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Direct Cementitious Waste Option Study Report

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ABSTRACT

A settlement agreement between the Department of Energy (DOE) and the State of Idaho mandates that all high-level radioactive waste (HLW) now stored at the Idaho Chemical Processing Plant (ICPP) will be treated so that it is ready to be moved out of Idaho for disposal by a target date of 2035. This study investigates the direct grouting of all ICPP calcine (including the HLW dry calcine and those resulting from calcining sodium-bearing liquid waste currently residing in the ICPP storage tanks) as the treatment method to comply with the settlement agreement. This method involves grouting the calcined waste and casting the resulting hydroceramic grout into stainless steel canisters. These canisters will be stored at the Idaho National Engineering and Environmental Laboratory (INEEL) until they are sent to a national geological repository. The operating period for grouting treatment will be from 2013 through 2032, and all the HLW will be treated and in interim storage by the end of 2032.

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SUMMARY

Treatment of high-level radioactive wastes at the Idaho Chemical Processing Plant (ICPP) at the Idaho National Engineering and Environmental Laboratory (INEEL) is mandated under a settlement agreement between the Department of Energy (DOE) and the State of Idaho. Among other things, the settlement agreement requires that this treated HLW be ready to be moved out of Idaho for disposal by a target date of 2035.

To comply with the settlement agreement, the INEEL proposes a treatment where the existing liquid Sodium Bearing Waste would be calcined and added to the other HLW calcine presently in the Calcined Solids Storage Facility (CSSF) at the ICPP. This calcine would be mixed with clay, blast furnace slag, caustic soda, and water such that analogs of naturally occurring feldspathoids/zeolites are generated. This grout mix would be extruded into stainless steel canisters where a curing process would produce a structurally sound and geologically stable hydroceramic waste product. The canister used would be the Savannah River Site (SRS) Defense Waste Plant Facility (DWPF) 61 cm (24 in.) diameter by 3 m (10 ft) long stainless steel canister. This treatment option is called the Nonseparations Alternative, Direct Cementitious Waste Option (DCWO).

This study investigated the processes and equipment for (a) retrieving calcine from the CSSF using a calcine retrieval and transport system (CRTS), (b) receiving and handling the grout ingredients, (c) grout mixing, (d) canister filling, (e) grout curing, (f) canister closure and decontamination, and (g) canister delivery to an ICPP interim storage facility (ISF). The study discussed possible disposal sites, but because disposal is not part of the study, disposal costs are not included.

The objective of this study is to obtain bounding scoping data — process, facility layout, and costs — for the DCWO and provide information on potential environmental impacts. Costs included are for calcine retrieval and transport, a grouting facility, interim storage, and utilities. The operating period for these activities is expected to be from January 2013, the start of grouting facility operations, to December 2032, the end of grouting facility operations. Additional effort was made to provide bounding scoping data for, and specific to, the nonseparations cementitious waste option (CWO) study.

While performing this study, various possibilities were researched and assumptions made about the grouted waste (its composition, physical properties, and total volume), the proposed grouting facility, and requirements and regulations that apply. Costs were estimated for facilities, process equipment, and operations. Project risks were identified and evaluated and failure modes were noted. Project data were estimated and summarized.

Requirements, assumptions, suggested designs, analyzed risks, impacts, and costs are documented and included in this report. Detailed discussions and information on assumptions, operations, regulations, costs, designs, and risks are attached to this report as appendices.

The CWO also made an evaluation of a hot isostatic process (HIP), added to the CWO process, designed to reduce final waste form volume and provide a waste form similar to vitrified glass. This study made a qualitative comparison to the CWO study for a similar HIPO variation to the DCWO process.

The study indicates, at a preliminary level, a reasonableness to continue evaluation of the DCWO, and that the calcine can be processed into a grout form and placed into interim storage within a 20-year operating cycle which will support the time requirements of the settlement agreement. Major show stoppers come from issues outside the bounds of this study, but of significant importance, and are related to final waste form acceptance and disposal location.

The basic technology used in the DCWO is well developed with applied research on similar wastes occurring as long as 20 years ago. Applied research on INEEL surrogate wastes has recently occurred and significant evidence suggests this technology can be implemented with relatively little development and a perceived low risk of failure.

Approximately 18,000 grout filled canisters (12,860 m^3 of grout product) will be produced if the DCWO treatment process is implemented. One potential advantage of the DCWO is that it does not generate a process derived low level waste nor a large secondary low level fraction waste, partly because of recycling process waste water.

The total cost for the DCWO follow and include the calcine retrieval and transport system, the grouting facility, interim storage, and utilities:

- Total cost (unescalated) is $2,749,004,000
- Total cost (w/escalation, mgmt reserve, & contingency) is $7,382,526,000
- Discounted cost (escalated) is $1,855,178,000.

Construction and operations to implement the DCWO could result in some minor potential environmental impacts. However, no specific impact was determined to be serious.

The CWO Study Report concluded that the cost of the HIP variation, as a viable waste modification method, is too high to be taken seriously for the value provided. Based on a qualitative comparison, this study concludes the same. This variation was developed in the CWO study to show that it was considered, however it is not considered to be a viable alternative.

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Bob Turk	Life-cycle cost estimate

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ACRONYMS

BNFL	British Nuclear Fuels Limited
CRTS	calcine retrieval and transport system
CSSF	calcined solids storage facility
CWO	cementitious waste option
D&D	decommissioning and dismantlement
DCWO	Direct Cementitious Waste Option
DET	determination of equivalent treatment
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWPF	Defense Waste Plant Facility
EDF	engineering design file
EIS	environmental impact statement
EP1	Encapsulation Plant 1
EPA	Environmental Protection Agency
ES&H	environmental, safety, and health
GC	glass canister
GCD	greater confinement disposal
GCDF	Greater Confinement Disposal Facility
GCDT	Greater Confinement Disposal Test
HAW	high activity waste
HIP	hot isostatic press
HLW	high-level radioactive waste
HWO	Hot Isostatic Pressure Waste Option
ICPP	Idaho Chemical Processing Plant

INEEL	Idaho National Engineering and Environmental Laboratory
ISF	interim storage facility
LAW	low activity waste
LCC	life-cycle cost
LDR	Land Disposal Restriction
LLW	low-level waste
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
NWCF	New Waste Calcining Facility
NWPA	Nuclear Water Policy Amended Act
OCRWM	Office of Civilian Radioactive Waste Management (a DOE office)
PPA	preliminary performance assessment
RCRA	Resource Conservation Recovery Act
SBW	sodium bearing waste
SNF	spent nuclear fuel
SNL	Sandia National Laboratory
SRS	Savannah River Site
S Assumptions	study assumptions
TEC	total estimated cost
UK	United Kingdom
VIC	ventilation, instrumentation, and control
VWO	vitrification waste option
WAC	waste acceptance criteria
WAPS	waste acceptance product specification

WA-SRD	waste acceptance system requirements document
WS Assumptions	work scope assumptions
WTF	waste treatment facilities

Direct Cementitious Waste Option Study Report

1. INTRODUCTION

Treatment of high-level radioactive wastes (HLW) at the Idaho Chemical Processing Plant (ICPP) at the Idaho National Engineering and Environmental Laboratory (INEEL) is mandated under a settlement agreement between the Department of Energy (DOE) and the State of Idaho.[1] The agreement requires that this treated HLW be ready to be moved out of Idaho for disposal by a target date of 2035.

A proposed HLW treatment, known as the separations option, involves dissolving the ICPP calcine followed by separating both the dissolved calcine and the existing liquid sodium bearing waste (SBW) into high-activity waste (HAW) and low-activity waste (LAW). The HAW would be mixed with a glass matrix and poured into canisters to provide a vitrified waste form termed glass canisters (GCs). A number of other possible HLW treatments, known as the nonseparations options, do not separate out the HAW and LAW and include a vitrified waste option (VWO), a hot isostatic pressure waste option (HWO), a cementitious waste option (CWO) involving recalcining of the Al and Zr calcine with the sodium bearing waste (SBW), and a direct cementitious waste option (DCWO).

This study investigated the direct cementitious waste option treatment. The DCWO process includes the direct grouting of ICPP calcine, to include calcined SBW waste, into Savannah River Site (SRS) Defense Waste Plant Facility (DWPF) 0.6 m (24 in.) in diameter by 3 m (10 ft) long HLW stainless steel canisters, and placing the canisters into interim storage to await shipment to a final repository. The operating period for these activities will be 20 years beginning in 2013. The process schematic (HLW Study: Nonseparations alternative direct cementitious waste option), indicating the pathway and the integrated waste volume, is found in Appendix B.

1.1 Background

Calcination is a treatment process performed at the ICPP to transform liquid waste into a more stable granular solid waste form. Past calcining activities produced large calcine inventories now stored in the Calcined Solids Storage Facility (CSSF) at the ICPP. In addition, SBW is stored in the ICPP tank farm. Various possible HLW treatment alternatives are being considered, however, the treatment method considered for this study is the direct grouting (nonseparations option) of the HLW.

The most current information on HLW forms is found in the Waste Acceptance System Requirements Document (WA-SRD)[2] and the Waste Acceptance Product Specifications (WAPS).[3] One of the acceptable waste form containers described is the SRS DWPF 0.6 m (24 in.) in diameter by 3 m (10 ft) long stainless steel canister (Savannah River Site Canister drawing M-1 in Appendix D), similar to that described in reference 4. This canister is the one used in the report in the grouting process to contain the grout and for interim storage.

1.2 Objective and Scope of Work

This study is preliminary to provide basic reasonable cost estimate and environmental impact data for analysis in the INEEL High-Level Waste and Facilities Disposition Environmental Impact Statement (HLW&FD EIS) process. Therefore, all aspects of implementation feasibility for this option have not been considered.

The objective of this study was to determine process systems and facilities for the DCWO; provide environmental impact information for all stages of the facilities and operation life from construction to decommissioning and dismatlement (D&D); and generate construction, capital, and life-cycle cost (LCC) estimates for the systems, facilities, and operations. The DCWO facilities include calcine retrieval and transport facilities, a grouting facility, interim storage, and utilities. The DCWO schedule is based on a 20-year grouting process operating schedule.

The basic scenario for DCWO is:

1. Retrieve calcine, to include calcined SBW liquid

2. Grout the calcine into SRS DWPF 0.6 m (24 in.) in diameter by 3 m (10 ft) long canisters over a 20-year period

3. Send the grout filled canisters to interim storage.

Appendix B includes flow diagrams for the DCWO processes. Drawing C-1 (Appendix D) is a site plan showing the location of the DCWO facilities at the ICPP.

To support the CWO study process and facility design costs for a grouting facility were determined, based on a 5-year grouting process operating schedule. In addition, a simple qualitative process and cost comparison between DCWO and CWO for a HIP variation is included.

To perform this study it was necessary to research possibilities and make assumptions about the grouted waste forms (composition, physical properties, and total volume), the proposed processes for grouting, the related facilities, and the requirements and regulations that will apply. The processes and facilities were developed to a level that would provide adequate information to generate bounding cost estimates and show a reasonableness to continue the DCWO. Costs were estimated for required facilities, equipment, and operations. Project uncertainties were identified and evaluated. Project data were estimated and summarized and include information regarding costs, environmental impacts, energy and water consumption, personnel requirements, and product and waste streams produced. Requirements, assumptions, and conceptual designs were documented in engineering design files (EDFs), which are referenced and included in Appendix E to this report.

Although this study evaluated the processes and facilities for grouting the HLW calcine into SRS DWPF 0.6 m (24 in.) in diameter by 3 m (10 ft) long stainless steel canisters, the decision to proceed with this nonseparations option for HLW treatment must certainly consider many additional factors. The possible scenario presented in this study is just one piece of a larger picture that must include, among other things, transportation and disposal considerations. In particular, disposal criteria that precludes or allows the grouted waste form as a final disposal form could be an important factor. This and all other such considerations were beyond the scope of this study.

2. DESIGN BASIS/KEY ASSUMPTIONS/REQUIREMENTS

2.1 Design Basis

The following subsections detail the design basis for the calcine retrieval and transport system, the grouting process, grouting facility, and interim storage facility are briefly summarized.

The DCWO 20-year processing schedule was chosen to accommodate a reasonable start date and to meet the settlement agreement[1] date to have the high-level waste currently at INEEL treated and ready to be moved out of Idaho for disposal by a target date of 2035.

The CWO process design basis is dictated by factors related specifically to that option, including a shortened time frame and using a modified New Waste Calcining Facility (NWCF). Specifics on the design basis are found in the CWO Study Report.[5] The 5-year grouting facility design basis included in this study was selected to support the CWO study.

2.1.1 Calcine Retrieval

The HLW calcine to be processed in the grouting facility is stored at the ICPP CSSF in seven sets of stainless steel bin sets enclosed in concrete vaults. The calcine retrieval and transportation system (CRTS) is designed to supply calcine from two of the CSSF bin sets simultaneously at a flow rate that is acceptable for calcine processing. The overall design for the system is based on the Fluor-Daniels' design.[5] However, additional design criteria and key assumptions have been included. Details for the design basis are documented in EDF-WTS-002 (Appendix E).

2.1.2 Grouting Process

This process design is based on a hydroceramic stabilization technology developed by Dr. D. D. Seimer and at the INEEL.[6]

In this process, calcined HLW and calcined SBW are combined with clay, blast furnace slag, and caustic soda to generate analogs of naturally occurring feldspathoids/zeolites. The resulting stabilized waste form is structurally sound, geologically stable and not expected to be considered RCRA hazardous waste.[7] Further discussion on the design basis is documented in EDF-DCWO-011 (Appendix E).

The hydroceramic grouting process is unique because it can stabilize relatively high concentrations of soluble salts and moderate to high concentrations of RCRA metals. Both salts and RCRA metals, specifically mercury, are significant components in INEEL calcines. Salt stabilization occurs by chemical reaction of the salt ions, becoming chemically bound in the resulting hydroceramic or zeolitic structure, which is highly insoluble. Stabilization of mercury compounds occurs by a mechanism that is essentially an in situ amalgamation. In the mercury stabilization mechanism, sulfide, from iron sulfide in the blast furnace slag, reacts with mercury to form a highly insoluble mercuric sulfide precipitate.

2.1.2.1 HLW Canister. The HLW container used as the design basis container in this study is the Savannah River Site (SRS) Defense Waste Plant Facility 0.6 m (24 in.) in diameter by 3 m (10 ft) long stainless steel canister, as depicted on drawing M-1 (Appendix D). This canister has been identified in EM-WAPS Rev. 01, Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,[3] May 1995, as an acceptable HLW canister and is being used at SRS in their HLW vitrification process. The WAPS information provides physical requirements and limitations for a HLW container, such as the

SRS DWPF stainless steel canister, which was considered in this study in the grouting process and for interim storage.

EDF-DCWO-010 (Appendix E) documents the total number of canisters to be filled, canister throughput rate in the grouting facility, and canister weight loading.

Although the canister used in this study is based on the 3 m (10 ft) long SRS DWPF canister, the DOE Hanford Facility has been directed to adopt a 4.5 m (15 ft) long canister for containing immobilized HLW. If the 4.5 m (15 ft) canister was used in the DCWO process, facility, equipment and operational changes, for both the grouting and interim storage facilities, would be required to accommodate the longer and heavier canisters. However, the total number of 4.5 m (15 ft) canisters would be approximately two-thirds of the 18,000 3 m (10 ft) canisters. Consideration of the 4.5 m (15 ft) canister is further addressed in Section 10.3, Future Studies.

2.1.3 Grouting Facility

The major facility in the DCWO is the grouting or processing facility. Location of the facility in the Northeast area of the ICPP was chosen for space availability and proximity to the existing CSSF. Facility design is based on the physical needs of the grouting process and equipment chosen and must accommodate the receiving end equipment for the CRTS and interface with the underground tunnel that will connect the grouting facility to the interim storage facility. Description and requirements details are documented in EDF-DCWO-013 (Appendix E).

The total number of canisters to be processed through the grouting facility is approximately 18,000 (12,860 m^3 of grout product) with each canister weighing approximately 1,700 kg (3,748 lb). Throughput capacity, based on 50% up time, for a 5-year grouting schedule is approximately 36 canisters per day or 144 per week on a 4 day per week loading schedule. Throughput capacity for a 20-year grouting schedule is approximately 9 canisters per day or 36 per week on a 4 day per week loading schedule.

2.1.4 Interim Storage Facility

A facility is required near the processing facility to store the grouted HLW from the time it leaves the processing facility until it can be moved to a permanent waste repository. Details on the design basis are found in the Interim Storage Study Report.[8]

2.2 Key Assumptions

The following subsections list the key assumptions used throughout this study. Appendix A offers more detail on these assumptions and their basis. All assumptions used throughout this study fall into one of three categories:

- Work Scope assumptions – could effect the feasibility or are fundamental to the approach used
- Study assumptions – affect the design, cost, or schedule
- Minor assumptions – helped establish a basis for calculations, with no appreciable impact on design or cost.

Assumptions listed below include work scope and study assumptions, while minor assumptions are noted only in EDFs or other pertinent locations where needed.

2.2.1 Work Scope Assumptions

The following work scope (WS) assumptions formed the framework, for this study. Although some of these assumptions are highly subject to change, it is beyond the scope of this study to evaluate the associated risk.

WS-1 The grouting facility will be licensed under 10 CFR 72.[9] RCRA requirements do apply.

WS-2 The RCRA listed wastes in the grouted product will be delisted prior to placement of the grouted product in interim storage. (Reference EDF-WTS-003 in Appendix E)

WS-3 The canister used in forming, containing, and handling the grouted HLW is the one used at the Defense Waste Processing Facility (DWPF) at the Savannah River Site. This canister is fabricated from 24 in. stainless steel pipe and has dimensions of approximately 61 cm outside diameter and 3 m long.

WS-4 The physical characteristics of the grouted HAW will meet or exceed shipment, and storage requirements of DOT and NRC, and will meet DOE definition of road ready when properly packaged in a shipping cask. It is also assumed that the HAW will meet all of the physical requirements necessary to be accepted by potential target repositories.

WS-5 The final waste form package — 61 cm outside diameter x 3 m long canister — will meet the requirements for transportation of HAW under 10 CFR 72 , and DOT 10 CFR 71, as defined by NRC and DOT. (Delisting in Idaho for storage does not automatically delist the waste in all states, therefore, a delisting petition must be granted for each state or region through which the waste will travel on the way to a disposal facility)

WS-6 The grouted waste product will be acceptable at potential target repositories when sealed inside the standard SRS DWPF 61 cm outside diameter by 3 m long HLW canister.

WS-7 The SBW will be calcined prior to the operation of the grouting facility.

WS-8 Existing ICPP utility facilities and facility maintenance capability will be available to support the grouting facility and operations.

WS-9 Analytical/laboratory support will be provided by a new or modified existing facility for which costs are not included in this study.

WS-10 Existing ICPP facility maintenance capability, not unique to grouting operations, will be available to support the grouting facility.

WS-11 New waste generated after 2012 will not be processed by DCWO.

WS-12 Under EPA 40CFR 268.42(b), an equivalency petition for using the DCWO waste treatment technology will be granted by the EPA, thus allowing disposal at Yucca Mountain or an alternative site.

WS-13 Congressional changes to the National Waste Policy Act will be made to allow disposal of HLW somewhere other than Yucca Mountain

2.2.2 Study Assumptions

The following Study (S) Assumptions were identified during the study and used to establish a basis for design and cost:

Note: Data in S-1 through S-4 are based on preliminary data that is incomplete.

S-1 Calcine volume is 5435 m^3 with an average density of 1,408 kg/$m.^3$

S-2 Calcine waste loading is 35 wt% with a grout density of 1,700 kg/m^3 resulting in a grout volume of approximately 13,000 $m.^3$

S-3 Canister loading is 0.72 $m.^3$ The number of canisters produced is approximately 18,000 (12,860 m^3 of grout product).

S-4 The radiation dose rate at contact for the canisters ranges from 4.2 to 287 R/hr.

S-5 For onsite facilities (INEEL), physical security requirements can be met with typical access controls such as card readers and alarmed doors to the facility using the same requirements and systems as used for SNF.

S-6 The maximum number of quality control samples required per grout line per day is one.

S-7 Mercury contained in the calcine is not released during the curing and dewater processes.

S-8 One percent of all canisters processed through the grouting facility will need to be recycled.

S-9 The vendor providing the canisters will be capable of supplying the required quantities to meet the waste production rate and schedule.

S-10 The calcine particle size, and particle size distribution, as delivered to the grouting facility via the calcine retrieval system can be used without further size reduction processing.

2.3 Requirements

2.3.1 Performance

Section C.3 of the settlement agreement[1] between DOE and the State of Idaho states that DOE shall treat all high-level waste currently at INEL so that it is ready to be moved out of Idaho for disposal by a target date of 2035. The DCWO process, as proposed in this study, will start producing grout filled canisters in the grouting facility by 2013 and finish by 2032 which is ahead of the target date.

2.3.2 Design Criteria

Documented in EDF-WTS-004 (Appendix E) are the design requirements for the nonseparations and TRU only separations options for the Waste Treatment Facilities (WTF) feasibility studies. Although this study is only at a scoping level the requirements addressed in the EDF are still relevant. The following information has been extrapolated from the EDF.

The facilities will be designed and constructed under one of three possible regulatory scenarios: (1) performance in accordance with U.S. Department of Energy (DOE) Orders with maintenance of status-quo interfaces with other regulatory and oversight agencies such as the Environmental Protection Agency (EPA) (State of Idaho) and the Defense Nuclear Facilities Safety Board (DNFSB), (2) performance against DOE Orders with all current regulatory/oversight relationships maintained and or Nuclear Regulatory Commission (NRC) oversight to achieve NRC Equivalency (to the intent of NRC regulations) 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.

The EDF identifies the applicable DOE orders, regulations and guidance documents that would be used in the design of the facilities. Currently no NRC regulations exist for licensing waste processing facilities such as those discussed in the EDF. The only WTF activities for which the NRC has been routinely involved is the licensing of waste storage and disposal facilities. In addition, the waste products to be produced are in many cases destined for NRC licensed storage facilities. Therefore, some NRC requirements 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.

The criteria contained in the EDF are based only on the rudimentary descriptions of the processes presented in Section 1.1 of the EDF. Going beyond the scoping level when designs are developed further, some of the criteria may become nonapplicable, and others will be identified. The purpose, as stated in the EDF, is to provide a set of high-level requirements to guide development of the conceptual designs of the facilities and provide a reasonable basis for cost estimating purposes. In general, the EDF does not attempt to cover criteria outside design and construction of the facilities. Process criteria such as the waste form acceptance criteria and treatment standards are addressed in the Waste Disposal Options Feasibility Study.[7]

2.3.3 Regulations

Identification and survey of existing environmental regulations and standard criteria pertaining to design, construction, operations, and performance of the proposed Waste Treatment Facilities at the ICPP, of which the DCWO is included, are documented in EDF-WTS-003 (Appendix E). Also included in the EDF is an assessment of current NRC regulations and their potential applicability to the proposed facilities.

The principal sources of requirements for the design, construction, and operations for the grouting facility are the DOE, the DOE Idaho Operations Office (DOE-ID), the EPA, the Idaho laws and regulations, the National Environmental Policy Act (NEPA), and other local codes and standards.

It is expected that DOE-ID will continue to implement the QA Program described in DOE-RW-0333P,[10] *Quality Assurance Requirements and Description (QARD),* and will apply it to this effort as well. The impact of implementing DOE-RW-0333P is reflected in the capital and operating cost estimates generated by this Study.

It is assumed that the neither the grouting facility nor the CRTS will be NRC licensed, but will be designed and constructed under 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). These facilities will be designed and built to DOE Orders, including 6430.1A, *General Design Criteria.* No current NRC regulations exist for licensing waste processing facilities such as the grouting facility. The interim storage facility, however will be NRC licensed under 10 CFR 72.

The HLW canisters will be NRC licensed for ISF storage under 10 CFR 72, and NRC licensed for transportation in a Type B shipping container under 10 CFR 71.

A radiological evaluation, EDF-HWO-006 (Appendix E), was performed for the HWO Study[11] and is also applicable to this study. Included is a regulatory discussion related to air emissions and area monitoring equipment, hot cell manned entry, and breathing air.

2.3.4 Applicable Codes and Standards

Codes and standards, as may be applicable to the proposed facility, are discussed in detail in both EDF-WTS-003 and EDF-WTS-004 (Appendix E).

Codes and standards related to radiological issues are listed in EDF-HWO-006 (Appendix E).

2.3.5 Repository Waste Acceptance Criteria

The primary disposal location for the DCWO grouted waste is intended to be in a deep alluvial soil structure similar to that found at the Nevada Test Site (NTS). Another possible disposal site would be at a HLW repository such as Yucca Mountain. Although not defined for the DCWO grouted waste, the following subsections discuss repository Waste Acceptance Criteria (WAC) information currently available.

2.3.5.1 Greater Confinement Disposal Facility WAC. A discussion of the WAC for the Greater Confinement Disposal Facility GCDF) at the NTS is found in the *Waste Disposal Operations Feasibility Study, the Environmental Regulations and Standard Repositories Criteria for the Disposal of Waste Forms from the INEEL Proposed High-Level Waste Processing Alternatives,* and *the Preliminary Design of the Nevada Test Site Greater confinement Disposal Facility.* The term greater confinement disposal (GCD) is a disposal strategy that consists of placing the waste in the bottom of deep large diameter boreholes and covering it with soil, clay, gravel, sand, or concrete. The GCD was first developed in the early 1980s as a method of disposing low-level waste (LLW) not suitable for near-surface disposal in shallow land burial (SLB) sites. Hence the name "greater confinement." Traditionally, LLW has been disposed in SLB sites that are less than 98.4 ft (30 m) below the upper surface of the earth. The minimum GCD disposal depth is now equal to or greater than 98.4 ft (30 m) relative to current law. To date, greater-than-class-C (GTCC), TRU, and classified LLW have been disposed in GCDs at the NTS. Also, no waste has been accepted for NTS-GCD disposal since 1989.

Although the Nuclear Waste Policy Amendments Act (MWPAA) mandates Yucca Mountain to get the only disposal site for HLW, the GCDF is being considered for its potential cost savings based on the

assumptions that , (1) the GCDF-WAC will accept the INEEL-grouted and recalcined HLW, (2) the INEEL RCRA listed waste will be de-listed, (3) the classified RCRA waste treated by the grouting process will be acceptable to the GCDF-WAC, and the (4) the canister used for INEEL waste (identical to the SRS DWPF canister design) will meet the GCDF-WAC.

A preliminary performance assessment (PPA) will be required prior to the classification of the NTS-GCDF and the related WAC for HLW disposal. Three previous PPAs were developed for the GCD Test (GCDT) performed on the NTS during the 1980s. The first two were developed before and during the GCDT. The third was developed years after the completion of the test (Preliminary Performance Assessment of the Greater Confinement Disposal Facility at the Nevada Test Site) using established information and collected instrumentation data. The behavior of the GCD site was analyzed using a HLW performance assessment methodology developed at Sandia National Laboratories (SNL) for the NRC. This methodology was used to determine if the GCD site could comply with the EPA's requirements for the disposal of spent nuclear fuel (SNF), HLW, and TRU waste, as set forth in 40 CFR 191. The third and last PPA for the GCDT was concerned with EPA compliance only. Political and legal issues were not considered. Results of the PPA analyses were not conclusive because other factors needed to be determined prior to making a recommendation. The PPA method is only a tool that provides information and data to decisionmakers for final judgements.

Currently the NTS-WAC only accepts LLW and mixed LLW for disposal or storage from waste generators outside the State of Nevada (DOE-NV) prior to waste shipment. Presently, the INEEL is neither a designated nor approved waste generator and must obtain this status prior to any shipment offsite to the NTS. No GCDF-WAC currently exists on the NTS; therefore a GCDF-WAC for HLW must be generated before INEEL waste can be shipped to the NTS for disposal.

2.3.5.2 HLW Repository WAC. A formal waste acceptance criteria (WAC) for the HLW repository does not exist, however, the most current information related to vitrified high-level waste is found in EM-WAPS Rev. 01, Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms,[3] May 1995. The WAPS is derived from the requirements listed in DOE/RW-0351P Revision 02, Waste Acceptance System Requirements Document,[2] December 1996. A summary of the acceptance criteria is documented in the Waste Disposal Options Feasibility Study.[7]

The standard waste form is borosilicate glass, although provisions exist for qualifying other waste forms. However, RCRA hazardous waste is not allowed in the waste form. In addition to waste form requirements, the WAPS information is useful to this study in that it provides physical requirements and limitations associated with the standard 0.6 m (24 in.) in diameter by 3 m (10 ft) long HLW stainless steel canister described in the WAPS.

As detailed in the Waste Disposal Options Feasibility Study,[7] the grouted waste is not a Land Disposal Restriction (LDR)-specified technology and a determination of equivalent treatment (DET) petition would have to be submitted to the EPA, in accordance with 40 CFR 268.42(b),[12] for the grouting method to be acceptable.

3. PROCESS AND SYSTEM DESCRIPTIONS

The DCWO grouting process design is detailed in EDF-DCWO-011 (Appendix E) and includes sections on requirements, process design basis and assumptions, process description, issues and recommendations, process flow diagrams (located in Appendix B for this report), material balances, equipment sizing and list, and utilities. Details related to CRTS, interim storage and the utilities are found in EDF-WTS-002 (Appendix E), reference 8, and reference 13 respectively.

In addition to information for the DCWO 20-year grouting facility and to assist in the generation of the report, the DCWO study includes grouting process and grouting facility design information for a 5-year CWO grouting facility.

In an effort to avoid completing two independent grouting process and facility designs, the approach taken was to design one process and one facility and then scale from that to get the required information for the second process and facility. The model chosen was for the 5-year CWO grouting process and facility because scaling was deemed to be better when applied to a larger process building. The scaling details are documented in EDF-DCWO-015 (Appendix E).

3.1 DCWO Operations

The description is identical for both the 20-year DCWO and 5-year CWO grouting process. Except as noted in this section, the processes described are detailed further and documented in EDF-DCWO-011 (Appendix E).

The proposed process for the DCWO uses a batch method applied to the 10-hour work day. The general processing steps proposed under this study include:

- Receipt of commercial materials for the grout mix
- Receipt of empty SRS DWPF canisters
- Retrieval of the Al, ZR, and SBW calcine from the ICPP CSSF (from the modified NWCF for CWO)
- Mixing and sampling of calcine to determine grout recipe
- Mixing of calcine and recipe ingredients to form grout
- Filling the canisters with grout
- Controlling contamination spread through surface surveys and use of HEPA filters
- Autoclaving the filled canisters to cure the grout
- Dewatering the cured canisters
- Seal welding the canister plug in the top of the canisters
- Verifying fill volume

- Recycling of off-spec product

- Transporting the canisters to interim storage.

Drawing DCWO-00 (Appendix B) includes a block diagram showing the general processing steps listed above. Appendix B also includes process flow diagrams showing more detailed materials flow and processing equipment.

EDF-DCWO-010 (Appendix E) estimates the reasonable maximum number of canisters produced for the DCWO to be 18,000 (12,860 m^3 of grout product). The number of canisters produced in a week is based on a grouting work schedule of four 10 hour days per week. Processes such as the autoclave and dewatering cycles are on a continuous 24–hour schedule.

All operations involving the calcine are performed remotely using robotics for activities such as canister movement, canister manipulation and decontamination surveys and cleaning.

No strategic or critical materials, as listed in the Stockpile Report to the Congress,[14] are used in the process.

3.1.1 Personnel Staffing

An evaluation of personnel required for the 20-year DCWO operating schedule was developed from the personnel required for the 5-year CWO operating schedule and is documented in EDF-DCWO-012 (Appendix E). A total of 140 administrative, technical support, operational, and process maintenance personnel are required. Facility maintenance capability, not unique to the grouting facility operations, is assumed to be available through the existing ICPP infrastructure. Labor costs for this function are included in the DCWO costs. The 5-year CWO evaluation is documented in EDF-DCWO-001. A total of 157 personnel are identified. The differences between the 20-year DCWO and the 5-year CWO schedules occurs most noticeably in the process maintenance personnel. Administrative, operational, and ES&H areas are affected little due to the need to maintain a base staff.

3.1.2 Calcine Retrieval and Transport

Calcine will be removed from a bin and placed in a closed-loop vacuum operated pneumatic transport system. The transport system provides the ability to retrieve from two bins independently, but simultaneously. Calcine retrieval from a single bin is at a rate of 2,700 kg/hr which provides a maximum system rate of 5,400 kg/hr when retrieving from two bins. The system will be remotely operated to reduce worker exposure with a minimization of moving parts to increase system reliability. Delivery times to the grouting facility will be determined by the grouting process weekly schedule and will be continuous until the correct batch quantity has been delivered. When delivery is not required, the retrieval system will be inactive.

Several modifications to Fluor-Daniels' design[4] have been identified to meet the needs of the grouting process. Details of the calcine retrieval process are documented in EDF-WTS-002 (Appendix E).

Calcine retrieval and transport is different for DCWO and CWO as follows:

- Al, Zr, and SBW calcine is sent directly to the DCWO 20-year grouting facility for processing.

- Al and Zr calcine and SBW liquid are sent to the modified NWCF for recalcination with the recalcined material then being sent to the CWO 5-year grouting facility for processing.

3.1.3 Calcine Blending and Sampling

A weeks supply of calcine, approximately 20 $m,^3$ will be blended to provide a homogeneous mix and then mechanically mixed with any recycled and batch bin cleanout materials. A sample will be taken to determine the chemical and physical makeup of the batch so that the recipe for the grout mix can be defined.

A weeks supply of calcine for the CWO 5-year facility would be approximately 80 $m.^3$

3.1.4 Grout Mixing

Once the grout recipe is determined, the calcine blend and the grout ingredients consisting of clay, blast furnace slag, sodium hydroxide, and water are delivered through a series of blenders and mixers to a kneeder extruder for final mixing.

The CWO 5-year facility has four kneeder extruders.

3.1.5 Canister Filling

From the kneeder extruder the grout mixture is delivered to the canister injection head through which the canister is filled. The canister is lifted from its cart to interface with the injection head. During filling, the canister is subjected to a vibration induced by the mechanism used to raise and lower the canister. When filled, the canister is lowered back to its cart. Each canister will be filled with approximately 1,225 kg (2,700 lb) of grout.

The CWO 5-year facility has four canister filling stations.

3.1.6 Contamination Control

Radiological contamination control is maintained throughout the process through the use of engineered building boundaries, filtration systems, and canister surface checks and cleaning. Off-gassing from the various tanks and vessels is routed through a HEPA filtration system. Once the canisters have been filled and before they have their caps welded, they are surface checked and cleaned, if required, followed by the attachment of a HEPA filter to the canister inlet. The HEPA filter remains attached through the curing and dewatering stages.

3.1.7 Grout Curing

Grout curing occurs in saturated steam conditions through an autoclave process operating in the range of 250 ^{0}C (577 psia) to 300 ^{0}C (1,246 psia). Eighteen canisters at a time are placed in the single autoclave which will operate through a 48-hour cycle.

The CWO 5-year facility has four autoclaves.

3.1.8 Dewatering

Following curing, the canisters are removed from the autoclave and sent to the dewatering chambers. Canister movement through the chambers follows a serpentine route with the chambers providing the environment for raising canister temperature to 250 ^{0}C and 25% relative humidity at atmospheric pressure using an airflow through the chambers to carry off the water vapor. Total time in the dewatering cycle is approximately seven days. The chambers are sized to accommodate 50 canisters.

The CWO 5-year facility chambers are sized to accommodate 200 canisters.

3.1.9 Seal Welding

From the dewatering chamber, the canisters travel to the welding room where the canisters' caps are remotely installed and welded in place. After the welding and testing steps are complete, the canisters are once again processed through a decontamination check station for surface surveys and cleaning, if required.

A specific welding process has not been identified, but recognized as being required. Future study on this subject is discussed in Section 10.3.

The CWO 5-year facility has two welding units.

3.1.10 Quality Control

During the canister filling stage, sample coupon(s) are taken for chemical analysis to verify the contents of the batch of grout being processed. These coupons are packaged for delivery to the analytical laboratory. Verification that the canister is properly filled is obtained through the use of sonic tomography. This provides a nonintrusive method to check for voids and determine the height of the grout within the canister.

The CWO 5-year facility has four contamination check stations and four sonic tomography stations.

3.1.11 Off-Spec Product Recycling

Off-spec product is determined from the results of the sample coupons taken and the sonic tomography checks. The coping study assumption is that 1% of the canisters will be recycled as a result of being out-of-spec. Off-spec is not defined in this study, but would include such things as uncured grout, trapped water, an under-filled canister, or as a result of a process upset condition.

Both the 20-year DCWO and 5-year CWO facilities have a single recycling station.

3.1.12 Interim Storage

Canisters that have completed the process through the grouting facility are sent to interim storage via an underground tunnel connecting the grouting and interim storage facilities. Operations at the interim storage facility are presented in the interim storage study report.[8]

3.2 System Descriptions

Location of the DCWO facilities is in the northeast area of ICPP as shown in Drawing A-1 (Appendix D). Based on this location, security perimeter fence upgrades are not required. No environmental nor safety and health needs beyond those of the existing ICPP area were identified.

Cursory and conservative analyses for radiological shielding, thermal output, and criticality issues were performed related to the calcine and the resulting grouted waste form and are noted in flow sheet HLW Nonseparations Alternative Direct Cementitious Waste Option (Appendix B) and documented in EDF-FDO-002 Rev. 1 found in the Waste Disposal Options Feasibility Study.[7] Radiological shielding has been incorporated into the facility designs, however thermal output is negligible and criticality is not a concern.

3.2.1 Calcine Retrieval and Transport

The CRTS facilities system and equipment details are documented in EDF-WTS-002 (Appendix E) and briefly summarized here.

Two structures will be located at each bin set, a confinement structure and a ventilation, instrumentation, and control (VIC) building. The confinement structure, a premanufactured steel building, is a nonreactor nuclear facility placed over a bin set. It provides contamination control through a negative pressure system and houses the local equipment used for calcine retrieval. The VIC building is placed adjacent to the bin set and houses the HVAC, instrumentation, and control equipment which support the retrieval activities in the confinement structure.

Calcine retrieval is provided through the use of two parallel and identical sets of equipment. The main components for each set are a transport air blower, a large sintered metal filter, a cyclone separator, a HEPA filter train, an aftercooler, and a reheater. This equipment is housed in the grouting facility and connected to the CSSF bin sets through stainless steel pipe. Because the air transport system is a closed loop, three lines for each equipment set are used between the bin sets and the cyclone separator, two (4 in. diameter) for delivery of calcine to the grouting facility (one is a spare) and the other (8 in. diameter) for air return to the bin sets. Running at ground level from the bin sets and encased in concrete pipe chases for radiological shielding, the transport lines rise to approximately 150 ft to deliver the calcine to the cyclone separator. Approximately 10% of the transport airflow is exhausted through the grouting facility off-gas system after having been filtered and heated.

The distance between the CSSF and the grouting facility is considered to be greater than what a vacuum transport system can handle. For this study, the cost of an intermediate relay station has been included in the CRTS cost estimate. A future study recommendation on this subject is found in Section 10.3.

3.2.2 Grouting Facility

The grouting facility is designed to house all activities involving the grouting process from receipt of calcine and grout ingredients to preparation of the filled canisters for transfer to the interim storage facility. Description and requirements details for the model CWO 5-year facility are documented in EDF-DCWO-013 (Appendix E). Scaling from this design was used to obtain facility information required to support the cost estimate.

3.2.2.1 Layout. The model design is for the CWO 5-year grouting facility and the drawings in Appendix D depict a building for this schedule. The facility size for the DCWO 20-year grouting facility was scaled from this 5-year facility with the scaling details documented in EDF-DCWO-015 (Appendix E). Due to study limitations, additional drawings for the DCWO 20-year facility were not developed. After adjusting equipment quantities for the grouting process and determining the number of personnel required for a 20-year operation, the related areas of the CWO 5-year facility were scaled down to obtain a square footage relevant to the DCWO 20-year operation. The resulting building square footage for the DCWO 20-year facility is approximately 18,327 m^3 (197,275 ft^2) or 30% of the CWO 5-year facility. The scaling details are documented in EDF-DCWO-015 (Appendix E).

Located in the northeast area of the ICPP as depicted on the site plan drawing C-1 (Appendix D), the facility footprint for the CWO 5-year facility is approximately 58 m (190 ft) by 100 m (330 ft) with an approximate area of 26,607 m^3 (286,400 ft^2). To accommodate the gravity feed systems for the calcine and grout ingredients processes, the facility incorporates seven levels or floors as depicted in drawing A-11 (Appendix D) and is organized into three categories of radiological process, nonradiological process, and service and support facilities as depicted in the architectural (A) drawings (Appendix D).

A detailed description of the CWO 5-year grouting facility layout is documented in EDF-DCWO-013 (Appendix E).

3.2.2.2 Electrical Power. An evaluation of electrical power requirements has been performed for the model CWO 5-year facility and documented in EDF-DCWO-004 (Appendix E). Power requirements for normal, standby, and uninterruptible power supply are included. The major loads are from HVAC and lighting systems.

The estimated connected load for the CWO 5-year facility is 2,157 kVA with projected demand at 1,247 kVA.

The estimate for the 20-year facility is scaled from the CWO 5-year facility to be approximately 1,488 kVA connected with demand at approximately 860 kVA.

3.2.2.3 Instrumentation and Control. An evaluation of the instrumentation and control requirements for the CWO 5-year facility has been performed and documented in EDF-DCWO-002 (Appendix E). All processes will be operated remotely from a control room with a number of operations requiring robotic handling. Due to the automated nature of the facility, approximately 9,800 measurements have been identified.

Scaling for the DCWO 20 facility results in approximately 6,800 measurements.

3.2.2.4 HVAC and Off-Gas. As a minimum, the grouting facility will have three air confinement zones — administration, nonradiological, and radiological areas. The HVAC system is a once through air system where make-up air to the radiological areas comes from the nonradiological areas. Both heating and cooling are provided through the use of steam. All radiological process ventilation and off-gas will be HEPA filtered and exhausted to the atmosphere. A detailed description of the CWO 5-year grouting facility HVAC and off-gas systems is documented in EDF-DCWO-014 (Appendix E) with scaled down information used in the cost estimate for the DCWO 20-year grouting facility.

3.2.2.5 Remote Handling. All processes involving calcine and the grouted waste form will be performed remotely and under computer control. Robotic handling includes radio controlled carts for

canister movement through the grouting facility and canister manipulation at the filling station, decontamination stations, and the recycling station.

3.2.2.6 Radiological Monitoring. Radiological monitoring of stack emissions and certain areas within the grouting facility will be provided and are discussed in EDF-HWO-006 (Appendix E).

3.2.2.7 Fire Protection and Life Safety Systems. Fire protection and life safety systems are included in the facility and will be as required by applicable codes and regulations. These systems have not been discussed nor detailed beyond this section. They are included in the cost estimates.

3.2.3 Grouting Process Equipment

The details, including description and sizing, about the grouting process equipment are documented in EDF-DCWO-011 (Appendix E). Additional information on canister filling, canister HEPA filters, the decontamination stations, the remote cap seal welder, and the canister rail conveying system is documented in EDF-DCWO-009 (Appendix E) and the recycling equipment in EDF-HWO-011 (Appendix E).

3.2.4 Utilities

Utility needs for the DCWO have been identified and are summarized in the following subsections. The scope and cost for new facilities or upgrades to existing facilities for these utilities have not been included in this study, but are included in the Utilities and Infrastructure Study.[13]

3.2.4.1 Electrical Power

The estimated connected load is 2,157 kVA with projected demand at 1,247 kVA for the CWO 5-year grouting facility.

The estimated connected load is 1,488 kVA with projected demand at 860 kVA for the DCWO 20-year grouting facility.

3.2.4.2 Steam

Steam is required for both grouting facility space heating and the grouting process. Sizing/quantity is based on the CWO 5-year grouting facility with approximately 25,000 lb per hour of steam required divided between facility space heating (80%) and the grouting process (20%). Space heating saturated steam condition is considered the same as that generated from the existing ICPP steam plant (150 psia at approximately 181^{0}C). Steam requirements, up to 300^{0}C and 1,246 psia for the grouting process, are beyond the existing ICPP plant capability.

Scaling for the DCWO 20 facility results in a steam requirement of approximately 17,250 lb. per hour.

3.2.4.3 Breathing Air. The use of breathing air has been identified and is discussed in EDF-HWO-006. Specific equipment for the facility breathing air system has not been identified due to the scoping level of this study. However, it is deemed necessary and is included the cost estimate.

3.2.4.4 Plant Air. Specific equipment for the facility plant air has not been identified due to the scoping level of this study. However, it is deemed necessary and is included in the cost estimate.

3.2.4.5 Process Waste. No facilities for process waste will be required as all process waste will be recycled and included in subsequent grout mixtures.

3.2.5 Laboratory

Laboratory requirements are minimal. A sample of the calcine in the Dry Process Lot Tank will be taken at the beginning of each batch and must be analyzed to determine the constituents. This information will be used to determine the ingredients ratios in the grout mix. A sample coupon will be taken once a day from the grout mixture at the grout Injection Head (IJ-408) for chemical analysis.

The CWO 5-year facility will have one coupon for each of its four injection heads.

The scope and cost estimate for the laboratory are not included in this study and will be determined by a future study.

3.2.6 Interim Storage

The interim storage facility and related equipment are discussed and detailed in the Interim Storage Study.[8] Drawings related to the facility are included in that study.

4. COSTS

Two separate cost estimates have been developed for the two different sizes of grouting facilities included in this study. One for the DCWO 20-year grouting facility and the second for the CWO 5-year grouting facility.

Because of process differences between DCWO and CWO, only the grouting facility costs have been included in this report for use in the CWO Study. Calcine retrieval, interim storage, and canister procurement (in the life-cycle costs) for CWO will be different from that listed for DCWO because the calcine is not handled the same and the number of canisters for CWO is less. Although grout recipes will be different between the DCWO and CWO grouting processes, the grouting facility costs relative to process are considered to be comparable.

Table 1 presents the detailed summary costs for the DCWO study. Table 2 presents the detailed summary cost for the CWO 5-year Grouting Facility. Details of the Grouting Facility costs are in Appendix C. Detailed costs for the CRTS, interim storage, and the utilities facilities are found in EDF-WTS-002, reference 8 and reference 13 respectively. TPC is the sum of total estimated cost (TEC) for design and construction plus other project costs (OPC). Other project costs include development, predesign, and post-construction activities and are considered the same for both the DCWO and CWO grouting facilities.

Table 1. Estimated DCWO costs.

Cost Item	CRTS (k$)	Grouting Facility (k$)	Interim Storage (k$)	Utilities (k$)	Total (k$)
OPC (unescalated)	21,267	86,562	16,228	1,422	125,479
OPC Escalation	9,358	12,708	4,138	323	26,527
OPC Mgmt Reserve	0	877	0	0	877
OPC Contingency	10,475	34,853	5,133	455	50,916
Total OPC	**41,100**	**135,000**	**25,500**	**2,200**	**203,799**
TEC (unescalated)	127,031	348,450	451,415	11,983	938,879
TEC Escalation	53,841	102,603	163,984	4,332	324,760
TEC Mgmt Reserve	13,788	32,823	48,663	1,139	96,413
TEC Contingency	51,611	126,124	73,938	3,547	255,220
Total TEC	**246,271**	**610,000**	**738,000**	**21,000**	**1,615,272**
TPC (unescalated)	148,298	435,011	467,644	13,405	1,064,358
TPC Escalation	63,199	115,311	168,122	4,655	351,287
TPC Mgmt Reserve	13,788	33,701	48,663	1,139	97,291
TPC Contingency	62,086	160,977	79,071	4,001	306,135
Total TPC	**287,371**	**745,000**	**763,500**	**23,200**	**1,819,071**
Operations (unescalated)	72,781	1,056,066	206,580	58	1,335,485
Operations Escalation	71,923	1,005,090	371,029	67	1,448,109
Operations Contingency	43,411	618,347	173,283	38	835,079
Total Operations	**188,115**	**2,679,503**	**750,893**	**163**	**3,618,673**
Post Operations (unescalated)	21,960	204,154	122,735	311	349,160
Post Operations Escalation	37,071	345,549	770,341	677	1,153,638
Post Operations Contingency	8,855	164,911	267,923	296	441,985
Total Post Operations	**67,886**	**714,614**	**1,160,998**	**1,284**	**1,944,783**
Total Cost (unescalated)	**243,039**	**1,695,232**	**796,959**	**13,774**	**2,749,004**
Total Cost (w/escalation, mgt reserve, & contingency)	**543,371**	**4,139,117**	**2,675,391**	**24,647**	**7,382,526**
Discounted Cost (escalated)	**196,876**	**1,140,469**	**505,982**	**11,851**	**1,855,178**

Table 2. Estimated CWO grouting facility costs.

Cost Item	Grouting Facility ($)
OPC (unescalated)	86,562
OPC escalation	12,708
OPC Mgmt Reserve	877
OPC Contingency	34,853
Total OPC	**135,000**
TEC (unescalated)	682,374
TEC escalation	216,257
TEC Mgmt Reserve	64,303
TEC Contingency	287,064
Total TEC	**1,250,000**
TPC (unescalated)	768,936
TPC Escalation	228,965
TPC Mgmt Reserve	65,181
TPC Contingency	321,918
Total TPC	**1,385,000**
Operations (unescalated)	404,043
Operations Escalation	234,917
Operations Contingency	191,688
Total Operations	**830,648**
Post Operations (unescalated)	367,385
Post Operations Escalation	286,339
Post Operations Contingency	196,117
Total Post Operations	**849,841**
Total Cost (unescalated)	**1,540,365**
Total Cost (w/escalation, mgt reserve, & contingency)	**3,065,489**
Discounted Cost (escalated)	**1,323,511**

4.1 DCWO HIP Variation

A possible variation to the DCWO process would add a hot isostatic press (HIP) process after the grouting phase and prior to placement of the canistered waste product into interim storage. The HIP variation for DCWO is similar to that discussed in the CWO Study Report.[5] Discussion in this report is of a qualitative nature and only to indicate differences between the HIP variation for CWO and DCWO. The DCWO process directly grouts the calcine waste into SRS DWPF canisters and then places the canisters into interim storage. The HIP variation would directly grout the calcine waste into special HIP containers, process these containers through a HIP process for size reduction, place the size reduced HIP containers into the SRS DWPF canisters, and then place the canisters into interim storage. Costs related to a DCWO HIP variation can be extrapolated from the CWO study report with adjustments made for the following:

- The calcine volume to be processed for CWO is 4,705 m^3 and 5,435 m^3 for DCWO.
- The grouted waste volume for CWO (11,465 m^3) results in approximately 16,000 canisters and the grouted waste volume for DCWO (12,860 m^3) results in approximately 18,000 canisters.
- The DCWO grouting process is on a 20-year schedule. The CWO grouting process is on a 5-year schedule. The HIP variation grouting process schedules are the same.
- The HIP variation process schedule for both DCWO and CWO is 20 years, beginning the same time as the grouting process.
- Canistered HIP containers from the DCWO HIP variation are sent to interim storage as they are produced. To accommodate the CWO HIP variation schedule for the grouting process (5 years) and the HIP process (20 years), HIP containers filled with grout will be temporarily placed into interim storage awaiting the actual HIP process and then the canistered HIP containers will be sent back to interim storage.

5. SCHEDULE

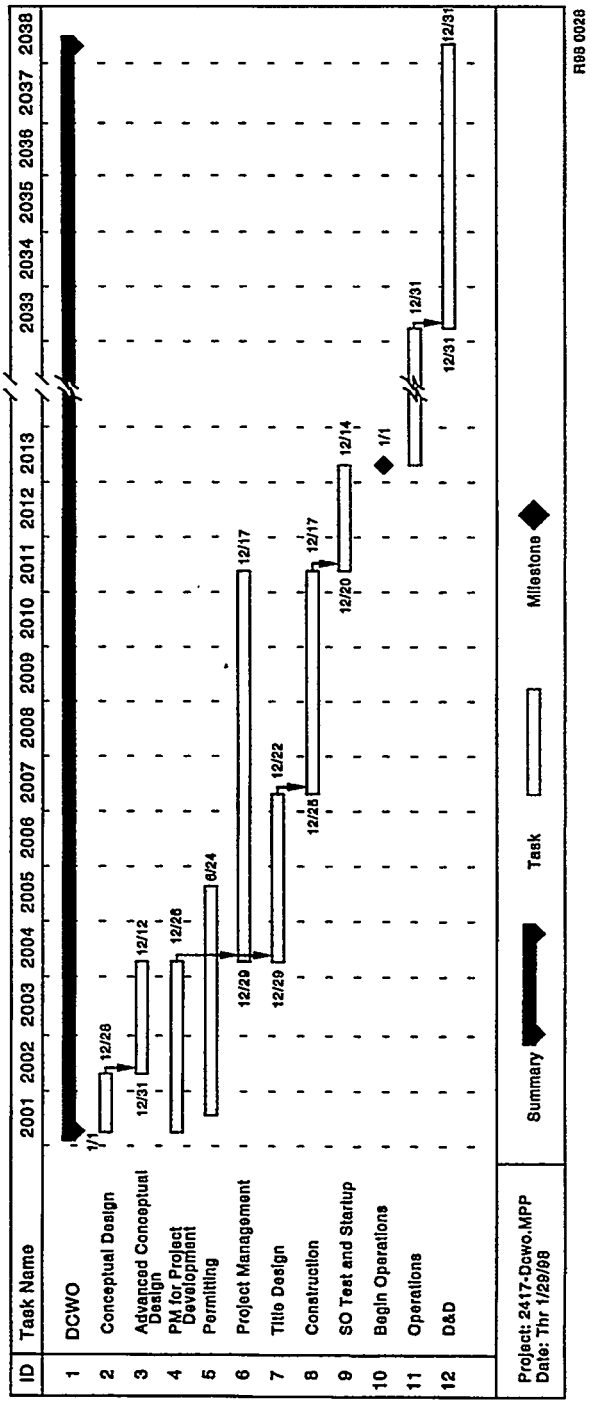


Figure 1. Schedule for DCWO.

6. UNCERTAINTIES

6.1 Maturity of Grouting Technology

Guidance for determining the maturity of the grouting technology is found in the Interim Guidance-Office of Science and Technology Technical Decision Process, DOE Standard Operating Procedure,[15] of which the portion related to the following discussion is found in Appendix H. The maturity is classified by Stages 1 through 7 titled "Basic Research, Applied Research, Exploratory Development, Advanced Development, Engineering Development, Demonstration, and Implementation." Requirements for each stage dealing with minimum goals, objectives, measures of effectiveness, actions, and responsibilities to include requirements for entry into the next stage are detailed in the reference.

The basic technology used in the DCWO option is well developed with applied research on similar wastes occurring as long as 20 years ago. Applied research on INEEL surrogate wastes has recently occurred and there is significant evidence that this technology can be implemented with relatively little development, and a perceived low risk of failure.

Based on guidance of reference 15, the DCWO technology is considered to be nearly complete with respect to exploratory development, Stage 3, and has met most requirements for entrance into the advanced development Stage, Gate 3. The major issue to resolve in completing Gate 3 is in securing regulator acceptance. The DCWO technology is not the recognized BDAT for treating high-level waste and, at this time, does not have regulatory acceptance.

Certain technology development categories for the DCWO process are at the Stage 4 and Stage 5 category. Technical specification development and infrastructure development plans are at the Stage 4 level. A few aspects of engineering development could be considered as Stage 5 level.

The overall technology development process for the DCWO is expected to be straight forward. This is in part substantiated by the fact the operating facilities, utilizing similar cement-based stabilization technologies exist and are successful. A specific example is the EP1 plant operated by BNFL in Sellafield, UK. In this plant, Magnox swarf (a radioactive, fine grained, high metallic content, powder) is mixed with other cement-based ingredients and cast and cured in 0.5 m^3 waste canisters. Waste processing rates, radiological fields, chemical ingredients, process equipment and many other factors are very similar to the DCWO study.

6.2 Risk Assessment

Schedule and cost risks identified in this study are categorized below according to the source of the risk. No effort was expended to identify or assess risks related to the HIP variation activities. Data Sheets for all the identified risks are included in Appendix F. The risk rating calculation is explained in this subsection.

Most of the risks are derived from the possibility that the study (S) assumptions listed in Section 2.2.2 of this report might be incorrect. The work scope (WS) Assumptions provide the framework for this study. If any WS assumptions are incorrect, they would cause programmatic risks that are not listed or evaluated here, and dealing with the consequences and required contingency plans for a high-rated WS risk is outside the scope of this study.

The risk matrix in Table 3 shows what action to take as a function of the risk rating. The actions are defined in Table 4.

For the DCWO, the following risks were evaluated. In the Project category, the highest risk found is rated at 3. In the Technical category, the highest risk found is rated at 4. In the Environmental Safety and Health (ESH) category, the highest risk found is rated at 1. The highest possible risk rating is 9. The 4-rated risk is discussed in detail below.

6.2.1 Project Risk

P.1 - Recycle percentage too low. Risk = 2 (Probability = 2, Impact = 1)

P.2 - Canisters not delivered on time. Risk = 3 (Probability = 1, Impact = 3)

6.2.2 Technical Risk

T.1 - Calcine volume and density incorrect. Risk = 4 (Probability = 2, Impact = 2)

Calcine volume is determined from the existing volume plus the volume estimated as a result of calcining the SBW liquid. Best available data results in calculated calcine volume at 5,435 cubic meters with an average density of 1,408 kg per cubic meter. For the 35% weight waste loading and grout density

Table 3. Risk matrix risk = probability x impact.

	Impact		
Probability	Low (1)	Medium (2)	High (3)
High (3)	Evaluate (3)	Contingency Plan (6)	Eliminate Risk (9)
Medium (2)	Monitor (2)	Contingency Plan (4)	Contingency Plan (6)
Low (1)	Forget (1)	Monitor (2)	Evaluate (3)

Table 4. Risk action definition.

Risk Rating	Action
9	Any risk determined to be in this category will be mitigated through additional design or analysis until the risk is no longer in this category.
6 and 4	Risks in these categories will be mitigated to the extent feasible within the cost and schedule guidelines. For those risks that cannot be mitigated, contingency plans have been made to deal with the risk if it occurs.
3	Risks in this category will be evaluated during the project to identify if they are becoming problems.
2	These risks will be monitored with no specific action identified.
1	These risks are noted for interest only.

of 1,700 kg/m^3, approximately 3-1/3 canisters are filled for each cubic meter of calcine. The variation in volume by 5% results in a variation in number of canisters by 900 which can have a significant effect on processing time, procurement costs, and interim storage costs. Low confidence in the best available data is the reason the Probability is 2. The impact on cost and schedule is the reason the Impact is 2.

T.2 - Waste loading %/grout density incorrect. Risk = 2 (Probability = 1, Impact = 2)

T.3 - Canister loading volume incorrect. Risk = 2 (Probability = 1, Impact = 2)

T.4 - Mercury release. Risk = 3 (Probability = 1, Impact = 3)

T.5 - Calcine particle size affects processing. Risk = 2 (Probability = 1, Impact = 2)

6.2.3 ES&H Risk

ESH.1 - Radiological dose rates incorrect. Risk = 1 (Probability = 1, Impact = 1)

6.3 Failure Modes

The following possible failure scenarios were identified during this study but their evaluation is outside the current work scope.

Failure modes are considered to fall under one of three categories—electrical, mechanical, and handling.

In general, electrical power failures will have the effect of shutting down operations. Electrical operations involving crane activities are considered to be fail safe on loss of power and thus pose no risk to workers, the general public, or environment. The failure of the auto-welder can be considered similar to loss of power in that termination of the auto-welder due to a system failure can be accomplished by turning off power to it. Standby power and uninterupptable power supply are included for the facility to support such items as lighting, exhaust fans, life safety systems, and other essential loads. Electrical shutdown of the process will impact the schedule, but would have no negative environmental impact. Batch mixing steps may have to be restarted, but the balance of the process can be reactivated. Special steps may need to be taken to assure the final waste form has had enough time in curing and dewatering stages.

Failure modes for the various facilities will be addressed in the respective safety analysis reports (SAR). The design of the facilities will include provisions for minimizing the probability of a failure and mitigating the possible effects.

The following is a list of possible significant failure modes for the grouting facility:

- Calcine retrieval blower fails
- Calcine line failure
- Static gravity mixer clogs
- Valve(s) fail

- Mechanical agitator fails
- Calcine mechanical conveyor fails
- Off-gas filter(s) fail
- Grout ingredients silo(s) plug
- NaOH tank heater(s) fail
- NaOH pump(s) fail
- Ribbon blender(s) fail
- Load cell(s) fail
- Grout mix line fails
- Kneeder extruder fails
- Sample coupon station fails
- Sample coupon cask drop
- Injection head fails
- Canister vibration system fails
- High shear mixer(s) fail
- Make-up water supply fails
- Make-up water line fails
- Canister cart(s) fail
- Canister conveyor system fails
- Contamination check/decontamination station(s) fail
- Canister HEPA filter installer(s) fail
- Canister HEPA filter(s) fail
- Autoclave(s) fail
- Steam supply fails
- Steam/condensate line(s) fail

- Control system failures
- HVAC/off-gas fan(s) fail
- Canister HEPA filter remover(s) fail
- Automatic welder(s) fail
- Sonic tomography system failure
- Sonic tomography water tank breech
- Recycling saw fails
- Recycling press crusher fails
- Recycling jaw crusher fails
- Recycling vacuum system failure
- Crane(s) fail
- Canister drops—empty or loaded

In an assumed catastrophic accident, the maximum releasable radioactive and hazardous material quantities are 120 m^3 of calcine for the CWO 5-year schedule and 30 m^3 for the DCWO 20-year schedule. The waste inventories/characterization study[16] contains detailed information on the calcine. The release quantity is from the retrieved calcine stored in the static gravity mixer and the weekly batch being processed in the dry process lot tank. The 80 m^3 gravity mixer is intended to be full at all times. The 50 m^3 lot tank, at 120% oversize, will hold a batch quantity of 42 m^3 at the beginning of the batch cycle and slowly empty out as the batch is being processed through the rest of the plant. Although the entire process time is two weeks, the second week involves the dewatering and later steps when the grout form is stabilized and not considered releasable.

7. PROJECT DATA SHEET—SUMMARY OF IMPACTS

Table 5 is the project data sheet for the DCWO grouting facility only. Data are presented for the construction, operation, and decommissioning phases of the project. Estimates are included for the following parameters:

- Cost
- Schedule
- Air emissions
- Liquid effluents
- Solid wastes
- Utilities used
- Manpower requirements
- Regulatory requirements.

Because this project is at a very preliminary stage of design, much of the information presented in this project data sheet is based on representative literature values, existing laboratory data, and engineering judgement. The cost data in this table were obtained from the cost estimates in Appendix C. Appendix G contains the support information for the remainder of the data in the table.

Project data sheets for the CRTS, interim storage, and utilities facilities are found in EDF-WTS-002 (Appendix E), the Interim Storage Study Report[8] and the Utilities and Infrastructure Report.[13] The combination of the CRTS, grouting facility, interim storage, and utilities facilities project data sheets is required to obtain the overall DCWO project data.

No effort was expended to identify or assess environmental impacts resulting from the HIP variation activities.

Table 5. Project data sheet for nonseparations direct cementitious waste option.

Project Data Sheet for Grouting Facility - 20 Year (DCWO)					
Generic Information					
Description/function		Directly grout HLW calcine in preparation for road-ready storage awaiting shipment to a permanent repository			
EIS Alternatives (A, B, etc.)		Nonseparations - Direct Cementitious Option			
Project type or waste stream		Grouted HLW calcine.			
Action type		New			
Structure type					
Size (m^2)		18,334	m^2		
Other features (e.g. pits, ponds, power/water/sewer lines)		None			
Location					
Inside/outside of fence		Inside ICPP fence			
Inside/outside of building		Inside Grouting Facility			
Candidate for privatization?		Yes			
Construction Information					
Cost ($): Pre-operations (w/ escalation & contingency)					
Conceptual Design		$81,925,000			
Management		$8,571,250			
Permitting and Documentation		$4,283,750			
Startup Activities		$4,489,651			
Management Reserve and Contingency		$35,730,349			
Total Preconstruction		$135,000,000			
Cost ($): Construction (w/escalation & contingency)					
ED&I		$70,610,000			
Management (PM/CM)		$52,210,000			
Construction		$306,808,379			
G&A/PIF		$18,356,148			
Procurement Fees, Management Reserve and Contingency		$162,015,473			
Total Construction (TEC)		$610,000,000			
Schedule start/end: Preconstruction		January 2001 through December 2006			
Schedule start/end: Construction		January 2007 through December 2010			
Schedule start/end: SO Test & Start-up		January 2011 through December 2012			
Number of workers each year of construction (new/existing)					
Nonradiation		100	New workers/yr		
Number of radiation workers (construction)		None			
Average annual worker radiation dose (rem/yr)		None			
Heavy equipment					
Equipment used		Excavator, grader, crane, material delivery trucks			
Trips (construction materials delivery)		3,567			
Hours of operation (including materials delivery vehicles)		14,695	hours (total)		
Acres disturbed and duration of disturbance		January 2001 through December 2010			
New		None			
Previous		4.5	acres		

Table 5. (continued).

Project Data Sheet for Grouting Facility - 20 Year (DCWO)			
Revegetated	None		
Air emissions			
Dust	259	tons (total)	
Major gases (CO_2, H_20, O_2, N_2) from diesel exhaust	12,730	tons (total)	
Contaminants (Particulates, CO, NO_x, SO_2, hydrocarbons) from diesel exhaust.	75	tons (total)	
SO testing air emissions (trace SO_x, NO_2)	-	tons (total)	
Total air emissions	13,064	tons (total)	
Effluents			
SO testing process wastewater (non-radioactive)	-	liters (total)	
Sanitary wastewater	12,774,375	liters (total)	
Lube Oil	1,417	liters (total)	
Solid wastes			
Type - construction trash	4,742	m^3 (total)	
Radioactive wastes	None		
Hazardous/toxic chemicals and wastes (type)			
Storage/inventory	13	m^3	
Pits/Ponds created (m^2)	None		
Water usage:			
Dust control	605,600	liters (total)	
SO testing process water	583,831	liters (total)	
Domestic water (construction and SO testing)	12,774,375	liters (total)	
Hazardous/toxic chemicals and wastes			
Hazardous waste (SO Testing)	2.8	m^3 (total)	
Hazardous waste (construction)	217	m^3 (total)	
Energy requirements			
Electrical (MWh/yr)	156	MWh/yr	
Fossil fuel (liters)	497,383	liters (total)	
Permits needed for construction	NEPA documentation (prior to start of Title II construction); New stationary sources/PTC/NOC/PSD for non-rad air emissions; HAP's and TAP's and RCRA (part AA,BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; report and specifications for drinking water supply;RCRA Part A and Part B permits.		
Operational Information			

Table 5. (continued).

Project Data Sheet for Grouting Facility - 20 Year (DCWO)					
Cost ($): Operations (unescalated dollars)					
Facility/Administration		$140,572,000			
Operations/Process Facility		$326,749,000			
Procurement, materials, utilities, maintenance		$588,744,000			
Total operations		$1,056,065,000			
Schedule start/end		January 2013 through December 2032			
Number of workers each year of operation (new/existing)					
Operations		59			
Maintenance		34			
Support		47			
Total		140			
Number of radiation workers		93	(included in above total)		
Average annual work radiation dose (rem/yr)		0.19	rem/yr	per worker	
Heavy Equipment		None			
Air Emissions					
Radioactive off-gas		None			
Effluents					
Sanitary Wastewater		4,835,338	liters/yr		
Radioactive wastewater		None			
Solid Wastes					
Sanitary/Industrial Trash		776	m^3/yr		
Radioactive wastes (canisters)		648	m^3/yr	1,182,600	Ci/yr
HEPA filters		59	m^3/yr	Trace	Ci/yr
Hazardous/toxic chemicals and wastes					
Pits/Ponds used (m^2)		None			
Caustic (material, not waste)		38,278	kg/yr		
Water usage:					
Process water		291,915	liters/yr		
Domestic water		4,835,338	liters/yr		
Energy Requirements:					
Electrical (MWh/yr)		3,767	MWh/yr		
Steam		68,686,364	kg/yr		
Fossil fuel (liters/yr)		None			
Permits needed (for facility operations)		HAP's and TAP's and RCRA (part AA,BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; report and specifications for drinking water supply;RCRA Part A and Part B permits.			

Table 5. (continued).

Project Data Sheet for Grouting Facility - 20 Year (DCWO)					
Decontamination & Decommissioning (D&D) Information					
Cost ($): D&D (unescalated dollars)					
Decommission		$34,500,000			
Decontamination		$65,252,000			
Demolition		$104,403,000			
Total D&D		$204,155,000			
Schedule start/end: D&D		January 2033 through December 2035			
Number of workers each year of D&D (new/existing)		492	New workers/yr		
Number of radiation workers (D&D)		363	New workers/yr		
Average annual worker radiation dose (rem/yr)		0.19	rem/yr	per worker	
Heavy equipment:					
Equipment used		Mobile Cranes, Roll-off trucks, Dozers, Loaders			
Trips	Roll-off trucks	15	per day		
Hours of operation (all heavy equipment)		68,175	Hours		
Acres disturbed and duration of disturbance		January 2033 through December 2035			
New		None			
Previous		4.5	acres		
Revegetated		None			
Air emissions					
non-radioactive	Fuel combustion gases (CO_2, H_2O, O_2, N_2)	39,625	tons (total)		
non-radioactive	Fuel combustion contaminants (CO, particulates, NO_x, SO_2, hydrocarbons)	231	tons (total)		
radioactive	HEPA filtered off-gas	78,518	tons (total)		
Effluents					
radioactive	Spent decontamination solution	5,109,750	liters (total)	5,110	Ci
non-radioactive	Sanitary wastewater	31,434,834	liters (total)		
non-radioactive	Lube oil	12,902	liters (total)		
Solid wastes:					
radioactive		33,013	m^3	330	Ci
Non-radioactive (industrial)		24,822	m^3		
Hazardous		11	m^3		
Hazardous/toxic chemicals and wastes (type)					
Storage/inventory		205	m^3 (total)		
Pits/Ponds created (m^2)		None			
radioactive	(mixed waste)	141	m^3 (total)	1	Ci
Water usage:					
Process water		6,854,625	liters (total)		
Domestic water		31,434,834	liters (total)		
Source of water		ICPP site wells			

Table 5. (continued).

Project Data Sheet for Grouting Facility - 20 Year (DCWO)				
Energy requirements:				
Electrical (MWh/yr)	156	MWh/yr		
Fossil fuel (liters)	1,548,254	liters (total)		
Permits needed (e.g. for facility closures, physical characteristics and quantities of radioactive and hazardous materials remaining after closure)	Work will be done under closure provisions of existing permits.			

8. PROJECT-SPECIFIC OPTIONS

This report section is not applicable since no project-specific options were assigned, identified or evaluated.

9. POTENTIAL IMPACTS OF NRC LICENSING

The DCWO and CWO grouting facilities presented in this report are not NRC licensed and therefore, neither the grouting facilities design nor the cost estimates included were modified to include NRC licensing. This section contains a brief discussion, gleaned from data contained in The Regulatory Requirements and Criteria for ICPP Proposed Waste Processing Facilities, EDF-WTS-003 (Appendix E) and from the Waste Treatment Facilities Feasibility Study Report[4] of the potential impacts of NRC licensing on the Waste Treatment Facilities (WTF).

Existing NRC regulations are compiled in 10 CFRs, Energy. These regulations follow a similar philosophy espoused by the DOE, the EPA, etc. The Commission has also issued regulatory guides that provide acceptable methods to comply with the NRC regulations; they contain criteria for facility design, operations, and health and safety.

The only WTF-type activity that the NRC has routinely licensed is HLW waste storage. Currently NRC regulations do not exist to license WTF-type HLW separations or treatment facilities. The most applicable licensing process regulations to the WTF are contained in: (1) 10 CFR 2, 10 CFR 30, 10 CFR 51, and 10 CFR 61 for low level waste (LLW) facilities, and (2) 10 CFR 2, 10 CFR 50, 10 CFR 52, 10 CFR 70, and 10 CFR 72 for HLW or HAW facilities. Licensing a nuclear facility requires preparing and submitting an application and supporting documents to the NRC, such as safety analysis reports, environmental reports, quality assurance documents, training plans, monitoring plans, and safeguards and security plans. The NRC licensing process is divided into four stages: preapplication stage, application review stage, construction and operating license stage, and decontamination and site closure stage. The licensing duration from submitting the application to receiving of the license is expected to take three to five years, or longer. The benefits of NRC licensing are enhanced operating safety, strengthened relationships with stakeholders, and license-holder participation in future regulation development.

According to data developed in the Fluor Daniel Inc. Waste Treatment Facilities Feasibility Study Report,[4] estimated capital cost percentage increases for NRC licensing of WTS facilities above current DOE requirements for those facilities are as follows:

Waste separations	21%
Low-activity waste treatment	13%
High-activity waste interim storage	26%
Low-activity waste collection	8%
Calcine dissolution	15%
Calcine transfer	14%
High-activity waste treatment	26%
Infrastructure (utilities)	9%

These estimates are hypothetical and highly speculative. The capital costs listed here are equivalent to the escalated, current dollar TEC in the cost estimate presented in Section 4. of this report.

Reference 4 also estimated the operating schedule impact and dollar-value increase in annual operating costs for three groups of systems as follows:

Group I	Minimal schedule impact	$1.3M
Group I	Minimal schedule impact	$2.7M
Group III	Significant schedule impact	$4.7M

Group I includes the LAW collection, infrastructure, and tank heel; Group II includes the waste separations, LAW treatment, condensate collection, and environmental analysis Laboratory; and Group III includes the HAW independent storage, calcine dissolution, calcine transfer, and HAW treatment. Additional costs resulting from operating schedule impacts experienced due to NRC involvement are based on a *best guess* reflecting perceived likelihood of NRC's difficulty in assimilating the group into their new regulatory framework. *Negligible* could range from no costs, to tens of thousands of dollars. *Minimal* could range from a few thousand dollars to several hundred thousand dollars. *Significant* could range from a hundred thousand to several million dollars.

The DCWO is best characterized by Group III except it does not have a calcine dissolution system, so the portion of the increased cost associated with that facility must be subtracted from $4,700,000 Group III cost to determine the DCWO increase. Assuming the NRC licensing annual cost increase for the calcine dissolution system is one third this total, the annual cost increase for the DCWO (the remainder of the Group III system) is approximately $3,100,000.

In the event that the DCWO is licensed by the NRC, the increases in capital cost (based on a 14% escalated TEC cost increase for the CRTS, a 26% escalated TEC cost increase for the ISF and the grouting facility, and a 9% escalated TEC cost increase for infrastructure) and the 20-year operating cost, will be $386,848,000 and $62,000,000 respectively, for a total of $448,848,000.

Some of the potential major impacts associated with NRC licensing of WTF, other than cost, are:

- Increased oversight, including more public involvement and input in all decision processes
- More restrictive physical limits on some parameters, including exposure limits, seismic, and tornado
- More strict radiation monitoring
- Restrictions on sharing utilities between facilities
- More stringent evaluations of the impact from offsite hazards.
- Full testing required for emergency utilities
- Physical changes to the plant and equipment
- More elapsed schedule time required
- The methods to comply with some other codes and standards may be complicated and require more time

- Although the NRC may license the WTF, it may not automatically inherit or adopt the same agreements and obligations with the State of Idaho and EPA Region 10 that are in place for DOE and INEEL.

10. RECOMMENDATIONS

10.1 Process

The hydroceramic stabilization technology utilized in the grouting process design has not been demonstrated or utilized at a scale or extent as large as that presented in this study. Therefore scaling factors generate significant uncertainty. Much of the design uncertainty could be reduced by development work that addresses design issues.

It is suspected that the grout formulation used in this design is not fully optimized. It is recommended that additional research work be conducted to better understand the relationship between grout formulation and grout performance. Additionally, research should be conducted to demonstrate how variations in calcine properties affect grout performance. Specific research needs include:

- Chemical constituent variations
- Trace metals (mercury in particular) variations
- Particle size of calcine
- Function of calcine properties on wasteform porosity.

Based on the experience of BNFL in completing a similar cement stabilization facility, (EP1, comp. 1990, Sellafield, United Kingdom) a phased approach to the research, concurrent with facility design can be accomplished. BNFL recommends the following product development phases:

- Product review
- Matrix definition
- Detailed product evaluation and long-term studies
- Establishing product envelope and additional product evaluation studies.

BNFL's process design/process verification research for the Sellafield EP1 plant included the following phases:

- Small scale nonactive
- Small scale active
- Full scale nonactive
- Full scale active

The cost estimates, especially for interim storage, are sensitive to the assumed number of grout filled canisters. Therefore, although this study used reasonable estimates as indicated, future actual waste processing design efforts should emphasize minimizing the resulting number of canisters as much as possible.

10.2 Licensing and Permitting

When it is decided how to treat and store the waste, and what the road-ready form will be, then communication should be initiated early with the NRC, State of Idaho, EPA, repository, and each state and EPA region through which the waste will be transported for disposal.

10.3 Future Studies

The following issues should be studied in depth if the DCWO is considered further.

Overall design of the grouting facility should be studied in greater depth. Detailed design has not been performed in this study. As a result, issues such as process equipment redundancy and process efficiency have not been addressed. Facility design was performed at an extremely high-level at the same time as the process was being developed. As a result, the layout and efficiency of the facility has not been fine tuned. The emphasis was placed on facility needs for the grouting process so additional study effort is recommended in the area of maintenance philosophy and related equipment.

Quality assurance requirements for waste certification are not well defined and these requirements significantly affect process design. For the purposes of this design it is assumed that some form of statistical process control can be implemented such that infrequent sampling of the stabilized waste is required, but that critical process parameters and selected feed parameters are closely monitored and controlled. In addition, off-spec product recycling has been included in the costs for DCWO. Further study should be performed to evaluate the actual need for recycling versus qualifying the grouting process and possible overpacking of off-spec product.

The location of the grouting facility, near where the Fluor Daniel Inc. Vitrification Facility design [4] is located, should be addressed for the following reasons, if the DCWO is chosen:

- The height of the proposed grouting facility causes concern because of the close proximity of the ICPP main stack effluent to the grouting facility.

- The single stage CRTS can only reliably deliver calcine to the position of the Fluor Daniel Inc. design. The location of the proposed grouting facility is beyond the reach of the CRTS without the aid of a relay station.

Further study into a welding process for canister closure should be made. The specific welding process has not been defined, but recognized as being required for costing purposes. The choice of a system spans from a simple remote welding head system to the more complex welding system used by the Savannah River Site for sealing the canisters. The SRS DWPF process uses a temporary plug, a 125-ton press, and a 230,000-amp resistance welder. The welding system costs in the DCWO study do not cover the assumed more expensive SRS DWPF system. This study should cover defining which welding process and thus which NDE processes should be considered during future design efforts if the DCWO is chosen. In addition, the study should determine GC closure-weld QA requirements for meeting 10 CFR 72 for storage and 10 CFR 71 and 49 CFR 173 for shipping. If 100 % volumetric weld inspection is

required, a new ultrasonic inspection system may have to be added. The associated cost increase to the grouting facility is expected to be a very small percentage of the total cost.

Scaling the CWO 5-year process and grouting facility to obtain data for the DCWO 20-year process and grouting facility was a logical approach for this study, but injects a level of uncertainty that could be removed with a more detailed study of just a 20-year process and grouting facility. This study should be revisited and refined to focus only on the 20-year process and grouting facility.

Specialized equipment such as the canister HEPA filter used in the curing and dewatering stages is not commercially available for this application, however the technology such as sintered metal filtration exists, but would need some application development to meet the DCWO needs.

Use of the Hanford 4.5 m (15 ft) canister in lieu of the SRS DWPF 3 m (10 ft) canister should be studied to determine the impact on the results of this study. Canister length, weight, and quantity have an impact on facility, equipment, and operations designs, however detailed analysis is required to determine the effects of one canister size over another on these designs. Although not part of the DCWO study, transportation and ultimate storage would also be affected by canister size and weight differences.

11. CONCLUSIONS

The study indicates that, at a preliminary level, it is reasonable to continue evaluation of the DCWO and that the calcine can be processed into a grout form and placed into interim storage within a 20-year operating cycle. Major show stoppers come from issues outside the bounds of this study, but of significant importance, and are related to final waste form acceptance and disposal location.

The basic technology used in the DCWO option is well developed with applied research on similar wastes occurring as long as 20 years ago. Applied research on INEEL surrogate wastes has recently occurred and there is significant evidence that this technology can be implemented with relatively little development and a perceived low risk of failure.

This process does not generate a process low-level waste nor a large secondary low-level fraction waste, in part due to recycling of process waste water.

Approximately 18,000 grout filled canisters (12,860 m^3 of grout product) will be produced if the DCWO treatment process is implemented.

The total cost for the DCWO is summarized as follows and includes costs for the calcine retrieval and transport system, the grouting facility, interim storage, and utilities:

- Total cost (unescalated) is $2,749,004,000
- Total cost (w/escalation, mgmt reserve, & contingency) is $7,382,526,000
- Discounted cost (escalated) is $1,855,178,000.

Construction and operations to implement the DCWO could result in some minor potential environmental impacts. However, no specific impact was determined to be serious.

The CWO Study Reort[5] concluded that the cost of the HIP variation, as a viable waste modification method, is too high to be taken seriously for the value provided. Based on a qualitative comparison, this study concludes the same. This variation was developed in the CWO study to show that it was considered, however, it is not considered to be a viable alternative.

12. REFERENCES

1. October 17, 1995, *Consent Order and settlement agreement between DOE and the State of Idaho.*

2. DOE/RW-0351P Revision 02, *Waste Acceptance System Requirements Document,* December 1996.

3. EM-WAPS Rev. 01, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*, May, 1995.

4. *Idaho Chemical Processing Plant Waste Treatment Facilities Feasibility Study Report*, Fluor Daniel, Inc. Government Services Operating Company, DOE Delivery Order DE-AD07-97ID60036, December, 1997.

5. INEEL/EXT-97-1400, *Cementitious Waste Option Study Report.*

6. INEL-95/00343, *Hot Isostatic Pressure (HIP) Vitrification of Radwaste Concretes*, 1995.

7. INEEL/EXT-97-01145 *Draft, Waste Disposal Options Feasibility Study*, October, 1997.

8. INEEL/EXT-97-01393, *Interim Storage Study.*

9. Title 10, Code of Federal Regulations (CFR), Part 72 *Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.*

10. U.S. Department of Energy, Office of Civilian Radioactive Waste Management (OCRWM), *Quality Assurance Requirements and Description (QARD)*, DOE/RW-0333P.

11. INEEL/EXT-97-01392, Hot Isostatic Press Waste Option Study Report.

12. 40 CFR 268.42(b).

13. INEEL/EXT-97-01398, *Utilities and Infrastructure Study.*

14. *Stockpile Report to the Congress* — Fiscal Year 1996.

15. *Interim Guidance* Office of Science and Technology Technical Decision Process, DOE Standard Operating Procedure, May 8, 1997.

16. INEL/EXT-97-00600, *Waste Inventories/Characterization Study, September*, 1997.

Appendix A

Key Assumptions

WORK SCOPE(WS) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
1-WS 10/30/97 RED	The Grouting Facility will be licensed under 10 CFR 72. RCRA requirements do apply.				
Basis	An assumption was made that the facility would be licensed under 10 CFR 72, reference 1. The key component of the INEEL waste management plan is the de-listing of various hazardous wastes in the various waste streams such that RCRA requirements do not apply (reference 2). However, the timing for this action is uncertain and RCRA requirements are assumed to apply.	(1) 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 (2) 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).	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others.	G. W. Wachs (208)526-9796
2-WS 10/30/97 RED	The RCRA listed wastes, in the grouted waste form, will be delisted prior to the grouted waste form being placed in interim storage.				
Basis	An assumption provided in reference 1 states that a final waste form for HAW will be developed only after the system performance requirements and Waste Acceptance Criteria for HLW requiring permanent isolation in geological repository are issued. The key component of the INEEL waste management plan is the de-listing of various hazardous wastes in the various waste streams such that RCRA requirements do not apply (reference 2)	(1) DOE/ID-10544, Regulatory Analysis and Proposed Path Forward for the Idaho National Engineering Laboratory High-Level Waste Program, U. S. Department of Energy, Idaho Operations Office, Idaho National Engineering Laboratory, Nuclear Operations Division High-Level Waste Directorate, October 1996. (2) 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).	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others.	G. W. Wachs (208)526-9796

WORK SCOPE(WS) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
3-WS 10/30/97 RED	The canister used in forming, containing, and handling the grouted HLW is the one used at the Defense Waste Processing Facility (DWPF) at the Savannah River site. This canister is fabricated from 24 in. stainless steel pipe and has dimensions of approximately 61 cm outside diameter and 3 meters long.				
Basis	The use of this canister is programmatically directed to be consistant with the canister used in the Fluor Feasibility Study. The Fluor 60% Design states that the preferred canister is the standard HLW canister. The Fluor 30% Design stated that the preferred canister is the West Valley Demonstration Project (WVDP) canister. Both the WVDP and DWPF canisters are approximately 61 cm in diameter and 3 meters long. Canister glass loading weight of 1650 kg (both 30% and 60% designs) would indicate a DWPF canister is being used by Fluor. An 8/21/97 Dafoe/Jacobson memo of conversation includes statement that Jacobson told Fluor that the DWPF canister was the one to use.	Idaho Chemical Processing Plant Waste Treatment Facilities Feasibility Study Report, Fluor Daniel, Inc. Government Services Operating Company, DOE Delivery Order DE-AD07-97ID60036, December, 1997.	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	V. L. Jacobson, Project Manager (208) 526-3763
4-WS 10/30/97 RED	The physical characteristics of the grouted HAW will meet or exceed shipment, and storage requirements of DOT and NRC, and will meet DOE definition of "road ready" when properly packaged in a shipping cask. It is also assumed that the HAW will meet all of the physical requirements necessary to be accepted by potential target repositories.				
Basis	This is a necessary assumption to proceed with this study since a final determination has not be provided that the grouted HAW as proposed will be acceptable at any potential repository. Fundamentally this assumption must be made or there is no point in performing the study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	P. M. Rice (208) 526-2884
5-WS 10/30/97 RED	The final waste form package – 61 cm outside diameter x 3 m long canister – will meet the requirements for transportation of HAW under 10 CFR 72 , and DOT 10 CFR 71, as defined by NRC and DOT. (Delisting in Idaho for storage does not automatically delist the waste in all states, therefore, a delisting petition must be granted for each state or region through which the waste will travel on the way to a disposal facility)				
Basis	An assumption is provided in the referenced document states that the Department of Transportation (DOT) Research and Special Programs Administration will approve shipment of special form HAW in NRC approved Type "B" shipping containers.	DOE/ID-10544, Regulatory Analysis and Proposed Path Forward for the Idaho National Engineering Laboratory High-Level Waste Program, U. S. Department of Energy, Idaho Operations Office, Idaho National Engineering Laboratory, Nuclear Operations Division High-Level Waste Directorate, October 1996	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	G. W. Wachs (208)526-9796

WORK SCOPE(WS) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
6-WS 10/30/97 RED	The grouted waste product will be acceptable at potential target repositories when sealed inside the standard SRS DWPF 61 cm outside diameter by 3 m long HLW canister.				
Basis	This is a necessary assumption to proceed with this study since a final determination has not be provided that the grouted HAW as proposed will be acceptable at any potential repository. Fundamentally this assumption must be made or there is no point in performing the study. The current WAPS only lists borosilicate glass as the acceptable waste form. The grouted product must eventually be acceptable for disposal for this study to proceed.	EM-WAPS Rev. 01, Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms, May, 1995. DOE/RW-0351P Rev 02 DCN 02, Waste Acceptance System Requirements Document, December , 1996	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
7-WS 11/19/97 RED	The SBW will be calcined prior to the operation of the Grouting Facility.				
Basis	This is a necessary assumption, to proceed with this study, used to limit the scope of the study. The Grouting Facility will only be capable of handling calcined materials. The SBW currently is in liquid form and must be calcined prior to commencement of grouting operations.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
8-WS 1/24/98 RED	Existing ICPP utility facilities will be available to support the grouting facility and operations.				
Basis	This is a necessary assumption, to proceed with this study, used to limit the scope of the study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
9-WS 1/24/98 RED	Analytical/laboratory support will be provided by a new or modified existing facility for which costs are not included in this study.				
Basis	This is a necessary assumption, to proceed with this study, used to limit the scope of the study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056

WORK SCOPE(WS) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
10-WS 1/24/98 RED	Existing ICPP facility maintenance capability, not unique to grouting operations, will be available to support the grouting facility.				
Basis	This is a necessary assumption, to proceed with this study, used to limit the scope of the study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
11-WS 1/24/98 RED	New waste generated after 2012 will not be processed by DCWO.				
Basis	This is a necessary assumption, to proceed with this study, used to limit the scope of the study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
12-WS 1/26/98 RED	Under EPA 40CFR 268.42(b), an equivalency petition for using the DCWO waste treatment technology will be granted by the EPA, thus allowing disposal at Yucca Mountain or an alternative site.				
Basis	This is a necessary assumption,to proceed with this study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056
13-WS 1/26/98 RED	Congressional changes to the National Waste Policy Act will be made to allow disposal of HLW somewhere other than Yucca Mountain				
Basis	This is a necessary assumption to proceed with this study.	None	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	B. R. Helm 208-526-8056

STUDY(S) ASSUMPTIONS

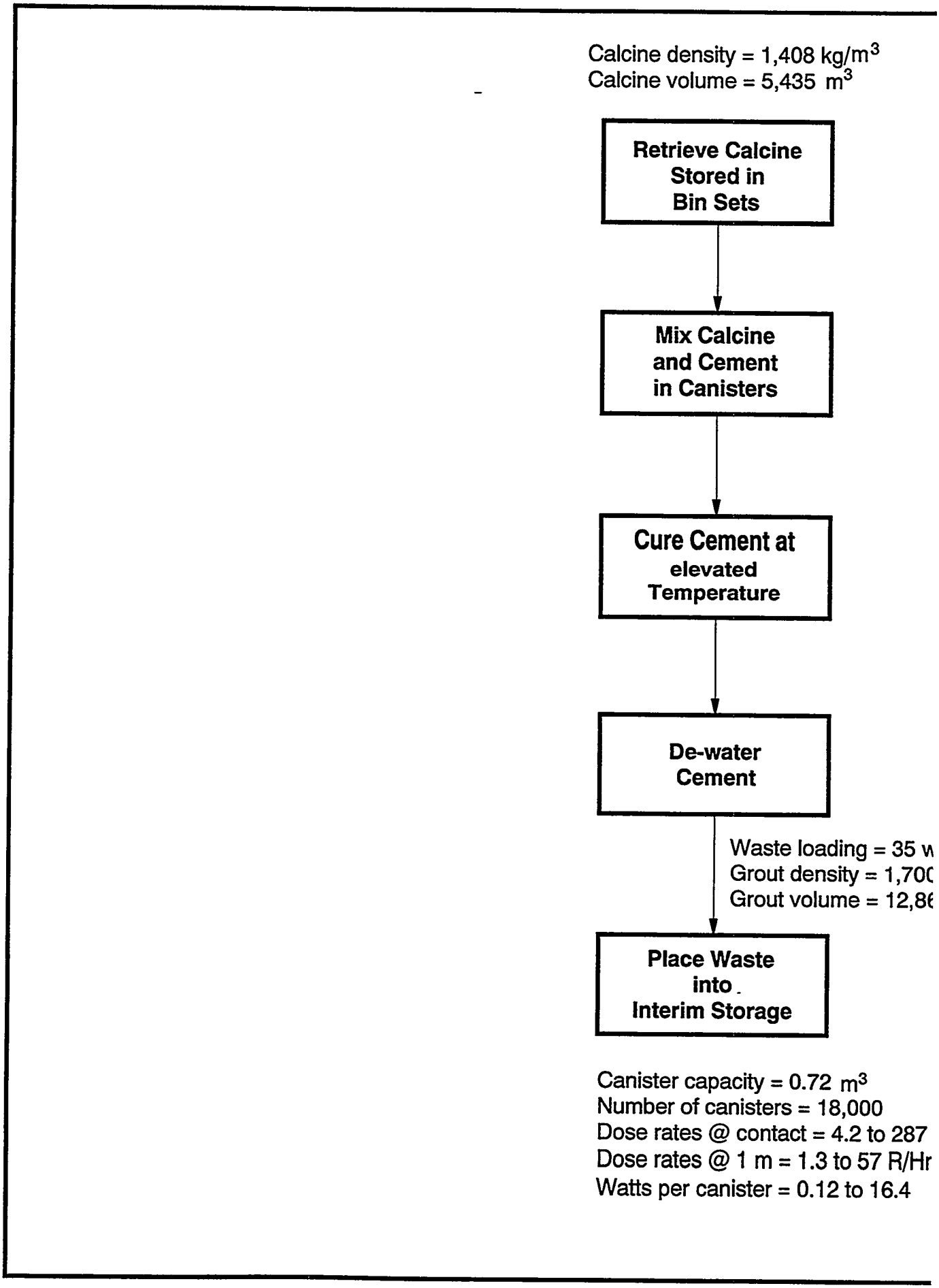
Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
1-S 11/24/97 RED	Calcine volume is 5435 m^3 with an average density of 1408 kg per m^3.				
Basis	Best information available is documented in Barnes EDF-FDO-001. This data is required to determine the number of grout filled canisters that will be produced.	EDF-FDO-001, Estimates of Feed and Waste Volumes, Compositions and Properties, C. M. Barnes, August 21, 1997.	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	C. M. Barnes 208-526-0864
2-S 11/24/97 RED	Calcine waste loading is 35 wt% with a grout density of 1700 kg/m^3 resulting in a grout volume of approximately 13,000 m^3.				
Basis	Based on theoretical and laboratory work performed by Dr. D. D. Siemer and others at the INEEL. Further substantiated by ADTECHS Corporation on surrigate calcines from Fernald Silo 3 treatability studies.	EDF-FDO-001, Estimates of Feed and Waste Volumes, Compositions and Properties, C. M. Barnes, August 21, 1997. ADTECHS Corporation; Treatability study performance data for Fernald Silo 3 calcine, scope performed to RFP# F98P132339 INEEL Electronic Communication; Dean D. Taylor to Brent R. Helm, 10/30/97, 09:11 PM, Subject: Grouting Data INEEL Electronic Communication; Dr. D. D. Siemer to Dean D. Taylor, 11/03/97, 07:48 AM, Subject: Grouting Data	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	C. M. Barnes 208-526-0864
3-S 11/24/97 RED	Canister loading is 0.72 m^3. The number of canisters produced is approximately 18,000 (12,860 m^3 of grout product).				
Basis	The capacity of the Savannah river Site HLW canister is listed at 25.3 ft^3 or 0.72 m^3. The assumption is that the canister can and will be filled to capacity.	Savannah River site HLW canister drawing, ORNL DWG 90-418.	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	R. E. Dafoe 208-526-6772

STUDY(S) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
4-S 11/24/97 RED	The radiation dose rate at contact for the grout filled canisters ranges from 4.2 to 287 R/Hr.				
Basis	Best information available for calculating radiological dose rate is documented in the reference. This data is required to determine shielding requirements for calcine retrieval and the grouting process.	EDF-FDO-001, Estimates of Feed and Waste Volumes, Compositions and Properties, C. M. Barnes, August 21, 1997.	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	C. M. Barnes 208-526-0864
5-S 8/27/97 PMR	For on-site facilities (INEEL), physical security requirements can be met with typical access controls such as card readers and alarmed doors to the facility using the same requirements and systems as used for SNF.				
Basis	The requirements applicable to security systems are continuing to evolve. This assumption is primarily a result of interpretations of existing regulations (10 CFR 73) and an understanding of proposed NRC rules. Where questions concerning the interpretation of 10 CFR 73 arise, guidance has been sought from NUREG-1497.	10 CFR 73 NUREG-1497	This refers to EIS volume numbers and will be completed by others.	This refers to the EIS alternatives and will be completed by others.	J. L. Rohrbaugh (208) 526-0687
6-S 11/10/97 RED	The maximum number of quality control samples required per grout line per day is one.				
Basis	Sampling of the grout mixture prior to pouring into the waste canister is assumed to be required for quality control purposes. Because the grout mix is in batch form which is a homogeneous mixture prior to pouring, engineering judgement is used to say that no more than one sample per line is required per day. This assumption is used to determine the rrom size and equipment quantity required for the sampling.	None	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	R. E. Dafoe 208-526-6772

STUDY(S) ASSUMPTIONS

Number Latest Rev Initials	Assumption	References	Application to Volumes	Application to Alternatives	Contact and Date
7-S 12/8/97 SYL	Mercury contanined in the calcine is not released during the curing and dewater processes.				
Basis	The curing and dewater temperatures are 250^0C, not considered high enough to drive off the mercury.	"Waste Inventories/Characterization Study" by R.S. Garcia, INEL/EXT-97-00600 CRC Handbook of Chemistry and Physics Oak Ridge Y-12 Plant document entitled "Thermal Decomposition of Mercuric Sulfide," by J. H. Leckey and L. E. Nulf, 10/28/94, Y/DZ-1124	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	S. J. Losinski 208-526-5962
8-S 12/8/97 SYL	One percent of all canisters processed through the grouting facility will need to be recycled.				
Basis	Some recycling do to off-spec canisters and destructive tesitng will require that recycling equipment be included in the facility. Engineering judgement was used to determine percent.	None	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	S. J. Losinski 208-526-5962
9-S 12/8/97 RED	The vendor providing the canisters will be capable of supplying the required quantities to meet the waste production rate and schedule.				
Basis	The maximum number of canisters required will be approximately 18,000 during a 5 year operating time. Procurment of canisters can begin prior to their use, thus avoiding manufacturing capcity concerns.	None	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	R. E. Dafoe 208-526-6772
10-S 1/27/98 SYL	The calcine particle size, and particle size distribution, as delivered to the grouting facility via the calcine retrieval system can be used without further size reduction processing.				
Basis	Laboratory work performed by Dr. D. D. Siemer and others at the INEEL suggest that calcine particle size as delivered from the calcine storage bins will not be a significant factor in wasteform properties.	None	This refers to EIS volume numbers and will be completed by others	This refers to the EIS alternatives and will be completed by others	S. J. Losinski 208-526-5962


Calcine density = 1,408 kg/m3
Calcine volume = 5,435 m3
Retrieve Calcine Stored in Bin Sets
Mix Calcine and Cement in Canisters
Cure Cement at elevated Temperature
De-water Cement
Waste loading = 35 w
Grout density = 1,70(
Grout volume = 12,8(
Place Waste into Interim Storage
Canister capacity = 0.72 m3
Number of canisters = 18,000
Dose rates @ contact = 4.2 to 287
Dose rates @ 1 m = 1.3 to 57 R/Hr
Watts per canister = 0.12 to 16.4

Date: 1/20/98

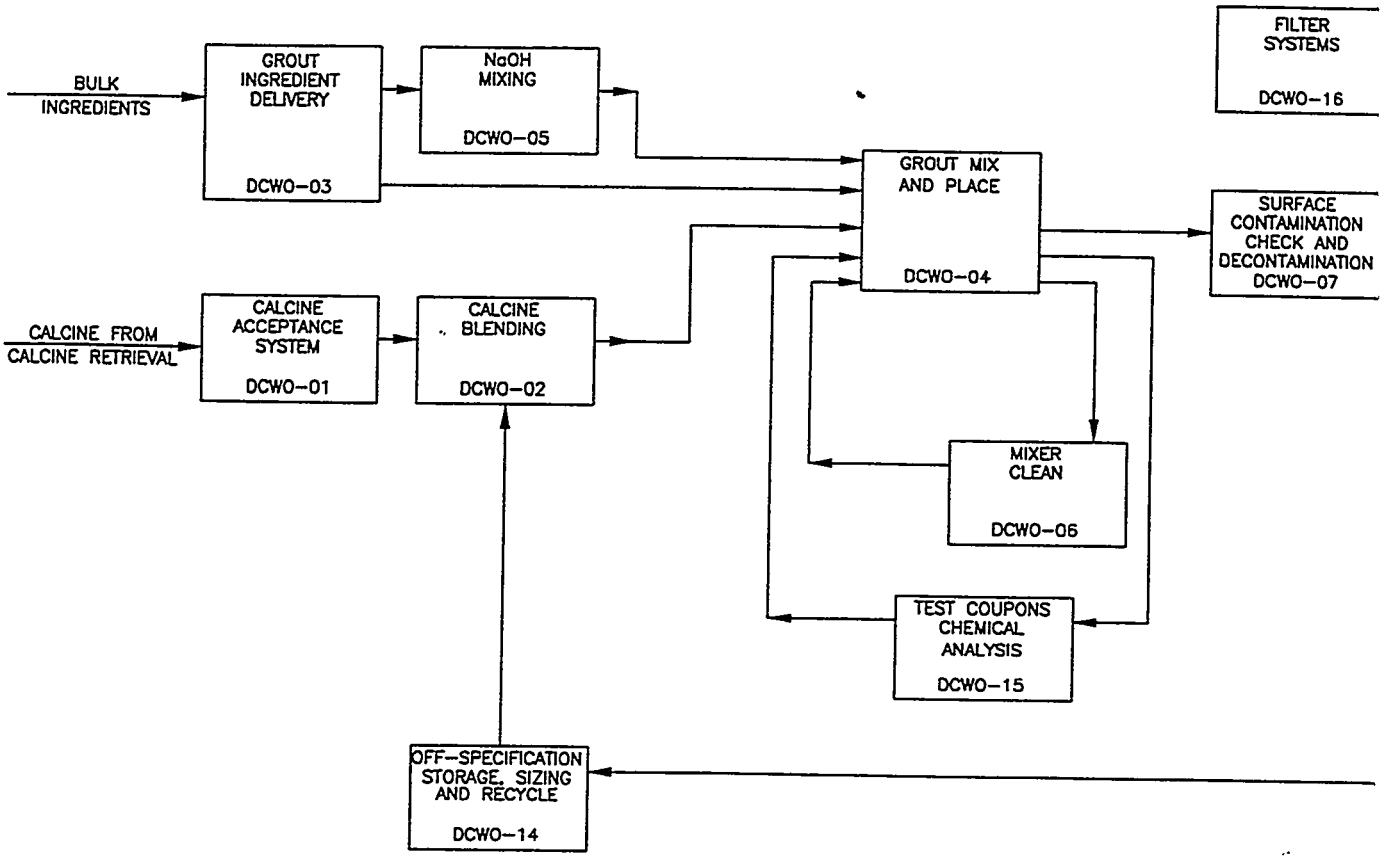
Assumptions

- All listed hazardous materials will be treated and de-listed
- Non-listed hazardous materials will be treated to meet acceptance criteria
- All waste will be calcined before grouting
- This option will not process new waste generated after 2012
- All direct-grouting processes will occur from 2013 through 2032
- The cement waste form will be ready to be moved out of Idaho for disposal by a target date of 2035
- This waste form will equal or exceed the BDAT

%
kg/m^3
m^3

/Hr

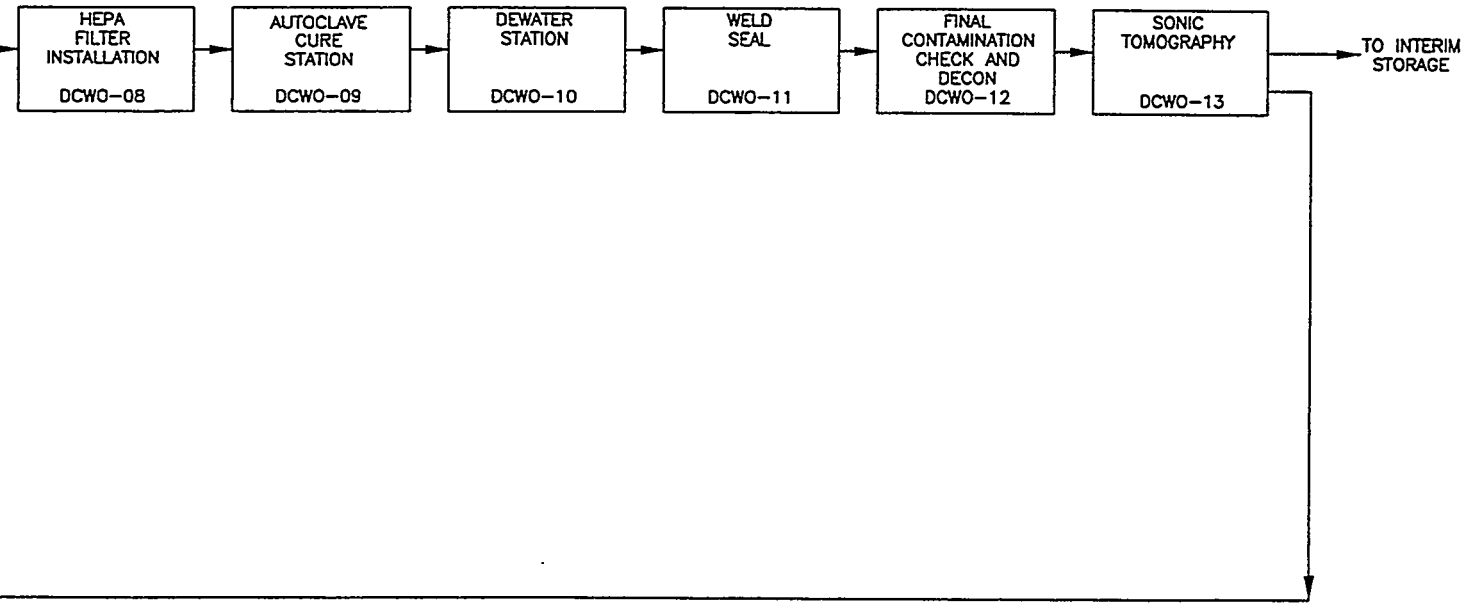
HLW Study:
Nonseparations Alternative
Direct Cementitious Waste Option



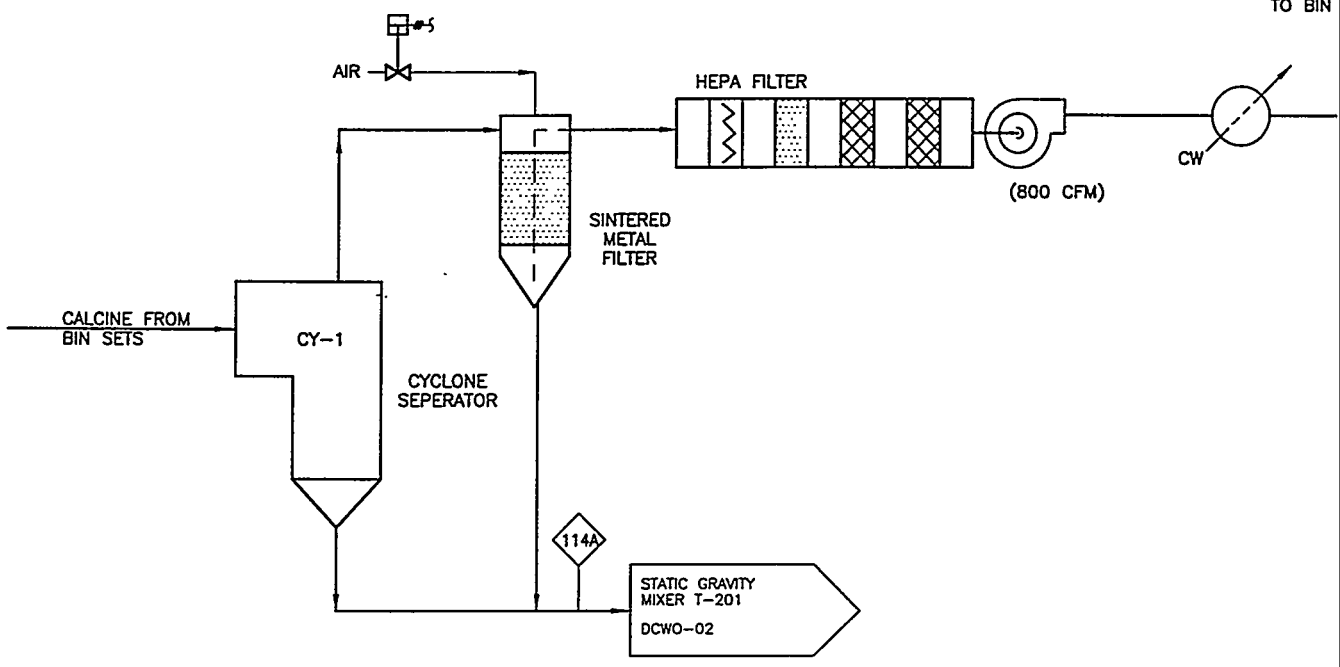
SALIENT PROCESS INFORMATION
PROCESS DURATION 5 YEARS @ 50% O.L.F.
INITIAL CALCINE VOLUME 5,435 m3
FINAL GROUT VOLUME 12,860 m3
NUMBER OF GROUT CANNISTERS 17,860
FINAL GROUT WASTEFORM–HYDROCERAMIC

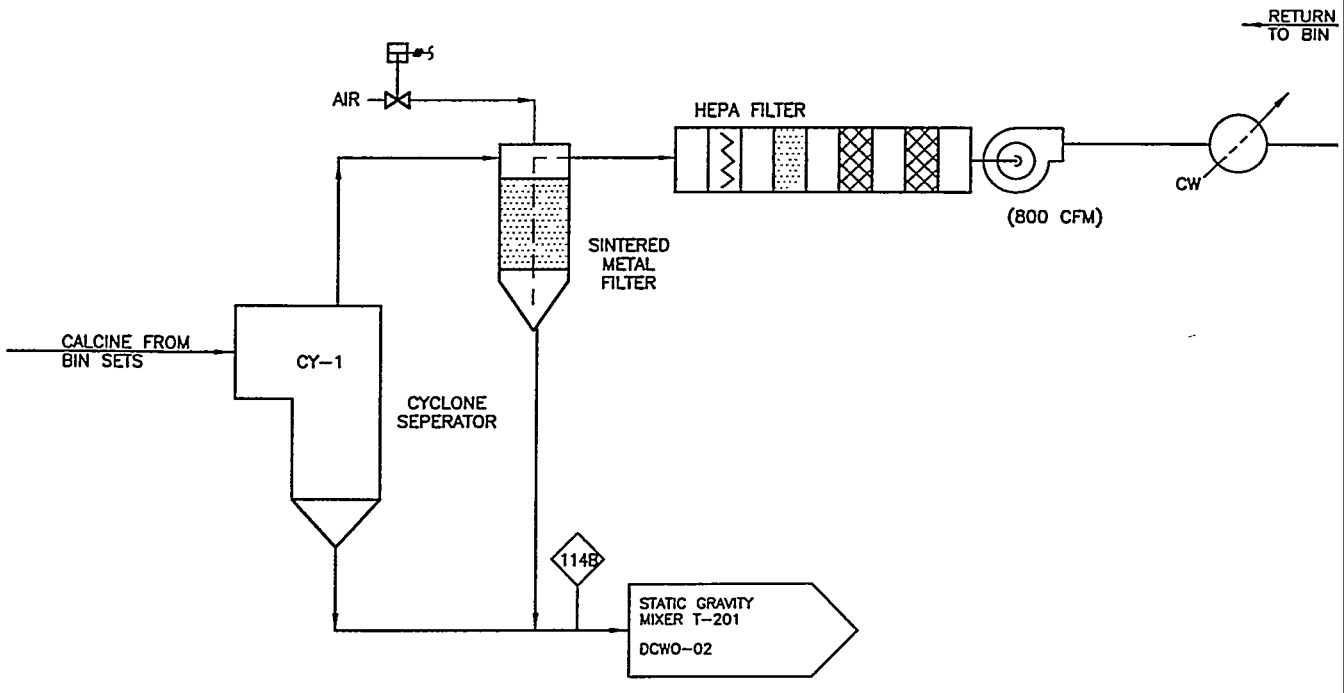
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DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, ORG 530; DWG-; REV
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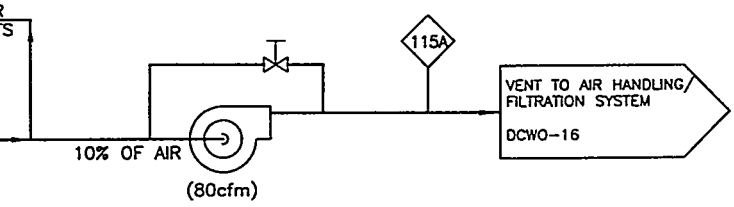


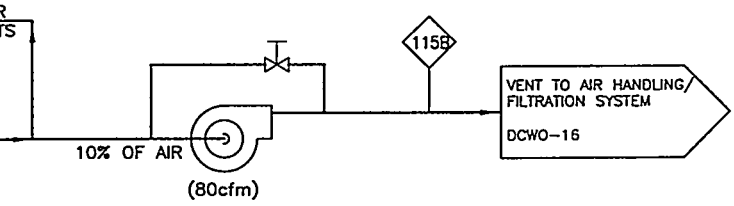


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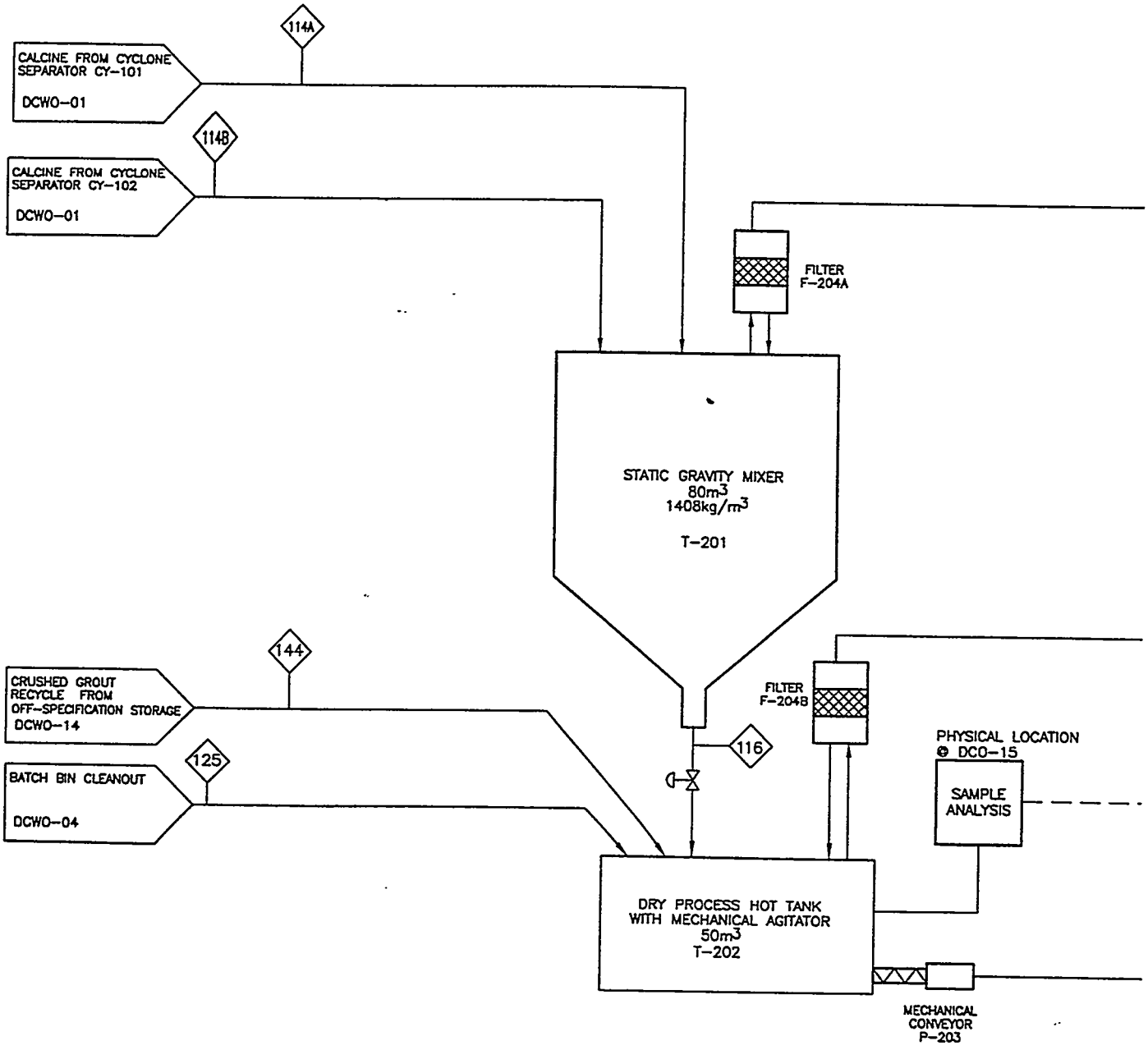


NOTE:

CYCLONE SEPARATORS AND FILTERS ARE PHYSICALLY LOCATED AT DCWO FACILITY, BUT ARE INCLUDED IN CALCINE RETRIEVAL SYSTEM DESIGN.

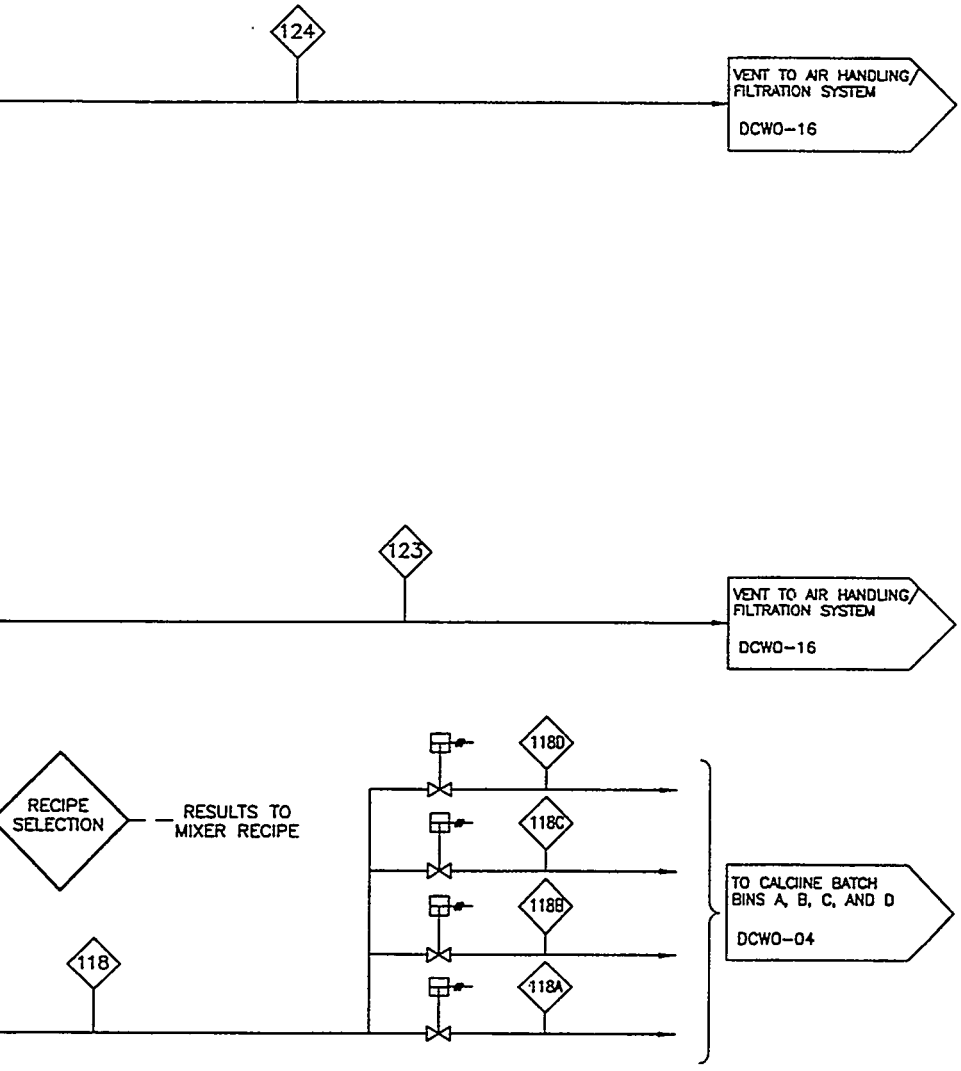
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DRAWN: EM SNELL	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, ORG 530; DWG-; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-01

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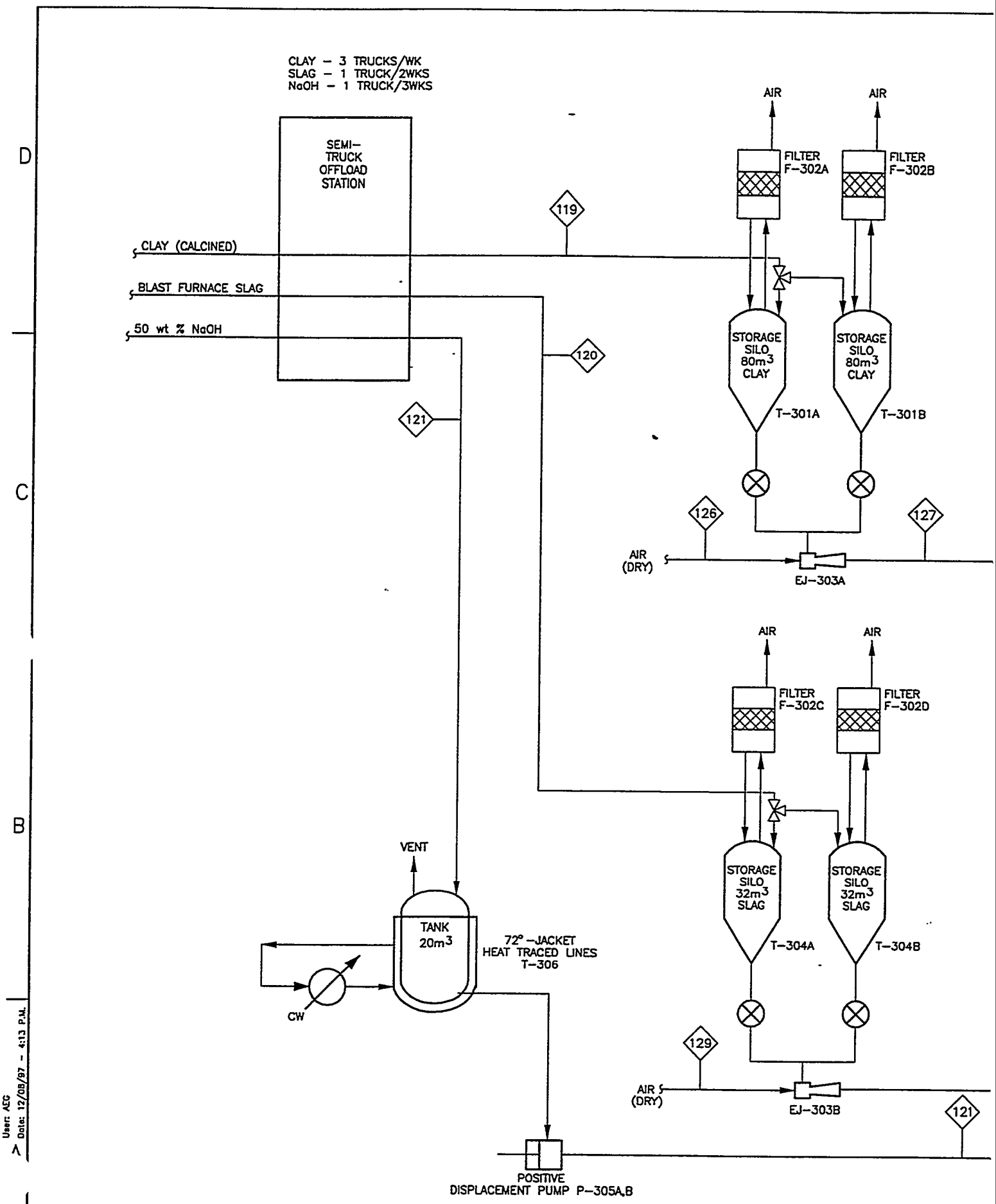


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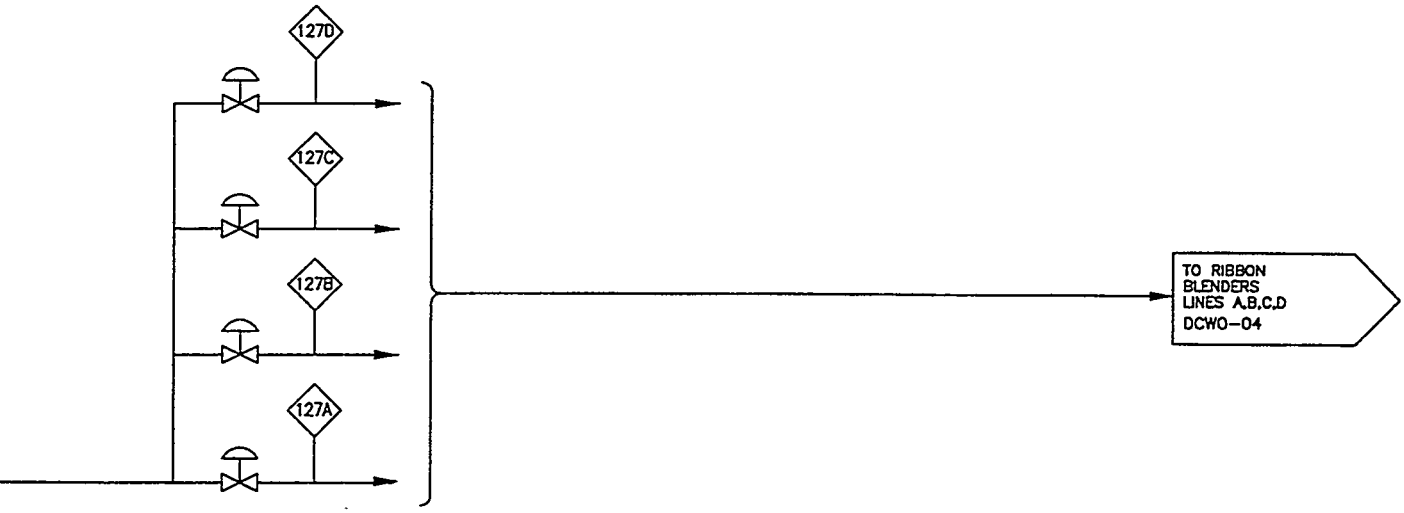


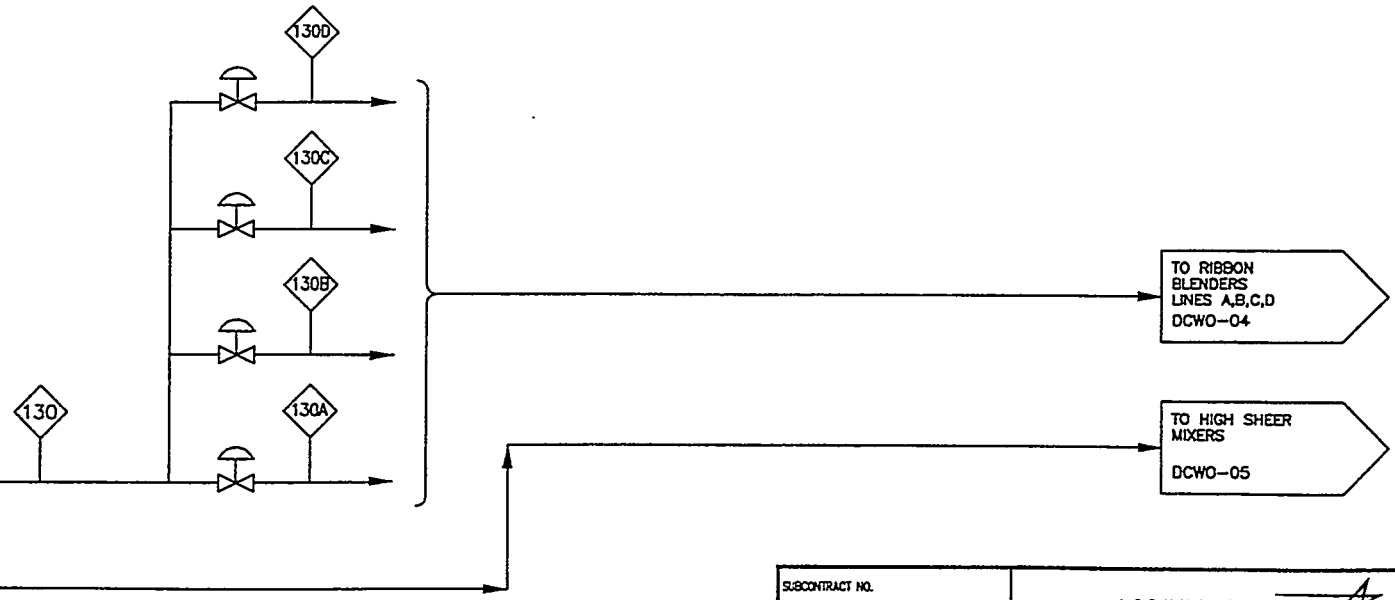
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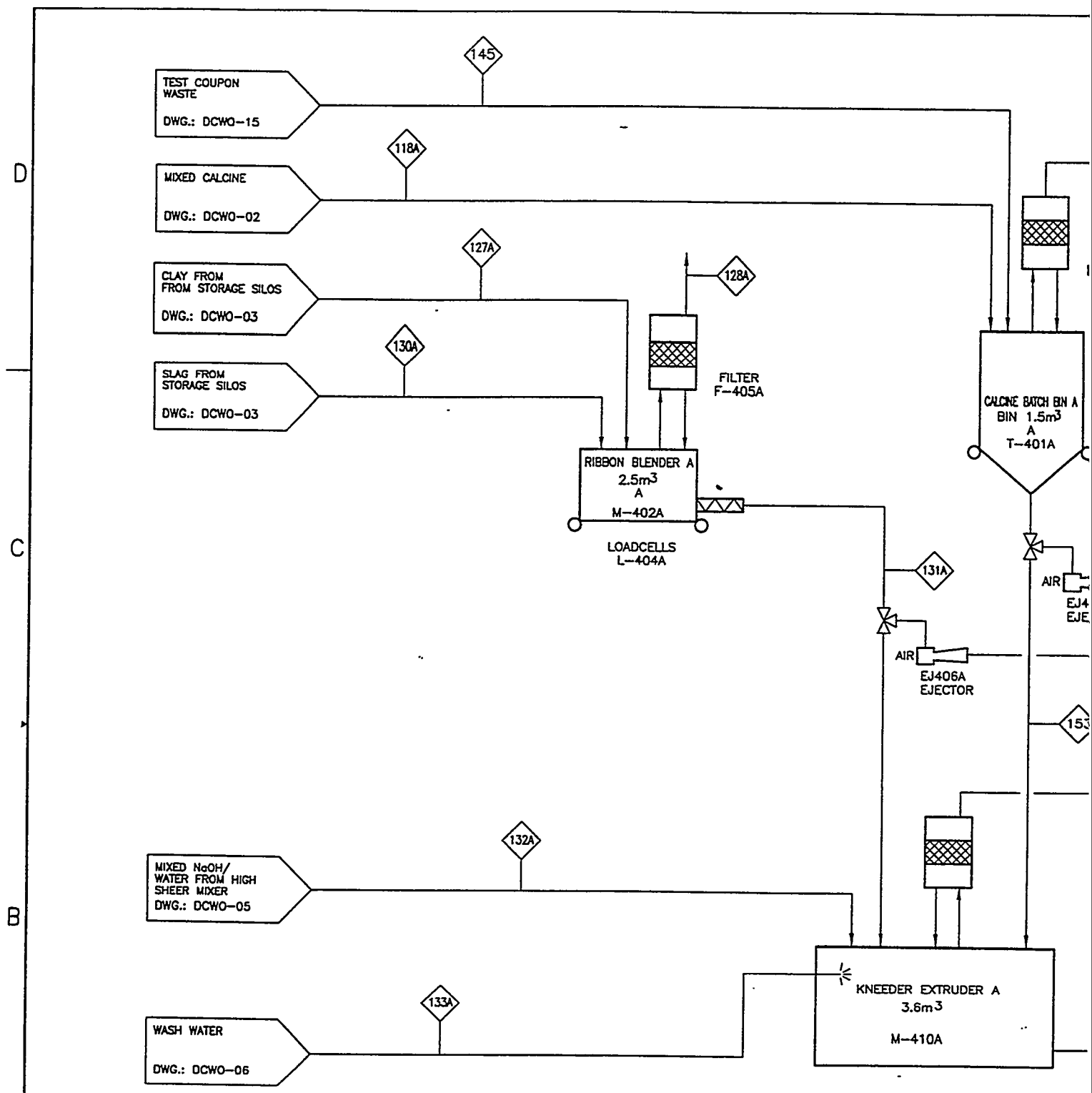
REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:





SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION GROUT INGREDIENT DELIVERY
DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBS 530; DWG-; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-03

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User: EMS
Date: 12/09/97 - 2:05 P.M.
File: dcwo-04.dwg
Path: E:\ema\1522-akaich\

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

112

VENT TO AIR HANDLING /FILTRATION SYSTEM

DWG.: DCWO-16

TER
-11A

LOADCELLS
L-403A

125

BATCH BIN CLEANOUT TO DRY PROCESS LOT TANK

DWG.: DCWO-02

146

TO SIZING/REDUCTION BLEND STORAGE TANK

DWG.: DCWO-14

113

VENT TO AIR HANDLING /FILTRATION SYSTEM

DWG.: DCWO-16

134A

VENT TO AIR HANDLING /FILTRATION SYSTEM

DWG.: DCWO-16

135A

TEST COUPONS CHEMICAL ANALYSIS

DWG.: DCWO-15

136A

WASH WATER TO MIXER CLEAN TANK

DWG.: DCWO-06

INJECTION HEAD IJ-408A

2'x10' CONTAINER

137A

FILLED GROUT CANNISTER TO SURFACE CONTAMINATION CHECK

DWG.: DCWO-07

VIBRATOR SYSTEM

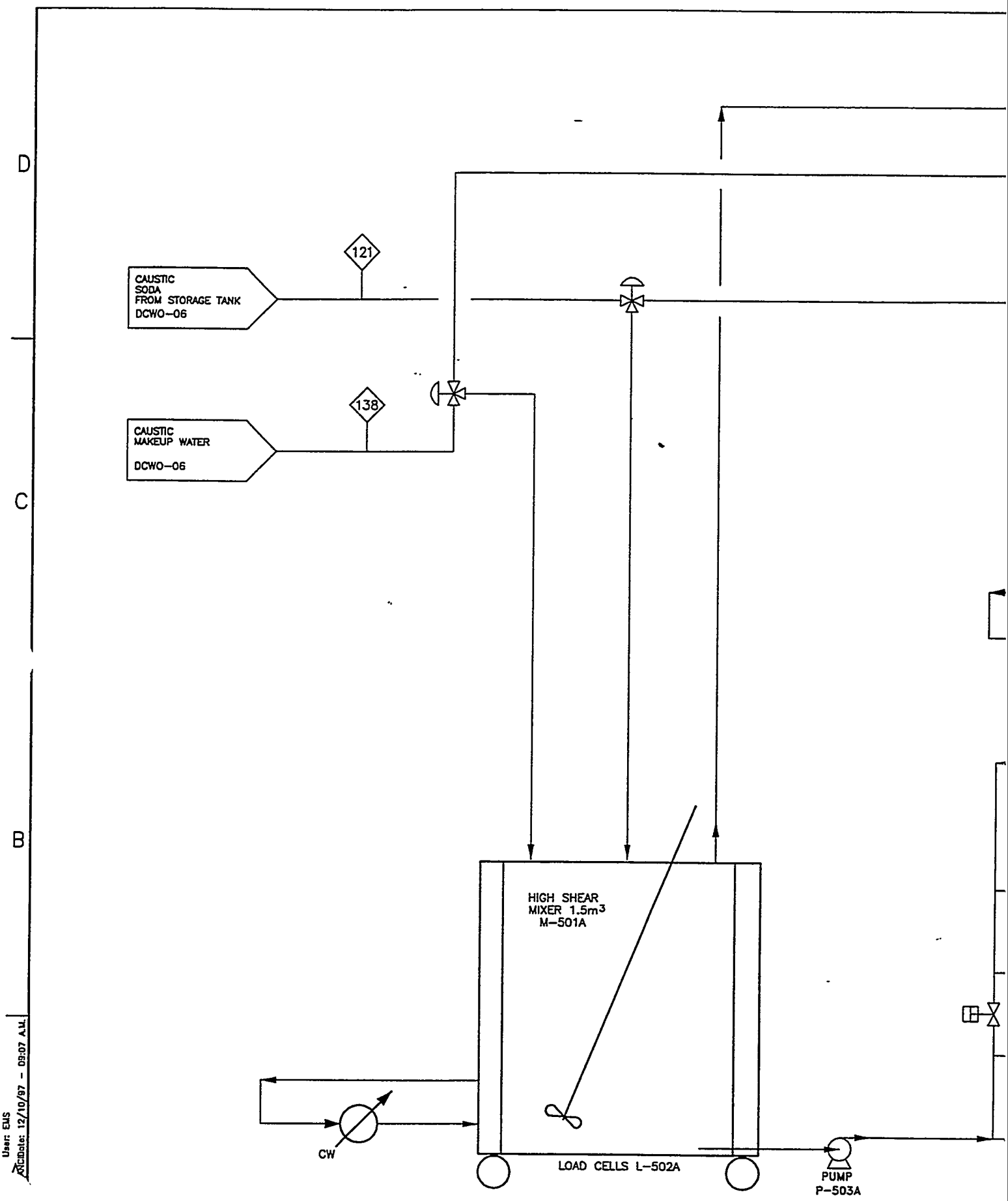
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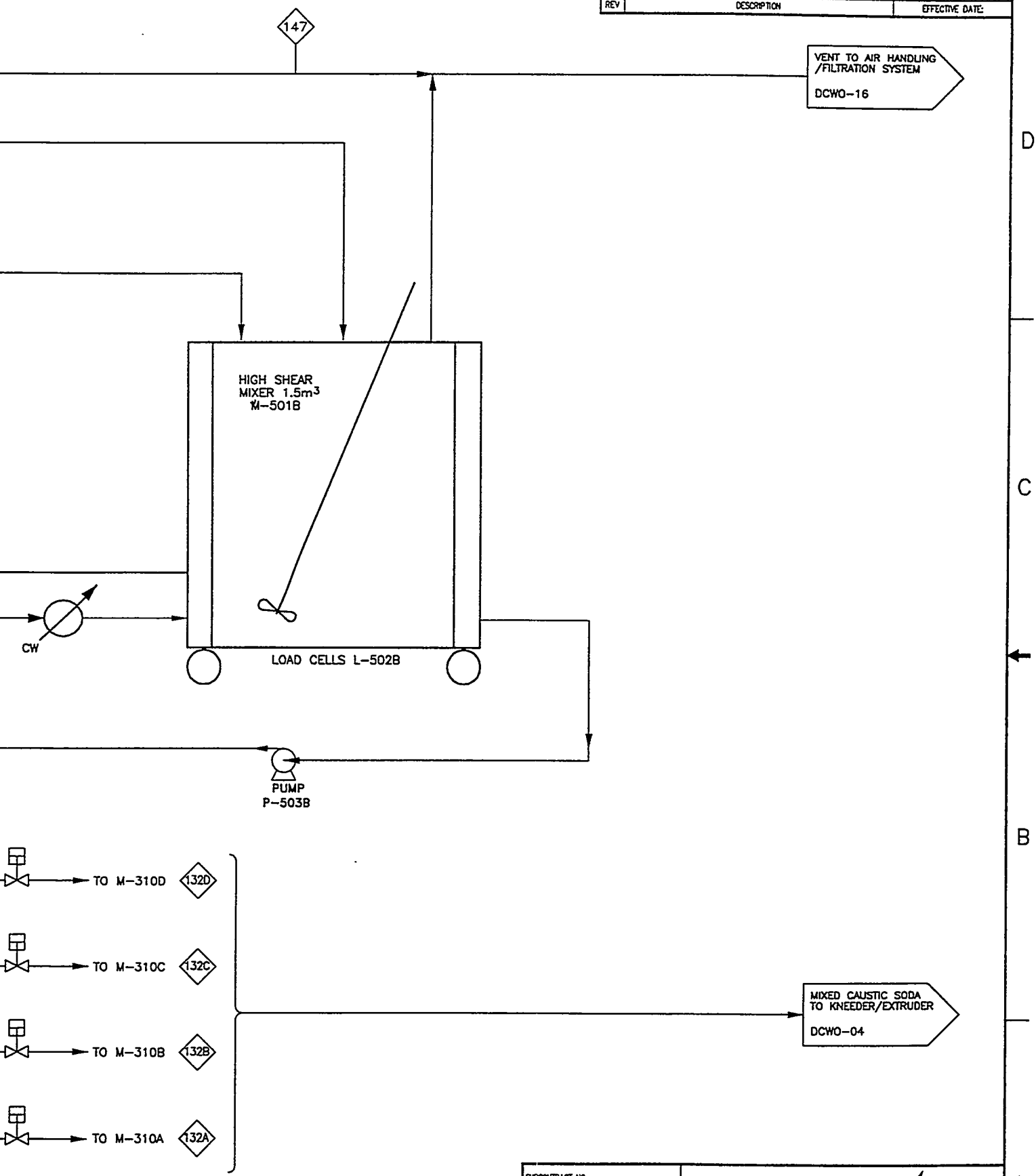
SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP
DESIGN:	WASTE TREATMENT FACILITIES
DRAWN: EM SHELL	DIRECT CEMENTITIOUS WASTE OPTION
PROJECT NO.	GROUT MIX AND PLACE MIXER LINE A
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CI, ORG 530; DWG- ; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-04



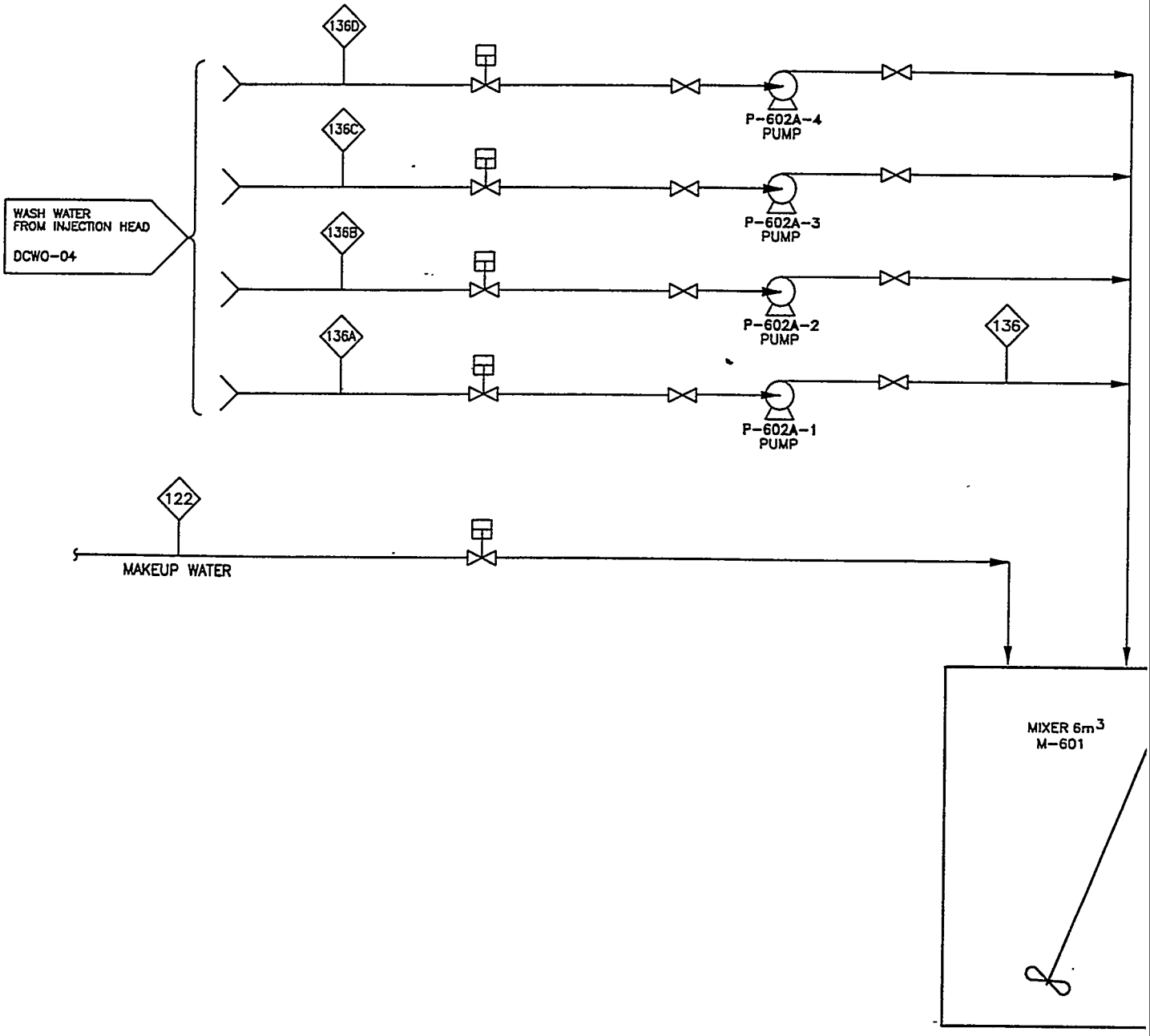
User: EMS
Plotted: 12/10/97 - 09:07 A.M.
File: DCWO-05.dwg
Path: E:\EMS\1522-akale.

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION NaOH MIXING
DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, SYS, OBG 530; DWG-; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-05



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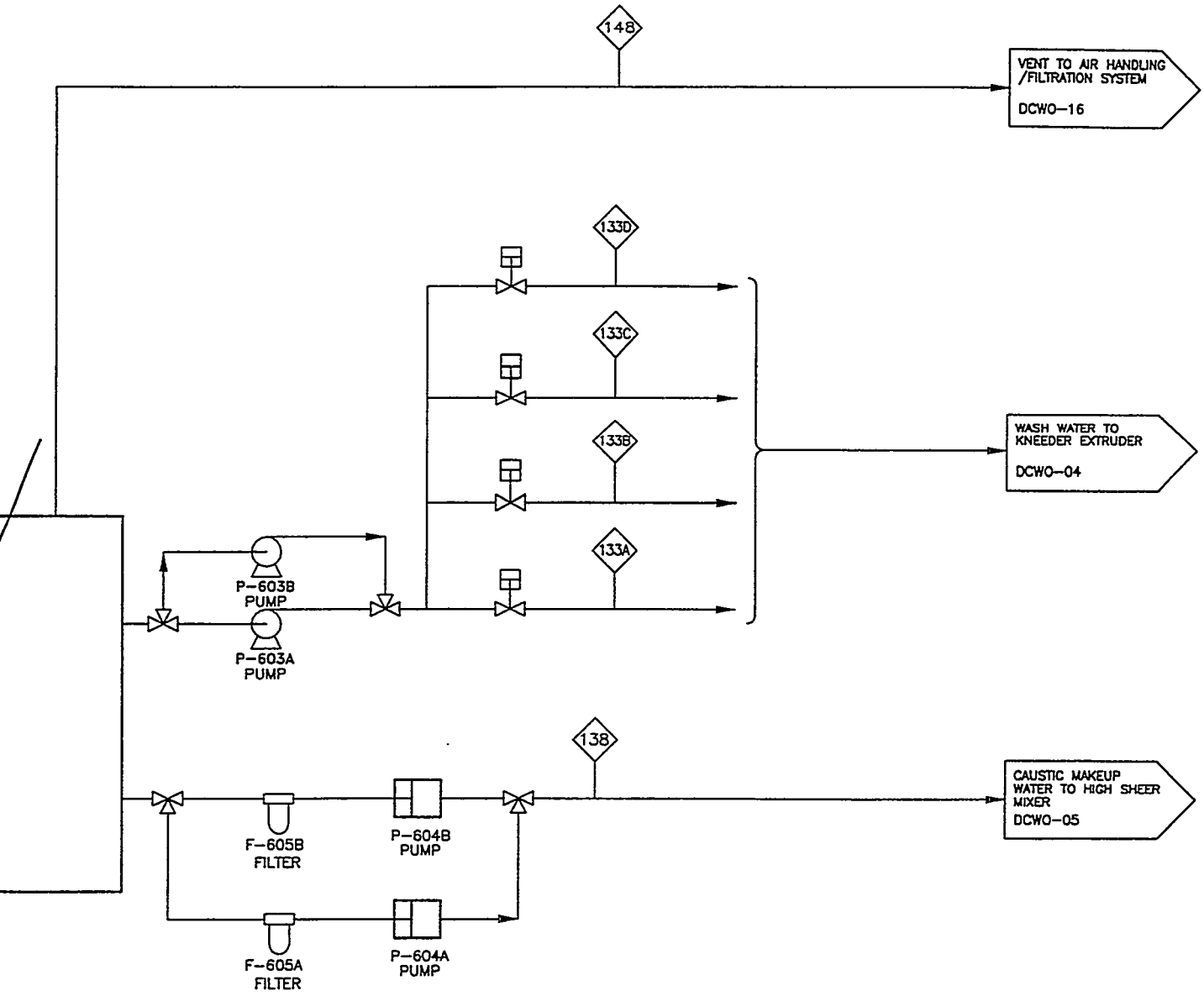
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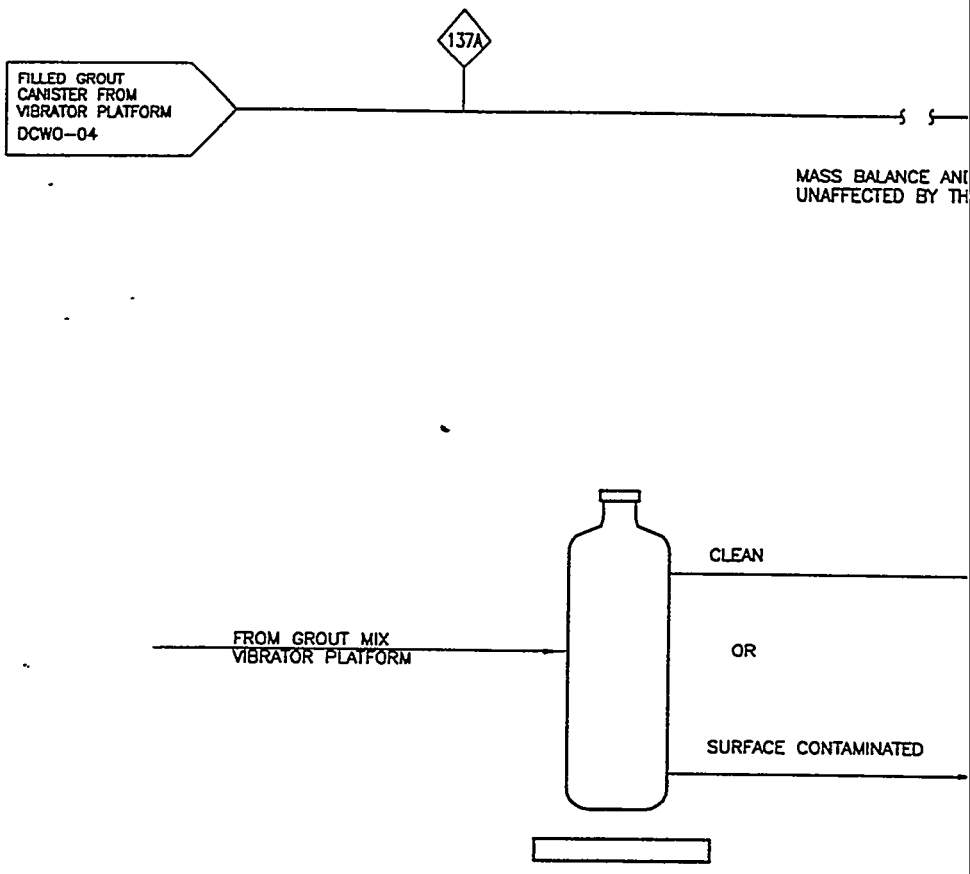
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File: DCWO-08.dwg
Path: E:\aeg\WEZ

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REV	DESCRIPTION	EFFECTIVE DATE:



SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP
DESIGN:	WASTE TREATMENT FACILITIES
DRAWN: AE GB8S	DIRECT CEMENTITIOUS WASTE OPTION
PROJECT NO.	MIXER CLEAN
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OPSC 530; DWG-; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-06



ROBOTIC CONTAMINATION
CHECK STATION
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User: EMS
Date: 12/09/97 - 2:08 P.M.

File: dcwo-07.dwg
Path: E:\ems\1522-sketc

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

137A

DECONTAMINATED GROUT CANISTER TO HEPA FILTER INSTALLATION DCWO–08

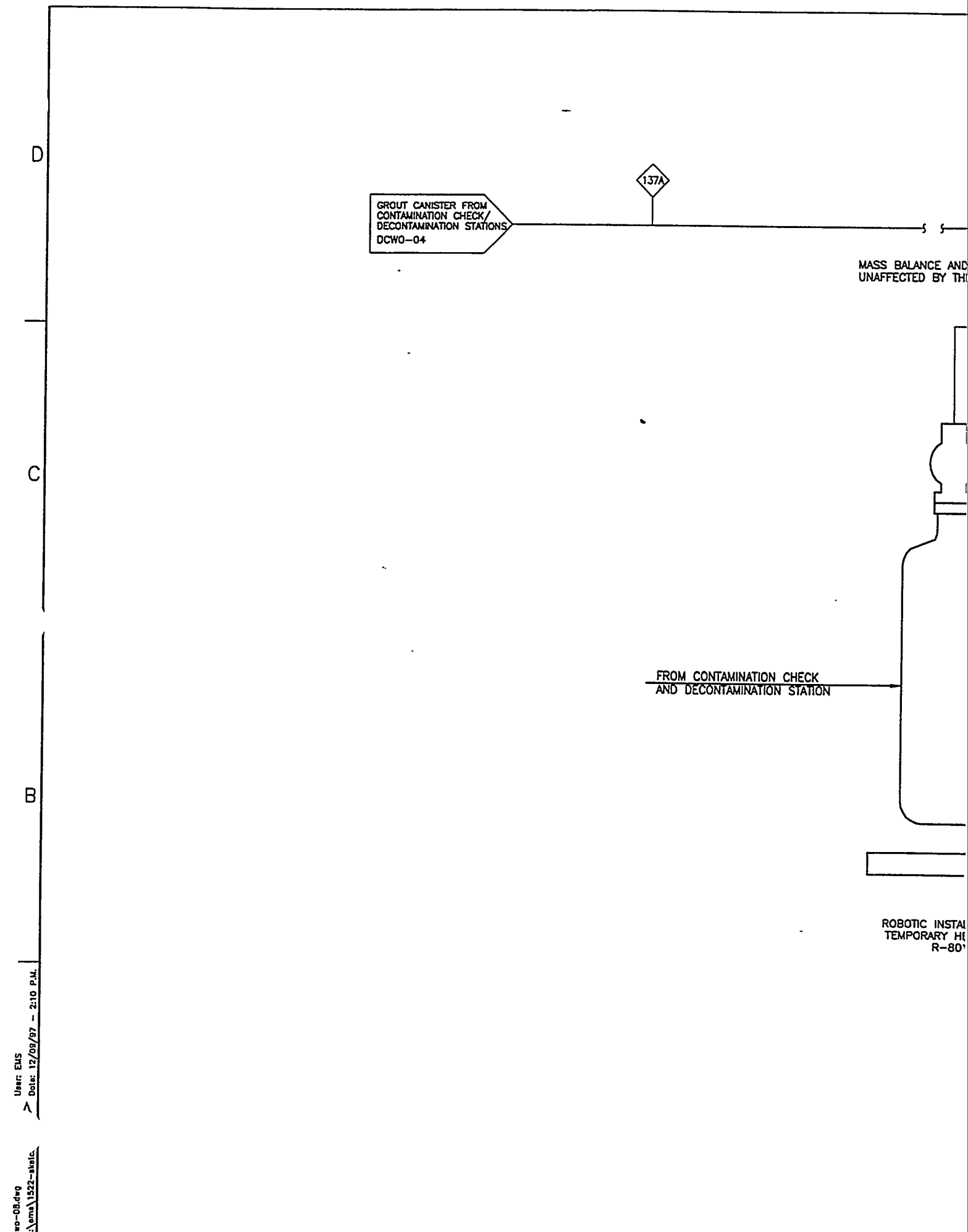
ASTE COMPOSITION
PROCESS STEP



TO HEPA FILTER INSTALLATION

NTAMINATION
STATION
CS–702A

SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION SURFACE CONTAMINATION CHECK AND SURFACE DECON–LINE A
DESIGN:	
DRAWN: EM SNELL	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBS 530; DWG–; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO–07



User: EMS
Date: 12/09/97 - 2:10 P.M.

File: dcwo-08.dwg
Path: E:\ema\1522-akeic

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

137A

GROUT CANISTER
TO AUTOCLAVE
CURE STATION
DCWO-09

STE COMPOSITION
ROCESS STEP

HEPA FILTER
CARTRIGE

TO CURE
STATION

NOTE: PURPOSE OF TEMPORARY HEPA FILTER IS TO PROVIDE CONTAMINATION CONTROL DURING CURE AND DEWATER PROCESS STEPS.

TION OF
FILTER

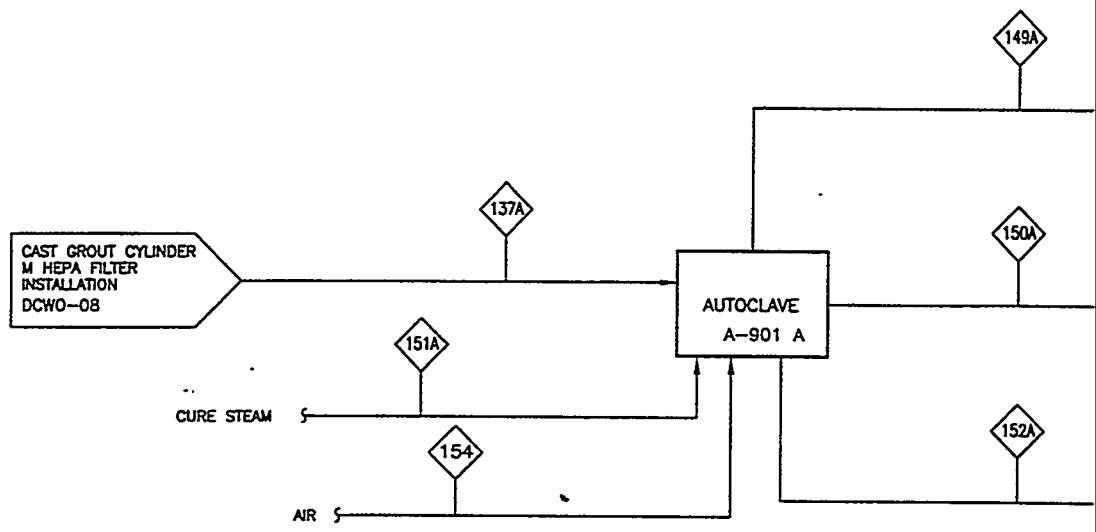
SUBCONTRACT NO.	LOCKHEED MARTIN						
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION HEPA FILTER INSTALLATION LINE A						
DESIGN:							
DRAWN: EM SNELL							
PROJECT NO.							
SPEC CODE							
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D	CAGE CODE: 01MF3	INDEX CODE NUMBER: AREA 200	TYPE	SL	DSG 530	DWG-
EFFECTIVE DATE:	SCALE: NONE						SHEET DCWO-08

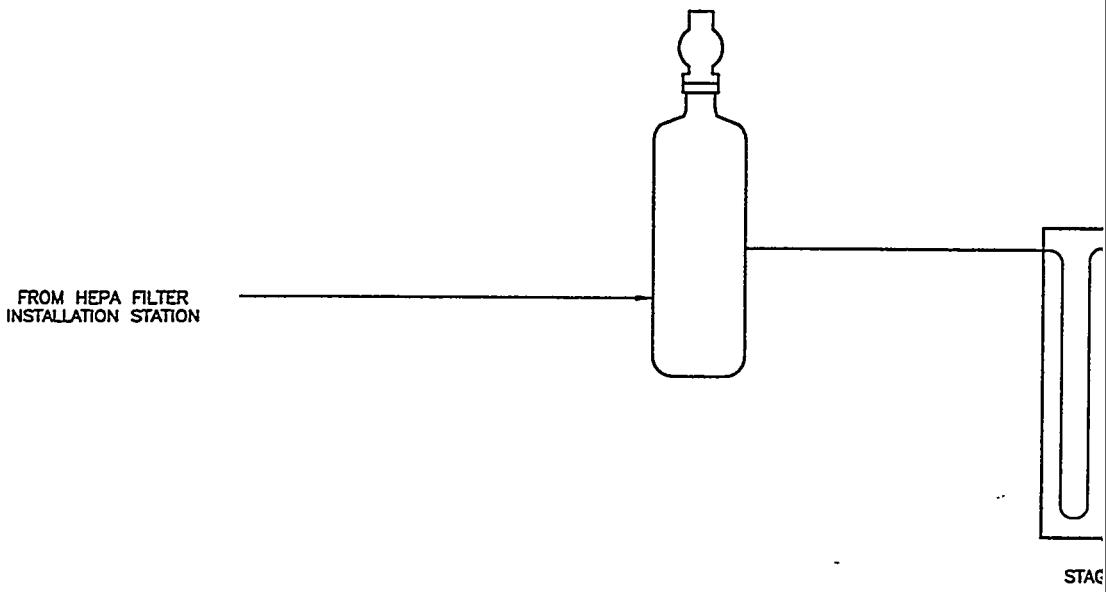
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User: EMS
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

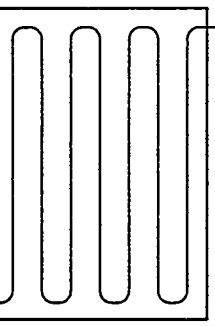
VENT TO AIR HANDLING FILTRATION SYSTEM

DCWO–16

AUTOCLAVED GROUT TO DEWATER STATION

DCWO–10

STEAM CONDENSATE TO STEAM PLANT



AUTOCLAVE

TO DEWATER STATION

AREA: 18 POSITIONS

NOTE: AUTOCLAVE CURE CYCLE REQUIRES 35 HOURS CANISTER RESIDENCE TIME IN PRESENCE OF 250°C SATURATED STEAM. TOTAL ASSUMED PROCESS CYCLE IS 48 HOURS

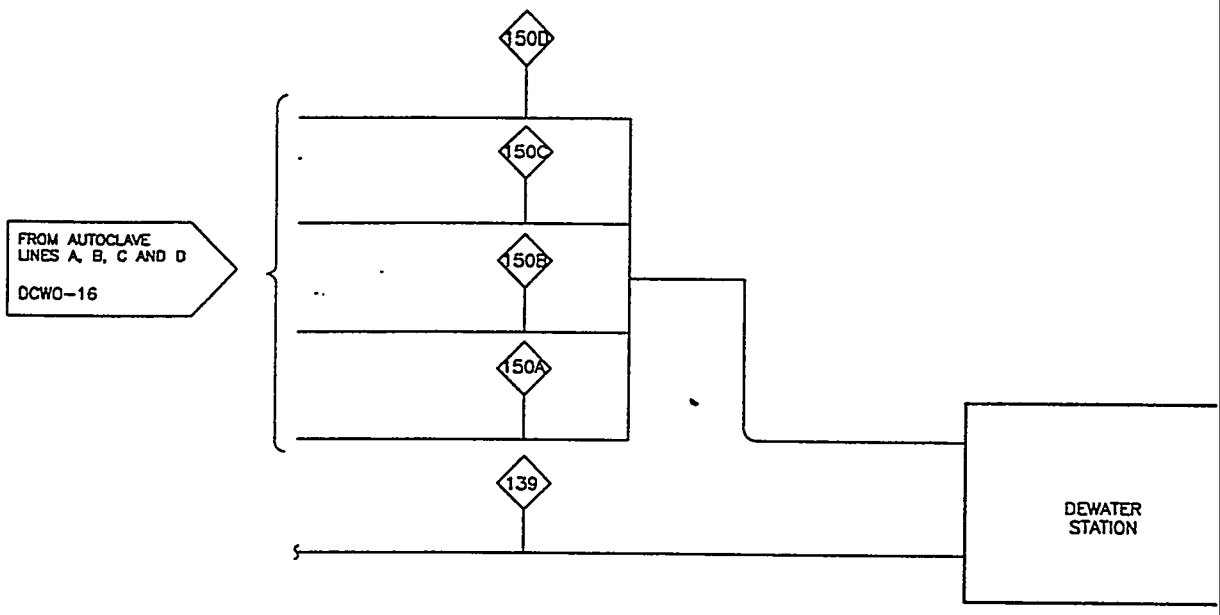
SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION AUTOCLAVE CURE STATION–LINE A
DESIGN:	
DRAWN: EM SNELL	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, QL, ORG 530; DWG– ; REV
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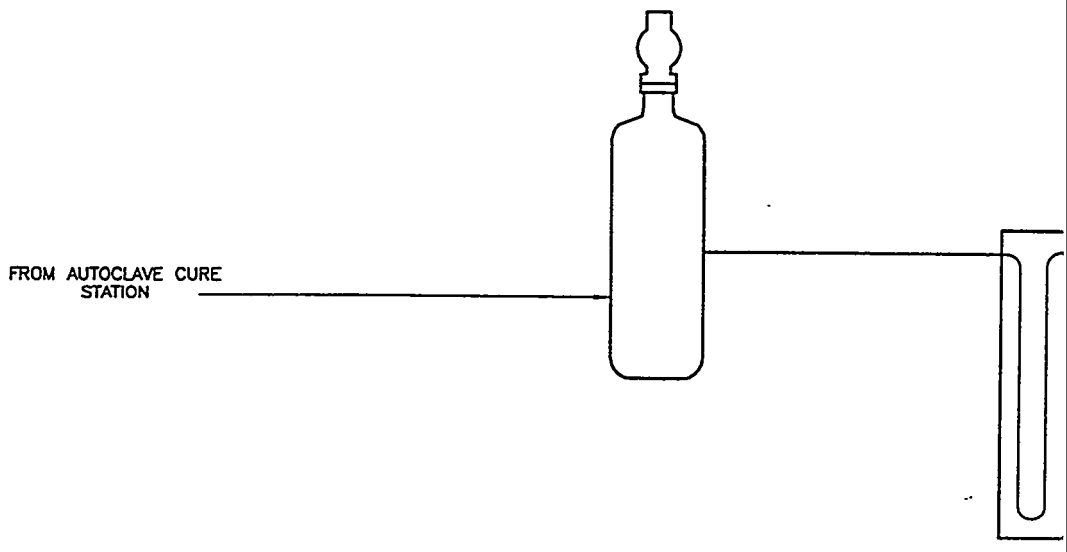
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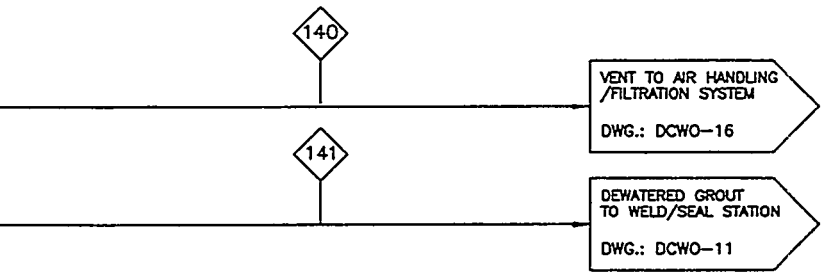
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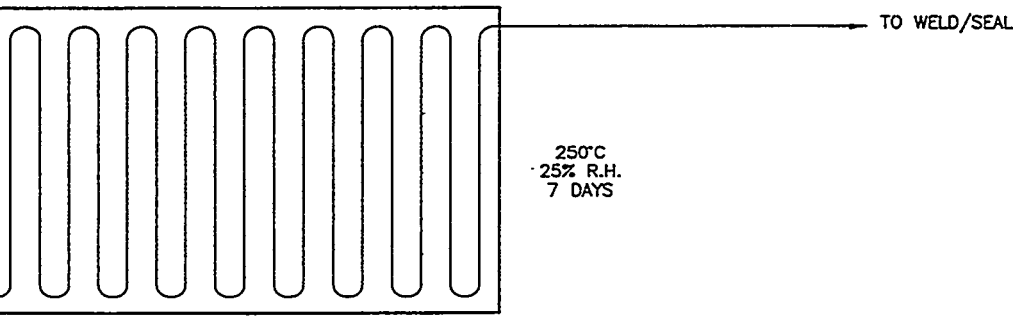
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

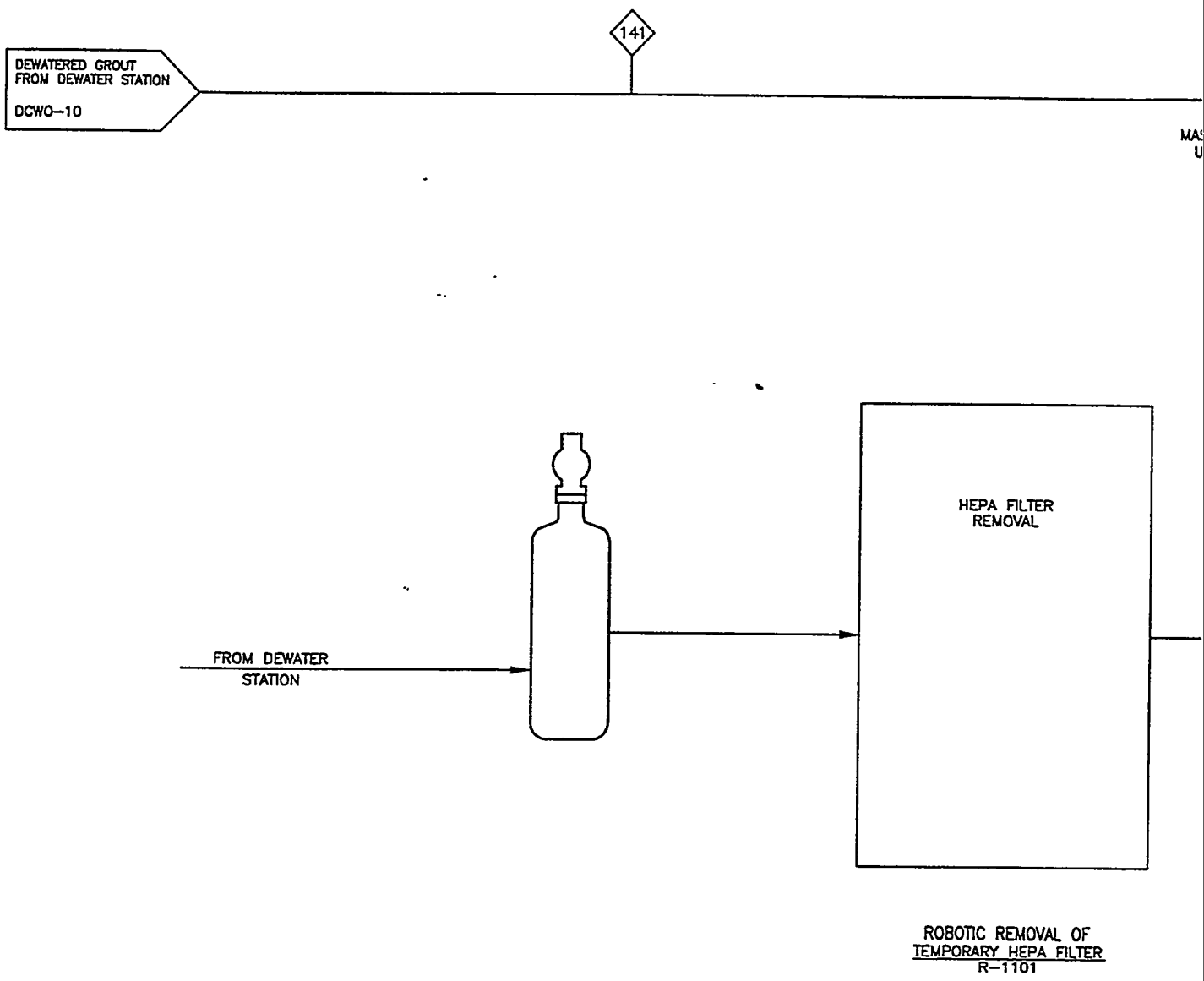




DEWATER STATION

NOTE: DEWATER STATION IS A CONTROLLED ENVIRONMENT ROOM IN WHICH TEMPERATURE IS 250°C AND RELATIVE HUMIDITY IS 25%. CONVEYOR SYSTEM PROVIDES THAT WASTE CANNISTER HAS RESIDENCE TIME OF AT LEAST 7 DAYS VENTILATION SYSTEM OF STATION MUST CAPTURE ALL EVOLVED WATER.

SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION DEWATER STATION
DESIGN:	
DRAWN: EM SNELL	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, Q, ORG 530; DWG- ; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-10



User: AEG
Date: 12/09/97 - 09:03 A.M.
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

BALANCE AND WASTE COMPOSITION
FECTED BY THIS PROCESS STEP

141

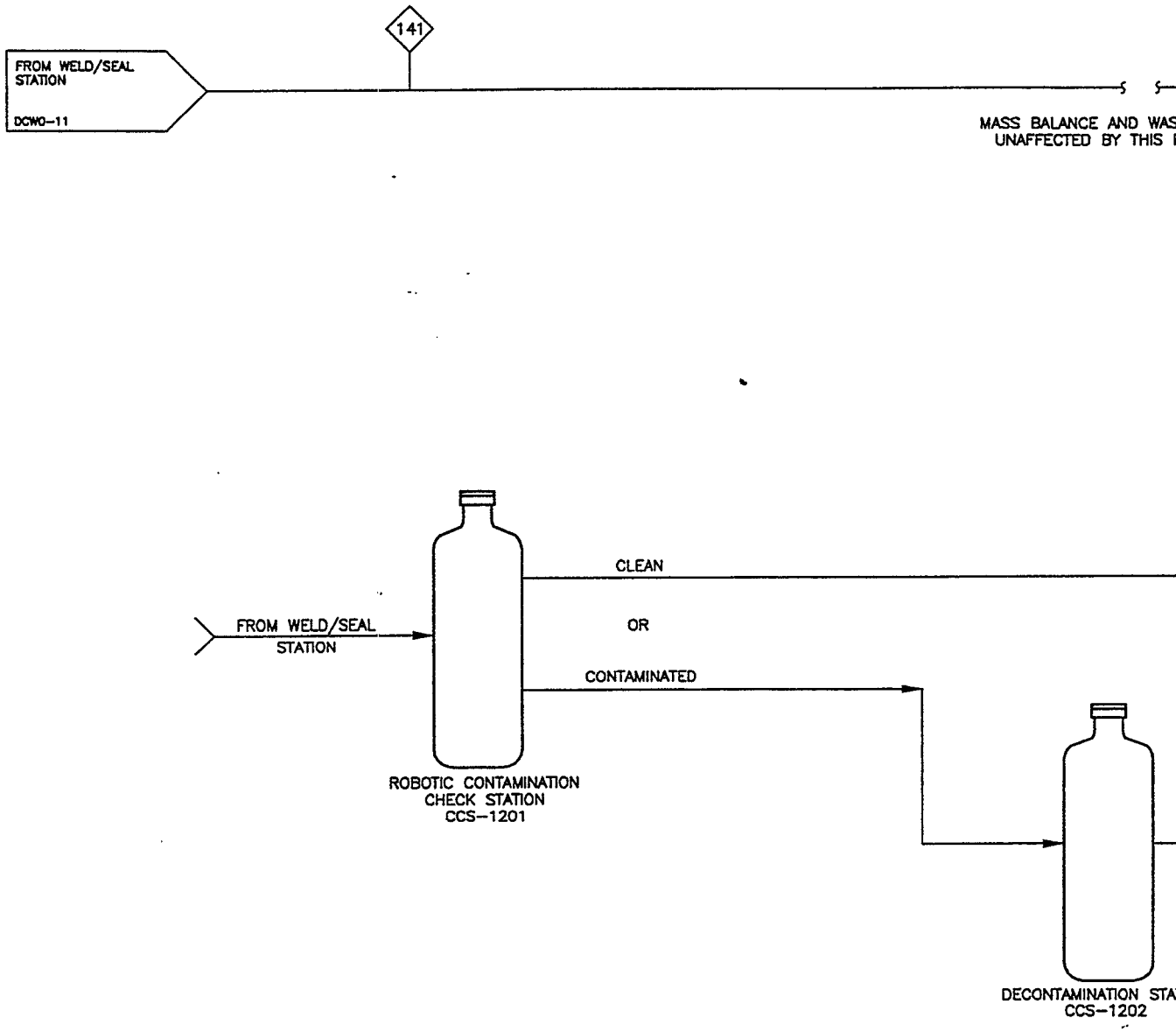
SEALED GROUT CANISTER TO SURFACE CONTANIMATION CHECK DCWO-12

WELD CAP
AND SEAL CHECK

TO FINAL SURFACE
CONTAMINATION CHECK

AUTOMATIC WELD/
SEAL CHECK STATION
R-1102

SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP
DESIGN:	WASTE TREATMENT FACILITIES
DRAWN: AE GB8S	DIRECT CEMENTITIOUS WASTE OPTION
PROJECT NO.	WELD SEAL
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBJ 530; DWG--; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-11



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User: AEG
Date: 12/09/97 - 09:05 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

141

TO SONIC TOMOGRAPHY STATION

DCWO-13

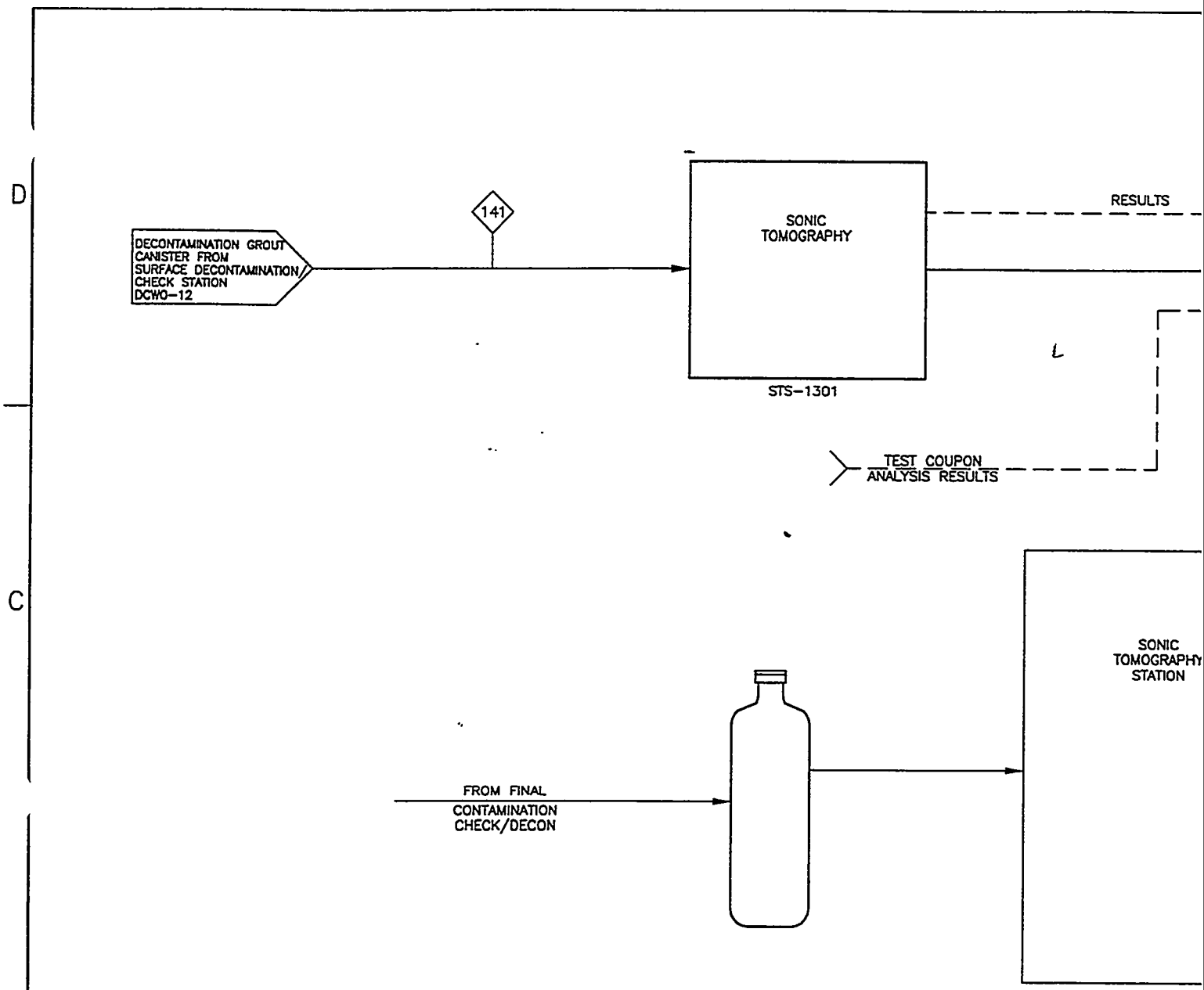
COMPOSITION
OCESS STEP

TO SONIC TOMOGRAPHY

SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION CHECK AND SURFACE DECON
DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR No. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBG 530; DWG-; REV
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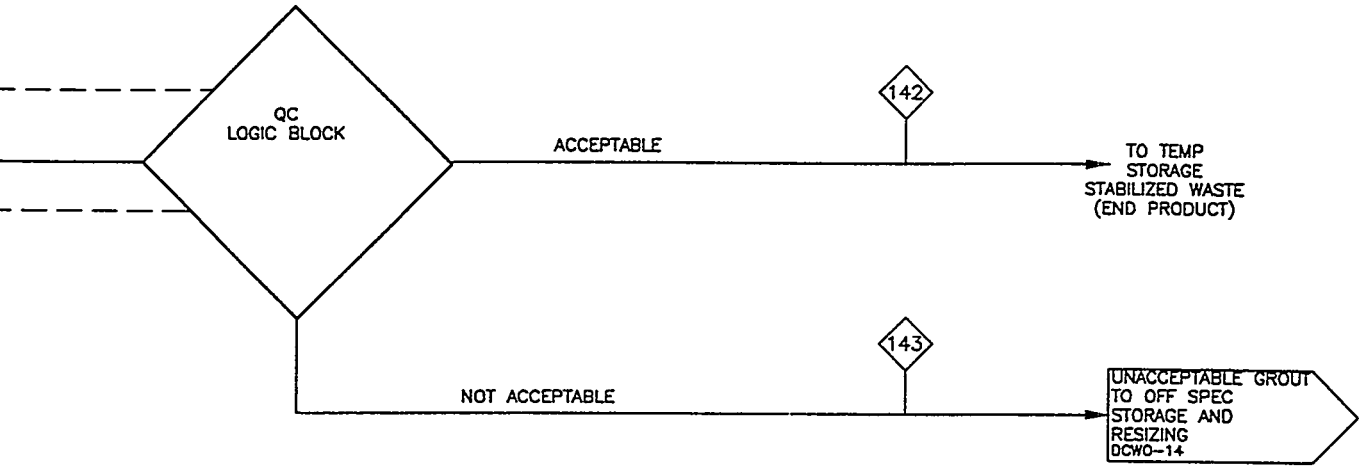


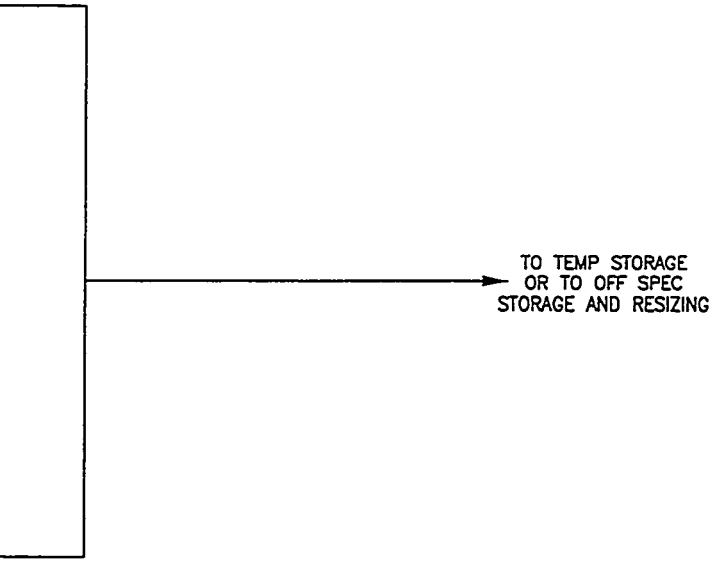
NOTE: SONIC TOMOGRAPHY STATION WILL DEVELOP 3 DIMENSIONAL IMAGE OF SONIC VELOCITY OF WASTE CANISTER, THIS METHOD WILL IDENTIFY UNCURED GROUT AND PROVIDE REASONABLE CORRELATION WITH COMPRESSIVE STRENGTH

User: AEG
Date: 11/20/97 - 09:02 A.M.
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Path: E:\AEG\WE2

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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:





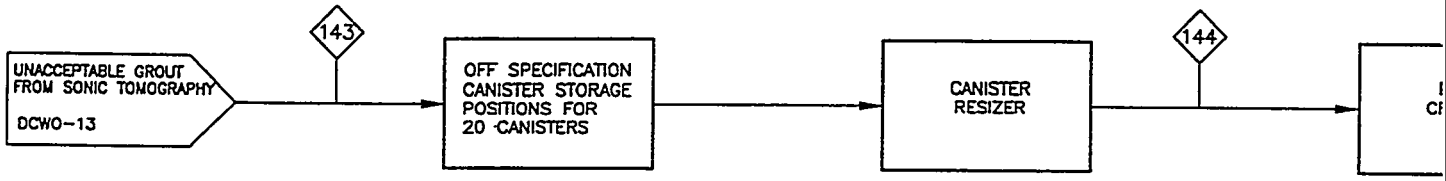
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SUBCONTRACT NO.		LOCKHEED MARTIN					
REQUESTER:		ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION SONIC TOMOGRAPHY					
DESIGN:							
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PROJECT NO.							
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FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D	CAGE CODE: 01MF3	INDEX CODE NUMBER: AREA 200	TYPE	CL	OBG 530	DWG-- REV
EFFECTIVE DATE:	SCALE: NONE						SHEET DCWO-13

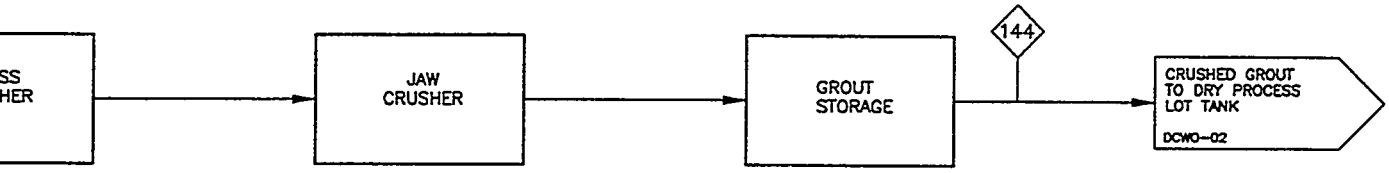


THIS OPERATION IS NOT WELL DEFINED, BUT IS ENVISIONED TO INCLUDE:

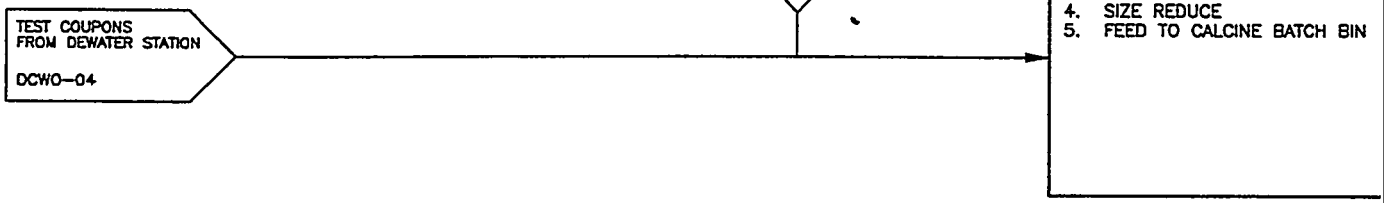
1. OFF-SPEC CANISTER STORAGE
2. CANISTER STRIP FROM WASTE
3. WASTE GROUT CRUSHER
4. CRUSHED GROUT (RECYCLE) STORAGE
5. CANISTER FRAGMENT STORAGE

User: EMS
Date: 12/10/97 - 09:13 A.M.
File: DCWO-14.dwg
Path: E:\EMS\1522-sketc

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



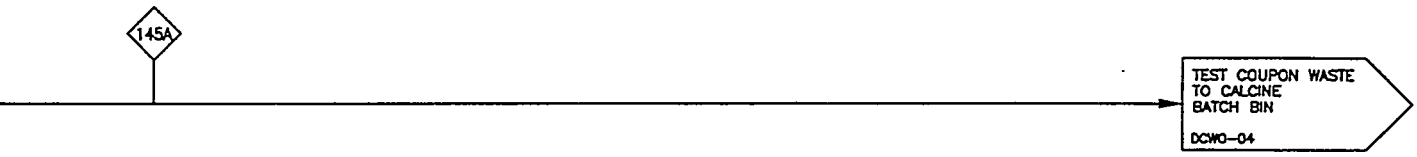
SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION SIZING AND RECYCLE
DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBSC 530; DWG-; REV
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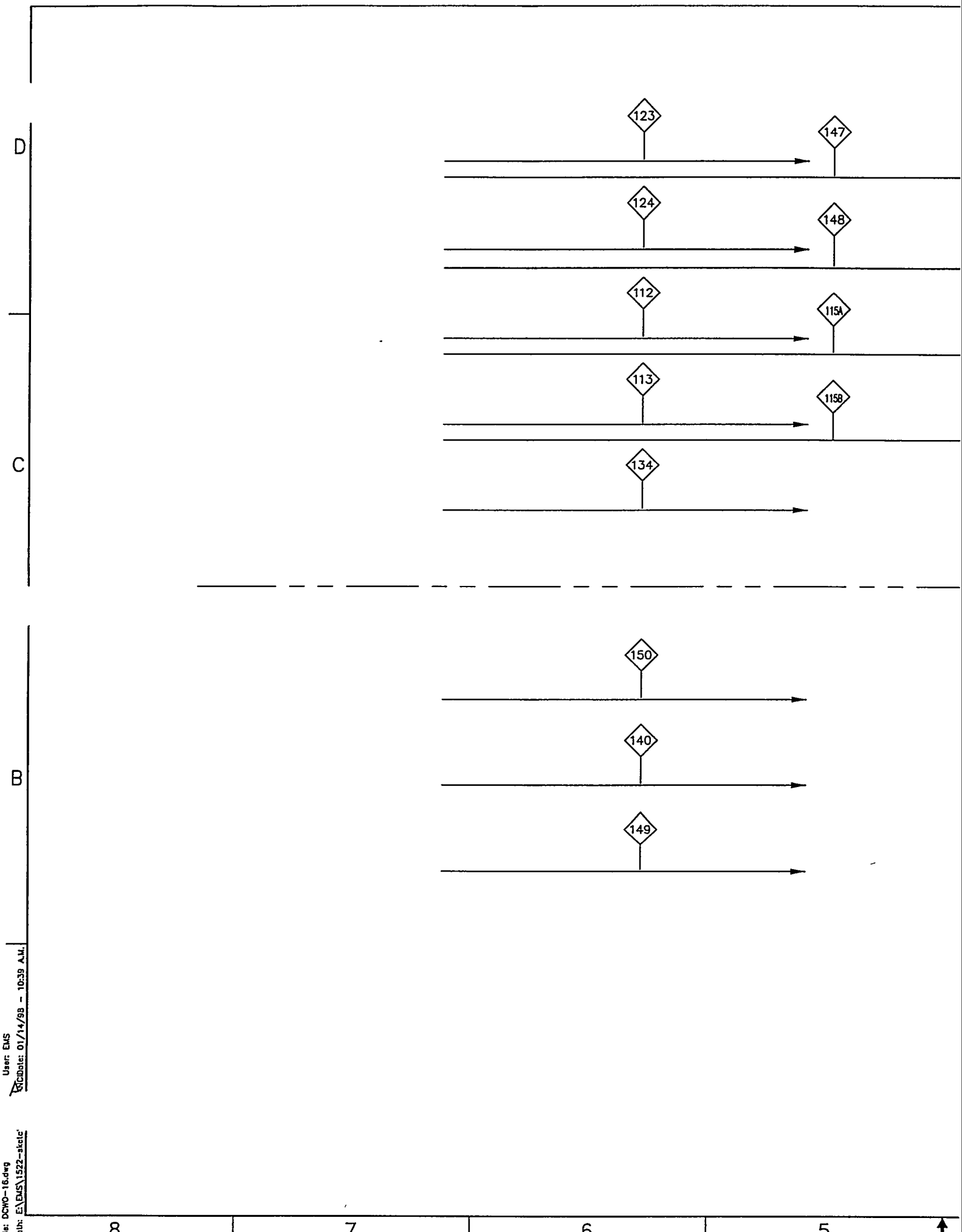
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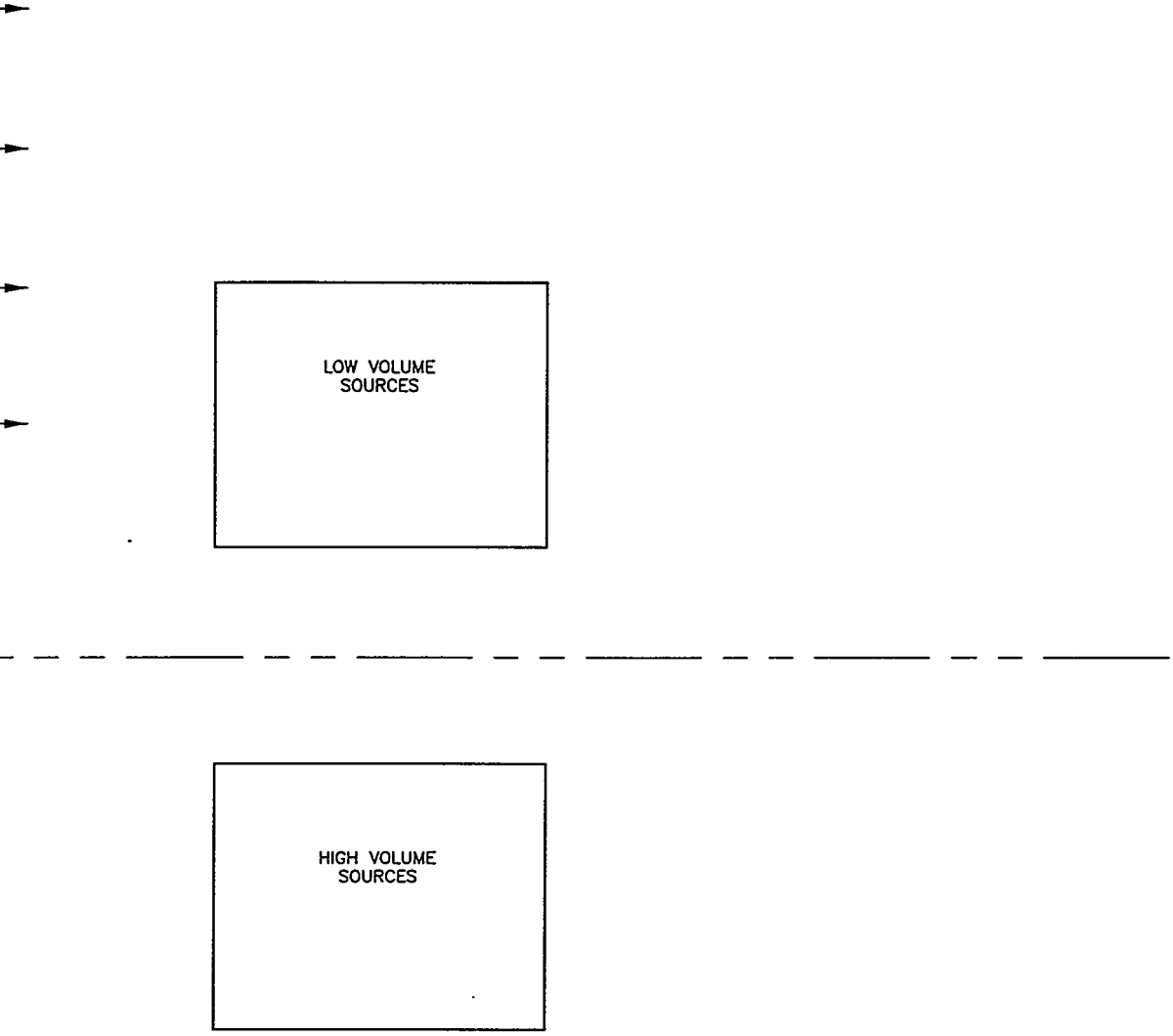
REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP
DESIGN:	WASTE TREATMENT FACILITIES
DRAWN: AE GIBBS	DIRECT CEMENTITIOUS WASTE OPTIO
PROJECT NO.	TEST COUPONS AND CHEMICAL ANALYSIS
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OBJ 530; DWG-; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-15


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User: EMS
Date: 01/14/98 - 10:39 A.M.
File: DCWO-16.dwg
Path: E:\EMS\1522-sketc

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP WASTE TREATMENT FACILITIES DIRECT CEMENTITIOUS WASTE OPTION AIR HANDLING/FILTRATION SYSTEM
DESIGN:	
DRAWN: AE GIBBS	
PROJECT NO.	
SPEC CODE	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, ORIG 530; DWG-; REV
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	
EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-16

Appendix C

Cost Estimate

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: January 26, 1998

To: R. E. Dafoe MS 3765 6-6772

From: T. E. Sivill MS 3655 6-9273

Subject: HLW EIS WASTE TREATMENT SCOPING STUDIES - TES-1-98

Cost Estimating has revised the attached Rough Order of Magnitude Planning Cost Estimates for the above referenced project. Total Estimated Costs have been provided for a five-year and 20-year Grout Facility option. A separate operating dollar estimate has been provided to derive a Total Project Cost (TPC) ready for operation of the facility. Costs have been presented in current year FY 1997 dollars and escalated dollars.

Costs are based upon information and guidance provided by program personnel and cognizant engineers. Costs extrapolated from projects similar in nature, as well as historical data and vendor quotes, have been referenced. Assumptions forming the basis of the attached costs and any concerns that may effect the costs have been itemized on the following Recapitulation Sheet.

Should you have any questions, please feel free to contact Terry Sivill, OV ID - TES, phone, 526-9273.

tes

Attachments

cc: Estimate File #2417-A
T. E. Sivill File
R. D. Adams File

LOCKHEED Martin Idaho Technologies Co.
(Rev. 6/20/96)

COST ESTIMATE SUPPORT DATA RECAPITULATION

Project Title: HLW EIS Waste Treatment Scoping Studies
Estimator: TES/SQB
Type of Estimate: Planning
Date: 1/26/98
File No: 2417-A
Approved By:

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

The project scope includes a calcine grouting facility located at INEEL-ICPP area. Costs are presented in two, "rough order of magnitude," Total Estimated Cost (TEC) estimates: The first estimate includes the capital costs associated with the design and construction of a five- year process facility. The second includes the capital costs associated with the design and construction of a 20-year process facility. An operating dollar estimate has been prepared including costs for conceptual design, permitting, systems operations testing and operational readiness reviews. The operating dollar estimate, combined with either TEC estimate, will provide a Total Project Cost (TPC) encompassing all project costs from conception to ready for operation.

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

- HLW-EIS Waste Treatment Scoping Studies Planning Estimate, File No. 2417, dated 12/10/97.
- Fluor Daniel Northwest Feasibility Study Estimate, ICPP HLW Waste Treatment Projects, project number 04435336, dated 10/20/97.
- LMITCO Conceptual Estimate, ICPP Spent Nuclear Fuel Dry Storage Project, File No. 2314B, dated 6/17/96.
- LMITCO Planning Estimate, ICPP Coal Fired Boiler Plant, File No. 2333-A, dated 5/12/96.
- Preliminary sketches, process equipment list, and verbal direction from design team.

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

- The five-year process facility is assumed to be a 7-story 286,000 sq ft facility. It is assumed that the process portion of the facility will be concrete construction with 5 foot thick shielding walls around the primary containment. Secondary and tertiary administrative areas are assumed a combination of concrete and engineered metal structures.

-continued on page 2-

COST ESTIMATE SUPPORT DATA RECAPITULATION
(CONTINUATION)

III. **ASSUMPTIONS:** (Continued)

- The 20-year facility is assumed to be a 7-story, 200,000 sq ft facility with similar construction characteristics as the five-year facility. The deleted square footage is primarily all process areas housing redundant systems required to meet the five year goal. Deletion of process equipment and process facility areas has a significant impact on costs that is not linear to the deletion of square footage.

- Two Summary Sheets have been included for each facility; Costs are reflected in FY97 dollars and dollars escalated to the midpoint of individual activities.

- As per direction from the program DCWO team, the grouting facility shall be ready to operate in FY 2013. The following schedule has been assumed for escalation purposes. Conceptual Design in FY 2001-FY 2003, Title Design in FY 2004-FY 2006, Permitting/Documentation is assumed a three to four year duration and will be accomplished in conjunction with the design activities, Construction in FY 2007-FY 2010, SO Testing and ORR's in FY 2010 and FY 2012.

- The facility costs were based on minimal design sketches. A parametric approach was used patterning the ICPP Spent Nuclear Fuel Dry Transfer Cell Conceptual Design. The SNF Dry Transfer Cell Conceptual Design included a 20,000 sf facility with concrete hot cell area, remote control capability, administrative support, and transport drive thru area.

- It is assumed that the facility will be located inside the security area, in the northeast corner of ICPP. The Interim Storage Facility is assumed to be within 200 lf of the grouting facility. No costs have been included for demolition or relocation of any existing buildings, utilities, or roadways. Minimal costs have been included for site improvements.

- All utilities required for the facility are assumed available at the outside wall of the facility. A separate HLW - Infrastructure package shall include all underground utilities, overhead/underground power supply and emergency power generators.

- All calcine material will be delivered to the grouting facility as part of a separate HLW - Package/Estimate.

-continued on page 3-

III. **ASSUMPTIONS:** (Continued)

- A 200 lf waste transfer tunnel has been included in the grouting facility cost for transfer of canisters to the Interim Storage Facility.
- The entire grouting process is assumed to be remote controlled operation throughout the process from a central location within the facility. Allowances have been included for a control center based on minimal design information.
- The HLW Fluor Daniels documentation/estimate presents a comprehensive breakdown of cost and scope. Although scope differences exist in the treatment processes now being considered, some specific equipment unit costs and labor were deemed common and reasonable for use.
- The primary process equipment costs were derived from vendor quotes based on minimal design information. Due to the capacity required of selected pieces of equipment, off the shelf items were not available. Costs were based smaller equipment sales and scaled to the desired design capacity. Allowances were given to specialized equipment such as the automated conveyance system based on engineer's judgement and minimal vendor input. Allowances for secondary systems, (ie; process offgas and piping systems were based similar functions in the Fluor Daniels estimate.
- It is assumed the cost of 18,000 canisters and hepa filter assemblies are part of the facility operations cost and are not included in this estimate.
- All bulk grouting materials are assumed part of the operations cost and are not included in this estimate.
- The coupon sample collection/transfer system assumes a remote golvebox fill and cask loading operation. Casks will be manually transferred to the ICPP Remote Analytical Laboratory. Costs have been included for the glovebox and sample collection and transport equipment. No costs have been included for actual sample collection activities or sample analysis.
- It is assumed the sonic tomography process identified will satisfy any NDA/NDE inspection, DOT requirements, and final waste disposal acceptance criteria requirements.

-continued on page 4-

COST ESTIMATE SUPPORT DATA RECAPITULATION
(CONTINUATION)

III. **ASSUMPTIONS:** (Continued)

- Project support activities are included as a percentage of the project costs. Listed below, are averaged percentages that are consistent for all HLW estimate options.

  Capital Dollar Activities: It is assumed Project Management and Construction Management will be included at 10% of the construction costs respectively. Title III Inspection is included at 5% of the construction costs. Engineering and Design (Title I & II) will be included at 20% of construction costs.

  Operating Dollar Activities (i.e., Conceptual Design, Permitting, SO Testing, and ORR's): Engineering and Design,(Conceptual), will be included at 5% of the construction costs. Project Management for project development during the permitting and documentation stage is applied at 5% of the operating activities cost. Project support is included at 4% of the operating activities cost.

  Indirect markups are assumed as follows:

  - Consumables and small tools - 3% of labor
  - Construction equipment (cranes, etc.) - 10%of labor
  - NQA-1 Quality requirements - 25% of material
  - DOE/RW/0333P Quality standards - 10% of material
  - Subcontractor procurement costs - 1% of equipment and material
  - General's profit on subcontracts - 10% of subcontracts
  - Bond - 2% of Construction costs
  - Labor indirects, overhead and profit - 50% of labor

- Procurement Fee, G&A and PIF have been included at 1%, 23% and 5.5% respectively.

COST ESTIMATE SUPPORT DATA RECAPITULATION
(CONTINUATION)

File No: 2417-A

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 is currently included in the estimates at approximately 35%. Typically for ROM Planning Estimates with remote process systems would average 30% to 50% contingency. Facility layouts were estimated on preliminary sketches. The equipment list provides a general description of major process components. "Off-the-shelf" equipment will require engineering and modifications to accommodate remote hot cell operations.

V. OTHER COMMENTS/CONCERNS SPECIFIC TO THE ESTIMATE:

The Functional and Operational Requirements (F&OR's) were initially based on the five-year facility. The 20-year facility was derived from the HLW-team projecting what systems/processes and facility areas would be eliminated from the five-year option. As a result the 20-year facility becomes a single process line eliminating all process system redundancy. As the preliminary design is developed it may become apparent that process system redundancy may be required for safety, quality, or rate production reasons. Costs will be impacted significantly should redundancy become an issue.

The revised estimate incorporates review comments to the original Planning Estimate No. 2417, dated 12/10/97. Listed below are major line item differences:

- Proof of Process costs were added to the conceptual/operating dollars cost estimate. Demonstrating the safe remote handling of high level waste during grouting and mixing processes is required. Costs allowances were assumed similar to the HIP/VIT proposals.
- Capital equipment costs were added/adjusted based on the latest vendor quote information.
- Procurement Fee @ 1%, G&A @ 23% and PIF @ 5.5% were added to the capital dollar estimates.
- Contingency was increased at the direction of the project team to approximately 35%.

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6-96

PROJECT NAME: HLW-DCWO Operating-Grout Facility
ON 1: INEEL-ICPP
ITOR: R. Dafoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SQB
REPORT NAME: Cost Estimate Summary

DATE: 27-Jan-1998
TIME: 09:28:23
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $81,925,000
1.1.1	CONCEPTUAL DESIGN	72,500,000	9,425,000	81,925,000
1.2	MANAGEMENT COSTS			>> $8,571,250
1.2.1	PM FOR PROJECT DEVELOPMENT	4,000,000	920,000	4,920,000
1.2.2	PROJECT SUPPORT	3,175,000	476,250	3,651,250
1.3	PERMITTING			>> $4,283,750
1.3.1	PERMITTING	3,725,000	558,750	4,283,750
1.4	STARTUP ACTIVITIES			>> $4,489,651
1.4.1	STARTUP ACTIVITIES	3,161,726	1,327,925	4,489,651
1.5	G&A/PIF			>> $0
1.5.1	G&A/PIF ADDER	0	0	0
1.5.2	PROCUREMENT FEES	0	0	>> $0
	SUBTOTAL INCLUDING ESCALATION	86,561,726	12,707,925	>> $99,269,651
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $877,340
	CONTINGENCY			>> $34,853,009
	TOTAL ESTIMATED COST			>> $135,000,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *35.99%*

Lockheed Martin Idaho Technologies Co.
Rev. 6-96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW-DCWO Operating-Grout Facility
LOCATION 1: INEEL-ICPP
REQUESTOR: R. Dafoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SQB
REPORT NAME: Cost Estimate Summary

DATE: 27-Jan-1998
TIME: 09:22:03
CHECKED BY: _____
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $72,500,000
1.1.1	CONCEPTUAL DESIGN	72,500,000	0	72,500,000
1.2	MANAGEMENT COSTS			>> $7,175,000
1.2.1	PM FOR PROJECT DEVELOPMENT	4,000,000	0	4,000,000
1.2.2	PROJECT SUPPORT	3,175,000	0	3,175,000
1.3	PERMITTING			>> $3,725,000
1.3.1	PERMITTING	3,725,000	0	3,725,000
1.4	STARTUP ACTIVITIES			>> $3,161,726
1.4.1	STARTUP ACTIVITIES	3,161,726	0	3,161,726
1.5	G&A/PIF			>> $0
1.5.1	G&A/PIF ADDER	0	0	0
1.5.2	PROCUREMENT FEES	0	0	>> $0
	SUBTOTAL INCLUDING ESCALATION	86,561,726	0	>> $86,561,726
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $688,6
	CONTINGENCY			>> $28,749,601
	TOTAL ESTIMATED COST			>> $116,000,000

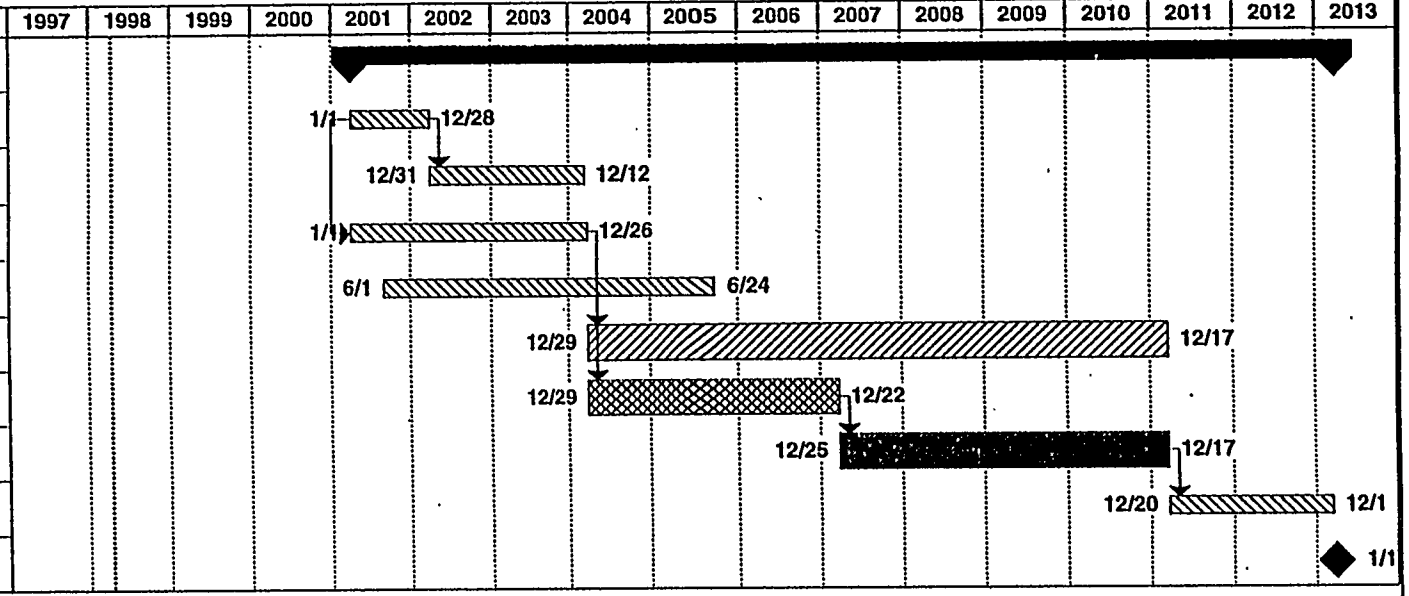
PROJECT COST PARAMETERS

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

CONTINGENCY= *34.01%*

DCWO

ID	Task Name
1	DCWO
2	CONCEPTUAL DESIGN
3	ADVANCED CONCEPTUAL DESIGN
4	PM FOR PROJECT DEVELOPMENT
5	PERMITTING
6	PROJECT MANAGEMENT
7	TITLE DESIGN
8	CONSTRUCTION
9	SO TEST & STARTUP
10	BEGIN OPERATIONS



Project: 2417-Dcwo.MPP
Date: Wed 1/7/98

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

Lockheed Martin Idaho Technologies Co.

Rev 6-96

DETAILED COST ESTIMATE SHEET

PAGE # 1

PROJECT NAME: HLW-DCWO
Operating-Grout Facility
LOCATION 1 INEEL-ICPP
REQUESTOR R. Dafoe

TYPE OF ESTIMATE: Planning I
PROJECT NO.: 2417-A
PREPARED BY: TES/SQB

DATE 27-Jan-1998
TIME: 09:21:49
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	**CONCEPTUAL DESIGN**											
	Conceptual Design @ 5% of Construction	1	lot			0.000					22,500,000	22,500,000
	Proof of Process	1	ls			0.000					50,000,000	50,000,000
	CONCEPTUAL DESIGN S/T						0				$72,500,000	$72,500,000
.2.1 0301000	**PM FOR PROJECT DEVELOPMENT**											
	Project Manager Cost @ 5% of Operating Dollar Activities	1	LS			1.000	1				4,000,000	4,000,000
	PM FOR PROJECT DEVELOPMENT S/T						1				$4,000,000	$4,000,000
.2.2 0400100	**PROJECT SUPPORT**											
	Project Support @ 4% of Operating Dollar Activities	1	ls			1.000	1				3,175,000	3,175,000
	PROJECT SUPPORT S/T						1				$3,175,000	$3,175,000
.3.1	**PERMITTING**											
	HWMA/RCRA Permitting	1	ls			0.000					240,000	240,000
	Clean Air Act (CAA) Permiting	1	ls			0.000					135,000	135,000
	Environmental Compliance Documentation	1	ls			0.000					1,100,000	1,100,000
	Health and Safety	1	ls			0.000					2,100,000	2,100,000
	Quality Documentation	1	ls			0.000					150,000	150,000

DETAILED COST ESTIMATE SHEET

ODE	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
3.1	PERMITTING											
	PERMITTING S/T						0				$3,725,000	$3,725,000
4.1	STARTUP ACTIVITIES											
	Systems Operation Testing											
	Develop Checklist for Testing and Acceptance Criteria	3	fte		Z-5120	400.000	1,200	81,348				81,348
	Perform Component Checkout Test for Equipment	8	fte		Z-5120	600.000	4,800	325,392				325,392
	Perform Systems Operations Testing	8	fte		Z-5120	600.000	4,800	325,392				325,392
	Reporting of Testing	3	fte		Z-5120	160.000	480	32,639				32,639
	Management and Assessment											
	Prepare Self Assessment Plan	3	fte		Z-5120	640.000	1,920	130,157				130,157
	Conduct Self Assessment Audit/Survey	3	fte		Z-5120	640.000	1,920	130,157				130,157
	Submit Self Assessment Report	3	fte		Z-5120	640.000	1,920	130,157				130,157
	Operational Readiness Review											
	Develop and Issue ORR Plan of Action	3	fte		Z-5120	640.000	1,920	130,157				130,157
	Prepare ans Issue Readiness to Proceed Memorandum	1	fte		Z-5120	160.000	160	10,846				10,846
	Develop and Issue ORR Implementation Plan	8	fte		Z-5120	960.000	7,680	520,627				520,627

ockheed Martin Idaho Technologies Co.

DETAILED COST ESTIMATE SHEET

Rev 6-96
OJECT NAME HLW-DCWO
Operating-Grout Facility
CATION 1: INEEL-ICPP
QUESTOR. R. Dafoe

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SQB

DATE 27-Jan-1998
TIME. 09:21:49
REPORT NAME: Detail Cost Estimate Sheet

)DE	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
4.1	STARTUP ACTIVITIES											
	Mobilization of Independent ORR Team	8	fte		Z-5120	80.000	640	43,386				43,386
	Review of ORR Plan by ESH&Q	3	fte		Z-5120	320.000	960	65,078				65,078
	Prepare and Issue ORR Results and Final Startup	8	fte		Z-5120	960.000	7,680	520,627				520,627
	Support to DOE-ID Operations to Perform Independent ORR	3	fte		Z-5120	960.000	2,880	195,235				195,235
	Training Documentation											
	Identification of Training Requirements	4	fte		Z-5120	960.000	3,840	260,314				260,314
	Develop Training Plans	4			Z-5120	960.000	3,840	260,314				260,314
	STARTUP ACTIVITIES S/T						46,640	$3,161,726				$3,161,726
5.1 /01000	G&A/PIF ADDER											
	G&A	1	LOT			0.000						
	PIF	1	LOT			0.000						
	G&A/PIF ADDER S/T						0					
	PROJECT SUBTOTAL						46,642	$3,161,726	$0	$0	$83,400,000	$86,561,726

Lockheed Martin Idaho Technologies Co.

CONTINGENCY ANALYSIS

PROJECT NAME: HLW-DCWO Operating-Grout Facility
ION 1: INEEL-ICPP
ESTOR: R. Dafoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SQB

DATE: 27-Jan-1998
TIME: 09:21:27

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	CONCEPTUAL DESIGN	72,500,000	83.76	5	40	4.19	33.50	29.733%	86.94%	25,594,820	98,094,820
1.2.1	PM FOR PROJECT DEVELOPMENT	4,000,000	4.62	5	40	0.23	1.85	1.640%	4.80%	1,412,128	5,412,128
1.2.2	PROJECT SUPPORT	3,175,000	3.67	0	0	0.00	0.00	0.000%	0.00%	0	3,175,000
1.3.1	PERMITTING	3,725,000	4.30	5	40	0.22	1.72	1.528%	4.47%	1,315,044	5,040,044
1.4.1	STARTUP ACTIVITIES	3,161,726	3.65	5	40	0.18	1.46	1.297%	3.79%	1,116,190	4,277,916
1.5.1	G&A/PIF ADDER	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.5.2	PROCUREMENT FEES	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
	ESCALATION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	92	92
	SUBTOTAL	86,561,726	100.00					34.198%			
	CALCULATED CONTINGENCY	29,602,288									
	RESULTANT TEC	116,164,014									
	ROUNDED TEC	116,000,000									
	PROJECT CONTINGENCY	29,438,274						34.01%			
	MANAGEMENT RESERVE	688,673									
	CONTINGENCY	28,749,601									
	TOTAL ESTIMATED COST	116,000,000								29,438,274	116,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
The Lockheed Martin 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. **CONTINGENCY ANALYSIS**

PROJECT NAME: HLW-DCWO Operating-Grout Facility
LOCATION 1: INEEL-ICPP
REQUESTOR: R. Dafoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SQB

DATE: 27-Jan-1998
TIME: 09:28:09

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	CONCEPTUAL DESIGN	72,500,000	73.03	5	40	3.65	29.21	25.927%	76.73%	27,416,486	99,916,486
1.2.1	PM FOR PROJECT DEVELOPMENT	4,000,000	4.03	5	40	0.20	1.61	1.430%	4.23%	1,512,634	5,512,634
1.2.2	PROJECT SUPPORT	3,175,000	3.20	0	0	0.00	0.00	0.000%	0.00%	0	3,175,000
1.3.1	PERMITTING	3,725,000	3.75	5	40	0.19	1.50	1.332%	3.94%	1,408,640	5,133,640
1.4.1	STARTUP ACTIVITIES	3,161,726	3.18	5	40	0.16	1.27	1.131%	3.35%	1,195,633	4,357,359
1.5.1	G&A/PIF ADDER	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.5.2	PROCUREMENT FEES	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
	ESCALATION	12,707,925	12.80	5	35	0.64	4.48	3.968%	11.74%	4,196,956	16,904,881
	SUBTOTAL	99,269,651	100.00					33.789%			
	CALCULATED CONTINGENCY	33,541,744									
	RESULTANT TEC	132,811,395									
	ROUNDED TEC	135,000,000									
	PROJECT CONTINGENCY	35,730,349						35.99%			
	MANAGEMENT RESERVE	877,340									
	CONTINGENCY	34,853,009									
	TOTAL ESTIMATED COST	135,000,000								35,730,349	135,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
The Lockheed Martin 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.

Rev. 6-96

COST ESTIMATE SUMMARY

'T NAME: HLW-DCWO
5 Yr. Grout Facility
.ON 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB
REPORT NAME: Cost Estimate Summary

DATE: 26-Jan-1998
TIME: 09:20:13
CHECKED BY: RDH
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $138,150,000
1.1.1	DESIGN ENGINEERING TITLE I & II	90,000,000	18,000,000	108,000,000
1.1.2	TITLE III INSPECTION	22,500,000	7,650,000	30,150,000
1.2	MANAGEMENT COSTS			>> $117,450,000
1.2.1	PROJECT MANAGEMENT	45,000,000	12,150,000	57,150,000
1.2.2	CONSTRUCTION MANAGEMENT	45,000,000	15,300,000	60,300,000
1.3	CONSTRUCTION			>> $601,555,711
1.3.1	GENERAL CONDITIONS	1,128,389	383,652	1,512,041
1.3.2	SITEWORK	10,411,459	3,539,896	13,951,355
1.3.3	CONCRETE	97,555,368	33,168,825	130,724,193
1.3.4	MASONRY	0	0	0
1.3.5	METALS	16,191,603	5,505,145	21,696,748
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,573,915	535,131	2,109,046
1.3.8	DOORS & WINDOWS	71,516,875	24,315,738	95,832,613
1.3.9	FINISHES	10,707,858	3,640,672	14,348,530
1.3.10	SPECIALTIES	280,500	95,370	375,870
.11	EQUIPMENT	117,511,157	39,953,793	157,464,950
.3.12	FURNISHINGS	336,600	114,444	451,044
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	6,171,000	2,098,140	8,269,140
1.3.15	MECHANICAL	65,166,808	22,156,715	87,323,523
1.3.16	ELECTRICAL	50,370,640	17,126,018	67,496,658
1.5	G&A/PIF			>> $35,460,554
1.5.1	G&A/PIF ADDER	26,463,100	8,997,454	35,460,554
1.5.2	PROCUREMENT FEES	4,489,222	1,526,335	>> $6,015,557
	SUBTOTAL INCLUDING ESCALATION	682,374,494	216,257,328	>> $898,631,822
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $64,303,182
	CONTINGENCY			>> $287,064,996
	TOTAL ESTIMATED COST			>>$1,250,000,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *39.10%*

Lockheed Martin Idaho Technologies Co.

Rev. 6-96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW-DCWO
5 Yr. Grout Facility
LOCATION 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB
REPORT NAME: Cost Estimate Summary

DATE: 26-Jan-1998
TIME: 09:23:05
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $112,500,000
1.1.1	DESIGN ENGINEERING TITLE I & II	90,000,000	0	90,000,000
1.1.2	TITLE III INSPECTION	22,500,000	0	22,500,000
1.2	MANAGEMENT COSTS			>> $90,000,000
1.2.1	PROJECT MANAGEMENT	45,000,000	0	45,000,000
1.2.2	CONSTRUCTION MANAGEMENT	45,000,000	0	45,000,000
1.3	CONSTRUCTION			>> $448,922,172
1.3.1	GENERAL CONDITIONS	1,128,389	0	1,128,389
1.3.2	SITEWORK	10,411,459	0	10,411,459
1.3.3	CONCRETE	97,555,368	0	97,555,368
1.3.4	MASONRY	0	0	0
1.3.5	METALS	16,191,603	0	16,191,603
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,573,915	0	1,573,915
1.3.8	DOORS & WINDOWS	71,516,875	0	71,516,875
1.3.9	FINISHES	10,707,858	0	10,707,858
1.3.10	SPECIALTIES	280,500	0	280,500
1.3.11	EQUIPMENT	117,511,157	0	117,511,157
1.3.12	FURNISHINGS	336,600	0	336,600
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	6,171,000	0	6,171,000
1.3.15	MECHANICAL	65,166,808	0	65,166,808
1.3.16	ELECTRICAL	50,370,640	0	50,370,640
1.5	G&A/PIF			>> $26,463,100
1.5.1	G&A/PIF ADDER	26,463,100	0	26,463,100
1.5.2	PROCUREMENT FEES	4,489,222	0	>> $4,489,222
	SUBTOTAL INCLUDING ESCALATION	682,374,494	0	>> $682,374,494
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $47,987,449
	CONTINGENCY			>> $189,638,057
	TOTAL ESTIMATED COST			>> $920,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *34.82%*

ckheed Martin Idaho Technologies Co.

Rev 6-96

JECT NAME. HLW-DCWO
5 Yr. Grout Facility

CATION 1. INEEL - ICPP

QUESTOR R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

DE	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 101000	DESIGN ENGINEERING TITLE I & II Title Design Costs @ 20% of Construction	1	ls			0.000					90,000,000	90,000,000
	DESIGN ENGINEERING TITLE I & II S/T						0				$90,000,000	$90,000,000
1.2 101000	TITLE III INSPECTION Inspection and Overview @ 5% of Construction	1	ls			1.000	1				22,500,000	22,500,000
	TITLE III INSPECTION S/T						1				$22,500,000	$22,500,000
2.1 501000	PROJECT MANAGEMENT Project Manager Cost @ 10% of Construction	1	ls			1.000	1				45,000,000	45,000,000
	PROJECT MANAGEMENT S/T						1				$45,000,000	$45,000,000
2.2 400100	CONSTRUCTION MANAGEMENT Construction Management @ 10% of Construction	1	ls			1.000	1				45,000,000	45,000,000
	CONSTRUCTION MANAGEMENT S/T						1				$45,000,000	$45,000,000

Lockheed Martin Idaho Technologies Co.

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DETAILED COST ESTIMATE SHEET

PROJECT NAME: HLW-DCWO
5 Yr. Grout Facility
LOCATION 1 INEEL - ICPP
REQUESTOR R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
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
.3.1	GENERAL CONDITIONS											
	Supervision	8	fte		SKWK	3760.00	30,080	995,949				995,949
	Training of Construction Personnel	50	fte		SKWK	80.000	4,000	132,440				132,440
	GENERAL CONDITIONS S/T						34,080	$1,128,389				$1,128,389
.3.2	SITEWORK											
	Sitework Allowance	270,000	sf	20.00	GEN	0.000				5,400,000		5,400,000
	Excavation/Hauling for Basement Area	200,000	cy	8.00	GEN	0.000				1,600,000		1,600,000
	SITEWORK S/T						0			$7,000,000		$7,000,000
.3.3	CONCRETE											
	Radiation Areas - Remote Handling Cells	130,000	sf	455.00	GEN	0.000				59,150,000		59,150,000
	Non-Radiation Process Areas	56,000	sf	82.50	GEN	0.000				4,620,000		4,620,000
	Support and Administrative Areas	100,000	sf	18.20	GEN	0.000				1,820,000		1,820,000
	CONCRETE S/T						0			$65,590,000		$65,590,000
.3.4	MASONRY											

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
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REPORT NAME: Detail Cost Estimate Sheet

DE	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
.4	MASONRY											
	MASONRY S/T						0					
.5	METALS											
	Radiation Areas - Remote Handling Cells	130,000	sf	55.30	GEN	0.000				7,189,000		7,189,000
	Non-Radiation Process Areas	56,000	sf	23.70	GEN	0.000				1,327,200		1,327,200
	Support and Administrative Areas	100,000	sf	23.70	GEN	0.000				2,370,000		2,370,000
	METALS S/T						0			$10,886,200		$10,886,200
.6	WOOD & PLASTICS											
	WOOD & PLASTICS S/T						0					
.7	THERMAL & MOISTURE PROTECTION											
	Radiation Areas - Remote Handling Cells	130,000	sf	3.70	GEN	0.000				481,000		481,000
	Non-Radiation Process Areas	56,000	sf	3.70	GEN	0.000				207,200		207,200
	Support and Administrative Areas	100,000	sf	3.70	GEN	0.000				370,000		370,000
	THERMAL & MOISTURE PROTECTION S/T						0			$1,058,200		$1,058,200

E	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
8	DOORS & WINDOWS											
	Radiation Areas - Remote Handling Cells	130,000	sf	365.81	GEN	0.000				47,555,300		47,555,300
	Non-Radiation Process Areas	56,000	sf	5.43	GEN	0.000				304,080		304,080
	Support and Administrative Areas	100,000	sf	2.24	GEN	0.000				224,000		224,000
	DOORS & WINDOWS S/T						0			$48,083,380		$48,083,380
9	FINISHES											
	Radiation Areas - Remote Handling Cells	130,000	sf	51.52	GEN	0.000				6,697,600		6,697,600
	Non-Radiation Process Areas	56,000	sf	2.53	GEN	0.000				141,680		141,680
	Support and Administrative Areas	100,000	sf	3.60	GEN	0.000				360,000		360,000
	FINISHES S/T						0			$7,199,280		$7,199,280
10	SPECIALTIES											
	Speciality Equipment Allowance	1	ls		GEN	0.000					250,000	250,000
	SPECIALTIES S/T						0				$250,000	$250,000
11	EQUIPMENT											
	Calcine Acceptance and Blending System											

DE	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
3.11	**EQUIPMENT** CY-101&2 Cyclone Separator (By Others)											
	T-201 Static Gravity Mixer	1	ea	700,000.00	SKWK GEN	600.000	600	19,866		700,000		719,866
Memo:	Vendor,(Ross Mixing Co.), has capability of building of constructing an 2,825 cf (80m3) gravity mixer. Pricing is not readily available for custom items. An allowance based on Fluor estimate has been used.											
	T-202 Dry Process Tank with Blender	1	ea	750,000.00	SKWK GEN	160.000	160	5,298		750,000		755,298
Memo:	A vendor has not been identified that can construct a 2,825 cf (80m3) gravity mixer. Cost allowance have been included based on information from a vendor sale of a system similar in function but about half the size											
	P-203 Mechanical Screw Conveyor	50	lf	40,000.00	SKWK GEN	24.000	1,200	39,732		2,000,000		2,039,732
Memo:	Cost allowance based on similar material in Fluor estimate.											
	F-204 A/B Hepa Filter	2	ea	3,500.00	SHEE GEN	8.000	16	555		7,000		7,555
Memo:	Cost allowance based on similar material in Fluor estimate.											
	DCO-15 Sample Glovebox	1	ea	250,000.00	SKWK GEN	8.000	8	265		250,000		250,265
Memo:	Cost allowance based on information from LMITCO Conceptual estimate on the Waste Characterization Facility.											
	Process Offgas System	2	ea	50,000.00	SHEE GEN	240.000	480	16,637		100,000		116,637
Memo:	Cost allowance is based on ductwork, filter, and fan assembly from the Fluor estimate											
	Process Piping System Allowance (6"CSx4"-304L SS)	150	lf	200.00	PIPF GEN	0.000				30,000		30,000
Memo:	Cost Allowance based on Fluor estimate											
	Control/Isolation Valves Allowance	10	ea		PIPF GEN	16.000	160	6,459				6,459
Memo:	Cost allowance based on Fluor estimate											
	Clay and Blast Furnace Slag Feed System											

ODE	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
3.11	EQUIPMENT											
	T-301A/B Cone Bottom Storage Silo	2	ea	50,000.00	IRWF	160.000	320	12,669		100,000		112,669
Memo:	Cost Allowance based on LMITCO Planning				GEN							
	Estimate ICPP Coal Fired Boiler Plant Bulk Storage Feed System.											
	T-304A/B Cone Bottom Storage Silo	2	ea	25,000.00	IRWF	80.000	160	6,334		50,000		56,334
Memo:	Cost Allowance based on LMITCO Planning				GEN							
	Estimate ICPP Coal Fired Boiler Plant Bulk Storage Feed System											
	F-302A/B/C/D Hepa Filter	2	ea	3,500.00	SHEE	8.000	16	555		7,000		7,555
Memo:	Cost Allowance Based on Fluor estimate				GEN							
	Truck Unload/Silo Pneumatic Feed Systems Allowance	2	ea	50,000.00	PIPF	40.000	80	3,230		100,000		103,230
					GEN							
	Silo Foundation and Concrete Base	2	ea			0.000					50,000	50,000
	Process Piping System Allowance	100	lf	20.00	PIPF	0.000				2,000		2,000
Memo:	Cost allowance based on Fluor estimate				GEN							
	Control/Isolation Valves Allowance	14	ea	3,500.00	PIPF	16.000	224	9,043		49,000		58,043
Memo:	Cost allowance based on Fluor estimate				GEN							
	NaOH Feed System											
	T-306 NaOH Storage Tank with Heating Jacket	1	ea	75,000.00	SKWK	160.000	160	6,298		75,000		80,298
Memo:	Cost allowance based on similar tank in Fluor estimate				GEN							
	P-305A/B Positive Displacement Pumps	2	ea	10,000.00	PIPF	80.000	160	6,459		20,000		26,459
Memo:	Cost allowance based on Fluor estimate				GEN							
	EJ-303A/B Air Ejector	2	ea	5,000.00	PIPF	24.000	48	1,938		10,000		11,938
Memo:	Cost allowance based on Fluor estimate				GEN							
	M-501A/B High Shear Mixers	2	ea	20,000.00	SKWK	40.000	80	2,649		40,000		42,649
Memo:	Cost allowance based on Fluor estimate				GEN							
	L-502A/B Load Cells	2	ea	2,000.00	SKWK	24.000	48	1,589		4,000		5,589
Memo:	Cost allowance based on vendor quote.				GEN							
	M-501A/B Jacketed Chilled Water System	2	ea	30,000.00	PIPF	80.000	160	6,459		60,000		66,459
					GEN							
	P-503A/B Feed Pumps	2	ea	5,000.00	PIPF	40.000	80	3,230		10,000		13,230
Memo:	Cost allowance based on Fluor estimate				GEN							
	Mixer Clean System											

DE	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
11	EQUIPMENT											
	M-601 Mixer	1	ea	20,000.00	SKWK GEN	40.000	40	1,324		20,000		21,324
	P-602A/B Wash Water Injection Pumps	2	ea	5,000.00	PIPF GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	P-603A/B Wash Water to Extruder Pumps	2	ea	5,000.00	PIPF GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	P-604A/B Caustic Makeup Pumps	2	ea	5,000.00	PIPF GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	F-605A/B Caustic Makeup Filters	2	ea	500.00	PIPF GEN	4.000	8	323		1,000		1,323
Memo:	Cost allowance based on Fluor estimate											
	Process Offgas System	12	ea	50,000.00	SHEE GEN	240.000	2,880	99,821		600,000		699,821
Memo:	Cost allowance based on Fluor estimate											
	Process Piping System Allowance	100	lf	20.00	PIPF GEN	0.000				2,000		2,000
	Control/Isolation Valves Allowance	25	ea	3,500.00	PIPF GEN	16.000	400	16,148		87,500		103,648
	Grout Mix and Place											
	M-402A/B/C/D Ribbon Blender	4	ea	40,000.00	SKWK GEN	40.000	160	5,298		160,000		165,298
Memo:	Cost allowance based on Vendor Quote.											
	F-405A/B/C/D Hepa Filter	4	ea	3,500.00	SHEE GEN	8.000	32	1,109		14,000		15,109
Memo:	Cost allowance based on Fluor estimate											
	P- Mechanical Screw Conveyor	4	ea	40,000.00	SKWK GEN	60.000	240	7,946		160,000		167,946
Memo:	Cost allowance based on Fluor estimate											
	T-401A/B/C/D Calcine Batch Bins	4	ea	20,000.00	SKWK GEN	80.000	320	10,595		80,000		90,595
	F-411A/B/C/D Hepa Filter	4	ea	3,500.00	SHEE GEN	8.000	32	1,109		14,000		15,109
Memo:	Cost allowance based on Fluor estimate											
	EJ-400/407A/B/C/D Air Ejector	8	ea	5,000.00	PIPF GEN	24.000	192	7,751		40,000		47,751
Memo:	Cost allowance based on Fluor estimate											
	IJ-408A/B/C/D&M-410A/B/C/D Kneeder	4	ea	400,000.00	SKWK GEN	160.000	640	21,190		1,600,000		1,621,190
Memo:	Extruder with Injection Head Cost allowance based on Vendor Quote											
	F-412A/B/C/D Hepa Filter	4	ea	3,500.00	SHEE GEN	8.000	32	1,109		14,000		15,109
Memo:	Cost allowance based on Fluor estimate											
	VP-409/A/B/C/D Canister Fill/Vibrator	4	ea	130,000.00	SKWK GEN	80.000	320	10,595		520,000		530,595
Memo:	System Cost allowance based on Engineer's judgement											
	using Richardson's handbook											
	Process Offgas System	12	ea	50,000.00	SHEE GEN	240.000	2,880	99,821		600,000		699,821
Memo:	Cost allowance based on Fluor estimate											

ODE	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
3.11	EQUIPMENT											
	Process Piping System Allowance (6"CSx4"-304L SS)	150	lf	200.00	PIPF GEN	0.000				30,000		30,000
Memo:	Cost allowance based on Fluor estimate											
	Control/Isolation Valves Allowance	50	ea	3,500.00	PIPF GEN	16.000	800	32,296		175,000		207,296
Memo:	Cost allowance based on Fluor estimate											
	Canister Autoclave/Dewatering/and Delivery Prep											
	CCS-701A/B/C/D Robotic Contamination Check Station	4	ea	200,000.00	SKWK GEN	80.000	320	10,595		800,000		810,595
Memo:	Cost allowance based on vendor quote											
	R-801 A/B/C/D Robot Hepa Filter Placement	4	ea	150,000.00	SKWK GEN	160.000	640	21,190		600,000		621,190
Memo:	Cost allowance based on Engineer's judgement assuming a small trolley/PAR system											
	A-901A/B/C/D Autoclave	4	ea	7,500,000.00	SKWK GEN	640.000	2,560	84,762		30,000,000		30,084,762
Memo:	Costs are based on two vendor quotes...neither has build an autoclave of this size or operating prossure											
	A-901A/B/C/D Autoclave Lift Station	8	ea	500,000.00	SKWK GEN	160.000	1,280	42,381		4,000,000		4,042,381
Memo:	Costs Based on Vendor Quote.											
	R-1101 Hepa Filter Remover	4	ls	150,000.00	SKWK GEN	160.000	640	21,190		600,000		621,190
Memo:	Cost allowance vendor quote based on a small trolley/manipulator system											
	R-1102 Robot Weld/Seal Check Canister	2	ls	450,000.00	SKWK GEN	160.000	320	10,595		900,000		910,595
Memo:	Cost allowance based on Fluor estimate											
	CCS-1201 Robotic Contamination Check Station	4	ls	200,000.00	SKWK GEN	80.000	320	10,595		800,000		810,595
Memo:	Cost allowance based on Vendor quote.											
	DS-1202 Decontamination Station	1	ls	850,000.00	SKWK GEN	240.000	240	7,946		850,000		857,946
Memo:	Cost allowance for (3) Decon Systems (Abrasive Blaster,Shroud & Vacuum System,Manipulators)based on Vendor Quote											
	STS-1301 Sonic Tomography	4	ea	3,500,000.00	SKWK GEN	160.000	640	21,190		14,000,000		14,021,190
Memo:	Cost Allowance is based on similar systems designed, constructed and operated by LMITCO Nuclear Physics personnel.											
	Process Offgas System	1	ls	150,000.00	SHEE GEN	240.000	240	8,318		150,000		158,318
Memo:	Cost allowance based on Fluor estimate											

ckheed Martin Idaho Technologies Co.

Rev 6-96

JECT NAME: HLW-DCWO
5 Yr. Grout Facility

ATION 1: INEEL - ICPP

UESTOR: R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

)E	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
11	**EQUIPMENT**											
	Control/Isolation Valves Allowance	50	ea	3,500.00	PIPF	16.000	800	32,296		175,000		207,296
Memo:	Cost allowance based on Fluor estimate				GEN							
	Dewatering System Allowance	1	ls		GEN	0.000					1,000,000	1,000,000
	Sample Transfer Cask System (Samples to RAL)	6	ea		GEN	0.000					30,000	30,000
Memo:	Cost allowance based on Fluor estimate											
	Canister Conveyance Systems Allowance	1	ls	*,***,***.**	GEN	0.000				12,700,000	2,300,000	15,000,000
Memo:	Costs include Conveyance Rails, Carts, Turntables, and Floor to Floor Lift Stations based on vendor input											
	Canister Recycle System	1	ls		GEN	0.000					2,000,000	2,000,000
Memo:	Cost allowance Engineer's input											
	EQUIPMENT S/T						21,232	$739,634		$74,086,500	$5,380,000	$80,206,134
.12	**FURNISHINGS**											
	Furniture	1	ls		GEN	0.000					300,000	300,000
	FURNISHINGS S/T						0				$300,000	$300,000
.13	**SPECIAL CONSTRUCTION**											
	SPECIAL CONSTRUCTION S/T						0					
.14	**CONVEYING SYSTEMS**											
	Elevators	1	ls		GEN	0.000					500,000	500,000

DE	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
14	CONVEYING SYSTEMS Bridge Cranes/Catwalks/etc.	1	ls		GEN	0.000					5,000,000	5,000,000
	CONVEYING SYSTEMS S/T						0				$5,500,000	$5,500,000
15	MECHANICAL											
	HVAC - Radiation Areas - Remote Handling Cells	130,000	sf	280.00	GEN	0.000				36,400,000		36,400,000
	HVAC - Non-Radiation Process Areas	56,000	sf	20.00	GEN	0.000				1,120,000		1,120,000
	HVAC - Support and Administrative Areas	100,000	sf	20.00	GEN	0.000				2,000,000		2,000,000
	Fire Protection - Radiation Areas - Remote Handling Cells	130,000	sf	7.00	GEN	0.000				910,000		910,000
	Fire Protection - Non-Radiation Process Areas	56,000	sf	4.00	GEN	0.000				224,000		224,000
	Fire Protection - Support and Administrative Areas	100,000	sf	2.00	GEN	0.000				200,000		200,000
	Plumbing/Piping Systems - Radiation Areas - Remote Handling Cells	130,000	sf	10.00	GEN	0.000				1,300,000		1,300,000
	Plumbing/Piping Systems - Non-Radiation Process Areas	56,000	sf	10.00	GEN	0.000				560,000		560,000

ockheed Martin Idaho Technologies Co.
Rev 6-96
OJECT NAME: HLW-DCWO
5 Yr. Grout Facility
CATION 1: INEEL - ICPP
OUESTOR. R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

DE	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
.15	MECHANICAL Plumbing/Piping Systems - Support and Administrative Areas	100,000	sf	11.00	GEN	0.000				1,100,000		1,100,000
	MECHANICAL S/T						0			$43,814,000		$43,814,000
.16	ELECTRICAL											
	ELECTRICAL S/T						0					
.16.1	SWITCHGEAR AND TRANSFORMERS 2000 kVA cast coil 13.8-480 transformers, pri & sec. protection	2	ea	65,000.00	ELEC GEN	24.000	48	1,599	5,000	130,000		136,599
	2000 amp armor clad bus, includes ells, transition pcs., etc.	80	lf	500.00	ELEC GEN	1.500	120	3,997		40,000		43,997
	2000 amp 480 volt Nema 1 Metal Clad Switchgear, double ended	1	ea	125,000.00	ELEC GEN	160.000	160	5,330	2,500	125,000		132,830
	Note: Assume 13.8 sectionalizing switches are existing.											
	High Voltage Sectionalizing Switches for feed 2400 volt standby	2	ea	17,000.00	ELEC GEN	16.000	32	1,066		34,000		35,066
	750 kVA cast coil 2300-480 transformers, pri & sec. protection	2	ea	60,000.00	ELEC GEN	24.000	48	1,599	5,000	120,000		126,599
	1000 amp armor clad bus, includes ells, transition pcs., etc. for standby feed	80	lf	400.00	ELEC GEN	1.500	120	3,997		32,000		35,997
	UCS for Main Switchgear	1	lot	35,000.00	ELEC GEN	120.000	120	3,997		35,000		38,997

DE	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
.16.1	**SWITCHGEAR AND TRANSFORMERS**											
	UPS, assume 150 kVA 3 phase unit	1	ea	200,000.00	ELEC GEN	72.000	72	2,398		200,000		202,398
	MCC-1, 800 amp, 480 volt, Nema 1, 10 section	1	ea	25,000.00	ELEC GEN	120.000	120	3,997		25,000		28,997
	MCC-2, 800 amp, 480 volt, Nema 1, 10 section	1	ea	25,000.00	ELEC GEN	120.000	120	3,997		25,000		28,997
	****MCC's include 25% spare cubicles****											
	400 amp 480 volt dist power panels	14	ea	5,000.00	ELEC GEN	12.000	168	5,596		70,000		75,596
	225 amp 120/208 lighting panels	25	ea	1,500.00	ELEC GEN	8.000	200	6,662		37,500		44,162
	75 kVA 480 - 120/208 dry transformer for lighting and recpt's	7	ea	3,000.00	ELEC GEN	12.000	84	2,798		21,000		23,798
	Local motor control	1	lot	2,500.00	ELEC GEN	80.000	80	2,665		2,500		5,165
	30 amp 600 volt disconnect switches	27	ea	96.00	ELEC GEN	1.500	41	1,349		2,592		3,941
	60 amp 600 volt disconnect switches	21	ea	164.00	ELEC GEN	1.750	37	1,224		3,444		4,668
	100 amp 600 volt disconnect switches	4	ea	258.00	ELEC GEN	2.000	8	266		1,032		1,298
	200 amp 600 volt disconnect switches	26	ea	444.00	ELEC GEN	3.000	78	2,598		11,544		14,142
	SWITCHGEAR AND TRANSFORMERS S/T						1,655	$55,136	$12,500	$915,612		$983,248
3.16.2	**LIGHTING**											
	Non Rad Process Lighting	56,000	sf		GEN	0.000					140,000	140,000
	Rad Process Lighting	130,000	sf		GEN	0.000					1,300,000	1,300,000

ockheed Martin Idaho Technologies Co.

Rev 6-96

OJECT NAME: HLW-DCWO
5 Yr. Grout Facility

CATION 1: INEEL - ICPP

QUESTOR: R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

ODE	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
3.16.2	LIGHTING Support Area Lighting	100,000	sf		GEN	0.000					225,000	225,000
	LIGHTING S/T						0				$1,665,000	$1,665,000
3.16.3	RACEWAYS & ENCLOSURES 3/4" rigid conduit with fittings, ells, and supports	20,000	lf	2.17	ELEC GEN	0.080	1,600	53,296		43,400		96,696
	1" rigid conduit with fittings, ells, and supports	5,000	lf	3.28	ELEC GEN	0.090	450	14,990		16,400		31,390
	2" rigid conduit with fittings, ells, and supports	30,000	lf	6.85	ELEC GEN	0.200	6,000	199,860		205,500		405,360
	3" rigid conduit with fittings, ells, and supports	10,000	lf	14.43	ELEC GEN	0.280	2,800	93,268		144,300		237,568
	4" rigid conduit with fittings, ells, and supports	8,000	lf	20.56	ELEC GEN	0.440	3,520	117,251		164,480		281,731
	5" rigid conduit with fittings, ells, and supports	1,000	lf	40.00	ELEC GEN	0.600	600	19,986		40,000		59,986
	Additional labor costs for conduit embeds	1	lot		ELEC GEN	480.000	480	15,989				15,989
	Pull ropes, jet line, and labels	1	lot	3,000.00	ELEC GEN	60.000	60	1,999		3,000		4,999
	J- boxes, enclosures, inst. racks, and terminal strips	1	lot	30,000.00	ELEC GEN	1000.00	1,000	33,310		30,000		63,310
	RACEWAYS & ENCLOSURES S/T						16,510	$549,948		$647,080		$1,197,028

E	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
16.4	CONDUCTORS AND GROUNDING											
	#14 thhn	40,000	lf	0.08	ELEC GEN	0.006	240	7,994		3,200		11,194
	#12 thhn	100,000	lf	0.11	ELEC GEN	0.008	800	26,648		11,000		37,648
	#10 thhn	20,000	lf	0.17	ELEC GEN	0.010	200	6,662		3,400		10,062
	#8 thhn	30,000	lf	0.28	ELEC GEN	0.012	360	11,992		8,400		20,392
	#6 thhn	10,000	lf	0.45	ELEC GEN	0.014	140	4,663		4,500		9,163
	#4 thhn	5,000	lf	0.71	ELEC GEN	0.016	80	2,665		3,550		6,215
	#3 thhn	10,000	lf	0.87	ELEC GEN	0.018	180	5,996		8,700		14,696
	#2 thhn	60,000	lf	1.08	ELEC GEN	0.022	1,320	43,969		64,800		108,769
	1/0 thhn	3,000	lf	1.68	ELEC GEN	0.026	78	2,598		5,040		7,638
	250 mcm thhn	8,000	lf	3.94	ELEC GEN	0.044	352	11,725		31,520		43,245
	300 mcm thhn	7,500	lf	5.50	ELEC GEN	0.046	345	11,492		41,250		52,742
	500 mcm thhn	15,000	lf	7.67	ELEC GEN	0.050	750	24,983		115,050		140,033
	750 mcm thhn	5,000	lf	9.25	ELEC GEN	0.070	350	11,669		46,250		57,909
	Misc. communications, securily, and signal cables	1	lot	50,000.00	ELEC GEN	4000.00	4,000	133,240		50,000		183,240
	Motor connections	78	ea	125.00	ELEC GEN	2.500	195	6,495		9,750		16,245
	Connect chillers	2	ea	125.00	ELEC GEN	4.000	8	266		250		516
	Building ground wire, assume 4/0	12,000	lf	2.00	ELEC GEN	0.040	480	15,989		24,000		39,989
	Cadwelds and jumpers	1	lot	5,000.00	ELEC GEN	240.000	240	7,994		5,000		12,994
	Wire labels	1	lot	5,000.00	ELEC GEN	120.000	120	3,997		5,000		8,997
	Allowance for thermal couples	1	lot	25,000.00	ELEC GEN	240.000	240	7,994		25,000		32,994

ockheed Martin Idaho Technologies Co.
Rev 6-96
OJECT NAME. HLW-DCWO
5 Yr. Grout Facility
CATION 1: INEEL - ICPP
QUESTOR: R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

)DE	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
3.16.4	CONDUCTORS AND GROUNDING ****Lightning protection, Based on 32000 sf****											
	Lightning protection, air terminals, alum, 1/2" dia x 12" (to 75' ht)	90	ea	18.00	ELEC GEN	0.500	45	1,499		1,620		3,119
	Lightning protection, cable, cu, 220 lb. per thousand ft. (to 75' ht)	10,000	lf	1.07	ELEC GEN	0.025	250	8,328		10,700		19,028
	3/4" x 10' copper weld ground rod with clamp	24	ea	35.00	ELEC GEN	1.000	24	799		840		1,639
	CONDUCTORS AND GROUNDING S/T						10,797	$359,648		$478,820		$838,468
3.16.6	WIRING DEVICES & SPECIAL SYSTEMS Welding recpts	8	ea	600.00	ELEC GEN	2.000	16	533		4,800		5,333
	Remote welding	1	lot	150,000.00	ELEC GEN	120.000	120	3,997		150,000		153,997
	Switches and recpt's	92,000	sf		GEN	0.000					138,000	138,000
	Voice paging and evac	1	lot	30,000.00	ELEC GEN	1000.00	1,000	33,310		30,000		63,310
	Fire detection and arlarm	222,000	sf		GEN	0.000					388,500	388,500
	Telephone and communications	1	lot	40,000.00	ELEC GEN	240.000	240	7,994		40,000		47,994
	****Security Systems****											
	Argus security equipment, card readers, dectection, etc.	1	lot	250,000.00	GEN	0.000				250,000		250,000
	Rad Monitoring	1	lot	500,000.00	ELEC GEN	1000.00	1,000	33,310		500,000		533,310

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
.3.16.5	WIRING DEVICES & SPECIAL SYSTEMS Labor and materials to install	1	lot	25,000.00	ELEC GEN	1000.00	1,000	33,310		25,000		58,310
	WIRING DEVICES & SPECIAL SYSTEMS S/T						3,376	$112,455		$999,800	$526,500	$1,638,755
.3.16.6	INSTRUMENTATION & CONTROLS Field instruments, control equipment and wiring	820	ea		ELEC GEN	0.000					3,690,000	3,690,000
	Assume 3000 signals, assume 2 points per signal	9,000	ea	1,250.00	ELEC GEN	24.000	216,000	7,194,960		11,250,000		18,444,960
	Air lock control, 8 places	1	lot	2,000.00	ELEC GEN	40.000	40	1,332		2,000		3,332
	Control room consols, includes PLC's, graphics panels, etc.	1	lot	1,000,000.00	GEN	0.000				1,000,000		1,000,000
	Control systems CPU, assume 2 systems	1	lot		GEN	0.000					150,000	150,000
	Instrument racks, assume 3000 points	1	lot	25,000.00	ELEC GEN	480.000	480	15,989		25,000		40,989
	Systems programing, assume 80,000 hours @ 65.00	1	lot		GEN	0.000					5,200,000	5,200,000
	INSTRUMENTATION & CONTROLS S/T						216,520	$7,212,281		$12,277,000	$9,040,000	$28,529,281
.3.16.6.1	CLOSED CIRCUIT TV Cameras, with Pan-Tilt-Unit and control system	45	ea	3,200.00	ELEC ELECT	40.000	1,800	59,958		144,000		203,958
	Reciever and transmiter	45	ea	2,000.00	ELEC ELECT	8.000	360	11,992		90,000		101,992
	Fiber optic cable system, includes connectors and testing	12,000	lf		ELEC ELECT	0.015	180	5,996				5,996

.ockheed Martin Idaho Technologies Co.

Rev 6-96

DETAILED COST ESTIMATE SHEET

ROJECT NAME HLW-DCWO
5 Yr. Grout Facility
CATION 1 INEEL - ICPP
QUESTOR R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:20:26
REPORT NAME: Detail Cost Estimate Sheet

ODE	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
.3.16.6.1	CLOSED CIRCUIT TV											
	CCTV monitors	3	ea	800.00	ELEC ELECT	8.000	24	799		2,400		3,199
	Channel switchers	3	ea	6,000.00	ELEC ELECT	8.000	24	799		18,000		18,799
	Graphic control interface for CCTV	1	lot		ELECT	0.000					50,000	50,000
	Programing for Graphic control	1	lot		ELECT	0.000					65,000	65,000
	Misc. mounting brackets and supports	1	lot	3,000.00	ELEC ELECT	48.000	48	1,599		3,000		4,599
	CLOSED CIRCUIT TV S/T						2,436	$81,143		$257,400	$115,000	$453,543
1.3.16.7	TESTING											
	CC testing of systems and equipment	1	lot		ELEC GEN	2400.00	2,400	79,944				79,944
	TESTING S/T						2,400	$79,944				$79,944
1.5.1	G&A/PIF ADDER											
0701000	G&A	1	ls			0.000					920,000	920,000
	PIF	1	ls			0.000					25,543,100	25,543,100
	G&A/PIF ADDER S/T						0				$26,463,100	$26,463,100
	PROJECT SUBTOTAL						309,009	$10,318,579	$12,500	$273,293,272	$251,739,600	$535,363,951

Lockheed Martin Idaho Technologies Co.

CONTINGENCY ANALYSIS

PROJECT NAME: HLW-DCWO
5 Yr. Grout Facility
)N 1: INEEL - ICPP
STOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB

DATE: 26-Jan-1998
TIME: 09:19:53

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	DESIGN ENGINEERING TITLE I & II	90,000,000	10.02	5	35	0.50	3.51	3.105%	9.35%	32,864,365	122,864,365
1.1.2	TITLE III INSPECTION	22,500,000	2.50	5	35	0.13	0.88	0.776%	2.34%	8,216,091	30,716,091
1.2.1	PROJECT MANAGEMENT	45,000,000	5.01	5	35	0.25	1.75	1.552%	4.68%	16,432,183	61,432,183
1.2.2	CONSTRUCTION MANAGEMENT	45,000,000	5.01	5	35	0.25	1.75	1.552%	4.68%	16,432,183	61,432,183
1.3.1	GENERAL CONDITIONS	1,128,389	0.13	5	35	0.01	0.04	0.039%	0.12%	412,042	1,540,431
1.3.2	SITEWORK	10,411,459	1.16	5	35	0.06	0.41	0.359%	1.08%	3,801,844	14,213,303
1.3.3	CONCRETE	97,555,368	10.86	5	45	0.54	4.89	4.342%	13.08%	45,965,523	143,520,891
1.3.4	MASONRY	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.5	METALS	16,191,603	1.80	5	45	0.09	0.81	0.721%	2.17%	7,629,057	23,820,660
1.3.6	WOOD & PLASTICS	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,573,915	0.18	0	0	0.00	0.00	0.000%	0.00%	0	1,573,915
1.3.8	DOORS & WINDOWS	71,516,875	7.96	5	35	0.40	2.79	2.467%	7.43%	26,115,074	97,631,949
1.3.9	FINISHES	10,707,858	1.19	5	40	0.06	0.48	0.423%	1.27%	4,477,669	15,185,527
1.3.10	SPECIALTIES	280,500	0.03	5	45	0.00	0.01	0.012%	0.04%	132,164	412,664
1.3.11	EQUIPMENT	117,511,157	13.08	2	45	0.26	5.88	5.270%	15.88%	55,783,427	173,294,584
1.3.12	FURNISHINGS	336,600	0.04	5	40	0.00	0.01	0.013%	0.04%	140,755	477,355
1.3.13	SPECIAL CONSTRUCTION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.14	CONVEYING SYSTEMS	6,171,000	0.69	5	40	0.03	0.27	0.244%	0.73%	2,580,506	8,751,506
1.3.15	MECHANICAL	65,166,808	7.25	5	40	0.36	2.90	2.574%	7.76%	27,250,586	92,417,394
[illegible]	ELECTRICAL	50,370,640	5.61	5	40	0.28	2.24	1.990%	5.99%	21,063,322	71,433,962
	G&A/PIF ADDER	26,463,100	2.94	5	10	0.15	0.29	0.250%	0.75%	2,649,602	29,112,702
1.5.2	PROCUREMENT FEES	4,489,222	0.50	5	10	0.02	0.05	0.042%	0.13%	449,481	4,938,703
	ESCALATION	216,257,328	24.07	5	35	1.20	8.42	7.460%	22.47%	78,972,304	295,229,632
	SUBTOTAL	898,631,822	100.00					33.194%			
	CALCULATED CONTINGENCY	298,288,569									
	RESULTANT TEC	1,196,920,391									
	ROUNDED TEC	1,250,000,000									
	PROJECT CONTINGENCY	351,368,178						39.10%			
	MANAGEMENT RESERVE	64,303,182									
	CONTINGENCY	287,064,996									
	TOTAL ESTIMATED COST	1,250,000,000								351,368,178	1,250,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
The Lockheed Martin 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.

CONTINGENCY ANALYSIS

PROJECT NAME: HLW-DCWO
5 Yr. Grout Facility
LOCATION 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB

DATE: 26-Jan-1998
TIME: 09:22:47

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	DESIGN ENGINEERING TITLE I & II	90,000,000	13.19	5	35	0.66	4.62	4.089%	12.06%	28,669,210	118,669,210
1.1.2	TITLE III INSPECTION	22,500,000	3.30	5	35	0.16	1.15	1.022%	3.02%	7,167,302	29,667,302
1.2.1	PROJECT MANAGEMENT	45,000,000	6.59	5	35	0.33	2.31	2.044%	6.03%	14,334,605	59,334,605
1.2.2	CONSTRUCTION MANAGEMENT	45,000,000	6.59	5	35	0.33	2.31	2.044%	6.03%	14,334,605	59,334,605
1.3.1	GENERAL CONDITIONS	1,128,389	0.17	5	35	0.01	0.06	0.051%	0.15%	359,445	1,487,834
1.3.2	SITEWORK	10,411,459	1.53	5	35	0.08	0.53	0.473%	1.40%	3,316,537	13,727,996
1.3.3	CONCRETE	97,555,368	14.30	5	45	0.71	6.43	5.719%	16.87%	40,097,997	137,653,365
1.3.4	MASONRY	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.5	METALS	16,191,603	2.37	5	45	0.12	1.07	0.949%	2.80%	6,655,204	22,846,807
1.3.6	WOOD & PLASTICS	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,573,915	0.23	0	0	0.00	0.00	0.000%	0.00%	0	1,573,915
1.3.8	DOORS & WINDOWS	71,516,875	10.48	5	35	0.52	3.67	3.249%	9.59%	22,781,470	94,298,345
1.3.9	FINISHES	10,707,858	1.57	5	40	0.08	0.63	0.557%	1.64%	3,906,092	14,613,950
1.3.10	SPECIALTIES	280,500	0.04	5	45	0.00	0.02	0.016%	0.05%	115,293	395,793
1.3.11	EQUIPMENT	117,511,157	17.22	2	45	0.34	7.75	6.940%	20.48%	48,662,640	166,173,797
1.3.12	FURNISHINGS	336,600	0.05	5	40	0.00	0.02	0.018%	0.05%	122,787	459,387
1.3.13	SPECIAL CONSTRUCTION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.14	CONVEYING SYSTEMS	6,171,000	0.90	5	40	0.05	0.36	0.321%	0.95%	2,251,103	8,422,103
1.3.15	MECHANICAL	65,166,808	9.55	5	40	0.48	3.82	3.390%	10.00%	23,772,033	88,93
1.3.16	ELECTRICAL	50,370,640	7.38	5	40	0.37	2.95	2.620%	7.73%	18,374,576	68,
1.5.1	G&A/PIF ADDER	26,463,100	3.88	5	10	0.19	0.39	0.330%	0.97%	2,311,379	28,7
1.5.2	PROCUREMENT FEES	4,489,222	0.66	5	10	0.03	0.07	0.056%	0.17%	392,104	4,881,326
	ESCALATION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	1,124	1,124
	SUBTOTAL	682,374,494	100.00					33.889%			
	CALCULATED CONTINGENCY	231,248,798									
	RESULTANT TEC	913,623,292									
	ROUNDED TEC	920,000,000									
	PROJECT CONTINGENCY	237,625,506						34.82%			
	MANAGEMENT RESERVE	47,987,449									
	CONTINGENCY	189,638,057									
	TOTAL ESTIMATED COST	920,000,000								237,625,506	920,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
The Lockheed Martin 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

G&A/PIF ADDER CALCULATION SHEET

PROJECT: HLW - DCWO

ESTIMATE NUMBER: 2417

PROCUREMENT FEE @ 1%		CONSTRUCTION	$450,000,000	x 0.01 =	$13,500,000
		GFE		x 0.01 =	$0
TOTAL PROCUREMENT FEE					$13,500,000
G&A @ 23%	YEAR				
Note: Ceiling of $500,000 Imposed	1	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	2	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	3	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	4	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
TOTAL G&A					$920,000
PIF @ 5.5%		CONSTRUCTION	$450,000,000		
		GFE	$0		
		PROCUREMENT FEE	$13,500,000		
		G&A	$920,000		
TOTAL PIF			$464,420,000	x.055 =	$25,543,100

NOTE: Assume expenditures will vary per year but always reach maximum G&A

Lockheed Martin Idaho Technologies Co.

Rev. 6-96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
N 1: INEEL - ICPP
STOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB
REPORT NAME: Cost Estimate Summary

DATE: 26-Jan-1998
TIME: 09:29:45
CHECKED BY: RDA
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $70,610,000
1.1.1	DESIGN ENGINEERING TITLE I & II	46,000,000	9,200,000	55,200,000
1.1.2	TITLE III INSPECTION	11,500,000	3,910,000	15,410,000
1.2	MANAGEMENT COSTS			>> $52,210,000
1.2.1	PROJECT MANAGEMENT	23,000,000	6,210,000	29,210,000
1.2.2	CONSTRUCTION MANAGEMENT	23,000,000	0	23,000,000
1.3	CONSTRUCTION			>> $306,808,379
1.3.1	GENERAL CONDITIONS	1,128,389	383,652	1,512,041
1.3.2	SITEWORK	5,622,188	1,911,544	7,533,732
1.3.3	CONCRETE	50,551,499	17,187,510	67,739,009
1.3.4	MASONRY	0	0	0
1.3.5	METALS	10,011,064	3,403,762	13,414,826
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,100,640	374,218	1,474,858
1.3.8	DOORS & WINDOWS	34,942,745	11,880,533	46,823,278
1.3.9	FINISHES	5,491,122	1,866,982	7,358,104
1.3.10	SPECIALTIES	140,250	47,685	187,935
.11	EQUIPMENT	49,465,572	16,818,295	66,283,867
.12	FURNISHINGS	224,400	76,296	300,696
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	3,927,000	1,335,180	5,262,180
1.3.15	MECHANICAL	34,619,588	11,770,660	46,390,248
1.3.16	ELECTRICAL	31,737,019	10,790,586	42,527,605
1.5	G&A/PIF			>> $18,356,148
1.5.1	G&A/PIF ADDER	13,698,618	4,657,530	18,356,148
1.5.2	PROCUREMENT FEES	2,289,615	778,469	>> $3,068,084
	SUBTOTAL INCLUDING ESCALATION	348,449,709	102,602,902	>> $451,052,611
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $32,823,261
	CONTINGENCY			>> $126,124,128
	TOTAL ESTIMATED COST			>> $610,000,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *35.24%*

Lockheed Martin Idaho Technologies Co.

Rev. 6-96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
LOCATION 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB
REPORT NAME: Cost Estimate Summary

DATE: 26-Jan-1998
TIME: 09:32:50
CHECKED BY: RDA
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $57,500,000
1.1.1	DESIGN ENGINEERING TITLE I & II	46,000,000	0	46,000,000
1.1.2	TITLE III INSPECTION	11,500,000	0	11,500,000
1.2	MANAGEMENT COSTS			>> $46,000,000
1.2.1	PROJECT MANAGEMENT	23,000,000	0	23,000,000
1.2.2	CONSTRUCTION MANAGEMENT	23,000,000	0	23,000,000
1.3	CONSTRUCTION			>> $228,961,476
1.3.1	GENERAL CONDITIONS	1,128,389	0	1,128,389
1.3.2	SITEWORK	5,622,188	0	5,622,188
1.3.3	CONCRETE	50,551,499	0	50,551,499
1.3.4	MASONRY	0	0	0
1.3.5	METALS	10,011,064	0	10,011,064
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,100,640	0	1,100,640
1.3.8	DOORS & WINDOWS	34,942,745	0	34,942,745
1.3.9	FINISHES	5,491,122	0	5,491,122
1.3.10	SPECIALTIES	140,250	0	140,250
1.3.11	EQUIPMENT	49,465,572	0	49,465,572
1.3.12	FURNISHINGS	224,400	0	224,40
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	3,927,000	0	3,927,000
1.3.15	MECHANICAL	34,619,588	0	34,619,588
1.3.16	ELECTRICAL	31,737,019	0	31,737,019
1.5	G&A/PIF			>> $13,698,618
1.5.1	G&A/PIF ADDER	13,698,618	0	13,698,618
1.5.2	PROCUREMENT FEES	2,289,615	0	>> $2,289,615
	SUBTOTAL INCLUDING ESCALATION	348,449,709	0	>> $348,449,709
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $24,494,971
	CONTINGENCY			>> $102,055,320
	TOTAL ESTIMATED COST			>> $475,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *36.32%*

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OJECT NAME. HLW-DCWO
20 Yr.-Grout Facility

CATION 1. INEEL - ICPP

QUESTOR. R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:30:00
REPORT NAME: Detail Cost Estimate Sheet

)DE	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 101000	DESIGN ENGINEERING TITLE I & II Title Design Costs @ 20% of Construction	1	ls			0.000					46,000,000	46,000,000
	DESIGN ENGINEERING TITLE I & II S/T						0				$46,000,000	$46,000,000
1.2 201000	TITLE III INSPECTION Inspection and Overview @ 5% of Construction	1	ls			1.000	1				11,500,000	11,500,000
	TITLE III INSPECTION S/T						1				$11,500,000	$11,500,000
2.1 301000	PROJECT MANAGEMENT Project Manager Cost @ 10% of Construction	1	ls			1.000	1				23,000,000	23,000,000
	PROJECT MANAGEMENT S/T						1				$23,000,000	$23,000,000
2.2 400100	CONSTRUCTION MANAGEMENT Construction Management @ 10% of Construction	1	ls			1.000	1				23,000,000	23,000,000
	CONSTRUCTION MANAGEMENT S/T						1				$23,000,000	$23,000,000

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Rev 6-96

JECT NAME. HLW-DCWO
20 Yr.-Grout Facility

ATION 1. INEEL - ICPP

UESTOR. R. Defoe

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:30:00
REPORT NAME: Detail Cost Estimate Sheet

DE	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	GENERAL CONDITIONS											
	Supervision	8	fte		SKWK	3760.00	30,080	995,949				995,949
	Training of Construction Personnel	50	fte		SKWK	80.000	4,000	132,440				132,440
	GENERAL CONDITIONS S/T						34,080	$1,128,389				$1,128,389
2	SITEWORK											
	Sitework Allowance	135,000	sf	20.00	GEN	0.000				2,700,000		2,700,000
	Excavation/Hauling for Basement Area	135,000	cy	8.00	GEN	0.000				1,080,000		1,080,000
	SITEWORK S/T						0			$3,780,000		$3,780,000
3	CONCRETE											
	Radiation Areas - Remote Handling Cells	63,000	sf	455.00	GEN	0.000				28,665,000		28,665,000
	Non-Radiation Process Areas	44,000	sf	82.50	GEN	0.000				3,630,000		3,630,000
	Support and Administrative Areas	93,000	sf	18.20	GEN	0.000				1,692,600		1,692,600
	CONCRETE S/T						0			$33,987,600		$33,987,600
4	MASONRY											

DETAILED COST ESTIMATE SHEET

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:30:00
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
1.3.4	MASONRY											
	MASONRY S/T						0					
1.3.5	METALS											
63,000.00	Radiation Areas - Remote Handling Cells	63,000	sf	55.30	GEN	0.000				3,483,900		3,483,900
44,000.00	Non-Radiation Process Areas	44,000	sf	23.70	GEN	0.000				1,042,800		1,042,800
93,000.00	Support and Administrative Areas	93,000	sf	23.70	GEN	0.000				2,204,100		2,204,100
	METALS S/T						0			$6,730,800		$6,730,800
1.3.6	WOOD & PLASTICS											
	WOOD & PLASTICS S/T						0					
1.3.7	THERMAL & MOISTURE PROTECTION											
	Radiation Areas - Remote Handling Cells	63,000	sf	3.70	GEN	0.000				233,100		233,100
	Non-Radiation Process Areas	44,000	sf	3.70	GEN	0.000				162,800		162,800
	Support and Administrative Areas	93,000	sf	3.70	GEN	0.000				344,100		344,100
	THERMAL & MOISTURE PROTECTION S/T						0			$740,000		$740,000

DE	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
.8	DOORS & WINDOWS											
	Radiation Areas - Remote Handling Cells	63,000	sf	365.81	GEN	0.000				23,046,030		23,046,030
	Non-Radiation Process Areas	44,000	sf	5.43	GEN	0.000				238,920		238,920
	Support and Administrative Areas	93,000	sf	2.24	GEN	0.000				208,320		208,320
	DOORS & WINDOWS S/T						0			$23,493,270		$23,493,270
.9	FINISHES											
	Radiation Areas - Remote Handling Cells	63,000	sf	51.52	GEN	0.000				3,245,760		3,245,760
	Non-Radiation Process Areas	44,000	sf	2.53	GEN	0.000				111,320		111,320
	Support and Administrative Areas	93,000	sf	3.60	GEN	0.000				334,800		334,800
	FINISHES S/T						0			$3,691,880		$3,691,880
.10	SPECIALTIES											
	Speciality Equipment Allowance	1	ls		GEN	0.000					125,000	125,000
	SPECIALTIES S/T						0				$125,000	$125,000
.11	EQUIPMENT											
	Calcine Acceptance and Blending System											

ODE	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
.3.11	EQUIPMENT CY-101&2 Cyclone Separator (By Others)											
	T-201 Static Gravity Mixer	1	ea	320,000.00	SKWK GEN	275.000	275	9,105		320,000		329,105
Memo:	Vendor,(Ross Mixing Co), has capability of building of constructing an 2,825 cf (80m3) gravity mixer. Pricing is not readily available for custom items. An allowance based on Fluor estimate has been used.											
	T-202 Dry Process Tank with Blender	1	ea	345,000.00	SKWK GEN	76.000	76	2,516		345,000		347,516
Memo:	A vendor has not been identified that can construct a 2,825 cf (80m3) gravity mixer. Cost allowance have been included based on information from a vendor sale of a system similar in function but about half the size.											
	P-203 Mechanical Screw Conveyor	50	lf	40,000.00	SKWK GEN	0.000				2,000,000		2,000,000
Memo:	Cost allowance based on similar material in Fluor estimate.											
	F-204 A/B Hepa Filter	2	ea	3,500.00	SHEE GEN	8.000	16	555		7,000		7,555
Memo:	Cost allowance based on similar material in Fluor estimate											
	DCO-15 Sample Glovebox	1	ea	250,000.00	SKWK GEN	8.000	8	265		250,000		250,265
Memo:	Cost allowance based on information from LMITCO Conceptual estimate on the Waste Characterization Facility											
	Process Offgas System	2	ea	50,000.00	SHEE GEN	240.000	480	16,637		100,000		116,637
Memo:	Cost allowance is based on ductwork, filter, and fan assembly from the Fluor estimate.											
	Process Piping System Allowance (6"CSx4"-304L SS)	100	lf	200.00	PIPF GEN	0.000				20,000		20,000
Memo:	Cost Allowance based on Fluor estimate											
	Control/Isolation Valves Allowance	6	ea		PIPF GEN	16.000	96	3,876				3,876
Memo:	Cost allowance based on Fluor estimate											
	Clay and Blast Furnace Slag Feed System											

DE	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
.11	EQUIPMENT											
	T-301A/B Cone Bottom Storage Silo	2	ea	30,000.00	IRWF	100.000	200	7,918		60,000		67,918
Memo:	Cost Allowance based on LMITCO Planning				GEM							
	Estimate ICPP Coal Fired Boiler Plant Bulk Storage Feed System.											
	T-304A/B Cone Bottom Storage Silo	2	ea	25,000.00	IRWF	80.000	160	6,334		50,000		56,334
Memo:	Cost Allowance based on LMITCO Planning				GEM							
	Estimate ICPP Coal Fired Boiler Plant Bulk Storage Feed System.											
	F-302A/B/C/D Hepa Filter	2	ea	3,500.00	SHEE	8.000	16	555		7,000		7,555
Memo:	Cost Allowance Based on Fluor estimate				GEM							
	Truck Unload/Silo Pneumatic Feed Systems Allowance	2	ea	50,000.00	PIPF	40.000	80	3,230		100,000		103,230
					GEM							
	Silo Foundation and Concrete Base	2	ea			0.000					50,000	50,000
					GEM							
	Process Piping System Allowance	100	lf	20.00	PIPF	0.000				2,000		2,000
Memo:	Cost allowance based on Fluor estimate				GEM							
	Control/Isolation Valves Allowance	14	ea	3,500.00	PIPF	16.000	224	9,043		49,000		58,043
Memo:	Cost allowance based on Fluor estimate				GEM							
	NaOH Feed System											
	T-306 NaOH Storage Tank with Heating Jacket	1	ea	75,000.00	SKWK	160.000	160	5,298		75,000		80,298
Memo:	Cost allowance based on similar tank in Fluor estimate				GEM							
	P-305A/B Positive Displacement Pumps	2	ea	10,000.00	PIPF	80.000	160	6,459		20,000		26,459
Memo:	Cost allowance based on Fluor estimate				GEM							
	EJ-303A/B Air Ejector	2	ea	5,000.00	PIPF	24.000	48	1,938		10,000		11,938
Memo:	Cost allowance based on Fluor estimate				GEM							
	M-501A/B High Shear Mixers	2	ea	20,000.00	SKWK	40.000	80	2,649		40,000		42,649
Memo:	Cost allowance based on Fluor estimate				GEM							
	L-502A/B Load Cells	2	ea	2,000.00	SKWK	24.000	48	1,589		4,000		5,589
Memo:	Cost allowance based on vendor quote.				GEM							
	M-501A/B Jacketed Chilled Water System	2	ea	30,000.00	PIPF	80.000	160	6,459		60,000		66,459
					GEM							
	P-503A/B Feed Pumps	2	ea	5,000.00	PIPF	40.000	80	3,230		10,000		13,230
Memo:	Cost allowance based on Fluor estimate				GEM							
	Mixer Clean System											

Lockheed Martin Idaho Technologies Co.

Rev 6-96

DETAILED COST ESTIMATE SHEET

PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
LOCATION 1: INEEL - ICPP
REQUESTOR. R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:30:00
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	EQUIPMENT											
	M-601 Mixer	1	ea	20,000.00	SKWK GEN	40.000	40	1,324		20,000		21,324
	P-602A/B Wash Water Injection Pumps	2	ea	5,000.00	PIPF, GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	P-603A/B Wash Water to Extruder Pumps	2	ea	5,000.00	PIPF, GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	P-604A/B Caustic Makeup Pumps	2	ea	5,000.00	PIPF, GEN	16.000	32	1,292		10,000		11,292
Memo:	Cost allowance based on Fluor estimate											
	F-605A/B Caustic Makeup Filters	2	ea	500.00	PIPF, GEN	4.000	8	323		1,000		1,323
Memo:	Cost allowance based on Fluor estimate											
	Process Offgas System	12	ea	50,000.00	SHEE, GEN	240.000	2,880	99,821		600,000		699,821
Memo:	Cost allowance based on Fluor estimate											
	Process Piping System Allowance	100	lf	20.00	PIPF, GEN	0.000				2,000		2,000
	Control/Isolation Valves Allowance	25	ea	3,500.00	PIPF, GEN	16.000	400	16,148		87,500		103,648
	Grout Mix and Place											
	M-402A/B/C/D Ribbon Blender	1	ea	40,000.00	SKWK GEN	40.000	40	1,324		40,000		41,324
Memo:	Cost allowance based on Vendor Quote.											
	F-405A/B/C/D Hepa Filter	1	ea	3,500.00	SHEE, GEN	8.000	8	277		3,500		3,777
Memo:	Cost allowance based on Fluor estimate											
	P- Mechanical Screw Conveyor	1	ea	40,000.00	SKWK, GEN	60.000	60	1,987		40,000		41,987
Memo:	Cost allowance based on Fluor estimate											
	T-401A/B/C/D Calcine Batch Bins	1	ea	20,000.00	SKWK, GEN	80.000	80	2,649		20,000		22,649
	F-411A/B/C/D Hepa Filter	1	ea	3,500.00	SHEE, GEN	8.000	8	277		3,500		3,777
Memo:	Cost allowance based on Fluor estimate											
	EJ-400/407A/B/C/D Air Ejector	4	ea	5,000.00	PIPF, GEN	24.000	96	3,876		20,000		23,876
Memo:	Cost allowance based on Fluor estimate											
	IJ-408A/B/C/D&M-410A/B/C/D Kneeder	1	ea	400,000.00	SKWK, GEN	160.000	160	5,298		400,000		405,298
Memo:	Extruder with Injection Head Cost allowance based on Vendor Quote											
	F-412A/B/C/D Hepa Filter	1	ea	3,500.00	SHEE GEN	8.000	8	277		3,500		3,777
Memo:	Cost allowance based on Fluor estimate											
	VP-409/A/B/C/D Canister Fill/Vibrator	1	ea	130,000.00	SKWK, GEN	80.000	80	2,649		130,000		132,649
Memo:	System Cost allowance based on Engineer's judgement using Richardson's handbook											
	Process Offgas System	6	ea	50,000.00	SHEE GEN	240.000	1,440	49,910		300,000		349,910
Memo:	Cost allowance based on Fluor estimate											

ODE	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
3.11	EQUIPMENT											
Memo:	Process Piping System Allowance (6"CSx4"-304L SS) Cost allowance based on Fluor estimate	100	lf	200.00	PIPF GEN	0.000				20,000		20,000
Memo:	Control/Isolation Valves Allowance Cost allowance based on Fluor estimate	30	ea	3,500.00	PIPF GEN	16.000	480	19,378		105,000		124,378
	Canister Autoclave/Dewatering/and Delivery Prep											
Memo:	CCS-701A/B/C/D Robotic Contamination Check Station Cost allowance based on vendor quote	1	ea	200,000.00	SKWK GEN	80.000	80	2,649		200,000		202,649
Memo:	R-801 A/B/C/D Robot Hepa Filter Placement Cost allowance based on Engineer's judgement assuming a small trolley/PAR system	1	ea	150,000.00	SKWK GEN	160.000	160	5,298		150,000		155,298
Memo:	A-901A/B/C/D Autoclave Costs are based on two vendor quotes...neither has build an autoclave of this size or operating pressure	1	ea	7,500,000.00	SKWK GEN	640.000	640	21,190		7,500,000		7,521,190
Memo:	A-901A/B/C/D Autoclave Lift Station Cost Based on Vendor Quote	2	ea	500,000.00	SKWK GEN	160.000	320	10,595		1,000,000		1,010,595
Memo:	R-1101 Hepa Filter Remover Cost allowance based on Vendor Quote.	1	ls	150,000.00	SKWK GEN	160.000	160	5,298		150,000		155,298
Memo:	R-1102 Robot Weld/Seal Check Canister Cost allowance based on Fluor estimate	1	ls	450,000.00	SKWK GEN	160.000	160	5,298		450,000		455,298
Memo:	CCS-1201 Robotic Contamination Check Station Cost allowance based on Vendor quote.	1	ls	200,000.00	SKWK GEN	80.000	80	2,649		200,000		202,649
Memo:	DS-1202 Decontamination Station Cost allowance based on (3) Decon System	1	ls	850,000.00	SKWK GEN	240.000	240	7,946		850,000		857,946
Memo:	STS-1301 Sonic Tomography Cost Allowance is based on similar systems designed, constructed and operated by LMITCO Nuclear Physics personnel.	1	ea	3,500,000.00	SKWK GEN	24.000	24	795		3,500,000		3,500,795
Memo:	Process Offgas System Cost allowance based on Fluor estimate	1	ls	150,000.00	SHEE GEN	240.000	240	8,318		150,000		158,318
Memo:	Control/Isolation Valves Allowance Cost allowance based on Fluor estimate	30	ea	3,500.00	PIPF GEN	16.000	480	19,378		105,000		124,378

DETAILED COST ESTIMATE SHEET

Rev 6-96
PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
LOCATION 1. INEEL - ICPP
REQUESTOR. R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO.: 2417-A
PREPARED BY: TES/SMB

DATE 26-Jan-1998
TIME: 09:30:00
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	**EQUIPMENT**											
	Dewatering System Allowance	1	ls		GEN	0.000					5,000,000	5,000,000
	Sample Transfer Cask System (Samples to RAL)	3	ea		GEN	0.000					15,000	15,000
Memo:	Cost allowance based on Fluor estimate											
	Canister Conveyance Systems Allowance	1	ls	7,000,000.00	GEN	0.000	-			7,000,000	1,150,000	8,150,000
Memo:	Cost include conveyance rails,carts, turntables,floor to floor lift stations based on vendor input											
	Canister Recycle System	1	ls		GEN	0.000					2,000,000	2,000,000
Memo:	Cost allowance .Engineer's input											
	EQUIPMENT S/T						10,835	$386,461		$26,610,000	$8,215,000	$35,211,461
1.3.12	**FURNISHINGS**											
	Furniture	1	ls		GEN	0.000					200,000	200,000
	FURNISHINGS S/T						0				$200,000	$200,000
1.3.13	**SPECIAL CONSTRUCTION**											
	SPECIAL CONSTRUCTION S/T						0					
1.3.14	**CONVEYING SYSTEMS**											
	Elevators	1	ls		GEN	0.000					500,000	500,000

DE	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
.14	CONVEYING SYSTEMS Bridge Cranes/Catwalks/etc.	1	ls		GEN	0.000					3,000,000	3,000,000
	CONVEYING SYSTEMS S/T						0				$3,500,000	$3,500,000
.15	MECHANICAL											
	HVAC - Radiation Areas - Remote Handling Cells	63,000	sf	280.00	GEN	0.000				17,640,000		17,640,000
	HVAC - Non-Radiation Process Areas	44,000	sf	20.00	GEN	0.000				880,000		880,000
	HVAC - Support and Administrative Areas	93,000	sf	20.00	GEN	0.000				1,860,000		1,860,000
	Fire Protection - Radiation Areas - Remote Handling Cells	63,000	sf	7.00	GEN	0.000				441,000		441,000
	Fire Protection - Non-Radiation Process Areas	44,000	sf	4.00	GEN	0.000				176,000		176,000
	Fire Protection - Support and Administrative Areas	93,000	sf	2.00	GEN	0.000				186,000		186,000
	Plumbing/Piping Systems - Radiation Areas - Remote Handling Cells	63,000	sf	10.00	GEN	0.000				630,000		630,000
	Plumbing/Piping Systems - Non-Radiation Process Areas	44,000	sf	10.00	GEN	0.000				440,000		440,000

ODE	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
.3.15	MECHANICAL Plumbing/Piping Systems - Support and Administrative Areas	93,000	sf	11.00	GEN	0.000				1,023,000		1,023,000
	MECHANICAL S/T						0			$23,276,000		$23,276,000
.3.16	ELECTRICAL											
	ELECTRICAL S/T						0					
.3.16.1	SWITCHGEAR AND TRANSFORMERS 2000 kVA cast coil 13.8-480 transformers, pri & sec. protection	2	ea	65,000.00	ELEC GEN	24.000	48	1,599	5,000	130,000		136,599
	2000 amp armor clad bus, includes ells, transition pcs., etc.	80	lf	500.00	ELEC GEN	1.500	120	3,997		40,000		43,997
	2000 amp 480 volt Nema 1 Metal Clad Switchgear, double ended	1	ea	125,000.00	ELEC GEN	160.000	160	5,330	2,500	125,000		132,830
	Note: Assume 13.8 sectionalizing switches are existing.											
	High Voltage Sectionalizing Switches for feed 2400 volt standby	2	ea	17,000.00	ELEC GEN	16.000	32	1,066		34,000		35,066
	750 kVA cast coil 2300-480 transformers, pri & sec. protection	2	ea	60,000.00	ELEC GEN	24.000	48	1,599	5,000	120,000		126,599
	1000 amp armor clad bus, includes ells, transition pcs., etc. for standby feed	80	lf	400.00	ELEC GEN	1.500	120	3,997		32,000		35,997
	UCS for Main Switchgear	1	lot	35,000.00	ELEC GEN	120.000	120	3,997		35,000		38,997

ODE	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
3.16.1	**SWITCHGEAR AND TRANSFORMERS**											
	UPS, assume 150 kVA 3 phase unit	1	ea	200,000.00	ELEC GEN	72.000	72	2,398		200,000		202,398
	MCC-1, 800 amp, 480 volt, Nema 1, 10 section	1	ea	25,000.00	ELEC GEN	120.000	120	3,997		25,000		28,997
	MCC-2, 800 amp, 480 volt, Nema 1, 10 section	1	ea	25,000.00	ELEC GEN	120.000	120	3,997		25,000		28,997
	****MCC's include 25% spare cubicles****											
	400 amp 480 volt dist power panels	14	ea	5,000.00	ELEC GEN	12.000	168	5,596		70,000		75,596
	225 amp 120/208 lighting panels	25	ea	1,500.00	ELEC GEN	8.000	200	6,662		37,500		44,162
	75 kVA 480 - 120/208 dry transformer for lighting and recpt's	7	ea	3,000.00	ELEC GEN	12.000	84	2,798		21,000		23,798
	Local motor control	1	lot	2,500.00	ELEC GEN	80.000	80	2,665		2,500		5,165
	30 amp 600 volt disconnect switches	27	ea	96.00	ELEC GEN	1.500	41	1,349		2,592		3,941
	60 amp 600 volt disconnect switches	21	ea	164.00	ELEC GEN	1.750	37	1,224		3,444		4,668
	100 amp 600 volt disconnect switches	4	ea	258.00	ELEC GEN	2.000	8	266		1,032		1,298
	200 amp 600 volt disconnect switches	26	ea	444.00	ELEC GEN	3.000	78	2,598		11,544		14,142
	SWITCHGEAR AND TRANSFORMERS S/T						1,655	$55,136	$12,500	$915,612		$983,248
3.16.2	**LIGHTING**											
	Non Rad Process Lighting	44,000	sf		GEN	0.000					110,000	110,000
	Rad Process Lighting	63,000	sf		GEN	0.000					630,000	630,000

DE	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
.16.2	LIGHTING											
	Support Area Lighting	93,000	sf		GEN	0.000					209,250	209,250
	LIGHTING S/T						0				$949,250	$949,250
.16.3	RACEWAYS & ENCLOSURES											
	3/4" rigid conduit with fittings, ells, and supports	10,000	lf	2.17	ELEC GEN	0.080	800	26,648		21,700		48,348
	1" rigid conduit with fittings, ells, and supports	2,500	lf	3.28	ELEC GEN	0.090	225	7,495		8,200		15,695
	2" rigid conduit with fittings, ells, and supports	15,000	lf	6.85	ELEC GEN	0.200	3,000	99,930		102,750		202,680
	3" rigid conduit with fittings, ells, and supports	5,000	lf	14.43	ELEC GEN	0.280	1,400	46,634		72,150		118,784
	4" rigid conduit with fittings, ells, and supports	4,000	lf	20.56	ELEC GEN	0.440	1,760	58,626		82,240		140,866
	5" rigid conduit with fittings, ells, and supports	500	lf	40.00	ELEC GEN	0.600	300	9,993		20,000		29,993
	Additional labor costs for conduit embeds	1	lot		ELEC GEN	480.000	480	15,989				15,989
	Pull ropes, jet line, and labels	1	lot	3,000.00	ELEC GEN	60.000	60	1,999		3,000		4,999
	J- boxes, enclosures, inst. racks, and terminal strips	1	lot	30,000.00	ELEC GEN	1000.00	1,000	33,310		30,000		63,310
	RACEWAYS & ENCLOSURES S/T						9,025	$300,623		$340,040		$640,663

ODE	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
3.16.4	CONDUCTORS AND GROUNDING											
	#14 thhn	20,000	lf	0.08	ELEC GEN	0.006	120	3,997		1,600		5,597
	#12 thhn	50,000	lf	0.11	ELEC GEN	0.008	400	13,324		5,500		18,824
	#10 thhn	10,000	lf	0.17	ELEC GEN	0.010	100	3,331		1,700		5,031
	#8 thhn	15,000	lf	0.28	ELEC GEN	0.012	180	5,996		4,200		10,196
	#6 thhn	5,000	lf	0.45	ELEC GEN	0.014	70	2,332		2,250		4,582
	#4 thhn	2,500	lf	0.71	ELEC GEN	0.016	40	1,332		1,775		3,107
	#3 thhn	5,000	lf	0.87	ELEC GEN	0.018	90	2,998		4,350		7,348
	#2 thhn	30,000	lf	1.08	ELEC GEN	0.022	660	21,985		32,400		54,385
	1/0 thhn	1,500	lf	1.68	ELEC GEN	0.026	39	1,299		2,520		3,819
	250 mcm thhn	4,000	lf	3.94	ELEC GEN	0.044	176	5,863		15,760		21,623
	300 mcm thhn	3,750	lf	5.50	ELEC GEN	0.046	173	5,746		20,625		26,371
	500 mcm thhn	7,500	lf	7.67	ELEC GEN	0.050	375	12,491		57,525		70,016
	750 mcm thhn	2,500	lf	9.25	ELEC GEN	0.070	175	5,829		23,125		28,954
	Misc. communications, security, and signal cables	1	lot	50,000.00	ELEC GEN	4000.00	4,000	133,240		50,000		183,240
	Motor connections	78	ea	125.00	ELEC GEN	2.500	195	6,495		9,750		16,245
	Connect chillers	2	ea	125.00	ELEC GEN	4.000	8	266		250		516
	Building ground wire, assume 4/0	6,000	lf	2.00	ELEC GEN	0.040	240	7,994		12,000		19,994
	Cadwelds and jumpers	1	lot	5,000.00	ELEC GEN	240.000	240	7,994		5,000		12,994
	Wire labels	1	lot	5,000.00	ELEC GEN	120.000	120	3,997		5,000		8,997
	Allowance for thermal couples	1	lot	25,000.00	ELEC GEN	240.000	240	7,994		25,000		32,994

)DE	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
3.16.4	CONDUCTORS AND GROUNDING ****Lightning protection, Based on 32000 sf****											
	Lightning protection, air terminals, alum, 1/2" dia x 12" (to 75' hi)	90	ea	18.00	ELEC GEN	0.500	45	1,499		1,620		3,119
	Lightning protection, cable, cu, 220 lb. per thousand ft. (to 75' hi)	5,000	lf	1.07	ELEC GEN	0.025	125	4,164		5,350		9,514
	3/4" x 10' copper weld ground rod with clamp	24	ea	35.00	ELEC GEN	1.000	24	799		840		1,639
	CONDUCTORS AND GROUNDING S/T						7,835	$260,967		$288,140		$549,107
3.16.5	WIRING DEVICES & SPECIAL SYSTEMS Welding recpts	8	ea	600.00	ELEC GEN	2.000	16	533		4,800		5,333
	Remote welding	1	lot	150,000.00	ELEC GEN	120.000	120	3,997		150,000		153,997
	Switches and recpt's	46,000	sf		GEN	0.000					69,000	69,000
	Voice paging and evac	1	lot	30,000.00	ELEC GEN	1000.00	1,000	33,310		30,000		63,310
	Fire detection and arlarm	121,000	sf		GEN	0.000					211,750	211,750
	Telephone and communications	1	lot	40,000.00	ELEC GEN	240.000	240	7,994		40,000		47,994
	****Security Systems****											
	Argus security equipment, card readers, dectection, etc.	1	lot	250,000.00	GEN	0.000				250,000		250,000
	Rad Monitoring	1	lot	500,000.00	ELEC GEN	1000.00	1,000	33,310		500,000		533,310

ODE	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
3.16.5	WIRING DEVICES & SPECIAL SYSTEMS Labor and materials to install	1	lot	25,000.00	ELEC *GEN*	1000.00	1,000	33,310		25,000		58,310
	WIRING DEVICES & SPECIAL SYSTEMS S/T						3,376	$112,455		$999,800	$280,750	$1,393,005
3.16.6	INSTRUMENTATION & CONTROLS Field instruments, control equipment and wiring	820	ea		ELEC *GEN*	0.000					3,690,000	3,690,000
	Assume 2250 signals, assume 2 points per signal	4,500	ea	1,250.00	ELEC *GEN*	24.000	108,000	3,597,480		5,625,000		9,222,480
	Air lock control, 8 places	1	lot	2,000.00	ELEC *GEN*	40.000	40	1,332		2,000		3,332
	Control room consols, includes PLC's, graphics panels, etc.	1	lot	1,000,000.00	 *GEN*	0.000				1,000,000		1,000,000
	Control systems CPU, assume 2 systems	1	lot		 *GEN*	0.000					150,000	150,000
	Instrument racks, assume 3000 points	1	lot	25,000.00	ELEC *GEN*	480.000	480	15,989		25,000		40,989
	Systems programing, assume 60,000 hours @ 65.00	1	lot		 *GEN*	0.000					3,900,000	3,900,000
	INSTRUMENTATION & CONTROLS S/T						108,520	$3,614,801		$6,652,000	$7,740,000	$18,006,801
3.16.6.1	CLOSED CIRCUIT TV Cameras, with Pan-Tilt-Unit and control system	24	ea	3,200.00	ELEC *ELECT*	40.000	960	31,978		76,800		108,778
	Reciever and transmiter	24	ea	2,000.00	ELEC *ELECT*	8.000	192	6,396		48,000		54,396
	Fiber optic cable system, includes connectors and testing	8,000	lf		ELEC *ELECT*	0.015	120	3,997				3,997

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
1.3.16.6.1	CLOSED CIRCUIT TV											
	CCTV monitors	3	ea	800.00	ELEC ELECT	8.000	24	799		2,400		3,199
	Channel switchers	3	ea	6,000.00	ELEC ELECT	8.000	24	799		18,000		18,799
	Graphic control interface for CCTV	1	lot		ELECT	0.000					50,000	50,000
	Programing for Graphic control	1	lot		ELECT	0.000					65,000	65,000
	Misc. mounting brackets and supports	1	lot	3,000.00	ELEC ELECT	48.000	48	1,599		3,000		4,599
	CLOSED CIRCUIT TV S/T						1,368	$45,568		$148,200	$115,000	$308,768
1.3.16.7	TESTING											
	CC testing of systems and equipment	1	lot		ELEC GEN	2400.00	2,400	79,944				79,944
	TESTING S/T						2,400	$79,944				$79,944
1.5.1	G&A/PIF ADDER											
10701000	G&A	1	ls			0.000					690,000	690,000
	PIF	1	LOT			0.000					13,008,618	13,008,618
	G&A/PIF ADDER S/T						0				$13,698,618	$13,698,618
	PROJECT SUBTOTAL						179,097	$5,984,343	$12,500	$131,653,342	$138,323,618	$275,973,803

Lockheed Martin Idaho Technologies Co.

CONTINGENCY ANALYSIS

PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
N 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB

DATE: 26-Jan-1998
TIME: 09:29:30

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	DESIGN ENGINEERING TITLE I & II	46,000,000	10.20	5	40	0.51	4.08	3.620%	10.55%	16,772,752	62,772,752
1.1.2	TITLE III INSPECTION	11,500,000	2.55	5	40	0.13	1.02	0.905%	2.64%	4,193,188	15,693,188
1.2.1	PROJECT MANAGEMENT	23,000,000	5.10	5	40	0.25	2.04	1.810%	5.28%	8,386,376	31,386,376
1.2.2	CONSTRUCTION MANAGEMENT	23,000,000	5.10	5	40	0.25	2.04	1.810%	5.28%	8,386,376	31,386,376
1.3.1	GENERAL CONDITIONS	1,128,389	0.25	5	35	0.01	0.09	0.078%	0.23%	359,285	1,487,674
1.3.2	SITEWORK	5,622,188	1.25	5	40	0.06	0.50	0.442%	1.29%	2,049,991	7,672,179
1.3.3	CONCRETE	50,551,499	11.21	5	40	0.56	4.48	3.979%	11.60%	18,432,342	68,983,841
1.3.4	MASONRY	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.5	METALS	10,011,064	2.22	5	40	0.11	0.89	0.788%	2.30%	3,650,285	13,661,349
1.3.6	WOOD & PLASTICS	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,100,640	0.24	0	0	0.00	0.00	0.000%	0.00%	0	1,100,640
1.3.8	DOORS & WINDOWS	34,942,745	7.75	5	40	0.39	3.10	2.750%	8.02%	12,741,000	47,683,745
1.3.9	FINISHES	5,491,122	1.22	5	35	0.06	0.43	0.377%	1.10%	1,748,401	7,239,523
1.3.10	SPECIALTIES	140,250	0.03	5	40	0.00	0.01	0.011%	0.03%	51,139	191,389
1.3.11	EQUIPMENT	49,465,572	10.97	2	40	0.22	4.39	3.926%	11.44%	18,188,806	67,654,378
1.3.12	FURNISHINGS	224,400	0.05	5	35	0.00	0.02	0.015%	0.04%	71,450	295,850
1.3.13	SPECIAL CONSTRUCTION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.14	CONVEYING SYSTEMS	3,927,000	0.87	5	40	0.04	0.35	0.309%	0.90%	1,431,883	5,358,883
1.3.15	MECHANICAL	34,619,588	7.68	5	40	0.38	3.07	2.725%	7.94%	12,623,169	47,242,757
	ELECTRICAL	31,737,019	7.04	5	40	0.35	2.81	2.498%	7.28%	11,572,112	43,309,131
	G&A/PIF ADDER	13,698,618	3.04	5	40	0.15	1.21	1.078%	3.14%	4,994,859	18,693,477
1.5.2	PROCUREMENT FEES	2,289,615	0.51	5	30	0.03	0.15	0.135%	0.39%	623,199	2,912,814
	ESCALATION	102,602,902	22.75	5	35	1.14	7.96	7.052%	20.55%	32,670,776	135,273,678
	SUBTOTAL	451,052,611	100.00					34.309%			
	CALCULATED CONTINGENCY	154,750,174									
	RESULTANT TEC	605,802,785									
	ROUNDED TEC	610,000,000									
	PROJECT CONTINGENCY	158,947,389						35.24%			
	MANAGEMENT RESERVE	32,823,261									
	CONTINGENCY	126,124,128									
	TOTAL ESTIMATED COST	610,000,000								158,947,389	610,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
The Lockheed Martin 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.

CONTINGENCY ANALYSIS

PROJECT NAME: HLW-DCWO
20 Yr.-Grout Facility
LOCATION 1: INEEL - ICPP
REQUESTOR: R. Defoe

TYPE OF ESTIMATE: Planning
PROJECT NO: 2417-A
PREPARED BY: TES/SMB

DATE: 26-Jan-1998
TIME: 09:32:38

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. -	Prob. % Var. From Est. +	Wt. % of Prob. -	Wt. % of Prob. +	Contingency	%	Cost	Total Cost by Element
1.1.1	DESIGN ENGINEERING TITLE I & II	46,000,000	13.20	5	40	0.66	5.28	4.686%	13.28%	16,809,071	62,809,071
1.1.2	TITLE III INSPECTION	11,500,000	3.30	5	40	0.17	1.32	1.172%	3.32%	4,202,268	15,702,268
1.2.1	PROJECT MANAGEMENT	23,000,000	6.60	5	40	0.33	2.64	2.343%	6.64%	8,404,536	31,404,536
1.2.2	CONSTRUCTION MANAGEMENT	23,000,000	6.60	5	40	0.33	2.64	2.343%	6.64%	8,404,536	31,404,536
1.3.1	GENERAL CONDITIONS	1,128,389	0.32	5	35	0.02	0.11	0.100%	0.28%	360,063	1,488,452
1.3.2	SITEWORK	5,622,188	1.61	5	40	0.08	0.65	0.573%	1.62%	2,054,430	7,676,618
1.3.3	CONCRETE	50,551,499	14.51	5	40	0.73	5.80	5.150%	14.60%	18,472,256	69,023,755
1.3.4	MASONRY	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.5	METALS	10,011,064	2.87	5	40	0.14	1.15	1.020%	2.89%	3,658,189	13,669,253
1.3.6	WOOD & PLASTICS	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	1,100,640	0.32	0	0	0.00	0.00	0.000%	0.00%	0	1,100,640
1.3.8	DOORS & WINDOWS	34,942,745	10.03	5	40	0.50	4.01	3.560%	10.09%	12,768,589	47,711,334
1.3.9	FINISHES	5,491,122	1.58	5	35	0.08	0.55	0.489%	1.38%	1,752,186	7,243,308
1.3.10	SPECIALTIES	140,250	0.04	5	40	0.00	0.02	0.014%	0.04%	51,249	191,499
1.3.11	EQUIPMENT	49,465,572	14.20	2	40	0.28	5.68	5.082%	14.40%	18,228,192	67,693,764
1.3.12	FURNISHINGS	224,400	0.06	5	35	0.00	0.02	0.020%	0.06%	71,605	296,005
1.3.13	SPECIAL CONSTRUCTION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	0	0
1.3.14	CONVEYING SYSTEMS	3,927,000	1.13	5	40	0.06	0.45	0.400%	1.13%	1,434,983	5,361,983
1.3.15	MECHANICAL	34,619,588	9.94	5	40	0.50	3.97	3.527%	10.00%	12,650,503	47,270 [illegible]
1.3.16	ELECTRICAL	31,737,019	9.11	5	40	0.46	3.64	3.233%	9.16%	11,597,170	43,3
1.5.1	G&A/PIF ADDER	13,698,618	3.93	5	40	0.20	1.57	1.396%	3.96%	5,005,675	18,7[illegible]
1.5.2	PROCUREMENT FEES	2,289,615	0.66	5	30	0.03	0.20	0.174%	0.49%	624,548	2,914,163
	ESCALATION	0	0.00	0	0	0.00	0.00	0.000%	0.00%	242	242
	SUBTOTAL	348,449,709	100.00					35.283%			
	CALCULATED CONTINGENCY	122,943,275									
	RESULTANT TEC	471,392,984									
	ROUNDED TEC	475,000,000									
	PROJECT CONTINGENCY	126,550,291						36.32%			
	MANAGEMENT RESERVE	24,494,971									
	CONTINGENCY	102,055,320									
	TOTAL ESTIMATED COST	475,000,000								126,550,291	475,000,000

CONFIDENCE LEVEL AND ASSUMED RISKS:
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Experimental/Special Conditions	.....Up to 40%
TITLE I	10% – 20%
TITLE II	5% – 15%
TITLE II/AFC	Market Conditions

G&A/PIF ADDER CALCULATION SHEET

PROJECT: HLW - 20 Yr.-DCWO

ESTIMATE NUMBER: 2417

PROCUREMENT FEE @ 1%					
		CONSTRUCTION	$228,961,475	x 0.01 =	$6,868,844
		GFE		x 0.01 =	$0
TOTAL PROCUREMENT FEE					$6,868,844
G&A @ 23%	YEAR				
Note: Ceiling of $500,000 Imposed	1	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	2	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	3	CONSTRUCTION	$500,000	x .23 =	$115,000
		PROCUREMENT FEE	$500,000	x .23 =	$115,000
	4	CONSTRUCTION		x .23 =	$0
		PROCUREMENT FEE		x .23 =	$0
TOTAL G&A					$690,000
PIF @ 5.5%		CONSTRUCTION	$228,961,475		
		GFE	$0		
		PROCUREMENT FEE	$6,868,844		
		G&A	$690,000		
TOTAL PIF			$236,520,319	x.055 =	$13,008,618

NOTE: Assume expenditures will vary per year but always reach maximum G&A

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date:	February 2, 1998		
To:	R. E. Dafoe	MS 3765	6-6772
From:	R. J. Turk	MS 3875	6-3611
Subject:	ECONOMIC AND LIFE CYCLE ANALYSIS CONDUCTED for the DIRECT CEMENTITIOUS WASTE TWENTY-YEAR OPTION-RJT-11-98		

Purpose:

As requested an Economic and Life-Cycle Cost (LCC) has been conducted to evaluate the NON-SEPARATIONS DIRECT CEMENTITIOUS WASTE TWENTY-YEAR OPTION (DCWO). This process is proposed to treat the ICPP Spent Nuclear Fuel (SNF) high level waste (HLW) calcine into a form suitable for final disposition. The DCWO facility will include a calcine receiving system, grouting material receiving and handling system, a blending system, a grouting process, product lag storage, an off-gas treatment system with supporting utilities system.

This economic analysis is based on information provided Sara Gifford, Randy Heyrend, Sylvester Losinski, Jila Banaee, Ross Johnson, Ron Averill, Byron Blakely, John Duggan and other team members. Terry Sivill and Sue Bradford provided cost estimates. Dianne Stoddard provided process personnel modeling.

Methodology:

The Economic Evaluation assumed a 35-year period, (2001-2035) since this is the estimated time required to complete all of the anticipated remediation activities. The LCC identifies 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 6.30% 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's 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 six years with construction completed in four years, followed by two 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 twenty-years, followed by three-years of post-operations activities. Utilities were assumed to cost $0.0824/kwh for the facility. Grouting material and Calcine Clay were assumed to cost $150/ton. Due to this projects 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.

Results:

The Twenty-year Direct Cementitious Option has a Discounted LCC of $1.141 billion.

Attachments:

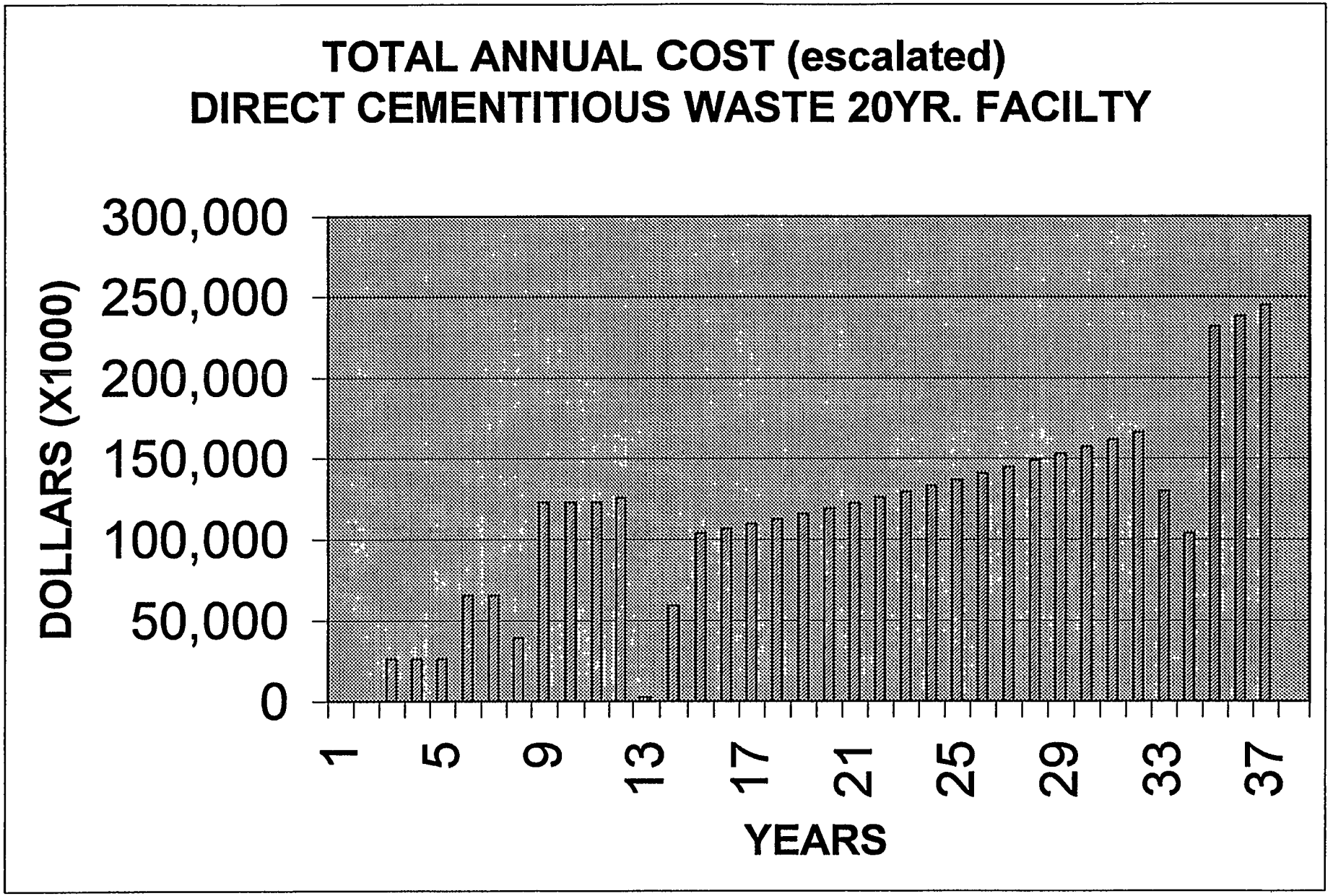
cc: R. J. Turk File

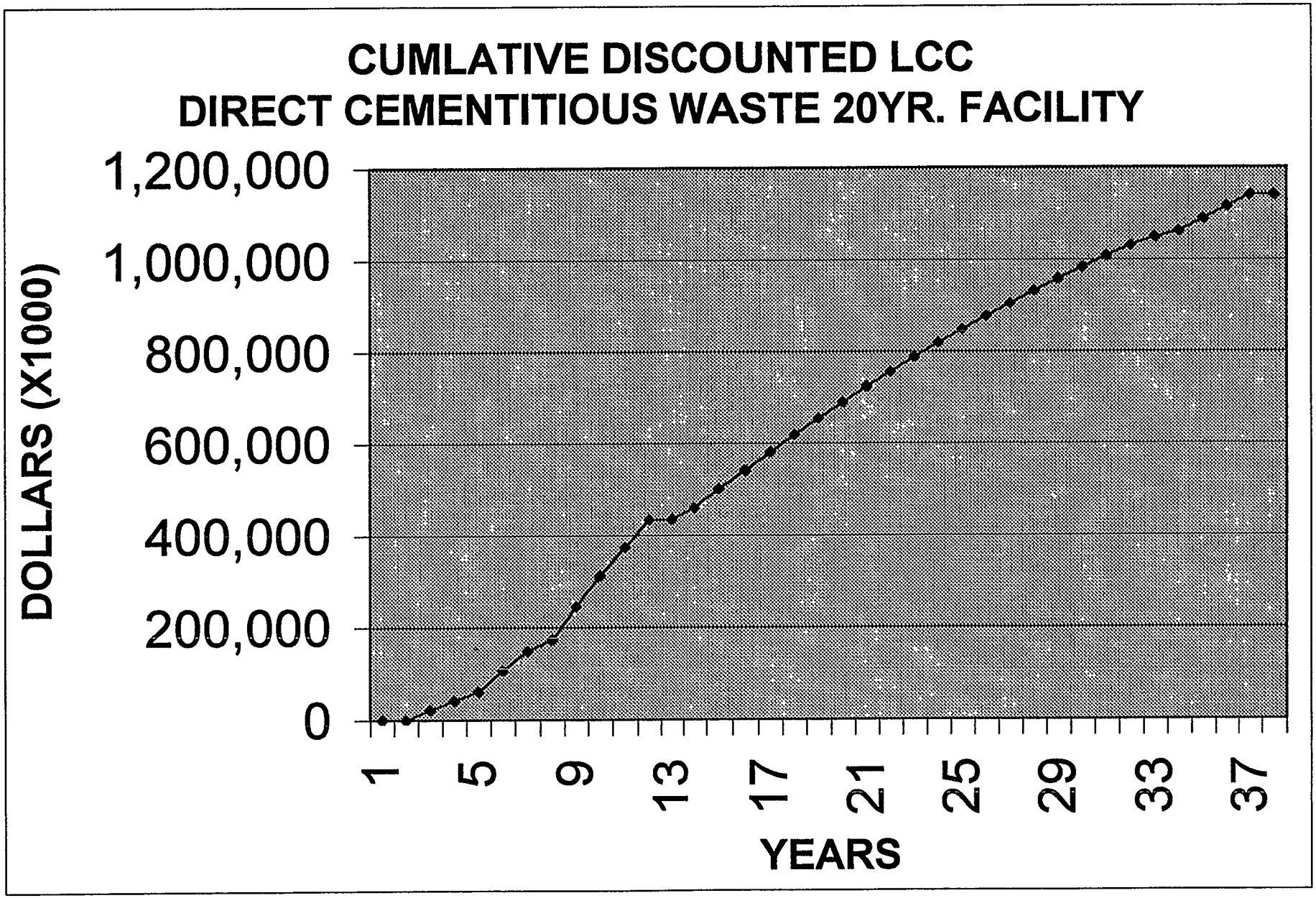
DIRECT CEMENTITIOUS WASTE OPTION					fical year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Life-Cycle Cost (LCC) Analysis					counting year	1	2	3	4	5	6	7	8	9	10
(ALL COST X1000)					Escalation Factor	1.024	1.053	1.082	1.112	1.144	1.176	1.209	1.242	1.277	1.313
Other Project Cost (OPC)															
OPC unescalated															
Conceptual Design, Project Mgt, & Permitting								16,680	16,680	16,680	16,680	16,680			
Testing and Start-up															
Total OPC (unescalated)						0	0	16,680	16,680	16,680	16,680	16,680	0	0	0
plus escalation of						0	0	2,449	2,449	2,449	2,449	2,449	0	0	0
plus management reserve of						0	0	169	169	169	169	169	0	0	0
plus contingency of						0	0	6,716	6,716	6,716	6,716	6,716	0	0	0
Total OPC including escalation, mgt reserve, & contingency						0	0	26,014	26,014	26,014	26,014	26,014	0	0	0
Total Estimated Cost (TEC)															
TEC unescalated													0	0	0
Title Design, Inspection											19,167	19,167	19,167		
Project mgt											3,286	3,286	3,286	3,286	3,286
Construction Mgt														5,750	5,750
Construction, Equip, G&A & Procurement														61,237	61,237
Total TEC (unescalated)						0	0	0	0	0	22,452	22,452	22,452	70,273	70,273
plus escalation of						0	0	0	0	0	6,611	6,611	6,611	20,692	20,692
plus management reserve of						0	0	0	0	0	2,115	2,115	2,115	6,620	6,620
plus contingency of						0	0	0	0	0	8,127	8,127	8,127	25,438	25,438
Total TEC including escalation, mgt reserve, contingency						0	0	0	0	0	39,305	39,305	39,305	123,021	123,021
Total Project Cost (TPC)															
TPC unescalated						0	0	16,680	16,680	16,680	39,132	39,132	22,452	70,273	70,273
plus escalation of						0	0	2,449	2,449	2,449	9,060	9,060	6,611	20,692	20,692
plus management reserve of						0	0	169	169	169	2,284	2,284	2,115	6,620	6,620
plus contingency of						0	0	6,716	6,716	6,716	14,843	14,843	8,127	25,438	25,438
Total TPC including esc, mgt res, contingency						0	0	26,014	26,014	26,014	65,319	65,319	39,305	123,021	123,021
Operations	2080 hr-shift/yr.														
Facility/Administration	39														
Managers		3	FTE @	$125	/ hr.										
Engineers		14	FTE @	$108	/ hr.										
Other Tech.		12	FTE @	$85	/ hr.										
Administration/Support		10	FTE @	$85	/ hr.										
Operations/Process Facility	101														
Managers		4	FTE @	$125	/ hr.										
Engineers		17	FTE @	$108	/ hr.										
Other Tech.		12	FTE @	$85	/ hr.										
Supervisors		11	FTE @	$85	/ hr.										
Administration/Support		4	FTE @	$85	/ hr.										
Operators		19	FTE @	$85	/ hr.										
Maintenance		34	FTE @	$85	/ hr.										
Procurement		18000	units	$10,000	ea.										
Calcine Clay		13,300	ton	$150.00	/ kg										
Blast Furnace Slag		1,500	ton	$150.00	/ kg										
Utilities		3,766,800	kwh/yr	$0.082	/ SF										
Maintenance of Equipment		8.00%	of	244,950											
Operations subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	0
Total Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Post Operations															
Decommission		20.00%	of	Engineering costs											
Decontamination		5.00%	of	Pre-operation Costs											
Demolition		8.00%	of	Pre-operation Costs											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						0	0	16,680	16,680	16,680	39,132	39,132	22,452	70,273	70,273
Cumulative Total LCC (unescalated)						0	0	16,680	33,360	50,040	89,172	128,305	150,757	221,030	291,303
Total Cost (w/ escalation, mgt reserve, & contingency)						0	0	26,014	26,014	26,014	65,319	65,319	39,305	123,021	123,021
Cumulative Total LCC (escalated)						0	0	26,014	52,028	78,041	143,361	208,680	247,985	371,006	494,027
discount factor @ OMB discount rate of		6.30%		for escalated costs		1.063	1.130	1.201	1.277	1.357	1.443	1.534	1.630	1.733	1.842
Discounted Annual Cost						$0	$0	$21,657	$20,374	$19,166	$45,273	$42,590	$24,109	$70,987	$66,780
Cumulative Discounted LCC						0	0	21,657	42,031	61,197	106,471	149,061	173,170	244,157	310,937

DIRECT CEMENTITIOUS WASTE OPTION					fical year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Life-Cycle Cost (LCC) Analysis					counting year	11	12	13	14	15	16	17	18	19	20
(ALL COST X1000)					Escalation Factor	1.350	1.387	1.426	1.466	1.507	1.550	1.593	1.638	1.683	1.730
Other Project Cost (OPC)															
OPC unescalated															
Conceptual Design, Project Mgt, & Permitting															
Testing and Start-up							1,581	1,581							
Total OPC (unescalated)						0	1,581	1,581	0	0	0	0	0	0	0
plus escalation of						0	232	232	0	0	0	0	0	0	0
plus management reserve of						0	16	16	0	0	0	0	0	0	0
plus contingency of						0	637	637	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						0	2,465	2,465	0	0	0	0	0	0	0
Total Estimated Cost (TEC)															
TEC unescalated						0									
Title Design, Inspection															
Project mgt						3,286	3,286								
Construction Mgt						5,750	5,750								
Construction, Equip, G&A & Procurement						61,237	61,237								
Total TEC (unescalated)						70,273	70,273	0	0	0	0	0	0	0	0
plus escalation of						20,692	20,692	0	0	0	0	0	0	0	0
plus management reserve of						6,620	6,620	0	0	0	0	0	0	0	0
plus contingency of						25,436	25,436	0	0	0	0	0	0	0	0
Total TEC including escalation, mgt reserve, contingency						123,021	123,021	0	0	0	0	0	0	0	0
Total Project Cost (TPC)															
TPC unescalated						70,273	71,854	1,581	0	0	0	0	0	0	0
plus escalation of						20,692	20,924	232	0	0	0	0	0	0	0
plus management reserve of						6,620	6,636	16	0	0	0	0	0	0	0
plus contingency of						25,436	26,072	637	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency						123,021	125,486	2,465	0	0	0	0	0	0	0
Operations	2080	hr-shift/yr.													
Facility/Administration	39														
Managers		3	FTE @	$125	/hr.				390	780	780	780	780	780	780
Engineers		14	FTE @	$108	/hr.				1,572	3,145	3,145	3,145	3,145	3,145	3,145
Other Tech.		12	FTE @	$85	/hr.				1,061	2,122	2,122	2,122	2,122	2,122	2,122
Administration/Support		10	FTE @	$65	/hr.				676	1,352	1,352	1,352	1,352	1,352	1,352
Operations/Process Facility	101														
Managers		4	FTE @	$125	/hr.				520	1,040	1,040	1,040	1,040	1,040	1,040
Engineers		17	FTE @	$108	/hr.				1,909	3,819	3,819	3,819	3,819	3,819	3,819
Other Tech.		12	FTE @	$85	/hr.				1,061	2,122	2,122	2,122	2,122	2,122	2,122
Supervisors		11	FTE @	$85	/hr.				972	1,945	1,945	1,945	1,945	1,945	1,945
Administration/Support		4	FTE @	$65	/hr.				270	541	541	541	541	541	541
Operators		19	FTE @	$65	/hr.				1,284	2,569	2,569	2,569	2,569	2,569	2,569
Maintenance		34	FTE @	$65	/hr.				2,298	4,597	4,597	4,597	4,597	4,597	4,597
Procurement		18000	units	$10,000	ea.				9,000	9,000	9,000	9,000	9,000	9,000	9,000
Calcine Clay		13,300	ton	$150.00	/kg				100	100	100	100	100	100	100
Blast Furnace Slag		1,500	ton	$150.00	/kg				113	225	225	225	225	225	225
Utilities		3,766,800	kwh/yr	$0.082	/SF				8	16	16	16	16	16	16
Maintenance of Equipment		8.00%	of	244,950					9,798	19,596	19,596	19,596	19,596	19,596	19,596
Operations subtotal (unescalated)						0	0	0	31,033	52,966	52,966	52,966	52,966	52,966	52,966
plus Escalation						0	0	0	14,469	26,871	29,106	31,404	33,766	36,195	38,691
plus Operations Contingency @		30.0%				0	0	0	13,651	23,951	24,822	25,311	26,020	26,748	27,497
Total Operations (w/ escalation & contingency)						0	0	0	59,153	103,788	106,894	109,682	112,753	115,910	119,155
Post Operations															
Decommission		20.00%	of	Engineering costs											
Decontamination		5.00%	of	Pre-operation Costs											
Demolition		6.00%	of	Pre-operation Costs											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						70,273	71,854	1,581	31,033	52,966	52,966	52,966	52,966	52,966	52,966
Cumulative Total LCC (unescalated)						361,577	433,431	435,011	466,045	519,011	571,978	624,944	677,910	730,877	783,843
Total Cost (w/ escalation, mgt reserve, & contingency)						123,021	125,486	2,465	59,153	103,788	106,894	109,682	112,753	115,910	119,155
Cumulative Total LCC (escalated)						617,048	742,535	745,000	804,153	907,942	1,014,836	1,124,518	1,237,070	1,352,980	1,472,136
discount factor @ OMB discount rate of		6.30%		for escalated costs		1.958	2.082	2.213	2.352	2.500	2.658	2.825	3.003	3.193	3.394
Discounted Annual Cost						$62,822	$60,283	$1,114	$25,149	$41,510	$40,143	$38,821	$37,543	$36,307	$35,111
Cumulative Discounted LCC						373,759	434,043	435,157	460,305	501,815	541,958	580,779	618,322	654,629	689,740

DIRECT CEMENTITIOUS WASTE OPTION						fical year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Life-Cycle Cost (LCC) Analysis						counting year	21	22	23	24	25	26	27	28	29	30
(ALL COST X1000)						Escalation Factor	1.779	1.829	1.880	1.933	1.987	2.042	2.100	2.158	2.219	2.281
Other Project Cost (OPC)																
OPC unescalated																
Conceptual Design, Project Mgt, & Permitting																
Testing and Start-up																
Total OPC (unescalated)							0	0	0	0	0	0	0	0	0	0
plus escalation of							0	0	0	0	0	0	0	0	0	0
plus management reserve of							0	0	0	0	0	0	0	0	0	0
plus contingency of							0	0	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency							0	0	0	0	0	0	0	0	0	0
Total Estimated Cost (TEC)																
TEC unescalated																
Title Design, Inspection																
Project mgt																
Construction Mgt																
Construction, Equip, G&A & Procurement																
Total TEC (unescalated)							0	0	0	0	0	0	0	0	0	0
plus escalation of							0	0	0	0	0	0	0	0	0	0
plus management reserve of							0	0	0	0	0	0	0	0	0	0
plus contingency of							0	0	0	0	0	0	0	0	0	0
Total TEC including escalation, mgt reserve, contingency							0	0	0	0	0	0	0	0	0	0
Total Project Cost (TPC)																
TPC unescalated							0	0	0	0	0	0	0	0	0	0
plus escalation of							0	0	0	0	0	0	0	0	0	0
plus management reserve of							0	0	0	0	0	0	0	0	0	0
plus contingency of							0	0	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency							0	0	0	0	0	0	0	0	0	0
Operations	2080 hr-shift/yr.															
Facility/Administration	39															
Managers		3	FTE @	$125	/hr.		780	780	780	780	780	780	780	780	780	780
Engineers		14	FTE @	$108	/hr.		3,145	3,145	3,145	3,145	3,145	3,145	3,145	3,145	3,145	3,145
Other Tech.		12	FTE @	$85	/hr.		2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122
Administration/Support		10	FTE @	$85	/hr.		1,352	1,352	1,352	1,352	1,352	1,352	1,352	1,352	1,352	1,352
Operations/Process Facility	101															
Managers		4	FTE @	$125	/hr.		1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
Engineers		17	FTE @	$108	/hr.		3,819	3,819	3,819	3,819	3,819	3,819	3,819	3,819	3,819	3,819
Other Tech.		12	FTE @	$85	/hr.		2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122
Supervisors		11	FTE @	$85	/hr.		1,945	1,945	1,945	1,945	1,945	1,945	1,945	1,945	1,945	1,945
Administration/Support		4	FTE @	$85	/hr.		541	541	541	541	541	541	541	541	541	541
Operators		19	FTE @	$85	/hr.		2,569	2,569	2,569	2,569	2,569	2,569	2,569	2,569	2,569	2,569
Maintenance		34	FTE @	$85	/hr.		4,597	4,597	4,597	4,597	4,597	4,597	4,597	4,597	4,597	4,597
Procurement		18000	units	$10,000	ea.		9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Calcine Clay		13,300	ton	$150.00	/kg		100	100	100	100	100	100	100	100	100	100
Blast Furnace Slag		1,500	ton	$150.00	/kg		225	225	225	225	225	225	225	225	225	225
Utilities		3,766,800	kwh/yr	$0.092	/SF		16	16	16	16	16	16	16	16	16	16
Maintenance of Equipment		8.00%	of	244,950			19,596	19,596	19,596	19,596	19,596	19,596	19,596	19,596	19,596	19,596
Operations subtotal (unescalated)							52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966
plus Escalation							41,258	43,896	46,608	49,396	52,263	55,209	58,238	61,352	64,553	67,843
plus Operations Contingency @		30.0%					28,287	29,059	29,872	30,709	31,569	32,453	33,361	34,295	35,256	36,243
Total Operations (w/ escalation & contingency)							122,492	125,921	129,447	133,072	136,798	140,628	144,566	148,614	152,775	157,052
Post Operations																
Decommission		20.00%	of	Engineering costs												
Decontamination		5.00%	of	Pre-operation Costs												
Demolition		8.00%	of	Pre-operation Costs												
Post-Operations Subtotal (unescalated)							0	0	0	0	0	0	0	0	0	0
plus Escalation							0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		30.0%					0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)							0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)							52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966	52,966
Cumulative Total LCC (unescalated)							836,810	889,776	942,743	995,709	1,048,676	1,101,642	1,154,609	1,207,575	1,260,542	1,313,508
Total Cost (w/ escalation, mgt reserve, & contingency)							122,492	125,921	129,447	133,072	136,798	140,628	144,566	148,614	152,775	157,052
Cumulative Total LCC (escalated)							1,594,627	1,720,549	1,849,996	1,983,068	2,119,866	2,260,494	2,405,060	2,553,673	2,706,448	2,863,501
discount factor @ OMB discount rate of		6.30%		for escalated costs			3.607	3.835	4.076	4.333	4.606	4.896	5.205	5.533	5.881	6.252
Discounted Annual Cost							$33,955	$32,837	$31,756	$30,711	$29,699	$28,722	$27,778	$26,861	$25,977	$25,122
Cumulative Discounted LCC							723,696	756,533	788,289	819,000	848,699	877,421	905,197	932,058	958,035	983,156

DIRECT CEMENTITIOUS WASTE OPTION Life-Cycle Cost (LCC) Analysis (ALL COST X1000)					fical year counting year Escalation Factor	2029 31 2.345	2030 32 2.410	2031 33 2.478	2032 34 2.547	2033 35 2.619	2034 36 2.692	2035 37 2.767	2036 38 2.845	Total Cost
Other Project Cost (OPC)														
OPC unescalated														
Conceptual Design, Project Mgt, & Permitting														83,400
Testing and Start-up														3,162
Total OPC (unescalated)						0	0	0	0	0	0	0	0	86,562
plus escalation of						0	0	0	0	0	0	0	0	12,706
plus management reserve of						0	0	0	0	0	0	0	0	877
plus contingency of						0	0	0	0	0	0	0	0	34,853
Total OPC including escalation, mgt reserve, & contingency						0	0	0	0	0	0	0	0	135,000
Total Estimated Cost (TEC)														
TEC unescalated														
Title Design, Inspection														57,500
Project mgt														23,000
Construction Mgt														23,000
Construction, Equip, G&A & Procurement														244,950
Total TEC (unescalated)						0	0	0	0	0	0	0	0	348,450
plus escalation of						0	0	0	0	0	0	0	0	102,603
plus management reserve of						0	0	0	0	0	0	0	0	32,823
plus contingency of						0	0	0	0	0	0	0	0	126,124
Total TEC including escalation, mgt reserve, contingency						0	0	0	0	0	0	0	0	610,000
Total Project Cost (TPC)														
TPC unescalated						0	0	0	0	0	0	0	0	435,011
plus escalation of						0	0	0	0	0	0	0	0	115,311
plus management reserve of						0	0	0	0	0	0	0	0	33,701
plus contingency of						0	0	0	0	0	0	0	0	160,977
Total TPC including esc, mgt res, contingency						0	0	0	0	0	0	0	0	745,000
Operations	2080 hr-shift/yr.													
Facility/Administration	39													
Managers		3	FTE @	$125	/ hr.	780	780	195	195					14,820
Engineers		14	FTE @	$108	/ hr.	3,145	3,145	786	786					59,754
Other Tech.		12	FTE @	$85	/ hr.	2,122	2,122	530	530					40,310
Administration/Support		10	FTE @	$65	/ hr.	1,352	1,352	338	338					25,688
Operations/Process Facility	101													0
Managers		4	FTE @	$125	/ hr.	1,040	1,040	260	260					19,760
Engineers		17	FTE @	$108	/ hr.	3,819	3,819	955	955					72,559
Other Tech.		12	FTE @	$85	/ hr.	2,122	2,122	530	530					40,310
Supervisors		11	FTE @	$85	/ hr.	1,945	1,945	486	486					36,951
Administration/Support		4	FTE @	$85	/ hr.	541	541	135	135					10,275
Operators		19	FTE @	$85	/ hr.	2,569	2,569	2,569	2,569					52,660
Maintenance		34	FTE @	$85	/ hr.	4,597	4,597	4,597	4,597					94,234
Procurement		18000	units	$10,000	ea.	9,000	9,000	9,000						180,000
Calcine Clay		13,300	ton	$150.00	/ kg	100	100	100	100					2,095
Blast Furnace Slag		1,500	ton	$150.00	/ kg	225	225	225	225					4,613
Utilities		3,766,800	kwh/yr	$0.082	/ SF	16	16	16	16					318
Maintenance of Equipment		8.00%	of	244,950		19,596	19,596	19,596	19,596					401,719
Operations subtotal (unescalated)						52,966	52,966	40,318	31,318	0	0	0	0	1,058,066
plus Escalation						71,226	74,703	59,585	46,457	0	0	0	0	1,005,090
plus Operations Contingency @		30.0%				37,258	38,301	29,971	23,933	0	0	0	0	616,347
Total Operations (w/ escalation & contingency)						161,450	165,971	129,874	103,708	0	0	0	0	2,679,503
Post Operations														
Decommission		20.00%	of	Engineering costs						11,500	11,500	11,500		34,500
Decontamination		5.00%	of	Pre-operation Costs						21,751	21,751	21,751		65,252
Demolition		8.00%	of	Pre-operation Costs						34,801	34,801	34,801		104,403
Post-Operations Subtotal (unescalated)						0	0	0	0	68,051	68,051	68,051	0	204,154
plus Escalation						0	0	0	0	110,147	115,138	120,266	0	345,549
plus Post-Operations Contingency @		30.0%				0	0	0	0	53,459	54,956	56,495	0	164,911
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	231,658	238,144	244,812	0	714,614
Total Cost (unescalated)						52,966	52,966	40,318	31,318	68,051	68,051	68,051	0	1,695,232
Cumulative Total LCC (unescalated)						1,368,475	1,419,441	1,459,759	1,491,077	1,559,129	1,627,180	1,695,232	1,695,232	
Total Cost (w/ escalation, mgt reserve, & contingency)						161,450	165,971	129,874	103,708	231,658	238,144	244,812	0	4,139,117
Cumulative Total LCC (escalated)						3,024,951	3,190,921	3,320,795	3,424,503	3,656,160	3,894,305	4,139,117	4,139,117	
discount factor @ OMB discount rate of		6.30%		for escalated costs		6.646	7.064	7.509	7.982	8.485	9.020	9.588	10.192	
Discounted Annual Cost						$24,294	$23,495	$17,295	$12,992	$27,301	$26,402	$25,533	$0	1,140,469
Cumulative Discounted LCC						1,007,451	1,030,945	1,048,240	1,061,233	1,088,534	1,114,936	1,140,469	1,140,469	


TOTAL ANNUAL COST (escalated)
DIRECT CEMENTITIOUS WASTE 20YR. FACILTY
DOLLARS (X1000)
300,000
250,000
200,000
150,000
100,000
50,000
0
1
5
9
13
17
21
25
29
33
37
YEARS


CUMLATIVE DISCOUNTED LCC
DIRECT CEMENTITIOUS WASTE 20YR. FACILITY
DOLLARS (X1000)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1
5
9
13
17
21
25
29
33
37
YEARS

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date:	February 2, 1998		
To:	R. E. Dafoe	MS 3765	6-6772
From:	R. J. Turk	MS 3875	6-3611
Subject:	ECONOMIC AND LIFE CYCLE ANALYSIS CONDUCTED for the DIRECT CEMENTITIOUS WASTE FIVE-YEAR OPTION-RJT-12-98		

Purpose:

As requested an Economic and Life-Cycle Cost (LCC) has been conducted to evaluate the NON-SEPARATIONS DIRECT CEMENTITIOUS WASTE FIVE-YEAR OPTION (DCWO). This process is proposed to treat the ICPP Spent Nuclear Fuel (SNF) high level waste (HLW) calcine into a form suitable for final disposition. The DCWO facility will include a calcine receiving system, grouting material receiving and handling system, a blending system, a grouting process, product lag storage, an off-gas treatment system with supporting utilities system.

This economic analysis is based on information provided by Sara Gifford, Randy Heyrend, Sylvester Losinski, Jila Banaee, Ross Johnson, Ron Averill, Byron Blakely, John Duggan and other team members. Terry Sivill and Sue Bradford provided cost estimates. Dianne Stoddard provided process personnel modeling.

Methodology:

The Economic Evaluation assumed a 20-year period (2001-2020) since this is the estimated time required to complete all of the anticipated remediation activities. The LCC identifies evaluated the initial development, construction, operation and post-operation costs over the life-cycle. A discounted LCC analysis assumes a current-dollar basis, discounted to 1998 using a 6.30% discount rate per the Office of Management and Budget (OMB) Circular A-94. All costs are conservatively discounted assuming the end-of-year convention.

Assumptions:

The scope of work and requirements of all related activities are vague at this time. Facility and processing costs were developed from historical experience associated with DD&D work at the

INEEL. The LCC analysis was generated to match Cost Estimating's 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 six years with construction completed in four years, followed by two 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 three-years of post-operations activities. Utilities were assumed to cost $0.0824/kwh for the facility. Grouting material and Calcine Clay were assumed to cost $150/ton. Due to this projects 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.

Results:

The Five-year Direct Cementitious Option has a Discounted LCC of $1.324 billion.

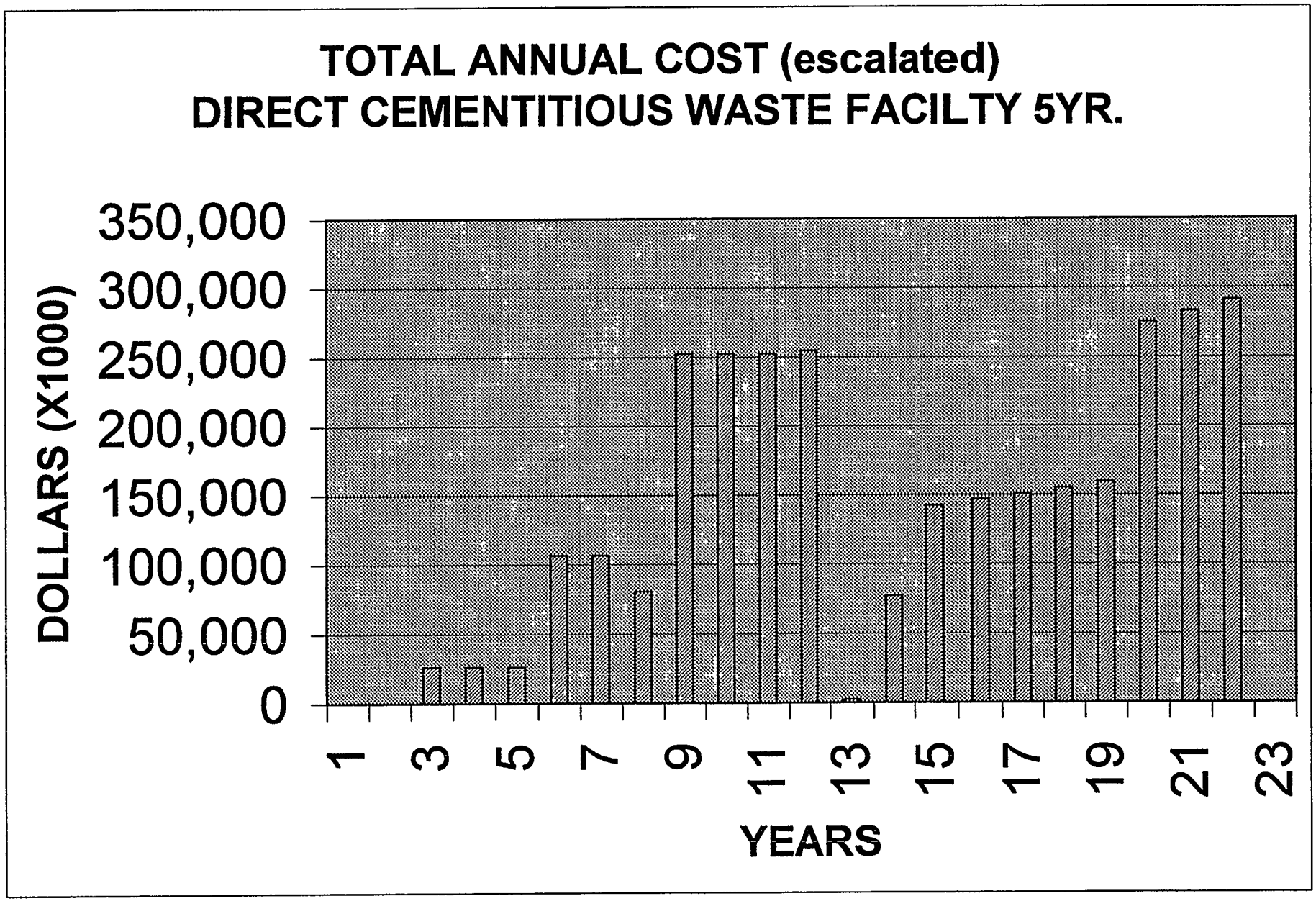
Attachments:

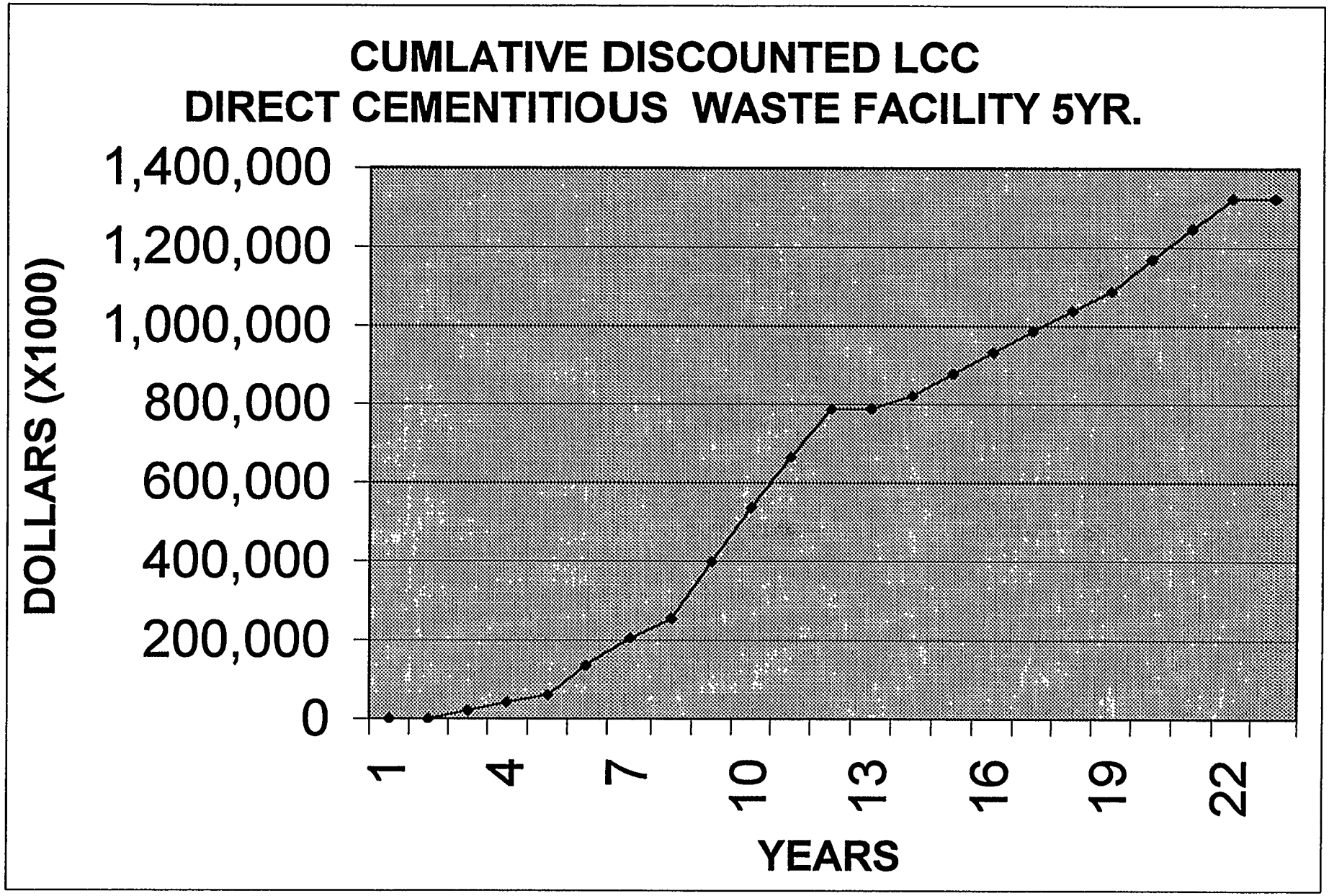
cc: R. J. Turk File

DIRECT CEMENTITIOUS WASTE OPTION-5yr.						fical year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Life-Cycle Cost (LCC) Analysis						counting year	1	2	3	4	5	6	7	8	9	10
(ALL COST X1000)						Escalation Factor	1.024	1.053	1.082	1.112	1.144	1.176	1.209	1.242	1.277	1.313
Other Project Cost (OPC)																
OPC unescalated																
Conceptual Design, Project Mgt, & Permitting									16,680	16,680	16,680	16,680	16,680			
Testing and Start-up																
Total OPC (unescalated)							0	0	16,680	16,680	16,680	16,680	16,680	0	0	0
plus escalation of							0	0	2,449	2,449	2,449	2,449	2,449	0	0	0
plus management reserve of							0	0	169	169	169	169	169	0	0	0
plus contingency of							0	0	6,716	6,716	6,716	6,716	6,716	0	0	0
Total OPC including escalation, mgt reserve, & contingency							0	0	26,014	26,014	26,014	26,014	26,014	0	0	0
Total Estimated Cost (TEC)																
TEC unescalated														0	0	0
Title Design, Inspection												37,500	37,500	37,500		
Project mgt												6,429	6,429	6,429	6,429	6,429
Construction Mgt															11,250	11,250
Construction, Equip, G&A & Procurement															119,969	119,969
Total TEC (unescalated)							0	0	0	0	0	43,929	43,929	43,929	137,647	137,647
plus escalation of							0	0	0	0	0	13,922	13,922	13,922	43,623	43,623
plus management reserve of							0	0	0	0	0	4,140	4,140	4,140	12,971	12,971
plus contingency of							0	0	0	0	0	18,480	18,480	18,480	57,906	57,906
Total TEC including escalation, mgt reserve, contingency							0	0	0	0	0	80,470	80,470	80,470	252,147	252,147
Total Project Cost (TPC)																
TPC unescalated							0	0	16,680	16,680	16,680	60,609	60,609	43,929	137,647	137,647
plus escalation of							0	0	2,449	2,449	2,449	16,371	16,371	13,922	43,623	43,623
plus management reserve of							0	0	169	169	169	4,309	4,309	4,140	12,971	12,971
plus contingency of							0	0	6,716	6,716	6,716	25,196	25,196	18,480	57,906	57,906
Total TPC including esc, mgt res, contingency							0	0	26,014	26,014	26,014	106,484	106,484	80,470	252,147	252,147
Operations	2080 hr-shift/yr.															
Facility/Administration	37															
Managers		4	FTE @	$125	/hr.											
Engineers		7	FTE @	$108	/hr.											
Other Tech.		16	FTE @	$85	/hr.											
Administration/Support		10	FTE @	$65	/hr.											
Operations/Process Facility	120															
Managers		11	FTE @	$125	/hr.											
Engineers		7	FTE @	$108	/hr.											
Other Tech.		16	FTE @	$85	/hr.											
Supervisors		9	FTE @	$85	/hr.											
Administration/Support		2	FTE @	$65	/hr.											
Operators		45	FTE @	$65	/hr.											
Maintenance		30	FTE @	$65	/hr.											
Procurement		16000	units	$10,000	ea.											
Calcine Clay		13,300	ton	$150.00	/kg											
Blast Furnace Slag		1,500	ton	$150.00	/kg											
Utilities		5,475,000	kwh/yr	$0.082	/SF											
Maintenance of Equipment		8.00%	of	479,874												
Operations subtotal (unescalated)							0	0	0	0	0	0	0	0	0	0
plus Escalation							0	0	0	0	0	0	0	0	0	0
plus Operations Contingency @		30.0%					0	0	0	0	0	0	0	0	0	0
Total Operations (w/ escalation & contingency)							0	0	0	0	0	0	0	0	0	0
Post Operations																
Decommission		20.00%	of	Engineering costs												
Decontamination		5.00%	of	Pre-operation Costs												
Demolition		8.00%	of	Pre-operation Costs												
Post-Operations Subtotal (unescalated)							0	0	0	0	0	0	0	0	0	0
plus Escalation							0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		30.0%					0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)							0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)							0	0	16,680	16,680	16,680	60,609	60,609	43,929	137,647	137,647
Cumulative Total LCC (unescalated)							0	0	16,680	33,360	50,040	110,649	171,257	215,186	352,833	490,480
Total Cost (w/ escalation, mgt reserve, & contingency)							0	0	26,014	26,014	26,014	106,484	106,484	80,470	252,147	252,147
Cumulative Total LCC (escalated)							0	0	26,014	52,028	78,041	184,525	291,009	371,479	623,627	875,774
discount factor @ OMB discount rate of		6.30%		for escalated costs			1.063	1.130	1.201	1.277	1.357	1.443	1.534	1.630	1.733	1.842
Discounted Annual Cost							$0	$0	$21,657	$20,374	$19,166	$73,805	$69,431	$49,359	$145,497	$136,874
Cumulative Discounted LCC							0	0	21,657	42,031	61,197	135,002	204,433	253,792	399,289	536,164

DIRECT CEMENTITIOUS WASTE OPTION-5yr. Life-Cycle Cost (LCC) Analysis (ALL COST X1000)					fical year counting year Escalation Factor	2009 11 1.350	2010 12 1.387	2011 13 1.426	2012 14 1.466	2013 15 1.507	2014 16 1.550	2015 17 1.593	2016 18 1.638	2017 19 1.683	2018 20 1.730
Other Project Cost (OPC)															
OPC unescalated															
Conceptual Design, Project Mgt, & Permitting															
Testing and Start-up							1,581	1,581							
Total OPC (unescalated)						0	1,581	1,581	0	0	0	0	0	0	0
plus escalation of						0	232	232	0	0	0	0	0	0	0
plus management reserve of						0	16	16	0	0	0	0	0	0	0
plus contingency of						0	637	637	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						0	2,465	2,465	0	0	0	0	0	0	0
Total Estimated Cost (TEC)															
TEC unescalated						0									
Title Design, Inspection															
Project mgt						6,429	6,429								
Construction Mgt						11,250	11,250								
Construction, Equip, G&A & Procurement						119,969	119,969								
Total TEC (unescalated)						137,647	137,647	0	0	0	0	0	0	0	0
plus escalation of						43,623	43,623	0	0	0	0	0	0	0	0
plus management reserve of						12,971	12,971	0	0	0	0	0	0	0	0
plus contingency of						57,906	57,906	0	0	0	0	0	0	0	0
Total TEC including escalation, mgt reserve, contingency						252,147	252,147	0	0	0	0	0	0	0	0
Total Project Cost (TPC)															
TPC unescalated						137,647	139,228	1,581	0	0	0	0	0	0	0
plus escalation of						43,623	43,855	232	0	0	0	0	0	0	0
plus management reserve of						12,971	12,987	16	0	0	0	0	0	0	0
plus contingency of						57,906	58,543	637	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency						252,147	254,613	2,465	0	0	0	0	0	0	0
Operations	2080 hr-shift/yr.														
Facility/Administration	37														
Managers		4	FTE @	$125	/ hr.				520	1,040	1,040	1,040	1,040	1,040	
Engineers		7	FTE @	$108	/ hr.				786	1,572	1,572	1,572	1,572	1,572	
Other Tech.		16	FTE @	$85	/ hr.				1,414	2,829	2,829	2,829	2,829	2,829	
Administration/Support		10	FTE @	$65	/ hr.				676	1,352	1,352	1,352	1,352	1,352	
Operations/Process Facility	120														
Managers		11	FTE @	$125	/ hr.				1,430	2,860	2,860	2,860	2,860	2,860	
Engineers		7	FTE @	$108	/ hr.				786	1,572	1,572	1,572	1,572	1,572	
Other Tech.		16	FTE @	$85	/ hr.				1,414	2,829	2,829	2,829	2,829	2,829	
Supervisors		9	FTE @	$85	/ hr.				796	1,591	1,591	1,591	1,591	1,591	
Administration/Support		2	FTE @	$65	/ hr.				135	270	270	270	270	270	
Operators		45	FTE @	$65	/ hr.				3,042	6,084	6,084	6,084	6,084	6,084	
Maintenance		30	FTE @	$65	/ hr.				2,028	4,056	4,056	4,056	4,056	4,056	
Procurement		16000	units	$10,000	ea.				8,000	8,000	8,000	8,000	8,000	8,000	
Calcine Clay		13,300	ton	$150.00	/ kg				50	100	100	100	100	100	
Blast Furnace Slag		1,500	ton	$150.00	/ kg				6	11	225	225	225	225	
Utilities		5,475,000	kwh/yr	$0.082	/ SF				11	23	23	23	23	23	
Maintenance of Equipment		6.00%	of	479,874					19,195	38,390	38,390	38,390	38,390	38,390	
Operations subtotal (unescalated)						0	0	0	40,290	72,580	72,793	72,793	72,793	72,793	0
plus Escalation						0	0	0	18,785	36,821	40,001	43,180	46,406	49,744	0
plus Operations Contingency @		30.0%				0	0	0	17,723	32,820	33,838	34,786	35,760	36,761	0
Total Operations (w/ escalation & contingency)						0	0	0	76,798	142,220	146,633	150,739	154,960	159,298	0
Post Operations															
Decommission		20.00%	of	Engineering costs											22,500
Decontamination		5.00%	of	Pre-operation Costs											38,447
Demolition		8.00%	of	Pre-operation Costs											61,515
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	122,462
plus Escalation						0	0	0	0	0	0	0	0	0	89,457
plus Post-Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	63,576
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	275,494
Total Cost (unescalated)						137,647	139,228	1,581	40,290	72,580	72,793	72,793	72,793	72,793	122,462
Cumulative Total LCC (unescalated)						628,127	767,355	768,936	809,226	881,806	954,599	1,027,393	1,100,186	1,172,979	1,295,441
Total Cost (w/ escalation, mgt reserve, & contingency)						252,147	254,613	2,465	76,798	142,220	146,633	150,739	154,960	159,298	275,494
Cumulative Total LCC (escalated)						1,127,922	1,382,535	1,385,000	1,461,798	1,604,018	1,750,651	1,901,390	2,056,350	2,215,648	2,491,143
discount factor @ OMB discount rate of		6.30%		for escalated costs		1.958	2.082	2.213	2.352	2.500	2.658	2.825	3.003	3.193	3.394
Discounted Annual Cost						$128,762	$122,315	$1,114	$32,650	$56,880	$55,170	$53,353	$51,598	$49,898	$81,180
Cumulative Discounted LCC						664,926	787,241	788,356	821,006	877,886	933,056	986,409	1,038,005	1,087,903	1,169,082

DIRECT CEMENTITIOUS WASTE OPTION-5yr. Life-Cycle Cost (LCC) Analysis (ALL COST X1000)					fical year counting year Escalation Factor	2019 21 1.779	2020 22 1.829	2021 23 1.880	Total Cost
Other Project Cost (OPC)									
OPC unescalated									
Conceptual Design, Project Mgt, & Permitting									83,400
Testing and Start-up									3,182
Total OPC (unescalated)						0	0	0	86,582
plus escalation of						0	0	0	12,708
plus management reserve of						0	0	0	877
plus contingency of						0	0	0	34,853
Total OPC including escalation, mgt reserve, & contingency						0	0	0	135,000
Total Estimated Cost (TEC)									
TEC unescalated									
Title Design, Inspection									112,500
Project mgt									45,000
Construction Mgt									45,000
Construction, Equip, G&A & Procurement									479,874
Total TEC (unescalated)						0	0	0	682,374
plus escalation of						0	0	0	216,257
plus management reserve of						0	0	0	64,303
plus contingency of						0	0	0	287,065
Total TEC including escalation, mgt reserve, contingency						0	0	0	1,250,000
Total Project Cost (TPC)									
TPC unescalated						0	0	0	768,936
plus escalation of						0	0	0	228,965
plus management reserve of						0	0	0	65,181
plus contingency of						0	0	0	321,918
Total TPC including esc, mgt res, contingency						0	0	0	1,385,000
Operations	2080 hr-shift/yr.								
Facility/Administration	37								
Managers		4	FTE @	$125	/ hr.				5,720
Engineers		7	FTE @	$108	/ hr.				8,649
Other Tech.		16	FTE @	$85	/ hr.				15,558
Administration/Support		10	FTE @	$65	/ hr.				7,436
Operations/Process Facility	120								0
Managers		11	FTE @	$125	/ hr.				15,730
Engineers		7	FTE @	$108	/ hr.				8,649
Other Tech.		16	FTE @	$85	/ hr.				15,558
Supervisors		9	FTE @	$85	/ hr.				6,752
Administration/Support		2	FTE @	$65	/ hr.				1,487
Operators		45	FTE @	$65	/ hr.				33,462
Maintenance		30	FTE @	$65	/ hr.				22,308
Procurement		16000	units	$10,000	ea.				48,000
Calcine Clay		13,300	ton	$150.00	/ kg				549
Blast Furnace Slag		1,500	ton	$150.00	/ kg				917
Utilities		5,475,000	kwh/yr	$0.082	/ SF				124
Maintenance of Equipment		8.00%	of	479,874					211,145
Operations subtotal (unescalated)						0	0	0	404,043
plus Escalation						0	0	0	234,917
plus Operations Contingency @		30.0%				0	0	0	191,688
Total Operations (w/ escalation & contingency)						0	0	0	830,648
Post Operations									
Decommission		20.00%	of	Engineering costs		22,500	22,500		67,500
Decontamination		5.00%	of	Pre-operation Costs		38,447	38,447		115,340
Demolition		8.00%	of	Pre-operation Costs		61,515	61,515		184,545
Post-Operations Subtotal (unescalated)						122,462	122,462	0	367,385
plus Escalation						95,391	101,491	0	286,339
plus Post-Operations Contingency @		30.0%				65,356	67,186	0	196,117
Total Post-Operations (w/ escalation & contingency)						283,208	291,138	0	849,841
Total Cost (unescalated)						122,462	122,462	0	1,540,365
Cumulative Total LCC (unescalated)						1,417,903	1,540,365	1,540,365	
Total Cost (w/ escalation, mgt reserve, & contingency)						283,208	291,138	0	3,065,489
Cumulative Total LCC (escalated)						2,774,351	3,065,489	3,065,489	
discount factor @ OMB discount rate of		6.30%		for escalated costs		3.607	3.835	4.076	
Discounted Annual Cost						$78,507	$75,922	$0	1,323,511
Cumulative Discounted LCC						1,247,589	1,323,511	1,323,511	


TOTAL ANNUAL COST (escalated)
DIRECT CEMENTITIOUS WASTE FACILTY 5YR.
DOLLARS (X1000)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1
3
5
7
9
11
13
15
17
19
21
23
YEARS


CUMLATIVE DISCOUNTED LCC
DIRECT CEMENTITIOUS WASTE FACILITY 5YR.
DOLLARS (X1000)
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1
4
7
10
13
16
19
22
YEARS

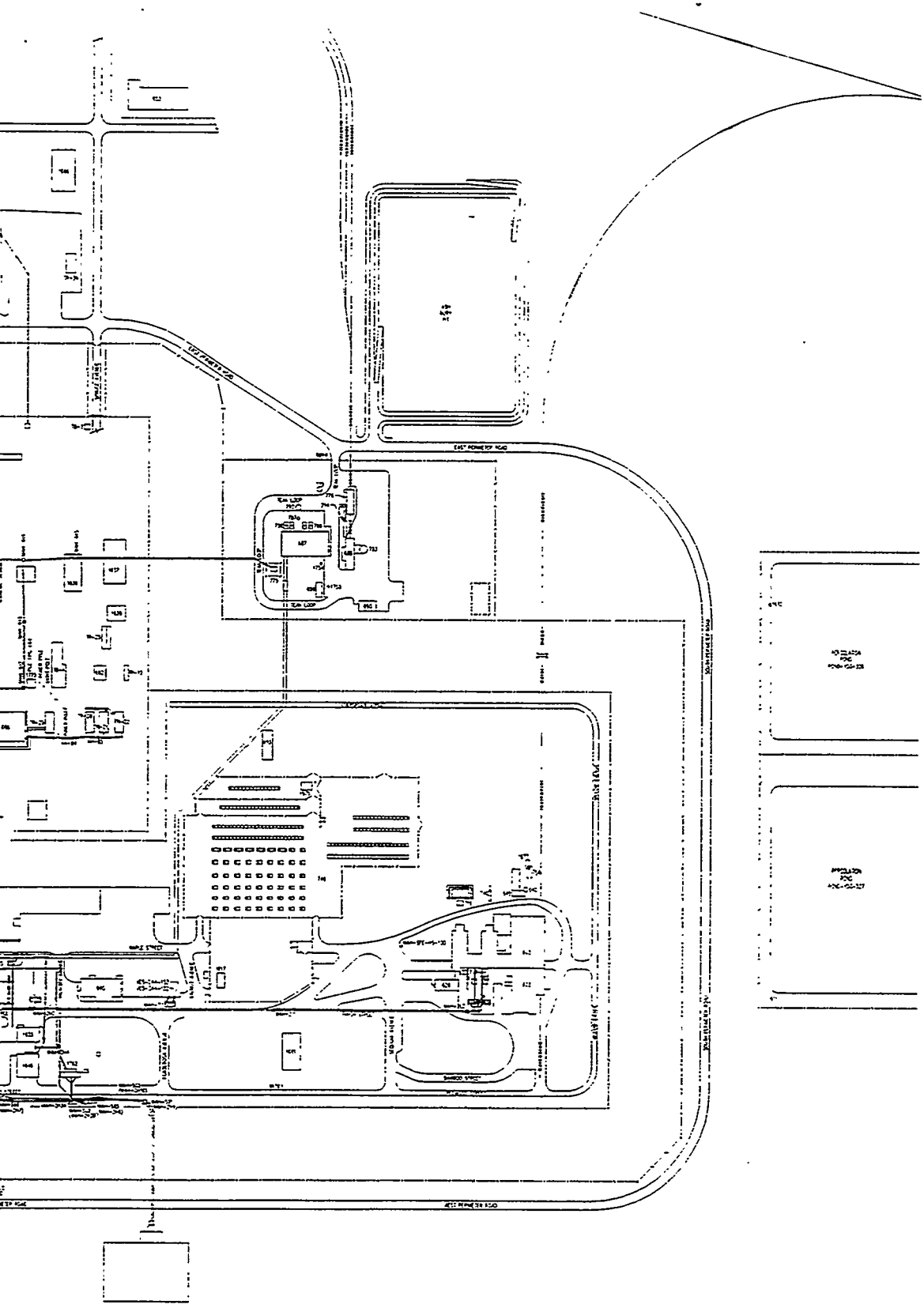
Appendix D

Drawings

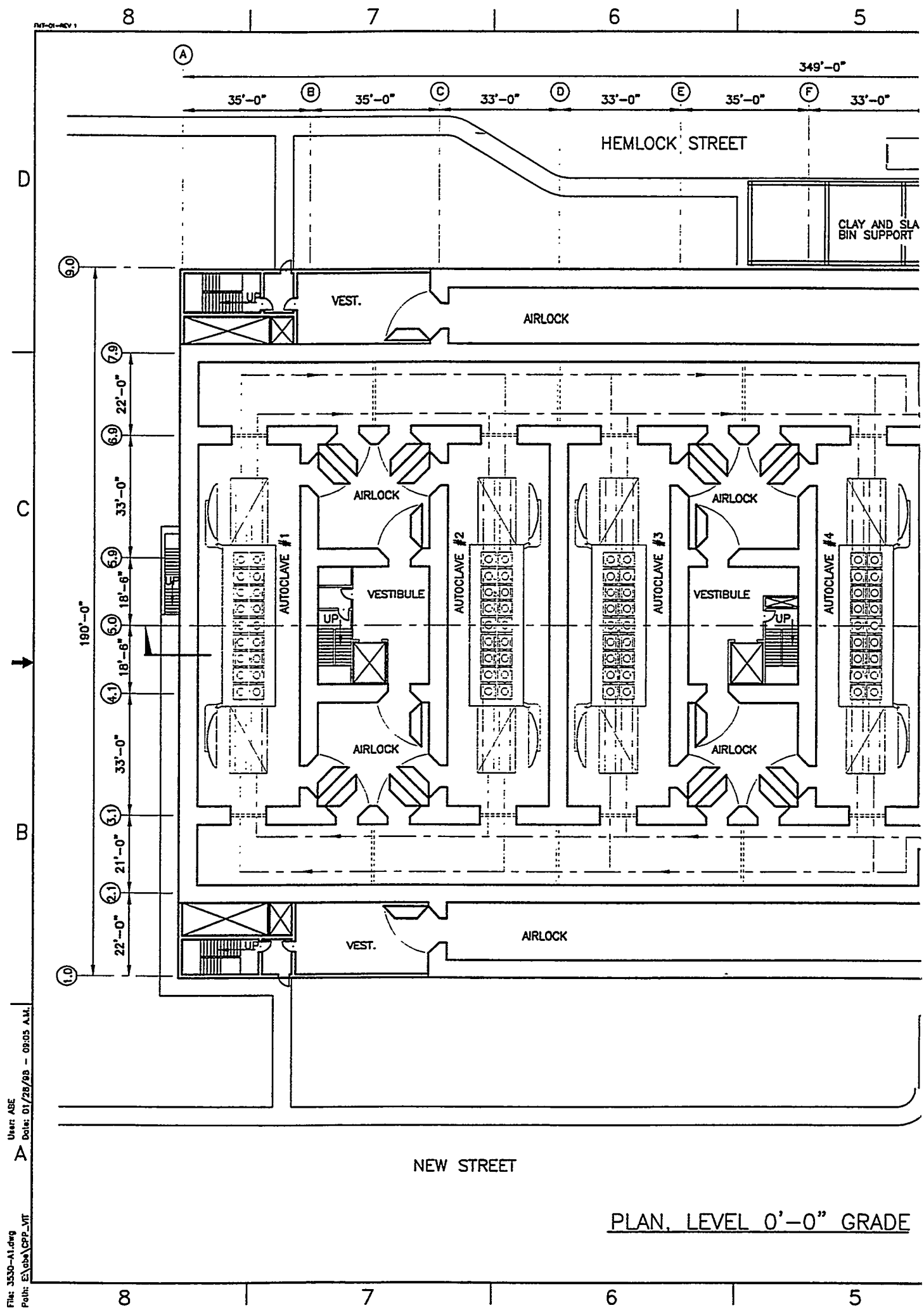
SITE PLAN

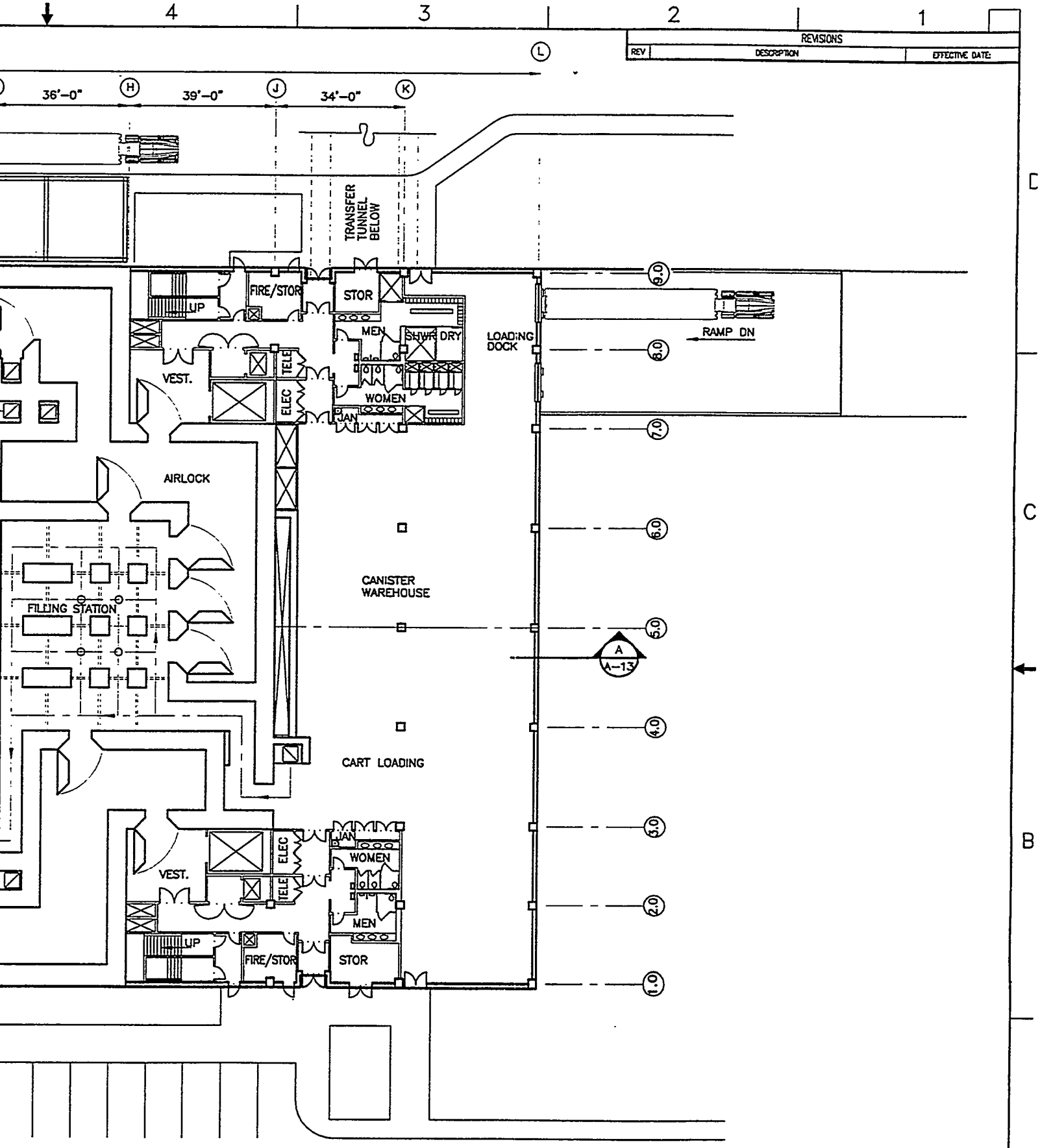
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REVISIONS		
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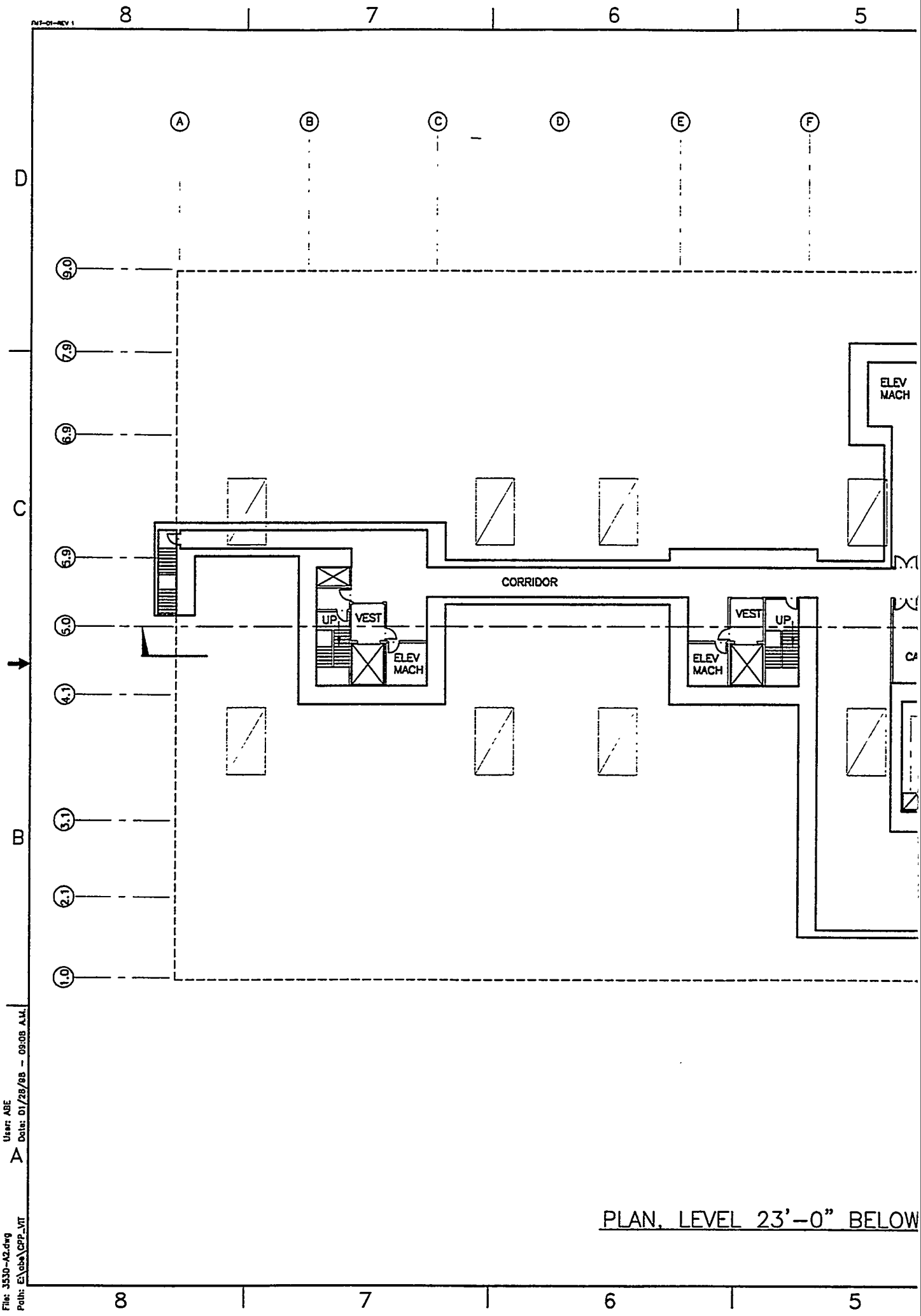
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200' 100' 50' 0 200' SCALE: 1" = 200.0'	REQUESTER:	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION
	DESIGN:	
	DRAWN:	
	PROJECT NO.	
	SPEC CODE	SITE PLAN
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D | CAGE CODE: 01MF3 | INDEX CODE NUMBER: AREA 200 | TYPE 0100 | CI 02 | ORG 530 | DWG- | REV
QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1"=200.0' | SHEET DCWO-C-1


8
7
6
5
D
C
B
A
349'-0"
35'-0"
35'-0"
33'-0"
33'-0"
35'-0"
33'-0"
HEMLOCK STREET
CLAY AND SLA
BIN SUPPORT
VEST.
AIRLOCK
UP
AUTOCLAVE #1
AUTOCLAVE #2
AUTOCLAVE #3
AUTOCLAVE #4
VESTIBULE
AIRLOCK
180'-0"
22'-0"
33'-0"
18'-6"
18'-6"
33'-0"
21'-0"
22'-0"
NEW STREET
PLAN, LEVEL 0'-0" GRADE
User: ABE
Date: 01/28/98 - 09:05 A.M.
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

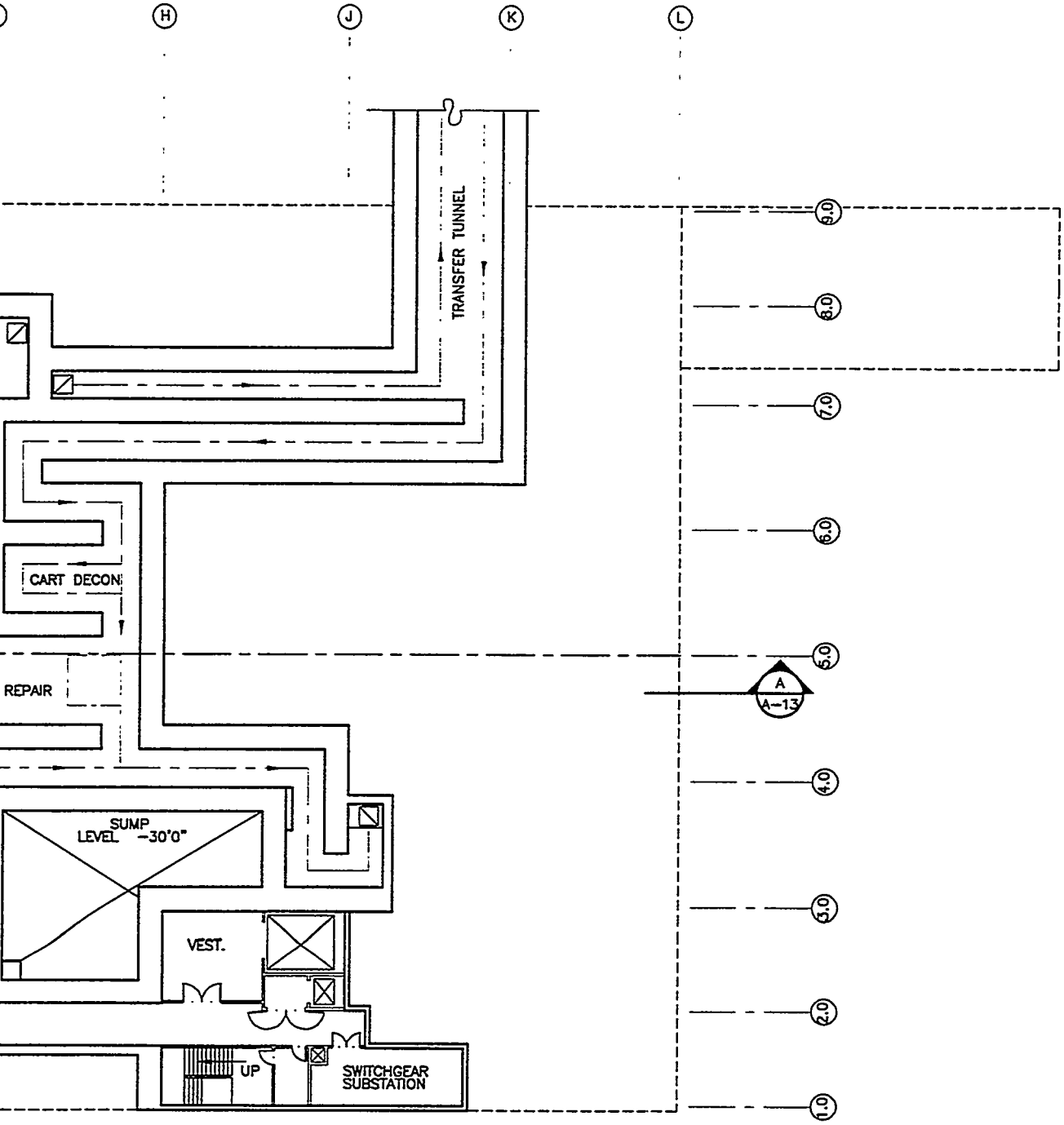
FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
SCALE: 1/16" = 1'-0"	REQUESTER:	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION GROUTING FACILITY PLAN, LEVEL 0-0" GRADE
	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / CI / DISC 530; DWG-; REV
QUALITY LEVEL: III	SEE DAR NO.	SCALE: 1/16" = 1'-0"
	EFFECTIVE DATE:	SHEET DCWO-A-1



PLAN, LEVEL 23'-0" BELOW

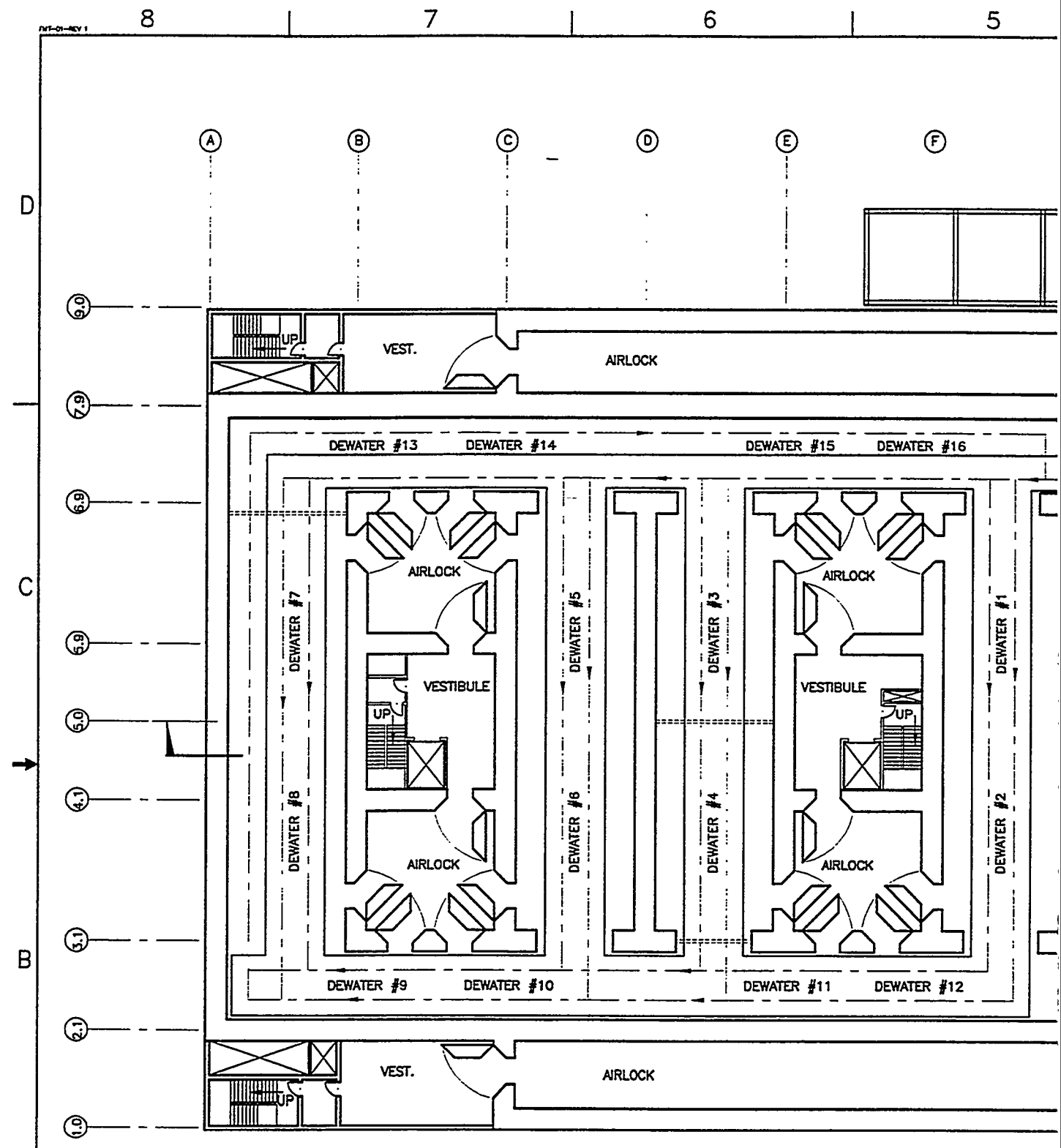
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



GRADE

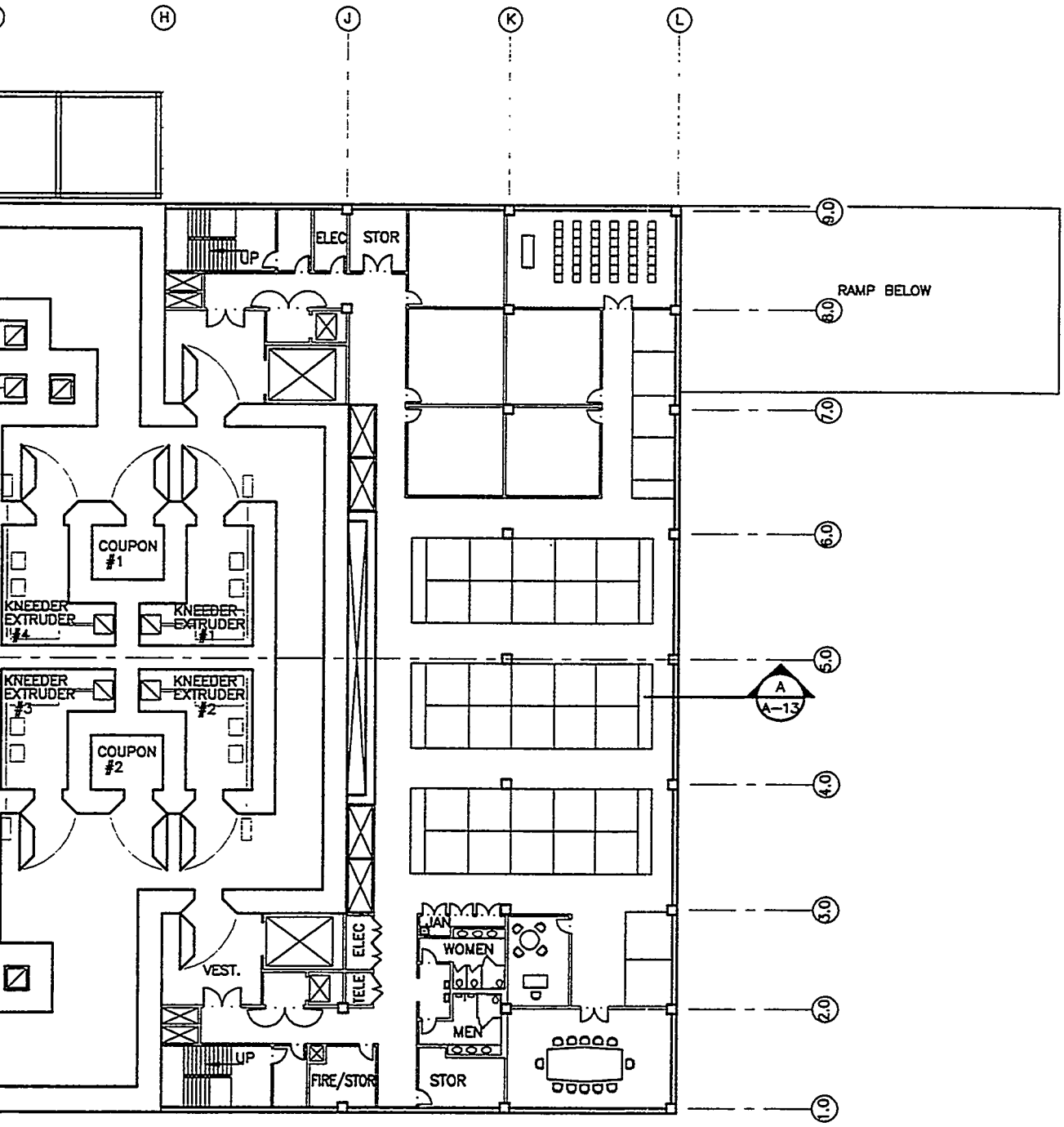
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SCALE: 1/16" = 1'-0"	REQUESTER: DESIGN: R. JOHNSON DRAWN: C.A. BEHM DEC/97 PROJECT NO. SPEC CODE	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION GROUTING FACILITY PLAN, LEVEL 23'-0" BELOW GRADE
DESIGN PHASE: SCOPING QUALITY LEVEL: III	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. EFFECTIVE DATE:	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYP / SYS / OBJ: 530; DWG-; REV SCALE: 1/16" = 1'-0"; SHEET DCWO-A-2



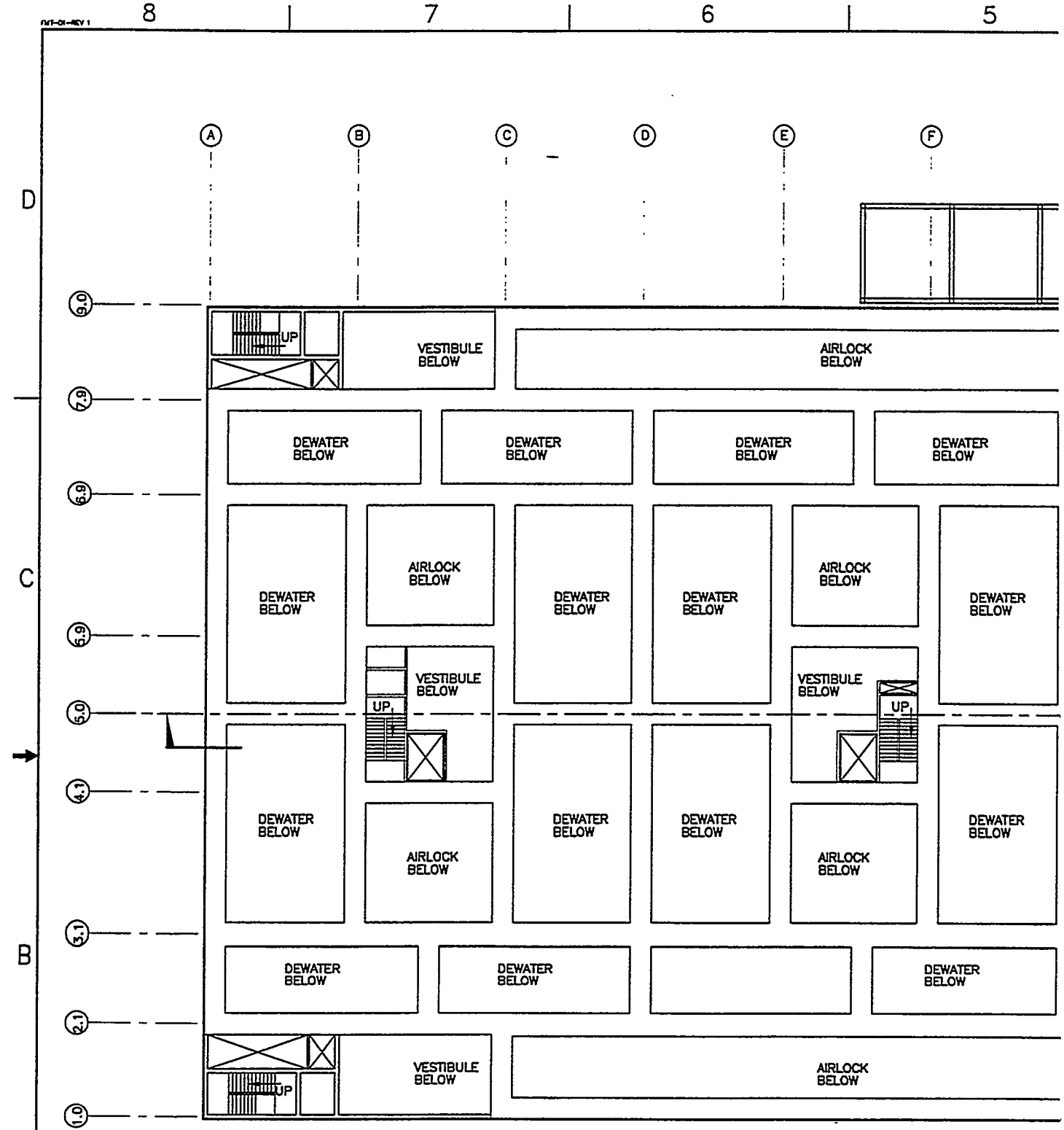
PLAN, LEVEL +27'-0"

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User: ABE
Date: 01/28/98 - 09:09 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



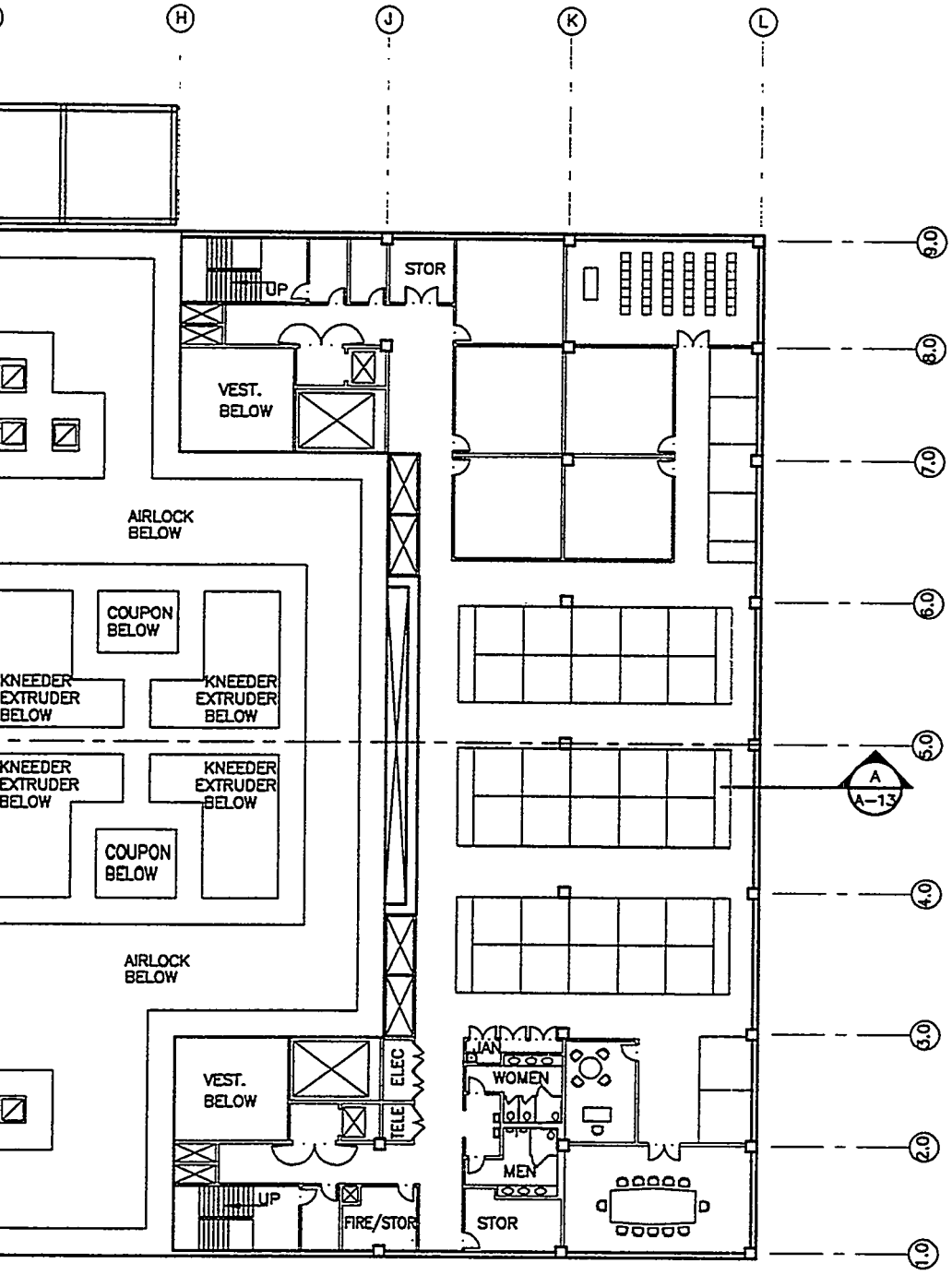
FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
1'0" 3' 5' 10' 20' SCALE: 1/16" = 1'-0"	REQUESTER: DESIGN: R. JOHNSON DRAWN: C.A. BEHM DEC/97 PROJECT NO. SPEC CODE	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION GROUTING FACILITY PLAN, LEVEL +27'-0"
DESIGN PHASE: SCOPING QUALITY LEVEL: III	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. EFFECTIVE DATE:	SIZE: D | CAGE CODE: 01MF3 | INDEX CODE NUMBER: AREA, TYPE, CI, 530 | DWG- | REV SCALE: 1/16" = 1'-0" | SHEET DCWO-A-3



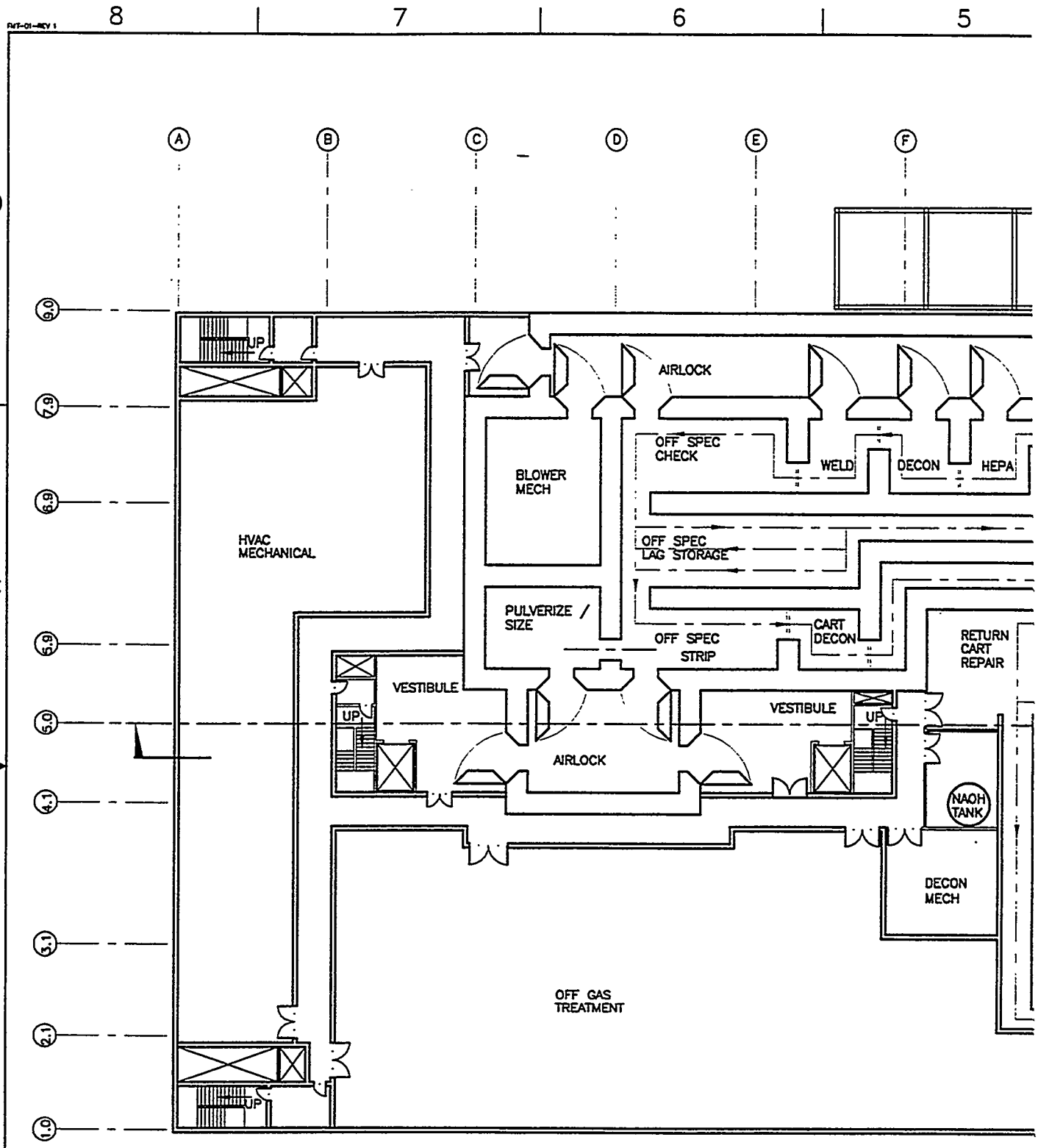
PLAN, LEVEL +40'-6"

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User: ABE
Date: 01/28/98 - 09:09 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



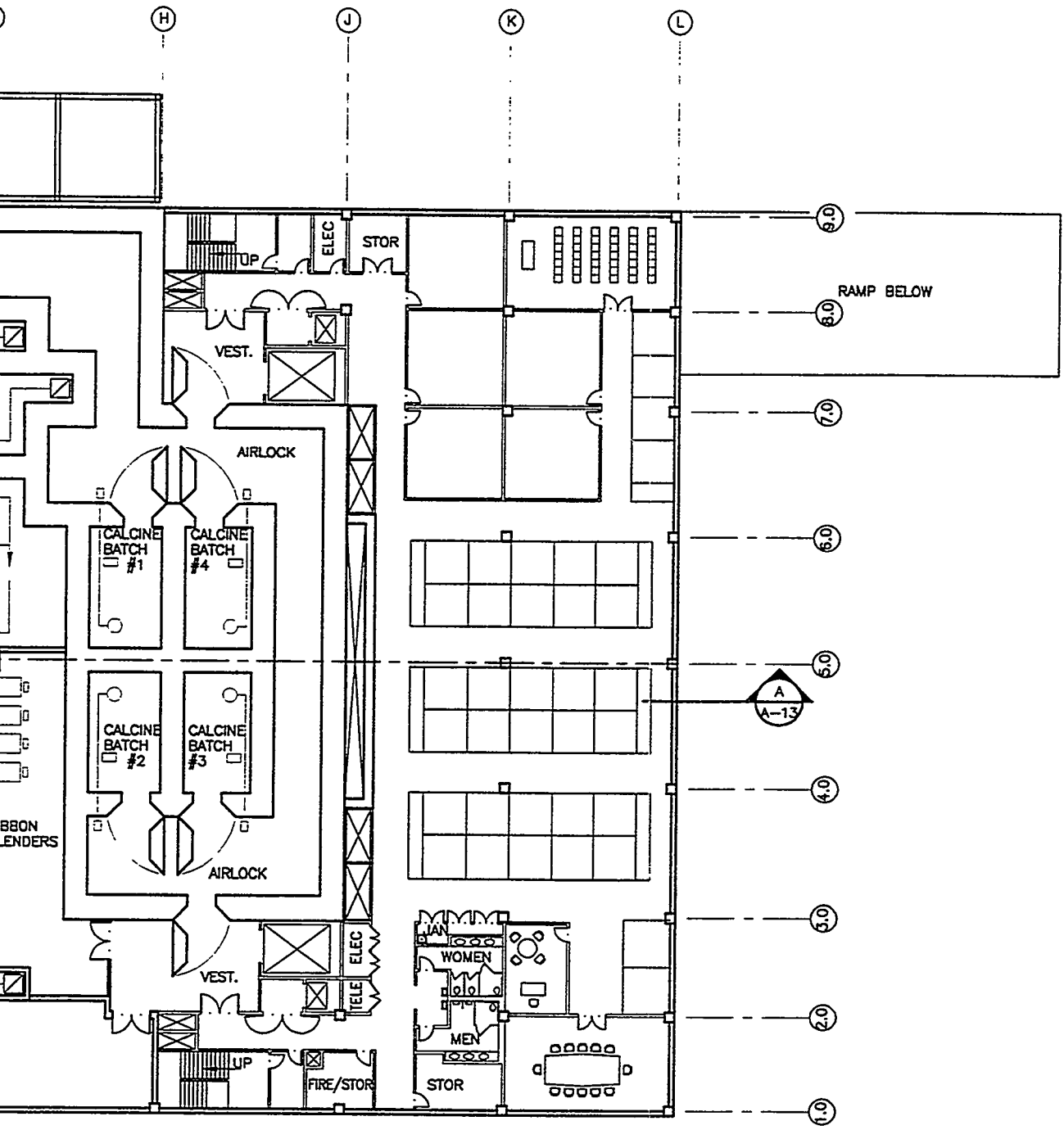
FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / CI / DISC: 530; DWG-; REV
QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1/16" = 1'-0"; SHEET DCWO-A-4



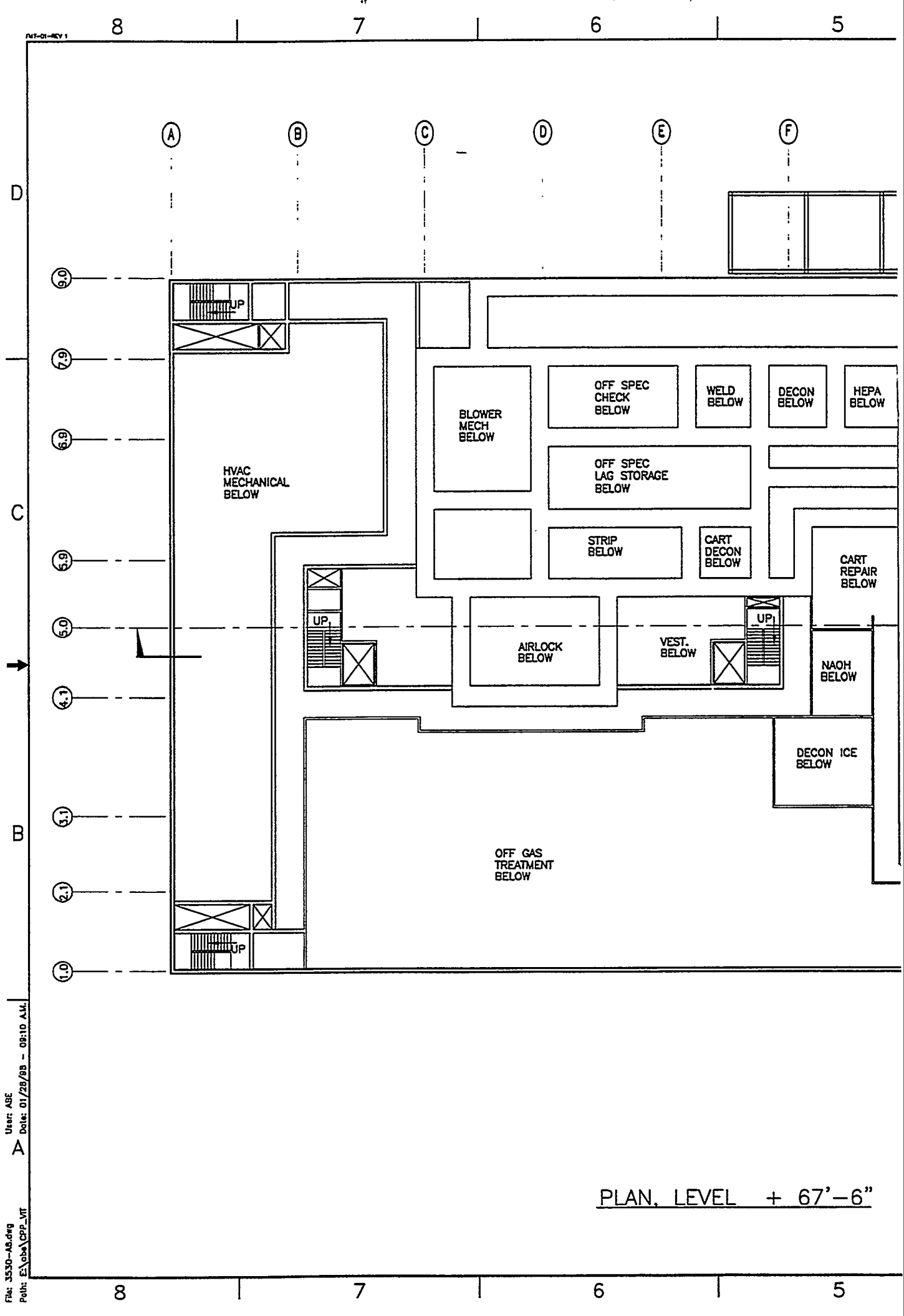
PLAN, LEVEL +54'-0"

User: ABE
Date: 01/28/98 - 09:10 A.M.
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



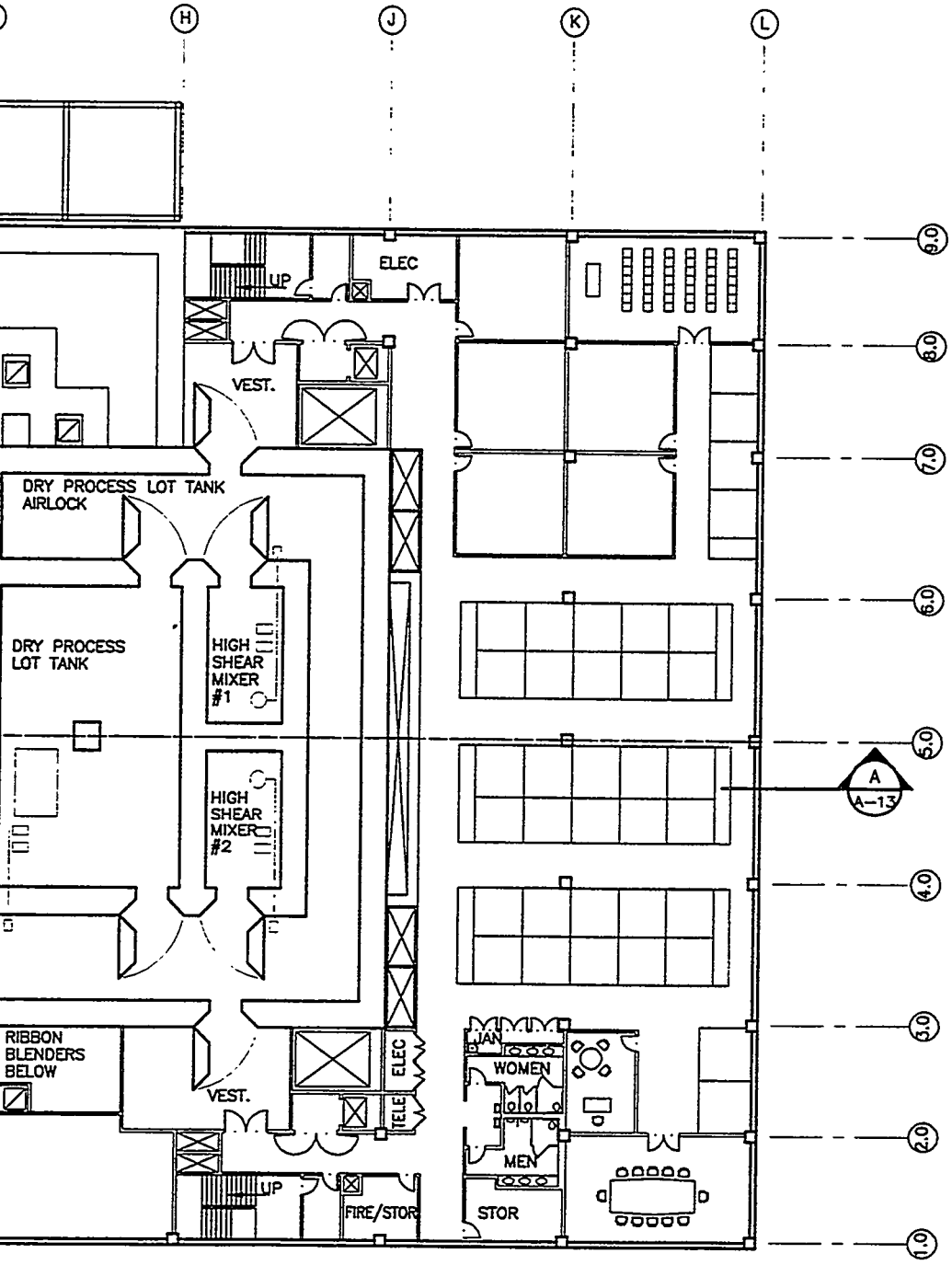
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SCALE: 1/16" = 1'-0"	REQUESTER:	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION GROUTING FACILITY PLAN, LEVEL +54'-0"
	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / Q / SEQ: 530; DWG-; REV
QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1/16" = 1'-0"; SHEET DCWO-A-5



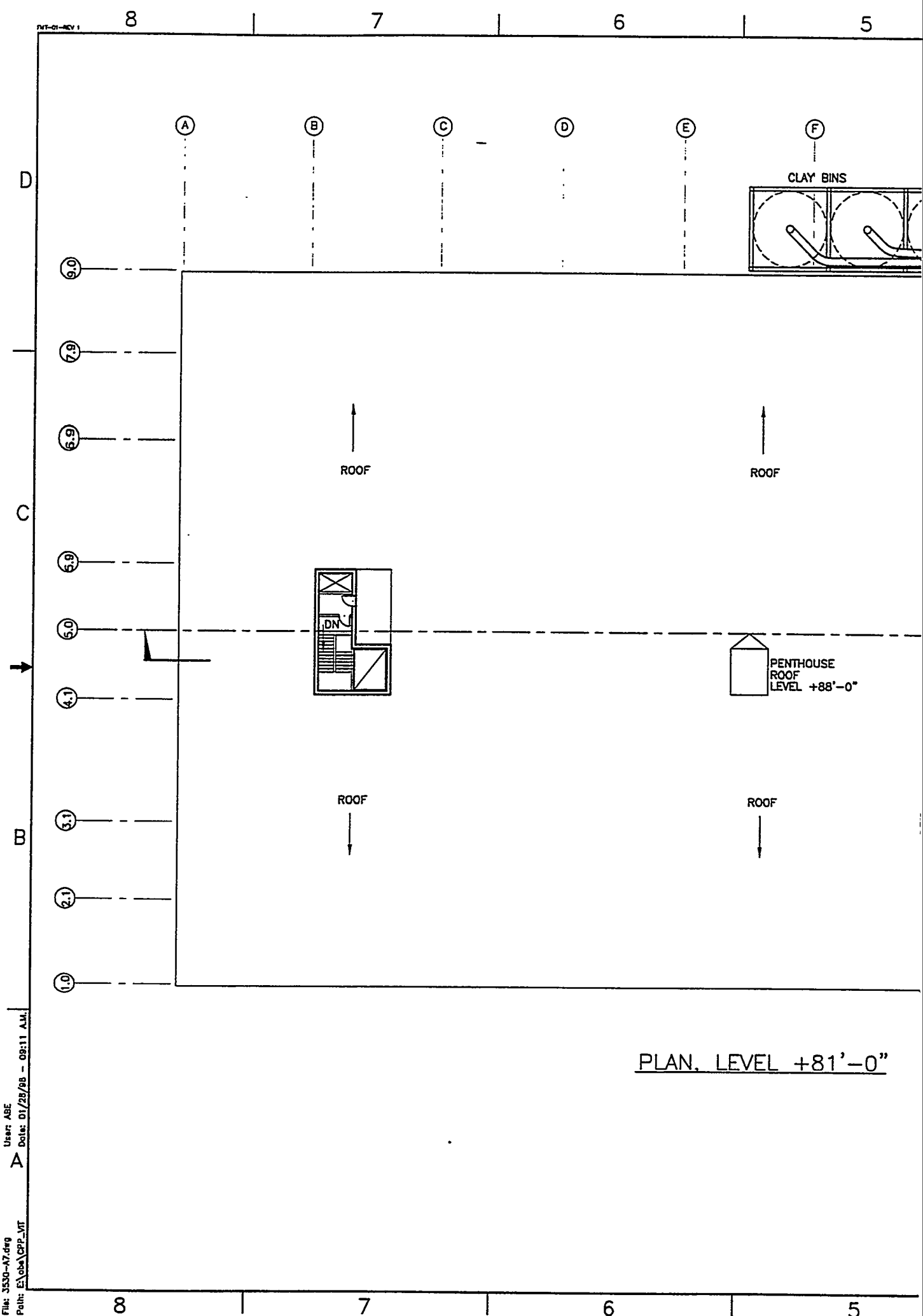
PLAN, LEVEL + 67'-6"

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User: ABE
Date: 01/28/98 - 09:10 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



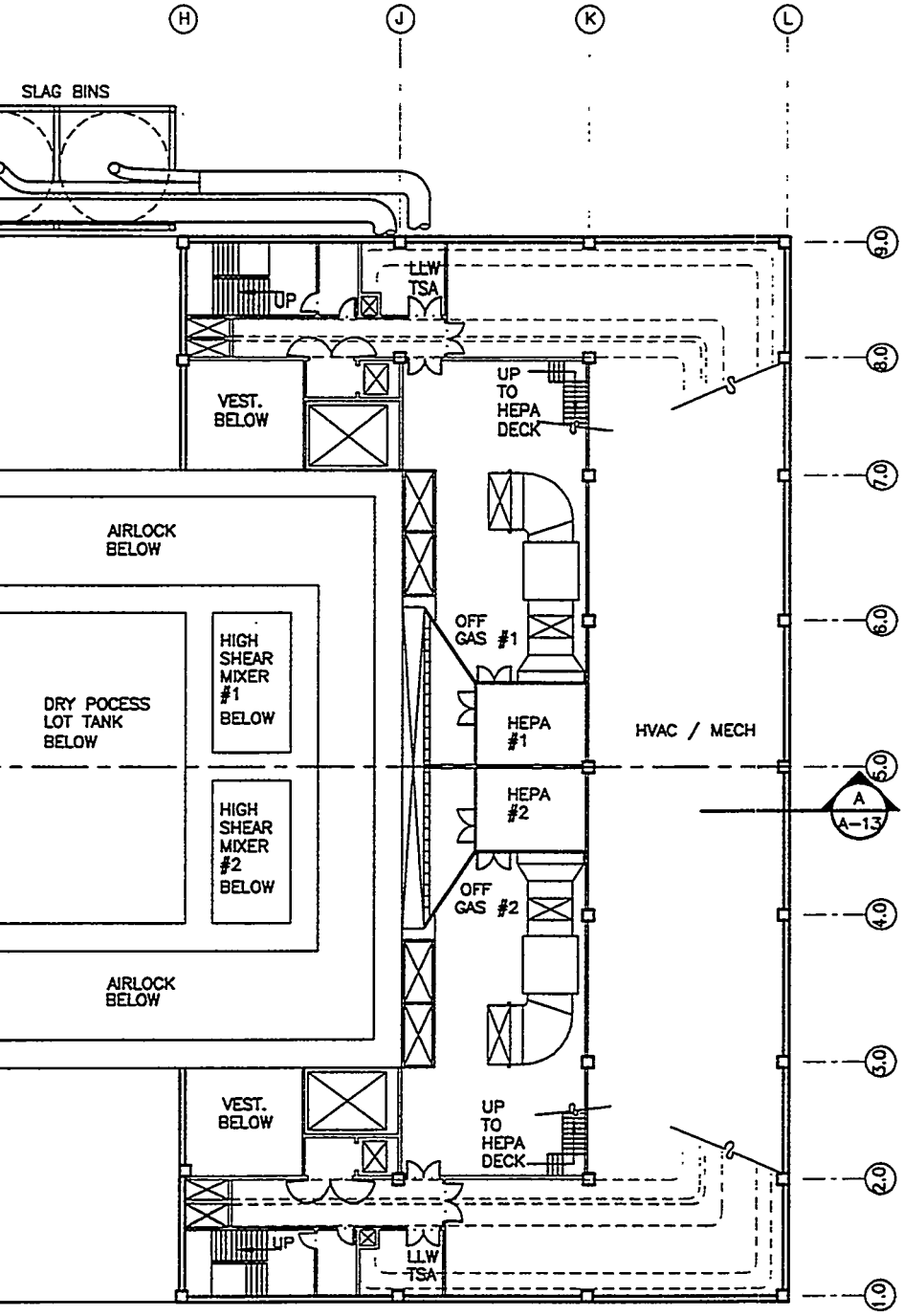
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA, TYPE, SEQ: 530; DWG-; REV
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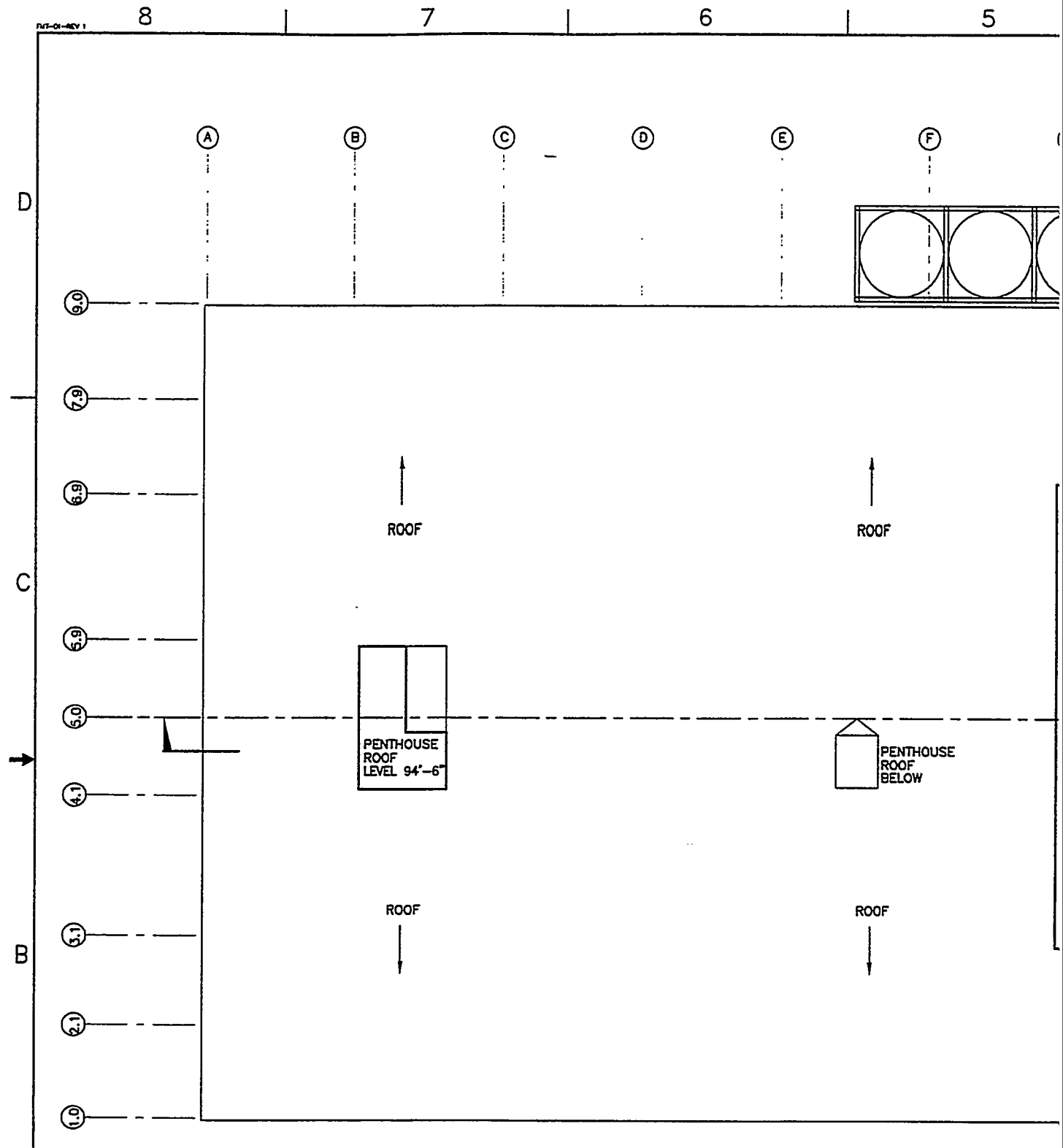
PLAN, LEVEL +81'-0"

User: ABE
Date: 01/28/98 - 09:11 A.M.
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REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



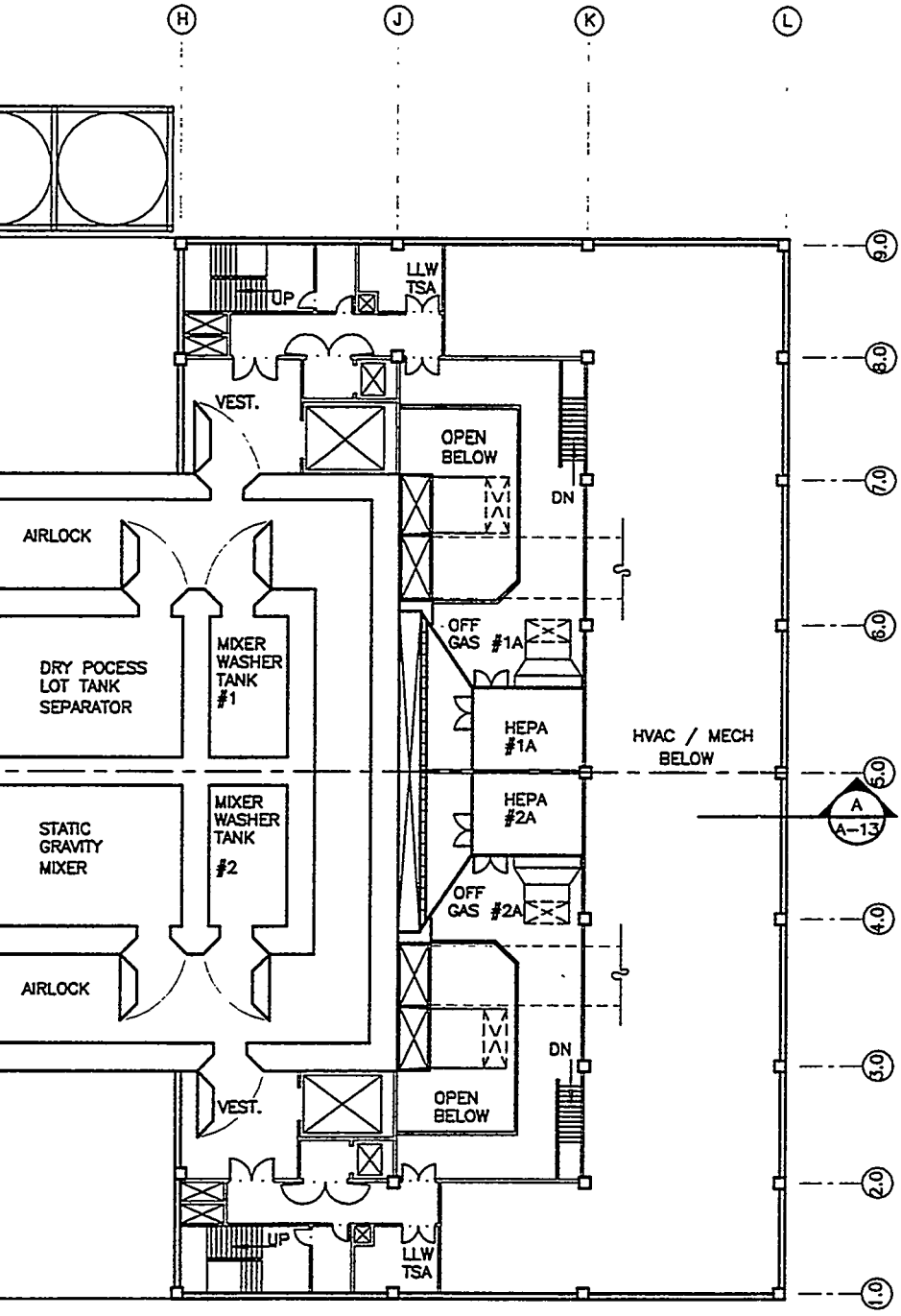
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA, TYPE, SI, ORG: 530; DWG-; REV
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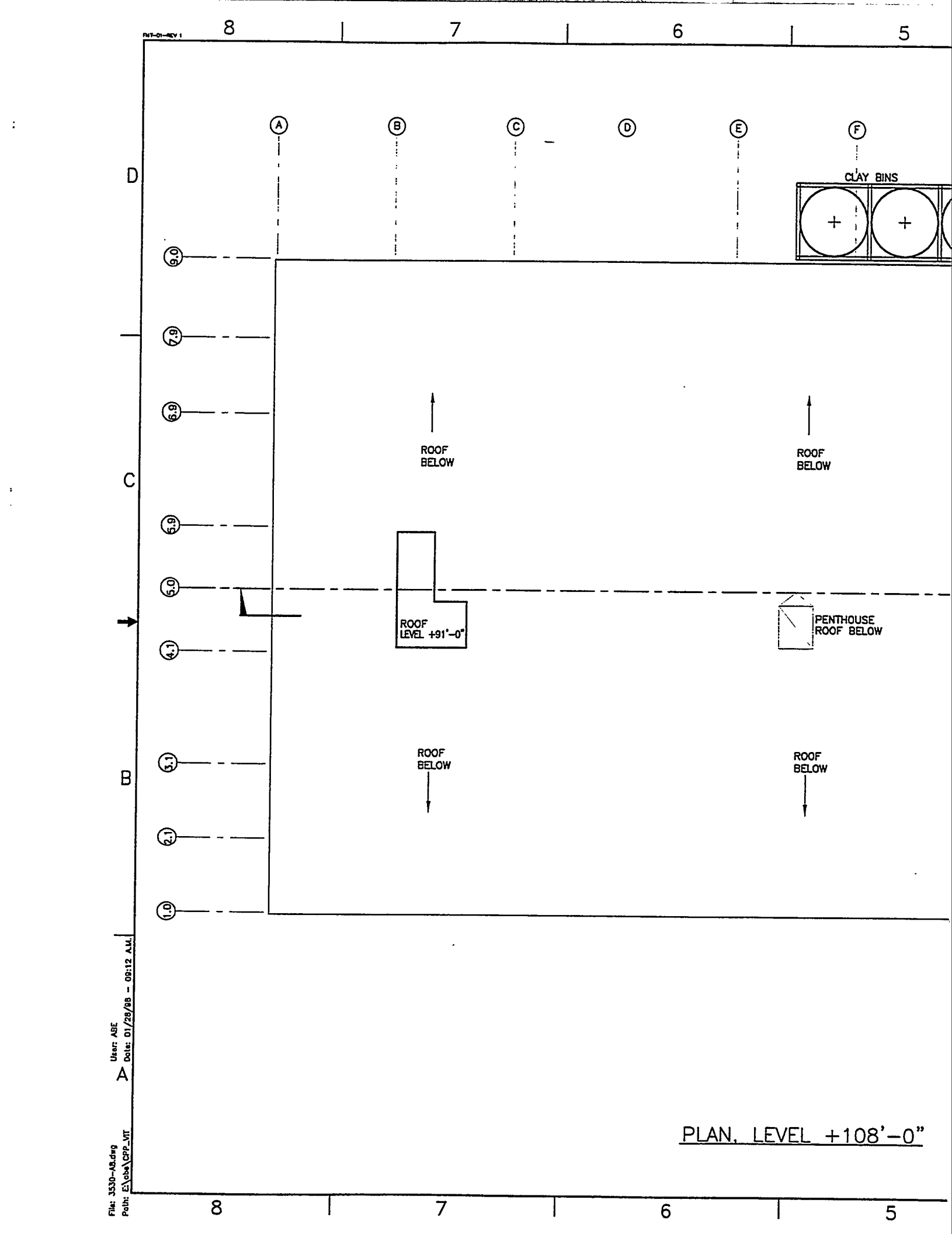
PLAN, LEVEL +94'-6"

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Date: 01/25/08 - 09:11 A.M.
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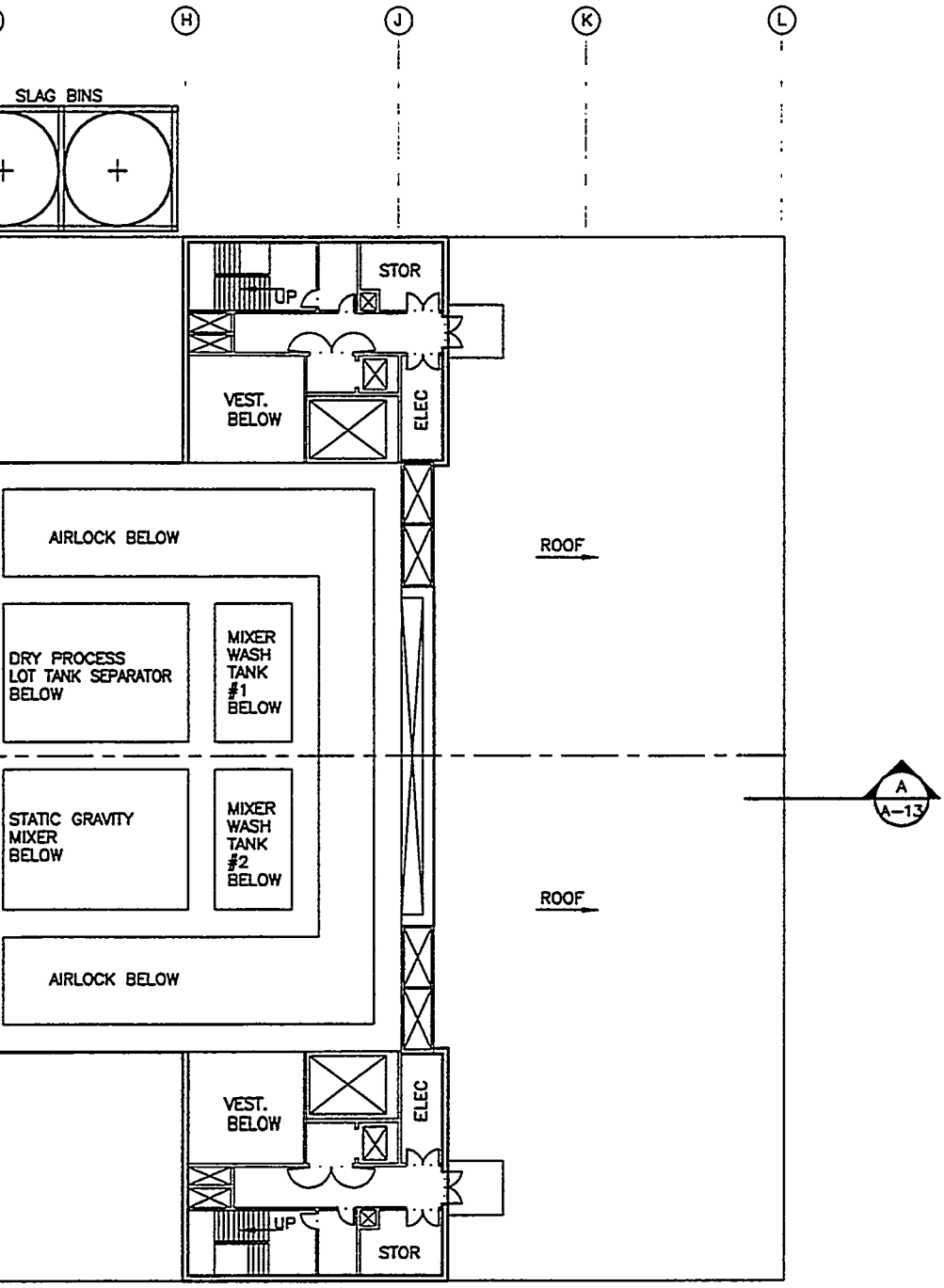
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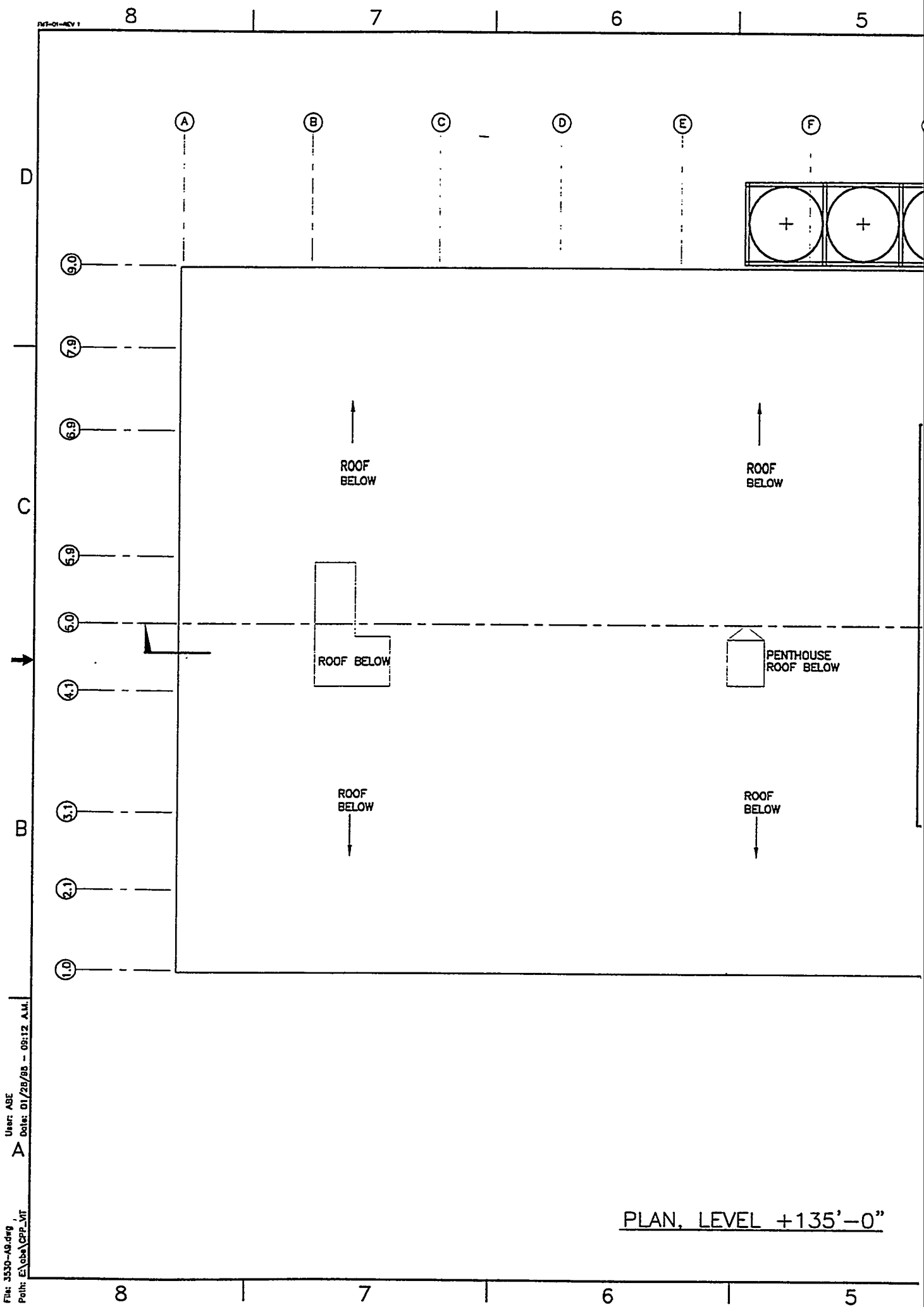
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
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QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1/16" = 1'-0"; SHEET DCWO-A-8


8
7
6
5
A
B
C
D
E
F
CLAY BINS
9.0
7.9
6.9
5.0
4.1
3.1
2.1
1.0
ROOF BELOW
ROOF BELOW
ROOF LEVEL +91'-0"
PENTHOUSE ROOF BELOW
ROOF BELOW
ROOF BELOW
PLAN, LEVEL +108'-0"
File: 3530-A8.dwg
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User: ABE
Date: 01/28/98 - 09:12 A.M.

REVISIONS		
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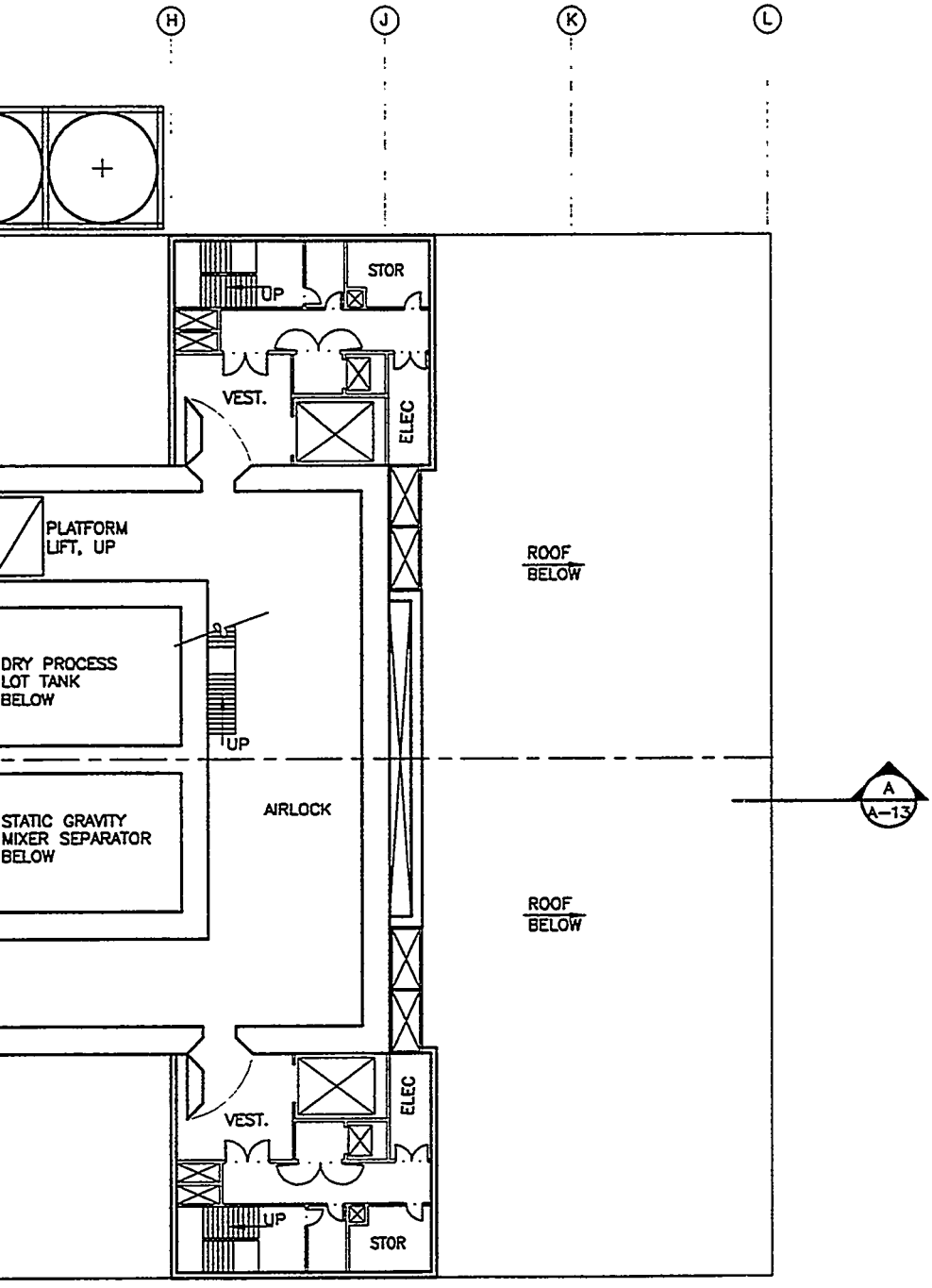
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / G / 0SG: 530; DWG-; REV
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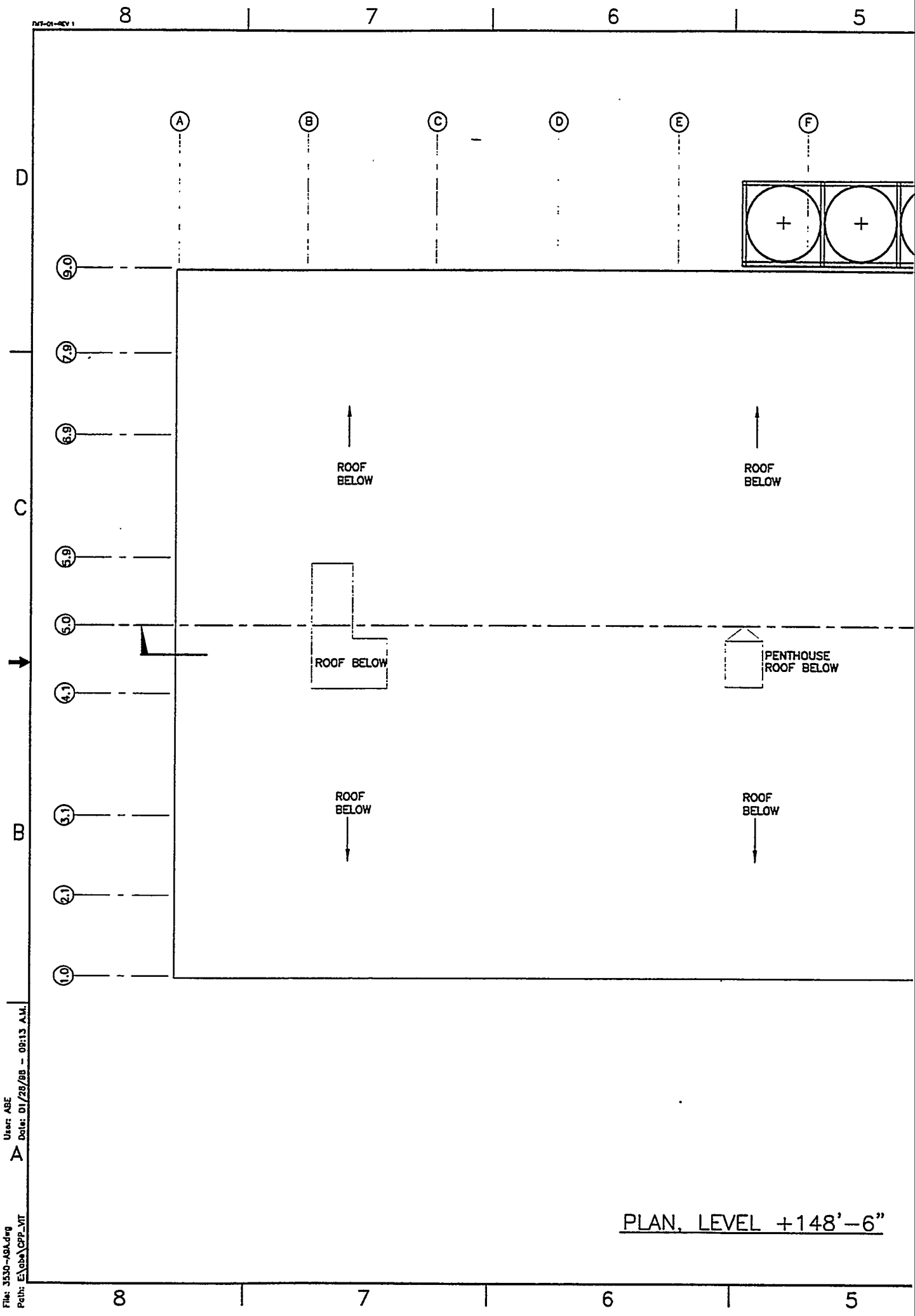
PLAN, LEVEL +135'-0"

File: 3530-A9.dwg
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User: ABE
Date: 01/28/95 - 09:12 A.M.

REVISIONS		
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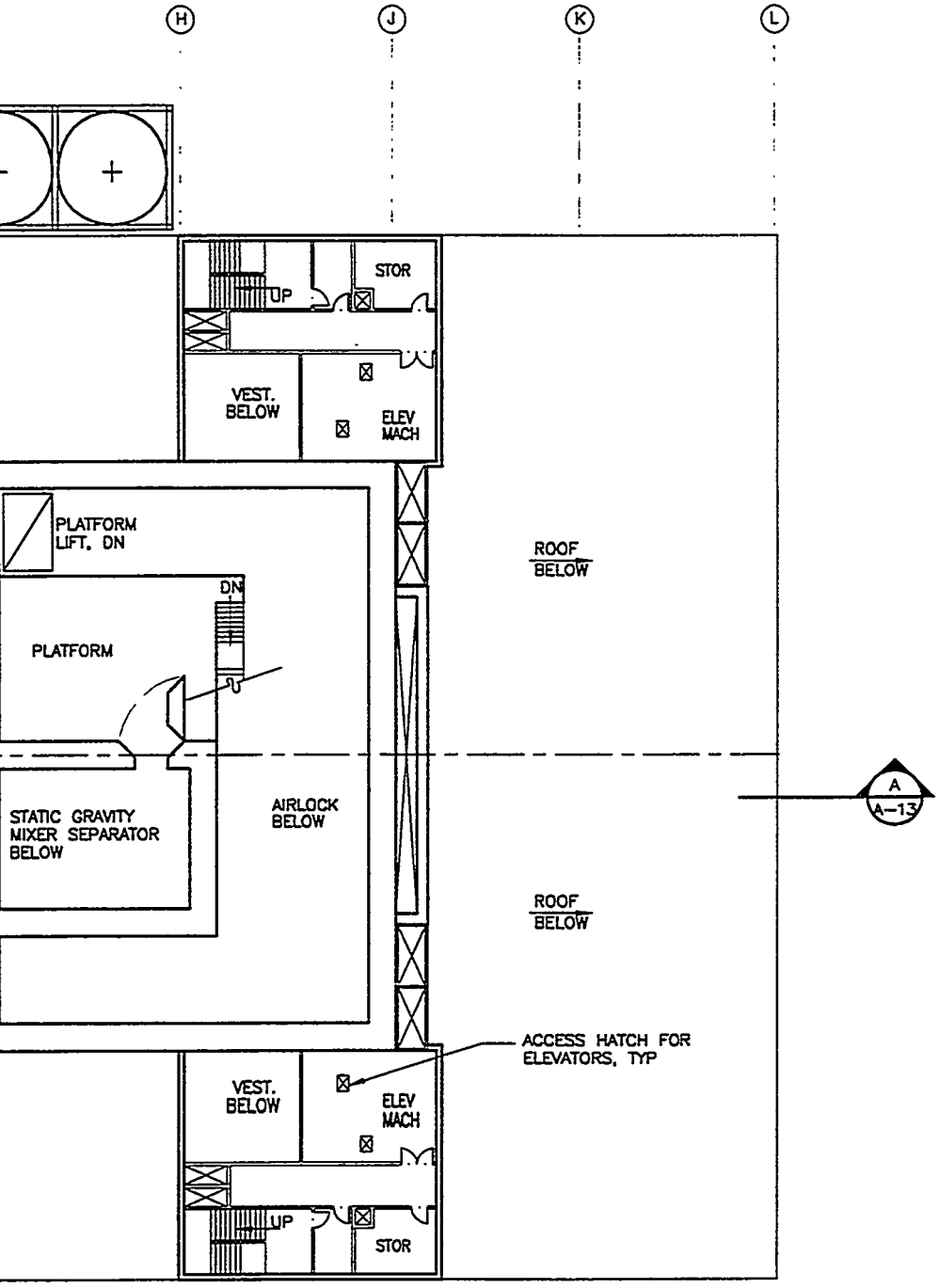
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / Q / SEQ: 530; DWG-; REV
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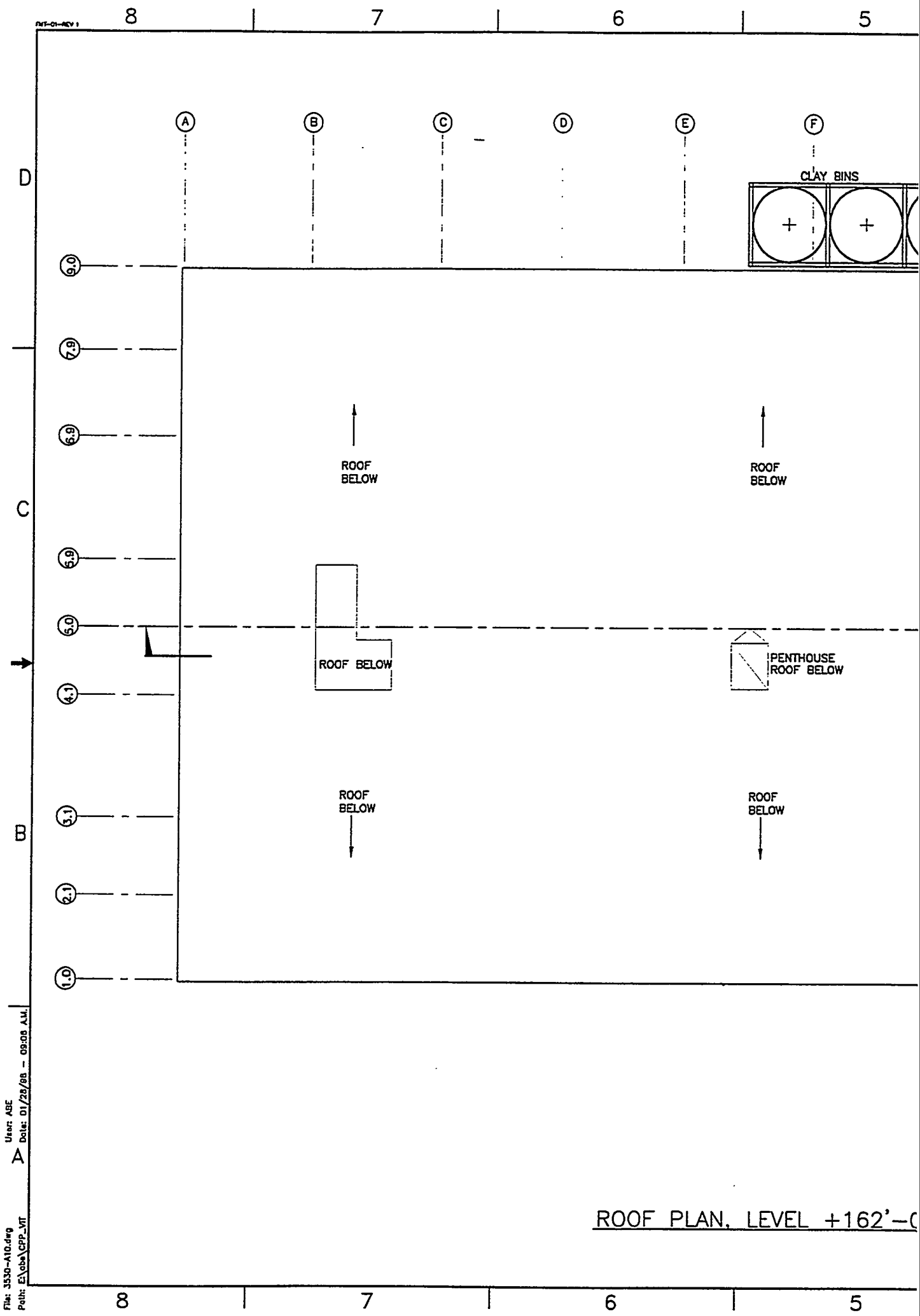
PLAN, LEVEL +148'-6"

User: ABE
Date: 01/29/98 - 09:13 A.M.
File: 3530-A9A.dwg
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REVISIONS		
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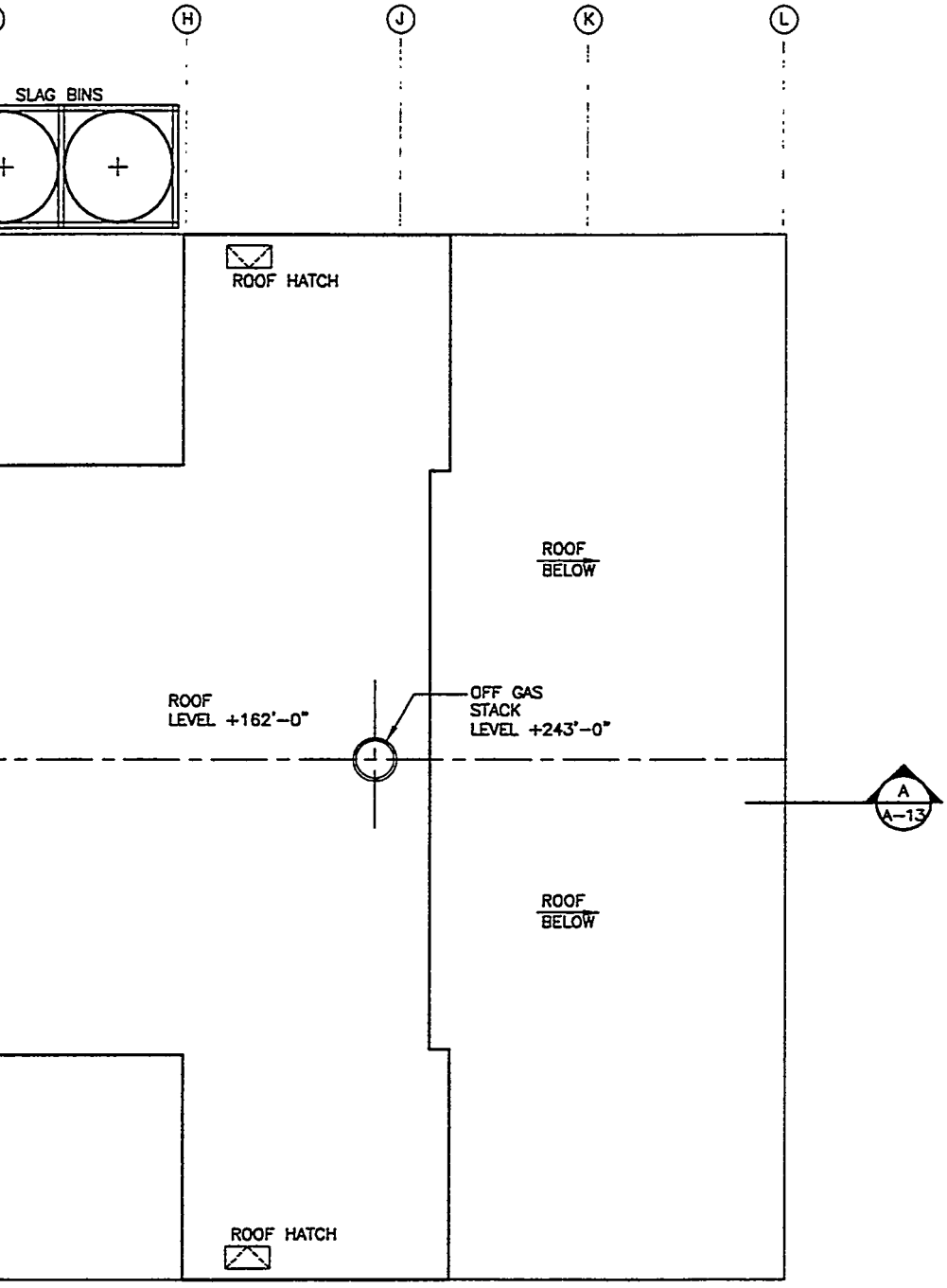


FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
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	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA, TYPE, Q, SEQ: 530; DWG-; REV
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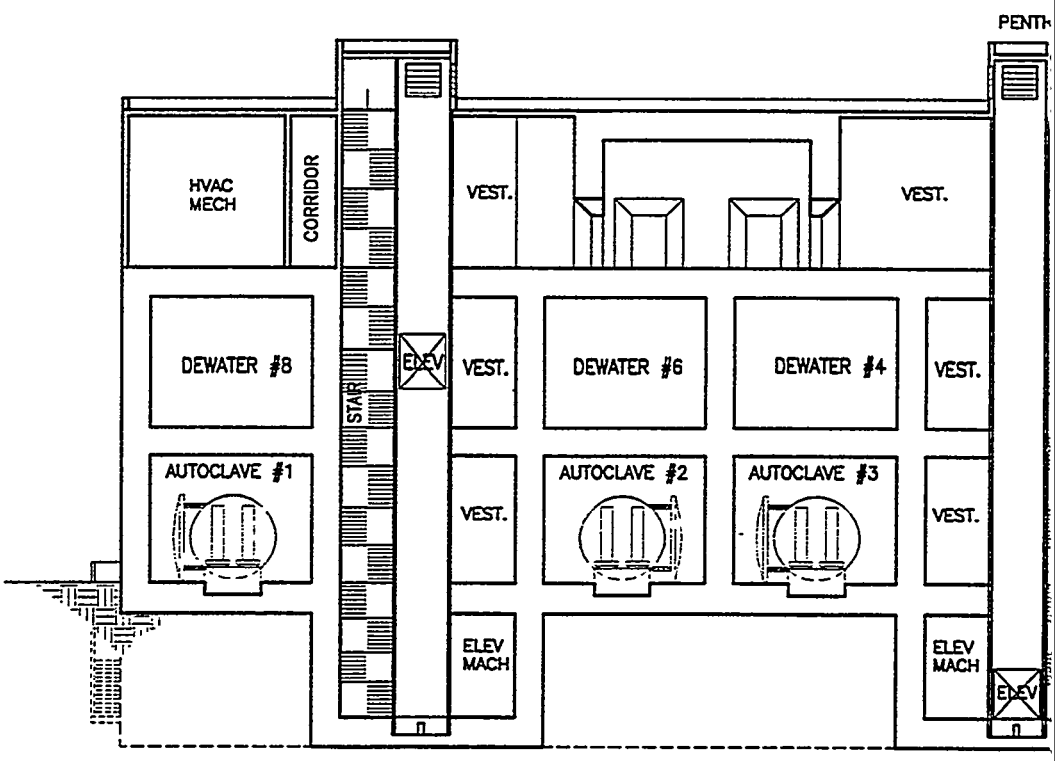


ROOF PLAN, LEVEL +162'-0

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:

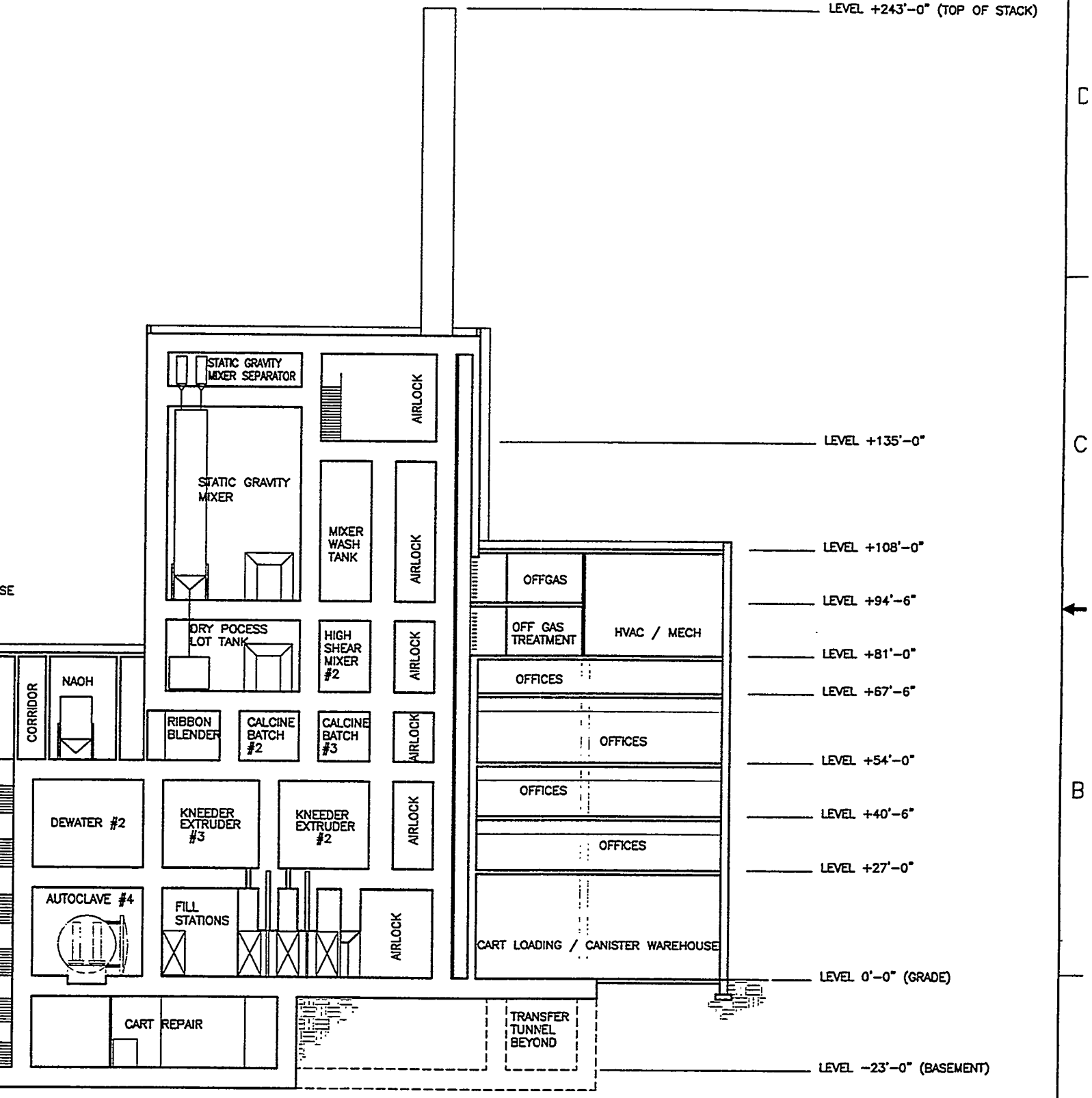


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1'0" 3' 5' 10' 20' SCALE: 1/16" = 1'-0"	REQUESTER:	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION GROUTING FACILITY ROOF PLAN, LEVEL +162'-0"
	DESIGN: R. JOHNSON	
	DRAWN: C.A. BEHM DEC/97	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / SQ / DISC: 530; DWG-; REV
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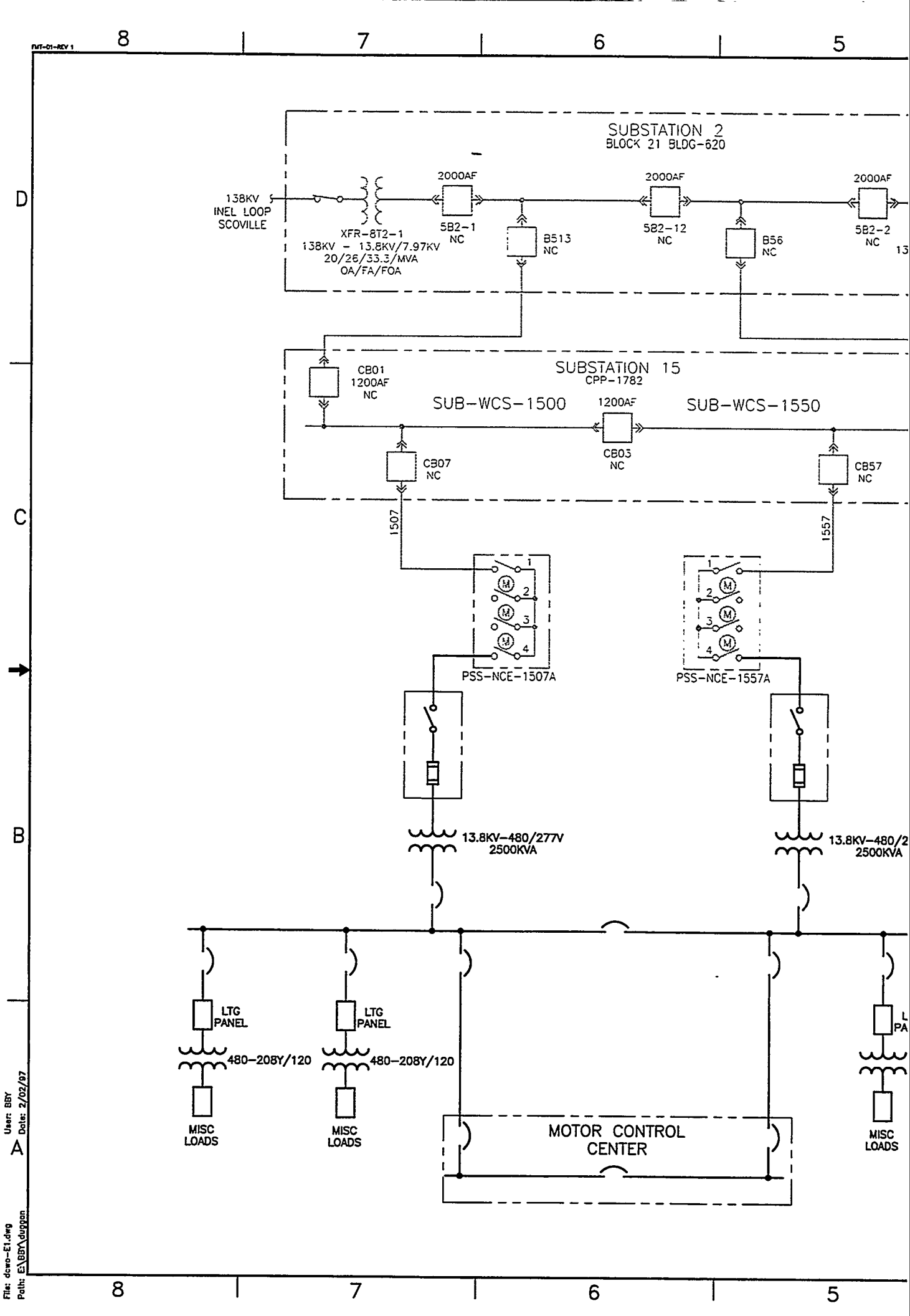
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REVISIONS		
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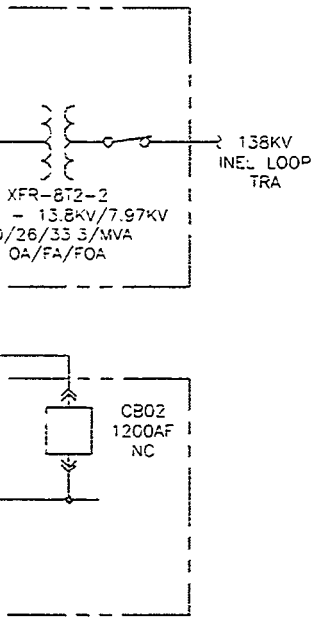


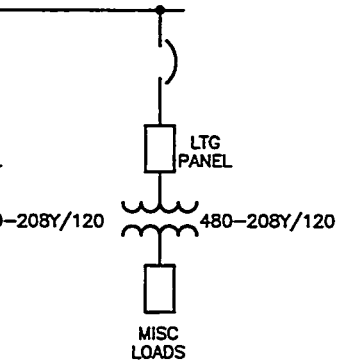
SECTION A
A-1 THRU A-12

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	DESIGN: R. JOHNSON	
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	PROJECT NO.	
	SPEC CODE	
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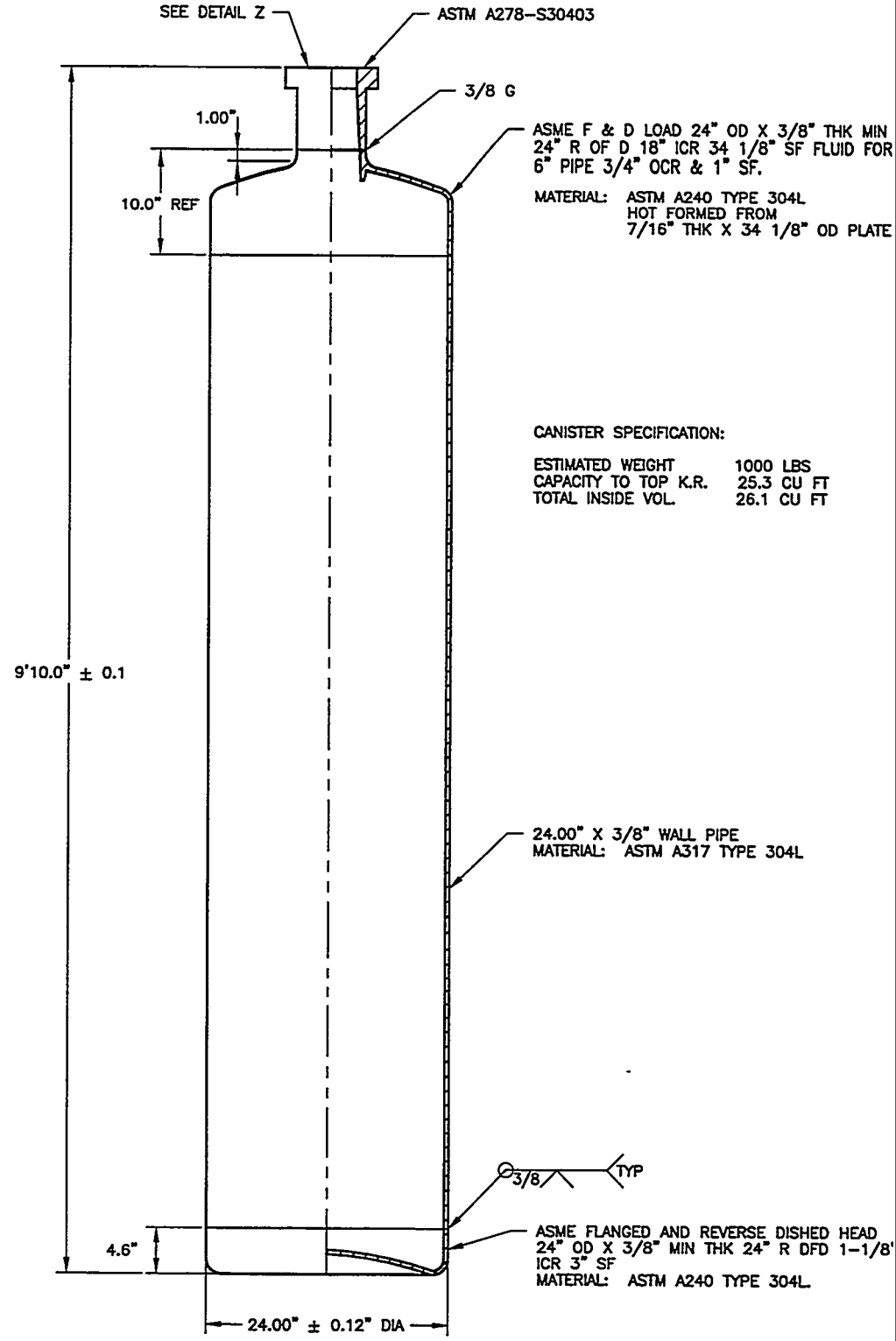

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BLOCK 21 BLDG-620
138KV
INEL LOOP
SCOVILLE
XFR-8T2-1
138KV - 13.8KV/7.97KV
20/26/33.3/MVA
OA/FA/FOA
2000AF
5B2-1
NC
B513
NC
2000AF
5B2-12
NC
B56
NC
2000AF
5B2-2
NC
SUBSTATION 15
CPP-1782
CB01
1200AF
NC
SUB-WCS-1500
1200AF
SUB-WCS-1550
CB03
NC
CB07
NC
CB57
NC
1507
1557
PSS-NCE-1507A
PSS-NCE-1557A
13.8KV-480/277V
2500KVA
13.8KV-480/2
2500KVA
LTG
PANEL
LTG
PANEL
480-208Y/120
480-208Y/120
MISC
LOADS
MISC
LOADS
MOTOR CONTROL
CENTER
MISC
LOADS
8
7
6
5
D
C
B
A
User: BBY
Date: 2/02/97
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REVISIONS		
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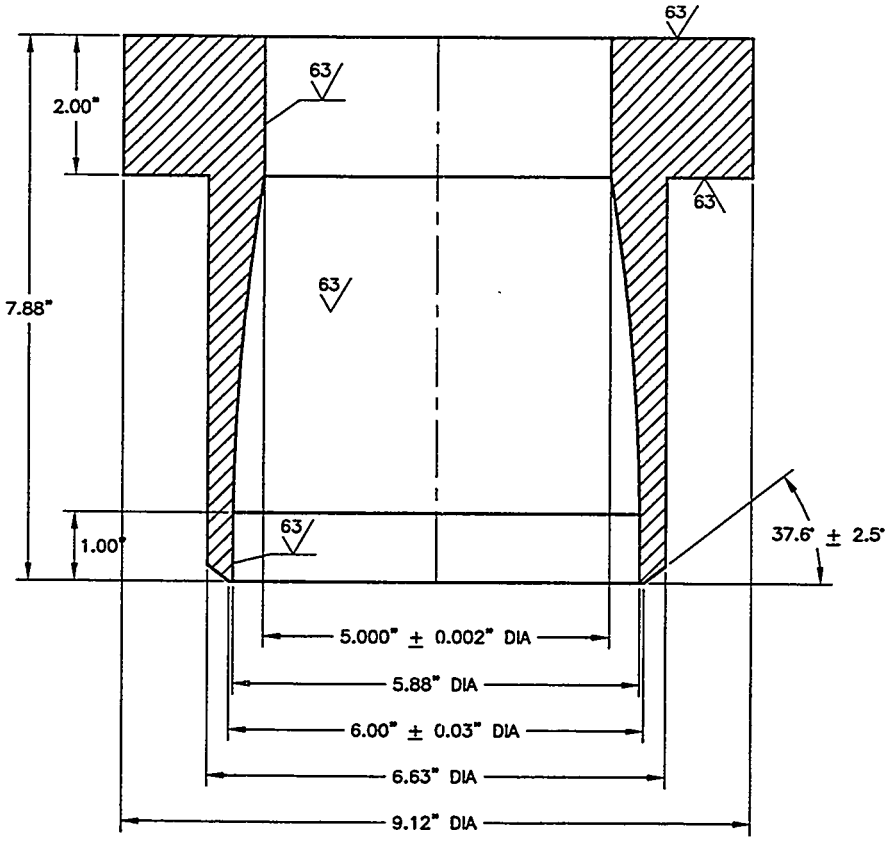


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	DESIGN: J.E. DUGGAN	
	DRAWN: D.H. MANWILL	
	PROJECT NO.	
	SPEC CODE	
DESIGN PHASE:	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, Q, DRG 10 530; DWG-; REV
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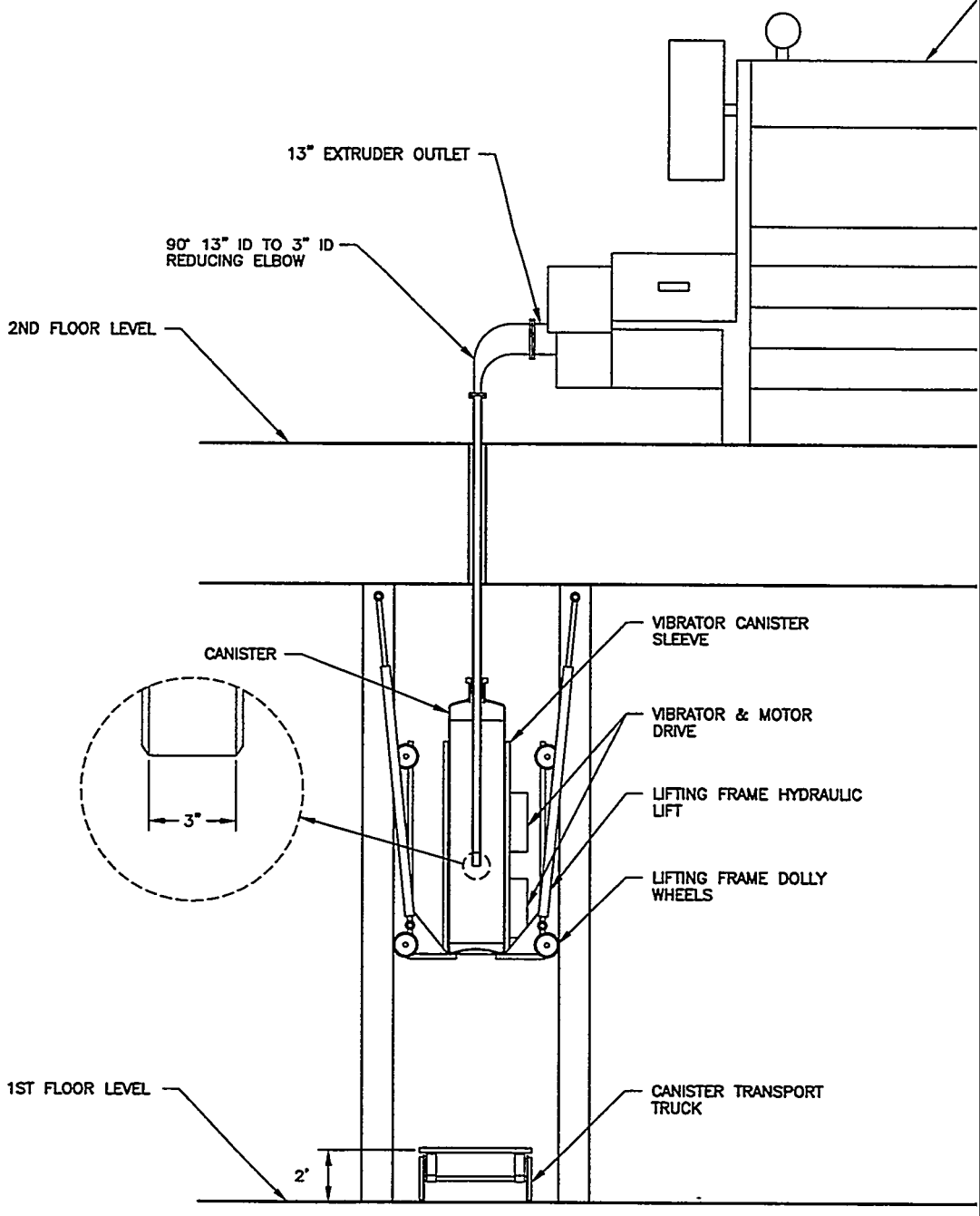
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User: EMS
Date: 02/02/98 - 10:28 A.M.
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Path: E:\EMS

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



DETAIL Z

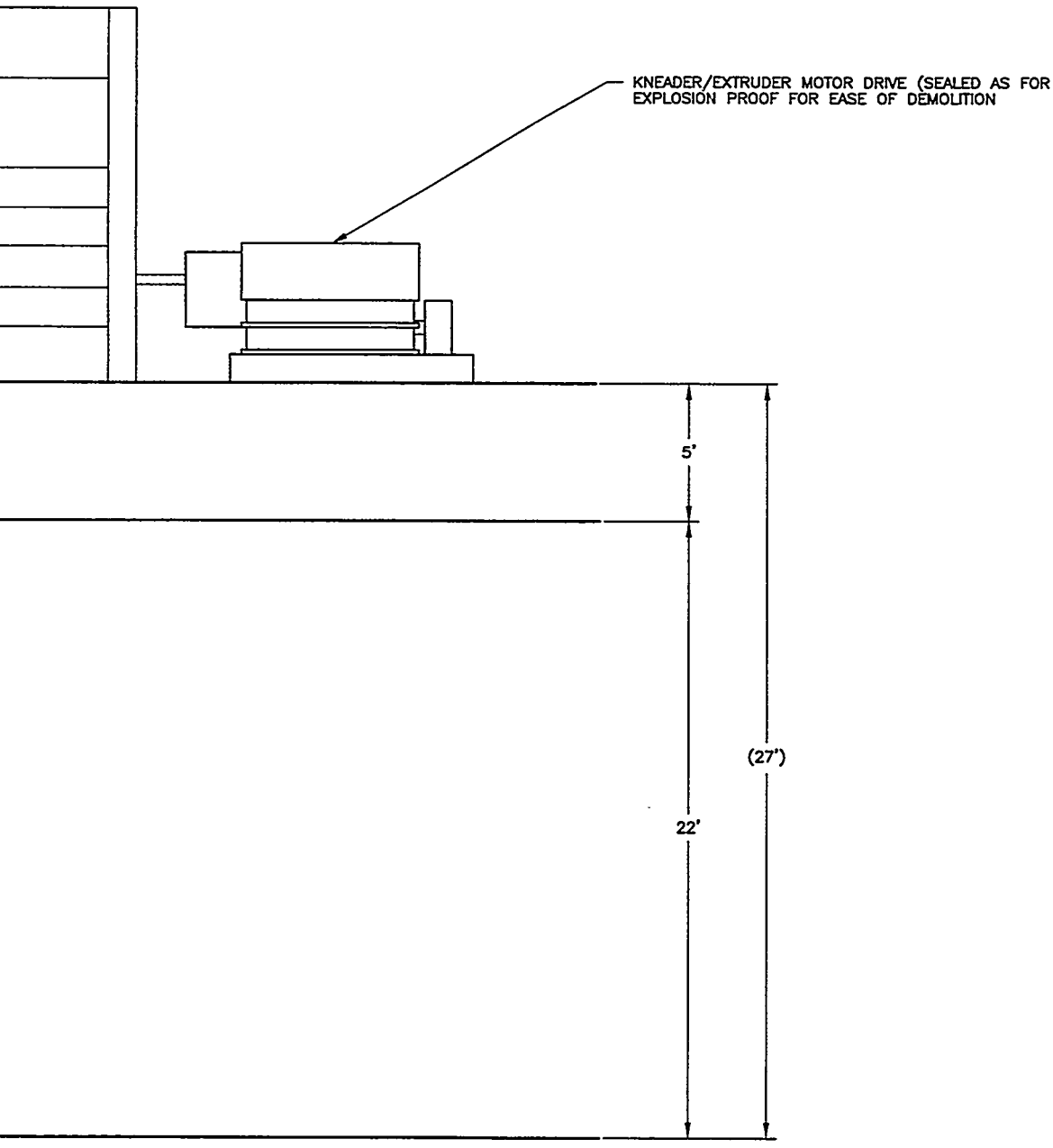
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DESIGN PHASE: SCOPING STUDY QUALITY LEVEL:	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. EFFECTIVE DATE:	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / CL / OSC: 530; DWG-; REV SCALE: NONE; SHEET DCWO-M-1



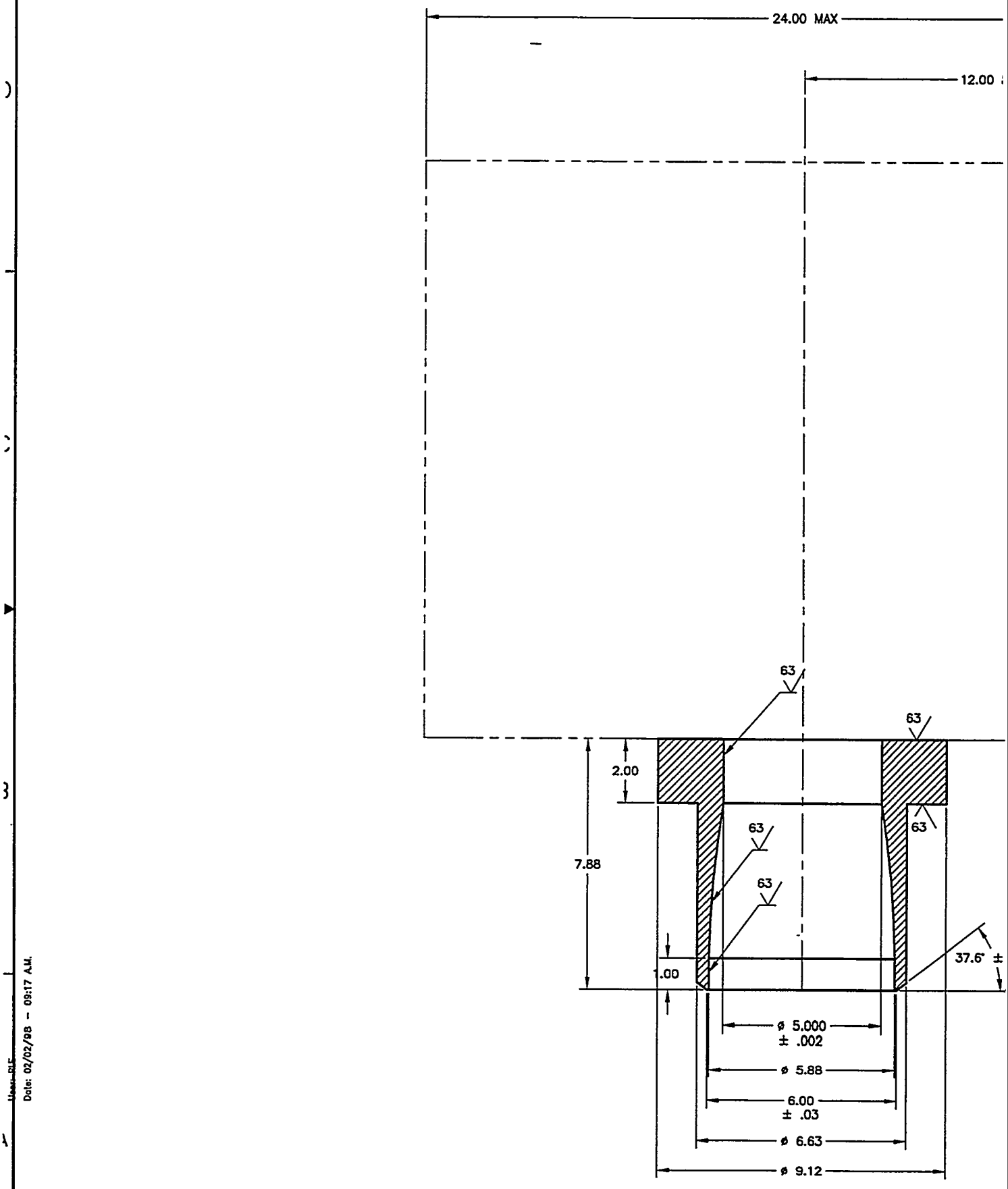
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REVISIONS		
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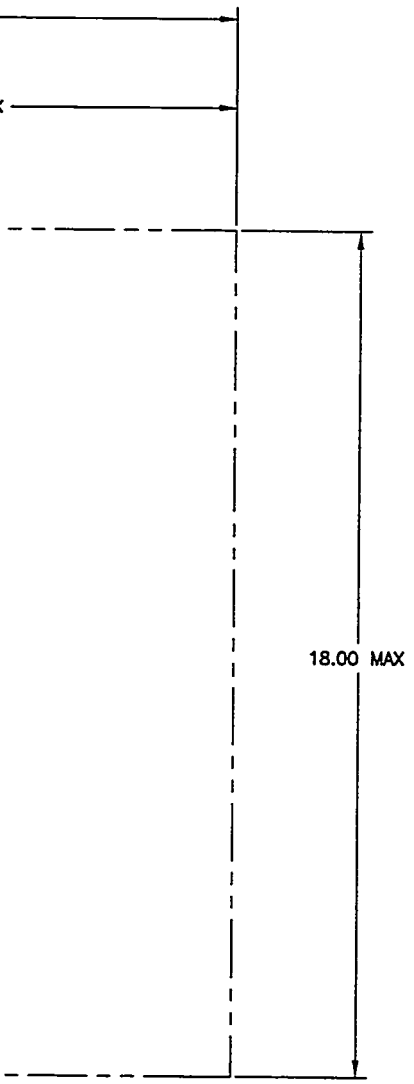
KNEADER/EXTRUDER



FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
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DESIGN PHASSCOPING STUDY	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA / TYPE / SQ / GRP: 530; DWG-; REV
QUALITY LEVEL:	EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-M2


24.00 MAX
12.00
63
63
2.00
63
63
7.88
63
37.6° ±
1.00
ø 5.000
± .002
ø 5.88
6.00
± .03
ø 6.63
ø 9.12

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
NO SCALE	REQUESTER: DESIGN: DENIS KIASER DRAWN: R. EAGLE PROJECT NO. SPEC CODE	ICPP WASTE TREATMENT FACILITY DIRECT CEMENTITIOUS WASTE OPTION WASTE CANISTER HEPA FILTER
DESIGN PHASSCOPING STUD	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, SYS 530; DWG-; REV
QUALITY LEVEL:	EFFECTIVE DATE:	SCALE: NONE; SHEET DCWO-M-3

Appendix E

Engineering Design File

LOCKHEED MARTIN

ENGINEERING DESIGN FILE

PROJECT FILE NO. 02BE0

EDF SERIAL NO. EDF-DCW0-001

FUNCTIONAL FILE NO. SPR-01

DATE 11/20/97

PROJECT/TASK Waste Treatment Project Feasibility Studies

SUBTASK Direct Cementitous Waste Option Scoping Study

SUBJECT **Man-loading and Physical Space Identification**

ABSTRACT

The following investigation identifies associated activities that may be required for the operations of this facility. Space allocation based on these activities has been estimated. Man-loading has been extrapolated from previous projects similar in nature, resource documents and engineering judgment based on experience.

KEYWORDS (e.g. area, structure no., general subject matter, etc.)

High Level Waste, CPP, Man-loading,

DISTRIBUTION (COMPLETE PACKAGE):

WTP EIS Studies Library, R.E. Dafoe, D.J. Harrell, B.R. Helm, K.L. Williams, S.J. Losinski, R.E. Johnson

DISTRIBUTION (COVER SHEET ONLY):

AUTHOR	DEPT.	REVIEWED	DATE	APPROVED	DATE
D. N. Stoddard	4130	S. J. Losinski	11/21/97	R.E. Dafoe	11/21/97
		LMITCO REVIEW	DATE	LMITCO APPROVAL	DATE
				S.W. Shepherd, P.E.	11/21/97

HLW DCWO MAN-LOADING

November 20, 1997

Assume: One (4)-10's shift for main process, administrative and support. One skeleton and autoclave process (3) shifts rotating in addition. Total man-loading is 157 personnel.

FACILITY – ADMINISTRATION

A separate, detached building will house approximately 46+ personnel and ancillary spaces supporting the main process and its functions. Physical requirements have been estimated based on an average of 500 square feet allowance per person.

FUNCTION/FACILITY REQUIREMENT	Main Shift	Rotating
• Manager(s)/Supervisor(s)	2	2
• Administrative Support Secretarial/Clerical Budget/Cost Control Schedule	3	-
• Waste Tracking/Data Acquisition Tech (Receipt, Entry, Examination, Sampling, Repack, Storage/Shipping, etc., Manifest, Chain of Custody	4	2

File/Document Storage Office Machines

FACILITY – TECHNICAL SUPPORT

• Engineering	10	4
• Control Systems Tech (Matrix personnel during const. Overhaul, redesign or mods)	6	4
• Draftsman	2	-

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Additional drafting is assumed to be one of these.

Storage – spare parts, work bench for repair/maintenance

FACILITY – DOCUMENT CONTROL

• Document control personnel	4	3

File/Document Storage Fire Vault, Library, Office Machines

FACILITY – TRAINING (Physical requirements only)

- Training personnel offices
- Classroom(s)
- File/Document storage training aids, equipment
- Conference room
- Equipment storage (audio/video, etc.)
- Conference Room(s)
- File/Document Storage Office Machines

FACILITY – COMMON ANCILLARY SPACE (Physical requirements only)

- Lunch Room
- Toilet Rooms
- Janitor Room
- Storage
- Circulation
- Electrical
- Communications
- Mechanical

FACILITY – MAINTENANCE

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Facility maintenance is assumed to be one of these.

DOE @ FACILITY OFFICE(S) - (Physical requirements only)

- Offices (2)

PROCESS FACILITY/OPERATIONS

Space required in addition to the main process areas is estimated at approximately 30,000 square feet. Ancillary and support functions critical to the process will be housed within the same physical facility. Approximately 111+ personnel have been identified. Physical requirements have been estimated based on an average of 500 square feet allowance per person.

FUNCTION/FACILITY REQUIREMENT	Main Shift	Rotating
• Operations Manager(s)	2	3
• Shift Supervisor(s)	2	-
• On-duty Shift supervisor(s)	2	3
• Shift Operator(s) – (See Control Room Below)		
• Operations Technicians	2	3
• Lab Technicians (sampling)	2	-
• Rad-con Tech (RCT/HP) Manager	1	3

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Laboratory testing and analysis capabilities is assumed to be one of these.

File/Document Storage Office Machines

PROCESS CONTROL (Process Control Console, Alarm Panels, Communications)

• Calcine retrieval to Cyclone Separator	1	-
Mixer, Dry Process Agitator		
• Off-Load & Transfer Grout Mix (NaOH, Slag, Clay)	2	-
NaOH Mixer (2) mix stations (1) wash station		
• Sample Analysis	1	-
• Calcine Batch Bins (4) batch stations (1) wash station	4	-
Ribbon Blender		-
Calcine Batch Bin		
Kneeder/Extruder		-
Containerize		-
Injector		
Vibrator Platform		
• Test Coupons	1	-
• Survey, Decon, HEPA Filter Install/Removal,	1	3
Cap/Seal, Analysis		
• Autoclave (4) stations	1	3
• Transfer to storage	1	3

E S & Q

• Safety	3	4
• RCT (Rad-Con Tech)	4	4
• Quality	2	4
• Equipment storage (surveillance, analyzers, etc)		

PROCESS MAINTENANCE

• Manager	1	1
• Supervisors	1	1
• Electrical	6	2
• Mechanical	8	2
• I&C Technicians	6	3
• Maintenance Planner	3	-
• Preventive Maintenance/Work Order	6	-
• Attendant	1	-
• Transfer systems (i.e., cart) maintenance	2	3

PROCESS 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
- EOC
- Mechanical, Electrical and Communications
- Shop – Materials and Equipment Storage, Work Bench Area
- Instrument Shop – I&C, Protected Storage for Calibrated Instruments, Work Bench
- Contaminated, Hot Maintenance Area
- Transfer systems (i.e., carts) survey, decon and maintenance areas
- Tool Room – Storage of Issue Tools
- Storage - Clean Containers
- Storage - Lag/Lead
- Storage - Process Interim

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. The following functions and facilities have been assumed to exist and have the capabilities of servicing this process:

- Machine Shop
- Welding Shop
- Storage Ware House
- Mock-up Area
- Laydown Area

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: Instrumentation and Controls

Summary:

This EDF documents the effort to estimate instruments and controls required for the Direct Cementitious Waste Option Grout Facility processes.

The results are based on a scoping level effort for a Grout Facility having a 5 year operating life and requiring operation of instrumentation hardware in approximately 90 R/hr radiation fields and in corrosive environments.

The contents are in two sections, one for HVAC instrumentation and the second for the remainder of plant.

Conclusions:
All processes will be handled remotely from a control room with a number of operations requiring robotic handling. Approximately 9800 measurements have been identified.

Distribution (complete package): WTP EIS Studies Library, R. H. Averill M.S. 3890, R. E. Dafoe M.S. 3765, D. J. Harrell M. S. 3211, B. R. Helm M. S. 3765, S. J. Losinski M. S. 3625, K. L. Williams M. S. 3765

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
22Dec97	4140		12/22/97		12/23/97
		LMITCO Review	Date	LMITCO Approval	Date

Instrumentation for the Direct Cementitious (Grout) Waste Option

Introduction

This report presents an outline of the instrumentation needed to support the operation of the Direct Cementitious (Grout) Waste option (DCWO) to be used in treat calcined waste into a form suitable for final disposal. The process will blend clay and slag with the calcine and inject the mixture into a container to be stored.

Process

The DCWO facilities will include a calcine receiving system, grouting material receiving and delivery system, a blending system, a grouting process, product lag storage, an off gas treatment system, and supporting utilities systems. The process will begin by mixing clay and slag with the calcine in a mixer. The resulting blend will be injected into the containers which will be 24 inches in diameter by 118 inches long. The containers then will have a HEPA filter temporarily installed on the top while the containers pass through an autoclave to cure the grout and a dewater station to dry it After the dewater station, the HEPA filter will be removed and a seal cap will be welded in place. Lastly, the container will be transferred to an interim storage area.

All processes, transfer of the materials and all other operations are to be handled remotely from the control room. This requires many instruments and operation controls. Also several of the operations will be performed by robots. Some of the operations requiring robotic handling are;

a) transferring the HEPA filters from a holding location to the installation location

b) installation of the HEPA filter on the container

c) swipes to check for contamination

d) removal of the HEPA filter after curing and drying

e) transferring the HEPA filters from the removal location to a holding area

f) transferring the seal cap from a holding area to the installation area

g) installing and welding the seal cap to the container

h) tomography after the container is sealed

i) laser cutting and removal of the container for defective waste forms

j) transferring the grout from the cutting area to a crusher

k) obtaining test coupons at several locations

l) transferring test coupons to a receiving and testing location

In addition to these robotic operations, the containers will necessarily be moved remotely on a track system throughout the facility. It is estimated that up to 400 containers will be moving at any one time. Each container will be mounted to a cart and each cart will be remotely controlled. To hold the containers on the cart while the carts are moving, a holding system will be on each cart and this also will be remotely controlled. The tracks will move the carts from one area to another through a system of air locks. All the air locks will be controlled from the control room. Several transfer tracks will be needed along the tracks to provide the option of removing any one cart (and container) from the normal flow in case of a problem.

Instrumentation

Instrumentation will be provided to monitor the condition of the grout through the process stream and to control the process functions. All tanks and bins will have a means of measuring the inventory either through a level or weight measurement. The pressure and temperature in the tanks will also be measured. The tanks and bins with off-gas lines will have a differential pressure measurement between the tank and the off-gas line. Controls for the remotely operated valves and pumps will come with input provided by the various measurements.

Controls will also be provided for the several robotic operations mentioned above. Controls for the track/cart system to be used in transferring the containers through the facility will provided. Positioning and limit switches will be provided for robotics and track systems.

Because of the lack of accessibility to the facility by personnel, redundancy of instruments and instrumentation controls are included. All pumps and valves have redundant counterparts. All level, pressure, and temperature measurements are duplicated.

In this report, no support for the HVAC system has been provided. Instruments for this system will be described under another report specifically for the HVAC.

The control room will be used to monitor the plant operations, control and display the processing stages of the grout, control the several robotic operations that will need to be

performed, tracking the 400 containers through the facility, and maintaining a log of all the collected data. These operations will require several work stations as well as two super computers to handle the massive amounts of data and controls.

Assumptions

The facility design life is 5 years. The hardware will be required to operate for the design life in a radiation field of about 90 R/hr and in a corrosive environment.

All operations and processes will be remotely controlled. All robotic systems will be remotely controlled. The track system used to transfer the containers through the facility will be remotely controlled.

There will be redundancy of all instruments, pumps, and valves.

All valves will have a system of positive feedback of valve position.

In general, the process control and facility instrumentation to be provided will be with standard instrument accuracy. The exception to this rule are levels on some of the tanks, which are required to be accurate to 1% full scale. In addition, the controls of the robotic systems will require precision adjustments for all of the operations.

Wiring for the instruments to the data system will be twisted-shielded pair run in conduit. There will be a redundant set of wiring through a separate and physically distant path from the original wiring. The majority of the instrument and process signals will be 4-20 mA. All wiring from the instrumentation and operations will be routed into the computer room to instrument patch panels and the signals will be redistributed from there.

A new control room, computer room, and a minimum of ten work stations will be required. The work station will monitor and control the plant functions, plant alarms, radiation monitor alarms, the plant processes, the robotic controls, and the transfer track system.

Approximately 30 video cameras will be used throughout the facility strictly for observation assistance in the operations used in the processing. These will be viewed on several monitors in the control room.

In this report, no support for the HVAC system has been provided. Instruments for this system are to be described under another report specifically for the HVAC.

Instrument List

The attached list for the proposed instrumentation is for those systems which have been identified to date. The list is tentative and there is a high degree of uncertainty in the numbers and type of instruments involved, since most of the operations and processes

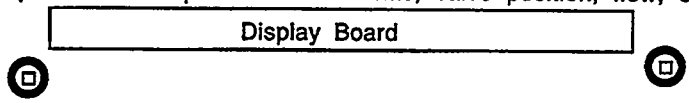
are not well defined. In general, the instruments are listed by measurement type and not instrument type. For instance, a level measurement may refer to a differential pressure, a load cell, an ultrasonic, a float, or a laser instrument. No significant effort has been made at this time to identify types of instruments to meet the intended needs.

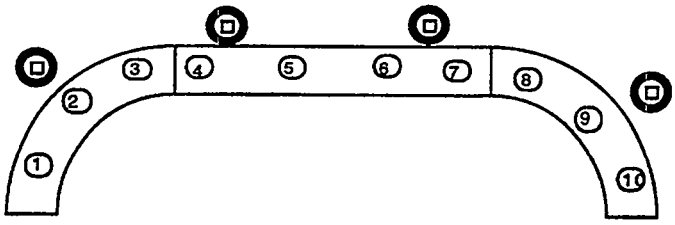
References

Sixteen draft flow diagrams were provided by the process engineer which indicated the process flow of the facility. Conversations with the process engineer, the building design engineer, and the mechanical equipment engineer were held and a general description of the various parts were discussed. Based on these flow diagrams and conversations, this instrumentation package was developed.

DCWO
Main Control Room

(shows entire process with alarms, valve position, flow, etc)

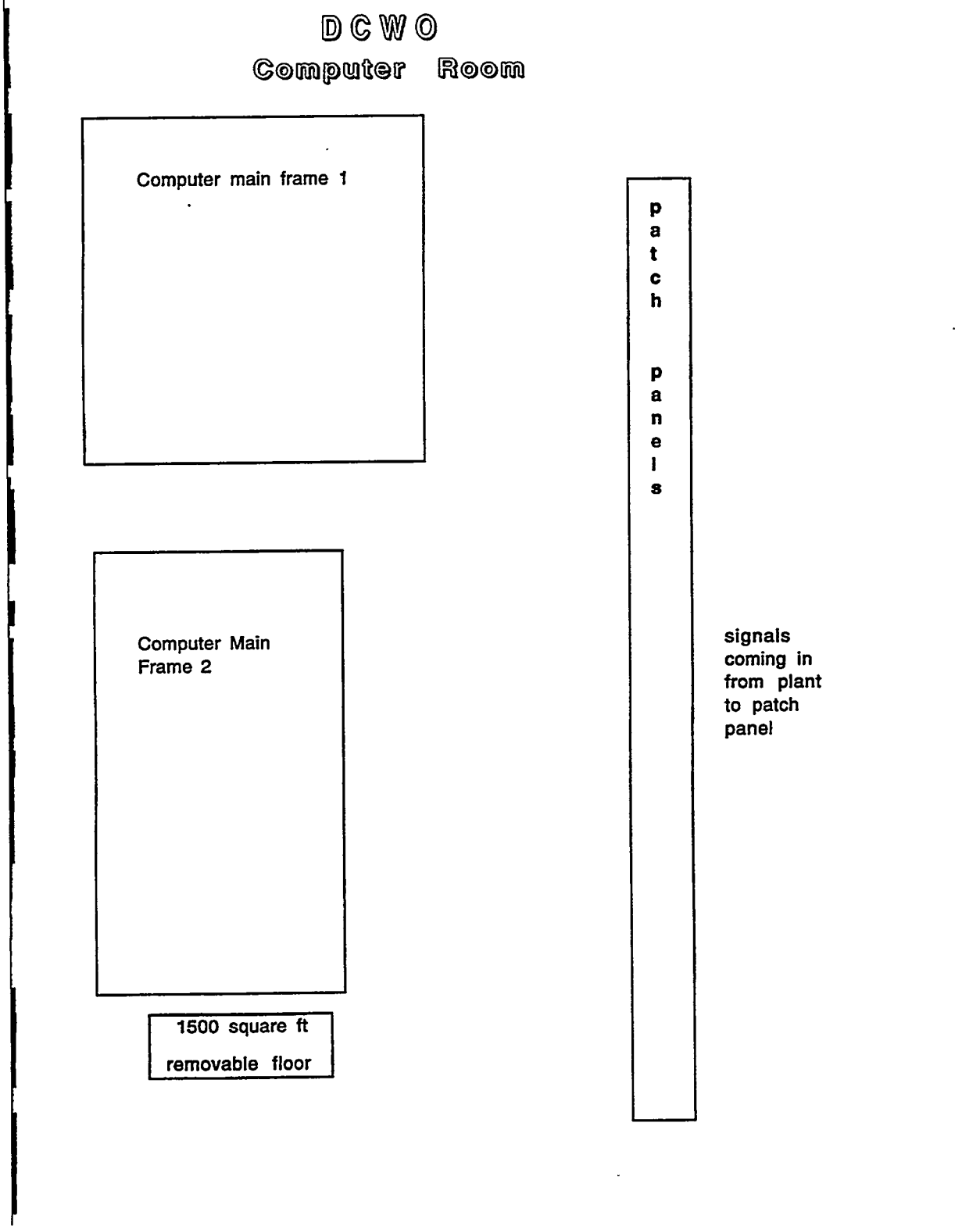




Key

Monitor	1 = plant controls	6 = process c
Work Station	2 = plant alarms	7 = process d
	3 = rad alarms	8 = process e
	4 = process a	9 = robot controls a
	5 = process b	10 = robot controls b

1500 square ft
removable floor


DCWO
Computer Room
Computer main frame 1
Computer Main Frame 2
1500 square ft
removable floor
patch panels
signals coming in from plant to patch panel

Dec 9, 97

POTENTIAL INSTRUMENTS for DIRECT CEMENTITIOUS GROUT WASTE OPTION

Page	Instr count	Instr description	Instr type	Instr ID	num of locations	num of meas/loc	total of meas
general	190	19 air locks (alarm/status/open/close)	control		19	10	190
general	380	camera between airlocks	camera		19	10	190
general	570	radiation monitor between airlocks	rad		19	10	190
general	589	pressure between airlocks	pressure		19	1	19
general	608	temp between airlocks	RTD		19	1	19
general	627	rel humidity between airlocks	RH		19	1	19
general	817	13 vestibules (alarms/status/open/close)	control		19	10	190
DCWO-01	819	on/off swtich to calcine bin	switch		1	2	2
DCWO-01	829	camera at bin	camera		1	10	10
DCWO-01	831	Off gas flow/cyclone separator/CY-101	Diff press	DP-101	1	2	2
DCWO-01	832	Cyclone Separator/CY101	load cell	LC-101A	1	1	1
DCWO-01	833	Cyclone Separator/CY101	load cell	LC-101B	1	1	1
DCWO-01	836	output cyclone separator/T-101	valve contl	V-101	1	3	3
DCWO-01	837	switch/positive open/cyclone/T-101	valve sw	S-V-101-U	1	1	1
DCWO-01	838	switch/positive closed/cyclone/T-101	valve sw	S-V-101-D	1	1	1
DCWO-01	840	Off gas flow/cyclone separator/CY-102	Diff press	DP-102	1	2	2
DCWO-01	841	Cyclone Separator/CY102	load cell	LC-102A	1	1	1
DCWO-01	842	Cyclone Separator/CY102	load cell	LC-102B	1	1	1
DCWO-01	845	output cyclone separator/T-102	valve contl	V-102	1	3	3

DCWO-01	846	switch/positive open/cyclone/T-102	valve sw	S-V-102-U	1	1	1
DCWO-01	847	switch/positive closed/cyclone/T-102	valve sw	S-V-102-D	1	1	1
DCWO-01	849	area radiation monitor/area 01	rad monitor	rad-101	1	2	2
******	****	**********	*********	**********	******	******	*****
DCWO-02	852	(on/off/spd) mech conveyor/0.2 m3/min	control	P-203	1	3	3
DCWO-02	854	Off gas flow /static grav mix/T-201	diff press	DP-201	1	2	2
DCWO-02	856	Off gas flow/dry process lot tank/T-202	diff press	DP-202	1	2	2
DCWO-02	857	Load cell/tank 201	Level	LVL-201A	1	1	1
DCWO-02	858	Load cell/tank 201	Level	LVL-201B	1	1	1
DCWO-02	861	output static gravity mixer/T-201	valve contl	V-201	1	3	3
DCWO-02	862	switch/pos open/static grav mix/T-201	valve sw	S-V-201-U	1	1	1
DCWO-02	863	switch/pos closed/static grav mix/T-201	valve sw	S-V-201-D	1	1	1
DCWO-02	864	feedback contl /CY101 to input T-201	feedbk contrl	C-201A	1	1	1
DCWO-02	865	feedback contl / CY202 to input T-201	feedbk contrl	C-201B	1	1	1
DCWO-02	868	(on/off/speed) Mixer agitator contl/T202	control	C-202	1	3	3
DCWO-02	869	Level/Mixer/T202	Level	LVL-202A	1	1	1
DCWO-02	870	Level/Mixer/T202	Level	LVL-202B	1	1	1
DCWO-02	871	output to calcine batch bin/T202	valve contl	V-202	1	1	1
DCWO-02	872	switch/pos open/calcine batch bin/118A	valve sw	S-V-202U	1	1	1
DCWO-02	873	switch/pos closed/calcine batch bin/118A	valve sw	S-V-202D	1	1	1
DCWO-02	874	output to calcine batch bin/118B	valve contl	V-203	1	1	1
DCWO-02	875	switch/pos open/calcine batch bin/118B	valve sw	S-V-203U	1	1	1

DCWO-02	876	switch/pos closed/calcine batch bin/118B	valve sw	S-V-203D	1	1	1
DCWO-02	877	output to calcine batch bin/118C	valve contl	V-204	1	1	1
DCWO-02	878	switch/pos open/calcine batch bin/118C	valve sw	S-V-204U	1	1	1
DCWO-02	879	switch/pos closed/calcine batch bin/118C	valve sw	S-V-204D	1	1	1
DCWO-02	880	output to calcine batch bin/118D	valve contl	V-205	1	1	1
DCWO-02	881	switch/pos open/calcine batch bin/118D	valve sw	S-V-205U	1	1	1
DCWO-02	882	switch/pos closed/calcine batch bin/118D	valve sw	S-V-205D	1	1	1
DCWO-02	884	area radiation monitor/area 02	rad monitor	rad-201	1	2	2
DCWO-02	886	area radiation monitor/area 02	rad monitor	rad-202	1	2	2
DCWO-02	890	feedback switch to shut off separator	control		1	4	4
DCWO-02	894	sonic level	level		2	2	4
DCWO-02	896	area monitor	rad		1	2	2
DCWO-02	906	robot controls/sample	control		1	10	10
DCWO-02	910	robot controls/valves & positions	control		1	4	4
DCWO-02	930	area cameras	camera		2	10	20
DCWO-02	932	alarms on filters	alarm		1	2	2
DCWO-02	934	flow control of V201	control		1	2	2
******	****	**********	*********	**********	******	******	*****
DCWO-03	936	Off gas flow /across vent/T306	diff press	DP-306	2	1	2
DCWO-03	937	Level/NAOH tank/T306	liquid level	LVL-306A	1	1	1
DCWO-03	938	Level/NAOH tank/T306	liquid level	LVL-306B	1	1	1
DCWO-03	939	Temperature/NaOH tank/T306	RTD	T-306	1	1	1
DCWO-03	940	Heater control/NaOH tank/T306	control	SW-306A	1	1	1
DCWO-03	941	Heater control/NaOH tank/T306	control	SW-306B	1	1	1
DCWO-03	942	Heater control/NaOH tank/T306	control	SW-306C	1	1	1
DCWO-03	943	Heater control/NaOH tank/T306	control	SW-306D	1	1	1
DCWO-03	944	pos displacemnt pump/T306/ (20	control	P-305A	1	1	1

		l/min)					
DCWO-03	945	pos displacemnt pump/T306/ (20 l/min)	control	P-305B	1	1	1
DCWO-03	948	input from clay to tanks/T301A&B	valve contl	V-301C	1	3	3
DCWO-03	949	switch/pos open/clay to tank A/T301A	valve sw	S-V-301C-UtoA	1	1	1
DCWO-03	950	switch/pos open/clay to tank B/T301B	valve sw	S-V-301C-UtoB	1	1	1
DCWO-03	951	switch/pos closed/clay to tanks 301 A&B	valve sw	S-V-301CD	1	1	1
DCWO-03	953	off gas flow/across filter F-302A/T301A	diff press	DP-301A	2	1	2
DCWO-03	954	Filter alarm/across filter F-302A/T-301A	Alarm	AL-301A	1	1	1
DCWO-03	957	output clay tank/T301	valve contl	V-301A	1	3	3
DCWO-03	958	switch/positive open/clay tank A/T301A	valve sw	S-V-301AU	1	1	1
DCWO-03	959	switch/positive closed/clay tank A/T301A	valve sw	S-V-301AD	1	1	1
DCWO-03	960	Level/Clay tank A/T301A	Level	LVL-301A	1	1	1
DCWO-03	961	Level/Clay tank A/T301A/redunant	Level	LVL-301A/red	1	1	1
DCWO-03	962	Off gas flow /across filter F-302B/T-301B	diff press	DP-301B	1	1	1
DCWO-03	963	Filter alarm/across filter F-302B/T-301B	Alarm	AL-301B	1	1	1
DCWO-03	964	output clay tank B/T301B	valve contl	V-301B	1	1	1
DCWO-03	965	switch/positive open/clay tank B/T301B	valve sw	S-V-301BU	1	1	1
DCWO-03	966	switch/positive closed/clay tank B/T301B	valve sw	S-V-301BD	1	1	1
DCWO-03	967	Level/Clay tank B/T301B	Level	LVL-301B	1	1	1
DCWO-03	968	Level/Clay tank B/T301B/redundant	Level	LVL-301B/red	1	1	1

DCWO-03	969	Air Ejector/from tanks T301A&B	control	EJ-303A	1	1	1
DCWO-03	970	Air valve/from air supply (126)	control	AV-301	1	1	1
DCWO-03	971	output to blender/127A	valve contl	V-301-127A	1	1	1
DCWO-03	972	switch/positive open/to blender/127A	valve sw	S-V-301-127AU	1	1	1
DCWO-03	973	switch/positive closed/to blender/127A	valve sw	S-V-301-127AD	1	1	1
DCWO-03	974	output to blender/127B	valve contl	V-301-127B	1	1	1
DCWO-03	975	switch/positive open/to blender/127B	valve sw	S-V-301-127BU	1	1	1
DCWO-03	976	switch/positive closed/to blender/127B	valve sw	S-V-301-127BD	1	1	1
DCWO-03	977	output to blender/127C	valve contl	V-301-127C	1	1	1
DCWO-03	978	switch/positive open/to blender/127C	valve sw	S-V-301-127CU	1	1	1
DCWO-03	979	switch/positive closed/to blender/127C	valve sw	S-V-301-127CD	1	1	1
DCWO-03	980	output to blender/127D	valve contl	V-301-127D	1	1	1
DCWO-03	981	switch/positive open/to blender/127D	valve sw	S-V-301-127DU	1	1	1
DCWO-03	982	switch/positive closed/to blender/127D	valve sw	S-V-301-127DD	1	1	1
DCWO-03	983	input from slag to tanks/T304A&B	valve contl	V-304C	1	1	1
DCWO-03	984	switch/pos open/slag to tank A/T304A	valve sw	S-V-304C-UtoA	1	1	1
DCWO-03	985	switch/pos open/slag to tank B/T304B	valve sw	S-V-304C-UtoB	1	1	1
DCWO-03	986	switch/pos closed/slag to tanks 304 A&B	valve sw	S-V-304CD	1	1	1
DCWO-03	987	Off gas flow /across filter F-302C/T-304A	diff press	DP-304A	1	1	1
DCWO-03	988	Filter alarm/across filter F-302C/T-304A	Alarm	AL-304A	1	1	1

DCWO-03	989	output slag Tank A/T304A	valve contl	V-304A	1	1	1
DCWO-03	990	switch/positive open/slag Tank A/T304A	valve sw	S-V-304AU	1	1	1
DCWO-03	991	switch/positive closed/slag Tank A/T304A	valve sw	S-V-304AD	1	1	1
DCWO-03	992	Level/slag Tank A/T304A	Level	LVL-304A	1	1	1
DCWO-03	993	Level/slag Tank A/T304A/redundant	Level	LVL-304A/red	1	1	1
DCWO-03	994	Off gas flow /across filter F-302D/T-304B	diff press	DP-03-D	1	1	1
DCWO-03	995	Filter alarm/across filter F-302D/T-304B	Alarm	AL-304B	1	1	1
DCWO-03	996	output slag Tank B/T304B	valve contl	V-304B	1	1	1
DCWO-03	997	switch/positive open/slag Tank B/T304B	valve sw	S-V-304BU	1	1	1
DCWO-03	998	switch/positive closed/slag Tank B/T304B	valve sw	S-V-304BD	1	1	1
DCWO-03	999	Level/slag Tank B/T304B	Level	LVL-304B	1	1	1
DCWO-03	1000	Level/slag Tank B/T304B/redundant	Level	LVL-304B/red	1	1	1
DCWO-03	1001	Air Ejector/from tanks T304A&B	control	EJ-303B	1	1	1
DCWO-03	1002	Air valve/from air supply (129)	control	AV-302	1	1	1
DCWO-03	1003	output to blender/130A	valve contl	V-304-130A	1	1	1
DCWO-03	1004	switch/positive open/to blender/130A	valve sw	S-V-304-130AU	1	1	1
DCWO-03	1005	switch/positive closed/to blender/130A	valve sw	S-V-304-130AD	1	1	1
DCWO-03	1006	output to blender/130B	valve contl	V-304-130B	1	1	1
DCWO-03	1007	switch/positive open/to blender/130B	valve sw	S-V-304-130BU	1	1	1
DCWO-03	1008	switch/positive closed/to blender/130B	valve sw	S-V-304-130BD	1	1	1
DCWO-03	1009	output to blender/130C	valve contl	V-304-130C	1	1	1

DCWO-03	1010	switch/positive open/to blender/130C	valve sw	S-V-304-130CU	1	1	1
DCWO-03	1011	switch/positive closed/to blender/130C	valve sw	S-V-304-130CD	1	1	1
DCWO-03	1012	output to blender/130D	valve contl	V-304-130D	1	1	1
DCWO-03	1013	switch/positive open/to blender/130D	valve sw	S-V-304-130DU	1	1	1
DCWO-03	1014	switch/positive open/to blender/130D	valve sw	S-V-304-130DD	1	1	1
DCWO-03	1015	area radiation monitor/area 03	rad monitor	rad-301	1	1	1
DCWO-03	1016	area radiation monitor/area 03	rad monitor	rad-302	1	1	1
DCWO-03	1018	alarms/NaOH tank	control		1	2	2
DCWO-03	1022	temperature	RTD		1	4	4
DCWO-03	1026	timing/on/off/FJ303	control		1	4	4
DCWO-03	1030	add pump 305A & B	control		1	4	4
DCWO-03	1034	add flow control 304A & B	control		1	4	4
******	****	**********	*********	**********	******	******	*****
DCWO-04	1036	Off gas flow /vent/T-401A	diff press	DP-401A	2	1	2
DCWO-04	1037	Filter alarm/across filter/T-401A	Alarm	AL-401A	1	1	1
DCWO-04	1038	mass/calcine batch tank A/T401A	load cell	LC-403AA	1	1	1
DCWO-04	1039	mass/calcine batch tank A/T401A	load cell	LC-403AB	1	1	1
DCWO-04	1041	Off gas flow /vent/T-401B	diff press	DP-401B	2	1	2
DCWO-04	1042	Filter alarm/across filter/T-401B	Alarm	AL-401B	1	1	1
DCWO-04	1043	mass/calcine batch tank B/T401B	load cell	LC-403BA	1	1	1
DCWO-04	1044	mass/calcine batch tank C/T401B	load cell	LC-403BB	1	1	1
DCWO-04	1046	Off gas flow /vent/T-401C	diff press	DP-401C	2	1	2
DCWO-04	1047	Filter alarm/across filter/T-401C	Alarm	AL-401C	1	1	1
DCWO-04	1048	mass/calcine batch tank C/T401C	load cell	LC-403CA	1	1	1
DCWO-04	1049	mass/calcine batch tank D/T401C	load cell	LC-403CB	1	1	1
DCWO-04	1051	Off gas flow /vent/T-401D	diff press	DP-401D	2	1	2
DCWO-04	1052	Filter alarm/across filter/T-401D	Alarm	AL-401D	1	1	1
DCWO-04	1053	mass/calcine batch tank D/T401D	load cell	LC-403DA	1	1	1
DCWO-04	1054	mass/calcine batch tank D/T401D	load cell	LC-403DB	1	1	1

DCWO-04	1055	Air ejector for batch bin T401A	control	EJ-407A	1	1	1
DCWO-04	1056	Air ejector for batch bin T401B	control	EJ-407B	1	1	1
DCWO-04	1057	Air ejector for batch bin T401C	control	EJ-407C	1	1	1
DCWO-04	1058	Air ejector for batch bin T401D	control	EJ-407D	1	1	1
DCWO-04	1059	input from T401A to Kneeder M410A	valve contl	V-401A	1	1	1
DCWO-04	1060	switch/pos open/T401A to M410A	valve sw	S-V-401AU	1	1	1
DCWO-04	1061	switch/pos closed/T401A to M410A	valve sw	S-V-401AD	1	1	1
DCWO-04	1062	input from T401B to Kneeder M410B	valve contl	V-401B	1	1	1
DCWO-04	1063	switch/pos open/T401B to M410B	valve sw	S-V-401BU	1	1	1
DCWO-04	1064	switch/pos closed/T401B to M410B	valve sw	S-V-401BD	1	1	1
DCWO-04	1065	input from T401C to Kneeder M410C	valve contl	V-401C	1	1	1
DCWO-04	1066	switch/pos open/T401C to M410C	valve sw	S-V-401CU	1	1	1
DCWO-04	1067	switch/pos closed/T401C to M410C	valve sw	S-V-401CD	1	1	1
DCWO-04	1068	input from T401D to Kneeder M410D	valve contl	V-401D	1	1	1
DCWO-04	1069	switch/pos open/T401D to M410D	valve sw	S-V-401DU	1	1	1
DCWO-04	1070	switch/pos closed/T401D to M410D	valve sw	S-V-401DD	1	1	1
DCWO-04	1072	area radiation monitor/area 04/T-401A	rad monitor	rad-401A	1	2	2
DCWO-04	1074	area radiation monitor/area 04/T-401B	rad monitor	rad-401B	1	2	2
DCWO-04	1076	area radiation monitor/area 04/T-401C	rad monitor	rad-401C	1	2	2
DCWO-04	1078	area radiation monitor/area 04/T-401D	rad monitor	rad-401D	1	2	2
DCWO-04	1080	Off gas flow /Filter F-405A/M402A	diff press	DP-402A	2	1	2
DCWO-04	1081	Filter alarm/across filter 405A/T-402A	Alarm	AL-402A	1	1	1

DCWO-04	1082	mass/Blender tank A/M402A	load cell	LC-404AA	1	1	1
DCWO-04	1083	mass/Blender tank A/M402A	load cell	LC-404AB	1	1	1
DCWO-04	1084	feedback contl /M402A to input slag silo	feedbk contrl	C-402A	1	1	1
DCWO-04	1086	Off gas flow /Filter F-405B/M402B	diff press	DP-402B	2	1	2
DCWO-04	1087	Filter alarm/across filter 405B/T-402B	Alarm	AL-402B	1	1	1
DCWO-04	1088	mass/Blender tank B/M402B	load cell	LC-404BA	1	1	1
DCWO-04	1089	mass/Blender tank B/M402B	load cell	LC-404BB	1	1	1
DCWO-04	1090	feedback contl/M402B to input slag silo	feedbk contrl	C-402B	1	1	1
DCWO-04	1092	Off gas flow /Filter F-405C/M402C	diff press	DP-402C	2	1	2
DCWO-04	1093	Filter alarm/across filter 405C/T-402C	Alarm	AL-402C	1	1	1
DCWO-04	1094	mass/Blender tank C/M402C	load cell	LC-404CA	1	1	1
DCWO-04	1095	mass/Blender tank C/M402C	load cell	LC-404CB	1	1	1
DCWO-04	1096	feedback contl /M402C to input slag silo	feedbk contrl	C-402C	1	1	1
DCWO-04	1098	Off gas flow /Filter F-405D/M402D	diff press	DP-402D	2	1	2
DCWO-04	1099	Filter alarm/across filter 405D/T-402D	Alarm	AL-402D	1	1	1
DCWO-04	1100	mass/Blender tank D/M402D	load cell	LC-404DA	1	1	1
DCWO-04	1101	mass/Blender tank D/M402D	load cell	LC-404DB	1	1	1
DCWO-04	1102	feedback contl /M402D to input slag silo	feedbk contrl	C-402D	1	1	1
DCWO-04	1103	Air ejector for ribbon blender M402A	control	EJ-406A	1	1	1
DCWO-04	1104	Air ejector for ribbon blender M402B	control	EJ-406B	1	1	1
DCWO-04	1105	Air ejector for ribbon blender M402C	control	EJ-406C	1	1	1
DCWO-04	1106	Air ejector for ribbon blender N402D	control	EJ-406D	1	1	1

DCWO-04	1107	input from T402A to Kneeder M410A	valve contl	V-402A	1	1	1
DCWO-04	1108	switch/pos open/T402A to M410A	valve sw	S-V-402AU	1	1	1
DCWO-04	1109	switch/pos closed/T402A to M410A	valve sw	S-V-402AD	1	1	1
DCWO-04	1110	input from T402B to Kneeder M410B	valve contl	V-402B	1	1	1
DCWO-04	1111	switch/pos open/T402B to M410B	valve sw	S-V-402BU	1	1	1
DCWO-04	1112	switch/pos closed/T402B to M410B	valve sw	S-V-402BD	1	1	1
DCWO-04	1113	input from T402C to Kneeder M410C	valve contl	V-402C	1	1	1
DCWO-04	1114	switch/pos open/T402C to M410C	valve sw	S-V-402CU	1	1	1
DCWO-04	1115	switch/pos closed/T402C to M410C	valve sw	S-V-402CD	1	1	1
DCWO-04	1116	input from T402D to Kneeder M410D	valve contl	V-402D	1	1	1
DCWO-04	1117	switch/pos open/T402D to M410D	valve sw	S-V-402DU	1	1	1
DCWO-04	1118	switch/pos closed/ T402D to M410D	valve sw	S-V-402DD	1	1	1
DCWO-04	1120	Off gas flow /vent/M410A	diff press	DP-410A	2	1	2
DCWO-04	1121	Level/Kneeder Extruder Tank/M410A	load cell	LC-410AA	1	1	1
DCWO-04	1122	Lvl/Kneeder Extruder/M410A/redundant	load cell	LC-410AB	1	1	1
DCWO-04	1124	Off gas flow /vent/M410B	diff press	DP-410B	2	1	2
DCWO-04	1125	Level/Kneeder Extruder Tank/M410B	load cell	LC-410BA	1	1	1
DCWO-04	1126	Lvl/Kneeder Extruder/M410B/redundant	load cell	LC-410BB	1	1	1
DCWO-04	1128	Off gas flow /vent/M410C	diff press	DP-410C	2	1	2
DCWO-04	1129	Level/Kneeder Extruder Tank/M410C	load cell	LC-410CA	1	1	1
DCWO-04	1130	Lvl/Kneeder Extruder/M410C/redundant	load cell	LC-410CB	1	1	1

DCWO-04	1132	Off gas flow /vent/M410D	diff press	DP-410D	2	1	2
DCWO-04	1133	Level/Kneeder Extruder Tank/M410D	load cell	LC-410DA	1	1	1
DCWO-04	1134	Lvl/Kneeder Extruder/M410D/redundant	load cell	LC-410DB	1	1	1
DCWO-04	1135	(on/off/speed) kneeder/extruder A	control	M-410A	1	1	1
DCWO-04	1136	(on/off/speed) kneeder/extruder B	control	M-410B	1	1	1
DCWO-04	1137	(on/off/speed) kneeder/extruder C	control	M-410C	1	1	1
DCWO-04	1138	(on/off/speed) kneeder/extruderD	control	M-410D	1	1	1
DCWO-04	1139	alarm/on line from 132A	Alarm	AL-410-1A	1	1	1
DCWO-04	1140	alarm/on line from 132B	Alarm	AL-410-1B	1	1	1
DCWO-04	1141	alarm/on line from 132C	Alarm	AL-410-1C	1	1	1
DCWO-04	1142	alarm/on line from 132D	Alarm	AL-410-1D	1	1	1
DCWO-04	1143	alarm/on line from 133A	Alarm	AL-410-2A	1	1	1
DCWO-04	1144	alarm/on line from 133B	Alarm	AL-410-2B	1	1	1
DCWO-04	1145	alarm/on line from 133C	Alarm	AL-410-2C	1	1	1
DCWO-04	1146	alarm/on line from 133D	Alarm	AL-410-2D	1	1	1
DCWO-04	1148	area radiation monitor/area 04/M-410A	rad monitor	rad-410A	1	2	2
DCWO-04	1150	area radiation monitor/area 04/M-410B	rad monitor	rad-410B	1	2	2
DCWO-04	1152	area radiation monitor/area 04/M-410C	rad monitor	rad-410C	1	2	2
DCWO-04	1154	area radiation monitor/area 04/M-410D	rad monitor	rad-410D	1	2	2
DCWO-04	1155	Injection head move control/A	control	IJ-408A	1	1	1
DCWO-04	1156	Injection head open/close control/A	control	IJ-408A-1	1	1	1
DCWO-04	1157	Injection head move control/B	control	IJ-408B	1	1	1
DCWO-04	1158	Injection head open/close control/B	control	IJ-408B-1	1	1	1
DCWO-04	1159	Injection head move control/C	control	IJ-408C	1	1	1
DCWO-04	1160	Injection head open/close control/C	control	IJ-408C-1	1	1	1
DCWO-04	1161	Injection head move control/D	control	IJ-408D	1	1	1
DCWO-04	1162	Injection head open/close control/D	control	IJ-408D-1	1	1	1

DCWO-04	1164	Off gas flow /IJ-408A	diff press	DP-408A	2	1	2
DCWO-04	1166	Off gas flow /IJ-408B	diff press	DP-408B	2	1	2
DCWO-04	1168	Off gas flow /IJ-408C	diff press	DP-408C	2	1	2
DCWO-04	1170	Off gas flow /IJ-408D	diff press	DP-408D	2	1	2
DCWO-04	1171	collect/test coupons line a	UNKNOWN		1	1	1
DCWO-04	1172	collect/test coupons line b	UNKNOWN		1	1	1
DCWO-04	1173	collect/test coupons line c	UNKNOWN		1	1	1
DCWO-04	1174	collect/test coupons line d	UNKNOWN		1	1	1
DCWO-04	1175	move wash water from injection head A	UNKNOWN		1	1	1
DCWO-04	1176	move wash water from injection head B	UNKNOWN		1	1	1
DCWO-04	1177	move wash water from injection head C	UNKNOWN		1	1	1
DCWO-04	1178	move wash water from injection head D	UNKNOWN		1	1	1
DCWO-04	1181	(on/off/speed) Vibrator Platform A	control	VP-409A	1	3	3
DCWO-04	1184	(on/off/speed) Vibrator Platform B	control	VP-409B	1	3	3
DCWO-04	1187	(on/off/speed) Vibrator Platform C	control	VP-409C	1	3	3
DCWO-04	1190	(on/off/speed) Vibrator Platform D	control	VP-409D	1	3	3
DCWO-04	1191	Level/End Container Tank/VP-409A	load cell	LC-409AA	1	1	1
DCWO-04	1192	Lvl/End Container/VP-409A/redundant	load cell	LC-409AB	1	1	1
DCWO-04	1193	Level/End Container Tank/VP-409B	load cell	LC-409BA	1	1	1
DCWO-04	1194	Lvl/End Container/VP-409B/redundant	load cell	LC-409BB	1	1	1
DCWO-04	1195	Level/End Container Tank/VP-409C	load cell	LC-409CA	1	1	1
DCWO-04	1196	Lvl/End Container/VP-409C/redundant	load cell	LC-409CB	1	1	1
DCWO-04	1197	Level/End Container Tank/VP-	load cell	LC-409DA	1	1	1

		409D					
DCWO-04	1198	Lvl/End Container/VP-409D/redundant	load cell	LC-409DB	1	1	1
DCWO-04	1201	feedback contl /LC409A to input kneeder A	feedbk contrl	C-409A	1	3	3
DCWO-04	1204	feedback contl / LC409B to input kneeder B	feedbk contrl	C-409B	1	3	3
DCWO-04	1207	feedback contl /LC409C to input kneeder C	feedbk contrl	C-409C	1	3	3
DCWO-04	1210	feedback contl /LC409D to input kneeder D	feedbk contrl	C-409D	1	3	3
DCWO-04	1212	area rad monitor/at container A	rad monitor	rad-409A	1	2	2
DCWO-04	1214	area rad monitor/area 04/at container B	rad monitor	rad-409B	1	2	2
DCWO-04	1216	area rad monitor/area 04/at container C	rad monitor	rad-409C	1	2	2
DCWO-04	1218	area rad monitor/area 04/at container D	rad monitor	rad-409D	1	2	2
DCWO-04	1226	feedback/calcine T401A to P203	control		4	2	8
DCWO-04	1234	feedback/blender M402A to clay	control		4	2	8
DCWO-04	1242	control belt at blender M402	control		4	2	8
DCWO-04	1258	Kneeder M410	control		4	4	16
DCWO-04	1322	logic/control/of mtls into extruder	control		4	16	64
DCWO-04	1326	rad monitor	rad monitor		4	1	4
DCWO-04	1342	hydro ram at platform	control		4	4	16
DCWO-04	1358	vibrators	control		4	4	16
DCWO-04	1390	sonic measurement	control		4	8	32
DCWO-04	1402	sample port valves	control		4	3	12
DCWO-04	1426	robotic to take sample	control		4	6	24
DCWO-04	1466	trolly controls for canisters	control		4	10	40
DCWO-04	1486	at injection head	camera		2	10	20
DCWO-04	1502	limit swtiches on hydro ram	control		4	4	16
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DCWO-05	1504	vent from mixer/M501A	diff press	DP-501A	2	1	2
DCWO-05	1505	mass/mixer A/M501A	load cell	LC-502AA	1	1	1
DCWO-05	1506	mass/mixer A/M501A	load cell	LC-502AB	1	1	1
DCWO-05	1509	(on/off/speed) control of mixer A/M501A	control	C-501A	1	3	3
DCWO-05	1510	Temperature top tank M501A	RTD	T-501A-1	1	1	1
DCWO-05	1511	Temperature mid tank M501A	RTD	T-501A-2	1	1	1
DCWO-05	1512	Temperature lower tank M501A	RTD	T-501A-3	1	1	1
DCWO-05	1513	Temperature bottom tank M501A	RTD	T-501A-4	1	1	1
DCWO-05	1516	(on/off/vari) Temperature contl M501A	control	TC-501A	1	3	3
DCWO-05	1518	vent from mixer/M501B	diff press	DP-501B	2	1	2
DCWO-05	1519	mass/mixer B/M501B	load cell	LC-502BA	1	1	1
DCWO-05	1520	mass/mixer B/M501B	load cell	LC-502BB	1	1	1
DCWO-05	1523	(on/off/speed) control of mixer B/M501B	control	C-501B	1	3	3
DCWO-05	1524	Temperature top tank M501B	RTD	T-501B-1	1	1	1
DCWO-05	1525	Temperature mid tank M501B	RTD	T-501B-2	1	1	1
DCWO-05	1526	Temperature lower tank M501B	RTD	T-501B-3	1	1	1
DCWO-05	1527	Temperature bottom tank M501B	RTD	T-501B-4	1	1	1
DCWO-05	1530	(on/off/vari) Temperature contl M501B	control	TC-501B	1	3	3
DCWO-05	1533	positive displacement pump from M501A	control	P-503A	1	3	3
DCWO-05	1536	positive displacement pump from M501B	control	P-503B	1	3	3
DCWO-05	1537	move from mixer A & B	valve contl	V-501	1	1	1
DCWO-05	1538	switch/positive open/from mixer A to B	valve sw	S-V-501UA	1	1	1
DCWO-05	1539	switch/positive closed/from mixer A to B	valve sw	S-V-501DA	1	1	1
DCWO-05	1540	output to M410A	valve contl	V-502	1	1	1
DCWO-05	1541	switch/positive open/to M410A	valve sw	S-V-502U	1	1	1

DCWO-05	1542	switch/positive closed/to M410A	valve sw	S-V-502D	1	1	1
DCWO-05	1543	output to M410B	valve contl	V-503	1	1	1
DCWO-05	1544	switch/positive open/to M410B	valve sw	S-V-503U	1	1	1
DCWO-05	1545	switch/positive closed/to M410B	valve sw	S-V-503D	1	1	1
DCWO-05	1546	output to M410C	valve contl	V-504	1	1	1
DCWO-05	1547	switch/positive open/to M410C	valve sw	S-V-504U	1	1	1
DCWO-05	1548	switch/positive closed/to M410C	valve sw	S-V-504D	1	1	1
DCWO-05	1549	output to M410D	valve contl	V-505	1	1	1
DCWO-05	1550	switch/positive open/to M410D	valve sw	S-V-505U	1	1	1
DCWO-05	1551	switch/positive closed/to M410D	valve sw	S-V-505D	1	1	1
DCWO-05	1552	input from water makeup	valve contl	V-507	1	1	1
DCWO-05	1553	switch/pos open/input from water makeup	valve sw	S-V-507U	1	1	1
DCWO-05	1554	switch/pos closed/input from water makeup	valve sw	S-V-507D	1	1	1
DCWO-05	1555	input from NaOH tank	valve contl	V-506	1	1	1
DCWO-05	1556	switch/positive open/input from NaOH tank	valve sw	S-V-506U	1	1	1
DCWO-05	1557	switch/positive closed/input from NaOH tank	valve sw	S-V-506D	1	1	1
DCWO-05	1559	area radiation monitor/area 05	rad monitor	rad-501	1	2	2
DCWO-05	1561	area radiation monitor/area 05	rad monitor	rad-502	1	2	2
DCWO-05	1569	temp control on mixers	RTD		2	4	8
DCWO-05	1577	temp inside mixers	RTD		2	4	8
DCWO-05	1585	mixer controls on/off/speed	control		2	4	8
DCWO-05	1593	add a pump to line	control		2	4	8
DCWO-05	1617	add 4 valves to bypass pump	control		2	12	24
DCWO-05	1621	rad monitor	rad monitor		2	2	4
DCWO-05	1641	camera at each location	camera		2	10	20
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DCWO-06	1642	input from wash water A (136A)	valve contl	V-601A	1	1	1
DCWO-06	1643	switch/pos open/input from wash water A	valve sw	S-V-601UA	1	1	1

DCWO-06	1644	switch/pos closed/input from wash water A	valve sw	S-V-601DA	1	1	1
DCWO-06	1645	input from wash water B (136B)	valve contl	V-601B	1	1	1
DCWO-06	1646	switch/pos open/input from wash water B	valve sw	S-V-601UB	1	1	1
DCWO-06	1647	switch/pos closed/input from wash water B	valve sw	S-V-601DB	1	1	1
DCWO-06	1648	input from wash water C (136C)	valve contl	V-601C	1	1	1
DCWO-06	1649	switch/pos open/input from wash water C	valve sw	S-V-601UC	1	1	1
DCWO-06	1650	switch/pos closed/input from wash water C	valve sw	S-V-601DC	1	1	1
DCWO-06	1651	input from wash water D (136D)	valve contl	V-601D	1	1	1
DCWO-06	1652	switch/pos open/input from wash water D	valve sw	S-V-601UD	1	1	1
DCWO-06	1653	switch/pos closed/input from wash water D	valve sw	S-V-601DD	1	1	1
DCWO-06	1654	input from makeup water	valve contl	V-602	1	1	1
DCWO-06	1655	switch/pos open/input from makeup water	valve sw	S-V-602U	1	1	1
DCWO-06	1656	switch/pos closed/input from makeup water	valve sw	S-V-602D	1	1	1
DCWO-06	1657	to pumps 602 A&B	valve contl	V-603	1	1	1
DCWO-06	1658	switch/positive open/to pumps 602 A&B	valve sw	S-V-603U	1	1	1
DCWO-06	1659	switch/positive closed/to pumps 602 A&B	valve sw	S-V-603D	1	1	1
DCWO-06	1660	after pumps 602 A&B	valve contl	V-604	1	1	1
DCWO-06	1661	switch/pos open/after pumps 602 A&B	valve sw	S-V-604U	1	1	1
DCWO-06	1662	switch/pos closed/after pumps 602 A&B	valve sw	S-V-604D	1	1	1
DCWO-06	1665	positive displacement pump to	control	P-602A	1	3	3

		M601					
DCWO-06	1668	positive displacement pump to M601	control	P-602B	1	3	3
DCWO-06	1669	(on/off/speed) control of mixer/M601	control	C-601	1	1	1
DCWO-06	1670	vent from mixer/M601	diff press	DP-601	1	1	1
DCWO-06	1671	alarm/on line from mixer 601	Alarm	AL-601	1	1	1
DCWO-06	1672	mass/mixer wash tank/M601	load cell	LC-601A	1	1	1
DCWO-06	1673	mass/mixer wash tank/M601	load cell	LC-601B	1	1	1
DCWO-06	1676	feedback control/to makeup water/M601	feedbk contrl	C-602	1	3	3
DCWO-06	1677	to pumps 603 A&B	valve contl	V-605	1	1	1
DCWO-06	1678	switch/positive open/to pumps 603 A&B	valve sw	S-V-605U	1	1	1
DCWO-06	1679	switch/positive closed/to pumps 603 A&B	valve sw	S-V-605D	1	1	1
DCWO-06	1680	after pumps 603 A&B	valve contl	V-606	1	1	1
DCWO-06	1681	switch/pos open/after pumps 603 A&B	valve sw	S-V-606U	1	1	1
DCWO-06	1682	switch/pos closed/after pumps 603 A&B	valve sw	S-V-606D	1	1	1
DCWO-06	1685	pos displacemnt pump/M601 to wash water	control	P-603A	1	3	3
DCWO-06	1688	pos displacemnt pump/M601 to wash water	control	P-603B	1	3	3
DCWO-06	1689	to pumps 604 A&B	valve contl	V-607	1	1	1
DCWO-06	1690	switch/positive open/to pumps 604 A&B	valve sw	S-V-607U	1	1	1
DCWO-06	1691	switch/positive closed/to pumps 604 A&B	valve sw	S-V-607D	1	1	1
DCWO-06	1692	after pumps 604 A&B	valve contl	V-608	1	1	1
DCWO-06	1693	switch/pos open/after pumps 604 A&B	valve sw	S-V-608U	1	1	1

DCWO-06	1694	switch/pos closed/after pumps 604 A&B	valve sw	S-V-608D	1	1	1
DCWO-06	1695	across filter 605A	diff press	DP-602	1	1	1
DCWO-06	1696	filter 605A	Alarm	AL-602	1	1	1
DCWO-06	1698	across filter 605B	diff press	DP-603	2	1	2
DCWO-06	1699	filter 605B	Alarm	AL-603	1	1	1
DCWO-06	1702	pos displacemnt pump/ M601 to makeup	control	P-604A	1	3	3
DCWO-06	1705	pos displacemnt pump/ M601 to makeup	control	P-604B	1	3	3
DCWO-06	1706	to wash water (133A)	valve contl	V-609A	1	1	1
DCWO-06	1707	switch/pos open/ to wash water (133A)	valve sw	S-V-609UA	1	1	1
DCWO-06	1708	switch/pos closed/to wash water (133A)	valve sw	S-V-609DA	1	1	1
DCWO-06	1709	to wash water (133B)	valve contl	V-609B	1	1	1
DCWO-06	1710	switch/pos open/ to wash water (133B)	valve sw	S-V-609UB	1	1	1
DCWO-06	1711	switch/pos closed/to wash water(133B)	valve sw	S-V-609DB	1	1	1
DCWO-06	1712	to wash water (133C)	valve contl	V-609C	1	1	1
DCWO-06	1713	switch/pos open/ to wash water (133C)	valve sw	S-V-609UC	1	1	1
DCWO-06	1714	switch/pos closed/to wash water (133C)	valve sw	S-V-609DC	1	1	1
DCWO-06	1715	to wash water (133D)	valve contl	V-609D	1	1	1
DCWO-06	1716	switch/pos open/ to wash water (133D)	valve sw	S-V-609UD	1	1	1
DCWO-06	1717	switch/pose closed/to wash water (133D)	valve sw	S-V-609DD	1	1	1
DCWO-06	1719	area radiation monitor/area 06	rad monitor	rad-601	1	2	2
DCWO-06	1721	area radiation monitor/area 06	rad monitor	rad-602	1	2	2
DCWO-06	1723	rad monitor	rad monitor		1	2	2

DCWO-06	1724	alarms	alarm		1	1	1
******	****	**********	*********	**********	******	******	*****
DCWO-07	1725	Robotic Contamination Check station	DeCon ck	CCS-701A	1	1	1
DCWO-07	1726	Robotic Contamination Check station	DeCon ck	CCS-701B	1	1	1
DCWO-07	1727	Robotic Contamination Check station	DeCon ck	CCS-701C	1	1	1
DCWO-07	1728	Robotic Contamination Check station	DeCon ck	CCS-701D	1	1	1
DCWO-07	1729	Decontamination check Station	DeCon ck	DS-702A	1	1	1
DCWO-07	1730	Decontamination check Station	DeCon ck	DS-702B	1	1	1
DCWO-07	1731	Decontamination check Station	DeCon ck	DS-702C	1	1	1
DCWO-07	1732	Decontamination check Station	DeCon ck	DS-702D	1	1	1
DCWO-07	1737	Read bar code at CCS-701A	barcode read	BC-701A	1	5	5
DCWO-07	1742	Read bar code at CCS-701B	barcode read	BC-701B	1	5	5
DCWO-07	1747	Read bar code at CCS-701C	barcode read	BC-0701C	1	5	5
DCWO-07	1752	Read bar code at CCS-701D	barcode read	BC-701D	1	5	5
DCWO-07	1754	area radiation monitor/area 07	rad monitor	rad-701	1	2	2
DCWO-07	1756	area radiation monitor/area 07	rad monitor	rad-702	1	2	2
DCWO-07	3356	rail system (undefined) 400 carts	control		400	4	1600
DCWO-07	3376	camera at each location	camera		2	10	20
DCWO-07	3740	hydro ram	control		91	4	364
DCWO-07	4104	limit switches for ram	control		91	4	364
DCWO-07	4120	swipes/on/forward/side/open	control		1	16	16
DCWO-07	5030	pneumatic controls	control		91	10	910
DCWO-07	5394	rotate canister 360 deg	control		91	4	364
DCWO-07	5398	track switch to decon station	control		1	4	4
DCWO-07	5498	high press dry ice/rotate/press	control		1	100	100
DCWO-07	5522	decon flr/wash water/pump/valves	control		1	24	24
DCWO-07	5530	position switches	control		1	8	8
******	****	**********	*********	**********	******	******	*****
DCWO-08	5531	HEPA fliter placement, Robot	Filter Place	R-801A	1	1	1

DCWO-08	5532	HEPA fliter placement, Robot	Filter Place	R-801B	1	1	1
DCWO-08	5533	HEPA fliter placement, Robot	Filter Place	R-801C	1	1	1
DCWO-08	5534	HEPA fliter placement, Robot	Filter Place	R-801D	1	1	1
DCWO-08	5539	Read bar code at R-801A	barcode read	BC-801A	1	5	5
DCWO-08	5544	Read bar code at R-801B	barcode read	BC-801B	1	5	5
DCWO-08	5549	Read bar code at R-801C	barcode read	BC-801C	1	5	5
DCWO-08	5554	Read bar code at R-801D	barcode read	BC-801D	1	5	5
DCWO-08	5556	area radiation monitor/area 08	rad monitor	rad-801	1	2	2
DCWO-08	5558	area radiation monitor/area 08	rad monitor	rad-802	1	2	2
DCWO-08	5578	tracking switching from decon sta	control		1	20	20
DCWO-08	5598	robot/get filter on track sys	control		1	20	20
DCWO-08	5618	robot /move filter into position	control		1	20	20
DCWO-08	5628	limit switches on robots	control		1	10	10
DCWO-08	5632	sys to push ring down	control		1	4	4
DCWO-08	5636	limit switches on push mech	control		1	4	4
DCWO-08	5646	camera	camera		1	10	10
******	****	******************************	*********	**********	******	******	*****
DCWO-09	5651	Read bar code at cure station	barcode read	BC-901	1	5	5
DCWO-09	5652	Temperature at cure station	RTD	T-901	1	1	1
DCWO-09	5653	Relative Humidity at cure station	Humidity	HU-901	1	1	1
DCWO-09	5655	area radiation monitor/area 09	rad monitor	rad-901	1	2	2
DCWO-09	5657	area radiation monitor/area 09	rad monitor	rad-902	1	2	2
DCWO-09	5677	track switching/stage area/5 doors	control		5	4	20
DCWO-09	5727	each door like an airlock	control		5	10	50
DCWO-09	5767	camera at each door	camera		4	10	40
DCWO-09	5771	pressure at lack	pressure		4	1	4
DCWO-09	5779	temperature at lock	RTD		4	2	8
DCWO-09	5787	rad monitor at lock	rad		4	2	8
DCWO-09	5847	autoclave valves	control		4	15	60
DCWO-09	5855	pressure within autoclave	pressure		4	2	8
DCWO-09	5895	temperature within autoclave	RTD		4	10	40
DCWO-09	5911	RH within autoclave	RH		4	4	16
DCWO-09	5919	rad monitor	rad		4	2	8

******	****	******************************	*********	**********	******	******	*****
DCWO-10	5924	Read bar code at Dewater station	barcode read	BC-1001	1	5	5
DCWO-10	5925	Temperature at Dewater station	RTD	T-1001	1	1	1
DCWO-10	5926	Relative Humidity at Dewater station	Humidity	HU-1001	1	1	1
DCWO-10	5928	area radiation monitor/area 10	rad monitor	rad-1001	1	2	2
DCWO-10	5930	area radiation monitor/area 10	rad monitor	rad-1002	1	2	2
DCWO-10	5950	area camera	camera		2	10	20
DCWO-10	5970	track switch/4 autoclave loc/one dewater	control		4	5	20
DCWO-10	5990	track switch/out of area (5 doors)	control		5	4	20
DCWO-10	6040	each door like an airlock	control		5	10	50
DCWO-10	6050	temperature	RTD		1	10	10
DCWO-10	6052	RH	RH		1	2	2
DCWO-10	6056	pressure	pressure		2	2	4
DCWO-10	6060	rad monitor	rad		2	2	4
******	****	******************************	*********	**********	******	******	*****
DCWO-11	6140	HEPA Filter removal, robot	Filter remove	R-1101	4	20	80
DCWO-11	6220	Weld/seal check Cannister, Robot	Weld/Seal Ck	R-1102	4	20	80
DCWO-11	6240	Read bar code at HEPA filter/weld seal sta	barcode read	BC-1101	4	5	20
DCWO-11	6248	area radiation monitor/area 11	rad monitor	rad-1101	4	2	8
DCWO-11	6256	area radiation monitor/area 11	rad monitor	rad-1102	4	2	8
DCWO-11	6296	area camera	control		4	10	40
DCWO-11	6312	robot to pull up ring	control		4	4	16
DCWO-11	6352	limit switches to move filter off canister	control		4	10	40
DCWO-11	6432	robot to move filter to hold area/track sys	control		4	20	80
DCWO-11	6448	limit switch for canister location	control		4	4	16
DCWO-11	6464	limit switches for position	control		4	4	16
DCWO-11	6504	robot to retrieve and postion cap	control		2	20	40
DCWO-11	6544	resistance weld robot	control		2	20	40

		)pos/current/volts)					
DCWO-11	6564	area camera	camera		2	10	20
******	****	**********	*********	**********	******	******	*****
DCWO-12	6584	Robotic Contamination Check station	DeCon Ck	CCS-1201	1	20	20
DCWO-12	6604	Decontamination check Station	DeCon Ck	CCS-1202	1	20	20
DCWO-12	6609	Read bar code at surface contamination ck sta	barcode read	BC-1201	1	5	5
DCWO-12	6611	area radiation monitor/area 12	rad monitor	rad-1201	1	2	2
DCWO-12	6613	area radiation monitor/area 12	rad monitor	rad-1202	1	2	2
DCWO-12	6621	track switch to decon sta	control		2	4	8
DCWO-12	6631	area camera	camera		1	10	10
DCWO-12	6635	hydro ram	control		1	4	4
DCWO-12	6639	limit switches on ram	control		1	4	4
DCWO-12	6655	swipe controls	control		1	16	16
DCWO-12	6665	pnumatic controls	control		1	10	10
DCWO-12	6669	rotate camera	control		1	4	4
DCWO-12	6769	high press dry ice for decon	control		1	100	100
DCWO-12	6819	decon floor	control		1	50	50
DCWO-12	6827	position swtiches	control		2	4	8
DCWO-12	6831	rad monitor	rad monitor		2	2	4
DCWO-12	6833	pressure	pressure		1	2	2
DCWO-12	6841	track switch out of decon	control		2	4	8
******	****	**********	*********	**********	******	******	*****
DCWO-13	6861	Sonic Tomography	Tomography	STS-1301	1	20	20
DCWO-13	6866	Read bar code at surface sonic tomagraphy sta	barcode read	BC-1301	1	5	5
DCWO-13	6868	area radiation monitor/area 13	rad monitor	rad-1301	1	2	2
DCWO-13	6870	area radiation monitor/area 13	rad monitor	rad-1302	1	2	2
DCWO-13	6910	sonic tomography	control		1	40	40
DCWO-13	6950	sonic controls	control		1	40	40
DCWO-13	6954	position switches	control		1	4	4
DCWO-13	6958	rad monitor	rad monitor		2	2	4

DCWO-13	6968	area camera	camera		1	10	10
******	****	**********	*********	**********	******	******	*****
DCWO-14	6972	track switch /bad tomography	control		1	4	4
DCWO-14	7052	position switch for 20 canisters	control		20	4	80
DCWO-14	7062	rad monitors	rad monitor		5	2	10
DCWO-14	7072	positioning mach to laser off canister shell	control		1	10	10
DCWO-14	7082	laser controls	control		1	10	10
DCWO-14	7086	laser power	control		1	4	4
DCWO-14	7096	turn canister 360 deg	control		1	10	10
DCWO-14	7196	transfer grout to crusher	control		1	100	100
DCWO-14	7296	grush grout	control		1	100	100
DCWO-14	7396	transfer grout to storage	control		1	100	100
DCWO-14	7446	area camera	camera		5	10	50
DCWO-14	7456	pressure	pressure		5	2	10
DCWO-14	7556	move shell to storage	control		1	100	100
******	****	**********	*********	**********	******	******	*****
DCWO-15	7578	11 waste streams to measure	pressure		11	2	22
DCWO-15	7600	11 waste streams to measure	rad monitor		11	2	22
DCWO-15	7644	11 waste streams to measure	alarm		11	4	44
DCWO-15	7666	11 waste streams to measure	flow velocity		11	2	22
******	****	**********	*********	**********	******	******	*****
			TTL OF	7666	measurements		No HVAC on this chart

Heating Ventilation and Air Conditioning
Instrumentation estimates
for the
Direct Cementitious Waste Option

26 November, 1997

Introduction

This report presents an estimate for the Heating Ventilation and Air Conditioning (HVAC) system instrumentation needed to support the operation of the Direct Cementitious (Grout) Waste option (DCWO) to be used in treat calcined waste into a form suitable for final disposal. (This process will blend clay and slag with the calcine and inject the mixture into a container to be stored.)

System Process

The DCWO facilities will include a calcine receiving system, grouting material receiving and delivery system, a blending system, a grouting process, product lag storage, an off gas treatment system, and supporting utilities systems. The process will begin by mixing clay and slag with the calcine in a mixer. The resulting blend will be injected into the containers which will be 24 inches in diameter by 118 inches long. The containers then will have a HEPA filter temporarily installed on the top while the containers pass through an autoclave to cure the grout and a dewater station to dry it After the dewater station, the HEPA filter will be removed and a seal cap will be welded in place. Lastly, the container will be transferred to an interim storage area.

All processes, transfer of the materials and all other operations are to be handled remotely from the control room. This requires many instruments and operation controls. Also several of the operations will be performed by robots.

HVAC Instrumentation

Miscellaneous controls and sensors will by supplied to measure, status, and control the various equipment and sub-systems associated with the HVAC. These items include a couple of chillers for cold water, water, several air handling units, several exhaust units, several glove boxes, hot process waste, cold process waste, steam and condensate system, plant raw water, plant de-mineralized water, plant cold water. Sensor types include water level, water temperature, air flows, and air temperature.

It was assumed that there will be 200,000 square feet of office space and 160 personnel at the facility. This area will be divided into about 100 zones and each zone will have 6 sensors for a total of 600 sensors. The non-radiation areas will have another 600 sensors and the radiation areas will have another 100 sensors. All together this is 1300 sensors.

In addition, there will be 100 differential pressures for ventilation control The pressures will not be required to have a readout in the control room, but each will have an alarm signal in the control room.

There will be approximately 50 breathing air alarms (lost of pressure) stationed in several locations within the radiation areas, which will have an alarm in the control room.

There are estimated to be 300 locations needed for HEPA filters and each location will have two filters, one for redundancy. Each of the 600 filters will have a differential pressure across it and a signal alarm will be sent to the control room.

There will be approximately 10 radiation monitors in the air exhaust downstream of the filters.

There will be a dedicated work station to monitor and control those equipment and measurements associated directly with the HVAC systems. This work station will be in the control room.

Assumptions

The facility design life is 5 years. The hardware will be required to operate for the design life in a radiation field of about 90 R/hr and in a corrosive environment.

Wiring for the instruments to the data system will be twisted-shielded pair run in conduit. There will be a redundant set of wiring through a separate and physically distant path from the original wiring. The majority of the instrument and process signals will be 4-20 mA. All wiring from the instrumentation and operations will be routed into the computer room to instrument patch panels and the signals will be redistributed from there.

Instrument List

The attached list for the proposed instrumentation is for those systems which have been identified to date. The list is tentative and there is a high degree of uncertainty in the numbers and type of instruments involved, since most of HVAC system is not well defined. No significant effort has been made at this time to identify types of instruments to meet the intended needs.

References

Conversations with the HVAC engineer were held and a general description of the various parts were discussed. Based on conversations, this instrumentation package was developed.

Potential HVAC Instrumentation for the Direct Cementitious Waste Option

Instrument type	Number of Instruments
Water Level	10
Water Temperature	20
Air Flow	20
Air Temperature	10
General sensors in office space area	600
General sensors in non-radiation area	600
General sensors in radiation area	100
Alarms from DP in ventilation control	100
Alarms for air breathing (loss of pressure)	50
Alarms from DP across HEPA filters	600
Radiation air monitors in the air exhaust	10
Total of measurements delivered to control room	2120

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project
Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: DCWO Canister Heat Transfer Analysis

Summary: During the course of developing a conceptual design for the Direct Cementitious Waste Option (DCWO) it became evident that heat transfer properties of the cast and cured stabilized waste would have a significant impact on equipment sizes and other factors of the design.

The following investigation develops estimates of heat transfer properties, the time required to cure the wasteform, mass and energy change during adiabatic decompression, the time to dewater the wasteform, and the process heat load.

Based on this investigation the following results were obtained:

- The thermal conductivity of the wet grout is expected to be approximately 0.5 Btu/hr-ft-°F
- The specific heat of the cured and dried grout is expected to be approximately 0.20 Btu/lbm-°F
- The time required to cure a canister filled with the grout wasteform in an autoclave in the presence of 250°C condensing steam is approximately 35 hours.
- During the depressurization of the autoclave, the grout is expected to vaporize approximately 30% of the free water in the grout and spontaneously cool to around 100°C.
- The time required to dry the remaining water from the grout is approximately 7 days.
- The theoretical process heat load to autoclave and dewater a canister of grout is approximately 1.5×10^6 Btu.

Distribution (complete package): WTP EIS Studies Library, R. E. Dafoe M.S.3765, D. J. Harrell M.S. 3211, B. R. Helm M. S. 3765, K. L. Williams M. S. 3765

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
S.J.Losinski	4170	C M Barnes	1-14-98	R E Dafoe	1/14/98
C.D. Fletcher	4110				
C.B. Davis	4110				
S. J. Losinski C.D. Fletcher C.B. Davis	1/14/98 1/14/98 1/14/98	LMITCO Review	Date	LMITCO Approval	Date

Thermal Conductivity

Direct measurements of thermal conductivity have not been made on grout forms under consideration for the DCWO, therefore it is necessary to estimate this property. The following properties and grout formulation were provided by D.D. Siemer:

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(1) The density of the final hydroceramic waste form (after dewatering to 2 wt% total water content) is 1.7 gm/cc;
(2) The waste loading in the grout will be such as to achieve 35 wt% of waste in the final (dewatered) hydroceramic waste form;
(3) The recipe to be used in mixing the grout is as follows (wt%):

	NaOH	Water	Calcine	Clay	Slag	TOTAL
DRY MIXTURE	1.74%	0.00%	35.71%	56.29%	6.25%	100.00%
WET GROUT	1.36%	22.00 %	27.86%	43.91%	4.88%	100.00%
FINAL WASTE	1.70%	2.00%	35.00%	55.17%	6.13%	100.00%

Based on these properties and formula, materials with similar compositions and densities were considered.

Attached is a correlation of thermal conductivities for lightweight concretes (FAX from G. Moore to S. Losinski). Based on the assumption of no volume change during drying and a 22% wet grout water loading the net density of wet grout is calculated to be 136 lbm/ft^3 .See CALCULATION WORK SHEET (pg 4 of 14). The correlation for lightweight concrete shows an average value of

6 Btu/((ft^2 -hr-°F)/(in)) which is equivalent to 0.5 BTU/hr-ft-°F .

Attached also is a table of the thermal properties of lightweight concretes (Table 18.1). Reported thermal conductivities of cements similar in density range from 0.26-0.4 BTU/hr-ft-°F . (See arrows on table)

Attached also is a Figure (Labeled Figure 7) from a report from ORNL (ORNL/TM-8579) on FUETAP grouts (similar in form and function to DCWO grouts). This figure shows that grout conductivities ranged from 0.45-1.0 W/(m-K) (or 0.26-0.57 BTU/hr-ft-°F)

Conclusion: DCWO grout thermal conductivity is $\cong$ 0.5 BTU/hr-ft-°F

Specific Heat

Attached is a Table of specific heats for miscellaneous materials (Labled as Table 3-201) From the Chemical Engineering Handbook by Perry and Chilton. As indicated by the drawn arrows-------most cements, bricks, concrete ingredients, and porcelains have specific heats nearly equal to 0.2cal/gm °C (0.2 Btu/lbm °F).

Conclusion: DCWO grout specific heat is ≅ 0.2 BTU/lbm-°F.

TIME REQUIRED TO CURE WASTEFORM, MASS AND ENERGY CHANGE DURING ADIABATIC DECOMPRESSION, TIME TO DEWATER WASTEFORM, AND PROCESS HEAT LOAD,

Attached is a self explanatory evaluation of the above referenced items as prepared by C.D. Fletcher and C.B. Davis.

Conclusions

- The time required to cure a canister filled with the grout wasteform in an autoclave in the presence of 250°C condensing steam is approximately 35 hours.
- During the depressurization of the autoclave, the grout is expected to vaporize approximately 30% of the free water in the grout and spontaneously cool to around 100°C.
- The time required to dry the remaining water from the grout is approximately 7 days.
- The theoretical process heat load to autoclave and dewater a canister of grout is approximately 1.5×10^6 Btu.

CALCULATION WORK SHEET

Waste Cannister Thermal Analysis
Prepared by C. D. Fletcher CDF.
Checked by C. B. Davis CBD

November 17, 1997

Introduction and Purpose

Waste grout, contained in open cylindrical stainless steel vessels, is to be processed using a three-step method to drive off its initial 22%-by-weight moisture content:

Step 1

Raise the temperature of the grout (and the moisture bound within it) from an ambient 22°C (72°F) to 200°C (392°F) at the grout centerline using a saturated steam bath at 250°C (482°F) or 300°C (572°F).

Step 2

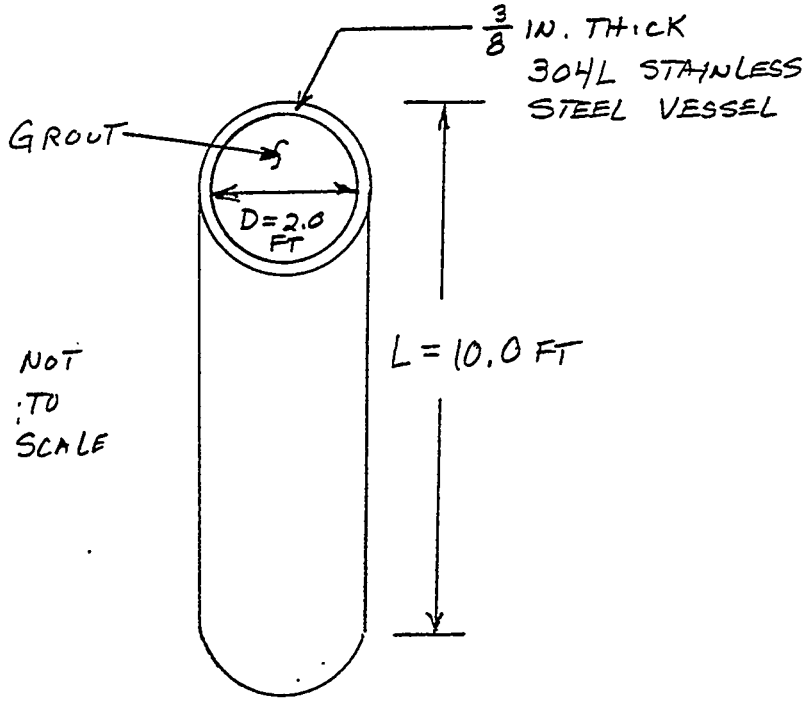
Depressurize and cool down the grout to atmospheric pressure and 100°C (212°F) at the centerline.

Step 3

Reheat the grout to 230°C (446°F) at the centerline using steam or hot air at 250°C (482°F) or 300°C (572°F).

The purpose of the work described here is to determine the times required to accomplish Steps 1 and 3 for the various assumed source temperatures and heating mediums. Results specified to within two significant digits are considered acceptable.

Problem Geometry



A vessel L/D of 5.0 was considered sufficiently large to allow an analysis based on an "infinite cylinder" approach. The effect of this assumption is to ignore heat transfer to the circular cylinder ends, which represent about 9% of the total surface area of the cylinder.

Material Thermal Properties

Stainless Steel

T, Temperature (°F)	k, Thermal Conductivity (Btu/hr-ft-°F)	rho*C_p, (Btu/ft^3-°F)
50	7.92	52.97
100	8.17	55.04
500	10.2	63.48
800	11.7	65.72
1000	12.7	67.31
1500	15.2	73.28

Reference: ASME Boiler and Pressure Vessel Code, Section III, 1971.

Dry Grout

k, Thermal Conductivity:	0.30 Btu/hr-ft-°F
rho, Density	106.13 lbm/ft^3
C_p, Specific Heat	0.20 Btu/lbm-°F

Reference: Personal communication with S. Losinski

The thermal properties of wet grout are calculated below as a part of the step 1, 2 and 3 problem setup.

General Analysis Method

The waste cannister is modeled using the RELAP5/MOD3 computer code: "RELAP5/MOD3 Code Manual," Idaho National Engineering Laboratory, NUREG/CR-5535, INEL-95/0174, August 1995.

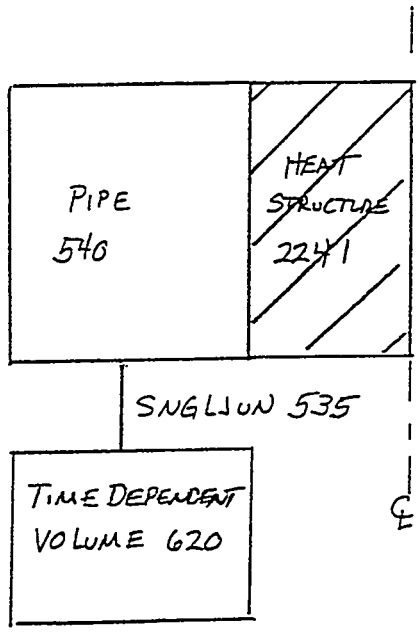
This code was developed for analysis of commercial nuclear power plants and includes a six-equation formulation for the conservation of fluid mass, momentum and energy. For this analysis problem, the pertinent processes represented with the code are:

Axially-symmetric thermal conduction in a two-composition (grout and steel) cylindrical geometry,

Condensation heat transfer from the surrounding steam to the outer vessel wall, and

Convection heat transfer from the surrounding air to the outer vessel wall.

A sketch of the RELAP5/MOD3 model developed to analyze this problem is shown here. The specific code version used to perform the calculations was 3.2.1.2.



The Heat Structure 2241 represents the grout region using 31 mesh points from the centerline to the vessel inner wall and the vessel outer wall with another mesh point. An inherent assumption is that there is no contact thermal resistance between the grout and vessel wall.

The surrounding fluid boundary conditions (gas species, pressure, temperature) are specified in Time Dependent Volume 620. For the steam cases, this fluid is allowed to migrate into Pipe 540 adjacent to the vessel outer wall as needed to replenish steam removed via condensation heat and mass transfer. For the cases with air, this migration would not be large enough to sustain the source temperature and Pipe 540 was made arbitrarily large so that the source temperature would not vary significantly during the calculation.

The fluid and structure were initialized as appropriate for each calculated case and a transient simulation was performed from time zero to the time at which the grout centerline reached its target value. The advancement through time was made using discrete time steps of 0.1 seconds.

Specific Analysis Inputs

Step 1 - Heatup from 22°C (72°F) to 200°C (392°F)

A moisture content of 22% by weight is assumed in the grout. A wet grout thermal conductivity of 0.5 Btu/hr-ft-°F was assumed, based on personal communication with S. Losinski.

The C_p for liquid water at 100°C (212°F) is 1.01 Btu/lbm-°F. The wet grout C_p was calculated using mass weighting:

$$C_{p\ wet\ grout} = (0.22 \times 1.01\ Btu/lbm\text{-}°F) + (0.78 \times 0.20\ Btu/lbm\text{-}°F)$$
$$= 0.38\ Btu/lbm\text{-}°F$$

The wet grout density was calculated as follows:

$rho_{dry\ grout} = 106.13\ lbm/ft^3$ (from p. 2)

let l = liquid, d = dry grout and m = mass.

then, $m_l / (m_d + m_l) = 0.22$
$m_l = 0.22\ m_d + 0.22\ m_l$
$m_l = 0.282\ m_d$
$m_{wet\ grout} = m_l + m_d = 1.282\ m_d$

so, $rho_{wet\ grout} = 1.282 \times 106.13\ lbm/ft^3 = 136.06\ lbm/ft^3$

The steam source for Step 1 assumed two different conditions:

Case 1 - Stagnant Saturated Steam at 250°C (482°F), 3.97 MPa (576 psia)
Case 3 - Stagnant Saturated Steam at 300°C (572°F), 8.57 MPa (1243 psia)

Step 2 - Depressurize and Cool Down from Step-1 End Conditions

This step was not calculated using RELAP5. The depressurization and cooldown from the Step 1, Case 1 and Case 3 end points (T_{grout} = 200°C (392°F), P as specified above) to the initial state for Step 3 (T_{grout} = 100°C (212°F), P = 0.101 MPa (14.7 psia) are hand calculated as follows to determine the wet grout density present at the start of Step 3.

Assume an isenthalpic blowdown from 576 psia to 14.7 psia. The results are almost identical for a blowdown from 1243 psia.

Initial enthalpy (liquid at 200°C (392°F), 3.97 MPa (576 psia)) = 366.89 Btu/lbm
Final enthalpy (liquid at 100°C (212°F), 0.101 MPa (14.7 psia)) = 180.18 Btu/lbm
h_{fg}, latent heat of vaporization at 0.101 MPa (14.7 psia) = 970.3 Btu/lbm

The fraction of liquid converted to steam from the depressurization is:

$$x = (366.89 - 180.18)/970.3 = 0.192$$

Next, calculate the fraction of liquid boiled away as a result of cooldown of the grout.

Initial grout temperature = 392°F
Final grout temperature = 212°F
Grout delta T = 180°F

Let V = total volume
M_G = mass of grout
M_L = mass of liquid.

The heat loss needed to cool the dry grout (per unit volume) is:

$$Q_G = (M_G C_p \times \text{delta}_T)/V = \text{rho}_{\text{dry grout}} \times C_p \times \text{delta T}$$
$$= 106.13 \text{ lbm/ft}^3 \times 0.2 \text{ Btu/lbm-°F} \times 180°F = 3{,}821 \text{ Btu/ft}^3$$

The initial water density per unit volume of grout at the start of Step 2 is:

$$\text{rho}_L = \text{rho}_{\text{wet grout}} - \text{rho}_{\text{dry grout}} = 136.06 - 106.13 \text{ (from p. 2 and 4)}$$
$$= 29.93 \text{ lbm/ft}^3$$

So the fraction of liquid boiled off to cool the grout is calculated:

$$x = Q_G/(h_{fg} \times \text{rho}_L) = 3{,}821 \text{ Btu/ft}^3 / (970.3 \text{ Btu/lbm} \times 29.93 \text{ lbm/ft}^3)$$
$$= 0.132$$

The total fraction of liquid lost is therefore 0.192 (blowdown) + 0.132 (cooldown) = 0.324.

The remaining water density becomes (1.0 - 0.324) x 29.93 lbm/ft^3
= 20.23 lbm/ft^3

and the wet grout density for the beginning of Step 3 is:

$$\text{rho}_{\text{wet grout}} = 106.13 \text{ lbm/ft}^3 + 20.23 \text{ lbm/ft}^3 = 126.36 \text{ lbm/ft}^3$$

This is a moisture content of (20.23/126.36 =) 16.0% by weight.

Step 3 - Heatup from Step-2 End Conditions to 230°C (446°F)

Initial wet grout density = 126.36 lbm/ft$_3$ (from p. 5)
Final dry grout density = 106.13 lbm/ft$_3$ (from p. 2)

Initial wet grout C_p - calculate by weighting by mass (16% water):

$C_{p\ dry\ grout}$ = 0.2 Btu/lbm-°F (from p. 2)
$C_{p\ water}$ = 1.01 Btu/lbm-°F (from steam tables)

$C_{p\ initial}$ = (0.16 x 1.01) + (0.84 x 0.2) = 0.33 Btu/lbm-°F

$C_{p\ final}$ = $C_{p\ dry\ grout}$ = 0.2 Btu/lbm-°F

Assume that the water is vaporized to steam over the temperature range from 212°F to 222°F, a delta T of 10°F. The water density (per unit volume of grout), rho_L, is 20.23 lbm/ft^3 (from p. 5). The additive effective heat capacity to account for vaporizing all the water therefore is:

$$Q_{vap} = (h_{fg} \times rho_L)/\text{delta T} = (970.3\ \text{Btu/lbm} \times 20.23\ \text{lbm/ft}^3)/180°\text{F}$$
$$= 1{,}962.92\ \text{Btu/ft}^3\text{-°F}$$

The following table of effective heat capacity ($rho_L C_p + Q_{vap}$) as a function of temperature was used for the Step-3 heatup:

T (°F)	rho_L (lbm/ft^3)	C_p (Btu/lbm-°F)	Q_{vap} (Btu/ft^3-°F)	Effective Heat Capacity (Btu/ft^3-°F)
0.	126.36	0.33	0.	41.70
212.	126.36	0.33	0.	41.70
212.01	126.36	0.33	1962.92	2004.62
222.	106.13	0.20	1962.92	1984.15
222.01	106.13	0.20	0.	21.22
1000.	106.13	0.20	0.	21.22

The thermal conductivity of the grout was ramped linearly from the wet grout value (0.5 Btu/hr-ft-°F) to the dry grout value (0.3 Btu/hr-ft-°F) over the same 10°F temperature range:

T (°F)	k (Btu/hr-ft-°F)
0.	0.5
212.	0.5
212.01	0.5
222.	0.3
222.01	0.3
1000.	0.3

Four cases were run for the Step 3 heatup using different assumptions regarding heat source gas species and temperature:

Case 2a - Stagnant Saturated Steam at 250°C (482°F), 3.97 MPa (576 psia)
Case 2b - Stagnant Hot Air at 250°C (482°F), 0.101 MPa (14.7 psia)
Case 4a - Stagnant Saturated Steam at 300°C (572°F), 8.57 MPa (1243 psia)
Case 4b - Stagnant Hot Air at 300°C (572°F), 0.101 MPa (14.7 psia)

Results

The analysis assumptions and primary results are summarized in Table 1. The values shown in the "heatup time, hours" column are the times required for the cylinder centerline temperatures to reach the specified end temperatures.

Comparisons of the heatup times among the various cases indicated the expected trends:

- Heatup times are shorter when the higher source temperature is used, and
- Heatup times are shorter when heat transfer on the outer vessel wall is due to condensing steam than when it is due to natural convection to hot air.

The calculated grout centerline temperature responses for for the 250°C source temperature cases are shown in Figure 1. Note that times shown on the plots are in seconds. The longer time delays indicated in the responses for the Step 3 cases (2a and 2b), as compared with the Step 1 case, are the result of the effects of evaporation. In Step 3 of the process, heat from the external source cannot reach the centerline until the water in all of the grout is evaporated.

For the purpose of sizing a steam supply system, the vessel outer wall heat transfer coefficient responses for Cases 1 and 2a are shown in Figure 2. For the purpose of investigating improvements in the heat transfer from air to the vessel, the outer wall heat transfer coefficient response for Case 2b is shown in Figure 3.

The calculated grout centerline temperature responses for the 300°C source temperature cases are shown in Figure 4. The outer wall heat transfer coefficient responses for Cases 3 and 4a are shown in Figure 5.

Conclusions

Step 1 of the process (raising the temperature of wet grout to 200°C in a stagnant steam environment) will require about 1.5 days if 250°C steam is used and about 1.1 days if 300°C steam is used.

Step 3 of the process (raising the temperature of the grout to 230°C and evaporating the water content from it) will require about:

3.6 days in a stagnant, 250°C steam environment,
7.5 days in a stagnant, 250°C hot air environment,
2.5 days in a stagnant, 300°C steam environment, and
4.8 days in a stagnant, 300°C hot air environment.

Table 1. Summary of results from grout heatup calculations.

Step and Case	Start Temp, °C	End Temp, °C	Environment	Grout State	Heatup Time, hours
Step 1 Case 1	22	200	Stagnant steam at 250°C	Wet[1] (22% by weight, no evaporation)	35
Step 3 Case 2a	100	230	Stagnant steam at 250°C	Initially wet[2] (16% by weight, with evaporation)	87
Step 3 Case 2b	100	230	Stagnant air at 250°C	Initially wet[2] (16% by weight, with evaporation)	179
Step 1 Case 3	22	200	Stagnant steam at 300°C	Wet[1] (22% by weight, no evaporation)	27
Step 3 Case 4a	100	230	Stagnant steam at 300°C	Initially wet[2] (16% by weight, with evaporation)	61
Step 3 Case 4b	100	230	Stagnant air at 300°C	Initially wet[2] (16% by weight, with evaporation)	116

1. rho = 136 lbm/ft^3, c_p = 0.38 Btu/lbm-°F, k = 0.50 Btu/hr-ft-°F

2. 106 < rho < 126 lbm/ft^3, 0.20 < c_p < 0.33 Btu/lbm-°F, 0.30 < k < 0.50 Btu/hr-ft-°F. For each parameter, the initial value corresponds to the dry state and the final value corresponds to the wet state.

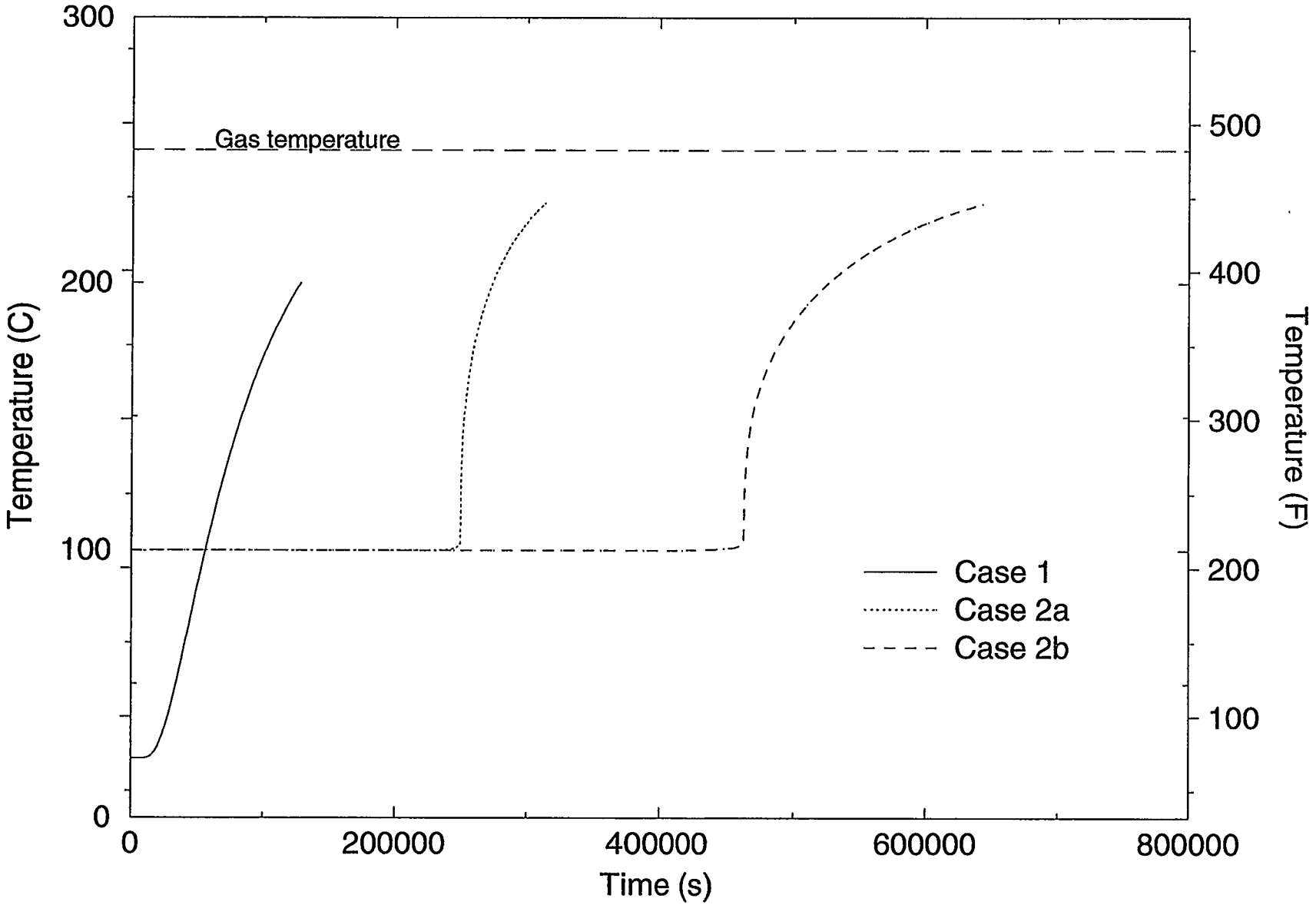


Figure 1. Grout centerline temperatures for a gas temperature of 250 C.

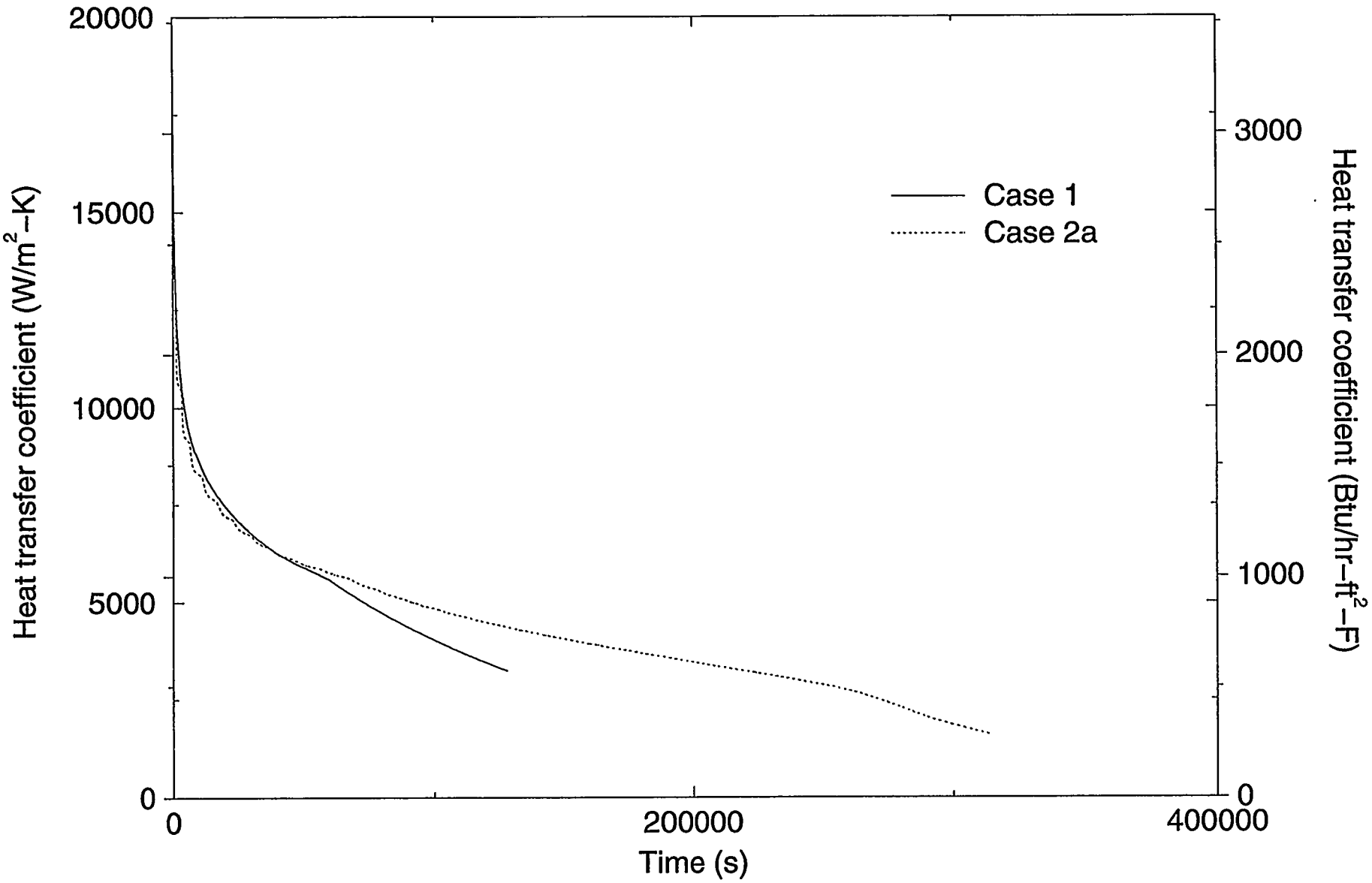


Figure 2. Heat transfer coefficient for a steam temperature of 250 C.

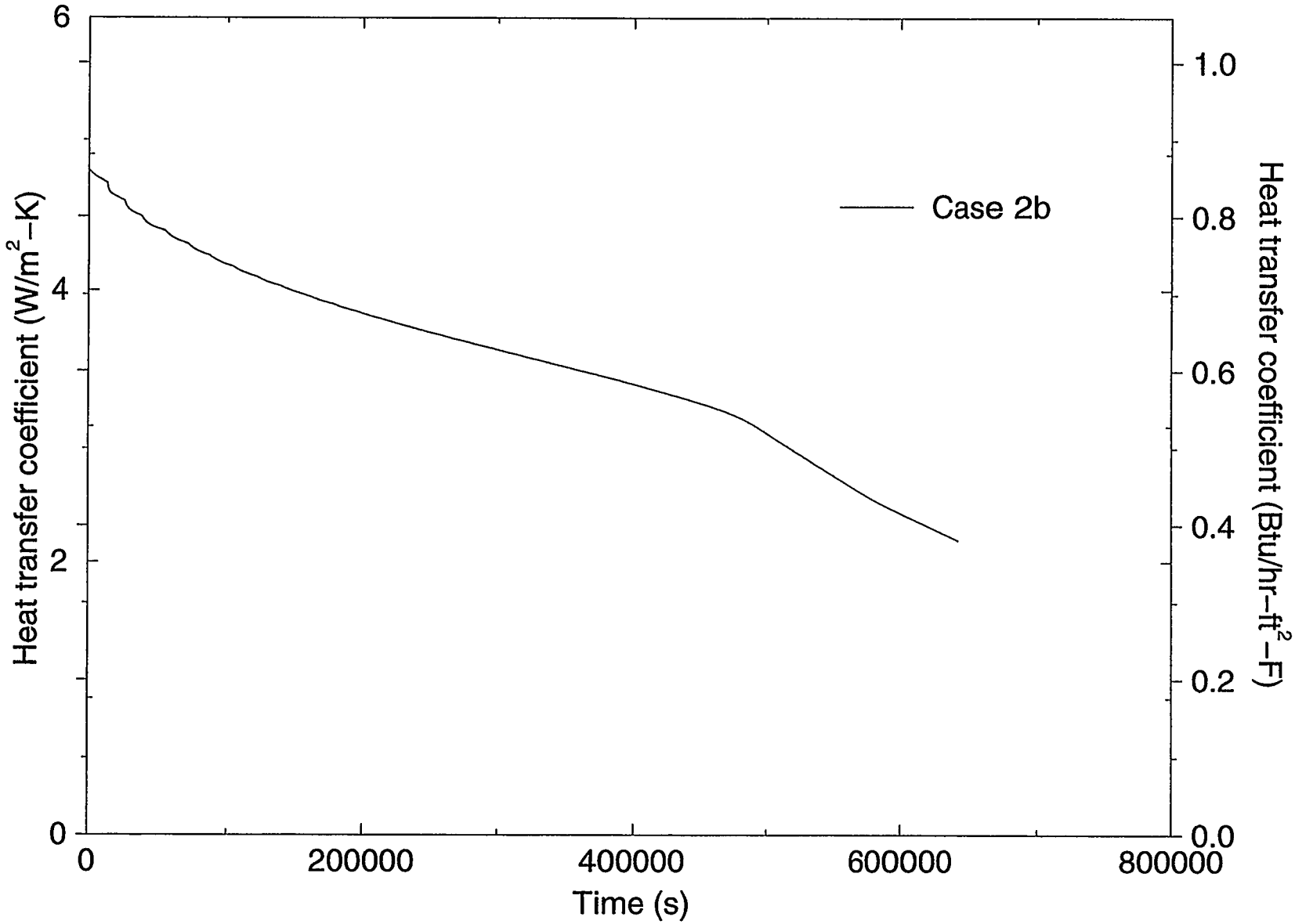


Figure 3. Heat transfer coefficient for an air temperature of 250 C.

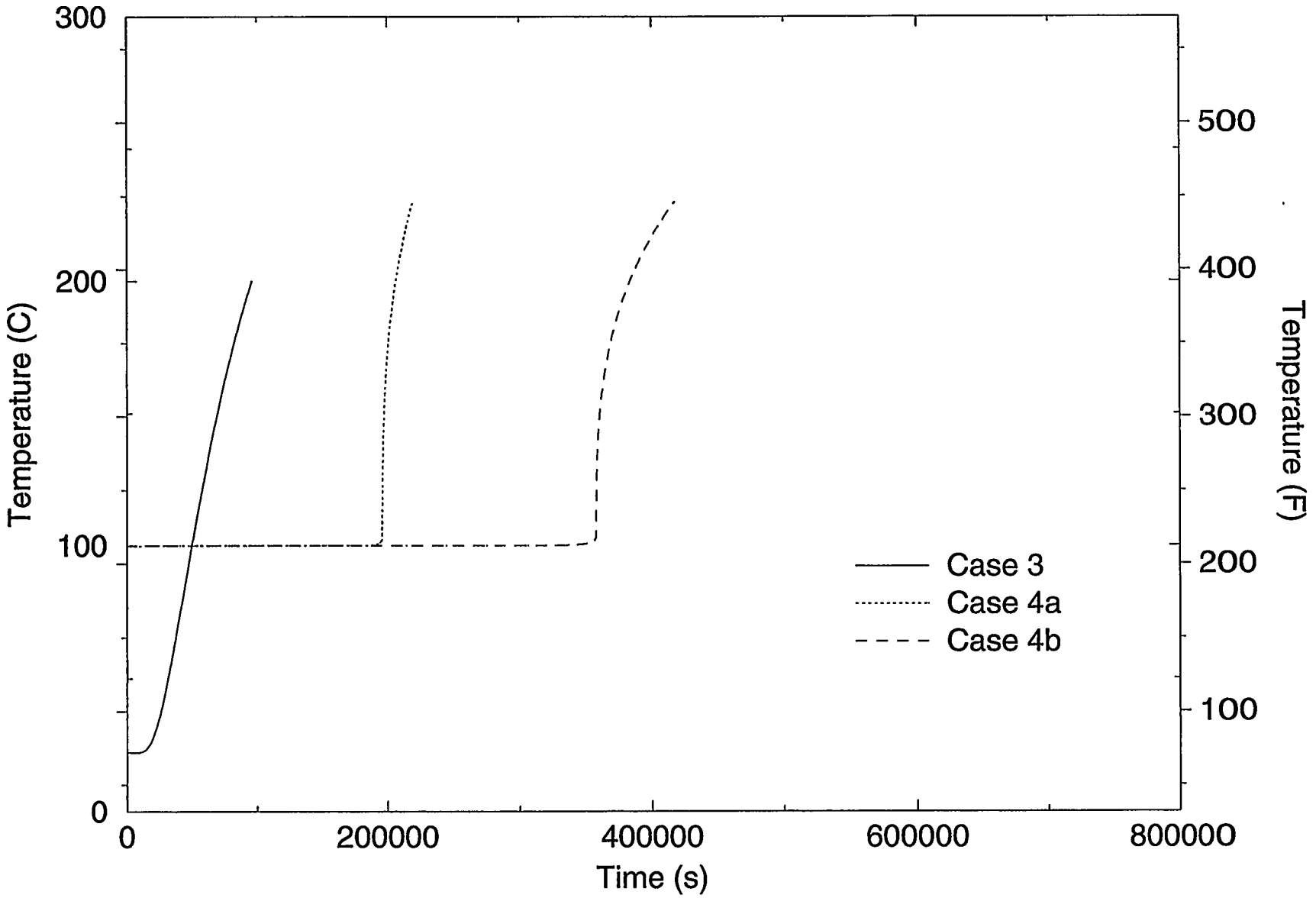


Figure 4. Grout centerline temperatures for a gas temperature of 300 C.

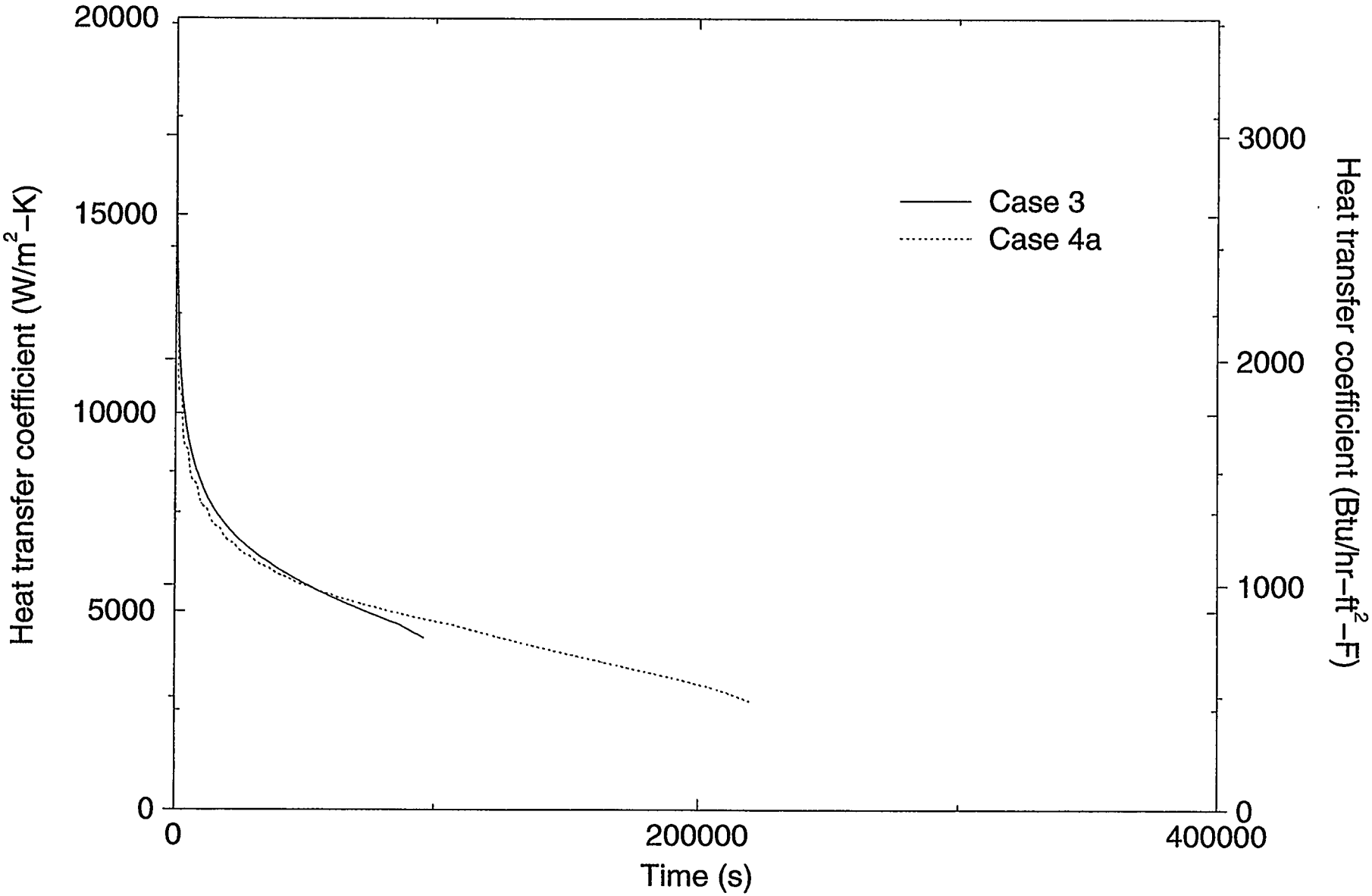
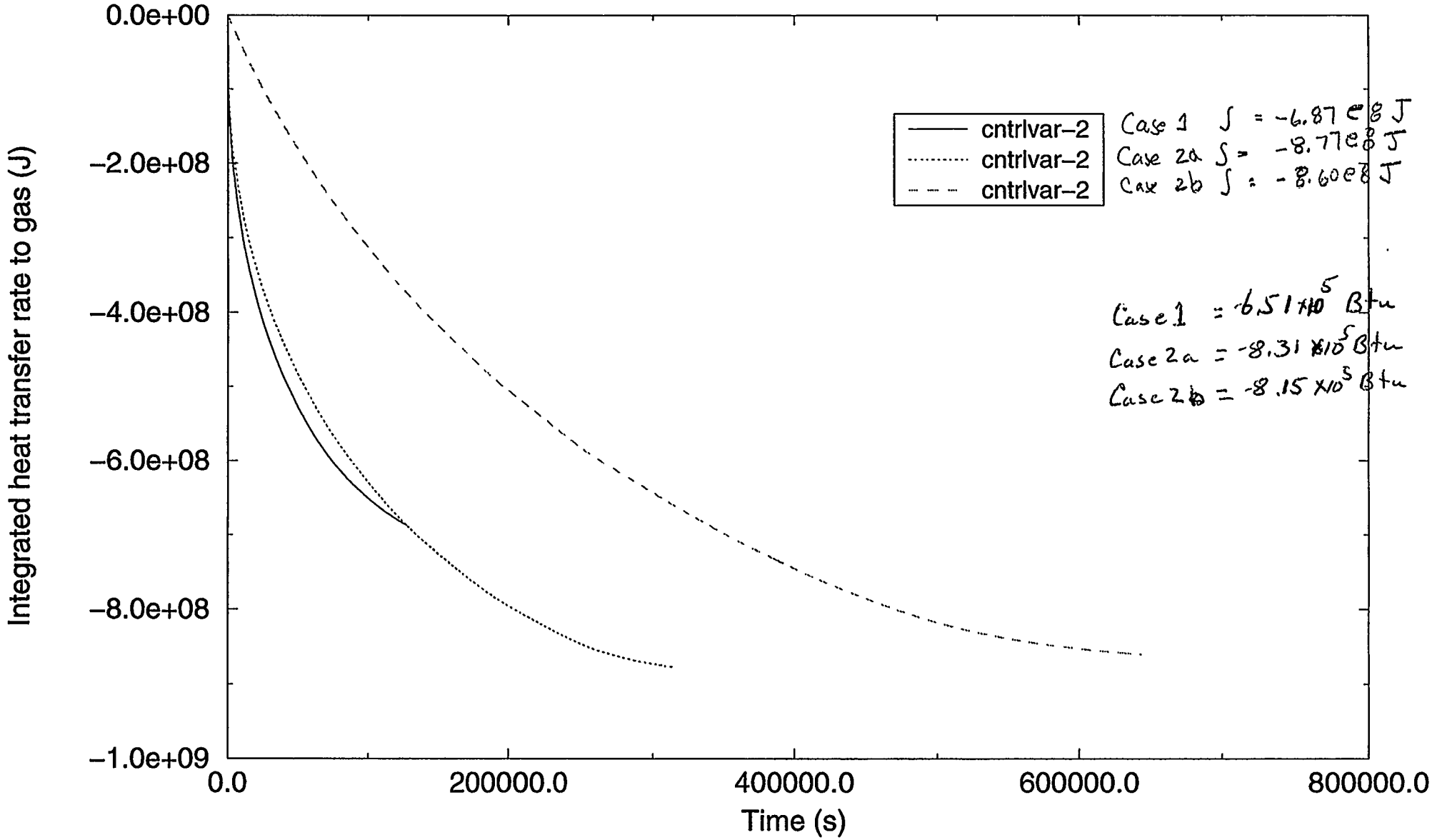


Figure 5. Heat transfer coefficient for a steam temperature of 300 C.


0.0e+00
−2.0e+08
−4.0e+08
−6.0e+08
−8.0e+08
−1.0e+09
Integrated heat transfer rate to gas (J)
0.0
200000.0
400000.0
600000.0
800000.0
Time (s)
cntrlvar−2
cntrlvar−2
cntrlvar−2
Case 1 ∫ = −6.87e8 J
Case 2a ∫ = −8.77e8 J
Case 2b ∫ = −8.60e8 J
Case 1 = −6.51×10^5 Btu
Case 2a = −8.31×10^5 Btu
Case 2b = −8.15×10^5 Btu

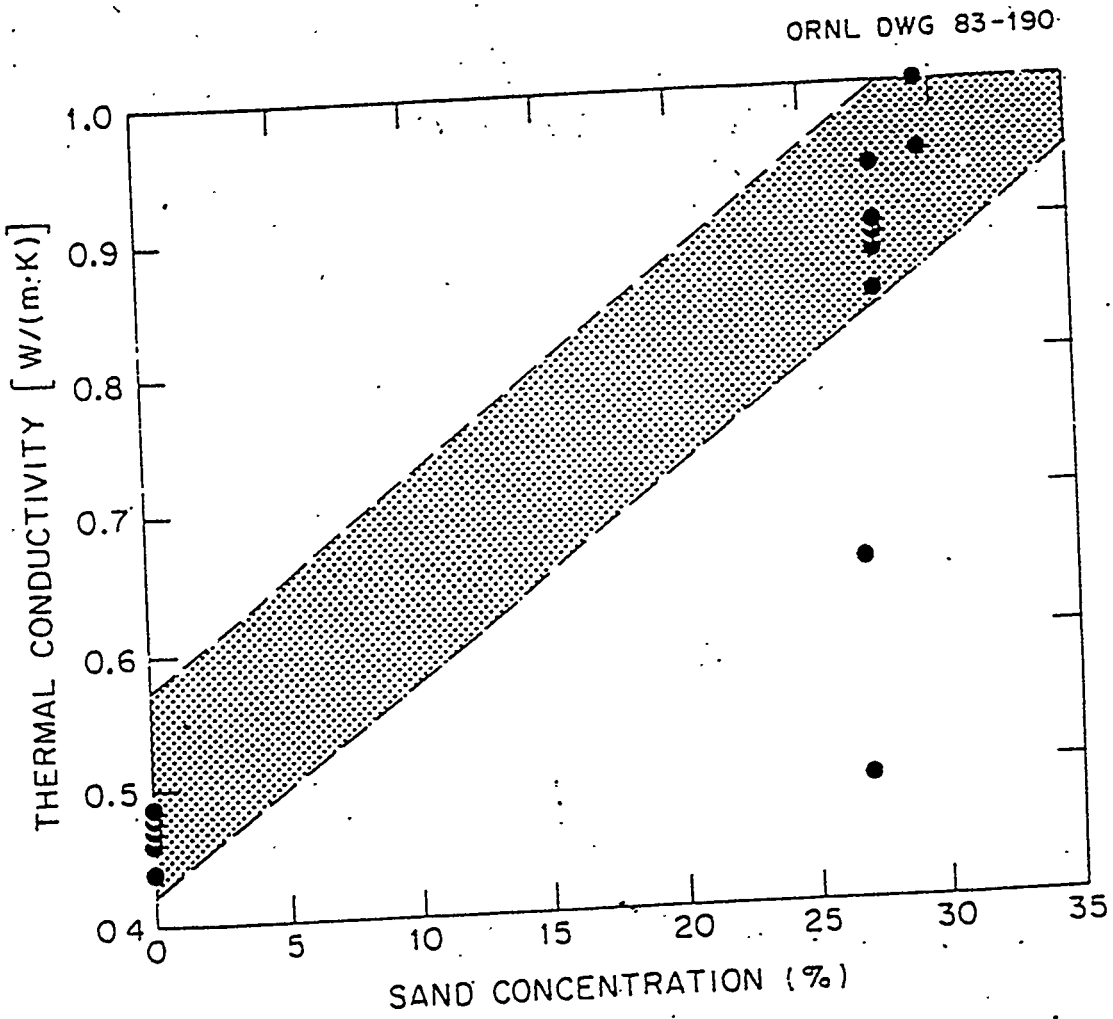


Fig. 7. Thermal conductivity of SRP FUETAP concretes as a function of sand concentration.

Table 3-196. Methyl Alcohol

Mole % CH_3OH	Specific heat, cal./g. °C.		
	5°C.	20°C.	40°C.
5.88	1.02	1.0	0.995
12.3	0.975	0.982	.98
27.3	.877	.917	.92
45.8	.776	.811	.83
69.6	.681	.708	.726
100	.576	.60	.617

Table 3-197. Ethyl Alcohol

Mole % C_2H_5OH	Specific heat, cal./g. °C.		
	3°C.	23°C.	41°C.
4.16	1.05	1.02	1.02
11.5	1.02	1.03	1.03
37.0	0.805	0.86	0.875
61.0	.67	.727	.748
100.0	.54	.577	.621

Table 3-198. Normal Propyl Alcohol

Mole % C_3H_7OH	Specific heat, cal./g. °C.		
	5°C.	20°C.	40°C.
1.55	1.03	1.02	1.01
5.03	1.07	1.06	1.03
11.4	1.035	1.032	0.99
23.1	0.877	0.90	.91
41.2	.75	.78	.815
73.0	.612	.645	.708
100.0	.534	.57	.621

Table 3-199. Glycerol

Mole % $C_3H_5(OH)_3$	Specific heat, cal./g. °C.	
	15°C.	32°
2.12	0.961	0.
4.66	.929	
11.5	.851	.84
22.7	.765	.758
43.9	.67	.672
100.0	.555	.576

NOTE.—For the specific heats of non-aqueous solutions, see "International Critical Tables," vol. 5, pp. 116, 125.

Table 3-200. Aniline (at 20°C.)

Mol % aniline	100	95	90.5	82.3	75.2
Cal./g. °C.	0.497	0.52	0.53	0.56	0.581

SPECIFIC HEATS OF MISCELLANEOUS MATERIALS

Table 3-201. Specific Heats of Miscellaneous Liquids and Solids

Material	Specific Heat, cal./g. °C.
Alumina	0.2 (100°C.); 0.274 (1500°C.)
Alundum	0.186 (100°C.)
Asbestos	0.25
Asphalt	0.22
Bakelite	0.3 to 0.4
Brickwork	About 0.2
Carbon	0.168 (26° to 76°C.)
	0.314 (40° to 892°C.)
	0.387 (56° to 1450°C.)
(gas retort)	0.204
(See under Graphite)	
Cellulose	0.32
Cement, Portland Clinker	0.186
Charcoal (wood)	0.242
Chrome brick	0.17
Clay	0.224
Coal	0.26 to 0.37
tar oils	0.34 (15° to 90°C.)
Coal tars	0.35 (40°C.); 0.45 (200°C.)
Coke	0.265 (21° to 400°C.)
	0.359 (21° to 800°C.)
	0.403 (21° to 1300°C.)
Concrete	0.156 (70° to 312°F.); 0.219 (72° to 1472°F.)
Cryolite	0.253 (16° to 55°C.)
Diamond	0.147
Fireclay brick	0.198 (100°C.); 0.298 (1500°C.)
Fluorspar	0.21 (30°C.)
Gasoline	0.53
Glass (crown)	0.16 to 0.20
(flint)	0.117
(pyrex)	0.20
(silicate)	0.188 to 0.204 (0 to 100°C.)
	0.24 to 0.26 (0 to 700°C.)
wool	0.157
Granite	0.20 (20° to 100°C.)
Graphite	0.165 (26° to 76°C.); 0.390 (56° to 1450°C.)
Gypsum	0.259 (16° to 46°C.)
Kerosene	0.47
Limestone	0.217
Litharge	0.055
Magnesia	0.234 (100°C.); 0.188 (1500°C.)
Magnesite brick	0.222 (100°C.); 0.195 (1500°C.)
Marble	0.21 (18°C.)
Pyrites (copper)	0.131 (19° to 50°C.)
(iron)	0.136 (15° to 98°C.)
Quartz	0.17 (0°C.); 0.28 (350°C.,
Sand	0.191
Silica	0.316
Steel	0.12
Stone	About 0.2
Turpentine	0.42 (18°C.)
Wood (oak)	0.570
Most woods vary between	0.45 and 0.65

Oils (animal, vegetable, mineral oils)

$$C_p(\text{cal./g. °C.}) = \frac{A}{\sqrt{d_4^{15}}} + B(t - 15)$$

Oils	A	B
Castor	0.500	0.0007
Citron	(0.438 at 54°C.)	
Fatty drying	0.440	
non-drying	0.450	
semidrying	0.445	
oils (except castor)	0.450	
Naphthene base	0.405	0.0009
Olive	(0.47 at 7°C.)	
Paraffin base	0.425	0.0009
Petroleum oils	0.415	0.0009

Porcelain	Average specific heat between 20°C. and			
	100°C.	300°C.	500°C.	1100°C.
Fired Berlin	0.189	0.203	0.222	0.337
Green Berlin	.185	.197	.228	
Fired Berlin (glaze)	.179	.189	.199	.245
Green Berlin (glaze)	.170	.183	.208	
Fired earthenware	.186	.203	.223	.324
Green earthenware	.181	.192	.215	

Pyrex glass	0.20
Pyroxylin plastics	0.34 to 0.38
Rubber (vulcanized)	0.415
Silica brick	0.202 (100°C.); 0.195 (1500°C.)
Silicon carbide brick	0.202 (100°C.)
Silk	0.33
Stoneware (common)	0.185 to 0.191 (20° to 100°C.)
Wool	0.325
Zirconium oxide	0.11 (100°C.); 0.179 (1500°C.)

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To Syl Losinski @ 6-4017 CP425
From Glenn Moore or Ron Dafoe

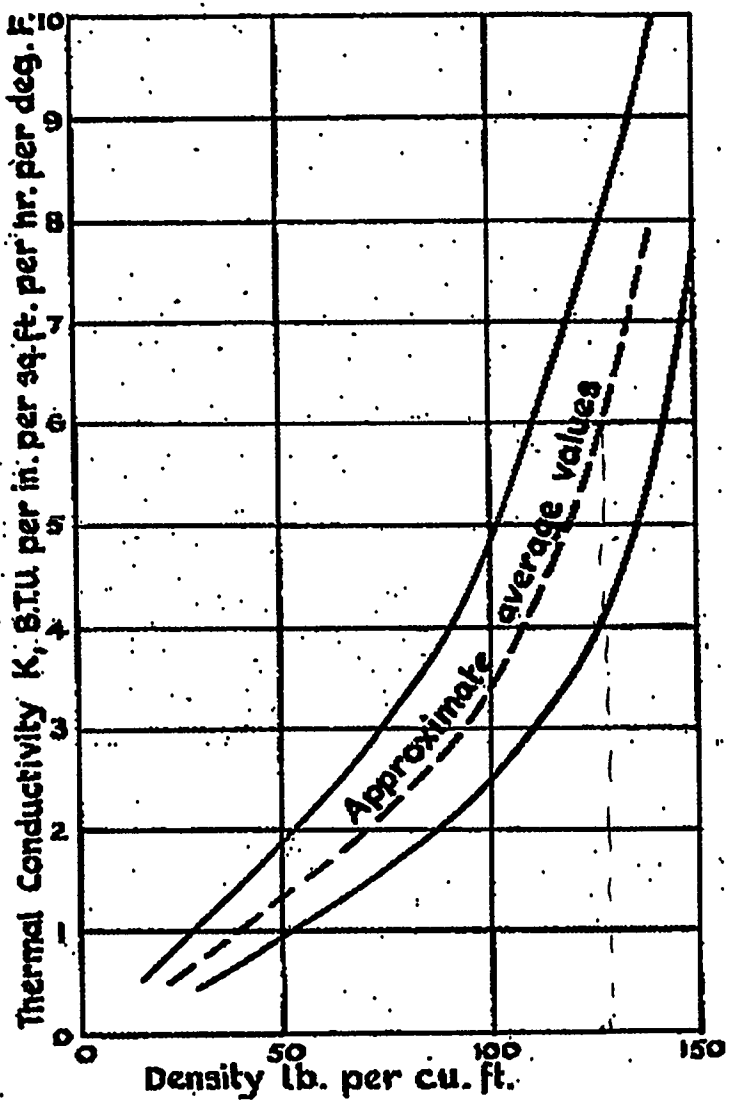


FIG. 4.2. Range of thermal conductivity for lightweight aggregate concretes.

3·5 mm per m (0·1 to 0·35 per cent). The shrinkage may however be greatly decreased by autoclave curing, which enables values nearer those for lightweight aggregate concrete to be obtained.

According to the United States Housing and Home Finance Agency, little trouble is likely to be experienced if the shrinkage is less than 0·06 per cent, but a shrinkage of over 0·10 per cent is definitely excessive.

Thermal Conductivity

The relationship between the thermal conductivity and the density of lightweight aggregate concrete according to a number of authorities has been collected by Whitaker[3] and the range of conductivities together with very approximate average values are given in Fig. 4.2. When lightweight aggregates are used the thermal characteristics of the concrete reflect those of the aggregate, but apart from this the thermal conductivity increases as the density increases.

It should be borne in mind that the thermal resistivity, which is the reciprocal of the conductivity, decreases considerably with an increase in moisture content and a reduction of as much as 50 per cent is possible with some materials. If lightweight concrete is to preserve its property of high

TABLE 4. III. THERMAL CONDUCTIVITY AND RESISTIVITY OF COMMON BUILDING MATERIALS

Material	Average density lb per cu ft	Conductivity k BTU per sq ft per h per °F difference per in of thickness	Resistivity 1/k
Brickwork	100	8·0	0·125
Plaster	90	4·0	0·25
Wood	40	1·0	1·00
Cement rendering	130	6·0	0·17
Gravel concrete 1:2:4	152	10·0	0·10
No-fines concrete	100	5·3	0·19
Clinker concrete 1:10	95	2·3	0·44
Foamed slag concrete 1:2½:7½	65	1·9	0·53
Expanded clay concrete 1:7	50	2·0	0·50
Vermiculite concrete 1:4	35	1·1	0·91
Pumice concrete 1:2½:7½	45	1·3	0·77
Cellular concrete 1:4	40	1·0	1·00
Sawdust concrete 1:2½	65	2·0	0·5

Table 18.1: Typical properties of lightweight concretes

Type of concrete		Bulk density of aggregate kg/m³	Bulk density of aggregate lb/ft³	Mix proportions by volume cement:aggregate
Aerated	PFA[a]	950	60	1:3
	sand	1600	100	1:3
Autoclaved aerated		–	–	–
Expanded slag	fine	900	50	1:8
	coarse	650	40	1:6 1:3.5
Rotary-kiln expanded clay	fine	700	45	1:11
	coarse	400	25	1:6 1:5 1:4
Rotary-kiln expanded clay with natural sand	coarse	400	25	1:5
Sinter-strand expanded clay	fine	1050	65	1:5
	coarse	650	40	1:4
Rotary-kiln expanded slate	fine	950	60	1:6
	coarse	700	45	1:4.5
Sintered pulverized fuel ash	fine	1050	65	1:5.9 1:5.3
	coarse	800	50	1:4.5 1:3.1
Sintered pulverized fuel ash with natural sand	coarse	800	50	1:6.1 1:5.5 1:5.0 1:3.6
Pumice		500–800	30–50	1:6 1:4 1:2
Exfoliated vermiculite		65–130	4–8	1:6
Perlite		95–130	6–8	1:6

[a] PFA = pulverized fuel ash (fly ash).

Dry density of concrete kg/m³	Dry density of concrete lb/ft³	Compressive strength MPa	Compressive strength psi	Drying shrinkage 10^{-6}	Thermal conductivity J/m²s °C/m	Thermal conductivity Btu/ft²h °F/ft
750	47	3	500	700	0.19	0.11
900	55	6	800		0.22	0.13
800	55	4	600	800	0.25	0.14
1700	105	7	1000	400	0.45	0.26
1850	115	21	3000	500	0.69	0.40
2100	130	41	6000	600	0.76	0.44
650–1000	42–62	3–4	400–600	–	0.17	0.10
1100	70	14	2000	550	0.31	0.18
1200	75	17	2500	600	0.38	0.22
1300	80	19	2800	700	0.40	0.23
1350–1500	85–95	17	2500	–	0.57	0.33
1500	95	24	3500	600	0.55	0.32
1600	100	31	4500	750	0.61	0.35
1700	105	28	4000	400	0.61	0.35
1750	110	35	5000	450	0.69	0.40
1490	93	20	2900	300	–	–
1500	95	25	3600	300	–	–
1540	96	30	4400	350	–	–
1570	98	40	5800	400	–	–
1670	104	20	2900	300	–	–
1700	106	25	3600	300	–	–
1750	109	30	4400	350	–	–
1790	112	40	5800	400	–	–
1200	74	14	2000	1200	–	–
1250	77	19	2800	1000	0.14	0.08
1450	90	29	4200	–	–	–
300–500	20–30	2	300	3000	0.10	0.06
–	–	–	–	2000	0.05	0.03

ENGINEERING DESIGN FILE

Project File Number _____

Project/Task Waste Treatment Project
Feasibility Studies

Subtask Direct Cementitious Waste Facility

Title: Electrical Requirements					
Summary: This EDF evaluated the electrical requirements for the Direct Cementitious Waste Facility. The connected loads were estimated to be 2,157 kVA, an evaluation of the usage indicated that the demand would be approximately 1,247 kVA. Since heating in the process will be accomplished with steam, the majority of the demand is from the Building lighting and HVAC. These loads would be fed from a load center with a secondary voltage of 480 Volts. This load center would be fed from Power Sectionalizing Switches located in the northeast quadrant of the plant. These switches are fed directly from Substation 15. Standby power would be supplied over the normal power distribution system from Substation 60 via Substation 15 and the Power Sectionalizing Switches. The standby requirements for this facility are estimated to be 440 kVA.					
Distribution (complete package):					
Distribution (summary package only):					
Author John E. Duggan	Dept. AEDL	Reviewed	Date 12-17-97	Approved	Date 12/18/97
		LMITCO Review	Date	LMITCO Approval	Date

See Management Control Procedure (MCP) 6 for instructions on use of this form.

DIRECT CEMENTITIOUS WASTE OPTION

1.0 ELECTRICAL REQUIREMENTS

1.1 EXISTING AND PLANNED ELECTRICAL UTILTIIES AT ICPP

The ICPP ties into the 138kV INEL 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 Substation 10 which is located within the ICPP complex. Power at 13.8kV is than distributed from Substation 10 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 than be distributed through the complex by the new 13.8kV distribution system, The Utility Control System (UCS) will control the usage of standby power.

1.2 POWER REQUIREMENTS

1.2.1 NORMAL POWER

The electrical requirements of the Direct Cementation Facility were analyzed and determined to be 2,157 kVA connected, with a demand projected to be 1,247kVA. The results of the analysis are shown in Tables 1 and 2. The major loads with the Direct Cementation Facility are the HVAC equipment, and lighting.

Normal power will be supplied to the Direct Cementation Facility by 13.8 kV feeders from Substation 15. 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 Direct Cementation Facility were analyzed and determined to be 440 kVA. The results of the analysis are shown in Table 3. The standby loads for the Direct Cementation Facility will consist of the following:

- UPS Normal and Bypass feeders
- Selected lighting and miscellaneous loads
- Exhaust fan
- Other loads as determined in later designs

Standby power to the Direct Cementation facility will be provided over the normal power distribution system from Substation 60, the Standby power plant substation via Substation 15. The standby power system is at or near capacity. Upon completion of the EUSU project, an evaluation of the spare capacity will be performed. If necessary, a 2000 kVA diesel generator and associated equipment will be installed in the space available in the standby generator plant. Shedding of the non-essential loads will be performed by the UCS. The UCS will control the operation of circuit breakers and equipment to assure that only those loads requiring standby power remain in operation

1.2.3 DISTRIBUTION SYSTEM

Both normal and standby power will be provided by one set of redundant feeders. The EUSU project will install a redundant pair of sectionalizing switches in the north east quadrant of the complex. These switches, PSS-NCE-1507A and PSS-NCE-1557A are supplied by one set of 500KCMIL cables each. These switches are fed directly from Substation 15 and are very lightly loaded. New duct banks will be run from these switches to a new load center. The load center will be double ended and will provide a redundant source of power to the Direct Cementation facility.

1.2.4 UNINTERRUBTABLE POWER SUPPLY (UPS)

A solid state UPS with a static transfer switch will be provided. The UPS will be provided with a 20 minute battery backup. Both the normal feed and the bypass feed to the UPS will be on standby power. The UPS will feed a 208Y/120 Volt panel. The UPS and the panel will be located in the electrical room. The UPS will support the following loads: Voice paging/evacuation systems, environmental monitoring 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 of pendant mounted fluorescent fixtures. These fixtures will be operated at 277 Volts 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 cell and so that the fixtures are easily accessible for maintenance. The light source will be metal halide. The lighting design will take 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

Two 13.8 kV feeders will provided the primary service to the site. The feeders will originate from Substation 2 located outside the fence. Power for the Direct Cementation Facility will be carried over existing feeders up to Substation 15. From Substation 15, new feeders will be routed through new and existing duct banks.

1.4.3.2 STANDBY POWER

Standby power will be provided at 13.8kV over the existing primary distribution system. The existing UCS in conjunction with the Plant Control System which will be installed in the Direct Cementation Facility will control selected circuit breakers to limit the standby power distribution only to those loads deemed important.

1.4.3.3 UTILIZATION VOLTAGES

Three and possibly four utilization voltages will be provided for the Direct Cementation facility. Transformers and load centers located near the facility will transform the 13.8kV to 480Y/277 Volt, transformers down stream will transform the 480 Volts to 208Y/120 Volts. The third and fourth utilization will be determined during the conceptual and title designs. 4160Y/2400 Volts is desired as the third utilization however, the ICPP currently utilizes 2400Y/1386 Volts. Preferably, only one will be used. Equipment selection and operating personnel preference will determine the voltage to be utilized.

Electrical loads will be assigned voltages as follows:

- Motors 100 HP and larger - 4160V, 3 phase or 2400V, 3 phase
- Resistive loads 100 kVA and larger - 4160V, 3 phase or 2400V, 3 phase
- 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.

In certain circumstances, 480V, 3 phase will be utilized for motors over 100 HP and loads over 100 kVA. This will be determined on an individual basis after the effects have been evaluated.

1.4.4 EQUIPMENT

1.4.4.1 LOAD CENTERS

One load center will be provided. The load center will be located outside the Direct Cementation Facility and will be a NEMA 3R Walk-in type similar to the load centers currently in use at the ICPP. The load center will provide 480Y/277 Volts and will be double ended. Each transformer will be sized to provide service to all loads on the load center. The load centers will be provided with all equipment and wiring to insure that it is fully compatible with the existing UCS System.

1.4.4.2 TRANSFORMERS

Transformers 5,000 kVA and below will be cast coil, dry type transformers. Transformers over 5,000 kVA will be oil filled.

1.4.5 LIGHTING

Lighting levels will conform the Illuminating Engineer's Society (IES) handbook and standard practices at the ICPP. 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 ICPP 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 ICPP are connected to this ground system. As well, the Direct Cementation facility will be connected to the ground system. Grounding within the facility and at the outdoor load centers and other structures 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.

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TABLE 1

WASTE TREATMENT PROJECT
FEASIBILITY STUDIES

CONNECTED LOAD
DIRECT CEMENTITIOUS WASTE OPTION

LOAD	kVA
General Building Lighting 286,550 sq. Ft @ 1.75 Watts per sq. Ft = 501,462Watts	501
Miscellaneous Loads 286,550 sq. Ft. @ 1.0 Watts per sq. Ft = 286,550Watts	286
HVAC Loads: Supply Fan Motors 1 @ 150HP Exhaust Fan Motors 2@200HP Miscellaneous HVAC Cooling Tower 1 @ 50HP 50 HP Small HVAC loads	 150 400 50 50
Process Equipment: Conveyor Motors 50@2HP ea. 4 Kneader/Extruder @ 80 HP 2 Grinder @ 50 HP ea. 4 Elevators @ 50 HP ea.	 100 320 100 200
Total connected kVA	**2,157**

TABLE 2

WASTE TREATMENT PROJECT
FEASIBILITY STUDIES

DEMAND
DIRECT CEMENTITIOUS WASTE OPTION

LOAD	DEMAND	kVA
General Building Lighting 286,550 sq. Ft @ 1.75 Watts per sq. Ft = 501,462 Watts	501,462 @ 90% Demand	451
Miscellaneous Loads 286,550 sq. Ft. @ 1.0 Watts per sq. Ft = 286,550 Watts	286,550 @ 50% Demand	143
HVAC Loads: Supply Fan Motors 1 @ 150HP Exhaust Fan Motors 2@200HP Miscellaneous HVAC Cooling Tower 1 @ 50HP 50 HP Small HVAC loads	 1 @ 150HP 1 @ 200HP 1 @ 50 HP 50HP @ 25% Demand	 150 200 50 13
Process Equipment: Conveyor Motors 50@2HP ea. 4 Kneaded/Extruder @ 80 HP 2 Grinder @ 50 HP ea. 4 Elevators @ 50 HP ea.	 100HP @ 10% Demand 1 @ 80 HP 1 @ 50 HP 2 @ 50 HP	 10 80 50 100
Total Demand kVA		**1,247**

TABLE 3

WASTE TREATMENT PROJECT
FEASIBILITY STUDIES

STANDBY POWER REQUIREMENTS
DIRECT CEMENTITIOUS WASTE OPTION

LOAD	STANDBY POWER	kVA
General Building Lighting 286,550 sq. Ft @ 1.75 Watts per sq. Ft = 501,462Watts	10% OF 501,462 = 50,146	50
Miscellaneous Loads 286,550 sq. Ft. @ 1.0 Watts per sq. Ft = 286,550 Watts	10% 0F 286,550 = 28,655	27
HVAC Loads: Supply Fan Motors 1 @ 150HP Exhaust Fan Motors 2@200HP Miscellaneous HVAC Cooling Tower 1 @ 50HP 50 HP Small HVAC loads	 0 1 @ 200HP 0 25% OF 50HP	 0 200 50 13
Process Equipment: Conveyor Motors 50@2HP ea. 4 Kneaded/Extruder @ 80 HP 2 Grinder @ 50 HP ea. 4 Elevators @ 50 HP ea.	 0 0 0 2 @ 50 HP	 0 0 0 100
Total Standby kVA		**440**

Project File Number 02BE0

Project/Task Waste Treatment Project Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: Canister Rail Conveyor System

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

The waste canister conveyor system that is proposed for the Direct Cementitious Waste Option is a rail guided truck system. The rails should be similar to those for a roller coaster system, in that, the trucks or carts that transport the waste canisters must engage both the top and bottom of the rails, in order to prevent the carts from tipping over during acceleration loads. The carts should also be heavy duty, like those for a mining application, and made of stainless steel, in order to facilitate radioactive decontamination. Each cart must be self propelled and remotely operated by a computer control system. In fact all of the equipment in the entire conveyor system must be remotely operated by a computer control system, because the radioactivity levels are simply to high to allow local operations by personnel.

The purpose of this Engineering Design File report is to briefly describe and give an approximate cost estimate for:

- The canister rail transport trucks (carts)
- The rails
- The rail turntables
- The filling station, waste canister lift and vibrator assembly
- The first stage canister decontamination station
- The autoclave multi-canister/cart lift platforms
- The floor-to-floor canister/cart lifts
- The robotic HEPA filter removal/replacement assemblies
- The canister cap seal welding assembly
- The final canister decontamination station

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General Description

The equipment described in this EDF is applicable to both the 5 and 20 year grouting processes and facilities. Multiple units as required are reflected in the DCWO Study Report cost estimates. Facility description refers to the 5 year grouting facility layout as noted in the DCWO Study Report facility drawings.

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- The autoclave multi-canister/cart lift platforms
- The floor-to-floor canister/cart lifts
- The robotic HEPA filter removal/replacement assemblies
- The canister cap seal welding assembly
- The final canister decontamination station
- The cart decontamination station
- The cart maintenance station

A brief description of the canister conveyor system follows:

1. A cart will move from the basement to the first floor (i.e. ground level) via the cart return lift and onto the conveyor entrance turntable. The turntable will then turn the cart towards the forward direction of the conveyor track. A canister will be loaded upon each cart, a HEPA filter assembly will be placed on the canister, and the canister will be started through the conveyor system. The cart and canister will then move along the tracks, through several turntables, into the Filling Station to a position under one of four Waste Canister Lift and Vibrator Assemblies.
2. At the Filling Station, a robotic manipulator will remove the HEPA filter and move it aside, the Waste Canister Lift and Vibrator Assembly will drop down so that the waste canister is inside the vibrator clamshell sleeve. Upon engaging the bottom of the canister, the canister and cart will be centered under the grout fill nozzle, the clamshell will close, the lift will raise the canister so that the grout fill nozzle is inserted through the canister inlet to within 45 cm from the canister bottom. At this point filling the canister with grouted waste begins.
3. The Kneader/Extruder located on the facility second floor, which extrudes the grouted waste through a pipe and into the grout fill nozzle fills the canister with grouted waste. As the grout fills the canister, the Waste Canister Lift and Vibrator Assembly will simultaneously begin to both vibrate and lower the canister. This action fluidizes the grout, expels air bubbles, and maintains the fill nozzle at approximately a constant height above the grout level in the canister. As the Kneader/Extruder empties, the fill nozzle and pipe assembly is also vibrated expelling the remaining grout. Lowering of the canister back onto the cart is then completed which also withdraws the fill nozzle. The robotic

manipulator will replace the HEPA filter. The cart and canister will then move through a system of tracks and turntables into one of two parallel tracks and to one of four Autoclave staging areas.

4. The Autoclave staging areas are actually platform lifts at which between 2 and 10 carts with canisters will be lifted about 1.22 m (4 ft) above the first floor level to the track level within an Autoclave. Each Autoclave contains two parallel sets of tracks, and will contain 18 carts and canisters. Each platform lift will therefore have to perform several lifts in order to stage a full Autoclave load.
5. After the grout is cured in an Autoclave the carts and canisters are staged out of the Autoclave utilizing platform lifts similar to those described for an incoming stage.
6. Each cart will then proceed down one of two parallel tracks through several turntables, merging to a single track, and into a floor-to-floor lift that will take the carts to the second floor.
7. Exiting the lift to the second floor, each cart will move down a single track to one of several turntables that lead to one of four de-watering ovens.
8. Each de-watering oven contains two parallel sets of tracks. Each cart and canister will move through the ovens in about 7 days, and will exit the oven, move through several turntables and merge into a single track, with turntables, leading to the floor-to-floor lift to the third floor.
9. Exiting the lift to the third floor, each cart will move down a single track through a pair of turntables to the HEPA filter removal station.
10. At the HEPA filter removal station a remotely controlled arm assembly will remove the canister HEPA filter and place it in either a disposal bag or a shielded container on the cart. If the HEPA filter is re-useable it will be placed in the shielded container. If the HEPA filter is not re-useable it will be placed in a disposal bag and sent to the ICPP filter disposal facility. Upon removal of the HEPA filter the cart and canister will move through a pair of turntables to the canister cap welding station.
11. At the canister cap welding station a cap suitable for the Savannah River Site HLW canister is welded into place by pressing the cap into place and either induction or resistance welded to the canister. This weld must be a statistically designed weld similar to that specified for the Savannah River HLW canisters in the Waste Compliance Plan for the Defense Waste Processing Facility (DWPF). After the welding operation, the cart and canister will move to the final decontamination station.
12. At the final decontamination station the canister will be decontaminated either by abrasive blasting, swabbing, and bagging the canister, or by metal spraying the entire canister and cladding it with stainless steel. Upon completion of the decontamination process the cart and canister moves to the acoustic tomography station.
13. At the acoustic tomography station, the canister and grout composition will be checked using an acoustic tomography process. If the canister and grout composition pass the inspection then the cart and canister move to the track and turntables leading to the basement floor-to-floor lift. If the canister and grout do not pass the inspection, then the cart and canister move to the track leading to the canister and grout recycling station.
14. Exiting the basement lift the cart and canister will move down a single track to a turntable and track exiting the DCWO process to the Interim Storage Facility where the canisters will be removed from the transport cart and placed into storage vaults to await shipment. The transport carts are then returned to the DCWO facility basement via a track that runs in parallel to the track just utilized to exit the DCWO process.
15. At the canister and grout recycling station, the metal canister is cut and stripped from the grout inside and the grout is then sent to a crusher where it is pulverized. The pulverized grout is then fed back into the grout-mixing stream where it will be recycled through the entire process.

Waste Canister HEPA Filters

A HEPA filter is needed to prevent the spread of radioactivity from within a waste canister to the process conveyor system. The process conveyor system is redundantly contained and isolated from the natural surroundings so that the filter is needed only to prevent the spread of contaminants inside the process path. A sketch of the waste canister is shown in Appendix A of this EDF and is titled "ICPP Waste Treatment Facility Direct Cementitious Waste Option Savannah River Site Canister". The sketch gives the dimensions of the waste canister. The second fsketch in Appendix A of this EDF is titled "ICPP Waste

Treatment Facility Direct Cementitious Waste Option Waste Canister HEPA Filter" and shows the maximum size that the filter can be when attached to the canister top.

In the second sketch, the area enclosed by the dashed line represents the maximum size that the filter can be. The filter is assumed to be cylindrical about the vertical centerline shown. Although it can be of any geometry as long as it does not exceed 45.72 cm (18 in) above the canister top nor 30.48 cm (12 in) radius from the canister vertical centerline.

The purpose of each filter is to prevent the escape of radioactively contaminated moisture from the interior of each canister during the curing and de-watering of grout stabilized radioactive waste. The curing and de-watering process will be done in three stages:

1. First, curing occurs within an autoclave in which eighteen canisters are heated by pressurized saturated steam to 250 C (482 F). The canisters will be maintained at this state for about one day. During this heating process, some of the water inside the container will vaporize and some of the steam will condense on the outside of the filter housing and canister.
2. Second, at the end of one day, the steam supply will be shut off and the autoclave will be depressurized. This will cause some of the water inside the waste canister to vaporize. The depressurization can be controlled so that moisture carry-over through the filter will be minimized.
3. Third, the eighteen canisters will be moved from the autoclave vessel to an oven. Within the oven, the canisters will be heated at atmospheric pressure to 250 C (482 F), which will vaporize the remaining water to a dry superheated state. This is the final de-watering stage, which will last about 4 days.

Each canister will then exit the oven, the filter will be removed and a cap will be welded into place, permanently sealing the canister.

18,000 canisters will be processed. It is desirable to make the filters re-useable; in order to reduce costs and reduce the volume of radioactively contaminated process items. Thus about 18,000 or fewer filter units will be required.

The cost estimate for filters of this type is approximately $300.00 each ($5,400,000.00 Total).

Canister Conveyance System - Canister Rail Transport Truck (Carts)

Approximately 300 Canister Rail Transport Trucks (carts) are required, for the 5 year grouting facility, for transporting the waste canisters through the waste stream loading and curing process. The size of the carts must be 1.219 m (4 ft) long by 1.219 m (4 ft) wide or less, and be a maximum of 0.61 m (2 ft) high from the ground to the platform upon which the bottom of the waste canister will sit. The cart wheel system must provide a set of wheels that engage the top of the transport rails and provide the driving force to move the cart, and a set of wheels that engage the bottom of the rails and prevent the loaded cart from tipping over during acceleration loads. The carts will require a custom design utilizing standard parts. Each cart should be self-propelled utilizing a sealed electric motor drive. Explosion proof motors are recommended because this design is most suitable for decontamination. The entire cart either must be constructed of stainless steel or must be covered by a stainless steel shroud suitable for providing ease of decontamination. The entire cart propulsion system and all mechanistic systems must be remotely operated by a computer controlled robotic control system. Each cart will also be provided with a computerized tracking device that will allow locating the cart and canister at any point in the waste loading process. Operating temperature range for the carts is from -34 C (-30 F), which is near the ambient temperature in the winter, to 250 C (482 F), which is the temperature of the grout curing and de-watering process. This temperature cycle is about the maximum range that will be encountered and will occur over a period of two weeks. The cart must support itself and a 3175-kg (7000 lbm) load. The load will be a stainless steel (304L) Savannah River High Level Waste (HLW) canister, that is standing vertically. The canister will occupy a space of 0.6096 m (2 ft) diameter and 2.997 m (9 ft 10 in) high. The top of the canister is a flanged pipe inlet of 12.7 cm (5 in) inside diameter (ID) and 23.16 cm (9.12 in) outside

diameter (OD) that is welded to the elliptical canister top. The canister bottom is a reverse dished head. The platform upon which the canister sits must be able to rotate and be accurately positioned in a controlled manner. The vertical position of the canister must be supported, at the canister midpoint or higher, in order to prevent the canister from tipping over when the cart and canister are moved. The canister vertical supports should provide approximately a 7.62 cm (3 in) clearance around the circumference of the canister and cannot circumvent the canister, because an opening must be provided along both sides of the cart from the top of the vertical supports to the bottom of the canister. This support clearance and opening is required in order to allow the Fill Station, Waste Canister Lift and Vibrator Assembly to drop down over the canister, engage the canister bottom and lift the canister.

The estimated cost for these kinds of carts, based on vendor input, ranges from $27,000.00 to $31,000.00 each ($2,325,000.00 for 75 carts to $8,100,000.00 for 300 carts, Total).

Canister Conveyance System - Rails

Approximately 1951 m (6400 ft) of track composed of two rails separated by 0.914 m (3 ft) to 1.219 m (4 ft) is required in the 5 year grouting facility. The track must be capable of carrying the carts, described above, with wheels that engage both the top and bottom of the rails, as for a roller-coaster cart. The track should be made of stainless steel in order to ease decontamination. Three phase, 480 VAC electric power must be furnished through at least one rail in order to power the carts. This bus bar should also carry the control system signals. All of the tracks will be flat, horizontal, and contain neither curves nor turns. Turning of the carts will be performed by a series of turntables that are described below.

The estimated cost for these types of tracks, based on vendor input, is about $328.00 per lineal m ($100.00 per lineal ft), for a total of about $640,000.00 for the 5 year grouting facility.

Canister Conveyance System - Rail Turntables

Approximately 90 turntables are required, in the 5 year grouting facility, to provide a capability to turn the carts 90 degrees within a confined space. The spatial constraint for turning a cart is to turn it within a circle of about 6.25 ft diameter, which is about 10% larger diameter than a circle of 5.66 ft diameter that describes the corners of a cart. The term cart refers to the Canister Rail Transport Trucks described above. Transport cart rails must be mounted an the turntable platform, which must be at floor level. Both the track and turntable platform must be constructed of stainless steel for ease of radioactive decontamination. Remote control of the turntable by a computer control system is required. The cart track must extend across the full diameter of the turntable, so that a cart may either be transported across the table or stopped at mid-table and turned, as desired.

The cost estimate for these turntables, based on vendor input, is about $40,000.00 each ($3,600,000.00 Total for the 5 year grouting facility).

Waste Canister Filling Station - Lift and Vibrator Assembly

The lift frame is composed of a structure similar to that for the Floor-To-Floor Single Canister/Cart Lifts described below. The approximate cost for each lift frame is $90,000.00.

The vibrator canister sleeve is a stainless steel cylinder of an inside diameter that is slightly smaller than the outside diameter of a waste canister. The sleeve is split vertically into two halves. One side of the split is hinged so that the split cylinder can be open and closed like a clamshell. The other side of the split includes a pneumatic or hydraulic mechanism that will open the clamshell, in order to move down over a waste canister, and close the clamshell, in order to grip and firmly hold the waste canister. The clamshell cylinder must have a step, at its bottom, upon which the waste canister will sit after the clamshell is closed. Attached to the outside of the clamshell must be two vibrator and motor drives. These motors and vibrators must also be of explosion proof design within stainless steel housings, in order to ease

decontamination. The vibrator sleeve assembly must be mounted on the lift frame hydraulic lift via a vibration isolator mounting system. The vibrator canister sleeve is essentially like a standard concrete culvert mold, except that it must be constructed of stainless steel and it must expand like a clamshell device and close to firmly grip a waste canister. The estimated cost of the vibrator canister sleeve is about $40,000 each.

Prior to lifting the canister, for filling with grouted waste, the canister HEPA filter must be removed, utilizing a robotic HEPA filter removal/replacement assembly. This assembly is briefly described in the section of this EDF entitled, "Robotic HEPA Filter Removal/Replacement Assembly". Of course, after the canister is filled, then the HEPA filter must be replaced, before the canister is allowed to proceed to the next process station.

Total cost for each vibrator canister filling system is therefore, $130,000.00, and the total for four systems is $520,000.00 for the 5 year grouting facility.

Waste Canister Filling Station - Waste Grout Kneader/Extruder With Injector Head

The Kneader/Extruder located on the facility second floor, which extrudes the grouted waste through a pipe and into the grout fill nozzle fills the canister with grouted waste. As the grout fills the canister, the Waste Canister Lift and Vibrator Assembly will simultaneously begin to both vibrate and lower the canister. This action fluidizes the grout, expels air bubbles, and maintains the fill nozzle at approximately a constant height above the grout level in the canister. As the Kneader/Extruder empties, the fill nozzle and pipe assembly is also vibrated expelling the remaining grout. Lowering of the canister back onto the cart is then completed which also withdraws the fill nozzle. A schematic of the Kneader/Extruder and Vibrator Canister Filling System is in Appendix B of this EDF titled "ICPP Waste Treatment Facility Direct Cementitious Waste Option Vibrator Canister Filling System."

The cost estimate for a single kneader/extruder system, based on vendor input, is approximately $400,000.00 and the total for four systems, for the 5 year grouting facility, is approximately $1,600,000.00.

First Stage Canister/Cart Decontamination Station

The most cost-effective system proposed was that proposed by the decontamination personnel at the ICPP. This system is composed of a standard air powered abrasive-blasting unit that will utilize the blast furnace slag, proposed for this DCWO process, as the abrasive medium. This blasting assembly would be contained within a high performance vacuum shroud that would act like a vacuum cleaner nozzle and transport the abrasive medium and contaminant, through a duct, to the waste stream grout mixing system. Thus, the blast furnace slag and contaminant would be recycled back into the process stream. The entire blaster and shroud assembly would be moved up and down the side of the waste canister by a single arm automatic manipulator. The cart rotating platform, upon which the waste canister sits, would be turned as the blaster is moved up and down. Thus, the entire surface of the waste canister would be blasted clean.

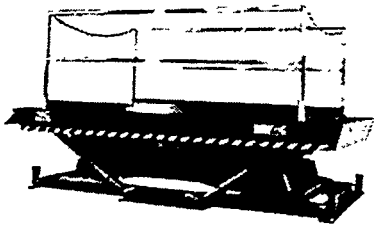
The cost estimate for this system is:

1. Abrasive blaster, $350,000.00 each
2. Shroud and vacuum system, $350,000.00 each
3. Single arm automatic manipulator, $150,000.00 each

Thus, the total cost for each unit is $850,000.00.

Canister Conveyance System - Autoclave Multi-Canister/Cart Lift Platforms

Eight platform lifts are required, for the 5 year grouting facility, for staging up to 10 carts and canisters both into and out of the Autoclaves. A Multi-Canister/Cart Lift Platform for staging up to 10 carts and canisters is envisioned to be a platform, of about 12 ft by 24 ft, that can be lifted and maintained level utilizing either a hydraulic or a "scissors" type of lifting mechanism. A stainless steel shroud should cover and extend down under the platform in order to provide ease of decontamination. Two parallel sets of tracks must be installed on the surface of the platform for staging up to 10 carts and canisters. When a sufficient number of carts and canisters are located on the platform the load is lifted about 4 ft, to the level of the track system inside the Autoclave. The carts will then move from the platform into the Autoclave. Two or more stages will have to be performed in order to fill the Autoclave with 18 carts and canisters. A scissors type of platform lift is shown in the following figure.

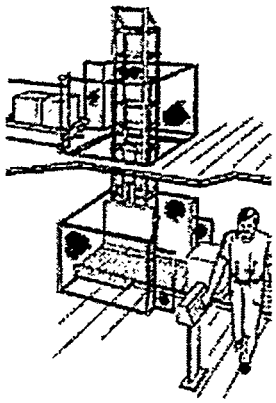


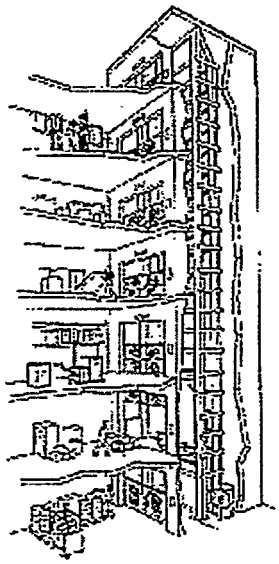
The cost estimate for a platform lift, based on vendor input, is about $500,000.00 each.

Canister Conveyance System - Floor-To-Floor Single Canister/Cart Lifts

Five single canister/cart lifts are required to lift each cart up to or down from the different floor levels. Three single story lifts and two three story lifts are required. The single story lifts must either lift or lower a cart and canister from one floor level to the next successive floor level, a floor-to-floor distance of 27 ft. Two of these lifts must carry a fully loaded canister and one lift must carry only an unloaded cart. The three story lifts must either raise or lower a fully loaded cart between the third floor level and the basement level, a floor-to-floor distance of 81 ft. These lifts must have the space exposed to the cart and canister covered by a stainless steel shroud in order to ease decontamination. Examples of a single story lift and a multi-story lift are shown in the following two figures, respectively.

The cost estimate, based on vendor input, is about $90,000.00 each.





Robotic HEPA Filter Removal/Replacement Assemblies

The HEPA Filter Robotic Removal/Replacement Assembly is a single arm automatic manipulator that is designed to:

1. Engage the HEPA filter canister

2. Detach the HEPA filter canister from the waste canister

3. Move the HEPA filter canister aside for the duration of a process, such as the filling of the waste canister with grout

4. Replace the HEPA filter canister on the waste canister when the process is completed.

These types of manipulators are standard items in American industry and do not require a detailed discussion here. The cost estimate for a manipulator arm and operating mechanism is about $150,000.00 each for this kind of application. Two HEPA filter manipulator arms will be required; one for the Filling Station, Waste Canister Lift and Vibrator Assembly, and one for the HEPA Filter Removal Station on the facility third floor. Thus, the total cost is $300,000.00.

Canister Cap Seal Welding Assembly

The Canister Cap Seal Welding Assembly is a single arm automatic manipulator that is designed to:

5. Engage and detach a waste canister cap from its supply feed system

6. Move the waste canister cap to the waste canister top and press it into place

7. Engage the cap with the welding head, energize the welding head and weld the cap into place.

These types of manipulators and welders are commonly used in modern industrial production lines, such as those utilized for producing automobile bodies or chassis. Thus, they are standard items in American industry and do not require a detailed discussion here. The cost estimate for a manipulator arm and operating mechanism is about $150,000.00 each for this kind of application, and for a resistance or induction welding head is about $225,000.00 each for this kind of application, or $375,000.00 Total, for each canister cap seal welder assembly.

Final Canister/Cart Decontamination Station

Alternative 1: Canister Abrasive Blasting, Swabbing and Bagging System

The abrasive blasting system and its cost estimate are described in the section entitled "First Stage Canister/Cart Decontamination Station".

The swabbing and bagging operation must be done by utilizing a remotely operated single arm automatic manipulator. This manipulator required would be similar to that described above for the canister cap seal welding assembly. To perform the swab, the manipulator would place the swab in contact with the exterior canister wall and move the swab up and down while the canister is simultaneously rotated using

the transport cart rotating platform. After the canister is swabbed, the swab must be placed in a sample container, sealed and sent to the Radiation Analysis Laboratory in order to verify that the outside of the canister is not contaminated.

After the swabbing operation, in order to help prevent the possibility of spreading contamination, a polyethylene bag must be places over the canister, the canister must be lifted, the bag sealed, and the canister lowered back onto the cart. Following the bagging operation, the cart and canister must be parked in the "lag " storage area until verification of decontamination is received. After decontamination verification is received, the cart and canister can proceed to the lift that will lower the cart to the basement for transfer to the interim storage area.

Alternative 2: Canister Metal Spray System

Currently, low level waste (LLW) drums are reconditioned at the RWMC complex at the INEEL, by cladding the drums with a layer of metal that is sprayed on the drum outside surface. This process performs a one step process for containing any surface contamination within a metal cladding. The same process can be used for final decontamination of the DCWO waste canisters. This will eliminate the abrasive blasting, swabbing, and bagging processes, discussed in Alternative 1, and will eliminate the sample transport cask and radiological laboratory analysis of the swab.

The cost estimate for a unit that can be utilized in this environment, based on vendor input, is $1,500,000.00.

Appendix A: Waste Canister and HEPA Filter Sketches

The following drawings are found in Appendix "E" of the DCWO Study Report.

DCWO-M-1 ICPP Waste Treatment Facility Direct Cementitious Waste Option Savannah River Site Canister.

DCWO-M-3 ICPP Waste Treatment Facility Direct Cementitious Waste Option Waste Canister HEPA Filter.

Appendix B: Kneader/Extruder and Vibrator Canister Filling System Sketch

The following drawing is found in Appendix "E" of the DCWO Study Report.

DCWO-M-2 ICPP Waste Treatment Facility Direct Cementitious Waste Option Vibrator Canister Filling System.

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: Canister Loading

Summary:

This EDF documents the total number of canisters to be filled, canister throughput rate in the grout facility, and canister weight loading.

References:

1. EDF-FDO-001, Estimates of Feed and Waste Volumes, Compositions and Properties, C.M. Barnes, October, 1997
2. Savannah River Site HLW Canister drawing, ORNL DWG 90-418

Conclusions:

Number of canisters to be filled = 18,000
Loaded canister weight = 1700 kg (3748 lb)
5 year schedule throughput = 72 canisters per week
20 year schedule throughput = 18 canisters per week

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12/9/97		LMITCO Review	Date	LMITCO Approval	Date

The following statistics relating to calcine and the waste loading percentage, grout density, and resulting grout volume for the Direct Cemetitious Waste Option are discussed and documented in EDF-FDO-001, Rev 1. The calcine volume and density are provided in ranges, but for this and the other non-separations options, program direction requires the use of the quantities listed below.

Calcine volume = 5435 m^3
Calcine density = 1408 kg/m^3
Waste Loading = 35 wt%
Grout density = 1700 kg/m^3
Grout volume = 12,860 m^3

The Savannah River Site canister fill volume capacity is listed as 25.3 ft^3 (0.72 m^3) as shown on the drawing. Empty canister weight is listed at 1000 lb (454 kg).

Based on the above information the following results are obtained:

Number of canisters produced = 12,860 $m^3/0.72^3$/canister = 17,861
Rounded to 2 significant digits = 18,000 canisters

Loaded canister weight = 1700 kg/m^3 x 0.72 m^3/canister + 454 kg
= 1224 kg + 454 kg = 1678 kg
Rounded to 2 significant digits = 1700 kg (3748 lb) per canister

Throughput for a 5 year schedule = 18,000 canisters/5yr/52weeks = 69.2 canisters per week.

To accommodate using even numbers, say that for a 4 day work week, 18 canisters a day are required, or 72 canisters per week.

Throughput for a 20 year schedule is ¼ of the 5 year and is 18 canisters per week.

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project
Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: Direct Cementitious Waste Option - Process Design

Summary: This EDF describes the proposed process for the Direct Cementitious Waste Option (DCWO) for treating high level radioactive waste calcine at the Idaho Chemical Processing Plant (ICPP) at the Idaho National Engineering and Environmental Laboratory (INEEL). The DCWO process is designed to stabilize previously calcined HLW and calcined SBW by combining this waste material with clay, blast furnace slag, and caustic soda to produce a hydroceramic form of feldspathoid/zeolite. The process includes mixing a thick paste of calcine and hydroceramic additives, casting the paste into a waste canister, curing the hydroceramic using elevated temperature and pressure, removing the free water from the hydroceramic by baking, and then sealing the canister The DCWO process facility will be designed to operate 10 hours per day and four days per week for casting grout. A process description, operational steps, processing rates, material balances, equipment lists, utility requirements and process flow sheets are provided.

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S.J. Losinski	2/2/98	LMITCO Review	Date	LMITCO Approval	Date 2/2/98

DIRECT CEMENTITIOUS OPTION PROCESS DESIGN

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REQUIREMENTS

Process requirements are established by statutory laws, DOE orders, and the Batt agreement between DOE and the State of Idaho. These requirements are described in detail in Ref.1.

II. PROCESS DESIGN BASIS AND ASSUMPTIONS

General assumptions used to develop this process design for the Direct Cementitous Option (DCWO) are included in this section. This design is based on hydroceramic stabilization technology developed by Dr. D. D. Seimer and others at the INEEL.

In this process, calcined High Level Waste (HLW) and calcined Sodium Bearing Waste (SBW) are combined with clay, blast furnace slag, and caustic soda such that analogs of naturally occurring feldspathoids/zeolites are generated.. The resulting stabilized waste forms are structurally sound, geologically stable and expected to not be considered RCRA hazardous, thus allowing permanent placement in a high level waste repository such as Yucca Mountain NV.

1. The DCWO alternative is based on processing existing calcine wastes and future calcine wastes generated through 2012. Future waste generation quantities are based on evaluations of the No Action Alternative and the assumption that calciner modifications will be made for higher temperature operation.(Refer to CMB-04-97)
2. It is assumed that the storage of SBW calcine is not included in this design. Furthermore, it is assumed that SBW calcine will be delivered to the DCWO facility through the common calcine retrieval system.
3. The DCWO alternative includes mixing a thick paste of calcine and hydroceramic additives, casting the paste into a 0.72 m^3 waste canister, curing the hydroceramic under temperature and pressure, removing the free water from the hydroceramic by baking, and then sealing the canister so that it is "road ready" for shipment to a waste repository.
4. The total calcine quantity estimated to be stabilized in the DCWO facility is 5435 m^3 and it is estimated that it will have a bulk average density of 1408 Kg/m^3 .
5. The DCWO is based on the assumption that the final waste form will have a 35% weight loading of calcine and that it will have a density of 1700 Kg/m^3 .
6. The stabilized waste will meet the acceptance criteria for disposal at Yucca Mountain; and that "equivalency" will be demonstrated between the hydroceramic waste form generated in this process and vitrified waste which is the BDAT.

7. Flow rates through the DCWO process are based on a 5 year processing cycle for the total calcine inventory with production starting in the year 2013. A 50% on-line factor is applied to processing equipment with batch operations occurring on a single 4/10 days-only schedule
8. Material balances were calculated based on "average" calcine compositions. It is assumed that the DCWO process is capable of stabilizing all forms of calcine in inventory with minor variations of the hydroceramic ingredient recipe. The material balances provide the basis for sizing equipment and estimating utilities and quantities of stabilization chemicals required.
9. It is assumed that mercury contained in the calcine is not released during the autoclave cure cycle or high temperature drying process.
10. Heat transfer properties of the cast hydroceramic grout and cured grout strongly affect the process residence times of the autoclave step and the dewatering step. Because no empirical data on the heat transfer properties of the grout formulation have been collected, these properties were estimated. (See Engineering Design File on canister heat transfer. EDF-DCWO-003). Residence times, and hence the size of process equipment in the autoclave and dewatering steps, may change significantly when empirical data are collected.
11. It is assumed that one percent of all canisters processed through the DCWO will need to be recycled. Destructive analysis and the generation of off specification waste canisters are expected to be the major contributors.

III. PROCESS DESCRIPTION

The DCWO process is designed to stabilize previously calcined HLW and calcined SBW by combining this waste material with clay, blast furnace slag, and caustic soda to produce a hydroceramic form of feldspathoid/zeolite. The process includes mixing a thick paste of calcine and hydroceramic additives, casting the paste into a waste canister, curing the hydroceramic under temperature and pressure, removing the free water from the hydroceramic by baking, and then sealing the canister. Each of the various process systems are discussed below.

A. Calcine Acceptance System

A system for retrieval of calcine will be described in other documents. However, some equipment in the calcine retrieval system will be physically located at the DCWO facility. This equipment includes, two sets of cyclones and sintered filter assemblies, delivery piping, and ancillary equipment associated with recycle of entrainment air.

The calcine retrieval system will be capable of simultaneously delivering calcine from two bin sets. The calcine retrieval system will be operated in a batch mode

such that it delivers one weeks worth of calcine inventory to the DCWO facility in approximately 11 hours. For the remainder of the week the calcine retrieval system will not operate.

The calcine will be air conveyed to the DCWO via two double walled and radiologically shielded process lines. Each line will feed a cyclone and filter system which will separate the calcine from the air. The calcine will be delivered to the gravity blender of the DCWO process, and the air will be recycled back to the calcine retrieval system. Each of the two feed lines is capable of delivering 2700 Kg/hr of calcine for a total feed capacity of calcine of 5400 Kg/hr..

Controls for the calcine retrieval system will be interlocked with controls of the DCWO process such that calcine can be delivered only when enabled by DCWO process operations.

B. Calcine Blending

Calcine blending at the DCWO facility is accomplished using two major pieces of process equipment. The first major piece of equipment is a static gravity blender and the second is a mechanically agitated dry process lot tank. The static gravity blender serves to moderate the variability of calcine composition as it is supplied by the calcine retrieval system. The mechanically agitated dry process lot tank serves to thoroughly blend one weeks worth of calcine, thus forming a production lot.

The calcine blending process consists of three separate steps.

In the first step calcine is delivered via the calcine retrieval system to the static gravity blender, which in turn fills the mechanically agitated dry process lot tank. When the dry process lot tank is filled the calcine retrieval system is turned off. The dry process lot tank is sized such that it has a working capacity of 42 m^3 of calcine. (It should be noted that to operate properly the static gravity blender must remain full at all times. It should also be noted that the dry process lot tank will be full at the beginning of a weeks production and empty by the end of the week.)

The second step in the blending process is to operate the mechanically agitated dry process lot tank for a sufficient period of time to thoroughly blend the calcine. The calcine will then be chemically analyzed and assigned a process lot number. All calcine in the process lot will be stabilized using a stabilization recipe that is tailored to the chemical composition of the calcine process lot.

The third step in the blending process is to feed mixer-batch quantities of the blended calcine to the calcine batch bins of each grout mixer line. Each mixer batch of calcine is approximately 0.9 m^3

C. Grout Ingredient Delivery

Grout ingredient delivery capability is provided for calcined clay, blast furnace slag, and caustic soda (aqueous 50% sodium hydroxide). Each of these ingredients will be delivered in industry-standard semi truck quantities and processed through an off load station. Based on mass balance calculations the following delivery frequencies are anticipated; calcined clay 3 trucks/week, blast furnace slag 1 truck/2weeks, and caustic soda 1 truck/3weeks.

Calcined clay will be air lifted into storage silos using the standard air delivery system supplied by the clay vendor (standard equipment of the semi truck bulk delivery system). There are two 80 m^3 storage silos which will provide storage capacity for approximately two weeks worth of production. Each storage silo is also provided with a dust abatement filter.

Blast furnace slag will be delivered in the same way as the calcined clay. There are two 32 m^3 storage silos which will provide bulk storage capacity for approximately four weeks production. Each storage silo is sized such that it can accept the total volume of a semi truck delivery. Each silo is provided with a dust abatement filter.

Caustic soda will be delivered in industry-standard 48,000 pound (22,000 Kg) shipments. The caustic soda will be pumped from the semi truck into a heat traced storage tank using the pump system provided on the semi truck. The heat traced storage tank is sized at 20 m^3 to accept 150% of a standard delivery volume.

The grout ingredient delivery system also includes the equipment to feed the ingredients into the grout mixing line. Calcine clay and blast furnace slag are fed to the mixing line using an air ejector feed system. Caustic soda is fed to the mixing line using a positive displacement pump.

D. Sodium Hydroxide Mixing

The sodium hydroxide mixing system consists of two jacketed high shear mixers on load cells. The function of the mixing system is to combine caustic soda (concentrated sodium hydroxide) with water in the correct ratios to provide the liquid component for each mixer batch of grout. Each mixer volume of 1.5 m^3 has adequate capacity to supply the liquid for one batch of grout. The cooling jacket on the mixer is provided to control the heat liberated during mixing.

Each of the jacketed mixers is designed to provide mixed sodium hydroxide for two grout mixer lines. However, transfer piping is included so that each mixer can fill any one of the four grout mixers.

Caustic soda from the bulk storage tank will be metered into the high sheer mixer until the proper weight is added. While the mixer contents are being agitated, water from the mixer wash storage tank will be slowly metered into the mixer until the target batch weight is obtained. (Utilization of mixer wash water prevents the generation of a secondary waste stream.)

When the mixed sodium hydroxide has been cooled to the proper temperature it can then be transferred to the grout mixing process.

E. Grout Mix and Place

The grout mix and place operation is where the calcine, dry grout ingredients, and liquid grout ingredients are combined and mixed. After mixing, the paste-like grout is cast into a waste canister.

Calcined clay and blast furnace slag are fed into a 2.5 m^3 ribbon blender which is on load cells. The proper weight of each dry ingredient for making one mixer batch of grout is added to the ribbon blender and then gently blended until homogeneous. The blended dry ingredients are then ready for introduction to the grout mixer.

Calcine from the dry process lot tank is metered into the 1.5 m^3 calcine batch bin until the required weight for one mixer batch of grout is obtained. The calcine is then ready for introduction to the grout mixer.

Mixing of the grout is accomplished in a 3.6 m^3 kneeder extruder mixer. First, the grout-recipe quantity of liquid ingredients from the high sheer mixer are added to the kneeder extruder. Then, under constant agitation in the kneeder extruder, the pre weighed quantity of calcine from the calcine batch bin is added. Upon completion of addition of the calcine, the calcined clay and blast furnace slag in the ribbon blender are added. All ingredients are mixed in the kneeder extruder for approximately 15 minutes. The grout is ready for casting into waste canisters.

After the grout is mixed in the kneeder extruder the grout is cast in the canisters using a robotically controlled injection head. In the casting process the canisters are placed under the injection head and the extruder portion of the kneeder extruder is actuated. The injection head controls flow of grout to the canister, ventilates the canister, obtains a test coupon sample, and then stops the flow of grout when the canister is full. Approximately three canisters are filled with the injection head per

kneeder extruder mixer batch. Further detail on the function of the injection head system can be found in EDF-DCWO-005.

Canisters are placed on a mechanical conveyance system where they are transported to a surface decontamination/check station.

F. Mixer Clean

The mixer cleaning operation serves to wash residual grout from the kneeder extruder mixers at the end of each production day. Because the grout hardens slowly, washing of the mixers is required only at the end of each day.

An agitated 6 m^3 mixer wash tank contains the wash water that will be used to wash the kneeder extruder mixer. High pressure pumps pump water from the mixer wash tank to a spray nozzle located in each kneeder extruder. The kneeder extruder mixing arms and extruder flights are rotated during the wash cycle to assure that all surfaces are cleaned. Wash water will be pumped through the robotic injection head at the end of each wash cycle to ensure that the injection head is cleaned as well.

To avoid the generation of a secondary waste stream the wash water is used as the water supply for the grout mix. Clean makeup water is added to the mixer wash tank to maintain an adequate supply of wash water.

G. Surface Check and Decontamination

The surface check and decontamination station is designed to detect and then remove any possible external contamination of the canister that may have occurred during the grout filling process. Although it is unlikely that any external contamination of the canister will occur, this station will provide assurance that contamination is not spread to other process equipment in the DCWO facility. Further detail on the design of the surface check and decontamination station can be found in EDF-DCWO-007.

H. HEPA Filter Installation

After the exterior surface of the canister is decontaminated a HEPA filter will be installed on the top of the canister. The function of the HEPA filter is to prevent radiologically contaminated particles from being released from inside the canister. Because the curing and drying steps are performed at elevated temperatures and pressures, the canister must be allowed to breathe so that a pressure differential is

not generated across canister and so that water vapor can escape during the drying process. Further detail on the design of the HEPA filter can be found in EDF-DCWO-006.

I. Autoclave Cure

The purpose of the autoclave cure cycle is to heat the cast grout canisters to ensure complete curing of the grout. For this design, cure of the grout is considered complete when the internal centerline temperature of the canister reaches 200°C

In the autoclave cure process 18 grout canisters are loaded into one of four autoclaves and the autoclave is sealed. Saturated steam at 250°C is introduced to the autoclave so that condensing steam directly contacts the grout canister.

Heat transfer calculations indicate that 35 hours of residence time in the presence of saturated steam is required to drive the centerline temperature to 200°C. After the centerline temperature of the grout canisters has reached 200°C the autoclave will be depressurized and purged with air. The autoclave will be opened and the grout canister will be moved to the dewatering station.

It is anticipated that one autoclave cure cycle, including loading and unloading of the canisters, can be accomplished in 48 hours.

It is assumed that the grout in the grout canisters will release approximately 30% of its moisture content during the depressurizarion of the autoclave. (Adiabatic decompression) This decompression step will also result in a lowering of the internal temperature of the grout to approximately 100°C.

J. Dewater Station

The dewatering station serves to dry the cured grout in the canisters such that the residual moisture content of grout is less than 2% of the grout by weight.

Cured grout canisters from the autoclaves will be placed on a conveyor and moved into the dewatering station. The dewatering station is nothing more than a controlled environment room in which the temperature is maintained at 250°C and a relative humidity of less than 25%. Under these conditions the remaining free water in the grout will slowly evaporate. Total residence time of the grout canister in the dewatering station is designed to be a minimum of 7 days.

K. Weld and Seal

After the canister containing the grout is cured and dried a permanent cap will be welded onto the canister. The cap will be installed using a robotically controlled welder as described in EDF-DCWO-008.

L. Final Contamination Check and Decontamination

Although highly unlikely, it is possible that contamination of the exterior of the canister may occur in the curing, drying, or weld sealing steps of the DCWO process. A final contamination check and, if needed, decontamination of the canister will occur. The design of this station is detailed in EDF-DCWO-007.

M. Sonic Tomography

The sonic tomography process serves to provide quality assurance that the cured and dried grout meets minimum compressive strength and canister fill requirements.

In the sonic tomography process a grout canister is placed in a fixture, immersed in water and subjected to an ultrasonic signal. Via arrays of sensors detecting transmittance and back scatter of the ultrasonic signal, it is possible generate a three dimensional image of the waste in the canister. This image can be processed to interpret if there are any internal voids or uncured spots in the filled waste canister.

N. Off-Specification Storage, Sizing, and Recycle

While every effort will be made to avoid the generation of off-specification canisters, it is anticipated that the materials from some waste canisters will have to be recycled back into the DCWO process and regrouted. Destructive testing and upsets during the grout manufacturing process are anticipated as the major contributors of off-specification materials. It is assumed that one percent of all canisters made will have to be recycled.

This design includes the provision to store twenty canisters pending sizing and recycle. When it is determined that the canisters will be recycled they will be loaded into a concrete saw and sliced into sections. The sections will be crushed in a screw press and then further reduced in size in a jaw crusher. The resulting small particles will be stored in a collection hopper and reintroduced into the DCWO process. Further detail on this recycle system can be found in EDF-HWO-011.

O. Air Handling/Filter Systems

Air handling and filtration systems in this process are not well defined. It is known that several different air handling and filtration systems will be required to support all the process needs of the DCWO facility. The larger systems are considered below.

An air handling and filtration system will be required to vent all radiologically contaminated tanks and process vessels operating at atmospheric pressure. This system is required to assure that the tanks and process vessels do not become pressurized or release radiological contaminants to the surrounding area. This system is expected to process a low volume of air.

An air handling and filtration system will be required to process the high temperature, high humidity, high volume, air flows associated with the autoclave purge cycles and grout drying process. These air streams are expected to be approximately 250°C and nearly saturated with water vapor when entering the filtration system. This system will present a significant process design challenge.

An air handling and filtration system will also be needed to address the HVAC requirements of the ambient temperature hot cells containing process equipment. Further detail on the design of this system can be found in EDF-DCWO-014.

IV. ISSUES AND RECOMMENDATIONS

The hydroceramic stabilization technology utilized in this design has not been demonstrated or utilized at a scale or extent as large as that presented in this design. Physical and chemical properties associated with process reaction kinetics, mechanical properties, and heat transfer properties of the waste are not well understood and generate significant uncertainty in this design. It is recommended that research work be conducted to quantify the following:

1. Cure Reaction Kinetics
2. Cure Reaction Thermodynamics
3. Compressive Strength and Coefficient of Thermal Expansion
4. Specific Heat and Thermal Conductivity

It is suspected that the grout formulation used in this design is not fully optimized. It is recommended that additional research work be conducted to better understand the relationship between grout formulation and grout performance. Additionally, research should be conducted to demonstrate how variations in calcine properties affect grout performance. Specific research needs include:

1. Chemical Constituent Variations
2. Trace Metals (Mercury in particular) Variations
3. Particle Size of Calcine
4. Function of Calcine Properties on Wasteform Porosity

Based on the experience of BNFL in completing a similar cement stabilization facility, (EP1, comp. 1990, Sellafield, United Kingdom) a phased approach to the research, concurrent with facility design can be accomplished. BNFL recommends the following product development phases:

1. Product Review
2. Matrix Definition
3. Detailed Product Evaluation and Long Term Studies
4. Establishing Product Envelope and Additional Product Evaluation Studies

BNFLs process design/process verification research for the Sellafield EP1 plant included the following phases:

1. Small Scale Non-Active
2. Small Scale Active
3. Full Scale Non-Active
4. Full Scale Active

This design was produced with limited knowledge of the quality assurance and waste acceptance criteria that will be imposed on the waste when it is shipped to the geological waste repository. Often these criteria significantly affect the process design because they dictate where, when, and how often process data, and sampling must occur. In a general sense, it is not known what "pedigree" of data must accompany each canister of waste. For the purposes of this design it was assumed that some form of statistical process control can be implemented such that infrequent sampling of the stabilized waste is required, but that critical process parameters and selected feed parameters are closely monitored and controlled. It was also assumed that non-destructive analysis techniques could be used to satisfy certain waste acceptance criteria.

V. PROCESS FLOW DIAGRAMS

PFD Number	Title
DCWO-00	Block Flow Diagram
DCWO-01	Calcine Acceptance System
DCWO-02	Calcine Blending
DCWO-03	Grout Ingredient Delivery
DCWO-04	Mixer - Line A
DCWO-05	NaOH Mixing
DCWO-06	Mixer Clean
DCWO-07	Surface Contamination Check and Surface Decon - Line A
DCWO-08	HEPA Filter Installation - Line A
DCWO-09	Autoclave Cure Station - Line A
DCWO-10	Dewater Station
DCWO-11	Weld/Seal
DCWO-12	Final Surface Contamination Check & Surface Decon
DCWO-13	Sonic Tomography
DCWO-14	Off-Specification Storage, Sizing, and Recycle
DCWO-15	Test Coupons and Chemical Analysis
DCWO-16	Filter Systems

Note: Four parallel process lines exist for the grout mixing through grout curing steps of the process. To simplify the PFDs, only process Line A is shown. Process lines B,C, and D are identical to Line A.

V. MATERIAL BALANCES

Material Balances for the DCWO are presented on the following thirteen pages. There are seven pages which quantify major chemical constituents for each flow number and there are six pages which quantify anticipated radionuclide concentrations. Quantities reported in the material balances are for the total DCWO production cycle. It should be noted that an air balance was not performed on this design so air stream mass quantities are reported as zero. A flow stream locator table is provided to correlate the process stream number with the relevant PFDs.

Flow Stream Locator

Stream Number	Description	Starting Drawing	Exists on Drawings	Ends on Drawing
101	Reserved for Calcine			
102	Reserved for Calcine			
103	Reserved for Calcine			
104	Reserved for Calcine			
105	Reserved for Calcine			
106	Reserved for Calcine			
107	Reserved for Calcine			
108	Reserved for Calcine			
109	Reserved for Calcine			
110	Reserved for Calcine			
112	Air Vent from Calcine Batch Bin	04	04,16	16
113	Air Vent from Kneeder Extruder	04	04,16	16
114 A,B	Calcine from Cyclone Separator	01	01,02	02
115 A,B	Calcine Retrieval System Purge Vent	01	01,16	16
116	Static Gravity Mixer Blend (Calcine)	02	02,	02
118	Mixed Calcine	02	02,04	04
119	Calcined Clay	03	03	03
120	Blast Furnace Slag	03	03	03
121	Caustic Soda, 50% Wt Sodium Hydroxide	03	03,05	05
122	Water to Grout Plant	06	06	06

Stream Number	Description	Starting Drawing	Exists on Drawings	Ends on Drawing
123	Vent, Process Lot Tank	02	02,16	16
124	Vent, Static Gravity Mixer	02	02,16	16
125 A,B,C,D	Batch Bin Cleanout	04	04,02	02
126	Ejector Air Clay	03	03	03
127	Entrained Clay	03	03, 04	04
128 A,B,C,D	Ribbon Blender Air	04	04,16	16
129	Ejector Air Slag	03	03	03
130	Entrained Slag	03	03,04	04
131 A,B,C,D	Blended Clay and Slag	04	04	04
132 A,B,C,D	Mixed Caustic Soda/ Water	05	05,04	04
133 A,B,C,D	Mixer Wash Water	06	06,04	04
134 A,B,C,D	Injection Head Vents	04	04,16	16
135 A,B,C,D	Test Coupons	04	04,15	15
136 A,B,C,D	Mixer Outlet Wash Water	04	04,06	06
137 A,B,C,D	Cast Grout	04	04,07,08 ,09,	09
138	Caustic Water Makeup	06	06,05	05
139	Air to Dewater Station	10	10	10
140	Air from Dewater Station	10	10,16	16
141	Dewatered Grout	10	10,11,12 ,13	13
142	Acceptable Grout	13	13	Product
143	Unacceptable Grout	13	13,14	14
144	Crushed Grout (Recycle)	14	14,02	02
145	Test Coupon Waste	15	15,04	04
146	Ribbon Blender Cleanout	04	04,14	14
147	Vent, High Sheer Mixer	05	05,16	16
148	Vent, Mixer Wash Tank	06	06,16	16

Stream Number	Description	Starting Drawing	Exists on Drawings	Ends on Drawing
149 A,B,C,D	Vent, Autoclave	09	09,16	16
150 A,B,C,D	Autoclaved Grout	09	09,10	10
151 A,B,C,D	Cure Steam	17	17,09	09
152 A,B,C,D	Steam Condensate	09	09,17	17
153 A,B,C,D	Calcine Batch	04	04	04
154 A,B,C,D	Autoclave Purge Air	09	09	09

			MASS BALANCE				
		AIR VENT	AIR VENT	CALCINE	GRAVITY	MIXED	CALCINED
		CALCINE	KNEEDER	CYCLONE	BLENDER	CALCINE	CLAY
		BATCH BIN	EXTRUDER	SEPARATOR			
STREAM NUMBER		112	113	114	116	118	119
Al2O3		0.000	0.000	25.466	25.466	24.990	0.000
Al2(SO4)3		0.000	0.000	0.080	0.080	0.078	0.000
AlPO4		0.000	0.000	0.004	0.004	0.004	0.000
B2O3		0.000	0.000	2.126	2.126	2.087	0.000
BaO		0.000	0.000	0.052	0.052	0.051	0.000
CaCO3		0.000	0.000	2.016	2.016	1.978	0.000
CaF2		0.000	0.000	35.828	35.828	35.158	0.000
CaO		0.000	0.000	3.012	3.012	2.956	0.000
Ca3(PO4)2		0.000	0.000	0.601	0.601	0.590	0.000
CaSO4		0.000	0.000	0.055	0.055	0.054	0.000
CdO		0.000	0.000	0.622	0.622	0.610	0.000
Cr2O3		0.000	0.000	0.255	0.255	0.251	0.000
Fe2O3		0.000	0.000	0.443	0.443	0.435	0.000
Gd2O3		0.000	0.000	0.003	0.003	0.003	0.000
HgO		0.000	0.000	0.328	0.328	0.322	0.000
KAlO2		0.000	0.000	1.964	1.964	1.928	0.000
K2SO4		0.000	0.000	1.104	1.104	1.083	0.000
MgCO3		0.000	0.000	1.717	1.717	1.685	0.000
MnO		0.000	0.000	0.055	0.055	0.054	0.000
MoO3		0.000	0.000	0.004	0.004	0.004	0.000
NaAlO2		0.000	0.000	6.857	6.857	6.729	0.000
NaCl		0.000	0.000	0.199	0.199	0.195	0.000
NaNO3		0.000	0.000	6.603	6.603	6.480	0.000
Na3(PO4)2		0.000	0.000	0.045	0.045	0.044	0.000
Na2SO4		0.000	0.000	0.483	0.483	0.474	0.000
Nb2O5		0.000	0.000	0.056	0.056	0.055	0.000
NiO		0.000	0.000	0.014	0.014	0.014	0.000
PbO		0.000	0.000	0.013	0.013	0.013	0.000
SnO2		0.000	0.000	0.141	0.141	0.138	0.000
UO2		0.000	0.000	0.004	0.004	0.004	0.000
ZrO2		0.000	0.000	9.850	9.850	9.665	0.000
CLAY		0.000	0.000	0.000	0.000	1.592	100.000
SLAG		0.000	0.000	0.000	0.000	0.172	0.000
NaOH		0.000	0.000	0.000	0.000	0.049	0.000
H2O		0.000	0.000	0.000	0.000	0.057	0.000
Percent Total		0.000	0.000	100.000	100.000	100.000	100.000
Total Volume, ft3 (Solids)				191886	191886	197518	298392
Total Volume, m3				5434	5434	5594	8451
Specific Gravity				1.409	1.409	1.409	1.470
Total Mass, kg				7656108	7656108	7880827	12422435
AIR - ft3		0.0	0.0	0.0	0.0	0.0	0.0

MASS BALANCE

	BLAST FURNACE SLAG	CAUSTIC SODA	MAKEUP WATER	VENT PROCESS LOT TANK	VENT STATIC GRAVITY MIXER	BATCH BIN CLEANOUT	EJECTOR AIR CLAY
STREAM NUMBER	120	121	122	123	124	125	126
Al2O3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Al2(SO4)3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AlPO4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B2O3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BaO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CaCO3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CaF2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CaO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Ca3(PO4)2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CaSO4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CdO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cr2O3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fe2O3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gd2O3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HgO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
KAlO2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
K2SO4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MgCO3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MnO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MoO3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaAlO2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaCl	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NaNO3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Na3(PO4)2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Na2SO4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nb2O5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NiO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PbO	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SnO2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UO2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZrO2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CLAY	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SLAG	100.000	0.000	0.000	0.000	0.000	0.000	0.000
NaOH	0.000	50.000	0.000	0.000	0.000	0.000	0.000
H2O	0.000	50.000	100.000	0.000	0.000	0.000	0.000
Percent Total	100.000	100.000	100.000	0.000	0.000	0.000	0.000
Total Volume, ft3 (Solids)	47348	17902	206225				
Total Volume, m3	1341	507	5840				
Specific Gravity	1.000	1.510	1.000				
Total Mass, kg	1340913	765566	5840411	0	0	0	0
AIR - ft3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

		MASS BALANCE					
		ENTRAINED	RIBBON	EJECTOR	ENTRAINED	BLENDED	MIXED
		CLAY	BLENDER	AIR	SLAG	CLAY AND	CAUSTIC
			AIR	SLAG		SLAG	SODA/
							WATER
STREAM NUMBER		127	128	129	130	131	132
Al2O3		0.000	0.000	0.000	0.000	0.000	0.000
Al2(SO4)3		0.000	0.000	0.000	0.000	0.000	0.000
AlPO4		0.000	0.000	0.000	0.000	0.000	0.000
B2O3		0.000	0.000	0.000	0.000	0.000	0.000
BaO		0.000	0.000	0.000	0.000	0.000	0.000
CaCO3		0.000	0.000	0.000	0.000	0.000	0.000
CaF2		0.000	0.000	0.000	0.000	0.000	0.000
CaO		0.000	0.000	0.000	0.000	0.000	0.000
Ca3(PO4)2		0.000	0.000	0.000	0.000	0.000	0.000
CaSO4		0.000	0.000	0.000	0.000	0.000	0.000
CdO		0.000	0.000	0.000	0.000	0.000	0.000
Cr2O3		0.000	0.000	0.000	0.000	0.000	0.000
Fe2O3		0.000	0.000	0.000	0.000	0.000	0.000
Gd2O3		0.000	0.000	0.000	0.000	0.000	0.000
HgO		0.000	0.000	0.000	0.000	0.000	0.000
KAlO2		0.000	0.000	0.000	0.000	0.000	0.000
K2SO4		0.000	0.000	0.000	0.000	0.000	0.000
MgCO3		0.000	0.000	0.000	0.000	0.000	0.000
MnO		0.000	0.000	0.000	0.000	0.000	0.000
MoO3		0.000	0.000	0.000	0.000	0.000	0.000
NaAlO2		0.000	0.000	0.000	0.000	0.000	0.000
NaCl		0.000	0.000	0.000	0.000	0.000	0.000
NaNO3		0.000	0.000	0.000	0.000	0.000	0.000
Na3(PO4)2		0.000	0.000	0.000	0.000	0.000	0.000
Na2SO4		0.000	0.000	0.000	0.000	0.000	0.000
Nb2O5		0.000	0.000	0.000	0.000	0.000	0.000
NiO		0.000	0.000	0.000	0.000	0.000	0.000
PbO		0.000	0.000	0.000	0.000	0.000	0.000
SnO2		0.000	0.000	0.000	0.000	0.000	0.000
UO2		0.000	0.000	0.000	0.000	0.000	0.000
ZrO2		0.000	0.000	0.000	0.000	0.000	0.000
CLAY		100.000	0.000	0.000	0.000	90.257	0.000
SLAG		0.000	0.000	0.000	100.000	9.743	0.000
NaOH		0.000	0.000	0.000	0.000	0.000	5.794
H2O		0.000	0.000	0.000	0.000	0.000	94.206
Percent Total		100.000	0.000	0.000	100.000	100.000	100.000
Total Volume, ft3 (Solids)		298392			47348	345740	219021
Total Volume, m3		8451			1341	9792	6203
Specific Gravity		1.470			1.000	1405.635	1.065
Total Mass, kg		12422435	0	0	1340913	13763347	6605977
AIR - ft3		0.0	0.0	0.0	0.0	0.0	0.0

		MASS BALANCE					
		MIXER WASH WATER	VENT INJECTION HEAD	TEST COUPONS	MIXER OUTLET WASH WATER	CAST GROUT	CAUSTIC WATER MAKEUP
STREAM NUMBER		133	134	135	136	137	138
Al2O3		0.000	0.000	0.000	0.000	6.971	0.000
Al2(SO4)3		0.000	0.000	0.000	0.000	0.022	0.000
AlPO4		0.000	0.000	0.000	0.000	0.001	0.000
B2O3		0.000	0.000	0.000	0.000	0.582	0.000
BaO		0.000	0.000	0.000	0.000	0.014	0.000
CaCO3		0.000	0.000	0.000	0.000	0.552	0.000
CaF2		0.000	0.000	0.000	0.000	9.808	0.000
CaO		0.000	0.000	0.000	0.000	0.825	0.000
Ca3(PO4)2		0.000	0.000	0.000	0.000	0.165	0.000
CaSO4		0.000	0.000	0.000	0.000	0.015	0.000
CdO		0.000	0.000	0.000	0.000	0.170	0.000
Cr2O3		0.000	0.000	0.000	0.000	0.070	0.000
Fe2O3		0.000	0.000	0.000	0.000	0.121	0.000
Gd2O3		0.000	0.000	0.000	0.000	0.001	0.000
HgO		0.000	0.000	0.000	0.000	0.090	0.000
KAlO2		0.000	0.000	0.000	0.000	0.538	0.000
K2SO4		0.000	0.000	0.000	0.000	0.302	0.000
MgCO3		0.000	0.000	0.000	0.000	0.470	0.000
MnO		0.000	0.000	0.000	0.000	0.015	0.000
MoO3		0.000	0.000	0.000	0.000	0.001	0.000
NaAlO2		0.000	0.000	0.000	0.000	1.877	0.000
NaCl		0.000	0.000	0.000	0.000	0.054	0.000
NaNO3		0.000	0.000	0.000	0.000	1.808	0.000
Na3(PO4)2		0.000	0.000	0.000	0.000	0.012	0.000
Na2SO4		0.000	0.000	0.000	0.000	0.132	0.000
Nb2O5		0.000	0.000	0.000	0.000	0.015	0.000
NiO		0.000	0.000	0.000	0.000	0.004	0.000
PbO		0.000	0.000	0.000	0.000	0.004	0.000
SnO2		0.000	0.000	0.000	0.000	0.039	0.000
UO2		0.000	0.000	0.000	0.000	0.001	0.000
ZrO2		0.000	0.000	0.000	0.000	2.696	0.000
CLAY		0.000	0.000	0.000	0.000	44.417	0.000
SLAG		0.000	0.000	0.000	0.000	4.795	0.000
NaOH		0.000	0.000	0.000	0.000	1.369	0.000
H2O		0.000	0.000	0.000	0.000	22.045	100.000
Percent Total		0.000	0.000	0.000	0.000	100.000	100.000
Total Volume, ft3 (Solids)						466755	206225
Total Volume, m3						13219	5840
Specific Gravity						2.137	1.000
Total Mass, kg		0	0	0	0	28250151	5840411
AIR - ft3		0.0	0.0	0.0	0.0	0.0	0.0

		MASS BALANCE				
		AIR TO DEWATER STATION	AIR FROM DEWATER STATION	DEWATERED GROUT	ACCEPTABLE GROUT	UNACCEPTABLE GROUT
STREAM NUMBER		139	140	141	142	143
Al2O3		0.000	0.000	8.764	8.764	8.764
Al2(SO4)3		0.000	0.000	0.027	0.027	0.027
AlPO4		0.000	0.000	0.001	0.001	0.001
B2O3		0.000	0.000	0.732	0.732	0.732
BaO		0.000	0.000	0.018	0.018	0.018
CaCO3		0.000	0.000	0.694	0.694	0.694
CaF2		0.000	0.000	12.330	12.330	12.330
CaO		0.000	0.000	1.037	1.037	1.037
Ca3(PO4)2		0.000	0.000	0.207	0.207	0.207
CaSO4		0.000	0.000	0.019	0.019	0.019
CdO		0.000	0.000	0.214	0.214	0.214
Cr2O3		0.000	0.000	0.088	0.088	0.088
Fe2O3		0.000	0.000	0.152	0.152	0.152
Gd2O3		0.000	0.000	0.001	0.001	0.001
HgO		0.000	0.000	0.113	0.113	0.113
KAlO2		0.000	0.000	0.676	0.676	0.676
K2SO4		0.000	0.000	0.380	0.380	0.380
MgCO3		0.000	0.000	0.591	0.591	0.591
MnO		0.000	0.000	0.019	0.019	0.019
MoO3		0.000	0.000	0.002	0.002	0.002
NaAlO2		0.000	0.000	2.360	2.360	2.360
NaCl		0.000	0.000	0.068	0.068	0.068
NaNO3		0.000	0.000	2.272	2.272	2.272
Na3(PO4)2		0.000	0.000	0.016	0.016	0.016
Na2SO4		0.000	0.000	0.166	0.166	0.166
Nb2O5		0.000	0.000	0.019	0.019	0.019
NiO		0.000	0.000	0.005	0.005	0.005
PbO		0.000	0.000	0.004	0.004	0.004
SnO2		0.000	0.000	0.048	0.048	0.048
UO2		0.000	0.000	0.001	0.001	0.001
ZrO2		0.000	0.000	3.390	3.390	3.390
CLAY		0.000	0.000	55.838	55.838	55.838
SLAG		0.000	0.000	6.027	6.027	6.027
NaOH		0.000	0.000	1.721	1.721	1.721
H2O		0.000	100.000	2.000	2.000	2.000
Percent Total		0.000	100.000	100.000	100.000	100.000
Total Volume, ft3 (Solids)				466755	462087	4668
Total Volume, m3				13219	13087	132
Specific Gravity				1.700	1.700	1.700
Total Mass, kg		0	3760479	22471900	22247181	224719
AIR - ft3		0.0	0.0	0.0	0.0	0.0

MASS BALANCE

	CRUSHED GROUT RECYCLE	TEST COUPON WASTE	RIBBON BLENDER CLEANOUT	VENT HIGH SHEER MIXER	VENT MIXER WASH TANK	VENT AUTOCLAVE
STREAM NUMBER	144	145	146	147	148	149
Al2O3	8.764	0.000	0.000	0.000	0.000	0.000
Al2(SO4)3	0.027	0.000	0.000	0.000	0.000	0.000
AlPO4	0.001	0.000	0.000	0.000	0.000	0.000
B2O3	0.732	0.000	0.000	0.000	0.000	0.000
BaO	0.018	0.000	0.000	0.000	0.000	0.000
CaCO3	0.694	0.000	0.000	0.000	0.000	0.000
CaF2	12.330	0.000	0.000	0.000	0.000	0.000
CaO	1.037	0.000	0.000	0.000	0.000	0.000
Ca3(PO4)2	0.207	0.000	0.000	0.000	0.000	0.000
CaSO4	0.019	0.000	0.000	0.000	0.000	0.000
CdO	0.214	0.000	0.000	0.000	0.000	0.000
Cr2O3	0.088	0.000	0.000	0.000	0.000	0.000
Fe2O3	0.152	0.000	0.000	0.000	0.000	0.000
Gd2O3	0.001	0.000	0.000	0.000	0.000	0.000
HgO	0.113	0.000	0.000	0.000	0.000	0.000
KAlO2	0.676	0.000	0.000	0.000	0.000	0.000
K2SO4	0.380	0.000	0.000	0.000	0.000	0.000
MgCO3	0.591	0.000	0.000	0.000	0.000	0.000
MnO	0.019	0.000	0.000	0.000	0.000	0.000
MoO3	0.002	0.000	0.000	0.000	0.000	0.000
NaAlO2	2.360	0.000	0.000	0.000	0.000	0.000
NaCl	0.068	0.000	0.000	0.000	0.000	0.000
NaNO3	2.272	0.000	0.000	0.000	0.000	0.000
Na3(PO4)2	0.016	0.000	0.000	0.000	0.000	0.000
Na2SO4	0.166	0.000	0.000	0.000	0.000	0.000
Nb2O5	0.019	0.000	0.000	0.000	0.000	0.000
NiO	0.005	0.000	0.000	0.000	0.000	0.000
PbO	0.004	0.000	0.000	0.000	0.000	0.000
SnO2	0.048	0.000	0.000	0.000	0.000	0.000
UO2	0.001	0.000	0.000	0.000	0.000	0.000
ZrO2	3.390	0.000	0.000	0.000	0.000	0.000
CLAY	55.838	0.000	0.000	0.000	0.000	0.000
SLAG	6.027	0.000	0.000	0.000	0.000	0.000
NaOH	1.721	0.000	0.000	0.000	0.000	0.000
H2O	2.000	0.000	0.000	0.000	0.000	100.000
	0.000					
Percent Total	100.000	0.000	0.000	0.000	0.000	100.000
Total Volume, ft3 (Solids)	7213					71247
Total Volume, m3	204					2018
Specific Gravity	1.100					1.000
Total Mass, kg	224719	0	0	0	0	2017771
AIR - ft3	0.0	0.0	0.0	0.0	0.0	0.0

		MASS BALANCE				
		AUTOCLAVED	CURE	STEAM	CALCINE	AUTOCLAVE
		GROUT	STEAM	CONDENSATE	BATCH	PURGE AIR
STREAM NUMBER		150	151	152	153	154
Al2O3		7.508	0.000	0.000	24.990	0.000
Al2(SO4)3		0.023	0.000	0.000	0.078	0.000
AlPO4		0.001	0.000	0.000	0.004	0.000
B2O3		0.627	0.000	0.000	2.087	0.000
BaO		0.015	0.000	0.000	0.051	0.000
CaCO3		0.594	0.000	0.000	1.978	0.000
CaF2		10.562	0.000	0.000	35.158	0.000
CaO		0.888	0.000	0.000	2.956	0.000
Ca3(PO4)2		0.177	0.000	0.000	0.590	0.000
CaSO4		0.016	0.000	0.000	0.054	0.000
CdO		0.183	0.000	0.000	0.610	0.000
Cr2O3		0.075	0.000	0.000	0.251	0.000
Fe2O3		0.131	0.000	0.000	0.435	0.000
Gd2O3		0.001	0.000	0.000	0.003	0.000
HgO		0.097	0.000	0.000	0.322	0.000
KAlO2		0.579	0.000	0.000	1.928	0.000
K2SO4		0.325	0.000	0.000	1.083	0.000
MgCO3		0.506	0.000	0.000	1.685	0.000
MnO		0.016	0.000	0.000	0.054	0.000
MoO3		0.001	0.000	0.000	0.004	0.000
NaAlO2		2.021	0.000	0.000	6.729	0.000
NaCl		0.059	0.000	0.000	0.195	0.000
NaNO3		1.947	0.000	0.000	6.480	0.000
Na3(PO4)2		0.013	0.000	0.000	0.044	0.000
Na2SO4		0.142	0.000	0.000	0.474	0.000
Nb2O5		0.016	0.000	0.000	0.055	0.000
NiO		0.004	0.000	0.000	0.014	0.000
PbO		0.004	0.000	0.000	0.013	0.000
SnO2		0.041	0.000	0.000	0.138	0.000
UO2		0.001	0.000	0.000	0.004	0.000
ZrO2		2.904	0.000	0.000	9.665	0.000
CLAY		47.834	0.000	0.000	1.592	0.000
SLAG		5.163	0.000	0.000	0.172	0.000
NaOH		1.474	0.000	0.000	0.049	0.000
H2O		16.049	100.000	100.000	0.057	0.000
Percent Total		100.000	0.000	0.000	100.000	0.000
Total Volume, ft3 (Solids)		466755			197518	
Total Volume, m3		13219			5594	
Specific Gravity		1.984			1.409	
Total Mass, kg		26232380	0	0	7880827	0.000
AIR - ft3		0.0	0.0	0.0	0.0	0.000

Rad Mass Balance

			AIR VENT	AIR VENT	CALCINE	GRAVITY	MIXED	CALCINED
			CALCINE	KNEEDER	CYCLONE	BLENDER	CALCINE	CLAY
			BATCH BIN	EXTRUDER	SEPARATOR			
	STREAM NUMBER		112	113	114	116	118	119
	STREAM WEIGHT kg		0	0	7656108	7656108	7880827	12422435
Ci/g								
Am-241			0	0	1.99E-07	1.99E-07	1.99E-07	0
Am-243			0	0		0.00E+00	0.00E+00	0
Cm-242			0	0		0.00E+00	0.00E+00	0
Cm-244			0	0		0.00E+00	0.00E+00	0
Np-237			0	0	8.73E-09	8.73E-09	8.73E-09	0
Pa-233			0	0		0.00E+00	0.00E+00	0
Pu-238			0	0	2.64E-06	2.64E-06	2.64E-06	0
Pu-239			0	0	2.81E-07	2.81E-07	2.81E-07	0
Pu-240			0	0	6.84E-08	6.84E-08	6.84E-08	0
Pu-241			0	0	2.52E-06	2.52E-06	2.52E-06	0
Pu-242			0	0	4.32E-11	4.32E-11	4.32E-11	0
U-233			0	0	6.03E-10	6.03E-10	6.03E-10	0
U-234			0	0	3.89E-10	3.89E-10	3.89E-10	0
U-235			0	0	6.29E-11	6.29E-11	6.29E-11	0
U-236			0	0	4.03E-12	4.03E-12	4.03E-12	0
U-237			0	0		0.00E+00	0.00E+00	0
U-238			0	0	9.48E-11	9.48E-11	9.48E-11	0
Th-230			0	0		0.00E+00	0.00E+00	0
Th-231			0	0		0.00E+00	0.00E+00	0
Ba-137m			0	0		0.00E+00	0.00E+00	0
Cd-113m			0	0		0.00E+00	0.00E+00	0
Ce-144			0	0	2.13E-05	2.13E-05	2.13E-05	0
Co-60			0	0	1.01E-06	1.01E-06	1.01E-06	0
Cs-134			0	0	4.00E-06	4.00E-06	4.00E-06	0
Cs-135			0	0	1.93E-09	1.93E-09	1.93E-09	0
Cs-137			0	0	1.45E-04	1.45E-04	1.45E-04	0
Eu-152			0	0		0.00E+00	0.00E+00	0
Eu-154			0	0	8.41E-07	8.41E-07	8.41E-07	0
Eu-155			0	0	1.35E-06	1.35E-06	1.35E-06	0
I-129			0	0	6.64E-09	6.64E-09	6.64E-09	0
Nb-93m			0	0		0.00E+00	0.00E+00	0
Pd-107			0	0		0.00E+00	0.00E+00	0
Pm-147			0	0		0.00E+00	0.00E+00	0
Ru-106			0	0	8.65E-06	8.65E-06	8.65E-06	0
Sb-125			0	0	1.70E-06	1.70E-06	1.70E-06	0
Sb-126			0	0		0.00E+00	0.00E+00	0
Sb-126m			0	0		0.00E+00	0.00E+00	0
Se-79			0	0		0.00E+00	0.00E+00	0
Sm-151			0	0		0.00E+00	0.00E+00	0
Sn-121m			0	0		0.00E+00	0.00E+00	0
Sn-126			0	0		0.00E+00	0.00E+00	0
Sr-90			0	0	1.37E-04	1.37E-04	1.37E-04	0
Tc-99			0	0	3.82E-08	3.82E-08	3.82E-08	0
Y-90			0	0		0.00E+00	0.00E+00	0
Zr-93			0	0		0.00E+00	0.00E+00	0
Ni-63			0	0	1.70E-07	1.70E-07	1.70E-07	0

	BLAST	CAUSTIC	MAKEUP	VENT	VENT	BATCH	EJECTOR	ENTRAINED
	FURNACE	SODA	WATER	PROCESS	STATIC	BIN	AIR	CLAY
	SLAG			LOT TANK	GRAVITY	CLEANOUT	CLAY	
	120	121	122	123	124	125	126	127
	1340913	765566	5840411	0	0	0	0	12422435
Ci/g								
Am-241	0	0	0	0	0	1.99E-07	0	0
Am-243	0	0	0	0	0	0.00E+00	0	0
Cm-242	0	0	0	0	0	0.00E+00	0	0
Cm-244	0	0	0	0	0	0.00E+00	0	0
Np-237	0	0	0	0	0	8.73E-09	0	0
Pa-233	0	0	0	0	0	0.00E+00	0	0
Pu-238	0	0	0	0	0	2.64E-06	0	0
Pu-239	0	0	0	0	0	2.81E-07	0	0
Pu-240	0	0	0	0	0	6.84E-08	0	0
Pu-241	0	0	0	0	0	2.52E-06	0	0
Pu-242	0	0	0	0	0	4.32E-11	0	0
U-233	0	0	0	0	0	6.03E-10	0	0
U-234	0	0	0	0	0	3.89E-10	0	0
U-235	0	0	0	0	0	6.29E-11	0	0
U-236	0	0	0	0	0	4.03E-12	0	0
U-237	0	0	0	0	0	0.00E+00	0	0
U-238	0	0	0	0	0	9.48E-11	0	0
Th-230	0	0	0	0	0	0.00E+00	0	0
Th-231	0	0	0	0	0	0.00E+00	0	0
Ba-137m	0	0	0	0	0	0.00E+00	0	0
Cd-113m	0	0	0	0	0	0.00E+00	0	0
Ce-144	0	0	0	0	0	2.13E-05	0	0
Co-60	0	0	0	0	0	1.01E-06	0	0
Cs-134	0	0	0	0	0	4.00E-06	0	0
Cs-135	0	0	0	0	0	1.93E-09	0	0
Cs-137	0	0	0	0	0	1.45E-04	0	0
Eu-152	0	0	0	0	0	0.00E+00	0	0
Eu-154	0	0	0	0	0	8.41E-07	0	0
Eu-155	0	0	0	0	0	1.35E-06	0	0
I-129	0	0	0	0	0	6.64E-09	0	0
Nb-93m	0	0	0	0	0	0.00E+00	0	0
Pd-107	0	0	0	0	0	0.00E+00	0	0
Pm-147	0	0	0	0	0	0.00E+00	0	0
Ru-106	0	0	0	0	0	8.65E-06	0	0
Sb-125	0	0	0	0	0	1.70E-06	0	0
Sb-126	0	0	0	0	0	0.00E+00	0	0
Sb-126m	0	0	0	0	0	0.00E+00	0	0
Se-79	0	0	0	0	0	0.00E+00	0	0
Sm-151	0	0	0	0	0	0.00E+00	0	0
Sn-121m	0	0	0	0	0	0.00E+00	0	0
Sn-126	0	0	0	0	0	0.00E+00	0	0
Sr-90	0	0	0	0	0	1.37E-04	0	0
Tc-99	0	0	0	0	0	3.82E-08	0	0
Y-90	0	0	0	0	0	0.00E+00	0	0
Zr-93	0	0	0	0	0	0.00E+00	0	0
Ni-63	0	0	0	0	0	1.70E-07	0	0

Rad Mass Balance

	RIBBON BLENDER AIR	EJECTOR AIR SLAG	ENTRAINED SLAG	BLENDED CLAY AND SLAG	MIXED CAUSTIC SODA/	MIXER WASH WATER	VENT INJECTION HEAD	TEST COUPONS
	128	129	130	131	132	133	134	135
	0	0	1340913	13763347	6605977	0	0	0
Ci/g								
Am-241	0	0	0	0	0	0	0	5.5649E-08
Am-243	0	0	0	0	0	0	0	0
Cm-242	0	0	0	0	0	0	0	0
Cm-244	0	0	0	0	0	0	0	0
Np-237	0	0	0	0	0	0	0	2.4344E-09
Pa-233	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	7.3692E-07
Pu-239	0	0	0	0	0	0	0	7.8454E-08
Pu-240	0	0	0	0	0	0	0	1.9071E-08
Pu-241	0	0	0	0	0	0	0	7.0395E-07
Pu-242	0	0	0	0	0	0	0	1.206E-11
U-233	0	0	0	0	0	0	0	1.6809E-10
U-234	0	0	0	0	0	0	0	1.085E-10
U-235	0	0	0	0	0	0	0	1.7543E-11
U-236	0	0	0	0	0	0	0	1.1233E-12
U-237	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	2.6444E-11
Th-230	0	0	0	0	0	0	0	0
Th-231	0	0	0	0	0	0	0	0
Ba-137m	0	0	0	0	0	0	0	0
Cd-113m	0	0	0	0	0	0	0	0
Ce-144	0	0	0	0	0	0	0	5.9482E-06
Co-60	0	0	0	0	0	0	0	2.8203E-07
Cs-134	0	0	0	0	0	0	0	1.1164E-06
Cs-135	0	0	0	0	0	0	0	5.3933E-10
Cs-137	0	0	0	0	0	0	0	4.0367E-05
Eu-152	0	0	0	0	0	0	0	0
Eu-154	0	0	0	0	0	0	0	2.3472E-07
Eu-155	0	0	0	0	0	0	0	3.7566E-07
I-129	0	0	0	0	0	0	0	1.8511E-09
Nb-93m	0	0	0	0	0	0	0	0
Pd-107	0	0	0	0	0	0	0	0
Pm-147	0	0	0	0	0	0	0	0
Ru-106	0	0	0	0	0	0	0	2.4138E-06
Sb-125	0	0	0	0	0	0	0	4.7532E-07
Sb-126	0	0	0	0	0	0	0	0
Sb-126m	0	0	0	0	0	0	0	0
Se-79	0	0	0	0	0	0	0	0
Sm-151	0	0	0	0	0	0	0	0
Sn-121m	0	0	0	0	0	0	0	0
Sn-126	0	0	0	0	0	0	0	0
Sr-90	0	0	0	0	0	0	0	3.8256E-05
Tc-99	0	0	0	0	0	0	0	1.0667E-08
Y-90	0	0	0	0	0	0	0	0
Zr-93	0	0	0	0	0	0	0	0
Ni-63	0	0	0	0	0	0	0	4.7512E-08

	MIXER OUTLET WASH	CAST GROUT	CAUSTIC WATER MAKEUP	AIR TO DEWATER STATION	AIR FROM DEWATER STATION	DEWATERE GROUT	ACCEPTABL GROUT	UNACCEPT GROUT
	136	137	138	139	140	141	142	143
	0	28250151	5840411	0	3760479	22471900	22247181	224719
Ci/g								
Am-241	0	5.5649E-08	0	0	0	6.9958E-08	6.9958E-08	6.9958E-08
Am-243	0	0	0	0	0	0	0	0
Cm-242	0	0	0	0	0	0	0	0
Cm-244	0	0	0	0	0	0	0	0
Np-237	0	2.4344E-09	0	0	0	3.0604E-09	3.0604E-09	3.0604E-09
Pa-233	0	0	0	0	0	0	0	0
Pu-238	0	7.3692E-07	0	0	0	9.2641E-07	9.2641E-07	9.2641E-07
Pu-239	0	7.8454E-08	0	0	0	9.8627E-08	9.8627E-08	9.8627E-08
Pu-240	0	1.9071E-08	0	0	0	2.3975E-08	2.3975E-08	2.3975E-08
Pu-241	0	7.0395E-07	0	0	0	8.8496E-07	8.8496E-07	8.8496E-07
Pu-242	0	1.206E-11	0	0	0	1.5161E-11	1.5161E-11	1.5161E-11
U-233	0	1.6809E-10	0	0	0	2.1131E-10	2.1131E-10	2.1131E-10
U-234	0	1.085E-10	0	0	0	1.3639E-10	1.3639E-10	1.3639E-10
U-235	0	1.7543E-11	0	0	0	2.2054E-11	2.2054E-11	2.2054E-11
U-236	0	1.1233E-12	0	0	0	1.4122E-12	1.4122E-12	1.4122E-12
U-237	0	0	0	0	0	0	0	0
U-238	0	2.6444E-11	0	0	0	3.3243E-11	3.3243E-11	3.3243E-11
Th-230	0	0	0	0	0	0	0	0
Th-231	0	0	0	0	0	0	0	0
Ba-137m	0	0	0	0	0	0	0	0
Cd-113m	0	0	0	0	0	0	0	0
Ce-144	0	5.9482E-06	0	0	0	7.4777E-06	7.4777E-06	7.4777E-06
Co-60	0	2.8203E-07	0	0	0	3.5455E-07	3.5455E-07	3.5455E-07
Cs-134	0	1.1164E-06	0	0	0	1.4035E-06	1.4035E-06	1.4035E-06
Cs-135	0	5.3933E-10	0	0	0	6.7801E-10	6.7801E-10	6.7801E-10
Cs-137	0	4.0367E-05	0	0	0	5.0746E-05	5.0746E-05	5.0746E-05
Eu-152	0	0	0	0	0	0	0	0
Eu-154	0	2.3472E-07	0	0	0	2.9507E-07	2.9507E-07	2.9507E-07
Eu-155	0	3.7566E-07	0	0	0	4.7226E-07	4.7226E-07	4.7226E-07
I-129	0	1.8511E-09	0	0	0	2.3271E-09	2.3271E-09	2.3271E-09
Nb-93m	0	0	0	0	0	0	0	0
Pd-107	0	0	0	0	0	0	0	0
Pm-147	0	0	0	0	0	0	0	0
Ru-106	0	2.4138E-06	0	0	0	3.0344E-06	3.0344E-06	3.0344E-06
Sb-125	0	4.7532E-07	0	0	0	5.9754E-07	5.9754E-07	5.9754E-07
Sb-126	0	0	0	0	0	0	0	0
Sb-126m	0	0	0	0	0	0	0	0
Se-79	0	0	0	0	0	0	0	0
Sm-151	0	0	0	0	0	0	0	0
Sn-121m	0	0	0	0	0	0	0	0
Sn-126	0	0	0	0	0	0	0	0
Sr-90	0	3.8256E-05	0	0	0	4.8093E-05	4.8093E-05	4.8093E-05
Tc-99	0	1.0667E-08	0	0	0	1.341E-08	1.341E-08	1.341E-08
Y-90	0	0	0	0	0	0	0	0
Zr-93	0	0	0	0	0	0	0	0
Ni-63	0	4.7512E-08	0	0	0	5.9729E-08	5.9729E-08	5.9729E-08

Rad Mass Balance

	CRUSHED GROUT RECYCLE	TEST COUPON WASTE	RIBBON BLENDER CLEANOUT	VENT HIGH SHEER	VENT MIXER WASH	VENT AUTOCLAV	AUTOCLAV GROUT	CURE STEAM
	144	145	146	147	148	149	150	151
	224719	0	0	0	0	2017771	26232380	0
Ci/g								
Am-241	6.9958E-08	6.9958E-08	0	0	0	0	5.9929E-08	0
Am-243	0	0	0	0	0	0	0	0
Cm-242	0	0	0	0	0	0	0	0
Cm-244	0	0	0	0	0	0	0	0
Np-237	3.0604E-09	3.0604E-09	0	0	0	0	2.6217E-09	0
Pa-233	0	0	0	0	0	0	0	0
Pu-238	9.2641E-07	9.2641E-07	0	0	0	0	7.936E-07	0
Pu-239	9.8627E-08	9.8627E-08	0	0	0	0	8.4489E-08	0
Pu-240	2.3975E-08	2.3975E-08	0	0	0	0	2.0538E-08	0
Pu-241	8.8496E-07	8.8496E-07	0	0	0	0	7.581E-07	0
Pu-242	1.5161E-11	1.5161E-11	0	0	0	0	1.2987E-11	0
U-233	2.1131E-10	2.1131E-10	0	0	0	0	1.8102E-10	0
U-234	1.3639E-10	1.3639E-10	0	0	0	0	1.1684E-10	0
U-235	2.2054E-11	2.2054E-11	0	0	0	0	1.8893E-11	0
U-236	1.4122E-12	1.4122E-12	0	0	0	0	1.2097E-12	0
U-237	0	0	0	0	0	0	0	0
U-238	3.3243E-11	3.3243E-11	0	0	0	0	2.8478E-11	0
Th-230	0	0	0	0	0	0	0	0
Th-231	0	0	0	0	0	0	0	0
Ba-137m	0	0	0	0	0	0	0	0
Cd-113m	0	0	0	0	0	0	0	0
Ce-144	7.4777E-06	7.4777E-06	0	0	0	0	6.4058E-06	0
Co-60	3.5455E-07	3.5455E-07	0	0	0	0	3.0372E-07	0
Cs-134	1.4035E-06	1.4035E-06	0	0	0	0	1.2023E-06	0
Cs-135	6.7801E-10	6.7801E-10	0	0	0	0	5.8082E-10	0
Cs-137	5.0746E-05	5.0746E-05	0	0	0	0	4.3472E-05	0
Eu-152	0	0	0	0	0	0	0	0
Eu-154	2.9507E-07	2.9507E-07	0	0	0	0	2.5277E-07	0
Eu-155	4.7226E-07	4.7226E-07	0	0	0	0	4.0456E-07	0
I-129	2.3271E-09	2.3271E-09	0	0	0	0	1.9935E-09	0
Nb-93m	0	0	0	0	0	0	0	0
Pd-107	0	0	0	0	0	0	0	0
Pm-147	0	0	0	0	0	0	0	0
Ru-106	3.0344E-06	3.0344E-06	0	0	0	0	2.5994E-06	0
Sb-125	5.9754E-07	5.9754E-07	0	0	0	0	5.1188E-07	0
Sb-126	0	0	0	0	0	0	0	0
Sb-126m	0	0	0	0	0	0	0	0
Se-79	0	0	0	0	0	0	0	0
Sm-151	0	0	0	0	0	0	0	0
Sn-121m	0	0	0	0	0	0	0	0
Sn-126	0	0	0	0	0	0	0	0
Sr-90	4.8093E-05	4.8093E-05	0	0	0	0	4.1199E-05	0
Tc-99	1.341E-08	1.341E-08	0	0	0	0	1.1488E-08	0
Y-90	0	0	0	0	0	0	0	0
Zr-93	0	0	0	0	0	0	0	0
Ni-63	5.9729E-08	5.9729E-08	0	0	0	0	5.1166E-08	0

	STEAM	CALCINE	AUTOCLAVE
	CONDENSATE	BATCH	PURGE AIR
	152	153	154
	0	7880827	0.000
Ci/g			
Am-241	0	1.99E-07	0
Am-243	0	0.00E+00	0
Cm-242	0	0.00E+00	0
Cm-244	0	0.00E+00	0
Np-237	0	8.73E-09	0
Pa-233	0	0.00E+00	0
Pu-238	0	2.64E-06	0
Pu-239	0	2.81E-07	0
Pu-240	0	6.84E-08	0
Pu-241	0	2.52E-06	0
Pu-242	0	4.32E-11	0
U-233	0	6.03E-10	0
U-234	0	3.89E-10	0
U-235	0	6.29E-11	0
U-236	0	4.03E-12	0
U-237	0	0.00E+00	0
U-238	0	9.48E-11	0
Th-230	0	0.00E+00	0
Th-231	0	0.00E+00	0
Ba-137m	0	0.00E+00	0
Cd-113m	0	0.00E+00	0
Ce-144	0	2.13E-05	0
Co-60	0	1.01E-06	0
Cs-134	0	4.00E-06	0
Cs-135	0	1.93E-09	0
Cs-137	0	1.45E-04	0
Eu-152	0	0.00E+00	0
Eu-154	0	8.41E-07	0
Eu-155	0	1.35E-06	0
I-129	0	6.64E-09	0
Nb-93m	0	0.00E+00	0
Pd-107	0	0.00E+00	0
Pm-147	0	0.00E+00	0
Ru-106	0	8.65E-06	0
Sb-125	0	1.70E-06	0
Sb-126	0	0.00E+00	0
Sb-126m	0	0.00E+00	0
Se-79	0	0.00E+00	0
Sm-151	0	0.00E+00	0
Sn-121m	0	0.00E+00	0
Sn-126	0	0.00E+00	0
Sr-90	0	1.37E-04	0
Tc-99	0	3.82E-08	0
Y-90	0	0.00E+00	0
Zr-93	0	0.00E+00	0
Ni-63	0	1.70E-07	0

VI. EQUIPMENT SIZING

Shown below is a table of major process equipment included in the DCWO design.

Equipment ID	Name	Design Capacity	Number of Items	Diameter or Rating	Height	Pressure Rating	Material	Power	PFD
CY-101	Cyclone Separator								DCWO-01
CY-102	Cyclone Separator		1						DCWO-01
T-201	Static Gravity Mixer	80 m^3	1	4m	15m	Atm	304L		DCWO-02
T-202	Dry Process Tank with Ribbon Blender Agitator	50 m^3	1	3m x 4m	4m	Atm	304L		DCWO-02
P-203	Mechanical Conveyor	0.2 m^3/min	1			Atm	304L		DCWO-02
F-204 A,B	Filter (Air) Auto Shake	5 micron 0.2 m^3/min	2			25cm WC	304L		DCWO-02
T-301 A,B	Cone Bottom Storage Silo	80 m^3	2	4m	15m	Atm	CS		DCWO-03
F-302 A,B,C,D	Filter (Air) Auto Shake	5 micron 0.2 m^3/min	4			25cm WC			DCWO-03
EJ-303 A,B	Air Ejector		2						DCWO-03
T-304 A,B	Cone Bottom Storage Silo	32 m^3	2	3m	9m	Atm	CS		DCWO-03
P-305 A,B	Positive Displacement Pump, Heated Barrel	20 l/min	2			20m - head	CS		DCWO-03
T-306	Tank; Heat Traced @ 70 F	20 m^3	1	3m	3m	Atm	CS		DCWO-03
T-401 A,B,C,D	Cone Bottom Tank	1.5 m^3	4	1m	2m	Atm	304L		DCWO-04
M-402 A,B,C,D	Ribbon Blender	2,5 m^3	4	1.5m x1.5m	2m	Atm	CS		DCWO-04
L-403 A,B,C,D	Load Cell for Calcine Batch Bins	2000 Kg Full Scale	4	± 0.5% FS					DCWO-04
L-404 A,B,C,D	Load Cell for Ribbon Blenders	3000 Kg Full Scale	4	± 0.5% FS					DCWO-04

Equipment ID	Name	Design Capacity	Number of Items	Diameter or Rating	Height	Pressure Rating	Material	Power	PFD
F-405 A,B,C,D	Filter (Air) for Ribbon Blender	5 micron 0.2 m^3/min	4			25cm WC			DCWO-04
EJ-406 A,B,C,D	Ejector for Ribbon Blenders		4						DCWO-04
EJ-407 A,B,C,D	Ejector for Calcine Batch Bins		4						DCWO-04
IJ-408 A,B,C,D	Robotic Grout Injection Head	Dennis Keiser	4						DCWO-04
VP-409 A,B,C,D	Vibrator Platform	Dennis Keiser	4						DCWO-04
M-410 A,B,C,D	Mixer, Kneader/Extruder	3.6 m^3	4			Atm	304L		DCWO-04
F-411 A,B,C,D	Filter, (Air) Calcine Batch Bin	5 micron 0.2 m^3/min	4			25cm WC			DCWO-04
F-412 A,B,C,D	Filter, (Air) Kneeder/Extruder	5 micron 0.2 m^3/min	4			25cm WC			DCWO-04
M-501 A,B	High Sheer Mixer with Cooling Jacket	1.5 m^3	2	1m	2m	Atm	304L		DCWO-05
L-502 A,B	Load Cell for High Sheer Mixer	1500 Kg Full Scale	2	± 0.25% FS					DCWO-05
P-503 A,B	Pump	20 l/min	2			20 m head	304L		DCWO-05
M-601	Mixer, for Wash Tank	6 m^3	1	2m	2m	Atm	304L		DCWO-06
P-602 A,B	Pump, Wash Return	3 l/sec	2			20 m head	304L		DCWO-06
P-603 A,B	Pump, Mixer Spray/Wash	3 l/sec	2			30m head	304L		DCWO-06
P-604 A,B	Pump, Caustic Makeup Water	20 l/min	2			20 m head	304L		DCWO-06
CCS-701 A,B,C,D	Robotic Contamination Check Station	Dennis Keiser	4						DCWO-07
DS-702 A,B,C,D	Decontamination Station	Dennis Keiser	4						DCWO-07

Equipment ID	Name	Design Capacity	Number of Items	Diameter or Rating	Height	Pressure Rating	Material	Power	PFD
R-801 A,B,C,D	Robot, HEPA Filter Placement	Dennis Keiser	4						DCWO-08
A-901 A,B,C,D	Autoclave	300 C 1.1 x 10^4 KPa	4	4.9m	15.5m				DCWO-09
R-1101	Robot, HEPA Filter Removal	Dennis Keiser	1						DCWO-11
R-1102	Robot, Weld/Seal Check Cannister	Dennis Keiser	1						DCWO-11
CCS-1201	Robotic Contamination Check Station	Dennis Keiser	1						DCWO-12
DS-1202	Decontamination Station	Dennis Keiser	1						DCWO-12
STS-1301	Sonic Tomography		1						DCWO-13

In the following section a brief description of major process equipment and the parameters used to size the equipment are presented. Process equipment supporting calcine blending, grout mixing and canister casting is based on batch operations utilizing a 4-day work week with days-only operation. The autoclave cure process is batch by nature but because of the fact that it requires two days to complete a batch will be staffed as a continuous operation (24 hour shift coverage). The drying process which takes seven days to complete will also be staffed as a continuous process.

For both the days-only and continuous shifts it is assumed that the associated processes will achieve a 50% on line factor. To meet the requirement of stabilizing the entire inventory of calcine in 5 years the DCWO must average processing 29,450 Kg/week of calcine. Therefore, because of the on-line factor, the DCWO calcine throughput design rate must be 58.900 Kg/week of calcine/

The most feasible approach to obtaining the desired calcine stabilization rate is to have parallel grout processing lines. This approach was used because it allows for a reasonable time to fill a canister, and can use grout mixing equipment of reasonable capacity. For the DCWO facility four parallel grout processing lines are included.

Cyclone Separator (CY-101,102)

The cyclone separators are used to separate the entrained solid calcine materials from the air stream which has delivered them. The entrained calcine is expected to be delivered from two different calcine bin sets with one cyclone for each bin set. The design and sizing of this equipment is being performed as a separate effort, however the separators and associated filtration equipment will be located in the DCWO facility. Each cyclone system will be designed to deliver approximately 2700 Kg/hr of calcine from the calcine bin sets.

The approximate dimensional characteristics for the cyclone are as shown in Perry's Handbook of Chemical Engineering (pg 20-82)

Shell Diameter = Approximately 0.75 m

Height = Approximately 2.0 m

Static Gravity Mixer (T-201)

This unit serves to moderate the variability of calcine composition with respect to time. This unit will remain full of calcine at all times. It is sized such that it will

hold two weeks worth of calcine, based on full production capacity of the grout mixing lines. Experience indicates this will result in semi-uniform calcine blending. It should be noted that this type of device works only if it remains completely filled.

The conceptual operation is that calcine from the calcine retrieval system will be fed to the static gravity mixer once per week during the weekend when the grout mixing operation is off-line. The calcine retrieval system will feed the static gravity mixer at approximately 5400 kg/hr; and at the same rate calcine will automatically feed from the bottom of the static gravity mixer into the dry process tank. Feed of calcine from the calcine retrieval system will stop when the dry process lot tank is filled with one weeks worth of calcine.

Diameter = Approximately 4 m

Height = Approximately 15 m

Dry Process Tank with Ribbon Blender Agitator T-202

The dry process tank serves to provide a one weeks reservoir of calcine for use in grout mixing. Each tank quantity of calcine will be processed as a production lot. The dry process lot tank is sized such that it has a working capacity of 42 m^3 , with a total volumetric capacity of 50 m^3. The ribbon blender agitator serves to mix the tank contents until they are homogenious.

Approximate physical dimensions are: 3 m (w) X 4m (h) X 5m (l)

Bulk Hoppers Calcined Clay T-301 A, B

Sizing of this bulk hopper system is based on the assumption that two weeks production of calcined clay must be in inventory at the DCWO. A two silo system is used so that calcined clay can be delivered to one silo while the other silo is supplying calcined clay to the process. Two 80 m^3. silos are required

Diameter = Approximately 4 m

Height = Approximately 15 m

Bulk Hoppers Blast Furnace Slag T-304 A, B

Sizing of this bulk hopper system is based on the assumption that each individual silo must be able to receive 150% of a standard delivery volume of slag. A two

silo system is used so that slag can be delivered to one silo while the other silo is supplying slag to the process. Two 32 m^3. silos are required

Diameter = Approximately 3 m

Height = Approximately 9 m

Bulk Hopper Sodium Hydroxide T-306

Caustic soda (50% wt sodium hydroxide) is delivered in standard shipments of 48,000 lb (21,800 Kg), which is significantly more that the 5700 Kg/wk DCWO process utilization rate. Therefore the sodium hydroxide store tank size was based an the ability to accept a standard delivery volume. A single 20 m^3 tank is required.

Because caustic soda freezes at approximately 60 °F the tank must be heat traced.

Diameter = Approximately 3 m

Height = Approximately 3 m

Cone Bottom Tank (Calcine Batch Bin) T-401 A,B,C,D

The purpose of the calcine batch bin is to collect the calcine for one kneeder extruder batch of grout. Each batch of grout requires approximately 0.9 m^3 of calcine and the tank is conservatively sized at 1.5 m^3

Diameter = Approximately 1 m

Height = Approximately 2 m

Ribbon Blender T-402 A,B,C,D

The purpose of the ribbon blender is to collect and mix the calcine clay and blast furnace slag for one kneeder extruder batch of grout. After both the clay and slag are added to the mixer, they will be blended to assure that they are well mixed before introduction to the kneeder extruder. The combined volumes of clay and slag for a single batch is 1.52 m^3 and the ribbon blender is conservatively sized at 2.5 m^3 .

Approximate physical dimensions are: 1.5 m (w) X 2m (h) X 1.5m (l)

High Sheer Mixer with Cooling Jacket M-501 A,B

The purpose of the high sheer mixers is to mix caustic soda with water to provide the liquid ingredients for one batch of grout. The DCWO design includes two high sheer mixers to service the four grout mixing lines. Each batch of grout requires 0.99 m^3 of liquid ingredients and the mixer is conservatively sized at 1.5 m^3 . Mixing of water with caustic soda is exothermic and therefor requires a cooling jacket to reduce the liquid mixtures temperature before introduction to the kneeder extruder.

Diameter = Approximately 1 m

Height = Approximately 2 m

Kneeder Extruder Mixer M-410 A,B,C,D

The purpose of the kneeder extruder mixer is to combine the liquid and dry ingredients and generate the paste-like grout material which is then loaded into the canisters. First, the grout-recipe quantity of liquid ingredients from the high sheer mixer are added to the kneeder extruder. Then, under constant agitation in the kneeder extruder, the pre weighed quantity of calcine from the calcine batch bin is added. Upon completion of addition of the calcine, the calcined clay and blast furnace slag in the ribbon blender are added. All ingredients are mixed in the kneeder extruder for approximately 15 minutes. The grout is ready for casting into waste canisters. The actual volume of the grout ingredients is 2.38 m^3 and the kneeder mixer is conservatively sized at 3.6 m^3 . Grout is cast in canisters by actuating the extruder portion of the mixer which will force mixed grout through the injection head and into the canister.

Approximate physical dimensions are: 2 m (w) X 2m (h) X 3m (l)

VII. UTILITIES

Electrical:

There are no large electrical loads identified in the DCWO process. Process equipment electrical loads are expected to be minimal relative to the building electrical loads, therefore it is appropriate to use standard facility electric loads as an estimate. Please see EDF-DCWO-004

Steam:

Steam will be required in the autoclave cure process and the as the heat source in the drying process. Thermodynamic calculations indicate that the process load of steam for the autoclave cure process is 950 lb/hr and for the air drying process is 1200 lb/hr (see EDF-DCWO-003). These steam requirements are a small increment of the estimated HVAC heating load.

LOCKHEED MARTIN

ENGINEERING DESIGN FILE

PROJECT FILE NO. 02BE0

EDF SERIAL NO. EDF-DCWO-012

FUNCTIONAL FILE NO. SPR-09

DATE 12/08/97

PROJECT/TASK Waste Treatment Project FeasibilityStudies

SUBTASK Direct Cementitious Waste Option Scoping Study

SUBJECT **20 Year Operations - Man-loading and Physical Space Identification**

ABSTRACT

The following investigation identifies associated activities that may be required for a 20 year schedule in operations of this facility. Space allocation based on these activities has been estimated. Man-loading has been extrapolated from previous projects similar in nature, resource documents and engineering judgement based on experience.

The transition from the five year operations to 20 year operations recognizes the need for a base skeleton staff to maintain administrative functions. A reduction in personnel will occur most noticeably in the process maintenance personnel. Reduction from a 4-line process to a single line process will still maintain a base skeleton staff in the areas of ES&H and operations

KEYWORDS (e.g. area, structure no., general subject matter, etc.)

High Level Waste, CPP, Man-loading,

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		S.W. Shepherd, P.E. 12/8/97

20 YEAR OPERATIONS - HLW DCWO MAN-LOADING

December 8, 1997

Assume: One (1)-10-hr shift for main process, administrative and support. One skeleton crew continuous at autoclave process = (3) shifts rotating. Total man-loading is 140 personnel.

FACILITY – ADMINISTRATION

A separate, detached building will house approximately 46+ personnel and ancillary spaces supporting the main process and its functions. Physical requirements have been estimated based on an average of 500 square feet allowance per person.

FUNCTION/FACILITY REQUIREMENT	Main Shift	Rotating
• Manager(s)/Supervisor(s)	2	2
• Administrative Support Secretarial/Clerical Budget/Cost Control Schedule	3	-
• Waste Tracking/Data Acquisition Tech (Receipt, Entry, Examination, Sampling, Repack, Storage/Shipping, etc., Manifest, Chain of Custody	4	2

File/Document Storage Office Machines

FACILITY – TECHNICAL SUPPORT

• Engineering	10	4
• Control Systems Tech (Matrix personnel during const. Overhaul, redesign or mods)	6	4
• Draftsman	2	-

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Additional drafting is assumed to be one of these.

Storage – spare parts, work bench for repair/maintenance

FACILITY – DOCUMENT CONTROL

• Document control personnel	4	3

File/Document Storage Fire Vault, Library, Office Machines

FACILITY – TRAINING (Physical requirements only)

- Training personnel offices
- Classroom(s)
- File/Document storage training aids, equipment
- Conference room
- Equipment storage (audio/video, etc.)
- Conference Room(s)
- File/Document Storage Office Machines

FACILITY – COMMON ANCILLARY SPACE (Physical requirements only)

- Lunch Room
- Toilet Rooms
- Janitor Room
- Storage
- Circulation
- Electrical
- Communications
- Mechanical

FACILITY – MAINTENANCE

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Facility maintenance is assumed to be one of these.

DOE @ FACILITY OFFICE(S) - (Physical requirements only)

- Offices (2)

PROCESS FACILITY/OPERATIONS

Space required in addition to the main process areas is estimated at approximately 30,000 square feet. Ancillary and support functions critical to the process will be housed within the same physical facility. Approximately 94+ personnel have been identified. Physical requirements have been estimated based on an average of 500 square feet allowance per person.

FUNCTION/FACILITY REQUIREMENT	Main Shift	Rotating
• Operations Manager(s)	2	3
• Shift Supervisor(s)	2	-
• On-duty Shift supervisor(s)	2	3
• Shift Operator(s) – (See Control Room Below)		
• Operations Technicians	2	3
• Lab Technicians (sampling)	2	-
• Rad-con Tech (RCT/HP) Manager	1	3

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. Laboratory testing and analysis capabilities is assumed to be one of these.

File/Document Storage Office Machines

PROCESS CONTROL (Process Control Console, Alarm Panels, Communications)

• Calcine retrieval to Cyclone Separator Mixer, Dry Process Agitator	1	-
• Off-Load & Transfer Grout Mix (NaOH, Slag, Clay) NaOH Mixer (2) mix stations (1) wash station	2	-
• Sample Analysis	1	-
• Calcine Batch Bins (1) batch station (1) wash station	2	-
Ribbon Blender		-
Calcine Batch Bin		
Kneeder/Extruder		-
Containerize		-
Injector		
Vibrator Platform		
• Test Coupons	1	-
• Survey, Decon, HEPA Filter Install/Removal, Cap/Seal, Analysis	1	3
• Autoclave (1) station	1	3
• Transfer to storage	1	3

E S & Q

• Safety	2	3
• RCT (Rad-Con Tech)	3	3
• Quality	2	3
• Equipment storage (surveillance, analyzers, etc)		

PROCESS MAINTENANCE

• Manager	1	1
• Supervisors	1	1
• Electrical	4	2
• Mechanical	6	2
• I&C Technicians	4	3
• Maintenance Planner	2	-
• Preventive Maintenance/Work Order	3	-
• Attendant	1	-
• Transfer systems (i.e., cart) maintenance	2	3

PROCESS 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
- EOC
- Mechanical, Electrical and Communications
- Shop – Materials and Equipment Storage, Work Bench Area
- Instrument Shop – I&C, Protected Storage for Calibrated Instruments, Work Bench
- Contaminated, Hot Maintenance Area
- Transfer systems (i.e., carts) survey, decon and maintenance areas
- Tool Room – Storage of Issue Tools
- Storage - Clean Containers
- Storage - Lag/Lead
- Storage - Process Interim

Assume: ICPP will have infrastructure services and capabilities to accommodate some tasks not unique to this project. The following functions and facilities have been assumed to exist and have the capabilities of servicing this process:

- Machine Shop
- Welding Shop
- Storage Ware House
- Mock-up Area
- Laydown Area

LOCKHEED MARTIN

ENGINEERING DESIGN FILE

PROJECT FILE NO. 02BE0

EDF SERIAL NO. DCWO-013

FUNCTIONAL FILE NO. SPR-10

DATE 12/12/97

PROJECT/TASK Waste Treatment Project Feasibility Studies

SUBTASK Direct Cementitious Waste Option Scoping Studies

SUBJECT **Architectural Design Description**

ABSTRACT

This Engineering Design File (EDF) summarizes the physical and functional requirements for the DCWO Direct Grout Facility.

The Direct Cementitious Waste Option (DCWO) for the High Level Waste Treatment Environmental Impact Statement evaluates the scope requirements for directly grouting the high-level waste at ICPP for shipment to a permanent repository outside the INEEL.

The scope of this option proposes that a Direct Grout Facility and an Interim Storage Facility be provided to prepare and store the final waste form for an interim term prior to shipment outside the INEEL.

This EDF describes the general physical and functional features in the Direct Grout Facility scope design, including:

- Site Description
- General Building Description
- Radiolological Process Room Functions/ Uses
- Area Summary

KEYWORDS (e.g. area, structure no., general subject matter, etc.)

DCWO, building, design, room description, area summary, waste treatment, feasibility, EIS. environmental impact

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DCWO Architectural Design Description

Site Description

Location

The Direct Grout Facility shall be adjacent to the Interim Storage Facility near the northeast corner of ICPP. This general area was selected for all the option studies in the High Level Waste EIS for a comparable basis having adequate space for siting all facilities in these studies.

Specifically, the location as shown was selected to allow:

- Direct in-line transfer of canisters from the Direct Grout Facility to the Interim Storage Facility.
- Clear rail access to the Interim Storage Facility.
- Easy truck docking access from existing roads and streets.
- Parallel-parking truck access to bulk material bins on a continuous street.
- Least replacement/ relocation of existing facilities.

Subsurface Conditions

The selected location is within the 100-yr. flood plain. However, existing process facilities have been sited in this area and designed so that the lowest process is above the flood plain.

Bedrock and water tables in this area are at an adequate depth below grade so as not to present any construction problems.

Access/Pavement

Hemlock Street shall be extended to Chestnut Avenue to provide parallel-parking truck access for bulk materials delivery to the Direct Grout Facility. A portion of Palm Avenue between Hemlock and Lodgepole Streets shall be relocated to Cypress Avenue allowing adequate site area and continuous vehicle circulation around for the Interim Storage Facility. Also, a new street has been provided on the west side of the Direct Grout Facility between Chestnut and Palm

Avenues to provide a public way for exiting and circulation on all sides.

An exterior dock ramp has been provided for unloading new canisters and material supplies for semi-trucks at the Cannister Warehouse.

Eight convenience parking stalls has been provided on the west side of the Direct Grout Facility for DOE passenger vehicles inside ICPP. No ADA-compliant stalls have been provided.

Pedestrian walkways, curbs, and gutters are included with all street improvements.

Bicycle racks shall be provided at the east and west entrances to the building.

Utilities

Adequate service for potable, raw, fire, demineralized, surface drainage, and waste water is available and shall be provided from existing facilities as needed.

Steam and condensate returns for building and process heat shall be provided from the Steam Plant.

The Direct Grout Facility shall replace an existing electrical ductbank and substation running north to south between Chestnut and Palm Streets.

Adequate service for data, fire/life safety, and communications are assumed to be available and shall be supplied for existing facilities as needed.

General Building Description

General

The building is generally organized in three categories. These are:

- Radiological process facilities.

- Nonradiological process facilities.
- Service and support facilities.

Flow design for processing the waste is generally organized to process solid calcine material from its receipt through the process to the final product transfer.

The building is designed for two distinct process flow streams--cycling of canisters on carts from filling through curing and transfer to the Interim Storage Facility; and, cycling of batched high level calcine through processing from receipt to canister filling. Cart cycling is generally designed as a horizontal flow process whereas the calcine cycling is designed specifically as a vertical flow process.

Track-mounted carts were selected in the design instead of overhead cranes for horizontal canister conveyance to allow for rapid flow overhead operations on each canister. Because overhead cranes would require additional height, area, and clustering of canisters to maintain required flow rates, a cart system is preferred for horizontal movement.

Because of its abrasive properties and to control variability in batch mixes, solid calcine is received at the top floor and processed through gravity flows with the least bends and shortest distances between processes prior to filling canisters. The calcine is blown through piping and cyclone-seperated as it is received. Calcine air streams are HEPA-filtered and returned in a closed system for reuse. Because the calcine is gravity-fed, processing begins at the top floor and flows to the first floor (above the 100-year floor plain).

Because of the height required for gravity-fed processes, one concern with this concept is that the building may be exposed to waste air streams from the existing calcine stack at ICPP and may cause turbulence at the existing stack. An alternate to this concept could be cycling calcine in a horizontal flow process requiring more bends, longer feeds between processes, and more periodic maintenance, repair, and decontamination. For those reasons that alternate was rejected.

Radiological process facilities include highly shielded cells for processing high level waste and airlock cells. Generally, each process and equipment is provided with airlock access for periodic remote

maintenance, repair, and decontamination. Process cells are subdividable by computer-controlled motor-operated shield access sliding doors for isolation of individual equipment and processes. Motors, gears, and fluid supplies for equipment operations inside process cells shall be located to the greatest extent practicable in adjoining airlock cells.

Vertical shafts for conveying filled canisters are designed and shielded as separate process cells. Vertical shafts for conveying empty canisters or carts are designed as nonradiological process facilities. Openings at each floor include shielded access doors and separate ventilation/exhaust systems. Conveyance equipment shall be stainless steel clad for decontaminability. Shafts shall include elevator pits with drainage to the secondary containment sump. Shaft walls, pit, and ceiling shall have liquid-tight decontaminable finishes.

Radiological and non radiological process facilities require ventilation and exhaust air systems separate from the remainder of the building. Ventilation shall be 100 percent exhausted through HEPA offgas treatment facilities.

Design for non radiological process areas assumes at least a minimal level of shielding and occupancy separation from service and support facilities due to their proximities and interaction with radiological process facilities. Openings and penetrations in separations from service and support facilities shall be protected with air-sealed self-closing fire assemblies.

Roofs above the 75 feet from ground elevation shall be provided with window washing davits, mules, and staging equipments. All roofs shall be accessible from interior stair enclosures.

Radiological Process Facility Construction

Radiological process cells shall assume construction with the following features:

- 5-ft. shielded structural concrete on floors walls, and ceilings with 5-ft. mat foundation.
- 27-ft. floor-to-floor elevations with 42-ft. max. (22-ft. median) spans.

- UBC Type I Construction and minimum 1-hour fire-rated occupancy separation at cell.
- 4-hour fire-rated area separations with maximum of 4 hazardous material control areas between separations.
- Stainless-steel decontaminatable finish on all exposed surfaces.
- Offset shielded penetrations.
- Net 6x12x3-ft. fire-rated shielded motor-operated swing doors from airlock cells.
- Minimum 5x13x1-ft. remote-controlled shielded motor-operated sliding doors at cart/canister access passthrough openings in cell subdivisions.
- Robotic and computer-generated control of process flow systems and equipment.
- Fiber-optic closed-circuit video remote viewing of processes and process flow.
- Motors, gears, and fluid supplies required for process equipment operations located remotely in airlock cells adjoining process cells.
- Downdraft ventilation and offgas exhaust through HEPA-filtered registers and thickwall stainless steel ductwork with offset wall penetrations to/from central offgas air shafts.
- Holed hydraulic traction freight and cart-handling elevators below third level roof with fire-separated shielded shaft enclosures.
- Rapid response automatic fire sprinklers.

Exhaust duct HEPA filters shall be replaced through ports in adjoining airlocks by remote operations. Ducts shall be scrubbed periodically with in-duct robots using decon solutions and drained to central offgas exhaust shafts. Offgas shafts shall drain to the secondary containment sump in the basement of the building. The central offgas shaft shall be stainless-steel lined and shall also be periodically scrubbed with an in-shaft robot using decon solutions.

Non Radiological Process Facility Construction

Non radiological process areas include rooms for nomimally non radiological or low-level contact-handled radiological processes.

These areas include temporary accummulation areas for HEPA filter accummulation; offgas treatment and mechanical ventilation rooms in support of hot cells; airlock vestibules; bulk material handling; and freight elevator shafts and vestibules.

Non radiological process areas assume construction with the following features:

- Type I Construction.
- Minimum 13.5-ft. floor-to-floor room elevation, except 27-ft. at Cannister Warehouse, offgas treatment, and mechanical ventilation areas.
- Maximum 40-ft. and 30-ft. median support spans.
- Cementitious fireproofed structural steel framing, or structural concrete.
- Interior steel stud/gypsum partitions and shaftwalls with decontaminable finishes.
- Composite cell floors.
- Suspended decontaminable hard-surface ceilings.
- Decontaminable hard-surface flooring.
- Insulated glazed aluminum exterior curtainwall with 25 percent wall area R-8 glazing, 25 percent wall area R-11 glazing, and 50 percent R-30 insulated wall area, except provide reinforced concrete at floor areas above or surrounded by radiological processes cells.
- Holed hydraulic traction freight and cart-handling elevators below third level roof with fire-separated shaft enclosures.
- Smokeproof stair enclosures with stair vestibules and separate ventilation.
- Rapid response automatic fire sprinklers.

Service and Support Facility Construction

Service and support facilities include all ancillary areas necessary to support process operations and form the remainder of the building.

These areas include rooms for process administration and control; technical support; sanitation; utilities and housekeeping services; general mechanical ventilation; circulation and access; and walls, supports, and miscellaneous spaces outside process areas.

Service and support areas assume construction with the following features:

- Type I Construction.

- Minimum 13.5-ft. floor-to-floor room elevation, except 27-ft. at Cannister Warehouse, offgas treatment, and mechanical ventilation areas.
- Maximum 40-ft. and 30-ft. median support spans.
- Cementitious fireproofed structural steel framing, or structural concrete.
- Interior steel stud/gypsum partitions and shaftwalls with decontaminable finishes.
- Composite cell floors.
- Suspended decontaminable hard-surface ceilings.
- Decontaminable hard-surface flooring.
- Insulated glazed aluminum exterior curtainwall with 25 percent wall area R-8 glazing, 25 percent wall area R-11 glazing, and 50 percent R-30 insulated wall area, except provide reinforced concrete at floor areas above or surrounded by radiological processes cells.
- Geared traction passenger elevators above third floor with fire-separated elevator lobbies and shaft enclosures.
- Holed hydraulic traction freight elevators below third level roof with fire-separated shaft enclosures.
- Smokeproof stair enclosures with stair vestibules and separate ventilation.
- Rapid response automatic fire sprinklers.

Radiolological Process Room Functions/ Uses

Secondary Containment Sump 1416 SF

Function/ Use Description: Central drainage collection point for secondary containment of contaminated and hazardous material leakage and fire water. Includes system for remote monitoring leakage fill level and retrieval system for offsite treatment at an approved location away from the building. Also includes an overflow draining to an approved location away for the building, public way, and pedestrian exitways.

Interim Storage Transfer Tunnel 6858 SF

Function/ Use Description: Shielded underground canister/cart access for tranferring final high level waste form in canisters on track-mounted carts to the Interim Storage Facility. Carts return

empty to the Direct Grout Facility after canisters are offloaded in this tunnel.

Return Cart Decon Hot Cell, basement **1045 SF**

Function/ Use Description: Remote decontamination and check of carts returned from the Interim Storage Facility.

Return Cart Transfer Cell, basement **906 SF**

Function/ Use Description: Transfer access space for return cart transit between high level radiaoctive Return Cart Return Decon Cell and non radioactive Return Cart Repair Room.

Fill Station Hot Cell **2784 SF**

Function/ Use Description: Subdividable hot cell with 4 fill stations centered under the Kneeder-Extruder gravity-fed fill spouts on the floor above. Ceiling-mounted equipment lift and vibrate each canister during filling. As filling is completes, an automated decon check is performed each canister and decontamination is performed as required. HEPA filters supplied on each cart are then remotely installed before carts are directed to the next process.

Fill Station Airlock **10,870 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to occupied spaces. Motors and controls for operating shielded sliding and swing doors inside the fill station hot cell are located in this space.

Fill Station Transfer Cell **504 SF**

Function/ Use Description: Transfer access space for cart transit between hot cells.

Autoclave Hot Cells, 4 ea. total **21,860 SF**

Function/ Use Description: Space for steam-curing grouted canisters under pressure in autoclave equipment. Space includes

subdividable space for periodic robotic decontamination control, maintenance and repairs.

Autoclave Airlocks, 4 ea. total **4500 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside each hot cell are located in this space.

Dewatering Hot Cells, 16 ea. total **21,860 SF**

Function/ Use Description:

Dewatering Airlocks, 4 ea. total **4500 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the fill station hot cell are located in this space.

HEPA-Filter Removal Hot Cell **370 SF**

Function/ Use Description: Shielded space for remote operated removal of HEPA filters from grouted canisters. Used filters shall be in the cell and periodically removed for treatment and disposal at existing ICPP facilities.

Decon/Check Hot Cell **380 SF**

Function/ Use Description: Shielded space for remote operated automated decontamanation check and decontamination as required.

Weld/Seal Hot Cell **288 SF**

Function/ Use Description: Shielded space for remote operated automated sealing and welding tops to open end of canisters.

Off Spec Check Hot Cell **720 SF**

Function/ Use Description: Shielded space for automated examination of grouted canisters for verification of compliance with final repository receipt specifications. Examinations include sonic tomography check and other nondistructive examinations as necessary.

On Spec Transfer Cell **600 SF**

Function/ Use Description: Transfer access space for cart transit between hot cells.

Off Spec Lag Storage Hot Cell **1130 SF**

Function/ Use Description: Shielded space for lag storing between reprocessing cycles those grouted canisters not meeting receipt specifications.

Off Spec Stripping Hot Cell **693 SF**

Function/ Use Description: Shielded space for removing off spec canisters from each cart and stripping of canisters from the off spec final grouted waste form in closed-system equipment.

Off Spec Pulverizing/Sizing Hot Cell **720 SF**

Function/ Use Description: Shielded space for sizing and pulverizing off spec grouted waste forms in closed-system equipment.

Off Spec Pulvervizing Airlock **1164 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the hot cell are located in this space.

Blower Mechanical Hot Cell **1212 SF**

Function/ Use Description: Shielded space for closed-system blower equipment used to return resized off spec grout material to the Dry Process Lot Tank Hot Cell.

Off Spec Cart Decon Hot Cell **424 SF**

Function/ Use Description: Shielded space for remote decontamination and check of carts after off spec canisters are removed.

Off Spec Cart Transfer Cell **700 SF**

Function/ Use Description: Transfer access space for cart transit between hot cells and non radiological processes areas requiring contact handling.

Coupon Sampling Hot Cells, 2 ea. total **608 SF**

Function/ Use Description: Shielded spaces adjoining Kneeder-Extruder Hot Cells for passthrough and collection of coupon samples from each canister as it is being filled. Coupons are automatically placed in shielded casks and periodically removed and transported to ICPP hot laboratories for analyses.

Kneeder-Extruder Hot Cells, 4 ea. total **2812 SF**

Function/ Use Description: Shielded space for the final calcine grout process prior to filling the grout into canisters.

Kneeder-Extruder Airlock **11,500 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the hot cell are located in this space.

Calcine Batch Mixer Hot Cells, 4 ea. total **2340 SF**

Function/ Use Description: Shielded space for processing dry grout materials subdivided in four parallel process lines prior to mixing liquids with dry grout mix.

Calcine Batch Mixer Airlock **3311 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to

non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside each hot cell are located in this space.

High Shear Mixer Hot Cells, 2 ea. total **1110 SF**

Function/ Use Description: Shielded space for high shear mixer process.

Dry Process Lot Tank Hot Cell **2510 SF**

Function/ Use Description: Shielded space for dry process lot tank process.

Dry Process Lot Tank Airlock **3311 SF**

Function/ Use Description: Intermediate contamination control space as an access transition from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the hot cell are located in this space.

Dry Process Lot Tank Separator Hot Cell **1810 SF**

Function/ Use Description: Shielded space adjoining the Dry Process Lot Tank Hot Cell at one level above for cyclone separator equipment used to filter and separate lot tank particulates from the process exhaust air stream.

Mixer Wash Tank Hot Cells, 2 ea. total **1110 SF**

Function/ Use Description: Shielded space for mixer wash tank process.

Static Gravity Mixer Hot Cell **976 SF**

Function/ Use Description: Shielded space for the static gravity mixer process.

Static Gravity Mixer Airlock **3874 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to

non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the hot cell are located in this space.

Static Gravity Mixer Separator Hot Cell **6174 SF**

Function/ Use Description: Shielded space adjoining the Static Gravity Mixer Hot Cell at one level above for cyclone separator equipment used to filter and separate mixer particulates from the process exhaust air stream.

Static Gravity Mixer Separator Airlock **4428 SF**

Function/ Use Description: Intermediate contamination control space as an access transistion from high level radiation field and to non radioactive spaces. Motors and controls for operating shielded sliding and swing doors inside the hot cell are located in this space.

Off Gas Exhaust Shaft Enclosure, 6 floors **3670 SF**

Function/ Use Description: Central vertical shaft space for collecting off gas exhaust streams from each floor prior to treatment in off gas treatment mechanical rooms.

Cart Handling Elevators **1200 SF**

Function/ Use Description: Elevators in shielded shaft enclosures with shielded sliding doors for vertical conveying canisters on track-mounted carts from floor to floor.

Cart Handling Elevator Machine Room, basement 720 SF

Function/ Use Description: Space for hydraulic elevator machine equipment, fluid reserve tanks, and elevator power and signal equipment.

Area Summary

Radiological Processes

Secondary Containment Sump	1416 SF
Interim Storage Transfer Tunnel	6858

Return Cart Decon Hot Cell, basement	1045
Return Cart Transfer Cell, basement	906
Fill Station Hot Cell	2784
Fill Station Airlock	10,870
Fill Station Transfer Cell	504
Autoclave Hot Cells, 4 ea. total	21,860
Autoclave Airlocks, 4 ea. total	4500
Dewatering Hot Cells, 16 ea. total	21,860
Dewatering Airlocks, 4 ea. total	4500
HEPA-Filter Removal Hot Cell	370
Decon/Check Hot Cell	380
Weld/Seal Hot Cell	288
Off Spec Check Hot Cell	720
On Spec Transfer Cell	600
Off Spec Lag Storage Hot Cell	1130
Off Spec Stripping Hot Cell	693
Off Spec Pulvervizing/Sizing Hot Cell	760
Off Spec Cart Decon Hot Cell	424
Off Spec Cart Transfer Cell	720
Off Spec Pulvervizing Airlock	1164
Blower Mechanical Hot Cell	1212
Kneeder-Extruder Hot Cells, 4 ea. total	2812
Kneeder-Extruder Airlock	11,500
Coupon Sampling Hot Cells, 2 ea. total	608
Calcine Batch Mixer Hot Cells, 4 ea. total	2340
Calcine Batch Mixer Airlock	3311
High Shear Mixer Hot Cells, 2 ea. total	1110
Dry Process Lot Tank Hot Cell	2510
Dry Process Lot Tank Airlock	3874
Dry Process Lot Tank Separator Hot Cell	1810
Mixer Wash Tank Hot Cells, 2 ea. total	1110
Static Gravity Mixer Hot Cell	976
Static Gravity Mixer Airlock	3874
Static Gravity Mixer Separator Hot Cell	994
Static Gravity Mixer Separator Airlock	6174
Off Gas Exhaust Shaft Enclosure, 6 floors	3670
Cart Handling Elevator Shaft Enclosures, all floors, 4 ea. total	1200
Cart Handling Elevator Machine Room, basement	720
Gross Subtotal	132,239 GSF

Nonradiological Processes

Freight Elevator Vestibule, basement, 3 ea. total	530 SF
Freight Elevator Shaft Enclosures, all floors	2200
Freight Elevator Machine Rooms, basement, 2 ea. total	1240
Return Cart Repair, basement	1665
Canister Warehouse	8935
Autoclave Airlock Vestibules, 4 ea. total	2390
Kneeder-Extruder Airlock Vestibules, 4 ea. total	800
Dewatering Airlock Vestibules, 4 ea. total	2390
Calcine Batch Mixer Airlock Vestibules, 2 ea. total	989
LLW HEPA Filter TSA, 4 ea. total	780
Ribbon Blenders	1295
NaOH Tank Storage	307
Decon Mechanical Room	699
Blower Mechanical Vestibule	250
Off Spec Pulvervizing Airlock Vestibule	780
Off Spec Return Cart Repair	1291
Off Spec HVAC Mechanical	5900
Off Spec OffGas Treatment Mechanical	10,399
OffGas Treatment Mechanical, total	5940
Gross Subtotal	48,780 GSF

Service and Support

Offices, Conference, Training, Control Rooms, total	45,472 SF
Office HVAC Mechanical	8260
Men/Women Change Rooms, total	585
Men/Women Restrooms, 5 floors, 2 ea. total	4550
Telephone/Electrical Branch/Janitor, total	2124
Fire Riser/Storage, 5 floors, 2 ea. total	1700
Switchgear/Substation Room, basement	432
Pass. elevators/shafts/stairs/corridors, basement total	6218
Pass. elevators/shafts/stairs/corridors, 7 floors total	21,301
Pass. Elevator Machine Rooms, total	950
Gross Subtotal	91,592 GSF

Radiological Processes, Subtotal	**132,239 GSF**
Non Radiological Processes, Subtotal	**48,780 GSF**
Service and Support, Subtotal	**91,592 GSF**
Total Gross Square Footage	**272,611 TGSF**

LOCKHEED MARTIN

ENGINEERING DESIGN FILE

PROJECT FILE NO. 02BE0

EDF SERIAL NO. DCWO-014

FUNCTIONAL FILE NO. C-04

Waste Treatment Project Feasibility Studies

PROJECT/TASK HVAC Sizing Calculations

DATE 12/10/97

SUBTASK Direct Cementitous Waste Option Scoping Study

SUBJECT **DCWO BUILDING HEATING AND COOLING LOAD ESTIMATE**

ABSTRACT

The DCWO building will require mechanical heating, cooling, ventilation and special air filtration systems for year around operation. Attached is the preliminary HVAC system sizing calculations for the facility. Calculations performed are based on INEL site specific "rules of thumb" and engineering assumptions. The intent of all calculations is to provide an approximate estimate of expected loads and air flows required for the DCWO.

Conclusions:

Estimated Building Heating Load: 13.3 MBTUH
Estimated Maximum Steam Demand: 25,000 lbs/hr
Estimated Building Exhaust Air Flow: 135,000 CFM

KEYWORDS (e.g. area, structure no., general subject matter, etc.)

HVAC

AUTHOR/P. E. STAMP

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LMITCO Review	DATE	LMITCO Review	DATE

1/5/98

Direct Cementious Waste Option;

Administration area total @ 65,500 SF
Average Cooling Required @ 300 SF/TON
Average Office Area CFM=1.4 CFM/SF
Non-radiation areas will require mechanical cooling at @ 400 SF/TON
Required air flow for area is @ 1 CFM/SF
Radiation Areas will not require mechanical heating and cooling because these areas will be located in the interior spaces of building.
Ventilation air will be provided in radiation areas.
Assume radiation areas to be UBC H-7 occupancy and ventilate per UBC (1.5 CFM/SF

Building Cooling Load Estimate:

Administration Area

Q=80,000 sf x 1/300 ton/sf = **267 TONS OF COOLING**

Cfm = 65,000 sf x 1.4 = **91,000 CFM**

Non-Radiation Areas:

Q= 30,000 sf x 1/400 ton/sf = **75 TONS OF COOLING**

Cfm = 1 x 30,000 = **30,000 CFM**

Radiation Area ;

Ventilation CFM = 1.5 cfm/sf x 180,000 sf = **270,000 CFM**
(Assume ½ of ventilation air can be recirculated in radiation process area)

Total exhaust cfm @ **135,000 CFM**

DIRECT CEMENTIOUS WASTE OPTION: BUILDING HEAT LOSS ESTIMATE CALCULATION:

PROBLEM: ESTIMATE DCWO BUILDING HEAT LOSS

SOLUTION: USING BUILDING HEAT LOAD ESTIMATE PROCEDURE FROM " HANDBOOK OF DATA SHEETS FOR MECHANCIAL SYSTEMS PROPLEMS" SEE ATTACHED. THE BUILDING HEAT LOAD IS:

ESTIMATED BUILDING FOOT PRINT SQUARE FOOTAGE = 70,000 SF

ESTIMATED BUILDING PERIMETER = 1100 FT

AREA/PERIMETER RATIO = 70,00/1100 = M= 63.6

BUILDING VOLUME (ASSUME APPROX. 80 FT TALL) = 70,000 SF * 80 FT = 5,600,000 CU.FT.

B=1

ROOF FACTOR = 0.12

INFILTERATION = 1.26

Ufactor = 1 + 1.26 + 0.12 = 2.38

5,600,000 * 2.38 = **13,328,000 BTUH**

ESTIMATED BUILDING HEATING LOSS = 13,328,000 BTUH

ESTIMATE BUILDING STEAM USAGE BASED ON BUIDLING HEATING LOAD CALCUALTION:

SOLUTION: ICPP STEAM IS @ 150 PSIA , ASSUME SAT. STEAM PROPERTIES.

H fg = 864 BTU/LBM

LBS/HR STEAM = 13,328,000BTUH / 864BTU/LBM = 15,425 LBS/HR

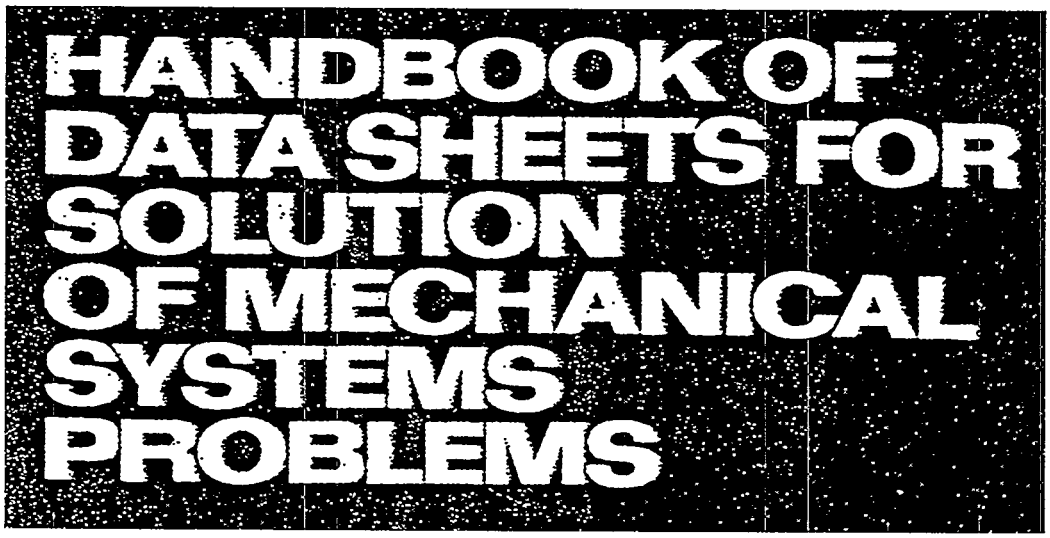
ASSUME 25% OVERSIZE AND SAFETY FACTORY

LBS/HR STEAM = 15,425 LBS/HR * 1.25 = 19,282 LBS/HR STEAM

@ 20,000 LBS/HR OF STEAM REQUIRED FOR HEATING.

FOR PROCESS STEAM ASSUME ADDITIONAL 25 %

TOTAL STEAM ESTIMATED USAGE = 25,000 LBS /HR


HANDBOOK OF
DATA SHEETS FOR
SOLUTION
OF MECHANICAL
SYSTEMS
PROBLEMS

How to Make Rough Estimates of Building Heat Losses

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Consulting engineers often have need for a direct and simple approach to roughly estimating the total heat loss of a building. The chart on the next page can be used to derive these estimates. While the information given should not be used as the final determination of heat loss, it does provide working data which can be applied in lieu of more exacting calculation.

The total heat loss for a building is the sum of wall and glass transmission losses, roof transmission losses, and infiltration and ventilation losses.

The chart derives these losses as follows:

(1) Wall and glass transmission losses are obtained from the chart as a function of the area/perimeter factor and fenestration factor (percentage of glass area to gross wall area).
(2) Roof transmission losses are obtained as a function of building height.
(3) Infiltration and ventilation losses are determined as a function of air changes per hour.

The following example illustrates the use of the chart.

EXAMPLE

What is the heat loss, in Btu per hr, for a building 100 ft high × 200 ft long × 50 ft wide, with a 60 percent glass exterior?

Solution. This is calculated:

1. M = area/perimeter
   = 10,000/500
   = 20
2. Volume = 1 million cu ft
3. From the graph for $F = 60$ percent and $M = 20$, $B = 2.7$
4. Roof factor = 0.10
5. Assuming one air change per hr, infiltration factor = 1.26
6. The sum of 3, 4, and 5 is 4.06 Btu per cu ft per hr
7. 4.06 Btu per cu ft per hr × 1 million cu ft = 4,060,000 Btu per hr

The chart is based on a U value of 0.20 Btu per hr per sq ft per F deg for the wall and 1.13 Btu per hr per sq ft per F dg for the glass.

For different glass and wall U values, a corrected value for B may be computed from the graph as per the formula:

$$B' = B_{\text{F-100 percent}}\,(F)\,(U\ \text{glass}\ /\,1.13) + B_{\text{F-0 percent}}\,(1.00 - F)\,(U\ \text{wall}/0.20)$$

ENGINEERING DESIGN FILE

Function File Number – SPR-04
EDF Serial Number – EDF-DCWO-014
Page 6 of

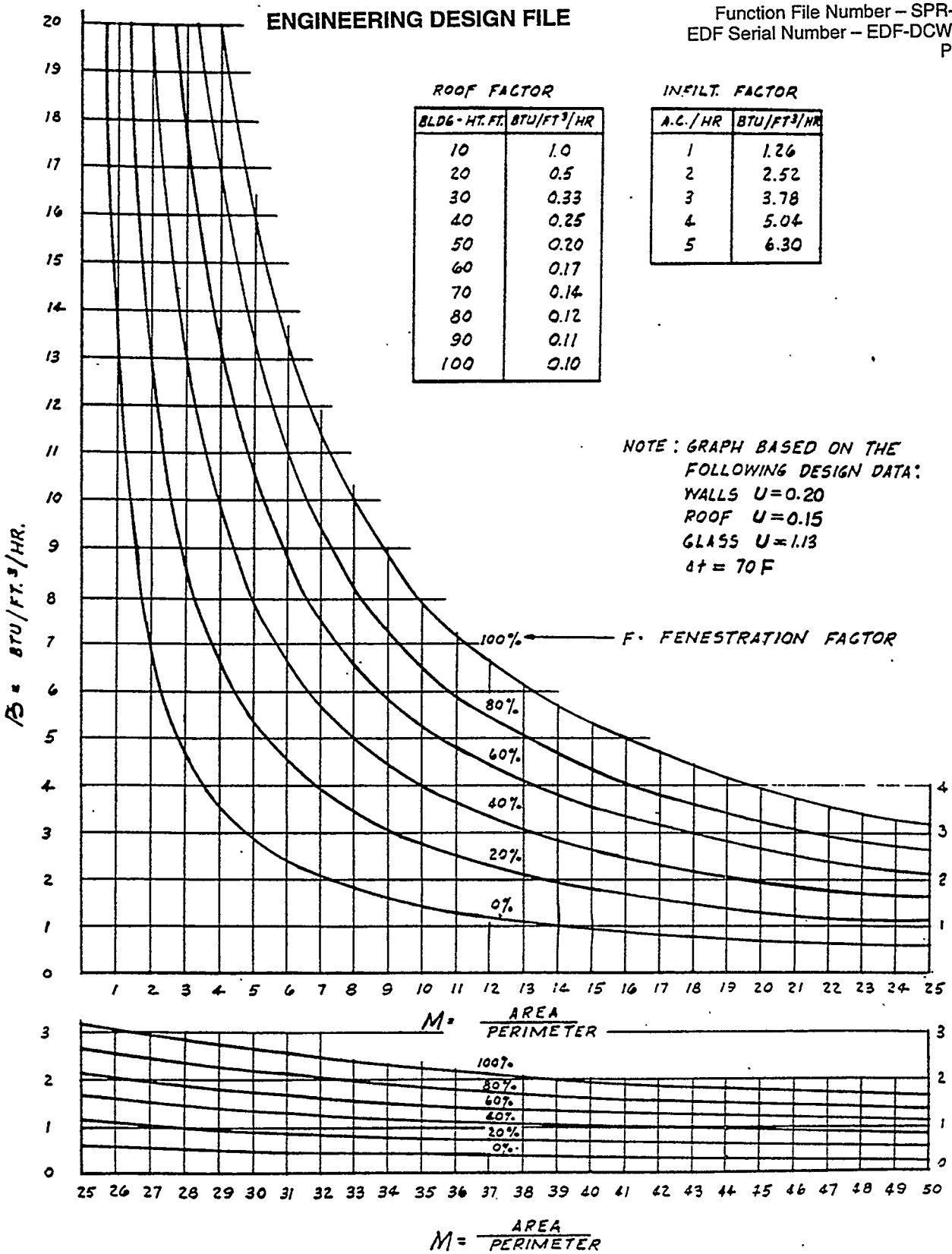
ROOF FACTOR

BLDG - HT. FT.	BTU/FT³/HR
10	1.0
20	0.5
30	0.33
40	0.25
50	0.20
60	0.17
70	0.14
80	0.12
90	0.11
100	0.10

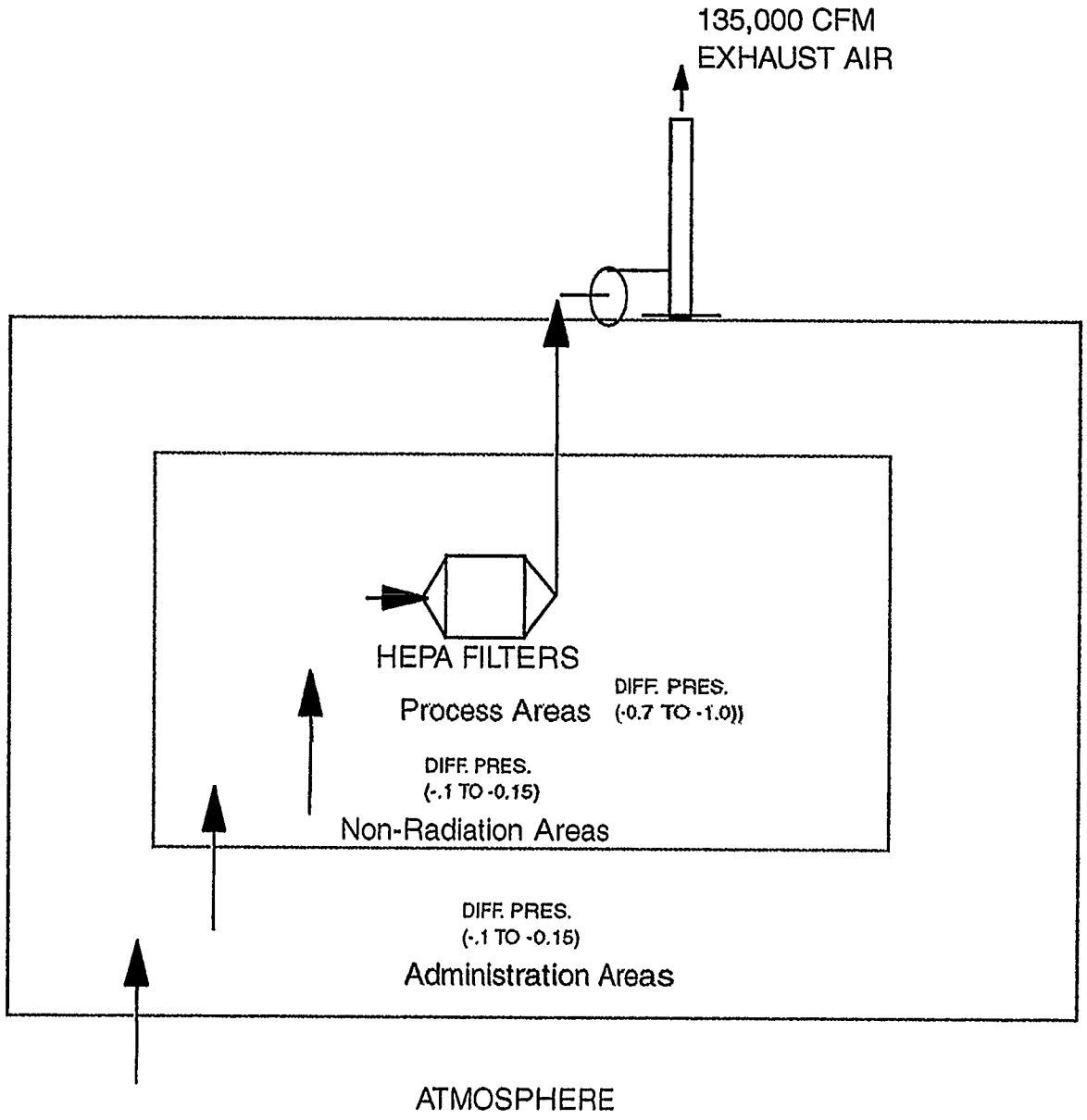
INFILT. FACTOR

A.C./HR	BTU/FT³/HR
1	1.26
2	2.52
3	3.78
4	5.04
5	6.30

NOTE: GRAPH BASED ON THE FOLLOWING DESIGN DATA:
WALLS U = 0.20
ROOF U = 0.15
GLASS U = 1.13
Δt = 70 F



Heat loss for a building is determined by totaling wall and glass transmission losses. roof transmission losses, infiltration and ventilation losses. How to use this chart to find these quantities is explained on preceding page.



DCWO HVAC CONFINEMENT AIR FLOW

air flow

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: 20 Year Scaling

Summary:

The DCWO study used a model process and facility to obtain data for the DCWO and CWO grout facilities. The model used the larger of the two facilities (CWO) and was based on the CWO requirement to grout its calcine volume in 5 years. Due to study constraints, information for the DCWO 20 year grout process and facility was obtained by scaling the CWO 5 year grout process and facility. This EDF documents the steps taken in this scaling process.

References:

1. Plant Design and Economics for chemical Engineers, 4th edition, Peters and Timmerhaus
2. EDF-DCWO-012, 20 Year Manloading and Physical Space Identification.

Conclusions:

Scaling used an industry guide for process reduction with resulting facility reduction of 31% over the 5 year facility based on estimated square footage reduction.

Distribution (complete package): WTP EIS Studies Library, R. E. Dafoe M.S. 3765, D. J. Harrell M. S. 3211, B. R. Helm M. S. 3765, S. J. Losinski M. S. 3625, T. E. Sivill M. S. 3655, K. L. Williams M. S. 3765

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
R Dafoe	4130		2/2/98		2/2/98
		LMITCO Review	Date	LMITCO Approval	Date

The objective of the Direct Cementitious Waste Option (DCWO) was to provide a cost estimate for a grouting process and facility that would support the needs of both the DCWO and the Cementitious Waste Option (CWO). The operating schedule for the CWO grout facility is 5 years and 20 years for the DCWO grout facility. Time alotted for this study did not lend itself to generating two complete process and facility scoping level designs. Because the actual grouting process does not change, a scaling approach was determined to be a legitimate method for obtaining the costs and related process and facility scoping level designs for one of the processes and facility. The model chosen was based on the CWO 5 year schedule requirement. Engineering judgement indicated that scaling down from a larger volume process and building was preferred to scaling up.

Scaling began with determining the quantity of process equipment required then estimating the amount of facility square footage reduction as a result. Personnel requirements were estimated also and documneted in reference 2. This information was then used in determining a new cost estimate.

The ratio of 5 years to 20 years (1/4) was used to scale down equipment quantities or size. The CWO 5 year grouting process, where required, includes 4 process lines at the batch mixing, canister loading, grout curing (autoclaves), decontamination, and sonic tomography stations. For the DCWO the 4 lines were reduced to one. Single line components such as the static gravity mixer, dry process hot tank, and dewatering chamber were scaled down using percentages provided in reference 1. Some components such as the clay and slag bins were not changed because they were originally sized to accommodate standard delivery load quantities.

Building drawings (draft stage) included as part of this EDF, show where facility square footage was adjusted. Study constraints did not permit reconfiguring the building. The following is a comparison, by area type, between the CWO 5 year and DCWO 20 year estimated facility footage:

	CWO 5 year	DCWO 20 year	
Admin	103,000 (9569)	92,050 (8551)	
Non-Radiation	57,100 (5305)	43,625 (4053)	in ft^2 (m^2)
Radiation	126,500 (11,752)	61,600 (5723)	
Total	286,600 (26,626)	197,275 (18,327)	

From this evaluation, the DCWO 20 year facility square footage is approximately 69% of the CWO 5 year facility. This same percentage was applied to the grout facility support systems, such as power, I&C, and HVAC.

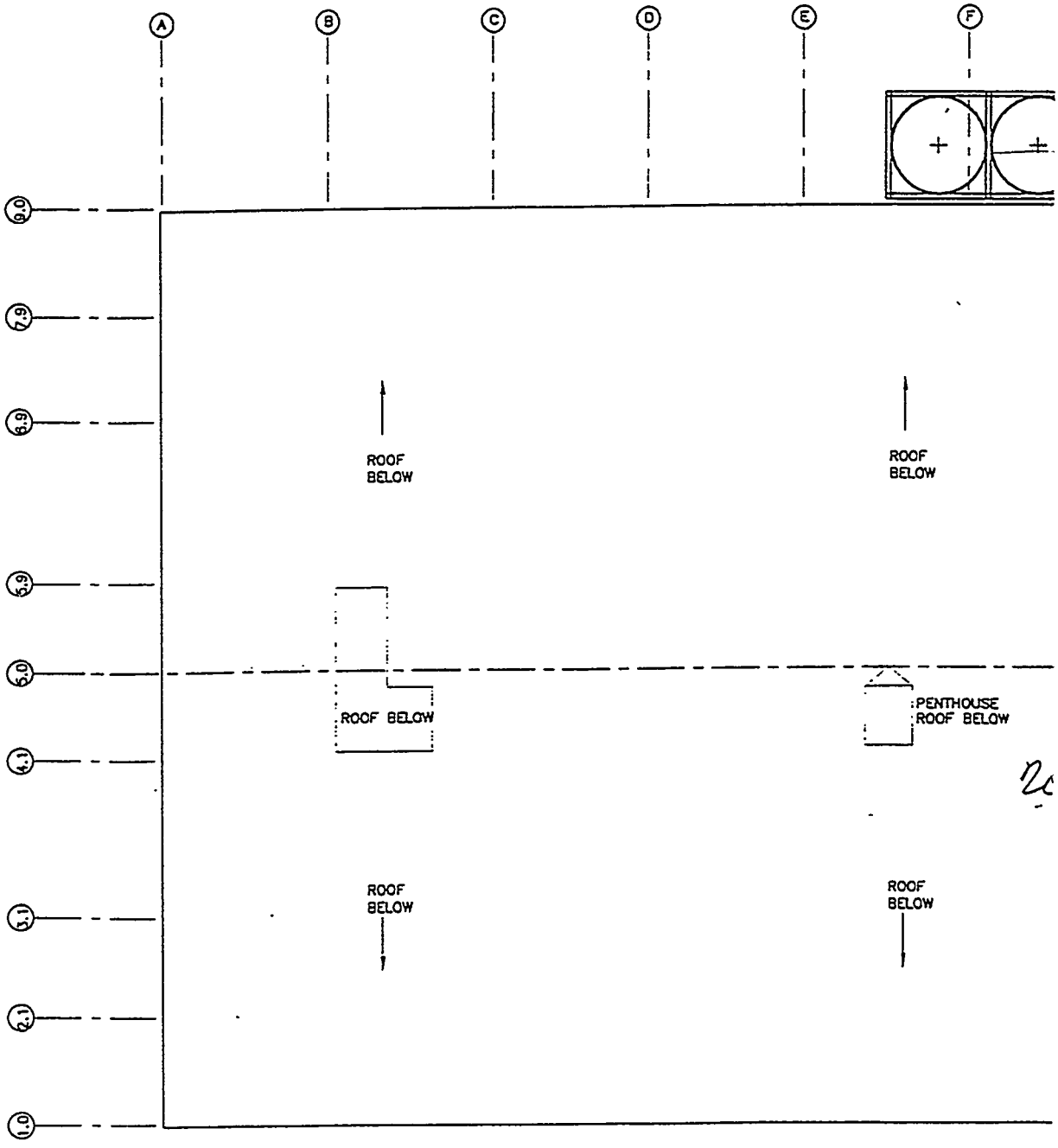
20yr.

Hot Cell - 61,600SF
Cold Process - 43,625SF.
Admin. - 92,050SF.
197,275SF.

5yr.

Hot Cell - 126,500SF
Cold Process - 57,100SF
Admin. 103,000SF
286,550SF

3rd.



2

LEVEL +135'-0" (6

160,000 SF

30,000SF

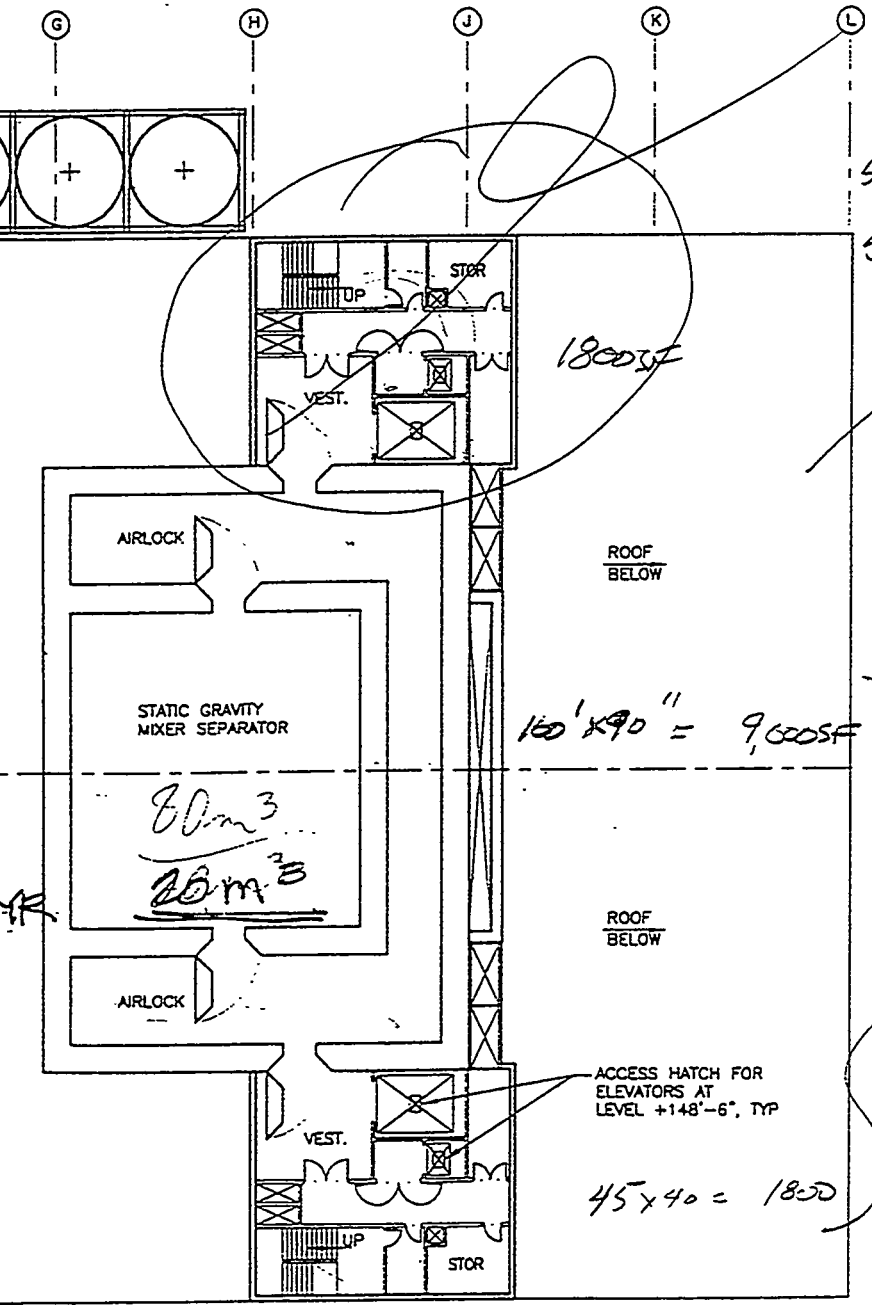
90,000SF

BTAC FACILITY 286,400SF

HOT CELL = 9,000SF

COLD PROCESS

ADMIN. = 3600SF.



1800SF

20yr.

50% HOT CELL - 4,500SF

50% ADMIN. - 1800SF

6,300SF.

160'x90" = 9,000SF

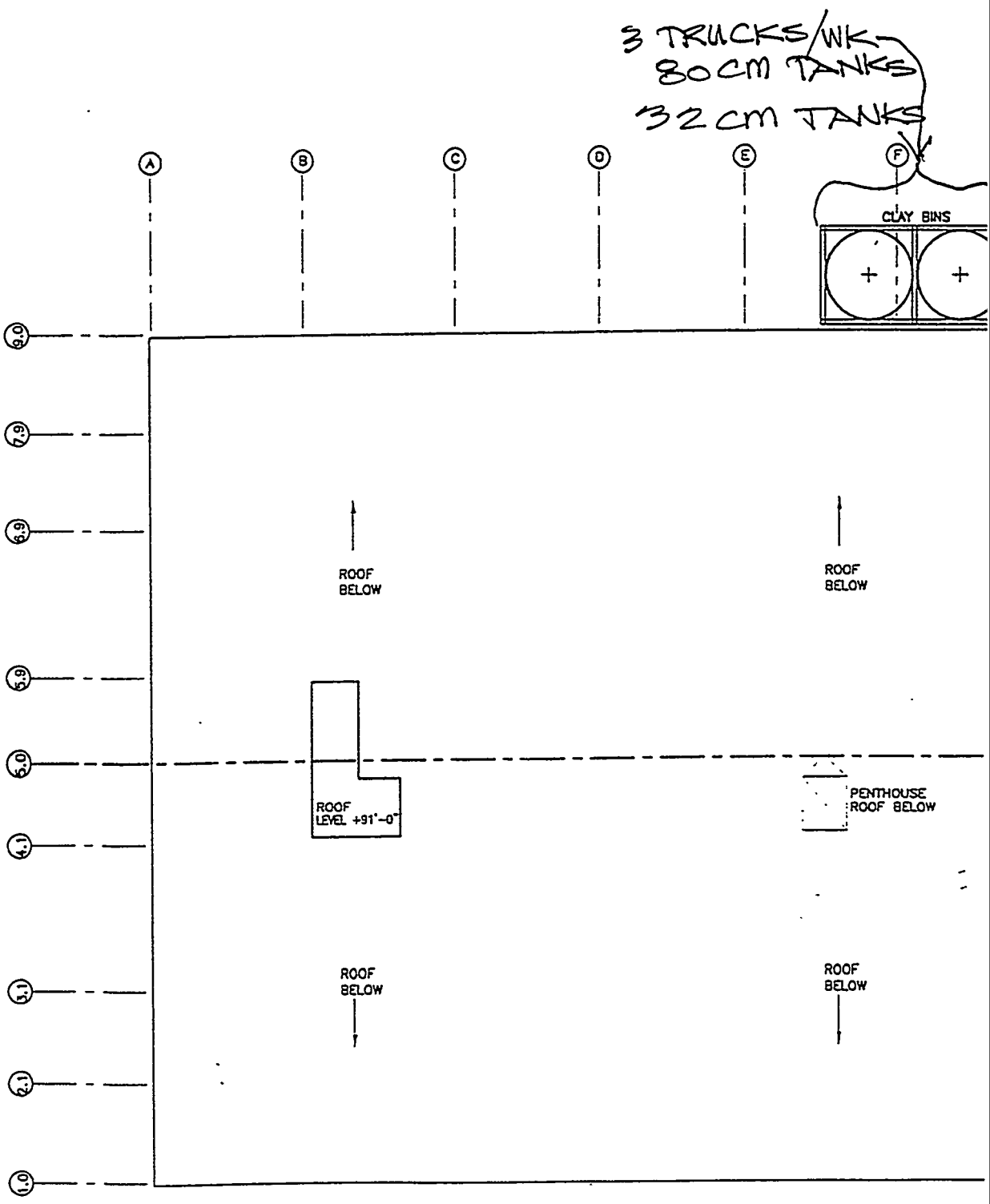
80m3

25m3

10,800SF

45x40 = 1800

= 12,600SF.

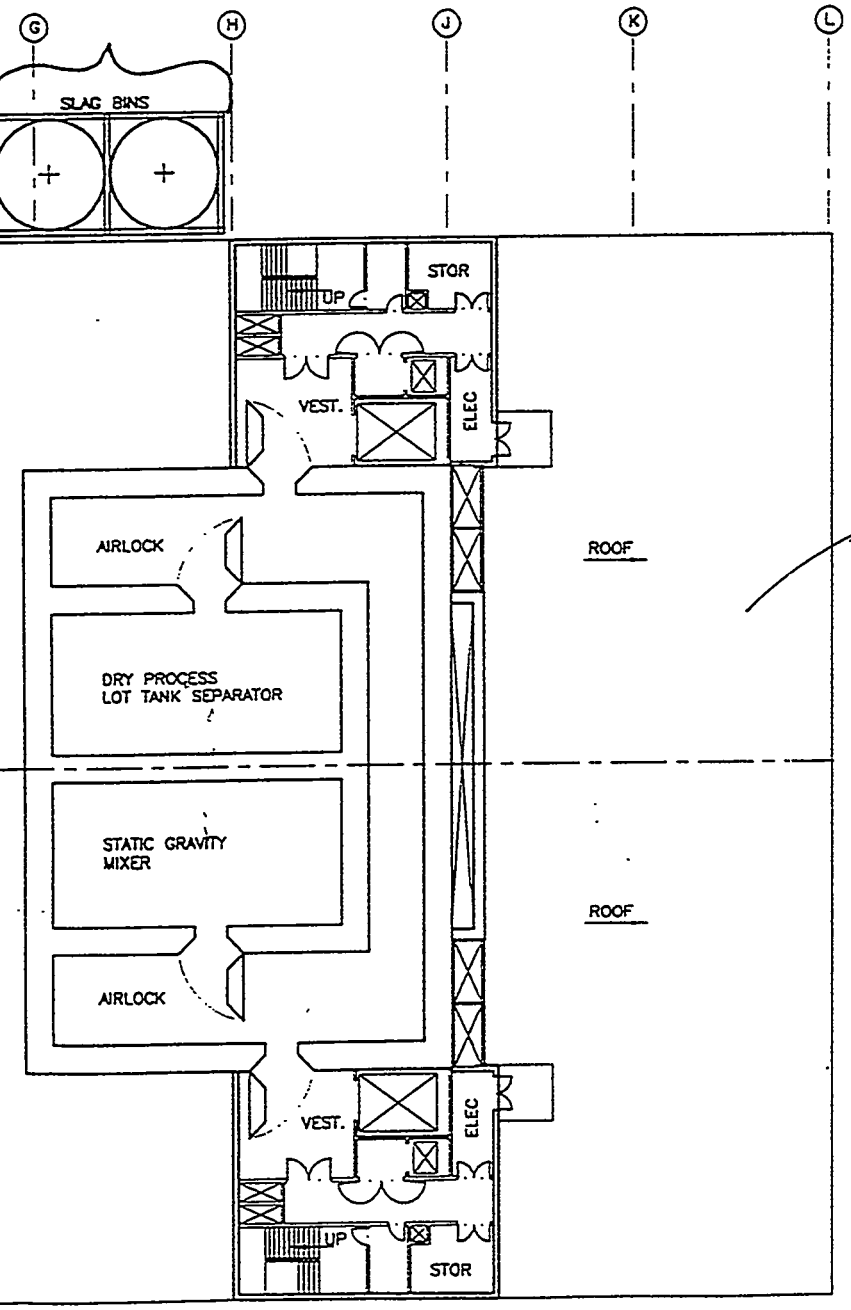

3 TRUCKS/WK
80CM TANKS
32CM TANKS
A
B
C
D
E
F
CLAY BINS
9.0
7.9
6.9
ROOF BELOW
ROOF BELOW
5.8
6.0
4.1
ROOF LEVEL +91'-0"
PENTHOUSE ROOF BELOW
ROOF BELOW
ROOF BELOW
3.1
2.1
1.0

LEVEL +108'-0" (5)

EVERYTHING REDUCES BY .25 x

STD DELIVERY STET SIZE

WASH TANK MIXER STAYS SAME



HOT CELL — 9,~~600~~900SF.
COLD CELL —
ADMIN. — 3,600SF

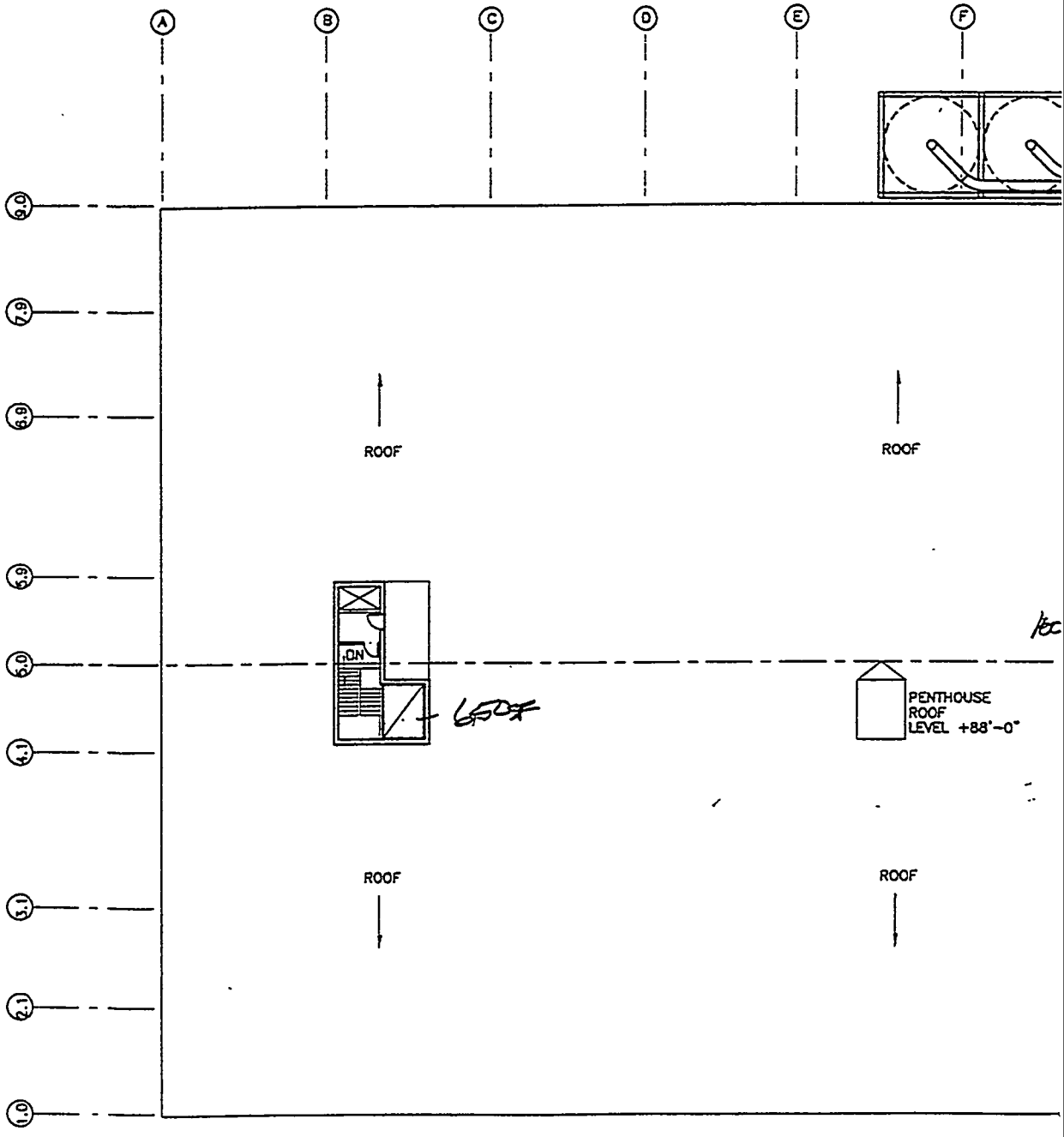
~~9,600~~

CUT BY 20%.

HOT CELL - 4,500SF
ADMIN. - 1,800SF

TOTAL = 6,300SF.

= 12,600SF


A
B
C
D
E
F
9.0
7.9
6.9
6.0
4.1
3.1
2.1
1.0
ROOF
ROOF
ON
650#
PENTHOUSE
ROOF
LEVEL +88'-0"
ROOF
ROOF

LEVEL +81'-0" (4)

20yr.

HOT CELL – 4,500SF

COLD PACKS. – 15,500SF

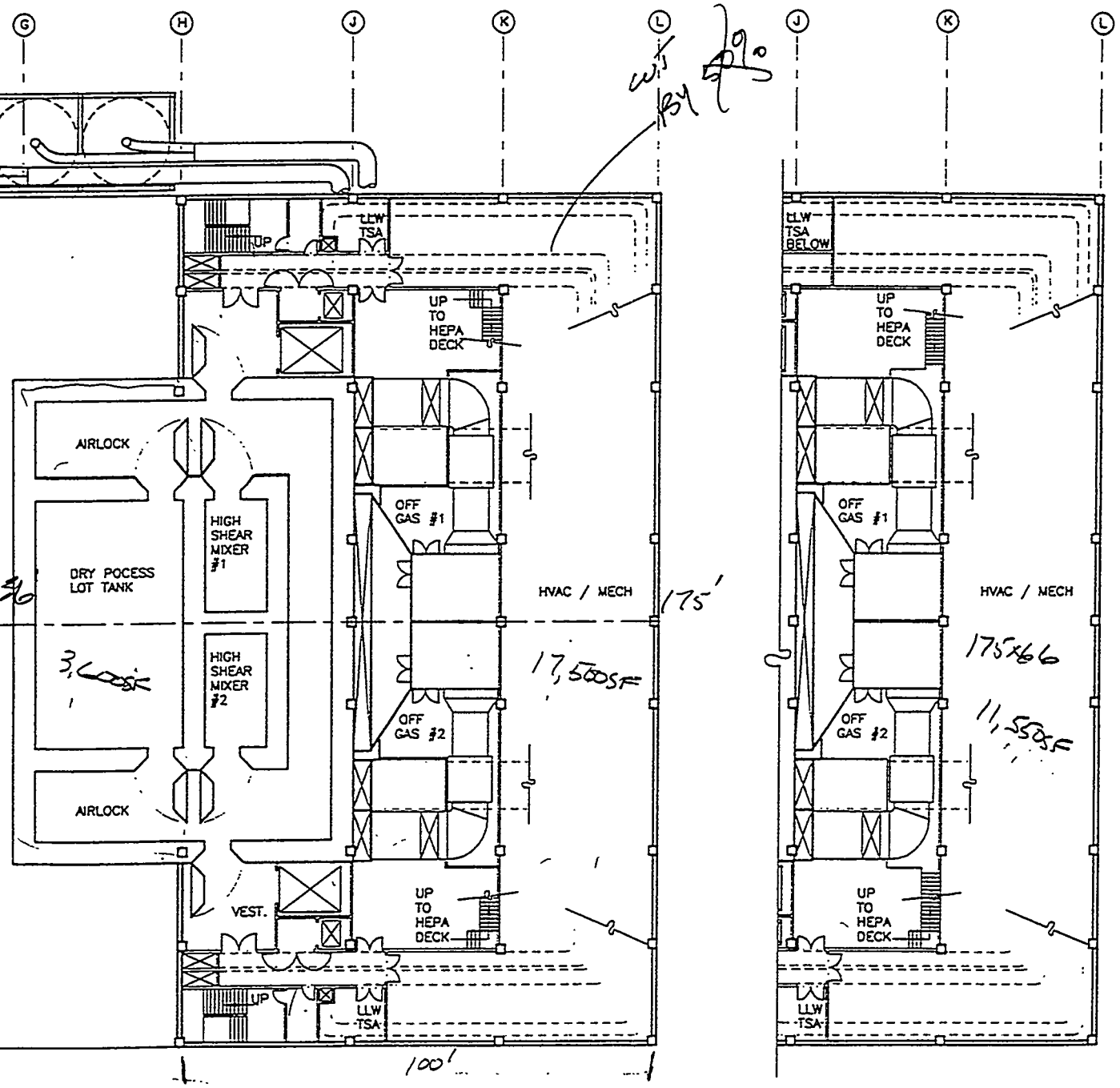
ADMIN. – 3,600SF

TOTAL → 23,550

HOT CELL – 9,000SF

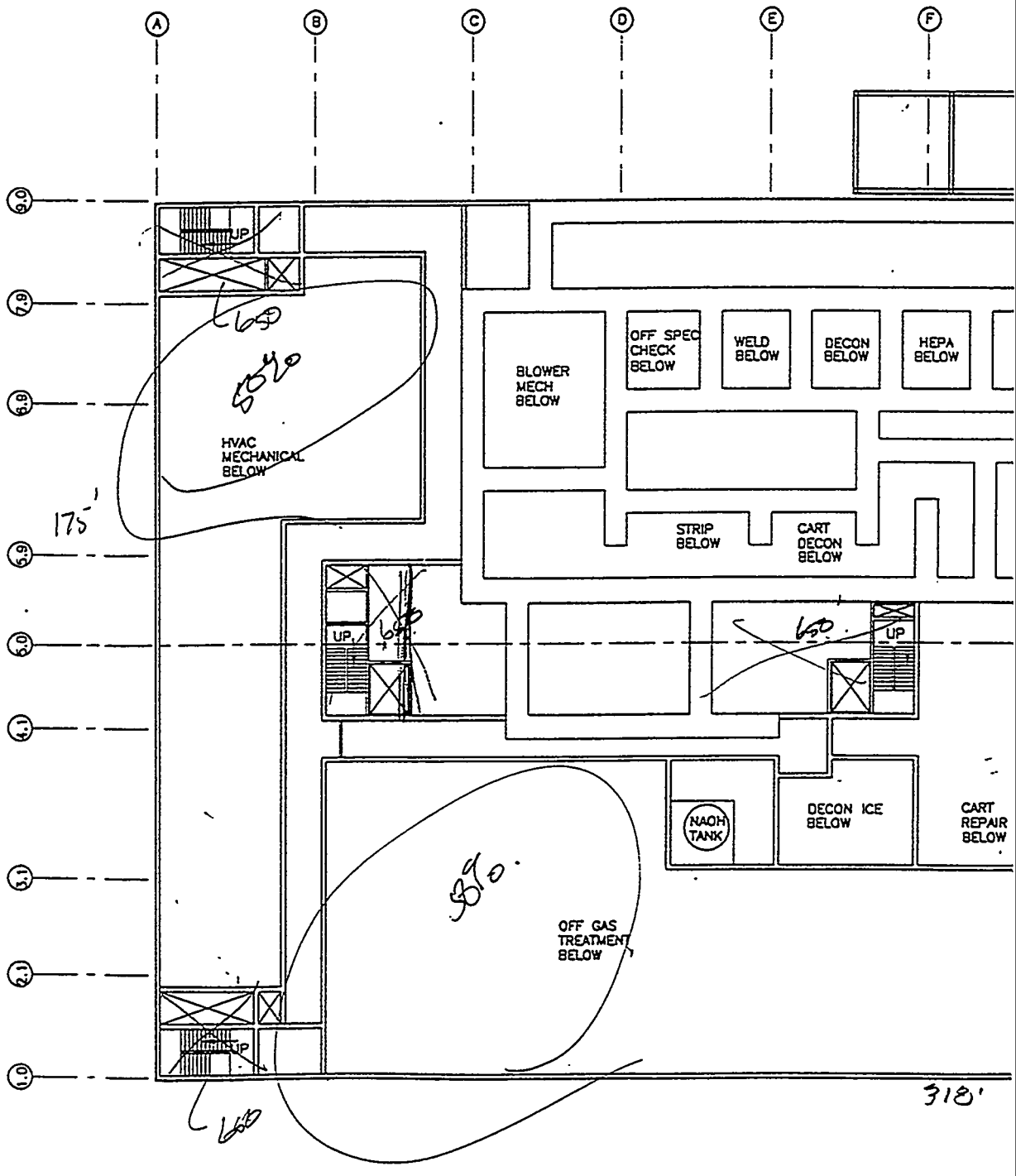
COLD PACKS – 20,600SF.

ADMIN. – 3,660 SF



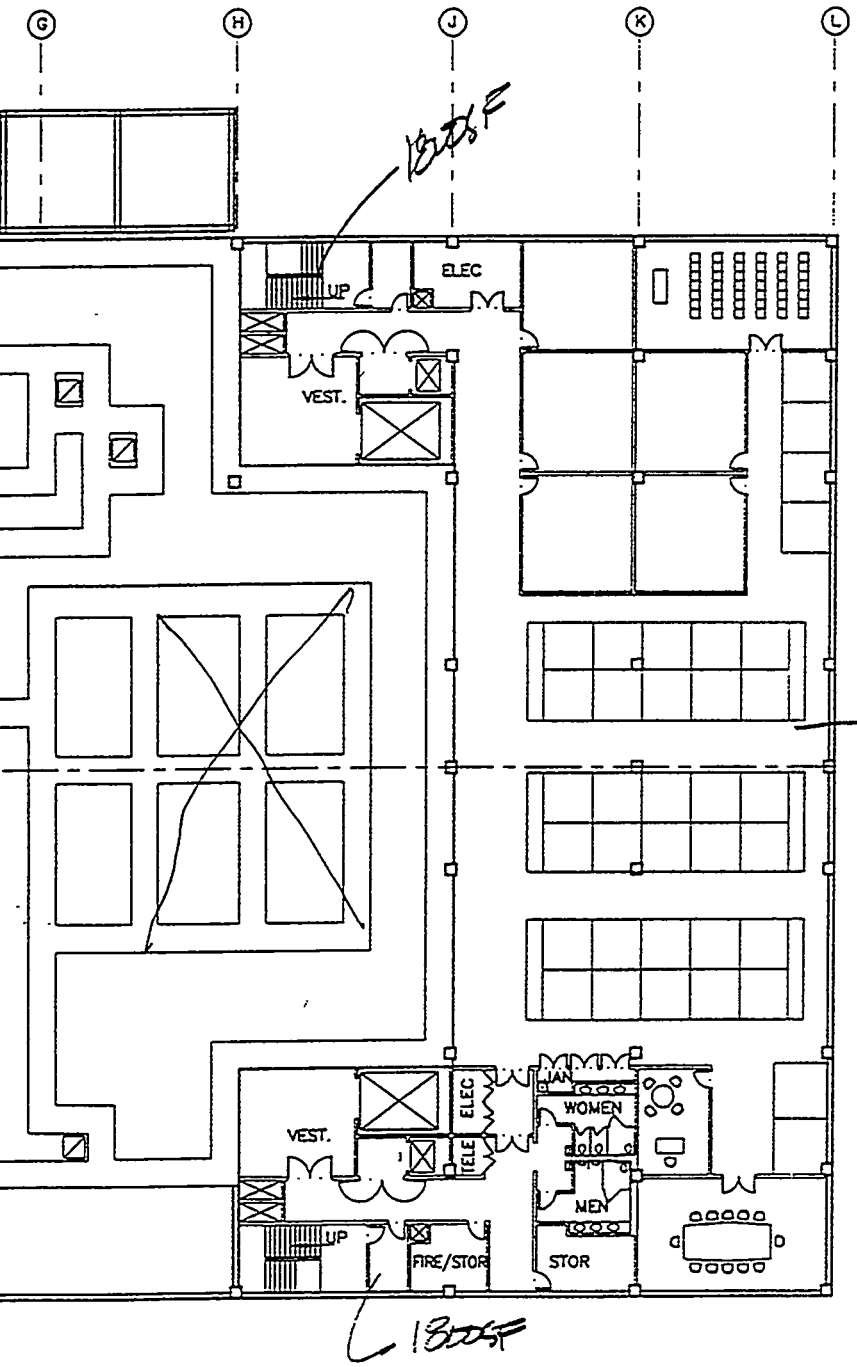
33,250SF

LEVEL +94–6" (4A)


A
B
C
D
E
F
9.0
7.9
6.8
5.9
5.0
4.1
3.1
2.1
1.0
UP
HVAC MECHANICAL BELOW
BLOWER MECH BELOW
OFF SPEC CHECK BELOW
WELD BELOW
DECON BELOW
HEPA BELOW
STRIP BELOW
CART DECON BELOW
UP
UP
NAOH TANK
DECON ICE BELOW
CART REPAIR BELOW
OFF GAS TREATMENT BELOW
UP
175'
318'

LEVEL + 67'-6" (

HOT CELL – 0
COMP PANELS – 9
ADMIN. – 18,000SF.



18,000SF

W/ 25-9 PANELS.

20 YR.

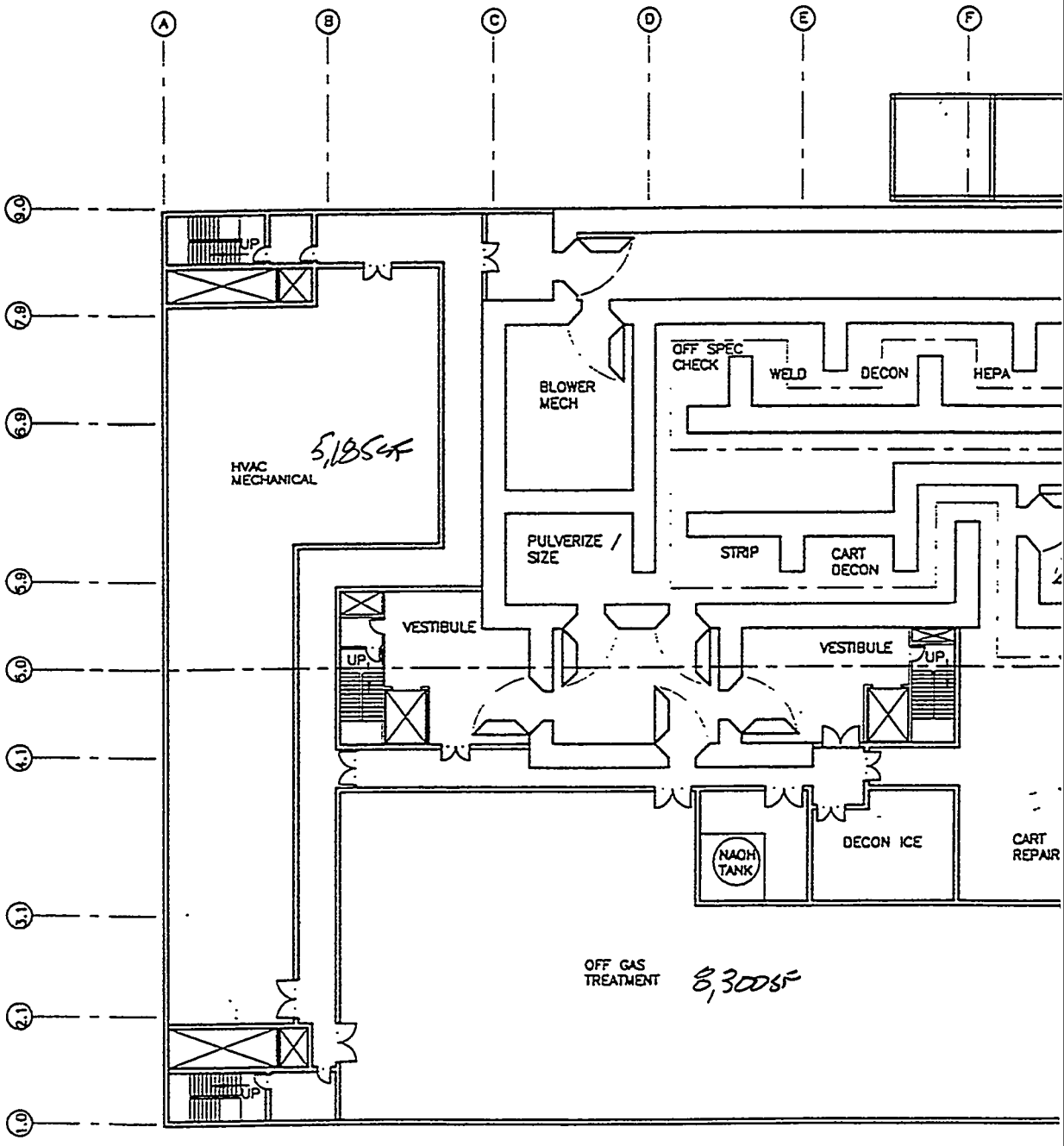
HOT CELL 0
COMP 0
ADMIN. = 18,000SF.

TOTAL = 18,000

125 x 66 =
11,550SF.

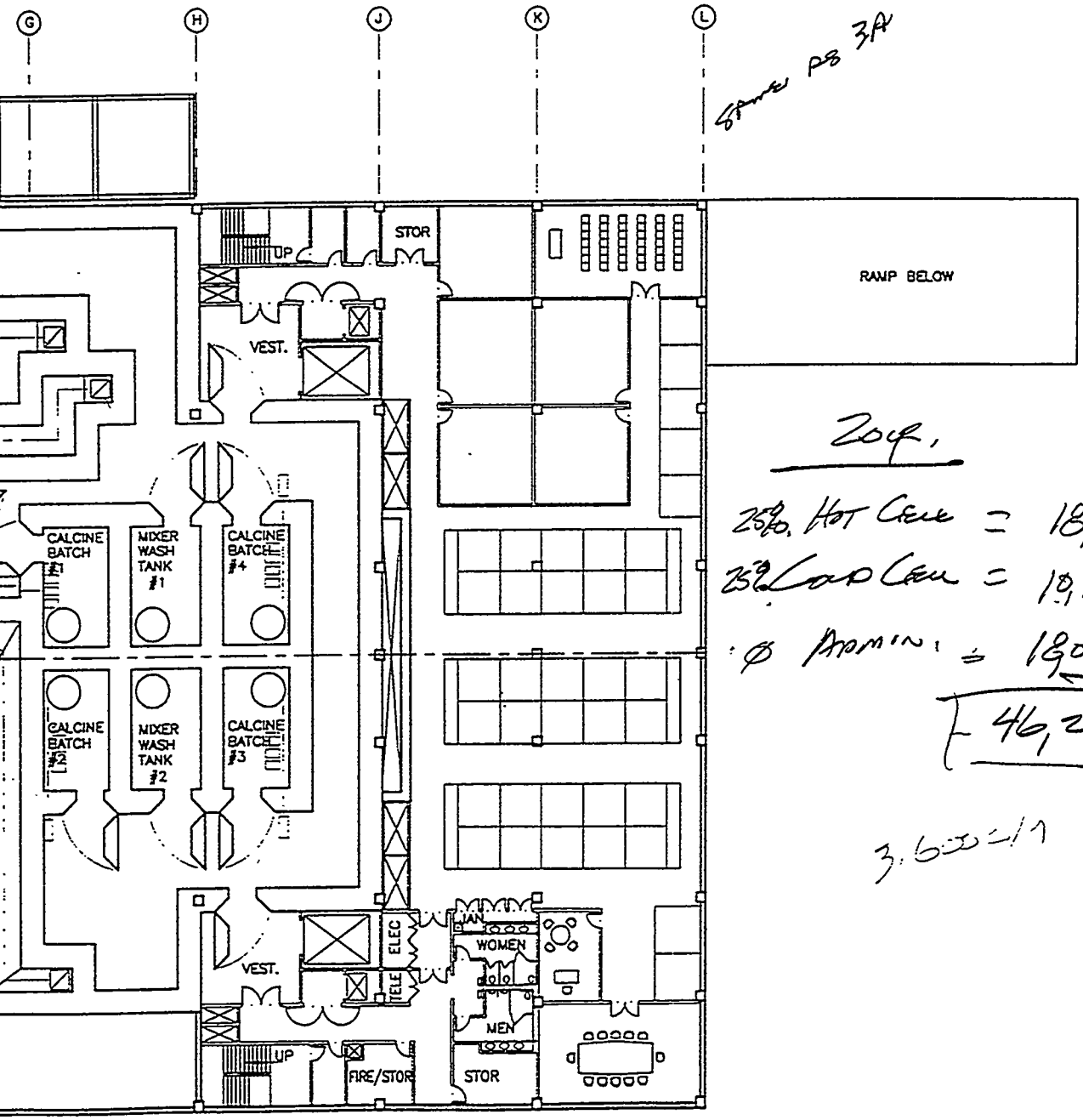
18,000SF

)=-18,000SF. (ADMIN/STAIRS)


A
B
C
D
E
F
9.9
7.8
6.8
6.8
6.0
4.1
2.1
1.0
UP
HVAC MECHANICAL
5,185SF
BLOWER MECH
OFF SPEC CHECK
WELD
DECON
HEPA
PULVERIZE / SIZE
STRIP
CART DECON
VESTIBULE
VESTIBULE
UP
UP
NAOH TANK
DECON ICE
CART REPAIR
OFF GAS TREATMENT
8,300SF
UP

LEVEL +54'-0" (3)

HOT CELL – 24,150SF.
COLD CELL – 13,500SF
ADMIN – 18,000SF



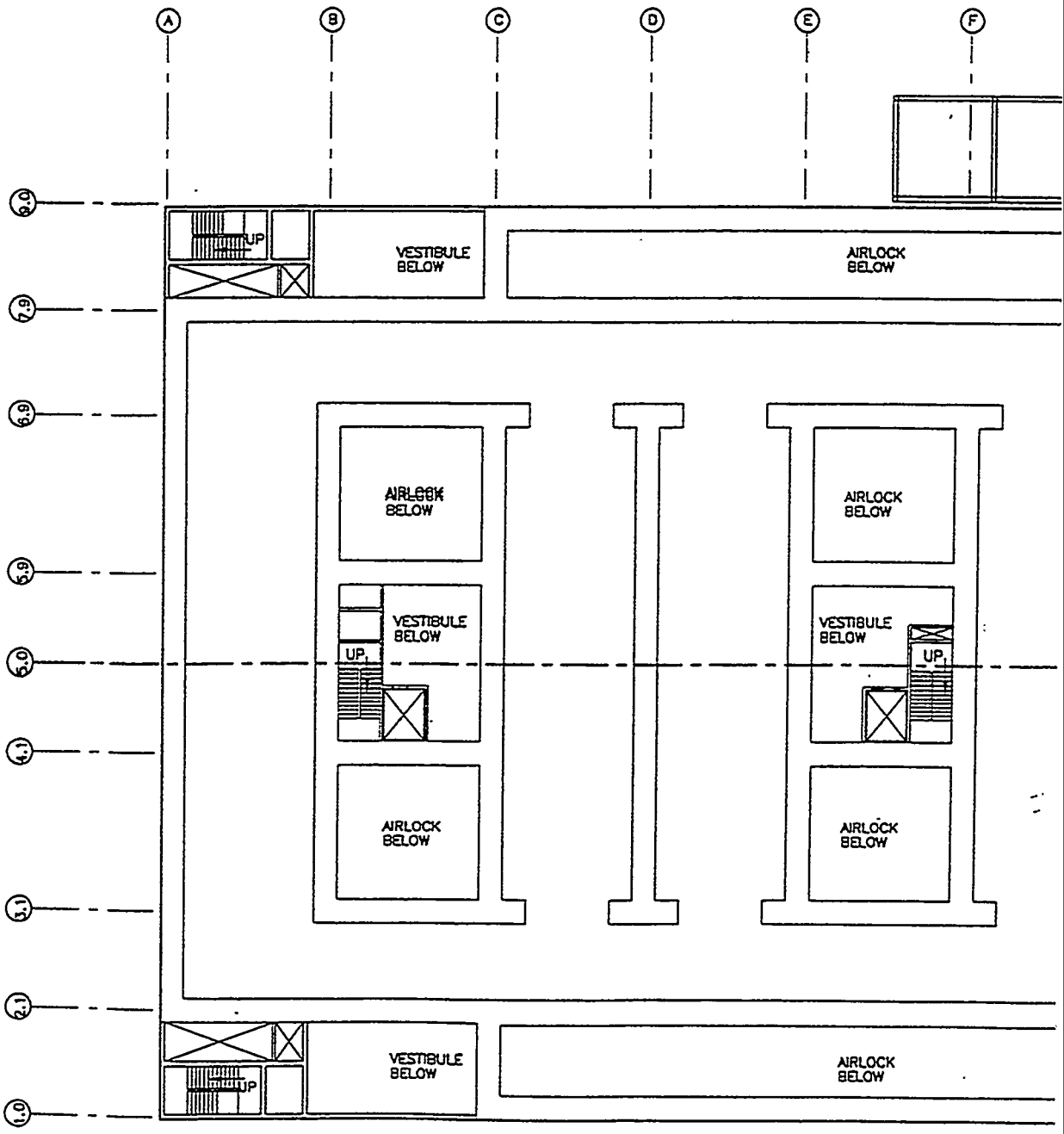
2ND FL.

25% HOT CELL = 18,120SF.
25% COLD CELL = 18,125SF.
ADMIN = 18,000SF.

46,200SF.

3.6:1

= 55,650SF

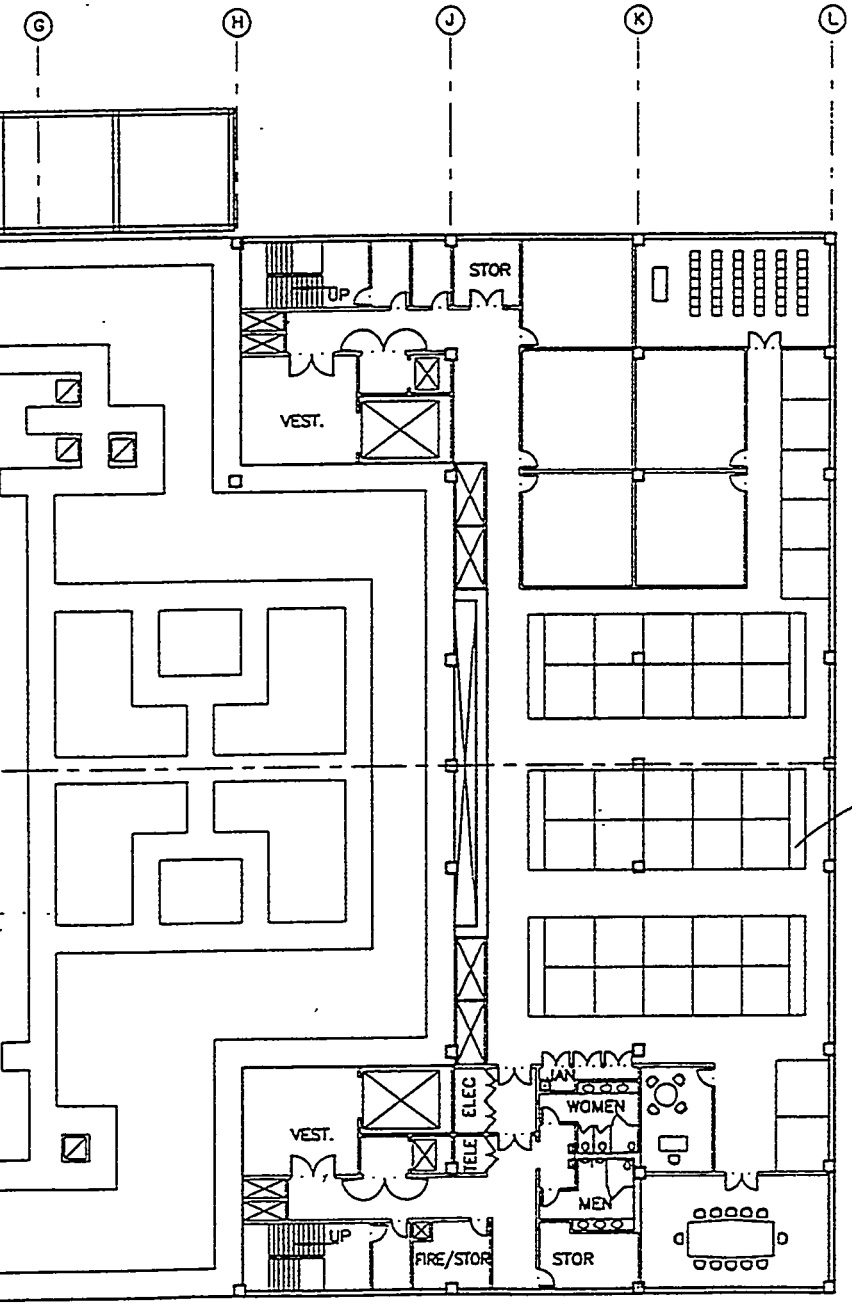

A
B
C
D
E
F
9.0
7.9
6.9
5.9
5.0
4.1
3.1
2.1
1.0
UP
VESTIBULE BELOW
AIRLOCK BELOW
AIRLOCK BELOW
VESTIBULE BELOW
UP
AIRLOCK BELOW
AIRLOCK BELOW
VESTIBULE BELOW
UP
AIRLOCK BELOW
UP
VESTIBULE BELOW
AIRLOCK BELOW

LEVEL +40'-6" (2A

Hot Cell - 0

Cold Cell - 0

Admin - 18,000SF



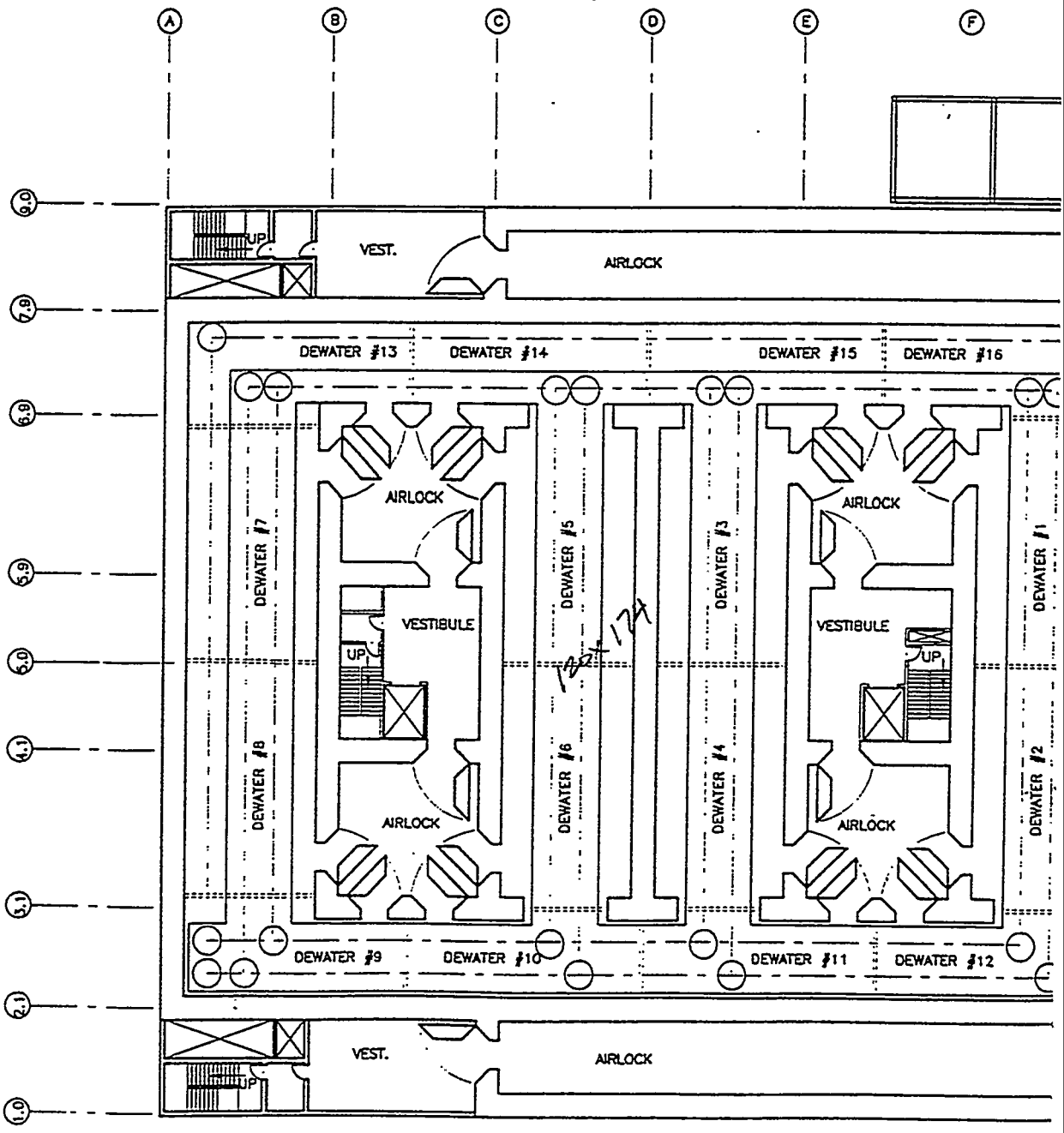
Zone.

Admin = 18,000

Total = 13,000SF

cut off 7th process

=18,000SF



200 c

50 «

LEVEL +27'-0" (2)=

REDUCE CONVEYANCE .5 X

NO. OF PIGS REDUCE TO (3)

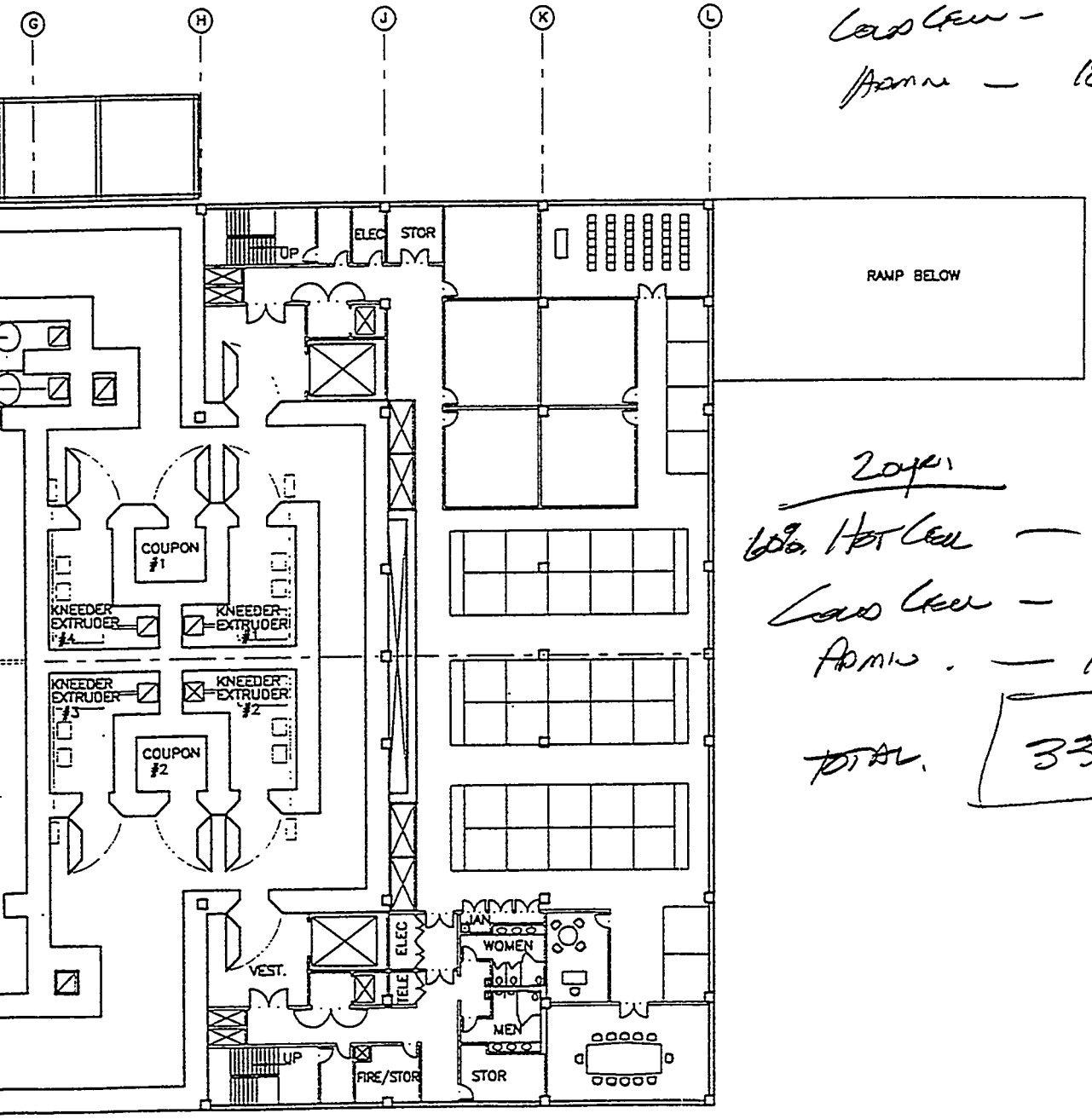
300 CARTS - 90 TURN TABLES

75 CARTS - 50-60 " "

Hot Cell — 37,650SF

Cold Cell — ∅

Admin — 18,000SF



2nd:

60% Hot Cell — 15,000 SF.

Cold Cell — ∅

Admin. — 18,000SF

TOTAL 33,000SF.

ANS

PANS

55,650SF

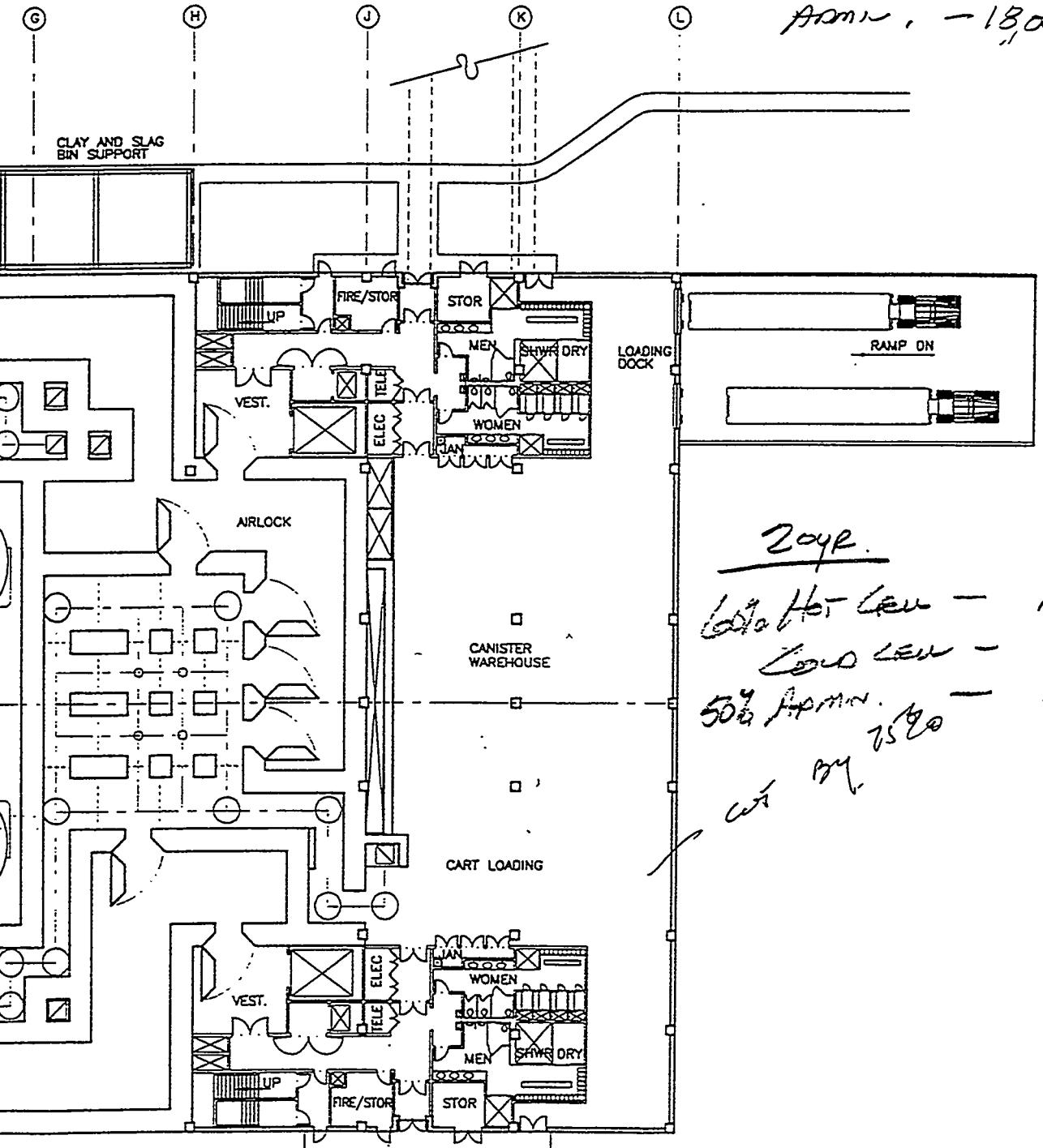
(4) AUTOCLAVES

(1) AUTOCLAVE LEVEL 0'-0" (GRADE

User: ADE
Date: 12/04/97 - 11:03 A.M.

RECYCLE CELL STET

Hot Cell 37,650.
Cold Cell - ϕ
Admin. - 18,000.

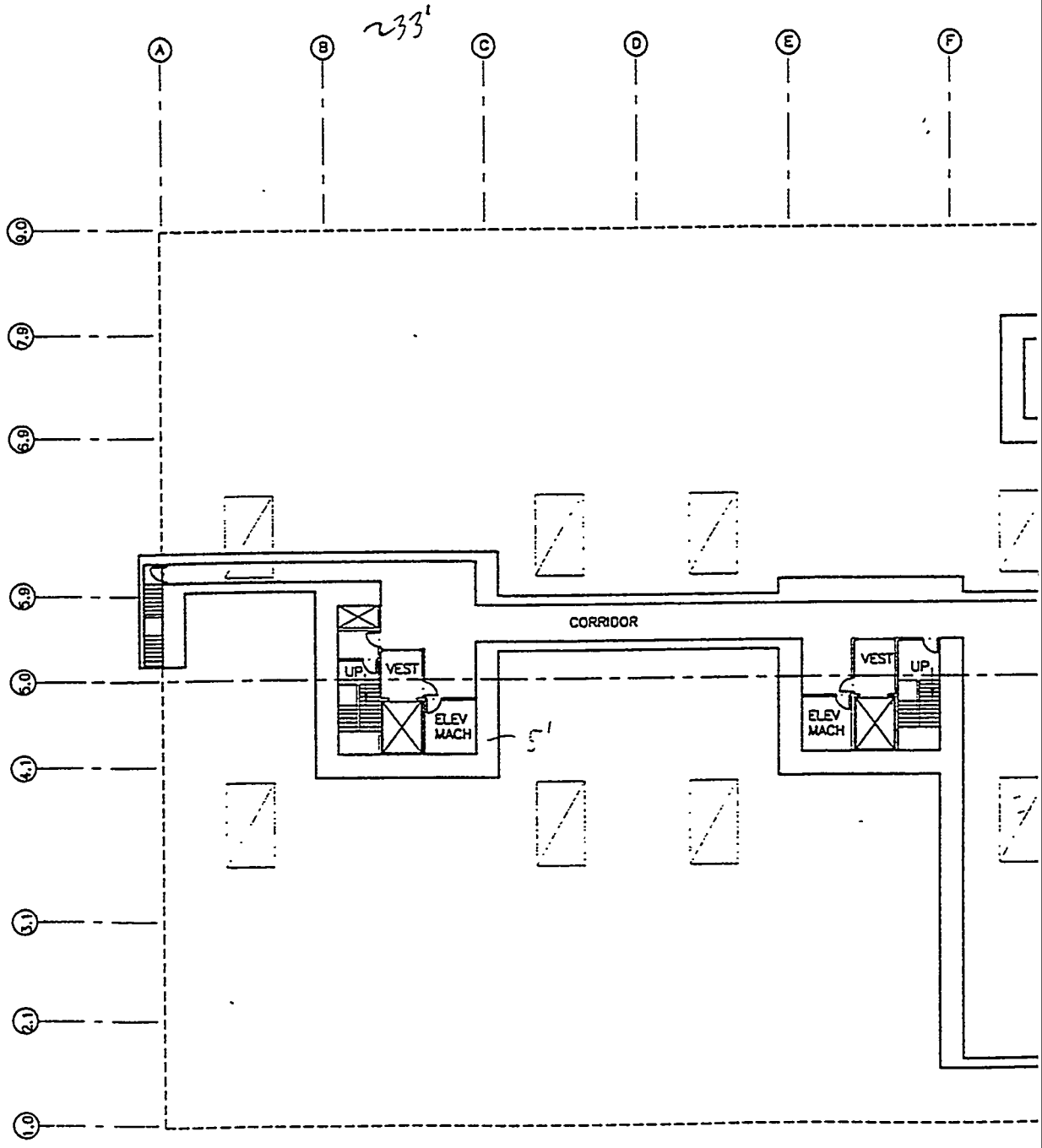


20yr.

Lost Hot Cell — 15,000 SF
Cold Cell — ϕ
50% Admin. — 9,000 SF

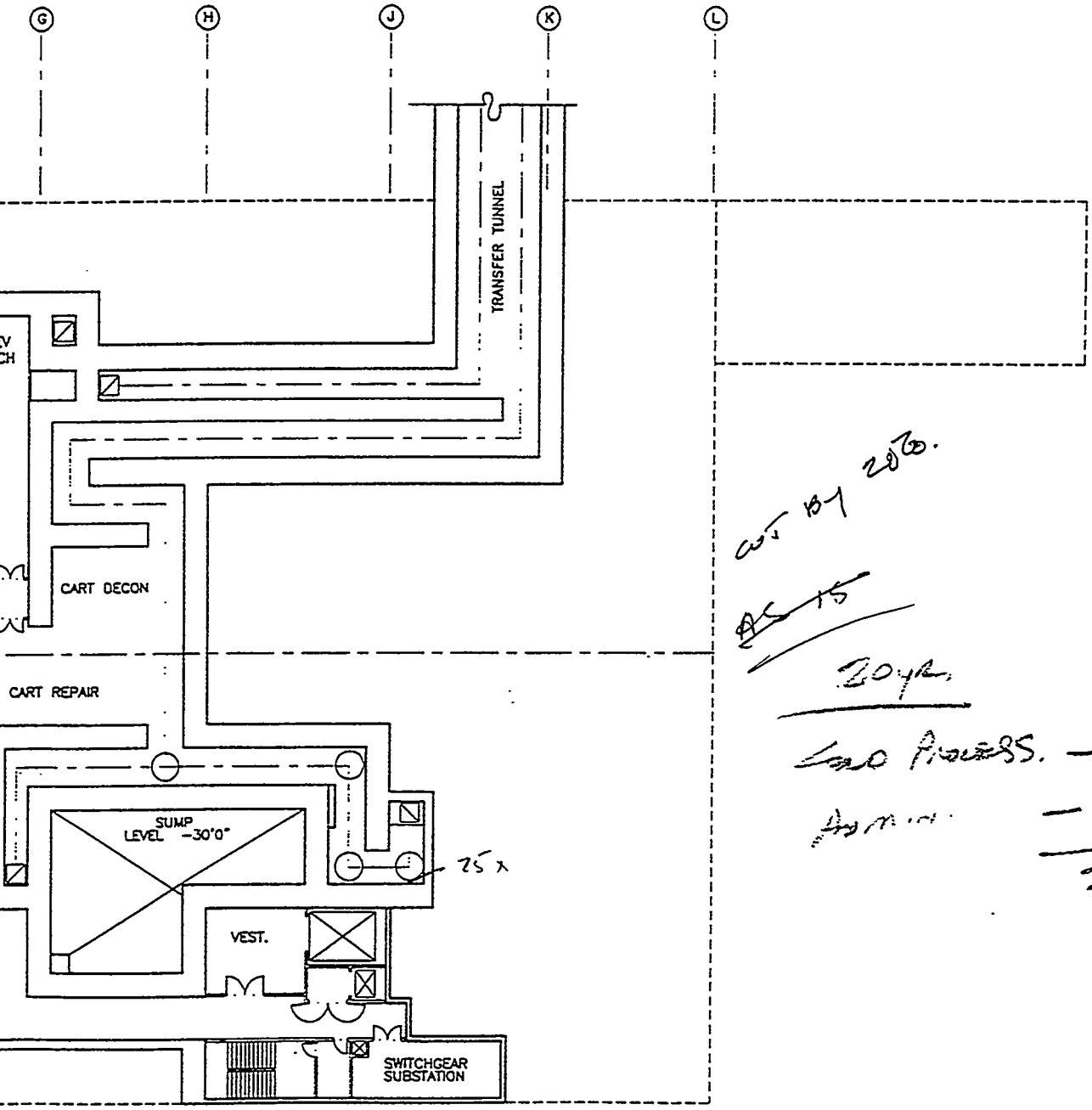
1500 BY

= 55,650 SF



LEVEL -23'0" (BASE

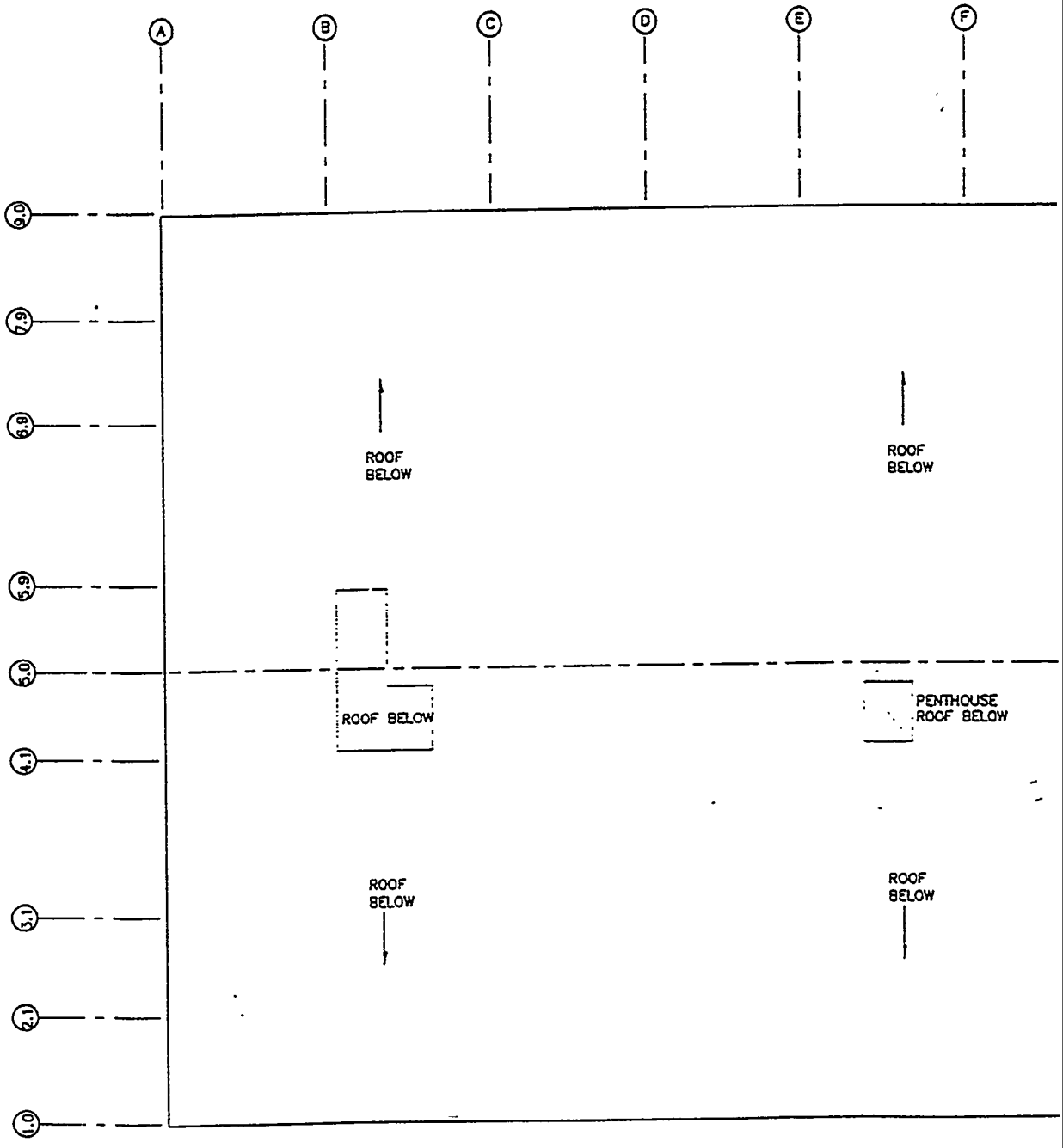
Hot Cell — 9
Load process — 23,000SF
Admin — 2,000SF.



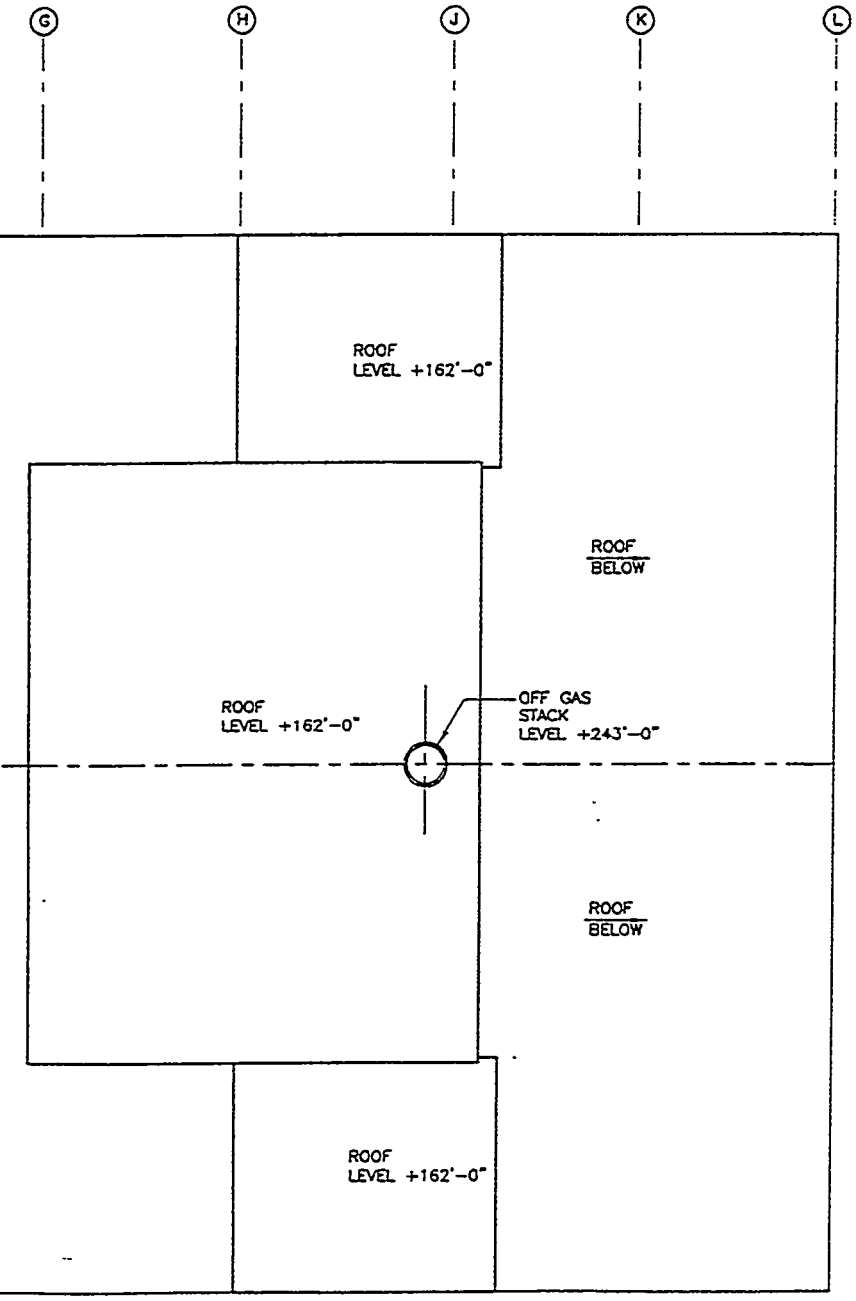
~~15~~ 20yr.

Load Process. — 18,000SF.
Admin — 2,000SF
20,000SF.

ENT) = 25,000SF


A
B
C
D
E
F
9.0
7.9
6.8
5.9
5.0
4.1
3.1
2.1
1.0
ROOF BELOW
ROOF BELOW
ROOF BELOW
PENTHOUSE ROOF BELOW
ROOF BELOW
ROOF BELOW

LEVEL +162'-0" (R


G
H
J
K
L
ROOF
LEVEL +162'-0"
ROOF
BELOW
ROOF
LEVEL +162'-0"
OFF GAS
STACK
LEVEL +243'-0"
J
ROOF
BELOW
ROOF
LEVEL +162'-0"

OF/7)

ENGINEERING DESIGN FILE

Project File Number 02BE0

Project/Task Waste Treatment Project Feasibility Studies

Subtask Direct Cementitious Waste Option Scoping Study

Title: DCWO Base Facility Design Shielding Calculations

Summary:

This EDF cover sheet provides documentation accounting of the attached EDF, Function file Number CFA-97087, EDF number 1000-72, for the Direct Cementitious Waste Option EDF file system. Reference 1 of EDF 1000-72 is included under this cover.

The purpose for the calculations is to confirm that the 5 ft thick walls in the grout facility design (assumed before dose rate data was available) are adequate and to provide a scoping level indication of how much shielding may be required for the calcine transport lines. The referenced request was made assuming the conditions described would be worse case for the grout facility.

Conclusions: Five foot thick walls appear to be more than adequate. Analysis indicates a required minimum of 89.5 cm (35 in.). For the configuration listed in the referenced request and detailed in the EDF, required shielding for transport lines, where personnel are in close proximity, is on the order of 76.5 cm (30 in.)

Distribution (complete package): WTP EIS Studies Library, R. E. Dafoe M.S. 3765, D. J. Harrell M. S. 3211, B. R. Helm M. S. 3765, K. L. Williams M. S. 3765

Distribution (summary package only):

Author T. S. Bohn	Dept. 1341	Reviewed H. K. Peterson	Date	Approved	Date 1/8/98
Signature on EDF-1000-72 12-17-97		Signature on EDF-1000-72 12-17-97	Date	LMITCO Approval	Date

Reference 1. of EDF-1000-72

From: RED --INELVM1 Date and time 12/01/97 10:12:34
To: TGM4 --INELVM1 T G McDonald
cc: WZL --INELVM1 K L Williams

FROM: Ron Dafoe (RED)
MC&I Eng. EROB
6-6772, M.S.3765
Subject: DCWO Dose Request

Base facility design is using 5 ft thick walls. What do the results of the questions below require for concrete shielding assuming a minimum 1 ft gap between source and wall?

What is worse case estimated dose on contact and at 1 meter for 4 in. schedule 40 SST pipe carrying air entrained calcine? Figure 50% loading.

What is worse case estimated dose on contact and at 1 meter for 4 in. schedule 40 SST pipe carrying calcine. Figure 100% loading?

What is worse case estimated dose on contact and at 1 meter for a full 80 cubic meter SST tank, 4 meters in diameter by 15 meters tall, containing calcine?

What is worse case estimated area dose (or whatever) for an array of 18 full canisters in two rows of 9 each with a spacing of 4 feet between canisters? Figure 0.72 cubic meters per canister.

Information needed last month (ha, ha), but soon would be nice.

Results in EDF format. Thanks.

E N D O F N O T E

ENGINEERING DESIGN FILE

Project File Number TSB-43-97

Project/Task DCWO Gamma Dose-Rate Determination for Various Calcine Tank and Pipe Configurations for Base Facility Design

Subtask Determine Shielding Thickness per Configuration

Title: DCWO Base Facility Design Shielding Calculations
Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.
This EDF includes calculated dose rates for various calcine tanks and pipe configurations. Four configurations were described. Calculation results at contact (1 centimeter), one foot and one meter from the shielding surface were made are reported. Calculations were also made and reported with no shield. The sources consist of Alumina Calcine with radionuclide activities taken from Tables 7 and 17 in reference 4 with concrete substituted for the calcine material. The Microshield Version 5.01 was used to perform the calculations. Copies of the computer runs are included in the attachment.
Distribution (complete package): T. G. McDonald (MS 3765), T. S. Bohn File (MS 4138), Radiological Support EDF File (MS 4138) Distribution (summary package only): G. W. Clarke (MS 4138), W. C. Craft III (MS 4138), H. K. Peterson (MS 2107)

Author	Dept.	Reviewed	Date	Approved	Date
T. S. Bohn	1341	H. K. Peterson	12/17/97	G. W. Clarke	12-18-97
	12-17-97				
		LMITCO Review	Date	LMITCO Approval	Date

Included in this EDF are four cases as described in a note from Ron Dafoe to T. G. McDonald (reference 1) where calculations determine the dose-rate of various shielded and bare calcine tank configurations. All calculations have been performed using MicroShield, Version 5.01 (reference 2). Generally, the dose-rates at three distances from the shield are calculated, one centimeter, one foot and one meter. In some cases the shield is optimized to <0.1 mR/hour at one foot (general body distance) in accordance with the full-time occupancy conditions for design dose-rates (reference 3)

Case 1- Pipe Containing 50% Loaded Air Entrained Alimina Calcine

A four-inch stainless steel pipe, assumed to be infinite in length (50 feet), carries air entrained alumina calcine (50% loading). The pipe is assumed to be Schedule 40 SST having an outside diameter of 4.500 inches and a wall thickness of 0.237 inches. The source term for the alumina calcine was taken from Table 7 of reference 4 where the radionuclides (activity reduce by 50%) have been decayed to the year 2016. The air entrained alumina calcine of 50% loading has a concrete density of 0.545 g/cc. A concrete shield ($\rho = 2.35$ g/cc) is located one foot from the pipe. Its thickness is optimized such that the dose-rate at one foot beyond the shield is 0.1 mR/hr in accordance with the design criteria for full-time occupancy (reference 3). Dose-rates are determined with and without the shield. The results of the dose-rate calculations are as follows:

With an optimized concrete shield thickness of 71.0 cm,

Doserate @ 1 cm (mR/hr)	0.13
Doserate @ 1 foot (mR/hr)	0.10
Doserate @ 1 meter (mR/hr)	0.067

With no shield

Doserate @ 1 cm (R/hr)	100
Doserate @ 1 foot (R/hr)	30
Doserate @ 1 meter (R/hr)	10

Case 2 – Pipe Containing 100% Loaded Alumina Calcine

This case is the same as Case 1 except that the alumina calcine in the pipe is 100% loaded or has a density of 1.09 g/cc and twice the Case 1 source term activity. Dose-rates are determined with and without an optimized shield. The results of the dose-rate calculations are as follows:

With an optimized concrete shield thickness of 76.5 cm,

Doserate @ 1 cm (mR/hr)	0.13
Doserate @ 1 foot (mR/hr)	0.10
Doserate @ 1 meter (mR/hr)	0.068

With no shield

Doserate @ 1 cm (R/hr)	221
Doserate @ 1 foot (R/hr)	54
Doserate @ 1 meter (R/hr)	18

Case 3 – 80 m^3 Alunina Calcine Filled Tank

An 80-m^3 stainless steel conical tank with dimensions of 4 m diameter and 15 m height is filled with alumina calcine with the same source term as case 2 and 1.09 g/cc density. Since the shape if the tank is difficult to model in MicroShield and these are scoping calculations, it was determined to be sufficient to model the tank as a cylinder 10 m in height and ID of 3.2 m which has an 80 m^3 volume. Also a tank wall thickness of 3/8 inches stainless steel was assumed. A concrete shield (ρ = 2.35 g/cc) is placed 3 feet from the tank. Dose-rates are determined with and without the shield. The results of the dose-rate calculations are as follows:

With an optimized concrete shield thickness of 89.5 cm,

Doserate @ 1 cm (mR/hr)	0.10
Doserate @ 1 foot (mR/hr)	0.097
Doserate @ 1 meter (mR/hr)	0.088

With no shield

Doserate @ 1 cm (R/hr)	58
Doserate @ 1 foot (R/hr)	53
Doserate @ 1 meter (R/hr)	43

Case 4 – Eighteen Canister Array

Eighteen canisters, filled with 0.72 m^3 each of alumina calcine grout (reference 4, Table 17), are in an array of two rows of nine canisters each with a spacing of four feet between canisters. The source term depicted in Table 17 was reduced to Cs-137 (2100 Ci/m^3) since it is the major contributor to the dose-rate. The array is surrounded by a concrete shield (ρ = 2.35 g/cc) three feet from the canisters whose thickness is optimized to allow a maximum of 0.1 mR/hr at a distance of one foot beyond the shield. Each canister contains 0.72 m^3 of alumina calcine grout modeled as concrete (ρ = 1.7 g/cc). Each canister is stainless steel with an OD of 24 inches, an ID of 23.25 inches and a length of 105 inches. Dose-rate calculations were made at following distances beyond the shield:

With an optimized concrete shield of 88.5 cm @ 3 feet from three array,

Doserate @ 1 cm (mR/hr)	0.11
Doserate @ 1 foot (mR/hr)	0.10
Doserate @ 1 meter (mR/hr)	0.096

References

1. Ron Dafoe note to T. G. McDonald, DCWO Dose Request, December 1, 1997.

2. MicroShield, Version 5.01, Grove Engineering, Rockville, MD.

3. Operational Safety Design Criteria Manual, Section IV.B.1, ID-12044, W. L. Williams et al.

4. Estimates of Feed and Waste Volumes, Compositions and Properties, by C. M. Barnes, EDF-FDO-001, Revision 1.

If there are any questions or comments concerning this analysis, please call me at the 526-1279/526-7455 or by Pager (5841).

Page : 1
DOS File : DCWO1A01.MS5
Date : December 16, 1997
Run Time: 3:30:24 PM
Duration : 00:01:21

File Ref: _____
Date: 12/17/97
By: [signature]
Checked: [signature]

Case Title: DCWO1A01
Description: 50ftx4in 40 SST Air Entr Calcine 50% 1cm from shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	108.195 cm	762 cm	0 cm
	3 ft 6.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	71.0 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1A01.MS5
Run Date : December 16, 1997
Run Time: 3:30:24 PM
Duration : 00:01:21

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	5.019e-311	1.686e-26	1.739e-312	5.839e-28
0.03	4.943e+11	4.534e-98	3.462e-22	4.493e-100	3.431e-24
0.04	1.175e+11	3.590e-47	2.182e-22	1.588e-49	9.652e-25
0.05	2.241e+08	2.237e-31	1.361e-24	5.959e-34	3.625e-27
0.06	3.188e+06	6.357e-25	2.771e-23	1.263e-27	5.503e-26
0.08	7.633e+07	1.260e-16	8.981e-15	1.995e-19	1.421e-17
0.1	1.692e+09	1.734e-12	2.394e-10	2.653e-15	3.662e-13
0.15	3.371e+03	2.310e-15	5.573e-13	3.804e-18	9.177e-16
0.2	2.770e+08	4.157e-09	1.069e-06	7.337e-12	1.887e-09
0.3	5.619e+03	3.239e-12	5.883e-10	6.144e-15	1.116e-12
0.4	2.935e+07	1.802e-07	2.152e-05	3.511e-10	4.192e-08
0.5	8.920e+06	3.146e-07	2.605e-05	6.175e-10	5.113e-08
0.6	7.551e+12	1.050e+00	6.365e+01	2.050e-03	1.242e-01
0.8	1.581e+09	1.749e-03	6.481e-02	3.326e-06	1.233e-04
1.0	1.248e+09	6.354e-03	1.626e-01	1.171e-05	2.998e-04
1.5	1.582e+09	1.046e-01	1.440e+00	1.759e-04	2.423e-03
TOTALS:	8.170e+12	1.163e+00	6.531e+01	2.241e-03	1.271e-01

Page : 1
File : DCWO1B02.MS5
Date : December 16, 1997
Run Time: 3:20:50 PM
Duration : 00:01:19

File Ref: _____
Date: 12/17/97
By: [signature]
Checked: [signature]

Case Title: DCWO1A02

Description: 50ftx4in 40 SST Air Entr Calcine 50% 1ft from shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	137.675 cm	762 cm	0 cm
	4 ft 6.2 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	71.0 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1B02.MS5
Run Date : December 16, 1997
Run Time: 3:20:50 PM
Duration : 00:01:19

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	1.078e-310	1.290e-26	3.735e-312	4.467e-28
0.03	4.943e+11	4.136e-98	2.648e-22	4.099e-100	2.625e-24
0.04	1.175e+11	2.669e-47	1.670e-22	1.180e-49	7.384e-25
0.05	2.241e+08	1.574e-31	1.041e-24	4.194e-34	2.773e-27
0.06	3.188e+06	4.503e-25	1.971e-23	8.944e-28	3.916e-26
0.08	7.633e+07	9.345e-17	6.693e-15	1.479e-19	1.059e-17
0.1	1.692e+09	1.323e-12	1.842e-10	2.025e-15	2.818e-13
0.15	3.371e+03	1.813e-15	4.408e-13	2.985e-18	7.260e-16
0.2	2.770e+08	3.295e-09	8.530e-07	5.816e-12	1.505e-09
0.3	5.619e+03	2.587e-12	4.710e-10	4.907e-15	8.934e-13
0.4	2.935e+07	1.442e-07	1.721e-05	2.809e-10	3.353e-08
0.5	8.920e+06	2.516e-07	2.079e-05	4.938e-10	4.081e-08
0.6	7.551e+12	8.390e-01	5.070e+01	1.638e-03	9.895e-02
0.8	1.581e+09	1.393e-03	5.142e-02	2.649e-06	9.780e-05
1.0	1.248e+09	5.044e-03	1.286e-01	9.297e-06	2.371e-04
1.5	1.582e+09	8.258e-02	1.134e+00	1.389e-04	1.908e-03
TOTALS:	8.170e+12	9.280e-01	5.201e+01	1.788e-03	1.012e-01

Page : 1
File : DCWO1A03.MS5
Date : December 16, 1997
Run Time: 3:33:42 PM
Duration : 00:01:17

File Ref: _____
Date: 12/17/97
By: _____
Checked: _____

Case Title: DCWO1A03
Description: 50ftx4in 40 SST Air Entr Calcine 50% 1m from shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	207.195 cm	762 cm	0 cm
	6 ft 9.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	71.0 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1A03.MS5
Run Date : December 16, 1997
Run Time : 3:33:42 PM
Duration : 00:01:17

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	1.358e-310	8.034e-27	4.705e-312	2.783e-28
0.03	4.943e+11	2.531e-98	1.650e-22	2.508e-100	1.635e-24
0.04	1.175e+11	1.469e-47	1.040e-22	6.498e-50	4.600e-25
0.05	2.241e+08	9.417e-32	6.486e-25	2.509e-34	1.728e-27
0.06	3.188e+06	2.900e-25	1.281e-23	5.761e-28	2.544e-26
0.08	7.633e+07	6.311e-17	4.529e-15	9.987e-20	7.167e-18
0.1	1.692e+09	8.981e-13	1.250e-10	1.374e-15	1.912e-13
0.15	3.371e+03	1.223e-15	2.965e-13	2.015e-18	4.883e-16
0.2	2.770e+08	2.213e-09	5.702e-07	3.905e-12	1.006e-09
0.3	5.619e+03	1.725e-12	3.128e-10	3.273e-15	5.933e-13
0.4	2.935e+07	9.577e-08	1.139e-05	1.866e-10	2.220e-08
0.5	8.920e+06	1.667e-07	1.374e-05	3.272e-10	2.698e-08
0.6	7.551e+12	5.551e-01	3.348e+01	1.083e-03	6.536e-02
0.8	1.581e+09	9.200e-04	3.395e-02	1.750e-06	6.457e-05
1.0	1.248e+09	3.331e-03	8.495e-02	6.140e-06	1.566e-04
1.5	1.582e+09	5.456e-02	7.498e-01	9.179e-05	1.261e-03
TOTALS:	8.170e+12	6.139e-01	3.435e+01	1.183e-03	6.684e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO1B01.MS5
Date : December 16, 1997
Run Time: 8:02:13 AM
Duration : 00:01:16

File Ref:
Date: 12/17/97
By:
Checked:

Case Title: DCWO1B01
Description: 50ftx4in 40 SST Air Entr Calcine 50% 1cm, No Shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	6.715 cm	762 cm	0 cm
	2.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Shield 1

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1B01.MS5
Run Date : December 16, 1997
Run Time: 8:02:13 AM
Duration : 00:01:16

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	1.180e-80	2.333e-25	4.088e-82	8.080e-27
0.03	4.943e+11	5.162e-22	3.345e-21	5.116e-24	3.315e-23
0.04	1.175e+11	2.746e-08	3.251e-08	1.215e-10	1.438e-10
0.05	2.241e+08	1.379e-05	1.794e-05	3.674e-08	4.779e-08
0.06	3.188e+06	6.698e-05	9.497e-05	1.330e-07	1.886e-07
0.08	7.633e+07	2.560e-01	4.275e-01	4.052e-04	6.766e-04
0.1	1.692e+09	4.580e+01	8.761e+01	7.007e-02	1.340e-01
0.15	3.371e+03	6.652e-04	1.561e-03	1.095e-06	2.571e-06
0.2	2.770e+08	1.209e+02	3.137e+02	2.134e-01	5.536e-01
0.3	5.619e+03	5.543e-03	1.457e-02	1.052e-05	2.764e-05
0.4	2.935e+07	4.748e+01	1.186e+02	9.251e-02	2.310e-01
0.5	8.920e+06	2.072e+01	4.850e+01	4.067e-02	9.520e-02
0.6	7.551e+12	2.336e+07	5.139e+07	4.560e+04	1.003e+05
0.8	1.581e+09	7.606e+03	1.509e+04	1.447e+01	2.870e+01
1.0	1.248e+09	8.381e+03	1.537e+04	1.545e+01	2.833e+01
1.5	1.582e+09	1.912e+04	3.084e+04	3.218e+01	5.189e+01
TOTALS:	8.170e+12	2.340e+07	5.145e+07	4.566e+04	1.004e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
DOS File : DCWO1B02.MS5
Date : December 18, 1997
Run Time: 4:28:38 PM
Duration : 00:02:04

File Ref:
Date: 12-18-97
By:
Checked:

Case Title: DCWO1B02
Description: 50ftx4in 40 SST Air Entr Calcine 50% 1ft, No Shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	36.215 cm	762 cm	0 cm
	1 ft 2.3 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1B02.MS5
Run Date : December 18, 1997
Run Time: 4:28:38 PM
Duration : 00:02:04

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	7.607e-57	1.627e-25	2.635e-58	5.634e-27
0.03	4.943e+11	1.098e-14	3.341e-13	1.088e-16	3.311e-15
0.04	1.175e+11	3.675e-05	2.365e-03	1.625e-07	1.046e-05
0.05	2.241e+08	4.864e-04	3.885e-02	1.296e-06	1.035e-04
0.06	3.188e+06	4.222e-04	2.753e-02	8.386e-07	5.469e-05
0.08	7.633e+07	3.623e-01	1.161e+01	5.734e-04	1.837e-02
0.1	1.692e+09	3.619e+01	6.226e+02	5.536e-02	9.525e-01
0.15	3.371e+03	3.198e-04	2.281e-03	5.266e-07	3.756e-06
0.2	2.770e+08	4.937e+01	2.320e+02	8.714e-02	4.095e-01
0.3	5.619e+03	1.979e-03	6.353e-03	3.754e-06	1.205e-05
0.4	2.935e+07	1.584e+01	4.172e+01	3.086e-02	8.129e-02
0.5	8.920e+06	6.610e+00	1.532e+01	1.298e-02	3.008e-02
0.6	7.551e+12	7.210e+06	1.524e+07	1.407e+04	2.974e+04
0.8	1.581e+09	2.239e+03	4.152e+03	4.258e+00	7.897e+00
1.0	1.248e+09	2.386e+03	4.081e+03	4.398e+00	7.523e+00
1.5	1.582e+09	5.164e+03	7.799e+03	8.688e+00	1.312e+01
TOTALS:	8.170e+12	7.220e+06	1.526e+07	1.409e+04	2.977e+04

File Ref:
Date: 12-18-97
By:
Checked:

Case Title: DCWO1B03
Description: 50ftx4in 40 SST Air Entr Calcine 50% 1m, No Shld
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	105.715 cm	762 cm	0 cm
	3 ft 5.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	0.545
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	2.2680e+002	8.3917e+012	1.8120e+003	6.7044e+007
Cs-134	1.2331e-006	4.5626e+004	9.8520e-006	3.6452e-001
Cs-137	2.3977e+002	8.8715e+012	1.9156e+003	7.0877e+007
Eu-154	1.0960e-001	4.0553e+009	8.7565e-001	3.2399e+004
Eu-155	6.6439e-003	2.4582e+008	5.3080e-002	1.9640e+003
Sb-125	3.6305e-005	1.3433e+006	2.9005e-004	1.0732e+001
Sm-151	4.8649e+000	1.8000e+011	3.8867e+001	1.4381e+006
Sr-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007
Y-90	2.1922e+002	8.1110e+012	1.7514e+003	6.4802e+007

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO1B03.MS5
Run Date : December 18, 1997
Run Time : 4:33:23 PM
Duration : 00:02:02

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	5.322e+07	1.567e-55	5.231e-26	5.429e-57	1.812e-27
0.03	4.943e+11	6.258e-15	1.819e-13	6.202e-17	1.802e-15
0.04	1.175e+11	1.060e-05	6.698e-04	4.689e-08	2.962e-06
0.05	2.241e+08	1.347e-04	1.094e-02	3.590e-07	2.915e-05
0.06	3.188e+06	1.240e-04	8.469e-03	2.463e-07	1.682e-05
0.08	7.633e+07	1.163e-01	3.912e+00	1.840e-04	6.191e-03
0.1	1.692e+09	1.196e+01	2.121e+02	1.829e-02	3.245e-01
0.15	3.371e+03	1.072e-04	7.775e-04	1.765e-07	1.280e-06
0.2	2.770e+08	1.660e+01	7.908e+01	2.930e-02	1.396e-01
0.3	5.619e+03	6.671e-04	2.161e-03	1.265e-06	4.100e-06
0.4	2.935e+07	5.347e+00	1.418e+01	1.042e-02	2.762e-02
0.5	8.920e+06	2.233e+00	5.202e+00	4.384e-03	1.021e-02
0.6	7.551e+12	2.438e+06	5.171e+06	4.758e+03	1.009e+04
0.8	1.581e+09	7.575e+02	1.407e+03	1.441e+00	2.677e+00
1.0	1.248e+09	8.076e+02	1.382e+03	1.489e+00	2.548e+00
1.5	1.582e+09	1.749e+03	2.636e+03	2.942e+00	4.435e+00
TOTALS:	8.170e+12	2.441e+06	5.177e+06	4.764e+03	1.010e+04

Page : 1
File : DCWO2A01.MS5
Date : December 16, 1997
Run Time: 8:19:26 AM
Duration : 00:01:18

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO2a01
Description: 50ftx4in 40 SST Calcine 100% Loading w/conc shld 1cm
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	113.695 cm	762 cm	0 cm
	3 ft 8.8 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	76.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2A01.MS5
Run Date : December 16, 1997
Run Time : 8:19:26 AM
Duration : 00:01:18

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	0.000e+00	9.658e-26	0.000e+00	3.345e-27
0.03	9.886e+11	1.652e-104	1.700e-20	1.638e-106	1.685e-22
0.04	2.350e+11	2.237e-50	3.569e-20	9.892e-53	1.579e-22
0.05	4.483e+08	2.103e-33	6.180e-22	5.603e-36	1.646e-24
0.06	6.376e+06	2.075e-26	2.126e-22	4.122e-29	4.222e-25
0.08	1.527e+08	1.185e-17	1.301e-13	1.875e-20	2.059e-16
0.1	3.384e+09	2.516e-13	2.308e-09	3.850e-16	3.530e-12
0.15	6.743e+03	5.243e-16	2.331e-12	8.634e-19	3.838e-15
0.2	5.541e+08	1.173e-09	2.513e-06	2.071e-12	4.436e-09
0.3	1.124e+04	1.187e-12	8.217e-10	2.252e-15	1.559e-12
0.4	5.871e+07	7.828e-08	2.434e-05	1.525e-10	4.742e-08
0.5	1.784e+07	1.549e-07	2.688e-05	3.041e-10	5.277e-08
0.6	1.510e+13	5.705e-01	6.288e+01	1.114e-03	1.227e-01
0.8	3.163e+09	1.100e-03	6.316e-02	2.093e-06	1.201e-04
1.0	2.495e+09	4.451e-03	1.604e-01	8.204e-06	2.956e-04
1.5	3.165e+09	8.747e-02	1.516e+00	1.472e-04	2.550e-03
TOTALS:	1.634e+13	6.635e-01	6.462e+01	1.271e-03	1.257e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO2A02.MS5
Date : December 15, 1997
Run Time: 2:36:46 PM
Duration : 00:02:39

File Ref: _____
Date: 12-18-97
By: _____
Checked: _____

Case Title: DCWO2a02
Description: 50ftx4in 40 SST Calcine 100% Loading w/conc shld 1ft
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	143.175 cm	762 cm	0 cm
	4 ft 8.4 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	76.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2A02.MS5
Run Date : December 15, 1997
Run Time : 2:36:46 PM
Duration : 00:02:39

Results

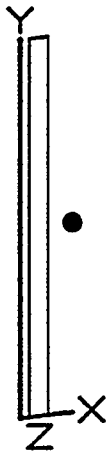
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	0.000e+00	7.466e-26	0.000e+00	2.586e-27
0.03	9.886e+11	1.503e-104	1.314e-20	1.490e-106	1.303e-22
0.04	2.350e+11	1.680e-50	2.759e-20	7.431e-53	1.220e-22
0.05	4.483e+08	1.500e-33	4.777e-22	3.996e-36	1.273e-24
0.06	6.376e+06	1.491e-26	1.520e-22	2.961e-29	3.019e-25
0.08	1.527e+08	8.901e-18	9.911e-14	1.409e-20	1.568e-16
0.1	3.384e+09	1.944e-13	1.808e-09	2.974e-16	2.767e-12
0.15	6.743e+03	4.162e-16	1.871e-12	6.854e-19	3.080e-15
0.2	5.541e+08	9.404e-10	2.028e-06	1.660e-12	3.580e-09
0.3	1.124e+04	9.581e-13	6.646e-10	1.817e-15	1.261e-12
0.4	5.871e+07	6.328e-08	1.966e-05	1.233e-10	3.830e-08
0.5	1.784e+07	1.251e-07	2.167e-05	2.457e-10	4.254e-08
0.6	1.510e+13	4.603e-01	5.058e+01	8.984e-04	9.873e-02
0.8	3.163e+09	8.848e-04	5.060e-02	1.683e-06	9.625e-05
1.0	2.495e+09	3.568e-03	1.281e-01	6.577e-06	2.361e-04
1.5	3.165e+09	6.975e-02	1.206e+00	1.174e-04	2.028e-03
TOTALS:	1.634e+13	5.345e-01	5.196e+01	1.024e-03	1.011e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO2A03.MS5
Date : December 15, 1997
Run Time: 2:39:28 PM
Duration : 00:02:30

File Ref: _____
Date: 12-18-97
By: GBeh
Checked: [signature]

Case Title: DCWO2a003
Description: 50ftx4in 40 SST Calcine 100% Loading w/conc shld 1m
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	212.695 cm	762 cm	0 cm
	6 ft 11.7 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition	30.48 cm	Air	0.00122
Shield 3	76.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2A03.MS5
Run Date : December 15, 1997
Run Time: 2:39:28 PM
Duration : 00:02:30

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	0.000e+00	4.711e-26	0.000e+00	1.632e-27
0.03	9.886e+11	9.339e-105	8.294e-21	9.256e-107	8.220e-23
0.04	2.350e+11	9.392e-51	1.741e-20	4.154e-53	7.700e-23
0.05	4.483e+08	9.079e-34	3.015e-22	2.419e-36	8.031e-25
0.06	6.376e+06	9.709e-27	9.956e-23	1.929e-29	1.977e-25
0.08	1.527e+08	6.087e-18	6.813e-14	9.632e-21	1.078e-16
0.1	3.384e+09	1.337e-13	1.243e-09	2.045e-16	1.902e-12
0.15	6.743e+03	2.847e-16	1.273e-12	4.688e-19	2.096e-15
0.2	5.541e+08	6.399e-10	1.372e-06	1.129e-12	2.422e-09
0.3	1.124e+04	6.476e-13	4.470e-10	1.228e-15	8.479e-13
0.4	5.871e+07	4.259e-08	1.318e-05	8.298e-11	2.569e-08
0.5	1.784e+07	8.401e-08	1.451e-05	1.649e-10	2.848e-08
0.6	1.510e+13	3.085e-01	3.384e+01	6.021e-04	6.605e-02
0.8	3.163e+09	5.921e-04	3.384e-02	1.126e-06	6.437e-05
1.0	2.495e+09	2.387e-03	8.568e-02	4.399e-06	1.579e-04
1.5	3.165e+09	4.668e-02	8.073e-01	7.854e-05	1.358e-03
TOTALS:	1.634e+13	3.581e-01	3.477e+01	6.862e-04	6.763e-02

Page : 1
File : DCWO2B01.MS5
Date : December 15, 1997
Run Time: 2:42:01 PM
Duration : 00:02:31

File Ref:
Date: 12-18-97
By:
Checked:

Case Title: DCWO2b01
Description: 50ftx4in 40 SST Calcine 100% Loading no shld 1cm
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	6.715 cm	762 cm	0 cm
	2.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup

The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2B01.MS5
Run Date : December 15, 1997
Run Time: 2:42:01 PM
Duration : 00:02:31

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	2.905e-91	1.553e-24	1.006e-92	5.379e-26
0.03	9.886e+11	3.724e-25	2.734e-19	3.691e-27	2.710e-21
0.04	2.350e+11	1.229e-09	1.610e-07	5.437e-12	7.122e-10
0.05	4.483e+08	2.649e-06	5.357e-04	7.057e-09	1.427e-06
0.06	6.376e+06	2.458e-05	4.672e-03	4.882e-08	9.280e-06
0.08	1.527e+08	1.613e-01	1.694e+01	2.552e-04	2.680e-02
0.1	3.384e+09	3.597e+01	2.057e+03	5.503e-02	3.147e+00
0.15	6.743e+03	6.501e-04	1.366e-02	1.071e-06	2.250e-05
0.2	5.541e+08	1.298e+02	1.599e+03	2.290e-01	2.822e+00
0.3	1.124e+04	6.570e-03	4.621e-02	1.246e-05	8.765e-05
0.4	5.871e+07	5.973e+01	3.068e+02	1.164e-01	5.978e-01
0.5	1.784e+07	2.720e+01	1.132e+02	5.339e-02	2.223e-01
0.6	1.510e+13	3.168e+07	1.130e+08	6.184e+04	2.205e+05
0.8	3.163e+09	1.082e+04	3.097e+04	2.058e+01	5.890e+01
1.0	2.495e+09	1.234e+04	3.060e+04	2.275e+01	5.641e+01
1.5	3.165e+09	2.976e+04	5.904e+04	5.007e+01	9.933e+01
TOTALS:	1.634e+13	3.174e+07	1.131e+08	6.193e+04	2.207e+05

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO2b02
Description: 50ftx4in 40 SST Calcine 100% Loading no shld 1ft
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	36.195 cm	762 cm	0 cm
	1 ft 2.3 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2B02.MS5
Run Date : December 15, 1997
Run Time: 2:44:34 PM
Duration : 00:02:21

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	6.890e-57	3.255e-25	2.387e-58	1.128e-26
0.03	9.886e+11	1.032e-14	3.144e-13	1.022e-16	3.116e-15
0.04	2.350e+11	3.749e-05	2.445e-03	1.658e-07	1.081e-05
0.05	4.483e+08	5.530e-04	4.614e-02	1.473e-06	1.229e-04
0.06	6.376e+06	5.218e-04	3.677e-02	1.036e-06	7.304e-05
0.08	1.527e+08	4.874e-01	1.775e+01	7.713e-04	2.809e-02
0.1	3.384e+09	5.043e+01	1.025e+03	7.715e-02	1.568e+00
0.15	6.743e+03	4.633e-04	4.019e-03	7.629e-07	6.618e-06
0.2	5.541e+08	7.308e+01	4.183e+02	1.290e-01	7.384e-01
0.3	1.124e+04	3.015e-03	1.155e-02	5.719e-06	2.190e-05
0.4	5.871e+07	2.463e+01	7.594e+01	4.800e-02	1.480e-01
0.5	1.784e+07	1.045e+01	2.793e+01	2.050e-02	5.482e-02
0.6	1.510e+13	1.154e+07	2.780e+07	2.253e+04	5.426e+04
0.8	3.163e+09	3.656e+03	7.588e+03	6.954e+00	1.443e+01
1.0	2.495e+09	3.956e+03	7.475e+03	7.293e+00	1.378e+01
1.5	3.165e+09	8.795e+03	1.435e+04	1.480e+01	2.414e+01
TOTALS:	1.634e+13	1.156e+07	2.783e+07	2.256e+04	5.431e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO2B03.MS5
Date : December 18, 1997
Run Time: 12:12:57 PM
Duration : 00:02:07

File Ref: _____
Date: 12-18-97
By: _____
Checked: _____

Case Title: DCWO2b03
Description: 50ftx4in 40 SST Calcine 100% Loading no shld 1m
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.5e+3 cm	50 ft
Radius	5.113 cm	2.0 in

Dose Points

	X	Y	Z
# 1	105.715 cm	762 cm	0 cm
	3 ft 5.6 in	25 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.25e+05 cm³	Concrete	1.09
Shield 1	.602 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	4.5363e+002	1.6784e+013	3.6242e+003	1.3410e+008
Cs-134	2.4663e-006	9.1253e+004	1.9704e-005	7.2905e-001
Cs-137	4.7953e+002	1.7743e+013	3.8311e+003	1.4175e+008
Eu-154	2.1920e-001	8.1106e+009	1.7513e+000	6.4798e+004
Eu-155	1.3288e-002	4.9165e+008	1.0616e-001	3.9279e+003
Sb-125	7.2609e-005	2.6865e+006	5.8010e-004	2.1464e+001
Sm-151	9.7297e+000	3.6000e+011	7.7734e+001	2.8762e+006
Sr-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008
Y-90	4.3842e+002	1.6222e+013	3.5027e+003	1.2960e+008

Buildup
The material reference is : Transition

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO2B03.MS5
Run Date : December 18, 1997
Run Time: 12:12:57 PM
Duration : 00:02:07

Results

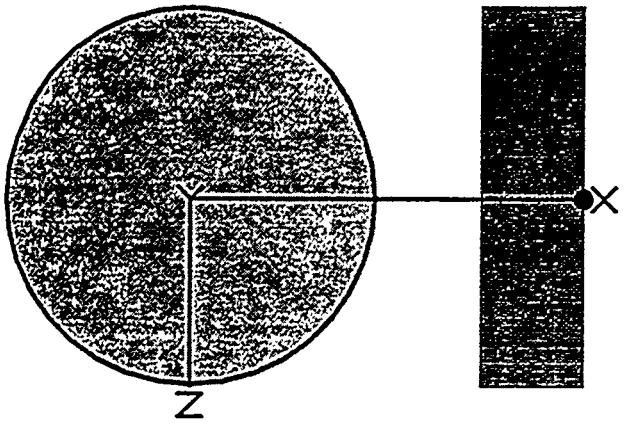
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	1.064e+08	1.566e-55	1.046e-25	5.425e-57	3.624e-27
0.03	9.886e+11	6.290e-15	1.829e-13	6.234e-17	1.812e-15
0.04	2.350e+11	1.106e-05	7.052e-04	4.891e-08	3.119e-06
0.05	4.483e+08	1.524e-04	1.287e-02	4.060e-07	3.427e-05
0.06	6.376e+06	1.510e-04	1.111e-02	2.999e-07	2.206e-05
0.08	1.527e+08	1.543e-01	5.933e+00	2.441e-04	9.389e-03
0.1	3.384e+09	1.652e+01	3.485e+02	2.527e-02	5.332e-01
0.15	6.743e+03	1.547e-04	1.369e-03	2.547e-07	2.254e-06
0.2	5.541e+08	2.451e+01	1.425e+02	4.325e-02	2.515e-01
0.3	1.124e+04	1.014e-03	3.929e-03	1.924e-06	7.453e-06
0.4	5.871e+07	8.304e+00	2.582e+01	1.618e-02	5.031e-02
0.5	1.784e+07	3.525e+00	9.492e+00	6.919e-03	1.863e-02
0.6	1.510e+13	3.899e+06	9.444e+06	7.610e+03	1.843e+04
0.8	3.163e+09	1.236e+03	2.576e+03	2.352e+00	4.900e+00
1.0	2.495e+09	1.339e+03	2.536e+03	2.468e+00	4.675e+00
1.5	3.165e+09	2.979e+03	4.862e+03	5.011e+00	8.180e+00
TOTALS:	1.634e+13	3.904e+06	9.454e+06	7.620e+03	1.845e+04

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO3D01.MS5
Date : December 16, 1997
Run Time: 7:37:16 AM
Duration : 00:01:28

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3D01
Description: Cylindrical 80 m3 tank;2 ft air;3 ft conc; 1cm
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	342.897 cm	500 cm	0 cm
	11 ft 3.0 in	16 ft 4.9 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition	91.44 cm	Air	0.00122
Shield 3	89.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3D01.MS5
Run Date : December 16, 1997
Run Time: 7:37:16 AM
Duration : 00:01:28

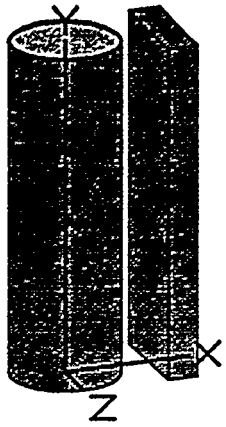
Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	0.000e+00	7.435e-24	0.000e+00	2.575e-25
0.03	6.352e+14	1.939e-128	1.527e-19	1.922e-130	1.513e-21
0.04	1.510e+14	1.820e-61	9.626e-20	8.050e-64	4.257e-22
0.05	2.880e+11	8.152e-40	6.002e-22	2.172e-42	1.599e-24
0.06	4.097e+09	1.041e-30	6.128e-23	2.068e-33	1.217e-25
0.08	9.809e+10	3.330e-20	3.142e-18	5.270e-23	4.972e-21
0.1	2.174e+12	3.421e-15	7.416e-13	5.234e-18	1.135e-15
0.15	4.332e+06	3.198e-17	1.362e-14	5.266e-20	2.243e-17
0.2	3.560e+11	1.388e-10	6.631e-08	2.449e-13	1.170e-10
0.3	7.220e+06	2.996e-13	1.002e-10	5.684e-16	1.902e-13
0.4	3.772e+10	3.228e-08	6.839e-06	6.289e-11	1.333e-08
0.5	1.146e+10	9.218e-08	1.313e-05	1.809e-10	2.578e-08
0.6	9.704e+15	4.546e-01	4.612e+01	8.874e-04	9.003e-02
0.8	2.032e+12	1.376e-03	8.183e-02	2.618e-06	1.557e-04
1.0	1.603e+12	7.832e-03	3.107e-01	1.444e-05	5.728e-04
1.5	2.033e+12	2.792e-01	5.666e+00	4.698e-04	9.533e-03
TOTALS:	1.050e+16	7.431e-01	5.218e+01	1.374e-03	1.003e-01

Page : 1
File : DCWO3D02.MS5
Date : December 16, 1997
Run Time: 2:24:31 PM
Duration : 00:01:19

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3D02
Description: Cylindrical 80 m3 tank;2 ft air;3 ft conc; 1ft
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	372.397 cm	500 cm	0 cm
	12 ft 2.6 in	16 ft 4.9 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition	91.44 cm	Air	0.00122
Shield 3	89.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3D02.MS5
Run Date : December 16, 1997
Run Time : 2:24:31 PM
Duration : 00:01:19

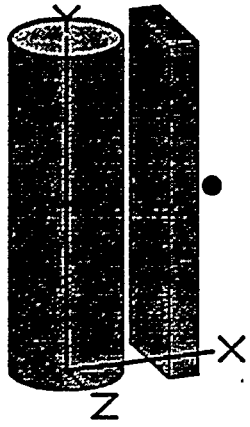
Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	0.000e+00	6.531e-24	0.000e+00	2.262e-25
0.03	6.352e+14	1.745e-128	1.341e-19	1.729e-130	1.329e-21
0.04	1.510e+14	1.739e-61	8.456e-20	7.693e-64	3.740e-22
0.05	2.880e+11	7.870e-40	5.272e-22	2.096e-42	1.404e-24
0.06	4.097e+09	9.984e-31	5.383e-23	1.983e-33	1.069e-25
0.08	9.809e+10	3.195e-20	3.014e-18	5.056e-23	4.770e-21
0.1	2.174e+12	3.297e-15	7.147e-13	5.044e-18	1.093e-15
0.15	4.332e+06	3.099e-17	1.320e-14	5.103e-20	2.173e-17
0.2	3.560e+11	1.347e-10	6.431e-08	2.377e-13	1.135e-10
0.3	7.220e+06	2.907e-13	9.714e-11	5.514e-16	1.843e-13
0.4	3.772e+10	3.128e-08	6.617e-06	6.094e-11	1.289e-08
0.5	1.146e+10	8.920e-08	1.269e-05	1.751e-10	2.490e-08
0.6	9.704e+15	4.393e-01	4.449e+01	8.576e-04	8.685e-02
0.8	2.032e+12	1.327e-03	7.873e-02	2.523e-06	1.498e-04
1.0	1.603e+12	7.534e-03	2.983e-01	1.389e-05	5.498e-04
1.5	2.033e+12	2.674e-01	5.413e+00	4.499e-04	9.107e-03
TOTALS:	1.050e+16	7.156e-01	5.028e+01	1.324e-03	9.665e-02

Page : 1
File : DCWO3D03.MS5
Run Date : December 16, 1997
Run Time: 2:16:41 PM
Duration : 00:01:18

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3D03
Description: Cylindrical 80 m3 tank;2 ft air;3 ft conc; 1m
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	441.897 cm	500 cm	0 cm
	14 ft 6.0 in	16 ft 4.9 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition	91.44 cm	Air	0.00122
Shield 3	89.5 cm	Concrete	2.35
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Shield 3

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3D03.MS5
Run Date : December 16, 1997
Run Time: 2:16:41 PM
Duration : 00:01:18

Results

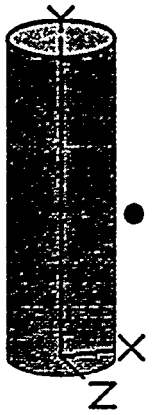
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	0.000e+00	4.959e-24	0.000e+00	1.718e-25
0.03	6.352e+14	1.491e-128	1.018e-19	1.477e-130	1.009e-21
0.04	1.510e+14	1.577e-61	6.421e-20	6.973e-64	2.840e-22
0.05	2.880e+11	7.034e-40	4.004e-22	1.874e-42	1.067e-24
0.06	4.097e+09	8.927e-31	4.088e-23	1.773e-33	8.119e-26
0.08	9.809e+10	2.897e-20	2.733e-18	4.584e-23	4.325e-21
0.1	2.174e+12	3.017e-15	6.539e-13	4.616e-18	1.000e-15
0.15	4.332e+06	2.861e-17	1.217e-14	4.712e-20	2.004e-17
0.2	3.560e+11	1.245e-10	5.935e-08	2.198e-13	1.047e-10
0.3	7.220e+06	2.683e-13	8.940e-11	5.090e-16	1.696e-13
0.4	3.772e+10	2.878e-08	6.069e-06	5.608e-11	1.182e-08
0.5	1.146e+10	8.183e-08	1.160e-05	1.606e-10	2.276e-08
0.6	9.704e+15	4.019e-01	4.055e+01	7.844e-04	7.914e-02
0.8	2.032e+12	1.207e-03	7.136e-02	2.296e-06	1.357e-04
1.0	1.603e+12	6.826e-03	2.691e-01	1.258e-05	4.961e-04
1.5	2.033e+12	2.401e-01	4.841e+00	4.040e-04	8.145e-03
TOTALS:	1.050e+16	6.500e-01	4.573e+01	1.203e-03	8.792e-02

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO3C01.MS5
Run Date : December 16, 1997
Run Time: 8:30:13 AM
Duration : 00:01:12

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3c01
Description: Cylindrical est of 80 m3 tank: 1cm
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	161.952 cm	500 cm	190.5 cm
	5 ft 3.8 in	16 ft 4.9 in	6 ft 3.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition		Air	0.00122 ←
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3C01.MS5
Run Date : December 16, 1997
Run Time: 8:30:13 AM
Duration : 00:01:12

Results

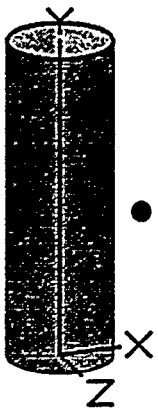
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	2.492e-84	3.651e-23	8.633e-86	1.265e-24
0.03	6.352e+14	3.729e-23	6.428e-18	3.696e-25	6.371e-20
0.04	1.510e+14	1.042e-08	1.164e-06	4.607e-11	5.148e-09
0.05	2.880e+11	1.029e-05	1.642e-03	2.740e-08	4.373e-06
0.06	4.097e+09	6.919e-05	1.004e-02	1.374e-07	1.994e-05
0.08	9.809e+10	3.724e-01	3.031e+01	5.892e-04	4.797e-02
0.1	2.174e+12	7.829e+01	3.630e+03	1.198e-01	5.553e+00
0.15	4.332e+06	1.323e-03	2.608e-02	2.179e-06	4.294e-05
0.2	3.560e+11	2.569e+02	3.305e+03	4.535e-01	5.833e+00
0.3	7.220e+06	1.285e-02	1.054e-01	2.437e-05	2.000e-04
0.4	3.772e+10	1.178e+02	7.444e+02	2.295e-01	1.450e+00
0.5	1.146e+10	5.450e+01	2.882e+02	1.070e-01	5.657e-01
0.6	9.704e+15	6.475e+07	2.990e+08	1.264e+05	5.836e+05
0.8	2.032e+12	2.309e+04	8.780e+04	4.392e+01	1.670e+02
1.0	1.603e+12	2.753e+04	9.162e+04	5.074e+01	1.689e+02
1.5	2.033e+12	7.360e+04	1.984e+05	1.238e+02	3.338e+02
TOTALS:	1.050e+16	6.487e+07	2.994e+08	1.266e+05	5.843e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO3C02.MS5
Date : December 16, 1997
Run Time: 8:31:26 AM
Duration : 00:01:14

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3c02
Description: Cylindrical est of 80 m3 tank: 1ft
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	191.4325 cm	500 cm	190.5 cm
	6 ft 3.4 in	16 ft 4.9 in	6 ft 3.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition		Air	0.00122 ←
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3C02.MS5
Run Date : December 16, 1997
Run Time: 8:31:26 AM
Duration : 00:01:14

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	7.374e-87	3.247e-23	2.554e-88	1.125e-24
0.03	6.352e+14	5.071e-24	5.716e-18	5.025e-26	5.665e-20
0.04	1.510e+14	4.661e-09	5.480e-07	2.061e-11	2.424e-09
0.05	2.880e+11	7.301e-06	1.237e-03	1.945e-08	3.295e-06
0.06	4.097e+09	5.877e-05	8.890e-03	1.167e-07	1.766e-05
0.08	9.809e+10	3.396e-01	2.782e+01	5.374e-04	4.403e-02
0.1	2.174e+12	7.167e+01	3.328e+03	1.096e-01	5.092e+00
0.15	4.332e+06	1.211e-03	2.388e-02	1.994e-06	3.932e-05
0.2	3.560e+11	2.351e+02	3.022e+03	4.149e-01	5.334e+00
0.3	7.220e+06	1.175e-02	9.624e-02	2.229e-05	1.826e-04
0.4	3.772e+10	1.077e+02	6.792e+02	2.098e-01	1.323e+00
0.5	1.146e+10	4.982e+01	2.629e+02	9.778e-02	5.160e-01
0.6	9.704e+15	5.916e+07	2.726e+08	1.155e+05	5.321e+05
0.8	2.032e+12	2.109e+04	8.002e+04	4.012e+01	1.522e+02
1.0	1.603e+12	2.513e+04	8.347e+04	4.632e+01	1.539e+02
1.5	2.033e+12	6.714e+04	1.806e+05	1.130e+02	3.039e+02
TOTALS:	1.050e+16	5.928e+07	2.730e+08	1.157e+05	5.327e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO3C03.MS5
Date : December 16, 1997
Run Time: 8:32:41 AM
Duration : 00:01:13

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO3c03
Description: Cylindrical est of 80 m3 tank: 1m
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	1.0e+3 cm	32 ft 9.7 in
Radius	160.0 cm	5 ft 3.0 in

Dose Points

	X	Y	Z
# 1	260.9525 cm	500 cm	190.5 cm
	8 ft 6.7 in	16 ft 4.9 in	6 ft 3.0 in

Shields

Shield Name	Dimension	Material	Density
Source	8.04e+07 cm³	Concrete	1.09
Shield 1	.953 cm	Iron	7.86
Transition		Air	0.00122
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/cm³	Bq/cm³
Ba-137m	2.9148e+005	1.0785e+016	3.6242e+003	1.3410e+008
Cs-134	1.5847e-003	5.8634e+007	1.9704e-005	7.2905e-001
Cs-137	3.0812e+005	1.1400e+016	3.8311e+003	1.4175e+008
Eu-154	1.4085e+002	5.2114e+012	1.7513e+000	6.4798e+004
Eu-155	8.5379e+000	3.1590e+011	1.0616e-001	3.9279e+003
Sb-125	4.6654e-002	1.7262e+009	5.8010e-004	2.1464e+001
Sm-151	6.2517e+003	2.3131e+014	7.7734e+001	2.8762e+006
Sr-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008
Y-90	2.8170e+005	1.0423e+016	3.5027e+003	1.2960e+008

Buildup
The material reference is : Air Gap

Integration Parameters

Radial	23
Circumferential	23
Y Direction (axial)	20

DOS File : DCWO3C03.MS5
Run Date : December 16, 1997
Run Time: 8:32:41 AM
Duration : 00:01:13

Results

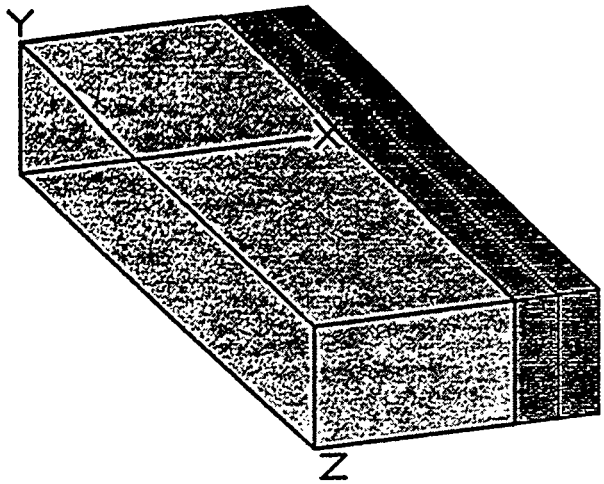
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.02	6.840e+10	1.007e-84	2.467e-23	3.490e-86	8.546e-25
0.03	6.352e+14	1.732e-23	4.343e-18	1.717e-25	4.305e-20
0.04	1.510e+14	5.390e-09	6.077e-07	2.384e-11	2.688e-09
0.05	2.880e+11	6.224e-06	1.034e-03	1.658e-08	2.753e-06
0.06	4.097e+09	4.800e-05	7.267e-03	9.534e-08	1.443e-05
0.08	9.809e+10	2.783e-01	2.288e+01	4.404e-04	3.620e-02
0.1	2.174e+12	5.868e+01	2.729e+03	8.977e-02	4.176e+00
0.15	4.332e+06	9.888e-04	1.949e-02	1.628e-06	3.210e-05
0.2	3.560e+11	1.917e+02	2.456e+03	3.383e-01	4.335e+00
0.3	7.220e+06	9.565e-03	7.789e-02	1.814e-05	1.478e-04
0.4	3.772e+10	8.754e+01	5.486e+02	1.706e-01	1.069e+00
0.5	1.146e+10	4.046e+01	2.121e+02	7.943e-02	4.163e-01
0.6	9.704e+15	4.802e+07	2.197e+08	9.373e+04	4.289e+05
0.8	2.032e+12	1.709e+04	6.441e+04	3.251e+01	1.225e+02
1.0	1.603e+12	2.034e+04	6.711e+04	3.749e+01	1.237e+02
1.5	2.033e+12	5.421e+04	1.449e+05	9.121e+01	2.439e+02
TOTALS:	1.050e+16	4.811e+07	2.200e+08	9.389e+04	4.294e+05

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO4B01.MS5
Run Date : December 16, 1997
Run Time: 8:52:21 AM
Duration : 00:00:22

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO4b01
Description: 18 Canisters, 2 Rows of 9, 4 ft apart, 3 ft fm Wall, 1cm
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	426.72 cm	14 ft 0.0 in
Width	1.7e+3 cm	56 ft 0.0 in
Height	262.89 cm	8 ft 7.5 in

Dose Points

	X	Y	Z
# 1	607.66 cm	131.45 cm	853.44 cm
	19 ft 11.2 in	4 ft 3.8 in	28 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.91e+08 cm³	Mixed ->	0.150059
		Concrete	0.11518
		Iron	0.034879
Shield 1	91.44 cm	Air	0.00122
Shield 2	88.5 cm	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	2.5746e+004	9.5261e+014	1.3446e+002	4.9750e+006
Cs-137	2.7216e+004	1.0070e+015	1.4214e+002	5.2590e+006

Buildup
The material reference is : Shield 2

Integration Parameters

X Direction	23
Y Direction	23
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
.0318	1.972e+13	6.361e-88	3.617e-21	5.299e-90	3.012e-23
0.0322	3.639e+13	5.156e-85	6.934e-21	4.149e-87	5.580e-23

DOS File : DCWO4B01.MS5
Run Date : December 16, 1997
Run Time: 8:52:21 AM
Duration : 00:00:22

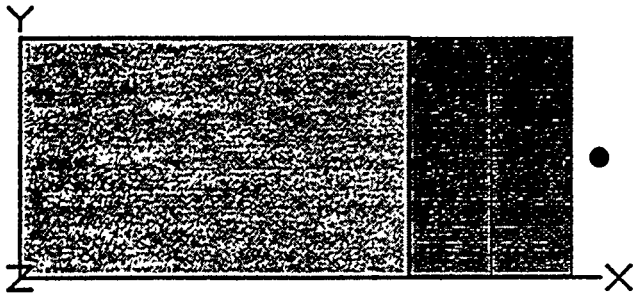
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0364	1.324e+13	8.469e-63	3.864e-21	4.812e-65	2.195e-23
0.6616	8.572e+14	7.079e-01	5.518e+01	1.372e-03	1.070e-01
TOTALS:	9.265e+14	7.079e-01	5.518e+01	1.372e-03	1.070e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO4B02.MS5
Run Date : December 16, 1997
Run Time: 8:47:36 AM
Duration : 00:00:21

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO4b02
Description: 18 Canisters, 2 Rows of 9, 4 ft apart, 3 ft fm Wall, 1ft
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	426.72 cm	14 ft 0.0 in
Width	1.7e+3 cm	56 ft 0.0 in
Height	262.89 cm	8 ft 7.5 in

Dose Points

	X	Y	Z
# 1	637.14 cm	131.45 cm	853.44 cm
	20 ft 10.8 in	4 ft 3.8 in	28 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.91e+08 cm³	Mixed ->	0.150059
		Concrete	0.11518
		Iron	0.034879
Shield 1	91.44 cm	Air	0.00122
Shield 2	88.5 cm	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	2.5746e+004	9.5261e+014	1.3446e+002	4.9750e+006
Cs-137	2.7216e+004	1.0070e+015	1.4214e+002	5.2590e+006

Buildup
The material reference is : Shield 2

Integration Parameters

X Direction	23
Y Direction	23
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
.0318	1.972e+13	5.988e-88	3.239e-21	4.988e-90	2.698e-23
0.0322	3.639e+13	4.842e-85	6.210e-21	3.897e-87	4.998e-23

DOS File : DCWO4B02.MS5
Run Date : December 16, 1997
Run Time: 8:47:36 AM
Duration : 00:00:21

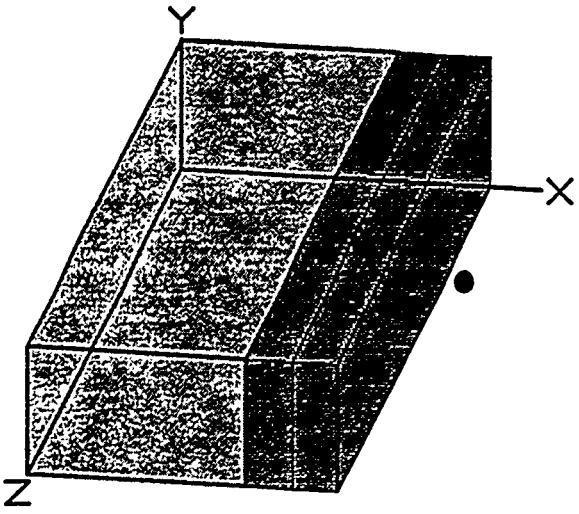
Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0364	1.324e+13	7.845e-63	3.461e-21	4.457e-65	1.966e-23
0.6616	8.572e+14	6.904e-01	5.363e+01	1.339e-03	1.040e-01
TOTALS:	9.265e+14	6.904e-01	5.363e+01	1.339e-03	1.040e-01

MicroShield v5.01 (5.01-00121)
Lockheed Martin Idaho Technologies Company

Page : 1
File : DCWO4B03.MS5
Date : December 16, 1997
Run Time: 8:56:31 AM
Duration : 00:00:21

File Ref: _____
Date: 12-18-97
By: [signature]
Checked: [signature]

Case Title: DCWO4b03
Description: 18 Canisters, 2 Rows of 9, 4 ft apart, 3 ft fm Wall, 1m
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	426.72 cm	14 ft 0.0 in
Width	1.7e+3 cm	56 ft 0.0 in
Height	262.89 cm	8 ft 7.5 in

Dose Points

	X	Y	Z
# 1	706.66 cm	131.45 cm	853.44 cm
	23 ft 2.2 in	4 ft 3.8 in	28 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.91e+08 cm³	Mixed ->	0.150059
		Concrete	0.11518
		Iron	0.034879
Shield 1	91.44 cm	Air	0.00122
Shield 2	88.5 cm	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Ba-137m	2.5746e+004	9.5261e+014	1.3446e+002	4.9750e+006
Cs-137	2.7216e+004	1.0070e+015	1.4214e+002	5.2590e+006

Buildup
The material reference is : Shield 2

Integration Parameters

X Direction	23
Y Direction	23
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
.0318	1.972e+13	5.150e-88	2.566e-21	4.290e-90	2.138e-23
0.0322	3.639e+13	4.169e-85	4.921e-21	3.355e-87	3.960e-23

DOS File : DCWO4B03.MS5
Run Date : December 16, 1997
Run Time: 8:56:31 AM
Duration : 00:00:21

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0364	1.324e+13	6.988e-63	2.742e-21	3.970e-65	1.558e-23
0.6616	8.572e+14	6.402e-01	4.935e+01	1.241e-03	9.568e-02
TOTALS:	9.265e+14	6.402e-01	4.935e+01	1.241e-03	9.568e-02

EDF Serial Number CPP-97083
EDF-HWO-006
Functional File Number 4000-14
SPR-01

ENGINEERING DESIGN FILE

Radiological Evaluation for the Calcine Hot Isostatic Press (HIP) Feasibility Study

By
B. J. Schrader

November 26, 1997

EDF Serial Number CPP-97083
Functional File Number 4000-14

ENGINEERING DESIGN FILE

Radiological Evaluation For the Calcine Hot Isostatic Press (HIP) Feasibility Study

By

B.J. Schrader

November 26, 1997

ENGINEERING DESIGN FILE

Project File Number N/A

Project/Task N/A

Subtask N/A

Title: **Radiological Evaluation for the Calcine Hot Isostatic Press (HIP) Feasiblity Study**

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

This EDF evaluates and documents the radiological requirements for the feasibility of the Hot Isostatic Press (HIP) option for immobilization of the calcine. Areas of discussion in this evaluation are as follows:

1) Applicable codes and Standards

2) Radiological Monitoring Equipment

3) Hot Cell Manned Entry Requirements

4) Breathing Air Requirements

5) Radiological Risk Evaluation of Process

The discussion of each of the listed topics includes references to mandatory and non-mandatory requirements. The basis for this evaluation is the Department of Energy (DOE) would operate the facility under all currently applicable constraints and requirements. No attempt was made to evaluate the probability of changing requirements.

Distribution (complete package): N.E. Russell MS- 3765 G. W. Clarke MS-4145
B.J. Schrader MS-5209 File

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
B.J. Schrader	Radiological Support	N.E. Russell	12/01/97		12/1/97
		LMITCO Review	Date	LMITCO Approval	Date

See Management Control Procedure (MCP) 6 for instructions on use of this form.

SUMMARY

The Hot Isostatic Press (HIP) option of the Calcine Immobilization Program evaluates the feasibility of using the process to convert calcine into an acceptable glass-ceramic waste form suitable for terminal storage in a federal geologic repository. The fact that the calcine is highly radioactive requires that a radiological evaluation of the process and flow paths is performed to ensure that the process can be performed safely and maintain personnel exposure As Low As Reasonably Achievable (ALARA).

This EDF evaluates and documents the radiological requirements for the feasibility of the Hot Isostatic Press (HIP) option for immobilization of the calcine. Areas of discussion in this evaluation are as follows:

1) Applicable codes and Standards

2) Radiological Monitoring Equipment

3) Hot Cell Manned Entry Requirements

4) Breathing Air Requirements

5) Radiological Risk Evaluation of Process

The discussion of each of the listed topics includes references to mandatory and non-mandatory requirements. The basis for this evaluation is the Department of Energy (DOE) would operate the facility under all currently applicable constraints and requirements. No attempt was made to evaluate the probability of changing requirements.

The evaluation and recommendations of this EDF are based on existing technology and proven techniques and methods for handling highly radioactive material. The lessons learned from the NWCF Calciner, GSF canning station and the FSA fuel handling areas were evaluated for inclusion in this document.

This EDF does not include an evaluation of how the calcine will be removed from the Bin sets and moved into the facility. The process evaluation starts with the addition of the mixing agent with the calcine.

Key Assumptions

The assumptions made during the development of this EDF are included below. These assumptions will require verification during follow-on design efforts. In some cases, the assumptions may have a strong bearing on the direction of the design; in other cases, the assumptions simply identify important issues that need to be addressed as the design progresses.

- The calcine will be processed in a facility that will be operated under the requirements and oversight of the Department of Energy. All applicable regulations and standards for the Department of Energy will be enforced.

- The mixing agent used in the process will be non-radiological or of such low level activity that shielding will not be required.

- Exposures to personnel both on and off-site will be maintained within the codified requirements of 10CFR20 and 10CFR835.

- The exhaust system will be monitored in accordance with ANSI-N42.17B-1989 to ensure and validate regulatory compliance with emission requirements.

- ANSI/ANS 57.8-1992 is the primary design document for configuring the HVAC systems and identifying contamination control zones. The DOE-ID Architect-Engineer (A-E) Standard was used for guidance when specific direction was not provided in ANSI/ANS 57.8.

- Siting of the facility will ensure that adequate utilities and process systems are available. Siting will also include an evaluation on methods of movement of the calcine from the bin sets to the facility that maintains exposures ALARA.

CODES and STANDARDS

Code/Standard	TITLE
10 CFR 20	Standards for Protection Against Radiation
10 CFR 71	Packaging and Transportation of Radioactive Material
10 CFR 830	Nuclear Safety Management
10 CFR 835	Occupational Radiation Protection
29 CFR 1910	Occupational Safety and Health Standards for General Industry
29 CFR 1926	Occupational Safety and Health Standards for Construction
40 CFR 53	Ambient Air Monitoring Reference and Equivalent Methods
40 CFR 58	Ambient Air Quality Surveillance
49 CFR 173 Sub Part I	Shippers – General Requirements for Shipments and Packages of Radioactive Materials
ANSI/ASME N510-1989	Testing of Nuclear Air-Cleaning Systems
ANSI/ASME NQA-1-1989	Quality Assurance Program
ANSI/NFPA 801-1995	Facilities Handling Radioactive Materials
ANSI N13.1-1969	Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities
ANSI N42.17B-1989	Performance Specifications for Health Physics Instrumentation Occupational Airborne Radioactivity Monitoring Instrumentation
ANSI/ANS 57.8-1992	HEPA Systems
DOE-ID A-E Manual	Architectural – Engineering Manual
INEL RadCon Manual	Radiological Control Manual for the INEEL

The table listed above is a brief summary of the requirements and documents that are the basis for the design. It is also assumed that the applicable DOE orders will be implemented. Currently DOE is phasing out the order system in favor of codifying the requirements. Therefore no effort was made to determine the applicable orders and estimate if they will be changed over to CFR status. Let it be sufficient that at the time of title design a document search of the remaining DOE orders should be performed.

Radiological Monitoring Equipment

The following is a list of the radiation monitoring equipment that would be required under the configuration as it exists on 11/20/97. Any deviation from this configuration would require evaluation/modification of this list. Most of the instruments listed must be capable of transmitting data to a microprocessor-based system for display, recording, alarm and trending. The instruments will also be connected to the Radiation, Environmental and Safety (RE&S) computer system for remote monitoring. The RE&S interface is available at several locations in the plant and is available in the utility tunnel.

Instrument Type	Radiation Area Monitor	Constant Air Monitor	Stack Monitor	Liquid Effluent Monitor	Personnel Contamination Monitor
Location					
Can Loading Bay		X			X
Control Room	X	X			X
Calcine Storage Room	X				
HVAC	X On Filter Banks	X	X		X
Main Floor Control Area	X 4 for each Train	X 4 for each Level		X All drains	X At all exit points from the facility.
Transfer Tunnel	X	X		X	
Electrical Room		X			X
Change Rooms		X			X
Outer Offices					X Hand Held
Elevator					X At exit Points

Hot Cell Manned Entry Requirements

The Hot cell manned entry requirements will change if the methods of processing or the configuration changes.

Although the facility will be designed for the maximum remote operation and maintenance, the cells will require manned entry to perform non-periodic maintenance. The facility as referred to here is the process train area. The entry requirements for the facility are as follows:

- The facility shall be equipped with a breathing air system compliant with the applicable sections of 29CFR1910.
- The facility entrance will need to have a change out area that can isolate the operating area from the hot cells. This change out area should be air locked from the hot cells as a minimum with Zoned ventilation as defined in ANSI/ANS 57.8-1992.
- The cells shall be isolated from the access corridor by means of a door as a minimum. It is not necessary to airlock the cell entryways.
- The access corridor shall be wide enough to allow unencumbered access and egress. In addition, it is required that an outer pair of anti-contamination clothing be removed at the exit from the cell. The access corridor must be wide enough to allow an anti-c doffing station.
- An area large enough to store contaminated tools and equipment should be available inside of the contamination area.
- The access corridor will be maintained as a Contamination Area (CA) and Radiation Area (RA) in accordance with the requirements of 10CFR835. The cells will be controlled as High Contamination Areas (HCAs) and High Radiation Areas (HRAs) also in accordance with the requirements of 10CFR835.
- The cells must be capable of remote decon operations in addition to the requirements for manned entry decon. The cells shall have RCRA compliant drains and supporting systems.
- Fire suppression systems and alarms compliant with applicable codes and standards shall be available.
- The access corridor will need to be shielded from the cells. The shielding does not need to be as thick as the exterior walls.

Breathing Air Requirements

Compressed air used for respiration shall comply with the quality requirements contained in 29CFR1910 Part 134(d). Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in the Compressed Gas Association Commodity Specification G-7.1-1966.

The Breathing Air supply that will provide air for airline respirators is contained in 29CFR1910 Part 134. The system should supply air to a minimum of two OSHA compliant manifolds capable of supporting 6 airlines. One system per train would be required. The system will need to be provided with backup compressed gas cylinder air. The standby air shall comply with 29CFR1910(d)(2)(ii). Alarms to indicate compressor failure and overheating would be required.

The breathing air system will need to be capable of supporting personnel in an atmosphere as defined by OSHA - Immediately Dangerous to Life or Health (ILDH).

Although not all cells in the facility will need the requirement for ILDH supply air, some of them will.

Radiological Risk Evaluation of Process

The process has several parts that could increase the risk of radiological exposure and should be further evaluated in the design process.

- The ventilation system must be adequate to contain the radiological contaminants. The Hot cell area must be controlled as a process contamination area. Supply air ducting and exhaust ducting will be routed to and from the cells. These cell penetrations are a potential source of radiation streaming. The design must include a shielding evaluation.

- The utility support penetrations into the cells are a potential source of radiation exposure outside the cells and into the operating corridors.

- The Transfer tunnel could potentially be a source of very high exposure if maintenance is required while calcine is stuck in the tunnel. Consideration should be given to a method of remotely removing cans stuck in transit.

- The insertion of calcine into the process cell will be a weak point in the process. Calcine in notorious for solidifying in lines. Lessons learned in the process development of transferring the calcine to the bin sets from the calciner should be considered in further development of this option.

- Containment of the contaminants within the cell will be difficult. Spread of radiological contamination must be minimized through the use of ventilation and air locks.

Summary

The evaluation and recommendations of this EDF are based on existing technology and proven techniques and methods for handling highly radioactive material. The lessons learned from the NWCF Calciner, GSF canning station and the FSA fuel handling areas were evaluated for inclusion in this document. The process and facilities as currently defined provide a strong measure of radiological control and will maintain personnel exposures ALARA. Further studies should consider the recommendations and concerns as defined in this EDF.

FORM INEL-2631

Project File Number 02BG0
EDF Serial Number EDF-HWO-011
Functional File Number SPR-09
Date 3 December 1997

ENGINEERING DESIGN FILE

Project/Task:
Subtask: HIP Waste Option

Title: Recycle Sizing Cell

Abstract In the Hot Isostatic Press (HIP) waste processing there will be a small portion of the HIPed cans which will be recycled into the process due to Quality Assurance destructive examination of a representative portion of the cans or failure of the cans to meet output specifications. The HIPed material in these cans will need to be reduced to a granular size which can be placed back into the HIP process stream. This EDF documents a sizing operation which can be performed in a small cell. Included is a step by step process, an equipment list and a sketch of the equipment layout.

Distribution:

Author	Dept.	Reviewed / Date	Approved / Date
Ted R. Reed	4130	T.E. Rinell 2/2/98	T.E. Rinell 2/2/98

This EDF discusses a method to reduce the HIPed monoliths of reject and QA cans to a granular form which can be fed back into the process and re-HIPed. The object of this method is to use equipment which is small and thus fit into the available space.

Step 1 Reject HIP can is received into the cell through a double door port. Transfer in the cell will be by means of an overhead crane.

Step 2 Wafers are sliced off the can using a large concrete saw. This saw assembly will have a 36 inch diameter concrete saw which is capable of two axis motion to properly position the blade on the HIP can. The can will be mounted on a rotary table which can be turned by an out-cell mounted manual turn wheel or electric motor. Dust and particle debris will be collected in a vacuum dust collection system connected to a lexan dust hood which will enclose the cutting operation.

Step 3 Wafers are lifted from the concrete saw to the screw press. An electromechanical manipulator using an 'ice tong' type of tool will lift the approximately 4 inch thick wafers from the saw to the screw press. The top of the press will swing out of the way to allow top placement of the wafer into the press.

Step 4 Wafers are crushed in the screw press. The 250 ton press will crush the wafers into approximately 4 inch chunks. The press uses a curved surface die to assure that the wafer sections will be placed in a bending mode which will allow the wafer sections to fail in tension, the weakest failure mode for these types of materials. The can material will be placed in a separate hopper for disposal. A 5 hp motor will power the press and can be mounted outside the cell. A screw press is used to preclude hydraulic fluid leaks in the cell.

Step 5 Wafer sections are moved from the screw press to the jaw crusher using master slave manipulators, electromechanical manipulators and the vacuum system.

Step 6 The jaw crusher will reduce the 4 inch pieces to approximately 1/16 in granules. The 5 horsepower crusher has a rated capacity of 1800 lb/hr. Discharge from the crusher will fall directly into a granule/dust hopper which will also receive dust from the dust collection system.

Step 7 The HIPed calcine dust and granules will be pneumatically transferred to the fill station for re-entry into the HIP process.

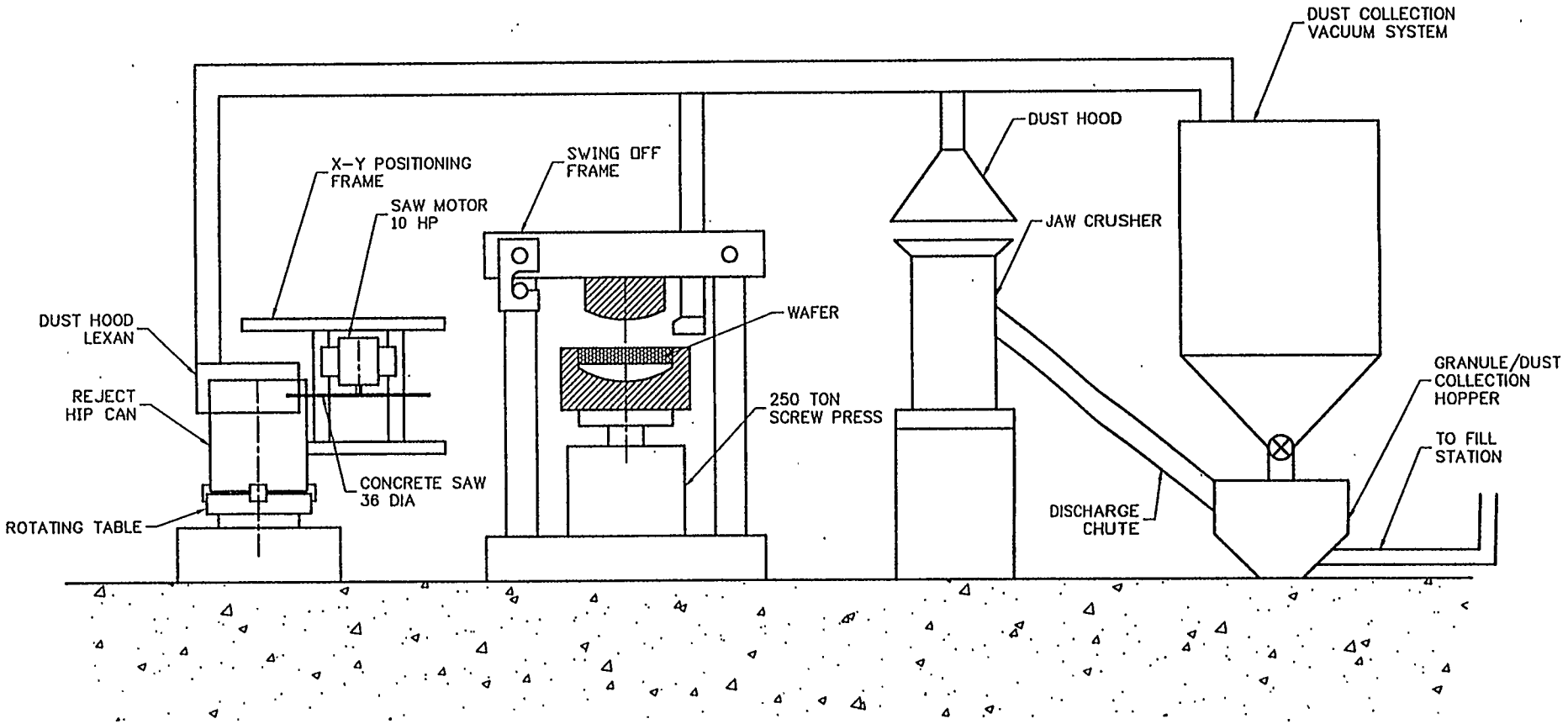
Step 8 The can material will be compacted in the screw press and bagged out of the cell.

Assumptions

1) Maximum rate of handling will be 1 reject HIP can per week per recycle cell.
2) Alpha contamination will not be a big problem.
3) 1/16 inch granule size can be handled by the main HIP process system.
4) Stainless steel skin on cans can be broken away from the HIPed calcine.
5) Grinding the HIPed calcine will be inherently dusty. Manned entry into the cell will require considerable cell clean-up.

Equipment List

1) Overhead Crane, 2 Ton
2) Electromechanical Manipulator, 500 lb lift capacity
3) Manipulator, master/slave, 2 each
4) Concrete saw, 36 in diameter, 10 hp, mounted on x-y table, custom designed
5) 250 ton screw press, 5 hp, custom designed
6) Jaw crusher, 5 hp
7) Dust collection system, custom designed
8) Pneumatic transfer system, custom designed
9) Wafer handling tool
10) Rotating positioning table



RECYCLE CELL EQUIPMENT SKETCH

Project File Number 02BD7

Project/Task Waste Treatment Facility Study

Subtask Retrieve calcine from CSSFs and deliver it to the Waste Treatment Facility

Title: Calcine Retrieval and Transportation

Summary:

A calcine retrieval and transportation system is presented to retrieve calcine from the CSSFs and transport it to the Waste Treatment Facility. The calcine retrieval and transportation system is designed to supply calcine to the treatment options currently understudy {Cementitious Waste Option (CWO), Direct Cementitious Waste Option (DCWO), Hot Isostatic Press (HIP) Waste Option (HWO), Vitrification Waste Option (VWO), and TRU Separations options). The system is divided into three subsystems: CSSF access method, calcine retrieval system, and calcine transportation system. During CSSF access, the buildings, equipment, and piping are removed from the superstructure of each CSSF. Retrieval risers are installed and accessed. The CSSFs are prepared for calcine retrieval. The calcine retrieval system presents a viable method to retrieve calcine from the CSSFs. The system relies on an air jet and a suction nozzle. The calcine transportation system is a pneumatic system similar to one currently used at the ICPP for transportation of calcine. A process data sheet and cost estimate were developed for the calcine retrieval and transportation system.

Three cost estimates are presented to meet the needs of each waste treatment option. Each waste treatment option requires the same access activities for the seven CSSFs. The retrieval method is the same for each waste treatment option. The locations of the waste treatment facilities developed by each option necessitates variations in the transport system. The length of the transport system is the basic difference between the transport systems. The cost estimate includes costs associated with removing corrosion coupons prior to retrieving the calcine and installing D&D risers after retrieval activities are complete.

The first cost estimate was developed to meet the 5-year operating schedule of the Cementitious Waste Option (CWO). This system delivers calcine from the CSSFs to an NWCF addition. A second estimate was developed to deliver calcine to the TRU Separations options' calcine dissolution facility. A third cost estimate for the calcine retrieval and transportation system is presented for the DCWO, HWO, and VWO options which require an intermediate transport station (ITS) to deliver the calcine to the Waste Treatment Facility.

The CWO option has a five year operating period that begins 1/1/2013. The total unescalated cost for the calcine retrieval and transportation system is $176,566,000. The total cost including escalation, management reserve, and contingency is $348,880,000. The discounted annual cost is $166,409,000.

The TRU-Separations Options have twenty year operating periods that begin 1/1/2013. The total unescalated cost for the calcine retrieval and transportation system is $237,389,000. The total

Project File Number 02BD7

cost including escalation, management reserve, and contingency is $531,023,000. The discounted annual cost is $192,309,000.

The DCWO, HWO, and VWO options have twenty year operating periods that begin 1/1/2013. The total unescalated cost for the calcine retrieval and transportation system is $243,039,000. The total cost including escalation, management reserve, and contingency is $543,371,000. The discounted annual cost is $196,878,000.

The scope of this study was limited to the Fluor-Daniels feasibility design. The purpose was to compare this system directly to the Fluor-Daniels system. However, two issues that warranted further review and inclusion in the cost estimate were identified. Separate cost estimates were developed for the removal of corrosion coupons from the bins and installation of D&D risers.

Distribution (complete package): A complete copy of this EDF will be included in the following reports:

R. E. Dafoe, *Direct Cementitious Waste Option Study Report,* INEEL/EXT-97-01399, February 1998.

W. H. Landman, *TRU Separations Options Study Report,* INEEL/EXT-97-01428, February 1998.

A. E. Lee, *Cementitious Waste Option Preliminary Study Report,*INEEL/EXT-97-01400, February 1998.

D. A. Lopez, *Vitrified Waste Option Study Report,* INEEL/EXT-97-01389, February 1998.

N. E. Russell, *Hot Isostatic Press (HIP) Waste Option Study Report,*INEEL/EXT-97-01392, February 1998.

Distribution (summary package only):

Author	Dept.	Reviewed	Date	Approved	Date
S.E. Gifford Sara E. Gifford 2/3/98	M C&I E	H. Forsythe H. Forsythe	2/3/98	K. L. Williams K. L. Williams	2/4/98

See Management Control Procedure (MCP) 6 for instructions on use of this form.

Outline

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- 1.2 Purpose and Scope

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- 2.1 Design Criteria
- 2.2 Key Assumptions
- 2.3 Requirements

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- 3.1 CSSF Access
  - 3.1.1 Process Basis
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- B. References
- C. Equipment List

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Acronyms

CSSF	Calcined Solids Storage Facility
CWO	Cementitious Waste Option
DCWO	Direct Cementitious Waste Option
HAW	High Activity Waste
HLW	High Level Waste
HWO	Hot Isostatic Pressing (HIP) Waste Option
ICPP	Idaho Chemical Processing Plant
INEEL	Idaho National Engineering and Environmental Laboratory
ITS	Intermediate Transport Station
LAW	Low Activity Waste
NRC	Nuclear Regulatory Commission
NWCF	New Waste Calcining Facility
SBW	Sodium Bearing Waste
VDA	Vertical Deployment Apparatus
VIC	Ventilation Instrumentation and Control Building
VWO	Vitrified Waste Option
WCF	Waste Calcining Facility
WTF	Waste Treatment Facility (generic facility name for the facility developed in each waste treatment option)
WTS	Waste Treatment Study

1.0 Introduction

At the ICPP, a fluidized bed calcination process changes the chemical composition of high-level radioactive mixed liquid waste generated from the reprocessing of spent nuclear fuel and sodium bearing waste (SBW) generated from decontamination activities. The calcination process converts the liquid waste to a solid waste and reduces the volume of the waste by a factor of 7. After the calcination process, the resulting solid waste, called calcine, is pneumatically transported from the calciner to one of seven storage facilities, named calcined solids storage facilities (CSSF).

The settlement agreement between the Department of Energy and the State of Idaho mandates that high level waste be ready for removal from Idaho by a target date of 2035 for disposal. The calcine in the CSSFs must be retrieved from the CSSFs and treated. This EDF details a method to access and prepare the CSSFs for calcine retrieval, a calcine retrieval system, and a transport system to deliver the calcine to the Waste Treatment Facility. The information presented is applicable to the non-separations waste treatment options (DCWO, HWO, and VWO) and the TRU Separations waste treatment options.

1.1Background Information

The calcine is stored in cylindrical steel bins within a CSSF. The number of separate, self contained bins in a CSSF varies from 3 to 7. The bins are either cylindrical or annular. The outside diameter of the bins is approximately 12 ft. The length of the bins range from 24 ft to 61 ft. A passive convection cooling system is used to cool the bins inside a large concrete vault. Above the bin vault are structures that house the necessary equipment to receive the calcine. These structures form the superstructure of each CSSF. Figure 1 shows a sketch of each CSSF.

Calcine production began in November 1963[1]. The first six CSSFs store several forms of calcine. Currently, CSSF 6 is being filled while CSSF 7 remains empty. As of 1996, the CSSFs housed approximately 134,500 ft^3 of calcine. There are three main calcine types: alumina calcine, zirconia calcine, and calcine blends. The amount of calcine stored in each CSSF is shown in Table 1. The information for this Table was taken from reference 1.

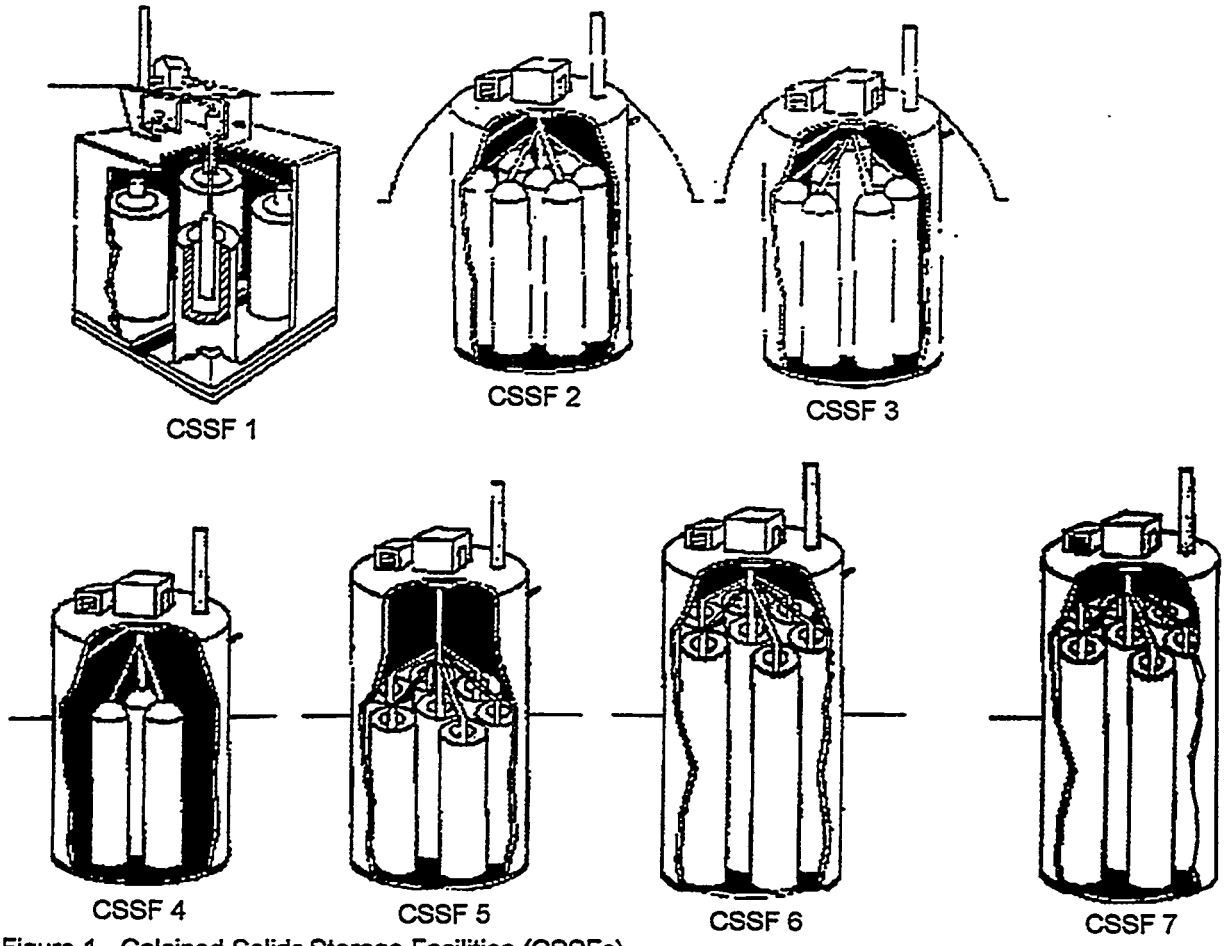


Figure 1. Calcined Solids Storage Facilities (CSSFs).

Table 1. Volume of Calcine Type in Each CSSF As of 1997.

CSSF	Alumina Calcine (ft^3)	Zirconia Calcine (ft^3)	Other (ft^3)	Calcine Blends (ft^3) / Description	Cold/ Dolomite (ft^3)	Total (ft^3)
1	7292				373	7665
2	10,754	18,582			900	30,236
3	2,250	24,844	50	5,580 / Zr-SBW	5,810	38,534
4		5,210		11,130 / 1 % Al-Zr & 99 % Zr-SBW	910	17,250
5			50	31,303 / Al-Zr-SBW	3,670	35,023
6				5,010 / Al-Zr-SBW	730	5,740
7						0

1.2 Purpose and Scope

The purpose of this study is to define a calcine retrieval and transportation plan that is compatible with the calcine processing options currently under study by the WTF program (namely the CWO, DCWO, HWO, VWO, and the TRU Separations Options). The plan will consist of accessing the calcine in each CSSF, removing the calcine from the bins, and transporting the calcine from each CSSF to the Waste Treatment Facility (the processing facility developed in each option study). Three versions of this plan were necessary to meet the needs of each waste treatment option. The equipment necessary for CSSF access, calcine retrieval and transportation will be approximately sized. A cost estimate for each option will be developed. The cost estimate will include capital equipment costs as well as operating and maintenance costs over the life of the project. As necessary, sketches will be included to clarify the systems and processes developed.

The scope of EDF is limited to the scope of the Fluor-Daniels[2] design for the calcine retrieval and transportation system as presented in reference 2. The design presented in this EDF should not seek to define unique systems to accomplish the overall tasks. Modifications to the systems presented in the Fluor-Daniels[2] design should only be made to accommodate the unique needs of the five processing options currently under study. The issues and recommendations for future study identified during this study will be documented. Additional activities, that are necessary to fully implement the calcine retrieval and transportation system but are beyond the scope of the Fluor-Daniels design, will be included in the cost estimate.

2.0 Design Basis

Although the overall design is based on the Fluor-Daniels[2] design, design criteria and key assumptions were made. The requirements that must be met are explained in section 2.3. The criteria, assumptions, and requirements were independently developed and applied to the calcine retrieval and transportation system.

2.1 Design Criteria

The design criteria are listed below. All portions of the design must satisfy criteria in the general category. These criteria are essential to satisfy ES&H goals.

General:

1. Minimize worker radiation exposure and spread of contamination.
2. The systems should be designed to withstand any credible fire or other applicable accidents and still serve as a confinement barrier.
3. The systems should be designed to withstand appropriate natural phenomena hazards.
4. Provide primary and secondary confinement at all times while minimizing the confinement volumes.
5. Adequately heat and cool occupied areas of enclosures.
6. Provide instrumentation and control for operation and data acquisition.

7. Facility equipment and calcine retrieval and transport systems must be capable of being decontaminated and/or replaced safely and easily.
8. The systems should minimize the generation of hazardous wastes.

Retrieval:

1. Minimize the amount of remote mechanical equipment placed in the bins. In effect, minimize the potential for equipment breakdown.
2. The bin pressure must remain slightly more negative than the surrounding vault space during retrieval. Controls are required to maintain the negative-pressure confinement.
3. Calcine will be retrieved from one bin in a CSSF a time. Although, calcine from more than one CSSF can be retrieved from at a given time.
4. Retrieval will be performed only if the transportation systems are operational.
5. Retrieve and deliver calcine to the Waste Treatment Facility according to the demand of the process.

Transportation:

1. Design the transportation system for a 30 year service life.
2. The transportation system should be readily maintainable.
3. Provide the appropriate amount of rod-out stations for the pneumatic transport system.

2.2 Key Assumptions

The scope of this study mandates the first and foremost assumption is that Fluor-Daniels[2] has developed a viable and competitive option for calcine retrieval and transportation. The remaining assumptions are outlined below. They are divided into three categories: CSSF access, calcine retrieval, and transportation. A basis for each assumption is provided.

Assumption	Basis
CSSF Access:	
Installation of risers can be accomplished with little modification to existing technology.	Similar risers were installed on hazardous waste bins. The technology was developed by West Valley Nuclear, Inc. and applied to the CSSFs by Raytheon Engineers and Constructors. References: 3 and 4
10% of the ground fill removed for construction and CSSF 1 access is contaminated.	References: 2 and 3
Transport piping from WCF and NWCF to the CSSFs will be decontaminated as	Closure plans of WCF and NWCF Reference: 5 and 6

outlined in the WCF and NWCF closure plans. This piping will remain accessible for D&D without endangering personnel.	
Access activities do not reduce CSSF integrity. Additionally, superstructure demolition reduces static stress on the CSSF.	Shoring activities will occur during fill removal. The Raytheon study analyzed the roof of CSSF 1 and found that these activities would help to stabilize CSSF 1. Reference: 3
An adequate place for retrieval riser attachment can be located on each bin. Piping inside the bin vault will not interfere with riser location.	The exact location of retrieval risers was not determined because it is highly dependent on the requirements of the riser welding method. This method is currently being studied at the ICPP. However, locations for 40 retrieval risers were found for CSSF 1. This number far exceeds the 24 retrieval risers required for CSSF1. The remaining CSSFs at most require an additional 8 retrieval risers to be installed. Reference: 3
Bins will not be structurally weakened by the attachment of retrieval risers. Measures to avoid this (support retrieval riser weight above bin and installation of a self-supporting floor) can be taken but are not documented.	Reference: 3 and 4
Remote equipment can be sized appropriately from equipment developed for previous projects.	Reference: 4
Retrieval:	
All types of calcine in all the bins are retrievable as a dilute phase using the retrieval method provided.	Reference: 2
The retrieval method is a viable option for all bin shapes. This is pertinent to the cylindrical bins.	Reference: 8 and S. E. Gifford, telephone conversation with Dan Griffith, INEEL.
Relocation of retrieval equipment (VDA and jumper) from one CSSF to another will take approximately 1 week.	In the Fluor-Daniels[2] cost estimate relocation of the confinement enclosure and all associated equipment is accomplished in two weeks. Reference: 2
Calcine is assumed to have remained unchanged. This mainly means that it has not agglomerated in any of the CSSFs.	This assumption allows the same retrieval equipment design to be used in all the CSSFs. Samples from CSSF 2 indicate that the calcine can remain unchanged

	during storage. Samples from all CSSFs are necessary to validate this assumption for future studies. Reference: 7
During calcine retrieval no less than 95% of the calcine in a bin will be removed. Beyond this level, as much of the calcine as is reasonable will be retrieved.	The 95% of the calcine in a bin has been demonstrated to be retrievable at a high rate. The next 4.7% of the calcine is retrievable at a significantly lower rate. Reference: 8
No internal obstructions (stiffening rods, thermowells, etc.) will interfere with extending the retrieval lines into the bins.	The internal obstructions are well documented. It is anticipated that the retrieval risers can be located to avoid these obstructions. The scope of this study does not permit an in depth examination of this issue. Reference: INEEL drawings
No miscellaneous materials will enter the suction nozzle. Where possible, such material will be removed from the bins prior to retrieval activities.	The scope of this study does not permit an in depth examination of this issue. However, this is necessary that miscellaneous materials present in the bins do not enter the transportation system. References: 3 and S. E. Gifford, separate conversations with Dan Griffith and Dan Staiger, INEEL.
Transportation:	
All above ground piping must be shielded. The concrete chase and earthen berm are adequate to meet the radiological shielding needs of dilute phase calcine.	Reference: 3
All directional changes will utilize blinded tees and laterals. All components, including the cyclone, should be reinforced with nitronic wear plates to prevent erosion failures.	Reference: 11

2.3 Requirements

Statutory law, DOE orders, and the Batt Agreement establish the requirements for the calcine retrieval and transportation system. These requirements are examined in reference 9.

3.0 Process Design

The process design has been split into three sections to provide clarity to the description. CSSF access (section 3.1) will prepare each bin for calcine retrieval by decontaminating the CSSF superstructure and installing or accessing the retrieval risers. Calcine retrieval (section 3.2) will remove the calcine from each bin and place it directly in the transportation system. The transportation system (section 3.3) will deliver the calcine to the Waste Treatment Facility and provide the motive for r. A basis, process description, equipment description, and process issues are detailed for each section of the design.

3.1 CSSF Access

3.1.1 Process Basis

CSSF access prepares each bin for calcine retrieval by reducing radiation exposure, adding necessary retrieval risers, and accessing existing retrieval risers. The CSSFs will be prepared for calcine retrieval by erecting permanent confinement enclosures. The access method presented by Fluor-Daniels[2] was originally developed in the Raytheon[3] design for CSSF 1. The specific details for each CSSF may vary but the overall the process is the same for all CSSFs.

3.1.2 Process Description

The primary goal of this phase of the retrieval and transport system is to prepare the CSSFs for retrieval. Bin vault ventilation systems will be replaced, confinement enclosures will be constructed, and retrieval lines will be installed and accessed. All modifications to the CSSFs and construction of new buildings will comply with the general design criteria outlined in reference 10. The CSSF access process is outlined in 9 steps. In order to protect the integrity of each CSSF some of these steps may overlap in the schedule.

1. **Earthwork.** Extensive excavation of CSSF 1 will expose the superstructure down to the bin vault roof. The excavation necessary to reach CSSF 1 will affect the earthen berms of CSSFs 2 and 3. Retaining walls must be installed to preserve these shielding berms. The uncontaminated portion of excavated fill, which must be covered, is estimated at 90%. The contaminated fill must be disposed of appropriately. This work begins in an uncontaminated work area. Shoring of the CSSFs, construction of the retaining wall for CSSF 1, and removal of 10% contaminated fill require work in a radiation zone. Therefore, shielded or remote equipment should be used during this step.

   An equipment ramp must be built to CSSF 1. This ramp will be used during the installation of the bridge crane and the construction of the confinement buildings. For CSSF 2-7, a mobile crane will place the equipment on the CSSF roof. This work will primarily occur under a temporary decontamination tent. The cooling air stacks will interfere with locating the confinement enclosure on the bin vault roof. Relocation of the cooling air stacks will begin in this step.

2. **Construct ventilation, instrumentation, and control (VIC) building for each CSSF.** The primary purpose of the VIC building is to house the ventilation, instrumentation, and control equipment. It will be a pre-manufactured steel building placed adjacent to each CSSF. During this step the HVAC, instrumentation, and control equipment will be installed. The HVAC equipment will regulate and decontaminate air from the bin vault, confinement enclosure, and this building. The interface between the VIC building and confinement enclosure for each CSSF is shown in sketch CRT-01. Temperature control will be maintained in the control room and operating areas with this system. Air flow will be monitored to minimize the risk of contamination spread by circulating air from low risk areas to high risk areas. Sampling ports will be provided to ensure the HVAC equipment is compliant with the applicable standards.

   Installation of instrumentation will consist of relocating panels and rewiring because the instrumentation is functional in each CSSF. The control room will house the remote operations control and instrumentation. It will allow for internal viewing of the bins through the CCTV system as well as aide in installation of retrieval risers. Construction of this building includes floor, lights, windows, doors, OH doors, insulation, and fire protection. For all the CSSFs, this building will have the same layout and size. The VIC building for all CSSFs will require electricity, water, heating and/or cooling, breathing air, and plant air.

3. **Construct confinement enclosure for each CSSF.** The confinement enclosure is a nonreactor nuclear facility. It is pictured in figure 2 as it would appear on CSSF 5, 6, or 7. For CSSFs 1, 2, 3, and 4 the confinement enclosure will be constructed on the roof of the bin vault. It acts as a confinement barrier during retrieval activities. This enclosure is a pre-manufactured steel building. This enclosure also includes ladder, guardrail, steel plate, and structural steel. It will be complete with fire protection equipment, lighting, equipment wiring and CCTV capabilities. The interior of the confinement enclosure will be coated with strippable coatings for decontamination purposes.

   A negative pressure will be maintained inside the enclosure in order to reduce the risk of contamination spread. The confinement enclosure will house a bridge crane, core drilling platform, welding equipment, vertical deployment equipment, and shielded jumpers. The bridge crane will be installed for use during decontamination of the superstructure equipment and piping, core drilling procedures, and calcine retrieval.

   This building will be decontaminated several times throughout the calcine retrieval process. The confinement enclosures for all the CSSFs will require electricity, water, breathing air, plant air, high pressure steam, service water, and instrument air. After construction of the confinement enclosure, the temporary confinement tent over the construction site may be removed.

4. **Access vaults that require decontamination and decommissioning.** In this step, equipment inside the vaults will not be disturbed. CSSFs 1, 2, 3, and 4 require installation of access ways to the vaults. This will be accomplished by core drilling into the inaccessible rooms. Existing access ways to the vaults (CSSFs 5, 6, and 7) will be cleared. Necessary portable shielding should be placed at the vault entry locations. For all CSSFs, external

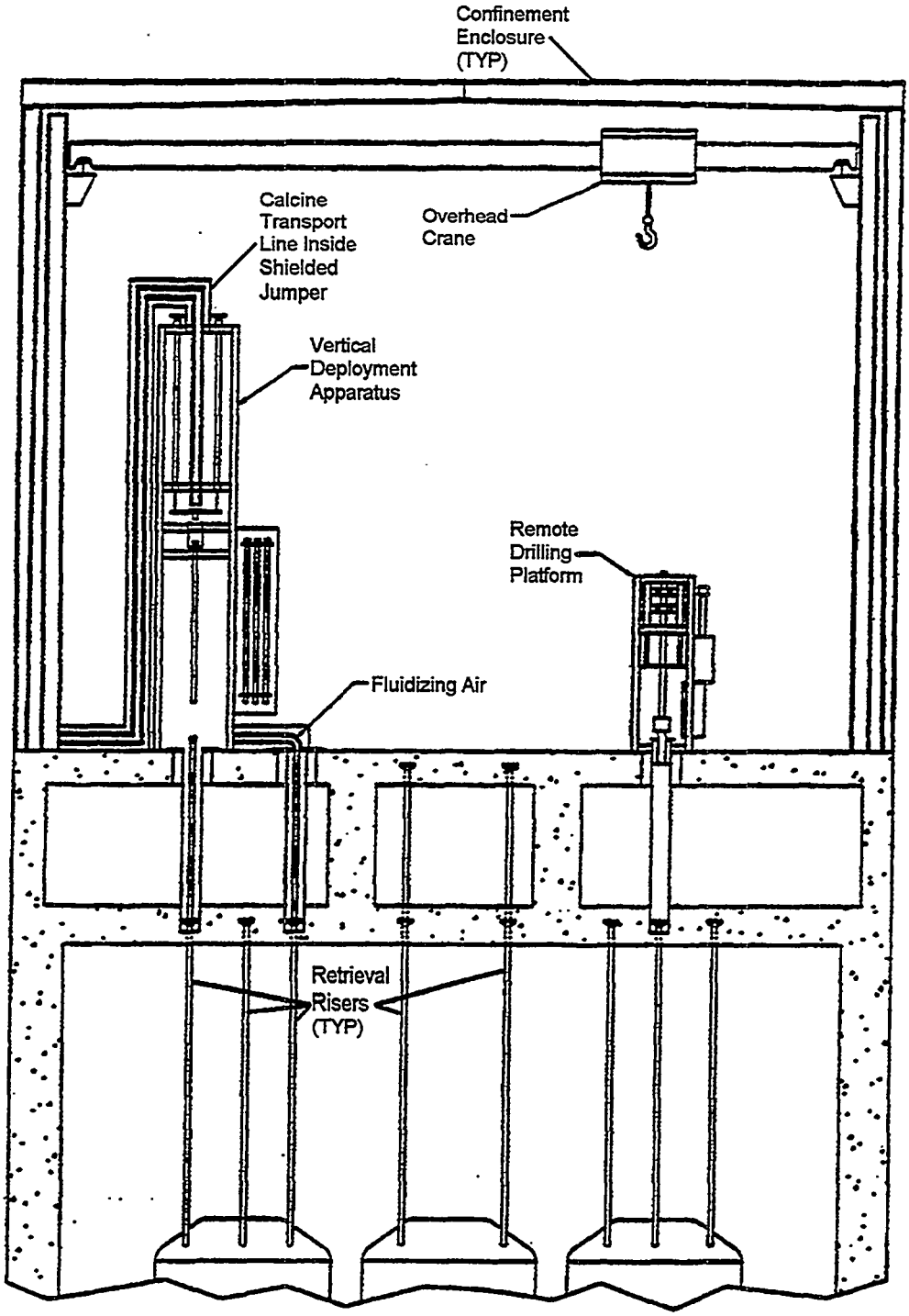


Figure 2. Confinement Enclosure and equipment pictured for CSSF 5, 6, or 7.

and

structures and equipment such as corrugated metal buildings, cooling stack ductwork, cooling air blowers, and their associated ductwork will be removed. As necessary, installation of plugs in ductwork penetrations will reduce worker exposure. Lead brick and conduit will be removed during this step. This work will be performed in a low radiation zone.

5. **Decontaminate superstructure vaults and rooms.** The vaults and rooms above the large concrete vault housing the bins comprise the superstructure of the CSSFs. The cyclone vault, equipment vault, instrument room, fan room, inlet plenum room, and exhaust plenum room will be decontaminated during this step. The vault that contains the calcine storage bins will not be decontaminated during CSSF access. Portable shielding should be placed in the vaults to reduce the exposure to acceptable limits. Remotely vacuum vault floors before entering with HEPA filtered vacuums. These vacuums have the ability to remove small debris and dust but not large objects. Strippable coating should be applied to the walls and floors of vaults that will be entered. Cut existing transport, probe, off-gas, rod out, monitoring and other nonessential piping that penetrate vault and room floors. The cut lines should then be plugged to prevent contamination spread during calcine retrieval. In CSSF 1, 2, 3, and 4 the pipes must be accessible after the new concrete floor is poured for closure activities. Access to the pipes should be provided in a similar manner to the accesses of existing retrieval lines in CSSFs 5, 6, and 7.

   Once access to the vaults has been gained, decontamination activities begin. These activities require extensive shielding if it is to be accomplished manually. A better alternative is to employ remote equipment. This remote equipment must be designed and tested. The relative level of radiation in the superstructure vault is shown in Table 2. These relative levels of radiation are based on the function of the vault and if calcine was ever present in the vault. In the high radiation areas, shielding concrete floors should be poured before temporary shielding is installed. Furthermore, Table 2 notes vaults that may have solids accumulations[2]. These accumulations are a result of damage to transport piping during filling of several CSSFs. Efforts may have been made to clean and repair these vaults but a conservative approach is to assume these vaults are extremely contaminated.

   During this step, piping, vessels, and conduit will be disassembled and packaged in appropriate containers. The bridge crane will be used to remove the packages from the CSSF. Wall penetrations should be plugged when the piping is removed. Contaminated lines that lead away from the CSSFs (such as transport lines from the WCF or the NWCF) should be decontaminated and flushed. Flushing activities are discussed in section 3.1.4.

Table 2. Assumed Bin Vault Relative Radiation Levels

CSSF	Low Radiation Zone	High Radiation Zone	Known Solids Accumulations
1	Ventilation Exhaust Room	Cyclone Vault	
2	Instrument Building	Cyclone Vault	Cyclone Vault
3	Instrument Building Equipment Vault	Cyclone Vault	Cyclone Vault
4	Instrument Building	Cyclone Vault Ventilation Equipment Room	
5	Instrument Room Access Cell	Cyclone Vault	
6	Instrument Room Fan Room Inlet Plenum Room Exhaust Plenum Room	Cyclone Vault Off-Gas Filter Room	
7	Instrument Room Fan Room Inlet Plenum Room Exhaust Plenum Room	Cyclone Vault Off-Gas Filter Room	

6. **Demolish CSSF superstructure.** This step will only be conducted for CSSF 1. The superstructures of CSSF 2, 3, and 4 will have been removed during step 1, as the superstructure enclosures are metal buildings and not concrete. During step 5, the superstructure vaults of CSSF 5, 6, and 7 will be decontaminated. The superstructures of the last 3 CSSFs are much more robust than superstructures of previous CSSFs. The walls and roof of these will be left in place.

   For CSSF 1, the temporary shielding and structural support steel will be removed from the vaults with the bridge crane. Demolish vault roof and walls. It is not necessary to demolish the CSSF superstructure for CSSFs 5, 6, and 7 because of the lower radiation levels in these CSSFs. The vault superstructure is a more permanent and integral part of the CSSF structure. At this point, the superstructure roof of CSSFs 5, 6, and 7 will be core drilled to allow access to the existing retrieval risers located in the superstructure floor.

7. **Prepare confinement enclosure for bin access.** This is accomplished by removing and replacing strippable coatings. Portable CO_2 decontamination equipment will be used to remove any residue contamination on the walls and floors. After the confinement enclosure is decontaminated, the shielding concrete pad will be poured on the bin vault roof. Attention must be given to maintaining access to all piping exiting the bin vault through the floor and existing retrieval risers. The concrete pad will be 21 in. thick for CSSF 1 and 18 in. thick for

CSSFs 2, 3, and 4. CSSFs 5,6, and 7 do not require shielding floors because the superstructure will provide shielding.

8. **Access bins.** The distinction between CSSFs is significant in this step. CSSF 1 requires all new access lines. Retrieval lines must be uncapped for CSSFs 4, 5, 6, and 7. In CSSFs 2 and 3, the existing retrieval lines must be uncapped and new retrieval lines must be added. Table 3 details the location of existing risers by CSSFs and superstructure location. Retrieval lines in CSSFs 5, 6, and 7 have multiple lengths. The shorter lines rise from the bins to the floor of the superstructure. The longer lines pass through the cyclone vault.

Table 3. Location of Existing Retrieval Risers

CSSF	1	2	3	4	5	6	7
Vault Roof		7	7	6			
Instrument Room					13	7	7
Cyclone Room Floor						4	2
Cyclone Room Roof					6	4	4
Fan Room						6	8
Access Cell					9		
Exhaust Plenum						4	4
Off-Gas Filter Room						1	1
Inlet Plenum						2	2
Total Existing Retrieval Risers	0	7 (1 / bin)	7 (1 / bin)	6 (2 / bin)	28 (4 / bin)	28 (4 / bin)	28 (4 / bin)
Additional Lines Required (Length)	24 (8 are 16 ft & 16 are 23 ft)	8 (26 ft)	7 (20 ft)	0	0	0	0
Retrieval Line Required per Bin	2	2 in WC-136-1 and 1 in the remaining bins	1	0	0	0	0
Current Rise in Retrieval Line from Bin to End	0	28 ft	18 ft	18 ft	4 are 38 ft 2 are 37 ft 22 are 24 ft	4 are 39 ft 24 are 26 ft	4 are 39 ft 24 are 26 ft
Total Length of Retrieval	1016 ft	959 ft	1038 ft	438 ft	1232 ft	1309 ft	1309 ft

Lines							

The steps involved in adding risers and accessing risers are explained separately.

Additional Retrieval Line Access: The core drilling equipment will be placed with the overhead crane. A 1 in. pilot hole will be drilled through the concrete floor to the bin vault. A 9 in. diameter hole will then be drilled through the concrete floor. Core capture equipment will prevent the core from falling into the bin vault and damaging the bins. The 8 in. retrieval lines will be extended and welded to the top of each bin. Inspection of the welds is necessary to ensure that calcine will not be released. Each bin requires two retrieval risers for calcine retrieval. The system used to install the risers will require further development and testing. It was used to access bins at the West Valley Demonstration Project[4]. In that project, the pipe diameter was half the size and the concrete floor was nearly twice as thick. A throughway between the riser and the bin will be made with remote equipment. A remotely operated hole saw could be used to cut a hole in the bin. Then a plug will be placed on the top end of the retrieval riser to minimize contamination of the confinement enclosure. CSSFs 1-3 and the bins will be inspected for safety hazards prior to welding and cutting operations. If hazards are identified (such as the presence of explosive gases) these hazards will be mitigated or a different welding or cutting method will be used.

Existing Retrieval Line Access: The flanged and welded terminations of the existing retrieval lines should have been located in the vault demolition step. These lines will be opened and capped until needed for calcine retrieval. It will be necessary to core drill through the confinement enclosure floor to access some of the retrieval lines in CSSF 5, 6, and 7. The existing retrieval risers will be plugged with steel lined, concrete plugs. At the conclusion of each of these activities the radiation levels of the confinement enclosure should be inspected. If they are found to be excessive the enclosure should be decontaminated.

At the conclusion of step 9, the CSSF is prepared for calcine retrieval activities. The retrieval lines will remain in the bins. The retrieval risers will be plugged with the steel lined, concrete, stepped plugs. Step 10 occurs during CSSF closure.

9. **CSSF D&D preparation.** The bins will be prepared for D&D by adding 18 in. diameter risers. The method used to install retrieval risers will be used to install the D&D risers. It is anticipated the same core drilling platform can be used to install the D&D risers and the new retrieval risers. However, a larger drill bit will be required. The riser will be welded to the bin and extended to the floor of the confinement enclosure. A steel lined plug will be placed on top of the riser. As a safety precaution, the bin will not be opened into the D&D risers until D&D begins. Annular bins require two D&D risers (CSSF 1, 5, 6, and 7). Cylindrical bins require one D&D riser (CSSF 1 center bins, 2, 3, and 4). The riser will be used to insert a robot to aid in the retrieval of the final 5% of the calcine in the bins. The installation of the D&D risers is essential to CSSF closure plan presented in reference 12. The cost of installing the D&D risers is included in the cost estimate (see section 6.0).

The retrieval system will be available for D&D. The positive displacement blower, vertical deployment apparatus (VDA), and shielded jumper will be available for D&D. The retrieval lines will remain in each bin. The retrieval lines are basically too hot to do anything else. Some minor adjustment to the retrieval system may be necessary (such as relocating the shielded jumper and VDA within a CSSF). The installation of the D&D risers are costed separately from the capital equipment. The operation of the retrieval system, once the CSSF is declared empty, is the responsibility of the CSSF closure team. These costs are documented in section 6.0.

3.1.3 Process Equipment Description

The equipment necessary for CSSF access mainly consists of ventilation and riser installation equipment. The ventilation equipment will satisfy the ventilation requirements of the bin vault and the confinement enclosure. This equipment is described in the equipment list in appendix A. The riser installation equipment consists of an overhead crane (used to remove packaged, contaminated equipment and place the remote drilling platform), remote drilling platform, and remote welding equipment.

The remote drilling platform will drill penetrations through the bin vault roof (2 ft to 3 ft of concrete) of each CSSF. Retrieval risers and D&D risers will be inserted through these penetrations. The basic operation is as follows: drill a pilot hole (1 in. to 2 in.), insert a toggle type capture mechanism (to prevent the core from falling into the CSSF and damaging the bins), finally, drill a larger diameter hole (allowing installation of the risers). Secondary confinement will be provided during drilling operations by a tent confinement around the drilling platform. The tent confinement will reduce exposure to workers and contamination spread within the confinement enclosure. The remote drilling platform will be relocated from bin to bin within a CSSF. This will require coordinating the construction schedules. The platform will be secured to the confinement enclosure floor with anchor bolts. Safety barriers and warning signs will prevent exposure to shine radiation directly above the open penetration. A riser plug will be installed to provide a shielding barrier once the penetrations have been drilled.

The remote welding device will weld the new risers to the bins. Commercially, resistance welding is often used to join tubs to surfaces in a hands on manner. A test program is currently underway at the INEEL to better understand the parameters involved in converting this technique to remote operation. In general terms, flanged risers, approximately 4 ft to 5 ft long, will be welded to the top of each bin. The remaining length of the riser will be bolted to the flanged riser. It is anticipated that the welds will need to be inspected prior to opening the bins through the risers. At this stage, a remote weld inspection technique has not been identified. However, it should be a simple matter to convert a test method for remoter inspection of the welds. The best time to develop a remote weld inspection method is during the weld test program.

The remote hole drill will be used to provide a throughway into the bin from the new retrieval riser. It will cut a circular hole, inside a new retrieval riser, on the top of a bin. The retrieval lines will be inserted into the bins through these holes. Bins with existing retrieval risers will not require the use of this equipment. This equipment should be purchased off-the-shelf and then converted for remote operation. The core should be captured to prevent it from falling into the

bins.

3.1.4 Process Issues

The CSSF access plan described above is not perfect, complete, or final. It is based on methods developed by Raytheon and Fluor-Daniels[2] in previous and current studies. The details of the CSSF access plan are broad. They do not address the requirements of each CSSF individually. The specific points remain to be identified in a feasibility report. This section attempts to point out potential errors and concerns in the CSSF access method. They are not expected to impact the cost or schedule of the project but they warrant further examination and study.

Radiation Levels in CSSF Superstructure:
The radiation levels vary throughout the vault superstructure of each CSSF. The cost of demolishing the vault superstructure increases as the radiation level increases. At this stage in the design process, relative radiation levels were used to develop the cost estimate. The function of the room and evidence of operational anomalies determined the relative radiation level. Not all of the CSSFs contain all of these rooms. For future studies and cost estimates, a survey of each superstructure vault should be completed to quantify the level of radiation in the vaults.

The cyclone vault and the off-gas filter room were considered to be the highest radiation areas. These areas were exposed to the greatest levels of calcine solids. The cyclone vault houses the cyclone and the distribution piping. In CSSF 2 and 3, erosion failures are known to have occurred in this vault[a]. The accumulated calcine was cleaned up but higher levels should be expected in the cyclone vault for CSSF 2 and 3. All equipment housed in this vault should be considered highly contaminated. During filling, the bins were vented through filters in the off-gas filter room. The HEPA filters in this room are highly contaminated. After filling, this room was isolated to minimize contamination spread. Shielding is necessary for work in this room. The cyclone vaults and the off-gas filter rooms should be considered high radiation areas.

The instrument room, equipment room, and access cell are assumed to be low radiation zones. These rooms house the instrumentation and equipment used to monitor the CSSF. Calcine did not enter these rooms. The inlet and exhaust plenum rooms are used to passively cool the bin vault. It is unlikely these rooms have levels of contamination beyond that of a radiation area. The fan room contains HEPA filters used only if contamination is detected in the exhaust plenum room. This system has never permanently activated in any of the CSSFs. It is unlikely the HEPA filters in this room are contaminated but they should be treated as such for disposal purposes. The equipment and ductwork downstream from the HEPA filters should be considered uncontaminated. The remaining rooms in the superstructure are assumed to be radiation areas. Unless noted above, the piping or bins in the vault are assumed to be intact.

Existing Lines from the Calcining Facilities (WCF & NWCF) to the CSSFs: The CSSF access plan calls for the original calcine transport lines to be cut and capped at the CSSFs. The cost of cutting and capping these lines is reflected in the cost estimate (section 6.0). However, the cost of decontaminating these lines is not included. The cost of decontaminating, cutting, and

[a] Staiger, D., "Review of High-Level Wastes Stored at the ICPP", draft, September 1997.

capping the lines from the NWCF to the CSSFs is part of the NWCF closure cost. The WCF closure plan calls for the line from CSSF 1 to be used to flush the calcine transport line back to the WCF. The line will be flushed with a grout slurry. Eventually, the line will back up. The grout slurry will solidify just past the first wye. This makes it difficult to flush the lines that run from CSSFs 2 and 3 to the WCF. It would be advantageous to develop detailed plans to flush and properly close these lines. Closure plans for other contaminated lines should be developed as they are identified.

Weight Loading of CSSFs: The weight loading on the CSSFs during access activities and retrieval operations is not expected to be a significant problem. The amount of equipment used during these activities has been minimized to reduce the weight loading on the CSSFs. The final design of the calcine retrieval and transportation system will incorporate the weight loading restrictions of the CSSFs. This issue will be resolved during the design stages of the calcine retrieval and transportation system.

3.2 Calcine Retrieval

3.2.1 Process Basis

The calcine retrieval system will remove the calcine from a bin and place it directly in the pneumatic transport system. The system minimizes the number of moving parts used to retrieve the calcine to reduce the risk of failure and downtime. The remote operation design of the calcine retrieval system reduces worker exposure.

The calcine retrieval system consists of the equipment necessary to remove calcine from a bin. Each CSSF is equipped with a complete set of retrieval equipment. The retrieval system relies on the transport system to provide the means for the calcine retrieval. There are two transport systems. The calcine retrieval system and the calcine transportation system are separate and distinct. Neither system can operate without the other. The interface between the calcine retrieval system and the calcine transportation system is shown in sketches CRT-02 and CRT-03.

Several modifications have been made to Fluor-Daniels[2] design to satisfy the needs of the processing options. The basic design, equipment, and process are based on the Fluor-Daniels[2] design for calcine retrieval. The Fluor-Daniels[2] design specifies that alumina calcine and zirconia calcine are retrieved and transported using separate systems. The overall system will be more efficient if there are no restrictions placed on the type of calcine that can be retrieved and transported by a system. The alumina calcine system would be idle a large part of the time because the CSSFs contain more zirconia calcine. The duplicated systems allow two bins, in separate CSSFs, to be retrieved from at one time. Safety and efficiency issues require that one bin be completely emptied before another bin is retrieved from within a CSSF.

3.2.2 Process Description

Calcine retrieval will be accomplished pneumatically with a suction nozzle and an air jet. The air jet will fluidize the calcine inside the bin. The suction nozzle will lift the fluidized calcine out of the bin. Calcine will enter the transport system through a shielded jumper from the retrieval line. A retrieval system has been mocked up at the INEEL as a pilot plant facility. It is the only system to have successfully demonstrated solids retrieval from a full-scale bin model.

Two retrieval lines will be placed 180° apart inside the bin. The retrieval lines will be composed of rigid, concentric pipes. The outer diameter of the retrieval lines will be 5 in.. The inner pipe will function as the suction line. It will be fitted with a nozzle designed to prevent clogging and uptake of miscellaneous items in the bins. The annulus will be an air jet. It will be fitted with an appropriate fluidizing nozzle. At a given time, a retrieval line will function as a suction line or an air jet. The suction nozzle and air jet will not be housed in the same retrieval line. The function of the retrieval lines will alternate, one line will act as the suction line while the other acts as the air jet. Calcine retrieval will be more efficient. Each line will have the capability to sweep a full circle but it will not be continuously rotating. This will aid in fluidizing agglomerated calcine.

The pressure inside a bin during retrieval should be slightly negative. The negative pressure reduces the risk of contamination spread while a vault is open for retrieval. The negative pressure will provide an additional safety if the confinement were to fail. The negative pressure must not maximum exceed the design pressure of the bins. The design pressure rating varies by CSSF.

A vertical deployment apparatus (VDA) will be used to keep the retrieval lines near the surface of the bulk calcine. This equipment is similar to well-drilling equipment. The retrieval lines will be sectioned. The length of each retrieval line can be extended as the calcine is retrieved. The retrieval system functions most effectively when the suction nozzle and air jet are near the calcine surface. However, it is necessary to adjust the level of each line independently. After the bin is emptied, the lines will be disconnected from the VDA and remain in the bin. The retrieval risers will be plugged, with steel-lined stepped plugs, before the VDA is decontaminated and moved to the next bin.

The calcine will be retrieved at a rate of 2700 kg/hr from each bin. When both transport systems are operating, calcine will be delivered to the Waste Treatment Facility at a rate of 5400 kg/hr. The retrieval rate is set by Fluor-Daniels[2]. The mock-up tests[8] reveal that retrieval rates above 2300 kg/hr can be achieved with 3 in. retrieval lines and a maximum air flow rate of 300 scfm at 12-15 psig. The higher retrieval rate could be reached by increasing the air flow rate and the blower capacity. More testing is necessary to show that this is a sustainable retrieval rate. The retrieval rate is dependent upon how agglomerated the calcine is. This issue is discussed further in section 3.2.3.

The retrieval system will retrieve at least 95% of the calcine each bin. This estimate is based on results from a pilot plant program (reference 8). The ¼ and full-scale mockup tests provide the best information about the amount of calcine that can be retrieved using this retrieval method. The details of the tests are not explained in this EDF. The target retrieval rate was not maintained after 95% of the solids were retrieved. In the 1/4 scale test, less than 1% of the initial retrieval

rate could be maintained during retrieval of the final 3% of solids. A significant amount of time is necessary to retrieve the final 3-4% of calcine at the bottom of the bin. For the full-scale tests, the retrieval rate dropped as the amount of solids in the bin decreased. The retrieval rate dropped below the target retrieval rate when 95.8% of the solids had been retrieved.

A conservative retrieval estimate is 95%. A conservative approach is taken for several reasons. The calcine in the "nooks and crannies" created by thermowells, internal stiffening rods, and the bottom of the bins will be difficult to remove with this retrieval method. This system has not been tested on a caked material. It is highly possible that calcine in some of the bins may be caked. Such a material would have a greater tendency to stick to the walls, floors, and internal structure of the bins. It should be noted that in the actual operation of the retrieval system, retrieval should continue as long as a reasonable retrieval rate can be maintained. The schedule and other processing requirements must define that rate.

Throughout calcine processing, retrieval will switch from CSSF to CSSF as CSSFs are emptied or different calcine types are reached. For example, the CWO option requires frequent switching between CSSFs to achieve the correct calcine blend. The other processes need to switch CSSFs once a CSSF is emptied. Safety issues prevent switching from bin to bin within a CSSF before the first bin is emptied. Additionally, such a feature is not necessary to meet the process requirements. The process of switching the retrieval to another CSSF is outlined below: *Let bin A be the bin that is currently being retrieved and let bin B be the bin that retrieval is being switched to.*

1. **Turn off retrieval system for bin A:** This is accomplished by shutting off the transport air blower connected to the suction nozzle and air jet. Flush the shielded jumper and upper line with dolomite to remove any calcine deposited in the lines. Close the valve at the CSSF transport line connection. Disconnect the vertical deployment apparatus from the retrieval lines. The lines will rest on the bottom surface of the bin. Place the steel-lined, concrete plugs on the retrieval risers. Disconnect the shielded jumper from the VDA. Decontaminate and relocate the VDA to bin B.
2. **Adjust Transport System:** Diverter valves will be used to connect the CSSF leads to the main transport system. The diverter valves will be pneumatically controlled from the control room adjacent to each CSSF. The steam traced lines in the transportation system will condensation in the return air lines.
3. **Turn on retrieval system for bin B:** If necessary, the VDA must be transported to and correctly positioned at bin B. The correct set of retrieval line extensions must be placed in the extension tube carousel. The confinement tenting will be replaced around the VDA. The shielded jumper will connect the retrieval lines to the transport system. The plugs on the retrieval risers will be pulled. Retrieval lines will be extended to the top of the calcine in bin B. The power to the retrieval blower and suction jet will be turned on. Retrieval from bin B begins.

3.2.3 Process Equipment Description

The Vertical Deployment Apparatus (VDA) will extend the retrieval lines into the bins during calcine retrieval. The VDA will extend the retrieval lines independently. The equipment is

similar to well drilling equipment. Temporary ventilation and confinement shielding is required. This will be accomplished with a confinement tent and a portable blower. A catch pan will collect radioactive dust and runoff water introduced in the VDA confinement area. The VDA is relocated with the bridge crane. It will be stabilized with anchor bolts attached to the confinement enclosure floor. The apparatus is 5 ft to 6 ft square and 25 ft tall. External shielding panels, 2 ½ in. thick, reduce radiation fields inside the confinement enclosure during retrieval. An external ladder and gate provide maintenance access to the VDAs. When the plug is removed from the retrieval riser, the confinement area within the VDA has the same ventilation requirements as the calcine bin.

The VDA is equipped with a plug removal hoist, extension tube carousel, and extension tubes and couplings. A detailed description of their function appears in reference 3. The plug removal hoist lifts the plug from the retrieval riser and stores it inside the VDA. The motor, brake, controls, and cable require periodic inspection. The load carrying capacity should also be regular checked. The extension tube carousel stores the extension tubes for the risers and retrieval lines.

The extension tubes with couplings form the retrieval line sections. As the retrieval lines are lowered into the bins, a section of tube is added. Each CSSF requires a particular set of extension tubes. These must be loaded into the VDA each time it is relocated.

The shielded jumper connects the discharge of the calcine retrieval line (top of the VDA) to the transport line. The jumper configuration will allow this connection to be made regardless of location of VDA. The shielded jumper is made of double walled, heavy pipe. The jumper is composed of 4 ft to 5 ft sections that are equipped with lifting lugs for easy handling. The jumper must be flushed with high velocity dolomite to reduce the amount of contamination in the line before it is moved.

The CCTV system contains a camera, light, boom, and control system. This system is installed to allow viewing inside the bins. It is not an essential component for the retrieval operation but it will be useful if unforeseen problems develop.

The retrieval equipment described in this section is located inside the confinement enclosure. This equipment must interface with the transport system in order for calcine to be retrieved.

3.2.4 Process Issues

The calcine retrieval system described has been tested at the INEEL. Even so, some unresolved issues exist regarding the system. Raytheon[3] developed the equipment used in this system in a previous study. The purpose of this section is to ensure the feasibility of the calcine retrieval system by expressing concerns and issues that warrant further examination and study.

Corrosion Coupons and Miscellaneous Items in CSSFs:
Calcine retrieval will be hampered by internal obstructions inside the bins. At some point during the retrieval process, these obstructions should be removed from the bins. For example, the corrosion coupons should be retrieved from each CSSF prior to decontamination of the confinement enclosure during CSSF access. The corrosion coupons in each bin are hung from ¼

in. J hooks. In 1978, some of the corrosion coupon sets were retrieved from CSSF 2. A crane was used to pull the coupons from the bins. However, at least one of the coupon sets was dropped during this operation. In order to minimize the risk of dropping additional corrosion coupon sets the CCTV system should oversee the corrosion coupon removal. The bridge crane can be used to retrieve the corrosion coupons sets. Upon removal of the corrosion coupons, they should be placed in a shielded cask. The coupons should be examined for evidence of corrosion. This information is valuable for retrieval and closure of the CSSFs. The analysis should take place at ICPP in a shielded cell. After the coupons have been analyzed they should be disposed of as radioactive waste. Table 4 describes the corrosion coupons in each CSSF.

Table 4. Corrosion Coupon Description

CSSF	Number Remaining in Bin	Bin Location	Description
1	0		
2	3 / bin	VES-WCS-136-1 and VES-WCS-136-4	Wall mounted
3	5	VES-WC-140-1	Inside riser
4	5 / bin	All bins	Wall mounted
5	5 / bin	VES-WS5-149 and VES-WS5-151	Corrosion coupon retrieval through nozzle J (6 in. Sch 40)
6	5 / bin	VES-WS5-156 and VES-WS6-159	Corrosion coupon retrieval through nozzle J (8 in.)
7	5	VES-WS7-164	Corrosion coupons in retrieval nozzle F

There are other miscellaneous items (such as rodout lines, weighted lines, lost samplers and penetrometer points) in the bins[b]. These items will not be as easy to retrieve as the corrosion coupons because their location is not known. Some of these items may be below the calcine surface while others may be on the surface of the calcine. Something must be done to reduce the risk of these items damaging the bins, the retrieval lines, and the transportation system. The air jet could pick up these items. The bin walls may not survive an impact. The bin could be breached. If these items enter the transportation system they could clog or puncture the system. The ideal solution is to detect and remove these items from the bins.

It is necessary to remove the corrosion coupons from the bins before retrieval begins. It is assumed that this activity will occur during the construction phase of the project for each CSSF. For purposes of developing a bounding cost estimate, the corrosion coupon removal activity was included in the cost estimate. A cost estimate was developed to remove the corrosion coupons. The escalated cost of planning and equipment to remove the corrosion coupons from all the

[b] Staiger, D. "Review of High-Level Wastes Stored at the ICPP", draft, September 1997.

CSSFs is $1,620,000. This activity was also included in the operating and maintenance cost estimate (See section 6.0 for details).

Control of Retrieval Rate:
The retrieval rate cannot be rigidly controlled due to the nature of the system. The retrieval rate depends upon several factors. As the calcine supply in the bin diminishes the retrieval rate decreases. The retrieval rate also depends upon how free flowing the calcine is. This retrieval method has been extensively tested with free flowing solids. It is anticipated that agglomerated calcine can be broken up and placed in a dilute phase by the air jet. However, retrieval of agglomerated solids in this manner has not been tested. This issue has not been examined because of the difficulty of simulating agglomerated solids on a large scale. The bins should be sampled to determine if the calcine has agglomerated. If agglomerated calcine is found, a pilot plant study should be conducted to determine the ability of agglomerated calcine to be retrieved with this retrieval method.

Location and Number of Retrieval Lines:
Limited testing has been conducted to identify the optimum location and number of retrieval lines. The number, size and location of the air jet and suction nozzles will effect the efficiency of the calcine retrieval system. It is necessary to determine if the most efficient configuration has been selected. Reference 8 suggests that two suction nozzles located ±90° from the air jet may be more efficient. The costs associated with this activity are included in the cost estimate for the design of the retrieval system.

Additionally, the performance of the retrieval system in a cylindrical bin is not known. Tests[3] have been conducted on an annular bin mock-up. Preliminary indications from the annular bin mock up tests suggest that the retrieval system will be even more effective for these bins. This is a source of concern because the optimal suction nozzle and air jet configuration may vary significantly from that of the annular bin.

CSSF Retrieval Order:
The order that the CSSFs will be retrieved is not identified in this EDF. Each CSSF will be ready for retrieval by 1/1/2013. The order of retrieval is heavily dependent upon the operation of the Waste Treatment Facility. The operation of the Waste Treatment Facility determines when the calcine will be retrieved. The majority of the treatment options do not require a specific blend of calcine. Therefore, they do not have a preference for the CSSF retrieval order. However, it would be beneficial to the Waste Treatment Facility operating crews to retrieve and process the more homogeneous calcine in CSSF 1 and 2 first. The closure study[12] for the CSSF facilities would prefer the placement of class C grout in the better constructed CSSF 5, 6, and 7. The order the CSSFs should be retrieved to accommodate the closure schedule is CSSF1, CSSF 5, CSSF 6, CSSF 7, CSSF 2, CSSF 3, and finally CSSF 4. This is an issue that must be coordinated between the waste treatment options and CSSF closure. Political input should be considered a major factor in determining the retrieval order.

3.3 Calcine Transport

3.3.1 Process Basis

The calcine transportation system will deliver the retrieved calcine from the CSSFs to the calcine Waste Treatment Facility with a pneumatic transport system. It also provides the motivation for the suction nozzle and air jet necessary for calcine retrieval (see sketches CRT-02 and CRT-03). Pneumatic transport systems have been used to transport calcine from the calcining facility (NWCF or WCF) to the CSSFs for more than 30 years. Additionally, Raytheon[3] studied the advantages and disadvantages of open-loop, closed-loop, and combined loop (combining a retrieval system with a closed-loop transport system) pneumatic transportation systems. The combined loop pneumatic transport system provides the best alternative for calcine transportation because recycling of the transport air minimizes the amount of air released.

The Fluor-Daniels[2] design consists of two independent transportation systems. The independent transportation systems were specified to transport zirconia and alumina calcine separately. There appears to be no advantage, to the non-separations options and TRU Separations options, to keep the zirconia calcine separate from the alumina calcine. The two independent transportation systems, in this study, will allow retrieval and transportation of calcine from 2 CSSFs at one time.

3.3.2 Process Design

The calcine transport system will deliver calcine from the CSSFs to the Waste Treatment Facility. Each CSSF will be connected to one of the two pneumatic transport systems. The double transport systems will provide greater flexibility during calcine retrieval (allow more desirable calcine blends to be achieved) and CSSF closure (allow retrieval of the remaining 5% of calcine in the bins during off-peak hours).

The pneumatic transport system reduces the risk of calcine release by conveying the calcine under negative pressure. If a break develops in the transport line, air will flow in rather than out. This minimizes the risk of calcine release by reducing the potential for calcine to leave the transport line. The momentum of large particles may overcome the negative pressure and escape at an erosion failure (particularly those in bends or other direction changes). The risk of calcine release is lower for a vacuum system than for a pressure system. In a pressure system the calcine particles would be pushed out of the transport system at all erosion failures. Additionally, erosion failures in the transport piping can be minimized through proper layout of the transport system[11]. The costs associated with properly designing the transport system are reflected in the cost estimate (section 6.0).

Each of the two transport systems will convey calcine in a 10 mm (4 in) 304L stainless steel line encased in 15 mm (6 in) 304L stainless steel line. Each transport system will have a backup calcine transport line, to be used if the original line becomes permanently clogged or otherwise unusable. Rod out stations will be placed along straight runs to clear clogged transport lines. The transport lines will be accompanied by two return air lines, one for each transport system.

The return air lines will be 20 mm (8 in) 304L stainless steel. These lines will be steam-traced to prevent water from condensing.

The transport lines and the return air lines will be surrounded by a concrete pipe chase. The pipe chase will be designed to allow access to the diverter valves and rod out stations. The pipe chase will minimize "shine" radiation at accessible locations. An earthen berm will shield the pipe chase. Raytheon[3] examined many routings and found a large number of obstructions from CSSF 1 to CSSF 6 that prevent burying the transport lines. For purposes of this study, it is assumed that it is more convenient and cost efficient to lay the transport lines above grade. Although, above ground placement does not preclude necessary relocation of some utility lines.

Diverter valves will be used to prevent back flow of calcine into CSSF connections. These valves will be manufactured out of stainless steel. Diverter valves are a typical component of pneumatic systems. Three diverter valves will be necessary to ensure that calcine can be transported from the CSSFs to the Waste Treatment Facility in either line of the transport system. These valves are ideal for use in the calcine transport system because they require little maintenance over their service life.

It is generally accepted in industry, that a vacuum transport system can transport fluidized solids up to 300 ft efficiently. The CWO and TRU Separations options require calcine to be delivered to the NWCF and the Calcine Dissolution Facility, respectively. The site plan for the CWO option is shown in sketch CRT-05. The site plan for the TRU Separations options can be found in the TRU Separations options study report (sketches TRU-C-6 and TRU-C-12). Calcine can be transported from all the CSSFs to these facilities without exceeding the transport distance limitation. The Waste Treatment Facility in the DCWO, HWO, and VWO options are located in the north east corner of ICPP. The required transport distance from CSSF 3 to the Waste Treatment Facility is approximately 550 ft. An Intermediate Transport Station (ITS) and two separate transport system legs must be included in the transport system design to deliver calcine from the CSSFs to the Waste Treatment Facility for the DCWO, HWO, and VWO options. The relationship between the ITS and the transport system is shown in sketches CRT-03 and CRT-04.

For the DCWO, HWO, and VWO options, the calcine transport from the CSSFs to the Waste Treatment Facility is accomplished with two transport system legs (each leg contains piping and equipment for each transport system). The first leg transports calcine from the CSSFs to the ITS. At the ITS, the transport air is separated from the fluidized calcine with a cyclone and sintered metal filter. The calcine enters a storage hopper. As the calcine is metered out of the hopper it is fluidized by the second leg of the pneumatic transport system. The calcine is then transported from the ITS to the Waste Treatment Facility, as shown in CRT-04.

3.3.3 Process Equipment Description

For the CWO and TRU-Separations Options, there are two independent transportation systems. For the DCWO, HWO, and VWO options, there are four transportation systems (two from the CSSFs to the ITS and two from the ITS to the Waste Treatment Facility). Each transportation system has a backup calcine transport line installed. Two sets of transport equipment (transport air blower, cyclone, sintered metal filter, heat exchanger, and balancing air blower) are located

inside the Waste Treatment Facility for all the waste treatment options. The DCWO, HWO, and VWO options have two additional sets of transport equipment located in the ITS. The shielding concrete chase is located between the CSSFs and the Waste Treatment Facility.

The transport air blower is a positive displacement blower. It functions as the transport air blower. For the CWO and TRU Separations options, it also serves as the retrieval blower. It has a capacity of 800 cfm and 150kPa (10psi). The blower sized in the Fluor-Daniels[2] design was examined in reference 11. It was found that it is slightly oversized for the longest transport line length (CSSF 3 to the Calcine Dissolution Facility). The pressure drop and solids velocity are higher than optimum for a vacuum system. However, the blower is also used to retrieve the calcine from the bins. The extra capacity may be necessary to retrieve the calcine from the bottom of the bins.

The cyclone separates approximately 99% of the calcine solids from the transport air. It is sized at 2 ft ID X 6 ft. This size is slightly higher than the one specified by Fluor-Daniels[2]. A larger cyclone is suggested by the Raytheon studies. It will be reinforced with nitronic plating to reduce the risk of erosion failures.

The sintered metal filter separates the entrained calcine particulates after the transport air leaves the cyclone. About 99.9% of these particles will be removed as the transport air passes through the sintered metal filter. Air will be back blown through the sintered metal filter to deliver calcine to the process batch bin.

The heat exchanger cools the air after it leaves the transport air blower. It is anticipated this will be water cooled heat exchanger. After the air leaves the heat exchanger it will be separated. Most of the air will be recycled but 10% of it will be exhausted through the process facility exhaust system.

The balancing air blower removes excess air from transport system. It is used to maintain a slightly negative pressure in the bin being retrieved. This is necessary to provide an additional contamination confinement.

The concrete shielding chase provides shielding to the transport lines that run from CSSFs to Waste Treatment Facility. The radiation fields are reduced to acceptable levels outside the chase. The design of the chase is similar to Raytheon design. The wall thickness is increased to account for the higher transport rate. It will protect the transport lines from weather damage.

3.3.4 Process Issues

Even though pneumatic transport systems have been used to transport calcine for over 30 years, some process issues remain for future study. Concerns and areas requiring further study that were identified during this study are detailed in this section.

Centrally Locate the Waste Treatment Facility:
Central location of the Waste Treatment Facility will serve to minimize the length of pipe runs. This will raise the efficiency of the transport equipment. Currently, the Waste Treatment Facility

for the DCWO, HWO, and VWO options is located far from the CSSFs (as shown in sketch CRT-04). The location chosen by the TRU Separations Options (as shown in sketches TRU-C-6 and TRU-C-12.) is a better location considering the limitations of a vacuum transport system. However, even this location has its own unresolved issues. The requirements to move the ICPP fence must be identified. The Waste Treatment Facility will extend off the current ICPP site boundary marked by the fence. It is not known if the fence can simply be moved. The Waste Treatment Facility should be located as close to the CSSFs as possible.

3.4 Implementation

The calcine retrieval and transportation system could be implemented in several ways. Initially, two options were examined for the capital cost estimate. Alternative A was designed to meet the minimum need of the majority of the processing options (DCWO, HWO, VWO, and TRU Separations). Alternative B was designed to satisfy the requirements of CWO and CSSF closure activities. Both of these options differ from the implementation plan presented by Fluor-Daniels[2]. Alternative B was selected as the best implementation plan. A cost estimate is included in section 6.0 based on alternative B.

Alternative A was based on the requirements of the majority of the waste treatment options. The DCWO, HWO, VWO, and TRU Separations options require a well-blended and accurately categorized batch of calcine. These treatment options do not require a specific blend of calcine. In alternative A, the CSSFs were accessed (a confinement enclosure and VIC building were constructed for each CSSF) during the construction phase of the project. Two sets of retrieval equipment (consisting of a VDA and a shielded jumper) will be purchased. The retrieval equipment will be moved from CSSF to CSSF as the CSSFs are emptied. The retrieval equipment must be decontaminated before relocation. Moving the retrieval equipment between CSSFs is assumed to take less than one week.

The drawback to this implementation alternative is the impact it will have on D&D work. CSSF closure requires that as much calcine as possible be removed from each bin. After, calcine retrieval as much as 5% of the calcine may remain in each bin. The CSSF closure study[12] expects to use the retrieval equipment to remove as much as possible of the remaining calcine. The capital cost estimate for alternative A was not significantly lower that the estimate for alternative B (a copy of the preliminary capital cost estimate for alternative A is located in the project file). For these reasons, alternative A was not selected for further study.

Alternative B satisfies the requirements of the remaining waste treatment option, CWO, and CSSF closure. CWO requires a specific blend of calcine for each processing batch. The calcine blend is achieved with calcine from up to four CSSFs (see reference 13 for details). Switching between CSSFs is required to maintain the blend as large layers of calcine are encountered in the bins. The large number of required moves between CSSFs make purchasing seven sets of retrieval equipment the most cost effective selection. It is not necessary, in this alternative to move the VDAs and shielded jumpers from CSSF to CSSF. The retrieval equipment will be moved between bins within a CSSF. It is expected that moving the retrieval equipment within a CSSF can be accomplished in less than a day.

Alternative B does not adversely impact CSSF closures. Closure can begin on each CSSF when it is emptied. The calcine remaining in the bins will be retrieved when the high calcine retrieval rate is not necessary. Alternative B also satisfies the requirements of the DCWO, HWO, VWO, and TRU Separations options. Table 5 outlines the similarities and differences between the implementation alternatives.

Table 5. Characteristics of Calcine Retrieval System Options

Characteristic	Option A	Option B
Retrieval Rate / Transport System	2700 kg/hr	2700 kg/hr
Number of Independent Transport Systems	2	2
Number of Confinement Enclosure and VIC Building Sets	7	7
Number of VDAs Required	2	7
Relocation of VDAs between CSSFs (Relocation Time)	Yes (< 1 week due to decontamination activities)	Not required
CSSFs Costed with New VDAs	1 and 2	1, 2, 3, 4, 5, 6, and 7
VDAs Relocated to CSSFs	3, 4, 5, 6, and 7	--
Tasks to Utilize Alternative	DCWO, HWO, VWO, TRU Separations	CWO (also DCWO, HWO, VWO, TRU Separations)
Transport System Available for Closure of CSSFs during operations	No	Yes

Alternative B was selected as the best implementation option. It was used as the basis for the cost estimate.

4.0 Input to Project Data Sheet

A project data sheet was not completed for the calcine retrieval and transportation system. Instead the data was appended to the project data sheets for each waste treatment option. Table 6 shows the data that should be incorporated into the project data sheets of the each waste treatment option. It summarizes construction, operations, and some D&D project data. Appendix D contains the calculations and justification for the data presented in Table 6.

The closure of the CSSFs is currently being studied, therefore, the D&D project data for the CSSFs will be reported in reference 12. Reference 12 will cover closing of the CSSF structures, added confinement enclosures, VIC buildings, and the retrieval equipment. D&D project data is included in Table 6 for closure of the transport lines, ITS (building and transport equipment), and

transport equipment located in the WTF. The D&D project data included in Table 6 is not comprehensive because a closure method for the transport lines, ITS, and transport equipment has not been developed. It was assumed that the D&D portion of the project would have a 1-year duration. The work may be more effectively accomplished over a longer period of time. A comprehensive examination of the D&D requirements of the transportation system, based on a closure method, should be completed.

Table 6. Input to Project Data Sheets

Generic Information		
Structure Size (m^2)	Seven Confinement Enclosures which are each 40 ft X 40 ft (978 m^2 total)	
	Seven VIC Buildings which are each 40 ft X 60 ft (1560 m^2 total)	
	One ITS Building that is 600 ft^2 (55.7 m^2)	
Location	A Confinement Enclosure will be built on the roof of each CSSF.	
	A VIC Building will be built adjacent to each CSSF.	
	An ITS Building will be built mid way between the CSSFs and the Waste Treatment Facility.	
Construction Information		
Cost ($): Preconstruction (escalation included)	CWO, DCWO, HWO, VWO & TRU Separations Options	
Conceptual Design	$ 18,000,000	
Project Management	$ 2,700,000	
Permitting and Documentation	$ 4,800,000	
Start Up Activities	$ 5,100,000	
Contingency	$ 10,500,000	
Total Preconstruction	$ 41,100,000	
Cost ($): Construction (escalation included)	CWO & TRU Separations Options	DCWO, HWO, & VWO
Engineering, Design, and Inspection	$ 18,500,000	$ 19,400,000
Management Reserve (PM/CM)	$ 22,900,000	$ 23,500,000
Construction	$ 104,200,000	$ 106,500,000
Government Furnished Eqiupment	$ 18,200,000	$ 19,300,000
G&A/PIF	$ 10,400,000	$ 10,700,000

Procurement Fees, Management Reserve, and Contingency	$ 64,600,000	$ 66,600,000
Total Construction	$ 238,800,000	$ 246,100,000
Schedule start/end: Preconstruction	1/1/2004 – 12/31/2007	
Schedule start/end: Construction	1/1/2008 – 12/32/2012	
Number of workers each year of construction	100 workers per year	
Number of radiation workers (construction)	90 workers per year	
Average annual worker radiation dose (rem/yr)	252 mrem/yr per worker	
Heavy equipment		
Equipment used	Mobile crane, roll off truck, loader, bulldozer, and cement truck	
Trips	Cycle time/operation not applicable	
Hours of operation	12,480 hr (total)	
Acres disturbed and duration of disturbance	0.5 acres for VIC Buildings, Transport Line Chase, ITS building and ramps	
Air emissions		
Major gases (CO2, H2O, O2, N2)	7,255 tons	
Contaminants (Particulates, CO, NOx, SO2, hydrocarbons)	42.5 tons	
Radioactive wastes		
Type	Contaminated fill (1500 yd^3) Steel/asbestos (279,000 lb) Lead bricks/mixed wastes (4,900 lb)	
Energy requirements		
Electrical (MWh/yr)	156 MWh/yr	
Fossil fuel (liters)	283,452 liters (total)	
Permits needed for construction	NEPA documentation (prior to start of Title II construction); New stationary sources/PTC/NOC/PSD for non-rad air emissions; HAP's and TAP's and RCRA (part AA, BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; reports and specifications for drinking water supply; RCRA Part A and Part B permits.	

Operational Information

Cost ($): Operations (not escalated)	CWO	TRU Separations Options	DCWO, HWO, VWO

Facility Operations	$ 1,218,000	$ 4,661,000	$ 4,761,000
Utilities	$ 1,054,000	$ 4,158,000	$ 4,158,000
Maintenance of Equipment	$ 7,866,000	$ 28,840,000	$ 28,840,000
Building Maintenance	$ 9,255,000	$ 33,933,00	$ 35,120,000
Total Operations	$ 19,393,000	$ 71,594,000	$ 72,781,000

Schedule start/end

5-Year Operation: 1/1/2013 – 12/31/2017

20-Year Operation: 1/1/2013 – 12/31/2032

Number of workers each year of operation

	5-Year Operation	20-Year Operation
Managers	0.5	0.25
Engineers and other technicians	0.75	0.5
Supervisors and Administation/Support	3	2
Operators	6	3
Maintenance	1	1

Number of radiation workers

5-Year Operation: 10 workers

20-Year Operation: 6 workers

Average annual work radiation dose (rem/year)

192 mrem/year per worker

Air Emissions

Type (radioactive/chemical)

Calcine

Quantity (Ci/year, ton/year)

CWO Option: 5.6×10^{-6} ton/year

TRU Separations Options: 1.4×10^{-6} ton/year

DCWO, HWO, VWO Options: 2.8×10^{-6} ton/year

Release of Ci/year dependent on the type and storage length of the calcine released.

Energy Requirements

Electrical (MWh/yr)

CWO Option: 93.2 MWh/yr

TRU Separations Options: 74.1 MWh/yr

DCWO, HWO, VWO Options: 88.7 MWh/yr

Permits needed (for facility operations)

HAP's and TAP's and RCRA (part AA, BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; report specifications for drinking water supply; RCRA Part A and Part B permits.

Decontamination & Decommissioning (D&D) Information

Cost ($): DD&D (Unescalated)	CWO	TRU-Separations Options	DCWO, HWO, & VWO
Decommission	$ 2,555,000	$ 2,555,000	$ 2,681,000
Decontamination	$ 7,223,000	$ 7,223,000	$ 7,415,000
Demolition	$ 4,935,000	$ 11,557,000	$ 11,864,000
Total DD&D	$ 14,713,000	$ 21,335,000	$ 21,960,000

Schedule start/end: D&D	CWO: 1/1/2018 – 12/31/2018 TRU-Separations Options: 1/1/2034 – 12/31/2034 DCWO, HWO, & VWO: 1/1/2034 – 12/31/2034
Number of workers each year of D&D (new/existing)	CWO: 108 TRU-Separations Options: 155 DCWO, HWO, & VWO: 160
Number of radiation workers (D&D)	CWO: 75 TRU-Separations Options: 104 DCWO, HWO, VWO: 102
Average annual worker radiation dose (rem/yr)	252 mrem/yr for each worker
Heavy equipment	
Equipment used	Mobile Cranes, Roll-off Trucks, Dozers, Loaders, cement trucks, and other specialty equipment used during D&D
Hours of operation	CWO: 4,992 hr TRU-Separations Options: 6,240 hr DCWO, HWO, & VWO: 7,488 hr
Acres disturbed and duration of disturbance	CWO & TRU-Separations Options (transport lines only): 0.09 acre DCWO, HWO, & VWO (ITS & transport lines): 0.11 acre
Air emissions	
Major gases (CO2, H2O, O2, N2)	CWO: 2,902 tons (total) TRU-Separations: 3,627 tons (total) DCWO, HWO & VWO: 4,353 tons (total)
Contaminants (Particulates, CO, NOx, SO2, hydrocarbons)	CWO: 17 tons (total) TRU-Separations: 21 tons (total) DCWO, HWO, & VWO: 25 tons (total)
Solid wastes	

Type	Metal building and uncontaminated transport equipment
Quantity (m^3)	CWO & TRU-Separations Options: 45 m^3
	DCWO, HWO, & VWO options: 90 m^3
Radioactive wastes	Cyclones, metal filters, and hoppers from transport system
Type and Quantity	CWO & TRU-Separations Options: 1.2 m^3
	DCWO, HWO, & VWO options: 2.6 m^3
Energy requirements	
Electrical (MWh/yr)	156 MWh/yr (based on John Duggan's estimate of 3000kWh/wk, 52 wk/yr)
Fossil fuel (liters)	CWO: 113,380 liters
	TRU-Separations Options: 141,725 liters
	DCWO, HWO, & VWO: 170,070 liters
Permits needed (e.g. for facility closures, physical characteristics and quantities of radioactive and hazardous materials remaining after closure)	Work will be done under closure provisions f existing permits

Some differences are present between the input to project data sheets and the more formal project data sheet. The primary difference involves the waste streams generated by the system. Quantities for effluents, solid wastes, hazardous/toxic chemicals and wastes, and pits/ponds were not reported. These values are negligible, therefore, the categories have been eliminated from Table 6. The most significant waste stream is the radioactive waste removed from the CSSFs during construction activities.

5.0 Program Schedule

The calcine retrieval and transportation system will observe the same construction schedule for each waste treatment option (CWO, DCWO, HWO, VWO, and TRU Separations Options). The DCWO, HWO, VWO and TRU Separations options operate under a 20-year schedule. The CWO option has a 5-year operational schedule. The calcine retrieval system has the capacity to meet both of these schedules.

Conceptual Design	1/1/2004 – 12/31/2005
Title Design	1/1/2006 – 12/31/2007
Construction	1/1/2008 - 12/31/2012
Operations	1/1/2013 –12/31/2032 or 1/1/2013-12/31/2017

At the end of construction all of the CSSFs should be ready for retrieval by 1/1/2013. SO testing and operational readiness reviews will be conducted during the construction period. The waste treatment options require that calcine retrieval begin on 1/1/2013 to allow time for D&D of the

Waste Treatment Facility and the CSSFs by the target date of 2035 for storage of road ready HLW.

The calcine retrieval and transportation system described above has the capacity to retrieve the estimated total volume of calcine during the operations time period. The total estimated volume of calcine present in the CSSFs by 2013 is 5435 m^3 (determined in reference 14). The average bulk density of calcine is 1400 kg/m^3 (according to reference 1). The calcine retrieval and transportation system has the capacity to retrieve calcine at a combined retrieval rate of 5400 kg/hr (two independent systems with a retrieval rate of 2700 kg/hr). The calcine retrieval and transportation system will need to operate for 1409 hr to retrieve the total estimated volume of calcine. The waste treatment facilities generally assume a downtime factor of 50% to allow for equipment maintenance. Accounting for the 50% downtime factor, the calcine retrieval and transportation system will need to operate for 10.8 hr/wk and 2.7 hr/wk for the 5-year and 20-year operation schedules, respectively. The short operating time suggests that the optimum retrieval rate could be reduced without adversely impacting the schedule. The calcine retrieval and transportation system has the capacity to retrieve the total estimated volume of calcine during the required operational periods.

A retrieval schedule for the CSSFs not presented in this EDF. There are too many unknown parameters to develop a complete and optimum calcine retrieval schedule. The retrieval schedule must be coordinated between the Waste Treatment Facility and the CSSF closure study[12]. This section is merely intended to show that the proposed retrieval system has the capacity to retrieve the estimated volume of calcine in the time period outlined by the Consent Order. The Consent Order requires that all high level waste be placed in a road ready form by a target date of 2035. The above calculation shows the total estimated calcine volume can be retrieved and delivered to the Waste Treatment Facility in the necessary time frame.

6.0 Costs

The cost estimate for the calcine retrieval and transportation system was completed in modular sections to accommodate the differences in the waste treatment options. Each CSSF was independently evaluated. CSSFs 5, 6, and 7 are similar therefore one cost estimate, which may be applied to CSSF 5, 6, and 7, was developed. Two transport system costs were developed. Transport system A reflects the cost of transporting calcine from the CSSF to the necessary facilities for the CWO and TRU Separations options. Transport system B reflects the cost of transporting calcine from the CSSFs to the Waste Treatment Facility for the DCWO, HWO, and VWO options. Estimates to purchase and install D&D risers and remove corrosion coupons are also included. The cost estimate from implementation alternative B (see section 4.0) is presented below. A preliminary cost estimate for implementation of alternative A can be found in the project file.

Appendix F contains the Cost Estimate Support Data Recapitulation, summary sheets, and contingency analysis for each module of the capital cost estimate and the complete life cycle cost estimate. The detail sheets used to develop the capital cost estimate are not included in this EDF. They are located in the project file and are available upon request.

Although the Fluor-Daniels study was the basis for this study, the total estimated cost (TEC) of the calcine retrieval and transportation system developed in this EDF is nearly twice the TEC for the Fluor-Daniels[2] design. The higher cost estimate can be attributed to 4 factors. First, more demolition work during the CSSF access phase was estimated for this design than for the Fluor-Daniels design. The higher cost of demolition work is a result of higher estimated radiation levels in the superstructure and removal of more equipment (including the cyclone and its associated piping). Second, Fluor-Daniels specified that 2 sets of retrieval equipment (confinement enclosures, bridge cranes, VDAs, and shielded jumpers) were necessary. The sets of retrieval equipment would be moved from CSSF to CSSF. Seven sets of retrieval equipment were necessary for the design presented in this EDF because of the interfaces with the Waste Treatment Facility and the CSSF closure study. Third, the location of the Waste Treatment Facility for the DCWO, HWO, and VWO options requires an intermediate transport station to deliver the calcine to the Waste Treatment Facility. This resulted in 2 more sets of transport equipment (transport air blowers, balancing air blowers, HEPA filters, heat exchangers, cyclones, and sintered metal filters) as well as additional transport piping. This additional equipment resulted in a higher cost for the transport system. Fourth, the Fluor-Daniels study did not examine removal of corrosion coupons or installation of D&D risers. During this study it was found to be necessary to remove the corrosion coupons prior to retrieval activities. The corrosion coupons present a significant risk to the safe and efficient operation of the calcine retrieval and transportation system. D&D risers, installed after retrieval operations are complete, are necessary to interface with the CSSF closure project. The TEC of the calcine retrieval and transportation system developed in this EDF is nearly twice the TEC for Fluor-Daniels[2] calcine retrieval and transportation system.

Table 7. Cost Summary of the Calcine Retrieval and Transportation System (Costs Shown are x1000)

Cost Item	CWO	DCWO	HWO	VWO	TRU Separations
OPC (unescalated)	21,267	21,267	21,267	21,267	21,267
OPC Escalation	9,358	9,358	9,358	9,358	9,358
OPC Mgmt Reserve	0	0	0	0	0
OPC Contingency	10,475	10,475	10,475	10,475	10,475
Total OPC	41,100	41,100	41,100	41,100	41,100
TEC (unescalated)	123,193	127,031	127,031	127,031	123,193
TEC Escalation	52,330	53,841	53,841	53,841	52,330
TEC Mgmt Reserve	13,406	13,788	13,788	13,788	13,406
TEC Contingency	49,992	51,611	51,611	51,611	49,992
Total TEC	238,921	246,271	246,271	246,271	238,921
TPC (unescalated)	144,460	148,298	148,298	148,298	144,460
TPC Escalation	61,688	63,199	63,199	63,199	61,688
TPC Mgmt Reserve	13,406	13,788	13,788	13,788	13,406
TPC Contingency	60,467	62,086	62,086	62,086	60,467
Total TPC	280,021	287,371	287,371	287,371	280,021
Operations (unescalated)	19,393	72,781	72,781	72,781	71,594
Operations Escalation	11,085	71,923	71,923	71,923	70,751
Operations Contingency	9,143	43,411	43,411	43,411	42,704
Total Operations	39,621	188,115	188,115	188,115	185,049
Post Operations (unescalated)	14,713	21,960	21,960	21,960	21,335
Post Operations Escalation	10,712	37,071	37,071	37,071	36,016
Post Operations Contingency	3,814	8,855	8,855	8,855	8,603
Total Post Operations	29,239	67,886	67,886	67,886	65,954
Total Cost (unescalated)	178,566	243,039	243,039	243,039	237,389
Total Cost (w/escalation, mgt reserve, & contingency)	348,880	543,371	543,371	543,371	531,023
Discounted Cost (escalated)	166,409	196,876	196,876	196,876	192,309

7.0 Recommendations for Further Study

Issues that should be further studied are identified in sections 3.1.4, 3.2.4, and 3.3.4. The majority of these issues will be resolved as feasibility studies and title design are completed. Several have significantly more impact on whether or not the design is viable. Efforts should be made to characterize the state of calcine in the bins as well as the radiation levels in the CSSF superstructures. The limits on the transport length of a vacuum system should be identified. The feasibility of an intermediate transport station and its configuration should be examined. A closure method should be developed for the transportation system. There are several issues that require coordination with the Waste Treatment Facility and the CSSF closure study[12]. These issues must be resolved before title design can begin.

8.0 Uncertainties

Many issues and their associated uncertainties were discussed in sections 3.1.4, 3.2.4, and 3.3.4. These issues will not be repeated in this section. The major uncertainties, which apply to the overall project, will be discussed in this section.

8.1 Maturity of Technology

Guidance for determining the maturity of technology is found in the U.S. Department of Energy Standard Operating Procedure, Interim Guidance, Office of Science and Technology,Technology Decision Process, May 8, 1997. The technological maturity is classified into stages 1 through 7. They are titled Basic Research, Applied Research, Exploratory Development, Advanced Development, Engineering Development, Demonstration, and Implementation. This reference details the minimum goals, objectives, measures of effectiveness, actions, and responsibilities to include requirements for entry into the next stage.

The basic technologies (brief descriptions of these basic technologies can be found in sections 3.1.2, 3.2.2, and 3.3.2) necessary to implement the calcine retrieval and transportation system are generally well developed. The classifications of the various technologies range from the "Exploratory Development" stage to the "Implementation" stage. Some of these technologies (particularly the remote welding device and VDA) have been proven in industry in hands on applications. They must be converted for remote use prior to implementation in the calcine retrieval and transportation system. The majority of the remote technologies necessary for decontamination have been demonstrated at the INEEL and other facilities. Applied research on INEEL surrogate calcine has shown that free flowing calcine is retrievable using this technology. These systems require development and testing to ensure their reliability and performance in this application. Some aspects of engineering development require considerably more work.

8.2 Risk Assessment

Schedule and cost risks are identified in this EDF. They are categorized below according to the source of the risk. The risks are the same for both implementation options and project schedules. Risk Assessment Forms for all identified risks are included in Appendix E along with an explanation of the Risk Rating calculation method.

The risk ratings can vary from "1" to "9". The highest risk in each category is rated at "4". The risks with the highest ratings will be discussed in this section.

8.2.1 Project Risk

P.1 Integrity of CSSF maintained	risk = 3
P.2 Location of retrieval risers	risk = 3
P.3 Estimated retrieval percentage too high	risk = 2
P.4 Internal obstructions prevent retrieval	risk = 2
P.5 Waste Treatment Facility too slow	risk = 2
P.6 Miscellaneous materials prevent retrieval	risk = 4

This risk is discussed in some detail in section 3.2.4. However, it bears repeating here. During filling of the CSSFs, miscellaneous materials entered the bins. No attempt has been made to remove these materials from the bins. There is a high potential that the material is scattered throughout the bins. These materials may damage the bins or the calcine retrieval and transportation system if they were to be picked by the suction nozzle or air jet. Therefore, this

risk was assigned a probability of "2." There is some potential that the schedule will be disrupted, costs will increase, and the performance of the system may be degraded. The impact of this risk is rated at "2" because the calcine retrieval and transportation system minimizes the impact. The potential for schedule disruption and increased costs are reduced because each transport system has a back up transport line and retrieval could be switched to another bin or CSSF.

8.2.2 Technical Risk

T.1 Objective retrieval rate too high	risk = 3
T.2 All calcines are not retrievable	risk = 4

This risk is based on an assumption. It was necessary to assume at the onset that all types of calcine could be retrieved with one system. It is possible that some of the calcine in the CSSFs is agglomerated. If it is agglomerated the potential exists that it is not retrievable. Schedule disruptions and increased costs are possible if a significant amount of calcine is not retrievable using the calcine retrieval and transportation system. This risk was assigned a probability and impact of "2" because it is possible that it will occur and adversely affect the schedule and costs.

8.2.3 ES&H Risk

ESH.1 Construction radiation dose rates incorrect	risk = 4

The radiation levels in the CSSF superstructures are not known. A comprehensive survey of these areas has not been conducted. The relative radiation levels used to develop the cost estimates were assumed. It is likely that these levels were incorrectly estimated. The radiation levels may be significantly higher in the CSSF superstructure. If the actual radiation levels are different from the estimated levels there is a potential to impact the schedule and costs. Therefore, the probability and impact were each assigned a value of "2." The risk is given a value of "4."

8.3 Failure Modes

Possible failure scenarios are identified in this section. It is outside the work scope of this study to evaluate these scenarios. However, efforts have been made to ensure that double confinement of the calcine is maintained at all times. This reduces the risk of a source-term release due to a failure of the calcine retrieval and transportation system. The failure modes include:

- Loss of negative pressure in the confinement enclosure
- Leakage in the confinement enclosure
- Bin breach caused during installation of additional retrieval risers leading to a calcine release into the bin vault
- Loss of calcine confinement around the retrieval equipment during operation of retrieval equipment
- Erosion failure in the transport lines

- Erosion failure in the cyclone
- Power failure during calcine retrieval

A failure would most significantly affect the schedule. The level of significance is dependent upon the failure. Any failure is expected to halt all activities involving calcine retrieval and transportation until the cause of the failure is resolved and necessary modifications are made. The current schedule for calcine retrieval allows 50% downtime for maintenance. This allows some slack time for unanticipated failures.

8.4 Cost Estimate Uncertainties

Competent cost estimators who are familiar with work conducted at the ICPP prepared the cost estimate. Efforts have been made to ensure the cost estimate for the calcine retrieval and transportation system is consistent with the cost estimates for the non-separations options and the TRU Separation option. Radiation zone work has been conservatively estimated based on known incidents during filling of the CSSFs (Dan Staiger's draft report "Review of High Level Wastes Stored at the ICPP"). The assumptions used to develop the cost estimate are outlined in the introductory letter. The cost estimate is well detailed.

9.0 Potential Impacts of NRC Licensing

Licensing a nuclear facility requires preparing and submitting an application and supporting documents to the NRC, such as Safety Analysis Reports, an Environmental Reports, quality assurance documents, training plans, monitoring plans, and safeguards and security plans. 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 submitting the application to receiving the license is expected to require a minimum of an additional three to five years. The benefits of NRC licensing are enhanced operating safety, strengthened relationships with stakeholders, and license-holder participation in future regulation development.

According to data developed by Fluor-Daniels[2], the estimated cost for NRC licensing is 14% of the escalated Total Estimated Cost to comply with the NRC requirements that exceed the current DOE requirements. A NRC licensed facility will experience greater costs during the operating period. These additional costs are discussed in the reports for the separate processing options (in the section titled "Potential Impacts of NRC Licensing").

Some of the potential major impacts associated with NRC licensing of Waste Treatment Facilities, other than cost, are:

- Increased oversight, including more public involvement and input in all decision processes

- More restrictive physical limits on some parameters, including exposure limits, seismic, and tornado

- More strict radiation monitoring
- Restrictions on sharing utilities between facilities
- More stringent evaluations of the impact from off-site hazards.
- Full testing required for emergency utilities
- Physical changes to the plant and equipment
- More elapsed schedule time required
- The methods to comply with some other codes and standards may be complicated and require more time
- Although the NRC may license the WTS facilities, it may not automatically inherit or adopt the same agreements and obligations with the State of Idaho and EPA Region 10 that are in place for DOE and INEEL

10.0 Summary and Conclusions

The calcine retrieval and transportation system presented above combines the best elements of previous studies (references 2, 3, and 8), pilot plant tests, and experience. The system meets the requirements set forth in the Consent Order, statutory law, and DOE orders. The assumptions used to develop this system have strong bases.

The system was discussed in three sections: CSSF access, calcine retrieval system, and calcine transportation system. During CSSF access, the CSSFs will be prepared for calcine retrieval. Superstructure buildings, equipment, and piping will be decontaminated and removed from CSSFs 1-4. The concrete vaults of CSSFs 5-7 will be decontaminated but not removed. Existing retrieval lines will be accessed. New retrieval lines will be added to CSSFs 1, 2, and 3. The calcine retrieval and transportation systems will function simultaneously. Calcine will be retrieved from the CSSFs using a fluidizing air jet and a suction nozzle. Then the calcine will be directly placed in the pneumatic transport system for transport to the Waste Treatment Facility.

There are several issues that must be resolved before the calcine retrieval and transportation system can be termed feasible. A plan to deal with the corrosion coupons and other miscellaneous items in the bins should be developed. These items should be removed from the bins or prevented from entering the transport system. The transport system currently calls for longer transport distances than are accepted by industry. It was proposed that testing be done to verify that a vacuum system (with intermediate transport stations, if necessary) can be efficiently used over long distances. Resolving these issues will increase the feasibility of the calcine retrieval and transportation system. The remaining issues (sections 3.1.4, 3.2.4, and 3.3.4) should be resolved over the course of feasibility studies and title design.

The cost estimate was developed in modules to allow an "apples to apples" comparison with the Fluor-Daniels retrieval and transportation system. Initially, two alternatives for implementation were examined. The first alternative was removed from consideration. It did not satisfy all the processing options and adversely impacted CSSF closure study[12] because only 2 sets of retrieval equipment were specified. The second alternative represents a retrieval and transportation system that interfaces with the Waste Treatment Facility and the CSSF closure study[12]. A cost estimate based on the second alternative bounds the cost of the project. Separate capital cost estimates were developed for installation of D&D risers and removal of corrosion coupons.

Life cycle costs for construction, operation, and closure of the calcine retrieval and transportation system were developed. Removal of corrosion coupons and installation of D&D risers are included in the life cycle cost estimate for each waste treatment option.

The CWO option requires a 5-year operating period. This option uses transport system A to deliver the calcine from the CSSFs to the NWCF. The total unescalated cost for the CWO option is $178,566,000. The total cost with escalation, management reserve, and contingency is $348,880,000. The discounted annual cost for the CWO option is $166, 409,000.

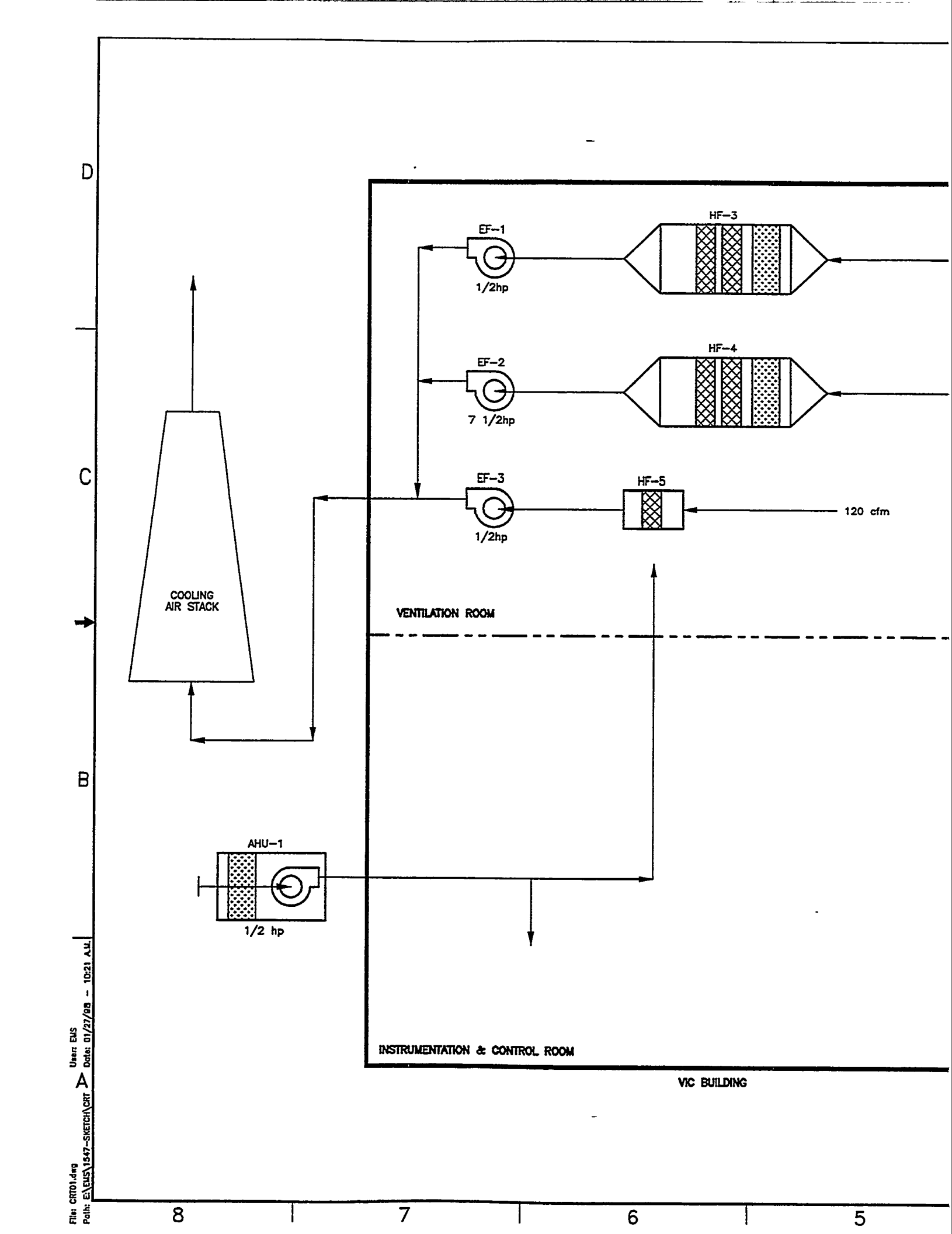
The TRU-Separations Options requires the calcine retrieval and transportation system to operate for 20 years. This option employs transport system A to deliver the calcine from the CSSFs to the Calcine Dissolution Facility. The total unescalated cost for the CWO option is $237,389,000. The total cost with escalation, management reserve, and contingency is $531,023,000. The discounted annual cost for the CWO option is $192, 309,000.

The DCWO, HWO, and VWO options have a 20 year operating period. These options require transport system B to deliver the calcine from the CSSFs to the Waste Treatment Facilities. The total unescalated cost for the CWO option is $243,039,000. The total cost with escalation, management reserve, and contingency is $543,371,000. The discounted annual cost for the CWO option is $196, 876,000.

Appendix A

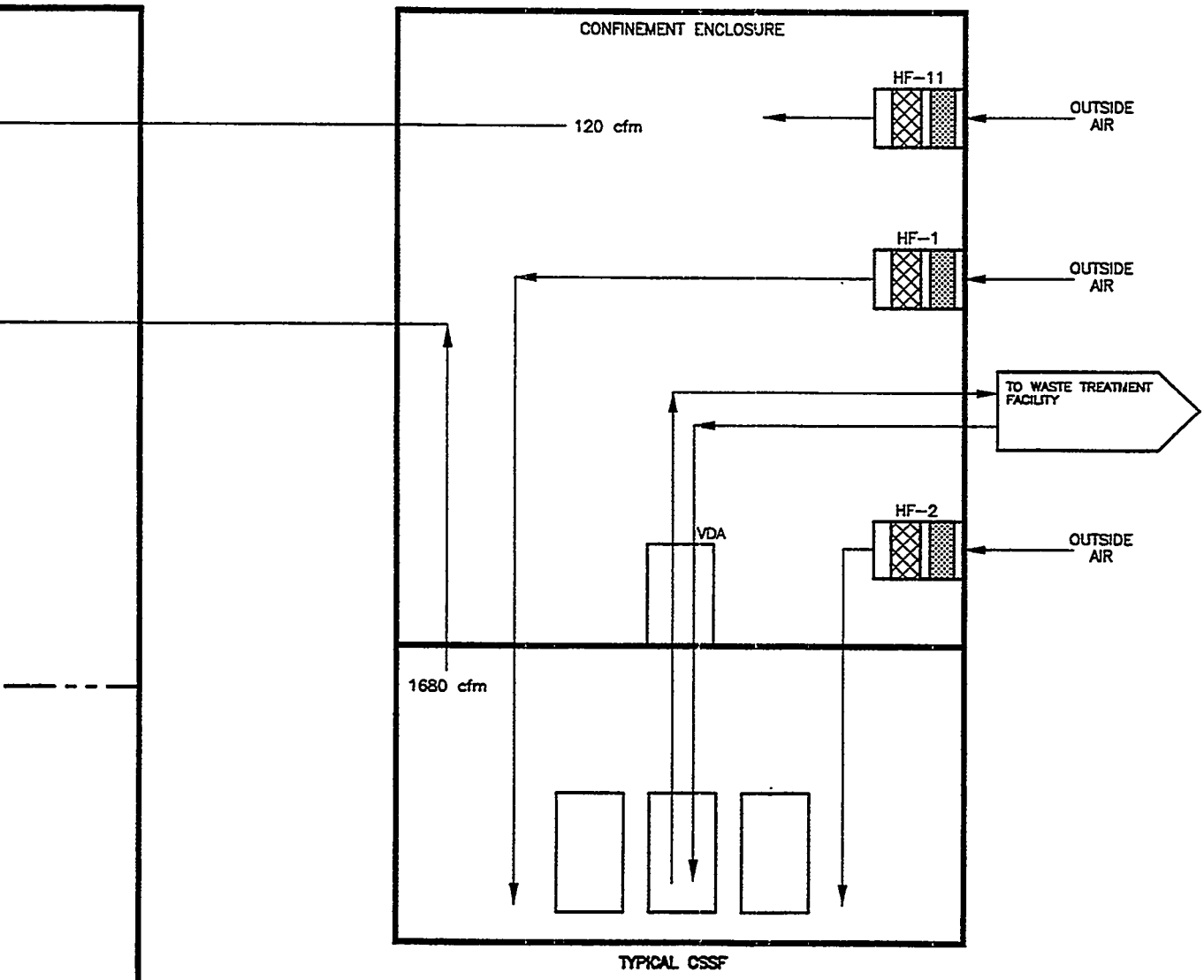
Drawing

CRT-01 HVAC Flow Diagram
CRT-02 Pneumatic Transport System
CRT-03 Intermediate Transport Station (ITS)
CRT-04 Site Plan for DCWO, HWO, and VWO
CRT-05 Site Plan for CWO



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REVISIONS		
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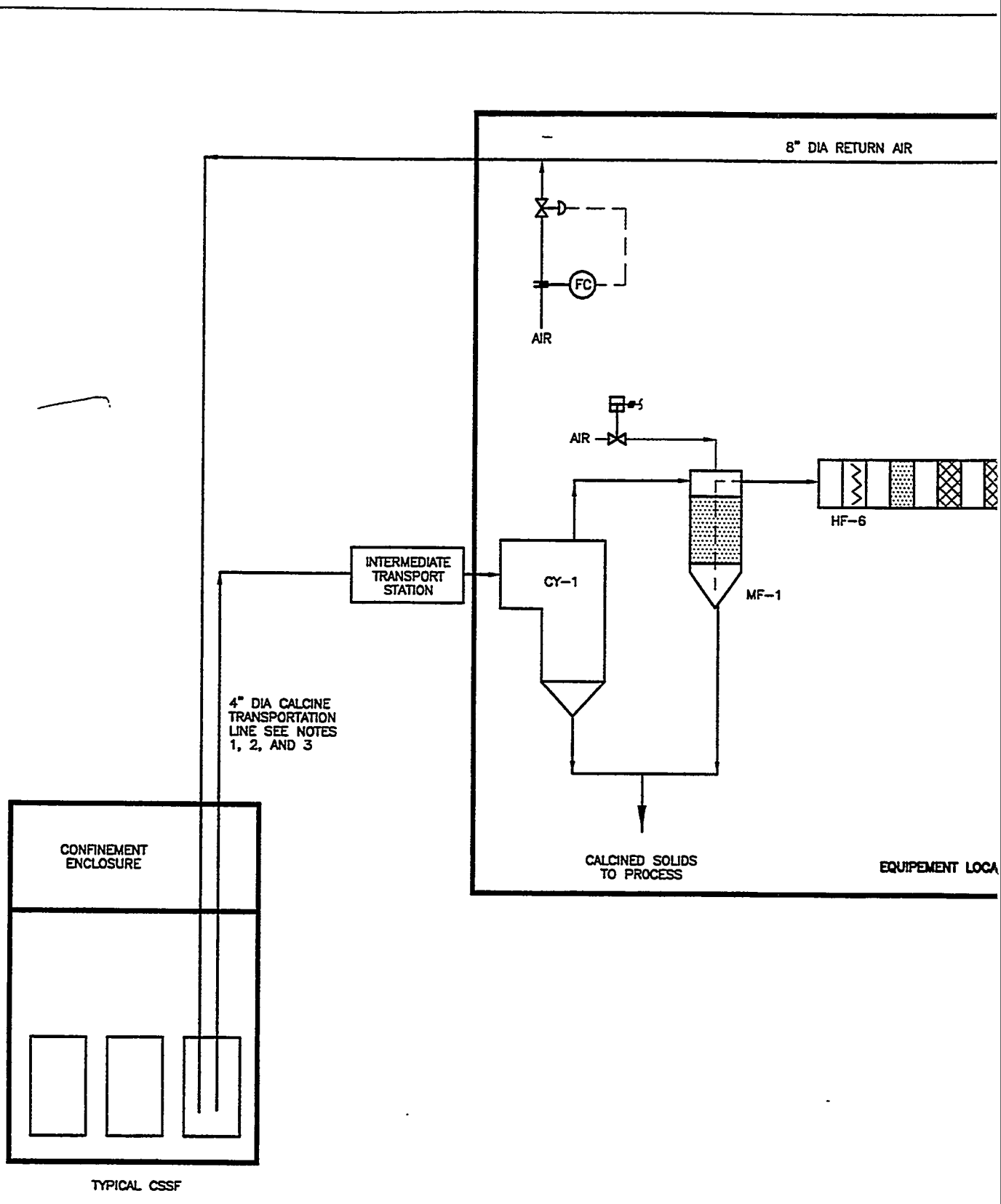
TYPICAL CSSF

LEGEND:

— — — — INDICATES ROOMS

———— INDICATES BUILDINGS

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DRAWN: AE GIBBS	CALCINE RETRIEVAL AND TRANSPORTATION SYSTEM
PROJECT NO.	HVAC FLOW DIAGRAM
SPEC CODE:	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE, CL, OSC 530; DWG–; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET CRT–01



TYPICAL CSSF

CY-1
CALCINE
TRANSPORT
CYCLONE
0.6m IDx2m
(2' IDx6')

MF-1
CALCINE
SINTERED METAL
FILTER
0.3 MICRON
7.3mx4.6m
22'-0"x14'-0"

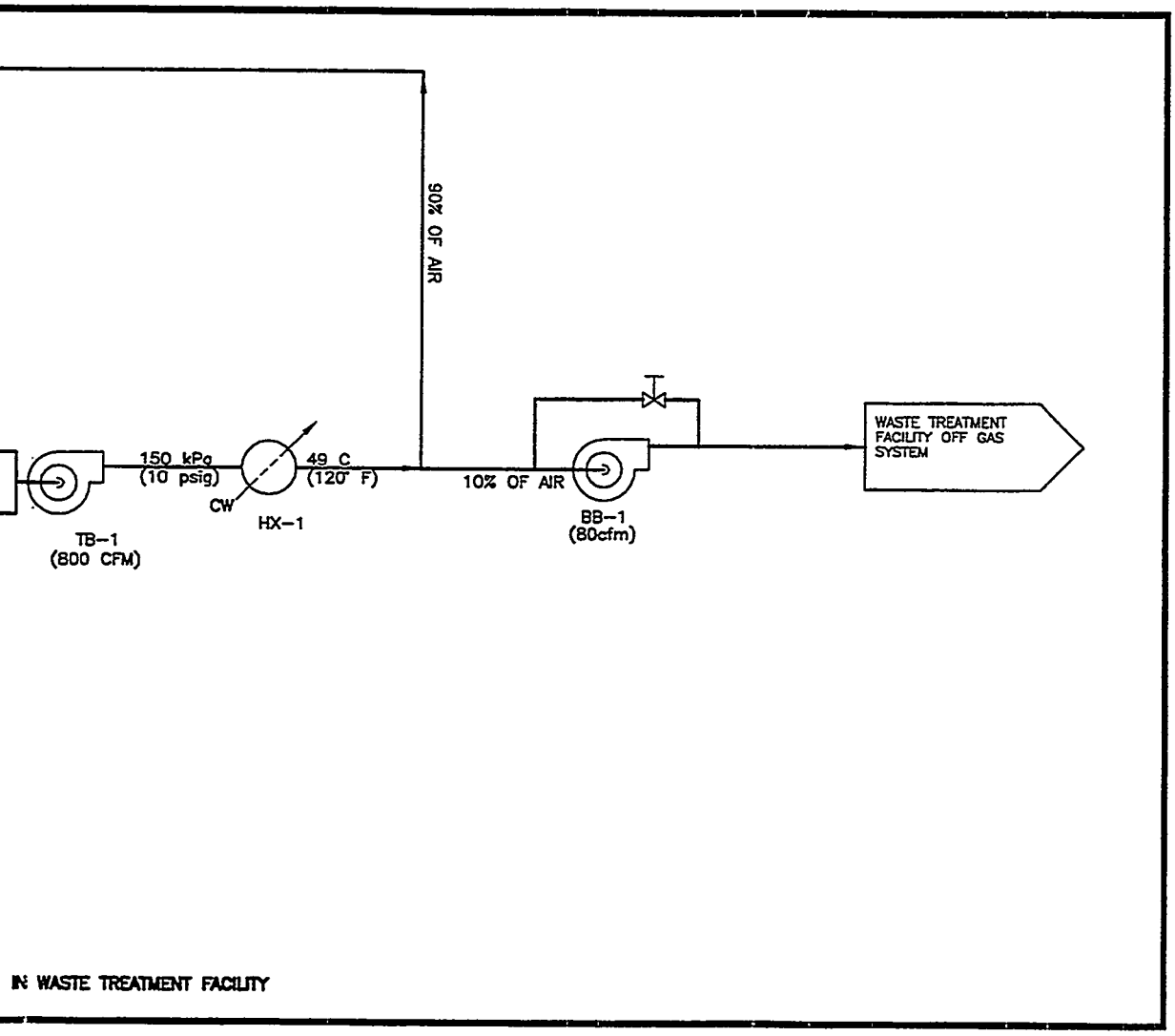
HF-6
CALCINE
FILTER TRAIN
0.3 MICRON
800 cfm

TB-1
TRANSPORT AIR
BLOWER
800 cfm

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8 7 6 5

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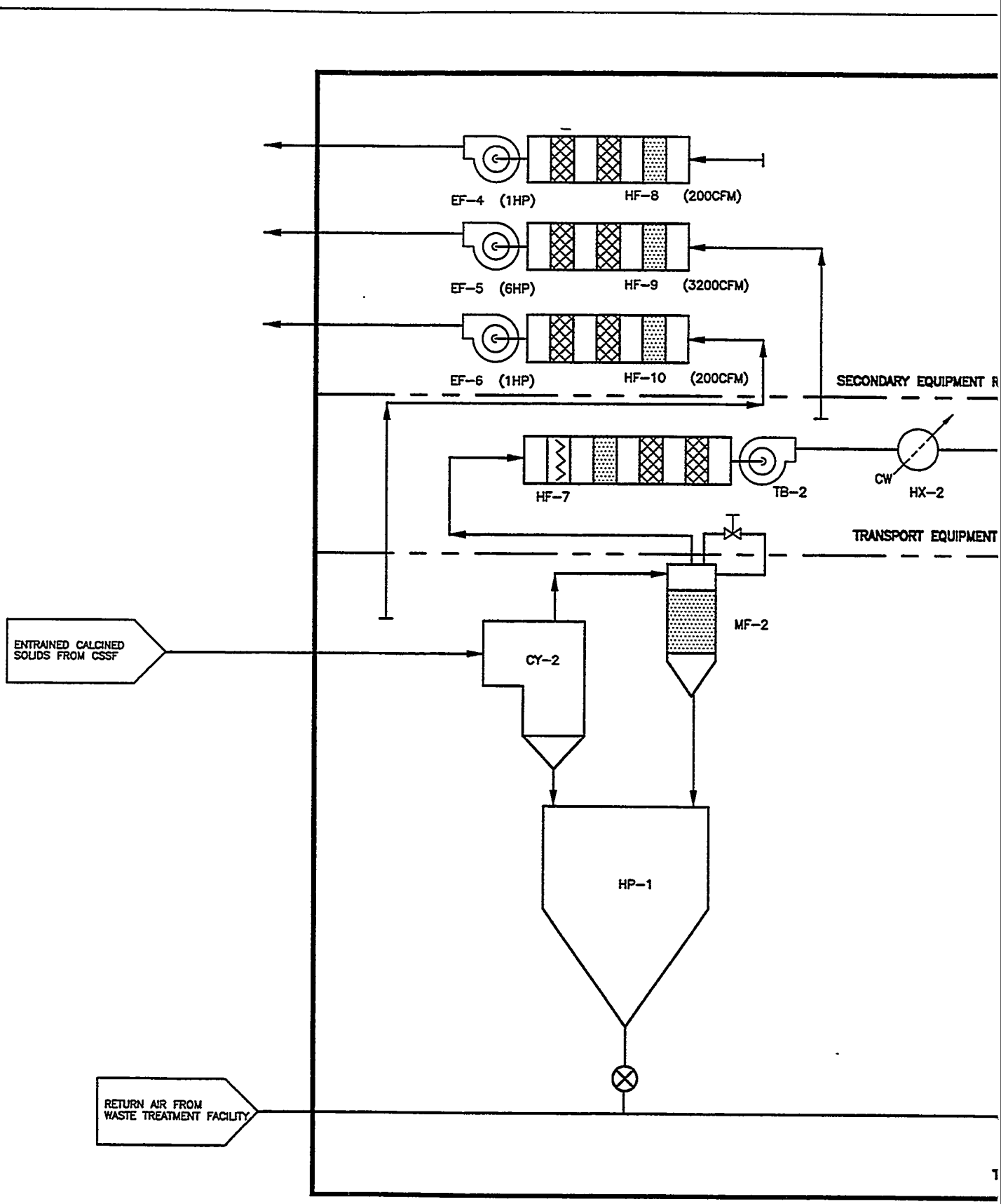
NOTES:

1. CALCINE TRANSPORT EQUIPMENT AND LINE SIZES BASED ON 2700kg/HR CALCINE FLOWRATE AND THE LONGEST TRANSPORT ROUTE (CSSF 3 TO WASTE TREATMENT FACILITY).
2. BACKUP CALCINE TRANSPORT LINE INSTALLED.
3. ROD OUT STATIONS LOCATED EVERY 200 FT ON STRAIGHT RUNS.
4. TWO SETS OF TRANSPORT EQUIPMENT ARE PRESENT IN THE PROCESSING FACILITY.

HX-1
CALCINE VACUUM
AFTERCOOLER
38kw (0.13 MBtu/hr)
0.3mx6.2m
1'-0x6.5'

BB-1
BALANCING AIR
BLOWER
80 cfm

SUBCONTRACT NO.	LOCKHEED MARTIN
REQUESTER:	ICPP
DESIGN:	WASTE TREATMENT FACILITIES
DRAWN: EM SNELL	CALCINE RETRIEVAL AND TRANSPORTATION SYSTEM
PROJECT NO.	PNEUMATIC TRANSPORT SYSTEM
SPEC CODE	
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EFFECTIVE DATE:	SCALE: NONE; SHEET CRT-02



CY-2
INTERMEDIATE CALCINE TRANSPORT CYCLONE
0.6m IDx2m
(2' IDx6')

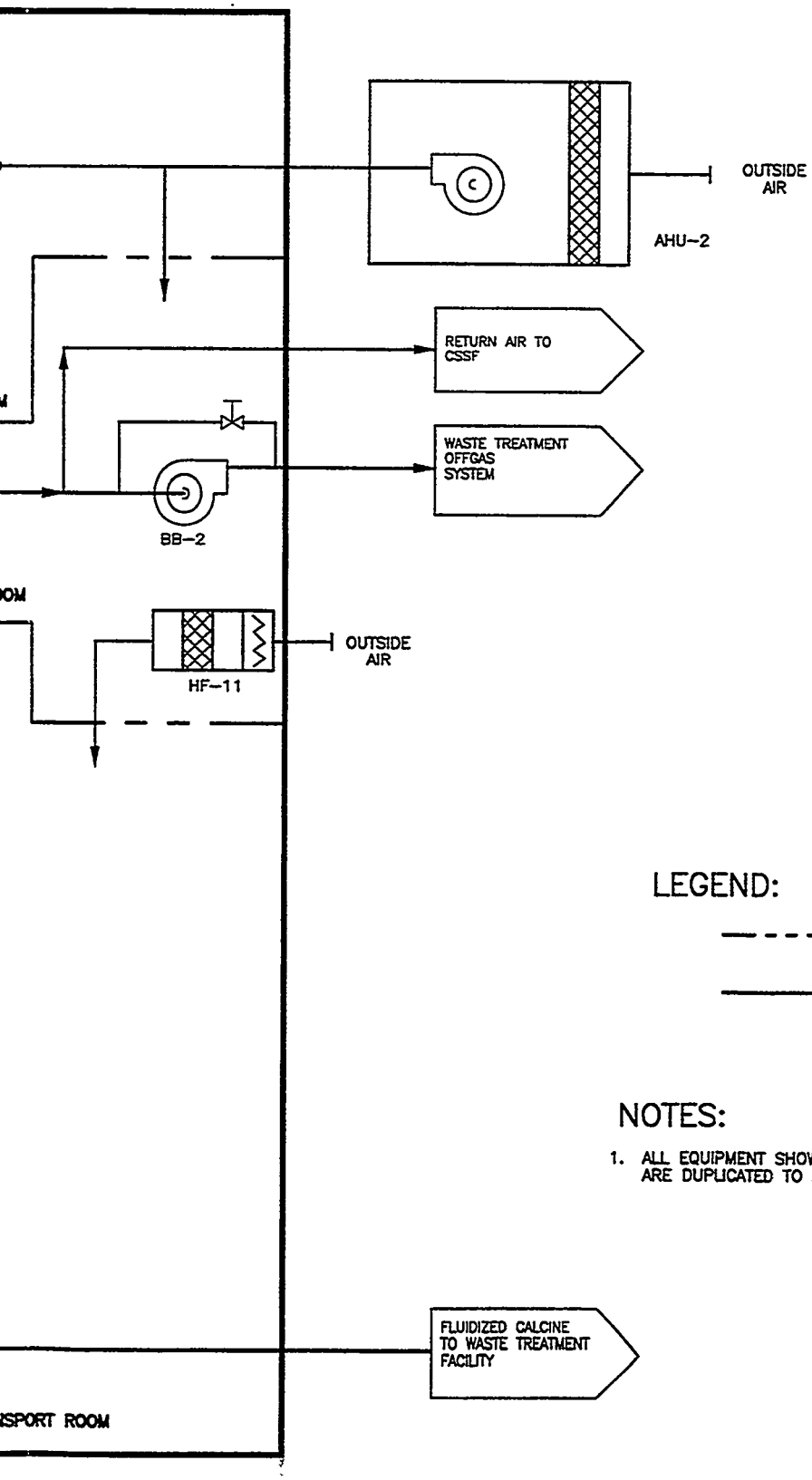
MF-2
INTERMEDIATE SINTERED METAL FILTER
0.3 MICRON
7.3mx4.6m
22'-0"x14'-0"

TB-2
INTERMEDIATE TRANSPORT AIR BLOWER
800 cfm

BB
INTERMEDIATE BALANCING AIR BLOWER
80 cfm

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Date: 01/27/98 - 10:22 A.M.

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



LEGEND:

– – – – – INDICATES ROOMS

——————— INDICATES BUILDINGS

NOTES:

1. ALL EQUIPMENT SHOWN IN TRANSPORT EQUIPMENT ROOM AND TRANSPORT ROOM ARE DUPLICATED TO ACCOMODATE TWO INDEPENDENT TRANSPORT SYSTEMS.

HX–2
INTERMEDIATE
AFTERCOOLER
38kw (0.13 MBtu/hr)
0.3mx6.2m
1'–0x6.5'

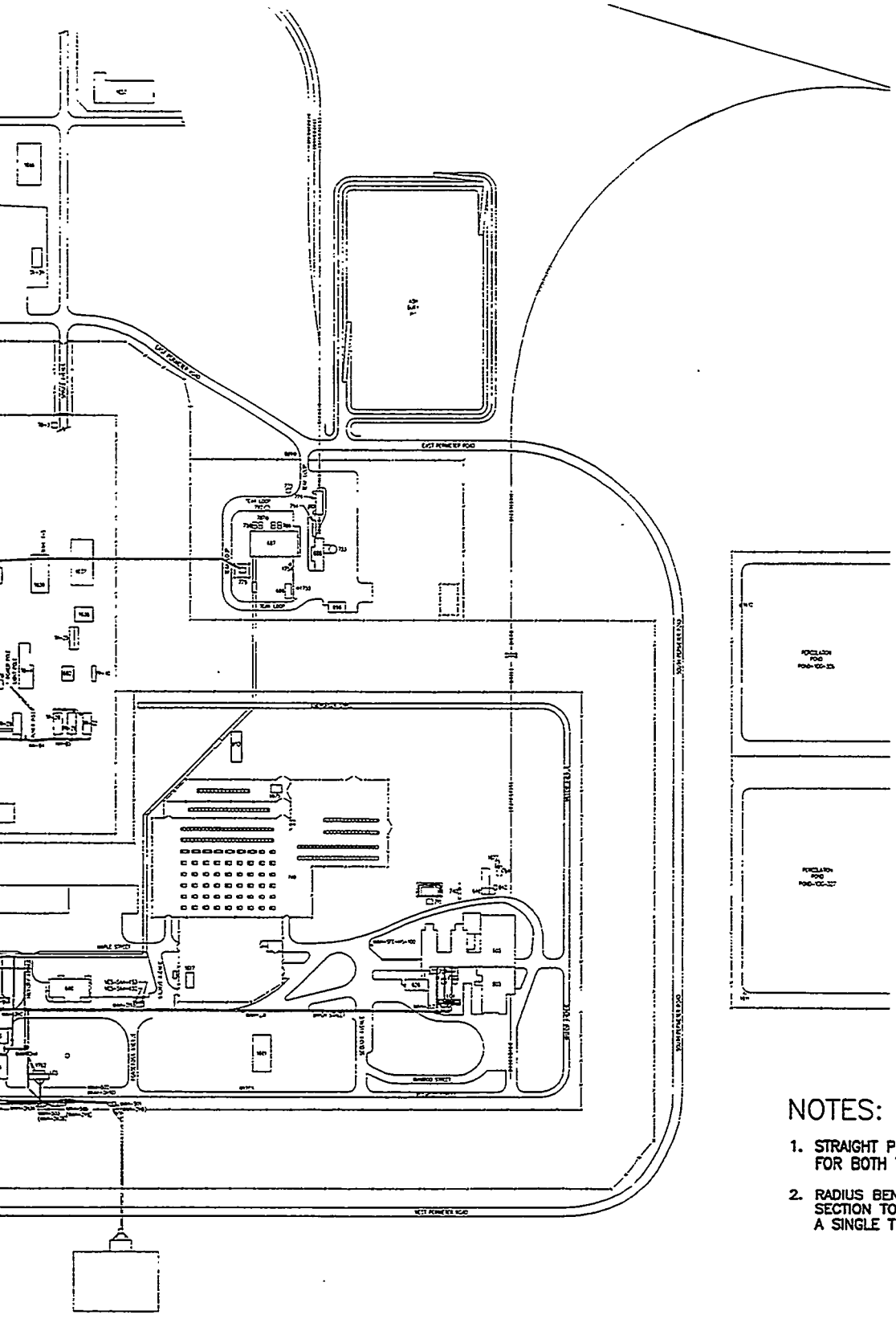
HP–1
INTERMEDIATE
TRANSPORT HOPPER
4.8 m3
170'–0"3

SUBCONTRACT NO.	LOCKHEED MARTIN
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DESIGN:	
DRAWN: EM SNELL	
PROJECT NO.	
SPEC CODE	
FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO. 1522	SIZE D; CAGE CODE 01MF3; INDEX CODE NUMBER AREA 200, TYPE, SI, SEQ 530; DWG–; REV
EFFECTIVE DATE:	SCALE: NONE; SHEET CRT–03

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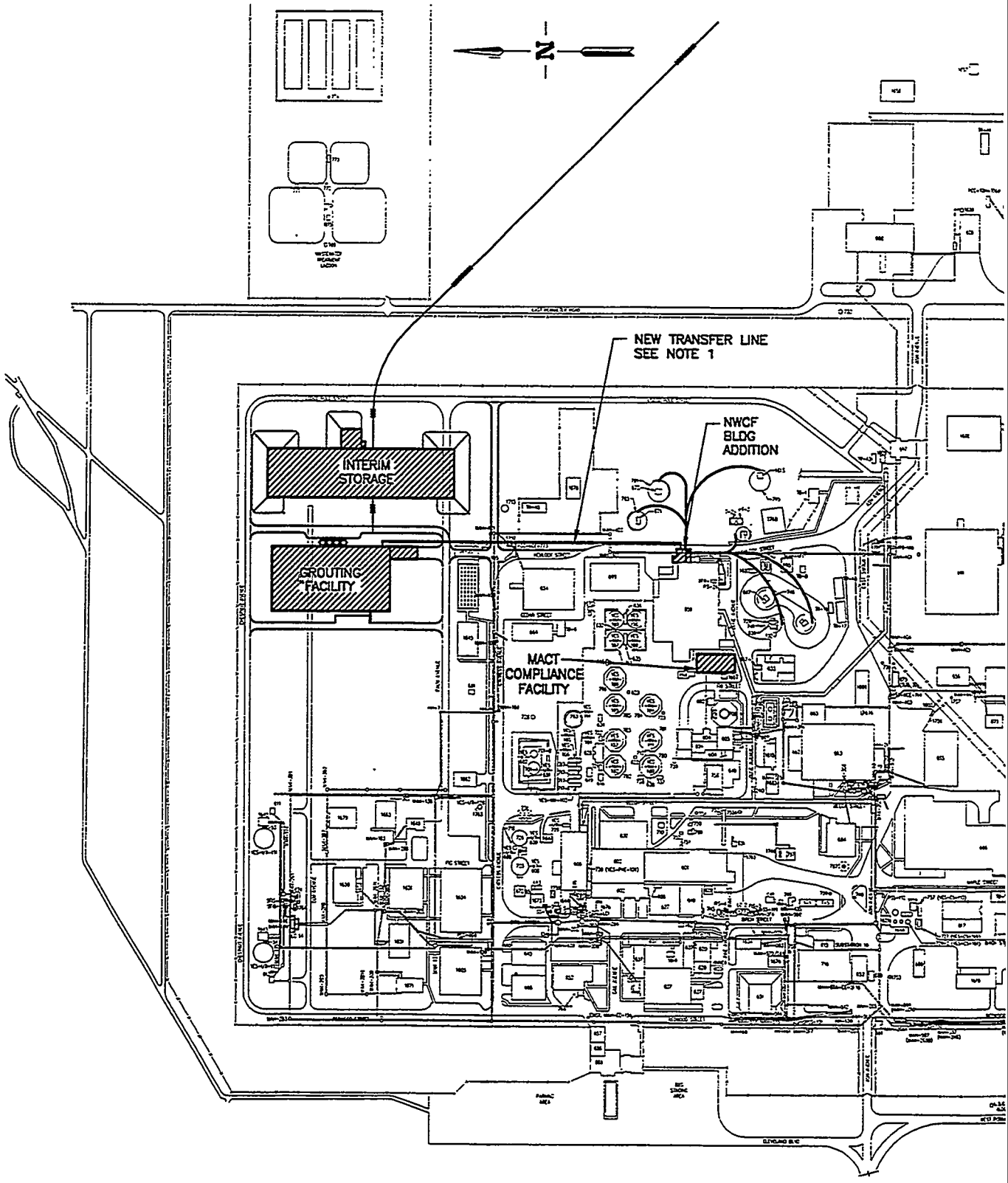
REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



NOTES:

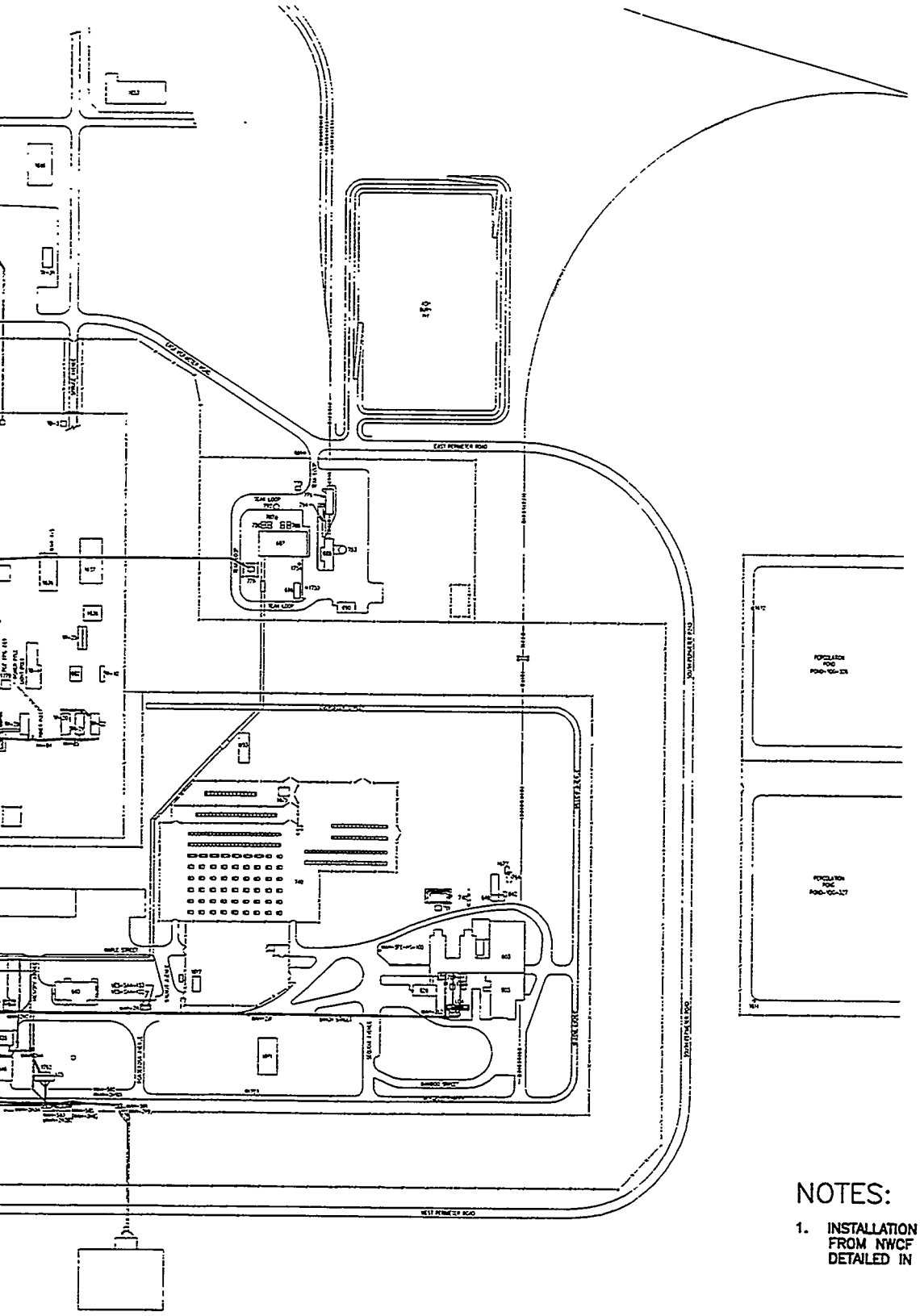
1. STRAIGHT PIPE SECTION CONTAINS PIPING FOR BOTH TRANSPORT SYSTEMS.
2. RADIUS BENDS FROM STRAIGHT PIPE SECTION TO CSSFS, CONTAINS PIPING FOR A SINGLE TRANSPORT SYSTEM.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
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	DESIGN:	
	DRAWN: ERIC E THOMAS	
	PROJECT NO.	SITE PLAN FOR HWO, VWO, & DCWO
	SPEC CODE	
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D | CAGE CODE: 01MF3 | INDEX CODE NUMBER: AREA 200 | TYPE 0100 | SI 02 | SEQ 530 | DWG-CRT-04 | REV
QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1"=200.0' | CWO | SHEET


N
NEW TRANSFER LINE
SEE NOTE 1
NWCF
BLDG
ADDITION
INTERIM
STORAGE
GROUTING
FACILITY
MACT
COMPLIANCE
FACILITY

SITE PLAN

REVISIONS		
REV	DESCRIPTION	EFFECTIVE DATE:



NOTES:

1. INSTALLATION & DESIGN OF TRANSPERT SYSTEM FROM NWCF TO THE GROUTING FACILITY IS DETAILED IN REFERENCE 13.

FOR DRAWING INDEX SEE DRAWING NO.	SUBCONTRACT NO.	LOCKHEED MARTIN
200' 100' 50' 0 200' SCALE: 1" = 200.0'	REQUESTER:	ICPP WASTE TREAMENT FACILITIES CALCINE RETRICIAL & TRANSPORTATION SYSTEM
	DESIGN:	
	DRAWN: ERIC E THOMAS	
	PROJECT NO.	
	SPEC CODE	SITE PLAN FOR CWO
DESIGN PHASE: SCOPING	FOR REVIEW/APPROVAL SIGNATURES SEE DAR NO.	SIZE: D; CAGE CODE: 01MF3; INDEX CODE NUMBER: AREA 200, TYPE 0100, O. 02, DISC 530; DWG-CRT-05; REV
QUALITY LEVEL: III	EFFECTIVE DATE:	SCALE: 1"=200.0'; CWO; SHEET

Appendix B

References

1. INEEL, *Waste Inventories / Characterization Study*, INEEL/EXT-97-00600, September 1997.

2. Fluor-Daniels, Inc. (Government Services Operating Company), *Idaho Chemical Processing Plant Waste Treatment Facilities Feasibility Study*, Delivery Order 94-36, 30% Design Review Package, June 1997, 60% Design Review Package, August 1997, and 90% Design Review, October 1997.

3. Raytheon Engineers and Constructors, Inc., *Idaho Chemical Processing Plant Bin Set 1 Calcine Recovery Project: Phase I and II Special Studies Report Volume I*, DE-AC07-89ID-12679, February 1995.

4. West Valley Nuclear Services Inc., *West Valley Nuclear Services, Inc. Remote Installation of Risers on Underground Nuclear Waste Storage Tanks*, DOE/NE/44139-45 (DE88010531), 1988.

5. INEEL, *HWMA Closure Plan for the Waste Calcining Facility at the Idaho National Engineering and Environmental Laboratory rev 2*, INEEL-96/0189, June 1997.

6. INEEL, *New Waste Calcining Facility Deactivation Option for Low-level Waste Grout Disposal*, INEEL/EXT-97/01076, December 1997.

7. Westra, A.G., J.S. Schofield, S.J. Horn, J.A. Hendricks, G.S. Pomiak, *Sampling of Stored High-Level Radioactive Calcined Waste at ICPP*, ICP-1186, May 1979

8. D. L. Griffith, *Status of Calcine Retrieval Development Work –DLG-06-96*, September 1996.

9. *Regulatory Requirements and Standard Criteria for the ICPP Proposed Waste Processing Facilities*, EDF-WTF-003.

10. *Regulatory Design Requirements for Waste Treatment Facilities*, EDF-WTS-004.

11. Calculations by Dan Griffith, December 1997 (included in this Appendix).

12. INEEL, *Calcined Solids Storage Facility Closure Study*, INEEL/EXT-97-01296, 1998.

13. INEEL, *Cementitious Waste Option Study Report*, INEEL/EXT-97-01400, 1998.

14. Estimates of Feed and Waste Volumes, Compositions, and Properties, EDF-FDO-011 rev. 1, 1998.

Memo of Conversation

Name	Organization	Phone
Dan Griffith	LMITCO Chief Engineer	6-3760
Sara Gifford	MC&I Engineering	6-5162

Date: 12 November 1997

Subject: Nozzle design and retrieval system efficiency

Discussion:

In the mock up facility, the retrieval method appears to be just as efficient (if not more so) for cylindrical bins as it is for annular bins. This is evidenced by returning the solids to the outer bin.

Previous designs indicate that it is not too difficult to design a nozzle that will prevent uptake of extraneous materials. The nozzles used in the Rover project shown that it not be a significant design effort to develop a nozzle for the retrieval lines.

Date: November 19, 1997

To: Sara Gifford

From: Dan Griffith

Subject: Pressure Drop in Proposed Pneumatic Transport System

As requested I have calculated pressure drop for four cases as shown below. All cases are vacuum systems with a length of 315 feet. Inlet pressure to the transport line is 12.3 psia. I assumed the transfer line was steel pipe.

Diameter Inches	Flow Rate at Blower cfm	Solids to Air Ratio lb/lb	Solids Flow kg/hr	Inlet Velocity fpm	Out. Vel. fpm	Pres. Drop psi
4.026	800	3.9	2700	4635	9049	6.0
4.026	350	6.0	2700	2993	3959	3.0
4.026	350	2.7	1360	3380	3959	1.8
3.068	175	2.7	680	2896	3409	1.9

These results do not include a return air line.

Note that for the first two cases the pressure at the blower will fall below 10 psia which is the pressure you specified. The first case may not be feasible for a vacuum system because of the high pressure drop. The second case may not be feasible for a vacuum system because the high solids to air ratio might result in transport line plugging. The other two cases also have a fairly high solids to air ratios, but I believe they are feasible. If it is important to achieve such high transfer rates, we should mock this up. I could test anything but the first case in my existing pilot plant. All we would need is a feeder to meter solids in at the desired rate and 300 feet of pipe. We could consider using plastic pipe to save money. We probably have components in the old pilot plant which we could use for the feeder.

Appedix C

Equipment List

Appendix C

Equipment List

Equipment ID	Equipment Title	Description	Qty.	Remarks
CSSF Access Method: HVAC				
AHU-1	Air Handling Unit	Air handling unit consists of a supply fan, heating coil, cooling coil, filters, and dampers	7	100% outside air unit to furnish air to the VIC buildings
HF-1, HF-2	HEPA Filter Unit	Unit consists of a prefilter, one stage of HEPA filter, and control dampers. 840 CFM	14	These units filter outside air supplied to each CSSF.
HF-3	HEPA Filter Unit	Unit consists of a prefilter, two stages of HEPA filter, and control dampers. 1680 CFm	7	This unit filters exhaust air from each CSSF.
HF-4	HEPA Filter Unit	Unit is a canister type consisting of one stage HEPA filter. 120 CFM	14	This unit filters exhaust air from the vault ventilation shack.
EF-1, EF-3	Exhaust Fan	Centrifugal exhaust fan 1/2 hp	14	The fan is part of the exhaust filter train for each CSSF.
EF-2	Exhaust Fan	Centrifugal exhaust fan 7 1/2 hp	7	The fan is part of the exhaust filter train for the vault ventilation equipment enclosure.
CSSF Access Method: Mechanical				
	Bridge Crane	10 ton cap. 30' span	7	Drilling platform placement and corrosion coupon retrieval
	Portable CO2 Decontamination System	Decontaminate vaults	1	Reuseable from CSSF to CSSF
	New Retrieval Risers	8" Sch 40	830'	w/ couplings each end 304L steel lines
	Shielded Windows	View inside confinement enclosure	14	
CSSF Retrieval System: Remote Equipment				
	Remote Drilling Platform a. Plug Removal Hoist b. Drill Motor c. Drill Bit Turret d. Remote Operating Station	Remotely drill through vault roof 8" Core w/ 1" pilot hole Bridge crane placement Remote drill bit exchange	1	Ventilation confinement Floor anchor bolts Core capture feature Safety barriers (handrail & signs) Maintain negative pressure Reuseable
	Protable Drilling Dust Collector with Exhaust Fan	Controls contamination spread 2000 CFM w/ HEPA filter	2	Availvable on site Reuseable

Equipment ID	Equipment Title	Description	Qty.	Remarks
	Remote Welding Equipment including Weld Inspection Unit	Remotely welds the risers to the bins. Then inspect the integrity of the welds.	1	Similar technology used in Reference 4 Reuseable
	Remote Hole Saw	Open bins into added retrieval risers	1	Capture core to prevent problems during retrieval Reuseable
	CCTV Equipment a. Camera Lens & Lighting b. Extension Tubes c. Video Workstation w/ Camera d. Switching Panel, 2 Monitors, Light Control e. TPZ Head Control, Drive Interface Patch Panel	Direct during retrieval riser installation, View inside of bins to ensure retrieval is complete.	7	Inspect riser welds
Calcine Retrieval System: Mechanical				
	Retrieval lines	rigid lines that form the suction and air jet lines; stainless steel	2310'	coupling at each end size:5" diameter
Calcine Retrieval System: Remote Equipment				
	Vertical Deployment Apparatus a. Plug Removal Hoist b. Rotation Drive c. Extension Tube Carousel/Turret d. Air Supply House Reel e. Confinement Casing f. Ladder & Platforms g. External Drives h. Telescoping Line with Lower Seal i. Vertical Position Indicator	Deploys extension pipe for retrieval risers 25' tall, 6'X6' base maximum Vestibule houses carousel Ventilation connection	7	Ventilation confinement SS casing for shielding Anchor to floor bolts Safety barrier (handrail & signs) Should be fitted so that it can be used to install retrieval risers as well as extend retrieval lines.
	Shielded Jumper	Connects discharge of retrieval system to the transport system	7	double wall, heavy wall pipe, shielded and independently mounted (steel flanged, gasketed)
Calcine Transportation System: HVAC (equipment located in Waste Treatment Facility)				
HF-6	Filter Train	Prefilter and 2 stage HEPA filters 380 L/s (800 cfm) 304L stainless steel	2	Filter air before entering transport air blower 380L/s (800 cfm)
Calcine Transportation System: Mechanical (equipment located in Waste Treatment Facility)				
BB-1	Balancing Air Blower	80 cfm	2	
TB-1	Transport Air Blower	380 L/s(800 cfm) at 69 kPa (10psi) 304L stainless steel	2	Provide transport air for system as well as suction and air jets

Equipment ID	Equipment Title	Description	Qty.	Remarks
MF-1	Sintered Metal Filter	0.3 micron 380 L/s (800 cfm) 22" X 14' 304L stainless steel	2	Removes calcine fines entrained in air exiting the cyclone and delivers to hopper
CY-1	Cyclone	0.3m ID X 0.6m (1' ID X 2') Raytheon recommends a longer length 3'-6'	2	Separates calcine from transport air and delivers it to facility hopper
HX-1	Heat Exchanger	38 kW (0.13 Mbtu/hr) 0.3m X 2.4m 380 L/s (800cfm) 304L stainless steel	2	Cools air from transport blower to acceptable operating temperature of the balancing air blower
	Flat Side Diverter Valve	Two-way stainless steel valve, electric motor controlled	21	Air tight valves void of leakage motor located outside of shielding to ease repair and maintenance
	Transport Air Lines	20 mm (8 in) 304L stainless steel (length depends on location of Waste Treatment Facility)	2	Provides air for the pneumatic transport system; recycled to reduce releases to the environment
	Calcine Transport Lines	10 mm (4 in) 304L stainless steel (length depends on location of Waste Treatment Facility)	4	Transport calcine from the CSSF to processing facility
	Encasement Lines	15 mm (6 in) 304L stainless steel (length depends on location of Waste Treatment Facility)	4	Encase calcine transport lines
Calcine Transportation System: HVAC (Additional for DCWO, HWO, VWO: equipment located in Intermediate Transport Station)				
AHU-2	Air Handling Unit	Air handling unit consists of a supply fan, heating coil, cooling coil, filters, and dampers	1	100% outside air unit to furnish air to the ITS
HF-7	Filter Train	Prefilter and 2 stage HEPA filters 380 L/s (800 cfm) 304L stainless steel	2	Filter air before entering transport air blower 380L/s (800 cfm)
HF-8	Filter Train	Prefilter and 2 stage HEPA filters 200 cfm	1	Filter air exiting Secondary Equipment Room in ITS
HF-9	Filter Train	Prefilter and 2 stage HEPA filters 3200 cfm	1	Filter air exiting Transport Equipment Room in ITS
HF-10	Filter Train	Prefilter and 2 stage HEPA filters 200 cfm	1	Filter air exiting Transport Room in ITS

Equipment ID	Equipment Title	Description	Qty.	Remarks
HF-11	Prefilter	Prefilter and single stage HEPA filter	1	Filter air entering Transport Room in ITS
EF-4	Exhaust Fan	Centrifugal exhaust fan 1 hp	1	Exhaust fan for Secondary Equipment Room in ITS
EF-5	Exhaust Fan	Centrifugal exhaust fan 6 hp	1	Exhaust fan for Transport Equipment Room in ITS
EF-6	Exhaust Fan	Centrifugal exhaust fan 1 hp	1	Exhaust fan for Transport Room in ITS
Calcine Transportation System: Mechanical (For DCWO, VWO, HWO: equipment located in Intermediate Transport Station)				
BB-2	Balancing Air Blower	80 cfm	2	
TB-2	Transport Air Blower	380 L/s(800 cfm) at 69 kPa (10psi) 304L stainless steel	2	Provide transport air for system as well as suction and air jets
MF-2	Sintered Metal Filter	0.3 micron 380 L/s (800 cfm) 22" X 14' 304L stainless steel	2	Removes calcine fines entrained in air exiting the cyclone and delivers to hopper
CY-2	Cyclone	0.3m ID X 0.6m (1' ID X 2') Raytheon recommends a longer length 3'-6'	2	Separates calcine from transport air and delivers it to facility hopper
HX-2	Heat Exchanger	38 kW (0.13 Mbtu/hr) 0.3m X 2.4m 380 L/s (800cfm) 304L stainless steel	2	Cools air from transport blower to acceptable operating temperature of the balancing air blower
HP-1	Transport Hopper	4.8 m3	2	Collects calcine from first leg of transport system and delivers it to the second leg of the transport system

Appendix D

Background for Project Data Sheets

Table 6 is repeated here for convenience. The justifications for the data entered in this table are found below along with brief explanations. Reference letters coordinate the data.

Table D-1. Input to Project Data Sheet

Generic Information			
Structure Size (m^2)	Seven Confinement Enclosures which are each 40 ft X 40 ft (978 m^2 total) Seven VIC Buildings which are each 40 ft X 60 ft (1560 m^2 total) One ITS Building that is 600 ft^2 (55.7 m^2)		A
Location	A Confinement Enclosure will be built on the roof of each CSSF. A VIC Building will be built adjacent to each CSSF. An ITS Building will be built mid way between the CSSFs and the Waste Treatment Facility.		
Construction Information			
Cost ($): Preconstruction (escalated included)	CWO, DCWO, HWO, VWO & TRU Separations Options		B
Conceptual Design	$ 18,000,000		
Project Management	$ 2,700,000		
Permitting and Documentation	$ 4,800,000		
Start Up Activities	$ 5,100,000		
Contingency	$ 10,500,000		
Total Preconstruction	$ 41,100,000		
Cost ($): Construction (escalation included)	CWO & TRU Separations Options	DCWO, HWO, & VWO	
Engineering, Design, and Inspection	$ 18,500,000	$ 19,400,000	C
Management Reserve (PM/CM)	$ 22,900,000	$ 23,500,000	
Construction	$ 104,200,000	$ 106,500,000	
Government Furnished Eqiupment	$ 18,200,000	$ 19,300,000	
G&A/PIF	$ 10,400,000	$ 10,700,000	

Procurement Fees, Management Reserve, and Contingency	$ 64,600,000	$ 66,600,000	
Total Construction	$ 238,800,000	$ 246,100,000	
Schedule start/end: Preconstruction	1/1/2004 – 12/31/2007		
Schedule start/end: Construction	1/1/2008 – 12/31/2013		
Number of workers each year of construction	100 workers per year		D
Number of radiation workers (construction)	90 workers per year		
Average annual worker radiation dose (rem/yr)	252 mrem/yr per worker		E
Heavy equipment			F
Equipment used	Mobile crane, roll off truck, loader, bulldozer, and cement truck		
Trips	Cycle time/operation not applicable		
Hours of operation	12,480 hr (total)		
Acres disturbed and duration of disturbance	0.5 acres for VIC Buildings, Transport Line Chase, ITS building and ramps		G
Air emissions			H
Major gases (CO2, H2O, O2, N2)	7,255 tons (total)		
Contaminants (Particulates, CO, NOx, SO2, hydrocarbons)	42.5 tons (total)		
Radioactive wastes			I
Type (Quantity)	Contaminated fill (1500 yd^3)		
	Steel/asbestos (279,000 lb)		
	Lead bricks/mixed wastes (4,900 lb)		
Energy requirements			J
Electrical (MWh/yr)	156 MWh/yr		
Fossil fuel (liters)	283,452 liters (total)		
Permits needed for construction	NEPA documentation (prior to start of Title II construction); New stationary sources/PTC/NOC/PSD for non-rad air emissions; HAP's and TAP's and RCRA (part AA, BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; reports and specifications for drinking water supply; RCRA Part A and Part B permits.		

Operational Information

Cost ($): Operations (includes contingency but not escalation)	CWO	TRU Separations Options	DCWO, HWO, VWO
			K
Facility Operations	$ 1,218,000	$ 4,661,000	$ 4,761,000
Utilities	$ 1,054,000	$ 4,158,000	$ 4,158,000
Maintenance of Equipment	$ 7,866,000	$ 28,840,000	$ 28,840,000
Building Maintenance	$ 9,255,000	$ 33,933,00	$ 35,120,000
Total Operations	$ 19,393,000	$ 71,594,000	$ 72,781,000

Schedule start/end

5-Year Operation: 1/1/13 – 1/1/18

20-Year Operation: 1/1/13 – 1/1/33

Number of workers each year of operation (new/existing) L

	5-Year Operation	20-Year Operation
Managers	0.5	0.25
Engineers and other technicians	0.75	0.5
Supervisors and Administration/Support	3	2
Operators	6	3
Maintenance	1	1

Number of radiation workers

5-Year Operation: 10 workers

20-Year Operation: 6 workers

Average annual work radiation dose (rem/yr) 192 mrem/year per worker M

Air Emissions N

Type (radioactive/chemical) Calcine

Quantity (Ci/year, tons/year)

CWO Option: 5.6×10^{-6} ton/year

TRU Separations Options: 1.4×10^{-6} ton/year

DCWO, HWO, VWO Options: 2.8×10^{-6} ton/year

Release of Ci/year dependent on the type and storage length of the calcine released.

Energy Requirements O

Electrical (MWh/yr)

CWO Option: 93.2 MWh/yr

TRU Separations Options: 74.1 MWh/yr

DCWO, HWO, VWO Options: 88.7 MWh/yr

Permits needed (for facility operations)

HAP's and TAP's and RCRA (part AA, BB, and CC for air) for hazardous air emissions; air operating permit; NESHAP's, NPDES, NESHAP's subpart H for rad air emissions; approval of Engineering Plans; Cross Connection Control Plans; report specifications for drinking water supply; RCRA Part A and Part B permits.

Decontamination & Decommissioning (D&D) Information

Cost ($): DD&D (Unescalated)	CWO	TRU-Separations Options	DCWO, HWO, & VWO
Decommission	$ 2,555,000	$ 2,555,000	$ 2,681,000
Decontamination	$ 7,223,000	$ 7,223,000	$ 7,415,000
Demolition	$ 4,935,000	$ 11,557,000	$ 11,864,000
Total DD&D	$ 14,713,000	$ 21,335,000	$ 21,960,000

P

Schedule start/end: D&D	CWO: 1/1/2018 – 12/31/2018 Q TRU-Separations Options: 1/1/2034 – 12/31/2034 DCWO, HWO, & VWO: 1/1/2034 – 12/31/2034
Number of workers each year of D&D (new/existing)	CWO: 108 TRU-Separations Options: 155 DCWO, HWO, & VWO: 160
Number of radiation workers (D&D)	CWO: 75 TRU-Separations Options: 104 DCWO, HWO, VWO: 102
Average annual worker radiation dose (rem/yr)	252 mrem/yr for each worker R
Heavy equipment	S
Equipment used	Mobile Cranes, Roll-off Trucks, Dozers, Loaders, cement trucks, and other specialty equipment used during D&D
Hours of operation	CWO: 4,992 hr TRU-Separations Options: 6,240 hr DCWO, HWO, & VWO: 7,488 hr
Acres disturbed and duration of disturbance	CWO & TRU-Separations Options (transport lines only): 0.09 acre T DCWO, HWO, & VWO (ITS & transport lines): 0.11 acre
Air emissions	U
Major gases (CO_2, H_2O, O_2, N_2)	CWO: 2,902 tons (total) TRU-Separations: 3,627 tons (total) DCWO, HWO & VWO: 4,353 tons (total)
Contaminants (Particulates, CO, NO_x, SO_2, hydrocarbons)	CWO: 17 tons (total) TRU-Separations: 21 tons (total) DCWO, HWO, & VWO: 25 tons (total)

Solid wastes	V
Type	Metal building and uncontaminated transport equipment
Quantity (m^3)	CWO & TRU-Separations Options: 45 m^3 DCWO, HWO, & VWO options: 90 m^3
Radioactive wastes	Cyclones, metal filters, and hoppers from transport system
	W
Type and Quantity	CWO & TRU-Separations Options: 1.2 m^3 DCWO, HWO, & VWO options: 2.6 m^3
Energy requirements	X
Electrical (MWh/yr)	156 MWh/yr (based on John Duggan's estimate of 3000kWh/wk, 52 wk/yr)
Fossil fuel (liters)	CWO: 113,380 liters TRU-Separations Options: 141,725 liters DCWO, HWO, & VWO: 170,070 liters
Permits needed (e.g. for facility closures, physical characteristics and quantities of radioactive and hazardous materials remaining after closure)	Work will be done under closure provisions f existing permits

A. Confinement Enclosures: (30 ft 6 in. X 30 ft 6 in.) + 6(40 ft X 40 ft) = 10530 ft^2 = 978 m^2
VIC Buildings: 7(40 ft X 60 ft) = 16,800 ft^2 = 1560 m^2
ITS building: 600 ft^2 = 55.7 m^2

B. Preconstruction costs taken from the Cost Estimate prepared by Frosty Hanson (see escalated summary sheets in Appendix F). The reported costs reflect the cost associated with CSSFs 1-7, installation of D&D risers, removal of corrosion coupons, and the appropriate transportation system. The values reported include escalation, contingency, and management and management reserve.

C. Construction costs taken from the Cost Estimate prepared by Frosty Hanson (see escalated summary sheets in Appendix F). The reported costs reflect the cost associated with CSSFs 1-7, installation of D&D risers, removal of corrosion coupons, and the appropriate transportation system. The values reported include escalaton.

D. The number of construction workers per year was developed from information provided by F. P. Hanson in the capital cost estimate. A spreadsheet details how the number of construction workers was developed. The number of rad workers was taken as a high percentage (90%) of the total number of workers due to the nature of the construction work. Typically, the number of rad workers is closer to 80% of the total work force. In this case, the electricians, welders, and other finishing personnel should receive rad worker training.

E. Entry into and demolition work will occur in highly contaminated areas throughout the construction phase of the project. The historical dose rates at ICPP were examined to develop a reasonable estimate of the worker dose. The average annual worker dose rates at ICPP were examined for the period 1994-1996. The dose rates were highest in 1995 when a significant amount of work was completed on the tank farm. It was assumed that the 1995 dose would be representative of the average annual worker dose rate during construction. The average annual worker dose rates for 1994-1996 at ICPP are reported in a memo "Average Worker Dose Rate at ICPP" dated 11/24/97.

F. The most prominent pieces of heavy equipment used during the construction phase of this project include a mobile crane, roll off truck, loader, bulldozer, and cement truck. It is estimated that at any given time an average of 4 vehicles will be in operation during the 5-year construction period. Each vehicle was assumed to operate for 624 hr/yr (which is approximately 1/3 of a man-year). The hours of operation are (4 vehicles)(624 hr/vehicle*yr)(5 yr) =12,480 hr.

G. For CWO and TRU-Separations Options:
VIC Buildings: 1560 m^2 = 0.39 acre (approximately the VIC building footprint)
Transport Lines: (800 ft) (5 ft) = 4000 ft^2 = 0.09 acre (approximately the footprint of the shielding chase)
Total = 0.48 acre which is approximately 0.5 acre

For DCWO, HWO, and VWO options:
VIC Buildings: 1560 m^2 = 0.39 acre (approximately the VIC building footprint)
Transport Lines: (925 ft) (5 ft) = 4625 ft^2 = 0.1 acre (approximately the footprint of the shielding chase)
ITS building: 600 ft^2 = 0.01 acre
Total = 0.5 acre

H. The construction air emissions are primarily derived from emissions of heavy equipment. A spreadsheet was developed by Rod Kimmitt to analyze the air emissions produced by heavy equipment. A copy of the spreadsheet is attached for the calcine retrieval and transportation system.

I. An estimate of the radioactive wastes removed from CSSF 1 is made in reference 3. This estimate includes removal of equipment and concrete vaults. The removed contaminated fill is estimated to be 1,500 yd^3. The removed steel and suspected asbestos material is estimated to weigh 5,300 lb. The lead bricks are estimated to weigh 300 lb. These estimates were used as the basis for the radiactive wastes removed from CSSF 2 – 7.

CSSF 2 and 3 are estimated to be similar to CSSF 1 because similar construction will occur on these CSSFs. However, the amount of contaminated fill is assumed to be negligible. There is no need to (except no contaminated fill is removed).

CSSF 4, 5, 6, and 7 are expected to have less concrete and steel removed because the superstructure vaults will not be demolished. There is no fill removal for these CSSFs.

Equipment (steel) that is removed is estimated to weigh about 3,000 lb. The lead bricks are assumed to weigh 1,000 lb.

Contaminated fill:	1,500 yd^3
Steel and suspected asbestos material:	3(5,300 lb) + 4(3,000 lb) = 279,000 lb
Lead bricks and mixed waste:	3(300 lb) + 4 (1,000 lb) = 4,900 lb

J. The electrical energy requirement is derived from John Duggan's suggestion that construction requires 3000 kWh/wk. (3000 kWh/wk)(52wk/yr) = 156MWh/yr. The estimated fossil fuel consumed during the construction phase of this project was determined from an average value for fuel consumption of heavy equipment. The John Deere Construction equipment web page (www.deere.com) indicates an average fuel consumption of heavy equipment to be 6 gal/hr. (6 gal/ hr)(12,480 hr) = 74,880 gal = 283,452 liters.

K. Operational costs are derived from the Cost Estimate prepared by Bob Turk. The operational costs associated with retrieving calcine from CSSF 1-7 and transport system, installation of D&D risers, and removal of corrosion coupons are included. These values are not escalated.

L. Operational crew requirements were developed with the assistance of Jack Prendergast for the 5-year and 20-year operations options. The number of radiation workers was derived from the number of operators, maintenance workers, and other technicians.

M. The average value of the average annual dose rates at ICPP for 1994-1996 was used to determine the average annual work radiation does rate during operations. The average over the 3 year period is more representative of work that would occur during the operations phase of the calcine retrieval and transportation system. (180 mrem/yr + 252 mrem/yr + 143 mrem/yr) / 3 = 192 mrem/yr. See attached memo (also referenced in E).

N. During normal operations and idle time for each CSSF, air emissions are assumed to be negligible due to the multiple layers of confinement. These layers include several stages of HEPA filters. Air emissions were estimated for the exhausted transport air. This estimate is developed for the transport air after it has been through a two stage HEPA filter. The air emissions are primarily composed of calcine particles. The radioactivity of the calcine emitted to the environment varies depending upon the type of calcine and its length of storage.

Assuming the cyclone will have 99% efficiency, the sintered metal filter will have 99.9% efficiency, and the HEPA filter will have 99.97% efficiency. Rod Kimmitt provided these efficiencies.

Calcine remaining in the transport air after HEPA filters:
(0.01)(0.001)(0.0003)(2700 kg/hr) = 0.009 g/hr

Total hours each transport system must operate:
(5435 m^3)(1400 kg/ m^3)(1 hr/5400kg) = 1409 hr

For CWO (5-Year Operations):
Assuming all the transport air is exhausted through the Waste Treatment Facility off-gas system.

The transportation system will release:
$2(0.009 \text{ g/hr})(1409 \text{ hr}) = 25 \text{ g} = 2.8 \times 10^{-5} \text{ ton}$

The total air emissions from both transportation systems are 2.8×10^{-5} ton for 5-years (5.6×10^{-6} ton/yr).

For TRU Separations Options (20-Year Operation):
Assuming all the transport air is exhausted through the Waste Treatment Facility off-gas system.

The transportation system will release:
$2(0.009 \text{ g/hr})(1409 \text{ hr}) = 25 \text{ g} = 2.8 \times 10^{-5} \text{ ton}$

The total air emissions from both transportation systems are 2.8×10^{-5} ton for 20-years (1.4×10^{-6} ton/yr).

For DCWO, HWO, and VWO (20-Year Operation):
Assuming all the transport air is exhausted through the Waste Treatment Facility off-gas system.

The transportation system will release:
$4(0.009 \text{ g/hr})(1409 \text{ hr}) = 50 \text{ g} = 5.6 \times 10^{-5} \text{ ton}$

The total air emissions from the 4 transportation system legs are 5.6×10^{-5} ton for 20-years (2.8×10^{-6} ton/yr).

For actual operations the air emissions would be much lower because 90% of the air is recycled in the transportation system. These calculations assume that all of the transport air is released through the facility off-gas system.

O. The power requirement is determined by the power needs of the transportation equipment, ventilation equipment, and VDA. The transport air blower and balancing air blower require 37.8 kW and 4 kW of power, respectively. The exhaust fans (EF-1 and EF-3) require 50 W of power. The remaining exhaust fan (EF-2) requires 1 kW. The VDA is estimated to require 15 kW. These power consumption values used to compute the power requirement are estimates based on manufacturer specifications.

For CWO (5-Year Operation):
The transportation system operates 10.8 hr/wk for 26 wk/yr. The ventilation blowers in each VIC building operated 24 hr/day everyday. The VDA is estimated to be in operation approximately 3 hr/wk during calcine retrieval.

$$Power = 2\left(10.8\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(37.8kW + 4kW)$$
$$+7\left(24\frac{hr}{day}\right)\left(365\frac{day}{yr}\right)(2(0.05kW) + 1kW)$$
$$+2\left(3\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(15kW) = 93.2\frac{MW \cdot hr}{yr}$$

For TRU Separations Options (20-Year Operation):
The transportation system operates 2.7 hr/wk for 26 wk/yr in this alternative. The ventilation blowers in each VIC building operate 24 hr/day every day. The VDA is estimated to be in operation approximately 1 hr/wk during calcine retrieval.

$$Power = 2\left(2.7\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(37.8kW + 4kW)$$
$$+7\left(24\frac{hr}{day}\right)\left(365\frac{day}{yr}\right)(2(0.05kW) + 1kW)$$
$$+2\left(1\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(15kW) = 74.1\frac{MW \cdot hr}{yr}$$

For DCWO, HWO, VWO (20-Year Operation):
There are 4 transportation system legs operating 2.7 hr/wk for 26 wk/yr in these alternatives. Therefore, there are 4 transport air blowers and 4 balancing air blowers. The ventilation blowers in each VIC building operate 24 hr/day every day. The VDA is estimated to be in operation approximately 1 hr/wk during calcine retrieval. Additionally, the ventilation blowers in the ITS run 24 hr/day every day. The power requirement for EF-4 and EF-6 is estimated to be 100 W each. The power requirement for EF-5 is estimated to 800 W based on the estimate for EF-2.

$$Power = 4\left(2.7\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(37.8kW + 4kW)$$
$$+7\left(24\frac{hr}{day}\right)\left(365\frac{day}{yr}\right)(2(0.05kW) + 1kW)$$
$$+2\left(1\frac{hr}{wk}\right)\left(26\frac{wk}{yr}\right)(15kW) + \left(24\frac{hr}{day}\right)\left(365\frac{day}{yr}\right)(2(0.1kW) + 0.8kW)$$
$$= 88.7\frac{MW \cdot hr}{yr}$$

P. D&D costs taken from life cycle cost estimate developed by Bob Turk. See Appendix F. The numbers presented are not escalated.

Q. The number of workers needed during D&D was developed from the unescalated D&D costs (See Appendix F). The unescalated costs for each option was inputed into a spreadsheet developed by Rod Kimmitt. The spreadsheets are attached.

R. D&D work will occur in highly contaminated areas of the transportation system. The historical dose rates at ICPP were examined to develop a reasonable estimate of the worker dose. The average annual worker dose rates at ICPP were examined for the period 1994-1996. The dose rates were highest in 1995 when a significant amount of work was completed on the tank farm. It was assumed that the 1995 dose would be representative of the average annual worker dose rate during construction. The average annual worker dose rates for 1994-1996 at ICPP are reported in a memo "Average Worker Dose Rate at ICPP" dated 11/24/97. The dose during the D&D phase was assumed to be the same as during the construction phase of the project.

S. The most prominent pieces of heavy equipment used during the D&D phase of this project include a mobile crane, roll off truck, loader, bulldozer, cement trucks, and other specialized demolition equipment.

For the CWO options, it is estimated that at any given time an average of 8 vehicles will be in operation during the 1-year construction period. Each vehicle was assumed to operate for 624 hr/yr (which is approximately 1/3 of a man-year). The hours of operation are (8 vehicles)(624 hr/vehicle*yr)(1 yr) = 4,992 hr.

For the TRU-Separations Options, it is estimated that at any given time an average of 10 vehicles will be in operation during the 1-year construction period. Each vehicle was assumed to operate for 624 hr/yr (which is approximately 1/3 of a man-year). The hours of operation are (10 vehicles)(624 hr/vehicle*yr)(1 yr) = 6,240 hr.

For the DCWO, HWO, and VWO options, it is estimated that at any given time an average of 12 vehicles will be in operation during the 1-year construction period. Each vehicle was assumed to operate for 624 hr/yr (which is approximately 1/3 of a man-year). The hours of operation are (12 vehicles)(624 hr/vehicle*yr)(1 yr) = 7,488 hr.

T. For the CWO and TRU-Separations Options, only the transport lines are D&D.
Transport Lines: (800 ft) (5 ft) = 4000 ft^2 = 0.09 acre (approximately the footprint of the shielding chase)
Total = 0.09 acre which is approximately 0.5 acre

For DCWO, HWO, and VWO options:
Transport Lines: (925 ft) (5 ft) = 4625 ft^2 = 0.1 acre (approximately the footprint of the shielding chase)
ITS building: 600 ft^2 = 0.01 acre

Total = 0.11 acre

T. The D&D air emissions are primarily derived from emissions of heavy equipment. A spreadsheet was developed by Rod Kimmitt to analyze the air emissions produced by heavy equipment. A copy of the spreadsheet is attached for D&D work on the calcine transportation system.

U. For the CWO and TRU-Separations Options:
The solid wastes disposed of during the D&D of the transport system include the 2 transport system blowers, 2 heat exchangers, and the associated piping and duct work. The transport equipment for a single transport system is located in a 10 ft X 20 ft area. The equipment is assumed to be no greater than 5 ft tall. The transport equipment is assumed to occupy 60% of the area. The associated piping is assumed to occupy 20% of the transport equipment area.

$$Volume = 2(0.6)(10\,ft \times 20\,ft \times 5\,ft) + 2(0.2)(10\,ft \times 20\,ft \times 5\,ft)$$
$$= 1200\,ft^3 + 400\,ft^3 = 1600\,ft^3 = 45m^3$$

For the DCWO, HWO, and VWO options:
The solid wastes include metal from the metal building in the ITS, 4 transport system blowers, 4 heat exchangers, and the associated piping and duct work. The upper level of the ITS is 20 ft X 30 ft X 14 ft. It is assumed that the metal can be compacted into no more than 5 m^3.

$$Volume = 4(0.6)(10\,ft \times 20\,ft \times 5\,ft) + 4(0.2)(10\,ft \times 20\,ft \times 5\,ft) + 5m^3$$
$$= 2400\,ft^3 + 800\,ft^3 + 5m^3 = 95m^3$$

W. For the CWO and TRU-Separations Options:
The radioactive wastes include the 2 cyclones and 2 sintered metal filters. The cyclone has a 2 ft diameter and is 6 ft long. The sintered metal filter has a volume of 3.1 ft^3. This equipment is located in the Waste Treatment Facility.

$$Volume = (2)\left[\pi\left(\frac{2\,ft}{2}\right)^2 (6\,ft)\right] + (2)(3.1\,ft^3) = 44\,ft^3 = 1.2m^3$$

For the DCWO, HWO, and VWO options:
The radioactive wastes include 4 cyclones, 2 sintered metal filters, and hoppers. The additional equipment is located in the ITS. The hoppers hold 4.8 m^3 it is assumed that it may be compacted 50%.

$$Volume = (4)\left[\pi\left(\frac{2\,ft}{2}\right)^2 (6\,ft)\right] + (4)(3.1\,ft^3) + (0.5)(2)(4.8m^3) = 92.8\,ft^3 = 2.6m^3$$

X. The electrical energy requirement is derived from John Duggan's suggestion that construction requires 3000 kWh/wk. (3000 kWh/wk)(52wk/yr)(1yr) = 156MWh

The estimated fossil fuel consumed during the construction phase of this project was determined from an average value for fuel consumption of heavy equipment. The John Deere Construction equipment web page (www.deere.com) indicates an average fuel consumption of heavy equipment to be 6 gal/hr.

For CWO: (6 gal/ hr)(4,992 hr) = 29,952 gal = 113,380 liters

For TRU-Separations Options: (6 gal/hr)(6,240 hr) = 37,440 gal = 141,725 liters

For DCWO, HWO, and VWO options: (6gal/hr)(7,488 hr) = 44,928 gal = 170,070 liters

Backup to
E, M, & R

Memo of Telephone Conversation

Name	Organization	Phone
Steve Aitken	LMITCO S&H ICPP ALARA Coordinator	6-3174
Bill Landman	Chemical and Environmental Eng'g	6-5279

Date: November 24, 1997 **Time:** 4:15 pm

Subject: Average Worker Dose Rate at ICPP

Discussion:

Steve was contacted for information to support development of the Project Data Sheet for the Separations Options. He provided the following information for the ICPP site:

Average dose (per worker) for 1996	180 mR/hr
Average dose (per worker) for 1995	252 mR/hr
Average dose (per worker) for 1994	143 mR/hr

The 1995 year average was higher due to extensive work on the tank farm.

Back up to #

Construction

Estimate of Diesel Engine Emissions				
Calcine Retrieval & Transportation				
Bases & Assumptions:				
1. Air to fuel ratio = 25:1 (Mass Basis)			from Wark, K. and C.F. Warner, Air Pollution, Its Origin and Control, IEP, New York, 1976, p. 446, 423	
2. Diesel fuel density = 7.5 lbs./gal.				
3. Air is 21% O2, 79% N2, with a pseudomolecular weight of 29.				
4. Combustion is simulated as: C9H18 + 13.5O2 ---> 9CO2 + 9H2O				
5. Particulates = 5 mg/scf			Wark and Warner, p. 446	
6. CO = 2,500 ppmv			Wark and Warner, p. 446	
7. NOx = 2,000 ppmv			Wark and Warner, p. 446	
8. Unburned hydrocarbons = 100 ppmv			Wark and Warner, p. 446	
9. Diesel fuel (# 2 fuel oil) contains 1 wt. % sulfur			Wark and Warner, p. 336	
10. Combustion is about 99% efficient.				
Lbs. Of Construction Fuel			561,235	
Lbs. Of Operations Fuel			-	
Lbs. Of D&D Fuel			-	
Total Lbs. of Fuel Used			**561,235**	
Lb-Moles of Construction Fuel			4,454	
Lb-Moles of Operations Fuel			-	
Lb-Moles of D&D Fuel			-	
Total Lb-Moles of Fuel (as C9H18)			**4,454**	
Lbs of Air for Construction Fuel (based on air-to-fuel ratio)			14,030,874	
Lbs.of Air for Operations Fuel (based on air-to-fuel ratio)			-	
Lbs.of Air for D&D Fuel (based on air-to-fuel ratio)			-	
Total Lbs. of Air Added			**14,030,874**	
Lb-Moles of Air for Combustion Fuel			**483,823**	
Lb-Moles of Air for Operations Fuel			-	
Lb-Moles of Air for D&D Fuel			-	
Total Lb- Moles of Air			**483,823**	
Grand Total of Materials Fed, Lbs.			***14,592,109***	
Exhaust Gases, Construction Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	1,746,242	873	39,687	14,247,751
H2O	714,372	357	39,687	14,247,751
O2	1,346,300	673	42,072	15,103,807
N2	10,702,170	5,351	382,220	137,217,109
Subtotal of Major Gases	**14,509,085**	**7,255**	**503,667**	**180,816,419**
SO2	11,225	5.6		
Particulates	1,991	1.0		
CO	35,257	17.6		
NOx (assumed NO)	30,220	15.1		
Unburned Hydrocarbons	6,346	3.2		

Subtotal of Contaminants 85,039 42.5

Backup to Q

indicates applicability to CWO option.

Project Data Sheet for Calcine Retrieval - CWO					
ontamination & Decommissioning (D&D) Information					
Cost ($): D&D (Undiscounted dollars)					
Decommission		$2,555,000			
Decontamination		$7,223,000			
Demolition		$4,935,000			
Total D&D		$14,713,000			
Schedule start/end: D&D		January 2033 through December 2037			
Number of workers each year of D&D (new/existing)		108	New workers/yr		
Number of radiation workers (D&D)		75	New workers/yr		
Average annual worker radiation dose (rem/yr)		0.19	rem/yr	per worker	
Heavy equipment:					
Equipment used		Mobile Cranes, Roll-off trucks, Dozers, Loaders			
Trips	Roll-off trucks	15	per day		
Hours of operation (all heavy equipment)		27,990	Hours		
Acres disturbed and duration of disturbance		January 2033 through December 2037			
New		None			
Previous		2.7	acres		
Revegetated		None			
Air emissions					
non-radioactive	Fuel combustion gases (CO_2, H_2O, O_2, N_2)	16,269	tons (total)		
-radioactive	Fuel combustion contaminants (CO, particulates, NO_x, SO_2, hydrocarbons)	95	tons (total)		
radioactive	HEPA filtered off-gas	26,173	tons (total)		
Effluents					
radioactive	Spent decontamination solution	1,703,250	liters (total)	1,703	Ci
non-radioactive	Sanitary wastewater	2,295,160	liters (total)		
non-radioactive	Lube oil	5,297	liters (total)		
Solid wastes:					
radioactive		29,421	m^3	294	Ci
Non-radioactive (industrial)		22,122	m^3		
Hazardous		10	m^3		
Hazardous/toxic chemicals and wastes (type)					
Storage/inventory		205	m^3 (total)		
Pits/Ponds created (m^2)		None			
radioactive	(mixed waste)	47	m^3 (total)	0	Ci
Water usage:					
Process water		2,284,875	liters (total)		
Domestic water		2,295,160	liters (total)		
Source of water		ICPP site wells			
gy requirements:					

D&D Labor											
Crew #	Crew Function	Total MH/day	Total $/day	Material $/day	Equipment $/day	Total $/day		D&D Cost Allocated (FY 97 dollars)		Total MH	Man-hours/yr
D	Documentation	18	$1,136	$114	$ -	$1,250		$ 750,000		10,800	10,800
1	Characterization	44	$2,302	$460	$691	$3,453		$ 1,805,000		23,000	23,000
2	Rad Demolition-Systems	77	$4,091	$818	$1,023	$5,932		$ 2,500,000		32,451	32,451
2A	Rad Demolition-Building	99	$5,319	$1,064	$1,596	$7,979		$ 500,000		6,204	6,204
3	Demolition-Systems	72	$3,762	$752	$941	$5,455		$ 750,000		9,899	9,899
3A	Demolition-Building	88	$4,808	$962	$1,442	$7,212		$ 500,000		6,101	6,101
4	Asbestos Abatement	77	$3,753	$375	$188	$4,316		$ -		-	-
5	Decontamination	77	$3,753	$751	$1,126	$5,630		$ 5,000,000		68,384	68,384
6	Prep/Fabrication	61	$3,217	$643	$965	$4,826		$ 678,000		8,570	8,570
7	RADCON Surveys	50	$2,596	$519	$779	$3,894		$ 2,230,000		28,634	28,634
Total								$ 14,713,000		194,043	194,043
vailable								$ 14,713,000			
Notes:											
1	Crew functions and daily estimates are from the D&D program (Dave Haycraft)										
2	Total costs are based on life cycle estimate by R. Turk										
3	Assume all workers in crews 2, 2A, 5, and 7 are rad workers										
4	Assume a man-year is 1800 hours.										

Duration of D & D =	1	years					
Heavy Equipment		# Used	Hours/day	Days/wk	Wks/yr	Hours/yr	
	Mobile Crane	1	3	4	45	540	
	Roll-Off Truck	5	8	5	45	9,000	
	Dozer	2	5	5	45	2,250	
	Loader	5	8	5	45	9,000	
	Scabbler (w/ Vacuum System)	3	8	5	45	5,400	
	Pneumatic Ram	1	4	4	45	720	
	Demolition Machine (Remote Control)	2	4	3	45	1,080	
Total hours/yr						27,990	
Total heavy equipment hours =						27,990	
Assume each piece of equipment uses 6 gallon of diesel fuel per hour. Consumption rate from John Deere Web Site (Construction Equipment - http://www.deere.com/ind/product/product.html)							
No. of gallons of fuel used during D & D =			167,940	gal =	635,653	liters (total)	
Acreage disturbed is the same as for construction =			2.7	acres			
D & D labor requirements are taken from D & D labor and equipment spreadsheet.							
D & D costs come from the life cycle cost estimate.							
Assume each roll-off truck makes 3 trips per day to RWMC							
No. of trips =			15				
Miles traveled @ 12 miles/round trip=			180	miles/day			
Decontamination solution stored=			2,000	gallons	205	m^3	
Daily process water usage=			3000	gal/day =	2,284,875	liters (total)	
(washing, decon, etc.; based on 225 days/yr)							
Domestic water usage =		2,295,160	liters (total)				
Sanitary wastewater = same as domestic water usage							
Assume portable HEPA systems off-gas rate=			2000	scfm =	26,173	Tons (total)	
(assumes 225 days/yr)							
Assume daily spent decon. solution=			2000	gal/day	1,703,250	liters (total)	
(assumes 225 days/yr total)							
Solid Waste Generation	(factors from Dave Kenoyer - D&D Program)						
Waste Type	Factor (cu.ft./sq.ft.)	Sq.Ft. in Facility	Cu.Ft. of Waste	Cu. Meters			
WERF-LLW Combustible PPEs	0.167	175,878	29,372	832			
WERF-LLW Combustible Building Debris	0.128	175,878	22,512	638			

WERF-LLW Compactable Building Debris	0.195	175,878	34,296	972			
RWMC-LLW Non-Compactable Equipment	0.513	175,878	90,225	2,556			
RWMC-LLW Non-Compt Building Debris	0.684	175,878	120,301	3,408			
RWMC-LLW Non-Compt Concrete Rubble	3.44	175,878	605,020	17,139	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
RWMC-LLW Non-Compt Scrap Metal	0.778	175,878	136,833	3,876			
RWMC-LLW Asbestos/ACM Covered Pipe	0	175,878	-	-			
CFA Landfill Non-Compt Building Debris	1.99	175,878	349,997	9,915			
CFA Landfill Non-Compt Concrete Rubble	2.45	175,878	430,901	12,207	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
CFA Landfill Asbestos	0	175,878	-	-			
HWSF Hazardous Mtrls (Hg/PCBs/etc)	0.002	175,878	352	10			
Metal Recycle	0.022	175,878	3,869	110			
LLW =			1,038,560	29,421			
Non-Rad =			780,898	22,122			
Hazardous =			352	10			
Metal =			3,869	110			
Electric power usage =	156,000	kWh/yr	156	MWh/yr			
(based on 3,000 kWh/wk - John Duggan)							
Air emissions from fuel are based on the diesel emissions spreadsheet.							
1 manyear of labor =	1800	manhours					
Lube oil =	5,297	liters (total)					
(based on 3 gal for every 60 hours of operation)							
Mixed waste =	12,375	gal (total) =	47	m3 (total)			
(based on an assumed 5 55-gallon drums generated per week... work only 45 weeks/yr)							
Radioactivity associated with waste materials:							
Spent decontamination solution =		1,703	Ci				
(based on an assumed average activity concentration of 1 uCi/ml)							
Radioactive solid waste =		294	Ci				
(based in an assumed activity concentration of 0.01 uCi/cc [0.01Ci/m^3])							
Mixed waste =		0	Ci				
(based on an assumed activity concentration of 0.01 uCi/cc [0.01 Ci/m^3])							

Backup to Q

indicates applicability to TRU-Separations options.

Project Data Sheet for Calcine Feed - TRU-Sep

ontamination & Decommissioning (D&D) Information					
Cost ($): D&D (Unescalated dollars)					
Decommission		$2,555,000			
Decontamination		$7,223,000			
Demolition		$11,557,000			
Total D&D		$21,335,000			
Schedule start/end: D&D		January 2033 through December 2037			
Number of workers each year of D&D (new/existing)		155	New workers/yr		
Number of radiation workers (D&D)		104	New workers/yr		
Average annual worker radiation dose (rem/yr)		0.19	rem/yr	per worker	
Heavy equipment:					
Equipment used		Mobile Cranes, Roll-off trucks, Dozers, Loaders			
Trips	Roll-off trucks	15	per day		
Hours of operation (all heavy equipment)		27,990	Hours		
Acres disturbed and duration of disturbance		January 2033 through December 2037			
New		None			
Previous		2.7	acres		
Revegetated		None			
Air emissions					
non-radioactive	Fuel combustion gases (CO_2, H_2O, O_2, N_2)	16,269	tons (total)		
-radioactive	Fuel combustion contaminants (CO, particulates, NO_x, SO_2, hydrocarbons)	95	tons (total)		
radioactive	HEPA filtered off-gas	26,173	tons (total)		
Effluents					
radioactive	Spent decontamination solution	1,703,250	liters (total)	1,703	Ci
non-radioactive	Sanitary wastewater	3,301,896	liters (total)		
non-radioactive	Lube oil	5,297	liters (total)		
Solid wastes:					
radioactive		29,421	m^3	294	Ci
Non-radioactive (industrial)		22,122	m^3		
Hazardous		10	m^3		
Hazardous/toxic chemicals and wastes (type)					
Storage/inventory		205	m^3 (total)		
Pits/Ponds created (m^2)		None			
radioactive	(mixed waste)	47	m^3 (total)	0	Ci
Water usage:					
Process water		2,284,875	liters (total)		
Domestic water		3,301,896	liters (total)		
Source of water		ICPP site wells			
rgy requirements:					

D&D Labor											
Crew #	Crew Function	Total MH/day	Total $/day	Material $/day	Equipment $/day	Total $/day		D&D Cost Allocated (FY 97 dollars)		Total MH	Man-hours/yr
D	Documentation	18	$1,136	$114	$ -	$1,250		$ 750,000		10,800	10,800
1	Characterization	44	$2,302	$460	$691	$3,453		$ 1,755,000		22,363	22,363
2	Rad Demolition-Systems	77	$4,091	$818	$1,023	$5,932		$ 6,000,000		77,883	77,883
2A	Rad Demolition-Building	99	$5,319	$1,064	$1,596	$7,979		$ 1,000,000		12,408	12,408
3	Demolition-Systems	72	$3,762	$752	$941	$5,455		$ 2,100,000		27,718	27,718
3A	Demolition-Building	88	$4,808	$962	$1,442	$7,212		$ 1,442,760		17,604	17,604
4	Asbestos Abatement	77	$3,753	$375	$188	$4,316		$ -		-	-
5	Decontamination	77	$3,753	$751	$1,126	$5,630		$ 5,000,000		68,384	68,384
6	Prep/Fabrication	61	$3,217	$643	$965	$4,826		$ 1,057,240		13,363	13,363
7	RADCON Surveys	50	$2,596	$519	$779	$3,894		$ 2,230,000		28,634	28,634
Total								$ 21,335,000		279,156	279,156
vailable								$ 21,335,000			
Notes:											
1	Crew functions and daily estimates are from the D&D program (Dave Haycraft)										
2	Total costs are based on life cycle estimate by R. Turk										
3	Assume all workers in crews 2, 2A, 5, and 7 are rad workers										
4	Assume a man-year is 1800 hours.										

WERF-LLW Compactable Building Debris	0.195	175,878	34,296	972			
RWMC-LLW Non-Compactable Equipment	0.513	175,878	90,225	2,556			
RWMC-LLW Non-Compt Building Debris	0.684	175,878	120,301	3,408			
RWMC-LLW Non-Compt Concrete Rubble	3.44	175,878	605,020	17,139	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
RWMC-LLW Non-Compt Scrap Metal	0.778	175,878	136,833	3,876			
RWMC-LLW Asbestos/ACM Covered Pipe	0	175,878	-	-			
CFA Landfill Non-Compt Building Debris	1.99	175,878	349,997	9,915			
CFA Landfill Non-Compt Concrete Rubble	2.45	175,878	430,901	12,207	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
CFA Landfill Asbestos	0	175,878	-	-			
HWSF Hazardous Mtrls (Hg/PCBs/etc)	0.002	175,878	352	10			
Metal Recycle	0.022	175,878	3,869	110			
LLW =			1,038,560	29,421			
Non-Rad =			780,898	22,122			
Hazardous =			352	10			
Metal =			3,869	110			
Electric power usage =	156,000	kWh/yr	156	MWh/yr			
(based on 3,000 kWh/wk - John Duggan)							
Air emissions from fuel are based on the diesel emissions spreadsheet.							
1 manyear of labor =	1800	manhours					
Lube oil =	5,297	liters (total)					
(based on 3 gal for every 60 hours of operation)							
Mixed waste =	12,375	gal (total) =	47	m3 (total)			
(based on an assumed 5 55-gallon drums generated per week... work only 45 weeks/yr)							
Radioactivity associated with waste materials:							
Spent decontamination solution =		1,703	Ci				
(based on an assumed average activity concentration of 1 uCi/ml)							
Radioactive solid waste =		294	Ci				
(based in an assumed activity concentration of 0.01 uCi/cc [0.01Ci/m^3])							
Mixed waste =		0	Ci				
(based on an assumed activity concentration of 0.01 uCi/cc [0.01 Ci/m^3])							

Back up to Q

indicates applicability to DCWO, HWO, +VWO options.

Project Data Sheet for Calcine Retrieval - VWO, DCWO, HWO					
Decontamination & Decommissioning (D&D) Information					
Cost ($): D&D (Undiscounted dollars)					
Decommission		$2,681,000			
Decontamination		$7,415,000			
Demolition		$11,864,000			
Total D&D		$21,960,000			
Schedule start/end: D&D		January 2033 through December 2037			
Number of workers each year of D&D (new/existing)		160	New workers/yr		
Number of radiation workers (D&D)		102	New workers/yr		
Average annual worker radiation dose (rem/yr)		0.19	rem/yr	per worker	
Heavy equipment:					
Equipment used		Mobile Cranes, Roll-off trucks, Dozers, Loaders			
Trips	Roll-off trucks	15	per day		
Hours of operation (all heavy equipment)		27,990	Hours		
Acres disturbed and duration of disturbance		January 2033 through December 2037			
New		None			
Previous		2.7	acres		
Revegetated		None			
Air emissions					
non-radioactive	Fuel combustion gases (CO_2, H_2O, O_2, N_2)	16,269	tons (total)		
non-radioactive	Fuel combustion contaminants (CO, particulates, NO_x, SO_2, hydrocarbons)	95	tons (total)		
radioactive	HEPA filtered off-gas	26,173	tons (total)		
Effluents					
radioactive	Spent decontamination solution	1,703,250	liters (total)	1,703	Ci
non-radioactive	Sanitary wastewater	3,412,304	liters (total)		
non-radioactive	Lube oil	5,297	liters (total)		
Solid wastes:					
radioactive		29,421	m^3	294	Ci
Non-radioactive (industrial)		22,122	m^3		
Hazardous		10	m^3		
Hazardous/toxic chemicals and wastes (type)					
Storage/inventory		205	m^3 (total)		
Pits/Ponds created (m^2)		None			
radioactive	(mixed waste)	47	m^3 (total)	0	Ci
Water usage:					
Process water		2,284,875	liters (total)		
Domestic water		3,412,304	liters (total)		
Source of water		ICPP site wells			
Energy requirements:					

D&D Labor											
Crew #	Crew Function	Total MH/day	Total $/day	Material $/day	Equipment $/day	Total $/day		D&D Cost Allocated (FY 97 dollars)		Total MH	Man-hours/yr
D	Documentation	18	$1,136	$114	$ -	$1,250		$ 750,000		10,800	10,800
1	Characterization	44	$2,302	$460	$691	$3,453		$ 1,931,000		24,606	24,606
2	Rad Demolition-Systems	77	$4,091	$818	$1,023	$5,932		$ 6,000,000		77,883	77,883
2A	Rad Demolition-Building	99	$5,319	$1,064	$1,596	$7,979		$ 500,000		6,204	6,204
3	Demolition-Systems	72	$3,762	$752	$941	$5,455		$ 3,000,000		39,597	39,597
3A	Demolition-Building	88	$4,808	$962	$1,442	$7,212		$ 500,000		6,101	6,101
4	Asbestos Abatement	77	$3,753	$375	$188	$4,316		$ -		-	-
5	Decontamination	77	$3,753	$751	$1,126	$5,630		$ 5,415,000		74,060	74,060
6	Prep/Fabrication	61	$3,217	$643	$965	$4,826		$ 1,864,000		23,561	23,561
7	RADCON Surveys	50	$2,596	$519	$779	$3,894		$ 2,000,000		25,681	25,681
Total								$ 21,960,000		288,491	288,491
vailable								$ 21,960,000			
Notes:											
1	Crew functions and daily estimates are from the D&D program (Dave Haycraft)										
2	Total costs are based on life cycle estimate by R. Turk										
3	Assume all workers in crews 2, 2A, 5, and 7 are rad workers										
4	Assume a man-year is 1800 hours.										

Duration of D & D =	1	years					
Heavy Equipment		# Used	Hours/day	Days/wk	Wks/yr	Hours/yr	
	Mobile Crane	1	3	4	45	540	
	Roll-Off Truck	5	8	5	45	9,000	
	Dozer	2	5	5	45	2,250	
	Loader	5	8	5	45	9,000	
	Scabbler (w/ Vacuum System)	3	8	5	45	5,400	
	Pneumatic Ram	1	4	4	45	720	
	Demolition Machine (Remote Control)	2	4	3	45	1,080	
Total hours/yr						27,990	
Total heavy equipment hours =						27,990	
Assume each piece of equipment uses 6 gallon of diesel fuel per hour. Consumption rate from John Deere Web Site (Construction Equipment - http://www.deere.com/ind/product/product.html)							
No. of gallons of fuel used during D & D =			167,940	gal =	635,653	liters (total)	
Acreage disturbed is the same as for construction =			2.7	acres			
D & D labor requirements are taken from D & D labor and equipment spreadsheet.							
D & D costs come from the life cycle cost estimate.							
Assume each roll-off truck makes 3 trips per day to RWMC							
No. of trips =			15				
Miles traveled @ 12 miles/round trip=			180	miles/day			
Decontamination solution stored=			2,000	gallons	205	m^3	
Daily process water usage=			3000	gal/day =	2,284,875	liters (total)	
(washing, decon, etc.; based on 225 days/yr)							
Domestic water usage =		3,412,304	liters (total)				
Sanitary wastewater = same as domestic water usage							
Assume portable HEPA systems off-gas rate=			2000	scfm =	26,173	Tons (total)	
(assumes 225 days/yr)							
Assume daily spent decon. solution=			2000	gal/day	1,703,250	liters (total)	
(assumes 225 days/yr total)							
Solid Waste Generation	(factors from Dave Kenoyer - D&D Program)						
Waste Type	Factor (cu.ft./sq.ft.)	Sq.Ft. in Facility	Cu.Ft. of Waste	Cu. Meters			
WERF-LLW Combustible PPEs	0.167	175,878	29,372	832			
WERF-LLW Combustible Building Debris	0.128	175,878	22,512	638			

WERF-LLW Compactable Building Debris	0.195	175,878	34,296	972			
RWMC-LLW Non-Compactable Equipment	0.513	175,878	90,225	2,556			
RWMC-LLW Non-Compt Building Debris	0.684	175,878	120,301	3,408			
RWMC-LLW Non-Compt Concrete Rubble	3.44	175,878	605,020	17,139	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
RWMC-LLW Non-Compt Scrap Metal	0.778	175,878	136,833	3,876			
RWMC-LLW Asbestos/ACM Covered Pipe	0	175,878	-	-			
CFA Landfill Non-Compt Building Debris	1.99	175,878	349,997	9,915			
CFA Landfill Non-Compt Concrete Rubble	2.45	175,878	430,901	12,207	This factor is twice as large as that recommended by the D&D program to account for that large amounts of concrete used.		
CFA Landfill Asbestos	0	175,878	-	-			
HWSF Hazardous Mtrls (Hg/PCBs/etc)	0.002	175,878	352	10			
Metal Recycle	0.022	175,878	3,869	110			
LLW =			1,038,560	29,421			
Non-Rad =			780,898	22,122			
Hazardous =			352	10			
Metal =			3,869	110			
Electric power usage =	156,000	kWh/yr	156	MWh/yr			
(based on 3,000 kWh/wk - John Duggan)							
Air emissions from fuel are based on the diesel emissions spreadsheet.							
1 manyear of labor =	1800	manhours					
Lube oil =	5,297	liters (total)					
(based on 3 gal for every 60 hours of operation)							
Mixed waste =	12,375	gal (total) =	47	m3 (total)			
(based on an assumed 5 55-gallon drums generated per week... work only 45 weeks/yr)							
Radioactivity associated with waste materials:							
Spent decontamination solution =		1,703	Ci				
(based on an assumed average activity concentration of 1 uCi/ml)							
Radioactive solid waste =		294	Ci				
(based in an assumed activity concentration of 0.01 uCi/cc [0.01Ci/m^3])							
Mixed waste =		0	Ci				
based on an assumed activity concentration of 0.01 uCi/cc [0.01 Ci/m^3])							

Back up to 4

Estimate of Diesel Engine Emissions				
Calcine Retrieval for CWO				
Bases & Assumptions:				
1. Air to fuel ratio = 25:1 (Mass Basis)			from Wark, K. and C.F. Warner, Air Pollution, Its Origin and Control, IEP, New York, 1976, p. 446, 423	
2. Diesel fuel density = 7.5 lbs./gal.				
3. Air is 21% O2, 79% N2, with a pseudomolecular weight of 29.				
4. Combustion is simulated as: C9H18 + 13.5O2 ---> 9CO2 + 9H2O				
5. Particulates = 5 mg/scf			Wark and Warner, p. 446	
6. CO = 2,500 ppmv			Wark and Warner, p. 446	
7. NOx = 2,000 ppmv			Wark and Warner, p. 446	
8. Unburned hydrocarbons = 100 ppmv			Wark and Warner, p. 446	
9. Diesel fuel (# 2 fuel oil) contains 1 wt. % sulfur			Wark and Warner, p. 336	
10. Combustion is about 99% efficient.				
Lbs. Of Construction Fuel			-	
Lbs. Of Operations Fuel			-	
Lbs. Of D&D Fuel			224,492	
Total Lbs. of Fuel Used			**224,492**	
Lb-Moles of Construction Fuel			-	
Lb-Moles of Operations Fuel			-	
Lb-Moles of D&D Fuel			1,782	
Total Lb-Moles of Fuel (as C9H18)			**1,782**	
Lbs of Air for Construction Fuel (based on air-to-fuel ratio)			-	
Lbs.of Air for Operations Fuel (based on air-to-fuel ratio)			-	
Lbs.of Air for D&D Fuel (based on air-to-fuel ratio)			5,612,310	
Total Lbs. of Air Added			**5,612,310**	
Lb-Moles of Air for Combustion Fuel			-	
Lb-Moles of Air for Operations Fuel			-	
Lb-Moles of Air for D&D Fuel			**193,528**	
Total Lb- Moles of Air			**193,528**	
Grand Total of Materials Fed, Lbs.			***5,836,802***	
Exhaust Gases, Construction Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	-	-	-	-
H2O	-	-	-	-
O2	-	-	-	-
N2	-	-	-	-
Subtotal of Major Gases	-	-	-	-
SO2	-	-		
Particulates	-	-		
CO	-	-		
NOx (assumed NO)	-	-		
Unburned Hydrocarbons	-	-		

Subtotal of Contaminants	-	-		
Exhaust Gases, Operations Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	-	-	-	-
H2O	-	-	-	-
O2	-	-	-	-
N2	-	-	-	-
Subtotal of Major Gases	-	-	-	-
SO2	-	-		
Particulates	-	-		
CO	-	-		
NOx (assumed NO)	-	-		
Unburned Hydrocarbons	-	-		
Subtotal of Contaminants	-	-		
Exhaust Gases, D&D Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	698,492	349	15,875	5,699,060
H2O	285,747	143	15,875	5,699,060
O2	538,516	269	16,829	6,041,480
N2	4,280,837.83	2,140	152,887	54,886,457
Subtotal of Major Gases	**5,803,593**	**2,902**	**201,465**	**72,326,057**
SO2	4,350	2.2		
Particulates	797	0.4		
CO	14,103	7.1		
NOx (assumed NO)	12,088	6.0		
Unburned Hydrocarbons	2,538	1.3		
Subtotal of Contaminants	**33,875**	**17**		

Back up to U

Estimate of Diesel Engine Emissions				
Calcine Retrieval for TRU-Sep				
Bases & Assumptions:				
1. Air to fuel ratio = 25:1 (Mass Basis)			from Wark, K. and C.F. Warner, Air Pollution, Its Origin and Control, IEP, New York, 1976, p. 446, 423	
2. Diesel fuel density = 7.5 lbs./gal.				
3. Air is 21% O2, 79% N2, with a pseudomolecular weight of 29.				
4. Combustion is simulated as: C9H18 + 13.5O2 ---> 9CO2 + 9H2O				
5. Particulates = 5 mg/scf			Wark and Warner, p. 446	
6. CO = 2,500 ppmv			Wark and Warner, p. 446	
7. NOx = 2,000 ppmv			Wark and Warner, p. 446	
8. Unburned hydrocarbons = 100 ppmv			Wark and Warner, p. 446	
9. Diesel fuel (# 2 fuel oil) contains 1 wt. % sulfur			Wark and Warner, p. 336	
10. Combustion is about 99% efficient.				
Lbs. Of Construction Fuel			-	
Lbs. Of Operations Fuel			-	
Lbs. Of D&D Fuel			280,616	
Total Lbs. of Fuel Used			**280,616**	
Lb-Moles of Construction Fuel			-	
Lb-Moles of Operations Fuel			-	
Lb-Moles of D&D Fuel			2,227	
Total Lb-Moles of Fuel (as C9H18)			**2,227**	
Lbs of Air for Construction Fuel (based on air-to-fuel ratio)			-	
Lbs.of Air for Operations Fuel (based on air-to-fuel ratio)			-	
Lbs.of Air for D&D Fuel (based on air-to-fuel ratio)			7,015,388	
Total Lbs. of Air Added			**7,015,388**	
Lb-Moles of Air for Combustion Fuel			-	
Lb-Moles of Air for Operations Fuel			-	
Lb-Moles of Air for D&D Fuel			**241,910**	
Total Lb- Moles of Air			**241,910**	
Grand Total of Materials Fed, Lbs.			***7,296,003***	
Exhaust Gases, Construction Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	-	-	-	-
H2O	-	-	-	-
O2	-	-	-	-
N2	-	-	-	-
Subtotal of Major Gases	-	-	-	-
SO2	-	-		
Particulates	-	-		
CO	-	-		
NOx (assumed NO)	-	-		
Unburned Hydrocarbons	-	-		

Subtotal of Contaminants	-	-		
Exhaust Gases, Operations Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	-	-	-	-
H2O	-	-	-	-
O2	-	-	-	-
N2	-	-	-	-
Subtotal of Major Gases	-	-	-	-
SO2	-	-		
Particulates	-	-		
CO	-	-		
NOx (assumed NO)	-	-		
Unburned Hydrocarbons	-	-		
Subtotal of Contaminants	-	-		
Exhaust Gases, D&D Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	873,115	437	19,844	7,123,825
H2O	357,183	179	19,844	7,123,825
O2	673,145	337	21,036	7,551,850
N2	5,351,047.29	2,676	191,109	68,608,071
Subtotal of Major Gases	**7,254,491**	**3,627**	**251,832**	**90,407,572**
SO2	5,437	2.7		
Particulates	996	0.5		
CO	17,628	8.8		
NOx (assumed NO)	15,110	7.6		
Unburned Hydrocarbons	3,173	1.6		
Subtotal of Contaminants	**42,344**	**21**		

Backup to U

Estimate of Diesel Engine Emissions					
Calcine Retrieval for VWO, HWO, DCWO					
Bases & Assumptions:					
1. Air to fuel ratio = 25:1 (Mass Basis)				from Wark, K. and C.F. Warner, Air Pollution, Its Origin and Control, IEP, New York, 1976, p. 446, 423	
2. Diesel fuel density = 7.5 lbs./gal.					
3. Air is 21% O2, 79% N2, with a pseudomolecular weight of 29.					
4. Combustion is simulated as: C9H18 + 13.5O2 ---> 9CO2 + 9H2O					
5. Particulates = 5 mg/scf				Wark and Warner, p. 446	
6. CO = 2,500 ppmv				Wark and Warner, p. 446	
7. NOx = 2,000 ppmv				Wark and Warner, p. 446	
8. Unburned hydrocarbons = 100 ppmv				Wark and Warner, p. 446	
9. Diesel fuel (# 2 fuel oil) contains 1 wt. % sulfur				Wark and Warner, p. 336	
10. Combustion is about 99% efficient.					
Lbs. Of Construction Fuel				-	
Lbs. Of Operations Fuel				-	
Lbs. Of D&D Fuel				336,739	
Total Lbs. of Fuel Used				**336,739**	
Lb-Moles of Construction Fuel				-	
Lb-Moles of Operations Fuel				-	
Lb-Moles of D&D Fuel				2,673	
Total Lb-Moles of Fuel (as C9H18)				**2,673**	
Lbs of Air for Construction Fuel (based on air-to-fuel ratio)				-	
Lbs.of Air for Operations Fuel (based on air-to-fuel ratio)				-	
Lbs.of Air for D&D Fuel (based on air-to-fuel ratio)				8,418,465	
Total Lbs. of Air Added				**8,418,465**	
Lb-Moles of Air for Combustion Fuel				-	
Lb-Moles of Air for Operations Fuel				-	
Lb-Moles of Air for D&D Fuel				**290,292**	
Total Lb- Moles of Air				**290,292**	
Grand Total of Materials Fed, Lbs.				***8,755,204***	
Exhaust Gases, Construction Fuel		Total Lbs.	Total Tons	Total Moles	Total SCF
CO2		-	-	-	-
H2O		-	-	-	-
O2		-	-	-	-
N2		-	-	-	-
Subtotal of Major Gases		-	-	-	-
SO2		-	-		
Particulates		-	-		
CO		-	-		
NOx (assumed NO)		-	-		
Unburned Hydrocarbons		-	-		

Subtotal of Contaminants	-	-		
Exhaust Gases, Operations Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	-	-	-	-
H2O	-	-	-	-
O2	-	-	-	-
N2	-	-	-	-
Subtotal of Major Gases	-	-	-	-
SO2	-	-		
Particulates	-	-		
CO	-	-		
NOx (assumed NO)	-	-		
Unburned Hydrocarbons	-	-		
Subtotal of Contaminants	-	-		
Exhaust Gases, D&D Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO2	1,047,738	524	23,812	8,548,590
H2O	428,620	214	23,812	8,548,590
O2	807,775	404	25,243	9,062,220
N2	6,421,256.75	3,211	229,331	82,329,685
Subtotal of Major Gases	**8,705,390**	**4,353**	**302,198**	**108,489,086**
SO2	6,524	3.3		
Particulates	1,195	0.6		
CO	21,154	10.6		
NOx (assumed NO)	18,132	9.1		
Unburned Hydrocarbons	3,808	1.9		
Subtotal of Contaminants	**50,813**	**25**		

Appendix E

Risk Assessment Data Sheets

This appendix contains a Risk Assessment Form for each significant risk identified in the calcine retrieval and transportation system. The risks have been assigned to one of three categories: Project, Technical, and ES&H (Environmental, Health, and Safety).

Project Risk (cost or schedule):

P.1 Integrity of CSSF maintained	Risk = 3
P.2 Location of retrieval risers	Risk = 3
P.3 Estimated retrieval percentage too high	Risk = 2
P.4 Internal obstructions prevent retrieval	Risk = 2
P.5 Waste Treatment Facility too slow	Risk = 2
P.6 Miscellaneous materials prevent retrieval	Risk = 4

Technical Risk:

T.1 Objective retrieval rate too high	Risk = 3
T.2 All calcines are not retrievable	Risk = 4

ES&H Risk (environment, safety, or health):

ESH.1 Construction radiation dose rates incorrect	Risk = 4

As risks were evaluated, the probability of occurrence and the impact if the risk is realized were rated. The probability and impact were assigned numerical values of "3" for high, "2" for medium, and "1" for low. The equation for risk calculation is Risk = Probability X Impact. The maximum risk rating is "9."

The risk matrix, Table E-1, shows what action to take as a function of risk rating. These actions are defined in table E-2.

Table E-1. Risk Matrix
Risk = Probability X Impact

Probability	Impact: Low (1)	Impact: Medium (2)	Impact: High (3)
High (3)	Evaluate (3)	Contingency Plan (6)	Eliminate Risk (9)
Medium (2)	Monitor (2)	Contingency Plan (6)	Contingency Plan (6)
Low (1)	Forget (1)	Monitor (2)	Evaluate (3)

Table E-2. Risk Action Definition

Risk Rating	Action
9	Any risk determined to be in this category will be mitigated through additional design or analysis until the risk is not longer in this category.
6 and 4	Risks in these categories will be mitigated to the extent feasible within the cost and schedule guidelines. For those risks that cannot be mitigated, contingency plans have been made to deal with the risk if it occurs.
3	Risks in this category will be evaluated during the project to identify if they are becoming problems.
2	These risks will be monitored with no specific action identified.
1	These risks are noted for interest only.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: **Integrity of CSSFs maintained**

Significant construction activities will occur on the roof of each CSSF. For nearly all CSSFs, 8" holes must be drilled through the concrete roof. There is a possibility that the structural integrity of the CSSFs will be reduced.

PREVENTIVE PLANS

As part of locating the retrieval risers, a structural analysis of the CSSF roofs will be conducted.

PROBABLE CAUSE(S):

Structural integrity of the CSSF roofs will b compromised during access activities.

CONSEQUENCES IF RISK NOT RESOLVED

The schedule and cost would be effected by this risk. The CSS roof would need to be shored up. This would slow down the construction schedule and increase the cost.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ◉ High (3)
- ○ Medium (2)
- ○ Low (1)

Risk = 3

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

The CSSF storage vault roof should be shored up.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

During feasibility studies, a structural analysis of the CSSF roofs should be conducted.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: Location of retrieval risers

Locations for installation of retrieval risers must be identified. Enough locations may not exist on each bin to install the necessary retrieval risers.

PREVENTIVE PLANS

This risk has been significantly minimized by decreasing the number of retrieval lines need for calcine retrieval.

PROBABLE CAUSE(S):

The requirements for installing retrieval risers are not currently known. However, pipes in the bin vault may prevent the installation of the retrieval risers. There may not be adequate space on the bins to install the retrieval risers.

CONSEQUENCES IF RISK NOT RESOLVED

Calcine retrieval using the proposed calcine retrieval and transportation system would be prevented if the retrieval risers could not be installed. This would significantly impact the schedule and costs.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ◉ High (3)
- ○ Medium (2)
- ○ Low (1)

Risk = 3

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Develop a less restrictive method for installing the retrieval lines.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

The requirements of the riser installation process must be know prior to the early identification of this risk.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: **Estimated retrieval percentage too high**

It is estimated that 95% of the calcine in each bin can be retrieved. This estimate is based on the best available data fro pilot plant tests (ref. 9)

PREVENTIVE PLANS

The optimum configuration of suction nozzles and air jets should be identified through pilot plant study. The optimum configuratio should minimize the number of retrieval lines while maximizing the retrieval rate.

PROBABLE CAUSE(S):

Calcine may stick to the walls of the bin. It may get wedged in the "nooks and crannies" created by thermowells and internal stiffening rings and rods. The more agglomerated the calcine is the harder it is to retrieve.

CONSEQUENCES IF RISK NOT RESOLVED

This risk will effect the closure of the CSSFs the most. The mor calcine left in each bin will increase closure costs and lengthen the closure schedule. Pilot plant tests show that 97% of the calcine (ref. 9) is retrievable at a high retrieval rate.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 2

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

The best that can be done is to provide ample time in the schedule for CSSF closure.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

During operation of the calcine retrieval and transportation system.

Risk Assessment - Data Sheet

Risk Type (●) Project ( ) Technical ( ) ESH

RISK: **Internal obstructions prevent retrieval**

Internal obstructions may interfere with extension of the rigid retrieval lines into the bins.

PREVENTIVE PLANS

Examine the available CSSF drawings to determine retrieval ris locations that will not interfere with existing, internal obstructions

PROBABLE CAUSE(S):

Each bin has its own set of stiffening rods and thermowells. The retrieval lines may run into these internal obstructions.

CONSEQUENCES IF RISK NOT RESOLVED

Calcine retrieval may be completely stopped from a bin. This would adversely impact the schedule and drive costs up.

PROBABILITY

- ( ) High (3)
- ( ) Medium (2)
- (●) Low (1)

IMPACT

- ( ) High (3)
- (●) Medium (2)
- ( ) Low (1)

Risk = 2

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

During operation of the calcine retrieval and transportation system.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: Waste Treatment Facility too slow

The waste treatment facility cannot process calcine fast enough. It falls behind the retrieval rate of calcine.

PREVENTIVE PLANS

The processing capacity of the Waste Treatment Facility should be defined during the conceptual design phase. The operation o the Waste Treatment Facility and the calcine retrieval and transportation system must be coordinated.

PROBABLE CAUSE(S):

The waste treatment facility may be slowed down by an equipment failure. The processing rate may be over estimated i the adjoining scoping studies.

CONSEQUENCES IF RISK NOT RESOLVED

The calcine retrieval and transportation system should not operate unless the WTF requires additional calcine. The 50% u time estimate provides for some operational lapses. The risk is that the calcine batch bins will overflow with calcine. This will further contaminate the shielded cell when calcine is delivered t the Waste Treatment Facility.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 2

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

The amount of calcine retrieved should be adjusted to match the amount of calcine processed in each batch.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Changes in operations of the Waste Treatment Facility would identify the need to adjust the calcine retrieval rate.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: **Miscellaneous material prevents retrieval**

The miscellaneous material may damage or plug the calcine retrieval and transportation system. Damage tot he calcine retrieval and transportation system or the bins may occur when this material is picked up by the air jet. Clogging can occur if an item enters the transportation system

PREVENTIVE PLANS

As much of this miscellaneous materias should be removed as possible.

PROBABLE CAUSE(S):

Over the years, non-calcine materials have entered the CSSFs 2, and 3. Rod out lines have been lost. Weighted lines have purposefully fallen into the bins. And other foreign materials hav entered the bins. This material is scattered throughout the calcine. It is at different levels. It is not known exactly what material entered the CSSFs 1, 2, and 3.

CONSEQUENCES IF RISK NOT RESOLVED

The schedule can tolerate a fair amount of down time (currently operated 50% of the time). The backup transportation lines should minimize delays in the schedule. This will impact the cos if the damage is extensive.

PROBABILITY

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 4

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Implement a method to remove these items before they enter th transport system.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

During operation of the calcine retrieval and transport system.

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **Objective retrieval rate too high**

The objective retrieval rate is 2700 kg/hr. It is expected that calcine can be retrieved near this rate. This rate is based on the Fluor-Daniels design retrieval rate. Retrieval tests (ref. 9) show that it is difficult to maintain any given retrieval rate.

PREVENTIVE PLANS

A minimum and maximum retrieval rate should be defined. The operator should be able to control, to some extent, the retrieval rate by changing the heights of the suction and air jet nozzles.

PROBABLE CAUSE(S):

The retrieval rate appears to be directly related to the amount of calcine in the bin. The less calcine there is to retrieve the less calcine can be retrieved. Agglomerated calcine is more difficult to retrieve than free flowing calcine. The transport air blower, which provides the air jet and suction nozzles, may be undersized to retrieve such a large volume of calcine near the bottom of the bins.

CONSEQUENCES IF RISK NOT RESOLVED

The schedule should not be adversely impacted as long as the calcine can be retrieved at a rate greater than approximately 50 kg/hr. However, the cost will increase for operations if the calcine retrieval and transportation system must be operated for more than two 10 hr days/week.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ◉ High (3)
- ○ Medium (2)
- ○ Low (1)

Risk = 3

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Calcine retrieval will be conducted using extra shifts if the calcin can be retrieved at a reasonable rate. The reasonable rate will be determined by the needs of the waste treatment process. A good general number would be on the order of 500 lb/hr.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Operation of the calcine retrieval and transportation system

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **All calcines are not retrievable**

All types of calcine are retrievable as a dilute phase using this calcine retrieval and transportation system.

PREVENTIVE PLANS

Pilot plant tests should be conducted on agglomerated calcine. Also samples of the calcine in the CSSFs should be taken and analyzed to determine if the calcine has agglomerated.

PROBABLE CAUSE(S):

The calcine may be agglomerated. It is anticipated that agglomerated calcine will not fluidize as readily as free flowing calcine

CONSEQUENCES IF RISK NOT RESOLVED

The retrieval rate could be significantly lower than expected. Th operating costs will increase. The schedule may fall behind.

PROBABILITY

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 4

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

The agglomerated calcine must be broken up before it retrieved. If the potential for agglomerated calcine is high for a particular bin, a vibrator should be added to the end of the retrieval line before it is inserted into the bin. If agglomerated calcine is not suspected, then the air jet should be increased.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Operation of the calcine retrieval and transportation system on actual calcine.

Risk Assessment - Data Sheet

Risk Type ○ Project ○ Technical ◉ ESH

RISK: **Construction radiation dose rates incorrect**

The radiation dose rates are estimated from the best available data. The big unknown is the radiation levels in the CSSF superstructures.

PREVENTIVE PLANS

Proposed radiological surveys of each CSSF superstructure.

PROBABLE CAUSE(S):

A comprehensive radiological survey of the CSSF superstructures has not been conducted. The radiation levels in the superstructures are not known. They may be significantly higher than estimated.

CONSEQUENCES IF RISK NOT RESOLVED

More workers will be needed during the construction phase of th project. This will negatively impact the schedule and costs during construction. There is a high confidence that the radiatio levels can be maintained at lower levels during the operations phase of the project.

PROBABILITY

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 4

Risk =Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

More workers and time will b e necessary during the constructio phase of the project.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

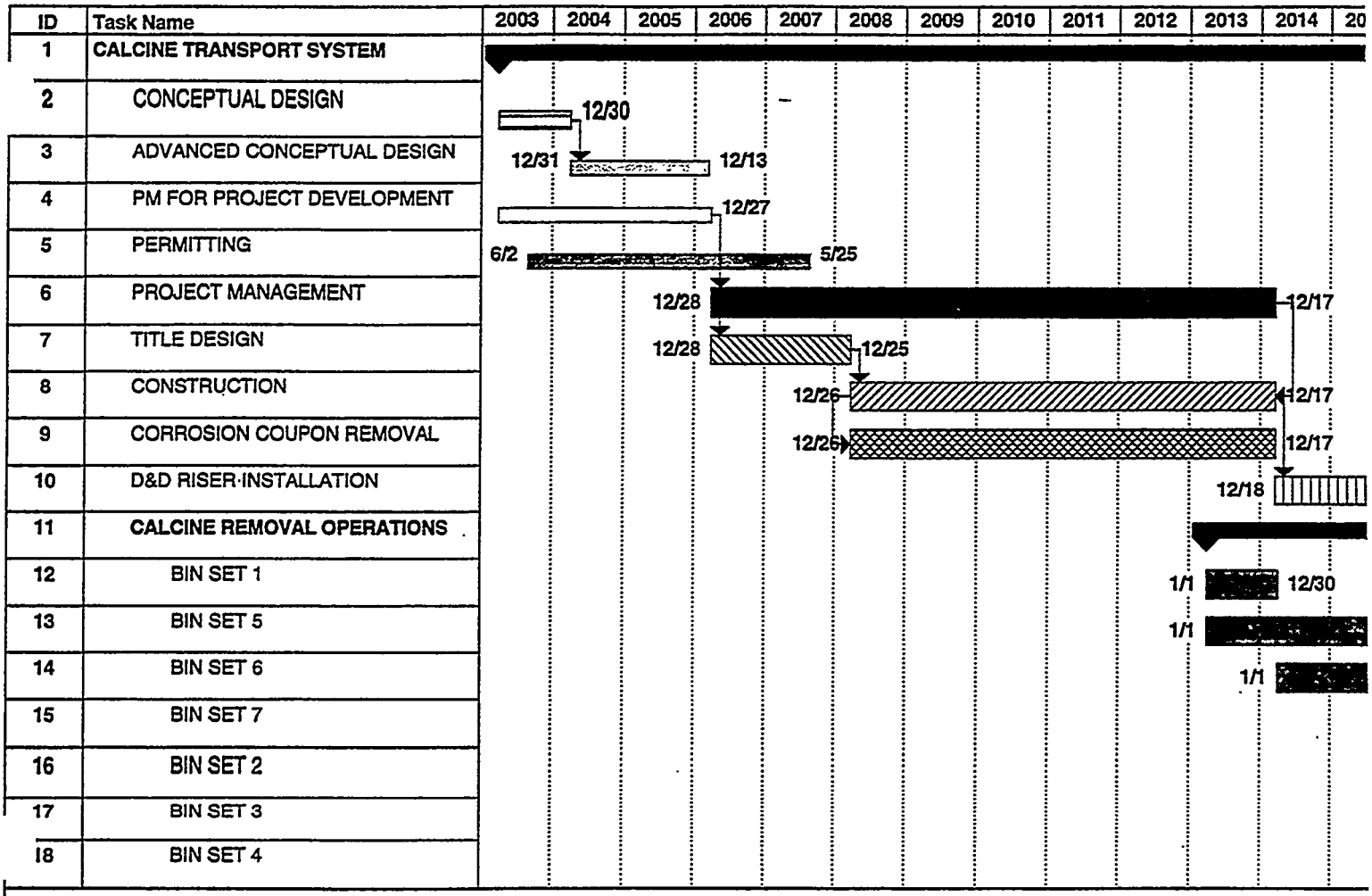
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Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

This risk should be addressed during the conceptual design phase. If not, it well become evident during construction.

Appendix F

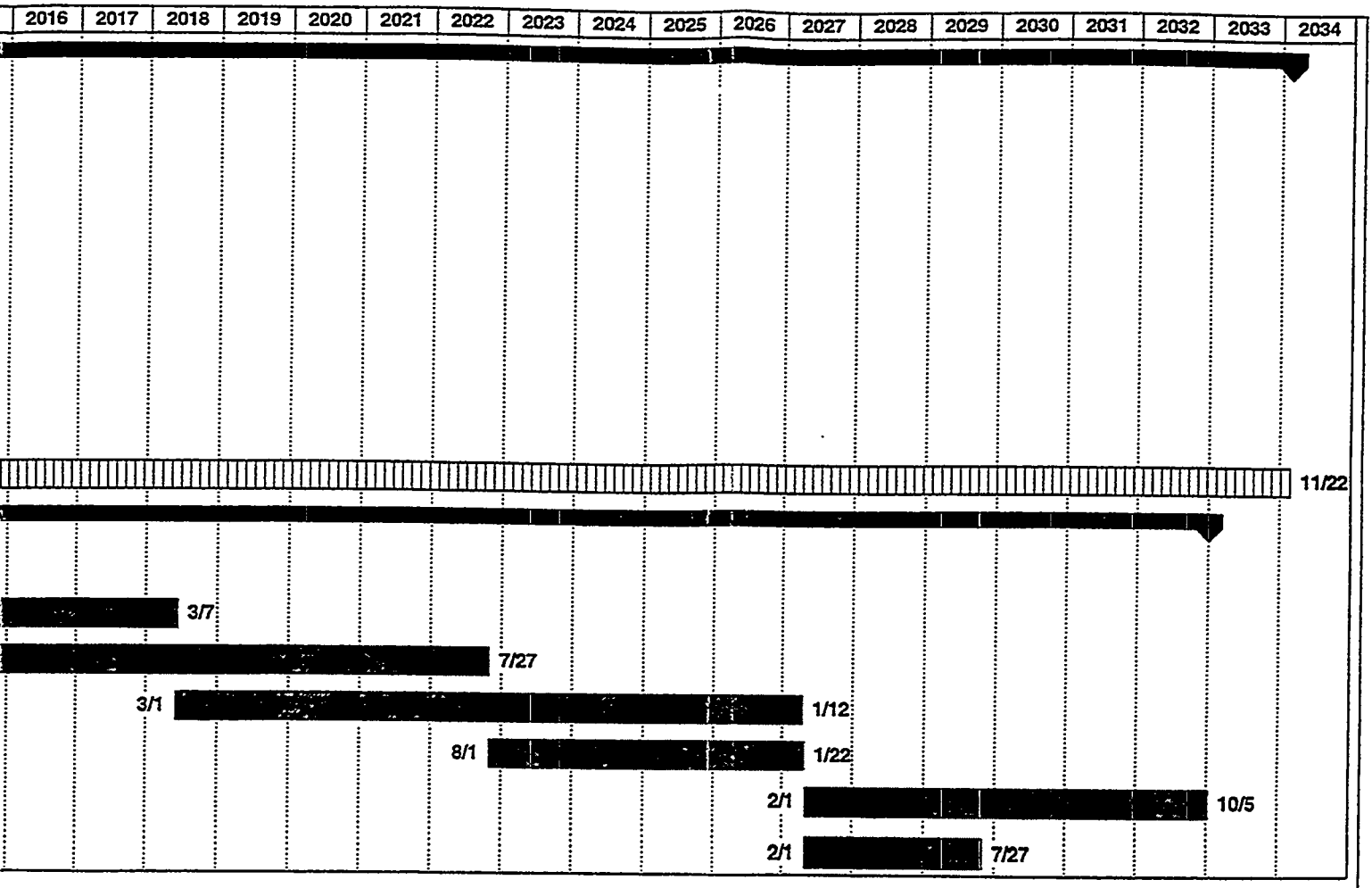
Cost Estimates



This schedule represents calcine retrieval and transportation activities for the DCWO, HWO, VWO and TRU-Separations Options. Activities 12-18 represent retrieval of calcine from a specific CSSF. The CSSFs retrieval order has not been determined. The order must be coordinated between CSSF closure and the Waste Treatment Facility needs. All CSSFs will be prepared for retrieval by 1/1/2013.

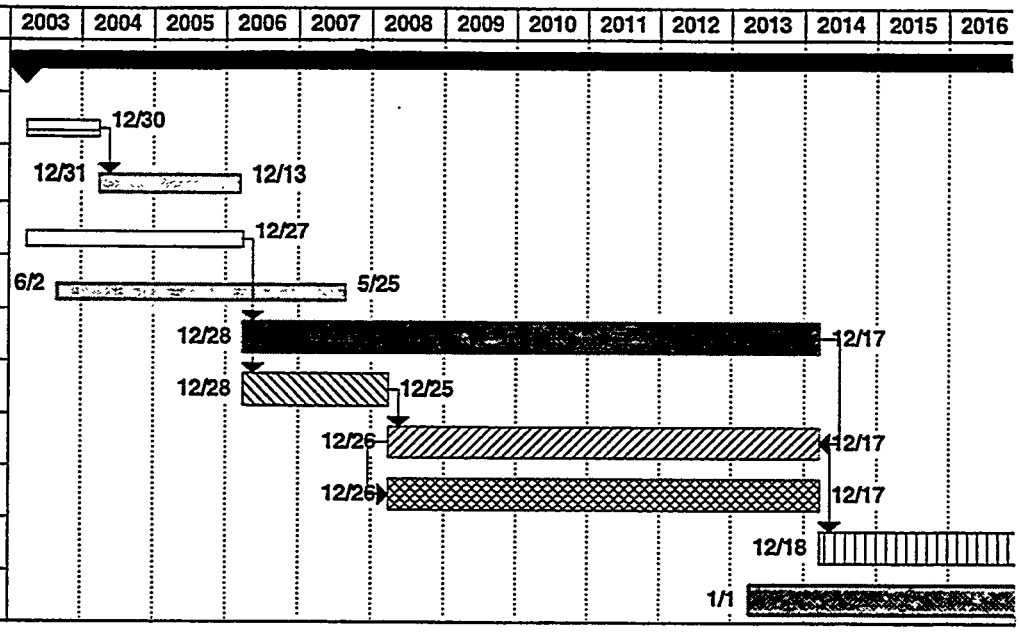
Project: 2414CTS.MPP
Date: Thu 1/29/98

Task | Milestone | Rolled Up Task
Progress | Summary | Rolled Up Milestone

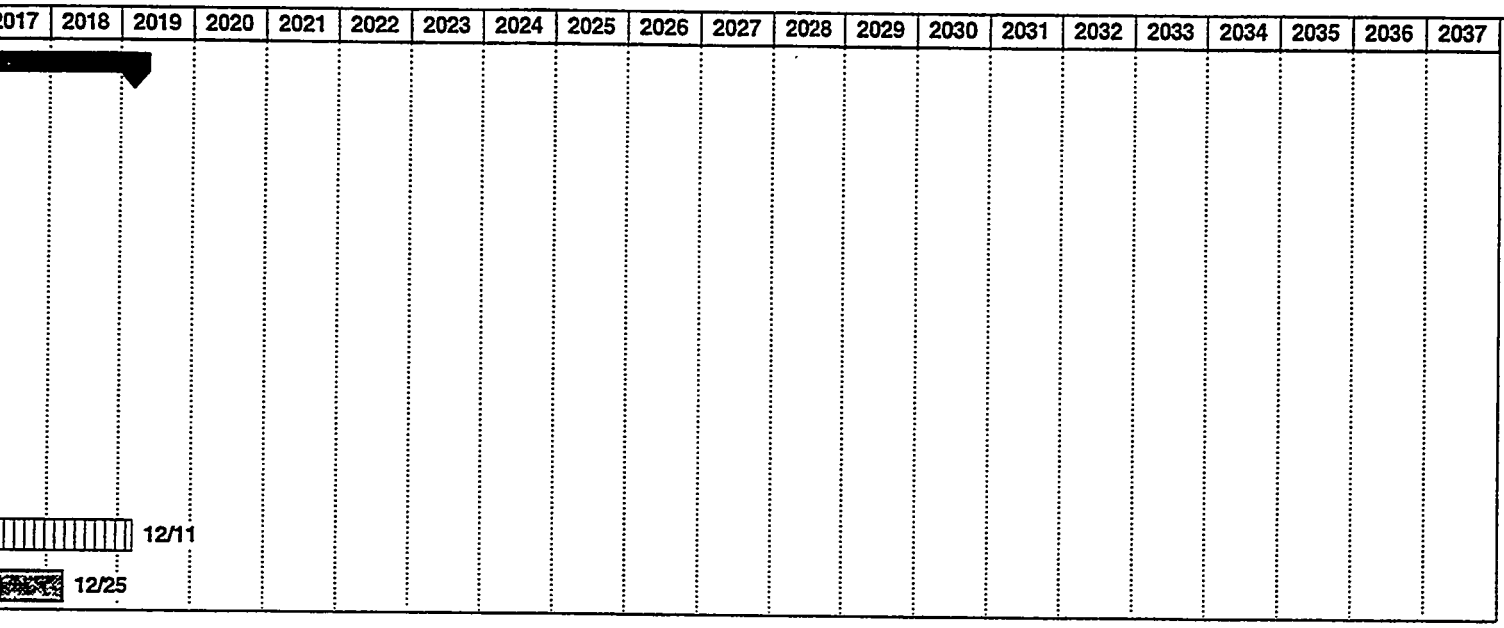


Rolled Up Progress

ID	Task Name
	CALCINE TRANSPORT SYSTEM
2	CONCEPTUAL DESIGN
3	ADVANCED CONCEPTUAL DESIGN
4	PM FOR PROJECT DEVELOPMENT
5	PERMITTING
6	PROJECT MANAGEMENT
7	TITLE DESIGN
8	CONSTRUCTION
9	CORROSION COUPON REMOVAL
10	D&D RISER INSTALLATION
11	CALCINE REMOVAL OPERATIONS



RANSPORT SYSTEM
R OPTION



Rolled Up Progress

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date: January 24, 1998

To: S. E. Gifford MS 3765 6-5162

From: F. P. Hanson MS 3655 6-0548

Subject: HLW EIS WASTE TREATMENT SCOPING STUDIES - FPH-01-98

Reference: F. P. Hanson letter to S. E. Gifford, FPH-33-97, Same Subject, December 9, 1997

Cost Estimating has reviewed the referenced draft cost estimates and prepared the attached final Planning Cost Estimates for the subject project. Nine estimates have been prepared for the activities shown below; the work scope for each activity is described in the respective estimate.

1. Other Project Costs (OPC) including conceptual design, proof of process, permitting and documentation, start-up activities, and related project management costs.

2. One estimate each for Option B for Calcined Solids Storage Facilities (CSSFs) 1 through 4, and one estimate for CSSFs 5 through 7. Since the scope and nature of work for CSSFs 5 through 7 are nearly identical, one estimate has been prepared showing costs which may be applied to each of those CSSFs.

3. Installation of D&D risers

4. Removal of corrosion coupons

5. One estimate each for Option A and Option B for the Calcine Transport System. Option B incorporates an Intermediate Transport Station with associated equipment.

The general scope of work covered by the estimates includes necessary modification of the CSSF vaults and CSSFs; construction of a new Containment Enclosure and a new Ventilation, Instrumentation, and Control (VIC) Building at each CSSF; construction of a new calcine transport system; and removal of corrosion coupons from the CSSFs.

The estimates incorporate all comments received to date, including your review of the draft estimates dated December 9, 1997 and intermediate draft estimates for the Calcine Transport System, as well as appropriate internal reviews. In addition, G&A and Performance Incentive Factor (PIF) fees, not previously applied, have been added to the estimates as appropriate.

Option A for modification of the CSSFs incorporated relocation and reuse of certain operational equipment. An examination of this option showed that it did not fully meet the needs of the system and was not sufficiently cost effective to warrant further consideration; therefore, in accordance with your directive, estimates are provided for Option B only.

Assumptions which form the bases of the estimates and any concerns that may affect the costs are shown in the attached Support Data Recapitulation Sheets. Cost Estimate Summary Sheets, Detail Sheets, and Contingency Analysis Sheets for each estimate are also attached for your information. These describe in detail the scope of work and unit costs upon which the estimates are based. In addition, a Summary of Cost Estimates has been prepared showing the Total Project Cost for each estimate. If you have further comments or questions regarding the estimates, please feel free to call.

fph

Attachment

cc: Estimate File #2414-1
F. P. Hanson File

Lockheed Martin Idaho Technologies Co.
(Rev. 06/96)

COST ESTIMATE SUPPORT DATA RECAPITULATION

Project Title: HLW EIS Waste Treatment
Scoping Studies
Calcine Retrieval and Transport

Estimator: F. P. Hanson
Date: 1-24-98

Type of Estimate: Planning
File No: 2414-1

Approved By: _____

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

This project will prepare Calcined Solids Storage Facilities (CSSFs) #1 through #7 for retrieval and transport of calcined waste to a processing facility. Each CSSF vault and CSSF will be modified as required, a new Containment Enclosure, and a new Ventilation, Instrumentation, and Control (VIC) Building will be constructed at each CSSF, and a new calcine transport system will be constructed. Construction of treatment and process facilities are not in the scope of the attached estimates.

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

a. Cost Estimate for Alternative 3, Phase I & II Special Studies, Bin Set 1. Bin Set 1 Calcine Retrieval System, Raytheon Engineers and Constructors, Inc., 11-8-94.

b. Feasibility Study Cost Estimate, Waste Treatment Facilities, Fluor Daniel Northwest, 10-22-97.

c. Draft Bin Set Access Plan with accompanying tables, provided by S. E. Gifford, cognizant technical lead.

d. Drawings, sketches, and miscellaneous supporting information provided by S. E. Gifford.

e. Title II Cost Estimate, Waste Characterization Facility, Lockheed Idaho Technologies Co., 11-22-94. This estimate provides the basis for costs for the Calcine Transport System Intermediate Transport Station. Costs are updated to current costs.

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

1. The Raytheon estimate provides a comprehensive breakdown of work tasks and associated costs for work required to prepare CSSF #1. The Fluor Daniel estimate addresses CSSFs #2 and #3, and closely reflects the Raytheon estimate, with no further scope or significant cost development. Because the Raytheon estimate represents the primary scope and cost development, it has been used as the basis of costs and scope of work addressed by the attached estimates. Work scopes and associated labor and material costs have been adjusted as deemed appropriate for subsequent CSSFs.

2. It has been assumed that the Raytheon estimate was developed from a reasonably well developed description of work scope, therefore, quantities, unit costs, and labor effort have been incorporated as presented in the Raytheon estimate, except as otherwise determined by factors specific to this estimate effort. The costs provided in the attached estimates are dependent upon the underlying assumptions, inclusions, exclusions, and basis of quantity development and pricing for the Raytheon estimate.

3. Design, Title III Inspection, and Management costs were applied in the Raytheon estimate as a percentage of construction costs. Those rates have been modified for the attached estimates as follow: Title Design at 20% of construction and GFE; Title III at 5% of construction and GFE; and PM and CM each at 10% of construction and GFE. Title design modifications for CSSFs #2 through #7 have been assumed at 20% of Title design costs for CSSF #1, assuming only relatively minor design modifications would be required.

4. Conceptual design and process development costs have been assumed at 30% of Title design costs for CSSF #1. It is assumed that conceptual design costs would not be impacted by subsequent Title design modifications for the remaining CSSFs. See Section IV for further comments.

6. It has been assumed that removal of corrosion coupons will be accomplished by LMITCO operating personnel.

(Continued)

III. **ASSUMPTIONS:** (Continued)

5. It is assumed that all demolition and new construction work will be competitively bid and performed by a general contractor as the prime subcontractor, with specialty lower tier subcontractors as appropriate. One tier of subcontractor markups has been applied, at 40% for overhead and profit, plus 1% for bonding, in accordance with the Raytheon estimate.

7. The Raytheon estimate does not specifically identify costs for subcontractor supervision. It has been assumed that the labor figures incorporated include allowances for subcontractor project coordination and supervision. Costs for personnel OS&H and site specific training have been included at 2% of project labor, per the Raytheon estimate, for CSSF #1, and at 1% of labor for the remaining CSSFs, assuming primarily refresher and update training for subsequent CSSFs. Construction of the Calcine Transport System and installation of the D&D risers are assumed to require additional personnel, therefor, the 2% allowance for training has been applied to those estimates.

8. Unit costs are assumed to include all costs necessary to accomplish the work including, but not necessarily limited to, site preparation, installation and removal of waste products, decontamination and cleanup, mobilization and demobilization, and cost of supporting organizations.

9. The labor hours shown in the Raytheon estimate have been incorporated; however, current INEEL Site Stabilization Agreement rates have been used, which may differ from the rates shown in the reference.

10. Allowances for undefined costs and for NQA-1 have been applied as shown in the Raytheon estimate, and are assumed to be appropriate for the project.

11. Material costs have been applied as shown in the Raytheon estimate, as appropriate, and further escalated at approximately 1.5% per year from the date of the estimate to the current date.

12. The Raytheon estimate does not include costs for the Containment Enclosure or the VIC Building. The attached estimates assume both the structures to be pre-engineered metal buildings, complete with appropriate services nd equipment. The Containment Enclosure is assumed to be 30′ x 30′ or 40′ x 40′, depending upon the vault dimension, with a 60′ eave height. The VIC building is assumed to be 40′ x 60′ x 14′ eave height in all cases. Costs are based on historical data and estimating judgement.

(Continued)

COST ESTIMATE SUPPORT DATA RECAPITULATION
(CONTINUATION)

III. **ASSUMPTIONS:** (Continued)

13. It is assumed that minimal site preparation will be required. Costs have not been included for additional service and access roads.

14. The following equipment is associated with the Calcine Transport System and is to be located in the processing facility; costs are assumed to be addressed in the appropriate facility cost estimate and have not been included herein. Equipment numbers are identified in appropriate drawings and equipment lists.

    - Air Handling Unit, 2,130 CFM
    - Exhaust Fan, 830 CFM
    - Exhaust Fan, 230 CFM
    - HEPA Filter w/Prefilter, 530 CFM
    - HEPA Canisters w/Prefilters, 230 CFM

15. The cost estimate for Other Project Costs (OPC) is intended to show all permitting costs associated with the entire CSSF modification and construction of the transport system. Costs for permitting and documentation are assumed to encompass all activities required.

16. The estimates identify certain activities related to demolition, earthwork, and construction which are to be accomplished during the overall time frame shown, rather than showing labor hours for the specific activities. It is assumed that the time frames and labor loading shown are adequate to accomplish the activities.

17. The proposed schedule shown in the Raytheon estimate calls for engineering from 10/1997 to 10/1999, with a mid-pint of 10/1998, and all other activities from 12/2000 to 5/2005, with a mid-point of 11/2002. Using the schedule of operations provided, the following activity mid-points have been established for purposes of calculating escalation:

    - Conceptual design: 2003 - 2005, mid-point 2004.
    - Title design: 2005 - 2007, mid-point 2006.
    - Construction: 2008 - 2013, mid-point 2011.

(Continued)

III. **ASSUMPTIONS:** (Continued)

- Installation of D&D risers: Mid-point of operations (2014 - 2033), 2023
- Removal of corrosion coupons: Mid-point of construction, 2011

19. It is assumed that the Calcine Transport System will consist of two separate systems. The quantities shown in the estimate reflect total quantities for the two systems.

21. It is assumed that the Intermediate Transport Station for Option B will be of reinforced concrete construction housing process equipment, with a pre-engineered metal building portion housing utilities and support equipment, and that the facility will require normal features for equipment shielding and accessibility, personnel protection, and normal utilities, HVAC, and electrical services.

20. Information available to the cognizant technical lead indicates that, due to corrosion failure of piping in CSSFs 2 and 3, radiological conditions arising from contamination are similar to CSSF #1. The estimates for CSSFs 2 and 3 have been prepared with that factor in mind, and labor allowances incorporated accordingly.

22. LMITCO G&A has been applied at 23% of construction and GFE, with a $500,000 ceiling applied, and the Performance Incentive Fee (PIF) has been applied at 5.5%. Procurement fees have been assumed at 1%, as procurement support to DOE, rather than the normal 3% fee. Adders are applied to each estimate based on the assumption the work addressed therein will be accomplished in one year.

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.*

Time constraints and lack of definitive design and project requirements have been taken into consideration in generating the costs and attendant rates of contingency shown in the estimate. Very little is known at this time regarding specific facility and process requirements, and there is a very real potential for encountering radiological conditions beyond those anticipated, resulting in increased labor and equipment costs. This, together with the unknowns associated with subsurface work and radiological conditions, with the inherent possibility of encountering differing conditions as existing work is opened up, create a high potential for increased costs. Some equipment may not be standard and may require development, and the schedule extends over many years. For these reasons, the rate of contingency typically exceeds the guidelines for a planning estimate and extends into the range for special conditions, as defined by DOE/FM 50, Cost Estimating Guide, Vol. 6, and the INEEL Cost Estimating Guide.

Overall contingency rates for escalated estimates are slightly higher than unescalated estimates, due to the assumed higher degree of associated risk as activities and costs are extended into the out years.

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

Individual estimates have been prepared for Other Project Costs (OPC); two options for the Calcine Transport System; and each of CSSFs 1 through 4. Since the scope and nature of work for CSSFs 5 through 7 are nearly identical, one estimate has been prepared showing costs which may be applied to each of those CSSFs. After analyzing draft cost estimates for Option A and Option B, for CSSF modifications, it was determined by the cognizant technical lead that Option A did not sufficiently meet system requirements and would not be further pursued; therefore, complete estimates are provided only for Option B for each case, and Summary Sheets are provided for both escalated and unescalated costs for each estimate. Separate estimates have also been prepared for installing D&D risers and for removing corrosion coupons.

The allowance of 30% of construction for Title Design included in the Raytheon estimate appears excessive for this magnitude of work. It was determined by the cognizant technical lead that this allowance was based on the total lack of a proven retrieval method at the time the Raytheon estimate was prepared. Because of subsequent design development, the allowance is reduced to 20% in the attached estimates.

Lockheed Martin Idaho Technologies Co.

SUMMARY OF COST ESTIMATES

HLW EIS WASTE TREATMENT **SCOPING STUDIES** **CALCINE RETRIEVAL AND TRANSPORT** LOCATION: INEEL-ICPP REQUESTOR: K. L. WILLIAMS	PLANNING ESTIMATE ESTIMATE NO. 2414-1 PREPARED BY: F. P. HANSON	DATE: 24 JAN 1998 CHECKED APPROVED

ACTIVITY	OPTION B	
	UNESCALATED COSTS	ESCALATED COSTS
OTHER PROJECT COSTS (OPC)	$28,300,000	$41,100,000
CSSF #1	$37,100,000	$52,750,000
CSSF #2	$24,000,000	$34,000,000
CSSF #3	$23,400,000	$33,100,000
CSSF #4	$16,000,000	$22,500,000
CSSF #5	$14,700,000	$21,000,000
CSSF #6	$14,700,000	$21,000,000
CSSF #7	$14,700,000	$21,000,000
INSTALL D&D RISERS	$5,100,000	$10,300,000
REMOVE CORROSION COUPONS	$1,125,000	$1,620,000
TOTAL PROJECT COST (LESS TRANSPORT SYSTEM)	**$179,125,000**	**$258,370,000**
CALCINE TRANSPORT SYSTEM OPTIONS		
CWO & TRU SEPARATION OPTIONS (A)	$15,300,000	$21,650,000
HWO, VWO, DCWO OPTIONS (B)	$20,400,000	$29,000,000

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (OPC)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 22-Jan-1998
TIME: 15:09:12
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	OTHER PROJECT COSTS - DESIGN			>> $18,000,000
1.1.1	CONCEPTUAL DESIGN	12,500,000	5,500,000	18,000,000
1.2	OTHER PROJECT COSTS - MANAGEMENT			>> $2,700,000
1.2.1	DESIGN PROJECT MANAGEMENT	1,875,000	825,000	2,700,000
1.3	PERMITTING AND DOCUMENTATION			>> $4,809,600
1.3.1	PLANS AND SAFETY REVIEWS	3,340,000	1,469,600	4,809,600
1.4	STARTUP ACTIVITIES			>> $5,115,456
1.4.1	SO TESTING AND ORR	3,552,400	1,563,056	5,115,456
1.5	G&A/PIF			>> $0
1.5.1	G&A/PIF ADDER	0	0	0
1.5.2	PROCUREMENT FEES	0	0	>> $0
	SUBTOTAL INCLUDING ESCALATION	21,267,400	9,357,656	>> $30,625,056
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $0
	CONTINGENCY			>> $10,474,94
	TOTAL ESTIMATED COST			>> $41,100,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *34.20%*

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
ATION 1: INEEL - ICPP
QUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (OPC)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 22-Jan-1998
TIME: 15:15:43
CHECKED BY:
APPRD BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	OTHER PROJECT COSTS - DESIGN			>> $12,500,000
1.1.1	CONCEPTUAL DESIGN	12,500,000	0	12,500,000
1.2	OTHER PROJECT COSTS - MANAGEMENT			>> $1,875,000
1.2.1	DESIGN PROJECT MANAGEMENT	1,875,000	0	1,875,000
1.3	PERMITTING AND DOCUMENTATION			>> $3,340,000
1.3.1	PLANS AND SAFETY REVIEWS	3,340,000	0	3,340,000
1.4	STARTUP ACTIVITIES			>> $3,552,400
1.4.1	SO TESTING AND ORR	3,552,400	0	3,552,400
1.5	G&A/PIF			>> $0
1.5.1	G&A/PIF ADDER	0	0	0
1.5.2	PROCUREMENT FEES	0	0	>> $0
	SUBTOTAL INCLUDING ESCALATION	21,267,400	0	>> $21,267,400
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $0
	CONTINGENCY			>> $7,032,600
	TOTAL ESTIMATED COST			>> $28,300,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *33.07%*

Lockheed Martin Idaho Technologies Co.
Rev. 6/96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-1 (CSSF 1)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 08:54:22
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $5,760,000
1.1.1	DESIGN ENGINEERING	3,600,000	864,000	4,464,000
1.1.2	TITLE III INSPECTION	900,000	396,000	1,296,000
1.2	MANAGEMENT COSTS			>> $5,184,000
1.2.1	PROJECT MANAGEMENT	1,800,000	792,000	2,592,000
1.2.2	CONSTRUCTION MANAGEMENT	1,800,000	792,000	2,592,000
1.3	CONSTRUCTION			>> $22,815,105
1.3.1	GENERAL CONDITIONS	236,475	104,049	340,524
1.3.2	SITEWORK	11,013,683	4,846,020	15,859,703
1.3.3	CONCRETE	1,521,726	669,560	2,191,286
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	16,575	54,246
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	15,026	49,176
1.3.9	FINISHES	59,314	26,098	85,412
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,380,985	607,633	1,988,61
1.3.12	FURNISHINGS	0	0	
1.3.13	SPECIAL CONSTRUCTION	221,687	97,542	319,229
1.3.14	CONVEYING SYSTEMS	251,836	110,808	362,644
1.3.15	MECHANICAL	594,246	261,468	855,714
1.3.16	ELECTRICAL	492,051	216,502	708,553
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,891,863
1.4.1	GOVERNMENT FURNISHED EQUIP.	2,126,370	765,493	2,891,863
1.5	G&A/PIF			>> $1,849,679
1.5.1	G&A/PIF ADDER	1,284,499	565,180	1,849,679
1.5.2	PROCUREMENT FEES	179,702	77,368	>> $257,070
	SUBTOTAL INCLUDING ESCALATION	27,534,395	11,223,322	>> $38,757,717
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $2,781,372
	CONTINGENCY			>> $11,210,911
	TOTAL ESTIMATED COST			>> $52,750,000

PROJECT COST PARAMETERS

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

CONTINGENCY= *36.10%*

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-1 (CSSF 1)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 08:59:23
CHECKED BY:
APPR'D BY:

ATION 1: INEEL - ICPP
JUESTOR: K. L. WILLIAMS

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $4,500,000
1.1.1	DESIGN ENGINEERING	3,600,000	0	3,600,000
1.1.2	TITLE III INSPECTION	900,000	0	900,000
1.2	MANAGEMENT COSTS			>> $3,600,000
1.2.1	PROJECT MANAGEMENT	1,800,000	0	1,800,000
1.2.2	CONSTRUCTION MANAGEMENT	1,800,000	0	1,800,000
1.3	CONSTRUCTION			>> $15,843,824
1.3.1	GENERAL CONDITIONS	236,475	0	236,475
1.3.2	SITEWORK	11,013,683	0	11,013,683
1.3.3	CONCRETE	1,521,726	0	1,521,726
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	0	37,671
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	0	34,150
1.3.9	FINISHES	59,314	0	59,314
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,380,985	0	1,380,985
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	221,687	0	221,687
1.3.14	CONVEYING SYSTEMS	251,836	0	251,836
1.3.15	MECHANICAL	594,246	0	594,246
1.3.16	ELECTRICAL	492,051	0	492,051
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,126,370
1.4.1	GOVERNMENT FURNISHED EQUIP.	2,126,370	0	2,126,370
1.5	G&A/PIF			>> $1,284,499
1.5.1	G&A/PIF ADDER	1,284,499	0	1,284,499
1.5.2	PROCUREMENT FEES	179,702	0	>> $179,702
	SUBTOTAL INCLUDING ESCALATION	27,534,395	0	>> $27,534,395
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,943,439
	CONTINGENCY			>> $7,622,166
	TOTAL ESTIMATED COST			>> $37,100,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *34.74%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-2 (CSSF 2)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 09:45:18
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,972,800
1.1.1	DESIGN ENGINEERING	720,000	316,800	1,036,800
1.1.2	TITLE III INSPECTION	650,000	286,000	936,000
1.2	MANAGEMENT COSTS			>> $3,111,000
1.2.1	PROJECT MANAGEMENT	1,275,000	0	1,275,000
1.2.2	CONSTRUCTION MANAGEMENT	1,275,000	561,000	1,836,000
1.3	CONSTRUCTION			>> $15,903,115
1.3.1	GENERAL CONDITIONS	79,168	34,834	114,002
1.3.2	SITEWORK	6,912,013	3,041,286	9,953,299
1.3.3	CONCRETE	1,020,501	449,020	1,469,521
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	16,575	54,246
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	15,026	49,176
1.3.9	FINISHES	64,411	28,341	92,752
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,199,716	527,875	1,727,591
1.3.12	FURNISHINGS	0	0	
1.3.13	SPECIAL CONSTRUCTION	291,171	128,115	419,286
1.3.14	CONVEYING SYSTEMS	278,560	122,567	401,127
1.3.15	MECHANICAL	596,103	262,285	858,388
1.3.16	ELECTRICAL	530,366	233,361	763,727
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,290,530
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	606,317	2,290,530
1.5	G&A/PIF			>> $1,412,031
1.5.1	G&A/PIF ADDER	980,577	431,454	1,412,031
1.5.2	PROCUREMENT FEES	127,280	54,656	>> $181,936
	SUBTOTAL INCLUDING ESCALATION	17,755,900	7,115,512	>> $24,871,412
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,978,761
	CONTINGENCY			>> $7,149,827
	TOTAL ESTIMATED COST			>> $34,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *36.70%*

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-2 (CSSF 2)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 09:47:27
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,370,000
1.1.1	DESIGN ENGINEERING	720,000	0	720,000
1.1.2	TITLE III INSPECTION	650,000	0	650,000
1.2	MANAGEMENT COSTS			>> $2,550,000
1.2.1	PROJECT MANAGEMENT	1,275,000	0	1,275,000
1.2.2	CONSTRUCTION MANAGEMENT	1,275,000	0	1,275,000
1.3	CONSTRUCTION			>> $11,043,830
1.3.1	GENERAL CONDITIONS	79,168	0	79,168
1.3.2	SITEWORK	6,912,013	0	6,912,013
1.3.3	CONCRETE	1,020,501	0	1,020,501
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	0	37,671
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	0	34,150
1.3.9	FINISHES	64,411	0	64,411
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,199,716	0	1,199,716
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	291,171	0	291,171
1.3.14	CONVEYING SYSTEMS	278,560	0	278,560
1.3.15	MECHANICAL	596,103	0	596,103
1.3.16	ELECTRICAL	530,366	0	530,366
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,684,213
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	0	1,684,213
1.5	G&A/PIF			>> $980,577
1.5.1	G&A/PIF ADDER	980,577	0	980,577
1.5.2	PROCUREMENT FEES	127,280	0	>> $127,280
	SUBTOTAL INCLUDING ESCALATION	17,755,900	0	>> $17,755,900
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,383,590
	CONTINGENCY			>> $4,860,510
	TOTAL ESTIMATED COST			>> $24,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *35.17%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-3 (CSSF 3)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:00:49
CHECKED BY: RDA
APPRD BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,929,600
1.1.1	DESIGN ENGINEERING	720,000	316,800	1,036,800
1.1.2	TITLE III INSPECTION	620,000	272,800	892,800
1.2	MANAGEMENT COSTS			>> $3,050,000
1.2.1	PROJECT MANAGEMENT	1,250,000	0	1,250,000
1.2.2	CONSTRUCTION MANAGEMENT	1,250,000	550,000	1,800,000
1.3	CONSTRUCTION			>> $15,447,410
1.3.1	GENERAL CONDITIONS	79,215	34,855	114,070
1.3.2	SITEWORK	6,564,926	2,888,567	9,453,493
1.3.3	CONCRETE	1,020,501	449,020	1,469,521
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	16,575	54,246
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	15,026	49,176
1.3.9	FINISHES	64,411	28,341	92,752
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,207,349	531,234	1,738,583
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	291,171	128,115	419,286
1.3.14	CONVEYING SYSTEMS	278,560	122,567	401,127
1.3.15	MECHANICAL	619,048	272,381	891,429
1.3.16	ELECTRICAL	530,366	233,361	763,727
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,290,530
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	606,317	2,290,530
1.5	G&A/PIF			>> $1,385,611
1.5.1	G&A/PIF ADDER	962,230	423,381	1,385,611
1.5.2	PROCUREMENT FEES	124,116	53,264	>> $177,380
	SUBTOTAL INCLUDING ESCALATION	17,337,927	6,942,604	>> $24,280,531
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,930,093
	CONTINGENCY			>> $6,889,376
	TOTAL ESTIMATED COST			>> $33,100,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *36.32%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
CATION 1: INEEL - ICPP
VESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-3 (CSSF 3)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:03:48
CHECKED BY: LOA
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,340,000
1.1.1	DESIGN ENGINEERING	720,000	0	720,000
1.1.2	TITLE III INSPECTION	620,000	0	620,000
1.2	MANAGEMENT COSTS			>> $2,500,000
1.2.1	PROJECT MANAGEMENT	1,250,000	0	1,250,000
1.2.2	CONSTRUCTION MANAGEMENT	1,250,000	0	1,250,000
1.3	CONSTRUCTION			>> $10,727,368
1.3.1	GENERAL CONDITIONS	79,215	0	79,215
1.3.2	SITEWORK	6,564,926	0	6,564,926
1.3.3	CONCRETE	1,020,501	0	1,020,501
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	0	37,671
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	0	34,150
1.3.9	FINISHES	64,411	0	64,411
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,207,349	0	1,207,349
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	291,171	0	291,171
1.3.14	CONVEYING SYSTEMS	278,560	0	278,560
1.3.15	MECHANICAL	619,048	0	619,048
1.3.16	ELECTRICAL	530,366	0	530,366
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,684,213
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	0	1,684,213
1.5	G&A/PIF			>> $962,230
1.5.1	G&A/PIF ADDER	962,230	0	962,230
1.5.2	PROCUREMENT FEES	124,116	0	>> $124,116
	SUBTOTAL INCLUDING ESCALATION	17,337,927	0	>> $17,337,927
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,349,792
	CONTINGENCY			>> $4,712,281
	TOTAL ESTIMATED COST			>> $23,400,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *34.96%*

Lockheed Martin Idaho Technologies Co.
Rev. 6/96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-4 (CSSF 4)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:21:27
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,641,600
1.1.1	DESIGN ENGINEERING	720,000	316,800	1,036,800
1.1.2	TITLE III INSPECTION	420,000	184,800	604,800
1.2	MANAGEMENT COSTS			>> $2,013,000
1.2.1	PROJECT MANAGEMENT	825,000	0	825,000
1.2.2	CONSTRUCTION MANAGEMENT	825,000	363,000	1,188,000
1.3	CONSTRUCTION			>> $9,452,399
1.3.1	GENERAL CONDITIONS	42,042	18,499	60,541
1.3.2	SITEWORK	2,818,113	1,239,970	4,058,083
1.3.3	CONCRETE	1,020,501	449,020	1,469,521
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	16,575	54,246
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	15,026	49,176
1.3.9	FINISHES	59,314	26,098	85,412
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	944,094	415,401	1,359,495
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	246,630	108,517	355,147
1.3.14	CONVEYING SYSTEMS	251,836	110,808	362,644
1.3.15	MECHANICAL	599,245	263,668	862,913
1.3.16	ELECTRICAL	510,570	224,651	735,221
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,290,530
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	606,317	2,290,530
1.5	G&A/PIF			>> $1,038,041
1.5.1	G&A/PIF ADDER	720,862	317,179	1,038,041
1.5.2	PROCUREMENT FEES	82,484	34,945	>> $117,429
	SUBTOTAL INCLUDING ESCALATION	11,841,725	4,711,274	>> $16,552,999
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,289,840
	CONTINGENCY			>> $4,657,161
	TOTAL ESTIMATED COST			>> $22,500,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *14.00%*

CONTINGENCY= *35.93%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
ATION 1: INEEL - ICPP
UESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-4 (CSSF 4)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:15:51
CHECKED BY: RDA
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,140,000
1.1.1	DESIGN ENGINEERING	720,000	0	720,000
1.1.2	TITLE III INSPECTION	420,000	0	420,000
1.2	MANAGEMENT COSTS			>> $1,650,000
1.2.1	PROJECT MANAGEMENT	825,000	0	825,000
1.2.2	CONSTRUCTION MANAGEMENT	825,000	0	825,000
1.3	CONSTRUCTION			>> $6,564,166
1.3.1	GENERAL CONDITIONS	42,042	0	42,042
1.3.2	SITEWORK	2,818,113	0	2,818,113
1.3.3	CONCRETE	1,020,501	0	1,020,501
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	0	37,671
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	0	34,150
1.3.9	FINISHES	59,314	0	59,314
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	944,094	0	944,094
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	246,630	0	246,630
1.3.14	CONVEYING SYSTEMS	251,836	0	251,836
1.3.15	MECHANICAL	599,245	0	599,245
1.3.16	ELECTRICAL	510,570	0	510,570
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,684,213
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	0	1,684,213
1.5	G&A/PIF			>> $720,862
1.5.1	G&A/PIF ADDER	720,862	0	720,862
1.5.2	PROCUREMENT FEES	82,484	0	>> $82,484
	SUBTOTAL INCLUDING ESCALATION	11,841,725	0	>> $11,841,725
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $905,172
	CONTINGENCY			>> $3,253,103
	TOTAL ESTIMATED COST			>> $16,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *14.00%*

CONTINGENCY= *35.12%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-5 (CSSFs 5 - 7)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:36:37
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,332,000
1.1.1	DESIGN ENGINEERING	720,000	172,800	892,800
1.1.2	TITLE III INSPECTION	305,000	134,200	439,200
1.2	MANAGEMENT COSTS			>> $2,188,800
1.2.1	PROJECT MANAGEMENT	760,000	334,400	1,094,400
1.2.2	CONSTRUCTION MANAGEMENT	760,000	334,400	1,094,400
1.3	CONSTRUCTION			>> $8,533,071
1.3.1	GENERAL CONDITIONS	33,568	14,770	48,338
1.3.2	SITEWORK	2,818,113	1,239,970	4,058,083
1.3.3	CONCRETE	113,649	50,006	163,655
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	16,575	54,246
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	15,026	49,176
1.3.9	FINISHES	64,411	28,341	92,752
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,116,330	491,185	1,607,515
1.3.12	FURNISHINGS	0	0	
1.3.13	SPECIAL CONSTRUCTION	291,171	128,115	419,286
1.3.14	CONVEYING SYSTEMS	278,560	122,567	401,127
1.3.15	MECHANICAL	619,048	272,381	891,429
1.3.16	ELECTRICAL	519,072	228,392	747,464
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,290,530
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	606,317	2,290,530
1.5	G&A/PIF			>> $984,743
1.5.1	G&A/PIF ADDER	683,849	300,894	984,743
1.5.2	PROCUREMENT FEES	76,100	32,136	>> $108,236
	SUBTOTAL INCLUDING ESCALATION	10,914,905	4,522,475	>> $15,437,380
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,191,658
	CONTINGENCY			>> $4,370,962
	TOTAL ESTIMATED COST			>> $21,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *12.00%*

CONTINGENCY= *36.03%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
INVESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1-5 (CSSFs 5 - 7)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:39:47
CHECKED BY: [signature]
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,025,000
1.1.1	DESIGN ENGINEERING	720,000	0	720,000
1.1.2	TITLE III INSPECTION	305,000	0	305,000
1.2	MANAGEMENT COSTS			>> $1,520,000
1.2.1	PROJECT MANAGEMENT	760,000	0	760,000
1.2.2	CONSTRUCTION MANAGEMENT	760,000	0	760,000
1.3	CONSTRUCTION			>> $5,925,743
1.3.1	GENERAL CONDITIONS	33,568	0	33,568
1.3.2	SITEWORK	2,818,113	0	2,818,113
1.3.3	CONCRETE	113,649	0	113,649
1.3.4	MASONRY	0	0	0
1.3.5	METALS	37,671	0	37,671
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	34,150	0	34,150
1.3.9	FINISHES	64,411	0	64,411
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	1,116,330	0	1,116,330
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	291,171	0	291,171
1.3.14	CONVEYING SYSTEMS	278,560	0	278,560
1.3.15	MECHANICAL	619,048	0	619,048
1.3.16	ELECTRICAL	519,072	0	519,072
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,684,213
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,684,213	0	1,684,213
1.5	G&A/PIF			>> $683,849
1.5.1	G&A/PIF ADDER	683,849	0	683,849
1.5.2	PROCUREMENT FEES	76,100	0	>> $76,100
	SUBTOTAL INCLUDING ESCALATION	10,914,905	0	>> $10,914,905
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $836,990
	CONTINGENCY			>> $2,948,105
	TOTAL ESTIMATED COST			>> $14,700,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *13.00%*

CONTINGENCY= *34.68%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (D&D RISERS)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 11:01:18
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $590,200
1.1.1	DESIGN ENGINEERING	260,000	62,400	322,400
1.1.2	TITLE III INSPECTION	130,000	137,800	267,800
1.2	MANAGEMENT COSTS			>> $1,071,200
1.2.1	PROJECT MANAGEMENT	260,000	275,600	535,600
1.2.2	CONSTRUCTION MANAGEMENT	260,000	275,600	535,600
1.3	CONSTRUCTION			>> $5,361,072
1.3.1	GENERAL CONDITIONS	21,208	22,481	43,689
1.3.2	CSSF #1	653,462	692,670	1,346,132
1.3.3	CSSF #2	228,733	242,457	471,190
1.3.4	CSSF #3	228,733	242,457	471,190
1.3.5	CSSF #4	98,069	103,953	202,022
1.3.6	CSSF #5	457,419	484,864	942,283
1.3.7	CSSF #6	457,419	484,864	942,283
1.3.8	CSSF #7	457,419	484,864	942,283
1.5	G&A/PIF			>> $560,746
1.5.1	G&A/PIF ADDER	272,207	288,539	560,746
1.5.2	PROCUREMENT FEES	26,025	27,586	>> $53,611
	SUBTOTAL INCLUDING ESCALATION	3,810,694	3,826,135	>> $7,636,829
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $597,543
	CONTINGENCY			>> $2,065,628
	TOTAL ESTIMATED COST			>> $10,300,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *34.87%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
LOCATION 1: INEEL - ICPP
QUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (D&D RISERS)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 10:56:11
CHECKED BY: ROH
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $390,000
1.1.1	DESIGN ENGINEERING	260,000	0	260,000
1.1.2	TITLE III INSPECTION	130,000	0	130,000
1.2	MANAGEMENT COSTS			>> $520,000
1.2.1	PROJECT MANAGEMENT	260,000	0	260,000
1.2.2	CONSTRUCTION MANAGEMENT	260,000	0	260,000
1.3	CONSTRUCTION			>> $2,602,462
1.3.1	GENERAL CONDITIONS	21,208	0	21,208
1.3.2	CSSF #1	653,462	0	653,462
1.3.3	CSSF #2	228,733	0	228,733
1.3.4	CSSF #3	228,733	0	228,733
1.3.5	CSSF #4	98,069	0	98,069
1.3.6	CSSF #5	457,419	0	457,419
1.3.7	CSSF #6	457,419	0	457,419
1.3.8	CSSF #7	457,419	0	457,419
1.5	G&A/PIF			>> $272,207
1.5.1	G&A/PIF ADDER	272,207	0	272,207
1.5.2	PROCUREMENT FEES	26,025	0	>> $26,025
	SUBTOTAL INCLUDING ESCALATION	3,810,694	0	>> $3,810,694
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $290,069
	CONTINGENCY			>> $999,237
	TOTAL ESTIMATED COST			>> $5,100,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *15.00%*

CONTINGENCY= *33.83%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (CORR CPNS)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 11:58:00
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $85,456
1.1.1	DESIGN ENGINEERING	43,600	10,464	54,064
1.1.2	TITLE III INSPECTION	21,800	9,592	31,392
1.2	MANAGEMENT COSTS			>> $129,600
1.2.1	PROJECT MANAGEMENT	45,000	19,800	64,800
1.2.2	CONSTRUCTION MANAGEMENT	45,000	19,800	64,800
1.3	CONSTRUCTION			>> $627,799
1.3.1	GENERAL CONDITIONS	233,310	102,656	335,966
1.3.2	SITEWORK	0	0	0
1.3.3	CONCRETE	0	0	0
1.3.4	MASONRY	0	0	0
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	202,662	89,171	291,833
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	0	0	0
1.3.16	ELECTRICAL	0	0	0
1.4	GOVERNMENT FURNISHED SERVICES			>> $143,578
1.4.1	COUPON RETRIEVAL	99,707	43,871	143,578
1.5	G&A/PIF			>> $211,105
1.5.1	G&A/PIF ADDER	146,601	64,504	211,105
1.5.2	PROCUREMENT FEES	4,285	1,886	>> $6,171
	SUBTOTAL INCLUDING ESCALATION	841,965	361,744	>> $1,203,709
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $98,865
	CONTINGENCY			>> $317,426
	TOTAL ESTIMATED COST			>> $1,620,000

1 MAN YEAR

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *11.00%*

CONTINGENCY= *34.58%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT
LOCATION 1: INEEL - ICPP
ESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (CORR CPNS)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 11:52:04
CHECKED BY: _____
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $65,400
1.1.1	DESIGN ENGINEERING	43,600	0	43,600
1.1.2	TITLE III INSPECTION	21,800	0	21,800
1.2	MANAGEMENT COSTS			>> $90,000
1.2.1	PROJECT MANAGEMENT	45,000	0	45,000
1.2.2	CONSTRUCTION MANAGEMENT	45,000	0	45,000
1.3	CONSTRUCTION			>> $435,972
1.3.1	GENERAL CONDITIONS	233,310	0	233,310
1.3.2	SITEWORK	0	0	0
1.3.3	CONCRETE	0	0	0
1.3.4	MASONRY	0	0	0
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	202,662	0	202,662
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	0	0	0
1.3.16	ELECTRICAL	0	0	0
1.4	GOVERNMENT FURNISHED SERVICES			>> $99,707
1.4.1	COUPON RETRIEVAL	99,707	0	99,707
1.5	G&A/PIF			>> $146,601
1.5.1	G&A/PIF ADDER	146,601	0	146,601
1.5.2	PROCUREMENT FEES	4,285	0	>> $4,285
	SUBTOTAL INCLUDING ESCALATION	841,965	0	>> $841,965
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $68,657
	CONTINGENCY			>> $214,378
	TOTAL ESTIMATED COST			>> $1,125,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *12.00%*

CONTINGENCY= *33.62%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (TRANS SYS A)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 13:48:01
CHECKED BY:
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $2,606,400
1.1.1	DESIGN ENGINEERING	1,450,000	638,000	2,088,000
1.1.2	TITLE III INSPECTION	360,000	158,400	518,400
1.2	MANAGEMENT COSTS			>> $1,756,800
1.2.1	PROJECT MANAGEMENT	720,000	0	720,000
1.2.2	CONSTRUCTION MANAGEMENT	720,000	316,800	1,036,800
1.3	CONSTRUCTION			>> $8,870,190
1.3.1	GENERAL CONDITIONS	32,491	14,296	46,787
1.3.2	SITEWORK	264,243	116,267	380,510
1.3.3	CONCRETE	945,754	416,132	1,361,886
1.3.4	MASONRY	0	0	0
1.3.5	METALS	0	0	0
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	0	0	0
1.3.9	FINISHES	0	0	0
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	322,925	142,087	465,012
1.3.12	FURNISHINGS	0	0	
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	4,594,441	2,021,554	6,615,995
1.3.16	ELECTRICAL	0	0	0
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,427,453
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,049,598	377,855	1,427,453
1.5	G&A/PIF			>> $1,143,343
1.5.1	G&A/PIF ADDER	793,988	349,355	1,143,343
1.5.2	PROCUREMENT FEES	72,095	30,882	>> $102,977
	SUBTOTAL INCLUDING ESCALATION	11,325,535	4,581,628	>> $15,907,163
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,154,396
	CONTINGENCY			>> $4,588,441
	TOTAL ESTIMATED COST			>> $21,650,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *36.10%*

Lockheed Martin Idaho Technologies Co.

COST ESTIMATE SUMMARY

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
CATION 1: INEEL - ICPP
QUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (TRANS SYS A)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 13:37:11
CHECKED BY: _____
APPR'D BY: _____

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $1,810,000
1.1.1	DESIGN ENGINEERING	1,450,000	0	1,450,000
1.1.2	TITLE III INSPECTION	360,000	0	360,000
1.2	MANAGEMENT COSTS			>> $1,440,000
1.2.1	PROJECT MANAGEMENT	720,000	0	720,000
1.2.2	CONSTRUCTION MANAGEMENT	720,000	0	720,000
1.3	CONSTRUCTION			>> $6,159,854
1.3.1	GENERAL CONDITIONS	32,491	0	32,491
1.3.2	SITEWORK	264,243	0	264,243
1.3.3	CONCRETE	945,754	0	945,754
1.3.4	MASONRY	0	0	0
1.3.5	METALS	0	0	0
1.3.6	WOOD & PLASTICS	0	0	0
1.3.7	THERMAL & MOISTURE PROTECTION	0	0	0
1.3.8	DOORS & WINDOWS	0	0	0
1.3.9	FINISHES	0	0	0
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	322,925	0	322,925
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	0	0	0
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	4,594,441	0	4,594,441
1.3.16	ELECTRICAL	0	0	0
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,049,598
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,049,598	0	1,049,598
1.5	G&A/PIF			>> $793,988
1.5.1	G&A/PIF ADDER	793,988	0	793,988
1.5.2	PROCUREMENT FEES	72,095	0	>> $72,095
	SUBTOTAL INCLUDING ESCALATION	11,325,535	0	>> $11,325,535
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $807,553
	CONTINGENCY			>> $3,166,912
	TOTAL ESTIMATED COST			>> $15,300,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *35.09%*

Lockheed Martin Idaho Technologies Co. **COST ESTIMATE SUMMARY**

Rev. 6/96

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B
LOCATION 1: INEEL - ICPP
REQUESTOR: K. L. WILLIAMS

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (TRANS SYS B)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 15:40:38
CHECKED BY: PCA
APPR'D BY:

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $3,513,600
1.1.1	DESIGN ENGINEERING	1,950,000	858,000	2,808,000
1.1.2	TITLE III INSPECTION	490,000	215,600	705,600
1.2	MANAGEMENT COSTS			>> $2,379,000
1.2.1	PROJECT MANAGEMENT	975,000	0	975,000
1.2.2	CONSTRUCTION MANAGEMENT	975,000	429,000	1,404,000
1.3	CONSTRUCTION			>> $11,345,257
1.3.1	GENERAL CONDITIONS	39,795	17,510	57,305
1.3.2	SITEWORK	342,206	150,571	492,777
1.3.3	CONCRETE	1,009,448	444,157	1,453,605
1.3.4	MASONRY	0	0	0
1.3.5	METALS	38,216	16,815	55,031
1.3.6	WOOD & PLASTICS	1,332	586	1,918
1.3.7	THERMAL & MOISTURE PROTECTION	4,808	2,115	6,923
1.3.8	DOORS & WINDOWS	8,801	3,872	12,673
1.3.9	FINISHES	12,391	5,452	17,843
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	660,480	290,611	951,091
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	28,952	12,739	41,691
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	5,656,948	2,489,057	8,146,005
1.3.16	ELECTRICAL	75,274	33,121	108,395
1.4	GOVERNMENT FURNISHED EQUIP.			>> $2,525,494
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,856,981	668,513	2,525,494
1.5	G&A/PIF			>> $1,354,244
1.5.1	G&A/PIF ADDER	940,447	413,797	1,354,244
1.5.2	PROCUREMENT FEES	97,356	41,351	>> $138,707
	SUBTOTAL INCLUDING ESCALATION	15,163,435	6,092,867	>> $21,256,302
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,536,370
	CONTINGENCY			>> $6,207,328
	TOTAL ESTIMATED COST			>> $29,000,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *36.43%*

Lockheed Martin Idaho Technologies Co.

Rev. 6/96

COST ESTIMATE SUMMARY

PROJECT NAME: HLW EIS -WASTE TREATMENT SCOPING STUDIES
CALCINE RETRIEVAL AND TRANSPORT - OPTION B

TYPE OF ESTIMATE: PLANNING
PROJECT NO: 2414-1 (TRANS SYS B)
PREPARED BY: F. P. HANSON
REPORT NAME: Cost Estimate Summary

DATE: 23-Jan-1998
TIME: 15:41:59
CHECKED BY:
APPR'D BY:

\TION 1: INEEL - ICPP
JESTOR:. K. L. WILLIAMS

WBS Element	Cost Estimate Element	Total Unescalated	Escalation	Total Incl Escalation
1.1	ENGINEERING, DESIGN AND INSPECTION			>> $2,440,000
1.1.1	DESIGN ENGINEERING	1,950,000	0	1,950,000
1.1.2	TITLE III INSPECTION	490,000	0	490,000
1.2	MANAGEMENT COSTS			>> $1,950,000
1.2.1	PROJECT MANAGEMENT	975,000	0	975,000
1.2.2	CONSTRUCTION MANAGEMENT	975,000	0	975,000
1.3	CONSTRUCTION			>> $7,878,651
1.3.1	GENERAL CONDITIONS	39,795	0	39,795
1.3.2	SITEWORK	342,206	0	342,206
1.3.3	CONCRETE	1,009,448	0	1,009,448
1.3.4	MASONRY	0	0	0
1.3.5	METALS	38,216	0	38,216
1.3.6	WOOD & PLASTICS	1,332	0	1,332
1.3.7	THERMAL & MOISTURE PROTECTION	4,808	0	4,808
1.3.8	DOORS & WINDOWS	8,801	0	8,801
1.3.9	FINISHES	12,391	0	12,391
1.3.10	SPECIALTIES	0	0	0
1.3.11	EQUIPMENT	660,480	0	660,480
1.3.12	FURNISHINGS	0	0	0
1.3.13	SPECIAL CONSTRUCTION	28,952	0	28,952
1.3.14	CONVEYING SYSTEMS	0	0	0
1.3.15	MECHANICAL	5,656,948	0	5,656,948
1.3.16	ELECTRICAL	75,274	0	75,274
1.4	GOVERNMENT FURNISHED EQUIP.			>> $1,856,981
1.4.1	GOVERNMENT FURNISHED EQUIP.	1,856,981	0	1,856,981
1.5	G&A/PIF			>> $940,447
1.5.1	G&A/PIF ADDER	940,447	0	940,447
1.5.2	PROCUREMENT FEES	97,356	0	>> $97,356
	SUBTOTAL INCLUDING ESCALATION	15,163,435	0	>> $15,163,435
	PROJECT CONTINGENCY			
	MANAGEMENT RESERVE			>> $1,077,343
	CONTINGENCY			>> $4,159,222
	TOTAL ESTIMATED COST			>> $20,400,000

PROJECT COST PARAMETERS

EDI AS A % OF CONST. + GFE= *25.00%*

CONTINGENCY= *34.53%*

LOCKHEED MARTIN

Lockheed Martin Idaho Technologies Company

INTERDEPARTMENTAL COMMUNICATION

Date:	January 28, 1998		
To:	S. E. Gifford	MS 3765	6-5162
From:	R. J. Turk	MS 3875	6-3611
Subject:	ECONOMIC AND LIFE CYCLE ANALYSIS CONDUCTED FOR CALCINE RETRIEVAL SYSTEM -RJT-08-98		

Purpose:

As requested an Economic and Life-Cycle Cost (LCC) has been conducted to evaluate the CALCINE RETRIEVAL SYSTEM. This process is proposed to retrieve calcine from the Calcine Solids Storage Facilities (CSSF) and transport it to the waste treatment facility. The calcine retrieval and transportation system is designed to supply calcine to the treatment options of Vitrification, Direct Cementitious, Cementitious, Hot Isostatic Pressing and TRU currently understudy. A five and a twenty-year option utilizing a transport system "A or B" per your direction was conducted to coincide with various waste treatment activities.

This economic analysis is based on information provided by Karen Williams, Sara Gifford, A. E. Lee, Ron DaFoe, Dan Griffith, D. Lopez, N. Russell, B. Landman, R. Kimmett and other team members.
F. P. Hanson provided cost estimates. Jack Prendergast provided process personnel modeling.

Methodology:

The Economic Evaluation assumed a five-year and a 20-year operations period since this is the estimated time required to supply the calcine to the waste treatment options currently being evaluated. The LCC identifies and evaluates the initial development, construction, operation and post-operating costs over the life-cycle. A discounted LCC assumes a current 1998-dollar basis, discounted at 6.30% annually 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 was assumed to be accomplished in five years with construction completed in six years, complete with eighteen months 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 these facilities was modeled for five and twenty years, followed by one year of post-operations activities. Utilities were assumed to cost $3.00/sf for the facility. Due to this projects 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 total unescalated pre-operation cost, and demolition costs equal to 8% of total unescalated pre-operation cost.

Results:

The Five-year operation of the CALCINE RETRIEVAL SYSTEM "A"Option has a Discounted LCC of $167 million.

The Twenty-year operation of CALCINE RETRIEVAL SYSTEM "A" Option has a Discounted LCC of $192 million.

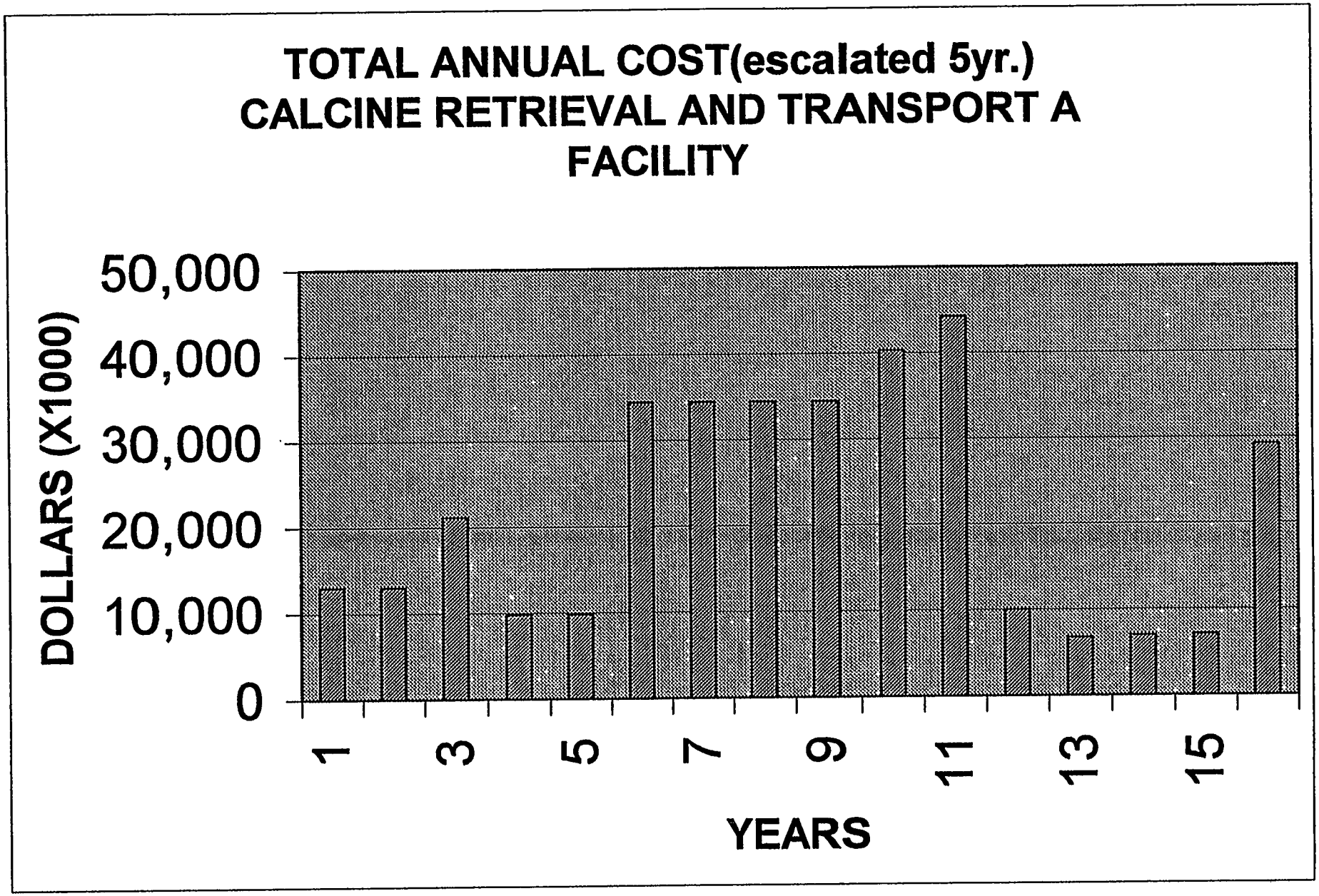
The Twenty-year operation of CALCINE RETRIEVAL SYSTEM "B" Option has a Discounted LCC of $ 197 million.

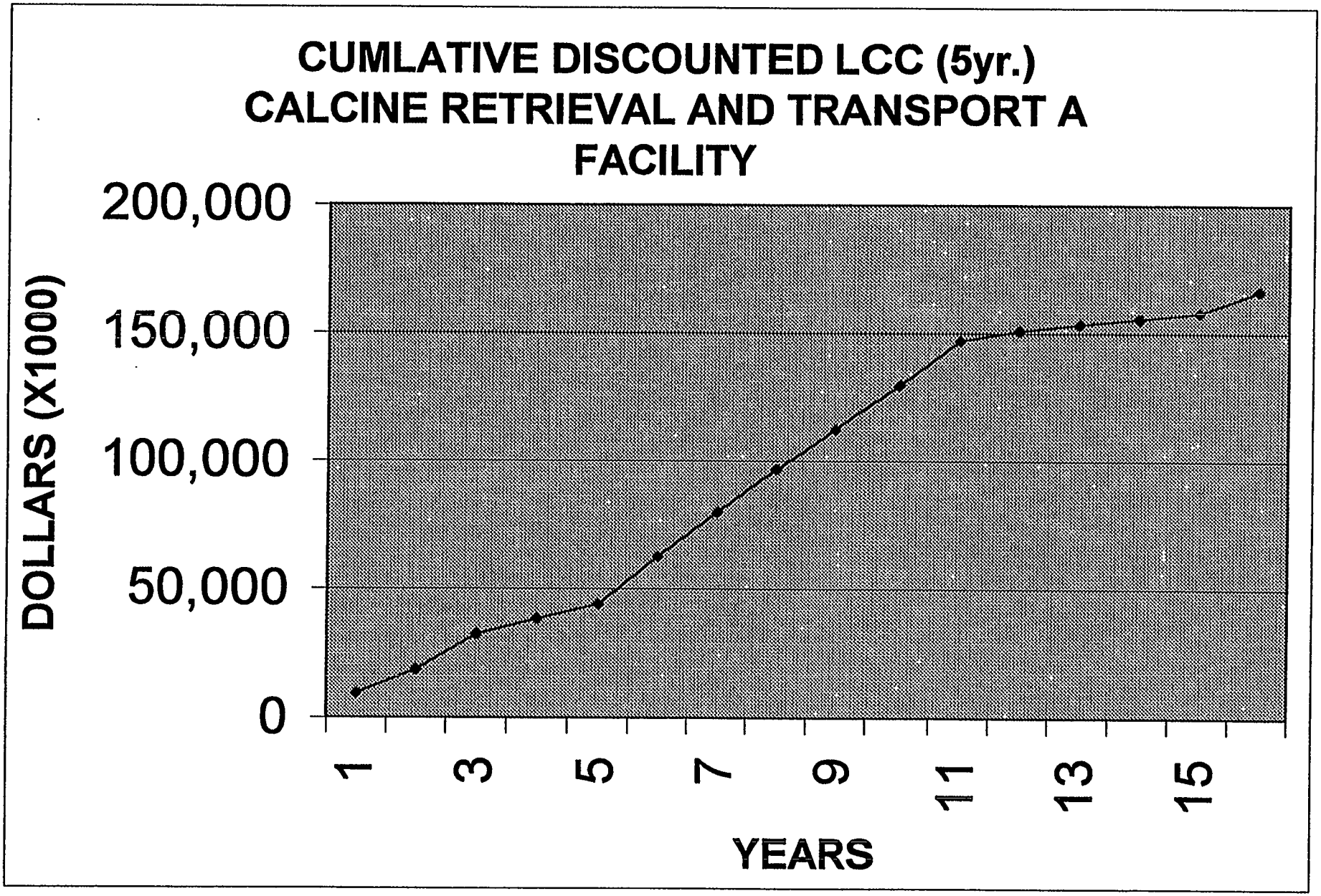
Attachments:

cc: R. J. Turk File

Calcine Removal and Transport(5-yr sys A)					fiscal year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Life-Cycle Cost (LCC) Analysis					counting year	1	2	3	4	5	6	7	8	9	10
Escalation Factor					escalation factor	1.142	1.174	1.207	1.241	1.275	1.311	1.348	1.386	1.424	1.464
(All cost X1000)															
Other Project Cost for ALL BIN 7 SETS (OPC)															
OPC unescalated															
Conceptual Design, Proj Mgt, & Permitting						5,905	5,905	5,905							
Testing and Start-up															
Total OPC (unescalated)						5,905	5,905	5,905	0	0	0	0	0	0	0
plus escalation of						2,598	2,598	2,598	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						2,908	2,908	2,908	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						11,412	11,412	11,412	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)													0	0	0
TEC unescalated								4,258	4,258	4,258					
Title Design, Inspection						769	769	769	769	769	769	769	769	769	769
Project mgt											1,409	1,409	1,409	1,409	1,409
Construction Mgt											15,585	15,585	15,585	15,585	15,585
Construction, Equip, G&A & Procurement											17,762	17,762	17,762	17,762	17,762
Total TEC (unescalated)						769	769	5,027	5,027	5,027	7,545	7,545	7,545	7,545	7,545
plus escalation of						326	326	2,135	2,135	2,135	1,933	1,933	1,933	1,933	1,933
plus management reserve of						84	84	547	547	547	1,933	1,933	1,933	1,933	1,933
plus contingency of						312	312	2,040	2,040	2,040	7,208	7,208	7,208	7,208	7,208
Total TEC including esc, mgt res, contingency						1,491	1,491	9,750	9,750	9,750	34,448	34,448	34,448	34,448	34,448
Total Project Cost for ALL 7 BIN SETS (TPC)															
TPC unescalated						6,674	6,674	10,932	5,027	5,027	17,762	17,762	17,762	17,762	17,762
plus escalation of						2,925	2,925	4,734	2,135	2,135	7,545	7,545	7,545	7,545	7,545
plus management reserve of						84	84	547	547	547	1,933	1,933	1,933	1,933	1,933
plus contingency of						3,220	3,220	4,948	2,040	2,040	7,208	7,208	7,208	7,208	7,208
Total TPC including esc, mgt res, contingency						12,902	12,902	21,161	9,750	9,750	34,448	34,448	34,448	34,448	34,448
Operations	260 hr-shift/yr.														
Facility/Administration	0														
Managers		0	FTE	$125	$/hr.										
Engineers		0	FTE	$108	$/hr.										
Other Tech.		0	FTE	$85	$/hr.										
Administration/Support		0	FTE	$65	$/hr.										
Operations/Process Facility	11														4
Managers		0.5	FTE	$125	$/hr.										4
Engineers		0.5	FTE	$108	$/hr.										1
Other Tech.		0.25	FTE	$85	$/hr.										11
Supervisors		2	FTE	$85	$/hr.										4
Administration/Support		1	FTE	$65	$/hr.										101
Operators		8	FTE	$65	$/hr.										17
Maintenance		1	FTE	$65	$/hr.										64
Utilities		28,000	SF @	$3.00	$/SF										1,311
Maintenance of Equipment		6.00%	of	$16,387											1,542
Building Maintenance		2.00%	of	$77,121											3,080
Operations subtotal (unescalated)						0	0	0	0	0	0	0	0	0	1,430
plus Escalation						0	0	0	0	0	0	0	0	0	1,353
plus Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	5,862
Total Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	
Post Operations															
Decommission		20.00%	of	Eng. costs											
Decontamination		5.00%	of	Pre-operation											
Demolition		8.00%	of	Pre-operation											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						6,674	6,674	10,932	5,027	5,027	17,762	17,762	17,762	17,762	20,842
Cumulative Total Cost (unescalated)						6,674	13,347	24,279	29,306	34,334	52,096	69,858	87,621	105,383	126,225
Total Cost (w/ escalation, mgt reserve, & contingency)						12,902	12,902	21,161	9,750	9,750	34,448	34,448	34,448	34,448	40,311
Cumulative Total Cost (escalated)						12,902	25,805	46,966	56,715	66,465	100,913	135,362	169,810	204,258	244,569
discount factor @ OMB discount rate of		6.30%	for escalated costs			1.357	1.443	1.534	1.630	1.733	1.842	1.958	2.082	2.213	2.352
Discounted Annual Cost						$9,506	$8,943	$13,798	$5,980	$5,626	$18,700	$17,591	$16,549	$15,568	$17,138
Cumulative Discounted Costs(escalated)						9,506	18,449	32,246	38,227	43,853	62,552	80,144	96,693	112,261	129,399

Calcine Removal and Transport(5-yr sys A)					fiscal year	2013	2014	2015	2016	2017	2018	Total
Life-Cycle Cost (LCC) Analysis					counting year	11	12	13	14	15	16	Cost
Escalation Factor					escalation factor	1.505	1.547	1.591	1.635	1.681	1.728	
(All cost X1000)												
Other Project Cost for ALL BIN 7 SETS (OPC)												
OPC unescalated												
Conceptual Design, Proj Mgt, & Permitting												17,715
Testing and Start-up						1,776	1,776					3,552
Total OPC (unescalated)						1,776	1,776	0	0	0	0	21,267
plus escalation of						782	782	0	0	0	0	9,358
plus management reserve of						0	0	0	0	0	0	0
plus contingency of						875	875	0	0	0	0	10,475
Total OPC including escalation, mgt reserve, & contingency						3,433	3,433	0	0	0	0	41,100
Total Estimated Cost for ALL BIN 7 SETS (TEC)												
TEC unescalated						0						
Title Design, Inspection												12,775
Project mgt						769						8,455
Construction Mgt						1,409						8,455
Construction, Equip, G&A & Procurement						15,585						93,507
Total TEC (unescalated)						17,762	0	0	0	0	0	123,193
plus escalation of						7,545	0	0	0	0	0	52,330
plus management reserve of						1,933	0	0	0	0	0	13,406
plus contingency of						7,208	0	0	0	0	0	49,992
Total TEC including esc, mgt res, contingency						34,448	0	0	0	0	0	238,920
Total Project Cost for ALL 7 BIN SETS (TPC)												
TPC unescalated						19,539	1,776	0	0	0	0	144,460
plus escalation of						8,327	782	0	0	0	0	61,687
plus management reserve of						1,933	0	0	0	0	0	13,406
plus contingency of						8,083	875	0	0	0	0	60,467
Total TPC including esc, mgt res, contingency						37,881	3,433	0	0	0	0	280,020
Operations	260 hr-shift/yr.											
Facility/Administration	0											
Managers		0	FTE	$125	$/hr.	0	0	0	0	0	0	0
Engineers		0	FTE	$108	$/hr.	0	0	0	0	0	0	0
Other Tech.		0	FTE	$85	$/hr.	0	0	0	0	0	0	0
Administration/Support		0	FTE	$65	$/hr.	0	0	0	0	0	0	0
Operations/Process Facility	11											0
Managers		0.5	FTE	$125	$/hr.	16	16	16	16	16	0	85
Engineers		0.5	FTE	$108	$/hr.	14	14	14	14	14	0	74
Other Tech.		0.25	FTE	$85	$/hr.	6	6	6	6	6	0	29
Supervisors		2	FTE	$85	$/hr.	44	44	44	44	44	0	232
Administration/Support		1	FTE	$65	$/hr.	17	17	17	17	17	0	89
Operators		6	FTE	$65	$/hr.	101	101	101	101	101	0	606
Maintenance		1	FTE	$65	$/hr.	17	17	17	17	17	0	101
Utilities		28,000	SF @	$3.00	$/SF	194	194	194	194	194	0	1,054
Maintenance of Equipment		6.00%	of	$16,387		1,311	1,311	1,311	1,311	1,311	0	7,866
Building Maintenance		2.00%	of	$77,121		1,542	1,542	1,542	1,542	1,542	0	9,255
Operations subtotal (unescalated)						3,263	3,263	3,263	3,263	3,263	0	19,393
plus Escalation						1,648	1,786	1,927	2,072	2,222	0	11,065
plus Operations Contingency @		30.0%				1,473	1,515	1,557	1,601	1,645	0	9,143
Total Operations (w/ escalation & contingency)						6,384	6,563	6,747	6,936	7,130	0	39,621
Post Operations												
Decommission		20.00%	of	Eng. costs							2,555	2,555
Decontamination		5.00%	of	Pre-operation							7,223	7,223
Demolition		8.00%	of	Pre-operation							4,935	4,935
Post-Operations Subtotal (unescalated)						0	0	0	0	0	14,713	14,713
plus Escalation						0	0	0	0	0	10,712	10,712
plus Post-Operations Contingency @		15.0%				0	0	0	0	0	3,814	3,814
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	29,239	29,239
Total Cost (unescalated)						22,901	5,039	3,263	3,263	3,263	14,713	176,566
Cumulative Total Cost (unescalated)						149,026	154,065	157,328	160,590	163,853	178,566	
Total Cost (w/ escalation, mgt reserve, & contingency)						44,265	9,995	6,747	6,936	7,130	29,239	348,660
Cumulative Total Cost (escalated)						268,634	298,629	305,376	312,312	319,441	348,680	
discount factor @ OMB discount rate of		6.30%		for escalated costs		2.500	2.658	2.825	3.003	3.193	3.394	
Discounted Annual Cost						$17,704	$3,761	$2,388	$2,309	$2,233	$8,616	166,409
Cumulative Discounted Costs(escalated)						147,102	150,863	153,251	155,560	157,793	166,409	


TOTAL ANNUAL COST(escalated 5yr.)
CALCINE RETRIEVAL AND TRANSPORT A
FACILITY
DOLLARS (X1000)
50,000
40,000
30,000
20,000
10,000
0
1
3
5
7
9
11
13
15
YEARS

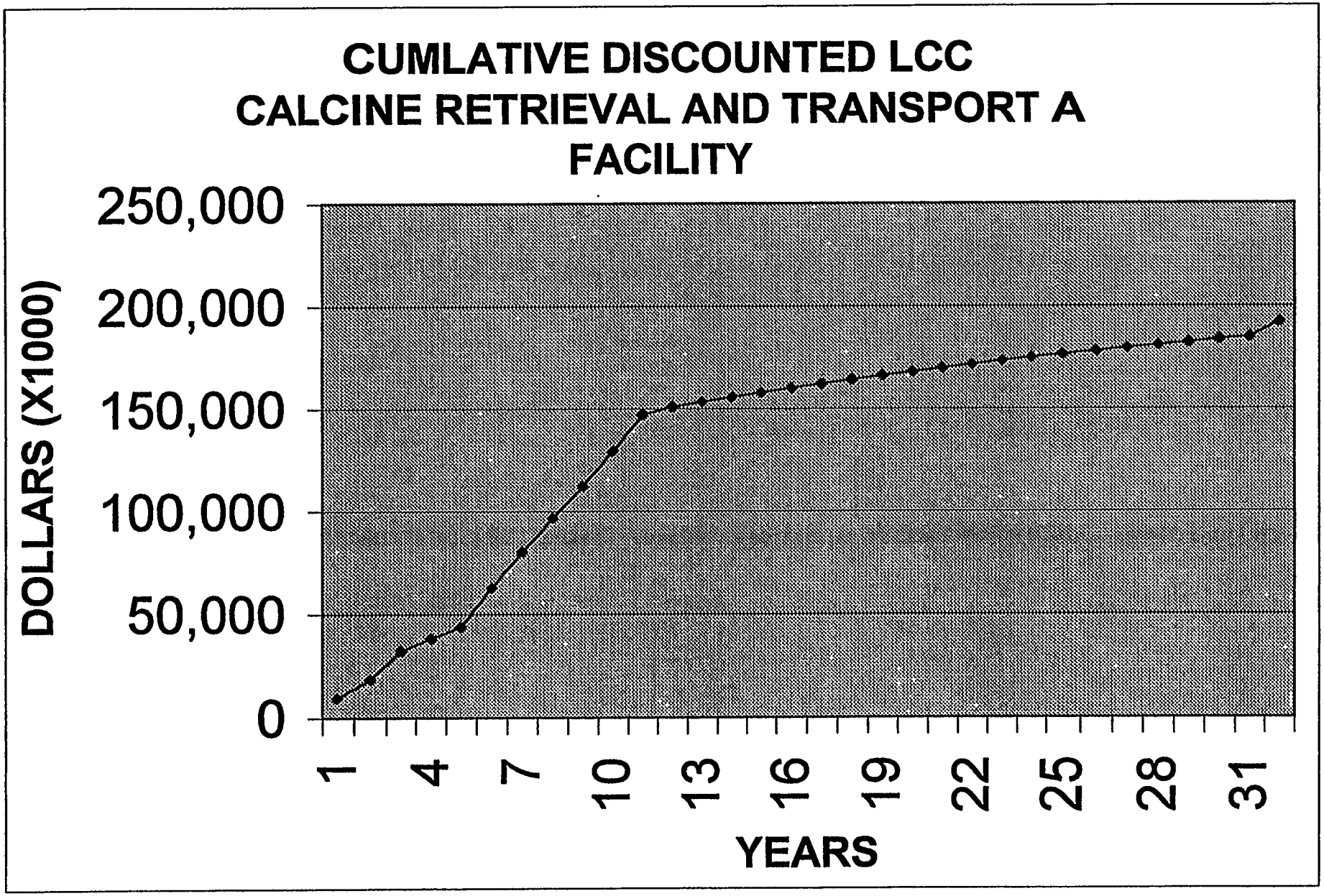

CUMLATIVE DISCOUNTED LCC (5yr.)
CALCINE RETRIEVAL AND TRANSPORT A
FACILITY
DOLLARS (X1000)
200,000
150,000
100,000
50,000
0
1
3
5
7
9
11
13
15
YEARS

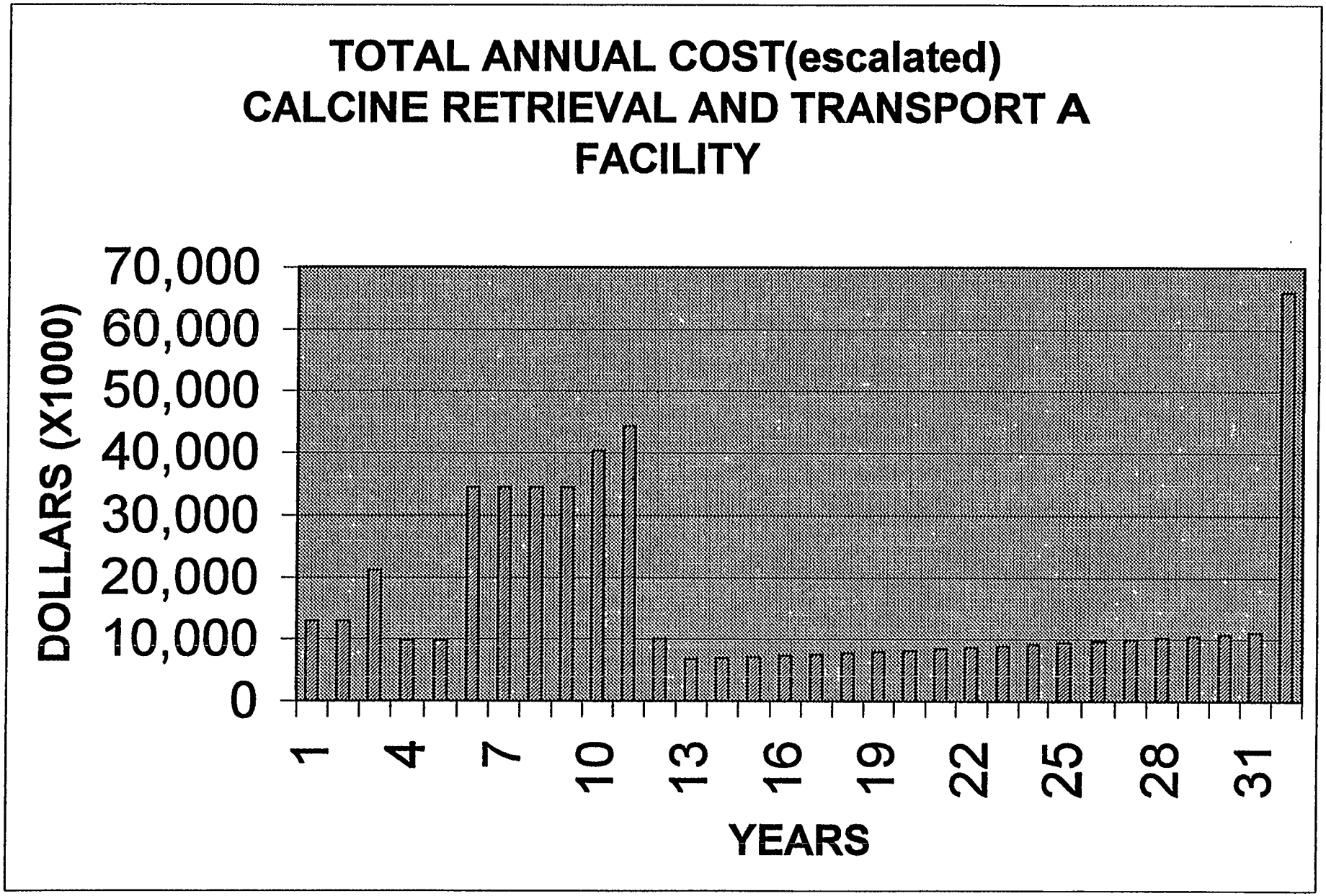
Calcine Removal and Transport(20-yr sys A)				fiscal year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Life-Cycle Cost (LCC) Analysis				counting year	1	2	3	4	5	6	7	8	9	10
Escalation Factor				escalation factor	1.142	1.174	1.207	1.241	1.275	1.311	1.348	1.386	1.424	1.464
(All cost X1000)														
Other Project Cost for ALL BIN 7 SETS (OPC)														
OPC unescalated														
Conceptual Design, Proj Mgt, & Permitting					5,905	5,905	5,905							
Testing and Start-up														
Total OPC (unescalated)					5,905	5,905	5,905	0	0	0	0	0	0	0
plus escalation of					2,598	2,598	2,598	0	0	0	0	0	0	0
plus management reserve of					0	0	0	0	0	0	0	0	0	0
plus contingency of					2,908	2,908	2,908	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency					11,412	11,412	11,412	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)														
TEC unescalated												0	0	0
Title Design, Inspection							4,258	4,258	4,258					
Project mgt					769	769	769	769	769	769	769	769	769	769
Construction Mgt										1,409	1,409	1,409	1,409	1,409
Construction, Equip, G&A & Procurement										15,585	15,585	15,585	15,585	15,585
Total TEC (unescalated)					769	769	5,027	5,027	5,027	17,762	17,762	17,762	17,762	17,762
plus escalation of					326	326	2,135	2,135	2,135	7,545	7,545	7,545	7,545	7,545
plus management reserve of					84	84	547	547	547	1,933	1,933	1,933	1,933	1,933
plus contingency of					312	312	2,040	2,040	2,040	7,208	7,208	7,208	7,208	7,208
Total TEC including esc, mgt res, contingency					1,491	1,491	9,750	9,750	9,750	34,448	34,448	34,448	34,448	34,448
Total Project Cost for ALL 7 BIN SETS (TPC)														
TPC unescalated					6,674	6,674	10,932	5,027	5,027	17,762	17,762	17,762	17,762	17,762
plus escalation of					2,925	2,925	4,734	2,135	2,135	7,545	7,545	7,545	7,545	7,545
plus management reserve of					84	84	547	547	547	1,933	1,933	1,933	1,933	1,933
plus contingency of					3,220	3,220	4,048	2,040	2,040	7,208	7,208	7,208	7,208	7,208
Total TPC including esc, mgt res, contingency					12,902	12,902	21,161	9,750	9,750	34,448	34,448	34,448	34,448	34,448
Operations	260 hr-shift/yr.													
Facility/Administration	0													
Managers		0	FTE	$125 $/hr.										
Engineers		0	FTE	$108 $/hr.										
Other Tech.		0	FTE	$85 $/hr.										
Administration/Support		0	FTE	$65 $/hr.										
Operations/Process Facility	11													
Managers		0.5	FTE	$125 $/hr.										4
Engineers		0.5	FTE	$108 $/hr.										4
Other Tech.		0.25	FTE	$85 $/hr.										1
Supervisors		2	FTE	$85 $/hr.										11
Administration/Support		1	FTE	$65 $/hr.										4
Operators		6	FTE	$65 $/hr.										101
Maintenance		1	FTE	$65 $/hr.										17
Utilities		28,000	SF @	$3.00 $/SF										84
Maintenance of Equipment		8.00%	of	$16,387										1,311
Building Maintenance		2.00%	of	$77,121										1,542
Operations subtotal (unescalated)					0	0	0	0	0	0	0	0	0	3,080
plus Escalation					0	0	0	0	0	0	0	0	0	1,430
plus Operations Contingency @		30.0%			0	0	0	0	0	0	0	0	0	1,353
Total Operations (w/ escalation & contingency)					0	0	0	0	0	0	0	0	0	5,862
Post Operations														
Decommission		20.00%	of	Eng. costs										
Decontamination		5.00%	of	Pre-operation										
Demolition		8.00%	of	Pre-operation										
Post-Operations Subtotal (unescalated)					0	0	0	0	0	0	0	0	0	0
plus Escalation					0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%			0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)					0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)					6,674	6,674	10,932	5,027	5,027	17,762	17,762	17,762	17,762	20,842
Cumulative Total Cost (unescalated)					6,674	13,347	24,279	29,306	34,334	52,096	69,858	87,621	105,383	126,225
Total Cost (w/ escalation, mgt reserve, & contingency)					12,902	12,902	21,161	9,750	9,750	34,448	34,448	34,448	34,448	40,311
Cumulative Total Cost (escalated)					12,902	25,805	46,966	56,715	66,465	100,913	135,362	169,810	204,258	244,569
discount factor @ OMB discount rate of		6.30%		for escalated costs	1.357	1.443	1.534	1.630	1.733	1.842	1.958	2.082	2.213	2.352
Discounted Annual Cost					$9,506	$8,943	$13,798	$5,980	$5,626	$18,700	$17,591	$16,549	$15,568	$17,138
Cumulative Discounted Costs(escalated)					9,506	18,449	32,246	38,227	43,853	62,552	80,144	96,693	112,261	129,399

Calcine Removal and Transport(20-yr sys A)						fiscal year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Life-Cycle Cost (LCC) Analysis						counting year	11	12	13	14	15	16	17	18	19	20
Escalation Factor						escalation factor	1.505	1.547	1.591	1.635	1.681	1.728	1.776	1.826	1.877	1.930
(All cost X1000)																
Other Project Cost for ALL BIN 7 SETS (OPC)																
OPC unescalated																
Conceptual Design, Proj Mgt, & Permitting																
Testing and Start-up							1,776	1,776								
Total OPC (unescalated)							1,776	1,776	0	0	0	0	0	0	0	0
plus escalation of							782	782	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							875	875	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency							3,433	3,433	0	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)																
TEC unescalated							0									
Title Design, Inspection																
Project mgt							769									
Construction Mgt							1,409									
Construction, Equip, G&A & Procurement							15,585									
Total TEC (unescalated)							17,762	0	0	0	0	0	0	0	0	0
plus escalation of							7,545	0	0	0	0	0	0	0	0	0
plus management reserve of							1,933	0	0	0	0	0	0	0	0	0
plus contingency of							7,208	0	0	0	0	0	0	0	0	0
Total TEC including esc, mgt res, contingency							34,448	0	0	0	0	0	0	0	0	0
Total Project Cost for ALL 7 BIN SETS (TPC)																
TPC unescalated							19,539	1,776	0	0	0	0	0	0	0	0
plus escalation of							8,327	782	0	0	0	0	0	0	0	0
plus management reserve of							1,933	0	0	0	0	0	0	0	0	0
plus contingency of							8,083	875	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency							37,881	3,433	0	0	0	0	0	0	0	0
Operations	260 hr-shift/yr.															
Facility/Administration	0															
Managers		0	FTE		$125	$/hr.	0	0	0	0	0	0	0	0	0	0
Engineers		0	FTE		$108	$/hr.	0	0	0	0	0	0	0	0	0	0
Other Tech.		0	FTE		$85	$/hr.	0	0	0	0	0	0	0	0	0	0
Administration/Support		0	FTE		$65	$/hr.	0	0	0	0	0	0	0	0	0	0
Operations/Process Facility	11															
Managers		0.5	FTE		$125	$/hr.	16	16	16	16	16	16	16	16	16	16
Engineers		0.5	FTE		$108	$/hr.	14	14	14	14	14	14	14	14	14	14
Other Tech.		0.25	FTE		$85	$/hr.	6	6	6	6	6	6	6	6	6	6
Supervisors		2	FTE		$85	$/hr.	44	44	44	44	44	44	44	44	44	44
Administration/Support		1	FTE		$65	$/hr.	17	17	17	17	17	17	17	17	17	17
Operators		6	FTE		$65	$/hr.	101	101	101	101	101	101	101	101	101	101
Maintenance		1	FTE		$65	$/hr.	17	17	17	17	17	17	17	17	17	17
Utilities		28,000	SF @		$3.00	$/SF	194	194	194	194	194	194	194	194	194	194
Maintenance of Equipment		8.00%	of		$16,387		1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311
Building Maintenance		2.00%	of		$77,121		1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542
Operations subtotal (unescalated)							3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263
plus Escalation							1,648	1,786	1,927	2,072	2,222	2,375	2,533	2,696	2,862	3,034
plus Operations Contingency @		30.0%					1,473	1,515	1,557	1,601	1,645	1,691	1,739	1,787	1,837	1,889
Total Operations (w/ escalation & contingency)							6,384	6,563	6,747	6,936	7,130	7,329	7,535	7,746	7,962	8,185
Post Operations																
Decommission		20.00%	of	Eng. costs												
Decontamination		5.00%	of	Pre-operation												
Demolition		8.00%	of	Pre-operation												
Post-Operations Subtotal (unescalated)							0	0	0	0	0	0	0	0	0	0
plus Escalation							0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%					0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)							0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)							22,601	5,039	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263
Cumulative Total Cost (unescalated)							149,026	154,065	157,328	160,590	163,853	167,115	170,378	173,641	176,903	180,166
Total Cost (w/ escalation, mgt reserve, & contingency)							44,265	9,995	6,747	6,936	7,130	7,329	7,535	7,746	7,962	8,185
Cumulative Total Cost (escalated)							288,834	298,829	305,576	312,512	319,641	326,971	334,505	342,251	350,213	358,398
discount factor @ OMB discount rate of		6.30%		for escalated costs			2.500	2.658	2.826	3.003	3.193	3.394	3.607	3.835	4.076	4.333
Discounted Annual Cost							$17,704	$3,761	$2,388	$2,309	$2,233	$2,160	$2,089	$2,020	$1,953	$1,889
Cumulative Discounted Costs(escalated)							147,102	150,863	153,251	155,560	157,793	159,953	162,042	164,062	166,015	167,904

Calcine Removal and Transport(20-yr sys A)					fiscal year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Life-Cycle Cost (LCC) Analysis					counting year	21	22	23	24	25	26	27	28	29	30
Escalation Factor					escalation factor	1.984	2.039	2.097	2.155	2.216	2.278	2.341	2.407	2.474	2.544
(All cost X1000)															
Other Project Cost for ALL BIN 7 SETS (OPC)															
OPC unescalated															
Conceptual Design, Proj Mgt, & Permitting															
Testing and Start-up															
Total OPC (unescalated)						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						0	0	0	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)															
TEC unescalated															
Title Design, Inspection															
Project mgt															
Construction Mgt															
Construction, Equip, G&A & Procurement															
Total TEC (unescalated)						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total TEC including esc, mgt res, contingency						0	0	0	0	0	0	0	0	0	0
Total Project Cost for ALL 7 BIN SETS (TPC)															
TPC unescalated						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency						0	0	0	0	0	0	0	0	0	0
Operations	260 hr-shift/yr.														
Facility/Administration	0														
Managers		0	FTE	$125	$/hr.	0	0	0	0	0	0	0	0	0	0
Engineers		0	FTE	$108	$/hr.	0	0	0	0	0	0	0	0	0	0
Other Tech.		0	FTE	$85	$/hr.	0	0	0	0	0	0	0	0	0	0
Administration/Support		0	FTE	$65	$/hr.	0	0	0	0	0	0	0	0	0	0
Operations/Process Facility	11														
Managers		0.5	FTE	$125	$/hr.	16	16	16	16	16	16	16	16	16	16
Engineers		0.5	FTE	$108	$/hr.	14	14	14	14	14	14	14	14	14	14
Other Tech.		0.25	FTE	$85	$/hr.	6	6	6	6	6	6	6	6	6	6
Supervisors		2	FTE	$85	$/hr.	44	44	44	44	44	44	44	44	44	44
Administration/Support		1	FTE	$65	$/hr.	17	17	17	17	17	17	17	17	17	17
Operators		6	FTE	$65	$/hr.	101	101	101	101	101	101	101	101	101	101
Maintenance		1	FTE	$65	$/hr.	17	17	17	17	17	17	17	17	17	17
Utilities		28,000	SF @	$3.00	$/SF	194	194	194	194	194	194	194	194	194	194
Maintenance of Equipment		8.00%	of	$16,387		1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311
Building Maintenance		2.00%	of	$77,121		1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542	1,542
Operations subtotal (unescalated)						3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263
plus Escalation						3,210	3,391	3,578	3,769	3,966	4,169	4,377	4,590	4,810	5,036
plus Operations Contingency @		30.0%				1,942	1,996	2,052	2,110	2,169	2,229	2,292	2,356	2,422	2,490
Total Operations (w/ escalation & contingency)						8,416	8,650	8,892	9,141	9,397	9,660	9,931	10,209	10,495	10,789
Post Operations															
Decommission		20.00%	of	Eng. costs											
Decontamination		6.00%	of	Pre-operation											
Demolition		8.00%	of	Pre-operation											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263	3,263
Cumulative Total Cost (unescalated)						183,426	186,691	189,953	193,216	196,479	199,741	203,004	206,268	209,529	212,791
Total Cost (w/ escalation, mgt reserve, & contingency)						8,416	8,650	8,892	9,141	9,397	9,660	9,931	10,209	10,495	10,789
Cumulative Total Cost (escalated)						366,813	375,463	384,355	393,497	402,894	412,554	422,485	432,694	443,189	453,978
discount factor @ OMB discount rate of		6.30%		for escalated costs		4.606	4.898	5.205	5.533	5.881	6.252	6.648	7.064	7.509	7.982
Discounted Annual Cost						$1,827	$1,767	$1,709	$1,652	$1,598	$1,545	$1,494	$1,445	$1,398	$1,352
Cumulative Discounted Costs(escalated)						169,731	171,497	173,206	174,858	176,456	178,001	179,496	180,941	182,338	183,690

Calcine Removal and Transport(20-yr sys A)					fiscal year	2033	2034	Total
Life-Cycle Cost (LCC) Analysis					counting year	31	32	Cost
Escalation Factor					escalation factor	2.615	2.688	
(All cost X1000)								
Other Project Cost for ALL BIN 7 SETS (OPC)								
OPC unescalated								
Conceptual Design, Proj Mgt, & Permitting								17,715
Testing and Start-up								3,552
Total OPC (unescalated)						0	0	21,267
plus escalation of						0	0	9,358
plus management reserve of						0	0	0
plus contingency of						0	0	10,475
Total OPC including escalation, mgt reserve, & contingency						0	0	41,100
Total Estimated Cost for ALL BIN 7 SETS (TEC)								
TEC unescalated								
Title Design, Inspection								12,775
Project mgt								8,455
Construction Mgt								8,455
Construction, Equip, G&A & Procurement								93,507
Total TEC (unescalated)						0	0	123,193
plus escalation of						0	0	52,330
plus management reserve of						0	0	13,406
plus contingency of						0	0	49,992
Total TEC including esc, mgt res, contingency						0	0	238,920
Total Project Cost for ALL 7 BIN SETS (TPC)								
TPC unescalated						0	0	144,460
plus escalation of						0	0	61,687
plus management reserve of						0	0	13,406
plus contingency of						0	0	60,467
Total TPC including esc, mgt res, contingency						0	0	280,020
Operations	260 hr-shift/yr.							
Facility/Administration	0							
Managers		0	FTE	$125	$/hr.	0	0	0
Engineers		0	FTE	$108	$/hr.	0	0	0
Other Tech.		0	FTE	$85	$/hr.	0	0	0
Administration/Support		0	FTE	$65	$/hr.	0	0	0
Operations/Process Facility	11							0
Managers		0.5	FTE	$125	$/hr.	18	0	345
Engineers		0.5	FTE	$108	$/hr.	14	0	298
Other Tech.		0.25	FTE	$85	$/hr.	6	0	117
Supervisors		2	FTE	$85	$/hr.	44	0	939
Administration/Support		1	FTE	$65	$/hr.	17	0	359
Operators		6	FTE	$65	$/hr.	101	0	2,231
Maintenance		1	FTE	$65	$/hr.	17	0	372
Utilities		28,000	SF @	$3.00	$/SF	194	0	4,158
Maintenance of Equipment		8.00%	of	$16,387		1,311	0	28,640
Building Maintenance		2.00%	of	$77,121		1,542	0	33,933
Operations subtotal (unescalated)						3,283	0	71,594
plus Escalation						5,269	0	70,751
plus Operations Contingency @		30.0%				2,559	0	42,704
Total Operations (w/ escalation & contingency)						11,091	0	185,049
Post Operations								
Decommission		20.00%	of	Eng. costs			2,655	2,655
Decontamination		5.00%	of	Pre-operation			7,223	7,223
Demolition		8.00%	of	Pre-operation			11,657	11,657
Post-Operations Subtotal (unescalated)						0	21,335	21,335
plus Escalation						0	38,016	38,016
plus Post-Operations Contingency @		15.0%				0	6,603	6,603
Total Post-Operations (w/ escalation & contingency)						0	65,954	65,954
Total Cost (unescalated)						3,283	21,335	237,389
Cumulative Total Cost (unescalated)						216,054	237,389	
Total Cost (w/ escalation, mgt reserve, & contingency)						11,091	65,954	531,023
Cumulative Total Cost (escalated)						465,069	531,023	
discount factor @ OMB discount rate of		6.30%		for escalated costs		8.485	9.020	
Discounted Annual Cost						$1,307	$7,312	192,309
Cumulative Discounted Costs(escalated)						184,997	192,309	


CUMLATIVE DISCOUNTED LCC
CALCINE RETRIEVAL AND TRANSPORT A
FACILITY
DOLLARS (X1000)
250,000
200,000
150,000
100,000
50,000
0
1
4
7
10
13
16
19
22
25
28
31
YEARS

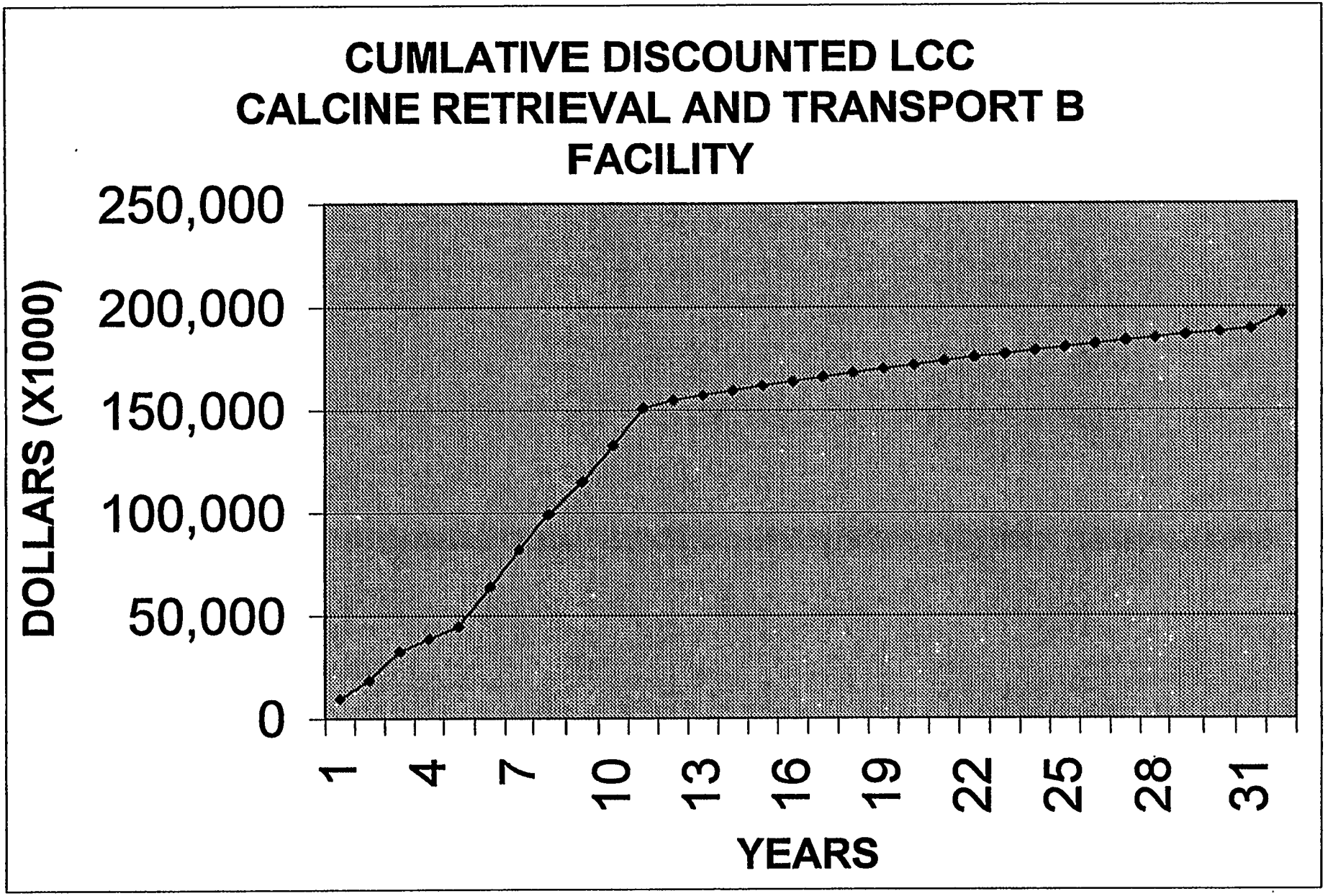

TOTAL ANNUAL COST(escalated)
CALCINE RETRIEVAL AND TRANSPORT A FACILITY
DOLLARS (X1000)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1
4
7
10
13
16
19
22
25
28
31
YEARS

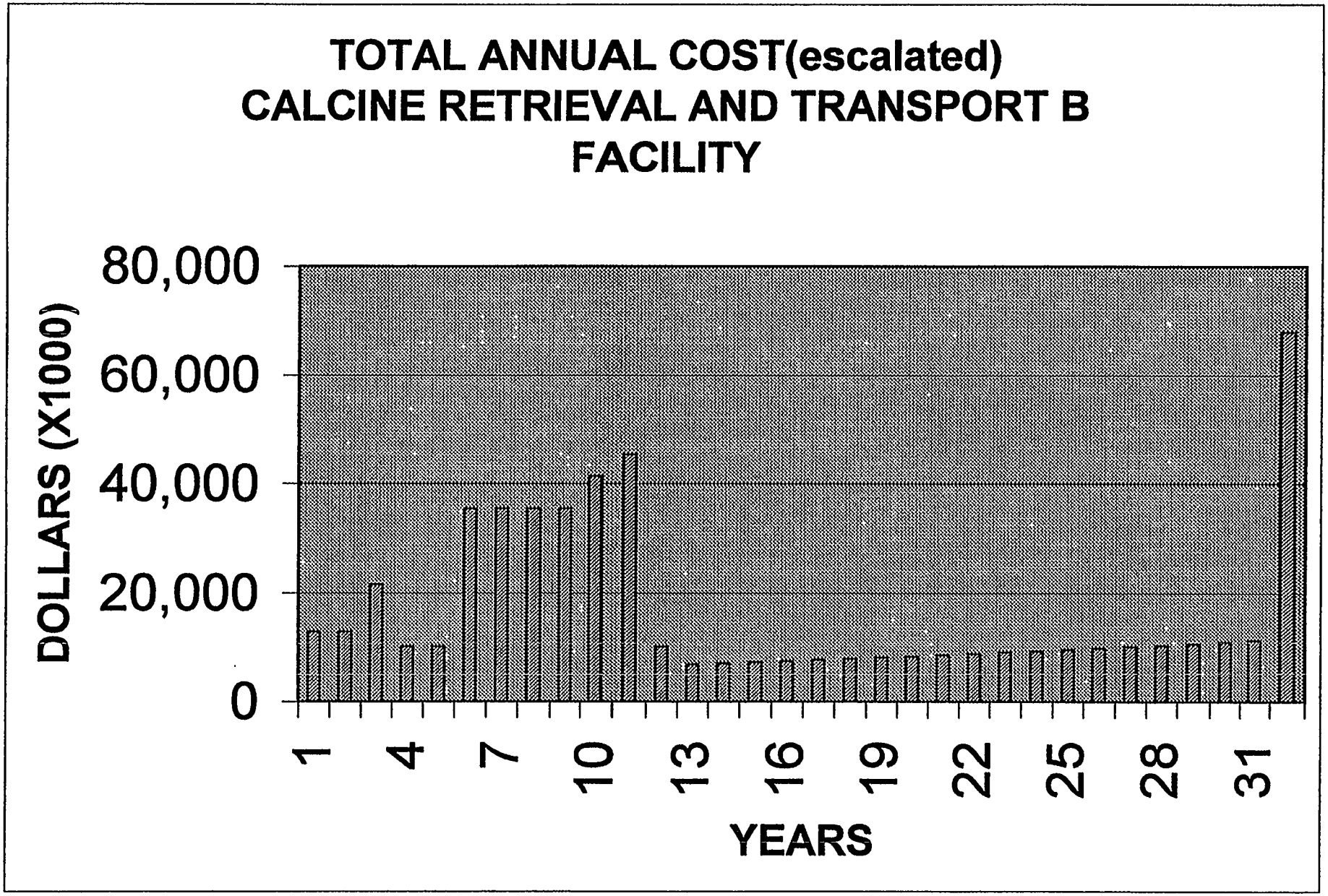
Calcine Removal and Transport(20-yr sys B)					fiscal year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Life-Cycle Cost (LCC) Analysis					counting year	1	2	3	4	5	6	7	8	9	10
Escalation Factor					escalation factor	1.142	1.174	1.207	1.241	1.275	1.311	1.348	1.386	1.424	1.464
(All cost X1000)															
Other Project Cost for ALL BIN 7 SETS (OPC)															
OPC unescalated															
Conceptual Design, Proj Mgt, & Permitting						5,905	5,905	5,905							
Testing and Start-up															
Total OPC (unescalated)						5,905	5,905	5,905	0	0	0	0	0	0	0
plus escalation of						2,598	2,598	2,598	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						2,908	2,908	2,908	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						11,412	11,412	11,412	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)															
TEC unescalated													0	0	0
Title Design, Inspection								4,488	4,488	4,488					
Project mgt						792	792	792	792	792	792	792	792	792	792
Construction Mgt											1,452	1,452	1,452	1,452	1,452
Construction, Equip, G&A & Procurement											16,034	16,034	16,034	16,034	16,034
Total TEC (unescalated)						792	792	5,280	5,280	5,280	18,278	18,278	18,278	18,278	18,278
plus escalation of						336	336	2,230	2,230	2,230	7,747	7,747	7,747	7,747	7,747
plus management reserve of						66	66	571	571	571	1,984	1,984	1,984	1,984	1,984
plus contingency of						322	322	2,137	2,137	2,137	7,426	7,426	7,426	7,426	7,426
Total TEC including esc, mgt res, contingency						1,535	1,535	10,198	10,198	10,198	35,434	35,434	35,434	35,434	35,434
Total Project Cost for ALL 7 BIN SETS (TPC)															
TPC unescalated						6,697	6,697	11,185	5,280	5,280	18,278	18,278	18,278	18,278	18,278
plus escalation of						2,934	2,934	4,828	2,230	2,230	7,747	7,747	7,747	7,747	7,747
plus management reserve of						66	66	571	571	571	1,984	1,984	1,984	1,984	1,984
plus contingency of						3,230	3,230	5,046	2,137	2,137	7,426	7,426	7,426	7,426	7,426
Total TPC including esc, mgt res, contingency						12,947	12,947	21,610	10,198	10,198	35,434	35,434	35,434	35,434	35,434
Operations	260 hr-shift/yr.														
Facility/Administration	0														
Managers		0	FTE	$125	$/hr.										
Engineers		0	FTE	$108	$/hr.										
Other Tech.		0	FTE	$85	$/hr.										
Administration/Support		0	FTE	$65	$/hr.										
Operations/Process Facility	11														
Managers		0.5	FTE	$125	$/hr.										4
Engineers		0.5	FTE	$108	$/hr.										4
Other Tech.		0.25	FTE	$85	$/hr.										1
Supervisors		2	FTE	$85	$/hr.										11
Administration/Support		1	FTE	$65	$/hr.										4
Operators		6	FTE	$85	$/hr.										101
Maintenance		1	FTE	$65	$/hr.										17
Utilities		28,000	SF @	$3.00	$/SF										84
Maintenance of Equipment		6.00%	of	$16,387											1,311
Building Maintenance		2.00%	of	$79,819											1,596
Operations subtotal (unescalated)						0	0	0	0	0	0	0	0	0	3,134
plus Escalation						0	0	0	0	0	0	0	0	0	1,455
plus Operations Contingency @		30.0%				0	0	0	0	0	0	0	0	0	1,377
Total Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	5,965
Post Operations															
Decommission		20.00%	of	Eng. costs											
Decontamination		5.00%	of	Pre-operation											
Demolition		6.00%	of	Pre-operation											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						6,697	6,697	11,185	5,280	5,280	18,278	18,278	18,278	18,278	21,412
Cumulative Total Cost (unescalated)						6,697	13,394	24,559	29,819	35,079	53,357	71,635	89,913	108,190	129,602
Total Cost (w/ escalation, mgt reserve, & contingency)						12,947	12,947	21,610	10,198	10,198	35,434	35,434	35,434	35,434	41,400
Cumulative Total Cost (escalated)						12,947	25,893	47,503	57,701	67,899	103,333	138,767	174,202	209,636	251,036
discount factor @ OMB discount rate of		6.30%		for escalated costs		1.357	1.443	1.534	1.630	1.733	1.842	1.958	2.082	2.213	2.352
Discounted Annual Cost						$9,539	$8,973	$14,090	$6,255	$5,885	$19,235	$18,095	$17,023	$16,014	$17,601
Cumulative Discounted Costs(escalated)						9,539	18,512	32,602	38,858	44,742	63,977	82,072	99,095	115,108	132,709

Calcine Removal and Transport(20-yr sys B)						fiscal year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Life-Cycle Cost (LCC) Analysis						counting year	11	12	13	14	15	16	17	18	19	20
Escalation Factor						escalation factor	1.605	1.647	1.691	1.735	1.781	1.828	1.876	1.926	1.977	1.030
(All cost X(1000)																
Other Project Cost for ALL BIN 7 SETS (OPC)																
OPC unescalated																
Conceptual Design, Proj Mgt, & Permitting																
Testing and Start-up							1,776	1,776								
Total OPC (unescalated)							1,776	1,776	0	0	0	0	0	0	0	0
plus escalation of							782	782	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							875	875	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency							3,433	3,433	0	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)																
TEC unescalated							0									
Title Design, Inspection																
Project mgt							792									
Construction Mgt							1,452									
Construction, Equip, G&A & Procurement							16,034									
Total TEC (unescalated)							18,278	0	0	0	0	0	0	0	0	0
plus escalation of							7,747	0	0	0	0	0	0	0	0	0
plus management reserve of							1,984	0	0	0	0	0	0	0	0	0
plus contingency of							7,426	0	0	0	0	0	0	0	0	0
Total TEC including esc, mgt res, contingency							35,434	0	0	0	0	0	0	0	0	0
Total Project Cost for ALL 7 BIN SETS (TPC)																
TPC unescalated							20,054	1,776	0	0	0	0	0	0	0	0
plus escalation of							8,529	782	0	0	0	0	0	0	0	0
plus management reserve of							1,984	0	0	0	0	0	0	0	0	0
plus contingency of							8,301	875	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency							38,867	3,433	0	0	0	0	0	0	0	0
Operations	260 hr-shift/yr.															
Facility/Administration	0															
Managers		0	FTE	$125	$/hr.		0	0	0	0	0	0	0	0	0	0
Engineers		0	FTE	$108	$/hr.		0	0	0	0	0	0	0	0	0	0
Other Tech.		0	FTE	$85	$/hr.		0	0	0	0	0	0	0	0	0	0
Administration/Support		0	FTE	$65	$/hr.		0	0	0	0	0	0	0	0	0	0
Operations/Process Facility	11															
Managers		0.5	FTE	$125	$/hr.		16	16	16	16	16	16	16	16	16	16
Engineers		0.5	FTE	$108	$/hr.		14	14	14	14	14	14	14	14	14	14
Other Tech.		0.25	FTE	$85	$/hr.		6	6	6	6	6	6	6	6	6	6
Supervisors		2	FTE	$85	$/hr.		44	44	44	44	44	44	44	44	44	44
Administration/Support		1	FTE	$65	$/hr.		17	17	17	17	17	17	17	17	17	17
Operators		6	FTE	$65	$/hr.		101	101	101	101	101	101	101	101	101	101
Maintenance		1	FTE	$65	$/hr.		17	17	17	17	17	17	17	17	17	17
Utilities		28,000	SF @	$3.00	$/SF		194	194	194	194	194	194	194	194	194	194
Maintenance of Equipment		8.00%	of	$16,387			1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311
Building Maintenance		2.00%	of	$79,819			1,596	1,596	1,596	1,596	1,596	1,596	1,596	1,596	1,596	1,596
Operations subtotal (unescalated)							3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317
plus Escalation							1,678	1,815	1,959	2,107	2,259	2,415	2,575	2,740	2,910	3,084
plus Operations Contingency @		30.0%					1,496	1,540	1,583	1,627	1,673	1,719	1,768	1,817	1,868	1,920
Total Operations (w/ escalation & contingency)							6,490	6,671	6,858	7,050	7,248	7,451	7,659	7,874	8,094	8,321
Post Operations																
Decommission		20.00%	of	Eng. costs												
Decontamination		6.00%	of	Pre-operation												
Demolition		6.00%	of	Pre-operation												
Post-Operations Subtotal (unescalated)							0	0	0	0	0	0	0	0	0	0
plus Escalation							0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%					0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)							0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)							23,370	5,093	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317
Cumulative Total Cost (unescalated)							152,972	158,065	161,382	164,698	168,015	171,331	174,648	177,964	181,281	184,597
Total Cost (w/ escalation, mgt reserve, & contingency)							45,357	10,104	6,858	7,050	7,248	7,451	7,659	7,874	8,094	8,321
Cumulative Total Cost (escalated)							296,392	306,496	313,354	320,405	327,652	335,103	342,762	350,636	358,730	367,050
discount factor @ OMB discount rate of		6.30%		for escalated costs			2.500	2.658	2.825	3.003	3.193	3.394	3.607	3.835	4.078	4.333
Discounted Annual Cost							$18,140	$3,802	$2,427	$2,347	$2,270	$2,195	$2,123	$2,053	$1,986	$1,920
Cumulative Discounted Costs(escalated)							150,849	154,651	157,078	159,426	161,696	163,891	166,014	168,068	170,053	171,974

Calcine Removal and Transport(20-yr sys B)					fiscal year	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Life-Cycle Cost (LCC) Analysis					counting year	21	22	23	24	25	26	27	28	29	30
Escalation Factor					escalation factor	1.984	2.039	2.097	2.155	2.216	2.278	2.341	2.407	2.474	2.544
(All cost X1000)															
Other Project Cost for ALL BIN 7 SETS (OPC)															
OPC unescalated															
Conceptual Design, Proj Mgt, & Permitting															
Testing and Start-up															
Total OPC (unescalated)						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total OPC including escalation, mgt reserve, & contingency						0	0	0	0	0	0	0	0	0	0
Total Estimated Cost for ALL BIN 7 SETS (TEC)															
TEC unescalated															
Title Design, Inspection															
Project mgt															
Construction Mgt															
Construction, Equip, G&A & Procurement															
Total TEC (unescalated)						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total TEC including esc, mgt res, contingency						0	0	0	0	0	0	0	0	0	0
Total Project Cost for ALL 7 BIN SETS (TPC)															
TPC unescalated						0	0	0	0	0	0	0	0	0	0
plus escalation of						0	0	0	0	0	0	0	0	0	0
plus management reserve of						0	0	0	0	0	0	0	0	0	0
plus contingency of						0	0	0	0	0	0	0	0	0	0
Total TPC including esc, mgt res, contingency						0	0	0	0	0	0	0	0	0	0
Operations	260 hr-shift/yr.														
Facility/Administration	0														
Managers		0	FTE	$125	$/hr.	0	0	0	0	0	0	0	0	0	0
Engineers		0	FTE	$108	$/hr.	0	0	0	0	0	0	0	0	0	0
Other Tech.		0	FTE	$85	$/hr.	0	0	0	0	0	0	0	0	0	0
Administration/Support		0	FTE	$85	$/hr.	0	0	0	0	0	0	0	0	0	0
Operations/Process Facility	11														
Managers		0.5	FTE	$125	$/hr.	16	16	16	16	16	16	16	16	16	16
Engineers		0.5	FTE	$108	$/hr.	14	14	14	14	14	14	14	14	14	14
Other Tech.		0.25	FTE	$85	$/hr.	6	6	6	6	6	6	6	6	6	6
Supervisors		2	FTE	$85	$/hr.	44	44	44	44	44	44	44	44	44	44
Administration/Support		1	FTE	$85	$/hr.	17	17	17	17	17	17	17	17	17	17
Operators		6	FTE	$85	$/hr.	101	101	101	101	101	101	101	101	101	101
Maintenance		1	FTE	$85	$/hr.	17	17	17	17	17	17	17	17	17	17
Utilities		28,000	SF @	$3.00	$/SF	194	194	194	194	194	194	194	194	194	194
Maintenance of Equipment		6.00%	of	$18,387		1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311	1,311
Building Maintenance		2.00%	of	$79,819		1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598	1,598
Operations subtotal (unescalated)						3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317
plus Escalation						3,283	3,447	3,637	3,832	4,032	4,237	4,449	4,668	4,890	5,120
plus Operations Contingency @		30.0%				1,974	2,029	2,086	2,144	2,204	2,266	2,330	2,395	2,462	2,531
Total Operations (w/ escalation & contingency)						8,554	8,793	9,039	9,293	9,553	9,820	10,095	10,378	10,668	10,967
Post Operations															
Decommission		20.00%	of	Eng. costs											
Decontamination		6.00%	of	Pre-operation											
Demolition		8.00%	of	Pre-operation											
Post-Operations Subtotal (unescalated)						0	0	0	0	0	0	0	0	0	0
plus Escalation						0	0	0	0	0	0	0	0	0	0
plus Post-Operations Contingency @		15.0%				0	0	0	0	0	0	0	0	0	0
Total Post-Operations (w/ escalation & contingency)						0	0	0	0	0	0	0	0	0	0
Total Cost (unescalated)						3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317	3,317
Cumulative Total Cost (unescalated)						187,914	191,230	194,547	197,863	201,180	204,496	207,813	211,129	214,446	217,762
Total Cost (w/ escalation, mgt reserve, & contingency)						8,554	8,793	9,039	9,293	9,553	9,820	10,095	10,378	10,668	10,967
Cumulative Total Cost (escalated)						376,604	384,397	393,437	402,729	412,282	422,102	432,197	442,575	453,243	464,211
discount factor @ OMB discount rate of		6.30%		for escalated costs		4.606	4.896	5.205	5.533	5.881	6.252	6.646	7.064	7.509	7.982
Discounted Annual Cost						$1,857	$1,796	$1,737	$1,680	$1,624	$1,571	$1,519	$1,469	$1,421	$1,374
Cumulative Discounted Costs(escalated)						173,631	175,427	177,363	179,043	180,667	182,238	183,757	185,226	186,647	188,021

Calcine Removal and Transport(20-yr sys B)					fiscal year	2033	2034	Total
Life-Cycle Cost (LCC) Analysis					counting year	31	32	Cost
Escalation Factor					escalation factor	2.615	2.688	
(All cost X1000)								
Other Project Cost for ALL BIN 7 SETS (OPC)								
OPC unescalated								
Conceptual Design, Proj Mgt, & Permitting								17,715
Testing and Start-up								3,652
Total OPC (unescalated)						0	0	21,267
plus escalation of						0	0	9,358
plus management reserve of						0	0	0
plus contingency of						0	0	10,475
Total OPC including escalation, mgt reserve, & contingency						0	0	41,100
Total Estimated Cost for ALL BIN 7 SETS (TEC)								
TEC unescalated								
Title Design, Inspection								13,405
Project mgt								8,710
Construction Mgt								8,710
Construction, Equip, G&A & Procurement								96,205
Total TEC (unescalated)						0	0	127,031
plus escalation of						0	0	53,841
plus management reserve of						0	0	13,788
plus contingency of						0	0	51,611
Total TEC including esc, mgt res, contingency						0	0	246,270
Total Project Cost for ALL 7 BIN SETS (TPC)								
TPC unescalated						0	0	148,298
plus escalation of						0	0	63,199
plus management reserve of						0	0	13,788
plus contingency of						0	0	62,085
Total TPC including esc, mgt res, contingency						0	0	287,370
Operations	260 hr-shift/yr.							
Facility/Administration	0							
Managers		0	FTE	$125	$/hr.	0	0	0
Engineers		0	FTE	$108	$/hr.	0	0	0
Other Tech.		0	FTE	$85	$/hr.	0	0	0
Administration/Support		0	FTE	$65	$/hr.	0	0	0
Operations/Process Facility	11							0
Managers		0.5	FTE	$125	$/hr.	16	0	345
Engineers		0.5	FTE	$108	$/hr.	14	0	298
Other Tech.		0.25	FTE	$85	$/hr.	6	0	117
Supervisors		2	FTE	$85	$/hr.	44	0	939
Administration/Support		1	FTE	$65	$/hr.	17	0	350
Operators		6	FTE	$65	$/hr.	101	0	2,231
Maintenance		1	FTE	$65	$/hr.	17	0	372
Utilities		26,000	SF @	$3.00	$/SF	194	0	4,158
Maintenance of Equipment		8.00%	of	$16,387		1,311	0	28,640
Building Maintenance		2.00%	of	$79,819		1,596	0	35,120
Operations subtotal (unescalated)						3,317	0	72,781
plus Escalation						5,358	0	71,923
plus Operations Contingency @		30.0%				2,602	0	43,411
Total Operations (w/ escalation & contingency)						11,274	0	188,115
Post Operations								
Decommission		20.00%	of	Eng. costs			2,681	2,681
Decontamination		5.00%	of	Pre-operation			7,415	7,415
Demolition		8.00%	of	Pre-operation			11,864	11,864
Post-Operations Subtotal (unescalated)						0	21,960	21,960
plus Escalation						0	37,071	37,071
plus Post-Operations Contingency @		15.0%				0	8,855	8,855
Total Post-Operations (w/ escalation & contingency)						0	67,886	67,886
Total Cost (unescalated)						3,317	21,960	243,039
Cumulative Total Cost (unescalated)						221,079	243,039	
Total Cost (w/ escalation, mgt reserve, & contingency)						11,274	67,886	543,371
Cumulative Total Cost (escalated)						475,485	543,371	
discount factor @ OMB discount rate of		6.30%		for escalated costs		5.485	9.020	
Discounted Annual Cost						$1,329	$7,526	196,876
Cumulative Discounted Costs(escalated)						189,349	196,876	


CUMLATIVE DISCOUNTED LCC
CALCINE RETRIEVAL AND TRANSPORT B
FACILITY
DOLLARS (X1000)
250,000
200,000
150,000
100,000
50,000
0
1
4
7
10
13
16
19
22
25
28
31
YEARS


TOTAL ANNUAL COST(escalated)
CALCINE RETRIEVAL AND TRANSPORT B FACILITY
DOLLARS (X1000)
80,000
60,000
40,000
20,000
0
1
4
7
10
13
16
19
22
25
28
31
YEARS

ENGINEERING DESIGN FILE

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

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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.

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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 form 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 send 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

[a] Vitrification 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.

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[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[c] 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

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[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 RWMC LLW 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 exits 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 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 and 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

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[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

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[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 ~~HAW~~ 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)[g]. 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, lighting, 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.

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[g] 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."

<u>Seismic systems criteria</u>

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)."

NUREG/CR-3874, "Near-Ground Tornado Wind Fields," McDonald, J.R., Texas Tech. University, July 1984.

NUREG/CR-3848, "Experimental Investigation of Unsteady Tornadic Wind Loads on Structures," Jischke, M.C., Oklahoma Teaching Hospitals, June 1984.

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.

<u>Water level (flood) design</u>

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.

NUREG/CR-2462, "Capacity of Nuclear Power Plant Structures to Resist Blast Loading," Kennedy, R.P. et al., Sandia National Laboratories, September 1983.

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 CFRR 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 or 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 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.

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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 process[33] 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 Handing, 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 handing, 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 ICPP 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 safety[2] 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.

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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 × 4 ×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

Risk Assessment Data Sheets

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: **P.1: Recycle percentage too low**

The percentage used is based on engineering judgment and may be incorrect. Equipment for recycling is anticipated to be required, but minimal recycling is anticipated.

PREVENTIVE PLANS

None

PROBABLE CAUSE(S):

More off-spec canisters produced and more destructive analysis required than anticipated.

CONSEQUENCES IF RISK NOT RESOLVED

Effect is mostly to schedule in that more time would be required to re-process more recycled material. Consequence should be minimal because of 50% up time considered in the process and that the recycle equipment is not utilized full time.

PROBABILITY

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

IMPACT

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

Risk = 2

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

During processing.

Risk Assessment - Data Sheet

Risk Type ◉ Project ○ Technical ○ ESH

RISK: **P.2: Canisters not delivered on time**

The maximum number of canisters required is approximately 18,000 over a year period. The assumption that a manufacturer could produce at the rate required may be incorrect.

PREVENTIVE PLANS

Ensure procurement schedule is adequate to meet production.

PROBABLE CAUSE(S):

Procurement not started early enough.

CONSEQUENCES IF RISK NOT RESOLVED

Schedule would be adversely affected. Production would be stopped if canisters are not available.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ◉ High (3)
- ○ Medium (2)
- ○ Low (1)

Risk = 3

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Canister receipt schedule does not accommodate grout production schedule.

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **T.1: Calcine volume and density incorrect**

Best available data results in calculated calcine volume at 5435 cubic meters with an average density of 1408 kg per cubic meter, but may be incorrect.

PREVENTIVE PLANS

None

PROBABLE CAUSE(S):

Best available data is based on small amount of information about calcine which may not be representative.

CONSEQUENCES IF RISK NOT RESOLVED

Time required to process total calcine will increase or decrease affecting estimated cost and schedule.

Number of canisters produced will increase or decrease affecting estimated cost and schedule.

PROBABILITY

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 4

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Sample calcine and analyze for data required.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Data obtained from detailed sampling.

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **T.2: Waste loading %/grout density incorrect**

Calcine waste loading at 35% and grout density of 1700 kg per cubic meter resulting in a grout volume of approximately 13,000 cubic meters have been determined in this study based on best data available about the calcine which may be incorrect.

PREVENTIVE PLANS

The grout "recipe" is flexible in that a variety of calcines can be mixed without requiring significant changes in the ingredient ratios.

PROBABLE CAUSE(S):

Best available data is based on small amount of information about calcine which may not be representative.

CONSEQUENCES IF RISK NOT RESOLVED

Volume of end product may increase or decrease resulting in respective change in time required to process total calcine which will affect estimated cost and schedule.

Number of canisters produced will increase or decrease affecting estimated cost and schedule.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 2

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

None

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **T.3: Canister loading volume incorrect**

Canister loading is based on 0.72 cubic meters per canister which is the advertised capacity of a Savannah River Site canister. The number of canisters produced is then approximately 18,000.

PREVENTIVE PLANS

Canister loading to 100% capacity is physically feasible.

PROBABLE CAUSE(S):

Canister loading is less than canister capacity.

CONSEQUENCES IF RISK NOT RESOLVED

Number of canisters produced will increase affecting estimated cost and schedule. Increase should not be more than 5%.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 2

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Mock-up test and Facility start-up operating tests results.

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **T.4: Mercury release**

The assumption that the curing and dewater processes temperature of 250 degrees C will not release mercury may be incorrect.

PREVENTIVE PLANS

process development associated with small-scale active tests and large-scale inactive tests will easily establish if this is a risk and its potential impact.

PROBABLE CAUSE(S):

Mercury compounds in calcine do not behave as anticipated because calcine is a complex mixture of chemicals and anomalies may result. This, however, is considered highly unlikely.

CONSEQUENCES IF RISK NOT RESOLVED

Would likely not be able to obtain air permits without firm data relative to air emissions.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ◉ High (3)
- ○ Medium (2)
- ○ Low (1)

Risk = 3

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Install a calcine pre-treatment step that removes mercury, such as a high temperature roaster with mercury capture.

or

Include mercury scrubbing capability on process vent systems of autoclave and drying steps.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Risk Assessment - Data Sheet

Risk Type ○ Project ◉ Technical ○ ESH

RISK: **T.5 Calcine particle size affects processing**

Calcine particle size are to large to effectively be stabilized in the hydroceramic.

PREVENTIVE PLANS

Development of the process must be completed to determine particle size effects.

PROBABLE CAUSE(S):

Physical and chemical limitations of calcine.

CONSEQUENCES IF RISK NOT RESOLVED

Due to the friable nature of the calcine and because equipment is readily available to perform particle size reduction, it is not likely that the technical impact on the process design would be significant. The consequence is that one more process step and a likely incremental increase in facility size would be required.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ◉ Medium (2)
- ○ Low (1)

Risk = 2

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

None

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

Risk Assessment - Data Sheet

Risk Type ○ Project ○ Technical ◉ ESH

RISK: **ESH.1: Radiological dose rates incorrect**

Radiological dose rates for calcine and grouted waste form are based on best available information about the calcine which may not be complete.

PREVENTIVE PLANS

The grout facility design uses 5 ft thick walls for shielding comparable to that in the NWCF.

PROBABLE CAUSE(S):

Radiological data for all the calcine is not available.

CONSEQUENCES IF RISK NOT RESOLVED

Shielding thickness would be increased or decreased resulting in a respective change in facility cost.

PROBABILITY

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

IMPACT

- ○ High (3)
- ○ Medium (2)
- ◉ Low (1)

Risk = 1

Risk = Probability x Impact

CONTINGENCY PLAN(S) IF RISK IS REALIZED:

Sample calcine and analyze for required data.

Probability Definition

High - Likely to occur during the project.
Medium - Has the potential to occur during the project.
Low - Has little potential to occur during the project.

Impact Definition

High - Likely to cause significant disruption of schedule, increase in cost, or degradation of performance.
Medium - Has the potential to cause some disrutpion to schedule, increase in cost, or degradation of performance.
Low - Has little potential to cause disruption to schedule, increase in cost, or degradation of performance.

TRIGGER POINT(S) FOR EARLY RISK IDENTIFICATION:

None

Appendix G

Grouting Facility Project Data Sheet Supporting Data

Construction Assumptions

Construction duration =	4	years					
SO testing =	2	years					
Total years =	6						
Labor - use a total of	100	new workers/yr					
from Dan James							
Sanitary Wastewater =	562,500	gal/yr =	12,774,375	liters (total			
(based on 25 gal/person-day and 225 days/year of construction)							
(Benefield, LD and C.W. Randall, Biological Process Design for Wastewater Treatment, InPrint, Inc., 1987, p. 104 - wastewater generation = 15-30 gal/day-person)							
Water used for dust control =	2000	gal/wk =	605,600	liters (total)			
(assumes dust control required 20 weeks/yr... R. Kimmitt)							
Electrical usage assumed to be 3,000 kWh (from John Duggan)							
156	MWh/yr						
Assume 3 gallons of lubricating oil and hydraulic fluid generated for every 60 hours of operation of heavy equipment =				1,417	liters (total)		
Square footage =	197,350	sq.ft =	18,334	m^2			
(Stephanie Austed, 1/12/98)							
Acres disturbed =	196,020	sq.ft. =	18,211	m^2 =	4.5	acres (previous)	
(Stephanie Austed, 1/12/98)							
Heavy equipment =	3 vehicles @ 624 hrs/yr during construction =			7,488	hrs total		
Equipment fuel usage (see http://www/deere.com/ind) =				6	gal/hr		
Total heavy equipment fuel usage =		44928	gal =	170,052	liters (total)		
Dust during construction = 1.2 `tons/month-acre =			259	tons (total)			
(from USEPA Office of Ar Quality Planning and Standards)							
Construction costs are from life cycle cost estimate (R. Turk)							
Air emissions from fuel usage are based on the diesel emissions spreadsheet.							
Hazardous waste generation	275	gal/week =		217	m^3 (total)		
(based on an assumed generation rate of 5 55-gallon drums of waste per week)							
Hazardous waste storage =	3300	gal =	13	m^3			
(Assume waste is accumulated for 12 weeks [84 days] in a 90-day accumulation area, then picked up for disposal.)							
Construction trash =	6200	yd^3 (total) =	4,742	m^3			
1 man-year of labor =	1800	manhours					
SO testing liquid effluent =	-	lbs. total =		-	liters (total)		
Hazardous waste (SO testing) =		2.8	m^3 (total)				
(based on an assumed 50 cu.ft. of spent activated carbon/yr)							

Construction Assumptions

Total process water usage =	291,915	liters/yr =	583,831	liters (total)			
(based on stream 122... see material balances.. EDF -DCWO-011 and 2 years of SO testing)							
Excavation: Excavated earth will be spread in a spoil area adjacent to ICPP, except for backfill soil.							
Concrete:							
Amount used =	56,481	yd3 (value obtained by ratio of concrete costs with those from VWO)					
Number of truckloads =	2,567	(based on 22 yd^3/load... tandem trailers)					
Fuel usage =	56,481	gal (assumes 5 mpg and round trip of 110 miles)					
Materials delivery:							
Number of truckloads =	1000	(assumed)					
Fuel usage =	30,000	gal (assumes 5 mpg and round trip of 150 miles)					
Hours of use for heavy equipment =		7,488					
Hours of use for delivery trucks =		7,207					
Total heavy Equipment hours =		14,695					
Total heavy equipment and materials delivery fuel used =			497,383	liters			

Labor:	140							
Operating costs are taken from the life cycle cost estimate.								
Radiation worker annual dose is based on the average annual dose received at ICCP during the last three years (see attached memorandum)								
Radioactive air emissions =		-	lbs/yr =		-	Tons/yr		
(no routine radioactive air emissions)								
Radioactive wastewater =			-	lbs/yr =		-	liters/yr	
(water will be reused in process of making grout.)								
Caustic usage =		38,278	kg/yr					
(from material balance..EDF DCWO-011)								
Sanitary wastewater =			1,277,500	gal/yr =		4,835,338	liters/yr	
(based on 25 gal/day per worker, facility occupied year-round)								
Domestic water usage= same as sanitary wastewater rate.								
Sanitary/Industrial trash =			1,015	yd^3/yr		776	m^3/yr	
(based on 7.25 yd3/person-year... Bob Skinner [cuber facility])								
Radioactive solid waste:								
Product canisters =		648	m^3/yr					
(based on 18000 canisters in 20 years @ 0.72 m^3/canister)								
HEPA filters:								
	Total ventilation =		2096	ft^3/yr =		59	m^3/yr	
	(based on 2 filters with a volume of 4 ft^3 each every year for every 1,000 cfm of air. Design is for 262,000 cfm of ventilation air see EDF-DCWO-013, p. 2)							
Hazardous waste =		100	ft^3/yr =		3	m^3/yr		
(assumed volume - R. Kimmitt)								
Total process water usage =			291,915	liters/yr				
(based on stream 122... see material balances.. EDF -DCWO-011)								
Electric power usage =			3,766,800	kWh/yr =		3,767	MWh/yr	
(based on 430 kW...half of the connected load)								
Total Steam =		17250	lbs/hr =		68,686,364	kg/yr		
(This is 69% of the DCWO 5-year system steam demand...see EDF-DCWO-015)								
Radioactivity associate with waste materials:								
HEPA Filters =		Trace	Ci/yr					
Grouted waste =		1,182,600	Ci/yr					
(based on processing a total of approximately 16,200,000 lbs of calcine with an average activity content of 1.46 Ci/lb.)								

D&D Labor											
Crew #	Crew Function	Total MH/day	Total $/day	Material $/day	Equipment $/day	Total $/day		D&D Cost Allocated (FY 97 dollars)		Total MH	Man-hours/yr
D	Documentation	18	$1,136	$114	$ -	$1,250		$ 6,000,000		86,400	28,800
1	Characterization	44	$2,302	$460	$691	$3,453		$ 28,500,000		363,162	121,054
2	Rad Demolition-Systems	77	$4,091	$818	$1,023	$5,932		$ 60,000,000		778,827	259,609
2A	Rad Demolition-Building	99	$5,319	$1,064	$1,596	$7,979		$ 25,000,000		310,189	103,396
3	Demolition-Systems	72	$3,762	$752	$941	$5,455		$ 8,000,000		105,591	35,197
3A	Demolition-Building	88	$4,808	$962	$1,442	$7,212		$ 5,000,000		61,009	20,336
4	Asbestos Abatement	77	$3,753	$375	$188	$4,316		$ -		-	-
5	Decontamination	77	$3,753	$751	$1,126	$5,630		$ 40,252,000		550,516	183,505
6	Prep/Fabrication	61	$3,217	$643	$965	$4,826		$ 6,403,000		80,933	26,978
7	RADCON Surveys	50	$2,596	$519	$779	$3,894		$ 25,000,000		321,007	107,002
Total								$ 204,155,000		2,657,635	885,878
vailable								$ 204,155,000			
Notes:											
1	Crew functions and daily estimates are from the D&D program (Dave Haycraft)										
2	Total costs are based on life cycle estimate by R. Turk										
3	Assume all workers in crews 2, 2A, 5, and 7 are rad workers										
4	Assume a man-year is 1800 hours.										
5	The number of radiation workers per year is the workers represented in the rad demolition, decontamination, and radcon survey groups.										

Duration of D & D =	3	years					
Heavy Equipment		# Used	Hours/day	Days/wk	Wks/yr	Hours/yr	
	Mobile Crane	1	3	4	45	540	
	Roll-Off Truck	5	8	5	45	9,000	
	Dozer	1	5	5	45	1,125	
	Loader	5	8	5	45	9,000	
	Scabbler (w/ Vacuum System)	1	8	5	45	1,800	
	Pneumatic Ram	1	4	4	45	720	
	Demolition Machine (Remote Control)	1	4	3	45	540	
Total hours/yr						22,725	
Total heavy equipment hours =						68,175	
Assume each piece of equipment uses 6 gallon of diesel fuel per hour. Consumption rate from John Deere Web Site (Construction Equipment - http://www.deere.com/ind/product/product.html)							
No. of gallons of fuel used during D & D =			409,050	gal =	1,548,254	liters (total)	
Acreage disturbed is the same as for construction =			4.5	acres			
D & D labor requirements are taken from D & D labor and equipment spreadsheet.							
D & D costs come from the life cycle cost estimate.							
Assume each roll-off truck makes 3 trips per day to RWMC							
No. of trips =			15				
Miles traveled @ 12 miles/round trip=			180	miles/day			
Decontamination solution stored=			2,000	gallons	205	m^3	
Daily process water usage=			3000	gal/day =	6,854,625	liters (total)	
(assumed for washing, decon, etc.; based on 225 days/yr)							
Domestic water usage =		31,434,834	liters (total)				
(based on 25 gal/day for each worker)							
Sanitary wastewater = same as domestic water usage							
Assume portable HEPA systems off-gas rate=			2000	scfm =	78,518	Tons (total)	
(assumes 225 days/yr)							
Assume daily spent decon. solution=			2000	gal/day	5,109,750	liters (total)	
(assumes 225 days/yr total)							
Solid Waste Generation	(factors from Dave Kenoyer - D&D Program)						
Waste Type	Factor (cu.ft./sq.ft.)	Sq.Ft. in Facility	Cu.Ft. of Waste	Cu. Meters			
WERF-LLW Combustible PPEs	0.167	197,350	32,957	934			
WERF-LLW Combustible Building Debris	0.128	197,350	25,261	716			

WERF-LLW Compactable Building Debris	0.195	197,350	38,483	1,090			
RWMC-LLW Non-Compactable Equipment	0.513	197,350	101,241	2,868			
RWMC-LLW Non-Compt Building Debris	0.684	197,350	134,987	3,824			
RWMC-LLW Non-Compt Concrete Rubble	3.44	197,350	678,884	19,232	Factor is twice that used by D&D to account for the large amount of concrete used in construction.		
RWMC-LLW Non-Compt Scrap Metal	0.778	197,350	153,538	4,350			
RWMC-LLW Asbestos/ACM Covered Pipe	0	197,350	-	-			
CFA Landfill Non-Compt Building Debris	1.99	197,350	392,727	11,125			
CFA Landfill Non-Compt Concrete Rubble	2.45	197,350	483,508	13,697	Factor is twice that used by D&D to account for the large amount of concrete used in construction.		
CFA Landfill Asbestos	0	197,350	-	-			
HWSF Hazardous Mtrls (Hg/PCBs/etc)	0.002	197,350	395	11			
Metal Recycle	0.022	197,350	4,342	123			
LLW =			1,165,352	33,013			
Non-Rad =			876,234	24,822			
Hazardous =			395	11			
Metal =			4,342	123			
Electric power usage =	156,000	kWh/yr	156	MWh/yr			
(based on 3,000 kWh/wk - John Duggan)							
Air emissions from fuel are based on the diesel emissions spreadsheet.							
1 manyear of labor =	1800	manhours					
Lube oil =	12,902	liters (total)					
(based on 3 gal for every 60 hours of operation)							
Mixed waste =	37,125	gal (total) =	141	m3 (total)			
(based on an assumed 5 55-gallon drums generated per week... work only 45 weeks/yr)							
Radioactivity associated with waste materials:							
Spent decontamination solution =		5,110	Ci				
(based on an assumed average activity concentration of 1 uCi/ml)							
Radioactive solid waste =		330	Ci				
(based in an assumed activity concentration of 0.01 uCi/cc [0.01Ci/m^3])							
Mixed waste =		1	Ci				
(based on an assumed activity concentration of 0.01 uCi/cc [0.01 Ci/m^3])							

Estimate of Diesel Engine Emissions

DCWO - 20 Year

Bases & Assumptions:					
1. Air to fuel ratio = 25:1 (Mass Basis)				from Wark, K. and C.F. Warner, Air Pollution, Its Origin and Control, IEP, New York, 1976, p. 446, 423	
2. Diesel fuel density = 7.5 lbs./gal.					
3. Air is 21% O_2, 79% N_2, with a pseudomolecular weight of 29.					
4. Combustion is simulated as: $C_9H_{18} + 13.5O_2 \longrightarrow 9CO_2 + 9H_2O$					
5. Particulates = 5 mg/scf				Wark and Warner, p. 446	
6. CO = 2,500 ppmv				Wark and Warner, p. 446	
7. NO_x = 2,000 ppmv				Wark and Warner, p. 446	
8. Unburned hydrocarbons = 100 ppmv				Wark and Warner, p. 446	
9. Diesel fuel (# 2 fuel oil) contains 1 wt. % sulfur				Wark and Warner, p. 336	
10. Combustion is about 99% efficient.					
Lbs. Of Construction Fuel				984,818	
Lbs. Of Operations Fuel				-	
Lbs. Of D&D Fuel				3,065,543	
Total Lbs. of Fuel Used				**4,050,362**	
Lb-Moles of Construction Fuel				7,816	
Lb-Moles of Operations Fuel				-	
Lb-Moles of D&D Fuel				24,330	
Total Lb-Moles of Fuel (as C9H18)				**32,146**	
Lbs of Air for Construction Fuel (based on air-to-fuel ratio)				24,620,462	
Lbs.of Air for Operations Fuel (based on air-to-fuel ratio)				-	
Lbs.of Air for D&D Fuel (based on air-to-fuel ratio)				76,638,585	
Total Lbs. of Air Added				**101,259,047**	
Lb-Moles of Air for Combustion Fuel				**848,981**	
Lb-Moles of Air for Operations Fuel				**-**	
Lb-Moles of Air for D&D Fuel				**2,642,710**	
Total Lb- Moles of Air				**3,491,691**	
Grand Total of Materials Fed, Lbs.				***105,309,409***	

Exhaust Gases, Construction Fuel	Total Lbs.	Total Tons	Total Moles	Total SCF
CO_2	3,064,192	1,532	69,641	25,001,024
H_2O	1,253,533	627	69,641	25,001,024
O_2	2,362,400	1,181	73,825	26,503,175
N_2	18,779,469	9,390	670,695	240,779,626
Subtotal of Major Gases	**25,459,595**	**12,730**	**883,802**	**317,284,848**
SO_2	19,696	9.8		
Particulates	3,494	1.7		
CO	61,866	30.9		

NO_x (assumed NO)		53,028	26.5		
Unburned Hydrocarbons		11,136	5.6		
Subtotal of Contaminants		**149,221**	**75**		
Exhaust Gases, Operations Fuel		Total Lbs.	Total Tons	Total Moles	Total SCF
CO_2		-	-	-	-
H_2O		-	-	-	-
O_2		-	-	-	-
N_2		-	-	-	-
Subtotal of Major Gases		-	-	-	-
SO_2		-	-		
Particulates		-	-		
CO		-	-		
NO_x (assumed NO)		-	-		
Unburned Hydrocarbons		-	-		
Subtotal of Contaminants		-	-		
Exhaust Gases, D&D Fuel		Total Lbs.	Total Tons	Total Moles	Total SCF
CO_2		9,538,219	4,769	216,778	77,823,199
H_2O		3,901,999	1,951	216,778	77,823,199
O_2		7,353,680	3,677	229,802	82,499,096
N_2		58,456,741.67	29,228	2,087,741	749,498,938
Subtotal of Major Gases		**79,250,640**	**39,625**	**2,751,099**	**987,644,432**
SO_2		59,395	29.7		
Particulates		10,877	5.4		
CO		192,577	96.3		
NO_x (assumed NO)		165,066	82.5		
Unburned Hydrocarbons		34,664	17.3		
Subtotal of Contaminants		**462,579**	**231**		

Memo of Telephone Conversation

Name	Organization	Phone
Steve Aitken	LMITCO S&H ICPP ALARA Coordinator	6-3174
Bill Landman	Chemical and Environmental Eng'g	6-5279

Date: November 24, 1997 **Time:** 4:15 pm

Subject: Average Worker Dose Rate at ICPP

Discussion:

Steve was contacted for information to support development of the Project Data Sheet for the Separations Options. He provided the following information for the ICPP site:

Average dose (per worker) for 1996	180 mR/hr
Average dose (per worker) for 1995	252 mR/hr
Average dose (per worker) for 1994	143 mR/hr

The 1995 year average was higher due to extensive work on the tank farm.

Appendix H

Maturity of Technology Guidance



U.S. DEPARTMENT OF ENERGY STANDARD OPERATING PROCEDURE

INTERIM GUIDANCE

OFFICE OF SCIENCE AND TECHNOLOGY TECHNOLOGY DECISION PROCESS

Prepared for the Office of Science and Technology
Office of Environmental Restoration
and Waste Management
U.S. Department of Energy

May 8, 1997

the DOE-EM system for consideration of research, development, or implementation must be subjected to the stage/gate criteria by the FA. Consideration for a commercial-scale demonstration to obtain performance and cost-of-performance data on a real-world environmental management problem may be appropriate.

5.1 Stage and Gate Minimum Procedure Requirements

Attachment C is a diagrammatic description of the OST Technology Decision Process. The following procedure defines the related specific minimum goals, objectives, measures of effectiveness, actions, and responsibilities associated with each stage and gate.

5.1.1 Stage 1: Basic Research

This stage represents fundamental scientific research for building and documenting core knowledge not tied to a specific, defined need. It includes basic laboratory experimentation, development of theory and analytical models, and proof of principle.

Stage Goal: Generate new ideas.
Objectives: Identify new environmental technology/use of good science.
Measures of Effectiveness: Satisfy programmatic driver criteria (technology end user need, technical merit, costs, and safety/health/environmental protection/risk).

5.1.2 Gate 1: Entrance into Applied Research Stage

Research/studies addressing environmental performance needs. TD/PI addresses programmatic driver criteria (technology end user need, technical merit, costs, and safety/health/environmental protection/risk).

5.1.3 Stage 2: Applied Research

At this stage, directed scientific/engineering research is conducted that has a link to environmental management needs. Included are proof of principle and laboratory-scale experimentation.

Stage Goal: Conduct systems studies to address DOE-EM high-priority needs.
Objectives: Define data requirements, prepare experimental designs, determine material requirements, and determine business attributes.
Measures of Effectiveness: Satisfy experimental design plan acceptance criteria and programmatic driver criteria (technology end user need, technical merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.4 Gate 2: Entrance into Exploratory Development Stage

- Linked with clearly defined DOE-EM priority performance needs.
- Satisfied experimental design criteria.
- TD/PI initiates baseline comparison.
- TD/PI addresses gate programmatic driver criteria (technology end user need, technical merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.5 Stage 3: Exploratory Development

In this stage, technical feasibility in terms of potential applications is evaluated (i.e., can the technology be sufficiently developed to solve the problem). Included are laboratory-scale prototyping, analysis of user needs, estimates of life-cycle costs, and identification of functional performance requirements and operational concepts.

Stage Goal: Conduct system study to address FA/CC/IP and/or STCG identified priority needs.

Objectives: Verify concept linked to specific needs.

Measures of Effectiveness: Continues to satisfy experimental design plan acceptance criteria and experimental performance meets program expectations and programmatic driver criteria (technology end user need, technical merit, costs, safety/health/ environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.6 Gate 3: Entrance into Advanced Development Stage

- Linked with clearly defined DOE-EM/private sector priority performance needs.
- TD/PI continues baseline comparison.
- TD/PI addresses gate programmatic driver criteria (technology end user need, technical merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.7 Stage 4: Advanced Development

In this stage, proof of design is required. This includes full-scale laboratory testing, preliminary field testing, technical specification development, and infrastructure development plans.

Stage Goal: Specific DOE-EM application of product, concept, or subsystems that includes studies, advanced analysis, and laboratory-scale models.

Objectives: Review group application validation, specifications assessment.

Measures of Effectiveness: Satisfy external assessment of application specifications and programmatic driver criteria (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.8 Gate 4: Entrance into the Engineering Development Stage (major decision point; includes review group interaction)

- Review group completes review of information supplied by FA/CC/IP, TD/PI, and others.
- Technology assessed as being the right technology, at the right place, at the right time.
- TD/PI addresses gate programmatic driver criteria (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.9 Stage 5: Engineering Development

This stage includes systematic use of the knowledge gained from research and development to develop a detailed approach for full-scale design. Components include documentation such as drawings, schematics, and computer codes; construction and demonstration units; prototypes and pilot-scale systems; system evaluation; reliability testing; infrastructure plans; and procurement specifications.

Stage Goal: Classified as a technology or system likely to exceed DOE-EM baseline or likely to meet select government performance requirements or a problem set.

Objectives: Scale-up and refine detailed design for prototypes and pilots; clarify DOE deployment strategy and schedules to meet internal/external performance needs.

Measures of Effectiveness: Completed and documented preliminary test results and satisfied test plans and programmatic driver criteria (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.10 Gate 5: Entrance into the Demonstration Stage

- DOE-EM deployment schedule established.
- Completed and documented preliminary test results and satisfied test plan requirements.
- An Innovative Technology Summary Report referenced herein is issued unless a full-scale demonstration is to be performed in Stage 6.
- TD/PI addresses gate programmatic driver criteria (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/regulator/tribal, and commercial viability).

5.1.11 Stage 6: Demonstration

At this stage, the product or technology is subjected to a "real world" demonstration, either at a DOE site or at another location, using actual or simulated waste streams and/or anticipated operating conditions to verify assumptions made to this point.

Stage Goal: Verification of design through test and evaluation of full-scale system.
Objectives: System suitability, full-scale testing, system testing and market conditioning.
Measures of Effectiveness: End user accepts the technology and programmatic driver criteria (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/ regulator/tribal, and commercial viability) are met.

5.1.12 Gate 6: Entrance into the Implementation Stage

- Results of technology/system test is fully documented and a final Innovative Technology Summary Report is issued. A Cost and Performance Report for environmental remedial projects shall also be prepared at this gate for EM-40-funded technologies.
- Technology partner is fully invested (i.e., procurement path defined).
- Implementation and commercialization viability have been clearly defined according to accepted business standards.
- Gate programmatic driver criteria have been fully engaged (technology end user need, technology merit, costs, safety/health/environmental protection/risk, stakeholder/ regulator/tribal, and commercial viability).

5.1.13 Stage 7: Implementation

The product or technology has been proven to be viable, cost-effective, and applicable to required needs and is put into service by the end user. The technology must be available for transfer to the private sector or already commercially available for commercial use.

5.2 Stage and Gates Procedure Operations Management

Attachment D depicts the OST Technology Decision Process Gate Requirements and Deliverables. Attachment E is the Requirements and Deliverables Matrix.

5.2.1 Stage Procedure Operations Management Responsibilities

The FA/CC/IP—through the assigned TD/PI and others, as appropriate—is responsible for documentation of all the requirements defined in Sections 5.1.1 through 5.1.13 and as outlined further in Attachment D. The FA/CC/IP in concert with the TD/PI will plan, arrange, and carry out activities and responsibilities according to the stage conditions/requirements for purposes of presenting, justifying, and meeting each of the gate criteria.