and valves will be removed prior to removing the earth down to elevation (–)4 ft–11 in.
- 138 Cap and plug the solids sample pipe just past the valves—The pipe will be capped and plugged to eliminate the chances of a release into the confinement enclosure. As the earth is being removed down to (–) 4 ft–11 in., streaming from the vault will probably require temporary shielding to be added around the pipe. The rest of the pipe will be removed in work activity 146.
- 139 Remotely remove the offgas vent piping, 3-in. VGA-3088, with 10-in. diameter containment and concrete encasement. Terminate near the wall of the confinement enclosure—The present VGA line routed to Bin Sets 2 and 3 allow the bins to vent to the INTEC stack through the Bin Set 1 pipe routing. The pipeline is installed at approximately (+)4 ft–10 in. The south wall of the

confinement enclosure will be near the retaining wall. A temporary HEPA will be mounted on the end of the pipe.

- 140 Remove the earth fill down to the ductbanks—The ductbanks are approximately 18 in. below grade. Removal of some fill will be required to gain access to the ductbanks.
- 141 Remove the ductbanks to Bin Set 1 and 3 and install temporary wiring—All the circuits will be disturbed during the demolition activities. The ductbanks will be exposed during earth removal. They will be severed to allow for earth removal. To accomplish this, all circuits must first be de-energized and removed. The ductbank cut toward CPP-633 should be made to allow for a pull cabinet to be installed. The thermocouple circuits from the bin set will be disconnected from the termination cabinet in CPP-639 and taped back for future reconnection. The cable pig tails will be sufficiently protected by wrapping a heavy plastic bag around them so they will not be damaged during demolition activities. A new termination cabinet will be installed (or the old one reinstalled if adequate) and the thermocouple circuits reterminated. A temporary thermocouple cable (type SO) will be run and routed overhead to avoid construction traffic.

The electrical ductbank to Bin Set 3 will also be disturbed. The ductbank will be severed in two places to facilitate the installation of the reinforcing wall. The ductbank should be reused if at all possible to avoid disturbing the soil around the bin sets to place a new ductbank. This can be accomplished by first de-energizing and removing the circuits in the ductbank, then installing pull boxes at both severed ends of the ductbank. Once the pull boxes have been installed and earth removal is completed, a new ductbank run can be made to connect the two pull boxes and the circuits can be reinstalled to restore service. For this study a new ductbank was included in the cost estimate. A temporary thermocouple cable (type SO) will be erected during construction. The building grounding cable may also be disturbed during earth removal. If it becomes exposed, it should be removed. A new grounding cable will be run around the building and stack below finish grade and reconnected to the plant ground grid before any electrical circuits are energized.

- 142 Decontaminate and remove the confinement enclosure (approximately 50 × 50-ft)—The enclosure will be dismantled to gain access to the earth fill which will then be removed down to (-)4 ft-11 in. The enclosure will be reinstalled in work activity 145. The mobile ventilation system used for the enclosure will remain available when the enclosure is erected again in work activity 145.
- 143 Remove the earth fill down to (-)4 ft-11 in. elevation 4911.62 (use shielded mobile equipment)—All of the earth fill is assumed to be contaminated and will be packaged. Removal of the fill will permit the continued demolition of the rest of the facility down to (-)4 ft-11 in. The fill removal is assumed to be accomplished in the open environment.
- 144 Install a 17-in.-thick concrete shielding slab on top of the bin set roof at (-)4 ft-11 in. elevation 4911.62—As the roof of the vault is exposed, precast concrete shielding will be raised by a crane and installed on top of the vault roof. Calculations indicate that the dose rate will be reduced to 0.1 mrem/h.
- 144.5 Install new ductbanks to Bin Set 1 and 3—After demolition is completed and a new structure has been erected, the circuits should be reinstalled to the pull cabinet at the end of the ductbank, then routed into a new ductbank (or above ground) to the new structure. A new thermocouple monitoring station will be installed when construction has been completed.

- 145 Install a confinement enclosure around Bin Set 1 at (-) 4 ft-11 in. elevation 4911.62 (approximately 50 × 50 ft)—The same confinement enclosure that is planned for the bin set working elevation at (+)4 ft-10 in., will be assembled again to provide confinement for the work activities through work activity 153.
- 145.5 Install a permanent HEPA filter at the end of the 3-in. VGA-3088 pipe line—Once the earth fill has been lowered to (-)4 ft-11 in., the permanent HEPA filter servicing Bin Sets 2 and 3 can be installed. The permanent HEPA provides for the equalization of bin pressure with ambient conditions as well as prevent the discharge of contamination to the environment.
- 146 Install temporary shielding and remotely remove the solids sample disposal system diving and plug the piping at (-)4 ft-11 in. elevation 4911.62, then remove shielding—The rest of the sample disposal piping will be removed down to the top of the shielding floor. Remote removal and plugging of the pipe will be required. Temporary shielding will be used to reduce the exposure of personnel.
- 147 Install temporary shielding and remotely remove and plug the concrete encased calcine lines, 3-in. TAA-3001 and 3-in. TAA-3009, from the cyclone vault room wall penetration down to (-)4 ft-11 in. elevation 4911.62, then remove shielding—The radiation values in the transport and return calcine lines are expected to be as high as 5 R gamma and 30 R beta.
- 148 Install temporary shielding and remotely remove and plug piping 3-in. PUA-3006 and 3/4-in. PSA-3081, (running inside of the 3-in. line), from the cyclone vault room wall penetration down to (-)4 ft-11 in. elevation 4911.62 then remove shielding—These lines are part of the offgas piping which is presently routed back to the INTEC stack. Once these lines are removed above (-)4 ft-11 in., the stubs will be capped.
- 149 Install temporary shielding and remotely remove and plug piping 1-in. HSA-3023 and 1-in. WRA-3009, then remove shielding—These two 1 in. lines are used for the sump pump. The lines will be removed down to the top of the shielding floor. They will be plugged to remove potential streaming. However, they will remain in service in the event that water is detected in the sump.
- 150 Remove and terminate the remaining non-radioactive piping, valves, conduit and wiring from the cyclone vault room down to (-)4 ft-11 in., elevation 4911.62—It is assumed that all of the nonradioactive piping, valves, conduit, and wiring will be manually removed and that shielding and remote equipment will not be required.
- 151 Demolish the walls of the cyclone vault room—The walls of the room will be demolished to establish level surface from which core drilling and future retrieval can be accomplished. The walls will be cut into pieces small enough to be placed into plywood boxes. Strippable coating placed on the walls in work activity 135, will remain to minimize the spread of contamination.
- 152 Demolish the walls of the ventilation exhaust room—The walls of the room will be demolished to establish a level surface from which core drilling and future retrieval can be accomplished. The walls will be cut into pieces small enough to be placed into plywood boxes. Strippable coating placed on the walls in work activity 122, will remain to minimize the spread of contamination.
- 153 Install strippable coatings on exposed concrete surfaces of the cyclone and ventilation room walls and on top of precast concrete floor shielding—Once strippable coating is placed on the cut

surfaces and the shield floor, the entire surface, approximately 30 × 30 ft will be ready for the installation of the permanent weather enclosure.

153.3 Decontaminate and remove the confinement enclosure (approximately 50 × 50 ft)

153.7 Replace the temporary HEPA filter on top of Bin Set 1 with a permanent one routed outside of the permanent weather enclosure—The temporary HEPA filter installed in work activity 131.5 will be removed and replaced with a permanent unit outdoors on the south side of the weather enclosure. Piping from the offgas piping will be routed to the south side of the building and encased in concrete.

5 Waste Generated

Nearly 6 million pounds and over 44,000 ft³ of waste were estimated to be generated. Approximately 92% of the waste weight, 5.5 million pounds or 41,000 ft³ (approx. 1,500 yd³), will be generated from removal of the contaminated earth fill.

The corrugated metal buildings and HEPA filters are suspected to contain asbestos. They constitute approximately 5,300 lb of steel and suspected asbestos material. Of this amount, approximately 2,500 lb is suspected to contain asbestos. The drawings reviewed indicated the piping was not insulated. Trace amounts of the asbestos may also be found in conduit installed in the 1950s.

The only mixed waste identified through the review of drawings was the lead bricks. They are presently being used to shield the relief valves and piping at two locations in the corrugated metal building. There are a total of 300 lead bricks which constitute nearly 7,900 lb, or 11 ft³.

Appendix D
Engineering Design Files

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

EDF

for

Environmental and Permitting Requirements for the Idaho
Nuclear Technology and Engineering Center (INTEC) Bin
Set 1 Calcine Transfer Project

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program
3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: Environmental and Permitting requirements for the Idaho Nuclear Technology and Engineering Center (INTEC) Bin Set 1 Calcine Transfer Project				
5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.				
<p>For high-level radioactive (mixed) waste storage facilities, both the primary and secondary confinement systems are required to maintain their integrity during normal operations, and at least one confinement system must retain its integrity during postulated accidents (per DOE Order 6430.1A Section 1324 and 40 CFR 265) to prevent release of the calcine to the environment. In 1989, a seismic analysis study was conducted. This study indicated that the Bin Set 1 structure would be overstressed by a Design Basis Seismic event. Bin Set 1 does not have primary and secondary confinement systems of the required structural integrity to safely withstand design loading as required by DOE Order 6430.1A, Section 1324.</p> <p>In order to place the calcine in Bin Set 1 in a safe and regulatory compliant configuration, the proposed action is to transfer the calcine from Bin Set 1 to Bin Set 6. This involves, demolition of Bin Set 1 superstructure to the top of the concrete vault, disposal of radioactive (and mixed) waste from demolition, construction of a temporary environmental/ weather enclosure over area, installation new vault vent exhaust system, placement of shielding slabs on the top of the concrete vault roof, core drilling of the vault roof slab and precast support beams, installation of risers to the bins through the core-drilled penetrations, cutting penetrations through the top of the bins inside the risers, construction of the calcine transfer system, transfer of calcine from Bin Set 1 to Bin Set 6, and disposal of calcine Bin Set 1 weather enclosure. Provided in this engineering design file are the directly applicable environmental regulations, DOE Orders, Federal Acts, and INEEL requirements governing the CSSF and the Bin Set 1 calcine transfer project.</p>				
6. Distribution (complete package): B. Helm, MS 3765; J. Jackson, MS 3428; V. Jacobson, MS 3211; D. Lopez, MS 3765; D. Lord, MS 3211; M. Spinti, MS 3650; Project File				
Distribution (summary package only):				
7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)				
	R/A	Printed Name	Signature	Date
Author Kelly J. Galloway	R	KELLY J. GALLOWAY	<i>Kelly J. Galloway</i>	4-28-99
Independent Verification Kirk Nielsen	R	Kirk Nielsen	<i>Kirk Nielsen</i>	4-28-99
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Requestor Daryl Lopez	A	Daryl Lopez	<i>Daryl Lopez</i>	4-29-99

1. Facility Description

Part of the Department of Energy's (DOE) new mission for the Idaho Nuclear Technology and Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL) includes receiving, storing, and managing spent nuclear fuel (SNF). In addition, INTEC manages radioactive and hazardous wastes generated from activities of reprocessing uranium from SNF and other plant activities in accordance with Federal, State, and local regulations.

Calcine at the INTEC facility is produced by calcining high-level liquid waste (HLLW), resulting from the reprocessing of spent nuclear fuel, in a fluidized-bed calciner. The fluidized-bed calciner converts the liquid waste to a mixture of fine solid particles. In its current form, the INTEC calcine is defined as high-level waste (HLW) in accordance with Appendix F, 10 CFR 50 and DOE 5820.2A. In addition, the calcine material is classified as mixed hazardous waste. Because the solid calcine waste is mixed waste that does not meet Land Disposal Restrictions (LDR) standards, further treatment is required to meet LDRs within the Resource Conservation and Recovery Act (RCRA) 40 Code of Federal Regulations (CFR) 268, Subpart D, for final disposal.

At the INTEC, calcine is stored in seven RCRA regulated units which comprise the Calcined Solids Storage Facility (CSSF). These units are called Bin Sets. Each of the seven calcine solid storage units or Bin Sets contain three to seven stainless steel storage vessels referred to as bins. These bins provide primary confinement to the stored calcine. The bins are enclosed in a reinforced concrete vault, which provides secondary confinement to the calcine stored in the bins.

Bin Set 1 was constructed from 1959 to 1963, and was placed into service in 1963. The structure is completely below ground and has a rectangular concrete vault. Bin Set 1 was the prototype facility for calcine storage at the INTEC and differs in design features from the latter bin sets, especially with regard to there being no provisions in place at Bin Set 1 to facilitate retrieval of the stored calcine. Bin Set 1 contains four calcine storage bins and is filled with approximately 7800 ft³ of alumina calcine produced by the Waste Calcining Facility (WCF). The WCF has been shutdown and the calcining operations have been conducted at the New Waste Calcining Facility (NWCF) since 1980.¹

2. Problem

Both the primary and secondary confinement systems are required to maintain their integrity during normal operations and at least one confinement system must retain its integrity during postulated accidents (per DOE Order 6430.1A Section 1324) to prevent release of the calcine to the environment. In 1989, a seismic analysis study was conducted. This study indicated that the Bin Set 1 structure would be overstressed by a Design Basis Seismic event.¹

The results of the augmented seismic analysis confirmed that the bin attachments in Bin Set 1 were severely overstressed, especially the attachment to the radial support beams. The magnitude of the overstress is sufficiently large to cause a loss of the bin structural integrity and a possible loss of the bin contents. In addition, the seismic analysis of the vault indicated significant overstress in the vault walls adjacent to the berms for Bin Sets 2 and 3, causing yielding of the wall reinforcing, excessive deflection and substantial cracking of the vault concrete walls. The static analysis of the vault also indicated overstress in the vault walls due to the earth pressure loading from the berms. Calcine solids are hygroscopic. If exposed to moisture by a breach of containment, the calcine physical properties will turn from particulate to cement like making it difficult to manage or remove.

As a result of the above postulated failure conditions for the bins and the vault on account of the Design Basis Seismic event, as well as due to the static earth pressure loading, the calcine stored in Bin Set 1 does not have primary and secondary confinement systems of the required structural integrity to safely withstand design loading as required by DOE Order 6430.1A, Section 1324.

3. Solution

In order to place the calcine in Bin Set 1 in a safe and regulatory compliant configuration, the proposed action is to transfer the calcine from Bin Set 1 to Bin Set 6. The planned steps in this process involve:¹

- Demolition of Bin Set 1 superstructure to the top of the concrete vault
- Dispose of radioactive (and mixed) waste from demolition
- Construct a temporary environmental/weather enclosure over area
 - HVAC room and shielded control room
- Install new vault vent exhaust system
- Place shielding slabs on the top of the concrete vault roof
- Core drill the vault roof slab and precast support beams (as necessary)
- Install and secure risers to the bins through the core-drilled penetrations
- Cut penetrations through the top of the bins inside the risers
- Construct calcine transfer system which includes:
 - New construction on top of Bin Set 6 to hold the new cyclone
 - A new facility to house the calcine transfer equipment at the base of Bin Set 6
 - A 650 ft at grade piping system to tie Bin Set 1 to Bin Set 6
 - Vacuum/air jet systems for removal of the calcine from Bin Set 1
 - Primary and secondary HVAC systems
- Transfer of calcine from Bin Set 1 to Bin Set 6
- Remove/dispose of calcine Bin Set 1 weather enclosure

4. Permit Status

Currently, the CSSF (comprised of the seven Bin Sets), is operating as an interim status waste management unit in the INEEL Part A Permit Application and is subject to the requirements of 40 CFR 265: Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subpart J, Tank Systems.²

The State of Idaho regulates the hazardous components stored at the CSSF through the Idaho Department of Health and Welfare (IDHW) Rules, Regulations, and Standards for Hazardous Waste, adopted pursuant to the Idaho Hazardous Waste Management Act of 1983 (HWMA). The IDHW Division of Environmental Quality's Hazardous Waste Permitting Bureau (HWPB) is the state organization with oversight of HWMA-regulated facilities. The HWMA incorporates the federal regulations of RCRA.³

A RCRA Part B Permit Application for the CSSF has not been submitted to the State of Idaho. The RCRA Part B Permitting analysis is awaiting the INEEL High-Level Waste and Facilities Disposition Environmental Impact Statement (EIS) and subsequent Record of Decision (ROD) to determine the appropriate actions for the CSSF. It is anticipated that the INEEL High-Level Waste and Facilities Disposition EIS will be released August 1999, and the ROD will follow in October 1999. In accordance with the Settlement Agreement between Governor E. Batt, the

Department of Energy, and the Department of Navy, October 1995, the RCRA Part B Permit Application for the CSSF is due by year 2012.

Modifications to the CSSF under interim status will require an INEEL document action request submitted to the INTEC facility for revising the facility documentation, including drawings. A revised Part A permit application with State of Idaho approval may be necessary prior to the modification. An Engineering Change Form, INEEL Form 431.37, will also be required. This form addresses the process for facility modifications and addresses affected documentation, including environmental documentation. See Attachment 1 for an example of form 431.37. Sections 6, 7, and 19 of this form specifically address affected environmental documentation. Form 435.29, RCRA Permit Modification Review, is included in Attachment 1. If the CSSF Part B Permit is acquired prior to the Bin Set 1 calcine transfer, then 40 CFR 264: TSD Facility Standards, Subpart J, Tank Systems, requirements will apply. In this case, it is anticipated that a class 2 or possibly a class 3 permit modification request in accordance with 40 CFR 270.42 would be required for State of Idaho review and approval.

5. Assumptions

1. RCRA Closure of Bin Set 1 is not within the scope of this project. The preparation and submission of closure and post-closure plans are required by 40 CFR 265.197, "Closure and Post-closure Care." The 40 CFR 265.197 in turn hands off to 40 CFR 265 Subparts G and H. Subparts G and H details the closure and post-closure activities and steps. The closure plan describes how the owner and operator will conduct cleanup, what cleanup levels will be attained, and how cleanup will be verified. This includes preparation of a post-closure plan, engineered cover, and long-term monitoring and maintenance.⁴
2. The CSSF, including Bin Set 1, currently does not have a State of Idaho approved closure plan meeting the requirements found in 40 CFR 265.197, Closure and Post-Closure Care. An approved closure plan will not be necessary prior to transferring the calcine from Bin Set 1 to Bin Set 6 if the transfer is considered part of operations. (An operator can initiate closure of an interim status unit prior to approval of the closure plan, though he/she does at the risk of the State of Idaho Administrator later rejecting the efforts undertaken, or worse, possibly receiving enforcement action. The CSSF Closure Plan will be developed after the INEEL High-Level Waste and Facilities Disposition EIS is released. A closure plan schedule will be negotiated with the State of Idaho.
3. The following Environmental Protection Agency (EPA) Hazardous Waste Numbers apply to the calcine waste in Bin Set 1:

EPA Characteristic Hazardous Waste Numbers (40 CFR 261, Subpart C-Characteristics of Hazardous Waste)

D002	Corrosivity (pH) (possibly won't apply to solid calcine)
D004	Arsenic
D005	Barium
D006	Cadmium
D007	Chromium (total)
D008	Lead
D009	Mercury
D010	Selenium
D011	Silver

Other applicable Characteristic Hazardous Waste Numbers

D018	Benzene
D019	Carbon Tetrachloride
D021	Chlorobenzene
D022	Chloroform
D026	Cresol
D028	1,2-Dichloroethane
D032	Hexachlorobenzene
D034	Hexachloroethane
D035	Methyl ethyl ketone
D036	Nitrobenzene
D038	Pyridine
D039	Tetrachloroethylene
D040	Trichloroethylene

Listed EPA Hazardous Waste Numbers
(40 CFR 261, Subpart D-Lists of Hazardous Waste^{4,5})

F001	Carbon tetrachloride, 1,1,1-Trichloroethane, Trichloroethylene
F002	Carbon tetrachloride, Tetrachloroethylene, 1,1,1-Trichloroethane, Trichloroethylene
F005	Benzene, Carbon disulfide, Pyridine, Toluene
U134	Hydrofluoric Acid

4. Treatment of the calcine waste for final disposal is outside the scope of this project. Treatment standards must however comply with Land Disposal Restrictions (LDR) requirements specified in LDR 40 CFR 268.
5. The retrieved calcine from Bin Set 1 will not have to be treated prior to being transferred into Bin Set 6.
6. The calcine in Bin Set 1 is similar in chemical composition and physical characteristics to the calcine located in Bin Set 6. (If possible, additional characterization, such as sampling and analysis of the Bin Set 1 calcine, for hazardous (RCRA regulated) constituents would be prudent prior to initiating calcine transfer to Bin Set 6. This would help identify possible constituent or treatment incompatibilities. Characterization of high level waste is required by DOE Order 5820.2A, 40 CFR 261, and 40 CFR 264. Sufficient characterization is subject to regulatory interpretation.)
7. Characterization of the calcine for RCRA regulated constituents will need to be completed prior to treatment and disposal. This will provide data for further evaluation of the calcine in the CSSF to support submittal of delisting petitions (as applicable) with the Environmental Protection Agency (EPA).

6. Applicable Regulations

Provided in this section are the directly applicable environmental regulations, DOE Orders, Federal Acts, and INEEL requirements governing the CSSF and the Bin Set 1 calcine transfer project. Table 1 provides a summary of the regulations and Orders and the specific compliance requirements.

6.1 DOE Orders

There are two primary DOE Orders that govern the storage, treatment, and disposal of high-level solid wastes. These DOE Orders are 5820.2A, Chapter 1, High-Level Waste and 6430.1A, Section 1324, Radioactive Solid Waste Facilities. The DOE Orders outlined in the 5400 series, establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable Federal, State and local environmental protection laws and regulations, Executive orders, and internal Department policies.

6.1.1 DOE Order 5820.2A, Chapter 1, High-Level Waste

DOE Order 5820.2A, Chapter 1, High-Level Waste, establishes the policies and guidelines for managing the DOE's high-level waste. All high-level waste generated by DOE operations shall be safely stored, treated, and disposed of according to requirements set forth in this Order. Designs for new storage (including new processing or waste handling systems) shall also meet the requirements of DOE 6430.1, applicable EM Orders and 40 CFR 264. Some of the specific requirements in 5820.2A, Chapter 1, related to the Bin Set 1 calcine transfer are summarized below:

- Solidified high-level waste shall be characterized consistent with radiation protection requirements to determine its hazardous components, per 40 CFR 261 and 40 CFR 264. Characterization shall satisfy requirements and may reflect knowledge of waste generating processes, laboratory testing results, and/or the results of periodic sampling and analysis. Examples of required information are chemical composition, physical properties, radionuclide concentrations, and pH.
- Waste characteristics and compatibility information shall be documented in a safety analysis report and be used as a basis for designing new facilities.
- All new high-level waste handling, transfer, and storage facilities (e.g., tanks, bins, pipelines, and capsules) shall be doubly contained.
- Secondary containment systems for solidified high-level waste shall provide for physical isolation of the waste from the environment.
- To the extent practical, waste shall be segregated by type (sludge, salt, high activity, and low activity) to make accessibility for future processing easier.
- Where required, ventilation and filtration systems shall be provided to maintain radionuclide releases within the guidelines specified in DOE 5480.23 and applicable EM Orders. Ventilation systems shall be provided where the possibility exists for generating flammable and explosive mixtures of gases (e.g., hydrogen/air or organic/air).
- Facilities using cathodic corrosion protection systems shall include engineered features that protect against abnormal conditions such as stray currents or system failure. The cathodic protection systems shall be calibrated annually, and all sources of impressed current shall be inspected and/or tested at least every other month.

- Nuclear criticality safety considerations and controls shall be evaluated for normal operations and, before any significant operational changes are made, to protect against an uncontrolled nuclear criticality incident.
- Each facility shall utilize remote maintenance features and other appropriate techniques to minimize personnel radiation exposure in accordance with DOE 5480.23.
- Upon loss and subsequent recovery of normal electrical power, high-level waste transfer equipment shall not have the capability to restart without active operator action.
- Monitoring and leak detection capability shall be incorporated in the engineering systems to provide rapid identification of failed containment, and measurement of abnormal temperatures. The following, at a minimum, shall be monitored; temperature; pressure; radioactivity in ventilation exhaust; and liquid effluent streams associated with high-level waste facilities. Where the possibility exists for the generation of flammable and explosive mixtures of gases, monitoring shall be conducted.
- Leak detection systems (e.g., conductivity probes) shall be designed and operated so that they will detect the failure of the primary containment boundary, the occurrence of waste release, or accumulated liquid in the secondary containment system.
- Electrical monitoring and leak detection devices essential to safe operations shall be provided with backup power, as appropriate, to ensure operability under emergency conditions.

6.1.2 DOE Order 6430.1A, Section 1300, Radioactive Solid Waste Facilities

The criteria in DOE Order 6430.1A, Section 1300, General Requirements, applies to all nonreactor nuclear facilities. This order provides the general guidance and design requirements associated with nonreactor nuclear facilities. It provides the directives to protect the public and facility personnel from hazards associated with the use of radioactive and other hazardous materials as a result of normal operations, anticipated operational occurrences, and Design Based Accident conditions, including the effects of natural phenomena pertinent to the site, and maintain these effects As Low As Reasonably Achievable (ALARA).

DOE Order 6430.1A, Section 1324, Radioactive Solid Waste Facilities, outlines the specific requirements for radioactive solid waste facilities which store, treat, and dispose of the range of solid waste generated by DOE nuclear facilities and reactor facilities. The environmental, safety, and health concerns to be addressed to fulfill the design requirements for these facilities vary significantly according to the nature of the waste, the waste management techniques that are implemented, and the characteristics of the facility site. Special design features such as off-gas treatment systems, confinement systems, effluent control and monitoring are addressed in DOE Order 6430.1A, Section 1324.

The CSSF is currently not regulated by the Nuclear Regulatory Commission (NRC). If the CSSF were to become regulated by the NRC, the requirements specified in 10 CFR 60, Disposal of High-Level Radioactive Wastes in Geological Repositories, and 10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Waste, shall take precedence if a conflict arises between those regulations and these criteria.

6.1.3 DOE Order 5400 Series

DOE Order 5400.1, General Environmental Protection Program, establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable Federal, State and local environmental protection laws and regulations, Executive orders, and internal Department policies. This DOE Order provides Environmental Protection Standards, Notification and Reports, Environmental Protection Program Plans, and Environmental Monitoring Requirements.

DOE Order 5820.2A and 6430.1A both reference DOE Order 5481.1B as the applicable order for the preparation of safety analysis reports for high-level waste operations. This, however, is no longer the case. DOE 5481.1B has been obsoleted for high-level waste activities. DOE Order 5480.23, Nuclear Safety Analysis Reports, provides the guidance for safety analysis reports. DOE Order 5480.21, Unreviewed Safety Questions (USQ), describes the process for completing the USQ determinations. A USQ determination for the proposed Bin Set 1 calcine transfer project will be necessary. The USQ screen may determine that a safety analysis report revision and a readiness assessment are necessary. DOE Order 5480.23, has a primary role of preserving the DOE authorization basis for each nuclear facility while allowing for "operational" flexibility. The USQ process was established to allow contractors to make physical and procedural changes and to conduct tests and experiments without prior DOE approval, as long as these changes do not explicitly or implicitly affect the authorization basis of the facility or result in a Technical Safety Requirement (DOE Order 5480.22) change. See Attachment 2 for an example of the INEEL form for USQ screening and USQ safety evaluation.

6.2 RCRA Regulations

6.2.1 40 CFR 265

The requirements set forth in RCRA 40 CFR 265, Interim Status standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, apply to the CSSF. The 40 CFR 265 contains specific design and operating requirements and standards for owners and operators of hazardous interim status TSD facilities and is the primary governing RCRA regulation for the CSSF. Subparts A through G of 40 CFR 265 provides the general interim status TSD requirements and management practices. Subpart J of 40 CFR 265, Tank Systems, specifically addresses the regulations for interim status tank systems for which the CSSF has been defined. If the Part B Permit is obtained for the CSSF, then 40 CFR 264 applies.

6.2.2 40 CFR 268

The requirements in RCRA 40 CFR 268, Land Disposal Restrictions, apply to the calcine waste in the CSSF prior to final disposal. The 40 CFR 268 restricts the land disposal of most hazardous/mixed waste and specifies strict treatment standards that must be met before hazardous wastes can be land disposed, unless other LDR treatment standards are agreed to by the agencies through the petitioning process in 40 CFR 268.42 (b) or a variance is pursued per 40 CFR 268.44. For the Bin Set 1 calcine transfer activity, the LDRs outlined in this regulation do not specifically apply since the waste is simply being moved from Bin Set 1 to Bin Set 6 of the CSSF. For final treatment and calcine waste disposition, the requirements set forth in 40 CFR 268 will apply. Subpart D of 40 CFR 268 provides the specific treatment standards and applicable treatment technologies for hazardous wastes.

6.3 Environmental Checklist

The INEEL Environmental Checklist, Forms 451.01 and 451.02, identifies the potential impacts of the proposed activities on existing regulatory policies and permits and assists in identifying if addition permits or approvals are necessary prior to commencing the proposed activities. The INEEL Environmental Checklist will need to be completed prior to starting any construction activity associated with the calcine transfer from Bin Set 1 to Bin Set 6. See Attachment 3 for an example of the Environmental Checklist form.

6.4 Waste Generator Services

The INEEL Waste Generator Services (WGS) organization provides management of the characterization, storage, treatment, and disposal of generated wastes at the INEEL facilities. The waste generator is required to contact the INTEC WGS facility representative as early as possible in the planning stages of the Bin Set 1 calcine transfer project in order to initiate the WGS services waste planning process. The generator brings a waste stream to the attention of WGS and provides the process knowledge information to the WGS facility representative. Where subcontractors are performing work at the INEEL, the facility person who requested the work assumes responsibilities of a waste generator, assuming ownership of all waste generated by the subcontractor as a result of the work.

The waste generator and the INTEC WGS facility representative initiate the waste management process by collaborating to complete the initial process knowledge determination of INEEL form 435.39, Waste Determination and Disposition Form (WDDF). A hazardous waste determination includes the completed WDDF, related attachments, and INEEL Integrated Waste Tracking System (IWTS) material and container profiles. Attachment 4 provides an example of the WDDF form.

Upon completion of the process knowledge determination and assignment of waste type(s), a WGS technical specialist assumes responsibilities for a give waste stream. It is imperative that the INEEL waste generator, the subcontractor, the WGS facility representative, and the WGS technical specialist collaborate and continually communicate during the course of the Bin Set 1 calcine waste transfer project.

The INEEL Site Treatment Plan (STP) may require updating. The source, in conjunction with the subcontractor and INTEC WGS facility representative, will be required to notify the INEEL Site Treatment Plan Office and to estimate the volume of waste to be generated from the proposed Bin Set 1 calcine transfer activities. If the volume of waste generated exceeds the current revision STP volumes, then the STP will need to be updated. The INEEL STP is generally updated annually.

6.5 Air Permitting

An environmental checklist and an air permit applicability determination (APAD) will be required to assess the potential air and radionuclide emissions from the proposed calcine transfer from Bin Set 1 to Bin Set 6 project. The governing regulations for the control of air pollution are found in the Idaho Administrative Procedures Act (IDAPA) 16.01.01, "Rules for the Control of Air Pollution in Idaho," Title 01, Chapter 01. It is anticipated that the Bin Set 1 calcine transfer will require a Category 1 Exemption or a Permit to Construct (PTC) from the State of Idaho as identified in 16.01.01.201.

6.6 National Emission Standards for Hazardous Air Pollutants (NESHAPs)

Potential radionuclide emissions are also regulated through NESHAPs regulations. To determine NESHAPs compliance, modeling associated with the calcine transfer from Bin Set 1 to Bin Set 6 would be necessary to determine the dose to the maximally exposed individual at the INEEL boundary. If the modeled unmitigated potential emissions would exceed 0.1 mrem per year, a continuous emissions monitor would be required for each emission source. If the radionuclide emissions exceed 0.1 mrem per year using 40 CFR 61 Appendix D criteria, an application to construct would be required.

6.7 National Historic Preservation Act

The CSSF is potentially eligible for listing in the national register of historic places. Activities associated with the calcine transfer from Bin Set 1 to Bin Set 6 would require consultation with Idaho State Historic Preservation Officer and compliance with any substantive requirements identified. This consultation, required by Section 106 of the National Historic Preservation Act, would be conducted prior to the initiation of any demolition activities associated with the Bin Set 1 calcine transfer.

6.8 Storm Water Pollution Prevention Plan (SWPPP)

Within the INTEC facility, projects that involve soil disturbance by subcontractors must have a project specific storm water pollution prevention plan for construction, (INEEL Form 450.16). The project manager or designated alternate is responsible for preparing the plan. Such requirements are identified during the preparation of the Environmental Checklist. See Attachment 5 for an example of the SWPPP form.

6.9 Federal Facility Agreement/Consent Order [FFA/CO]

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) coordination will be required. CERCLA sites in Waste Area Group (WAG) 3, the INTEC facility, may be impacted due to ground-disturbing activities at CSSF, specifically Bin Set 1. Wastes and residue left in place would also require evaluation to determine the impact on the CERCLA Record of Decision (ROD). Soil disturbing activities for the construction of the Bin Set 1 calcine transfer system may impact Environmentally Controlled Areas at the INTEC. As a minimum, the requirements for working in Environmentally Controlled Areas are: personnel must be Hazardous Waste Operations (HAZWOPER) and Radiation Worker trained, a Health and Safety Plan is needed, and a waste management plan is needed in the event soil disturbance does affect contaminated areas.

6.10 Atomic Energy Act and Nuclear Regulatory Commission

Although the transfer of calcine from Bin Set 1 to Bin Set 6 does not trigger closure (40 CFR 265.197), the intent of the project is to transfer as much calcine from Bin Set 1 as technically feasible in order to support potential, future closure activities. The future use/final disposition of Bin Set 1 has not yet been determined. During closure of the CSSF, however, residue remaining in the bins will be assessed to determine its classification as either being high-level waste or incidental. It is preferred that residues remaining in bins would be processed and managed so as to meet the Incidental Waste Criteria specified by the Nuclear Regulatory Commission (NRC), "Incidental Waste Criteria," (58 FR 12345).³

The NRC identified three tests for determining if a waste is an incidental waste in accordance with "Incidental Waste Criteria" (58 FR 12345).³

- High-level waste has been processed (or will be further processed) to remove key radionuclides to the maximum extent that is technically and economically practical.
- Incidental wastes will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.
- Incidental wastes are to be managed pursuant to the Atomic Energy Act, so that safety requirements comparable to the performance objectives set out in 10 CFR 61 are satisfied.

Based on these criteria, if a waste can be demonstrated to be incidental, the waste is not high-level waste and is not subject to NRC licensing.³ The incidental waste can then be managed by DOE as possibly low-level waste (mixed). It is anticipated that the Bin Set 1 superstructure (including removed soils to top of concrete vault) and the environmental enclosure demolition wastes will be classified as incidental wastes. INEEL Waste Generator Services will assist in determining the waste characterization and final disposition.

It is assumed that the CSSF bins will have residue remaining after closure. This is due to the design of the bins that make it impractical to recover all of the waste residue. Approximately 5% of the calcined waste is estimated to remain in each bin following the Calcine Retrieval and Transportation Project in support of final closure.⁷ It is assumed that the waste residue will be concentrated on the bottom and in the "nooks and crannies" of the bins inaccessible using retrieval equipment.^{3, 7} In order to assist in the future closure plans, the Bin Set 1 calcine transfer project should have a removal efficiency of 95% or greater, leaving 5% or less residual calcine in each bin of Bin Set 1.

6.11 Federal Facilities Compliance Act

Under the Federal Facilities Compliance Act, DOE is required to comply with RCRA and various other environmental regulations, such as the Clean Air Act (IDAPA Rules for the Control of Air Pollution in Idaho), Clean Water Act (SWPPP), NESHAPS, etc. DOE has committed to comply with environmental regulations, safety requirements, and agreements with the State of Idaho. Failure to operate acceptable waste storage and processing facilities will place DOE in violation of RCRA, the Settlement Agreement, and the Federal Facilities Compliance Act.

6.12 Settlement Agreement

The applicable commitments for high-level waste and calcine waste associated with the Settlement Agreement between the State of Idaho (under Governor Batt), the Department of Energy, and the Department of Navy, October 16, 1995 are provided below:⁸

- DOE shall treat all high-level waste currently at INEEL so that it is ready to be moved out of Idaho for disposal by a target date of 2035.
- DOE shall accelerate efforts to evaluate alternatives for the treatment of calcined waste so as to put it into a form suitable for transport to a permanent repository or interim

storage facility outside Idaho. To support this effort, DOE shall solicit proposals for feasibility studies by July 1, 1997. By December 31, 1999, DOE shall commence negotiating a plan and schedule with the State of Idaho for calcined waste treatment. The plan and schedule shall provide for completion of the treatment of all calcined waste located at INEEL by a date established by the Record of Decision for the Environmental Impact Statement that analyzes the alternatives for treatment of such waste. Such Record of Decision shall be issued not later than December 31, 2009. It is presently contemplated by DOE that the plan and schedule shall provide for the completion of the treatment of all calcined waste located at INEEL by a target date of December 31, 2035. The State expressly reserves its right to seek appropriate relief from the Court in the event that the date established in the Record of Decision for the Environmental Impact Statement that analyzes the alternatives for treatment of such waste is significantly later than DOE's target date. In support of the effort to treat such waste, DOE shall submit to the State of Idaho its application for a RCRA (or statutory equivalent) Part B permit by December 1, 2012.

Table 1. Summary of potential permits and approvals for Bin Set 1 calcine transfer.

Law, Order, Consent Order Impacted	Discussion
DOE Orders	Compliance required: 5820.2A, Chapter 1 6430.1A, Section 1300, 1324 5400 Series
HWMA/RCRA	Compliance required: 40 CFR 265, Subpart J or 40 CFR 264, Subpart J
INEEL Environmental Checklist	Completion of Environmental Checklist required. Checklist identifies other impacted policies and permits.
Waste Generator Services and INEEL Site Treatment Plan	Notification of Waste Generator Services required in planning stages. Update STP as necessary – estimate volume of waste generated from activities. If the volume of waste generated exceeds the STP volumes, update plan. Plan is updated annually.
IDAPA Rules for the Control of Air Pollution in Idaho	Compliance required: IDAPA – Permit to Construct (PTC) or Category 1 Exemption analysis required.
National Emission Standards for Hazardous Air Pollutants (NESHAPS)	Compliance required: NESHAPS analysis required.
National Historic Preservation Act	Compliance required: Consultation with Idaho State Historic Preservation Officer and compliance with substantive requirements identified.
Clean Water Act-Stormwater Pollution Prevention Plan (SWPPP)	Compliance required: A project specific SWPPP to address impacts from activity will be required.
Federal Facility Agreement/Consent Order [FFA/CO (CERCLA)]	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) coordination required. CERCLA sites in WAG 3 may be impacted due to ground-disturbing activities at CSSF, specifically Bin Set 1. Wastes and residue left in place would require evaluation to determine the impact on the CERCLA Record of Decision (ROD). A waste management plan and a health and safety plan may be necessary if soil disturbances affect Environmentally Controlled Areas.
Atomic Energy Act (AEA) and Nuclear Regulatory Commission	Incidental Waste Determination – Determination prepared as part of closure design package. Determination identifies the ability to manage the bin HLW residue so as to leave only incidental waste residue in the bins.
Federal Facilities Compliance Act	Compliance required: This Act identifies all the environmental regulations Federal Facilities are required to comply with.
Settlement Agreement	Compliance with Schedule Required – requires submittal of application for RCRA Part B permit by December 1, 2012 and treatment of all calcined waste by a target date on December 31, 2035

7. References

1. Raytheon Engineers and Constructors Inc., "Idaho Chemical Processing Plant Phase I & II Special Studies Calcine Recovery Bin Set #1 Project," March 1995, Volume 1, Project No. 9354.200, 204.
2. RCRA Regulations and Keyword Index, 1998 Edition, Published by Elsevier Science, Inc., USA.
3. Dahlmeir, M. M., et. al., "Calcined Solids Storage Facility Closure Study," February 1998, INEEL/EXT-97-01396.
4. Wichmann, T., Brooks, N., and Heiser, M., "Regulatory Analysis and Proposed Path Forward for the Idaho National Engineering Laboratory High Level Waste Program," Revision 1, October 1996, DOE/ID-10544.
5. Carlos L. Tellez Letter to Distribution, February 11, 1999, "Implementation of a Regulatory Analysis and Reassessment of U. S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System," Rev. 1, February 1999, CLT-18-99
6. Gilbert, K. L. and Venneman, T. E., "A Regulatory Analysis and Reassessment of U. S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System," February 1999, Revision 1, INEEL/EXT-98-01213.
7. McAllister, K. D., "Bin Set Closure Starting Conditions," January 13, 1998, EDF-BXC-005.
8. DOE 1995, "Settlement Agreement" between the State of Idaho, Department of Navy, and the Department of Energy, October 16, 1995.

Attachment 1
Engineering Change Form

This form is used in conjunction with MCP-2811, Engineering Change Control
If additional space is needed for any of the sections, continue on last page.

This form has been verified to be the latest revision:

1. SSC Engineer: _____	Org/Facility: _____
2. Change Title:	
3. Affected System (Consider interfaces with other facilities/systems): SSC Identification No(s): <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> <div style="width: 30%;">_____</div> </div>	
4. Description/Justification:	
5. 10 CFR 72.48 Screen: (APPLICABLE TO NRC LICENSED FACILITIES ONLY) Printed name: _____ Signature: _____ / / <div style="display: flex; justify-content: space-between; width: 100%;"> 10 CFR 72.48 Screener Date </div>	6. Is USQ screen required? ☐ No – Non-Nuclear Facility ☐ Yes – If Yes, is USQ evaluation needed? ☐ No ☐ Yes – If Yes, attach Form 431.20 or equivalent. Printed name: _____ Signature: _____ / / <div style="display: flex; justify-content: space-between; width: 100%;"> USQ Representative (Screener/Evaluator) Date </div>
7. Does change affect a listed RCRA Facility (MCP-405 Appendix A)? ☐ No ☐ Yes – If Yes, Attach Form 435.29 Printed name: _____ Signature: _____ / / <div style="display: flex; justify-content: space-between; width: 100%;"> RCRA Evaluator Date </div>	
8. Management Controls: ☐ Yes ☐ No Describe or Reference:	
9. Approval of proposed change (Blocks 2-7), Team Composition (Block 10), and Req'd Approvals (Block 11): <div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="width: 80%;"> _____ Program, Project, or Facility Manager </div> <div style="width: 15%; text-align: center;"> / / Date </div> </div>	

ENGINEERING CHANGE FORM

ECF Number: _____ Rev. _____

Project File No.: _____

SSC Quality Level: ☐ 1 ☐ 2 ☐ 3

10. Change Input/Review Team Signatures/Date (Check applicable discipline reviews required):

Change Input	Change Review	Not Req'd	Team Composition	Change Input		Change Review	
			Printed Name	Signature	Date	Signature	Date
☐	☐	☐	Configuration Management	_____	____/____/____	_____	____/____/____
☐	☐	☐	Crafts	_____	____/____/____	_____	____/____/____
☐	☐	☐	Criticality	_____	____/____/____	_____	____/____/____
☐	☐	☐	Design Engineer	_____	____/____/____	_____	____/____/____
☐	☐	☐	Emergency Preparedness	_____	____/____/____	_____	____/____/____
☐	☐	☐	Environmental Affairs	_____	____/____/____	_____	____/____/____
☐	☐	☐	Fire Protection	_____	____/____/____	_____	____/____/____
☐	☐	☐	Hoisting & Rigging Engineer	_____	____/____/____	_____	____/____/____
	☐	☐	Independent Verification	_____	____/____/____	_____	____/____/____
☐	☐	☐	Industrial Hygiene	_____	____/____/____	_____	____/____/____
☐	☐	☐	Industrial Safety	_____	____/____/____	_____	____/____/____
☐	☐	☐	Operations	_____	____/____/____	_____	____/____/____
☐	☐	☐	Quality Engineering	_____	____/____/____	_____	____/____/____
☐	☐	☐	Radiological Engineering	_____	____/____/____	_____	____/____/____
☐	☐	☐	Safeguards & Security	_____	____/____/____	_____	____/____/____
☐	☐	☐	Safety Analysis	_____	____/____/____	_____	____/____/____
☐	☐	☐	Training	_____	____/____/____	_____	____/____/____
☐	☐	☐	Other	_____	____/____/____	_____	____/____/____
☐	☐	☐	Other	_____	____/____/____	_____	____/____/____

ENGINEERING CHANGE FORM

ECF Number: _____ Rev. _____

Project File No.: _____

SSC Quality Level: ☐ 1 ☐ 2 ☐ 3

11. Final Change Authorization:

<u>Req'd</u>	<u>Not Req'd</u>	<u>Printed Name</u>	<u>Signature</u>	<u>Date</u>
☐	☐	Design Engineer		/ /
☐		SSC Engineer		/ /
☐	☐	Engineering Supervisor		/ /
☐	☐	Engineering Manager		/ /
☐	☐	Operations Manager		/ /
☐	☐	ISRC/SORC		/ /
☐		Program, Project, or Facility Manager		/ /
☐	☐	Other		/ /
☐	☐	Independent Chairperson		/ /

12. Design Verification: (check all that apply) ☐ Alternate Calculations ☐ Qualification Testing ☐ Design Review

Justification:

13. Technical Input: ☐ Technical Inputs Listed Below ☐ Attached Technical Input Documentation ☐ Reference Technical Input Documents

14. Davis Bacon Review: Covered Work: ☐ Yes ☐ No

Reference:

ENGINEERING CHANGE FORM

ECF Number: _____ Rev. _____

Project File No.: _____

SSC Quality Level: ☐ 1 ☐ 2 ☐ 3

DOCUMENT REVISIONS

15.	Work Order Number (and/or Construction Contract Number)	Maintenance Task Completion Date	Work Order Number (and/or Construction Contract Number)	Maintenance Task Completion Date
	_____	____/____/____	_____	____/____/____
	_____	____/____/____	_____	____/____/____
	_____	____/____/____	_____	____/____/____
	_____	____/____/____	_____	____/____/____

16. System Description/Operating Procedures:

Ops Turn.	Type*	Number	DAR	Issue Date
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
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☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____

* Type
System Description Document (SDD) Technical Procedure (TPR)
Management Control Procedure (MCP) Approved Test Procedure (ATP)
Project Directive (PD)

17. Maintenance Documents:

Ops Turn.	Type*	Number	Change Doc.	Issue Date
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
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☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____

* Type
Preventive Maintenance (PM) Spare Parts Document (SPT)
Predictive Maintenance (PDM) Standard Plan (SP)

18. Essential (Key) and Master Facility Drawings

Ops Turn.	Essential/MFD	Number	DAR	Issue Date
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
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☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____
☐	_____	_____	_____	____/____/____

19. Safety/Environmental Documentation:

Ops Turn.	Type*	Number	DAR*	Issue Date
☐	NEPA	_____	_____	____/____/____
☐	RRD	_____	_____	____/____/____
☐	RRD Matrix	_____	_____	____/____/____
☐	SAR	_____	_____	____/____/____
☐	SAR Matrix	_____	_____	____/____/____
☐	HWMA/RCRA Permit	_____	_____	____/____/____
☐	HWMA/RCRA Interim Status Documentation	_____	_____	____/____/____
☐	Permit	_____	_____	____/____/____
☐	Inspection Plan	_____	_____	____/____/____
☐	Contingency Plan	_____	_____	____/____/____
☐	Sample Analysis Plan	_____	_____	____/____/____
☐	Training Plan	_____	_____	____/____/____
☐	Closure Plan	_____	_____	____/____/____
☐	PPP	_____	_____	____/____/____
☐	PTC	_____	_____	____/____/____
☐	Storm Water PPP	_____	_____	____/____/____

* Note changes to documentation that will be accomplished in an annual update cycle with an asterisk in the DAR column.

ENGINEERING CHANGE FORM

ECF Number: _____ Rev. _____

Project File No.: _____

SSC Quality Level: ☐ 1 ☐ 2 ☐ 3

20. Vendor Data: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Ops Turn.</th> <th style="text-align: left;">Number</th> <th style="text-align: left;">DAR</th> <th style="text-align: left;">Issue Date</th> </tr> </thead> <tbody> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> </tbody> </table>	Ops Turn.	Number	DAR	Issue Date	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	21. Other Databases/Documents: <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Ops Turn.</th> <th style="text-align: left;">Type*</th> <th style="text-align: left;">DAR*</th> <th style="text-align: left;">Issue Date</th> </tr> </thead> <tbody> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> <tr><td>☐</td><td>_____</td><td>_____</td><td>___/___/___</td></tr> </tbody> </table> <p>* Type Master Facility Drawing List (MFDL) Master Equipment List (MEL) Commitment Tracking System (CTS) Quality List (QL) Comprehensive Equipment List (CEL) Project Files (PF)</p>	Ops Turn.	Type*	DAR*	Issue Date	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___	☐	_____	_____	___/___/___
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24. Conduct of Operations Turnover: <div style="border-bottom: 1px solid black; width: 100%;"></div> <div style="display: flex; justify-content: space-between;"> Operations Supervision ___/___/___ Date </div>	25. ECF Closure Acceptance: <div style="display: flex; justify-content: space-between;"> <div style="border-bottom: 1px solid black; width: 80%;"></div> <div style="text-align: right;">___/___/___ Date</div> </div> <div style="display: flex; justify-content: space-between;"> <div style="border-bottom: 1px solid black; width: 80%;"></div> <div style="text-align: right;">___/___/___ Date</div> </div>																																																				
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RCRA PERMIT MODIFICATION REVIEW

CHANGE PROPOSAL TITLE:

CHANGE PROPOSAL NUMBER:
(IF APPLICABLE)

CHANGE PROPOSAL DATE:

(For RCRA Permitting Use Only)
RCRA TRACKING No:
CHECKED:
Initials/Date
REVISED? ☐ YES ☐ NO

Is the proposed change a possible RCRA Final Partial Permit (See MCP-405), RCRA Part A permit application (See MCP-406), or RCRA Part B permit application (See MCP-407) modification?

☐ Yes ☐ Final Partial Permit ☐ Part A application ☐ Part B application

Affected permit or application and module or section _____ Basis/Class _____ / _____

- ☐ No
- ☐ Unknown
- ☐ Temporary (≤ 180 days)

Reviewer/Date

If response (for permit only) is yes or unknown, check the NOTICE block below.

If response is yes (for both permit and applications) or unknown, submit a copy of this form and the associated change proposal documentation to NEPA/Permitting, MS 3427, or fax to 526-7291.

If the change proposal requires immediate action, contact NEPA/Permitting at 526-7291.

Attach the original form to the change proposal documentation.

Other comments?

☐ **NOTICE:** This change may require modification of a RCRA permit, as indicated above. This change may not be implemented until notification is received from NEPA/Permitting.

Attachment 2

Unresolved Safety Question Screening and Safety Evaluation

USQ SAFETY EVALUATION SCREENING FOR FACILITY MODIFICATIONS

Nuclear Facility or Activity: _____

USQ Determination No.: _____ Revision No.: _____

Title of Proposed Modification: _____

Describe the Proposed Modification and its potential effects:

List the reference location(s) of safety requirement(s) in the authorization basis or any Technical Safety Requirement (TSR) related to the Proposed Modification:

USQ Screening:

Could the change adversely affect the safety function of a structure, system, or component (SSC) or part of a larger SSC described in the authorization basis? Consider the following specific possibilities as a minimum.

YES NO

1. Could the operability or effectiveness of instrumentation important to safety be degraded?	☐	☐
2. Could the change adversely affect the ability of a shielding structure to mitigate the consequences of a criticality accident or other major radiation incident?	☐	☐
3. Could the change adversely affect an HVAC exhaust air filtration system in controlling airborne radioactivity releases to the environment or in mitigating the consequences of an accident?	☐	☐
4. Could the change adversely affect the integrity of a fuel storage rack or storage fixture?	☐	☐
5. Could the change result in a criticality scenario different from those considered in the authorization basis (for example, different assembly mechanism, composition or configuration of a postulated critical array)?	☐	☐
6. Could a plant protection system be adversely affected?	☐	☐
7. Could the change adversely affect a safety class or safety significant design feature, an engineered safety feature (ESF), or other equipment important to safety?	☐	☐
8. Could construction-related activities adversely affect a safety function?	☐	☐

If the answer to any of questions 1 through 8 above is "Yes", a USQ safety evaluation must be performed and documented on Form 431.20, USQ Safety Evaluation, or equivalent (see MCP-123).

Provide an explanation of the screening results below:

USQ Screener
(Type Name)

USQ Screener
(Signature)

Date

USQ SAFETY EVALUATION

Nuclear Facility or Activity: _____

Safety Evaluation No.: _____ Revision No.: _____

Title of Proposed Action or New Information: _____

1. Indicate which type: Proposed Action: ☐ New Information: ☐
2. Describe the Proposed Action or New Information:
3. Identify applicable section of the authorization basis document or the Technical Safety Requirement or both:
4. Identify applicable procedural, operating, design, or technical document or criterion (including drawings, diagrams, schematics, etc.):
5. Identify applicable safety or operating function:
6. Identify applicable operating condition:
7. Identify applicable hazard, failure mode, or accident or malfunction of equipment important to safety evaluated in the authorization basis, together with mitigating action or function:

PART I: POTENTIAL FOR AN INCREASE IN PROBABILITY OR CONSEQUENCE OF AN ACCIDENT OR MALFUNCTION EVALUATED IN THE AUTHORIZATION BASIS

1. Could the Proposed Action or New Information increase the probability of occurrence of an accident previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:
2. Could the Proposed Action or New Information increase the consequences of an accident previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:
3. Could the Proposed Action or New information increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:

USQ SAFETY EVALUATION

4. Could the Proposed Action or New Information increase the consequences of a malfunction of equipment important to safety previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:

PART II: POTENTIAL FOR CREATION OF AN UNANALYZED ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE

5. Could the Proposed Action or New Information create the possibility of an accident of a different type than previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:

6. Could the Proposed Action or New Information create the possibility of a malfunction of equipment important to safety of a different type than previously evaluated in the authorization basis? Yes ☐ No ☐

Explain:

PART III: POTENTIAL FOR REDUCTION IN A MARGIN OF SAFETY

7. Could the Proposed Action or New Information reduce the margin of safety as defined in the bases for any Technical Safety Requirement? Yes ☐ No ☐

Explain:

PART IV: SAFETY EVALUATION CONCLUSION

Based on the evaluations in Part I, Part II, and Part III, does the Proposed Action or New Information involve an Unreviewed Safety Question? Yes ☐ No ☐

Explain:

_____ USQ Evaluator (Typed Name)	_____ USQ Evaluator (Signature)	_____ Date
_____ *Independent Review – USQ Evaluator (Typed Name)	_____ *Independent Review – USQ Evaluator (Signature)	_____ Date
_____ Approval/Manager of the Nuclear Facility or Activity (Typed Name)	_____ Approval/Manager of the Nuclear Facility or Activity (Signature)	_____ Date
_____ *Concurrence – ISRC Committee Chair (Typed Name)	_____ *Concurrence – ISRC Committee Chair (Signature)	_____ Date

* USQ Evaluator Independent Review may be performed by ISRC Chair.

Attachment 3
INEEL Environmental Checklist

ENVIRONMENTAL CHECKLIST COVER SHEET

The following information is required by the Environmental Affairs Branch Policy and Permitting, Lockheed Martin Idaho Technologies Company (LMITCO) to initiate processing of an Environmental Checklist 451.01.

Project Title: _____

Note: Please start project title with name of facility (e.g., TAN, TRA, CFA...)

Charge No.: _____

Originating LMITCO Org. _____

DOE Funding Org. _____

DOE Program Mgr. _____

Phone # _____ Fax # _____ MS _____

Facility Operations Mgr. _____

Phone # _____ Fax # _____ MS _____

Project/Program Mgr. _____

Phone # _____ Fax # _____ MS _____

Project/Tech. Contact _____

Phone # _____ Fax # _____ MS _____

Alternate Contact _____

Phone # _____ Fax # _____ MS _____

Environmental Support Contact _____

Phone # _____ Fax # _____ MS _____

DATE STAMP

Project/Construction Start Date: ____ / ____ / ____ (Title II if applicable)

Please attach drawings, sketches, maps, project & planning documents and include cost estimate and schedule information if applicable).

Other Information: _____

Policy and Permitting Department Use Only

CX: ☐ EA: ☐ EIS: ☐ CERCLA: ☐ Previously Approved NEPA Documents: ☐ Not Covered in 10 CFR 1021 ☐

Document Log No.: _____ Assigned To: _____

Date Received: ____ / ____ / ____ Date sent to LMITCO Programs: ____ / ____ / ____

NEPA Level Determination: _____

10 CFR 1021 Reference No. (e.g., Bl.3): _____

Conditions: (Provide Type, Responsible Party, and Status of all conditions – e.g., open, complete, to-be-determined):

Condition Type	Condition	Responsible Party	Status
Air			
NEPA			
Other			
RCRA			
Sensitive Resources			
Water			

Comments: _____

451.01
06/03/98
Rev. 06

ENVIRONMENTAL CHECKLIST
U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

Page 2

EC Document No. _____

Project Description (continued):

Sources of Impacts (continued): Would the action involve, generate, or result in changes to any of the following:
(If you answered Yes to any Section C items, explain below)?

ENVIRONMENTAL CHECKLIST
U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

EC Document No. _____

DIRECTIONS: Section A through D to be completed by the program/project manager. Section E & F to be completed by the LMITCO's Policy and Permitting Organization, the DOE-ID NEPA Compliance Officer (NCO), or as indicated.

SECTION A. PROJECT TITLE:

DOE-HQ PROGRAM:

PROJECT NUMBER:

PERFORMING ORGANIZATION:

DATE:

DOE PROJECT TECHNICAL MANAGER:

TELEPHONE NUMBER:

PERFORMING ORGANIZATION CONTACT:

TELEPHONE NUMBER:

SECTION B. Project description: Attach a complete and concise description of the project or action, including type of action (e.g., new construction, process modification, maintenance, new activity, research and development, or work for others), purpose and need, pollution prevention and waste minimization measures, projected start and end dates, and approximate cost.

SECTION C. Sources of impact: Would the action involve, generate, or result in changes to any of the following? (If yes, explain on attachment.)

Source	Yes	No	Source	Yes	No	Source	Yes	No
1. Air Emissions	☐	☐	8. Water/Well Use	☐	☐	15. Hazardous Waste	☐	☐
2. Asbestos	☐	☐	9. Water Course Modification	☐	☐	16. Radioactive Waste	☐	☐
3. Work Force Adjustment	☐	☐	10. Pesticide Use	☐	☐	17. Mixed Waste	☐	☐
4. Excess Noise Levels	☐	☐	11. Chemical Use/Storage	☐	☐	18. Radiation Exposure	☐	☐
5. Utility Modification	☐	☐	12. Petroleum Storage	☐	☐	19. Liquid Effluent	☐	☐
6. Soil Disturbance	☐	☐	13. Solid Waste	☐	☐	20. Sensitive Resources	☐	☐
7. Water Treatment	☐	☐	14. PCBs	☐	☐	21. CERCLA/RCRA Site	☐	☐

SECTION D. The action is determined as: (check one of the following or if unsure call Policy and Permitting)

☐ **Appendix A Actions**

10 CFR 1021 Appendix A to Subpart D

Appendix A Project Manager Signature: _____

☐ **Routine Maintenance Actions**

10 CFR 1021 Appendix B to Subpart D, Subsection B1.3

Trained RM Reviewer Signature: _____

☐ **Further NEPA documentation is required. Forward to Policy and Permitting for NEPA determination and environmental review.**

*******TO BE FILLED OUT BY THE POLICY AND PERMITTING ORGANIZATION*******

SECTION E. Category evaluation criteria: Would the action... (If yes, explain on attachment.)

	Yes	No
1. Require cultural, historical, or biological clearances?	☐	☐
2. Potentially impact sensitive resources identified in Item 1 above. Describe the mitigation plan.	☐	☐
3. Require or modify federal, state, or local permits, approvals, etc.?	☐	☐
4. Be inconsistent with any existing consent orders or agreements (i.e., FFA-CO, site wide treatment plans, etc.)?	☐	☐
5. Create waste for which there is no disposition, Waste Generation Number, or Solid Hazardous Waste Determination from the Waste Management Authority?	☐	☐
6. Require siting, construction, or modification of a RCRA or TSCA regulated facility?	☐	☐

SECTION F. NEPA level of documentation and reference(s).

CX: ☐ EA: ☐ EIS: ☐ CERCLA: ☐ Previously Approved NEPA Documents: ☐ Not Covered in 10 CFR 1021 ☐

Reference(s): _____

The proposed action would not: 1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, including requirements of DOE orders; 2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; 3) disturb hazardous substances, pollutants, contaminants, or CERCLA-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; 4) adversely affect environmentally sensitive resources. In addition, no extraordinary circumstances related to the proposal exist which would affect the significance of the action, and the action is not "connected" nor "related" (40 CFR 1508.25(a)(1) and (2), respectively) to other actions with potentially or cumulatively significant impacts.

Name: _____

Telephone No.: _____

Signature: _____

Date: _____

Attachment 4

INEEL Waste Determination and Disposition Form

435.39
02/22/99
Rev. 02

INEEL WASTE DETERMINATION & DISPOSITION FORM (WDDF)

Waste Stream Name: _____

Waste Stream #: _____

Date # Assigned: _____

Material Profile #: _____

Charge #: _____

☐ Preliminary

☐ Final

Waste Stream Contacts

Contact	Name	E-Mail	Phone	Pager	Mail Stop	Title
Generator						
Facility Representative						
Technical Specialist						
Independent Reviewer						

SECTION I: PROCESS EVALUATION

Waste Generation Location: Facility: _____ Building/Room: _____ Area: _____

Process Description: (Attachment Included: ☐ Yes ☐ No)

Were any documented waste minimization activities a part of this process: ☐ Yes ☐ No (If Yes, provide description or reference)

Generation Status: ☐ Anticipated ☐ Existing Frequency: ☐ One Time Only ☐ Ongoing Start Date (est.): _____ End Date (est.): _____

Near Term Generation Rate: _____ (e.g. gal/week or gal/month) Long-Term Generation Rate: _____ (m³/year)

Physical Description (check all that apply): ☐ Solid ☐ Organic Liquid ☐ Aqueous Liquid ☐ Sludge ☐ Aerosol ☐ Gas Cylinder ☐ Multi-Layered

What is the waste? (Detailed description) (Attachment Included: ☐ Yes ☐ No)

For on going waste, is the waste form expected to vary over time? ☐ Yes ☐ No Explain: _____

Sources used for process evaluation (e.g. MSDS, operational logs, procedures, analyses): _____

Waste Characteristics (If Yes to any, list in chemical characteristics table):

Liquids		Solids		All	
pH(aqueous only):	Method: _____	Pyrophoric (Air Reactive)	☐ Yes ☐ No	Cyanide $\geq$ 250 mg/kg	☐ Yes ☐ No
Flash Point (organic only):	Method: _____	Pyrophoric (Water Reactive)	☐ Yes ☐ No	Sulfide $\geq$ 500 mg/kg	☐ Yes ☐ No
Are total suspended solids <1%	☐ Yes ☐ No	Flammable Solid	☐ Yes ☐ No	Explosive	☐ Yes ☐ No
Is total organic carbon <1%	☐ Yes ☐ No	Estimated Density: _____ g/cm ³		Oxidizer	☐ Yes ☐ No
Estimated Specific Gravity: _____ g/mL		Free liquids: ☐ Yes ☐ No If Yes, quantity _____ volume %		Compressed gas bottle or cylinder	☐ Yes ☐ No
Fuming Acid/Acid Gases	☐ Yes ☐ No	Debris (>60 mm) (> 50% by visual inspection)	☐ Yes ☐ No	Treatment Residue	☐ Yes ☐ No
Pyrophoric (Air Reactive)	☐ Yes ☐ No	Asbestos	☐ Yes ☐ No	PCBs: If Yes, provide concentrations (actual and source) in composition table.	☐ Yes ☐ No
Water Reactive	☐ Yes ☐ No			Radioactive: If Yes, complete radioisotope table	☐ Yes ☐ No
Pyrophoric (Water Reactive)	☐ Yes ☐ No			Halogens (Chlorine, Fluorine or Bromine)	☐ Yes ☐ No

INEEL WASTE DETERMINATION & DISPOSITION FORM (WDDF)

Waste Stream Name: _____

Waste Stream #: _____

Chemical Composition: (Attachment Included: ☐ Yes ☐ No ☐ N/A)

Constituent	CAS No.	Analysis or PK	Concentration Range (If constituent is <1%, use mg/kg or mg/L, otherwise report in %)			Comments
			From	To	Units	

Radioisotopes: (N/A if not applicable) (Attachment Included: ☐ Yes ☐ No)

Isotope	Analysis or Scaled	Activity Range			Fissile per DOT*	Fissile For Storage	Accountable Nuclear Material	Comments
		From	To	Units				
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	
					☐ Y/ ☐ N	☐ Y/ ☐ N	☐ Y/ ☐ N	

* To be completed with input from P&T

SECTION II: PROBABLE WASTE TYPE: (Used to assign waste technical specialist and for appropriate management until final waste determination is made.)

Based on evaluation of the process and available data the waste type indicated is (check all that apply):

☐ Hazardous Only	☐ Mixed	☐ Radioactive Only	☐ Conditional Industrial	☐ Used Oil
☐ Material Exchange	☐ Lab Pack	☐ Non-conditional Industrial	☐ TSCA	☐ Other – Describe:
☐ Recyclable: ☐ Clean Lead ☐ Lead Batteries ☐ Silver ☐ RCRA Scrap metal				

Indicated Waste Codes:

INEEL WASTE DETERMINATION & DISPOSITION FORM (WDDF)

Waste Stream Name: _____

Waste Stream #: _____

CERTIFICATION

I certify that the information in Section I of this form and the applicable attachments are fully disclosed. A good faith effort has been put forward to acquire and verify the information. Willful or deliberate omissions have not been made, and all known and suspected hazards have, to the best of my knowledge, been identified. A probable waste type has been assigned in Section II by the WGS Facility Representative based on information provided.

Generator Name Typed/Printed	Signature	Date
WGS Facility Representative Name Typed/Printed	WGS Facility Representative Signature	Date

SECTION III WASTE DETERMINATION AND DISPOSITION

Waste Determination

- 1) Is this a solid waste (per 40 CFR 261.2)? ☐ Yes ☐ No (If No, attach regulatory citation)
- 2) Is waste excluded from regulation under 40 CFR 261.4? ☐ Yes ☐ No If Yes, regulatory citation:
- 3) Does ultimate disposition of waste or treatment residues involve land disposal? ☐ Yes ☐ No (If Yes, complete WW/NWW and Specified Treatment columns)
(If No, identify waste codes, sign Section III and forward this determination to appropriate operation.)
- 4) Is waste listed in Subpart D of 40 CFR 261? ☐ Yes ☐ No (If Yes, provide waste codes and short explanation of determination) Attachment Included: ☐ Yes ☐ No

Waste Code	Explanation	WW/NWW	Spec. Treatment	Waste Code	Explanation	WW/NWW	Spec. Treatment

- 5) Is waste characteristic per Subpart C of 40 CFR 261? ☐ Yes ☐ No (If Yes, provide waste codes and a short explanation of determination) Attachment Included: ☐ Yes ☐ No

Waste Code	Explanation	WW/NWW	Spec. Treatment	Waste Code	Explanation	WW/NWW	Spec. Treatment

INEEL WASTE DETERMINATION & DISPOSITION FORM (WDDF)

Waste Stream Name: _____

Waste Stream #: _____

6) If hazardous, is the waste excluded for recycling in accordance with 40 CFR 261.2(e)(1)? ☐ No ☐ Yes If Yes, regulatory citation: _____

7) Is waste TSCA regulated for either of the following? PCBs: ☐ No ☐ Yes / Asbestos ☐ No ☐ Yes If Yes to either, provide concentrations on chemical composition table in Section I.

Evaluation of Underlying Hazardous Constituents (UHCs)

Do any of the specified treatments from items 4 and 5 above require evaluation of waste in accordance with 40 CFR 268.48? ☐ Yes ☐ No If Yes include constituents in the chemical composition table in Section I and identify the constituent as a UHC in the comments section of the table.

Disposition and Data Gap Evaluation: (Attachment Included: ☐ Yes ☐ No)

Proposed Disposition (storage, treatment, disposal pathway): _____

STP ID (mixed only): _____

Will this waste be treated in a <90 storage area? ☐ Yes ☐ No (If Yes, attach plan) (Mixed and Hazardous Only)

Is the information provided adequate for complete waste determination, management, transportation, treatment, and disposal of waste? ☐ Yes ☐ No If No, complete data gap table below and designate this WDDF as preliminary. If no data gaps are present, designate WDDF as final when all sections are completed.

Data Gap	Required Action	Date Initiated	Date Completed

Verification requirements:

Will physical verification be performed on this waste? ☐ Yes ☐ No If Yes, at what point(s) in management process will verification occur?

At Initial Storage Location: ☐ Yes ☐ No

Immediately Prior to shipment: ☐ Yes ☐ No

What is the verification frequency?

Justification for verification frequency:

Packaging and Transportation Requirements (to be completed by P&T):

Is waste a DOT Regulated Hazardous Material? ☐ Yes ☐ No If Yes:

DOT Primary Hazard: _____

DOT Secondary Hazard: _____

Recommended packaging:

Probable Basic Description:

Other information (special shipping conditions, etc.):

If containers are already generated, are they packaged correctly for the DOT hazard class? ☐ Yes ☐ No If No, list container required in Container Table (Form 435.39A):

Packaging & Transportation
Name Typed/Printed

Packaging & Transportation
Signature

Date

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Rev. 02

INEEL WASTE DETERMINATION & DISPOSITION FORM (WDDF)

Waste Stream Name: _____

Waste Stream #: _____

CERTIFICATIONS

Material Profile Assigned:

I certify that the information in Section III of this form and the applicable attachments are fully disclosed and accurate. A good faith effort has been put forward to acquire and verify the information. Willful or deliberate omissions have not been made, and all known and suspected hazards have, to the best of my knowledge, been identified.

WGS Technical Specialist Name
Typed/Printed

WGS Technical Specialist
Signature

Date

WGS Independent Reviewer Name
Typed/Printed

WGS Independent Reviewer Signature

Date

Additional Narrative Information (As Needed):

Attachment 5

Storm Water Pollution Prevention Plan for Construction Activities

**Storm Water Pollution Prevention Plan
For Construction Activities (SWPPP-CA)
LONG-FORM PROJECT**

PROJECT TITLE: _____

Facility or Location: _____ NEPA or CX No. _____

Project Description: _____

Project Construction Date/Duration: _____

Total Area of Site: _____ Area of Site to be disturbed: _____

Requirements included in project documents:

- ☐ Post SWPPP-CA notice near main entrance of construction site.
- ☐ Spill prevention measures and prompt cleanup of any liquid or dry material spills.
- ☐ Minimize offsite tracking of sediments from vehicles.
- ☐ Minimize area of disturbance and preserve vegetation.
- ☐ Good Housekeeping procedures:
 - ☐ Proper and orderly storage of chemicals, pesticides, fertilizers, fuel, and other hazardous materials.
 - ☐ Proper and regular disposal of sanitary, construction, and hazardous wastes.
- ☐ Fugitive dust control measures.
- ☐ Perform inspections monthly, after storms, and prior to project close-out.
- ☐ Attach a site map which indicates drainage patterns, discharge locations, potential pollution sources (equipment and material storage areas including soil piles), areas of soil disturbance, erosion and sediment controls, storm water control measures, and stabilization practices.

Erosion and Sediment Controls: (Describe controls to divert storm water from exposed soil and retain sediments on site, such as diversion structures, silt fences, and sediment basins. Identify the entities responsible for implementation and maintenance.)

Sequence: (Describe the sequence of major activities, control measure implementation, and control measure removal.)

Runoff Coefficient and Storm Water Management: (Calculate runoff coefficients and explain the technical basis for permanent storm water management measures if the coefficient after construction is greater than before.)

**Storm Water Pollution Prevention Plan
For Construction Activities (SWPPP-CA)
LONG-FORM PROJECT**

Final Stabilization: (Identify soil stabilization measures and describe scheduling. Identify the entities responsible for implementation and maintenance.)

Industrial Activities: (Identify industrial sources of pollutants such as asphalt and concrete plants and describe pollution prevention measures.)

Allowable Non-Storm Water Discharge: (Identify type of discharge and describe pollution prevention measures.)

Material Inventory: (Identify construction materials and wastes.)

Endangered Species: (Identify listed species or critical habitat in proximity to the construction activity. Describe any adverse impact and mitigative measures.)

I have evaluated and identified controls adequate to meet the requirements of the INEEL Storm Water Pollution Prevention Plan for Construction Activities.

Project Manager

Signature

Date

Name (Please Print)

Phone Number

I am in agreement with the provisions set forth in this plan.

INEEL SWPPP Coordinator:

Date:

CERTIFICATION:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based upon my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

**Storm Water Pollution Prevention Plan
For Construction Activities (SWPPP-CA)
LONG-FORM PROJECT**

Signature: _____

Date: _____

Title: Environmental Affairs Director
For: Lockheed Martin Idaho Technologies Company
Reference: Transfer Signature Authority Letter – GEE-78-98

Signature: _____

Date: _____

Title: Environmental Programs and Settlement Agreement Manager
For: DOE-Idaho Operations Office
Reference: Transfer Signature Authority Letter – OPE-EP & SA-98-091

Worksheet must be appended to the Generic Plan or Facility SWPPP-CA.

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

EDF

for

AE Civil/Mechanical Design

Lockheed Martin Idaho Technologies Company

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program

3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: AE Civil/Mechanical Design

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

This EDF contains a description of the facilities required for Bin Set 1 retrieval and transportation. The design is based on the study done by Raytheon Engineers & Constructors "Calcine Recovery Bin Set #1 Project" dated March 1995. The design includes changes to the Raytheon Transport Facility (located near Bin Set 6), a new Retrieval Facility (located near Bin Set 1), and the HVAC systems required to support the retrieval and transport operations. The Weather Enclosure from the Raytheon study has not been changed and two sketches of it are attached.

The Transport Facility has been modified to place the transport line blower, HEPA filter, heat exchanger, and filter change-out facility in a cell. The building was enlarged to add a secondary confinement around the cell. Remote change-out of HEPA filters and equipment was added by including an overhead bridge crane and an overhead PaR in the cell. An operating corridor with shielding windows and remote control console was added. Change-out of filters is designed to be done remotely, placing used filters into drums that are removed through an air-lock.

The new Retrieval Facility was added to increase the transport reliability from Bin Set 1 to Bin Set 6. The Retrieval Facility is similar in design to the Transport Facility, with additional space in the cell for a Calcine Retrieval Cyclone Separator, Sintered Metal Filter, and Calcine Blending Tank on load cells.

The HVAC systems have been modified to support the retrieval and transport operations, including negative air separations between the different zones in the process.

See the attached written description and sketches C-1, S-1, S-2, S-3, HV-1, HV-2, HV-3, HV-4, HV-5, SK-BSI-01 and Raytheon sketches attached for reference SK-A-01 & SK-G-07.

6. Distribution (complete package): B. R. Helm MS 3765, V. L. Jacobson MS 3211, D. B. Lord MS 3211, Project File

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	T. A. Langenwalter		9/20/99
Independent Verification	R	B. G. Harris		9/23/99
Requestor	A	D. A. Lopez		9/27/99

1.0 Bin Set 1 Calcine Recovery Facilities

The facilities required for Bin Set 1 retrieval and transportation include a Bin Set 1 Weather Enclosure (with control room and HVAC equipment area), a Retrieval Facility located near Bin Set 1, a Transport Facility located near Bin Set 6, and modifications to Bin Set 6. The design is based on the study done by Raytheon Engineers & Constructors "Calcine Recovery Bin Set #1 Project" dated March 1995. This EDF design includes changes to the Raytheon Transport Facility and a new Retrieval Facility.

The Transport Facility has been modified to place the transport line blower, HEPA filter, heat exchanger, and filter change-out Facility in a cell. The building was enlarged to add a secondary confinement around the cell. Remote change-out of HEPA filters and equipment was added by including an overhead bridge crane and an overhead PaR in the cell. An operating corridor with shielding windows and remote control console was added. Change-out of filters is designed to be done remotely, placing used filters into drums that are removed through an air-lock.

The new Retrieval Facility was added to increase the reliability of calcine transport from Bin Set 1 to Bin Set 6. The Retrieval Facility is similar in design to the Transport Facility, with additional space in the cell for a Calcine Retrieval Cyclone Separator, Sintered Metal Filter, and Calcine Weigh Tank on load cells. The new Retrieval Facility is located adjacent to the Weather Enclosure that is on top of Bin Set 1. The Weather Enclosure from the Raytheon study has not been modified.

1.1 Site Description

The Transport Facility will be located adjacent to Bin Set 6. A new access roadway for personnel and for removal of used HEPA filters in drums will need to be extended from Hemlock Street, approximately 100 ft away.

The Retrieval Facility will be located in the area of the existing earth berm around Bin Set 1. Excavation additional to the excavation and shoring around Bin Set 1 will be required for the Retrieval Facility. A new access roadway for personnel and for removal of used HEPA filters in drums will need to be extended from Olive Avenue approximately 20 ft away.

1.2 Underground Utilities

The underground utilities will be limited to electrical power, steam, and plant air. The concrete encased transfer line will run from Bin Set 1 to Bin Set 6 as shown in the Raytheon study. See sketch C-1.

1.3 Fences and Roads

No new permanent fencing will be required. Construction fencing will be required to provide a safe work environment for INTEC personnel during project construction. New access roadways will be required at the Transport Facility and at the Retrieval Facility as stated above. No other existing roadway modifications are anticipated.

1.4 Facility Layout

1.4.1 Changes to the Transport Facility.

The Transport Facility will be a single-story building that extends approximately 22 ft above grade, and has a footprint occupying an area measuring 39 ft x 32 ft. The Transport Facility floor plan and cross sections are shown on sketch S-3. It will be designed to house the equipment and operations for transport of calcine from Bin Set 1 and will be located near the Bin Set 6 location. It will be designed to provide essential features for safe and efficient operation and maintenance.

The Transport Facility has been modified from the Raytheon design to place the transport line blower, HEPA filter, heat exchanger, and filter change-out facility in a centralized cell. The building was enlarged to add a secondary confinement around the cell. Capability for remote change-out of HEPA filters and equipment was added by including an overhead bridge crane and an overhead PaR manipulator in the cell. An operating corridor with shielding windows and remote control console was added. Change-out of filters is designed to be done remotely. Used filters will be placed in drums and removed through an air-lock.

The remainder of the facility houses a HEPA filtered and valved balancing blower that exhausts to a stack, a HEPA filter and blower for cell ventilation, and a HEPA filter and blower for ventilation of the remainder of the facility. Personnel entry into the facility is through one of two air-locks.

The facility is constructed of concrete foundations and floors, concrete shielding walls and ceiling for the cell, concrete enclosure walls and roof, and a single ply roofing membrane.

1.4.2 New Retrieval Facility.

The Retrieval Facility will be a single-story building that extends approximately 22 ft above grade, and has a footprint occupying an area measuring 52 ft x 32 ft. The Retrieval Facility floor plan and cross sections are shown on sketches S-1 and S-2. It will be designed to house the equipment and operations for retrieval and transport of calcine from Bin Set 1 to Bin Set 6. It will be designed to provide essential features for safe and efficient operation and maintenance.

The new Retrieval Facility was added to increase the reliability of calcine transport from Bin Set 1 to Bin Set 6. The Retrieval Facility is similar in design to the Transport Facility with additional space in the cell for a Calcine Retrieval Cyclone Separator, Sintered Metal Filter, and Calcine Weigh Tank on load cells. The new Retrieval Facility is located adjacent to the Weather Enclosure at Bin Set 1.

The remainder of the facility houses a HEPA filtered and valved balancing blower that exhausts to a stack, a HEPA filter and blower for cell ventilation, and a HEPA filter and blower for ventilation of the remainder of the facility. Personnel entry into the facility is through one of two air-locks.

The facility is constructed of concrete foundations and floors, concrete shielding walls and ceiling for the cell, concrete enclosure walls and roof, and a single ply roofing membrane.

1.5 Occupancy Classification

The Transport Facility and the Retrieval Facility are classified as a Uniform Building Code (UBC) Group H Division 7 Occupancy. The H-7 occupancy applies to buildings or portions thereof containing materials that constitute a high health hazard.

1.6 Construction Type

The Transport Facility and the new Retrieval Facility both have a construction type classification of UBC Type II-F.P. Allowable area for H-7 occupancy Type II-F.P. is 39,900 ft². If auto sprinklered throughout, twice the area is allowed or 79,800 ft² per section 505.3. The Transport Facility has 1,248 ft² of building area, well below the allowable area. The Retrieval Facility has 1,664 ft² of building area, also well below the allowable area.

Occupancy H-7 Type II-F.P. construction requires exterior bearing walls to be four hour fire rated, interior bearing walls to be two hour, permanent partition to be one hour, and structural frame, floors and ceilings to be one hour. Because of the nature of the facility, all walls are concrete and will meet the required fire rating. Doors will need to be fire rated. In the cells, shielding doors and shielding windows will need to be fire rated.

1.7 Facility Ventilation

Each facility containing calcine materials is complete with confinement pressure boundaries (or confinement zones). Each confinement zone is kept at a negative pressure with respect to atmosphere, with the most negative being the calcine containment boundary. Each of the confinement zones is described below. The confinement ventilation system flows are shown on sketch HV-1.

Primary Confinement: Primary confinement zones consist of the calcine bin sets, transport lines, and associated piping and equipment constituting the calcine storage and transport system. This system will be maintained at a negative pressure of at least 1.0 inches water gage with respect to the outside environment. The primary confinement zone equipment is described in the calcine storage, retrieval, and transport sections of the Raytheon Engineers & Constructors study. For primary confinement zone designation see sketch HV-2.

Secondary Confinement: Secondary confinement zones exist around primary confinement zones where it may be reasonably expected that a breach in the primary confinement may occur at some point in time. Examples of such breaches are at the bin-set tie-in points, filters, blowers, separators, etc... Secondary confinement zones include the existing bin-set vaults, vault exhaust ventilation systems up to the exhaust HEPA filters, vault supply ventilation from the inlet HEPA filters, enclosures around the bin-set tie-in equipment, and calcine transport system blower/separator vaults and associated inlet and exhaust ventilation systems up to the HEPA filters. Secondary confinement zones may become primary confinement during operations when the normal primary confinement is opened or breached. Each secondary confinement zone will be maintained at a negative pressure of at least 0.3 inches water gage with respect to the outside environment, and 0.7 inches water gage positive with respect to primary confinement zones. For secondary confinement zone designation see sketch HV-3.

Tertiary Confinement: Tertiary confinement zones exist around secondary confinement zones where it may be reasonably expected that the secondary confinement may have to function as a primary confinement for any reason. Examples of such events are primary zone filter change-out, pump replacement, etc... During these events, the secondary zone will act as a temporary primary confinement boundary, and the tertiary confinement becomes a temporary secondary confinement boundary. Each tertiary confinement zone will be maintained at a negative pressure of 0.1 inches water gage with respect to the outside environment, and 0.2 inches positive with respect to the secondary confinement zones. For tertiary confinement zone designation see sketch HV-4.

Non-Confinement: Administrative areas and control rooms are non-confinement areas of the facilities. These areas will be maintained at positive pressures of approximately 0.1 inches water gage (exact pressure not regulated) with respect to the outside environment, or approximately 0.2 inches positive with respect to tertiary confinement areas. These areas are expected to be "clean" at all times. For non-confinement zone designation see sketch HV-5.

D

C

B

A

NEW RETRIEVAL FACILITY
SEE DWG S-1

EXISTING BIN SET 1
CALCINE BINS

PLOT PL

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SUBCONTRACT NO.		LOCKHEED MARTIN	
REQUESTER		INTEC	
DESIGN: T LANGENWALTER		BIN SET 1 - RETRIEVAL SYSTEM	
DRAWN: KL ANDERSON		CLOSED LOOP SYSTEM	
PROJECT NO.		TRANSPORT PIPE ROUTING	
SPEC CODE		PLOT PLAN	
FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE
SEE DAR NO.		D	01MF3
EFFECTIVE DATE:		AREA	TYPE
		200	1530
		INDEX CODE NUMBER	REV
		DWG-	
		SCALE: 1"=40.0'	SHEET C-1

D

C

B

A

RETRIEVAL FACILITY

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN INTEC BEN SET 1 - RETRIEVAL SYSTEM CLOSED LOOP SYSTEM TRANSPORT PIPE ROUTING RETRIEVAL FACILITY			
REQUESTER: DESIGN: T LANGENWALTER DRAWN: KLA/RLS PROJECT NO. SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. EFFECTIVE DATE:					
DESIGN PHASE: QUALITY LEVEL:		SCALE: NOTED		SHEET S-1			

D

C

B

SECTION

1/4"=1'-0"

A
S-1

File: EN2A.dwg
User: RLX
Date: 09/27/99 - 07:30 A.M.
Plot: S:\Inteca
A

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN				A													
 SCALE: 1/4" = 1'-0"		REQUESTER:		INTEC BIN SET 1 - RETRIEVAL SYSTEM CLOSED LOOP SYSTEM TRANSPORT PIPE ROUTING RETRIEVAL FACILITY																	
		DESIGN: T LANGENWALTER																			
		DRAWN: R L SMITH																			
PROJECT NO.		SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SEE DAR NO.		EFFECTIVE DATE													
DESIGN PHASE:		QUALITY LEVEL:		SIZE		CAGE CODE		INDEX CODE NUMBER		DWG-		REV									
				D		01MF3		AREA		TYPE		Q		I		ORG		DWG-		REV	
								200				51		530							
								SCALE: NOTED				SHEET		S-2

D

C

B

A

CONTAINED TRANSPORT
PIPING RISER

NEW EXHAUST
STACK RISER

BIN SET 6
OUTER WALL

TRANSPORT FACILITY

User: RLX
Date: 09/08/99 - 12:23 P.M.

File: BIN-1.dwg
Path: S:\Ince

SECTION A
1/4" = 1'-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN			
 SCALE: 1/4" = 1'-0"		REQUESTER:		INTEC BIN SET 1 - RETRIEVAL SYSTEM CLOSED LOOP SYSTEM TRANSPORT PIPE ROUTING TRANSPORT FACILITY			
 SCALE: 3/4" = 1'-0"		DESIGN: T LANGERWALTER					
DESIGN PHASE: TITLE II		DRAWN: KLA/RLS					
QUALITY LEVEL: 3		PROJECT NO.		SPEC CODE		REV	
FOR REVIEW/APPROVAL SIGNATURES		SEE DAR NO.		EFFECTIVE DATE:		SIZE: D CASE CODE: 01MF3 AREA: 200 INDEX CODE NUMBER: 511530 DWG- SHEET S-3

R	DOP TEST
	X
	X
	X
	X
	X
	X

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN			
NO SCALE		REQUESTER:		INTEC BIN SET-1 RETRIEVAL SYSTEM VENTILATION FLOW DIAGRAM			
		DESIGN: T LANGENWALTER					
		DRAWN: R L SMITH					
		PROJECT NO.					
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE: D CAGE CODE: 01MF3 AREA: 200 TYPE: 51 CL: 530 DWG-		REV	
DESIGN PHASE:		SEE DAR NO.		SCALE: NONE		SHEET HV-1	
QUALITY LEVEL:		EFFECTIVE DATE:					

D

C

B

A

VACUUM VENTILATION
EQUIPMENT ENCLOSURE

VACUUM COLLECTOR

RETRIEVAL/TRANSFER
EQUIPMENT BUILDING

AHU-3

CONTROL
ROOM

5" Ø RETURN
AIR LINE

5" Ø TRANSPORT LINE

OUTSIDE
AIR

LEGEND

= STACK

= FAN

= SUPPLY
FILTER

= EXHAUST
FILTER

= PRIMARY CONFINEMENT ZONE

= OTHER ZONES

BIN SET 1

Users: RLX
Date: 09/27/99 - 07:42 A.M.
Path: S:\Inlets

File: BIN-4.dwg
Path: S:\Inlets

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN					
NO SCALE		REQUESTER:		INTEC BIN SET-1 RETRIEVAL SYSTEM PRIMARY CONFINEMENT ZONE					
		DESIGN: T. LANGENWALTER							
		DRAWN: R. L. SMITH							
		PROJECT NO.							
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV
QUALITY LEVEL:		SEE DAR NO.		D	01MF3	AREA 1 TYPE	Q. 1 ORG		
EFFECTIVE DATE:				SCALE: NONE		S11530		SHEET HV-2	

D

C

B

A

AHU-3

CONTROL ROOM

5" Ø RETURN AIR LINE

RETRIEVAL/TRANSFER EQUIPMENT BUILDING

5" Ø TRANSPORT LINE

F-1

F-2

F-5

F-6

LEGEND

= STACK

= FAN

= SUPPLY FILTER

= EXHAUST FILTER

= SECONDARY CONFINEMENT ZONE

= OTHER ZONES

BIN SET 1

User: RLX
Date: 09/27/99 - 07:43 A.M.

File: BIN-5.dwg
Path: S:\Inlce

BIN SET 6

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
NO SCALE		REQUESTOR:		INTEC BIN SET-1 RETRIEVAL SYSTEM SECONDARY CONFINEMENT ZONE	
		DESIGN: T. LANGENWALTER			
		DRAWN: R. L. SMITH			
		PROJECT NO.			
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE: CAGE CODE: INDEX CODE NUMBER	
DESIGN PHASE:		SEE DAR NO.		D 01MF3 AREA: 200 TYPE: G. L. ORG. 51.530 DWG-	
QUALITY LEVEL:		EFFECTIVE DATE:		SCALE: NONE	
				SHEET HV-3	

D

C

B

A

**Vault Ventilation
Equipment Enclosure**

Vault Cover

**RETRIEVAL/TRANSFER
EQUIPMENT BUILDING**

AHU-3

CONTROL ROOM

5" Ø RETURN
AIR LINE

5" Ø TRANSPORT LINE

OUTSIDE AIR

BIN SET 1

LEGEND

= STACK

= FAN

= SUPPLY FILTER

= EXHAUST FILTER

= TERTIARY CONFINEMENT ZONE

= OTHER ZONES

User: RLX
Date: 09/27/99 - 07:44 AM

File: BIN-6.dwg
Plot: S:\plots

4

3

2

1

30,000
CFM (1400)

REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE:

BIN SET 6

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN					
NO SCALE		REQUESTER:		INTEC BIN SET-1 RETRIEVAL SYSTEM TERTIARY CONFINEMENT ZONE					
		DESIGN: T LANGENWALTER							
		DRAWN: R L SMITH							
		PROJECT NO.							
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER	DWG-	REV	
DESIGN PHASE:		SEE DAR NO.		D	01MF3	AREA 1 TYPE 200	Q 1 ORG 51	530	
QUALITY LEVEL:		EFFECTIVE DATE:		SCALE: NONE				SHEET HV-4	

4

3

2

1

D

C

B

A

VAULT VENTILATION
EQUIPMENT ENCLOSURE

VAULT COVER

RETRIEVAL/TRANSFER
EQUIPMENT BUILDING

AHU-3

CONTROL
ROOM

F-1

5" Ø RETURN
AIR LINE

5" Ø TRANSPORT LINE

OUTSIDE
AIR

LEGEND

= STACK

= FAN

= SUPPLY
FILTER = EXHAUST
FILTER

= NON CONFINEMENT ZONES

= CONFINEMENT ZONES

BIN SET 1

User: RLX
Date: 09/27/99 - 07:56 A.M.File: BN-7.dwg
Path: S:\Inlec

BIN SET 6

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN INTEC BIN SET-1 RETRIEVAL SYSTEM NON CONFINEMENT ZONE	
NO SCALE		REQUESTER:			
		DESIGN: T LANGENWALTER			
		DRAWN: R L SMITH			
		PROJECT NO.			
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		REV	
DESIGN PHASE:		SEE DAR NO.		REV	
QUALITY LEVEL:		EFFECTIVE DATE:		REV

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN				
NO SCALE	REQUESTER:	HLW-BIN SET 1 TRANSFER FEASIBILITY STUDY PROCESS FLOW DIAGRAM				
	DESIGN: CM NOAKES					
	DRAWN: KL ANDERSON					
	PROJECT NO.					
	SPEC CODE					
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES	SIZE: D	CAGE CODE: 01MF3	INDEX CODE NUMBER: AREA TYPE I CL ORG	DWG-	REV
QUALITY LEVEL:	EFFECTIVE DATE:	SCALE: NONE		SHEET SK-BSI-01

REV.	REVISION DESCRIPTION	APPROVED		
		DATE	UE&C	WNCO
A	DRAFT PHASE 1 SPECIAL STUDIES	01/20/94

VAULT WEATHER ENCLOSURE
PLAN OF EL. (-)4'-11"

DESIGN INTERFACE		DATE	DRAWING STATUS		APPROVALS	DATE
ARCHITECTURAL			DESIGN	DATE	ORIGINATOR	TRE
STRUCTURAL			PHASE	APPROVED	CHECKER	01/25/94
ENVIRONMENTAL					RESPONSIBLE LOC	01/25/94
ELECTRICAL					TASK MANAGER	
INSTRUMENTATION					QA ENGINEER	
MECHANICAL					CHIEF ENGINEER	
PROCESS					LEADS PROJECT MGR.	
PIPING					WMO PROJECT MGR.	
STRESS ANALYSIS						
			QUALITY LEVEL		PROJECT NO. 2354 200	
					SUBCONTRACT NO.	
					ISSUED FOR CONSTRUCTION	
					SCALE 1/4" = 1'-0"	

Raytheon
Engineering & Construction
 A Division of Raytheon Co. 1000
 10000 W. 10th Ave. Suite 1000
 Denver, CO 80202
 TEL: 303.733.1000
 FAX: 303.733.1001

ICPP PHASE 1 SPECIAL STUDIES B.D.G. 729
 BIN SET 1 - RETRIEVAL SYSTEM
 ARCHITECTURAL
 WEATHER ENCLOSURE PLAN/SECTION
 SIZE D (4x11) (1/4" = 1'-0") (1/8" = 1'-0")
 DRAWING NO. 10111
 REV. A
 A/E SHEET NO. 10111-1

8

7

6

5

SECTION

8

7

6

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4

3

2

1

9

REV.	REVISION DESCRIPTION	APPROVED		
		DATE	REAC	WINCO
0	DRAFT PHASE II - SPECIAL STUDIES	09/12/94

VAULT WEATHER ENCLOSURE
PLAN OF EL. (-)3'-2" T.O. NEW CONCRETE SLAB

DESIGN INTERFACE	DATE	DRAWING STATUS	APPROVALS		DATE
ARCHITECTURAL		DESIGN PHASE	ORIGINATOR	THE	09/13/94
STRUCTURAL			CHECKER		09/13/94
ENVIRONMENTAL			RESPONSIBLE LDR		09/13/94
ELECTRICAL			TASK MANAGER		09/13/94
INSTRUMENTATION			QA ENGINEER		
MECHANICAL			CHIEF ENGINEER		
PROCESS			REAC PROJECT MGR.		
PIPING			WMO PROJECT MGR.		
STRESS ANALYSIS					
		QUALITY LEVEL	PROJECT NO. 2354.204		
			SUBCONTRACT NO.		
			ISSUED FOR CONSTRUCTION		
			SCALE 3/16"=1'-0"		
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Lockheed Martin Idaho Technologies Company

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

EDF

for

Design Requirements – Remote Operations and
Maintenance

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program

3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: Design Requirements – Remote Operations and Maintenance

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

This EDF provides the basic approach for remote operations and maintenance philosophies pertinent to the HLW Program concerning the feasibility study for Bin Set 1 calcine retrieval and transport for storage in Bin Set 6. The remote operations philosophy is to use the tele-operated approach with operators looking through shielding type windows directly and/or assisted by strategically placed cameras to assist in viewing to perform operations remotely. Remote maintenance activities will need to be performed in those areas that are not accessible and/or are not suitable for personnel entry to perform hands-on maintenance due to high radiation/contamination levels.

6. Distribution (complete package): B. R. Helm MS 3765, V. L. Jacobson MS 3211, D. B. Lord MS 3211, Project File

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	S. M. Berry		9/20/99
Independent Verification	R	M. J. Ross		9/20/99
Requestor	A	D. A. Lopez		9/20/99

The Binset 1 remote equipment design will include provision for remote replacement of process equipment, which past experience has shown to be prone to failure. Equipment such as tanks, vessels, and piping which have anticipated maintenance intervals of greater than 10 years will be designed for hands-on maintenance where applicable.

General

The terms "remote maintenance" and "remote replacement" are generally used interchangeably. Items requiring remote maintenance for the Bin Set 1 calcine retrieval system will be remotely removed from service, and decontaminated, and maintenance on the item will then be performed hands-on.

Component Configuration and Essential Features for Remote Maintenance

The features of Bin Set 1 calcine retrieval and transport facilities that will promote the remote handling capabilities of these facilities include the following:

- Manipulator/Crane Parking and Maintenance Areas - Shielded areas designed for maintenance of major in-cell remote handling equipment. These areas will have the capability of being isolated and shielded from high radiation/contamination areas during maintenance operations and will permit removal of the major remote handling equipment from the high radiation and contamination areas when the equipment is not being used.
- Remotely Operated Manipulators – Electro Mechanical manipulators with extended reach and intermediate handling capability that can be controlled from one or more locations in an operating corridor.
- Remotely Operated Cranes – Conventional cranes for lifting and transport of heavy items inside the shielded areas of the facility controlled stations adjacent to shielded viewing windows with control transferable from one window to another.
- Shielded Viewing Windows – Stations that permit direct viewing of operational areas inside the shielded cells.
- Remotely Replaceable Lighting – Removable lighting units which provide adequate lighting in the shielded areas. Lighting units are replaced using remote handling equipment.
- Filtered Exhaust Ventilation - A remotely changeable system designed to achieve maximum contamination control by filtering cubicle and corridor ventilation air at its exhaust point. Provisions for increased airflow during hatch removal will be provided. The preferred approach is the top-loading filter system for handling the changeout

The following will also be provided to permit in-cell remote handling operations and to reduce operator exposure where applicable:

- Permanently located lifting devices and scaffolding to aid in direct or remote maintenance operations.
- Tool ports, in-cell tool racks, and tables.
- Decontamination system for external and internal equipment surfaces as well as cell surfaces.

- Quick-disconnect piping connections/remote flanging with captive bolts.
- Controlled entry for personnel access.
- Remotely controlled video-viewing systems.
- Stainless steel lining for the inside corridor surfaces to facilitate decontamination.
- Remote maintenance service stations with remote connectors for utilities needed inside the shielded areas, including air, fluids (water, decontamination solutions) electric and video.

Equipment Items

High maintenance equipment items include valves, pumps, heat exchangers, cell, system off-gas HEPA filters, etc. These items will be grouped into common shielded areas and the areas provided with remote equipment, (e.g., cranes, manipulators, and viewing windows). The remote areas must also be adequately illuminated with remotely replaceable lights, remote maintenance service stations (RMSS)¹, tool-drop ports and worktables where applicable. Closed circuit video capability will also be provided if supplemental viewing is required.

Equipment which is not prone to failure such as tanks, vessels, and calcine transport piping will also be located in shielded cells, vaults, trenches, etc., but those areas will not be equipped to permit remote replacement of these items. Rather, maintenance of these items will be hands-on after appropriate decontamination efforts have been completed. These areas will be equipped for maintenance access and equipment removal without interference from adjacent equipment. Permanently installed working platforms with ladders for maintenance access will be considered on a case-by-case basis. Although certain equipment items are identified as hands-on maintenance items, to reduce operator exposure remote features such as quick-disconnects, remote flanges, captive bolts, and lifting bales may be incorporated into their design if such features are determined to be necessary. The purpose of these features is twofold: a) to permit potential hands-on maintenance activities to proceed more rapidly, and b) to permit remote or partially remote (i.e., overhead crane and overhead manipulator) operations to take place if the radiation fields are expected to be excessively high.

"Skyrights" will be provided to assure equipment accessibility with overhead equipment. In addition, visibility, accessibility, and interferences must be considered during facility design. Center-of-gravity lifting bails will be provided on all remotely removable process equipment (e.g., valves). Remotely removable valves, pumps, and other equipment will be installed on self-aligning jumper assemblies to enhance remote removal and replacement.

Throughout the facility, remote concepts and equipment must be "proven" technology. Development items and unproven state-of-the-art items will not be included in the production facility unless the concepts/equipment can be proven by demonstration prior to incorporation. Remote tooling and equipment provisions must be maintained as practical, straightforward, and simple as possible. Standardization (sizes, shapes, arrangement) will also be maximized.

¹ A centralized grouping of selected utilities located in hot cells that can be accessed (connected/disconnected/used) by manipulators and used to support in-cell remote activities.

To provide remote handling in the retrieval and transport facilities certain remote capabilities are required:

- The capability for viewing and remotely transferring radioactive items and materials as required to maintain personnel radiation exposures to as-low-as-reasonably achievable levels.
- Remote transfer equipment will be accessible for ease of operation and maintenance.
- All in-cell mechanical and electrical equipment (windows, video equipment, manipulators, electrical enclosures, etc.) will be sealed or otherwise protected from penetration of decon solutions and gases.
- In-cell lights for remote cells will be designed for remote replacement.
- Provision will be made for tool storage and worktables as required.
- Closed circuit video will be provided for supplemental viewing with both fixed and movable in-cell support assemblies as necessary.
- Ladders, piping and platforms will provide minimum interference with equipment replacement and will be remotely removable where necessary.
- Remote cell cranes and manipulators will be equipped with retrieval systems. Remote cell cranes will be equipped with remote load lowering devices
- To assure maximum ease and efficiency of remote maintenance of HEPA filters, inspection ports and equipment, each operation will be defined and described in detail. Exact location of remote flanges, bolts and other disconnect devices relative to manipulator operation and viewing will be studied in front, top and side views to verify impact wrench clearances, equipment installation and removal clearances and potential interference problems.
- Decontamination capability will include remotely controlled sprays and wash-down techniques where applicable.
- Remote connectors, bolts, flanges, wrenches, sockets, extensions, and other tooling should be standardized to the extent possible to reduce the need for wrench changes and varied operating envelopes during equipment replacement.
- Equipment will be movable, maintainable and replaceable without disturbing adjacent equipment whenever possible.
- Design of in-cell equipment supports and concrete embedments will consider possible retrofit of alternate transfer/filter equipment.
- Equipment components and subsystems will be of modular design, where possible, to facilitate removal and replacement.
- All remotely serviced equipment will be checked for dimensional fit and proper operation prior to installation.

Retrieval and Transport Facility Requirements

To accommodate remote requirements, these facilities will include the following requirements:

- Incorporation of embedments for viewing windows.
- Complete ceiling hatch access to all cells.
- Incorporation of a bridge crane and electro-mechanical manipulator in the maintenance area.
- Labyrinth cell entryways with utility maintenance service stations (UMSS).²
- A sufficient number of crane and electro-mechanical manipulator control station outlets will be adjacent to viewing windows and other operating locations to permit unrestricted remote operation.
- Dedicated shielded areas, which can be isolated from any radioactive sources, will be provided for parking/maintenance in-cell cranes and electro-mechanical manipulators, to permit hands-on maintenance.

Operational Requirements

A remote handling and replacement (hot) cell, located in the retrieval and transport facilities, will be provided near those processing areas where radiation exposure and radiological hazards justifies the additional facility cost. Failure and/or maintenance prone equipment will be located within this cell. Basic equipment and process design will minimize the total amount of maintenance that will be required. When maintenance or vessel inspection is required, the facility design will provide features that will reduce radiation exposure to personnel to the extent feasible from an operation and cost standpoint. The operational features of such philosophy will include both remote and direct maintenance and will include less emphasis on remote capabilities as the calcine transfer process proceeds with purification of the air transfer stream.

Some of the operational features of this philosophy would include the following remote capabilities:

- Transporting tools, failed equipment, and/or HEPA filters to a shielded decontamination, packaging, and transfer area.
- Maintenance of radiation and contamination control at all times
- Arrangements of equipment to facilitate remote and direct maintenance operations.
- Collection of decontamination solutions for recycle to salvage or waste disposal collection systems.
- Remote replacement of exhaust HEPA filters for the calcine transfer system.
- Adequate lighting, viewing, and utility systems to support remote handling and replacement operations.

² A centralized grouping of selected utilities located in process cell entryways that will be available for use during cells entries

Remote Equipment

Standard remote handling equipment will include bridge-mounted electro-mechanical manipulators and bridge cranes, and jib cranes. The primary usage of this equipment will be the remote replacement of components. All in-cell remote handling equipment will be provided with redundant features and retrieval systems to minimize the effect of failures.

Shielded viewing windows will be used to provide unrestricted viewing of remote operations, and will provide additional viewing angles from adjacent windows where applicable. Remote operating and maintenance tasks will be located within the normal viewing angle of the windows. Remotely replaceable hot-side shields will be provided for the viewing windows where necessary.

Mockups

All remote equipment, and major remote operations, will be mocked up in full scale at the Remote Mockup and Test Facility (RMTF) and tested prior to design completion and procurement. Mockups will include mechanical equipment, remote handling equipment, viewing, and cell sizes and arrangements. Items being checked will include accessibility, interference, visibility, maintainability, operability, transfer routes, and lifting mechanisms and devices.

Maintenance Requirements

The facility will be designed to provide for repair or replacement of any process component while minimizing personnel radiation or contamination exposures, maintenance cost, and downtime. All mechanical equipment, windows, video cameras, and other equipment in potentially radioactive or contamination areas will be sealed or otherwise designed to prevent penetration by contamination and/or decontamination solutions. Materials such as plastics and insulation that degrade in radiation environments will be excluded whenever possible. If used, they will be encased and shielded or otherwise protected from excessive radiation exposure. These materials will be installed for periodic inspection and replacement.

The maintenance philosophy for radioactive calcine transfer retrieval and transport facilities equipment in these facilities will be to replace high maintenance items such as HEPA filters and blowers. These components will be isolated from the system (if required), uncoupled from the system, and removed to a maintenance/decontamination area. The repaired or replacement component will then be reinstalled and returned to service. In selected cases, spare components will be available for service. Direct contact maintenance will be used, for items that are not expected to fail more than once every 10 years and in areas where the component can be decontaminated and expected radiation levels will be minimal.

Equipment will be designed to permit decontamination, inspection, replacement, and/or repair with minimum radiation exposure to personnel. Cells will have provisions for visual inspection or radiation monitoring without exposing the inspector to radiation or contamination hazards. Access ports for transfer of small tools and equipment will be provided in areas requiring remote replacement or repair operations. RMSS will be located in selected remote maintenance cells and will be equipped with remote connectors for electrical, video, air and water utilities.

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

EDF

for

Bin Set 1 Retrieval and Transport Chemical Engineering
Study

Lockheed Martin Idaho Technologies Company

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program

3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: Bin Set 1 Retrieval and Transport Chemical Engineering Study

5. Summary:

An EDF was requested by this feasibility study to validate line sizes in the two-loop design for Alternate 3 in the 1995 Raytheon Study, which is the calcine retrieval and transport of Bin Set 1 to Bin Set 6. Also, sizing two heat exchangers was requested. To validate the line sizes, an idealized energy and material balance (EMB) was required. This was performed on the retrieval loop of Alternate 3 (Raytheon Dwg. SK-F-01) and was found to be beyond the scope of this project in detail. It was then determined to accept the line sizes for the transport loop of Alternate 3 (Raytheon Dwg. SK-F-03) as stated in the Raytheon study without performing a EMB. The study found the initial flow rate insufficient for entraining the calcine, the pipe sizes both undersized and oversized depending on the location in the process, and the heat exchangers and blowers oversized. The study recommends performing a non-idealized EMB on a well-defined design for determining pipe and equipment sizes.

6. Distribution (complete package): B. R. Helm – MS 3765; V. L. Jacobson – MS 3211; D. B. Lord – MS 3211; M. S. Spinti – MS 3650; Frank Lopez - MS 4106; S.A. Davies - MS 3650; D. L. Crandall MS - 3650; J. J. Quigley – MS 3625; D. A. Lopez – MS 3765; C. M. Noakes – MS 3898

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

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Introduction

An EDF was requested by this feasibility study to validate line sizes in the two-loop design for Alternate 3 in the 1995 Raytheon Study, which is the calcine retrieval and transport of Bin Set 1 to Bin Set 6. Also, sizing two heat exchangers was requested. To validate the line sizes, an idealized energy and material balance (EMB) was required. This was performed on the retrieval loop of Alternate 3 (Raytheon Dwg. SK-F-01) and was found to be beyond the scope of this project in detail. It was then determined to accept the line sizes for the transport loop of Alternate 3 (Raytheon Dwg. SK-F-03) as stated in the Raytheon study without performing a EMB. The primary recommendations resulting from this study are as follows.

1. Perform a complete, non-idealized EMB for the Conceptual Design Report effort. The current EMB is based on a closed system. Bin Set 1 actually has a vent opened to the atmosphere, that, when combined with the thermal inertia of the earth, keeps Bin Set 1 at a slight vacuum. There is also an air take-off line downstream of the retrieval heat exchanger that must be taken into account. In addition to this, SK-F-01 does not accurately depict Point X as having a flexible hose with a nozzle, but rather as an abruptly ending pipe.
2. After performing a complete non-idealized EMB, resize the retrieval heat exchanger. It is estimated that the blower adds approximately 47,000 BTUs to the system, while the heat exchanger, with its sizing based on bringing the temperature down from 803°R to 540°R rather than on balancing energy, removes approximately 129,000 BTUs.
3. Increase the retrieval air velocity to 127 ft/sec. The Raytheon report sets the retrieval air velocity at 66 ft/sec.
4. Reduce the size of the blower on the retrieval line. The current design recycles 75% of the air out of the blower immediately back into the blower. This represents a significant waste of energy.
5. Change the design to use the following line sizes:
Points A – D: 2.5", Sch. 40 pipe
Points E – H: 5" nominal
Points J – L: 5" nominal
Points N – P: 5" nominal
Points R – T: 5" nominal
Points U – W: 1" nominal

This study did validate that the discharge velocity of the air returned to Bin Set 1 is approximately 800 ft/s and produces no shockwave inside Bin Set 1 as sonic velocity is not attained. This is desirable velocity for blowing the calcine from the discharge side of the bin to the retrieval side. The mass flow rate calculated at this point represents the maximum, with any value below that maximum being acceptable.

Customer Requirements

Customer Requirements for the March 1995 Raytheon study of Bin Set Transfer:

1. Define the chemical engineering concerns;
 - a. piping system
 - b. sizing
 - c. flow rate, pressure requirements
 - d. materials of construction
 - e. fabrication/installation details
 - f. cooler sizing
2. Validate/update data and technology; and
3. Include details/strategy that would make for a successful technical services procurement document for a Conceptual Design Report (CDR).

Assumptions

1. This is a nuclear facility according to DOE O 425.1A.
2. The calcine is not fissionable or is a criticality accident hazard per Lopez 4/14/99 EMAIL.
3. This is NOT considered either an explosive- or flammable-hazardous action.
4. This is a DOE Hazard Code 2 as per DOE-STD-1027.

Suggested Procurement Strategy

1. Write a Safety Analysis Report prior to writing a procurement package.
2. Let the vendor perform the calculations/design, and let LMITCO concur. Include a complete EMB in doing these calculations/design.
3. Determine if this is to be an equipment/services procurement or an equipment-only procurement. Consider the consequences of each. An equipment/services procurement puts responsibility of making the installed product work, but you have to deal with on-site subcontractor liabilities and potential labor issues. The DOE customer typically favors the equipment/services approach as it is considered privatization. An equipment-only procurement puts the installation and start-up responsibility on LMITCO, but there are no on-site subcontractor liabilities or labor issues.
4. Be sure the requirements include availability of utilities, such as water for coolant in the heat exchanger and electricity for motors.

Chemical Engineering Concerns

Per LMITCO A/E Standard, Section 15404 – Process Piping – ASME/ANSI B31.3 – Chemical Plant and Petroleum Refinery Piping – is to be used for the calcine transfer.

According to ASME B31.3, this is a Category TA application where bulk solids are transported by air. Two types of material are to be used: Nitronic 50 and Stainless Steel 304L.

The INEEL A/E standard states that for the calcine, Nitronic 50 pipe is to be used, and the reasoning behind this is for Halide resistance and material that is abrasion-resistant to continuous particulate impingement.¹ The 1995 Raytheon study lists double-walled pipe made of stainless steel. The concerns with the Raytheon approach are:

1. If double-walled stainless steel is used, how susceptible to breach is the inner pipe?
2. If the stainless steel pipe is breached, what measurement(s) would you take to know it? How big of a breach would it take to be able to measure that parameter(s)?
3. If material leaked from the inner pipe to the outer pipe, how would it be cleaned? Have these procedures been written yet?
4. If material did leak to the outer pipe, how susceptible to breach is the containment pipe?
5. If Nitronic 50 piping must be used, is it still commercially available? If no, what would serve as a substitute?
6. Would it be feasible to NOT use Nitronic 50 pipe on the return line where there should be no calcine abrasion?

There are at least two sources for commercially available Nitronic 50 piping. The web addresses of these companies are:

<http://pyacht.com/nitronic.htm> – Performance Yacht Gibb Phone: (410) 268-9696

<http://www.electralloy.com/nit.htm> – ElectraAlloy Phone: (800) 458-7273

However, halides were only in the solution form of the SBW, and, after calcination, there were no halides in the calcine flakes, so 304L can be used for the nitric acid².

The data that is to be validated is found in the Raytheon Table 4-1³.

¹ Jolley, Dale to Clemence Noakes; telephone conversation during the fourth quarter of FY 1999.

² Swenson, Mike to Clemence Noakes; telephone conversation during the fourth quarter of FY 1999.

³ Raytheon Engineers & Constructors, Inc., *ICPP Bin Set 1 Calcine Recovery Project, Phase I & II*, March 1995, pg. 4-154.

Raytheon Table 4-1. Transport System Comparison: Closed Loop Data

Design Features	Closed Loop Data	Verification/Commentary
Retrieval Pipe Dia. (in)	2	2" or 2.5" o.k.
Return Pipe dia. (in)	6	From Dwg. SK-F-03, which was not analyzed
Retrieval Air (ACFM @ Cyclone)	120	Resize blower; present requirement is 5.11 ACFS
Retrieval Air (ΔP in Hg @ blower)	9	Present design has 2.39 psi as ΔP from entrance to blower
Retrieval Air (Blower HP)	7.5	Present design has 57.4 BHP, which is way too much
Retrieval rate (510 lbs/hr for Zirconia-based calcine);	500 lbs/hr	o.k.
calcine bulk density	1.1 gm/cm ³	o.k.
particle density	2.61 gm/cm ³	o.k.
calcine inlet velocity	66.7 ft./sec	Must increase to 127 ft/sec
transport system rate must equal or exceed the retrieval rate	N/a	Transport system not analyzed, but mass in must equal mass out, regardless of the speed.
maximum pressure drop allowable	80 in water	Transport system not analyzed, therefore this cannot be validated
transport pipe	schedule 40 SS	field-approved ⁴

From a November 19, 1997, memo⁵, the following information is obtained:

1. The inlet pressure is 12.3 psia; and
2. The total equivalent length of pipe (retrieval + transport) between Bin Set 1 and Bin Set 6 is 315 ft. The total equivalent length of pipe (return) is also 315 ft. This information is useful for future EMB calculations involving the Transport System of Dwg. SK-F-03.

The following assumptions are made:

1. The air/particle mixture is Neutonian;
2. Turbulent flow will be used for maximum drag; and
3. The individual particles are rigid spheres.

Transport Heat Exchanger Sizing:

"A heat exchanger is located at the discharge of the conveying air blower. The discharge temperature of the blower is estimated to be above 225°F. The heat exchanger maintains an inlet air temperature through the transport line and back into the conveying air blower below 100°F. this allows the blower to operate within the manufacturer's specifications. This is shown diagrammatically on SK-F-03 for the Closed Loop System."⁶

⁴ Swenson, Mike to Clemence Noakes; telephone conversation during the fourth quarter of FY 1999.

⁵ Griffith, Dan to Sara Gifford; personal communication dated November 19, 1997, "Subject: Pressure Drop in Proposed Pneumatic Transport System".

⁶ Raytheon March 1995; *ICPP Phase I & II Special Studies Calcine Recovery Bin Set #1 Project*, Vol. 1, pg. 4-151.

As the referenced inlet temperature of the process air⁷ is above 225°F, let the design be based on $T_{IN-P} = 250^{\circ}\text{F}$. The referenced outlet temperature of the process air is below 100°F; therefore, let the design be based on $T_{OUT-P} = 80^{\circ}\text{F}$. Water for coolant is available at 55°F, 70 psig, and whatever flowrate is required.⁸

In determining the Log Mean Temperature Differential:

$$\Delta T_2 = \text{Greater Terminal } \Delta T = \Delta T_{IN-P} - \Delta T_{OUT-C} = 250^{\circ}\text{F} - 90^{\circ}\text{F} = 160^{\circ}\text{F}$$

$$\Delta T_1 = \text{Lesser Terminal } \Delta T = \Delta T_{OUT-P} - \Delta T_{IN-C} = 80^{\circ}\text{F} - 55^{\circ}\text{F} = 25^{\circ}\text{F}$$

$$\Delta T_M = \text{Log Mean } \Delta T = \frac{(\Delta T_2 - \Delta T_1)}{\ln(\Delta T_2/\Delta T_1)} = \frac{(160^{\circ}\text{F} - 25^{\circ}\text{F})}{\ln(160^{\circ}\text{F}/25^{\circ}\text{F})} = \frac{135^{\circ}\text{F}}{1.86} = 73^{\circ}\text{F}$$

The typical overall heat exchanger coefficient for a tubular heat exchanger with shellside water and tubeside compressed air is between 20 – 40 BTU/(hr•ft²•°F)⁹. For the purposes of this design, the median value of 30 BTU will be used.

A 10-ft long TEMA Type P 1-pass heat exchanger with a 1"OD tube, 10" ID shell has 30 tubes.¹⁰ Calculating the outside area of the tubes yields the following:

$$A_o = \pi d L = \frac{(\pi) (1 \text{ in/tube}) (1 \text{ ft}) (30 \text{ tubes}) (10 \text{ ft})}{(12 \text{ in})} = 78.5 \text{ ft}^2$$

$$Q = U_o A_o \Delta T_M = (30 \text{ BTU}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})) (78.5 \text{ ft}^2) (73^{\circ}\text{F}) = 172,002 \text{ BTU/hr}$$

⁷ *Ibid.*, pg. 4-151.

⁸ Law, Jim to Clemence Noakes; telephone conversation during the fourth quarter of FY 1999.

⁹ Robinson, R. N.; *Chemical Engineering Reference Manual*, 4th Edition, Professional Publications; Table 7.8 – Typical Overall Heat Transfer Coefficients in Tubular Heat Exchangers; pg. 7-13.

¹⁰ Perry, Robert H. and D. Green; *Perry's Chemical Engineers' Handbook*, 6th Edition; McGraw-Hill Publications; Table 11-3 – Tube-Sheet Hole Count; pg. 11-15.

Mass, Flow, and Pressure Summary - Loop 1 - Dwg. SK-F-01

	A	B	C	E	G	J	K	L	N	O	P	Q	R
1	Point on Dwg. SK-F- 01	Composition	air pressure (psia)	Air Temp (F)	Air Viscosity (cP)	air specific volume (cu.ft./lbs)	air density (lbs/cu.ft)	Cross Sectional Area of Container (ft ²)	Air Volumetric Flow (acfs)	Air Linear Flow Rate (ft/sec)	Air Mass Flow (lb/sec)	Air Mass Flux (lb _m /sec•ft ²)	Reynolds Number Air
2	A, pg. 2-2	calcine + air	12.30	80.0	1.85E-02	16.2	6.16E-02	0.033	4.23	127.2	0.260	7.831	108,496
3	B, pg. 2-2	calcine + air	12.30	80.0	1.85E-02	16.2	6.16E-02	0.033	4.23	127.2	0.260	7.831	108,496
4	C, pg. 2-2	calcine + air	12.30	80.0	1.85E-02	16.2	6.16E-02	0.033	4.23	127.2	0.260	7.831	108,496
5	D-E, pg. 2-2	calcine + air	10.90	61.7	1.85E-02	17.7	5.65E-02	0.033	4.60	138.5	0.260	7.821	108,366
6	F, pg. 2-4	air	10.90	61.6	1.85E-02	17.7	5.65E-02	0.139	4.61	33.2	0.260	1.874	63,412
7	G-H, pg. 2-6	air	10.89	61.6	1.85E-02	17.7	5.64E-02	0.139	4.62	33.3	0.261	1.879	63,585
8	I, pg. 2-8	air	10.89	61.6	1.61E-02	17.7	5.64E-02	2.638	4.60	1.7	0.260	0.098	9,103
9	J, pg. 2-10	air	10.89	61.5	1.61E-02	17.7	5.64E-02	0.139	4.61	33.2	0.260	1.874	72,831
10	K, pg. 2-12	air	10.89	61.5	1.61E-02	17.7	5.64E-02	0.139	4.62	33.3	0.261	1.879	73,030
11	L, pg. 2-12	air	10.89	61.5	1.61E-02	17.7	5.64E-02	0.139	4.62	33.3	0.261	1.879	73,030
12	M, pg. 2-14	air	10.84	61.5	1.61E-02	17.8	5.62E-02	1.000	4.64	4.6	0.261	0.261	24,091
13	N, pg. 2-15	air	10.84	61.4	1.61E-02	17.8	5.62E-02	0.139	4.64	33.4	0.260	1.876	72,921
14	O, pg. 2-17	air	10.82	61.2	1.61E-02	17.8	5.61E-02	0.139	4.64	33.4	0.260	1.874	72,844
15	P, pg. 2-17	air	10.82	61.2	1.61E-02	17.8	5.61E-02	0.139	4.64	33.4	0.260	1.874	72,844
16	Q, pg. 2-19	air	blower	blower	blower	blower	blower	blower	blower	blower	blower	blower	blower
17	R, pg. 2-19	air	37.00	249.0	2.32E-02	7.1	0.1410	0.139	1.85	13.3	0.260	1.876	50,606
18	S, pg. 2-20	air	37.00	342.9	2.32E-02	8.0	0.1245	0.139	2.09	15.1	0.260	1.876	50,598
19	T, pg. 2-20	air	36.99	342.9	2.32E-02	8.0	0.1245	0.139	2.09	15.1	0.260	1.874	50,554
20	U, pg. 2-21	air	36.05	80.0	1.85E-02	5.5	0.1804	0.399	1.44	3.6	0.260	0.650	37,299
21	V, pg. 2-25	air	36.05	80.0	1.85E-02	5.5	0.1804	0.006	1.44	239.9	0.260	43.286	2,483,682
22	W, pg. 2-25	air	12.30	80.0	1.85E-02	11.9	0.0837	0.006	4.76	793.4	0.398	66.410	3,810,498
23	X, pg. 2-9	air	12.30	8.6	1.85E-02	14.1	0.0709	13.628	4.22	0.3	0.300	0.019	1,262
24													
25	Page 4-152 of the March 1995 Raytheon Report, Vol. I, sets the design requirement of 500 lb/hr. of calcine being conveyed. This works out to 0.139 lb. Calcine/hr. Page 4-70 of this same												
26	report states that the calcine bulk density is 1.1 gms/cm ³ . The particle density is found to be 2.61 gms/cm ³ . This section also states that the calcine inlet velocity was set at 4000 ft/min (67												
27	ft/sec); this speed was found to be inadequate and was changed to 127 ft/sec. The terminal velocity for each individual particle was found to be 13.38 ft/sec. The required entrainment												
28	flow rate is well above this.												
29	Air viscosity is found from Table 3-309, Perry's 6th Edition.												
30													
31	Pg. 212 of Bennet & Meyer states, "If the downstream velocity becomes very large, the kinetic energy term, which has been omitted in the above equations (e.g., fanning friction factor)												
32	becomes important. As the relative pressure drop rises above 20 to 30 percent, so-called compressibility effects become important; the velocity in adiabatic flow in a uniform pipe cannot												
33	exceed the velocity of sound."												
34													
35													

Perry's 6th has a section on preliminary design for conveying solids on pg. 7-20. By using the given nomographs, conservative approximations of conveyor size and power for a given product bulk density, conveyor equivalent length, and required capacity can be obtained.

Step 1: To begin preliminary calculations, first determine the equivalent length of the system being considered. From Bennet and Myers, 2nd Ed., Figure 14-3, the equivalent lengths for a 2.5" pipe are:

Ordinary Entrance: 3.5 ft

Standard Tee with side outlet: 15 ft

Sudden Enlargement, $d/D = 2.5/9.25 = 6$ ft

Assumption: 40 ft of pipe with one entrance (3.5 ft) + one square elbow (15 ft) + one sudden enlargement (6 ft) equals 64.5 ft = L.

Step 2: The second step consists of choosing from Table 7-13 (Perry's 6th) an initial air velocity that will move the product. The bulk density is 1.1 gm/cm³ or 68.67 lbm/ft³. Via interpolation, this gives a required velocity of 7634 ft/min or 127 ft/sec. To accommodate the required calcine flow rate of 500 lbm/hr, the air mass flow rate must be 0.260 lbm/sec. To achieve this at a starting pressure of 12.3 psia and 80°F, a pipe size of 2.5 inches is required.

Step 3: Referring now to Nomograph 1 (Perry's 6th ed, Fig. 7-13), draw a straight line between the air-velocity and the pipe-diameter scales so that when the line is extended it will intersect the air-volume scale at a certain point. The volumetric air flow required is 275 ft³/min.

Step 4: Turn now to Nomograph 2 and locate in their respective scales the air volume and the calculated system capacity. A straight line between these two points intersects the scale in between them, thus providing at the intersection point the value of the solids ratio. In calculating the system capacity, 500 lbm/hr calcine (given) plus 1020 lb/hr air or 1520 lbm/hr total (see below) is required. The design capacity should have the required amount at its 75% point, making the design capacity 2026 lbm/hr. This yields a solids ratio of 2:1.

air density @ initial conditions	6.16E-02 lb/ft ³
air volumetric flow	275 ft ³ /min
air mass flow, minutes	1.69E+01 lb/min
air mass flow, hours	1.02E+03 lb/hr

Step 5: Locate in Nomograph 3 the pipe diameter and the air volume found in Nomograph 1. A line between these two points yields the design factor. This gives the design factor being approximately 180.

Step 6: Locating now in their respective scales on Nomograph 4 the design factor and the calculated equivalent length, draw an extended straight line to intersect the pivot line in the center. Now connect this point in the pivot line with the solids-ratio scale and read the system pressure loss. This yields a system pressure loss of approximately 1.4 psi. With the decrease in pressure comes an associated decrease in temperature, which is found via the adiabatic expansion equation.

Original
Temperature
Equation

$$\frac{T_1}{T_0} = \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$$

Eqn. 5-93
Perry's 6th

$T_1 = T_{\text{CYCLONE}}$	522
$T_0 = T_{\text{BIN}}$	540
$P_1 = P_{\text{CYCLONE}}$	10.90
$P_0 = P_{\text{BIN}}$	12.30
k	1.4

HOW POINT F WAS DETERMINED:

Bernoulli's equation with equivalent lengths of pipe was used to determine the pressure drop. Bennet & Meyers, 2nd ed, pg. 198, show $d/D = 0.5$ as being 8 equivalent lengths for $d = 5"$. This pressure drop was found to be negligible; therefore the temperature was assumed to have changed negligibly. The ideal gas law was used to find the specific volume of the air at these conditions inside the cyclone.

Details on the dimensions of the cyclone can be found on dwg. SK-M-01, which is in Appendix D. The volume in the "F" section is $1.85E-02$ cu.ft. This diameter, however, reducing from 4" to 3" is unsuitable. It is recommended (and thus calculated) that the 4" x 3" pipe reducer be deleted, and the 4" cap replaced with a 5" cap.

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

$$h_L = \frac{4fLF^2}{2Dg_c}$$

$$f = 0.04/N_{RE}^{0.16}$$

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.2
$\rho_{IN} = \rho_{OUT}$ (lb/cu.ft.)	ρ	$5.65E-02$
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.2599106
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	63,427

Mass, Temperature, and Pressure at Point F, Dwg. SK-F-01

D (ft)	D	0.4205833	
L (ft)	L	8	
z _{IN} (ft)	z _{IN}	0	
z _{OUT} (ft)	z _{OUT}	0.5	
P _{IN} (lb _f /in ²)	P _{IN}	10.90	
gravitational constant (lb _m •ft/lb _f •sec ²)	g _c	32.2	
Excel equation for P _{OUT} , absolute (lb _f /in ²)	P _{OUT}	10.90	
Excel equation for h _L (ft)	h _L	8.88	
Excel equation for f	f	0.01	
$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$			
Temperature In Pipe			
Variables/ Constants		Value	
ratio of gaseous specific heats (C _p /C _v)	k	1.4	
temperature in (°R)	T ₀	521.67481	
temperature out (°R)	T ₁	521.62	
pressure in, absolute (lb _f /in ²)	P ₀	10.90	
pressure out, absolute (lb _f /in ²)	P ₁	10.90	
mass flux (lb _m /sec•ft ₂)	G	1.8743828	
maximum mass flux (lb _m /sec•ft ₂)	G ⁰	3.05	
gravitational constant (lb _m •ft/lb _f •sec ²)	g _c	32.2	
gas constant ((lb _f •ft ³)/(in ² •lbmol•°R))	R	10.73	
molecular weight (lb _m /lb _m mol)	M	29	
Excel equation for Temperature Out (°)	T ₁	521.62	
Excel equation for Temperature In (°R)	T ₀	521.67	
Excel equation for Maximum Flux (lb _m /sec•ft ²)	G ⁰	3.05	

Mass, Temperature, and Pressure at Points G H, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

HOW POINT G WAS DETERMINED:

The methodology used in Point G is the same as that used in Point F. $L = 4'$ pipe + $6'$ entrance.

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

$$h_L = \frac{4fLF^2}{2Dg_c}$$

$$f = 0.04/N_{RE}^{0.16}$$

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.2
$\rho_{IN} = \rho_{OUT}$	ρ	5.65E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.260275
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	63,412
D (ft)	D	0.420583
L (ft)	L	10
z_{IN} (ft)	z_{IN}	0
z_{OUT} (ft)	z_{OUT}	0
P_{IN} (lb _f /in ²)	P_{IN}	10.90
gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	10.89
Excel equation for h_L (ft)	h_L	11.10
Excel equation for f	f	0.01

Mass, Temperature, and Pressure at Points G H, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

			$\frac{k-1}{k}$
Temperature In Pipe	$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$		
Variables/ Constants		Value	
ratio of gaseous specific heats (C_p/C_v)	k	1.4	
temperature in large chamber (°R)	T_0	521.6245	
temperature in pipe (°R)	T_1	521.56	
pressure in large chamber, absolute (lb_f/in^2)	P_0	10.90	
pressure in pipe, absolute (lb_f/in^2)	P_1	10.89	
mass flux ($lb_m/sec \cdot ft_2$)	G	1.874383	
maximum mass flux ($lb_m/sec \cdot ft_2$)	G^0	3.05	
gravitational constant ($lb_m \cdot ft/lb_f \cdot sec^2$)	g_c	32.2	
gas constant ($(lb_f \cdot ft^3)/(in^2 \cdot lbmol \cdot ^\circ R)$)	R	10.73	
molecular weight (lb_m/lb_mol)	M	29	
Excel equation for Temperature Out (°)	T_1	521.56	
Excel equation for Temperature In (°R)	T_0	521.62	
Excel equation for Maximum Flux ($lb_m/sec \cdot ft^2$)	G^0	3.05	

Mass, Temperature, and Pressure At Point I
(See Pall Corp. Cut Sheets in Appendix for Equations)

HOW POINT I WAS DETERMINED:

Data on sintered metal filter is from Pall Corporation, and the vendor literature is in Appendix D. Jet pulse/reverse flow is assumed. It is assumed that a medium grade filter PH is required. A 14" diameter filter is needed. The temperature differential was determined using the adiabatic equation.

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.3
$\rho_{IN} = \rho_{OUT}$	ρ	5.64E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.260984
K_V	K_V	2.40E-05
K_M	K_M	2
Q (acfm)	Q	277.44
μ (cP)	μ	1.85E-02
Required Filter Area = $[Q \text{ ACFM} / (10 \text{ acfm/ft}^2)] \text{ (ft}^2\text{)}$	RFA	27.74401
P_{IN} (lb _f /in ²)	P_{IN}	10.89
Element Quantity = FA/4	EQ	6.936003
Actual Filter Area = $[\text{No. GS Elements} * (4 \text{ acfm/ft}^2)] \text{ (ft}^2\text{)}$	AFA	40
Actual Flow Density = $Q / \text{AFA} \text{ (acfm/ft}^2\text{)}$	AFD	6.936003
$\Delta P = [K_V \cdot r \cdot Q^2 + K_M \cdot \mu \cdot (Q / \text{AFA})] \text{ (psi)}$	ΔP	3.61E-01
P_{OUT} (lb _f /in ²)	P_{OUT}	10.53
<div style="display: flex; align-items: center; justify-content: center;"> <div style="text-align: center;"> <p>Temperature</p> <p>In Pipe</p> </div> <div style="margin: 0 20px;"> $T_1 = T_0$ </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> $\frac{P_1}{P_0}$ </div> <div style="margin-left: 20px;"> $\frac{k-1}{k}$ </div> </div>		
Variables/ Constants		Value
ratio of gaseous specific heats (C_P/C_V)	k	1.4

Mass, Temperature, and Pressure At Point I
(See Pall Corp. Cut Sheets in Appendix for Equations)

temperature in (°R)	T_0	521.565
temperature out (°R)	T_1	516.57
pressure in, absolute (lb_f/in^2)	P_0	10.89
pressure out, absolute (lb_f/in^2)	P_1	10.53
mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G	0.09849
maximum mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G^0	3.05
gravitational constant ($\text{lb}_m \cdot \text{ft}/\text{lb}_f \cdot \text{sec}^2$)	g_c	32.2
gas constant ($(\text{lb}_f \cdot \text{ft}^3)/(\text{in}^2 \cdot \text{lbmol} \cdot ^\circ\text{R})$)	R	10.73
molecular weight ($\text{lb}_m/\text{lb}_m\text{mol}$)	M	29
Excel equation for Temperature Out (R°)	T_1	516.57
Excel equation for Temperature In(°R)	T_0	521.56
Excel equation for Maximum Flux ($\text{lb}_m/\text{sec} \cdot \text{ft}^2$)	G^0	3.05

Mass, Temperature, and Pressure at Point J, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

HOW POINT J WAS DETERMINED:

The methodology used for Point J was the same as that for Point F.

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

$$h_L = \frac{4fL F^2}{2Dg_c}$$

$$f = 0.04 / N_{RE}^{0.16}$$

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

Variables/ Constants	Value	
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.2
$\rho_{IN} = \rho_{OUT}$	ρ	5.64E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.25978
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	72,844
D (ft)	D	0.42058
L (ft)	L	6
z_{IN} (ft)	z_{IN}	0
z_{OUT} (ft)	z_{OUT}	0
P_{IN} (lb _f /in ²)	P_{IN}	10.89
gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	10.89
Excel equation for h_L (ft)	h_L	6.51

Mass, Temperature, and Pressure at Point J, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

Excel equation for f	f	0.01
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Temperature
In Pipe

$$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$$

Variables/ Constants		Value
ratio of gaseous specific heats (C_p/C_v)	k	1.4
temperature in ($^{\circ}\text{R}$)	T_0	521.565
temperature out ($^{\circ}\text{R}$)	T_1	521.53
pressure in, absolute (lb_f/in^2)	P_0	10.89
pressure out, absolute (lb_f/in^2)	P_1	10.89
mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G	0.09849
maximum mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G^0	3.05
gravitational constant ($\text{lb}_m \cdot \text{ft}/\text{lb}_f \cdot \text{sec}^2$)	g_c	32.2
gas constant ($(\text{lb}_f \cdot \text{ft}^3)/(\text{in}^2 \cdot \text{lbmol} \cdot ^{\circ}\text{R})$)	R	10.73
molecular weight ($\text{lb}_m/\text{lb}_m\text{mol}$)	M	29
Excel equation for Temperature Out ($^{\circ}\text{R}$)	T_1	521.53
Excel equation for Temperature In ($^{\circ}\text{R}$)	T_0	521.56
Excel equation for Maximum Flux ($\text{lb}_m/\text{sec} \cdot \text{ft}^2$)	G^0	3.05

Mass, Temperature, and Pressure at Points K - L, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

$$h_L = \frac{4fLF^2}{2Dg_c}$$

$$f = 0.04/N_{RE}^{0.16}$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

HOW POINTS K - L WERE DETERMINED:

The methodology used for Points K - L was the same as that for Point F. $L = 4' + 6'$ entrance loss.

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.20
$\rho_{IN} = \rho_{OUT}$	ρ	5.64E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.043
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	72831.38
D (ft)	D	0.420583
L (ft)	L	10
z_{IN} (ft)	z_{IN}	0
z_{OUT} (ft)	z_{OUT}	0
P_{IN} (lb _f /in ²)	P_{IN}	10.89
gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	10.89
Excel equation for h_L (ft)	h_L	10.86
Excel equation for f	f	0.01
Variables/ Constants		Value
ratio of gaseous specific heats (C_P/C_V)	k	1.4
temperature in large chamber (°R)	T_0	521.53
temperature in pipe (°R)	T_1	521.47
pressure in large chamber, absolute (lb _f /in ²)	P_0	10.89
pressure in pipe, absolute (lb _f /in ²)	P_1	10.89
mass flux (lb _m /sec•ft ₂)	G	1.873534

Mass, Temperature, and Pressure at Points K - L, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

Temperature
In Pipe

$$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$$

maximum mass flux (lb _m /sec•ft ₂)	G ⁰	3.05
gravitational constant (lb _m •ft/lb _f •sec ²)	g _c	32.2
gas constant ((lb _f •ft ³)/(in ² •lbmol•°R))	R	10.73
molecular weight (lb _m /lb _m mol)	M	29
Excel equation for Temperature in Pipe (°)	T ₁	521.47
Excel equation for Maximum Flux (lb _m /sec•ft ²)	G ⁰	3.05

Mass, Temperature, and Pressure at Point M, Dwg. SK-F-01
(See Appendix A for Adiabatic Equations)

HOW POINT M WAS DETERMINED:

Vendor literature was used to determine the pressure drop at Point M. A 4" Pureform Filter Element Model CC-D having 125 cfm capacity and 1.3"HOH resistance is assumed from pg. 5 of the Flanders Nuclear-Grade HEPA filters. This filter is 12" H x 12" W x 5-7/8" D. Adiabatic temperature drop was then determined.

Variables/ Constants		Value
ratio of gaseous specific heats (C_p/C_v)	k	1.4
temperature in ($^{\circ}\text{R}$)	T_0	522.12
temperature out ($^{\circ}\text{R}$)	T_1	521.47
pressure in, absolute (lb_f/in^2)	P_0	10.89
pressure out, absolute (lb_f/in^2)	P_1	10.84
mass flux ($\text{lb}_m/\text{sec}\cdot\text{ft}_2$)	G	1.878653
maximum mass flux ($\text{lb}_m/\text{sec}\cdot\text{ft}_2$)	G^0	3.04
gravitational constant ($\text{lb}_m\cdot\text{ft}/\text{lb}_f\cdot\text{sec}^2$)	g_c	32.2
gas constant ($(\text{lb}_f\cdot\text{ft}^3)/(\text{in}^2\cdot\text{lbmol}\cdot^{\circ}\text{R})$)	R	10.73
molecular weight ($\text{lb}_m/\text{lb}_m\text{mol}$)	M	29
Temperature out (R°)	T_1	521.47
Excel equation for Temperature in ($^{\circ}\text{R}$)	T_0	522.12
Excel equation for Maximum Flux ($\text{lb}_m/\text{sec}\cdot\text{ft}^2$)	G^0	3.04

Mass, Temperature, and Pressure at Point N, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

$$h_L = \frac{4fLF^2}{2Dg_c}$$

$$f = 0.04/N_{RE}^{0.16}$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.3
$\rho_{IN} = \rho_{OUT}$	ρ	5.62E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.26064
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	72,715
D (ft)	D	0.42058333
L (ft)	L	6
z_{IN} (ft)	z_{IN}	0
z_{OUT} (ft)	z_{OUT}	0
P_{IN} (lb _f /in ²)	P_{IN}	10.84
gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	10.84
Excel equation for h_L (ft)	h_L	6.55
Excel equation for f	f	0.01

Temperature
In Pipe

$$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$$

Mass, Temperature, and Pressure at Point N, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

Variables/ Constants		Value
ratio of gaseous specific heats (C_p/C_v)	k	1.4
temperature in large chamber ($^{\circ}\text{R}$)	T_0	521.471822
temperature in pipe ($^{\circ}\text{R}$)	T_1	521.44
pressure in large chamber, absolute (lb_f/in^2)	P_0	10.84
pressure in pipe, absolute (lb_f/in^2)	P_1	10.84
mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G	0.26064
maximum mass flux ($\text{lb}_m/\text{sec} \cdot \text{ft}_2$)	G^0	3.03
gravitational constant ($\text{lb}_m \cdot \text{ft}/\text{lb}_f \cdot \text{sec}^2$)	g_c	32.2
gas constant ($(\text{lb}_f \cdot \text{ft}^3)/(\text{in}^2 \cdot \text{lbmol} \cdot ^{\circ}\text{R})$)	R	10.73
molecular weight ($\text{lb}_m/\text{lb}_m\text{mol}$)	M	29
Excel equation for Temperature in Pipe ($^{\circ}$)	T_1	521.44
Excel equation for Temperature in Large Chamber ($^{\circ}\text{R}$)	T_0	521.47
Excel equation of Pressure in Pipe, absolute (lb_f/in^2)	P_1	10.84
Excel equation of Pressure in Large Chamber, absolute (lb_f/in^2)	P_0	10.84
Excel equation for Maximum Flux ($\text{lb}_m/\text{sec} \cdot \text{ft}^2$)	G^0	3.03

Mass, Temperature, and Pressure at Points O - P, Dwg. SK-F-01
(See Appendix B for Bernoulli Equations)

$$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$$

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

$$h_L = \frac{4fLF^2}{2Dg_c}$$

$$f = 0.04/N_{RE}^{0.16}$$

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

HOW POINTS O - P WERE DETERMINED:

The methodology used for Points K - L was the same as that for Point F. L = 4' + 6' entrance loss.

Temperature
In Pipe

$$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$$

Variables/ Constants		Value
$F_{IN} = F_{OUT}$ (ft/sec)	F	33.40
$\rho_{IN} = \rho_{OUT}$	ρ	5.62E-02
$M_{IN} = M_{OUT}$ (lb _m /sec)	M_{MASS}	0.2602
$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	72921.11
D (ft)	D	0.42058
L (ft)	L	10
z_{IN} (ft)	z_{IN}	0
z_{OUT} (ft)	z_{OUT}	0
P_{IN} (lb _f /in ²)	P_{IN}	10.84
gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	10.82
Excel equation for h_L (ft)	h_L	41.20
Excel equation for f	f	0.01
Variables/ Constants		Value
ratio of gaseous specific heats (C_P/C_V)	k	1.4
temperature in (°R)	T_0	521.437
temperature out (°R)	T_1	521.22
pressure in, absolute (lb _f /in ²)	P_0	10.84
pressure out, absolute (lb _f /in ²)	P_1	10.82
mass flux (lb _m /sec•ft ₂)	G	1.87584
maximum mass flux (lb _m /sec•ft ₂)	G^0	3.03

Mass, Temperature, and Pressure at Points O - P, Dwg. SK-F-01
 (See Appendix B for Bernoulli Equations)

gravitational constant ($\text{lb}_m \cdot \text{ft} / \text{lb}_f \cdot \text{sec}^2$)	g_c	32.2
gas constant ($(\text{lb}_f \cdot \text{ft}^3) / (\text{in}^2 \cdot \text{lbmol} \cdot ^\circ\text{R})$)	R	10.73
molecular weight ($\text{lb}_m / \text{lb}_m \text{mol}$)	M	29
Excel equation for temperature out ($^\circ\text{R}$)	T_1	521.22
Excel equation for Maximum Flux ($\text{lb}_m / \text{sec} \cdot \text{ft}^2$)	G^0	3.03

Mass, Temperature, and Pressure at Points Q - R, Dwg. SK-F-01
(See Appendix C for Carnot Equations)

HOW POINTS Q - S WERE DETERMINED:

The data from the Whispair Blower Curves was used. These curves and associated vendor literature is included in Appendix D.

Variables/ Constants		Value
Q_{IN} (ACFM)	Q_{IN}	278.27
Q_{OUT} (ACFM)	Q_{OUT}	106.80
P_{IN} (lb _f /in ²)	P_{IN}	10.82
P_{OUT} (lb _f /in ²)	P_{OUT}	37.00
T_{IN} (°R)	T_{IN}	521.215636
T_{OUT} (°R)	T_{OUT}	709.00

Mass, Temperature, and Pressure at Point S/T
(See Appendix B for Bernoulli Equations)

	A	B	C	D	E	F	G	H
1						Variables/ Constants		Value
2	P_{IN}					$F_{IN} = F_{OUT}$ (ft/sec)	F	13.3
3	z_{IN}					$\rho_{IN} = \rho_{OUT}$	ρ	0.14
4						$M_{IN} = M_{OUT}$ (lb _m /sec)	M	0.26
5	$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$					$N_{RE-IN} = N_{RE-OUT}$	N_{RE}	50,606
6	$h_L = \frac{4fLF^2}{2Dg_c}$					D (ft)	D	0.4205833
7	$f = 0.04/N_{RE}^{0.16}$					L (ft)	L	10
8						z_{IN} (ft)	z_{IN}	0
9						z_{OUT} (ft)	z_{OUT}	0
10						P_{IN} (lb _f /in ²)	P_{IN}	37.00
11						gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2
12								
13						Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	37.00
14						[H10+((H3/144)*(H8-H9-H15))]		
15						Excel equation for h_L (ft)	h_L	1.85
16						[(4*H17*H7*H2)/(2*H6*H11)]		
17						Excel equation for f	f	0.01
18						[0.04/POWER(H5,0.16)]		
19								
20								
21								
22								
23								

Eqn. 5-25
ChE Ref. Man.,
4th Ed.

Eqn. 5-57
Perry's 6th

Eqn. 5-66
Perry's 6th

HOW POINTS S - T WERE DETERMINED:

Bennet & Meyers (1962) state on pg. 210 that, "compressibility effects are unimportant in a change from 30 to 29 psia, but very important in a change from 2 to 1". Section S - T fits this category of "unimportant compressibility effects", so Bernoulli's equation will be used to determine the pressure at Point T. An implicit assumption is that Section S - T is isothermal. Length (4') plus entrance effects (6') were used.

Mass, Temperature, and Pressure at Point U

	C	D	E	F
1	<p>HOW POINT U WAS DETERMINED:</p> <p>There were two parts to Point U: fluid flow and heat flow. First, the heat exchanger had to be sized, which was done using equations 7.24 and 7.25 from <i>Chemical Engineering Reference Manual</i>, 4th edition, edited by R. N. Robinson.</p> <p>Equivalent lengths for the internals of the heat exchanger, as listed below, was then used. A combined enthalpy/motion/heat equation was used to determine P_{OUT}.</p> <p>Outlet temperatures for the shell had to be estimated. The tube side outlet temperature was a design criterium. The inlet water temperature was given by the site personnel. The overall heat transfer coefficient, U_o, was taken from Table 7.8, <i>Ibid.</i>, for air on the tube side and water on the shell side.</p> <p>The cross sectional area is $\pi r^2 \cdot 30 = 0.073 \text{ ft}^2$.</p> <div style="text-align: center;"> </div> <p>$Q = U_o \cdot A_o \cdot \Delta T_M$</p> <p>$\Delta T_2 = \text{Greater Terminal } \Delta T = \Delta T_{IN-P} - \Delta T_{OUT-C}$</p> <p>$\Delta T_1 = \text{Lesser Terminal } \Delta T = \Delta T_{OUT-P} - \Delta T_{IN-C}$</p> <p>$\Delta T_M = \text{Log Mean } \Delta T = \frac{\Delta T_2 - \Delta T_1}{\ln(\Delta T_2 / \Delta T_1)}$</p>			
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Mass, Temperature, and Pressure at Point U

	C	D	E	F
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51				
52	$h_L = \frac{4fL\dot{V}^2}{2Dg_c}$			
53	$f = 0.4/N_{RE}^{0.16}$			
54	Fluid Flow Analysis for given for TEMA P 1-pass w/30 tubes, water shell side,			
55	process air tube side:			
56	1. One entrance into exchanger;			
57	2. Eddie loss in bulk head - twice;			
58	3. Entrance into tube sheet - 30 times			
59	4. Line loss (L = 10 ft) - 1 time			
60	5. Exit out of tube sheet - 30 times			
61	6. One exit out of exchanger.			
62	$A_O = \pi \cdot d_o \cdot L \cdot (\pi) \cdot (d_o / \text{tube}) \cdot (\# \text{ tubes}) \cdot (L)$			
63				
64	Variables/ Constants		Value	
65	Tube Side Inlet Process Air (°F)	T _{IN-P}	342.9	
66	Shell Side Inlet Cooling Water (°F)	T _{IN-C}	55	
67	Shell Side Outlet Cooling Water (°F)	T _{OUT-C}	90	
68	Tube Side Outlet Process Air (°F)	T _{OUT-P}	80	
69	Greater Terminal ΔT (°F)	ΔT ₂	252.9	
70	Lesser Terminal ΔT (°F)	ΔT ₁	25	
71	Log Mean ΔT (°F)	ΔT _M	98	
72	Outside Area of Tubes (ft²)	A _O	65.5475	
73	Inside Area of Tubes (ft²)	A _I	52.595	
74	Outside Diameter of Each Tube (ft)	d _O	0.069583333	
75	Inside Diameter of Each Tube (ft)	r _I	0.055833333	
76	Number of Tubes	#	30	
77	Length of Each Tube (ft)	L	10.00	

Mass, Temperature, and Pressure at Point U

	C	D	E	F
78	Overall Heat Xfer Coefficient (BTU/(hr•ft ² •°F))	U _o	20.00	
79	Heat Transferred (BTU/hr)	Q	129,106	
80	Total Mass Flux, Process Air (lb _m /hr•ft ²)	G	12805.08	
81	Pressure loss from one entrance into exchanger (ft)	h ₁	3	
82	equivalent length of pipe for ordinary entrance into ID=2" per Fig. 15-3, Momentum, Heat, and Mass Transfer, Bennet & Myers, 1962			
83	Pressure loss from eddies in bulk head (ft)	h ₂	54	
84	equivalent length of pipe for sudden expansion into ID=10", twice, per Fig. 15-3, Momentum, Heat, and Mass Transfer, Bennet & Myers, 1962			
85	Pressure loss from entrance into tube sheet (ft)	h ₃	1.3	
86	equivalent length of pipe for ordinary entrance into ID=1", taken once as thirty pipes are in parallel, per Fig. 15-3, Momentum, Heat, and Mass Transfer, Bennet & Myers, 1962			
87	Pressure loss from exit out of tube sheet (ft)	h ₄	2.5	
88	equivalent length of pipe for Borda entrance into ID=1", taken once as thirty pipes are in parallel, per Fig. 15-3, Momentum, Heat, and Mass Transfer, Bennet & Myers, 1962			
89	Pressure loss from exit out of exchanger (ft)	h ₅	5	
90	equivalent length of pipe for Borda entrance into ID=2", once, per Fig. 15-3, Momentum, Heat, and Mass Transfer, Bennet & Myers, 1962			
91	G _{IN} = G _{OUT} (lb _m /sec•ft ²)	G	0.65	
92	D (ft)	D	0.17225	
93	L (ft)	L	75.8	
94	l (ft)	l	10	

Mass, Temperature, and Pressure at Point U

	C	D	E	F
95	z_{IN} (ft)	z_{IN}	0	
96	z_{OUT} (ft)	z_{OUT}	0	
97	P_{IN} (lb _f /in ²)	P_{IN}	36.99	
98	gravitational constant (lb _m •ft/lb _f •sec ²)	g_c	32.2	
99	h_L (ft)	h_L	437.74	
100	f	f	0.07	
101	V_{IN} (ft/sec)	V_{IN}	15.05	
102	N_{RE}	N_{RE}	50553.64	
103	$A_{INSIDE\ PIPE}$ (ft ²)	A_{IP}	0.023290999	
104				
105	Introduction to Chemical Engineering Thermodynamics, 3rd ed., by			
106	Smith and van Ness, eqn. E on pg. 459, provides the following			
107	relationship among enthalpy, motion, and heat, with the correct			
108	value of R to use as being 1,545 (ft•lb _f)/(lbmol•°R):			
109	$\left(\frac{G_{IN}^2}{g_c} \right) \cdot \left(\ln \frac{T_{OUT} \cdot P_{IN}}{T_{IN} \cdot P_{OUT}} \right) + \left(\frac{M_{WEIGHT} \cdot (P_{OUT}^2 - P_{IN}^2)}{2 \cdot R \cdot T_{AVG}} \right) + \left(\frac{2 \cdot f \cdot G_{IN}^2 \cdot l}{g_c \cdot D} \right) = 0$			
110				
111				
112				
113	All values are known except P_{OUT} ; iteration must occur to determine			
114	P_{OUT} . T_{AVG} is the average temperature of air.			
115	V_{OUT} is calculated using the equation for u_2 , pg. 459, <i>Ibid</i> ., and Q_{KE} is			
116	calculated using the Eqn. A on pg. 458, <i>Ibid</i> .			
117				
118	P_{OUT} (lb _f /in ²)	P_{OUT}	36.05	
119	enthalpy/motion/heat balance zero	0	61.9807	
120	$V_{OUT} = V_{IN} \cdot (T_{OUT} \cdot P_{IN} / T_{IN} \cdot P_{OUT})$ (ft/sec)	V_{OUT}	3.60	
121	$Q_{KE} = (C_{Pm} \cdot (T_{OUT} - T_{IN})) + ((V_{OUT}^2 - V_{IN}^2) / 2g_c)$ (BTU/hr)	Q_{KE}	-67.68	

Mass, Temperature, and Pressure at Points V - W (See Appendix B for Bernoulli Equations)

	A	B	C	D	E	F
1	This section of text is taken from <i>Flow of Fluids Through Valves, Fittings, and Pipe</i> , Technical Paper No. 410, by the Crane					
2						
3	Because the expected pressure drop between Points V and W is greater than 10%, Bernoulli's equation is not used because the					
4						
5						
6						
7	When dealing with compressible fluids, the following restrictions should be observed in applying the Darcy formula:					
8	1. If the calculated pressure drop is less than about 10% of the inlet pressure, reasonable accuracy will be obtained if the					
9						
10	2. If the calculated pressure drop is greater than 10% but less than 40% of the inlet pressure, the Darcy equation may be used					
11						
12						
13	3. For greater pressure drops, such as are often encountered in long pipe lines, methods modified for isothermal, simple					
14						
15	At Point V, P = 36.05 psia. At Point W, P = 12.3 psia. This is a drop in pressure of 23.75 psi, or 66%. Therefore, Darcy					
16	methods modified for Isothermal, Simple Compressible Flow, and Limiting Flow will be considered.					
17	The flow of gases in long pipe lines closely approximates isothermal conditions. The pressure drop is such lines if often large					
18						
19						
20						
21	Simplified Compressible Flow Darcy equations are horizontal pipes. The pipe between Points V and W is, again, vertical.					
22						
23						

Mass, Temperature, and Pressure at Points V - W (See Appendix B for Bernoulli Equations)

	A	B	C	D	E	F
24	<p>In the Isothermal Darcy and Simplified Compressible Flow Darcy equations, the feature not evident is that the weight rate of flow of a compressible fluid in a pipe, with a given upstream pressure, will approach a certain maximum rate which it cannot exceed, no matter how much the downstream pressure is further reduced.</p>					
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34	<p>The maximum velocity of a compressible fluid in pipe is limited by the velocity of propagation of a pressure wave which travels at the speed of sound in the fluid. Since pressure falls off and velocity increases as fluid proceeds downstream in pipe of uniform cross section, the maximum velocity occurs in the downstream end of the pipe. If the pressure drop is sufficiently high, the exit velocity will reach the velocity of sound. Further decrease in the outlet pressure will not be felt upstream because the pressure wave can only travel at sonic velocity, and the "signal" will never translate upstream. The "surplus" pressure drop obtained by lowering the outlet pressure after the maximum discharge has already been reached takes place beyond the end of the pipe. This pressure is lost in shock waves and turbulence of the jetting fluid.</p>					
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44	<p>The maximum possible velocity in the pipe is sonic velocity, which is expressed as:</p> $V_{\text{SONIC}} = (k \cdot g \cdot R \cdot T)^{0.5} = (k \cdot g \cdot 144 \cdot P' \cdot \underline{V})^{0.5}$					
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	<p>The value of k, the ration of specific heats at constant pressure to constant volume, is 1.4 for most diatomic gases. This velocity will occur at the outlet end or in a constricted area, when the pressure drop is sufficiently high. The pressure, temperature, and specific volume are those occurring at the point in question. When compressible fluids discharge from the end of a reasonably short pipe of uniform cross section into an area of larger cross section, the flow is usually considered to be adiabatic. This assumption is supported by experimental data on pipe having lengths of 220 and 130 pipe diameters discharging into atmosphere. The 1", sch. 40 pipe between Points V and W is 456 pipe lengths and of uniform cross section, and it discharges into an area of larger cross section. Investigation of the complete theoretical analysis of adiabatic flow has led to a basis for establishing correction factors, which may be applied to the Darcy equation for this condition of flow. Since these correction factors compensate for the changes in fluid properties due to expansion of the fluid, they are identified as "Y" net expansion factors.</p>					
	<p>The Limiting Flow Darcy equation, including the Y factor, is:</p>					

Mass, Temperature, and Pressure at Points V - W (See Appendix B for Bernoulli Equations)

	A	B	C	D	E	F
53	$w = 0.525 \cdot Y \cdot d^2 \cdot ((\Delta P / (K \cdot P_1))^{0.5}$ where K is the resistance coefficient $K = f \cdot L / D$, and represents the total resistance coefficient of the pipe line, including entrance and exit losses when they exist, and losses due to valves and fittings. The pressure drop, ΔP , in the ration $\Delta P / P_1$, which is used for the determination of Y from the charts on page A-22 (<i>Crane's</i>) is the measured difference between the inlet pressure and the pressure in the area of larger cross section. In a system discharging compressible fluids to atmosphere, this ΔP is equal to the inlet gauge pressure, or the difference between absolute inlet pressure and atmospheric pressure. This value of ΔP is also used in the Limiting Flow Darcy equation, whenever the Y factor falls within the limits defined by the resistance factor K curves in the charts on page A-22 of <i>Crane's</i> . When the ration of $\Delta P / P_1$, using ΔP as defined above, falls beyond the limits of the K curves in the charts, sonic velocity occurs at the point of discharge or at some restriction within the pipe, and the limiting values for Y and ΔP , as determined from the tabulations to the right of the charts on page A-22 (<i>Crane's</i>) must be used in the Limiting Flow Darcy equation.					
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75	$\Delta P / P_1$	0.66				
76	ΔP	23.75				
77	P_1	36.05				
78	d (in.)	1.049				
79	d^2 (in. ²)	1.10				
80	D (ft.)	0.087				
81	N_{RE}	2,483,682				

Mass, Temperature, and Pressure at Points V - W (See Appendix B for Bernoulli Equations)

	A	B	C	D	E	F
82	f	0.023				
83	L (ft)	40				
84	K _{PIPE}	10.524				
85	K _{ENTRANCE}	0.78 (pipe assumed to be inward projecting)				
86	K _{EXIT}	1 (pipe assumed to be projecting)				
87	K _{TOTAL}	12.304				
88	P _{DISCHARGE} (psia)	12.30				
89						
90	<p>Page A-22 from <i>Crane's</i>, chart $k = 1.4$, shows that at $\Delta P/P_1 = 0.66$ and $K = 12.3$, then $Y = 0.76$. The associated table "Limiting Factors For Sonic Velocity, $k = 1.4$", shows that when $\Delta P/P_1 = 0.66$ and $K = 12.3$, the velocity inside the pipe does not attain sonic velocity. It can be assumed that the pressure does drop to atmospheric pressure upon discharge of the pipe and that no shock wave inside the bin set. The flow rate (scfm) can be found from the equation:</p> $q'_m = 678 \cdot Y \cdot d^2 \cdot ((\Delta P \cdot P_1) / (K \cdot T_1 \cdot S_g))^{0.5}$					
91						
92						
93						
94						
95						
96						
97	T ₁ (°R)	540				
98	q' _m (scfm)	204				
99	q _m (acfm)	286				
100	q' _s (acfs)	5				
101						
102	Temperature In Pipe		$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$			
103						
104						
105						
106	T2	397				

Mass, Temperature, and Pressure at Point X, Dwg. SK-F-01
(See Appendix A for Adiabatic Equations)

	A	B	C
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2			
3			
4			
5			
6			
7			
8			
9			
10			
11	Variables/ Constants		Value
12	ratio of gaseous specific heats (C_p/C_v)	k	1.4
13	temperature in large chamber ($^{\circ}\text{R}$)	T_0	397.16
14	temperature in pipe ($^{\circ}\text{R}$)	T_1	397.16
15	pressure in large chamber, absolute (lb_f/in^2)	P_0	12.30
16	pressure in pipe, absolute (lb_f/in^2)	P_1	12.30
17	mass flux ($\text{lb}_m/\text{sec}\cdot\text{ft}^2$)	G	0.0191
18	maximum mass flux ($\text{lb}_m/\text{sec}\cdot\text{ft}^2$)	G^0	3.94
19	gravitational constant ($\text{lb}_m\cdot\text{ft}/\text{lb}_f\cdot\text{sec}^2$)	g_c	32.2
20	gas constant ($(\text{lb}_f\cdot\text{ft}^3)/(\text{in}^2\cdot\text{lbmol}\cdot^{\circ}\text{R})$)	R	10.73
21	molecular weight ($\text{lb}_m/\text{lb}_m\text{mol}$)	M	29
22			
23	Excel equation for Temperature in Pipe ($^{\circ}$) - data given	T_1	397.16
24	Excel equation for Temperature in Large Chamber ($^{\circ}\text{R}$)	T_0	397.16
25	[I4*(POWER(I6/I5,(1-I2)/(I2)))]		
26	Pressure in Pipe, absolute ($(\text{lb}_f/\text{in}^2)$ - data given	P_1	12.30
27	Excel equation of Pressure in Large Chamber, absolute (lb_f/in^2)	P_0	12.30
28	[I6*(POWER((1+((POWER(I7,2)*(I2-1)*I10*I4)/(2*144*I9*I2*I11*(Power(I6,2))),(-I2/(I2-1))))))]		
29	Excel equation for Maximum Flux ($\text{lb}_m/\text{sec}\cdot\text{ft}^2$)	G^0	3.94
30	[I5*SQRT(((I9*I11*I2)/(R\+I10*I3))*POWER(2/(I2+1),(I2+1)/(I2-1)))]		

Adiabatic Expansion Equations

	A	B	C	D	E	F	G	H	I
1				Throat of Nozzle			Variables/ Constants		Value
2	<u>LARGE CHAMBER</u>		T_1	T_2			ratio of gaseous specific heats (C_p/C_v)	k	1.4
3	P_0 pressure						temperature in large chamber (°R)	T_0	x
4	V_0 velocity		P_1	P_2			temperature in pipe (°R)	T_1	x
5	G_0 mass flux					Table 3-185 Perry's 6th	pressure in large chamber, absolute (lb_f/in^2)	P_0	x
6	T_0 temperature						pressure in pipe, absolute (lb_f/in^2)	P_1	x
7							mass flux ($lb_m/sec \cdot ft_2$)	G	x
8	Original Temperature Equation						maximum mass flux ($lb_m/sec \cdot ft_2$)	G^0	x
9			$\frac{T_1}{T_0} = \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$				gravitational constant ($lb_m \cdot ft / lb_f \cdot sec^2$)	g_c	32.2
10						Eqn. 5-93 Perry's 6th	gas constant ($(lb_f \cdot ft^3) / (in^2 \cdot lbmol \cdot ^\circ R)$)	R	10.73
11	Temperature In Pipe		$T_1 = T_0 \left[\frac{P_1}{P_0} \right]^{\frac{k-1}{k}}$				molecular weight ($lb_m / lb_m mol$)	M	29
12									
13							Excel equation for Temperature in Pipe (°)	T_1	#VALUE!
14	Temperature In Large Chamber		$T_0 = T_1 \left[\frac{P_1}{P_0} \right]^{\frac{1-k}{k}}$				[I3*(POWER(I6/I5,(I2-1)/I2))]		
15							Excel equation for Temperature in Large Chamber (°R)	T_0	#VALUE!
16							[I4*(POWER(I6/I5,(1-I2)/(I2)))]		
17							Excel equation of Pressure in Pipe, absolute (lb_f/in^2)	P_1	#VALUE!

Adiabatic Expansion Equations

	A	B	C	D	E	F	G	H	I
18			Eqn. 5-94 Perry's 6th			$\frac{k}{k-1}$	[I5*POWER(1+((POWER(I7,2))*(I2-1)*I10*I4)/(2*I9*I2*I11*(POWER(I6,2))))*(-I2)/(I2-1)))] - NOTE: Requires iteration		
19	Original Pressure Equation		$\frac{P_0}{P_1} = \left[1 + \frac{G^2}{2g_c} \frac{k-1}{k} \frac{RT_1}{M P_1^2} \right]^{\frac{k}{k-1}}$				Excel equation of Pressure in Large Chamber, absolute (lb _f /in ²)	P ₀	#VALUE!
20						$\frac{k}{k-1}$	[I6*(POWER((1+((POWER(I7,2)*(I2-1)*I10*I4)/(2*I9*I2*I11*(POWER(I6,2))))*(-I2)/(I2-1))))]		
21	Pressure In Large Chamber		$P_0 = P_1 \left[1 + \frac{G^2}{2g_c} \frac{k-1}{k} \frac{RT_1}{M P_1^2} \right]^{\frac{k}{k-1}}$				Excel equation for Maximum Flux (lb _m /sec•ft ²)	G ⁰	#VALUE!
22						$\frac{-k}{k-1}$	[I5*SQRT(((I9*I11*I2)/(R\+I10*I3))*POWER(2/(I2+1),(I2+1)/(I2-1)))]		
23	Pressure In Pipe		$P_1 = P_0 \left[1 + \frac{G^2}{2g_c} \frac{k-1}{k} \frac{RT_1}{M P_1^2} \right]^{\frac{-k}{k-1}}$						
24									
25									
26									
27									
28									
29									
30			Eqn. 5-95 Perry's 6th						
31									
32									
33									
34	Maximum Mass Flux		$G^0 = P_0 \sqrt{\frac{g_c M k}{R T_0} \left(\frac{2}{k+1} \right)^{\frac{k+1}{k-1}}}$						
35									
36									
37									

Bernoulli Equations

	A	B	C	D	E	F	G	H				
1	<div><div><div><div><div></div><div>P_{IN}</div><div>z_{IN}</div></div><div><div></div><div></div><div></div></div><div><div></div><div>P_{OUT}</div><div>z_{OUT}</div></div></div></div></div> <div>$P_{OUT} = P_{IN} + \rho(z_{IN} - z_{OUT} - h_L)$</div> <div>$h_L = \frac{4fLF^2}{2Dg_c}$</div> <div>$f = 0.04/N_{RE}^{0.16}$</div> <div>Eqn. 5-25 ChE Ref. Man., 4th Ed.</div> <div>Eqn. 5-57 Perry's 6th</div> <div>Eqn. 5-66 Perry's 6th</div>					Variables/ Constants			Value			
2						$F_{IN} = F_{OUT}$ (ft/sec)					F	x
3						$\rho_{IN} = \rho_{OUT}$					ρ	x
4						$M_{IN} = M_{OUT}$ (lb _m /sec)					M	x
5	$N_{RE-IN} = N_{RE-OUT}$					N_{RE}	x					
6	D (ft)					D	x					
7	L (ft)					L	x					
8	z_{IN} (ft)					z_{IN}	x					
9	z_{OUT} (ft)					z_{OUT}	x					
10	P_{IN} (lb _f /in ²)					P_{IN}	x					
11	gravitational constant (lb _m •ft/lb _f •sec ²)					g_c	32.2					
12												
13						Excel equation for P_{OUT} , absolute (lb _f /in ²)	P_{OUT}	#####				
14						[H10+((H3/144)*(H8-H9-H15))]						
15						Excel equation for h_L (ft)	h_L	#####				
16						[(4*H17*H7*H2)/(2*H6*H11)]						
17						Excel equation for f	f	#####				
18						[0.4/POWER(H5,0.16)]						

Carnot Cycle Equations

Variables/ Constants		Value
V_{IN} (ft ³)	V_{IN}	x
V_{OUT} (ft ³)	V_{OUT}	#####
P_{IN} (lb _f /in ²)	P_{IN}	x
P_{OUT} (lb _f /in ²)	P_{OUT}	x
k	k	x
a constant	AC	#####
Excel equation for a constant		AC
[H4*POWER(H2,H6)]		
Excel equation for V_{OUT} (ft)	V_{OUT}	#####
[(4*H17*H7*H2)/(2*H6*H11)]		

Fig. 8-10, Smith ^
Van Ness, 2nd Ed.

Single Stage Compressor Cycle With Clearance
(Adiabatic)

Original
Compressor
Equation

$$PV^k = \text{a constant}$$

Compressor
Equation for
Volume

$$V = \left(\frac{\text{a constant}}{P} \right)^{\frac{1}{k}}$$

Pg. 263, Smith
& Van Ness,
2nd Ed.

$$R=(PV)/(nT)$$

Metric

1 gram•mole
22.4 liters
1 atm
273 °K

British

0.002205 lb•mole
0.791 ft³
14.7 psia
491 °R

R Values

0.08205128 $\frac{\text{atm}\cdot\text{lit}}{\text{gmol}\cdot^{\circ}\text{K}}$

10.7399864 $\frac{\text{psia}\cdot\text{ft}^3}{\text{lbmol}\cdot^{\circ}\text{R}}$

* Blower Specs

F = 120 CFM

P = 38 PSIA

SPEED = 2000 RPM

POWER = 43 HP

CALCINE RETRIEVAL FROM BIN SET 1

(OPEN OR CLOSED LOOP CONCEPT)

TO OPEN LOOP TRANSPORT SYSTEM SK-F-02

TO CLOSED LOOP TRANSPORT SYSTEM SK-F-03

[illegible]

PLAN VIEW

NORTH ELEVATION

F

E

REV.	REVISION DESCRIPTION	APPROVED		
		DATE	REAC	MANCS
3	GRASP PHASE 1 - SPECIAL STUDIES	09/12/94	.	.
		.	.	.

NOTES:

1. On Retrieval Cyclone, the inlet Pipe Reducer is not used.
2. On Retrieval Cyclone, the outlet Pipe Reducer is a 4" x 2".
3. Assumption: at steady state the volume of calcine in the cyclone is 10.6 in^3 . The "free" volume is 297 in^3 (0.172 ft^3).
4. The West Elevation View shows the Points "E" and "F" from JK-F-03.

$$\leftarrow V = \frac{1}{2} \pi r^2 L = \frac{1}{2} \pi \left(\frac{9.25 \text{ in}}{2} \right)^2 (8 \text{ in}) = 36.3 \text{ in}^3$$

$$\leftarrow V = \frac{1}{2} h (a+b) L = \left(\frac{1}{2} \right) (16) (16.3 + 16.3) = 261 \text{ in}^3$$

$$P_{\text{FHTFE}} = \frac{RT}{V} = \left(\frac{53.33 \text{ ft} \cdot \text{lb}}{\text{lb} \cdot ^\circ\text{R}} \right) \left(\frac{540^\circ\text{R}}{0.172 \text{ ft}^3} \right) = 4955 \frac{\text{lb}}{\text{ft}^2} = 34.41 \text{ psia}$$

$$-V = \frac{1}{2} \pi r^2 L = \frac{1}{2} \pi (1.5 \text{ in})^2 (3 \text{ in}) = 10.6 \text{ in}^3$$

WEST ELEVATION

DESIGN INTERFACE:		DRAWING STATUS		APPROVALS		DATE	
ARCHITECTURAL		DESIGN PHASE	DATE APPROVED	CHECKED BY	J.M. HARTZ		
STRUCTURAL				PREPARED BY	P.S. 10/19/86		
ENVIRONMENTAL				DIA MANAGER	P.S. 10/19/86		
ELECTRICAL				QA ENGINEER			
Mechanical				Chief Engineer			
MECHANICAL				REAL PROJECT MGR			
PROCESS				WPI PROJECT MGR			
PIPEING				PROJECT NO.	733A-204		
STRESS ANALYSIS				SUBCONTRACT NO.			
		GROUP LEVEL		ISSUED FOR CONSTRUCTION			

Ravithcon
Measurements & Construction
a subsidiary of WPI Inc. or CPT

FOR _____
IN DEPARTMENT OF ENERGY
AND SPECIAL DIVISION
Good Faith, Ours

HPP PHASE II SPECIAL SPILL/BLOG TSP
BIN SET I - CALICHE RECOVERY
CYCLONE DETAILS

DATE	SCALE	REVISIONS	ISSUING NO.	REV
0	1" = 1'-0"	0		0

Post-it Fax Note 7671 Date 1/25/96 pages 1

To Rick Morro	From Dana Leao
Co./Dept.	Co. LM-09
Phone #	Phone # 214-526-9121
Fax # 516-484-0364	Fax # 214-526-9121

Pall Corporation

SIZING AND SELECTION

Sizing

Divide gas flow rate (ACFM) by the recommended sizing (8-10 ACFM/ft² for initial sizing) to determine the total filter area required.

Each standard GS filter element provides 4 ft² of filter area. Number of elements = total area/4.

Select the vessel from the table below that will accommodate the required number of elements.

Element Selection

Element Part Number: GS ☐ ☐ ☒ ☐ ☐ ☐

Alloy	
no code	316L medium/304 hardware
I:	All Inconel 600
M:	All Monel 400
N:	All Nickel 200
X:	All High nickel / chrome
7:	All 347SST
3:	All 316SST
4:	All 304SST

Medium Thickness	
Medium	02: 1/16 inch
P: PSS	03: 3/32 inch
	04: 1/8 inch

Blowback	
JP: Jet Pulse	
RP: Reverse Flow	

Typical Filter Vessel Characteristics

Number of GS Elements	Vessel Diameter (inches)		Nozzles (inches)	Vessel Length (inches)	Differential Pressure (K _v) Loss Factor	
	Jet Pulse/Reverse Flow	Downdraft			Reverse Flow (K _v)	Jet Pulse (K _v)
5	10	12	3	100	7.5x10 ⁻⁵	1.9x10 ⁻⁴
10	14	16	4	110	2.4x10 ⁻⁴	5.1x10 ⁻⁴
19	18	22	6	120	4.7x10 ⁻⁴	1.3x10 ⁻³
31	22	26	8	128	1.5x10 ⁻³	4.6x10 ⁻³
42	26	28	10	132	6.1x10 ⁻³	2.4x10 ⁻²
68	32	36	12	140	2.9x10 ⁻²	9.5x10 ⁻²
96	38	42	14	152	1.8x10 ⁻¹	5.0x10 ⁻¹
130	44	46	18	164	6.5x10 ⁻¹	2.5x10 ⁻¹
170	50	54	20	176	4.2x10 ⁻¹	1.5x10 ⁻¹

Notes: 1. Nozzle sizes as indicated are typical, RF 150lb. design.
2. The vessel length includes a 60° angle cone for solids discharge.

Element Characteristics

Standard GS elements have the following characteristics:

Overall element length: 80 inches
Sections per element: 4 x 19 inches each

Element diameter: 2 1/2 inches

Element area: 4 ft²

Filter medium thickness: 3/32 inches (standard)

Maximum pressure drop: 100 psid up to 800°F (standard)

Vessel Alloy:

Carbon Steel is standard
Other alloys available, including refractory lined and jacketed vessels.

Design Pressure:

150 psig is standard
Other designs available up to 1000 psig.

Clean Pressure Drop:

$$\text{Clean } \Delta P = \Delta P_{\text{vessel}} + \Delta P_{\text{filter elements}} \\ = K_v Q^2 + K_m \mu Q/A$$

where K_v and K_m are loss coefficients for the vessel and filter medium respectively, ρ is the gas density in lb/ft³, μ is the viscosity of the gas at operating conditions in centipoise, Q is the gas flow rate in ACFM, and A is the filter area in ft². The terminal pressure drop at which the filter is blown back is determined by the customer to fit within the pressure drop available in the system.

K_v values are given in table: "Typical Filter Vessel Characteristics"

K_m values are: PSS Grade | K_m (for 3/32" medium thickness)

PH	2.0
PF	0.45

Example

For a 3500 ACFM gas stream at 600°F containing catalyst particles with 15 percent smaller than 10 μ m, and a bulk density of 60 lb/ft³.

$$\text{Filter area} = 3500 \text{ ACFM} / 10 \text{ ACFM/ft}^2 \\ = 350 \text{ ft}^2$$

$$\text{Number of elements} = 350/4 = 87.5$$

Select a 38 inch diameter vessel containing 96 GS Series elements giving 384 ft² of filter area.

$$\text{Actual flow density} = \frac{3500}{384} = 9.1 \text{ ACFM/ft}^2$$

Select jet pulse blowback for these high density solids. Element part number: GSPH03FJP

Elements are 80 inches long, 4 ft² area elements constructed of 316L porous medium and 304 hardware, flanged to the tubesheet.

Filter medium grade: Select PH (1.3 μ m absolute) due to high percentage of particles below 20 μ m in size. The standard medium thickness of 3/32 inch is used.

The vessel specification is completed by providing required materials of construction, gasketing, design temperature and pressure, pressure vessel code and any special maintenance or other requirements.

Flanders®

Nuclear Grade HEPA Filters

Rectangular, Round,
and Nipple-Connected
Type B Filters Constructed
and Tested in Accordance with

■ MIL-STD-282

■ IES-RP-CC-001.3

Round Filters

Round Nuclear Grade filters are available with Flanders' PUREFORM™ filter element and with separator-type elements. Frames are made of Type 304 or Type 409 stainless steel, and are available for both gasket or fluid seal applications. Round filters are also manufactured for high temperature applications. (See page 8 for information on high-temperature sealants.) Round Nuclear Grade filters are made of the same materials specified in MIL-F-51068 but are not tested for rough handling, wet over-pressure, or heated air as called out by that specification. Flanders performs acceptance testing of penetration and resistance only.

PUREFORM™ Filters

SIZE	DIMENSIONS			DEPTH OF FILTER ELEMENT	NOMINAL RATED CAPACITY	MAXIMUM INITIAL RESISTANCE
	X	Y	Z			
B	6-5/8"	8"	8"	4"	35	1.0" w.g.
C	10-5/8"	12"	8"	4"	100	

Separator-Type Filters

SIZE	DIMENSIONS			DEPTH OF FILTER ELEMENT	NOMINAL RATED CAPACITY	MAXIMUM INITIAL RESISTANCE
	X	Y	Z			
A	6-5/8"	8"	5-1/4"	3-1/16"	20	
B	6-5/8"	8"	8"	5-1/2"	35	1.0" w.g.
C	10-5/8"	12"	8"	5-1/2"	100	

Company: ROOTS Division
 Address: 900 West Mount St., Connersville, Indiana 47331
 765-827-9200 / 765-825-7669

Contact:

ROOTS BLOWER PERFORMANCE SUMMARY: (06/22/1999)

AMBIENT CONDITIONS:

Gas	AIR
Relative Humidity	36.00%
Molecular Wt.	28.822
k-Value	1.395
Specific Gravity	.995
Ambient Temp.	75 deg F
Ambient Pressure	11.68 PSIA

INPUT CONDITIONS:

Actual Volume	257	ACFM
Std. Volume	195	SCFM
System Inlet Pressure	11.68	PSIA
Inlet Pr. Loss	0.3	PSI
Blower Inlet Pressure	11.38	PSIA
System Disch Pressure	26.1	PSIG
Disch Pr. Loss	0.2	PSI
Blower Disch Pressure	27.98	PSIA
Inlet Temperature	75.4	deg F

STANDARD CONDITIONS:

Pressure	14.7	PSIA
Temperature	68	deg F
Relative Humidity	36	%

SELECTED UNIT DETAIL:

Model	406	RAM-DPJ
Speed	2912	RPM 72.8%
Power at Blower Shaft	57.4	BHP
Blower Differential Pressure	26.60	PSI 88.7%
Temperature Rise	174	deg F 63.2%
Discharge Temperature	249	deg F
Discharge Volume	410	ACFM
Jet Pressure	36.98	PSIA
Jet Temperature	85	deg F
Jet Weight Flow	44	#/min
Jet Volume Flow	243	ACFM
Gear Tip Speed	3433	FPM
V-Belt: Est. B10 Brg Life:	266954	hours
Coupling: Est. B10 Brg Life:	2046652	hours
Est. Free Field Noise @ 1 m.	100.6	dBa
CFR	0.167	
Weight	365	lbs.
Shaft Dia.	1.5	in.
Min. Sheave Dia.	7.1	in.
Inlet/Disch Conn.	4T/5T/4T(JET)	

SELECTION SUMMARY (AVAILABLE UNITS)...ALL PRICES SUBJECT TO CHANGE !

Size	Unit Description	RPM	%RPM	%Press.	BHP	Noise	Price
406	RAM-DPJ	2912	72.8%	88.7%	57.4	100.6

NOTE: • **OPTIONAL SILENCER MAY BE REQUIRED AFTER COOLER FOR COOLER PROTECTION FROM BLOWER PULSE.**

DPJ SYSTEM SCHEMATIC

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

EDF

for

BIN SET 1 RETRIEVAL AND TRANSPORT STUDY -
MECHANICAL SYSTEMS

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program

3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: Mechanical Systems

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

This EDF covers the mechanical process systems for HLW FY-99 Feasibility Studies for the HLW Program, Bin Set 1 Retrieval and Transport Study. The 1995 Raytheon Bin Set 1 feasibility study report¹ was used as a baseline. The Raytheon systems were evaluated and changes and refinements were made to update the process systems to current codes and standards and to further develop and refine some of the components and systems which were in need of further feasibility work. The systems that were evaluated are the process systems in the proposed Environmental Enclosure above Bin Set 1, the calcine pneumatic retrieval facility at Bin Set 1, and calcine pneumatic transport systems at Bin Set 6.

6. Distribution (complete package): B. R. Helm MS 3765, V. L. Jacobson MS 3211, D. B. Lord MS 3211, M. S. Spinti MS 3650, Project File

Distribution (summary package only):

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author	R	D. A. Lopez		8/31/99
Independent Verification	R	S. E. Gifford		8/31/99
Requestor	A	D. B. Lord		8/31/99

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1 INTRODUCTION

The mechanical systems EDF includes the Mechanical design criteria, and covers the pneumatic transport system and the movable mechanisms and systems within the environmental enclosure that will be constructed over the Bin Set 1 vault. The EDF will concentrate on changes to the designs presented in Reference 1 (RFR¹ design).

2 MECHANICAL DESIGN ASSUMPTIONS AND CRITERIA

The mechanical assumptions and criteria are similar to those of Reference 1 with some modifications. The following is a list of the modified assumptions and requirements:

2.1 Requirements

The following design requirements were established as the basis for the development and selection of the recommended vault access, retrieval, and transport systems:

1. Transport system should be designed for a 20-year life.
2. Design the system to transport calcine from Bin Set 1 to Bin Set 6
3. Design should minimize worker radiation exposure, and minimize spread of contamination.
4. Select a reliable vault entry, retrieval, and transport method. These methods must be tested in a mock-up facility.
5. Minimize the amount of remote electro-mechanical equipment that would be placed in the bins to minimize the potential for equipment breakdowns.
6. Use a pneumatic transport system concept. Incorporate transport system enhancements based on new technologies and current safety requirements.
7. A closed loop transport air system should be developed if practical.
8. The transport air systems should be the vacuum, low-density type to keep the calcine transport pipes at a negative pressure.
9. If conveying air temperatures are excessive, use heat exchangers to control the conveying air temperature and to protect the blowers and HEPA filters.
10. The systems should be designed to withstand any credible fire or other applicable accidents and still serve as a confinement barrier.
11. The facility should be designed to withstand appropriate natural phenomena hazards.
12. Establish a transport system that can be readily maintained.
13. Provide for future tie-in capability to Bin Sets 2 and 3.
14. Design the retrieval system such that the calcine is delivered to Bin Set 6 within one year.

15. Provide primary and secondary confinement at all times; minimize confinement volumes.
16. Design the retrieval system such that it can be assembled, dismantled, and transported from one Bin Set to the next, and from one bin to another bin for calcine retrieval.
17. Provide cleanouts in the transport line.
18. Provide adequate heating and cooling in all occupied areas of the enclosures.
19. Provide instrumentation and control for operation and data acquisition.
20. Provide a remote viewing system for the vault and bin interiors, to allow assessment of calcine retrieval progress.
21. Facility equipment and calcine retrieval and transport systems must be capable of being decontaminated and/or replaced safely and easily.
22. Minimize generation of hazardous and radioactive waste.

2.2 Key Assumptions:

2.2.1 General

1. The Bin Set 1 retrieval and transport facilities are classified as a moderate hazard facilities.
2. The system will be based on the preferred alternatives from the Phase I and II of Reference 1.
3. This feasibility study will be based on the 20-riser design in Reference 1. This will facilitate two risers on each of the eight annular bins and one riser on each of the four cylindrical bins.
4. The facilities will not fall under NRC over-site and regulation. The design will be in accordance with DOE Orders with maintenance of status-quo interfaces with other regulatory and oversight agencies such as the Environmental Protection Agency (EPA), State of Idaho, and the Defense Nuclear Facilities Safety Board (DNFSB). No additional costs will be considered for NRC oversight.
5. Calcine bulk density is 1.1 gm/cm³.
6. The calcine particle density of cold alumina calcine is 2.61 gm/cm (as found by an independent testing laboratory)
7. Calcine inlet velocity was set at 4000 ft/min (66.7 ft/sec). Zirconia-type calcine was pneumatically conveyed at a velocity ranging from 19.7 to 65.6 ft/sec as described in INTEC report "A Prototype Facility to Demonstrate Retrieval of Simulated INTEC Calcined Waste. "
8. The calcine will be retrieved and transported using vacuum pneumatic systems so the pressure inside the calcine transfer piping is always negative with respect to its surroundings.
9. There will be two independent pneumatic systems, one for retrieval at Bin Set 1, and one for the 650-ft transport from Bin Set 1 to Bin Set 6. This will allow finely measured quantities of calcine to enter the transport piping thus reducing the possibility of undesirable slug flow in the transport line.

10. The bin pressure must remain slightly more negative than the surrounding vault space during retrieval, with controls as required to maintain confinement.
11. The volume of calcine stored in Bin Set 1 is 7500 to 8000 ft³
12. Present calcine temperature in the vault is approximately 80° F and is maintained in a steady state by free convection only.
13. Calcine material will be retrieved from one bin at a time.
14. The size of the retrieval system and retrieval rate is dictated by the size of the line that can penetrate the vault and the conveying distance.
15. Minimize, to the extent practicable, the amount of radioactive material released to the environment as a result of the transfer operations.
16. The existing Bin Set 1 ventilation system is not operational.
17. As close to 100 percent of the calcine will be retrieved as practical.
18. The mean particle size used for alumina calcine is 0.63 mm (from "Properties of Radioactive Calcine Retrieved from the Second Calcined Solids Storage Facility at ICPP").
19. The calcine contained within Bin Set 1 has basically remained unchanged, and has not become agglomerated during the storage period. Therefore, the calcine can be easily reclaimed pneumatically.

2.2.2 Radiological

1. A Dose rate of less than 0.1 mrem/hr is required for routinely occupied areas.
2. Criticality is not a factor in the system design.
3. The existing cyclone at Bin Set 1 has remained intact and no calcine is expected to be found within the cyclone room.

2.2.3 Piping

1. The transport pipe is schedule 40, stainless steel.
2. Nitronic reinforced blind tees and laterals will be installed at all changes in direction per Reference 2.
3. Rodout ports are required along all straight pipe runs.
4. Double containment must be maintained through the entire transport process including the retrieval, transport, and return lines.
5. All above ground piping must be shielded.

6. A six-inch minimum diameter schedule 80 pipe riser will be used to achieve commonality with the other bin sets.
7. The pneumatic transport system design need not include a third line for a spare.
8. Steam tracing will be required inside the secondary confinement encasing the pipe, to prevent or remove condensation of water inside the transport line.
9. Transport and return line piping can be placed in a concrete enclosure whose top is at grade as long as 0.1 mrem/hr is not exceeded. Below grade installation is unnecessary.
10. All piping shall be in accordance with ANSI/ASME B31.3 Fluid Category "M" with 100% radiography.

2.2.4 Structural

1. Bin set 1 is classified as a Moderate Hazard Facility.

2.2.5 Heating and Ventilation

1. The existing vault ventilation system is not operational and should not be used.
2. The secondary confinement surrounding the at-grade run of retrieval and return piping will be sealed but will not be actively maintained at a negative pressure. All other ventilation zone I and zone II confinement exhausts will be HEPA filtered and exhausted to the environment via new stacks at Bin Set 1 and Bin Set 6.
3. The control system for the new heating and ventilation equipment will be the electronic type.
4. Enclosure heating will be by electric coils.

2.2.6 Architectural

1. The retrieval enclosures will be designed to DOE Order 420.1 with the following assumptions: nonreactor nuclear facility, moderate hazard, NFPA 101 Life Safety Code, special purpose industrial.
2. Ten percent of the ground fill is considered to be contaminated.

3 ENVIRONMENTAL ENCLOSURE MECHANICAL SYSTEMS

This section describes of the mechanical systems within the environmental enclosure over the Bin Set 1 vault. The existing structures on Bin Set 1 will be removed down to the (-4) ft -11 in. elevation as described in Reference 1 and shown in Figure 1. Figure 1 also shows the 1 ft-7 in. thick reinforced concrete cap slab poured over the existing vault roof slabs. As indicated in Reference 3, the dose rate in the area above the cap slab will be less 0.1 mrem/hr before any penetrations are made. This meets the requirement for full time personnel occupancy. In addition to providing biological shielding, the cap slab will reinforce the vault roof so it can withstand the loads of the equipment that will be used for calcine retrieval, and it will provide a surface that is level with the top of the existing precast concrete beams that support the existing 1 ft-9 in. vault roof panels. A level surface is required to ensure that the retrieval equipment can be properly located on the floor without obstructions. A weather enclosure will be erected over the vault and pad as shown in Reference 4. The mechanical systems described in this section are the movable mechanisms that will be used in the

weather enclosure. These systems are for coring the concrete vault roof, inserting 20 risers (consisting of two risers on each of eight annular bins and one riser on each of four circular bins), attaching the risers to the top of the bins, cutting the bin tops inside the risers, retrieving the calcine from the bins, and transporting the calcine to the at-grade piping in the transfer line trench at the east wall of the weather enclosure. In addition, ancillary equipment is needed for video inspection of the inside of the bins through the risers and injecting dolomite to clean the inside of the retrieval piping and pipe jumpers. These systems are described below.

All of the equipment described in this section is in the feasibility design stage, and as such, will require mock-up testing and development during the conceptual design phase of the facility. The mock-up testing during conceptual design may alter the details of the feasibility design, but the primary equipment and functions should remain as described here.

3.1 System Descriptions

3.1.1 Concrete Vault Roof Coring Machine

A remote drilling platform (RDP) will be used for drilling 20 penetrations through the 21-in thick the concrete vault roof and four penetrations through the 48-in. thick precast concrete roof support beams. The proposed RDP is similar to that shown in Figure 4-24 of the RFR¹ (also contained in Attachment 3), except that the hole can be cored using a single drill bit and extension tube setup. Therefore the drill bit extension tube, magazine, and loader and indexer, are not required. This modification of the RDP is shown in Figure 2. The mechanism in Figure 2 is a completely engineered component. However, during conceptual design, consideration should be given to using a commercial electric or hydraulic core drill such as a Hoffman or Longyear, during conceptual design. The core drill will core 9-in. diameter holes through the vault roof. It will be located in a field-erectable tent inside the environmental enclosure. The tent will be connected to a portable blower and HEPA filter unit. The tent will control the spread of contamination that may be associated with the vault penetration operation. The core drill itself will be attached to the cap slab with anchor bolts. The core drill will use a 1-in. diameter pilot bit to drill through the floor, capturing dust by a shop vacuum system as the hole is plunged through the reinforced concrete. When the pilot hole breaks through, a toggle-type tong at the end of a post, and central to the 9-in. diameter core drill bit, will capture the concrete core. In this way, as the core penetration is completed, the core will be retained in the bit and prevented from falling into the vault.

The RDP will first core four holes through the roof near the corners of the vault. Cameras will be lowered through these penetrations for accurately triangulating the positions of the RDP over the remaining 20 core hole locations above the bin sets. Radiation shine emitted through the cored holes from the calcine in the bins will prevent operators from passing near the open penetrations. The RDP will be equipped with suitable safety barriers and warning signs to prevent personnel exposure. As soon as a core is removed, the tent and core drill will be removed using the environmental enclosure's 10-ton crane.

3.1.2 Shield Plugs

A steel-lined shield plug will be installed in the cored hole to eliminate radiation shine through the hole. The shield plug also serves as a ventilation barrier that will separate the vault space from the inside of the weather enclosure. The shielding provided by the plug will equal that provided by the vault roof and cap slab. The plug will be stepped to prevent streaming from its edges.

During vault penetration operations, the vault interior space will be maintained at a negative pressure. Although it is not expected that the vault space will be contaminated, the negative pressure will serve as a ventilation confinement barrier. In case there is any contamination in the vault interior, this barrier will prevent it from migrating into the weather enclosure.

Figure 4-30 in Reference 1 (also included in Attachment 3) shows a shield plug protruding well above the top of the cap slab. This would interfere with subsequent placement of the vertical deployment apparatus (VDA) (described below) and with the calcine transfer spool pieces inside the weather enclosure. To avoid this, a new configuration for the shield plug is proposed in Figure 3. A concrete insert will be placed in a cast hole in the cap slab, and the shield plug will be inserted into the riser. The shield plug and the insert are flush with the top of the cap slab to eliminate vertical protrusions. The shield plug lifting eye can be removed to maintain a flat surface. This arrangement cannot be used for the four risers in the vault's precast concrete beams. This is because the tops of the beams are flush with the top of the cap slab and the insert cannot be used. The precast beams have to be core drilled because the four center cylindrical bins lie directly below them.

3.1.3 Riser Installation and Bin Top Cutting

Highly specialized equipment will be needed to clean the top of the bins, to weld the risers to the bins, and to cut the top of the bins inside the risers. Reference 1 indicates that the 21 ft-7 in. long risers will be lowered through the holes immediately after coring the vault roof. It does not indicate what equipment and methods will be used to lower, align, or attached the risers to the bins. The report relies, for feasibility, on similar equipment that was used at West Valley⁵ for cleaning the top of a waste tank, welding 30-in. diameter risers to the tank lid, and cutting the tank lid inside the risers.

Reference 6 provides guidance for riser installation and bin set cutting. Reference 6 is based on work that Tri-Tool Incorporated performed for INEEL. Tri-tool has indicated (see Attachment 2) that these operations are feasible in risers down to 6 in. in diameter. Tri-Tool proposes that a weld stud first be welded to the top of the bin at the center position of each riser. An abrasive tool head would be lowered through the cored hole to remotely grind the top of the bin in preparation for riser welding. The grinder could use the weld stud as a central guide. The environmental enclosure's 10-ton crane would then lower the riser through the cored hole and onto the bin, centering the lower end of the riser on the weld stud. The riser would then be remotely welded using a specially designed welding head that would be lowered down the riser to the top of the bin. This head would be reconfigured and lowered down the riser to remotely trepan a hole in the top of the bins. The trepanning head would engage the weld stud so that the circular section cut from the bin lid would be removed with the head. More details are provided in Attachment 2. Attachment 2 also contains an updated cost estimate for this equipment. This estimate does not include installation, setup, or operation of the equipment. It is assumed here that the installation equipment would be mounted at the end of a mast more than 20 ft long that would be lowered into the riser by the 10-ton environmental enclosure crane.

3.1.4 Calcine Retrieval Nozzle and Extension Tubes

The calcine retrieval nozzle (CRN) and extension tubes are similar in function to drill string sections used for well drilling. The designs are based on results from Reference 7, which reports the results of mockup testing on transfer of simulated calcine in a scaled annular bin. Reference 7 indicates that good calcine removal volumes and rates can be obtained by placing an airjet at one side of the annular bin to blow the calcine to a vacuum nozzle located at the other side of the bin. Most of the calcine from the bin can be removed by repeatedly switching the airjet and vacuum nozzle functions from one side of the bin to the other. It would be very complex and time consuming to move the VDAs back and forth from one side of the bin to the other. This EDF therefore, recommends that each VDA incorporate a hybrid pipe string design that can be used as either the vacuum, or the airjet, or both simultaneously. This is accomplished by the CRN and extension tube design discussed below.

Figure 4 shows details of the CRN and extension tubes. The 10-ft long CRN consists of an inner 4-in.-schedule 40 pipe and a concentric 6-in.-schedule 80 pipe surrounding it. The inner vacuum pipe will remove air and calcine from the bins. Its lower end is open and acts as the calcine-vacuuming nozzle. The annulus between the two pipes is a path for returning the air, that was removed by the vacuum nozzle, back to the bin. In the CRN design, the lower end of the outer

pipe is sealed to the inner pipe. A radial hole in the side of the outer annular pipe acts as the airjet nozzle for blowing calcine to the opposite side of the bin. The upper ends of the CRN and the extension tubes have female drill casing threads and O-ring seals that separate the annulus from the inner pipe bore when the tubes are connected. The lower end of each extension tube has male drill-casing threads and an internal seal surface that mates with the O-ring seal.

3.1.5 Vertical Deployment Apparatus (VDA)

The feasibility design of the VDA is shown in Figure 5. Its primary function is to help remove calcine from the bins. A secondary function is to lower a CCTV camera inside the bins to determine the progress of calcine removal. The VDA includes equipment that remotely handles and joins the CRN and extension tubes that will actually remove the calcine from the bins. The VDA joins the 10-ft tube sections in a continuous string up to a height of 50 ft, as it lowers the string into the bins. The VDA equipment also functions as an interface between the pipe assembly and the stationary vacuum and air return lines in the transfer line trench at the east wall of the weather enclosure. The individual components and operations are described in this section

3.1.5.1 Structure

The VDA is a portable tower that can be relocated from riser to riser as retrieval operations progress. It is a rectangular structural steel tower, approximately five feet square at its base and approximately 25 ft tall. Its frame is constructed to AISC specifications from vertical structural steel rectangular tube sections with diagonal bracing on four sides to form an integral steel tower. The stainless steel sheet metal skin is seal welded and attached to the interior of the tower. It has radiused corners to facilitate decontamination. The sheet metal skin includes a catch pan at the bottom of the VDA to capture radioactive dust or to contain decontamination solution used to clean the VDA interior. The catch pan seal lid will be opened to allow access to the shield plug and the riser.

The VDA is lifted and moved by the 10-ton bridge crane inside the weather enclosure. Lifting points on the tower, for attachment to the overhead crane, are adjustable to accommodate center of gravity shifts. An external caged ladder, with gate and handrail-equipped platforms at the various levels, allow personnel access for service to the externally mounted equipment items along the full height of the tower. All platforms are equipped with OSHA handrails and spring closed gates. Alternate methods of service access include use of a portable scissors lift. The structure of the platforms is integrated with the structure of the tower. The tower contains various drive gear motors that are mounted externally to facilitate maintenance access. Gearmotor shafts pass through the sheet metal skin through shaft sealing glands. The glands are externally replaceable, with the used seal being pushed inside the interior of the frame by the new replacement seal. The VDA has external connections for ventilation ductwork, controls, electric power, video signal output, compressed air, and decontamination solution. The decontamination liquid used to flush the inside of the VDA will be prevented from entering the riser by a seal door mounted on a vertical tube built into the catch pan at the bottom of the VDA. Decontamination solution from the catch pan will be pumped to a wastewater storage container.

3.1.5.2 Shielding Panels

Removable, 2-1/2-in. thick carbon steel panels will cover the bottom half of the VDA exterior during calcine transfer. Their function is to attenuate radiation fields incurred during calcine transfer so that the grade-level control room adjacent to the vault is suitable for full time occupancy. The panels are mounted on all four sides of the lower portion of the VDA tower. The shielding spans from the floor to an elevation equal of the end of the telescoping tube (about 15 ft).

As an alternative to the steel shield panels, a 'hybrid' design can be produced. This hybrid puts part of the shielding on the wall separating the control room from the area over the vault, and places the remainder of the shielding on the VDA. The intent of this design would be to reduce the shield weight on the VDAs which must be moved from riser to

riser (at least 20 times during the retrieval process). Removal, relocation, and re-attachment of the shield panels may prove cumbersome, time consuming, and a safety intensive effort. The effort may also be reduced by placing exterior shielding around the walls of the weather enclosure adjacent to the manned control room. The design basis for the shielding (less than 0.1 mrem/hr) allows full time occupancy in the control room. This field will also be required at external areas surrounding the site (on Olive Ave. etc.) which may be occupied by site personnel not associated with the project. Beyond the site perimeter fencing (which may be protected by administrative controls during transfer operations), the dose rate must be low. There is a tradeoff between the shielding thickness, calcine jumper shielding thickness, overhead crane load capacity, and weather enclosure construction (which may be made with a reinforced overlapping tip-up concrete wall panel system for the bottom 10 ft of wall rather than metal siding). The required trade-offs should be considered during conceptual design.

3.1.5.3 Ventilation system

The VDA inner skin forms a ventilation confinement space within the tower. The VDA interior is maintained at a pressure slightly below that in the weather enclosure. The interior VDA space will be a primary confinement space when the VDA is in place and the shield plug is removed from the top of the riser. The interior airspace is ventilated by a portable fan and HEPA filter. The duct connection must be broken and reconnected each time the VDA is relocated. The ventilation system must operate when the shield plug is removed from the riser, and when used vacuum pipes are stored inside the vestibule.

3.1.5.4 Quill

The top half of the VDA contains a 10-ft long telescoping tube quill. The quill consists of a set of two stationary and two sliding concentric tubes, a rotation gear drive, a threaded nose, shielding, and seals. The quill is externally shielded by a 2-1/2-in. thick carbon steel cylinder. The two sliding tubes are nested within the two stationary tubes (See the detail view in Figure 5). Seals at the bottom ends of the stationary tubes maintain two separate airflow paths. The inner cylindrical path is for calcine vacuum air and the outer annular path is for returning air that has been removed from the bin during vacuuming. The two nested airflow paths diverge into two individual stationary pipes near the top of the VDA. The nose of the quill is threaded to couple to the CRN and extensions tubes.

3.1.5.5 Quill Elevator Mechanism

The VDA is equipped with a quill elevator mechanism that raises or lowers the sliding quill tubes. The mechanism consists of a drive gearmotor, a chain drive, and a slide. The gearmotor is located on the side of the VDA, outside of the inner sheet metal skin. A drive shaft connects the gearmotor to the chain drive sprocket inside the VDA. The chain raises or lowers a dovetail slide carriage that is connected to the movable nose of the quill. The elevator mechanism lowers and raises the CRN and extension tube sections into and out of the bins.

3.1.5.6 Quill Rotation Mechanism

A set of gears located at the bottom of the quill allows the sliding tube assembly to be rotated about its vertical centerline. The gearmotor for the quill rotation is located at the top and outside of the VDA's sheet metal skin. The gearmotor turns a vertical splined shaft that rotates the drive gear in the quill head. As the quill is raised or lowered, the internally splined drive gear traverses the length of the shaft to maintain constant engagement with the spline. Rotation is necessary to make and break the threaded connections at the ends of the CRN and extension tubes that will be lowered into the bins for calcine removal. It also allows the CRN airjet nozzle to be rotated to the various azimuth orientations inside the annular bins to blow calcine from one side of the bin to the other side where the calcine is being vacuumed.

3.1.5.7 Vestibule

An external sheet-metal-enclosed vestibule is located on the side of the VDA, and it is an integral part of the tower structure. It houses a carousel that holds the CRN and extension tubes, and can be used to lower a CCTV mast inside the bins. The vestibule, like the tower, has an external structure with an internal sheet metal skin. Its floor is sloped to drain into the tower confinement. The carousel is driven by an external gearmotor and indexing mechanism mounted on top of the vestibule. The motor turns the central shaft of the carousel which normally holds one CRN and four extension tubes. The carousel indexes and stages one of these tubes at a time toward the quill centerline so it can be moved into position beneath the retracted quill by the tube trolley (discussed below). Tubes and CCTV camera sections can be inserted and removed from the vestibule. There is a tube slot in the common wall, between the vestibule and the tower, can be closed off with a sliding knife gate. There is also a sliding knife gate at the outer side of the vestibule. The inner gate is open and the outer gate is closed under normal retrieval operations. With the gates in these positions, the vestibule confinement shares the same air space as the interior of the tower. The inner gate is closed and the outer gate is opened during maintenance and when new CRN and extension tubes are being added or removed from the vestibule. The vestibule can thereby isolated from the tower. The used CRN and extension tube sections are bagged out through the open gate. Shine from this gate is controlled by a shadow shield on the back wall of the vestibule. The knife gates are manually opened and closed using external handles.

3.1.5.8 Tube Trolley

A pneumatically actuated trolley is located just below the raised quill. It rides on rails, which run horizontally across the interior of the VDA tower. The trolley has pneumatically actuated gripper jaws for grasping the upper end of the CRN and extension tubes. The function of the trolley is to advance to the vestibule, grasp a tube section that has been moved into position by the carousel, and transfer the tube to a station just below the quill end thread.

3.1.5.9 Pipe Clamps

The VDA contains an upper and lower set of pneumatically actuated pipe clamps. The upper clamp is located just below the trolley while the lower clamp is located near the bottom of the VDA. The upper clamp holds the CRN or an extension tube while it is being threaded onto, or unthreaded from, the quill threads. The upper clamp is actuated to grasp the tube before the trolley jaws release.

The lower clamp holds the section of pipe that is held by the quill at its lowest position. After the lower clamp grips the pipe section, the quill is rotated to unscrew this pipe section. With the pipe section (and all the pipe string below it) hanging from the lower clamp, the quill is free to raise and acquire another pipe section. After the new pipe section is attached to the quill using the trolley and the upper clamp, it is lowered slightly and screwed onto the pipe string that is hanging from the lower clamp. The lower clamp is then released, and the pipe string can be lowered by the quill. This procedure is reversed to break the pipe string down and return the sections to the vestibule carousel.

3.1.5.10 Jumper

The externally shielded calcine jumper pipe connects to the calcine transfer vacuum pipe at top of the VDA and terminates at the bottom of the VDA. In addition, a unshielded air return line is also routed down the outside of the VDA, and, by means of interchangeable spools, is connected to the transfer line trench at the east wall of the weather enclosure. The inside of the environmental enclosure acts as the secondary confinement for the calcine jumper pipes.

3.1.5.11 Plug Removal Hoist

The plug removal hoist is located inside the VDA on the wall opposite the vestibule. It is powered by an external gearmotor. The function of the hoist is to remove the shield plug from its location in the riser, and stow it out of the way of CRN and extension tubes as they are lowered through the riser and into the bins. This jib hoist can be swiveled from above the bin penetration by operators outside of the VDA. Once the shield plug has been removed, radiation shine emitted from the calcine in the bins prevents operators from passing near the open penetration. The hoist motor, brake, controls, cable, pivots, and sheaves, will require periodic inspection and the hoist system will require periodic load testing. When the shield plug is removed, the confinement zone inside the VDA becomes Zone 1 because it is directly connected to the interior of the bin. If the ventilation system requires shutdown, or otherwise is non-operational, the shield plug must be replaced in the riser by the plug removal hoist.

3.1.5.12 Ventilation Ductwork Connection

The VDA tower interior is operated at a pressure slightly below the pressure in the environmental enclosure. The interior space serves as part of the primary confinement when the riser shield plug is removed. The interior airspace is connected via temporary ductwork to the its own ventilation system in the environmental enclosure's HVAC room. The duct connection must be broken and reconnected when the VDA is relocated.

3.1.6 Calcine Pipe Spool Pieces

Shielded spool pieces are used to connect to the discharge of the VDA jumper pipe and the airjet return pipe at the bottom of the VDA. These pipes are connected to the calcine transfer line and airjet return line at the transfer line trench in the east wall of the environmental enclosure. Regardless of the particular riser position at which the VDA is stationed, the spool piece configurations will be such that these two ends are connected. These spool pieces are fabricated in four to five-foot lengths for ease of handling. Each spool piece will be equipped with lifting eyes for handling by the overhead crane. When the spool pieces are in operation, the environmental enclosure acts as the secondary confinement for the calcine inside the spool piece pipes. Each spool piece contains two pipes. One pipe will be dedicated to retrieving calcine from the bin and the other will be dedicated to returning the cleaned air back to the bin. The return air will be HEPA filtered and under pressure. The spool pieces will be shielded as required for reducing the radiation field within the environmental enclosure when calcine is being transferred. Blind tees with shielded caps will be located at all 90-degree elbows in the spool piece pipes. The spool pieces will be laid out and configured, in flanged sections, as necessary to tie together the end points. Similarly, the shielding will be arranged to correspond to the configuration of the spools. The inside of the calcine spool and jumper pipes will be cleaned by a dolomite flush system discussed below.

3.1.7 Dolomite Injection System

Residual calcine and dust may cling to the interior walls of the CRN, extension tubes, VDA jumper, and spool pieces after calcine has been transferred. Because the residual calcine is less than that present when material is being retrieved, the fields will not be as high. A small amount of calcine, however, can still be highly radioactive. Therefore, a dolomite backflush system will be used to clean the dust from inside the piping system before it is removed.

Reference 1 recommends that the point at which the spools are connected to the lines in the transfer line trench be equipped with a double valve and tee arrangement to serve as a point for high velocity injection of dolomite. Backflushing the line with dolomite from this point back to the bin would scour the interior of the transfer lines before remake of the jumpers, spools, and retrieval pipe connections. This would limit the amount of material present in the line and decrease the potential for spread of contamination. However, this implies the injection point would be pressurized thus placing the spools, jumpers, and possibly the bin, at a positive pressure with respect to the environmental enclosure secondary confinement. This is not advisable because it can be considered a flow reversal from an area of higher

contamination potential (the piping and bin) to an area of lower contamination potential (the inside of the environmental enclosure).

Dolomite could be vacuumed (using the same system as used for calcine vacuuming) through the CRN or extension tubes near the bottom of the VDA as they are separated from the tube below them and before being returned to carousel. This would keep the piping run at a negative internal pressure while cleaning the extension tubes, CRN, and jumpers. This would require a method for delivering dolomite into the VDA and at a location close to the bottom clamp where the CRN and extension tubes are separated. The dolomite would be vacuumed to the retrieval cyclone and then be transported to Bin Set 6 by the calcine transport system. The dolomite flush system must be studied and further developed during conceptual design.

3.2 CALCINE RETRIEVAL OPERATIONS

3.2.1 *Annular Bins*

Two VDAs will be deployed for retrieving calcine from each annular bin. The environmental enclosure 10-ton crane will position one VDA over the appropriate riser plug location on an annular bin, and align it with the four bolt holes in the cap slab for that riser location. The second VDA is similarly positioned over the riser location that is diametrically opposed across the annular bin from the first VDA (See Figure 6). Once in position, both VDAs are secured to the cap slab with four anchor bolts. These will be the same anchors that were used to fix the vault roof core drill during coring. The external 2-1/2-in thick steel shield panels are then hung on the outside of the VDAs using the 10-ton crane. The VDA jumpers, spool pieces, and spool piece shielding sections are then put in place to connect the VDA vacuum and air return lines to the corresponding lines in the transfer line trench in the east wall of the environmental enclosure (see Figure 6). The VDA and jumpers positions will have to be planned carefully to avoid interference with these four shield plugs protruding from the precast beams discussed above. In addition, a shielded vault ventilation duct on top of the cap slab will run from near the center of the cap slab to the new exhaust HEPA filter located just south of the environmental enclosure. Spool pieces for some of the VDA locations will also have to be routed around the duct and around the four shield plug protrusions. The riser locations must be selected such that the VDAs will not interfere with the ventilation duct. Figure 6 shows the approximate location of this ventilation duct on the cap slab.

This setup is capable of removing the calcine to within one or two inches of the bottom of the bin. Figure 6 shows a typical installation for retrieving calcine from an annular bin. After installation of this equipment, the environmental enclosure is vacated and the remaining operations are performed remotely from the control room. Refer to Figures 5 and 6 for the following VDA operation description.

The following operations are identical for both VDAs located above the annular bin. The VDA plug hoist removes and stows the riser shield plug. The CRN and extension tube sections are next combined. To accomplish this, the tube trolley obtains the CRN from the vestibule carousel and places it below the threads at bottom end of the quill. The upper clamp secures the CRN and the trolley is stowed. The quill thread is screwed into the thread at the top of the CRN. The upper clamp is released, the quill lowered fully, and the lower clamp actuated to hold the top of the CRN. The quill is then unscrewed from the top of the CRN and returned to its upper position. The CRN will now be suspended from the lower clamp and will protrude approximately 8 ft into the riser. The carousel is then indexed to align the first extension tube to the tube trolley. The tube trolley then obtains the first extension tube from the vestibule carousel and positions it below the quill. The extension tube is fastened to the quill in the same manner as just described for the CRN. The quill lowers slightly until the threads at the bottom of the extension tube contacts the threads at the top of the CRN. The quill then rotates and screws the extension tube to the CRN. The lower clamp is then released and the quill is lowered until vacuum nozzle at the bottom of the CRN contacts the calcine in the bin. The identical operations are performed for the other VDA until the CRN nozzle contacts the calcine at the other side of the bin. The spool pieces and selection valves

shown in Figure 6 are set so that one VDA will be vacuuming through its CRN center pipe, and the other VDA will return air through its CRN outer annular pipe and airjet nozzle.

While calcine vacuuming is in progress, the interior of the bin set is held at a vacuum of about 1-in. H₂O with respect to the vault, while the return air is at approximately 20 psig inside the CRN and extension tube's annulus. The 20-psig pressure drop occurs across the airjet nozzle in the side of the CRN annular pipe. This pressure drop creates a horizontal jet of air whose azimuth can be directed, by rotation of the quill, to blow calcine to the other side of the annular bin.

The calcine retrieval blower is located in the retrieval equipment building north of the environmental enclosure. As the calcine is removed from the bin, the VDA quills will be lowered to follow the lowering surface of the calcine. When either VDA quill reaches its lowest position, the blower will be stopped. Another extension tube will then be obtained from the vestibule and fastened to the top of the pipe string. This will be performed in a manner identical to that described above for the first extension tube. While one VDA is vacuuming through the CRN vacuum nozzle at one side of the bin, the other is returning the air to the other side of the bin and blowing calcine to the vacuum nozzle. Almost all of the calcine should be able to be removed from the bins with this single setting of the selection valves. When the vacuum nozzle nears the bottom of the bin, a mound of calcine will form at either side of the vacuum nozzle. These two mounds will not be able to be retrieved by the nozzle. When that happens, the blower will be stopped and the selection valves will be reset so that the vacuum VDA will become the air return VDA, and visa versa. With this new configuration, the two calcine mounds will be located at the sides of what is now the airjet nozzle. When the blower is started, the airjet nozzle VDA quill will be rotated as necessary to blow the calcine mounds to the other side of the bin for vacuuming by the other VDA. The valve settings will be changed back and forth as necessary, until all mounds are removed and the calcine level is within one or two inches of the bottom of the bin. This completes the calcine retrieval operation for this bin. The remainder of the calcine in that bin will be removed during D&D operations which are outside the scope of the retrieval task.

The CRN and extension tube string will be retracted from the bin and broken down in the reverse order in which it was connected. The extension tubes and CRN will be returned to the VDA vestibule and the shield plug is returned to the riser. The used CRN and extension tubes can be bagged out of the vestibule sliding knife gate. The CCTV boom and its extension pieces can then be bagged in. After evacuating the environmental enclosure, the shield plug will be removed and the CCTV camera will be deployed down the riser, in a manner similar to that used to install the CRN and extension tubes. Once in the bin, the camera will be used to determine the if the calcine has been sufficiently removed or if more vacuuming is required. If there is significant calcine left, the CCTV equipment will be bagged out of the VDA and the CRN and extension tubes will be bagged back in for further vacuuming and airjetting.

3.2.2 Cylindrical Bins

Each of the four central cylindrical bins will have only one riser and thus only one VDA and one set of jumpers and spool pieces will be installed to retrieve the calcine. One VDA will be setup over the cylindrical bin riser. Jumpers and spool pieces will be installed to connect the VDA vacuum and airjet lines to the lines in the transfer line trench. The transfer line trench selection valves in Figure 6 in the will be set to operate both vacuum and airjet lines in the single VDA. Therefore, the CRN central vacuum and the outer annular air return pipes will be operated simultaneously during calcine retrieval from the central bins. The CRN and extension tubes from this VDA will be deployed as described above. All other VDA and retrieval operations are as described above for the annular bins. The only exception is that the selection valve positions will not need to be reset to switch between vacuuming and air return operations. The CCTV camera will be used to determine the extent of calcine retrieval from the cylindrical bin. It will be deployed as described above for the annular bin operations.

4 CALCINE TRANSPORT METHODS

Section 4.3.6 in the RFR¹ discusses the various technologies of transporting calcine from the VDA to Bin Set 6. In general, the RFR recommended the use of a negative-pressure dilute-phase pneumatic-transport system for moving the calcine from Bin Set 1 to Bin Set 6. The four different pneumatic transport systems discussed in the RFR¹ were an open loop, a closed loop, a combined loop, and a mobile transport option (pneumatic transport to a cask and cask transport to Bin Set 6). Of these, the RFR selected the combined loop transport method that is shown in RFR sketch SK-F-05 (see Attachment 3). This was selected in the RFR because it offers a simpler design and eliminates redundancy compared to the more conservative closed loop method. However, the combined loop system is less reliable than the closed loop system and is more prone to clogging. This EDF recommends that the closed loop method be adopted because it is more reliable when considering the transport piping length of over 600 feet from Bin Set 1 to Bin Set 6. A modified version of the Raytheon closed loop flow diagram is shown SK-BS1-01 in Attachment 1. This is judged the most reliable method of moving the calcine from Bin Set 1 to Bin Set 6. In addition, its cost will bound that of the other options investigated. The closed loop pneumatic transport system consists of three parts: the calcine retrieval facility, the calcine transport facility, and the transport piping between Bin Set 1 and Bin Set 6. These systems are shown on SK-BS1-01, and discussed below.

4.1 Calcine Retrieval Facility (at bin set 1)

The retrieval system will be located in a separate shielded retrieval equipment building to the north of the environmental enclosure. Reference 4 includes physical arrangement sketches of calcine retrieval facility West of Bin Set 1. The system will provide airflow and calcine handling for vacuuming the calcine from the Bin Set 1. It also provides air filtration and air return to the bin. The closed loop retrieval system blower pulls the calcine up through the CRN and into a cyclone separator that removes the calcine from the air stream. To minimize the amount of air released to the atmosphere and keep the pressure of the bin at slightly below atmospheric, the discharge blower air is piped back into the bin through the airjet nozzle. A sintered metal filter and HEPA filter are installed upstream of the blower. These components will capture contaminated particles before they enter the blower, and provide two-stage HEPA cleaning of the air stream fraction discharged to the process stack to the atmosphere. The retrieval system cyclone feeds a calcine weigh tank and rotary valve that meters calcine to the transport system pipe for transport to Bin Set 6. A heat exchanger is located at the discharge of the retrieval conveying air blower. The discharge temperature of the blower will be above 225°F. The heat exchanger ensures that the temperature of the air that will enter the bypass air HEPA filter and blower, and subsequently return to the retrieval blower inlet HEPA filter and retrieval blower will be below 100°F. This allows the all HEPA filters and blowers to operate within their manufacturers' specifications. A balancing air blower and HEPA filter is installed downstream of the heat exchanger. This blower will maintain and control a slight vacuum in the bins. In addition, it will expel the air inleakage through the bin risers, the sintered metal filter blowback air system, and any instrument air used in the system controls.

4.2 Calcine Transport Piping and Transport Facility

SK-BS1-01 shows the calcine transport piping and transport system at Bin set 6. Calcine transport piping runs from the Bin Set 1 retrieval facility weigh tank to Bin Set 6, and back. The calcine transport piping will be as detailed in the RFR¹. The system has a 5-in. diameter calcine transport pipe and a 6-in. diameter return airline. Both the transport and the return air lines are schedule 40 stainless steel, and are enclosed in a 22-in. diameter schedule 10 stainless steel secondary confinement pipe which is completely seal welded for insured environmental isolation. The calcine transport pipe will have reinforced fittings at all changes in direction, and the return airline will be designed with long radius elbows. The secondary confinement annular space will be heated by means of a steam trace line and will have internal pipe supports every 8 feet. In order to provide adequate seismic support as well as provide shielding from the radioactive calcine being transported, the secondary confinement pipe and all internal piping will be enclosed inside a precast system of concrete sections. These precast concrete sections will be approximately 5 ft x 4 ft–3 in. x 9 ft long. Precast concrete

sections are being used in order to facilitate construction, minimize cost, and allow for easier and more cost-effective removal of the system after transfer of the calcine is complete. A typical detail showing a section of the secondary confinement piping and precast concrete shielding sections is shown on RFR sketch SK-P-03 (included in Attachment 3).

The routing selected for the piping from Bin Set 1 to Bin Set 6 was established taking into considerations the following criteria: 1) Keep the routing as short as possible with minimum change in direction in order to minimize piping pressure drops 2) Select a routing that considers the location of existing services, constructibility, and future demolition characteristics in order to minimize time required during construction as well as contain construction/demolition costs were possible.

The criteria listed above resulted in a routing which is shown on drawing RFR¹ drawing SK-P-02 (included in Attachment 3). The at-grade piping system was selected. The general routing for the transport piping is as follows: The calcine transport piping starts at the calcine retrieval facility's rotary valve. The piping will exit the retrieval approximately 5 ft below grade. Here the piping will drop into the transport trench that will be approximate at elevation 4909 ft-6 in. This will locate the top of the precast concrete shielding at approximately 4912 ft-0 in. that is grade elevation in this area of the plant site. As the transport piping exits the Bin Set enclosure building it connects into the main trunk line which has a future connection for the calcine removal from Bin Set 2. From this intersection, the transport line turns north for about 100 ft to just south of Olive Avenue. At the south side of Olive Avenue, the piping turns east for approximately 180 ft to a point just south-west of the intersection of Olive Avenue and Hemlock Street. At this position, it will be necessary to relocate a fire station hose house to make room for the direct routing of the transport line. Here the line turns 45 degrees to the north-east and drops under Hemlock Street. This line continues at an approximate burial depth of 12 ft for about 120 ft where it rises back up to grade elevation and heads due north paralleling Hemlock Street for another 150 ft. Here it turns north-east for 70 ft where it turns directly east and passes under the Retrieval/Transfer Equipment Building. At the base of the Bin Set 6 vault, the transport piping (which is encased in a reinforced concrete shielding) rises up the outside and to the top of Bin Set 6. Here it enters a new cyclone separator that will remove and transfer the calcine into Bin Set 6. The return air piping returns from the cyclone at Bin Set 6, continues down the concrete encased riser, and then enters the shielded calcine transport building at the base of Bin Set 6. Reference 4 includes physical arrangement sketches of the calcine transport facility and equipment. Before the air enters the transport blower, it is filtered by two stages of HEPA filtration. A heat exchanger is located at the discharge of the blower to cool the air similar to that in the calcine retrieval facility. A balancing air blower is installed downstream of the heat exchanger. It will maintain and control the vacuum in the calcine transport lines. In addition, it will expel the excess air ingress into the system from the rotary valves, the sintered metal filter blowback air system, and any instrument air used in the system controls. The cyclone separator, sintered metal filter, and enclosure on top of Bin Set 6, are as shown in RFR¹ sketch SK-A-02 (included in Attachment 3).

5 REFERENCES

1. Idaho Chemical Processing Plant Phase I and II Special Studies Calcine Recovery Bin Set # 1 Project, Raytheon Engineers and Constructors, March 1995
2. Bodner, S. S., "Effects of Bend Configuration on Dilute-Phase Pneumatic Transport", ENICO-1084, May 1981
3. H. K. Peterson, Radiological Review of Raytheon's Shielding Calculations as Presented in Phase I & II Special studies calcine recovery Bin Set #1 Project, EDF-1213.
4. T. A. Langerwalter, AE/Civil/Mechanical Design, EDF-1109.
5. Jackson, J. P. and Gessner, R. F., Remote Installation of Risers on Underground Nuclear Waste Storage Tanks, DOE/NE/44139-45, March 1988.
6. Berry, S. M., letter to Law, J. P., Transmittal of Report on Analysis of Methods to access Binset 1 for Calcine Retrieval, SMB-04-94, March 29, 1994.
7. Griffith, D. L., letter to Distribution, "Status of Calcine Retrieval Development Work," DLG-06-96, September 26, 1996.

6 ATTACHMENTS

- 1 Figures and Sketch SK-BS1-01
- 2 Tri-Tool International Data
- 3 Figures and drawings from the RFR¹

Figure 4-24

Figure 4-30

SK-F-05

SK-P-03

SK-P-02

SK-A-02

SK-T-02

Attachment 1
Figures and SK-BS1-01

EXISTING FACILITY &
EQUIPMENT TO BE
REMOVED

A	CRAFT PHASE 1 SPECIAL STUDIES	01/20/94

Figure 1. Bin Set 1 after demolition and with poured cap slab

Figure 2. Modified Remote Drilling Platform

Figure 3. Riser installation for flush shield plug

Figure 4. Calcine retrieval nozzle and extension tube

Figure 5. Vertical Deployment Apparatus

Figure 6. Typical lactation of VDAs on vault

BIN SET 1
WEATHER ENCLOSURE

RETRIEVAL FACILITY

D

C

B

A

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SUBCONTRACT NO.		LOCKHEED MARTIN						
REQUESTER:		HLW-BIN SET 1 TRANSFER FEASIBILITY STUDY PROCESS FLOW DIAGRAM						
DESIGN: C. M. NOAKES								
DRAWN: R. L. SMITH								
PROJECT NO.								
SPEC CODE		SIZE	CAGE CODE	INDEX CODE NUMBER	DWG	REV		
FOR REVIEW/APPROVAL SIGNATURES		D	01MF3	ASCA	TYPE	G	530	SK-BSI-0
SEE DAR NO.		SCALE: NONE		SHEET		1 OF 1		
EFFECTIVE DATE:								

431.02
08/12/98
Rev. 06

ENGINEERING DESIGN FILE

Functional File No. _____
EDF No. EDF- _____
Page 19 of 20

Attachment 2

Tri-Tool International Data

TRI TOOL INC.
TRI TOOL INTERNATIONAL

3806 SECURITY PARK DRIVE
RANCHO CORDOVA, CA 95742-6990
(800)345 5015 (916)351 0144
FAX SALES FAX
(916)351 0372 (916)351 0979

FAX MESSAGE

May 6, 1999

FAX NUMBER: 208-526-2681

NUMBER OF PAGES (INCLUDING THIS PAGE)

6

TO: Mike Berry
Lockheed Martin Idaho

FROM: Daryl L Anderson
Regional Manager

SUBJECT: Technical Discussion

MESSAGE:

Dear Mike,

Here is the copy of the proposal we made back in 1994 I have whited out the pricing. If you have any question's please call me.

TRI TOOL INC.

TRI TOOL INTERNATIONAL INC.
TRI TOOL SERVICES, INC.

3806 SECURITY PARK DRIVE
RANCHO CORDOVA, CA 95742-6990

(800) 345 5015 (916) 351 0144
TELEX 377-364 (FAX) 351 0372

BINSET PENETRATION EQUIPMENT TECHNICAL AND ROM COST PROPOSAL

Prepared for

Mike Barry
of
WINCO Remote System Applications

March 31, 1994

BACKGROUND:

This technical approach and ROM cost proposal has been prepared based on data submitted to and discussions with TRI TOOL™ by WINCO.

The basic problem is to machine openings for installation of risers into the top of various elements of a BINSET to allow removal of calcined high level waste from the BINSET. The BINSET is installed in an underground concrete vault and covered with earth. Due to the radiation level the operation must be performed using remote equipment with only minimum direct operator involvement. The working deck is 20' (nominal) above the top of the bins.

The basic sequence of events planned by WINCO is:

1. Remove the overburden.
2. Construct a containment facility over the vault.
3. Install as required any insets into the vault top.
4. Core drill through the vault top.
5. Install riser penetrations through the top of the Bin elements.
6. Use an air transport system to remove the calcined material.
7. Decontaminate the Bins and remove for low level waste burial.

TECHNICAL DISCUSSION;

Tri Tool is presenting information regarding an approach for installing the risers onto and penetrating of the bin tops.

The sequence of events being suggested for the riser installations is:

1. Prepare the risers with an internal flange ring.
2. Install a stud at the planned center of the penetration.
3. Clean the top of the bin surface for welding (use the stud as a center pivot if required).
4. Install the riser down onto the bin surface
5. Install the ID welding system into the ID of the riser.
6. Weld the riser to the top of the bin.
7. Remove the welding head.
8. Install the machining system and trepan cut the penetration hole.

Removal of the riser is planned to be accomplished using the same machining system with different tooling.

INTERNAL WELD FLANGE CONFIGURATION

Figure 1

EQUIPMENT DESCRIPTIONS AND ROM COSTS:

1. Riser preparation:

Figure 1 shows the basic configuration of the proposed (suggested) riser configuration. Tri Tool recommends that the flange rings be pre-machined, welded to the risers and then machined on the bottom surface to remove any out of flatness and angularity before installation. Note use a fillet weld in lieu of an autogenous weld will optimize the weld reliability and also allow a dissimilar metal weld joint if desired.

The bevel on the ends of the risers could be machined with a Tri Tool Model 212B BEVELMASTER™ and the bottoms of the flanges machined with a 212B fitted with a 212B Flange Facing Module. Both the BEVELMASTER and the FF Module are standard equipment with Tri Tool. A firm fixed price proposal can be prepared if so desired.

2. Capture Stud Installation:

The machining operation planned to make the penetration through the bin top is to do a trepanning cut which will release a circular plate. To keep the plate from dropping down into the bin a mechanism for holding onto the plate is required. Preferable a mechanism which does not open the riser to radiation shine or particulate contamination is preferred. Current thinking is that a stud could be resistance welded to the plate to serve two purposes, 1) to provide a pivot center for a weld surface cleaning tool and 2) to allow a capture mechanism in the machining tool to hold onto the plate when the cutting operation

performed. The stud must be in the center of the riser.

3. Bin Surface Cleaning:

The surface of the bin where the weld is to be made must be cleaned of any scale, dust, etc. which will interfere with the welding process to follow. Physical abrasive cleaning is the preferred method.

4. Riser Installation:

The riser must be installed down hole to be flat to the surface and centered (around the stud if pre-installed). For optimum welding condition it is preferred that the bottom of the riser be in full contact with the bin top. However the orbital welding system could handle up to about .050" gap without special procedures. If a larger gap is detected with the Video system than a multiple pass weld cycle could be programmed as required to handle larger gaps.

5. Automatic Welder Installation:

Tri Tool is proposing to supply an Automatic Orbital ID Welding System with the following elements:

1. ID Welding Head with clamping and drive motor.
1. 300 Amp Auto-Tig Power Supply (contains a Lap Top Computer for programming and program storage).
2. AVC Function Module. Automatic Arc Voltage control.
3. Oscillation Module. Provides cross seam oscillation control.
4. Wire Feed System. Provide for addition of filler metal.
5. Video system with remote monitor and set-up light.
6. Power, Gas and Video inter-connect cables.

The Welding Head drive system is planned to be the same drive as used for the machining system to minimize costs and variations in procedures. To use drive for welding, a DC electric drive motor is mounted in lieu of the pneumatic motor as used for machining.

Basic installation sequence for installing the Head down hole is:

1. Connect all cables and verify functions.
2. Lower Head down the riser to a location stop on the ID flange of the riser.
3. Actuate ID lock Clamps.
4. Sweep the head around the joint to verify fit-up conditions.
5. Perform welding operation.
6. Sweep the head around to verify weld conditions.
7. Release the ID lock clamps and remove the welding head.

5a. AUTOMATIC WELDER ROM COSTS:

System complete as defined less Drive and ID Locking System and with 75' of inter-connect cables

System complete as defined with Drive and ID Locking System and with 75' of inter-connect cable

If only 20' of inter-connect cables is desired, deduct from either of the above price estimates.

The prices quoted for system are Rough Order of Magnitude (ROM) only at this time due the unknown such as:

1. Final Inside Diameter of the riser.

NOTE: The planning to date has assumed an ID of at least 9". It looks technically feasible to design the system elements for bores as small as 6", but at a considerable increased cost for the machining system. Also to make the system small may increase the complexity of the system and therefor the inherent reliability.

2. The exact weld design and strength requirements.
3. Definition of the system to be used for capturing the plate (to keep it from dropping into the bin).
4. Definition of the riser material and wall thickness.

6. Machining System:

Tri Tool is proposing to design an ID mounting machine trepan cut a hole through the bin top at a diameter just inside the fillet weld attaching the riser to the bin. The concept being proposed allows use of a machine with only axial feed capabilities for both the penetration cut and the riser removal cut.

The basic machine concept for the cost estimate basis shall have the following characteristics:

1. Fixed locator pads (2) to establish center of the pipe and either 1 or 2 clamping pads for a locking mechanism. The locking mechanism shall be based on a pneumatic motor driven thread and ramp system to provide positive lock-up.
2. Pneumatic motor drive for cutting operations and a DC electric motor drive to provide the variable low orbit speeds for welding. Control of the speed for welding to be provided through the welding program.
3. A through hole in the middle of the machine shall provide for a mechanism to hold onto the plate to be cut out of the bin top and to provide for cables and wire feed through the body of the machine for welding operations.
4. Cutting shall be either with a hole saw type cutter or with a multiple tool bit holder system for tool bits. Final design details and testing against 405 Stainless Steel shall be used to define the exact configuration.
5. Cutter head down feed shall be an auto-feed system linked to the head rotation to provide an exact feed increment per revolution.
6. A control panel shall be provided to for remote operation

up to 75" from the machine.

7. Cutter system to release the riser from the bin top.

6A. MACHINING SYSTEM ROM PRICES:

The estimated price for the design and development of the system described (assuming a 9" nominal ID) is:

SUMMARY:

A Budgetary number of .. for purchase of equipment for both the welding .. machining .. equipment is quite accurate for the scope of work discussed.

Also, as discussed by phone, Tri Tool has standard production machines to trim the riser flush to the work deck. If minimum material is to be removed, an ID mounting machine would function very well. However, if a significant length is to be cut off than an OD mounting machine to sever cut the tube may be a better options.

In summary, the technology for attachment of the risers, penetration of the bin top and release of the risers does not push the state of the art. Equipment for performing these kinds of operations has been previously designed and manufactured by Tri Tool and our associated company. It is a question of combining the existing technology elements and fine tuning the design for the specific conditions.

Prepared by:

William E. Sandford
Technical Director and
Systems Concept Engineer

WES/ws

cc: John Snead
Daryl Anderson
Mark Marshall

TRI TOOL INC.
TRI TOOL INTERNATIONAL

3806 SECURITY PARK DRIVE
RANCHO CORDOVA, CA 95742-6990
(800)345 5015 (916)351 0144
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May 19, 1999

Mr. Mike Berry
LMITCO
P O Box 1625
Idaho Falls, ID 83415-7125

Subject: PM-2103

Dear Mike,

Thank you for the opportunity to quote on the remote cutting and welding system for the BINSET project. The following quote is in three segments. This quote does not cover the stud welding process.

Remote Operated Bin Preparation System.	97,000.00
Included 212B and Flange facer to prep the Riser.	

Remote Operated Automatic Welding System.	295,000.00
Includes Video and lighting for set up.	

Remote Operated Autofeed Trepanning System.	<u>225,000.00</u>
---	-------------------

PACKAGE TOTAL \$ 617,000.00

This quote is based on the proposal submitted March 31, 1994.

Net 30
FOB Rancho Cordova
Est. ship date 12 weeks ARO

If we may be of further service or provide additional information, please do not hesitate to contact us.

Regards,

Mr. Val Astle
Sales Coordinator

Stephen M Berry

06/02/99 11:30 AM

To: Daryl A Lopez/PEZ/LMITCO/INEEL/US@INEL
cc: Maurice J Ross/MJR1/LMITCO/INEEL/US@INEL

Subject: Cost Multiplier for 8 inch Riser versus 12 inch Riser on Tri-Tool Estimate

Daryl:

I contacted Tri-Tool yesterday as a followup to my request of approximately 10 days ago when I asked what the impact would be on their cost estimate to go to 8 inch riser installation equipment versus the quoted price for installation of 12 inch risers for Binset 1 calcine retrieval. Per Mr. Val Astle, Sales Coordinator for Tri-Tool, the cost increase would be approximately 30 percent for a cost multiplier of 1.3 to the revised estimate of \$617,000. Therefore, the 8 inch riser installation equipment would be approximately \$802,100. This 30 percent increase reflects the need to design the equipment to fit into an 8 inch riser, while the equipment currently exists for the 12 inch riser installation. If you need more information, please let me know.

Mike Berry
Remote Systems

Attachment 3

Figures and Drawings from the RFR¹

FIGURE 4-24

FIGURE 4-30

TYPICAL PENETRATION
REMOTE CALCINE REMOVAL

NOTE:

THIS CONCEPT USES A SINGLE PNEUMATIC SYSTEM COMBINING RETRIEVAL FROM BIN SET 1 TRANSPORT TO BIN SET 6.

COMBINED LOOP

A

B

C

FORM NO. 24

8

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6

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REV.	REVISION DESCRIPTION	APPROVED		
		DATE	UE&C	WINCO
A	DRAFT PHASE 1 SPECIAL STUDIES	01/20/94

CONVEYING
AND

ALCINE TRANSPORT

DESIGN INTERFACE	DATE	DRAWING STATUS	APPROVALS	DATE
ARCHITECTURAL		DESIGN PHASE	ORIGINATOR	11/4/93
STRUCTURAL		APPROVED	CHECKER	11/11/93
ENVIRONMENTAL			RESPONSIBLE LDC	11/11/93
ELECTRICAL			TASK MANAGER	
MECHANICAL			QA ENGINEER	
INSTRUMENTATION			CHIEF ENGINEER	
PROCESS			TRAC PROJECT MGR	
PIPING			SAFETY PROJECT MGR	
STRESS ANALYSIS				
		QUALITY LEVEL	PROJECT NO. 9354200	
			SUBCONTRACT NO.	
			ISSUED FOR CONSTRUCTION	
			SCALE	NONE
			SCALE	1" = 1'

Davidson
Engineering & Construction
A Division of Fluor Daniel Inc.

US DEPARTMENT OF ENERGY
DAVID OPERATIONS OFFICE
SANDY HILLS, ALABAMA

KPP PHASE 1 SPECIAL STUDIES BLDG. 72
BIN SET 1 - RETRIEVAL SYSTEM
FLOW DIAGRAM
COMBINED TRANSPORT SYSTEM

SIZE D
DRAWING NO. 161
REV. A

SCALE NONE
SCALE 1" = 1'

CAD NO: C02P0003.DWG
RJ SCALE 1" = 1'

2 01/19/94 09:34
9354200

PEN 123456789012345678
PNAME HHHHHHHHHHHHHHHHHHHHH

CAD NO: C02P0003.DWG
RJ SCALE 1" = 1'

PLAN
COIL TUBING RETRIEVAL SYSTEM
 SCALE: 1/4" = 1'-0"

ELEVATION
COIL TUBING RETRIEVAL SYSTEM
 SCALE: 1/4" = 1'-0"

NOTES:

- 1 6" DIA. & 5" DIA. LINES DEPICTED FOR THE COMBINED LOOP SYSTEM ARRANGEMENT. (SEE SKETCH SK-F-05)
- 2 RETURN LINE DOES NOT EXIST FOR THE OPEN LOOP SYSTEM ARRANGEMENT. (SEE SKETCH SK-F-02)
- 3 4" DIA. TRANSPORT PIPE REQUIRED FOR THE CLOSED LOOP SYSTEM ARRANGEMENT. (SEE SKETCH SK-F-03)

REV.	REVISION DESCRIPTION	APPROVED		
		DATE	UE&C	WINCO
A	DRAFT PHASE I SPECIAL STUDIES	01/20/94		

DESIGN INTERFACE		DATE	DRAWING STATUS	APPROVALS		DATE
ARCHITECTURAL			DESIGN PHASE	ORIGINATOR	WIN	10/8/93
STRUCTURAL				CHECKER	KN	1/18/94
ENVIRONMENTAL				RESPONSIBLE LDE	KN	1/18/94
ELECTRICAL				TASK MANAGER		
INSTRUMENTATION				QA ENGINEER		
MECHANICAL				CHIEF ENGINEER		
PROCESS				UE&C PROJECT MGR.		
PIPING				WINCO PROJECT MGR.		
STRESS ANALYSIS						
QUALITY LEVEL				PROJECT NO. 2354.200		
				SUBCONTRACT NO.		
				ISSUED FOR CONSTRUCTION		

Raytheon
 Engineers & Constructors
 A Contractor to DOE and USMC
 FOR
 US DEPARTMENT OF ENERGY
 SANDHILL OPERATIONS OFFICE
 SANDHILL, OHIO

ICPP PHASE I SPECIAL STUDIES BLDG. 729
 BIN SET I - RETRIEVAL SYSTEM
 PIPING DETAILS
 SHEET 1

SIZE	PROJECT CODE NUMBER	DRAWING NO.	REV.
D	12345678901234567890		A
AS NOTED	12345678901234567890

FORM 100-1-01

REV.	REVISION DESCRIPTION	APPROVED		
		DATE	RE&C	WINCO
A	DRAFT PHASE I SPECIAL STUDIES	01/20/94

UTILITIES & SERVICE ABOVE PROPOSED
CALCINE TRANSPORT LINE ROUTING

- ① 8" FIREWATER LINE (2). APPROX. EL 4904'
- ② ELECTRICAL DUCT BANKS (4). APPROX. EL 4909'-4912'
- ③ CALCINE TRANSPORT BANK. APPROX. EL 4903'

LEGEND

NEW CALCINE TRANSPORT PIPING
APPROX. T.O.C. EL 4913'-0"

- LEGEND
- 1. FUTURE TIE-IN POINTS FOR BIN SET 2.
 - 2. FUTURE TIE-IN POINTS FOR BINSET 3.
 - 3. RELOCATE HHS-NCE-938-1.
 - 4. SEE DRAWING NO. SK-P-03 FOR PIPING DETAILS.
 - 5. LOCATE ROD-OUT STATION APPROXIMATELY MIDWAY ALONG TRENCH.

DESIGN INTERFACE	DATE	DRAWING STATUS	APPROVALS	DATE
ARCHITECTURAL		DESIGN PHASE	ORIGINATOR	TRE 10/1/93
STRUCTURAL		APPROVED	CHECKER	KN 11/1/93
ENVIRONMENTAL			RESPONSIBLE LDE	KN 11/1/93
ELECTRICAL			TASK MANAGER	
INSTRUMENTATION			QA ENGINEER	
MECHANICAL			CHIEF ENGINEER	
PROCESS			REAC PROJECT MGR.	
PIPING			M&O PROJECT MGR.	
STRESS ANALYSIS				
QUALITY LEVEL			PROJECT NO. 2354.200	
			SUBCONTRACT NO.	
			ISSUED FOR CONSTRUCTION	

Raytheon
Engineers & Constructors
A Subsidiary of Boeing and VEC

FOR
U.S. DEPARTMENT OF ENERGY
CHMO OPERATIONS OFFICE
CHMO FALLS, CHMO

ICPP PHASE I SPECIAL STUDIES BLDG. 729
BIN SET 1 - RETRIEVAL SYSTEM
CLOSED LOOP SYSTEM
TRANSPORT PIPE ROUTING

SIZE: 11" x 17" (A) 11" x 17" (B) 11" x 17" (C) 11" x 17" (D)

SCALE: 1" = 40' - 0"

DRAWING NO. REV

1 A

DATE: 01/20/94 10:29
BY: 3354299

PEN 112345678910111213141516171819

AD NO: C35PP0031VG
SHEET 1 OF 1

8

7

6

5

D

EXISTING JIB HOIST
RELOCATEDNEW VOG LINES
T.O. ROOF EL. 4973'-4"EXISTING EQUIPMENT
BLDG. CPP-673
RELOCATEDNEW BIN SET
EQUIPMENT
ENCLOSUREEXISTING AIR
FILTERSNEW TRANSPORT
LINE

C

NEW
CYCLONESINTERED
METAL
FILTEREXISTING
VOG LINESEXISTING
CYCLONEEXISTING TRANSPORT
SUPPLY LINE

B

A

SECTION

10-101-1000

8

7

6

5

BIN SET 1 - PLAN @ GRADE

SCALE: 1/8" = 1'-0"

BIN SET 1 - ELEVATION

SCALE: 1/8" = 1'-0"

NOTE:

EXISTING PLAN & ELEVATION DEPICTED.

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

Engineering Design File

for

Radiological Review of Raytheon's Shielding Calculations
as Presented in ICPP Phase I & II Special Studies-
Calcline Recovery Bin Set #1 Project

Lockheed Martin Idaho Technologies Company

1. Project File No. 020943 2. Project/Task FY-99 Feasibility Studies for the HLW Program
3. Subtask Bin Set 1 Retrieval and Transport Study

4. Title: Radiological Review of Raytheon's Shielding Calculations as Presented in ICPP Phase I & II Special Studies Calcine Recovery Bin Set #1 Project

5. Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

The shielding studies presented in the subject document have been reviewed for sufficiency and completeness. Although the calculations appear to be carefully documented, the input/output listings of the individual calculations presented are those of MicroShield, Version 4.10 which had problems extensive enough that Grove Engineering quickly issued Version 5 of the MicroShield code. Because of this problem with the version 4 calculations, I have duplicated the more important calculations to determine if there is a consistently high pattern for them or a consistently low pattern. There is no consistency one way or the other. However, in general, calculations reported in the subject document are conservatively high because several of the model assumptions are conservative, the density of the concrete used for shielding is unusually low, and the density of the source material is low. Assumptions concerning the source loading of the fill lines and the proximity to these fill lines will greatly influence the magnitude of the dose rate just beneath the bin ceiling. Radiation field measurements made in 1995 confirm the dose rates to be lower than calculated by Raytheon.

Recent calculations, made with MicroShield, Ver. 5.01, and assumptions used, are reported in the following pages. These calculations illustrate that, with the proposed changes/modifications, the Bin set #1 calcine can be transferred to Bin Set #6 in a safe manner and in compliance with the radiological provisions of the RadCon Manual.

6. Distribution (complete package): Distribution (summary package only): V. L. Jacobson MS 3211, D. B. Lord MS3211, M. S. Spinti MS 3650, Project File

7. Review (R) and Approval (A) Signatures: (Minimum reviews and approvals are listed. Additional reviews/approvals may be added as necessary.)

	R/A	Printed Name	Signature	Date
Author Henry K. Peterson	R	Henry K. Peterson		8/24/99
Independent Verification Paul D. Ritter	R	Paul Ritter		8/26/99
Technical Review G. G. Hall	R/A	GREGORY G. HALL		8/27/99
Requestor Daryl A. Lopez	R/A	D.A. Lopez		8/30/99
	R			
	A			

Problem Statement – Seismic calculations performed for Bin Set #1 show that the structure could be overstressed by a Safe Shutdown Earthquake (SSE). Because of this apparent inadequacy, the current plan is to move the calcine from Bin Set #1 to Bin Set #6. For this operation to take place, personnel will have to occupy certain locations above the ceiling of the Bin Set #1 and at other locations for extended periods of time. Raytheon performed extensive calculations for Bin Set #1 that are documented for the purpose of the work of transferring the calcine from Bin Set #1 to Bin Set #6 and then for the D&D of Bin Set #1 (Ref.1). In 1995 radiation field measurements were made for various locations around and in Bin Set #1 (Ref.2) that indicated the Raytheon calculations were conservatively high. The review and analysis provided by this document is a critical evaluation of the Raytheon calculations to determine qualitatively the amount of conservatism and the appropriateness of the assumptions used for those calculations.

Analysis – All of the calculations reported here were calculated with the MicroShield, Ver. 5.01, computer code (Ref.3) and all input/output listings are attached for reference.

The first, and major, calculation that is discussed here involves the radiation field from the calcine-filled bin set at two points below the 21-inch thick concrete slab that is above and separates the bins from a location where personnel potentially have to work. These points, just below the 21-inch concrete slab and at 7 feet below the concrete slab, were chosen to correspond with the points at which measurements were made in 1995 (Ref.2) by lowering a high-range radiological survey instrument from a duct that was located just above the point where bin #1 and bin #4 are closest to each other. The dose rate was calculated for the two points on a vertical line located between bins #1 and #4. To model a bin, a right-circular cylinder 20 feet in height and 142 inches in diameter was used. In all cases for a bin or a bin extension, each was assumed to be full of calcine with a density of 1.1 g/cc as suggested by references 4 and 5. The top of the bin was assumed to be covered with a ¼-inch thick sheet of stainless steel and the outside was assumed to be clad with 3/16-inch stainless steel. To account for the central tank being 4 feet longer than the adjacent annular tanks for WC-115-1, -2, and -3 and 6 feet higher than the adjacent annular tanks for WC-115-4, the extension was modeled separately and assumed to be placed on top of and in the center of the annular, lower configuration. Since the upper portion of the central, longer tank would self-shield the lower section of this longer tank and would attenuate radiation from another portion of the lower set of tanks, depending on the angle defined by the location of the measuring radiation field instrument to the bin in question, the calculated field from individual components had to be modified. To account for shielding of the lower portion of the bin by the bin extension, 6.4%, i.e., $[(18")^2 \times 3.14] / [(71")^2 \times 3.14]$ of the dose rate for the 20-ft high lower tank was subtracted from the larger bottom section dose rate. In addition to the self-shielded center portion, the center bin extension "shadows" an additional portion of the bottom, 20-foot high bin. The length of this shadowed portion was calculated with the aid of the scale diagram of Figure 1. The length of this shadowed portion times the 3-foot diameter of the bin extension was then calculated in terms of the percentage of the lower bin that should also be subtracted from the lower bin dose rate. The dose rate from the top section of the central and longer tank was then added to the modified bottom-section dose rate to provide the dose rate for the total bin. The resulting dose rate from the one set of bins with the central tank being 6 feet longer than the annular tanks (tank WC-115-4) for a point just below the concrete slab was calculated to be 82.8

R/hr. Following the same methodology, the dose rates from the other three bins were calculated to be 82.7 R/hr from Bin #3 and 52.3 R/hr for each of the two remaining bins. However, for the location for which this calculation is made, the two "remaining bins" are shadowed by the first two bins considered. With a scale model of the bin set arrangement, it was estimated that about 60 to 70% of the "Remaining bins" are visible from an emitting gamma standpoint. If 60% of these two bins is appropriate, the total dose rate for the point just below the concrete slab is 228 R/hr. If 70% is appropriate, the total dose for this point is 239 R/hr. For comparison, the measured dose rate at this corresponding point is 240 R/hr.

Performing the same type calculation for the point 7 feet below the concrete slab, a dose rate of 416 R/hr was calculated assuming 50% of the adjacent bins were shadowed by the first two bins. If 60% of the adjacent bins are shadowed, the calculated dose rate is 398 R/hr. These values are to be compared with the measured dose rate of 360 R/hr.

Dose rates were also calculated for three thicknesses of concrete flooring above the bin set: 21 inches, 38 inches, and 42 inches. At 2 cm above the 21-inch floor the dose rate was calculated to be 78 mrem/hr; at 2 cm above the 38-inch floor, it is calculated to be 0.04 mrem/hr, and at 2 cm above the 42-inch floor, it is calculated to be 0.006 mrem/hr. Therefore, the 38-inch floor will be more than adequate to maintain the area above the floor at a "full-time occupancy" with a dose rate of less than 0.1 mrem/hr.

In addition to the above calculations, a calculation was made to determine the thickness of the shield wall that separates the cyclone separator from the operational area. Assuming that the cyclone separator is 9 inches in diameter, three feet long, and completely filled with calcine, the concrete wall thickness will have to be 32 inches thick to attenuate the radiation field from the separator to 0.1 mrem/hr on the outside surface of the wall. This calculation assumes a 5-foot distance from the center of the cyclone separator to the outside surface of the shielding wall.

In conclusion, several of the more significant Raytheon calculations were duplicated with the MicroShield Version 5.01 code using the same parameters that were used for the Raytheon calculations. These duplications were made to determine if there were some consistency of conservatism in the Raytheon calculations. Some of the duplications produced slightly higher values for the dose rate and some produced slightly lower values. However, when the Raytheon calculations were performed with MicroShield 5.01 and the more conventional density of concrete of 2.35 g/cc (instead of 2.16 g/cc) and with a source density of 1.1 g/cc (instead of 0.806 g/cc), the final answers decreased and correspond more closely with the measured values.

Note that all of the appended MicroShield calculations are listed with the last two numbers of the EDF number are transposed with the first two numbers, i.e., they are listed as EDF-1312 where they should be EDF-1213.

References

1. Raytheon Engineers and Constructors, Inc., Idaho Chemical Processing Plant Phase I & II Special Studies Calcine Recovery Bin Set #1 Project, March 1995, Volume I
2. Griffith, D. L., Remote Inspection of CSSF 1 Storage Vault, INEEL/EXT-97-01376, June 1998
3. MicroShield, Version 5.01, Grove Engineering, Rockville, MD
4. Staples, B. A., G. S. Pomiak, E. L. Wade, Properties of Radioactive Calcine Retrieved from the Second Calcined Solids Storage Facility at ICPP, UC-70, March 1979
5. Wenzel, D. R., "Evaluation of Radionuclide Inventory for AI Calcine", Engineering Design File (EDF) Serial No. CPP-97067, October 14, 1997

Fig. 1. Scale Dwg. for Bin Set #1

461510

10 X 10 TO THE CENTIMETER 10 X 25 CM
KEUFFEL & ESSER CO. MADE IN U.S.A.

Feet

20
18
16
14
12
10
8
6
4
2

Concrete Slab

2 4 6 8 10 12 14 16 18 20 22 24

Feet

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
 File: BINSETEV.MS5
 Date: March 23, 1999
 Time: 4:22:22 PM
 tion: 00:01:18

File Ref: EDF-1213
 Date: 3/23/99
 By: HR/Johnson
 Checked: PDR 8/26/99

Case Title: binset1
Description: R/hr from 3 ft. section of bin fill pipe
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
 Height 91.0 cm 2 ft 11.8 in
 Radius 3.81 cm 1.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	260 cm	548 cm	0 cm
	8 ft 6.4 in	17 ft 11.7 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	4149.934 cm ³	Concrete	1.1
Shield 1	.31 cm	Iron	7.86
Shield 2	456.69 cm	Air	0.0011
Air Gap		Air	0.0011
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.9202e+001	7.1047e+011	4.6270e+003	1.7120e+008
Ce-144	1.5607e-012	5.7746e-002	3.7608e-010	1.3915e-005
Cs-134	2.5485e-005	9.4294e+005	6.1411e-003	2.2722e+002
Cs-137	2.0300e+001	7.5110e+011	4.8916e+003	1.8099e+008
Pm-147	4.7297e-003	1.7500e+008	1.1397e+000	4.2169e+004
Pr-144	1.5607e-012	5.7746e-002	3.7608e-010	1.3915e-005
Pr-144m	2.7780e-014	1.0278e-003	6.6940e-012	2.4768e-007
Rh-106	1.9419e-010	7.1852e+000	4.6794e-008	1.7314e-003
Ru-106	1.9419e-010	7.1852e+000	4.6794e-008	1.7314e-003
Sm-147	1.2147e-009	4.4943e+001	2.9270e-007	1.0830e-002
Sr-90	1.7259e+001	6.3860e+011	4.1589e+003	1.5388e+008
Y-90	1.7259e+001	6.3860e+011	4.1589e+003	1.5388e+008

Buildup
The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

Page : 2
 DOS File: BINSETEV.MS5
 Run Date: March 23, 1999
 Run Time: 4:22:22 PM
 Duration: 00:01:18

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>		<u>Exposure Rate</u> <u>mR/hr</u>	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	5.631e+07	1.342e-70	3.440e-27	1.151e-71	2.951e-28
0.02	1.062e+07	7.938e-34	1.841e-27	2.750e-35	6.376e-29
0.03	4.302e+10	6.288e-09	1.047e-07	6.231e-11	1.037e-09
0.04	1.022e+10	8.407e-04	2.719e-02	3.718e-06	1.203e-04
0.05	7.613e+02	1.048e-08	3.884e-07	2.791e-11	1.035e-09
0.06	3.199e-05	5.008e-15	1.537e-13	9.947e-18	3.052e-16
0.08	1.900e-02	2.558e-11	4.272e-10	4.048e-14	6.760e-13
0.1	4.984e+03	1.690e-05	1.719e-04	2.586e-08	2.629e-07
0.15	6.237e-03	5.693e-11	3.007e-10	9.375e-14	4.951e-13
0.2	1.986e+02	2.954e-06	1.121e-05	5.214e-09	1.978e-08
0.3	1.358e+02	3.652e-06	1.012e-05	6.928e-09	1.920e-08
0.4	1.271e-02	5.076e-10	1.183e-09	9.890e-13	2.305e-12
0.5	1.377e+04	7.417e-04	1.543e-03	1.456e-06	3.028e-06
0.6	6.378e+11	4.375e+04	8.377e+04	8.539e+01	1.635e+02
0.8	8.876e+05	8.876e-02	1.510e-01	1.688e-04	2.873e-04
1.0	2.640e+04	3.525e-03	5.578e-03	6.497e-06	1.028e-05
1.5	2.867e+04	6.404e-03	9.052e-03	1.077e-05	1.523e-05
2.0	1.465e-02	4.662e-09	6.173e-09	7.210e-12	9.546e-12
3.0	1.206e-03	6.217e-10	7.694e-10	8.434e-13	1.044e-12
TOTALS:	6.911e+11	4.375e+04	8.377e+04	8.539e+01	1.635e+02

Page : 1
DOS File: CYCLONEB.MS5
Run Date: June 3, 1999
Run Time: 5:09:18 PM
Duration: 00:01:32

File Ref: EDF-1312
Date: 8/24/99
By: AKH/BJM
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Concrete shielding for the cyclone Separator - 2.6-feet
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 91.0 cm 2 ft 11.8 in
Radius 11.43 cm 4.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	154.5 cm	45.5 cm	0 cm
	5 ft 0.8 in	1 ft 5.9 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	3.73e+04 cm ³	Concrete	1.1
Transition	61.035 cm	Air	0.0011
Shield 2	79.3 cm	Concrete	2.35
Shield 3	2.0 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.635 cm	Iron	7.86
Top Clad	.635 cm	Iron	7.86

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.7282e+002	6.3943e+012	4.6271e+003	1.7120e+008
Ce-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Cs-134	2.2936e-004	8.4863e+006	6.1409e-003	2.2721e+002
Cs-137	1.8270e+002	6.7599e+012	4.8916e+003	1.8099e+008
Pm-147	4.2568e-002	1.5750e+009	1.1397e+000	4.2170e+004
Pr-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Pr-144m	2.5002e-013	9.2507e-003	6.6941e-012	2.4768e-007
Rh-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Ru-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Sm-147	1.0932e-008	4.0448e+002	2.9270e-007	1.0830e-002
Sr-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008
Y-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	20
Circumferential	22
Y Direction (axial)	26

Results

: 2

File: CYCLONEB.MS5

Run Date: June 3, 1999

Run Time: 5:09:18 PM

Duration: 00:01:32

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.015	5.068e+08	0.000e+00	2.402e-25	0.000e+00	2.060e-26
0.02	9.557e+07	0.000e+00	7.126e-26	0.000e+00	2.468e-27
0.03	3.872e+11	2.135e-108	6.385e-22	2.115e-110	6.328e-24
0.04	9.200e+10	3.432e-52	4.023e-22	1.518e-54	1.779e-24
0.05	6.852e+03	7.823e-39	9.795e-29	2.084e-41	2.609e-31
0.06	2.879e-04	5.465e-37	4.918e-35	1.085e-39	9.768e-38
0.08	1.710e-01	1.665e-26	1.360e-24	2.634e-29	2.152e-27
0.1	4.486e+04	5.715e-18	9.681e-16	8.743e-21	1.481e-18
0.15	5.613e-02	1.011e-20	3.142e-18	1.665e-23	5.174e-21
0.2	1.788e+03	1.001e-14	3.371e-12	1.766e-17	5.950e-15
0.3	1.222e+03	3.941e-13	9.266e-11	7.476e-16	1.758e-13
0.4	1.144e-01	5.078e-16	7.663e-14	9.895e-19	1.493e-16
0.5	1.239e+05	3.803e-09	3.908e-07	7.465e-12	7.670e-10
0.6	5.741e+12	8.016e-01	5.931e+01	1.565e-03	1.158e-01
0.8	7.988e+06	1.094e-05	4.833e-04	2.082e-08	9.193e-07
1.0	2.376e+05	1.742e-06	5.209e-05	3.212e-09	9.603e-08
1.5	2.580e+05	3.120e-05	4.861e-04	5.250e-08	8.178e-07
2.0	1.318e-01	9.074e-11	9.585e-10	1.403e-13	1.482e-12
3.0	1.086e-02	5.985e-11	3.933e-10	8.120e-14	5.335e-13
TOTALS:	6.220e+12	8.017e-01	5.931e+01	1.565e-03	1.158e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File: CYCLONEB.MS5
Date: June 3, 1999
Time: 5:00:25 PM
Version: 00:01:31

File Ref: EDF-1312
Date: 8/24/99
By: *[Signature]*
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Concrete shielding for the cyclone Separator - 24-inches
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height $\sqrt{91.0}$ cm 2 ft 11.8 in
Radius $\sqrt{11.43}$ cm 4.5 in

Dose Points
1 X Y Z
 154.4 cm 45.5 cm 0 cm
 5 ft 0.8 in 1 ft 5.9 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	$3.73e+04$ cm ³	Concrete	1.1
Transition	79.375 cm	Air	0.0011
Shield 2	$\sqrt{60.96}$ cm	Concrete	2.35
Shield 3	2.0 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86
Top Clad	.635 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	1.7282e+002	6.3943e+012	4.6271e+003	1.7120e+008
Ce-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Cs-134	2.2936e-004	8.4863e+006	6.1409e-003	2.2721e+002
Cs-137	1.8270e+002	6.7599e+012	4.8916e+003	1.8099e+008
Pm-147	4.2568e-002	1.5750e+009	1.1397e+000	4.2170e+004
Pr-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Pr-144m	2.5002e-013	9.2507e-003	6.6941e-012	2.4768e-007
Rh-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Ru-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Sm-147	1.0932e-008	4.0448e+002	2.9270e-007	1.0830e-002
Sr-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008
Y-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 20
Circumferential 22
Y Direction (axial) 26

Results

: 2

File: CYCLONEB.MS5

Run Date: June 3, 1999

Run Time: 5:00:25 PM

Duration: 00:01:31

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.015	5.068e+08	0.000e+00	2.405e-25	0.000e+00	2.063e-26
0.02	9.557e+07	1.492e-276	7.135e-26	5.169e-278	2.472e-27
0.03	3.872e+11	5.626e-87	6.393e-22	5.576e-89	6.336e-24
0.04	9.200e+10	1.655e-41	4.028e-22	7.320e-44	1.781e-24
0.05	6.852e+03	5.857e-32	9.807e-29	1.560e-34	2.613e-31
0.06	2.879e-04	8.292e-32	2.871e-30	1.647e-34	5.703e-33
0.08	1.710e-01	1.007e-22	6.265e-21	1.593e-25	9.915e-24
0.1	4.486e+04	9.461e-15	1.080e-12	1.447e-17	1.652e-15
0.15	5.613e-02	4.457e-18	8.403e-16	7.340e-21	1.384e-18
0.2	1.788e+03	2.319e-12	4.542e-10	4.092e-15	8.016e-13
0.3	1.222e+03	4.230e-11	5.855e-09	8.024e-14	1.111e-11
0.4	1.144e-01	3.308e-14	3.062e-12	6.445e-17	5.967e-15
0.5	1.239e+05	1.715e-07	1.117e-05	3.367e-10	2.193e-08
0.6	5.741e+12	2.715e+01	1.311e+03	5.299e-02	2.558e+00
0.8	7.988e+06	2.413e-04	7.265e-03	4.591e-07	1.382e-05
1.0	2.376e+05	2.811e-05	5.938e-04	5.181e-08	1.095e-06
1.5	2.580e+05	3.008e-04	3.512e-03	5.061e-07	5.908e-06
2.0	1.318e-01	6.404e-10	5.227e-09	9.903e-13	8.082e-12
3.0	1.086e-02	2.946e-10	1.558e-09	3.997e-13	2.113e-12
TOTALS:	6.220e+12	2.715e+01	1.311e+03	5.299e-02	2.558e+00

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: CYCLONEA.MS5
Run Date: June 3, 1999
Run Time: 4:54:19 PM
Duration: 00:01:30

File Ref: EDF-1312
Date: 8/24/99
By: R. H. Johnson
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Concrete shielding for the cyclone Separator - 18-inches
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 91.0 cm 2 ft 11.8 in
Radius 11.43 cm 4.5 in

Dose Points

	X	Y	Z
# 1	154.4 cm	45.5 cm	0 cm
	5 ft 0.8 in	1 ft 5.9 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.73e+04 cm ³	Concrete	1.1
Transition	94.615 cm	Air	0.0011
Shield 2	45.72 cm	Concrete	2.35
Shield 3	2.0 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.635 cm	Iron	7.86
Top Clad	.635 cm	Iron	7.86

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	1.7282e+002	6.3943e+012	4.6271e+003	1.7120e+008
Ce-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Cs-134	2.2936e-004	8.4863e+006	6.1409e-003	2.2721e+002
Cs-137	1.8270e+002	6.7599e+012	4.8916e+003	1.8099e+008
Pm-147	4.2568e-002	1.5750e+009	1.1397e+000	4.2170e+004
Pr-144	1.4046e-011	5.1970e-001	3.7607e-010	1.3915e-005
Pr-144m	2.5002e-013	9.2507e-003	6.6941e-012	2.4768e-007
Rh-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Ru-106	1.7477e-009	6.4665e+001	4.6793e-008	1.7314e-003
Sm-147	1.0932e-008	4.0448e+002	2.9270e-007	1.0830e-002
Sr-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008
Y-90	1.5533e+002	5.7472e+012	4.1588e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	20
Circumferential	22
Y Direction (axial)	26

Results

Pa : 2
 DO: File: CYCLONEA.MS5
 Run Date: June 3, 1999
 Run Time: 4:54:19 PM
 Duration: 00:01:30

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.015	5.068e+08	0.000e+00	2.405e-25	0.000e+00	2.063e-26
0.02	9.557e+07	6.484e-222	7.135e-26	2.246e-223	2.472e-27
0.03	3.872e+11	3.627e-69	6.393e-22	3.594e-71	6.336e-24
0.04	9.200e+10	1.273e-32	4.028e-22	5.628e-35	1.781e-24
0.05	6.852e+03	3.064e-26	3.098e-25	8.163e-29	8.254e-28
0.06	2.879e-04	1.692e-27	3.982e-26	3.361e-30	7.910e-29
0.08	1.710e-01	1.406e-19	6.470e-18	2.226e-22	1.024e-20
0.1	4.486e+04	4.497e-12	3.451e-10	6.879e-15	5.280e-13
0.15	5.613e-02	7.042e-16	7.968e-14	1.160e-18	1.312e-16
0.2	1.788e+03	2.146e-10	2.420e-08	3.787e-13	4.271e-11
0.3	1.222e+03	2.063e-09	1.671e-07	3.914e-12	3.169e-10
0.4	1.144e-01	1.065e-12	5.979e-11	2.075e-15	1.165e-13
0.5	1.239e+05	4.068e-06	1.661e-04	7.984e-09	3.261e-07
0.6	5.741e+12	5.072e+02	1.584e+04	9.900e-01	3.091e+01
0.8	7.988e+06	3.156e-03	6.457e-02	6.002e-06	1.228e-04
1.0	2.376e+05	2.834e-04	4.189e-03	5.224e-07	7.722e-06
1.5	2.580e+05	1.977e-03	1.712e-02	3.326e-06	2.880e-05
2.0	1.318e-01	3.247e-09	2.038e-08	5.021e-12	3.152e-11
3.0	1.086e-02	1.107e-09	4.705e-09	1.502e-12	6.383e-12
TOTALS:	6.220e+12	5.072e+02	1.584e+04	9.901e-01	3.091e+01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: BINSETEV.MS5
Run Date: June 3, 1999
Run Time: 4:40:52 PM
Duration: 00:01:43

File Ref: EDF-1312
Date: 8/24/99
By: AKH
Checked: PDR 8/26/99

Case Title: binset1
Description: R/hr from 3 ft. section of bin fill pipe
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 91.0 cm 2 ft 11.8 in
Radius 11.43 cm 4.5 in

Dose Points
1 X Y Z
154.4 cm 233.415 cm 0 cm
5 ft 0.8 in 7 ft 7.9 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	3.73e+04 cm ³	Concrete	1.1
Shield 1	94.615 cm	Iron	7.86
Shield 2	45.72 cm	Air	0.0011
Shield 3	2.0 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	1.7282e+002	6.3942e+012	4.6270e+003	1.7120e+008
Ce-144	1.4046e-011	5.1971e-001	3.7608e-010	1.3915e-005
Cs-134	2.2936e-004	8.4865e+006	6.1411e-003	2.2722e+002
Cs-137	1.8270e+002	6.7599e+012	4.8916e+003	1.8099e+008
Pm-147	4.2568e-002	1.5750e+009	1.1397e+000	4.2169e+004
Pr-144	1.4046e-011	5.1971e-001	3.7608e-010	1.3915e-005
Pr-144m	2.5002e-013	9.2506e-003	6.6940e-012	2.4768e-007
Rh-106	1.7477e-009	6.4666e+001	4.6794e-008	1.7314e-003
Ru-106	1.7477e-009	6.4666e+001	4.6794e-008	1.7314e-003
Sm-147	1.0932e-008	4.0449e+002	2.9270e-007	1.0830e-002
Sr-90	1.5533e+002	5.7474e+012	4.1589e+003	1.5388e+008
Y-90	1.5533e+002	5.7474e+012	4.1589e+003	1.5388e+008

Buildup
The material reference is : Shield 1

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

Results

: 2
 File: BINSETEV.MS5
 Run Date: June 3, 1999
 Run Time: 4:40:52 PM
 Duration: 00:01:43

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	5.068e+08	0.000e+00	9.189e-26	0.000e+00	7.882e-27
0.02	9.557e+07	0.000e+00	2.724e-26	0.000e+00	9.434e-28
0.03	3.872e+11	0.000e+00	1.515e-22	0.000e+00	1.502e-24
0.04	9.200e+10	0.000e+00	5.505e-23	0.000e+00	2.435e-25
0.05	6.852e+03	0.000e+00	5.863e-30	0.000e+00	1.562e-32
0.06	2.879e-04	0.000e+00	3.597e-37	0.000e+00	7.145e-40
0.08	1.710e-01	3.684e-223	4.270e-34	5.830e-226	6.757e-37
0.1	4.486e+04	2.341e-137	2.294e-28	3.582e-140	3.509e-31
0.15	5.613e-02	2.097e-81	1.582e-33	3.454e-84	2.606e-36
0.2	1.788e+03	1.879e-59	2.089e-28	3.316e-62	3.687e-31
0.3	1.222e+03	5.439e-47	6.911e-28	1.032e-49	1.311e-30
0.4	1.144e-01	3.025e-45	1.616e-31	5.894e-48	3.149e-34
0.5	1.239e+05	1.683e-35	2.201e-25	3.303e-38	4.321e-28
0.6	5.740e+12	4.165e-25	1.326e-17	8.130e-28	2.588e-20
0.8	7.988e+06	5.214e-27	2.024e-23	9.918e-30	3.849e-26
1.0	2.376e+05	1.042e-25	1.817e-23	1.921e-28	3.350e-26
1.5	2.580e+05	4.017e-21	3.434e-19	6.758e-24	5.778e-22
2.0	1.318e-01	7.908e-25	4.581e-23	1.223e-27	7.084e-26
3.0	1.086e-02	3.775e-23	1.381e-21	5.122e-26	1.873e-24
TOTALS:	6.220e+12	4.056e-21	1.360e-17	6.811e-24	2.646e-20

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
DO File: BINSET22.MS5
Run Date: May 11, 1999
Run Time: 7:33:02 AM
Duration: 00:00:06

File Ref: EDF-1312
Date: 8/24/99
By: J. H. Johnson
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate below floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points
1 X Y Z
0 cm 1198.9 cm 0 cm
0.0 in 39 ft 4.0 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2
 DO File: BINSET22.MS5
 Run Date: May 11, 1999
 Run Time: 7:33:02 AM
 Run Location: 00:00:06

Results

Energy keV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec		mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	3.413e+12	1.257e-127	8.539e-23	1.078e-128	7.324e-24
0.02	6.436e+11	1.114e-57	4.569e-23	3.860e-59	1.583e-24
0.03	2.607e+15	1.409e-14	4.461e-13	1.396e-16	4.421e-15
0.04	6.194e+14	9.748e-05	6.650e-03	4.311e-07	2.941e-05
0.05	4.613e+07	7.331e-08	6.549e-06	1.953e-10	1.745e-08
0.06	1.938e+00	2.308e-13	1.784e-11	4.584e-16	3.543e-14
0.08	1.151e+03	5.629e-09	2.328e-07	8.907e-12	3.685e-10
0.1	3.020e+08	6.684e-03	1.620e-01	1.023e-05	2.478e-04
0.15	3.779e+02	3.640e-08	4.263e-07	5.994e-11	7.020e-10
0.2	1.204e+07	2.213e-03	1.816e-02	3.906e-06	3.205e-05
0.3	8.230e+06	3.167e-03	1.794e-02	6.008e-06	3.403e-05
0.4	7.704e+02	4.811e-07	2.198e-06	9.375e-10	4.283e-09
0.5	8.345e+08	7.535e-01	2.974e+00	1.479e-03	5.838e-03
0.6	3.865e+16	4.709e+07	1.664e+08	9.191e+04	3.248e+05
0.8	5.380e+10	1.052e+02	3.173e+02	2.002e-01	6.035e-01
1.0	1.600e+09	4.526e+00	1.227e+01	8.343e-03	2.261e-02
1.5	1.737e+09	9.611e+00	2.199e+01	1.617e-02	3.699e-02
2.0	8.875e+02	7.840e-06	1.625e-05	1.212e-08	2.513e-08
3.0	7.310e+01	1.225e-06	2.253e-06	1.662e-09	3.057e-09
TOTALS:	4.188e+16	4.709e+07	1.664e+08	9.191e+04	3.248e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET22.MS5
Date: April 8, 1999
Run Time: 1:58:58 PM
Duration: 00:00:07

File Ref: EDF-1312
Date: 8/24/99
By: PDR
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate above 42" floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points
1 X Y Z
0 cm 1307.59 cm 0 cm
0.0 in 42 ft 10.8 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Shield 3	106.68 cm	Concrete	2.35
Shield 4	2.0 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 3

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2

D File: BINSET22.MS5
 Run Date: April 8, 1999
 Run Time: 1:58:58 PM
 Duration: 00:00:07

Energy MeV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	3.413e+12	0.000e+00	4.017e-23	0.000e+00	3.445e-24
0.02	6.436e+11	0.000e+00	1.192e-23	0.000e+00	4.129e-25
0.03	2.607e+15	8.198e-140	1.068e-19	8.125e-142	1.058e-21
0.04	6.194e+14	1.615e-67	6.726e-20	7.143e-70	2.975e-22
0.05	4.613e+07	1.751e-48	1.638e-26	4.664e-51	4.363e-29
0.06	1.938e+00	3.991e-44	4.940e-33	7.927e-47	9.811e-36
0.08	1.151e+03	1.426e-31	2.133e-29	2.257e-34	3.376e-32
0.1	3.020e+08	3.334e-22	9.170e-20	5.101e-25	1.403e-22
0.15	3.779e+02	4.349e-24	2.568e-21	7.162e-27	4.228e-24
0.2	1.204e+07	1.179e-17	8.073e-15	2.082e-20	1.425e-17
0.3	8.230e+06	1.614e-15	7.623e-13	3.062e-18	1.446e-15
0.4	7.704e+02	4.768e-18	1.382e-15	9.289e-21	2.693e-18
0.5	8.345e+08	6.651e-11	1.261e-08	1.305e-13	2.476e-11
0.6	3.865e+16	2.293e-02	3.026e+00	4.475e-05	5.906e-03
0.8	5.380e+10	6.640e-07	4.966e-05	1.263e-09	9.446e-08
1.0	1.600e+09	1.851e-07	8.999e-06	3.411e-10	1.659e-08
1.5	1.737e+09	8.603e-06	2.055e-04	1.447e-08	3.458e-07
2.0	8.875e+02	4.569e-11	7.172e-10	7.065e-14	1.109e-12
3.0	7.310e+01	6.249e-11	5.848e-10	8.477e-14	7.935e-13
TOTALS:	4.188e+16	2.294e-02	3.026e+00	4.477e-05	5.907e-03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: BINSET22.MS5
Run Date: April 8, 1999
Run Time: 2:00:39 PM
Duration: 00:00:07

File Ref: EDF-1312
Date: 8/24/99
By: HHB
Checked: PRR 8/26/99

Case Title: Bin Set #1
Description: Dose rate above 42" floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points
1 X Y Z
 0 cm 1307.59 cm 0 cm
 0.0 in 42 ft 10.8 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Shield 3	106.68 cm	Concrete	2.35
Shield 4	2.0 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2

File: BINSET22.MS5

Run Date: April 8, 1999

Run Time: 2:00:39 PM

Duration: 00:00:07

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Results</u>			
		<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	3.413e+12	0.000e+00	6.740e-23	0.000e+00	5.781e-24
0.02	6.436e+11	0.000e+00	3.606e-23	0.000e+00	1.249e-24
0.03	2.607e+15	8.198e-140	2.769e-18	8.125e-142	2.744e-20
0.04	6.194e+14	1.615e-67	5.808e-18	7.143e-70	2.569e-20
0.05	4.613e+07	1.751e-48	3.927e-24	4.664e-51	1.046e-26
0.06	1.938e+00	3.991e-44	8.155e-31	7.927e-47	1.620e-33
0.08	1.151e+03	1.426e-31	7.060e-27	2.257e-34	1.117e-29
0.1	3.020e+08	3.334e-22	7.389e-18	5.101e-25	1.130e-20
0.15	3.779e+02	4.349e-24	6.117e-20	7.162e-27	1.007e-22
0.2	1.204e+07	1.179e-17	7.294e-14	2.082e-20	1.287e-16
0.3	8.230e+06	1.614e-15	2.774e-12	3.062e-18	5.261e-15
0.4	7.704e+02	4.768e-18	3.298e-15	9.289e-21	6.426e-18
0.5	8.345e+08	6.651e-11	2.381e-08	1.305e-13	4.674e-11
0.6	3.865e+16	2.293e-02	4.949e+00	4.475e-05	9.660e-03
0.8	5.380e+10	6.640e-07	6.887e-05	1.263e-09	1.310e-07
1.0	1.600e+09	1.851e-07	1.143e-05	3.411e-10	2.108e-08
1.5	1.737e+09	8.603e-06	2.353e-04	1.447e-08	3.959e-07
2.0	8.875e+02	4.569e-11	7.708e-10	7.065e-14	1.192e-12
3.0	7.310e+01	6.249e-11	6.019e-10	8.477e-14	8.166e-13
TOTALS:	4.188e+16	2.294e-02	4.950e+00	4.477e-05	9.661e-03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET1.MS5
Date: April 8, 1999
Time: 1:45:41 PM
Position: 00:00:06

File Ref: EDF-1312
Date: 8/24/99
By: *[Signature]*
Checked: PDR 9/26/99

Case Title: Bin Set #1
Description: Dose rate below floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points
1 X 0 cm 1198.9 cm 0 cm
0.0 in 39 ft 4.0 in 0.0 in

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

Page : 2
 File: BINSET1.MS5
 Run Date: April 8, 1999
 Run Time: 1:45:41 PM
 Duration: 00:00:06

Energy MeV	Activity photons/sec	Results			
		Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	3.413e+12	1.257e-127	8.539e-23	1.078e-128	7.324e-24
0.02	6.436e+11	1.114e-57	4.569e-23	3.860e-59	1.583e-24
0.03	2.607e+15	1.409e-14	4.461e-13	1.396e-16	4.421e-15
0.04	6.194e+14	9.748e-05	6.650e-03	4.311e-07	2.941e-05
0.05	4.613e+07	7.331e-08	6.549e-06	1.953e-10	1.745e-08
0.06	1.938e+00	2.308e-13	1.784e-11	4.584e-16	3.543e-14
0.08	1.151e+03	5.629e-09	2.328e-07	8.907e-12	3.685e-10
0.1	3.020e+08	6.684e-03	1.620e-01	1.023e-05	2.478e-04
0.15	3.779e+02	3.640e-08	4.263e-07	5.994e-11	7.020e-10
0.2	1.204e+07	2.213e-03	1.816e-02	3.906e-06	3.205e-05
0.3	8.230e+06	3.167e-03	1.794e-02	6.008e-06	3.403e-05
0.4	7.704e+02	4.811e-07	2.198e-06	9.375e-10	4.283e-09
0.5	8.345e+08	7.535e-01	2.974e+00	1.479e-03	5.838e-03
0.6	3.865e+16	4.709e+07	1.664e+08	9.191e+04	3.248e+05
0.8	5.380e+10	1.052e+02	3.173e+02	2.002e-01	6.035e-01
1.0	1.600e+09	4.526e+00	1.227e+01	8.343e-03	2.261e-02
1.5	1.737e+09	9.611e+00	2.199e+01	1.617e-02	3.699e-02
2.0	8.875e+02	7.840e-06	1.625e-05	1.212e-08	2.513e-08
3.0	7.310e+01	1.225e-06	2.253e-06	1.662e-09	3.057e-09
TOTALS:	4.188e+16	4.709e+07	1.664e+08	9.191e+04	3.248e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET22.MS5
Date: April 8, 1999
Time: 1:52:00 PM
ation: 00:00:06

File Ref: EDF-1312
Date: 8/24/99
By: H. H. H. H.
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate above 21" floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points

#	X	Y	Z
1	0 cm	1254.24 cm	0 cm
	0.0 in	41 ft 1.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Shield 3	53.34 cm	Concrete	2.35
Shield 4	2.0 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Page : 2
 DC: File: BINSET22.MS5
 Run Date: April 8, 1999
 Run Time: 1:52:00 PM
 Duration: 00:00:06

Results					
<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	3.413e+12	0.000e+00	7.549e-23	0.000e+00	6.475e-24
0.02	6.436e+11	2.132e-249	4.039e-23	7.385e-251	1.399e-24
0.03	2.607e+15	2.143e-77	3.101e-18	2.123e-79	3.074e-20
0.04	6.194e+14	2.496e-36	6.506e-18	1.104e-38	2.877e-20
0.05	4.613e+07	2.309e-28	4.839e-24	6.150e-31	1.289e-26
0.06	1.938e+00	6.432e-29	2.589e-25	1.278e-31	5.143e-28
0.08	1.151e+03	2.027e-20	8.796e-17	3.208e-23	1.392e-19
0.1	3.020e+08	1.111e-12	3.991e-09	1.699e-15	6.106e-12
0.15	3.779e+02	3.112e-16	5.576e-13	5.124e-19	9.182e-16
0.2	1.204e+07	1.299e-10	1.212e-07	2.292e-13	2.138e-10
0.3	8.230e+06	1.882e-09	6.447e-07	3.569e-12	1.223e-09
0.4	7.704e+02	1.289e-12	2.179e-10	2.512e-15	4.245e-13
0.5	8.345e+08	6.126e-06	6.196e-04	1.203e-08	1.216e-06
0.6	3.865e+16	9.107e+02	6.162e+04	1.778e+00	1.203e+02
0.8	5.380e+10	7.464e-03	2.817e-01	1.420e-05	5.358e-04
1.0	1.600e+09	8.281e-04	2.072e-02	1.527e-06	3.820e-05
1.5	1.737e+09	8.402e-03	1.092e-01	1.414e-05	1.838e-04
2.0	8.875e+02	1.770e-08	1.563e-07	2.737e-11	2.417e-10
3.0	7.310e+01	8.294e-09	4.662e-08	1.125e-11	6.324e-11
TOTALS:	4.188e+16	9.107e+02	6.162e+04	1.778e+00	1.203e+02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
File: BINSET22.MS5
Date: April 8, 1999
Time: 1:52:42 PM
Date: 00:00:06

File Ref: EDF-1312
Date: 8/24/99
By: *W. H. H. H.*
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate above 21" floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points

	X	Y	Z
# 1	0 cm	1254.24 cm	0 cm
	0.0 in	41 ft 1.8 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.51e+08 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Shield 3	53.34 cm	Concrete	2.35
Shield 4	2.0 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 3

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

: 2
 ie: BINSET22.MS5
 te: April 8, 1999
 ime: 1:52:42 PM
 ion: 00:00:06

Y	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
15	3.413e+12	0.000e+00	4.499e-23	0.000e+00	3.859e-24
2	6.436e+11	2.132e-249	1.335e-23	7.385e-251	4.625e-25
3	2.607e+15	2.143e-77	1.196e-19	2.123e-79	1.185e-21
4	6.194e+14	2.496e-36	7.535e-20	1.104e-38	3.332e-22
5	4.613e+07	2.309e-28	2.039e-26	6.150e-31	5.431e-29
6	1.938e+00	6.432e-29	1.855e-27	1.278e-31	3.684e-30
8	1.151e+03	2.027e-20	1.115e-18	3.208e-23	1.764e-21
1	3.020e+08	1.111e-12	1.087e-10	1.699e-15	1.663e-13
15	3.779e+02	3.112e-16	4.907e-14	5.124e-19	8.080e-17
2	1.204e+07	1.299e-10	2.124e-08	2.292e-13	3.748e-11
3	8.230e+06	1.882e-09	2.226e-07	3.569e-12	4.222e-10
4	7.704e+02	1.289e-12	1.046e-10	2.512e-15	2.038e-13
5	8.345e+08	6.126e-06	3.568e-04	1.203e-08	7.003e-07
6	3.865e+16	9.107e+02	3.998e+04	1.778e+00	7.803e+01
8	5.380e+10	7.464e-03	2.097e-01	1.420e-05	3.989e-04
1.0	1.600e+09	8.281e-04	1.663e-02	1.527e-06	3.066e-05
1.5	1.737e+09	8.402e-03	9.625e-02	1.414e-05	1.619e-04
2.0	8.875e+02	1.770e-08	1.447e-07	2.737e-11	2.237e-10
3.0	7.310e+01	8.294e-09	4.495e-08	1.125e-11	6.099e-11
TOTALS:	4.188e+16	9.107e+02	3.998e+04	1.778e+00	7.803e+01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET01.MS5
Date: March 19, 1999
Time: 3:39:38 PM
ation: 00:00:36

File Ref: EDF-1312
Date: 8/24/99
By: J. H. Johnson
Checked: PDR 8/25/99

Case Title: binset1

Description: bin set 8 energy group source term (no Y-90m)

Geometry: 13 - Rectangular Volume

Source Dimensions

Length	731.52 cm	24 ft
Width	609.6 cm	20 ft 0.0 in
Height	609.6 cm	20 ft 0.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	816.97 cm	1143 cm	609.6 cm
	26 ft 9.6 in	37 ft 6.0 in	20 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.72e+08 cm ³	Concrete	0.806
Shield 1	.63 cm	Iron	7.86
Shield 2	7.62 cm	Air	0.0011
Shield 3	76.2 cm	Concrete	2.16
Air Gap		Air	0.0011
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.3100e+006	4.8470e+016	4.8190e+003	1.7830e+008
Ce-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Cs-134m	8.3000e+000	3.0710e+011	3.0532e-002	1.1297e+003
Cs-137	1.3840e+006	5.1208e+016	5.0912e+003	1.8837e+008
Pm-147	1.0730e+003	3.9701e+013	3.9471e+000	1.4604e+005
Pr-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Pr-144m	1.2000e-007	4.4400e+003	4.4143e-010	1.6333e-005
Rh-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Ru-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Sm-147	1.2000e-003	4.4400e+007	4.4143e-006	1.6333e-001
Sr-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008
Y-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008

Buildup

The material reference is : Shield 3

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Pac : 2
 DOS file: BINSET01.MS5
 Run Date: March 19, 1999
 Run Time: 3:39:38 PM
 Duration: 00:00:36

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.15	3.788e+12	0.000e+00	4.542e-23	0.000e+00	3.895e-24
0.02	7.143e+11	0.000e+00	1.348e-23	0.000e+00	4.668e-25
0.03	2.935e+15	2.319e-118	1.224e-19	2.299e-120	1.214e-21
0.04	6.974e+14	4.134e-57	7.715e-20	1.828e-59	3.412e-22
0.05	1.727e+08	1.789e-41	6.247e-26	4.765e-44	1.664e-28
0.06	1.653e+02	1.671e-37	4.292e-31	3.320e-40	8.525e-34
0.08	1.001e+04	2.221e-27	1.972e-25	3.515e-30	3.120e-28
0.1	1.131e+09	5.882e-19	1.152e-16	8.999e-22	1.762e-19
0.15	3.851e+10	5.159e-14	1.962e-11	8.496e-17	3.231e-14
0.2	1.355e+05	7.642e-18	3.253e-15	1.349e-20	5.741e-18
0.3	1.479e+03	7.107e-18	2.143e-15	1.348e-20	4.065e-18
0.4	2.396e+04	2.092e-15	4.045e-13	4.076e-18	7.882e-16
0.5	2.791e+06	2.098e-12	2.757e-10	4.119e-15	5.411e-13
0.6	4.351e+16	1.786e-01	1.684e+01	3.485e-04	3.288e-02
0.8	6.028e+04	3.261e-12	1.826e-10	6.202e-15	3.472e-13
1.0	2.665e+05	9.765e-11	3.682e-09	1.800e-13	6.786e-12
1.5	3.149e+04	2.955e-10	5.778e-09	4.971e-13	9.722e-12
2.0	2.908e+04	2.112e-09	2.801e-08	3.267e-12	4.331e-11
3.0	2.274e+03	1.994e-09	1.642e-08	2.705e-12	2.227e-11
TOTALS:	4.715e+16	1.786e-01	1.684e+01	3.485e-04	3.288e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Case : 1
File: BINSET01.MS5
Date: March 19, 1999
Time: 3:43:52 PM
Duration: 00:00:36

File Ref: EDF-1312
Date: 8/24/99
By: JH Johnson
Checked: PDR 8/26/99

Case Title: binset1

Description: bin set 8 energy group source term (no Y-90m)
Geometry: 13 - Rectangular Volume

Source Dimensions
Length 731.52 cm 24 ft
Width 609.6 cm 20 ft 0.0 in
Height 609.6 cm 20 ft 0.0 in

Dose Points
1 X Y Z
816.97 cm 1143 cm 609.6 cm
26 ft 9.6 in 37 ft 6.0 in 20 ft 0.0 in

Shields
Shield Name Dimension Material Density
Source 2.72e+08 cm³ Concrete 0.806
Shield 1 .63 cm Iron 7.86
Shield 2 7.62 cm Air 0.0011
Shield 3 76.2 cm Concrete 2.16
Air Gap Air 0.0011
Immersion Air 0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.3100e+006	4.8470e+016	4.8190e+003	1.7830e+008
Ce-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Cs-134	8.3000e+000	3.0710e+011	3.0532e-002	1.1297e+003
Cs-137	1.3840e+006	5.1208e+016	5.0912e+003	1.8837e+008
Pm-147	1.0730e+003	3.9701e+013	3.9471e+000	1.4604e+005
Pr-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Pr-144m	1.2000e-007	4.4400e+003	4.4143e-010	1.6333e-005
Rh-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Ru-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Sm-147	1.2000e-003	4.4400e+007	4.4143e-006	1.6333e-001
Sr-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008
Y-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008

Buildup
The material reference is : Shield 3

Integration Parameters
X Direction 10
Y Direction 20
Z Direction 20

Results

Page : 2
 DOS File: BINSET01.MS5
 Run Date: March 19, 1999
 Run Time: 3:43:52 PM
 Duration: 00:00:36

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	3.788e+12	0.000e+00	4.542e-23	0.000e+00	3.895e-24
0.02	7.143e+11	0.000e+00	1.348e-23	0.000e+00	4.668e-25
0.03	2.935e+15	2.319e-118	1.224e-19	2.299e-120	1.214e-21
0.04	6.974e+14	4.134e-57	7.715e-20	1.828e-59	3.412e-22
0.05	1.727e+08	1.789e-41	6.247e-26	4.765e-44	1.664e-28
0.06	1.653e+02	1.671e-37	4.292e-31	3.320e-40	8.525e-34
0.08	1.001e+04	2.221e-27	1.972e-25	3.515e-30	3.120e-28
0.1	1.131e+09	5.882e-19	1.152e-16	8.999e-22	1.762e-19
0.15	3.237e+04	4.336e-20	1.649e-17	7.141e-23	2.715e-20
0.2	6.463e+07	3.646e-15	1.552e-12	6.435e-18	2.739e-15
0.3	4.422e+07	2.126e-13	6.410e-11	4.033e-16	1.216e-13
0.4	2.396e+04	2.092e-15	4.045e-13	4.076e-18	7.882e-16
0.5	4.486e+09	3.373e-09	4.430e-07	6.620e-12	8.696e-10
0.6	4.351e+16	1.786e-01	1.684e+01	3.486e-04	3.288e-02
0.8	2.891e+11	1.564e-05	8.755e-04	2.974e-08	1.665e-06
1.0	8.599e+09	3.151e-06	1.188e-04	5.809e-09	2.190e-07
1.5	9.336e+09	8.760e-05	1.713e-03	1.474e-07	2.882e-06
2.0	2.908e+04	2.112e-09	2.801e-08	3.267e-12	4.331e-11
3.0	2.274e+03	1.994e-09	1.642e-08	2.705e-12	2.227e-11
TOTALS:	4.715e+16	1.787e-01	1.685e+01	3.487e-04	3.288e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET01.MS5
Date: March 19, 1999
Time: 3:46:19 PM
Position: 00:02:39

File Ref: EDF-1312
Date: 8/24/99
By: *AK Robinson*
Checked: PDP 8/26/99

Case Title: binset1

Description: bin set 8 energy group source term (no Y-90m)
Geometry: 13 - Rectangular Volume

Source Dimensions			
Length	731.52 cm		24 ft
Width	609.6 cm	20 ft 0.0 in	
Height	609.6 cm	20 ft 0.0 in	

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	816.97 cm	1143 cm	609.6 cm
	26 ft 9.6 in	37 ft 6.0 in	20 ft 0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.72e+08 cm ³	Concrete	0.806
Shield 1	.63 cm	Iron	7.86
Shield 2	7.62 cm	Air	0.0011
Shield 3	76.2 cm	Concrete	2.16
Air Gap		Air	0.0011
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.3100e+006	4.8470e+016	4.8190e+003	1.7830e+008
Ce-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Cs-134	8.3000e+000	3.0710e+011	3.0532e-002	1.1297e+003
Cs-137	1.3840e+006	5.1208e+016	5.0912e+003	1.8837e+008
Pm-147	1.0730e+003	3.9701e+013	3.9471e+000	1.4604e+005
Pr-144	8.1000e-006	2.9970e+005	2.9797e-008	1.1025e-003
Pr-144m	1.2000e-007	4.4400e+003	4.4143e-010	1.6333e-005
Rh-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Ru-106	3.6600e-004	1.3542e+007	1.3464e-006	4.9816e-002
Sm-147	1.2000e-003	4.4400e+007	4.4143e-006	1.6333e-001
Sr-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008
Y-90	1.1610e+006	4.2957e+016	4.2709e+003	1.5802e+008

Buildup
The material reference is : Shield 3

Integration Parameters	
X Direction	20
Y Direction	30
Z Direction	30

Results

: 2

File: BINSET01.MS5
 Date: March 19, 1999
 Time: 3:46:19 PM
 Duration: 00:02:39

Energy keV	Activity photons/sec	Fluence Rate MeV/cm ² /sec		Exposure Rate mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
015	3.788e+12	0.000e+00	4.542e-23	0.000e+00	3.895e-24
02	7.143e+11	0.000e+00	1.348e-23	0.000e+00	4.668e-25
03	2.935e+15	8.628e-118	1.224e-19	8.551e-120	1.214e-21
04	6.974e+14	5.587e-57	7.715e-20	2.471e-59	3.412e-22
05	1.727e+08	1.908e-41	6.247e-26	5.083e-44	1.664e-28
06	1.653e+02	1.698e-37	4.292e-31	3.372e-40	8.525e-34
08	1.001e+04	2.225e-27	1.975e-25	3.522e-30	3.125e-28
01	1.131e+09	5.885e-19	1.152e-16	9.003e-22	1.762e-19
015	3.237e+04	4.336e-20	1.649e-17	7.141e-23	2.716e-20
0.2	6.463e+07	3.646e-15	1.552e-12	6.435e-18	2.739e-15
0.3	4.422e+07	2.126e-13	6.410e-11	4.033e-16	1.216e-13
0.4	2.396e+04	2.092e-15	4.045e-13	4.076e-18	7.882e-16
0.5	4.486e+09	3.373e-09	4.430e-07	6.620e-12	8.696e-10
0.6	4.351e+16	1.786e-01	1.684e+01	3.486e-04	3.288e-02
0.8	2.891e+11	1.564e-05	8.755e-04	2.974e-08	1.665e-06
1.0	8.599e+09	3.151e-06	1.188e-04	5.809e-09	2.190e-07
1.5	9.336e+09	8.760e-05	1.713e-03	1.474e-07	2.882e-06
2.0	2.908e+04	2.112e-09	2.801e-08	3.267e-12	4.331e-11
3.0	2.274e+03	1.994e-09	1.642e-08	2.705e-12	2.227e-11
TOTALS:	4.715e+16	1.787e-01	1.685e+01	3.487e-04	3.288e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File Ref: EDF-1312
Date: 8/24/99
By: [Signature]
Checked: PDR 8/26/99

: 1
File: BINSETFL.MS5
Date: March 24, 1999
Time: 5:01:59 PM
tion: 00:03:04

Case Title: binset #1
Description: R/hr from 6-inch fill line
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 185.4 cm 6 ft 1.0 in
Radius 7.62 cm 3.0 in

Dose Points
1 X Y Z
10.255 cm 185 cm 0 cm
4.0 in 6 ft 0.8 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 3.38e+04 cm³ Concrete 1.1
Shield 1 .635 cm Iron 7.86
Transition 2.0 cm Air 0.0011
Air Gap Air 0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.5648e+002	5.7898e+012	4.6269e+003	1.7119e+008
Ce-144	1.2719e-011	4.7060e-001	3.7608e-010	1.3915e-005
Cs-134	2.0769e-004	7.6845e+006	6.1411e-003	2.2722e+002
Cs-137	1.6543e+002	6.1209e+012	4.8915e+003	1.8099e+008
Pm-147	3.8545e-002	1.4262e+009	1.1397e+000	4.2170e+004
Pr-144	1.2719e-011	4.7060e-001	3.7608e-010	1.3915e-005
Pr-144m	2.2639e-013	8.3764e-003	6.6940e-012	2.4768e-007
Rh-106	1.5826e-009	5.8556e+001	4.6795e-008	1.7314e-003
Ru-106	1.5826e-009	5.8556e+001	4.6795e-008	1.7314e-003
Sm-147	9.8990e-009	3.6626e+002	2.9270e-007	1.0830e-002
Sr-90	1.4065e+002	5.2041e+012	4.1588e+003	1.5388e+008
Y-90	1.4065e+002	5.2041e+012	4.1588e+003	1.5388e+008

Buildup
The material reference is : Shield 1

Integration Parameters
Radial 30
Circumferential 22
Y Direction (axial) 30

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Results</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>Fluence Rate</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>MeV/cm²/sec</u>	<u>No Buildup</u>	<u>With Buildup</u>
			<u>With Buildup</u>		
0.015	4.589e+08	1.779e-124	4.365e-24	1.526e-125	3.744e-25

: 2

File: BINSETFL.MS5

Run Date: March 24, 1999

Run Time: 5:01:59 PM

Duration: 00:03:04

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
.02	8.653e+07	9.935e-57	1.294e-24	3.441e-58	4.481e-26
.03	3.506e+11	1.164e-14	1.269e-14	1.153e-16	1.257e-16
.04	8.330e+10	6.058e-05	7.078e-05	2.679e-07	3.130e-07
.05	6.204e+03	4.628e-08	5.869e-08	1.233e-10	1.563e-10
.06	2.607e-04	1.602e-13	2.196e-13	3.182e-16	4.362e-16
.08	1.549e-01	4.797e-09	7.569e-09	7.591e-12	1.198e-11
.1	4.062e+04	6.556e-03	1.162e-02	1.003e-05	1.778e-05
.15	5.083e-02	4.148e-08	8.904e-08	6.831e-11	1.466e-10
.2	1.619e+03	2.620e-03	6.204e-03	4.624e-06	1.095e-05
.3	1.107e+03	3.763e-03	9.170e-03	7.138e-06	1.739e-05
.4	1.036e-01	5.619e-07	1.323e-06	1.095e-09	2.578e-09
.5	1.122e+05	8.614e-01	1.928e+00	1.691e-03	3.785e-03
.6	5.198e+12	5.269e+07	1.121e+08	1.028e+05	2.187e+05
.8	7.233e+06	1.129e+02	2.201e+02	2.148e-01	4.187e-01
1.0	2.152e+05	4.672e+00	8.504e+00	8.612e-03	1.568e-02
1.5	2.336e+05	9.105e+00	1.474e+01	1.532e-02	2.480e-02
2.0	1.194e-01	6.917e-06	1.049e-05	1.070e-08	1.622e-08
3.0	9.832e-03	9.684e-07	1.358e-06	1.314e-09	1.843e-09
TOTALS:	5.632e+12	5.269e+07	1.121e+08	1.028e+05	2.187e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
File: BINSETFL.MS5
Date: March 30, 1999
Time: 4:14:28 PM
tion: 00:02:59

File Ref: EDE-1312
Date: 8/24/99
By: *AKB*
Checked: PDR 8/26/99

Case Title: binset #1
Description: R/hr at 6'4" from 6-inch fill line - just under floor
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 185.4 cm 6 ft 1.0 in
Radius 7.62 cm 3.0 in

Dose Points
1 X 193 cm Y 185 cm Z 0 cm
6 ft 4.0 in 6 ft 0.8 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 3.38e+04 cm³ Concrete 1.1
Shield 1 .635 cm Iron 7.86
Transition 184.745 cm Air 0.0011
Air Gap Air 0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	1.5648e+002	5.7898e+012	4.6269e+003	1.7119e+008
Ce-144	1.2719e-011	4.7060e-001	3.7608e-010	1.3915e-005
Cs-134	2.0769e-004	7.6845e+006	6.1411e-003	2.2722e+002
Cs-137	1.6543e+002	6.1209e+012	4.8915e+003	1.8099e+008
Pm-147	3.8545e-002	1.4262e+009	1.1397e+000	4.2170e+004
Pr-144	1.2719e-011	4.7060e-001	3.7608e-010	1.3915e-005
Pr-144m	2.2639e-013	8.3764e-003	6.6940e-012	2.4768e-007
Rh-106	1.5826e-009	5.8556e+001	4.6795e-008	1.7314e-003
Ru-106	1.5826e-009	5.8556e+001	4.6795e-008	1.7314e-003
Sm-147	9.8990e-009	3.6626e+002	2.9270e-007	1.0830e-002
Sr-90	1.4065e+002	5.2041e+012	4.1588e+003	1.5388e+008
Y-90	1.4065e+002	5.2041e+012	4.1588e+003	1.5388e+008

Buildup
The material reference is : Shield 1

Integration Parameters
Radial 30
Circumferential 22
Y Direction (axial) 30

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Results		Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
			Fluence Rate MeV/cm ² /sec With Buildup			
.015	4.589e+08	3.307e-126	1.038e-25		2.836e-127	8.903e-27

: 2
 File: BINSETFL.MS5
 Date: March 30, 1999
 Time: 4:14:28 PM
 ation: 00:02:59

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>		<u>Exposure Rate</u> <u>mR/hr</u>	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.02	8.653e+07	2.009e-58	3.076e-26	6.959e-60	1.066e-27
0.03	3.506e+11	3.703e-16	4.036e-16	3.670e-18	4.000e-18
0.04	8.330e+10	2.276e-06	2.659e-06	1.006e-08	1.176e-08
0.05	6.204e+03	1.865e-09	2.367e-09	4.968e-12	6.306e-12
0.06	2.607e-04	6.646e-15	9.125e-15	1.320e-17	1.813e-17
0.08	1.549e-01	1.969e-10	3.108e-10	3.116e-13	4.919e-13
0.1	4.062e+04	2.599e-04	4.590e-04	3.976e-07	7.022e-07
0.15	5.083e-02	1.545e-09	3.261e-09	2.544e-12	5.370e-12
0.2	1.619e+03	9.476e-05	2.178e-04	1.672e-07	3.845e-07
0.3	1.107e+03	1.324e-04	3.078e-04	2.512e-07	5.838e-07
0.4	1.036e-01	1.947e-08	4.328e-08	3.793e-11	8.433e-11
0.5	1.122e+05	2.949e-02	6.196e-02	5.790e-05	1.216e-04
0.6	5.198e+12	1.787e+06	3.553e+06	3.487e+03	6.936e+03
0.8	7.233e+06	3.768e+00	6.844e+00	7.166e-03	1.302e-02
1.0	2.152e+05	1.538e-01	2.607e-01	2.835e-04	4.806e-04
1.5	2.336e+05	2.920e-01	4.412e-01	4.914e-04	7.423e-04
2.0	1.194e-01	2.180e-07	3.091e-07	3.371e-10	4.780e-10
3.0	9.832e-03	2.983e-08	3.934e-08	4.047e-11	5.337e-11
TALS:	5.632e+12	1.787e+06	3.553e+06	3.487e+03	6.936e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: BINSET03.MS5
 Run Date: March 22, 1999
 Run Time: 8:09:27 AM
 Duration: 00:00:05

File Ref: EDF-1312
 Date: 8/24/99
 By: W. H. H. H.
 Checked: PDR 8/26/99

Case Title: binset#1
Description: Bin Set #1 LowerShield Dose Rates from bins
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height	609.6 cm	20 ft 0.0 in
Radius	182.88 cm	6 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	571.5 cm	1227.22 cm	0 cm
	18 ft 9.0 in	40 ft 3.2 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	6.41e+07 cm ³	Concrete	0.806
Shield 1	.63 cm	Iron	7.86
Shield 2	562.65 cm	Air	0.00122
Shield 3	53.34 cm	Concrete	2.16
Air Gap		Air	0.00122
Immersion		Concrete	0.806

Source Input
Grouping Method : Standard Indices
Number of Groups : 4
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	3.2750e+005	1.2118e+016	5.1131e+003	1.8918e+008

Buildup
The material reference is : Source

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

		Results			
<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.509e+14	1.748e-76	1.076e-20	1.456e-78	8.966e-23
0.0322	4.629e+14	7.871e-74	2.064e-20	6.334e-76	1.661e-22
0.0364	1.684e+14	9.375e-54	1.150e-20	5.327e-56	6.535e-23
0.6616	1.090e+16	8.265e+01	3.732e+03	1.602e-01	7.235e+00
TOTALS:	1.179e+16	8.265e+01	3.732e+03	1.602e-01	7.235e+00

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
 File: BINSET1.MS5
 Date: March 31, 1999
 Time: 2:03:01 PM
 tion: 00:01:28

File Ref: EDF-13'2
 Date: 8/24/9
 By: W. H. Johnson
 Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate off axis above 1 bin (Bin Set #1) - 1999
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height	609.6 cm	20 ft 0.0 in
Radius	180.9 cm	5 ft 11.2 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	260 cm	1199.54 cm	0 cm
	8 ft 6.4 in	39 ft 4.3 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	589.3 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 1

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

e : 2
 DO: File: BINSET1.MS5
 Run Date: March 31, 1999
 Run Time: 2:03:01 PM
 Duration: 00:01:28

Energy MeV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	8.523e+11	2.480e-133	1.124e-23	2.127e-134	9.640e-25
0.02	1.607e+11	2.009e-60	3.331e-24	6.960e-62	1.154e-25
0.03	6.510e+14	1.001e-15	1.091e-15	9.917e-18	1.081e-17
0.04	1.547e+14	1.593e-05	1.863e-05	7.045e-08	8.241e-08
0.05	1.152e+07	1.457e-08	1.851e-08	3.881e-11	4.930e-11
0.06	4.841e-01	4.893e-14	6.717e-14	9.719e-17	1.334e-16
0.08	2.875e+02	1.254e-09	1.975e-09	1.985e-12	3.125e-12
0.1	7.541e+07	1.518e-03	2.683e-03	2.322e-06	4.105e-06
0.15	9.436e+01	8.392e-09	1.831e-08	1.382e-11	3.015e-11
0.2	3.006e+06	5.126e-04	1.269e-03	9.047e-07	2.239e-06
0.3	2.055e+06	7.365e-04	1.972e-03	1.397e-06	3.741e-06
0.4	1.924e+02	1.121e-07	3.013e-07	2.184e-10	5.870e-10
0.5	2.084e+08	1.759e-01	4.612e-01	3.452e-04	9.053e-04
0.6	9.651e+15	1.100e+07	2.795e+07	2.148e+04	5.455e+04
0.8	1.343e+10	2.465e+01	5.880e+01	4.688e-02	1.118e-01
1.0	3.996e+08	1.062e+00	2.400e+00	1.958e-03	4.425e-03
1.5	4.339e+08	2.265e+00	4.618e+00	3.810e-03	7.770e-03
2.0	2.216e+02	1.853e-06	3.558e-06	2.865e-09	5.503e-09
3.0	1.826e+01	2.906e-07	5.136e-07	3.942e-10	6.968e-10
TOTALS:	1.046e+16	1.100e+07	2.795e+07	2.148e+04	5.455e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
 File: BINSET1.MS5
 Date: March 31, 1999
 Time: 2:04:57 PM
 tion: 00:01:25

File Ref: EDE-1312
 Date: 3/24/99
 By: AKK/Johnson
 Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate off axis above 1 bin (Bin Set #1) - 1999
Geometry: 8 - Cylinder Volume - End Shields

	Source Dimensions	
Height	609.6 cm	20 ft 0.0 in
Radius	180.9 cm	5 ft 11.2 in

	Dose Points		
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	260 cm	1199.54 cm	0 cm
	8 ft 6.4 in	39 ft 4.3 in	0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	6.27e+07 cm ³	Concrete	0.806
Shield 1	.635 cm	Iron	7.86
Shield 2	589.3 cm	Air	0.0011
Air Gap		Air	0.001
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 1

Integration Parameters	
Radial	28
Circumferential	20
Y Direction (axial)	20

: 2

File: BINSET1.MS5

Date: March 31, 1999

Time: 2:04:57 PM

Position: 00:01:25

Energy keV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	8.523e+11	3.827e-131	1.124e-23	3.283e-132	9.640e-25
0.02	1.607e+11	1.816e-59	3.331e-24	6.289e-61	1.154e-25
0.03	6.510e+14	2.073e-15	2.260e-15	2.054e-17	2.239e-17
0.04	1.547e+14	2.363e-05	2.763e-05	1.045e-07	1.222e-07
0.05	1.152e+07	2.014e-08	2.556e-08	5.365e-11	6.810e-11
0.06	4.841e-01	6.684e-14	9.166e-14	1.328e-16	1.821e-16
0.08	2.875e+02	1.707e-09	2.687e-09	2.701e-12	4.252e-12
0.1	7.541e+07	2.064e-03	3.648e-03	3.157e-06	5.582e-06
0.15	9.436e+01	1.140e-08	2.480e-08	1.876e-11	4.085e-11
0.2	3.006e+06	6.956e-04	1.717e-03	1.228e-06	3.031e-06
0.3	2.055e+06	9.984e-04	2.668e-03	1.894e-06	5.061e-06
0.4	1.924e+02	1.518e-07	4.068e-07	2.959e-10	7.927e-10
0.5	2.084e+08	2.380e-01	6.217e-01	4.672e-04	1.220e-03
0.6	9.651e+15	1.488e+07	3.761e+07	2.905e+04	7.341e+04
0.8	1.343e+10	3.329e+01	7.899e+01	6.333e-02	1.502e-01
1.0	3.996e+08	1.433e+00	3.219e+00	2.642e-03	5.933e-03
1.5	4.339e+08	3.048e+00	6.174e+00	5.128e-03	1.039e-02
2.0	2.216e+02	2.488e-06	4.747e-06	3.847e-09	7.340e-09
3.0	1.826e+01	3.888e-07	6.827e-07	5.275e-10	9.262e-10
TOTALS:	1.046e+16	1.488e+07	3.761e+07	2.905e+04	7.341e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File : 1
File: BINSET05.MS5
Date: March 22, 1999
Time: 8:26:45 AM
Location: 00:00:02

File Ref: EDF-1312
Date: 8/24/99
By: *[Signature]*
Checked: PDR 8/26/99

Case Title: binset#1

Description: Bin Set #1 Lower Shield Dose Rates From Bin Top Annuli
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 134.62 cm 4 ft 5.0 in
Radius 45.72 cm 1 ft 6.0 in

Dose Points

	X	Y	Z
# 1	571.5 cm	616.99 cm	381 cm
	18 ft 9.0 in	20 ft 2.9 in	12 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.84e+05 cm ³	Concrete	0.806
Shield 1	.63 cm	Iron	7.86
Shield 2	427.4 cm	Air	0.00122
Shield 3	53.34 cm	Concrete	2.16
Air Gap		Air	0.0012
Immersion		Air	0.00122

Source Input

Grouping Method : User Defined Energies

Group	Energy	Activity	Volume Source	% Energy
#	(MeV)	Photons/sec	Photons/sec/cm ³	Activity
1	0.6616	1.5050e+014	1.7024e+008	100.000

Buildup

The material reference is : Shield 3

Integration Parameters

Radial	20
Circumferential	10
Y Direction (axial)	10

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate		Exposure Rate	
			MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup	
0.6616	1.505e+14	9.538e-01	5.672e+01	1.849e-03	1.100e-01	
TOTALS:	1.505e+14	9.538e-01	5.672e+01	1.849e-03	1.100e-01	

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
File: BINSET1.MS5
Date: March 11, 1999
Time: 1:57:57 PM
ation: 00:00:06

File Ref: EDF-1312
Date: 8/24/99
By: N. H. H. H.
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate above 1 bin (Bin Set #1) - 1999
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points
1 X Y Z
0 cm 1198.9 cm 0 cm
0.0 in 39 ft 4.0 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	589.3 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 1

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

Results

e : 2
 File: BINSET1.MS5
 Run Date: March 11, 1999
 Time: 1:57:57 PM
 Duration: 00:00:06

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec		mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	8.523e+11	6.801e-02	8.741e-02	5.833e-03	7.498e-03
0.02	1.607e+11	1.146e-01	1.844e-01	3.969e-03	6.388e-03
0.03	6.510e+14	4.259e+03	1.096e+04	4.221e+01	1.086e+02
0.04	1.547e+14	2.968e+03	1.124e+04	1.313e+01	4.971e+01
0.05	1.152e+07	4.392e-04	2.306e-03	1.170e-06	6.143e-06
0.06	4.841e-01	2.970e-11	1.888e-10	5.899e-14	3.750e-13
0.08	2.875e+02	3.254e-08	2.312e-07	5.149e-11	3.659e-10
0.1	7.541e+07	1.260e-02	8.599e-02	1.928e-05	1.316e-04
0.15	9.436e+01	2.903e-08	1.641e-07	4.781e-11	2.702e-10
0.2	3.006e+06	1.387e-03	6.545e-03	2.448e-06	1.155e-05
0.3	2.055e+06	1.669e-03	6.294e-03	3.166e-06	1.194e-05
0.4	1.924e+02	2.343e-07	7.647e-07	4.566e-10	1.490e-09
0.5	2.084e+08	3.490e-01	1.029e+00	6.850e-04	2.019e-03
0.6	9.651e+15	2.102e+07	5.731e+07	4.102e+04	1.119e+05
0.8	1.343e+10	4.452e+01	1.084e+02	8.468e-02	2.062e-01
1.0	3.996e+08	1.843e+00	4.159e+00	3.397e-03	7.667e-03
1.5	4.339e+08	3.680e+00	7.340e+00	6.191e-03	1.235e-02
2.0	2.216e+02	2.899e-06	5.367e-06	4.483e-09	8.300e-09
3.0	1.826e+01	4.363e-07	7.354e-07	5.919e-10	9.978e-10
TOTALS:	1.046e+16	2.102e+07	5.733e+07	4.108e+04	1.120e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: BINSET1.MS5
Date: March 29, 1999
Time: 4:26:39 PM
ation: 00:01:28

File Ref: EDF-1312
Date: 8/24/99
By: H. K. K. K.
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate off axis above 1 bin (Bin Set #1) - 1999
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points

	X	Y	Z
# 1	431.7 cm	1198.9 cm	0 cm
	14 ft 2.0 in	39 ft 4.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	589.3 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 1

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Page : 2
DO. File: BINSET1.MS5
Run Date: March 29, 1999
Run Time: 4:26:39 PM
Duration: 00:01:28

Results

Energy keV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
.015	8.523e+11	1.388e-09	2.374e-09	1.191e-10	2.036e-10
.02	1.607e+11	1.312e-04	3.292e-04	4.544e-06	1.140e-05
.03	6.510e+14	7.631e+02	3.321e+03	7.563e+00	3.291e+01
.04	1.547e+14	1.319e+03	7.130e+03	5.832e+00	3.154e+01
.05	1.152e+07	2.307e-04	1.350e-03	6.147e-07	3.597e-06
.06	4.841e-01	1.608e-11	1.045e-10	3.193e-14	2.076e-13
.08	2.875e+02	1.779e-08	1.294e-07	2.815e-11	2.047e-10
.1	7.541e+07	6.931e-03	5.000e-02	1.060e-05	7.650e-05
.15	9.436e+01	1.640e-08	1.043e-07	2.701e-11	1.718e-10
.2	3.006e+06	8.024e-04	4.322e-03	1.416e-06	7.628e-06
.3	2.055e+06	9.940e-04	4.264e-03	1.886e-06	8.089e-06
.4	1.924e+02	1.421e-07	5.230e-07	2.769e-10	1.019e-09
.5	2.084e+08	2.146e-01	7.081e-01	4.213e-04	1.390e-03
.6	9.651e+15	1.307e+07	3.964e+07	2.552e+04	7.737e+04
.8	1.343e+10	2.822e+01	7.555e+01	5.367e-02	1.437e-01
.0	3.996e+08	1.186e+00	2.917e+00	2.185e-03	5.377e-03
.5	4.339e+08	2.433e+00	5.214e+00	4.094e-03	8.772e-03
.0	2.216e+02	1.951e-06	3.849e-06	3.017e-09	5.952e-09
.0	1.826e+01	3.000e-07	5.333e-07	4.070e-10	7.235e-10
ALS:	1.046e+16	1.308e+07	3.965e+07	2.553e+04	7.744e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET1.MS5
Date: April 8, 1999
Time: 8:45:15 AM
ation: 00:01:30

File Ref: EDE-1312
Date: 8/24/99
By: JH Johnson
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate 7' below floor for Bin Set #1- next bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points
1 X 431.7 cm 1198.9 cm Z 0 cm
14 ft 2.0 in 39 ft 4.0 in 0.0 in

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2

File: BINSET1.MS5

Date: April 8, 1999

Time: 8:45:15 AM

Run: 00:01:30

F	Y	Activity photons/sec	Results			
			Fluence Rate		Exposure Rate	
			<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
			No Buildup	With Buildup	No Buildup	With Buildup
0	5	8.523e+11	4.356e-144	1.789e-23	3.736e-145	1.534e-24
		1.607e+11	1.704e-65	9.571e-24	5.903e-67	3.315e-25
		6.510e+14	1.358e-17	5.000e-16	1.346e-19	4.956e-18
0	4	1.547e+14	1.639e-06	1.303e-04	7.248e-09	5.763e-07
0	5	1.152e+07	3.396e-09	3.607e-07	9.047e-12	9.608e-10
0	6	4.841e-01	1.699e-14	1.572e-12	3.375e-17	3.122e-15
0	8	2.875e+02	6.147e-10	3.015e-08	9.727e-13	4.771e-11
0	1	7.541e+07	8.514e-04	2.424e-02	1.302e-06	3.708e-05
0	15	9.436e+01	5.361e-09	7.429e-08	8.827e-12	1.223e-10
0	2	3.006e+06	3.451e-04	3.347e-03	6.091e-07	5.907e-06
0	3	2.055e+06	5.204e-04	3.430e-03	9.872e-07	6.507e-06
0	4	1.924e+02	8.132e-08	4.265e-07	1.584e-10	8.311e-10
0	5	2.084e+08	1.299e-01	5.825e-01	2.551e-04	1.143e-03
0	6	9.651e+15	8.248e+06	3.279e+07	1.610e+04	6.401e+04
0	8	1.343e+10	1.889e+01	6.323e+01	3.593e-02	1.203e-01
1	0	3.996e+08	8.279e-01	2.464e+00	1.526e-03	4.542e-03
1	5	4.339e+08	1.817e+00	4.484e+00	3.057e-03	7.543e-03
2	0	2.216e+02	1.512e-06	3.346e-06	2.339e-09	5.174e-09
3	0	1.826e+01	2.418e-07	4.685e-07	3.280e-10	6.356e-10
TOTALS:		1.046e+16	8.248e+06	3.279e+07	1.610e+04	6.401e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: BINSETET.MS5
Run Date: March 31, 1999
Run Time: 1:52:51 PM
Duration: 00:01:20

File Ref: EDF-1312
Date: 8/24/99
By: [Signature]
Checked: PDR 8/26/99

Case Title: binset1

Description: R/hr from 4' ext. sect. of center tank just beneath floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 122.0 cm 4 ft 0.0 in
Radius 45.72 cm 1 ft 6.0 in

Dose Points

#	X	Y	Z
1	431.7 cm	609.6 cm	0 cm
	14 ft 2.0 in	20 ft 0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.01e+05 cm ³	Concrete	0.806
Shield 1	.635 cm	Iron	7.86
Shield 2	486.965 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	3.7070e+003	1.3716e+014	4.6270e+003	1.7120e+008
Ce-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Cs-134	4.9200e-003	1.8204e+008	6.1411e-003	2.2722e+002
Cs-137	3.9190e+003	1.4500e+014	4.8916e+003	1.8099e+008
Pm-147	9.1310e-001	3.3785e+010	1.1397e+000	4.2169e+004
Pr-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Pr-144m	5.3630e-012	1.9843e-001	6.6940e-012	2.4768e-007
Rh-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Ru-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Sm-147	2.3450e-007	8.6765e+003	2.9270e-007	1.0830e-002
Sr-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008
Y-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

: 2
 DC File: BINSETET.MS5
 Run Date: March 31, 1999
 Run Time: 1:52:51 PM
 Duration: 00:01:20

Energy	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.15	1.087e+10	4.079e-161	4.357e-25	3.498e-162	3.737e-26
0.2	2.050e+09	6.708e-74	2.331e-25	2.324e-75	8.075e-27
0.3	8.306e+12	5.490e-21	2.494e-19	5.441e-23	2.472e-21
0.4	1.973e+12	1.670e-08	1.538e-06	7.385e-11	6.802e-09
0.5	1.470e+05	1.109e-10	1.381e-08	2.953e-13	3.678e-11
0.6	6.177e-03	8.946e-16	9.561e-14	1.777e-18	1.899e-16
0.8	3.668e+00	4.580e-11	2.513e-09	7.248e-14	3.977e-12
1.0	9.622e+05	7.277e-05	2.358e-03	1.113e-07	3.608e-06
1.5	1.204e+00	5.428e-10	8.651e-09	8.938e-13	1.425e-11
2.0	3.834e+04	3.744e-05	4.067e-04	6.608e-08	7.177e-07
3.0	2.621e+04	5.951e-05	4.221e-04	1.129e-07	8.006e-07
4.0	2.455e+00	9.503e-09	5.234e-08	1.852e-11	1.020e-10
5.0	2.658e+06	1.536e-02	7.104e-02	3.015e-05	1.395e-04
6.0	1.231e+14	9.822e+05	3.977e+06	1.917e+03	7.764e+03
8.0	1.714e+08	2.265e+00	7.565e+00	4.308e-03	1.439e-02
10.0	5.097e+06	9.944e-02	2.911e-01	1.833e-04	5.365e-04
15.0	5.534e+06	2.167e-01	5.131e-01	3.646e-04	8.633e-04
20.0	2.828e+00	1.779e-07	3.724e-07	2.751e-10	5.759e-10
30.0	2.329e-01	2.753e-08	4.974e-08	3.734e-11	6.748e-11
TOTALS:	1.334e+14	9.822e+05	3.977e+06	1.917e+03	7.764e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: BINSETET.MS5
Run Date: March 31, 1999
Run Time: 1:32:22 PM
Duration: 00:01:20

File Ref: EDF1312
Date: 8/24/99
By: W. Johnson
Checked: PDR 8/26/99

Case Title: binset1

Description: R/hr from 4' ext. sect. of center tank just beneath floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 122.0 cm 4 ft 0.0 in
Radius 45.72 cm 1 ft 6.0 in

Dose Points

	X	Y	Z
# 1	431.7 cm	609.6 cm	0 cm
	14 ft 2.0 in	20 ft 0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.01e+05 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	486.965 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	3.7070e+003	1.3716e+014	4.6270e+003	1.7120e+008
Ce-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Cs-134	4.9200e-003	1.8204e+008	6.1411e-003	2.2722e+002
Cs-137	3.9190e+003	1.4500e+014	4.8916e+003	1.8099e+008
Pm-147	9.1310e-001	3.3785e+010	1.1397e+000	4.2169e+004
Pr-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Pr-144m	5.3630e-012	1.9843e-001	6.6940e-012	2.4768e-007
Rh-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Ru-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Sm-147	2.3450e-007	8.6765e+003	2.9270e-007	1.0830e-002
Sr-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008
Y-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

: 2
 File: BINSETET.MS5
 Date: March 31, 1999
 Time: 1:32:22 PM
 ation: 00:01:20

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
.015	1.087e+10	1.141e-161	4.357e-25	9.784e-163	3.737e-26
.02	2.050e+09	3.833e-74	2.331e-25	1.328e-75	8.075e-27
.03	8.306e+12	4.014e-21	1.873e-19	3.978e-23	1.856e-21
.04	1.973e+12	1.225e-08	1.129e-06	5.420e-11	4.993e-09
.05	1.470e+05	8.161e-11	1.018e-08	2.174e-13	2.711e-11
.06	6.177e-03	6.609e-16	7.084e-14	1.313e-18	1.407e-16
.08	3.668e+00	3.402e-11	1.882e-09	5.384e-14	2.978e-12
.1	9.622e+05	5.423e-05	1.780e-03	8.296e-08	2.723e-06
.15	1.204e+00	4.060e-10	6.593e-09	6.686e-13	1.086e-11
.2	3.834e+04	2.807e-05	3.116e-04	4.954e-08	5.500e-07
.3	2.621e+04	4.478e-05	3.256e-04	8.495e-08	6.176e-07
.4	2.455e+00	7.175e-09	4.057e-08	1.398e-11	7.905e-11
.5	2.658e+06	1.163e-02	5.530e-02	2.283e-05	1.085e-04
.6	1.231e+14	7.459e+05	3.107e+06	1.456e+03	6.065e+03
.8	1.714e+08	1.729e+00	5.950e+00	3.289e-03	1.132e-02
1.0	5.097e+06	7.629e-02	2.303e-01	1.406e-04	4.245e-04
1.5	5.534e+06	1.682e-01	4.115e-01	2.830e-04	6.924e-04
2.0	2.828e+00	1.394e-07	3.020e-07	2.156e-10	4.669e-10
3.0	2.329e-01	2.191e-08	4.097e-08	2.973e-11	5.558e-11
TOTALS:	1.334e+14	7.459e+05	3.107e+06	1.456e+03	6.065e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET1.MS5
Date: March 29, 1999
Time: 4:24:05 PM
Position: 00:01:28

File Ref: EDF-1312
Date: 8/24/99
By: H. H. H. H.
Checked: PDR 8/24/99

Case Title: Bin Set #1

Description: Dose rate off axis above 1 bin (Bin Set #1) - 1999 - d 7'
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 609.6 cm ✓ 20 ft 0.0 in
Radius 180.9 cm ✓ 5 ft 11.2 in

Dose Points

	X	Y	Z
# 1	431.7 cm ✓	985.5 cm ✓	0 cm
	14 ft 2.0 in	32 ft 4.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	375.9 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 1

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Page : 2
DO: File: BINSET1.MS5
Run Date: March 29, 1999
Run Time: 4:24:05 PM
Duration: 00:01:28

			Results		
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>		<u>mR/hr</u>	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	8.523e+11	1.678e-10	2.909e-10	1.440e-11	2.495e-11
0.02	1.607e+11	5.278e-05	1.363e-04	1.828e-06	4.723e-06
0.03	6.510e+14	7.238e+02	3.408e+03	7.174e+00	3.378e+01
0.04	1.547e+14	1.640e+03	9.877e+03	7.255e+00	4.368e+01
0.05	1.152e+07	3.147e-04	1.976e-03	8.383e-07	5.264e-06
0.06	4.841e-01	2.254e-11	1.479e-10	4.477e-14	2.938e-13
0.08	2.875e+02	2.525e-08	1.839e-07	3.996e-11	2.910e-10
0.1	7.541e+07	9.965e-03	7.525e-02	1.524e-05	1.151e-04
0.15	9.436e+01	2.451e-08	1.666e-07	4.036e-11	2.743e-10
0.2	3.006e+06	1.224e-03	6.969e-03	2.160e-06	1.230e-05
0.3	2.055e+06	1.542e-03	6.899e-03	2.926e-06	1.309e-05
0.4	1.924e+02	2.223e-07	8.467e-07	4.332e-10	1.650e-09
0.5	2.084e+08	3.375e-01	1.147e+00	6.624e-04	2.251e-03
0.6	9.651e+15	2.063e+07	6.419e+07	4.027e+04	1.253e+05
0.8	1.343e+10	4.477e+01	1.225e+02	8.516e-02	2.330e-01
1.0	3.996e+08	1.888e+00	4.733e+00	3.481e-03	8.725e-03
1.5	4.339e+08	3.899e+00	8.469e+00	6.561e-03	1.425e-02
2.0	2.216e+02	3.137e-06	6.257e-06	4.851e-09	9.676e-09
3.0	1.826e+01	4.841e-07	8.675e-07	6.567e-10	1.177e-09
TOTALS:	1.046e+16	2.064e+07	6.420e+07	4.029e+04	1.254e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: BINSET1.MS5
Date: April 8, 1999
Time: 8:32:46 AM
ation: 00:01:29

File Ref: EDF-1312
Date: 8/24/99
By: *[Signature]*
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate 7' below floor for Bin Set #1- next bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points
1 X Y Z
431.7 cm 985.54 cm 0 cm
14 ft 2.0 in 32 ft 4.0 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 6.27e+07 cm³ Concrete 1.1
Shield 1 .635 cm Iron 7.86
Shield 2 375.305 cm Air 0.0011
Air Gap Air 0.00122
Wall Clad .476 cm Iron 7.86
Immersion Air 0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 2

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2
 DC File: BINSET1.MS5
 Run Date: April 8, 1999
 Run Time: 8:32:46 AM
 Duration: 00:01:29

Energy eV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	8.523e+11	4.350e-159	2.763e-23	3.731e-160	2.370e-24
0.02	1.607e+11	2.710e-72	1.479e-23	9.388e-74	5.122e-25
0.03	6.510e+14	7.753e-20	4.363e-18	7.683e-22	4.324e-20
0.04	1.547e+14	1.480e-07	1.348e-05	6.546e-10	5.961e-08
0.05	1.152e+07	9.041e-10	1.142e-07	2.408e-12	3.041e-10
0.06	4.841e-01	7.818e-15	8.824e-13	1.553e-17	1.753e-15
0.08	2.875e+02	4.775e-10	2.911e-08	7.556e-13	4.607e-11
0.1	7.541e+07	8.356e-04	2.968e-02	1.278e-06	4.541e-05
0.15	9.436e+01	6.591e-09	1.090e-07	1.085e-11	1.795e-10
0.2	3.006e+06	4.568e-04	5.114e-03	8.062e-07	9.025e-06
0.3	2.055e+06	7.271e-04	5.335e-03	1.379e-06	1.012e-05
0.4	1.924e+02	1.164e-07	6.671e-07	2.268e-10	1.300e-09
0.5	2.084e+08	1.888e-01	9.134e-01	3.707e-04	1.793e-03
0.6	9.651e+15	1.212e+07	5.153e+07	2.366e+04	1.006e+05
0.8	1.343e+10	2.820e+01	9.967e+01	5.363e-02	1.896e-01
1.0	3.996e+08	1.249e+00	3.894e+00	2.303e-03	7.178e-03
1.5	4.339e+08	2.789e+00	7.120e+00	4.692e-03	1.198e-02
2.0	2.216e+02	2.343e-06	5.332e-06	3.624e-09	8.245e-09
3.0	1.826e+01	3.782e-07	7.488e-07	5.132e-10	1.016e-09
TOTALS:	1.046e+16	1.212e+07	5.153e+07	2.366e+04	1.006e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Pa : 1
 DO: File: BINSETET.MS5
 Run Date: March 31, 1999
 Run Time: 1:23:35 PM
 Duration: 00:01:20

File Ref: EDF-1312
 Date: 8/24/99
 By: N. H. H. H.
 Checked: DDK 8/26/99

Case Title: binset1

Description: R/hr from 4' ext. sect. of center tank at 7' beneath floor
 Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 122.0 cm ✓ 4 ft 0.0 in
 Radius 45.72 cm ✓ 1 ft 6.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	431.7 cm ✓	396.24 cm ✓	0 cm
	14 ft 2.0 in	13 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	8.01e+05 cm ³	Concrete	1.1
Shield 1	.635 cm ✓	Iron	7.86
Shield 2	273.605 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm ✓	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	3.7070e+003	1.3716e+014	4.6270e+003	1.7120e+008
Ce-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Cs-134	4.9200e-003	1.8204e+008	6.1411e-003	2.2722e+002
Cs-137	3.9190e+003	1.4500e+014	4.8916e+003	1.8099e+008
Pm-147	9.1310e-001	3.3785e+010	1.1397e+000	4.2169e+004
Pr-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Pr-144m	5.3630e-012	1.9843e-001	6.6940e-012	2.4768e-007
Rh-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Ru-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Sm-147	2.3450e-007	8.6765e+003	2.9270e-007	1.0830e-002
Sr-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008
Y-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2 ✓

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

Page : 2
DO: File: BINSETET.MS5
Run Date: March 31, 1999
Run Time: 1:23:35 PM
Duration: 00:01:20

Energy V	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
.015	1.087e+10	7.957e-218	7.105e-25	6.825e-219	6.094e-26
.02	2.050e+09	2.135e-99	3.801e-25	7.394e-101	1.317e-26
.03	8.306e+12	3.037e-29	2.920e-20	3.009e-31	2.893e-22
.04	1.973e+12	2.730e-12	3.835e-10	1.208e-14	1.696e-12
.05	1.470e+05	9.024e-13	1.886e-10	2.404e-15	5.023e-13
.06	6.177e-03	4.394e-17	8.061e-15	8.728e-20	1.601e-17
.08	3.668e+00	1.038e-11	9.965e-10	1.643e-14	1.577e-12
.1	9.622e+05	3.151e-05	1.747e-03	4.820e-08	2.673e-06
.15	1.204e+00	4.133e-10	9.509e-09	6.805e-13	1.566e-11
.2	3.834e+04	3.342e-05	4.817e-04	5.899e-08	8.503e-07
.3	2.621e+04	5.930e-05	5.200e-04	1.125e-07	9.864e-07
.4	2.455e+00	9.940e-09	6.546e-08	1.937e-11	1.275e-10
.5	2.658e+06	1.657e-02	8.970e-02	3.252e-05	1.761e-04
.6	1.231e+14	1.084e+06	5.059e+06	2.115e+03	9.874e+03
.8	1.714e+08	2.582e+00	9.742e+00	4.911e-03	1.853e-02
.0	5.097e+06	1.161e-01	3.784e-01	2.140e-04	6.976e-04
.5	5.534e+06	2.634e-01	6.801e-01	4.431e-04	1.144e-03
.0	2.828e+00	2.216e-07	5.007e-07	3.426e-10	7.742e-10
.0	2.329e-01	3.531e-08	6.803e-08	4.790e-11	9.229e-11
TALS:	1.334e+14	1.084e+06	5.059e+06	2.115e+03	9.874e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSETET.MS5
Date: March 31, 1999
Time: 1:15:15 PM
Position: 00:01:21

File Ref: EDF-1312
Date: 8/24/99
By: PDR
Checked: PDR 8/26/99

Case Title: binset1

Description: R/hr from 4' ext. sect. of center tank at 7' beneath floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 122.0 cm 4 ft 0.0 in
Radius 45.72 cm 1 ft 6.0 in

Dose Points

#	X	Y	Z
1	193 cm 6 ft 4.0 in	396.24 cm 13 ft 0.0 in	0 cm 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.01e+05 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	273.605 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	3.7070e+003	1.3716e+014	4.6270e+003	1.7120e+008
Ce-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Cs-134	4.9200e-003	1.8204e+008	6.1411e-003	2.2722e+002
Cs-137	3.9190e+003	1.4500e+014	4.8916e+003	1.8099e+008
Pm-147	9.1310e-001	3.3785e+010	1.1397e+000	4.2169e+004
Pr-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Pr-144m	5.3630e-012	1.9843e-001	6.6940e-012	2.4768e-007
Rh-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Ru-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Sm-147	2.3450e-007	8.6765e+003	2.9270e-007	1.0830e-002
Sr-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008
Y-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

e : 2
 DC File: BINSETET.MS5
 Run Date: March 31, 1999
 Run Time: 1:15:15 PM
 Duration: 00:01:21

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	1.087e+10	1.044e-143	1.433e-24	8.951e-145	1.229e-25
0.02	2.050e+09	6.631e-66	7.667e-25	2.297e-67	2.656e-26
0.03	8.306e+12	3.125e-18	1.146e-16	3.098e-20	1.135e-18
0.04	1.973e+12	4.581e-07	3.663e-05	2.026e-09	1.620e-07
0.05	1.470e+05	1.077e-09	1.146e-07	2.869e-12	3.053e-10
0.06	6.177e-03	5.591e-15	5.108e-13	1.111e-17	1.015e-15
0.08	3.668e+00	2.021e-10	9.487e-09	3.198e-13	1.501e-11
0.1	9.622e+05	2.768e-04	7.454e-03	4.235e-07	1.140e-05
0.15	1.204e+00	1.731e-09	2.298e-08	2.851e-12	3.784e-11
0.2	3.834e+04	1.115e-04	1.042e-03	1.968e-07	1.840e-06
0.3	2.621e+04	1.678e-04	1.069e-03	3.184e-07	2.028e-06
0.4	2.455e+00	2.615e-08	1.326e-07	5.095e-11	2.583e-10
0.5	2.658e+06	4.162e-02	1.802e-01	8.170e-05	3.537e-04
0.6	1.231e+14	2.634e+06	1.011e+07	5.141e+03	1.973e+04
0.8	1.714e+08	5.992e+00	1.931e+01	1.140e-02	3.673e-02
1.0	5.097e+06	2.610e-01	7.463e-01	4.811e-04	1.376e-03
1.5	5.534e+06	5.642e-01	1.330e+00	9.492e-04	2.239e-03
2.0	2.828e+00	4.630e-07	9.751e-07	7.160e-10	1.508e-09
3.0	2.329e-01	7.210e-08	1.323e-07	9.782e-11	1.795e-10
TOTALS:	1.334e+14	2.634e+06	1.011e+07	5.141e+03	1.973e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
File: BINSETET.MS5
Date: March 31, 1999
Time: 1:08:02 PM
ation: 00:01:22

File Ref: EDF-1312
Date: 8/24/99
By: AKB/brm
Checked: PDR 8/26/99

Case Title: binset1

Description: R/hr from 4' ext. sect. of center tank beneath floor

Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 122.0 cm 4 ft 0.0 in
Radius 45.72 cm 1 ft 6.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	193 cm	609.6 cm	0 cm
	6 ft 4.0 in	20 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	8.01e+05 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	486.965 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.635 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	3.7070e+003	1.3716e+014	4.6270e+003	1.7120e+008
Ce-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Cs-134	4.9200e-003	1.8204e+008	6.1411e-003	2.2722e+002
Cs-137	3.9190e+003	1.4500e+014	4.8916e+003	1.8099e+008
Pm-147	9.1310e-001	3.3785e+010	1.1397e+000	4.2169e+004
Pr-144	3.0130e-010	1.1148e+001	3.7608e-010	1.3915e-005
Pr-144m	5.3630e-012	1.9843e-001	6.6940e-012	2.4768e-007
Rh-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Ru-106	3.7490e-008	1.3871e+003	4.6794e-008	1.7314e-003
Sm-147	2.3450e-007	8.6765e+003	2.9270e-007	1.0830e-002
Sr-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008
Y-90	3.3320e+003	1.2328e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

e : 2
 File: BINSETET.MS5
 Date: March 31, 1999
 Time: 1:08:02 PM
 ation: 00:01:22

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
.015	1.087e+10	2.067e-132	6.301e-25	1.773e-133	5.404e-26
.02	2.050e+09	9.394e-61	3.371e-25	3.254e-62	1.168e-26
.03	8.306e+12	1.401e-16	4.599e-15	1.388e-18	4.558e-17
.04	1.973e+12	1.930e-06	1.354e-04	8.536e-09	5.989e-07
.05	1.470e+05	1.696e-09	1.534e-07	4.517e-12	4.088e-10
.06	6.177e-03	5.510e-15	4.256e-13	1.094e-17	8.453e-16
.08	3.668e+00	1.349e-10	5.479e-09	2.135e-13	8.670e-12
0.1	9.622e+05	1.595e-04	3.764e-03	2.440e-07	5.759e-06
.15	1.204e+00	8.668e-10	1.008e-08	1.427e-12	1.660e-11
0.2	3.834e+04	5.291e-05	4.392e-04	9.338e-08	7.751e-07
0.3	2.621e+04	7.627e-05	4.426e-04	1.447e-07	8.396e-07
0.4	2.455e+00	1.165e-08	5.466e-08	2.269e-11	1.065e-10
0.5	2.658e+06	1.830e-02	7.420e-02	3.592e-05	1.456e-04
0.6	1.231e+14	1.148e+06	4.161e+06	2.240e+03	8.121e+03
0.8	1.714e+08	2.577e+00	7.948e+00	4.901e-03	1.512e-02
1.0	5.097e+06	1.113e-01	3.074e-01	2.051e-04	5.666e-04
1.5	5.534e+06	2.377e-01	5.493e-01	3.999e-04	9.242e-04
2.0	2.828e+00	1.941e-07	4.037e-07	3.002e-10	6.243e-10
3.0	2.329e-01	3.019e-08	5.509e-08	4.095e-11	7.475e-11
TALS:	1.334e+14	1.148e+06	4.161e+06	2.240e+03	8.121e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File Ref: EDF-1312
Date: 8/24/99
By: ALB
Checked: PDR 8/26/99

: 1
File: BINSETET.MS5
Date: March 30, 1999
Time: 8:36:21 AM
tion: 00:01:24

Case Title: binset1

Description: R/hr from ext. sect. of center tank beneath floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 183.0 cm ✓ 6 ft 0.0 in
Radius 45.72 cm ✓ 1 ft 6.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	193 cm ✓	609.6 cm ✓	0 cm
	6 ft 4.0 in	20 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.20e+06 cm ³	Concrete	1.1
Shield 1	.635 cm ✓	Iron	7.86
Shield 2	425.965 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	5.5605e+003	2.0574e+014	4.6270e+003	1.7120e+008
Ce-144	4.5195e-010	1.6722e+001	3.7608e-010	1.3915e-005
Cs-134	7.3800e-003	2.7306e+008	6.1411e-003	2.2722e+002
Cs-137	5.8785e+003	2.1750e+014	4.8916e+003	1.8099e+008
Pm-147	1.3697e+000	5.0677e+010	1.1397e+000	4.2169e+004
Pr-144	4.5195e-010	1.6722e+001	3.7608e-010	1.3915e-005
Pr-144m	8.0445e-012	2.9765e-001	6.6940e-012	2.4768e-007
Rh-106	5.6235e-008	2.0807e+003	4.6794e-008	1.7314e-003
Ru-106	5.6235e-008	2.0807e+003	4.6794e-008	1.7314e-003
Sm-147	3.5175e-007	1.3015e+004	2.9270e-007	1.0830e-002
Sr-90	4.9980e+003	1.8493e+014	4.1589e+003	1.5388e+008
Y-90	4.9980e+003	1.8493e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2 ✓

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

: 2

DC File: BINSETET.MS5

Run Date: March 30, 1999

Run Time: 8:36:21 AM

Duration: 00:01:24

Energy eV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	1.631e+10	9.579e-135	1.060e-24	8.216e-136	9.091e-26
0.02	3.075e+09	1.038e-61	5.671e-25	3.595e-63	1.964e-26
0.03	1.246e+13	8.249e-17	2.762e-15	8.175e-19	2.737e-17
0.04	2.960e+12	1.685e-06	1.208e-04	7.452e-09	5.341e-07
0.05	2.205e+05	1.732e-09	1.607e-07	4.613e-12	4.282e-10
0.06	9.265e-03	6.053e-15	4.796e-13	1.202e-17	9.527e-16
0.08	5.503e+00	1.573e-10	6.525e-09	2.490e-13	1.033e-11
0.1	1.443e+06	1.905e-04	4.623e-03	2.915e-07	7.073e-06
0.15	1.806e+00	1.073e-09	1.324e-08	1.768e-12	2.180e-11
0.2	5.752e+04	6.688e-05	5.912e-04	1.180e-07	1.043e-06
0.3	3.932e+04	9.838e-05	6.036e-04	1.866e-07	1.145e-06
0.4	3.682e+00	1.518e-08	7.483e-08	2.958e-11	1.458e-10
0.5	3.987e+06	2.403e-02	1.018e-01	4.717e-05	1.999e-04
0.6	1.847e+14	1.515e+06	5.719e+06	2.958e+03	1.116e+04
0.8	2.570e+08	3.431e+00	1.095e+01	6.527e-03	2.083e-02
1.0	7.646e+06	1.491e-01	4.244e-01	2.748e-04	7.824e-04
1.5	8.301e+06	3.218e-01	7.620e-01	5.415e-04	1.282e-03
2.0	4.242e+00	2.646e-07	5.621e-07	4.092e-10	8.692e-10
3.0	3.494e-01	4.146e-08	7.714e-08	5.625e-11	1.046e-10
TOTALS:	2.001e+14	1.515e+06	5.719e+06	2.958e+03	1.116e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File Ref: EDE-1312
Date: 8/24/99
By: Altitude
Checked: PDR 8/24/99

: 1
File: BINSETET.MS5
Date: March 30, 1999
Time: 8:48:18 AM
tion: 00:01:24

Case Title: binset1

Description: R/hr from ext. sect. of center tank 7' beneath floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 183.0 cm ✓ 6 ft 0.0 in
Radius 45.72 cm ✓ 1 ft 6.0 in

Dose Points

	X	Y	Z
# 1	193 cm ✓	396.24 cm ✓	0 cm
	6 ft 4.0 in	13 ft 0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.20e+06 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	212.605 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	5.5605e+003	2.0574e+014	4.6270e+003	1.7120e+008
Ce-144	4.5195e-010	1.6722e+001	3.7608e-010	1.3915e-005
Cs-134	7.3800e-003	2.7306e+008	6.1411e-003	2.2722e+002
Cs-137	5.8785e+003	2.1750e+014	4.8916e+003	1.8099e+008
Pm-147	1.3697e+000	5.0677e+010	1.1397e+000	4.2169e+004
Pr-144	4.5195e-010	1.6722e+001	3.7608e-010	1.3915e-005
Pr-144m	8.0445e-012	2.9765e-001	6.6940e-012	2.4768e-007
Rh-106	5.6235e-008	2.0807e+003	4.6794e-008	1.7314e-003
Ru-106	5.6235e-008	2.0807e+003	4.6794e-008	1.7314e-003
Sm-147	3.5175e-007	1.3015e+004	2.9270e-007	1.0830e-002
Sr-90	4.9980e+003	1.8493e+014	4.1589e+003	1.5388e+008
Y-90	4.9980e+003	1.8493e+014	4.1589e+003	1.5388e+008

Buildup

The material reference is : Shield 2 ✓

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

Results

: 2
File: BINSETET.MS5
Date: March 30, 1999
Time: 8:48:18 AM
tion: 00:01:24

<u>rgy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>eV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
.015	1.631e+10	1.365e-154	2.530e-24	1.171e-155	2.170e-25
.02	3.075e+09	1.066e-70	1.354e-24	3.692e-72	4.689e-26
.03	1.246e+13	9.994e-20	4.101e-18	9.905e-22	4.064e-20
.04	2.960e+12	9.706e-08	8.533e-06	4.293e-10	3.774e-08
.05	2.205e+05	4.881e-10	5.867e-08	1.300e-12	1.563e-10
.06	9.265e-03	3.676e-15	3.830e-13	7.301e-18	7.607e-16
.08	5.503e+00	1.844e-10	1.002e-08	2.919e-13	1.586e-11
.1	1.443e+06	2.949e-04	9.496e-03	4.511e-07	1.453e-05
.15	1.806e+00	2.202e-09	3.434e-08	3.626e-12	5.654e-11
.2	5.752e+04	1.509e-04	1.603e-03	2.663e-07	2.830e-06
.3	3.932e+04	2.379e-04	1.664e-03	4.512e-07	3.156e-06
.4	3.682e+00	3.782e-08	2.070e-07	7.370e-11	4.033e-10
.5	3.987e+06	6.099e-02	2.819e-01	1.197e-04	5.534e-04
.6	1.847e+14	3.896e+06	1.584e+07	7.604e+03	3.091e+04
.8	2.570e+08	8.980e+00	3.034e+01	1.708e-02	5.770e-02
.0	7.646e+06	3.947e-01	1.175e+00	7.276e-04	2.166e-03
.5	8.301e+06	8.659e-01	2.105e+00	1.457e-03	3.541e-03
.0	4.242e+00	7.167e-07	1.549e-06	1.108e-09	2.396e-09
.0	3.494e-01	1.127e-07	2.114e-07	1.529e-10	2.868e-10
ALS:	2.001e+14	3.896e+06	1.584e+07	7.604e+03	3.091e+04

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

: 1
 File: BINSET1.MS5
 Date: April 8, 1999
 Time: 8:11:30 AM
 Position: 00:01:31

File Ref: EDF-1312
 Date: 8/24/99
 By: *W. H. H. H.*
 Checked: PDR 8/26/99

Case Title: Bin Set #1
 Description: Dose rate 7' below floor for Bin Set #1- next bin
 Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
 Height 609.6 cm 20 ft 0.0 in
 Radius 180.9 cm 5 ft 11.2 in

Dose Points

	X	Y	Z
# 1	193 cm	985.54 cm	0 cm
	6 ft 4.0 in	32 ft 4.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	375.305 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded
 Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
 The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

: 2
 File: BINSET1.MS5
 Run Date: April 8, 1999
 Run Time: 8:11:30 AM
 Duration: 00:01:31

Energy MeV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	8.523e+11	1.152e-131	3.822e-23	9.885e-133	3.278e-24
0.02	1.607e+11	1.617e-59	2.045e-23	5.600e-61	7.084e-25
0.03	6.510e+14	2.805e-15	9.197e-14	2.779e-17	9.115e-16
0.04	1.547e+14	3.367e-05	2.356e-03	1.489e-07	1.042e-05
0.05	1.152e+07	2.903e-08	2.653e-06	7.734e-11	7.068e-09
0.06	4.841e-01	9.849e-14	7.833e-12	1.956e-16	1.556e-14
0.08	2.875e+02	2.626e-09	1.121e-07	4.156e-12	1.775e-10
0.1	7.541e+07	3.250e-03	8.063e-02	4.972e-06	1.234e-04
0.15	9.436e+01	1.831e-08	2.164e-07	3.015e-11	3.564e-10
0.2	3.006e+06	1.123e-03	9.228e-03	1.982e-06	1.629e-05
0.3	2.055e+06	1.614e-03	9.122e-03	3.061e-06	1.730e-05
0.4	1.924e+02	2.453e-07	1.118e-06	4.779e-10	2.177e-09
0.5	2.084e+08	3.842e-01	1.512e+00	7.542e-04	2.968e-03
0.6	9.651e+15	2.401e+07	8.457e+07	4.686e+04	1.651e+05
0.8	1.343e+10	5.363e+01	1.611e+02	1.020e-01	3.065e-01
1.0	3.996e+08	2.305e+00	6.226e+00	4.249e-03	1.148e-02
1.5	4.339e+08	4.888e+00	1.114e+01	8.225e-03	1.873e-02
2.0	2.216e+02	3.982e-06	8.216e-06	6.158e-09	1.270e-08
3.0	1.826e+01	6.206e-07	1.136e-06	8.419e-10	1.541e-09
TOTALS:	1.046e+16	2.401e+07	8.457e+07	4.686e+04	1.651e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

1 : 1
File: BINSET1.MS5
Date: April 8, 1999
Time: 8:00:42 AM
Position: 00:01:31

File Ref: EDE312
Date: 8/24/99
By: W. Johnson
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate off axis above 1 bin (Bin Set #1) - 1999

Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points

	X	Y	Z
# 1	193 cm	1198.9 cm	0 cm
	6 ft 4.0 in	39 ft 4.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	588.665 cm	Air	0.0011
Air Gap		Air	0.0011
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 2

Integration Parameters

Radial	28
Circumferential	20
Y Direction (axial)	20

? : 2
 File: BINSET1.MS5
 Run Date: April 8, 1999
 Run Time: 8:00:42 AM
 Duration: 00:01:31

Results					
<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.015	8.523e+11	9.780e-132	2.165e-23	8.389e-133	1.857e-24
0.02	1.607e+11	1.492e-59	1.158e-23	5.168e-61	4.013e-25
0.03	6.510e+14	2.539e-15	8.320e-14	2.516e-17	8.245e-16
0.04	1.547e+14	2.793e-05	1.937e-03	1.235e-07	8.567e-06
0.05	1.152e+07	2.132e-08	1.893e-06	5.679e-11	5.043e-09
0.06	4.841e-01	6.500e-14	4.945e-12	1.291e-16	9.821e-15
0.08	2.875e+02	1.527e-09	6.209e-08	2.417e-12	9.825e-11
0.1	7.541e+07	1.787e-03	4.262e-02	2.734e-06	6.520e-05
0.15	9.436e+01	9.616e-09	1.115e-07	1.584e-11	1.837e-10
0.2	3.006e+06	5.826e-04	4.733e-03	1.028e-06	8.354e-06
0.3	2.055e+06	8.316e-04	4.674e-03	1.577e-06	8.865e-06
0.4	1.924e+02	1.261e-07	5.725e-07	2.458e-10	1.115e-09
0.5	2.084e+08	1.974e-01	7.745e-01	3.875e-04	1.520e-03
0.6	9.651e+15	1.233e+07	4.335e+07	2.406e+04	8.461e+04
0.8	1.343e+10	2.751e+01	8.260e+01	5.233e-02	1.571e-01
1.0	3.996e+08	1.182e+00	3.192e+00	2.180e-03	5.885e-03
1.5	4.339e+08	2.507e+00	5.714e+00	4.218e-03	9.614e-03
2.0	2.216e+02	2.043e-06	4.221e-06	3.159e-09	6.527e-09
3.0	1.826e+01	3.188e-07	5.847e-07	4.326e-10	7.933e-10
TOTALS:	1.046e+16	1.233e+07	4.335e+07	2.406e+04	8.461e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: 1
File: BINSET1B.MS5
Date: March 31, 1999
Time: 2:40:22 PM
ation: 00:01:32

File Ref: EDF-1312
Date: 8/24/99
By: ALM
Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate off axis above 1 bin (Bin Set #1) - above floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 180.9 cm 5 ft 11.2 in

Dose Points
1 X Y Z
193 cm 1274.18 cm 0 cm
6 ft 4.0 in 41 ft 9.6 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 6.27e+07 cm³ Concrete 1.1
Shield 1 .635 cm Iron 7.86
Shield 2 609.6 cm Air 0.0011
Shield 3 53.34 cm Concrete 2.35
Shield 4 1.0 cm Air 0.0011
Air Gap Air 0.0011
Wall Clad .476 cm Iron 7.86
Immersion Air 0.0011

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 3

Integration Parameters
Radial 28
Circumferential 20

: 2
File: BINSET1B.MS5
Date: March 31, 1999
Time: 2:40:22 PM
ation: 00:01:32

Y Direction (axial)

20

Energy MeV	Activity photons/sec	Results			
		<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	8.523e+11	0.000e+00	1.092e-23	0.000e+00	9.364e-25
0.02	1.607e+11	2.484e-251	3.240e-24	8.606e-253	1.122e-25
0.03	6.510e+14	4.008e-78	2.902e-20	3.972e-80	2.876e-22
0.04	1.547e+14	8.099e-37	1.828e-20	3.582e-39	8.086e-23
0.05	1.152e+07	7.961e-29	5.160e-27	2.121e-31	1.374e-29
0.06	4.841e-01	2.177e-29	6.252e-28	4.324e-32	1.242e-30
0.08	2.875e+02	6.563e-21	3.589e-19	1.039e-23	5.680e-22
0.1	7.541e+07	3.500e-13	3.393e-11	5.354e-16	5.190e-14
0.15	9.436e+01	9.483e-17	1.473e-14	1.562e-19	2.426e-17
0.2	3.006e+06	3.890e-11	6.249e-09	6.865e-14	1.103e-11
0.3	2.055e+06	5.512e-10	6.398e-08	1.046e-12	1.214e-10
0.4	1.924e+02	3.719e-13	2.962e-11	7.246e-16	5.770e-14
0.5	2.084e+08	1.746e-06	9.989e-05	3.428e-09	1.961e-07
0.6	9.651e+15	2.571e+02	1.109e+04	5.018e-01	2.165e+01
0.8	1.343e+10	2.076e-03	5.740e-02	3.948e-06	1.092e-04
1.0	3.996e+08	2.277e-04	4.504e-03	4.197e-07	8.303e-06
1.5	4.339e+08	2.265e-03	2.561e-02	3.810e-06	4.308e-05
2.0	2.216e+02	4.712e-09	3.806e-08	7.287e-12	5.886e-11
3.0	1.826e+01	2.175e-09	1.167e-08	2.951e-12	1.583e-11
TOTALS:	1.046e+16	2.571e+02	1.109e+04	5.018e-01	2.165e+01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

File: BINSET1B.MS5
 Date: March 31, 1999
 Time: 2:43:44 PM
 Duration: 00:01:33

File Ref: EDF-1312
 Date: 8/24/99
 By: *[Signature]*
 Checked: PDR 8/26/99

Case Title: Bin Set #1

Description: Dose rate off axis above 1 bin (Bin Set #1) - above floor
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions

Height	609.6 cm	20 ft 0.0 in
Radius	180.9 cm	5 ft 11.2 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	193 cm	1327.52 cm	0 cm
	6 ft 4.0 in	43 ft 6.6 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	6.27e+07 cm ³	Concrete	1.1
Shield 1	.635 cm	Iron	7.86
Shield 2	609.6 cm	Air	0.0011
Shield 3	106.68 cm	Concrete	2.35
Shield 4	1.0 cm	Air	0.0011
Air Gap		Air	0.00122
Wall Clad	.476 cm	Iron	7.86
Immersion		Air	0.0011

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : ICRP-38

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	2.9055e+005	1.0750e+016	4.6361e+003	1.7154e+008
Ce-144	2.3613e-008	8.7369e+002	3.7678e-010	1.3941e-005
Cs-134	3.8574e-001	1.4272e+010	6.1549e-003	2.2773e+002
Cs-137	3.0714e+005	1.1364e+016	4.9007e+003	1.8133e+008
Nb-95	2.5763e-056	9.5323e-046	4.1108e-058	1.5210e-053
Nb-95m	8.5840e-059	3.1761e-048	1.3697e-060	5.0678e-056
Pm-147	7.1563e+001	2.6478e+012	1.1419e+000	4.2249e+004
Pr-144	2.3614e-008	8.7371e+002	3.7679e-010	1.3941e-005
Pr-144m	4.2032e-010	1.5552e+001	6.7067e-012	2.4815e-007
Rh-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Ru-106	2.9385e-006	1.0872e+005	4.6887e-008	1.7348e-003
Sm-147	1.8382e-005	6.8013e+005	2.9330e-007	1.0852e-002
Sr-90	2.6117e+005	9.6631e+015	4.1672e+003	1.5419e+008
Y-90	2.6123e+005	9.6655e+015	4.1682e+003	1.5422e+008
Zr-95	1.1604e-056	4.2936e-046	1.8516e-058	6.8510e-054

Buildup

The material reference is : Shield 3

Integration Parameters

Radial	28
Circumferential	20

: 2
File: BINSET1B.MS5
Date: March 31, 1999
Time: 2:43:44 PM
tion: 00:01:33

Y Direction (axial)

20

Energy eV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	8.523e+11	0.000e+00	9.776e-24	0.000e+00	8.385e-25
0.02	1.607e+11	0.000e+00	2.901e-24	0.000e+00	1.005e-25
0.03	6.510e+14	1.487e-140	2.598e-20	1.473e-142	2.575e-22
0.04	1.547e+14	5.237e-68	1.637e-20	2.316e-70	7.240e-23
0.05	1.152e+07	6.163e-49	3.986e-27	1.642e-51	1.062e-29
0.06	4.841e-01	1.402e-44	1.202e-33	2.785e-47	2.388e-36
0.08	2.875e+02	4.893e-32	6.644e-30	7.743e-35	1.051e-32
0.1	7.541e+07	1.123e-22	3.077e-20	1.718e-25	4.707e-23
0.15	9.436e+01	1.427e-24	8.355e-22	2.349e-27	1.376e-24
0.2	3.006e+06	3.807e-18	2.579e-15	6.719e-21	4.552e-18
0.3	2.055e+06	5.093e-16	2.376e-13	9.660e-19	4.507e-16
0.4	1.924e+02	1.479e-18	4.233e-16	2.881e-21	8.249e-19
0.5	2.084e+08	2.034e-11	3.809e-09	3.993e-14	7.477e-12
0.6	9.651e+15	6.930e-03	9.033e-01	1.353e-05	1.763e-03
0.8	1.343e+10	1.969e-07	1.455e-05	3.744e-10	2.767e-08
1.0	3.996e+08	5.404e-08	2.597e-06	9.961e-11	4.787e-09
1.5	4.339e+08	2.444e-06	5.775e-05	4.112e-09	9.717e-08
2.0	2.216e+02	1.275e-11	1.980e-10	1.971e-14	3.062e-13
3.0	1.826e+01	1.705e-11	1.581e-10	2.313e-14	2.145e-13
TOTALS:	1.046e+16	6.933e-03	9.034e-01	1.353e-05	1.763e-03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

: 1
File: BINSET22.MS5
Date: May 11, 1999
Time: 7:48:14 AM
tion: 00:00:07

File Ref: EDF-1312
Date: 8/24/99
By: *[Signature]*
Checked: PDR 8/26/99

Case Title: Bin Set #1
Description: Dose rate above 38" floor for Bin Set #1- total bin
Geometry: 8 - Cylinder Volume - End Shields

Source Dimensions
Height 609.6 cm 20 ft 0.0 in
Radius 362.0 cm 11 ft 10.5 in

Dose Points
1 X Y Z
 0 cm 1297.43 cm 0 cm
 0.0 in 42 ft 6.8 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 2.51e+08 cm³ Concrete 1.1
Shield 1 .635 cm Iron 7.86
Shield 2 588.665 cm Air 0.0011
Shield 3 96.52 cm Concrete 2.35
Shield 4 2.0 cm Air 0.0011
Air Gap Air 0.00122
Wall Clad .476 cm Iron 7.86

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : ICRP-38

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	1.1635e+006	4.3049e+016	4.6361e+003	1.7154e+008
Ce-144	9.4557e-008	3.4986e+003	3.7678e-010	1.3941e-005
Cs-134	1.5447e+000	5.7152e+010	6.1549e-003	2.2773e+002
Cs-137	1.2299e+006	4.5507e+016	4.9007e+003	1.8133e+008
Nb-95	1.0317e-055	3.8171e-045	4.1108e-058	1.5210e-053
Nb-95m	3.4374e-058	1.2718e-047	1.3697e-060	5.0678e-056
Pm-147	2.8657e+002	1.0603e+013	1.1419e+000	4.2249e+004
Pr-144	9.4560e-008	3.4987e+003	3.7679e-010	1.3941e-005
Pr-144m	1.6832e-009	6.2277e+001	6.7067e-012	2.4815e-007
Rh-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Ru-106	1.1767e-005	4.3538e+005	4.6887e-008	1.7348e-003
Sm-147	7.3609e-005	2.7235e+006	2.9330e-007	1.0852e-002
Sr-90	1.0458e+006	3.8695e+016	4.1672e+003	1.5419e+008
Y-90	1.0461e+006	3.8705e+016	4.1682e+003	1.5422e+008
Zr-95	4.6469e-056	1.7194e-045	1.8516e-058	6.8510e-054

Buildup
The material reference is : Shield 3

Integration Parameters
Radial 28
Circumferential 20
Y Direction (axial) 20

: 2
 File: BINSET22.MS5
 Date: May 11, 1999
 Time: 7:48:14 AM
 tion: 00:00:07

Results

Energy eV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec		mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	3.413e+12	0.000e+00	4.102e-23	0.000e+00	3.519e-24
0.02	6.436e+11	0.000e+00	1.217e-23	0.000e+00	4.216e-25
0.03	2.607e+15	6.209e-128	1.090e-19	6.153e-130	1.080e-21
0.04	6.194e+14	1.377e-61	6.869e-20	6.092e-64	3.038e-22
0.05	4.613e+07	1.163e-44	1.672e-26	3.097e-47	4.455e-29
0.06	1.938e+00	3.071e-41	5.044e-33	6.100e-44	1.002e-35
0.08	1.151e+03	1.855e-29	1.815e-27	2.935e-32	2.873e-30
0.1	3.020e+08	2.124e-20	5.011e-18	3.249e-23	7.666e-21
0.15	3.779e+02	1.335e-22	6.437e-20	2.199e-25	1.060e-22
0.2	1.204e+07	2.539e-16	1.393e-13	4.482e-19	2.458e-16
0.3	8.230e+06	2.270e-14	8.661e-12	4.307e-17	1.643e-14
0.4	7.704e+02	5.085e-17	1.213e-14	9.908e-20	2.363e-17
0.5	8.345e+08	5.785e-10	9.166e-08	1.136e-12	1.799e-10
0.6	3.865e+16	1.701e-01	1.900e+01	3.320e-04	3.709e-02
0.8	5.380e+10	3.879e-06	2.501e-04	7.378e-09	4.757e-07
1.0	1.600e+09	9.082e-07	3.862e-05	1.674e-09	7.118e-08
1.5	1.737e+09	3.166e-05	6.755e-04	5.326e-08	1.137e-06
2.0	8.875e+02	1.411e-10	2.002e-09	2.183e-13	3.096e-12
3.0	7.310e+01	1.576e-10	1.355e-09	2.138e-13	1.838e-12
TOTALS:	4.188e+16	1.701e-01	1.900e+01	3.321e-04	3.709e-02