

# **ATTACHMENT 3**



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

# Office of Civilian Radioactive Waste Management System Analyses

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Jeffrey R. Williams**  
Office of Science & Technology and Information Division of  
Office of Civilian Radioactive Waste Management  
U.S. Department of Energy

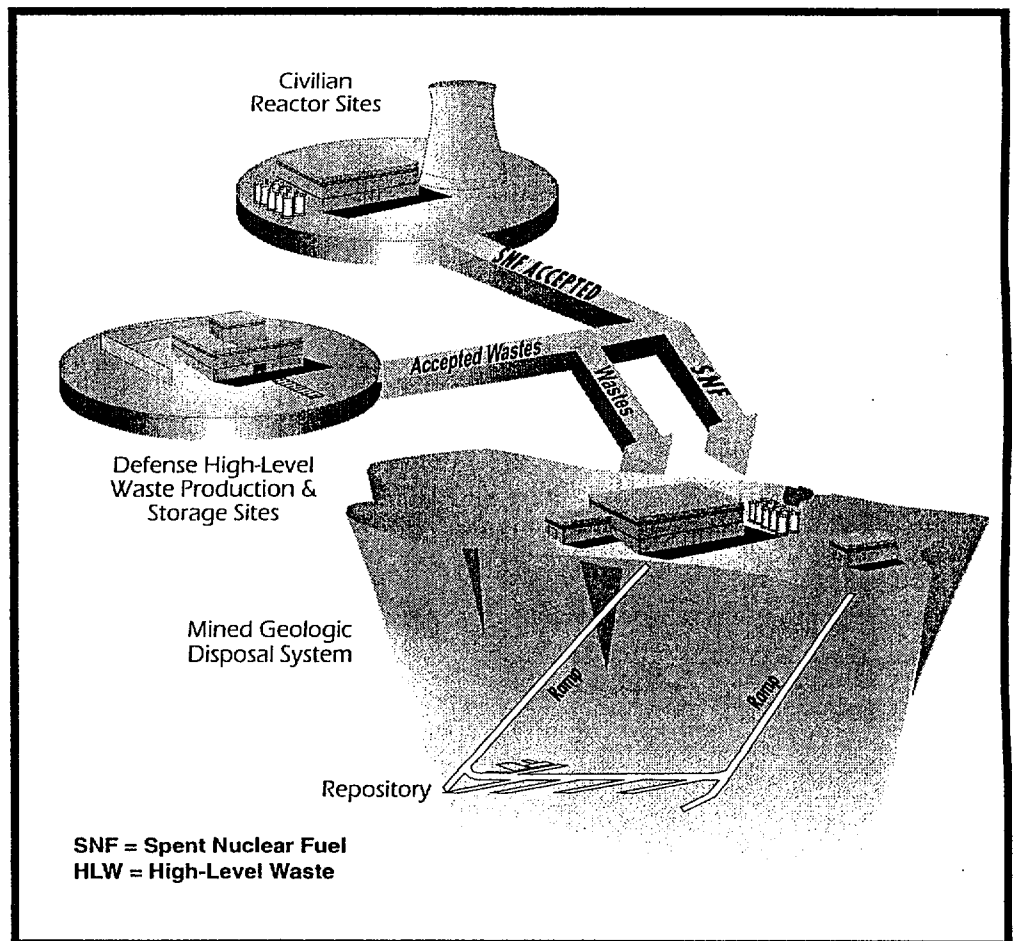
**For Information Only - Unapproved Conceptual Design Information**

# Background

- **As part of its program integration responsibility, the Office of Civilian Radioactive Waste Management (OCRWM) evaluates cross-cutting issues that impact the safe operation or architecture of the entire system**
- **This task includes conducting system-level analyses to support repository design, operating concepts, transportation planning, waste stream projections, and requirements development**
- **These studies provide information to management to evaluate nuclear safety impacts and alternatives to the current technical baseline**
- **The project is moving from conceptual design phase to preliminary design development**

# System Architecture

- **Underground repository**
- **Surface facilities**
- **Nevada transportation mode**
- **National transportation mode**
- **Receipt, storage, and emplacement rates and quantities**
- **Operating mode**
- **Waste types and quantities**



**Different design and construction approaches can affect nuclear safety, funding needs, and acceptance amounts**



# Office of Civilian Radioactive Waste Management System Studies

- **System studies performed by OCRWM have addressed topics such as:**
  - **Transportation alternatives (National and Nevada)**
  - **Storage alternatives**
  - **Waste form alternatives**
  - **Phased implementation approach**
  - **Early reactor shutdowns and reactor life extensions**
  - **Variations in acceptance and emplacement rates**
  - **Second repository**
  - **Early receipt options**
  - **Multi-purpose canister systems**

# **Phased Implementation Approach**

- **The most significant repository design concept considered recently is the phased implementation approach**
- **Reasons for moving toward a design concept that supports a phased implementation approach**
  - **Provides maximum flexibility to adjust to future changes in funding, schedule, and waste stream while maintaining safe operation**
  - **Allows for the implementation of a small initial disposal capability**
  - **Consistent with findings of the National Academies Panel on Staged Repository Development**

# **Office of Civilian Radioactive Waste Management System Studies Related to Phased Implementation**

- **Since 1998, several system studies have evaluated a phased approach to repository implementation**
  - **1998: Evaluated a modular wet Waste Handling Building (WHB); initial receipt using a Dry Transfer System; alternative transportation options (truck, heavy haul)**
  - **2001: Integrated a modular dry WHB concept into the 1998 studies**

# **Office of Civilian Radioactive Waste Management System Studies Related to Phased Implementation**

(Continued)

- 2002: Modular Construction System Evaluation (MCSE)**
  - ♦ **Evaluated a possible License Application (LA) design concept developed in the April 2002 Repository Design Evolution Study**
    - » **Phased, mostly dry waste handling facilities**
    - » **Phased subsurface construction**
    - » **Initial subsurface test facility**
    - » **Transportation options including delayed rail**
    - » **Constrained funding**
  - ♦ **Scenarios analyzed with varying receipt rates, start of Nevada rail service, and emplacement rates**

# **Key 2002 Modular Construction System Evaluation Conclusions**

- **The phased repository implementation approach can be implemented under 10 CFR 63 requirements while maintaining safe operation**
- **The phased implementation approach recommended in the Design Evolution Study is adaptable and appears sufficiently flexible to encompass a variety of receipt rates, emplacement rates, transportation options, and funding profiles**
- **A phased implementation approach can reduce peak Civilian Radioactive Waste Management System (CRWMS) annual costs and total costs through 2010**

# Summary

- **The design and operational concept of the CRWMS has evolved significantly over the life of the Program**
- **Since 1998, OCRWM has performed several system studies that have supported a phased approach to repository implementation**
- **The presentations being given today will provide more detailed information about the current approach being taken to LA design**
- **Final decisions and approvals of the LA Design have not been made**



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



# Potential Phased Approach to Surface Facility Development

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Larry J. Trautner/Gene W. Rowe**  
**Repository Design Project**  
**Bechtel SAIC Company, LLC**

November 5, 2002  
Las Vegas, Nevada

**For Information Only - Unapproved Conceptual Design Information**

# Agenda

- **Waste Handling Facility Functions**
- **Site Recommendation Design Waste Handling Facility**
- **Design Approach**
- **Design Process**
- **Phased Surface Facilities Approach**
- **Waste Processing Flow**
- **Omni-directional Lift Transporter (OLT)**
- **Cask Transporter Receipt and Processing**
- **Disposal Container (DC) Receipt and Processing**
- **Dry Waste Transfer**
- **Waste Package (WP) Loadout**
- **Waste Package Emplacement**
- **Remediation Building**
- **Present Status**





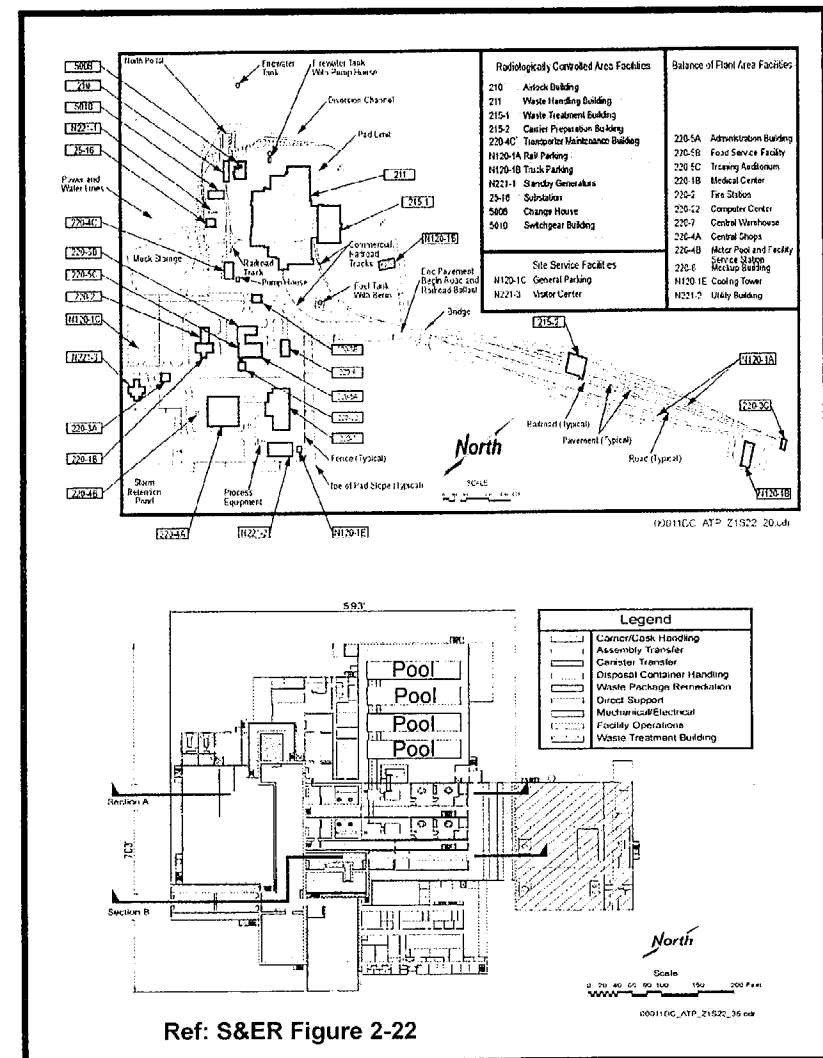
# **Waste Handling Functions**

- **Receive waste delivered to the repository via rail, legal weight truck, or heavy haul truck**
- **Prepare the shipping cask for unloading**
- **Transfer the waste from the shipping cask to the appropriate waste package**
- **Seal the waste package**
- **Prepare the waste package for movement to the underground repository**
- **Emplace the waste packages**
- **Ship empty casks off-site**
- **Manage low level radioactive waste**



# Site Recommendation Design Waste Handling Facility

- **Single Waste Handling Building**
- **Includes all waste handling functions**
  - **Cask receipt**
  - **Waste transfer (Wet for Commercial Spent Nuclear Fuel (CSNF), dry for High Level Waste (HLW)/DOE Spent Nuclear Fuel (SNF))**
  - **Waste Package prep & welding**
  - **4 CSNF blending pools = 5,000 MT**



# Design Approach

- **Design Methodology**
  - **Maintain public and worker safety**
    - ♦ **Minimize dose (as low as is reasonably achievable [ALARA])**
    - ♦ **Minimize number of potential event sequences**
      - » **Minimize number of lifts and lift heights**
    - ♦ **Incorporate design features such as redundancy, diversity, passive features, and physical separation**
  - **Meet programmatic requirements**
  - **System Reliability**
    - ♦ **Simplify process**
      - » **Same basic process for all waste forms**



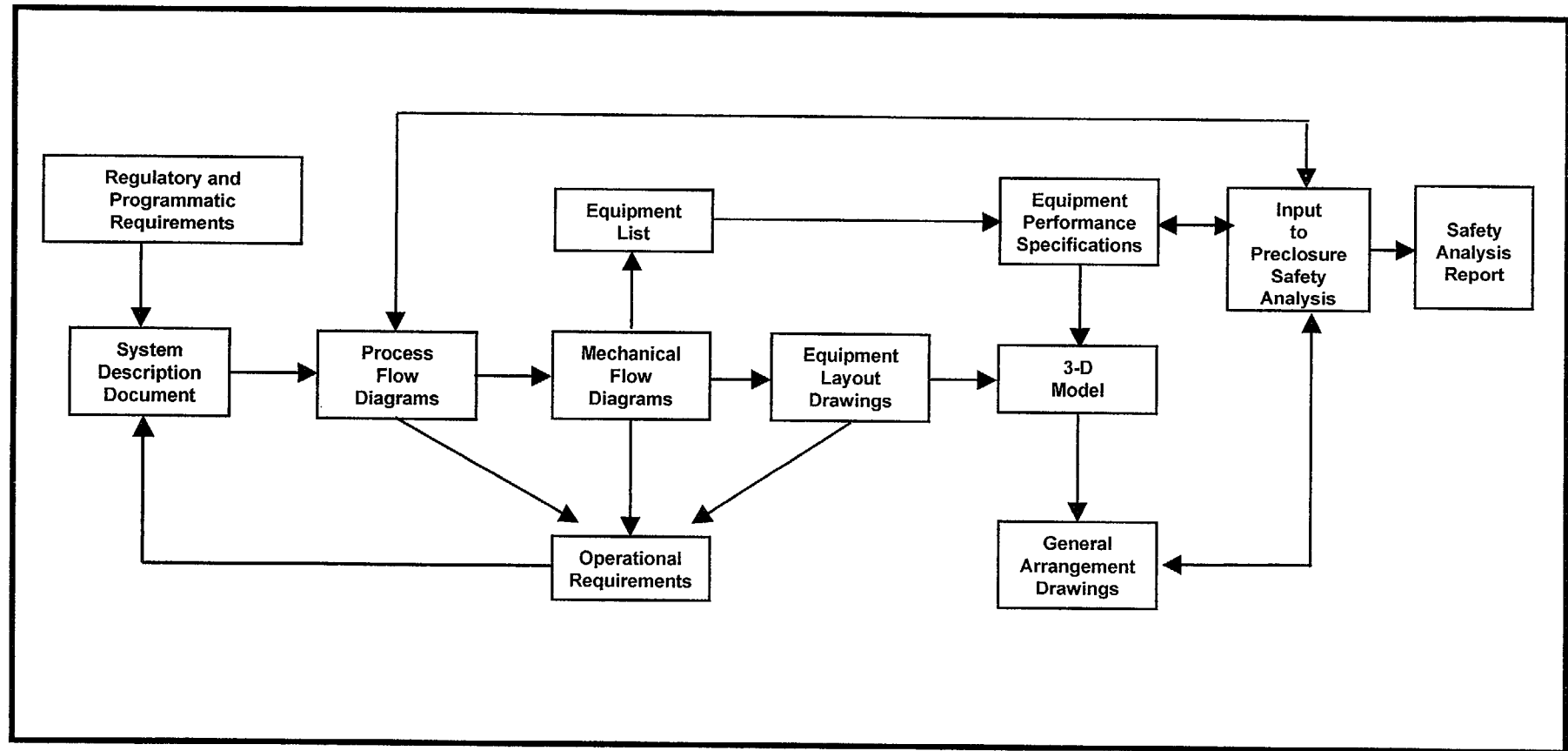
# **Design Approach**

(Continued)

- ♦ **Minimize permanent in-plant equipment**
  - » **Allows performing surveillance off line**
  - » **Minimizes down time to repair equipment**
- **System Flexibility**
  - ♦ **Ability to receive various waste forms**
  - ♦ **Ability to receive casks of various sizes**
- **Provide personnel access to recover from off-normal events**
  - ♦ **Casks and DC/WP transporters have temporary shields**



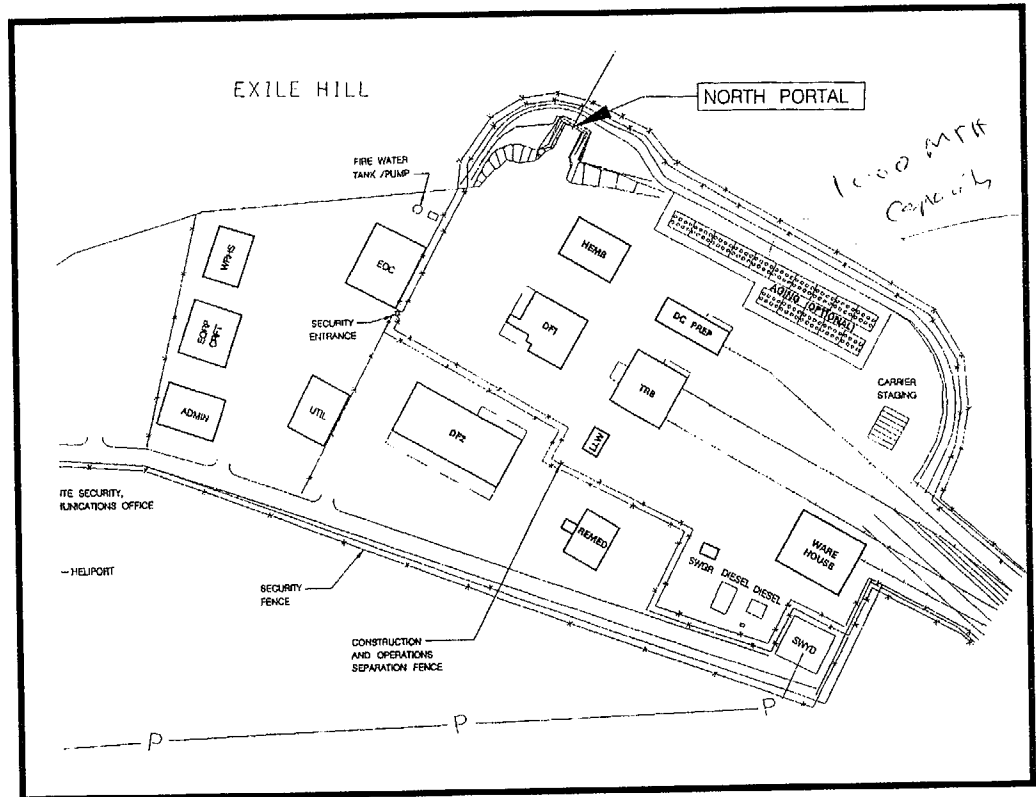
100% - QA



# Phased Surface Facilities Approach

## • Phase 1 *2010*

- 1/3 — Dry Facility #1 (~ 500-1,000 MTHM/yr)
- DC Preparation Building
- Transporter Receipt Building
- Low Level Waste Building
- Aging Pad (~ 1,000 MTHM)
- Heavy Equipment Maintenance Building
- Warehouse
- Operations Support Facilities

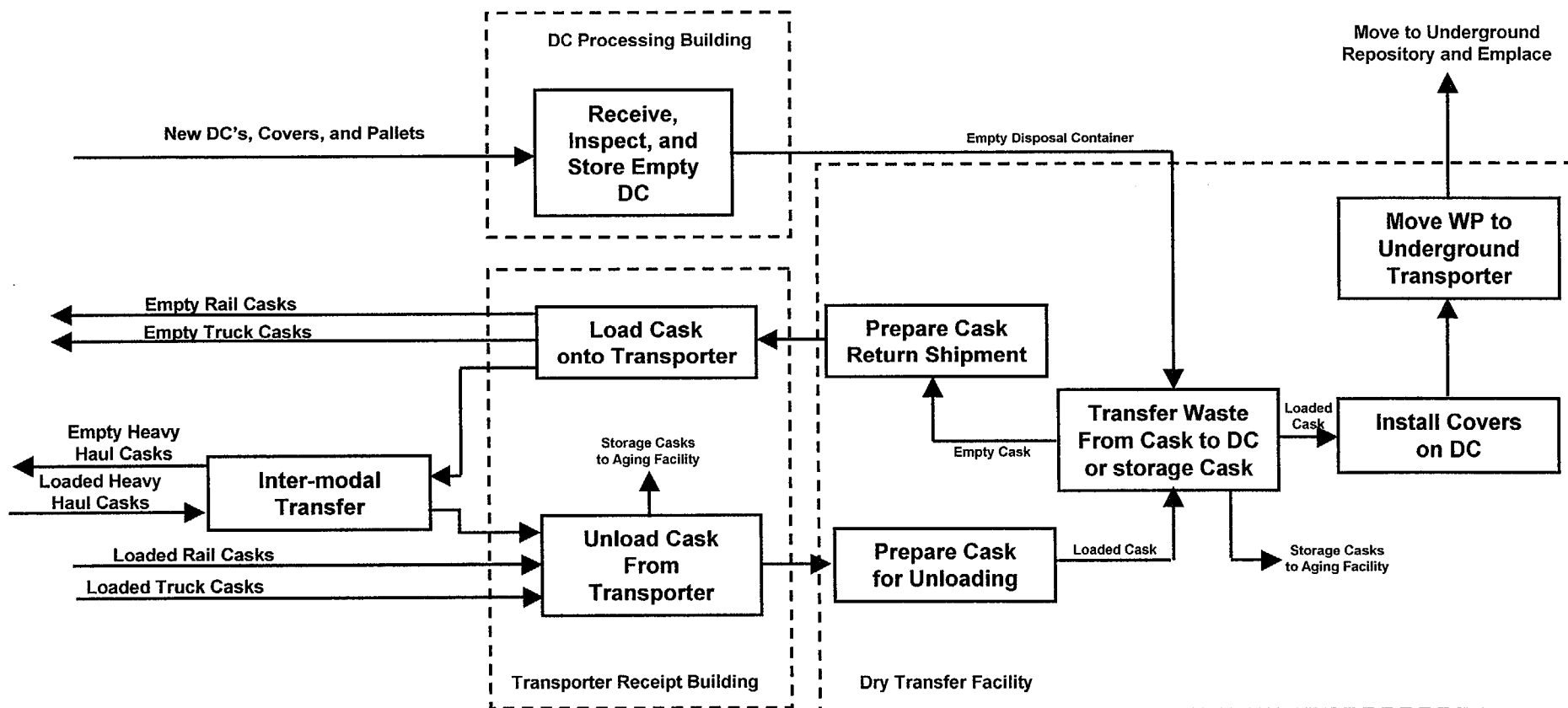


## • Phase 2 *2011 to 2015*

- 2/3 — Dry Facility #2
- Remediation Building
- Potential additional aging pad(s)



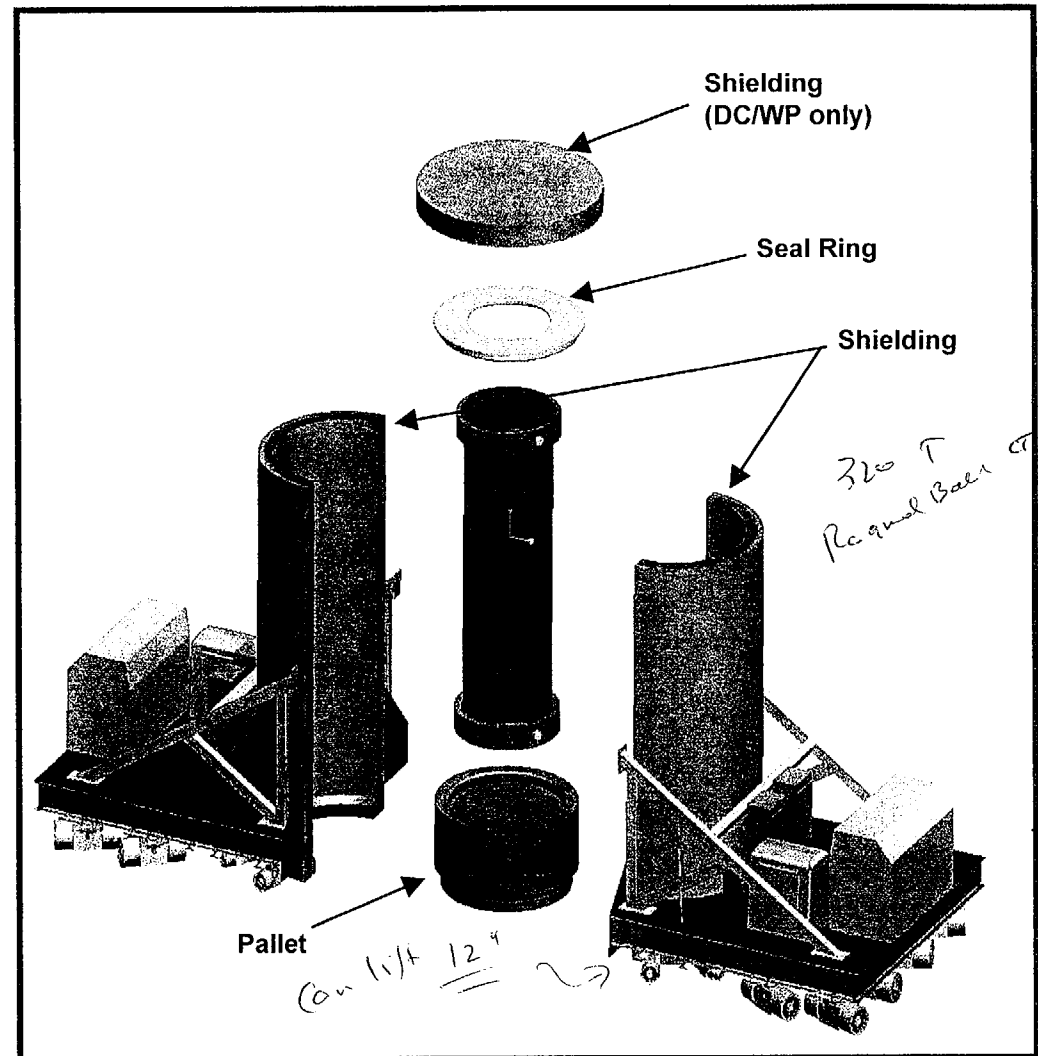
# Waste Processing Flow



Gone Rowe

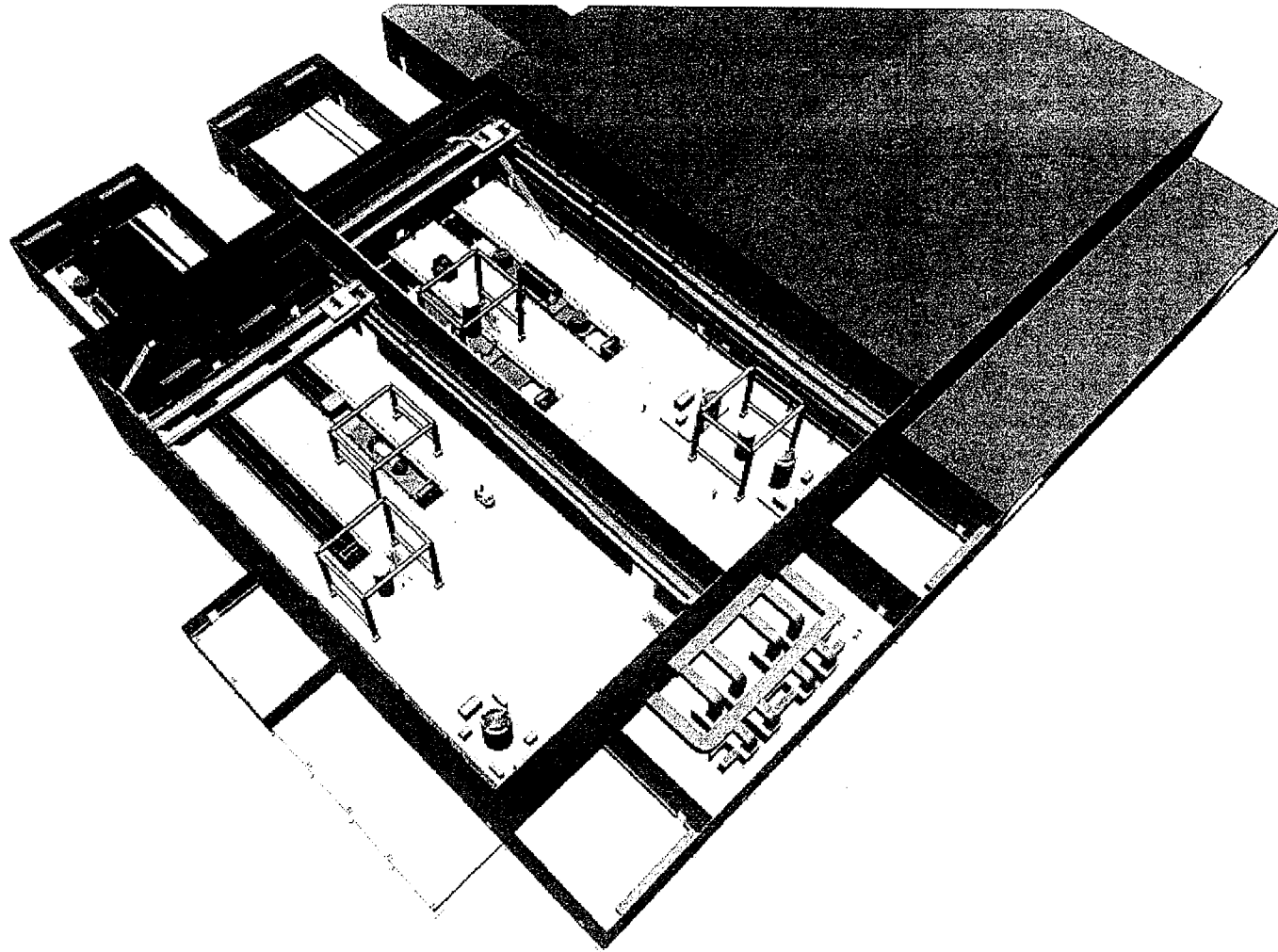
# Omni-directional Lift Transporter Surface Transportation

- Used to transport casks and waste packages within the surface facility
- Accommodates different cask/WP sizes by adjusting pallet height
- Integral shielding to allow personnel access to recover from off-normal events
- Minimizes both the height and frequency of lifts
- Working with Preclosure Safety Assessment (PSA) to evaluate and minimize any potential event sequences

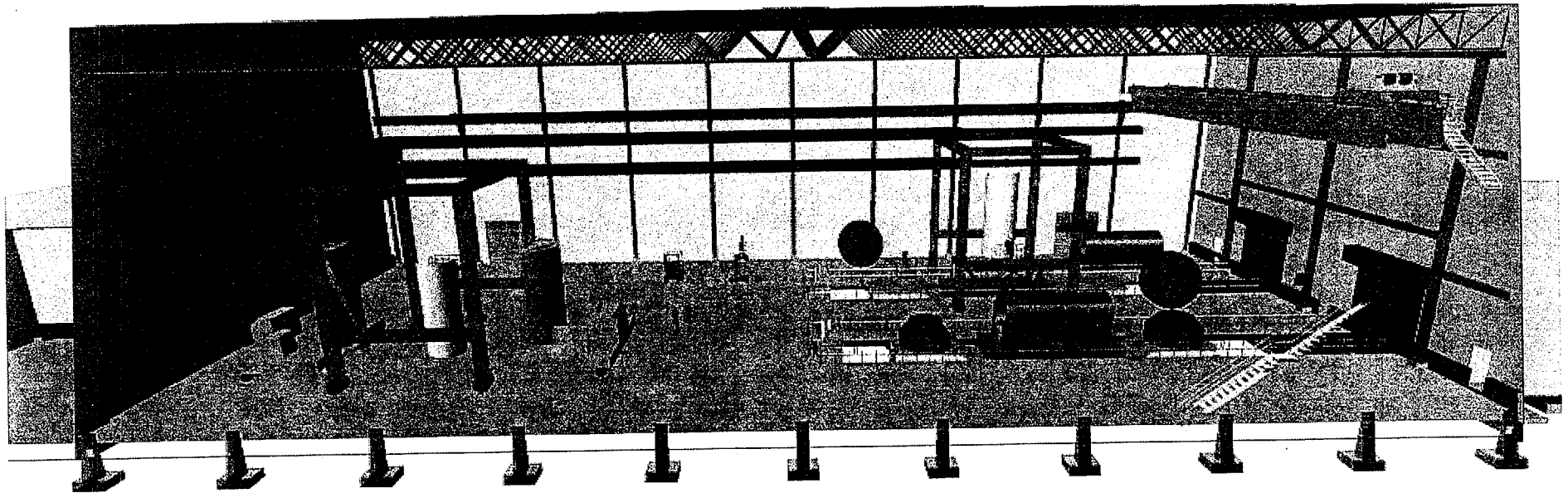




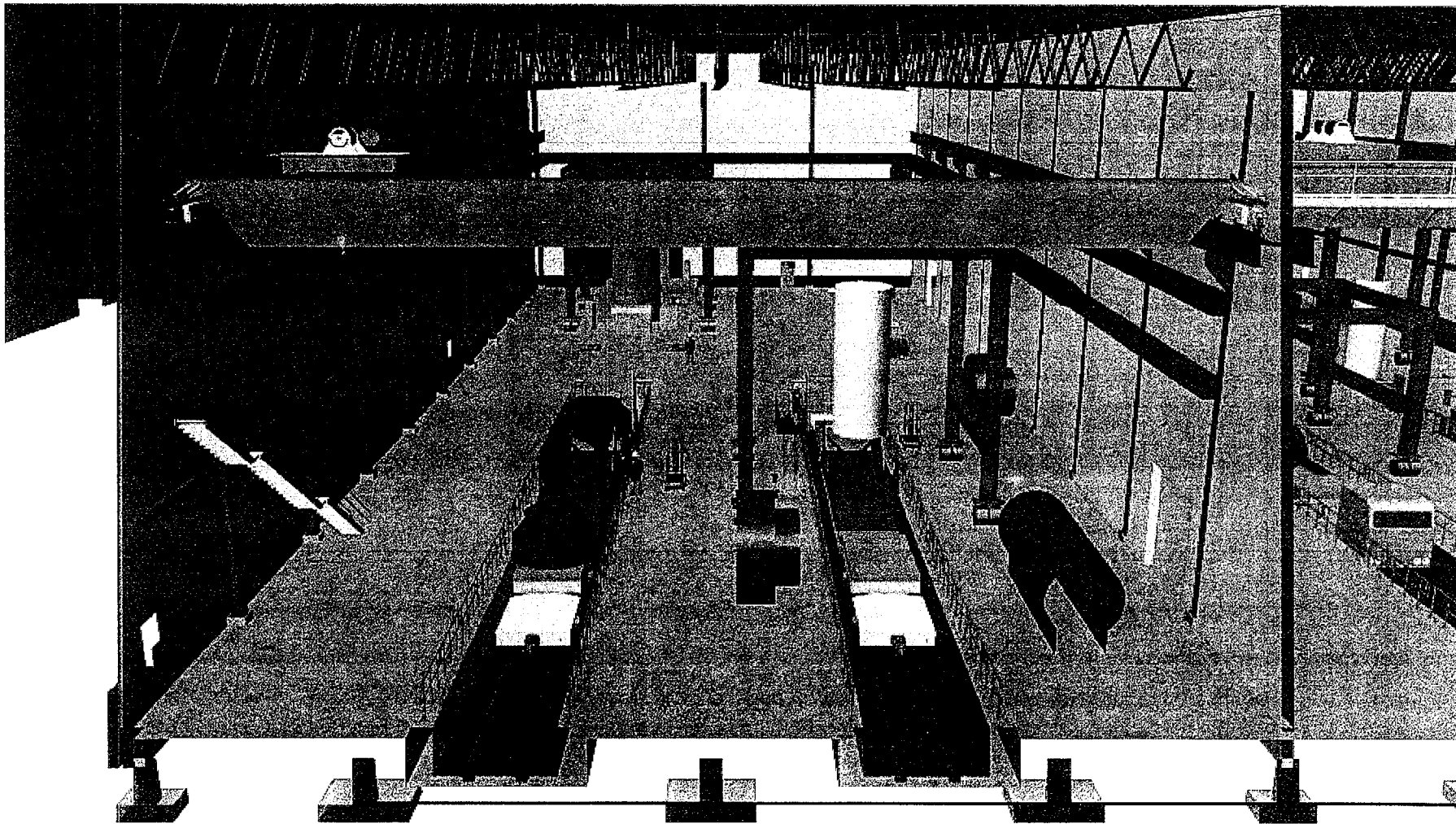
# Cask Transporter Receipt Building Overview



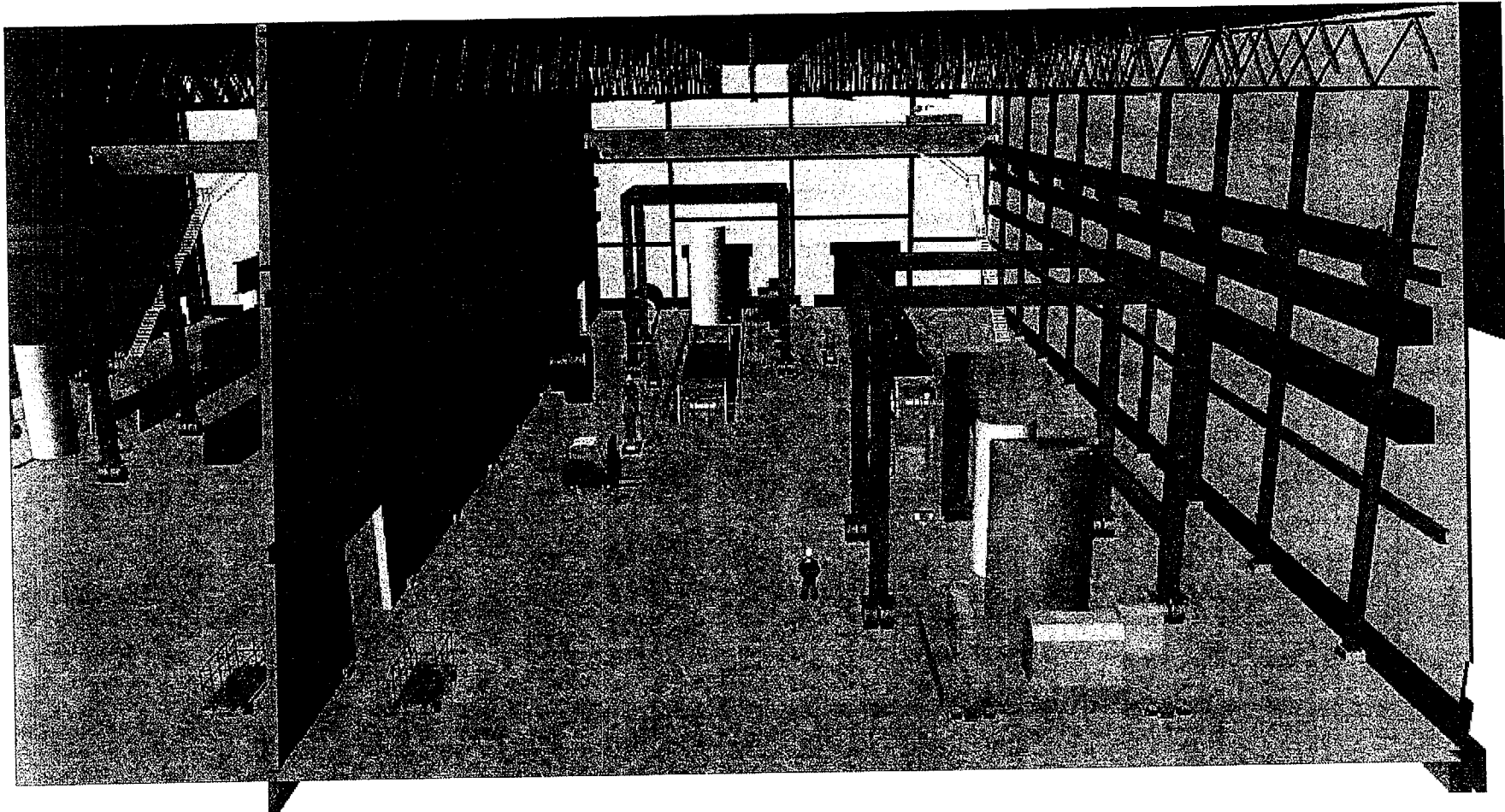
# Cask Transporter Receipt Building Side View



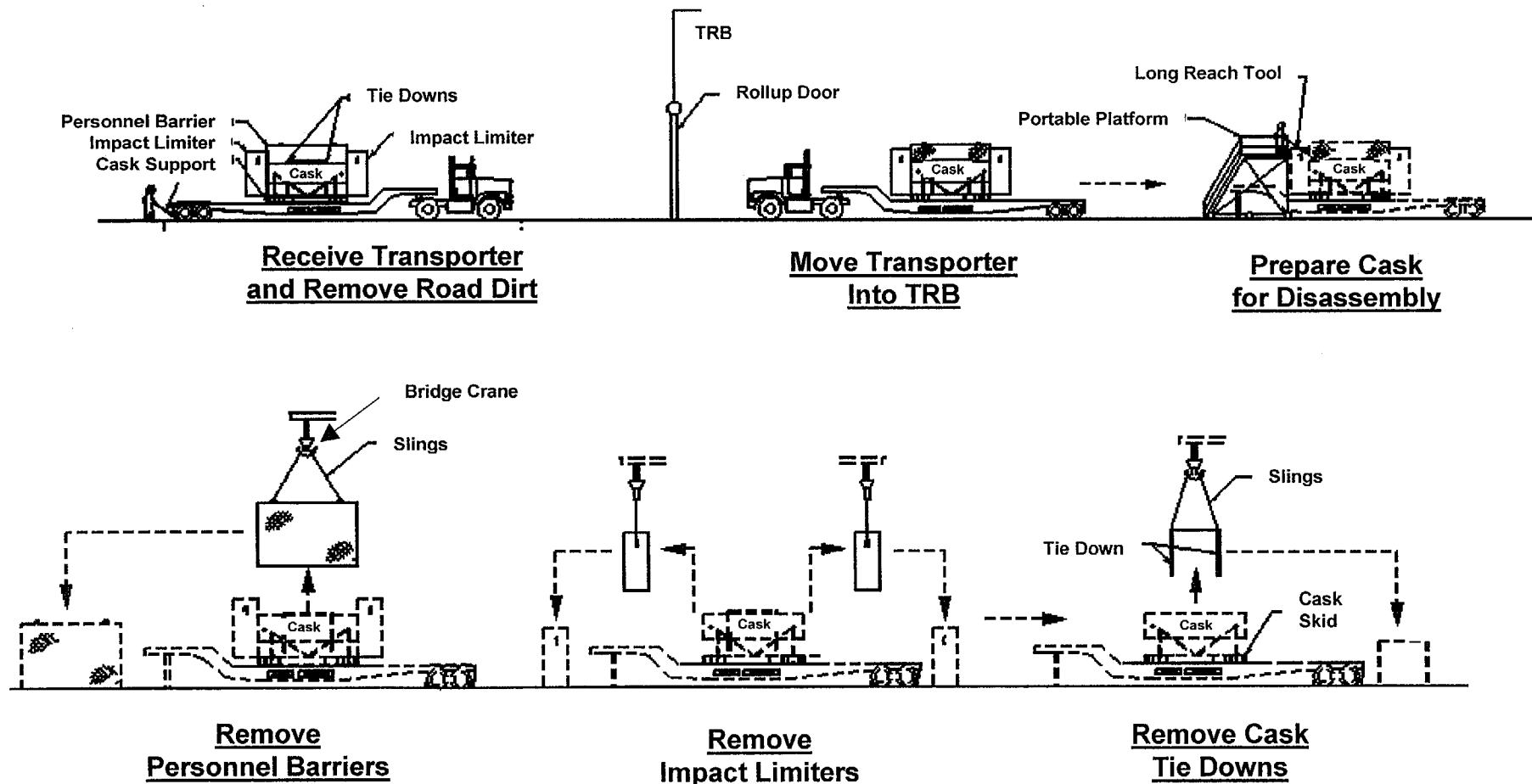
# Cask Transporter Receipt Building Looking from Transporter Entrance



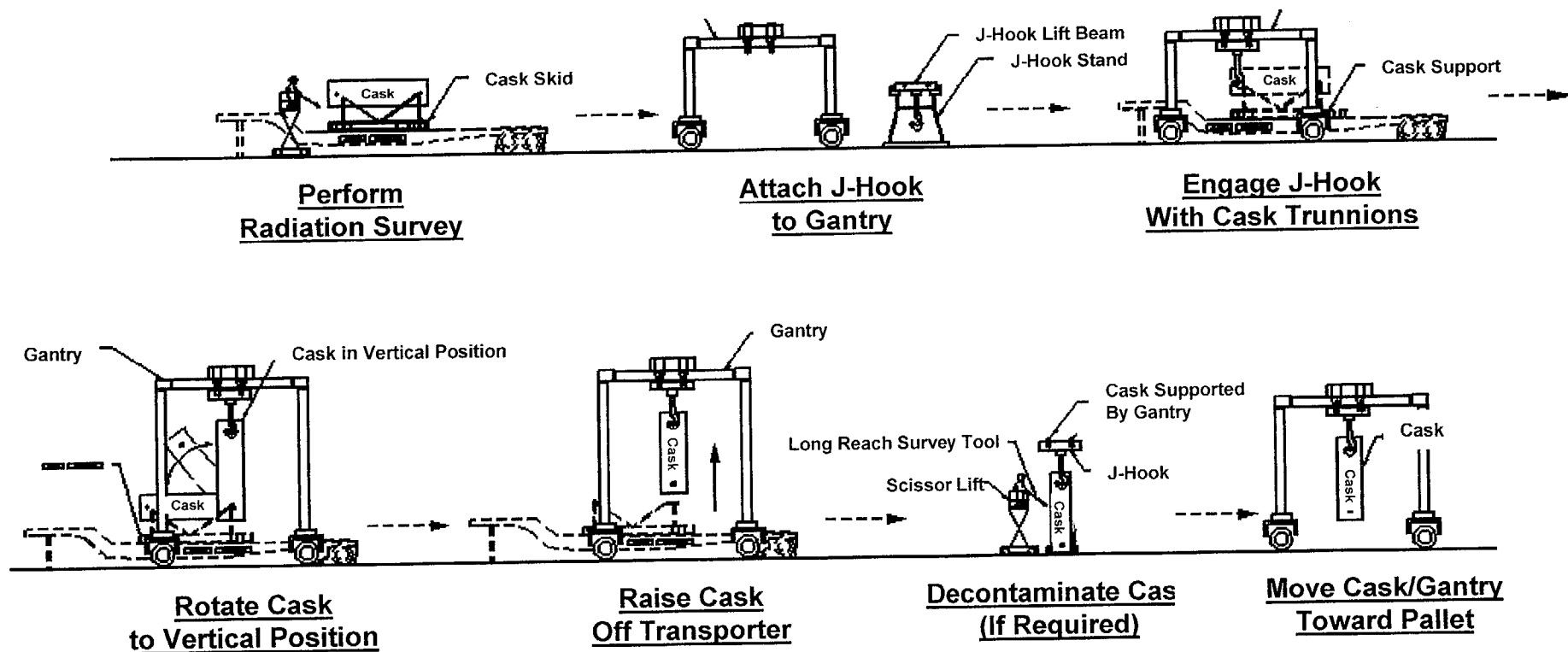
# Cask Transporter Receipt Building Looking from Omni-directional Lift Transporter Exit



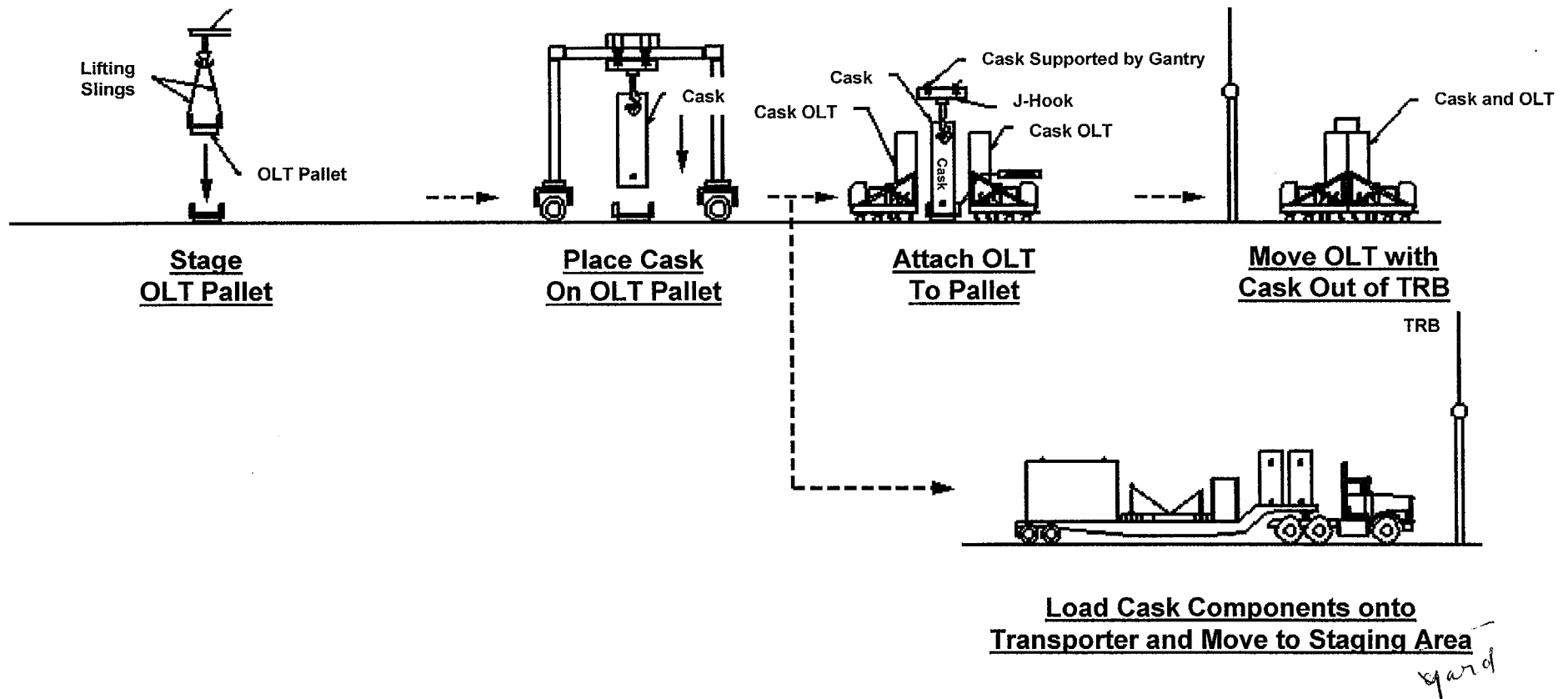
# Cask Transporter Receipt Process Flow (Slide 1)



# Cask Transporter Receipt Process Flow (Slide 2)

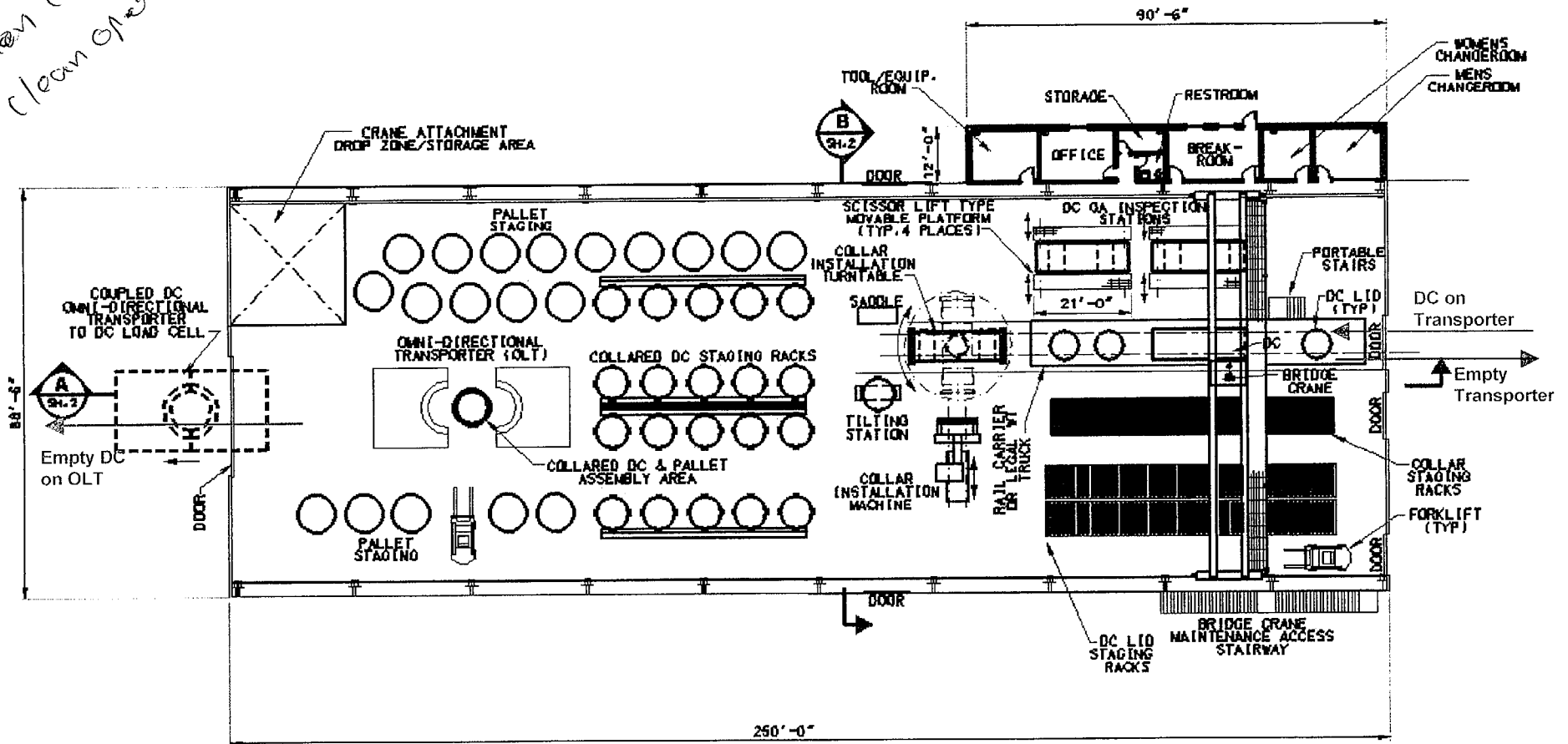


# Cask Transporter Receipt Process Flow (Slide 3)



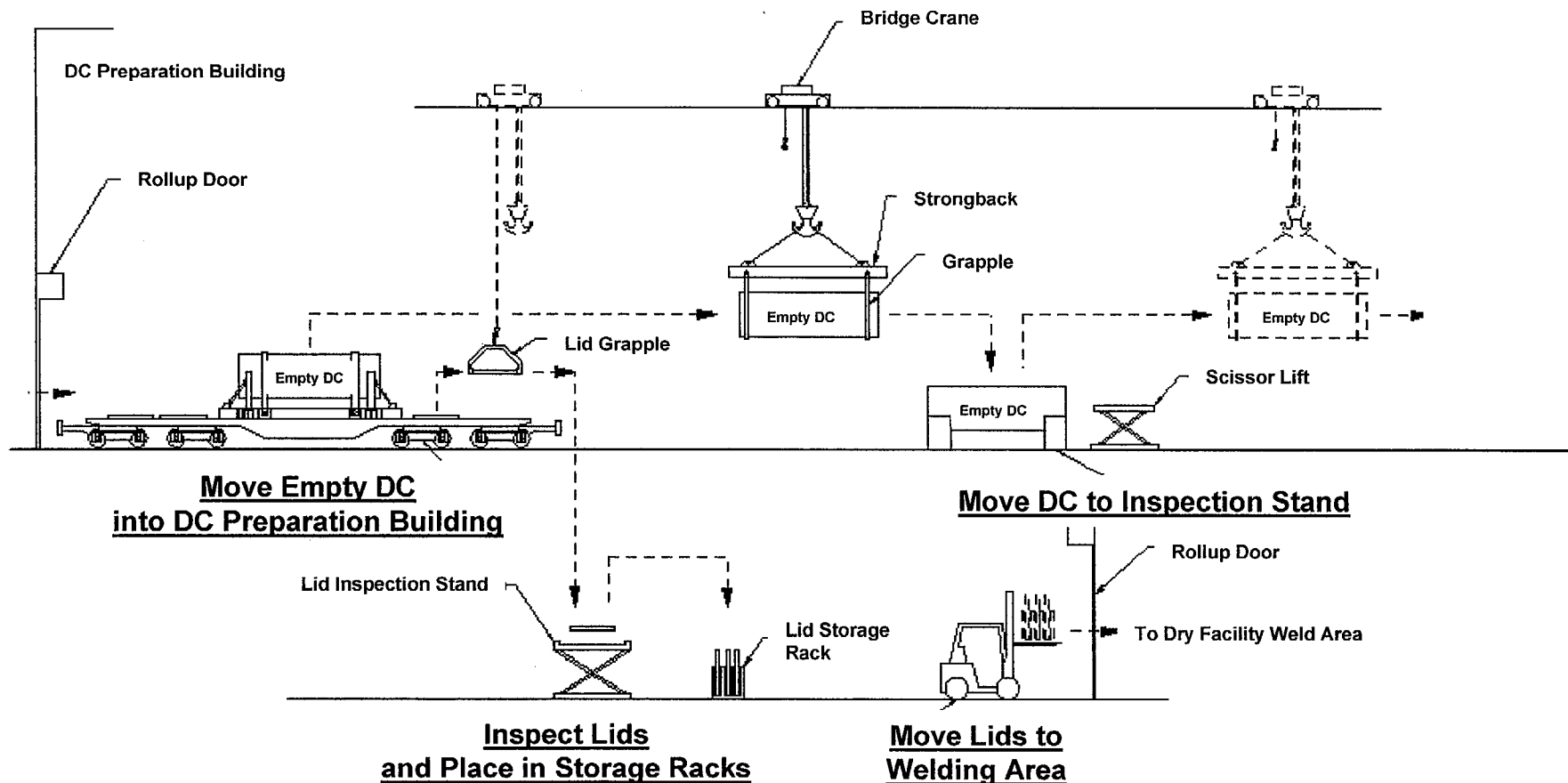
# Disposal Container Processing Building Equipment Layout

*Non contaminated  
clean operation*

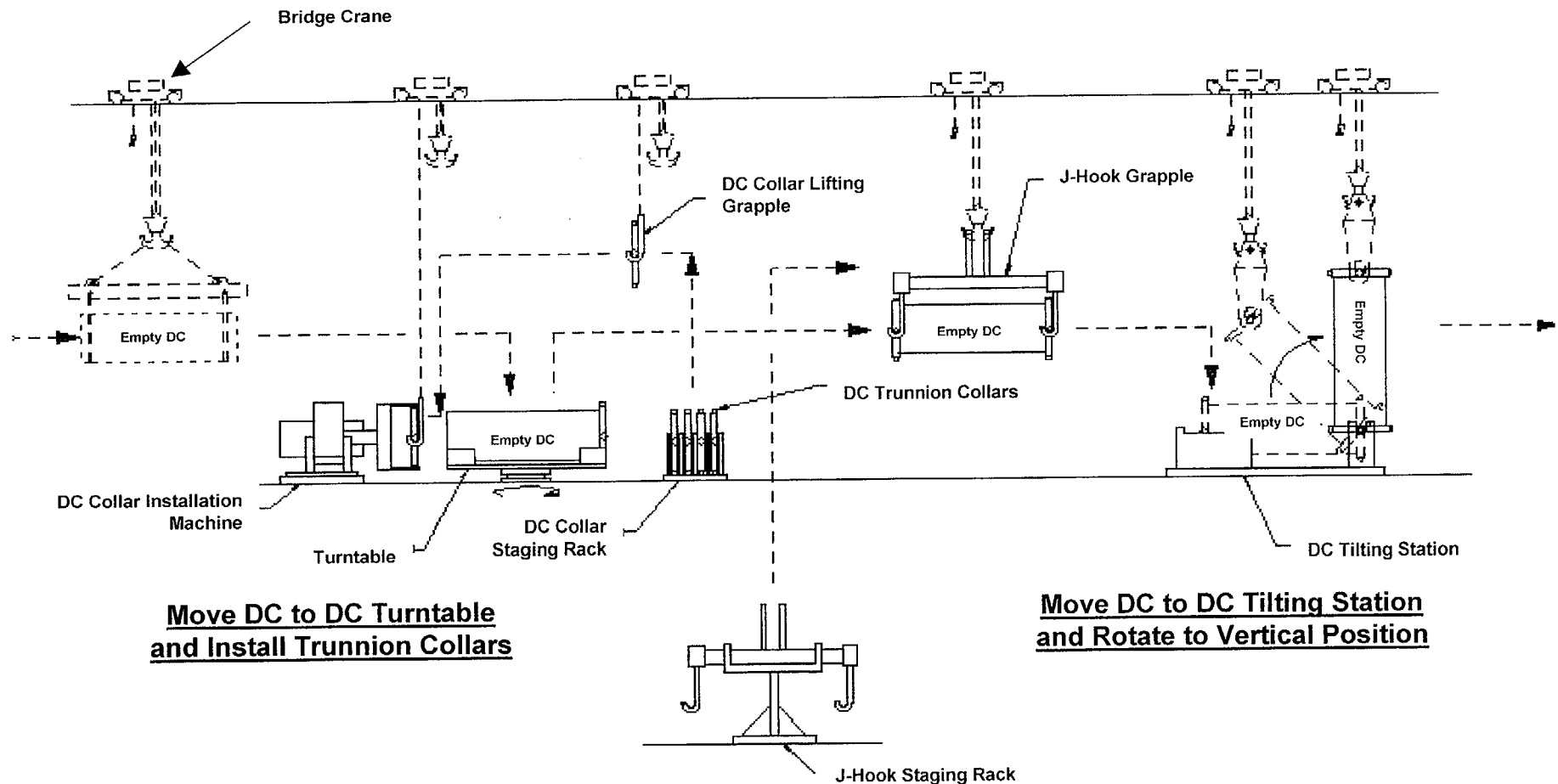




# Disposal Container Process Flow (Slide 1)

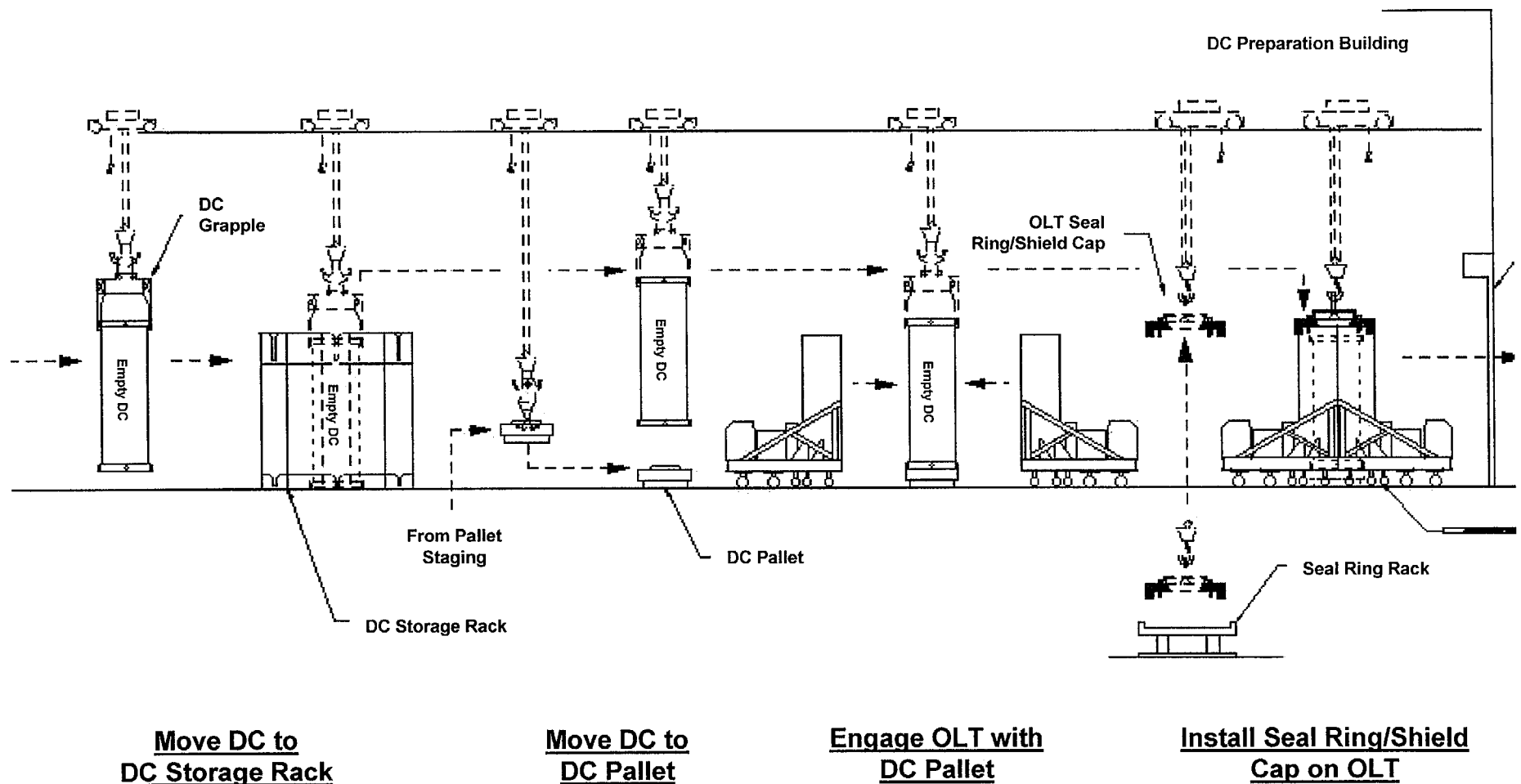


# Disposal Container Process Flow (Slide 2)



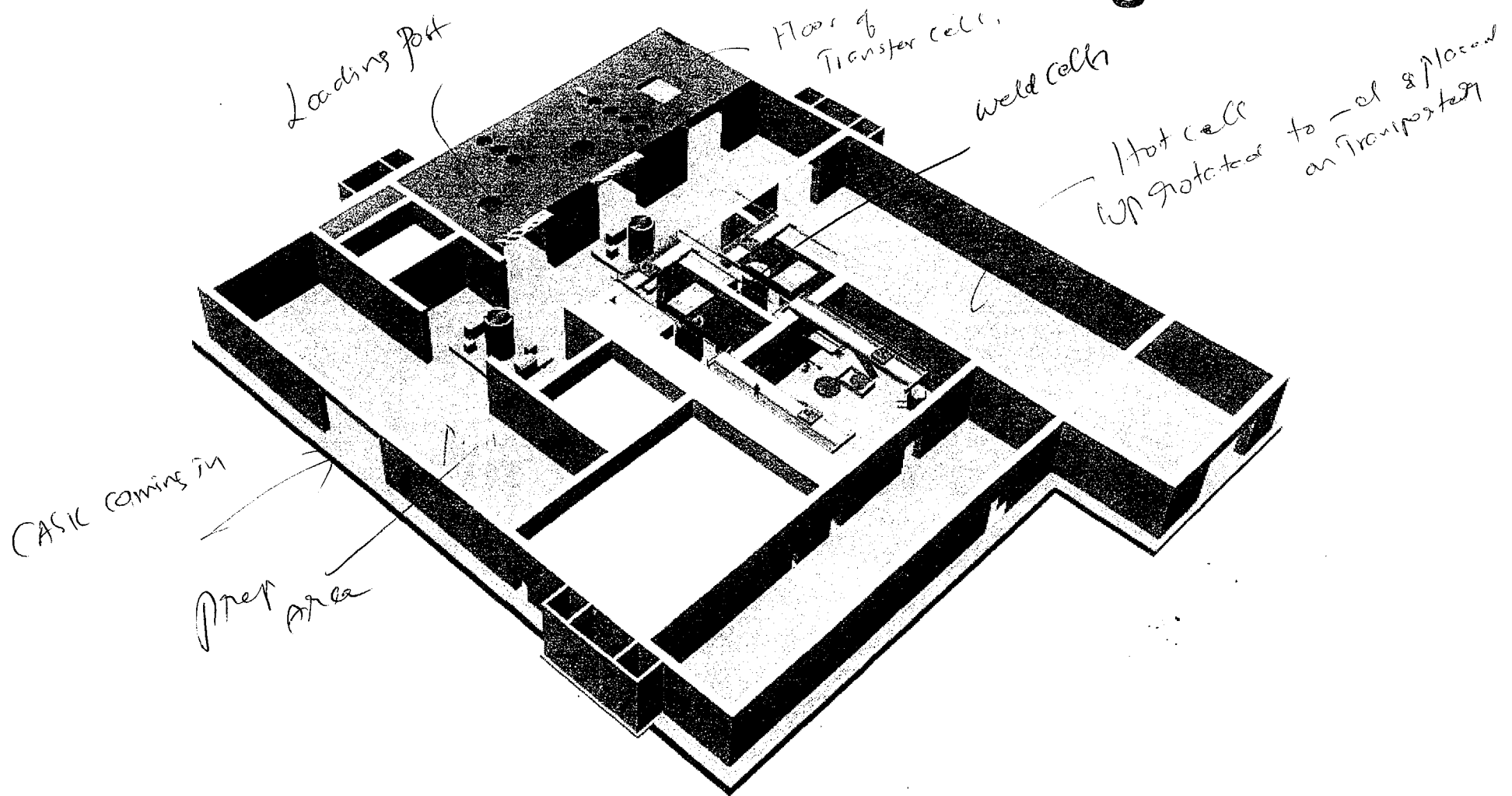
# Disposal Container Process Flow

## (Slide 3)



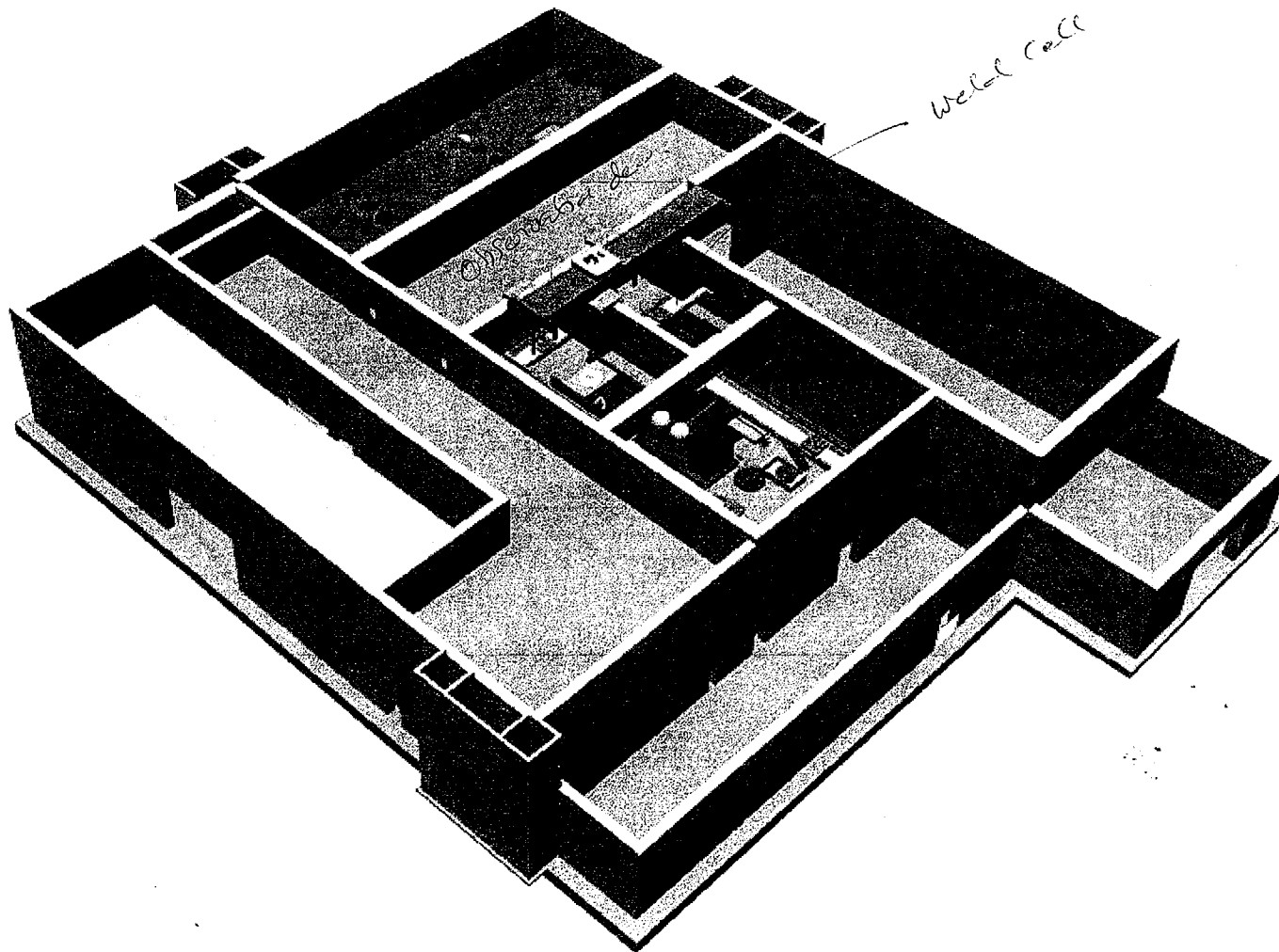
# Dry Facility #1

## First Floor 3-D Rendering

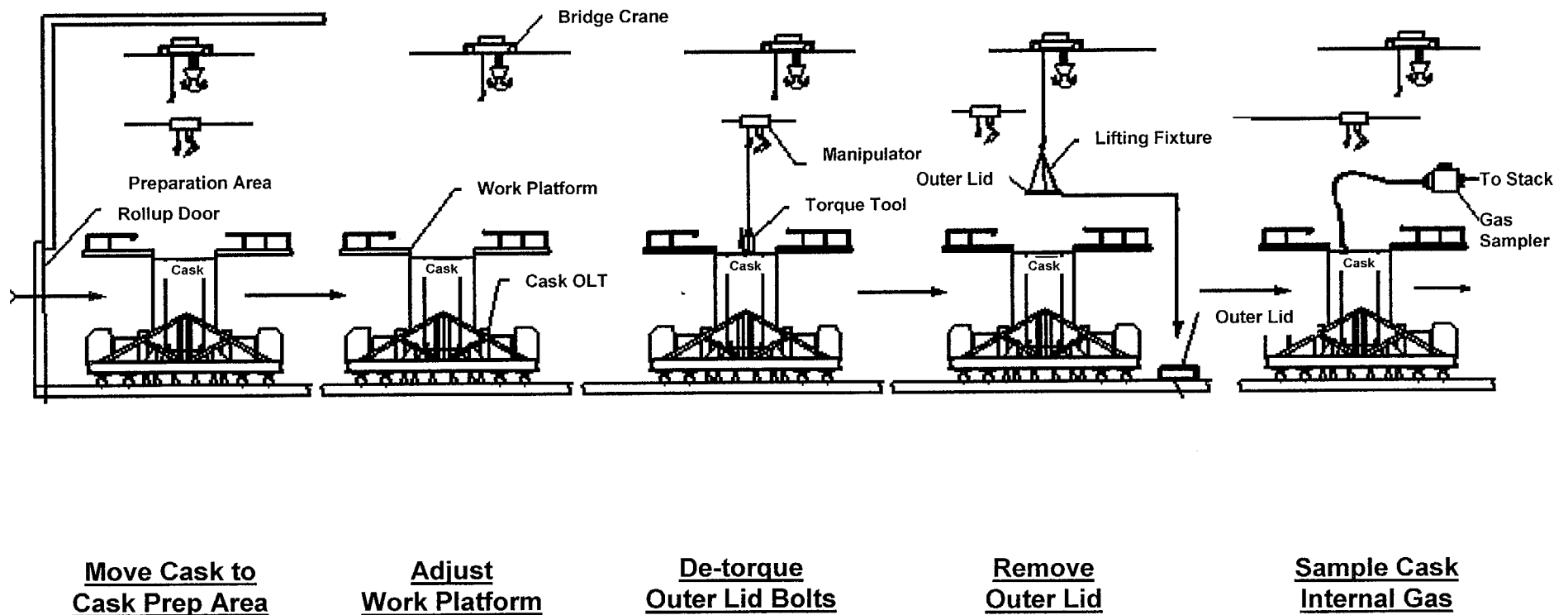


# Dry Facility #1

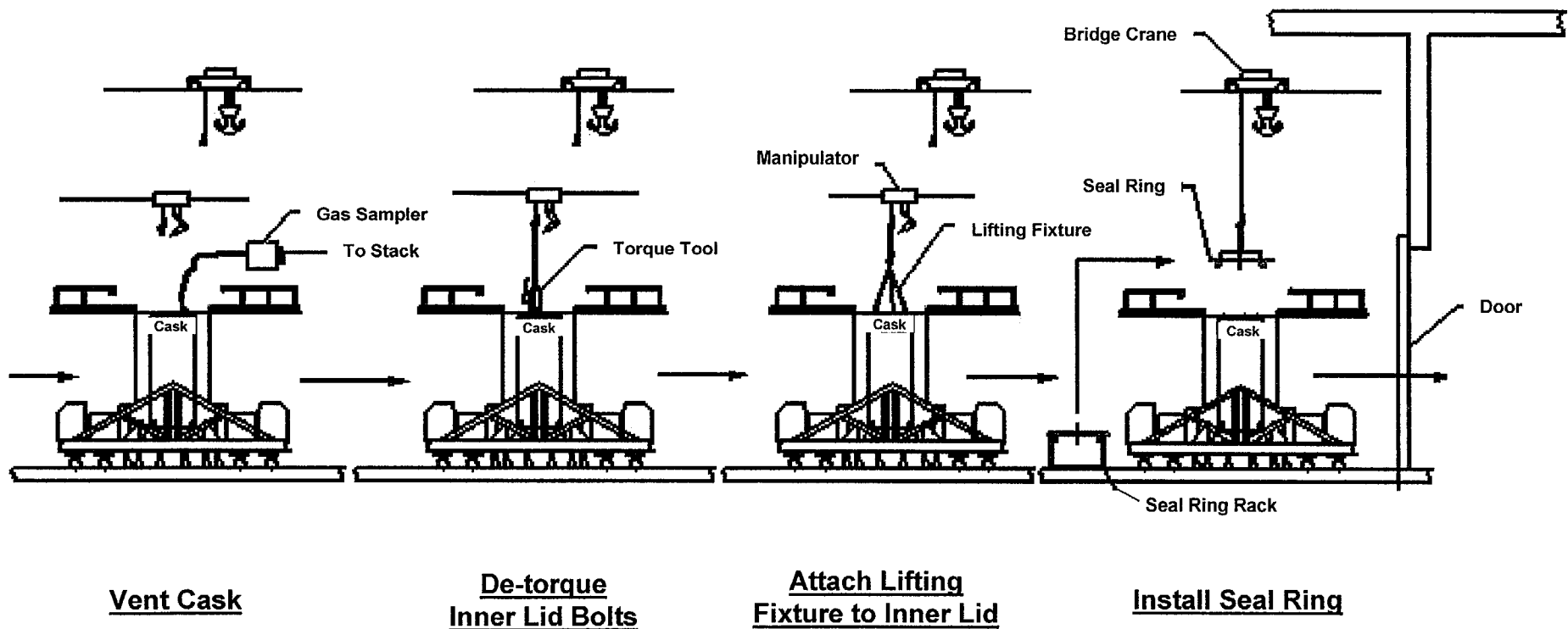
## Second Floor 3-D Rendering



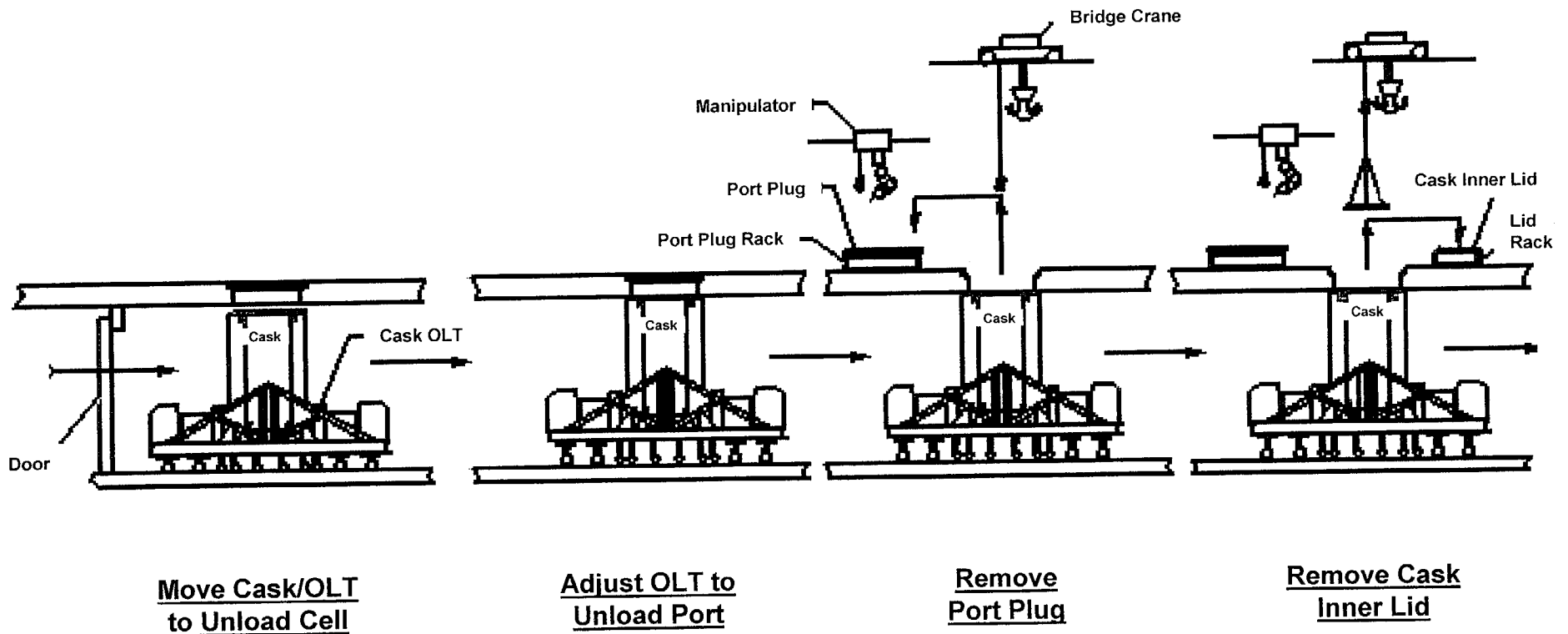
# Dry Waste Transfer Process Flow (Sheet 1)



# Dry Waste Transfer Process Flow (Sheet 2)

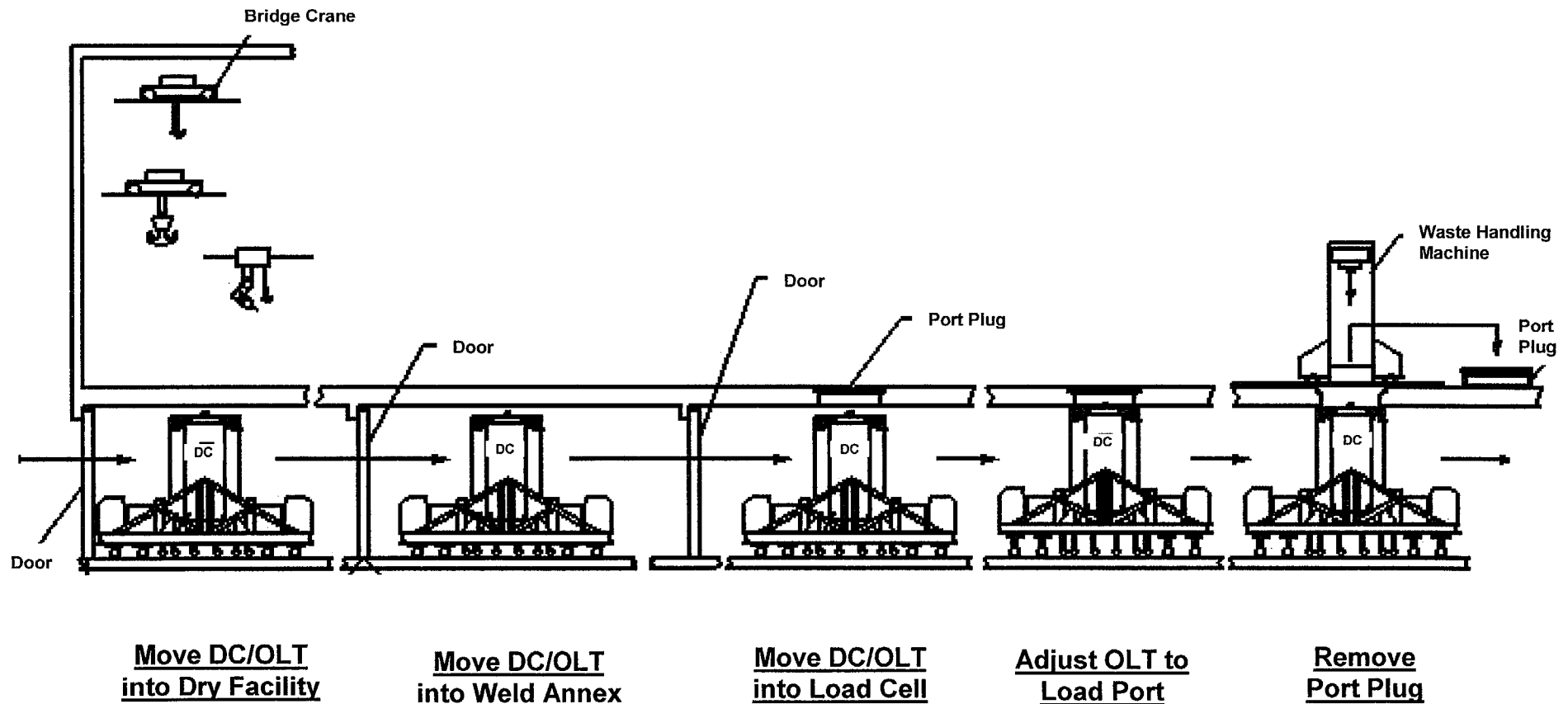


# Dry Waste Transfer Process Flow (Sheet 3)

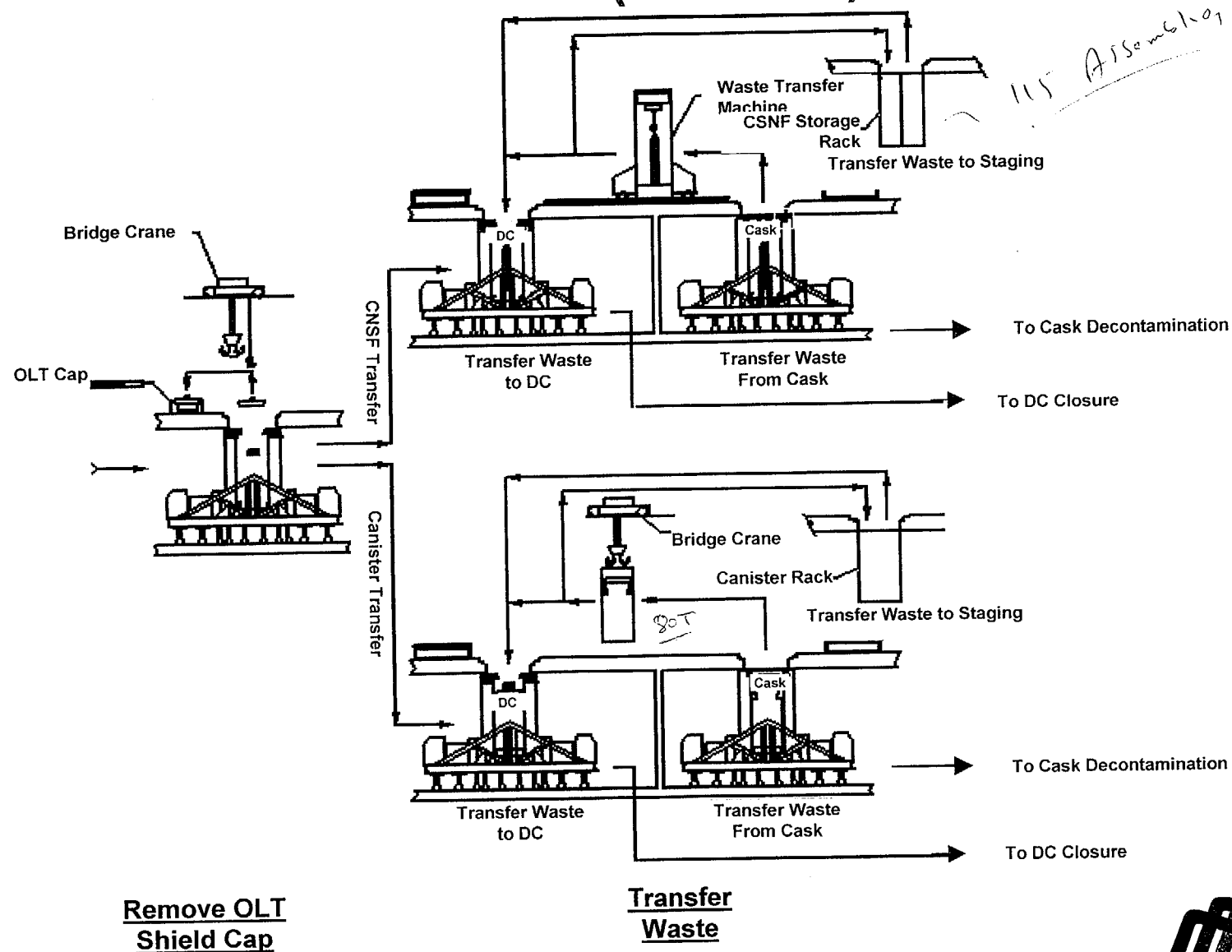




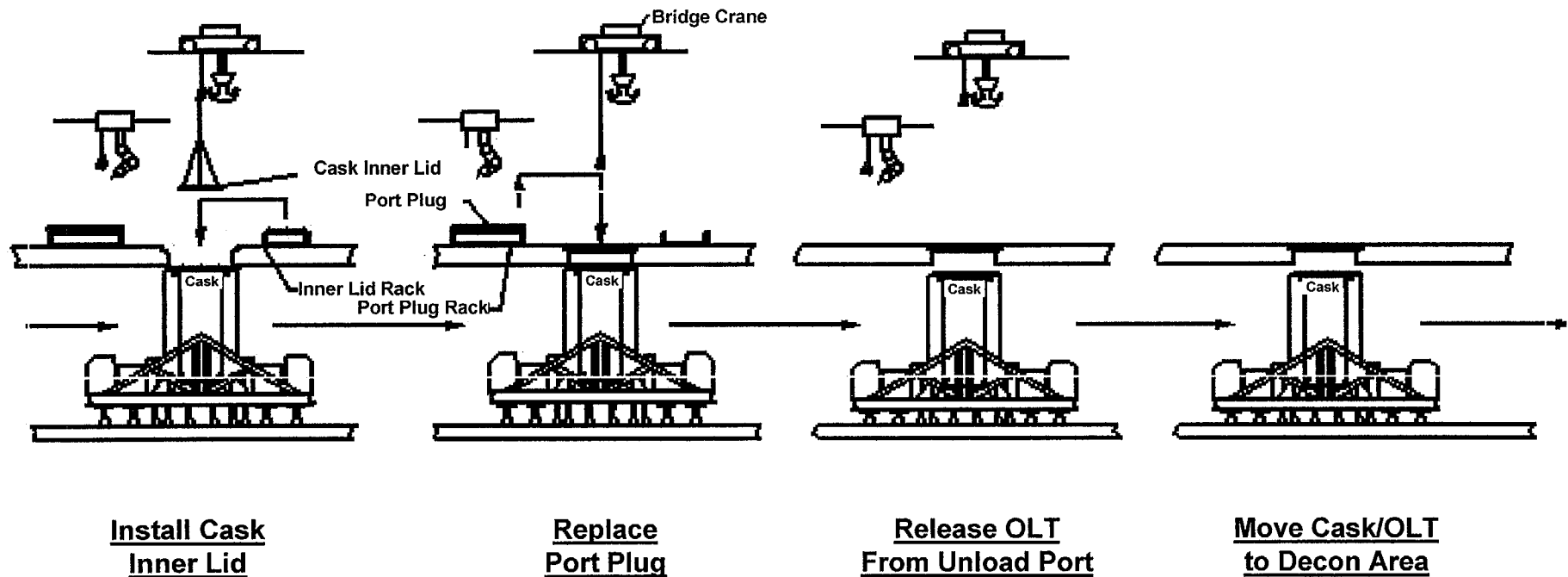
# Dry Waste Transfer Process Flow (Sheet 4)



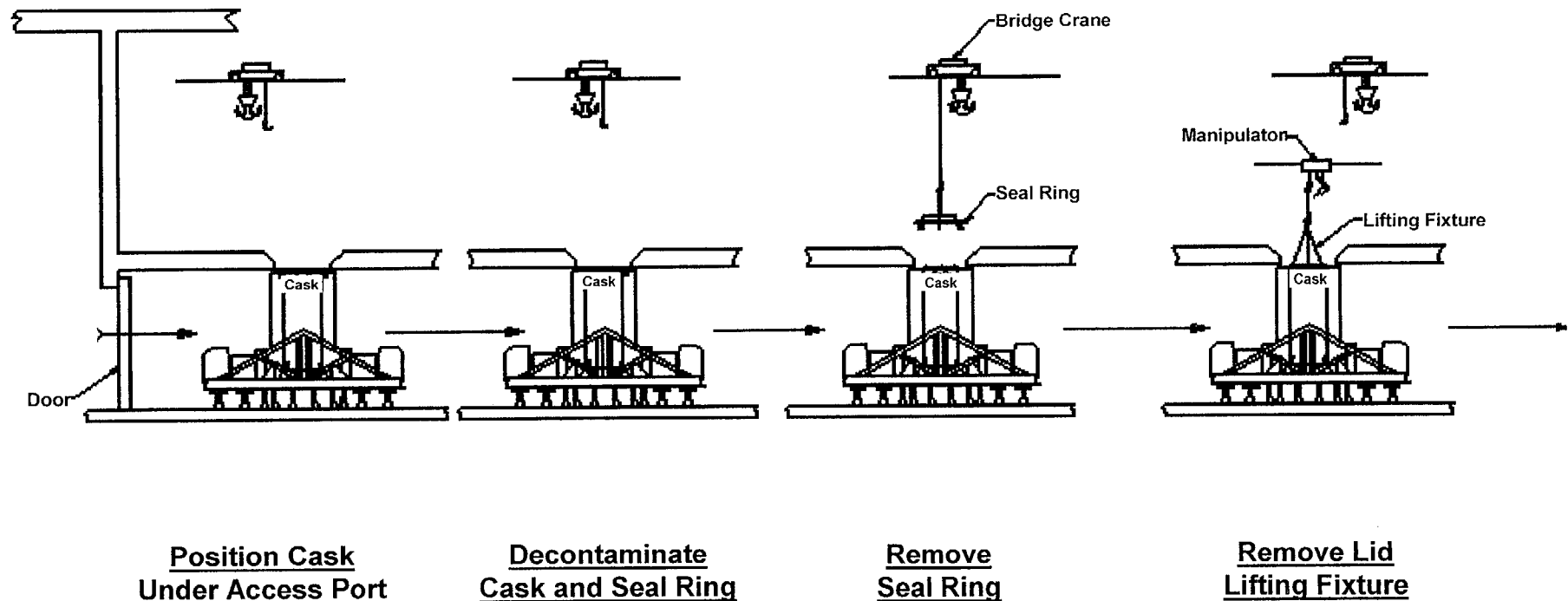
# Dry Waste Transfer Process Flow (Sheet 5)



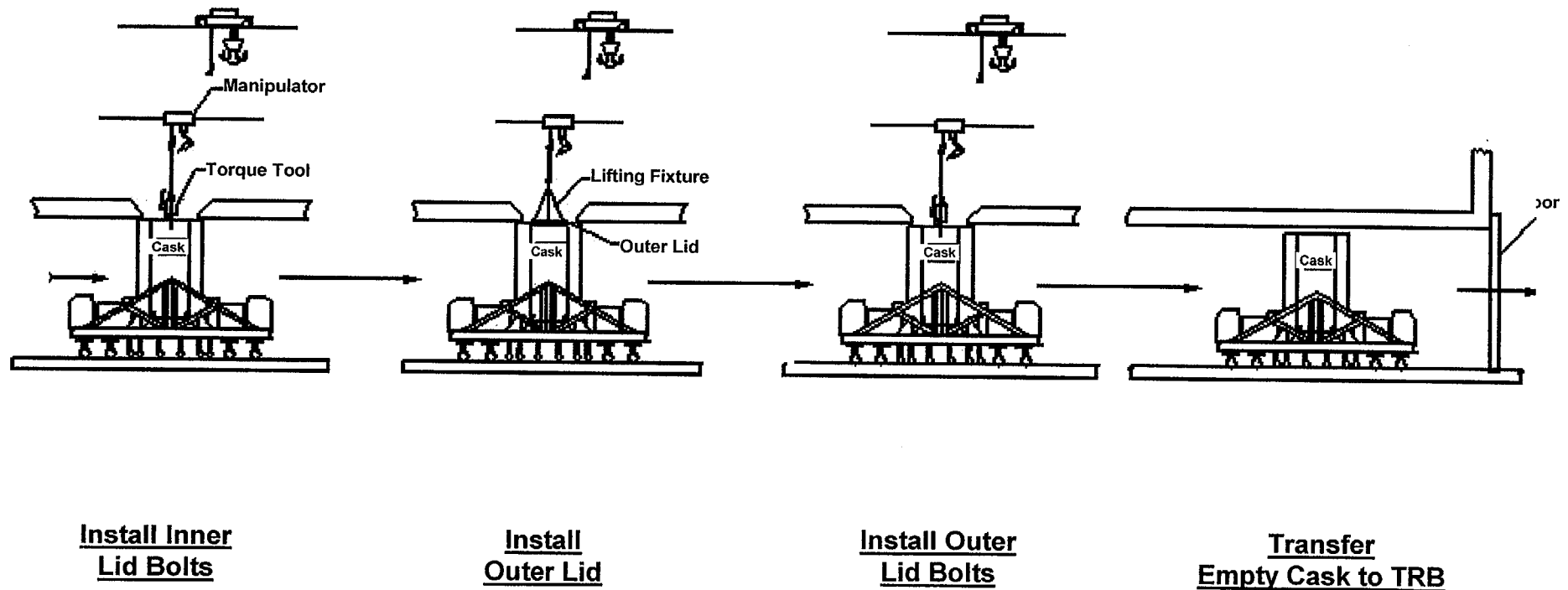
# Dry Waste Transfer Process Flow (Sheet 6)



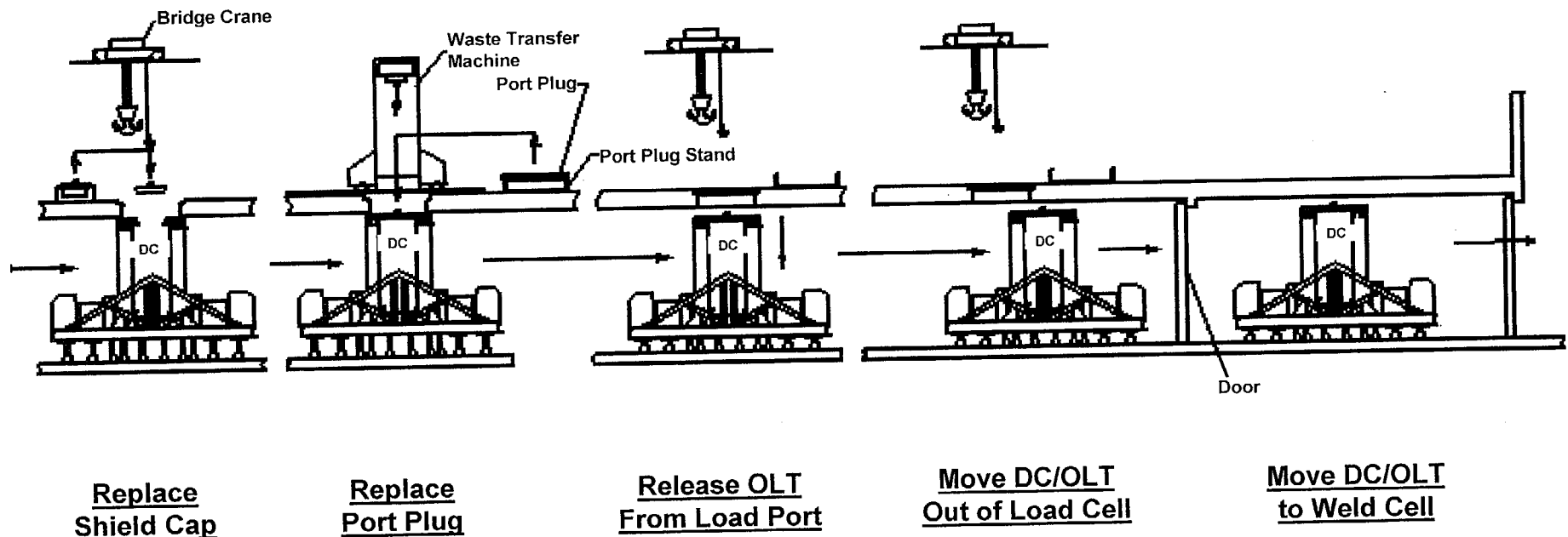
# Dry Waste Transfer Process Flow (Sheet 7)



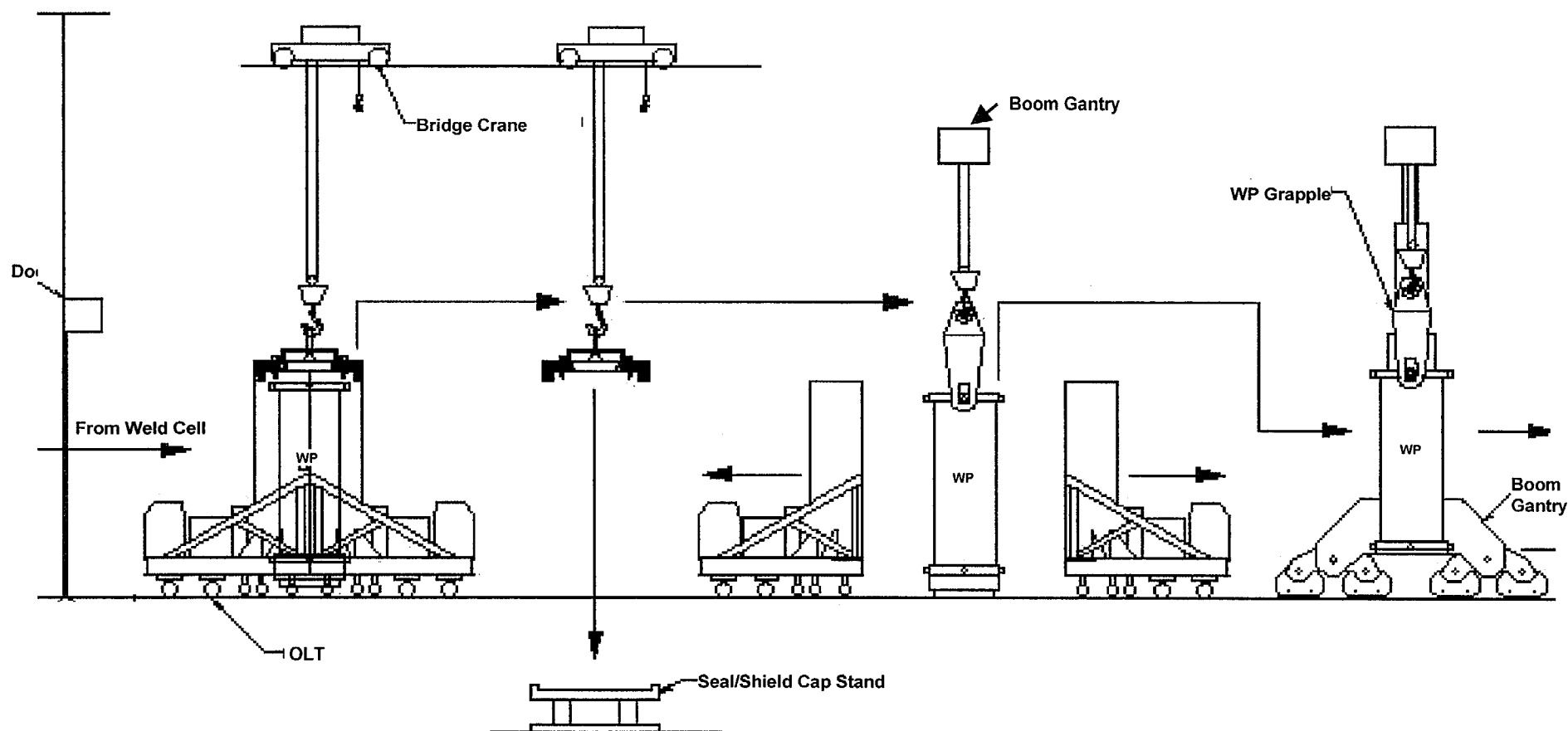
# Dry Waste Transfer Process Flow (Sheet 8)



# Dry Waste Transfer Process Flow (Sheet 9)



# Waste Package Loadout Process Flow (Sheet 1)

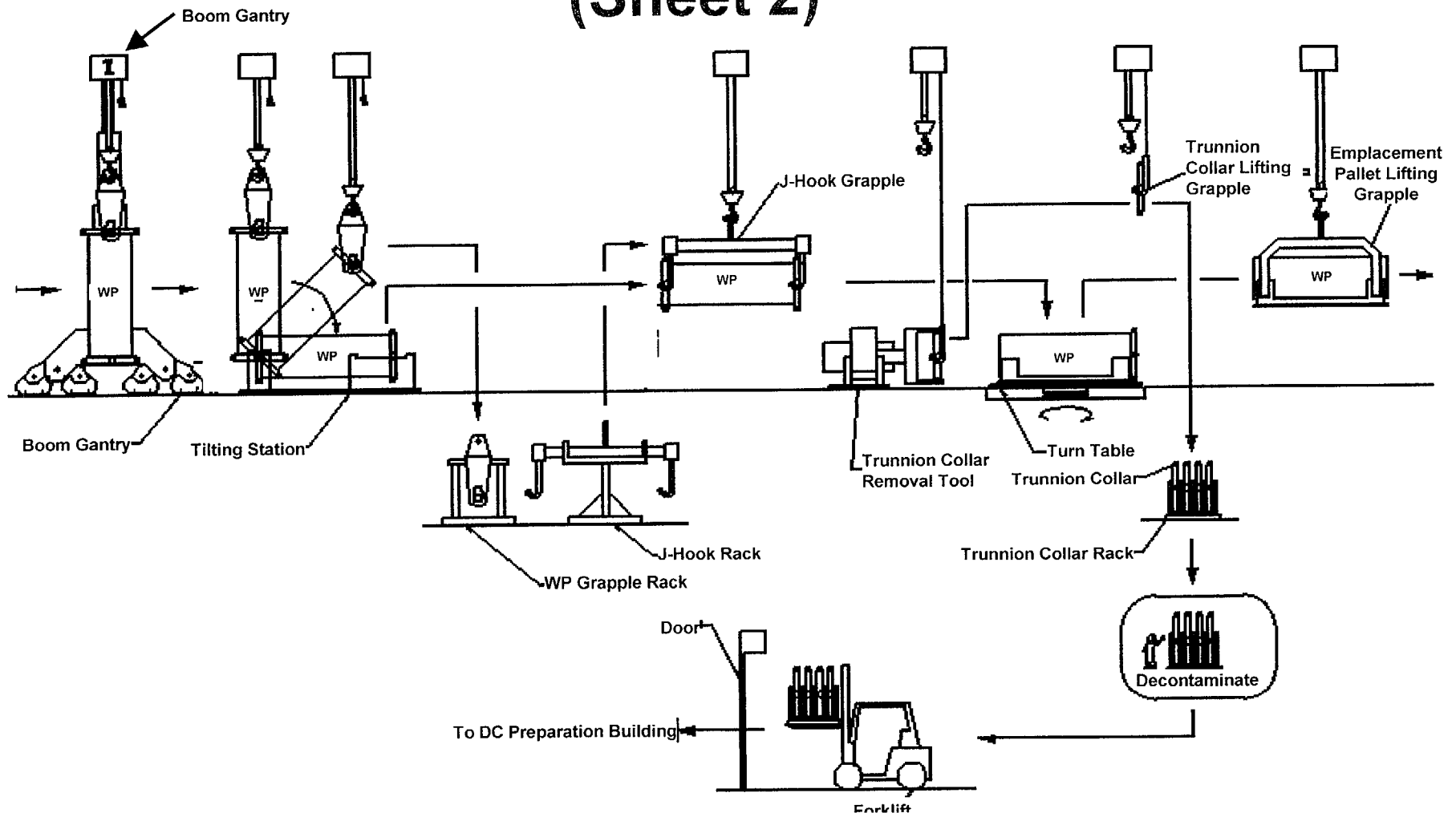


Remove OLT Seal/Shield Cap

Engage WP With Boom Gantry  
And Disengage OLT

Move WP  
to Tilting Station

# Waste Package Loadout Process Flow (Sheet 2)

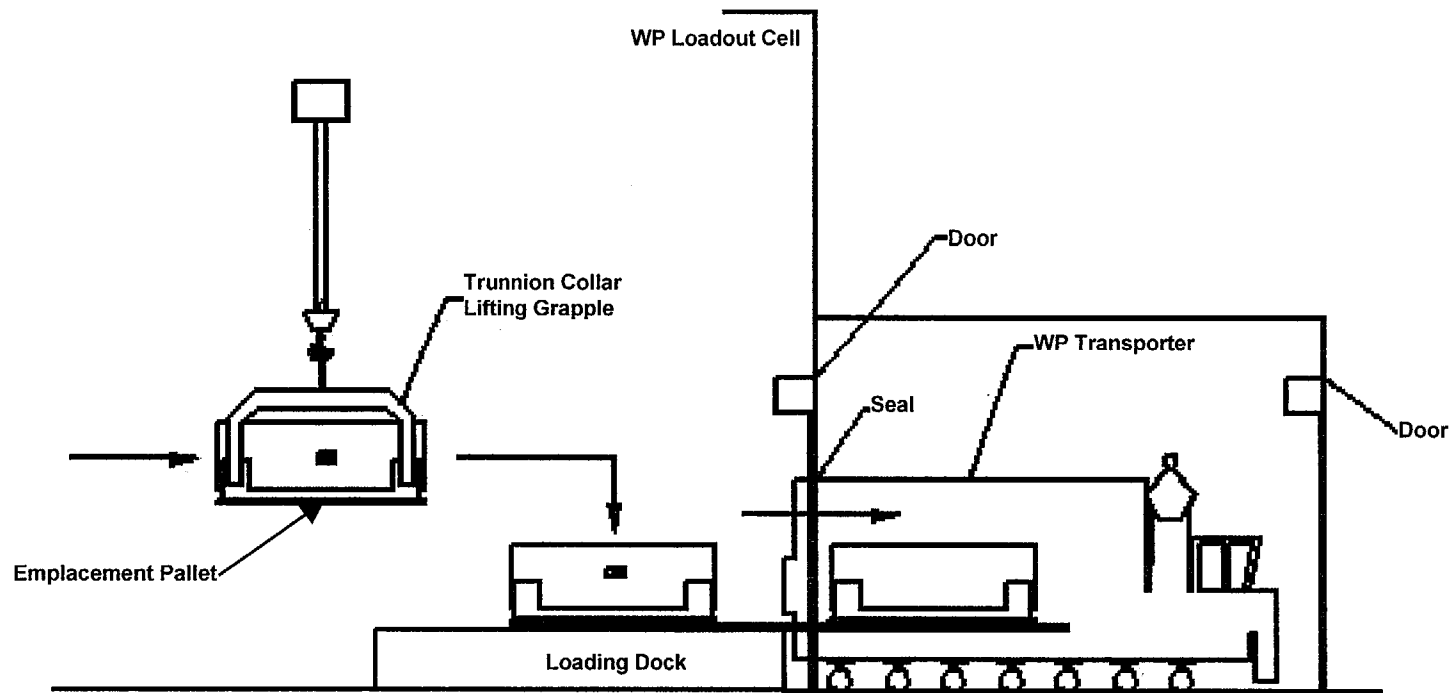


Rotate WP to Horizontal Position

Move WP to Turntable, Place on Emplacement Pallet and Remove Trunnion Collars

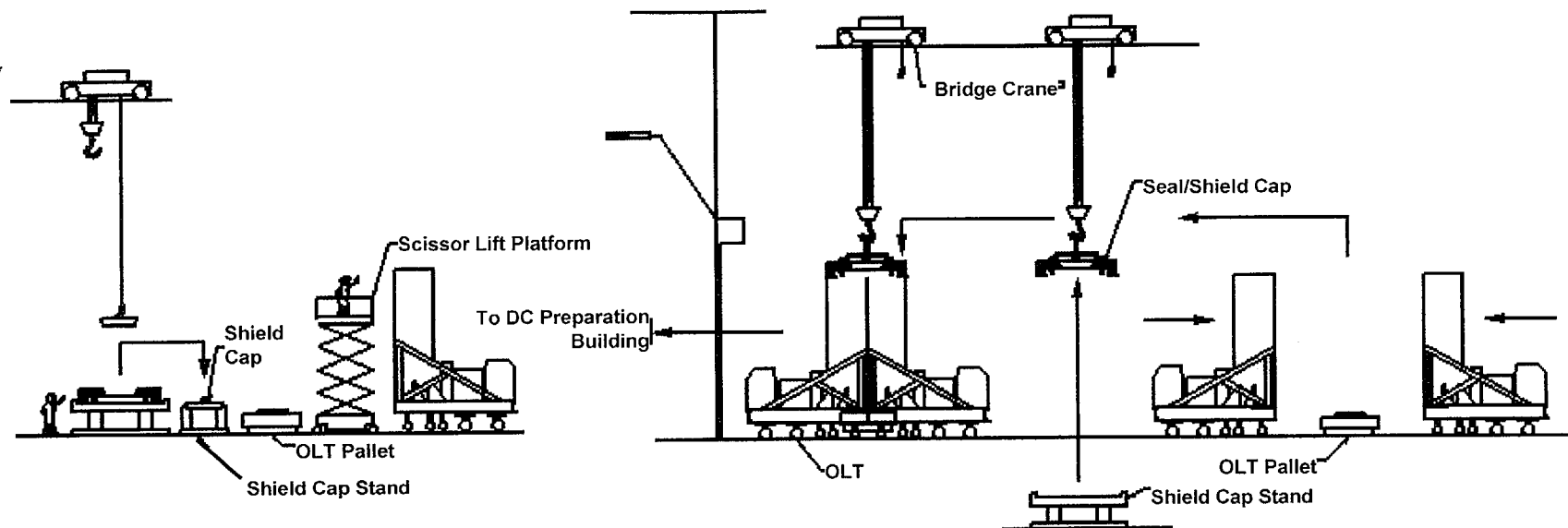


# Waste Package Loadout Process Flow (Sheet 3)



Move WP Into WP Transporter

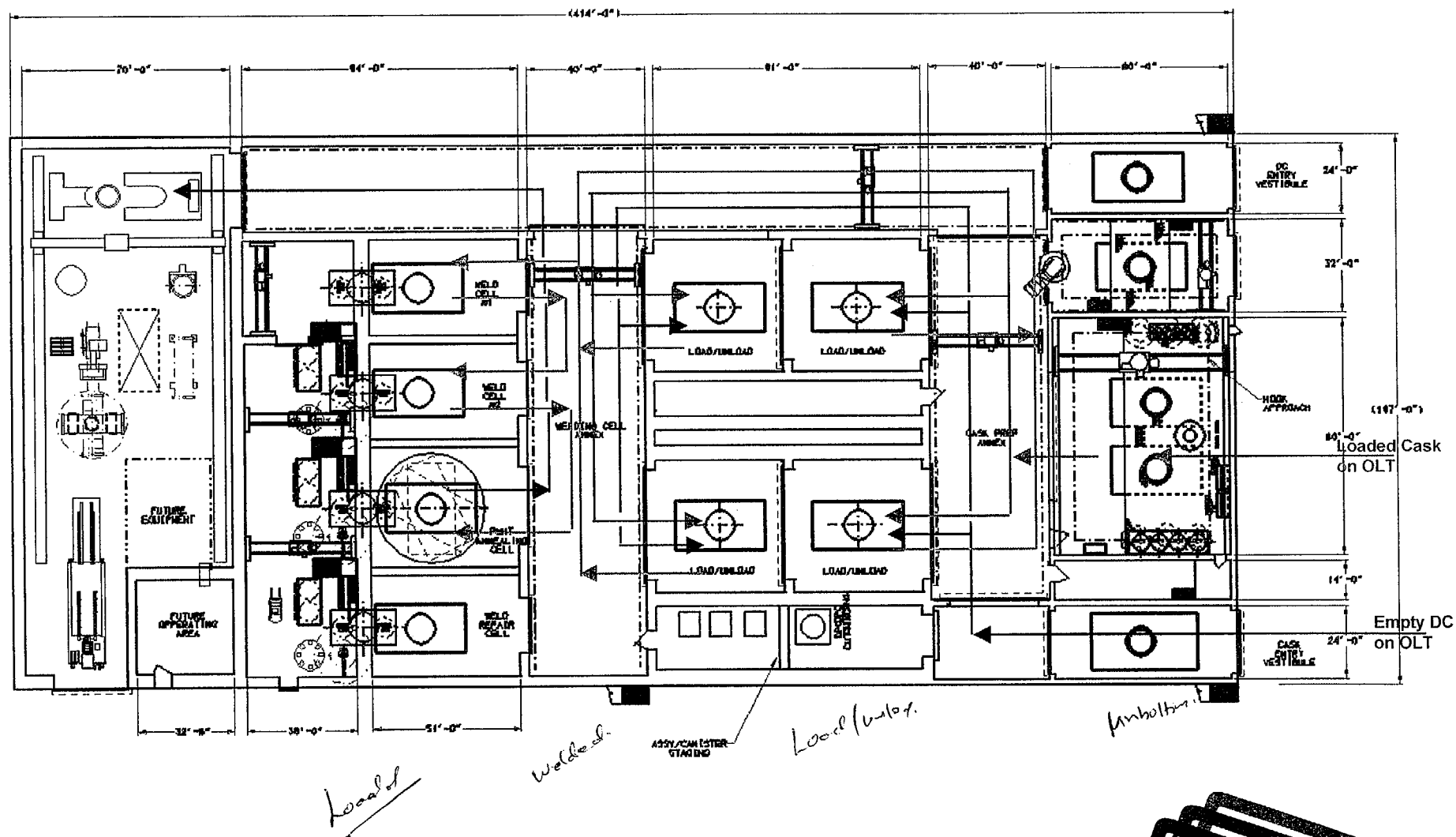
# Waste Package Loadout Process Flow (Sheet 4)



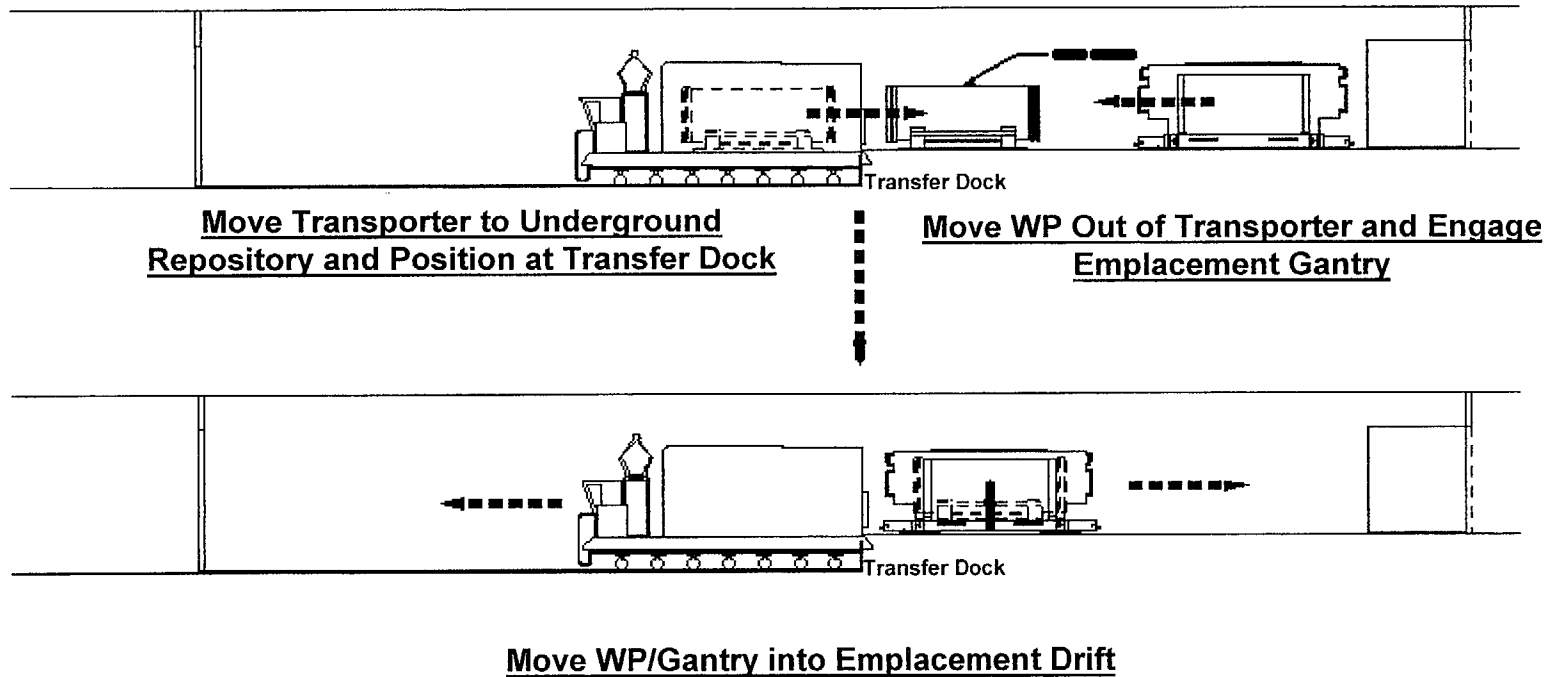
Survey and Decontaminate OLT  
(If Necessary)

Assemble OLT and Return  
to DC Preparation Building

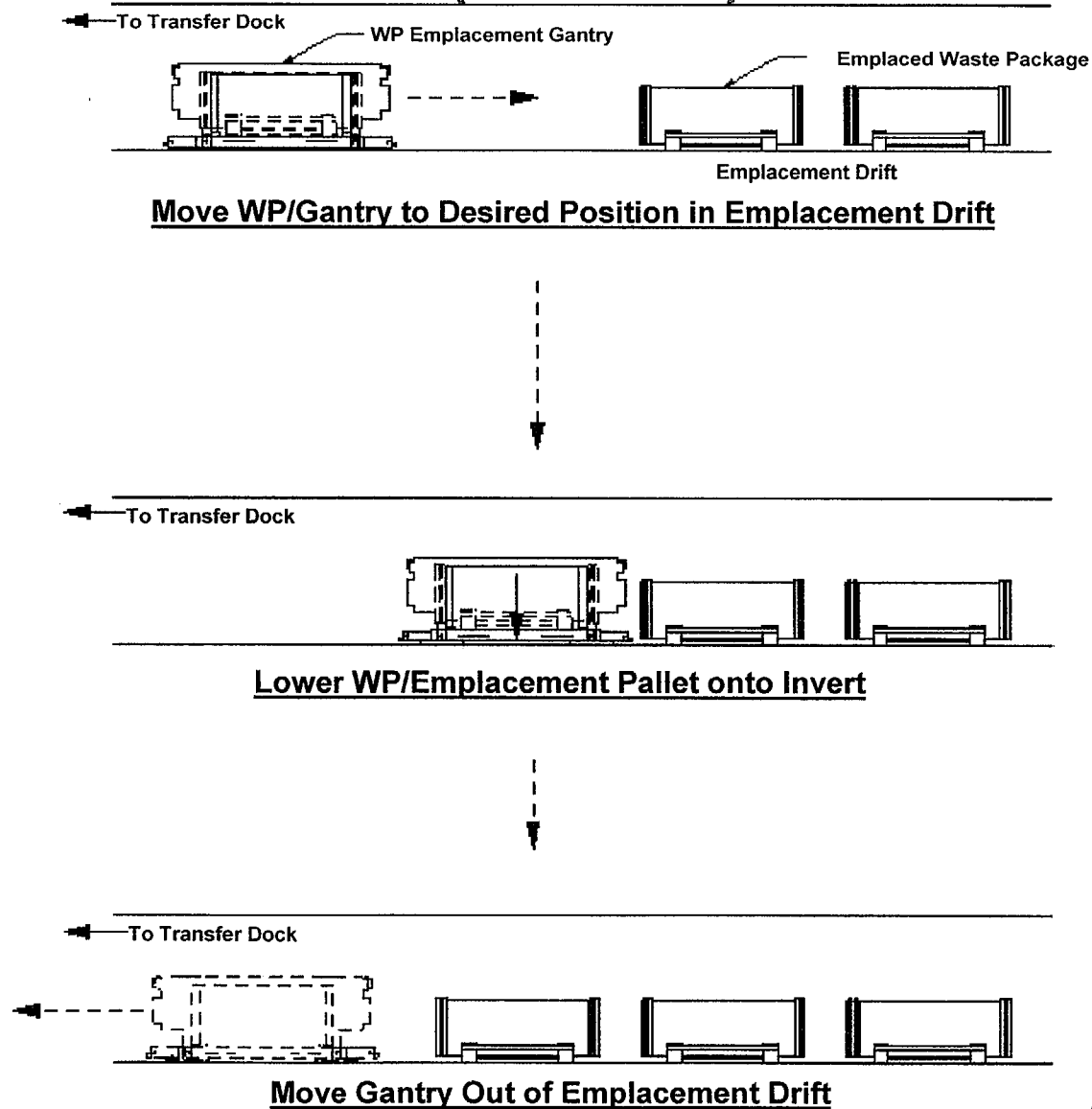
# Dry Facility #2 Equipment Layout



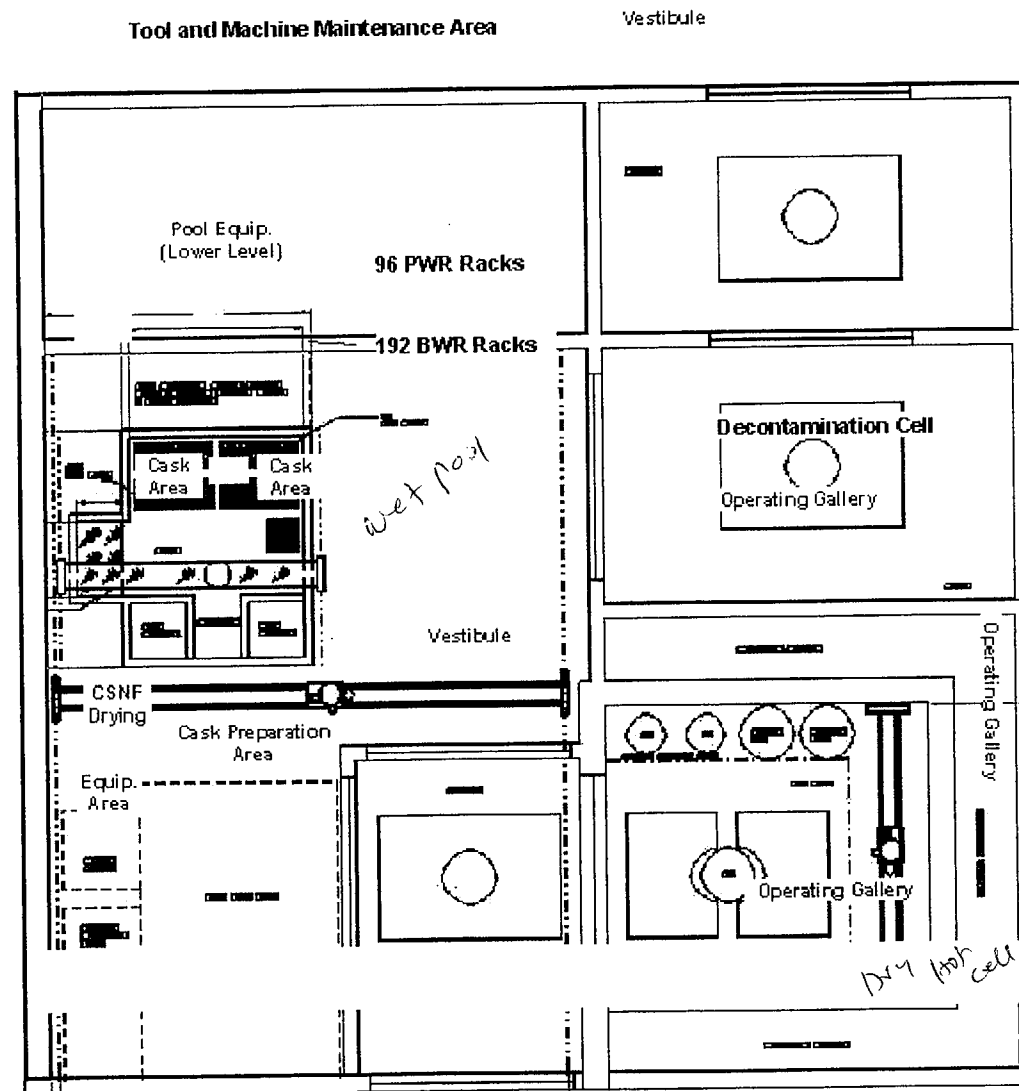
# Waste Emplacement Process Flow (Sheet 1)



# Waste Emplacement Process Flow (Sheet 2)



# Remediation Building Equipment Layout



# Present Status

- **Transporter Receipt Building**
  - Draft (Revision A) Block Flow Diagrams issued
  - Draft (Revision A) Mechanical Flow Diagrams issued
  - Equipment Layout Drawing issued
  - 3-D model under development
- **DC Processing Building**
  - Draft (Revision A) Block Flow Diagrams issued
  - Draft (Revision A) Mechanical Flow Diagrams issued
  - Equipment Layout Drawing issued



# Present Status

(Continued)

- **Dry Facility # 1**
  - Draft (Revision A) of Block Flow Diagrams issued
  - Draft (Revision A) of Mechanical Flow Diagrams issued
  - Equipment Layout Drawing issued
  - 3-D model under development
- **Dry Facility # 2**
  - Draft (Revision A) of Block Flow Diagrams issued
  - Draft (Revision A) of Mechanical Flow Diagrams issued
  - Equipment Layout Drawing issued
  - 3-D model under development





# **Present Status**

(Continued)

- **Remediation Building**
  - **Draft (Revision A) of Block Flow Diagrams under development**
  - **Draft (Revision A) of Mechanical Flow Diagrams under development**
  - **Requirements Drawing under development**





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Office of Civilian Radioactive Waste Management



# Potential Phased Approach to Subsurface Facility Development

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Alan Linden**  
Repository Design Project  
Bechtel SAIC Company, LLC

November 5-6, 2002  
Las Vegas, Nevada

**For Information Only - Unapproved Conceptual Design Information**

# Objectives of Designing the Subsurface Layout for License Application

- Reevaluate the footprint area within which the repository will be sited
- Reevaluate the geologic horizon(s)
- Reevaluate the repository layout so that it can be flexible and accommodate a phased approach

# Repository Layout Considerations

- **Assure waste isolation and repository safety**
- **Impact on Key Technical Issue (KTI) agreements**
- **Impact on modeling uncertainties or confidence**
  - Geometric complexity of layout and impact on models
  - Sufficiency of model input - is data sufficient and of proper quality for model validations and predictions
  - Geologic complexity and variability
  - Schedule implications for Performance Assessment process model modifications
- **Impact of disruptive events**
  - Igneous intrusion
  - Seismic stability of excavations
- **Constructability**
  - Flexibility of layout
  - Complexity of construction



# Footprint Assumptions and Criteria

- **Restricted to existing characterized area**
- **Accommodate 70,000 MTHM under a range of thermal management modes**
- **Minimize number of emplacement levels in the repository**
- **Standoff between emplacement levels (non overlapping areas)**
- **PTn (Paintbrush Unit) offset to avoid thermal alterations**
- **CH (Calico Hills Unit) offset to avoid chemical alterations**
- **Reduce uncertainties associated with disruptive events**



# Footprint Bounding Criteria

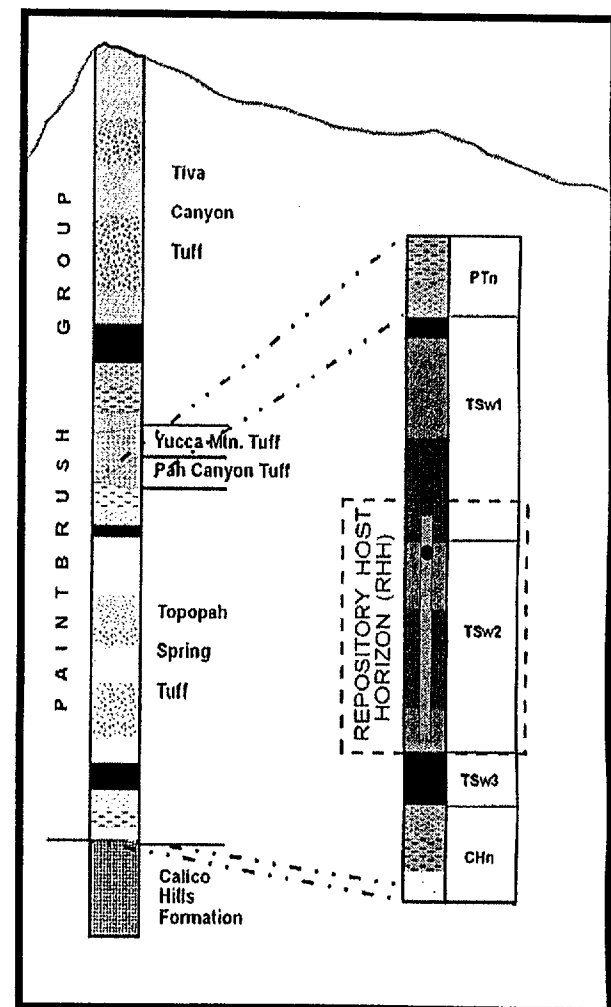
- **Maintain waste isolation and repository safety**
- **Water table offset to accommodate potential future water level rise (climate change)**
- **Perched water offset to avoid vaporization**
- **Standoff from Type 1 faults**
- **Overburden Standoff**



# Repository Host Horizon

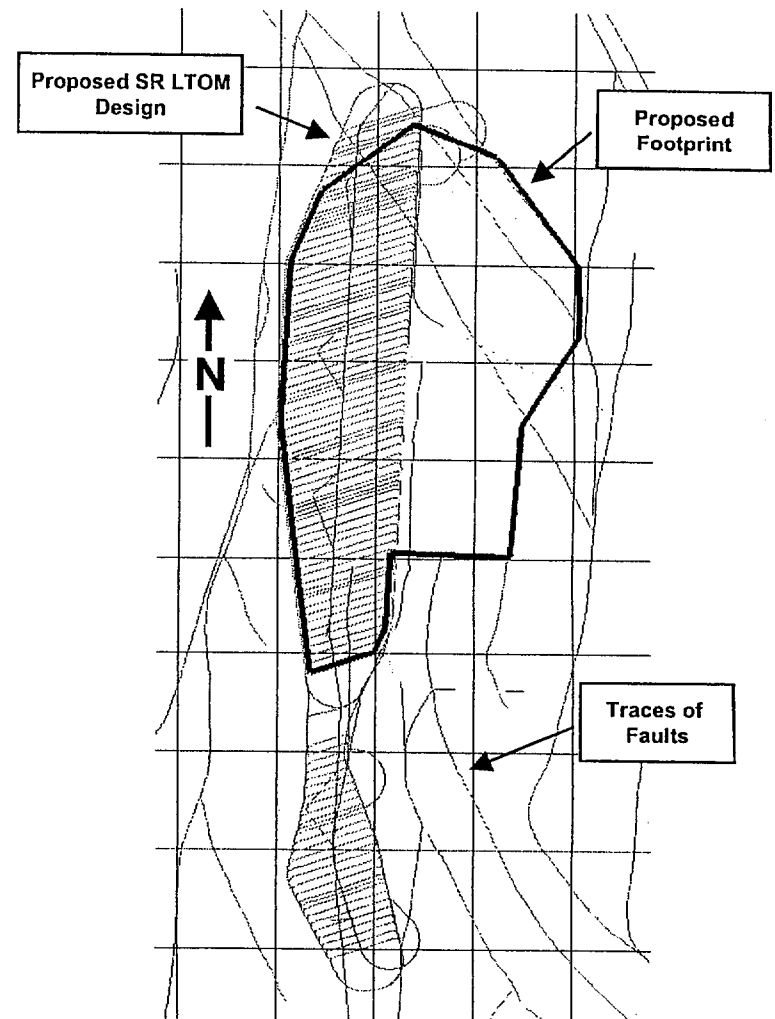
- **Host Horizon Consists of Four Subunits of the Topopah Spring Formation**

Subunit	Thickness
Upper Lith (Tptpul)	50 to 80 m
Middle Non-Lith (Tptpmn)	30 to 40 m
Lower Lith (Tptpli)	70 to 120 m
Lower Non-Lith (Tptpli)	10 to 60 m



# Proposed Footprint

- **Proposed footprint within the bounds of the Final Environmental Impact Statement (FEIS) and the Characterized Area**
- **The emplacement areas were reduced from the Site Recommendation (SR) for the proposed footprint to help reduce modeling uncertainties**
  - **SR Emplacement Area has been reduced by 23% (11% in the Southern Area)**
  - **81% of the proposed footprint lies within the SR Emplacement Area**





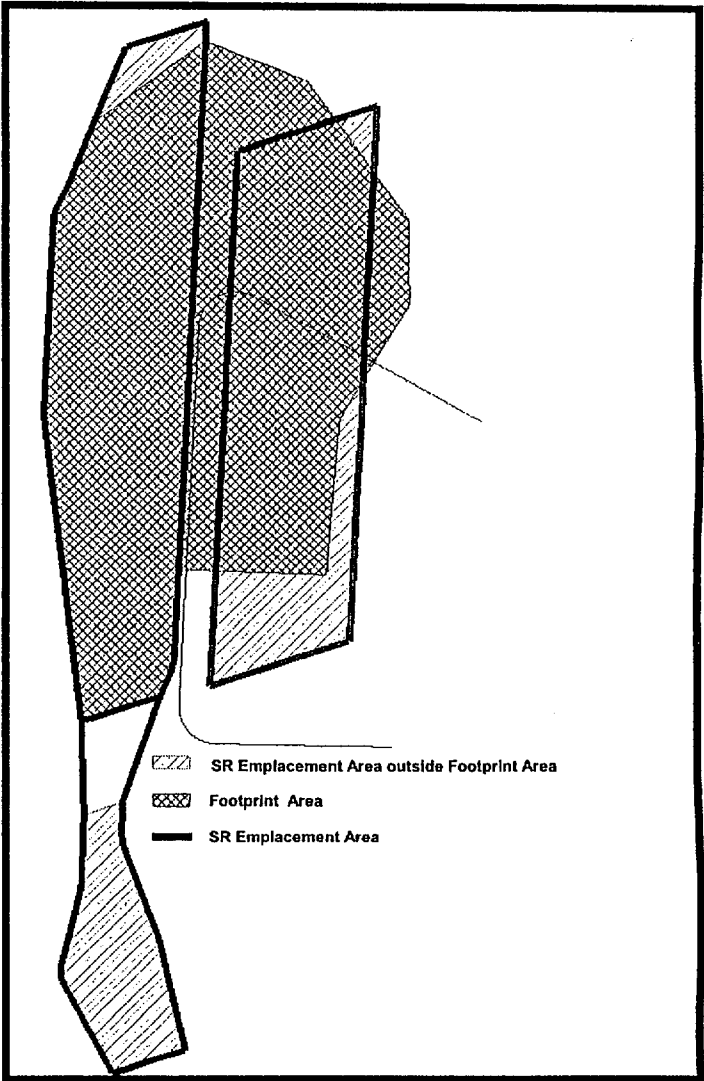
# Proposed Footprint

(Continued)

- **SR Emplacement Areas that were reduced for modeling uncertainties**
  - North Area - Water table uncertainties
  - Southeast Area - Faulting uncertainties (Imbricate fault system)
  - South and West Areas - Limited characterization data

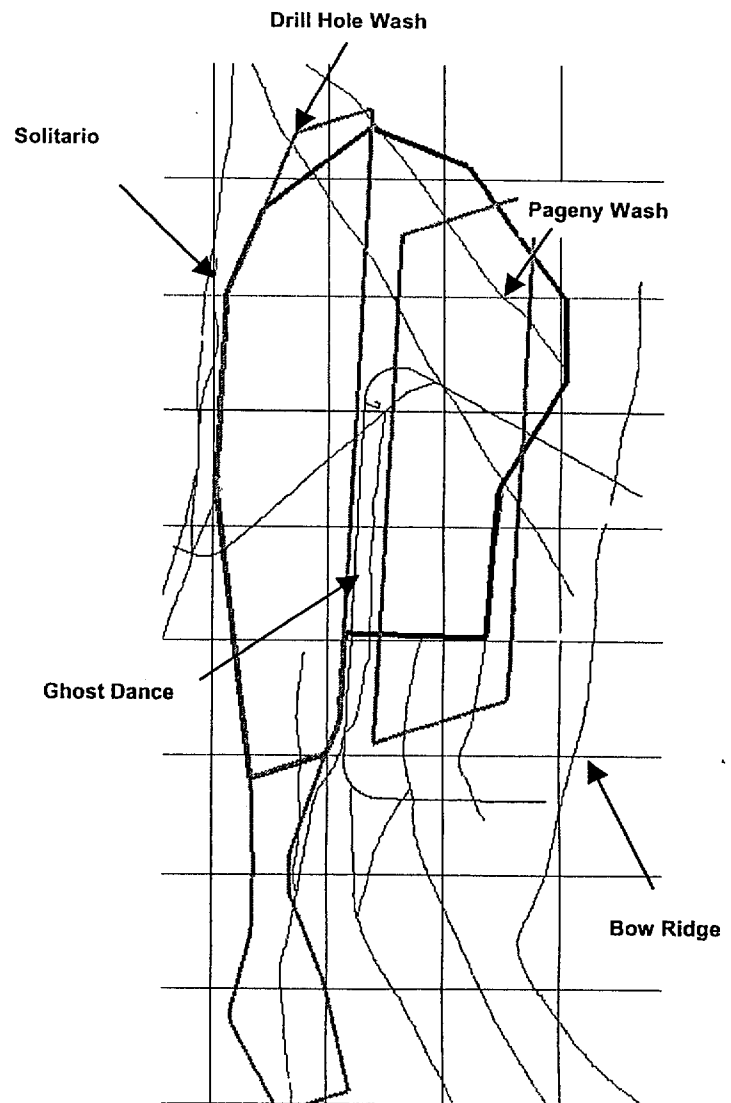
- **Geological Subunit Distribution for 70,000 metric tons of heavy metal (MTHM)**

Subunit	SR	Proposed
Tptpul	0 %	6%
Tptpmn	7%	23%
Tptpll	73 %	68%
Tptpln	20%	3%



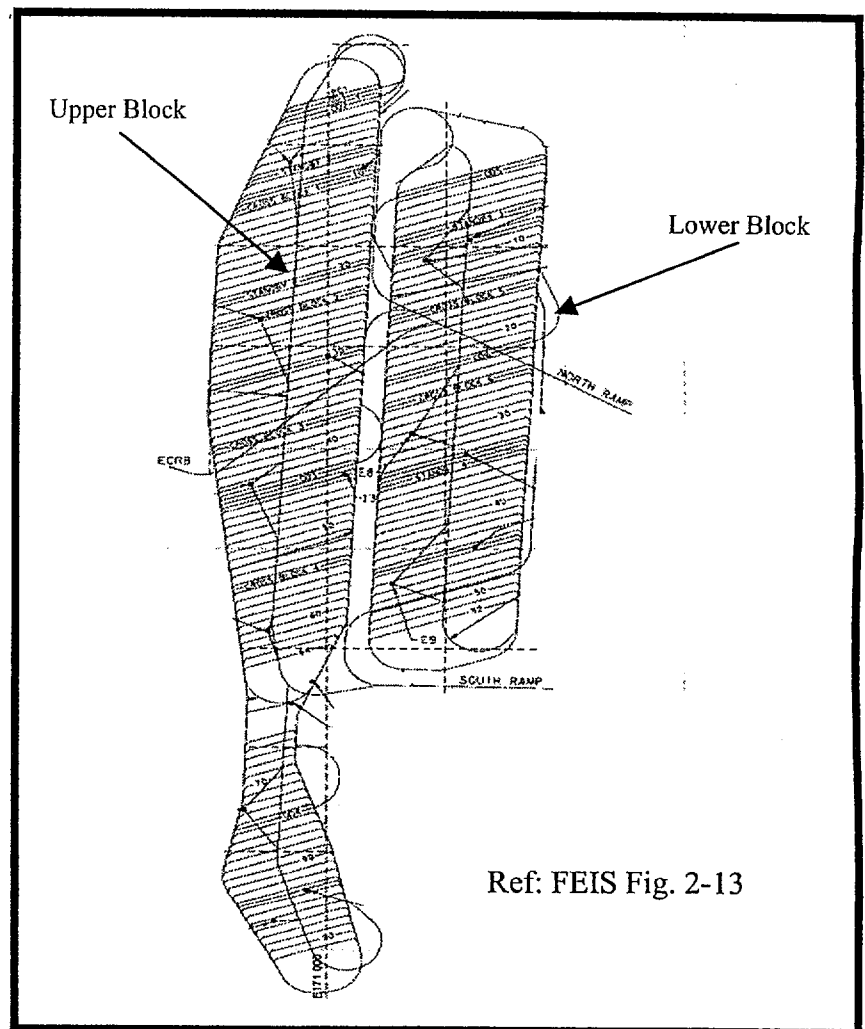
# Faults

- The proposed footprint is bounded by the two Type 1 Faults
  - Solitario
  - Bow Ridge
- Minimal area disturbed by other faults
  - Ghost Dance
  - Drill Hole Wash
  - Pageny Wash
- Faults that are no longer within the proposed emplacement area
  - Dune Wash
  - Abandon Wash
  - Imbricate System



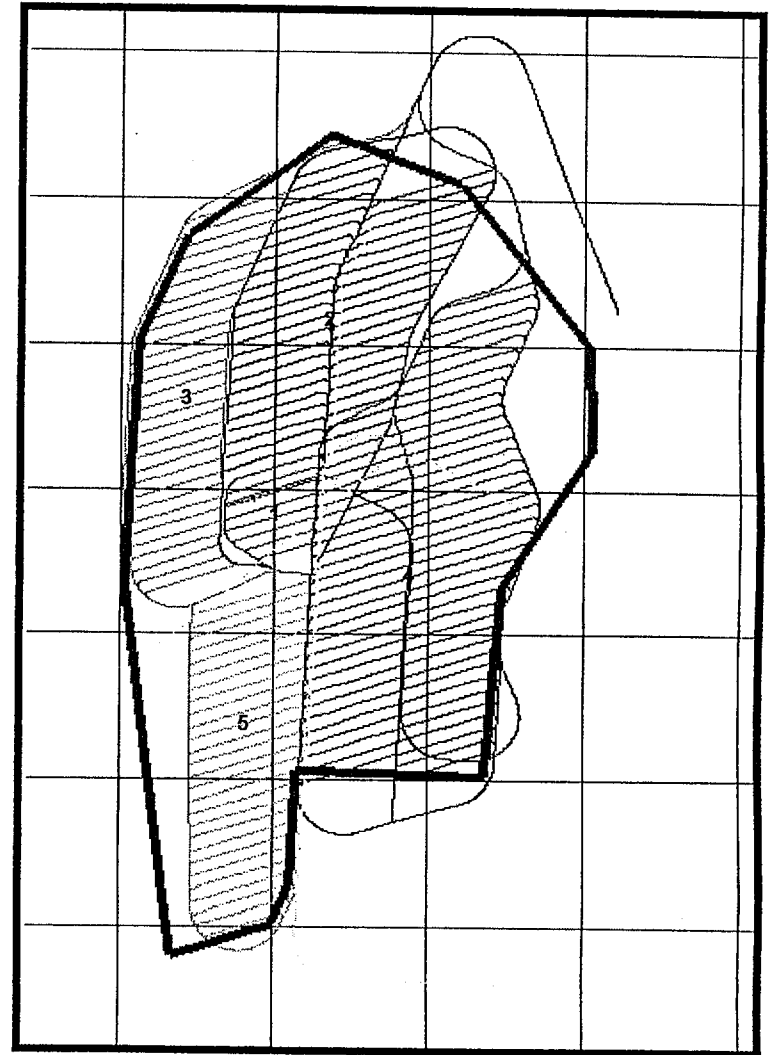
# Site Recommendation Design Subsurface Layout

- **Upper Block for reference design (SR) emplacement (70,000 MT)**
- **Lower Block available for expansion, consistent with FEIS**



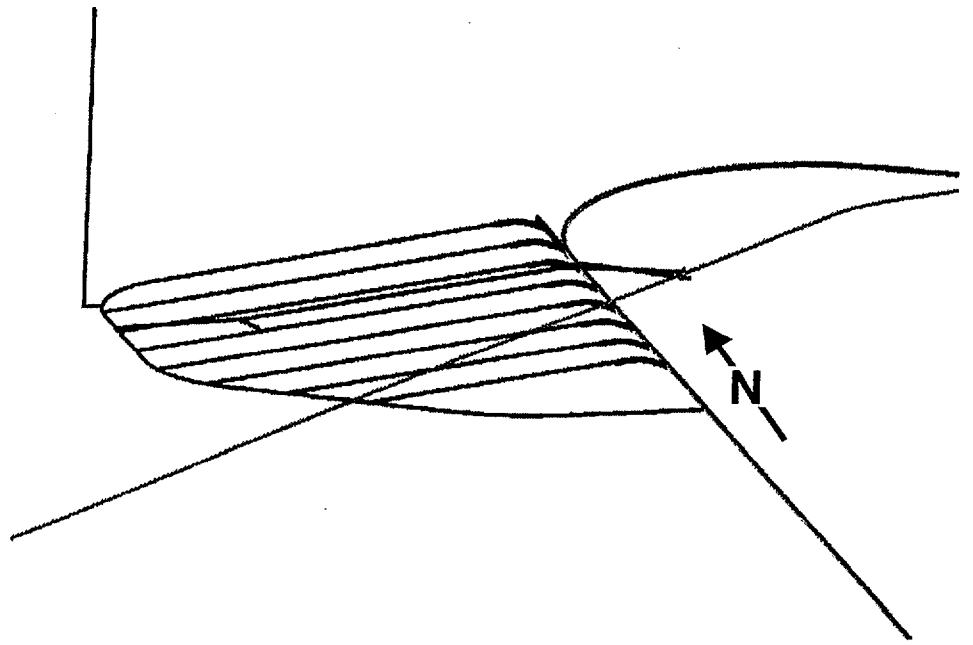
# Proposed Underground Layout

- **Phased panel layout**
  - “Adaptive staging” for applying lessons learned
  - Improved incremented exploration and performance confirmation testing
  - Improved ventilation scheme
  - 3rd access ramp
- **Proposed layout has:**
  - 69 miles (110 km) of emplacement drift (5 panels)
  - 3.5 miles (5.5 km) less total excavation than SR design for 70,000 MTHM case
  - 5 miles (8 km) more emplacement drift than SR design for 70,000 MTHM case



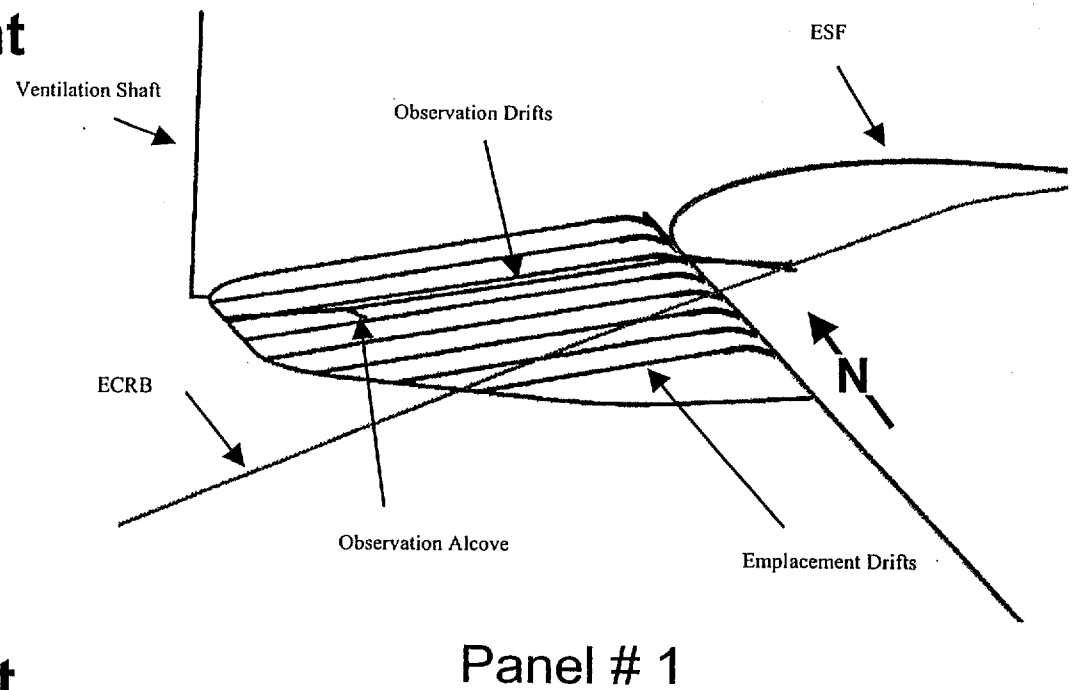
# Initial Construction Concept (Panel 1)

- Utilizes Exploratory Studies Facility (ESF) for construction of small initial emplacement Panel 1
- Panel #1 consists of 8 emplacement drifts
- 4100 m (13,000 ft) of useable drift
- Panel # 1 located in Tptpll (60%) and in Ttpmn (40%)
- Ventilation independent using North Ramp and Exhaust Raise
- A portion of Panel #1 can be used as a test area



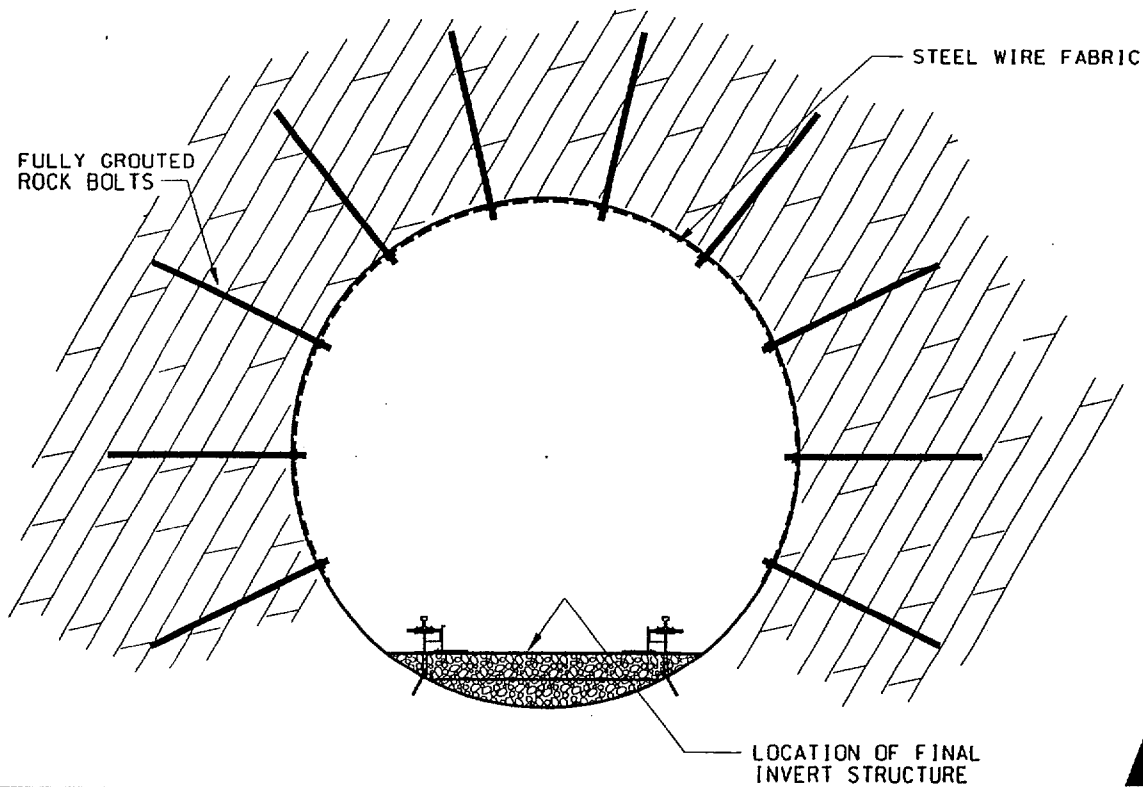
# Proposed Test Facility

- Utilize portion of Panel 1 to acquire additional engineering and scientific data, prior to emplacement
- Defines future testing program
- Testing program starts in the early stages of emplacement operations
- Representative location
- Minimal impact on the underground development schedule

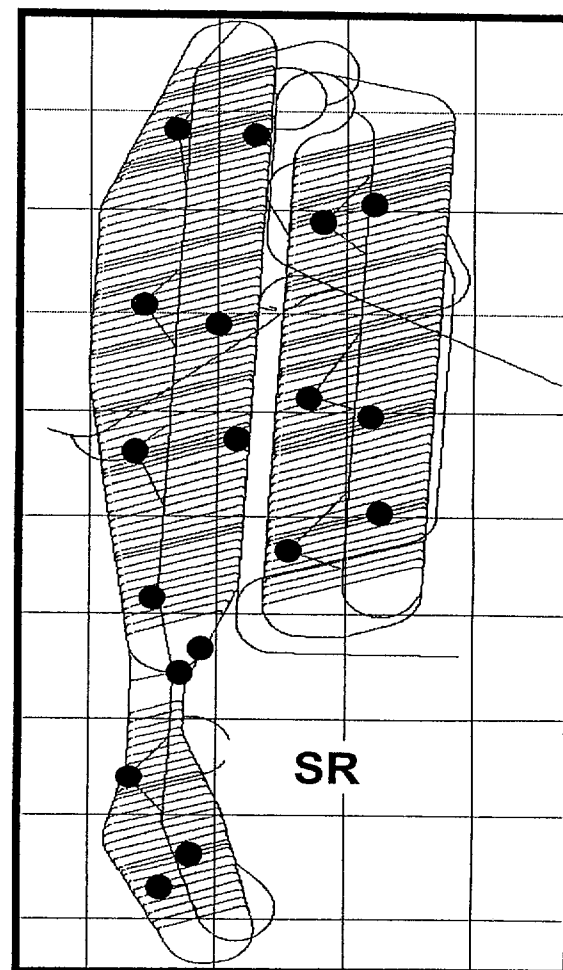
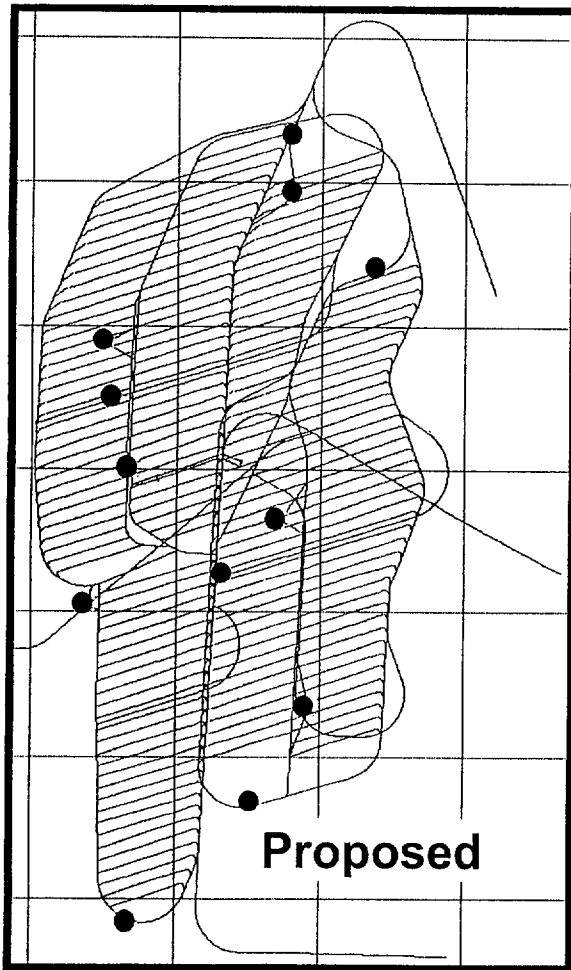


# In-Drift Configuration

- **Recommended from the Re-Evaluation**
  - **Circular tunnel with a rock bolt and mesh ground support system (with steel sets as required), and the SR invert, a steel structure with ballast**



# Ventilation



Proposed  
locations of  
Ventilation  
Shafts

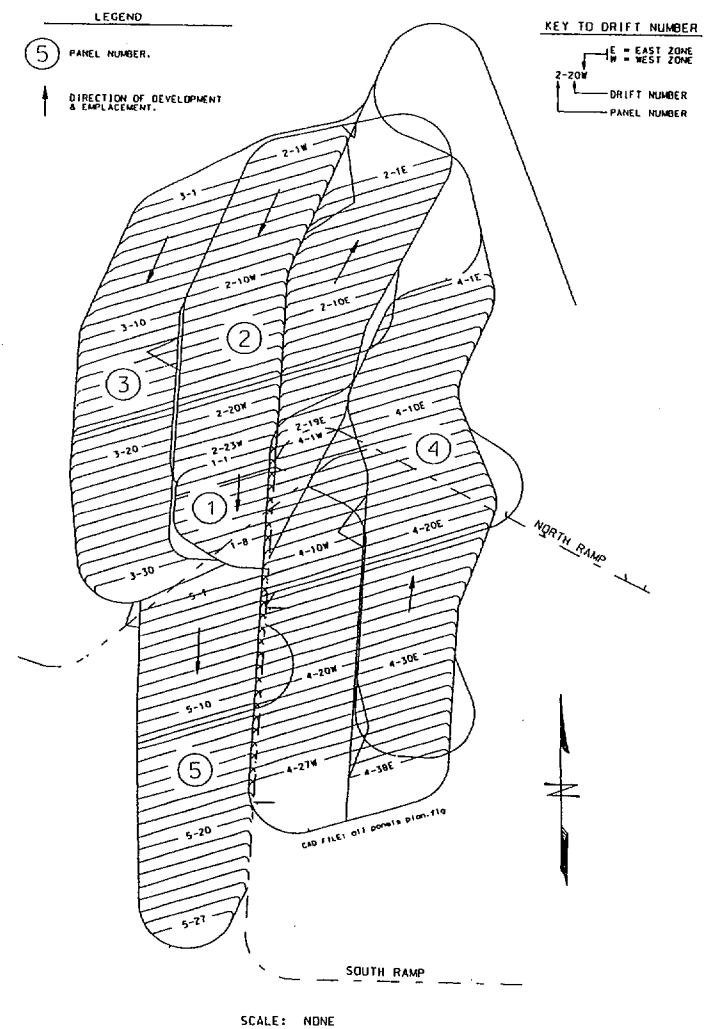
- Overall ventilation system concept remains the same
- Reduced the overall number of shafts
- Simplified the ventilation control system





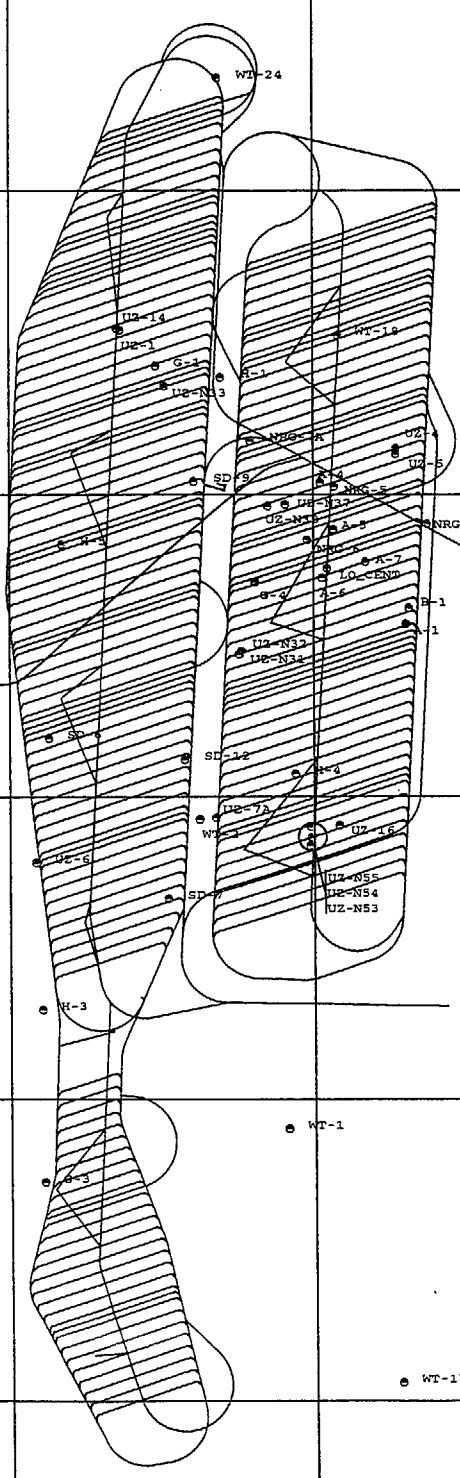
# Proposed Construction/Emplacement Sequence

- Panel 1 is constructed and emplaced North to South
- Panel 2 is constructed and emplaced South to North
- Panel 3 is constructed and emplaced North to South
- Panel 4 is constructed and emplaced South to North
- Panel 5 is constructed and emplaced North to South
- Separation between Operation and Construction is maintained by independent accesses and bulkheads

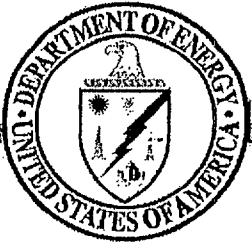


	● UZ-N11	● WT-6		
	● G-2			
	● WT-24	● WT-16		
	● WT-15			
● H-6	● WT-14			
● WT-7	● WT-13			
● H-3	● WT-12			
● G-3	● WT-11			
● WT-10	● WT-10			
	● WT-9			
	● WT-8			
	● WT-7			
	● WT-6			
	● WT-5			
	● WT-4			
	● WT-3			
	● WT-2			
	● WT-1			
	● WT-17			
	● WT-18			
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	● WT-97			
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	● WT-99			
	● WT-100			

Proposed Underground Layout  
with Boreholes Locations



SR Design Subsurface Layout  
with Boreholes Locations



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



# Status of Waste Package Design and Fabrication

Presented to:

**Nuclear Regulatory Commission**

Presented by:

**Jack D. Cloud**

**Repository Design Project**

**Bechtel SAIC Company, LLC**

**November 5-6, 2002**

**Las Vegas, Nevada**

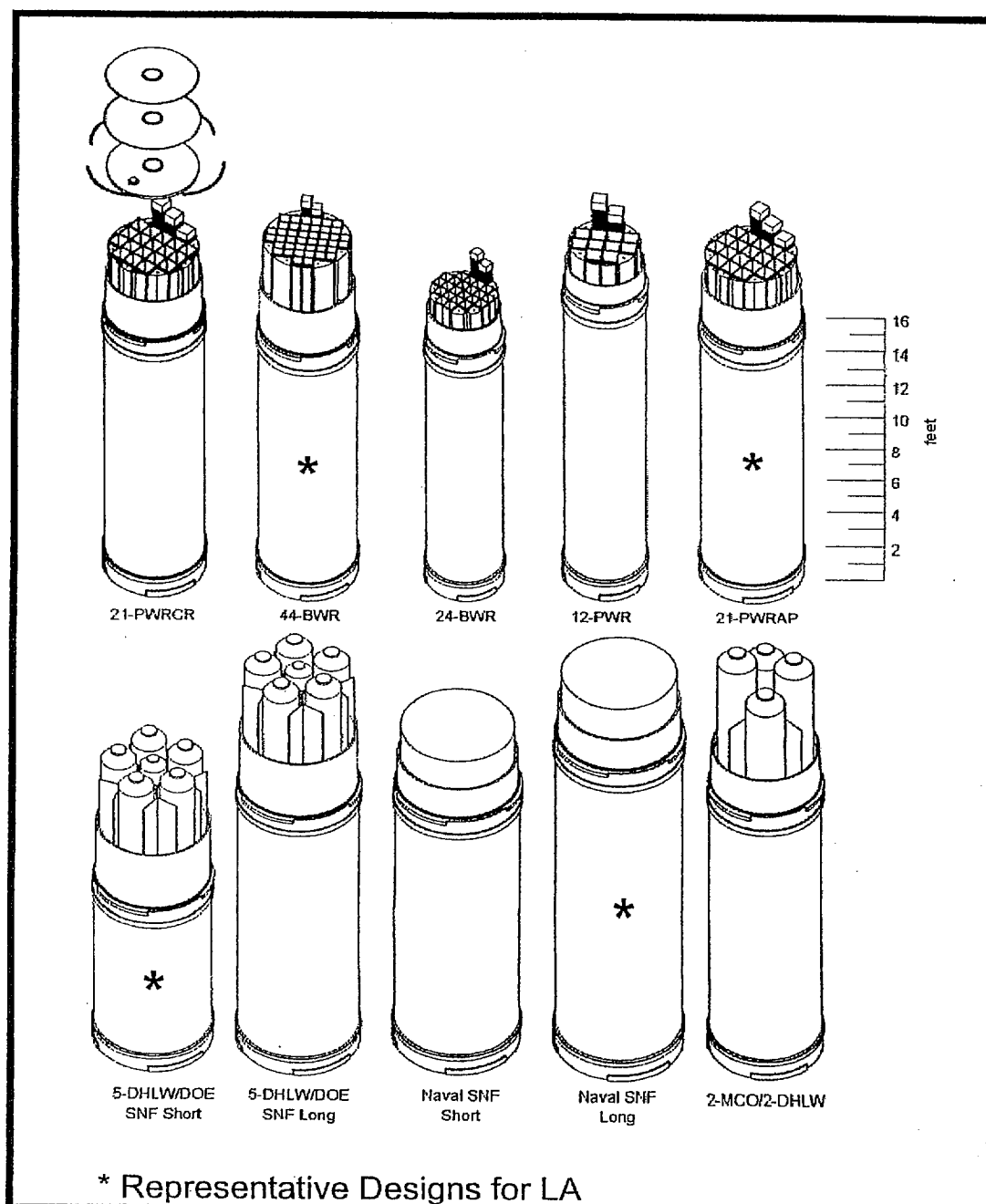
**For Information Only - Unapproved Conceptual Design Information**

# Topics

- **Design Status**
  - Basic design approach
  - Proposed design improvements
- **Fabrication Status**
  - Current development studies
  - Prototype strategy

# Basic Design Approach for License Application

- Current plans call for 10 waste packages
- Compliance to safety/design requirements will be demonstrated in the preliminary design for the following four representative waste package designs in the initial License Application (LA) submittal
  - 21-Pressurized-Water Reactor (PWR) Absorber Plate waste package
  - 44-Boiling Water Reactor (BWR) Absorber Plate waste package
  - Naval Canistered Spent Nuclear Fuel (SNF) Long waste package
  - 5-Defense High Level Waste/DOE SNF Co-disposal Short waste package



# Basic Design Approach for License Application

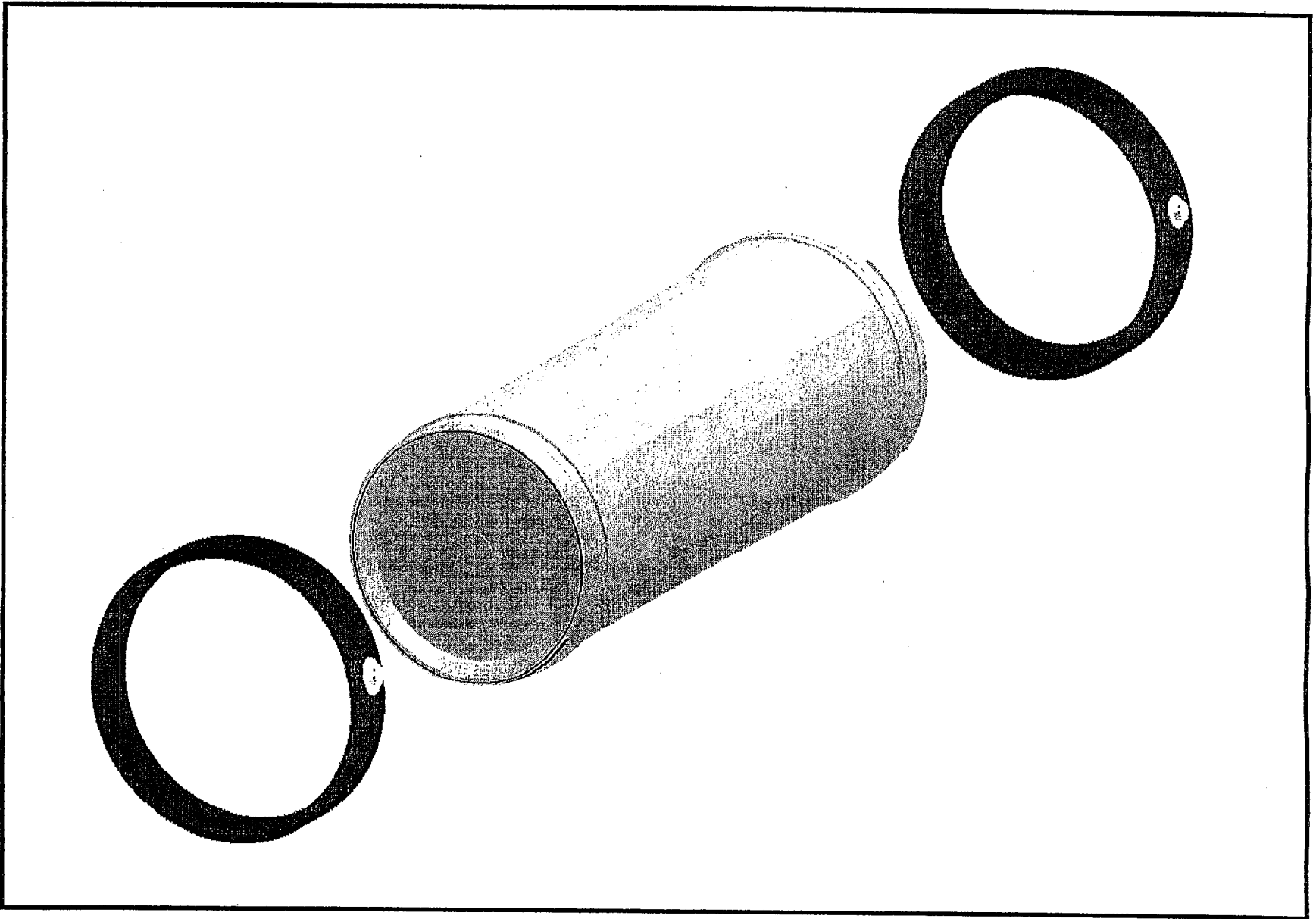
(Continued)

- These four representative preliminary designs will be completed for initial License Application in December 2004
  - The current waste form types are represented
  - 65 percent of emplaced waste packages representing 75 percent MTHM
  - Design methodology and preliminary design will be complete and demonstrated for the four representative waste packages
  - Design methodology will be identical for all 10 waste packages
  - All designs rely on the same performance components
- ? Preliminary design of the remaining 6 waste packages and detailed design for all 10 waste packages are targeted to be completed by Calendar Year (CY) 2008

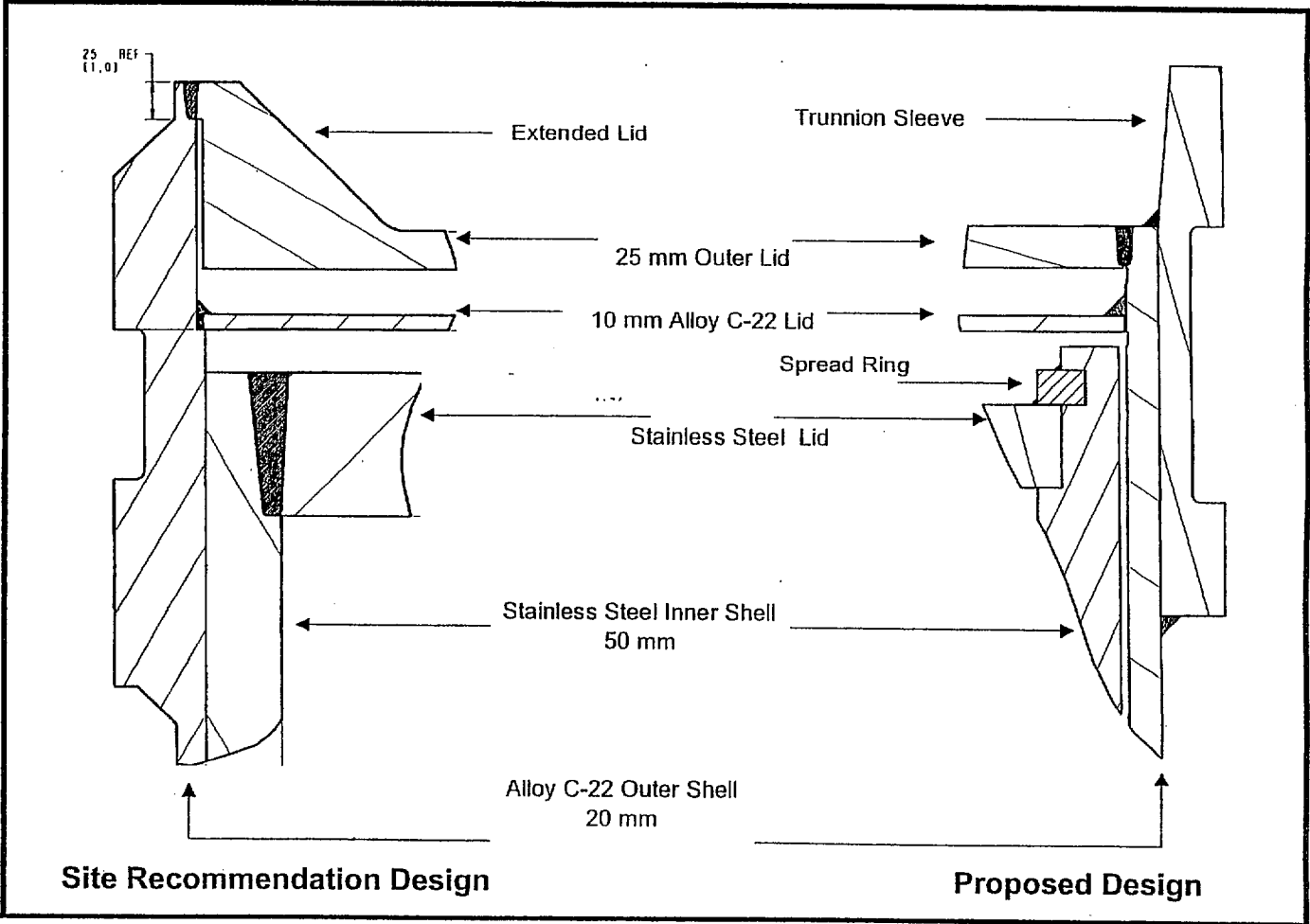


# Proposed Waste Package Design Improvements

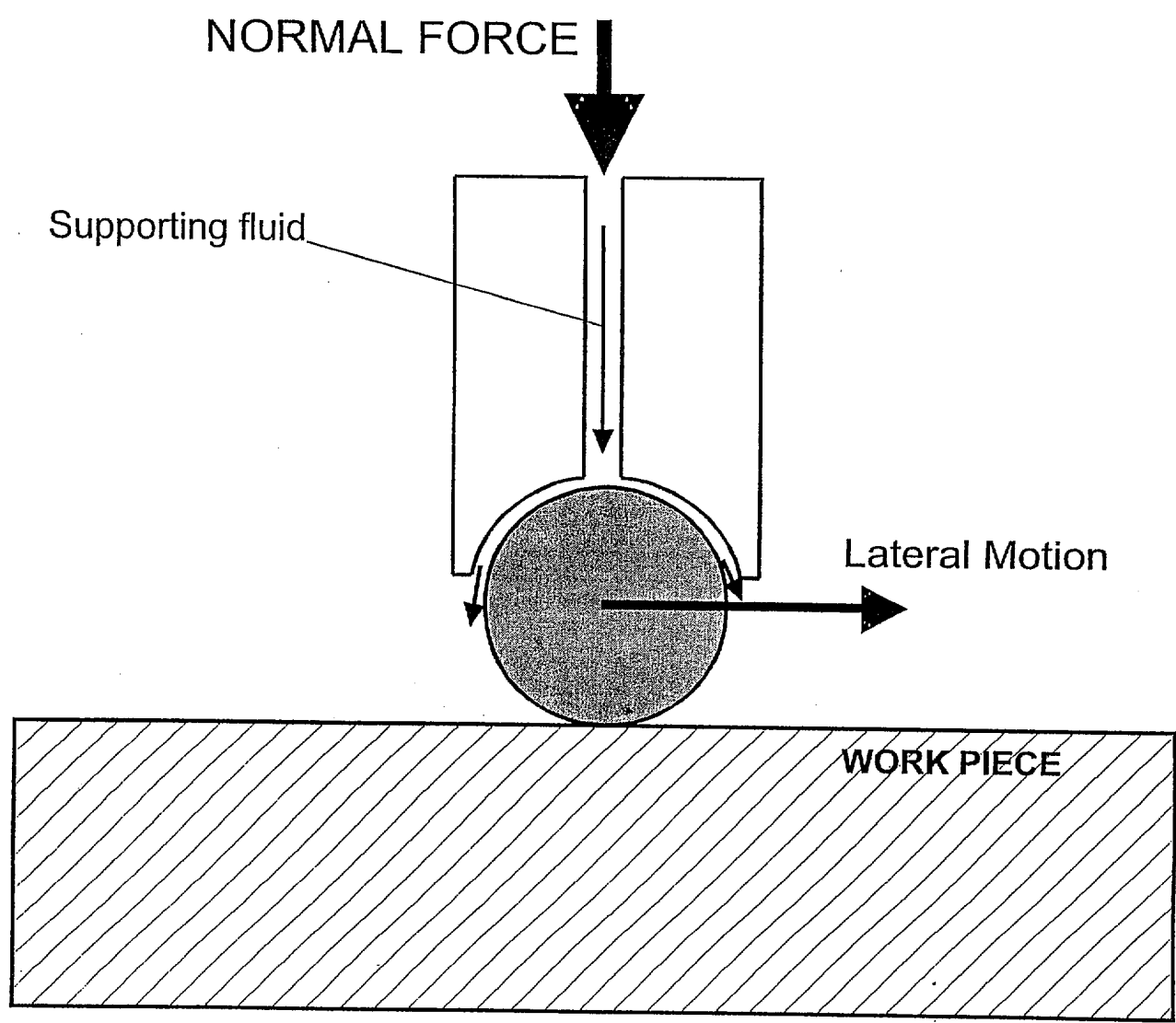
- **Handling features on waste package refined**
  - Rotating trunnion collar proposed
- **Proposed Alloy C-22 closure lids change**
  - Flat final closure lid
  - Weld remediation applied only to the final closure lid
  - Two possible stress mitigation methods:
    - ♦ Laser peening
    - ♦ Low-plasticity burnishing



# Changes to Waste Package Final Closure



# Low-plasticity Burnishing



# Current Development Studies

- Senior Flexonics Pathway is working on the Weld Flaw Study
- Ajax Magnethermics is performing the induction annealing on the FY 00 Mockup
- Lawrence Livermore National Laboratory is performing laser peening studies
- Surface Enhancement Technologies is performing low-plasticity burnishing studies
- Weld Material and Base Material Variability Study (commercial procurement in process)

# Prototype Strategy

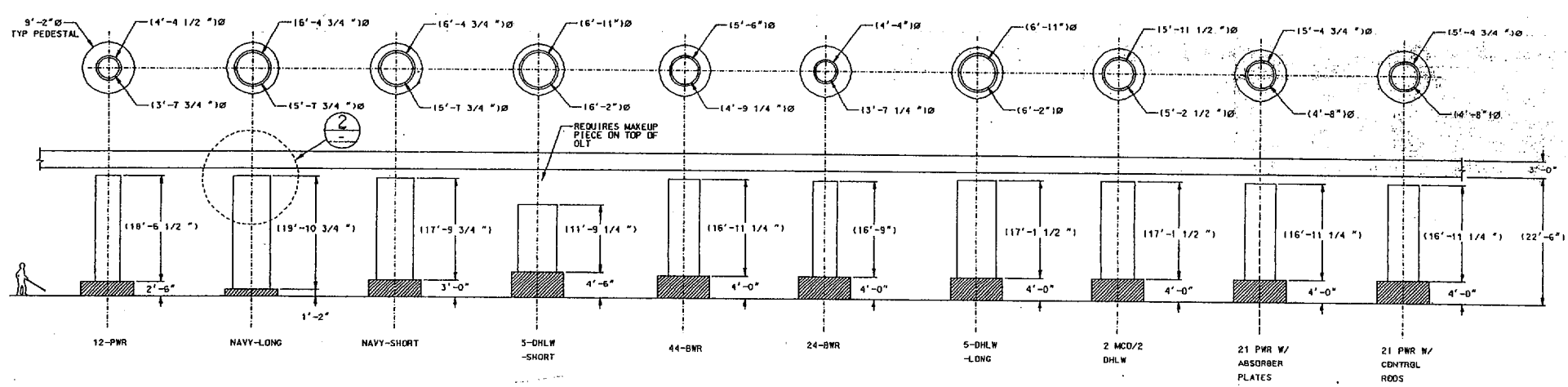
- **Purpose of prototype development**
  - Determine population of qualified material suppliers and fabricators
  - Demonstrate fabrication processes
  - Verify closure weld processes (welding non-destructive examination, stress mitigation, robotics)
  - Use in training facility for operator training and demonstrate waste package handling processes
  - Potential destructive and non-destructive testing

# Prototype Strategy

(Continued)

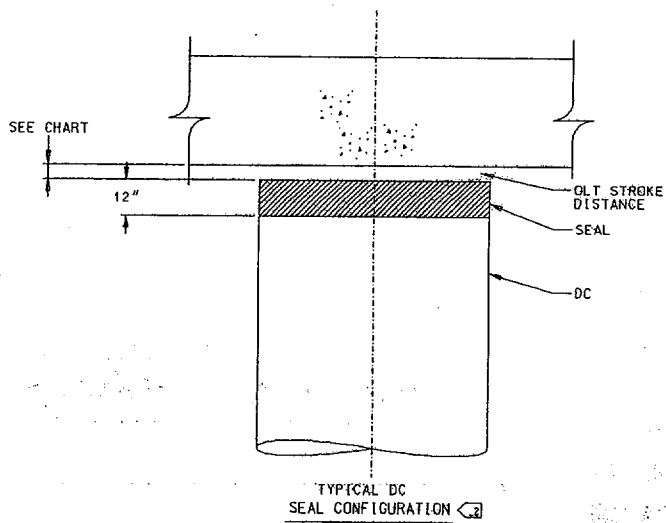
- **Send out 21-PWR prototype procurement documents for bid and contract award during CY 2003**
  - Produced 21- PWR prototype preliminary drawings
  - Developing 21-PWR prototype preliminary fabrication specification
- **Complete 21-PWR prototype in CY 2005**
- **Procure additional prototypes in CY 2005 through CY 2008**

DC Height Comparison



DC	DROP HEIGHT	OD	ID	DC HEIGHT	OLT STROKE DISTANCE	REF. DRAWING
12-PWR	22.00'	4'-4 1/2"	3'-7 3/4"	18'-6 1/2"	5 1/2"	DWG-UDC-ME-000004
NAVY-LONG	23.33'	6'-4 3/4"	5'-7 3/4"	19'-10 3/4"	5 1/4"	DWG-VDC-ME-000002
NAVY-SHORT	21.50'	6'-4 3/4"	5'-7 3/4"	17'-9 3/4"	8 1/4"	DWG-VDC-ME-000003
5-DHLW-SHORT	*20.00'	6'-11"	6'-2"	11'-9 1/4"	4"	DWG-DDC-ME-000001
44-BWR	20.50'	5'-6"	4'-9 1/4"	16'-11 1/4"	6 3/4"	DWG-UDC-ME-000002
24-BWR	20.50'	4'-4"	3'-7 1/4"	16'-9"	9"	DWG-UDC-ME-000003
5-DHLW-LONG	*20.50'	6'-11"	6'-2"	17'-1 1/2"	4 1/2"	DWG-DDC-ME-000002
2 MCO/2DHLW	20.50'	5'-11 1/2"	5'-2 1/2"	17'-1 1/2"	4 1/2"	DWG-EDC-ME-000001
21 PWR W/ABS PLTS	20.50'	5'-4 3/4"	4'-8"	16'-11 1/4"	6 3/4"	DWG-UDC-ME-000001
21 PWR W/CONTROL RDDS	20.50'	5'-4 3/4"	4'-8"	16'-11 1/4"	6 3/4"	DWG-UDC-ME-000007

\* CRITICAL DROP HEIGHT  
(CAN NOT EXCEED 23')







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



# Document Hierarchy/Requirements Management

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Robert M. Sandifer**  
**Requirements and Configuration Management**  
**Bechtel SAIC Company, LLC**

**November 5-6, 2002**  
**Las Vegas, Nevada**

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# Definitions

- **Programmatic Requirement**
  - Performance Assessment (PA), licensing, and design mission input demands by DOE or imposed by statutes, laws , or regulations contained within the DOE requirements hierarchy documents that identify and define requirements associated with processes, procedures, programs, and policies (i.e., health, safety, security, quality, or administrative requirements)
- **Technical Requirement**
  - PA, licensing, and design mission input demands by DOE or imposed by statutes, laws, or regulations contained within the DOE requirements hierarchy source documents that identify and define requirements for performance, functional, operational, and maintenance characteristics/parameters that the facility Structures, Systems and Components (SSCs) are to be designed to satisfy

Source: Requirements Management Plan, REV 00, PLN-MGR-AD-000004



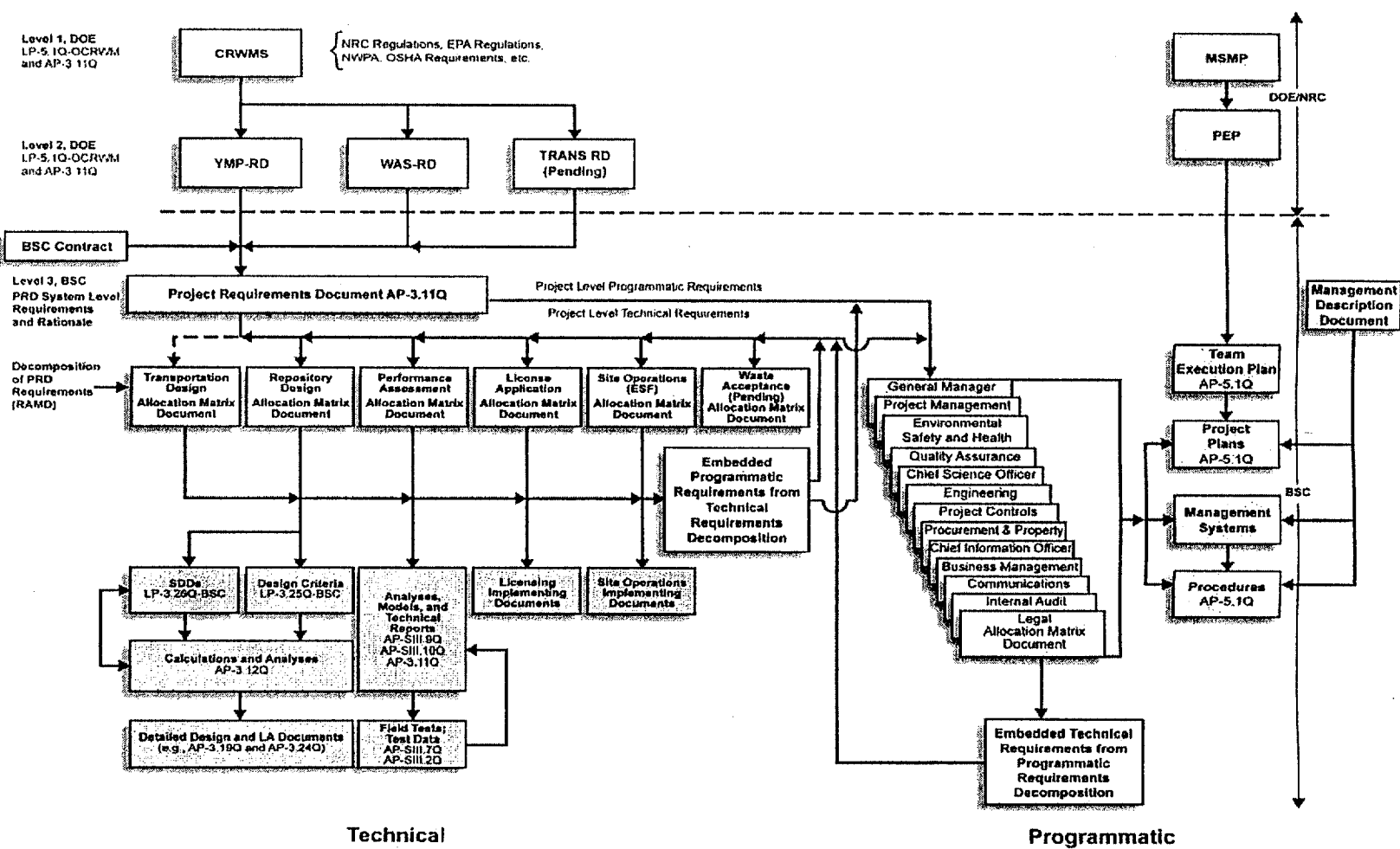
# Requirements Management Strategy

- **Objectives**

- Manage the process used by BSC to identify, subdivide, and allocate regulatory and all other applicable requirements, such as 10 CFR 63
- Provide consistency among technical and programmatic requirements
- Manage practices and processes for the development of requirements in accordance with DOE requirements
- Facilitate an integrated approach with DOE and the NRC to develop and maintain a rigorous and defensible set of requirements documents that assure a safe design, and are traceable from the Program level to the implementing product document or SSC (structure, system, or component)



# Requirements Management Strategy



# CRWMS Requirements Document Description

- **Civilian Radioactive Waste Management System Requirements Document, Rev 05 ICN 05 (CRD)**
  - ♦ **Level 1 Requirements Document**
  - ♦ **Contains Mission, Conceptual Description, Planning Considerations, Baseline, and Requirements**
  - ♦ **Requirements Addressed:**
    - » **Regulatory Requirements, specifically 10 CFR63**
    - » **System Level Requirements**
    - » **Waste Acceptance and Transportation Requirements**
    - » **MGR Requirements**
    - » **CISF Requirements**
    - » **Interface Requirements**
  - ♦ **Functional Definitions**



# **Yucca Mountain Project Requirements Document Description**

- **Yucca Mountain Project Site Characterization Requirements Document, Rev 04 DCN 02 (YMP-RD)**
  - ♦ **Level 2 (YMP controlled) Requirements Document**
  - ♦ **Contains the following requirements:**
    - » **MGR Requirements**
    - » **Testing Requirements**
    - » **SR Product Requirements**
    - » **LA Product Requirements**
    - » **LA Update Requirements**
    - » **LA Amendment Requirements**
    - » **Environmental, Safety, and Health Requirements**
  - ♦ **Nevada Transportation Requirements**



# Waste Acceptance System Requirements Document Description

- **Waste Acceptance System Requirements Document, Rev 04 (WAS-RD)**
  - ♦ **Level 2 Requirements Document**
  - ♦ **Contains Planning Considerations, Functional Description, System Definition, Assumptions, Requirements, Acceptance Criteria, and Conformance Verification**
  - ♦ **Requirements Addressed:**
    - » **Regulatory Requirements**
    - » **Waste Acceptance Element Performance Requirements**
    - » **Transportation Element Performance Requirements**
    - » **CRWMS Interface Requirements**
    - » **Acceptance Criteria Addressed:**
      - » **Commercial SNF**
      - » **Government Managed Nuclear Materials**



# Transportation System Requirements Document Description

- **Transportation System Requirements Document (TRANS-RD) DOE/RW-0425**
  - ♦ **Level 2 Requirements Document**
  - ♦ **Format is a short, focused, high level document (similar in length to CRD)**
  - ♦ **Requirements addressed:**
    - » **Federal Laws and regulations**
    - » **Orders, Directives, and other sources of requirements**
    - » **Functional and Performance requirements**





# Project Requirements Document Description

- Project Requirements Document, TER-MGR-MD-000001, Rev 00, approved on July 31, 2002
  - ♦ Level 3 Requirements Document
  - ♦ Captures flowdown of all source requirements from DOE Level 1 and Level 2 requirements documents and BSC/DOE Contract
  - ♦ Further breaks down the project level requirements, such as 10 CFR 63 into component programmatic and technical requirements
  - ♦ Allocates requirements to the responsible implementing BSC project or functional organization
  - ♦ Revision 00 of the document presents allocations of Technical requirements, issued on July 31, 2002
  - ♦ Revision 01 of the document, now under development, presents allocations of both technical and programmatic requirements



# Requirements Allocation Matrix Document Description

- **Requirements Allocation Matrix Document (RAMD)**
  - ♦ **Developed by each Project and Functional Organization**
  - ♦ **Clearly shows the linkage between requirements allocated by the PRD to each organization and the implementing mechanism(s) that satisfy the requirement**
  - ♦ **The RAMD purpose and description is defined in the Requirements Management Plan, PLN-MGR-AD-000004**
  - ♦ **To ensure that all RAMDs are complete and consistent, a RAMD procedure is now under development**



# **Benefits of Requirements Document Management**

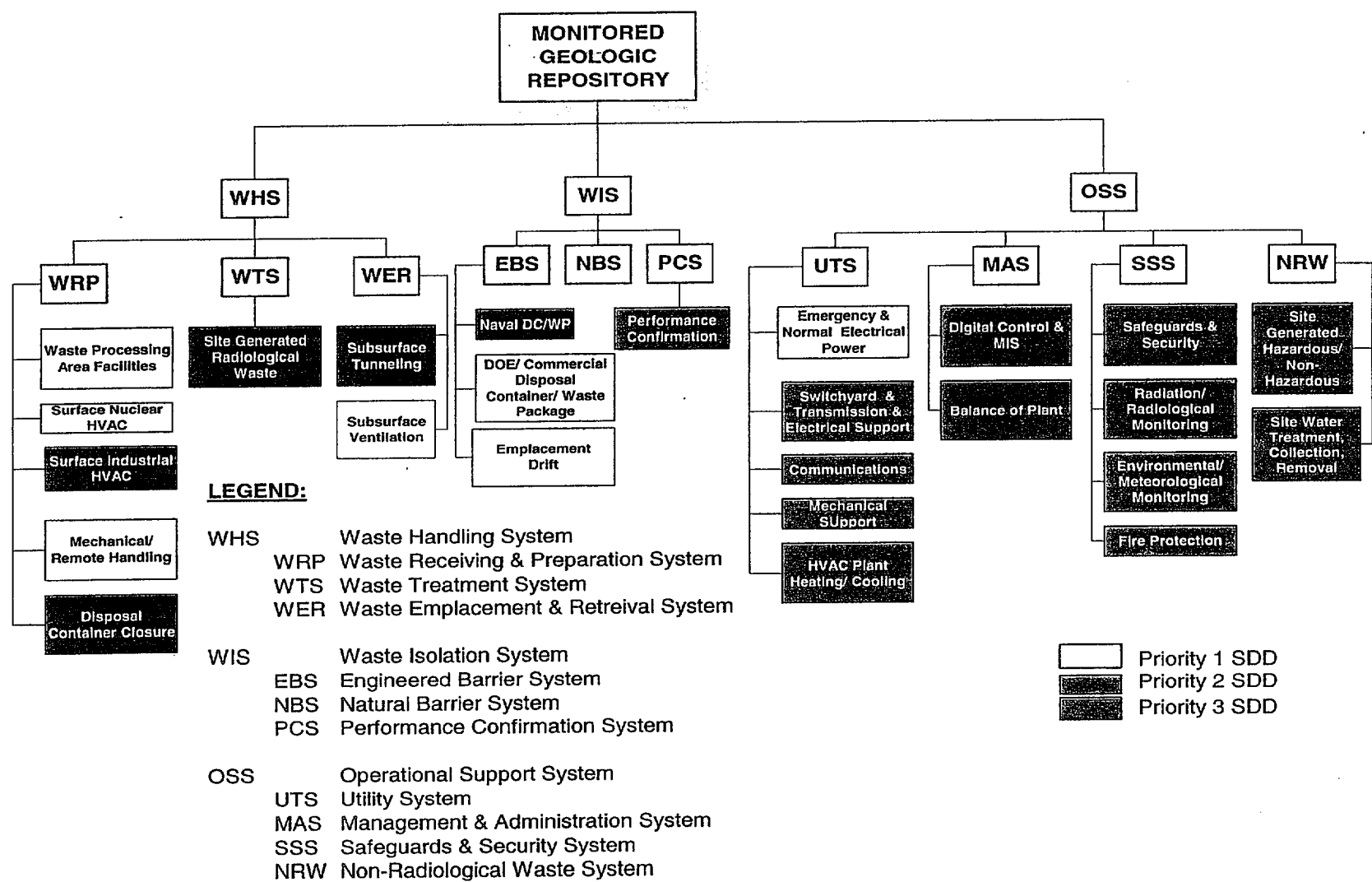
- **Clear and concise identifications of requirements for technical implementation and functional process integration**
- **Clear basis for change control actions**
- **Enhances identification of roles and responsibilities internal to contractor and between contractor and DOE**
- **Coupled with appropriate thresholds for change approval, allows decision making at proper level in appropriate Organization**
- **Contributes to improvement in overall project efficiency and acceptance by the regulator**



# Conclusions

- The requirements hierarchy identifies **ALL** of the requirements that DOE/BSC are obligated to satisfy
- Requirements document flowdown is structured to present the regulator with a rigorous method to verify that any requirement can be traced from its source to the structure, system, or component level
- The Requirements Management process is focused on maintaining the integrity of the requirements hierarchy and minimizing the number of unverifiable requirements, proposed design solutions, etc. that are not driven by regulation







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



# System Description Document and Project Design Criteria

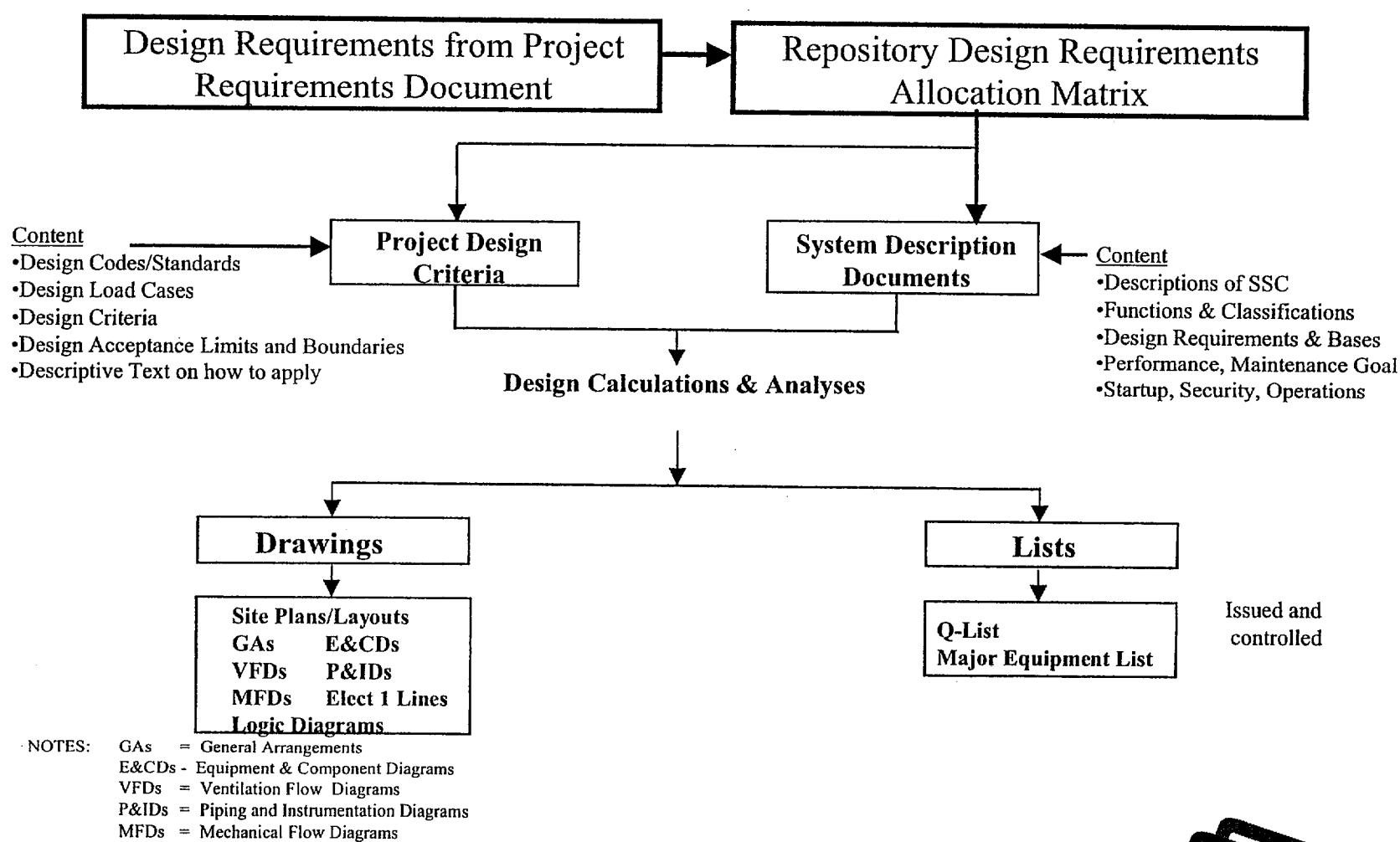
Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Gordon D. Pedersen**  
Repository Design Project  
Bechtel SAIC Company, LLC

November 5-6, 2002  
Las Vegas, Nevada

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# Repository Design Level 3 Technical Baseline Document Hierarchy



# System Description Documents

- **System Description Documents (SDDs) will contain high level requirements that flow directly from the Project Requirements Document**
- **In addition, SDDs will include an overview of Structure, Systems, and Components (SSCs) functions, classifications, operation, design requirements and bases, and system description**
- **A total of 25 SDDs will be developed during preliminary design in accordance with established priorities and in three phases with increased details as design evolves**





# System Description Documents

(Continued)

- **SDDs represent a consolidated and reconfigured version of Site Recommendation (SR) baselined SSCs**
- **SDD structure and scope have been changed from the previous versions**
- **PDCs contained in earlier versions of SDDs have been moved to a Project Design Criteria Document**
- **New SDD Structure will include descriptions of SSC; functions and classifications; design requirements and bases; performance and maintenance goals; and startup, security and operations**



# System Description Documents

(Continued)

- **Priority 1 SDDs are those that need to be in place before the LA design effort commences**
- **Priority 2 SDDs are for systems that may contain Quality Level 1, 2 or 3 subsystems but do not need to be in place before the License Application (LA) design effort commences**
- **Priority 3 SDDs are for Conventional Quality (CQ) systems**



# System Description Documents

(Continued)

- SDD Scope and Estimated Schedule by Phases

PHASE	SDD SCOPE	PRIORITY 1 SDDs		PRIORITY 2 SDDs		PRIORITY 3 SDDs	
		NO.	APPROX COMPL DATE	NO.	APPROX COMPL DATE	NO.	APPROX COMPL DATE
I	<ul style="list-style-type: none"><li>Purpose/function of system</li><li>Upper level requirements and their bases</li></ul>	7	Nov 02	9	Nov 02	9	Dec 02
II	In addition to Phase I: <ul style="list-style-type: none"><li>Description of system/components</li><li>Requirements/bases developed during preliminary design</li></ul>	7	Mar 04	9	Mar 04	9	Mar 04
III	In addition to Phase II: <ul style="list-style-type: none"><li>Principles of system operation, operating procedures, setpoints, limitations, upset conditions, recovery procedures, overall maintenance philosophy, and critical maintenance procedures</li></ul>	7	After LA-CA submittal	9	After LA-CA submittal	9	After LA-CA submittal



# **Project Design Criteria Document**

- **Project Design Criteria (PDC) document provides design criteria necessary to support the development of preliminary and final design**
- **Project Design Criteria document includes standards, codes, laws, regulations, and general discipline design criteria, that shall be used as a basis for acceptance of design for SSCs to satisfy requirements**
- **Design Criteria will include consideration of NRC regulatory guidance documents (Regulatory Guides and NUREGs), and other project requirements documents as applicable**
- **The criteria for SSCs will be based on their Quality Levels**



# Sample Design Criterion

- **Sample Design Criterion:**
- **“Deflections in reinforced concrete members shall be computed based on cracked section properties. Control of deflections in reinforced concrete members shall be in accordance with Section 9.5 of ACI 349-01.” (PDC Section 4.2.2.4.6)**
- **The PDC document will be prepared in phases as the design evolves and matures**





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



# License Application Design Products and Sample Drawings

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Stephen J. Cereghino**  
License Application Project  
Bechtel SAIC Company, LLC

November 5-6, 2002  
Las Vegas, NV

**For Information Only - Unapproved Conceptual Design Information**

# **Primary Design Product Types Planned for License Application**

- **License Application-Construction Authorization (LA-CA) will contain adequate information to support Nuclear Regulatory Commission (NRC) licensing Review**
- **Amount of design information available and provided will increase as design evolves from preliminary design at LA-CA to detailed design at LA-Receive & Possess (LA-R&P)**
- **The project will keep NRC informed as the design evolves**
- **Following typical design documents are for illustrative purposes**



# Primary Design Product Types Planned for License Application

(Continued)

- **Project Design Criteria Document**
  - Includes design codes/standards, design load cases, design load combinations, design acceptance limits and boundaries, and generic design criteria
- **System Description Documents**
  - Includes an overview of structure, system, or component functions, classifications, and operation; requirements and bases; and system description





# **Primary Product Types Planned for License Application**

(Continued)

- **Material Specifications**

- Includes reference codes and standards defining quality requirements such as ASTM, ASME, SMACNA, ASHRAE, IEEE
- Any special requirements for Systems, Structures, and Components
- Chemistry ranges of materials
- Applicability limitations, and restrictions
- Installation/application techniques as applicable
- Outline-type specification for major and important-to-safety equipment and components



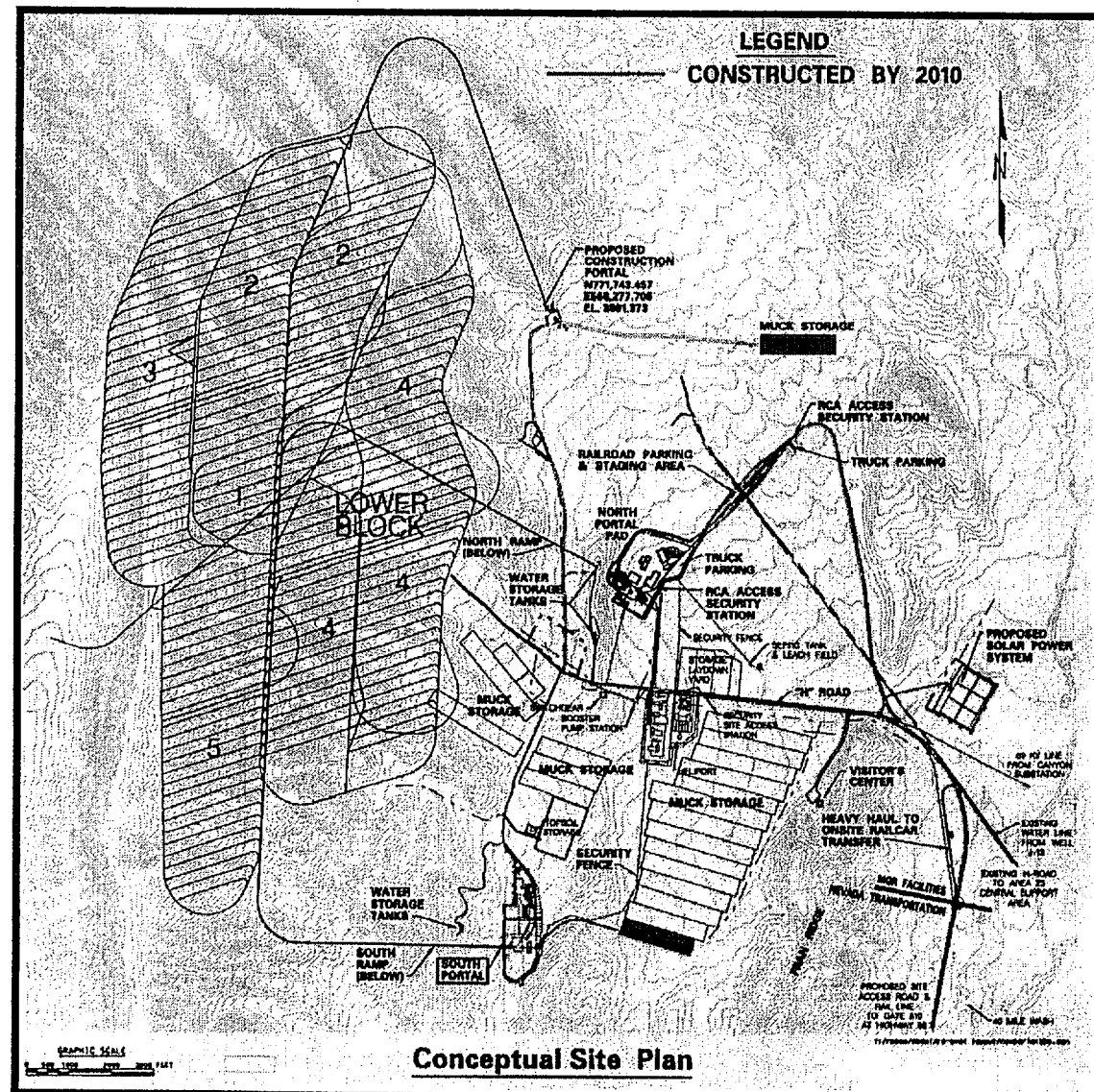
# Primary Product Types Planned for License Application

(Continued)

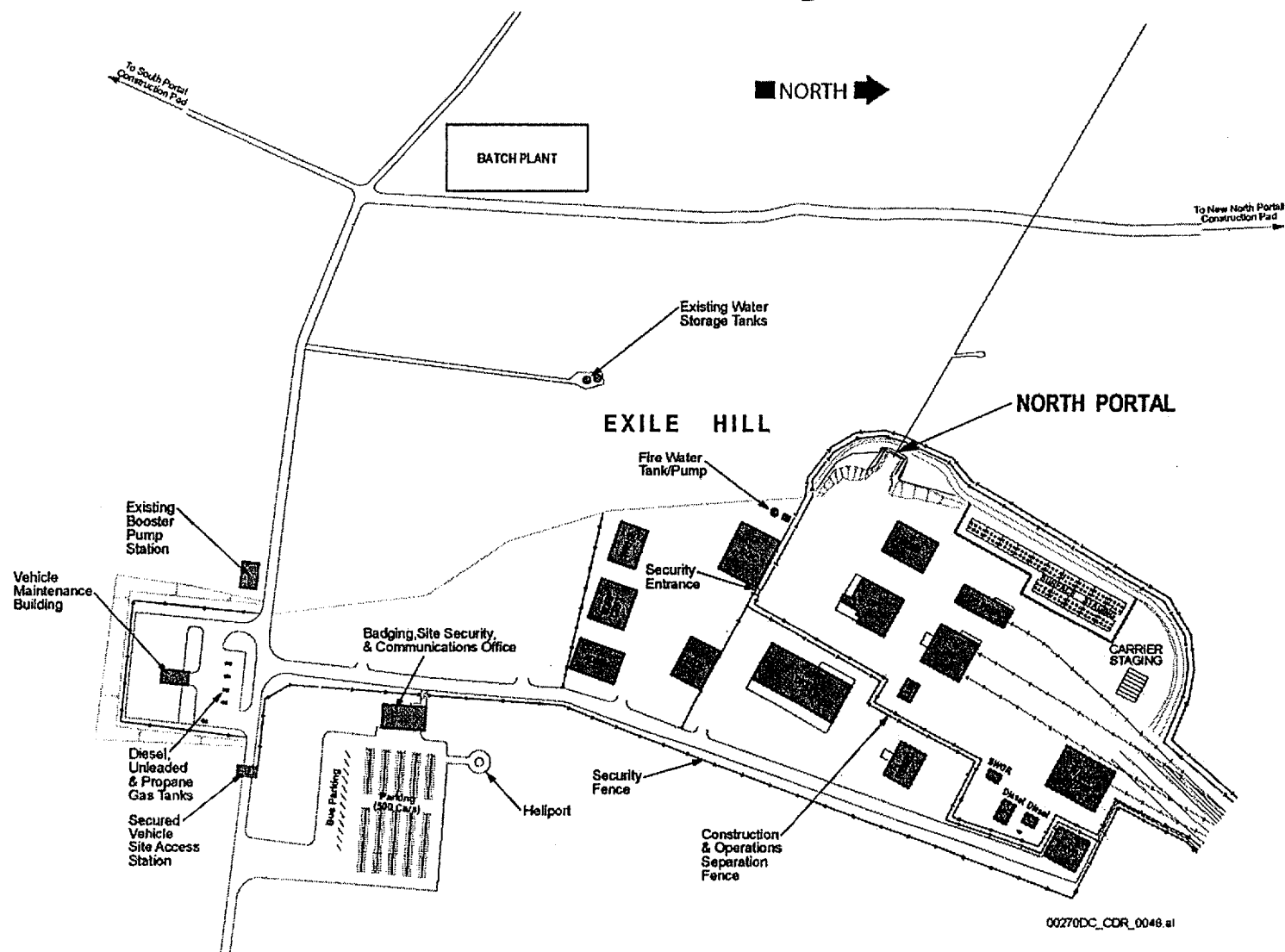
- **Site Plan/Site Layout Drawings**
  - Major outdoor equipment locations
  - Topography
  - Building locations
  - Utilities, roads, lighting
  - Owner controlled area, Geologic Repository Operations Area, and waste processing areas
  - Distances from site boundary



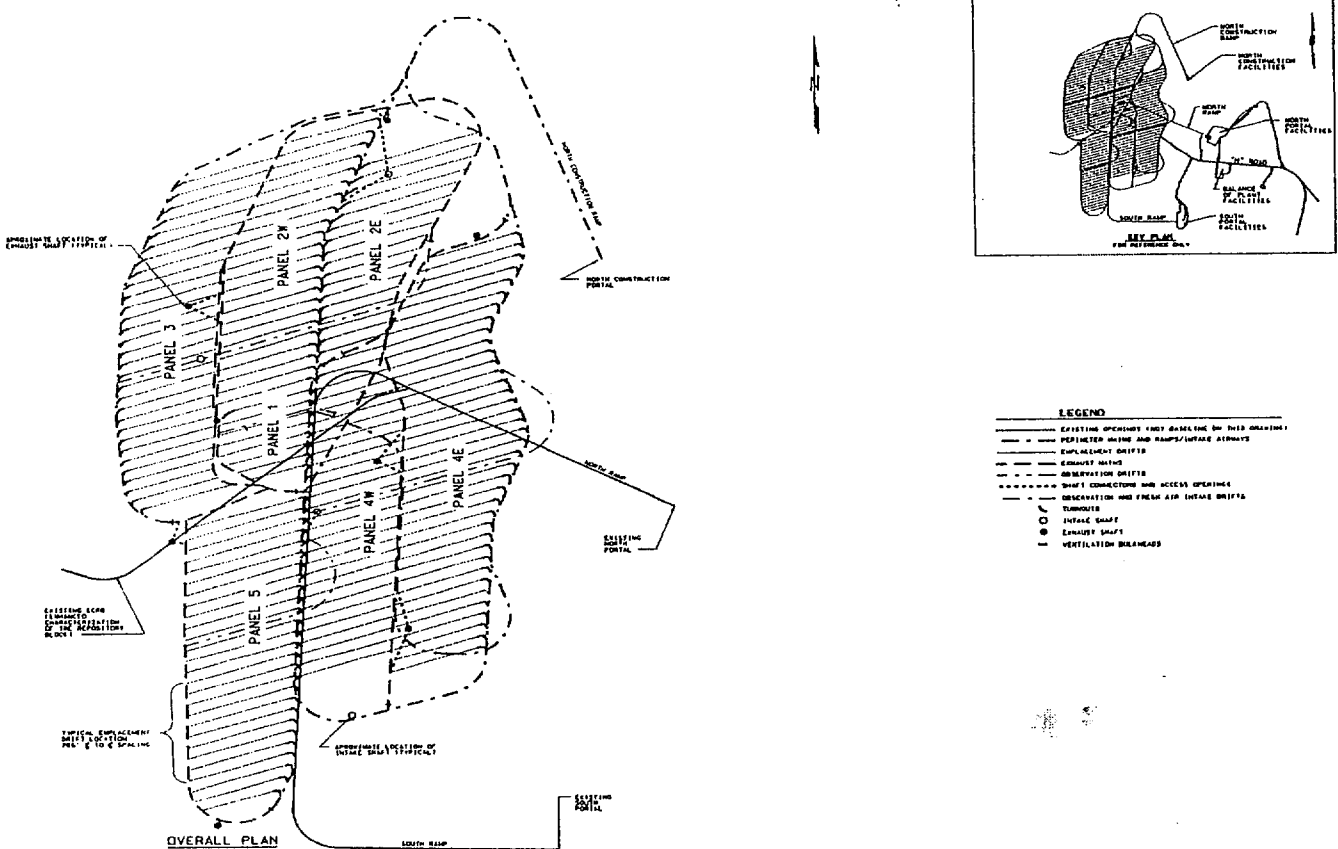
# Overall Site Plan



# North Portal Repository Area Site Plan



# Subsurface Facilities Layout



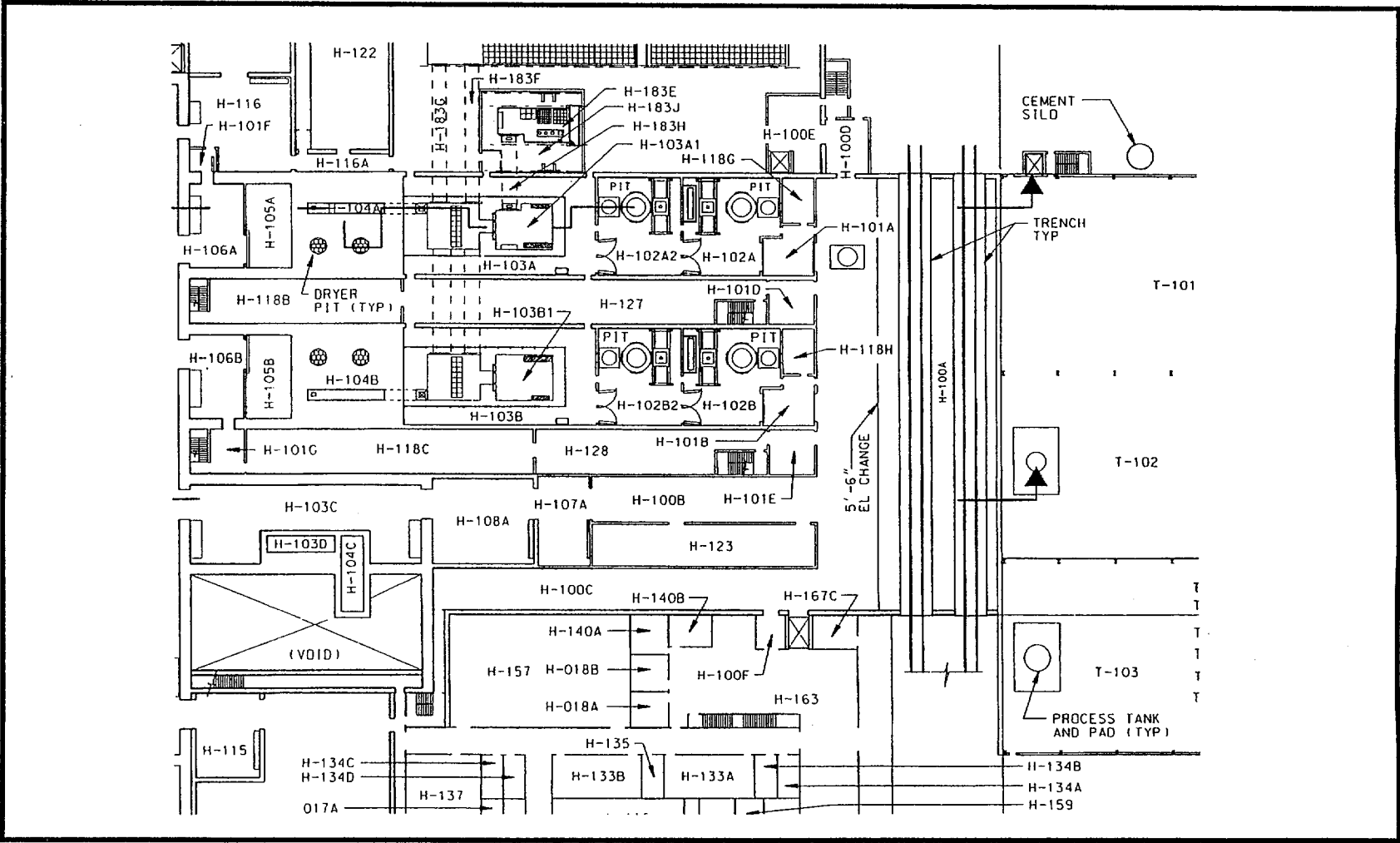
# Primary Product Types Planned for License Application

(Continued)

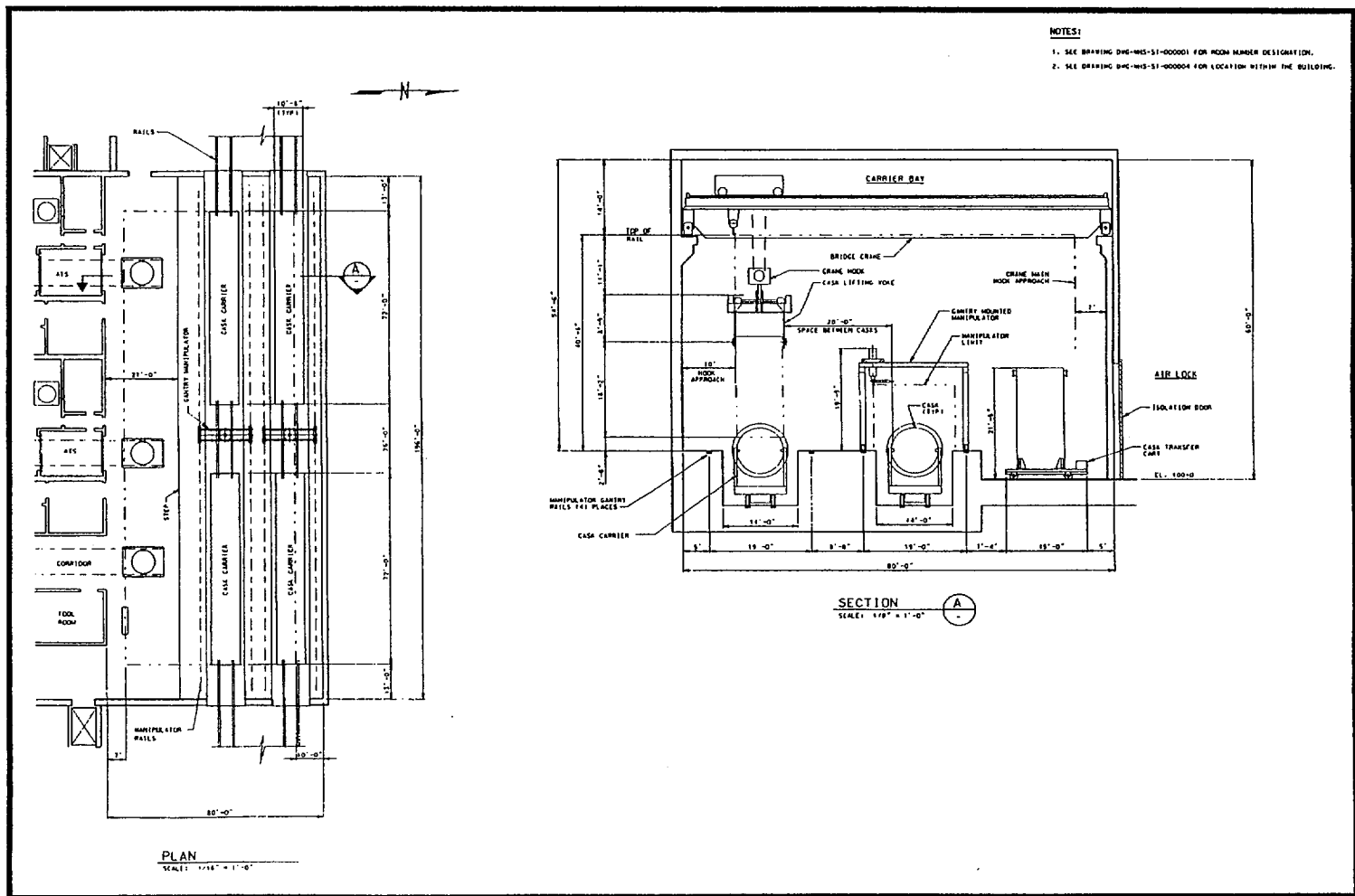
- **General Arrangement Drawings**
  - Layout of building/system utilities (e.g., pipe chases, electrical raceway, ductwork)
  - Buildings/rooms/hot cells (plans, sections, elevation details)
  - Major equipment
  - Fire area/zone boundaries
  - Radiation zoning drawings



# Waste Handling/Waste Treatment Building Partial Floor Plan at EL. 100+0 General Arrangement



# Waste Handling Building Carrier Bay Plan and Section General Arrangement





This is a detailed architectural floor plan of the second floor of the World Trade Center. The plan shows the layout of the Twin Towers and the Oculus. The Twin Towers are shown as two large, rectangular structures with a central core. The Oculus is a circular structure located to the right of the Twin Towers. The plan includes various rooms, corridors, elevators, and stairs. Room numbers are indicated throughout the plan. A north arrow is located in the top right corner.

AP-ANALYSIS OF THE DATA		
ANALYSIS TIME	ANALYSIS TIME (HOURS)	ANALYSIS TIME (MINUTES)
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00



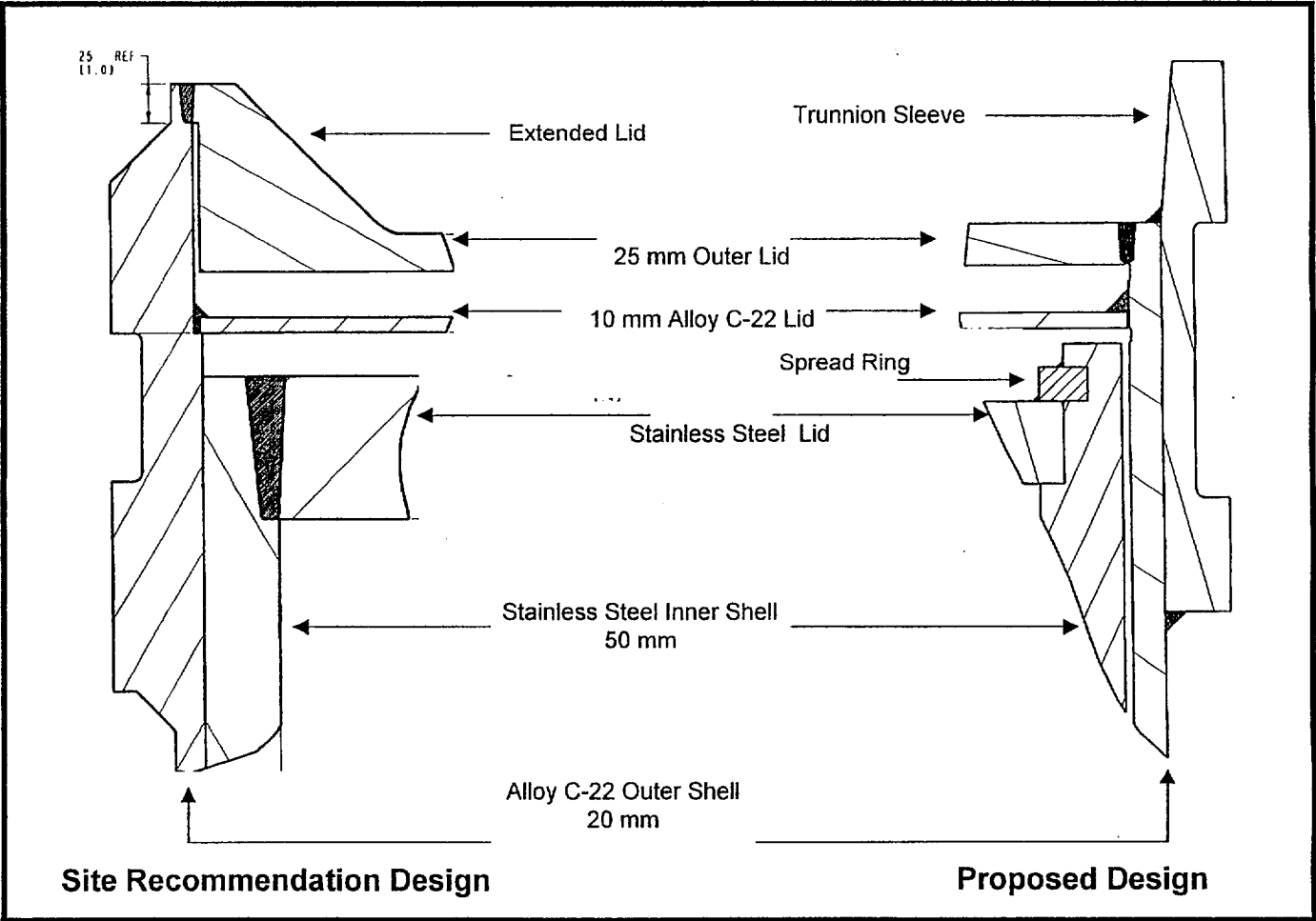
# Primary Product Types Planned for License Application

(Continued)

- **Equipment/Component Drawings**
  - Specific equipment/components
  - Waste Package
  - Details of important and unique features



# Example of Equipment/Component Drawing



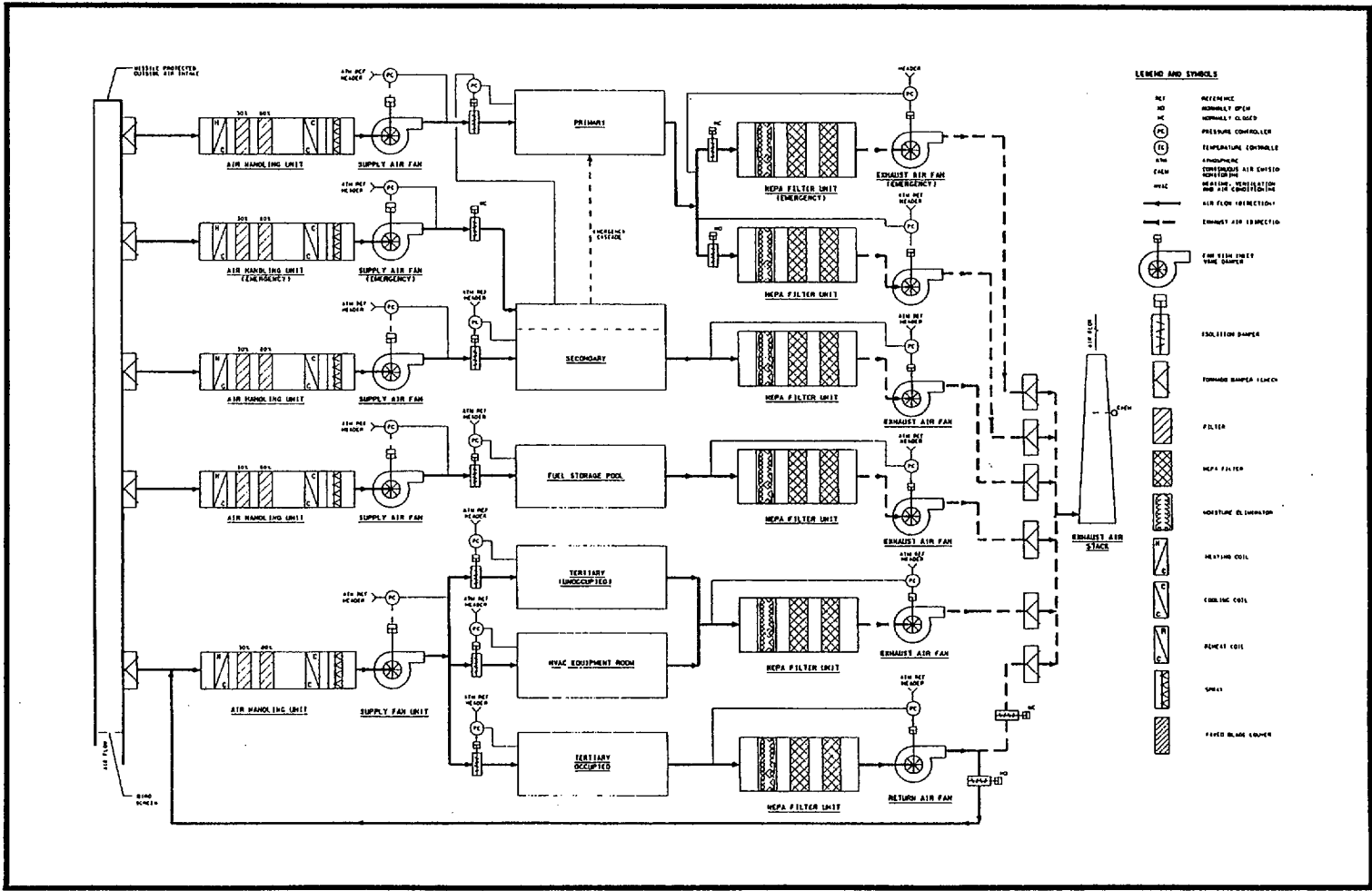
# **Primary Product Types Planned for License Application**

(Continued)

- **Ventilation Flow Diagrams**
  - Major ductwork, airflow rates
  - Major components including air handling units, fans, dampers, and high efficiency particulate air filters
  - Instrumentation involved in automatic actions
  - System interfaces and boundaries
  - Confinement zone class & zone pressures
  - Quality Level boundaries
  - Typical airflow patterns for different stages of repository development and operations



# Waste Handling Building-Heating, Ventilation, and Air-Conditioning Confinement Area Ventilation Flow Diagram



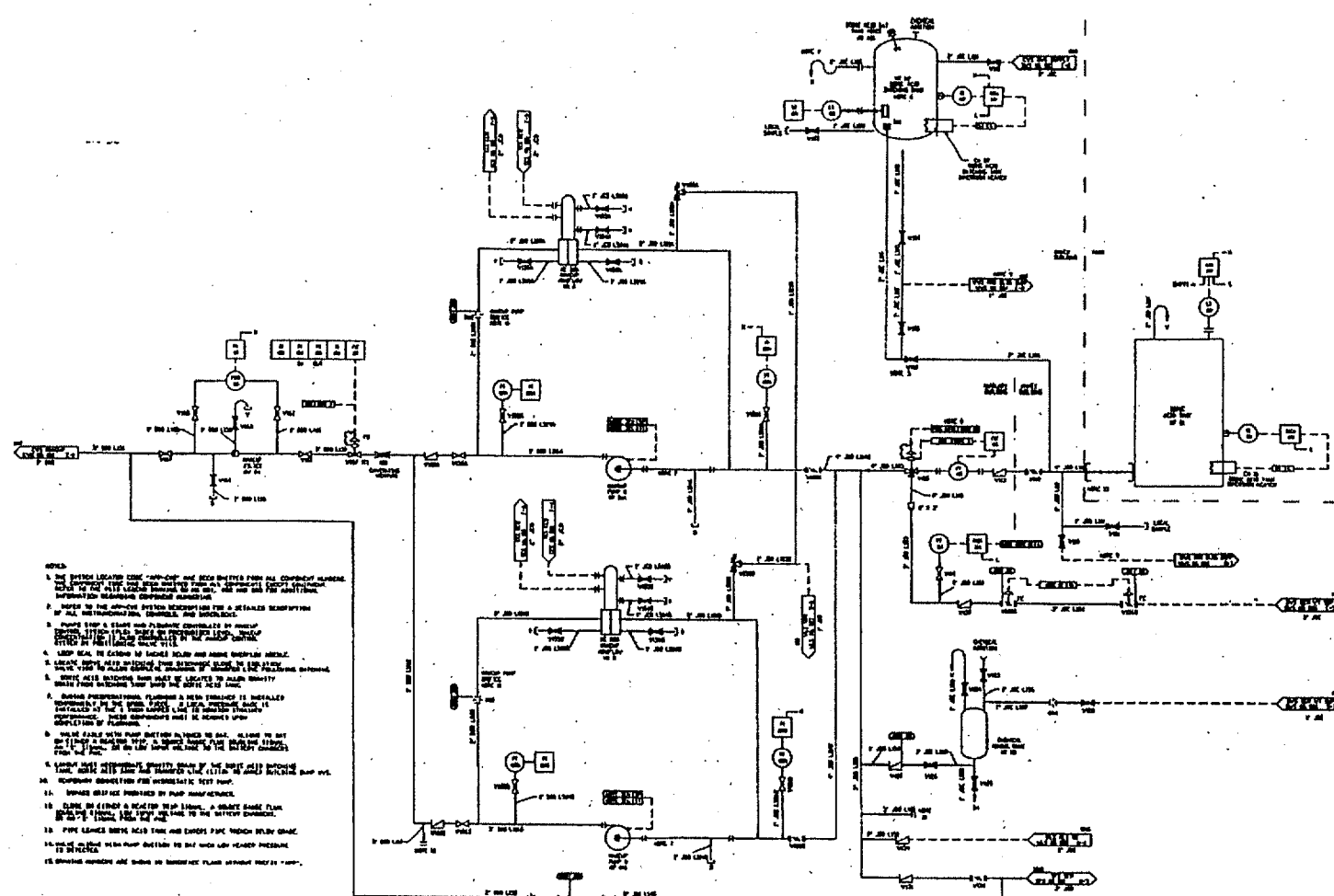
# **Primary Product Types Planned for License Application**

(Continued)

- **Piping and Instrumentation Diagrams**
  - Major piping
  - Major components
  - Major valves
  - Major instrumentation
  - System interfaces and boundaries
  - Interlocks and automatic functions
  - Materials of construction
  - Quality Level boundaries



# Piping and Instrumentation Diagram



# Primary Product Types Planned for License Application

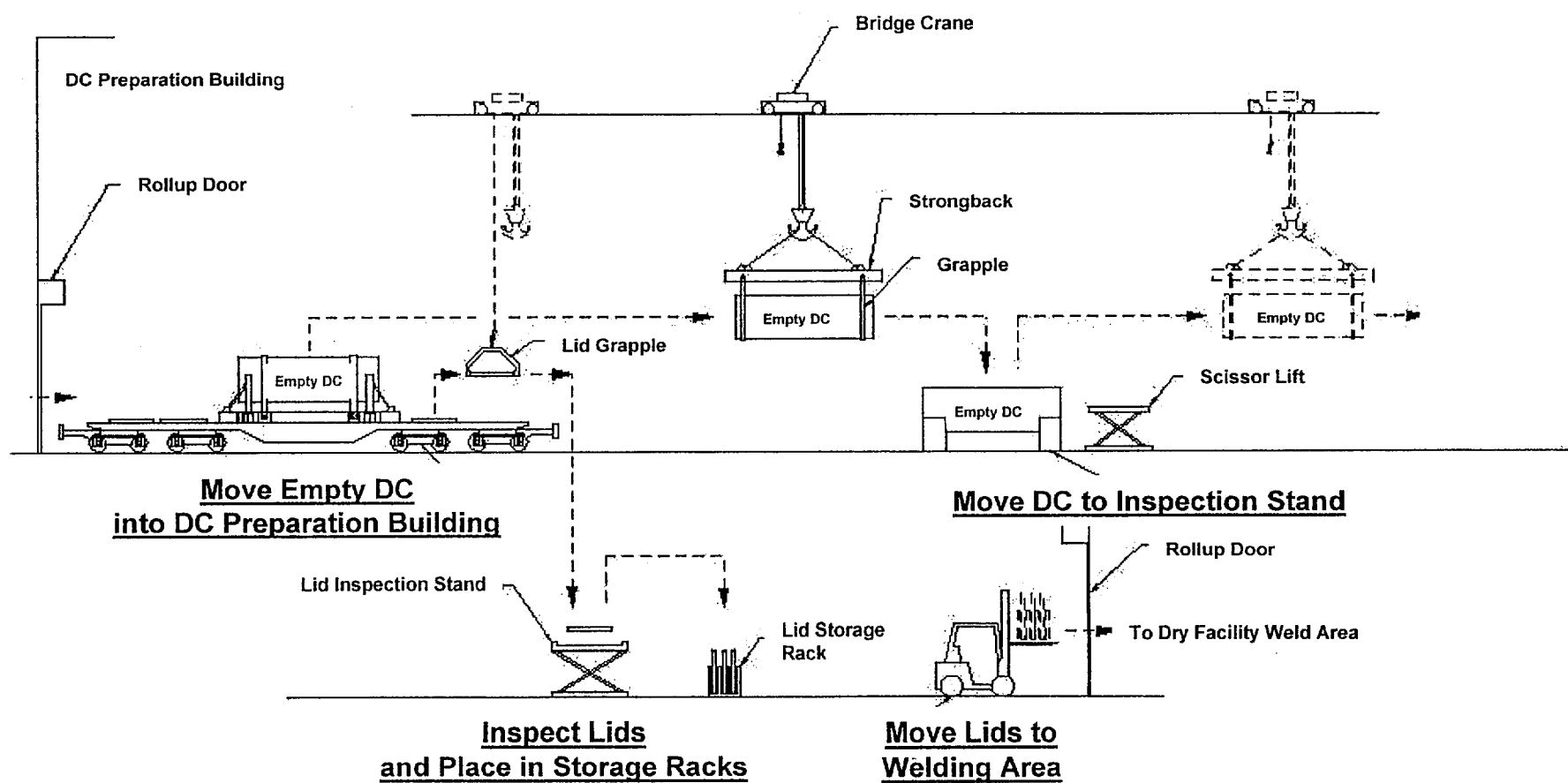
(Continued)

- **Mechanical Flow Diagrams**
  - Handling/processing sequences
  - Major components
  - Interfaces and boundaries
  - Sequential movements and equipment interfaces with enough detail to describe basic functions and critical controls
  - Interlocks





# Waste Handling Building-Disposal Container Handling System Mechanical Flow Diagram



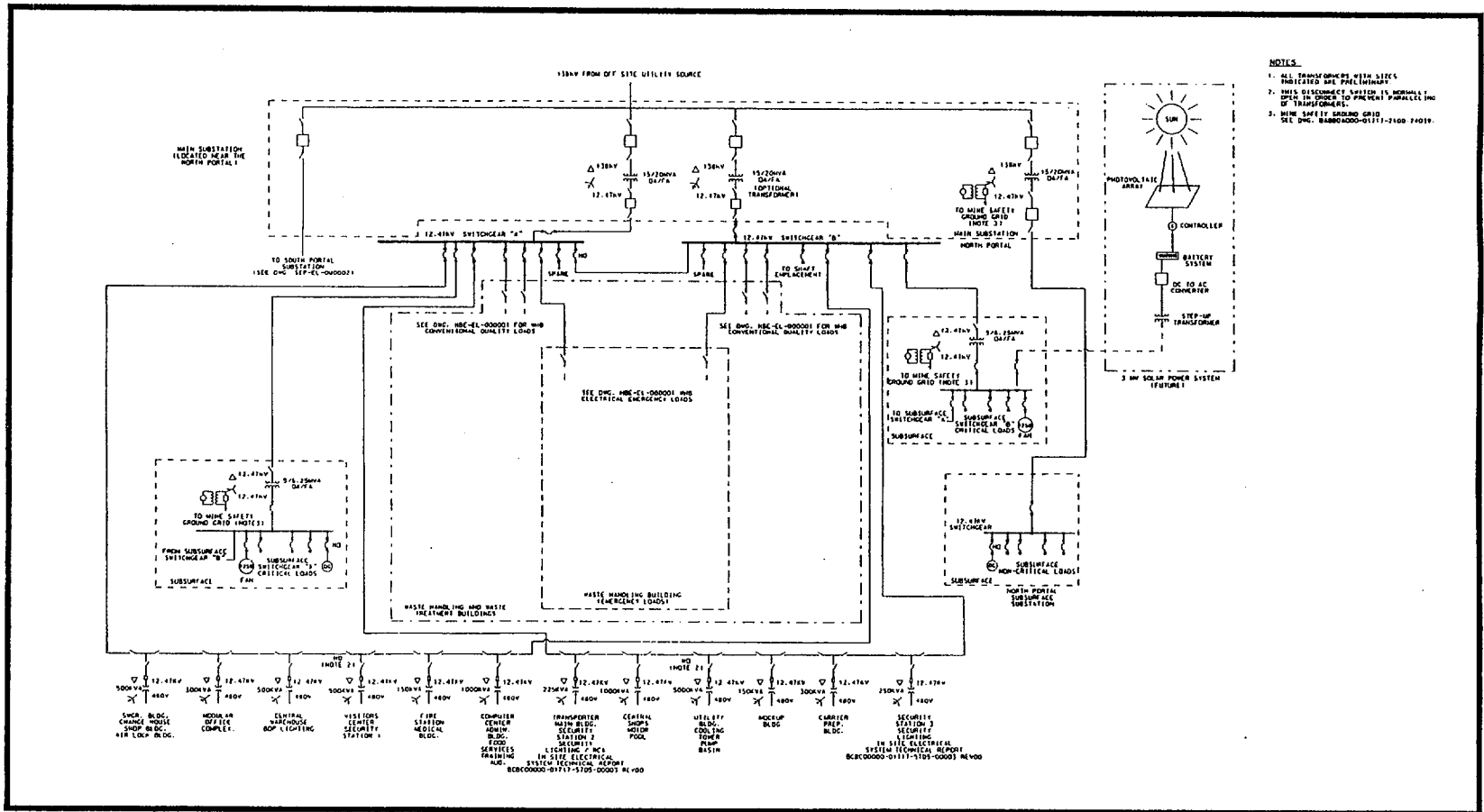
# Primary Product Types Planned for License Application

(Continued)

- **Electrical One-Line Diagrams**
  - Main and secondary feeder lines
  - Major electrical loads
  - Switchyard electrical equipment
  - Transmission lines
  - Major distribution buses and electrical equipment of various voltage levels



# Monitored Geologic Repository Site Electrical Power Distribution One-Line Diagram



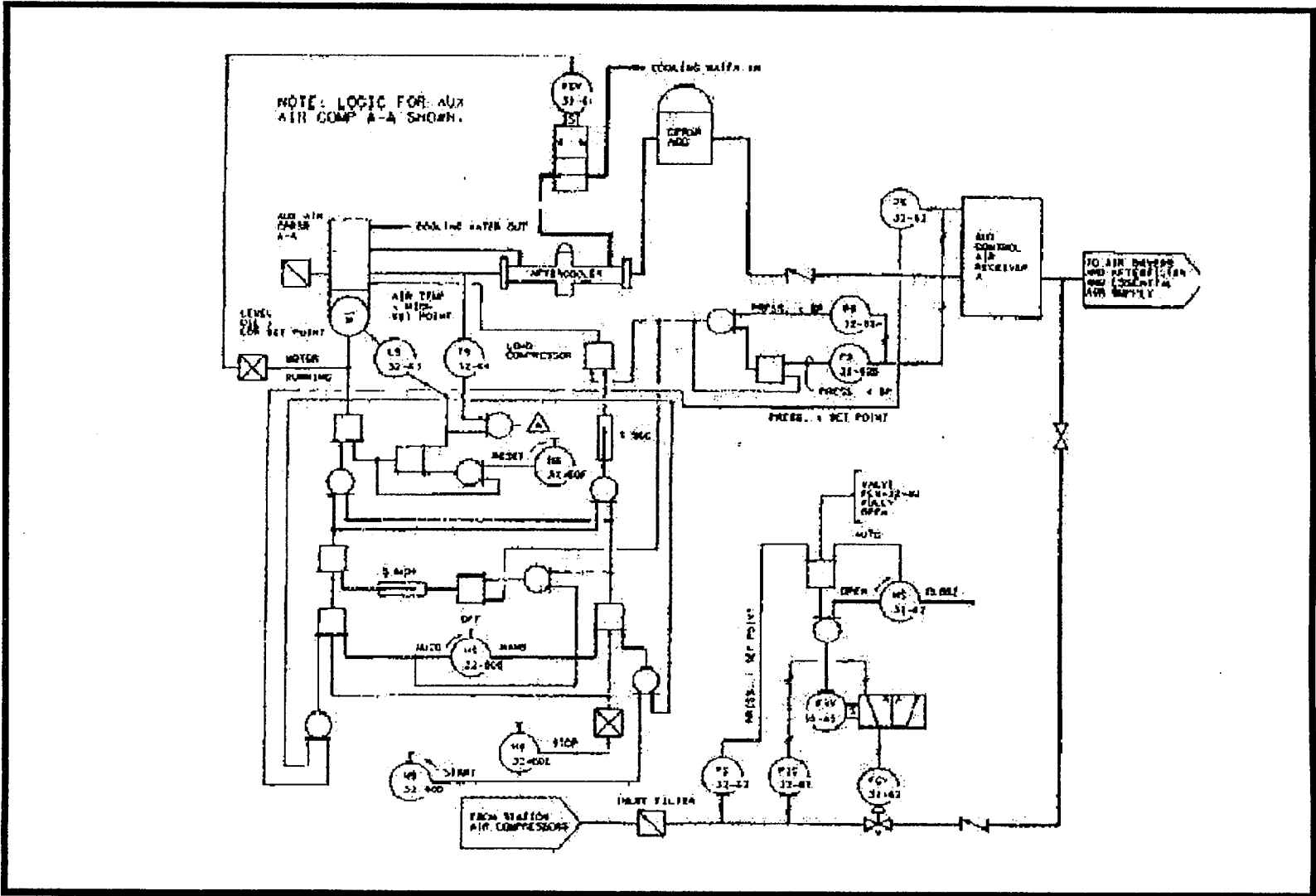
# Primary Product Types Planned for License Application

(Continued)

- **Logic Diagrams**
  - **Input signals**
  - **Activation logic**
  - **Important-to-safety system/components**



# Sample Logic Diagram



# Primary Product Types Planned for License Application

(Continued)

- **Engineered Barrier and Special Process Equipment Drawings**
  - **Engineered barriers**
    - ♦ Disposal containers
    - ♦ Waste packages
    - ♦ Drip shields
    - ♦ Pallets
  - **Special processes**
    - ♦ Welding
    - ♦ Peening/burnishing
    - ♦ Ultrasonic and Eddy Current inspection systems
    - ♦ Remote Visual Inspection systems
    - ♦ Inerting and Leak Detection systems



# **Primary Product Types Planned for License Application**

(Continued)

- **Engineered Barrier Fabrication Specifications**
  - Fabrication processes
  - Heat-treatment processes
  - Forming of materials (by forging, bending, rolling)
  - Welding processes and essential variables
  - Cleaning and surface treatment
  - Destructive and non-destructive examination



# Primary Product Types Planned for License Application

(Continued)

- **Engineered Barrier Technical Reports**
  - Material selection
  - Corrosion allowances
  - Structural analyses





# Primary Product Types Planned for License Application

(Continued)

- **Engineered Barrier Design Analyses**
  - These analyses will address:
    - ♦ Mechanisms for early waste package failure
    - ♦ Misloading
    - ♦ Preclosure event sequences
    - ♦ Postclosure features, events, and processes
    - ♦ Weld non-destructive examination process reliability



License Application (LA) Design Product Matrix

System / Subsystem Information (See Note 1)					Primary Product Types Planned For LA (See Notes 3 through 5)																	
Level 3 System Designation	SDD Level System Designation	Subsystem Name	Projected QA Classification (See Note 2)				Project Design Criteria	System Description Documents	Material Specifications	Site Plan / Site Layout	General Arrangement Drawings	Equipment / Component Drawings	Ventilation Flow Diagrams	Piping & Instrumentation Diagrams	Mechanical Flow Diagrams	Electrical One-Line Diagrams	Logic Diagrams	Eng'd Barrier-Specific Process Equip. Drawings	Eng'd Barrier Fabrication Specs	Eng'd Barrier Technical Reports	Eng'd Barrier Design Analysis	
			1	2	3	CQ																
Waste Receiving and Preparation System (WRP)	Waste Processing Area Facilities (CS)							X		X												
		Dry Facility 1	X				X	X	X		X	X										
		Dry Facility 2	X				X	X	X		X	X										
		Remediation Building	X				X	X	X		X	X										
		Transporter Receipt Building				X	X	X			X											
		DC Preparation Building				X	X	X			X											
		Low Level Waste Treatment Building		X			X	X			X	X										
		Heavy Equipment Maintenance Facility				X	X	X			X											
		Waste Storage Pad and Aging Area		X			X	X			X											
		Surface Support Facilities				X	X	X														
		Yard Transportation				X	X	X														
		Subsurface Transportation				X	X	X														
		Site Infrastructure				X	X	X														
	Surface Nuclear HVAC (VS)	Surface Nuclear HVAC		X			X	X			X	X										
	Surface Industrial HVAC (VI)	Surface Industrial HVAC				X	X	X			X	X										
	Mechanical & Remote Handling (HM)						X															
		Dry Waste Transfer	X				X	X	X			X				X						
		Cask Transporter Processing		X			X	X							X							
		Disposal Container Processing				X	X	X							X							
		Waste Aging Facility		X			X	X			X				X							
		Waste Emplacement/Retrieval	X				X	X	X			X			X							
		Waste Package Loadout		X			X	X							X							
		Remediation & Repair Facility		X			X	X			X											
	Disposal Container Closure (HW)						X															
		Welding		X			X	X										X	X	X		
		Non-Destructive Testing (NDT)				X	X	X											X	X	X	
		Stress Relief				X	X	X														
Waste Treatment System (WTS)	Site Generated Radiological Waste (MR)						X															
		Fuel Pool Cooling and Cleanup		X			X	X						X								
		Liquid Waste		X			X	X					X									
		Solid Waste		X			X	X					X									
		Gaseous Waste		X			X	X					X									

System / Subsystem Information (See Note 1)					Primary Product Types Planned For LA (See Notes 3 through 5)																								
Level 3 System Designation	SDD Level System Designation	Subsystem Name	Projected QA Classification (See Note 2)				Project Design Criteria	System Description Documents	Material Specifications	Site Plan / Site Layout	General Arrangement Drawings	Equipment / Component Drawings	Ventilation Flow Diagrams	Piping & Instrumentation Diagrams	Mechanical Flow Diagrams	Electrical One-Line Diagrams	Logic Diagrams	Engine Barrier Special Process Equip. Drawings	Engine Barrier Publication Specs	Engine Barrier Technical Reports	Engine Barrier Design Analysis								
			1	2	3	CQ																							
Waste Emplacement & Retrieval System (WER)	Subsurface Tunneling (TU)							X		X																			
		Non-Emplacement Drift Openings				X	X	X		X	X																		
	Ground Control for Non-Emplacement Drift Openings				X	X	X		X	X																			
	Excavation				X	X	X		X																				
	Closures and Seals				X	X	X			X																			
	Subsurface Ventilation (VU)							X																					
		Emplacement Ventilation				X	X	X				X	X																
Engineered Barrier System (EBS)	Naval Disposal Container / Waste Package (DN)							X																					
		Naval Spent Nuclear Fuel	X				X	X	X																				
	DOE & Commercial Disposal Container / Waste Package (DS)							X																					
		Defense High Level Waste	X				X	X	X																				
		Uncanistered Spent Nuclear Fuel	X				X	X	X																				
		Canistered Spent Nuclear Fuel	X				X	X	X																				
	Emplacement Drift System (TE)	DOE Spent Nuclear Fuel	X				X	X	X																				
		Non-Fuel Components	X				X	X	X																				
								X																					
		Emplacement Drifts	X				X	X	X		X	X																	
	Performance Confirmation System (PCS)	Performance Confirmation (JP)	Ground Control for Emplacement Drifts		X			X	X				X																
			Drip Shield	X				X	X	X																			
			Invert	X				X	X					X															
			WP Emplacement Pallet				X	X	X					X															
			Backfill (if used)	X				X	X	X		X	X																
								X																					
		Performance Confirmation Data Acquisition / Monitoring	X				X	X	X			X				X													
		Performance Confirmation Emplacement Drift Monitoring	X				X	X	X			X				X													
		Performance Confirmation Waste Isolation Verification / Validation	X				X	X	X			X				X													

System / Subsystem Information (See Note 1)					Primary Product Types Planned For LA (See Notes 3 through 5)																
Level 3 System Designation	SDD Level System Designation	Subsystem Name	Projected QA Classification (See Note 2)				Project Design Criteria	System Description Documents	Material Specifications	Site Plan / Site Layout	General Arrangement Drawings	Equipment / Component Drawings	Ventilation Flow Diagrams	Piping & Instrumentation Diagrams	Mechanical Flow Diagrams	Electrical One-Line Diagrams	Logic Diagrams	Engineer Review Special Process Equip. Drawings	Engineer Review Fabrication Specs	Engineer Review Technical Reports	Engineer Review Design Analysis
			1	2	3	CQ															
Utility System (UTS)	Emergency & Normal Electrical Power (EE)							X													
		Emergency Diesel Generator System		X			X	X								X	X				
		Emergency DC Power System		X			X	X								X	X				
		Emergency UPS Power System		X			X	X								X	X				
		Normal Electrical Power				X										X	X				
	Switchyard and Transmission (ET)							X								X	X				
		Site Electrical Distribution System				X	X	X													
	Electrical Support (EU)							X													
		Lighting				X	X	X													
		Lightning Protection				X	X	X													
		Grounding				X	X	X													
		Cathodic Protection				X	X	X													
		Heat Trace Raceway				X	X	X													
	Communications (EC)							X													
		Telephone				X	X	X													
		Radio				X	X	X													
		CCTV				X	X	X													
	Mechanical Support (PA)	Public Address				X	X	X													
								X													
		Air				X	X	X													
		Service Gases				X	X	X													
		Fuel Oils				X	X	X													
	HVAC Plant Heating and Cooling (VP)	Water Supply				X	X	X													
								X													
		HVAC Heating				X	X	X						X							
		HVAC Cooling				X	X	X						X							
Management & Administration System (MAS)	Digital Control and Management Information (JD)							X													
		Digital Control		X			X	X													
	Management Information					X	X	X									X				
		Management Information						X													
	Balance of Plant (SB)							X													
		Administration Building				X	X	X													
		Mockup Building				X	X	X													
		Utility Building				X	X	X													
		Fire Station				X	X	X													
		Central Warehouse				X	X	X													
		Central Shops				X	X	X													
		Visitors Center				X	X	X													
		Food Service Facility				X	X	X													
		Training Auditorium				X	X	X													
		Medical Center				X	X	X													
		Computer Center				X	X	X													
		Motor Pool and Service Station				X	X	X													
		Security Station				X	X	X													

System / Subsystem Information (See Note 1)							Primary Product Types Planned For LA (See Notes 3 through 5)																
Level 3 System Designation	SDD Level System Designation	Subsystem Name	Projected QA Classification (See Note 2)				Project Design Criteria	System Description Documents	Material Specifications	Site Plan / Site Layout	General Arrangement Drawings	Equipment / Component Drawings	Ventilation Flow Diagrams	Piping & Instrumentation Diagrams	Mechanical Flow Diagrams	Electrical One-Line Diagrams	Logic Diagrams	Eng'd Barter Special Process Equip. Drawings	Eng'd Barter Publication Specs	Eng'd Barter Technical Reports	Eng'd Barter Design Analysis		
			1	2	3	CQ																	
Safeguards and Security System (SSS)	Safeguards and Security (ES)							X															
		Monitor Devices				X	X	X															
		Perimeter Security				X	X	X															
	Radiation / Radiological Monitoring (JR)	Radiation / Radiological Monitoring			X		X	X									X						
	Environmental / Meteorological Monitoring (JE)	Environmental / Meteorological Monitoring				X	X	X									X						
	Fire Protection (PF)							X															
		Fire Water				X	X	X						X									
		Fire Barriers				X	X				X												
		Explosion Protection				X	X																
		Fire Suppression				X	X	X						X									
		Fire Detection				X	X	X						X						X			
		Fire Alarm				X	X	X											X				
Non-Radiological Waste System (NRW)	Site Generated Hazardous, Non-hazardous, and Sanitary Waste (MN)							X															
		Fuel Pool Cooling and Cleanup				X	X	X						X									
		Liquid Waste				X	X	X						X									
		Solid Waste				X	X	X															
		Gaseous Waste				X	X	X						X									
	Site Water Collection / Treatment / Removal (MC)							X															
		Surface Water Collection / Treatment / Removal				X	X	X															
	Subsurface Water Collection / Treatment / Removal				X	X	X																



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



# License Application Overview

Presented to:  
**Nuclear Regulatory Commission**

Presented by:  
**Martin C. Bryan**  
License Application Project  
Bechtel SAIC Company, LLC

November 5-6, 2002  
Las Vegas, Nevada

**For Information Only - Unapproved Conceptual Design Information**

# Considerations in Developing Content and Format of Safety Analysis Report

- Expected level of detail provided in License Application (LA) and support documents will increase from License Application-Construction Authorization (LA-CA) to LA-Receive & Possess (R&P)
- Level of detail at LA-CA will be sufficient to allow the NRC to make the findings required by 10 CFR 63.31
- 10 CFR 63.21
- Yucca Mountain Review Plan
- Other Review Plans
- Other Dockets
  - Private Fuel Storage
  - Mixed Oxide Fuel Fabrication Facility
  - Commercial power reactors



# **Current License Application Table of Contents - General Information**

- **General Description**
- **Proposed Schedule for Construction, Receipt and Emplacement of Waste**
- **Physical Protection Plan**
- **Material Control and Accounting Plan**
- **Site Characterization**





# **Current License Application Table of Contents - Safety Analysis Report**

- 1. REPOSITORY SAFETY BEFORE PERMANENT CLOSURE**
  - 1.1 Site Description as it Pertains to Preclosure Safety Analysis**
  - 1.2 Surface Structures, Systems, Components, Equipment, and Operational Process Activities Surface Facilities**
    - 1.2.1 Surface Systems**
  - 1.3 Subsurface Structures, Systems, Components, Equipment, and Operational Process Activities**
    - 1.3.1 Subsurface Facilities**
    - 1.3.2 Subsurface Systems**
  - 1.4 Structures, Systems, Components, Equipment, and Operation Process Activities for Systems Shared by Surface and Subsurface**
    - 1.4.1 Mechanical Systems**
    - 1.4.2 Electrical Systems**
    - 1.4.3 Control and Monitoring Systems**
    - 1.4.4 Water Collection / Treatment / Removal Systems**

# **Current License Application Table of Contents - Safety Analysis Report**

- 1.5 Waste Package**
  - 1.5.1 Characteristics of Spent Nuclear Fuel and High Level Waste**
  - 1.5.2 General Description of Waste Packages and their components**
  - 1.5.3 Design of Waste Packages**
- 1.6 Hazard Analysis and Initiating Events**
- 1.7 Event Sequences**
- 1.8 Consequence Analyses**
- 1.9 Structures, Systems, and Components Important to Safety;  
Safety Controls; and Measures to Ensure Availability of the  
Safety Systems**
- 1.10 Meeting the ALARA Requirements for Normal Operations and  
Category 1 Event Sequences**
- 1.11 Plans for Retrieval and Alternate Storage of Radioactive Waste**
- 1.12 Plans for Permanent Closure and Decontamination, or  
Decontamination and Dismantlement of Surface  
Facilities**

# **Current License Application Table of Contents - Safety Analysis Report**

## **2. REPOSITORY SAFETY AFTER PERMANENT CLOSURE**

**2.1 System Description and Demonstration of Multiple Barriers**

**2.2 Scenario Analysis and Event Probability**

**2.3 Model Abstraction**

**2.3.1 Degradation of Engineered Barriers**

**2.3.2 Mechanical Disruption of Engineered Barriers**

**2.3.3 Quantity and Chemistry of Water Contacting Waste Packages  
and Waste Forms**

**2.3.4 Radionuclide Release Rates and Solubility Limits**

**2.3.5 Climate and Infiltration**

**2.3.6 Flow Paths in the Unsaturated Zone**

**2.3.7 Radionuclide Transport in the Unsaturated Zone**

**2.3.8 Flow Paths in the Saturated Zone**

**2.3.9 Radionuclide Transport in the Saturated Zone**

# **Current License Application Table of Contents - Safety Analysis Report**

- 2.3.10 Volcanic Disruption of Waste Packages
- 2.3.11 Airborne Transport of Radionuclides
- 2.3.12 Representative Volume
- 2.3.13 Redistribution of Radionuclides in Soil
- 2.3.14 Biosphere Characteristics
- 2.4 **Demonstration of Compliance with the Postclosure Public Health and Environmental Standards**
  - 2.4.1 Demonstration of Compliance with the Postclosure Individual Protection Standards
  - 2.4.2 Demonstration of Compliance with the Human Intrusion Standard
  - 2.4.3 Analysis of Repository Performance that Demonstrates Compliance with the Separate Ground-Water Protection Standards

# **Current License Application Table of Contents - Safety Analysis Report**

## **3. RESEARCH AND DEVELOPMENT PROGRAM TO RESOLVE SAFETY QUESTIONS**

**3.1 Safety Questions**

**3.2 R&D Programs to Resolve Safety Questions**

**3.3 Schedule for Completion**

**3.4 Design Alternatives or Operational Restrictions**

## **4. PERFORMANCE CONFIRMATION PROGRAM**

**4.1 General Requirements**

**4.2 Geotechnical and Design Parameters**

**4.3 Design Testing Other Than Waste Packages**

**4.4 Monitoring and Testing Waste Packages**

# **Current License Application Table of Contents - Safety Analysis Report**

## **5. ADMINISTRATIVE AND PROGRAMMATIC REQUIREMENTS**

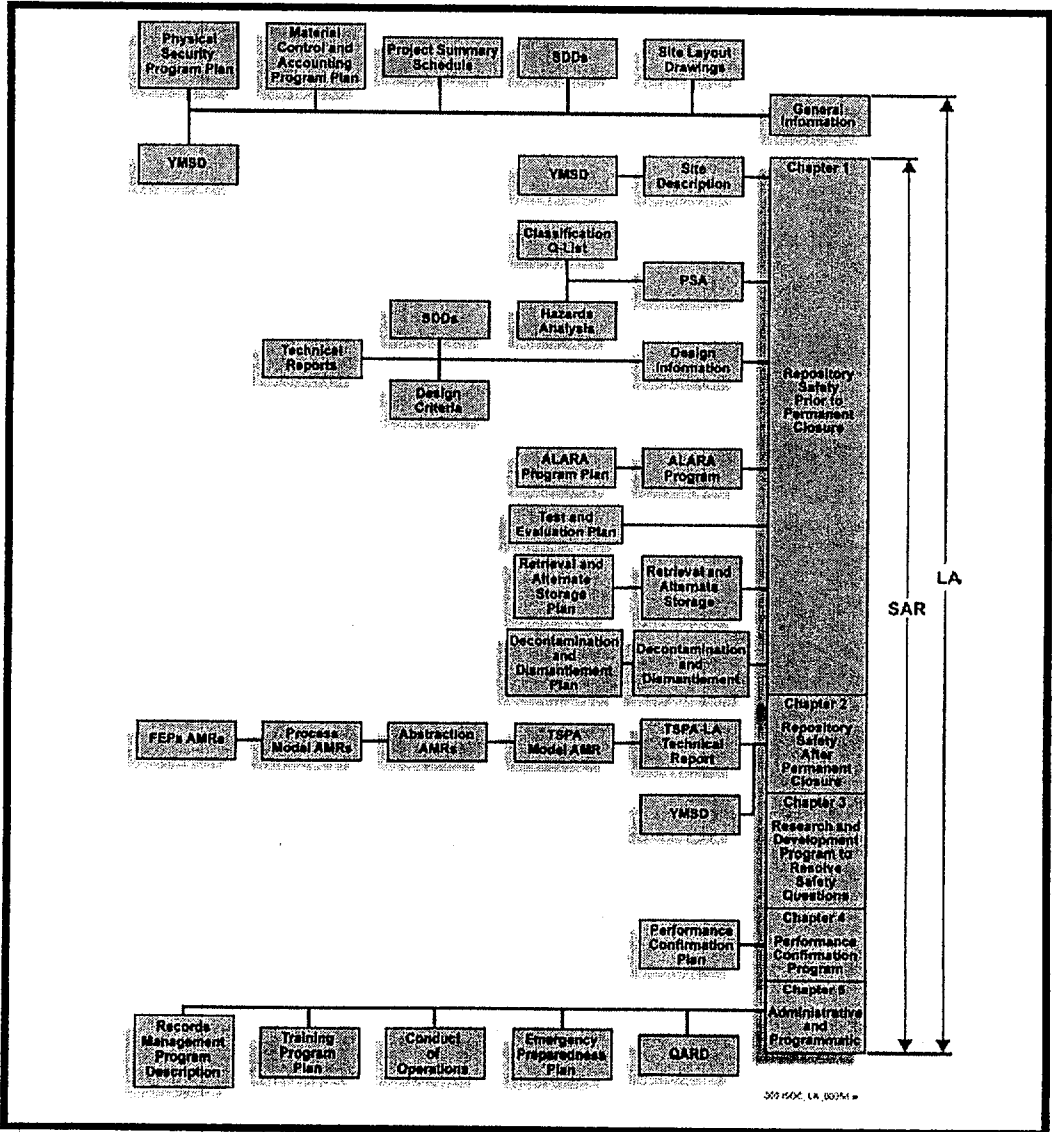
- 5.1 Quality Assurance Program**
- 5.2 Records, Reports, Tests, and Inspections**
- 5.3 Training and Certification of Personnel**
- 5.4 Expert Elicitation**
- 5.5 Plans for Startup Activities and Testing**
- 5.6 Plans for Conduct of Normal Activities Including Maintenance, Surveillance, and Periodic Testing**
- 5.7 Emergency Planning**
- 5.8 Controls to Restrict Access and Regulate Land Uses**
- 5.9 Uses of Geologic Repository Operations Area for Purposes Other Than Disposal of Radioactive Wastes**
- 5.10 License Specifications**
- 5.11 Radiation Protection**
- 5.12 Administrative Controls and Procedures**

# Illustration of Safety Analysis Report Subsection for Repository System

1. REPOSITORY SAFETY BEFORE PERMANENT CLOSURE
  - 1.1 Site Description as it Pertains to Preclosure Safety Analysis
  - 1.2 Surface Structures, Systems, Components, Equipment,  
and Operational Process Activities
    - 1.2.1 Surface Facilities
    - 1.2.2 Surface Systems
      - 1.2.2.1 Mechanical and Remote Handling Systems
      - 1.2.2.2 Mechanical Systems
        - 1.2.2.2.1 HVAC Systems
        - 1.2.2.2.1.1 Description
        - 1.2.2.2.1.2 GROA Operation Processes and Procedures
        - 1.2.2.2.1.3 Important to Safety Considerations
        - 1.2.2.2.1.4 Administrative or Procedural Safety Controls to  
Prevent Event Sequences or Mitigate their Effects
        - 1.2.2.2.1.5 Design Criteria
        - 1.2.2.2.1.6 Design Methodologies
        - 1.2.2.2.1.7 Consistency of Materials with Design Methodologies
        - 1.2.2.2.1.8 Design Codes and Standards
        - 1.2.2.2.1.9 Loan Combinations used for Normal and Cat 1 and 2 Events  
Sequence Conditions
        - 1.2.2.2.1.10 Performance and Documentation of Design  
Analyses



# Key Products and Programs that Support the License Application





# **Path Forward for Demonstrating Compliance with Nuclear Regulatory Commission Regulations**

- **Iterative process that leads to LA design**
- **Preclosure Safety Assessment (PSA) Determines:**
  - **Quality Level classification**
  - **10 CFR 63.2 design bases and associated design criteria**
  - **10 CFR 63.112 evaluations**
- **Safety Analysis Report (SAR) provides the compliance assessment with NRC regulations**
- **Future changes to design after LA-CA are evaluated in the PSA and are reflected in SAR updates**



# **DOE - NRC Interactions Supporting License Application Development**

- **Discussion and resolution of Key Technical Issues**
- **Keep NRC informed of proposed technical solutions**
- **Clarify expectations for General Information and Safety Analysis Report format and content**