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CsIX/TRU Grout Feasibility Study

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ABSTRACT

A settlement agreement between the Department of Energy (DOE) and the State of Idaho mandates that liquid waste now stored at the Idaho Nuclear Technology Engineering Center (INTEC — formerly the Idaho Chemical Processing Plant, ICPP) will be calcined by the end of year 2012. This study investigates an alternative treatment of the liquid waste that removes undissolved solids (UDS) by filtration and removes cesium by ion exchange, followed by cement-based grouting of the remaining liquid into 55-gal drums. Operations are assumed to be from January 2008 through December 2012. The grouted waste will be contact-handled and will be shipped to the Waste Isolation Pilot Plant (WIPP) in New Mexico for disposal. The small volume of secondary wastes such as the filtered solids and cesium sorbent (resin) would remain in storage at the Idaho National Engineering and Environmental Laboratory for treatment and disposal under another project, with an option to dispose of the filtered solids as a remote-handled waste at WIPP.

SUMMARY

This report addresses regulatory requirements to process radioactive waste at the Idaho Nuclear Technology Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL), proposes a process to prepare the waste for shipment to the Waste Isolation Pilot Plant (WIPP), and investigates the feasibility of two facility designs that will carry out the process.

There are two regulatory mandates for treatment of radioactive waste at INTEC: an October 16, 1995 Settlement Agreement between the DOE, the U.S. Navy, and the State of Idaho, and an April 3, 1992 Consent Order to a Notice of Noncompliance between the EPA and State of Idaho. Among other things, the Settlement Agreement requires that liquid sodium-bearing waste (SBW) be calcined by the end of year 2012. The Consent Order requires removal of liquid waste from the INTEC underground waste storage tanks. It also requires that DOE "cease use" of five of the eleven tanks, which are contained in pillar and panel vaults, by March 31, 2009. The second modification to this Consent Order moved the date of "cease use" of these tanks up to June 30, 2003. Closure of the remaining six tanks is scheduled to begin in October 2008. Because of the closure of these tanks, there will not be enough volume to hold all the liquid waste in the remaining tanks unless removal and processing of the waste has started on or before January 2008. This report investigates a waste treatment process that if used will meet this deadline.

There is, however, a need for an alternative to the calcining requirement because the New Waste Calcining Facility (NWCF) at INTEC is currently not operating, and this study assumes that operations will never resume. As an alternative to calcination, this study investigates treatment of the liquid waste by the Cesium Ion Exchange/Transuranic (CsIX/TRU) grout process. The CsIX/TRU grout process will remove undissolved solids (UDS) by filtration and remove cesium through ion exchange, followed by cement-based grouting of the remaining liquid into 55-gal drums. This operation will occur January 2008 through December 2012. The grouted waste will be shipped during this time to the WIPP in New Mexico for disposal.

This study investigated four possible absorbents for the primary wastes: grout, low-density silica-based absorbent (Ultrisorb), clay-based absorbent (Aquaset), and inorganic polymer absorbent (Acidbond). Each was evaluated on the following criteria: (1) process simplicity, (2) minimized solid waste volume, (3) mature development status, and (4) low cost. The evaluation selected grout for the waste form to use in this feasibility study because of the test data available for grouting of SBW, along with the results showing a higher volume for Ultrisorb, additional costs and a relatively small reduced volume for Aquaset, and the high absorbent cost and unknown long-term stability for Acidbond.

The WIPP Waste Acceptance Criteria (WAC) provide requirements for waste forms WIPP receives, all of which are met by the CsIX/TRU grout process waste form. The WIPP criteria most important to the process definition are:

- The waste must be contact-handled (200 mrem/hr or less at contact)
- The waste must contain more than 100 nCi/g TRU
- The waste must contain less than 2 liters of free liquid per 55-gal drum.

Environmental and regulatory aspects of the CsIX/TRU grout process were evaluated. The study concluded that the grouted waste form will meet WIPP waste acceptance criteria, although negotiations with WIPP will be necessary on issues of RCRA constituents, and characterization and inspection of waste.

The study also considered disposal requirements for the small amount of secondary waste streams, such as the solids filtered from the liquid waste and the cesium-loaded ion exchange sorbent. These wastes will remain in storage at INTEC until they can be treated and disposed of under another project, such as a future Idaho vitrification plant to process the calcine or the Hanford vitrification plant. Another option is for the filtered UDS to be sent to WIPP for disposal.

This study investigated and prepared designs and facility layouts for two facility scenarios: one scenario constructs new buildings to house and operate all the process and waste storage equipment; the second scenario constructs new buildings for all operations except the most radiologically hazardous, which are housed instead in the NWCF building.

The study concluded that this process is feasible for the all-new-building scenario, with a total life cycle cost (escalated and discounted) of about \$279 million. However, the scenario of locating the process in the NWCF in time to meet the schedule requirements is not feasible, due primarily to the high personnel radiation exposure rate during rip-out and construction in the NWCF.

The process as presented in this report, although containing individual processes used separately in industry, has not been tested as described and hence has not been optimized. Because the primary goal is to design a *feasible* process, and because limited empirical data are available on the CsIX/TRU grout process concept, most assumptions and decisions have leaned toward the conservative or upper bounding case. Substantial reductions of both capital and operating costs and waste volumes can probably be achieved by simplifying and improving design concepts beyond those proposed here and acquiring supporting information. Research and testing are necessary to support this; the study recommends some specific future studies.

In order for the CsIX/TRU grout process concept and project to meet the 2012 date, it is imperative that actions begin soon on the following recommendations:

- Successful negotiation with DOE and/or the State of Idaho to reduce the number of Resource Conservation and Recovery Act (RCRA) listed hazardous waste numbers (HWNs) contained in the INTEC liquid waste from 105 to 4
- A ruling by DOE and/or NRC that SBW/Newly Generated Liquid Waste (NGLW) is not high-level waste (HLW)
- Start and succeed in negotiations with WIPP to accept the waste
- Start the Line-Item Project funding cycle now to begin Conceptual Design no later than early FY-2001.
- Sample and analyze the Tank Farm solids (both suspended and settled), and have the Tank Farm Closure team determine what is to be done with the bulk settled solids in the tanks.
- Start the RCRA permitting process for the SBW CsIX/TRU grout treatment system.
- Start the National Environmental Policy Act (NEPA) process for SBW independently of the HLW & FD (Facility Disposition) Environmental Impact Statement.
- Fund and aggressively pursue various studies investigating technical development issues.

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ACRONYMS

AE	(DOE-ID) Architectural Engineering (Standards)
CAO	Carlsbad Area Office
CFR	Code of Federal Regulations
CH	Contact Handled
CPP	Chemical Processing Plant (recently renamed "INTEC")
CsIX	cesium ion exchange
CST	crystalline silicotitanate (a type of sorbent used to remove cesium)
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy, Idaho Office
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EUSU	Electrical and Utility Systems Upgrade
FD	Facility Disposition (EIS)
FGE	Fissile Gram Equivalent
GFE	Government-Furnished Equipment
HEPA	High-Efficiency Particulate Air (filter)
HF	uncomplexed hydrofluoric acid
HLLWE	High Level Liquid Waste Evaporator
HLW	High-Level Radioactive Waste
HVAC	Heating, Ventilation, and Air Conditioning
HWMA	Hazardous Waste Management Act (State of Idaho)
HWN	Hazardous Waste Number
ICPP	Idaho Chemical Processing Plant (recently renamed "INTEC")
INTEC	Idaho Nuclear Technology Engineering Center (previously named "ICPP")
INEEL	Idaho National Engineering and Environmental Laboratory
LDR	land disposal restrictions
LET&D	Liquid Effluent Treatment and Disposal
NGLW	Newly Generated Liquid Waste
NRC	Nuclear Regulatory Commission
NWCF	New Waste Calcining Facility
P&V	Piping and Valve (corridor)

PC	Performance Category
PE	plutonium equivalent
PEWE	Process Effluent Waste Evaporator
QA	Quality Assurance
QAPjPs	Quality Assurance Project Plans
RCRA	Resource Conservation and Recovery Act
RH	Remote Handled
SBW	Sodium-bearing waste
SO	system operability (testing)
STD	Standard
SWB	(WIPP's) Standard Waste Box
TDOP	ten drum overpack
TRAMPACs	TRUPACT-II Authorization Methods for Payload Controls
TRU	transuranic
UCS	Utility Control System
UDS	undissolved solids
UPS	Uninterruptable Power Supply
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant
WWIS	WIPP Waste Information System

CsIX/TRU Grout Feasibility Study

1. INTRODUCTION

This report addresses regulatory requirements to process radioactive waste at the Idaho Nuclear Technology Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory (INEEL), proposes a process to prepare the waste for shipment to the Waste Isolation Pilot Plant (WIPP), and investigates the feasibility of two facility designs that will carry out the process.

Treatment of radioactive waste at the Idaho Nuclear Technology Engineering Center (INTEC) at the Idaho National Engineering and Environmental Laboratory is mandated under a Settlement Agreement (October 16, 1995) between the U.S. Department of Energy (DOE), the U.S. Navy, and the State of Idaho. Among other things, the Agreement requires that liquid sodium-bearing waste (SBW) be calcined by the end of year 2012. However, the New Waste Calcining Facility (NWCF) at INTEC is currently not operating, and this study assumes for conservatism (i.e., sizing of the CsIX TRU Grout plant) that NWCF operations will never resume.

An additional driver for scheduling of INTEC liquid waste management is the need to remove waste from the INTEC underground waste storage tanks. An April 3, 1992 Consent Order to a Notice of Noncompliance between the EPA and the State of Idaho requires that DOE "cease use" of five of the eleven tanks, which are contained in pillar and panel vaults, by March 31, 2009. The second modification to this Consent Order moved the date of "cease use" of these tanks up to June 30, 2003. Closure of the remaining tanks is scheduled to begin in 2008. Because of the early closure of these tanks, there will not be enough volume to hold all the liquid waste in the remaining tanks unless removal and processing of the waste has started early in 2008.

Because the NWCF is never expected to resume calcining operations, this study investigates an alternative treatment of the liquid waste by the Cesium Ion Exchange/Transuranic (CsIX/TRU) grout process. This process will remove undissolved solids (UDS) by filtration and remove cesium by ion exchange, followed by a cement-based grouting of the remaining liquid into 55-gal drums. Operation will occur January 2008 through December 2012. The grouted waste will be contact-handled and will be shipped to WIPP in New Mexico for disposal. A small volume of secondary wastes will be generated; the cesium sorbent will remain in storage at INTEC until it can be treated and disposed of under another project, such as the HLW Vitrification Facility. The filtered solids will be sent to WIPP or, if this is not possible, can also be stored at INTEC awaiting treatment and storage by another project such as the HLW Vitrification Facility.

1.1 Background

This study investigates treatment of the current INTEC tank farm liquid waste inventory, plus any newly generated liquid waste (NGLW) produced before January 2013 and stored in the INTEC tank farm. It assumes that the NWCF calciner will not be operational. The liquid waste is assumed to not be HLW.

The total volume of liquid waste that must be treated by the end of 2012 is about 1,200,000 gal. After 2012, only about 5,500 gal of NGLW is expected to be generated per year. It would not be economical to operate the CsIX/TRU plant to treat this waste, as it amounts to only 2.4% of its normal operating capacity. Also, it is likely the waste produced after 2012 will not have sufficient TRU activity to meet the WIPP Waste Acceptance Criteria. The plant will not support other disposal options either; it does not treat Resource Conservation and Recovery Act (RCRA) wastes (e.g., remove mercury) nor does it prepare a "performance waste form" (i.e., with strong mechanical properties and capable of passing

leach tests) or have the equipment to prove that it does (i.e., sampling or nondestructive examination stations). Therefore NGLW after 2012 would be kept in a storage tank for later treatment; other options are being considered for treatment of the waste generated after 2012.

To support tank closure schedule requirements, waste treatment operations must start on or before January 2008.

The WIPP Waste Acceptance Criteria (WAC) provides guidance for the waste form requirements, all of which are met by the CsIX/TRU grout process waste form. The WIPP criteria most important to the process definition are:

- The waste must be contact-handled (200 mrem/hr or less at the surface of the waste container)
- The waste must contain more than 100 nCi TRU/g of waste matrix
- The waste must contain less than 0.5% (2 liters) of free liquid per 55-gal drum.

1.2 Objective and Scope of Work

The primary objectives of this study are to determine the feasibility of the CsIX/TRU grout process and estimate project cost and schedule necessary to implement the process.

This study targets the following two goals for treatment of the SBW and NGLW at INTEC:

- Remove the liquid waste from the tank farm tanks in time to meet the required 2009/2012 dates
- Bring the SBW and NGLW to final waste disposal forms which do not intermingle with the calcine high-level waste (HLW), and which meet the WIPP WAC.

The CsIX/TRU grout process and waste chemistry were evaluated in light of these goals. Various primary waste forms were investigated. The study also gave significant consideration to disposal requirements for secondary waste streams such as the solids filtered from the liquid waste, and the cesium-loaded ion exchange sorbent.

This study conservatively assumes that the NWCF will not start up again, so that the CsIX/TRU grout process must treat all liquid waste currently in the tank farm, plus all liquid waste that will be generated before December 31, 2012. Tank heel processing and tank closure will be accomplished by another project. For tanks closed in the operations timeframe of this study (i.e., through 2012), waste from those tank closure activities will be processed through this plant.

Environmental and regulatory aspects of the CsIX/TRU grout process were evaluated. A permitting strategy was developed to point out problem areas that might arise and make recommendations for their resolution. Permitting was included in the schedules and cost estimates.

This study investigated and prepared designs and facility layouts for two facility scenarios:

- Scenario 1 constructs new buildings to house and operate all the process and waste storage equipment;
- Scenario 2 constructs new buildings for all operations except the most radiologically hazardous, which are housed instead in the NWCF building. The use of the NWCF offers

easier access to waste feed from the tank farm, use of the significant existing radiological shielding, and possible storage for the loaded sorbent and/or filtered UDS as well as their subsequent removal and transport to final processing. The study also evaluated whether installation of these systems inside the NWCF would trigger any problematic regulatory or environmental permitting requirements above that for a new facility.

1.3 Existing Facility Descriptions

INTEC - The Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (ICPP), was constructed in 1951 and began operations in 1952. Within the confines of INTEC are all the facilities necessary to receive and store spent nuclear fuels, to process the fuels for recovery of uranium-235, and to handle waste generated by those functions. In 1992, however, DOE officially discontinued reprocessing fuel and changed the INTEC mission. The current mission includes receipt and storage of spent nuclear fuel and the isolation and solidification of the waste fission products from the spent reactor fuel recovery processes.

Tank Farm - The waste tank farm was designed and built to provide interim storage of highly radioactive liquid waste generated during fuel processing operations and process decontamination operations. The tank farm consists of eleven 300,000-gal underground storage tanks (VES-WM-180 through VES-WM-190). All of the tanks are connected by a system of lines, valves, and diversion boxes that allow transfers to and from other INTEC areas. Gravity, airlift plus gravity, or steam jet plus gravity supply the motive force for the transfers. Liquid wastes are stored in the tank farm until they can be converted to solid form in the NWCF.

NWCF - The NWCF began operations in 1982 and uses a fluidized-bed calcination process to convert highly radioactive liquid waste into a granular material called calcine. The calcine product is pneumatically transported to the Calcined Solids Storage Facilities (bin sets) for storage.

Evaporators - It is assumed that existing INTEC evaporator systems can be operated as necessary to support the SBW/TRU grout process:

HLLWE - The high-level liquid waste evaporator (HLLWE) is located in the NWCF. Many of the liquid waste solutions currently stored in the tank farm are not concentrated as much as feasible. As a result, the HLLWE was designed and built to concentrate liquid waste to maximize the storage capacity of the tank farm.

PEWE - Liquid wastes are collected and processed through the Process Equipment Waste Evaporator (PEWE). The PEWE concentrates this dilute waste within its operational capacity. This effectively reduces the volume of liquid waste, which must be stored and further treated. The evaporator concentrate is sent to the tank farm for interim storage. The condensate is sent to the Liquid Effluent Treatment and Disposal (LET&D) facility for further processing.

LET&D - The LET&D process concentrates the trace nitric acid in the PEW evaporator condensate by fractionating the waste into steam vapor and concentrated fractionator bottoms. The steam vapor is superheated and discharged to the INTEC stack for release to the environment. The concentrated bottoms are sent to the acid recycle system.

1.4 Concept Overview

The basic CsIX/TRU grout process is described in EDF-CSIX-001 in Appendix B, and consists of the following major steps (see Figure 1):

1. Rough filtration of UDS from the liquid waste feed streams
2. Cesium removal by ion exchange (CsIX)
3. Neutralization as required before grouting
4. Grout mixing
5. Grout packaging in 55 gal drums
6. Sampling and inspection of grouted waste form to meet the WIPP WAC
7. Interim storage for grouted waste drums (since WIPP can not receive them as fast as they are produced)

Figure 1. CsIX/TRU grout process flow.

For the first facility scenario, all of the above steps will be staged in new facilities. However, under the second facility scenario, the first two steps will be performed in the NWCF.

Waste products from this process are expected to be:

- Dried waste UDS from liquid waste filtration – about 10 m³ (step 1)
- Dried waste sorbent from cesium removal from the liquid waste - about 10 m³ (step 2)
- Contact handled (CH) grouted TRU waste in 55-gal drums, from grouting and packaging the liquid waste—about 7,500 m³ in 38,000 drums (steps 4 and 5).

The first two waste types will be stored at INTEC until they can be treated and disposed of under another project such as the HLW Vitrification Facility. The third and primary waste type will be shipped to WIPP as quickly as INEEL shipping and WIPP receiving capabilities allow. An interim storage capacity of approximately 24,000 drums will be required at INTEC to accommodate the difference between the anticipated waste production rate of 146 drums/week and the anticipated WIPP receipt rate of 52 drums/week (see EDF-CsIX-002 in Appendix E for more details).

2. STUDY ASSUMPTIONS AND REQUIREMENTS

2.1 Assumptions

See Appendix A for a list of the major assumptions and decisions made during this study. The following is a list of major process and design assumptions, garnered from Appendices A and B, and from evaluation of environmental issues:

1. The liquid SBW and NGLW can be classified as TRU waste incidental to fuel reprocessing, and are not HLW (Assumption No. 1 in Appendix A).
2. The NWCF will not restart; waste inventories are as of April 1998 (No. 32 in Appendix A).
3. The waste will be assigned only four RCRA-listed hazardous waste numbers (HWNs), which will be acceptable at WIPP. (Three of these four RCRA-listed waste codes are already identified in Part A of the WIPP Permit; the fourth, U134 (uncomplexed hydrofluoric acid, HF), is not. This code must be delisted from the Idaho waste or it must be added to the WIPP Permit before the TRU waste can be shipped.) (No. 4 and 5 in Appendix A). In addition, the waste is assigned eight HWNs for the characteristically toxic metals (D004-D011).
4. A RCRA permitted interim storage facility will be required for the 55-gal drums filled with CH-TRU waste (No. 36 in Appendix A).
5. The WIPP WAC can be interpreted as-is (No. 14 in Appendix A). Any regulatory and volume issues involved with acceptance of the waste at WIPP will be addressed independently of this study.
6. UDS will only be removed from the tank liquid waste. No tank heel UDS will be removed. (No. 8 from Appendix A)
7. It is acceptable to continue to put liquid waste into the tank farm tanks, as it is generated, up to the end of 2012 (No. 21 from Appendix A).
8. The process will use an inorganic, commercially available sorbent, UOP's IONSIV IE-911 CST sorbent, to remove cesium (No. 2 from Appendix A).
9. The CsIX sorbent will not be regenerated (No. 3 from Appendix A).
10. Contamination of the CsIX sorbent (with UDS deposits, or by partial sorbtion of contaminants) need not be prevented except to keep the sorbent's cesium removal performance from degrading (No. 12 and 17 from Appendix A).
11. CsIX sorbent will be dried and stored in a pneumatically transferrable form by the CsIX/TRU Grout Project for future treatment and disposal under another Project. Filtered UDS will also be dried, but will be sent to WIPP for disposal or, if this is not possible, will also be stored for future treatment and disposal under another Project. (No. 16 and 18 in Appendix A).

12. The treatment operating schedule is from January 1, 2008 through December 31, 2012. The process will operate 24 hours per day for 200 days per year. This assumes approximately 75% on-stream operating time at 75% efficiency. (No. 27 and 28 in Appendix A).
13. The existing PEWE, HLLWE, and LET&D fractionator will be available to concentrate NGLW through the end of 2012.
14. Following concentration in existing INTEC evaporators, no effort will be made to keep different types of NGLW waste streams separate from each other or from SBW in tank farm tanks.
15. The cost of either recycling or preventing off-spec waste product will be represented by selecting an off-spec scenario, such as the grout not setting up, and providing the system necessary to recycle the resulting off-spec waste product (No. 23 in Appendix A).

2.2 Regulations

This section outlines the major environmental regulations for the design of the CsIX/TRU grout process and associated activities. The primary drivers are the requirements for the final waste forms as identified in the WIPP WAC; this section provides the key waste form requirements. It draws from EDF-WTS-003 and EDF-WTS-004 in Appendix E, and from Reference 1.

The permitting strategy consists of two parts that will have to be carried out in parallel, before construction can begin:

1. Permitting of the storage and treatment units necessary for the solids removal, Cs removal, TRU grouting, and storage as hazardous waste management units as required by the State of Idaho.
2. Negotiate with WIPP and the State of New Mexico by supplying documentation on a surrogate waste that the final TRU waste will meet the WIPP WAC. The demonstration would show that the waste will not be corrosive, ignitable, reactive, or contain free liquids > 0.5 %. In addition, the demonstration would show that the waste would generate head space gas < 500 ppm TOC. This demonstration will be based on analytical data for the waste in the Tank Farm Facility (TFF) and surrogate testing of the organic waste loading that would be below the waste acceptance criteria.

2.2.1 Mixed Waste

The SBW stored in the tank farm is a radioactive and hazardous mixed waste. The hazardous constituents are subject to RCRA regulations as incorporated into the State of Idaho Hazardous Waste Management Act (HWMA) and the radioactive constituents are subject to DOE orders and regulations. The air emissions from the CsIX process will have to be below the emission limits for the INEEL.

The SBW is a mixture of decontamination and laboratory wastes that were corrosive at the point of generation and contain hazardous toxic metals and listed wastes. The listed waste constituents are designated by hazardous waste numbers (HWNs) F001, F002, F005, and U134. The characteristic constituents are designated by HWNs D002 and D004 through D011. Table 1 includes HWNs assigned to the tank farm waste, as well as 29 chemicals that are being evaluated to determine if the manner of their use would cause the application of additional listed HWNs to the waste.

The evaluation being conducted for listed hazardous waste is assessing the past uses of chemicals to determine if any unused or off-specification chemicals were discharged to the PEW-TFF system that would result in assigning additional HWNs to the four listed HWNs. This determination consists of asking the laboratory personnel (1) was the chemical used at INTEC, (2) how was the chemical used, (3) in what form was the chemical discharged to the PEW-TFF system, and (4) was the chemical ever discharged as an unused or off-spec chemical product. The determination to date has identified chemicals used as solvents that require that the waste be assigned the F001, F002, and F005 HWNs. In addition, unused HF collected for purity analysis was complexed and discharged through lab drains into the system, which resulted in assigning the U124 HWN. To date, the usage and discharge of all the other chemicals was in a form that would not require the assigning of listed HWNs.

The major activities associated with the CsIX/TRU grout treatment process, which include UDS filtration, Cs removal, neutralization, grouting, and interim storage, will be subject to HWMA permitting and regulation as hazardous wastes.

The CxIX/TRU grout treatment process is expected to produce three wastes:

- Filtered UDS
- Cesium-bearing sorbent
- Grouted TRU waste.

These will all be considered listed waste, based on the EPA “derived-from” rule (i.e., residues derived from a listed waste must be managed as a listed waste). Treating a listed waste does not remove the listed designation or the requirement to manage the treated waste residue as a hazardous waste.

Table 1. HWNs assigned to the SBW at INTEC.

D002	*U002	*U171	*P098
D004	*U003	*U188	*P104
D005	*U012	*U196	*P105
D006	*U044	*U210	*P106
D007	*U080	*U211	*P119
D008	*U108	*U219	*P120
D009	*U122	*U220	
D010	*U123	*U225	
D011	*U133	*U226	
F001	*U138	*U227	
F005	*U140	*U228	
F002	*U159		

*Hazardous waste constituents being evaluated for potential designation as listed waste in the SBW.

2.2.2 WIPP Waste Acceptance Criteria

This section discusses key parameters and outlines the steps necessary to qualify the TRU grout for disposal at WIPP. WIPP WAC are contained in Reference 2. The description of the WIPP WAC can be found in Reference 1.

TRU Waste Generator/Storage Sites participating in the National Transuranic Program must certify their TRU waste to the criteria and requirements defined in the WIPP WAC before transport and disposal at WIPP. Each participating Site shall submit copies of TRU Waste Certification Plans, TRUPACT-II

Authorization Methods for Payload Control (TRAMPACs) and associated Quality Assurance (QA) plans, and TRU Waste Characterization Quality Assurance Project Plans (QAPjPs) to the Carlsbad Area Office (CAO) for review and approval.

Site-specific plans and procedures shall contain details of the processes, controls, techniques, tests, and other actions to be applied to each TRU waste payload container and/or waste stream. Method of compliance with each criterion and requirement shall be documented or specifically referenced. A waste stream is defined as waste material generated from a single process or activity that is similar in material, physical form, isotopic makeup, and hazardous constituents.

The primary reference document for establishing the RCRA waste characterization requirements for TRU mixed wastes is the WIPP Waste Analysis Plan. Sites must characterize their waste using the methods defined in the WIPP Waste Analysis Plan. The WIPP WAC identifies the RCRA HWNs acceptable at WIPP and the conditions for receipt of waste. Transuranic mixed waste shipped to WIPP does not have to be treated to meet the RCRA land disposal restrictions (LDR) for the constituents evaluated in the performance assessment. The performance assessment identifies the transuranic mixed wastes that are excluded from the RCRA LDR requirements when received at WIPP. The generator must report the type and quantity of hazardous constituents on the target analyte lists in the Site data package and the WIPP Waste Information System (WWIS) database. The target analyte list and HWNs acceptable at WIPP are identified in Table 2.

For compliance with 40 CFR 268, the State of New Mexico requires that the type and quantity of hazardous constituents on the target analyte lists be reported in the Site's data package and in the WWIS database. It is not clear at this time if hazardous constituents not identified in the performance assessment will require a new performance assessment, LDR treatment, be excluded by the Land Withdrawal Act, or require a separate petition to exclude. The current WIPP WAC and draft permit do not address the protocol necessary for the shipment and receipt of hazardous constituents not identified in Table 2. It is anticipated that a new performance assessment will be required as well as negotiations on concentration limits with the State of New Mexico, in order to allow the receipt of INTEC waste at WIPP.

Table 2. EPA Hazardous Waste Numbers Acceptable at WIPP.

D004	D027	F001
D005	D028	F002
D006	D029	F003
D007	D030	F004
D008	D032	F005
D009	D034	P015
D01	D035	
D01	D036	
D01	D037	
D01	D038	
D021	D039	
D022	D040	
D026	D043	

2.2.2.1 WIPP WAC Required Chemical and Physical Properties for Mixed TRU Waste

1. Free liquids <0.5%
2. Not corrosive, reactive, and ignitable
3. Not pyrophoric
4. Not have contained gases
5. Total VOCs in the headspace of a payload container is limited to 500 ppm.

2.2.2.2 WIPP WAC Nuclear Property Limits for CH-TRU Waste

1. >100 nCi TRU/g of waste matrix
2. <200 mrem/hr contact dose rate per canister
3. <200 g Pu-239 fissile gram equivalent (FGE)/55-gal drum
4. <325 g Pu-239 FGE per Standard Waste Box (SWB)
5. <325 g Pu-239 FGE per ten-drum overpack (TDOP)
6. <325 g Pu-239 FGE/TRUPACT-II
7. Untreated CH-TRU waste shall not exceed 80 Plutonium Equivalent Curies (PE-Ci) of activity per 55-gal drum or 130 PE-Ci of activity per SWB. 55-gal drums containing solidified/vitrified CH-TRU waste shall not exceed 1800 PE-Ci of activity per drum.

2.2.2.3 WIPP WAC Nuclear Property Limits for RH-TRU Waste

1. >100 nCi TRU/g waste matrix
2. <1,000 rem/hr per canister at contact
3. <1,000 Pu-239 equivalent activity PE-Ci/canister
4. <325 g/ cask Pu-239 FGE
5. <200 mrem/hr external dose rate at the surface of a loaded RH-TRU 72-B Cask
6. <10 mrem/hr dose rate at the distance of 2 meters from a loaded RH-TRU 72-B Cask
7. No more than 5 % of the RH canisters received at the WIPP are allowed to have dose rates > 100 rem/hr. Neutron contributions are limited to 270 mrem/hr.

2.3 Functional and Design Requirements

2.3.1 Operational

2.3.1.1 Schedule and Processing Rates

The 10/16/98 Settlement Agreement between DOE, the U.S. Navy, and the State of Idaho requires that SBW be calcined by the end of 2012. This project investigates treatment of the waste by the CsIX/TRU grout process in time to meet the same schedule. In addition, the process must remove waste from the INTEC tank farm in a timeframe and at a rate that meets the tank closure deadlines, as discussed below:

The proposed schedule for tank closure³ is as follows:

<u>Tank</u>	<u>Begin closure</u>	<u>Complete closure</u>
WM-182	Oct 1, 1999	Sept 30, 2005
WM-183	Oct 1, 2004	Sept 30, 2006
WM-184	Oct 1, 2005	Sept 30, 2007
WM-185	Oct 1, 2006	Sept 30, 2008
WM-186	Oct 1, 2007	Sept 30, 2009
WM-180	Oct 1, 2008	Sept 30, 2010
WM-181	Oct 1, 2009	Sept 30, 2011
WM-187	Oct 1, 2011	Sept 30, 2013
WM-188	Oct 1, 2012	Sept 30, 2014
WM-189	Oct 1, 2013	Sept 30, 2015
WM-190	Oct 1, 2014	Sept 30, 2016

The first five tanks listed above are contained in pillar and panel vaults. Use of these tanks must cease by June 30, 2003. According to the above schedule, closure for three tanks will have been completed by September 2007, closure for two other tanks will have been started, and the remaining six tanks will still be available to hold waste. Since each tank has an operational capacity of approximately 285,000 gal, the available volume by October 2007 will be about 1,710,000 gal. However, WM-190 is reserved for Type 2 NGLW that has a lower radionuclide content than the waste in the other tanks, which contain SBW and Type 1 NGLW. Thus only 5 tanks, or 1,425,000 gal of capacity, will be available for SBW and Type 1 NGLW by October 2007. By October 2008, the available capacity for SBW and Type 1 NGLW will be reduced to four tanks, or about 1,140,000 gal.

The volume of existing SBW, after concentration by the HLLWE, will be about 1,000,000 gal. The projected volume of NGLW generated from 1998 through 2008, after evaporation, is about 200,000 gal. Thus a tank capacity of at least 1,200,000 gal is needed on January 1, 2008, and processing must begin

early in 2008 to reduce the waste inventory to a maximum of 1,140,000 gal by October 2008. If the waste volume generation estimates and the HLLWE estimates are accurate, processing could begin at the latest by about May 2008, with enough tank capacity still available to meet demand. However, considering the potential inaccuracies of these estimates and to allow for operating tank capacities slightly less than 300,000 gal per tank, processing should begin by January 2008. Also, the processing rate of the CsIX/TRU grout process must be sufficient to support the closure schedule of one tank per year subsequent to 2009, and the corresponding loss of 300,000 gal of capacity per year.

To meet this requirement, the CsIX/TRU plant must provide operating capability such that the projected amount of waste is less than the available storage volume:

<u>Tank Farm Volume, gal</u>		
<u>Date</u>	<u>Available Storage</u>	<u>Projected Waste*</u>
Oct 1, 2007	1,425,000	1,200,000
Oct 1, 2008	1,140,000	1,000,000
Oct 1, 2009	855,000	750,000
Oct 1, 2010	855,000	520,000
Oct 1, 2011	570,000	290,000
Oct 1, 2012	285,000	60,000
Oct 1, 2013	0	0

*Assuming CsIX/TRU Grout Plant operations 24 hrs/day at 200 days per year

2.3.1.2 NGLW Treatment and Storage

From 1998 through 2012, approximately 470,000 gal of Type 1 NGLW and 4,100,000 gal of Type 2 NGLW will be generated. To avoid the costs of additional tankage and replacement evaporators, the existing INTEC evaporators are needed to concentrate this NGLW.

Following concentration in existing INTEC evaporators, no effort will be made to keep different types of NGLW waste streams separate from each other or from SBW in tank farm tanks.

2.3.1.3 Process Systems and Equipment

This study assumes that calcining operations in the NWCF will never restart and that degradation of calciner operability will be allowed in order to accommodate the installation of CsIX/TRU grout process equipment in Scenario 2. However, the following NWCF systems must remain operational:

- High Level Liquid Waste Evaporator (HLLWE)
- Filter Leach System

- Decontamination Facility
- Building HVAC
- Vessel Off-gas
- Waste Water Collection
- Pneumatic Transfer System.

In addition, the CsIX/TRU process equipment must meet the following requirements:

- Valves, pumps and other mechanical equipment should have remote maintenance and operating capability.
- The UDS container storage location must have the capability to manage and store up to 50 radiologically shielded 55-gal drums
- The most radiologically hazardous equipment in the process, i.e., the CsIX columns, spent sorbent preparation tank, spent sorbent drier, spent sorbent storage tank, UDS slurry storage tank, and UDS drier must have adequate radiological shielding.

2.3.1.4 Functional

To produce a contact-handled waste form, radioactive cesium must be removed from the liquid waste before generating the final waste form.

TRU removal or concentration is not required to meet the WIPP WAC, which requires waste with a TRU concentration greater than 100 nCi/g. The liquid waste contains approximately 1,200 nCi/g on average.

The CsIX/TRU grout process shall be capable of drying and storing the UDS and spent sorbent waste streams so that they are available for future pneumatic transfer by another project. In Scenario 2, the spent sorbent storage tank must be connected to the NWCF pneumatic transfer system for future removal of the dried spent sorbent, while in Scenario 1, a new pneumatic transfer system must be provided.

2.3.2 Facility Design

Facilities shall be provided to accommodate the CsIX/TRU process and related activities, located at INTEC, as close as possible to the INTEC tank farm.

Process facility feasibility designs shall be provided for two different approaches, one using all new facilities and the second using the existing NWCF to house at least the most radioactively hazardous parts of the CsIX/TRU processes.

2.3.3 Waste Form

The main waste product generated by the CsIX/TRU process must meet the WIPP WAC for contact handled waste (there is only limited space available at WIPP for remote handled waste). The process, including its waste-form characterization systems, must be configured such that it will be qualified to meet the WIPP WAC with minimal sampling of the waste-form product itself.

The anticipated secondary waste streams of filtered UDS and cesium-loaded sorbent must be stored in a form that is pneumatically retrievable/transferable for future processing under another project.

2.4 Codes and Standards

The regulations, codes, and standards listed in Appendix G are those presently assumed to be applicable to the CsIX/TRU Process facilities. The facilities will be designed and constructed in accordance with the DOE-ID Architectural Engineering (AE) Standards, which invoke most of the required codes and standards. Some special systems will be designed to codes and standards not listed in the AE Standards.

Requirements for safety analysis, environmental evaluation and protection, project management, quality assurance and other activities necessary to support the design and construction of the facility are generally not included in the AE Standards, but the related references are included in Appendix G.

The following EDFs (Appendix E) contain additional information on laws, regulations, codes, and standards that may be applicable to this project.

- EDF-WTS-003, Regulatory Requirements for the Design, Construction, and Operations of the ICPP Proposed Waste Processing Facilities.
- EDF-WTS-004, Regulatory and Design Requirements for Waste Treatment Facilities.

3. PROCESS AND SYSTEM DESCRIPTIONS

Section 3.1 contains a brief description of the CsIX/TRU grout process and summary material balance tables. The material balance details are provided in EDF-CsIX-001 in Appendix B. Section 3.2 describes the process equipment.

3.1 Process Overview

3.1.1 Process Description

SBW and NGLW will be transferred by steam or air jet from the INTEC tank farm to Liquid Waste Feed Tanks. From there the waste will be pumped through filters to remove UDS. Periodically these filters will be backflushed to transfer the UDS to a system that will dry them and place them in an interim storage location. The liquid waste will then pass through two in-series CsIX columns before entering the CsIX Effluent Hold Tanks.

The CsIX columns contain a crystalline silicotitanate (CST) sorbent that absorbs cesium ions in the liquid waste. The CST sorbent, which contains 10–25% silicon dioxide, 25–40% titanium dioxide, 10–20% sodium oxide and 15–25% of a proprietary material,⁴ is inorganic, making it resistant to chemical and radiation degradation. It is also compatible with ultimate disposal by vitrification. The sorbent has been developed for application to DOE wastes for approximately the last 18 years.⁴ CST sorbent, which has a large affinity for cesium, even in the presence of high concentrations of sodium and high acidity, has recently been tested with SBW.^{5,6} The absorption of cesium on the sorbent is irreversible,⁴ hence the cesium loaded sorbent becomes a secondary waste in the CsIX/TRU process.

The CsIX columns are designed to remove 99.9% of the cesium in the waste feed. The design includes three columns, two operating in series while the third is being loaded, unloaded, or is on standby. When breakthrough in the first of the two in-series columns is reached (and caught by the second column), the waste flow is stopped. The first column is valved out and the second column rotates to the lead location with the third column (recently recharged) rotated to the lag position. The spent sorbent in the first column is sluiced out and replaced with fresh sorbent. After removal, the slurry of spent sorbent is filtered, with liquid and fines being returned to an operating column, and the sorbent solid particles going to a drier. The sorbent then flows by gravity to its interim storage location in a spent sorbent storage tank.

The CsIX column effluent is pumped in batches from the CsIX Effluent Hold Tank to the Grout Feed Tank. In the Grout Feed Tank, solid calcium oxide is added to partially neutralize the waste. The neutralized waste is then fed to the grout mixer, where it is mixed with Portland cement, blast furnace slag, flyash, and cure-rate control chemicals. From the mixer, the uncured grout is transferred to 55-gal drums. The grout is allowed to cure in the drums and then sent through a dewatering process. The filled drums are subsequently placed in interim storage awaiting inspection and shipment to WIPP (see Figure 1 for an illustration of the process).

Table 3 summarizes the overall material balance for processing the SBW and all NGLW, including that generated through 2012.

Table 3. Overall Material Balance for Processing SBW and NGLW.

Feeds	Liters	Kg
Composite SBW	3.65E+06	4.79E+06
Concentrated NGLW	7.42E+05	9.27E+05
Jet dilution water	3.82E+05	3.82E+05
Other water	3.28E+05	3.28E+05
CaOs		2.30E+05
Grout additives		7.97E+06
Cs Sorbent		8.97E+04
Total feeds		1.46E+07

Products		
Grouted waste	7.53E+06	1.43E+07
UDS waste	1.02E+04	1.43E+04
Spent sorbent	8.99E+03	8.99E+03
Condensate to PEWE	3.28E+05	3.28E+05
Total products		1.46E+07

3.1.2 Waste Forms

A very brief evaluation was performed to determine the form of the TRU waste to be used in this study. The criteria used to select the waste form included:

- Minimized solid waste volume
- Low cost
- Process operational simplicity. Does the waste form require a mixer? Does the waste form require neutralization?
- Mature development status. Is there data to support waste loading, chemical interactions with the solidification media, final waste density, etc.?

The four waste forms considered and their evaluation are as follows:

- Absorbed waste on a low density silica-based absorbent

The potential advantage of a low-density, silica- or polymer-based absorbent is process operational simplicity. A waste container would be filled with a given amount of absorbent and liquid waste would be added. The process would feature no mixing, no neutralization, quick curing, and little decontamination of equipment. Based on a brief review of commercial absorbents, Ultrasorb 244, a product of the Molton Corporation, was selected as representative of a high-capacity, inorganic absorbent for aqueous liquids. Ultrasorb 244, a granular diatomaceous earth, absorbs approximately 150% of its weight. Based on product literature for Ultrasorb, neutralization would not be required, as the product is stable with all acids except HF.

- Absorbed waste on an inorganic polymer absorbent

Inorganic polymer absorbents offer even higher absorption capacities, although at a higher cost. ACIDBOND A660, marketed by Nochar, was recently tested using INEEL wastes, including an SBW simulant. The tests showed a waste loading of 80-85 wt% could be achieved, resulting in a volume increase of about 10%. The resultant waste is a soft, rubber-like solid. Although the vendor had reported the product was an inorganic polymer, subsequent investigation revealed that it is a polyacrylate (organic)-based polymer. When nitrate salt solutions are solidified with Acid-Bond A660 and allowed to dry, the resultant material is readily ignitable. Heating tests of absorbed SBW suggest that the polymer undergoes a reaction with nitric acid present in SBW. Because of concerns about flammability and product stability, stabilization of SBW with ACIDBOND A660 was not recommended.⁷

- Absorbed waste on a clay-based absorbent

The potential advantage of a clay-based absorbent is a lower final waste volume. The Aquaset/Petroset products of Fluid Tech, Inc. were selected as representative of a clay-absorbent. Fluid Tech products have been tested and/or used in numerous nuclear waste applications, including some at the INEEL. Testing has not been done for solidification of SBW. For aqueous wastes containing a high level of dissolved salts, Fluid Tech literature recommends using 125–175 lb of Aquaset II per 43–47 gal of waste. For acidic wastes, neutralized to a pH of 5–10, the formulation is similar, 125–175 lb of a combination of Aquaset II and Petroset to 42–47 gal of waste. Mixing of the waste with Aquaset/Petroset would be required.

- Grout

Grouting is a known technology with easily available and relatively inexpensive ingredients. An INEEL development program has been exploring the use of “performance” (high strength mechanical properties, leach resistant) grouting for solidification of INTEC liquid wastes. Before grouting in the CsIX/TRU grout process, the liquid waste would be neutralized to a specified set point of pH 1.3 by mixing it with calcium oxide (lime). Solid ingredients—cement, blast-furnace slag, and fly ash—would then be added and blended with the liquid waste to form a grout product, which would be poured into 55-gal drums.

Table 4 compares the four waste forms.

Table 4. Comparison of TRU Waste Forms.

	Grout	Ultrasorb	Aquaset	Acidbond
Waste Volume, m ³	7,500	12,500	6,100-6,800	5,300
Neutralization req'd	Yes(1)	No (2)	Yes(3)	No
Mixing Required	Yes	No	Yes	No
Cost of absorbent	\$430,000	\$465,000	\$1,800,000	\$32,000,000
Test data available	Yes	No	No	No

Notes

1. Neutralization to pH of 1.3 with CaO
 2. Neutralization not needed except possibly to tie up HF
 3. Neutralization to pH 7 with NaOH
-

The comparison shows that Ultrasorb results in a much higher volume of waste than the other alternatives. The range of waste volumes shown for Aquaset are based on (1) 45 gal of waste with 175 lb of absorbent per drum and (2) 41 gal of waste with 250 lb of absorbent per drum. The higher waste loading is based on Fluid Tech literature. The lower loading is based on treatability study data for concentrated nitric acid waste performed at Sandia.⁴ As shown in Table 4, the volume of waste, when solidified with Aquaset/Petroset, is potentially 14–22% less than when grouted; however, no equipment savings would be expected, and the cost of the solidification agents would be 3–5 times more than that of the grout ingredients.

Based on the limited information presently available for ACIDBOND, it appears that its use would result in about 30% less final waste volume than a grout product. Data is needed to evaluate the long-term stability of the product, its chemical interactions with SBW, the ability to vitrify the absorbed waste, and the potential for radiological decomposition or hydrogen generation.

The development program for grouting INTEC liquid wastes has focused on producing a high-strength grout,^{5,6} however, the WIPP WAC does not contain a strength requirement. It is expected that with further development, with the goal of minimizing waste volume and not being constrained by a grout strength requirement, the volume of final waste can be reduced to the range shown above for Aquaset or ACIDBOND. Grout was selected for the waste form to use in this feasibility study because of the test data available for SBW grouting, a higher expected volume for Ultrasorb, additional costs and a relatively small reduced volume for Aquaset, and the high absorbent cost and unknown long-term stability for ACIDBOND. Based on the SBW grouting data,⁵ there is high confidence that the grout volume shown in the material balance can be achieved. Should the CsIX/TRU grout process/project be carried into conceptual design, additional studies on waste forms are recommended. These studies should include testing evaporation of the ion exchange effluent, other grout formulations, waste loadings other than those tested to date, and absorbents that have the potential for minimizing the final waste volume.

One final waste form, not considered in this study, is the crystalline solid produced when SBW is evaporated at 130–140°C and then cooled. Although this waste form is expected to be both hygroscopic and highly soluble, it may prove to be acceptable for disposal at WIPP. A recent small-scale test demonstrated the feasibility of the concept using a SBW simulant and achieved about 70% volume reduction.⁸ If this same volume reduction could be achieved for the entire SBW, the final waste volume would be only 1,400 m³.

3.1.3 Personnel Staffing

The following basis was used to estimate the number of personnel needed to operate the CsIX/TRU grout facilities:

- The CsIX/TRU grout processing facility will be in operation for approximately 5 years from January 2008 through December 2012.
- Shipment of CH TRU drums to WIPP is independent of the waste treatment process, in that this activity will be performed from the interim storage facilities location, and is anticipated to occur from January 2008 through December 2021 (EDF-CsIX-002, *Interim Storage for CH TRU Waste Drums*).
- Process operations are based on 24 hours per day, 7 days a week, with up-time of 200 days per year. The 200 days are rounded from 205 and based on previously used HLW program drivers stating that operations will be based on a 75% up-time at 75% efficiency ($0.75 \times 0.75 \times 365 = 205$).
- Four rotating shifts of personnel will be required to support the schedule for main process and drum output handling/transfer to interim storage. Included in the four rotating shifts are personnel for process maintenance, QA, Safety, and Rad Con.
- New facility space will be required for final drum analysis to meet WIPP requirements. This space will be for videography (visual inspection of the head space area via camera) and head space gas analysis activities.
- Activities related to drum videography, drum head space gas analysis, and CH TRU drum shipments to WIPP occur only during the day shift.
- All personnel listed will be included for estimating life cycle costs.
- Office space is available in existing nearby facilities; therefore, new administrative facility space is not included in the Study. Personnel not housed in the process facility include the facility administration, engineering support, and training staffs. Operating costs for the facilities they use are a cost incurred by the project.
- A single day shift will include personnel for administration, administrative support, technical support, general building maintenance, and activities related to drum videography, drum head space gas analysis, and CH TRU drum shipments to WIPP.
- Management for support functions – QA, Safety, RadCon, Training, Engineering, Drafting, and Maintenance – is supplied from the existing INTEC infrastructure. Proportional costs for this management and their space are a cost incurred by the project.

- Ancillary and support functions critical to the process will be housed within the same physical facility.
- INTEC will have infrastructure services and capabilities to accommodate some tasks not unique to this project, such as additional engineering and drafting support, common warehouse and storage, major support areas such as machine, weld, sheetmetal, fitter, electrician, and electronics/instrument shops, mock-up area(s), and laydown area(s).
- No special personnel requirements are required for the interim storage facilities that cannot be handled by day shift and rotating shift personnel.

3.1.4 Personnel Summary:

Total estimated number of personnel, summarized in Table 5, is 97, of whom 62 are considered radiation workers. This data was used in determining new facility space needs, performing life cycle cost analysis, and as input to the Project Data Sheet. See EDF-CsIX-003 in Appendix E for details.

Table 5. Summary of Personnel Staffing Requirements.

	Day Shift	Rotating Shifts (4)	Radiation Workers	New Facility Office Space	New Facility Ops/Maint
Facility Admin	6	0	0	0	0
Engineering Support	3	0	0	0	0
Training	2	0	0	0	0
Operations Admin	3	8	0	3	0
Process Operators	10	32	42	2	11
QA, Safety, RadCon	2	12	5	3	0
Process Maintenance	0	12	12	0	3
Facility Maintenance	<u>7</u>	<u>0</u>	<u>3</u>	<u>1</u>	<u>0</u>
Total	33	64	62	9	14

3.2 System Descriptions

3.2.1 Tank Farm Liquid Waste Transfer

Major portions of the existing tank farm liquid waste transfer system, connecting the tank farm to NWCF, will be used to transfer liquid waste to the CsIX/TRU Grout Facility. Modifications to the transfer system are required for the stand-alone facility scenario, however, it is possible that the existing system will be adequate, without modification, for the NWCF scenario.

The transfer system uses steam jets and air lifts to transfer liquid waste from tanks WM-180,-181,-182,-183,-184,-185,-186,-187, and -188, and uses air jets to transfer liquid waste from tanks WM-189 and -190. Receiving tanks in the CsIX/TRU Grout Facility will be capable of accepting liquid waste from all tanks.

Modifications to the existing steam and air jet transfer system, for the all-in-one facility scenario, include a tie-in to the existing transfer lines and the addition of a lift station which would develop adequate head pressure to deliver liquid waste to the new facility's liquid waste feed tanks.

Liquid waste will be transferred to the CsIX/TRU Grout Facility in batch mode. A batch mode was chosen because the existing transfer system is not capable of conveying liquid waste at the low (1gpm) feed rate used in the CsIX/TRU grout process, and sampling of waste materials for purposes of process control will be performed on a batch basis.

The CsIX/TRU grout process design includes two tanks capable of accepting liquid waste from the tank farm waste transfer system. Each tank is sized nominally at 3,500 gal capacity, which allows for a reasonable batch cycle time of approximately 2 hours, based on the tank farm transfer system feed rate.

3.2.2 UDS Filtration

The CsIX/TRU grout process design includes provisions for filtering out undissolved solids from the liquid waste before its introduction to the CsIX columns. The primary function of the filtration system is to protect the ion exchange resin bed from becoming blinded with solids particles. The design also includes provisions for drying and packaging the UDS collected during filtration.

Considerable uncertainty exists in the quantity and character of the suspended UDS in the waste stream. Limited data available on the particle size distribution shows that a large fraction of the UDS in the liquid waste is in the sub-micron size; this indicates a potentially significant filtration problem if these particles must be removed. An additional issue is that there is some evidence the sub-micron particles also carry a large fraction of the radionuclide inventory of the UDS. As recommended later in this report, empirical UDS data must be obtained on the liquid wastes to further refine the filtration process chosen for this study.

A combination of two vertical leaf pressure filters will provide continuous filtering capability at a capacity of 1.2 gpm. Filter media will be selected that removes particles larger than 10 microns. The filter will also be equipped with a scavenger leaf to allow draining of vessel water from the filter cake. At any given time, one filter will be on-line while the other is being serviced. The off-line filter will be drained and the filter cake back flushed with deionized water into a slurry tank. Filter transition from on-line to off-line will be initiated by setpoint pressure differential.

Slurry from the slurry tank, assumed to be 10% solids by weight, will be metered at approximately 1.7 Kg/min to a rotary wiped film evaporator, where the slurry will be dried and sized to a flowable particulate solid. Solids from the evaporator will be stored in radioactively shielded 55 gal drums. Off-gas from the evaporator will be directed through a condenser before it is sent to the Vent Off Gas System. Condensed water will be returned to the HLLWE.

3.2.3 Cesium Removal

Cesium removal is proposed by ion exchange using a crystalline silicotitanate (CST) sorbent. The system includes three ion exchange columns nominally 16 in. diameter by 96 in. tall, containing 0.25 m³ of sorbent. At any given time, two columns will be on-line and configured for in-series flow at a nominal capacity of 1.2 gpm. The third column will be off-line ready for use. A column requiring sorbent recharge will be taken off-line after which the spent sorbent will be sluiced from the column and fresh sorbent added.

Fresh sorbent, received dry in 50-lb bags, will be preconditioned by mixing with water in the sorbent preparation tank. When a column is ready, fresh sorbent will be pumped to it, after which the sluice water will be gravity drained from the column.

Pressure drop through the ion exchange columns is expected to be less than 3 psi, based on theoretical calculations and experience operating similar ion exchange columns at ORNL.⁸

Lead-lag configuration and valve timing of the ion exchange columns will be automatically controlled, based on cesium breakthrough of the lead ion exchange column. When breakthrough of the lead column is detected by continuous in-line monitors located between the lead and lag columns, rotation of the columns will be sequenced so that the lag column will become the lead column and the recharged off-line column will become the lag column.

3.2.4 Evaporation

Evaporation of the CsIX effluent, before neutralization and grouting, was considered in this study, but was not included in the proposed CsIX/TRU process design.

Evaporation may reduce the final grout volume; however, no test data are available for grouting SBW more concentrated than bottoms from the HLLWE. Most SBW grouting tests have been done with simulants less concentrated than HLLWE bottoms (0.77 M H⁺, 2.67 M NO₃⁻). Very recent tests have used a waste composition based on HLLWE bottoms. The results from these tests should be reviewed to determine if modifications are needed to the design basis used for grouting in this study. If future tests show that waste more concentrated than HLLWE bottoms can be adequately grouted, evaporator tests are recommended as outlined in Section 10 of this report.

Added to the test data inadequacy is the lack of a good basis for design of an evaporator to concentrate the waste. As SBW is concentrated, precipitates will form at some point, which may cause deposition on evaporator walls or fouling on the evaporator heat transfer surfaces. The concentrated bottoms, which could thicken or solidify when cooled, may present additional handling problems. Maintenance of the evaporator may be problematic. Thus, to stay within the grouting parameters for which data is available, a pre-grouting evaporator system was not included in the proposed design.

3.2.5 Solidification

SBW and NGLW, having passed through the CsIX columns, will then be grouted to form a solid TRU waste form. To do this, the liquid waste will be partially neutralized in grout feed tanks, mixed with cement ingredients, and then cast in 55-gal drums. The cement-based grout will be allowed to cure, be dewatered, and the drums finally sent to the interim storage facility for inspection and storage.

Neutralization of the liquid waste to a specified setpoint of pH1.3 will be accomplished by the addition of calcium oxide (lime) to a grout feed tank. Accurate pH measurement is difficult for a highly acidic mixture containing various ionic compounds. To more easily obtain accurate measurements, an automated system will titrate a known small volume of the liquid waste to a neutral pH. Results of this titration will be utilized to calculate the quantity of CaO required to neutralize the grout feed tank to the setpoint.

Neutralized liquid waste will be metered to one of three grout mixers. Each ribbon blender type mixer is sized for a single 55-gal batch. Premeasured quantities of the cement, blast furnace slag, and fly ash solid ingredients will be added to the liquid waste in the mixer and thoroughly blended. The mixer will convey the resulting grout mixture into a casting head through which the 55-gal drums are filled.

Immediately at the end of a mix cycle, the next batch of liquid waste will be added to the mixer. This timing is required to prevent residual grout from hardening in the mixer. A wash/decontamination system, connected to the mixers through high-pressure nozzles, is provided for cleaning the mixers when they are turned off at the end of a production run or for maintenance purposes.

Table 6 provides a time estimate for the steps in a mixer cycle.

Table 6. Mixer Cycle Time.

Step	Description	Time (min)
1	Operator Initiation of Mix	10
2	Feed Liquid	10
3	Operator Validation of Wet and Dry Ingredients	5
4	Dry Ingredient Delivery	15
5	Continuous Mix	10
6	Cast Mix	10
7	Operator Validation of Mix	10
Total		70

3.2.6 Drum Handling

3.2.6.1 General

The drum handling system, used for moving drums through the grouting, curing, and dewatering processes, is fully automated with operator oversight and override capability, and provides for minimal human contact with a drum. Although two facility scenarios are proposed for the CsIX/TRU grout process, both scenarios have similar drum handling features.

3.2.6.2 New Drum Lag Storage

The loading dock of the grout facility will temporarily store up to 630, or a two-week supply of, 55-gal drums used in the grout process. Each drum includes a drum body, a removable lid, two filters installed in the lid, and a cinch ring for securing the lid to the drum.

Each drum will have a bar-code label attached and will be scanned before being placed on the inlet conveyor to the air lock leading into the grout fill area. These initial drum preparation steps will be performed on a contact-handled basis. Once in position, the drum will be routed automatically by the conveyor system and can be tracked through the facility to the load-out dock. Although similar, there are variances in the layouts of the routing system for each of the proposed scenarios.

3.2.6.3 Grout Filling

Grout filling requires a drum to pass through two airlocks and three enclosures – an inlet airlock, an outlet airlock, a grout filling enclosure, a drum lid installation enclosure, and a decontamination booth. Each of these has a set of doors for drum entrance and a set for drum exiting. This arrangement provides contamination control as a drum passes through the stages of the grout filling system.

Drum introduction to the grout filling area is by the inlet conveyor that passes through the inlet airlock. Inside the grout fill area, the inlet conveyor becomes a staging line for the drums, which are positioned automatically at one of three grout filling station lines by the conveyor.

For each line, a drum will first enter the grout filling enclosure. A drum fill hood will be lowered and a valve will be used for on- and off-grout flow control at the same time the drum is being vibrated to help settle the grout. After filling is complete, the hood is raised and a time for residual grout dripping is allowed before the drum is moved to the next enclosure.

The next stop for the drum is the lid installation enclosure. Inside the enclosure, the drum is rotated 360 degrees on its axis while a mechanical arm is used to clean the drum lip. The lid is then installed and secured with the cinch ring. Filters installed in the lid are provided as an escape path for evaporated moisture as the grout cures.

Filled drums, from all three lines, are moved to a transferring section of the conveyor system. This section is used to send the drums to one of three decontamination booths. Each booth contains a video camera used to inspect a drum for visible contamination – spilled or dripped grout. A remote arm will make a RadCon swipe of any suspect areas with on-line counting of the swipe provided. For large areas of grout material, water or decontamination fluid spray will be available. Decontamination fluid will be collected at the bottom of the booth, sent to a collection tank, and then transported to the PEWE or LET&D for concentration. It will eventually be routed back for treatment through the CsIX/TRU grout process.

After decontamination is complete, the drums pass to the discharge conveyor, which positions the drums at the grout fill area exit airlock. Movement through this airlock places the drums in the curing cell.

See EDF-CsIX-005 in Appendix E for more information on the equipment and sequencing of the grout fill and drum handling system.

3.2.6.4 Grout Cure Cell

The grout cure cell encloses the cure line conveyor system, acting as the primary containment, and is fabricated from stainless steel for contamination control. Access panels and windows will be provided for maintenance activities and visual inspection of drum movement. Ventilation through the cell will remove the moisture given off by the curing process.

The cure line conveyor system includes two lines, one at floor level and the other directly over the first. The upper line is used as a back-up for the first or if more cure time is required. A drum is positioned at the appropriate cure line by a drum lift after which the conveyor moves the drum onto the line. Drum spacing on the line is set at 6 in.

The cure line conveyor will move a drum along the conveyor path for a period of 24 hours. When the drum reaches the end of the cure line, it will stop and be staged to enter into another drum lift. This lift will receive drums from both cure lines and will lower or pass the drum through to the second floor drum elevator, depending on the cure line. After being raised to the second floor, a drum is conveyed to the dewatering station area.

See EDF-CsIX-006 in Appendix E for more information on equipment and process sequencing for the grout curing line drum handling.

3.2.6.5 Dewatering Station

Nine dewatering stations are provided for the removal of residual water from the headspace of the drum after the grout has cured. These stations will dewater the drums for a 4-hour period with heated air.

Dewatering is performed through the filters in the drum lid, so, to locate the filters, the first stop for a drum is at an indexing/positioning table. The table is raised to an arm that indexes the drum when it is rotated and the arm comes in contact with a filter. The drum is lowered and conveyed to one of the dewatering stations. After being positioned in the station, a hooded manifold is lowered over the filters. The hoods will seal to the drum lid. Air heated to 150°F (65.5C) will be drawn through one of the filters into the drum head space by the off-gas system which is exhausting the drum head space through the other filter. Dewatering will take place over a four-hour period.

After dewatering is complete, the manifold will raise and the dewatering station conveyor will move the drum back onto the staging conveyor line. The staging conveyor will then move the drum to the load-out conveyor, which is used to move the drum to a point where the drum is removed by a manual hydraulic lift and placed on a pallet for shipment to interim storage.

See EDF-CsIX-007 in Appendix E for more information on equipment and process sequencing for the dewatering process drum handling.

3.2.6.6 Drum Transport to Interim Storage Facilities

The grout facility drum lag storage capacity will be 1 day's production or 38 drums. A covered flat bed truck will move these drums from the grout facility lag storage to the interim storage facility making three round trips a day, carrying four pallets of four drums each. This scenario provides a rate that exceeds the estimated grout-filled drum production rate. After receipt at the interim storage facilities, drums will be stacked and ready for future sampling and video inspection of the drum head space.

See EDF-CsIX-007 in Appendix E for more information on lag storage and transporting to interim storage. See EDF-CsIX-002 for more information on interim storage capacity requirements.

3.2.6.7 Drum Head Space Inspection and Sampling

Before shipment to WIPP, a gas sample must be taken from the drum head space to determine VOC and hydrogen levels. Because WIPP limits the amount of free liquid to less than 0.5% by volume, the head space must also be inspected for free liquid. A drum must be temperature conditioned for a 72-hour period before the sampling and inspection.

A drum will be placed in a temperature-controlled area of the interim storage for the 72-hour conditioning period after which it will be staged on a conveyor. The drum is initially conveyed to an indexing/positioning table for location and positioning of the drum lid filters. This process is identical to that used in the drum dewatering system. After indexing, the drum is passed through an airlock to a glovebox, where the inspection and sampling occur.

Once positioned in the glovebox, a clear hood will be lowered over the drum lid to provide additional containment. All subsequent inspection and sampling activities will occur within the hood environment. A filter removal/headspace sampler tool will lower to and engage one of the drum lid filters. The filter will be twisted off and allowed to drop into the headspace of the drum. A headspace gas sample will be taken as soon as the filter is removed. The filter removal/headspace sampler tool will be removed and a fiber optic video camera with lighting will be moved into position over the drum opening. The camera will be lowered through the opening and digitally record a 360 degree rotational view of the drum headspace. After video inspection, the camera will be removed and a new filter installed. The clear hood will raise from the drum and a mechanical arm will take a RadCon swipe of the drum lid surface. Online counting will be provided for swipe examination.

Once cleanliness is verified, the drum will pass through an exit airlock to the unloading conveyor, and be returned to interim storage or transported to the TRUPACT loading facility.

See EDF-CsIX-010 in Appendix E for more information on drum head space sampling and inspection.

3.2.7 Interim Storage

The grout-filled contact-handled TRU waste drums produced from the grout facility will be shipped to WIPP for final disposal. The drum production rate has been determined to be quite high relative to the rate at which WIPP could feasibly receive them (See EDF-CsIX-002, Appendix E). As a result, interim storage for up to approximately 24,000 drums will be required.

Data from EDF-CsIX-002, *Interim Storage for CH TRU Waste Drums*, in Appendix E, is summarized below:

- Total number of drums produced = 38,000.
- Average production rate over 5-year operating period = 633/year, 146/week, or 21/day.
- Maximum actual daily rate considering efficiencies = 38.
- Filled drum weight is 888 lb (403 kg).
- Maximum number of grout-filled drums per TRUPACT-II is 7.
- TRUPACT-II payload for CsIX/TRU drums is 6,864 lb (max allowed is 7,265 lb).
- Shipping rate is assumed to be 5 shipments (3 TRUPACT-IIs per shipment) every 2 weeks (105 drums).
- Interim storage capacity required is for approximately 24,000 (24,350 calculated) drums.
- Last date for drum shipment to WIPP is estimated to be December 2021.

The efficiencies referred to in the 3rd bullet are 75% up-time with a 75% efficiency when up, based on a 24 hour per day operation, 7 days per week (Ref EDF-CsIX-003, Appendix E). The result is that drum production for an actual day must make up for the overall efficiency of 55% if the total drum production is to be completed in 5 years – $21/\text{day}/55\% = 38$.

The peak for interim storage will be the last month of drum production, which is assumed to be December 2012. The 24,000 drum interim storage requirement is more than the capacity (17,000 drum equivalent) of a single Type II RCRA qualified storage module currently used at RWMC for interim storage of TRU waste drums destined for WIPP. The interim storage facility proposed in this study is a single facility sized to the equivalent of two of the RWMC Type II modules. This extra capacity provides the space required for housing the drum head space inspection and sampling structure, equipment, and related activities.

3.2.8 UDS Treatment and Storage

The UDS drum handling and filling systems are similar for both facility scenarios. The systems for scenario 1 are located in the grout facility building, but for scenario 2 are in the NWCF.

When the UDS filter pressure drop reaches a predetermined level, the filter is taken off-line and back flushed with deionized water. The flush is collected in the UDS slurry tank. When the UDS evaporator is operating, the slurry leaves the tank and passes to the evaporator feed pump. From the feed pump, the slurry is fed to the UDS evaporator. The dried solids flow by gravity from the evaporator into a discharge tube. When the tube is full, a UDS drum is lifted into position and filled.

Because the UDS drum filling rate is low, at one drum per month, and space limitations in the NWCF are a concern, the drums will be shielded to a contact-handled level. Due to the shielded drum weight, a crane will handle these special containers before filling. First placed on a staging conveyor, a container will pass through the inlet and outlet doors of the decontamination booth and be positioned in the UDS loading station. The container will be raised to permit a dust-tight loading cone to mate with a dust tight cone on the drum lid, after which the loading cone will be opened to permit drum filling. Once the drum is filled, the drum movement process will be reversed and the drum moved back to the decontamination booth.

The decontamination booth is similar to the one used in the drum grout-filling process. In addition to the RadCon swipe, counting, and decontamination capabilities, the booth will also be used to install a shield over the fill cone on the drum lid. The drum is then moved out of the decontamination booth to the staging conveyor. Drum handling after decontamination is manual. Generation of up to 50 UDS drums is anticipated over the entire process period.

From the staging conveyor, the drum is crane-loaded onto a pallet for movement to the UDS drum storage area. The storage space in scenario 1 will be in the southeast corner on the 1st floor of the grout facility. For scenario 2, storage will be near the new decontamination booth on the 3rd floor of NWCF. When several drums have accumulated in the storage area, they will be moved to the loading area for shipment and disposal at WIPP in a SWB.

See EDF-CsIX-008 in Appendix E for more information on equipment and sequencing of the UDS filling and handling systems.

3.2.9 Spent Sorbent Treatment and Storage

When break-through is observed in the lead CsIX column, the column is taken off line and the sorbent removed. To do this, deionized water is added to the column at the ratio of 10 water volumes per sorbent volume. The sorbent/water mixture exits the column and enters the spent sorbent prep tank, where free liquid is decanted from the sorbent. The sluice water is pumped through the sorbent fines filter and is saved for reuse.

After the dewatering, the sorbent will be fed to a hollow flight drier for drying, using heat and hot air. The hollow flight drier is nominally sized to process moist sorbent at a rate of 2.1 l/hr.

Dried sorbent will flow by gravity to a spent sorbent storage tank, sized at 15 m³ to hold all of the sorbent generated during the life cycle of the facility. The estimated total spent sorbent quantity is estimated to be 10.5 m³. The spent sorbent storage tank, when filled, will have a contact radiation reading of approximately 5,000 R/hr. The spent sorbent storage tank is piped into the existing NWCF for the second facility scenario, or the all-in-one facility's pneumatic transport system for the first scenario, to provide a mechanism for future removal of the sorbent from the facility under another project. The silica gel particle size is less than 60 mm, and therefore, cannot be classified as debris and must be disposed of as mixed hazardous waste. Options for treatment, storage, and disposal of spent sorbent are discussed in more detail in EDF-CsIX-004 in Appendix E.

Test data is needed to better determine the quantity of water required for sluicing the spent sorbent, the behavior of the sorbent during sluicing (amount of fines generated), requirements for filtering the sorbent, behavior of the sorbent during drying, and properties of the dried sorbent.

3.2.10 Shipment to WIPP

The Carlsbad Area Office (CAO) at WIPP will provide a fleet of NRC-approved transportation packages for shipment of TRU waste from the INEEL to the WIPP. The CAO will grant or suspend the INEEL's authority to certify TRU waste and to use the TRUPACT-II cask based on an assessment of the INEEL TRU Waste program and its implementation. WIPP will be responsible for shipping the loaded packages from the INEEL to WIPP.

Table 7 lists capacity and weight limits for various types of containers that can be shipped in the WIPP TRUPACT-II cask. EDF-CsIX-002 in Appendix E discusses the packaging issue further.

Table 7. TRUPACT-II cask capacity for various types of containers

Qty.	Container Type	Weight Limits
14	55-gal drums	@ <1,000 lb each
2	Standard waste boxes (SWB)	@ <4,000 lb each
2	SWB, containing one bin each	
2	SWB, containing four 55-gal drums, each	
1	Ten-drum over pack (TDOP), containing ten 55-gal drums	@ <6,450 lb
1	TDOP, containing one SWB	
1	TDOP, containing one bin within a SWB	
1	TDOP, containing four 55-gal drums within a SWB	
	TRUPACT-II	@ <19,250 lb
	RH-Canister	@ <8,000 lb

4. FACILITY DESCRIPTIONS

4.1 Facility Concepts – Overview

This study evaluates two scenarios for the CsIX/TRU Grout Facilities:

- Scenario 1: This scenario requires construction of a single facility for housing the CxIX/TRU grout processes. Interim storage for the grout-filled waste drums and a facility for waste drum loading/shipping preparation are also required. The new process building will be similar to the NWCF in building type and construction materials. The interim storage and waste drum loading/shipping facilities will be similar to the RWMC Type II Storage Modules and TRUPACK-II Loading Station.
- Scenario 2: This scenario requires the use of the NWCF for the filtration and cesium removal portions of the process. This would require demolition and modification of portions of the NWCF. A new facility will be required for the grouting portion of the process. Interim storage and waste drum loading/shipping preparation facilities are identical to those in Scenario 1. Building types will be similar to those in Scenario 1.

4.2 Civil

4.2.1 Siting

Siting for the new processing facilities was evaluated against the following criteria:

- Proximity to the tank farm
- Utilities availability
- Economy of construction
- Land availability (future planned use)
- Vehicle accessibility.

Limitations of the tank farm liquid transfer system make proximity to the tank farm a primary consideration. Four sites were selected for consideration - two directly east of NWCF across Hemlock Street, one east and beyond the perimeter fence, and one directly north of the tank farm. The importance of proximity to the tank farm reduced the selection possibilities to the site north of the tank farm. This preferred site is an environmentally controlled area. (See drawings in Appendix D.)

4.2.2 Surface Drainage, Erosion and Sediment Control

The area disturbed by this project will be within the INTEC boundaries. Most of the area is void of natural vegetation. The design will minimize the amount of soil that erodes from the site. Areas disturbed by construction activities will be stabilized with gravel.

The existing INTEC surface drainage system will be utilized with some slight modifications to drain surface water from the proposed project site.

4.2.3 Soil Excavation and Shoring

Initial earthwork will consist of minimal vegetation clearing and grubbing and grading. Excavation is required for utilities, paving, footings, and foundations with no rock excavation anticipated. Sampling of the existing soil may be necessary before final design begins.

Shoring may be required if the actual selected site is close to the existing tank farm.

4.2.4 Paving, Parking, and Roadways

Paving will be provided in the truck access areas, a small parking area, and necessary access roadways. All roadways will be designed for the AASHTO HS-20 truck load with all access roads being at least 12 ft wide.

4.2.5 Slabs, Sidewalks, and Stoops

Reinforced concrete stoops will be located at, and sloped away from, each exterior doorway.

Reinforced concrete slabs or pads will be provided for exterior utility equipment, exterior material storage bins and tanks, and exterior electrical equipment.

4.2.6 Fencing

Chain-link fencing will be provided around the Interim Storage and TRUPACT-II Loading Station Facilities if they will be located outside the existing INTEC perimeter fence.

4.2.7 Underground Utilities

Existing underground utility lines are shown on drawings 1-C1 and 2-C2. New underground utilities include:

- Potable water
- Fire water
- Sanitary sewer
- Steam
- Plant air.

4.3 Structural

4.3.1 Structural Design

The CsIX/TRU Grout Facilities will be designed to resist all applicable loads as required by the DOE-ID Architectural Engineering (AE) Standards. Structural design for natural phenomena shall conform to the AE Standards and DOE STD 1020. The latter give requirements for three different performance categories of buildings. The assumed Performance Category (PC) for each building in the CsIX/TRU Grout Project is as follows:

Interim Storage Building	PC-2
TRU Pack Loading Station Building	PC-2

Scenario 1

New CsIX/TRU Grout Building	PC-3
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Scenario 2

NWCF Modifications	PC-3
New Stand Alone Grout Building	PC-2

Unless otherwise noted, structures, systems, or components important to safety or for protection of the environment will be designed in accordance with the requirements imposed by DOE STD 1020 for the performance category of the building where the structures, systems, or components are located. Office areas and systems or components that are not important to safety may be designed to PC-1 design requirements.

4.3.2 Structural Features

Process areas will be in cells with reinforced concrete superstructures. Cell walls will be fabricated from normal weight reinforced concrete. Thickness will vary as required by radiological shielding requirements. The minimum thickness for any load-bearing wall will be 12 in. See drawings 1-A1 through 1-A4 in Appendix D for assumed thickness of radiological shielding walls.

Reinforced concrete floors will be provided for all elevated floors unless otherwise noted.

4.3.2.1 Footings and Foundations

Reinforced concrete mats will be used as footings for the cell areas of all applicable buildings. Large equipment or tank footings will also be provided with mat footings. Depth will be as indicated on the drawings. Concrete load bearing and shear, not associated with cells, will have shallow reinforced concrete spread footings. Buildings with structural steel framing, as the main load-resisting members, will have reinforced concrete pier footings and a perimeter foundation wall.

4.3.2.2 Hatches and Hatch Covers

The tops of all cells will have stepped concrete plug-type hatch covers that can be removed by the 3rd floor overhead bridge crane.

4.3.2.3 Building Framing Systems

The cell areas will have reinforced concrete floors, walls, and ceilings for radiological shielding purposes. These components will also provide the main building framing in the cell areas. The walls will be designed to support all vertical loads, and resist horizontal loads as shear walls.

Building superstructures, containing support areas such as the office area and the main building HVAC equipment, will be an ordinary braced frame consisting of structural steel.

The drum storage buildings and the TRUPACT Loading Station Building will also be ordinary braced frames consisting of structural steel.

4.4 Facility Description – Scenario 1

4.4.1 General Description

For Scenario 1, the CsIX/TRU grout process, which includes the UDS filter system, the ion exchange system, and the grout system will be housed in a single new facility. This facility will be a multistory building with an approximate footprint of 14,000 square ft. Drawings 1-A1 through 1-A4 in Appendix D illustrate the proposed floor plans for each level. Building sections are illustrated on drawing 1-A5.

Process equipment will be housed in reinforced concrete cells and corridors. Appendix F contains the CsIX/TRU Grout Project equipment list .

The periphery of the CsIX/TRU Grout Facility contains office space, change rooms, support areas, and truck delivery and loading areas. Most of these areas are at one end of the building. Stairways, corridors, and a freight elevator are provided for movement within the building.

A stack will be provided for exhausting ventilation air.

Two additional buildings are required for this scenario. The interim storage facility will provide space for drum storage and inspection, and the TRUPACT-II Loading station will provide the space and equipment needed for packaging the waste drums for shipment to WIPP.

4.4.2 Cell Lining

Process cells, the Piping and Valve (P&V) corridor, and decontamination areas will be lined with 1/4-in.-thick stainless steel plates on the floors and 1/8-in.-thick stainless steel plates on the walls. Except for the UDS Dryer Cell and the Waste Sorbent Preparation Cell, which will be fully lined with stainless steel, only the lower 4 ft of cell walls will be lined unless otherwise noted.

4.5 Facility Description – Scenario 2

4.5.1 General Description

For scenario 2, the CsIX/TRU grout processes for UDS filtration and the cesium ion exchange system will be housed in the existing NWCF facility. This scenario is explored in detail in EDF-CsIX-009 in Appendix E.

The processes related to grouting will be housed in a new facility. This new facility will be a multistory building with a limited number of cell areas. Radiological shielding will generally be limited to 12-in.-thick reinforced concrete. Grouting equipment that will process radioactive materials will be housed in reinforced concrete cells and corridors. See Drawings 2-A1 through 2-A4 in Appendix D, and Appendix F for the equipment list.

The periphery of the new building contains office space, change rooms, support areas, and truck delivery and loading areas. Most of these areas are at one end of the building.

Stairways, corridors, and a freight elevator are provided for movement within the building.

A stack will be provided for exhausting ventilation air.

Two additional buildings, for interim storage and TRUPACT-II loading and identical to those in Scenario 1, are also required for this scenario.

4.5.2 Cell Lining

Cell lining in the existing NWCF cells will not be changed. The P&V corridor and decontamination areas within the new grouting building will be lined with 1/4-in.-thick stainless steel plates on the floors and 1/8-in.-thick stainless steel plates on the walls. Only the lower 4 ft of cell walls will be lined unless otherwise noted.

4.5.3 Installation in the NWCF

Installation of CsIX equipment in the NWCF will take advantage of the existing NWCF infrastructure, which includes building utilities, HVAC, and off-gas systems. However, modifications are required to the NWCF to accommodate the CsIX equipment.

NWCF hot cell space was identified in the adsorber cell, calciner cell, valve cubicle, and hot sump tank removal cell sufficient to accommodate requirements of the CsIX/TRU grout process equipment installation. NWCF equipment will be used as much as possible to reduce the number of new items installed in the building (see Appendix F for the equipment list).

4.6 Interim Storage and TRUPACT Loading Facilities

The interim storage facility for this study is based on the capacity of the RWMC Type II Storage Modules. The proposed single building, as depicted in Drawings 1-C1, 2-C1, COM-A1, COM-A2, and COM-M1 (Appendix D), is twice the square footage of a Type II module. This will provide adequate interim storage space with room enough for the Drum Head Space Sampling and Inspection facility to be housed inside the structure. Not directly tied to the production of waste drums, but rather WIPP

acceptance criteria, the facility for drum headspace sampling and inspection activities is located where the supply of drums to be surveyed are stored.

The RCRA-qualified interim storage facility is an environmentally unconditioned steel structure with a concrete floor measuring 240 x 240 x 24 ft tall at eave elevation. Included in this facility is the Drum Head Space Sampling and Inspection building, which is an environmentally conditioned structure measuring 60 x 60 ft with an approximate ceiling height of 12 ft.

An additional facility, with two TRUPACT-II stations for the loading of drums for shipment to WIPP, is located next to the interim storage facility. This loading facility is based on the RWMC TRUPACT II loading station. The TRUPACT-II shipping container (Ref. EDF-CsIX-002) is specifically designed to accommodate 55-gal drums. Two TRUPACT-II loading stations are included in this facility because of the anticipated shipping rate. The TRUPACT-II loading station facility is an environmentally conditioned steel structure with a concrete floor measuring 80 x 100 x 24 ft tall at eave elevation.

The interim storage and TRUPACT-II loading facilities are provided with overhead doors that allow the transport vehicles inside the facilities for loading and unloading activities. The Drum Head Space Sampling and Inspection building houses the drum conveyors, indexing table, glovebox, and airlocks required for the related sampling and inspection activities. Adequate space in the interim storage facility will be available for the movement of drums from their storage locations to and from the Sampling and Inspection building.

See EDF-CsIX-002 for a discussion of requirements for interim storage space, and EDF-CsIX-010 for information on drum head space sampling and inspection. Both are located in Appendix E.

4.7 Offgas Treatment

Offgas treatment is very similar for both scenarios. The offgas system will be connected to condensing vessels and the dewatering stations. The system will contain a condenser, demister, superheater, and double High-Efficiency Particulate Air (HEPA) filter housing just upstream of the fan. The removed moisture will be sent to the collection tank for reprocessing into grout. Exhaust offgas will be sent to the stack. Two independent systems will be installed. This will allow change-out of the double HEPA filters and failure of a system without facility shutdown. One of the two systems will be connected to the standby power source. See EDF-CsIX-013 in Appendix E for more information on the offgas system.

4.8 Heating, Ventilation, and Air Conditioning (HVAC)

In addition to the offgas system, the CsIX/TRU Grout building will be required to have two ventilation confinement zones per DOE Order 6430.1A. This section describes the two confinement zones, and the nonconfinement area. A ventilation confinement system will be provided, which, in conjunction with the physical barriers, maintains a continuous airflow pattern from areas of low potential contamination to areas of high potential contamination. The objectives of the confinement systems are to prevent the spread of radioactive and other hazardous materials to occupied areas and to minimize the release of radioactive and other hazardous materials in facility effluents.

- The primary confinement consists of the process hot cells and hot maintenance areas, which will be exhausted through two stages of HEPA filters. The primary confinement boundary will comprise hot cell walls, welded stainless steel ductwork, and HVAC equipment designed to maintain its structural integrity during and after operational and natural-phenomena design basis accidents.

- The secondary confinement boundary consists of the operating corridors and other building structures that surround the primary confinement. The secondary confinement boundary contains all ventilation system equipment such as HEPA filter units and exhaust fans.
- The nonconfinement boundary consists of offices, control rooms and support areas outside the secondary confinement boundary. The nonconfinement zones do not require unique ventilation systems and will be maintained at a slight positive pressure with respect to ambient.

HEPA filters will remove contaminated particulates, but no carbon absorber beds will be provided in the primary filter trains, because semivolatile fission products and iodine will be removed by the off-gas system.

EDF-CsIX-011 and EDF-CsIX-012 contain HVAC requirements as well as drawings depicting air flow diagrams of the HVAC systems for the CsIX/TRU Grout Facilities.

The facility will be provided with an independent chilled water system consisting of central chillers and pumps, delivering chilled water to various cooling coils. This system removes heat generated by process equipment because cooling will not be required for personnel comfort in the operating corridor. The facility will obtain steam for comfort heating from an INTEC central steam supply facility. The HVAC system will be controlled by a central electronic system located within the facility.

Redundancy will ensure proper ventilation confinement during HEPA filter changeout or fan maintenance. Exhaust ductwork will be located in areas that will not be normally occupied. HEPA filter housings will have the capability to be leak tested and tested for filter efficiency in place. Single stage HEPA filtration will be provided at the hot cell intakes to prevent possible contamination from momentary back flow to the occupied areas. Confinement boundaries will be sealed to maintain isolation when pressure differentials fall below normal conditions.

Confinement zones will be supplied by once-through ventilation. All the airflow from these zones will be HEPA filtered and discharged to the exhaust stack, with no air recirculation. The supply and exhaust fans for the hot cells can be powered from the INEEL site standby power grid (see Reference 9). This allows the ventilation confinement to be maintained in the hot cells during a loss of off-site power condition.

This facility will be designed with the following ventilation parameters:

- Eight air changes per hour for primary confinement
- Four air changes per hour for secondary confinement
- 20 cfm per person for administrative areas
- One stage of testable HEPA filters for hot cell inlet
- Two stages of testable HEPA filters for hot cell exhaust
- One stage of testable HEPA filters for secondary confinement exhaust
- Once-through ventilation for primary and secondary confinement zones
- Zone pressures maintained per EDF-CsIX-011.

4.9 Remote Operations

4.9.1 General

The CsIX/TRU grout facility design will allow remote replacement of moderately to highly contaminated process equipment that past experience has shown to be prone to failure. Equipment such as tanks, vessels, and columns, which have anticipated maintenance intervals of greater than 10 years, will be designed for hands-on maintenance.

The terms "remote maintenance" and "remote replacement" are generally used interchangeably. Radioactively contaminated items requiring maintenance at the CsIX/TRU Grout facilities will be remotely removed from service and decontaminated, after which hands-on maintenance will be performed.

Features of the CsIX/TRU Grout facilities, which will expedite the remote handling capabilities, include:

- Remote Handling and Replacement Cubicle or Piping and Valve (P&V) Corridor - A radiologically shielded and enclosed area designed and equipped to provide remote handling and replacement for those items that must be isolated from the main process cells due to their high maintenance frequency and radiation hazard. Features required for direct maintenance will also be provided.
- Manipulator/Crane Parking and Maintenance Areas – Radiologically shielded areas designed for maintenance of major in-cell remote handling equipment. These areas will have the capability of being isolated and radiologically shielded from the P&V corridor 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, which can be controlled from a number of locations in the operating corridor.
- Remotely Operated Cranes – Conventional lifting and transport of heavy items inside the radiologically shielded areas of the facility controlled by remote means.
- Master-Slave Manipulators – Mechanical arms directly operated by personnel located at viewing stations when highly dexterous remote manipulation is required.
- Radiologically Shielded Viewing Windows – Stations that permit direct viewing of operational areas inside the radiologically shielded cells.
- Remotely Replaceable Lighting – Removable lighting units that provide adequate lighting in the radiologically shielded areas. Lighting units are replaced using remote handling equipment.
- Filtered Exhaust Ventilation - A remotely changeable system designed to achieve maximum radiological 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.

- Smear Cell - A radiologically shielded area for limited decontamination, packaging, and transfer of failed equipment to other decontamination or waste disposal facilities/area. This area will be designed so that it can be intermittently isolated from the remote corridor to allow hands-on repair/smear of slightly radioactively contaminated equipment. This cell will be adjacent to or part of the decontamination cell.
- Decontamination Cell - A radiologically shielded area for decontamination, packaging, and transfer of failed equipment to other waste disposal facilities/areas.
- Hands-On-Maintenance (Repair) Area – A minimally radiologically shielded area for repair of decontaminated equipment.

4.9.2 Equipment Used in Remote Operations

High-maintenance equipment items include such items as valves, pumps, cell and vessel off-gas HEPA filters, and heat exchangers. These items will be grouped into common radiologically shielded areas and the areas provided with remote equipment, such as, master-slave manipulators, wall-mounted manipulators, bridge-mounted manipulators, bridge cranes, and jib cranes, and viewing windows. The remote areas must also be adequately illuminated with remotely replaceable lights, remote maintenance service stations,¹ tool-drop ports, and work tables. Closed circuit video capability will also be provided if supplemental viewing is required. All in-cell remote handling equipment will be provided with redundant features and retrieval systems to minimize the effect of failures.

Equipment that is not prone to failure, such as tanks, vessels, columns, and airlifts, will also be located in radiologically shielded process cells, but the cells will not be equipped to permit remote replacement of these items. Rather, maintenance of these items will be hands-on after proper decontamination. 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 radiological exposure, remote features such as quick-disconnects, remote flanges, captive bolts, and lifting bales may be incorporated into their design. The purpose of these features is twofold: (1) to permit potential hands-on maintenance activities to proceed more rapidly, and (2) to permit remote or partially remote operations, using overhead cranes and manipulators, to take place if the radiation fields are expected to be excessively high.

“Skyrights” will be provided to ensure 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 before incorporation. Remote tooling and equipment provisions must be maintained as practical, straightforward, and simple as possible. Standardization of sizes, shapes, and arrangement will also be maximized.

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

A remote handling and replacement corridor, such as the P&V corridor, will be provided near those processing areas where radiation exposure and radiological hazards justify the additional facility cost. Failure-prone equipment will be located within this corridor. Basic equipment and process design will minimize the total amount of maintenance required. When maintenance or vessel inspection is required, the facility design will provide features that reduces radiation exposure to personnel. The operational features will include both remote and direct maintenance and will include less emphasis on remote capabilities as the process produces products with lower radiation fields and contamination levels.

Radiologically shielded viewing windows will provide unrestricted viewing of remote operations with additional viewing angles possible from adjacent windows. Remote operating and maintenance tasks will be located within the normal viewing angle of the windows. Remotely removable hot-side shields will be provided for the viewing windows where necessary.

4.9.3 Mockups

Mockups will be required for Scenario 2, for the rip-out and construction efforts of the NWCF. Costs for this mockup effort and associated training are included in this study's cost estimate.

All remote equipment, and major remote operations, will be mocked up in full scale (at the Remote Mockup and Test Facility located at the Test Reactor Area at the INEEL) and tested before 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.

4.9.4 Maintenance Requirements

The facility will be designed to allow 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, if installed, will be scheduled for periodic inspection and replacement.

The maintenance philosophy for radioactive process equipment will be to replace high maintenance items such as pumps and valves. These components will be isolated from the system, if required, uncoupled from the system, and removed to a 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. Remote maintenance service stations will be located in selected remote maintenance cells and will be equipped with remote connectors for electrical, video, air and water utilities.

Electrical systems will be designed to allow corrective and preventive maintenance on primary or emergency power systems without compromising safety or adequate environmental protection.

4.9.5 Remote Equipment Change/Cut-up/Disposal

Equipment in the P&V corridor that requires routine change-out will be capable of being remotely connected and disconnected, handled, and moved. The basic philosophy for a typical jumper change out would involve the use of an in-cell electro-mechanical manipulator and in-cell crane to remove the defective jumper to the decon cell area from the P&V corridor. These areas must be next to each other to afford adequate crane coverage to perform initial decon activities. The crane maintenance and decon areas will have lower radiologically contaminated/radiation conditions, and provide the space for working on equipment that has come from the P&V corridor, an area of higher radiologically contaminated/radiation conditions. Coverage by the P&V corridor crane will overlap coverage by the bridge crane coverage over the crane maintenance, pre-decon, and decon areas. This coverage overlap allows remote transfer of equipment from the P&V corridor up to the hands-on maintenance room area.

4.10 Utilities

The preferred site for the CsIX/TRU Grout facility is immediately north of the tank farm, and is near fire water, potable water, and sanitary sewer services. Steam, provided from the INTEC coal-fired plant, is available at the utility corridor near building CPP-606. Plant air will be provided from the new facility's own compressor.

Based on information taken from Reference 9, there is adequate capacity in the following systems to support CsIX/TRU Grout operations.

Raw Water – Raw water is pumped from two 3,000 gpm production wells. Current raw water usage at INTEC is 25% of production capability.

Treated Water – CPP-606 has the capability of producing 129 million gal/month, but present demand is 35-40 million gal/month.

Demineralized Water – CPP-606 produces demineralized water. INTEC uses approximately 50,000 gal/month. With the addition of a planned reverse osmosis system in 1998, capacity will be increased to 200 gpm.

Potable Water – Present usage of potable water is 1.5 million gal/month. This is 20% of the available production capacity.

4.11 Electrical

4.11.1 Available Electrical Utilities

The INTEC ties into the 138kV INEEL loop at Substation 2, which is located outside the area fence to the south. Substation 2 transforms the 138kV to 13.8kV and provides power to Substations 10 and 15, located within the INTEC complex. Power at 13.8kV is then distributed from these substations through the complex. The Electrical and Utility System Upgrade (EUSU) project, currently in the construction phase, will install a new 13.8kV electrical distribution system throughout the INTEC complex. This new system will provide greater safety, additional capacity, and greater reliability.

Standby power at INTEC is currently provided by each facility. Standby generators are located at the various facilities and operate as islands of power during a normal power outage. The EUSU project will construct a standby power plant, install new standby generators, and tie existing generators into the standby power system. After completion of the EUSU project, standby power will be distributed through the INTEC complex by the new 13.8kV distribution system and controlled through the Utility Control System (UCS), which also controls the normal power distribution system.

See EDF-CsIX-014 in Appendix E for details on the existing and required electrical utilities for the CsIX/TRU Grout project.

4.11.2 Normal Power

Normal power will be supplied to the CsIX/TRU facilities by 480kV feeders from Loadcenter 14. A combination of new and existing duct banks will route the feeders.

The major electrical loads for the CsIX/TRU Grout project are from various lighting, heating, and motor loads. The motor loads are from both process and ventilation motors. See EDF-CsIX-014 for details.

Electrical power requirements for scenario 1, the all-new facility, are estimated to be 698 kVA connected and 471 kVA demand.

Electrical power requirements for scenario 2, the use of NWCF plus a new grout facility, are estimated to be 569 kVA connected and 381kVA demand for all but the NWCF loads. There is probably a net decrease in the load to NWCF, although this has not been quantified. Other, unrelated activities will be occurring in the NWCF at the same time as the CsIX/TRU Grout Project. For cost estimating purposes, the CsIX/TRU Grout project's portion of the NWCF electrical consumption is estimated to be about one-half of the current NWCF electrical usage. This assumption is the basis for estimating the CsIX/TRU Grout Project electrical costs within NWCF, plus the project's costs for such common building systems as HVAC, off-gas, and maintenance.

4.11.3 Standby Power

Standby power to the CsIX/TRU facilities will be provided over the normal power distribution system from Substation 60. Shedding of the normal power loads will be performed by the UCS.

Standby power requirements for scenarios 1 and 2 are estimated to be 88 kVA and 53 kVA standby power, respectively. Standby loads consist of the following:

- UPS Normal and Bypass feeders
- Selected lighting and miscellaneous loads
- Exhaust and supply fans
- Other process loads

See EDF-CsIX-014 in Appendix E for details.

4.11.4 Uninterruptable Power Supply (UPS)

A solid-state uninterruptable power supply (UPS), with a static transfer switch, will provide a 15-minute battery backup and a feed to a 208Y/120 Volt panel. The UPS and the panel will be located in the electrical room and support the following loads:

- Voice paging/evacuation systems
- Environmental monitoring system
- Control system
- Other critical loads.

5. METHOD OF PERFORMANCE

5.1 Design, Procurement, and Construction

Conceptual Design will most likely be accomplished by LMITCO Engineering personnel, whereas 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 Section 7. Fabrication and installation of equipment 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.

5.2 Work Breakdown Structure

Figure 2 shows the preliminary Work Breakdown Structure for the CsIX/TRU Grout Project.

Figure 2. Work Breakdown Structure for the CsIX/TRU Grout Project.

5.3 Facility Decommissioning

A Decontamination and Decommissioning (D&D) Plan will be written and in place before start of operations. The estimated cost to perform the D&D work is summarized in Section 6. Detailed and life-cycle cost estimates are contained in Appendix C.

If scenario 2 is selected, the existing NWCF D&D Plan will be revised to reflect the modifications and additions generated by this project.

6. ESTIMATED COST

The capital cost, also called total project cost (TPC), was estimated for this project. A TPC estimate was prepared for each of the two CsIX/TRU Grout Project scenarios. These estimates are divided into total estimated costs (TECs) and other project costs (OPCs). TECs include 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 Departmental Price Change Index Fiscal Year 2000 Guidance – Anticipated Economic Escalation Rates, DOE Construction Projects and Operating Expenses," January 1998 update. The detailed cost breakdowns are included in Appendix C and are summarized in Table 8.

A life-cycle cost (LCC) analysis was performed for each of the two scenarios. The LCC analyses estimated costs for preoperation, operation, and postoperation activities. LCC postoperation activities comprise decommissioning, decontamination, and demolition (DD&D). The LCC analyses assume a 38-year period (2000-2037) since this is the estimated time required to complete all anticipated CsIX/TRU Grout Project and remediation activities. A discounted LCC analysis assumes a constant-dollar basis, discounted at 6.10% per the Office of Management and Budget (OMB Circular A-94).

The LCC analysis for scenario 2 does not include DD&D efforts for NWCF since it will be performed under another project (the NWCF closure project). For the preoperations portion of the cost analyses, the TPC estimates were used. Details on the LCC analyses are included in Appendix C and summarized in Table 8.

Table 8. Cost Estimates for the CsIX/TRU Grout Project.

Cost Estimate	Scenario 1	Scenario 2
Pre-Operations		
Total Estimated Cost (TEC)	\$ 102,000,000	\$ 130,300,000
Other Project Cost (OPC)	\$ 32,200,000	\$ 39,800,000
Total Project Cost (TPC=TEC+OPC)	\$ 134,200,000	\$ 170,100,000
Discounted TPC	\$ 92,400,000	\$ 117,000,000
Operations (with escalation & contingency)	\$ 367,400,000	\$ 411,800,000
Discounted Operations	\$ 181,600,000	\$ 203,900,000
Post Operations (DD&D)	\$ 48,122,000	\$ 59,300,000
Discounted Post Operations	\$ 5,000,000	\$ 6,200,000
Total Cost (unescalated, not discounted)	\$ 301,100,000	\$ 348,300,000
Total Cost (escalated, not discounted)	\$ 549,700,000	\$ 641,200,000
Discounted Total Cost	\$ 279,000,000	\$ 327,000,000

7. PROJECT SCHEDULE

Project schedules were created for each of the scenarios and are given in Figures 3 and 4. For Scenario 1, the schedule shows the design and construction phases being completed in time to support the closure of a sixth INTEC tank farm underground waste storage tank starting in October 2008. The operations phase is scheduled to begin by January 2008 to permit the processing of all liquid wastes by the end of 2012. There is no contingency in the schedule before 2008; the funding, design, permitting, procurement, construction, system operability (SO) testing, and operations activities are all assumed to proceed relatively smoothly. If more time is needed for the funding cycle, design, or construction phases and the process ending date of December 2012 is to be met, then the operating window must be shortened accordingly by increasing the plant throughput capacity.

Note that it is not feasible for Scenario 2 to support the 2008 tank closure date nor the 2012 date with a 5-year operating window. This is primarily because the high radiation exposure that personnel would experience during rip-out and construction in the NWCF must be spread out over a longer time period and therefore will require a longer construction period.

This no-contingency schedule requires timely performance of many activities, including the following:

- The Line Item Project Funding Cycle must be started immediately to begin Conceptual Design by no later than early FY-2001.
- The RCRA permitting process for the SBW CsIX/TRU grout treatment system must be started in FY-2001 to support a construction start in FY-2005 at the latest. Obtaining this permit will take 3 to 4 years.
- The NEPA process for SBW must be started independently of the HLW & Facility Disposition (FD) Environmental Impact Statement (EIS) if either
 1. The SBW is not considered HLW and therefore not covered under this document, or
 2. The HLW & FD EIS record of decision (ROD) is delayed for various reasons and cannot support the schedule required for the SBW CsIX/TRU Grout Project.

CsIX/TRU GROUT FACILITY SCENERIO #1 - PROJECT SCHEDULE

Figure 3. Scenario 1 Project Schedule.

CSX/TRU GROUT FACILITY SCENARIO #2 - PROJECT SCHEDULE

Figure 4. Scenario 2 Project Schedule.

8. REQUIREMENTS AND ASSESSMENTS

8.1 Radiological

8.1.1 General

TRU radionuclides in the waste pose radiological hazards. While the external radiation exposure associated with TRU radionuclides is minimal, these materials do present a significant internal radiation exposure. Therefore, the engineered controls for this facility must include standard features for reducing and confining the loose contamination and shielding from radiation exposure.

The majority of the process systems are enclosed in a double confinement structure. 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 air flow is from less contaminated areas to more contaminated areas. The primary containment is maintained at a negative pressure in relationship to the secondary containment and the secondary containment is maintained at a negative pressure in relationship to the environment. The ventilation system of the building is HEPA filtered.

The radiological contamination will be contained in the process system and the secondary confinement structures. This will be accomplished by use of radiological control work practices. These radiological work practices include the use of transfer sleeves for removal of radioactively contaminated material, maintaining the radiological contamination in the secondary confinement within established limits, and the use of airlocks for the removal of equipment and personnel from the secondary confinement.

See EDF-CsIX-015 and EDF-CsIX-016 in Appendix E for calculated radiation fields and shielding requirements for the CsIX/TRU grout waste form and facilities.

8.1.2 NWCF Radiation Exposure

The use of the NWCF in Scenario 2 provides the opportunity to use an existing facility and a significant portion of its equipment. However, rip-out of existing equipment and installation of new equipment for the CsIX/TRU process will require an estimated 40,000 hours of radiologically "hot" in-cell work, resulting in about 1,500 man-rem of exposure. This estimate assumes the calciner will be shut down permanently, so that the decontamination effort prior to any work would be very aggressive and effective. Decontamination methods would include a "sweep-out" with a final cold campaign, aggressive decontamination with strong acids or combinations that wouldn't normally be used due to potential corrosion damage to the vessels, and installation of local shielding. See EDF-CsIX-009 in Appendix E for discussion. To limit the yearly personnel dose rate, this exposure level will require work to proceed over 6 years, resulting in at least a 1-year delay to the schedule so that the 2012 date is not met. Due to this, it is evident that it is not feasible for Scenario 2 to meet the 2012 schedule.

8.2 Environmental

EDF-WTS-003, *Regulatory Requirements for the Design, Construction and Operation of the ICPP Proposed Waste Processing Processes*, located in Appendix E, provides an excellent description of the regulations and permitting activities that are required for this study; they are not repeated in this section.

A ruling is required by DOE and/or NRC that SBW/NGLW is not high-level waste (HLW). If the SBW is considered to be HLW, then a ruling should be sought that after removal of the cesium with the ion exchange system the cesium-free bulk liquid will no longer be HLW, but instead low-level transuranic waste that can be disposed of at WIPP.

Another requirement will be successful negotiation with DOE and/or the State of Idaho of a reduction of the number of RCRA-listed codes contained in the INTEC liquid waste from 105 to 4, as argued in Reference 10. (This must also include negotiation that only these four codes are contained in the existing INTEC liquid waste management equipment system that will continue to be used for SBW/NGLW processing. The liquid waste management equipment system was assumed to be contaminated with all 105 codes due to applying the RCRA Part A HWNs to the PEW-TFF waste and application of RCRA "derived-from" and "mixture" rule concepts. This is important if, for any reason, previously processed wastes such as HLW calcine may perhaps not be recognized as having only these same four codes.) Reference 10 is a hazardous waste determination to assign the appropriate HWNs to the INTEC wastes by proving that they were not discharged to the PEW-TFF system as listed wastes versus "delisting" the wastes as provided for in RCRA law. Failure at this effort would most likely require treatment or separations processes to be added for the RCRA constituents in the waste, as well as development of a leach resistant "performance" waste form. This would require major changes to the process concept, adding to its complexity and cost.

It is also required that the regulatory process be addressed relative to listed HWNs not addressed by the WIPP performance assessment and not listed on the Part A portion of the WIPP RCRA Permit. At a minimum, a petition will be required to exclude the U134 (uncomplexed hydrofluoric acid, HF) HWN or modify the WIPP Permit's Part A to allow the receipt of waste with this U134 HWN. It appears that the TRU grout waste form would meet all of the technical requirements identified in the WIPP WAC. The Cs-bearing sorbent and filtered UDS waste streams generated from the CsIX process will have to be treated to the appropriate LDR standards and be excluded from further hazardous waste management with a Petition to Exclude a Waste. Technically, the issue is not with achieving these LDR standards, since the concentration of listed constituents are minimal to start with and should not present an obstacle to delisting.

Negotiations with WIPP would also be desirable, as they have suggested, on issues such as bulk sampling of the waste feed to the CsIX/TRU grout plant to characterize the RCRA constituents, and characterization and inspection requirements for the final waste product (i.e., no-free-liquid determination, VOC analyses) with the goal of further reducing both capital and operational costs. WIPP personnel have suggested that these negotiations to reduce requirements are possible not only because of the homogenous nature of our feed (relative to "legacy wastes" which the WIPP WAC is primarily designed to protect against) but because of the control over the final waste form that would be achievable with proper system design.¹¹

The only treatment WIPP requires for the hazardous constituents expected to be in the grouted TRU waste is to treat the corrosive characteristic of the waste by deactivation and to eliminate the free liquids. The free liquids will be hydrated in the matrix of the cement and will produce a dry solid waste form.

Disposal of the cesium-loaded sorbent and filtered solids (UDS) should not present a problem. The sorbent and filtered UDS will contain sufficient TRU and Cs components to cause the waste to be greater than the Class C limits and would exhibit many of the characteristics of HLW.

The cesium-loaded spent sorbent, contaminated with transuranics from trace UDS, will be dried and stored for ultimate treatment and disposal by another project, probably in HLW glass in either the Idaho or Hanford vitrification plants. The solids will be disposed of at WIPP or, if this is not possible, treated in either the Idaho or Hanford vitrification plants and disposed of with the HLW.

The UDS filtrate contains transuranic constituents as well as other beta/gamma emitting radionuclides (e.g., cesium) in sufficient quantities that this waste product would probably qualify for disposal at WIPP. Otherwise, the filtrate could be treated by the vitrified waste process either at the INEEL or at Hanford.

The acceptance criteria for the disposal sites in the DOE complex where the final waste from the CsiX/TRU grout process might go are described in Reference 1.

The permitting of the facility, conceptual design, and negotiations on the waste acceptance agreement with WIPP must be conducted at the same time. The three issues are interlated and must be finalized before construction of the facility. If the approval for all three items cannot be achieved early in the conceptual design process, then an alternative process within the bounds of the HLW and FD EIS would have to be selected.

8.3 Quality

Appropriate quality program documentation will be generated and followed as necessary to confirm proper design, construction, and operation of the CsIX/TRU grout facility. Waste inspection requirements to assure compliance with WIPP WAC will be negotiated with WIPP; this study assumes that each waste drum must be visually inspected and a drum headspace gas sample taken and analyzed.

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 will apply it to this effort as well. The impact of implementing DOE-RW-0333P is reflected in the capital and life-cycle cost estimates generated by this Feasibility Study.

8.4 Safety

8.4.1 Facility Hazard Category and Performance Category

These categories are discussed under Section 4.3.1, "Structural Design."

8.4.2 Industrial Safety

The basic approach to worker safety for the CsIX/TRU Grout Project 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.

8.4.2.1 Construction Hazards

Construction hazards for this project are typical for most construction sites. For example, heavy equipment produces physical hazards of striking objects, crushing of hands or feet, and head injuries. Construction Subcontractors shall be required to comply with 10 CFR 1926, "Occupational Safety and Health for Construction," and monitored to ensure compliance.

8.4.2.2 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 procedure 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.

8.4.2.3 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.

8.4.2.4 Personnel Safety

In general, workers will be physically separated from most hazardous systems by shielding walls, glove ports, viewing windows, booths, equipment guards, or other physical features. Administrative procedures will allow workers access to some systems for maintenance or repair of equipment. Entries to cells and shielded corridors are viewed as hazardous and nonroutine and will require the use of safety permits. A Radiation Work Permit will 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.

8.4.2.5 *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.

9. UNCERTAINTIES AND ISSUES

9.1 General Concerns

The CsIX/TRU grout process was conceived as an alternative method for processing INTEC liquid wastes. Data in support of the process design was taken from development work performed for other projects. As such, there are numerous areas where data is missing, resulting in various issues and uncertainties associated with the process. The process as presented in this report, although containing individual processes used separately in industry, has not been tested as described and hence not optimized. Because the primary goal was to design a *feasible* process, most assumptions and decisions have leaned toward the conservative or upper-bounding case. Substantial reductions in waste volumes and capital costs could be achieved by obtaining, for example, sample data on the liquid and solid waste properties, and by improving the process and acquiring supporting information. This section discusses these areas and other issues. Section 10 contains recommendations for obtaining additional information to provide high confidence in the process and reduce costs by optimizing it.

9.1.1 Behavior of UDS in the Process and Effects on Products

The very limited analytical data available on UDS results in considerable uncertainty in the assumed quantity and composition of the UDS. Limited analytical data, combined with minimal physical characterization of the UDS upon which to base its performance in the process, results in several uncertainties in this study. These uncertainties include:

- The effect of UDS that pass through the filtration system and ion exchange columns on the radiation level of the TRU solid product (i.e., the ability to formulate contact-handled waste with reasonable waste loadings)
- The effect of UDS on both the chemical and physical performance of the cesium sorbent
- The effect of radionuclide (transuranic) and hazardous chemical species (RCRA) on the classification of the spent cesium sorbent, and resulting requirements for its further treatment and ultimate disposal
- The amount of U-235 in the UDS composition, and the criticality level resulting from concentrating the solids through evaporation. Equipment selection and layout did not consider criticality issues.

9.1.2 TRU Waste Volume

One of the greatest uncertainties of the process is the final TRU waste volume. The CsIX/TRU grout process, as described in this report, defaulted to two conservative assumptions because of the lack of data beyond "performance" grout waste forms (high strength mechanical properties, leach resistant). The two assumptions are: (1) further evaporation of the CsIX effluent will not be performed before solidification, and (2) solidification will be by grouting. The grout formulation used in this study was not volume-optimized to take advantage of the minimal requirements of the WIPP WAC. A brief evaluation, given in EDF-CsIX-001 in Appendix B, compares solidification with grout to absorption of the liquid waste on several absorbents, which shows a potential 30% reduction in waste volume. Other solidification methods that may significantly reduce waste volume include:

- Development of a grout loading/formulation specifically for the WIPP WAC

- Selection of an absorbent capable of a high waste loading
- Evaporation of the waste further before grouting
- Evaporation of the waste to a solid form
- A combination of these ideas.

9.1.3 Ion Exchange Performance

The main requirement of the process is to produce a contact-handled waste product acceptable at and ready for shipment to WIPP. The major process step that fulfills this requirement is the removal of cesium by ion exchange. To date, the selected ion exchange process has only been demonstrated at a very small scale (1 cm³), with very limited amounts of surrogate wastes, and to only a small fraction of cesium-breakthrough. Thus, there are uncertainties in the performance of the cesium sorbent in a full-scale column, using actual wastes, and operated to breakthrough. An expectation, although not proven, is that minor components in the waste will not affect the ability of the sorbent to remove cesium. Another expectation is that major waste components, with their variable quantities, will not affect the sorbent's performance.

All of these will determine the need to remove the solids and at what level of filtration efficiency. If very high efficiencies are required, it could affect the viability the process concept.

9.1.4 Liquid Waste Composition and Volume

Incomplete analyses are available of liquid waste for all tank farm tanks. Most analyses do not report on trace species, including organics, which may affect classification of the final wastes, or even the ability to solidify the TRU waste. Only limited data is available on the radionuclide components. There is also uncertainty in the total liquid waste feed volume because of (1) the undetermined, as yet, sequence of blending tank farm liquids before evaporation in the HLLWE, (2) the amount of waste that will be calcined, and (3) the amount of NGLW that will be generated, including tank farm heels and flushes from tank closure activities, and the proportion of that waste that would be processed by the CsIX/TRU grout process.

Related to the last point, the Tank Farm Closure team has still not determined what is to be done with the bulk settled solids in the tanks. If these solids are going to be removed from the tanks, the bleed-through of even trace levels of solids to the grout could cause significant problems in maintaining the WIPP CH limit for the waste. This is an important factor for the CsIX/TRU grout concept, and should be determined as soon as possible.

9.1.5 Processing and Disposition of UDS and Spent Sorbent

The requirements for final disposition of the filtered UDS and spent cesium sorbent have not been completely defined. As a result, there is uncertainty in defining the systems required to handle and store these wastes until their final disposition. Drying and handling characteristics, including pneumatic transport, of these products are largely unknown. The amount of backwash that will be required for processing UDS is also uncertain. A very conservative solids loading of 60 g/l in the backwash was assumed. This single assumption, to a large degree, determines the size and hence the cost of the entire UDS processing system.

9.1.6 Processing Grout Mixtures in Large-Scale Equipment

The requirements for mixing equipment, solids feed systems, cycle timing, grout rheology, and grout uniformity are not adequately defined. Also, little information is available on heat generation, water bleed, and other factors that require consideration in the cure cycle. Grout mixer cycle times directly influence the number and size of mixers that must be used to achieve the desired throughput. Cure cycle uncertainties directly affect the size of curing stations, ventilation and heat/ cooling loads, and the size/ need for dewatering stations.

9.1.7 WIPP Receipt Capability

Verbal discussion with WIPP personnel indicates that WIPP can receive the grouted waste on the schedule and at a shipment rate that is compatible with CsIX/TRU Grout Project objectives, and that prior negotiations and revision of Part A of the WIPP Permit will be successful. However, it is worth noting that WIPP is not yet receiving any waste, and the estimated average shipping rate of 5 shipments every 2 weeks through 2021 is perhaps an optimistic assumption.

9.1.8 Optimistic Schedule

The Project Schedule indicates that the 2012 date can be met for Scenario 1 if the funding, design, permitting, procurement, construction, SO testing, and operations activities all proceed relatively smoothly. However, no project of this complexity at the INEEL has proceeded in this short time in the recent past. This optimistic, no-contingency schedule is a concern. The schedule will become more realistic if future studies yield simpler design and operation. However, if funding, design, or construction take longer than is scheduled, so that less than 5 years will be available to process the waste, then it is possible that a larger scale plant with more capacity and higher throughput rate could be designed and built.

9.2 NWCF Facility Concerns

Scenario 2 was found to not be feasible to meet the 2012 date for processing the liquid waste, based primarily on the high radiation exposure that personnel would experience during rip-out and construction in the NWCF. If that factor could be overcome, however, the following additional issues should be considered when contemplating the installation of CsIX/TRU grout process equipment in the NWCF.

- The fundamental advantage of housing new processes in the NWCF is the possibility of utilizing the existing NWCF structure, radiological shielding, access to tank farm feed, utilities, chemical makeup, etc. With the NWCF and its equipment nearly 20 years old, finding spare parts and maintaining the aging equipment is becoming difficult. Spare parts are difficult to obtain, since many manufacturers no longer produce the equipment models installed in the NWCF.
- Previous INTEC experience with installing new processes in existing facilities has shown that cell penetrations are seldom in the correct locations nor are there sufficient penetrations for the new process. The scope of this problem is usually not fully understood until late in the title design phase causing escalation in the design and construction cost estimates.
- The building was designed for NWCF remote operations and not for CsIX/TRU grout operations. The cell windows, PARs, and master-slave manipulators may not be in the proper locations to provide for efficient remote activities.

- Since new equipment will be installed in existing cells and some existing equipment will be utilized, SO testing will be conducted in a contaminated facility with contaminated equipment. As a result, the testing process will be more complicated, last longer, and be more expensive.
- Design philosophy at the INTEC has been to minimize the number of in-cell mechanical items such as valves and pumps. The CsIX/TRU grout process requires several mechanical items; however, the NWCF building scenario leaves few options for equipment placement. As a result, the proposed location for several pieces of mechanical equipment is in-cell, in direct violation of this design philosophy.
- The CsIX/TRU grout layout calls for spent sorbent to be sluiced approximately 100 ft horizontally and 30 ft vertically from the adsorber cell to the top of the calciner cell. Such a transfer is possible, however questions surround the practicality of doing so.
- Radiation fields in excess of 100 R/hr raise questions concerning the reliability and life span of electrical and mechanical components.
- NWCF filters are being stored in the hot sump tank removal cell while waiting to be processed through the filter leach process. The filters must be removed and leached before construction, otherwise an alternate storage location must be found.

10. RECOMMENDATIONS

10.1 General

The following steps, all with the same relative schedule urgency (critical path), must be taken soon to make this process concept and project meet the 2012 "cease use" date for the Tank Farm tanks:

10.1.1 Negotiate Reduction in Number of HWNs in Waste

Reference 10 argues for successful negotiation with DOE and/or the State of Idaho to reduce the number of RCRA listed codes (hazardous waste numbers—HWNs) contained in the INTEC SBW/NGLW from 105 to 4. (This must also include negotiation that only these four codes are contained in the existing INTEC liquid waste management equipment system that will continue to be used for SBW/NGLW processing. The liquid waste management equipment system was assumed to be contaminated with all 105 codes due to applying the RCRA Part A HWNs to the PEW-TFF waste and application of RCRA "derived-from" and "mixture" rule concepts. This is important if, for any reason, previously processed wastes such as HLW calcine may perhaps not be recognized as having only these same four codes.) This document is a hazardous waste determination to assign the appropriate HWNs to the INTEC wastes by proving that they were not discharged to the PEW-TFF system as listed wastes versus "delisting" the wastes as provided for in RCRA law. Three of these four codes (F001, F002, and F005) are already accepted at WIPP; the fourth code, U134, (uncomplexed hydrofluoric acid, HF) will have to be proven to be complexed in the INTEC waste or added to the WIPP permit. Failure at this effort would most likely require treatment and/or separations processes to be added for the RCRA constituents in the waste as well as development of a leach resistant "performance" waste form requiring major changes to the process scheme, adding to its complexity and cost. As such, this issue should be settled as soon as possible.

10.1.2 Obtain Ruling that Waste is not HLW

A ruling by DOE and/or NRC should be pursued to the effect that SBW/NGLW is not high-level waste (HLW) or, if the SBW is considered to be HLW at present, that after removal of the cesium with the ion exchange system, the cesium-free bulk liquid will no longer be HLW but instead low-level transuranic waste that can be disposed of at WIPP.

10.1.3 Begin Negotiations with WIPP

Negotiations should be started with WIPP to accept the waste. Negotiations should cover at least these major issues: (a) overall volume of the waste, (b) receipt rate and schedule for the waste, (c) determination that SBW/NGLW satisfies the WIPP Land Withdrawal Act "defense waste" requirement, and (d) the need, as may be determined necessary, to revise various high-level WIPP documents such as the Performance Assessment or the Operating Permit (for example to add RCRA-listed code U134, HF). This should be started in FY-2001 at the latest.

10.1.4 Start Line Item Project Funding Cycle

The Line Item Project funding cycle must be started now to begin Conceptual Design by no later than early FY-2001.

10.1.5 Determine Fate of Solids in Tanks

A decision is needed from the Tank Farm Closure team on what is to be done with the bulk settled solids in the tanks. If the Tank Farm Closure Risk Assessment were to determine that they must be removed, this would be quite a challenge. Not only would their removal be difficult but so would their separation and disposal (a minimal estimate of 1/4 in. in all eleven tanks is 450 ft³ of solids; a more realistic 2-in. estimate is 3,600 ft³). The bleed-through of even trace levels of solids to the grout cause significant problems in obtaining the contact-handled dose rate for the waste. This is vitally important to the CsIX/TRU grout process concept and an answer is needed by mid FY-2000 at the latest.

10.1.6 Start RCRA Permitting

The RCRA permitting process for the SBW CsIX/TRU grout treatment system should be started soon. Obtaining this permit will take 3 to 4 years; it must be started in FY-2001 to support a construction start in FY-2005 at the latest.

10.1.7 Start NEPA Process

The NEPA process for SBW should be started independently of the HLW & FD EIS if (1) the SBW is not considered HLW, as assumed by this study, and therefore not covered under the EIS document or (2) the HLW & FD EIS record of decision (ROD) is delayed for various reasons and cannot support the schedule required for the SBW CsIX/TRU Grout Project.

10.2 Future Studies and Tests

It is recommended that the future studies listed in this section be funded and aggressively pursued, to reduce the uncertainties discussed in section 9.1 and to reduce project capital and operating costs. Work must proceed quickly to support starting Conceptual Design in FY-2001.

10.2.1 Tank Farm Liquid Waste Characterization

The results of sampling and analyses performed as part of the Tank Farm Closure and other programs should be used to prepare simulants for ion exchange tests and TRU waste minimization tests. Any continuation of design studies for the CsIX/TRU grout process should use the volumes of tank farm waste as currently provided and periodically updated on the High-Level Waste Systems Engineering web pages.

10.2.2 UDS Analyses

Characterization of UDS in the tank farm tanks, both suspended in the liquid and settled at the bottom, is needed to provide a basis for the design of UDS removal, handling, and packaging equipment, and to establish the required solids removal efficiency. Characterization of conditions, both before and after washing the tank, should include the total concentration and particle size distribution for each tank farm tank and the concentration of both hazardous and radionuclide species as a function of particle size. The radionuclide concentrations are of particular importance for determining the effect of UDS on the solidified TRU waste form, and as an important factor in the review for potential criticality or special nuclear material concerns. The concentration of fission products, notably ¹³⁷Cs, in the UDS must be known to ensure that the final TRU waste can be contact-handled with reasonable waste loadings. There is a large variation between contents of different tanks, so UDS from more than just a few tanks must be characterized.

10.2.3 UDS Removal Demonstration Tests

Testing is recommended to determine the degree of filtration required to avoid contaminating the cesium sorbent with TRU-containing solids, plugging the ion exchange column, and contaminating the TRU waste with high-dose contributing radionuclides. Additional to filter system testing, the tests should determine what fraction and UDS particle sizes pass through the CsIX column and what fraction and particle sizes are retained by the column. Follow-up testing of filtration equipment is recommended to demonstrate that the required removal efficiency of UDS can be achieved.

10.2.4 Ion Exchange Tests

The present data for the CST sorbent cesium loading is from 1-cm³ tests. Data from larger-scale tests are needed to confirm sorbent performance at increased volumes and to provide a basis for full-scale operations. Sorbent performance data are needed over the range of liquid waste compositions present in the tank farm tanks, particularly the range of cesium concentration, acid concentration, and other species that have a potential for chemical interaction with the sorbent. Long-term performance data are needed to discover kinetically slow chemical interactions of sorbent with the liquid waste, and to confirm models of sorbent performance from start of run to cesium breakthrough.

10.2.5 Final Waste Volume Optimization Studies

The goal of this recommended new study would be to define a process that minimizes the volume of waste shipped to WIPP. Three volume-minimization methods are recommended for study.

- Development of a high-waste-loading grout, meeting only the requirements of the WIPP WAC. Tests are recommended to better determine the limiting parameters for the grout including, but not limited to, minimum water, maximum solids, maximum nitrate, maximum chloride, and stability over time and temperature. Tests in which unneutralized SBW is grouted with Portland cement only are recommended.
- Use of an absorbent, such as an inorganic polymer absorbent or Aquaset/Petroset. This would include a thorough review of absorbents capable of absorbing high-solids-content acid solutions, followed by testing of the most promising.
- Evaporation of the ion-exchange effluent to a dry solid. Recent testing by R. J. Kirkham⁸ has shown that that a crystal-like solid product, less than 30% of the original volume, can be produced by evaporating a simulated SBW solution and cooling the concentrate. Additional testing of solidification by evaporation and cooling is recommended to verify Kirkham's preliminary test results. Tests for this scenario include determining offgas species during evaporation, determining the stability of the crystallized waste product, determining the type of evaporation and packaging equipment to be used in the process, and analysis of the materials of construction for this equipment. Possible problems with this process will need further evaluation. Preliminary reports indicate this waste form can be readily reliquefied upon application of heat. This could be a concern in certain transportation accident scenarios.

Development of the grout and testing of absorbents would be done in conjunction with evaporation tests that would concentrate the liquid to the limit set by the solidification agent. The possibility exists that the waste could be concentrated too much and thereby exceed the contact-handled dose rate. This could be mitigated in various ways by, for example, adding salts to the waste to make it solidify at a lesser concentration or providing some minor shielding in the waste package to reduce the field. Also, the possibility of sending remote-handled waste to WIPP could be further investigated.

Should partial evaporation in conjunction with grouting or absorption prove optimal, the following is recommended:

- Determine the nature of precipitates as waste is concentrated
- Determine if the optimum evaporator location is upstream or downstream of cesium removal or if separate systems are required on both ends to provide certain process capabilities such as, for example, fine tuning of waste loadings or concentration of various secondary process waste waters such as resin sluice water, filtration system flush water, etc.
- Evaluate evaporation methods and related equipment types, followed by demonstration tests of the selected equipment.
- Determine the extent of evaporation possible before encountering operational problems with either the evaporator or downstream equipment.

10.2.6 Process Simplification Study

Some of the systems presented in the CsIX/TRU grout process design were chosen based on assumptions that simpler process concepts may not work. These assumptions were the direct result of insufficient information being available to confidently demonstrate that more simple concepts will be effective. Thus, the design presented may include process concepts that are more complex than actually required and could result in higher than necessary equipment, facility, and operational costs. After the project and process uncertainties and assumptions have been reduced or eliminated by, among other things, INTEC Technical Development empirical work, further engineering study is recommended to rework the design with a view toward both operational simplicity and cost savings. Future brain-storming sessions to develop creative ideas, studies, and decision making should continue to include personnel from the various INTEC organizations, such as Technical Development, NWCF Operations, and Engineering. Experts in particular areas, such as filtration and remote handling, should also be included. The following three ideas are presented as issues to be considered:

- Eliminate active mechanical dryers in-cell. This can be accomplished for spent sorbent if testing shows a method of rinsing and drying (heat only or heat plus drying/fluidizing air) that allows the media to be dried in-place in the ion exchange column itself or in place-in the storage tank(s) after being sluiced there. For the UDS, various options could be considered to avoid a mechanical dryer in-cell. One option would be to produce a high solids content sludge, filter cake, or filter media that is placed in a drum and dried inside the drum.
- Identify filtration options that are relatively simple and amenable to remote operation and retrofit. A separate comprehensive concept evaluation and selection study should be considered that identifies and evaluates options for filtration and solids dewatering. Subtasks include collection of information from vendors and people involved in operation of filtration and dewatering systems, site visits to locations using various technologies and system concepts, some scoping tests, and discussions with consultants or other experts with broad experience in filtration and solids dewatering systems.
- Use of out-of-cell valve and instrumentation boxes for most of the extensive valving and monitoring needed for the multi-column ion exchange system concept. The valve actuators and position switches and most of the waste stream radiation monitoring hardware would be located outside the box where they could be directly maintained. Valves and any other items inside the box would be contact maintained after draining and flushing the lines and opening

the box. Or, use a modular, space efficient unit with the IX feed tank, columns, waste/flush tank, and pumps on a single skid (estimated size 4 x 12 ft). Implementing these two concepts for Scenario 2 may allow the ion exchange system to be located in the NWCF calciner cell without removing the calciner, eliminating the need to clean out the NWCF absorber cell.

10.2.7 UDS and Spent Cesium Sorbent Processing

Tests are needed to determine the washing requirements, if any, and the drying requirements of both the spent cesium sorbent and the separated UDS (independently) and to demonstrate the use of equipment to dry both to free-flowing, pneumatically transportable solids. An important consideration in these washing and drying tests is operational simplicity, to minimize maintenance on equipment that would process these high-radiation-field solids. As such, in-place dryers should be considered.

11. CONCLUSIONS

- For the all-in-one grout building scenario (#1), the CsIX/TRU grout process can feasibly be built and operated successfully in time to process all the liquid waste in the INTEC tank farm before the end of 2012, within a total life cycle cost (escalated and discounted) of \$279 million.
- Meeting the 2012 schedule requirement is not feasible for the scenario (#2) of locating the most radiologically hazardous part of the CsIX/TRU grout process in the NWCF. This is in large part due to the high worker radiation dose (about 1,500 man-rem total) during the rip-out and construction phases in the NWCF. In addition, this scenario costs more (total life cycle cost, escalated and discounted = \$327 million), and there are many other concerns surrounding the practicality of this scenario. Therefore, this scenario should not be pursued.
- The grouted waste form will meet WIPP waste acceptance criteria. The solid waste shipped to WIPP will contain approximately 500 nCi/g TRU on average. Negotiations with WIPP would be desirable, as they have suggested, on issues such as bulk sampling of the waste feed to the CsIX/TRU grout plant to characterize the RCRA constituents, and characterization and inspection requirements for the final waste product with the goal of further reducing both capital and operational costs. WIPP personnel have suggested that these negotiations to reduce requirements are possible not only because of the homogenous nature of our feed, but because of the control over the final waste form that would be achievable with proper system design.
- The four expected RCRA hazardous waste constituents in the SBW are identified in Part A of the WIPP Permit, with the exception of U134 (uncomplexed hydrofluoric acid, HF). This particular HWN must be delisted from the INTEC waste before the TRU waste can be shipped. If it cannot be delisted, then a performance assessment must be conducted for the addition of the U134 code to Part A of the WIPP Permit. (This performance assessment may need to address up to 30 chemicals, depending on the final assessment for designating listed HWNs for the SBW and NGLW.)
- The process as presented in this report, although containing individual processes used separately in industry, has not been tested as described and hence has not been optimized. Because of the primary goal of conceiving a *feasible* process, most assumptions and decisions have leaned toward the conservative or upper bounding case. Substantial reductions of both capital and operating costs and waste volumes can probably be achieved by improving the process and acquiring supporting information. Research and testing are necessary to substantiate this.
- It is imperative that action begins soon on the following recommendations (detailed in Section 10) in order for the CsIX/TRU grout process concept and project to meet the 2012 "cease use" date for the Tank Farm tanks:
 - Successful negotiation with DOE and/or the State of Idaho to reduce the number of RCRA-listed codes (HWNs) contained in the INTEC liquid waste from 105 to 4
 - A ruling by DOE and/or NRC that SBW/NGLW is not high-level waste (HLW)
 - Start and succeed in negotiations with WIPP to accept the waste
 - Start the Line Item Project funding cycle now to begin Conceptual Design by no later than early FY-2001.

- Have the Tank Farm Closure team determine what is to be done with the bulk settled solids in the tanks.
- Start the RCRA permitting process for the SBW CsIX/TRU Grout treatment system.
- Start the NEPA process for SBW independently of the HLW & FD EIS
- Fund and aggressively pursue various future studies, primarily investigating INTEC Technical Development issues.

12. REFERENCES

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- ⁵ T. A. Todd, K. N. Brewer, D. J. Wood, P. A. Tullock, L. G. Olson, A. L. Olson, "Evaluation and Testing of Inorganic Ion Exchange Sorbents for the Removal of Cesium-137 from Idaho Chemical Processing Plant Acidic Tank Waste," Submitted to *Separation Science & Technology*, December, 1997.
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- ⁷ M. D. Argyle, R. L. Demmer, "Tests of Acid-Bond A660 for Solidifying Sodium-Bearing Waste," *LMITCO Interdepartmental Correspondence*, MDA-02-98/RLD-05-98, October 12, 1998.
- ⁸ R. J. Kirkham, "Sodium Bearing Waste Solidification by Evaporation," *LMITCO Interdepartmental Communication*, RJK-6-98, September 29, 1998.
- ⁹ R. S. Garcia, *Utilities and Infrastructure Report*, INEEL/EXT-97-01398, February 1998.
- ¹⁰ Kenneth L. Gilbert, *Regulatory Analysis of INTEC Liquid Waste Stream U.S. Environmental Protection Agency Hazardous Waste Numbers*, INEEL/EXT-97-01453, July 1998.
- ¹¹ Bob Kehrman and Jim Bosley, "WIPP Telecon for CsIX on August 19, 1998," Functional File No. BC-CsIX-25.

Appendix A
Assumption/Decision Table

APPENDIX A
ASSUMPTION/DECISION LIST
(Functional File A-CsIX-01)

Project Title: CsIX/TRU Grout Feasibility Study

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
1	Assumption: SBW and NGLW (Type I, Type 2) are not HLW.				
Basis	This is part of the workscope direction for the study.	Cliff Olsen in the CsIX Feasibility Study SOW, pg 2.	Approved	Cliff Olsen 6/18/98	Cliff Olsen 6/18/98
2	Decision: CsIX sorbant will be CST type resin				
Basis	Meeting on 5/20/98 with Helm, Stegen, Jacobson, Olsen, Barnes, Todd, and Dafoe to discuss CsIX resin. Decision during that meeting was to use CST resin.	Function File No. BC-CsIX-07	Decided on 5/20/98	Cliff Olsen 5/20/98	Karen Williams 6/26/98
3	Assumption: CsIX sorbant will not be regenerated.				
Basis	Cs cannot be eluted off the chosen CST resin without actual destruction of this resin.	6-3-98 CsIX Project Kickoff Mtg	Approved	Cliff Olsen 6/18/98	Cliff Olsen 6/18/98
4	Decision: Waste will include only 4 listed hazardous constituents (F001, F002, F005 which are already acceptable per the WIPP WAC, and U134 = HF).				
Basis	Direction from J. Bosley at the 6-8-98 CsIX Process Engineering Mtg, based on his knowledge of current thinking, re: INEEL/EXT-97-01453 "Regulatory Analysis of INTEC Liquid Waste Stream U.S. Environmental Protection Agency Hazardous Waste Numbers"	Functional File BC-CsIX-02	Approved	Cliff Olsen 6/18/98	Cliff Olsen 6/18/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
5	<u>Assumption:</u> U134 (HF) can be delisted from the waste or (worst case) the WIPP permit can be modified to accept it.				
Basis	Per J. Bosley at 6/10/98 Weekly Meeting, based on his knowledge of current thinking, re: INEEL/EXT-97-01453 "Regulatory Analysis of INTEC Liquid Waste Stream U.S. Environmental Protection Agency Hazardous Waste Numbers," and on his knowledge of WIPP philosophies and discussions with WIPP personnel.	Functional File BC-Cslx-03	Approved	Cliff Olsen	Cliff Olsen
6	<u>Decision:</u> Contact handling of the grouted waste is possible. The study can safely proceed on this basis until calculations are done to confirm this (later calculations did confirm this).				
Basis	Based on Henry Peterson's dose calculations for a previous project (P-111) and a comparison of activity of the waste tanks with the SBW in that study (discussion during 6/8/98 Process Engineering Mtg.)	Functional File BC-Cslx-02	Decided on 6/8/98		Karen Williams 6/26/98, 11/12/98
7	<u>Decision:</u> The waste will be treated by grouting in preparation for sending to WIPP.				
Basis	Discussion at 6/8/98 Process Engineering meeting yielded decision. It is far preferable that the waste be contact-handled due to handling and facility design and WIPP capacity. Absorbents were considered, with no clear advantage to offset the higher volume or increased cost. If desired later, it can be noted in the Feasibility Study Report that evaporation and direct solidification into a more compact waste form could be a topic for a future study.	Functional File BC-Cslx-02, further comment in BC-Cslx-06	Decided on 6/8/98, further comment on 6/24/98		Karen Williams 6/30/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
8	Decision: No solids will be purposely removed from the tank farm tanks; only incidental suspended solids from liquid SBW/INGLW and heel/flush water removal will accompany the feed.				
Basis	Direction from Heiser to Bosley (representing the tank farm closure study team).	6/10/98 meeting/discussion with attendees Olsen, Heiser, Bosley, Dafoe, Williams, at WCB S-1 HLW conference room. Documented in Functional File BC-Cslx-03.	Decided on 6/10/98	Cliff Olsen 6/10/98	Cliff Olsen 6/10/98
9	Decision: RCRA wastes will either not sorb or can be successfully washed off the lx resin (CST) such that it will pass a TCLP test and will not be mixed waste. (It was later determined that this point is probably moot, since the resin will probably be treated and disposed of along with the calcine – so if the calcine is mixed waste, the treatment process will have to address that anyway.)				
Basis	Charles Barnes reported a conversation with Terry Todd where Terry said that he didn't think the CST resin would adsorb any of the heavy metals, and that it would pass a TCLP test. The only species they've seen absorbed besides cesium is calcium.	6/9/98 Lotus Note from Charles Barnes	Approved	Cliff Olsen 6/18/98	Cliff Olsen 6/18/98, Karen Williams 11/12/98
10	Decision: Solids estimates listed in Charles Barnes' material balance spreadsheet will be used for this study.				
Basis	Charles has reviewed the data and used his judgment to come up with the numbers in the spreadsheet. No better data is available.	Functional Files C-Cslx-01 and BC-Cslx-04	Decided on 6/17/98	Cliff Olsen 6/17/98	Karen Williams 6/26/98

Number Latest Rev.	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
11	<u>Decision:</u> Use the numbers in Charles Barnes' material balance spreadsheet (Functional File C-Cslx-01) relative to evaporation and grouting.				
Basis	Charles' discussion with Alan Herbst on 6/18/98.	Functional File BC-Cslx-05	Decided on 6/18/98		Karen Williams 6/26/98
12	<u>Decision:</u> Continue to include solids filtration in the process flowsheet, even though it might not be necessary unless the CsLx resin is limited to Class C-LLW. [No. 17 below indicates that only a rough filter is needed.]				
Basis	Discussion at 6/24/98 Weekly Meeting: The resin WILL be limited to Class C for the new all-in-one facility, and filtration will be necessary for that. We won't know for a while whether the resin from the NWCF will be Class C or not. [Only a rough filter is needed, per No. 17 below.]	Functional File BC-Cslx-06	Decided on 6/24/98 Modified on 7/2/98		Karen Williams 6/26/98 7/10/98
13	<u>Decision:</u> Solids filtration is necessary to limit the resin's TRU loading to less than the Class C limit (400 nCi/g) even if the Cs Loading is GTCC. [Cancelled by No. 17 below.]				
Basis	This will give much more flexibility later for resin disposal, e.g. the resin could be stored until the Cs decays to less than the Class C limit.	Functional File BC-Cslx-06	Direction by Cliff Olsen on 6/30/98 [Cancelled by No. 17 below.]		Karen Williams 6/30/98 7/10/98
14	<u>Decision:</u> Use straightforward interpretation of the WIPP WAC and other documents, and dependence on WIPP representatives' verbal statements. HLW Program and DOE will address Issues raised by Gordon Venable at a higher level (outside the scope of this study).				
Basis	Discussion at 6-24-98 weekly meeting. Issues raised in Venable's letter are Programmatic issues, beyond scope of this study. However, the issues should be noted in Feasibility Study Report.	Functional File BC-Cslx-06	Decided on 6/24/98	Approved/directed by Cliff Olsen on 6/24/98	Karen Williams 6/30/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
15	Decision: The waste stream will not be neutralized prior to the CsIX resin.				
Basis	Discussion at 7/1/98 Process Engineering meeting at INTEC (CPP). Resin performance is not substantially enhanced by waste neutralization, therefore this step is seen as not cost beneficial.	Functional File BC-Cslx-11 (Lotus Note from Cliff Olsen on 7/7/98, "Change in the SBW CslX-to-TRU-Grout Process")	Approved	Approved by Cliff Olsen 7/7/98	Karen Williams 7/10/98
16	Decision: Since the resin will be TRU contaminated (plus possibly contaminated with other constituents), it does not have to be washed in an attempt to remove liquid or solid phase TRU wastes or hazardous wastes from it. However, the resin may require water washing to remove the acidic interstitial liquid prior to drying it to be ready for pneumatic transport. It will eventually go to waste treatment (outside the scope of this study) along with whatever solids or hazardous contaminants have collected on it.				
Basis	The resin will be treated by the same system as that which will treat calcine or HLW. The other waste will have similar constituents to those in the possible resin contamination, so the system must be capable of treating them.	Functional File BC-Cslx-11 (Lotus Note from Cliff Olsen on 7/7/98, "Change in the SBW CslX-to-TRU-Grout Process"). Also Functional File BC-Cslx-12 (7/8/98 mtg. Minutes)	Approved	Approved by Cliff Olsen on 7/8/98	Karen Williams 7/10/98 (revised 10/5/98)

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
17	Decision: The resin is allowed to be GTCC for Cs, TRU, or any other constituents.				
Basis	The prefiltering requirements (99.99% efficiency) are too difficult to keep the TRU levels in the resin to below the Class C limit. Since the resin will therefore be above Class C for TRU, it can also be above Class C for all other constituents (this cancels No. 13 above).	Functional File BC-Cslx-11 (Lotus Note from Cliff Olsen on 7/7/98, "Change in the SBW CslX-to-TRU-Grout Process").	Decided on 7/2/98	Approved by Cliff Olsen on 7/2/98	Karen Williams 7/10/98
18	Decision: The filtered solids will be dried and sent to WIPP for disposal. If this is not possible, they will be stored for pneumatic transport to some eventual waste treatment and disposal under another Project. process (outside the scope of this study).				
Basis	Discussion at 7/2/98 meeting: The solids will likely be too hot to dispose of at WIPP. They will be dried and stored for eventual pneumatic transport to waste treatment or shipping. Design has evolved to require shielded containers for the UDS. As such, the UDS will be within the contact-handled limits and be acceptable for disposal at WIPP.	Functional File BC-Cslx-11 (Lotus Note from Cliff Olsen on 7/7/98, "Change in the SBW CslX-to-TRU-Grout Process"). Also Functional File BC-Cslx-12 (7/8/98 mtg. Minutes) BC-CslX-31 (9/23/98 mtg. Minutes)	Decided on 7/2/98 October 1998	Approved by Cliff Olsen on 7/2/98 October 1998	Karen Williams 7/10/98, 11/12/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
19	Decision: Do not perform additional waste evaporation prior to grouting.				
Basis	Grouting the highly concentrated waste is outside the experience of Tech Development. Eliminating the evaporator increases the likelihood of successful grout setup, simplifies the flowsheet, equipment, and operation, and will yield a lower rad level in the waste. It will cause a 16% increase in grouted waste volume, so is conservative from the standpoint of waste volume production. It is not, however, conservative from a cost estimating standpoint.	CMB Lotus Note on 7/7/98, also Functional File No. BC-Cslx-12.	Decided and approved on 7/8/98	Cliff Olsen approved on 7/8/98	Karen Williams 7/10/98
20	Decision: Use 55-gallon drums as the basis for the grouted waste package.				
Basis	55-gallon drum is the standard accepted at WIPP. Larger containers might decrease operations and storage cost by a small amount, but not significant and not conservative. The bottleneck is the weight limitations on shipping, which means that we will not be able to ship the volume any faster no matter what sized container we use.	Functional File No. BC-Cslx-12 (7/8/98 mtg minutes)	Decided and approved on 7/8/98	Approved by Cliff Olsen 7/8/98	Karen Williams 7/10/98
21	Assume: We can continue to put liquid waste into RCRA compliant tank farm tanks as it is generated.				
Basis		Feasibility Study SOW, 5/18/98	Approved	Cliff put into SOW 5/18/98	Karen Williams 8/5/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
22	<u>Decision:</u> Water from sluicing the resin will go back to RCRA compliant tank farm tanks and be treated as NGLW				
Basis	This is allowed per Assumption no. 21 above.	Functional File No. BC-CsIX-16 (7/15/98 mtg, minutes)	Decided and approved on 7/15/98	Approved by Cliff Olsen 7/15/98	Karen Williams 8/5/98
23	<u>Decision:</u> The cost of either recycling or preventing off-spec waste product will be addressed in the Feasibility Study by selecting a scenario and designing for recycle treatment.				
Basis	There will be cost involved in either recycling the off-spec waste, or attempting to prevent it. The cost is more easily quantified by a design to recycle it.	Functional File No. BC-CsIX-16 (7/15/98 mtg. Minutes)	Decided and approved on 7/15/98	Approved by Cliff Olsen 7/15/98	Karen Williams 8/5/98
24	<u>Decision:</u> The scenario of the grout not setting up or curing will be chosen as the representative scenario for dealing with off-spec waste. The recycle method will be to bake the entrained moisture out of the waste product.				
Basis	This is a likely off-spec scenario and representative recycle method.	Functional File No. BC-CsIX-18 (7/22/98 mtg. Minutes)	Decided and approved on 7/22/98	Approved by Cliff Olsen 7/22/98	Karen Williams 8/5/98
25	<u>Decision:</u> A rail spur to ship the waste out (to WIPP) will not be included as part of this study, but the interim storage facility should be located (east of INTEC) such that it would be accessible by a rail spur if that is pursued in the future by some other project.				
Basis	The most likely shipping mode is by truck. A rail spur would not be cost effective for this project alone.	Functional File No. BC-CsIX-18 (7/22/98 mtg. Minutes)	Directed by Cliff Olsen 7/22/98	Approved by Cliff Olsen 7/22/98	Karen Williams 8/5/98
26	<u>Decision:</u> Provide minimal facilities in the buildings; provide only enough office space for operations and support (e.g. HP, QA, record storage), but not for engineering, management, etc. Also not to include a locker room, lunchroom, etc.				
Basis	Other buildings are available to provide these facilities	Functional File No. BC-CsIX-18 (7/22/98 mtg. Minutes)	Directed by Cliff Olsen on 7/22/98	Approved by Cliff Olsen 7/22/98	Karen Williams 8/5/98, 11/12/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
27	Assumption: The CsIX/TRU grout processing facility will be in operation for approximately 5 years, from January 2008 through December 2012.				
Basis	The 2008 start time is required to support the tank farm closure schedule, and is probably a reasonable time to accomplish the activities required to get the facilities on-line, although the schedule will have no contingency. The 2012 end date supports the requirement to have the SBW out of the tank farm by 2012	Cliff Olsen, Karen Williams, and Rick Adams met on 9/21/98 to discuss	Approved	Approved by Cliff Olsen 9/21/98	Ron Dafoe 8/13/98, Karen Williams 10/16/98
28	Decision: Processing operation is based on a 24-hour, 7 days a week, with an up-time of 200 days per year.				
Basis	Continuous operations are logical for the process. Previous studies, to include a Raytheon study, incorporated a HLW program approved 75% up time with 75% efficiency resulting in an overall efficiency of $0.75 \times 0.75 = 0.56$ or 56%. For a full year the result is $365 \times 0.56 = 205$ days. This has been rounded to 200 days.	Conversation with Cliff Olsen	Approved	Approved by Cliff Olsen	Ron Dafoe 8/13/98
29	Assumption: It is acceptable to locate the facilities on CERCLA sites at INTEC that have been designated as "no action areas."				
Basis		Functional File No. BC-CsIX-18 (7/22/98 mtg. Minutes)	Directed by Cliff Olsen on 7/22/98	Directed/Approved by Cliff Olsen 7/22/98	R. Dafoe 10/2/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
30	<u>Decision:</u> Filtrations solids will be stored in drums rather than in tanks, as long as (1) a method is provided to remove the drums from the NWCF and All-New Facility, and (2) this drumming and load-out system does not become a major cost driver in the overall system design				
Basis	To provide more flexibility in case the solids volume is underestimated.	Functional File No. BC-CsIX-23 (8/19/98 mtg. Minutes)	Approved, contingent on provision statements above	Approved by Cliff Olsen on 9/19/98, contingent on provisions above	R. Dafoe 10/2/98
31	<u>Decision:</u> A new analytical laboratory will not be required.				
Basis	The waste generated by the CsIX/TRU process will be much better characterized than most of the waste sent to WIPP from other sources. QA and sampling requirements will be determined during negotiations. They could be fairly minimal, including analyzing just one sample from each tank farm tank prior to running the contents through the CsIX/TRU Grout process, and an occasional infrequent sample of grouted waste.	Functional File No. BC-CsIX-26 (8/26/98 mtg. Minutes)	Discussed and approved on 8/26/98	Approved by Cliff Olsen 8/26/98	R. Dafoe 10/2/98
32	<u>Decision:</u> This study will not change its baseline that assumed the NWCF would not be re-started.				
Basis	An announcement had been made that the NWCF would restart in 9/98 and operate until 4/99. The study might overestimate the number of grouted drums by about 25%, but, because the NWCF hasn't restarted, the study will stay with the defined workslope assumptions.	Functional File No. BC-CsIX-26 (8/26/98 mtg. Minutes)	Per Cliff Olsen	Directed/Approved by Cliff Olsen 8/26/98	R. Dafoe 10/2/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
33	Decision: Prior to shipment to WIPP, each grouted waste drum will have a headspace gas sample taken in addition to a visual inspection of the headspace through the use of fiber optics. These activities will be performed in the interim storage facility.				
Basis	To meet WIPP acceptance criteria. These steps decided on after a study meeting on 9/3/98 to determine the best path forward.	Functional File No. BC-CslX-28 (9/3/98 Drum QA mtg. Minutes) Functional File No. BC-CslX-29 (9/9/98 mtg. Minutes)	Approved	Approved by Cliff Olsen	R. Dafoe 10/2/98
34	Decision: The number of drums produced will be rounded to 38,000.				
Basis	The numbers generated from the material balance calculations are not accurate to 5 significant figures. Debatable to even 2 significant figures, based on uncertainties in data used for input material balances and other assumptions made.	Functional File No. BC-CslX-29 (9/9/98 mtg. Minutes)	Approved	Approved by Cliff Olsen	R. Dafoe 10/2/98
35	Assumption: The process facility will not be RCRA-permitted. (deleted per 10/21/98 direction from Cliff Olsen)				
Basis	The language in the Land Withdrawal Act This Assumption was deleted, due to too many questions still surrounding this issue.	Functional File No. BC-CslX-26 (8/26/98 mtg. Minutes) Functional File No. BC-CslX-25 (8/49/98 WIPP telecon notes) BC-CslX-35 (10/21/98 Mtg. Minutes)	Not approved - deleted per Cliff Olsen's direction 10/21/98		R. Dafoe 10/2/98 Karen Williams 11/12/98

Number Latest Rev	Assumption/Decision	References	Date & Status (e.g. unreviewed, being reviewed, approved final)	Approved by & date (after review)	Entered into this Table by Who, and Date
36	Assumption: Grout-filled TRU waste drums will require RCRA permitted storage for both lag storage in the process facility and interim storage.				
Basis	The language in the Land Withdrawal Act	Functional File No. BC-CslX-26 (8/26/98 mtg. Minutes) Functional File No. BC-CslX-25 (8/19/98 WIPP telecon notes)	Approved	Cliff Olsen 10/14/98	R. Dafoe. 10/2/98, Karen Williams 11/12/98
37	Assumption: 50% of the NWCF operating costs will be borne by this project during its operating years				
Basis	This project will be one of the major operations taking place in NWCF during those years, therefore a large share of the NWCF general operating costs will probably be charged to this project, and we should budget for it.	Functional File No. BC-CslX-32 (9/30/98 mtg minutes)	Approved	Approved by Cliff Olsen 9/30/98	Karen Williams 10/16/98

Appendix B

Material Balance and Flow Diagrams
(Contained in EDF-CsIX-001)

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask Material Balance and Process Flow Diagrams

Title: CsIX/TRU Grout Process Basis, Description, Material Balance and Process Flow Diagrams

Summary: This EDF contains:

1. Assumptions used in calculating the material balance for the CsIX Grout Process
2. A brief comparison of alternative solidified waste forms for the TRU waste product
3. A brief discussion of the rationale for selecting the cesium sorbant
4. A process description
5. Process flow diagrams
6. Material balance tables for the total composite waste
7. Material balance tables for WM-181, the expected highest dose rate case
8. Recommendations for development of the process.

Revision 1 contains a correction in ^{137}Ba activities for some streams in the material balance and minor other corrections.

Distribution (complete package): C. M. Barnes, S. J. Losinski, K. L. Williams, C. W. Olsen

Distribution (summary package only): J. J. McCarthy

Author	Dept.	Reviewed	Date	Approved	Date
C. M. Barnes <i>e m Barnes</i>	4170 <i>10/21/98</i>	S. J. Losinski <i>S. J. Losinski</i>	<i>10/21/98</i>	K. L. Williams <i>K. L. Williams</i>	<i>10/27/98</i>

1. Material Balance Assumptions

Feed Basis

1. The feed to the CsIX/TRU Grout process is assumed to include all tank farm liquid in tanks WM-180, -181, -182, -183, -184, -185, -186, -187, -188, and -189 as of Jan, 1998 plus liquid waste (NGLW, types 1 and 2) generated 1998-2012.

Tank Farm Volumes and Composition

2. The volumes of tank farm waste are taken from the tank farm summary web page prepared by Dan Staiger, <http://wcb08/nichtt/jm/tankdata/Tankmap.htm>, with volumes as of April 30, 1998.

3. The chemical and radiological composition of tank farm waste is taken from tank farm web pages prepared by Dan Staiger, <http://wcb08/nichtt/jm/tankdata/WM18i.htm>, $i = 0, 1, 2 \dots 9$, as updated 12/22/97 (WM-181, -183, -185, -186, 188), 12/23/97 (WM-180, -184, -187, 189), or 3/17/98 (WM-182).

4. Where chemical species concentrations were not available in the above source, data are taken from J. A. Nenni to W. B. Palmer, *Alternative Sodium-Bearing Waste Calcination Flow Sheet Estimations*, JAN-02-95, Sept. 21, 1995 or K. J. Rebish and J. A. Nenni to B. H. O'Brien and D. V. Croson, *Tank Farm Inventory – June, 1994*, KJR-02-94/JAN-03-94, June 23, 1994. Where a species concentration is not available in any source for a particular tank but is documented for other tanks, the unknown concentration is assumed to the same as the weighted average of the known tanks.

5. The nitrate concentration for each tank is adjusted to achieve a charge balance for all species.

6. The nonradioactive cesium concentration for each tank is assumed to be two times the total radioactive cesium concentration as of Jan, 1998. (Basis: discussions with Terry Todd, Ken Brewer and Gary Stegen.)

7. Concentrations of radionuclides are estimated when missing from the web page data based on concentrations in D. R. Wenzel, *Evaluation of Radionuclide Inventory for Sodium Bearing Waste*, EDF-FDO-006, CPP-97080, Nov. 26, 1997. Estimates are as follows:

- 7a. Am-243 = Am-241 times ratio of Am-243/Am-241 from Wenzel
- 7b. Cm-242 = Am-241 times ratio of Cm-242/Am-241 from Wenzel
- 7c. Cm-244 = Cm-242 times ratio of Cm-244/Cm-242 from Wenzel
- 7d. Th-230 = U-233 times ratio of Th-230/U-233 from Wenzel
- 7e. Th-231 = Th-230 times ratio of Th-231/Th-230 from Wenzel
- 7f. U-232 = U-235 times ratio of U-232/U-235 from Wenzel
- 7g. U-233 = Np-237 times ratio of U-233/Np-237 from Wenzel
- 7h. Bm-137 = Cs-137 times ratio of Bm-137/Cs-137 from Wenzel
- 7i. Ce-144 = composite Ce-144 (ave of tanks for which have data)
- 7j. Co-60 = composite Co-60 (ave of tanks for which have data)
- 7k. Cs-135 = Cs-137 times ratio of Cs-135/Cs-137 from Wenzel
- 7l. Eu-152 = Eu-152 times ratio of Eu-152/Eu-154 from Wenzel
- 7m. Eu-155 = Eu-152 times ratio of Eu-155/Eu-154 from Wenzel
- 7n. Pm-147 from Wenzel
- 7o. Pr-144 from Wenzel
- 7p. Ni-63 = composite Ni-63 (ave of tanks for which have data)
- 7q. Ru-106 = composite Ru-106 (ave of tanks for which have data)
- 7r. Sb-125 = composite Sb-125 (ave of tanks for which have data)
- 7s. Sm-154 from Wenzel
- 7t. Tc-99 from Wenzel
- 7u. Y-90 = Sr-90
- 7v. H-3 = composite H-3 (ave of tanks for which have data)
- 7w. I-129 = composite I-129 (ave of tanks for which have data)

8. Radionuclide activities are decayed to Jan. 2008. Decay products were not added except for ^{137}Ba from ^{137}Cs and ^{90}Y from ^{90}Sr .

9. UDS chemical composition is based on tank farm solids analyses documented in M. C. Swenson to M. R. Christiansen, *Historical Tank Farm Sample Results*, MCS-27-92, December 17, 1992, Attachments 3-10. Calculation of chemical composition is as followed:

- 9a. Because of incomplete analyses for other tanks, only analyses for WM-180, WM-181 and WM-186 solids were used
- 9b. Zr was assumed precipitated as a hydrated sulfate based on JDC-06-96 and Schi-28-96
- 9c. PO₄ was assumed precipitated as AlPO₄
- 9d. All other species assumed precipitated as oxides
- 9e. Analysis data was converted to compounds, and then the balance (1-total wt fraction) was assumed to be SiO₂
- 9f. Analytical data for the three tanks was averaged assuming equal UDS content in liquid from each tank

10. UDS fission product activity is also based on analytical data in MCS-27-92

10a. Only analyses for WM-180, WM-181, WM-184 and WM-186 solids are used

10b. Analytical data for the tanks was averaged assuming equal UDS content in the liquid from each tank

10c. Activities were decayed from date of analyses to Jan, 2008. Decay products were not included.

11. UDS actinide activity taken from an e-mail note from Arlin Olson to Vic Jacobson, 8/12/97 (and decayed from 1983 to Jan, 2008)

HLLW Evaporation

12. Tank farm liquid was assumed to be evaporated as follows:

12a. Liquid in WM-180, WM-183, WM-185, WM-188 & WM-189 was not evaporated, having specific gravities of 1.28, 1.24, 1.28, 1.32 and 1.31 respectively.

12b. Based on a phone conversation with Frank Ward, liquid in WM-181 was combined with WM-184 and evaporated in a 1:1 blend. The evaporated volume was as given in R. E. Schindler, *HLLWE Feed Blends for Wastes from WM-186, WM-184 and WM-181*, July 28, 1998, Schi-17-98.

12c. Liquid in WM-186 was evaporated to a volume given in R. E. Schindler, *HLLWE Feed Blends for Wastes from WM-186, WM-184 and WM-181*, July 28, 1998, Schi-17-98.

12d. Liquid in WM-183 and WM-187 was evaporated to a total dissolved solids concentration of about 530 g/l. This was equivalent to a concentration factor of 1.67 for WM-183 and 2.0 for WM-187.

Newly Generated Liquid Waste Volumes and Composition

13. NGLW volumes and compositions taken from the May, 1998 INEEL Liquid Waste Management Plan, draft to DOE-ID with exceptions as noted below. Volumes taken from Appendix C; compositions from Appendix B

14. Because tank farm heel volumes were included in the volume of the tank farm waste, they were deleted from the NGLW

15. Because the NWCF was assumed to be shut down as of 1998, all NGLW generated from NWCF operations after 1999 was deleted

16. NWCF wastes generated in 1999 was adjusted to be nearly equal (to

within 1%) to that shown in Appendix B for calciner closure flushes.

17. The composition of NGLW is assumed to be as follows:

- Type 1 The average for the tank farm was used for concentrated Type 1 waste
- Type 2 Group 1 The composition for waste 7o was used (for dilute waste)
- Type 2 Group 2 The composition for waste 7o was used (for dilute waste)
- Type 2 Group 3 The average for the tank farm was used for concentrated Type 1 waste
- Type 2 Group 4 The composition of stream 7c was used for it's volume, the composition of 7e for the rest of group 4 wastes.
- Type 2 Group 5 The composition for waste 5 was used (see PEW Descale worksheet)
- Type 2 Group 6 The average for the tank farm was used for concentrated Type 1 waste
- Type 2 Group 7 Since no compositions are available for this waste, all other streams were prorated up in volume to account for the Group 7 volume

Tank Farm Liquid Transfer

18. Transfer of liquid waste from the tank farm to the process feed tank by steam jet is assumed to add 8% to the volume.

UDS Filtration & UDS Product

19. 80% removal of UDS by filtration is assumed.

20. The UDS filter backwash is assumed to have an average solids content of 60 g/l.

21. A density of 1.4 g/cm³ is assumed for the dried UDS waste.

22. To bound composition and activities ranges of waste products, the material balance includes streams in which all of the 20% of UDS not removed by filtration is assumed to either remain with the ion exchange sorbant or pass through the ion exchange column and be mixed into the grout waste.

Cesium Removal

23. The assumed removal efficiency for cesium is 99.9%. (Basis: Gary Stegen, memo to W. B. Palmer, *Additional SBW Separations and Backup Options*, Nov. 11, 1997. Later dose rate calculations have confirmed that this efficiency results in grout with a dose rate under 200 mR/hr. Discussions with Terry Todd and Ken Brewer have confirmed that the assumed removal efficiency is achievable with the selected sorbant.)

24. It is assumed that no species other than cesium are removed in the ion exchange column.

25. Cesium is assumed to be removed with UOP's IONSIV IE-911 sorbant, a crystalline silicotitanate (CST). Cesium cannot be efficiently removed from this sorbant, hence it is not regenerated.

24a. The density of IONSIV IE-911 assumed to be 1.0 g/cm³, as per phone conversation with Terry Todd.

24b. The loading at change-out of the resin is obtained by prorating the value of 4.78 mg Cs/ g resin (at 9 mg/l Cs), obtained in e-mail note from Terry Todd, by the ratio of Cs in the feed

26. No pH adjustment will be made prior to ion exchange.

27. The amount of ions (Ca + 2, others) released by the resin in exchange for Cs⁺ is assumed negligible relative to the total solids in the IX effluent.

28. The spent Cs sorbant will not be washed before unloading to remove actinides or other species. The spent Cs sorbant will be sluiced out of the column with a volume of water 10 times that of the sorbant. (If future testing shows that this volume is inadequate to remove residual acidity and that acidity negatively affects the performance of the subsequent drying step or the sorbant storage, an in-column water wash step can be added to the process.)

Neutralization and Grouting

29. The ion exchange effluent will be neutralized with CaO to a pH of 1.3.

30. The volume of neutralized waste is assumed the sum of the ion exchange effluent and volume of water produced in the neutralization.

31. A waste loading of 40% (as liquid waste) is assumed for the grout. The grouted waste quantity is based on the liquid waste feed (tank farm liquid and NGLW) before dilution by jet transfer, water from sorbant sluicing, and neutralization. The 40% loading is equivalent, for the average material balance case, to a loading of 20% expressed as weight of waste solids per

unit weight of grout. (Basis for loading: Phone conversation with Alan Herbst, July 7, 1998)

32. Grout additives are Portland cement, blast furnace slag and fly ash in a weight ratio of 1:3:1. (Basis: Phone conversation with Alan Herbst, July 7, 1998)

33. The density of the grouted waste is assumed to be 1900 kg/m³. (Basis: Phone conversation between Syl Losinski and Alan Herbst, August xx, 1998)

2. TRU Waste Form Evaluation

A very brief evaluation was performed to determine the form of the TRU waste. Four waste forms were considered: grout, absorbed waste on a low density silica-based absorbant, absorbed waste on a clay-based absorbant, and absorbed waste on an inorganic polymer absorbant. The criteria used to select the waste form for the TRU waste included:

1. Process operational simplicity:
 - Does the waste form require a mixer?
 - Does the waste form require neutralization?
2. Solidified waste volume
3. Development status:
 - Is there data to support waste loading, chemical interactions with the solidification media, final waste density, etc.?
4. Cost.

The potential advantage of a low-density, silica- or polymer-based absorbant is process operational simplicity. A waste container would be filled with a given amount of absorbant and liquid waste would be added. No mixing, no neutralization, no curing, and no decontamination of equipment would be required. Based on a brief review of commercial absorbants, Ultrasorb 244, a product of the Molton Corporation, was selected as representative of a high-capacity, inorganic absorbant for aqueous liquids. Ultrasorb 244, a granular diatomaceous earth, absorbs approximately 150% of its weight. Based on product literature for Ultrasorb, neutralization would not be required, as the product is stable with all acids except HF.

Inorganic polymer absorbants offer even higher absorption capacities, although at a higher cost. ACIDBOND A660, marketed by Nochar, is presently being tested using INEEL wastes, including a SBW simulant. Although final test data is not

available, based on tests of other wastes it is reasonable to expect that ACIDBOND A660 would absorb 85 lbs of waste per 15 lbs of absorbant, and result in a 10-20% volume increase over the original liquid volume. The resultant waste is a soft, rubber-like solid.

The potential advantage of a clay-based absorbant is a lower final waste volume. The Aquaset/Petroset products of Fluid Tech, Inc. were selected as representative of a clay-absorbant. Fluid Tech products have been tested and/or used in numerous nuclear waste applications, including some at the INEEL. Testing has not been done for solidification of SBW. For aqueous wastes containing a high level of dissolved salts, Fluid Tech literature recommends using 125-175 lbs of Aquaset II per 43-47 gallons of waste. For acidic wastes, neutralized to a pH of 5-10, the formulation is similar, 125-175 lbs of a combination of Aquaset II and Petroset to 42-47 gallons of waste. Mixing of the waste with Aquaset/Petroset would be required.

Table 1 gives a comparison of the three waste forms.

Table 1. Comparison of TRU Waste Forms.

	Grout	Ultrisorb	Aquaset	Acidbond
Waste Volume, m3	7,500	12,500	6,100-6,800	5,300-5,700
Neutralization req'd	Yes(1)	No (2)	Yes(3)	No
Mixing Required	Yes	No	Yes	No
Cost of absorbant	\$430,000	\$465,000	\$1,800,000	\$32,000,000
Test data available	Yes	No	No	No

Notes

1. Neutralization to pH of 1.3 with CaO
2. Neutralization not needed except possibly to tie up HF
3. Neutralization to pH 7 with NaOH

The comparison shows that Ultrisorb results in a much higher volume of waste than the other alternatives. The range of waste volumes shown for Aquaset are based on (1) 45 gal of waste with 175 lbs of absorbant per drum and (2) 41 gal of waste with 250 lbs of absorbant per drum. The higher waste loading is based on Fluid Tech literature. The lower loading is based on treatability study data for concentrated nitric acid waste performed at Sandia.¹ As shown in the above table, the volume of waste when solidified with Aquaset/Petroset is potentially 14-22% less than when grouted; however, no saving would be expected on equipment, and the cost of the solidification agents would be 3-5 times more than grout.

Based on the limited information presently available for ACIDBOND, it appears to result in 20-30% less final waste volume than a grout product. Data from tests of ACIDBOND with SBW simulants is needed to confirm the above waste volume.

Also data is needed to evaluate the long-term stability of the product. The disadvantage of the ACIDBOND product are the cost of the absorbant.

The development program for grouting INTEC liquid wastes has focused on producing a high-strength grout.^{2,3} The WIPP WAC does not contain a strength requirement. It is expected that with further development, with the goal of minimizing waste volume and not being constrained by a grout strength requirement, the volume of final waste can be reduced to the range shown above for Aquaset or ACIDBOND. Because of the test data available for grouting of SBW, along with the comparison above that show a higher volume for Ultrasorb, additional costs and a relatively small reduced volume for Aquaset, and the high absorbant cost and unknown long-term stability for ACIDBOND, grout was selected for the waste form to use in this feasibility study. Because of the SBW grouting data² there is high confidence that the grout volume shown in the material balance can be achieved. Should the CsIX/TRU Grout be carried into a conceptual design, additional studies on waste forms are recommended. These studies should include testing of evaporation of the ion exchange effluent, grout formulations and loadings other than those tested to date and absorbants that have the potential for minimizing the final waste volume.

3. Rationale for Selecting the Cesium Sorbant

Ion exchange is a common separations process that in general is both highly efficient and highly selective. Removal of cesium by ion exchange has been tested or is being used at several DOE sites. No process other than ion exchange was considered for cesium removal.

The selection of the ion exchange resin or sorbant to remove cesium was based on the following factors:

1. The achievable efficiency of the process to remove cesium. A high efficiency is required in order to produce an effluent that, when solidified, will be contact handled.
2. The achievable selectivity of the process to remove cesium. The more selective for cesium, the lower the quantity of cesium-loaded waste is likely to be.
3. The available data for the sorbant/resin. The more data that is available for a process, the higher the confidence that expected efficiencies, selectivities, waste volumes, and costs can be achieved.
4. The composition of the cesium-loaded waste. The waste should be compatible with both anticipated future treatment requirements and anticipated storage requirements.
5. The availability and cost of the sorbant/resin needed for the process.

Three ion exchange sorbants have been evaluated for cesium removal from INTEC liquid waste.⁵ All three have been shown to be effective for removing cesium from INTEC liquid waste, although one, a potassium copper hexacyanoferrate sorbant (FS-2), has recently been shown to absorb mercury, which reduces the sorbant's capacity for cesium. The availability of FS-2 is also questionable, being manufactured only in Russia. A second sorbant, an ammonium molybdophosphate on a polyacrylonitrile binder (AMP-PAN), contains 15% organic material. Storage of the spent AMP-PAN sorbant would be problematic because of the potential for radiolytic degradation of the organic material. Also, the spent sorbant with its high cesium content may be eventually disposed by processing in a high level waste melter. The organic material present in the AMP-PAN sorbant may pose difficulties in a glass melter.³ The third sorbant tested, a commercially-available crystalline silicotitanate (CST) is inorganic, and has been shown to be compatible with high level waste vitrification.⁴ Thus, based on the above factors, the CST sorbant, UOP's IONSIV IE-911, was selected for cesium removal from INTEC waste. Additional data is needed on removal of cesium from tank farm wastes with IONSIV IE-911, specifically data absorption of other species and data from larger-scale tests.

4. Process Description

Waste Transport from Tank Farm

Transport of waste from the Tank Farm to the CsIX/TRU Grout Facility will use major portions of the existing Tank Farm Transport System which are capable of conveying waste from the Tank Farm to the NWCF. Modifications to the transport system are required for the stand-alone facility option, while it is possible that the existing system can function without modification for the NWCF option.

The existing system uses steam jets to transport waste from tanks WM-180,-181,-182, -183, -184, -185, -196, -187, and uses air jets to transport waste from tanks WM-189, and -190. Receiving tanks in the CsIX/TRU Grout Facility will be capable of accepting waste from all tanks.

Modifications to the existing steam and air jet transport system for the CsIX/TRU Grout Facility option include a tie-in to the existing transport lines and possible lift station which will develop adequate head pressure to deliver waste to the liquid waste feed tanks.

It is also assumed that waste will be transferred to the CsIX/TRU Grout Facility in batch mode. Two major reasons for this are that the existing transport system is not capable of conveying waste at the low (1gpm) steady state feed rate used in

the CsIX/TRU Grout process, and, it is expected that sampling of waste materials for purposes of process control will be performed on a batch basis.

This design includes two tanks capable of accepting waste from the Waste Transport System. Each tank is sized nominally at 3500 gal capacity. This tank size allows for a reasonable transport batch cycle time, of approximately 2 hours, and is based on the feed rate of the existing Tank Farm Transport Systems.

Solids Filtration

This design includes provisions for filtration of the liquid waste prior to introduction to the ion exchange columns. The primary function of the filtration system is to protect the ion exchange resin bed from becoming blinded with solids particles. The design also includes provisions for drying and packaging the UDS collected during filtration.

A combination of two vertical leaf pressure filters will provide continuous filtering capability at a capacity of 1.2 gpm. Filter media will be selected which provides for removal of particles larger than 10 microns. The filter will also be equipped with a scavenger leaf which will allow draining of vessel water off of the filter cake. At any given time one filter will be on-line while the other is being drained and back flushed. The filter that is off-line will be drained and the filter cake back flushed with deionized water into a slurry tank. Filter transition (from on-line to off-line) will be initiated by setpoint pressure differential.

Slurry from the slurry tank will be metered to a rotary wiped film evaporator where the slurry will be dried and sized to a flowable particulate solid. Slurry is assumed to be 10% solids by weight and will be fed to the evaporator at approximately 1.7 Kg/min. The evaporator will fill 55 gal drums with the particulate solids. Off-gas from the evaporator will be directed through a condenser and then sent to the Vent Off Gas System. Condensed water will be returned to the HLLWE.

Considerable uncertainty exists in the quantity and character of the suspended UDS in the waste stream, which makes specification of the filtration system quite difficult. Limited particle size distribution data available shows that a large fraction of the UDS in the liquid waste is in the sub-micron size, which is an indication of a potentially significant filtration problem should these particles need to be removed. As discussed later in this report empirical filtration data must be obtained on the liquid wastes to further refine this filtration process.

Cesium Removal

Cesium removal is accomplished in this design by the use of ion exchange columns packed with a crystalline silicotitanate (CST) sorbant. Three ion exchange columns are included in the design. The columns are nominally sized at 16" diameter by 96" tall and will contain 0.25 m³ sorbant. At any given time, two columns will be on-line and configured for in-series flow at a nominal capacity of 1.2 gpm. The third column will be off-line while spent sorbant is sluiced from the column and fresh sorbant is added.

Pressure drop through the ion exchange columns is expected to be less than 3psi based on theoretical calculations and experience with operating similar ion exchange columns at ORNL⁷.

Lead-lag configuration and valve timing of the ion exchange columns will be automatically controlled, and is based on cesium breakthrough of the lead ion exchange column. When breakthrough of the lead column is measured, the columns will sequence so that the lag column will become the lead column, the newly charged fresh column will become the lag column

Spent sorbant sluiced from the ion exchange column will be dried and stored in a bulk storage tank. The spent sorbant will be decanted of free liquid in a waste resin preparation column. The waste resin preparation column feeds a hollow flight drier which, using heat and hot air, will dry the sorbant. The hollow flight drier is nominally sized to process 2.1 l/hr of moist resin

Dried sorbant will flow by gravity to a spent resin storage tank. The spent resin storage tank is sized at 15 m³ to hold all of the sorbant generated during the life cycle of the facility. The estimated total spent resin quantity is estimated to be 10.5 m³.

Fresh sorbant will be preconditioned in a resin preparation tank and then sluiced to the off-line ion exchange column.

Solidification

SBW and NGLW, having passed through the cesium ion exchange columns, will then be grouted to form a solid TRU wasteform. The liquid waste will be neutralized in grout feed tanks, mixed with cement ingredients, and then cast in a 55 gal drum. The cement based grout will be allowed to cure, and the drum prepared for shipment to an interim storage facility.

Neutralization of the liquid waste to a specified setpoint of pH1.3, will be accomplished by the addition of calcium oxide (lime) to a grout feed tank. Because it is difficult to accurately measure the pH of a highly acidic mixture containing various ionic compounds, an automated system will titrate a known small volume of the liquid waste to a neutral pH. (It is easier to obtain accurate measurements at a neutral pH.) Results of this titration will be utilized to calculate the quantity of CaO required to neutralize the grout feed tank to the setpoint.

Neutralized liquid waste will then be metered to one of three grout mixers. Each ribbon blender type mixer is capable of mixing one 55 gal drum of grout. Premeasured quantities of solid ingredients (cement, blast furnace slag, and fly ash) will then be added to the liquid waste and thoroughly blended. The mixer will convey the grout into a casting head which will fill the waiting 55 gal drum.

Upon completion of a mix cycle the next batch of liquid waste to be solidified will be added to the mixer. This will be performed to prevent residual grout from hardening in the mixer. High pressure wash/ decontamination nozzles are also provided in the mixer so that the grout mixers can be turned off at the end of a production run, or for maintenance purposes.

Table 2 gives an approximate mixer cycle time. ,

Table 2. Mixer cycle Time

Step	Description	Time (min)
1	Operator Initiation of Mix	10
2	Feed Liquid	10
3	Operator Validation of Wet and Dry Ingredients	5
4	Dry Ingredient Delivery	15
5	Continuous Mix	10
6	Cast Mix	10
7	Operator Validation of Mix	10
Total		70

Cast drums of grout will be conveyed via a mechanical conveyor to a contamination check station to ensure that no external contamination of the 55 gal drum has occurred. After verification that the external surface of the container is clean, the drum will be moved to a cure station. The cure station will provide a 24 hour residence time so that the grout may harden.

After the grout has cured the 55 gal waste drum will be moved, via a mechanical conveyor, to a dewatering station where hot air will be passed through the head

space of the drum. Dewatering is performed to ensure that there is no free water in the headspace of the drum.

The cured waste drum will then be checked using video surveillance to ensure that the grout is properly set, and then properly labeled in accordance with applicable storage and shipping requirements. The labeled drum will be moved to the interim storage facility.

In conformance with WIPP waste acceptance requirements, grout drums will undergo a visual inspection for free liquids and sampling of the gas headspace for hydrogen, VOCs, and tritium. Equipment to perform the inspection and gas headspace sampling will be located in the interim storage facility

5. Process Flow Diagrams

Process flow diagrams for this process are attached at the end of this EDF.

Process Flow Diagrams

- 01 –Block Flow Diagram
- 02 –Materials Delivery/Storage
- 03 –Liquid Waste Feed/Storage
- 04 –UDS Filtration Drying/Packaging
- 05 –CslX Stripping
- 06 –IX Column Preparation/Washing, Spent Resin Drying/Packaging
- 07 –SBW Neutralization
- 08 –Grout Mixing/Casting, Mixer Decontamination
- 09 –Waste Drum Decontamination
- 10 –Cure/Dewater Station
- 11 –Grout Rework
- 12 –Off-Gas Control System
- 13 –Interim Storage Shipment

Also see the associated equipment list for the process equipment immediately following the process flow diagrams.

10/20/98		Average Composition Material Balance						p. 1 of 6	
		Case A = Unfiltered UDS passing through IX column to grout							
		Composite SBW		Newly Gen Liq Waste		Total Feed (Note 2)			
		(incl TF flushes)		1998 through 2012					
	Density, g/l	1314		1250			1279		
	Total Liters	3.6E+06		7.4E+05			4.8E+06		
	Stream No.	101	101	102	102		103	103	
MW		Moles/liter	g/liter	Moles/liter	g/liter		Moles/liter	g/liter	
107.868	Ag+2	2.31E-05	2.49E-03	1.37E-05	1.48E-03		1.98E-05	2.14E-03	
26.9815	Al+3	8.48E-01	2.29E+01	5.84E-01	1.57E+01		7.39E-01	1.99E+01	
74.92	As+3	4.86E-05	3.64E-03	2.85E-05	2.14E-03		4.16E-05	3.12E-03	
10.81	B+3	2.23E-02	2.41E-01	1.32E-02	1.42E-01		1.91E-02	2.07E-01	
137.34	Ba+2	5.98E-05	8.22E-03	3.54E-05	4.86E-03		5.13E-05	7.04E-03	
40.08	Ca+2	6.48E-02	2.60E+00	4.41E-02	1.77E+00		5.64E-02	2.26E+00	
112.4	Cd+2	3.75E-03	4.21E-01	2.20E-03	2.48E-01		3.21E-03	3.61E-01	
35.453	Cl-	3.68E-02	1.30E+00	3.13E-02	1.11E+00		3.30E-02	1.17E+00	
51.996	Cr+3	5.09E-03	2.65E-01	3.08E-03	1.60E-01		4.37E-03	2.27E-01	
132.9	Cs+ (Note 1)	2.53E-05	3.36E-03	1.49E-05	1.98E-03		2.17E-05	2.88E-03	
18.998	F-	1.27E-01	2.42E+00	1.16E-01	2.21E+00		1.15E-01	2.19E+00	
55.847	Fe+3	3.02E-02	1.68E+00	1.77E-02	9.89E-01		2.58E-02	1.44E+00	
1.008	H+	2.05E+00	2.07E+00	1.31E+00	1.32E+00		1.77E+00	1.79E+00	
200.59	Hg+2	2.72E-03	5.45E-01	1.74E-03	3.50E-01		2.35E-03	4.71E-01	
39.1	K+	2.28E-01	8.92E+00	1.44E-01	5.64E+00		1.97E-01	7.70E+00	
54.938	Mn+2	1.11E-02	6.10E-01	7.19E-03	3.95E-01		9.60E-03	5.28E-01	
95.94	Mo+6	6.61E-04	6.34E-02	3.88E-04	3.72E-02		5.65E-04	5.42E-02	
22.99	Na+	2.07E+00	4.76E+01	1.33E+00	3.07E+01		1.79E+00	4.12E+01	
92.906	Ni+2	2.21E-03	2.06E-01	1.32E-03	1.22E-01		1.90E-03	1.76E-01	
62.01	NO3-	6.96E+00	4.31E+02	4.56E+00	2.83E+02		6.03E+00	3.74E+02	
207.19	Pb+2	1.78E-03	3.69E-01	1.05E-03	2.17E-01		1.52E-03	3.15E-01	
94.972	PO4-3	1.58E-02	1.50E+00	9.29E-03	8.82E-01		1.35E-02	1.29E+00	
78.96	Se+4	2.55E-05	2.02E-03	1.52E-05	1.20E-03		2.19E-05	1.73E-03	
96.06	SO4-2	5.84E-02	5.61E+00	4.47E-02	4.29E+00		5.16E-02	4.96E+00	
237.7	U+4	4.03E-04	9.57E-02	3.65E-02	8.66E+00		5.98E-03	1.42E+00	
91.22	Zr+4	8.31E-03	7.58E-01	4.88E-03	4.45E-01		7.11E-03	6.49E-01	
	UDS, g/liter	3.42E+00	3.42E+00	7.32E+00	7.32E+00		3.75E+00	3.75E+00	
	Other			3.04E-03	(Note 3)				
	TOC, g/l			5.40E+00	(Note 4)				
	Total g/liter		5.35E+02		3.66E+02			4.66E+02	

For notes see after last table.

Note: Radionuclide concentrations are of the liquid and do not include activity of the UDS

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10/20/98	Average Composition Material Balance						p. 3 of 6	
	Filtered Feed		IX Effluent			Dried UDS	Spent IX Sorbant	
g/liter	1279		1279		Tot. kg	1.4E+04	1.3E+04	9.0E+03
Total liters	4.8E+06		4.8E+06		Tot. m3	10	12	9
Stream No.	105	105	106	106		107	108	108A
	Moles/liter	g/liter	Moles/liter	g/liter		Wt %	Wt %	Wt %
Ag+2	1.98E-05	2.14E-03	1.98E-05	2.14E-03	AlPO4	12.7		
Al+3	7.39E-01	1.99E+01	7.39E-01	1.99E+01	Al2O3	3.6		
As+3	4.16E-05	3.12E-03	4.16E-05	3.12E-03	B2O3	7.8		
B+3	1.91E-02	2.07E-01	1.91E-02	2.07E-01	CaO	1.3		
Ba+2	5.13E-05	7.04E-03	5.13E-05	7.04E-03	Cr2O3	0.3		
Ca+2	5.64E-02	2.26E+00	5.64E-02	2.26E+00	Fe2O3	2.1		
Cd+2	3.21E-03	3.61E-01	3.21E-03	3.61E-01	HgO	0.5		
Cl-	3.30E-02	1.17E+00	3.30E-02	1.17E+00	K2O	2.2		
Cr+3	4.37E-03	2.27E-01	4.37E-03	2.27E-01	MnO	0.6		
Cs+ Note1	2.17E-05	2.88E-03	2.17E-08	2.88E-06	Na2O	6.0		
F-	1.15E-01	2.19E+00	1.15E-01	2.19E+00	NiO	1.8		
Fe+3	2.58E-02	1.44E+00	2.58E-02	1.44E+00	SiO2	36.6		
H+	1.77E+00	1.79E+00	1.77E+00	1.79E+00	ZSQ	24.5		
Hg+2	2.35E-03	4.71E-01	2.35E-03	4.71E-01				
K+	1.97E-01	7.70E+00	1.97E-01	7.70E+00	ZSQ = Zr(SO4)2*4H2O			
Mn+2	9.60E-03	5.28E-01	9.60E-03	5.28E-01				
Mo+6	5.65E-04	5.42E-02	5.65E-04	5.42E-02	UDS Particle Size Distribution			
Na+	1.79E+00	4.12E+01	1.79E+00	4.12E+01	Microns	Percent		
Ni+2	1.90E-03	1.76E-01	1.90E-03	1.76E-01	>45	15-75		
NO3-	6.03E+00	3.74E+02	6.03E+00	3.74E+02	20-45	5-37		
Pb+2	1.52E-03	3.15E-01	1.52E-03	3.15E-01	11-20	4-16		
PO4-3	1.35E-02	1.29E+00	1.35E-02	1.29E+00	4.5-11	3-26		
Se+4	2.19E-05	1.73E-03	2.19E-05	1.73E-03	0.45-4.5	9-18		
SO4-2	5.16E-02	4.96E+00	5.16E-02	4.96E+00				
U+4	5.98E-03	1.42E+00	5.98E-03	1.42E+00				
Zr+4	7.11E-03	6.49E-01	7.11E-03	6.49E-01				
UDS, g/liter	7.51E-01	7.51E-01			Stream 119, Feed Sorbant, kg			9.0E+03
		4.63E+02		4.62E+02				liters
			Wt fraction		Water for UDS Backwash			2.4E+05
Tot non rad Cs removed, kg		13.7			UDS Drier Effluent to PEW			2.4E+05
Tot rad Cs removed, kg		6.8			Water for Sorbant Flush			9.0E+04
Ratio, nonrad to rad		2.0			Sorbant Drier Condensate to PEW			9.0E+04
Cs-137, kg		2.8	0.138		Stream 118, Total Feed Water			3.3E+05
Cs-135		4.0	0.193					
Cs-134		0.00	0.000					
Cs-133		13.7	0.669					

[illegible]

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10/20/98	Average Composition Material Balance						p. 5 of 6
					Grouted Waste		
		Neutralized Waste			w/o UDS	w/ UDS	
				Density, kg/m3	1900	1900	
Density, g/liter		1310		Total kg	1.4E+07	1.4E+07	
Total Liters		4,844,104		Total m3	7.5E+03	7.5E+03	
		113	113		117	117A	
		Moles/liter	g/liter		g/kg	g/kg	
Ag+2		1.95E-05	2.10E-03		7.13E-04	7.13E-04	
Al+3		7.28E-01	1.96E+01		6.65E+00	6.65E+00	
As+3		4.10E-05	3.07E-03		1.04E-03	1.04E-03	
B+3		1.88E-02	2.03E-01		6.89E-02	6.89E-02	
Ba+2		5.05E-05	6.93E-03		2.35E-03	2.35E-03	
Ca+2		9.03E-01	3.62E+01		1.23E+01	1.23E+01	
Cd+2		3.16E-03	3.55E-01		1.20E-01	1.20E-01	
Cl-		3.25E-02	1.15E+00		3.90E-01	3.90E-01	
Cr+3		4.30E-03	2.24E-01		7.58E-02	7.58E-02	
Cs+ (Note 1)		2.13E-08	2.84E-06		9.61E-07	9.60E-07	
F-		1.14E-01	2.16E+00		7.32E-01	7.31E-01	
Fe+3		2.54E-02	1.42E+00		4.81E-01	4.81E-01	
H+		5.00E-02	5.04E-02		0.00E+00	0.00E+00	
Hg+2		2.31E-03	4.64E-01		1.57E-01	1.57E-01	
K+		1.94E-01	7.58E+00		2.57E+00	2.57E+00	
Mn+2		9.46E-03	5.19E-01		1.76E-01	1.76E-01	
Mo+6		5.57E-04	5.34E-02		1.81E-02	1.81E-02	
Na+		1.76E+00	4.06E+01		1.37E+01	1.37E+01	
Ni+2		1.87E-03	1.74E-01		5.88E-02	5.88E-02	
NO3-		5.94E+00	3.68E+02		1.25E+02	1.25E+02	
Pb+2		1.50E-03	3.11E-01		1.05E-01	1.05E-01	
PO4-3		1.33E-02	1.27E+00		4.29E-01	4.29E-01	
Se+4		2.16E-05	1.70E-03		5.77E-04	5.76E-04	
SO4-2		5.08E-02	4.88E+00		1.65E+00	1.65E+00	
U+4		5.88E-03	1.40E+00		4.74E-01	4.74E-01	
Zr+4		7.00E-03	6.39E-01		2.16E-01	2.16E-01	
Si+4						4.28E-02	
Tot g/liter			4.87E+02		1.65E+02	1.65E+02	
Grout Additive Feeds				P. cement	1.11E+02	1.11E+02	
		Stream	kg	B.F. slag	3.34E+02	3.34E+02	
P. Cement		114	1,593,482	Flyash	1.11E+02	1.11E+02	
B. F. Slag		116	4,780,446	Water	2.78E+02	2.78E+02	
Flyash		115	1,593,482				
CaO		109	230,320				

ENGINEERING DESIGN FILE

10/20/98	Average Composition Material Balance						p. 6 of 6
	Neutralized Waste			Grouted Waste			
Stream No.	113			117	117	117A	117A
	Ci/liter			Ci/kg	Total Ci	Ci/kg	Total Ci
Am-241	4.58E-04			1.55E-04	2.22E+03	1.55E-04	2.22E+03
Am-243	2.07E-07			7.00E-08	1.00E+00	7.00E-08	1.00E+00
Cm-242	1.08E-06			3.67E-07	5.24E+00	3.66E-07	5.24E+00
Cm-244	1.46E-05			4.95E-06	7.07E+01	4.94E-06	7.07E+01
Np-237	2.51E-06			8.52E-07	1.22E+01	8.56E-07	1.22E+01
Pu-238	8.48E-04			2.87E-04	4.11E+03	3.05E-04	4.36E+03
Pu-239	6.47E-05			2.19E-05	3.13E+02	2.29E-05	3.27E+02
Pu-240	1.87E-05			6.34E-06	9.07E+01	6.64E-06	9.49E+01
Pu-241	3.74E-04			1.27E-04	1.81E+03	1.33E-04	1.90E+03
Pu-242	1.45E-08			4.92E-09	7.03E-02	5.36E-09	7.67E-02
Th-230	6.74E-10			2.28E-10	3.26E-03	2.28E-10	3.26E-03
Th-231	9.65E-08			3.27E-08	4.68E-01	3.27E-08	4.68E-01
U-232	1.90E-09			6.45E-10	9.23E-03	6.45E-10	9.23E-03
U-233	1.03E-11			3.48E-12	4.98E-05	3.48E-12	4.98E-05
U-234	9.64E-07			3.27E-07	4.67E+00	3.32E-07	4.76E+00
U-235	2.40E-08			8.15E-09	1.16E-01	8.28E-09	1.18E-01
U-236	4.69E-08			1.59E-08	2.27E-01	1.59E-08	2.28E-01
U-238	2.59E-08			8.79E-09	1.26E-01	8.81E-09	1.26E-01
Ba-137m	4.81E-05			1.63E-05	2.33E+02	1.63E-05	2.33E+02
Ce-144	1.35E-07			4.56E-08	6.52E-01	4.56E-08	6.52E-01
Co-60	5.07E-05			1.72E-05	2.45E+02	1.72E-05	2.46E+02
Cs-134	4.23E-08			1.43E-08	2.05E-01	1.56E-08	2.23E-01
Cs-135	9.40E-10			3.18E-10	4.55E-03	3.18E-10	4.55E-03
Cs-137	5.09E-05			1.72E-05	2.47E+02	5.01E-05	7.17E+02
Eu-152	2.77E-06			9.39E-07	1.34E+01	9.38E-07	1.34E+01
Eu-154	1.60E-04			5.43E-05	7.77E+02	5.43E-05	7.77E+02
Eu-155	6.98E-05			2.37E-05	3.38E+02	2.37E-05	3.38E+02
Pm-147	1.35E-04			4.58E-05	6.55E+02	4.58E-05	6.55E+02
Pr-144	5.88E-05			1.99E-05	2.85E+02	1.99E-05	2.85E+02
Ni-63	4.86E-05			1.65E-05	2.35E+02	1.65E-05	2.35E+02
Ru-106	3.22E-07			1.09E-07	1.56E+00	1.09E-07	1.56E+00
Sb-125	1.08E-05			3.65E-06	5.22E+01	3.79E-06	5.42E+01
Sm-151	4.76E-04			1.61E-04	2.30E+03	1.61E-04	2.30E+03
Sr-90	3.38E-02			1.14E-02	1.64E+05	1.15E-02	1.64E+05
Tc-99	1.47E-05			4.97E-06	7.10E+01	4.97E-06	7.10E+01
Y-90	3.38E-02			1.14E-02	1.64E+05	1.14E-02	1.64E+05
H-3	2.97E-05			1.01E-05	1.44E+02	1.01E-05	1.44E+02
I-129	6.79E-06			2.30E-06	3.29E+01	2.30E-06	3.29E+01

Notes for Average Composition Material Balance:

1. Cesium shown above is Cs-133 only
2. Total feed includes 8% dilution due to steam jet transfer
3. "Other" includes Mg, Si and 13 other trace ions, which are not carried forward in the material balance.
4. Approx. 50% oxalic acid, 10% kerosene, 30% TEA, 10% DEA
5. Includes condensate from drying of UDS and spent Cs sorbant
6. Activities for liquid only, activity for UDS shown under stream 107
7. Data is not available to determine sorption of TRU or other radionuclides on sorbant. Thus actual activity of spent sorbant may be very different from what is shown here.

7. Material Balance for Liquid Waste from WM-181

Material balance tables are shown below for liquid from tank WM-181. Based on initial calculations, waste in WM-181, after evaporation, had the highest level of the radionuclides, ^{137}Cs and others, that contributed to the dose rate. The material balance for WM-181 was thus made for a "worst case". However, it was learned later in the study WM-181 will likely be blended with WM-184 or WM-186, and evaporated to a greater degree than was initially assumed. With this higher degree of concentration, along with tank heels that show higher radionuclide concentrations than the full tanks, the ^{137}Cs level in the composite waste became greater than the WM-181 case. This material balance is included for reference, but was not used for equipment sizing or selection in the study.

Material Balance - Worst Case (WM-181)						p. 1 of 4	10/20/98	
			Before Evap	After Evaporation		After jet Dilution	Cs Ion Exchange	
							Feed	Effluent
Volume, liters			1.0E+06	5.2E+05	5.2E+05	5.7E+05	5.8E+05	5.8E+05
Density, kg/l			1.16	1.30	1.30	1.28	1.27	1.27
Stream Number			100	101	101	103	105	106
	MW		Moles/liter	Moles/liter	g/liter	Moles/liter	Moles/liter	Moles/liter
Ag+2	107.868		3.04E-05	6.12E-05	6.60E-03	5.63E-05	5.50E-05	5.50E-05
Al+3	26.9815		2.30E-01	4.63E-01	1.25E+01	4.26E-01	4.16E-01	4.16E-01
As+3	74.92		3.82E-05	7.68E-05	5.75E-03	7.07E-05	6.91E-05	6.91E-05
B+3	10.81		1.60E-02	3.22E-02	3.48E-01	2.96E-02	2.90E-02	2.90E-02
Ba+2	137.34		3.78E-05	7.62E-05	1.05E-02	7.01E-05	6.85E-05	6.85E-05
Ca+2	40.08		4.60E-02	9.26E-02	3.71E+00	8.52E-02	8.33E-02	8.33E-02
Cd+2	112.4		5.50E-03	1.11E-02	1.24E+00	1.02E-02	9.95E-03	9.95E-03
Cl-	35.453		1.26E-02	2.54E-02	8.99E-01	2.33E-02	2.28E-02	2.28E-02
Cr+3	51.996		3.00E-03	6.04E-03	3.14E-01	5.56E-03	5.43E-03	5.43E-03
Cs+	132.9		1.09E-05	2.19E-05	2.92E-03	2.02E-05	1.97E-05	1.97E-08
F-	18.998		9.40E-02	1.89E-01	3.60E+00	1.74E-01	1.70E-01	1.70E-01
Fe+3	55.847		1.30E-02	2.62E-02	1.46E+00	2.41E-02	2.35E-02	2.35E-02
H+	1.008		1.89E+00	3.81E+00	3.84E+00	3.50E+00	3.42E+00	3.42E+00
Hg+2	200.59		4.70E-04	9.46E-04	1.90E-01	8.71E-04	8.51E-04	8.51E-04
K+	39.1		1.50E-01	3.02E-01	1.18E+01	2.78E-01	2.71E-01	2.71E-01
Mn+2	54.938		1.29E-02	2.60E-02	1.43E+00	2.39E-02	2.33E-02	2.33E-02
Mo+6	95.94		5.47E-04	1.10E-03	1.06E-01	1.01E-03	9.90E-04	9.90E-04
Na+	22.99		9.50E-01	1.91E+00	4.40E+01	1.76E+00	1.72E+00	1.72E+00
Ni+2	92.906		1.30E-03	2.62E-03	2.43E-01	2.41E-03	2.35E-03	2.35E-03
NO3-	62.01		3.87E+00	7.79E+00	4.83E+02	7.17E+00	7.00E+00	7.00E+00
Pb+2	207.19		1.10E-03	2.21E-03	4.59E-01	2.04E-03	1.99E-03	1.99E-03
PO4-3	94.972		6.42E-03	1.29E-02	1.23E+00	1.19E-02	1.16E-02	1.16E-02
Se+4	78.96		3.01E-05	6.07E-05	4.79E-03	5.58E-05	5.45E-05	5.45E-05
SO4-2	96.06		2.50E-02	5.03E-02	4.83E+00	4.63E-02	4.52E-02	4.52E-02
U+4	237.7		3.19E-04	6.43E-04	1.53E-01	5.92E-04	5.78E-04	5.78E-04
Zr+4	91.22		4.84E-03	9.74E-03	8.89E-01	8.96E-03	8.76E-03	8.76E-03
UDS, g/liter			1.70E-01	3.42E-01	3.42E-01	3.15E-01	3.07E-01	
Total solids					5.77E+02			
Notes:								
1. Cesium shown above is Cs-133 only								

Material Balance - Worst Case (WM-181)						p. 2 of 4	10/20/98
Note: all activities are decayed to Jan. 2008 except the original WM-181 tank composition							
		(Jan, 1998)	(Jan, 2008)		After jet	Cs Ion Exchange	
		Before Evap	After Evaporation		Dilution	Feed	Effluent
Stream Number		100	101	101	103	105	106
		Ci/liter	Ci/liter	Tot Ci	Ci/liter	Ci/liter	Ci/liter
Am-241		2.08E-04	4.12E-04	2.15E+02	3.79E-04	3.70E-04	3.70E-04
Am-243		9.28E-08	1.87E-07	9.73E-02	1.72E-07	1.68E-07	1.68E-07
Cm-242		5.04E-07	9.75E-07	5.08E-01	8.97E-07	8.76E-07	8.76E-07
Cm-244		9.28E-06	1.27E-05	6.65E+00	1.17E-05	1.15E-05	1.15E-05
Np-237		1.93E-07	3.89E-07	2.03E-01	3.57E-07	3.49E-07	3.49E-07
Pu-238		6.15E-04	1.14E-03	5.97E+02	1.05E-03	1.03E-03	1.03E-03
Pu-239		1.30E-05	2.62E-05	1.36E+01	2.41E-05	2.35E-05	2.35E-05
Pu-240		3.65E-06	7.34E-06	3.83E+00	6.75E-06	6.60E-06	6.60E-06
Pu-241		2.75E-04	3.42E-04	1.78E+02	3.15E-04	3.08E-04	3.08E-04
Pu-242		8.63E-09	1.74E-08	9.06E-03	1.60E-08	1.56E-08	1.56E-08
Th-230		5.17E-11	1.04E-10	5.43E-05	9.58E-11	9.36E-11	9.36E-11
Th-231		7.41E-09	1.49E-08	7.78E-03	1.37E-08	1.34E-08	1.34E-08
U-232		1.85E-09	3.39E-09	1.77E-03	3.12E-09	3.04E-09	3.04E-09
U-233		7.89E-13	1.59E-12	8.28E-07	1.46E-12	1.43E-12	1.43E-12
U-234		8.53E-07	1.72E-06	8.96E-01	1.58E-06	1.54E-06	1.54E-06
U-235		2.14E-08	4.31E-08	2.25E-02	3.96E-08	3.87E-08	3.87E-08
U-236		7.56E-08	1.52E-07	7.94E-02	1.40E-07	1.37E-07	1.37E-07
U-238		2.11E-08	4.25E-08	2.22E-02	3.91E-08	3.82E-08	3.82E-08
Ba-137m		2.78E-02	4.44E-02	2.31E+04	4.08E-02	3.99E-02	3.99E-05
Ce-144		1.80E-06	5.05E-10	2.63E-04	4.64E-10	4.54E-10	4.54E-10
Co-60		2.61E-04	1.41E-04	7.36E+01	1.30E-04	1.27E-04	1.27E-07
Cs-134		2.33E-04	1.63E-05	8.49E+00	1.50E-05	1.46E-05	1.46E-08
Cs-135		4.45E-07	8.95E-07	4.67E-01	8.23E-07	8.05E-07	8.05E-10
Cs-137		2.94E-02	4.70E-02	2.45E+04	4.32E-02	4.22E-02	4.22E-05
Eu-152		4.02E-06	4.86E-06	2.53E+00	4.47E-06	4.37E-06	4.37E-06
Eu-154		2.99E-04	2.69E-04	1.40E+02	2.47E-04	2.42E-04	2.42E-04
Eu-155		9.49E-05	4.72E-05	2.46E+01	4.35E-05	4.25E-05	4.25E-05
Pm-147		8.06E-04	1.16E-04	6.03E+01	1.06E-04	1.04E-04	1.04E-04
Pr-144		7.16E-05	9.65E-05	5.03E+01	8.88E-05	8.68E-05	8.68E-05
Ni-63		6.22E-05	1.17E-04	6.09E+01	1.08E-04	1.05E-04	1.05E-04
Ru-106		5.58E-06	1.18E-08	6.17E-03	1.09E-08	1.06E-08	1.06E-08
Sb-125		8.96E-05	1.48E-05	7.71E+00	1.36E-05	1.33E-05	1.33E-05
Sm-151		4.32E-04	8.05E-04	4.20E+02	7.41E-04	7.24E-04	7.24E-04
Sr-90		2.82E-02	4.48E-02	2.33E+04	4.12E-02	4.02E-02	4.02E-02
Tc-99		1.24E-05	2.50E-05	1.30E+01	2.30E-05	2.24E-05	2.24E-05
Y-90		2.82E-02	4.48E-02	2.33E+04	4.12E-02	4.02E-02	4.02E-02
H-3		2.11E-05	2.42E-05	1.26E+01	2.22E-05	2.17E-05	2.17E-05
I-129		3.30E-07	6.64E-07	3.46E-01	6.11E-07	5.97E-07	5.97E-07

ENGINEERING DESIGN FILE

Material Balance - Worst Case (WM-181)					p. 3 of 4		10/20/98	
	Spent Cs Sorbant		Dried UDS		Neutralized Waste		Grouted Waste	
	w/o UDS	w/ UDS					w/o UDS	w/ UDS
Vol, m3	1.1	1.12	0.10	Vol, liters	6.0E+05	6.0E+05	8.9E+05	8.9E+05
Density, kg/l	1.0	1.0	1.4	Dens., g/cm3	1.32	1.32	1.70	1.70
Stream No.	108A	108	107		113	113	117	117A
			Wt %		Moles/liter	g/liter	g/kg	g/kg
				Ag+2	5.34E-05	5.76E-03	2.03E-03	2.03E-03
AlPO4			13.6	Al+3	4.04E-01	1.09E+01	3.84E+00	3.84E+00
B2O3			3.9	As+3	6.70E-05	5.02E-03	1.77E-03	1.77E-03
Al2O3			1.4	B+3	2.81E-02	3.04E-01	1.07E-01	1.07E-01
CaO			1.5	Ba+2	6.65E-05	9.13E-03	3.22E-03	3.22E-03
Cr2O3			0.7	Ca+2	1.72E+00	6.88E+01	2.43E+01	2.43E+01
MnO			1.5	Cd+2	9.66E-03	1.09E+00	3.83E-01	3.83E-01
Na2O			3.2	Cl-	2.21E-02	7.85E-01	2.77E-01	2.77E-01
NiO			3.9	Cr+3	5.27E-03	2.74E-01	9.66E-02	9.66E-02
Zr(SO4)2*4H2O			20.9	Cs+	1.91E-08	2.54E-06	8.98E-07	8.98E-07
K2O			5.8	F-	1.65E-01	3.14E+00	1.11E+00	1.11E+00
HgO			0.013	Fe+3	2.28E-02	1.28E+00	4.50E-01	4.50E-01
Fe2O3			2.7	H+	5.00E-02	5.04E-02	0.00E+00	0.00E+00
SiO2			40.8	Hg+2	8.26E-04	1.66E-01	5.84E-02	5.84E-02
				K+	2.63E-01	1.03E+01	3.63E+00	3.63E+00
Total kg	1,092	1,128	143	Mn+2	2.27E-02	1.24E+00	4.39E-01	4.39E-01
				Mo+6	9.61E-04	9.22E-02	3.25E-02	3.25E-02
				Na+	1.67E+00	3.84E+01	1.35E+01	1.35E+01
				Ni+2	2.28E-03	2.12E-01	7.48E-02	7.48E-02
				NO3-	6.80E+00	4.22E+02	1.49E+02	1.49E+02
	Stream			Pb+2	1.93E-03	4.00E-01	1.41E-01	1.41E-01
Sorbant In	119	1,128 kg		PO4-3	1.13E-02	1.07E+00	3.78E-01	3.78E-01
Water In	118	13,278 liters		Se+4	5.29E-05	4.18E-03	1.47E-03	1.47E-03
				SO4-2	4.39E-02	4.22E+00	1.49E+00	1.49E+00
CaO	109	54,805 kg		U+4	5.61E-04	1.33E-01	4.70E-02	4.70E-02
				Zr+4	8.50E-03	7.76E-01	2.74E-01	2.73E-01
				Total solids, g/liter		5.65E+02		
				Waste solids, g/kg			199	199
				Water, g/kg			268	268
				Grout additives, g/kg			533	533
				Total kg			1.7E+06	1.7E+06
					Stream No.			
				P. Cement, kg	114		1.8E+05	1.8E+05
				B. F. Slag, kg	116		5.4E+05	5.4E+05
				Flyash, kg	115		1.8E+05	1.8E+05

ENGINEERING DESIGN FILE

Material Balance - Worst Case (WM-181)						p. 4 of 4		10/20/98	
Note: all activities are decayed to Jan. 2008 except the original WM-181 tank composition									
	Spent Cs Sorbant		Dried		Neutralized Waste		Grouted Waste		
	w/o UDS	w/ UDS	UDS				w/o UDS	w/ UDS	
Stream No.	108A	108	107		113	113	117	117A	
	Ci/kg	Ci/kg	Ci/kg		Ci/l	Tot. Ci	Ci/kg	Ci/kg	
Am-241		3.75E-05	1.19E-03		3.60E-04	2.15E+02	1.27E-04	1.27E-04	
Am-243					1.63E-07	9.73E-02	5.74E-08	5.74E-08	
Cm-242					8.50E-07	5.08E-01	3.00E-07	3.00E-07	
Cm-244					1.11E-05	6.65E+00	3.92E-06	3.92E-06	
Np-237		5.51E-07	1.74E-05		3.39E-07	2.03E-01	1.20E-07	1.20E-07	
Pu-238		2.25E-03	7.12E-02		9.98E-04	5.97E+02	3.52E-04	3.54E-04	
Pu-239		1.21E-04	3.82E-03		2.28E-05	1.36E+01	8.05E-06	8.13E-06	
Pu-240		3.79E-05	1.20E-03		6.40E-06	3.83E+00	2.26E-06	2.28E-06	
Pu-241		7.82E-04	2.47E-02		2.99E-04	1.78E+02	1.05E-04	1.06E-04	
Pu-242		5.64E-08	1.78E-06		1.52E-08	9.06E-03	5.35E-09	5.38E-09	
Th-230					9.08E-11	5.43E-05	3.20E-11	3.20E-11	
Th-231					1.30E-08	7.78E-03	4.59E-09	4.59E-09	
U-232					2.95E-09	1.77E-03	1.04E-09	1.04E-09	
U-233					1.39E-12	8.28E-07	4.89E-13	4.89E-13	
U-234		7.52E-07	2.38E-05		1.50E-06	8.96E-01	5.28E-07	5.29E-07	
U-235		1.66E-08	5.24E-07		3.76E-08	2.25E-02	1.33E-08	1.33E-08	
U-236		7.86E-09	2.48E-07		1.33E-07	7.94E-02	4.68E-08	4.68E-08	
U-238		2.46E-09	7.76E-08		3.71E-08	2.22E-02	1.31E-08	1.31E-08	
Ba-137m					3.87E-02	2.31E+01	1.37E-05	1.37E-05	
Ce-144		8.40E-14	2.66E-12		4.40E-10	2.63E-04	1.55E-10	1.55E-10	
Co-60		8.76E-07	2.77E-05		1.23E-07	7.36E-02	4.34E-08	4.34E-05	
Cs-134	7.77E-03	7.52E-03	4.93E-06		1.42E-08	8.49E-03	5.01E-09	5.11E-09	
Cs-135	4.27E-04	4.13E-04			7.81E-10	4.67E-04	2.75E-10	2.75E-10	
Cs-137	2.24E+01	2.17E+01	1.31E-01		4.10E-05	2.45E+01	1.45E-05	1.72E-05	
Eu-152					4.24E-06	2.53E+00	1.49E-06	1.49E-06	
Eu-154					2.35E-04	1.40E+02	8.27E-05	8.27E-05	
Eu-155					4.12E-05	2.46E+01	1.45E-05	1.45E-05	
Pm-147					1.01E-04	6.03E+01	3.56E-05	3.56E-05	
Pr-144					8.42E-05	5.03E+01	2.97E-05	2.97E-05	
Ni-63					1.02E-04	6.09E+01	3.60E-05	3.60E-05	
Ru-106		7.75E-10	2.45E-08		1.03E-08	6.17E-03	3.64E-09	3.64E-09	
Sb-125		1.76E-05	5.58E-04		1.29E-05	7.71E+00	4.55E-06	4.56E-06	
Sm-151					7.03E-04	4.20E+02	2.48E-04	2.48E-04	
Sr-90		5.56E-04	1.76E-02		3.90E-02	2.33E+04	1.38E-02	1.38E-02	
Tc-99					2.18E-05	1.30E+01	7.68E-06	7.68E-06	
Y-90					3.90E-02	2.33E+04	1.38E-02	1.38E-02	
H-3					2.11E-05	1.26E+01	7.43E-06	7.43E-06	
I-129					5.80E-07	3.46E-01	2.04E-07	2.04E-07	

8. Process Development Recommendations

As detailed in the Section 1, the CsIX/TRU grout process design is based on many assumptions, including assumptions regarding feed waste composition, assumptions about equipment performance, and assumptions about process requirements. This sections identifies tests that are recommended to better define process requirements and waste feed compositions, and to confirm the performance of process equipment. Development activities are recommended in three areas - final waste volume minimization, process equipment scale-up and demonstration, and feed and product characterization. Following a discussion of recommended development activities, Table 8-1 presents relative priorities for these activities.

8.1 Final Waste Volume

Minimization of the final waste volume is critical to establishing the feasibility of the process. The total project cost will be highly dependent on this volume, as it will determine interim waste storage requirements and waste transportation costs. Also, minimization of the waste volume is important because of the limited space available at WIPP. To minimize the final waste volume, studies should be performed in two areas – grout and absorbant tests, and evaporation tests

8.1.1 Final Waste Form Testing

Testing of commercial absorbants is recommended to determine waste loadings using small batches of simulated waste. Testing is also recommended of alternative grout formulations with the potential for high waste loadings. The tests should include determination of the limiting parameters for the grout, including minimum water, maximum solids, maximum nitrate, and the sensitivity of the grout/absorbant formulation to waste composition. Limiting concentrations of waste constituents, e.g. acid for an absorbant or nitrate for grout, also need to be determined. The constraints for these tests is the WIPP Waste Acceptance Criteria, which include a limit for free liquids but do not include a waste strength requirement.

8.1.2 Evaporation Testing

In conjunction with these tests, waste evaporation tests are recommended to determine the maximum degree of evaporation possible based on the constraints of evaporator equipment and solidification requirements, e.g., water needed in the grout formulation. Testing of specific evaporation equipment, such as thin-film or wiped-film evaporators is recommended. Because of the tendency of the waste to form sticky-solids and solidify at relatively low temperatures, data on fouling,

precipitation, and corrosion in an evaporator is needed to demonstrate its feasibility and performance

8.2 Feed and Product Characterization

Recommended characterization activities include characterization of feed waste undissolved solids (UDS) and determination of radionuclide and hazardous chemical species absorbed onto the ion exchange column sorbant. Behavior of the spent sorbant during sluicing, filtration and drying is also needed.

8.2.1 UDS Characterization

Characterization of UDS in the tank farm liquids is needed to provide a basis for the design of UDS solids removal, handling and packaging equipment, and to establish the required solids removal efficiency. Characterization should include the total concentration and total particle size distribution for each tank, and the concentration of both hazardous and radionuclide species as a function of particle size, and both before and after washing. The radionuclide concentrations are of particular importance to determine the effect of UDS that are not removed on the dose rate for the solidified TRU waste. The concentration of fission products, notably ^{137}Cs , in the UDS must be known to ensure that final TRU waste is contact-handled.

8.2.2 Spent Cs Sorbant Characterization

To determine disposal options for the spent cesium ion exchange sorbant, characterization data is needed. Initial small-scale column tests could determine the extent, if any, to which hazardous metal and TRU radionuclide species are absorbed on the column, and whether these species are desorbed during sorbant removal. Tests are also needed to determine physical and drying properties of the spent sorbant, in order to adequately design for removal of the sorbant from the column, filtration of sluiced sorbant, and drying of the sorbant. Data needed includes the amount of fines generated during sluicing, the particle size distribution upstream of filtration and after drying, and thermal properties of the sorbant.

8.2.3 Dried UDS Characterization

Tests are needed to determine washing requirements for the separated UDS, and also the handling and processing requirements to dry the solids to a flowable, pneumatically-transferable material.

8.3 Process Equipment Demonstration Tests

Testing is recommended to better establish the performance and process requirements of filtration equipment, the ion exchange sorbant, and the grouting process.

8.3.1 Filtration Requirements and Demonstration Tests

Testing is needed to determine the degree of filtration required to avoid contaminating the TRU waste with high-dose contributing radionuclides, contaminating the cesium sorbant with TRU-containing solids, and plugging the ion exchange column. The tests should include a determination of what fraction and UDS particle size range pass through the ion exchange column and what fraction and particle size range are retained by the sorbant. Testing of filtration equipment is then recommended to demonstrate that the required removal efficiency of UDS can be achieved.

8.3.2 Ion Exchange Tests

The present data for the CST sorbant cesium loading is from 1 cm³ column tests. Data from larger-scale tests is needed to confirm the performance at larger scale and to provide a base for scale-up to full scale. Performance data for the sorbant is needed over the range of compositions present in the tank farm, particularly the range of cesium concentration, acid concentration, and other species which have a potential for chemical interaction with the sorbant. Long term performance data is needed to discover kinetically slow chemical interactions of resin with the feed waste.

8.3.3 Grouting Process Tests

Should grouting prove to be the optimum solidification technology, tests are needed to establish the grouting process kinetics and thermodynamics. These would include tests to determine the grout viscosity versus time, the heat of grout formation, and the effect and requirement for plasticizers and cure enhancer or retarder additives.

8.4 Development Recommendation Priorities

Table 8-1 presents relative priorities for the recommended development activities.

Table 8-1. Relative Priorities for CsIX/TRU Grout Process Development.

Activity	Priority
Final Waste Form (8.1.1)	1
Evaporation (8.1.2)	1
UDS Characterization (8.2.1)	1
Cs Sorbant Loading for Hazardous and Non-Cs Radionuclides (8.2.2)	2
UDS Washing and Drying Characterization (8.2.3)	3
Filtration Requirements (8.3.1a)	1
Filtration Equipment Demonstration (8.3.1b)	2
Larger-Scale Ion Exchange Tests (8.3.2a)	1
Sorbant Performance Versus Feed Composition (8.3.2b)	2
Sorbant Long-Term Performance (8.3.2c)	3
Grout Kinetic and Thermodynamic Tests (8.3.3)	3

9. References

1. S. Carson, Y.-C. Cheng, L. Yellowhorse, P. Peterson, *Stabilization of Liquid Low-Level and Mixed Waste: A Treatability Study*, SAND-96-0297C, 1996.
2. A. K. Herbst, D. W. Marshall, J. A. McCray, *Idaho Chemical Processing Plant Low-Activity Waste Grout Stabilization Development Program FY-97 Status Report*, INEEL/EXT-98-00116, February, 1998.
3. C. W. Olsen, Minutes From 5/20/98 Meeting with Terry Todd, BC-CSIX-07
4. A. K. Herbst, *Idaho Chemical Processing Plant Low-Activity Waste Grout Stabilization Development Program FY-96 Status Report*, AKH-07-96, September 18, 1996.
5. T. A. Todd, K. N. Brewer, D. J. Wood, P. A. Tullock, L. G. Olson, A. L. Olson, "Evaluation and Testing of Inorganic Ion Exchange Sorbents for the Removal of Cesium-137 from Idaho Chemical Processing Plant Acidic Tank Waste," Submitted to *Separation Science & Technology*, December, 1997.
6. M. K. Andrews, *Glass Formulation Development in Testing for the Vitrification of Cesium-Loaded Crystalline Silicotitanate (CST)*, WSRC-MS-97-0041, June, 1997.
7. J.F. Walker, et al., "Cesium Removal Demonstration Utilizing Crystalline Silicotitanate Sorbent for Processing Melton Valley Storage Tank Supernate: Final Report., ORNL/TM-13503, March, 1998.

D

C

B

A

LIQUID WASTE FEED
4.8x10⁶ LITERS
SPECIFIC GRAVITY 1.28

D

C

B

A

TRUCK
UNLOADING
STATION

TRUCK UNLOADING STATION

- 1- LOAD CEMENT/MO
- 1- LOAD BFS/MO
- 3.1- LOADS FLY ASH/MO
- 1- LOADS CaO/5MO
- OTHER MATERIALS
- 1- IX RESIN/YEAR
- 1- DECON FLUIDS
- 1- SEMI LOAD EMPTY DRUMS/ WEEK

4

3

2

1

REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE

SUBCONTRACT NO.

REQUESTER:

DESIGN:

DRAWN: EM SNELL

PROJECT NO.

SPEC CODE

FOR REVIEW/APPROVAL SIGNATURES
SEE DAR NO.

EFFECTIVE DATE:

LOCKHEED MARTIN

CsIX/TRU GROUT FEASIBILITY STUDY
MATERIALS DELIVERY/STORAGE

SIZE

CAGE CODE

INDEX CODE NUMBER

AREA

TYPE

Q

ORIG

DWG-02

1530

REV

SCALE: NONE

SHEET 1 OF 1

D

BOTTOM TANK
PEW CONCENTRATE
PEW

HIGH LEVEL LIQUID
WASTE EVAPORATOR
HLLWE

WM
-180, -181, 182
-183, -184, -185
-186 AND -187

WM
-189 AND -190

STEAM

AIR

C

E-101
DWG 04

F-102
DWG 06

T-103 A, B
DWG 05

F-105, T-106
DWG 08

DRUM
DECONTAMINATION
STATION
DWG 09

AIR

T-111
WASTE WATER
TANK

B

A

User: EMS
Date: 10/28/88 - 12:56 P.M.

File: calx-3.dwg
Plot: P:\CSX

SUBCONTRACT NO.		LOCKHEED MARTIN					
REQUESTER:		CSIX/TRU GROUT FEASIBILITY STUDY LIQUID WASTE FEED/STORAGE					
DESIGN:							
DRAIN:							
PROJECT NO.:							
SPEC CODE:		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-03	REV
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		D	01MF3	AREA	TYPE		
EFFECTIVE DATE:		SCALE: NONE				SHEET	

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CE

SUBCONTRACT NO.		LOCKHEED MARTIN				A					
REQUESTER:		CSI/TRUE GROUT FEASIBILITY STUDY UDS FILTRATION DRYING/PACKAGING									
DESIGN:											
DRAWN:											
PROJECT NO.:											
SPEC CODE:		SIZE		CAGE CODE		INDEX CODE NUMBER		DWG-04		REV	
FOR REVIEW/APPROVAL SIGNATURES		D		01MF3		AREA		TYPE		Q	
SEE DAR NO.								530			
EFFECTIVE DATE:				SCALE: NONE						SHEET	

D

F-101 A, B
DWG 04

V-105
DWG 6

105

C

B

COLUMN DIMENSIONS

- 1) DIAMETER 16"
HEIGHT 96"
WORKING VOLUME 0.25M³
- 2) FILL COLUMNS AT BEGINNING
WITH ~.25m³ OF RESIN

SUBCONTRACT NO.		LOCKHEED MARTIN			
REQUESTER:		CsIX/TRU GROUT FEASIBILITY STUDY CsIX STRIPPING			
DESIGN:					
DRAFTER: EM SNEEL					
PROJECT NO.					
SPEC CODE:		SIZE	CAGE CODE	INDEX CODE NUMBER	REV
FOR REVIEW/APPROVAL SIGNATURES		D	01MF3	AREA TYPE CL ORG	DWG-05
SEE DAR NO.		530			
EFFECTIVE DATE:		SCALE: NONE			SHEET 1 OF 1

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SUBCONTRACT NO.		LOCKHEED MARTIN			
REQUESTER:		CSIX/TRU GROUT FEASIBILITY STUDY IX COLUMN PREPARATION/WASHING SPENT RESIN DRYING/PACKAGING			
DESIGN:					
DRAWN:					
PROJECT NO.					
SPEC CODE					
FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER	REV
SEE DAR NO.		D	01MF3	ARCA TYPE Q ORG 530	DWG-06
EFFECTIVE DATE:		SCALE: NONE			SHEET

D

C

B

A

B-102
DWG 02

112

T-103 A, B
DWG 05

106

B-107

CaO
BATCH
BINT-104 A, B
GROUT FEED
TANKS

CW

LOAD CELL

P-105 A, B
GROUT MIXER FEED
PUMPN-10
F
SAM
NEUTR

- BATCH NEUTRALIZATION TO pH 1.3
- SIDE STEAM TITRATION TO NEUTRAL pH
- CONTROL LOGIC CALCULATES BATCH QUANTITY CaO
- LOAD CELLS
- COOLING JACKET

4

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REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE

E-103
DWG 12

D

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B

A

B
R
ZER

113

T-105 A, B AND C
DWG 08

SUBCONTRACT NO.		LOCKHEED MARTIN				REV		
REQUESTER:		CSIX/TRU GROUT FEASIBILITY STUDY SBW NEUTRALIZATION						
DESIGN:								
DRAWN: AE GIBBS								
PROJECT NO.								
SPEC CODE		INDEX CODE NUMBER				DWG-07		
FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	AREA	TYPE		CL	ORIG
SEE DAR NO.		D	01MF3				530	
EFFECTIVE DATE:		SCALE: NONE				SHEET		

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

B-103
DWG 02

TO V-101
DWG 12

T-102
DWG 02

T-109
DWG 02

T-110
DWG 02

MIXER WASH
TANK
T-106

P-106
DECON AGENT PUMP

SPENT
DECON
FILTER
F-105

117

TO T-111
DWG 03

WASTE DRUMS
TO DECON STATION
DWG 09

SUBCONTRACT NO.		LOCKHEED MARTIN
REQUESTER:		CsIX/TRU GROUT FEASIBILITY STUDY GROUT MIXING/CASTING MIXER DECONTAMINATION			
DESIGN:					
DRAWN:					
PROJECT NO.					
SPEC CODE					
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE	CAGE CODE	INDEX CODE NUMBER	REV
EFFECTIVE DATE:		D	01MF3	AREA TYPE CL ORG 530	DWG-08
		SCALE: NONE			SHEET

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

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WASTE DRUMS
TO CURE
DWG 10

TO T-111
DWG 03

SUBCONTRACT NO.		LOCKHEED MARTIN				DWG-09	REV						
REQUESTER:		CsIX/TRU GROUT FEASIBILITY STUDY WASTE DRUM DECONTAMINATION											
DESIGN:													
DRAWN:													
PROJECT NO.													
SPEC CODE:		<table border="1"> <tr> <th colspan="2">INDEX CODE NUMBER</th> </tr> <tr> <td>AREA</td> <td>TYPE</td> </tr> <tr> <td></td> <td>530</td> </tr> </table>				INDEX CODE NUMBER		AREA	TYPE		530		
INDEX CODE NUMBER													
AREA	TYPE												
	530												
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE D		CAGE CODE 01MF3									
EFFECTIVE DATE:		SCALE: NONE		SHEET									

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

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E-103
DWG 12

T-111
DWG 03

TRANSPORT GROUT
TO TEMPORARY
STORAGE
DWG 13

TO GROUT RECYCLE
DWG 11

18
TE PUMP

E WASTEFORM

SUBCONTRACT NO.		LOCKHEED MARTIN
REQUESTER:		CsIX/TRU GROUT FEASIBILITY STUDY CURE/DEWATER STATION			
DESIGN:					
DRAWN:					
PROJECT NO.					
SPEC CODE:		SIZE	CAGE CODE	INDEX CODE NUMBER	
FOR REVIEW/APPROVAL SIGNATURES		D	01MF3	AREA	TYPE
SEE DAR NO.				Q	Q882
EFFECTIVE DATE:				530	DWG-10
		SCALE: NONE			REV
					SHEET

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

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SUBCONTRACT NO.		LOCKHEED MARTIN
REQUESTER:		CsIX/TRU GROUT FEASIBILITY STUDY GROUT REWORK						
DESIGN:								
DRAWN:								
PROJECT NO.:								
SPEC CODE:		SIZE	CAGE CODE	INDEX CODE NUMBER			DWG-11	REV
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		D	01MF3	AREA	TYPE	CL		
EFFECTIVE DATE:		SCALE: NONE						SHEET

4

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

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SUBCONTRACT NO.		LOCKHEED MARTIN CsIX/TRU GROUT FEASIBILITY STUDY OFF-GAS CONTROL SYSTEM				DWG-12		REV			
REQUESTER:						AREA		TYPE	CL	ORG	
DESIGN:						AREA		TYPE	CL	ORG	
DRAWN:						AREA		TYPE	CL	ORG	
PROJECT NO.						AREA		TYPE	CL	ORG	
SPEC CODE		AREA		TYPE	CL	ORG					
FOR REVIEW/APPROVAL SIGNATURES		SIZE		CAGE CODE		INDEX CODE NUMBER					
SEE DAR NO.		D		01MF3		530					
EFFECTIVE DATE:		SCALE: NONE				SHEET					

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D

C

B

User: EMS

Date: 10/28/98 - 1:14 P.M.

A

CAPACITY
 24,000 DRUMS

4

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1

REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE:

VISUAL
SECTION/GAS
HEADSPACE
ANALYSIS

TRUPAC
LOADING STATION

WASTE DRUMS
TO WIPP

D

C

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A

SUBCONTRACT NO.

REQUESTER:

DESIGN:

DRAWING:

PROJECT NO.

SPEC CODE

FOR REVIEW/APPROVAL SIGNATURES

SEE DAR NO.

EFFECTIVE DATE:

LOCKHEED MARTIN

CsIX/TRU GROUT FEASIBILITY STUDY
INTERIM STORAGE/SHIPMENT

SIZE

CAGE CODE

INDEX CODE NUMBER

ASCA TYPE CL ORG

D

01MF3

530

DWG-13

REV

SCALE: NONE

SHEET

4

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Appendix C

Cost Estimates

- 1. Capital Cost Estimate**
- 2. Life Cycle Cost Estimate**

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: October 15, 1998

To: K. L. Williams MS3765 6-7260

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

Subject: CsIx/TRU GROUT FEASIBILITY STUDY - RDA-47-98

Cost Estimating has prepared Planning cost estimates for the subject project. These estimates were based on information received from August 20, 1998 to October 7, 1998.

The Total Estimated Cost (TEC) for scenario #1 of this project is \$102,000,000. The Total Estimated Cost (TEC) for scenario #2 of this project is \$130,300,000. These costs include direct and indirect construction costs, G&A, PIF, procurement fee, Engineering costs, Inspection costs, Project Management costs, Construction Management costs, escalation and contingency. The estimated costs have been escalated to the midpoint of the attached schedule. 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 scenario #1 of \$32,200,000 and for scenario #2 of \$39,800,000.

If you have any questions regarding these estimates, please contact me at 526-2963.

RDA

Attachments:

cc: Estimate File #2484 & #2484A
R. J. Turk MS3875
R. D. Adams File

COST ESTIMATE SUPPORT DATA RECAPITULATION

Project Title: CsIX TRU Grout Feasibility Study – Scenario #1
Estimator: R. D. Adams
Date: October 15, 1998
Estimate Type: Planning
File: 2484
Approved By:

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

This project will construct a CsIX/TRU grout facility. This process includes undissolved solids (UDS) removal via filtration and cesium removal via ion exchange, followed by a cement-based grouting of the remaining liquid into 55-gallon drums. An interim storage facility and a TRUPAC loading facility will be built to temporarily house the waste drums and load them for shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico for disposal.

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

The estimate is based on the preliminary design drawings, the feasibility description, and an equipment list.

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

1. Utilities and transfer lines are included in the estimate for the various facilities as needed.
2. All concrete surfaces in hot cells will be coated with stainless steel liner or epoxy coating as identified on the drawings.
3. Supervisor hours are figured at 5% of total labor hours.
4. Training hours are equal to 3% of total labor hours.
5. All building foundations start at -6'-0 unless shown otherwise on the drawings.
6. Epoxy coating system is included on the Interim Storage Facility and TRUPAC Loading Station concrete floors.
7. All structural components of Grout facility are concrete except roof framing.
8. Grout Facility roof is standing seam-roofing panels over structural steel framing.
9. All overhead doors are motor-operated.
10. The exterior of the Grout Facility is left exposed concrete.
11. Included a concrete pad under the Grout Facility outside bin/tank area.

COST ESTIMATE SUPPORT DATA RECAPITULATION

- Continued -

Project Title: CsIX TRU Grout Feasibility Study- Scenario #1
File: 2484

Page 2

12. TRUPAC loading facility includes two 10ton-bridge cranes, work platforms, pallet scales, stretch wrap machine, and vacuum pump system.
13. TRUPAC station will require minimal H&V (twelve 20kw electric unit heaters).
14. An exhaust stack with appropriate monitoring is required for the Grout Facility.
15. Interim Storage Facility includes a ventilation system not shown on the drawings.
16. Ten shielded containers are included for storage of UDS. The remaining 40 containers needed during production will be supplied by operations.
17. The initial charge of ion exchange resin is included in this estimate. The remaining resin required for production will be supplied by operations.

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.*

Contingency for this scenario has been calculated to be 33.97%. Most systems have not been detailed. Many changes to the assumed requirements will appear as these systems are developed further.

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

- A. Costs from the Detailed Cost Estimate sheets are direct costs for material, labor, equipment, and special subcontracts. Costs for corresponding divisions on the Cost Estimate Summary sheet include all applicable indirect costs (overhead, profit, commission on subcontracts, sales tax, and bond).
- B. Costs for each activity represent present day costs escalated to the appropriate activity midpoint.
- C. Subcontractor labor costs reflect INEEL Site Jurisdictional Agreement craft labor rates.
- D. Costs for Lockheed Martin General and Administrative allowance (G & A) and Performance Incentive Factor (PIF) have been included in this estimate.

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6/96
PROJECT NAME: **CsIx/TRU GROUT FEASIBILITY STUDY**
SCENARIO #1
LOCATION 1: **INEEL/INTEC**
REQUESTOR: **K. L. WILLIAMS**

TYPE OF ESTIMATE: **PLANNING**
PROJECT NO: **2484**
PREPARED BY: **R.D.ADAMS**
REPORT NAME: **Cost Estimate Summary**

DATE: **26-Oct-1998**
TIME: **08:07:40**
CHECKED BY: *[Signature]*
APPROD BY: *[Signature]*

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	<u>ENGINEERING, DESIGN AND INSPECTION</u>			>> \$11,266,230
1.1.1	DESIGN ENGINEERING TITLE I & II	7,962,000	875,820	8,837,820
1.1.2	QUALITY ASSURANCE	1,990,500	437,910	2,428,410
1.2	<u>MANAGEMENT COSTS</u>			>> \$11,544,900
1.2.1	PROJECT MANAGEMENT	5,573,400	1,114,680	6,688,080
1.2.2	CONSTRUCTION MANAGEMENT	3,981,000	875,820	4,856,820
1.3	<u>CONSTRUCTION</u>			>> \$48,568,002
1.3.1	GENERAL CONDITIONS	2,496,329	549,192	3,045,521
1.3.2	SITWORK	863,098	189,882	1,052,980
1.3.3	CONCRETE	4,209,942	926,187	5,136,129
1.3.5	METALS	1,406,944	309,528	1,716,472
1.3.7	THERMAL & MOISTURE PROTECTION	205,553	45,222	250,775
1.3.8	DOORS & WINDOWS	128,013	28,163	156,176
1.3.9	FINISHES	1,064,376	234,163	1,298,539
1.3.10	SPECIALTIES	19,410	4,270	23,680
1.3.11	EQUIPMENT	15,759,339	3,467,055	19,226,394
1.3.12	FURNISHINGS	221,438	48,716	270,154
1.3.13	SPECIAL CONSTRUCTION	1,167,753	256,906	1,424,659
1.3.14	CONVEYING SYSTEMS	1,987,042	437,149	2,424,191
1.3.15	MECHANICAL	6,457,307	1,420,608	7,877,915
1.3.16	ELECTRICAL	3,823,293	841,124	4,664,417
1.5	<u>G&A/PIF</u>			>> \$3,178,566
1.5.1	G&A/PIF ADDER	2,605,382	573,184	3,178,566
1.5.2	PROCUREMENT FEES	1,194,295	262,745	>> \$1,457,040
	SUBTOTAL INCLUDING ESCALATION	63,116,414	12,898,324	>> \$76,014,738
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> \$5,320,361
	CONTINGENCY			>> \$20,664,901
	TOTAL ESTIMATED COST			>> \$102,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= **23.00%**

CONTINGENCY= **34.18%**

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: **Cs/TRU GROUT FEASIBILITY STUDY**
 SCENARIO #1
 LOCATION 1: **INEEL/INTEC**
 REQUESTOR: **K. L. WILLIAMS**

DETAILED COST ESTIMATE SHEET

PAGE # 1

TYPE OF ESTIMATE: **PLANNING**
 PROJECT NO.: **2484**
 PREPARED BY: **R.D.ADAMS**
 DATE: **26-Oct-1998**
 TIME: **08:10:12**
 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	DESIGN ENGINEERING TITLE I & II											
	DESIGN @ 20% OF CONSTRUCTION & GFE COSTS	1	LOT			0.000		7,962,000				7,962,000
	DESIGN ENGINEERING TITLE I & II S/T						0	\$7,962,000				\$7,962,000
1.1.2	QUALITY ASSURANCE											
	QA @ 5% OF CONSTRUCTION & GFE COSTS	1	LOT			0.000		1,990,500				1,990,500
	QUALITY ASSURANCE S/T						0	\$1,990,500				\$1,990,500
1.2.1	PROJECT MANAGEMENT											
	PM @ 14% OF CONSTRUCTION & GFE COSTS	1	LOT			0.000		5,573,400				5,573,400
	PROJECT MANAGEMENT S/T						0	\$5,573,400				\$5,573,400
1.2.2	CONSTRUCTION MANAGEMENT											
	CM @ 10% OF CONSTRUCTION & GFE COSTS	1	LOT			0.000		3,981,000				3,981,000
	CONSTRUCTION MANAGEMENT S/T						0	\$3,981,000				\$3,981,000
1.3.1	GENERAL CONDITIONS SUPERVISION	9,350	HRS		PIPF GEN	1.000	9,350	377,460				377,460
	TRAINING	5,610	HRS		SKWK GEN	1.000	5,610	185,747				185,747

DETAILED 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
1.3.1	GENERAL CONDITIONS SMALL TOOLS & CONSUMABLES	1	LOT	255,900.00		0.000				255,900		255,900
Memo:	@ .4% OF LABOR COSTS				GEN							
Memo:	MISC. EQUIPMENT	1	LOT		GEN	0.000			467,700			467,700
	@ \$.25 PER LAB. HOUR	4,160	HRS		ENGR	1.000	4,160	131,248	416,000			547,248
	CRANE SUPPORT				GEN							
	MOBILIZATION/DEMOLITION	1	LOT		SKWK	2400.00	2,400	79,464				79,464
					GEN							
	GENERAL CONDITIONS S/T						21,520	\$773,919	\$883,700	\$255,900		\$1,913,519
1.3.2	SITework											
	SITework S/T						0					
1.3.2.1	UTILITIES TRENCHING	5,830	CY		ENGR	0.500	2,915	91,968	104,940			196,908
	REPAIR PAVEMENT	7,300	SF		PAVE	0.000						
	STEAM, FIREWATER, POTABLE WATER, SEWER PIPING	1,475	LF	10.00	PIPE	0.500	738	27,133		14,750	43,800	43,800
					PIPE							41,883
	1x & WASTE FEED LINES	710	LF	45.00	PIPE	1.200	852	31,345		31,950		63,295
Memo:	ASSUME 304L STAINLESS SCH 40. 2"				PIPE							
	PRIMARY PIPE W/ 4" SCH 10 SECONDARY PIPE.											
	STEAM PIPE INSULATION (GILSULATE)	1,100	LF	20.00	LABR	0.100	110	3,194		22,000		25,194
					PIPE							
	UTILITIES S/T						4,615	\$153,640	\$104,940	\$68,700	\$43,800	\$371,080
1.3.2.2	INTERIM STORAGE FACILITY EXCAVATION	3,200	CY		ENGR	0.150	480	15,144	19,200			34,344
					DIRT							

Lockheed Martin Idaho Technologies Co.

Rev. 606

PROJECT NAME: CSIX/TRU GROUT FEASIBILITY STUDY
SCENARIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

PAGE # 3

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484
PREPARED BY: R.D.ADAMS

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.2.2	INTERIM STORAGE FACILITY BACKFILL	2,930	CY		ENGR DIRT	0.200	586	18,488	17,580			35,068
	INTERIM STORAGE FACILITY S/T						1,066	\$33,632	\$36,780			\$70,412
1.3.2.3	TRUPAC STATION EXCAVATION	1,180	CY		ENGR DIRT	0.150	177	5,584	7,080			12,664
	BACKFILL	1,080	CY		ENGR DIRT	0.200	216	6,815	6,480			13,295
	TRUPAC STATION S/T						393	\$12,399	\$13,560			\$25,959
1.3.2.4	CSIX/TRU GROUT FACILITY EXCAVATION	2,940	CY		ENGR DIRT	0.150	441	13,914	17,640			31,554
	BACKFILL	2,600	CY		ENGR DIRT	0.200	520	16,406	15,600		65,000	32,006
	AREA PAVING	13,000	SF		PAVE	0.000						65,000
	CSIX/TRU GROUT FACILITY S/T						961	\$30,320	\$33,240		\$65,000	\$128,560
1.3.3	CONCRETE											
	CONCRETE S/T						0					
1.3.3.2	INTERIM STORAGE FACILITY FOUNDATION CONCRETE - COMPLETE	280	CY	150.00	LABR CONC	10.000	2,800	81,312		42,000		123,312
	SLAB-ON-GRADE - COMPLETE	2,130	CY	110.00	CONC CONC	7.000	14,910	477,567		234,300		711,867

DETAILED COST ESTIMATE SHEET

Lockheed Martin Idaho Technologies Co.

Rev. 609
PROJECT NAME: Cslx/TRU GROUT FEASIBILITY STUDY

SCENERIO #1

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.3.2	INTERIM STORAGE FACILITY ELEVATED DECK FILL - COMPLETE	35	CY	110.00	CONC CONC	6.000	210	6,726		3,850		10,576
	INTERIM STORAGE FACILITY S/T						17,920	\$565,606		\$280,150		\$845,756
1.3.3.3	TRUPAC STATION FOUNDATION CONCRETE - COMPLETE	100	CY	150.00	LABR CONC	10.000	1,000	29,040		15,000		44,040
	SLAB-ON-GRADE - COMPLETE ALLOW 2" THICK SLAB FOR TRUPAC & TRUCK.	600	CY	110.00	CONC CONC	7.000	4,200	134,526		66,000		200,526
	TRUPAC STATION S/T						5,200	\$163,566		\$81,000		\$244,566
1.3.3.4	Cslx/TRU GROUT FACILITY POUR & FINISH CONCRETE	3,390	CY	70.00	CONC CONC	4.500	15,255	488,618		237,300		725,918
	FORMWORK	110,000	SF	0.40	CARP GEN	0.300	33,000	1,100,880		44,000		1,144,880
	HATCH COVERS	360	SF	180.00	CONC GEN	1.000	360	11,531		64,800		76,331
	Cslx/TRU GROUT FACILITY S/T						48,615	\$1,601,028		\$346,100		\$1,947,128
1.3.5	METALS											
	METALS S/T						0					
1.3.5.2	INTERIM STORAGE FACILITY BAR JOISTS	1,800	LF	3.53	IRON STEEL	0.060	108	3,975		6,354		10,329

DETAILED 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
1.3.5.2	INTERIM STORAGE FACILITY METAL DECK PAN	3,600	SF	2.20	SHEE STEEL	0.010	36	1,247		7,920		9,167
	INTERIM STORAGE FACILITY S/T						144	\$5,223		\$14,274		\$19,497
1.3.5.4	Cslx/Tru Grout Facility ROOF FRAMING	41	TONS	1,500.00	IRON STEEL	25.000	1,025	37,730		61,500		99,230
	PIPE RAILING	95	LF	13.00	IRON STEEL	0.150	14	525		1,235		1,760
	CAGED LADDER	10	VLF	20.00	IRON STEEL	0.350	4	129		200		329
	REBAR	255	TON	400.00	RODM STEEL	15.000	3,825	125,460		102,000		227,460
	EMBEDDED METAL	21	TON	1,000.00	RODM STEEL	200.000	4,200	137,760		21,000		158,760
	SST LINER	2,290	SF	21.00	IRON STEEL	2.000	4,580	168,590		48,090		216,680
	Cslx/Tru Grout Facility S/T						13,648	\$470,193		\$234,025		\$704,218
1.3.5.2	TRUPAC STATION CRANE SUPPORT STEEL	43	TON	1,500.00	IRON STEEL	20.000	860	31,657		64,500		96,157
	WORK PLATFORM INCLUDES HYDRAULICS & CONTROLS	2	EA	30,000.00	IRON STEEL	1260.00	2,520	92,761		60,000		152,761
	TRUPAC STATION S/T						3,380	\$124,418		\$124,500		\$248,918
1.3.7	THERMAL & MOISTURE PROTECTION											
	THERMAL & MOISTURE PROTECTION S/T						0					

PROJECT NAME: CSM/TRU GROUT FEASIBILITY STUDY

SCENARIO #1

LOCATION 1:

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 6

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.7.2	INTERIM STORAGE FACILITY INSULATE INSPECTION ROOM	6,480	SF		INSUL	0.000					8,424	8,424
	INTERIM STORAGE FACILITY S/T						0				\$8,424	\$8,424
1.3.7.4	CSM/TRU GROUT FACILITY STANDING SEAM METAL ROOF	13,640	SF		SHEE STEEL	0.000					88,660	88,660
	INSULATION - ALLOW	13,640	SF		INSUL	0.000					47,740	47,740
	CSM/TRU GROUT FACILITY S/T						0				\$136,400	\$136,400
1.3.8	DOORS & WINDOWS											
	DOORS & WINDOWS S/T						0					
1.3.8.2	INTERIM STORAGE FACILITY 28'X15' OVERHEAD, MOTOR-OPERATED DOOR	4	EA		IRON GEN	0.000					30,000	30,000
	HEAD SPACE GAS ANALYSIS & VIDEOSCOPY DOOR	1	EA		GEN	0.000					2,000	2,000
	INTERIM STORAGE FACILITY S/T						0				\$32,000	\$32,000
1.3.8.3	TRUPAC STATION 20'X15' OVERHEAD, MOTOR-OPERATED DOOR	4	EA		GEN	0.000					16,800	16,800
	TRUPAC STATION S/T						0				\$16,800	\$16,800

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY

SCENARIO #1

LOCATION 1:

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 7

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.3.4	CSIXTRU GROUT FACILITY PERSONNEL DOORS, FRAMES & HARDWARE	45	EA	600.00	CARP GEN	6.000	270	9,007		27,000		36,007
	OVERHEAD, MOTOR-OPERATED DOOR	2	EA		IRON GEN	0.000					8,000	8,000
	WINDOWS, DBL PANE, METAL FRAME	24	EA	120.00	CARP GEN	2.000	48	1,601		2,880		4,481
	CSIXTRU GROUT FACILITY S/T						318	\$10,608		\$29,880	\$8,000	\$48,488
1.3.3	FINISHES											
	FINISHES S/T						0					
1.3.3.2	INTERIM STORAGE FACILITY 6" METAL STUD, LOAD-BEARING PARTITION	2,880	SF	1.00	CARP GEN	0.030	86	2,882		2,880		5,762
	GYP. BOARD	8,640	SF	0.22	CARP GEN	0.020	173	5,765		1,901		7,665
	PAINT GYP. BD. & UNDERSIDE OF DECK	9,360	SF	0.10	PAIN PAINT	0.009	84	2,354		936		3,290
	EPOXY FLOOR SYSTEM INCLUDES SHOT BLAST PREP.	57,600	SF		PAINT	0.000					374,400	374,400
	INTERIM STORAGE FACILITY S/T						343	\$11,001		\$5,717	\$374,400	\$391,117
1.3.3.4	CSIXTRU GROUT FACILITY EPOXY COATING	58,140	SF	2.00	PAIN PAINT	0.080	4,651	129,955		116,280		246,235
	PAINTING	18,550	SF	0.10	PAIN PAINT	0.009	167	4,665		1,855		6,520
	GYP. BOARD NONLOAD-BEARING PARTITIONS W/ 5/8" GYP BD BOTH SIDES	10,520	SF	0.90	CARP GEN	0.050	526	17,547		9,468		27,015
	FLOOR COVERING	6,900	SF		GEN	0.000					13,800	13,800

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY
SCENARIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484
PREPARED BY: R.D. ADAMS

PAGE # 11

DATE 26-Oct-1998
TIME: 08:10:12
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
1.3.11.4.2 F-106A&B	CSIX REMOVAL EQUIPMENT RESINS FINES FILTER	2	EA	4,000.00	PIPE	4.000	8	294		8,000		8,294
T-103A&B	IX EFFLUENT HOLD TANK - 14 M3	2	EA	53,000.00	PIPE	100.000	200	7,358		106,000		113,358
P-103A&B	CSIX EFFLUENT PUMP - 76 L/MIN	2	EA	8,000.00	PIPE	30.000	60	2,207		16,000		18,207
P-112	SPENT CSIX SORBANT PUMP - 420 L/MIN	1	EA	8,000.00	PIPE	40.000	40	1,472		8,000		9,472
V-106	EASTE RESIN PREP COLUMN - 1.25 M3	1	EA	15,000.00	PIPE	60.000	60	2,207		15,000		17,207
P-104A&B	FINES RECYCLE PUMP - 4 L/MIN	2	EA	6,000.00	PIPE	10.000	20	736		12,000		12,736
F-102	CS SORBANT FINES SCREEN - 4 L/MIN	1	EA	4,000.00	PIPE	10.000	10	368		4,000		4,368
D-102	CS SORBANT DRIER - 2 L/HR	1	EA	50,000.00	PIPE	60.000	60	2,207		50,000		52,207
E-102	VAPOR CONDESER - 1 Kg/hr	1	EA	50,000.00	PIPE	60.000	60	2,207		50,000		52,207
P-113	SORBANT DRIER CONDENSATE PUMP - 4 L/MIN	1	EA	6,000.00	PIPE	10.000	10	368		6,000		6,368
T-112	SPENT RESIN STORAGE TANK - 15 M3	1	EA	65,000.00	PIPE	100.000	100	3,679		65,000		68,679
Memo:	MECHANICAL JUMPERS ASSUME 2 PER PUMP IN P&V CORRIDOR	24	EA	30,000.00	PIPE	10.000	240	8,830		720,000		728,830
Memo:	REMOTE CONTROL VALVE JUMPERS NUMBER PER FLOW DIAGRAM 15. JUMPERS INCLUDE VALVES.	24	EA	40,000.00	PIPE	20.000	480	17,659		960,000		977,659
Memo:	ELECTRICAL/INSTRUMENTATION JUMPERS ALLOW 2 PER PUMP AND 1 PER BGV	48	EA	15,000.00	ELEC	8.000	384	12,791		720,000		732,791
	P&V CORRIDOR PAR	1	EA	150,000.00	SKWK	300.000	300	9,933		150,000		159,933
	WASTE RESIN CELL MANIPULATOR	1	EA	120,000.00	SKWK	120.000	120	3,973		120,000		123,973
	MAINTENANCE PAR	1	EA	150,000.00	SKWK	300.000	300	9,933		150,000		159,933
	SHIELDING WINDOWS - 2'-2" THK	12	EA	170,000.00	SKWK	100.000	1,200	39,732		2,040,000		2,079,732
	SHIELDING WINDOWS - 3'-2" THK	2	EA	190,000.00	SKWK	100.000	200	6,622		380,000		386,622
	CSIX REMOVAL EQUIPMENT S/T						4,832	\$168,631		\$6,226,500		\$6,395,131

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484
PREPARED BY: R.D.ADAMS

DATE: 26-Oct-1998
TIME: 08:10:12
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
1.3.11.4.3	UDS LOADING CELL STAGING CONVEYOR	1	EA	10,000.00	SKWK	40.000	40	1,324		10,000		11,324
	DECON BOOTH	1	EA	100,000.00	SKWK	200.000	200	6,622		100,000		106,622
	ROATION TABLE	1	EA	20,000.00	SKWK	30.000	30	993		20,000		20,993
	DECON CONVEYOR	1	EA	10,000.00	SKWK	40.000	40	1,324		10,000		11,324
	DECON EQUIPMENT	1	LOT	30,000.00	SKWK	100.000	100	3,311		30,000		33,311
	INSPECTION EQUIPMENT	1	LOT	50,000.00	SKWK	100.000	100	3,311		50,000		53,311
	CELL DOOR	1	EA	10,000.00	SKWK	50.000	50	1,656		10,000		11,656
	LOADOUT CONVEYOR	1	EA	10,000.00	SKWK	40.000	40	1,324		10,000		11,324
	LIFT TABLE	1	EA	10,000.00	SKWK	30.000	30	993		10,000		10,993
	LIFT TABLE CONVEYOR	1	EA	5,000.00	SKWK	30.000	30	993		5,000		5,993
	DRUM DUST TIGHT DISCHARGE CONE	1	EA	20,000.00	SKWK	40.000	40	1,324		20,000		21,324
	SHIELDED DRUM	10	EA	10,000.00	SKWK	0.000				100,000		100,000
	DRYING CELL MANIPULATOR	1	EA	120,000.00	SKWK	120.000	120	3,973		120,000		123,973
	UDS LOADING CELL S/T						820	\$27,150		\$495,000		\$522,150
1.3.11.4.4	GROUTING EQUIPMENT											
B-102	CaO BIN - 38 M3	1	EA	45,000.00	PIPE	60.000	60	2,207		45,000		47,207
B-103	PORTLAND CEMENT BIN - 34 M3	1	EA	45,000.00	PIPE	60.000	60	2,207		45,000		47,207
B-104	FLYASH BIN - 34 M3	1	EA	45,000.00	PIPE	60.000	60	2,207		45,000		47,207
B-105	BLAST FURNACE SLAG BIN - 58 M3	1	EA	55,000.00	PIPE	80.000	80	2,943		55,000		57,943
ED-101,2,3,4	AIR EDUCTOR - 9 Kg-S/hr	4	EA	3,500.00	PIPE	10.000	40	1,472		14,000		15,472
B-107	CaO WEIGHT BIN - .4 M3	1	EA	4,000.00	PIPE	30.000	30	1,104		4,000		5,104

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY
SCENARIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484
PREPARED BY: R.D.ADAMS

DATE 26-Oct-1998
TIME: 08:10:12
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
1.3.11.4.4 T-104A&B	GROUTING EQUIPMENT GROUT FEED TANK - 7 M3	2	EA	35,000.00	PIPE	80,000	160	5,886		70,000		75,886
N-101A&B	pH SAMPLER/NEUTRALIZER	2	EA	6,000.00	PIPE	10,000	20	736		12,000		12,736
P-105A&B	GROUT MIXER FEED PUMP - 2-16 L/MIN	2	EA	6,000.00	PIPE	15,000	30	1,104		12,000		13,104
F-106	KNOCKOUT FILTER -	1	EA	8,000.00	PIPE	15,000	15	552		8,000		8,552
B-108A,B&C	DRY INGREDIENT WEIGH BIN - .2 M3	3	EA	2,000.00	PIPE	15,000	45	1,656		6,000		7,656
C-101A,B&C	SOLIDS FEED CONVEYOR - 8 Kg/MIN	3	EA	2,500.00	PIPE	10,000	30	1,104		7,500		8,604
M-101A,B&C	GROUT MIXER - .3 M3	3	EA	20,000.00	PIPE	60,000	180	6,622		60,000		66,622
B-106A	DRY GROUT ADMIXTURES BIN - .4 M3	1	EA	2,500.00	PIPE	20,000	20	736		2,500		3,236
B-106B&C	LIQUID GROUT ADMIXTURES TANK	2	EA	500.00	PIPE	15,000	30	1,104		1,000		2,104
P-106	DECON AGENT PUMP - 78 L/MIN	1	EA	8,000.00	PIPE	30,000	30	1,104		8,000		9,104
P-115	METERING PUMP/ADMIXTURES - 1 L/MIN	1	EA	5,000.00	PIPE	10,000	10	368		5,000		5,368
T-106	MIXER WASH TANK - 1 M3	1	EA	10,000.00	PIPE	50,000	50	1,840		10,000		11,840
P-116	DECON RETURN PUMP - 78 L/MIN	1	EA	8,000.00	PIPE	30,000	30	1,104		8,000		9,104
F-105	SPENT DECON SOLUTION FILTER -	1	EA	5,000.00	PIPE	10,000	10	368		5,000		5,368
	GROUTING EQUIPMENT S/T						990	\$36,422		\$423,000		\$459,422
1.3.11.4.5	GROUTED WASTE DRUM FILL/SEAL AREA STORAGE AREA CONVEYOR	1	EA	10,000.00	SKWK	40,000	40	1,324		10,000		11,324
	AIRLOCK	1	EA	80,000.00	SKWK	200,000	200	6,622		80,000		86,622
	AIRLOCK CONVEYOR	1	EA	10,000.00	SKWK	40,000	40	1,324		10,000		11,324
	MAIN INLET CONVEYOR	1	EA	35,000.00	SKWK	100,000	100	3,311		35,000		38,311
	TRANSVERSE SECTION LIFT	2	EA	10,000.00	SKWK	30,000	60	1,987		20,000		21,987

PROJECT NAME: CSXTRU GROUT FEASIBILITY STUDY
SCENERIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

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1.3.11.4.5	GROUTED WASTE DRUM FILL/SEAL AREA INSPECTION EQUIPMENT	1	LOT	50,000.00	SKWK GEN	100.000	100	3,311		50,000		53,311
	DISCHARGE SECTION TUNNEL	1	EA	70,000.00	SKWK GEN	200.000	200	6,622		70,000		76,622
	DISCHARGE SECTION INLET CONVEYOR	3	EA	10,000.00	SKWK GEN	40.000	120	3,973		30,000		33,973
	MAIN DISCHARGE CONVEYOR	1	EA	35,000.00	SKWK GEN	100.000	100	3,311		35,000		38,311
	TRANSFER SECTION LIFT	3	EA	10,000.00	SKWK GEN	30.000	90	2,980		30,000		32,980
	AIRLOCK	1	EA	80,000.00	SKWK GEN	200.000	200	6,622		80,000		86,622
	AIRLOCK CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	TILT & PAN CAMERA	14	EA	2,000.00	ELEC ELEC	10.000	140	4,663		28,000		32,663
	CAMERA CONTROL STATION	1	EA	15,000.00	ELEC ELEC	40.000	40	1,332		15,000		16,332
	GROUTED WASTE DRUM FILL/SEAL AREA S/T						3,320	\$109,961		\$1,098,000		\$1,207,961
1.3.11.4.6	GROUT CURING ROOM EQUIPMENT INLET STAGING, DRUM LIFT, CURE LINE & DRUM LIFT ENCLOSURE	1	LOT	250,000.00	SKWK GEN	500.000	500	16,555		250,000		266,555
	INLET STAGING CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	DRUM LIFT	2	EA	10,000.00	SKWK GEN	30.000	60	1,987		20,000		21,987
	DRUM LIFT CONVEYOR	2	EA	10,000.00	SKWK GEN	40.000	80	2,649		20,000		22,649
	CURE LINE CONVEYOR	2	EA	10,000.00	SKWK GEN	40.000	80	2,649		20,000		22,649
	180 DEGREE CONVEYOR	8	EA	20,000.00	SKWK GEN	60.000	480	15,893		160,000		175,893
	CURE LINE CONVEYOR 13'	8	EA	20,000.00	SKWK GEN	60.000	480	15,893		160,000		175,893
	STAGING CONVEYOR	1	EA	5,000.00	SKWK GEN	20.000	20	662		5,000		5,662

DETAILED 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
1.3.11.4.6	GROUT CURING ROOM EQUIPMENT DRUM ELEVATOR & ENCLOSURE	1	EA	200,000.00	SKWK GEN	400.000	400	13,244		200,000		213,244
	GROUT CURING ROOM EQUIPMENT S/T						2,140	\$70,855		\$845,000		\$915,855
1.3.11.4.7	GROUT DEWATERING ROOM INLET INDEXING LIFT CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	INDEXING LIFT TABLE	1	EA	10,000.00	SKWK GEN	30.000	30	993		10,000		10,993
	INDEXING ARM	1	EA	20,000.00	SKWK GEN	100.000	100	3,311		20,000		23,311
	DEWATERING STATION 30' CONVEYOR	1	EA	40,000.00	SKWK GEN	70.000	70	2,318		40,000		42,318
	90 DEG TRANSFER & LIFT	2	EA	5,000.00	SKWK GEN	20.000	40	1,324		10,000		11,324
	DEWATERING STATION CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	AIR HEATERS	9	EA	2,000.00	ELEC GEN	10.000	90	2,998		18,000		20,998
	DEWATERING STATION LINE LIFT	9	EA	10,000.00	SKWK GEN	30.000	270	8,940		90,000		98,940
	DRUM OFF LOAD CONVEYOR	1	EA	20,000.00	SKWK GEN	60.000	60	1,987		20,000		21,987
	HYDRAULIC DRUM LIFT	1	EA	20,000.00	SKWK GEN	50.000	50	1,656		20,000		21,656
E-104	VAPOR CONDENSER - 2 Kg/hr	1	EA	50,000.00	PIPE PIPE	60.000	60	2,207		50,000		52,207
P-118	CONDENSATE PUMP - 4 L/MIN	1	EA	6,000.00	PIPE PIPE	10.000	10	368		6,000		6,368
	GROUT DEWATERING ROOM S/T						860	\$28,750		\$304,000		\$332,750
1.3.11.4.9	DECONTAMINATION/WASTE WATER EQUIPMENT											
T-102	DI WATER FEED TANK - 4 M3	1	EA	2,000.00	PIPE PIPE	20.000	20	736		2,000		2,736
T-109	DECONTAMINATION AGENT ACID - 4 M3	1	EA	15,000.00	PIPE PIPE	60.000	60	2,207		15,000		17,207

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: **CSX/TRUE GROUT FEASIBILITY STUDY**
 SCENARIO #1
 LOCATION 1: **INEEL/INTEC**
 REQUESTOR: **K. L. WILLIAMS**

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: **PLANNING**
 PROJECT NO.: **2484**
 PREPARED BY: **R.D. ADAMS**

PAGE # **17**

DATE **26-Oct-1998**
 TIME: **08:10:12**
 REPORT NAME: **Detail Cost Estimate Sheet**

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MATL	S/C (OTHER 1)	TOTAL COST
1.3.11.4.9	DECONTAMINATION/WASTE WATER EQUIPMENT											
T-110	DECONTAMINATION AGENT BASE - 4 M3	1	EA	15,000.00	PIPE	60.000	60	2,207		15,000		17,207
P-102A&B	DI WATER PUMP - 420 L/MIN	2	EA	8,000.00	PIPE	40.000	80	2,943		16,000		18,943
P-108	ACID DECON PUMP - 20 L/MIN	1	EA	6,000.00	PIPE	15.000	15	552		6,000		6,552
P-109	BASE DECON PUMP - 20 L/MIN	1	EA	6,000.00	PIPE	15.000	15	552		6,000		6,552
T-111	WASTE WATER TANK - 19 M3	1	EA	75,000.00	PIPE	100.000	100	3,679		75,000		78,679
P-111A&B	WASTE WATER PUMP - 76 L/MIN	2	EA	8,000.00	PIPE	40.000	80	2,943		16,000		18,943
P-117	DECON RETURN PUMP - 20 L/MIN	1	EA	6,000.00	PIPE	15.000	15	552		6,000		6,552
	MECHANICAL JUMPERS	4	EA	30,000.00	PIPE	10.000	40	1,472		120,000		121,472
	ELECTRICAL JUMPERS	4	EA	15,000.00	ELEC	8.000	32	1,066		60,000		61,066
	ASSUME 2 PER PUMP IN THE B&V CORRIDOR (ONE FOR POWER, ONE FOR SIGNAL)											
	DECONTAMINATION/WASTE WATER EQUIPMENT S/T						517	\$18,909		\$337,000		\$355,909
1.3.11.4.10	VOG SYSTEM											
E-103	VOG CONDENSER -	1	EA	26,000.00	PIPE	50.000	50	1,840		26,000		27,840
V-101	VOG VAPOR DEMISTER	1	EA	5,000.00	SHOE	40.000	40	1,386		5,000		6,386
EH-101	VOG SUPERHEATER	1	EA	50,000.00	SHOE	100.000	100	3,465		50,000		53,465
F-103,104A&B	HEPA FILTER BANK	1	EA	24,000.00	SHOE	40.000	40	1,386		24,000		25,386
BL-101A&B	OFF GAS BLOWER	2	EA	2,000.00	SHOE	20.000	40	1,386		4,000		5,386
	VOG SYSTEM S/T						270	\$9,463		\$109,000		\$118,463
1.3.11.3	TRUPAC STATION											
	TRUPAC LID STANDS	8	EA	2,000.00	SKWK GEN	4.000	32	1,060		16,000		17,060

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.13.2	INTERIM STORAGE FACILITY											
	INTERIM STORAGE FACILITY S/T						2,880	\$106,013		\$633,600		\$739,613
1.3.13.3	TRUPAC STATION											
	PRE-ENGINEERED METAL BUILDING	8,000	SF	13.00	IRON GEN	0.070	560	20,614		104,000		124,614
	TRUPAC STATION S/T						560	\$20,614		\$104,000		\$124,614
1.3.14	CONVEYING SYSTEMS											
	CONVEYING SYSTEMS S/T						0					
1.3.14.2	INTERIM STORAGE FACILITY											
	DRUM MOVEMENT TRUCK	1	EA	40,000.00	GEN	0.000				40,000		40,000
	DRUM MOVEMENT FORKLIFT	1	EA	20,000.00	GEN	0.000				20,000		20,000
	DRUM MOVEMENT LIFTING FIXTURES	1	EA	5,000.00	GEN	0.000				5,000		5,000
	INTERIM STORAGE FACILITY S/T						0			\$65,000		\$65,000
1.3.14.3	TRUPAC STATION											
	TRUPAC LOADING CRANE - 10 TON & LIFTING DEVICE	2	EA	250,000.00	SKWK GEN	400.000	800	26,488		500,000		526,488
	TRUPAC STATION S/T						800	\$26,488		\$500,000		\$526,488

PROJECT NAME: CSX/TRUE GROUT FEASIBILITY STUDY
SCENARIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

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1.3.15.3	TRUPAC STATION											
	TRUPAC STATION S/T						120	\$3,997		\$14,400	\$24	\$18,421
1.3.15.4.1	PIPING FIRE PROTECTION SYSTEM	38,770	SF			0.000					116,310	116,310
	DISTRIBUTION PIPING	19,360	LF	15.00	PIPE	0.250	4,840	178,064		290,400		468,464
	0.5 LEGS OF BUILDING FITTINGS @ 20'	970	EA	20.00	PIPE	0.200	194	7,137		19,400		26,537
	WELDS @ 2EAFITTING	1,940	EA		PIPE	2.500	4,850	178,432				178,432
	X-RAYS @ 10%	194	EA		PIPE	0.000					25,220	25,220
	BRANCH PIPING	9,600	LF	15.00	PIPE	0.250	2,400	88,296		144,000		232,296
	0.50 LETANK. BIN. PUMP. ETC. FITTINGS @ 10'	960	EA	20.00	PIPE	0.200	192	7,064		19,200		26,264
	WELDS @ 2EAFITTING	1,920	EA		PIPE	2.500	4,800	176,592				176,592
	X-RAYS @ 10%	192	EA		PIPE	0.000					24,960	24,960
	PIPING S/T						17,276	\$635,584		\$473,000	\$166,490	\$1,275,074
1.3.15.4.2	HVAC HEATING COILS	1	LOT	25,000.00	SHEE HVAC	200.000	200	6,930		25,000		31,930
	ROUGH PREFILTER	1	LOT	30,000.00	SHEE HVAC	20.000	20	693		30,000		30,693
	ZONE 2 HEPA FILTER HOUSING - 2X5 REDUNDANT	2	EA	125,000.00	SHEE HVAC	40.000	80	2,772		250,000		252,772
	ZONE 2 SUPPLY FAN - 10,500 CFM	2	EA	11,000.00	SHEE HVAC	30.000	60	2,079		22,000		24,079
	ZONE 3 EXHAUST FAN - 8500 CFM	2	EA	10,000.00	SHEE HVAC	30.000	60	2,079		20,000		22,079

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY

SCENERIO #1

LOCATION 1:

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 22

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1.3.15.4.2	HVAC ZONE 3 EXHAUST HEPA FILTER - 2X5 REDUNDANT	2	EA	115,000.00	SHEE HVAC	40.000	80	2,772		230,000		232,772
	ZONE 3 INLET FAN - 10,500 CFM	2	EA	11,000.00	SHEE HVAC	30.000	60	2,079		22,000		24,079
	ZONE 3 SUPPLY HEPA FILTER - 2X5 REDUNDANT	2	EA	125,000.00	SHEE HVAC	40.000	80	2,772		250,000		252,772
	MAKEUP AIR HANDLING UNIT	1	EA	25,000.00	SHEE HVAC	100.000	100	3,465		25,000		28,465
	GALV DUCTWORK	80,000	LBS	0.70	SHEE HVAC	0.080	6,400	221,760		56,000		277,760
	SST DUCTWORK	150,000	LBS	2.00	SHEE HVAC	0.200	30,000	1,039,500		300,000		1,339,500
	EXHAUST STACK - ALLOW 5'DIA X 100' TALL	1	EA	115,000.00	IRON STEEL	500.000	500	18,405		115,000		133,405
	ISOKINETIC STACK SAMPLING SYSTEM	1	EA	250,000.00	ELEC ELEC	500.000	500	16,655		250,000		266,655
	HVAC S/T						38,140	\$1,321,961		\$1,595,000		\$2,916,961
1.3.16	ELECTRICAL											
	ELECTRICAL S/T						0					
1.3.16.2	INTERIM STORAGE FACILITY ELECTRICAL/LIGHTING	57,600	SF		ELEC ELEC	0.000					115,200	115,200
	VOICE PAGING/EVAC. SYSTEM	57,600	SF		ELEC ELEC	0.000					43,200	43,200
	INSTRUMENTATION	1	LOT		ELEC ELEC	0.000					30,000	30,000
	INTERIM STORAGE FACILITY S/T						0				\$188,400	\$188,400

PROJECT NAME: Csx/TRUE GROUT FEASIBILITY STUDY
SCENARIO #1
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

PAGE # 23

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1.3.16.3	TRUPAC STATION ELECTRICAL/LIGHTING	8,000	SF		ELEC	0.000					32,000	32,000
	VOICE PAGING/EVAC. SYSTEM	8,000	SF		ELEC	0.000					8,000	8,000
	TRUPAC STATION S/T						0				\$40,000	\$40,000
1.3.16.4.1	SWITCHGEAR AND TRANSFORMERS TRANSFORMER	1	EA	66,000.00	ELEC	24.000	24	799		66,000		66,799
	ARMOR CLAD BUS	40	LF	440.00	ELEC	1.000	40	1,332		17,600		18,932
	SWITCHGEAR	1	EA	125,000.00	ELEC	120.000	120	3,997		125,000		128,997
	UCS	1	LOT	25,000.00	ELEC	100.000	100	3,331		25,000		28,331
	UPS	1	EA	100,000.00	ELEC	40.000	40	1,332		100,000		101,332
	MCC	1	LOT	110,000.00	ELEC	360.000	360	11,992		110,000		121,992
	POWER DISTRIBUTION PANEL	2	EA	5,000.00	ELEC	12.000	24	799		10,000		10,799
	LIGHTING PANELS	3	EA	15,000.00	ELEC	8.000	24	799		45,000		45,799
	DRY TRANSFORMERS	2	EA	2,500.00	ELEC	10.000	20	666		5,000		5,666
	DISCONNECT SWITCHES	1	LOT	15,000.00	ELEC	240.000	240	7,994		15,000		22,994
	SWITCHGEAR AND TRANSFORMERS S/T						992	\$33,044		\$518,600		\$551,644
1.3.16.4.2	LIGHTING BUILDING & CELL LIGHTING	38,770	SF		ELEC	0.000					116,310	116,310
	LIGHTING S/T						0				\$116,310	\$116,310

PROJECT NAME: CalxTRU GROUT FEASIBILITY STUDY

SCENARIO #1

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

DETAILED COST ESTIMATE SHEET

PAGE # 24

DATE 26-Oct-1998

TIME: 08:10:12

REPORT NAME: Detail Cost Estimate Sheet

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MATL	S/C (OTHER 1)	TOTAL COST
1.3.16.4.3	RACEWAYS & ENCLOSURES CONDUIT & RACEWAY ALLOWANCE	9,000	LF	10.00	ELEC	0.270	2,430	80,943		90,000		170,943
	RACEWAYS & ENCLOSURES S/T						2,430	\$80,943		\$90,000		\$170,943
1.3.16.4.4	CONDUCTORS AND GROUNDING WIRE & CABLE ALLOWANCE	45,000	LF	0.20	ELEC	0.010	450	14,990		9,000		23,990
	GROUNDING	1	LOT	22,000.00	ELEC	350.000	350	11,659		22,000		33,659
	LIGHTNING PROTECTION	14,300	SF	0.10	ELEC	0.002	29	953		1,430		2,383
	CONDUCTORS AND GROUNDING S/T						829	\$27,601		\$32,430		\$60,031
1.3.16.4.5	WIRING DEVICES AND SPECIAL SYSTEMS WIRING DEVICES	1	LOT	40,000.00		530.000	530			40,000		40,000
	WIRING DEVICES AND SPECIAL SYSTEMS S/T						530			\$40,000		\$40,000
1.3.16.4.6	INSTRUMENTATION AND CONTROLS INSTRUMENTS - ALLOW	200	EA		INSTR	0.000					900,000	900,000
	CONTROLS (LIMIT SWITCHES, PROXIMITY SWITCHES, ETC.)	1	LOT		INSTR	0.000					50,000	50,000
	INSTRUMENTATION AND CONTROLS S/T						0				\$950,000	\$950,000
1.3.16.4.7	DCS DCS ALLOWANCE	1	LOT		INSTR	0.000					500,000	500,000
	DCS S/T						0				\$500,000	\$500,000

Lockheed Martin Idaho Technologies Co.

Rev. 698

PROJECT NAME: CSX/TRUE GROUT FEASIBILITY STUDY

SCENERIO #1

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484

PREPARED BY: R.D.ADAMS

PAGE # 25

DATE 26-Oct-1998

TIME: 08:10:12

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
1.3.16.4.8	TESTING TESTING	1	LOT		ELEC ELEC	400.000	400	13,324				13,324
	TESTING S/T						400	\$13,324				\$13,324
1.5.1 00701000	G&A/PIF ADDER G&A - 27%	1	LOT			0.000					727,460	727,460
	PIF - 4.5%	1	LOT			0.000					1,877,922	1,877,922
	G&A/PIF ADDER S/T						0				\$2,605,382	\$2,605,382
	PROJECT SUBTOTAL						208,590	\$26,579,207	\$1,072,220	\$17,057,859	\$5,351,650	\$50,060,935

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

 PROJECT NAME: **CSIX/TRUE GROUT FEASIBILITY STUDY**

SCENARIO #1

 LOCATION 1: **INEEL/INTEC**

 REQUESTOR: **K. L. WILLIAMS**
CONTINGENCY ANALYSIS

 TYPE OF ESTIMATE: **PLANNING**

 PROJECT NO: **2484**

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

 DATE: **26-Oct-1998**

 TIME: **08:08:03**

 REPORT NAME: **Contingency Analysis**

PROBABLE % VARIATION								PROJECT CONTINGENCY		SUMMARY	
WBS Element	Cost Estimate Element	Total Cost w/o Contingency	% Total Cost	Prob. % Var. Frpm Est.		Wt. % of Prob.		Contingency	%	Cost	Total Cost by Element
				-	+	-	+				
1.1.1	DESIGN ENGINEERING TITLE I & II	7,962,000	10.47	10	35	1.05	3.67	3.195%	9.36%	2,432,288	10,394,288
1.1.2	QUALITY ASSURANCE	1,990,500	2.62	10	35	0.26	0.92	0.799%	2.34%	608,072	2,598,572
1.2.1	PROJECT MANAGEMENT	5,573,400	7.33	10	35	0.73	2.57	2.236%	6.55%	1,702,602	7,276,002
1.2.2	CONSTRUCTION MANAGEMENT	3,981,000	5.24	10	40	0.52	2.09	1.833%	5.37%	1,395,575	5,376,575
1.3.1	GENERAL CONDITIONS	2,496,329	3.28	10	40	0.33	1.31	1.149%	3.37%	875,110	3,371,439
1.3.2	SITWORK	863,098	1.14	10	40	0.11	0.45	0.397%	1.16%	302,567	1,165,665
1.3.3	CONCRETE	4,209,942	5.54	10	40	0.55	2.22	1.938%	5.68%	1,475,833	5,685,775
1.3.5	METALS	1,406,944	1.85	10	40	0.19	0.74	0.648%	1.90%	493,217	1,900,161
1.3.7	THERMAL & MOISTURE PROTECTION	205,553	0.27	10	40	0.03	0.11	0.095%	0.28%	72,058	277,611
1.3.8	DOORS & WINDOWS	128,013	0.17	10	40	0.02	0.07	0.059%	0.17%	44,876	172,889
1.3.9	FINISHES	1,064,376	1.40	10	40	0.14	0.56	0.490%	1.44%	373,127	1,437,503
1.3.10	SPECIALTIES	19,410	0.03	10	40	0.00	0.01	0.009%	0.03%	6,804	26,214
1.3.11	EQUIPMENT	15,759,339	20.73	10	45	2.07	9.33	8.189%	23.99%	6,234,880	21,994,219
1.3.12	FURNISHINGS	221,438	0.29	10	35	0.03	0.10	0.089%	0.26%	67,646	289,084
1.3.13	SPECIAL CONSTRUCTION	1,167,753	1.54	10	40	0.15	0.61	0.538%	1.58%	409,366	1,577,119
1.3.14	CONVEYING SYSTEMS	1,987,042	2.61	10	45	0.26	1.18	1.033%	3.03%	786,135	2,773,177
1.3.15	MECHANICAL	6,457,307	8.49	10	40	0.85	3.40	2.973%	8.71%	2,263,667	8,720,974
1.3.16	ELECTRICAL	3,823,293	5.03	10	40	0.50	2.01	1.760%	5.16%	1,340,290	5,163,583
1.5.1	G&A/PIF ADDER	2,605,382	3.43	10	35	0.34	1.20	1.045%	3.06%	795,911	3,401,293
1.5.2	PROCUREMENT FEES	1,194,295	1.57	10	35	0.16	0.55	0.479%	1.40%	364,842	1,559,137
	ESCALATION	12,898,324	16.97	10	35	1.70	5.94	5.175%	15.16%	3,940,396	16,838,720
SUBTOTAL		76,014,738	100.00					34.130%			
CALCULATED CONTINGENCY		25,943,705									
RESULTANT TEC		101,958,443									
ROUNDED TEC		102,000,000									
PROJECT CONTINGENCY		25,985,262						34.18%			
MANAGEMENT RESERVE		5,320,361									
CONTINGENCY		20,664,901									
TOTAL ESTIMATED COST		102,000,000								25,985,262	102,000,000

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.

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.
 PROJECT: Cslx/TRUE GROUT FEASIBILITY STUDY
 SCENARIO #1
 LOCATION: INEEL/INTEC
 ESTIMATOR: R.D.ADAMS
 CLIENT: K. L. WILLIAMS

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: October 26, 1998
 ESTTYPE: PLANNING

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
PRIME CONTRACTOR		\$0	\$42,000	\$0	\$0	\$42,000		0.15%	0.11%
TOTAL FOR PRIME CONTRACTOR	530	\$0	\$42,000	\$0	\$0	\$42,000			
CONCRETE CONTRACTOR - CONC		\$1,217,789	\$628,373	\$0	\$0	\$1,846,162		6.41%	4.64%
PROFIT	10.00%	\$121,779	\$62,837	\$0	\$0	\$184,616	10.00%		
OVERHEADS	15.00%	\$200,935	\$103,681	\$0	\$0	\$304,617	16.50%		
TOTAL FOR CONCRETE CONTRACTOR - CONC	38,375	\$1,540,503	\$794,891	\$0	\$0	\$2,335,395	26.50%		
EARTHWORK CONTRACTOR - DIRT		\$168,319	\$0	\$188,520	\$0	\$356,839		1.24%	0.90%
PROFIT	10.00%	\$16,832	\$0	\$18,852	\$0	\$35,684	10.00%		
OVERHEADS	15.00%	\$27,773	\$0	\$31,106	\$0	\$58,878	16.50%		
TOTAL FOR EARTHWORK CONTRACTOR - DIRT	5,335	\$212,924	\$0	\$238,478	\$0	\$451,402	26.50%		
ELECTRICAL CONTRACTOR - ELEC		\$199,081	\$1,851,602	\$0	\$344,734	\$2,395,416		8.32%	6.03%
PROFIT	10.00%	\$19,908	\$185,160	\$0	\$34,473	\$239,542	10.00%		
OVERHEADS	15.00%	\$32,848	\$305,514	\$0	\$56,881	\$395,244	16.50%		
TOTAL FOR ELECTRICAL CONTRACTOR - ELEC	5,977	\$251,837	\$2,342,276	\$0	\$436,089	\$3,030,201	26.50%		
FIRE PROTECTION CONTRACTOR - FP		\$0	\$0	\$0	\$116,310	\$116,310		0.40%	0.29%
PROFIT	10.00%	\$0	\$0	\$0	\$11,631	\$11,631	10.00%		
OVERHEADS	18.00%	\$0	\$0	\$0	\$23,029	\$23,029	19.80%		
TOTAL FOR FIRE PROTECTION CONTRACTOR - FP	0	\$0	\$0	\$0	\$150,970	\$150,970	29.80%		
GENERAL CONTRACTOR - GEN		\$2,535,719	\$9,003,549	\$883,700	\$85,020	\$12,507,989		43.43%	31.47%
PROFIT	10.00%	\$253,572	\$900,355	\$88,370	\$8,502	\$1,250,799	10.00%		
OVERHEADS	5.00%	\$139,465	\$495,195	\$48,604	\$4,676	\$687,939	5.50%		
TOTAL FOR GENERAL CONTRACTOR - GEN	73,827	\$2,928,756	\$10,399,099	\$1,020,674	\$98,198	\$14,446,727	15.50%		
HVAC CONTRACTOR - HVAC		\$1,343,488	\$1,449,210	\$0	\$20,000	\$2,812,698		9.77%	7.08%
PROFIT	10.00%	\$134,349	\$144,921	\$0	\$2,000	\$281,270	10.00%		
OVERHEADS	18.00%	\$266,011	\$286,944	\$0	\$3,960	\$556,914	19.80%		
TOTAL FOR HVAC CONTRACTOR - HVAC	38,770	\$1,743,847	\$1,881,075	\$0	\$25,960	\$3,650,881	29.80%		

Lockheed Martin Idaho Technologies Co.
 PROJECT: Csk/TRUE GROUT FEASIBILITY STUDY
 SCENARIO #1
 LOCATION: INEEL/INTEC
 ESTIMATOR: R.D.ADAMS
 CLIENT: K. L. WILLIAMS

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: October 26, 1998
 ESTTYPE: PLANNING

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
INSTRUMENTATION CONTRACTOR - INSTR	10.00%	\$0	\$0	\$0	\$1,450,000	\$1,450,000	10.00%	5.03%	3.65%
PROFIT	18.00%	\$0	\$0	\$0	\$145,000	\$145,000	10.00%		
OVERHEADS		\$0	\$0	\$0	\$287,100	\$287,100	19.80%		
TOTAL FOR INSTRUMENTATION CONTRACTOR - INSTR	0	\$0	\$0	\$0	\$1,882,100	\$1,882,100	29.80%		
INSULATION CONTRACTOR - INSUL	10.00%	\$0	\$0	\$0	\$56,164	\$56,164	10.00%	0.20%	0.14%
PROFIT	15.00%	\$0	\$0	\$0	\$5,616	\$5,616	10.00%		
OVERHEADS		\$0	\$0	\$0	\$9,267	\$9,267	16.50%		
TOTAL FOR INSULATION CONTRACTOR - INSUL	0	\$0	\$0	\$0	\$71,047	\$71,047	26.50%		
PAINTING CONTRACTOR - PAINT	10.00%	\$136,973	\$125,025	\$0	\$426,400	\$688,397	10.00%	2.39%	1.73%
PROFIT	15.00%	\$13,697	\$12,502	\$0	\$42,640	\$68,840	10.00%		
OVERHEADS		\$22,601	\$20,629	\$0	\$70,356	\$113,586	16.50%		
TOTAL FOR PAINTING CONTRACTOR - PAINT	4,902	\$173,271	\$158,156	\$0	\$539,396	\$870,823	26.50%		
PAVING CONTRACTOR - PAVE	10.00%	\$0	\$0	\$0	\$108,800	\$108,800	10.00%	0.38%	0.27%
PROFIT	18.00%	\$0	\$0	\$0	\$10,880	\$10,880	10.00%		
OVERHEADS		\$0	\$0	\$0	\$21,542	\$21,542	19.80%		
TOTAL FOR PAVING CONTRACTOR - PAVE	0	\$0	\$0	\$0	\$141,222	\$141,222	29.80%		
PIPING CONTRACTOR - PIPE	10.00%	\$852,699	\$4,298,805	\$0	\$50,180	\$5,201,684	10.00%	18.06%	13.09%
PROFIT	20.00%	\$85,270	\$429,881	\$0	\$5,018	\$520,168	10.00%		
OVERHEADS		\$187,594	\$945,737	\$0	\$11,040	\$1,144,370	22.00%		
TOTAL FOR PIPING CONTRACTOR - PIPE	23,203	\$1,125,563	\$5,674,423	\$0	\$66,238	\$6,866,223	32.00%		
STRUCTURAL STEEL CONTRACTOR - STEEL	10.00%	\$618,239	\$512,189	\$0	\$88,660	\$1,219,088	10.00%	4.23%	3.07%
PROFIT	15.00%	\$61,824	\$51,219	\$0	\$8,666	\$121,909	10.00%		
OVERHEADS		\$102,009	\$84,511	\$0	\$14,629	\$201,150	16.50%		
TOTAL FOR STRUCTURAL STEEL CONTRACTOR - STEEL	17,672	\$782,072	\$647,919	\$0	\$112,155	\$1,542,146	26.50%		

Lockheed Martin Idaho Technologies Co.
 PROJECT: C&I/TRU GROUT FEASIBILITY STUDY
 SCENERIO #1
 LOCATION: INEEL/INTEC
 ESTIMATOR: R.D.ADAMS
 CLIENT: K. L. WILLIAMS

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: October 26, 1998
 ESTTYPE: PLANNING

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
TOTAL DIRECT COST	208,690	\$7,072,307	\$17,910,762	\$1,072,220	\$2,746,288	\$28,801,546		100.00%	
TOTAL SUBCONTRACTOR MARKUPS		\$1,686,466	\$4,029,087	\$186,931	\$777,107	\$6,679,591			16.81%
TOTAL COST TO PRIME		\$8,768,772	\$21,939,839	\$1,269,151	\$3,523,376	\$35,481,138			
PRIME CONTRACTOR MARKUP	12.02%	\$1,047,973	\$2,641,986	\$153,616	\$421,827	\$4,265,402			10.73%
TOTAL PROJECT COST		\$9,806,745	\$24,581,825	\$1,412,768	\$3,945,202	\$39,746,540			

FY-99 G&A/PIF ADDER CALCULATION SHEET**PROJECT: Csix/TRU GROUT FACILITY SCENERIO #1****DATE: 10/14/98****PROCUREMENT FEE:**

CONSTRUCTION =	\$39,809,836	
GFE =	\$0	
Subtotal	\$39,809,836	
FEE @ 3.0% =	\$39,809,836 • 0.03 =	\$1,194,295

G&A @ 27% (with a ceiling of \$500,000 imposed per year)**CONSTRUCTION \$ OR CEILING * # OF YEARS**

YEARS OF CONST. = 3	\$1,500,000	
GFE =	\$0	
PROCUREMENT FEE =	\$1,194,295	
Subtotal	\$2,694,295	
FEE @ 27% =	\$2,694,295 • 0.27 =	\$727,460

PIF @ 4.5%

CONSTRUCTION =	\$39,809,836	
GFE =	\$0	
PROCUREMENT FEE =	\$1,194,295	
G&A =	\$727,460	
Subtotal	\$41,731,591	
FEE @ 4.5% =	\$41,731,591 • 0.045 =	\$1,877,922

TOTAL PROCUREMENT FEE: \$1,194,295**TOTAL G&A FEE: \$727,460****TOTAL PIF: \$1,877,922**

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: Cslx/TRU GROUT FEASIBILITY STUDY
SCENERIO #1 - OPC
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

COST ESTIMATE SUMMARY

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 24840
PREPARED BY: R.D.ADAMS/D.A.ROWLEY
REPORT NAME: Cost Estimate Summary

DATE: 15-Oct-1998
TIME: 07:30:00

CHECKED BY: DZ

APPRD BY: [Signature]

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	CONCEPTUAL DESIGN			>> \$2,364,330
1.1.1	CONCEPTUAL DESIGN	2,230,500	133,830	2,364,330
1.2	MANAGEMENT COSTS			>> \$10,059,930
1.2.1	PROJECT MANAGEMENT & PROCESS	9,490,500	569,430	10,059,930
1.3	PERMITTING			>> \$1,383,065
1.3.1	PERMITTING	1,268,867	114,198	1,383,065
1.4	SO TEST & STARTUP			>> \$10,068,800
1.4.1	SO TEST & STARTUP	8,120,000	1,948,800	10,068,800
1.5.2	PROCUREMENT FEES	0	0	>> \$0
SUBTOTAL INCLUDING ESCALATION		21,109,867	2,766,258	>> \$23,876,125
PROJECT CONTINGENCY				
MANAGEMENT RESERVE				>> \$0
CONTINGENCY				>> \$8,323,875
TOTAL ESTIMATED COST				>> \$32,200,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= 21.00%

CONTINGENCY= 34.86%

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
1.1.1	CONCEPTUAL DESIGN											
	DESIGN @ 5% OF TCC & GFE	1	LOT		LIMITCO	0.000		1,990,500				1,990,500
	CONCEPTUAL DESIGN S/T						0	\$1,990,500				\$1,990,500
1.1.3	A-E PROCUREMENT A-E PROCUREMENT COSTS	1	LOT			0.000		240,000				240,000
	A-E PROCUREMENT S/T						0	\$240,000				\$240,000
1.2.1	PROJECT MANAGEMENT & PROCESS DEVELOPMENT											
	ACDC/SOW,CPDS,PEP,DC/SOW & REVIEWS @6% OF TCC	1	LOT		LIMITCO	0.000		1,990,500				1,990,500
	PSAR & SAR	1	LOT		LIMITCO	0.000		2,500,000				2,500,000
	PILOT PLANT & PROCESS DEVELOPMENT	1	LOT			0.000		5,000,000				5,000,000
	PROJECT MANAGEMENT & PROCESS DEVELOPMENT S/T						0	\$9,490,500				\$9,490,500
1.3.1	PERMITTING											
	CONCEPTUAL DESIGN REVIEW	1	LOT		Z-4170	320.000	320	23,347				23,347
	SITING AGREEMENT	1	LOT		Z-4170	320.000	320	23,347				23,347
	HWM/MRCRA PERMIT	1	LOT		Z-4170	2880.00	2,880	210,125				210,125
	PERMIT TO CONSTRUCT	1	LOT		Z-4170	1800.00	1,800	131,328				131,328

DETAILED COST ESTIMATE SHEET

PAGE # 2

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 24840

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 15-Oct-1998

TIME: 07:29:21

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
1.3.1	PERMITTING CWA, STORM WATER, HISTORICAL, OTHER REG. COMPLIANCE	1	LOT		Z-4170	1000.00	1,000	72,960				72,960
	P.E. CERTIFICATION	1	LOT			0.000					50,000	50,000
	HEALTH & SAFETY ISSUES	1	LOT			0.000					200,000	200,000
	QUALITY REVIEWS	1	LOT			0.000					120,000	120,000
	INCIDENTAL WASTE DETERMINATION BY NRC	1	LOT		Z-4170	2000.00	2,000	145,920				145,920
	WIPP ACCEPTANCE OF TRU PRODUCT	1	LOT		Z-4170	4000.00	4,000	291,840				291,840
	PERMITTING S/T						12,320	\$898,867			\$370,000	\$1,268,867
1.4.1	SO TEST & STARTUP											
	ORR	1	LOT			0.000		2,000,000				2,000,000
	SO TEST & TRAINING @ 3% OF TEC	1	LOT		LIMITCO	0.000		3,060,000				3,060,000
	SO TEST & STARTUP S/T						0	\$5,060,000				\$5,060,000
1.4.1.1	PROJECT SUPPORT SUPPORT DURING DESIGN, CONSTRUCTION & STARTUP @ 3% OF TEC	1	LOT		LIMITCO	0.000		3,060,000				3,060,000
	PROJECT SUPPORT S/T						0	\$3,060,000				\$3,060,000
	PROJECT SUBTOTAL						12,320	\$20,739,867		\$0	\$0	\$21,109,867

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: Cslx/TRUE GROUT FEASIBILITY STUDY
 SCENERIO #1 - OPC
 LOCATION 1: INEEL/INTEC
 REQUESTOR: K. L. WILLIAMS

CONTINGENCY ANALYSIS

TYPE OF ESTIMATE: PLANNING
 PROJECT NO: 24840
 PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE: 15-Oct-1998
 TIME: 07:29:54

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	2,230,500	9.34	10	40	0.93	3.74	3.270%	9.34%	777,614	3,008,114
1.2.1	PROJECT MANAGEMENT & PROCESS	9,490,500	39.75	10	40	3.97	15.90	13.912%	39.75%	3,308,650	12,799,150
1.3.1	PERMITTING	1,268,867	5.31	10	40	0.53	2.13	1.860%	5.31%	442,362	1,711,229
1.4.1	SO TEST & STARTUP	8,120,000	34.01	10	40	3.40	13.60	11.903%	34.01%	2,830,856	10,950,856
1.5.2	PROCUREMENT FEES	0	0.00	10	40	0.00	0.00	0.000%	0.00%	0	0
	ESCALATION	2,766,258	11.59	10	40	1.16	4.63	4.055%	11.59%	964,393	3,730,651
	SUBTOTAL	23,876,125	100.00					35.000%			
	CALCULATED CONTINGENCY	8,356,644									
	RESULTANT TEC	32,232,769									
	ROUNDED TEC	32,200,000									
	PROJECT CONTINGENCY	8,323,875						34.85%			
	MANAGEMENT RESERVE	0									
	CONTINGENCY	8,323,875									
	TOTAL ESTIMATED COST	32,200,000								8,323,875	32,200,000

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

COST ESTIMATE SUPPORT DATA RECAPITULATION

Project Title: CsIX TRU Grout Feasibility Study – Scenario #2
Estimator: Adams / Rowley
Date: October 13, 1998
Estimate Type: Planning
File: 2484-A
Approved By:

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

This project consists of several parts. Cells in the existing New Waste Calcining Facility (NWCF) will be used to house the Cesium Ion Exchange equipment. A new facility will be built to grout the resulting liquid waste into drums. An interim storage facility and a TRUPAC loading facility will be built to temporarily house the waste drums and load them for shipment to WIPP.

The estimate includes all work associated with modifying the existing NWCF facility at INTEC to house a new Cesium Ion Exchange (CsIX) process. Modifications include:

- A. Demolition of existing piping, structural steel and electrical in the calciner cell.
- B. Removal of silica gel from the existing adsorber vessels.
- C. Demolition of existing piping, structural steel, vessels, equipment, and electrical from the adsorber cell.
- D. Demolition of other piping and electrical in NWCF as required.
- E. Installation of a new partition wall inside the calciner cell.
- F. Installation of new piping, equipment, and electrical in the calciner cell.
- G. Installation of new piping, equipment, and electrical in the adsorber cell.
- H. Installation of new piping, equipment, and electrical in the valve cubicle.
- I. Installation of new piping, equipment, and electrical in the hot sump tank removal cell.

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

The estimate is based on the preliminary design drawings, the feasibility description, equipment list, and discussions held with H. S. Forsythe.

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

For NWCF:

COST ESTIMATE SUPPORT DATA RECAPITULATION

- Continued -

Project Title: CsIX TRU Grout Feasibility Study- Scenario #2

File: 2484-A

Page 2

- A. Assume sufficient "cold" work will be available to enable workers to remain working after they have received their maximum annual radiation exposure.
- B. Assume the radiation general body fields will not exceed the estimated fields provided by Maria Dumas and Griff Colson 10/1/98.
- C. Assume the construction period will be four (4) years beginning in FY-04.
- D. Assume the silica gel will be removed from the adsorber vessels and boxed as mixed waste. Final disposition and disposal costs are not included.
- E. Personnel training estimates are based on workers being allowed to receive a total body exposure of 1.5R per year.
- F. Assume LMITCO operations personnel will operate the overhead crane.

General:

- 1. Due to the amount of hot work in NWCF, this work will drive the schedule from three years to four years.
- 2. Utilities and transfer lines are included in the estimate for the various facilities as needed.
- 3. All concrete surfaces in hot cells will be coated with stainless steel liner or epoxy coating as identified on the drawings.
- 4. For non-NWCF work, supervisor hours are figured at 5% of total labor hours.
- 5. Training hours are equal to 3% of total labor hours.
- 6. All building foundations start at -6'-0 unless shown otherwise on the drawings.
- 7. Epoxy coating system is included on the Interim Storage Facility and TRUPAC Loading Station concrete floors.
- 8. All structural components of Grout facility are concrete except roof framing.
- 9. Grout Facility roof is standing seam-roofing panels over structural steel framing.
- 10. All overhead doors are motor-operated.
- 11. The exterior of the Grout Facility is left exposed concrete.
- 12. Included a concrete pad under the Grout Facility outside bin/tank area.
- 13. TRUPAC loading facility includes two 10ton-bridge cranes, work platforms, pallet scales, stretch wrap machine, and vacuum pump system.
- 14. TRUPAC station will require minimal H&V.
- 15. An exhaust stack with appropriate monitoring is required for the Grout Facility.
- 16. Interim Storage Facility includes a ventilation system not shown on the drawings.
- 17. Ten shielded containers are included for storage of UDS. The remaining 40 containers needed during production will be supplied by operations.
- 18. The initial charge of ion exchange resin is included in this estimate. The remaining resin required for production will be supplied by operations.

COST ESTIMATE SUPPORT DATA RECAPITULATION

- Continued -

Project Title: CsIX TRU Grout Feasibility Study- Scenario #2
File: 2484-A

Page 3

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.*

Contingency for this scenario has been calculated to be 35.2%. Items of possible risk considered for this calculation are:

- A. High to moderate levels of radioactive contamination. With regards to the ALARA program, work in the "hot" areas will be extremely difficult and radiation exposure to workers will be higher than desired.
- B. The silica gel is anticipated to contain extremely high levels of radiation and is compounded by being a mixed waste for which a disposal process does not currently exist. It is possible that a new facility will have to be erected for the sole purpose of processing the contaminated silica gel for final disposal.
- C. Due to the radiation fields, which are known to exist in NWCF, maintaining a constant work force will be difficult. Sufficient "clean" work will have to be worked concurrently with this scenario in order to sustain a constant work force.
- D. It is anticipated that "travelers" (craftsmen from geographical areas other than the Idaho Falls / Pocatello area) will make up a majority of the work force. These workers tend to work for short periods of time and then return home. As a result the training allowance for this scenario appears to be high but could be substantially higher.
- E. Most systems have not been detailed. Many changes to the assumed requirements will appear as these systems are developed further.

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

- A. Costs from the Detailed Cost Estimate sheets are direct costs for material, labor, equipment, and special subcontracts. Costs for corresponding divisions on the Cost Estimate Summary sheet include all applicable indirect costs (overhead, profit, commission on subcontracts, sales tax, and bond).
- B. Costs for each activity represent present day costs escalated to the appropriate activity midpoint.
- C. Subcontractor labor costs reflect INEEL Site Jurisdictional Agreement craft labor rates.
- D. Costs for Lockheed Martin General and Administrative allowance (G & A) and Performance Incentive Factor (PIF) have been included in this estimate.

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

 PROJECT NAME: **CsIX/TRUE GROUT FEASIBILITY STUDY**
 SCENARIO #2 (NWCF)
 LOCATION 1: **INEEL/INTEC**
 REQUESTOR: **K. L. WILLIAMS**
COST ESTIMATE SUMMARY

 TYPE OF ESTIMATE: **PLANNING**
 PROJECT NO: **2484A**
 PREPARED BY: **R.D.ADAMS/D.A.ROWLEY**
 REPORT NAME: **Cost Estimate Summary**

 DATE: **14-Oct-1998**
 TIME: **15:41:37**
 CHECKED BY: DR
 APPRD BY: Bolly

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	<u>ENGINEERING, DESIGN AND INSPECTION</u>			>> \$14,050,317
1.1.1	DESIGN ENGINEERING TITLE I & II	9,877,200	1,086,492	10,963,692
1.1.2	QUALITY ASSURANCE	2,469,300	617,325	3,086,625
1.2	<u>MANAGEMENT COSTS</u>			>> \$13,636,330
1.2.1	PROJECT MANAGEMENT	6,914,000	1,521,080	8,435,080
1.2.2	CONSTRUCTION MANAGEMENT	4,161,000	1,040,250	5,201,250
1.3	<u>CONSTRUCTION</u>			>> \$52,012,853
1.3.1	GENERAL CONDITIONS	6,676,627	1,669,157	8,345,784
1.3.2	SITWORK	825,688	206,422	1,032,110
1.3.3	CONCRETE	2,631,536	657,884	3,289,420
1.3.5	METALS	638,131	159,533	797,664
1.3.7	THERMAL & MOISTURE PROTECTION	105,632	26,408	132,040
1.3.8	DOORS & WINDOWS	87,785	21,946	109,731
1.3.9	FINISHES	824,547	206,137	1,030,684
1.3.10	SPECIALTIES	13,315	3,329	16,644
1.3.11	EQUIPMENT	12,321,818	3,080,454	15,402,272
1.3.12	FURNISHINGS	133,566	33,391	166,957
1.3.13	SPECIAL CONSTRUCTION	1,503,468	375,867	1,879,335
1.3.14	CONVEYING SYSTEMS	2,176,670	544,168	2,720,838
1.3.15	MECHANICAL	8,925,228	2,231,307	11,156,535
1.3.16	ELECTRICAL	4,746,271	1,186,568	5,932,839
1.4	<u>GOVERNMENT FURNISHED EQUIP.</u>			>> \$9,719,666
1.4.1	GOVERNMENT FURNISHED EQUIP.	7,775,733	1,943,933	9,719,666
1.5	<u>G&A/PIF</u>			>> \$4,682,054
1.5.1	G&A/PIF ADDER	3,745,643	936,411	4,682,054
1.5.2	PROCUREMENT FEES	1,328,484	332,121	>> \$1,660,605
SUBTOTAL INCLUDING ESCALATION		77,881,642	17,880,183	>> \$95,761,825
PROJECT CONTINGENCY				
MANAGEMENT RESERVE				>> \$6,807,518
CONTINGENCY				>> \$27,730,657
TOTAL ESTIMATED COST				>> \$130,300,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= 23.00%

CONTINGENCY= 36.07%

[illegible]

PAGE # 4

DATE 14-Oct-1998

TIME: 15:37:18

REPORT NAME: Detail Cost Estimate Sheet

[illegible]

DETAILED COST ESTIMATE SHEET

[illegible]

PROJECT NAME: C&I/TRU GROUT FEASIBILITY STUDY

TYPE OF ESTIMATE: PLANNING

DATE 14-Oct-1998

LOCATION 1: INEEL/INTEC

PROJECT NO.: 2484A

TIME: 15:37:18

REQUESTOR: K. L. WILLIAMS

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

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
1.3.3	CONCRETE											
	CONCRETE S/T						0					
1.3.3.2	INTERIM STORAGE FACILITY FOUNDATION CONCRETE - COMPLETE	280	CY	150.00	LABR CONC	10.000	2,800	81,312		42,000		123,312
	SLAB-ON-GRADE - COMPLETE	2,130	CY	110.00	CONC	7.000	14,910	477,567		234,300		711,867
	ELEVATED DECK FILL - COMPLETE	35	CY	110.00	CONC CONC	6.000	210	6,726		3,850		10,576
	INTERIM STORAGE FACILITY S/T						17,920	\$565,606		\$280,150		\$845,756
1.3.3.3	TRUPAC STATION FOUNDATION CONCRETE - COMPLETE	100	CY	150.00	LABR CONC	10.000	1,000	29,040		15,000		44,040
	SLAB-ON-GRADE - COMPLETE	600	CY	110.00	CONC CONC	7.000	4,200	134,526		66,000		200,526
	TRUPAC STATION S/T						5,200	\$163,566		\$81,000		\$244,566
1.3.3.4	GROUT FACILITY POUR & FINISH CONCRETE	920	CY	70.00	CONC CONC	4.500	4,140	132,604		64,400		197,004
	FORMWORK	35,400	SF	0.40	CARP GEN	0.300	10,620	354,283		14,160		368,443
	GROUT FACILITY S/T						14,760	\$486,987		\$78,560		\$565,447
1.3.3.1	NEW WORK - CONCRETE - CALCINER New Shielding Wall - 2' Thick - Precast Special Aggregate	50	Cy	800.00	LABR GEN	5.000	250	7,260		40,000		47,260
	Rebar For Shielding Wall	25,000	Lb	0.40	IRON GEN	0.010	250	9,203		10,000		19,203

Lockheed Martin Idaho Technologies Co.

Rev. 0/06

PROJECT NAME: C&I/TRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)

LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

PAGE # 10

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY
DATE 14-Oct-1998
TIME: 15:37:18
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
1.3.7.2	INTERIM STORAGE FACILITY INSULATE INSPECTION ROOM	6,480	SF		INSUL	0.000					8,424	8,424
	INTERIM STORAGE FACILITY S/T						0				\$8,424	\$8,424
1.3.7.4	GROUT FACILITY STANDING SEAM METAL ROOF	6,600	SF		SHEE STEEL	0.000					42,900	42,900
	INSULATION - ALLOW	6,600	SF		INSUL	0.000					23,100	23,100
	GROUT FACILITY S/T						0				\$66,000	\$66,000
1.3.8	DOORS & WINDOWS											
	DOORS & WINDOWS S/T						0					
1.3.8.2	INTERIM STORAGE FACILITY 28'X15' OVERHEAD, MOTOR-OPERATED DOOR	4	EA		IRON GEN	0.000					30,000	30,000
	HEAD SPACE GAS ANALYSIS & VIDEO SCOPY DOOR	1	EA		GEN	0.000					2,000	2,000
	INTERIM STORAGE FACILITY S/T						0				\$32,000	\$32,000
1.3.8.3	TRUPAC STATION 20'X15' OVERHEAD, MOTOR-OPERATED DOOR	4	EA		GEN	0.000					16,800	16,800
	TRUPAC STATION S/T						0				\$16,800	\$16,800

Lockheed Martin Idaho Technologies Co.

Rev. 9/98

PROJECT NAME: **Cs/ITRU GROUT FEASIBILITY STUDY**

SCENARIO #2 (NWCF)

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: **PLANNING**

PROJECT NO.: **2484A**

PREPARED BY: **R.D.ADAMS/D.A.ROWLEY**

PAGE # **11**

DATE **14-Oct-1998**

TIME: **15:37:18**

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
1.3.9.4	GROUT FACILITY											
	PERSONNEL DOORS, FRAMES & HARDWARE	9	EA	600.00	CARP GEN	6.000	54	1,801		5,400		7,201
	OVERHEAD, MOTOR-OPERATED DOOR	2	EA		IRON GEN	0.000					8,000	8,000
	WINDOWS, DBL PANE, METAL FRAME	18	EA	120.00	CARP GEN	2.000	36	1,201		2,160		3,361
	GROUT FACILITY S/T						90	\$3,002		\$7,560	\$8,000	\$18,562
1.3.9	FINISHES											
	FINISHES S/T						0					
1.3.9.2	INTERIM STORAGE FACILITY											
	6" METAL STUD, LOAD-BEARING PARTITION	2,980	SF	1.00	CARP GEN	0.030	86	2,882		2,880		5,762
	GYP. BOARD	8,640	SF	0.22	CARP GEN	0.020	173	5,765		1,901		7,665
	PAINT GYP. BD. & UNDERSIDE OF DECK	9,360	SF	0.10	PAINT PAINT	0.009	84	2,354		936		3,290
	EPOXY FLOOR SYSTEM	57,600	SF		PAINT	0.000					374,400	374,400
	INTERIM STORAGE FACILITY S/T						343	\$11,001		\$5,717	\$374,400	\$391,117
1.3.9.4	GROUT FACILITY											
	EPOXY COATING	23,200	SF	2.00	PAINT PAINT	0.080	1,856	51,857		46,400		98,257
	PAINTING	2,060	SF	0.10	PAINT PAINT	0.009	19	518		206		724
	GYP. BOARD NONLOAD-BEARING PARTITIONS W/ 5/8" GYP BD BOTH SIDES	1,030	SF	0.90	CARP GEN	0.050	52	1,718		927		2,645
	FLOOR COVERING	3,800	SF		GEN	0.000					7,600	7,600

PROJECT NAME: C&WTRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998
TIME 15:37:18
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
1.3.10.4	GROUT FACILITY RESTROOM PARTITIONS	3	EA	200.00	CARP	3.000	9	300		600		900
	WATERCLOSETS	2	EA	250.00	PIPE	3.000	6	221		500		721
	URINALS	1	EA	400.00	PIPE	3.000	3	110		400		510
	LAVATORIES	2	EA	150.00	PIPE	3.000	6	221		300		521
	SHOWERS	2	EA	500.00	PIPE	12.000	24	883		1,000		1,883
	LOCKERS, ALLOW	10	EA	110.00	CARP	1.000	10	334		1,100		1,434
	BENCHES	10	LF	14.00	CARP	0.200	2	67		140		207
	GROUT FACILITY S/T						80	\$2,803		\$4,540	\$2,000	\$9,343
1.3.11	EQUIPMENT											
	EQUIPMENT S/T						0					
1.3.11.2.1	HEAD SPACE SAMPLING & VIDEO INSPECTION	1	EA	20,000.00	SKWK	60.000	60	1,987		20,000		21,987
	INLET/LOAD CONVEYOR	1	EA	10,000.00	SKWK	40.000	40	1,324		10,000		11,324
	INDEX TABLE CONVEYOR	1	EA	10,000.00	SKWK	40.000	40	1,324		10,000		11,324
	INDEX ARM	1	EA	20,000.00	SKWK	100.000	100	3,311		20,000		23,311
	AIR LOCK/GLOVEBOX	280	CF	1,000.00	SKWK	2.000	560	18,542		280,000		288,542
	VIDEO CAMERA/CONTROL STATION	1	EA	17,000.00	ELEC	20.000	20	666		17,000		17,666
	HEADSPACE SAMPLE TUBE	1	EA	20,000.00	SKWK	40.000	40	1,324		20,000		21,324

PROJECT NAME: CS/MTU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)

LOCATION 1: INEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

PAGE # 14

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.11.2.1	HEAD SPACE SAMPLING & VIDEO INSPECTION MECHANICAL SWIPE ARM	1	EA	20,000.00	SKWK GEN	100.000	100	3,311		20,000		23,311
	FILTER REMOVAL ARM	1	EA	20,000.00	SKWK GEN	100.000	100	3,311		20,000		23,311
	FILTER INSTALLATION ARM	1	EA	20,000.00	SKWK GEN	100.000	100	3,311		20,000		23,311
	HEAD SPACE SAMPLING & VIDEO INSPECTION S/T						1,160	\$38,412		\$437,000		\$475,412
1.3.11.4.8	GROUT RECYCLE STATION OVEN	1	EA	20,000.00	PIPE	60.000	60	2,207		20,000		22,207
E-105	VAPOR CONDENSER - 2 kg/hr	1	EA	50,000.00	PIPE PIPE PIPE	60.000	60	2,207		50,000		52,207
	GROUT RECYCLE STATION S/T						120	\$4,415		\$70,000		\$74,415
1.3.11.4.1	TRUCK UNLOADING STATION DUST CONTROL MECHANISM	4	EA	2,000.00	SKWK GEN	5.000	20	662		8,000		8,662
	AIR ENDUCTOR	4	EA	3,500.00	SKWK GEN	10.000	40	1,324		14,000		15,324
	TRUCK UNLOADING STATION S/T						60	\$1,987		\$22,000		\$23,987
1.3.11.4.4 B-102	GROUTING EQUIPMENT CaO BIN - 38 M3	1	EA	45,000.00	PIPE PIPE	60.000	60	2,207		45,000		47,207
B-103	PORTLAND CEMENT BIN - 34 M3	1	EA	45,000.00	PIPE PIPE	60.000	60	2,207		45,000		47,207
B-104	FLYASH BIN - 34 M3	1	EA	45,000.00	PIPE PIPE	60.000	60	2,207		45,000		47,207
B-105	BLAST FURNACE SLAG BIN - 58 M3	1	EA	55,000.00	PIPE PIPE	80.000	80	2,943		55,000		57,943
ED-101,2,3,4	AIR EDUCTOR - 9 Kg-S/hr	4	EA	3,500.00	PIPE PIPE	10.000	40	1,472		14,000		15,472

PROJECT NAME: C&I/TRUE GROUT FEASIBILITY STUDY
SCENERIO #2 (NWCF)

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.11.4.4 B-107	GROUTING EQUIPMENT C&O WEIGHT BIN - 4 M3	1	EA	4,000.00	PIPE	30.000	30	1,104		4,000		5,104
T-104A&B	GROUT FEED TANK - 7 M3	2	EA	35,000.00	PIPE	80.000	160	5,886		70,000		75,886
N-101A&B	pH SAMPLER/NEUTRALIZER	2	EA	6,000.00	PIPE	10.000	20	736		12,000		12,736
P-105A&B	GROUT MIXER FEED PUMP - 2-18 L/MIN	2	EA	6,000.00	PIPE	15.000	30	1,104		12,000		13,104
F-108	KNOCKOUT FILTER -	1	EA	8,000.00	PIPE	15.000	15	552		8,000		8,552
B-109A,B&C	DRY INGREDIENT WEIGH BIN - 2 M3	3	EA	2,000.00	PIPE	15.000	45	1,656		6,000		7,656
C-101A,B&C	SOLIDS FEED CONVEYOR - 8 Kg/MIN	3	EA	2,500.00	PIPE	10.000	30	1,104		7,500		8,604
M-101A,B&C	GROUT MIXER - .3 M3	3	EA	20,000.00	PIPE	60.000	180	6,622		60,000		66,622
B-106A	DRY GROUT ADMIXTURES BIN - .4 M3	1	EA	2,500.00	PIPE	20.000	20	736		2,500		3,236
B-106B&C	LIQUID GROUT ADMIXTURES TANK	2	EA	500.00	PIPE	15.000	30	1,104		1,000		2,104
P-108	DECON AGENT PUMP - 76 L/MIN	1	EA	8,000.00	PIPE	30.000	30	1,104		8,000		9,104
P-115	METERING PUMP/ADMIXTURES - 1 L/MIN	1	EA	5,000.00	PIPE	10.000	10	368		5,000		5,368
T-106	MIXER WASH TANK - 1 M3	1	EA	10,000.00	PIPE	50.000	50	1,840		10,000		11,840
P-116	DECON RETURN PUMP - 76 L/MIN	1	EA	8,000.00	PIPE	30.000	30	1,104		8,000		9,104
F-105	SPENT DECON SOLUTION FILTER -	1	EA	5,000.00	PIPE	10.000	10	368		5,000		5,368
	SHIELDED VIEWING WINDOW - 1'-6" THK	2	EA		SKWK GEN	0.000						
	GROUTING EQUIPMENT S/T						990	\$36,422		\$423,000		\$459,422
1.3.11.4.5	GROUTED WASTE DRUM FILL/SEAL AREA STORAGE AREA CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	AIRLOCK	1	EA	80,000.00	SKWK GEN	200.000	200	6,622		80,000		86,622
	AIRLOCK CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324

CSIX/TRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWC/F)
INTEL/INTEC
K. L. WILLIAMS
 LOCATION 1:
 REQUESTOR:

[illegible]

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: C&WTRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)

LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 17

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.11.4.5	GROUTED WASTE DRUM FILL/SEAL AREA ROTATING TABLE	1	EA	20,000.00	SKWK GEN	100.000	100	3,311		20,000		23,311
	DECON EQUIPMENT	1	LOT	30,000.00	SKWK GEN	100.000	100	3,311		30,000		33,311
	INSPECTION EQUIPMENT	1	LOT	50,000.00	SKWK GEN	100.000	100	3,311		50,000		53,311
	DISCHARGE SECTION TUNNEL	1	EA	70,000.00	SKWK GEN	200.000	200	6,622		70,000		76,622
	DISCHARGE SECTION INLET CONVEYOR	3	EA	10,000.00	SKWK GEN	40.000	120	3,973		30,000		33,973
	MAIN DISCHARGE CONVEYOR	1	EA	35,000.00	SKWK GEN	100.000	100	3,311		35,000		38,311
	TRANSFER SECTION LIFT	3	EA	10,000.00	SKWK GEN	30.000	90	2,980		30,000		32,980
	AIRLOOK	1	EA	80,000.00	SKWK GEN	200.000	200	6,622		80,000		86,622
	AIRLOCK CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	TILT & PAN CAMERA	14	EA	2,000.00	ELEC ELEC	10.000	140	4,663		28,000		32,663
	CAMERA CONTROL STATION	1	EA	15,000.00	ELEC ELEC	40.000	40	1,332		15,000		16,332
	GROUTED WASTE DRUM FILL/SEAL AREA S/T						3,320	\$108,961		\$1,098,000		\$1,207,961
1.3.11.4.6	GROUT CURING ROOM EQUIPMENT INLET STAGING, DRUM LIFT, CURE LINE & DRUM LIFT ENCLOSURE	1	LOT	250,000.00	SKWK GEN	500.000	500	16,555		250,000		266,555
	INLET STAGING CONVEYOR	1	EA	10,000.00	SKWK GEN	40.000	40	1,324		10,000		11,324
	DRUM LIFT	2	EA	10,000.00	SKWK GEN	30.000	60	1,987		20,000		21,987
	DRUM LIFT CONVEYOR	2	EA	10,000.00	SKWK GEN	40.000	80	2,649		20,000		22,649
	CURE LINE CONVEYOR	2	EA	10,000.00	SKWK GEN	40.000	80	2,649		20,000		22,649
	180 DEGREE CONVEYOR	8	EA	20,000.00	SKWK GEN	60.000	480	15,893		160,000		175,893
	CURE LINE CONVEYOR 13'	8	EA	20,000.00	SKWK GEN	60.000	480	15,893		160,000		175,893

Lockheed Martin Idaho Technologies Co.

Rev. 606
PROJECT NAME: CSX/TRUE GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 19

DATE 14-Oct-1998
TIME: 15:37:18
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
1.3.11.4.9	DECONTAMINATION/WASTE WATER EQUIPMENT											
P-109	BASE DECON PUMP - 20 L/MIN	1	EA	6,000.00	PIPE	15.000	15	552		6,000		6,552
T-111	WASTE WATER TANK - 19 M3	1	EA	75,000.00	PIPE	100.000	100	3,679		75,000		78,679
P-111A&B	WASTE WATER PUMP - 78 L/MIN	2	EA	8,000.00	PIPE	40.000	80	2,943		16,000		18,943
P-117	DECON RETURN PUMP - 20 L/MIN	1	EA	6,000.00	PIPE	15.000	15	552		6,000		6,552
T-102	DI WATER FEED TANK - 4 M3	1	EA	2,000.00	PIPE	20.000	20	736		2,000		2,736
P-102A&B	DI WATER PUMP - 420 L/MIN	2	EA	8,000.00	PIPE	40.000	80	2,943		16,000		18,943
	DECONTAMINATION/WASTE WATER EQUIPMENT S/T						325	\$11,957		\$127,000		\$138,957
1.3.11.4.10	VOG SYSTEM											
E-103	VOG CONDENSER -	1	EA	26,000.00	PIPE	50.000	50	1,840		26,000		27,840
V-101	VOG VAPOR DEMISTER	1	EA	5,000.00	SHEE HVAC	40.000	40	1,386		5,000		6,386
EH-101	VOG SUPERHEATER	1	EA	50,000.00	SHEE HVAC	100.000	100	3,465		50,000		53,465
F-103,104A&B	HEPA FILTER BANK	1	EA	24,000.00	SHEE HVAC	40.000	40	1,386		24,000		25,386
BL-101A&B	OFF GAS BLOWER	2	EA	2,000.00	SHEE HVAC	20.000	40	1,386		4,000		5,386
	VOG SYSTEM S/T						270	\$9,463		\$109,000		\$118,463
1.3.15.1.2.2	ADSORBER CELL - ADSORBER TANKS DEMO											
	*****REMOVE SILICA GEL *****	0										
	Special HEPA Vacuum For Removing Silica Gel	1	Ea		MECH	0.000					1,200,000	1,200,000
	Remove Silica Gel - 3 Vessels	1,140	Cf		LABR MECH	2.000	2,280	66,211				66,211

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.15.1.2.2	ADSORBER CELL - ADSORBER TANKS DEMO Labor Adjustment For Working In "Hot" Area - 200%	1	Lot		LABR MECH	4560.00	4,560	132,422				132,422
		0										
	*****DEMO ADSORBER VESSELS*****	0										
	Scaffolding Around Adsorber Vessels	3	P/c	500.00	LABR GEN	30.000	90	2,614		1,500		4,114
	Remove Scaffolding	1	Lot		LABR GEN	60.000	60	1,742				1,742
	Cut Top Off Adsorber Vessel - Prior To Silica Gel Removal - Top Bed	3	P/c		PIPE MECH	120.000	360	13,244				13,244
	Cut Off Second Level Of Adsorber	3	P/c		PIPE MECH	120.000	360	13,244				13,244
	Remove Bottom Section Of Adsorber	3	Ea		PIPE MECH	90.000	270	9,933				9,933
	Cut Off Anchor Bolts At Floor	3	P/c		PIPE MECH	10.000	30	1,104				1,104
	Labor Adjustment For Working In "Hot" Area - 200%	1	Lot		PIPE MECH	2220.00	2,220	81,674				81,674
		0										
	*****DEMO TENT WORK*****	0										
	Decontaminate Vessel Shells	3	Ea		PIPE MECH	120.000	360	13,244				13,244
	Cut Up Vessels For "Hot Boxing"	3	Ea		PIPE MECH	400.000	1,200	44,148				44,148
	Hot Box Materials	6	Box		PIPE MECH	10.000	60	2,207				2,207
		0										
	Mock-Up Training - 50% Of Unadjusted Work	1	Lot		PIPE MECH	555.000	555	20,418				20,418
	ADSORBER CELL - ADSORBER TANKS DEMO SIT						12,405	\$402,207		\$1,500	\$1,200,000	\$1,603,707

Rev. 6/96
PROJECT NAME: **CsIX/TRU GROUT FEASIBILITY STUDY**
SCENERIO #2 (NWCF)
INEEL/INTEC
LOCATION 1: **K. L. WILLIAMS**
REQUESTOR:

[illegible]

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PROJECT NO.: 2-1047A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: CS/X/TRY GROUT FEASIBILITY STUDY

SCENERIO #2 (NWCF)

Lockheed Martin Idaho Technologies Co.

Rev 6/98

PROJECT NAME: **CSIXTRU GROUT FEASIBILITY STUDY**
SCENARIO #2 (NWCF)
LOCATION 1: **INEEL/INTEC**
REQUESTOR: **K. L. WILLIAMS**

DETAILED COST ESTIMATE SHEET

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TYPE OF ESTIMATE: **PLANNING**
PROJECT NO.: **2484A**
PREPARED BY: **R.D.ADAMS/D.A.ROWLEY**
DATE **14-Oct-1998**
TIME: **15:37:18**
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
1.3.15.2.4.1	HOT SUMP TANK REMOVAL CELL - NEW EQUIPMENT											
	Lift Table	1	Ea	30,000.00	LABR GEN	100.000	100	2,904		30,000		32,904
	Lift Table Conveyor	1	Ea	30,000.00	LABR GEN	100.000	100	2,904		30,000		32,904
	Dust-Tight Drum Discharge Cone	1	Ea	20,000.00	LABR GEN	100.000	100	2,904		20,000		22,904
	Shielded Drum	10	Ea	10,000.00	LABR GEN	50.000	500	14,520		100,000		114,520
		0										
	Labor Adjustment For Working In "Hot" Area - 200%	1	Lot		LABR GEN	2600.00	2,600	75,504				75,504
		0										
	Mock-Up Training - 50% Of Unadjusted Work	1	Lot		PIPE MECH	650.000	650	23,914				23,914
	HOT SUMP TANK REMOVAL CELL - NEW EQUIPMENT S/T						4,800	\$144,430		\$450,000		\$594,430
1.3.15.2.5.2	ROOM 429 - NEW EQUIPMENT											
	DI Water Tank - 5' Dia. x 8' - Plastic	1	Ea	1,000.00	PIPE MECH	10.000	10	368		1,000		1,368
	DI Water Pump - 420 Liter / Min. - SST	2	Ea	8,000.00	PIPE MECH	40.000	80	2,943		16,000		18,943
	ROOM 429 - NEW EQUIPMENT S/T						90	\$3,311		\$17,000		\$20,311
1.3.15.3	MECHANICAL - MISCELLANEOUS											
	Consumables & Small Tool Allowance	1	Lot	230,000.00	MECH	0.000				230,000		230,000
	Miscellaneous Labor Support	1	Lot		PIPE MECH	500.000	500	18,395				18,395
	MECHANICAL - MISCELLANEOUS S/T						500	\$18,395		\$230,000		\$248,395

DETAILED COST ESTIMATE SHEET

Lockheed Martin Idaho Technologies Co.

Rev. 0096

PROJECT NAME: C&I/TRU GROUT FEASIBILITY STUDY

SCENERIO #2 (NWC/F)

LOCATION 1: INEEL/ANTEC

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.11.3	TRUPAC STATION TRUPAC LID STANDS	8	EA	2,000.00	SKWK GEN	4,000	32	1,060		16,000		17,060
	STRETCH-WRAPPER	2	EA	5,000.00	SKWK GEN	20,000	40	1,324		10,000		11,324
	PALLET SCALE	2	EA	4,000.00	SKWK GEN	12,000	24	795		8,000		8,795
	VACUUM PUMP SYSTEM	2	EA	28,000.00	PIPE PIPE	80,000	160	5,886		56,000		61,886
	TRUPAC STATION S/T						256	\$9,065		\$90,000		\$99,065
1.3.12	FURNISHINGS											
	FURNISHINGS S/T						0					
1.3.12.4	GROUT FACILITY MOVABLE OFFICE PARTITIONS	400	LF	78.00	LABR GEN	0.140	56	1,626		31,200		32,826
	OFFICE FURNISHINGS	12	SETS	4,500.00	LABR GEN	3,000	36	1,045		54,000		55,045
	LUNCH & BREAK ROOM FURNISHINGS	1	LOT	10,000.00	LABR GEN	15,000	15	436		10,000		10,436
	GROUT FACILITY S/T						107	\$3,107		\$95,200		\$98,307
1.3.13	SPECIAL CONSTRUCTION											
	SPECIAL CONSTRUCTION S/T						0					
1.3.13.2	INTERIM STORAGE FACILITY PRE-ENGINEERED METAL BUILDING	57,600	SF	11.00	IRON GEN	0.050	2,880	106,013		633,600		739,613

Lockhead Martin Idaho Technologies Co.

Rev. 6/93

PROJECT NAME: Cslx/TRUE GROUT FEASIBILITY STUDY
SCENERIO #2 (NWCF)

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 28

DATE 14-Oct-1998

TIME: 15:37:18

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
1.3.13.1	CELL SHIELDING HATCHES Allowance To Fab & Install Temporary Cell Cover	1	Ea		GEN	0.000					16,500	16,500
	CELL SHIELDING HATCHES S/T						240	\$6,970			\$49,500	\$56,470
1.3.13.2	MOCK-UPS Allowance To Fabricate Adsorber Cell Mock-Up	1	Lot	60,000.00	LABR GEN	2000.00	2,000	58,080		60,000		118,080
	Fabricate Mock-Up Of Adsorber Vessel	1	Ea	10,000.00	IRON GEN	150.000	150	5,522		10,000		15,522
	MOCK-UPS S/T						2,150	\$83,602		\$70,000		\$133,602
1.3.13.3	RADIATION ENCLOSURE Radiation Enclosure For Above Cells	3	Ea		CARP GEN	0.000					60,000	60,000
	Demo Rad Enclosures	3	Ea		LABR GEN	40.000	120	3,485				3,485
	Hot Box Rad Enclosures	3	Ea		CARP GEN	20.000	60	2,002				2,002
	RADIATION ENCLOSURE S/T						180	\$5,486			\$60,000	\$65,486
1.3.14	CONVEYING SYSTEMS											
	CONVEYING SYSTEMS S/T						0					
1.3.14.2	INTERIM STORAGE FACILITY	0										
	DRUM MOVEMENT TRUCK	1	EA	40,000.00	GEN	0.000				40,000		40,000

Lockheed Martin Idaho Technologies Co.

Rev. 6/98

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)
LOCATION 1: INEEL/JNTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

PAGE # 29

DATE 14-Oct-1998
TIME: 15:37:18
REPORT NAME: Detail Cost Estimate Sheet

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

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
1.3.14.2	INTERIM STORAGE FACILITY DRUM MOVEMENT FORKLIFT	1	EA	20,000.00	GEN	0.000				20,000		20,000
	DRUM MOVEMENT LIFTING FIXTURES	1	EA	5,000.00	GEN	0.000				5,000		5,000
	INTERIM STORAGE FACILITY S/T						0			\$65,000		\$65,000
1.3.14.3	TRUPAC STATION TRUPAC LOADING CRANE - 10 TON & LIFTING DEVICE	2	EA	250,000.00	SKWK GEN	400.000	800	26,488		500,000		526,488
	TRUPAC STATION S/T						800	\$26,488		\$500,000		\$526,488
1.3.14.4	GROUT FACILITY UDS UNLOADING CRANE - 5 TON	1	EA	120,000.00	IRON GEN	700.000	700	25,767		120,000		145,767
	P&V CORRIDOR CRANE - 5 TON	1	EA	120,000.00	IRON GEN	700.000	700	25,767		120,000		145,767
	CELL HATCH CRANE - 30 TON/ 5 TON	1	EA	300,000.00	IRON GEN	1000.00	1,000	36,810		300,000		336,810
	MAINTENANCE MONORAIL - 5 TON	1	EA	70,000.00	IRON GEN	400.000	400	14,724		70,000		84,724
	FREIGHT ELEVATOR	1	EA	125,000.00	MILL GEN	400.000	400	12,512		125,000		137,512
	DRUM MOVEMENT FORKLIFT	1	EA	20,000.00	GEN	0.000				20,000		20,000
	DRUM MOVEMENT LIFTING FIXTURES	1	EA	5,000.00	GEN	0.000				5,000		5,000
	GROUT FACILITY S/T						3,200	\$116,580		\$760,000		\$876,580
1.3.14.5	NWCF 5-Ton Overhead Crane	1	Ea	120,000.00	LABR GEN	700.000	700	20,328		120,000		140,328

PROJECT NAME: CSIXTRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF)
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 2484A
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE 14-Oct-1998
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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
1.3.14.5	NWCF											
	NWCF S/T						700	\$20,328		\$120,000		\$140,328
1.3.15	MECHANICAL											
	MECHANICAL S/T						0					
1.3.15.2	INTERIM STORAGE FACILITY H&V IN INSPECTION ROOM	1	LOT			0.000					20,000	20,000
	EXHAUST BLOWERS	2	EA	15,000.00	SH	40.000	80	2,772		30,000		32,772
	EXHAUST DUCTWORK - GALV.	16,000	LBS	0.70	SH	0.080	1,280	44,352		11,200		55,552
	INTERIM STORAGE FACILITY S/T						1,360	\$47,124		\$41,200	\$20,000	\$108,324
1.3.15.3	TRUPAC STATION ELECTRIC UNIT HEATERS	12	EA	1,200.00	ELEC	10.000	120	3,997		14,400	24	18,421
	TRUPAC STATION S/T						120	\$3,997		\$14,400	\$24	\$18,421
1.3.15.4.1	PIPING FIRE PROTECTION SYSTEM	11,760	SF			0.000					35,280	35,280
	DISTRIBUTION PIPING @ 5 LBS/INCH BUILDING FITTINGS @ 20'	5,880	LF	15.00	PIPE	0.250	1,470	54,081		88,200		142,281
	WELDS @ 2EA/FITTING	294	EA	20.00	PIPE	0.200	59	2,163		5,880		8,043
	X-RAYS @ 10%	588	EA		PIPE	2.500	1,470	54,081				54,081
		59	EA		PIPE	0.000					7,670	7,670

DETAILED COST ESTIMATE SHEET

CODE	DESCRIPTION	QTY	UOM	MATL UNIT COST	CREW SUB	UNIT LAB HOURS	TOTAL LAB HRS	LABOR	CONST. EQUIP.	MATL	S/C (OTHER 1)	TOTAL COST
1.3.15.4.1	PIPING	9,600	LF	15.00	PIPE	0.250	2,400	89,296		144,000		232,296
	BRANCH PIPING				PIPE							
	150 LBTANK, ENL PUMP, ETC.				PIPE							
	FITTINGS @ 10'	960	EA	20.00	PIPE	0.200	192	7,064		19,200		26,264
	WELDS @ 2EA/FITTING	1,920	EA		PIPE	2.500	4,800	176,592				176,592
	X-RAYS @ 10%	192	EA		PIPE	0.000					24,960	24,960
	PIPING SIT						10,391	\$382,278		\$257,280	\$67,910	\$707,468
1.3.15.4.2	HVAC	2	EA	125,000.00	SHEE HVAC	40.000	80	2,772		250,000		252,772
	ZONE 2 HEPA FILTER HOUSING - 2X5 REDUNDANT											
	ZONE 2 SUPPLY FAN - 6400 CFM	2	EA	7,000.00	SHEE HVAC	30.000	60	2,079		14,000		16,079
	ZONE 3 EXHAUST FAN - 3400 CFM	2	EA	4,000.00	SHEE HVAC	20.000	40	1,386		8,000		9,386
	ZONE 3 EXHAUST HEPA FILTER - 2X2 REDUNDANT	2	EA	40,000.00	SHEE HVAC	30.000	60	2,079		80,000		82,079
	ZONE 3 INLET FAN - 6400 CFM	2	EA	7,000.00	SHEE HVAC	30.000	60	2,079		14,000		16,079
	ZONE 3 SUPPLY HEPA FILTER - 2X3 REDUNDANT	2	EA	77,000.00	SHEE HVAC	40.000	80	2,772		154,000		156,772
	MAKEUP AIR HANDLING UNIT	1	EA	10,000.00	SHEE HVAC	30.000	30	1,040		10,000		11,040
	GALV DUCTWORK	40,000	LBS	0.70	SHEE HVAC	0.080	3,200	110,880		28,000		138,880
	SST DUCTWORK	75,000	LBS	2.00	SHEE HVAC	0.200	15,000	519,750		150,000		669,750
	EXHAUST STACK - ALLOW 2'DIA X 100' TALL	1	EA	50,000.00	IRON STEEL	300.000	300	11,043		50,000		61,043

Rev. 6/98

PROJECT NAME: **CsIXTRU GROUT FEASIBILITY STUDY**
 SCENARIO #2 (NWCf)
 INEEL/INTEC
 LOCATION 1: **K. L. WILLIAMS**
 REQUESTOR: **K. L. WILLIAMS**

DETAILED COST ESTIMATE SHEET

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[illegible]

REV. 6/98

PROFESSIONAL: CREDIT RISK ASSESSMENT

PROJECT NAME: OSIA IIRU GHOLI (EAGLE) CONFERENCE #10 (MAY/04)

SCENE #2

LOCATION 1: INEEL/INTEC

TYPE OF ESTIMATE: PLANNING

PROJECT NO. 2484A

PROJECT NO: Z404A

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Lockheed Martin Idaho Technologies Co.

Rev. 9/93

PROJECT NAME: C&I/TRU GROUT FEASIBILITY STUDY

SCENARIO #2 (NW/CF)

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO.: 2494A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 36

DATE 14-Oct-1998

TIME: 15:37:18

REPORT NAME: Detail Cost Estimate Sheet

DETAILED 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
1.3.15.2.3.1	VALVE CUBICLE - NEW PIPING Mock-Up Training - 50% Of Unadjusted Work	1	Lot		PIPE MECH	3100.00	3,100	114,049				114,049
	VALVE CUBICLE - NEW PIPING S/T						21,730	\$799,447		\$89,700		\$889,147
1.3.15.2.5.1	ROOM 429 - NEW PIPING Piping Allowance	1	Lot	2,000.00	PIPE MECH	120.000	120	4,415		2,000		6,415
	ROOM 429 - NEW PIPING S/T						120	\$4,415		\$2,000		\$6,415
1.3.16	ELECTRICAL											
	ELECTRICAL S/T						0					
1.3.16.2	INTERIM STORAGE FACILITY ELECTRICAL/LIGHTING	57,600	SF		ELEC	0.000					115,200	115,200
	VOICE PAGING/EVAC. SYSTEM	57,600	SF		ELEC	0.000					43,200	43,200
	INSTRUMENTATION	1	LOT		ELEC	0.000					30,000	30,000
	INTERIM STORAGE FACILITY S/T						0				\$188,400	\$188,400
1.3.16.3	TRUPAC STATION ELECTRICAL/LIGHTING	8,000	SF		ELEC	0.000					32,000	32,000
	VOICE PAGING/EVAC. SYSTEM	8,000	SF		ELEC	0.000					8,000	8,000
	TRUPAC STATION S/T						0				\$40,000	\$40,000

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: C&I/TRU GROUT FEASIBILITY STUDY

SCENARIO #2 (NWCF)

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING

PROJECT NO: 2484A

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 38

DATE 14-Oct-1998

TIME: 15:37:18

REPORT NAME: Detail Cost Estimate Sheet

DETAILED 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
1.3.16.4.4	CONDUCTORS AND GROUNDING GROUNDING	1	LOT	22,000.00	ELEC	350.000	350	11,659		22,000		33,659
	LIGHTNING PROTECTION	14,300	SF	0.10	ELEC	0.002	29	953		1,430		2,383
	CONDUCTORS AND GROUNDING S/T						829	\$27,601		\$32,430		\$60,031
1.3.16.4.5	WIRING DEVICES AND SPECIAL SYSTEMS WIRING DEVICES	1	LOT	40,000.00		530.000	530			40,000		40,000
	WIRING DEVICES AND SPECIAL SYSTEMS S/T						530			\$40,000		\$40,000
1.3.16.4.6	INSTRUMENTATION AND CONTROLS INSTRUMENTS - ALLOW	200	EA		INSTR	0.000					900,000	900,000
	CONTROLS (LIMIT SWITCHES, PROXIMITY SWITCHES, ETC.)	1	LOT		INSTR	0.000					50,000	50,000
	INSTRUMENTATION AND CONTROLS S/T						0				\$950,000	\$950,000
1.3.16.4.7	DCS DCS ALLOWANCE	1	LOT		INSTR	0.000					500,000	500,000
	DCS S/T						0				\$500,000	\$500,000
1.3.16.4.8	TESTING TESTING	1	LOT		ELEC	400.000	400	13,324				13,324
	TESTING S/T						400	\$13,324				\$13,324

LOCKHEED MARTIN TECHNOLOGICAL
 Rev. 6/98
CSIX/TRUE GROUT FEASIBILITY STUDY
PROJECT NAME: SCENERIO #2 (NWCF)
INTEL/INTEC
LOCATION 1: K. L. WILLIAMS
REQUESTOR:

[illegible]

DETAILED 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
1.4.1.1	GOVERNMENT CRANE OPERATION *****ADSORBER CELL NEW WORK***** Crane Operator Allowance - Plant Operations	0 90	 Wks			 40.000 Z-6530 LIMITCO		 205,560				 205,560
	GOVERNMENT CRANE OPERATION S/T						7,840	\$447,664				\$447,664
1.4.1.2	RADIATION CONTROL TECHNICIANS (*)Radiation Control Technicians NOTE: Assume six (6) RCT's will be required full time for the duration of the project - four (4) years.	6	RCT		Z-7132 LIMITCO	8320.00	49,920	2,236,416				2,236,416
	RCT Management Support - 10% Of RCT Amount	1	Lot		LIMITCO	0.000					223,000	223,000
	RADIATION CONTROL TECHNICIANS S/T						49,920	\$2,236,416			\$223,000	\$2,459,416
1.4.1.3	ENVIRONMENTAL SAFETY & HEALTH (*)Environmental Safety & Health NOTE: Assume three (3) ES&H workers will be required full time for the duration of the project - four (4) years.	3	ESH		Z-7120 LIMITCO	8920.00	24,960	1,542,278				1,542,278
	ES&H Management Support - 10% Of ES&H Cost	1	Lot		LIMITCO	0.000					154,000	154,000
	ENVIRONMENTAL SAFETY & HEALTH S/T						24,960	\$1,542,278			\$154,000	\$1,696,278
1.4.1.4	GFE MISCELLANEOUS GFE "Hot Boxes" & Disposal Allowance	55	Box	500.00	LIMITCO	0.000				27,500	275,000	302,500

DETAILED 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
1.4.1.4	GFE MISCELLANEOUS Allowance To Dispose Of Silica Gel	1,140	Cf			0.000					1,140,000	1,140,000
	Rad-Con Clothing	11,700	Set	100.00	LIMITCO	0.000				1,170,000		1,170,000
	Decontaminate Catcher Cell	1	Lot		LIMITCO	0.000					250,000	250,000
	Decontaminate Adsorber Cell	1	Lot		LIMITCO	0.000					250,000	250,000
	GFE MISCELLANEOUS S/T						0			\$1,197,500	\$1,915,000	\$3,112,500
1.5.1 00701000	G&A/PIF ADDER G&A - 27%	1	LOT			0.000					1,620,231	1,620,231
	PIF - 4.5%	1	LOT			0.000					2,125,412	2,125,412
	G&A/PIF ADDER S/T						0				\$3,745,643	\$3,745,643
	PROJECT SUBTOTAL						446.999	\$40,476,884	\$821,320	\$13,397,854	\$9,932,651	\$64,628,709

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

 PROJECT NAME: Cslx/TRU GROUT FEASIBILITY STUDY
 SCENERIO #2 (NWCF)
 LOCATION 1: INEEL/INTEC
 REQUESTOR: K. L. WILLIAMS

CONTINGENCY ANALYSIS

 TYPE OF ESTIMATE: PLANNING
 PROJECT NO: 2484A
 PREPARED BY: R.D.ADAMS/D.A.ROWLEY

 DATE: 14-Oct-1998
 TIME: 15:41:30

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			Total Cost by Element
				-	+	-	+				
1.1.1	DESIGN ENGINEERING TITLE I & II	9,877,200	10.31	0	35	0.00	3.61	3.249%	9.02%	3,115,702	12,992,902
1.1.2	QUALITY ASSURANCE	2,469,300	2.58	0	35	0.00	0.90	0.812%	2.26%	778,925	3,248,225
1.2.1	PROJECT MANAGEMENT	6,914,000	7.22	0	40	0.00	2.89	2.599%	7.22%	2,492,547	9,406,547
1.2.2	CONSTRUCTION MANAGEMENT	4,161,000	4.35	0	50	0.00	2.17	1.955%	5.43%	1,875,088	6,036,088
1.3.1	GENERAL CONDITIONS	6,676,627	6.97	0	40	0.00	2.79	2.510%	6.97%	2,406,972	9,083,599
1.3.2	SITWORK	825,688	0.86	0	45	0.00	0.39	0.349%	0.97%	334,875	1,160,563
1.3.3	CONCRETE	2,631,536	2.75	0	40	0.00	1.10	0.989%	2.75%	948,688	3,580,224
1.3.5	METALS	638,131	0.67	0	40	0.00	0.27	0.240%	0.67%	230,051	868,182
1.3.7	THERMAL & MOISTURE PROTECTION	105,632	0.11	0	40	0.00	0.04	0.040%	0.11%	38,081	143,713
1.3.8	DOORS & WINDOWS	87,785	0.09	0	40	0.00	0.04	0.033%	0.09%	31,647	119,432
1.3.9	FINISHES	824,547	0.86	0	45	0.00	0.39	0.349%	0.97%	334,412	1,158,959
1.3.10	SPECIALTIES	13,315	0.01	0	40	0.00	0.01	0.005%	0.01%	4,800	18,115
1.3.11	EQUIPMENT	12,321,818	12.87	0	50	0.00	6.43	5.790%	16.08%	5,552,631	17,874,449
1.3.12	FURNISHINGS	133,566	0.14	0	35	0.00	0.05	0.044%	0.12%	42,133	175,699
1.3.13	SPECIAL CONSTRUCTION	1,503,468	1.57	0	40	0.00	0.63	0.565%	1.57%	542,011	2,045,479
1.3.14	CONVEYING SYSTEMS	2,176,670	2.27	0	40	0.00	0.91	0.818%	2.27%	784,705	2,961,375
1.3.15	MECHANICAL	8,925,228	9.32	0	45	0.00	4.19	3.775%	10.48%	3,619,811	12,545,039
1.3.16	ELECTRICAL	4,746,271	4.96	0	40	0.00	1.98	1.784%	4.95%	1,711,065	6,457,336
1.4.1	GOVERNMENT FURNISHED EQUIP.	7,775,733	8.12	0	35	0.00	2.84	2.558%	7.10%	2,452,807	10,228,540
1.5.1	G&A/PIF ADDER	3,745,643	3.91	0	35	0.00	1.37	1.232%	3.42%	1,181,540	4,927,183
1.5.2	PROCUREMENT FEES	1,328,484	1.39	0	35	0.00	0.49	0.437%	1.21%	419,062	1,747,546
	ESCALATION	17,880,183	18.67	0	35	0.00	6.54	5.882%	16.33%	5,640,622	23,520,805
	SUBTOTAL	95,761,825	100.00					36.016%			
	CALCULATED CONTINGENCY	34,489,152									
	RESULTANT TEC	130,250,977									
	ROUNDED TEC	130,300,000									
	PROJECT CONTINGENCY	34,538,175						36.07%			
	MANAGEMENT RESERVE	6,807,518									
	CONTINGENCY	27,730,657									
	TOTAL ESTIMATED COST	130,300,000								34,538,175	130,300,000

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.
 PROJECT: C&I/TRUE GROUT FEASIBILITY STUDY
 LOCATION: SCENARIO #2 (NWCF)
 ESTIMATOR: R.D.ADAMS/D.A.ROWLEY
 CLIENT: K.L.WILLIAMS

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: October 14, 1998
 ESTTYPE: PLANNING

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
PRIME CONTRACTOR		\$0	\$42,000	\$0	\$0	\$42,000		0.14%	0.10%
TOTAL FOR PRIME CONTRACTOR	1,980	\$0	\$42,000	\$0	\$0	\$42,000			
CONCRETE CONTRACTOR - CONC		\$861,776	\$448,828	\$0	\$0	\$1,308,603		4.31%	3.15%
PROFIT	10.00%	\$86,178	\$44,683	\$0	\$0	\$130,860	10.00%		
OVERHEADS	15.00%	\$142,193	\$73,727	\$0	\$0	\$215,920	16.50%		
TOTAL FOR CONCRETE CONTRACTOR - CONC	27,260	\$1,090,146	\$565,237	\$0	\$0	\$1,655,383	26.50%		
EARTHWORK CONTRACTOR - DIRT		\$156,062	\$0	\$174,420	\$0	\$330,482		1.09%	0.80%
PROFIT	10.00%	\$15,606	\$0	\$17,442	\$0	\$33,048	10.00%		
OVERHEADS	15.00%	\$25,750	\$0	\$28,779	\$0	\$54,530	16.50%		
TOTAL FOR EARTHWORK CONTRACTOR - DIRT	4,947	\$197,419	\$0	\$220,641	\$0	\$418,060	26.50%		
ELECTRICAL CONTRACTOR - ELEC		\$918,210	\$1,692,789	\$3,000	\$344,734	\$2,958,733		9.75%	7.12%
PROFIT	10.00%	\$91,821	\$169,279	\$300	\$34,473	\$295,873	10.00%		
OVERHEADS	15.00%	\$151,505	\$279,310	\$495	\$56,881	\$488,191	16.50%		
TOTAL FOR ELECTRICAL CONTRACTOR - ELEC	26,730	\$1,161,536	\$2,141,378	\$3,795	\$436,089	\$3,742,797	26.50%		
FIRE PROTECTION CONTRACTOR - FP		\$0	\$0	\$0	\$35,280	\$35,280		0.12%	0.08%
PROFIT	10.00%	\$0	\$0	\$0	\$3,528	\$3,528	10.00%		
OVERHEADS	18.00%	\$0	\$0	\$0	\$6,985	\$6,985	19.80%		
TOTAL FOR FIRE PROTECTION CONTRACTOR - FP	0	\$0	\$0	\$0	\$45,793	\$45,793	29.80%		
GENERAL CONTRACTOR - GEN		\$1,912,778	\$5,947,796	\$592,900	\$202,740	\$8,656,214		28.52%	20.85%
PROFIT	10.00%	\$191,278	\$594,780	\$59,290	\$20,274	\$865,621	10.00%		
OVERHEADS	5.00%	\$105,203	\$327,129	\$32,610	\$11,151	\$476,092	5.50%		
TOTAL FOR GENERAL CONTRACTOR - GEN	57,037	\$2,209,258	\$6,869,705	\$684,800	\$234,165	\$9,997,927	15.50%		
HVAC CONTRACTOR - HVAC		\$701,423	\$901,110	\$0	\$20,000	\$1,622,533		5.35%	3.91%
PROFIT	10.00%	\$70,142	\$90,111	\$0	\$2,000	\$162,253	10.00%		
OVERHEADS	18.00%	\$138,882	\$178,420	\$0	\$3,960	\$321,262	19.80%		
TOTAL FOR HVAC CONTRACTOR - HVAC	20,240	\$910,447	\$1,169,641	\$0	\$25,960	\$2,106,048	29.80%		

DATE: October 14, 1988
ESTTYPE: PLANNING

CONTRACTOR MARKUP DISTRIBUTION REPORT

Lockheed Martin Idaho Technologies Co.
PROJECT: C&I/TRU GROUT FEASIBILITY STUDY
SCENERIO #2 (NWCF)
LOCATION: INEEL/INTEC
ESTIMATOR: R.D. ADAMS/D.A. ROWLEY
CLIENT: K. L. WILLIAMS

	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
CONTRACTOR									
INSTRUMENTATION CONTRACTOR - INSTR	10.00%	\$0	\$0	\$0	\$1,450,000	\$1,450,000	10.00%	4.78%	3.49%
PROFIT	18.00%	\$0	\$0	\$0	\$145,000	\$145,000	10.00%		
OVERHEADS		\$0	\$0	\$0	\$287,100	\$287,100	19.80%		
TOTAL FOR INSTRUMENTATION CONTRACTOR - INSTR	0	\$0	\$0	\$0	\$1,882,100	\$1,882,100	29.80%		
INSULATION CONTRACTOR - INSUL	10.00%	\$0	\$0	\$0	\$31,524	\$31,524	10.00%	0.10%	0.08%
PROFIT	15.00%	\$0	\$0	\$0	\$3,152	\$3,152	10.00%		
OVERHEADS		\$0	\$0	\$0	\$5,201	\$5,201	16.50%		
TOTAL FOR INSULATION CONTRACTOR - INSUL	0	\$0	\$0	\$0	\$39,878	\$39,878	26.50%		
MECHANICAL CONTRACTOR - MECH	10.00%	\$7,433,520	\$1,818,033	\$50,000	\$1,200,000	\$10,501,553	10.00%	34.59%	25.29%
PROFIT	10.00%	\$743,352	\$181,803	\$5,000	\$120,000	\$1,050,155	10.00%		
OVERHEAD		\$817,687	\$199,984	\$5,500	\$132,000	\$1,155,171	11.00%		
TOTAL FOR MECHANICAL CONTRACTOR - MECH	202,130	\$8,994,560	\$2,199,820	\$60,500	\$1,452,000	\$12,706,880	21.00%		
PAINTING CONTRACTOR - PAINT	10.00%	\$98,692	\$53,699	\$1,000	\$426,400	\$579,791	10.00%	1.91%	1.40%
PROFIT	15.00%	\$9,889	\$5,370	\$100	\$42,640	\$57,979	10.00%		
OVERHEADS		\$16,284	\$8,860	\$165	\$70,356	\$95,665	16.50%		
TOTAL FOR PAINTING CONTRACTOR - PAINT	3,403	\$124,845	\$67,929	\$1,265	\$539,396	\$733,435	26.50%		
PAVING CONTRACTOR - PAVE	10.00%	\$0	\$0	\$0	\$108,800	\$108,800	10.00%	0.36%	0.26%
PROFIT	18.00%	\$0	\$0	\$0	\$10,880	\$10,880	10.00%		
OVERHEADS		\$0	\$0	\$0	\$21,542	\$21,542	19.80%		
TOTAL FOR PAVING CONTRACTOR - PAVE	0	\$0	\$0	\$0	\$141,222	\$141,222	29.80%		
PIPING CONTRACTOR - PIPE	10.00%	\$516,137	\$1,643,439	\$0	\$32,630	\$2,192,206	10.00%	7.22%	5.28%
PROFIT	20.00%	\$51,614	\$164,344	\$0	\$3,263	\$219,221	10.00%		
OVERHEADS		\$113,550	\$361,557	\$0	\$7,179	\$482,285	22.00%		
TOTAL FOR PIPING CONTRACTOR - PIPE	14,054	\$681,300	\$2,169,339	\$0	\$43,072	\$2,893,711	32.00%		
STRUCTURAL STEEL CONTRACTOR - STEEL	10.00%	\$230,429	\$264,678	\$0	\$42,900	\$538,006	10.00%	1.77%	1.30%
PROFIT		\$23,043	\$26,468	\$0	\$4,290	\$53,801	10.00%		

Lockheed Martin Idaho Technologies Co.
 PROJECT: Csl/TRUE GROUT FEASIBILITY STUDY
 SCENERIO #2 (NWCF)
 LOCATION: INEEL/INTEC
 ESTIMATOR: R.D.ADAMS/D.A.ROWLEY
 CLIENT: K. L. WILLIAMS

CONTRACTOR MARKUP DISTRIBUTION REPORT

DATE: October 14, 1998
 ESTTYPE: PLANNING

CONTRACTOR	LABOR HOURS	LABOR	MATERIAL	EQUIPMENT	OTHERS	SUBTOTAL	% MARKUP	% DIRECT COST	% TOTAL COST
STRUCTURAL STEEL CONTRACTOR - STEEL OVERHEADS	15.00%	\$230,429 \$38,021	\$264,678 \$43,672	\$0 \$0	\$42,900 \$7,078	\$538,006 \$89,771	16.50%	1.77%	1.30%
TOTAL FOR STRUCTURAL STEEL CONTRACTOR - STEEL	6,499	\$291,492	\$334,617	\$0	\$54,269	\$680,578	26.50%		
TOTAL DIRECT COST	364,279	\$12,829,026	\$12,810,371	\$821,320	\$3,895,008	\$30,355,725		100.00%	
TOTAL SUBCONTRACTOR MARKUPS		\$2,831,977	\$2,749,495	\$149,681	\$998,936	\$6,730,088			16.21%
TOTAL COST TO PRIME		\$15,661,003	\$15,559,866	\$971,001	\$4,893,943	\$37,085,813			
PRIME CONTRACTOR MARKUP	11.97%	\$1,887,181	\$1,846,876	\$118,462	\$89,036	\$4,440,554			10.69%
TOTAL PROJECT COST		\$17,548,184	\$17,405,741	\$1,089,463	\$5,482,979	\$41,526,367			

FY-99 G&A/PIF ADDER CALCULATION SHEET
Cslx/TRU GROUT FACILITY SCENERIO #2

PROJECT:

DATE: 10/14/98

PROCUREMENT FEE:

CONSTRUCTION =	\$41,610,282	
GFE =	\$2,672,375	
Subtotal	\$44,282,657	
FEE @ 3.0% =	\$44,282,657 * 0.03 =	\$1,328,480

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

CONSTRUCTION \$ OR CEILING * # OF YEARS

YEARS OF CONST. = 4	\$2,000,000	
GFE =	\$2,672,375	
PROCUREMENT FEE =	\$1,328,480	
Subtotal	\$6,000,855	
FEE @ 27% =	\$6,000,855 * 0.27 =	\$1,620,231

PIF @ 4.5%

CONSTRUCTION =	\$41,610,282	
GFE =	\$2,672,375	
PROCUREMENT FEE =	\$1,328,480	
G&A =	\$1,620,231	
Subtotal	\$47,231,367	
FEE @ 4.5% =	\$47,231,367 * 0.045 =	\$2,125,412

TOTAL PROCUREMENT FEE: \$1,328,480

TOTAL G&A FEE: \$1,620,231

TOTAL PIF: \$2,125,412

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: **CsIX/TRU GROUT FEASIBILITY STUDY**
SCENARIO #2 (NWCF) - OPC
 LOCATION 1: **INEEL/INTEC**
 REQUESTOR: **K. L. WILLIAMS**

COST ESTIMATE SUMMARY

TYPE OF ESTIMATE: **PLANNING**
 PROJECT NO: **2484AO**
 PREPARED BY: **R.D.ADAMS/D.A.ROWLEY**
 REPORT NAME: **Cost Estimate Summary**

DATE: **15-Oct-1998**
 TIME: **07:35:23**

CHECKED BY:

APPRD BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	<u>CONCEPTUAL DESIGN</u>			>> <u>\$2,871,858</u>
1.1.1	CONCEPTUAL DESIGN	2,709,300	162,558	2,871,858
1.2	<u>MANAGEMENT COSTS</u>			>> <u>\$12,157,458</u>
1.2.1	PROJECT MANAGEMENT & PROCESS	11,469,300	688,158	12,157,458
1.3	<u>PERMITTING</u>			>> <u>\$1,383,065</u>
1.3.1	PERMITTING	1,268,867	114,198	1,383,065
1.4	<u>SO TEST & STARTUP</u>			>> <u>\$13,103,860</u>
1.4.1	SO TEST & STARTUP	10,318,000	2,785,860	13,103,860
1.5.2	PROCUREMENT FEES	0	0	>> <u>\$0</u>
SUBTOTAL INCLUDING ESCALATION		25,765,467	3,750,774	>> \$29,516,241
PROJECT CONTINGENCY				
MANAGEMENT RESERVE				>> \$0
CONTINGENCY				>> \$10,283,759
TOTAL ESTIMATED COST				>> \$39,800,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= 20.00%

CONTINGENCY= 34.84%

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: CS/ITRU GROUT FEASIBILITY STUDY
SCENARIO #2 (NWCF) - OPC
LOCATION 1: INEEL/INTEC
REQUESTOR: K. L. WILLIAMS

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: PLANNING
PROJECT NO.: 24840
PREPARED BY: R.D.ADAMS/D.A.ROWLEY

PAGE # 1

DATE 15-Oct-1998
TIME: 07:34:06
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 @ 5% OF TCC & GFE	1	LOT		LIMITCO	0.000		2,469,300				2,469,300
	CONCEPTUAL DESIGN S/T						0	\$2,469,300				\$2,469,300
1.1.3	AE PROCUREMENT A-E PROCUREMENT COSTS	1	LOT			0.000		240,000				240,000
	AE PROCUREMENT S/T						0	\$240,000				\$240,000
1.2.1	PROJECT MANAGEMENT & PROCESS DEVELOPMENT											
	ACDC/SOW, CPDS, PER, DC/SOW & REVIEWS @ 6% OF TCC	1	LOT		LIMITCO	0.000		2,469,300				2,469,300
	PSAR & SAR	1	LOT		LIMITCO	0.000		3,000,000				3,000,000
	PILOT PLANT & PROCESS DEVELOPMENT	1	LOT			0.000		6,000,000				6,000,000
	PROJECT MANAGEMENT & PROCESS DEVELOPMENT S/T						0	\$11,469,300				\$11,469,300
1.3.1	PERMITTING											
	CONCEPTUAL DESIGN REVIEW	1	LOT		Z-4170	320.000	320	23,347				23,347
	SITING AGREEMENT	1	LOT		Z-4170	320.000	320	23,347				23,347
	HWM/R/CRA PERMIT	1	LOT		Z-4170	2880.00	2,880	210,125				210,125
	PERMIT TO CONSTRUCT	1	LOT		Z-4170	1800.00	1,800	131,328				131,328

DETAILED 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
1.3.1	PERMITTING CWA, STORM WATER, HISTORICAL, OTHER REG. COMPLIANCE	1	LOT		Z-4170	1000.00	1,000	72,960				72,960
	P.E. CERTIFICATION	1	LOT			0.000					50,000	50,000
	HEALTH & SAFETY ISSUES	1	LOT			0.000					200,000	200,000
	QUALITY REVIEWS	1	LOT			0.000					120,000	120,000
	INCIDENTAL WASTE DETERMINATION BY NRC	1	LOT		Z-4170	2000.00	2,000	145,920				145,920
	WIPP ACCEPTANCE OF TRU PRODUCT	1	LOT		Z-4170	4000.00	4,000	291,840				291,840
	PERMITTING S/T						12,320	\$898,867			\$370,000	\$1,268,867
1.4.1	SO TEST & STARTUP											
	ORR	1	LOT			0.000		2,500,000				2,500,000
	SO TEST & TRAINING @ 3% OF TEC	1	LOT		LIMITCO	0.000		3,909,000				3,909,000
	SO TEST & STARTUP S/T						0	\$5,409,000				\$6,409,000
1.4.1.1	PROJECT SUPPORT SUPPORT DURING DESIGN, CONSTRUCTION & STARTUP @ 3% OF TEC	1	LOT		LIMITCO	0.000		3,909,000				3,909,000
	PROJECT SUPPORT S/T						0	\$3,909,000				\$3,909,000
	PROJECT SUBTOTAL						12,320	\$25,395,467	\$0	\$0	\$370,000	\$25,765,467

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

PROJECT NAME: Cslx/TRU GROUT FEASIBILITY STUDY

SCENARIO #2 (NWCF) - OPC

LOCATION 1: INEEL/INTEC

REQUESTOR: K. L. WILLIAMS

CONTINGENCY ANALYSIS

TYPE OF ESTIMATE: PLANNING

PROJECT NO: 2484AO

PREPARED BY: R.D.ADAMS/D.A.ROWLEY

DATE: 15-Oct-1998

TIME: 07:35:08

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	2,709,300	9.18	10	40	0.92	3.67	3.213%	9.18%	943,948	3,653,248
1.2.1	PROJECT MANAGEMENT & PROCESS	11,469,300	38.86	10	40	3.89	15.54	13.600%	38.86%	3,996,021	15,465,321
1.3.1	PERMITTING	1,268,867	4.30	10	40	0.43	1.72	1.505%	4.30%	442,086	1,710,953
1.4.1	SO TEST & STARTUP	10,318,000	34.96	10	40	3.50	13.98	12.235%	34.96%	3,594,896	13,912,896
1.5.2	PROCUREMENT FEES	0	0.00	10	40	0.00	0.00	0.000%	0.00%	0	0
	ESCALATION	3,750,774	12.71	10	40	1.27	5.08	4.448%	12.71%	1,306,808	5,057,582
	SUBTOTAL	29,516,241	100.00					35.000%			
	CALCULATED CONTINGENCY	10,330,684									
	RESULTANT TEC	39,846,925									
	ROUNDED TEC	39,800,000									
	PROJECT CONTINGENCY	10,283,759						34.84%			
	MANAGEMENT RESERVE	0									
	CONTINGENCY	10,283,759									
	TOTAL ESTIMATED COST	39,800,000								10,283,759	39,800,000

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

CsIX/TRU GROUT FACILITY SCENERIO #1 - PROJECT SCHEDULE

CsIx/TRUE GROUT FACILITY SCENERIO #2 - PROJECT SCHEDULE

Lockheed Martin Idaho Technologies Company**INTERDEPARTMENTAL COMMUNICATION**

Date: November 9, 1998

To: K. L. Williams MS 3765 6-6760

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

Subject: ECONOMIC AND LIFE CYCLE ANALYSIS CONDUCTED for the CsIx/TRU
GROUT FACILITY-RJT-84-98 (REV1)

Purpose:

As requested, an Economic and Life-Cycle Cost (LCC) has been conducted to evaluate the CsIx/TRU GROUT FACILITY. This facility is proposed to process undissolved solids removal via filtration and Cesium removal via ion exchange, followed by a cement-based grouting of the remaining liquid in 55 gallon drums. This economic analysis is based on information provided from Charles Barnes, Jim Bosley, Lynn Clapp, Ron Dafoe, Blair Grover, Tom Hipp, Scott Jensen and Syl Losinski. R. D. Adams provided cost estimates.

Methodology:

The Economic Evaluation assumed a 38-year period, (2000-2037) since this is the estimated time required to complete all of the anticipated remediation activities. The LCC evaluated the initial development, construction, operating and post operating costs over the life-cycle. A discounted LCC analysis assumes a constant-dollar basis, discounted at 6.10% 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 were developed from historical experience associated with DD&D work at the INEEL. The LCC analysis was generated to match cost estimating cost structure. These costs include Permitting, Direct and Indirect Construction, G&A, Procurement Fee, Engineering, Inspection, Project Management, Construction Management, Escalation and Contingency costs. The design period is assumed to be accomplished in three years with construction completed in

three years, followed by 1.25 years of start-up and testing. Labor rates were assumed as follows: Managers, \$125/hr; Engineers, \$108 \$/hr; Other Technicians \$ 85/hr; Administration/Support staff \$ 65/hr; Operators and Maintenance personnel \$ 65/hr. The operational period for this facility was assumed to be five years, followed by material placed in interim storage awaiting final disposition, followed by sixteen months of post-operations activities.

Utilities were assumed to cost \$0.082/kwh for the facility. Due to this project's lack of complexity and relative cleanliness this analysis assumed a decommissioning cost equal to 20% of the unescalated engineering design cost, decontamination costs equal to 5% of the unescalated pre-operation cost, and demolition costs equal to 8% of the unescalated total pre-operation cost. DD&D activities for scenario two do not include DD&D efforts for NWCF due to being incorporated by another study.

Results:

Scenario One has a Discounted LCC of \$ 279 million.

Scenario Two has a Discounted LCC of \$ 327 million.

Attachments:

cc: R. J. Turk File
R. D. Adams

CAG/IRU Costs Summary 1		Build year		2008												Total	
Life-Cycle Cost (LCC) Analysis		Building Year		2008												Cost	
LCC COST X1000		Building Year		2008												Cost	
Other Project Cost (OPC)		Building Year		2008												Cost	
Conceptual Design, Project Mgt, & Permitting		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Total OPC (unescalated)		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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plus management reserve of		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
plus contingency of		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Total OPC including escalation, mgt reserve, & contingency		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Total Estimated Cost (TEC)		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
TEC unescalated		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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plus contingency of		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Total TEC including escalation, mgt reserve, & contingency		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Total Project Cost (TPC)		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Total TPC including escalation, mgt reserve, & contingency		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Discount Factor @ 6.10% per escalation costs		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Discounted Annual Cost		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Operations		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Facility/Administration		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Managers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Operations/Process Facility		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Managers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
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Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Managers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Administration/Support		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Managers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Engineers		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Other Tech.		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	
Supervisors		Building Year		2008 <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-kind="ghost"></td> <td data-cs="2" data-kind="parent">Cost</td> <td data-kind="ghost"></td>												Cost	

CalVTRU Gross SENIORS 1 Life-Cycle Cost (LCC) Analysis	Final Year Escalating Year Escalation Factor	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
		1,730	1,778	1,829	1,880	1,933	1,987	2,042	2,100	2,160	2,219
Other Project Cost (OPC)											
OPC Unescalated											
Conceptual Design, Project Mgt, & Permitting		0	0	0	0	0	0	0	0	0	0
Testing and Start-Up		0	0	0	0	0	0	0	0	0	0
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 Redefined Cost (TEC)											
TEC Unescalated											
Design, Inspection		0	0	0	0	0	0	0	0	0	0
Project Mgt		0	0	0	0	0	0	0	0	0	0
Construction Mgt		0	0	0	0	0	0	0	0	0	0
Construction, Bldg, GSA & Procurement		0	0	0	0	0	0	0	0	0	0
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											
Design, Inspection		0	0	0	0	0	0	0	0	0	0
Project Mgt		0	0	0	0	0	0	0	0	0	0
Construction Mgt		0	0	0	0	0	0	0	0	0	0
Construction, Bldg, GSA & Procurement		0	0	0	0	0	0	0	0	0	0
Total 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 escalation, mgt reserve, contingency		0	0	0	0	0	0	0	0	0	0
Discount Factor @ 6.10% per escalated costs											
Discount Factor @ 6.10% per escalated costs		3,283	3,428	3,578	3,733	3,893	4,058	4,228	4,403	4,583	4,768
Discounted Annual Cost		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Operations											
2000 In-STRAT.											
Personnel/Administration		100	100	100	100	100	100	100	100	100	100
Managers		100	100	100	100	100	100	100	100	100	100
Engineers		100	100	100	100	100	100	100	100	100	100
Other Tech.		100	100	100	100	100	100	100	100	100	100
Administration/Support		100	100	100	100	100	100	100	100	100	100
Operations/Process Facility		100	100	100	100	100	100	100	100	100	100
Managers		100	100	100	100	100	100	100	100	100	100
Engineers		100	100	100	100	100	100	100	100	100	100
Other Tech.		100	100	100	100	100	100	100	100	100	100
Administration/Support		100	100	100	100	100	100	100	100	100	100
Operations		100	100	100	100	100	100	100	100	100	100
Maintenance		100	100	100	100	100	100	100	100	100	100
Preservation LDR CONTAINERS		100	100	100	100	100	100	100	100	100	100
DRUMS		100	100	100	100	100	100	100	100	100	100
CONSUMABLES		100	100	100	100	100	100	100	100	100	100
Utilities Power		100	100	100	100	100	100	100	100	100	100
Maintenance of Equipment		100	100	100	100	100	100	100	100	100	100
Building Maintenance		100	100	100	100	100	100	100	100	100	100
Disposal		100	100	100	100	100	100	100	100	100	100
Analysis		100	100	100	100	100	100	100	100	100	100
Operations subtotal (Unescalated)		100	100	100	100	100	100	100	100	100	100
plus escalation		100	100	100	100	100	100	100	100	100	100
plus Operations Contingency @ 30.0%		100	100	100	100	100	100	100	100	100	100
Total Operations (Unescalated & Contingency)		100	100	100	100	100	100	100	100	100	100
Discount Factor @ 6.10% per escalated costs		3,283	3,428	3,578	3,733	3,893	4,058	4,228	4,403	4,583	4,768
Discounted Annual Cost		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Peak Operations											
Decommission		100	100	100	100	100	100	100	100	100	100
Decommission		100	100	100	100	100	100	100	100	100	100
Decommission		100	100	100	100	100	100	100	100	100	100
Peak-Operations Subtotal (Unescalated)		100	100	100	100	100	100	100	100	100	100
plus escalation		100	100	100	100	100	100	100	100	100	100
plus Peak-Operations Contingency @ 30.0%		100	100	100	100	100	100	100	100	100	100
Total Peak-Operations (Unescalated & Contingency)		100	100	100	100	100	100	100	100	100	100
Discount Factor @ 6.10% per escalated costs		3,283	3,428	3,578	3,733	3,893	4,058	4,228	4,403	4,583	4,768
Discounted Annual Cost		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total Cost (Unescalated)											
Cumulative Total LCC (Unescalated)											
Total Cost (Unescalated)		100	100	100	100	100	100	100	100	100	100
plus escalation		100	100	100	100	100	100	100	100	100	100
plus management reserve of		100	100	100	100	100	100	100	100	100	100
plus contingency of		100	100	100	100	100	100	100	100	100	100
Total Cumulative Total LCC (Unescalated & Contingency)		100	100	100	100	100	100	100	100	100	100
Discount Factor @ 6.10% per escalated costs		3,283	3,428	3,578	3,733	3,893	4,058	4,228	4,403	4,583	4,768
Discounted Annual Cost		\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Cumulative Discounted LCC											
Cumulative Discounted LCC		100	100	100	100	100	100	100	100	100	100

COLUMBIA GROUP MEMORANDUM 1		Fiscal year		2008												2017	
Life-Cycle Cost (LCC) Analysis		starting year		2008												2017	
ALL COST (\$ MIL)		Discount Factor		1.131												1.533	
Other Project Cost (OPC)																	
Conceptual Design, Project Mgt. & Permitting																	
Total OPC (unescalated)																	
plus escalation of																	
plus management reserve of																	
plus contingency of																	
Total OPC including escalation, mgt reserve, & contingency																	
Total Subtotal Cost (TSC)																	
Title Design, Inspection																	
Project Mgt.																	
Construction Mgt.																	
Construction, Equip, O&M & Procurement																	
Total TSC (unescalated)																	
plus escalation of																	
plus management reserve of																	
plus contingency of																	
Total TSC including escalation, mgt reserve, & contingency																	
Total Project Cost (TPC)																	
TPC unescalated																	
plus escalation of																	
plus management reserve of																	
plus contingency of																	
Total TPC including escalation, mgt reserve, & contingency																	
Discount Factor @ 6.10% discount rate of																	
Discounted Annual Cost																	
Operations																	
Facility/Administration																	
Managers																	
Engineers																	
Construction																	
Operations/Process Facility																	
Managers																	
Engineers																	
Other Tech.																	
Supervisors																	
Administrative/Support																	
 																	

Other Project Cost (OPC)

Secret 2 Jts 11/12/90 1:25 PM

Sentido 2.3da 11/12/2016 1:32 PM

Barneo 2.3x5 11/12/2001:26 PM

Appendix D

Drawings

Index: Sheet T-1

Scenario 1: Sheet 1-xx

Scenario 2: Sheets 2-xx

Common to both scenarios:

Sheets COM-xx

D

C

B

SCENARIO 1				
DRAWING INDEX				
PAGE NO.	DWG NO.	A-E DWG NO.	REV	DRAWING TITLE
1		T-1		DRAWING INDEX
2		1-C1		LOCATION PLAN
3		1-C2		UNDERGROUND UTILITIES
4		1-A1		PLAN BELOW 0'-0"
5		1-A2		PLAN @ 0'-0"
6		1-A3		PLAN @ 12'-0"
7		1-A4		PLAN @ 22'-0"
8		1-A5		BUILDING SECTIONS
9		1-A6		PROCESS FLOW PLAN @ 0'-0"
10		1-A7		PROCESS FLOW PLAN @ 12'-0"
11		1-A8		PROCESS FLOW PLAN @ 22'-0"
12		1-A9		PROCESS FLOW PLAN BELOW 0'-0"
13		1-M1		MECHANICAL PLAN @ 0'-0"
14		1-M2		MECHANICAL PLAN @ 12'-0"
15		1-M3		MECHANICAL SECTIONS
16		1-M4		MECHANICAL VIEW
17		1-M5		MECHANICAL SECTION AND DETAIL
18		1-M6		MECHANICAL VIEWS

SCENARIO 2				
DRAWING INDEX				
PAGE NO.	DWG NO.	A-E DWG NO.	REV	DRAWING TITLE
19		2-C1		LOCATION PLAN
20		2-C2		UNDERGROUND UTILITIES
21		2-A6		PLAN @ 0'-0"
22		2-A7		PLAN @ 12'-0"
23		2-A8		SCENARIOS
24		2-A9		BUILDING SECTIONS
25		2-M1		MECHANICAL PLAN @ 0'-0"
26		2-M2		CPP-65
27		2-M3		CPP-65
28		2-M4		SECTION AND DETAIL
29		2-M5		SECTION AND DETAIL
30		2-M6		CPP-65

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SCENARIO 2
DRAWING INDEX
TITLE
PLAN
GROUND UTILITIES
0'-0"
0'-0"
PLAN @ 20'-0"
SECTIONS
PLAN @ 0'-0"
3RD LEVEL DEMOLITION PLAN
3RD LEVEL PLAN
1ST LEVEL PLAN

SCENARIO 1 & 2				
DRAWING INDEX				
PAGE NO.	DWG NO.	A-E DWG NO.	REV	DRAWING TITLE
31		COM-A1		INTERIM STORAGE FACILITY PLANS
32		COM-A2		INTERIM STORAGE FACILITY ELEVATIONS
33		COM-M1		MECHANICAL INTERIM STORAGE FACILITY PLAN

D

C

B

A

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN			
NO SCALE	REQUESTER:	Csix/TRU GROUT PROJECT SCENARIO 1 & 2 DRAWING INDEX			
	DESIGN:				
	DRAWN: B. SEARLE				
	PROJECT NO.				
	SPEC CODE	SIZE	CAGE CODE	INDEX CODE NUMBER	REV
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES	D	01MF3	AREA TYPE Q. ORG.	DWG-
QUALITY LEVEL: 3	EFFECTIVE DATE:	200		530	SHEET T-1

D

C

B

User: SEA
Date: 11/09/98 - 1:28 P.M.

A

File: 3607-STI.dwg
Path: P:\HLEVEL

INTEC AREA PLAN
SCALE: 1"=250.0'

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

D
C
B

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN
REQUESTER:		CsIX/TRU GROUT PROJECT SCENARIO 1 LOCATION PLAN													
		DESIGN:															
		DRAWN:															
		PROJECT NO.															
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">SIZE</td> <td style="width: 20%;">CAGE CODE</td> <td colspan="2" style="width: 40%;">INDEX CODE NUMBER</td> <td style="width: 10%;">DWG-</td> <td style="width: 10%;">REV</td> </tr> <tr> <td>D</td> <td>01MF3</td> <td>AREA</td> <td>TYPE</td> <td>CL</td> <td>530</td> </tr> </table>		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV	D	01MF3	AREA	TYPE	CL	530
SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV												
D	01MF3	AREA	TYPE	CL	530												
SEE DAR NO.		EFFECTIVE DATE:		SCALE: NOTED													
DESIGN PHASE:		QUALITY LEVEL:		SHEET 1-C1													

D

1766

C

NEW 4" SANITARY SEWER

NEW 2" POTABLE WATER

NEW STEAM LINE

TRUPACT FACILITY

EXISTING 6" SANITARY SEWER

B

A

TR-35

BLDG FND

BLDG FND

NEW 4" POTABLE WATER

681

1662

VES-UTI-120

1769

1713

1750

PCC-NCE-773

HEMLOC

654

CEDAR STREET

664

NEW 4" SANITARY SEWER

C&D/TRU GRO

NEW 6" F.W. LINE

NEW STEAM LINE 728

EXISTING 10" F.W. LINE

VES-UTI-682

701-A VES-UTI-68

701

VES-

736

1610

716

726

VES-UTI-608

164

INTEC AREA PLAN

SCALE: 1"=250.0'

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		<div style="text-align: right;"> </div>
REQUESTER:		<div style="text-align: center;"> <p>CSI/ TRU GROUT PROJECT</p> <p>SCENARIO 1</p> <p>UNDERGROUND UTILITIES</p> </div>						
		DESIGN:								
		DRAWN: B. SEARLE								
		PROJECT NO.								
		SPEC CODE								
DESIGN PHASE:		FOR REVIEW/ APPROVAL SIGNATURES SEE DAR NO.		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG--	REV	
QUALITY LEVEL: 3		EFFECTIVE DATE:		D	01MF3	ASBA	TYPE			G
				SCALE	NOTED				SHEET	1-C2

D

C

B

A

User: SEA
Date: 11/08/98 - 1:27 P.M.

File: 3607-BBrcd.dwg
Plot: P:\HLEVEL

PLAN

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

ELOW 0'-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
<p>SCALE: 1/8" = 1'-0"</p>		REQUESTER:			
		DESIGN:			
		DRAWN: B. SEARLE			
		PROJECT NO.			
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		INDEX CODE NUMBER	
QUALITY LEVEL: 3		SEE DAR NO.		200 530	
EFFECTIVE DATE:		SCALE: 1/8"=1'-0"		DWG- SHEET 1-A1

155'-0"

D

C

B

A

88'-0"

PLAN

D

C

B

88'-0"

User: SEA
Date: 11/08/98 - 1:27 P.M.

A

**** INSTALL STAINLESS STEEL LINER
TO FULLY LINE CELLS.**

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN

REQUESTER:	CslX/TRU GROUT PROJECT SCENARIO 1 PLAN @ 12'-0"			
DESIGN:					
DRAWN: B. SEARLE					
PROJECT NO.					
SPEC CODE		SIZE:	CAGE CODE	INDEX CODE NUMBER	REV
FOR REVIEW/APPROVAL SIGNATURES		D	01MF3	AREA 200 TYPE 1 Q 1530	DWG-
DESIGN PHASE:		SCALE: 1/8" = 1'-0"			SHEET 1-A3
QUALITY LEVEL: 3	EFFECTIVE DATE:				

D

C

B

A

88'-0"

HVAC
AREA

ELEV.

BUFFER
AREA

LADDER

MOTOR
CONTROL
CENTER

PLAN

User: SEA
Date: 11/06/98 - 1:27 P.M.

File: 3607-3rddwg
Path: P:\HLEVEL

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
		REQUESTER:			
		DESIGN:			
		DRAWN: B. SEARLE			
		PROJECT NO.			
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		SPEC CODE	
QUALITY LEVEL: 3		SEE DAR NO.		EFFECTIVE DATE:	
SIZE: D		PAGE CODE: 01MF3		INDEX CODE NUMBER: 200 530	
DWG- 1		SHEET 1-A4		REV	

D

SECTION

A
TYP

B

SECTION

B
TYP

User: SEA
Date: 11/05/03 - 1:28 P.M.

A

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN CslX/TRU GROUT PROJECT SCENARIO 1 BUILDING SECTIONS	
10 12 3 4 5 10 15 SCALE 1/8" = 1'-0"		REQUESTER: DESIGN: DRAWN: B. SEARLE PROJECT NO.: SPEC CODE: FOR REVIEW/APPROVAL SIGNATURES: SEE DAR NO.: EFFECTIVE DATE:			
DESIGN PHASE:		QUALITY LEVEL: 3		SIZE: D CAGE CODE: 01MF3 SCALE: NONE	INDEX CODE NUMBER: AREA: 200 TYPE: CL QRG: 530 DWG- SHEET 1-A5

8

7

6

5

D

C

B

User: SEA

Date: 11/09/88 - 1:27 P.M.

A

8

7

6

5

PLAN

D

C

B

User: SEA
Date: 11/09/03 - 1:28 P.M.

A

File: 3607-1FL.dwg
Path: P:\LEVEL

PLAN

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
REQUESTER:		DESIGN:		CslX/TRU GROUT PROJECT	
DRAWN: B. SEARLE		PROJECT NO.:		SCENARIO 1	
SPEC CODE:		FOR REVIEW/APPROVAL SIGNATURES		PROCESS FLOW 0'-0"	
SEE DAR NO.:		EFFECTIVE DATE:		DWG-	
DESIGN PHASE:		SCALE: 1/8" = 1'-0"		REV	
QUALITY LEVEL: 3		SIZE: D		CAGE CODE: 01MF3	
		AREA: 200		INDEX CODE: 530	
		TYPE: G		Q: 026	
		EFFECTIVE DATE:		SHEET 1-A7	

D

C

B

A

PLAN

User: SEA

Date: 11/08/98 - 1:27 P.M.

File: 3607-2rFL.dwg

Path: P:\HLEVEL

FOR DRAWING INDEX SEE DRAWING NO.		SUBTRACT NO.

REQUESTER:		CSI X/TRUE GROUT PROJECT SCENARIO 1 PROCESS FLOW @ 12'-0"			
		DESIGN:					
		DRAWN: B. SEARLE					
		PROJECT NO.					
		SPEC CODE					
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE: D CAGE CODE: 01MF3 INDEX CODE NUMBER: 200 Q: 086 530		DWG- SCALE: 1/8" = 1'-0"		REV	
DESIGN PHASE:		EFFECTIVE DATE:		SHEET		1-A8	
QUALITY LEVEL: 3							

D

C

B

HVAC
AREA

ELEV.

BUFFER
AREA

LADDER

MOTOR
CONTROL
CENTER

RES
PRE
TAN

B-101
CS SORBANT

PLAN

User: SEA
Date: 11/06/98 - 1:27 P.M.

A

File: 3607-SrFL.dwg
Plot: P:\HILEVEL

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

LEGEND

- UP TO ..
- DOWN FROM ..
- DOWN TO ..
- UP FROM ..

22'-0"

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN	
	REQUESTER:	CSIX/TRU GROUT PROJECT SCENARIO 1 PROCESS FLOW • 22'-0"	
	DESIGN:		
	DRAWN: B. SEARLE		
	PROJECT NO.		
DESIGN PHASE:	SPEC CODE	SIZE	CAGE CODE
QUALITY LEVEL: 3	FOR REVIEW/APPROVAL SIGNATURES	D	01MF3
EFFECTIVE DATE:	SEE DAR NO.	AREA	TYPE
		200	530
		SCALE 1/8"=1'-0"	REV
			DWG-
			SHEET 1-A9

D

C

B

User: SEA
Date: 11/05/98 -- 3:00 P.M.
A

File: 3607-1-M1.dwg
Path: P:\hlevel\

88'-0"

QA, SAFETY, RAD CON OFFICES

FILES

STORAGE

CHANGE ROOMS

ELEV.

SPENT RESIN

T-112

F10

IX EFF

F10

REST ROOMS

RAD CON

P-111A
P-111B
P-1113
P-1112
P-104A
P-104B
F-102 O

BUFFER AREA

COPY CENTER

BREAK ROOM

A
1-M3
LIFT

LOADOUT

B
1-M3

DOCK
LOADING

PLAN

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN

REQUESTER:		CslX/TRU GROUT PROJECT SCENARIO 1 MECHANICAL PLAN @ 0'-0"									
		DESIGN:											
		DRAWN: BUBBA											
		PROJECT NO.											
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE		CAGE CODE		INDEX CODE NUMBER		DWC-		REV	
DESIGN PHASE:		EFFECTIVE DATE:		D		01MF3		AREA 200		TYPE 1530			
QUALITY LEVEL: 3				SCALE: 1/8" = 1'-0"								SHEET 1-M1	

D

C

B

A

88'-0"

OFFICE SPACE

OFFICE SPACE

ELEV.

ROOM CONTROL

AREA BUFFER

CONDENSOR

PREP TANK
WASTE RESIN

IX

AREA STORAGE DRUM

LIFT

SEE V

PLAN

User: SEA

Date: 11/08/98 - 3:04 P.M.

File: 3607-1-145.dwg

Plot: P:\blevel

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

14

12'-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
		REQUESTER:		CSIX/TRU GROUT PROJECT SCENARIO 1 PLAN @ 12'-0"	
		DESIGN:			
		DRAWING: BUBBA			
		PROJECT NO.			
DESIGN PHASE:		SPEC CODE:		SIZE: D 01MF3	
QUALITY LEVEL: 3		FOR REVIEW/APPROVAL SIGNATURES		INDEX CODE: NUMBER	
EFFECTIVE DATE:		SEE DAR NO.		DWG- 530	
		EFFECTIVE DATE:		SCALE: 1/8"=1'-0"	
				SHEET 1-M2	

D

C

B

A

User: SEA
Date: 11/08/98 - 3:07 P.M.

File: 3507-1-M1.dwg
Path: P:\mlevel

SECTION

B
1-M1

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
		REQUESTER:		CsIX/TRU GROUT PROJECT SCENARIO 1 MECHANICAL SECTIONS	
		DESIGN:			
		DRAWN: BJUBBA			
		PROJECT NO.			
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE: D CAGE CODE: 01MF3 INDEX CODE NUMBER: 200 Q: 086 DWG- REV:	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: 1/8"=1'-0" SHEET: 1-M3	

D

C

B

User: SEA

Date: 11/09/98 - 3:10 P.M.

A

DISCHARGE SECTION

TUNNEL ENCLOSURE
W/ HATCHES AT WINDOWS

INSPECTION/DECON BOOTH

TRANSFER SECTION

VIEW

REVISIONS			16
REV	DESCRIPTION	EFFECTIVE DATE	

D
-M1

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.							
<p>SCALE: 1/8" = 1'-0"</p>		REQUESTER:		CslX/TRU GROUT PROJECT SCENARIO 1 MECHANICAL VIEW					
		DESIGN:							
		DRAWN: BUBBA							
		PROJECT NO.							
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV
FOR REVIEW/APPROVAL SIGNATURES		D	01MF3	AREA	TYPE	Q	ORIG		
SEE DAR NO.		EFFECTIVE DATE:		200			530	SHEET 1-M4	
QUALITY LEVEL: 3		SCALE: 1/8" = 1'-0"							

D

C

B

A

USER: SEA
DATE: 11/08/98 - 3:11 P.M.

File: 3507-1-14.dwg
Path: P:\level

MIXER

DOOR TYP

AIRLOCK

DRU

MIXER

AIR OPERATED SLIDE VALVE

DRUM FILL VENT

FILL DIP STICK

DRUM

DETAIL

3/4"=1'-0"

SECTION

3/8"=1'-0"

E
1-M3

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN CslX/TRU GROUT PROJECT SCENARIO 1 MECHANICAL SECTION AND DETAIL	
1' 0" 1' 2" 3" 4" 5" 10' 15' SCALE: 1/8" = 1'-0"		REQUESTER: DESIGN: DRAWN: BUEBBA PROJECT NO.: SPEC. CODE:			
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		SCALE: 1/8"=1'-0"	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SHEET 1-M5	

D

C

B

A

VIEW A
1-M2

ELEVATOR

VIEW C
-

4

3

2

1

18

REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
DESIGNER:		REQUESTER:		CSIX/TRU GROUT PROJECT	
DRAWN: BUESSA		PROJECT NO.		SCENARIO 1	
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		MECHANICAL VIEWS	
SEE DAR NO.		EFFECTIVE DATE:		SCALE: 1/8" = 1'-0"	
QUALITY LEVEL: 3		SIZE: D		CAGE CODE: 01MF3	
		AREA: 200		INDEX CODE NUMBER: 530	
		DWG-:		REV:	
		SHEET: 1-M6			

D

C

B

User: SEA

Date: 11/06/98 - 1:46 P.M.

A

INTEC AREA PLAN
SCALE: 1"=250.0'

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

D

C

B

A

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.							
DESIGN PHASE:		EFFECTIVE DATE:							
<p>SCALE: 1" = 250.0'</p>		REQUESTER: DESIGN: DRAWN: PROJECT NO. SPEC CODE		C91X/TRU GROUT PROJECT SCENARIO 2 LOCATION PLAN					
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV
QUALITY LEVEL:		EFFECTIVE DATE:		D	01MF3	AREA	TYPE	GL	0002
				530				SHEET 2-C1	

D

1766

C

NEW 4" SANITARY SEWER

NEW 2" POTABLE WATER

NEW STEAM LINE

TRUPACT FACILITY

EXISTING 6" SANITARY SEWER

B

A

User: SEA
Date: 11/08/98 - 1:48 P.M.

File: 3607-uti1.dwg
Path: P:\level

TR-35

NEW 4" POTABLE WATER

681

1713

1750

PCC-NCE-773

HEMLOC

654

CEDAR STREET

664

CYPRESS AVENUE

NEW 4" SANITARY

C&D/TRU GROUT F

NEW 6" F.W. LINE

NEW STEAM LINE 728

EXISTING 10" F.W. LINE

VES-UTI-701-T

VES-UTI-682

VES-UTI-701-A

VES-UTI-68

VES-701

1662

VES-UTI-120

1769

1663

1649

736

1610

716

726

VES-UTI-608

164

INTEC AREA PLAN

SCALE: 1"=250.0'

D

C

B

60'-0"

LOADING
DOCK

DRUM
DEWATERING,
LAG STORAGE
LOAD-OUT

OFFICES

OPERATI

CURE

ROOM

PLAN @

User: SEA

Date: 11/08/98 -- 3:28 P.M.

A

File: 3807-h2A.dwg

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

0'-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.					
		REQUESTER: DESIGN: DRAWN: B. SEARLE PROJECT NO. SPEC CODE: FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.					
DESIGN PHASE:	QUALITY LEVEL: 3	EFFECTIVE DATE:	SCALE: 1/8" = 1'-0"	SIZE: D	CAGE CODE: 01MF3	INDEX CODE NUMBER: 200	REV: 530
				DWG-		SHEET 2-A6	

D

C

B

60'-0"

PH SAMPLER

NEUTRALIZER & PUMP

GROUT FEED TANK PUMP

GROUT FEED TANK PUMP

PLAN ©

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
		REQUESTER:		CSIX/TRU GROUT PROJECT SCENARIO 2 PLAN @ 10'-0"	
		DESIGN:			
		DRAWN: B. SEARLE			
		PROJECT NO.			
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		DWG-	
SEE DAR NO.		EFFECTIVE DATE:		REV	
DESIGN PHASE:		QUALITY LEVEL: 3		SHEET 2-A7	

D

C

110'-0"

A
2-A9

ROOF
BELOW

60'-0"

ROOF
BELOW

B
2-A9

STA

WEIGH BINS

CaO
BINS

B

PLAN ©

User: SEA
Date: 11/09/88 - 2:05 P.M.

A

23

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE
-----	-------------	----------------

D

C

B

A

ROOF
BELOW

20'-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN					
 SCALE: 1/8" = 1'-0"		REQUESTER:		CSIX/TRU GROUT PROJECT SCENARIO 2 PLAN @ 20'-0"					
		DESIGN:							
		DRAWN: B. SEARLE							
		PROJECT NO.							
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE	NUMBER	DWG-	REV
QUALITY LEVEL: 3		EFFECTIVE DATE:		D	01MF3	200	530		
				SCALE: 1/8"=1'-0"				SHEET 2-A8	

D

SECTION

A
TYP

B

SECTION

B
TYP

4

3

2

1

24

REVISIONS

REV DESCRIPTION EFFECTIVE DATE

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN						
 SCALE: 1/8" = 1'-0"		REQUESTER:		CsIX/TRU GROUT PROJECT SCENARIO 2 BUILDING SECTIONS						
		DESIGN:								
		DRAWN: B. SEARLE								
		PROJECT NO.								
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV	
DESIGN PHASE:		SEE DAR NO.		D	01MF3	AREA	TYPE	Q. I. 052	530	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: 1/8" = 1'-0"				SHEET 2-A9		

4

3

2

1

D

C

B

A

60'-0"

LOADING
DOCK

LOAD OFF
CONVEYOR

DRUM
DEWATERING,
LAG STORAGE
LOAD-OUT

DEWATERING
STATIONS

DEWATERING
LOAD-OUT

DRUM INDEX TABLE

OFFICES

OPERATI

CURE

ROOM

PLAN @

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

0'-0"

D
C
B
A

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
<p>SCALE: 1/8" = 1'-0"</p>		REQUESTER:		CsIX/TRU GROUT PROJECT SCENARIO 2 MECHANICAL PLAN @ 0'-0"	
		DESIGN:			
		DRAWN: BUBBA			
		PROJECT NO.			
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.		SIZE: D 01MF3	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: 1/8" = 1'-0"	
				DWG- 2-M1

CPP-659 3RD LEVEL PLAN

SCALE: 1/16"=1'-0"

SECTION B

1/8"=1'-0"

4

3

2

1

26

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE

SECTION

1/4"=1'-0"

NOTES

1. CROSS HATCHED EQUIPMENT INDICATES DEMOLITION.
2. NOT ALL OF THE EQUIPMENT TO BE DEMOLITIONED IS SHOWN ON DRAWING. FOR COMPLETE LIST OF EQUIPMENT TO BE DEMOLITIONED SEE ABSORBER CELL DEMOLITION LIST BELOW.

ABSORBER CELL DEMOLITION LIST

VES-NCC-112
VES-NCC-113
VES-NCC-114
VES-NCC-116
VES-NCC-136
HE-NCC-333
HE-NCC-334
HE-NCC-335

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN											
NO SCALE		REQUESTER:		CSI/TRUE GROUT PROJECT SCENARIO 2 CPP-659 3RD LEVEL DEMOLITION PLAN											
		DESIGN:													
		DRAWN: BUBBA													
		PROJECT NO.													
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE		CAGE CODE		INDEX CODE NUMBER		DWG-		REV			
DESIGN PHASE:		SEE DAR NO.		D		01MF3		AUSA		TYPE		GL		0659	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: NOTED		SHEET		2-M2							

4

3

2

1

D

C

B

User: SEA
Date: 11/08/98 - 3:30 P.M.

A

File: 3607-2-M3.dwg
Path: P:\level

UDS DRUM FILLING STATION

HE-NCC-335

HE-NCC-336

HE-NCC-336

T-108

CPP-659 3RD

SCALE: 1/16"=1'

LEVEL PLAN
-0"

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN			
NO SCALE		REQUESTER:		CSIX/TRU GROUT PROJECT SCENARIO 2 CPP-659 3RD LEVEL PLAN			
		DESIGN:					
		DRAWN: BUEBA					
		PROJECT NO.					
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER	REV
DESIGN PHASE:		SEE DAR NO.		D	01MF3	200 10659 530	DWG-
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: NOTED		SHEET 2-M3

D

C

B

SECTION A
SCALE: 1/2"=1'-0" (2-M3)

User: SEA
Date: 11/08/85 - 3:30 P.M.

File: 3507-2-M4.dwg
Path: P:\Nileval

SECTION B
1/4" = 1'-0" (2-M3)

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN																			
<p>SCALE: 1/8" = 1'-0"</p>		REQUESTER:		<p>CsIX/TRU GROUT PROJECT SCENARIO 2 SECTIONS</p>																			
		DESIGN:																					
		DRAWN: BUBBA																					
		PROJECT NO.																					
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		<table border="1"> <tr> <th>SIZE</th> <th>CAGE CODE</th> <th>INDEX CODE NUMBER</th> <th>AREA</th> <th>TYPE</th> <th>CL</th> <th>OSG</th> <th>DWG</th> <th>REV</th> </tr> <tr> <td>D</td> <td>01MF3</td> <td>200</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>		SIZE	CAGE CODE	INDEX CODE NUMBER	AREA	TYPE	CL	OSG	DWG	REV	D	01MF3	200						
SIZE	CAGE CODE	INDEX CODE NUMBER	AREA	TYPE	CL	OSG	DWG	REV															
D	01MF3	200																					
SEE BAR NO.		EFFECTIVE DATE:		<p>SCALE: NOTED</p> <p>SHEET 2-M4</p>																			
DESIGN PHASE:		QUALITY LEVEL: 3																					

D

C

B

SECTION

SCALE: 1/4"=1'-0"

User: SEA
Date: 11/08/98 -- 3:31 P.M.
A

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SECTION D
 SCALE: 1/4"=1'-0" 2-M3

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN			
<p>SCALE: 1/8" = 1'-0"</p>		REQUESTER:		CsIX/TRU GROUT PROJECT SCENARIO 1 PLAN @ 0'-0"			
		DESIGN:					
		DRAWN: BUBBA					
		PROJECT NO.					
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE		CAGE CODE	
DESIGN PHASE:		SEE DAR NO.		D 01MF3		AREA	
QUALITY LEVEL: 3		EFFECTIVE DATE:		SCALE: NOTED		INDEX CODE NUMBER	
						DWG-	
						SHEET 2-M5	

D

C

B

User: SEA
 Date: 11/08/98 - 3:31 P.M.
 A

File: 3607-2-NB.dwg
 Plot: P:\hilevel

CPP-659 1ST LEVEL

SCALE: 1/16"=1'-0"

PLAN

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN
NO SCALE		REQUESTOR:		CSIX/TRU GROUT PROJECT SCENARIO 2 CPP-659 1ST LEVEL PLAN						
		DESIGN:								
		DRAWING: BUBBA								
		PROJECT NO.								
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV	
SEE DAR NO.		EFFECTIVE DATE:		D	01MF3	AREA	TYPE			G
DESIGN PHASE:		EFFECTIVE DATE:		SCALE: NOTED				SHEET 2-M6		

8

7

6

5

240'-0"

D

C

240'-0"

INTERIM STORAGE FACILITY

B

HEAD SPACE GAS
ANALYSIS & VIDEOSCOPY

PLAN

User: SEA
Date: 11/09/98 - 2:48 P.M.

A

8

7

6

5

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

PLAN

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN			
		REQUESTER:		CSIX/TRU GROUT PROJECT SCENARIO 1 & 2 INTERIM STORAGE FACILITY PLAN			
		DESIGN:					
		DRAWN: B. SEARLE					
		PROJECT NO.					
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE: D		CAGE CODE: 01MF3	
FOR REVIEW/APPROVAL SIGNATURES		SEE DAR NO.		AREA: 200		INDEX CODE: 530	
EFFECTIVE DATE:		SCALE: 1/16" = 1'-0"		DWG-		REV	
QUALITY LEVEL: 3				SHEET		COM-A1	

D

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B

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User: SEA
Date: 11/08/98 - 2:50 P.M.

File: 3507-hhE.dwg
Path: P:\level

ELEV INTER

ELEV INTER

FRONT

ELEV TR

4

3

2

1

32

REVISIONS

REV

DESCRIPTION

EFFECTIVE DATE

SIDESTORAGE FACILITYFRONTSTORAGE FACILITYSIDEIMPACT FACILITY

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN

SCALE: 1/16" = 1'-0"		REQUESTER:		CsiX/TRU GROUT PROJECT SCENARIO 1 & 2 INTERIM STORAGE FACILITY ELEVATIONS									
		DESIGN:											
		DRAWN: B. SEARLE											
		PROJECT NO.											
SPEC CODE		FOR REVIEW/APPROVAL SIGNATURES		SIZE		CAGE CODE		INDEX CODE NUMBER		DWG-		REV	
DESIGN PHASE:		SEE DAR NO.		EFFECTIVE DATE		D 01MF3		200		530			
QUALITY LEVEL: 3												SHEET COM-A2	

4

3

2

1

240'-0"

D

C

240'-0"

B

LOAD CONVEYOR

INDEX TABLE

AIRLOCK

GLOVEBOX

AIRLOCK

UNLOAD CONVEYOR

INTERIM STORAGE FACILITY

HEAD SPACE GAS
ANALYSIS & VIDEOSCOPY

PLAN

SCALE: 1/16"=1'-0"

User: SEA
Date: 11/08/98 - 2:11 P.M.

A

File: 3607-COM-M1.dwg
Plot: P:\birevel

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

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

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN	
		REQUESTED:		CslX/TRU GROUT PROJECT SCENARIO 1 & 2 MECHANICAL INTERIM STORAGE FACILITY PLAN	
		DESIGN:			
		DRAWN: BUBBA			
		PROJECT NO.			
DESIGN PHASE:		FOR REVIEW/APPROVAL SIGNATURES		SIZE: D	
QUALITY LEVEL: 3		EFFECTIVE DATE:		CAGE CODE: 01MF3	
				INDEX CODE NUMBER: 200	
				DWG- 530	
				REV	
				SHEET COM-M1	

Appendix E

Engineering Design Files

EDF-CsIX-001 "CsIX/TRU Grout Process Basis, Description, Material Balance and Process Flow Diagrams" –in Appendix B

EDF-CsIX-002 "Interim Storage for CH TRU Waste Drums"

EDF-CsIX-003 "Personnel Staffing and Space Requirements for CsIX/TRU Grout Operations"

EDF-CsIX-004 "SBW Treatment – Ion Exchange Media Disposition Concepts"

EDF-CsIX-005 "Handling of Containers Through the Grouting Area"

EDF-CsIX-006 "Handling of Containers Through the Cure Cell"

EDF-CsIX-007 "Handling of Containers Through the Dewatering Process"

EDF-CsIX-008 "UDS Drum Filling and Handling"

EDF-CsIX-009 "Equipment Installation in NWCF"

EDF-CsIX-010 "Drum Head Space Sampling and Inspection"

EDF-CsIX-011 "HVAC – Scenario 1"

EDF-CsIX-012 "HVAC – Scenario 2"

EDF-CsIX-013 "Off-Gas"

EDF-CsIX-014 "Electrical Requirements"

EDF-CsIX-015 "CsIX/TRU Component Projected Radiation Fields"

EDF-CsIX-016 "Determine Facility Shielding Requirements"

Not generated by this Feasibility Study, but appended for reference (not for review):

EDF-WTS-003 "Regulatory Requirements for the Design, Construction, and Operations of the ICPP Proposed Waste Processing Facilities"

EDF-WTS-004 "Regulatory and Design Requirements for Waste Treatment Facilities"

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Interim Storage Design

Title: Interim Storage for CH TRU Waste Drums

Summary:

This EDF contains the calculations used to determine how much interim storage capacity will be required for Contact Handled (CH) TRU waste drums produced during the CsIX/TRU Grout process. Also included is a brief guidance on current interim storage facilities, similar to those required for this study. The reference material – grout quantity and density - is documented in EDF-CsIX-001, *CsIX/TRU Grout Process Basis, Description, Material Balance, and Process Flow Diagram*.

Conclusions:

The numbers indicate an accuracy greater than really exists. Drum production rates and totals have been rounded and will vary from that listed when improved reference data becomes available.

- Total number of drums produced = 38,000.
- Average production rate over 5 year operating period = 633/year, 146/week, or 21/day.
- Maximum actual daily rate considering efficiencies = 38.
- Filled drum weight is 888 lb (403 kg).
- Maximum number of grout filled drums per TRUPACT-II is 7.
- TRUPACT-II payload for CsIX/TRU drums is 6864 lb (max allowed is 7265 lb).
- Shipping rate is assumed to be 5 TRUPACT-II shipments (3 TRUPACT-IIs per shipment) every 2 weeks (105 drums).
- Interim storage capacity required is for approximately 24,000 (24,350 calculated) drums.
- Last date for drum shipment to WIPP is estimated to be December, 2021.
- Type II Storage Modules at RWMC should be the basis for estimating size and cost.
- The RWMC TRUPACT-II loading station should be the basis for estimating size and cost.

Distribution (complete package): R. E. Dafoe, MS 3765, C. W. Olsen, S. J. Losinski, MS 3625, MS 3211, K. L. Williams, MS 3765, Project File, a copy will be included in report INEEL/INT-98-00869

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
Ron Dafoe	4130	S. J. Losinski	9/14/98	K. L. Williams	9/15/98

Introduction:

The number of drums to be generated is based on the material balance information provided in project EDF-CsIX-001, *CsIX/TRU Grout Process Basis, Description, Material Balance, and Process Flow Diagrams*. The volume of grout material produced, per the EDF, is 7500 m³ at a density of 1.9 kg/l. These quantities are used in the calculations shown in the latter pages of this EDF, with some of the following summary taken from the tables:

Production Rate:

Using a drum loading of 0.2 m³ of grout per drum, the total production of CH TRU waste drums is approximately 38,000. For the operating period of 5 years, this converts to approximate averages of 633 drums per month, 146 per week, or 21 per day. Considering operating up-time and efficiency estimates of approximately 55% (EDF-CsIX-003), any given day's output would be closer to 38 (21/0.55) drums a day.

TRUPACT-II Loading:

The NuPac TRUPACT-II SAR (Rev.3, July 1989) states that the total payload for a TRUPACT-II is 7265 lb, which, in addition to a maximum 14 55-gal drums, with contents, includes the inner components required to package the drums in the TRUPACT-II. The estimated drum weight from the CsIX Grout process is 888 lb (403 kg), which includes an estimated empty drum weight of 50 lb. Thus, the loading of a TRUPACT-II with these drums will be limited to 7. The remaining space in the TRUPACT-II is assumed to be filled with empty drums. This results in an estimated TRUPACT-II payload of approximately 6864 lb. TRUPACT-IIs are currently shipped in sets of 3 on a single trailer.

A major assumption is that the CsIX/TRU Grout process drum production rate will be greater than the rate at which the drums can be shipped to WIPP, their assumed ultimate destination. Functional File BC-CsIX-25, dated 8/25/98, which documents the 8/19/98 *TELECON with WIPP about acceptance of waste product from SBW treatment by the CsIX/TRU Grout process*, under item 8, indicates that WIPP will size its TRUPACT-II fleet and handling capability to match the generator's needs. To avoid the need for interim storage, approximately one TRUPACT-II shipment, which includes 3 TRUPACT-II containers, or 21 drums, would have to be made each day of the year. With up-time and efficiencies included, the actual rate would be at least 2 shipments a day. RWMC personnel indicate that it will be a struggle for them to make one shipment a day (Functional File No. BC-CsIX-21, *Notes from 8-12-98 CsIX/TRU Grout Weekly Technical Status Meeting*). For the purpose of this EDF, the assumption is that 2-1/2 shipments per week (5 every 2 weeks) (105 drums) can be made and that WIPP will be able to handle that rate.

Interim Storage:

The following table shows the effect that varying shipping rates has on interim storage capacity required (see tables for details).

# of drums per week to WIPP	# of TRUPACT loads per week to WIPP	# of drums in storage at INTEC by end of 2012	Date of last Shipment to WIPP
42	2	27,080	05/2025
52.5	2.5	24,350	12/2021
84	4	16,160	10/2016
147	7	0	12/2012

This summary indicates that significant savings in interim storage capital and operating costs can be had for even an incremental increase from 2 shipments a week to 2-1/2 a week. Four shipments per week could reduce the total shipping timeframe by 5 years from the 2-1/2 shipments-per-week schedule.

Interim Storage Facilities:

The Type II storage modules at RWMC are RCRA buildings designed to hold 17,500 55-gallon drum equivalents of CH TRU waste. Because the interim storage requirements for the CsIX/TRU Grout Feasibility Study are similar to the Type II Storage Modules, the design and cost estimating efforts for this study should be based on these facilities. The original design and cost estimate information is readily available. An initial ROM for 2 such buildings for interim RCRA storage of the CsIX Grout process CH TRU waste drums was approximately \$6M. Not included in this figure is the cost for a TRUPACT-II loading station which will be required for this study. An existing loading station exists at RWMC and should be the basis for one in this study.

Calculation Details and Summaries:

Reference is EDF-CslX-001, *CsIX/TRU Grout Process Basis, Description, Material Balance, and Process Flow Diagram*, which indicates in the material balance that the grout volume is 7,500 cubic meters at a density of 1.9 kg/l.

grout volume	7,500	m³	TRUPACT II payload =	7,265	lb	
	7,500,000	liters	Misc components=	300	lb	
	1,981,506	gal	empty drum=	50	lb	
grout density	1.9	kg/l	Total waste mat'l =	6,265	lb	
0.2 m³ =	52.84	gal	At 0.2m³ loading and 1.9 kg/l, max TRUPACT II			
			load is	395	gal	or 7.5 drums
Drum Generation Rate						
	Total	5 Year base				
	Drums	drum/yr	drum/mon	drum/week	drum/day	TRUPACT II/day
Full 55 gal drum	36,027	7,205	600	139	20	2.82
Full drum (57 gal)	34,763	6,953	579	134	19	2.72
90% full 55 gal drum	40,030	8,006	667	154	22	3.13
0.2 cubic meter	37,500	7,500	625	144	21	2.94
Use for calculations	38,000	7,600	633	146	21	2.97
Drum Weights						
	wt/drum	wt/drum	7 drums	8 drums	9 drums	
Loading	(kg)	(lb)	(lb)	(lb)	(lb)	
0.2 m³	403	888	6,214	7,102	7,990	
Full 55 gal	418	922	6,454	7,376	8,298	
Full 57 gal	433	954	6,676	7,630	8,583	
90% of 55 gal	379	835	5,844	6,678	7,513	
TRUPACT II Max Payload Load = 7,265 lb (14 drums, pallet, guide tubes, slip sheets,						
			and reinforcing plates)			
drum loading	0.2 m³	0.2 m³				
No. of waste drums	7	8				
No. empty drums	7	6				
Misc innards wt	300	300				
payload	6,864	7,702	Max number waste drums is 7			
Shipping Rates (38,000 drums @ 0.2 m³ drum loading)						
	No. of	No. of	Interim	Date of	Type II	No. of
Drums shipped	T-Packs	T-Pack	Storage	last	Module	Type II
per week		shipments	Req'd	shipment	Capacity	Req'd
42	6	2	27,080	May-25	17,500	1.55
52.5	7.5	2.50	24,350	Dec-21	17,500	1.39
63	9	3	21,620	Aug-19	17,500	1.24
84	12	4	16,160	Sep-16	17,500	0.92
105	15	5	10,700	Dec-14	17,500	0.61
126	18	6	5,240	Oct-13	17,500	0.30
147	21	7	0	Dec-12	17,500	0.00

The following tables (Excel spreadsheet) were used to determine the amount of interim storage required for a given production rate and varying shipping rates. There are 2 tables per page with each column and subsequent tables continuing on subsequent pages.

Total drums 38000
Int. Stor. 27080
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	42 remain
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2008	1	633	182	451
2008	2	633	182	903
2008	3	633	182	1354
2008	4	633	182	1805
2008	5	633	182	2257
2008	6	633	182	2708
2008	7	633	182	3159
2008	8	633	182	3611
2008	9	633	182	4062
2008	10	633	182	4513
2008	11	633	182	4965
2008	12	633	182	5416
2009	1	633	182	5867
2009	2	633	182	6319
2009	3	633	182	6770
2009	4	633	182	7221
2009	5	633	182	7673
2009	6	633	182	8124
2009	7	633	182	8575
2009	8	633	182	9027
2009	9	633	182	9478
2009	10	633	182	9929
2009	11	633	182	10381
2009	12	633	182	10832
2010	1	633	182	11283
2010	2	633	182	11735
2010	3	633	182	12186
2010	4	633	182	12637
2010	5	633	182	13089
2010	6	633	182	13540
2010	7	633	182	13991
2010	8	633	182	14443
2010	9	633	182	14894
2010	10	633	182	15345

Total drums 38000
Int. Stor. 24350
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	52.5 remain
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2008	1	633	227.5	406
2008	2	633	227.5	812
2008	3	633	227.5	1218
2008	4	633	227.5	1623
2008	5	633	227.5	2029
2008	6	633	227.5	2435
2008	7	633	227.5	2841
2008	8	633	227.5	3247
2008	9	633	227.5	3653
2008	10	633	227.5	4058
2008	11	633	227.5	4464
2008	12	633	227.5	4870
2009	1	633	227.5	5276
2009	2	633	227.5	5682
2009	3	633	227.5	6088
2009	4	633	227.5	6493
2009	5	633	227.5	6899
2009	6	633	227.5	7305
2009	7	633	227.5	7711
2009	8	633	227.5	8117
2009	9	633	227.5	8523
2009	10	633	227.5	8928
2009	11	633	227.5	9334
2009	12	633	227.5	9740
2010	1	633	227.5	10146
2010	2	633	227.5	10552
2010	3	633	227.5	10958
2010	4	633	227.5	11363
2010	5	633	227.5	11769
2010	6	633	227.5	12175
2010	7	633	227.5	12581
2010	8	633	227.5	12987
2010	9	633	227.5	13393
2010	10	633	227.5	13798

ENGINEERING DESIGN FILE

Total drums 38000				Total drums 38000			
Int. Stor. 27080				Int. Stor. 24350			
Req'd				Req'd			
		0.2 m ³	Shipped			0.2 m ³	Shipped
		drums	/week			drums	/week
Year	Month	generated	42 remain	Year	Month	generated	52.5 remain
2010	11	633	182 15797	2010	11	633	227.5 14204
2010	12	633	182 16248	2010	12	633	227.5 14610
2011	1	633	182 16699	2011	1	633	227.5 15016
2011	2	633	182 17151	2011	2	633	227.5 15422
2011	3	633	182 17602	2011	3	633	227.5 15828
2011	4	633	182 18053	2011	4	633	227.5 16233
2011	5	633	182 18505	2011	5	633	227.5 16639
2011	6	633	182 18956	2011	6	633	227.5 17045
2011	7	633	182 19407	2011	7	633	227.5 17451
2011	8	633	182 19859	2011	8	633	227.5 17857
2011	9	633	182 20310	2011	9	633	227.5 18263
2011	10	633	182 20761	2011	10	633	227.5 18668
2011	11	633	182 21213	2011	11	633	227.5 19074
2011	12	633	182 21664	2011	12	633	227.5 19480
2012	1	633	182 22115	2012	1	633	227.5 19886
2012	2	633	182 22567	2012	2	633	227.5 20292
2012	3	633	182 23018	2012	3	633	227.5 20698
2012	4	633	182 23469	2012	4	633	227.5 21103
2012	5	633	182 23921	2012	5	633	227.5 21509
2012	6	633	182 24372	2012	6	633	227.5 21915
2012	7	633	182 24823	2012	7	633	227.5 22321
2012	8	633	182 25275	2012	8	633	227.5 22727
2012	9	633	182 25726	2012	9	633	227.5 23133
2012	10	633	182 26177	2012	10	633	227.5 23538
2012	11	633	182 26629	2012	11	633	227.5 23944
2012	12	633	182 27080	2012	12	633	227.5 24350
2013	1	0	182 26898	2013	1	0	227.5 24123
2013	2	0	182 26716	2013	2	0	227.5 23895
2013	3	0	182 26534	2013	3	0	227.5 23668
2013	4	0	182 26352	2013	4	0	227.5 23440
2013	5	0	182 26170	2013	5	0	227.5 23213
2013	6	0	182 25988	2013	6	0	227.5 22985
2013	7	0	182 25806	2013	7	0	227.5 22758
2013	8	0	182 25624	2013	8	0	227.5 22530
2013	9	0	182 25442	2013	9	0	227.5 22303
2013	10	0	182 25260	2013	10	0	227.5 22075
2013	11	0	182 25078	2013	11	0	227.5 21848
2013	12	0	182 24896	2013	12	0	227.5 21620
2014	1	0	182 24714	2014	1	0	227.5 21393

ENGINEERING DESIGN FILE

Total drums 38000				Total drums 38000			
Int. Stor. 27080				Int. Stor. 24350			
Req'd				Req'd			
		0.2 m ³	Shipped			0.2 m ³	Shipped
		drums	/week			drums	/week
Year	Month generated		42 remain	Year	Month generated		52.5 remain
2014	2	0	182 24532	2014	2	0	227.5 21165
2014	3	0	182 24350	2014	3	0	227.5 20938
2014	4	0	182 24168	2014	4	0	227.5 20710
2014	5	0	182 23986	2014	5	0	227.5 20483
2014	6	0	182 23804	2014	6	0	227.5 20255
2014	7	0	182 23622	2014	7	0	227.5 20028
2014	8	0	182 23440	2014	8	0	227.5 19800
2014	9	0	182 23258	2014	9	0	227.5 19573
2014	10	0	182 23076	2014	10	0	227.5 19345
2014	11	0	182 22894	2014	11	0	227.5 19118
2014	12	0	182 22712	2014	12	0	227.5 18890
2015	1	0	182 22530	2015	1	0	227.5 18663
2015	2	0	182 22348	2015	2	0	227.5 18435
2015	3	0	182 22166	2015	3	0	227.5 18208
2015	4	0	182 21984	2015	4	0	227.5 17980
2015	5	0	182 21802	2015	5	0	227.5 17753
2015	6	0	182 21620	2015	6	0	227.5 17525
2015	7	0	182 21438	2015	7	0	227.5 17298
2015	8	0	182 21256	2015	8	0	227.5 17070
2015	9	0	182 21074	2015	9	0	227.5 16843
2015	10	0	182 20892	2015	10	0	227.5 16615
2015	11	0	182 20710	2015	11	0	227.5 16388
2015	12	0	182 20528	2015	12	0	227.5 16160
2016	1	0	182 20346	2016	1	0	227.5 15933
2016	2	0	182 20164	2016	2	0	227.5 15705
2016	3	0	182 19982	2016	3	0	227.5 15478
2016	4	0	182 19800	2016	4	0	227.5 15250
2016	5	0	182 19618	2016	5	0	227.5 15023
2016	6	0	182 19436	2016	6	0	227.5 14795
2016	7	0	182 19254	2016	7	0	227.5 14568
2016	8	0	182 19072	2016	8	0	227.5 14340
2016	9	0	182 18890	2016	9	0	227.5 14113
2016	10	0	182 18708	2016	10	0	227.5 13885
2016	11	0	182 18526	2016	11	0	227.5 13658
2016	12	0	182 18344	2016	12	0	227.5 13430
2017	1	0	182 18162	2017	1	0	227.5 13203
2017	2	0	182 17980	2017	2	0	227.5 12975
2017	3	0	182 17798	2017	3	0	227.5 12748
2017	4	0	182 17616	2017	4	0	227.5 12520

ENGINEERING DESIGN FILE

Total drums 38000				Total drums 38000			
Int. Stor. 27080				Int. Stor. 24350			
Req'd				Req'd			
		0.2 m ³	Shipped			0.2 m ³	Shipped
		drums	/week			drums	/week
Year	Month generated		42 remain	Year	Month generated		52.5 remain
2017	5	0	182 17434	2017	5	0	227.5 12293
2017	6	0	182 17252	2017	6	0	227.5 12065
2017	7	0	182 17070	2017	7	0	227.5 11838
2017	8	0	182 16888	2017	8	0	227.5 11610
2017	9	0	182 16706	2017	9	0	227.5 11383
2017	10	0	182 16524	2017	10	0	227.5 11155
2017	11	0	182 16342	2017	11	0	227.5 10928
2017	12	0	182 16160	2017	12	0	227.5 10700
2018	1	0	182 15978	2018	1	0	227.5 10473
2018	2	0	182 15796	2018	2	0	227.5 10245
2018	3	0	182 15614	2018	3	0	227.5 10018
2018	4	0	182 15432	2018	4	0	227.5 9790
2018	5	0	182 15250	2018	5	0	227.5 9562
2018	6	0	182 15068	2018	6	0	227.5 9335
2018	7	0	182 14886	2018	7	0	227.5 9107
2018	8	0	182 14704	2018	8	0	227.5 8880
2018	9	0	182 14522	2018	9	0	227.5 8652
2018	10	0	182 14340	2018	10	0	227.5 8425
2018	11	0	182 14158	2018	11	0	227.5 8197
2018	12	0	182 13976	2018	12	0	227.5 7970
2019	1	0	182 13794	2019	1	0	227.5 7742
2019	2	0	182 13612	2019	2	0	227.5 7515
2019	3	0	182 13430	2019	3	0	227.5 7287
2019	4	0	182 13248	2019	4	0	227.5 7060
2019	5	0	182 13066	2019	5	0	227.5 6832
2019	6	0	182 12884	2019	6	0	227.5 6605
2019	7	0	182 12702	2019	7	0	227.5 6377
2019	8	0	182 12520	2019	8	0	227.5 6150
2019	9	0	182 12338	2019	9	0	227.5 5922
2019	10	0	182 12156	2019	10	0	227.5 5695
2019	11	0	182 11974	2019	11	0	227.5 5467
2019	12	0	182 11792	2019	12	0	227.5 5240
2020	1	0	182 11610	2020	1	0	227.5 5012
2020	2	0	182 11428	2020	2	0	227.5 4785
2020	3	0	182 11246	2020	3	0	227.5 4557
2020	4	0	182 11064	2020	4	0	227.5 4330
2020	5	0	182 10882	2020	5	0	227.5 4102
2020	6	0	182 10700	2020	6	0	227.5 3875
2020	7	0	182 10518	2020	7	0	227.5 3647

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Total drums 38000
Int. Stor. 27080
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	42 remain
2020	8	0	182	10336
2020	9	0	182	10154
2020	10	0	182	9972
2020	11	0	182	9790
2020	12	0	182	9608
2021	1	0	182	9426
2021	2	0	182	9244
2021	3	0	182	9062
2021	4	0	182	8880
2021	5	0	182	8698
2021	6	0	182	8516
2021	7	0	182	8334
2021	8	0	182	8152
2021	9	0	182	7970
2021	10	0	182	7788
2021	11	0	182	7606
2021	12	0	182	7424
2022	1	0	182	7242
2022	2	0	182	7060
2022	3	0	182	6878
2022	4	0	182	6696
2022	5	0	182	6514
2022	6	0	182	6332
2022	7	0	182	6150
2022	8	0	182	5968
2022	9	0	182	5786
2022	10	0	182	5604
2022	11	0	182	5422
2022	12	0	182	5240
2023	1	0	182	5058
2023	2	0	182	4876
2023	3	0	182	4694
2023	4	0	182	4512
2023	5	0	182	4330
2023	6	0	182	4148
2023	7	0	182	3966
2023	8	0	182	3784
2023	9	0	182	3602
2023	10	0	182	3420

Total drums 38000
Int. Stor. 24350
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	52.5 remain
2020	8	0	227.5	3420
2020	9	0	227.5	3192
2020	10	0	227.5	2965
2020	11	0	227.5	2737
2020	12	0	227.5	2510
2021	1	0	227.5	2282
2021	2	0	227.5	2055
2021	3	0	227.5	1827
2021	4	0	227.5	1600
2021	5	0	227.5	1372
2021	6	0	227.5	1145
2021	7	0	227.5	917
2021	8	0	227.5	690
2021	9	0	227.5	462
2021	10	0	227.5	235
2021	11	0	227.5	7
2021	12	0	227.5	-220

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Total drums 38000
Int. Stor. 27080
Req'd

Total drums 38000
Int. Stor. 24350
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	42 remain
2023	11	0	182	3238
2023	12	0	182	3056
2024	1	0	182	2874
2024	2	0	182	2692
2024	3	0	182	2510
2024	4	0	182	2328
2024	5	0	182	2146
2024	6	0	182	1964
2024	7	0	182	1782
2024	8	0	182	1600
2024	9	0	182	1418
2024	10	0	182	1236
2024	11	0	182	1054
2024	12	0	182	872
2025	1	0	182	690
2025	2	0	182	508
2025	3	0	182	326
2025	4	0	182	144
2025	5	0	182	-38

Year Month 0.2 m³
drums Shipped
generated /week
52.5 remain

ENGINEERING DESIGN FILE

Total drums 38000 Int. Stor. 21620 Req'd					Total drums 38000 Int. Stor. 16160 Req'd				
Year	Month	0.2 m ³ drums generated	Shipped /week	63 remain	Year	Month	0.2 m ³ drums generated	Shipped /week	84 remain
2008	1	633	273	360	2008	1	633	364	269
2008	2	633	273	721	2008	2	633	364	539
2008	3	633	273	1081	2008	3	633	364	808
2008	4	633	273	1441	2008	4	633	364	1077
2008	5	633	273	1802	2008	5	633	364	1347
2008	6	633	273	2162	2008	6	633	364	1616
2008	7	633	273	2522	2008	7	633	364	1885
2008	8	633	273	2883	2008	8	633	364	2155
2008	9	633	273	3243	2008	9	633	364	2424
2008	10	633	273	3603	2008	10	633	364	2693
2008	11	633	273	3964	2008	11	633	364	2963
2008	12	633	273	4324	2008	12	633	364	3232
2009	1	633	273	4684	2009	1	633	364	3501
2009	2	633	273	5045	2009	2	633	364	3771
2009	3	633	273	5405	2009	3	633	364	4040
2009	4	633	273	5765	2009	4	633	364	4309
2009	5	633	273	6126	2009	5	633	364	4579
2009	6	633	273	6486	2009	6	633	364	4848
2009	7	633	273	6846	2009	7	633	364	5117
2009	8	633	273	7207	2009	8	633	364	5387
2009	9	633	273	7567	2009	9	633	364	5656
2009	10	633	273	7927	2009	10	633	364	5925
2009	11	633	273	8288	2009	11	633	364	6195
2009	12	633	273	8648	2009	12	633	364	6464
2010	1	633	273	9008	2010	1	633	364	6733
2010	2	633	273	9369	2010	2	633	364	7003
2010	3	633	273	9729	2010	3	633	364	7272
2010	4	633	273	10089	2010	4	633	364	7541
2010	5	633	273	10450	2010	5	633	364	7811
2010	6	633	273	10810	2010	6	633	364	8080
2010	7	633	273	11170	2010	7	633	364	8349
2010	8	633	273	11531	2010	8	633	364	8619
2010	9	633	273	11891	2010	9	633	364	8888
2010	10	633	273	12251	2010	10	633	364	9157
2010	11	633	273	12612	2010	11	633	364	9427
2010	12	633	273	12972	2010	12	633	364	9696
2011	1	633	273	13332	2011	1	633	364	9965
2011	2	633	273	13693	2011	2	633	364	10235

ENGINEERING DESIGN FILE

Total drums 38000				Total drums 38000			
Int. Stor. 21620				Int. Stor. 16160			
Req'd				Req'd			
		0.2 m ³	Shipped			0.2 m ³	Shipped
		drums	/week			drums	/week
Year	Month	generated	63 remain	Year	Month	generated	84 remain
2011	3	633	273 14053	2011	3	633	364 10504
2011	4	633	273 14413	2011	4	633	364 10773
2011	5	633	273 14774	2011	5	633	364 11043
2011	6	633	273 15134	2011	6	633	364 11312
2011	7	633	273 15494	2011	7	633	364 11581
2011	8	633	273 15855	2011	8	633	364 11851
2011	9	633	273 16215	2011	9	633	364 12120
2011	10	633	273 16575	2011	10	633	364 12389
2011	11	633	273 16936	2011	11	633	364 12659
2011	12	633	273 17296	2011	12	633	364 12928
2012	1	633	273 17656	2012	1	633	364 13197
2012	2	633	273 18017	2012	2	633	364 13467
2012	3	633	273 18377	2012	3	633	364 13736
2012	4	633	273 18737	2012	4	633	364 14005
2012	5	633	273 19098	2012	5	633	364 14275
2012	6	633	273 19458	2012	6	633	364 14544
2012	7	633	273 19818	2012	7	633	364 14813
2012	8	633	273 20179	2012	8	633	364 15083
2012	9	633	273 20539	2012	9	633	364 15352
2012	10	633	273 20899	2012	10	633	364 15621
2012	11	633	273 21260	2012	11	633	364 15891
2012	12	633	273 21620	2012	12	633	364 16160
2013	1	0	273 21347	2013	1	0	364 15796
2013	2	0	273 21074	2013	2	0	364 15432
2013	3	0	273 20801	2013	3	0	364 15068
2013	4	0	273 20528	2013	4	0	364 14704
2013	5	0	273 20255	2013	5	0	364 14340
2013	6	0	273 19982	2013	6	0	364 13976
2013	7	0	273 19709	2013	7	0	364 13612
2013	8	0	273 19436	2013	8	0	364 13248
2013	9	0	273 19163	2013	9	0	364 12884
2013	10	0	273 18890	2013	10	0	364 12520
2013	11	0	273 18617	2013	11	0	364 12156
2013	12	0	273 18344	2013	12	0	364 11792
2014	1	0	273 18071	2014	1	0	364 11428
2014	2	0	273 17798	2014	2	0	364 11064
2014	3	0	273 17525	2014	3	0	364 10700
2014	4	0	273 17252	2014	4	0	364 10336
2014	5	0	273 16979	2014	5	0	364 9972

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Total drums 38000
Int. Stor. 21620
Req'd

Total drums 38000
Int. Stor. 16160
Req'd

		0.2 m ³ drums	Shipped /week			0.2 m ³ drums	Shipped /week
Year	Month generated		63 remain	Year	Month generated		84 remain
2014	6	0	273 16706	2014	6	0	364 9608
2014	7	0	273 16433	2014	7	0	364 9244
2014	8	0	273 16160	2014	8	0	364 8880
2014	9	0	273 15887	2014	9	0	364 8516
2014	10	0	273 15614	2014	10	0	364 8152
2014	11	0	273 15341	2014	11	0	364 7788
2014	12	0	273 15068	2014	12	0	364 7424
2015	1	0	273 14795	2015	1	0	364 7060
2015	2	0	273 14522	2015	2	0	364 6696
2015	3	0	273 14249	2015	3	0	364 6332
2015	4	0	273 13976	2015	4	0	364 5968
2015	5	0	273 13703	2015	5	0	364 5604
2015	6	0	273 13430	2015	6	0	364 5240
2015	7	0	273 13157	2015	7	0	364 4876
2015	8	0	273 12884	2015	8	0	364 4512
2015	9	0	273 12611	2015	9	0	364 4148
2015	10	0	273 12338	2015	10	0	364 3784
2015	11	0	273 12065	2015	11	0	364 3420
2015	12	0	273 11792	2015	12	0	364 3056
2016	1	0	273 11519	2016	1	0	364 2692
2016	2	0	273 11246	2016	2	0	364 2328
2016	3	0	273 10973	2016	3	0	364 1964
2016	4	0	273 10700	2016	4	0	364 1600
2016	5	0	273 10427	2016	5	0	364 1236
2016	6	0	273 10154	2016	6	0	364 872
2016	7	0	273 9881	2016	7	0	364 508
2016	8	0	273 9608	2016	8	0	364 144
2016	9	0	273 9335	2016	9	0	364 -220
2016	10	0	273 9062				
2016	11	0	273 8789				
2016	12	0	273 8516				
2017	1	0	273 8243				
2017	2	0	273 7970				
2017	3	0	273 7697				
2017	4	0	273 7424				
2017	5	0	273 7151				
2017	6	0	273 6878				
2017	7	0	273 6605				
2017	8	0	273 6332				

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Total drums 38000
Int. Stor. 21620
Req'd

Total drums 38000
Int. Stor. 16160
Req'd

Year	Month	0.2 m ³ drums generated	Shipped /week	63 remain
2017	9	0	273	6059
2017	10	0	273	5786
2017	11	0	273	5513
2017	12	0	273	5240
2018	1	0	273	4967
2018	2	0	273	4694
2018	3	0	273	4421
2018	4	0	273	4148
2018	5	0	273	3875
2018	6	0	273	3602
2018	7	0	273	3329
2018	8	0	273	3056
2018	9	0	273	2783
2018	10	0	273	2510
2018	11	0	273	2237
2018	12	0	273	1964
2019	1	0	273	1691
2019	2	0	273	1418
2019	3	0	273	1145
2019	4	0	273	872
2019	5	0	273	599
2019	6	0	273	326
2019	7	0	273	53
2019	8	0	273	-220

0.2 m³ drums /week
Year Month generated 84 remain

ENGINEERING DESIGN FILE

Total drums 38000 Int. Stor. 10700 Req'd					Total drums 38000 Int. Stor. 5240 Req'd				
Year	Month	0.2 m ³ drums generated	Shipped /week	105 remain	Year	Month	0.2 m ³ drums generated	Shipped /week	126 remain
2008	1	633	455	178	2008	1	633	546	87
2008	2	633	455	357	2008	2	633	546	175
2008	3	633	455	535	2008	3	633	546	262
2008	4	633	455	713	2008	4	633	546	349
2008	5	633	455	892	2008	5	633	546	437
2008	6	633	455	1070	2008	6	633	546	524
2008	7	633	455	1248	2008	7	633	546	611
2008	8	633	455	1427	2008	8	633	546	699
2008	9	633	455	1605	2008	9	633	546	786
2008	10	633	455	1783	2008	10	633	546	873
2008	11	633	455	1962	2008	11	633	546	961
2008	12	633	455	2140	2008	12	633	546	1048
2009	1	633	455	2318	2009	1	633	546	1135
2009	2	633	455	2497	2009	2	633	546	1223
2009	3	633	455	2675	2009	3	633	546	1310
2009	4	633	455	2853	2009	4	633	546	1397
2009	5	633	455	3032	2009	5	633	546	1485
2009	6	633	455	3210	2009	6	633	546	1572
2009	7	633	455	3388	2009	7	633	546	1659
2009	8	633	455	3567	2009	8	633	546	1747
2009	9	633	455	3745	2009	9	633	546	1834
2009	10	633	455	3923	2009	10	633	546	1921
2009	11	633	455	4102	2009	11	633	546	2009
2009	12	633	455	4280	2009	12	633	546	2096
2010	1	633	455	4458	2010	1	633	546	2183
2010	2	633	455	4637	2010	2	633	546	2271
2010	3	633	455	4815	2010	3	633	546	2358
2010	4	633	455	4993	2010	4	633	546	2445
2010	5	633	455	5172	2010	5	633	546	2533
2010	6	633	455	5350	2010	6	633	546	2620
2010	7	633	455	5528	2010	7	633	546	2707
2010	8	633	455	5707	2010	8	633	546	2795
2010	9	633	455	5885	2010	9	633	546	2882
2010	10	633	455	6063	2010	10	633	546	2969
2010	11	633	455	6242	2010	11	633	546	3057
2010	12	633	455	6420	2010	12	633	546	3144
2011	1	633	455	6598	2011	1	633	546	3231
2011	2	633	455	6777	2011	2	633	546	3319

ENGINEERING DESIGN FILE

Total drums 38000					Total drums 38000				
Int. Stor. 10700					Int. Stor. 5240				
Req'd					Req'd				
		0.2 m ³	Shipped				0.2 m ³	Shipped	
		drums	/week				drums	/week	
Year	Month	generated	105	remain	Year	Month	generated	126	remain
2011	3	633	455	6955	2011	3	633	546	3406
2011	4	633	455	7133	2011	4	633	546	3493
2011	5	633	455	7312	2011	5	633	546	3581
2011	6	633	455	7490	2011	6	633	546	3668
2011	7	633	455	7668	2011	7	633	546	3755
2011	8	633	455	7847	2011	8	633	546	3843
2011	9	633	455	8025	2011	9	633	546	3930
2011	10	633	455	8203	2011	10	633	546	4017
2011	11	633	455	8382	2011	11	633	546	4105
2011	12	633	455	8560	2011	12	633	546	4192
2012	1	633	455	8738	2012	1	633	546	4279
2012	2	633	455	8917	2012	2	633	546	4367
2012	3	633	455	9095	2012	3	633	546	4454
2012	4	633	455	9273	2012	4	633	546	4541
2012	5	633	455	9452	2012	5	633	546	4629
2012	6	633	455	9630	2012	6	633	546	4716
2012	7	633	455	9808	2012	7	633	546	4803
2012	8	633	455	9987	2012	8	633	546	4891
2012	9	633	455	10165	2012	9	633	546	4978
2012	10	633	455	10343	2012	10	633	546	5065
2012	11	633	455	10522	2012	11	633	546	5153
2012	12	633	455	10700	2012	12	633	546	5240
2013	1	0	455	10245	2013	1	0	546	4694
2013	2	0	455	9790	2013	2	0	546	4148
2013	3	0	455	9335	2013	3	0	546	3602
2013	4	0	455	8880	2013	4	0	546	3056
2013	5	0	455	8425	2013	5	0	546	2510
2013	6	0	455	7970	2013	6	0	546	1964
2013	7	0	455	7515	2013	7	0	546	1418
2013	8	0	455	7060	2013	8	0	546	872
2013	9	0	455	6605	2013	9	0	546	326
2013	10	0	455	6150	2013	10	0	546	-220
2013	11	0	455	5695					
2013	12	0	455	5240					
2014	1	0	455	4785					
2014	2	0	455	4330					
2014	3	0	455	3875					
2014	4	0	455	3420					
2014	5	0	455	2965					

ENGINEERING DESIGN FILE

Total drums				38000	Total drums				38000
Int. Stor.				10700	Int. Stor.				5240
Req'd					Req'd				
		0.2 m ³	Shipped				0.2 m ³	Shipped	
		drums	/week				drums	/week	
Year	Month	generated	105 remain		Year	Month	generated	126 remain	
2014	6	0	455	2510					
2014	7	0	455	2055					
2014	8	0	455	1600					
2014	9	0	455	1145					
2014	10	0	455	690					
2014	11	0	455	235					
2014	12	0	455	-220					

Total drums				38000
Int. Stor.				0
Req'd				
		0.2 m ³	Shipped	
		drums	/week	
Year	Month	generated	147 remain	
2008	1	633	637	-4

Shipping faster than
generating.

Project File Number 02BM1

Project/Task CslX/TRU Grout Feasibility Study

Subtask D.5 Facility Design

Title: Personnel Staffing and Space Requirements for CslX/TRU Grout Operations

Summary:

This EDF contains an estimate of the number of personnel, by discipline, required to staff the CsIX/TRU Grout operations, and space needs not part of the direct operations. Also included is a listing of the assumptions used as the basis for the estimate.

The CsIX/TRU Grout operations involves the processing of the SBW and NGLW contained in the INTEC tank farm into a CH TRU grouted waste form. The process includes the removal, via filtration, of undissolved solids for improved ion exchange efficiency, ion exchange removal of cesium, to reduce the final product to a radioactively contact handled level, and finally, mixing the resulting waste stream with a grout mixture to form a solid cement-like waste in 55-gallon drums. Waste drum production is assumed to be higher than the shipping rate, so interim storage capability will be required (EDF-CslX-002 *Interim Storage for CH TRU Waste Drums*). New facility space for drum videography (visual inspection of the head space area via camera) and head space gas analysis will be located within or near the interim storage facilities. These two activities and shipping activities at the interim storage location will be independent of the grouting operations.

Occupying space for personnel not directly related to the process operations is assumed to be available from the existing INTEC infrastructure. The project however, would still be required to fund the infrastructure required.

Conclusions: The total number of personnel is 97, 71 of whom are considered radiation workers. Funding for personnel and the space they require, whether from the INTEC infrastrucure or new will be funded by the project. Occupying space for 23 individuals will be required in the new facilities.

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PERSONNEL STAFFING ASSUMPTIONS/SUMMARY

Assumptions:

- The CsIX/TRU grout processing facility will be in operation for approximately 5 years from January 2008 through December 2012.
- Shipment of CH TRU drums to WIPP is independent of the process, in that this activity will be performed from the interim storage facilities location, and is anticipated to occur from January 2008 through December 2021 (EDF-CsIX-002 *Interim Storage for CH TRU Waste Drums*).
- Process operations are based on twenty-four hours per day, 7 days a week, with up-time of 200 days per year. The 200 days is rounded from 205 and based on previously used HLW program drivers stating that operations will be based on a 75% up-time at 75% efficiency ($0.75 \times 0.75 \times 365 = 205$).
- Four rotating shifts of personnel will be required to support the schedule for main process and drum output handling/transfer to storage. Included in the 4 rotating shifts are personnel for process maintenance, QA, Safety, and Rad Con.
- New facility space will be required for final drum analysis to meet WIPP requirements. This space will be for videography (visual inspection of the head space area via camera) and head space gas analysis activities.
- Activities related to drum videography, drum head space gas analysis, and CH TRU drum shipments to WIPP occur only during the day shift.
- All personnel listed will be included for estimating Life Cycle Costs.
- Office space is available in existing nearby facilities, therefore new administrative facility space is not included in the Study. Personnel not housed in the process facility include the facility administration, engineering support, and training staffs. Operating costs for the facilities they use are a cost incurred by the project.
- A single day shift will include personnel for administration, administrative support, technical support, general building maintenance, and activities related to drum videography, drum head space gas analysis, and CH TRU drum shipments to WIPP.
- Management for support functions – QA, Safety, RadCon, Training, Engineering, Drafting, and Maintenance – is supplied from the existing INTEC infrastructure. Proportional costs for this management and their space are a cost incurred by the project.
- Ancillary and support functions critical to the process will be housed within the same physical facility.
- INTEC will have infrastructure services and capabilities to accommodate some tasks not unique to this project such as additional engineering and drafting support, common warehouse and storage, and major support areas such as machine, weld, sheetmetal, fitter, electrician, and electronics/instrument shops, common warehouse and storage, mock-up area(s), and laydown area(s).
- No special personnel requirements are required for the interim storage facilities that can't be handled by day shift and rotating shift personnel.
- Space needs are based on an average 150 ft² allowance for office personnel and 500 ft² for a single shift of operations personnel. The office space allowance is slightly above the current 130 ft² used at INTEC to be conservative, considering the space is related to an operating facility and not typical office space.

Personnel Summary:

Total estimated number of personnel is 97, 71 of whom are considered radiation workers. New office space for 9 and operating space for 14 individuals is required. The operating space for 14 individuals includes 3 considered as field type office space for the shippers, gas analyzers, and radiography technicians. The estimates are based on the entire CsIX/TRU process being housed in all new facilities. For the process scenario which uses the NWCF, new facility personnel space can be reduced by what ever NWCF space could be obtained. Per the assumptions, new space for all personnel will not be required in the new facility. The New Facility Office Space and New Facility Ops/Maint Space personnel numbers, listed below, take into account shift personnel sharing common space. This data will be used in determining new facility space needs, life cycle cost analysis, and as input to the Project Data Sheet.

	Day Shift	Rotating Shifts (4)	Radiation Workers	New Facility Office Space	New Facility Ops/Maint
Space					
Facility Admin	6	0	0	0	0
Engineering Support	3	0	0	0	0
Training	2	0	0	0	0
Operations Admin	3	8	0	3	0
Process Operators	10	32	42	2	11
QA, Safety, RadCon	2	12	14	3	0
Process Maintenance	0	12	12	0	3
Facility Maintenance	7	0	3	1	0
Total	33	64	71	9	14

ADMINISTRATION AND SUPPORT REQUIREMENTS

Admin/Admin Support (6) Day Shift

- Operations Managers 2
- Administrative Support 1
 - Secretarial/Clerical, Budget/Cost Control, Schedule
 - Physical requirements
 - File/Document Storage, Office Machines
- Waste Tracking/Data Acquisition Tech 2
 - (Receipt, Entry, Examination, Sampling, Repack,
 - Storage/Shipping, etc., Manifest, Chain of Custody)
 - Physical requirements
 - File/Document Storage, Office Machines
- Document control personnel 1
 - Physical requirements
 - File/Document Storage Fire Vault, Library, Office Machines

Technical Support (3) Day Shift

- Engineers 2
- Drafters 1

Training (2) **Day Shift**

- Trainers 2
- Physical requirements
 - Classroom(s)
 - Storage for files/documents, training aids, audio/visual, etc.

Admin Facility Maintenance (1) **Day Shift**

- Janitor (admin areas) 1

Common Ancillary Space (Physical requirements only)

- Small Lunch Room
- Toilet Rooms
- Janitor Room
- Storage
- Circulation
- Electrical
- Communications
- Mechanical

DOE Facility Office(s) - (Physical requirements only)

- None

PROCESS FACILITY/OPERATIONS

Operations Administration (11) **Day Shift** **Rotating**

Shift Supervisors	2	4
Operations Technicians	0	4
Process coordinator	1	0

Process Operators (42) **Day Shift** **Rotating**

• Material receipt	1	0
• SBW/NGLW retrieval from tank farm to feed tanks		
• Feed sampling and related activities		
• Raw material receipt – cement, slag, flyash, drums, etc.		
• Solids and Cs removal processes	0	12
• Grouting processes	0	12
• Material handling	0	8
• Empty drum feed to process		
• Full drum movement to lag and interim storage		
• Shipping from interim storage (loading drums into	3	0

TRUPACK II and prepping trucks)		
• Filled drum videography	3	0
• Drum head space gas analysis	3	0

<u>QA, Safety, RadCon</u>	<u>(14)</u>	<u>Day Shift</u>	<u>Rotating</u>
• QA		1	4
• Safety		0	4
• RadCon		1	4

Physical requirements

- Equipment storage (surveillance, analyzers, etc)

<u>Process Maintenance</u>	<u>(12)</u>	<u>Day Shift</u>	<u>Rotating</u>
Electrical		0	4
Mechanical		0	4
I&C		0	4

<u>Process Facility Maintenance</u>	<u>(6)</u>	<u>Day Shift</u>	<u>Rotating</u>
Electrical		1	0
Mechanical		1	0
I&C Technicians		1	0
Maintenance Planner/PMs/Work Orders		1	0
Attendant		1	0
Janitor		1	0

Process Facility Support (Physical Requirements only)

- Anti-C Issue Rooms
- Change Rooms/Shower Rooms
- Personnel Decon Area
- Ready Room (Break Room)
- Toilet Rooms and Janitor Room
- Emergency Equipment Room
- Mechanical, Electrical and Communications
- Mechanical Shops – Minimal space for minor work. Most shop work done at INTEC common shops
- Instrument Shop – Minimal space for protected storage for calibrated instruments and minor work. Most shop work done at INTECV common shops
- Contaminated, Hot Maintenance Area
- Drum Handling Systems (i.e., carts) Survey, Decon and Maintenance areas
- Tool Room - Storage of Issue Tools
- Long Term Storage - Clean Containers
- Short Term Storage - Lag/Lead for drums

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask E. Studies

Title: **SBW Treatment – Ion Exchange Media Disposition Concepts**

Summary:

The attached report provides information on requirements and options for disposal of spent ion exchange media from treating Sodium Bearing Waste (SBW). Example concepts are also provided for intermediate handling, storage, and related process steps, and for fitting the process into NWCF. This is provided for information ~~to~~ and is subject to review, iteration, and modification based on results of other parts of the study. Final process and equipment concepts in the CsIX/TRU Grout Feasibility Study are therefore likely to differ from examples described in the draft report.

Distribution (complete package):

Distribution (summary package only):

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G.E. Stegen	Cogema	<i>Ayl. Tosineh</i>	10/5/98	<i>K.L. Williams</i>	10/5/98

See Management Control Procedure (MCP) 6 for instructions on use of this form.

SBW TREATMENT
ION EXCHANGE MEDIA DISPOSITION

Gary E. Stegen
September 1998

Prepared for Lockheed Martin Idaho Technologies Company
Under Subcontract C95-175006

COGEMA Engineering Corporation
P.O. Box 840
Richland, Washington 99352

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SBW TREATMENT, DISPOSITION OF SPENT ION EXCHANGE MEDIA

G. E. STEGEN

September, 1998

1.0 INTRODUCTION

Lockheed Martin Idaho Technologies Company (LMITCO) has initiated an engineering study to evaluate treatment options for sodium-bearing waste (SBW). Options currently under evaluation are based on partial decontamination of the SBW in order to produce contact handled TRU as the primary bulk waste form. Processes to be considered include cesium removal by ion exchange, filtration to remove suspended solids; and concentration, solidification, and packaging of the resulting partially decontaminated liquid waste. The process generates spent ion exchange media heavily loaded with radio-cesium (principally ^{137}Cs). This paper provides a summary of requirements and concepts for disposal and intermediate handling of the resulting spent ion exchange media. Example design concepts for related systems components, comments on design considerations, and comments on ways the concepts might be implemented in existing NWCF cells are also provided. This is provided as input to the overall LMITCO study, which will include additional evaluation and comparison with other ideas before an actual implementation concept is recommended. Example concepts mentioned herein may therefore differ from the final study concept developed by LMITCO.

Four primary waste type and facility concepts are being considered in the study.

1. Production of a Class C waste form for disposal in a near surface low level waste disposal facility, with filtration and ion exchange performed in NWCF.
2. Ion exchange media waste form loaded to the maximum equilibrium cesium content (above Class C), and stored for future processing and disposal. Filtration and ion exchange is performed in NWCF.
3. Production of a Class C waste form for disposal in a near-surface, low-level waste disposal facility; with filtration and ion exchange performed in a new facility.
4. Ion exchange media waste form loaded to the maximum equilibrium cesium content (above Class C), and stored for future processing and disposal. Filtration and ion exchange is performed in a new facility.

As discussed in Section 4, Class C options have significant advantages in terms of disposal, however, ability to reliably produce a non-TRU sorbent that meets hazardous waste disposal requirements is uncertain. Significant additional work is required to develop and adequately evaluate this option. To limit the study effort and still produce a design concept with a high probability of working, a decision was made to limit process and facility concept development to fully loaded sorbent options (2 and 4). Additional evaluation of Class C options may be considered in the future.

In all cases, it is assumed that a non-regenerable ion exchange media (or "sorbent") referred to as crystalline silicotitanate or "CST" is used for removal of cesium. Reference 1 provides an extensive summary of the development history and properties of this sorbent. Reference 2 provides results of initial tests of this sorbent with INEEL sodium bearing waste. Reference 3 provides results of a demonstration program in which about 30,000 gallons of radioactive tank waste were processed with this sorbent. While CST is considered a suitable and desirable sorbent, other sorbents may prove to be even better, and selection of CST should therefore be considered as only a study basis rather than a final selection.

The following sections discuss spent sorbent disposal and intermediate disposition methods. Examples discuss the NWCF retrofit cases; however, most of the information is also applicable to new facility cases.

2.0 FULLY LOADED SORBENT

For fully loaded sorbent options, cesium content is not limited to Class C. Cesium loading may conceivably increase to near chemical equilibrium with inlet feed, unless a reason is identified to stop loading earlier. Two options may be considered for TRU components: a) Allow the final spent sorbent to be contaminated above the TRU limit (100 nCi/g); or, b) Attempt to maintain spent sorbent as a non-TRU waste. As discussed in Section 5, the main differences for the non-TRU option are that suspended solids need to be efficiently removed, and absorbed TRU must be stripped from the spent sorbent. Implementation of the non-TRU option increases final disposal options but is likely to increase complexity and initial cost of processing the SBW.

Sorbent disposal and intermediate handling options are discussed in Sections 2.1 and 2.2, but a final disposition option recommendation and complete system concept for final disposition of the spent sorbent are not provided in the current study. Rather, two interim storage concepts for spent sorbent are provided. In the first "storage tank" option, sorbent is sluiced from fixed ion exchange columns into interim storage tanks. In the second "modular column" option, a modular single-use column concept is described. Both of these concepts are compatible with reasonably likely final disposal options. It is assumed that the final decision on disposition method will not be made for some time, conceivably after the sorbent is placed in interim storage.

2.1 Sorbent Disposal Options

A significant number of intermediate and final sorbent disposition options may be considered. Primary ultimate disposition options include the following.

1. Co-processing in the Waste Treatment Facility (WTF) at INEEL. Spent sorbent is incorporated into the same waste form as other INEEL high level waste (HLW). The sorbent could be blended with other HLW feeds to the immobilization process or the sorbent could be immobilized separately using the same equipment to be used for HLW. Immobilized sorbent would then be handled, stored, and disposed along with the other wastes.
2. Co-processing at another DOE site. Incorporate spent sorbent into immobilized high level waste produced at a different DOE site (Savannah River or Hanford). Sorbent is integral with, and disposed with other HLW at a Federal repository.
3. Package and directly dispose sorbent at a Federal repository without additional treatment.
4. Package and directly dispose at a Federal repository after heat treatment.
5. Package and directly dispose sorbent as greater than Class C low-level waste.
6. Store until decayed below Class C. Then dispose as Class C waste. This is expected to require storage for roughly 60 years, possibly more.
7. Dispose (entomb) in the NWCF when it is closed.

2.1.1 Discussion – Sorbent Disposal

All of the listed options could be considered as potentially viable. If the waste treatment facility for immobilization and packaging of the HLW calcine is built at INEEL on a compatible schedule, the option of incorporating spent sorbent into the immobilized waste product appears reasonably feasible. Previous work has shown that spent CST sorbent is compatible with high level waste vitrification⁵. It can be blended with other HLW melter feeds, or it can be vitrified separately with a relatively high achievable waste loading⁵. Blending and vitrification along with high level waste eliminates the need to limit TRU level and also eliminates new disposal related hazardous waste issues. The previous WTF feasibility study already included blending of spent ion exchange media into HLW melter feed, and this appears to be reasonably practical. Evaluation of CST vitrification is in progress at other DOE sites. Previous work has also shown

that simply heating the CST will produce a very durable waste form⁶. While not directly tested, it also appears likely that blending of CST with waste feed would also be compatible with the direct cementitious and HIP waste form options. Shipment to an offsite plant is also likely to be feasible. However, increased cost, risk, inefficiencies, and institutional/political difficulties makes this less attractive than onsite co-processing unless the INEEL WTF is substantially delayed, there is a need to remove the sorbent from the NWCF, and transfer to the binsets is for some reason prohibited. The option of direct disposal in the repository could also be pursued; however, a significant effort would be required to attempt to get approval of this new waste type.

Options 5, 6, and 7 presume a non-TRU waste and therefore require efficient filtration and methods that assure TRU is not retained on the sorbent. There is a reasonable probability that Nevada Test Site and/or Hanford will be able to accept greater than Class C low-level waste (non-TRU) in the future. If so, this could prove to be an attractive disposal option. As discussed in Section 5 (Class C option), the ability to reliably produce a non-TRU product is uncertain, and at a minimum will require a more complex process system. Therefore, a decision was made to defer development of a design concept for the non-TRU option in the current study in order to focus available time and resources on the other options that appear to be lower risk.

2.1.2 Conclusions

Co-processing with HLW calcine at INEEL (Option 1d) and disposal as low level waste (options 5,6, and 7), are most likely to be the preferred options. Ability to reliably produce a non-TRU product is uncertain, and additional work is needed to define a process and equipment concepts for the low-level waste options.

2.2 Spent Sorbent Intermediate Handling

There are several options for intermediate handling and storage of the spent sorbent. Options that have been identified are briefly described below. All assume that interim storage is as a dry retrievable solid.

1. Retrieve dry spent sorbent using a pneumatic/vacuum line and transfer to the existing bin-sets using existing pneumatic transfer systems. The sorbent is later retrieved from the binsets and processed along with the stored calcine when the waste treatment facility is implemented. The WTF calcine processing system will be designed to accommodate sorbent mixed in with calcine.
2. Retrieve dry spent sorbent using a pneumatic/vacuum line and transfer out of the NWCF using portions of the existing pneumatic transfer system. However, the sorbent is not delivered to the bin sets. Rather, the pneumatic transfer lines are modified by the WTF project to deliver the sorbent directly to the WTF where it is processed for disposal.

3. Retrieve dry spent sorbent from the storage container using a pneumatic/vacuum line and transfer into a package used for shipment.
4. Entomb spent sorbent in the NWCF when it is closed. Either leave spent sorbent in interim storage containers, or retrieve and transfer to engineered, qualified containment/disposal packages placed in NWCF.
5. Use a modular column waste package concept in which spent sorbent would remain during intermediate storage, handling, and transportation (if used).

2.2.1 Discussion – Intermediate Handling

If the sorbent is water washed and dried at moderate temperature, it is expected to be inert and relatively easy to resuspend for pneumatic conveying. Sorbent bulk density (1 g/cc) is a little lower than calcine (1.2 to 1.6 g/cc). Typical sorbent particle size is in the range of 60 to 30 mesh,¹ which is slightly larger than typical calcine. The existing pneumatic transfer system is likely capable of transferring the -30/+60 mesh sorbent, however, a slightly smaller sorbent size could be specified if needed to facilitate pneumatic transfer. Some limited testing could verify resuspension and transfer of spent sorbent.

If on-site co-processing in the WTF is the selected disposition method, a decision to either keep the sorbent segregated, or to mix it with calcine can be made during conceptual design of the WTF. Either should be practical from a process and equipment point of view, and the choice requires optimization work which cannot be performed until other portions of the WTF conceptual design are defined. With the 1997 WTF FS process design, sorbent mixed with calcine would not likely be dissolved and would therefore be mixed with undissolved solids from calcine dissolvers. In the FS design, spent sorbent sluiced from ion exchange was blended with undissolved calcine solids prior to interim storage, followed by transfer to vitrification. Thus, the end point for sorbent mixed with calcine is the same as in the FS, and impacts from blending with the calcine appear minimal. In the future WTF design, process flowsheets may change. However, if the designers know the calcine will contain some ion exchange sorbent, it should not be a substantial additional complication to accommodate it in the process design. If necessary, a digestion step with HF or concentrated caustic could be considered to partially dissolve the sorbent.

Because the WTF will already be using pneumatic transfer of calcine and the NWCF is equipped with pneumatic transfer capabilities, it seems certain that pneumatic transfer out of the NWCF will be preferred over package transfer for the on-site co-processing option. Slurry transfer might also be considered during the WTF conceptual design, depending on compatibility with

the balance of the WTF process and facility design. The suggested spent sorbent storage concept should also be compatible with slurry transfer. However, the spent sorbent drying step could likely be avoided if it is known that slurry transfer is to be used.

The option of entombing spent sorbent in the NWCF when it is closed would presumably require that the sorbent be non-TRU. If the sorbent is non-TRU, it seems reasonable that placement of the sorbent in qualified 300+ year disposal containers which are entombed in concrete inside the NWCF, should provide an acceptable, low-risk, and possibly low-cost disposal option. However, increased complexity required to assure the sorbent is non-TRU, regulatory requirements, and licensing costs could offset facility and disposal cost savings. A more complete analysis of regulatory requirements, compliance strategy, compliance costs, and probability of success is needed to evaluate benefits of pursuing this option.

The option for offsite disposal as greater than class C waste is also viable provided feasibility of producing a non-TRU, non-hazardous sorbent product is verified. Efforts are ongoing to implement disposal of greater than Class C low-level waste which will presumably eventually be successful. To keep these options open, it is necessary to assure the spent sorbent is non-TRU.

3.0 Sorbent Storage Tank Option

This section discusses an interim storage option for spent ion exchange media that would use storage tanks.

3.1 Key Features and Assumptions

The ion exchange system and spent media interim storage concept includes the following key features and assumptions.

1. Three, or possibly four ion exchange columns are provided to allow one to be off-line for bed replacement while a minimum of two columns in series continue to operate.
2. When cesium capacity of the first column in series is expended, the feed is replaced with flushes of dilute acid followed by water. Spent sorbent is then sluiced from the bed using a recirculating water stream. Sorbent slurry flows to a storage tank where sorbent particles settle out and water is recirculated until spent sorbent is completely flushed from the column.
3. In order to keep the system simple and reliable, it is assumed that no attempt is made to certify spent sorbent as non-TRU. If carryover of solids through the ion exchange beds

and downstream processes proves acceptable, it could be feasible to get by with a simple system with little or no filtration except for that provided by the ion exchange bed. Possible plugging of the sorbent bed and impacts to downstream processing of the treated liquid (such as increased dose rate from SBW suspended solids and ion exchange media fines carryover) need to be evaluated prior to implementing a simple system without filtration. Certification that the sorbent is Non-TRU could be considered, but would face difficulties discussed for the Class C option in Section 5.

4. When a spent sorbent storage tank is filled, the sorbent is dried by draining free water followed by blowing or drawing warm air through the sorbent. Supplemental heating of the outside of the tanks may also be needed (such as a steam coil or jacket).
5. No further treatment is provided beyond dilute acid and water flushes of the spent sorbent bed followed by drying in the storage tank.

3.2 Column Design

The example column concept consists of a stainless steel canister with outside diameter of about 2 feet and a total height of about 6 feet [these dimensions are preliminary, and may be adjusted if needed]. All penetrations are made through a flange welded to the top of the canister. Upflow or downflow designs can be considered. For upflow, the inlet pipe passes down through the bed of ion exchange media to the distributor screens at the bottom. Feed material flows up through the bed, through media retainer screens, and out through a penetration in the top flange. Auxiliary penetrations are provided for filling the column with ion exchange media, sluicing out spent sorbent, draining the liquid, instrumentation, and spares. The column concept is similar to the modular column/waste package described in Section 4.2, except a closure plate and sealing ring is not required and one or two sluice out pipes are provided which penetrate through the screens into the bed area.

Assuming 2 foot outside diameter, 3/8 inch wall thickness, and a net loaded bed height of 5 ft, sorbent volume is calculated at 14.7 cubic feet or 0.42 cubic meters per bed load. Based on a nominal 1 gallon per minute feed rate, the lead column bed will need to be changed out after every three to four weeks of continuous operation. The suggested column size provides a reasonable bed change-out frequency, and a relatively low ratio of flow rate to bed volume, which is expected to provide a high decontamination factor for cesium. (based on one gallon per minute feed and two columns in series with 14.7 cubic feet of bed in each, the ratio is 0.27 bed volumes per hour).

3.3 Preparation of Column for Use

After emptying spent sorbent, the column is prepared for reuse. It is filled with sorbent, fines are flushed out with water, and the sorbent is preconditioned if needed. The sluice system valves are closed, and the column may be reconnected to the ion exchange system when desired.

3.4 Removal and Storage of Spent Sorbent

Sorbent is removed from the bed by increasing upflow of water until the bed begins to expand or fluidize, and then drawing the sorbent slurry out through one or more dip tubes located in the bed. Some of the finer sorbent particles are also elutriated in the bulk fluid. The streams from the column flow to the storage tank where solids settle, while decanted water is passed through a strainer and is recirculated for sluicing additional sorbent. Sorbent from multiple batches is transferred to the same tank, where solids continually build up. Sluice water is left in the tank until the tank is filled with sorbent. Liquid is then drained and the sorbent is dried. After drying, sorbent may be stored in the tank indefinitely. Any surplus sluicing water is filtered and transferred to the ion exchange feed tank.

If solids removed from the SBW are to be packaged and loaded out separately for disposal, care must be taken to avoid transfer of ion exchange media to the main undissolved solids filtration system. Ion exchange media transferred to the upstream solids filtration system would come to equilibrium with cesium content of the raw feed. Bulk ion exchange media loaded to equilibrium with SBW is estimated to have a contact dose rate on the order of 10,000 R/hr. Inclusion of even a small fraction of ion exchange media with the solids could substantially increase their dose rate making removal and handling of the undissolved solids more difficult than expected. Ion exchange media carried downstream could also cause operational problems. This media will come to equilibrium with product cesium concentrations. If uniformly dispersed, this may not be a major problem, however if ion exchange media collects in low points, tank bottoms etc. it could develop a significant dose rate. Guard filters, and provisions for detecting and flushing radioactive solids that may accumulate should be included in the system design.

As discussed in sections 2.1 and 2.2, there are a large number of options for final disposal of the sorbent, and for intermediate handling of the sorbent. A decision on the preferred approach requires decisions concerning other issues that are not likely to be resolved for some time. Therefore, a system for retrieval, handling and processing of the sorbent is not fully designed or installed initially. Rather, features such as ports in the top of the storage tanks are provided to facilitate retrieval, and the sorbent flushing and drying approach is designed to produce a free flowing dry sorbent that can be readily retrieved using a pneumatic suction system. This storage concept is expected to be compatible with all reasonably expected disposition options without incurring significant avoidable future liabilities.

3.5 NWCF Installation and Operating Concepts.

The calciner cell or the pump and valve corridor could be considered for the ion exchange process and spent sorbent storage tanks. Other areas such as the absorber cell or offgas cell could also be considered but would require more dismantling and removal of existing equipment. The calciner cell has piping connections for feeding solids into the existing pneumatic transfer system, and appears to have sufficient room for the ion exchange module and spent sorbent storage tanks. It also has more shielding than the pump and valve corridor. Based on a cursory evaluation, the calciner cell appears to be a logical location for the ion exchange columns and spent sorbent storage tanks.

Two tanks with 6 foot diameter and 7 foot working solids depth should be sufficient to hold all of the spent sorbent. Assuming approximately 12 inches of steel or lead shielding on the cell side of the tanks, it appears there is sufficient space in the calciner cell to accommodate these tanks plus a module with three ion exchange columns, a feed tank and a waste/flush tank. Some existing piping in the cell may need to be removed, but most of the piping and the calciner vessel should not need to be removed. However, this leaves little or no space for filtration within the calciner cell.

Features for future retrieval of the stored sorbent need to be considered in laying out the storage tanks. Spare ports on top of the tanks are needed that can be opened for insertion of retrieval vacuum lines. If feasible, height of the sorbent storage tanks could be limited so there is enough space above the tanks to install the remote sorbent retrieval system inside the cell. If this is not feasible, it could be necessary to construct a shielded enclosure in the operating area above the calciner cell for some of the retrieval equipment.

Extensive valving is required for switching the various feed, product, and flush flows for the column modules. It is probably best to put this valving in contact-maintained shielded valve-boxes located in the operating corridor or in the operating area above the cells. Valve actuators and position switches could be located outside the valve boxes allowing direct hands-on maintenance. For maintenance of valves inside the box, the lines would be drained and flushed before opening the box, in order to facilitate contact maintenance. If the filtration system is located in the pump and valve corridor, and the ion exchange is located in the calciner cell, transfer lines between the two systems will be needed. If a convenient in-cell route is not available, a small lightly shielded pipeway could be put in the operating corridor or the operating area above the cells, tying in to the ion exchange valve box. Due to the much higher dose rates, increased difficulty in flushing, and desirability of keeping the piping short, valves for the spent sorbent sluicing lines probably need to be inside the cell.

4.0 FULLY LOADED SORBENT, MODULAR COLUMN

For this option a "modular column waste package" (MCWP) concept is used in which the ion exchange column is a single use unit that also serves as the waste handling and storage package. The following sections discuss a preliminary concept based in the MCWP option.

4.1 MCWP Features and Assumptions

The proposed ion exchange media packaging and disposal concept for the MCWP option includes the following key features and assumptions.

1. A modular ion exchange column is used. After use, the column is mechanically closed and is used as the primary container for handling and storage. The combined unit is referred to herein as a modular-column waste-package or MCWP.
2. When the cesium capacity of the modular-column is expended, the column is flushed with dilute acid followed by water. It is then drained, and dried out by blowing or drawing heated air through the bed, and the penetrations are plugged. A bolted closure plate may be added if needed for handling or transportation.
3. If needed, external surfaces of the MCWP are decontaminated with a high pressure water spray, and the container is moved to a storage location in the NWCF where it remains until ready for the next disposal step which may be determined after the sorbent is placed in interim storage.
4. During operation, content of cesium and other radioisotopes are estimated for each MCWP by material balance.
5. It is assumed that acid and water flushes adequately strip weakly sorbed hazardous metals so that the resulting waste form passes TCLP leach criteria. It is further assumed that flushing decontaminates the sorbent well enough that delisting will be granted if needed for any listed wastes present in the SBW. These assumptions [if verified] allow the MCWP to be stored, transported and disposed as non-hazardous waste.
6. Options available for intermediate handling and disposal include all of those discussed in sections 2.1 and 2.2. In order to facilitate removal of the contents, one or more ports will be provided to allow vacuum lines to be inserted to suck the sorbent out of the MCWP.
7. The example MCWP is nominally 2 feet outside diameter by 6 ft to 15 ft tall. For

MCWP transportation options, a nominal 6 ft size could be used to allow 4 units to fit in a Chem-Nuclear Systems CNS 8-120 B type B shipping cask. Or 2 ft outside diameter by 10 ft or 15 ft length could potentially be transported in the same casks to be used for transportation of HLW glass canisters by the Savannah River or Hanford sites respectively. Package details, including lifting features (lugs, bails etc.), must be worked out as needed to facilitate movement and storage in the NWCF and possibly transportation to another facility.

4.2 Modular Column/Waste Package

A preliminary concept for the MCWP is shown in the Attachment. The MCWP consists of a stainless steel canister with outside diameter of about 2 feet and a total height of about 6 to 15 ft. Note that these dimensions are preliminary, and may be adjusted to facilitate handling and storage within the NWCF, and removal of spent sorbent from the facility for shipment. All penetrations are made through a flange welded to the top of the canister. The inlet pipe passes down through the bed of ion exchange media to the distributor screens at the bottom. Feed material flows up through the bed through media retainer screens and out through a penetration in the top flange. A downflow arrangement could also be used if desired. Auxiliary penetrations (not all shown) are provided for filling the MCWP with ion exchange media, removing spent media, draining the liquid, instrumentation, and spares. A ring with a sealing surface is provided for installation of a bolted closure plate when the MCWP is readied for storage or shipping.

Assuming 2 foot outside diameter, 3/8 in. wall thickness, and 6 ft. total height with a loaded bed height of 5 ft 3 inches, sorbent volume is calculated at 15.5 cubic feet or 0.44 cubic meters per package. If integral shielding of each MCWP is needed to facilitate handling, the useable volume may be significantly reduced. For example, a 2 inch thick wall, 2 foot outside diameter and a net bed depth of 5 feet results in a sorbent volume of 10.9 cubic feet (0.31 cubic meters), a 30 % reduction from the thin walled example above.

For the fully loaded sorbent case, about 8 to 12 cubic meters of sorbent is required. At 0.44 cubic meters of sorbent per package, a total of about 18 to 27 MCWPs [2 ft X6ft] is estimated to be required to process the total waste inventory. Layouts and remote handling equipment concepts need to be developed to evaluate feasibility of fitting this quantity in the existing NWCF cells, however, the quantity does not appear intractable. Larger column size can also be considered to help facilitate storage.

4.3 Preparation of Column for Use

Prior to transferring each MCWP into the NWCF hot cells, it is filled with sorbent, fines are flushed out with water, the sorbent is preconditioned if needed, and the unit is tested. Excess liquid is then drained and the unit is ready for transfer to the cell.

4.4 Preparation of Spent Sorbent Packages

It is assumed that at least 2, and possibly 3 MCWPs are operated in series. The first column in series is replaced when loaded to near full saturation, and a new column is placed in series after the remaining partially used column(s). Following is a preliminary list of steps in preparing a used MCWP prior to transfer to storage.

1. Line feed to the ion exchange system is shut off.
2. System feed is replaced with flush solution. The study flowsheet is based on flushing with 10 column volumes of dilute acid followed by 10 column volumes of water (10 times the gross volume of one MCWP, or about 5,000 liters). Flush solution from the spent column passes through the downstream columns and exits as other treated waste. It is assumed that this flush will remove any sorbed heavy metal sufficiently to allow the sorbent to pass the TCLP test. Similar sorbent used for treatment of tank waste at Oak Ridge was found to pass the TCLP test³. It may not be essential to flush the column with acid for the fully loaded case, however, it is recommended that basic hardware for both acid and water flush of the column be included in the preliminary design concept.
3. The spent MCWP is physically disconnected from the balance of the ion exchange system. The feed line is removed and connected to the following column and a new second column is connected. Ion exchange processing in the other columns can now proceed while the spent column is prepared for removal from the cell.
4. Water is drained from the spent column. An auxiliary drain line extends to the bottom of the vessel to facilitate complete draining.
5. After the column is drained, remaining water is evaporated by blowing or drawing heated air through the column. The nominal study basis is 30 SCFM of air heated to 190°F at the inlet to the column. For the 6-ft example column, this is estimated to completely dry out the bed in about 4 to 6 days.
6. Remaining lines are removed and the penetrations are plugged. The closure plate is then bolted in place.
7. The package is washed with a water spray to remove surface contamination.
8. The package is moved to a storage rack, where it remains until decisions are made and

additional features are provided for the next step in processing. The most likely disposition is expected to be pneumatic transfer of the spent sorbent to the WTF either directly or via the binsets.

9. Detailed operating sequence and equipment concepts for removing contents from MCWPs, or removing the packages from the cell is to be developed after decisions on disposition methods have been made.

5.0 CLASS C WASTE OPTIONS

For Class C options it is assumed that spent sorbent is to be disposed of at an offsite low level waste (LLW) disposal facility. Disposal facilities currently in operation are limited to disposal of LLW within Class C limits specified in 10CFR61. The radioisotopes of concern for meeting these limits are ^{137}Cs and transuranics (TRU). To satisfy these limits, cesium content of the loaded media will be controlled (limited) to keep the resulting package within the maximum Class C limits (4,600 Ci ^{137}Cs per cubic meter). Design features and operating practices will also be provided to assure transuranic isotope content is less than the Class C limit of 100 nCi/g. It is also assumed that it will be demonstrated that the resulting loaded media is not a hazardous waste. If it is found to be infeasible to operate the process to produce spent sorbent that is not hazardous waste, additional treatment will be needed to render spent sorbent suitable for disposal.

Two primary packaging suboptions may be considered for Class C spent sorbent: a) The "modular column waste package" (MCWP) concept in which the ion exchange column is a single use unit that also serves as the waste package; and b) an approach in which spent sorbent is sluiced out of the column directly into a waste disposal package or liner. The first option is similar to the fully loaded MCWP option. For the second option, location for filling the waste package can be chosen to facilitate loading for shipment. The package could be located near the shipping cask during sluicing and drying in order to reduce required equipment and to reduce risk from moving and loading the high dose rate sorbent package into the shipping cask. The following sections discuss Class C disposal requirements and preliminary example implementation concepts.

5.1 DISPOSAL REQUIREMENTS

The Nevada Test Site (NTS) and the Hanford Site are the most likely locations for disposal of Class C ion exchange media produced by treating the SBW. Baseline criteria for acceptance of waste at the Hanford Low-Level Burial Grounds (LLBG) are described in Reference 4. The LLBG includes both lined and unlined portions. The lined portions are permitted to accept

certain additional hazardous waste types that cannot be disposed in the unlined portions. Key requirements related to acceptance of INEEL ion exchange media are summarized below.

- The waste must be within Class C limits described in 10CFR61. Primary radioisotopes of concern relative to these limits are ^{137}Cs and alpha emitting transuranics (TRU).
- The generator must implement and maintain a waste certification program to ensure that any waste meets the acceptance requirements. Concentration of each "major radionuclide" must be established. A quality assurance program that complies with DOE 5700.6C is also required. Hanford would retain joint responsibility to assure that the waste meets the acceptance requirements.
- The generator must establish and maintain a waste minimization program to assure that the amount of radioactive waste generated and/or shipped is minimized.
- The generator must determine the physical and chemical characteristics of the waste with sufficient accuracy to properly designate the waste. This applies to both radioactive waste classifications and hazardous waste classifications. Guidelines on what constitutes acceptable knowledge of the waste characteristics are given in Reference 4.
- Free liquids must be absorbed or stabilized in accordance with Reference 4 Appendix E.
- Hazardous waste originally designated only with characteristic waste number D001 through D043 can be accepted in unlined portions of the LLBG if it is no longer hazardous and meets all applicable treatment standards of 40CFR268. In addition, waste with codes F001 through F005, waste with F039 containing F001 through F005 constituents, and Washington State only dangerous waste may be accepted at the lined portions of the LLBG. All wastes must meet applicable treatment standards of the land disposal restrictions.
- If radiolytic heat generation exceeds 3.5 watts per cubic meter, the package must be evaluated and approved. Class C spent sorbent is expected to exceed this limit.
- Mitigation measures must be used if radiolysis will produce gas concentrations exceeding the lower explosive limits. (Note: Additional evaluation is needed to determine if radiolytic gas generation from the sorbent is significant relative to this requirement.)
- The spent sorbent must either be packaged in an approved high integrity container or stabilized in concrete or other stabilization agent. Stabilized waste must meet the leach index and compressive strength requirements of the NRC Branch Technical Position Paper on Waste form, Section C.2 and Appendix A.
- If the waste contains mobile radionuclides above a threshold value, additional stabilization requirements could be imposed. Mobile radionuclides identified in Reference 4 include: ^3H , ^{14}C , ^{36}Cl , ^{79}Se , ^{93}Mo , ^{99}Tc , ^{129}I , ^{187}Re , and all uranium isotopes. If the acid and water flushing process described herein is followed, it is not expected that mobile isotopes will be a significant concern.
- Limits are established for removable contamination on accessible surfaces of the waste package.
- For all important-to-safety components the QA Program must meet DOE/RE/0333P

Requirements.

Certain waste types or waste characteristics are prohibited and may not be disposed at the Hanford LLBG. Prohibited waste types of interest for the INEEL spent sorbent case include the following.

- Waste containing free liquids
- Waste that poses substantial hazards due to formation of flammable or toxic gases, vapors or fumes.
- Wastes with RCRA U, P, and K waste number and F codes other than listed above cannot currently be disposed at the LLBG.
- Packages and sacrificial rigging shall not contain regulated materials such as lead.

5.2 MCWP Features and Assumptions

The proposed ion exchange media packaging and disposal concept for the MCWP Class C option includes the following key features and assumptions.

- A modular ion exchange column is used. After use, the column is mechanically closed and is used as the primary container for handling and disposal. The combined unit is referred to herein as a modular-column waste-package or MCWP.
- When the cesium capacity of the modular column is expended, the column is flushed with dilute acid followed by water. It is then drained, and dried out by blowing heated air through the bed, and the penetrations are plugged.
- If needed, external surfaces of the MCWP are decontaminated with a high pressure water spray, and the container is ready to be moved from the NWCF hot cells to a shielded cask used for shipment to a Class C low level waste disposal facility.
- During operation, cesium curie content for each MCWP is calculated by material balance to verify the overall package contains less than the Class C cesium limit.
- The waste is certified as non-TRU based on: a) Prior testing, to demonstrate that TRU absorbed from solution is adequately stripped by acid and water flushes; and, b) Primary filtration of TRU suspended solids followed by a backup guard filter to assure that the media is not contaminated with significant quantities of TRU solids. This approach is assumed to be acceptable to the disposal facility. However, the process control approach and associated operational requirements must be agreed to by the disposal facility operator⁴.
- It is assumed that the acid and water flushes adequately strip weakly sorbed hazardous metals so that the resulting waste form will pass the TCLP leach criteria. It is further assumed that flushing decontaminates the sorbent well enough that delisting will be granted if needed for any listed wastes present in the SBW. These assumptions [if verified] allow

the MCWP to be disposed as non-hazardous Class C low level waste.

- The example MCWP is nominally 2 feet outside diameter by 6 ft tall with final finished sizing to allow 4 units to fit in a Chem-Nuclear Systems CNS 8-120 B type B shipping cask. If needed to facilitate loading and unloading, a moderate thickness of integral shielding could be included in MCWP to achieve a moderate reduction in the surface dose rate of the filled MCWP. Package details, including lifting features (lugs bails etc.) and acceptable surface dose rates, must be worked out with the disposal facility operator.
- Discussions with Hanford personnel indicate that Hanford could accept the spent sorbent if it is less than Class C, and is either not hazardous waste or else it is treated to meet the land disposal restrictions. Cesium and TRU are the only components that appear to be significant considerations in meeting the Class C limits. The waste package must not contain free liquids, and the waste must either be stabilized or else packaged in a qualified high integrity container. Oak Ridge is also working with NTS, which has indicated it can accept their similar spent sorbent if it is within Class C limits and is not hazardous waste³.
- It is probably not cost effective to stabilize the waste or qualify the MCWP as a high integrity container (300year physical integrity after burial). It is therefore assumed that the MCWP will be placed in a qualified high integrity container prior to disposal (either before shipment or at the disposal facility). These details need to be finalized before the detailed package configuration can be finalized.

5.3 Modular Column/Waste Package

An example concept for the MCWP is shown on Page 1 of the Attachment. The MCWP consists of a stainless steel canister with outside diameter of about 2 feet and a total height of about 6 feet. Note that these dimensions are preliminary, and may be adjusted to facilitate removal of spent sorbent from the facility for shipment, or to allow the system to be fit into existing cells. All penetrations are made through a flange welded to the top of the canister. The inlet pipe passes down through the bed of ion exchange media to the distributor screens at the bottom. Feed material flows through the bed, through media retainer screens, and out through a penetration in the top flange. A downflow arrangement could also be used if desired. Auxiliary penetrations (not all shown) are provided for filling the MCWP with ion exchange media, draining the liquid, instrumentation, and spares. A ring with a sealing surface is provided for installation of a bolted closure plate when the MCWP is readied for shipping.

Assuming 2 foot outside diameter, 3/8 inch wall thickness, and a loaded bed height of 5 ft 3 inches, sorbent volume is calculated at 15.5 cubic feet or 0.44 cubic meters per package. If integral shielding of each MCWP is needed to facilitate handling, the useable volume may be significantly reduced. For example, a 2 inch thick wall, 2 foot outside diameter and a net bed depth of 5 feet results in a sorbent volume of 10.9 cubic feet (0.31 cubic meters), a 30 % reduction from the thin walled example above.

Based on a total ^{137}Cs inventory of about 250,000 Ci, Class C limit of 4,600 Ci ^{137}Cs per cubic meter, and assumed average loading efficiency of 90 % of the Class C limit; about 60 cubic meters of sorbent are required. At 0.44 cubic meters of sorbent per package, 137 MCWPs is estimated to be required to process the total waste inventory. Assuming 4 MCWPs per waste shipment if the Chem-Nuclear Systems CNS 8-120 B type B shipping cask is used, 35 shipments to the Class C LLW disposal facility are estimated.

5.4 MCWP Operations

Prior to transferring each MCWP into the NWCF hot cells, it is filled with sorbent, fines are flushed out with water, the sorbent is preconditioned if needed, and the unit is tested. Excess liquid is then drained out and the unit is ready for transfer to the cell.

It is assumed that at least 2, and possibly 3 MCWPs are operated in series. The first column in series is replaced when loaded to approximately the Class C limit, and a new column is placed in series after the remaining partially used column(s). The following discusses the steps in preparing a used MCWP prior to transfer out of the cell.

1. Feed to the ion exchange system is shut off.
2. System feed is replaced with flush solution. The study flowsheet is based on flushing with 10 column volumes of dilute acid followed by 10 column volumes of water (10 times the gross volume of one MCWP, or about 5,000 liters). Flush solution from the spent column passes through the downstream columns and exits as other treated waste.

The 10 column-volume acid flushing allowance is based on Table 10 of Reference 1, which shows a K_d value for Pu of 3.8 ml/g at a pH of 0.58. Based on an average bed density of about 1 g/ml, 3.8 bed volumes would be required to flush Pu from the column with an ideal vertical step function breakthrough curve. The assumed 10 column-volumes provides 2.6 times this minimum value. Additional data is needed to determine distribution coefficients for all of the transuranics, and to verify that they can actually be reliably stripped with an acceptable quantity of acid. Data is also needed to determine the preferred acid concentration. It is assumed that this flush will also remove any sorbed heavy metal sufficiently to allow the sorbent to pass the TCLP test. Similar sorbent used for treatment of tank waste at Oak Ridge was found to pass the TCLP test³. Limited data in Reference 1 also suggest that many of the characteristic hazardous metals are not significantly sorbed. However, the data are not complete, and additional tests are needed to verify that the assumed flushes are adequate to assure spent sorbent is not a characteristic hazardous waste.

3. The spent MCWP is physically disconnected from the balance of the ion exchange system. The feed line is removed and connected to the following column and a new second column is

connected. Ion exchange processing in the other columns can now proceed while the spent column is prepared for removal from the cell.

4. Water is drained from the spent column. An auxiliary drain line extends to the bottom of the vessel to facilitate complete draining.

5. After the column is well drained, remaining water is evaporated by blowing or drawing heated air through the column. 30 SCFM of air heated to 190°F at the inlet to the column is estimated to completely dry out the bed in about 4 to 6 days.

6. Remaining lines are removed and the penetrations are plugged. The closure plate is then bolted in place.

7. The package is decontaminated to remove surface contamination and smear tested.

8. The package is moved to a storage rack where it remains until removal from the cell.

9. The operating sequence and equipment concepts for removing the package from the cell and loading into a transportation cask have not been developed at this time. For the NWCF retrofit case, these may present a significant challenge.

5.5 Sluice-Out Ion Exchange Media to a Transportation Package

For the Class C option, another approach is to sluice the spent sorbent directly from the column into a transportation package or liner. This approach has a number of advantages and is already used in the nuclear industry. After the sorbent is transferred to the liner, drainable water is pumped out, and residual water is either removed by evaporation or taken up by drying or solidification agents added to the liner.

5.6 Filtration Requirements for Class C Options

For the Class C options, it is essential to avoid production of spent ion exchange media that cannot be certified to be non-TRU. Calculations summarized in the Attachment indicate that less than 0.4 % of the estimated SBW solids would be sufficient to contaminate the entire quantity of spent ion exchange media to the 100 nCi/g TRU limit. High reliability, and ability to defend the non-TRU certification to outside parties is essential for disposal as Class C waste. In specifying the required filtration efficiency an approximate safety factor of 10 is therefore recommended to allow for batch to batch variation in solids content of filter feed, uncertainties in measurements and analyses, and for the fact that some residual TRU will also be present from liquid phase

adsorption. If it is assumed that most of the solids passing through the filtration could become attached to the media, and a safety factor of 10 is provided, the allowed penetration is .04 % and the required filtration efficiency is estimated at 99.96 %.

5.7 Discussion – Class C Options

The Class C options have the significant advantage that there are currently disposal facilities in operation that can accept the spent ion exchange media if the acceptance requirements can be met. These options also have a number of uncertainties, risks, and disadvantages. Additional test data is needed to verify that a non-TRU product that meets hazardous waste disposal requirements can be reliably produced. Production of spent sorbent that does not meet these requirements would result in an "orphan" waste with no current disposal mechanism. It could presumably be disposed by vitrification with HLW as in the fully loaded options, however, the volume to be stored, handled, and disposed would be much larger than for the fully loaded options if cesium levels are restricted to Class C.

Additional engineering studies and test data is also needed to develop a design concept for filtration, concentration and solidification of filtered solids, and related support systems for the Class C option. Due to the limited time and resources and need for additional data, a decision was made to defer additional development of the Class C options for the current study. These may be considered further at a later date.

6.0 REFERENCES

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2. Todd, T. A., et. al., "Evaluation and Testing of Inorganic Ion Exchange Sorbents for the Removal of Cesium-137 from Idaho Chemical Processing Plant Acidic Tank Waste,," paper submitted for publication in Separations Science and Technology, December 1997.
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6. Balmer, M. L., and B. C. Bunker, "Inorganic Ion Exchange Evaluation and Design – Silicotitanate Ion Exchange Waste Conversion," PNL-10460, Pacific Northwest Laboratory, Richland Washington, March 1995.

ATTACHMENT-SKETCHES AND BACKUP CALCULATIONS

Prepared by _____					Checked by _____				
SBW Solids TRU Inventory and Filtration Requirements Calculation									
Basis:	Arlin Olson Fax of Oct 28, 1997 provides composition information on SBW undissolved solids								
	Charles Barnes 6/16/98 CSIX Flowsheet provides quantity estimate for SBW undissolved solids								
componen	solids								
	composition								
	% of total	ug/g	ci/g ele	ci/g solids	nci/g				
	element								
Am 241	100	0.36	3.43	1.23E-06					
Np 237	100	24.7	7.05E-04	1.74E-08					
238Pu	6.96	5.10168	17.12	8.73E-05					
239Pu	84	61.572	0.062	3.82E-06					
240Pu	7.34	5.38022	0.227	1.22E-06					
241Pu	1.1	0.8063	103	8.3E-05	not TRU (non-alpha)				
242Pu	0.63	0.46179	0.0036	1.66E-09					
Total Pu	100.03	73.3		0.000175					
total				0.000177					
-241Pu				8.3E-05					
total TRU				9.36E-05	93633.41				
total solids content					Class C Cs loading case				
g solids/L		3.62			Total resin	59,516	kg (Barnes)		
total L		4841675			uds TRU/resin	27574.1	nci TRU/g		
total g solids		17526864			minimum DF	275.741	at avg 100 nci/g		
total TRU ci		1641.1			target DF	2757.41	at avg 10 nCi/g		
total TRU nCi		1.64E+12			filtration efficiency	99.96373	at avg 10 nCi/g		
					Fully Cs loaded case				
					Total resin	10,000	kg (GES estimate)		
					uds TRU/resin	164110	nci/g		
					minimum DF	1641.1	at avg 100 nci/g		
					target DF	16411	at avg 10 nCi/g		
					filtration efficiency	99.99391	at avg 10 nCi/g		

ENGINEERING WORKSHEET

Prepared By:

Gary E. Stager

Date:

7/1/98

Project:

SBW - CSIX Treatment

Title/Subject:

Ion-Exchange Spent Media Concepts

Modular Column Waste Package Concept.

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Handling & Storage

Title: Handling of Containers Through the Grouting Area

Summary:

The final major step in the CsIX/TRU process is the encapsulation, in grout, of the dry product from the process. This EDF describes the method and equipment proposed for moving an empty 55-gal drum to the grout filling station and from the filling station through a number of intermediate stations to a curing cell.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements
- Attachment B – Equipment List for the Grouting Area
- Attachment C – Sequence of Moving a Drum Through Grouting Area
- Attachment D – Sketches

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT-98-00869.

Distribution (summary package only): None

Author	Dept.	Reviewed	Date	Approved	Date
R. J. <i>RC</i> Carpenedo	4130	<i>Blain Grover</i>	<i>9/14/98</i>	<i>Blain Grover</i>	<i>9/14/98</i>

Attachment A
CsIX/TRU Feasibility Study
Handling of Containers Through the Grouting Area

General

This EDF provides information on a method for filling 55-gal drums with grout produced in the CsIX/TRU process and moving the drums through an alpha contaminated environment. The filled drum will be checked for exterior contamination and cleaned if necessary then labeled and cured. After a specified curing, the drums will be dewatered then sent to the drum storage facility. Final examination will be performed just prior to shipment to WIPP.

Assumptions

The following assumptions have been made in the development of this design.

1. There will be no regular sampling of drums. The process will be qualified and only random verification sampling and testing of the grout will be done.
2. The grouted waste package will be a 55-gal, DOT-17C drum with a full removable head.
3. The filled drums will be considered contact handled, as will be maintenance activities for the drum line activities.
4. The ventilation scheme for the drum movement will be based on alpha type considerations.

Requirements

- The design of the drum handling portion of the facility will comply with the existing environmental regulations and standard criteria pertaining to the design, construction, operations and performance of the proposed CsIX facility at INTEC.
- The structures, systems, and components associated with the Separations Facility will conform to the applicable national, state, local, and DOE requirements. Specifically, the requirements mandated by the RCRA for hazardous waste treatment, storage and disposal facilities apply. The DOE requirements in DOE 420.1 and the applicable DOE Directives apply to this portion of the facility.
- The filling process will begin January 2008 and will be completed by December 2012.
- The facility will be operated 24 hours a day, 200 days a year and produce 45 drums per day.
- The waste will be treated by grouting in preparation for sending to WIPP.
- The specific gravity of the grout is 1.9 and the total grouted waste volume is 7500 m³.

Attachment A
CsIX/TRU Feasibility Study
Handling of Containers Through the Grouting Area

Process Description

A drum, without a lid, is retrieved from storage and placed on the inlet conveyor where it is given a unique tracking number. An operator starts the conveyor sending the drum through the grouting cell airlock. Once in the grouting cell, the drum is directed to one of three filling stations as determined by process control system. Drum movement is by a self-powered roller conveyor system set to operate at 10 fpm. Direction changes are completed by a small belt conveyor system that lifts the drum slightly above the inlet conveyor level and drives it perpendicular to the inlet conveyor.

The drum is driven into the mixer booth where a grout fill assembly apparatus is lowered into the top portion of the drum. A valve on the bottom of the mixer is opened and grout is gravity fed into the drum. The weight of the drum is monitored during the fill and controls the level in the drum. The maximum weight of a drum will be set at 900 lbs. (this assumes that the specific gravity of the mixture is 1.9). After the mixer valve is closed, the fill assembly and drum are vibrated to dislodge any residual grout and level the grout in the drum. The grout fill assembly is raised and the drum moved out of the mixer booth and into the lid placement booth. The mixer booth and the lid placement booth are stainless steel gloveboxes connected together and isolated from each other by a sealed door.

The filled drum is driven into position in the lid placement booth by a small belt conveyor located at the same elevation as the inlet conveyor. The belt conveyor is then lowered placing the drum on a table capable of rotating 360°. A robotic arm with a wiper attachment is moved so that the wiper contacts the rim of the drum. The drum is rotated and the wiper cleans the rim of grout residue, if any, prior to placement of the lid. The wiper is deposited in a collection can and will be disposed of as low-level waste. The lid placement device is lowered placing a lid, with filters installed, on the drum. Next the belt conveyor is raised lifting the drum off the table. In sequence, the outlet conveyor is started, the lid placement booth outlet door is opened and the small belt conveyor is started moving the drum out of the booth.

The drum is driven into the transfer section where it is directed to any one of the three inspection/decon booths. The transfer sections and the transfer tables are enclosed in a stainless steel tunnel arrangement that is integrally connected to the lid placement booths and the inspection/decon booths. Sealed doors provide isolation between the units. The transfer tables allow a drum to be driven perpendicular to the inlet conveyor. A small belt conveyor in the transfer table is raised to match the elevation of the conveyor sections in the transfer section. The drum is driven onto the belt conveyor and stopped. The belt conveyor is lowered placing the drum onto the table which is then turned 90° redirecting the drum to the open inspection/decon booth. This action has to take place twice for a drum to be redirected.

Attachment A
CsIX/TRU Feasibility Study
Handling of Containers Through the Grouting Area

The drum is driven into position in the inspection/decon booth by a small belt conveyor located at the same elevation as the inlet conveyor. The belt conveyor is then lowered placing the drum on an indexing table capable of rotating 360°. The table is actuated and the drum exterior surface is visually inspected using a remote camera. This is the only operator involvement required during the filling operation. If the operator sees an area that looks like it may have grout on it, he can program the coordinates into a robotic arm that will take a swipe of the area. The arm can be moved up and down and across the top of the drum so that all surfaces can be checked. The swipe is placed in an on-line alpha counter. If contamination is found, the robotic arm will be used to wipe the area with a damp cloth. The indexing table can be programmed to rotate over a small angle just enough to cover the suspected area. The area will be swiped again to verify the contamination has been removed. The cloth and the swipes will be disposed of as low-level waste. If needed, the drum can be sprayed with water or decon solution and then vacuum dried. The solution will be collected, filtered and pumped back into the system for treatment. Next the belt conveyor is raised lifting the drum off the indexing table. The inspection/decon booth is a stainless steel glovebox connected to the transfer section and the discharge section and isolated from them by sealed doors. To move the drum out of the booth, the inspection/decon booth outlet conveyor is started, the outlet door opened and the belt conveyor started.

The drum is driven into the discharge conveyor section where it is positioned on the discharge conveyor. The required direction change is made by a small belt conveyor system that moves the drum into position above the discharge conveyor level. The belt conveyor is lowered placing the drum on the discharge conveyor that runs perpendicular to the belt conveyor. The drum is then moved through the curing cell airlock into the curing cell. The discharge conveyor section is enclosed in a stainless steel tunnel arrangement that is integrally connected to the inspection/decon booths. Sealed doors provide isolation between the units.

If a drum goes through the farthest mixer line and back through the closest inspection/decon booth and has to be deconned, it is estimated that from the time it is placed on the inlet conveyor in the storage area to time it enters the curing tunnel it will take approximately 65 minutes. With three identical processing lines and a required processing rate of one drum every half-hour, the speed through a line is adequate.

Area Description

The drum fill area is located on the west side of the LAW treatment facility between the drum receiving/storage area and the curing area. It is a single room on the ground floor level measuring approximately 37 ft. by 48 ft. by 10 ft. high with personnel access through an airlock off the operating corridor. Drums enter the drum fill area on the southwest corner from the receiving/storage area and exit on the northeast corner into the curing area through airlocks. The airlocks prevent the spread of contamination if there is a release in the room. Inside the drum fill area are the gloveboxes for the

Attachment A
CsIX/TRU Feasibility Study
Handling of Containers Through the Grouting Area

different processing stations. The glovebox concept is employed to prevent the spread of contamination during the filling process and prior to placement of a lid. The room is a zone 2 ventilation area with the zone 1 area being the interior of the gloveboxes. Access to the equipment in the gloveboxes is through either gloveports or removable covers on the boxes. All operations in this area are automated and require no operator action. The walls separating the drum fill area from the storage area, the curing area and the operating corridor are 6 inch thick concrete walls providing shielding for the operators. Viewing windows will be provided in both the area walls and the glovebox walls. All maintenance tasks will be performed hands-on. No remote capabilities will be provided.

Attachment B

CsIX/TRU Feasibility Study
Equipment List for Grouting Area

Storage area conveyor – self powered rollers, 6 ft. long, 1200 W

Stainless steel airlock enclosure, 7 ga.

 Airlock doors (2) – electric motor driven, ½ HP

 Airlock conveyor – self powered rollers, 5 ft. long, 900 W

Main inlet conveyor w/3 90° transfer sections – self powered rollers, 24 ft. long, transfer sections to be belt driven w/lifting mechanism, 3 ft. long, 4500 W for conveyors and 1.5 HP for transfer section lifts

Mixer booth inlet conveyor – self powered rollers, 3 ft. long, 600 W

Mixer booth – stainless steel glovebox, 7 ga., w/electric motor driven entry and exit doors, ½ HP each

 Mixer booth conveyor – self powered rollers, 6 ft. long, 2200 W

 Fill assembly – telescoping fill tube, electric motor driven, ½ HP

Lid placement booth – stainless steel glovebox, 7 ga., w/electric motor driven exit door, ½ HP

 Lid placement inlet and exit conveyor sections – self powered rollers, 1.5 ft. long, 600 W each

 Belt driven conveyor section w/lifting mechanism – 3 ft. long, 2 HP

 Rotating table – stainless steel, electric motor driven 1 HP

 Drum rim cleaning mechanism – remote arm w/wiper assembly, ¼ HP

 Lid placement assembly – stainless steel, 2 HP total

Transfer section tunnel – stainless steel glovebox, 7 ga., 5 sections

 Transfer section inlet and outlet conveyors (3 places) – self powered rollers, 3 ft. long, 1200 W each (6 total)

 Transfer tables (3) w/belt driven conveyor sections – 3 ft. dia., stainless steel, 90° operation of table, reversible belt driven conveyors, belt driven conveyor sections have electric driven lifting mechanism, 1 HP for table, 2.5 HP for belt driven conveyor and lift

 Transverse conveyor sections (2) – self powered rollers, 5.5 ft. long, 1000 W

Inspection/decon booth – stainless steel, 7 ga., w/electric motor driven entry and exit doors, ½ HP each

 Inspection/decon booth inlet and exit conveyor sections – self powered rollers, 1.5 ft. long, 600 W each

 Belt driven conveyor section w/lifting mechanism – 3 ft. long, 2.5 HP

 Rotating table – 3 ft. dia., stainless steel, electric motor driven 1 HP

 Decon equipment including solution collection system – 1200 W

 Inspection equipment – automatic swipe of area of concern, remote mechanism, on-line counting, 3000 W

Discharge section tunnel – stainless steel glovebox, 7 ga., 3 inlet sections plus one long tunnel

 Discharge section inlet conveyor (3) – self powered rollers, 3 ft. long, 1200 W each

Main discharge conveyor w/3 90⁰ transfer sections – self powered rollers, 24 ft. long, transfer sections to be belt driven w/lifting mechanism, 3 ft. long, 9000 W for conveyors and 2.5 HP for transfer section lifts

Stainless steel airlock enclosure, 7 ga.

Airlock conveyor – self powered rollers, 5 ft. long, 1800 W

Airlock doors (2) – electric motor driven, ½ HP

Tilt & pan cameras w/zoom capability (14 req'd), - 400 W per camera

Attachment C
CxIX/TRU Feasibility Study
Sequence of Moving a Drum Through The Grouting Area

Retrieve drum w/o lid from storage

Place drum on conveyor

Place unique label on drum

Sequence through grouting cell airlock

- Stop conveyor when drum reaches airlock inlet door

- Open grouting cell airlock inlet door

- Start both conveyors (one inside airlock and then one the drum is on)

- Move drum into airlock

- Stop both conveyors

- Close airlock inlet door

- Pause to let airflow to adjust

- Open grouting cell airlock outlet door

- Start both conveyors (one in grouting area and then one inside airlock)

- Move drum into grouting cell (drum will automatically stop at the correct fill line based on computer decision)

- Stop both conveyors

- Close grouting cell airlock outlet door

Raise belt drive conveyor to match elevation of correct fill line

Start mixer booth inlet conveyor

Start belt drive conveyor moving drum to mixer inlet

Stop conveyors when drum reaches mixer inlet door

Sequence through mixer booth

- Open mixer inlet door

- Start conveyor inside mixer booth

- Start mixer inlet conveyor moving drum into position in mixer booth

- Stop both conveyors

- Close mixer inlet door

- Lower grout fill assembly to mate with drum

- Open valve on bottom of mixer

- Fill drum, vibrate to settle and level grout

- Raise fill assembly

- Pause to let residual material drip off

Sequence through lid placement booth

- Open mixer outlet/lid placement inlet door

- Start lid placement inlet conveyor

- Raise belt drive conveyor to match elevation of inlet conveyor

- Start belt drive conveyor

- Start mixer conveyor moving filled drum into position in lid placement booth

- Stop conveyors

- Close mixer outlet/lid placement inlet door

- Lower belt drive conveyor placing drum on rotating table

- Move wiper to contact drum rim

- Start table rotating drum and cleaning rim of grout residue, if any

- Stop table

Attachment C
CxIX/TRU Feasibility Study

Sequence of Moving a Drum Through The Grouting Area

Move wiper and deposit wiper pad in disposal port

Actuate lid placement device placing lid on drum

Sequence into transfer section

Open lid placement booth outlet door

Start transfer section inlet conveyor

Start lid placement booth outlet conveyor

Raise belt drive conveyor to match lid placement outlet conveyor elevation

Start belt drive conveyor moving drum into transfer section

Stop conveyors

Close lid placement outlet door

Sequence through transfer section (computer selects inspection/decon booth that is available)

Raise belt drive conveyor in transfer table to match elevation of conveyor sections in transfer section

Start belt drive conveyor and downstream conveyor section if drum is to be moved straight ahead

Start inlet transfer conveyor moving drum to inlet of inspection/decon booth

If the inspection/decon booth that is open is not directly ahead of the drum then the steps are as follows:

Raise belt drive conveyor in transfer table to match elevation of conveyor sections in transfer section

Start belt drive conveyor

Start inlet transfer conveyor moving drum to transfer table

Stop conveyors

Lower belt drive conveyor onto transfer table

Rotate table 90 degrees to direct drum to correct inspection/decon booth

Raise belt drive conveyor in transfer table to match elevation of conveyor sections in transfer section

Repeat these steps until drum is positioned in front of inspection/decon booth

Sequence through inspection/decon booth

Open inspection/decon inlet door

Start inspection/decon inlet conveyor

Raise belt drive conveyor to match elevation of inlet conveyor

Start belt drive conveyor

Start inspection/decon inlet conveyor moving drum into position in inspection/decon booth

Stop conveyors

Close inspection/decon inlet door

Lower belt drive conveyor placing drum on rotating table

Start table rotating drum and inspecting for contamination

Decon as necessary and vacuum drum removing liquid

Stop table

Sequence onto discharge conveyor

Open inspection/decon outlet door

Start discharge inlet conveyor

Start inspection/decon booth outlet conveyor moving drum to the discharge conveyor

Attachment C
CxIX/TRU Feasibility Study

Sequence of Moving a Drum Through The Grouting Area

Stop conveyors and close inspection/decon booth outlet door
Raise belt drive conveyor on discharge conveyor to match elevation of discharge inlet conveyor
Start belt drive conveyor
Start discharge inlet conveyor moving drum onto belt drive conveyor
Stop then lower belt drive conveyor placing drum on discharge conveyor
Start main discharge conveyor moving drum to curing cell airlock

Sequence through curing cell airlock

Stop discharge conveyor when drum reaches airlock inlet door
Open curing cell airlock inlet door
Start both conveyors (one inside airlock and then the discharge conveyor)
Move drum into airlock
Stop both conveyors
Close curing cell airlock inlet door
Pause to let airflow to adjust
Open curing cell airlock outlet door
Start both conveyors (one in curing cell and then one inside airlock)
Move drum into curing cell
Stop both conveyors
Close curing cell airlock outlet door

42391	100 SHEETS, FULLER 500	500
42392	50 SHEETS, FULLER 500	500
42393	100 SHEETS, FULLER 500	500
42394	100 SHEETS, FULLER 500	500
42395	200 SHEETS, FULLER 500	500
42396	200 SHEETS, FULLER 500	500
42397	100 RECYCLED WHITE 500	500
42398	100 RECYCLED WHITE 500	500
42399	100 RECYCLED WHITE 500	500
42400	100 RECYCLED WHITE 500	500

Fill
assembly

13 782 500 SHEETS, FILLER 5 SQUARE
42-331 50 SHEETS EYE EASE 5 SQUARE
42-332 100 SHEETS EYE EASE 5 SQUARE
42-339 200 SHEETS EYE EASE 5 SQUARE
42-396 200 RECYCLE WITH WHITE 5 SQUARE
42-399 200 RECYCLE WHITE 5 SQUARE

Made in U.S.A.

longest, time -		2nd longest table		30 place bid		inspecting 18 decn. booth		1st longest table		(65 min)		(4)	
36	18	15	15	30	18	18	1800	18	64.85	60	10.5		
30	15	60	15	5	60	18	1800	15	64.85	18	10.5		
30	11d	11d	15	30	18	18	1800	15	64.85	18	10.5		
60	placement	placement	15	5	18	18	1800	15	64.85	18	10.5		
18	booth	booth	15	30	18	18	1800	15	64.85	18	10.5		
18			15	5	18	18	1800	15	64.85	18	10.5		
36			15	30	18	18	1800	15	64.85	18	10.5		
36			15	5	18	18	1800	15	64.85	18	10.5		
18			15	30	18	18	1800	15	64.85	18	10.5		
18			15	5	18	18	1800	15	64.85	18	10.5		
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60			15	5	18	18	1800	15	64.85	18	10.5		
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18			15	5	18	18	1800	15	64.85	18	10.5		
60			15	30	18	18	1800	15	64.85	18	10.5		
18			15	5	18	18	1800	15	64.85	18	10		

1104 mixer
18.4 min booth

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Handling & Storage

Title: Handling of Containers Through the Curing Area

Summary:

This EDF describes movement of the grout filled 55 gallon drums through a curing cell after being filled and decontaminated. The curing process will be a 24-hour period and the drums will then be passed to a dewatering station. The equipment required for Option 1 and 2 are identical but the floor layouts are different.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements
- Attachment B – Equipment list for the cure cell
- Attachment C – Sequence of moving a Drum through the cure cell.
- Attachment D – Sketches

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130		9/28/98	K. L. Williams	9/28/98

Attachment A
CsIX/TRU Feasibility Study
Handling of Containers through the Curing Area

General

This EDF describes the method of transporting and providing curing time for the grout filled 55-gallon drum containers produced in the CsIX/TRU grouting process. After the containers have been filled with grout, sealed, and decontaminated, a 24-hour curing period will be required. After the curing period the containers will then be sent to a dewatering station and then to an interim storage facility.

Assumptions

1. Containers will be clean/decontaminated prior to entrance into the cure cell.

Requirements

1. The cure cell drum handling equipment must provide a remote automated curing period as determined by the process.
2. A 24-hour period is required for the grout placed in the drums prior to dewatering and shipment to the interim storage facility.
3. Maintenance performed on the automated handling equipment will be contact handled. No remote maintenance will be required in the cure cell and all equipment will be stainless steel for decontamination.
4. A redundant cure line will be required to provide for an equipment failure or in case the cure period needs to be increased.
5. The drum handling equipment must accept 45 drums per day when in operation.

Process Description

The fully automated conveyor system will require sequencing by a logic control system with an attending operator with oversight and override capabilities. After the drum has been filled with grout, a lid installed, and decontaminated, it will be transported through an air lock on a roller conveyor to the cure cell. After entering the cell the drum will stage on a 6-foot conveyor for entrance to a drum elevator. Once the elevator is determined to be vacant the drum will enter.

There will be two cure line conveyor systems. One system will be 2 feet above the floor and the second will be located directly over the first. Vertical distance between the cure lines will be 4 feet. If one of the conveying systems is inoperative the drum will be transferred to the operating cure line. Drums will be placed on the conveyor 6 inches apart. The cure line conveyors will operate at a speed of 4.75 feet per hour for a 24-hour cure period and traveling a distance of 114 feet. This rate may change or both conveyor systems will be used simultaneously if additional cure time is determined to be required.

The cure line conveyors will be encased in a stainless steel tunnel and ventilated to remove moisture produced from the curing process. The SST tunnels will have removable panels on the sides for access to maintenance items. Grease lines and other required lubrication lines will be placed on the exterior of the tunnel for ease of access. Windows will be incorporated into the tunnel for sight of the drum movement and visual inspection of the cure line conveyor equipment.

Once the drum has traveled to the end of the cure line it will enter into the lowering elevator. If the drum is on the top cure line conveyor it will enter and be lowered to the floor level conveyor system and staged to the second floor elevator. If the drum is on the floor level cure line it will stage to the second floor elevator.

Once the second floor elevator is determined to be vacant the drum will enter and be lifted to the second floor. Upon reaching the second level the elevator will stop and a set of doors on the second floor will open. The drum will be transferred past the doors into the dewatering area and the doors closed.

Attachment B
CsIX Feasibility Study
Equipment list for the Cure cell

Inlet staging conveyor – SST, self powered rollers, 6 ft long, 1200 Watt
Inlet staging conveyor enclosure with windows and access panels, 7 ga. SST.

Drum lift – SST, 3 ft x 3 ft, 4-ft lift, 1.5 Hp.
Drum lift conveyor – SST, self powered rollers, 3 ft long, 1200 Watt
Drum lift enclosure with windows and access panels, 7 ga. SST.

Cure line conveyor – 114 ft, self powered rollers and Chain driven
Conveyor – SST, self powered rollers, 2 ea. - 6 ft long, 1200 Watt ea.
180-degree conveyor – SST, chain driven, 8 ea. - 4.5 ft radius, 2 Hp ea.
Conveyor – SST, chain driven, 8 ea. - 13 ft long, 1 Hp ea.
Cure line conveyor enclosure with windows and access panels, 7 ga. SST.

Drum lift – SST, 3 ft x 3 ft, 4-ft lift, 1.5 Hp.
Drum lift conveyor – SST, self-powered rollers, 3 ft long, 1200 Watt
Drum lift enclosure with windows and access panels, 7 ga. SST.

Stage conveyor to elevator – SST, self powered rollers, 1.5 ft long, 400 Watt

Drum elevator to 2nd floor – SST, 3 ft x 3 ft, 12-ft lift, 2 Hp.
Drum elevator enclosure with windows and access panels, 7 ga. SST.
Drum elevator doors, 2nd floor - motor driven, SST, ½ Hp.

Attachment C
CsIX Feasibility Study
Sequence of Moving a Drum through the Cure cell

Receive drum from grout cell air lock
Stop conveyor when drum reaches lifting elevator
 Verify elevator is vacant
 Start conveyor and move drum into elevator and stop conveyor
 Determine which cure line conveyor drum will go to
 Lift drum to 2nd cure line if required
Start conveyor and move drum onto cure line
 Cure line conveyor transports drum for 24 hours
 Stop conveyor when drum reaches lowering elevator
 Verify elevator not in use
Start conveyor and move drum into elevator and stop conveyor
 Lower drum to floor cure line conveyor if required
Start conveyor and move drum to 2nd floor staging conveyor
 Stop conveyor when drum reaches 2nd floor elevator
 Verify elevator is not in use
Start conveyor and move drum into 2nd floor elevator and stop conveyor
 Elevator lifts to 2nd floor and stops
 Open elevator doors on 2nd floor
 Start conveyor and move drum through doors and stop conveyor
 Close elevator doors
 Elevator returns to 1st floor

431.02
06/17/97
Rev. #04

ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-04
EDF Serial Number – EDF-CsIX-006
Page 1 of 1

**Attachment D
CsIX Feasibility Study
Sketches and drawings**

ASTS

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Handling & Storage

Title: Handling of Containers through the Dewatering Process

Summary:

This EDF describes the movement of the cured 55-gallon grout drums through the automated dewatering stations and the process by which it is accomplished. The dewatering process is an automated 4 hour period of water removal from the drum head space. The stations are described in addition to the sequencing the drums must go through. Dewatering must be completed before the drums are placed on a pallet and shipped in a covered flat bed truck to the interim storage facility. Option 1 and option 2 are very similar in operation and equipment requirements. Differences are only in the layout due to the facility.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the Dewatering stations.
- Attachment C – Sequence of moving a Drum through the Dewatering area.
- Attachment D – Sketches

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130		9/28/98		9/28/98

Attachment A
CsIX/TRU Feasibility Study
Transportation of 55 gallon drum containers through Dewatering

General

This EDF describes the method of dewatering the headspace of the 55-gallon drum containers after a 24-hour cure period in the CsIX/TRU grouting process. After passing through the Cure cell, any remaining water in the head space or void portion of the drum must be removed. WIPP acceptance requirements dictate that there should be no more than 1% liquid by volume in the drums. The cured drums may have residual moisture in the void space or head of the drum due to the lid being installed prior to the curing period.

Assumptions

1. Drum lid filters will not degrade passing water vapor.
2. Loading of drums to pallets after completion at the dewatering stations will be contact handled.
3. Lag storage of palletized drums will be on the second floor in the dewatering area and on the first floor load-out dock.
4. A 120 air change per hour (approximately 1 CFM) on the drum head space at 150 degrees F (65.5 C) temperature is required for water removal. See attachment D for supporting information.
5. Pallets of drums will be removed from the facility on a flat bed truck in numbers of 4 pallets or 16 drums. Loading, round trip to interim storage, and unloading will take 2 hours per trip. Three trips per day in covered flat bed truck to interim storage will be sufficient for drum production rates. See attachment D for supporting information.

Requirements

1. A 4-hour dewatering period is called for from the process. See EDF-CsIX-001
2. The dewatering process must be an automated operation with operator oversight and override.

3. 9 dewatering stations will be required. 8 stations for accepting a new drum every 30 minutes for 4 hours and 1 redundant or backup station.
4. After dewatering, the drums must be placed on a pallet in the facility for shipment to the interim storage facility.
5. There must be enough lag storage at the grouting facility to accommodate a one day production run of drums. This entails 38 drums or with 4 drums per pallet, 9-1/2 pallets of drums. Maximum pallet stacking height is two.

Process Description

The handling and dewatering system is fully automated with the attending operator having oversight and override capabilities. After the containers have been through the 24-hour cure period any residual moisture in the head of the drum will be removed as the drums pass through the dewatering stations.

As the drum enters the dewatering station area from the elevator doors it will stage on an indexing lift and rotation table. The drum lids contain two identical filters. The indexing table will locate the drum lid filters and position them for alignment in the dewatering stations. As the drum exits the elevator doors, the conveyor will stop it on the indexing table. The table will lift the drum up a predetermined height to an arm that has a roller located on the end of it. Once this roller has made contact with the drum lid, the drum will then be rotated. As the drum rotates, the roller will rotate on the top of the drum and when a filter is contacted the arm will pivot. This pivoting motion will be used to flag the filter location. Once the filter has been oriented, the drum will lower back to the conveyor line and move forward to one of the nine dewatering stations.

Once the drum has been oriented to enter the dewatering stations, a side lift conveyor will raise the drum to enter one of the vacant dewatering stations. After the drum has entered the dewatering station, it will travel until it reaches the back drum location support. After positioning in the dewatering station, a manifold will lower from above the drum. The manifold will consist of two 2-inch lines with hoods that seal to the drum lid around the filters. One line will connect to the off-gas system pulling air from the drum. The other line will contain electric resistance heaters and heat the air entering into the drum. Air will be taken from the space, heated, pulled through the drum head space, and into the off-gas system. See sketches in Attachment E for more detail. After a 4-hour period in the station the drum will be shifted back onto the main conveyor line and moved to the end conveyor for loading onto a pallet.

Once the drum has traveled to the end of the conveyor system it will be removed with a manually operated hydraulic drum lift and placed on a pallet. Drums will be stacked 4 to a pallet, see drawing #449511 for pallet details. The pallet will then stage to be lowered to the first floor on the loading dock elevator for shipping in a covered flat bed truck to the interim storage facility. The lag storage on the second floor will be 4 pallets. First floor lag storage will be 6 pallets.

Attachment B
CsIX/TRU Feasibility Study
Equipment list for Dewatering stations

Inlet indexing lift conveyor – SST, self powered rollers, 3 ft long, 1200 watts

Indexing lift table – SST, 18 inch diameter, 1.5 Hp

Indexing table rotation motor – ½ Hp

Indexing arm – Roller assembly arm, no power required

Dewatering station conveyor – SST, self powered rollers, 30 ft long, 5600 watts

90-degree transfer and lift – SST, chain transfer, 3 ft long, 1.5 Hp ea.

Station conveyor – SST, self-powered rollers, 3 ft long, 1200 watts

Air heaters – electric heaters, 9 ea., 100 watts ea.

Dewater station line raise and lower – 9 ea., ½ Hp ea.

Drum load off conveyor – SST, self-powered rollers, 10 ft long, 2200 watts

90 degree transfer and lift – SST, chain transfer, 3 ft long, 1.5 Hp

Manual operated hydraulic drum lift

Attachment C
CsIX/TRU Feasibility Study
Sequencing of moving a Drum in/out of Dewatering station

Receive drum from cure cell elevator doors
 Stop drum over indexing table
 Raise drum to indexing arm
 Rotate drum to locate filters
 Lower drum to conveyor
 Determine dewatering station to receive drum and start conveyor
Stop conveyor at dewatering station
 Raise drum on 90-degree chain transfer section
 Start chain conveyor and self-powered roller conveyor
 Stop conveyors when in position and lower chain transfer section
Lower dewatering manifold onto drum
 Start dewatering process for 4 hours
 Raise dewatering manifold
Raise chain transfer section and start both chain and roller conveyor systems
 Move drum to main dewatering conveyor and stop conveyors
 Lower chain transfer section
Start Main dewatering conveyor and move drum to end of conveyor
 Stop conveyor on chain transfer section
 Raise chain transfer section
 Start chain transfer and load out conveyor
 Move drum to end of load out conveyor and stop
Move drum to pallet
 Fill pallet with 4 drums
Stage pallet to dock load out elevator
 Load pallet into load dock elevator
 Lower elevator to first floor dock
Stage pallet to be loaded into covered flat bed truck
 Load pallet into covered flat bed truck
 Ship to interim storage facility

Attachment D
CsIX/TRU Feasibility Study
Supporting calculations

Drum head space dewatering:

Drums will be filled to 95% of their volume:

$$\text{Total drum volume} = 8.05 \text{ ft}^3 (0.228 \text{ m}^3)$$

$$\text{Grout volume} = 8.05 \text{ ft}^3 \times 95\% = 7.65 \text{ ft}^3 (0.216 \text{ m}^3)$$

Head space remaining is the difference of the two volumes divided by the area of the drum.

$$\text{Volume} = 8.05 - 7.65 = 0.4 \text{ ft}^3$$

$$\text{Height} = (8.05 - 7.65) / 2.76 = .14 \text{ ft} = 1.73 \text{ inches (4.4 cm)}$$

Assume 120 air changes per hour ventilation to remove the water.

$$0.4 \text{ ft}^3 \times 120 \text{ AC/hr} = 48 \text{ ft}^3/\text{hr} = 0.8 \text{ ft}^3/\text{min} = 0.37 \text{ l/s}$$

Heating required for 70 F to 150 F rise.

$$Q = 0.92 \times 0.8 \times 80 = 58.8 \text{ Btu/hr} = 17.2 \text{ watts}$$

Assume that heating system will require back up and controls. Each system will be 50 watts, of which 2 will be required.

Drum transport from grout facility to interim storage facility:

Drum will already be placed on a pallet and be ready for loading into the cover flat bed truck. It is assumed the truck can hold 4 pallets of drums.

Loading of 4 pallets into truck at grout facility – 45 min

Driving time between facilities – 30 min

Unloading 4 pallets at interim storage facility – 45 min

Total 120 min (2 hr)

Trips made per day assuming 8 hour working day.

Mobilization – 2 hrs

Trips (3 @ 2hr ea.) – 6 hrs - which is 12 pallets or 48 drums per day.

Attachment E
CsIX/TRU Feasibility Study
Sketches and Drawings

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Assume $60 \frac{AC}{Hr}$ on
Head Space =>
.297 ≈ .3 CFM

De Watering Station

NOTES:

1. REMOVE ALL BURRS AND SHARP EDGES.
2. WELD PER AWS D1.3 USING ITEM 6, WELD FILLER METAL, WITH VISUAL INSPECTION PER AWS D1.3.
3. MARK PER STD-7006-2A WITH 449511-1 ASSEMBLY.
4. COAT ALL WELDS USING ITEM 5, GALVANIZING METAL COATING.

DETAIL 2
SCALE: 1/8

-1 ASSEMBLY
SCALE: 1/8

AR	2		WELD FILLER METAL	ER70S SERIES AWS A 5.18	6
AR	2		GALVANIZING METAL COATING	FED SPEC TT-P-641	5
3	2	-4	SLAT	SHEET, 12 GA (.108 THICK) GALVANIZED CS, ASTM A 527 OR EQUAL COATING DESIGNATION G90	4
8	2	-3	SLAT		3
3	2	-2	STRINGER		2
	2	-1	ASSEMBLY		1

QTY. REQD.	QUAL. LEVEL	PART OR IDENTIFYING NO.	DESCRIPTION/MATERIAL/SPECIFICATION	ITEM/FIND
PARTS LIST				
DIMENSIONING AND SYMBOLS ARE AMERICAN NATIONAL STANDARD UNLESS OTHERWISE SPECIFIED SURFACE ROUGHNESS $\sqrt{32}$ DIMENSIONS AND TOLERANCES ARE IN INCHES TOLERANCES: X $\pm .01$ DETAILS: XX $\pm .005$ JOX $\pm .010$ FRACTIONS $\pm 1/8$ ANGULAR ± 2 DO NOT SCALE DRAWING			NEXT ASSY/REF DWG. FINAL PROJECT NO. 015291-02 REQUESTOR <i>[Signature]</i> DATE 6-5-95 DESIGNED <i>[Signature]</i> DATE 6-5-95 CHECKED <i>[Signature]</i> DATE 6-5-95 B.E. RHODES RELEASE <i>[Signature]</i> DATE 6-5-95	
LOCKHEED Kaho Technologies Company WASTE CHARACTERIZATION AND STORAGE FACILITY PALLET (48" x 48")			SIZE INDEX CODE NUMBER DRAWING NO. 449511 D 098 0628 471 530 SCALE NOTED SHEET 1 OF 1	

ADDCS NO. 465819

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Handling & Storage

Title: UDS Drum Filling and Handling

Summary:

This EDF documents the requirements, assumptions, and description for the Undissolved Solids (UDS) drum filling and drum handling system. Both scenarios use the same configuration for UDS handling.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the UDS Drum Filling and Handling System.
- Attachment C – Sequence of moving a Drum through the UDS Drum Filling and Handling system.
- Attachment D – Sketches and Drawings

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130		10/15/98		10/16/98

Attachment A CsIX/TRU Feasibility Study

General

This EDF describes the process by which the UDS are conveyed into a 55-gallon (0.2 m³) drum and transported to a storage area within the grouting facility or NWCF. UDS produce a higher radiation field than the grout and require remote handling and special shielded drums. UDS will be stored in the new grouting facility or in the NWCF awaiting treatment from another project or shipment to WIPP.

Assumptions

1. Drums will be shielded to provide contact handling and filled weight will be less than 3000 lbs. (1360 kg).
2. After UDS drums have been filled, decontamination will allow contact handling in both NWCF and the grouting facility.
3. One UDS drum will be filled per month and exposure time periods to personnel will be low.
4. NWCF UDS storage area floor loading will not exceed capacity of the facility floor.

Requirements

1. UDS drums must have no more than 200-mR/hr contact exposure. Shielding must be provided to maintain minimum exposure limits.
2. Decontamination accommodations must be provided for UDS drums after filling. Remote decontamination mechanisms and online counting will be required
3. UDS drum filling and handling must be a remotely operated automated system.
4. Transfer of the UDS into the drums must be a dust tight configuration for contamination control.

Process Description

The automated UDS drum handling system will be sequenced by a logical control system and be overseen by an attending operator. Drum movement into the decontamination booth and fill cell will be fully automated. Handling of the drum to the fill area from storage and back into the storage area will be by personnel. Lifting of a UDS drum onto the staging conveyor will be from an overhead crane. The drum will then be moved into the fill cell, filled, decontaminated in the booth, and then removed for personnel handling. The drum will then be stacked in the storage area of the grout facility or NWCF. The UDS will be disposed of by a future project or shipped to WIPP for permanent storage.

Approximately fifty 55-gallon (0.2 m^3) drums will be required through the life of the CsIX/TRU process, see EDF-CsIX-002. These drums are shielded to protect personnel from radiological exposure.

The lid/fill mechanism is a cone shaped lid that raises and provides an opening into the drum. This cone is air operated and opens the tube discharge cone holding the UDS. Engagement of the cones will be from a lift table.

The engagement of the drum cone to the discharge cone will occur when the fill cell lift table raises the drum a predetermined height. Once engaged, the UDS will be gravity fed into the drum. By design, the cone can be pulsed to dislodge or break up the UDS in the discharge tube. After the drum filled, the cone will close and the drum will lower from the fill cone. The drum will then be moved to the decontamination booth for clean up. After decontamination, the drum will be moved out to an area where personnel can move it to a storage area.

The process is very similar in both scenarios. The only variance is where the filled drums are stored. The filled drums will be stored and wait for processing by a future project or shipment to WIPP for permanent storage. Further development on the drums is recommended.

Attachment B
CsIX/TRU Feasibility Study
Equipment list for the UDS Drum Filling and Handling system

Staging/Unloading conveyor – SST, chain driven, 4 ft long, 1Hp
Electric doors – Decontamination booth, SST, electric driven, ½ Hp
Decontamination Booth - shielded, SST
 Rotation table – SST, 3 ft diameter, 1 HP
Decontamination conveyor – SST, self powered rollers, 30 ft long, 5600 watts
Decontamination Equipment – 1200 watts
 Inspection Equipment – Area swipe remote mechanism, on-line counting,
 300 watts
Electric doors – SST, electric driven, ½ Hp
 Load out conveyor – SST, self powered rollers, 1.5 ft long, 600 watts
 Lift table – SST, Air operated
 Lift table conveyor – SST, self-powered rollers, 3 ft long, 1200 watts
Drum dust tight discharge cone – SST, air operated
Shielded drum with dust tight inlet cone – SST inner liner with shielding material
around exterior of drum – estimated 50 required over life of grout production run

Attachment C
CsIX/TRU Feasibility Study

Sequencing of moving a Drum through the UDS Drum Filling and Handling system

Once a drum is moved into position from the storage area, a crane will be used to lift the drum onto the staging conveyor. Once on the staging conveyor, the stage conveyor will move the drum to the doors of the decontamination booth. Once the booth has been reached, the doors to the booth will open. As the doors open the staging conveyor will move the drum through the doors into the decontamination booth. Once inside the booth, the doors will close.

When the drum conveyor has stopped in the decontamination booth, a mechanical arm will drop from the ceiling of the booth and remove a shielded cap from the top of the drum fill cone. The cone will be placed to the side and reinstalled after the drum has been filled. Shielding of the fill cone is required due to the relatively high radiation field of the UDS. Once the cone shield has been removed, the doors to the filling cell will open and the decontamination booth conveyor will start and move the drum into the fill cell.

When the drum enters into the fill cell on the conveyor, it will be on top of a lifting table. Once the drum is in the predetermined position in the fill cell, the conveyor will stop and the doors to the decontamination booth will close. The lift table will raise the drum a predetermined height to a discharge cone. The discharge cone is on the end of a collection tube that the UDS evaporator is connected to. When the UDS evaporator discharges the UDS, particulates are collected in the tube with the filling cone. Once the cones on the drum and discharge tube had been engaged, the filling cone raises, pneumatically, and the UDS flow into the drum. The filling process is dust tight and no outside surfaces of the drum are exposed to the UDS.

When the UDS drum is full, measured by weight from the lift table, the fill cone will be lowered. The discharge tube and UDS drum are thus closed. The drum will be lowered back to the conveyor plane and is ready to be moved into the decontamination booth for clean up and reinstallation of the cone shielding.

After the lift table is lowered to the conveyor line, the doors to the decontamination booth will open. The conveyor will start and move the UDS drum into the decontamination booth. Once in the booth, the conveyor will stop and the doors to the booth from the fill cell will close. The decontamination process will now start.

Areas of concern and the fill cone will be swiped with the mechanical arm located in the decontamination booth. The swipe will then be placed into an on-line counter and determined if contamination is present. The area can be cleaned with

the mechanical arm or if deemed necessary, the entire drum can be washed down with decontamination fluid. If decontamination fluid is used, it will be collected at the bottom of the booth and gravity fed to the waste collection system and routed back through the CsIX/TRU grout process. When the level of cleanliness has been reached, the mechanical arm will reinstall the cone shield enclosure.

After installation of the cone shield, the doors to the decontamination booth will open and the decontamination booth conveyor will start. The conveyor will move the drum through the doors onto the staging conveyor and stop. The doors to the decontamination booth will close and the drum is ready for removal from the staging conveyor. The drum is now contact handled to storage.

The overhead crane will lift the drum from the staging conveyor to a pallet. The pallet will be lifted by pallet jack and taken to the temporary storage in the grout facility or stacked with the overhead crane in the filling area of NWCF.

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-06
EDF Serial Number – EDF-CsIX-008
Page 1 of 1

Attachment D
CsIX/TRU Feasibility Study
Sketches and Drawings

UDS Loadout - New facility

B A U b b A

UDS Loadout Plan View

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Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask Equipment Installation in NWCF

Title: Installation of CsIX Equipment in NWCF

Summary:

This EDF evaluates the feasibility of installing the CsIX filtration and cesium removal processes within existing cells at the NWCF. The evaluation revealed the CsIX equipment can be installed in the calciner cell, adsorber cell, valve cubicle and hot sump tank removal cell.

EDF Contents:

- Attachment A – Evaluation of NWCF Hot Cell Space and Equipment Lay-out
- Attachment B – Equipment List
- Attachment C – Shielding Requirements
- Attachment D – NWCF Cell Radiological Filed Estimates
- Attachment E – NWCF Lay-out Drawings

Distribution (complete package): H.S. Forsythe, K. L. Williams, C. W. Olsen

Distribution (summary package only): J. J. McCarthy

Author	Dept.	Reviewed	Date	Approved	Date
H.S. Forsythe <i>H.S. Forsythe</i>	4170	<i>K.L. Williams</i>	10/28/98	K.L. Williams <i>K.L. Williams</i>	10/28/98

Attachment A
CsIX/TRU Feasibility Study
Evaluation of NWCF Hot Cell Space and Equipment Lay-out

Introduction

The CsIX/TRU Grout Feasibility Study investigates treatment of tank farm liquid waste via cesium removal followed by grouting into 55-gallon drums. The study examines two facility layout scenarios: one scenario constructs new buildings to house the processes; the second scenario constructs buildings for the grouting process leaving the most radiologically hot processes to be housed in the New Waste Calcining Facility (NWCF). This EDF evaluates the feasibility of placing the “hot” processes of filtration and cesium removal within existing cells at the NWCF.

CsIX Equipment

Based on the process defined in EDF-CsIX-001, five systems are required to accomplish the filtration and cesium removal steps. The five systems include solids processing, cesium ion exchange, waste water collection, process off-gas, and bulk chemical storage. NWCF equipment will be utilized as much as possible to reduce the number of new items installed in the building. The following tables identify the systems, the equipment required for each system, and NWCF equipment that can be substituted for required equipment.

Solids Processing - The solids filtration system includes provisions for accepting waste from the tank farm, filtering the liquid waste prior to introduction to the ion exchange columns, and drying and packaging the undissolved solids collected during filtration. The table below identifies the required equipment and the NWCF equipment that can be utilized.

Equipment Number	Description	NWCF Equipment
T-101-A,B	Liquid Waste Feed Tank	VES-NCC-102, -103
P-101-A,B	Liquid Waste Feed Pump	None
F-101-A,B	UDS Filter	None
T-108	UDS Slurry Tank	None
EV-101	UDS Rotary Evaporator	None
E-101	UDS Evaporator Condenser	None
P-110	Condensate Pump	Gravity
P-107	Evaporator Feed Pump	None
N/A	Drum Loading Station	None

The filtration system requires twelve components. VES-NCC-102 and -103 perform the same function as T-101-A, B; therefore they can be substituted for the liquid feed tanks. The evaporator condensate can flow by gravity to the

wastewater collection tank, VES-NCC-119, thereby eliminating the need for a condensate pump.

Cesium Removal and Resin Drying- The cesium removal system includes provisions for removing cesium using three ion exchange columns, sluicing resin into and out of the ion exchange columns, and drying and storing the spent resin. The table below identifies the required equipment and the NWCF equipment that can be utilized.

Equipment Number	Description	NWCF Equipment
V-104-A,B,C	CslX Columns	None
T-103-A,B	CslX Effluent Tank	None
P-103-A,B	CslX Effluent Pump	None
P-112	Spent Cs Resin Pump	None
V-105	Resin Prep Tank	VES-NCM-120
P-114	Resin Transfer Pump	P-NCM-220
V-106	Spent Resin Prep Tank	None
P-104-A,B	Spent Resin Sluice Pump	None
F-102	Resin Fines Filter	None
D-102	Cs Resin Drier	None
E-102	Resin Drier Condenser	None
P-113	Condensate Pump	Gravity
T-102	Spent Resin Storage Tank	None

The cesium removal system requires eighteen components. The new resin can be prepared in VES-NCM-120 and pumped to the ion exchange columns using P-NCM-220. The drier condensate can flow by gravity to the wastewater collection tank, VES-NCC-119, thereby eliminating the need for a condensate pump.

Waste Water Collection - The waste water collection system includes provisions for collecting waste water and transferring it to a treatment process (PEW, HLLWE, etc.). The table below identifies the required equipment and the NWCF equipment that can be utilized.

Equipment Number	Description	NWCF Equipment
T-111	Waste Water Tank	VES-NCC-119/122
P-111	Waste Water Pump	JET-NCC-519

The waste water collection system requires two components. The hot sump tanks, VES-NCC-119, -120, can be used as the waste water collection tanks and JET-NCC-519 and -520 can be used in place of the waste water pump.

Process Off-gas - The process off-gas system provides off-gas for all tanks and vessels. The process off-gas system includes a condenser, demister, superheater, prefilter, HEPA filter and blower. The table below identifies the required equipment and the NWCF equipment that can be utilized.

Equipment Number	Description	NWCF Equipment
E-103	Off-gas Condenser	HE-NCC-336
V-101	Off-gas Demister	VES-NCC-136
EH-101	Off-gas Superheater	HE-NCC-335
F-103	Prefilter	F-NCC-130
F-104-A,B	HEPA Filter	F-NCC-130
BL-101-A,B	Off-gas Blower	BL0-NCC-242

The process off-gas system requires eight components. The NWCF Vessel Off-gas (VOG) and Process Off-gas (POG) systems can be used, thus eliminate the need for any additional equipment.

Bulk Chemical Storage - The bulk chemical storage system provides bulk storage for decontamination chemicals and demineralized water. The table below identifies the required equipment and the NWCF equipment that can be utilized.

Equipment Number	Description	NWCF Equipment
B-101	Cs Resin Storage	None
T-109	Decon Chemical Storage	VES-NCM-117
T-110	Decon Chemical Storage	VES-NCM-118
T-102	DI Water Tank	None
P-108	Decon Chemical Pump	P-NCM-217
P-109	Decon Chemical Pump	P-NCM-218
P-102-A,B	DI Water Pump	None

The bulk chemical storage system requires eight components. The NWCF decon tanks and pumps can be used for chemical storage. A new DI water tank and pump will be installed in room 429, as shown on drawing 2-M6, to supply DI water to the process. The cesium resin storage bin will be eliminated and instead of bulk shipments, resin will be received in 50-pound bags.

Based on the information presented in the tables above, eighteen pieces of NWCF equipment can be used, leaving twenty-seven major pieces of CslX equipment to be installed. The NWCF scenario equipment list is included in Attachment B.

NWCF Facility Requirements and Assumptions

The installation of CslX equipment will take advantage of existing NWCF infrastructure, which includes building utilities, HVAC, and off-gas systems. This

EDF assumes these systems are adequate and that no changes or upgrades are needed to accommodate the new CslX equipment.

However, modifications are required to the NWCF in order to accommodate the CslX equipment. This EDF assumes the calcining process will no longer be needed and that calciner operability can be degraded as a result of new equipment installation. However, the following systems are needed, and their operational status cannot be degraded.

- High Level Liquid Waste Evaporator (HLLWE)
- Filter Leach System
- Decontamination Facility
- Building HVAC
- Vessel Off-gas
- Waste Water Collection
- Pneumatic Transfer System

In addition to the facility constraints listed above, the CslX equipment has the following constraints that must be met.

- Valves, pumps and other mechanical equipment should have remote maintenance and operating capability.
- The UDS container storage location must have the capability to remotely manage and store up to fifty 55 gallon drums
- The ion exchange columns, spent resin prep tank, spent resin drier, spent resin storage tank, UDS slurry storage tank and UDS drier must have adequate shielding to protect operating personnel.
- The spent resin storage tank must have access to the NWCF pneumatic transfer system.

Sufficient hot cell space, meeting all of the constraints listed above, was identified in the adsorber cell, calciner cell, valve cubicle and hot sump tank removal cell.

Cell Descriptions

Adsorber Cell – The adsorber cell has approximately 800 square feet of floor space and is 34 feet high. The cell houses three ruthenium adsorbers, the adsorber superheater, the process off-gas reheater, the off-gas mist collector, the vent condenser, and the vent condenser knock out drum. If the adsorbers are removed, the cell will provide space to house the following CslX equipment.

Equipment Number	Description
V-104-A,B,C	CslX Columns
T-103-A,B	CslX Effluent Tank
F-101-A,B	UDS Filters
T-108	UDS Slurry Tank
EV-101	UDS Rotary Evaporator
E-101	Evaporator Condenser
E-103 (HE-336)	Off-gas Condenser
V-101 (VES-136)	Off-gas Demister
EH-101 (HE-335)	Off-gas Superheater
None	UDS Drum Loading

The demolition of the adsorber cell, shown on drawing 2-M2, will include removing all processing equipment in the cell, including the off-gas reheater (HE-335), vent condenser (HE-336) and vent knock out drum (VES-136). These off-gas components are vital components of the off-gas system and will be redesigned and re-installed in the adsorber cell during the construction phase.

As shown on drawings 2-M3 and 2-M5 section C, the ion exchange columns will be mounted on the adsorber cell north wall near the ceiling, which will provide access to the valve cubicle for positioning of new valves. The contact radiation reading for a fully loaded resin column is estimated at 2,700 R/hr¹. The existing shielding is adequate to reduce the body field in occupied areas to less than 0.1 mR/hr².

The UDS drum filling station, shown on 2-M3, will be located adjacent to the adsorber cell west wall with an opening in the wall to allow UDS containers to pass between the hot sump tank removal cell and the adsorber cell. The filling station will be housed within a glove box enclosure (shown on 2-M4 section A) to keep the UDS containers free of external contamination. The containers will be shielded to provide contact handling, and the container filled weight will be less than 3000 lbs. Each container will hold 7.35 ft³ of solids, which, based upon the anticipated solids listed in the material balance in EDF-CslX-001, translates into approximately 50 containers. The UDS drum filling station is explained in further detail in EDF-CslX-008.

The UDS evaporator will be located above the drum loading station, and when filled with solids, will have a contact radiation reading of approximately 48 R/hr³.

The UDS evaporator can either be repaired remotely using the overhead PaR and crane or by hands-on maintenance. In either case, the radiation field in the cell must be reduced prior to maintenance activities. This is accomplished by removing solids from the evaporator and drum loading station, transferring ion exchange column resin out of the cell, and decontaminating process vessels.

¹ EDF-CslX-015,

² Attachment B

³ EDF-CslX-015,

Calciner Cell – The calciner cell has approximately 650 square feet of floor space and is about 34 feet high. The calciner vessel occupies the west half of the cell with the east half remaining relatively free of equipment. This open area to the east is an ideal location for the spent resin storage tank and provides clear access to the pneumatic transport line. In addition, with over 30 feet of cell height, the resin drier can be located above the storage tank with the spent resin prep tank located above the drier. This arrangement, as shown on 2-M4 section B, allows the resin to move by gravity from the prep tank to the storage tank. The proposed layout calls for the resin to be dewatered, dried and stored while the sluice water is filtered and returned to NCC-119. To accomplish these tasks the following equipment will be installed in the calciner cell.

Equipment Number	Description
V-106	Spent Resin Prep Tank
D-102	Resin Drier
E-102	Resin Drier Condenser
T-112	Spent Resin Storage Tank
P-104-A,B	Spent Resin Sluice Pump
F-102	Resin Fines Filter

The contact radiation reading at the spent resin storage tank, when full, is estimated at 5,000 R/hr⁴. The shielding required to achieve 0.1 mR/hr outside the cell is calculated to be 38 inches of concrete⁵. Since the calciner cell wall thickness is 57 inches, the cell walls will provide adequate shielding.

Remote maintenance will be performed on the resin drier, sluice water pumps and fines filter using the overhead PaR and crane. The PaR and crane gain access to the cell through the cell hatches, and the radiation field at the top of the cell must be less than 200 mR/hr when the cell hatches are removed. This will be accomplished by enclosing the spent resin storage tank with concrete shielding walls measuring 24 inches as shown on 2-M3 and 2-M4 section B.

Valve Cubicle – The valve cubicle is about 60 feet long, 11.5 feet wide, and 34 feet high. High-maintenance valves for the incoming feed line, the blend and hold tanks, and the adsorber cell are located in this cubicle. Adsorber cell valves associated with the adsorber off-gas lines and drain lines will be removed. Drawing 2-M2, detail A, highlights the valves to be removed. The free wall space will be used for new valves and pumps affiliated with the filtration and Cs removal operations. The table below lists the pumps and the approximate number of valves to be located in the valve cubicle.

⁴ EDF-CslX-015,

⁵ Attachment B

Equipment Number	Description
P-101-A,B	Liquid Waste Feed Pump
P-107	UDS Evaporator Feed Pump
P-103-A,B	CslX Effluent Pump
P-112	Spent Resin Transfer Pump
Valves	~30

Following demolition, approximately 648 square feet of wall space is available for new valves. According to Rick Lane with Specialty Engineering (remotes), each valve requires 25 square feet. Therefore, approximately 25 valves can be placed in the valve cubicle. The other valves must be installed in-cell with remote maintenance capabilities.

Hot Sump Tank Removal Cell – This cell has 780 square feet of floor space, is 35 feet high and contains no equipment. Presently, spent/used NWCF HEPA filters are stored in this cell, which would be removed prior to construction activities. The cell is contaminated but can be cleaned to low levels.

UDS containers will pass through the wall between the hot sump tank removal cell and the adsorber cell into an enclosed decontamination glovebox. The UDS containers will be surveyed, decontaminated, and then stored in the cell. A 5-ton crane will be installed in the cell to move and stack the 2,000-pound containers. If the containers are stacked two high, approximately 200 square feet of floor space will be needed. The cell layout is shown on Drawing 2-M3 and 2-M4, detail A.

Process Description

Waste is transferred to the NWCF using the existing Tank Farm transfer system and is received in one of two blend tanks, VES-NCC-102 or –103, in the blend and hold cell. From the blend tanks, the waste passes through the north wall into the valve cubicle. The waste is then pumped to the UDS filters in the adsorber cell using one of two liquid waste feed pumps, P-101-A or -B, located in the northeast corner of the valve cubicle. From the filters, the waste enters one of three ion exchange columns mounted on the north wall near the ceiling of the adsorber cell. From the lead column, the waste then enters the top of the lag column exiting at the bottom to one of two CslX effluent tanks, also located in the adsorber cell. When the effluent tank is full, the contents will be pumped to valve box B-11 and on to the grouting facility through a new transfer line.

When break-through is observed in the lead cesium ion exchange column, the column is taken off line and the resin removed and replaced with fresh resin. Deionized water is added to the column at the ratio of 10 water volumes per resin volume. The resin/water mixture exits the column and passes through the adsorber

cell north wall into the valve cubicle to the spent resin sluice pump, P-112. The resin is then pumped from the valve cubicle to the calciner cell via the second level mezzanine and flow meter cubicle. In the calciner cell, the resin enters the spent resin prep tank, V-106, and is dewatered. The sluice water is pumped, P-104-A, B, through the resin fines filter, F-102, and back to VES-NCC-119. The dewatered resin is fed to the resin drier, D-102, and collected in the spent resin storage tank, T-112. At a later date, the resin will be transported using the NWCF pneumatic transport line to the calcine bin sets or to a vitrification facility. The spent resin storage tank, when filled, will have a contact radiation reading of approximately 5,000 R/hr.

New resin is received in 50 pound bags and stored in the calcium nitrate make up room, 427. Resin is mixed with water and prepared for use in VES-NCC-120. When a column is ready, fresh resin is pumped from VES-NCC-120 to the column using P-NCC-220. The sluice water will drain by gravity from the column to VES-NCC-119. Once filled with fresh resin, the column is held in reserve until needed.

When the UDS filter pressure drop reaches a predetermined level, the filter is taken off-line and back flushed with deionized water. The flush is collected in the UDS slurry tank, T-108, located in the adsorber cell. When the UDS evaporator is operating, the slurry leaves T-108 and passes through the adsorber north wall into the valve cubicle to the evaporator feed pump, P-107. From the feed pump, the slurry is fed to the UDS evaporator, EV-101, located in the adsorber cell. The dried solids flow by gravity from the evaporator into a discharge tube. When full, a UDS container is lifted into position and filled. The container is then passed through the adsorber cell west wall into the hot sump tank removal cell. The container is surveyed, decontaminated and stored in the hot sump tank removal cell.

Waste Management

Waste generated during demolition of the adsorber cell and valve cubicle will be classified as mixed hazardous and will consist of silica gel, piping, adsorber vessels, and valves. According to Waste Generation Services⁶, the waste can be legally generated and would normally be subject to the one year LDR storage (40CFR268.50) prohibition. However, the one-year prohibition can be by-passed if the waste is included in the Site Treatment Plan maintained by Waste Generation Services.

Any waste generated that exceeds a 60 mm particle size can be classified as debris. Debris can be rendered nonhazardous provided it is rinsed for 15 minutes (40 CFR 268.45 Table One Item A-2) and passes a visual inspection for staining (clean debris surface inspection). In addition, the waste must be sized in a manner that will allow visual inspection of interior surfaces. Debris treatment must take place within 90 days of waste generation; otherwise the treatment process requires a RCRA permit.

⁶ Conversation with Tom Shea on August 31, 1998.

Unfortunately, the silica gel particle size is less than 60 mm, and therefore, can not be classified as debris and must be disposed of as mixed hazardous waste.

All projected liquid waste from decontamination and debris treatment must be included in the Waste Minimization Plan⁷ before it can be processed through the PEW evaporators.

NWCF Facility Concerns/Issues

The following items should be considered when contemplating the installation of CsIX equipment in the NWCF.

- a) The fundamental advantage of housing new processes in the NWCF is the possibility of utilizing the existing NWCF structure, shielding, access to tank farm feed, utilities, chemical makeup, etc. With the NWCF and its equipment nearly 20 years old, finding spare parts and maintaining the aging equipment is becoming difficult. Spare parts are difficult to obtain, since many manufacturers no longer produce the equipment models installed in the NWCF.
- b) Previous INTEC experience with installing new processes in existing facilities has shown that cell penetrations are seldom in the correct locations nor are there sufficient penetrations for the new process. The scope of this problem is usually not fully understood until late in the title design phase causing escalation in the design and construction cost estimates.
- c) The building was designed for NWCF remote operations and not for CsIX operations. The cell windows, PARs and masterslaves may not be in the proper locations to provide for truly remote activities.
- d) The UDS may contain a high percentage of U-235. Concentrating the solids through evaporation could pose a criticality hazard and the equipment selection and layout did not consider criticality issues.
- e) Since new equipment will be installed in existing cells and some existing equipment will be utilized, system operability (SO) testing will be conducted in a contaminated facility with contaminated equipment. As a result, the testing process will be more complicated, last longer, and be more expensive.
- f) Design philosophy at the INTEC has been to minimize the number of mechanical items (i.e. valves, pumps, etc.) in cell. The CsIX process requires several mechanical items, and the NWCF building scenario leaves few options for equipment placement. As a result, several pieces of mechanical equipment were located in cell in direct violation of this design philosophy.
- g) The CsIX layout calls for spent resin to be sluiced approximately 100 feet horizontally and 30 feet vertically from the adsorber cell to the top of the calciner cell. Such a transfer is possible, however questions surround its feasibility.
- h) Radiation fields in excess of 100 R/hr raise questions concerning the reliability and life span of electrical and mechanical components.

⁷ Conversation with Juile Tripp on September 1, 1998

- i) NWCF filters are being stored in the hot sump tank removal cell while waiting to be processed through the filter leach process at the rate of 0 – 100 filters per year. The filters must be removed and leached prior to construction, otherwise an alternate storage location must be found.

ALARA Estimate

The table below lists the in-cell construction hours and general body field estimates⁸ for both demolition and construction activities. The total estimated exposure for installing equipment in the NWCF is 1,528 R.

CELL	DEMOLITION (Hours)	GENERAL BODY FIELDS (mR/hr)	DEMOLITION (R)	NEW WORK (Hours)	GENERAL BODY FIELDS (mR/hr)	NEW WORK (R)
CALCINER	1,674	100	167	8,254	20	165
ABSORBER	8,263	97	801	12,582	10	126
FILTER CELL/VALVE CUBICLE	0		0	7764	30	233
SUMP	0		0	1,911	5	10
MISC.	225	85	19	305	20	6
TOTALS	10,162		988	30,816		540

⁸ Attachment C

Attachment B
CslX/TRU Feasibility Study
Equipment List

Cell	Equipment No.	Description
Adsorber Cell	V-104-A	CslX Column
	V-104-B	CslX Column
	V-104-C	CslX Column
	F-101-A	UDS Filter
	F-101-B	UDS Filter
	T-103-A	IX Effluent Hold Tank
	T-103-B	IX Effluent Hold Tank
	T-108	UDS Slurry Tank
	EV-101	UDS Evaporator
	E-101	Evaporator Condenser
	None	UDS Drum Loading
	EH-101	Off-gas Superheater (HE-NCC-335)
	E-103	Vent Condenser (HE-NCC-336)
	V-101	Mist Collector (VES-NCC-136)
Calciner Cell	V-106	Spent Resin Prep Tank
	D-102	Resin Drier
	E-102	Drier Condenser
	T-112	Spent Resin Storage Tank
	P-104-A	Spent Resin Sluice Pump
	P-104-B	Spent Resin Sluice Pump
	F-102	Resin Fines Filter
Valve Cubicle	P-101-A	Liquid Waste Feed Pump
	P-101-B	Liquid Waste Feed Pump
	P-103-A	CslX Effluent Pump
	P-103-B	CslX Effluent Pump
	P-107	UDS Evaporator Feed Pump
	P-112	Spent Resin Transfer Pump
	Valves	~30 Remote Valves
Hot Sump Tank Removal Cell	None	5-Ton Crane
	None	UDS Drum Glove Box
Room 429	T-102	DI Water Tank
	P-102-A	DI Water Pump
	P-102-B	DI Water Pump

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-07
EDF Serial Number – EDF-CsIX-009
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Attachment C
CsIX/TRU Feasibility Study
Memo from H.K. Peterson

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: September 23, 1998

To: H. S. Forsythe MS 3625 6-1603

From: H. K. Peterson *H. K. Peterson* MS 2107 6-8657

Subject: SHIELDING REQUIREMENTS FOR HIGH LEVEL WASTE PROCESSING COMPONENTS LOCATED IN THE NWCF-- HKP-16-98

References: a) H. K. Peterson ltr to J. L. Clapp, SHIELDING REQUIREMENTS FOR HIGH LEVEL WASTE PROCESSING COMPONENTS, HKP-15-98, August 31, 1998
b) MicroShield, Version 5.01, Grove Engineering, Rockville MD

Shielding calculations have been made that define the shielding requirements for the high level waste processing components (Ref.a). These requirements were compared against the shielding available for the proposed component placement in the NWCF as illustrated in Sketches 1 through 5. As proposed, the component placement positions the components where they will be more than adequately shielded. The modifications to this NWCF arrangement involve shielding overpacks for the waste drums before they are moved out of the cell where they are loaded and involve a shielded platform above the spent resin storage tank (T-112). All calculations were performed with the MicroShield (Ref.b) computer code and are appended for reference.

As discussed and tentatively decided, the overpacks should reduce the waste drum surface radiation field to a contact-handleable field, i.e., 200 mR/hr. The overpack thickness to accomplish this attenuation is 1.1 inches of lead (Pb) or 3.5 inches of steel.

The shielded platform proposed for above the spent resin storage tank was also sized to attenuate the radiation field at the top of the cell to 200 mR/hr. The thickness of this platform to accomplish this attenuation is 2.5 ft. of concrete or 6.25 inches of steel.

MicroShield input/output listings are on file with the Letter File copy of this analysis should they be required for reference or review. If there are any questions or comments concerning this analysis, please call me at the above-listed number.

hkp

cc: P. D. Ritter, LMITCO, MS 2107 *PD*
G. J. Stormberg, LMITCO, MS 2107 *GJS*
HKP Letter File

Attachment D
CsIX/TRU Feasibility Study
E-Mail from M.M. Dumas

Maria M. Dumas
10/1/98 10:28 AM

Subject: NWCF Cell Radiological Field Estimates

As requested, Griff Colson and I have come up with estimates for three NWCF process cells that are intended to be utilized in the CsIX process. We were asked to provide general body fields (GBF) after decontamination for the calciner cell (room 214), adsorber cell (room 206), and filter cell/valve cubicle (room 216). One year should be allowed to perform the necessary decontamination work prior to start of construction.

Calciner cell: Based on historical performance, this cell can be decontaminated to an average GBF of 300 mR/hr gamma. We believe that with use of considerable creative decontamination methods and with no regard to minimization of liquid waste generation that the cell can be decontaminated to 100 mR/hr gamma. Construction would then install permanent shielding walls in the cell and further in cell work would take place behind this shielding. The estimate for the GBF within this shielded area is 20 mR/hr gamma.

Adsorber cell: This cell has not been fully decontaminated in several years therefore estimates are based on the current undecontaminated radiological fields and a conservative assumption is made for what we reasonably believe we can decontaminate the cell to based on performance in other cells. After decontamination the cell's estimated GBF will be 300 mR/hr gamma. Construction would then remove the existing equipment from the cell in a manner to remove the equipment producing the higher fields first. After equipment removal the GBF is estimated to be 10 mR/hr gamma. Assume that the average GBF for the course of then entire ripout would be 97 mR/hr gamma.

Filter cell/valve cubicle: Based on historical performance, this cell can be decontaminated to an average GBF of 100 mRem/hr. We believe that with use of considerable creative decontamination methods and with no regard to minimization of liquid waste generation that the cell can be decontaminated to 30 mR/hr gamma. This assumes that all filters that are currently stored in the area are removed and either leached or stored in other areas of NWCF. It is estimated that if any further reduction in GBF is made after equipment removal it will be negligible due to the small amount of equipment to be removed (adsorber cell valve loops) relative to what will remain in the cell (filter banks and blend and hold cell valve loops).

Attachment E
CslX/TRU Feasibility Study
Scenario 2 Drawings

Drawing Number	Description
2M-2	Scenario 2, CPP-659 3 rd Level Demolition Plan
2M-3	Scenario 2, CPP-659 3 rd Level Plan
2M-4	Scenario 2 Sections
2M-5	Scenario 2 Sections
2M-6	Scenario 2, CPP-659 1st Level Plan

NOTES

1. CROSS HATCHED EQUIPMENT INDICATES DEMOLITION.
2. NOT ALL OF THE EQUIPMENT TO BE DEMOLITIONED IS SHOWN ON DRAWING. FOR COMPLETE LIST OF EQUIPMENT TO BE DEMOLITIONED SEE ABSORBER CELL DEMOLITION LIST BELOW.

ABSORBER CELL DEMOLITION LIST

- YES-HCC-112
YES-HCC-113
YES-HCC-114
YES-HCC-116
YES-HCC-138
HE-HCC-333
HE-HCC-334
HE-HCC-335

[illegible]

DATE	10/10/73	BY	SK-4
DESIGNED	10/10/73	CHECKED	SK-4
DRAWN	10/10/73	IN CHARGE	SK-4
SCALE	1/4"=1'-0"		
SHEET	1	TOTAL	3

Rev. 08/22/78 - 337 PM
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 10/10/73

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.4 Handling & Storage

Title: Drum Head Space Sampling and Inspection

Summary:

This EDF documents the requirements, assumptions, description, and calculations for the Drum Headspace Sampling and Inspection system.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the Sampling and Inspection stations.
- Attachment C – Sequence of moving a Drum through the Sampling and Inspection Station
- Attachment D – Sketches and Drawings

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130	<i>[Signature]</i>	10/22/98	<i>[Signature]</i>	10/23/98

Attachment A
CsIX/TRU Feasibility Study

General

This EDF describes the systems required to meet WIPP requirements for detection of free liquids in grout filled drums, and the need to take a gas sample of a drum's headspace.

The sampling and inspection will take place in a separate area within the interim storage facility. The drums will be stored in this temperature-controlled area for a 72-hour period prior to inspection and gas sampling. The system is remotely automated, but requires operator interface for inspection and drum feed. A drum oven will be used to evaporate off any liquid contents of the drums if inspection reveals the grout has not cured.

Assumptions

1. Baking of the drum contents will remove liquid if the grout did not cure properly.
2. Video inspection through the drum lid filter hole is attainable.
3. Hydrogen levels of the drum headspace will not require special combustion construction of the inspection booth.
4. Drum radiation levels are at contact limits.

Requirements

1. A drum being sent to WIPP must not contain free liquids in excess of 0.5% of the volume of the drum.
2. Drum VOC and Hydrogen levels must be below WIPP prescribed levels.
3. A drum must be temperature conditioned for a 72-hour period prior to the sampling and inspection.
4. A drum-baking oven will be required to cure drum grout that did not set properly.

Process Description

Pallets of drums will be moved from the Interim storage area to the conditioned space of the inspection and sampling area. Drum pallets will be stacked 2 high and require a 72-hour holding period. This time period allows the contents of the drum to reach a 70 °F (21 °C) temperature. Approximately 18 pallets (72 drums) must be maintained in the inspection area at all times. This allows the capacity of 1 TRUPACT shipment per day to WIPP if required.

After the 72-hour period has elapsed the drum will be placed on a staging conveyor. The drum bar code will be scanned to identify it for tracking and inspection results. The drum is initially conveyed to a locating/positioning table for positioning of the drum lid filters. This system is identical to that used in the drum dewatering system in the grouting facilities. After indexing, the drum is passed through an airlock to a glovebox where inspection and sampling occur.

Once positioned in the glovebox, a clear hood will be lowered over the drum lid to provide additional radiological containment. All subsequent inspection and sampling activities will occur within the hooded environment. A filter removal/headspace sampler tool will lower to and engage one of the predetermined drum lid filters. The filter will be twisted into the drum and allowed to drop into the headspace of the drum. During this same operation, a headspace gas sample will be taken as soon as the filter is removed. The filter removal/headspace sampler tool will be removed and a fiber optic video camera with lighting will be moved into position over the drum opening. The fiber optic camera will be lowered through the opening and digitally record a 360 degree rotational view of the drum headspace. Operator interface on the video inspection will be required. After video inspection, the camera will be removed and a new bung plug installed. The clear hood will rise from the drum and a mechanical arm will be used to take a RadCon swipe of the drum lid surface. On-line counting will be provided for swipe examination. Once cleanliness of the drum top is verified, the drum will pass through an exit airlock to an unloading conveyor.

If a drum is visually determined not to have set or cured, it will be removed from the unloading conveyor and moved to a drum oven. The oven will be steam heated and ventilated to the inspection booth exhaust system. Capacity of the drum oven will be 4 drums. The drums will be baked at 350° F (176.6° C) for a 72-hour period to evaporate off any moisture that may be present in the mixture. Following this baking of the drum contents another headspace inspection will be performed.

When inspections are complete, the drums will be transferred to the TRUPACT II loading facility. Drums will be placed in TRUPACT shipping units and shipped to WIPP for storage.

Attachment B
CsIX/TRU Feasibility Study

Equipment list for Drum head Space Sampling and Inspection station

Inlet/Load Conveyor – SST, chain drive, 10 ft long, 2Hp
Index Table – SST, self-powered rollers, 3 ft long, 1200 watts
 Index lift table – SST, 18 in. diameter, 1.5 Hp
 Index table rotation – ½ Hp
Index arm – roller assembly, arm, no power required.
Airlock – 7 gauge, ST with window and HEPA filter
 Airlock inlet doors – motor driven, SST, ½ HP
 Airlock conveyor – SST, self powered rollers, 4 ft long, 1600 watts
Glovebox – 7 gauge, SST with window and HEPA filter
 Glovebox inlet doors – SST, motor driven, ½ Hp
 Glovebox conveyor – SST, self powered rollers, 5 ft long, 2000 watts
 Video camera – hardened, ½ in. optic lens, rotatable, 1500 watts
 Headspace sample tube – SST, no power required
 Mechanical swipe arm – Auto swipe of area, remote, on-line counting, 3000 watts
 Hood enclosure – Clear, no power required
 Filter removal arm – SST, automated, 400 watts
 Filter installation arm – SST, automated, 400 watts
 Glovebox outlet doors – SST, motor driven, ½ Hp
Airlock – 7 gauge, SST with window
 Airlock conveyor – SST, self powered rollers, 4 ft long, 1600 watts
 Airlock outlet doors – SST, motor driven, ½ Hp
Unload conveyor – SST, Chain driven, 10 ft long, 2Hp
Glovebox exhaust fan – 2 each, 2 Hp, one unit on back-up power
Airlock exhaust fan – 2 each, 1 Hp, one unit on back-up power
Drum Bake Oven – Steam heated, SST, Pallet type

Attachment C
CsIX/TRU Feasibility Study

Sequencing of moving a Drum through the Sampling and Inspection Station:

A pallet of drums will be moved into headspace sampling and inspection area for 72-hour period. One drum will be removed from a pallet and placed on the staging conveyor to the inspection/sampling system. The bar code on the drum will be scanned for identification and inspection tracking. The staging conveyor starts and moves the drum to the locating/positioning table. Once the drum has reached the locating/positioning table, the staging conveyor stops.

The locating/positioning table raises the drum a predetermined height to the filter locating mechanical arm and stops. The table then rotates the drum for locating one of the lid filters. After the filter has been located, the drum has been positioned. The table then lowers the drum back to the staging conveyor.

When the drum has been lowered back to the conveyor, the doors to the inlet airlock will open and the conveyor moves the drum into the airlock. When the drum has moved into the airlock the conveyor stops and the inlet doors to the airlock close. Once the inlet doors to the airlock are closed the inlet doors to the inspection booth open. The airlock conveyor starts and moves the drum into the inspection booth. Once inside the inspection booth and positioned, the conveyor will stop. The inlet doors to the inspection booth close and inspection procedures begin.

A clear hood will lower from the ceiling of the booth and seal to the top of the drum. A filter/gas-sampler tool will move into position over the filter that was indexed. The tool will lower to the filter and engage into the filter. The filter will be twisted into the drum and allowed to drop into the drum headspace. A gas sample is drawn with the same tool as soon as the filter is removed. The filter/gas sampler tool is moved aside and a fiber optic camera with a lighted end will move into position over the filter hole. The camera will be lowered into the drum headspace and a 360-degree rotation will be made. Operator interface is required during this video inspection. Once the inspection is complete, the camera will raise and move aside. A plug installation tool will move into position over the drum filter hole. A new drum bung plug will lower on the installation tool end and be twisted into the drum lid. The plug tool will move aside and a RadCon mechanical swipe arm will move to the filter area. The RadCon arm will lower and swipe the area around the filter area. Once swiping is complete, the mechanical arm will raise and deposit the swipe in an on-line counter. Once cleanliness is verified, the mechanical arm and clear hood will rise and move aside. Inspection procedures are now complete.

After the RadCon arm and clear enclosure hood are moved aside, the exit doors to the inspection booth will open. The inspection booth conveyor will start and move the drum into the inspection booth exit airlock. Once the drum is inside of the airlock, the conveyor will stop and the inspection booth exit doors will close. After the inspection booth exit doors are closed, the airlock exit doors will open and the airlock conveyor will start. The airlock conveyor will move the drum out of the airlock and onto the unloading conveyor. When the drum is out of the airlock, the airlock exit doors will close and the unloading conveyor will move the drum to the end of the conveyor line. When the drum has reached the end of the unloading conveyor line, the conveyor will stop.

Drums will be removed from the unloading conveyor and placed on pallets. The pallets will then be taken, via forklift, to the TRUPACT II loading station for shipment to WIPP. If a drum does not meet video inspection requirements, it will be baked in a steam heated drum oven. Drums placed in the oven will be baked for a 72-hour period at 350 °F (176 °C). After the drum has completed the baking period, it will be sent back to the beginning of the inspection system and inspected again.

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06/17/97
Rev. #04

ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-09
EDF Serial Number – EDF-CsIX-010
Page 1 of 1

Attachment D
CsIX/TRU Feasibility Study
Sketches and Drawings

9/24/98

Head Space Sampling & Video Inspection

Br 1

Interim Storage Facility

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AS Jd. Reg.

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.5 Facility Design

Title: HVAC – Scenario 1

Summary:

This EDF describes documents requirements, assumptions, description, and calculations for the HVAC systems required for Scenario 1.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the Scenario 1 HVAC Systems.
- Attachment C – Supporting Calculations
- Attachment D – Sketches and Drawings

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130	<i>ME for Sisk</i>	10/27/98	<i>K.L. Williams</i>	10/27/98

Attachment A
CsIX/TRU Feasibility Study

General

This EDF describes the HVAC system required for the Scenario 1 Facility. The Interim Storage Facility and TRUPACT II Loading Facility are included in this EDF and are common to both scenarios. The Off-Gas system is covered under EDF-CsIX-013.

The HVAC system is comprised of three different zones for the Grouting facility. Each zone has its own air handling system. The primary and secondary zones have redundant systems with one redundant system connected to standby power for continuous operation. The office space has a split DX system with heating and the grouting process area has heating only. The Interim Storage Facility has both steam heating and DX cooling for the Headspace Sampling area within the storage unit. The TRUPACT II loading facility is heated with electric unit heaters. All three systems are as described below.

Assumptions

1. Eight air changes per hour for primary confinement.
2. Four air changes per hour for secondary confinement.
3. 20 cfm per person of outside air for administrative areas.
4. Only roughing filters are required on secondary zone outside air intake.
5. Only primary zone return air will require redundant HEPA filtration prior to discharge to the stack.

Requirements

1. The CsIX/TRU Grout building will be required to have two ventilation confinement zones per DOE Order 6430.1A.
2. Ventilation for primary and secondary zones are once through systems.
3. Steam heating will be used where applicable.
4. HEPA filtration will be required on both the primary and secondary zones.

Process Description

The HVAC system is comprised of three zones within the Grouting facility. These zones are primary confinement, secondary confinement, and office space. Pressure of the different zones are +0.1 inch W.C. for office space, -0.5 inch W.C. for secondary confinement, and -0.75 inch W.C. for primary confinement. Airflows and equipment will be as follows.

The office space of the facility will have a split direct expansion (DX) system with steam heating. The air handler will be located in the office space to eliminate the possibility of contamination and will provide 2800-CFM of air to the space. 285-CFM of fresh air for occupants will be taken in through a louvered inlet. Heating will be from a steam coil and cooling will be from a DX unit. The total loads for the office space are 7 Tons of cooling and 120 MBH of heating at the AE standards design conditions for the INEEL. Estimated annual energy consumption for heating the structure using a single measure check is 169.5×10^3 lbs. of steam per year. Annual cooling energy requirements using a single measure check are estimated at 11,168 kWh per year. The condenser or cooling unit will be located on a slab outside of the office space on the north side of the facility. Outside air will be introduced through a louvered inlet on the side of the building. See calculations for details on heating and cooling loads.

The Heating and Ventilation system for secondary confinement will be located on the third floor on the north end of the facility. Outside air will be taken into the system from a louver on the north side of the facility. The air will be rough filtered, heated, and then distributed to various locations throughout the building. The secondary confinement air system will be the main source of heating the process side of the building. 10500-CFM of outside air is required for this system. CFM quantities are based on a volumetric basis. Secondary zone air requirements are 4 air changes per hour for the area served. Heating will be from steam coils and require 2917 MBH of heating capacity. Estimated annual energy consumption for heating the building using a single measure check is 4.12×10^6 lbs. of steam per year. There will be two airhandlers for supply to the secondary confinement areas. The primary airhandling unit will be connected to backup power. There are two airhandlers for maintenance and failure purposes. Once air is passed through the secondary zone, it will be HEPA filtered prior to being supplied to the primary zone or discharge to the stack. Two 2x5 HEPA filter housings will be installed, one HEPA housing serve one airhandler. See airflow schematic in Appendix D for more detail on airflow patterns and equipment layout.

Exhaust from the secondary confinement zone will be from a duplicate set of airhandlers. One of the airhandler units will be connected to backup power for maintenance and failure purposes. These exhaust airhandlers also supply air to the

primary confinement zone and discharge to the stack. Air that is supplied to the primary confinement zones is exhausted by another set of airhandlers. Not all of the secondary confinement air is supplied to the primary confinement system and is sent to the stack.

The Ventilation system for the primary confinement zone will be located on the north side of third floor in the facility, see drawing 1-A3. The primary containment heating and ventilation system will receive air from the secondary containment system. The air discharged from the secondary zone is single HEPA filtered before entering into the primary zone. No heating or cooling capability is provided for the primary confinement zone system. Ductwork will be welded SST and be routed in areas not occupied by personnel. The primary zone system does not require the airflow that the secondary system does and for this reason, the secondary containment system bypasses 1000-CFM to the stack. See Scenario 1 airflow sketch in Appendix D for more detailed information on flow pattern. 9500-CFM of air is supplied to the primary confinement zone. CFM quantities are based on a volumetric basis. Primary confinement zone air requirements are 8 air changes per hour for the area served. The airhandler and HEPA filter system is redundant for maintenance and failure purposes. The primary airhandling unit will be connected to back up power. Once air has passed through the primary confinement zone, it will be double HEPA filtered and discharge to the stack.

The Interim Storage Facility has one area within the building that will be conditioned. This area is the headspace sampling area. The HVAC system in this area will be a split DX system. Heating will be from steam supplied to the facility. The air handler will be located above the headspace sampling area. The airhandler will deliver 3600-CFM of air to the space and requires a 107 MBH heating coil. 200-CFM of outside air will be taken in through a louvered inlet on the wall of the facility. Estimated annual energy consumption for heating the inspection area using a single measure check is 1561.2×10^3 lbs. of steam per year. Estimated annual cooling energy using a single measure check is 19,553 kWh per year. The 9-ton condensing unit will be located outside the facility on a concrete pad. There are two exhaust systems in this facility. The Inspection and Headspace sampling booth requires an exhaust system. This system will be connected to the inspection booth and the two air locks. The exhaust will be filtered with glovebox style HEPA filters. See EDF-CsIX-010 for more information on the inspection booth equipment. The main exhaust system is two 7.5 Hp dual speed utility units that ventilates the interim storage area. 14000-CFM is exhausted by each of the two main exhaust systems for a total of 28000-CFM ventilation. These main exhaust systems provide 0.5 CFM/ft² ventilation for the main interim storage area. Outside air is introduced into the facility by louvered inlets along the bottom of the outside walls.

The TRUPACT II Loading Facility will be electrically heated with unit heaters. The basis for electric heating on this building was the existing unit that is located at RWMC. The heaters will be ceiling mounted and be 20 kW each. There will be 12 unit heaters required to heat the facility when being ventilated by the exhaust system at AE design standard conditions. Estimated annual energy consumption for heating the building using a single measure check is 397,917 kWh per year. The exhaust system is very similar to the Interim Storage Facility. The ventilation fans are a sidewall unit and louvered inlets on the bottom of the outside walls allow air to enter the facility. Each fan provides 2250-CFM of ventilation when in operation for a total of 4500-CFM. Information provided on the TRUPACT II loading facility is based on existing plans that are available. See Appendix C for more information on calculated heating loads and Appendix D for plans of the existing facility at RWMC.

Attachment B
CsIX/TRU Feasibility Study
Equipment list for the Scenario 1 HVAC System

Grouting Facility

Office space airhandler – 2800-CFM, 2.75 inch W.C., steam heat coil, 3 Hp
Condenser – 7 ton cooling capacity, DX, pad mounted, 7.8 kWatts
Secondary confinement – Backward inclined Utility fan, Class II, 10,500-CFM,
3.4 inch W.C., SST, 15 Hp, 2 each, one connected to backup power
HEPA filter housing – 2x5, 10,500-CFM, SST, 2 each
Steam heat coils- 2917 MBH total load
Primary confinement supply fan – Backward inclined utility fan, Class II,
10,500-CFM, 6.75 inch W.C., SST, 15 Hp, 2 each
Exhaust Fan – Backward inclined utility fan, Class II, 10,500-CFM,
6.75 inch W.C., SST, 15 Hp, 2 each
HEPA filter housing – 2x5, 10,500-CFM, SST, redundant filters, 2 each

Interim Storage Facility

Inspection/Storage Airhandler – 3600-CFM, 2.75 inch W.C., steam heat coil, 3 Hp
Condenser – 9-ton cooling capacity, DX, pad mounted, 10.2 kWatts
Exhaust fan – Backward inclined utility fan, 7.5 Hp, two speed motor,
14000-CFM, 2 each

TRUPACT II Facility

Electric Unit heater – 20 kW, 12 each
Exhaust fan – Sidewall exhauster, ½ Hp, two speeds, 2250-CFM, 2 each

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-10
EDF Serial Number – EDF-CsIX-011
Page 1 of 1

Attachment C
CsIX/TRU Feasibility Study
Supporting Calculations

①
BFG

Growing
Here

Office Space: Single Measure Method

Assumed: $C_D = 0.62$

$$\text{Heat} = \frac{C_D \times 24 \times Q \times DD}{K \times Y \times \Delta T}$$

$$= \frac{0.62 \times 24 \times 2,917,000 \times 8640}{1.0 \times 1.0 \times 91^\circ \text{F}} = 4.121 \times 10^9 \frac{\text{Btu}}{\text{Year}}$$

$$= 4.121 \times 10^9 \frac{\text{Btu}}{\text{Year}} * \frac{1 \text{ Btu}_{\text{steam}}}{1000 \text{ Btu}} = 4.121 \times 10^6 \frac{\text{Btu}_{\text{steam}}}{\text{Year}}$$

$$\zeta = 1.0$$

$$\gamma \approx 1.0$$

$$D'D = 861$$

$$\Delta T = 91.67^\circ\text{F}$$

$$Q_T = 2,917,000 \frac{\text{Btu}}{\text{hr}}$$

Office Space: Single Measure Method

Assumed $C_D = .62$

$$\text{Heat} = \frac{C_p \times 24 \times Q_T \times DD}{K \times V \times \Delta T}$$

$$= \frac{0.62 \times 24 \times 120,000 \times 8640}{1.0 \times 1.0 \times 91} = 169.5 \frac{\text{Btu}}{\text{Year}}$$

$$= 169.5 \frac{\text{Btu}}{\text{Yea}} \times \frac{1 \text{ Bream}}{1000 \text{ Btu}} = 169.5 \frac{\text{Bream}}{\text{Year}}$$

$$K = 1.0$$

$$V = 1.0$$

$DD = 80$

$$\Delta T = 91^{\circ}\text{F}$$

$$Q_T = 120,000 \frac{\text{Btu}}{\text{hr}}$$

Total Steam Heat Consumption - Scenario #1 Grout Facility

$$4.121 \times 10^6 + 169.5 \times 10^3 = 4.29 \times 10^6 \frac{\text{lb steam}}{\text{Year}}$$

500 SHEETS, FILLER 5 SQUARE
50 SHEETS EYE-EAST® 5 SQUARE
100 SHEETS EYE-EAST® 5 SQUARE
200 SHEETS EYE-EAST® 5 SQUARE
100 RECYCLED WHITE 5 SQUARE
200 RECYCLED WHITE 5 SQUARE

Scenario #1 Energy Consumption - Cooling

②
BKG

OFFICE SPACE: Single Measure Check

Assumed: $\alpha_p = 0.1$

$$COF = 2.8 \text{ Ave}$$

$\angle DD = 343$

operation = 10 hr/day
36 Day/Year

From Calc's:

$$BLC = OA = 346.5$$

$$F_{cool} = \frac{24 * BLC * CDD * (1 + \alpha_o)}{COP}$$

$$= \frac{24 * 346.5 * 343 * (1 + 0.1)}{2.8} = 1.12 \times 10^6 \frac{\text{Btu}}{\text{Year}}$$

$$= 1.12 \times 10^6 \text{ Btu/year}$$

OTHER GAZONS: from Calc's

$$OSA = 5,244 \frac{\text{Btu}}{\text{hr}}$$

$$E_g := \frac{43,434 \text{ Btu}}{\text{lb}}$$

Total 48,678 $\frac{Btu}{Hr}$

$$F_{Iq} = 48,678 \times 10 \times 76 = 36,99 \times 10^6 \frac{\text{Blu}}{\text{year}}$$

Total Energy Consumption:

$$E_{total} = 36.99 \times 10^6 + 1.12 \times 10^6 = 38.11 \times 10^6 \frac{\text{Btu}}{\text{Year}}$$

$$= 11,168 \frac{\text{kWh}}{\text{Year}}$$

13 702 500 SHIFTS, FULL 5 SQUARE
42 381 50 SHIFTS, FIVE CASE 5 SQUARE
42 382 100 SHIFTS, FIVE CASE 5 SQUARE
42 389 200 SHIFTS, FIVE CASE 5 SQUARE
42 390 300 SHIFTS, FIVE CASE 5 SQUARE
42 391 100 CYCLED WASH 5 SQUARE
42 399 200 CYCLED WASH 5 SQUARE

Page 615 A

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BKG

Foot Print of A.H. is 3'x8'

by
the National Brand

9/24/98

ZONE 3 Air Requirements - Option 1

⑧
BKGAssumed: once thru air
8 A.C. / Hr

$$1^{st} \text{ Floor Area} \approx 3400 \text{ ft}^2 @ 12' \text{ Height} = 40,800 \text{ ft}^3$$

$$2^{nd} \text{ Floor Area} \approx 3050 \text{ ft}^2 @ 10' \text{ Height} = 30,500 \text{ ft}^3$$

$$\text{Total } 71,300 \text{ ft}^3$$

$$71,300 \times 8 \text{ A.C. / Hr} = 570,400 \frac{\text{ft}^3}{\text{Hr}} \approx 9,500 \text{ CFM} - 10 \text{ HEPA's}$$

Exhaust:

SP Calc's

$$\text{Space, Static} - 0.75''$$

$$\text{HEPAS - Dirty} - 4.0''$$

$$\text{Ducting - Assumed} - 2.0''$$

$$6.75'' \text{ W.C.}^*$$

* Supply from Zone 2 to Zone 3 Assume equal, ~~10~~
HEPA's Sized from Zone 2 supply Air

Eg:

Require two Systems; one for Backup and Change out
one of each Fan hooked up to Backup Power

Exhaust from Zone 3

2ea - Fans - 9,500 CFM @ 6.75" W.C., Class II, SST, 15 HP

2ea - HEPA Housings - 2x5 Redundant, SST.

Supply to Zone 3:

2ea - Fans - 10,500 CFM @ 6.75" W.C., Class II, SST, 15 HP

2ea HEPA Housings - 2x5 Redundant, SST. *

* HEPA Housings Sized from Air Supplied to Zone 2 Area.

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Project:	CslX/TRUE Grout Project		
Calculated by:	B. K. Grover	Date: Sept 24, 98	Checked By: RH
Zone:	Office space	Design Time	5 10 am to 5 pm

HEAT TRANSMISSION & SOLAR HEAT GAIN						
COMPONENT	Gross AREA (FT^2)	Net AREA (FT^2) x	TEMP. DIFF. (DEG. F) x	"U" FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF			62	0.04		
ACTUAL AREA	1,877					
NORTH WALL	1,936	1,839	25	0.06	2,729	
N.E. WALL			25	0.06		
EAST WALL	1,144	1,087	27	0.06	1,741	
S.E. WALL			27	0.06		
SOUTH WALL			31	0.06		
S.W. WALL			61	0.06		
WEST WALL	880	836	72	0.06	3,572	
N.W. WALL			55	0.06		
GLASS TRANS.	198	198	20	0.55	2,178	
MISC.						
MISC.						
COMPONENT	AREA (FT^2)	x SHGF	x CLF	x SC =		
N. GLASS SOLAR	97	37	0.75	0.55	1,477	
N.E. GLASS SOLAR		159	0.23	0.55		
E. GLASS SOLAR	57	215	0.23	0.55	1,556	
S.E. GLASS SOLAR		179	0.29	0.55		
S. GLASS SOLAR		128	0.41	0.55		
S.W. GLASS SOLAR		179	0.59	0.55		
W. GLASS SOLAR	44	215	0.56	0.55	2,914	
N.W. GLASS SOLAR		159	0.51	0.55		
SKYLIGHT SOLAR		254	0.56	0.50		
INTERNAL HEAT GAINS						
CFM per Person =	15	People Cooling Load Factor (CLF)	1.00			
Number of Occupants	19	Lighting Cooling Load Factor (CLF)	0.89			
Btu per Occupant	255	Sensible x CLF	255	Latent	4,845	4,845
Lights	2	W.Hr/FT^2	3,754	x 3.413 x CLF =	11,403	
Power	5	W.Hr/FT^2	9,385	x 3.413 =	32,031	
OUTSIDE AIR HEAT GAIN						
	CFM			Constant		
Sensible	285	Temp. Diff.	20	0.92	5,244	-
Latent	285	Ratio Difference	-0.0022	4840	-	Neg. Value
SUBTOTAL					69,690	4,845
Safety Factor =					1.10	
					76,659	4,845
Total Heat Gains =					76,659	4,845
Combined Total					- MBH	82
					- TONS	6.8
Total Cooling Load					- Btu/ft^2	43.4
					- Ft^2/Ton	276

Project:		CsIX/TRU Grout Project			
Calculated by:		B. K. Grover		Date: Sept 24, 98	
Zone:		Office space		Checked By: RH	
				Design Time 4	
Heating Transmission Loss					
Exposure	Gross Area Ft^2	Net Area x Ft^2	Temperature x Difference	"U" Factor =	Btu/Hr
Roof			91	0.04	
Walls	3,960	3,762	91	0.06	20,317
Glazing	198	198	91	0.55	9,910
Floor			91	0.54	
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference	
Basement Walls				91	
	Heat Loss x Coefficient	Area x Ft^2		Temperature = Difference	
Basement Floors				91	
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference	
Floor @ Grade	0.65	134		91	7,926
Infiltration Heat Loss					
	Zone Volume Ft^3	Air Changes x Per Minute	Air x Constant	Temperature = Difference	
Infiltration	41,294	0.0167	0.92	91	57,619
Room Height	22.0				
Fresh Air Heating Load					
	CFM x	Temperature x Difference (Degree F)		Air = Constant	
Fresh Air Intake	285	91		0.92	23,860
Total Heating Load				MBH	120
				kW	35
				Btu/Ft^2	64
Outside Balance Point Temperature (deg F)					35

Project:	CsIX/TRU Grout Project	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft:	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity
Winter Design @ 97.5%	-19	72	91	Ratio Difference
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18

Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54

Glazing/Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	Dbl Pain / Tinted	0.55	1-3/4" Metal Door	0.39

Glazing/Glass Doors	Properties	Shading Coefficient
Glazing	Dbl Pain / Tinted	0.55
Skylites	Double Pain	0.50

Project:	CSIX/TRU Grout Project Scenario 1		
Calculated by:	B. K. Grover	Date: Oct. 19,98	Checked By:
Zone:	Grouting Process	Design Time	5 10 am to 5 pm

HEAT TRANSMISSION & SOLAR HEAT GAIN

COMPONENT	Gross AREA (FT^2)	Net AREA (FT^2) x	TEMP. DIFF (DEG. F) x	"U" FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF	14,300	14,300	62	0.04	38,920	
ACTUAL AREA	41,500					
NORTH WALL	2,816	2,675	25	0.06	3,969	
N.E. WALL			25	0.06		
EAST WALL	4,960	4,861	27	0.06	7,789	
S.E. WALL			27	0.06		
SOUTH WALL	2,816	2,816	31	0.06	5,181	
S.W. WALL			61	0.06		
WEST WALL	4,960	4,861	72	0.06	20,770	
N.W. WALL			55	0.06		
GLASS TRANS.	339	339	20	0.55	3,731	
MISC.						
MISC.						
COMPONENT	AREA (FT^2)	x SHGE	x CLF	x SC =		
N. GLASS SOLAR	141	37	0.75	0.55	2,149	
N.E. GLASS SOLAR		159	0.23	0.55		
E. GLASS SOLAR	99	215	0.23	0.55	2,698	
S.E. GLASS SOLAR		179	0.29	0.55		
S. GLASS SOLAR		128	0.41	0.55		
S.W. GLASS SOLAR		179	0.59	0.55		
W. GLASS SOLAR	99	215	0.56	0.55	6,569	
N.W. GLASS SOLAR		159	0.51	0.55		
SKYLIGHT SOLAR		254	0.56	0.50		

INTERNAL HEAT GAINS

CFM per Person =	-	People Cooling Load Factor (CLF)	1.00		
Number of Occupants	-	Lighting Cooling Load Factor (CLF)	0.89		
Btu per Occupant	-	Sensible x CLF	-	Latent	
Lights	-	W/Hr/Ft^2		x 3.413 x CLF =	
Power	-	W/Hr/Ft^2		x 3.413 =	

OUTSIDE AIR HEAT GAIN

	CFM		Constant		
Sensible		Temp. Diff.	20	0.92	-
Latent		Ratio Difference	-0.0022	4840	Neg. Value

SUBTOTAL

				91,776	
--	--	--	--	--------	--

Safety Factor =

1.10

100,954

Total Heat Gains =

100,954

Combined Total

MBH

101

TONS

8.4

Total Cooling Load

Btu/ft^2

2.4

Ft^2/Ton

4933

Project:		CsIX/TRU Grout Project Scenario 1			
Calculated by:		B. K. Grover		Date: Oct. 19,98	Checked By:
Zone:		Grouting Process			Design Time 5
Heating Transmission Loss					
Exposure	Gross Area Ft^2	Net Area x Ft^2	Temperature x Difference	"U" Factor =	Btu/Hr
Roof	14,300	14,300	91	0.04	57,125
Walls	15,552	15,213	91	0.06	82,158
Glazing	339	339	91	0.55	16,977
Floor			91	0.54	
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference	
Basement Walls				91	
	Heat Loss x Coefficient	Area x Ft^2		Temperature= Difference	
Basement Floors				91	
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference	
Floor @ Grade	0.65	486		91	28,747
Infiltration Heat Loss					
	Zone Volume Ft^3	Air Changes x Per Minute	Air x Constant	Temperature = Difference	
Infiltration	1,328,000	0.0167	0.92	91	1,853,003
Room Height	32.0				
Fresh Air Heating Load					
	CFM x	Temperature x Difference (Degree F)		Air = Constant	
Fresh Air Intake	10,500	91		0.92	879,060
		Total Heating Load MBH 2,917			
		kW 855			
		Btu/Ft^2 70			
		Outside Balance Point Temperature (deg F) 72			

Project:	CslX/TRU Grout Project Scenario 1	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft:	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity
Winter Design @ 97.5%	-19	72	91	Ratio Difference
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R-Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18

Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R-Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54

Glazing/Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	DbI Pain / Tinted	0.55	1-3/4" Metal Door	0.39
Glazing/Glass Doors	Properties	Shading Coefficient		
Glazing	DbI Pain / Tinted	0.55		
Skylites	Double Pain	0.50		

Project:		CsIX/TRU Grout Project				
Calculated by:		B. K. Grover		Date: Sept 24, 98		
Zone:		Interim Storage QA inspection area		Checked By: RH		
				Design Time 2 10 am to 5 pm		
HEAT TRANSMISSION & SOLAR HEAT GAIN						
COMPONENT	Gross AREA (FT^2)	Net AREA (FT^2) x	TEMP. DIFF. (DEG. F) x	"U" FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF			48	0.04		
ACTUAL AREA	3,600					
NORTH WALL	720	720	23	0.06	983	
N.E. WALL			27	0.06		
EAST WALL	720	720	25	0.06	1,068	
S.E. WALL			36	0.06		
SOUTH WALL	720	720	46	0.06	1,966	
S.W. WALL			50	0.06		
WEST WALL	720	720	25	0.06	1,068	
N.W. WALL			27	0.06		
GLASS TRANS.			20	0.55		
MISC.						
MISC.						
COMPONENT	AREA (FT^2)	x SHGF	x CLF	x SC =		
N. GLASS SOLAR		37	0.75	0.55		
N.E. GLASS SOLAR		159	0.30	0.55		
E. GLASS SOLAR		215	0.31	0.55		
S.E. GLASS SOLAR		179	0.40	0.55		
S. GLASS SOLAR		128	0.59	0.55		
S.W. GLASS SOLAR		179	0.44	0.55		
W. GLASS SOLAR		215	0.29	0.55		
N.W. GLASS SOLAR		159	0.21	0.55		
SKYLIGHT SOLAR		254	0.67	0.50		
INTERNAL HEAT GAINS						
CFM per Person =	20	People Cooling Load Factor (CLF)		1.00		
Number of Occupants	10	Lighting Cooling Load Factor (CLF)		0.89		
Btu per Occupant	255	Sensible x CLF	255	Latent	2,550	2,550
Lights	2	W Hr/Ft^2	7,200	x 3.413 x CLF =	21,871	
Power	5	W Hr/Ft^2	18,000	x 3.413 =	61,434	
OUTSIDE AIR HEAT GAIN						
	CFM			Constant		
Sensible	200	Temp. Diff.	20	0.92	3,680	-
Latent	200	Ratio Difference	-0.0022	4840	-	Neg. Value
SUBTOTAL					94,619	2,550
Safety Factor =					1.10	104,081 2,550
Total Heat Gains =					104,081	2,550
Combined Total - MBH					107	
- TONS					8.9	
Total Cooling Load -Btu/ft^2					29.6	
-Ft^2/Ton					405	

Project:		CsIX/TRU Grout Project			
Calculated by:		B. K. Grover		Date: Sept 24, 98	Checked By: RH
Zone:		Interim Storage QA inspection area			Design Time 2
Heating Transmission Loss					
Exposure	Gross Area Ft ²	Net Area x Ft ²	Temperature x Difference	"U" Factor =	Btu/Hr
Roof	3,600		91	0.04	
Walls	2,880	2,880	91	0.06	15,554
Glazing			91	0.55	
Floor			91	0.54	
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference	
Basement Walls				91	
	Heat Loss x Coefficient	Area x Ft ²		Temperature = Difference	
Basement Floors				91	
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference	
Floor @ Grade	0.65	240		91	14,196
Infiltration Heat Loss					
	Zone Volume Ft ³	Air Changes x Per Minute	Air x Constant	Temperature = Difference	
Infiltration	43,200	0.0167	0.92	91	60,278
Room Height	12.0				
Fresh Air Heating Load					
	CFM x	Temperature x Difference (Degree F)		Air = Constant	
Fresh Air Intake	200	91		0.92	16,744
Total Heating Load				MBH	107
				kW	31
				Btu/Ft ²	30
Outside Balance Point Temperature (deg F)					(1)

Project:	CsIX/TRU Grout Project	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft:	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity
Winter Design @ 97.5%	-19	72	91	Ratio Difference
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18
Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54
Glazing/Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	Dbl Pain / Tinted	0.55	1-3/4" Metal Door	0.39
Glazing/Glass Doors	Properties	Shading Coefficient		
Glazing	Dbl Pain / Tinted	0.55		
Skylites	Double Pain	0.50		

Project:	CsiX/TRU Grout Project		
Calculated by:	B. K. Grover	Date: Oct. 19, 98	Checked By:
Zone:	TRUPACT II Loading Station	Design Time	2 10 am to 5 pm

HEAT TRANSMISSION & SOLAR HEAT GAIN						
COMPONENT	Gross AREA (FT ²)	Net AREA (FT ²) x	TEMP DIFF (DEG F) x	U FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF	8,000	8,000	48	0.04	16,857	
ACTUAL AREA	8,000					
NORTH WALL	2,418	2,418	23	0.06	3,300	
N.E. WALL			27	0.06		
EAST WALL	1,920	1,920	25	0.06	2,849	
S.E. WALL			36	0.06		
SOUTH WALL	2,418	2,418	46	0.06	6,600	
S.W. WALL			50	0.06		
WEST WALL	1,920	1,920	25	0.06	2,849	
N.W. WALL			27	0.06		
GLASS TRANS			20	0.55		
MISC						
MISC						
COMPONENT	AREA (FT ²)	x SHGF	x CLF	x SC =		
N GLASS SOLAR		37	0.75	0.55		
NE GLASS SOLAR		159	0.30	0.55		
E GLASS SOLAR		215	0.31	0.55		
SE GLASS SOLAR		179	0.40	0.55		
S GLASS SOLAR		128	0.59	0.55		
SW GLASS SOLAR		179	0.44	0.55		
W GLASS SOLAR		215	0.29	0.55		
NW GLASS SOLAR		159	0.21	0.55		
SKYLIGHT SOLAR		254	0.67	0.50		

INTERNAL HEAT GAINS					
*CFM per Person =	-	People Cooling Load Factor (CLF)	1.00		
Number of Occupants	-	Lighting Cooling Load Factor (CLF)	0.89		
*Btu per Occupant	-	Sensible x CLF	-	Latent	
*Lights	-	W/Hr/FT ²		x 3.413 x CLF =	
*Power	-	W/Hr/FT ²		x 3.413 =	

OUTSIDE AIR HEAT GAIN					
	CFM		Constant		
Sensible		Temp. Diff.	20	0.92	-
Latent		Ratio Difference	-0.0022	4840	Neg. Value
SUBTOTAL				32,454	
Safety Factor =				1.10	35,699

Total Heat Gains =		35,699
Combined Total	MBH	36
	TONS	3.0
Total Cooling Load	Btu/ft ²	4.5
	ft ² /Ton	2689

Project:	CsIX/TRU Grout Project					
Calculated by:	B. K. Grover		Date: Oct. 19, 98	Checked By:		
Zone:	TRUPACT II Loading Station			Design Time	2	
Heating Transmission Loss						
Exposure	Gross Area Ft^2	Net Area x Ft^2	Temperature x Difference	"U" Factor =	Btu/Hr	
Roof	3,600	8,000	91	0.04	31,958	
Walls	8,675	8,675	91	0.06	46,850	
Glazing			91	0.55		
Floor			91	0.54		
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference		
Basement Walls				91		
	Heat Loss x Coefficient	Area x Ft^2		Temperature = Difference		
Basement Floors				91		
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference		
Floor @ Grade	0.65	360		91	21,294	
Infiltration Heat Loss						
	Zone Volume Ft^3	Air Changes x Per Minute	Air x Constant	Temperature = Difference		
Infiltration	192,000	0.0167	0.92	91	267,904	
Room Height	24.0					
Fresh Air Heating Load						
	CFM x	Temperature x Difference (Degree F)		Air = Constant		
Fresh Air Intake	4,500	91		0.92	376,740	
Total Heating Load					MBH	745
					KW	218
					Btu/Ft^2	93
Outside Balance Point Temperature (deg F)						72

Project:	CsIX/TRU Grout Project	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity Ratio Difference
Winter Design @ 97.5%	-19	72	91	
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18
Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54
Glazing/Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	DbI Pain / Tinted	0.55	1-3/4" Metal Door	0.39
Glazing/Glass Doors	Properties	Shading Coefficient		
Glazing	DbI Pain / Tinted	0.55		
Skyllites	Double Pain	0.50		

431.02
06/17/97
Rev. #04

ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-10
EDF Serial Number – EDF-CsIX-011
Page 1 of 1

Attachment D
CsIX/TRU Feasibility Study
Sketches and Drawings

240'-0"

D

HEAD SPACE GAS
ANALYSIS & VIDEOSCOPY

60x60

C

30'-0"
TYP

INTERIM STORAGE FACILITY

B

PLAN

User: SEA
Date: 09/17/98 - 07:10 AM

A

240'-0"

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

PLAN

FOR DRAWING INDEX SEE DRAWING NO.		SUBCONTRACT NO.		LOCKHEED MARTIN
NO SCALE		REQUESTER:		INTERIM STORAGE FACILITY					
		DESIGN:							
		DRAWING: BSEARLE							
		PROJECT NO.							
SPEC CODE:		FOR REVIEW/APPROVAL SIGNATURES		PLANS					
DESIGN PHASE:		SEE DAR NO.		SIZE	CAGE CODE	INDEX CODE NUMBER		DWG-	REV
QUALITY LEVEL:		EFFECTIVE DATE:		D	01MF3	AREA	TYPE	Q	000
				SCALE: 1/16" = 1'-0"				SHEET	A-1

D

C

B

A

User: SEA

Date: 09/10/08 - 3:28 PM

File: h1E.dwg
Plot: P:\h1level

ELEV INTER

ELEV INTER

FRONT

ELEV IT

4 3 2 1

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE

SIDE
STORAGE FACILITY

FRONT
STORAGE FACILITY

J-PAC FACILITY
SIDE

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN			
NO SCALE	REQUESTOR:	INTERIM STORAGE FACILITY			
	DESIGN:				
	DRAWING: B. SEARLE				
	PROJECT NO.				
	SPEC CODE	ELEVATIONS			
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES	SIZE	CAGE CODE	INDEX CODE NUMBER	REV
QUALITY LEVEL:	SEE DAR NO.	D	01MF3	AREA TYPE I G L ORG	DWG-
	EFFECTIVE DATE:	SCALE: 1/16"=1'-0"			SHEET A-2

4 3 2 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
—	AS BUILT	—	—
1	SEE 1 DCN.	10/18/93	AL WILKINSON
2	CHANGED DWG CLASS AS BUILT AS OF 4/7/94	4/25/94	ALW
3	SEE 3 DCN AS BUILT AS OF 9/20/94	10/28/94	ALW

REFERENCE DRAWINGS	
DRAWING NO.	TITLE
173482	TRUPACT II WORKING PLATFORM ADDITION
426389	TRUPACT II WORKING PLATFORM LOCATION AND INSTALLATION
426439	TRUPACT II WORKING PLATFORM MAINFRAME STRUCTURAL DETAIL
426440	TRUPACT II WORKING PLATFORM GATE FRAME DETAIL
426441	TRUPACT II WORKING PLATFORM STAIR ASSEMBLY AND DETAILS
428733	TRUPACT II FLOOR PLAN, CROSS-SECTION SITE PLAN
428737	TRUPACT II LOADING STATION FIRE PROTECTION SYSTEM
169878	RWMC AREA WATER SYSTEM PIPING PLOT PLAN
446736	PANEL SCHEDULE

FOR DRAWING INDEX SEE DRAWING NO. 175603		APPROVALS		DATE		EG&G Idaho, Inc. FOR U.S. DEPARTMENT OF ENERGY	
PROJECT NO. N/A		DESIGNED BY P.J. D FRENCH		9/24/91		A/E CONTRACT NO. 1570	
DESIGN PHASE		DESIGNED BY DES MCR G KVAMME		9/24/91		BLDG 618	
APPROVED		CHECKED BY DR SCHIESS		9/24/91		WMF-618 FLOOR PLAN	
DATE		DRAWN BY M COOKE		7/2/91		REV 3	
SUBCONTRACT NO.		RELEASED		9/26/91 GRB		A/E SCL NO. N/A	
QUALITY LEVEL N/A		INDEX CODE NUMBER		175551		SCALE 1/4" = 1'-0"	
		DRAWN BY		0980618001220			

ADDCS NO. 149984

8

7

6

5

D

C

B

A

FLOOR PLAN

BUILDING DIMENSIONS
MAY VARY TO ACCOMMODATE
CRANE.

CRANE SUPPORT COLUMNS.
SUPPORT SYSTEM DESIGNED
AND INSTALLED AS PER
DIVISION I OF SPECIFICATIONS.
SYSTEM SHALL BE DESIGNED
FOR SEISMIC ZONE 3
REQUIREMENTS.

PROVIDE BERM

5'-0" APPROX.
FIELD VERIFY

10 TON BRIDGE CRANE
73'-0" (MIN) LONGITUDINAL
TRAVEL

BRACING

PROVIDE BRACING
TO RESTRICT
MOVEMENT

STRUC
SYSTEM

2'-0" APPR
FIELD VERIF

SECTION A

8

7

6

5

REVISIONS			
ZONE	REV.	DESCRIPTION	DATE
1	1	SEE 1 DCN	10-15-93

NOTES:

1. CRANE SUPPORT SYSTEM DESIGNED AND PROVIDED BY SUBCONTRACTOR.
2. SUBCONTRACTOR MUST DESIGN AND PROVIDE FOUNDATION FOR STRUCTURAL SUPPORTS OF CRANE. FOUNDATION SYSTEM SHOWN IS FOR REFERENCE ONLY. DESIGN SHALL BE BASED ON THE CRANE REQUIREMENTS SHOWN HERE AND DESCRIBED IN THE SPECIFICATIONS.

TOTAL CONTAINERS W/TIEDOWNS (3 EACH)	35,000 lbs.
TRAILER (W/TOOLS & SPARE TIRE)	8,500 lbs.
SUBTOTAL	41,000 lbs.
TOTAL PAYLOAD (3 CONTAINERS)	21,000 lbs.
TOTAL	62,000 lbs.

TRAILER LOADING DETAIL

N.T.S.

50'-0" x 80'-0" PRE-ENGINEERED METAL BUILDING FURNISHED AND INSTALLED BY SUBCONTRACTOR

STEEL SUPPORT FOR CRANE

INTERIOR ELEVATION MUST ALLOW FOR CLEARANCE OF CRANE

16'-0" x 16'-0" CENTER DRIVE DOOR

CRANE SUPPORT COLUMNS BOLTED TO CONCRETE. FOUNDATION WILL BE DESIGNED AND FURNISHED BY SUBCONTRACTOR.

SECTION B

DETAIL 1
SCALE: 1/2" = 1'-0"

FOR DRAWING INDEX SEE DRAWING NO. 171121

J. M. Bowerman R.D.		5/11/88		EG&G		A/E CONTRACT NO. 1570		FOR	
C.D. Fisher		5/11/88		U.S. DEPARTMENT OF ENERGY		IDAHO OPERATIONS OFFICE		IDAHO FALLS, IDAHO	
M. R. R. 100		5/11/88		RWMC		WMF 618			
DESIGN		TLC		DATE		4/88		TRUPACT II LOADING STATION	
PROJECT NO.		SUBCONTRACT NO. 56922.90		ISSUED FOR CONSTRUCTION		5-25-88		PLAN & SECTIONS	
APPROVED FOR CONSTRUCTION		5-25-88		SCALE		1/8" = 1'-0"		DRAWING NO. 171123	
QUALITY LEVEL		3		INDEX CODE NUMBER		D 098 061800 220		REV. 1	
				SPEC. CODE		A-1			

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.5 Facility Design

Title: HVAC – Scenario 2

Summary:

This EDF describes documents requirements, assumptions, description, and calculations for the HVAC system required for Scenario 2.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the Scenario 2 HVAC System.
- Attachment C – Supporting Calculations
- Attachment D – Sketches and Drawings

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130		10/27/98		10/27/98

Attachment A
CsIX/TRU Feasibility Study

General

This EDF describes the HVAC system required for the Scenario 2 Grout Facility. The facility in scenario 2 has a smaller building and thus a smaller HVAC system. Other common facilities such as the Interim Storage Facility and TRUPACT II loading facility remain unchanged. See EDF-CsIX-011 for information on the Interim Storage and TRUPACT II HVAC systems. Off-Gas is covered under EDF-CsIX-013.

The HVAC system is comprised of three different zones for the Grouting facility. Each zone has its own air handling system. The primary and secondary zones have redundant systems with one system connected to backup power for continuous operation. The system is described below.

Assumptions

1. Eight air changes per hour for primary confinement.
2. Four air changes per hour for secondary confinement.
3. 20-CFM per person of outside air for administrative areas.
4. Only roughing filters are required on secondary zone outside air intake.
5. Only primary zone return air will require redundant HEPA filtration prior to discharge to the stack.

Requirements

1. The CsIX/TRU Grout building will be required to have two ventilation confinement zones per DOE Order 6430.1A.
2. Ventilation for primary and secondary zones are once through systems.
3. Steam heating will be used where applicable.
4. HEPA filtration will be required on both the primary and secondary zones.

Process Description

The HVAC system for scenario 2 is very similar to scenario 1. There are three primary zones. These zones are primary confinement, secondary confinement, and office space. Pressures of the different zones are +0.1 inch W.C. for office space, -0.5 inch W.C. for secondary confinement space, and -0.75 inch W.C. for primary confinement space.

The office space of the grouting facility will have a packaged type through the wall system. Since there is only two spaces that require cooling and heating a package type unit will be used. The unit will have two separate airhandling units and one heat pump. The 1 1/2-ton heat pump will be mounted on a concrete pad just outside the facility by the office space and serve both airhandlers. The airhandling units will be located in the conditioned space and will supply a total of 400-CFM of air with 16 MBH total heating capacity. 100-CFM of outside air will be introduced to the spaces by the wall mounted airhandling units. Estimated annual energy consumption for heating is 6621 kWh per year and 1722 kWh per year cooling. See calculations in Appendix C for details on heating and cooling loads.

The heating and ventilation system for secondary confinement will be located on the east side of the second floor in the facility. Outside air will be taken into the system through a louvered inlet on the east wall. Total outside airflow is 6500-CFM for the secondary confinement system. CFM is based on a volumetric basis. 4 air changes per hour for the area served was used to develop the airflow requirements of the secondary air system. The air will be rough filtered, heated, and distributed to various areas throughout the building. The secondary confinement air system will be the main source of heating for the building. Heating will be from steam coils located on the outside air intake. Total capacity for the steam coil is 804 MBH using the AE design criteria for the INEEL. Estimated annual energy consumption for the secondary system using a single measure check is 1.16×10^6 lbs. of steam per year. There will be two 7 1/2 Hp airhandlers for supply to the secondary confinement areas. The primary airhandling unit will be connected to backup power. There are two airhandlers for maintenance and failure purposes. Once air is passed through the secondary zone, it will be HEPA filtered prior to being supplied to the primary zone or discharge to the stack. Two 2x3 HEPA filter housings will be installed, one HEPA housing will serve one airhandler. See airflow schematic in Appendix D for more detail on airflow patterns and equipment layout. See calculations in Appendix C for details on heating load.

Exhaust from the secondary confinement zone will be from another set of airhandlers. One of these two exhaust airhandlers will be connected to backup power for maintenance and failure purposes. Air exhausted from the secondary

confinement system is either supplied to the primary confinement areas or exhausted to the stack. These 10 Hp exhaust airhandlers are downstream of the HEPA filter housings. One airhandler is connected to one of the 2x3 HEPA housings. See air flow schematic in Appendix D for more detail on equipment connection and airflows.

The Ventilation system for the primary confinement zone will be located on the eastern side of second floor in the facility, see drawing 2-A7. The primary containment ventilation system will receive air from the secondary containment system. The air discharged from the secondary zone is single HEPA filtered before entering into the primary zone. No heating or cooling capability is provided for the primary confinement zone system. Ductwork will be welded SST and be routed in areas not occupied by personnel. The primary zone system does not require the airflow that the secondary system does and for this reason, the secondary containment system bypasses 3000-CFM to the stack. See Scenario 2 airflow sketch in Appendix D for more detailed information on flow pattern. 3400-CFM of air is supplied to the primary confinement zone. CFM quantities are based on a volumetric basis. Primary confinement zone air requirements are 8 air changes per hour for the area served. The 5 Hp airhandler and HEPA filter system is duplicated for maintenance and failure purposes. The primary airhandling unit will be connected to back up power. Once air has passed through the primary confinement zone, it will be double HEPA filtered and discharge to the stack.

The two common facilities, the Interim Storage and TRUPACT II Loading Facility, HVAC systems are described in EDF-CsIX-011. See that EDF for more information on those facilities.

Attachment B
CsIX/TRU Feasibility Study
Equipment list for the Scenario 2 HVAC System

Grouting Facility

Office space airhandlers – 400-CFM, packaged split system

Condenser – 1 ton cooling, pad mounted, DX, 1.2 kWatt

Secondary Confinement – Backward inclined Utility fan, Class II, 6400-CFM,
3.4 inch W.C., SST, 7.5 Hp, 2 each, one connected to backup power

HEPA filter housing – 2x3, 6400-CFM, SST, 2 each

Steam heat coils – 804 MBH total load

Primary confinement supply fan – Backward inclined utility fan, Class II, 6400-CFM
6.75 inch W.C., SST, 10 Hp, 2 each, one connected to backup power

Exhaust fans – Backward inclined utility fan, Class II, 3400-CFM,
6.75 inch W.C., SST, 5 Hp, 2 each, one connected to backup power

HEPA filter housing – 2x2, double filter, 3400-CFM, SST, 2 each

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-11
EDF Serial Number – EDF-CsIX-012
Page 1 of 1

Attachment C
CsIX/TRU Feasibility Study
Supporting calculations

Scenario #2 Energy Consumption - Cooling

OFFICE SPACE: Single Measure Check

From Calis:

$$BLC = UA = 26.25 = UA$$

$$E_{cool} = \frac{24 * BLC * CDD * (1 + d_o)}{COP}$$

$$= \frac{24 \times 26.25 \times 343 \times (1 + 0.1)}{2.8}$$

$$= 84.892 \times 10^3 \frac{\text{Btu}}{\text{year}}$$

OTHER GAINS:

GSA: 1840 Btu/lr

Ex. : 5,785 Btu/Hr

Total 7625 Btu
145

$$E_{IG} = 7,625 * 10 * 76 = 5.79 \times 10^6 \frac{\text{Btu}}{\text{Year}}$$

Total Energy Consumption:

$$E_{total} = 5.72 \times 10^6 + 84.8 \times 10^3 = 5.80 \frac{\text{EBtu}}{\text{lea}}$$

$$= 1,722 \frac{\text{KWh}}{\text{Year}}$$

$$= 1,722 \frac{\text{KWH}}{\text{Year}}$$

10/19/98

Scenario #2 Energy Consumption - Heating

②
BKK

Grouting Space: Single Measure Method

Assumed: $C_p = 0.62$ $K = 1.0$ $V = 1.0$ $DD = 8640$ $\Delta T = 91^\circ F$ $Q_T = 804,000 \frac{Btu}{hr}$

$$Heat = \frac{C_p * 24 * Q_T * DD}{K * V * \Delta T}$$

$$= \frac{0.62 * 24 * 804,000 * 8640}{1.0 * 1.0 * 91} = 1.135 \times 10^9 \frac{Btu}{Year}$$

$$= 1.135 \times 10^9 \frac{Btu}{Year} * \frac{1 \text{ lb steam}}{1000 Btu} = 1.14 \times 10^6 \frac{\text{lb steam}}{Year}$$

Office Space: Single Measure Method

Assumed: $C_p = 0.62$ $K = 1.0$ $V = 1.0$ $DD = 8640$ $\Delta T = 91^\circ F$ $Q_T = 16,000 \frac{Btu}{hr}$

$$Heat = \frac{C_p * 24 * Q_T * DD}{K * V * \Delta T}$$

$$= \frac{0.62 * 24 * 16,000 * 8640}{1.0 * 1.0 * 91} = 22.6 \times 10^6 \frac{Btu}{Year}$$

$$= 22.6 \times 10^6 \frac{Btu}{Year} * \frac{1 \text{ lb steam}}{1000 Btu} = 22.6 \times 10^3 \frac{\text{lb steam}}{Year}$$

$$= 22.6 \times 10^6 \frac{Btu}{Year} * \frac{KW}{3413 Btu} = 6,621 \frac{KW}{Year}$$

Total Steam Heat Consumption - Scenario #2 Grout Facility

$$22.6 \times 10^3 + 1.14 \times 10^6 = 1.16 \times 10^6 \frac{\text{lb steam}}{Year}$$

500 SHEETS, FULL 1/2 SQUARE
 400 SHEETS, FULL 1/4 SQUARE
 300 SHEETS, FULL 1/8 SQUARE
 200 SHEETS, FULL 1/16 SQUARE
 100 SHEETS, FULL 1/32 SQUARE
 50 SHEETS, FULL 1/64 SQUARE
 25 SHEETS, FULL 1/128 SQUARE
 12 SHEETS, FULL 1/256 SQUARE
 6 SHEETS, FULL 1/512 SQUARE
 3 SHEETS, FULL 1/1024 SQUARE
 1 SHEET, FULL 1/2048 SQUARE

11/07

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International Demand

9/29/98

OFFICE SPACE HVAC

Option 2

(3)
BKG

From Load Calc's

1 Ton Cooling

400 CFM Air

Pkgd Unit

1.2 KW

10-202 500 SHEETS FULLER 5 SQUARE
42-381 500 SHEETS EYE-FAST 5 SQUARE
42-382 100 SHEETS EYE-FAST 5 SQUARE
42-383 100 SHEETS EYE-FAST 5 SQUARE
42-384 100 SHEETS EYE-FAST 5 SQUARE
42-385 100 SHEETS EYE-FAST 5 SQUARE
42-386 100 SHEETS EYE-FAST 5 SQUARE
42-387 100 SHEETS EYE-FAST 5 SQUARE
42-388 100 SHEETS EYE-FAST 5 SQUARE
42-389 100 SHEETS EYE-FAST 5 SQUARE
Lump Sum

Project:	CsIX/TRU Grout Project		
Calculated by:	B. K. Grover	Date: Sept 24, 98	Checked By: RH
Zone:	Office space	Design Time	4 10 am to 5 pm

HEAT TRANSMISSION & SOLAR HEAT GAIN

COMPONENT	Gross AREA (FT^2)	Net AREA (FT^2) x	TEMP. DIFF. (DEG. F) x	"U" FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF			60	0.04		
ACTUAL AREA	250					
NORTH WALL			24	0.06		
N.E. WALL			26	0.06		
EAST WALL	300	285	29	0.06	491	
S.E. WALL			30	0.06		
SOUTH WALL			37	0.06		
S.W. WALL			63	0.06		
WEST WALL			67	0.06		
N.W. WALL			47	0.06		
GLASS TRANS.	15	15	20	0.55	165	
MISC.						
MISC.						
COMPONENT	AREA (FT^2)	x SHGF	x CLF	x SC =		
N. GLASS SOLAR		37	0.74	0.55		
N.E. GLASS SOLAR		159	0.26	0.55		
E. GLASS SOLAR	15	215	0.26	0.55	461	
S.E. GLASS SOLAR		179	0.33	0.55		
S. GLASS SOLAR		128	0.47	0.55		
S.W. GLASS SOLAR		179	0.58	0.55		
W. GLASS SOLAR		215	0.50	0.55		
N.W. GLASS SOLAR		159	0.42	0.55		
SKYLIGHT SOLAR		254	0.62	0.50		

INTERNAL HEAT GAINS

CFM per Person =	25	People Cooling Load Factor (CLF)	1.00		
Number of Occupants	4	Lighting Cooling Load Factor (CLF)	0.89		
Btu per Occupant	255	Sensible x CLF	255	Latent	1,020
Lights	2	W Hr/Ft^2	500	x 3.413 x CLF =	1,519
Power	5	W Hr/Ft^2	1,250	x 3.413 =	4,266

OUTSIDE AIR HEAT GAIN

	CFM		Constant		
Sensible	100	Temp. Diff.	20	0.92	1,840
Latent	100	Ratio Difference	-0.0022	4840	-

SUBTOTAL

					9,762	1,020
--	--	--	--	--	-------	-------

Safety Factor =

1.10

					10,738	1,020
--	--	--	--	--	--------	-------

Total Heat Gains =

10,738

1,020

Combined Total	- MBH	12
	- TONS	1.0
Total Cooling Load	- Btu/Ft^2	47.0
	- Ft^2/Ton	255

Project:		CSIX/TRU Grout Project			
Calculated by:		B. K. Grover		Date: Sept 24, 98	
Zone:		Office space		Checked By: RH	
				Design Time 4	
Heating Transmission Loss					
Exposure	Gross Area Ft^2	Net Area x Ft^2	Temperature x Difference	"U" Factor =	Btu/Hr
Roof			91	0.04	
Walls	300	285	91	0.06	1,539
Glazing	15	15	91	0.55	751
Floor			91	0.54	
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference	
Basement Walls				91	
	Heat Loss x Coefficient	Area x Ft^2		Temperature = Difference	
Basement Floors				91	
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference	
Floor @ Grade	0.65	25		91	1,479
Infiltration Heat Loss					
	Zone Volume Ft^3	Air Changes x Per Minute	Air x Constant	Temperature = Difference	
Infiltration	3,000	0.0167	0.92	91	4,186
Room Height	12.0				
Fresh Air Heating Load					
	CFM x	Temperature x Difference (Degree F)		Air = Constant	
Fresh Air Intake	100	91		0.92	8,372
		Total Heating Load MBH 16			
		kW 5			
		Btu/Ft^2 65			
		Outside Balance Point Temperature (deg F) 34			

Project:	CsIX/TRU Grout Project	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft:	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity
Winter Design @ 97.5%	-19	72	91	Ratio Difference
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18
Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54
Glazing\Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	DbI Pain / Tinted	0.55	1-3/4" Metal Door	0.39
Glazing\Glass Doors	Properties	Shading Coefficient		
Glazing	DbI Pain / Tinted	0.55		
Skylites	Double Pain	0.50		

Project:	CsIX/TRU Grout Project Scenario 2		
Calculated by:	B. K. Grover	Date: Oct. 19, 98	Checked By:
Zone:	Grouting Process	Design Time	4 10 am to 5 pm

HEAT TRANSMISSION & SOLAR HEAT GAIN						
COMPONENT	Gross AREA (FT ²)	Net AREA (FT ²) x	TEMP. DIFF. (DEG. F) x	U" FACTOR =	Btu/Hr	
					SENSIBLE	LATENT
ROOF	6,350	6,350	60	0.04	16,725	
ACTUAL AREA	11,446					
NORTH WALL	1,640	1,640	24	0.06	2,336	
N.E. WALL			26	0.06		
EAST WALL	2,000	2,000	29	0.06	3,442	
S.E. WALL			30	0.06		
SOUTH WALL	1,640	1,640	37	0.06	3,601	
S.W. WALL			63	0.06		
WEST WALL	2,300	2,300	67	0.06	9,145	
N.W. WALL			47	0.06		
GLASS TRANS.			20	0.55		
MISC.						
MISC.						
COMPONENT	AREA (FT ²)	x SHGF	x CLF	x SC =		
N. GLASS SOLAR		37	0.74	0.55		
N.E. GLASS SOLAR		159	0.26	0.55		
E. GLASS SOLAR		215	0.26	0.55		
S.E. GLASS SOLAR		179	0.33	0.55		
S. GLASS SOLAR		128	0.47	0.55		
S.W. GLASS SOLAR		179	0.58	0.55		
W. GLASS SOLAR		215	0.50	0.55		
N.W. GLASS SOLAR		159	0.42	0.55		
SKYLIGHT SOLAR		254	0.62	0.50		
INTERNAL HEAT GAINS						
CFM per Person =	-	People Cooling Load Factor (CLF)	1.00			
Number of Occupants	-	Lighting Cooling Load Factor (CLF)	0.89			
Btu per Occupant	-	Sensible x CLF	-	Latent		
Lights	-	W Hr/Ft ²		x 3.413 x CLF =		
Power	-	W Hr/Ft ²		x 3.413 =		
OUTSIDE AIR HEAT GAIN						
	CFM			Constant		
Sensible		Temp. Diff.	20	0.92		-
Latent		Ratio Difference	-0.0022	4840	-	Neg. Value
SUBTOTAL					35,250	
Safety Factor =					1.10	
					38,775	
Total Heat Gains =					38,775	
Combined Total					MBH	39
					TONS	3.2
Total Cooling Load					Btu/ft ²	3.4
					Ft ² /Ton	3542

Project:		CsIX/TRU Grout Project Scenario 2			
Calculated by:		B. K. Grover		Date: Oct. 19, 98	
Zone:		Grouting Process		Checked By:	
				Design Time	
				4	
Heating Transmission Loss					
Exposure	Gross Area Ft^2	Net Area x Ft^2	Temperature x Difference	"U" Factor =	Btu/Hr
Roof	6,350	6,350	91	0.04	25,367
Walls	7,580	7,580	91	0.06	40,936
Glazing			91	0.55	
Floor			91	0.54	
	Perimeter Ft x	Heat Loss Below Grade x		Temperature = Difference	
Basement Walls				91	
	Heat Loss x Coefficient	Area x Ft^2		Temperature = Difference	
Basement Floors				91	
	Heat Loss x @ Grade	Perimeter x Ft		Temperature = Difference	
Floor @ Grade	0.65	340		91	20,111
Infiltration Heat Loss					
	Zone Volume Ft^3	Air Changes x Per Minute	Air x Constant	Temperature = Difference	
Infiltration	130,141	0.0167	0.92	91	181,590
Room Height	11.4				
Fresh Air Heating Load					
	CFM x	Temperature x Difference (Degree F)		Air = Constant	
Fresh Air Intake	6,400	91		0.92	535,808
Total Heating Load					804
					kW
					236
					Btu/Ft^2
					70
Outside Balance Point Temperature (deg.F)					72

Project:	CsIX/TRU Grout Project Scenario 2	Latitude - degrees:	43
Calculated by:	B. K. Grover	Longitude - degrees:	112
Site Location	INEEL	Elevation - Ft:	4938

Design Conditions				
	Outside Temperature	Inside Temperature	Delta T	Cooling Air Humidity Ratio Difference
Winter Design @ 97.5%	-19	72	91	
Summer Design @ 2.5%	95	75	20	-0.0022

Zone "U" Factors				
Walls	Wall #1		Wall #2	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	15 MPH Moving Air	0.17
Outside Surface				
Outer Sheathing				
Insulation	R-16	16.00		
Inside Surface				
Inside Air Film	Still Air	0.68	Still Air	0.68
Other				
Other				
Total R Factor		16.85		0.85
"U" Factor - 1/R =		0.06		1.18
Floors and Roofs	Roof		Floor	
	Construction	"R" Value	Construction	"R" Value
Outside Air Film	15 MPH Moving Air	0.17	Still Air	0.92
Outside Surface				
Outer Sheathing				
Insulation	R-22	22		
Inside Surface				
Inside Air Film	Still Air	0.61	Still Air	0.92
Other				
Other				
Total R Factor		22.78		1.84
"U" Factor - 1/R =		0.04		0.54
Glazing/Glass Doors	Properties	"U" Value	Metal Doors	"U" Value
Winter and Summer	Dbl Pain / Tinted	0.55	1-3/4" Metal Door	0.39
Glazing/Glass Doors	Properties	Shading Coefficient		
Glazing	Dbl Pain / Tinted	0.55		
Skylites	Double Pain	0.50		

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-11
EDF Serial Number – EDF-CsIX-012
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Attachment D
CsIX/TRU Feasibility Study
Sketches and Drawings

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask D.5 Facility Design

Title: Off-Gas

Summary:

This EDF describes documents requirements, assumptions, description, and calculations for the Off-Gas system required.

EDF Contents:

- Attachment A – Detailed Process Description w/Assumptions & Requirements.
- Attachment B – Equipment list for the Off-Gas System.
- Attachment C – Supporting Calculations
- Attachment D – Sketches and Drawings

Distribution (complete package): C. W. Olsen MS 3211; K. L. Williams MS 3765; Project File; A copy of this EDF will be included in External Report No. INEEL/EXT = 98-00869.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B. K. Grover	4130	<i>ME Van Lick</i>	10/28/98	<i>K.L. Williams</i>	10/28/98

Attachment A
CsIX/TRU Feasibility Study

General

This EDF describes the Off-Gas system required for the Scenario 1 and 2 Grout Processing Facilities. HVAC is covered under EDF-CsIX-011 and EDF-CsIX-012.

Assumptions

1. Moisture will be removed from the off-gas system by the condensers.
2. No carbon filter absorbers are needed.
3. The off-gas systems for both scenarios have the same air flow and pressures.

Requirements

1. Double HEPA filtration is required per AE standards.
2. 2 inch W.C. negative pressure required at vessels.
3. Two identical and independent systems are required.
4. One of the two off-gas systems will be connected to backup power.

Process Description

The off-gas system for both scenarios are very similar. Equipment connected to the system will remove moisture at the source. Condensers are located at various locations throughout the facilities. Condensers are located on the CsIX Resin Dryer, UDS Rotary Evaporator, Dewatering Stations, and at the inlet to the off-gas fan. The condensers are located at the point of generation. Connections to various vessels in the facilities are also connected to the off-gas system. Total off-gas flow will be 500-CFM, see Appendix C for more detailed calculations. Two independent systems will be installed. This will allow change out of the HEPA filters and failure of a system without process shut down. One of the two 2.5 Hp fan systems will be connected to backup power. Each system will have a double HEPA filter housing with a 1x1 configuration. Just prior to the off-gas fan, there will be a mist eliminator and a superheater. Further analysis on installation of a carbon absorber should be investigated.

Attachment B
CsIX/TRU Feasibility Study
Equipment list for Off-gas System

Off-gas fans – 2 each, 4 ft by 4 ft, SST, 2.5 Hp, one connected to backup power

HEPA filter housings – 1x1 housing, double filters, 2 each

Note:

Condensers, mist eliminators, and the superheater are listed in EDF-CsIX-001.

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Functional File Number – SPR-CsIX-12
EDF Serial Number – EDF-CsIX-013
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Attachment C
CsIX/TRU Feasibility Study
Supporting calculations

13 782	500 SHILLIS, FINE IR	5 SQUARE
42 301	50 SHIRT IS T V I LAST	5 SQUARE
42 302	100 SHIRT IS T V I LAST	5 SQUARE
42 303	200 SHIRT IS T V I LAST	5 SQUARE
42 392	100 IN CYCLED VAMIE	5 SQUARE
42 393	200 IN CYCLED VAMIE	5 SQUARE

International Brand

Piping System + Eq.	2.0" W.G.
HEPA Filters, dirty	4.0" W.G.
Static @ Vessels to maintain	2.0" W.G.
	<hr/>
Total	8.0" W.G.

Eg list:

- 2ea - Otaggs Fan, 4'x4', SST, 2.5 HP *

* One system Connected to Backup Power

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ENGINEERING DESIGN FILE

Functional File Number – SPR-CsIX-12
EDF Serial Number – EDF-CsIX-013
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Attachment D
CsIX/TRU Feasibility Study
Sketches and Drawings

ENGINEERING DATA

Approximate Weight (Lb)	Class	Max. Motor Frame Size	WR ² (Lb-Ft ²)
(C/F)	II	445T	1

Motor Location
W

CONFIGURATION

Arrangement	Discharge Position	Rotation
1	Top Horizontal	CW

INSTALLATION

Inlet Conditions	Outlet Conditions	Inlet Vanes
Standard	Standard	None

MOTOR SPECS

Hp	V/C/P	Enclosure	RPM
3	460/60/3	Open Drip Proof	3600

PERFORMANCE

Qty.	Model	Volume (CFM)	SP (In WC)	CSP (In WC)	TS (Ft/m)	OV (Ft/m)	FRPM	Power (BHp)
1	8-BISW-41	500	8.000	8.000	13667	775	4972	2.28

SOUND

Inlet / Outlet Sound Power by Octave Band								LwA	dBA	Noise Criteria
63	125	250	500	1000	2000	4000	8000			
100	100	96	97	94	88	83	78	98	87	84
108	107	104	101	96	92	88	82	103	91	92

AIR DENSITY

Elevation (Ft)	Airstream Temp. (F)	Startup Temp. (F)
4800	70	70

LwA - A weighted sound power level, based on ANSI S1.4. dBA - A weighted sound pressure level, based on 11.5 dB attenuation per octave band at 5 feet. Noise Criteria (NC) level based on an average attenuation of 11.5 dB per octave band at 5 feet.

UNIT SIZE : 08

ARRANGEMENT : 1

BISW

Series 41 Backward Inclined
Single Width Centrifugal Fan

NOTES : All dimensions shown are in units of inches.

SIDE VIEW

Drawing No. SSS11TH-2-94

END VIEW

Drawing No. ESS12TH-2-94

OPTIONAL OUTLET FLANGE

FOOTPRINT

Model

8-BISW-41

Class

II

Moment of Inertia

1 Lb-Ft²

Unit Weight

N/A

Drive Type

Belt Drive

NOTE : All the dimensions shown are in units of inches.

Drawing No. SSS11TH-2-94

Project File Number 02BM1

Project/Task CslX/TRU Grout Feasibility Study

Subtask _____

Title: **ELECTRICAL REQUIREMENTS**

Summary: Facility Engineering has been tasked with a Feasibility Study examining the feasibility and estimating cost for a process to treat the sodium bearing waste and newly generated liquid waste for removal from the tank farm by the year 2012. In this EDF, a study was performed to determine the amount of electrical power, the source of electrical power, and a summary of the loads. For Scenario 1, all-in-one facility, the connected load would be 698 kVA with demand of 471 kVA. The standby power would be 88 kVA. For Scenario 2, grouting only in new building, the connected loads would be 569 kVA, demand load would be 381 kVA, and standby would be 53 kVA. The major differences in loads are due to lighting, miscellaneous, and H&V loads. The grouting only building is substantially less in size than the all-in-one building. The actual process loads are approximately the same. Either Scenario would be supported from INTEC Loadcenter 14 using 480 VAC, 3 phase. A combination of new and existing duct banks would be used to route the power to the new buildings. In Scenario 2, approximately 60 kVA of load would be added to NWCF. However, the net effect would likely be much less since existing loads in NWCF would likely be removed.

Distribution (complete package):

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
T.M. Hipp <i>T.M. Hipp</i> 11/11/98	Facility Engineering	<i>K.L.W</i>	11/12/98	<i>K.L. Williams</i>	11/12/98

See Management Control Procedure (MCP) 6 for instructions on use of this form.

CESIUM ION EXCHANGE GROUTING PROJECT

1.0 ELECTRICAL REQUIREMENTS

1.1 EXISTING AND PLANNED ELECTRICAL UTILITIES AT INTEC

The INTEC ties into the 138kV INEEL loop at Substation 2 which is located outside the area fence to the south . Substation 2 transforms the 138kV to 13.8kV and provides power to Substations 10 and 15 which are located within the INTEC complex. Power at 13.8kV is then distributed from these substation through the complex. The Electrical and Utility System Upgrade (EUSU) project is currently under construction. The EUSU Project will install a new 13.8kV electrical distribution system throughout the complex. This new system will provide greater safety, additional capacity and greater reliability.

Currently, standby power is provided by each facility. Standby generators are located at various facilities and operate as an island of power during a normal power outage. The EUSU project will construct a standby power plant, install new standby generators and tie existing generators into the standby power system. Standby power will then be distributed through the complex by the new 13.8kV distribution system, The Utility Control System (UCS) provides control of both the normal and standby power distribution systems.

1.2 POWER REQUIREMENTS

1.2.1 NORMAL POWER

The electrical requirements of the Cesium Ion Exchange Grouting Project (CslX) were analyzed and determined to be 698 kVA connected, with a demand projected to be 471 kVA . The results of the analysis are shown in Tables 1 and 2. The major loads with the CslX project are various lighting, heating, and motor loads. The motor loads consist of both process and ventilation motors.

Normal power will be supplied to the CslX Project by 480kV feeders from Loadcenter 14. A combination of new and existing duct banks will be used to route the feeders.

1.2.2 STANDBY POWER

The requirements for standby power for the CsIX facilities were analyzed and determined to be 88 kVA. The results of the analysis are shown in Table 3. The standby loads for the CsIX facilities will consist of the following:

- UPS Normal and Bypass feeders
- Selected lighting and miscellaneous loads
- Exhaust and supply fans
- Other process loads

Standby power to the CsIX facilities will be provided over the normal power distribution system from Substation 60. Shedding of the normal power loads will be performed by the UCS. The UCS will control the operation of circuit breakers and equipment to ensure that only those loads requiring standby power remain in operation

1.2.3 UNINTERRUPTABLE POWER SUPPLY (UPS)

A solid state UPS with a static transfer switch will be provided. The UPS will be provided with a 15 minute battery backup and feed a 208Y/120 Volt panel. The UPS and the panel will be located in the electrical room and support the following loads: Voice paging/evacuation systems, environmental monitoring system, control system, and other critical loads.

1.3 LIGHTING

1.3.1 INTERIOR LIGHTING

Lighting in office areas and other low ceiling areas will be supplied by recessed pendant mounted fluorescent fixtures. These fixtures will be operated at 277Volts and will be locally switched. Motion detectors will be utilized areas of low occupancy. Lighting in high bay areas will be will be supplied by metal halide fixtures operating at 277 volts. The metal halide fixtures will be switched at the lighting panel.

1.3.2 CELL LIGHTING

Lighting in the cells will be designed to allow for remote operation of the equipment via an in cell CCTV system or by operation through cell windows.

Lighting of the cells will be indirect. Translucent panels will be provided on the top of the cells and on the side walls as required. Fixtures will be mounted so that maximum light is directed into the cells and the fixtures are easily accessible for maintenance. The light source will be metal halide with the design will taking into account light loss through the translucent panels as well as the light lost in viewing operations through the cell windows.

1.3.3 EXTERIOR LIGHTING

The exterior of the building will be illuminated with high pressure sodium wall pack fixtures mounted over each personnel door. Loading areas will be provided with high pressure sodium wall pack fixtures on each side of the doors. The need for area lighting in maneuvering areas will be evaluated during the conceptual and final designs.

1.3.4 EMERGENCY AND EXIT LIGHTING

Emergency egress lighting will be in accordance with NFPA 101, Life Safety Code. In areas where illumination is provided by fluorescent fixtures, selected fixtures will be provided with integral battery back up. In areas where illumination is provided by metal halide fixtures, selected fixtures will be provided with a quartz lamp which will be used for emergency lighting. The quartz lamp will be connected to the UPS system or will be provided with an integral battery.

1.4 DESIGN DESCRIPTION

1.4.1 SITE CONDITIONS

Electrical equipment will be rated for continuous operation at an elevation of 5,000 feet above sea level.

1.4.2 HAZARDOUS LOCATIONS

Several areas within the facility will be used for storing or handling of hazardous materials. An evaluation will be performed during the conceptual design and the final design to determine the effects of these materials on the installation of electrical equipment. Flammable and Combustible Liquids Codes NFPA 30: National Electrical Code, NFPA 70; and Recommended Practice for Classification of Class I Hazardous Locations for Electrical Installations in Chemical Process Areas, NFPA 497A will be used in making the determination.

1.4.3 SERVICES

1.4.3.1 PRIMARY SERVICE

A single feed from Loadcenter 14 will supply 480V power to the CslX facilities. The feeders will be routed through both new and existing duct banks.

1.4.3.2 STANDBY POWER

Standby power will be provided at 480V over the existing distribution system. The existing UCS in conjunction with the CslX control system will control selected circuit breakers to limit the standby power distribution only to those loads deemed necessary.

1.4.3.3 UTILIZATION VOLTAGES

Two utilization voltages will be provided for the CslX facilities. Transformers Loadcenters 14 will transform 13.8kV to 480Y/277 Volt; transformers down stream will transform the 480 Volts to 208Y/120 Volts.

Electrical loads will be assigned voltages as follows:

- Motors ½ HP to less than 100 HP - 480V, 3 phase
- Resistive loads 1 kVA to less than 100 kVA - 480V, 3 phase
- Motors less than ½ HP 120V, single phase
- Miscellaneous loads less than 1 kVA - 120V, single phase
- Lighting - 277V single phase.

1.4.4 EQUIPMENT

1.4.4.1 TRANSFORMERS

Transformers 5,000 kVA and below will be cast coil, dry type transformers.

1.4.5 LIGHTING

Lighting levels will conform the Illuminating Engineer's Society (IES) handbook and standard practices at the INTEC. In general , the design will provide the following illumination levels:

- Work Stations 70 foot candles
- Work Areas 30 to 50 foot candles depending on activity
- Non-Work Areas 10 foot candles, 50 where data is obtained

1.4.6 GROUNDING

Grounding at the INTEC is accomplished with bare copper conductors installed in all duct banks and ground rods installed in every manhole. This in turn is solidly connected to the casing of the deep wells. Facilities and structures throughout the INTEC are connected to this ground system. Therefore, the CslX facilities will be connected to the ground system. Grounding within the facilities will be accomplished in accordance with the National Electrical Code and IEEE Standard 142-1991, "IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems."

1.4.7 LIGHTNING PROTECTION

Lightning protection will be provided in accordance with NFPA 78, "Lightning Protection Code."

1.5 SCENARIOS

Two scenarios have been proposed for the CslX Project. In scenario 1, the ion exchange and grouting would be performed in the same new building. In scenario 2, the grouting would be performed in a new building while the ion exchange would be performed in the existing New Waste Calcining Facility (NWCF). Tables 4, 5, and 6 give the loads for the 2nd scenario. As expected, the loads are less in scenario 2 primarily because of lighting, miscellaneous, and H&V loads since the grouting building would be smaller in floor space as compared to the combined process facility of scenario 1. The actual process and transport load differences are relatively minor. In scenario 2, the connected load would be 569 kVA, the demand load would be 381 kVA, and the standby load would be 53 kVA. This compares to 698, 471, and 88 kVA respectively for the loads of scenario 1. Scenario 2 will also add a maximum of 60 kVA to the load at NWCF. This load will consist of approximately twelve motors of five horsepower or less. The net impact of this addition will likely be less than 60 KVA since existing loads at NWCF will be removed to accommodate the ion exchange process.

TABLE 1
CsIX GROUTING PROJECT
CONNECTED LOAD STUDY
Scenario 1

Load	KVA
Lighting loads:	
Processing building	93
Interim storage	58
TruPac	8
Miscellaneous loads:	
Process building	41
Interim storage	4
TruPac	4
Process loads:	
Process building	81
Dewatering room	14
Cure room	11
Interim Storage	22
TruPac	10
Cranes:	
Processing	70
Transporting loads:	
Process building	72
H&V:	
Processing	56
Interim storage	34
TruPac	120
Total connected KVA	698

TABLE 2

**CsIX GROUTING PROJECT
DEMAND LOAD STUDY
Scenario 1**

Load	Demand	KVA
Lighting loads:		
Processing building	90%	83
Interim storage	90%	52
TruPac	90%	7
Miscellaneous loads:		
Process building	50%	21
Interim storage	50%	2
TruPac	50%	2
Process loads:		
Process building	specified	72
Dewatering room	25%	4
Cure room	25%	3
Interim	25%	5
TruPac	25%	3
Cranes:		
Processing	10%	7
Transporting loads:		
Process building	25%	18
H&V:		
Processing	100%Prce	45
Interim storage	s	34
TruPac	100%	120
	100%	
Total connected KVA		471

TABLE 3
CsIX GROUTING PROJECT
STANDBY LOAD STUDY
Scenario 1

Load	Standby	KVA
Lighting loads:		
Processing building	10% of 90%	8
Interim storage	10% of 90%	6
TruPac	10% of 90%	1
Miscellaneous loads:		
Process building	10% of 50%	2
Interim storage	10% of 50%	.2
TruPac	10% of 50%	.2
Process loads:		
Process building	10% of 72	7
Dewatering room	10% of 25%	.4
Cure room	10% of 25%	.3
Interim Storage	10% of 25%	1
Transporting loads:	10% of 25%	2
Process building		
H&V:		
Processing	10% of 100%	45
Interim storage	10% of 100%	3
TruPac	10% of 100%	12
Total connected KVA		88

TABLE 4

**CslX GROUTING PROJECT
CONNECTED LOAD STUDY
Scenario 2**

Load	KVA
Lighting loads:	
Processing building	33
Interim storage	58
TruPac	8
Miscellaneous loads:	
Process building	12
Interim storage	4
TruPac	4
Process loads:	
Process building	81
Dewatering room	14
Cure room	11
Interim Storage	22
TruPac	10
Cranes:	
Processing	70
Tansporting loads:	
Process building	72
H&V:	
Processing	16
Interim storage	34
TruPac	120
Total connected KVA	569

TABLE 5
CsIX GROUTING PROJECT
DEMAND LOAD STUDY
Scenario 2

Load	Demand	KVA
Lighting loads:		
Processing building	90%	30
Interim storage	90%	52
TruPac	90%	7
Miscellaneous loads:		
Process building	50%	6
Interim storage	50%	2
TruPac	50%	2
Process loads:		
Process building	specified	72
Dewatering room	25%	4
Cure room	25%	3
Interim	25%	5
TruPac	25%	3
Cranes:		
Processing	10%	7
Transporting loads:		
Process building	25%	18
H&V:		
Processing	100%Prs	16
Interim storage	s	34
TruPac	100%	120
	100%	
Total connected KVA		381

TABLE 6

**CslX GROUTING PROJECT
STANDBY LOAD STUDY
Scenario 2**

Load	Standby	KVA
Lighting loads:		
Processing building	10% of 90%	3
Interim storage	10% of 90%	6
TruPac	10% of 90%	1
Miscellaneous loads:		
Process building	10% of 50%	1
Interim storage	10% of 50%	.2
TruPac	10% of 50%	.2
Process loads:		
Process building	10% of 72	7
Dewatering room	10% of 25%	.4
Cure room	10% of 25%	.3
Interim Storage	10% of 25%	1
Transporting loads:	10% Of 25%	2
Process building		
H&V:		
Processing	10% of 100%	16
Interim storage	10% of 100%	3
TruPac	10% of 100%	12
Total connected KVA		53

Project File Number 02BM1

Project/Task CsIX/TRU Grout Feasibility Study

Subtask C.4 Determine Waste Radiation Levels

Title: CsIX/TRU Component Projected Radiation Fields					
Summary: This EDF contains:					
<ol style="list-style-type: none">1. A description of the cases considered and basis used to calculate projected radiation fields for in-process materials and completed waste forms.2. Compilation of radiation field and heat generation results.3. Implications of results and recommendations for further refinement of process assumptions.					
Distribution (complete package): H. K. Peterson, S. J. Losinski, K. L. Williams, C. W. Olsen					
Distribution (summary package only): J. J. McCarthy					
Author	Dept.	Reviewed	Date	Approved	Date
H. K. Peterson	4160	<i>T. McDonald</i>	<i>10-5-98</i>	<i>K. L. Williams</i>	<i>10/5/98</i>
S. J. Losinski	4170				

A. J. Losinski

1. Evaluation Description

Objective

This EDF contains an evaluation of projected radiation fields and heat generation rates for various intermediate products and completed waste forms of the CsIX/TRU Grout process. A description of the process is included in EDF-CsIX-001.

An objective of performing this evaluation was to determine if the processed waste generated from the CsIX/TRU Grout process would meet waste acceptance criteria for disposal at WIPP as a contact handled waste. A second objective was to determine approximate radiation fields for major pieces of process equipment in the CsIX/TRU Grout process so that hot cell shielding and equipment placement could be considered in a facility layout.

Two iterations of the analysis were performed. The first iteration used radionuclide concentration data from liquid in tank farm tank WM-181, which is expected to generate the highest dose rate stabilized grout based on Cs-137 concentration. The second iteration used "Averaged" radionuclide concentrations for all tank farm waste processed in the CsIX/TRU Grout process.

Variants of these iterations were also performed to evaluate waste form sensitivity to process assumptions related to filtration of undissolved solids (UDS).

Radionuclide Source Data

The radiation source data used for this evaluation are contained in EDF-CsIX-001. A detailed description of the assumptions used to generate the data are included in that document. It should be noted that many assumptions were required to generate source data and many of these assumptions may have a significant impact on the analysis. Areas of uncertainty include:

- Tank Farm Volumes and Composition
- HLLW Evaporation Schedule and Performance
- Newly Generated Liquid Waste Volumes and Composition
- Tank Farm Liquid Transfer
- UDS Quantities and Filtration Performance
- Cesium Removal Performance of the Ion Exchange Resin
- Neutralization and Grouting Formulation and Grout Density

In all cases the radiological source data has been decayed to Jan. 2008.

Equipment/ Waste Package Size

The following flow streams and equipment geometry were used in the first iteration of this study. This iteration represents processing of SBW from tank WM-181. Flow stream numbers refer to the material balance presented in Section 7 of EDF-CslX-001.

- a. Flow Stream 101, in a cylindrical tank 10' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents SBW from WM-181 which has been steam jetted into Liquid Waste Feed Tanks.
- b. Flow Stream 107, in a standard steel 55 gal drum that is full. This calculation represents dried UDS in a full 55 gal drum located at the rotary evaporator.
- c. Flow Stream 107 diluted by a factor of 10 with water, in a cylindrical tank 5' tall X 4' diameter, with 3/8" 304 SS wall thickness. This represents the expected backwash slurry of UDS and DI water from the pressure leaf filtration system.
- d. Flow Stream 108, in a cylindrical tank 8' tall X 1.33' diameter, with 3/8" 304 SS wall thickness, with .25 cubic meters dispersed uniformly in the cylinder. This represents an ion exchange column in which the IONSIV IE-911 resin has been full loaded with cesium.
- e. Flow Stream 106, in a cylindrical tank 10' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents the liquid effluent from the ion exchange column.
- f. Flow Stream 108, in a cylindrical tank 15' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents the spent and dried IONSIV IE-911 resin total inventory in the Spent Resin Storage Tank at the end of processing all SBW and NGLW.
- g. Flow Stream 106, in a half cylindrical tank 3' long X 2' diameter (full), with 3/8" 304 SS wall thickness. This calculation represents the grout mixer filled with a batch charge of liquid waste, before addition of other grout ingredients.

- h. Flow Stream 117, in a cylindrical tank 3' long X 2' diameter (full), with 3/8" 304 SS wall thickness. This represents the grout mixer with a completed batch of grout that is ready to be cast into a drum.
- i. Flow Stream 117, in a standard steel 55 gal drum that is full. This represents the final grout waste form.

The following flow streams and equipment geometry were used in the second iteration of this study. It should be noted that in this iteration SBW and NGLW were evaporated (in the HLLWE) to a slightly higher radionuclide concentration than the previously described iteration. This iteration represents the "average" processing of all SBW and NGLW. Also included are calculations that indicate sensitivity to the fate of UDS after filtration. Flow stream numbers refer to the material balance presented in Section 6 of EDF-CsIX-001.

- 1. Flow Stream 101, in a cylindrical tank 10' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents average liquid feed which has been steam jetted into Liquid Waste Feed Tanks.
- 2. Flow Stream 107, in a standard steel 55 gal drum that is full. This calculation represents dried UDS in a full 55 gal drum located at the rotary evaporator.
- 3. Flow Stream 107 diluted by a factor of 10 with water, in a cylindrical tank 5' tall X 4' diameter, with 3/8" 304 SS wall thickness. This represents the expected backwash slurry of UDS and DI water from the pressure leaf filtration system.
- 4. Flow Stream 108, in a cylindrical tank 8' tall X 1.33' diameter, with 3/8" 304 SS wall thickness, with .25 cubic meters dispersed uniformly in the cylinder. This represents an ion exchange column in which the IONSIV IE-911 resin has been full loaded with cesium.
- 5. Flow Stream 106, in a cylindrical tank 10' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents the liquid effluent from the ion exchange column.
- 6. Flow Stream 108, in a cylindrical tank 15' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents the spent and dried IONSIV IE-911 resin total inventory in the Spent Resin Storage Tank at the end of processing all SBW and NGLW. This calculation assumes that the 20% UDS which is not collected in the filtration system will pass through the ion exchange column as well.

7. Flow Stream 108a, in a cylindrical tank 15' tall X 8' diameter (full), with 1/2" 304 SS wall thickness. This calculation represents the spent and dried IONSIV IE-911 resin total inventory in the Spent Resin Storage Tank at the end of processing all SBW and NGLW. This calculation assumes that the 20% UDS which is not collected in the filtration system will be filtered out in the ion exchange column.
8. Flow Stream 113, in a half cylindrical tank 3' long X 2' diameter (full), with 3/8" 304 SS wall thickness. This calculation represents the grout mixer filled with a batch charge of liquid waste, before addition of other grout ingredients.
9. Flow Stream 117, in a cylindrical tank 3' long X 2' diameter (full), with 3/8" 304 SS wall thickness. This represents the grout mixer with a completed batch of grout that is ready to be cast into a drum. This iteration assumes that there are no UDS in the grout.
10. Flow Stream 117, in a standard steel 55 gal drum that is full. This represents the final grout waste form. This iteration assumes that there are no UDS in the grout.
11. Flow Stream 117- A, in a standard steel 55 gal drum that is full. This represents the final grout waste form. This iteration assumes that all UDS passing the filtration system is incorporated in the grout.

Evaluation Method

The calculations were made with the MicroShield, Version 5.01 computer code.

2. Evaluation Results

Table 2-1 presents the results of radiation field and heat generation calculations for the iteration of processing SBW from tank WM-181. All radiation fields are reported as dose at contact and heat generation is reported as total heat per container. Details of the analysis and the radionuclide tables are included as Attachment 1.

Table 2-1. Radiation Field and Heat Generation for Processing WM-181.

Item	Description	Radiation Field	Heat Generation
		@ Contact	Per Container
a	Liquid Waste Feed Tanks	13.3 R/hr.	
b	Drum of Dried UDS	49 R/hr.	
c	UDS Filtrate Slurry Tank	7.8 R/hr.	
d	Loaded Ion Exchange Column	2675 R/hr.	
e	Ion Exchange Liquid Effluent Tank	170 mR/hr.	
f	Spent Ion Exchange Resin Tank	5360 R/hr.	2068 W
g	Mixer With Liquid Waste	88 mR/hr.	
h	Mixer With Grout Batch	58 mR/hr.	
i	Finished Grout Waste Drum	65 mR/hr.	0.94 W

Table 2-2 presents the results of radiation field and heat generation calculations for the iteration of processing average SBW and NGLW. All radiation fields are reported as dose at contact and heat generation is reported as total heat per container. Details of the analysis and the radionuclide tables are included as Attachment 2.

Table 2-2. Radiation Field and Heat Generation for Processing Average Tank Waste.

Item	Description	Radiation Field	Heat Generation
		@ Contact	Per Container
1	Liquid Waste Feed Tanks	14.4 R/hr.	7.24 W
2	Drum of Dried UDS	48.6 R/hr.	0.94 W
3	UDS Filtrate Slurry Tank	7.8 R/hr.	0.8 W
4	Loaded Ion Exchange Column	2630 R/hr.	24 W
5	Ion Exchange Liquid Effluent Tank	185 mR/hr.	3.98 W
6	Spent Ion Exchange Resin Tank	7626 R/hr.	2050 W
7	Spent Ion Exchange Resin Tank (+ UDS)	10650 R/hr.	2840 W
8	Mixer With Liquid Waste	90 mR/hr.	0.037 W
9	Mixer With Grout Batch	70 mR/hr.	0.047 W
10	Finished Grout Waste Drum	115 mR/hr.	0.037 W
11	Finished Grout Waste Drum (+ UDS)	130 mR/hr.	0.037 W

3. Implications of Results and Recommendations

The results of this evaluation indicate that the quantity and fate of UDS plays a significant influence in the radiation dose rate of waste forms and intermediate products. Most notably the radiation field of the spent ion exchange resin increased by approximately 40% when it was assumed that all UDS that made it through the filtration system was captured in the ion exchange column.

It was also noted that UDS concentration had a moderate effect on the radiation dose rate of the finished grout product. The increase was calculated to be approximately 13%, which may be significant for waste products that are approaching the contact handled threshold limit.

The results of the evaluation also indicate that the degree of evaporation of wastes in the tank farm can have a significant influence of the radiation dose rate of the grouted waste. Implications of this analysis indicate that the actual management of tank farm wastes and their associated evaporation/concentration schedules may have a significant impact on the grouted wasteform.

431.02#
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Rev. #04

ENGINEERING DESIGN FILE

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EDF Serial Number – EDF-CsIX-15
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It is recommended that additional characterization of the inventory of UDS in the tank farm be performed (radionuclide speciation, particle size, and quantities).

It is also recommended that technological development of filtration equipment with UDS be conducted. Also, data must be collected on the performance of the ion exchange resin with respect to filtration of UDS.

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Rev. #04

ENGINEERING DESIGN FILE

Functional File Number – SPR-CslX-13
EDF Serial Number – EDF-CslX-15
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Attachment 1

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: August 6, 1998

To: S. J. Losinski MS 3625 6-5962

From: H. K. Peterson *H. K. Peterson* MS 2107 6-8657

Subject: CS IX/TRU COMPONENT PROJECTED RADIATION FIELDS -- HKP-12-98

References: a) MicroShield, Version 5.01, Grove Engineering, Rockville MD

Contact/near surface (1 cm from item surface) radiation field calculations have been made for the requested Cs IX/TRU Feasibility Study components and are summarized below. The calculations were made with the MicroShield, Version 5.01, computer code (Ref.a) and input/output listings for each are attached for reference. Also attached, for documentation purposes, are copies of the spreadsheet pages that list the stream numbers and the respective radiological concentrations.

- a) T-101 A & B Liquid Waste Feed Tank, assumed to be a right circular cylinder 10 feet tall, 8 ft in diameter, with a wall of ½ inches stainless steel (SS), and containing 14,234 liters of Stream 101. The calculated radiation field at 1 cm from the tank midline is 13.3 R/hr.
- b) EV-101 Rotary Evaporator, assumed to be the same as a standard 55-gal drum containing 291.2 kg of Stream 107. The calculated radiation field for this component is 49 R/hr.
- c) T-108 UDS Slurry Tank, assumed to be 5 ft tall, 4 ft in diameter, with a ¼ inch SS wall, and containing 249 kg of Stream 107 diluted by a factor of 10 with water. The calculated radiation field is 7.8 R/hr.
- d) V-104A Cesium Ion Exchange Column, assumed to be 8 ft tall, 1.33 ft in diameter, with a 3/8 inch SS wall, and containing 0.25 m³ of Stream 108 distributed uniformly in the column. The radiation field for this component is calculated to be 2675 R/hr.
- e) T-103 A & B Cs IX Effluent Tank, assumed to be 10 ft tall, 8 ft diameter, with a ½ inch SS wall, and containing 14234 liters of Stream 106. The radiation field for this component is 170 mR/hr.
- f) T-112 Spent Resin Storage Tank, assumed to be 15 ft high, 8 ft in diameter, with a ½ inch SS wall, and containing 21,350 kg of Stream 108. The radiation field is calculated to be 5360 R/hr.
- g) M-101 Mixer, assumed to be a half cylinder 2 ft in diameter, 3 ft long, with a 3/8-inch SS wall and containing 133.4 liters of Stream 106. The radiation field is calculated to be 88 mR/hr.

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- h) M-101 Mixer, assumed to be a full cylinder 3 ft long, 2 ft in diameter, with a 3/8-inch SS wall, and containing 453.7 kg of Stream 117. The radiation field for this component is calculated to be 58 mR/hr.
- i) Waste Drum, assumed to be a standard 55- gal drum with 239 kg of grouted waste from Stream 117. The radiation field for this package is calculated to be 65 mR/hr.

If there are any questions or comments concerning this analysis, please call me at the above-listed number.

hkp

cc:

T. S. Bohn, LMITCO, MS 4138
G. J. Stormberg, LMITCO, MS 2107
HKP Letter File

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181101.MS5
Run Date: July 31, 1998
Run Time: 8:51:44 AM
Duration: 00:01:49

File Ref: HRP-12-98
Date: 8/3/98
By: HRP
Checked: HRP

Case Title: WM-181

Description: T-101 A & B Liquid Waste Feed Tanks - Surface Rad.
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 304.8 cm 10 ft 0.0 in ✓
Radius 121.92 cm 4 ft ✓

Dose Points

	X	Y	Z
# 1	124.19 cm	152.4 cm	0 cm
	4 ft 0.9 in ✓	5 ft 0.0 in ✓	0.0 in ✓

Shields

Shield Name	Dimension	Material	Density
Source	1.42e+07 cm³	Mixed	->1.3
		Concrete	0.3
		Water	1
Shield 1	1.27 cm ✓	Iron	7.86 ✓
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Am-241	5.8640e+000	2.1697e+011	4.1198e-001 ✓	1.5243e+004
Am-243	2.6600e-003	9.8420e+007	1.8688e-004 ✓	6.9146e+000
Ba-137m	6.3197e+002	2.3383e+013	4.4400e+001 ✓	1.6428e+006
Ce-144	7.1900e-006	2.6603e+005	5.0514e-007 ✓	1.8690e-002
Cm-242	1.3880e-002	5.1356e+008	9.7516e-004 ✓	3.6081e+001
Cm-244	1.8080e-001	6.6896e+009	1.2702e-002 ✓	4.6999e+002
Co-60	2.0070e+000	7.4259e+010	1.4100e-001 ✓	5.2172e+003
Cs-134	2.3200e-001	8.5840e+009	1.6299e-002 ✓	6.0308e+002
Cs-135	1.2740e-002	4.7138e+008	8.9507e-004 ✓	3.3117e+001
Cs-137	6.6898e+002	2.4752e+013	4.7000e+001 ✓	1.7390e+006
Eu-152	6.9180e-002	2.5597e+009	4.8603e-003 ✓	1.7983e+002
Eu-154	3.8290e+000	1.4167e+011	2.6901e-001 ✓	9.9534e+003
Eu-155	6.7180e-001	2.4857e+010	4.7198e-002 ✓	1.7463e+003
H-3	3.4450e-001	1.2747e+010	2.4203e-002 ✓	8.9552e+002
I-129	9.4510e-003	3.4969e+008	6.6399e-004 ✓	2.4568e+001
Ni-63	1.6650e+000	6.1605e+010	1.1698e-001 ✓	4.3281e+003
Np-237	5.5370e-003	2.0487e+008	3.8901e-004 ✓	1.4393e+001
Pm-147	1.6510e+000	6.1087e+010	1.1599e-001 ✓	4.2917e+003
Pr-144	7.0872e-006	2.6223e+005	4.9792e-007 ✓	1.8423e-002
Pu-238	1.6226e+001	6.0036e+011	1.1400e+000 ✓	4.2179e+004
Pu-239	3.7290e-001	1.3797e+010	2.6199e-002 ✓	9.6935e+002
Pu-240	1.0450e-001	3.8665e+009	7.3418e-003 ✓	2.7165e+002
Pu-241	4.8680e+000	1.8012e+011	3.4201e-001 ✓	1.2654e+004

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 DOS File: WM181101.MS5
 Run Date: July 31, 1998
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 Duration: 00:01:49

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	2.4700e-004	9.1390e+006	1.7353e-005✓	6.4207e-001
Rh-106	1.6800e-004	6.2160e+006	1.1803e-005✓	4.3671e-001
Ru-106	1.6800e-004	6.2160e+006	1.1803e-005✓	4.3671e-001
Sb-125	2.1070e-001	7.7959e+009	1.4803e-002✓	5.4771e+002
Sm-151	1.1460e+001	4.2402e+011	8.0514e-001✓	2.9790e+004
Sr-90	6.3767e+002	2.3594e+013	4.4800e+001✓	1.6576e+006
Tc-99	3.5580e-001	1.3165e+010	2.4997e-002✓	9.2490e+002
Th-230	1.4800e-006	5.4760e+004	1.0398e-007✓	3.8472e-003
Th-231	2.1200e-004	7.8440e+006	1.4894e-005✓	5.5109e-001
U-233	2.2600e-008	8.3620e+002	1.5878e-009✓	5.8748e-005
U-234	2.4480e-002	9.0576e+008	1.7199e-003✓	6.3635e+001
U-235	6.1300e-004	2.2681e+007	4.3067e-005✓	1.5935e+000
U-236	2.1640e-003	8.0068e+007	1.5203e-004✓	5.6253e+000
U-238	6.0490e-004	2.2381e+007	4.2498e-005✓	1.5724e+000
Y-90	6.3767e+002	2.3594e+013	4.4800e+001✓	1.6576e+006

Buildup
 The material reference is : Source

Integration Parameters	
Radial	24
Circumferential	24
Y Direction (axial)	24

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	Results			
		<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Exposure Rate</u> <u>mR/hr</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	5.637e+10	8.067e-264	1.743e-21	6.919e-265	1.495e-22
0.02	7.244e+10	1.523e-117	5.738e-20	5.276e-119	1.988e-21
0.03	1.426e+12	3.167e-35	1.007e-16	3.138e-37	9.977e-19
0.04	3.746e+11	9.318e-15	1.563e-09	4.121e-17	6.913e-12
0.05	9.532e+09	1.602e-08	7.061e-04	4.268e-11	1.881e-06
0.06	7.786e+10	5.190e-04	6.038e+00	1.031e-06	1.199e-02
0.08	7.873e+09	5.814e-02	8.297e+01	9.201e-05	1.313e-01
0.1	6.336e+10	7.379e+00	2.874e+03	1.129e-02	4.397e+00
0.15	2.212e+08	3.126e-01	2.737e+01	5.148e-04	4.508e-02
0.2	1.052e+10	3.883e+01	1.627e+03	6.853e-02	2.871e+00
0.3	1.048e+09	1.028e+01	2.035e+02	1.951e-02	3.861e-01
0.4	3.758e+09	6.722e+01	8.895e+02	1.310e-01	1.733e+00
0.5	1.586e+09	4.430e+01	4.348e+02	8.696e-02	8.536e-01
0.6	2.101e+13	8.402e+05	6.632e+06	1.640e+03	1.294e+04
0.8	6.188e+10	4.343e+03	2.545e+04	8.260e+00	4.841e+01
1.0	1.196e+11	1.298e+04	6.170e+04	2.392e+01	1.137e+02
1.5	1.306e+11	3.112e+04	1.084e+05	5.236e+01	1.825e+02
2.0	3.469e+06	1.420e+00	4.168e+00	2.196e-03	6.445e-03
3.0	3.717e+03	3.158e-03	7.549e-03	4.285e-06	1.024e-05
TOTALS:	2.343e+13	8.889e+05	6.834e+06	1.725e+03	1.330e+04 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: August 2, 1998
Run Time: 8:31:55 AM
Duration: 00:01:54

File Ref: HKP-12-98
Date: 8/3/98
By: HHK/Johnson
Checked: 99/5/2

Case Title: WM181-107

Description: 55-gal drum loaded with 291.2 kg of Stream 107
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points

	X	Y	Z
# 1	30.37 cm	38.8 cm ✓	0 cm
	12.0 in	1 ft 3.3 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.08e+05 cm ³	Concrete	1.4 -
Shield 1	.16 cm ✓	Iron	7.86 -
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	3.4650e-001 ✓	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001 ✓	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010 ✓	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003 ✓	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003 ✓	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001 ✓	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003 ✓	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010 ✓	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001 ✓	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000 ✓	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001 ✓	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000 ✓	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004 ✓	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006 ✓	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006 ✓	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001 ✓	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000 ✓	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003 ✓	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004 ✓	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005 ✓	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005 ✓	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000 ✓	1.8963e+011	2.4639e+001	9.1166e+005

Buildup

The material reference is : Source

Page : 2
 DOS' File: WM181107.MS5
 Run Date: August 2, 1998
 Run Time: 8:31:55 AM
 Duration: 00:01:54

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Results</u>		<u>Exposure Rate</u>	
		<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Exposure Rate</u> <u>mR/hr</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	4.642e+10	1.017e-32	5.764e-22	8.724e-34	4.944e-23
0.02	1.397e+10	4.426e-14	5.581e-14	1.533e-15	1.933e-15
0.03	8.404e+10	1.814e-02	3.029e-02	1.797e-04	3.002e-04
0.04	1.978e+10	4.965e+00	1.112e+01	2.196e-02	4.917e-02
0.05	1.524e+07	8.413e-02	2.450e-01	2.241e-04	6.526e-04
0.06	4.584e+09	1.324e+02	4.625e+02	2.631e-01	9.187e-01
0.08	2.761e+07	4.212e+00	1.718e+01	6.666e-03	2.719e-02
0.1	1.084e+08	3.729e+01	1.572e+02	5.705e-02	2.405e-01
0.15	3.043e+07	2.747e+01	1.099e+02	4.523e-02	1.810e-01
0.2	4.433e+08	6.654e+02	2.481e+03	1.174e+00	4.379e+00
0.3	2.782e+07	7.896e+01	2.594e+02	1.498e-01	4.921e-01
0.4	1.892e+09	8.298e+03	2.464e+04	1.617e+01	4.801e+01
0.5	6.217e+08	3.816e+03	1.046e+04	7.490e+00	2.053e+01
0.6	1.201e+12	9.701e+06	2.481e+07	1.893e+04	4.843e+04
0.8	5.049e+07	6.301e+02	1.452e+03	1.199e+00	2.762e+00
1.0	2.997e+08	5.248e+03	1.120e+04	9.674e+00	2.065e+01
1.5	3.000e+08	9.715e+03	1.815e+04	1.635e+01	3.053e+01
2.0	3.805e+03	1.888e-01	3.257e-01	2.920e-04	5.036e-04
3.0	5.506e+01	4.879e-03	7.602e-03	6.619e-06	1.031e-05
TOTALS:	1.374e+12	9.729e+06	2.488e+07	1.899e+04	4.856e+04 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181171.MS5
Run Date: August 2, 1998
Run Time: 9:12:34 AM
Duration: 00:02:12

File Ref: HKP-12-98
Date: 8/8/98
By: PHH/gram
Checked: Jo B. h

Case Title: WM181-107
Description: UDS Slurry tank (T-108) with 249 kg Stream 107
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 152.4 cm 5 ft 0.0 in ✓
Radius 61.0 cm 2 ft 0.0 in ✓

Dose Points

	X	Y	Z
# 1	62.64 cm	76.2 cm	0 cm
	2 ft 0.7 in	2 ft 6.0 in ✓	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.78e+06 cm ³	Mixed ->	1.13
		Concrete	0.14
		Water	0.99
Shield 1	.635 cm ✓	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	2.9680e-001 ✓	1.0982e+010	1.6660e-001	6.1641e+003
Ba-137m	3.0910e+001 ✓	1.1437e+012	1.7350e+001	6.4196e+005
Ce-144	6.6300e-010 ✓	2.4531e+001	3.7215e-010	1.3770e-005
Co-60	6.9090e-003 ✓	2.5563e+008	3.8781e-003	1.4349e+002
Cs-134	1.2300e-003 ✓	4.5510e+007	6.9042e-004	2.5545e+001
Cs-137	3.2670e+001 ✓	1.2088e+012	1.8338e+001	6.7851e+005
Np-237	4.3400e-003 ✓	1.6058e+008	2.4361e-003	9.0136e+001
Pr-144	6.6300e-010 ✓	2.4531e+001	3.7215e-010	1.3770e-005
Pu-238	1.7760e+001 ✓	6.5712e+011	9.9689e+000	3.6885e+005
Pu-239	9.5280e-001 ✓	3.5254e+010	5.3482e-001	1.9788e+004
Pu-240	2.9930e-001 ✓	1.1074e+010	1.6800e-001	6.2160e+003
Pu-241	6.1610e+000 ✓	2.2796e+011	3.4583e+000	1.2796e+005
Pu-242	4.4400e-004 ✓	1.6428e+007	2.4922e-004	9.2213e+000
Rh-106	6.1110e-006 ✓	2.2611e+005	3.4302e-006	1.2692e-001
Ru-106	6.1110e-006 ✓	2.2611e+005	3.4302e-006	1.2692e-001
Sb-125	1.3900e-001 ✓	5.1430e+009	7.8023e-002	2.8868e+003
Sr-90	4.3900e+000 ✓	1.6243e+011	2.4642e+000	9.1174e+004
U-234	5.9360e-003 ✓	2.1963e+008	3.3320e-003	1.2328e+002
U-235	1.3070e-004 ✓	4.8359e+006	7.3364e-005	2.7145e+000
U-236	6.1850e-005 ✓	2.2885e+006	3.4717e-005	1.2845e+000
U-238	1.9350e-005 ✓	7.1595e+005	1.0861e-005	4.0187e-001
Y-90	4.3900e+000 ✓	1.6243e+011	2.4642e+000	9.1174e+004

Page : 2
 DOS File: WM181171.MS5
 Run Date: August 2, 1998
 Run Time: 9:12:34 AM
 Duration: 00:02:12

Buildup
 The material reference is : Source

Integration Parameters

Radial	26
Circumferential	26
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Results</u>		<u>Exposure Rate</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	3.977e+10	7.905e-128	9.819e-21	6.780e-129	8.422e-22
0.02	1.197e+10	4.889e-57	8.984e-20	1.694e-58	3.112e-21
0.03	7.198e+10	1.498e-16	6.395e-12	1.484e-18	6.338e-14
0.04	1.694e+10	9.645e-07	1.808e-02	4.266e-09	7.994e-05
0.05	1.306e+07	6.636e-06	3.354e-02	1.768e-08	8.934e-05
0.06	3.926e+09	1.425e-01	2.421e+02	2.831e-04	4.810e-01
0.08	2.363e+07	3.751e-02	1.427e+01	5.936e-05	2.258e-02
0.1	9.282e+07	7.418e-01	1.147e+02	1.135e-03	1.755e-01
0.15	2.604e+07	1.073e+00	5.032e+01	1.767e-03	8.287e-02
0.2	3.792e+08	3.210e+01	8.459e+02	5.666e-02	1.493e+00
0.3	2.380e+07	4.498e+00	6.096e+01	8.533e-03	1.156e-01
0.4	1.618e+09	5.140e+02	4.949e+03	1.001e+00	9.643e+00
0.5	5.318e+08	2.502e+02	1.821e+03	4.911e-01	3.575e+00
0.6	1.029e+12	6.653e+05	4.002e+06	1.299e+03	7.811e+03
0.8	4.325e+07	4.623e+01	2.140e+02	8.793e-02	4.071e-01
1.0	2.567e+08	4.056e+02	1.554e+03	7.476e-01	2.865e+00
1.5	2.570e+08	8.247e+02	2.411e+03	1.388e+00	4.056e+00
2.0	3.259e+03	1.711e-02	4.318e-02	2.646e-05	6.677e-05
3.0	4.716e+01	4.840e-04	1.012e-03	6.566e-07	1.373e-06
TOTALS:	1.176e+12	6.674e+05	4.014e+06	1.302e+03	7.833e+03 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: CSIEX1.MS5
Run Date: August 4, 1998
Run Time: 10:30:38 AM
Duration: 00:03:25

File Ref: HKP-12-98
Date: 8/8/98
By: D. Henderson
Checked: 996cm

Case Title: Cs I Exch Col
Description: Cs Ion Exchange column with 250 l of Stream 108
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 243.84 cm 8 ft ✓
Radius 20.32 cm 8.0 in ✓

Dose Points
1 $\frac{X}{22.2725 \text{ cm}}$ $\frac{Y}{121.92 \text{ cm}}$ $\frac{Z}{0 \text{ cm}}$
8.8 in 4 ft ✓ 0.0 in

Shields
Shield Name Dimension Material Density
Source 3.16e+05 cm³ Mixed -> 2
Carbon 1.8
Water 0.2
Shield 1 .953 cm ✓ Iron 7.86
Transition 1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Am-241	9.3750e-003 ✓	3.4688e+008	2.9639e-002	1.0967e+003
Ba-137m	5.1320e+003 ✓	1.8988e+014	1.6225e+004	6.0032e+008
Ce-144	2.1000e-011 ✓	7.7700e-001	6.6392e-011	2.4565e-006
Co-60	2.1900e-004 ✓	8.1030e+006	6.9238e-004	2.5618e+001
Cs-134	1.8800e+000 ✓	6.9560e+010	5.9437e+000	2.1992e+005
Cs-135	1.0330e-001 ✓	3.8221e+009	3.2659e-001	1.2084e+004
Cs-137	5.4250e+003 ✓	2.0073e+014	1.7151e+004	6.3460e+008
Np-237	1.3780e-004 ✓	5.0986e+006	4.3566e-004	1.6119e+001
Pr-144	2.1000e-011 ✓	7.7700e-001	6.6392e-011	2.4565e-006
Pu-238	5.6250e-001 ✓	2.0813e+010	1.7784e+000	6.5799e+004
Pu-239	3.0250e-002 ✓	1.1193e+009	9.5636e-002	3.5385e+003
Pu-240	9.4750e-003 ✓	3.5058e+008	2.9956e-002	1.1084e+003
Pu-241	1.9550e-001 ✓	7.2335e+009	6.1808e-001	2.2869e+004
Pu-242	1.4100e-005 ✓	5.2170e+005	4.4578e-005	1.6494e+000
Rh-106	1.9380e-007 ✓	7.1706e+003	6.1271e-007	2.2670e-002
Ru-106	1.9380e-007 ✓	7.1706e+003	6.1271e-007	2.2670e-002
Sb-125	4.4000e-003 ✓	1.6280e+008	1.3911e-002	5.1470e+002
Sr-90	1.3900e-001 ✓	5.1430e+009	4.3945e-001	1.6260e+004
U-234	1.8800e-004 ✓	6.9560e+006	5.9437e-004	2.1992e+001
U-235	4.1500e-006 ✓	1.5355e+005	1.3120e-005	4.8545e-001
U-236	1.9650e-006 ✓	7.2705e+004	6.2124e-006	2.2986e-001
U-238	6.1500e-007 ✓	2.2755e+004	1.9443e-006	7.1941e-002
Y-90	1.3900e-001 ✓	5.1430e+009	4.3945e-001	1.6260e+004

Page : 2
 DOS File: CSIEX1.MS5
 Run Date: August 4, 1998
 Run Time: 10:30:38 AM
 Duration: 00:03:25

Buildup
 The material reference is : Source

Integration Parameters

Radial	29
Circumferential	29
Y Direction (axial)	31

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec	<u>Results</u>		<u>Exposure Rate</u> mR/hr	<u>Exposure Rate</u> mR/hr
			<u>No Buildup</u>	<u>With Buildup</u>		
0.015	1.260e+09	5.261e-188	4.765e-23	4.513e-189	4.087e-24	
0.02	3.787e+08	9.996e-85	1.350e-22	3.462e-86	4.676e-24	
0.03	1.150e+13	2.236e-22	2.452e-16	2.216e-24	2.430e-18	
0.04	2.732e+12	7.487e-08	2.771e-04	3.311e-10	1.226e-06	
0.05	4.142e+05	5.401e-09	1.292e-05	1.439e-11	3.441e-08	
0.06	1.240e+08	6.873e-04	7.998e-01	1.365e-06	1.589e-03	
0.08	7.499e+05	7.686e-04	2.424e-01	1.216e-06	3.836e-04	
0.1	2.941e+06	2.583e-02	3.353e+00	3.951e-05	5.130e-03	
0.15	8.250e+05	5.715e-02	2.335e+00	9.411e-05	3.845e-03	
0.2	2.661e+07	4.294e+00	9.247e+01	7.579e-03	1.632e-01	
0.3	1.077e+07	4.255e+00	4.970e+01	8.072e-03	9.427e-02	
0.4	5.123e+07	3.543e+01	2.926e+02	6.904e-02	5.700e-01	
0.5	1.032e+09	1.086e+03	7.056e+03	2.131e+00	1.385e+01	
0.6	1.706e+14	2.513e+08	1.369e+09	4.905e+05	2.672e+06	
0.8	6.548e+10	1.636e+05	6.933e+05	3.112e+02	1.319e+03	
1.0	1.956e+09	7.352e+03	2.628e+04	1.355e+01	4.845e+01	
1.5	2.123e+09	1.659e+04	4.577e+04	2.791e+01	7.701e+01	
2.0	1.033e+02	1.332e-03	3.163e-03	2.059e-06	4.892e-06	
3.0	1.496e+00	3.777e-05	7.518e-05	5.125e-08	1.020e-07	
TOTALS:	1.849e+14	2.515e+08	1.370e+09	4.908e+05	2.674e+06	✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181106.MS5
Run Date: August 5, 1998
Run Time: 5:54:40 PM
Duration: 00:03:55

File Ref: HKP-12-98
Date: 8/8/98
By: [Signature]
Checked: [Signature]

Case Title: Cs IX Effluent tank
Description: Cs IX Effluent tank (T-103 A&B) w/14234 l St #106
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 304.8 cm 10 ft 0.0 in ✓
Radius 121.92 cm 4 ft ✓

Dose Points
1 X Y Z
124.19 cm 152.4 cm ✓ 0 cm
4 ft 0.9 in 5 ft 0.0 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.42e+07 cm ³	Water	1
Shield 1	1.27 cm ✓	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	5.2660e+000	1.9484e+011	3.6997e-001 ✓	1.3689e+004
Am-243	2.3900e-003	8.8430e+007	1.6791e-004 ✓	6.2128e+000
Ba-137m	5.6800e-001	2.1016e+010	3.9906e-002 ✓	1.4765e+003
Ce-144	1.2350e+000	4.5695e+010	8.6767e-002 ✓	3.2104e+003
Cm-242	1.2470e-002	4.6139e+008	8.7610e-004 ✓	3.2416e+001
Cm-244	1.6370e-001	6.0569e+009	1.1501e-002 ✓	4.2554e+002
Co-60	1.8080e-003	6.6896e+007	1.2702e-004 ✓	4.6999e+000
Cs-134	2.0780e-004	7.6886e+006	1.4599e-005 ✓	5.4017e-001
Cs-135	1.1460e-005	4.2402e+005	8.0514e-007 ✓	2.9790e-002
Cs-137	6.0000e-001	2.2200e+010	4.2154e-002 ✓	1.5597e+003
Eu-152	6.2200e-002	2.3014e+009	4.3699e-003	1.6169e+002
Eu-154	3.4450e+000	1.2747e+011	2.4203e-001 ✓	8.9552e+003
Eu-155	6.0500e-001	2.2385e+010	4.2505e-002 ✓	1.5727e+003
H-3	3.0890e-001	1.1429e+010	2.1702e-002 ✓	8.0298e+002
I-129	8.4970e-003	3.1439e+008	5.9697e-004 ✓	2.2088e+001
Ni-63	1.4950e+000	5.5315e+010	1.0503e-001 ✓	3.8862e+003
Np-237	4.9680e-003	1.8382e+008	3.4903e-004 ✓	1.2914e+001
Pm-147	1.4800e+000	5.4760e+010	1.0398e-001 ✓	3.8472e+003
Pr-144	1.2350e+000	4.5695e+010	8.6767e-002 ✓	3.2104e+003
Pu-238	1.4660e+001	5.4242e+011	1.0300e+000 ✓	3.8108e+004
Pu-239	3.3450e-001	1.2377e+010	2.3501e-002 ✓	8.6953e+002
Pu-240	9.3900e-002	3.4743e+009	6.5971e-003 ✓	2.4409e+002
Pu-241	4.3840e+000	1.6221e+011	3.0800e-001 ✓	1.1396e+004
Pu-242	2.2200e-004	8.2140e+006	1.5597e-005 ✓	5.7709e-001
Rh-106	1.5090e-004	5.5833e+006	1.0602e-005 ✓	3.9226e-001

Page : 2
 DOS File: WM181106.MS5
 Run Date: August 5, 1998
 Run Time: 5:54:40 PM
 Duration: 00:03:55

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ru-106	1.5090e-004	5.5833e+006	1.0602e-005 ✓	3.9226e-001
Sb-125	1.8930e-001	7.0041e+009	1.3300e-002 ✓	4.9208e+002
Sm-151	1.0310e+001	3.8147e+011	7.2434e-001 ✓	2.6801e+004
Sr-90	5.7220e+002	2.1171e+013	4.0201e+001 ✓	1.4874e+006
Tc-99	3.1880e-001	1.1796e+010	2.2398e-002 ✓	8.2872e+002
Th-230	1.3300e-006	4.9210e+004	9.3441e-008 ✓	3.4573e-003
Th-231	1.9070e-004	7.0559e+006	1.3398e-005 ✓	4.9572e-001
U-232	4.3270e-005	1.6010e+006	3.0400e-006 ✓	1.1248e-001
U-233	2.0350e-008	7.5295e+002	1.4297e-009 ✓	5.2899e-005
U-234	2.1900e-002	8.1030e+008	1.5386e-003 ✓	5.6929e+001
U-235	5.5080e-004	2.0380e+007	3.8697e-005 ✓	1.4318e+000
U-236	1.9500e-003	7.2150e+007	1.3700e-004 ✓	5.0690e+000
U-238	5.4370e-004	2.0117e+007	3.8198e-005 ✓	1.4133e+000
Y-90	5.7220e+002	2.1171e+013	4.0201e+001 ✓	1.4874e+006

Buildup

The material reference is : Source

Integration Parameters

Radial	32
Circumferential	32
Y Direction (axial)	31

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	5.081e+10	6.521e-252	7.027e-23	5.594e-253	6.027e-24
0.02	6.510e+10	2.084e-112	2.727e-22	7.218e-114	9.447e-24
0.03	9.947e+09	8.383e-36	9.026e-22	8.308e-38	8.945e-24
0.04	3.960e+10	4.891e-15	1.121e-12	2.163e-17	4.958e-15
0.05	8.631e+09	3.544e-08	1.205e-05	9.441e-11	3.211e-08
0.06	6.994e+10	8.056e-04	2.327e-01	1.600e-06	4.623e-04
0.08	7.997e+09	7.566e-02	1.041e+01	1.197e-04	1.647e-02
0.1	5.719e+10	7.873e+00	5.690e+02	1.204e-02	8.705e-01
0.15	5.134e+09	8.504e+00	2.375e+02	1.400e-02	3.912e-01
0.2	9.463e+09	4.149e+01	7.311e+02	7.324e-02	1.290e+00
0.3	9.360e+08	1.109e+01	1.153e+02	2.103e-02	2.187e-01
0.4	3.378e+09	7.359e+01	5.706e+02	1.434e-01	1.112e+00
0.5	1.313e+09	4.495e+01	2.841e+02	8.824e-02	5.577e-01
0.6	3.036e+10	1.494e+03	8.116e+03	2.917e+00	1.584e+01
0.8	4.841e+10	4.207e+03	1.835e+04	8.002e+00	3.491e+01
1.0	4.069e+10	5.490e+03	2.060e+04	1.012e+01	3.797e+01
1.5	5.066e+10	1.509e+04	4.461e+04	2.539e+01	7.506e+01
2.0	3.561e+08	1.829e+02	4.718e+02	2.829e-01	7.296e-01
3.0	9.562e+04	1.024e-01	2.242e-01	1.390e-04	3.041e-04
TOTALS:	4.999e+11	2.665e+04	9.467e+04	4.707e+01	1.690e+02 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181SRT.MS5
Run Date: August 11, 1998
Run Time: 5:30:29 PM
Duration: 00:04:14

File Ref: HKP12-98
Date: 8/11/98
By: AKK/Johnson
Checked: AKK/pl

Case Title: T-112 Spent Resin Tk
Description: T-112 Spent Resin Storage Tank with 21,350 kg of St # 108
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 457.2 cm 15 ft
Radius 121.92 cm 4 ft

Dose Points

	X	Y	Z
# 1	124.19 cm	228.6 cm	0 cm
	4 ft 0.9 in	7 ft 6.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.14e+07 cm ³	Mixed	->1.4
		Concrete	0.4
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Am-241	8.0100e-001	2.9637e+010	3.7517e-002	1.3881e+003
Ba-137m	4.3830e+005	1.6217e+016	2.0529e+004	7.5957e+008
Ce-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Co-60	1.8700e-002	6.9190e+008	8.7586e-004	3.2407e+001
Cs-134	1.6060e+002	5.9422e+012	7.5221e+000	2.7832e+005
Cs-135	8.8200e+000	3.2634e+011	4.1311e-001	1.5285e+004
Cs-137	4.6330e+005	1.7142e+016	2.1700e+004	8.0289e+008
Np-237	1.1760e-002	4.3512e+008	5.5081e-004	2.0380e+001
Pr-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Pu-238	4.8000e+001	1.7760e+012	2.2482e+000	8.3183e+004
Pu-239	2.5800e+000	9.5460e+010	1.2084e-001	4.4711e+003
Pu-240	8.0900e-001	2.9933e+010	3.7892e-002	1.4020e+003
Pu-241	1.6700e+001	6.1790e+011	7.8219e-001	2.8941e+004
Pu-242	1.2040e-003	4.4548e+007	5.6392e-005	2.0865e+000
Rh-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Ru-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Sb-125	3.7600e-001	1.3912e+010	1.7611e-002	6.5160e+002
Sr-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004
U-234	1.6060e-002	5.9422e+008	7.5221e-004	2.7832e+001
U-235	3.5400e-004	1.3098e+007	1.6580e-005	6.1348e-001
U-236	1.6780e-004	6.2086e+006	7.8593e-006	2.9080e-001
U-238	5.2500e-005	1.9425e+006	2.4590e-006	9.0982e-002
Y-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004

Page : 2
 DOS File: WM181SRT.MS5
 Run Date: August 11, 1998
 Run Time: 5:30:29 PM
 Duration: 00:04:14

Buildup
 The material reference is : Source

Integration Parameters

Radial	31
Circumferential	31
Y Direction (axial)	33

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			
0.015	1.075e+11	2.410e-260	1.655e-21	2.068e-261	1.419e-22	
0.02	3.233e+10	1.220e-116	1.153e-20	4.225e-118	3.993e-22	
0.03	9.821e+14	4.379e-32	2.991e-14	4.340e-34	2.964e-16	
0.04	2.333e+14	6.559e-12	6.443e-07	2.901e-14	2.850e-09	
0.05	3.534e+07	5.317e-11	1.520e-06	1.417e-13	4.050e-09	
0.06	1.060e+10	5.417e-05	4.369e-01	1.076e-07	8.679e-04	
0.08	6.401e+07	3.012e-04	3.425e-01	4.766e-07	5.420e-04	
0.1	2.510e+08	1.740e-02	6.084e+00	2.662e-05	9.308e-03	
0.15	7.045e+07	5.825e-02	5.097e+00	9.592e-05	8.394e-03	
0.2	2.274e+09	4.955e+00	2.026e+02	8.745e-03	3.576e-01	
0.3	9.200e+08	5.398e+00	1.052e+02	1.024e-02	1.995e-01	
0.4	4.378e+09	4.712e+01	6.105e+02	9.182e-02	1.189e+00	
0.5	8.819e+10	1.490e+03	1.437e+04	2.925e+00	2.821e+01	
0.6	1.457e+16	3.534e+08	2.742e+09	6.898e+05	5.353e+06	
0.8	5.593e+12	2.393e+05	1.383e+06	4.552e+02	2.630e+03	
1.0	1.671e+11	1.109e+04	5.216e+04	2.044e+01	9.614e+01	
1.5	1.813e+11	2.656e+04	9.187e+04	4.468e+01	1.546e+02	
2.0	8.818e+03	2.224e-03	6.480e-03	3.439e-06	1.002e-05	
3.0	1.274e+02	6.682e-05	1.590e-04	9.065e-08	2.157e-07	
TOTALS:	1.579e+16	3.537e+08	2.744e+09	6.903e+05	5.356e+06	

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM18116A.MS5
Run Date: August 4, 1998
Run Time: 11:18:10 AM
Duration: 00:01:35

File Ref: HKP-12-98
Date: 8/5/98
By: AKB
Checked: GB

Case Title: M-101 Mixer
Description: M-101 Mixer (1/2 cyl) with 133.4 l of Stream # 106
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 91.44 cm 3 ft ✓
Radius 30.48 cm 1 ft —

Dose Points

1 X Y Z
32.44 cm 45.72 cm ✓ 0 cm
1 ft 0.8 in 1 ft 6.0 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.67e+05 cm ³	Mixed	-> 1.27
		Concrete	0.27
		Water	1
Shield 1	.953 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	4.9370e-002 ✓	1.8267e+009	1.8499e-001	6.8446e+003
Am-243	2.2400e-005 ✓	8.2880e+005	8.3933e-005	3.1055e+000
Ba-137m	5.3270e-003 ✓	1.9710e+008	1.9960e-002	7.3853e+002
Ce-144	1.1580e-002 ✓	4.2846e+008	4.3390e-002	1.6054e+003
Cm-242	1.1690e-004 ✓	4.3253e+006	4.3802e-004	1.6207e+001
Cm-244	1.5340e-003 ✓	5.6758e+007	5.7479e-003	2.1267e+002
Co-60	1.6900e-005 ✓	6.2530e+005	6.3324e-005	2.3430e+000
Cs-134	1.9480e-006 ✓	7.2076e+004	7.2992e-006	2.7007e-001
Cs-135	1.0700e-007 ✓	3.9590e+003	4.0093e-007	1.4834e-002
Cs-137	5.6300e-003 ✓	2.0831e+008	2.1096e-002	7.8054e+002
Eu-152	5.8300e-004 ✓	2.1571e+007	2.1845e-003	8.0827e+001
Eu-154	3.2290e-002 ✓	1.1947e+009	1.2099e-001	4.4767e+003
Eu-155	5.6700e-003 ✓	2.0979e+008	2.1246e-002	7.8608e+002
H-3	2.8960e-003 ✓	1.0715e+008	1.0851e-002	4.0150e+002
I-129	7.9670e-005 ✓	2.9478e+006	2.9852e-004	1.1045e+001
Ni-63	1.4000e-002 ✓	5.1800e+008	5.2458e-002	1.9409e+003
Np-237	4.6570e-005 ✓	1.7231e+006	1.7450e-004	6.4564e+000
Pm-147	1.3880e-002 ✓	5.1356e+008	5.2008e-002	1.9243e+003
Pr-144	1.1580e-002 ✓	4.2846e+008	4.3390e-002	1.6054e+003
Pu-238	1.3700e-001 ✓	5.0690e+009	5.1334e-001	1.8994e+004
Pu-239	3.1360e-003 ✓	1.1603e+008	1.1751e-002	4.3477e+002
Pu-240	8.8100e-004 ✓	3.2597e+007	3.3011e-003	1.2214e+002
Pu-241	4.1100e-002 ✓	1.5207e+009	1.5400e-001	5.6981e+003

Page : 2
 DOS File: WM18116A.MS5
 Run Date: August 4, 1998
 Run Time: 11:18:10 AM
 Duration: 00:01:35

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Pu-242	2.0800e-006 ✓	7.6960e+004	7.7938e-006	2.8837e-001
Rh-106	1.4140e-006 ✓	5.2318e+004	5.2983e-006	1.9604e-001
Ru-106	1.4140e-006 ✓	5.2318e+004	5.2983e-006	1.9604e-001
Sb-125	1.7700e-003 ✓	6.5490e+007	6.6322e-003	2.4539e+002
Sm-151	9.6600e-002 ✓	3.5742e+009	3.6196e-001	1.3393e+004
Sr-90	5.3600e+000 ✓	1.9832e+011	2.0084e+001	7.4311e+005
Tc-99	2.9900e-003 ✓	1.1063e+008	1.1204e-002	4.1453e+002
Th-230	1.2490e-008 ✓	4.6213e+002	4.6800e-008	1.7316e-003
Th-231	1.7880e-006 ✓	6.6156e+004	6.6996e-006	2.4789e-001
U-232	4.0600e-007 ✓	1.5022e+004	1.5213e-006	5.6287e-002
U-233	1.9100e-010 ✓	7.0670e+000	7.1568e-010	2.6480e-005
U-234	2.0500e-004 ✓	7.5850e+006	7.6814e-004	2.8421e+001
U-235	5.1600e-006 ✓	1.9092e+005	1.9335e-005	7.1538e-001
U-236	1.8280e-005 ✓	6.7636e+005	6.8495e-005	2.5343e+000
U-238	5.1000e-006 ✓	1.8870e+005	1.9110e-005	7.0706e-001
Y-90	5.3600e+000 ✓	1.9832e+011	2.0084e+001	7.4311e+005

Buildup

The material reference is : Source

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	23

Results

Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	4.754e+08	6.068e-190	2.118e-22	5.205e-191	1.817e-23
0.02	6.101e+08	6.616e-85	7.182e-21	2.292e-86	2.488e-22
0.03	9.318e+07	2.249e-27	9.912e-20	2.228e-29	9.824e-22
0.04	3.712e+08	1.401e-11	6.508e-07	6.197e-14	2.878e-09
0.05	8.090e+07	1.494e-06	2.005e-02	3.979e-09	5.341e-05
0.06	6.557e+08	5.396e-03	2.297e+01	1.072e-05	4.562e-02
0.08	7.496e+07	1.254e-01	9.530e+01	1.984e-04	1.508e-01
0.1	5.360e+08	8.050e+00	2.072e+03	1.232e-02	3.170e+00
0.15	4.814e+07	5.899e+00	3.900e+02	9.714e-03	6.422e-01
0.2	8.868e+07	2.552e+01	8.384e+02	4.504e-02	1.480e+00
0.3	8.772e+06	6.211e+00	9.884e+01	1.178e-02	1.875e-01
0.4	3.161e+07	3.930e+01	4.245e+02	7.657e-02	8.271e-01
0.5	1.229e+07	2.326e+01	1.872e+02	4.565e-02	3.674e-01
0.6	2.846e+08	7.553e+02	4.927e+03	1.474e+00	9.617e+00
0.8	4.538e+08	2.044e+03	1.001e+04	3.888e+00	1.904e+01
1.0	3.814e+08	2.585e+03	1.032e+04	4.764e+00	1.903e+01
1.5	4.748e+08	6.683e+03	1.977e+04	1.124e+01	3.327e+01
2.0	3.339e+06	7.731e+01	1.937e+02	1.196e-01	2.996e-01
3.0	8.966e+02	4.031e-02	8.248e-02	5.468e-05	1.119e-04
TOTALS:	4.685e+09	1.225e+04	4.936e+04	2.169e+01	8.813e+01 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181117.MS5
Run Date: August 4, 1998
Run Time: 11:28:52 AM
Duration: 00:02:17

File Ref: HKP-12-93
Date: 8/5/98
By: AKH/Johnson
Checked: AKH

Case Title: M-101 Mixer
Description: M-101 Mixer (full cylinder) with 453.7 kg of stream #117
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	91.44 cm	3 ft —
Radius	30.48 cm	1 ft —

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	32.44 cm	45.72 cm	0 cm
	1 ft 0.8 in	1 ft 6.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.67e+05 cm ³	Mixed ->	1.9
		Concrete	1.7
		Water	0.2
Shield 1	.953 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Am-241	5.7638e-002 ✓	2.1326e+009	2.1597e-001	7.9908e+003
Am-243	2.6044e-005 ✓	9.6362e+005	9.7586e-005	3.6107e+000
Ba-137m	6.2200e-003 ✓	2.3014e+008	2.3306e-002	8.6234e+002
Ce-144	1.3474e-002 ✓	4.9853e+008	5.0486e-002	1.8680e+003
Cm-242	1.3613e-004 ✓	5.0366e+006	5.1006e-004	1.8872e+001
Cm-244	1.7786e-003 ✓	6.5809e+007	6.6645e-003	2.4659e+002
Co-60	1.9691e-005 ✓	7.2858e+005	7.3783e-005	2.7300e+000
Cs-134	2.2729e-006 ✓	8.4096e+004	8.5165e-006	3.1511e-001
Cs-135	1.2476e-007 ✓	4.6162e+003	4.6749e-007	1.7297e-002
Cs-137	6.5800e-003 ✓	2.4346e+008	2.4655e-002	9.1225e+002
Eu-152	6.7613e-004 ✓	2.5017e+007	2.5334e-003	9.3737e+001
Eu-154	3.7500e-002 ✓	1.3875e+009	1.4051e-001	5.1990e+003
Eu-155	6.5775e-003 ✓	2.4337e+008	2.4646e-002	9.1190e+002
H-3	3.3709e-003 ✓	1.2472e+008	1.2631e-002	4.6734e+002
I-129	9.2550e-005 ✓	3.4244e+006	3.4679e-004	1.2831e+001
Ni-63	1.6331e-002 ✓	6.0426e+008	6.1193e-002	2.2641e+003
Pm-147	1.6151e-002 ✓	5.9760e+008	6.0519e-002	2.2392e+003
Pr-144	1.3474e-002 ✓	4.9853e+008	5.0486e-002	1.8680e+003
Pu-238	1.5971e-001 ✓	5.9094e+009	5.9844e-001	2.2142e+004
Pu-239	3.6521e-003 ✓	1.3513e+008	1.3685e-002	5.0633e+002
Pu-240	1.0253e-003 ✓	3.7934e+007	3.8416e-003	1.4214e+002
Pu-241	4.7625e-002 ✓	1.7621e+009	1.7845e-001	6.6027e+003
Pu-242	2.4274e-006 ✓	8.9813e+004	9.0954e-006	3.3653e-001

Page : 2
 DOS File: WM181117.MS5
 Run Date: August 4, 1998
 Run Time: 11:28:52 AM
 Duration: 00:02:17

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Rh-106	1.6515e-006✓	6.1106e+004	6.1882e-006	2.2896e-001
Ru-106	1.6515e-006✓	6.1106e+004	6.1882e-006	2.2896e-001
Sb-125	2.0644e-003✓	7.6382e+007	7.7352e-003	2.8620e+002
Sm-151	1.1250e-001✓	4.1625e+009	4.2154e-001	1.5597e+004
Sr-90	6.2625e+000✓	2.3171e+011	2.3466e+001	8.6823e+005
Tc-99	3.4845e-003✓	1.2893e+008	1.3056e-002	4.8309e+002
Th-230	1.4520e-008✓	5.3724e+002	5.4406e-008	2.0130e-003
Th-231	2.0824e-006✓	7.7048e+004	7.8027e-006	2.8870e-001
U-232	4.7175e-007✓	1.7455e+004	1.7676e-006	6.5403e-002
U-233	2.2185e-010✓	8.2084e+000	8.3127e-010	3.0757e-005
U-234	2.3955e-004✓	8.8634e+006	8.9759e-004	3.3211e+001
U-235	6.0338e-006✓	2.2325e+005	2.2608e-005	8.3651e-001
U-236	2.1233e-005✓	7.8560e+005	7.9558e-005	2.9437e+000
U-238	5.9438e-006✓	2.1992e+005	2.2271e-005	8.2404e-001
Y-90	6.2625e+000✓	2.3171e+011	2.3466e+001	8.6823e+005

Buildup
 The material reference is : Source

Integration Parameters	
Radial	26
Circumferential	26
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	5.540e+08	2.821e-191	8.103e-24	2.420e-192	6.950e-25
0.02	7.120e+08	1.313e-85	2.579e-23	4.547e-87	8.935e-25
0.03	1.084e+08	9.738e-28	3.654e-23	9.651e-30	3.621e-25
0.04	4.312e+08	6.857e-12	4.270e-10	3.033e-14	1.888e-12
0.05	9.393e+07	7.935e-07	7.654e-05	2.114e-09	2.039e-07
0.06	7.655e+08	3.269e-03	3.186e-01	6.494e-06	6.328e-04
0.08	8.673e+07	8.937e-02	5.510e+00	1.414e-04	8.719e-03
0.1	6.223e+08	6.184e+00	2.346e+02	9.460e-03	3.589e-01
0.15	5.599e+07	4.800e+00	8.537e+01	7.905e-03	1.406e-01
0.2	1.030e+08	2.105e+01	2.529e+02	3.715e-02	4.464e-01
0.3	1.018e+07	5.168e+00	4.066e+01	9.803e-03	7.712e-02
0.4	3.682e+07	3.291e+01	2.022e+02	6.413e-02	3.941e-01
0.5	1.431e+07	1.952e+01	1.006e+02	3.831e-02	1.974e-01
0.6	3.318e+08	6.360e+02	2.867e+03	1.241e+00	5.596e+00
0.8	5.270e+08	1.722e+03	6.398e+03	3.275e+00	1.217e+01
1.0	4.429e+08	2.187e+03	7.109e+03	4.031e+00	1.310e+01
1.5	5.514e+08	5.717e+03	1.493e+04	9.618e+00	2.512e+01
2.0	3.885e+06	6.683e+01	1.542e+02	1.034e-01	2.384e-01
3.0	1.043e+03	3.526e-02	6.966e-02	4.783e-05	9.451e-05
TOTALS:	5.451e+09	1.042e+04	3.238e+04	1.844e+01	5.785e+01 ✓

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WD117.MS5
Run Date: August 4, 1998
Run Time: 11:36:46 AM
Duration: 00:02:14

File Ref: HKP-12-98
Date: 8/8/98
By: AKH/Johnson
Checked: gabel

Case Title: Waste Drum
Description: Waste Drum with 239 kg of grouted waste from St #117
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 69.84 cm 2 ft 3.5 in
Radius 29.21 cm 11.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	30.37 cm	31.04 cm	0 cm
	12.0 in	1 ft 0.2 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.87e+05 cm ³	Mixed ->	1.9
		Concrete	1.8
		Water	0.1
Shield 1	.16 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Am-241	3.0300e-002	✓ 1.1211e+009	1.6185e-001	5.9886e+003
Am-243	1.3700e-005	✓ 5.0690e+005	7.3182e-005	2.7077e+000
Ba-137m	3.2780e-003	✓ 1.2129e+008	1.7510e-002	6.4788e+002
Ce-144	7.1000e-003	✓ 2.6270e+008	3.7926e-002	1.4033e+003
Cm-242	7.1700e-005	✓ 2.6529e+006	3.8300e-004	1.4171e+001
Cm-244	9.3670e-004	✓ 3.4658e+007	5.0036e-003	1.8513e+002
Co-60	1.0370e-005	✓ 3.8369e+005	5.5394e-005	2.0496e+000
Cs-134	1.1970e-006	✓ 4.4289e+004	6.3941e-006	2.3658e-001
Cs-135	6.5700e-008	✓ 2.4309e+003	3.5095e-007	1.2985e-002
Cs-137	3.4650e-003	✓ 1.2821e+008	1.8509e-002	6.8484e+002
Eu-152	3.5600e-004	✓ 1.3172e+007	1.9017e-003	7.0361e+001
Eu-154	1.9760e-002	✓ 7.3112e+008	1.0555e-001	3.9055e+003
Eu-155	3.4650e-003	✓ 1.2821e+008	1.8509e-002	6.8484e+002
H-3	1.7750e-003	✓ 6.5675e+007	9.4816e-003	3.5082e+002
I-129	4.8750e-005	✓ 1.8038e+006	2.6041e-004	9.6352e+000
Ni-63	8.6030e-003	✓ 3.1831e+008	4.5955e-002	1.7003e+003
Np-237	2.8680e-005	✓ 1.0612e+006	1.5320e-004	5.6684e+000
Pm-147	8.5070e-003	✓ 3.1476e+008	4.5442e-002	1.6814e+003
Pr-144	7.0970e-003	✓ 2.6259e+008	3.7910e-002	1.4027e+003
Pu-238	8.4100e-002	✓ 3.1117e+009	4.4924e-001	1.6622e+004
Pu-239	1.9240e-003	✓ 7.1188e+007	1.0278e-002	3.8027e+002
Pu-240	5.4000e-004	✓ 1.9980e+007	2.8845e-003	1.0673e+002
Pu-241	2.5090e-002	✓ 9.2833e+008	1.3402e-001	4.9589e+003

Page : 2
 DOS File: WD117.MS5
 Run Date: August 4, 1998
 Run Time: 11:36:46 AM
 Duration: 00:02:14

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Pu-242	1.2780e-006 ✓	4.7286e+004	6.8267e-006	2.5259e-001
Rh-106	8.6980e-007 ✓	3.2183e+004	4.6462e-006	1.7191e-001
Ru-106	8.6980e-007 ✓	3.2183e+004	4.6462e-006	1.7191e-001
Sb-125	1.0870e-003 ✓	4.0219e+007	5.8065e-003	2.1484e+002
Sm-151	5.9260e-002 ✓	2.1926e+009	3.1655e-001	1.1712e+004
Sr-90	3.2980e+000 ✓	1.2203e+011	1.7617e+001	6.5183e+005
Tc-99	1.8350e-003 ✓	6.7895e+007	9.8021e-003	3.6268e+002
Th-230	7.6470e-009 ✓	2.8294e+002	4.0848e-008	1.5114e-003
Th-231	1.0970e-006 ✓	4.0589e+004	5.8599e-006	2.1682e-001
U-232	2.4850e-007 ✓	9.1945e+003	1.3274e-006	4.9115e-002
U-233	1.1690e-010 ✓	4.3253e+000	6.2445e-010	2.3105e-005
U-234	1.2620e-004 ✓	4.6694e+006	6.7413e-004	2.4943e+001
U-235	3.1780e-006 ✓	1.1759e+005	1.6976e-005	6.2811e-001
U-236	1.1180e-005 ✓	4.1366e+005	5.9721e-005	2.2097e+000
U-238	3.1300e-006 ✓	1.1581e+005	1.6720e-005	6.1863e-001
Y-90	3.2980e+000 ✓	1.2203e+011	1.7617e+001	6.5183e+005

Buildup
 The material reference is : Source

Integration Parameters

Radial	26
Circumferential	26
Y Direction (axial)	26

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	Exposure Rate mR/hr		
0.015	2.918e+08	1.648e-34	5.269e-24	1.414e-35	4.520e-25	
0.02	3.744e+08	1.386e-15	3.412e-15	4.802e-17	1.182e-16	
0.03	5.721e+07	1.041e-05	5.337e-05	1.031e-07	5.290e-07	
0.04	2.272e+08	4.695e-02	4.095e-01	2.076e-04	1.811e-03	
0.05	4.949e+07	2.267e-01	2.571e+00	6.038e-04	6.848e-03	
0.06	4.024e+08	9.636e+00	1.149e+02	1.914e-02	2.283e-01	
0.08	4.583e+07	5.754e+00	6.014e+01	9.105e-03	9.517e-02	
0.1	3.280e+08	9.248e+01	8.122e+02	1.415e-01	1.243e+00	
0.15	2.951e+07	2.178e+01	1.399e+02	3.587e-02	2.303e-01	
0.2	5.428e+07	6.661e+01	3.474e+02	1.176e-01	6.131e-01	
0.3	5.361e+06	1.246e+01	5.094e+01	2.364e-02	9.663e-02	
0.4	1.939e+07	6.979e+01	2.451e+02	1.360e-01	4.776e-01	
0.5	7.535e+06	3.804e+01	1.194e+02	7.466e-02	2.344e-01	
0.6	1.748e+08	1.164e+03	3.353e+03	2.272e+00	6.545e+00	
0.8	2.777e+08	2.869e+03	7.272e+03	5.457e+00	1.383e+01	
1.0	2.334e+08	3.400e+03	7.900e+03	6.267e+00	1.456e+01	
1.5	2.906e+08	7.914e+03	1.586e+04	1.332e+01	2.668e+01	
2.0	2.046e+06	8.630e+01	1.586e+02	1.335e-01	2.453e-01	
3.0	5.495e+02	4.210e-02	6.929e-02	5.712e-05	9.401e-05	
TOTALS:	2.871e+09	1.575e+04	3.643e+04	2.800e+01	6.509e+01 ✓	

Fax for: S. J. Losinski

Fax # 6-4017

3 pages - with this one.

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company
Case File Heat Generation
Case File: WM181107.MS5
Case Title: WM181-107

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	3.4650e-001	1.2821e+010	3.2755e-002	1.1350e-002
Ba-137m	3.6090e+001	1.3353e+012	3.5403e-003	1.2777e-001
Ce-144	7.7460e-010	2.8660e+001	6.0991e-004	4.7244e-013
Co-60	8.0660e-003	2.9844e+008	1.5417e-002	1.2435e-004
Cs-134	1.4360e-003	5.3132e+007	1.0149e-002	1.4574e-005
Cs-137	3.8150e+001	1.4116e+012	1.1086e-003	4.2291e-002
Np-237	5.0700e-003	1.8759e+008	2.8548e-002	1.4474e-004
Pr-144	7.7460e-010	2.8660e+001	7.3470e-003	5.6910e-012
Pu-238	2.0730e+001	7.6701e+011	3.2552e-002	6.7481e-001
Pu-239	1.1120e+000	4.1144e+010	3.0531e-002	3.3951e-002
Pu-240	3.4900e-001	1.2913e+010	3.0591e-002	1.0676e-002
Pu-241	7.1930e+000	2.6614e+011	3.1773e-005	2.2854e-004
Pu-242	5.1830e-004	1.9177e+007	2.9012e-002	1.5037e-005
Rh-106	7.1340e-006	2.6396e+005	9.5865e-003	6.8390e-008
Ru-106	7.1340e-006	2.6396e+005	5.9466e-005	4.2423e-010
Sb-125	1.6250e-001	6.0125e+009	3.0911e-003	5.0231e-004
Sr-90	5.1250e+000	1.8963e+011	1.1603e-003	5.9465e-003
U-234	6.9300e-003	2.5641e+008	2.8232e-002	1.9565e-004
U-235	1.5260e-004	5.6462e+006	2.7030e-002	4.1248e-006
U-236	7.2200e-005	2.6714e+006	2.6729e-002	1.9299e-006
U-238	2.2600e-005	8.3620e+005	2.4838e-002	5.6134e-007
Y-90	5.1250e+000	1.8963e+011	5.5407e-003	2.8396e-002

Total Heat Generation: 9.3642e-001

*Per
55-gal.
drum
JH
8/25/98*

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company
Case File Heat Generation
Case File: WM181SRT.MS5
Case Title: T-112 Spent Resin Tk

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	8.0100e-001	2.9637e+010	3.2755e-002	2.6237e-002
Ba-137m	4.3830e+005	1.6217e+016	3.5403e-003	1.5517e+003
Ce-144	1.7900e-009	6.6230e+001	6.0991e-004	1.0917e-012
Co-60	1.8700e-002	6.9190e+008	1.5417e-002	2.8829e-004
Cs-134	1.6060e+002	5.9422e+012	1.0149e-002	1.6299e+000
Cs-135	8.8200e+000	3.2634e+011	3.9913e-004	3.5203e-003
Cs-137	4.6330e+005	1.7142e+016	1.1086e-003	5.1359e+002
Np-237	1.1760e-002	4.3512e+008	2.8548e-002	3.3573e-004
Pr-144	1.7900e-009	6.6230e+001	7.3470e-003	1.3151e-011
Pu-238	4.8000e+001	1.7760e+012	3.2552e-002	1.5625e+000
Pu-239	2.5800e+000	9.5460e+010	3.0531e-002	7.8771e-002
Pu-240	8.0900e-001	2.9933e+010	3.0591e-002	2.4748e-002
Pu-241	1.6700e+001	6.1790e+011	3.1773e-005	5.3061e-004
Pu-242	1.2040e-003	4.4548e+007	2.9012e-002	3.4930e-005
Rh-106	1.6500e-005	6.1050e+005	9.5865e-003	1.5818e-007
Ru-106	1.6500e-005	6.1050e+005	5.9466e-005	9.8119e-010
Sb-125	3.7600e-001	1.3912e+010	3.0911e-003	1.1623e-003
Sr-90	1.1870e+001	4.3919e+011	1.1603e-003	1.3773e-002
U-234	1.6060e-002	5.9422e+008	2.8232e-002	4.5341e-004
U-235	3.5400e-004	1.3098e+007	2.7030e-002	9.5688e-006
U-236	1.6780e-004	6.2086e+006	2.6729e-002	4.4852e-006
U-238	5.2500e-005	1.9425e+006	2.4838e-002	1.3040e-006
Y-90	1.1870e+001	4.3919e+011	5.5407e-003	6.5768e-002

Total

Heat Generation:

2.0687e+003

per
resin storage
tank
AKB
8/25/98

431.02#
06/17/97
Rev. #04

ENGINEERING DESIGN FILE

Functional File Number – SPR-CslX-13
EDF Serial Number – EDF-CslX-15
Page 10 of 10

Attachment 2

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: September 30, 1998

To: S. J. Losinski MS 3625 6-5962

From: H. K. Peterson *H. K. Peterson* MS 2107 6-8657

Subject: "AVERAGE" CS IX/TRU COMPONENT PROJECTED RADIATION FIELDS
-- HKP-18-98

References: a) MicroShield, Version 5.01, Grove Engineering, Rockville MD

Contact/near surface (1 cm from item surface) radiation field calculations for "average" conditions have been made for the requested Cs IX/TRU Feasibility Study components and are summarized below. Also projected are the heat generation rates for these components for the corresponding source term concentrations. The calculations were made with the MicroShield, Version 5.01, computer code (Ref.a) and input/output listings for each are attached for reference.

- a) (Item #1) Assumed to be T-101 A & B Liquid Waste Feed Tank, which is a right circular cylinder 10 feet tall, 8 ft in diameter, with a wall of ½ inches stainless steel (SS), and containing 14,234 liters of Stream 103. The calculated radiation field at 1 cm from the tank midline is 14.4 R/hr and the heat generation rate (HGR) is 7.24 watts.
- b) (Item #2) Assumed to be EV-101 Rotary Evaporator, which is assumed to be the same as a standard 55-gal drum containing 291.2 kg of Stream 107. The calculated radiation field for this component is 48.6 R/hr and the HGR is 0.94 watts.
- c) (Item #3) Assumed to be the T-108 UDS Slurry Tank, which is 5 ft tall, 4 ft in diameter, with a 3/8-inch SS wall, and containing 249 kg of Stream 107 diluted by a factor of 10 with water. The calculated radiation field is 7.8 R/hr and the HGR is 0.8 watts.
- d) (Item #4) Assumed to be the V-104A Cesium Ion Exchange Column, modeled to be 8 ft tall, 1.33 ft in diameter, with a 3/8 inch SS wall, and containing 0.25 m³ of Stream 108 distributed uniformly in the column. The radiation field for this component is calculated to be 2630 R/hr and the HGR is 24 watts.
- e) (Item #5) Assumed to be the T-103 A & B Cs IX Effluent Tank and modeled to be 10 ft tall, 8 ft diameter, with a ½ inch SS wall, and containing 14234 liters of Stream 106. The calculated radiation field for this component is 185 mR/hr and the HGR is 4 watts.
- f) (Item #6) Assumed to be the T-112 Spent Resin Storage Tank and modeled to be 15 ft high, 8 ft in diameter, with a ½ inch SS wall, and containing 23112 kg of Stream 108. The radiation field is calculated to be 7630 R/hr and the HGR is 2050 watts.

- g) (Item #7) A recalculation of the T-112 Spent Resin Storage Tank containing 23,112 kg of Stream 108a modeled as in item #6. The radiation field is calculated to be 10,650 R/hr and the HGR is 2840 watts.
- h) (Item #8) Modeled the same as the M-101 Mixer, assumed to be a half cylinder 2 ft in diameter, 3 ft long, with a 3/8-inch SS wall and containing 133.4 liters of Stream 113. The radiation field is calculated to be 90 mR/hr and the HGR is 0.04 watts.
- i) (Item #9) Modeled the same as the M-101 Mixer, assumed to be a full cylinder 3 ft long, 2 ft in diameter, with a 3/8-inch SS wall, and containing 507.3 kg of Stream 117. The radiation field for this component is calculated to be 70 mR/hr and the HGR is 0.05 watts.
- j) (Item #10) Modeled the same as a Waste Drum, assumed to be a standard 55- gal drum with 395.2 kg of grouted waste from Stream 117. The radiation field for this package is calculated to be 115 mR/hr and has an HGR of 0.04 watts.
- k) (Item #11) Modeled the same as the component of item #10 but containing 395.2 kg of Stream 117a. The radiation field is calculated to be 130 mR/hr and the HGR is 0.04 watts.

If there are any questions or comments concerning this analysis, please call me at the above-listed number.

hkp

Attachments

cc:

P. D. Ritter, LMITCO, MS 2107 PDR
G. J. Stormberg, LMITCO, MS 2107 gjs
HKP Letter File

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: 181103SL.MS5
 Run Date: September 24, 1998
 Run Time: 8:40:42 AM
 Duration: 00:01:47

File Ref: HKP-18-98
 Date: 9/30/98
 By: [Signature]
 Checked: PR 9/30/98

Case Title: WM-181103
Description: T-101 A & B Liquid Waste Feed Tanks - Surface Rad./WS103
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	304.8 cm	10 ft 0.0 in
Radius	121.92 cm	4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	124.19 cm	152.4 cm	0 cm
	4 ft 0.9 in	5 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.42e+07 cm ³	Mixed -> 1.3 Concrete	0.3
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	1.0 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>
Am-241	6.6030e+000	2.4431e+011	4.6390e-001	1.7164e+004
Am-243	2.9820e-003	1.1033e+008	2.0950e-004	7.7517e+000
Ba-137m	6.9296e+002	2.5640e+013	4.8685e+001	1.8013e+006
Ce-144	8.4770e-001	3.1365e+010	5.9556e-002	2.2036e+003
Cm-242	1.5620e-002	5.7794e+008	1.0974e-003	4.0604e+001
Cm-244	2.1000e-001	7.7700e+009	1.4754e-002	5.4589e+002
Co-60	7.3100e-001	2.7047e+010	5.1357e-002	1.9002e+003
Cs-134	6.1060e-001	2.2592e+010	4.2898e-002	1.5872e+003
Cs-135	1.3560e-002	5.0172e+008	9.5268e-004	3.5249e+001
Cs-137	7.3414e+002	2.7163e+013	5.1578e+001	1.9084e+006
Eu-152	3.9900e-002	1.4763e+009	2.8032e-003	1.0372e+002
Eu-154	2.3150e+000	8.5655e+010	1.6264e-001	6.0178e+003
Eu-155	1.0067e+000	3.7248e+010	7.0727e-002	2.6169e+003
H-3	4.2880e-001	1.5866e+010	3.0126e-002	1.1147e+003
I-129	9.7980e-002	3.6253e+009	6.8837e-003	2.5470e+002
Ni-63	7.0150e-001	2.5956e+010	4.9285e-002	1.8235e+003
Np-237	3.6210e-002	1.3398e+009	2.5440e-003	9.4127e+001
Pm-147	1.9450e+000	7.1965e+010	1.3665e-001	5.0560e+003
Pr-144	8.4770e-001	3.1365e+010	5.9556e-002	2.2036e+003
Pu-238	1.2230e+001	4.5251e+011	8.5923e-001	3.1792e+004
Pu-239	9.3290e-001	3.4517e+010	6.5542e-002	2.4251e+003
Pu-240	2.6980e-001	9.9826e+009	1.8955e-002	7.0134e+002
Pu-241	5.3960e+000	1.9965e+011	3.7910e-001	1.4027e+004

Page : 2
 DOS File: 181103SL.MS5
 Run Date: September 24, 1998
 Run Time: 8:40:42 AM
 Duration: 00:01:47

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	2.0870e-004	7.7219e+006	1.4662e-005	5.4251e-001
Rh-106	4.6400e-003	1.7168e+008	3.2599e-004	1.2062e+001
Ru-106	4.6400e-003	1.7168e+008	3.2599e-004	1.2062e+001
Sb-125	1.5480e-001	5.7276e+009	1.0876e-002	4.0240e+002
Sm-151	6.8590e+000	2.5378e+011	4.8189e-001	1.7830e+004
Sr-90	4.8706e+002	1.8021e+013	3.4219e+001	1.2661e+006
Tc-99	2.1160e-001	7.8292e+009	1.4866e-002	5.5005e+002
Th-230	9.7130e-006	3.5938e+005	6.8240e-007	2.5249e-002
Th-231	1.3920e-003	5.1504e+007	9.7797e-005	3.6185e+000
U-232	2.7400e-005	1.0138e+006	1.9250e-006	7.1226e-002
U-233	1.4770e-007	5.4649e+003	1.0377e-008	3.8394e-004
U-234	1.3900e-002	5.1430e+008	9.7656e-004	3.6133e+001
U-235	3.4600e-004	1.2802e+007	2.4309e-005	8.9942e-001
U-236	6.7590e-004	2.5008e+007	4.7486e-005	1.7570e+000
U-238	3.7300e-004	1.3801e+007	2.6206e-005	9.6961e-001
Y-90	4.8706e+002	1.8021e+013	3.4219e+001	1.2661e+006

Buildup

The material reference is : Source

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	24

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	5.103e+10	7.302e-264	1.578e-21	6.263e-265	1.354e-22
0.02	7.875e+10	1.656e-117	6.237e-20	5.735e-119	2.161e-21
0.03	1.565e+12	3.475e-35	1.105e-16	3.444e-37	1.095e-18
0.04	3.999e+11	9.947e-15	1.669e-09	4.399e-17	7.381e-12
0.05	7.095e+09	1.192e-08	5.255e-04	3.176e-11	1.400e-06
0.06	8.780e+10	5.853e-04	6.809e+00	1.162e-06	1.352e-02
0.08	1.250e+10	9.234e-02	1.318e+02	1.461e-04	2.085e-01
0.1	4.313e+10	5.024e+00	1.956e+03	7.686e-03	2.993e+00
0.15	3.557e+09	5.026e+00	4.401e+02	8.277e-03	7.248e-01
0.2	6.442e+09	2.378e+01	9.961e+02	4.197e-02	1.758e+00
0.3	6.213e+08	6.098e+00	1.207e+02	1.157e-02	2.289e-01
0.4	2.589e+09	4.630e+01	6.127e+02	9.021e-02	1.194e+00
0.5	1.352e+09	3.776e+01	3.707e+02	7.413e-02	7.276e-01
0.6	2.305e+13	9.218e+05	7.275e+06	1.799e+03	1.420e+04
0.8	5.378e+10	3.774e+03	2.212e+04	7.179e+00	4.208e+01
1.0	5.493e+10	5.960e+03	2.834e+04	1.099e+01	5.224e+01
1.5	6.171e+10	1.471e+04	5.125e+04	2.474e+01	8.622e+01
2.0	2.450e+08	1.003e+02	2.944e+02	1.551e-01	4.552e-01
3.0	9.479e+04	8.053e-02	1.925e-01	1.093e-04	2.612e-04
TOTALS:	2.548e+13	9.464e+05	7.382e+06	1.842e+03	1.439e+04

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: 181103SL.MS5
 Case Title: WM-181103

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Becquerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	6.6030e+000	2.4431e+011	3.2755e-002	2.1628e-001
Am-243	2.9820e-003	1.1033e+008	3.1599e-002	9.4230e-005
Ba-137m	6.9296e+002	2.5640e+013	3.5403e-003	2.4533e+000
Ce-144	8.4770e-001	3.1365e+010	6.0991e-004	5.1702e-004
Cm-242	1.5620e-002	5.7794e+008	3.6195e-002	5.6537e-004
Cm-244	2.1000e-001	7.7700e+009	3.4375e-002	7.2188e-003
Co-60	7.3100e-001	2.7047e+010	1.5417e-002	1.1270e-002
Cs-134	6.1060e-001	2.2592e+010	1.0149e-002	6.1969e-003
Cs-135	1.3560e-002	5.0172e+008	3.9913e-004	5.4122e-006
Cs-137	7.3414e+002	2.7163e+013	1.1086e-003	8.1383e-001
Eu-152	3.9900e-002	1.4763e+009	7.3864e-003	2.9472e-004
Eu-154	2.3150e+000	8.5655e+010	8.7221e-003	2.0192e-002
Eu-155	1.0067e+000	3.7248e+010	6.4902e-004	6.5337e-004
H-3	4.2880e-001	1.5866e+010	3.3688e-005	1.4445e-005
I-129	9.7980e-002	3.6253e+009	4.7222e-004	4.6268e-005
Ni-63	7.0150e-001	2.5956e+010	1.0154e-004	7.1233e-005
Np-237	3.6210e-002	1.3398e+009	2.8548e-002	1.0337e-003
Pm-147	1.9450e+000	7.1965e+010	3.6732e-004	7.1444e-004
Pr-144	8.4770e-001	3.1365e+010	7.3470e-003	6.2280e-003
Pu-238	1.2230e+001	4.5251e+011	3.2552e-002	3.9811e-001
Pu-239	9.3290e-001	3.4517e+010	3.0531e-002	2.8483e-002
Pu-240	2.6980e-001	9.9826e+009	3.0591e-002	8.2535e-003
Pu-241	5.3960e+000	1.9965e+011	3.1773e-005	1.7145e-004
Pu-242	2.0870e-004	7.7219e+006	2.9012e-002	6.0548e-006
Rh-106	4.6400e-003	1.7168e+008	9.5865e-003	4.4482e-005
Ru-106	4.6400e-003	1.7168e+008	5.9466e-005	2.7592e-007
Sb-125	1.5480e-001	5.7276e+009	3.0911e-003	4.7851e-004
Sm-151	6.8590e+000	2.5378e+011	1.1669e-004	8.0035e-004
Sr-90	4.8706e+002	1.8021e+013	1.1603e-003	5.6514e-001
Tc-99	2.1160e-001	7.8292e+009	6.0024e-004	1.2701e-004
Th-230	9.7130e-006	3.5938e+005	2.7709e-002	2.6914e-007
Th-231	1.3920e-003	5.1504e+007	7.1148e-004	9.9037e-007
U-232	2.7400e-005	1.0138e+006	3.1460e-002	8.6201e-007
U-233	1.4770e-007	5.4649e+003	2.8571e-002	4.2200e-009
U-234	1.3900e-002	5.1430e+008	2.8232e-002	3.9243e-004
U-235	3.4600e-004	1.2802e+007	2.7030e-002	9.3525e-006
U-236	6.7590e-004	2.5008e+007	2.6729e-002	1.8066e-005
U-238	3.7300e-004	1.3801e+007	2.4838e-002	9.2646e-006
Y-90	4.8706e+002	1.8021e+013	5.5407e-003	2.6987e+000
Total			Heat Generation:	7.2392e+000

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: September 24, 1998
Run Time: 9:10:56 AM
Duration: 00:01:46

File Ref: HKP-18-98
Date: 9/30/98
By: W. H. Brown
Checked: DR 9/30/98

Case Title: WM181-107
Description: 55-gal drum loaded with 291.2 kg of Stream 107
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points
1 X Y Z
 30.37 cm 38.8 cm 0 cm
 12.0 in 1 ft 3.3 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 2.08e+05 cm³ Concrete 1.4
Shield 1 .16 cm Iron 7.86
Transition 1.0 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>
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Buildup
The material reference is : Source

Page : 2
 DOS File: WM181107.MS5
 Run Date: September 24, 1998
 Run Time: 9:10:56 AM
 Duration: 00:01:46

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	4.642e+10	1.017e-32	5.764e-22	8.724e-34	4.944e-23
0.02	1.397e+10	4.426e-14	5.581e-14	1.533e-15	1.933e-15
0.03	8.404e+10	1.814e-02	3.029e-02	1.797e-04	3.002e-04
0.04	1.978e+10	4.965e+00	1.112e+01	2.196e-02	4.917e-02
0.05	1.524e+07	8.413e-02	2.450e-01	2.241e-04	6.526e-04
0.06	4.584e+09	1.324e+02	4.625e+02	2.631e-01	9.187e-01
0.08	2.761e+07	4.212e+00	1.718e+01	6.666e-03	2.719e-02
0.1	1.084e+08	3.729e+01	1.572e+02	5.705e-02	2.405e-01
0.15	3.043e+07	2.747e+01	1.099e+02	4.523e-02	1.810e-01
0.2	4.433e+08	6.654e+02	2.481e+03	1.174e+00	4.379e+00
0.3	2.782e+07	7.896e+01	2.594e+02	1.498e-01	4.921e-01
0.4	1.892e+09	8.298e+03	2.464e+04	1.617e+01	4.801e+01
0.5	6.217e+08	3.816e+03	1.046e+04	7.490e+00	2.053e+01
0.6	1.201e+12	9.701e+06	2.481e+07	1.893e+04	4.843e+04
0.8	5.049e+07	6.301e+02	1.452e+03	1.199e+00	2.762e+00
1.0	2.997e+08	5.248e+03	1.120e+04	9.674e+00	2.065e+01
1.5	3.000e+08	9.715e+03	1.815e+04	1.635e+01	3.053e+01
2.0	3.805e+03	1.888e-01	3.257e-01	2.920e-04	5.036e-04
3.0	5.506e+01	4.879e-03	7.602e-03	6.619e-06	1.031e-05
TOTALS:	1.374e+12	9.729e+06	2.488e+07	1.899e+04	4.856e+04

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: WM181107.MS5
 Case Title: WM181-107

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	3.4650e-001	1.2821e+010	3.2755e-002	1.1350e-002
Ba-137m	3.6090e+001	1.3353e+012	3.5403e-003	1.2777e-001
Ce-144	7.7460e-010	2.8660e+001	6.0991e-004	4.7244e-013
Co-60	8.0660e-003	2.9844e+008	1.5417e-002	1.2435e-004
Cs-134	1.4360e-003	5.3132e+007	1.0149e-002	1.4574e-005
Cs-137	3.8150e+001	1.4116e+012	1.1086e-003	4.2291e-002
Np-237	5.0700e-003	1.8759e+008	2.8548e-002	1.4474e-004
Pr-144	7.7460e-010	2.8660e+001	7.3470e-003	5.6910e-012
Pu-238	2.0730e+001	7.6701e+011	3.2552e-002	6.7481e-001
Pu-239	1.1120e+000	4.1144e+010	3.0531e-002	3.3951e-002
Pu-240	3.4900e-001	1.2913e+010	3.0591e-002	1.0676e-002
Pu-241	7.1930e+000	2.6614e+011	3.1773e-005	2.2854e-004
Pu-242	5.1830e-004	1.9177e+007	2.9012e-002	1.5037e-005
Rh-106	7.1340e-006	2.6396e+005	9.5865e-003	6.8390e-008
Ru-106	7.1340e-006	2.6396e+005	5.9466e-005	4.2423e-010
Sb-125	1.6250e-001	6.0125e+009	3.0911e-003	5.0231e-004
Sr-90	5.1250e+000	1.8963e+011	1.1603e-003	5.9465e-003
U-234	6.9300e-003	2.5641e+008	2.8232e-002	1.9565e-004
U-235	1.5260e-004	5.6462e+006	2.7030e-002	4.1248e-006
U-236	7.2200e-005	2.6714e+006	2.6729e-002	1.9299e-006
U-238	2.2600e-005	8.3620e+005	2.4838e-002	5.6134e-007
Y-90	5.1250e+000	1.8963e+011	5.5407e-003	2.8396e-002
		Total	Heat Generation:	9.3642e-001

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181171.MS5
Run Date: September 24, 1998
Run Time: 9:25:54 AM
Duration: 00:02:06

File Ref: HHP-18-98
Date: 9/30/98
By: DAK/Anderson
Checked: PR 9/30/98

Case Title: WM181-107
Description: UDS Slurry tank (T-108) with 249 kg Stream 107 (Dil)
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 152.4 cm 5 ft 0.0 in
Radius 61.0 cm 2 ft 0.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	62.64 cm	76.2 cm	0 cm
	2 ft 0.7 in	2 ft 6.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.78e+06 cm ³	Mixed	->1.13
		Concrete	0.14
		Water	0.99
Shield 1	.635 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Am-241	2.9680e-001	1.0982e+010	1.6660e-001	6.1641e+003
Ba-137m	3.0910e+001	1.1437e+012	1.7350e+001	6.4196e+005
Ce-144	6.6300e-010	2.4531e+001	3.7215e-010	1.3770e-005
Co-60	6.9090e-003	2.5563e+008	3.8781e-003	1.4349e+002
Cs-134	1.2300e-003	4.5510e+007	6.9042e-004	2.5545e+001
Cs-137	3.2670e+001	1.2088e+012	1.8338e+001	6.7851e+005
Np-237	4.3400e-003	1.6058e+008	2.4361e-003	9.0136e+001
Pr-144	6.6300e-010	2.4531e+001	3.7215e-010	1.3770e-005
Pu-238	1.7760e+001	6.5712e+011	9.9689e+000	3.6885e+005
Pu-239	9.5280e-001	3.5254e+010	5.3482e-001	1.9788e+004
Pu-240	2.9930e-001	1.1074e+010	1.6800e-001	6.2160e+003
Pu-241	6.1610e+000	2.2796e+011	3.4583e+000	1.2796e+005
Pu-242	4.4400e-004	1.6428e+007	2.4922e-004	9.2213e+000
Rh-106	6.1110e-006	2.2611e+005	3.4302e-006	1.2692e-001
Ru-106	6.1110e-006	2.2611e+005	3.4302e-006	1.2692e-001
Sb-125	1.3900e-001	5.1430e+009	7.8023e-002	2.8868e+003
Sr-90	4.3900e+000	1.6243e+011	2.4642e+000	9.1174e+004
U-234	5.9360e-003	2.1963e+008	3.3320e-003	1.2328e+002
U-235	1.3070e-004	4.8359e+006	7.3364e-005	2.7145e+000
U-236	6.1850e-005	2.2885e+006	3.4717e-005	1.2845e+000
U-238	1.9350e-005	7.1595e+005	1.0861e-005	4.0187e-001
Y-90	4.3900e+000	1.6243e+011	2.4642e+000	9.1174e+004

Page : 2
 DOS File: WM181171.MS5
 Run Date: September 24, 1998
 Run Time: 9:25:54 AM
 Duration: 00:02:06

Buildup
 The material reference is : Source

Integration Parameters

Radial	26
Circumferential	26
Y Direction (axial)	26

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec	<u>Results</u>		<u>Exposure Rate</u> mR/hr	<u>Exposure Rate</u> mR/hr
			<u>No Buildup</u>	<u>With Buildup</u>		
0.015	3.977e+10	7.905e-128	9.819e-21	6.780e-129	8.422e-22	
0.02	1.197e+10	4.889e-57	8.984e-20	1.694e-58	3.112e-21	
0.03	7.198e+10	1.498e-16	6.395e-12	1.484e-18	6.338e-14	
0.04	1.694e+10	9.645e-07	1.808e-02	4.266e-09	7.994e-05	
0.05	1.306e+07	6.636e-06	3.354e-02	1.768e-08	8.934e-05	
0.06	3.926e+09	1.425e-01	2.421e+02	2.831e-04	4.810e-01	
0.08	2.363e+07	3.751e-02	1.427e+01	5.936e-05	2.258e-02	
0.1	9.282e+07	7.418e-01	1.147e+02	1.135e-03	1.755e-01	
0.15	2.604e+07	1.073e+00	5.032e+01	1.767e-03	8.287e-02	
0.2	3.792e+08	3.210e+01	8.459e+02	5.666e-02	1.493e+00	
0.3	2.380e+07	4.498e+00	6.096e+01	8.533e-03	1.156e-01	
0.4	1.618e+09	5.140e+02	4.949e+03	1.001e+00	9.643e+00	
0.5	5.318e+08	2.502e+02	1.821e+03	4.911e-01	3.575e+00	
0.6	1.029e+12	6.653e+05	4.002e+06	1.299e+03	7.811e+03	
0.8	4.325e+07	4.623e+01	2.140e+02	8.793e-02	4.071e-01	
1.0	2.567e+08	4.056e+02	1.554e+03	7.476e-01	2.865e+00	
1.5	2.570e+08	8.247e+02	2.411e+03	1.388e+00	4.056e+00	
2.0	3.259e+03	1.711e-02	4.318e-02	2.646e-05	6.677e-05	
3.0	4.716e+01	4.840e-04	1.012e-03	6.566e-07	1.373e-06	
TOTALS:	1.176e+12	6.674e+05	4.014e+06	1.302e+03	7.833e+03	

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: WM181171.MS5
 Case Title: WM181-107

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	2.9680e-001	1.0982e+010	3.2755e-002	9.7216e-003
Ba-137m	3.0910e+001	1.1437e+012	3.5403e-003	1.0943e-001
Ce-144	6.6300e-010	2.4531e+001	6.0991e-004	4.0437e-013
Co-60	6.9090e-003	2.5563e+008	1.5417e-002	1.0651e-004
Cs-134	1.2300e-003	4.5510e+007	1.0149e-002	1.2483e-005
Cs-137	3.2670e+001	1.2088e+012	1.1086e-003	3.6216e-002
Np-237	4.3400e-003	1.6058e+008	2.8548e-002	1.2390e-004
Pr-144	6.6300e-010	2.4531e+001	7.3470e-003	4.8710e-012
Pu-238	1.7760e+001	6.5712e+011	3.2552e-002	5.7813e-001
Pu-239	9.5280e-001	3.5254e+010	3.0531e-002	2.9090e-002
Pu-240	2.9930e-001	1.1074e+010	3.0591e-002	9.1560e-003
Pu-241	6.1610e+000	2.2796e+011	3.1773e-005	1.9575e-004
Pu-242	4.4400e-004	1.6428e+007	2.9012e-002	1.2881e-005
Rh-106	6.1110e-006	2.2611e+005	9.5865e-003	5.8583e-008
Ru-106	6.1110e-006	2.2611e+005	5.9466e-005	3.6340e-010
Sb-125	1.3900e-001	5.1430e+009	3.0911e-003	4.2967e-004
Sr-90	4.3900e+000	1.6243e+011	1.1603e-003	5.0937e-003
U-234	5.9360e-003	2.1963e+008	2.8232e-002	1.6759e-004
U-235	1.3070e-004	4.8359e+006	2.7030e-002	3.5329e-006
U-236	6.1850e-005	2.2885e+006	2.6729e-002	1.6532e-006
U-238	1.9350e-005	7.1595e+005	2.4838e-002	4.8061e-007
Y-90	4.3900e+000	1.6243e+011	5.5407e-003	2.4324e-002
		Total	Heat Generation:	8.0221e-001

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: 181108SL.MS5
 Run Date: September 24, 1998
 Run Time: 10:01:15 AM
 Duration: 00:03:10

File Ref: HKP-18-98
 Date: 9/30/98
 By: AKK/Johnson
 Checked: PR 9/30/98

Case Title: Cs I Exch Col
Description: Cs Ion Exchange column with 270 kg of Stream 108
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	243.84 cm	8 ft
Radius	20.32 cm	8.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	22.2725 cm	121.92 cm	0 cm
	8.8 in	4 ft	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	3.16e+05 cm ³	Mixed -> 2	
		Carbon	1.8
		Water	0.2
Shield 1	.953 cm	Iron	7.86
Transition	1.0 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>
Am-241	9.1300e-002	3.3781e+009	2.8865e-001	1.0680e+004
Ba-137m	5.0320e+003	1.8618e+014	1.5909e+004	5.8863e+008
Ce-144	2.0400e-010	7.5480e+000	6.4495e-010	2.3863e-005
Co-60	2.1300e-003	7.8810e+007	6.7341e-003	2.4916e+002
Cs-134	4.3740e+000	1.6184e+011	1.3829e+001	5.1166e+005
Cs-135	9.7700e-002	3.6149e+009	3.0888e-001	1.1429e+004
Cs-137	5.3190e+003	1.9680e+014	1.6816e+004	6.2220e+008
Np-237	1.3400e-003	4.9580e+007	4.2365e-003	1.5675e+002
Pr-144	2.0400e-010	7.5480e+000	6.4495e-010	2.3863e-005
Pu-238	5.4810e+000	2.0280e+011	1.7328e+001	6.4115e+005
Pu-239	2.9430e-001	1.0889e+010	9.3044e-001	3.4426e+004
Pu-240	9.2340e-002	3.4166e+009	2.9194e-001	1.0802e+004
Pu-241	1.9060e+000	7.0522e+010	6.0259e+000	2.2296e+005
Pu-242	1.3740e-004	5.0838e+006	4.3439e-004	1.6073e+001
Rh-106	1.8870e-006	6.9819e+004	5.9658e-006	2.2074e-001
Ru-106	1.8870e-006	6.9819e+004	5.9658e-006	2.2074e-001
Sb-125	4.2930e-002	1.5884e+009	1.3572e-001	5.0218e+003
Sr-90	1.3550e+000	5.0135e+010	4.2839e+000	1.5850e+005
U-234	1.8330e-003	6.7821e+007	5.7951e-003	2.1442e+002
U-235	4.0200e-005	1.4874e+006	1.2709e-004	4.7025e+000
U-236	1.9100e-005	7.0670e+005	6.0385e-005	2.2343e+000
U-238	5.9670e-006	2.2078e+005	1.8865e-005	6.9800e-001
Y-90	1.3550e+000	5.0135e+010	4.2839e+000	1.5850e+005

Page : 2
 DOS File: 181108SL.MS5
 Run Date: September 24, 1998
 Run Time: 10:01:15 AM
 Duration: 00:03:10

Buildup
 The material reference is : Source

Integration Parameters

Radial	29
Circumferential	29
Y Direction (axial)	31

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec	Results		<u>Exposure Rate</u> mR/hr	<u>Exposure Rate</u> mR/hr
			<u>No Buildup</u>	<u>With Buildup</u>		
0.015	1.227e+10	5.126e-187	4.643e-22	4.397e-188	3.982e-23	
0.02	3.690e+09	9.738e-84	1.315e-21	3.373e-85	4.556e-23	
0.03	1.128e+13	2.193e-22	2.404e-16	2.173e-24	2.383e-18	
0.04	2.679e+12	7.342e-08	2.718e-04	3.247e-10	1.202e-06	
0.05	4.033e+06	5.259e-08	1.258e-04	1.401e-10	3.350e-07	
0.06	1.208e+09	6.693e-03	7.789e+00	1.329e-05	1.547e-02	
0.08	7.294e+06	7.475e-03	2.357e+00	1.183e-05	3.730e-03	
0.1	2.865e+07	2.516e-01	3.267e+01	3.850e-04	4.998e-02	
0.15	8.041e+06	5.570e-01	2.276e+01	9.172e-04	3.748e-02	
0.2	1.511e+08	2.438e+01	5.250e+02	4.303e-02	9.266e-01	
0.3	3.065e+07	1.211e+01	1.414e+02	2.297e-02	2.683e-01	
0.4	4.998e+08	3.457e+02	2.854e+03	6.736e-01	5.562e+00	
0.5	2.527e+09	2.657e+03	1.727e+04	5.215e+00	3.390e+01	
0.6	1.673e+14	2.466e+08	1.343e+09	4.813e+05	2.622e+06	
0.8	1.523e+11	3.806e+05	1.613e+06	7.240e+02	3.068e+03	
1.0	4.610e+09	1.733e+04	6.195e+04	3.194e+01	1.142e+02	
1.5	4.999e+09	3.907e+04	1.078e+05	6.573e+01	1.813e+02	
2.0	1.005e+03	1.295e-02	3.077e-02	2.003e-05	4.758e-05	
3.0	1.456e+01	3.677e-04	7.319e-04	4.989e-07	9.929e-07	
TOTALS:	1.815e+14	2.470e+08	1.345e+09	4.821e+05	2.626e+06	

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: 181108SL.MS5
 Case Title: Cs I Exch Col

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	9.1300e-002	3.3781e+009	3.2755e-002	2.9905e-003
Ba-137m	5.0320e+003	1.8618e+014	3.5403e-003	1.7815e+001
Ce-144	2.0400e-010	7.5480e+000	6.0991e-004	1.2442e-013
Co-60	2.1300e-003	7.8810e+007	1.5417e-002	3.2837e-005
Cs-134	4.3740e+000	1.6184e+011	1.0149e-002	4.4391e-002
Cs-135	9.7700e-002	3.6149e+009	3.9913e-004	3.8995e-005
Cs-137	5.3190e+003	1.9680e+014	1.1086e-003	5.8964e+000
Np-237	1.3400e-003	4.9580e+007	2.8548e-002	3.8255e-005
Pr-144	2.0400e-010	7.5480e+000	7.3470e-003	1.4988e-012
Pu-238	5.4810e+000	2.0280e+011	3.2552e-002	1.7842e-001
Pu-239	2.9430e-001	1.0889e+010	3.0531e-002	8.9854e-003
Pu-240	9.2340e-002	3.4166e+009	3.0591e-002	2.8248e-003
Pu-241	1.9060e+000	7.0522e+010	3.1773e-005	6.0559e-005
Pu-242	1.3740e-004	5.0838e+006	2.9012e-002	3.9862e-006
Rh-106	1.8870e-006	6.9819e+004	9.5865e-003	1.8090e-008
Ru-106	1.8870e-006	6.9819e+004	5.9466e-005	1.1221e-010
Sb-125	4.2930e-002	1.5884e+009	3.0911e-003	1.3270e-004
Sr-90	1.3550e+000	5.0135e+010	1.1603e-003	1.5722e-003
U-234	1.8330e-003	6.7821e+007	2.8232e-002	5.1750e-005
U-235	4.0200e-005	1.4874e+006	2.7030e-002	1.0866e-006
U-236	1.9100e-005	7.0670e+005	2.6729e-002	5.1053e-007
U-238	5.9670e-006	2.2078e+005	2.4838e-002	1.4821e-007
Y-90	1.3550e+000	5.0135e+010	5.5407e-003	7.5076e-003
Total			Heat Generation:	2.3958e+001

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: 181106SL.MS5
Run Date: September 24, 1998
Run Time: 1:56:10 PM
Duration: 00:03:57

File Ref: HKP-18-98
Date: 9/30/98
By: J. B. Johnson
Checked: PR 9/30/98

Case Title: Cs IX Effluent tank
Description: Cs IX Effluent tank (T-103 A&B) w/14234 l St #106
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 304.8 cm 10 ft 0.0 in
Radius 121.92 cm 4 ft

Dose Points
1 X Y Z
124.19 cm 152.4 cm 0 cm
4 ft 0.9 in 5 ft 0.0 in 0.0 in

Shields
Shield Name Dimension Material Density
Source 1.42e+07 cm³ Water 1
Shield 1 1.27 cm Iron 7.86
Transition 1.0 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

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Am-241	6.6190e+000	2.4490e+011	4.6503e-001	1.7206e+004
Am-243	2.9890e-003	1.1059e+008	2.1000e-004	7.7699e+000
Ba-137m	6.9620e-001	2.5759e+010	4.8912e-002	1.8098e+003
Ce-144	8.4980e-001	3.1443e+010	5.9704e-002	2.2090e+003
Cm-242	1.5660e-002	5.7942e+008	1.1002e-003	4.0708e+001
Cm-244	2.1070e-001	7.7959e+009	1.4803e-002	5.4771e+002
Co-60	7.3300e-001	2.7121e+010	5.1498e-002	1.9054e+003
Cs-134	6.1200e-004	2.2644e+007	4.2997e-005	1.5909e+000
Cs-135	1.3590e-005	5.0283e+005	9.5478e-007	3.5327e-002
Cs-137	7.3590e-001	2.7228e+010	5.1702e-002	1.9130e+003
Eu-152	4.0000e-002	1.4800e+009	2.8103e-003	1.0398e+002
Eu-154	2.3200e+000	8.5840e+010	1.6299e-001	6.0308e+003
Eu-155	1.0090e+000	3.7333e+010	7.0889e-002	2.6229e+003
H-3	4.2990e-001	1.5906e+010	3.0203e-002	1.1175e+003
I-129	9.8200e-002	3.6334e+009	6.8992e-003	2.5527e+002
Ni-63	7.0320e-001	2.6018e+010	4.9404e-002	1.8280e+003
Np-237	3.6300e-002	1.3431e+009	2.5503e-003	9.4361e+001
Pm-147	1.9500e+000	7.2150e+010	1.3700e-001	5.0690e+003
Pr-144	8.4980e-001	3.1443e+010	5.9704e-002	2.2090e+003
Pu-238	1.2260e+001	4.5362e+011	8.6134e-001	3.1870e+004
Pu-239	9.3500e-001	3.4595e+010	6.5690e-002	2.4305e+003
Pu-240	2.7040e-001	1.0005e+010	1.8997e-002	7.0290e+002
Pu-241	5.4090e+000	2.0013e+011	3.8002e-001	1.4061e+004
Pu-242	2.0900e-004	7.7330e+006	1.4684e-005	5.4329e-001
Rh-106	4.6500e-003	1.7205e+008	3.2669e-004	1.2088e+001

Page : 2
 DOS File: 181106SL.MS5
 Run Date: September 24, 1998
 Run Time: 1:56:10 PM
 Duration: 00:03:57

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ru-106	4.6500e-003	1.7205e+008	3.2669e-004	1.2088e+001
Sb-125	1.5500e-001	5.7350e+009	1.0890e-002	4.0292e+002
Sm-151	6.8750e+000	2.5438e+011	4.8301e-001	1.7871e+004
Sr-90	4.8820e+002	1.8063e+013	3.4299e+001	1.2691e+006
Tc-99	2.1200e-001	7.8440e+009	1.4894e-002	5.5109e+002
Th-230	9.7360e-006	3.6023e+005	6.8402e-007	2.5309e-002
Th-231	1.3950e-003	5.1615e+007	9.8008e-005	3.6263e+000
U-232	2.7470e-005	1.0164e+006	1.9299e-006	7.1408e-002
U-233	1.4800e-007	5.4760e+003	1.0398e-008	3.8472e-004
U-234	1.3940e-002	5.1578e+008	9.7937e-004	3.6237e+001
U-235	3.4700e-004	1.2839e+007	2.4379e-005	9.0202e-001
U-236	6.7750e-004	2.5068e+007	4.7599e-005	1.7611e+000
U-238	3.7440e-004	1.3853e+007	2.6304e-005	9.7325e-001
Y-90	4.8820e+002	1.8063e+013	3.4299e+001	1.2691e+006

Buildup

The material reference is : Source

Integration Parameters

Radial	32
Circumferential	32
Y Direction (axial)	31

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	5.115e+10	6.565e-252	7.074e-23	5.631e-253	6.068e-24
0.02	7.894e+10	2.527e-112	3.307e-22	8.753e-114	1.146e-23
0.03	1.341e+10	1.130e-35	1.217e-21	1.120e-37	1.206e-23
0.04	3.140e+10	3.878e-15	8.889e-13	1.715e-17	3.931e-15
0.05	7.110e+09	2.919e-08	9.929e-06	7.777e-11	2.645e-08
0.06	8.801e+10	1.014e-03	2.929e-01	2.014e-06	5.817e-04
0.08	1.253e+10	1.186e-01	1.631e+01	1.876e-04	2.581e-02
0.1	4.323e+10	5.952e+00	4.301e+02	9.105e-03	6.581e-01
0.15	3.566e+09	5.906e+00	1.650e+02	9.726e-03	2.717e-01
0.2	6.451e+09	2.829e+01	4.984e+02	4.993e-02	8.797e-01
0.3	6.195e+08	7.339e+00	7.630e+01	1.392e-02	1.447e-01
0.4	2.593e+09	5.648e+01	4.379e+02	1.101e-01	8.532e-01
0.5	1.024e+09	3.505e+01	2.215e+02	6.881e-02	4.349e-01
0.6	3.128e+10	1.539e+03	8.361e+03	3.004e+00	1.632e+01
0.8	3.261e+10	2.834e+03	1.236e+04	5.390e+00	2.351e+01
1.0	5.443e+10	7.342e+03	2.755e+04	1.353e+01	5.078e+01
1.5	6.117e+10	1.823e+04	5.388e+04	3.067e+01	9.064e+01
2.0	2.456e+08	1.262e+02	3.254e+02	1.951e-01	5.033e-01
3.0	9.501e+04	1.018e-01	2.228e-01	1.381e-04	3.022e-04
TOTALS:	5.198e+11	3.021e+04	1.043e+05	5.305e+01	1.850e+02

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: 181106SL.MS5
 Case Title: Cs IX Effluent tnk

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	6.6190e+000	2.4490e+011	3.2755e-002	2.1680e-001
Am-243	2.9890e-003	1.1059e+008	3.1599e-002	9.4451e-005
Ba-137m	6.9620e-001	2.5759e+010	3.5403e-003	2.4647e-003
Ce-144	8.4980e-001	3.1443e+010	6.0991e-004	5.1830e-004
Cm-242	1.5660e-002	5.7942e+008	3.6195e-002	5.6682e-004
Cm-244	2.1070e-001	7.7959e+009	3.4375e-002	7.2429e-003
Co-60	7.3300e-001	2.7121e+010	1.5417e-002	1.1300e-002
Cs-134	6.1200e-004	2.2644e+007	1.0149e-002	6.2111e-006
Cs-135	1.3590e-005	5.0283e+005	3.9913e-004	5.4241e-009
Cs-137	7.3590e-001	2.7228e+010	1.1086e-003	8.1579e-004
Eu-152	4.0000e-002	1.4800e+009	7.3864e-003	2.9546e-004
Eu-154	2.3200e+000	8.5840e+010	8.7221e-003	2.0235e-002
Eu-155	1.0090e+000	3.7333e+010	6.4902e-004	6.5486e-004
H-3	4.2990e-001	1.5906e+010	3.3688e-005	1.4482e-005
I-129	9.8200e-002	3.6334e+009	4.7222e-004	4.6372e-005
Ni-63	7.0320e-001	2.6018e+010	1.0154e-004	7.1406e-005
Np-237	3.6300e-002	1.3431e+009	2.8548e-002	1.0363e-003
Pm-147	1.9500e+000	7.2150e+010	3.6732e-004	7.1628e-004
Pr-144	8.4980e-001	3.1443e+010	7.3470e-003	6.2435e-003
Pu-238	1.2260e+001	4.5362e+011	3.2552e-002	3.9909e-001
Pu-239	9.3500e-001	3.4595e+010	3.0531e-002	2.8547e-002
Pu-240	2.7040e-001	1.0005e+010	3.0591e-002	8.2719e-003
Pu-241	5.4090e+000	2.0013e+011	3.1773e-005	1.7186e-004
Pu-242	2.0900e-004	7.7330e+006	2.9012e-002	6.0635e-006
Rh-106	4.6500e-003	1.7205e+008	9.5865e-003	4.4577e-005
Ru-106	4.6500e-003	1.7205e+008	5.9466e-005	2.7652e-007
Sb-125	1.5500e-001	5.7350e+009	3.0911e-003	4.7913e-004
Sm-151	6.8750e+000	2.5438e+011	1.1669e-004	8.0221e-004
Sr-90	4.8820e+002	1.8063e+013	1.1603e-003	5.6646e-001
Tc-99	2.1200e-001	7.8440e+009	6.0024e-004	1.2725e-004
Th-230	9.7360e-006	3.6023e+005	2.7709e-002	2.6978e-007
Th-231	1.3950e-003	5.1615e+007	7.1148e-004	9.9251e-007
U-232	2.7470e-005	1.0164e+006	3.1460e-002	8.6422e-007
U-233	1.4800e-007	5.4760e+003	2.8571e-002	4.2285e-009
U-234	1.3940e-002	5.1578e+008	2.8232e-002	3.9356e-004
U-235	3.4700e-004	1.2839e+007	2.7030e-002	9.3796e-006
U-236	6.7750e-004	2.5068e+007	2.6729e-002	1.8109e-005
U-238	3.7440e-004	1.3853e+007	2.4838e-002	9.2993e-006
Y-90	4.8820e+002	1.8063e+013	5.5407e-003	2.7050e+000
Total			Heat Generation:	3.9785e+000

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: T112108.MS5
Run Date: September 24, 1998
Run Time: 2:16:24 PM
Duration: 00:04:05

File Ref: HKP-18-98
Date: 9/30/98
By: AKH/Johnson
Checked: PR 9/30/98

Case Title: T-112 Spent Resin Tk
Description: T-112 Spent Resin Storage Tank with 23,112 kg of St # 108
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	457.2 cm	15 ft
Radius	121.92 cm	4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	124.19 cm	228.6 cm	0 cm
	4 ft 0.9 in	7 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.14e+07 cm ³	Mixed ->	1.08
		Concrete	0.08
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	1.0 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>
Am-241	7.8119e+000	2.8904e+011	3.6589e-001	1.3538e+004
Ba-137m	4.3070e+005	1.5936e+016	2.0173e+004	7.4640e+008
Ce-144	1.7500e-008	6.4750e+002	8.1966e-010	3.0327e-005
Co-60	1.8260e-001	6.7562e+009	8.5525e-003	3.1644e+002
Cs-134	3.7670e+002	1.3938e+013	1.7644e+001	6.5282e+005
Cs-135	8.3670e+000	3.0958e+011	3.9189e-001	1.4500e+004
Cs-137	4.5530e+005	1.6846e+016	2.1325e+004	7.8903e+008
Np-237	1.1490e-001	4.2513e+009	5.3816e-003	1.9912e+002
Pr-144	1.7500e-008	6.4750e+002	8.1966e-010	3.0327e-005
Pu-238	4.6920e+002	1.7360e+013	2.1976e+001	8.1312e+005
Pu-239	2.5190e+001	9.3203e+011	1.1798e+000	4.3654e+004
Pu-240	7.9040e+000	2.9245e+011	3.7020e-001	1.3698e+004
Pu-241	1.6320e+002	6.0384e+012	7.6439e+000	2.8282e+005
Pu-242	1.1760e-002	4.3512e+008	5.5081e-004	2.0380e+001
Rh-106	1.6160e-004	5.9792e+006	7.5689e-006	2.8005e-001
Ru-106	1.6160e-004	5.9792e+006	7.5689e-006	2.8005e-001
Sb-125	3.6750e+000	1.3598e+011	1.7213e-001	6.3687e+003
Sr-90	1.1600e+002	4.2920e+012	5.4332e+000	2.0103e+005
U-234	1.5690e-001	5.8053e+009	7.3488e-003	2.7191e+002
U-235	3.4440e-003	1.2743e+008	1.6131e-004	5.9684e+000
U-236	5.7300e-003	2.1201e+008	2.6838e-004	9.9300e+000
U-238	5.1000e-004	1.8870e+007	2.3887e-005	8.8382e-001
Y-90	1.1600e+002	4.2920e+012	5.4332e+000	2.0103e+005

Page : 2
 DOS File: T112108.MS5
 Run Date: September 24, 1998
 Run Time: 2:16:24 PM
 Duration: 00:04:05

Buildup
 The material reference is : Source

Integration Parameters

Radial	31
Circumferential	31
Y Direction (axial)	33

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Results</u>		<u>Exposure Rate</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	1.051e+12	1.237e-253	6.779e-20	1.061e-254	5.815e-21
0.02	3.158e+11	4.053e-113	6.653e-19	1.404e-114	2.304e-20
0.03	9.652e+14	2.423e-31	2.012e-13	2.401e-33	1.994e-15
0.04	2.293e+14	1.345e-11	5.503e-06	5.949e-14	2.434e-08
0.05	3.453e+08	7.938e-10	6.229e-05	2.115e-12	1.659e-07
0.06	1.033e+11	7.224e-04	1.230e+01	1.435e-06	2.442e-02
0.08	6.252e+08	3.786e-03	7.098e+00	5.991e-06	1.123e-02
0.1	2.453e+09	2.165e-01	1.118e+02	3.312e-04	1.710e-01
0.15	6.884e+08	7.215e-01	7.643e+01	1.188e-03	1.259e-01
0.2	1.295e+10	3.575e+01	1.884e+03	6.310e-02	3.325e+00
0.3	2.636e+09	1.958e+01	4.604e+02	3.714e-02	8.733e-01
0.4	4.279e+10	5.834e+02	9.033e+03	1.137e+00	1.760e+01
0.5	2.175e+11	4.656e+03	5.205e+04	9.140e+00	1.022e+02
0.6	1.432e+16	4.404e+08	3.902e+09	8.595e+05	7.617e+06
0.8	1.312e+13	7.115e+05	4.567e+06	1.353e+03	8.687e+03
1.0	3.970e+11	3.341e+04	1.706e+05	6.158e+01	3.144e+02
1.5	4.305e+11	7.993e+04	2.921e+05	1.345e+02	4.915e+02
2.0	8.614e+04	2.756e-02	8.409e-02	4.262e-05	1.300e-04
3.0	1.247e+03	8.314e-04	2.037e-03	1.128e-06	2.763e-06
TOTALS:	1.553e+16	4.412e+08	3.907e+09	8.611e+05	7.626e+06

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: T112108.MS5
 Case Title: T-112 Spent Resin Tk

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	7.8119e+000	2.8904e+011	3.2755e-002	2.5588e-001
Ba-137m	4.3070e+005	1.5936e+016	3.5403e-003	1.5248e+003
Ce-144	1.7500e-008	6.4750e+002	6.0991e-004	1.0673e-011
Co-60	1.8260e-001	6.7562e+009	1.5417e-002	2.8151e-003
Cs-134	3.7670e+002	1.3938e+013	1.0149e-002	3.8231e+000
Cs-135	8.3670e+000	3.0958e+011	3.9913e-004	3.3395e-003
Cs-137	4.5530e+005	1.6846e+016	1.1086e-003	5.0473e+002
Np-237	1.1490e-001	4.2513e+009	2.8548e-002	3.2802e-003
Pr-144	1.7500e-008	6.4750e+002	7.3470e-003	1.2857e-010
Pu-238	4.6920e+002	1.7360e+013	3.2552e-002	1.5273e+001
Pu-239	2.5190e+001	9.3203e+011	3.0531e-002	7.6908e-001
Pu-240	7.9040e+000	2.9245e+011	3.0591e-002	2.4179e-001
Pu-241	1.6320e+002	6.0384e+012	3.1773e-005	5.1854e-003
Pu-242	1.1760e-002	4.3512e+008	2.9012e-002	3.4118e-004
Rh-106	1.6160e-004	5.9792e+006	9.5865e-003	1.5492e-006
Ru-106	1.6160e-004	5.9792e+006	5.9466e-005	9.6097e-009
Sb-125	3.6750e+000	1.3598e+011	3.0911e-003	1.1360e-002
Sr-90	1.1600e+002	4.2920e+012	1.1603e-003	1.3459e-001
U-234	1.5690e-001	5.8053e+009	2.8232e-002	4.4297e-003
U-235	3.4440e-003	1.2743e+008	2.7030e-002	9.3093e-005
U-236	5.7300e-003	2.1201e+008	2.6729e-002	1.5316e-004
U-238	5.1000e-004	1.8870e+007	2.4838e-002	1.2667e-005
Y-90	1.1600e+002	4.2920e+012	5.5407e-003	6.4272e-001
Total			Heat Generation:	2.0507e+003

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: T112108A.MS5
Run Date: September 24, 1998
Run Time: 2:28:02 PM
Duration: 00:02:02

File Ref: HKP-18-98
Date: 9/30/98
By: AKH/estrem
Checked: PR 9/30/98

Case Title: T-112 Spent Resin Tk
Description: T-112 Spent Resin Storage Tank with 23,112 kg of St # 108a
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	457.2 cm	15 ft
Radius	121.92 cm	4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	124.19 cm	228.6 cm	0 cm
	4 ft 0.9 in	7 ft 6.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.14e+07 cm ³	Mixed ->	1.08
		Concrete	0.08
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci/cm}^3$	Bq/cm ³
Ba-137m	6.0130e+005	2.2248e+016	2.8163e+004	1.0420e+009
Cs-134	5.2695e+002	1.9497e+013	2.4681e+001	9.1320e+005
Cs-135	1.1720e+001	4.3364e+011	5.4894e-001	2.0311e+004
Cs-137	6.3560e+005	2.3517e+016	2.9770e+004	1.1015e+009

Buildup

The material reference is : Source

Integration Parameters

Radial	31
Circumferential	31
Y Direction (axial)	33

Results

Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	1.347e+15	3.382e-31	2.808e-13	3.352e-33	2.783e-15
0.04	3.201e+14	1.878e-11	7.682e-06	8.305e-14	3.397e-08
0.2	4.094e+09	1.130e+01	5.955e+02	1.995e-02	1.051e+00
0.3	2.808e+09	2.085e+01	4.904e+02	3.956e-02	9.301e-01

Page : 2
 DOS File: T112108A.MS5
 Run Date: September 24, 1998
 Run Time: 2:28:02 PM
 Duration: 00:02:02

<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>
0.5	2.847e+11	6.093e+03	6.811e+04	1.196e+01	1.337e+02
0.6	2.000e+16	6.148e+08	5.448e+09	1.200e+06	1.063e+07
0.8	1.835e+13	9.953e+05	6.389e+06	1.893e+03	1.215e+04
1.0	5.459e+11	4.594e+04	2.345e+05	8.467e+01	4.323e+02
1.5	5.927e+11	1.101e+05	4.022e+05	1.852e+02	6.767e+02
TOTALS:	2.168e+16	6.159e+08	5.455e+09	1.202e+06	1.065e+07

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company
Case File Heat Generation
Case File: T112108A.MS5
Case Title: T-112 Spent Resin Tk

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Ba-137m	6.0130e+005	2.2248e+016	3.5403e-003	2.1288e+003
Cs-134	5.2695e+002	1.9497e+013	1.0149e-002	5.3480e+000
Cs-135	1.1720e+001	4.3364e+011	3.9913e-004	4.6778e-003
Cs-137	6.3560e+005	2.3517e+016	1.1086e-003	7.0460e+002
		Total	Heat Generation:	2.8387e+003

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: 181113SL.MS5
 Run Date: September 24, 1998
 Run Time: 2:53:01 PM
 Duration: 00:01:31

File Ref: HKP-18-98
 Date: 9/30/98
 By: AKB/turner
 Checked: PR 9/30/98

Case Title: M-101 Mixer
Description: M-101 Mixer (1/2 cyl) with 133.4 l of Stream # 113
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	91.44 cm	3 ft
Radius	30.48 cm	1 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	32.44 cm	45.72 cm	0 cm
	1 ft 0.8 in	1 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.67e+05 cm ³	Mixed ->	1.31
		Concrete	0.31
		Water	1
Shield 1	.953 cm	Iron	7.86
Transition	1.0 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>
Am-241	6.1100e-002	2.2607e+009	2.2894e-001	8.4708e+003
Am-243	2.7600e-005	1.0212e+006	1.0342e-004	3.8264e+000
Ba-137m	6.4200e-003	2.3754e+008	2.4056e-002	8.9006e+002
Ce-144	7.8440e-003	2.9023e+008	2.9391e-002	1.0875e+003
Cm-242	1.4400e-004	5.3280e+006	5.3957e-004	1.9964e+001
Cm-244	1.9480e-003	7.2076e+007	7.2992e-003	2.7007e+002
Co-60	6.7600e-003	2.5012e+008	2.5330e-002	9.3720e+002
Cs-134	5.6430e-006	2.0879e+005	2.1144e-005	7.8234e-001
Cs-135	1.2500e-007	4.6250e+003	4.6838e-007	1.7330e-002
Cs-137	6.7900e-003	2.5123e+008	2.5442e-002	9.4136e+002
Eu-152	3.6950e-004	1.3672e+007	1.3845e-003	5.1227e+001
Eu-154	2.1340e-002	7.8958e+008	7.9961e-002	2.9586e+003
Eu-155	9.3100e-003	3.4447e+008	3.4885e-002	1.2907e+003
H-3	3.9620e-003	1.4659e+008	1.4846e-002	5.4929e+002
I-129	9.0580e-004	3.3515e+007	3.3940e-003	1.2558e+002
Ni-63	6.4800e-003	2.3976e+008	2.4281e-002	8.9838e+002
Np-237	3.3480e-004	1.2388e+007	1.2545e-003	4.6416e+001
Pm-147	1.8000e-002	6.6600e+008	6.7446e-002	2.4955e+003
Pr-144	7.8440e-003	2.9023e+008	2.9391e-002	1.0875e+003
Pu-238	1.1300e-001	4.1810e+009	4.2341e-001	1.5666e+004
Pu-239	8.6300e-003	3.1931e+008	3.2337e-002	1.1965e+003
Pu-240	2.4900e-003	9.2130e+007	9.3300e-003	3.4521e+002
Pu-241	4.9900e-002	1.8463e+009	1.8698e-001	6.9181e+003

Page : 2
 DOS File: 181113SL.MS5
 Run Date: September 24, 1998
 Run Time: 2:53:01 PM
 Duration: 00:01:31

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	1.9340e-006	7.1558e+004	7.2467e-006	2.6813e-001
Rh-106	4.2950e-005	1.5892e+006	1.6093e-004	5.9545e+000
Ru-106	4.2950e-005	1.5892e+006	1.6093e-004	5.9545e+000
Sb-125	1.4400e-003	5.3280e+007	5.3957e-003	1.9964e+002
Sm-151	6.3500e-002	2.3495e+009	2.3793e-001	8.8036e+003
Sr-90	4.5090e+000	1.6683e+011	1.6895e+001	6.2512e+005
Tc-99	1.9600e-003	7.2520e+007	7.3441e-003	2.7173e+002
Th-230	8.9900e-008	3.3263e+003	3.3686e-007	1.2464e-002
Th-231	1.2870e-005	4.7619e+005	4.8224e-005	1.7843e+000
U-232	2.5350e-007	9.3795e+003	9.4987e-007	3.5145e-002
U-233	1.3740e-009	5.0838e+001	5.1484e-009	1.9049e-004
U-234	1.2860e-004	4.7582e+006	4.8186e-004	1.7829e+001
U-235	3.2000e-006	1.1840e+005	1.1990e-005	4.4365e-001
U-236	6.2560e-006	2.3147e+005	2.3441e-005	8.6733e-001
U-238	3.4550e-006	1.2784e+005	1.2946e-005	4.7900e-001
Y-90	4.5090e+000	1.6683e+011	1.6895e+001	6.2512e+005

Buildup
 The material reference is : Source

Integration Parameters	
Radial	23
Circumferential	23
Y Direction (axial)	23

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	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	4.718e+08	3.416e-190	1.767e-22	2.930e-191	1.515e-23
0.02	7.286e+08	6.178e-85	6.917e-21	2.140e-86	2.396e-22
0.03	1.239e+08	2.771e-27	1.044e-19	2.746e-29	1.035e-21
0.04	2.892e+08	1.041e-11	4.114e-07	4.603e-14	1.820e-09
0.05	6.548e+07	1.159e-06	1.391e-02	3.089e-09	3.705e-05
0.06	8.124e+08	6.432e-03	2.523e+01	1.278e-05	5.012e-02
0.08	1.156e+08	1.869e-01	1.348e+02	2.958e-04	2.134e-01
0.1	3.979e+08	5.790e+00	1.433e+03	8.858e-03	2.192e+00
0.15	3.291e+07	3.916e+00	2.546e+02	6.449e-03	4.192e-01
0.2	5.938e+07	1.660e+01	5.317e+02	2.930e-02	9.384e-01
0.3	5.716e+06	3.934e+00	6.154e+01	7.462e-03	1.167e-01
0.4	2.402e+07	2.903e+01	3.086e+02	5.655e-02	6.014e-01
0.5	9.474e+06	1.743e+01	1.387e+02	3.422e-02	2.723e-01
0.6	2.884e+08	7.444e+02	4.810e+03	1.453e+00	9.389e+00
0.8	3.000e+08	1.315e+03	6.399e+03	2.501e+00	1.217e+01
1.0	5.013e+08	3.308e+03	1.317e+04	6.097e+00	2.427e+01
1.5	5.634e+08	7.730e+03	2.286e+04	1.300e+01	3.846e+01
2.0	2.267e+06	5.123e+01	1.284e+02	7.923e-02	1.985e-01
3.0	8.772e+02	3.856e-02	7.902e-02	5.231e-05	1.072e-04
TOTALS:	4.792e+09	1.322e+04	5.025e+04	2.328e+01	8.930e+01

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: 181113SL.MS5
 Case Title: M-101 Mixer

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	6.1100e-002	2.2607e+009	3.2755e-002	2.0013e-003
Am-243	2.7600e-005	1.0212e+006	3.1599e-002	8.7215e-007
Ba-137m	6.4200e-003	2.3754e+008	3.5403e-003	2.2728e-005
Ce-144	7.8440e-003	2.9023e+008	6.0991e-004	4.7841e-006
Cm-242	1.4400e-004	5.3280e+006	3.6195e-002	5.2121e-006
Cm-244	1.9480e-003	7.2076e+007	3.4375e-002	6.6963e-005
Co-60	6.7600e-003	2.5012e+008	1.5417e-002	1.0422e-004
Cs-134	5.6430e-006	2.0879e+005	1.0149e-002	5.7270e-008
Cs-135	1.2500e-007	4.6250e+003	3.9913e-004	4.9891e-011
Cs-137	6.7900e-003	2.5123e+008	1.1086e-003	7.5271e-006
Eu-152	3.6950e-004	1.3672e+007	7.3864e-003	2.7293e-006
Eu-154	2.1340e-002	7.8958e+008	8.7221e-003	1.8613e-004
Eu-155	9.3100e-003	3.4447e+008	6.4902e-004	6.0424e-006
H-3	3.9620e-003	1.4659e+008	3.3688e-005	1.3347e-007
I-129	9.0580e-004	3.3515e+007	4.7222e-004	4.2774e-007
Ni-63	6.4800e-003	2.3976e+008	1.0154e-004	6.5800e-007
Np-237	3.3480e-004	1.2388e+007	2.8548e-002	9.5580e-006
Pm-147	1.8000e-002	6.6600e+008	3.6732e-004	6.6118e-006
Pr-144	7.8440e-003	2.9023e+008	7.3470e-003	5.7630e-005
Pu-238	1.1300e-001	4.1810e+009	3.2552e-002	3.6784e-003
Pu-239	8.6300e-003	3.1931e+008	3.0531e-002	2.6349e-004
Pu-240	2.4900e-003	9.2130e+007	3.0591e-002	7.6172e-005
Pu-241	4.9900e-002	1.8463e+009	3.1773e-005	1.5855e-006
Pu-242	1.9340e-006	7.1558e+004	2.9012e-002	5.6109e-008
Rh-106	4.2950e-005	1.5892e+006	9.5865e-003	4.1174e-007
Ru-106	4.2950e-005	1.5892e+006	5.9466e-005	2.5541e-009
Sb-125	1.4400e-003	5.3280e+007	3.0911e-003	4.4512e-006
Sm-151	6.3500e-002	2.3495e+009	1.1669e-004	7.4095e-006
Sr-90	4.5090e+000	1.6683e+011	1.1603e-003	5.2318e-003
Tc-99	1.9600e-003	7.2520e+007	6.0024e-004	1.1765e-006
Th-230	8.9900e-008	3.3263e+003	2.7709e-002	2.4911e-009
Th-231	1.2870e-005	4.7619e+005	7.1148e-004	9.1567e-009
U-232	2.5350e-007	9.3795e+003	3.1460e-002	7.9752e-009
U-233	1.3740e-009	5.0838e+001	2.8571e-002	3.9257e-011
U-234	1.2860e-004	4.7582e+006	2.8232e-002	3.6307e-006
U-235	3.2000e-006	1.1840e+005	2.7030e-002	8.6497e-008
U-236	6.2560e-006	2.3147e+005	2.6729e-002	1.6722e-007
U-238	3.4550e-006	1.2784e+005	2.4838e-002	8.5815e-008
Y-90	4.5090e+000	1.6683e+011	5.5407e-003	2.4983e-002
Total			Heat Generation:	3.6736e-002

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: 181117SL.MS5
 Run Date: September 24, 1998
 Run Time: 4:11:09 PM
 Duration: 00:02:13

File Ref: HKP-18-98
 Date: 9/30/98
 By: HKP
 Checked: PR 9/30/98

Case Title: M-101 Mixer
Description: M-101 Mixer (full cylinder) with 507.3 kg of stream #117
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	91.44 cm	3 ft
Radius	30.48 cm	1 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	32.44 cm	45.72 cm	0 cm
	1 ft 0.8 in	1 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.67e+05 cm ³	Mixed ->	1.9
		Concrete	1.7
		Water	0.2
Shield 1	.953 cm	Iron	7.86
Transition	1.0 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>
Am-241	7.8600e-002	2.9082e+009	2.9451e-001	1.0897e+004
Am-243	3.5500e-005	1.3135e+006	1.3302e-004	4.9217e+000
Ba-137m	8.2500e-003	3.0525e+008	3.0913e-002	1.1438e+003
Ce-144	1.0100e-002	3.7370e+008	3.7845e-002	1.4003e+003
Cm-242	1.8600e-004	6.8820e+006	6.9694e-004	2.5787e+001
Cm-244	2.5100e-003	9.2870e+007	9.4050e-003	3.4798e+002
Co-60	8.7300e-003	3.2301e+008	3.2711e-002	1.2103e+003
Cs-134	7.2500e-006	2.6825e+005	2.7166e-005	1.0051e+000
Cs-135	1.6100e-007	5.9570e+003	6.0327e-007	2.2321e-002
Cs-137	8.7300e-003	3.2301e+008	3.2711e-002	1.2103e+003
Eu-152	4.7600e-004	1.7612e+007	1.7836e-003	6.5992e+001
Eu-154	2.7500e-002	1.0175e+009	1.0304e-001	3.8126e+003
Eu-155	1.2020e-002	4.4474e+008	4.5039e-002	1.6664e+003
H-3	5.1200e-003	1.8944e+008	1.9185e-002	7.0983e+002
I-129	1.1700e-003	4.3290e+007	4.3840e-003	1.6221e+002
Ni-63	8.3700e-003	3.0969e+008	3.1362e-002	1.1604e+003
Pm-147	2.3200e-002	8.5840e+008	8.6930e-002	3.2164e+003
Pr-144	1.0100e-002	3.7370e+008	3.7845e-002	1.4003e+003
Pu-238	1.4600e-001	5.4020e+009	5.4706e-001	2.0241e+004
Pu-239	1.1100e-002	4.1070e+008	4.1592e-002	1.5389e+003
Pu-240	3.2200e-003	1.1914e+008	1.2065e-002	4.4642e+002
Pu-241	6.4400e-002	2.3828e+009	2.4131e-001	8.9284e+003
Pu-242	2.5000e-006	9.2500e+004	9.3675e-006	3.4660e-001

Page : 2
 DOS File: 181117SL.MS5
 Run Date: September 24, 1998
 Run Time: 4:11:09 PM
 Duration: 00:02:13

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Rh-106	5.5300e-005	2.0461e+006	2.0721e-004	7.6667e+000
Ru-106	5.5300e-005	2.0461e+006	2.0721e-004	7.6667e+000
Sb-125	1.8500e-003	6.8450e+007	6.9320e-003	2.5648e+002
Sm-151	8.1700e-002	3.0229e+009	3.0613e-001	1.1327e+004
Sr-90	5.7800e+000	2.1386e+011	2.1658e+001	8.0133e+005
Tc-99	2.5200e-003	9.3240e+007	9.4424e-003	3.4937e+002
Th-230	1.1600e-007	4.2920e+003	4.3465e-007	1.6082e-002
Th-231	1.6600e-005	6.1420e+005	6.2200e-005	2.3014e+000
U-232	3.2700e-007	1.2099e+004	1.2253e-006	4.5335e-002
U-233	1.7700e-009	6.5490e+001	6.6322e-009	2.4539e-004
U-234	1.6600e-004	6.1420e+006	6.2200e-004	2.3014e+001
U-235	4.1300e-006	1.5281e+005	1.5475e-005	5.7258e-001
U-236	8.0700e-006	2.9859e+005	3.0238e-005	1.1188e+000
U-238	4.4600e-006	1.6502e+005	1.6712e-005	6.1833e-001
Y-90	5.7800e+000	2.1386e+011	2.1658e+001	8.0133e+005

Buildup

The material reference is : Source

Integration Parameters

Radial	26
Circumferential	26
Y Direction (axial)	26

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	6.037e+08	3.075e-191	8.831e-24	2.637e-192	7.574e-25
0.02	9.365e+08	1.726e-85	3.393e-23	5.980e-87	1.175e-24
0.03	1.573e+08	1.412e-27	5.299e-23	1.400e-29	5.251e-25
0.04	3.728e+08	5.929e-12	3.692e-10	2.622e-14	1.633e-12
0.05	8.440e+07	7.130e-07	6.878e-05	1.899e-09	1.832e-07
0.06	1.045e+09	4.463e-03	4.349e-01	8.865e-06	8.639e-04
0.08	1.472e+08	1.517e-01	9.353e+00	2.401e-04	1.480e-02
0.1	5.118e+08	5.086e+00	1.929e+02	7.780e-03	2.951e-01
0.15	4.221e+07	3.619e+00	6.436e+01	5.959e-03	1.060e-01
0.2	7.639e+07	1.561e+01	1.876e+02	2.755e-02	3.311e-01
0.3	7.362e+06	3.738e+00	2.940e+01	7.090e-03	5.578e-02
0.4	3.089e+07	2.761e+01	1.697e+02	5.380e-02	3.306e-01
0.5	1.219e+07	1.663e+01	8.569e+01	3.263e-02	1.682e-01
0.6	3.708e+08	7.108e+02	3.204e+03	1.387e+00	6.254e+00
0.8	3.865e+08	1.263e+03	4.693e+03	2.403e+00	8.927e+00
1.0	6.467e+08	3.193e+03	1.038e+04	5.885e+00	1.913e+01
1.5	7.267e+08	7.533e+03	1.967e+04	1.267e+01	3.310e+01
2.0	2.919e+06	5.022e+01	1.158e+02	7.766e-02	1.791e-01
3.0	1.129e+03	3.817e-02	7.542e-02	5.179e-05	1.023e-04
TOTALS:	6.162e+09	1.282e+04	3.880e+04	2.256e+01	6.889e+01

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: 181117SL.MS5
 Case Title: M-101 Mixer

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	7.8600e-002	2.9082e+009	3.2755e-002	2.5745e-003
Am-243	3.5500e-005	1.3135e+006	3.1599e-002	1.1218e-006
Ba-137m	8.2500e-003	3.0525e+008	3.5403e-003	2.9207e-005
Ce-144	1.0100e-002	3.7370e+008	6.0991e-004	6.1601e-006
Cm-242	1.8600e-004	6.8820e+006	3.6195e-002	6.7323e-006
Cm-244	2.5100e-003	9.2870e+007	3.4375e-002	8.6282e-005
Co-60	8.7300e-003	3.2301e+008	1.5417e-002	1.3459e-004
Cs-134	7.2500e-006	2.6825e+005	1.0149e-002	7.3579e-008
Cs-135	1.6100e-007	5.9570e+003	3.9913e-004	6.4260e-011
Cs-137	8.7300e-003	3.2301e+008	1.1086e-003	9.6777e-006
Eu-152	4.7600e-004	1.7612e+007	7.3864e-003	3.5159e-006
Eu-154	2.7500e-002	1.0175e+009	8.7221e-003	2.3986e-004
Eu-155	1.2020e-002	4.4474e+008	6.4902e-004	7.8013e-006
H-3	5.1200e-003	1.8944e+008	3.3688e-005	1.7248e-007
I-129	1.1700e-003	4.3290e+007	4.7222e-004	5.5250e-007
Ni-63	8.3700e-003	3.0969e+008	1.0154e-004	8.4992e-007
Pm-147	2.3200e-002	8.5840e+008	3.6732e-004	8.5219e-006
Pr-144	1.0100e-002	3.7370e+008	7.3470e-003	7.4205e-005
Pu-238	1.4600e-001	5.4020e+009	3.2552e-002	4.7526e-003
Pu-239	1.1100e-002	4.1070e+008	3.0531e-002	3.3890e-004
Pu-240	3.2200e-003	1.1914e+008	3.0591e-002	9.8504e-005
Pu-241	6.4400e-002	2.3828e+009	3.1773e-005	2.0462e-006
Pu-242	2.5000e-006	9.2500e+004	2.9012e-002	7.2530e-008
Rh-106	5.5300e-005	2.0461e+006	9.5865e-003	5.3014e-007
Ru-106	5.5300e-005	2.0461e+006	5.9466e-005	3.2885e-009
Sb-125	1.8500e-003	6.8450e+007	3.0911e-003	5.7186e-006
Sm-151	8.1700e-002	3.0229e+009	1.1669e-004	9.5332e-006
Sr-90	5.7800e+000	2.1386e+011	1.1603e-003	6.7065e-003
Tc-99	2.5200e-003	9.3240e+007	6.0024e-004	1.5126e-006
Th-230	1.1600e-007	4.2920e+003	2.7709e-002	3.2143e-009
Th-231	1.6600e-005	6.1420e+005	7.1148e-004	1.1810e-008
U-232	3.2700e-007	1.2099e+004	3.1460e-002	1.0288e-008
U-233	1.7700e-009	6.5490e+001	2.8571e-002	5.0571e-011
U-234	1.6600e-004	6.1420e+006	2.8232e-002	4.6866e-006
U-235	4.1300e-006	1.5281e+005	2.7030e-002	1.1164e-007
U-236	8.0700e-006	2.9859e+005	2.6729e-002	2.1571e-007
U-238	4.4600e-006	1.6502e+005	2.4838e-002	1.1078e-007
Y-90	5.7800e+000	2.1386e+011	5.5407e-003	3.2025e-002
		Total	Heat Generation:	4.7130e-002

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: WD117SL.MS5
 Run Date: September 24, 1998
 Run Time: 4:33:44 PM
 Duration: 00:02:10

File Ref: HKP-18-98
 Date: 9/30/98
 By: AKH/Johnson
 Checked: PR 9/30/98

Case Title: Waste Drum
Description: Waste Drum with 395.2 kg of grouted waste from St #117
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	69.84 cm	2 ft 3.5 in
Radius	29.21 cm	11.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	30.37 cm	31.04 cm	0 cm
	12.0 in	1 ft 0.2 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.87e+05 cm ³	Mixed -> 1.9 Concrete	1.8
		Water	0.1
Shield 1	.16 cm	Iron	7.86
Transition	1.0 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>
Am-241	6.1300e-002	2.2681e+009	3.2745e-001	1.2116e+004
Am-243	2.7700e-005	1.0249e+006	1.4797e-004	5.4747e+000
Ba-137m	6.4300e-003	2.3791e+008	3.4347e-002	1.2709e+003
Ce-144	7.8600e-003	2.9082e+008	4.1986e-002	1.5535e+003
Cm-242	1.4500e-004	5.3650e+006	7.7455e-004	2.8658e+001
Cm-244	1.9600e-003	7.2520e+007	1.0470e-002	3.8738e+002
Co-60	6.8000e-003	2.5160e+008	3.6324e-002	1.3440e+003
Cs-134	5.6500e-006	2.0905e+005	3.0181e-005	1.1167e+000
Cs-135	1.2600e-007	4.6620e+003	6.7306e-007	2.4903e-002
Cs-137	6.8000e-003	2.5160e+008	3.6324e-002	1.3440e+003
Eu-152	3.7100e-004	1.3727e+007	1.9818e-003	7.3326e+001
Eu-154	2.1500e-002	7.9550e+008	1.1485e-001	4.2494e+003
Eu-155	9.3700e-003	3.4669e+008	5.0052e-002	1.8519e+003
H-3	3.9900e-003	1.4763e+008	2.1314e-002	7.8860e+002
I-129	9.0900e-004	3.3633e+007	4.8556e-003	1.7966e+002
Ni-63	6.5200e-003	2.4124e+008	3.4828e-002	1.2886e+003
Np-237	3.3670e-004	1.2458e+007	1.7986e-003	6.6547e+001
Pm-147	1.8100e-002	6.6970e+008	9.6686e-002	3.5774e+003
Pr-144	7.8600e-003	2.9082e+008	4.1986e-002	1.5535e+003
Pu-238	1.1300e-001	4.1810e+009	6.0362e-001	2.2334e+004
Pu-239	8.6500e-003	3.2005e+008	4.6206e-002	1.7096e+003
Pu-240	2.5100e-003	9.2870e+007	1.3408e-002	4.9609e+002
Pu-241	5.0200e-002	1.8574e+009	2.6816e-001	9.9217e+003

Page : 2
 DOS File: WD117SL.MS5
 Run Date: September 24, 1998
 Run Time: 4:33:44 PM
 Duration: 00:02:10

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	1.9400e-006	7.1780e+004	1.0363e-005	3.8343e-001
Rh-106	4.3100e-005	1.5947e+006	2.3023e-004	8.5185e+000
Ru-106	4.3100e-005	1.5947e+006	2.3023e-004	8.5185e+000
Sb-125	1.4400e-003	5.3280e+007	7.6921e-003	2.8461e+002
Sm-151	6.3600e-002	2.3532e+009	3.3973e-001	1.2570e+004
Sr-90	4.5050e+000	1.6669e+011	2.4065e+001	8.9039e+005
Tc-99	1.9600e-003	7.2520e+007	1.0470e-002	3.8738e+002
Th-230	9.0100e-008	3.3337e+003	4.8129e-007	1.7808e-002
Th-231	1.2900e-005	4.7730e+005	6.8908e-005	2.5496e+000
U-232	2.5500e-007	9.4350e+003	1.3621e-006	5.0399e-002
U-233	1.3750e-009	5.0875e+001	7.3449e-009	2.7176e-004
U-234	1.2900e-004	4.7730e+006	6.8908e-004	2.5496e+001
U-235	3.2200e-006	1.1914e+005	1.7200e-005	6.3641e-001
U-236	6.2800e-006	2.3236e+005	3.3546e-005	1.2412e+000
U-238	3.4700e-006	1.2839e+005	1.8536e-005	6.8583e-001
Y-90	4.5050e+000	1.6669e+011	2.4065e+001	8.9039e+005

Buildup
 The material reference is : Source

<u>Integration Parameters</u>	
Radial	26
Circumferential	26
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	4.726e+08	2.669e-34	8.532e-24	2.289e-35	7.318e-25
0.02	7.308e+08	2.706e-15	6.659e-15	9.373e-17	2.307e-16
0.03	1.243e+08	2.260e-05	1.159e-04	2.240e-07	1.149e-06
0.04	2.910e+08	6.015e-02	5.246e-01	2.660e-04	2.320e-03
0.05	6.594e+07	3.020e-01	3.425e+00	8.045e-04	9.123e-03
0.06	8.151e+08	1.952e+01	2.328e+02	3.877e-02	4.624e-01
0.08	1.163e+08	1.461e+01	1.527e+02	2.312e-02	2.416e-01
0.1	4.008e+08	1.130e+02	9.925e+02	1.729e-01	1.518e+00
0.15	3.299e+07	2.434e+01	1.563e+02	4.009e-02	2.574e-01
0.2	5.979e+07	7.338e+01	3.826e+02	1.295e-01	6.754e-01
0.3	5.744e+06	1.335e+01	5.459e+01	2.533e-02	1.035e-01
0.4	2.407e+07	8.664e+01	3.043e+02	1.688e-01	5.929e-01
0.5	9.502e+06	4.797e+01	1.506e+02	9.415e-02	2.956e-01
0.6	2.892e+08	1.925e+03	5.546e+03	3.757e+00	1.082e+01
0.8	3.022e+08	3.122e+03	7.914e+03	5.939e+00	1.505e+01
1.0	5.046e+08	7.351e+03	1.708e+04	1.355e+01	3.149e+01
1.5	5.672e+08	1.545e+04	3.095e+04	2.599e+01	5.208e+01
2.0	2.272e+06	9.581e+01	1.761e+02	1.482e-01	2.724e-01
3.0	8.794e+02	6.737e-02	1.109e-01	9.140e-05	1.504e-04
TOTALS:	4.814e+09	2.834e+04	6.410e+04	5.008e+01	1.139e+02

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: WD117SL.MS5
 Case Title: Waste Drum

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	6.1300e-002	2.2681e+009	3.2755e-002	2.0079e-003
Am-243	2.7700e-005	1.0249e+006	3.1599e-002	8.7531e-007
Ba-137m	6.4300e-003	2.3791e+008	3.5403e-003	2.2764e-005
Ce-144	7.8600e-003	2.9082e+008	6.0991e-004	4.7939e-006
Cm-242	1.4500e-004	5.3650e+006	3.6195e-002	5.2483e-006
Cm-244	1.9600e-003	7.2520e+007	3.4375e-002	6.7376e-005
Co-60	6.8000e-003	2.5160e+008	1.5417e-002	1.0483e-004
Cs-134	5.6500e-006	2.0905e+005	1.0149e-002	5.7341e-008
Cs-135	1.2600e-007	4.6620e+003	3.9913e-004	5.0290e-011
Cs-137	6.8000e-003	2.5160e+008	1.1086e-003	7.5382e-006
Eu-152	3.7100e-004	1.3727e+007	7.3864e-003	2.7404e-006
Eu-154	2.1500e-002	7.9550e+008	8.7221e-003	1.8753e-004
Eu-155	9.3700e-003	3.4669e+008	6.4902e-004	6.0813e-006
H-3	3.9900e-003	1.4763e+008	3.3688e-005	1.3442e-007
I-129	9.0900e-004	3.3633e+007	4.7222e-004	4.2925e-007
Ni-63	6.5200e-003	2.4124e+008	1.0154e-004	6.6206e-007
Np-237	3.3670e-004	1.2458e+007	2.8548e-002	9.6123e-006
Pm-147	1.8100e-002	6.6970e+008	3.6732e-004	6.6485e-006
Pr-144	7.8600e-003	2.9082e+008	7.3470e-003	5.7747e-005
Pu-238	1.1300e-001	4.1810e+009	3.2552e-002	3.6784e-003
Pu-239	8.6500e-003	3.2005e+008	3.0531e-002	2.6410e-004
Pu-240	2.5100e-003	9.2870e+007	3.0591e-002	7.6784e-005
Pu-241	5.0200e-002	1.8574e+009	3.1773e-005	1.5950e-006
Pu-242	1.9400e-006	7.1780e+004	2.9012e-002	5.6283e-008
Rh-106	4.3100e-005	1.5947e+006	9.5865e-003	4.1318e-007
Ru-106	4.3100e-005	1.5947e+006	5.9466e-005	2.5630e-009
Sb-125	1.4400e-003	5.3280e+007	3.0911e-003	4.4512e-006
Sm-151	6.3600e-002	2.3532e+009	1.1669e-004	7.4212e-006
Sr-90	4.5050e+000	1.6669e+011	1.1603e-003	5.2272e-003
Tc-99	1.9600e-003	7.2520e+007	6.0024e-004	1.1765e-006
Th-230	9.0100e-008	3.3337e+003	2.7709e-002	2.4966e-009
Th-231	1.2900e-005	4.7730e+005	7.1148e-004	9.1780e-009
U-232	2.5500e-007	9.4350e+003	3.1460e-002	8.0224e-009
U-233	1.3750e-009	5.0875e+001	2.8571e-002	3.9285e-011
U-234	1.2900e-004	4.7730e+006	2.8232e-002	3.6420e-006
U-235	3.2200e-006	1.1914e+005	2.7030e-002	8.7038e-008
U-236	6.2800e-006	2.3236e+005	2.6729e-002	1.6786e-007
U-238	3.4700e-006	1.2839e+005	2.4838e-002	8.6188e-008
Y-90	4.5050e+000	1.6669e+011	5.5407e-003	2.4961e-002
Total			Heat Generation:	3.6719e-002

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WD117ASL.MS5
Run Date: September 25, 1998
Run Time: 10:00:19 AM
Duration: 00:02:09

File Ref: HKP-18-98
Date: 9/30/98
By: *[Signature]*
Checked: PR 9/30/98

Case Title: Waste Drum
Description: Waste Drum with 395.2 kg of grouted waste from St #117a
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 69.84 cm 2 ft 3.5 in
Radius 29.21 cm 11.5 in

Dose Points

	X	Y	Z
# 1	30.37 cm	31.04 cm	0 cm
	12.0 in	1 ft 0.2 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.87e+05 cm ³	Mixed ->	1.9
		Concrete	1.8
		Water	0.1
Shield 1	.16 cm	Iron	7.86
Transition	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	6.1300e-002	2.2681e+009	3.2745e-001	1.2116e+004
Am-243	2.7700e-005	1.0249e+006	1.4797e-004	5.4747e+000
Ba-137m	1.8700e-002	6.9190e+008	9.9891e-002	3.6960e+003
Ce-144	7.8600e-003	2.9082e+008	4.1986e-002	1.5535e+003
Cm-242	1.4500e-004	5.3650e+006	7.7455e-004	2.8658e+001
Cm-244	1.9600e-003	7.2520e+007	1.0470e-002	3.8738e+002
Co-60	6.8000e-003	2.5160e+008	3.6324e-002	1.3440e+003
Cs-134	6.1700e-006	2.2829e+005	3.2959e-005	1.2195e+000
Cs-135	1.2600e-007	4.6620e+003	6.7306e-007	2.4903e-002
Cs-137	1.9800e-002	7.3260e+008	1.0577e-001	3.9134e+003
Eu-152	3.7100e-004	1.3727e+007	1.9818e-003	7.3326e+001
Eu-154	2.1500e-002	7.9550e+008	1.1485e-001	4.2494e+003
Eu-155	9.3700e-003	3.4669e+008	5.0052e-002	1.8519e+003
H-3	3.9900e-003	1.4763e+008	2.1314e-002	7.8860e+002
I-129	9.0900e-004	3.3633e+007	4.8556e-003	1.7966e+002
Ni-63	6.5200e-003	2.4124e+008	3.4828e-002	1.2886e+003
Np-237	3.3670e-004	1.2458e+007	1.7986e-003	6.6547e+001
Pm-147	1.8100e-002	6.6970e+008	9.6686e-002	3.5774e+003
Pr-144	7.8600e-003	2.9082e+008	4.1986e-002	1.5535e+003
Pu-238	1.2050e-001	4.4585e+009	6.4368e-001	2.3816e+004
Pu-239	9.0500e-003	3.3485e+008	4.8343e-002	1.7887e+003
Pu-240	2.6200e-003	9.6940e+007	1.3995e-002	5.1783e+002
Pu-241	5.2560e-002	1.9447e+009	2.8076e-001	1.0388e+004

Page : 2
 DOS File: WD117ASL.MS5
 Run Date: September 25, 1998
 Run Time: 10:00:19 AM
 Duration: 00:02:09

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	2.1180e-006	7.8366e+004	1.1314e-005	4.1861e-001
Rh-106	4.3100e-005	1.5947e+006	2.3023e-004	8.5185e+000
Ru-106	4.3100e-005	1.5947e+006	2.3023e-004	8.5185e+000
Sb-125	1.4980e-003	5.5426e+007	8.0019e-003	2.9607e+002
Sm-151	6.3600e-002	2.3532e+009	3.3973e-001	1.2570e+004
Sr-90	4.5450e+000	1.6817e+011	2.4278e+001	8.9829e+005
Tc-99	1.9600e-003	7.2520e+007	1.0470e-002	3.8738e+002
Th-230	9.0100e-008	3.3337e+003	4.8129e-007	1.7808e-002
Th-231	1.2900e-005	4.7730e+005	6.8908e-005	2.5496e+000
U-232	2.5500e-007	9.4350e+003	1.3621e-006	5.0399e-002
U-233	1.3750e-009	5.0875e+001	7.3449e-009	2.7176e-004
U-234	1.3100e-004	4.8470e+006	6.9977e-004	2.5891e+001
U-235	3.2700e-006	1.2099e+005	1.7467e-005	6.4630e-001
U-236	6.2800e-006	2.3236e+005	3.3546e-005	1.2412e+000
U-238	3.4800e-006	1.2876e+005	1.8589e-005	6.8780e-001
Y-90	4.5450e+000	1.6817e+011	2.4278e+001	8.9829e+005

Buildup

The material reference is : Source

Integration Parameters

Radial	26
Circumferential	26
Y Direction (axial)	26

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	4.890e+08	2.762e-34	8.829e-24	2.369e-35	7.573e-25
0.02	7.345e+08	2.720e-15	6.693e-15	9.421e-17	2.318e-16
0.03	1.528e+08	2.778e-05	1.425e-04	2.754e-07	1.412e-06
0.04	2.978e+08	6.154e-02	5.368e-01	2.722e-04	2.374e-03
0.05	6.594e+07	3.020e-01	3.425e+00	8.045e-04	9.124e-03
0.06	8.151e+08	1.952e+01	2.328e+02	3.877e-02	4.624e-01
0.08	1.163e+08	1.461e+01	1.527e+02	2.312e-02	2.416e-01
0.1	4.008e+08	1.130e+02	9.926e+02	1.729e-01	1.519e+00
0.15	3.300e+07	2.435e+01	1.564e+02	4.010e-02	2.575e-01
0.2	5.995e+07	7.357e+01	3.837e+02	1.299e-01	6.771e-01
0.3	5.754e+06	1.337e+01	5.468e+01	2.537e-02	1.037e-01
0.4	2.475e+07	8.907e+01	3.129e+02	1.735e-01	6.096e-01
0.5	9.724e+06	4.909e+01	1.541e+02	9.635e-02	3.025e-01
0.6	6.975e+08	4.644e+03	1.338e+04	9.064e+00	2.611e+01
0.8	3.022e+08	3.122e+03	7.914e+03	5.939e+00	1.505e+01
1.0	5.046e+08	7.351e+03	1.708e+04	1.355e+01	3.149e+01
1.5	5.672e+08	1.545e+04	3.095e+04	2.599e+01	5.208e+01
2.0	2.272e+06	9.581e+01	1.761e+02	1.482e-01	2.724e-01
3.0	8.794e+02	6.737e-02	1.109e-01	9.140e-05	1.504e-04
TOTALS:	5.279e+09	3.106e+04	7.195e+04	5.539e+01	1.292e+02

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company
 Case File Heat Generation
 Case File: WD117ASL.MS5
 Case Title: Waste Drum

<u>Isotope</u>	<u>Activity</u> <u>Curies</u>	<u>Activity</u> <u>Bequerels</u>	<u>Heat Generation</u> <u>Watts/Curie</u>	<u>Heat Generation</u> <u>Watts</u>
Am-241	6.1300e-002	2.2681e+009	3.2755e-002	2.0079e-003
Am-243	2.7700e-005	1.0249e+006	3.1599e-002	8.7531e-007
Ba-137m	6.4300e-003	2.3791e+008	3.5403e-003	2.2764e-005
Ce-144	7.8600e-003	2.9082e+008	6.0991e-004	4.7939e-006
Cm-242	1.4500e-004	5.3650e+006	3.6195e-002	5.2483e-006
Cm-244	1.9600e-003	7.2520e+007	3.4375e-002	6.7376e-005
Co-60	6.8000e-003	2.5160e+008	1.5417e-002	1.0483e-004
Cs-134	5.6500e-006	2.0905e+005	1.0149e-002	5.7341e-008
Cs-135	1.2600e-007	4.6620e+003	3.9913e-004	5.0290e-011
Cs-137	6.8000e-003	2.5160e+008	1.1086e-003	7.5382e-006
Eu-152	3.7100e-004	1.3727e+007	7.3864e-003	2.7404e-006
Eu-154	2.1500e-002	7.9550e+008	8.7221e-003	1.8753e-004
Eu-155	9.3700e-003	3.4669e+008	6.4902e-004	6.0813e-006
H-3	3.9900e-003	1.4763e+008	3.3688e-005	1.3442e-007
I-129	9.0900e-004	3.3633e+007	4.7222e-004	4.2925e-007
Ni-63	6.5200e-003	2.4124e+008	1.0154e-004	6.6206e-007
Np-237	3.3670e-004	1.2458e+007	2.8548e-002	9.6123e-006
Pm-147	1.8100e-002	6.6970e+008	3.6732e-004	6.6485e-006
Pr-144	7.8600e-003	2.9082e+008	7.3470e-003	5.7747e-005
Pu-238	1.1300e-001	4.1810e+009	3.2552e-002	3.6784e-003
Pu-239	8.6500e-003	3.2005e+008	3.0531e-002	2.6410e-004
Pu-240	2.5100e-003	9.2870e+007	3.0591e-002	7.6784e-005
Pu-241	5.0200e-002	1.8574e+009	3.1773e-005	1.5950e-006
Pu-242	1.9400e-006	7.1780e+004	2.9012e-002	5.6283e-008
Rh-106	4.3100e-005	1.5947e+006	9.5865e-003	4.1318e-007
Ru-106	4.3100e-005	1.5947e+006	5.9466e-005	2.5630e-009
Sb-125	1.4400e-003	5.3280e+007	3.0911e-003	4.4512e-006
Sm-151	6.3600e-002	2.3532e+009	1.1669e-004	7.4212e-006
Sr-90	4.5050e+000	1.6669e+011	1.1603e-003	5.2272e-003
Tc-99	1.9600e-003	7.2520e+007	6.0024e-004	1.1765e-006
Th-230	9.0100e-008	3.3337e+003	2.7709e-002	2.4966e-009
Th-231	1.2900e-005	4.7730e+005	7.1148e-004	9.1780e-009
U-232	2.5500e-007	9.4350e+003	3.1460e-002	8.0224e-009
U-233	1.3750e-009	5.0875e+001	2.8571e-002	3.9285e-011
U-234	1.2900e-004	4.7730e+006	2.8232e-002	3.6420e-006
U-235	3.2200e-006	1.1914e+005	2.7030e-002	8.7038e-008
U-236	6.2800e-006	2.3236e+005	2.6729e-002	1.6786e-007
U-238	3.4700e-006	1.2839e+005	2.4838e-002	8.6188e-008
Y-90	4.5050e+000	1.6669e+011	5.5407e-003	2.4961e-002
		Total	Heat Generation:	3.6719e-002

1. Project File No. 02BM1 2. Project/Task CsIX/TRU Grout Feasibility Study

3. Subtask Determine Facility Shielding Requirements

4. Title: Shielding Requirements for High Level Waste Processing Components

5. Summary: This EDF contains preliminary information on shielding requirements for the subject study. It includes a letter (HKP-15-98) from H. K. Peterson summarizing the concrete wall thickness required based on preliminary design information.

MicroShield, Version 5.01, Grove Engineering, Rockville MD was used for calculations. The MicroShield calculation input/output sheets related to this work are attached to the letter.

Since the results are based on preliminary design assumptions, this EDF is not final. Future design efforts will need to finalize the shielding requirements. Pertinent names are shown in the signature block but the EDF is not signed.

This EDF should be used only for the purposes of this study and as a basis for shielding calculations for future design efforts.

6. Distribution (complete package): H. K. Peterson, K. L. Williams, C. W. Olsen

Distribution (summary package only):

7. Signatures: Review and approval signatures are not necessary at this time.

	Printed Name	Signature	Date
Author	H. K. Peterson	See attached letter	
Reviewer	P. D. Ritter	See attached sheets	
Requestor	J. L. Clapp and S. A. Jensen		
Approved	K. L. Williams		11/10/98

Lockheed Martin Idaho Technologies Company**INTERDEPARTMENTAL COMMUNICATION**

Date: August 31, 1998

To: J. L. Clapp MS 3650 6-0307

From: H. K. Peterson MS 2107 6-8657

Subject: SHIELDING REQUIREMENTS FOR HIGH LEVEL WASTE PROCESSING COMPONENTS -- HKP-15-98

References: a) H. K. Peterson ltr to S. J. Losinski, CS IX/TRU COMPONENT PROJECTED RADIATION FIELDS, HKP-12-98, August 6, 1998
b) MicroShield, Version 5.01, Grove Engineering, Rockville MD

The requested review of the shielding requirements for the high level waste processing components as spaced and projected on the preliminary floor plans has been completed. It should be remembered that since the radiation field is dependent on the distance from a source, the shielding thicknesses reported here are preliminary, since the plans are preliminary; if the distances to occupied areas change for the final drawings, the shield thicknesses could also change. The source term for the various components are as defined in reference a and calculations were performed with MicroShield (Ref.b). The requirements are summarized below.

Spent Resin Storage Tank – Since the Spent Resin Storage Tank is contained in a cell that has occupied areas (Control room, RadCon, and the stairwell) adjacent to it, the shielding should attenuate the radiation field from this component to 0.1 mR/hr, in accordance with the requirements of MCP 91. The thickness of concrete that will adequately shield this component to 0.1 mR/hr for an adjacent full-time occupancy area is 38 inches.

The Cs IX Exchange columns are proposed for a cell that is above the Spent Resin Storage Tank cell. With the ion exchange columns placed as projected along the wall between this cell and the one containing the rotary dryer, 38 inches of concrete will be adequate to attenuate the radiation field to 0.1 mR/hr on the outside of this cell. Although this cell is projected to be 20 feet above ground level, there is a stairwell to the left of the cell and a resin prep location adjacent to the cell which could be full-time occupancy areas.

For the UDS (Undissolved Solids storage cell) it was assumed that the UDS would be stored in 55-gallon drums and stacked in the cell as opposed to storage in a single large tank. To provide the source term for these calculations, it was assumed that four 55-gallon drums were stacked on top of four other drums and placed against the shielding wall in question. To shield this cell on the outside wall will require 38 inches of concrete. This thickness can be relaxed somewhat on the other three walls because of adjacent, unoccupied cells and the P & V corridor. Since the P & V corridor will be an unoccupied area that will also contain substantial radiation sources, the wall between the operating corridor and the P & V corridor should be a shielding wall. That

J. L. Clapp
August 31, 1998
HKP-15-98
Page 2

wall, however, should only shield against the radiation sources within the P & V corridor and not be responsible for shielding against the components contained within the cells. The outside wall for UDS storage should be 30 inches of concrete to attenuate the field from undissolved solids storage to 0.1 mR/hr. The wall between that cell and the P & V corridor can be reduced to 26 inches of concrete.

The cell housing the Rotary dryer and the slurry tank requires an outside wall of 26 inches of concrete to attenuate the radiation field from these components to 0.1 mR/hr on the outside of the building. This thickness can be relaxed for the wall between the P & V corridor and the cell and will probably be sized for structural considerations.

The Waste Feed tanks (T-101A & -B) will require 26 inches of concrete on the outside wall to reduce the field from these components to 0.1 mR/hr at the outside surface of the wall. The wall between this cell and the P & V corridor could be reduced below the 26 inches and may be sized according to structural considerations.

The cell housing the IX effluent tanks will require 20 inches of concrete on the outside wall to attenuate the radiation field to 0.1 mR/hr. The other walls of this cell can be constructed with concrete whose thickness can be based on structural considerations.

MicroShield calculational input/output listings are on file with the Letter File copy of this analysis should they be wished for reference.

If there are any questions or comments concerning this analysis, please call me at the above-listed number.

hkp

cc: P. D. Ritter, LMITCO, MS 2107 *PDR* HKP Letter File
G. J. Stormberg, LMITCO, MS 2107 *gjs*

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: CSIEX1.MS5
 Run Date: August 26, 1998
 Run Time: 2:10:00 PM
 Duration: 00:03:31

File Ref: HKP 15/16/98
 Date: 10/1/98
 By: M. K. Johnson
 Checked: PR 9/30/98

Case Title: Cs I Exch Col
Description: Shielding for Cs Ion Exch col Cubicle with 250 l of Stream 10
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	243.84 cm	8 ft
Radius	20.32 cm	8.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	150.84 cm ✓	121.92 cm	0 cm
	4 ft 11.4 in ✓	4 ft	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
✓Source	3.16e+05 cm ³	Mixed -> 2	
		Carbon	1.8
		Water	0.2
Shield 1	.953 cm	Iron	7.86
Transition	30.5 cm	Air	0.0011
Shield 3	96.52 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	9.3750e-003	3.4688e+008	2.9639e-002	1.0967e+003
Ba-137m	5.1320e+003	1.8988e+014	1.6225e+004	6.0032e+008
Ce-144	2.1000e-011	7.7700e-001	6.6392e-011	2.4565e-006
Co-60	2.1900e-004	8.1030e+006	6.9238e-004	2.5618e+001
Cs-134	1.8800e+000	6.9560e+010	5.9437e+000	2.1992e+005
Cs-135	1.0330e-001	3.8221e+009	3.2659e-001	1.2084e+004
Cs-137	5.4250e+003	2.0073e+014	1.7151e+004	6.3460e+008
Np-237	1.3780e-004	5.0986e+006	4.3566e-004	1.6119e+001
Pr-144	2.1000e-011	7.7700e-001	6.6392e-011	2.4565e-006
Pu-238	5.6250e-001	2.0813e+010	1.7784e+000	6.5799e+004
Pu-239	3.0250e-002	1.1193e+009	9.5636e-002	3.5385e+003
Pu-240	9.4750e-003	3.5058e+008	2.9956e-002	1.1084e+003
Pu-241	1.9550e-001	7.2335e+009	6.1808e-001	2.2869e+004
Pu-242	1.4100e-005	5.2170e+005	4.4578e-005	1.6494e+000
Rh-106	1.9380e-007	7.1706e+003	6.1271e-007	2.2670e-002
Ru-106	1.9380e-007	7.1706e+003	6.1271e-007	2.2670e-002
Sb-125	4.4000e-003	1.6280e+008	1.3911e-002	5.1470e+002
Sr-90	1.3900e-001	5.1430e+009	4.3945e-001	1.6260e+004
U-234	1.8800e-004	6.9560e+006	5.9437e-004	2.1992e+001
U-235	4.1500e-006	1.5355e+005	1.3120e-005	4.8545e-001
U-236	1.9650e-006	7.2705e+004	6.2124e-006	2.2986e-001

Page : 2
 DOS File: CSIEX1.MS5
 Run Date: August 26, 1998
 Run Time: 2:10:00 PM
 Duration: 00:03:31

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>$\mu\text{Ci}/\text{cm}^3$</u>	<u>Bq/cm^3</u>
U-238	6.1500e-007	2.2755e+004	1.9443e-006	7.1941e-002
Y-90	1.3900e-001	5.1430e+009	4.3945e-001	1.6260e+004

Buildup
 The material reference is : Shield 3

Integration Parameters

Radial	29
Circumferential	29
Y Direction (axial)	31

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Results</u>			
		<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>$\text{MeV}/\text{cm}^2/\text{sec}$</u>	<u>$\text{MeV}/\text{cm}^2/\text{sec}$</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	1.260e+09	0.000e+00	5.434e-25	0.000e+00	4.661e-26
0.02	3.787e+08	0.000e+00	2.571e-25	0.000e+00	8.905e-27
0.03	1.150e+13	5.400e-136	1.726e-20	5.352e-138	1.711e-22
0.04	2.732e+12	4.332e-65	1.088e-20	1.916e-67	4.810e-23
0.05	4.142e+05	3.127e-46	5.390e-27	8.331e-49	1.436e-29
0.06	1.240e+08	2.998e-32	1.158e-23	5.954e-35	2.301e-26
0.08	7.499e+05	6.769e-25	6.725e-23	1.071e-27	1.064e-25
0.1	2.941e+06	1.869e-20	4.522e-18	2.859e-23	6.918e-21
0.15	8.250e+05	3.829e-17	1.870e-14	6.305e-20	3.080e-17
0.2	2.661e+07	8.118e-14	4.487e-11	1.433e-16	7.920e-14
0.3	1.077e+07	4.522e-12	1.731e-09	8.577e-15	3.283e-12
0.4	5.123e+07	5.215e-10	1.246e-07	1.016e-12	2.428e-10
0.5	1.032e+09	1.109e-07	1.760e-05	2.178e-10	3.455e-08
0.6	1.706e+14	1.167e-01	1.305e+01	2.278e-04	2.547e-02
0.8	6.548e+10	7.357e-04	4.747e-02	1.399e-06	9.029e-05
1.0	1.956e+09	1.733e-04	7.368e-03	3.194e-07	1.358e-05
1.5	2.123e+09	6.034e-03	1.286e-01	1.015e-05	2.163e-04
2.0	1.033e+02	2.556e-09	3.612e-08	3.953e-12	5.586e-11
3.0	1.496e+00	4.988e-10	4.252e-09	6.767e-13	5.769e-12
TOTALS:	1.849e+14	1.236e-01	1.323e+01	2.396e-04	2.579e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: UDSSTOR.MS5
 Run Date: August 26, 1998
 Run Time: 5:08:29 PM
 Duration: 00:02:15

File Ref: *HKP-15/16-98*
 Date: *10/1/98*
 By: *HKP/Johnson*
 Checked: _____

Case Title: UDS
Description: Shielding for UDS Storage
Geometry: 13 - Rectangular Volume

Source Dimensions

Length	44.0 cm	1 ft 5.3 in
Width	243.8 cm	7 ft 12.0 in
Height	155.0 cm	5 ft 1.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	117.67 cm	77.5 cm	121.9 cm
	3 ft 10.3 in	2 ft 6.5 in	3 ft 12.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.66e+06 cm ³	Concrete	1.4
Shield 1	28" 71.12 cm	Concrete	2.35
Shield 2	2.54 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 : Grove

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	2.8870e+002	1.0682e+013	1.7363e+002	6.4244e+006
Ce-144	6.1970e-009	2.2929e+002	3.7270e-009	1.3790e-004
Co-60	6.4500e-002	2.3865e+009	3.8792e-002	1.4353e+003
Cs-134	1.1520e-002	4.2624e+008	6.9284e-003	2.5635e+002
Cs-137	3.0520e+002	1.1292e+013	1.8356e+002	6.7915e+006
Pr-144	6.1970e-009	2.2929e+002	3.7270e-009	1.3790e-004
Rh-106	5.7100e-005	2.1127e+006	3.4341e-005	1.2706e+000
Ru-106	5.7100e-005	2.1127e+006	3.4341e-005	1.2706e+000
Sb-125	1.3000e+000	4.8100e+010	7.8185e-001	2.8929e+004
Sr-90	4.1000e+001	1.5170e+012	2.4658e+001	9.1236e+005
Y-90	4.1000e+001	1.5170e+012	2.4658e+001	9.1236e+005

Buildup
The material reference is : Shield 1

Integration Parameters

X Direction	22
Y Direction	32
Z Direction	32

<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>Exposure Rate</u>	<u>Exposure Rate</u>
			<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
			<u>No Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	6.508e+11	2.442e-82	1.816e-21	2.421e-84	1.800e-23

Page : 2
 DOS File: UDSSTOR.MS5
 Run Date: August 26, 1998
 Run Time: 5:08:29 PM
 Duration: 00:02:15

<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>
0.04	1.505e+11	1.319e-40	1.114e-21	5.835e-43	4.926e-24
0.06	3.039e-01	3.486e-30	1.263e-28	6.923e-33	2.509e-31
0.08	3.665e+00	2.659e-23	1.799e-21	4.208e-26	2.847e-24
0.1	1.256e+08	2.308e-13	3.093e-11	3.531e-16	4.732e-14
0.15	1.207e+08	7.975e-11	1.966e-08	1.313e-13	3.237e-11
0.2	3.651e+09	4.731e-08	1.277e-05	8.350e-11	2.255e-08
0.3	2.008e+08	1.006e-07	1.966e-05	1.909e-10	3.729e-08
0.4	1.506e+10	8.496e-05	1.102e-02	1.655e-07	2.147e-05
0.5	4.986e+09	1.714e-04	1.552e-02	3.364e-07	3.046e-05
0.6	9.629e+12	1.380e+00	9.186e+01	2.693e-03	1.793e-01
0.8	4.012e+08	5.050e-04	2.068e-02	9.606e-07	3.934e-05
1.0	2.398e+09	1.516e-02	4.299e-01	2.794e-05	7.924e-04
1.5	2.399e+09	2.341e-01	3.581e+00	3.939e-04	6.025e-03
2.0	1.775e+00	9.760e-10	1.031e-08	1.509e-12	1.594e-11
TOTALS:	1.046e+13	1.630e+00	9.592e+01	3.117e-03	1.862e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: UDSSTOR.MS5
Run Date: August 26, 1998
Run Time: 5:12:41 PM
Duration: 00:02:15

File Ref: HKP-15/16-78
Date: 10/1/98
By: AKK/Johnson
Checked: _____

Case Title: UDS
Description: Shielding for UDS Storage
Geometry: 13 - Rectangular Volume

Source Dimensions

Length	44.0 cm	1 ft 5.3 in
Width	243.8 cm	7 ft 12.0 in
Height	155.0 cm	5 ft 1.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	122.75 cm	77.5 cm	121.9 cm
	4 ft 0.3 in	2 ft 6.5 in	3 ft 12.0 in

*Volume = 7.2306
in 3 ft 12.0 in*

Shields

Shield Name	Dimension	Material	Density
Source	1.66e+06 cm ³	Concrete	1.4
✓Shield 1	30" 76.2 cm	Concrete	2.35
Shield 2	2.54 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 : Grove

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.8870e+002	1.0682e+013	1.7363e+002	6.4244e+006
Ce-144	6.1970e-009	2.2929e+002	3.7270e-009	1.3790e-004
Co-60	6.4500e-002	2.3865e+009	3.8792e-002	1.4353e+003
Cs-134	1.1520e-002	4.2624e+008	6.9284e-003	2.5635e+002
Cs-137	3.0520e+002	1.1292e+013	1.8356e+002	6.7915e+006
Pr-144	6.1970e-009	2.2929e+002	3.7270e-009	1.3790e-004
Rh-106	5.7100e-005	2.1127e+006	3.4341e-005	1.2706e+000
Ru-106	5.7100e-005	2.1127e+006	3.4341e-005	1.2706e+000
Sb-125	1.3000e+000	4.8100e+010	7.8185e-001	2.8929e+004
Sr-90	4.1000e+001	1.5170e+012	2.4658e+001	9.1236e+005
Y-90	4.1000e+001	1.5170e+012	2.4658e+001	9.1236e+005

Buildup

The material reference is : Shield 1

Integration Parameters

X Direction	22
Y Direction	32
Z Direction	32

Results

Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	6.508e+11	2.737e-88	1.691e-21	2.713e-90	1.676e-23

Page : 2
 DOS File: UDSSTOR.MS5
 Run Date: August 26, 1998
 Run Time: 5:12:41 PM
 Duration: 00:02:15

<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>
0.04	1.505e+11	1.395e-43	1.037e-21	6.169e-46	4.587e-24
0.06	3.039e-01	1.230e-31	5.133e-30	2.443e-34	1.020e-32
0.08	3.665e+00	2.285e-24	1.669e-22	3.616e-27	2.641e-25
0.1	1.256e+08	2.835e-14	4.235e-12	4.338e-17	6.480e-15
0.15	1.207e+08	1.411e-11	3.975e-09	2.324e-14	6.546e-12
0.2	3.651e+09	9.995e-09	3.114e-06	1.764e-11	5.496e-09
0.3	2.008e+08	2.628e-08	5.893e-06	4.985e-11	1.118e-08
0.4	1.506e+10	2.546e-05	3.747e-03	4.961e-08	7.300e-06
0.5	4.986e+09	5.683e-05	5.785e-03	1.115e-07	1.136e-05
0.6	9.629e+12	4.952e-01	3.675e+01	9.665e-04	7.174e-02
0.8	4.012e+08	2.040e-04	9.199e-03	3.880e-07	1.750e-05
1.0	2.398e+09	6.672e-03	2.063e-01	1.230e-05	3.802e-04
1.5	2.399e+09	1.187e-01	1.949e+00	1.998e-04	3.280e-03
2.0	1.775e+00	5.392e-10	6.064e-09	8.338e-13	9.377e-12
TOTALS:	1.046e+13	6.209e-01	3.893e+01	1.179e-03	7.543e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: September 1, 1998
Run Time: 4:54:40 PM
Duration: 00:01:57

File Ref: HRP-15/16-98
Date: 10/1/98
By: J. H. Johnson
Checked: P. R. 4/8/98

Case Title: WM181-107
Description: 55-gal drum loaded with 291.2 kg of Stream 107 (Pb shield)
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points

	X	Y	Z
# 1	32.91 cm	38.8 cm	0 cm
	1 ft 1.0 in	1 ft 3.3 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Shield 2	2.54 cm	Lead	11.34
Transition	1.0 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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Am-241	3.4650e+001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e+010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Buildup

Page : 2
 DOS File: WM181107.MS5
 Run Date: September 1, 1998
 Run Time: 4:54:40 PM
 Duration: 00:01:57

The material reference is : Shield 2

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	4.642e+10	0.000e+00	4.288e-22	0.000e+00	3.678e-23
0.02	1.397e+10	0.000e+00	1.720e-22	0.000e+00	5.959e-24
0.03	8.404e+10	0.000e+00	1.596e-21	0.000e+00	1.582e-23
0.04	1.978e+10	9.006e-171	5.151e-22	3.983e-173	2.278e-24
0.05	1.524e+07	2.275e-96	5.114e-25	6.060e-99	1.362e-27
0.06	4.584e+09	2.936e-57	1.934e-22	5.832e-60	3.842e-25
0.08	2.761e+07	2.886e-28	1.741e-24	4.567e-31	2.755e-27
0.1	1.084e+08	5.130e-68	2.711e-07	7.848e-71	4.148e-10
0.15	3.043e+07	6.969e-25	1.010e-22	1.148e-27	1.663e-25
0.2	4.433e+08	5.135e-11	7.516e-11	9.063e-14	1.327e-13
0.3	2.782e+07	1.601e-04	2.388e-04	3.036e-07	4.530e-07
0.4	1.892e+09	2.611e+00	4.367e+00	5.087e-03	8.509e-03
0.5	6.217e+08	1.037e+01	1.876e+01	2.036e-02	3.682e-02
0.6	1.201e+12	8.213e+04	1.554e+05	1.603e+02	3.033e+02
0.8	5.049e+07	1.696e+01	3.434e+01	3.227e-02	6.532e-02
1.0	2.997e+08	2.550e+02	5.317e+02	4.700e-01	9.802e-01
1.5	3.000e+08	9.084e+02	1.861e+03	1.528e+00	3.131e+00
2.0	3.805e+03	2.202e-02	4.459e-02	3.405e-05	6.895e-05
3.0	5.506e+01	6.525e-04	1.255e-03	8.852e-07	1.703e-06
TOTALS:	1.374e+12	8.333e+04	1.578e+05	1.624e+02	3.075e+02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: September 1, 1998
Run Time: 4:51:24 PM
Duration: 00:01:58

File Ref: HKP-1516-98
Date: 10/1/98
By: AKB/son
Checked: PR 9/30/98

Case Title: WM181-107
Description: 55-gal drum loaded with 291.2 kg of Stream 107 (Pb shield)
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	35.45 cm	38.8 cm	0 cm
	1 ft 2.0 in	1 ft 3.3 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Shield 2	5.08 cm	Lead	11.34
Transition	1.0 cm	Air	0.0011
Air Gap		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>
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Buildup

Page : 2
 DOS File: WM181107.MS5
 Run Date: September 1, 1998
 Run Time: 4:51:24 PM
 Duration: 00:01:58

The material reference is : Shield 2

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

Energy MeV	Activity photons/sec	Results		Exposure Rate	
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	4.642e+10	0.000e+00	3.663e-22	0.000e+00	3.142e-23
0.02	1.397e+10	0.000e+00	1.470e-22	0.000e+00	5.091e-24
0.03	8.404e+10	0.000e+00	1.364e-21	0.000e+00	1.351e-23
0.04	1.978e+10	0.000e+00	4.400e-22	0.000e+00	1.946e-24
0.05	1.524e+07	1.517e-189	4.369e-25	4.042e-192	1.164e-27
0.06	4.584e+09	1.203e-114	1.652e-22	2.389e-117	3.282e-25
0.08	2.761e+07	2.721e-55	1.487e-24	4.306e-58	2.353e-27
0.1	1.084e+08	2.620e-135	2.316e-07	4.009e-138	3.543e-10
0.15	3.043e+07	3.140e-49	7.484e-23	5.170e-52	1.232e-25
0.2	4.433e+08	4.061e-23	1.289e-22	7.167e-26	2.275e-25
0.3	2.782e+07	1.601e-09	2.600e-09	3.037e-12	4.931e-12
0.4	1.892e+09	2.729e-03	5.229e-03	5.318e-06	1.019e-05
0.5	6.217e+08	7.460e-02	1.593e-01	1.464e-04	3.127e-04
0.6	1.201e+12	1.597e+03	3.614e+03	3.117e+00	7.054e+00
0.8	5.049e+07	8.892e-01	2.201e+00	1.691e-03	4.187e-03
1.0	2.997e+08	2.195e+01	5.669e+01	4.046e-02	1.045e-01
1.5	3.000e+08	1.344e+02	3.480e+02	2.261e-01	5.855e-01
2.0	3.805e+03	3.898e-03	1.006e-02	6.028e-06	1.555e-05
3.0	5.506e+01	1.288e-04	3.159e-04	1.748e-07	4.285e-07
TOTALS:	1.374e+12	1.754e+03	4.021e+03	3.386e+00	7.749e+00

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: September 1, 1998
Run Time: 4:58:50 PM
Duration: 00:01:55

File Ref: HRP/15/16-98
Date: 10/1/98
By: JH/Johnson
Checked: PR 9/30/98

Case Title: WM181-107
Description: 55-gal drum loaded with 291.2 kg of Stream 107 (Fe shield)
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points
1 X Y Z
35.45 cm 38.8 cm 0 cm
1 ft 2.0 in 1 ft 3.3 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Shield 2	5.08 cm	Iron	7.86
Transition	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

2" Fe
shield case was
not on plot but
12255 consistent with line-fit

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
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Buildup

Page : 2
 DOS File: WM181107.MS5
 Run Date: September 1, 1998
 Run Time: 4:58:50 PM
 Duration: 00:01:55

The material reference is : Shield 2

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

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	4.642e+10	0.000e+00	3.700e-22	0.000e+00	3.174e-23
0.02	1.397e+10	0.000e+00	1.750e-22	0.000e+00	6.061e-24
0.03	8.404e+10	1.993e-141	1.446e-21	1.975e-143	1.433e-23
0.04	1.978e+10	1.049e-61	5.204e-22	4.638e-64	2.301e-24
0.05	1.524e+07	2.825e-35	5.732e-25	7.525e-38	1.527e-27
0.06	4.584e+09	1.828e-19	3.099e-19	3.631e-22	6.156e-22
0.08	2.761e+07	9.517e-11	2.219e-10	1.506e-13	3.511e-13
0.1	1.084e+08	4.543e-06	1.397e-05	6.950e-09	2.137e-08
0.15	3.043e+07	2.835e-03	1.402e-02	4.669e-06	2.308e-05
0.2	4.433e+08	4.817e-01	3.285e+00	8.502e-04	5.798e-03
0.3	2.782e+07	2.388e-01	1.982e+00	4.530e-04	3.759e-03
0.4	1.892e+09	4.862e+01	4.098e+02	9.473e-02	7.984e-01
0.5	6.217e+08	3.432e+01	2.726e+02	6.736e-02	5.351e-01
0.6	1.201e+12	1.198e+05	8.788e+05	2.339e+02	1.715e+03
0.8	5.049e+07	1.239e+01	7.719e+01	2.357e-02	1.468e-01
1.0	2.997e+08	1.445e+02	7.779e+02	2.664e-01	1.434e+00
1.5	3.000e+08	4.633e+02	1.900e+03	7.794e-01	3.196e+00
2.0	3.805e+03	1.234e-02	4.285e-02	1.908e-05	6.626e-05
3.0	5.506e+01	4.467e-04	1.248e-03	6.061e-07	1.693e-06
TOTALS:	1.374e+12	1.205e+05	8.822e+05	2.352e+02	1.721e+03

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181107.MS5
Run Date: September 1, 1998
Run Time: 5:03:43 PM
Duration: 00:01:54

File Ref: HKP-15/16-98
Date: 10/1/98
By: H. H. H. H.
Checked: PR 9/10/98

Case Title: WM181-107

Description: 55-gal drum loaded with 291.2 kg of Stream 107 (Fe shield)
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	40.53 cm	38.8 cm	0 cm
	1 ft 4.0 in	1 ft 3.3 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Shield 2	10.16 cm	Iron	7.86
Transition	1.0 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>
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Buildup

Page : 2
 DOS File: WM181107.MS5
 Run Date: September 1, 1998
 Run Time: 5:03:43 PM
 Duration: 00:01:54

The material reference is : Shield 2

Integration Parameters

Radial	24
Circumferential	24
Y Direction (axial)	26

Energy MeV	Activity photons/sec	Results			
		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.015	4.642e+10	0.000e+00	2.832e-22	0.000e+00	2.429e-23
0.02	1.397e+10	0.000e+00	1.339e-22	0.000e+00	4.640e-24
0.03	8.404e+10	2.875e-279	1.107e-21	2.849e-281	1.097e-23
0.04	1.978e+10	2.276e-122	3.983e-22	1.006e-124	1.762e-24
0.05	1.524e+07	9.434e-68	4.388e-25	2.513e-70	1.169e-27
0.06	4.584e+09	2.166e-39	1.927e-22	4.302e-42	3.827e-25
0.08	2.761e+07	1.319e-20	3.476e-20	2.087e-23	5.501e-23
0.1	1.084e+08	2.639e-12	1.014e-11	4.037e-15	1.552e-14
0.15	3.043e+07	1.001e-06	7.269e-06	1.649e-09	1.197e-08
0.2	4.433e+08	1.033e-03	1.190e-02	1.823e-06	2.101e-05
0.3	2.782e+07	1.874e-03	2.921e-02	3.555e-06	5.540e-05
0.4	1.892e+09	6.879e-01	1.125e+01	1.340e-03	2.192e-02
0.5	6.217e+08	7.084e-01	1.085e+01	1.391e-03	2.130e-02
0.6	1.201e+12	3.264e+03	4.520e+04	6.371e+00	8.822e+01
0.8	5.049e+07	5.044e-01	5.650e+00	9.594e-04	1.075e-02
1.0	2.997e+08	7.841e+00	7.233e+01	1.445e-02	1.333e-01
1.5	3.000e+08	3.993e+01	2.579e+02	6.717e-02	4.340e-01
2.0	3.805e+03	1.382e-03	7.182e-03	2.137e-06	1.111e-05
3.0	5.506e+01	6.597e-05	2.594e-04	8.950e-08	3.519e-07
TOTALS:	1.374e+12	3.314e+03	4.556e+04	6.457e+00	8.884e+01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: WM181106.MS5
Run Date: September 9, 1998
Run Time: 8:41:31 AM
Duration: 00:04:11

File Ref: HKP-15/10/98
Date: 10/1/98
By: D. H. H. H. H.
Checked: PR 9/30/98

Case Title: Cs IX Effluent tank
Description: Shielding 4 Cs IX Effluent tank (T-103 A&B) w/14234 l St #10
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 304.8 cm 10 ft 0.0 in
Radius 121.92 cm 4 ft

Dose Points

#	X	Y	Z
1	368.07 cm	152.4 cm	0 cm
	12 ft 0.9 in	5 ft 0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.42e+07 cm ³	Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	182.88 cm	Air	0.0011
Shield 3	61.0 cm	Concrete	2.35
Shield 4	1.0 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

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Am-241	5.2660e+000	1.9484e+011	3.6997e-001	1.3689e+004
Am-243	2.3900e-003	8.8430e+007	1.6791e-004	6.2128e+000
Ba-137m	5.6800e-001	2.1016e+010	3.9906e-002	1.4765e+003
Ce-144	1.2350e+000	4.5695e+010	8.6767e-002	3.2104e+003
Cm-242	1.2470e-002	4.6139e+008	8.7610e-004	3.2416e+001
Cm-244	1.6370e-001	6.0569e+009	1.1501e-002	4.2554e+002
Co-60	1.8080e-003	6.6896e+007	1.2702e-004	4.6999e+000
Cs-134	2.0780e-004	7.6886e+006	1.4599e-005	5.4017e-001
Cs-135	1.1460e-005	4.2402e+005	8.0514e-007	2.9790e-002
Cs-137	6.0000e-001	2.2200e+010	4.2154e-002	1.5597e+003
Eu-152	6.2200e-002	2.3014e+009	4.3699e-003	1.6169e+002
Eu-154	3.4450e+000	1.2747e+011	2.4203e-001	8.9552e+003
Eu-155	6.0500e-001	2.2385e+010	4.2505e-002	1.5727e+003
H-3	3.0890e-001	1.1429e+010	2.1702e-002	8.0298e+002
I-129	8.4970e-003	3.1439e+008	5.9697e-004	2.2088e+001
Ni-63	1.4950e+000	5.5315e+010	1.0503e-001	3.8862e+003
Np-237	4.9680e-003	1.8382e+008	3.4903e-004	1.2914e+001
Pm-147	1.4800e+000	5.4760e+010	1.0398e-001	3.8472e+003
Pr-144	1.2350e+000	4.5695e+010	8.6767e-002	3.2104e+003
Pu-238	1.4660e+001	5.4242e+011	1.0300e+000	3.8108e+004
Pu-239	3.3450e-001	1.2377e+010	2.3501e-002	8.6953e+002
Pu-240	9.3900e-002	3.4743e+009	6.5971e-003	2.4409e+002
Pu-241	4.3840e+000	1.6221e+011	3.0800e-001	1.1396e+004

Page : 2
 DOS File: WM181106.MS5
 Run Date: September 9, 1998
 Run Time: 8:41:31 AM
 Duration: 00:04:11

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	2.2200e-004	8.2140e+006	1.5597e-005	5.7709e-001
Rh-106	1.5090e-004	5.5833e+006	1.0602e-005	3.9226e-001
Ru-106	1.5090e-004	5.5833e+006	1.0602e-005	3.9226e-001
Sb-125	1.8930e-001	7.0041e+009	1.3300e-002	4.9208e+002
Sm-151	1.0310e+001	3.8147e+011	7.2434e-001	2.6801e+004
Sr-90	5.7220e+002	2.1171e+013	4.0201e+001	1.4874e+006
Tc-99	3.1880e-001	1.1796e+010	2.2398e-002	8.2872e+002
Th-230	1.3300e-006	4.9210e+004	9.3441e-008	3.4573e-003
Th-231	1.9070e-004	7.0559e+006	1.3398e-005	4.9572e-001
U-232	4.3270e-005	1.6010e+006	3.0400e-006	1.1248e-001
U-233	2.0350e-008	7.5295e+002	1.4297e-009	5.2899e-005
U-234	2.1900e-002	8.1030e+008	1.5386e-003	5.6929e+001
U-235	5.5080e-004	2.0380e+007	3.8697e-005	1.4318e+000
U-236	1.9500e-003	7.2150e+007	1.3700e-004	5.0690e+000
U-238	5.4370e-004	2.0117e+007	3.8198e-005	1.4133e+000
Y-90	5.7220e+002	2.1171e+013	4.0201e+001	1.4874e+006

Buildup

The material reference is : Shield 3

Integration Parameters

Radial	32
Circumferential	32
Y Direction (axial)	31

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	5.081e+10	0.000e+00	4.332e-24	0.000e+00	3.716e-25
0.02	6.510e+10	0.000e+00	8.733e-24	0.000e+00	3.025e-25
0.03	9.947e+09	2.032e-107	2.951e-24	2.014e-109	2.925e-26
0.04	3.960e+10	3.346e-51	3.115e-23	1.480e-53	1.378e-25
0.05	8.631e+09	9.080e-32	2.220e-23	2.419e-34	5.913e-26
0.06	6.994e+10	7.925e-22	3.599e-20	1.574e-24	7.149e-23
0.08	7.997e+09	2.981e-15	2.065e-13	4.717e-18	3.268e-16
0.1	5.719e+10	2.119e-11	2.735e-09	3.242e-14	4.184e-12
0.15	5.134e+09	1.654e-09	3.562e-07	2.723e-12	5.866e-10
0.2	9.463e+09	6.571e-08	1.488e-05	1.160e-10	2.627e-08
0.3	9.360e+08	2.235e-07	3.608e-05	4.240e-10	6.844e-08
0.4	3.378e+09	7.840e-06	8.467e-04	1.528e-08	1.650e-06
0.5	1.313e+09	1.635e-05	1.243e-03	3.210e-08	2.440e-06
0.6	3.036e+10	1.418e-03	7.988e-02	2.768e-06	1.559e-04
0.8	4.841e+10	1.680e-02	5.899e-01	3.196e-05	1.122e-03
1.0	4.069e+10	6.243e-02	1.536e+00	1.151e-04	2.832e-03
1.5	5.066e+10	9.626e-01	1.306e+01	1.620e-03	2.197e-02
2.0	3.561e+08	3.316e-02	3.148e-01	5.128e-05	4.869e-04
3.0	9.562e+04	6.213e-05	3.817e-04	8.429e-08	5.179e-07
TOTALS:	4.999e+11	1.076e+00	1.558e+01	1.821e-03	2.657e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: WM181106.MS5
 Run Date: September 9, 1998
 Run Time: 8:46:51 AM
 Duration: 00:04:21

File Ref: UKP-15/16-98
 Date: 10/1/98
 By: D. H. Johnson
 Checked: PR 9/30/98

Case Title: Cs IX Effluent tnk
Description: Shielding 4 Cs IX Effluent tank (T-103 A&B) w/14234 l St #10
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	304.8 cm	10 ft 0.0 in ✓
Radius	121.92 cm	4 ft ✓

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	337.59 cm	152.4 cm	0 cm
	11 ft 0.9 in	5 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
✓Source	1.42e+07 cm³	Water	1
✓Shield 1	1.27 cm	Iron	7.86
✓Transition	182.88 cm	Air	0.0011
Shield 3	30.48 cm	Concrete	2.35
Shield 4	1.0 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>
Am-241	5.2660e+000	1.9484e+011	3.6997e-001	1.3689e+004
Am-243	2.3900e-003	8.8430e+007	1.6791e-004	6.2128e+000
Ba-137m	5.6800e-001	2.1016e+010	3.9906e-002	1.4765e+003
Ce-144	1.2350e+000	4.5695e+010	8.6767e-002	3.2104e+003
Cm-242	1.2470e-002	4.6139e+008	8.7610e-004	3.2416e+001
Cm-244	1.6370e-001	6.0569e+009	1.1501e-002	4.2554e+002
Co-60	1.8080e-003	6.6896e+007	1.2702e-004	4.6999e+000
Cs-134	2.0780e-004	7.6886e+006	1.4599e-005	5.4017e-001
Cs-135	1.1460e-005	4.2402e+005	8.0514e-007	2.9790e-002
Cs-137	6.0000e-001	2.2200e+010	4.2154e-002	1.5597e+003
Eu-152	6.2200e-002	2.3014e+009	4.3699e-003	1.6169e+002
Eu-154	3.4450e+000	1.2747e+011	2.4203e-001	8.9552e+003
Eu-155	6.0500e-001	2.2385e+010	4.2505e-002	1.5727e+003
H-3	3.0890e-001	1.1429e+010	2.1702e-002	8.0298e+002
I-129	8.4970e-003	3.1439e+008	5.9697e-004	2.2088e+001
Ni-63	1.4950e+000	5.5315e+010	1.0503e-001	3.8862e+003
Np-237	4.9680e-003	1.8382e+008	3.4903e-004	1.2914e+001
Pm-147	1.4800e+000	5.4760e+010	1.0398e-001	3.8472e+003
Pr-144	1.2350e+000	4.5695e+010	8.6767e-002	3.2104e+003
Pu-238	1.4660e+001	5.4242e+011	1.0300e+000	3.8108e+004
Pu-239	3.3450e-001	1.2377e+010	2.3501e-002	8.6953e+002
Pu-240	9.3900e-002	3.4743e+009	6.5971e-003	2.4409e+002
Pu-241	4.3840e+000	1.6221e+011	3.0800e-001	1.1396e+004

Page : 2
 DOS File: WM181106.MS5
 Run Date: September 9, 1998
 Run Time: 8:46:51 AM
 Duration: 00:04:21

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-242	2.2200e-004	8.2140e+006	1.5597e-005	5.7709e-001
Rh-106	1.5090e-004	5.5833e+006	1.0602e-005	3.9226e-001
Ru-106	1.5090e-004	5.5833e+006	1.0602e-005	3.9226e-001
Sb-125	1.8930e-001	7.0041e+009	1.3300e-002	4.9208e+002
Sm-151	1.0310e+001	3.8147e+011	7.2434e-001	2.6801e+004
Sr-90	5.7220e+002	2.1171e+013	4.0201e+001	1.4874e+006
Tc-99	3.1880e-001	1.1796e+010	2.2398e-002	8.2872e+002
Th-230	1.3300e-006	4.9210e+004	9.3441e-008	3.4573e-003
Th-231	1.9070e-004	7.0559e+006	1.3398e-005	4.9572e-001
U-232	4.3270e-005	1.6010e+006	3.0400e-006	1.1248e-001
U-233	2.0350e-008	7.5295e+002	1.4297e-009	5.2899e-005
U-234	2.1900e-002	8.1030e+008	1.5386e-003	5.6929e+001
U-235	5.5080e-004	2.0380e+007	3.8697e-005	1.4318e+000
U-236	1.9500e-003	7.2150e+007	1.3700e-004	5.0690e+000
U-238	5.4370e-004	2.0117e+007	3.8198e-005	1.4133e+000
Y-90	5.7220e+002	2.1171e+013	4.0201e+001	1.4874e+006

Buildup
 The material reference is : Shield 3

Integration Parameters	
Radial	32
Circumferential	32
Y Direction (axial)	31

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	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	5.081e+10	0.000e+00	5.143e-24	0.000e+00	4.412e-25
0.02	6.510e+10	1.515e-220	1.037e-23	5.247e-222	3.592e-25
0.03	9.947e+09	1.051e-71	3.504e-24	1.042e-73	3.472e-26
0.04	3.960e+10	2.358e-33	3.699e-23	1.043e-35	1.636e-25
0.05	8.631e+09	2.997e-20	2.984e-19	7.985e-23	7.948e-22
0.06	6.994e+10	4.088e-13	8.291e-12	8.121e-16	1.647e-14
0.08	7.997e+09	7.535e-09	2.812e-07	1.192e-11	4.450e-10
0.1	5.719e+10	6.361e-06	3.574e-04	9.732e-09	5.468e-07
0.15	5.134e+09	5.618e-05	4.119e-03	9.251e-08	6.783e-06
0.2	9.463e+09	7.692e-04	5.442e-02	1.358e-06	9.605e-05
0.3	9.360e+08	7.259e-04	3.786e-02	1.377e-06	7.181e-05
0.4	3.378e+09	1.104e-02	4.175e-01	2.151e-05	8.135e-04
0.5	1.313e+09	1.244e-02	3.560e-01	2.442e-05	6.987e-04
0.6	3.036e+10	6.668e-01	1.511e+01	1.301e-03	2.949e-02
0.8	4.841e+10	3.838e+00	6.011e+01	7.300e-03	1.143e-01
1.0	4.069e+10	8.423e+00	9.956e+01	1.553e-02	1.835e-01
1.5	5.066e+10	5.441e+01	4.047e+02	9.154e-02	6.808e-01
2.0	3.561e+08	1.105e+00	6.221e+00	1.709e-03	9.620e-03
3.0	9.562e+04	1.122e-03	4.499e-03	1.522e-06	6.104e-06
TOTALS:	4.999e+11	6.847e+01	5.865e+02	1.174e-01	1.019e+00

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: SRSTSH.MS5
 Run Date: August 25, 1998
 Run Time: 1:44:40 PM
 Duration: 00:04:33

File Ref: HKP-1516/98
 Date: 10/1/98
 By: AKK
 Checked: _____

Case Title: T-112 Spent Resin Tk
Description: Shielding for T-112 Spent Resin Storage Tank
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	457.2 cm	15 ft
Radius	121.92 cm	4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	369.6 cm	228.6 cm	0 cm
	12 ft 1.5 in	7 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.14e+07 cm ³	Mixed ->	1.4
		Concrete	0.4
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	121.92 cm	Air	0.0011
Shield 3 (#')	121.92 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	8.0100e-001	2.9637e+010	3.7517e-002	1.3881e+003
Ba-137m	4.3830e+005	1.6217e+016	2.0529e+004	7.5957e+008
Ce-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Co-60	1.8700e-002	6.9190e+008	8.7586e-004	3.2407e+001
Cs-134	1.6060e+002	5.9422e+012	7.5221e+000	2.7832e+005
Cs-135	8.8200e+000	3.2634e+011	4.1311e-001	1.5285e+004
Cs-137	4.6330e+005	1.7142e+016	2.1700e+004	8.0289e+008
Np-237	1.1760e-002	4.3512e+008	5.5081e-004	2.0380e+001
Pr-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Pu-238	4.8000e+001	1.7760e+012	2.2482e+000	8.3183e+004
Pu-239	2.5800e+000	9.5460e+010	1.2084e-001	4.4711e+003
Pu-240	8.0900e-001	2.9933e+010	3.7892e-002	1.4020e+003
Pu-241	1.6700e+001	6.1790e+011	7.8219e-001	2.8941e+004
Pu-242	1.2040e-003	4.4548e+007	5.6392e-005	2.0865e+000
Rh-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Ru-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Sb-125	3.7600e-001	1.3912e+010	1.7611e-002	6.5160e+002
Sr-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004
U-234	1.6060e-002	5.9422e+008	7.5221e-004	2.7832e+001
U-235	3.5400e-004	1.3098e+007	1.6580e-005	6.1348e-001
U-236	1.6780e-004	6.2086e+006	7.8593e-006	2.9080e-001

Page : 2
 DOS File: SRSTSH.MS5
 Run Date: August 25, 1998
 Run Time: 1:44:40 PM
 Duration: 00:04:33

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
U-238	5.2500e-005	1.9425e+006	2.4590e-006	9.0982e-002
Y-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004

Buildup
 The material reference is : Shield 3

Integration Parameters

Radial	31
Circumferential	31
Y Direction (axial)	33

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	1.075e+11	0.000e+00	8.523e-24	0.000e+00	7.311e-25
0.02	3.233e+10	0.000e+00	4.034e-24	0.000e+00	1.397e-25
0.03	9.821e+14	4.152e-174	2.710e-19	4.115e-176	2.685e-21
0.04	2.333e+14	2.281e-83	1.707e-19	1.009e-85	7.551e-22
0.05	3.534e+07	2.127e-57	8.454e-26	5.666e-60	2.252e-28
0.06	1.060e+10	2.993e-40	1.819e-22	5.945e-43	3.613e-25
0.08	6.401e+07	2.659e-30	2.614e-24	4.207e-33	4.137e-27
0.1	2.510e+08	7.569e-25	3.065e-22	1.158e-27	4.689e-25
0.15	7.045e+07	1.465e-20	1.184e-17	2.412e-23	1.949e-20
0.2	2.274e+09	8.540e-17	8.217e-14	1.507e-19	1.450e-16
0.3	9.200e+08	1.523e-14	9.954e-12	2.890e-17	1.888e-14
0.4	4.378e+09	3.701e-12	1.441e-09	7.212e-15	2.807e-12
0.5	8.819e+10	1.360e-09	3.383e-07	2.669e-12	6.640e-10
0.6	1.457e+16	2.191e-03	3.718e-01	4.276e-06	7.258e-04
0.8	5.593e+12	2.627e-05	2.470e-03	4.996e-08	4.699e-06
1.0	1.671e+11	9.907e-06	5.927e-04	1.826e-08	1.092e-06
1.5	1.813e+11	7.589e-04	2.168e-02	1.277e-06	3.648e-05
2.0	8.818e+03	5.233e-10	9.681e-09	8.092e-13	1.497e-11
3.0	1.274e+02	1.820e-10	1.970e-09	2.469e-13	2.673e-12
TOTALS:	1.579e+16	2.986e-03	3.966e-01	5.621e-06	7.681e-04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: SRSTSH.MS5
Run Date: August 25, 1998
Run Time: 1:52:44 PM
Duration: 00:04:31

File Ref: HRP-15/16-98
Date: 10/1/98
By: AKHedmon
Checked: _____

Case Title: T-112 Spent Resin Tk
Description: Shielding for T-112 Spent Resin Storage Tank
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 457.2 cm 15 ft
Radius 121.92 cm 4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	339.16 cm	228.6 cm	0 cm
	11 ft 1.5 in	7 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.14e+07 cm ³	Mixed ->1.4	
		Concrete	0.4
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	121.92 cm	Air	0.0011
Shield 3 (3')	91.5 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	8.0100e-001	2.9637e+010	3.7517e-002	1.3881e+003
Ba-137m	4.3830e+005	1.6217e+016	2.0529e+004	7.5957e+008
Ce-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Co-60	1.8700e-002	6.9190e+008	8.7586e-004	3.2407e+001
Cs-134	1.6060e+002	5.9422e+012	7.5221e+000	2.7832e+005
Cs-135	8.8200e+000	3.2634e+011	4.1311e-001	1.5285e+004
Cs-137	4.6330e+005	1.7142e+016	2.1700e+004	8.0289e+008
Np-237	1.1760e-002	4.3512e+008	5.5081e-004	2.0380e+001
Pr-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Pu-238	4.8000e+001	1.7760e+012	2.2482e+000	8.3183e+004
Pu-239	2.5800e+000	9.5460e+010	1.2084e-001	4.4711e+003
Pu-240	8.0900e-001	2.9933e+010	3.7892e-002	1.4020e+003
Pu-241	1.6700e+001	6.1790e+011	7.8219e-001	2.8941e+004
Pu-242	1.2040e-003	4.4548e+007	5.6392e-005	2.0865e+000
Rh-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Ru-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Sb-125	3.7600e-001	1.3912e+010	1.7611e-002	6.5160e+002
Sr-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004
U-234	1.6060e-002	5.9422e+008	7.5221e-004	2.7832e+001
U-235	3.5400e-004	1.3098e+007	1.6580e-005	6.1348e-001
U-236	1.6780e-004	6.2086e+006	7.8593e-006	2.9080e-001

Page : 2
 DOS File: SRSTSH.MS5
 Run Date: August 25, 1998
 Run Time: 1:52:44 PM
 Duration: 00:04:31

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
U-238	5.2500e-005	1.9425e+006	2.4590e-006	9.0982e-002
Y-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004

Buildup
 The material reference is : Shield 3

Integration Parameters

Radial	31
Circumferential	31
Y Direction (axial)	33

<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	1.075e+11	0.000e+00	1.000e-23	0.000e+00	8.581e-25
0.02	3.233e+10	0.000e+00	4.735e-24	0.000e+00	1.640e-25
0.03	9.821e+14	1.466e-138	3.181e-19	1.453e-140	3.152e-21
0.04	2.333e+14	1.248e-65	2.004e-19	5.519e-68	8.863e-22
0.05	3.534e+07	5.661e-46	9.923e-26	1.508e-48	2.643e-28
0.06	1.060e+10	1.258e-31	2.135e-22	2.500e-34	4.242e-25
0.08	6.401e+07	5.479e-24	5.393e-22	8.671e-27	8.535e-25
0.1	2.510e+08	1.849e-19	4.292e-17	2.828e-22	6.566e-20
0.15	7.045e+07	4.060e-16	1.857e-13	6.686e-19	3.058e-16
0.2	2.274e+09	8.221e-13	4.219e-10	1.451e-15	7.446e-13
0.3	9.200e+08	4.131e-11	1.473e-08	7.835e-14	2.795e-11
0.4	4.378e+09	4.409e-09	9.893e-07	8.590e-12	1.928e-09
0.5	8.819e+10	8.842e-07	1.327e-04	1.736e-09	2.604e-07
0.6	1.457e+16	8.885e-01	9.451e+01	1.734e-03	1.845e-01
0.8	5.593e+12	5.252e-03	3.253e-01	9.989e-06	6.187e-04
1.0	1.671e+11	1.183e-03	4.867e-02	2.181e-06	8.971e-05
1.5	1.813e+11	3.875e-02	8.091e-01	6.520e-05	1.361e-03
2.0	8.818e+03	1.596e-08	2.231e-07	2.468e-11	3.450e-10
3.0	1.274e+02	3.056e-09	2.613e-08	4.147e-12	3.545e-11
TOTALS:	1.579e+16	9.336e-01	9.570e+01	1.812e-03	1.866e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: SRSTSH.MS5
 Run Date: August 25, 1998
 Run Time: 2:11:00 PM
 Duration: 00:04:30

File Ref: HKP-1516-98
 Date: 10/1/98
 By: Altuberna
 Checked: PDR 9/30/98

Case Title: T-112 Spent Resin Tk
Description: Shielding for T-112 Spent Resin Storage Tank
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	457.2 cm	15 ft
Radius	121.92 cm	4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	344.24 cm	228.6 cm	0 cm
	11 ft 3.5 in	7 ft 6.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.14e+07 cm ³	Mixed	->1.4
		Concrete	0.4
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	121.92 cm	Air	0.0011
Shield 3 (38")	96.58 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	8.0100e-001	2.9637e+010	3.7517e-002	1.3881e+003
Ba-137m	4.3830e+005	1.6217e+016	2.0529e+004	7.5957e+008
Ce-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Co-60	1.8700e-002	6.9190e+008	8.7586e-004	3.2407e+001
Cs-134	1.6060e+002	5.9422e+012	7.5221e+000	2.7832e+005
Cs-135	8.8200e+000	3.2634e+011	4.1311e-001	1.5285e+004
Cs-137	4.6330e+005	1.7142e+016	2.1700e+004	8.0289e+008
Np-237	1.1760e-002	4.3512e+008	5.5081e-004	2.0380e+001
Pr-144	1.7900e-009	6.6230e+001	8.3839e-011	3.1020e-006
Pu-238	4.8000e+001	1.7760e+012	2.2482e+000	8.3183e+004
Pu-239	2.5800e+000	9.5460e+010	1.2084e-001	4.4711e+003
Pu-240	8.0900e-001	2.9933e+010	3.7892e-002	1.4020e+003
Pu-241	1.6700e+001	6.1790e+011	7.8219e-001	2.8941e+004
Pu-242	1.2040e-003	4.4548e+007	5.6392e-005	2.0865e+000
Rh-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Ru-106	1.6500e-005	6.1050e+005	7.7282e-007	2.8594e-002
Sb-125	3.7600e-001	1.3912e+010	1.7611e-002	6.5160e+002
Sr-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004
U-234	1.6060e-002	5.9422e+008	7.5221e-004	2.7832e+001
U-235	3.5400e-004	1.3098e+007	1.6580e-005	6.1348e-001
U-236	1.6780e-004	6.2086e+006	7.8593e-006	2.9080e-001

Page : 2
 DOS File: SRSTSH.MS5
 Run Date: August 25, 1998
 Run Time: 2:11:00 PM
 Duration: 00:04:30

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
U-238	5.2500e-005	1.9425e+006	2.4590e-006	9.0982e-002
Y-90	1.1870e+001	4.3919e+011	5.5596e-001	2.0571e+004

Buildup
 The material reference is : Shield 3

Integration Parameters
 Radial 31
 Circumferential 31
 Y Direction (axial) 33

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<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	1.075e+11	0.000e+00	9.732e-24	0.000e+00	8.348e-25
0.02	3.233e+10	0.000e+00	4.606e-24	0.000e+00	1.595e-25
0.03	9.821e+14	1.693e-144	3.094e-19	1.678e-146	3.066e-21
0.04	2.333e+14	1.357e-68	1.949e-19	6.003e-71	8.622e-22
0.05	3.534e+07	6.975e-48	9.653e-26	1.858e-50	2.572e-28
0.06	1.060e+10	4.552e-33	2.077e-22	9.042e-36	4.126e-25
0.08	6.401e+07	4.816e-25	5.148e-23	7.621e-28	8.146e-26
0.1	2.510e+08	2.320e-20	5.834e-18	3.549e-23	8.925e-21
0.15	7.045e+07	7.325e-17	3.723e-14	1.206e-19	6.131e-17
0.2	2.274e+09	1.770e-13	1.019e-10	3.124e-16	1.799e-13
0.3	9.200e+08	1.099e-11	4.379e-09	2.084e-14	8.306e-12
0.4	4.378e+09	1.346e-09	3.342e-07	2.622e-12	6.512e-10
0.5	8.819e+10	2.986e-07	4.919e-05	5.862e-10	9.655e-08
0.6	1.457e+16	3.247e-01	3.766e+01	6.337e-04	7.351e-02
0.8	5.593e+12	2.160e-03	1.444e-01	4.108e-06	2.747e-04
1.0	1.671e+11	5.305e-04	2.338e-02	9.778e-07	4.309e-05
1.5	1.813e+11	2.003e-02	4.430e-01	3.369e-05	7.453e-04
2.0	8.818e+03	8.990e-09	1.323e-07	1.390e-11	2.046e-10
3.0	1.274e+02	1.903e-09	1.698e-08	2.581e-12	2.303e-11
TOTALS:	1.579e+16	3.474e-01	3.827e+01	6.725e-04	7.458e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: WM181101.MS5
 Run Date: August 25, 1998
 Run Time: 2:57:22 PM
 Duration: 00:01:57

File Ref: HKP-1516/98
 Date: 10/1/98
 By: AKH/MLP
 Checked: PR 9/30/98

Case Title: WM-181
Description: Shielding for T-101 A & B Liquid Waste Feed Tanks
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions
 Height 304.8 cm 10 ft 0.0 in
 Radius 121.92 cm 4 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	369.73 cm	152.4 cm	0 cm
✓	12 ft 1.6 in	✓ 5 ft 0.0 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	✓ 1.42e+07 cm ³	Mixed ->	1.3
		Concrete	0.3
		Water	1
Shield 1	1.27 cm	Iron	7.86
Transition	183.0 cm	Air	0.0011
Shield 3	61.0 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	5.8640e+000	2.1697e+011	4.1198e-001	1.5243e+004
Am-243	2.6600e-003	9.8420e+007	1.8688e-004	6.9146e+000
Ba-137m	6.3197e+002	2.3383e+013	4.4400e+001	1.6428e+006
Ce-144	7.1900e-006	2.6603e+005	5.0514e-007	1.8690e-002
Cm-242	1.3880e-002	5.1356e+008	9.7516e-004	3.6081e+001
Cm-244	1.8080e-001	6.6896e+009	1.2702e-002	4.6999e+002
Co-60	2.0070e+000	7.4259e+010	1.4100e-001	5.2172e+003
Cs-134	2.3200e-001	8.5840e+009	1.6299e-002	6.0308e+002
Cs-135	1.2740e-002	4.7138e+008	8.9507e-004	3.3117e+001
Cs-137	6.6898e+002	2.4752e+013	4.7000e+001	1.7390e+006
Eu-152	6.9180e-002	2.5597e+009	4.8603e-003	1.7983e+002
Eu-154	3.8290e+000	1.4167e+011	2.6901e-001	9.9534e+003
Eu-155	6.7180e-001	2.4857e+010	4.7198e-002	1.7463e+003
H-3	3.4450e-001	1.2747e+010	2.4203e-002	8.9552e+002
I-129	9.4510e-003	3.4969e+008	6.6399e-004	2.4568e+001
Ni-63	1.6650e+000	6.1605e+010	1.1698e-001	4.3281e+003
Np-237	5.5370e-003	2.0487e+008	3.8901e-004	1.4393e+001
Pm-147	1.6510e+000	6.1087e+010	1.1599e-001	4.2917e+003
Pr-144	7.0872e-006	2.6223e+005	4.9792e-007	1.8423e-002
Pu-238	1.6226e+001	6.0036e+011	1.1400e+000	4.2179e+004
Pu-239	3.7290e-001	1.3797e+010	2.6199e-002	9.6935e+002

Page : 2
 DOS File: WM181101.MS5
 Run Date: August 25, 1998
 Run Time: 2:57:22 PM
 Duration: 00:01:57

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Pu-240	1.0450e-001	3.8665e+009	7.3418e-003	2.7165e+002
Pu-241	4.8680e+000	1.8012e+011	3.4201e-001	1.2654e+004
Pu-242	2.4700e-004	9.1390e+006	1.7353e-005	6.4207e-001
Rh-106	1.6800e-004	6.2160e+006	1.1803e-005	4.3671e-001
Ru-106	1.6800e-004	6.2160e+006	1.1803e-005	4.3671e-001
Sb-125	2.1070e-001	7.7959e+009	1.4803e-002	5.4771e+002
Sm-151	1.1460e+001	4.2402e+011	8.0514e-001	2.9790e+004
Sr-90	6.3767e+002	2.3594e+013	4.4800e+001	1.6576e+006
Tc-99	3.5580e-001	1.3165e+010	2.4997e-002	9.2490e+002
Th-230	1.4800e-006	5.4760e+004	1.0398e-007	3.8472e-003
Th-231	2.1200e-004	7.8440e+006	1.4894e-005	5.5109e-001
U-233	2.2600e-008	8.3620e+002	1.5878e-009	5.8748e-005
U-234	2.4480e-002	9.0576e+008	1.7199e-003	6.3635e+001
U-235	6.1300e-004	2.2681e+007	4.3067e-005	1.5935e+000
U-236	2.1640e-003	8.0068e+007	1.5203e-004	5.6253e+000
U-238	6.0490e-004	2.2381e+007	4.2498e-005	1.5724e+000
Y-90	6.3767e+002	2.3594e+013	4.4800e+001	1.6576e+006

Buildup
 The material reference is : Shield 3

<u>Integration Parameters</u>	
Radial	24
Circumferential	24
Y Direction (axial)	24

		<u>Results</u>			
<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	5.637e+10	0.000e+00	4.764e-24	0.000e+00	4.086e-25
0.02	7.244e+10	0.000e+00	9.632e-24	0.000e+00	3.336e-25
0.03	1.426e+12	1.461e-105	4.191e-22	1.448e-107	4.154e-24
0.04	3.746e+11	1.874e-50	2.920e-22	8.289e-53	1.292e-24
0.05	9.532e+09	6.618e-32	2.430e-23	1.763e-34	6.472e-26
0.06	7.786e+10	6.199e-22	2.857e-20	1.231e-24	5.675e-23
0.08	7.873e+09	2.188e-15	1.516e-13	3.463e-18	2.399e-16
0.1	6.336e+10	1.793e-11	2.314e-09	2.743e-14	3.540e-12
0.15	2.212e+08	5.544e-11	1.194e-08	9.129e-14	1.966e-11
0.2	1.052e+10	5.710e-08	1.293e-05	1.008e-10	2.283e-08
0.3	1.048e+09	1.961e-07	3.165e-05	3.720e-10	6.004e-08
0.4	3.758e+09	6.840e-06	7.386e-04	1.333e-08	1.439e-06
0.5	1.586e+09	1.549e-05	1.177e-03	3.041e-08	2.311e-06
0.6	2.101e+13	7.700e-01	4.338e+01	1.503e-03	8.467e-02
0.8	6.188e+10	1.685e-02	5.919e-01	3.205e-05	1.126e-03
1.0	1.196e+11	1.440e-01	3.546e+00	2.654e-04	6.536e-03
1.5	1.306e+11	1.949e+00	2.646e+01	3.279e-03	4.452e-02
2.0	3.469e+06	2.538e-04	2.413e-03	3.925e-07	3.732e-06
3.0	3.717e+03	1.897e-06	1.168e-05	2.574e-09	1.584e-08
TOTALS:	2.343e+13	2.880e+00	7.398e+01	5.080e-03	1.369e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File: ROTDRY.MS5
Run Date: August 26, 1998
Run Time: 1:56:01 PM
Duration: 00:01:13

File Ref: HKP-15/16-98
Date: 10/1/98
By: HH/Johnson
Checked: PR 9/30/98

Case Title: WM181-107
Description: Shielding for Rotary dryer with 291.2 kg of Stream 107
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height 77.598 cm 2 ft 6.6 in
Radius 29.21 cm 11.5 in

Dose Points

#	X	Y	Z
1	275.79 cm 9 ft 0.6 in	38.8 cm 1 ft 3.3 in	0 cm 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Transition	182.88 cm	Air	0.0011
Shield 3 (2')	61.0 cm	Concrete	2.35
Shield 4	2.54 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	$\mu\text{Ci/cm}^3$	Bq/cm ³
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Page : 2
 DOS File: ROTDRY.MS5
 Run Date: August 26, 1998
 Run Time: 1:56:01 PM
 Duration: 00:01:13

Buildup
 The material reference is : Shield 3

Integration Parameters

Radial	21
Circumferential	21
Y Direction (axial)	21

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Results</u>		<u>Exposure Rate</u>	
		<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Fluence Rate</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	4.642e+10	0.000e+00	7.074e-24	0.000e+00	6.067e-25
0.02	1.397e+10	4.385e-234	3.349e-24	1.519e-235	1.160e-25
0.03	8.404e+10	2.752e-75	4.456e-23	2.728e-77	4.416e-25
0.04	1.978e+10	4.329e-37	2.781e-23	1.915e-39	1.230e-25
0.05	1.524e+07	3.139e-26	3.726e-25	8.362e-29	9.925e-28
0.06	4.584e+09	1.875e-17	5.423e-16	3.724e-20	1.077e-18
0.08	2.761e+07	2.242e-14	1.278e-12	3.549e-17	2.022e-15
0.1	1.084e+08	1.330e-11	1.393e-09	2.035e-14	2.132e-12
0.15	3.043e+07	7.161e-10	1.262e-07	1.179e-12	2.077e-10
0.2	4.433e+08	1.414e-07	2.618e-05	2.496e-10	4.620e-08
0.3	2.782e+07	2.094e-07	2.788e-05	3.972e-10	5.288e-08
0.4	1.892e+09	1.136e-04	1.024e-02	2.214e-07	1.996e-05
0.5	6.217e+08	1.749e-04	1.119e-02	3.433e-07	2.197e-05
0.6	1.201e+12	1.141e+00	5.449e+01	2.226e-03	1.064e-01
0.8	5.049e+07	3.035e-04	9.139e-03	5.774e-07	1.738e-05
1.0	2.997e+08	7.058e-03	1.502e-01	1.301e-05	2.769e-04
1.5	3.000e+08	7.088e-02	8.427e-01	1.193e-04	1.418e-03
2.0	3.805e+03	3.837e-06	3.209e-05	5.933e-09	4.962e-08
3.0	5.506e+01	3.240e-07	1.763e-06	4.396e-10	2.392e-09
TOTALS:	1.374e+12	1.219e+00	5.552e+01	2.360e-03	1.081e-01

MicroShield v5.01 (5.01-00121)
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Page : 1
 DOS File: ROTDRY.MS5
 Run Date: October 1, 1998
 Run Time: 3:41:37 PM
 Duration: 00:01:11

File Ref: *IKP-1516-98*
 Date: *10/1/98*
 By: *DA Johnson*
 Checked: *PDR 9/30/98*

Case Title: WM181-107

Description: Shielding for Rotary dryer with 291.2 kg of Stream 107
Geometry: 7 - Cylinder Volume - Side Shields

Source Dimensions

Height	77.598 cm	2 ft 6.6 in
Radius	29.21 cm	11.5 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	280.87 cm	38.8 cm	0 cm
	9 ft 2.6 in	1 ft 3.3 in	0.0 in

Shields

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	2.08e+05 cm ³	Concrete	1.4
Shield 1	.16 cm	Iron	7.86
Transition	182.88 cm	Air	0.0011
Shield 3	66.08 cm	Concrete	2.35
Shield 4	2.54 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>
Am-241	3.4650e-001	1.2821e+010	1.6659e+000	6.1637e+004
Ba-137m	3.6090e+001	1.3353e+012	1.7351e+002	6.4199e+006
Ce-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Co-60	8.0660e-003	2.9844e+008	3.8779e-002	1.4348e+003
Cs-134	1.4360e-003	5.3132e+007	6.9038e-003	2.5544e+002
Cs-137	3.8150e+001	1.4116e+012	1.8341e+002	6.7863e+006
Np-237	5.0700e-003	1.8759e+008	2.4375e-002	9.0187e+002
Pr-144	7.7460e-010	2.8660e+001	3.7240e-009	1.3779e-004
Pu-238	2.0730e+001	7.6701e+011	9.9663e+001	3.6875e+006
Pu-239	1.1120e+000	4.1144e+010	5.3462e+000	1.9781e+005
Pu-240	3.4900e-001	1.2913e+010	1.6779e+000	6.2082e+004
Pu-241	7.1930e+000	2.6614e+011	3.4582e+001	1.2795e+006
Pu-242	5.1830e-004	1.9177e+007	2.4918e-003	9.2198e+001
Rh-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Ru-106	7.1340e-006	2.6396e+005	3.4298e-005	1.2690e+000
Sb-125	1.6250e-001	6.0125e+009	7.8125e-001	2.8906e+004
Sr-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005
U-234	6.9300e-003	2.5641e+008	3.3317e-002	1.2327e+003
U-235	1.5260e-004	5.6462e+006	7.3365e-004	2.7145e+001
U-236	7.2200e-005	2.6714e+006	3.4712e-004	1.2843e+001
U-238	2.2600e-005	8.3620e+005	1.0865e-004	4.0202e+000
Y-90	5.1250e+000	1.8963e+011	2.4639e+001	9.1166e+005

Page : 2
 DOS File: ROTDRY.MS5
 Run Date: October 1, 1998
 Run Time: 3:41:37 PM
 Duration: 00:01:11

Buildup
 The material reference is : Shield 3

Integration Parameters
 Radial 21
 Circumferential 21
 Y Direction (axial) 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>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	4.642e+10	0.000e+00	6.820e-24	0.000e+00	5.850e-25
0.02	1.397e+10	2.621e-252	3.229e-24	9.078e-254	1.119e-25
0.03	8.404e+10	3.127e-81	4.297e-23	3.099e-83	4.258e-25
0.04	1.978e+10	4.660e-40	2.682e-23	2.061e-42	1.186e-25
0.05	1.524e+07	3.843e-28	6.800e-26	1.024e-30	1.811e-28
0.06	4.584e+09	6.757e-19	2.225e-17	1.342e-21	4.420e-20
0.08	2.761e+07	1.970e-15	1.230e-13	3.117e-18	1.946e-16
0.1	1.084e+08	1.671e-12	1.972e-10	2.556e-15	3.018e-13
0.15	3.043e+07	1.296e-10	2.655e-08	2.134e-13	4.372e-11
0.2	4.433e+08	3.054e-08	6.659e-06	5.391e-11	1.175e-08
0.3	2.782e+07	5.591e-08	8.723e-06	1.060e-10	1.655e-08
0.4	1.892e+09	3.481e-05	3.631e-03	6.783e-08	7.076e-06
0.5	6.217e+08	5.927e-05	4.344e-03	1.163e-07	8.526e-06
0.6	1.201e+12	4.182e-01	2.268e+01	8.163e-04	4.426e-02
0.8	5.049e+07	1.252e-04	4.221e-03	2.382e-07	8.028e-06
1.0	2.997e+08	3.173e-03	7.481e-02	5.849e-06	1.379e-04
1.5	3.000e+08	3.671e-02	4.749e-01	6.176e-05	7.991e-04
2.0	3.805e+03	2.165e-06	1.951e-05	3.347e-09	3.017e-08
3.0	5.506e+01	2.018e-07	1.169e-06	2.738e-10	1.586e-09
TOTALS:	1.374e+12	4.583e-01	2.324e+01	8.843e-04	4.522e-02

Project File Number 02BD7

Project/Task HLW EIS Supporting Studies

Subtask

Title: Regulatory Requirements for the Design, Construction, and Operations of the ICPP Proposed Waste Processing Facilities

Summary: This EDF identifies and provides the existing environmental regulations and codes pertaining to the design, construction, operations, and performance of the proposed waste treatment and storage facilities at the Idaho Chemical Processing Plant (ICPP). This study also presents an assessment of the current NRC regulations and their potential applicability to the proposed facilities if the facilities were to be licensed by the NRC in the future. The NRC requirements for regulating DOE facilities or activities have not been defined yet. The NRC requirements to be applied will need to be determined by the appropriate NRC and DOE Task Forces.

The principal sources of requirements for the design, construction, and operations presented here are the Department of Energy (DOE), the DOE Idaho Operations Office (DOE-ID), the Environmental Protection Agency (EPA), the Idaho laws and regulations, the National Environmental Policy Act (NEPA), and other local codes and standards. The proposed facilities under consideration in this study will provide waste retrieval, treatment, and interim storage capabilities. They will process various wastes that are considered mixed wastes. These are wastes that contain both radioactive and RCRA hazardous constituents. The RCRA constituents include characteristic heavy metals and "listed" hazardous constituents, as defined in 40 CFR 261, subparts C and D. The management of the wastes, as well as the facilities, is subject to the requirements of both the EPA and the Atomic Energy Act (AEA). The specific requirements for radioactive waste management developed under the AEA are administered through the DOE. The proposed treatment facilities are expected to process several types of waste and to convert them to distinct waste forms that are suitable for disposal. The regulatory requirements for the disposal of the various waste forms resulting from the proposed treatment options and the criteria of the potential target repositories are described in detail in INEEL/EXT-97-01147. It is assumed that the wastes resulting from the treatment options will be delisted and will no longer be considered RCRA hazardous waste prior to being sent to interim storage facilities.

Existing NRC requirements apply to commercial, non-DOE, facilities. The degree of applicability of these requirements to the proposed facilities should be determined by the NRC and the DOE, with input from the DOE contractor. Of the existing NRC regulations, it has been determined in this study that 10 CFR 61 will apply to the proposed near-surface disposal facility for the grouted Low-Activity Waste (LAW) or grouted LLW, and 10 CFR 72 will be applicable to the proposed interim storage facilities for the vitrified, Hot Isostatic Pressed (HIPed), or grouted High-Level Waste (HLW), and for the liquid High-Activity Waste (HAW) and vitrified HAW storage facilities. Independently, it was determined by Leroy and Morgan in "Nuclear Regulatory Commission (NRC) Licensing Assessment for the Idaho National Engineering and Environmental Laboratory (INEEL) High-Level Waste program," April 23, 1997, that 10 CFR 30 and 10 CFR 70

Project File Number 02BD7

will apply to the following facilities:

- 10 CFR 30 for the LAW collection and grouting facilities and for the collection and treatment of the LLW from the INEEL ongoing operations.
- 10 CFR 70 for the separations facility, for the interim storage of liquid HAW resulting from the separation processes, and for the HAW vitrification facility.
- 10 CFR 70 for the HLW vitrification, HIPing, or grouting facilities.
- 10 CFR 70 for the calcine retrieval and dissolution facilities.

Additional NRC regulations applicable to the proposed facilities are in 10 CFR 2, 10 CFR 19, 10 CFR 20, 10 CFR 21, 10 CFR 50, 10 CFR 51, 10 CFR 52, and 10 CFR 73. 10 CFR 71 and 49 CFR 173 (Department of Transportation) contain requirements for the packaging and transportation of waste. These requirements could have impact on the design and operations of the storage facilities. The existing facilities that will be modified to be used for storage of treated HLW or HAW are anticipated to be exempted by DOE from any further jurisdiction of NRC. Such a jurisdiction would be excessively difficult, costly, and complex to apply. All the work requirements for the modification of the existing facilities are expected to be performed in accordance with the DOE/RW/0333P, "Quality Assurance Requirements and Description."

If DOE facilities become regulated by NRC, the jurisdiction of other currently government applicable authorities will not automatically or necessarily cease. In particular, it is expected that local, State, Federal EPA, and some DOE regulatory requirements would still apply.

In addition to all the regulatory requirements established by the various government authorities discussed above, the schedule of the construction and operations of the proposed facilities must meet the terms and the dates of the commitments as stated in the Settlement Agreement between the State of Idaho and the DOE.

Distribution (complete package): HLW EIS Library, also contained in INEEL-EXT-01389 (VWO), INEEL-EXT-97-01392 (HWO), INEEL-EXT-97-01400 (CWO), INEEL-EXT-97-01399 (DCWO), and INEEL-EXT-97-01428 (TRU Separations), S. L. Austad MS 3650, J. B. Bosley MS 3428, R. E. Dafoe MS 3765, W. H. Landman MS 3625, A. E. Lee MS 3765, D. A. Lopez MS 3765, B. R. Helm MS 3765, J. J. McCarthy MS 3625, T. A. Solle MS 3428, N. E. Russell MS 3765, D. S. Vandel MS 3625.

Distribution (summary package only): D. J. Harrell MS 3211, K. L. Williams MS 3765.

Author	Dept.	Reviewed	Date	Approved	Date
J. Banaee	4170	<i>[Signature]</i>	1/8/98	<i>[Signature]</i>	1/14/98
<i>[Signature]</i>		<i>[Signature]</i>	1/8/98		
		<i>[Signature]</i>	1/13/98		
		<i>[Signature]</i>	1/13/98		

1. INTRODUCTION

This study identifies and presents the existing environmental regulations and standard codes for the design, construction, operations, and performance of the proposed waste treatment and storage facilities at the Idaho Chemical Processing Plant (ICPP). Also, it provides the applicable existing Nuclear Regulatory Commission (NRC) regulations and guidance documents to the proposed facilities if they were to be licensed by the NRC in the future. The existing licensing process and related licensing issues applicable to the proposed facilities are also discussed.

The environmental regulations are primarily based on safety and health considerations. The standards define the requirements that protect human health and the environment. The principal sources for the standard regulations and codes presented here are:

- Environmental Protection Agency
- Idaho Laws and regulations
- National Environmental Policy Act (NEPA)
- Department of Energy
- DOE Idaho Operations Office (DOE-ID)
- Other applicable standards and codes

In addition to the current regulations, the governing standards for the facility design and performance considerations of the future (i.e., DOE Orders 435.1) drafted at the time of preparation of this report are also presented.

The facilities under consideration in this study will provide waste retrieval, treatment, and interim storage capabilities. They will process various wastes that are considered mixed wastes. These are wastes that contain both radioactive and Resource Conservation and Recovery Act (RCRA) hazardous constituents. The RCRA constituents include characteristic heavy metals and "listed" hazardous constituents, as defined in 40 CFR 261, subparts C and D. The management of the wastes, as well as the facilities, is subject to the requirements of both the EPA and the Atomic Energy Act (AEA). The specific standards for radioactive waste management developed under AEA are administered through the DOE.

The proposed treatment facilities are expected to process several types of waste to convert them to distinct waste forms that are suitable for disposal. The wastes resulting from the proposed treatment options are assumed to be delisted prior to being transported to the proposed interim storage facilities. The waste forms are produced starting from a variety of mixed wastes including high-level liquid waste (HLLW), Sodium-bearing liquid waste (SBW), and other radioactive wastes from ongoing operations (1996-2012), known as the newly generated wastes (NGW). These wastes have been stored in the Tank Farm at the ICPP. Most of the HLLW have been calcined and stored at the Calcined Solids Storage Facility (CSSF).

The EPA has established treatment standards under the RCRA Land Disposal Restrictions (LDRs), in 40 CFR 268, for hazardous waste constituents prior to land disposal. The regulatory

requirements for the disposal of the various waste forms resulting from the proposed options and the criteria of the potential target repositories are described in detail in INEEL/EXT-97-01147.

2. PROPOSED WASTE TREATMENT OPTIONS

Several treatment options are being proposed including four non-separations and two separation processes. In addition, a no-action alternative will likely be considered, defined as the continuation of the current practice of calcination and storage in stainless steel bins at ICPP. The non-separation options include: (a) vitrified waste option (VWO), (b) Hot Isostatic Pressed (HIP) waste option (HWO), (c) direct cementitious waste option (DCWO), and (d) cementitious waste option (CWO). The separation processes are expected to generate up to three different waste streams; designated as high activity waste (HAW), low activity waste (LAW), and transuranic (TRU) waste. These options are summarized below:

Vitrified Waste Option

This option involves the following steps: 1) calcination of HLLW, SBW, and the NGW, 2) vitrification of all the calcine wastes (existing and future) and placing in canisters (2' x 10' or other canisters approved by the repository/NRC), and 3) interim storage prior to shipment to a HLW repository.

Process duration: 20 year Schedule

HIP Waste Option (HWO)

As in the VWO, the wastes will be calcined but instead of being vitrified, they will be directly HIP processed and placed in canisters (2' x 10' or other canisters approved by the repository/NRC), and 3) will be sent to an interim storage facility prior to shipment to and disposal at a HLW repository.

Process duration: 20 year schedule

Cementitious Waste Option (CWO)

This option includes calcining the HLLW, retrieving the calcine wastes, and recalcining with the SBW in the modified New Waste Calcining Facility (NWCF), grouting in canisters (2' x 10' canisters), and sending to an interim storage facility for transport to and ultimate disposal at an off-site HLW disposal facility. It is proposed that the cementitious waste would be suitable for disposal at the Nevada Test Site (NTS) using Greater Confinement Disposal (GCD) facility.

Currently, the GCD facility has not been approved for disposal of HLW and waste acceptance requirements for the GCD facility have not been defined. Pursuant to the 1987 Nuclear Waste Policy Amendments Act (NWPAA), the Yucca Mountain in Nevada is designated for characterization as the only candidate site for a HLW geologic repository. However, projections of future wastes suggests a need for a second repository at some time in the future, or expansion of the first potential repository. Criteria for acceptance and disposal of waste at the potential HLW repository at the Yucca Mountain have not been finalized. The current waste acceptance criteria are preliminary at the present time. These criteria are covered in detail in INEEL/EXT-97-01147.

Process duration: 5 year schedule

Direct Cementitious Waste Option

The DCWO consists of step 1 of the VWO, then direct grouting of all the calcined wastes and packaging in canisters (2' x 10' or other canisters approved by the repository/NRC), and interim storage prior to shipment to an off-site HLW repository such as the NTS-GCD, if approved for the HLW disposal, or possibly to a potential HLW geologic repository at the Yucca Mountain. This option is planned to have the same processing time as the CWO with the difference in starting date.

Separations Options

Two waste separation options have been proposed: HAW/LAW, known as full separations, and TRU separations. The full-separations option involves calcining the HLW and SBW, retrieving and dissolving the calcine, and feeding the dissolved calcine and the remaining liquid SBW and the NGW to a waste separations facility to separate them into the HAW and LAW streams. The NGW, if classified as LLW, would bypass the separations facility and would ultimately be combined with the LAW.

In the TRU separations, as in the HAW/LAW separation option, the dissolved calcine and the remaining liquid SBW, and the NGW will be fed to a waste separations system. Two separation alternatives are being considered under this option, designated as (1) TRU/LAW Class C and (2) TRU/LAW Class A/HAW. In the first alternative, the wastes would be separated into TRU waste and LAW. The TRU waste fraction is expected to contain alpha-emitting TRU radionuclides with half-lives greater than twenty years. The remaining waste stream, designated as LAW Class C, would contain Cesium (Cs) and strontium (Sr) isotopes, and low activity waste portion. It is anticipated that the LAW in this alternative would meet the definition of NRC LLW Class C. In the second alternative, Cs and Sr will be separated as HAW, and the remaining waste from separations will be designated as TRU and LAW. The LAW is expected to meet the definition of NRC LLW Class A.

The HAW is planned to be vitrified using the same process described in the VWO and be shipped to a HLW geological repository for permanent disposal. The HAW containing isolated Cs and Sr would be stored at the INEEL awaiting disposal in a HLW geologic repository or an alternate approved disposal facility. The TRU waste stream would be converted to a solid form to be sent to the Waste Isolation Pilot Plant (WIPP) for disposal. The LAW would be grouted and shipped to a LLW disposal facility. The disposal options being considered for the grouted LAW are the CSSF, the tanks at ICPP, or a LLW near-surface disposal facility. The requirements for the design and operations of a near-surface LLW disposal facility are covered in detail in EDF-FDO-008. This reference is contained in INEEL/EXT-98-00051.

Based on the NRC source term definition of HLW (10 CFR 60.2), the HAW, LAW and the TRU waste streams are actually considered HLW. These wastes do not conform to the existing classification for radioactive waste. Although, the separations alternatives and the resultant waste streams may be technically and economically feasible and attractive, they will need to receive evaluation, redefinition of types of waste, and the concurrence of applicable government authorities. It is assumed that a determination will be made by the appropriate authorities (e.g., the DOE and the NRC) that the TRU waste and the LAW streams meet the TRU waste and the NRC LLW-Class A or Class C definition, respectively. The LAW also meets the definition of incidental waste in the NRC evaluation of HLW separation processes at Hanford Site (58 FR, "State of Washington and Oregon, Denial for Petition for Rulemaking," U.S. Nuclear Regulatory Commission," March 4, 1993, p. 12342.). The HAW would be considered HLW and can be classified as HLW.

3. ASSUMPTIONS

- 1) All of the wastes produced from the treatment and storage facilities will meet the requirements enforced by the EPA, the DOE, the DOT, the NRC, and other potential target repositories for the disposal.
- 2) Under EPA 40 CFR 268.42(b), an equivalency petition for using alternative waste treatment technologies including CWO and DCWO to borosilicate glass^a will be granted by the EPA.
- 3) All of the wastes resulting from the various treatment options will be delisted prior to being transported to the interim storage facilities. The EPA Upfront Exclusions for the petitioned wastes will be granted to delist the RCRA listed hazardous waste codes. The EPA delisting

^aVitrification using borosilicate glass technology is considered by the EPA a best demonstrated available technology (BDAT) for treatment of mixed HLW (55 *Federal Register (FR)*, June 1, 1990, p.22627). DOE's studies of glass-ceramic process and comparison of glass-ceramic process and waste form with borosilicate glass waste have shown that glass-ceramic waste form meets the definition of EPA vitrification and borosilicate glass. EPA has concurred with the DOE conclusion and has determined that the glass-ceramic process is an acceptable technology to meet BDAT (see 57 FR, May 26, 1992, p. 22024).

criteria and processes for preparing a delisting petition are contained in "*Petitions to Delist Hazardous Wastes: A Guidance Manual*," Second Edition, PB93-169365, March 1993. The Upfront Exclusions may be granted for wastes and/or waste residues that have not been generated, but will be generated in the future. The EPA will evaluate the petitioned wastes based on available information such as the characteristics of the untreated wastes, process description, and bench-scale or pilot scale treatment data.

4) An off-site facility would need to be approved for the disposal of HLW resulting from the CWO, DCWO, and HWO.

4. ENVIRONMENTAL REGULATIONS, DOE CRITERIA, AND OTHER STANDARD CODES

4.1 FEDERAL AND STATE LAWS AND REGULATIONS

Resource Conservation and Recovery Act

The RCRA has established minimum national standard requirements which apply to owners or operators of all facilities that treat, store, or dispose of hazardous waste. The State of Idaho has the authority to implement the RCRA requirements through the Idaho Department of Health and Welfare (IDHW). The State of Idaho adopted the Federal RCRA regulations, pursuant to the Idaho Hazardous Waste Management Act of 1983. The regulations are incorporated by reference as provided in the Federal requirements under 40 CFR into the "Idaho Rules and Standards for Hazardous Waste", under administrative code known as Idaho Administrative Procedures Act (IDAPA) 16.01.05.

The RCRA requirements applicable to the hazardous waste facilities are defined in 40 CFR 264 (IDAPA 16.01.05.008), "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" and in 40 CFR 270 (IDAPA 16.01.05.012), "EPA Administered Permit Programs: the Hazardous Waste Permit Program."

40 CFR 264 sets regulatory requirements for the design, construction, and operation of the facility, quality assurance program, testing and maintenance of the equipment, air emission standards, groundwater protection standards, security, inspection, personnel training, preparedness and prevention, contingency plan and emergency procedures, manifest system and record keeping, closure and post-closure, financial requirements, and use and management of containers.

The existing hazardous waste facilities used for any future hazardous waste management activities can continue operations while meeting the requirements in 40 CFR 265 (16.01.05.009),

"Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities". This will allow the existing facilities to continue operations while meeting minimum operational requirements defined in 40 CFR 265. To be qualified for interim status, the existing facility must have been in operation or under construction on November 19, 1980 or have been in operation when the facility became subject to the RCRA requirements.

40 CFR 262.34 (subpart of 40 CFR 262 - IDAPA 16.01.05.006), "Accumulation Time" and 40 CFR 268.50 (subpart of 40 CFR 268 - IDAPA 16.01.05.011), "Prohibitions on Storage of Restricted Wastes" contain requirements, conditions, and time limits for storage of hazardous wastes. Based on 40 CFR 262.34, a generator may accumulate hazardous waste on-site for 90 days or less without a permit or an interim status, provided that the generator meet the conditions specified in 40 CFR 262.34. A generator who accumulates hazardous waste for more than 90 days is an operator of a storage facility and is subject to the requirements of 40 CFR 264 and 40 CFR 265, and the permit requirements of 40 CFR 270 unless the generator has been granted an extension to the 90-day period by the EPA. A 30-day extension may be granted at the discretion of the EPA on a case-by-case basis. A generator who accumulates hazardous waste greater than 100 kilograms but less than 1000 kilograms in a calendar month may accumulate hazardous waste on-site for 180 days or less without a permit or without an interim status provided the generator meets the requirements stated in 40 CFR 262.34.

Under 40 CFR 268.50, the storage of hazardous wastes such as those present in the Tank Farm is prohibited, unless the following conditions are met:

- (1) A generator stores such wastes in tanks, containers, or containment buildings on-site solely to facilitate proper recovery, treatment, or disposal and the generator complies with the requirements in 40 CFR 262.34, 40 CFR 264, and 40 CFR 265.
- (2) An owner/operator of a hazardous waste treatment, storage, or disposal facility stores such wastes in tanks, containers, or containment buildings to facilitate proper recovery, treatment, or disposal, and an owner/operator must comply with the operating record requirements specified in 40 CFR 264.73 and 40 CFR 265.73.

An owner/operator of a treatment, storage, or disposal facility may store hazardous waste restricted from land disposal beyond one year provided that the owner/operator proves to the EPA that such storage was solely for the purpose of facilitating proper recovery, treatment, or disposal.

The prohibition in storage does not apply to hazardous wastes that meet the LDR treatment standards and treatment equivalency as defined in 268.42(b). However, if the waste is still listed, the generator must comply with the RCRA requirements for hazardous waste storage.

Permit Requirements

Various permits are required prior to the construction and operations, and during the operations of the proposed facilities. These include RCRA permit, air emissions permit, wastewater discharges permit, etc. In addition, separate permits may be needed once the processes or activities are better known, as individual pilot plant operations or modifications to the existing facilities/systems may require separate permits. The applicable permit requirements are described below. A summary of the permit requirements and regulatory drivers is presented Section 5.

RCRA Permit

All facilities that treat, store, or dispose of hazardous wastes are required to obtain a RCRA permit during the active life (including the closure period). 40 CFR 270 establishes the requirements for obtaining a Permit. A RCRA Permit application consists of two parts, Part A and Part B. Part A of the permit application is a short standard form that collects general information about the treatment, storage, or disposal facility. Part B of the permit application includes a much more detailed technical description of the facility. The permit application covers all aspects of the design, construction, operation, monitoring, and maintenance of the facility. The requirements for Part A permit application are in 40 CFR 270.13, and for Part B Permit application are in 40 CFR 270.14 through 29.

Once the owner or operator of a facility has submitted a permit application, the regulator conducts an in-depth evaluation to determine if the application satisfies the RCRA requirements. For the new hazardous waste facilities, Parts A and Part B of the permit application must be submitted a least 180 days prior to physical construction is expected to commence. For the existing hazardous waste facilities, the requirements to submit an application is satisfied by submitting only Part A application to operate under interim status until the permitting agency sets a date for submitting Part B of the application.

Air Permit

Air permits will be required from the State of Idaho and/or EPA Region X prior to construction and operations of each of the treatment, storage, and disposal facilities with radioactive and nonradioactive emissions sources. The existing facilities that will be used for the proposed waste processing activities may require permit modification if the existing permit does not satisfy the permit requirements for the proposed use.

The Clean Air Act (CAA) sets permit requirements and emission standard limits. The CAA requirements are implemented by the IDHW under Idaho codes (see Idaho Codes and regulations below) or by EPA Region X. The CAA implementing regulations are in 40 CFR 50, 52, 60, 61, 62, 63, 70, 77, and 124. The air permit requirements are briefly described below.

For nonrad emissions a Permit to Construct (PTC) will be required from the IDHW for each of the new emission points prior to the construction or modifications of a facility. Individual pilot plant systems may require separate PTCs once the processes are known. Hazardous Air Pollutants (HAPs) and the Toxic Air Pollutants (TAPs) will need to be quantified prior to permitting.

The National Emission Standards for Hazardous Air Pollutants (NESHAPs), Subpart H sets the standards for the radioactive air emissions. The proposed facilities will qualify as radiological sources if they emit any radiological emissions. They are regulated by the EPA under the NESHAPs and the State of Idaho for radioactive air emissions. The state of Idaho treats the INEEL as one large facility. Currently, the maximum off-site limits for the total INEEL radiological emissions is 10 mrem/yr.

The National Ambient Air Quality Pollutants Standards (NAAQS) has established requirements for particulate matter, sulfur dioxide, ozone, nitrogen dioxide, carbon monoxide, fluoride, and lead. If their emissions are significant as defined in IDAPA 16.01.01.88, they must comply with the requirements of the Prevention to Significant Deterioration (PSD). The Best Available Control Technology (BACT) must be used to control pollutants if compliance with the PSD is required.

The air emissions must be calculated for each of the new facilities to determine the permit requirements and compliance with the regulatory standards, and to identify how they impact the sitewide total emissions at the INEEL because the State of Idaho treats the INEEL as one large facility. The determination of the expected air emissions is usually done during the Title II design.

Appendix D to 40 CFR 61 should be used for estimating the radionuclide emissions from the new sources to determine if a NESHAPs approval to construct is needed. If the estimated dose is greater than 0.1 mrem/year, the NESHAPs application will be required. In such case, a PSD evaluation will required by the State of Idaho.

Some of the process vents associated with the hazardous waste treatment units must meet the RCRA air emission standards in 40 CFR 264/265 Subparts AA. A process vent is any open-ended stack or pipe that is vented to the atmosphere. 40 CFR 264/265 Subparts BB and CC contain air emissions standards which are applicable only to certain types of processes such as equipment leaks, tanks, and containers.

The EPA proposed MACT Rule which enforces limits on air pollutants applies to hazardous waste incinerators or other comparable facilities which burn hazardous waste and/or are qualified as an incinerator by the EPA. This study assumes that the MACT Rule will be applicable to the vitrification and HIPing facilities. The MACT Rule sets emission limits for dioxin/furan, hydrocarbons, chlorine, carbon monoxide, lead, cadmium, mercury, antimony, arsenic, beryllium, chromium, and particulate matter.

Wastewater Effluent Discharges and Drinking Water Permit

The EPA has established requirements for stormwater and nonstormwater discharges into the environment under the National Pollution Discharge Elimination System (NPDES). The NPDES contains the requirements that control the discharge of pollutants to waters of the U.S. (e.g., Big Lost River) as defined in the Clean Water Act (CWA) in 40 CFR 122. These sources can include sanitary, industrial processes, and storm water runoff from industrial and construction areas.

A permit under the NPDES is required for storm and nonstorm waters (e.g., service water, sewer discharges). The INEEL has a general NPDES permit. Therefore, the existing INEEL NPDES permit should be evaluated to determine if there is a need for modifications of the INEEL permit or addendum to the permit to satisfy the permit requirements for the proposed facilities.

Wastewater Land Application Permits are required for construction, modifications, and operation of facilities that dispose of municipal and industrial wastewater to the land surface. The requirements are defined in 40 CFR 122 (CWA).

Pursuant to the CWA, the facilities that engage in storing, transferring, and consuming oil and oil products which could reasonably be expected to discharge oil in the Big Lost River or other waters of the U.S. must have Spill Control Prevention and Countermeasures Plans. The Plans are required if the oil discharges are in harmful quantities that violate the applicable water quality standards and cause harm to the human health and environment.

Idaho Laws and Regulations

This section lists the Idaho codes and standards for air and water pollution control and for releases into the environment. The standards are based on the Federal requirements established by the CAA, the CWA, and the RCRA.

Idaho Code 39-44, "Hazardous Waste Management Act"

IDAPA 16.01.05, "Rules and Standards for Hazardous Waste"

IDAPA 16.01.01, "Rules for the Control of Air Pollution in Idaho"

IDAPA 16.01.01.161, "Toxic Substances"

IDAPA 16.01.01.210, "Demonstration of Reconstruction Compliance with Toxic Standards"

IDAPA 16.01.01.575, "Air Quality Standards and Area Classification"

IDAPA 16.01.01.650, "Rules for Control of Fugitive Dust"

IDAPA 16.01.09, "Idaho Radiation Control Rules"

Idaho Code 39-36, "Water Quality Act"

IDAPA 16.01.02, "Water Quality Standards and Wastewater Treatment"

IDAPA 16.01.08.500, "Design Standards for Public Drinking water Systems"

IDAPA 16.01.08.551, "Construction Requirement for Public Water Systems"

IDAPA 16.01.08, "Idaho Rules for Public Drinking Water Systems"
IDAPA 16.01.17, "Wastewater Land Application Permit Regulations"

40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level Waste and Transuranic Waste"

The EPA has set radiation protection requirements for management of radioactive waste in 40 CFR 191. The radiation protection standards for management and storage of radioactive wastes apply to:

- (a) Radiation doses received by members of the public as a result of the management (except for transportation) and storage of spent nuclear fuel or HLW or TRU waste at any facility regulated by the NRC or by Agreement States, to the extent that such management and storage operations are not subject to the provisions of 40 CFR 190, "Environmental Radiation Protection Standards for Nuclear Power Operations"; and
- (b) Radiation doses received by members of the public as a result of the management and storage of spent nuclear fuel or HLW or TRU waste at any disposal facility that is operated by the DOE and that is not regulated by the NRC or by Agreement States.

40 CFR 257, "Criteria for Classification of Solid Waste Disposal Facilities and Practices"

The proposed LLW land disposal facility at the INEEL will be comparable to the LLW disposal facility of the Radioactive Waste Management Complex (RWMC). The Idaho Department of Environmental Quality (DEQ) evaluated the applicability of federal and state regulations to the RWMC LLW disposal facility. The DEQ^b has concluded that, in addition to other requirements, disposal of waste at RWMC is subject to Subtitle D landfill standards, 40 CFR 257. The environmental standards required by 40 CFR 257 are based on safety and health considerations which protect human health, wildlife, and the environment. The DOE or the NRC requirements for design and performance of a LLW disposal facility are much more stringent than those in 40 CFR 257 and supersede the subtitle D landfill standards.

40 CFR 257 requires that disposal facilities or practices in floodplains not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid wastes which pose a hazard to human life, wildlife, land or water resources. The disposal facilities shall not cause a discharge of pollutants into waters of the United States. Such a discharge would be a violation of the NPDES. Also, the facilities must not contaminate any underground drinking water source beyond solid waste facility boundary or beyond an alternative specified boundary.

^b DEQ letter to Jay Mitchell, Manager of LMITCO NEPA/Permitting, July 23, 1996.

4.2. DEPARTMENT OF ENERGY

The AEA of 1954 authorizes the DOE to establish standard criteria to ensure safe operations of its facilities, and to protect human health and to minimize dangers to life and property. The DOE has developed a series of Orders and Directives. They contain standards that require the planning, design, and construction of DOE facilities be performed in a manner that will satisfy all applicable Federal, State, and local environmental, safety and health laws and regulations, and the DOE criteria. The DOE and DOE-ID standards applicable to this study include the following:

DOE Order 6430.1A, "General Design Criteria"

Compliance with DOE Order 6430.1A is mandatory under the current LMITCO contract. DOE-ID Notice 430.1A, "Life Cycle Asset Management- ID expectations," requires that for facilities under the purview of the Defense Nuclear Facilities Safety Board (DNFSB), the DOE Order 6430.1A remains effective until 10 CFR 830.340, "Maintenance Management", and DOE Order 420.1, "Facility Safety", are finalized and incorporated into the LMITCO contract.

DOE-ID Notice 430.1A establishes the DOE-ID expectations of the contractor in areas covered by DOE Order 430.1, "Life Cycle Asset Management", in managing the INEEL. This order incorporates private industry standards safety design criteria, and requires additional nuclear safety criteria for nuclear facilities.

DOE Order 6430.1A provides general and specific design standards, guidance, and practices for use in the DOE facilities. The standards are to provide levels of design for occupant life safety, reduction in loss of government property, functioning essential operations and confinement of radioactive and hazardous material. Division 13, Section 1300, General Requirements, and Section 1324, Radioactive Solid Waste Facilities, address general and specific design criteria. Also, Section 0900-99.0, Nonreactor Nuclear Facilities, contains additional criteria relevant to

^c The term "defense" nuclear facility has not been defined anywhere in the regulations or by the DOE yet. I have spoken with a number of people in the LMITCO Mechanical, Civil, and Industrial Engineering Department and the DOE-ID (David Crandall, Scott Jensen, Lee Williams, and others) to learn what might constitute a "defense" nuclear facility and to find out the difference between a defense nuclear facility and a nuclear facility. They were not sure about the definition of a "defense" nuclear facility. However, they all believe that the facilities under consideration in this study could be considered "defense" nuclear facilities because they will be used for management of the DOE defense related wastes. According to Scott Jensen, the RWMCLLW disposal facility is considered a "defense" nuclear facility.

The definition of a nuclear facility is in MCP-2446. Based on this document, a "nuclear facility" is a facility with operations that involve radioactive and/or fissionable material in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. A nuclear facility includes nonreactor and reactor facilities.

facility design. All of these criteria provide minimally acceptable requirements for the facility design. It should be noted that the applicable local building codes and models always take precedence on the issues covered in the DOE order and provide additional design requirements not covered in the DOE order.

DOE-ID, "Architectural Engineering Standards" (AE)

The AE contains general design requirements such as those defined in DOE Order 6430.1A, and additional specific construction codes. The following is a list of some of the applicable standards and codes included in the AE documents:

- ICBO UBC, "Uniform Building Code, latest edition"
- ICBO UFC, "Uniform Fire Code, latest edition"
- 29 CFR 1910, "Occupational Safety and Health Standards"
- 29 CFR 1926, "Safety and Health Regulations for Construction"
- ADAAG, "Americans with Disabilities Act (ADA) -- Accessibility Guidelines"
- ASCE-4-86, "Seismic Analysis of Safety-Related Nuclear Structures"
- ASCE-7-93, "Minimum Design Loads for Buildings and Structures"
- DOE-STD-93, "Natural Phenomena Hazard Performance categorization"
- DOE-STD-1020-94, "Natural Phenomena Hazard Design and Evaluation Criteria for
Department of Energy Facilities"
- DOE-STD-1021-93, "Natural Phenomena Hazards Performance Categorization Guidelines for
Structures, Systems, and Components"

DOE Order 5820.2A, "Radioactive Waste Management"

DOE Order 5820.2A established policies and criteria for management of HLW, TRU, and LLW. The Order requires that radioactive and mixed waste be managed in a manner that is in compliance with all applicable Federal, State, and local environmental, safety, and health regulations and laws and DOE criteria.

Design objectives for facilities shall assure protection of the public and operating personnel from hazards associated with normal HLW operations, accident conditions, and the effects of natural phenomena. Other objectives are compliance with the DOE policies regarding nuclear safety, quality assurance, contingency plans, training, fire protection, pollution control, and safeguards and security protection for waste and protection of essential operations from the effects of potential accidents.

The development of large scale waste treatment facilities shall be supported by the appropriate documentation such as NEPA documentation, construction design report including projected

waste throughputs, and treatment methods, construction and operating cost estimates, and Safety Analysis Report (SAR).

All new HLW handling, transfer, and storage facilities shall be doubly contained. Where required, ventilation and filtration systems shall be provided to maintain radionuclide releases within the guidelines specified in DOE Order 5481.1B, "Safety Analysis and Review System", DOE Order 5480.23, "Nuclear Safety Analysis Report," and other applicable orders discussed in this EDF. Ventilation systems shall be provided where the possibility exists for generating flammable and explosive mixtures of gases (e.g., hydrogen or organic).

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 5481.1B, "Environment, Safety, and Health Program for Department of Energy Operations," DOE Order 5480.23, and DOE Order 5480.24, "Nuclear Criticality Safety."

Monitoring, surveillance, and leak detection capability shall be incorporated in the engineering systems (e.g., liquid level sensing devices and alarms for high-level waste liquid 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 HLW facilities. Where the possibility exists for the generation of flammable and explosive mixtures of gases, monitoring shall be conducted.

Training and qualification standards shall be developed and an up-to-date record of training status shall be maintained. Worker safety training must comply with the requirements of DOE 5480.1B and applicable Orders. Quality Assurance consistent with DOE Order 5700.6C, "Quality Assurance", shall be conducted in accordance with applicable requirements of the American National Standards Institute and other applicable codes.

As in HLW facilities, the TRU and LLW treatment and storage facilities must be equipped with monitoring, surveillance, and leak detection capabilities. The DOE Order 5820.2A requires that the TRU temporary storage area at the generator site, prior to shipment to the WIPP, be designed, constructed, operated, and monitored to minimize the possibility of fire, explosion, or accidental release of waste to the environment. The activities to assure the self storage of TRU waste shall also be consistent with the RCRA requirements and 40 CFR 191. In this study, no interim storage area is planned for the TRU waste because it is expected that the TRU waste will be road-ready for shipment to the WIPP. A temporary staging or package transfer area may be required for the waste container handling prior to the TRU waste transfer to the WIPP.

LLW disposal performance must be in a manner that assures external exposure to the waste and concentrations of radioactive material which may be released into surface water, ground, water, soil, plants and animals results in an effective dose equivalent that does not exceed 25 mrem/yr

to any member of the public. Releases to the atmosphere shall meet the requirements of 40 CFR 61. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

DOE Order 435.1 (Draft), "Radioactive Waste Management"

Currently, a draft DOE Order 435.1 has been issued by the DOE for review. This order will replace the current DOE Order 5820.2A, Radioactive Waste Management. The cancellation of this order does not, by itself modify or otherwise affect contractual obligation with the order. Therefore, the provisions of the 5820.2A will remain in effect until the LMITCO contract is modified to delete the reference to the requirements in the canceled order.

DOE Order 435.1 requires that facility siting and design be in compliance with all federal, state, and local laws and regulations, and be performed in accordance with the requirements in DOE Manual 435.1, Radioactive Waste Management Manual, and with other applicable DOE Orders.

DOE Manual 435.1 further describes and establishes the requirements of DOE Order 435.1 for management of DOE HLW, TRU, and LLW. Based on the DOE Manual 435.1, waste storage, pre-treatment, and treatment facilities design and operation are required to comply with the following applicable Orders and regulations.

- DOE O 151.1, "Comprehensive Emergency Management System"
- DOE O 420.1^d, "Facility Safety"
- DOE O 430.1, "Life-Cycle Asset Management"
- DOE O 440.1, "Worker Protection Management for DOE Federal and Contractor Employees"
- DOE O 460.1A, "Packaging and Transportation Safety"
- DOE O 4330.4B, "Maintenance Management Program"
- DOE O 5400.1, "General Environmental Protection Requirements"
- DOE O 5400.5, "Radiation Protection of the Public and the Environment"
- DOE O 5480.19, "Conduct of Operations Requirements for DOE Facilities"
- DOE O 5480.20A, "Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities"
- DOE O 5480.21, "Unreviewed Safety Questions"
- DOE O 5480.22, "Technical Safety Requirements"
- DOE O 5480.23, "Nuclear Safety Analysis Reports"
- DOE O 6430.1A, "General Design Criteria"
- 10 CFR 820, "Procedural Rules for DOE Nuclear Activities"
- 10 CFR 830.120, "Quality Assurance Requirements 10 CFR 835, Occupational Radiation Protection"
- 10 CFR 1021, "National Environmental Policy Act Implementing Procedures"
- 29 CFR 1910, "Occupational Safety and Health Standards"

^d DOE Order 420.1 will replace DOE Order 5480.24, "Nuclear Criticality Safety."

- 40 CFR 61, National Emission Standards for Hazardous Air Pollutants"
- 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Storage, Treatment, and Disposal Facilities"
- 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Storage, Treatment, and Disposal Facilities"
- 49 CFR 106 - 110 Subchapter A, "Hazardous Materials Transportation"
- 49 CFR 171-180 Subchapter C, "Hazardous Materials Regulations"

DOE Order 5400.5, "Radiation Protection of the Public and the Environment"

DOE Order 5400.5 establishes standards and requirements for operations of the DOE and contractors to protect the public and environment against undue risk from radiation

Chapter II, Requirements for Radiation Protection of the Public and the Environment, specifies that exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem. The 100 mrem limit is the sum of the effective dose equivalent from exposure to radiation sources external to the body during the year plus the committed effective dose equivalent from radionuclides taken into the body (radioactive decay inside the body) during the year. Exposure of members of the public to radioactive materials released to the atmosphere as a consequence of routine DOE activities shall not cause members of the public to receive an effective dose equivalent greater than 10 mrem annually.

Chapter IV, Residual Radioactive Material, presents radiological protection requirements and guidelines for cleanup of residual radioactive material and management of the resulting residues and release of property. Basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and control of the radioactive wastes and residues are provided.

DOE Order 5480.23, "Nuclear Safety Analysis Reports"

This Order establishes requirements for DOE-owned nuclear facilities and operations, and for contractors responsible for the design, construction, operation, decontamination, or decommissioning of nuclear facilities to develop safety analyses that establish and evaluate the adequacy of the safety bases of the facilities. The SAR required by this Order documents the results of the safety analysis.

DOE Order 5480.28, "Natural Phenomena Hazard Mitigation"

The requirements provided in this order shall be used in conjunction with the general design criteria in DOE 6430.1A and other departmental design criteria as applicable. DOE Order 5480.28 requires that facilities structures, systems, and components (SSCs) be designed and constructed to withstand the effects of natural phenomena hazards. An objective for all SSCs is to prevent loss of structural integrity endangering life safety. An additional objective for selected SSCs or site activities is to prevent loss of capability to perform functions consistent with: (1) importance to safety for workers and the public; (2) impact on the environment; (3) repair/replacement costs; or (4) programmatic mission.

DOE Order 5700.6C, "Quality Assurance"

The provisions of this Order apply to the work performed by all Departmental Elements and management and operating (M&O) contractors as provided by law and/or contract and as implemented by the Department's Contracting Officer. If conflicts between this and other Departmental Orders exist, the quality assurance requirements of DOE 5700.6C take precedent. Work licensed by the NRC or an NRC Agreement State and subject to the quality assurance requirements of that agency are excluded from this Order.

4.3 NATIONAL ENVIRONMENTAL POLICY ACT

Under 10 CFR 1021, the NEPA establishes national policy procedures promoting awareness of the environmental impacts of major federal activities during the planning and decisionmaking stages of a project. The NEPA requires all agencies of the federal government prepare a detailed EIS describing potential effects of the proposed major federal actions that may be significantly affect the quality of the human environment.

All federal facilities under the NEPA are encouraged, to the extent practicable, to incorporate Pollution Prevention/Waste Minimization (P2/WMin) criteria and recycling in the planning stages and in the design of the new facilities or modifications to the existing facilities. The P2/WMin and recycling activities will make facilities more efficient and compatible with future environmental regulations and increase energy efficiency and conservation.

4.4 OTHER STANDARDS AND CODES

In addition to the requirements discussed above, this section provides a list of other applicable standard codes pertinent to health and safety.

1) General design of structures, systems, and components

Uniform Building Code, International Conference of Building Officials
American Institute of Steel Construction
American Welding Society Standards
American Concrete Institute
DOE-ID Welding Procedure Specification Manual
DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techniques" for
Compliance with DOE Order 5480.23; "Nuclear Safety Analysis Reports"

The hazard categorization is based on a simple approach which is intended to meet DOE Order 5480.23 requirements for a preliminary assessment and hazard categorization. DOE Order 5480.23, states that a hazard categorization of the DOE facilities is to be performed on processes, operations, or activities and not necessarily whole facilities.

DOE-STD-3007-93, "Guidelines for Preparing Criticality Safety Evaluations at
Department of Energy Non-Reactor Nuclear Facilities"
DOE-STD-3009-94, "Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety
Analysis Reports"

2) Radiological control design features

INEL Radiological Control Manual
10 CFR 835^e, "Occupational Radiation Protection"

3) Fire design features

Uniform Fire Code, Western Fire Chiefs Association and International conference of
Building Officials
National Fire Protection Association (NFPA)
Uniform Building Code, Section 505 (e)
DOE Order 5480.7A, "Fire Protection"

4) Seismic design feature, Flood design features, and Wind design features

DOE-STD-1020-94(CH-1) Natural Phenomena Hazards Design and Evaluation Criteria for
Department of Energy Facilities
40 CFR 264.18
40 CFR 270.14

^e DOE Order 5480.11 has been canceled and replaced by 10 CFR 835.

5. SUMMARY OF REGULATORY DRIVERS AND PERMIT REQUIREMENTS

The following table presents a summary of the Federal and State regulatory requirements applicable to the construction and operations of the proposed facilities.

Media or type of stream	Requirements prior to:	Permit, approval, or requirements	Regulatory Agency	Regulatory citation
NEPA	Title II Design and procurement	NEPA documentation	DOE	10 CFR 1021
Nonrad air emissions	Construction and operation	PTC for new emission sources	IDHW, EPA	40 CFR 50 40 CFR 60 40 CFR 62 40 CFR 63 40 CFR 70 40 CFR 77 40 CFR 124
Nonrad air emissions	Construction and operation	NAAQS, PSD (if significant emissions)	IDHW, EPA	40 CFR 52
Nonrad air emissions	Construction and operation	HAPs and TAPs	IDHW, EPA	40 CFR 61 40 CFR 63 IDAPA 16.01.01
Hazardous waste air emissions	Construction and operation	Treatment, storage, and disposal facilities	IDHW, EPA	40 CFR 264, 40 CFR 265 (Subparts AA, BB, and CC), IDAPA 16.01.01 IDAPA 16.01.05
Radioactive air emissions	Construction and operation	NESHAPs	IDHW, EPA	40 CFR 61, Subpart H IDAPA 16.01.01
All air emissions	Operations	Air Operating Permit	IDHW, EPA	40 CFR 70 IDAPA 16.01.01
Asbestos	Renovation and demolition	Notification prior to renovation or demolition	IDHW, EPA	40 CFR 61, Subpart M
Ozone depleting substances	Operation, reporting, training	Release prevention, recovery/recycle, Certificate labeling	IDHW, EPA	40 CFR 82
Sanitary wastewater discharges	Discharges	NPDES Permit	EPA, IDHW	40 CFR 122, and 125 IDAPA 16.01.02
Land surface	Construction and	NPDES Permit	EPA, IDHW	40 CFR 122

wastewater discharges	Operations			IDAPA 16.01.02
Storm wastewater and nonstorm wastewater discharges	Construction and Operations	NPDES Permit or compliance with Idaho Water Quality Standards	EPA	40 CFR 122
Drinking water supply	Construction and operations	Approval of Engineering Plans, Cross Connection Control Plans, Report, and Spec.	IDHW, EPA	40 CFR 141, 40 CFR 143, IDAPA 16.01.08.
Hazardous waste treatment, storage, Disposal	Construction, operation, and maintenance of new facilities or modifications of existing facilities	Hazardous Waste Permit (Part A and B)	IDHW, EPA	40 CFR 270 40 CFR 264 40 CFR 265
Underground storage Tanks (UTSs)	Construction and operations	Technical standards	IDHW, EPA	40 CFR 280
Land disposal of waste	Construction, operations, disposal	LDRs	IDHW, EPA	40 CFR 268, 40 CFR 257, IDAPA 16.01.05, 10 CFR 61

6. SETTLEMENT AGREEMENT

The State of Idaho and the DOE signed an agreement on October 16, 1995. The Agreement contains several commitments for the treatment of the HLW and SBW and their transfer out of Idaho. Based on the Agreement, all remaining liquid HLW must be calcined by June 30, 1998, and calcination of all SBW must be completed by December 31, 2012. The Agreement requires that all HLW be treated and be road-ready to be moved out of Idaho for disposal by the year 2035. The calcination and the proposed treatment shall provide for completion of treatment of all calcine wastes by December 31, 2035.

It is stated in the Agreement that the DOE, as soon as practicable, commence the procurement of a treatment facility at INEEL for the treatment of mixed waste. The DOE shall execute a procurement contract for the Facility by June 1, 1997, complete construction of the Facility by December 31, 2002, and commence operation of the Facility by March 31, 2003. Commencement of construction is contingent upon Idaho approving necessary permits.

Based on the Agreement, the 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 an interim storage facility outside Idaho. To support this effort, the DOE shall solicit proposals for feasibility studies by July 1, 1997, and shall commence negotiating a plan and schedule with the State of Idaho for calcine treatment by December 31, 1999. The plan and schedule shall provide for completion of the treatment of all calcined waste located at the INEEL

by a date established by the Record of Decision (ROD) for the EIS that analyzes the alternatives for treatment of such waste. The State of Idaho expressly reserves its right to seek appropriate relief from the Court in the event that the date established in the ROD for the EIS that analyzes the alternatives for treatment of such waste is significantly later than the DOE's target date.

7. NUCLEAR REGULATORY COMMISSION

The purpose of this study is to provide an assessment of the current NRC regulations and their potential applicability to the proposed facilities if the facilities were to be licensed by the NRC in the future. The NRC requirement for regulating the DOE facilities or activities have not been defined yet. The requirements will need to be determined by the NRC and DOE Task Forces. Existing NRC regulations apply to commercial, non-DOE, facilities. The degree of applicability of the NRC requirements to the proposed facilities should be determined by the NRC and DOE, with input from the DOE contractor. If DOE facilities become regulated by NRC, the jurisdiction of other currently government applicable authorities will not automatically or necessarily cease. In particular, it is expected that local, State, Federal EPA, and some DOE regulatory requirements would still apply.

Currently, the NRC is not authorized by law to license DOE facilities for:

- HLW processing such as those for vitrification, solidification, Cs and Sr extraction,
- short term storage of HLW, for TRU waste storage and disposal from DOE activities, and
- DOE LLW processing, storage, and disposal.

However, based on the recent DOE proposal, the NRC could take responsibilities for regulating the DOE nuclear facilities. Existing NRC regulations are compiled in 10 CFR, titled "Energy". These regulations follow a similar philosophy as the DOE, the EPA, and other codes and standards previously discussed above. The Commission has also issued a number of regulatory guides (e.g., NUREG) and other guidance documents which provide acceptable methods for complying with the NRC regulations. They contain criteria for facility design, operations, and for safety and health.

Of the existing NRC regulations, it has been determined in this study that 10 CFR 61 will apply to the proposed LAW or the LLW disposal facility, and 10 CFR 72 will be applicable to the proposed interim storage facilities for the vitrified, HIPed, or grouted HLW, and for the liquid HAW and vitrified HAW storage facilities. Independently, it was determined by Leroy and Morgan in "Nuclear Regulatory Commission (NRC) Licensing Assessment for the Idaho National Engineering and Environmental Laboratory (INEEL) High-Level Waste program," April 23, 1997, that 10 CFR 30 and 10 CFR 70 will apply to the following facilities:

- 10 CFR 30 for the LAW collection and grouting facilities and for the collection and treatment of the LLW from the INEEL ongoing operations.
- 10 CFR 70 for the separations facility, for the interim storage of liquid HAW from the separation processes, and for the HAW vitrification facility.
- 10 CFR 70 for the HLW vitrification, HIPing, or grouting facilities.
- 10 CFR 70 for the calcine retrieval and dissolution facilities.

10 CFR 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material^f", and 10 CFR 70, "Domestic Licensing of Special Nuclear Material", are not specifically or directly applicable to the facilities listed above. According to Steve LeRoy (personal communication, 12/03/97), they are the only ones which came close to being applicable to the proposed treatment, separations, and retrieval facilities. It is believed that certain elements of 10 CFR 30 and 10 CFR 70 could potentially be applicable to licensing of the proposed facilities. The fact remains that NRC will most likely have to promulgate new regulations specifically for the DOE HLW, LLW, and calcine retrieval and treatment facilities or to revise the requirements of 10 CFR 30 and 10 CFR 70 if they were to apply them to the proposed facilities.

Additional NRC regulations that are applicable to all of the proposed facilities are in 10 CFR 2, 10 CFR 19, 10 CFR 20, 10 CFR 21, 10 CFR 50, 10 CFR 51, 10 CFR 52, and 10 CFR 73. 10 CFR 71 and 49 CFR 173 (Department of Transportation) contain requirements for the packaging and transportation of radioactive wastes. These requirements would have impact on the design and operations of the storage facilities.

Appendix A provides a detailed source list of the regulations used by the NRC in commercial, non-reactor, nuclear facilities. The regulations are primarily based on the health and safety considerations. The list includes applicable parts and subparts of 10 CFR 20, 21, 30, 50, 51, 61, 70, and 72 as well as related guidance documents. The requirements and guidance documents are listed under the following categories: 1) radioactive waste management, 2) design of structures, components, equipment, and systems, 3) electric power, utility services, and fire protection, 4) radiation protection, 5) conduct of operation, 6) safety analysis report criteria, 7) quality assurance, and 8) decommissioning.

The existing facilities that will be modified to be used for storage of HLW are expected to be exempted by DOE from any further jurisdiction of NRC. Such a jurisdiction would be excessively difficult, costly, and complex to apply. All the work requirements for the modification of the existing facilities are expected to be performed in accordance with the DOE/RW/0333P, "Quality Assurance Requirements and Description." The requirements in DOE/RW/0333P are endorsed by the Office of Civilian Radioactive Waste Management

^f Byproduct material means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material. Special nuclear material means (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing but does not include source material.

(OCRWM) which carries out the DOE mission for safe design and operation of a HLW geologic repository and a HLW storage facility.

Current Licensing Process

Most of the discussion in this section is based on the information contained in the DOE-STD-101-92, "Compilation of Nuclear Safety Criteria Potential Application to the DOE Nonreactor Facilities" and in the report by Morgan and LeRoy, "Nuclear Regulatory Commission (NRC) Licensing Assessment for the Idaho National Engineering and Environmental Laboratory (INEEL) High-Level Waste program," April 23, 1997.

The applicable NRC regulations that define licensing processes are in 10 CFR 2, 10 CFR 30, 10 CFR 51, and 10 CFR 61 for LLW facilities and in 10 CFR 2, 10 CFR 50, 10 CFR 52, 10 CFR 70, and 10 CFR 72 for HLW or HAW facilities. The licensing of a nuclear facility requires preparation and submittal of an application and a number of supporting documents to the NRC such as SAR, environmental report (ER), quality assurance document, training plan, monitoring plan, and safeguards and security plan. The following is a generic description of the various documents that will be applicable to the proposed facilities.

The ER must meet the NRC requirements in 10 CFR 51. Appendix A, Section 7 provides regulatory sources containing quality assurance procedures for the facility design, construction, and operations. The quality assurance requirements in DOE/RW-0333P are expected to be used for the existing facilities that will be modified to be used for storage of HLW or HAW. The SAR documents the adequacy of safety analysis for a nuclear facility to ensure that the facility can be designed, constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations. The SAR criteria must meet the regulations listed in Appendix A, Section 6. The training, monitoring, and safeguards and security plans used by the license applicant to protect health and minimize danger to life or property must be developed in accordance with the applicable regulations. The training program should include an analysis of the job, learning objectives and performance criteria, procedures for personnel monitoring, procedures to avoid accidents, etc. It is assumed that the DOE will retain the responsibility for safeguard and security for its facilities.

The NRC licensing process is divided into four stages: pre-application stage, application review stage, construction and operating license stage, and decontamination and site closure stage. The licensing duration from submittal of the application to receipt of the license is expected to take three to five years or longer.

Pre-application stage is prior to filing a license application with the NRC. It entails the development of the license application and the pre-submittal communications with the NRC. This includes the NRC and DOE interactions to clearly define the NRC acceptance criteria against which the ICPP proposed facilities license application will be reviewed.

The application review stage describes the activities after submittal of the license application to the NRC. A notification will be published in the Federal Register for public hearing when the NRC receives the application. This application review stage begins with a review process referred to as a "Docketing Review" which is usually performed within 1 to 3 months. This review is to ensure that the application is complete and contains the necessary information. The Docketing Review process is followed by a detailed safety review of the application by the NRC staff. The NRC will ensure that the regulatory requirements are met as established in the regulations. The NRC usually requests additional information during this review which can be extensive and delay the review. Submittal of high quality, complete, and detailed SAR will reduce the request for additional information, hence the review time.

The construction and operating license stage follows the receipt of the license. The NRC will have the regulatory oversight during construction and operations.

NRC issues a license for certain time period. Before a facility license expires, a decommissioning plan will be developed by the DOE for review by the NRC. It is expected that the EPA will regulate the decontamination and decommissioning activities. Before the final closure, the DOE must submit a closure plan to the NRC for review. The closure plan must describe how the owner/operator will conduct clean-up, what clean-up levels will be attained, and how clean-up will be verified. The plan also includes a post-closure, and long term monitoring and maintenance. Upon review and acceptance, the NRC will authorize closure. Monitoring will be performed during the post-closure plan in accordance with the applicable requirements. When all the monitoring and control requirements are met, the license will be terminated.

LLW Near-Surface Disposal

10 CFR 61, Licensing Requirements for Land Disposal of Radioactive Waste

10 CFR 61 contains specific technical requirements and performance objectives applicable to near-surface disposal of radioactive wastes. It contains requirements for design, operation, closure and post-closure, and monitoring. Near-surface disposal involves disposal of waste in the uppermost portion of the earth, approximately 30 meters or 100 feet of natural grade. The NRC maintains that the use of shallow land disposal is adequate for protection of individuals and the public, when properly sited, designed, and operated, as required by 10 CFR 61.

Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set in 10 CFR 20, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by 10 CFR 61.41. At the time a license application is submitted, the applicant shall have conducted a preoperational monitoring program to provide basic environmental data on the disposal site characteristics. The applicant shall

obtain information about the ecology, meteorology, climate, hydrology, geology, geochemistry, and seismology of the disposal site. For those characteristics that are subject to seasonal variation, data must cover at least a twelve month period.

The regulations for near surface disposal of radioactive wastes include a waste classification system which divides the wastes into three classes: Class A, B, and C. The classification system is based on the overall disposal hazards of the wastes. Certain minimum requirements must be met for all waste Classes as provided in 10 CFR 61.56 (a). In addition, Class B and C wastes are required to have structural stability as discussed in 10 CFR 61.56(b). The detailed information regarding the NRC requirements for a LLW disposal facility can be found in EDF-FDO-008.

HLW Storage

10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"

10 CFR 72 contains regulations and procedures that are applicable to HLW or ~~HLW~~ interim storage facilities. The regulations in this part establish requirements for the issuance of licenses to the DOE to receive, transfer, package, and possess HLW, spent fuel, and other radioactive materials associated with spent fuel and HLW storage, in a monitored retrievable storage facility (MRS)⁸. This part also defines requirements for the safety design features of the facility structure and equipment. It requires that structures, systems, and components be designed, fabricated, erected, and tested to provide protection against environmental conditions and natural phenomena such as earthquakes, tornadoes, lightning, hurricanes, and floods. The facilities should also be designed to prevent massive collapse of building structures or the dropping of heavy objects as a result of building structural failure on the spent fuel or high-level radioactive waste or on to structures, systems, and components important to safety. If the facilities are located over an aquifer which is a major water resource, measures must be taken to preclude the transport of radioactive materials to the environment through this potential pathway.

Structures, systems, and components against fires and explosions must be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions. Noncombustible and heat-resistant materials must be used wherever practical, particularly in locations vital to the control of radioactive materials and to the maintenance of safety control functions. Explosion and fire detection, alarm, and suppression systems shall be designed and provided with sufficient capacity and capability to minimize the adverse effects of fires and explosions on structures, systems, and components important to safety.

⁸ Pursuant to the Nuclear Waste Policy Act, a MRS is an option for providing safe and reliable long-term storage of HLW or spent nuclear fuel. However, disposal of HLW and spent fuel in a repository should proceed regardless of any construction of a MRS pursuant to the Act.

Other features that are important to safety must be designed to permit inspection, maintenance, and testing. Emergency capability must be designed to provide for accessibility to the equipment of onsite and available offsite emergency facilities and services such as hospitals, fire and police departments, ambulance service, and other emergency agencies.

Ventilation systems and off-gas systems must be provided where necessary to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions. Storage confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. Instrumentation and control systems must be provided to monitor systems that are important to safety over anticipated ranges for normal operation and off-normal operation. Those instruments and control systems that must remain operational under accident conditions must be identified in the SAR.

Control room or control area must be designed to permit occupancy and actions to be taken to monitor the facilities under normal conditions, and to provide safe control of the facilities under off-normal or accident conditions. Utility or other services must be designed to meet emergency conditions.

It is required that HLW be packaged in a manner that allows handling and retrievability without the release of radioactive materials to the environment or radiation exposures in excess of 10 CFR 20, "Standards for Protection Against Radiation", limits. The package must be designed to confine the high-level radioactive waste for the duration of the license. During normal operations and anticipated occurrences, the annual dose equivalent to any real individual who is located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid and 25 mrem to any other organ as a result of exposure to planned discharges of radioactive materials and decay products excepted, to the general environment, and direct radiation from operations. Operational restrictions must be established to meet as low as is reasonably achievable (ALARA) objectives for radioactive materials in effluents and direct radiation levels associated with storage operations. Operational limits must be established for radioactive materials in effluents and direct radiation levels associated operations to meet the limits given above.

10 CFR 72.124, "Criteria for nuclear criticality safety"

The design of handling, packaging, transfer, and storage systems must include margins of safety for the nuclear criticality parameters that are commensurate with the uncertainties in the data and methods used in calculations. It must demonstrate safety for the handling, packaging, transfer and storage conditions and in the nature of the immediate environment under accident conditions.

When practicable the design of an MRS must be based on favorable geometry, permanently fixed neutron absorbing materials (poisons), or both. Where solid neutron absorbing materials are used, the design shall provide for positive means to verify their continued efficacy.

A criticality monitoring system shall be maintained in each area where special nuclear material is handled, used, or stored which will energize clearly audible alarm signals if accidental criticality occurs. Monitoring of dry storage areas where special nuclear material is packaged in its stored configuration under a license issued under this subpart is not required.

10 CFR 72.128, "Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling"

The regulations of this subpart require that HLW storage and other systems that might contain or handle radioactive materials be designed to ensure adequate safety under normal and accident conditions. These systems must be designed with: (1) a capability to test and monitor components important to safety, and suitable shielding for radioactive protection under normal and accident conditions, (2) confinement systems, (3) a heat-removal capability having testability and reliability consistent with its importance to safety, and (4) means to minimize the quantity of radioactive wastes generated. Provisions must be made for the packing of site-generated low-level wastes in a form suitable for storage onsite awaiting transfer to disposal sites.

APPENDIX A

The following lists the current NRC requirements and guides applied to the areas of safety addressed in the SAR. The requirements are listed under the following categories: 1) radioactive waste management, 2) design of structures, components, equipment, and systems, 3) electric power, utility services, and fire protection, 4) radiation protection, 5) conduct of operation, 6) safety analysis report criteria, 7) quality assurance, and 8) decommissioning.

1) Radioactive waste management

This section identifies criteria for the control, collection, handling, processing, storage, and disposal of liquid, gaseous, and solid wastes that may contain radioactive materials, and the instrumentation used to monitor the release of radioactive materials. Also, as previously discussed, all RCRA hazardous and radioactive waste (mixed waste) management facilities are also subject to EPA RCRA regulations.

10 CFR 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

10 CFR 70.59, "Effluent Monitoring Reporting Requirements"

10 CFR 72.104, "Criteria in Effluents and Direct Radiation in Effluents and Direct Radiation from an ISFSI or MRS"

D. 10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Handling"

Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants."

Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants."

Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.13, "Guide for Acceptable Waste Storage Methods at UF6 Production Plants."

Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation (Water-Basin Type)."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

Regulatory Guide 4.18, "Standard Format and Contents of Environmental Reports for Near-surface Disposal of Radioactive Waste."

NUREG-1199, "Standard Format and Content of a License Application for a Low-level Radioactive Waste Disposal Facility."

NUREG-1200, "Standard Review Plan for the Review of a License Application for a Radioactive Low-level Waste Disposal Facility."

NUREG-1300, "Standard Review Plan for the Review of a License Application for a Radioactive Low-level Waste Disposal Facility."

NUREG-0800, Section 11.2, "Liquid Waste Management Systems."

NUREG-0800, Section 11.3, "Gaseous Waste Management Systems."

NUREG-0800, Section 11.4, "Solid Waste Management Systems."

NUREG-0800, Section 11.5, "Process and Effluents radiological Monitoring."

NUREG-1567, "Offgas Treatment and Ventilation."

2) Design of structures, components, equipment and systems

10 CFR 21, "Reporting of Defects and Noncompliance"

10 CFR 50.34, "Contents of Applications: Technical Information"

10 CFR 50, Appendix F, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities"

10 CFR 61.51, "Disposal Site Design for Land Disposal"

10 CFR 61.52, "Land Disposal Facility Operation and Disposal Site Closure"

10 CFR 61.54, "Alternative Requirements for Design and Operations"

10 CFR 70, "Domestic Licensing of Special Nuclear material"

10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"

10 CFR 72.120, "General Considerations"

10 CFR 72.122, "Overall Requirements"

10 CFR 72.124, "Criteria for Nuclear Criticality Safety"

10 CFR 72.126, "Criteria for Radiological Protection"

10 CFR 72.128, "Criteria for Spent Fuel, High-Level Radioactive Waste, and Other Radioactive Waste Storage and Hand-ling"

10 CFR 72.130, "Criteria for Decommissioning"

Regulatory Guide, 3.10, "Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants"

Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

Regulatory Guide 3.56, "General Guidance for Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills."

Regulatory Guide 5.25, "Design Considerations for Minimizing Residual Holdups of Special Nuclear Material in Equipment for Wet process Operations."

Seismic systems criteria

10 CFR 61.12, "Specific Technical Information"

10 CFR 72.120, "General Considerations"

Regulatory Guide 1.29, "Seismic Design Classification."

Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants."

Wind and Tornado Loading criteria

10 CFR 61.12, "Specific Technical Information"

10 CFR 72.40, "Issuance of License"

10 CFR 72.90, "General Considerations"

10 CFR 72.92, "Design Basis External Natural Events"

10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site"

10 CFR 72.122, "Overall Requirements"

Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."

Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.20, "Process Offgas Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

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NUREG/CR-3058, "A Methodology for Tornado Hazard Probability Assessment," McDonald, J.R., Texas Tech. University, October 1983.

NUREG/CR-2944, "Tornado Damage Risk Assessment," Reinhold, T.A. and Ellingwood, B., National Bureau of Standards, February 1983.

NUREG/CR-2565, "Structural Performance of HEPA Filters Under Simulated Tornado Conditions," Horak, H.L. and Smith, P.R., Los Alamos National Laboratory, May 1982.

NUREG/CR-2014, "Kinematics of Translating Tornado Wind Fields," Peterson, R.E., Texas Tech. University, April 1981.

NUREG/CR-1585, "Modeling Tornado Dynamics," Aeronautical Research Association, September 1980.

Water level (flood) design

10 CFR 61.12, "Specific Technical Information"

10 CFR 61.50, "Disposal Site Suitability Requirements for Land Disposal"

10 CFR 72.40, "Issuance of License"

10 CFR 72.90, "General Considerations"

10 CFR 72.92, "Design Basis External Natural Events"

10 CFR 72.94, "Design Basis External Man-Induced Events"

10 CFR 72.98, "Identifying regions Around and ISFSI or MRS Site"

10 CFR 72.122, "Overall Requirements"

Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills."

Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.40, "Design Basis Floods for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

NUREG/CR-2678, "Flood Risk Analysis Methodology Development Project - Final Report," Wagner, D.P. et al., Oak Ridge National Laboratory, July 1982.

Missile protection

10 CFR 61.12, "Specific Technical Information"

10 CFR 72.40, "Issuance of License"

10 CFR 72.90, "General Considerations"

10 CFR 72.92, "Design Basis External Natural Events"

10 CFR 72.94, "Design Basis External Man-Induced Events"

10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site"

10 CFR 72.122, "Overall Requirements"

Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

NUREG-0533, "Aircraft Impact risk Assessment, Data Base for Assessment of Air Carrier Impact Risk in the Vicinity of Airports," USNRC, July 1979.

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NUREG/CR-2859, "Evaluation of Aircraft Crash Hazards for Nuclear Power Plants," Kot, C.A. et al., Argonne National Laboratory, September 1982.

Seismic design

10 CFR 61.12, "Specific Technical Information"

10 CFR 70.22, "Contents of Applications"

10 CFR 70.23, "Requirements for the Approval of Applications"

10 CFR 72.40, "Issuance of License"

10 CFR 72.90, "General Considerations"

10 CFR 72.92, "Design Basis External Natural Events"

10 CFR 72.98, "Identifying Regions Around an ISFSI or MRS Site"

10 CFR 72.102 "Geological and Seismological Characteristics"

10 CFR 72.122, "Overall Requirements"

Regulatory Guide 3.10, "Liquid Waste Treatment Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.17, "Earthquake Instrumentation for Fuel Reprocessing Plants."

Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.31, "Emergency Water Supply Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation, (Water Basin Type)."

Regulatory Guide 3.53, "Applicability of Existing Regulatory Guides to the Design and Operation of an Independent Spent Fuel Storage Installation."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

NUREG/CR-1069, "Effects of Earthquakes on Underground Facilities: Literature Review and Discussion," Carpenter, D.W. and Chung, D.C., Lawrence Livermore National Laboratory, June 1986.

Ventilation and process off-gas systems

10 CFR 72.132, "Overall Requirements"

Regulatory Guide 1.140, "Design, Testing, and Maintenance for Normal Ventilation Systems."

Regulatory Guide 1.52, "Design, Testing, and Maintenance aCriteria for Post-accident engineered Safety Feature Ventilation Systems."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.20, "Process Off-gas Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants."

Regulatory Guide 3.49, "Design of an Independent Spent Fuel Storage Installation (Water Basin Type)."

Regulatory Guide 3.60, "Design of an Independent Spent Fuel Storage Installation (Dry Storage)."

NUREG-1567, Section 11.4.1.3 (DRAFT), "Ventilation offgas System Design Feature."

3) Electrical power, utility services, and fire protection

10 CFR 50.55(a), "Codes and Standards"

10 CFR 72.122, "Overall Requirements"

Regulatory Guide 1.108, "Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants."

Regulatory Guide 3.14, "Seismic Design Classification for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.16, "General Fire Protection Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.38, "General Fire Protection Guide for Fuel Reprocessing Plants."

4) Radiation protection

The criteria identified in this chapter are for the radiation protection of operating, construction, and maintenance personnel during normal and anticipated operational occurrences. The compilation includes criteria for facility equipment design and programs to minimize and monitor radiation exposure to meet the standards for protection against radiation of 10 CFR 20.

10 CFR 19.12, "Instructions to Workers"

10 CFR 20, "Standards for Protection Against Radiation"

10 CFR 61.41, "Protection of the General Population From Releases of Radioactivity"

10 CFR 61.43, "Protection of Individuals During Operations"

10 CFR 72.44, "License Conditions"

10 CFR 72.104, "Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS"

10 CFR 72.126, "Criteria for Radiological Protection"

Regulatory Guide 3.6, "Content of Technical Specifications for Fuel Reprocessing Plants."

Regulatory Guide 8.1, "Radiation Symbol."

Regulatory Guide 8.2, "Administrative Practices in Radiation Monitoring."

Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as is Reasonably Achievable."

Regulatory Guide 8.24, "Health Physics Surveys During Enriched Uranium Processing and Fuel Fabrication."

5) Conduct of operations

The criteria identified in this chapter address training, emergency planning, plant procedures, and the maintenance of records and reporting.

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

10 CFR 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions"

10 CFR 70, "Domestic Licensing of Special Nuclear Material"

10 CFR 72.190, "Operator Requirements"

10 CFR 72.192, "Operator Training and Certification Program"

10 CFR 72.194, "Physical Requirements."

Regulatory Guide 3.28, "Welder Qualification for Welding in Areas of Limited Accessibility in Fuel Reprocessing Plants and in Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.42, "Emergency Planning for Fuel Cycle Facilities and Plants Licensed Under 10 CFR Parts 50 and 70."

6) Safety analysis report criteria

10 CFR 20, "Standards for Protection Against Radiation"

10 CFR 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material"

10 CFR 50.33, "Contents of Application, General Information"

10 CFR 50.36(b), "Environmental Conditions"

10 CFR 50.55, "Conditions of Construction Permits"

10 CFR 50.71, "Maintenance of Records, making Reports"

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"

10 CFR 61.10, "Contents of Application"

10 CFR 70, "Domestic Licensing of Special Nuclear Material"

10 CFR 70.22, "Contents of Application"

10 CFR 70.23, "Requirements for the Approval of Applications"

10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"

10 CFR 72.22, "Contents of Application: General and Financial Information"

10 CFR 72.24, "Contents of Application: Technical Information"

10 CFR 72.30, "Decommissioning Planning, Including Financing and Record Keeping"

10 CFR 72.48, "Changes, Tests, and Experiments"

Regulatory Guide 3.15, "Standard Format and Content of License Application for Storage Only of Unirradiated Power Reactor Fuel and Associated Radioactive Material."

Regulatory Guide 3.25, "Standard Format and Content of Safety Analysis Reports for Uranium Enrichment Facilities."

Regulatory Guide 3.26, "Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants."

Regulatory Guide 3.39, "Standard Format and Content of License Applications for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.44, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Water-Basin Type)."

Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)."

Regulatory Guide 3.50, "Standard Format and Content for a License Application to Store Spent Fuel and High-Level Radioactive Waste."

Regulatory Guide 3.52, "Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Processing and Fuel Fabrication."

Regulatory Guide 3.55, "Standard Format and Content for the Health and Safety Sections of License Renewal Applications for Uranium Hexafluoride Production."

Regulatory Guide 3.61, "Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask."

Regulatory Guide 3.62, "Standard Format and Content for the Safety Analysis Report for Onsite Storage of Spent Fuel Storage Casks."

Accident analysis

The criteria in this chapter are for initiating events that result in a criticality accident.

10 CFR 50.34, "Contents of Applications: Technical Information"

10 CFR 61.13, "Technical Analyses"

10 CFR 70.22, "Content of Applications"

10 CFR 70.23, "Requirements for the Approval of Applications"

10 CFR 72.24, "Contents of Application: Technical Information"

10 CFR 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance"

Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel-Handling Accident in the Fuel-Handling and Storage Facility for Boiling and Pressurized Water Reactors."

Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants."

Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Releases."

Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants."

NUREG-1320, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," USNRC, May 1988.

NUREG-1179, "Rupture of Model 48Y UF₆ Cylinder and Release of Uranium Hexafluoride," USNRC, February 1986.

NUREG-0772, "The Effects of Natural Phenomena on the Exxon Nuclear Company Mixed-Oxide Fabrication Plant at Richland Washington," USNRC, September 1980.

NUREG/CR-4303, "High-Level Waste Preclosure Systems Safety Analysis," GA Technologies, Inc., September 1985.

NUREG/CR-3682, "Nuclear Fuel Cycle Risk Assessment-Review and Evaluation of Existing Methods," Pelto, P.J. et al., Battelle Pacific Northwest Laboratories, May 1984.

NUREG/CR-3210, "Low-Level Waste Risk Methodology Development," Cox, N.D. et al., EG&G Inc., May 1983.

NUREG/CR-3139, "Scenarios and Analytical Methods for UF₆ Releases at NRC-Licensed Fuel Cycle Facilities," Simantov, M. et al., Oak Ridge National Laboratory, July 1984.

7) Quality assurance during design, construction, and operation

10 CFR 50.4, "Written Communications"

10 CFR 50.55, "Conditions of Construction Permits"

10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

10 CFR 61.12, "Specific Technical Information"

10 CFR 72.40, "Issuance of License"

10 CFR 72 Subpart G, "Quality Assurance"

Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment."

Regulatory Guide 2.3, "Quality Verification for Plate-Type Uranium-Aluminum Fuel Elements for Use in Research Reactors."

Regulatory Guide 3.3, "Quality Assurance Program Requirements for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.10, "Liquid Waste Treatment System Design Guide for Plutonium Processing and Fuel Fabrication Plants."

Regulatory Guide 3.12, "General Design Guide for Ventilation Systems for Plutonium Processing and Fuel Fabrication Plants."

8) Decommissioning

10 CFR 50, Appendix F, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities."

10 CFR 50.75, "Reporting and Record Keeping for Decommissioning Planning"

10 CFR 50.82, "Application for Termination of Licenses"

10 CFR 61.12, "Specific Technical Information"

10 CFR 61.14, "Institutional Information"

10 CFR 61.23, "Standards for Issuance of a License"

10 CFR 61.24, "Conditions of Licenses"

10 CFR 61.28, "Contents of Application for Closure"

10 CFR 61.29, "Post Closure Observation and Maintenance"

10 CFR 61.30, "Transfer of License"

10 CFR 61.31, "Termination of License"

10 CFR 61.40, "General Requirement"

10 CFR 61.42, "Protection of Individuals From Inadvertent Intrusion"

10 CFR 61.44, "Stability of the Disposal Site After Closure"

10 CFR 61.52, "Land Disposal Facility Operation and Disposal Site Closure"

10 CFR 61.53, "Environmental Monitoring"

10 CFR 61.62, "Funding for Disposal Site Closure and Stabilization"

10 CFR 70.25, "Financial Assurance and Record Keeping for Decommissioning"

10 CFR 70.38, "Expiration and Termination of Licenses"

10 CFR 72.30, "Decommissioning Planning Including Financing and Record Keeping"

10 CFR 72.40, "Issuance of License"

10 CFR 72.54, "Application for Termination of License"

10 CFR 72.130, "Criteria for Decommissioning"

Regulatory Guide 3.65, "Standard Format and Content of Decommissioning Plans for Licensees Under 10 CFR Parts 30, 40, and 70."

NUREG-0436, Rev. 1 and Supplements 1 and 2, "Plan for Reevaluation of NRC Policy on Decommissioning of Nuclear Facilities," USNRC, December 1978.

NUREG-0278, Vol. 1 & Vol. 2, "Technology, Safety, and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant," Schneider, K.J. et al., Battelle Pacific Northwest Laboratory, October 1977.

NUREG/CR-1754, Addendum 1, "Technology, Safety, and Costs of Decommissioning Reference Non-Fuel-Cycle Nuclear Facilities," Short, S.M., Pacific Northwest Laboratory, October 1989.

Project File Number 02BD7

Project/Task Waste Treatment Project Feasibility Studies

Subtask WTF Design Requirements

Title: Regulatory and Design Requirements for Waste Treatment Facilities

SUMMARY: The purpose of this document is to delineate the design requirements for the non-separations and TRU only separations options for the Waste Treatment Facilities (WTF) feasibility studies. The facilities will be designed and constructed under one of three possible regulatory scenarios: 1) performance against US Department of Energy (DOE) Orders with maintenance of status-quo interfaces with other regulatory and oversight agencies such as the EPA (State of Idaho) and the Defense Nuclear Facilities Safety Board (DNFSB), 2) performance against DOE Orders with all current regulatory/oversight relationships maintained and or Nuclear Regulatory Commission (NRC) oversight to achieve "NRC Equivalency" or, 3) NRC licensing through replacement of DOE Orders with NRC Regulations and replacement of DNFSB oversight with NRC licensing process. For the purposes of this study and at the direction of the high level waste alternatives feasibility studies project manager, the base case for this study is performance against DOE Orders (scenario 1, above). This is consistent with the approach taken by Fluor Daniel, Inc., at the direction of the HLW Program in the preparation of the planning alternative and will provide an apples-to-apples comparison of the alternatives.

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Introduction

The purpose of this document is to delineate the design requirements for the non-separations and TRU only separations options for the Waste Treatment Facilities (WTF) feasibility studies. The facilities will be designed and constructed under one of three possible regulatory scenarios: 1) performance against US Department of Energy (DOE) Orders with maintenance of status-quo interfaces with other regulatory and oversight agencies such as the EPA (State of Idaho) and the Defense Nuclear Facilities Safety Board (DNFSB), 2) performance against DOE Orders with all current regulatory/oversight relationships maintained and or Nuclear Regulatory Commission (NRC) oversight to achieve "NRC Equivalency" or, 3) NRC licensing though replacement of DOE Orders with NRC Regulations and replacement of DNFSB oversight with NRC licensing process. For the purposes of this study and at the direction of the high level waste alternatives feasibility studies project manager, the base case for this study is performance against DOE Orders (scenario 1, above). This is consistent with the approach taken by Fluor Daniel, Inc., at the direction of the HLW Program in the preparation of the planning alternative and will provide an apples-to-apples comparison of the alternatives.

With the ground rules clearly established above, the following is a discussion of how they will be selectively applied/ignored.

This EDF will identify the applicable DOE orders, regulations and guidance documents that would be used in the design of the facilities. There are currently no NRC regulations in place for the licensing of waste processing facilities such as those discussed herein. The only WTF activities for which the NRC has been routinely involved is the licensing of waste storage and disposal facilities. Never-the-less, NRC requirements are looming on the horizon. In addition, the waste products to be produced are in many cases destined for NRC licensed storage facilities. Therefore, there are some NRC requirements that just cannot be ignored. Thus, where appropriate, NRC regulations are explicitly specified in the design requirements. Where specific design criteria is provided under NRC regulations and guidance documents whether directly applicable or for similar facilities, it will be referenced. This will be useful in helping to determine the cost differential between DOE regulatory/oversite and NRC licensing requirements.

1.0 Facilities For Which This Document Applies

1.1 Process Description

The following is a very brief description of each of the processes that this document will consider:

Direct Vitrification Direct vitrification is a process for converting calcine into a glass waste. In the direct vitrification process, calcine is mixed with "frit" materials and fed to a melter, which would operate at a temperature of around 1100°C. Numerous small-scale tests have been performed to determine frit formulations and glass properties, primarily leachability. No pilot data or design data is available for direct vitrification of calcine.

Direct Grout Grouting is an ambient temperature process for solidifying or stabilizing a waste material. Grouting utilizes hydraulic cement that hardens by chemical interactions with water, and various additives which may aid dispersion, control hardening, control pumping characteristics or enhance retention of certain contaminants in the waste.

Cementitious Waste Process Darryl Siemer has proposed a direct grouting process³³ with differences from that described above. Siemer suggests mixing existing calcine with existing SBW, and recalcining the resulting slurry in the existing calciner, using sugar as additive to permit calcination of high-sodium waste. This recalcined waste would then be mixed with a combination of cementitious agents and water, and transferred to a stainless steel can. After setting at ambient temperature, the can is transferred to an autoclave and cured with steam. If further processed by HIPing, the can would be vented and placed in a furnace to remove volatiles. Then the can would be transferred to the HIP chamber, an inert gas added to pressurize to 30-125 MPa (4350-18,100 psi), and the can heated at 850-1050°C for the required "soak" time.

Hot Isostatic Press (HIP) The HIP process uses high pressure and high temperature to convert calcine or other solid wastes to a glass-ceramic waste form. In a conceptual flowsheet proposed for processing calcine, calcine from storage is mixed with frit or other additives, fed to a HIP can, the can sealed and decontaminated, and then isostatically pressed in a furnace. Processing temperatures for the HIP process are similar to vitrification, typically 1050-1100°C. The typical HIP operating pressure is 20,000 psi.

TRU Waste Alternative In this alternative, calcine is dissolved and actinides removed from the resulting solution by the TRUEX process. TRUEX wash effluents and raffinate along with other ICPP low level wastes, are evaporated, denitrated and grouted. The TRUEX strip effluent is evaporated, denitrated and then packaged for shipment to WIPP. An alternative to denitration would be to neutralize and evaporate the effluents from separation.

1.2 Facility List

Below is a list of the primary, main ancillary, and common support facilities that will be required for each of the options discussed herein:

1. Non-Separations Direct Vitrification Option:

- Vitrification Facility

2. Non-Separations Direct Grout Option:

- Grouting Facility

3. Non-Separations Calcine Hot Isostatic Press (HIP) Option:

- Calcine HIP Facility

4. Non-Separations Cementitious Waste Option:

- Calcine Slurry and Grouting Facility

5. TRU-Only Separations:

- TRU Separations Facility
- TRU Product Handling, Packaging and Lag Storage Facility (TRU-only Separations Option):
- Class C Grouted Waste Interim Storage Facility:

In addition, a number of common support facilities/systems will be required to support the above facilities which include:

- Calcine Retrieval System (may vary depending on the process design for each option)
- Temporary Calcine (surge or staging) Storage
- Interim HLW Storage Facility

Note: For all of these alternatives, the study ends with interim storage of the waste product prior to shipment. Thus none of the studies includes facilities for receiving and internment of the final waste product at a repository.

2.0 Licensing Authority

As previously stated, for the purposes of this effort, the base case for this study is performance against DOE Orders. The following discussion is presented to defined under what NRC regulations each of the above referenced facilities would be licensed if NRC licensing were the preferred approach. This information is provided for reference only.

In early 1997 the INEEL Spent Nuclear Fuel, High-Level Waste and Related Programs prepared a licensing assessment report for proposed INEEL ICPP High Activity Waste Treatment Facilities (*Idaho Chemical Processing Plant High Activity Waste Treatment Project Regulatory Assessment Report*, prepared by R. G. Morgan and S. E. Leroy, Duke Engineering Services, Inc. S. E. Leroy letter to V. L. Jacobson, dated April 25, 1997) (1). The report provided an assessment of how the proposed ICPP Waste Treatment Facilities could be licensed under existing NRC regulations and processes. The report identifies the applicable NRC regulations and guidance documents that would be used in the licensing process. It also identifies those areas where additional NRC guidance documents, regulations, or rulemaking may be necessary.

The above referenced report specifically addresses the facilities defined in the 'preferred alternative', whereas this EDF is examining other methods of processing and disposing of the

calcined wastes at ICPP. For the purpose of defining the licensing criteria for the options discussed in this EDF, the above referenced report will be used. Licensing criteria will be based on similarities between the preferred alternative facilities and the facilities described here.

2.1 Non-Separations Options (Primary and Ancillary Facilities)

The non-separations options include: 1) direct vitrification, 2) direct grouting, 3) calcine HIPing, and 4) the Cementitious Waste options. Each option will include a facility to perform the appropriate operations to produce the end product (e.g., vitrification facility, direct grouting facility, HIPing facility, and a calcine slurry and grouting facility for the Cementitious Waste option).

The non-separations options are similar in scope to the High Activity Waste Treatment (HAWT) Facilities described in reference 1. The HAWT facilities include a calcine retrieval, transport, and receiving system; a calcine dissolution process; a high activity waste vitrification process; and vitrified product storage. The non-separations options include a calcine retrieval, transport, and receiving system; a waste stabilization process (vitrification, grouting, HIPing); and product storage.

The facilities which will be licensed are the Waste Stabilization (WS) Facilities (e.g., the vitrification, grouting, HIPing facilities), the temporary calcine (surge or staging) storage tanks associated with the receipt of the feed stock, the calcine retrieval system, and the interim HLW storage facility.

Based on the existing NRC regulations and rulemaking activities, it is expected that the following licenses would be required to support the non-separations option plan:

- Waste Stabilization (WS) Facilities (e.g., the vitrification, grouting, HIPing facilities) would require a 10 CFR Part 70 license
- Temporary calcine (surge or staging) storage tanks associated with the receipt of the feed stock would require a 10 CFR Part 70 license.
- Calcine retrieval system would require a 10 CFR Part 70 license.
- Interim (temporary) HLW storage facility would require a 10 CFR Part 72 license.

Other NRC regulations that are applicable to the design, licensing, and operations of the facilities will be addressed later in this EDF.

2.2 TRU-Only Separations Options (Primary and Ancillary Facilities)

As with the non-separations options, the TRU-only separations options licensing requirements were derived by similarity to the preferred option HAWT facilities.

The facilities which will be licensed are the TRU Separations (TS) facility, TRU product handling, packaging and lag storage facility, class C grouted waste interim storage facility, the

temporary calcine (surge or staging) storage tanks associated with the receipt of the feed stock, and the calcine retrieval system.

Based on the existing NRC regulations and rulemaking activities, it is expected that the following licenses would be required to support the non-separations option plan:

- TRU Separations (TS) facilities, including product handling, packaging, and lag storage would require a 10 CFR Part 70 license
- Temporary calcine (surge or staging) storage tanks associated with the receipt of the feed stock would require a 10 CFR Part 70 license.
- Calcine retrieval system would require a 10 CFR Part 70 license.

Other NRC regulations that are applicable to the design, licensing, and operations of the facilities will be addressed later in this EDF.

3.0 Design Requirements

3.1 Overview

The criteria contained in this document are based only on the rudimentary descriptions of the processes presented in section 1.1. As the design is developed further, some of the criteria may become nonapplicable, and others will be identified. The purpose here is to provide a set of high-level requirements to guide the development of the conceptual designs of the facilities and provide a reasonable basis for cost estimating purposes. In general this document will not attempt to cover criteria outside of the design and construction of the facilities. Process criteria such as the waste form acceptance criteria, treatment standards and so forth will be addressed by others.

3.1.1 A Note on NRC Regulations

NRC regulations are contained in Title 10, Energy of the Code of Federal Regulations. CFR's have the authority of legal mandates, and require compliance, under penalty of law, by all affected parties. NRC generates guidance documents as needed to provide clarification and elaboration of the regulations, describe information to be included in the reports, and give acceptance criteria. These publications truly are guidance documents which are not required to be followed but provide suggested methods for achieving successful licensing. Guidance documents include:

NRC Regulatory Guides

Regulatory Guides delineate acceptable methods of meeting NRC requirements. Different methods for meeting these requirements may be used if justified but the licensees usually attempt to use the Regulatory Guide methods because alternate approaches require extensive justification and additional NRC review. The use of the guides simplifies and shortens the licensing process.

There are over 480 Regulatory Guides that have been issued to support the licensing of commercial nuclear facilities. While many of the guides apply to nuclear reactors, others, such as those describing waste storage may be viewed as applicable to the WTF. However, no definitive guidance is available for the type of facilities discussed below.

NRC Reports

NRC Reports (NUREGs) and other NRC reports developed by contractors are published on a variety of technical and regulatory issues. They may pertain to specific proceedings such as Safety Evaluation reports or Environmental Impact statements.

NRC Technical Positions

Technical Position and Staff Position Papers are also prepared by the NRC as a means of providing guidance on requirements for specific facilities regulated by the agency.

Generic Communications

NRC Generic communications include NRC Information Notes, Generic Letters and NRC Bulletins. These documents provide the licensees with specific information on problems or matters of interest to the licensee.

National Standards

NRC regulations and documents often incorporate or refer to national codes such as the ASME boiler and pressure vessel codes. These codes then become a requirement and are used in developing design criteria. If the licensee wishes an exception, the exception must be identified and basis for the exception agreed to during the licensing process.

3.2 Non-Separations Options Waste Stabilization Facility

The non-separations options include: 1) direct vitrification, 2) direct grouting, 3) calcine HIPing, and 4) the Cementitious Waste options. Each option will include a facility to perform the appropriate operations to produce the end product (e.g., vitrification facility, direct grouting facility, HIPing facility, and a calcine slurry and grouting facility for the Cementitious Waste option). The requirements for supporting (ancillary) facilities will be discussed under separate headings.

3.2.2 Civil Requirements

3.2.2.1 Site Development

A suitable site shall be located for the Waste Stabilization Facility at the INEEL in the vicinity of the Idaho Chemical Processing Plant (ICPP) with the proximity to waste sources, utilities, other facilities, vehicular access, shipping and storage capability, and future growth. A study of the impact of this facility on site utilities and infrastructure shall be performed. Information regarding

topography, soil conditions, subsurface rock formations, road and structure locations shall be included in the final site decision process.

3.2.2.2 Flood Design

Flood design shall be in accordance with DOE-STD-1020. Additionally, if the facility is a RCRA facility, design shall be in accordance with 40 CFR 270.14. This standard requires the facility to be located above the 100-yr flood elevation or for engineered barriers against flooding of the site to be constructed. If the facility is a TSCA facility, 40 CFR 761.65 requires the facility to be located above the 100-yr flood elevation with no allowance for engineered barriers against flooding.

3.2.2.3 Surface Drainage

Design for surface drainage from local precipitation shall be in accordance with DOE-STD-1020 and should be consistent with the ICPP site drainage plan. The INEEL site specific local precipitation standard for a 25-year, 6-hour storm is 1.4 inches total.

3.2.2.4 Subsurface Investigation and Surveying

Surveying and subsurface investigation for design shall be conducted to determine depth of rock, confirm soil characteristics and evaluate existing soil for chemical and radiological contamination. Locations of ground surface interferences and site characteristics shall be determined with a survey of the site.

3.2.2.5 Soil Excavation and Shoring

Specifications for excavation work shall require that excavations comply with OSHA Standards, 29 CFR 1926, Subpart P (and Subpart U if blasting is necessary), Subsection 1926.641. Where major complex temporary support systems such as shoring, cribbing, sheet piling, etc. are required, they shall be fully design by the AE as part of the design package.

3.2.2.6 Paving and Surfacing

Paving shall be provided around the building for parking areas and access roads. All paved areas adjacent to buildings and structures shall have a 1% minimum slope away from the buildings or structures. Unpaved areas shall be sloped 2% minimum.

Design for paved roads shall conform to Idaho State Highway Standard Specifications and AASHTO HS-20 loading. Geometric design of all roads, streets, access drives and parking areas shall comply with AASHTO. Other loadings such as those imposed by transfer cask operations shall be incorporated into pavement design where applicable.

3.2.2.7 Slabs, Sidewalks, and Stoops

Sidewalks, door stoops, and approaches shall be provided at all building personnel exits or vehicle openings. Sidewalks shall be installed to provide a safe and efficient means for personnel to access doorways and walk to other nearby facilities. Concrete slabs, door stoops, truck ramps, etc., shall be sloped at least 2%.

3.2.2.8 Physical Protection

The facility shall be located within the ICPP security system and fence. Construction of the new facility may take place outside of the existing main security fence if an equivalent level of security protection is established.

3.2.2.9 Underground Utilities

Existing underground ICPP utilities (sewer, potable and fire water systems) shall be extended as necessary to provide necessary services. Design of potable systems shall be in accordance with the State of Idaho Department of Health and Welfare, Idaho Regulations for Public Drinking Water Systems. Sanitary waste water shall be routed to the ICPP sewage treatment system. Water used for cleaning of the hot cells, if applicable, shall be removed by floor drains or sumps, filtered, contained in double containment tanks, monitored for hazardous materials, and if allowable, routed to the sanitary-sewer system.

3.2.2.10 Site Demolition

Site demolition, as required, will be dependent of the final site location.

3.2.3 Architectural Requirements

3.2.3.1 General

Architectural designs shall be in accordance with the DOE-ID Architectural Engineering Standards, DOE 6430.1A, and the following design criteria. The facility shall have a minimum design life of 40 years. Interim Storage Facility design life shall be 50 years minimum. The facility shall be planned and laid out on the basis of repetitive or discrete processing steps. The need for safe normal and emergency access, egress and internal traffic flow shall be considered.

Energy conservation shall be given attention during planning and design in accordance with 10 CFR 435, Energy Conservation Voluntary Performance Standards for New Buildings, Mandatory for Federal Buildings.

3.2.3.1.1 Hot Cell.

Hot Cell design shall be based upon a Uniform Building Code (UBC) occupancy classification of Group H, Division 7. Occupancy separations and construction types shall be designed in accordance with the UBC.

Layout of the Hot Cell area shall include a buffer area for personnel entering and exiting the cell and shielded viewing windows for remote operations.

The Hot Cell shall include shielded, impervious and decontaminable walls, floors and ceilings as appropriate. The hot cell walls shall provide sufficient shielding to protect personnel from gamma and neutron radiation. The dose rate at the exterior of the Hot Cell wall in the operating gallery shall be below 0.1 mrem/hr.

3.2.3.1.2 Buffer Area.

A Buffer Area shall be provided between the Hot Cell and other areas. Design shall be based upon a UBC occupancy classification of Group H, Division 7. Facilities for changing anti-c clothing and personnel monitoring (frisking) devices shall be provided adjacent to the Hot Cell. A shielding labyrinth leading from the Hot Cell to the Buffer Area and then to an Anti-C Change Room shall be provided. These areas shall be separated from each other and the pressure barriers maintained.

The Buffer Area shall provide space for discarded protective clothing used in the Hot Cell and a step off pad for frisking of contamination by PCM machine. All surfaces in the Buffer Area shall be impervious and decontaminable as well as the floors and walls of the Anti-C room.

3.2.3.1.3 Operating Galleries.

Operating galleries shall be provided as required by view angles and retraction/repair of remote equipment. Space and utilities shall be provided to accommodate remote equipment operations. Operating galleries shall be separated from the Hot Cell by a concrete shielded wall.

3.2.3.1.4 Utility Support Areas.

Utility Support Areas design shall be based upon a UBC occupancy classification of H-7 and shall be designed to accommodate remote and contact maintenance of equipment.

3.2.3.1.5 Equipment Maintenance Areas.

Crane maintenance areas shall be provided to support maintenance of in-cell equipment.

3.2.3.1.6 Administrative Areas.

The Administrative Area design, which includes office and support areas, shall be based upon a UBC occupancy classification of Group B.

The Administrative Area shall include a minimum of three offices for a shift supervisor and HP support personnel. A Ready Room shall be provided for conduct of meetings and work breaks. Men's and women's lavatories, showers, lockers, and change facilities shall be provided. Storage space and a janitor's room shall also be provided.

3.2.3.2 Building Features

Materials selected for the walls shall address durability, low maintenance, shielding, insulation and decontamination. The walls shall meet the recommended R value of the DOE-ID A/E Standards. The UBC Construction Type of II-N shall be used for the Facility.

The entire surface area of the contaminated work areas shall be decontaminable. Where wash down or decontamination activities are to be located, the floors shall be sloped to drains that lead to appropriate holding tanks.

Devices (such as door types or air lock arrangements) shall maintain pressure barriers for the hot cell and operating gallery areas.

3.2.4 Structural Requirements

3.2.4.1 General

Structural design shall be in accordance with the DOE-ID Architectural Engineering Standards, DOE O 420.1, and DOE-STD-1020.

3.2.4.2 Classification and Design Loads

The performance categories for SSCs shall be established using DOE-STD-1021, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*. Site-specific studies and hazard assessments of the site, as needed, shall be developed in accordance with DOE-STD-1022, *Natural Phenomena Hazards Site Characterization Criteria* and DOE-STD-1023, *Natural Phenomena Hazards Assessment Criteria*.

All permanent and transient loads that could exist or be developed during normal operations of the facility shall be considered in the design of the facility. Loads to be considered shall include: dead, live, thermal, lateral soil, snow, natural phenomena, seismic, wind, flood, off-normal operating and accident loads, and load combinations.

Dead and live loads shall be determined in accordance with ANSI/ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. Loadings due to natural phenomena hazards (wind, seismic, flood, etc.) shall be determined in accordance with DOE-STD-1020, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*.

In accordance with DOE-STD-1020, the Uniform Building Code shall be used as the basis for seismic design for Performance Category 1 and 2 SSCs. The seismic input control motion for the INEEL for Performance Category 3 SSCs is specified by appropriately scaling the USNRC R.G. 1.60 horizontal spectra (0.18g). The input motion is assumed to occur in the free-field at the top of a real or hypothetical rock outcrop near the facility location. The vertical input spectra shall be taken as 2/3 of the horizontal spectra. A detailed soil amplification analysis or the soil surface spectra shall be taken to equal the rock outcrop spectra multiplied by:

- (a) 1.2 for soil overburden up to 20 ft.
- (b) 1.5 for soil overburden between 20 ft and 50 ft.

Snow loads shall be determined in accordance with ANSI/ASCE 7, with a ground snow load of 35 psf and a minimum roof snow load of 30 psf. Tornado loads are not anticipated and need not be included. Load combinations shall be determined in accordance with ANSI/ASCE 7.

3.2.4.2.1 NRC Specific—To meet NRC requirements, seismic loads shall be determined in accordance with 10 CFR 72, Subparts D and E, 10 CFR 100, and USNRC Reg. Guide 1.6. Tornado loads shall be determined in accordance with ANSI/ANS-2.3. Load combinations shall be designed using applicable load combinations and stress limits stipulated in ANSI/AISC N690 and ANSI/ACI-349.

3.2.4.3 Footings and Foundations

Footings shall be designed to support the structure and keep differential settlement within allowable limits. Design frost depth shall be 5-ft below grade. The Hot Cell and shielded storage areas shall be provided with continuous reinforced grade beams or wall footings as required for shielding.

3.2.4.4 Structural Features

The Hot Cell walls and roof design shall be consistent with shielding and loading requirements. Other shielded area walls and roofs shall be designed consistent with shielding and loading requirements. The structural design must support crane systems.

3.2.5 Handling Requirements

3.2.5.1 Cranes (Critical Lift Devices Only)

All crane designs shall meet the ASME NOG-1 and where applicable, CMAA 70, Crane Manufacturers Association of America, Inc., Specification for Electric Overhead Traveling Cranes and CMAA 74-1987, Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist.

In addition, all cranes shall meet the requirements of NUREG-0612, Control of Heavy Loads at Nuclear Power Plants.

Cranes shall have true vertical lift on the hoist and all motions shall be the slowest that are commercially available to allow for more precise control when placing or picking objects.

3.2.5.2 Work Platforms

The facility shall be equipped with decontaminable work platforms that shall provide a safe and convenient elevated work area for personnel as required. Design of the platforms and their means of access shall be in accordance with OSHA 1910. Removable guard rails may be utilized as necessary to meet process and handling requirements.

3.2.8 HVAC Requirements

All HVAC systems shall be in accordance with Regulatory Guides RG 1.140 *Design, testing, and maintenance for normal ventilation systems*, RG 1 *Design, testing, and maintenance criteria for post-accident engineered safety feature ventilation systems*, NUREG-0800 Section 9.4.3 *Auxiliary and radioactive waste area ventilation*, NUREG-0800 Section 11.3 *Gaseous waste management systems*, NUREG 0800 Section 11.5 *Process and effluent radiological monitoring*, NUREG-1567 *Offgas treatment and ventilation*, NUREG-1567 (Draft) Section 11.4.1.3, *Ventilation offgas system design features*.

HVAC systems shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart G (Occupational Health and Environmental Control) and Subpart Z (Toxic and Hazardous Substances).

The HVAC systems shall meet the air quality requirements addressed in 40 CFR 50-53, and 58.

The HVAC systems shall be in accordance with ANSI/ASME N509-1989, Nuclear Power Plant Air Cleaning Units and Components and ANSI/ASME N510-1989, Testing of Nuclear Air-Cleaning Systems.

The HVAC systems shall meet the requirements of Idaho Administrative Procedures Act (IDAPA) 16.01.01000-01999.

The HVAC systems shall be in accordance with MIL-F-51068C (Filter: Particulate High Efficiency, Fire Resistant) and MIL-F-51079A (Filter Medium: Fire Resistant, High Efficiency).

The Hot Cell atmospheric pressure shall be controlled during hot operations to -0.6 W. G. (or lower) below atmospheric pressure.

Heating loads shall be based on a minimum winter outdoor design temperature of -14°F. Cooling loads shall be based on temperatures of 93°F dry bulb and 61°F wet bulb. The HVAC system should maintain a minimum temperature of 65°F in the winter and approximately 76°F in the summer in the operations area (not including the vitrification cell). The HVAC system must maintain a minimum temperature of 65 °F in the winter and approximately 72°F in the summer in the Administrative areas. HVAC design for indoor temperature conditioning shall be based on ASHRAE 90.

Air shall flow from areas of least contamination potential to areas of highest contamination potential. The HVAC system shall collect exhaust air from contamination control areas and pass it through HEPA filters prior to discharge to the atmosphere.

3.2.9 Mechanical Utilities Requirements

Mechanical utilities systems shall meet the requirements of the ASME Code for Pressure Piping B31.

3.2.9.1 Compressed Air

Compressed air for plant and instrument air shall be provided for pneumatically operated HVAC system equipment and other pneumatic operations in the facility. The system design for compressed air shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart M (Compressed Gas and Compressed Air Equipment). Instrument air shall be ISO-141 Grade or better.

3.2.9.2 Compressed Gas

Argon compressed gas shall be supplied for welding processes

Helium compressed gas shall be supplied for pressure testing and inerting operations.

The system design for compressed gas shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart H (Hazardous Materials) and Subpart M (Compressed Gas and Compressed Air Equipment).

3.2.9.3 Potable Water

Potable water, including hot water where applicable, shall be provided to the facility to service water closets, urinal(s), sinks, showers, shower/eyewash facilities, evaporative coolant units, drinking fountains, and miscellaneous ports.

Cross-connection control shall be in accordance with the Idaho Code (IDAPA 16.01.08), "The Cross Connection Control Manual, Accepted Procedure and Practice" (Pacific Northwest Section of American Water Works Association), and the Foundation for Cross Connection Control and Hydraulic Research (University of Southern California.)

3.2.9.4 Waste Systems

3.2.9.4.1 Liquid Waste—Liquid waste system(s) shall be provided for in the Hot Cells and other process areas. The liquid waste systems shall be designed in accordance with NUREG-0800 Section 11.2 *Liquid waste management systems*. Condensate from HVAC equipment shall be disposed of using the liquid waste system. Liquid waste shall be collected and tested prior to being pumped into the waste line

3.2.9.4.2 Sanitary Systems—The sanitation system design shall be in accordance with 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart J (General Environmental Controls). Sanitary sewer drains, cleanouts, and vents shall be provided as needed.

3.2.9.5 Fire Protection

Fire water shall be provided in accordance with DOE 6430.1A, DOE Order 420.1, and the DOE-ID Architectural Engineering Standards. Fire protection systems shall ensure nuclear criticality and suppressant-HLW chemical reactions cannot occur. All underground fire water lines shall be cathodically protected and meet State of Idaho requirements for minimum distances from potable water piping.

3.2.9.6 Steam

Steam shall be provided and routed to the HVAC system as required. The steam lines shall be insulated.

3.2.10 Electrical Requirements

The criteria for the electrical design of the WTF is based on requirements from NFPA, ANSI, Factory Mutual (FM), DOE O 420.1 and 29 CFR 1910, Occupational Safety and Health Standards for General Industry, Subpart S (Electrical).

Electrical design and installation shall incorporate the most efficient methods of penetration, shielding integrity retention, efficiency, and operational convenience.

The facility shall require an electrical room a communications room, and an Uninterruptable Power Supply (UPS) room.

3.2.10.1 Power

The electric power system shall be designed to provide standard power to the facility and emergency electrical supply to essential instrumentation, emergency lighting, emergency communications, and physical security systems. Standby power shall be supplied for the Hot Cells, process areas, and HVAC system exhaust fan.

An Uninterruptable Power Supply (UPS) shall provide emergency power. The UPS shall support the Fire Alarm, Voice Paging, HVAC, Radiation Monitoring and Alarm, and security systems. There shall sufficient battery capacity to carry the rated load for a minimum of 30 minutes.

3.2.10.2 Grounding

Grounding shall be provided in accordance with the DOE-ID Architectural Engineering standards.

3.2.10.3 Cathodic Protection

Utility piping shall be protected through connection to the existing ICCP cathodic protection system. A testing/bonding station shall be included to periodically monitor the cathodic protection system.

3.2.10.4 Lighting

Interior and exterior lighting shall be designed and included in accordance with current Illuminating Engineering Society (IES) recommendations. Emergency and exit lighting shall be provided at each means of egress. Hot Cell lighting shall be provided by high-pressure sodium fixtures.

3.2.10.5 Lightning Protection

A lightning protection system shall be included and shall be designed in accordance with NFPA 780.

3.2.10.6 HVAC Controls

A HVAC control system shall be provided. It shall be a smart system that can automatically generate control signals to change HVAC equipment operating parameters based on signal received from various monitors. A computer monitor shall be provided in the Shift Supervisor's office for reviewing the operating status of the system and making adjustments to control setpoints.

Instrumentation shall be provided to detect and alarm both high and low differential pressure across filters in the HVAC system. Instrumentation shall be provided to initiate isolation of the HVAC system filters in the event of fire detection.

3.2.10.7 Equipment Controls

Facility control, process control, and data acquisition systems shall be provided.

Remotely controlled CCTV cameras shall be provided in the Hot Cells and process areas for general visual observation, operations, inspection, and documentation. Each Hot Cell window shall be equipped with a visual inspection station which shall include two high resolution cameras; a monitor; camera controls for pan, tilt, and zoom functions; and recording capability for archival purposes.

Instrumentation shall be provided to measure and record the facility structural response to an earthquake.

A system shall be provided for the collection of alarms from the HVAC system and other alarms. This shall be located in the Shift Supervisor's office.

3.2.10.8 Radiation Monitoring and Alarms

Radiation detection instrumentation shall be provided to warn operating personnel of radiation and airborne radioactivity levels above set limits. The RAMs shall alarm locally and remotely in the RadCon office.

Stack monitoring shall be provided for the detection of radioactive particulates in the air exhaust stream. These instruments shall comply with ANSI-N42.17B-1989.

Provisions shall be made in the design for monitoring groundwater in the vicinity of the storage area for radioactive contamination.

Activity monitors shall be provided in the wash water collected from the Hot Cells and process areas.

3.2.10.9 Communications and Alarms

Voice and data telecommunications lines shall be provided throughout the occupied areas of the facility. The existing Broadband Local Area Network (LAN) shall be made available in the facility. Access ports shall be provided in all normally occupied offices.

Fire alarm, emergency voice paging, and evacuation alarm systems shall be compatible with existing systems at ICPP.

3.2.10.10 Data Acquisition and Recording

A data entry station shall be provided to record and monitor all fuel movements. The stations shall be linked for data communications.

3.2.10.11 Security Systems

Physical protection of the facility shall be in accordance with 10 CFR 73 and 10 CFR 72, Subpart H.

3.2.11 Design Life Requirements

Design life of the facility and equipment shall be 30 years and have maintainable or replaceable life of 60 years

3.2.12 Safety Requirements

3.2.12.1 Safety Classification

The facility is assumed to be a Hazard Category 2.

3.2.12.2 Construction

The design of utility services and distribution systems that are important to safety shall include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions assuming a single failure.¹

The facility and its systems important to safety² shall be designed to be evaluated by appropriate tests or by other means acceptable to the NRC to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.

Structures, systems, and components important to safety shall be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions.

The design of the facility shall include provisions to protect against nuclear criticality that might otherwise result from the operation or the failure of fire suppression or decontamination systems.

Material handling, packaging, transfer, and storage systems shall be designed to be maintained subcritical under the worst case moderated and reflected conditions, and to ensure that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety.

Each entrance or access point into a high radiation area shall have either a control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

Process materials that are reactive with water or other chemicals shall be protected from exposure to those materials.

The facility shall be designed to prevent the dropping of critical loads under normal and off normal conditions including the design basis accidents (DBAs) that they shall withstand.

1. A single failure is an occurrence that results in the loss of capability of a component to perform its intended safety function(s). A multiple failure, i.e., loss of capability of several components, resulting from a single occurrence, is considered to be a single failure. Systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor, (2) a single failure of any passive component (assuming active components function properly) results in loss of the system's capability to perform its safety function(s).

2. Structures, systems, and components important to safety mean those features of the Storage Facility whose function is: (1) To maintain the conditions required to store spent fuel safely, (2) To prevent damage to the spent fuel waste container during handling and storage, or (3) To provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

The facility shall be designed to be able to recover from accidents involving dropping of critical loads.

In-cell equipment shall be designed for recovery from all possible conditions to the extent that manned entry into the cell, for maintenance, can be accomplished.

Fire doors shall be provided as required by UBC, UFC, NFPA-80, and NFPA-101. In addition, all fire doors and frames shall meet all requirements of the Underwriters Laboratories and shall bear the UL or FM label. Fire doors and frames shall be constructed from metal. Structural members, such as steel channels embedded in wall openings, shall not substitute as door frames. All fire doors shall be provided with fitted frames which are anchored to, but separate from, the building structural members. The fire doors shall contain windows fitted with UL approved safety glass which is not removable from the outside of the door. Their installation shall meet all of the requirements of NFPA-80 and NFPA-101.

The facility design shall mitigate natural phenomena hazards. The design shall address common cause effects and interactions for: earthquakes, volcanic events, tornadoes, hurricanes, high winds, floods, excessive rains, excessive snow, ice cover, lightning, and fires. The secondary natural phenomena include drought, fog, frost, high temperatures, low temperatures, landslides, subsidence, surface collapse, uplift, storm surges, and waterspouts. Damage and failure will be considered for systems, structures, and components. In addition, the facility shall have instrumentation or other means to detect and record the occurrence and severity of seismic events.

3.2.12.3 Operation

Radiation protection for occupational workers shall be per 10 CFR 835 (Occupational Radiation Protection) and the INEEL Radiological Control Manual

Facility design features and physical controls shall ensure occupational exposure is maintained ALARA during normal and off-normal operations

Personnel radiation exposure levels throughout facility shall not exceed 0.1 mr/hr for continuously-occupied areas.

The following radiation zones (as described in the DOE-ID AE Standards) shall apply during operations: TBD

Safe access will be provided to all packages, vehicles, and installed components for purposes of testing, inspection, and maintenance.

3.2.13 Environmental Requirements

Facility emission limits shall be per requirements listed in EDF-WTS-003, Section 5.

Administrative controls and Best Available Control Technology shall be used to minimize the impacts of air emissions

The facility processes and equipment shall be designed to limit solid waste generation of LLW and industrial (cold) waste

Solid radioactive waste produced by operations shall be packaged in standard RWMC 4 x 4 x 8-ft plywood boxes for contact-handled (CH) LLW or INEL Mark III concrete containers for remote-handled (RH) LLW, and shipped to RWMC for disposal

Means for measuring the amount and concentrations of radionuclides in effluents during normal operations, and under accident conditions, shall be provided for effluent control systems

Warm liquid waste shall be controlled and verified to meet the criteria for existing ICPP handling systems, and shall be transferred to those systems

If all or part of the facility is located outside of existing ICPP fences, the use of new land shall not exceed 551 acres when combined with other storage systems included in DOE/EIS-0203-F.

3.2.14 Safeguards and Security

The materials are not attractive as defined in DOE Order 5633.3B.

A data management system shall be provided to keep records. The data management system shall meet the requirements of 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, Subpart D (Records, Reports, Inspections, and Enforcement).

Dual records shall be maintained to ensure an off-normal event cannot result in the loss of the sole records. These records shall be retained for as long as the material is stored, and for a period of five years after the material is disposed of or transferred.

The following are NRC requirements that may or may not apply

Equipment shall be provided to conduct a physical inventory of all material in storage at intervals not to exceed 12 months unless otherwise directed by the Commission. A copy of the current inventory shall be retained as a record until the Commission terminates the license.

Physical protection of the facility and materials shall be in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, Subpart H (Physical Protection); 10 CFR 73, Physical Protection of Plants and Materials; and 10 CFR 1046, Physical Protection of Security Interests.

3.2.15 Quality Assurance Requirements

The applicable portions of DOE/RW-0333P, *Quality Assurance Requirements and Description*, shall be invoked as the baseline requirements document for developing and implementing quality assurance programs. These requirements apply to activities related to interim storage or disposal, including characterization for data collection, conditioning, or placing into a form for disposal. In addition, the EM-WAPS Rev. 01, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*, May 1995, also imposes a QA Program consistent with the QA requirements under the DOE/RW-0333P.

All purchased items will be restricted to those not suspect/counterfeit, misrepresented, used, or other than represented/advertised in accordance with INEL-95/227, "Guidelines for Identifying Suspect/Counterfeit Material."

Records, reports, and inspections shall be done in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart D (Records, Reports, Inspections, and Enforcement).

Training of personnel shall be performed in accordance with 10 CFR 72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, Subpart I (Training and Certification of Personnel).

4.0 References

Nuclear Regulatory Commission (NRC) Licensing Assessment for the Idaho National Engineering and Environmental Laboratory (INEEL) High-Level Waste Program, prepared by R. G. Morgan and S. E. Leroy, Duke Engineering Services, Inc., April 23, 1997. Referenced in *Idaho Chemical Processing Plant High Activity Waste Treatment Project Regulatory Assessment Report - SEL-11-97*, prepared by S. E. Leroy, dated April 25, 1997.

Appendix F

Equipment List

INTEC Liquid Waste Csl

N - New CslX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equip- ment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subs
		1 Bldg	2 Bldg				
Truck Unloading Station for New CsIX/Grout Bldg or New Grout Bldg							
	Dust Control Mechanism	N	G	Filter		Material storage	
	Dust Control Mechanism	N	G	Filter		Material storage	
	Dust Control Mechanism	N	G	Filter		Material storage	
	Dust Control Mechanism	N	G	Filter		Material storage	
	Air Enductor	N	G	Eductor	Venturi	Material storage	
	Air Enductor	N	G	Eductor	Venturi	Material storage	
	Air Enductor	N	G	Eductor	Venturi	Material storage	
	Air Enductor	N	G	Eductor	Venturi	Material storage	
Liquid Waste Feed Transfer Station							
	Air Jet Pump	N	NWCF	Pump		Waste feed	
CsIX Removal Equipment in the New CxIS/Grout Bldg or NWCF							
T-101A	Liquid Waste Feed Tank	N	n/a	Tank	Flat bottom	Waste feed	
T-101B	Liquid Waste Feed Tank	N	n/a	Tank	Flat bottom	Waste feed	
T-101A*	Liquid Waste Feed Tank	n/a	NWCF	Tank	Existing VES-NCC-102	Waste feed	
T-101B*	Liquid Waste Feed Tank	n/a	NWCF	Tank	Existing VES-NCC-102	Waste feed	
P-101A	Liquid Waste Feed Pump	N	NWCF	Pump	Metering	Waste feed	
P-101B	Liquid Waste Feed Pump	N	NWCF	Pump	Metering	Waste feed	
F-101A	UDS Filter	N	NWCF	Filter	Pressure leaf	UDS	UDS filtr
F-101B	UDS Filter	N	NWCF	Filter	Pressure leaf	UDS	UDS filtr
T-108	UDS Slurry Tank	N	NWCF	Tank	Flat botttom-air sparge	UDS	UDS dry
P-107	UDS Slurry Pump	N	NWCF	Pump	Metering	UDS	UDS dry
EV-101	Rotary Evaporator	N	NWCF	Evaporator	Wiped Film	UDS	UDS dry
E-101	UDS Drier Vapor Condenser	N	NWCF	Condenser	Shell & tube	UDS	UDS dry
P-110	Condensate Pump	N	n/a	Pump	Centrif, gravity for 2	UDS	UDS dry
B-101	Cs Sorbant Bin	N	NWCF	Bin	Cone bottom	Ion exchange	Material
ED-105	Air Eductor	N	NWCF	Eductor	Venturi	Ion exchange	Material
V-105	Resin Prep Tank	N	n/a	Tank		Ion exchange	Resin pr
V-105*	Resin Prep Tank	n/a	NWCF	Tank	Existing VES-NCM-120	Ion exchange	Resin pr
P-114	Resin Sluice Pump	N	n/a	Pump	High clearance diaphragm	Ion exchange	Resin pr
P-114*	Resin Sluice Pump	n/a	NWCF	Pump	Existing P-NCM-220	Ion exchange	Resin pr
V-104A	Cesium Ion Exchange Columns	N	NWCF	Column		Ion exchange	CslX strip
V-104B	Cesium Ion Exchange Columns	N	NWCF	Column		Ion exchange	CslX strip
V-104C	Cesium Ion Exchange Columns	N	NWCF	Column		Ion exchange	CslX strip
F-106A	Resin Fines Filter	N	NWCF	Filter	Cartridge	Ion exchange	CslX strip
F-106B	Resin Fines Filter	N	NWCF	Filter	Cartridge	Ion exchange	CslX strip
T-103A	IX Effluent Hold Tank	N	NWCF	Tank	Flat bottom	Ion exchange	CslX strip
T-103B	IX Effluent Hold Tank	N	NWCF	Tank	Flat bottom	Ion exchange	CslX strip
P-103A	CsIX Effluent Pump	N	NWCF	Pump	Centrifugal	Ion exchange	CslX strip
P-103B	CsIX Effluent Pump	N	NWCF	Pump	Centrifugal	Ion exchange	CslX strip
P-112	Spent CxIX Sorbant Pump	N	NWCF	Pump	High clearance diaphragm	Ion exchange	CslX strip
V-106	Waste Resin Prep Column	N	NWCF	Column		Ion exchange	Spent res
P-104A	Fines Recycle Pump	N	NWCF	Pump	Centrifugal	Ion exchange	Spent res
P-104B	Fines Recycle Pump	N	NWCF	Pump	Centrifugal	Ion exchange	Spent res
F-102	Cs Sorbant Fines Screen	N	NWCF	Filter	Cartridge	Ion exchange	Spent res
D-102	Cs Sorbant Dryer	N	NWCF	Dryer	Hollow flight	Ion exchange	Spent res
E-102	Vapor Condenser	N	NWCF	Condenser	Shell & tube	Ion exchange	Spent res

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Grouting Equipment List

10/28/98

Indicated scenario.		Size						Electrical Requirements		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	(W)	(HP)		
	2										
	2										
	2										
	2										
	2										
	2										
	2										
	2										
	2										
	3										
	3		14		8	10				SST	
	3		14		8	10				SST	
	3									SST	
	3									SST	
	3		2-16 l/min	4	2	3				SST	
	3		2-16 l/min	4	2	3				SST	
on	4		5 l/min		2	3				SST	
on	4		5 l/min		2	3				SST	
j	4		2		4	5				SST	
j	4		0-2 l/min	3	2	3				SST	
j	4		2 l/min	6	3						
j	4		103 Kg/hr	4	4	10				SST	
j	4		4 l/min	3	2	3				SST	
orage	2		2		3	12				Carbon steel	None
orage	2		2.5 Kg-S/hr	3	2	2					
	6		4		2	5				SST	
	6										
	6		420 l/min	4	3	3				SST	
	6										
ng	5		0.25		1.33	8				SST	
ng	5		0.25		1.33	8				SST	
ng	5		0.25		1.33	8				SST	
ng	5		10 l/min	2	2	2				SST	
ng	5		10 l/min	2	2	2				SST	
ng	5		14		8	10				SST	
ng	5		14		8	10				SST	
ng	5		76 l/min	4	2	3				SST	
ng	5		76 l/min	4	2	3				SST	
ng	5		420 l/min	4	3	3				SST	
	6		1.25		3	8				SST	
	6		4 l/min	3	2	3				SST	
	6		4 l/min	3	2	3				SST	
	6		4 l/min		1	2				SST	
	6		2 l/hr	4	3	4				SST	
	6		1 Kg/hr	2	2	4				SST	

N - New CsIX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equip- ment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subsy
		1 Bldg	2 Bldg				
P-113	Sorbant Drier Condensate Pump	N	n/a	Pump	Centrif, gravity for 2	Ion exchange	Spent re
T-112	Spent Resin Storage Tank	N	NWCF	Tank	Cone bottom	Ion exchange	Spent re
UDS Loading Cell in New CxIS/Grout Bldg or NWCF							
	Staging Conveyor	N	NWCF	Conveyor	Chain driven	UDS	UDS Loa
	Decon Booth	N	NWCF	Booth	Shielded, w/window	UDS	UDS Loa
	Decon Booth Door	N	NWCF	Door	Shielded	UDS	UDS Loa
	Decon Booth Door	N	NWCF	Door	Shielded	UDS	UDS Loa
	Rotation Table	N	NWCF	Mechanism		UDS	UDS Loa
	Decon Conveyor	N	NWCF	Conveyor		UDS	UDS Loa
	Decon Equipment	N	NWCF	Mechanism		UDS	UDS Loa
	Inspection Equipment	N	NWCF	Mechanism	Area swipe remote mech	UDS	UDS Loa
	Cell Door	N	NWCF	Door	Electric motor driven	UDS	UDS Loa
	Load Out Conveyor	N	NWCF	Conveyor	Self powered rollers	UDS	UDS Loa
	Lift Table	N	NWCF	Lift	Air operated	UDS	UDS Loa
	Lift Table Conveyor	N	NWCF	Conveyor		UDS	UDS Loa
	Drum Dust Tight Discharge Cone	N	NWCF	Mechanism	Air operated	UDS	UDS Loa
	Shielded Drum	N	NWCF	Drum	w/dust tight inlet cone	UDS	UDS Loa
Grouting Equipment in New CxIS/Grout Bldg or New Grout Bldg							
B-102	CaO Bin	N	G	Bin	Cone bottom	Grouting	Material
B-103	Portland Cement Bin	N	G	Bin	Cone bottom	Grouting	Material
B-104	Flyash Bin	N	G	Bin	Cone bottom	Grouting	Material
B-105	Blast Furnace Slag Bin	N	G	Bin	Cone bottom	Grouting	Material
ED-101	Air Eductor	N	G	Eductor	Venturi	Grouting	Material
ED-102	Air Eductor	N	G	Eductor	Venturi	Grouting	Material
ED-103	Air Eductor	N	G	Eductor	Venturi	Grouting	Material
ED-104	Air Eductor	N	G	Eductor	Venturi	Grouting	Material
B-107	CaO Weight Bin	N	G	Bin	Cone bottom	Grouting	Grout fe
T-104A	Grout Feed Tank	N	G	Tank	Flat bottom	Grouting	Grout fe
T-104B	Grout Feed Tank	N	G	Tank	Flat bottom	Grouting	Grout fe
N-101A	ph Sampler/Neutralizer	N	G	Neutralizer	Auto batch	Grouting	Grout fe
N-101B	ph Sampler/Neutralizer	N	G	Neutralizer	Auto batch	Grouting	Grout fe
P-105A	Grout Mixer Feed Pump	N	G	Pump	Metering	Grouting	Grout fe
P-105B	Grout Mixer Feed Pump	N	G	Pump	Metering	Grouting	Grout fe
F-106	Knockout Filter	N	G	Filter		Grouting	Grout fe
B-108A	Dry Ingredient Weigh Bin	N	G	Bin	Cone bottom	Grouting	Grout mi
B-108B	Dry Ingredient Weigh Bin	N	G	Bin	Cone bottom	Grouting	Grout mi
B-108C	Dry Ingredient Weigh Bin	N	G	Bin	Cone bottom	Grouting	Grout mi
C-101A	Solids Feed Conveyor	N	G	Conveyor	Vibratory	Grouting	Grout mi
C-101B	Solids Feed Conveyor	N	G	Conveyor	Vibratory	Grouting	Grout mi
C-101C	Solids Feed Conveyor	N	G	Conveyor	Vibratory	Grouting	Grout mi
M-101A	Grout Mixer	N	G	Mixer	Horizontal helical	Grouting	Grout mi
M-101B	Grout Mixer	N	G	Mixer	Horizontal helical	Grouting	Grout mi
M-101C	Grout Mixer	N	G	Mixer	Horizontal helical	Grouting	Grout mi
B-106A	Dry Grout Admixtures Bin	N	G	Bin	Cone bottom	Grouting	Material
B-106B	Liquid Grout Admixtures Tank	N	G	Tank		Grouting	Material
B-106C	Liquid Grout Admixtures Tank	N	G	Tank		Grouting	Material
P-106	Decon Agent Pump	N	G	Pump	Centrifugal-HP	Grouting	Decon/V

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Routing Equipment List

10/28/98

Indicated scenario.			Size					Electrical Requirements		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	(W)	(HP)		
	6		4 l/min	3	2	3				SST	
	6		15		8	15				SST	
ng	4			4	3				1.00		
ng	4									7 ga. SST	
ng	4								0.50	SST	
ng	4								0.50	SST	
ng	4				3				1.00	SST	
ng	4			3	3			1,200		SST	
ng	4							1,200			
ng	4							300			
ng	4								0.50	SST	
ng	4			1.5	3			600		SST	
ng	4							1,200		SST	
ng	4									SST	
ng	4									SST	
ng	4									SST	
Storage	2		38		10	25				Carbon steel	None
Storage	2		34		10	23				Carbon steel	None
Storage	2		34		10	23				Carbon steel	None
Storage	2		58		12	26				Carbon steel	None
Storage	2		9 Kg-S/hr	3	2	2					
Storage	2		9 Kg-S/hr	3	2	2					
Storage	2		9 Kg-S/hr	3	2	2					
Storage	2		9 Kg-S/hr	3	2	2					
	7		0.4		2	5				SST	
	7		7		6.5	7.5				SST	
	7		7		6.5	7.5				SST	
	7			3	3	4				SST	
	7			3	3	4				SST	
	7		2-16 l/min	4	2	3				SST	
	7		2-16 l/min	4	2	3				SST	
	8										
ng	8		0.2		1.5	5				Carbon steel	
ng	8		0.2		1.5	5				Carbon steel	
ng	8		0.2		1.5	5				Carbon steel	
ng	8		8 Kg/min	4	2	4				SST	
ng	8		8 Kg/min	4	2	4				SST	
ng	8		8 Kg/min	4	2	4				SST	
ng	8		0.3	6	4	5				SST	
ng	8		0.3	6	4	5				SST	
ng	8		0.3	6	4	5				SST	
Storage	8		0.4		2	5				Carbon steel	None
Storage	8		0.4							FW Plastic	
Storage	8		0.4							FW Plastic	
sh	8		76 l/min	4	2	3				SST	

N - New CsIX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equipment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subs
		1 Bldg	2 Bldg				
P-115	Metering Pump/Admixtures	N	G	Pump	Metering	Grouting	Grout f
T-106	Mixer Wash Tank	N	G	Tank	Flat bottom	Grouting	Decon
P-116	Decon Return Pump	N	G	Pump	Centrifugal	Grouting	Decon
F-105	Spent Decon Solution Filter	N	G	Filter	Cartridge	Grouting	Decon
Grouted Waste Drum Fill/Drum Seal Area							
	Storage Area Conveyor	N	G	Conveyor		Grouting	Drum f
	SST Airlock Enclosure	N	G	Booth		Grouting	Drum f
	Airlock Door	N	G	Door	Electric motor driven	Grouting	Drum f
	Airlock Door	N	G	Door	Electric motor driven	Grouting	Drum f
	Airlock Conveyor	N	G	Conveyor		Grouting	Drum f
	Main Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transverse Section Lifts	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum f
	Transverse Section Lifts	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum f
	Mixer Booth Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Mixer Booth	N	G	Booth		Grouting	Drum f
	Mixer Booth Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Fill Assembly	N	G	Mechanism	Telescoping fill tube	Grouting	Drum f
	Lid Placement Booth	N	G	Booth		Grouting	Drum f
	Lid Placement Exit Door	N	G	Door	Electric motor driven	Grouting	Drum f
	Lid Placement Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Lid Placement Exit Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Lid Placement Conveyor	N	G	Conveyor	Belt driven w/lifting mech.	Grouting	Drum f
	Rotating Table	N	G	Mechanism	Electric motor driven	Grouting	Drum f
	Drum Rim Cleaning Mechanism	N	G	Mechanism	Remote arm w/wiper	Grouting	Drum f
	Lid Placement Assembly	N	G	Mechanism		Grouting	Drum f
	Transfer Section Tunnel	N	G	Booth	Glovebox	Grouting	Drum f
	Transfer Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Section Exit Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Section Exit Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Section Exit Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transfer Table	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum f
	Transfer Table	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum f
	Transfer Table	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum f
	Transverse Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Transverse Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Inspection/Decon Booth	N	G	Booth		Grouting	Drum f
	Booth Door	N	G	Door		Grouting	Drum f
	Booth Door	N	G	Door		Grouting	Drum f
	Inspect/Decon Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Inspect/Decon Exit Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum f
	Inspect/Decon Conveyor	N	G	Conveyor	Belt driven w/lifting mech.	Grouting	Drum f
	Rotating Table	N	G	Mechanism	Electric motor driven	Grouting	Drum f
	Decon Equipment	N	G	Mechanism	w/solution collection	Grouting	Drum f
	Inspection Equipment	N	G	Mechanism	Automatic swipe	Grouting	Drum f
	Discharge Section Tunnel	N	G	Booth	Glovebox	Grouting	Drum f

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Grouting Equipment List

10/28/98

Indicated scenario.			Size					Electrical Requirements		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	(W)	(HP)		
d	8		1 l/min	3	2	3				SST	
ash	8		1		3	5				SST	
ash	8		76 l/min	4	2	3				SST	
ash	8		76 l/min								
	8			6	3			1,200			
	8									7 ga. SST	
	8								0.50	SST	
	8								0.50	SST	
	8			5	3			900			
	8			24	3			4,500			
	8			3	3				1.50		
	8			3	3				1.50		
	8			3	3			600			
	8									7 ga. SST	
	8			6	3			2,200			
	8								0.50		
	8									7 ga. SST	
	8								0.50	SST	
	8			1.5	3			600			
	8			1.5	3			600			
	8			3	3				2.00		
	8								1.00		
	8								0.25		
	8								2.00	SST	
	8									7 ga. SST	
	8			3	3			1,200			
	8			3	3			1,200			
	8			3	3			1,200			
	8			3	3			1,200			
	8			3	3			1,200			
	8			3	3			1,200			
	8				3				3.50	SST	
	8				3				3.50	SST	
	8				3				3.50	SST	
	8			5.5	3			1,000			
	9			5.5	3			1,000			
	9								0.50	SST	
	9								0.50	SST	
	9			1.5	3			600			
	9			1.5	3			600			
	9			3	3				2.50		
	9				3				1.00		
	9							1,200			
	9							3,000			
	9									7 ga. SST	

N - New CslX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equipment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subs
		1 Bldg	2 Bldg				
	Discharge Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum fil
	Discharge Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum fil
	Discharge Section Inlet Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum fil
	Main Discharge Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum fil
	Transfer Section Lifts	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum fil
	Transfer Section Lifts	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum fil
	Transfer Section Lifts	N	G	Lift	Belt driven w/lifting mech.	Grouting	Drum fil
	SST Airlock Enclosure	N	G	Booth		Grouting	Drum fil
	Airlock Door	N	G	Door	Electric motor driven	Grouting	Drum fil
	Airlock Door	N	G	Door	Electric motor driven	Grouting	Drum fil
	Airlock Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Drum fil
	Tilt & Pan Cameras (14 required)	N	G	Camera	w/zoom capability	Grouting	Drum fil
Grout Curing Room							
	Inlet Staging Enclosure	N	G	Booth	w/windows & access	Grouting	Curing
	Inlet Staging Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	Drum Lift Enclosure	N	G	Booth	w/windows & access	Grouting	Curing
	Drum Lift	N	G	Lift	4 ft lift	Grouting	Curing
	Drum Lift Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	Cure Line Enclosure	N	G	Booth	w/windows & access	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	180 Degree Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Cure Line Conveyor	N	G	Conveyor	Chain driven	Grouting	Curing
	Drum Lift Enclosure	N	G	Booth	w/windows & access	Grouting	Curing
	Drum Lift	N	G	Lift	4 ft lift	Grouting	Curing
	Drum Lift Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	Staging Conveyor	N	G	Conveyor	Selfpowered rollers	Grouting	Curing
	Drum Elevator Enclosure	N	G	Booth	w/windows & access	Grouting	Curing
	Drum Elevator Door	N	G	Door	Electric motor driven	Grouting	Curing
	Drum Elevator to 2nd Floor	N	G	Lift	12 ft lift	Grouting	Curing
Grout Dewatering Room							
	Inlet Indexing Lift Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Dewater
	Indexing Lift Table	N	G	Lift		Grouting	Dewater

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Grouting Equipment List

10/28/98

Indicated scenario.			Size					Electrical Requirements		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	(W)	(HP)		
	9			3	3			1,200			
	9			3	3			1,200			
	9			3	3			1,200			
	9			24	3			9,000			
	9			3	3				2.50		
	9			3	3				2.50		
	9			3	3				2.50		
	9									7 ga SST	
	9							0.50		SST	
	9							0.50		SST	
	9			5	3			1,800			
	9							5,600			
	10									7 ga. SST	
	10			6	6			1,200		SST	
	10									7 ga. SST	
	10			3	3				1.50	SST	
	10			3	3			1,200		SST	
	10									7 ga. SST	
	10			6	3			1,200		SST	
	10			6	3			1,200		SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10				9				2.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10			13	3				1.00	SST	
	10									7 ga. SST	
	10			3	3				1.50	SST	
	10			3	3			1,200		SST	
	10			1.5	3			400		SST	
	10									7 ga. SST	
	10								0.50	SST	
	10			3	3				2.00	SST	
	10			3	3			1,200		SST	
	10				1.5				2.00	SST	

N - New CsIX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part

Equipment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Sub
		1 Bldg	2 Bldg				
	Indexing Arm	N	G	Mechanism	Roller assembly arm	Grouting	Dewa
	Dewatering Station Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Dewa
	90 deg Transfer and Lift	N	G	Lift	Chain transfer	Grouting	Dewa
	Dewatering Station Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Dewa
	Air Heaters (9 ea.)	N	G	Heater		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Dewatering Station Line Lift	N	G	Lift		Grouting	Dewa
	Drum Off Load Conveyor	N	G	Conveyor	Self powered rollers	Grouting	Dewa
	90 deg Transfer and Lift	N	G	Lift	Chain transfer	Grouting	Dewa
	Hydraulic Drum Lift	N	G	Lift		Grouting	Dewa
E-104	Vapor Condenser	N	G	Condenser	Shell & tube	Grouting	Dewa
P-118	Condensate Pump	N	G	Pump	Centrifugal	Grouting	Dewa
Grout Recycle Station							
	Oven	N	G	Oven	Moderate Temperature	Grouting	Grout I
E-105	Vapor Condenser	N	G	Condenser	Shell & tube	Grouting	Grout r
Decontamination/Waste Water Equipment							
T-102	DI Water Feed Tank	N	G	Tank	Flat bottom	Decon/Wash	
T-109	Decontamination Agent Acid	N	n/a	Tank		Decon/Wash	
T-109*	Decontamination Agent Acid	n/a	NWCF	Tank	Existing VES-NCM-117	Decon/Wash	
T-110	Decontamination Agent Base	N	n/a	Tank		Decon/Wash	
T-110*	Decontamination Agent Acid	n/a	NWCF	Tank	Existing VES-NCM-118	Decon/Wash	
P-102A	DI Water Pump	N	G	Pump	Centrifugal	Decon/Wash	
P-102B	DI Water Pump	N	G	Pump	Centrifugal	Decon/Wash	
P-108	Acid Decon Pump	N	G	Pump	Centrifugal	Decon/Wash	
P-108*	Acid Decon Pump	n/a	NWCF	Pump	Existing P-NCM-217	Decon/Wash	
P-109	Base Decon Pump	N	G	Pump	Centrifugal	Decon/Wash	
P-109*	Base Decon Pump	na	NWCF	Pump	Existing P-NCM-218	Decon/Wash	
T-111	Waste Water Tank	N	G	Tank	Horizontal cylindrical	Waste water	Waste t
T-111*	Waste Water Tank	n/a	NWCF	Tank	Existing VES-NCC-119	Waste water	Waste t
T-111*	Waste Water Tank	n/a	NWCF	Tank	Existing VES-NCC-122	Waste water	Waste t
P-111A	Waste Water Pump	N	G	Pump	Centrifugal	Waste water	
P-111B	Waste Water Pump	N	G	Pump	Centrifugal	Waste water	
P-111*	Waste Water Pump	n/a	NWCF	Pump	Existing JET-NCC-519	Waste water	
P-117	Decon Return Pump	N	G	Pump	Centrifugal	Decon/Wash	Drum fil
HVAC Equipment for the New CsIX/Grout Bldg or New Grout Bldg							
E-103	VOG Condenser	N	G	Condenser		HVAC	Offgas
V-101	VOG Vapor Demister	N	G	Column		HVAC	Offgas
EH-101	VOG Superheater	N	G	Superheater		HVAC	Offgas
F-103	HEPA Prefilter	N	G	Filter		HVAC	Offgas
F-104A	HEPA Filter (Stage 1)	N	G	Filter		HVAC	Offgas

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Grouting Equipment List

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Indicated scenario.			Size					Electrical		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	Requirements (W)	(HP)		
ng	10										
ng	10			30	3			5,600		SST	
ng	10			3	3				1.50	SST	
ng	10			3	3			1,200		SST	
ng	10							900			
ng	10								0.50	SST	
ng	10										
ng	10										
ng	10										
ng	10										
ng	10										
ng	10										
ng	10			10	3			2,200		SST	
ng	10			3	3				1.50	SST	
ng	10		2 Kg/hr	2	2	4				SST	
ng	10		4 l/min	3	2	3				SST	
cycle	11										
cycle	11		2 Kg/hr	2	2	4				SST	
	2		4		5	8				FW Plastic	
	2		4		5	8				SST	
	2		4		5	8					
	2		4		5	8				SST	
	2		4		5	8					
	2		420 l/min	4	3	3				SST	
	2		420 l/min	4	3	3				SST	
	2		20 l/min	3	2	3				SST	
	2										
	2		20 l/min	3	2	3				SST	
	2										
ed	3		19	14	8					SST	
ed	3										
ed	3										
	3		76 l/min	4	2	3				SST	
	3		76 l/min	4	2	3				SST	
	9		20 l/min	3	2	3				SST	
	12										
	12										
	12									SST	
	12				2	2				SST	
	12										

N - New CsIX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equipment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subsy
		1 Bldg	2 Bldg				
F-104B	HEPA Filter (Stage 2)	N	G	Filter		HVAC	Offgas
BL-101A	Off Gas Blower	N	G	Blower		HVAC	Offgas
BL-101B	Off Gas Blower	N	G	Blower		HVAC	Offgas
	Heating Coils	N	G	Heating Coil Steam		HVAC	Zone 2
	Rough Prefilter	N	G	Filter		HVAC	Zone 2
	Zone 2 HEPA Filter Housing	N	G	Filter	2x5 redundant	HVAC	Zone 2
	Zone 2 HEPA Filter Housing	N	G	Filter	2x5 redundant	HVAC	Zone 2
	Zone 2 Supply Fan	N	n/a	Blower	10500 cfm @ 3.4" W.C	HVAC	Zone 2
	Zone 2 Supply Fan	N	n/a	Blower	10500 cfm @ 3.4" W.C	HVAC	Zone 2
	Zone 3 Exhaust Fan	N	n/a	Blower	9500 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Exhaust Fan	N	n/a	Blower	9500 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Exhaust HEPA Filter	N	n/a	Filter	2x5 redundant	HVAC	Zone3
	Zone 3 Exhaust HEPA Filter	N	n/a	Filter	2x5 redundant	HVAC	Zone3
	Zone 3 Inlet Fan	N	n/a	Blower	10500 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Inlet Fan	N	n/a	Blower	10500 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Supply HEPA Filter	N	n/a	Filter	2x5 redundant	HVAC	Zone3
	Zone 3 Supply HEPA Filter	N	n/a	Filter	2x5 redundant	HVAC	Zone3
	Office Space HVAC Unit	n/a	G	HVAC Unit	Pkged unit, 400 cfm, 1T	HVAC	Office
	Zone 2 Supply Fan	n/a	G	Blower	6,400 cfm @ 3.4" W.C.	HVAC	Zone 2
	Zone 2 Supply Fan	n/a	G	Blower	6,400 cfm @ 3.4" W.C.	HVAC	Zone 2
	Zone 3 Exhaust Fan	n/a	G	Blower	3400 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Exhaust Fan	n/a	G	Blower	3400 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Exhaust HEPA Filter	n/a	G	Filter	2x2 redundant	HVAC	Zone3
	Zone 3 Exhaust HEPA Filter	n/a	G	Filter	2x2 redundant	HVAC	Zone3
	Zone 3 Inlet Fan	n/a	G	Blower	6400 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Inlet Fan	n/a	G	Blower	6400 cfm @ 6.75" W.C.	HVAC	Zone3
	Zone 3 Supply HEPA Filter	n/a	G	Filter	2x3 redundant	HVAC	Zone3
	Zone 3 Supply HEPA Filter	n/a	G	Filter	2x3 redundant	HVAC	Zone3
Existing HVAC Equipment in NWCF							
E-103*	VOG Condenser	n/a	NWCF	Condenser	Existing HE-NCC-336	HVAC	Offgas
V-101*	VOG Vapor Demister	n/a	NWCF	Column	Existing VES-NCC-1360	HVAC	Offgas
EH-101*	VOG Superheater	n/a	NWCF	Superheater	Existing HE-NCC-335	HVAC	Offgas
F-103/104	HEPA Prefilter & Filter	n/a	NWCF	Filter	Existing F-NCC-130	HVAC	Offgas
BL-101*	Off Gas Blower	n/a	NWCF	Blower	Existing BLO-NCC-242	HVAC	Offgas
Electrical Equipment							
	Motor Control Center	N	G	Electrical			
	UPS	N	G	Electrical	30-50 kVA		
Cranes, PAR's & Manipulators							
	UDS Unloading Area Crane	N	NWCF	Crane		UDS	Operatic
	P&V Corridor Crane	N	G	Crane		Operations	
	Cell Hatch Crane	N	G	Crane		Operations	
	Maintenance Monorail	N	G	Crane		Operations	
	P&V Corridor PAR	N	n/a	Crane		Operations	
	Maintenance PAR	N	n/a	Crane		Operations	
	UDS Drying Cell Manipulator	N	n/a	Manipulator		UDS	Mainten
	Waste Resin Cell Manipulator	N	n/a	Manipulator		Ion exchange	Mainten
	TRUPACT Building Crane	S	S	Crane	10 ton bridge crane	Trupact	Interim S

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

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N - New CslX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part

Equipment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Sub
		1 Bldg	2 Bldg				
	TRUPACT Building Crane	S	S	Crane	10 ton bridge crane	Trupact	Interim
Miscellaneous Equipment							
	Freight Elevator	N	G	Lift		Operations	
	Drum Movement Forklift	N	G	Forklift		Drum movement	
	Drum Storage Forklift	S	S	Forklift		Drum storage	
	Drum Movement Lifting Fixtures	N	G	Mechanism		Drum movement	
	Drum Movement Lifting Fixtures	S	S	Mechanism		Drum movement	
Head Space Sampling & Video Inspection (Storage Building)							
	Inlet/Load Conveyor	S	S	Conveyor	Chain drive	Inspection	Interim
	Index Table Conveyor	S	S	Conveyor	Self powered rollers	Inspection	Interim
	Index Lift Table	S	S	Mechanism		Inspection	Interim
	Index Arm	S	S	Mechanism		Inspection	Interim
	Airlock	S	S	Booth		Inspection	Interim
	Airlock Door	S	S	Door	Electric motor driven	Inspection	Interim
	Airlock Door	S	S	Door	Electric motor driven	Inspection	Interim
	Airlock Conveyor	S	S	Conveyor	Self powered rollers	Inspection	Interim
	Glovebox	S	S	Booth	w/window & HEPA	Inspection	Interim
	Glovebox Inlet Door	S	S	Door	Electric motor driven	Inspection	Interim
	Glovebox Conveyor	S	S	Conveyor	Self powered rollers	Inspection	Interim
	Video Camera	S	S	Camera	Hardened, rotatable	Inspection	Interim
	Headspace Sample Tube	S	S	Mechanism		Inspection	Interim
	Mechanical Swip Arm	S	S	Mechanism	Auto swipe, remote	Inspection	Interim
	Hood Enclosure	S	S	Booth	Clear	Inspection	Interim
	Filter Removal Arm	S	S	Mechanism	Automated	Inspection	Interim
	Filter Install Arm	S	S	Mechanism	Automated	Inspection	Interim
	Glovebox Outlet Door	S	S	Door	Electric motor driven	Inspection	Interim
	Airlock	S	S	Booth		Inspection	Interim
	Airlock Door	S	S	Door	Electric motor driven	Inspection	Interim
	Airlock Door	S	S	Door	Electric motor driven	Inspection	Interim
	Airlock Conveyor	S	S	Conveyor	Self powered rollers	Inspection	Interim
	Unload Conveyor	S	S	Conveyor	Chain drive	Inspection	Interim
	Glovebox Exhaust Fan	S	S	Blower	One on backup power	Inspection	HVAC
	Glovebox Exhaust Fan	S	S	Blower		Inspection	HVAC
	Airlock Exhaust Fan	S	S	Blower	One on backup power	Inspection	HVAC
	Airlock Exhaust Fan	S	S	Blower		Inspection	HVAC
	Video Control Panel	S	S	Mechanism		Inspection	Interim
HVAC Equipment for the New Storage Bldg							
	Interim Storage Air Handler	S	S	HVAC Unit	3200 cfm @ 2.75" S.P.	Interim Storage HVAC	
	Interim Storage Condenser (10T)	S	S	Condenser	Air cooled, pad mount	Interim Storage HVAC	
	Interim Storage Exhaust Fan	S	S	Blower	1400 cfm, 2 speed	Interim Storage HVAC	
	Interim Storage Exhaust Fan	S	S	Blower	1400 cfm, 2 speed	Interim Storage HVAC	
TRUPACT II Building							
	Stretch Wrap Machines	S	S	Mechanism		Trupact	Interim
	Stretch Wrap Machines	S	S	Mechanism		Trupact	Interim
	Pallet Weight Machine	S	S	Mechanism		Trupact	Interim
	Pallet Weight Machine	S	S	Mechanism		Trupact	Interim
	Vacuum Pump	S	S	Mechanism	34 cfm	Trupact	Interim

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Grouting Equipment List

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Indicated scenario.			Size					Electrical		Material	Radiation Field
Item	Flow Diag Drawing Number	Ref Dwg	Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	Requirements (W)	(HP)		
Storage			10T								
Storage				10	3				2.00	SST	
Storage				3	3			1,200		SST	
Storage					1.5				2.00	SST	
Storage											
Storage										7 ga. SST	
Storage									0.50	SST	
Storage									0.50	SST	
Storage				4	3			1,600		SST	
Storage										7 ga. SST	
Storage									0.50	SST	
Storage				5	3			2,000		SST	
Storage								1,500			
Storage											
Storage								3,000			
Storage										Plastic	
Storage								400		SST	
Storage								400		SST	
Storage											
Storage										7 ga. SST	
Storage									0.50	SST	
Storage									0.50	SST	
Storage				4	3			1,600		SST	
Storage				10	3				2.00	SST	
									2.00		
									2.00		
									1.00		
									1.00		
Storage											
								10,200			
									7.50		
									7.50		
Storage				6	6						
Storage				6	6						
Storage				4	4						
Storage				4	4						
Storage									1.50		

N - New CslX/Grout Bldg, G - New Grout Bldg, NWCF - Existing Waste Calcining Facility, S - New Storage Bldg, n/a - not a part of

Equip- ment Number	Equipment Name	Scenario		Equipment Type	Additional Description	Main System	Subsy
		1 Bldg	2 Bldg				
	Vacuum Pump	S	S	Mechanism	34 cfm	Trupact	Interim S
	12 Electric Unit Heaters	S	S	HVAC Unit	20 Kw	Trupact	Interim S
	Exhaust Fan	S	S	Blower	Sidewall, 2 speed	Trupact	Interim S
	Exhaust Fan	S	S	Blower	Sidewall, 2 speed	Trupact	Interim S

TOTALS

The Scenario # Bldg columns indicate the building location of equipment for each scenario.

Routing Equipment List

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licated scenario.

m	Flow Diag Drawing Number	Ref Dwg	Size					Electrical Requirements		Material	Radiation Field
			Capacity (cu. meter or noted)	Length (ft)	Width or Dia. (ft)	Height (ft)	Weight (lbs)	(W)	(HP)		
rage									1.50		
rage								20,000			
rage									0.50		
rage									0.50		
								110,300	246		

Appendix G
List of Applicable Regulations, Codes, and Standards

Reference	Title	Applies to
Code of Federal Regulations		
10 CFR 435	Energy Conservation Voluntary Performance Standards for New Buildings, Mandatory for Federal Buildings	H&V system, lighting systems, building insulation.
10 CFR 820	Procedural Rules for DOE Nuclear Activities	Procedures
10 CFR 830.120	Quality Assurance Requirements for 10 CFR 835	Quality assurance activities
10 CFR 835	Occupational Radiation Protection	Radiation protection for occupational workers
10 CFR 1021	National Environmental Policy Act (NEPA) Implementing Procedures (Also in DOE O 5440.1D and 40 CFR 1500-1508)	Project pollution prevention systems
10 CFR 1046	Physical Protection of Security Interests	Security systems
20 CFR 1910	Occupational Safety and Health Standards for General Industry	Total facility and supporting systems
29 CFR 1926	Occupational Safety and Health Regulations for Construction	Construction of facility and supporting systems
40 CFR 61	National Emission Standards for Hazardous Air Pollutants	Air pollution control and monitoring systems
40 CFR 191	Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes	Radiation confinement structures and systems
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (IDAPA 16.01.05.008)	Regulatory requirements for design, construction and operation of the facility
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Storage, Treatment and Disposal Facilities	Operational procedures, and design requirements.
40 CFR 270.14	Contents of Part B: General Requirements	Interim storage facility design
State of Idaho, Statutes, Rules and Regulations		
Idaho Code 39-44	Hazardous Waste Management Act	Control of hazardous waste
IDAPA 16.01.01	Rules for the Control of Air Pollution in Idaho	Air pollution control equipment
IDAPA 16.01.01.161	Toxic Substances	Control of toxic substances
IDAPA 16.01.01.210	Demonstration of Reconstruction Compliance with Toxic Standards	Control of hazardous waste
IDAPA 16.01.01.575	Air Quality Standards and Area Classification	Air pollution control equipment

Appendix G

Regulations, Codes and Standards

Reference	Title	Applies to
IDAPA 16.01.01.650	Rules for Control of Fugitive Dust	Construction or demolition activities
IDAPA 16.01.02	Water Quality Standards and Wastewater Treatment	Waste water system
IDAPA 16.01.05	Rules and Standards for Hazardous Waste	RCRA regulations as adopted by the State of Idaho
IDAPA 16.01.08	Idaho Rules for Public Drinking Water Systems	Potable water utility system
IDAPA 16.01.09	Idaho Radiation Control Rules	Worker protection, radiation shielding
DOE Orders		
DOE O 151.1	Comprehensive Emergency Management System	Facility emergency plans
DOE O 420.1	Facility Safety	Criticality control, fire protection, design for natural phenomena
DOE O 430.1	Life Cycle Cost Asset Management	Facility design criteria
DOE O 430.2	In House Energy Management	H&V System
DOE O 435.1 (Draft)	Radioactive Waste Management	Replaces DOE 5820.2A when approved and incorporated into the site contract.
DOE O 440.1	Worker Protection Management for DOE Federal and Contractor Employees	Systems to protect employees
DOE 460.1A	Packaging and Transportation Safety	Packaging system
DOE 5400.1	General Environmental Protection Requirements	Environmental protection features
DOE 5400.5	Radiation Protection of the Public and the Environment	Features to limit radiation dose to the public
DOE 5480.4	Environmental Protection, Safety, and Health Protection Standards	Requires compliance to the OSHA standards
DOE 5480.7A	Fire Protection	
DOE 5480.11	Radiation Protection for Occupational Workers	Replaced by 10 CFR 835.
DOE 5480.19	Conduct of Operations Requirements for DOE Facilities	Operational procedures
DOE 5480.20A	Personnel Selection, Qualification and Training Requirements for DOE Nuclear Facilities	Requirements for personnel
DOE 5480.21	Unreviewed Safety Questions	Safety issues
DOE 5480.22	Technical Safety Requirements	Safety features
DOE 5480.23	Nuclear Safety Analysis Reports	Safety analysis
DOE 5480.28	Natural Phenomena Hazard Mitigation	Design of structures, systems and components to resist natural phenomena

Appendix G

Regulations, Codes and Standards

Reference	Title	Applies to
DOE 5481.1B	Environmental, Safety, and Health Program for DOE Operations	Safety analysis
DOE 5700.6C	Quality Assurance	Quality assurance activities
DOE 5820.2A	Radioactive Waste Management	Appropriate documentation of features for radioactive waste management

See Note 3.

DOE-ID References

DOE-ID AES	DOE-ID Architectural Engineering Standards (AES)	Total Facility and supporting systems
	INEEL Radiological Control Manual	Worker protection, radiation shielding
	INEEL Welding Manual	On-site welding

DOE Standards and Guides for Use in Complying with DOE Orders

DOE STD 1027	Hazard Categorization and Accident Analysis Techniques	Compliance with DOE 5480.23
DOE STD 3007	Guidelines for Preparing Criticality Safety Evaluations at DOE Non-Reactor Nuclear Facilities	Safety analysis/evaluations
DOE STD 3009	Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports	Safety analysis

DOE Standards and Guides Imposed by the DOE-ID AES

DOE STD 1020	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities	Facility and system design for natural phenomena
DOE STD 1021	Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components (SSC).	Categorization of SSC's for design per DOE STD 1020
DOE STD 1061	Fire Protection Design Criteria	Fire protection systems and facility materials
DOE HDBK 1062	DOE Fire Protection Handbook	Fire protection systems

National Codes and Standards Imposed by the DOE-ID AES

	Site and Civil	
AASHTO	Geometric Design of Highways and Streets	Geometric design of roads, streets, access drives and parking lots
	Architectural	
FM	Factory Mutual Engineering Association Approval Guide	Facility materials and construction
FM 1-28	Wind Loads to Roof Systems and Roof Deck Securement	Loading on roof systems

Appendix G Regulations, Codes and Standards

Reference	Title	Applies to
ICBO UBC	Uniform Building Code	Systems, structures and components not covered by other codes or standards
NFPA 80	Fire Doors and Windows	Fire doors and windows
NFPA 101	Life Safety Code	Life safety systems, building layout
UL	Underwriters Laboratories Fire Resistance Directory	Facility construction and materials and applicable equipment.
	Structural	
AISC (ASD)	Specification for Structural Steel Buildings (or)	Structural steel
AISC (LRFD)	LRFD Specification for Structural Steel Buildings	Structural steel
ACI 318	Building Code Requirements for Reinforced Concrete	Non-safety related concrete
ACI 349	Code Requirements for Nuclear Safety Related Concrete Structures	Safety related concrete structures
ANSI/AISC N690	Specification for the Design, Fabrication, and Erection of Steel Safety Related Structures of Nuclear Facilities	Safety related structural steel
ANSI/ASCE 4	Seismic Analysis of Safety-Related Nuclear Structures (optional)	Seismic analysis of safety related structures
ANSI/ASCE 7	Minimum Design Loads for Buildings and Other Structures	Building design loads
AWS D1.1	Structural Welding Code - Steel	Welding of structural steel
	Mechanical (General)	
IAPMCO/ICBO	Uniform Mechanical Code	Mechanical systems not covered by other standards
	Mechanical (Piping Systems and Vessels)	
ANSI B31.1	Power Piping	Steam and condensate piping systems not covered by B31.9.
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping	Process piping systems
ANSI B31.9	Building Service Piping	Building service piping systems (nonpotable water, air, etc.)
ASME	Boiler and Pressure Vessel Codes	Pressure vessels
	Mechanical (HVAC Systems)	
ASHRAE 90	Efficient Design of New Buildings Except Low-Rise Residential Buildings	HVAC systems
IAPMCO UPC	Uniform Plumbing Code	Plumbing systems (potable water, sewer) within the facility

Appendix G

Regulations, Codes and Standards

Reference	Title	Applies to
NFPA 90	Standard for the Installation of Air Conditioning and Ventilating System Mechanical (Cranes and Hoists)	HVAC systems
ANSI B30.16	Overhead Hoists (Underhung)	Overhead hoists
ASME B30.2	Overhead and Gantry Cranes	Cranes
ASME NOG-1	Rules for Construction of Overhead and Gantry Cranes	Overhead cranes carrying nuclear material
CMAA 70	Specification for Electrical Overhead Traveling Cranes	Overhead electrical cranes not covered by CMAA 74.
CMAA 74	Specification for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes	Single girder overhead cranes
	Fire Protection	
ICBO UFC	Uniform Fire Code	Fire protection systems
NFPA 13	Installation of Sprinkler Systems	Fire sprinkler system
NFPA 24	Installation of Private Fire Service Mains and Their Appurtenances	Firewater supply system
	Electrical	
ANSI C2	National Electrical Safety Code (NESC)	Electrical systems
IES	Lighting Handbook	Lighting system
NFPA 70	National Electrical Code	Electrical systems
NFPA 72	National Fire Alarm Code	Fire alarms, emergency notification system
NFPA 780	Lightning Protection Code	Lightning protection
	Radiation Monitoring	
ANSI N42.17 Series	Radiation Instrumentation Performance Specifications for Health Physics Instrumentation	Radiation monitoring equipment
Other National Codes and Standards Applicable to this Project		
	Mechanical (HVAC systems)	
ANSI/ASME N509	Nuclear Power Plant Air Cleaning Units and Components	HVAC systems for primary and secondary containment
ANSI/ASME N510	Testing of Nuclear Air Cleaning Systems	HVAC systems for primary and secondary containment
	Fire Protection	
NFPA 801	Facilities Handling Radioactive Materials	Fire protection systems, and materials
	Electrical	
NFPA 110	Emergency and Standby Power Systems	Emergency and standby power systems

Note 1. Additional requirements that will affect this project are found in EDF-WTS-003, Regulatory Requirements for the Design, Construction, and Operations of the ICPP Proposed Waste Processing Facilities

Note 2. Additional information is also found in EDF-WTS-004, Regulatory and Design Requirements for Waste Treatment Facilities.

Note 3. DOE 6430.1A is currently imposed by the LMITCO/DOE contract “for specific facilities under the purview of the Defense Nuclear Facilities Safety Board”. However, it will not apply after 10 CFR 830.340 and DOE O 420.1 are finalized and incorporated into the contract. It may be used as a guide for design but it will not be used as a requirement for this project.