



U.S. Department of Energy
Office of Civilian Radioactive Waste Management



DOE/NRC Technical Exchange on Level of Detail

Las Vegas, Nevada
February 3-4, 2004

Agenda

NRC/DOE Technical Exchange on Yucca Mountain Pre-Licensing Activities and Level of Design Detail

February 3 and 4, 2004

8:30 a.m. - 5:00 p.m. (PT)

11:30 Noon - 8:00 p.m. (ET)

Bechtel SAIC Company, LLC

Conference Room 915

9960 Covington Cross

Las Vegas, Nevada

And via videoconferencing to:

U. S. NRC
T-2B5
11545 Rockville Pike
Rockville, MD

CNWRA
Bldg. 189, Conference Room B232
6220 Culebra Road
San Antonio, TX

U.S. NRC Region IV
611 Ryan Plaza Drive
Arlington, TX

INTERESTED PARTIES MAY PARTICIPATE IN THE MEETING VIA TELECON BY CALLING
1-800-638-8081- Passcode 6860# or 301-231-5539 - Passcode 6860 #

February 3, 2004

	Topics	Discussion Lead	Time
I.	Introductions	Tim Kobetz, NRC Joe Price, DOE	8:30-8:40 a.m.
II.	Opening Remarks and Introductions	William Reamer, NRC Joe Ziegler, DOE	8:40-9:00 a.m.
III.	Content of License Application: A high-level overview of the license application and the supporting documents (e.g., General Information, Environmental Impact Statement, Safety Analysis Report, etc.)	Steve Cereghino, BSC	9:00-10:00 a.m.
	BREAK		10:00-10:15 a.m.
IV.	Safety Analysis Report (SAR) Outline: Discuss the content and format of the SAR and other documents that may be submitted to support the conclusions reached in the SAR. Discuss how the SAR relates to the Yucca Mountain Review Plan.	Steve Cereghino, BSC Dan Kane, DOE	10:15-11:30 p.m.
	LUNCH		11:30-12:45 p.m.
V.	Safety Analysis Report Level of Detail: Discuss the level of detail that will be supplied in the SAR submitted for a Construction Authorization and the updated license application that will be submitted to support the License to Receive and Possess (the discussion will focus on the HVAC that was submitted to NRC in September 2003, and DOE overviews of the Dry Transfer Facility and the Waste Package Design). Response to HVAC Comments	Cereghino, BSC Preston McDaniel, BSC Mark Board, BSC Neil Brown, BSC Steve Cereghino, BSC	12:45-4:30 p.m.
	BREAK		4:30-4:45 p.m.
VI.	Caucus: DOE and NRC caucus separately to identify issues which will require follow-up actions.		4:45-5:30 p.m.
VII.	Summary Discussion: Summarize status of the day's discussions and identify open items.	Tim Kobetz, NRC	5:30-6:00 p.m.
VIII.	Adjourn		6:00 p.m.

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February 4, 2004

	Topics	Discussion Lead	Time
I.	Introductions	Tim Kobetz, NRC Joe Price, DOE	8:30-8:45 a.m.
II.	Risk-Informed Approach to Reviewing the Yucca Mountain License Application: Discuss the use of risk-information by NRC to review the application.	NRC	8:45-10:00 a.m.
	BREAK		10:00-10:15 a.m.
III.	Path Forward to DOE's Submittal of the License Application: Discuss the future technical exchanges and other DOE activities that will take place prior to DOE submitting a license application.	April Gil, DOE	10:15-11:00 a.m.
IV.	Continuing DOE Activities: Discuss the continuation of design and other DOE activities subsequent to the submittal of the license application. Discuss how DOE intends to ensure design information in the application is current, as necessary.	Steve Cereghino, BSC	11:00-12:15 p.m.
	LUNCH		12:15-1:30 p.m.
V.	Proposed Conditions for a Potential Construction Authorization: A Preliminary Presentation for the types of Construction Authorization Conditions that would be contained in the License Application.	Steve Cereghino, BSC	1:30-2:30 p.m.
	BREAK		2:30-2:45 a.m.
VI.	Caucus: DOE and NRC caucus separately to identify issues which will require follow-up actions.		2:45-3:30
VII.	Summary Discussion: Summarize status of the day's discussions and identify open items.	Tim Kobetz, NRC	3:30-4:00 p.m.
VIII.	Adjourn		4:00 p.m.



U.S. Department of Energy
Office of Civilian Radioactive Waste
Management



Content of License Application

Presented to:

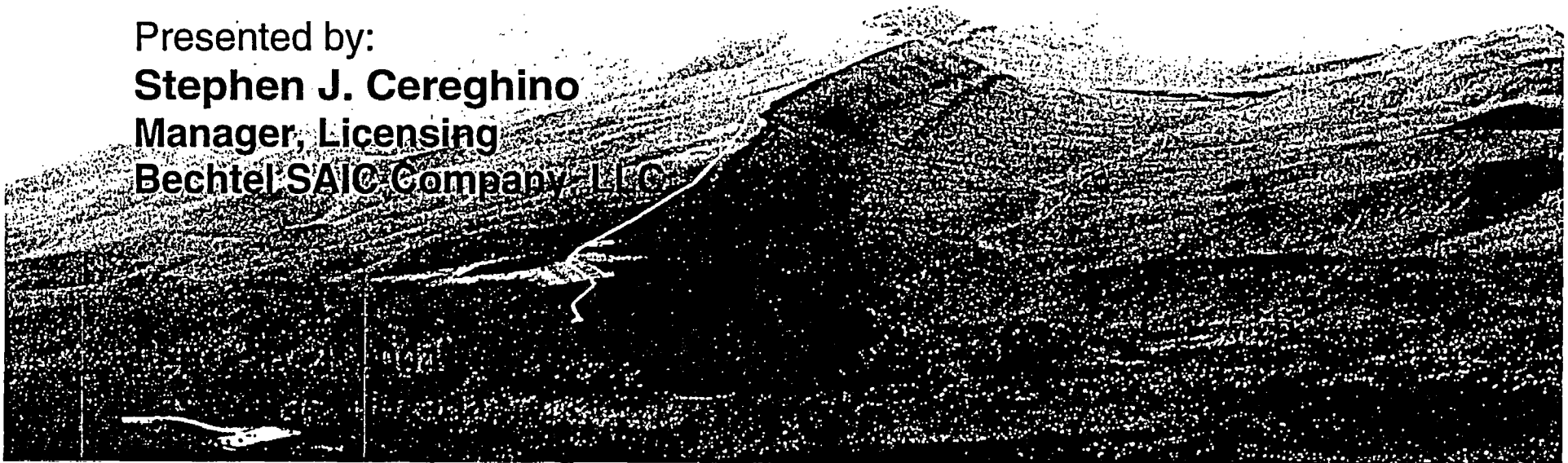
DOE/NRC Technical Exchange on Level of Detail

Presented by:

Stephen J. Cereghino

Manager, Licensing

Bechtel SAIC Company LLC



Purpose and Objectives

- **Purpose**

- Obtain mutual understanding of the material to be presented in the application for Construction Authorization (CA) versus material for licensing review and inspection

- **Objectives**

- Demonstrate that a two stage process is appropriate for project of this magnitude and consistent with the regulations
- Describe the growth of breadth and depth of information as design progresses
- Demonstrate how design flows into Safety Analysis Report (SAR)
- Show YMP examples of various design documents



Licensing Process

- **Licensing of the repository is a two-step process**
 - **Construction Authorization**
 - ♦ 63.31 specifies findings NRC must make to grant construction authorization
 - **License to Receive and Possess**
 - ♦ 63.41 specifies findings NRC must make to grant license to receive and possess
- **Similar licensing process for other projects of this magnitude**
 - Extended period of site characterization
 - Multiple complex structures, systems, and components
 - Long lead times for procurement, fabrication, and construction
 - Appropriate to demonstrate/commit bases, methodology, acceptance criteria in SAR for CA
 - Appropriate to update License Application (LA) as details developed and inspect for conformance



License Application Overview

- **License Application**
 - **Contents of LA**
 - ♦ Letter and Enclosures
 - ♦ General Information (GI) (Enclosure)
 - ♦ SAR (Enclosure)
 - ♦ Environmental Impact Statement (EIS) will accompany GI and SAR
 - **Contents of GI and SAR**
 - ♦ Conform with Yucca Mountain Review Plan (YMRP) (NUREG-1804) format to the extent practicable
 - ♦ Comply with 10 CFR 63.21
 - ♦ Responsive to Acceptance Criteria and Review Methods in YMRP
 - ♦ Cross-reference matrix to YMRP and regulations will be provided

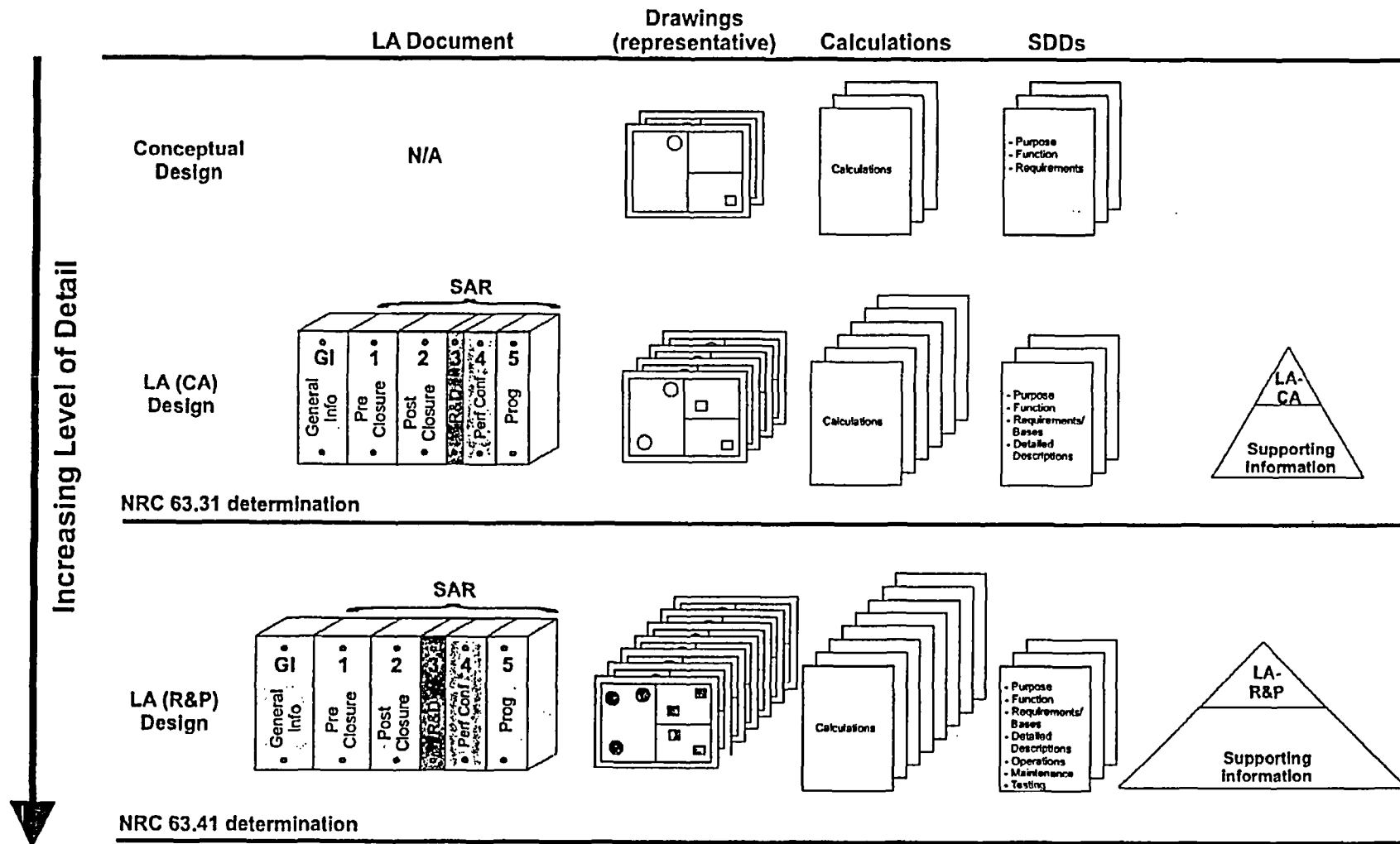


License Application Overview

- The LA will contain sufficient information to demonstrate the preclosure and postclosure safety assessments
 - Full set of surface facilities
 - ♦ Expected operations and hazards
 - ♦ Maximum throughput
 - Full set of subsurface facilities
 - ♦ Emplacement drifts
 - ♦ Support drifts
 - ♦ 70,000 MTHM
- Plans will be described in the LA in accordance with the regulations and YMRP and provided after initial LA submittal

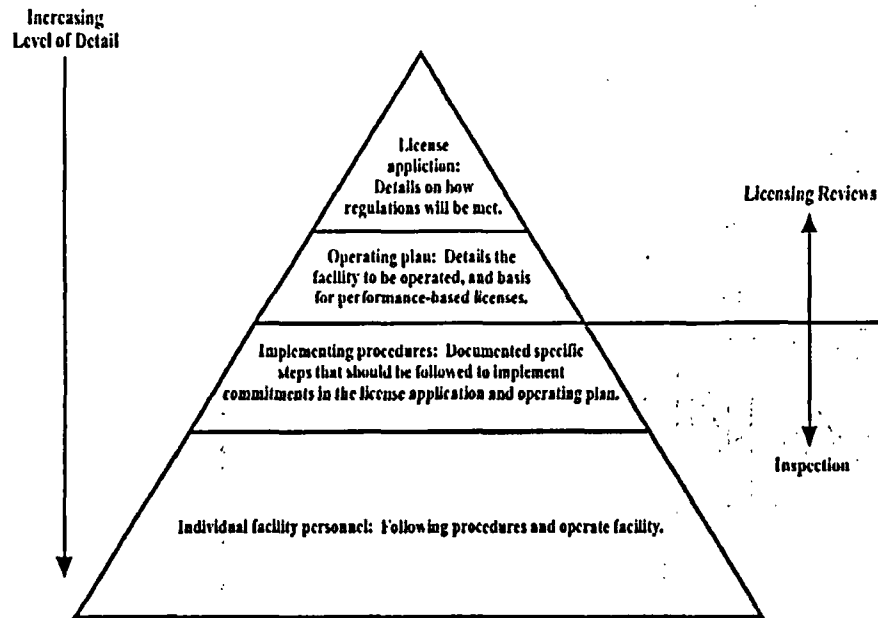


License Application and Supporting Information Development

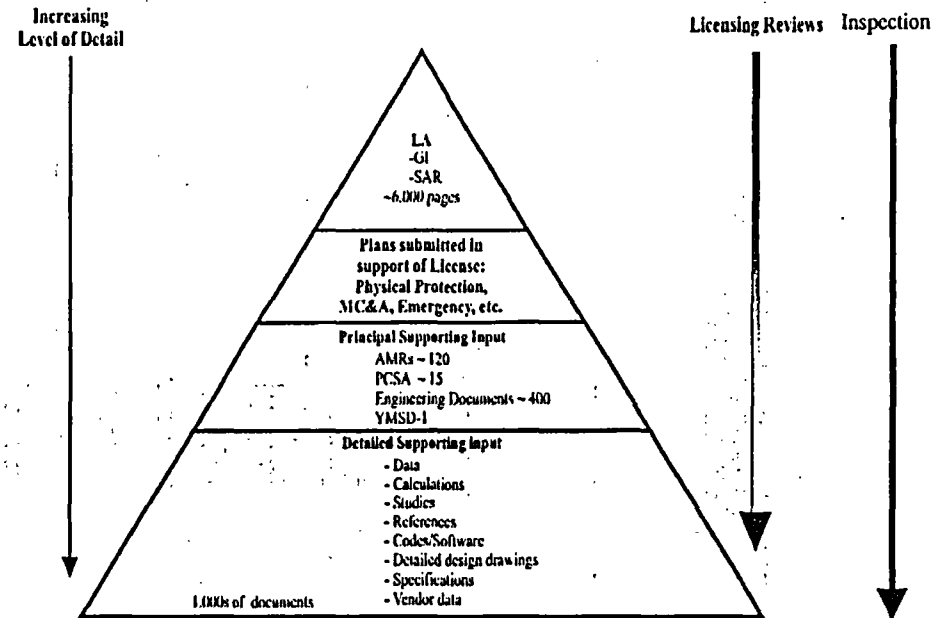


Licensing Reviews versus Inspection

Figure A1-1 from NUREG-1804



License Application and Supporting Documents



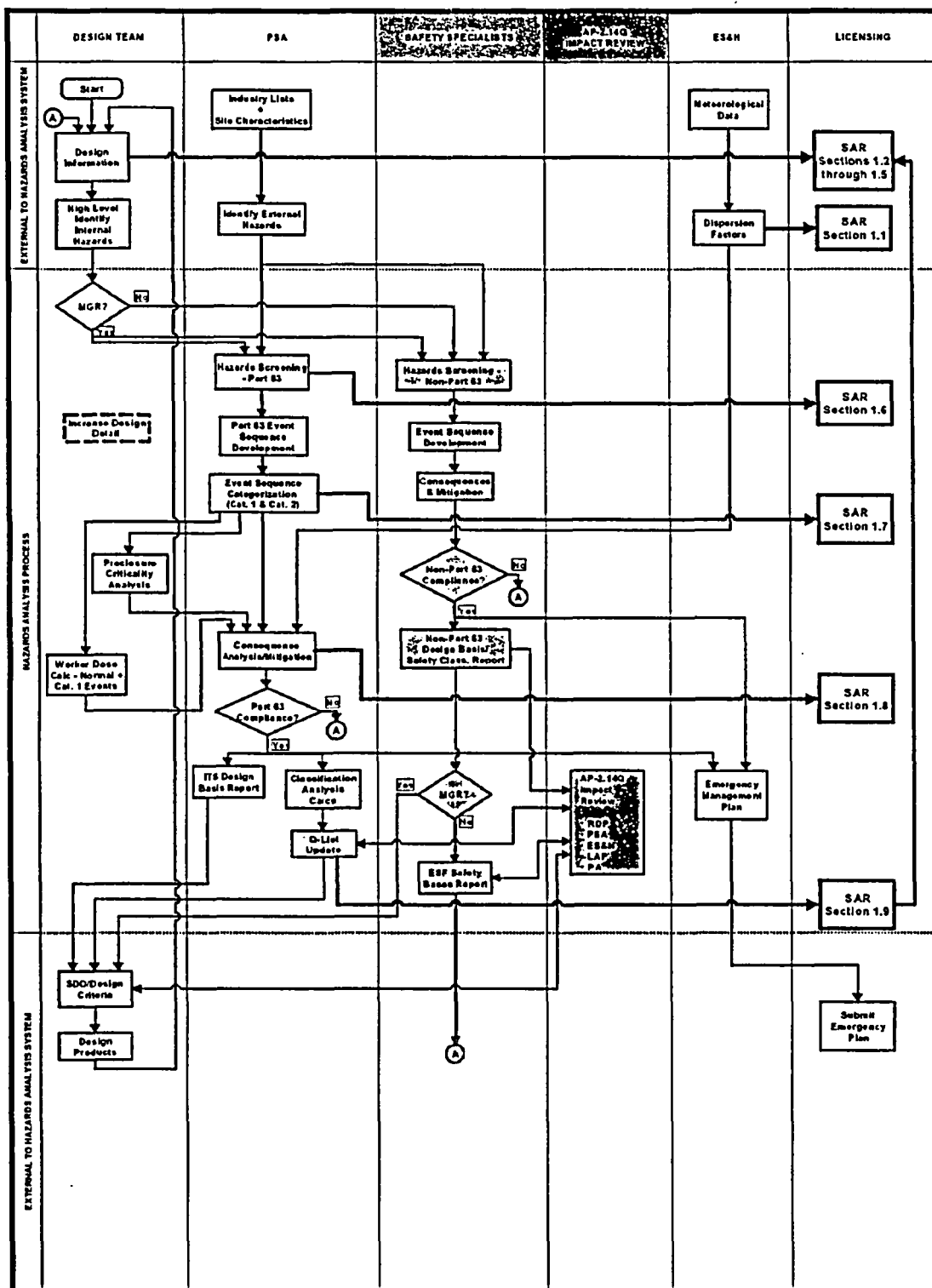
*FEIS about 3,000 pages

From NUREG-1804 page A-4

- The NRC role is not to monitor all licensee activities, but to oversee and audit them
- Review application to verify assumptions justified, methods used are acceptable and applicable over the range presented, models are properly applied, and results acceptable
- Otherwise, the NRC staff should review the application using staff audit calculations performed in limited situations, such as where there are unique proposals involving new methods or assumptions



Hazards Analysis



References versus Supporting Documents

- **The LA extracts the information from the supporting documents**
 - Descriptions
 - Design Bases
 - Methodologies
 - Acceptance Criteria
 - Results
- **The LA is written as a stand-alone document**
- **Other documents submitted in support of the review become part of the licensing record**
- **References are used to indicate where additional information is contained or cite off-project work**
 - Topical Reports
 - Codes, Standards
 - Other Significant Work



Comparison of Safety Analysis Reports

	PSA/ISA	HVAC	Q List
Idaho Spent Fuel Facility SAR Rev 0 Nov 16, 2001	Section 8.0 Accident Analysis 80 Pages text 3 Tables (5 pages) 1 Figure	Section 5.3.1.1 HVAC System 2 Pages text 4 Figures	Section 3.4 Classification of Structures, Systems, and Components 1 Pages text 1 Table (3 pages)
MOX Const Authorization Request (CAR) Feb 28, 2001	Section 5 Integrated Safety Analysis 124 Pages 43 Tables (158 pages) 1 Figure	Section 11.4 HVAC Systems and Confinement 36 Pages 1 Table 1 Figure	Section 5.6 Description of Principal Structures, Systems and Components 2 Pages text 1 Table (7 pages)
PFS SAR Amend 22 March 30, 2001	Section 8.0 Accident Analysis 160 Pages text 3 Tables 1 Figure	Section 4.3.1 Ventilation and Offgas Systems 3 lines (sealed canister design precludes need for ventilation or off-gas systems)	Section 3.4 Classification of Structures, Systems and Components 7 Pages text 1 Table 0 Figures
YMP (Draft)	1.6 Identification of Hazards and Initiating Events 70 Pages text + 20 Tables + 5 Figures 1.7 Event Sequences 23 Pages text + 29 Tables 1.8 Consequence Analysis 32 Pages text + 18 Tables + 1 Figure	30 pages of text tables and figures in the sample provided to NRC. Additionally other information related to HVAC would also be elsewhere in the SAR.	1.9 SSCs Important to Safety, Safety Controls, and Measures to assure Availability of Safety Systems 16 Pages text Table 1.9-1, 6 sheets-structure Table 1.9-2, 26 sheets-sys/com



Comparison of Safety Analysis Report Pages

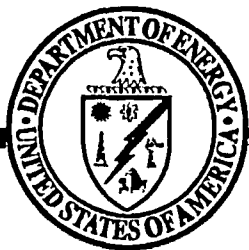
(Continued)

	Civil/Structural	Emergency Plan	Security Plan
Idaho Spent Fuel Facility SAR Rev 0 Nov 16, 2001	Section 3.2 Structural and Mechanical Safety criteria 22 Pages text 2 Tables (2 pages) 52 Figures	Section 9.5 Emergency Planning 1 Pages text (3 paragraphs) 0 Tables 0 Figures	Section 9.7 Physical Security and Safeguards and Contingency Plans 1 Page text (3 paragraphs) 0 Table 0 Figures
MOX Const Authorization Request (CAR) Feb 28, 2001	Section 11.1 Civil Structural Systems 24 Pages 3 Tables 40 Figures	Section 14 Emergency Management 1 Page text (4 paragraphs) 0 Tables 0 Figures	Section 13 Safeguards 1 Pages text 0 Tables 0 Figures
PFS SAR Amend 22 March 30, 2001	Section 3.2 Structural and Mechanical Safety Criteria 37 Pages text 2 Tables 0 Figures	Section 9.5 Emergency Planning 2 ½ Pages 0 Tables 0 Figures	Section 9.7 Physical Security and Safeguards Contingency Plans 2 ½ Pages text 0 Tables 0 Figures
YMP	1.2.2 General Surface Design Considerations. Not yet posted.	Section 5.7 Emergency Planning 5 Pages 0 Tables 0 Figures	GI 3 Physical Protection Plan 8 Pages text 0 Tables 0 Figures

Summary

- **LA will be responsive to YMRP**
- **Depth and breadth of design detail continues to grow, but within the bounds of safety analysis**
- **LA is written as a stand-alone document**
- **Documents supporting LA are available for licensing review and inspection**





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Management



Safety Analysis Report Outline

Presented to:

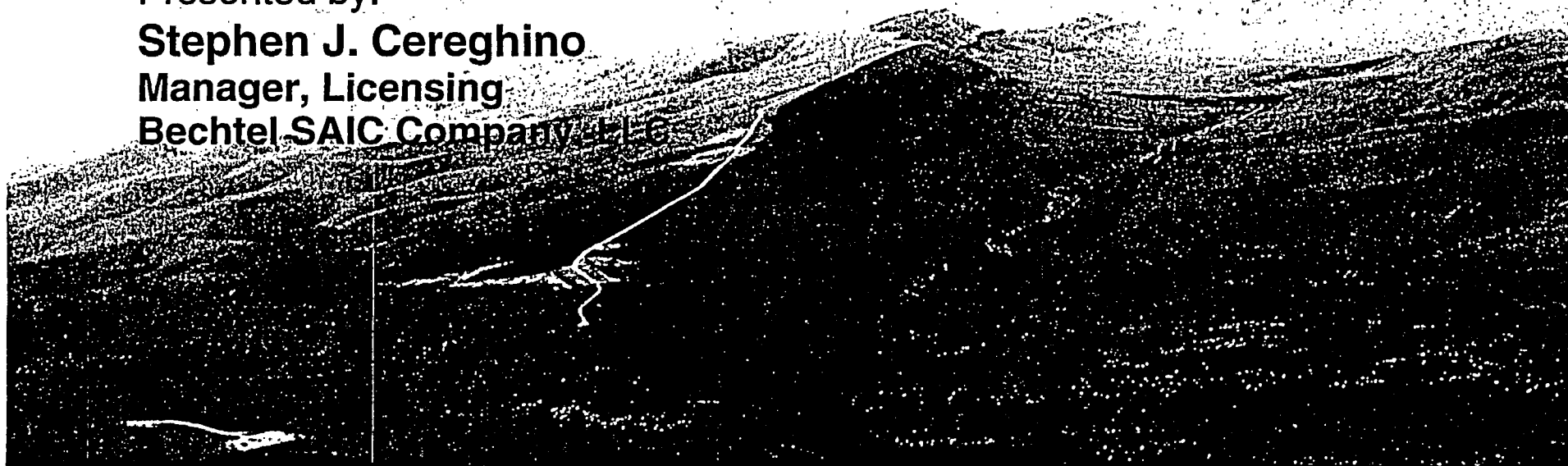
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Outline

- **General Information Outline**
- **Safety Analysis Report (SAR) Outline**
- **Relationship of Yucca Mountain Review Plan (YMRP) to SAR for Design**
- **Matrix of License Application (LA) to YMRP and Regulations**
- **Summary**



General Information Outline

- **GI-1 - Overview of repository**
- **GI-2 - Schedules describing how construction and operations will be phased**
- **GI-3 - Description of Physical Protection Plan**
 - Detailed description of what plan will contain
 - Plan itself to be submitted after LA
- **GI-4 - Description of Material Control and Accounting Plan**
 - Detailed description of what plan will contain
 - Plan itself to be submitted after LA
- **GI-5 - Description of Site Characterization**



Safety Analysis Report Outline

- **Ch 1 - Repository Safety Prior to Permanent Closure**
- **Ch 2 - Repository Safety After Permanent Closure**
- **Ch 3 - Research and Development Program to Resolve Safety Questions**
- **Ch 4 - Performance Confirmation Program**
- **Ch 5 - Administrative and Programmatic Requirements**



Safety Analysis Report Outline

(Continued)

- **Ch 1 - Repository Safety Prior to Permanent Closure**
 - **1.1 Site Description**
 - **1.2 Surface Structures, Systems, or Components (SSCs)**
 - **1.3 Subsurface SSCs**
 - **1.4 Infrastructure SSCs**
 - **1.5 Waste Package**



Safety Analysis Report Outline

(Continued)

- **Ch 1 - Repository Safety Prior to Permanent Closure**
 - **1.6 Identification of Hazards Analysis and Initiating Events**
 - **1.7 Event Sequences**
 - **1.8 Consequence Analysis**
 - **1.9 SSCs Important to Safety**
 - **1.10 As Low As Is Reasonably Achievable (ALARA)**
 - **1.11 Plans for Retrieval and Alternate Storage of Waste**
 - **1.12 Plans for Permanent Closure and Decontamination**
 - **1.13 Equipment Qualification Program**



Safety Analysis Report Outline

(Continued)

- **Ch 2 - Repository Safety After Permanent Closure**
 - **2.1 Discussion of Multiple Barriers**
 - **2.2 Discussion of Features, Events and Processes and Event Probability**
 - **2.3 Discussion of Model Abstractions**
 - ♦ **Based on Technical Basis Documents**
 - ♦ **Colloids Technical Basis Document incorporated in appropriate abstraction discussion**
 - **2.4 Demonstration of Compliance with Postclosure Public Health and Environmental Standards**



Safety Analysis Report Outline

(Continued)

- **Ch 3 - Research and Development Program to Resolve Safety Questions**
 - If safety questions are identified, the program to resolve them, including schedule, will be provided
- **Ch 4 - Performance Confirmation Program**
 - 10 CFR 63.21(c)(17) and Subpart F
 - ♦ Geologic mapping
 - ♦ Waste package
 - ♦ Other performance parameters



Safety Analysis Report Outline

(Continued)

- **Ch 5 - Administrative and Programmatic Requirements**
 - **5.1 Quality Assurance Program**
 - **5.2 Records, Reports, Tests and Inspections**
 - **5.3 Training and Certification of Personnel**
 - **5.4 Expert Elicitation**
 - **5.5 Plans for Startup Activities and Testing**
 - **5.6 Plans for Conduct of Normal Activities**
 - **5.7 Emergency Plan**
 - **5.8 Controls to Restrict Access and Regulate Land Use**
 - **5.9 Uses of the Geologic Repository Operations Area (GROA) for other than Disposal of Waste**
 - **5.10 License Specifications**
 - **5.11 Radiation Protection Program**



Safety Analysis Report Outline

(Continued)

- **1.2 Surface SSCs, Equipment and Operational Process Activities**
 - **1.2.1 Surface Operations Overview**
 - **1.2.2 General Surface Design Considerations**
 - **1.2.2.1 Surface Design Concepts**
 - **1.2.2.2 Surface Design Methodologies**
 - ♦ **Seismic**
 - ♦ **Criticality**
 - ♦ **ALARA**
 - ♦ **Shielding**
 - ♦ **Fire and Explosion Protection, etc.**



Safety Analysis Report Outline

(Continued)

- **1.2 Surface SSCs, Equipment and Operational Process Activities (Continued)**

- **1.2.2.3 Combined Load Criteria**
- **1.2.2.3.1 Design Loads**
 - ♦ **Dead Loads**
 - ♦ **Live Loads**
 - ♦ **Snow and Ice Loads**
 - ♦ **Earthquake Loads**
 - ♦ **Water Level (Floods)**
 - ♦ **Tornado and Wind Loadings, etc.**
- **1.2.2.3.2 Load Combinations**
 - ♦ **Reinforced Concrete**
 - ♦ **Structural Steel**
 - ♦ **Sliding and Overturning Stability**
- **1.2.2.4 Codes and Standards Used in Design**



Safety Analysis Report Outline

(Continued)

- **Outline of Surface SSC**

- 1.2.x.y.1 **SSC Description (F&OR, SDD, GA, P&ID)
[2.1.1.2.2 RM1, RM2, 2.1.1.2.3 AC1, AC2]**
- 1.2.x.y.2 **Operational Processes and Procedures
(SDD, P&ID) [2.1.1.2.2 RM6, 2.1.1.2.3 AC6]**
- 1.2.x.y.3 **Considerations Important to Safety
(SDD, P&ID, PCSA) [2.1.1.6.2 RM1, 2.1.1.6.3 AC1]**
- 1.2.x.y.4 **Administrative or Procedural Safety
Controls to Prevent Event Sequences or
Mitigate Their Effects (PCSA)
[2.1.1.6.2 RM2, 2.1.1.6.3 AC2]**
- 1.2.x.y.5 **Design Criteria and Design Bases
(Project Design Criteria, SDD and PCSA)
[2.1.1.7.2.1 RM1, 2.1.1.7.3.1 AC1]**

x-facility (e.g. DTF) y-system (Source) [YMRP]



Safety Analysis Report Outline

(Continued)

- **Outline of surface SSC** (Continued)
 - 1.2.x.y.6 Design Methodologies (SDD, Calculations) [2.1.1.7.2.2 RM1, 2.1.1.7.3.2 AC1]
 - 1.2.x.y.7 Consistency of Materials with Design Methodologies (SDD, P&ID and Calculations) [2.1.1.7.2.3 I RM2, 2.1.1.7.2.3 I AC2]
 - 1.2.x.y.8 Design Codes and Standards (PDC, SDD) [2.1.1.7.2.3 I RM1, 2.1.1.7.3.3 I AC1]
 - 1.2.x.y.9 Design Load Combinations (PDC, FDD, Calculations) [2.1.1.7.2.3 I RM3, 2.1.1.7.3.3 I AC3]

x-facility (e.g. DTF) y-system (Source) [YMRP]



Relationship of Yucca Mountain Review Plan to Safety Analysis Report for Design

YMRP Section	SAR Section
2.1.1 Preclosure Safety Analysis	1.0
2.1.1.1 Site Description as it Pertains to Preclosure Safety Analysis	1.1
2.1.1.2 Description of SSCs	1.2, 1.3, 1.4, 1.5
2.1.1.3 Identification of Hazards and Initiating Events	1.6
2.1.1.4 Identification of Event Sequences	1.7
2.1.1.5 Consequence Analyses	1.8
2.1.1.6 Identification of SSCs Important to Safety	1.9
2.1.1.7 Design of SSCs Important to Safety	1.2, 1.3, 1.4, 1.5
2.1.1.8 Meeting the 10 CFR Part 20 ALARA	1.10
2.1.2 Plans for Retrieval and Alternate Storage of Radioactive Wastes	1.11
2.1.3 Plans for Permanent Closure and Decontamination, or Decontamination and Dismantlement of Surface Facilities	1.12
NA Equipment Qualification Program	1.13



Matrix of License Application to Yucca Mountain Review Plan and Regulations

GI Section		YMRP	Regulations
3	Physical Protection Plan	1.3	10 CFR 73.51, 10 CFR 72.106, 10 CFR 63.21(b)(3)
3.1	Description and Schedule for Implementation	1.3.2 RM1	10 CFR 63.21(b)(3), 10 CFR 73.51
3.2	General Performance Objectives	1.3.2 RM2	10 CFR 73.51(b)
3.3	Protection Goal and Strategy	1.3.2 RM3	10 CFR 73.51, 10 CFR 72.106
3.4	Security Organization	1.3.2 RM4	10 CFR 73.51(d), 10 CFR 73 Appendices B, C and G
3.5	Physical Barrier Subsystems	1.3.2 RM5	10 CFR 73.2, 10 CFR 73.51(d)(1) and (2)
3.6	Access Control Subsystems and Procedures	1.3.2 RM6	10 CFR 73.51(d)(7) and (9)
3.7	Detection, Surveillance, Alarm Subsystems, and Procedures	1.3.2 RM7	10 CFR 73.51(d)(3) and (4)
3.8	Communication Subsystems	1.3.2 RM8	10 CFR 73.51(d)(8) and (11)
3.9	Equipment Operability and Compensatory Measures	1.3.2 RM9	10 CFR 73.51(d)
3.10	Contingency and Response Plans and Procedures	1.3.2 RM10	10 CFR 73.51(d)(6), and (10), 10 CFR 73 Appendix C
3.11	Reporting of Safeguards Events	1.3.2 RM11	10 CFR Part 73 Appendix G



Summary

- **LA format designed to align with the YMRP to the extent practicable**
- **Matrix of YMRP to LA will be provided**





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Similarities of 10 CFR 50 to 10 CFR 63

Presented to:
DOE/NRC Technical Exchange Level of Detail



Similarities in Licensing Review and Process Between Parts 50 and 63

Part 50

Bifurcated - CP (PSAR)
- OL (FSAR)

Part 63

Bifurcated - CA (initial LA)
- LR&P (updated LA)

"Part 63 provides for a multi-stage licensing process that affords the Commission the flexibility to make decisions in a logical time sequence ... The Commission believes the regulations, as proposed, provide the necessary flexibility for making licensing decisions consistent with the amount and level of information appropriate to each stage."

Part 63, Final Rule, 66 FR 55738 and 55739, November 2, 2001

Differentiated standards

for construction - 50.45

63.31

for operations - 50.57

63.41

CSC - 50.57(a)(1)

63.41(1) and (2)

in conformity with application AA,
provisions of the Act, and R&R of
the Commission - 50.57(a)(2)

63.41(b)

issuance not inimical to common defense
and security or to

public H&S - 50.57(a)(6)

63.41(c)

adequate in case of radiological

emergency - 50.47(a)(1)

63.41(d)



Similarities in Licensing Review and Process Between Parts 50 and 63

(Continued)

<u>Part 50</u>	<u>Part 63</u>
Vehicles for transmitting information	
General Information - 50.33	63.21(b)
Safety Analysis Report - 50.34	63.21(c)
Recognition of different levels of completeness in LA submittals based on "reasonably available" - 50.35(a)	63.21(a) and 63.24(a)
NRC guidance on LA submittals	
SF&C - Regulatory Guide 1.70	No regulatory guide
SRP - NUREG-0800	NUREG-1804
Areas of Review	Areas of Review
Acceptance Criteria	Acceptance Criteria
Evaluation Findings	Evaluation Findings
Division 1 and other division regulatory guides cited yes	yes



Similarities in Licensing Review and Process Between Parts 50 and 63

(Continued)

<u>Part 50</u>	<u>Part 63</u>
Acceptance Review prior to technical review 30 days	90 days
Years from docketing to construction approval mean < 3 years	3 to 3+1 years (114(d))
Limit on time from FSAR/Updated LA to license receipt	
Conditions	
on construction - 50.55	63.32
on operations - 50.54	63.42
Technical specifications 50.36	63.43
Records, reports, and inspections 50.70 - 50.75	63.71 - 63.78
Limitations on changes, tests, and experiments - 50.59	63.44



Similarities in Licensing Review and Process Between Parts 50 and 63

(Continued)

<u>Part 50</u>	<u>Part 63</u>
Personnel training 50.34(a)(6)	Subpart H
Physical Protection Plan prior to ops 50.34(c)	63.21(b)(3) / 73.51
Safeguards Contingency Plan prior to ops 50.34(d)	63.21(b)(3) / 73.51
Emergency Plan required prior to ops 50.47	63.161 / 72.32(b)
Quality Assurance program Appendix B	Subpart G
NRC staff documents evaluation findings in SER SSERs	SER (A.1.2) SSERs (A.1.2.2)

Comparison of Clinton Power Station's Preliminary Safety Analysis Report vs. Final Safety Analysis Report

A few spent fuel pool cooling and cleanup system components:

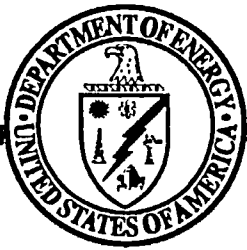
<u>PSAR</u>	<u>FSAR</u>
Temperature limit on pool water	120 F
Heat removal capability based on 25% core storage 25% of one core at 150 hrs conduction/convection from Rx	19.7 E6 Btu/hr/train
Redundant pumps - nominal flow not mentioned	1,000 gpm
Max flow rate - not mentioned	4038 gpm
Keep a covering over the fuel - level not mentioned	min. 15 ft
Bypass F/D if high temperature - no temperature mentioned	150 F



Summary

- **Comparison between 10 CFR Part 50, *Domestic Licensing of Production and Utilization Facilities*, and 10 CFR Part 63, *Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada* shows the following similarities:**
 - Two stage licensing process
 - Increasing level of detail between
 - ♦ Preliminary and Final Safety Analysis Reports (10 CFR 50)
 - ♦ License Application for Construction Authorization and Receive and Possess (10 CFR 63)





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Introduction to Engineering Documentation

Presented to:

DOE/NRC Technical Exchange on Level of Detail

Presented by:

Stephen J. Cunningham

Manager

Technical Support

Office of Civilian

Radioactive Waste

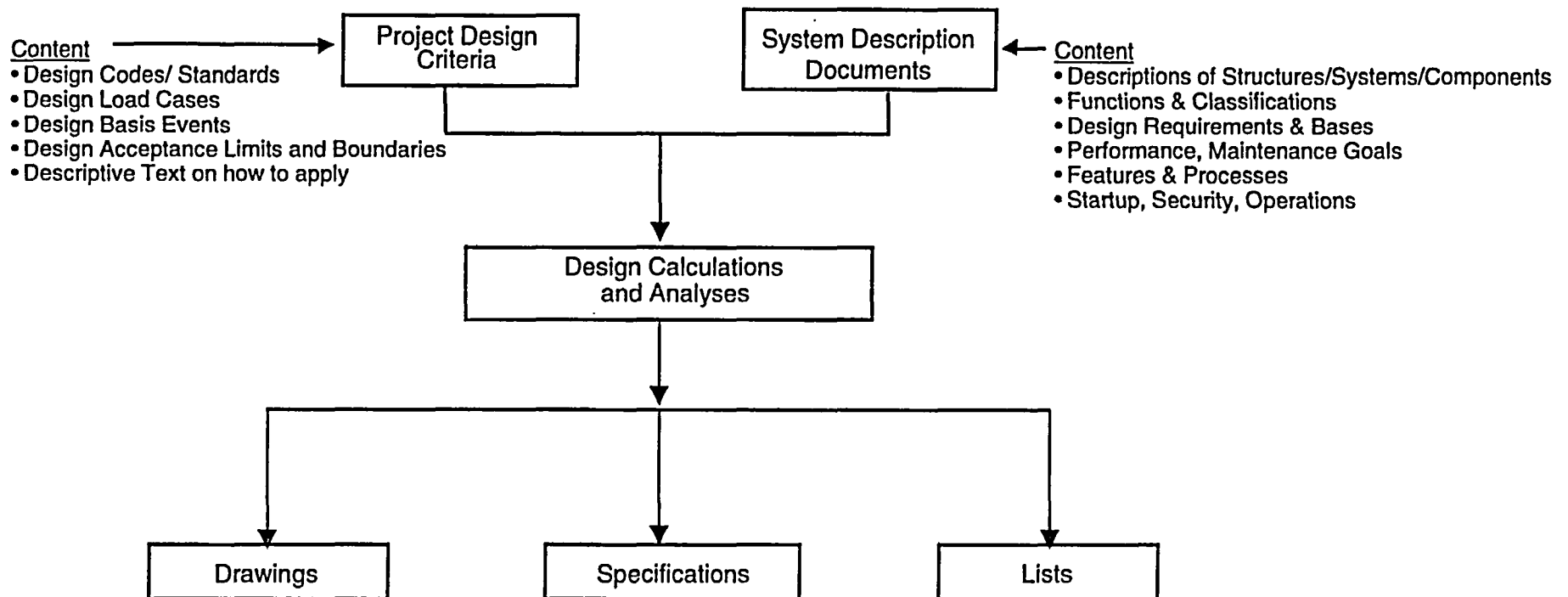
Management

U.S. Department of

Energy

Washington, D.C.

Engineering Document Hierarchy



Primary Design Products

- **Project Design Criteria**
- **System Description Documents**
 - System Descriptions
 - Facility Descriptions
- **Calculations/Analyses**
- **Drawings**
 - Mechanical Flow Diagrams
 - Piping & Instrument Diagrams
 - Air Flow Diagrams
 - Equipment/Component
 - Electrical One Line Diagrams
 - Instrument Block Diagrams
 - Logic Diagrams
 - Site Plan
 - Facility General Arrangements
 - Zoning
 - Civil/Structural
- **Specifications**

Developed in sufficient detail to support:

- Evaluation of repository safety*
- Evaluation of repository performance*
- Demonstration of compliance with objectives*



Design Products for Construction

- **License Application Primary Products**

- Project Design Criteria
- Calculations/Analyses
- Piping and Instrument Diagrams
- Equipment/Component
- Instrument Block Diagrams
- Site Plan
- Zoning
- Specifications
- System Description Documents
- Mechanical Flow Diagrams
- Air Flow Diagrams
- Electrical One Line Diagrams
- Logic Diagrams
- Facility General Arrangements
- Civil/Structural

- **Plus Detailed Design Products for Construction**

Detailed Engineering Calculations
Control Block Diagrams
Control Panel Layouts
Wiring Diagrams
Operator Interface Drawings
Control Loop Diagrams
Level Setting Diagrams
Equipment Detail Drawings
HVAC Layout Drawings
Piping Isometrics
Welding Procedures

Pipe Support Drawings
Cable Block Diagrams
Electrical Schematics
Electrical Equipment and Duct Bank
Electrical Commodity and Raceway
Electrical Cable Routing
Civil Site Drawings
Structural Steel Drawings
Concrete Drawings
Foundation/Rebar Drawings
Non-Destructive Examination
Procedures

Data Sheets
Procurement Specs
Control System Specs
Bulk Material Specs
Piping Specs
Equipment List
Piping Line List
Instrument List
Valve List
Electrical Load List
Vendor Data





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Surface Facilities Design

Presented to:

DOE/NRC Technical Exchange on Level of Detail

Presented by:

William J. ...

...

...



Outline Surface Facilities

- **Overview of Surface Facilities**
- **Process Flow Through Surface Facilities**
- **Canister Handling Facility**
- **Dry Transfer Facility 1**
- **Examples of Yucca Mountain Design Drawings**
- **Design Tools**
- **Summary**



Overview of Surface Facilities

- Design input from Cogema using extensive process experience from La Hague
- Design adapted for Yucca Mountain requirements
- Surface Facilities Primary Functions
 - Receive high-level radioactive waste
 - Unload, handle, and package waste
 - Age waste as required
 - Transport waste packages to underground facility
 - Monitor operations and system performance
 - Confine waste during preclosure event sequences
 - Meet safeguards and security requirements

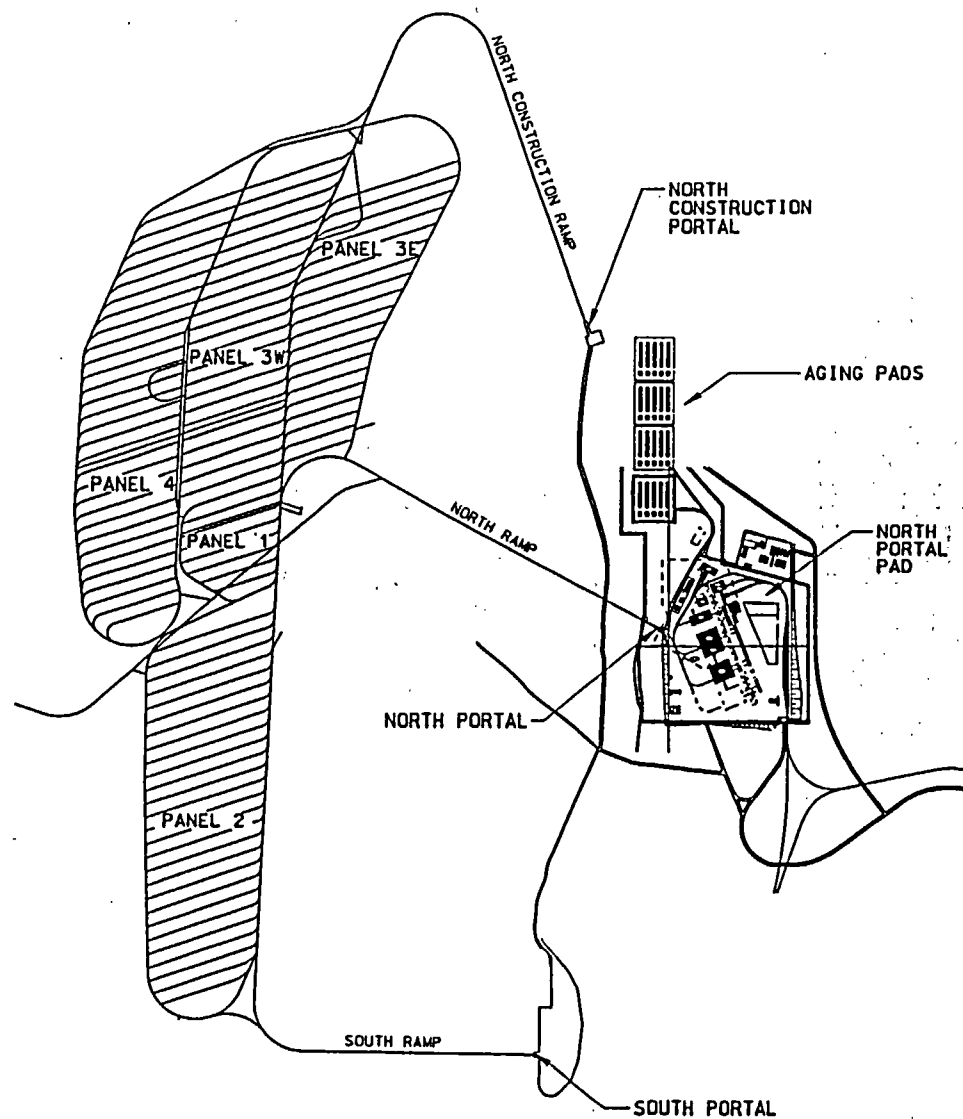


Surface Facilities Status

- **Current design meets 10 CFR 63.111 performance objectives**
- **Structures, systems, and components that are Important to Safety have been identified**
- **Preclosure Safety Analysis to be updated based upon License Application (LA) design**



Site Plan



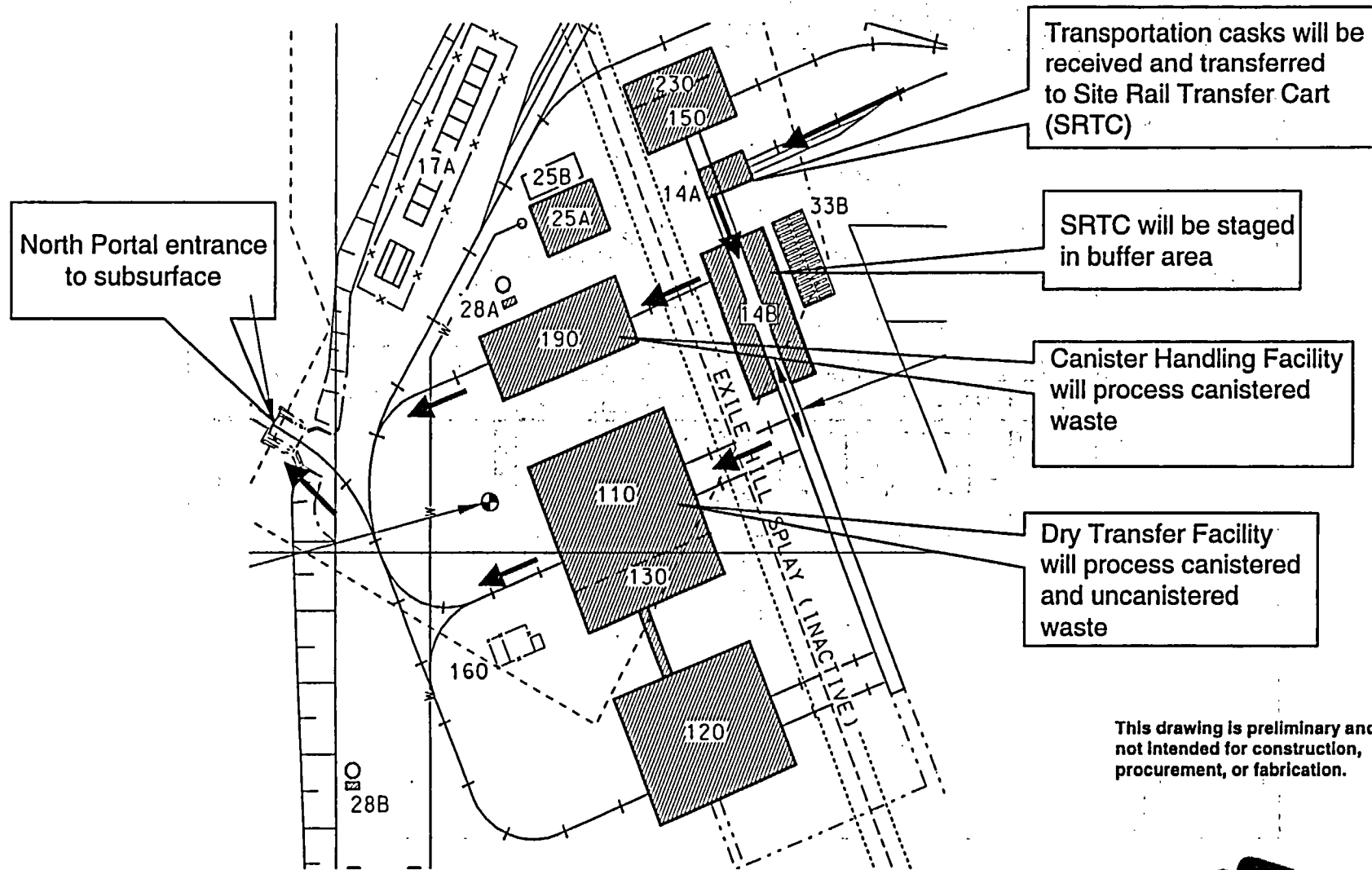
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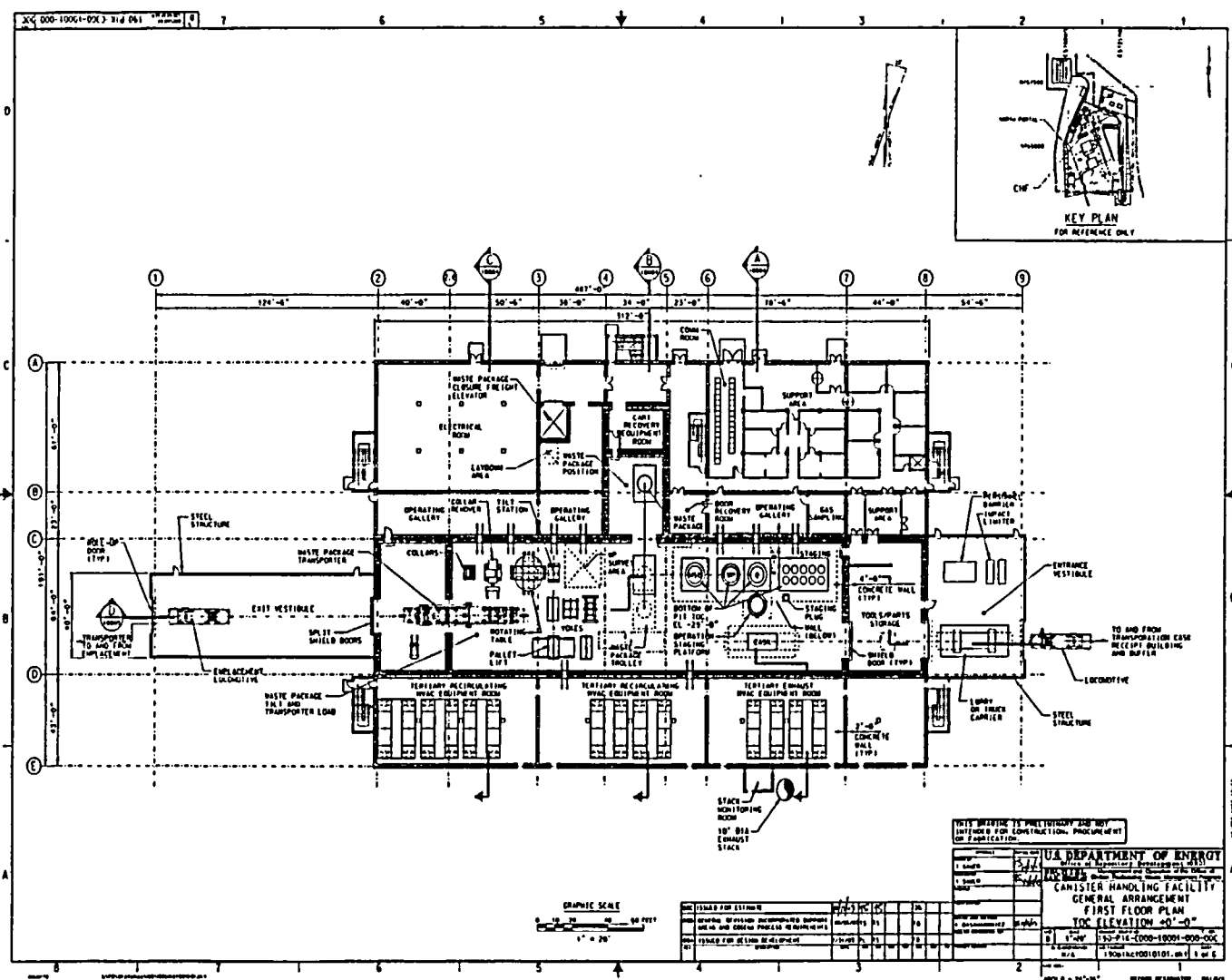


**This drawing is preliminary and
not intended for construction,
procurement, or fabrication.**

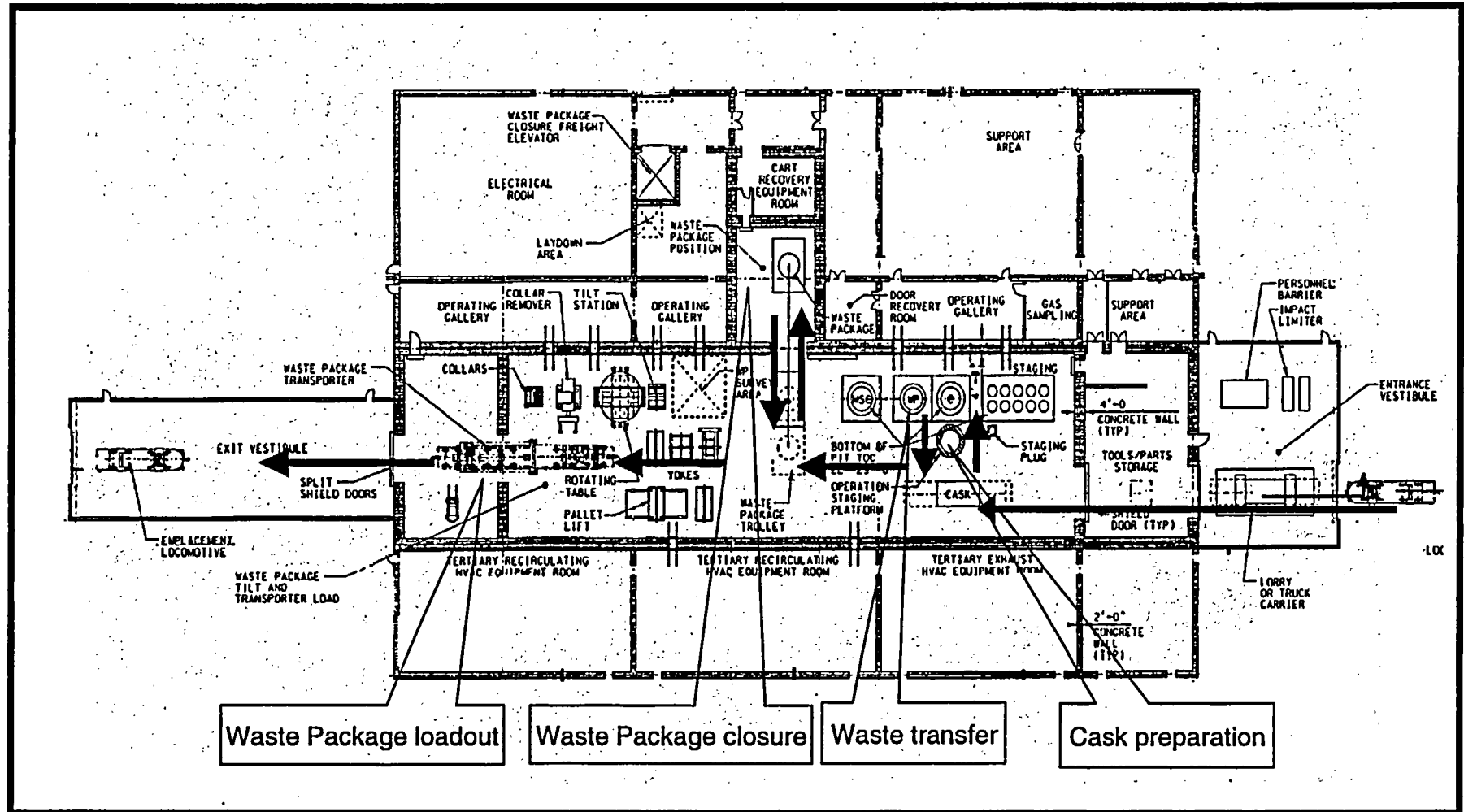
BSC Presentations DOE/NRC Level of Detail YMMcDaniel 02/03/04

Process Flow Through Surface Facilities

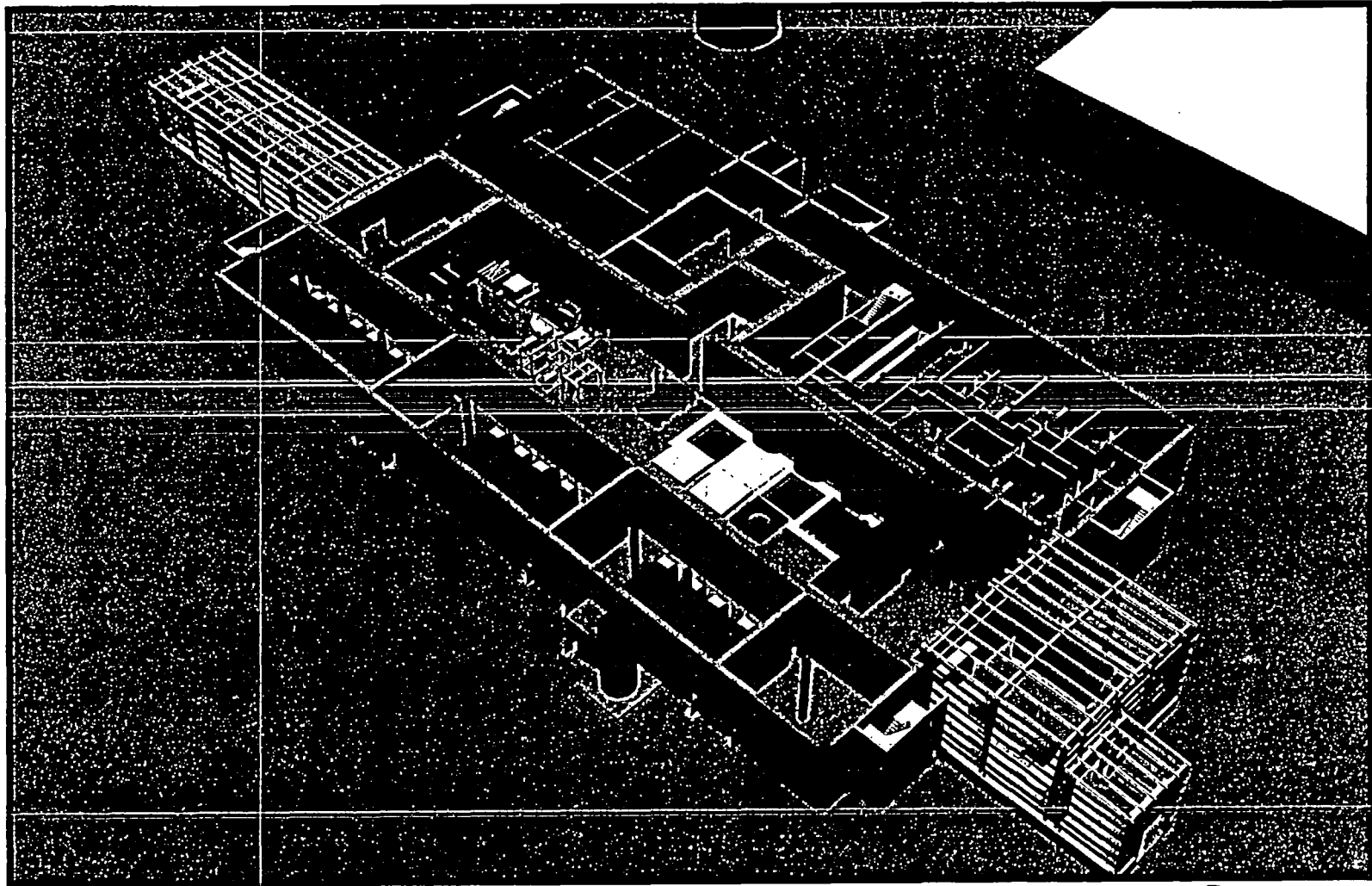




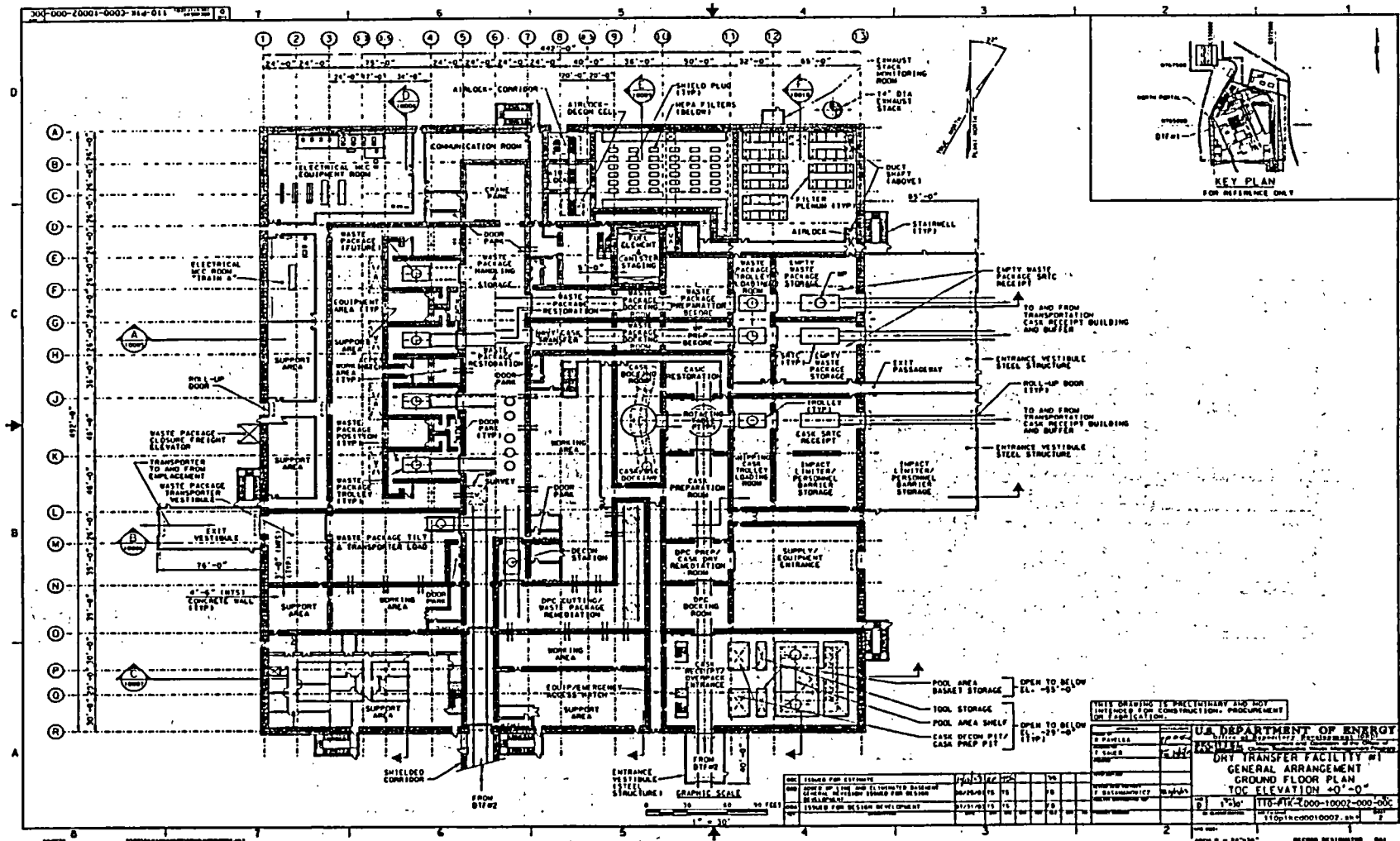
Canister Handling Facility Process Flow



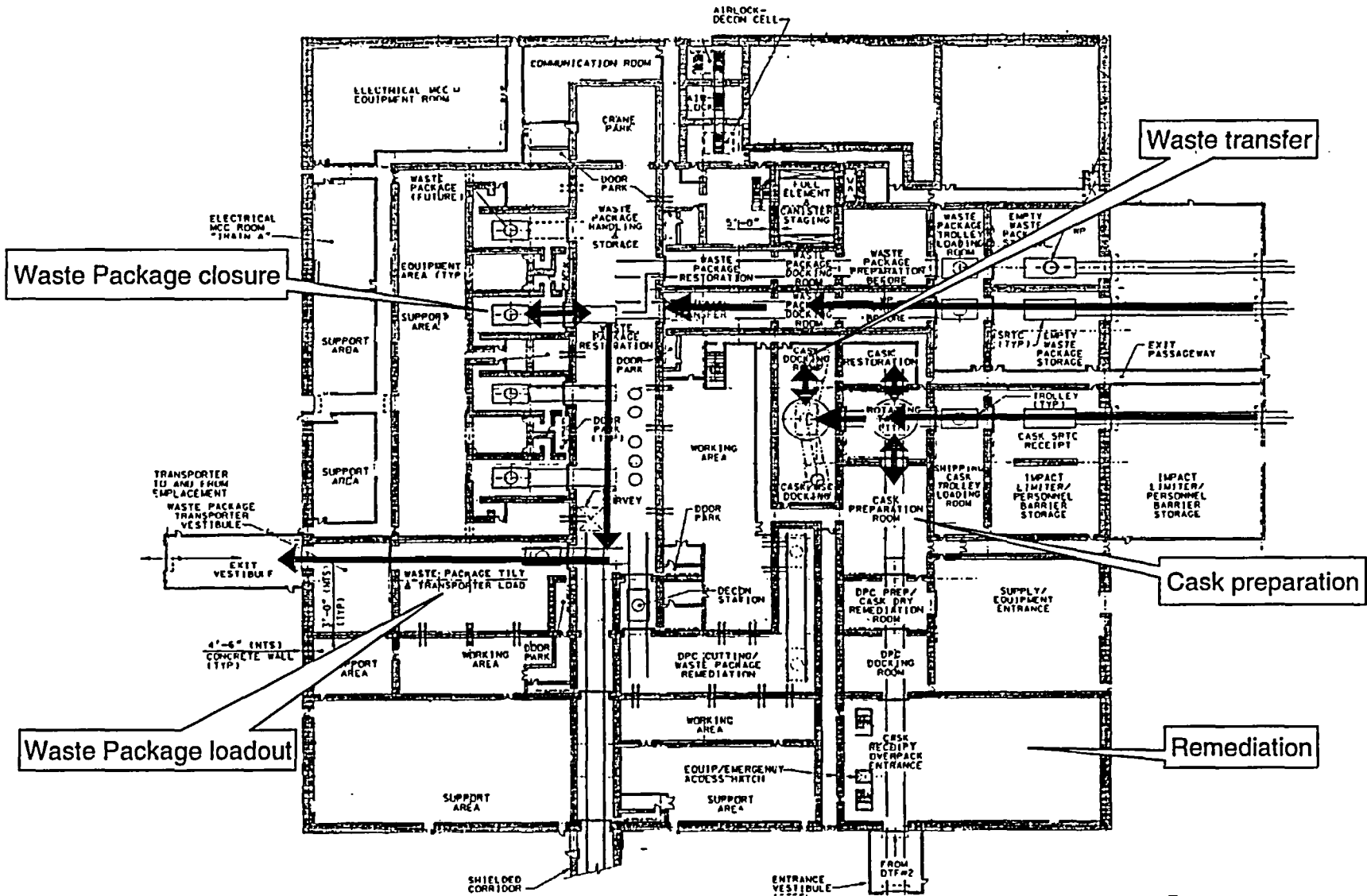
Canister Handling Facility 3D Computer Aided Design Model



Dry Transfer Facility 1 General Arrangement

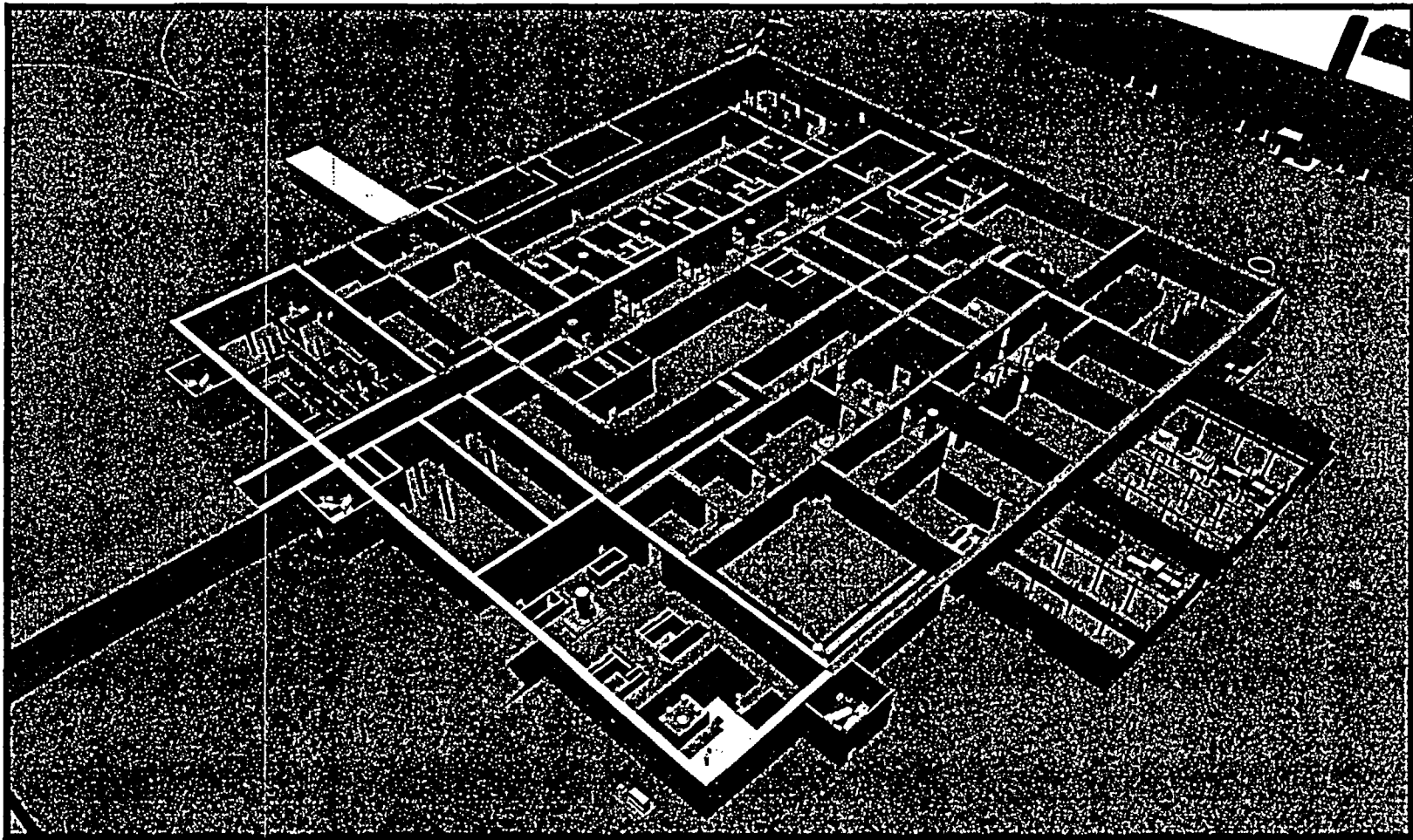


Dry Transfer Facility 1 Process Flow

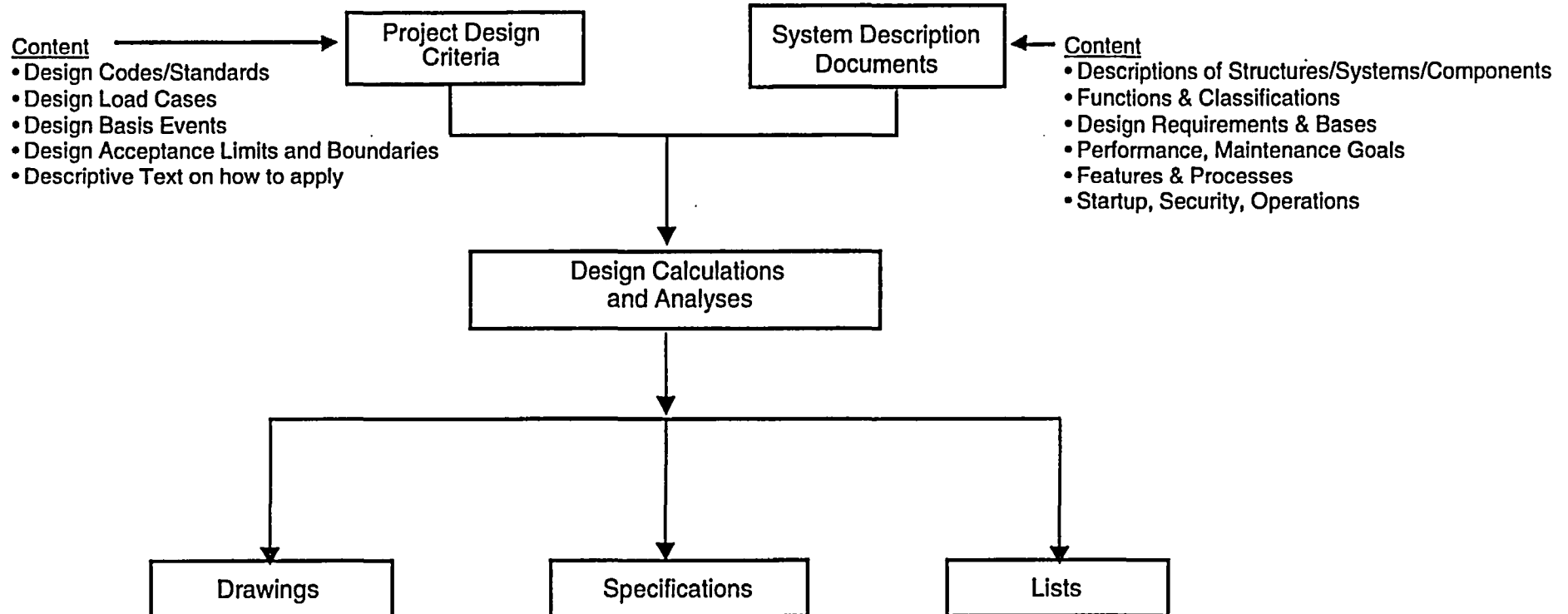


Dry Transfer Facility 1

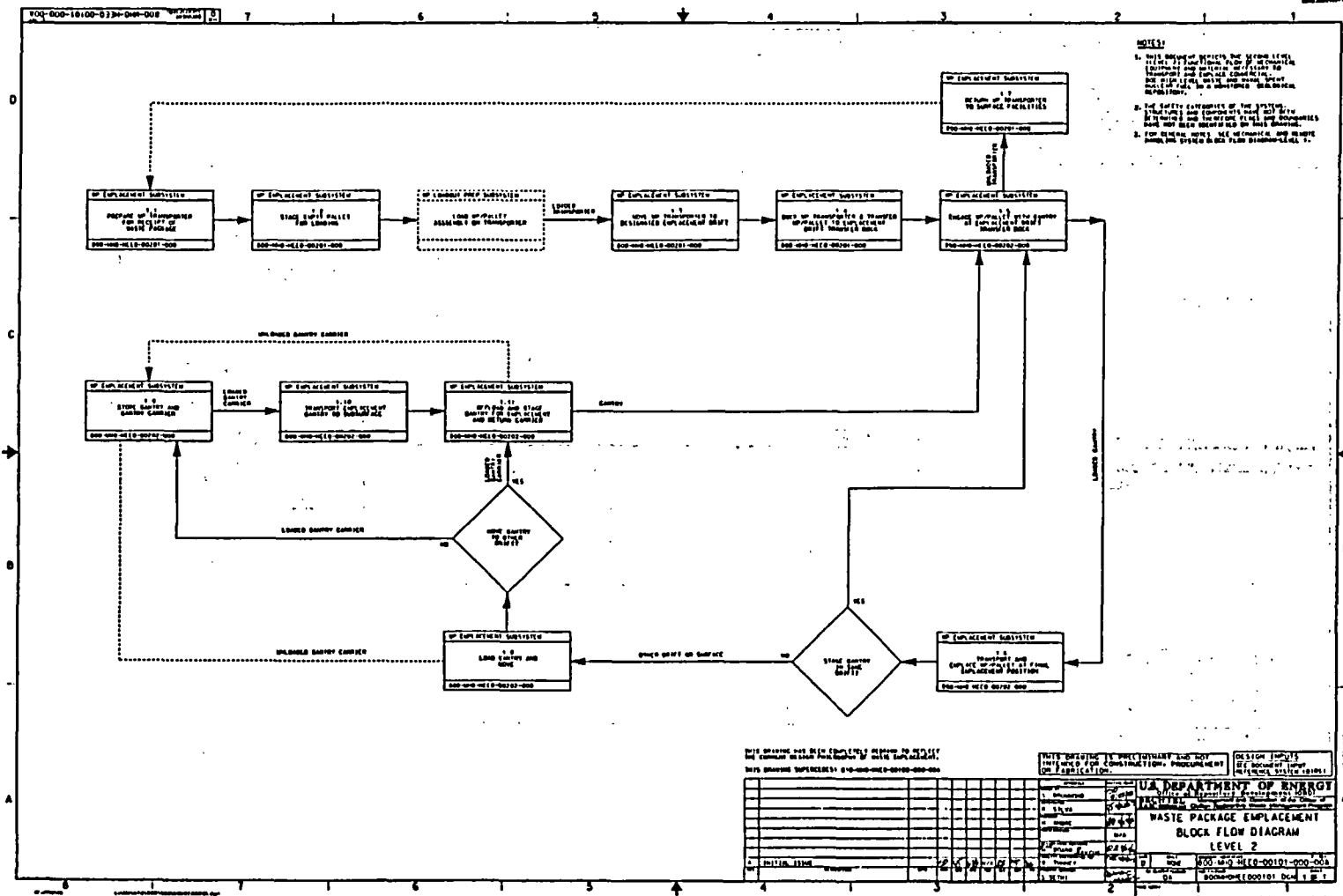
3D Computer Aided Design Model



Engineering Document Hierarchy



Typical Design Drawing Mechanical Block Flow Diagram



20000175 0013



[illegible]

Design Tools

- **3D Computer Aided Design Model**
 - Intergraph PDS
- **Structural Model**
 - GTSTRUDL
- **Waste Process Throughput Model**
 - Witness



Summary

- **Presented the Surface Facilities**
 - Overview
 - Process Flow
 - Canister Handling Facility
 - Dry Transfer Facility 1
 - Examples of Yucca Mountain Design Documents
 - Design Tools
- **Design Documents will be developed in sufficient level of detail to support the LA**





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Subsurface Facilities Design

Presented to:

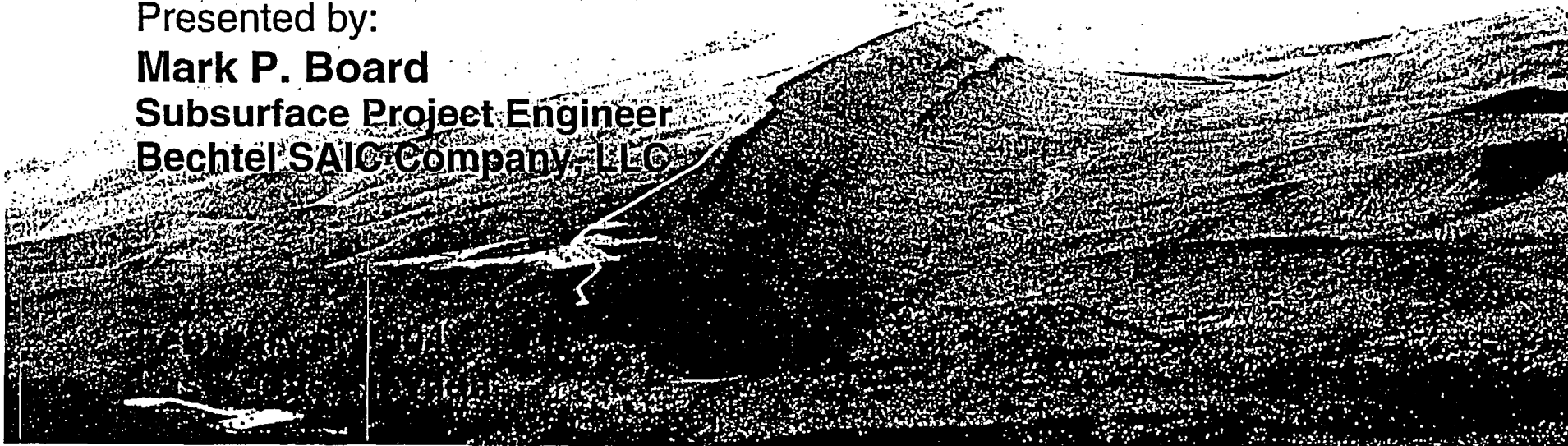
DOE/NRC Technical Exchange on Level of Detail

Presented by:

Mark P. Board

Subsurface Project Engineer

Bechtel SAIC Company, LLC



Outline

- **Overview of Subsurface Facility**
 - Facility components
 - High-level functions
- **Subsurface design and examples of level of detail to be provided in License Application (LA)**
- **Review of design process and LA products**
- **Design tools**
- **Summary**

Overview of Subsurface Facility

- **Facility Components**

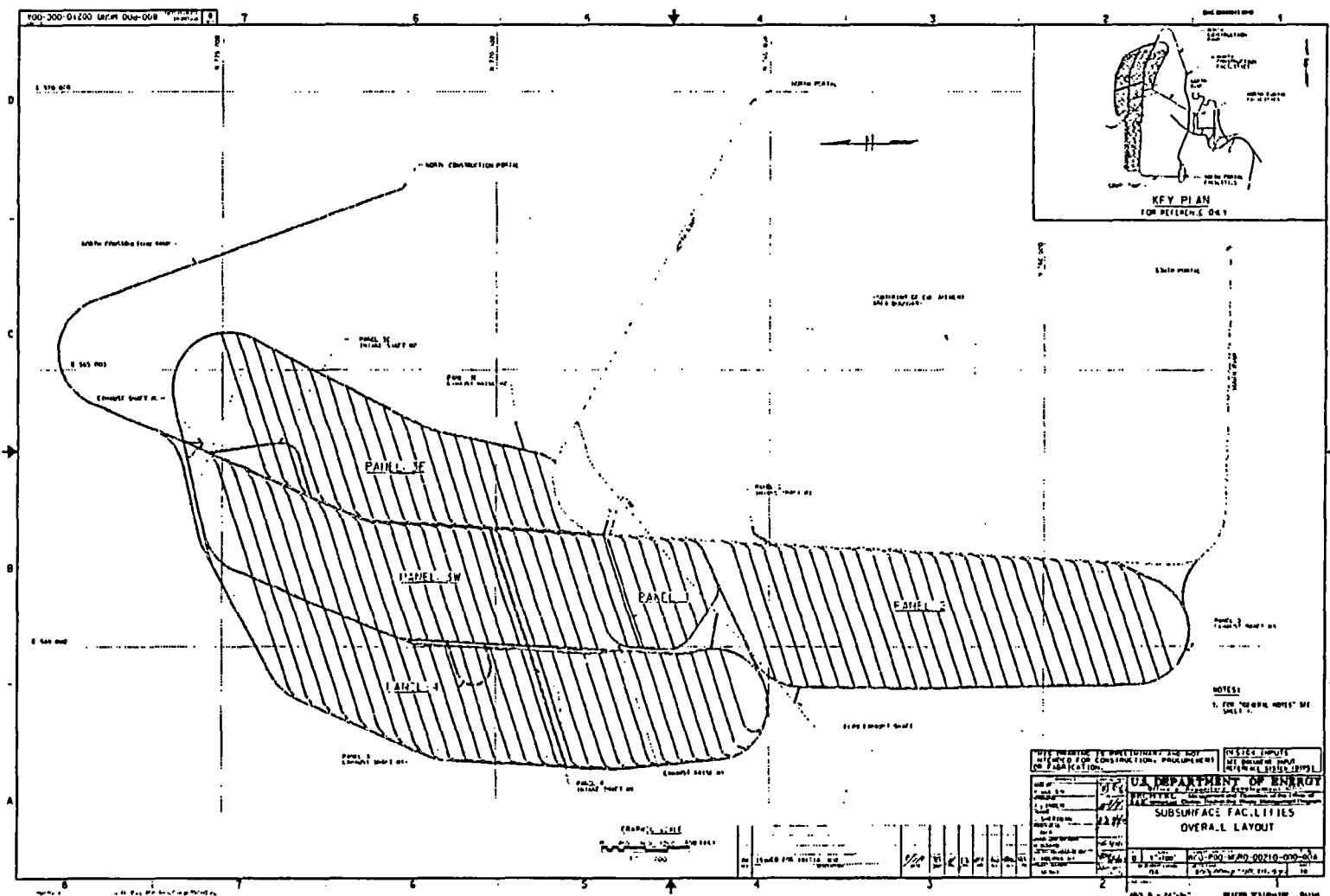
- Access and emplacement drift layout
- Ventilation
- Ground support
- Invert
- Subsurface waste transportation and emplacement

- **High-Level Functions**

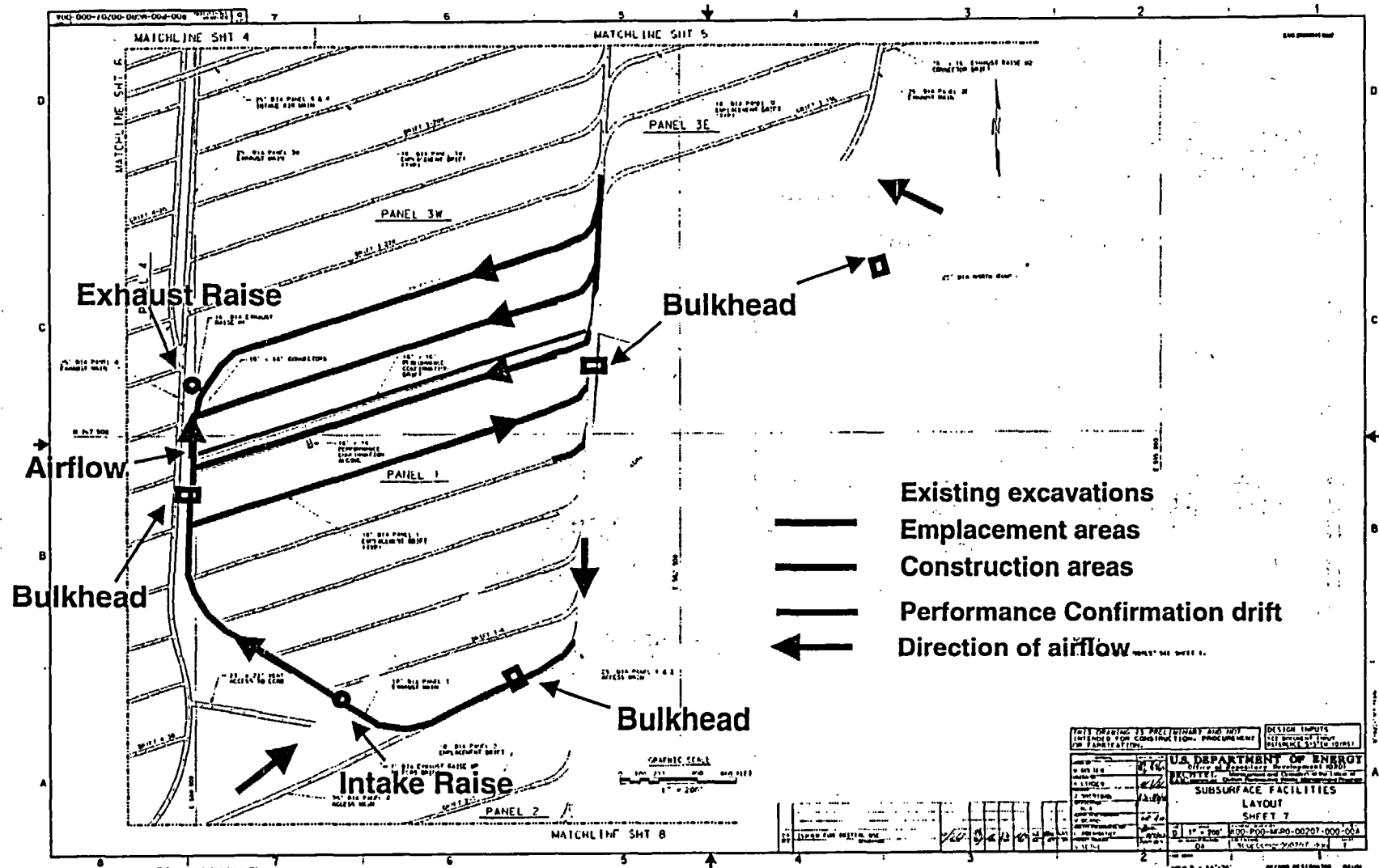
- Provide for disposal of 70,000 metric tons of heavy metal (MTHM)
- Provides safe working environment during construction and emplacement operations
- Accommodates Performance Confirmation activities
- Compatible with Performance Assessment requirements
- Allow for potential retrieval of waste during preclosure period (up to approximately 100 years after beginning of emplacement)



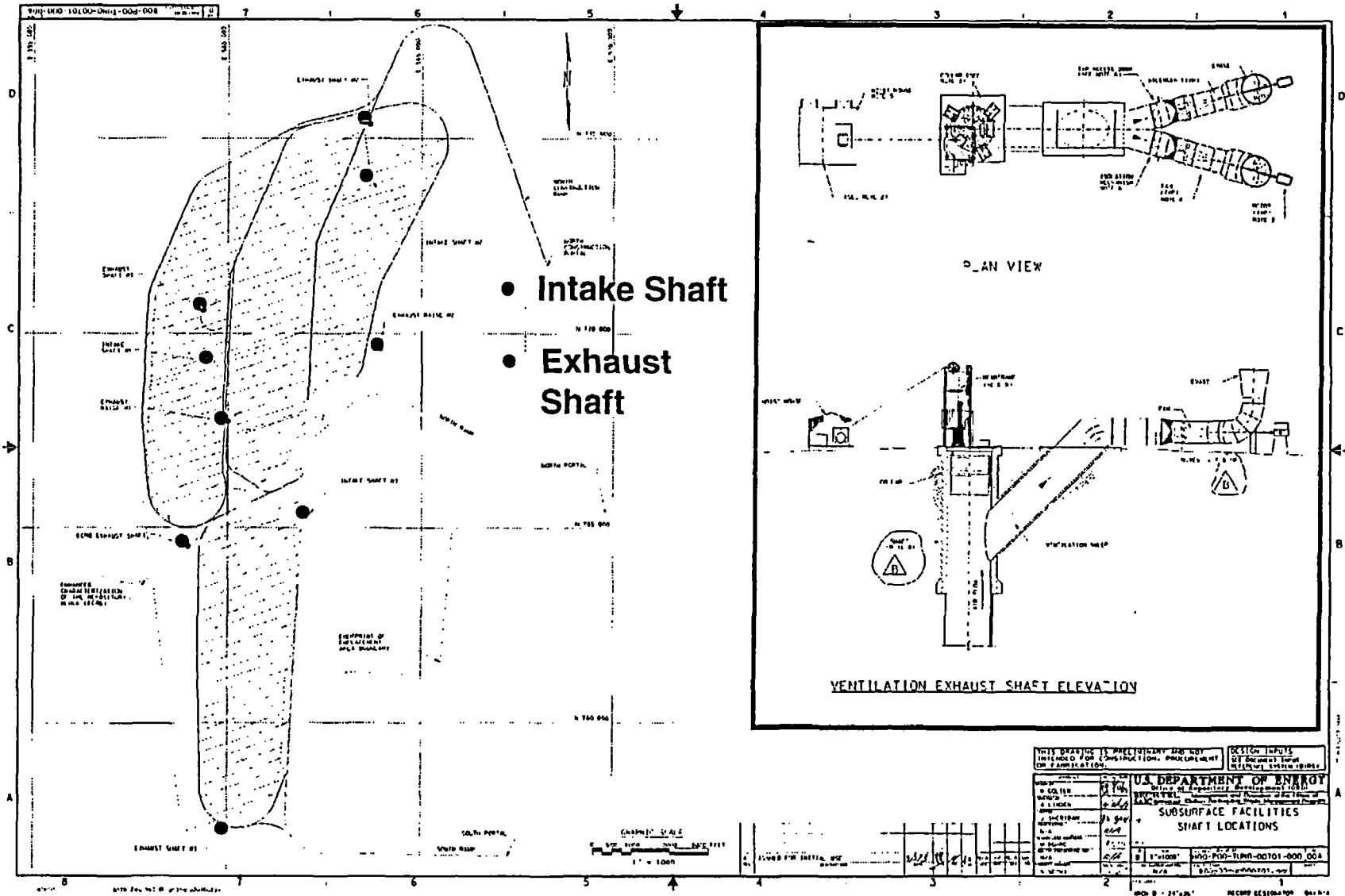
Subsurface Layout



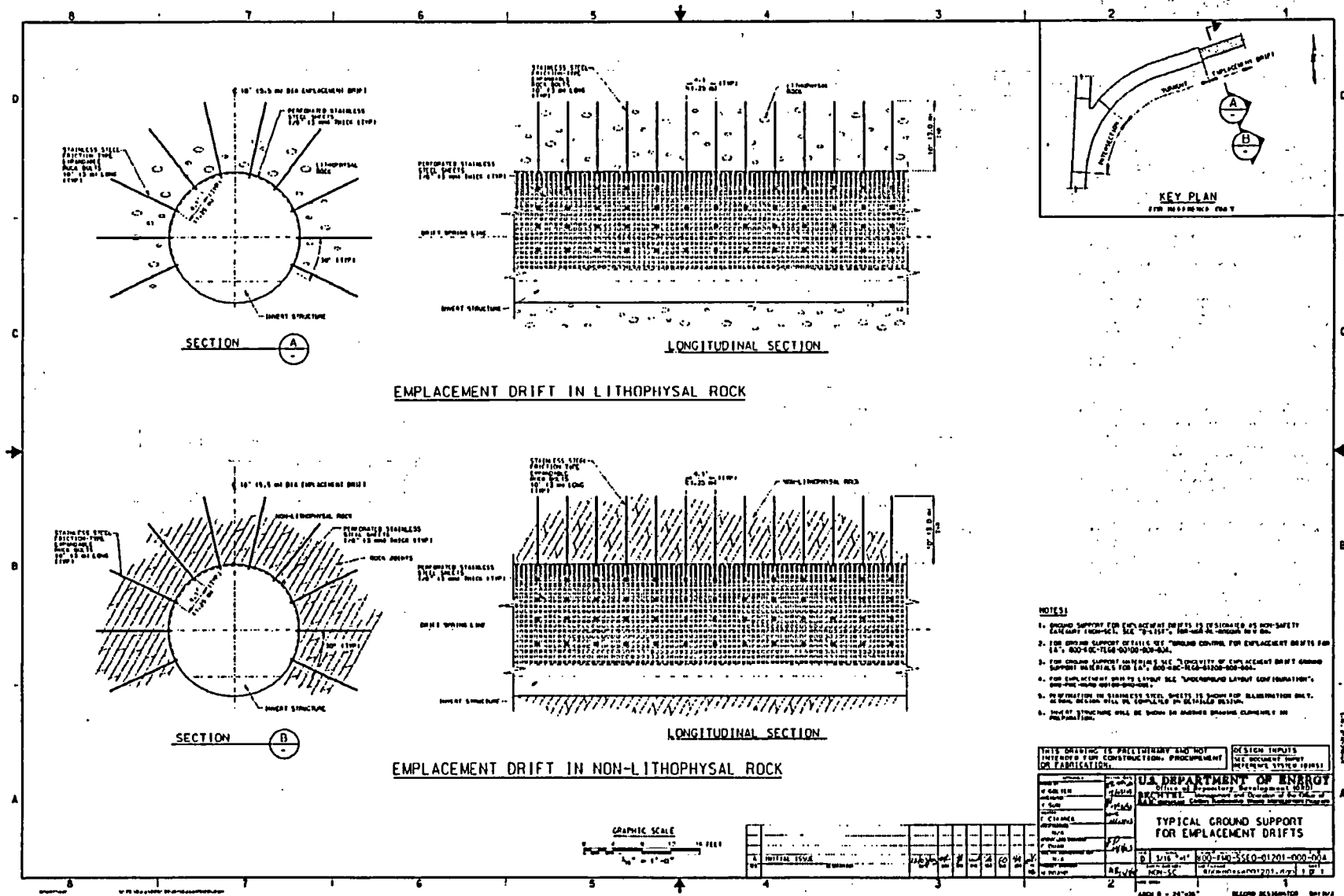
Example Emplacement/Construction Ventilation Method - Panel 1



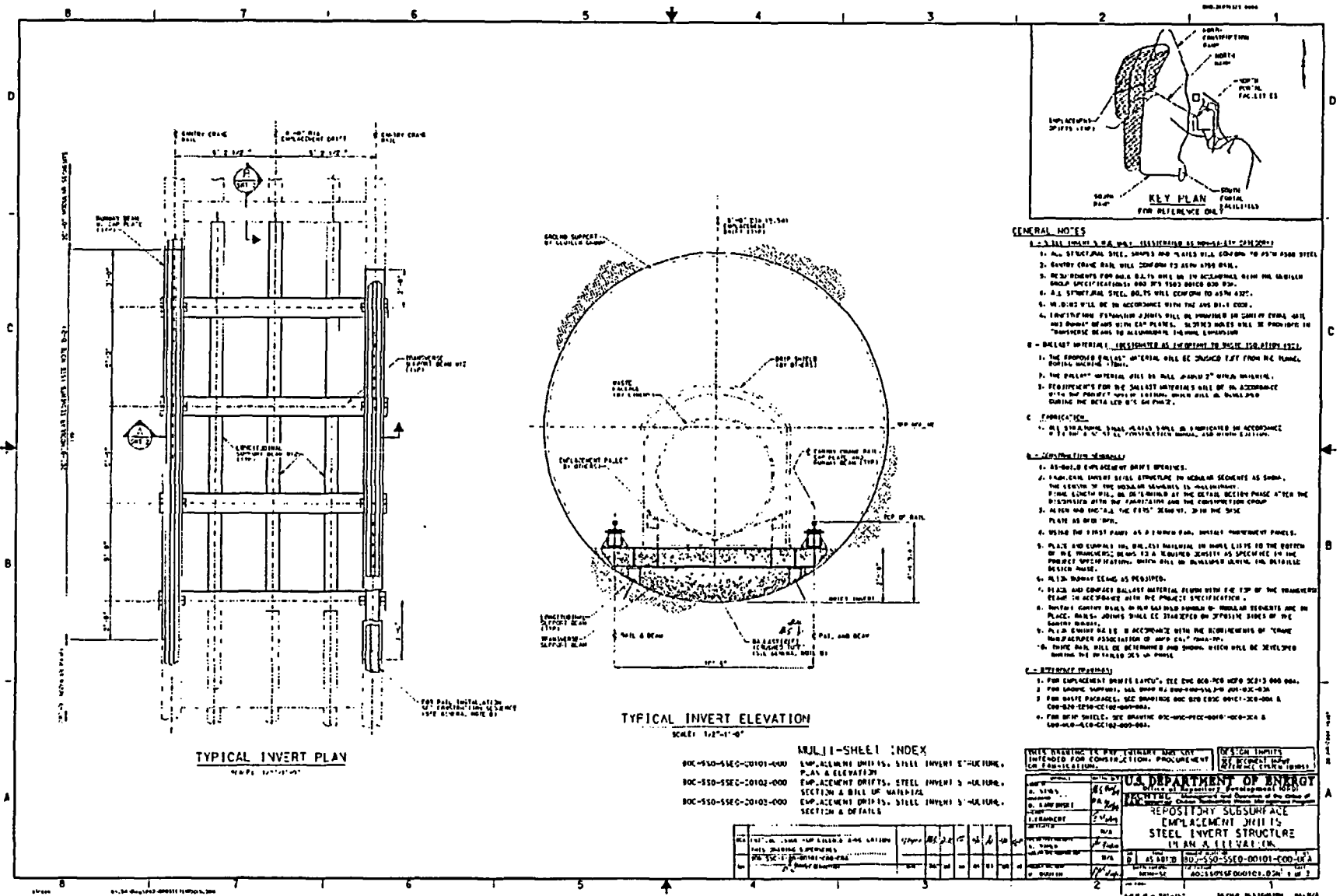
Forced Ventilation



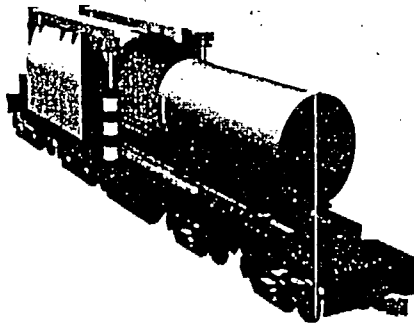
Ground Support for Emplacement Drifts



Emplacement Drift Invert

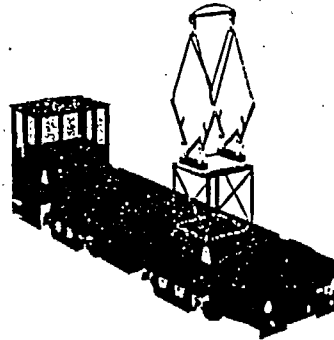


Emplacement and Retrieval Equipment



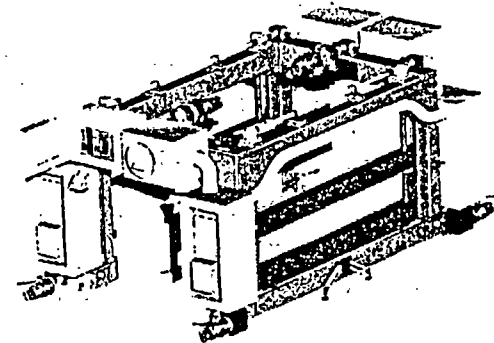
**Waste Package
Transporter**

- Will transport individual Waste Package Pallet Assemblies from the Surface Facilities to the Emplacement Drift
- Classified as "Important to Safety"



**Transport
Locomotive**

- Will provide propulsion for the Waste Package Transporter, as well as other support equipment
- Not Classified as "Important to Safety"



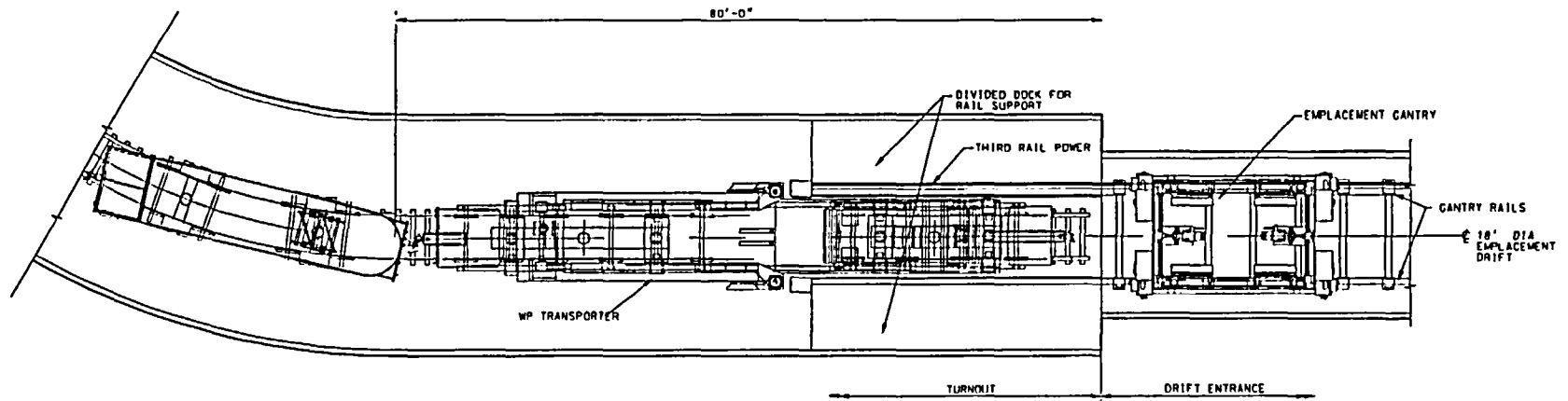
**Emplacement
Gantry**

- Will move and emplace Waste Package Pallet Assemblies within Emplacement Drift
- Classified as "Important to Safety"

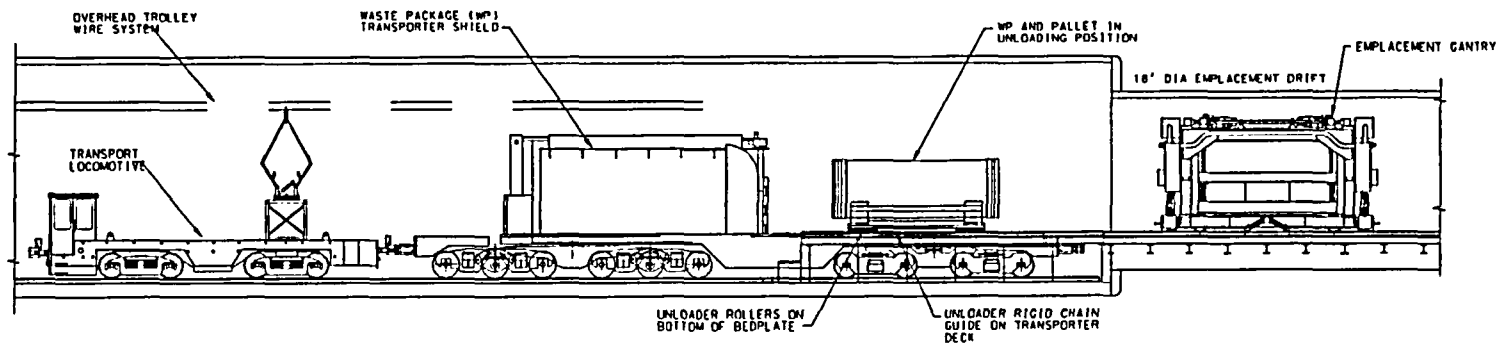
- System Design Description (SDD) provides functional and design requirements
- Outline and general arrangement drawings sufficient to assess function and safety of system
- Mechanical Flow Diagrams (MFDs) demonstrate the emplacement and retrieval processes



Operations at the Emplacement Drift Turnout



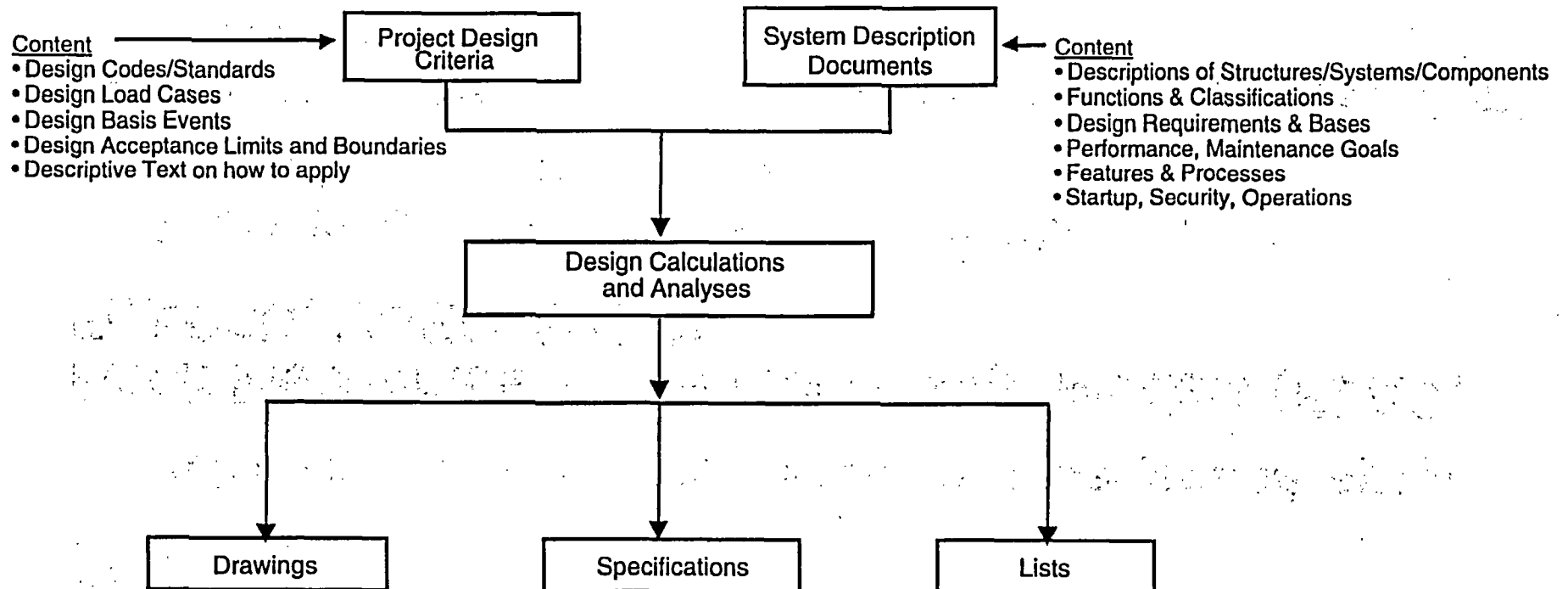
PLAN OF TURNOUT & DRIFT
SCALE: 1/8"=1'-0"



ELEVATION OF TURNOUT & DRIFT
SCALE: 1/8"=1'-0"



Engineering Document Hierarchy



Design Tools

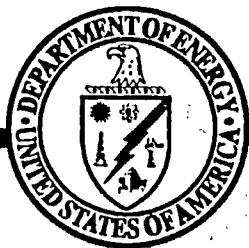
- **3 Dimensional Computer Aided Design Models (Vulcan)**
 - Vulcan model is used to design the underground layout
- **Rock Mechanics Numerical Design Models (FLAC, FLAC3D, UDEC, 3DEC)**
 - 2 dimensional and 3 dimensional continuum and discontinuum stress analysis tools
 - Structural stability, support design and pre-closure seismic rockfall analysis



Summary

- **Design products provide sufficient level of detail for LA**
- **Structures, systems, or components (SSCs) which are Important to Safety have been identified**
- **Preclosure Safety Analysis (PCSA) to be based upon completed LA design**





U.S. Department of Energy
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Waste Package and Drip Shield Design

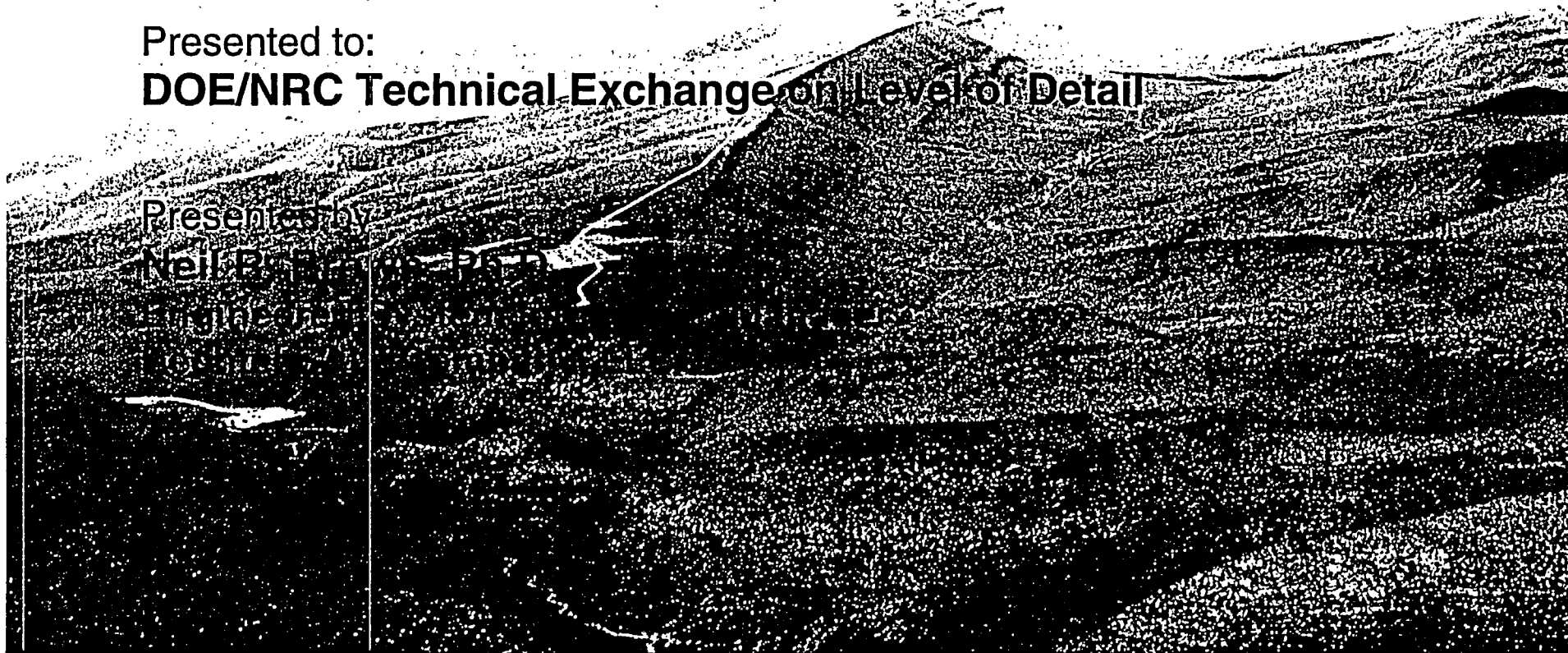
Presented to:
DOE/NRC Technical Exchange on Level of Detail

Presented by:

Neil B. [unclear] [unclear]

Engineer

[unclear]



Outline

- **Waste Package and Drip Shield Functional and Operational Requirements**
- **Waste Package and Drip Shield Design Process**
- **Waste Package Level of Design for License Application (LA)**
 - **Waste Package Configurations**
 - **Drawing Types and Details**
 - **Preclosure Safety Analysis Calculations**
 - **Inputs for Postclosure Safety Analysis**
- **Drip Shield Level of Design for LA**
- **Design Tools**
- **Summary**



Waste Package Functional and Operational Requirements

- **Preclosure - Important to Safety and must:**
 - Facilitate safe and efficient loading of spent nuclear fuel (SNF) and high-level waste
 - Be transportable within surface facilities and to emplacement drifts
 - Be safely and efficiently sealed remotely
 - Be retrievable
 - Meet preclosure safety requirements
 - ♦ Ensure breach is beyond Category 2 for design bases event sequences
 - ♦ Preclude criticality
- **Postclosure - Important to Waste Isolation and must:**
 - Meet long-term dose performance requirements



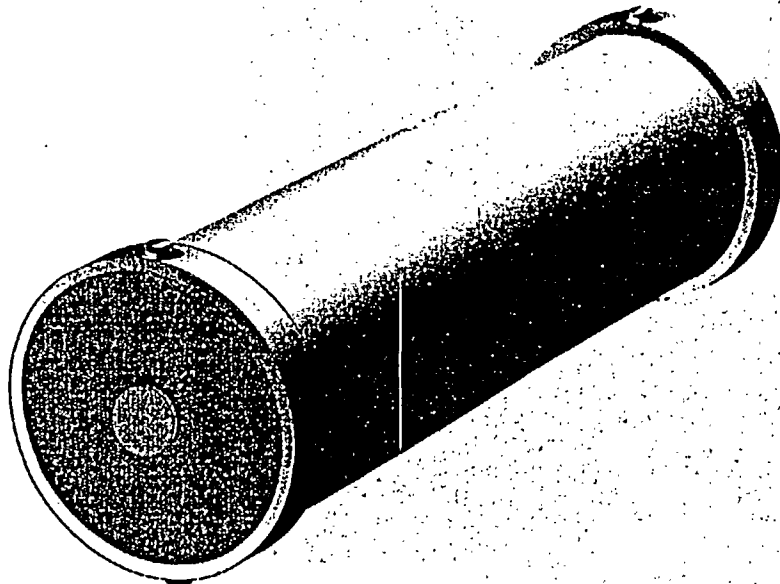
Drip Shield

Functional and Operational Requirements

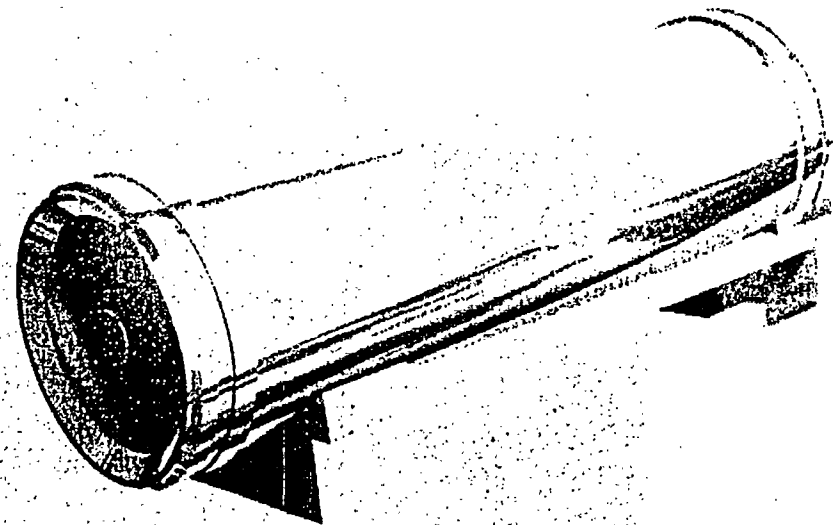
- **Preclosure - Not Important to Safety but must:**
 - Facilitate installation
 - Not preclude waste package retrieval
- **Postclosure - Important to Waste Isolation and must:**
 - Divert potential seepage away from the waste package
 - Provide additional protection for the waste package from rock fall



Waste Package Illustrations

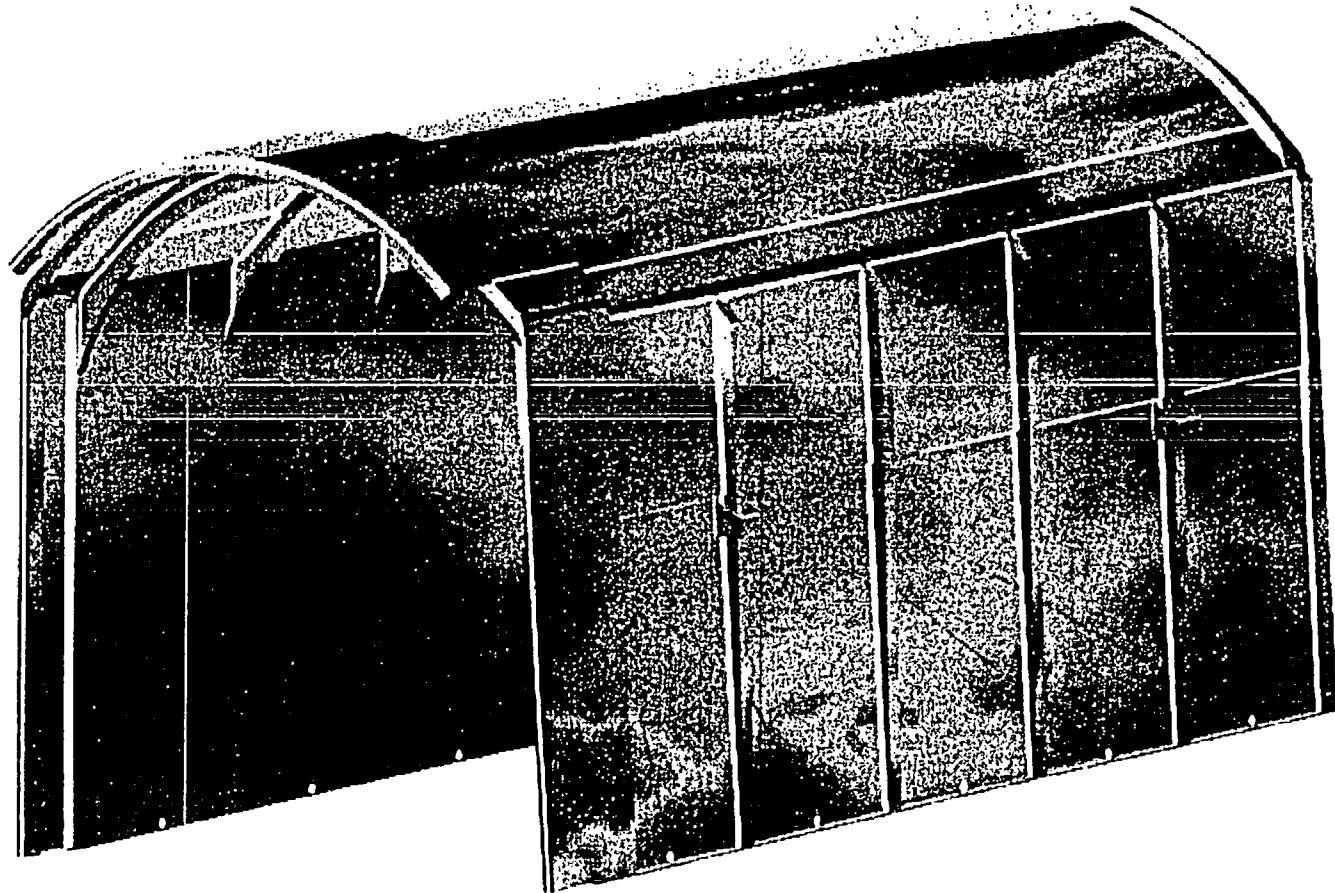


Waste package, with trunnion collars installed for surface facility handling

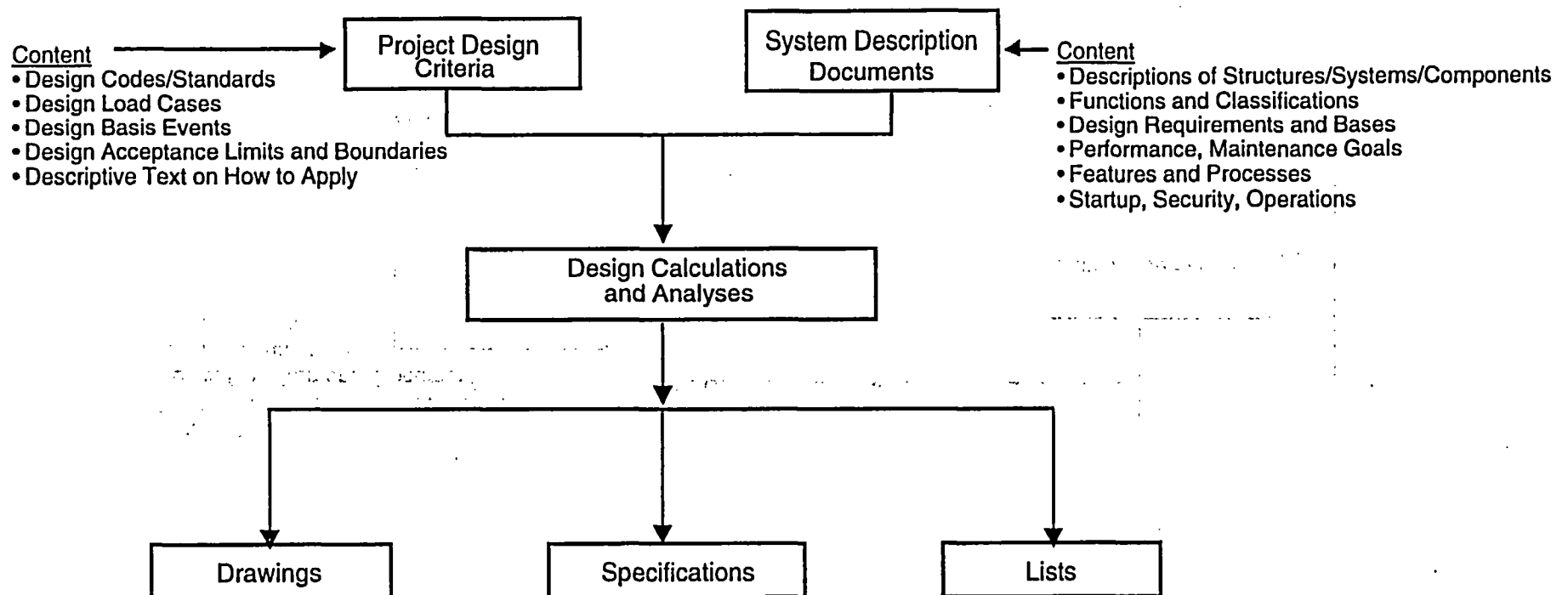


Waste package trunnion collars removed, on emplacement pallet ready for emplacement

Drip Shield Illustration



Engineering Document Hierarchy



YUCCA MOUNTAIN PROJECT



Waste Package Level of Design for License Application

- **1 waste package design for LA**
 - **Long-term performance components are the same for waste packages including:**
 - ♦ **Materials**
 - ♦ **Shell thickness**
 - ♦ **Lid design, closure, and stress mitigation**
 - **Design methodology is the same for all waste packages**
 - ♦ **Codes and Standards**
 - ♦ **Material Properties**
 - ♦ **Failure Criteria**
 - ♦ **Criticality Methodology**
 - **Design Bases are the same for all waste packages**



Waste Package Level of Design for License Application

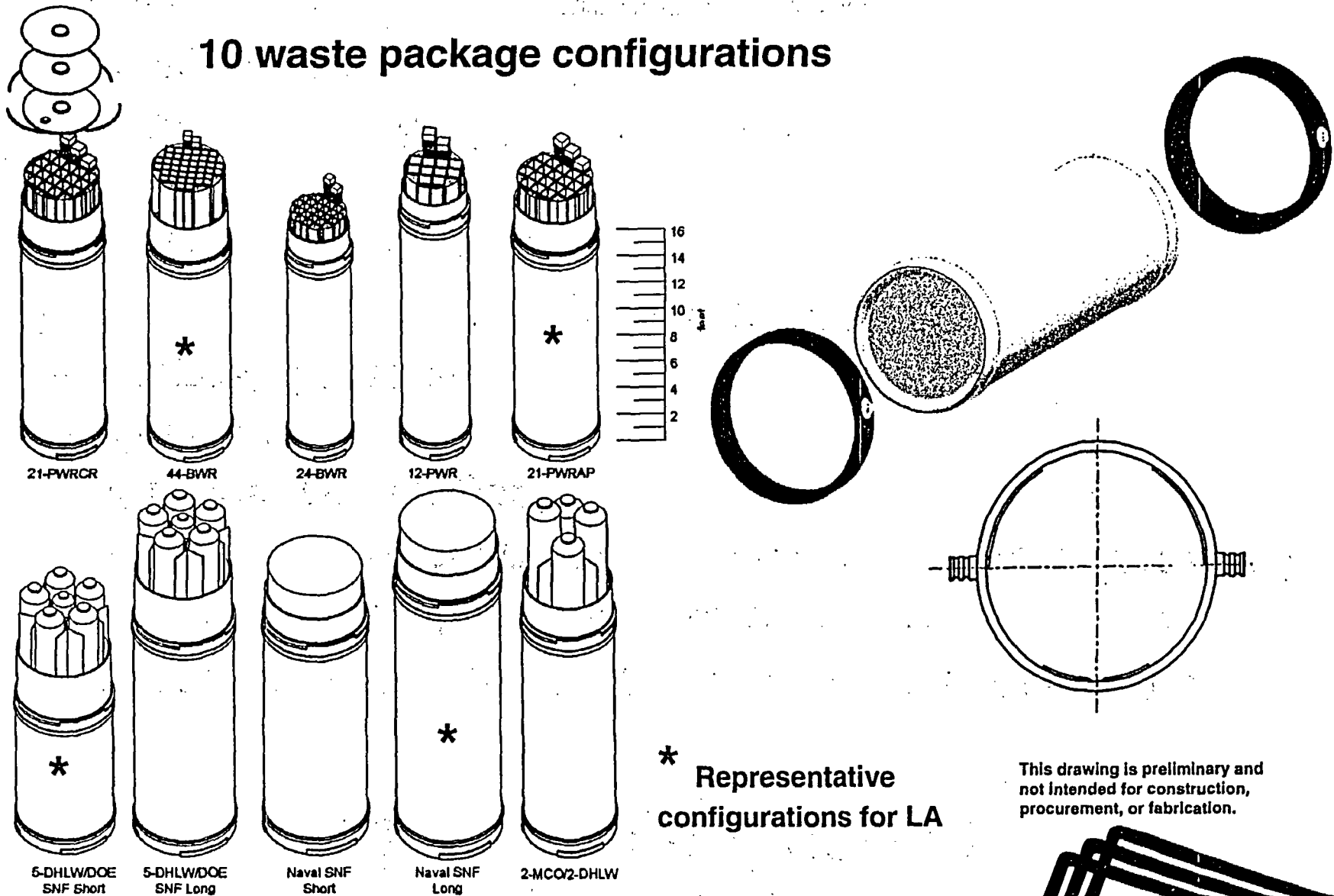
(Continued)

- **10 waste package configurations**
 - **Aligned with the various waste forms**
 - **One design with varying diameters, lengths, weights, and internal basket configurations**
 - **Configuration drawings will be submitted with the LA for the 10 waste package configurations that include:**
 - ♦ **Components, materials, and nominal dimensions**
 - ♦ **Lid and closure details**
 - ♦ **Internal configurations without assembly details**
- **4 representative waste package configurations will be further developed for LA**



Waste Package Configurations

10 waste package configurations



Waste Package Level of Design for License Application

(Continued)

- **4 representative configurations correspond to:**
 - ~75 percent of the waste packages to be emplaced
 - ~90 percent of metric tons of heavy metal to be received
 - Shortest and longest
 - Heaviest
 - Largest diameter
- **Representative configurations are:**
 - 21 PWR Absorber Plate
 - 44 BWR
 - 5 DHLW/DOE SNF Co-Disposal Short
 - Navy Canistered SNF Long

PWR - pressurized-water reactor

DHLW - defense high-level (radioactive) waste

SNF - spent nuclear fuel

BWR - boiling-water reactor

DOE - U.S. Department of Energy



Waste Package Level of Design for License Application

(Continued)

- **For the four representative configurations at LA:**
 - **Analysis will be completed that demonstrates application of the design methodology**
 - **Analysis will demonstrate that the configurations meet the established design bases**
 - **Assembly drawings (showing individual components) for the four representative configurations will be completed**



Waste Package Level of Design for License Application

(Continued)

Available Design and Analysis at time of:	License Application	Prior to Use
4 Representative Configurations		
Postclosure Design Features	✓	✓
Drawings		
• Envelope Drawings	✓	✓
• Configuration Drawings	✓	✓
• Assembly Drawings	✓	✓
Preclosure Design Bases		
• Preliminary Hazards Analysis	✓	
• Final Hazards Analysis		✓
• Preclosure Criticality	✓	✓
Fabrication Specifications and Drawings		
• 21 PWR Prototype	✓	
• Final		✓
Operational Specifications		✓
6 Remaining Configurations		
Postclosure Design Features	✓	✓
Drawings		
• Envelope Drawings	✓	✓
• Configuration Drawings	✓	✓
• Assembly Drawings		✓
Preclosure Design Bases		
• Final Hazards Analysis		✓
• Preclosure Criticality		✓
Fabrication Specifications and Drawings		✓
Operational Specifications		✓



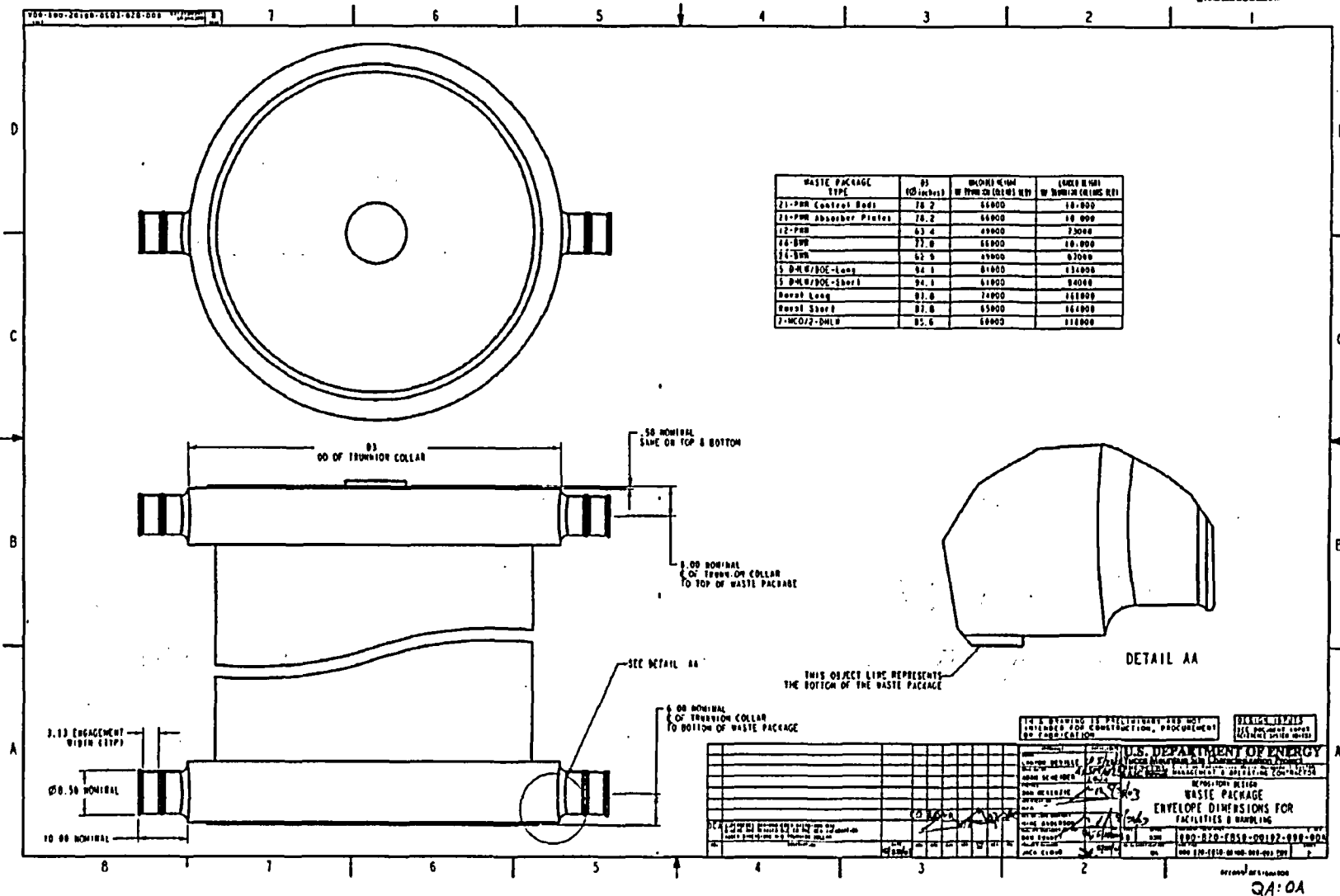
Waste Package Drawings

- **Submitted with LA**
 - Configuration Drawing for all 10 configurations
- **Additional design information available at LA**
 - Envelope Drawing - Design purposes, all 10 configurations
 - ♦ Lengths, masses, diameters with design margins
 - Assembly Drawing - Details to support analysis, four representative configurations
 - ♦ Individual parts
 - ♦ Assembly details, nominal dimensions
 - Fabrication Drawing - Procurement, 21 PWR Prototype
 - ♦ Individual parts with tolerances

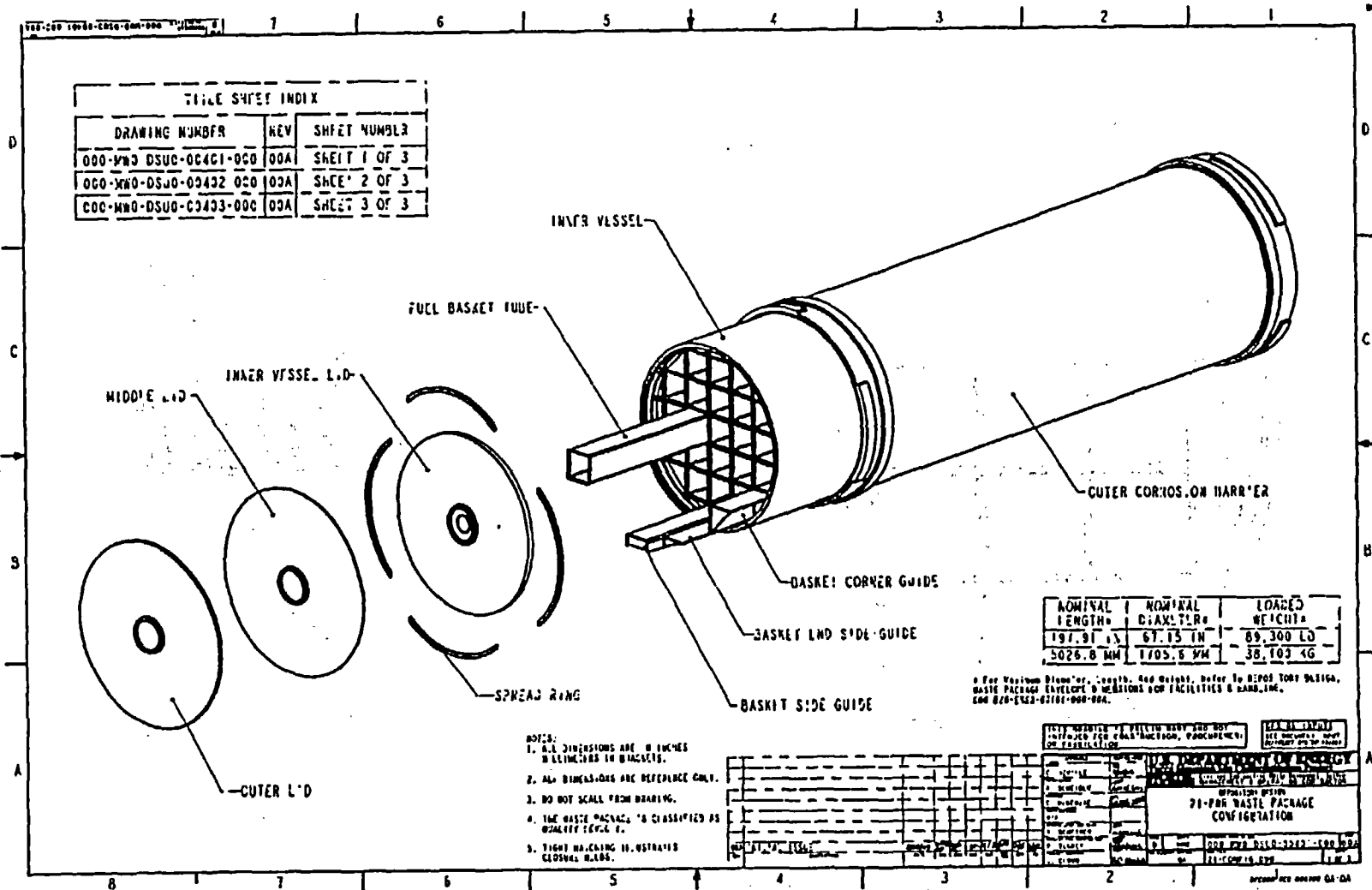


Waste Package Envelope Drawing

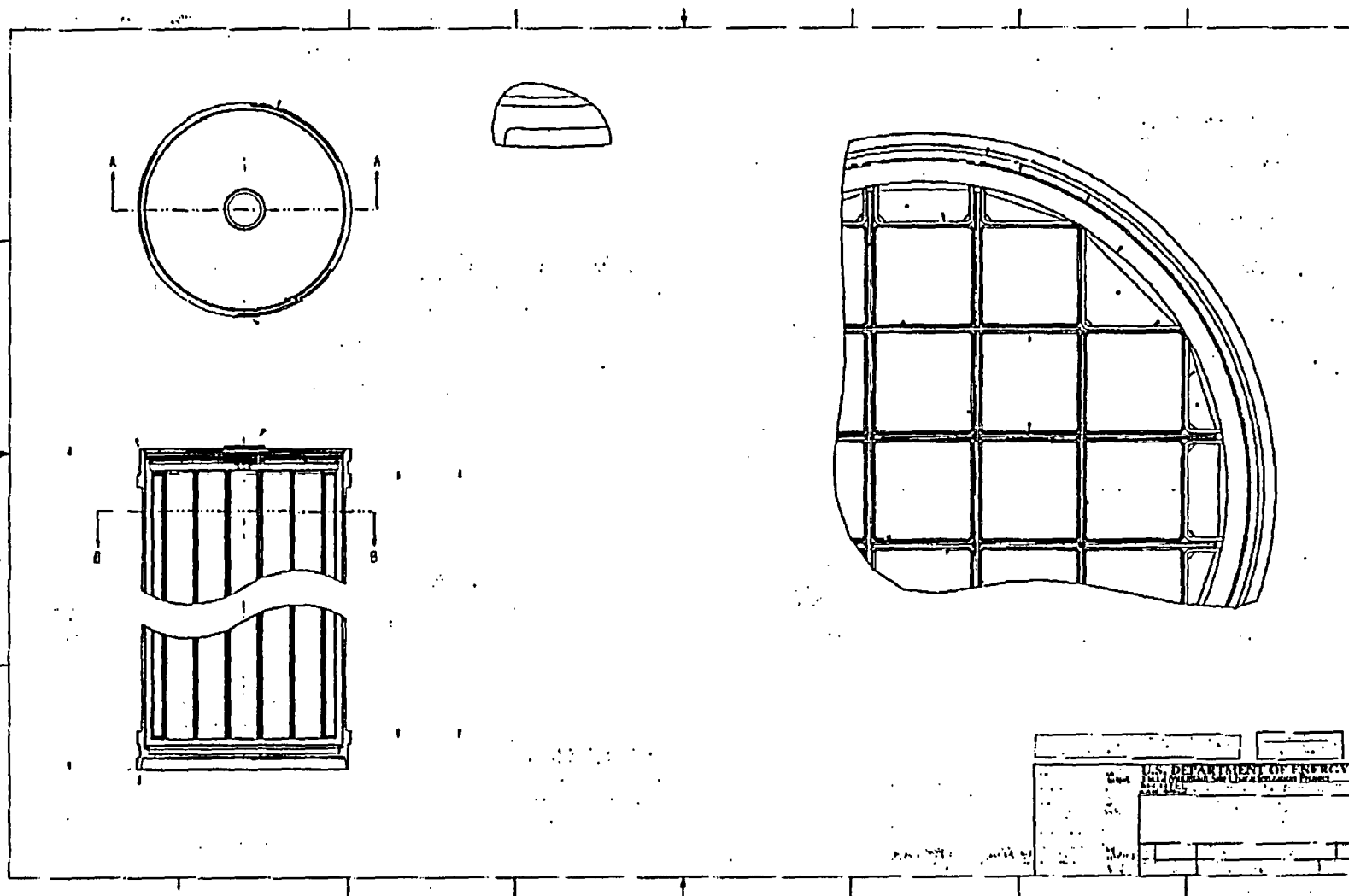
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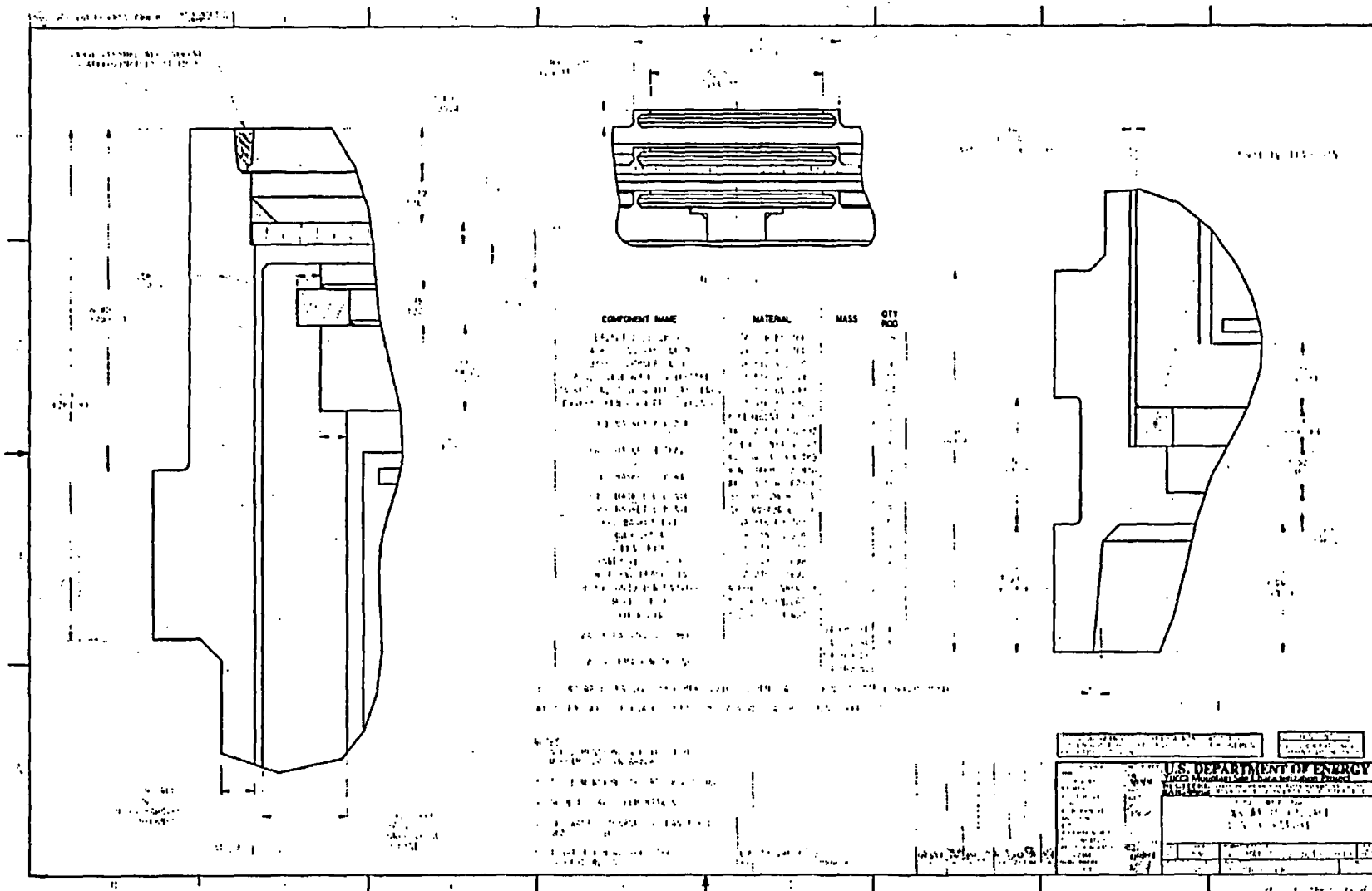
Waste Package Configuration Drawing



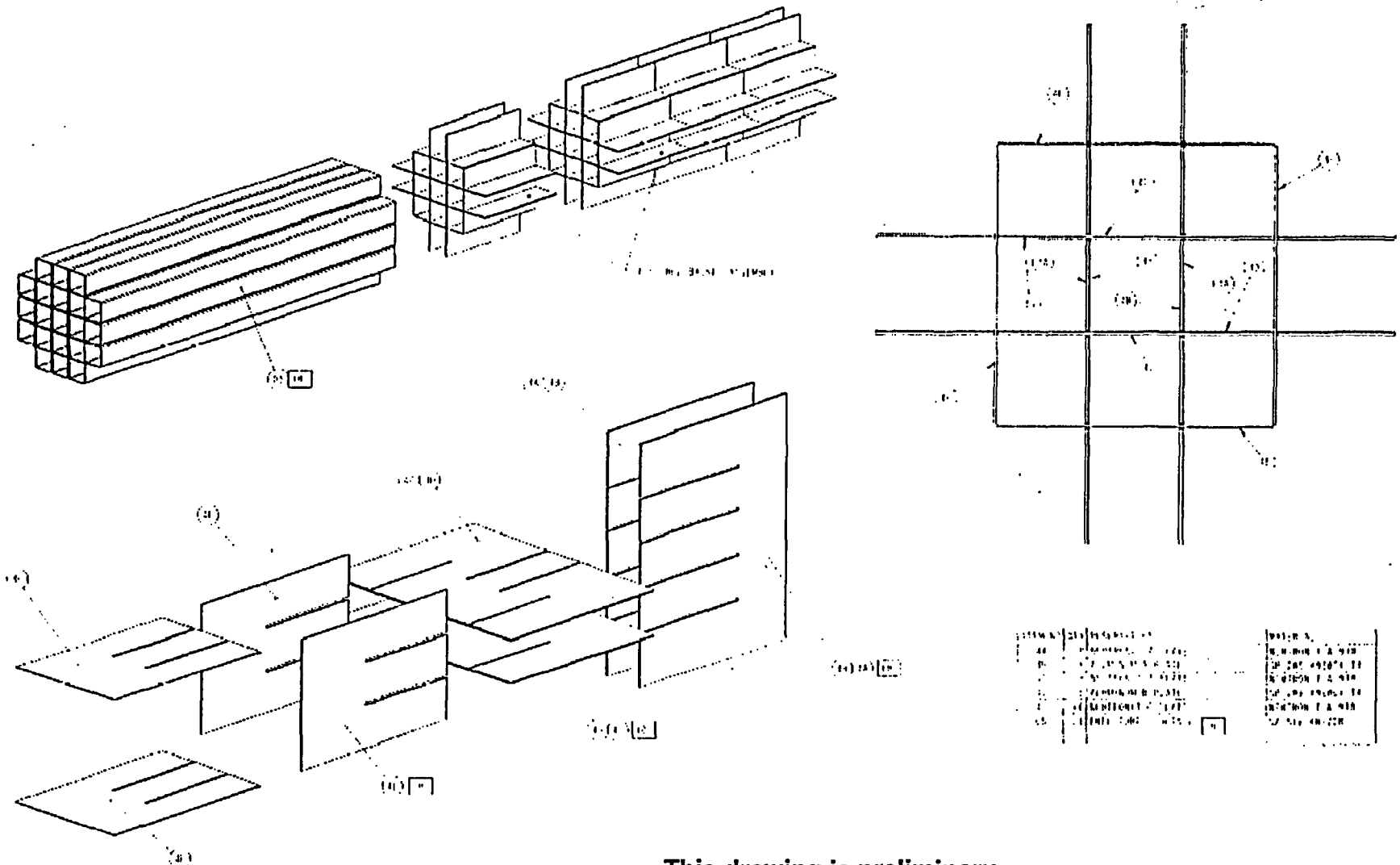
Waste Package Configuration Drawing



Waste Package Configuration Drawing



Waste Package Assembly Drawing

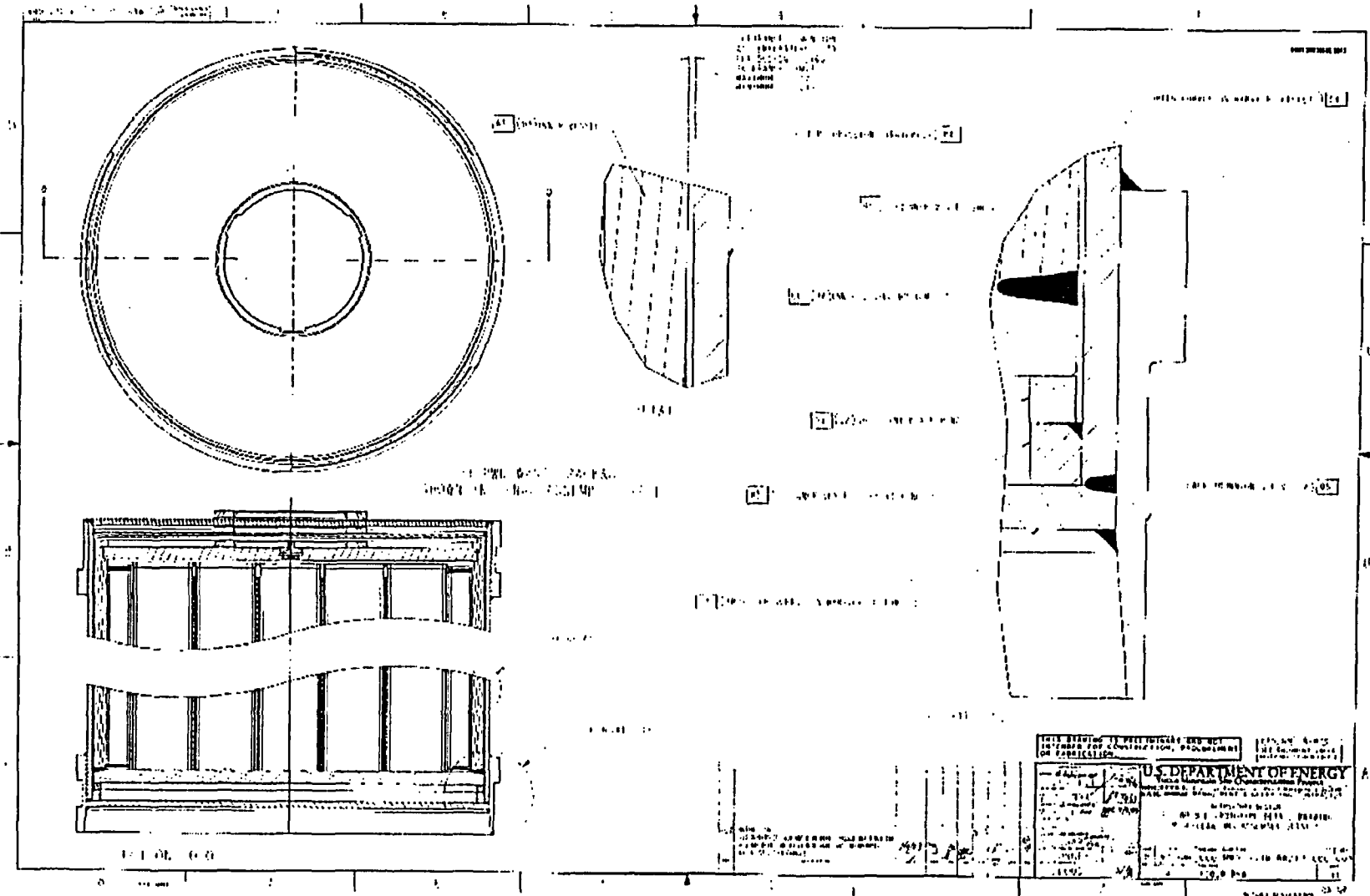


This drawing is preliminary
and not intended for
construction, procurement or
fabrication

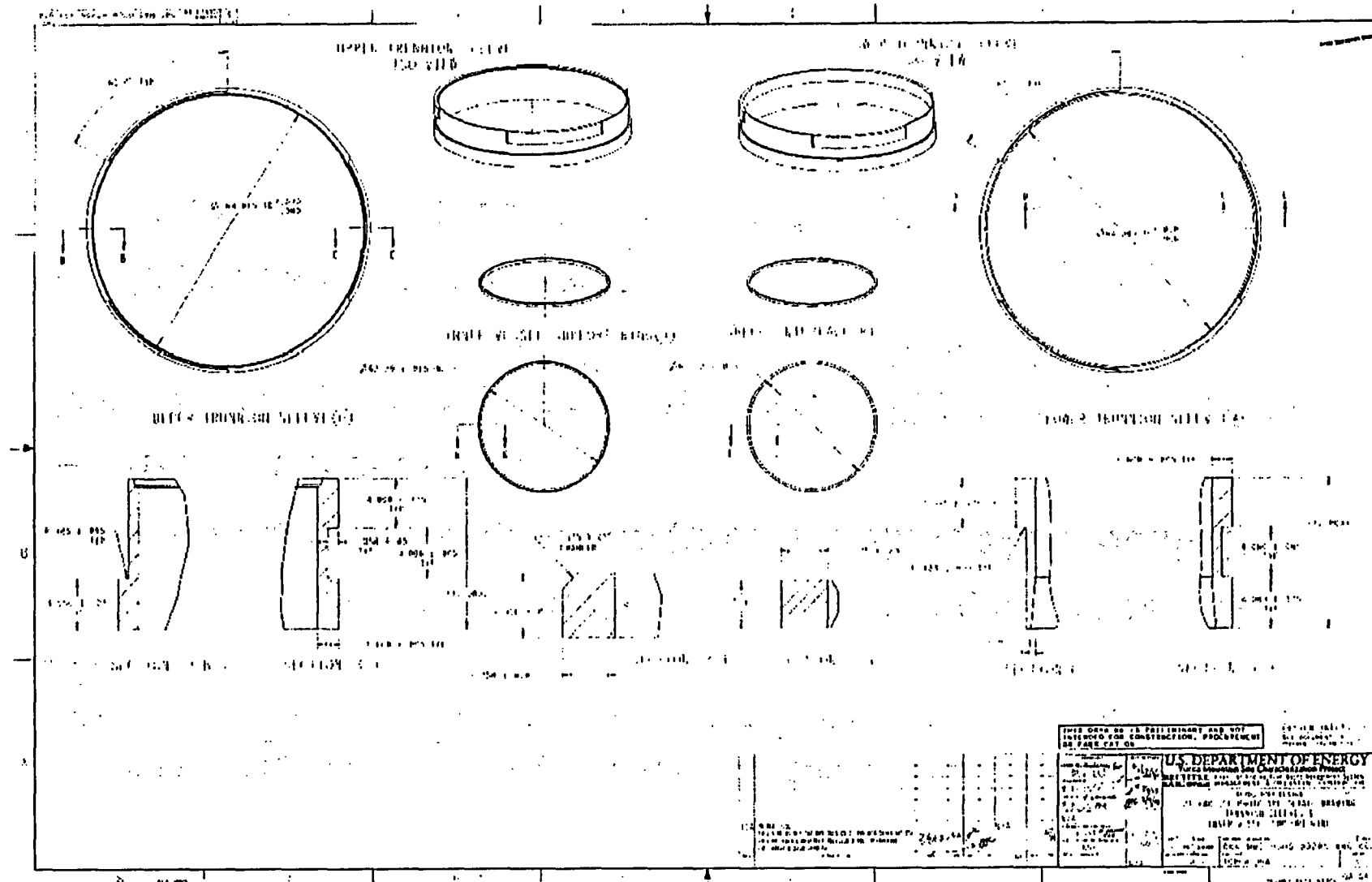


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Waste Package Fabrication Drawing



Waste Package Fabrication Drawing

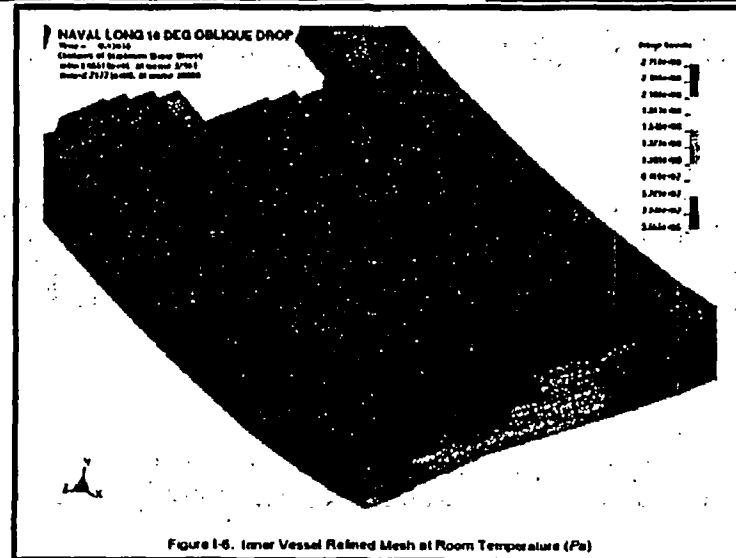
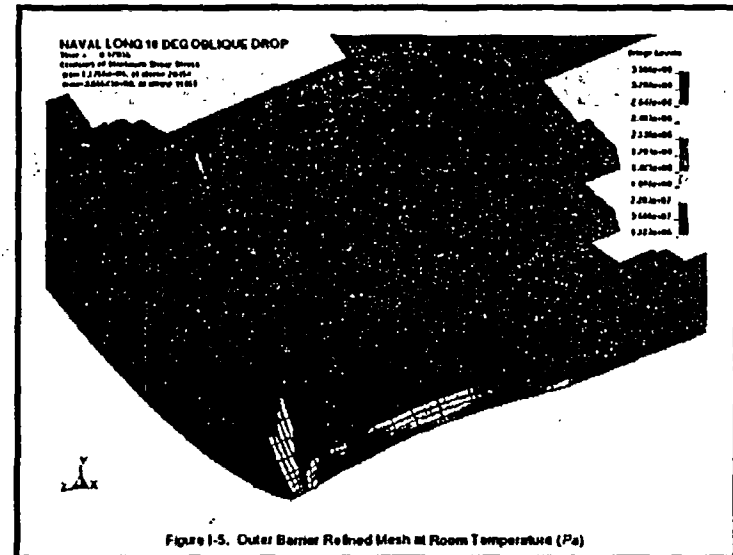
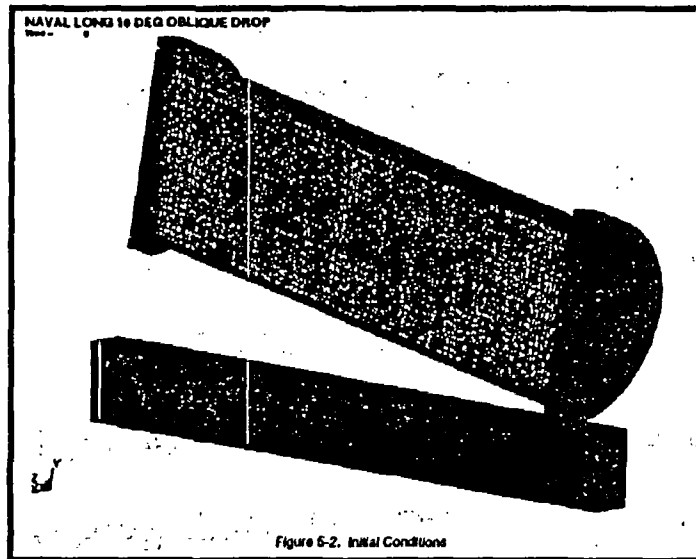


Waste Package Design Details for Preclosure Safety Analysis

- **For preclosure safety purposes, the waste package is designed such that breach is beyond Category 2 for design bases event sequences**
 - Normal handling (vertical lift by trunnions, lift by pallet)
 - Dynamic event sequences (drops, swingdown, rockfall)
 - Thermal events (fire)
- **For LA Analysis, separate analyses will be completed for the four Representative Configurations demonstrating:**
 - The design methodology
 - Configurations meet preclosure design bases



Finite Element Representation of Waste Package Drop Calculation



Waste Package Design Details for Postclosure Analysis

- **Level of Design Detail provides necessary information for Total System Performance Assessment at LA**
 - **Materials including waste package internals**
 - **Shell thickness**
 - **Lid and closure design details**
 - **Fabrication details**
 - ♦ **Weld processes, heat treatment**
 - ♦ **Surface and weld stress states**
 - ♦ **Weld flaw distribution after Nondestructive Evaluation and Repair**
 - ♦ **Seismic response**

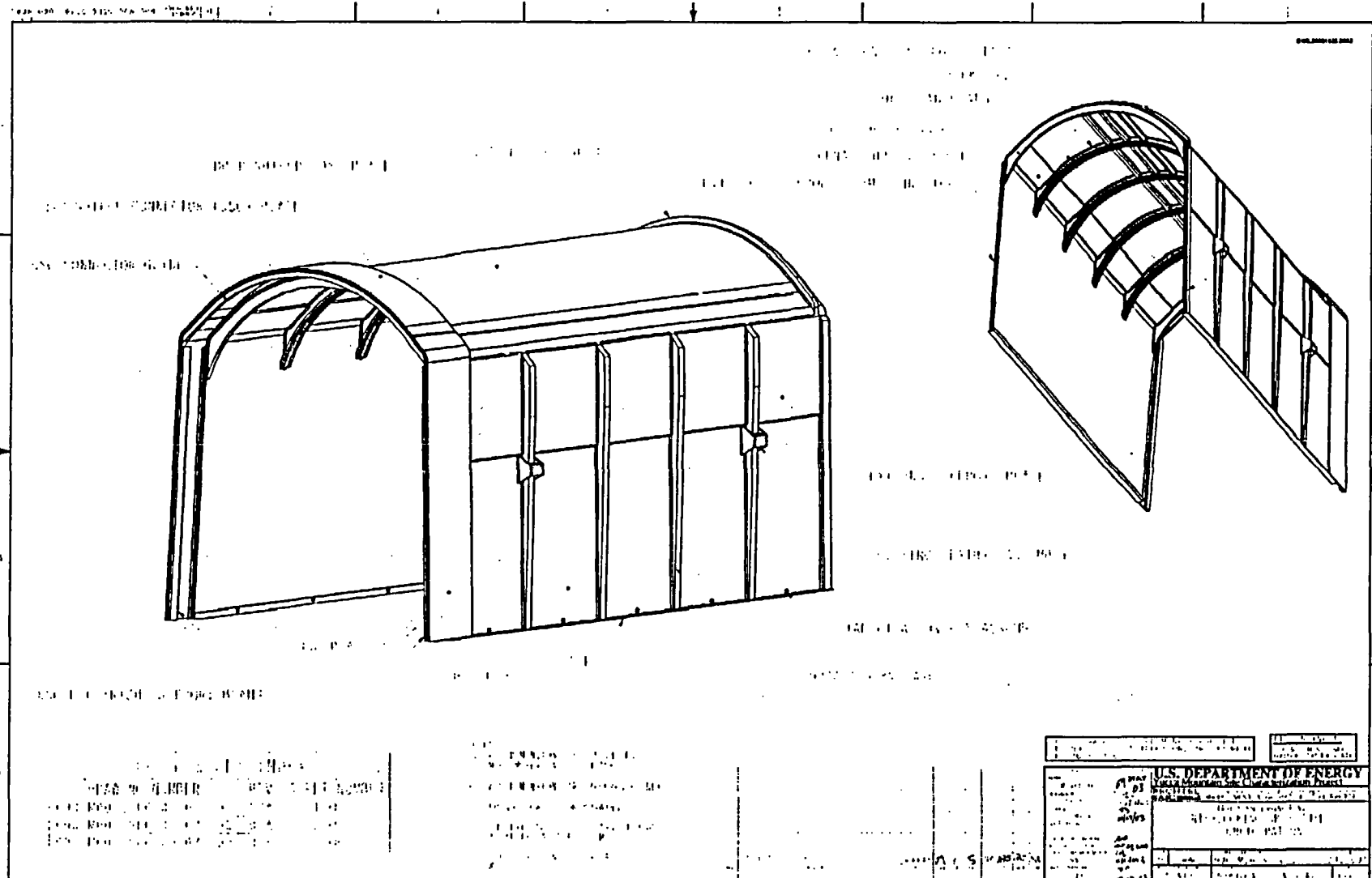


Drip Shield Level of Design for License Application

- **Drip Shield Drawings**
 - Configuration Drawing - will be included in the LA
 - Envelope Drawing - design interface purposes
 - Assembly Drawing - available to support LA
- **Drip Shield Design is sufficiently detailed to support necessary calculations and Total System Performance Assessment**
- **Calculations**
 - Rock fall
 - Multiple rock fall
 - Static load
 - Seismic response

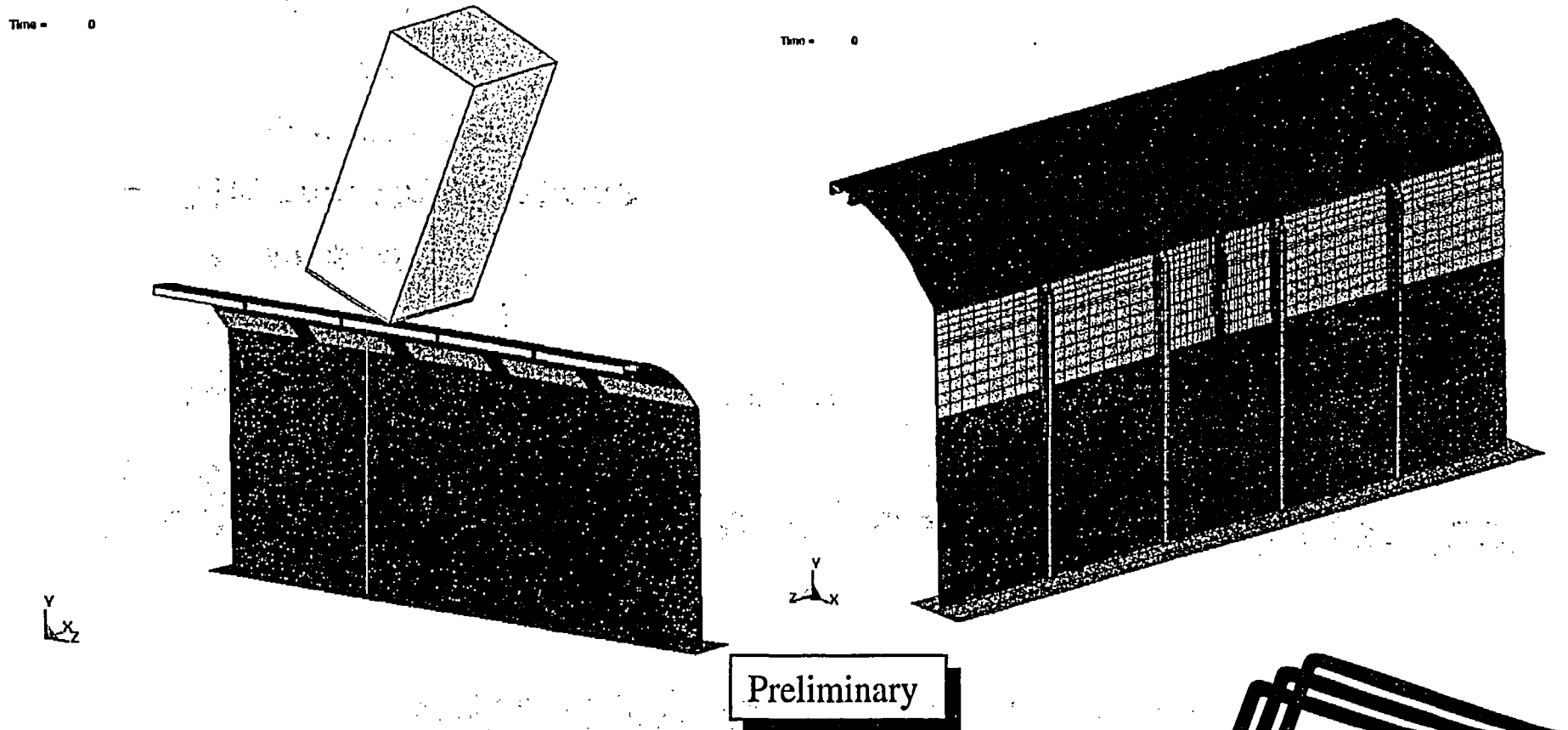


Drip Shield Configuration Drawing



Rock Fall Impact Calculation

Finite Element Analysis geometry (half-symmetry) for rock fall impact on drip shield (14.5 metric ton rock shown).



Primary Design Tools

- **Design Methodology Report documents the design tools, purpose and application**
 - **Dynamic Structural Calculations**
 - ♦ **LS- DYNA**
 - ♦ **ANSYS**
 - **Thermal Calculations**
 - ♦ **DRIFTFLOW**
 - ♦ **ACUSOLVE**
 - ♦ **FLUENT**
 - **Criticality and Shielding**
 - ♦ **SCALE**
 - ♦ **MCNP**

Summary

- **Presented the Waste Package and Drip Shield Functional and Operational Requirements**
 - Preclosure
 - Postclosure
- **Design Products will be available in sufficient detail for LA**
 - Drawings
 - Preclosure Event Sequence Response Calculations
 - Inputs to Total System Performance Assessment
- **Primary Design Tools**





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



DOE Assessment of NRC Evaluation of the Heating, Ventilation, and Air Conditioning Sample Safety Analysis Report Section

Presented to:

DOE/NRC Technical Exchange on Level of Detail

Presented by:

Stephen J. Ferguson

Manager, LTR-5003

West Valley

Introduction

- **DOE transmitted sample design of engineered system to NRC on September 19, 2003 to facilitate discussion**
 - **Example system was Heating, Ventilation, and Air Conditioning (HVAC) sample Safety Analysis Report section**
- **NRC provided comments on the example on December 11, 2003**
- **DOE's assessment of NRC's feedback is provided here**

DOE Assessment of NRC Evaluation of the Heating, Ventilation, and Air-conditioning as a System Not Important to Safety

- **Outdoor temperature and relative humidity fluctuations will be discussed**
- **Codes and Standards will be identified generically or for appropriate structure, system, or component (SSC) if application is limited**
- **Principal codes and standards will be identified**
- **Commitment to a code, standard or regulatory guide means conformance with the entirety, unless specific exceptions are identified**
- **It is not necessary to describe the approach for every section or paragraph of a code, standard or regulatory guide**



DOE Assessment of NRC Evaluation of the Heating, Ventilation, and Air-conditioning as a System Not Important to Safety

(Continued)

- **Safety Analysis Report (SAR) Section 1.9, Tables 1.9-1 and 1.9-2 list SSCs and indicate**
 - Important to safety
 - Important to waste isolation
- **If there is an impact on safety due to failure of an SSC that is not important to safety, it will be identified in the SAR**
- **If there is not an impact to safety, it will not be explicitly demonstrated in the SAR**
- **Features that protect important to safety SSCs will be included in the appropriate section of the SAR**
 - Physical separation
 - Electrical isolation
 - Barriers
 - Robust design



DOE Assessment of NRC Evaluation of the Heating, Ventilation, and Air-conditioning as a System Important to Safety

- **Mechanical and structural design basis and criteria will be included**
 - HVAC mechanical design bases and criteria will be covered in 1.2.4.7.5
 - Mechanical load combinations will be covered in 1.2.4.7.9
- **Concrete structural design basis and criteria will be covered in 1.2.2**
- **Design methodologies will be covered in 1.2.4.7.6**
- **Principal codes and standards will be covered in 1.2.4.7.8**
- **Thermal design basis will be covered in 1.2.4.7.5**
 - Outdoor temperature and humidity will be provided in 1.2.4.7.1 based on site data discussed in 1.1
 - Fire barriers and ratings details will be included in the Fire Hazards Analysis that is not replicated in SAR but discussed in 1.4.3
 - Design criteria and basis for temperature limits for other SSCs will be discussed with the individual SSC with overall HVAC capability discussed in 1.2.4.7.1



DOE Assessment of NRC Evaluation of the Heating, Ventilation, and Air-conditioning as a System Important to Safety

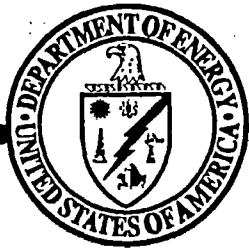
(Continued)

- **Shielding and confinement design basis and criteria as it impacts HVAC design will be covered in 1.2.2 and 1.2.4.7.5**
 - Zone maps for worker dose will be provided in 1.10, public dose in 1.8
 - Control and logic functions will be discussed in 1.2.4.7.2, and figures as appropriate
- **Facility power requirements will reflect ITS designation and will be addressed in 1.2.4.7.1, 1.2.4.7.3, 1.9, and 1.4.1**
- **Probable license specifications will be provided in 5.10**
- **Any applicable management controls will be specified in 1.2.4.7.4**
 - Any special maintenance requirements that have been identified at this stage will be specified in 1.2.4.7.1
 - Overall maintenance program discussed in 5.6
 - Evaluation of out of service conditions provided in 1.2.4.7.2
- **Relationship of design bases to design criteria will be specified in 1.2.4.7.5**



Summary

- **Safety Analysis Report is laid out to systemically provide information required by 10 CFR 63 as outlined in the YMRP**
- **Example section provides a demonstration of adequate level of detail**
- **It is expected that full context of the SAR will have eliminated these questions**
- **Appropriate cross-references in the SAR to facilitate review**



U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Path Forward to DOE's Submittal of the License Application

Presented to:
DOE/NRC Technical Exchange on Level of Detail

Presented by:
April V. Gil
Director, Regulatory Interactions and
U.S. Department of Energy



Overview

- **Key Technical Issue (KTI) Agreements**
- **Interactions**
 - **Management and Quality Assurance meetings**
 - **Issue-specific meetings**
 - **Discussion of Technical Basis Documents**
- **Preparations for Transition to NRC's Region IV Oversight**



Key Technical Issue Agreements

- KTI agreements will be addressed prior to submittal of License Application (LA)
- Schedule provided to NRC on November 28, 2003
- References requested by NRC staff will be provided as they are approved and issued
 - Documents posted to OCRWM web site
 - Compact disks transmitted to NRC
 - Hard copies can be made available in the NRC Onsite Representative's office
- Interactions supporting KTI agreements
 - Technical Basis Documents
 - As needed on other agreement topics



Regulatory Interactions

- **Quarterly Quality Assurance and Management Meetings**
- **Potential Technical Exchange Topics**
 - **Preclosure issues, e.g.**
 - ♦ **Seismic Design**
 - ♦ **Preclosure Safety Assessment**
 - ♦ **Classification of Items Important to Safety**
 - ♦ **Aircraft Hazards**
 - ♦ **Safeguards and Security**
 - ♦ **Repository Design**



Regulatory Interactions

(Continued)

- **Potential Technical Exchange Topics**
 - Interactions for KTI agreements
 - Technical Basis Documents
 - Igneous Consequences
 - Total System Performance Assessment for LA
 - Barriers Important to Waste Isolation
 - Performance Confirmation
 - Features, Events, and Processes



Preparation for NRC Region IV Oversight

- **DOE Compliance Lead function**
- **Regulatory Compliance organization support**
 - **Facilitate information availability for inspections**
 - **Prepare documentation for open item closure**



Summary

- **Resolution of KTI Agreements supported by**
 - Technical Basis Documents
 - Individual submittals
 - Supporting references are being made available
- **DOE will work with NRC to establish the prelicensing interactions schedule**
- **DOE is preparing for oversight by Region IV**





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Office of Civilian Radioactive Waste Management



Continuing DOE Activities

Presented to:
DOE/NRC Technical Exchange on Level of Detail

Presented by:
Stephen J. Cereghino
Licensing Manager
Bechtel SAIC Company LLC



Continuing DOE Activities

- **Complete the detailed design within the bounds of the Safety Analysis Report (SAR)**
- **Initiate procurement of long lead time items**
- **Facilitate licensing reviews and inspections**
 - **Respond to requests for additional information**
 - **Resolve safety evaluation report open and confirmatory items**
- **Submit plans described in SAR**



Continuing DOE Activities

(Continued)

- **Implement processes for**
 - 10 CFR 21, *Reporting of Defects and Noncompliance*
 - 10 CFR 63.73, *Reports of Deficiencies*
 - 10 CFR 63.32, *Conditions of Construction Authorization*
- **Report results of ongoing testing and research and development programs**
- **Update the SAR**
 - Responses to Requests for Additional Information (RAIs)
 - Pertinent, selected design details





U.S. Department of Energy
Office of Civilian Radioactive Waste Management



Proposed Conditions for a Potential Construction Authorization

Presented to:

DOE/NRC Technical Exchange on Level of Detail



Construction Authorization

- The License Application will describe the complete repository including the phasing of construction and operations
- DOE will request a construction authorization for a repository to dispose up to 70,000 metric tons
- Typical conditions during construction
 - Subject to conditions specified in the applicable regulations
 - Construct the facility described in the application
 - Construct on a schedule



License to Receive and Possess

- **License conditions would reflect standard NRC practice for issuance of licenses**
 - **Require applicable regulations to be met**
 - **Incorporate facility license specifications**
 - **Other unique conditions based on NRC staff review**



Summary

- **There will be standard conditions**
- **No unique conditions for Construction Authorization**
- **At Receive and Possess, there may be conditions driven by the safety review**



Risk Informed Review of Repository Safety

DOE NRC Technical Exchange
on Level of Detail
(Las Vegas, Nevada; February 3-4, 2004)

Presented by
Tim McCartin
Division of Waste Management, NRC

Outline

- 1) Risk Informed Approach**
- 2) Understanding Post-Closure
Performance**
- 3) Understanding Pre-Closure Safety**

Principles of Risk Informed Approach

- Quantitative understanding of performance relative to the safety requirements
- Pre-closure safety requirements
 - dose limits (worker and public)
 - numerical guides for design events
- Post-closure performance requirements
 - multiple barriers
 - dose limits
 - ground water protection
- Variety of analyses assist understanding
 - overall performance
 - intermediate results
 - sensitivity and uncertainty analyses

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Principles of Risk Informed Approach (cont.)

- Risk information used to:
 - 1) focus review
 - 2) assist determination of depth of information needed for NRC review
 - 3) assist the development of request for additional information

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Objectives of Risk Informed Approach

- Identification of important parameters, models, and assumptions
- Identification of important uncertainties
- Focus review on technical support in key areas of pre-closure safety analyses and performance assessment
 - risk dilution (e.g., arbitrary expansion of range for chemical retardation as a "conservative" approach)
 - inappropriate "conservatism" (e.g., adoption of conservative subsystem model or parameter that leads to a non-conservative overall result)

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Understanding Post-Closure Performance

- Risk Insight
 - inventory (potential risk)
 - identification of barriers important to waste isolation
 - uncertainties
- Regulatory Requirements (63.115)
 - identify barriers
 - describe capability of barriers
 - provide technical basis

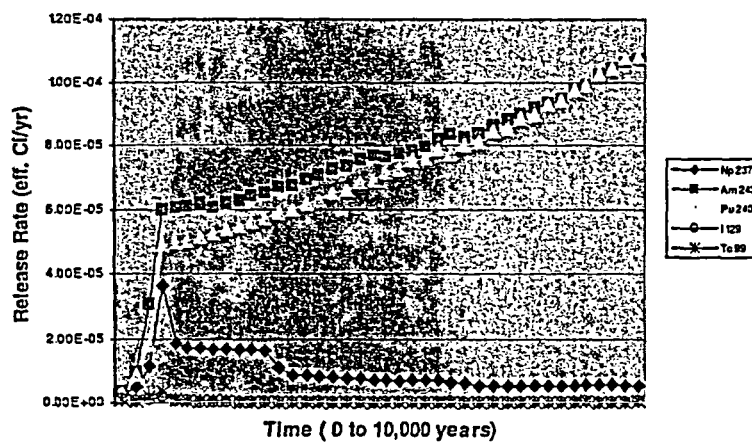
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Radionuclide Inventory

Nuclide	Half-Life (yrs)	Percent of Inventory at 1,000 yrs (by activity)	Percent of Inventory at 1,000 yrs (by activity - weighted by DCF)
Am 241	430	54%	56%
Pu 240	6,500	25%	25%
Pu 239	24,000	18%	18%
Am 243	7,400	1.2%	1.2%
Tc 99	210,000	0.7%	0.0003%
U 234	240,000	0.1%	0.01%
C 14	5,700	0.07%	0.00005%
Np 237	2,100,000	0.06%	0.08%
Cs 135	2,300,000	0.03%	0.00007%
U 238	4,500,000,000	0.02%	0.001%
I 129	16,000,000	0.002%	0.0002%
Th 230	77,000	0.001%	0.0002%

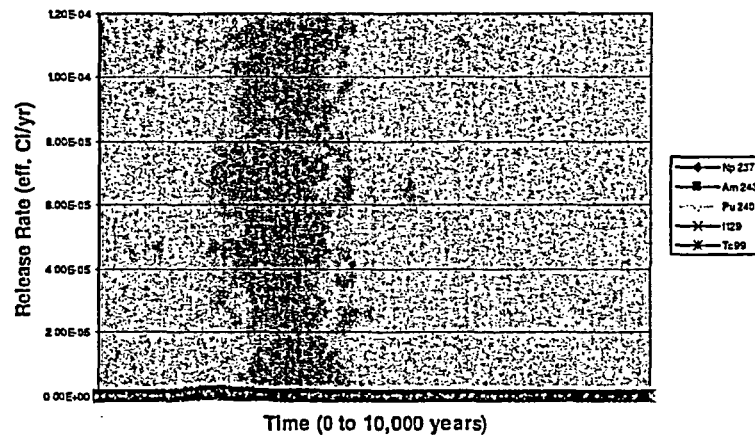
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Release from Waste Package (weighted by DCF)



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Release from Geologic Setting (weighted by DCF)



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Effectiveness of Repository Waste Isolation Functions

[D = delay time; L = lowering of release rate;
Increased letters denotes increased effectiveness]

Safety Functions	Important Features	Radionuclides in the Ground-Water Pathway											
		Am 241	Pu 240	Pu 239	Am 243	Tc 99	U 234	C 14	Np 237	Cs 135	U 238	I 129	Th 230
Onset of Release	Waste Package	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD	DDD
Release Rate From Engineered Barriers	Waste Form					LL		LLL		LL	L	L	LL
	Solubility Limits										LLL		L
	Solubility Limits; Limited Water		L	L	L		L		L		LLL		LL
Transport in Geosphere	Transport in Fractures	DDD	DD	DD	DD	D	D	D	D	DDD	D	D	DD
	Transport in Porous Media	DDD	DDD	DDD	DDD	D	DDD	D	DDD	DDD	DDD	D	DDD

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Examples of Waste Isolation Review

- Engineering (waste package)
- Engineering + Geology (release rates)
- Geology (saturated zone)

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Engineering Example

- How significant is waste package failure time?
- What controls the longevity of the waste package?
 - corrosion rates (including water chemistry)
 - effectiveness of drip shield
- Relevant design details
 - fabrication methods, weld characteristics, design stresses, inspection plans
 - materials in drift (effect on water chemistry)
 - repository layout (effect on temperature)

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Engineering + Geology Example

- How significant is the release rate?
 - release as a fraction of inventory
 - release as a fraction of dose limits
- What controls the release rate from the waste package
 - water contacting waste
 - dissolution of spent fuel
 - cladding
- Relevant design details
 - materials in waste package (effect on in-package chemistry)
 - cladding materials and conditions
 - repository layout (effect on temperature)

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Geology Example

- How significant is the transport times in the saturated zone?
- What controls transport through the saturated zone?
 - ground-water velocity
 - matrix diffusion
 - retardation in alluvium
- Relevant site characterization information
 - flow paths (direction and velocities)
 - transport properties (sorption coefficients)

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TSPA/SR Example

(Cumulative Releases – Igneous Intrusion)
[SR00_001ie5]

Nuclide	EBS	UZ	SZ
Pu 240	2100 Ci	3400 Ci	0.001 Ci
Am 243	9300 Ci	9600 Ci	0.001 Ci
Tc 99	38K Ci	34K Ci	27K Ci
Np 237	1400 Ci	1400 Ci	130 Ci
I 129	83 Ci	82 Ci	59 Ci

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Understanding Pre-Closure Safety

- Risk insights (based on general understanding of design, construction, and procedures governing operations)
 - offsite dose highly dependent on an energy source (e.g., fire)
 - worker dose dependent on direct exposure
 - quantitative efforts underway to quantify risk insights
- Pre-closure (63.112)
 - identification of structures, systems, components important to safety
 - provide design basis

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Examples of Pre-Closure Safety Review

- Off-site Dose (fire)
- Worker Dose (drop of fuel assembly or waste package)

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Off-site Dose Example

- How significant is potential release during a fire?
- What controls the initiation and suppression of a fire?
 - potential initiators of fire
 - severity of potential fire
- Relevant design details
 - proximity of combustible materials relative to waste handling operations (ignition sources)
 - fire detection and suppression
 - HVAC system including power system

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Worker Dose Example

- How significant is potential exposure from a dropped fuel assembly or waste package?
- What controls drop of a fuel assembly and waste package?
 - height of potential drop
 - frequency of potential drops
 - configurations and properties of surface
- Relevant design details
 - lift controls on waste handling operations
 - shielding for workers during waste handling including information on worker location
 - line drawings and specifications for materials

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Summary

- Risk insights based on comprehensive understanding of the repository system that:
 - identifies important parameters, models, and assumptions
 - considers uncertainties
 - provides an “informed” and focused approach for NRC’s review
 - indicates areas where more information is needed

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