



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



# Yucca Mountain Program Status

Presented to:  
**Advisory Committee on Nuclear Waste**

Presented by:  
**Joseph Ziegler**  
Director, Office of License Application and Strategy  
Office of Repository Development  
U.S. Department of Energy

**November 19, 2003**  
**Las Vegas, Nevada**



# Topics for Discussion

- **License Application Status**
- **DOE Feedback on NRC Risk-Ranking of Key Technical Issue Agreements**
- **Key Technical Issues Agreement Status**
- **Design Evolution**

# License Application Status

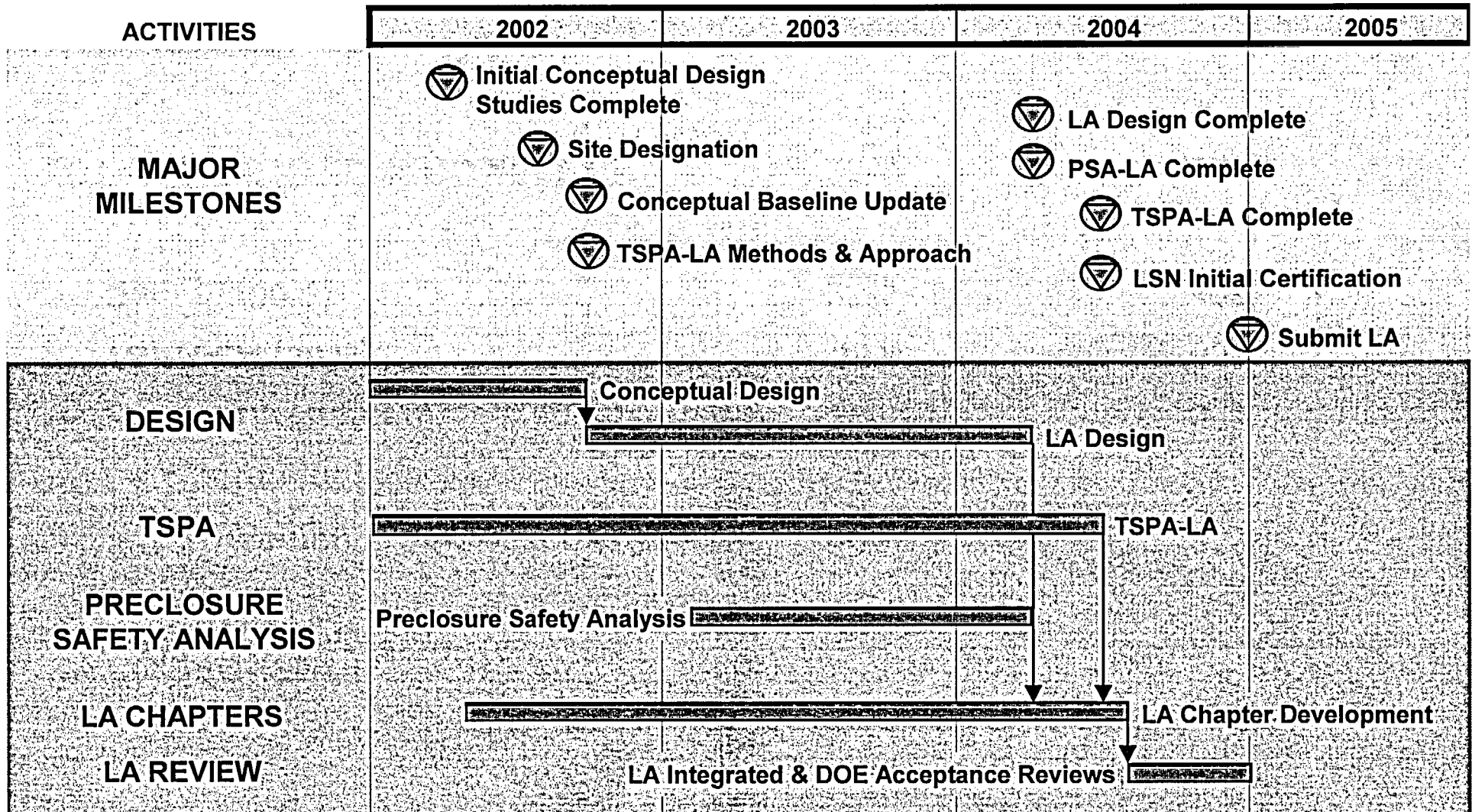
# License Application Status

- **DOE plans to submit a complete, high-quality License Application to NRC in December 2004**
- **Working toward initial Licensing Support Network certification 6 months prior to License Application submittal**





# Summary Schedule to License Application Submittal

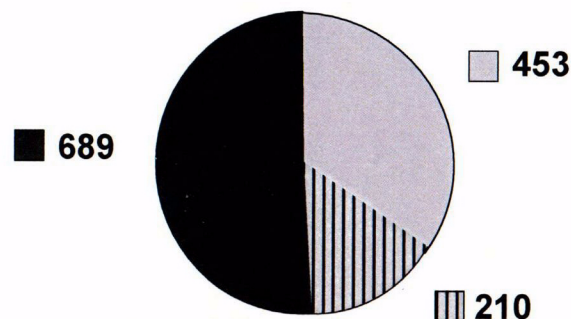


# Management Assessment of Progress Towards License Application

<u>COMPONENT (WEIGHT)</u>	<u>%COMPLETE (6/03)</u>	<u>%COMPLETE (10/03)</u>
KTI Agreements Addressed (10%)	50%	60%
LA Document (20%)	5%	7%
Preclosure Safety Assessment (10%)	14%	51%
TSPA-LA (30%)	35%	63%
Design (30%)	<u>25%</u>	<u>40%</u>
<b>TOTAL WEIGHTED % COMPLETE</b>	<b>25%</b>	<b>43%</b>

# Status of License Application Data, Codes, and Models<sup>1</sup>

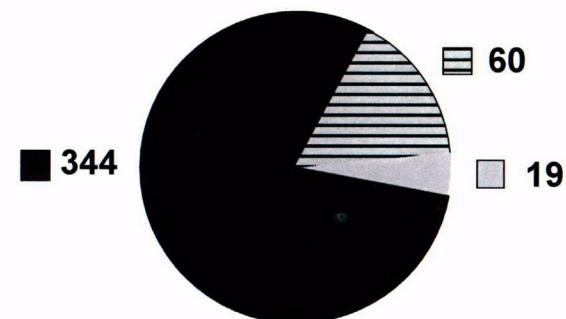
Data (Estimate)



**Total Data Sets: 1,352**

■ Qualified: 689 (51%)  
 ■ Being Verified: 453 (34%)  
 ■ Being Developed: 210 (15%)

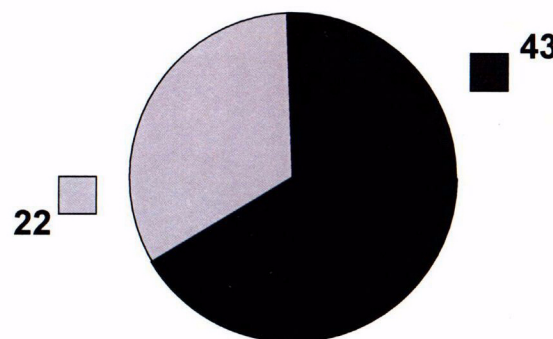
Codes (Estimate)



**Total Codes: 423**

■ Qualified & Verified: 60 (14%)  
 ■ Qualified (Legacy/re-testing): 344 (81%)  
 ■ Developing/verifying: 19 (5%)

Model Reports<sup>2</sup>



**Total Model Reports Directly Supporting LA: 65**

■ Completed: 43 (66%)  
 ■ Being Developed: 22 (34%)

<sup>1</sup> Status of qualification activities for LA and completion of reports

<sup>2</sup> Model Reports may contain multiple models

# DOE Feedback on NRC Risk-Ranking of Key Technical Issue Agreements

# DOE Feedback on NRC Risk Ranking

Risk associated with geologic disposal at Yucca Mountain is not high in an absolute sense.

KTl Agreement Subject	NRC Risk Ranking	DOE Relative Risk Ranking
Corrosion of Waste Package and Drip Shield	High	More Significant
Probability of Volcanic Disruption	High	More Significant
Aircraft Crash	High	More Significant
Mechanical Degradation of Waste Package and Drip Shield	High	Less Significant
Effects of In-Package Chemistry on Waste Form Dissolution	High	Less Significant
Radionuclide Transport in Saturated Zone	High	Less Significant
Radionuclide Transport in Volcanic Ash	High	Less Significant



# Key Technical Issues Agreement Status

# Key Technical Issue Approach

- **DOE plans to address each Key Technical Issue agreement prior to License Application submittal**
  - An integrated approach is being used to address groups of Key Technical Issue agreements within the context of their relationship to the repository system
  - Separate submittals for some agreements
  - Goal is effective resolution of agreements
  - Revised schedule for responses provided to NRC in June
  - Schedule being re-evaluated to accelerate submittals
- **Coordination with NRC staff**
  - Regulatory interactions will be held to assist NRC review
  - Current schedule of interactions will be updated as needed to reflect this approach

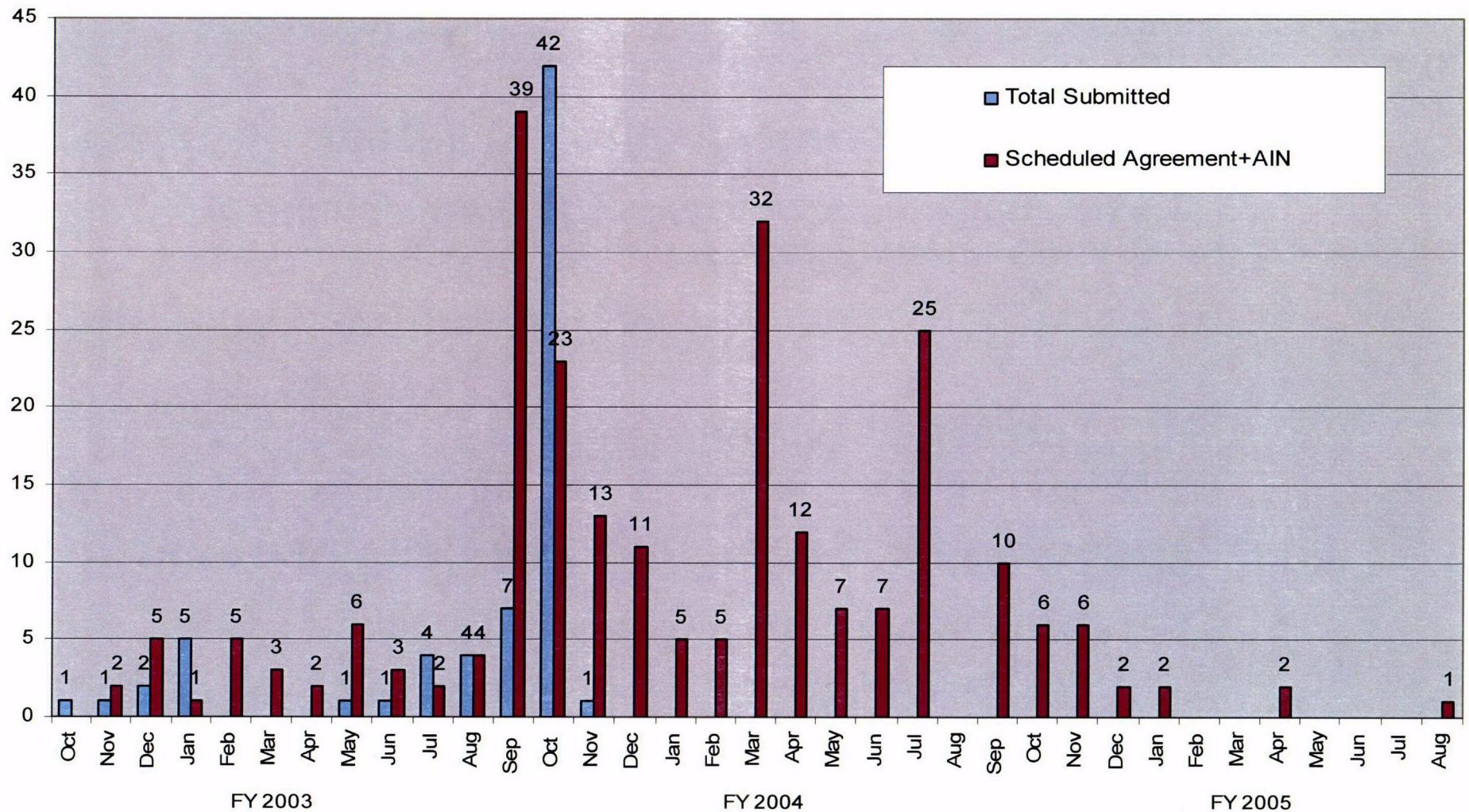


# Organization of Work

- **Develop the technical basis describing the physical processes and basis for repository performance**
- **Address Key Technical Issue agreements within the context of the technical basis**
- **Assign dedicated staff whose only priority is development of high quality responses to Key Technical Issue agreements**



# Scheduled Key Technical Issue Submittals Versus Actual



# Integrated Key Technical Issue Packages Submitted

- **Biosphere Transport (September 24, 2003)**
  - 7 Key Technical Issue Agreements (1 “medium” risk\*)
- **Saturated Zone Flow and Transport (October 2, 2003)**
  - 18 Key Technical Issue and related General Comment Agreements, 6 Additional Information Needed (2 “high”/ 7 “medium” risk\*)
- **Colloids (October 3, 2003)**
  - 7 Key Technical Issue and related General Comment Agreements, 4 Additional Information Needed (4 “medium” risk\*)
- **Water Seeping into Drifts (October 31, 2003)**
  - 4 Key Technical Issue and related General Comment Agreements, 2 Additional Information Needed (1 “high”/4 “medium” risk\*)

\* Indicates NRC risk ranking



# **Integrated Key Technical Issue Packages In Process for November**

- **Volcanic Events (October 2003)**
  - 3 Key Technical Issue Agreements, 2 Additional Information Needed (1 “high”/4 “medium” risk\*)
- **In-Drift Chemical Environment (October 2003)**
  - 16 Key Technical Issue Agreements (9 “high”/ 7 “medium” risk\*)
- **Waste Package and Drip Shield Corrosion (September 2003)**
  - 9 Key Technical Issue Agreements (1 “high”/3 “medium” risk\*)

\* Indicates NRC risk ranking

# **Future Integrated Key Technical Issue Packages**

- **Climate and Infiltration (March 2004)**
- **Unsaturated Zone Flow (March 2004)**
- **Mechanical Degradation and Seismic Effects (December 2003)**
- **In-Package Environment, Waste Form Degradation and Solubility (November 2003)**
- **Engineered Barrier System Transport (single agreement submitted with Colloids package)**
- **Unsaturated Zone Transport (March 2004)**
- **Low Probability Seismic Events (November 2003)**



# Key Technical Issue Agreement Summary - NRC Status

Reflects Activity Through November 11, 2003

KTID	Agreements Reached	Agreements Submitted to NRC	Responses Submitted In NRC Review	Partial Responses Submitted	NRC Needs Additional Information	Responses Remaining to be Submitted	Agreements Complete
CLST	58	35	2	2	11	23	20
ENFE	41	27	8	5	1	14	13
GEN	1	1	0	1	0	0	0
IA	22	18	4	0	2	4	12
PRE	9	5	2	0	2	4	1
RDTME	23	3	1	2	0	20	0
RT	29	22	17	0	0	7	5
SDS	10	10	2	3	1	0	4
TEF	15	12	1	3	1	3	7
TSPAI	58	32	13	3	9	26	7
USFIC	27	25	13	0	2	2	10
<b>Total =</b>	<b>293</b>	<b>190</b>	<b>63</b>	<b>19</b>	<b>29</b>	<b>103</b>	<b>79</b>

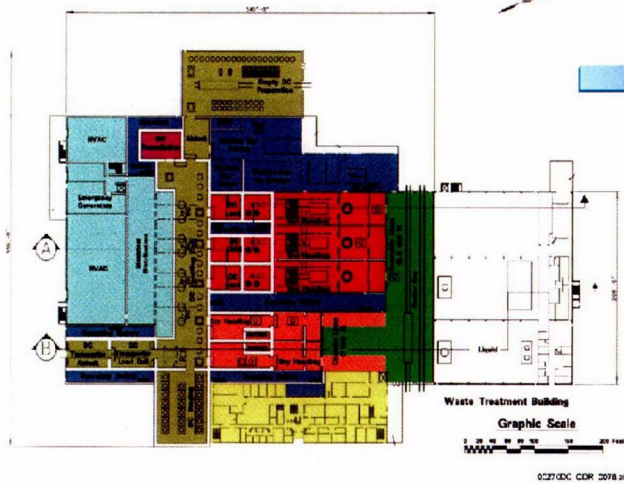
*Total responses to be submitted to NRC for closure (remaining responses, partial responses and AIN's) = 151*





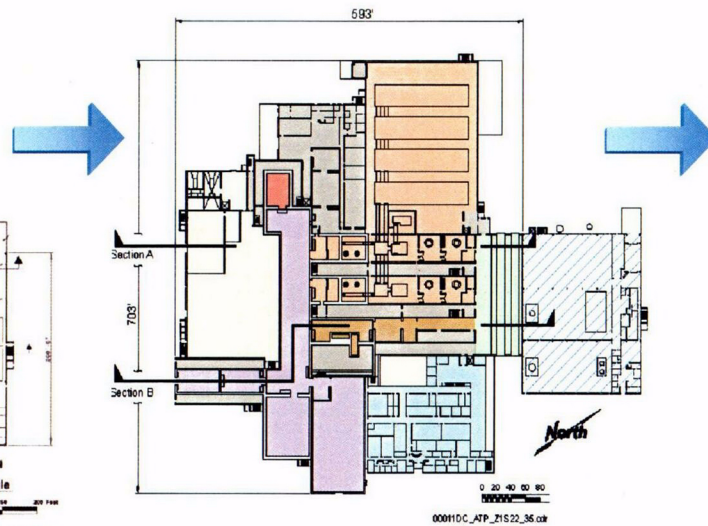
# Design Evolution

# Surface Facility Evolution



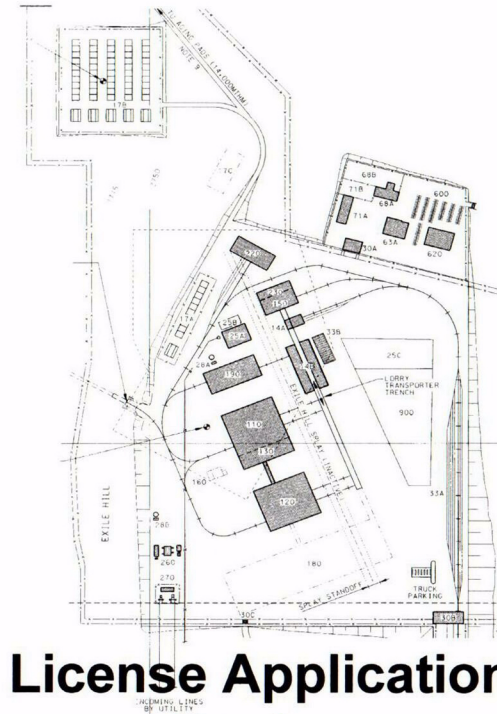
## Viability Assessment Design

- Single large building
- Wet handling for commercial spent nuclear fuel
- 5 transfer lines



## Site Recommendation Design

- Single large building
- Wet handling for commercial spent nuclear fuel
- 3 transfer lines
- 5,000 metric tons of heavy metal blending pools (to accommodate thermal blending)



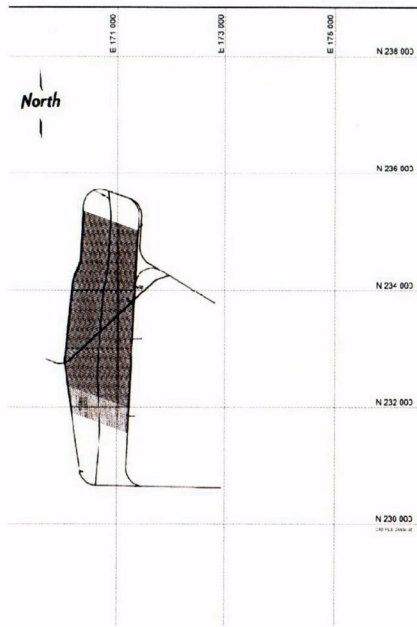
## License Application Design

- Multiple buildings
- Dry handling
- Small pool for remediation
- Phased construction
- Dry cask aging



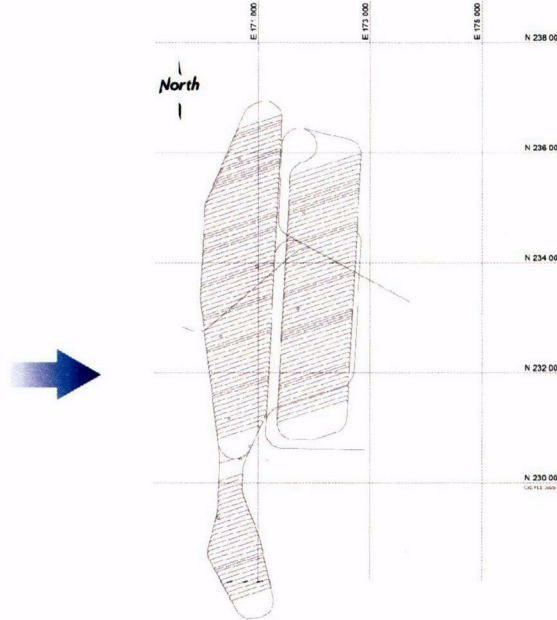
YUCCA MOUNTAIN PROJECT

# Subsurface Repository Evolution



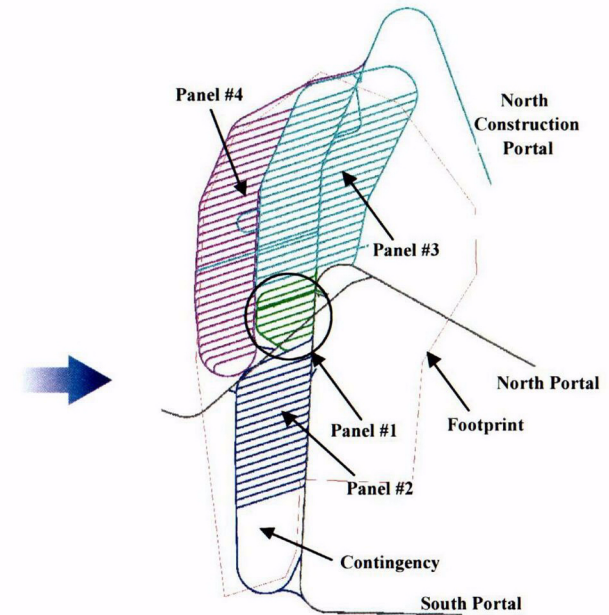
## Viability Assessment Design

- 92 ft drift spacing
- Above-boiling temperature throughout rock pillars
- Single level
- Minimal ventilation



## Site Recommendation Design

- 266 ft drift spacing
- Sub-boiling temperature in portion of rock pillars
- Two levels
- Robust forced ventilation with allowance for long-term natural ventilation



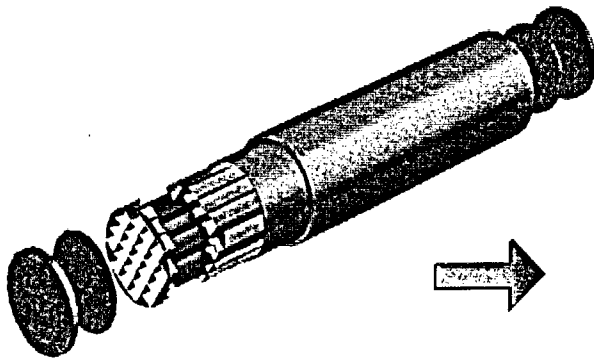
## License Application Design

- 266 ft drift spacing
- Sub-boiling temperature in portion of rock pillars
- One level, 4 panels, phased development
- Robust forced ventilation



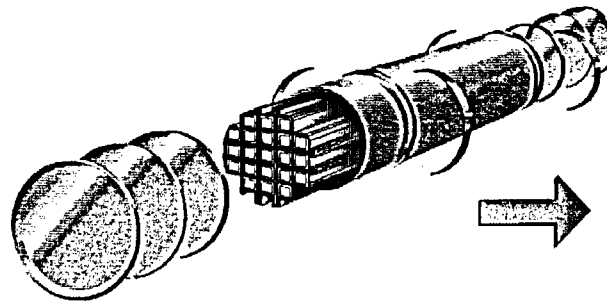


# Waste Package Evolution



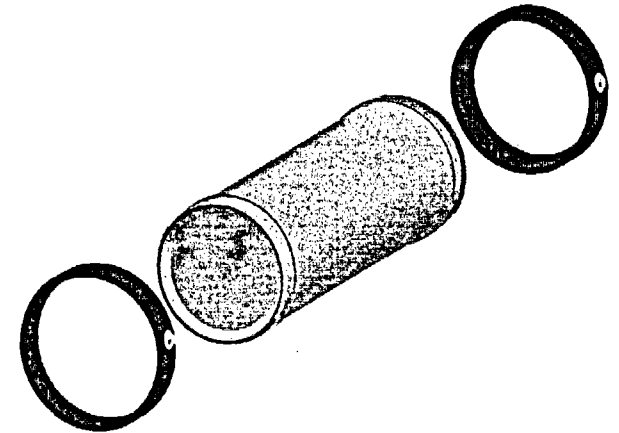
## Viability Assessment Design

- Outer Barrier carbon steel
- Inner Barrier Alloy 22
- 18 kW power limit



## Site Recommendation Design

- Outer Barrier Alloy 22
- Inner Barrier stainless steel
- 11.8 kW power limit
- Extended outer lid
- Split trunnion collar



## License Application Design

- Outer Barrier Alloy 22
- Inner Barrier stainless steel
- 11.8 kW power limit
- Flat outer lid
- One-piece twist-on trunnion collar



# Summary

- **DOE is completing actions to achieve progress and address long-standing management and quality assurance issues**
  - NRC is monitoring our performance
- **DOE plans to submit a complete, high-quality License Application to NRC in December 2004**
- **An integrated approach is being used to address groups of Key Technical Issue agreements within the context of their relationship to the repository system**
  - Responses provided for 75 agreements since September 1
  - Remaining agreements will be addressed prior to License Application submittal
- **Design is maturing toward the basis for the License Application**





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



# Repository Design Status

Presented to:  
**Advisory Committee for Nuclear Waste**

Presented by:  
**Paul Harrington**  
Office of Repository Development  
U. S. Department of Energy

November 19, 2003  
Las Vegas, Nevada

# Introduction

- **Presentation on design solutions with preliminary preclosure safety analysis results**
- **Design details to be added for License Application**
- **Preliminary preclosure safety analysis based upon April 2003 design**
- **Surface facilities changes implement Cogema expertise**
- **Subsurface facility layout and ground support changes**
- **Waste package design detail changes**



# Preclosure Safety Analysis Approach

- Internal and external hazards analyses identify hazards
- Categorization analyses estimate frequency of event sequences
- Consequence analyses estimate doses to public and workers from event sequences
- Classification analyses identify structures, systems, and components that are important to safety
- Nuclear safety design basis document captures design requirements



# Preclosure Safety Analysis Status

- Preliminary preclosure safety analysis of design as of April 2003 is complete
- Results of preliminary preclosure safety analysis will influence License Application design
- Preclosure safety analysis process will be repeated for License Application design
- Identified event sequences and dose consequences are expected to be substantially similar for License Application design



# Surface Facilities



**YUCCA MOUNTAIN PROJECT**

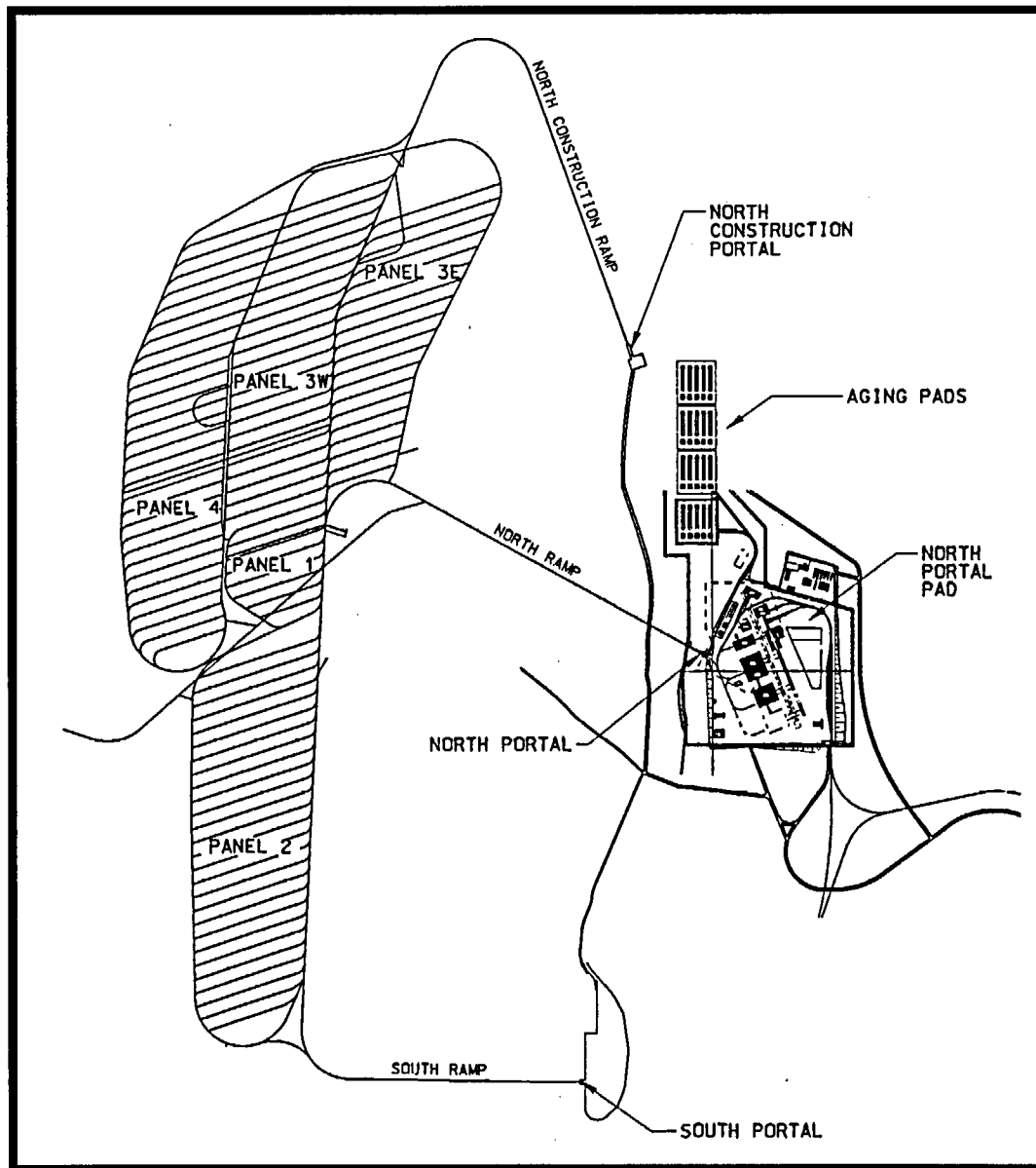
# Surface Facilities

- Design input from Cogema using extensive process experience from La Hague facility
- Design adapted for Yucca Mountain requirements
- Recent design changes
  - Transportation Cask Receipt Facility with buffer area
  - Canister Handling Facility
  - Integrated Dry Transfer Facility with remediation capability
  - Second Dry Transfer Facility to be built later
  - Processing is primarily dry with small pool for remediation
  - Rail-based transportation system





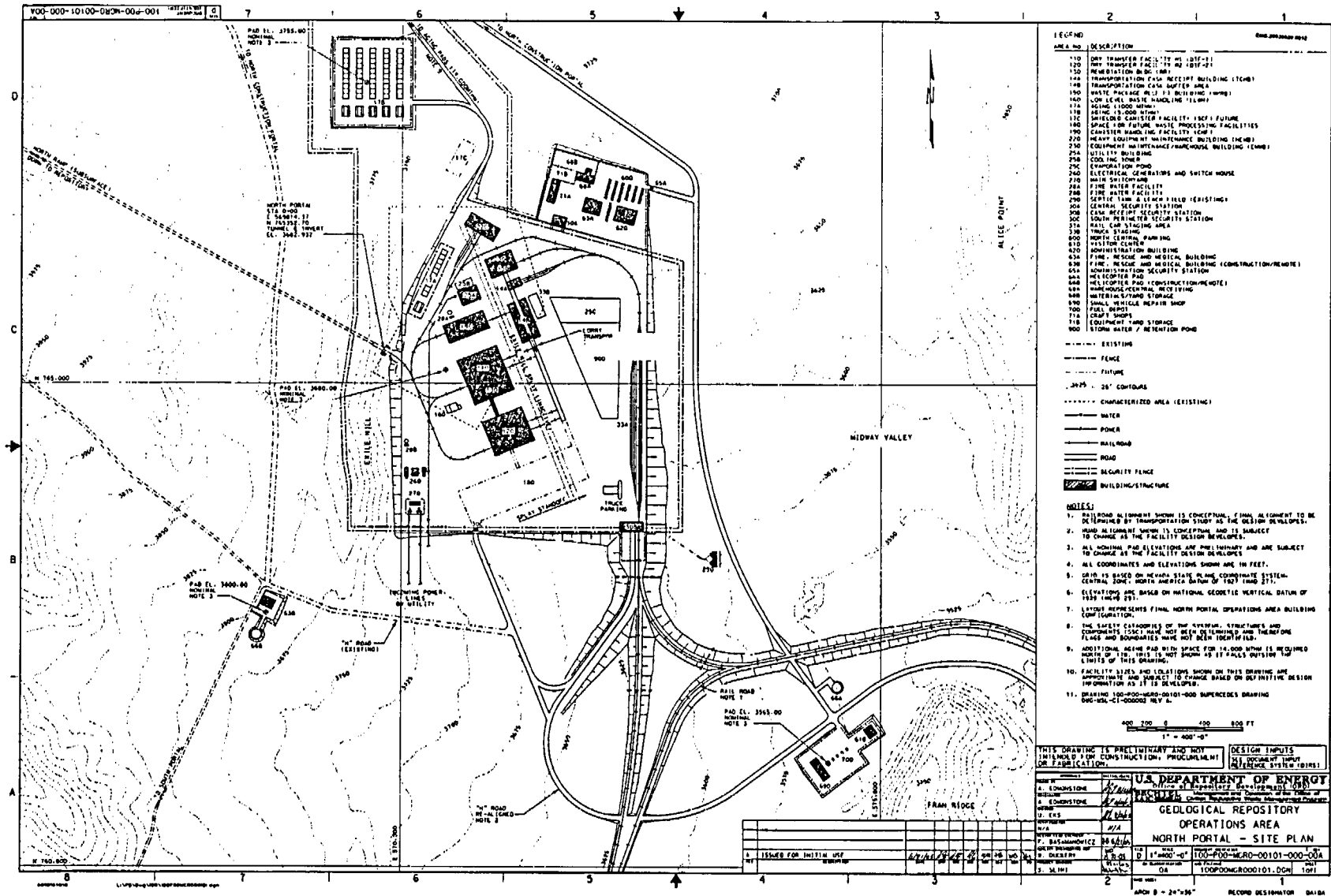
# Site Plan



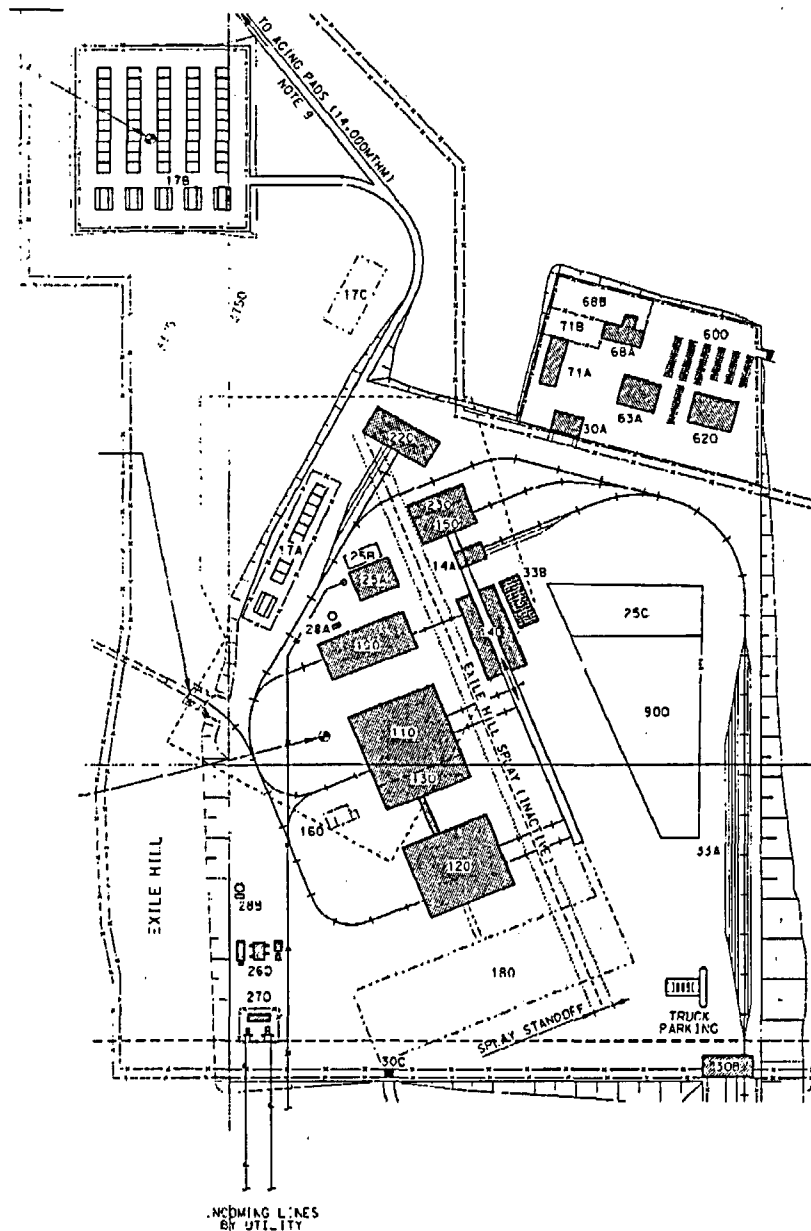
This drawing is preliminary and not intended for construction, procurement, or fabrication.



# Surface Facilities



# North Portal Plan



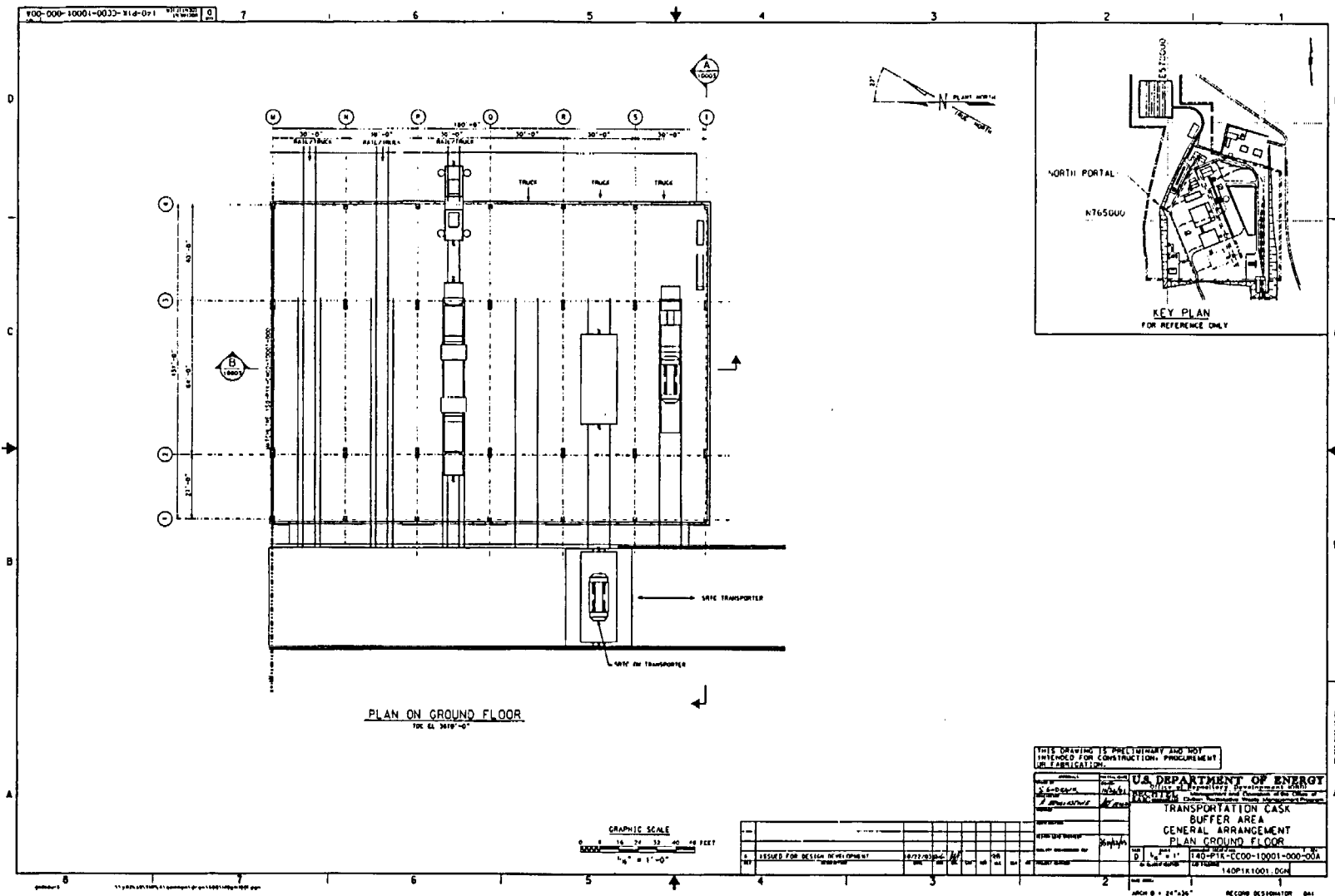
AREA NO.	DESCRIPTION
110	DRY TRANSFER FACILITY #1 (DTF-1)
120	DRY TRANSFER FACILITY #2 (DTF-2)
130	REMEDATION BLDG (RB)
140	TRANSPORTATION CASK RECEIPT BUILDING (TCRB)
148	TRANSPORTATION CASK BUFFER AREA
150	WASTE PACKAGE RECEIPT BUILDING (WPRB)
160	LOW LEVEL WASTE HANDLING (LLWH)
170	AGING (1000 MHM)
17B	AGING (15,000 MHM)
17C	SHIELDED CANISTER FACILITY (SCF) FUTURE
180	SPACE FOR FUTURE WASTE PROCESSING FACILITIES
190	CANISTER HANDLING FACILITY (CHF)
220	HEAVY EQUIPMENT MAINTENANCE BUILDING (HEMB)
230	EQUIPMENT MAINTENANCE/WAREHOUSE BUILDING (EMWB)
250	UTILITY BUILDING
25B	COOLING TOWER
25C	EVAPORATION POND
260	ELECTRICAL GENERATORS AND SWITCH HOUSE
270	MAIN SWITCHYARD
280	FIRE WATER FACILITY
28B	FIRE WATER FACILITY
290	SEPTIC TANK & LEACH FIELD (EXISTING)
300	CENTRAL SECURITY STATION
30B	CASK RECEIPT SECURITY STATION
30C	SOUTH PERIMETER SECURITY STATION
330	RAIL CAR STAGING AREA
33B	TRUCK STAGING
600	NORTH CENTRAL PARKING
610	VISITOR CENTER
620	ADMINISTRATION BUILDING
630	FIRE, RESCUE AND MEDICAL BUILDING
63B	FIRE, RESCUE AND MEDICAL BUILDING (CONSTRUCTION/REMOTE)
650	ADMINISTRATION SECURITY STATION
660	HELICOPTER PAD
66B	HELICOPTER PAD (CONSTRUCTION/REMOTE)
680	WAREHOUSE/CENTRAL RECEIVING
68B	MATERIALS/YARD STORAGE
690	SMALL VEHICLE REPAIR SHOP
700	FUEL DEPOT
710	CRAFT SHOPS
71B	EQUIPMENT YARD STORAGE
900	STORM WATER / RETENTION POND

- EXISTING
- FENCE
- FUTURE
- 25' CONTOURS
- CHARACTERIZED AREA (EXISTING)
- WATER
- POWER
- RAILROAD
- ROAD
- SECURITY FENCE
- BUILDING/STRUCTURE

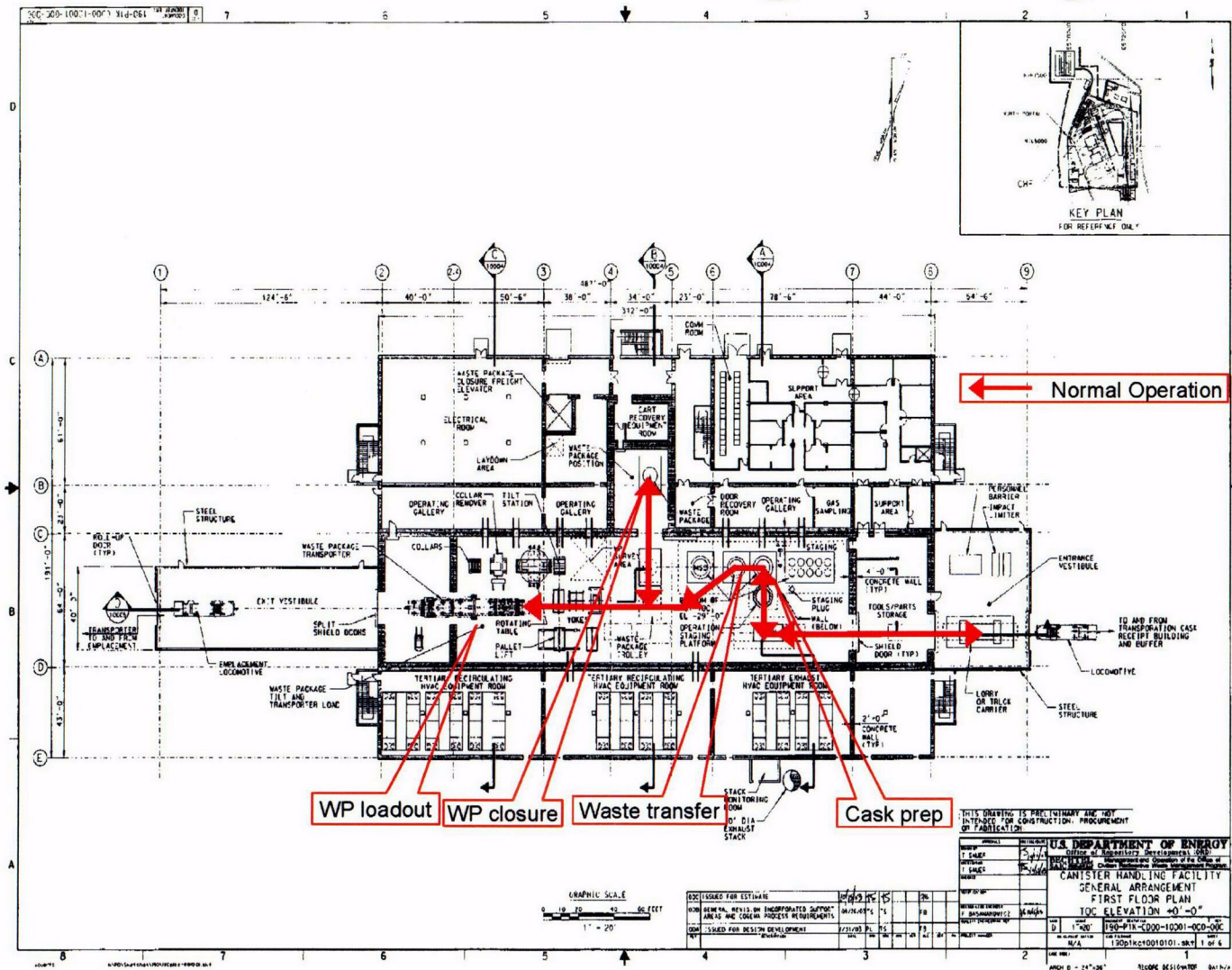
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# Transportation Cask Receipt Facility

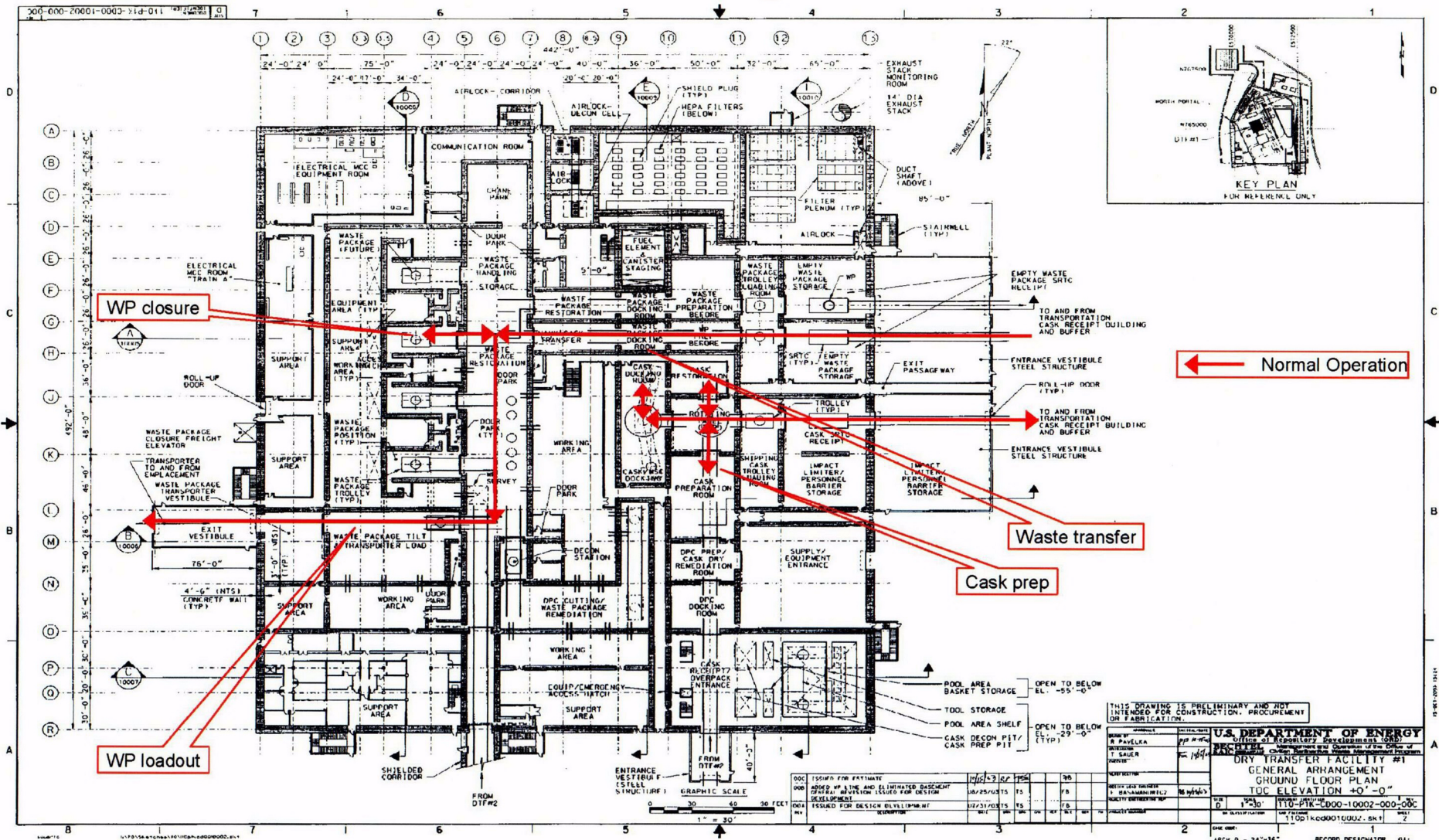


# Canister Handling Facility



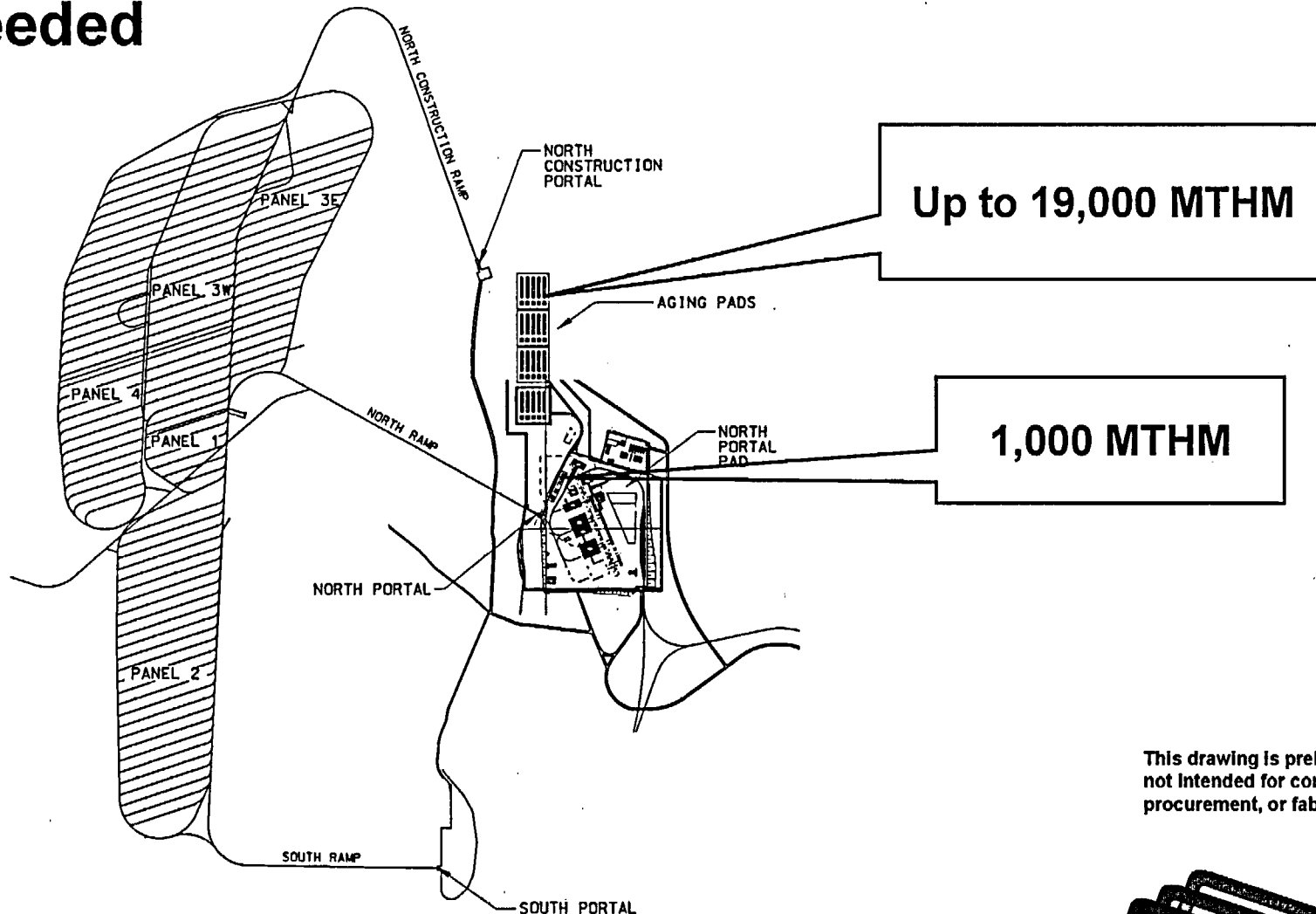


# Dry Transfer Facility 1/ Remediation



# Site Aging

Up to 20,000 metric tons of heavy metal capacity, built as needed

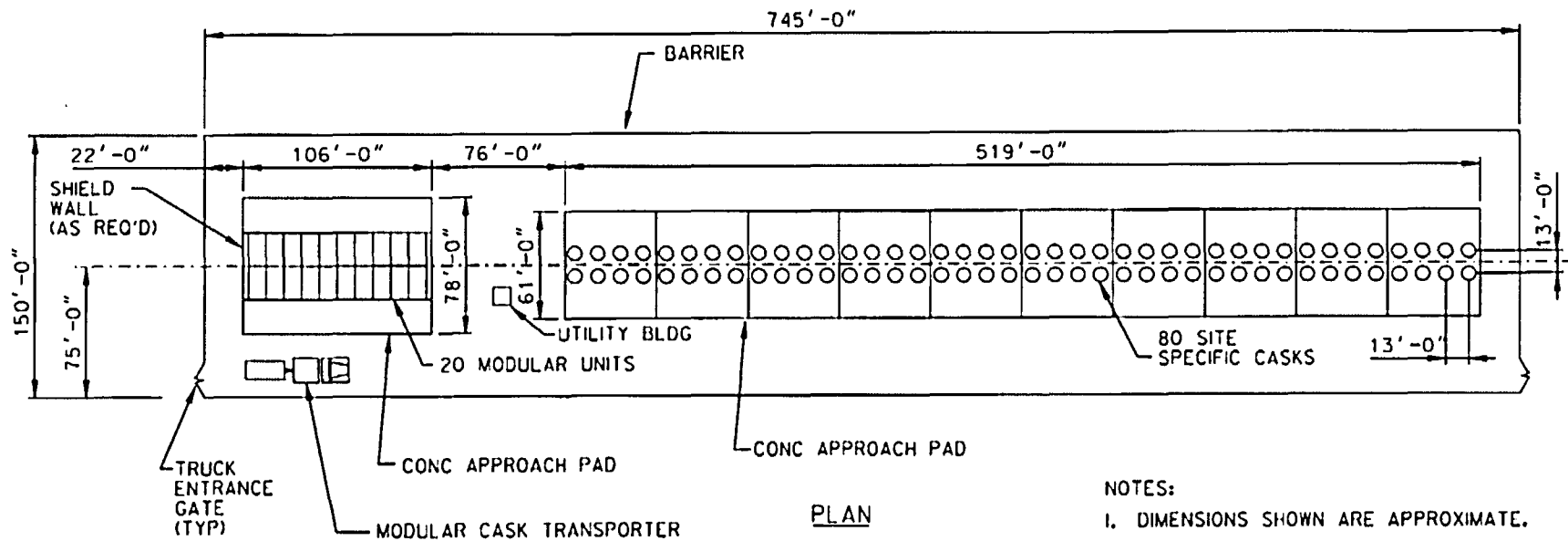


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# North Portal Aging Facility

1000 metric tons of heavy metal capacity



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





# Surface Facilities Phased Implementation

- **Allows for the implementation of a small initial disposal capability**
  - Increases confidence to meet 2010 initial operation
  - Remediation integral with fuel handling facility for more efficient processing and movement inside a single facility
  - Adopt lessons learned approach
- **Provides maximum flexibility to adjust to future changes in:**
  - Funding
  - Schedule
  - Incoming waste stream



# Surface Facilities Construction Sequence

- **Phase 1**
  - Transportation Cask Receipt Facility
  - Canister Handling Facility
  - Dry Transfer Facility 1
  - Aging - 6,000 metric tons of heavy metal, initial
  - Balance of Plant Facilities, partial
- **Phase 2**
  - Dry Transfer Facility 2
  - Aging - 20,000 metric tons of heavy metal, total
  - Balance of Plant, complete



# **Surface Facilities Preliminary Preclosure Safety Analysis Results**

- **No Category 1 or 2 external event sequences**
- **Two Category 1 internal event sequences involving drop or collision of commercial spent nuclear fuel assemblies in a Dry Transfer Facility**
- **31 Category 2 internal event sequences for cask, canister, and assembly handling (drops or collisions) in the surface facilities**
- **No Category 1 or 2 event sequences for 1,000 metric tons of heavy metal Waste Aging Facility**
- **Canister Handling Facility and 20,000 metric tons of heavy metal aging not addressed**



# **Surface Facilities Dose Consequences**

- **Sum of offsite doses from normal operations and frequency-weighted Category 1 event sequence doses are below regulatory limits**
- **Sum of worker doses from normal operations and Category 1 event sequences are below regulatory limits**
- **Category 2 offsite doses are below regulatory limits**

# Classification Analyses

- **Structures, systems, and components that are credited for prevention or mitigation of Category 1 or Category 2 event sequences are important to safety and are classified as Safety Category**
- **Natural or engineered barriers that are important to meeting 10 CFR 63.113 performance objectives are important to waste isolation and are classified as Safety Category**
- **Structures, systems, and components that are not important to safety or waste isolation are classified as Non-Safety Category**

# Surface Facilities Structures, Systems, and Components Classification Results

- Structures in which spent fuel assemblies, canisters, or casks without impact limiters are handled are important to safety
- Important to safety subsystems in the Cask Receipt and Return System include cask receipt, cask preparation, and the cask buffer subsystems
- Important to safety systems in the Dry Transfer Facilities include cask preparation, waste package, DOE canister, and spent nuclear fuel/high-level radioactive waste transfer systems
- Other important to safety systems include the transportation cask, waste packages, remediation system, emplacement and retrieval system, and the aging system



# Aircraft Hazard Evaluation

- **Hazards**
  - **Military flights within the Nevada Test and Training Range and Nevada Test Site**
  - **Commercial, general aviation, and military flights 8 miles or more away in the Beatty corridor**
- **Approach: Screen out hazard due to low probability**
  - **Methods similar to NUREG-0800**
  - **Flight counts from Federal Aviation Administration**
  - **Flight counts from Nevada Test and Training Range instrumentation**
  - **Crash rates from historical data by type of aircraft**



# Aircraft Hazard Evaluation

(Continued)

- Initial study screened out hazard for 100-year operation and 1,000 metric tons of heavy metal aging pad
- May also screen out hazard for 20,000 metric tons of heavy metal aging pad if waste is present for no more than 50 years
- Planned changes in use of the Nevada Test Site airspace by the Air Force require reevaluating the aircraft crash hazard





# **Surface Facilities As Low As Is Reasonably Achievable and Worker Safety**

- **As low as is reasonably achievable design goals - 500 mrem/yr for rad worker**
- **As low as is reasonably achievable design guide**
  - Minimize manual operations in radiation and contaminated areas
  - Increase the reliability of processes and equipment used
  - Increase the distance from the radiation source term and/or shield the radiation source
  - Engineer effective contamination controls into the design
  - Decrease exposure times
- **Examples of as low as is reasonably achievable implementation**
  - Remote operations for high radiation activities
  - Shield walls and limited personnel access during operations



# Subsurface Facilities

# Subsurface Facility

- **Thermal goals**
  - Limit cladding temperature to 350°C
  - Limit preclosure drift wall temperature to 96°C
  - Limit postclosure drift wall temperature to 200°C
  - Allow for pillar drainage (a portion of the drift pillar temperature will remain below the boiling point of water)
  - The ventilation system must provide 15 m<sup>3</sup>/s per emplacement drift for a period of 50 years after final emplacement to meet the thermal goals
- **Waste packages emplaced 0.1 m end to end**

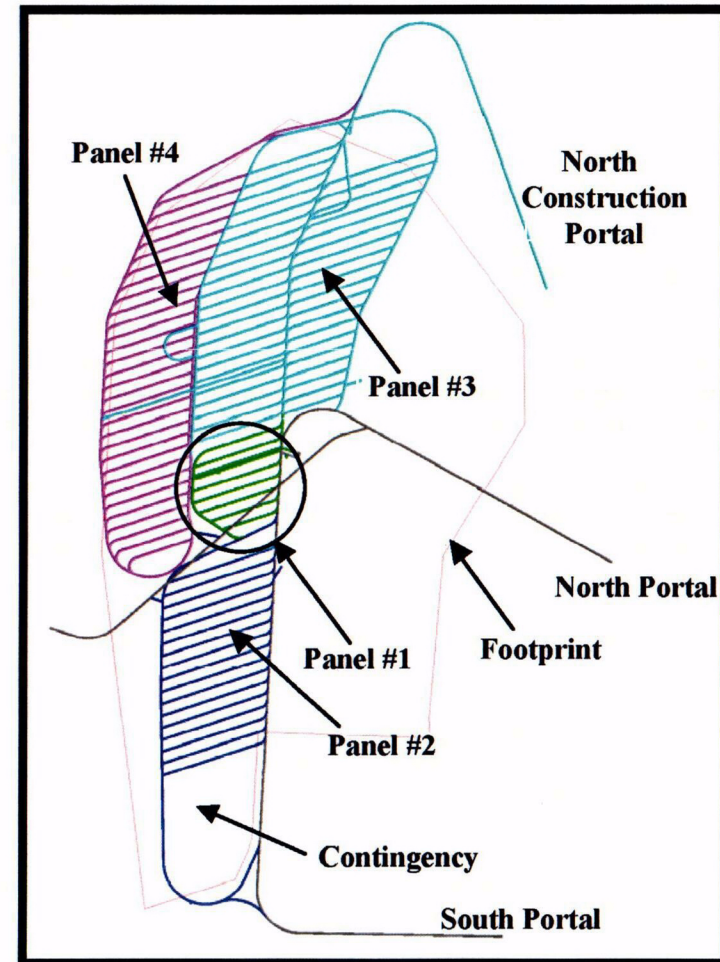


# Subsurface Design Changes

- **Recent design changes**
  - Revised panel layouts and ventilation system
  - Revised ground support
  - Returned to rail system for waste package transporter
  - Increased radius of emplacement drift turnouts
  - Moved ventilation control doors to outer end of turnouts

# Subsurface Configuration

- Panel numbers represent the proposed emplacement sequence
- Sequence:
  - Panel 1, Phase 1 for 2010
    - ◆ Develop at least 3 emplacement drifts
  - Panel 1, Phase 2
    - ◆ Complete Panel 1 drifts (8 total)
  - Panel 2
    - ◆ 17 drifts total (excludes contingency)
- Total emplacement length available is approximately 41 miles (65 km)
- Available contingency of 11 - 13.5 percent for the 70,000 metric tons of heavy metal case

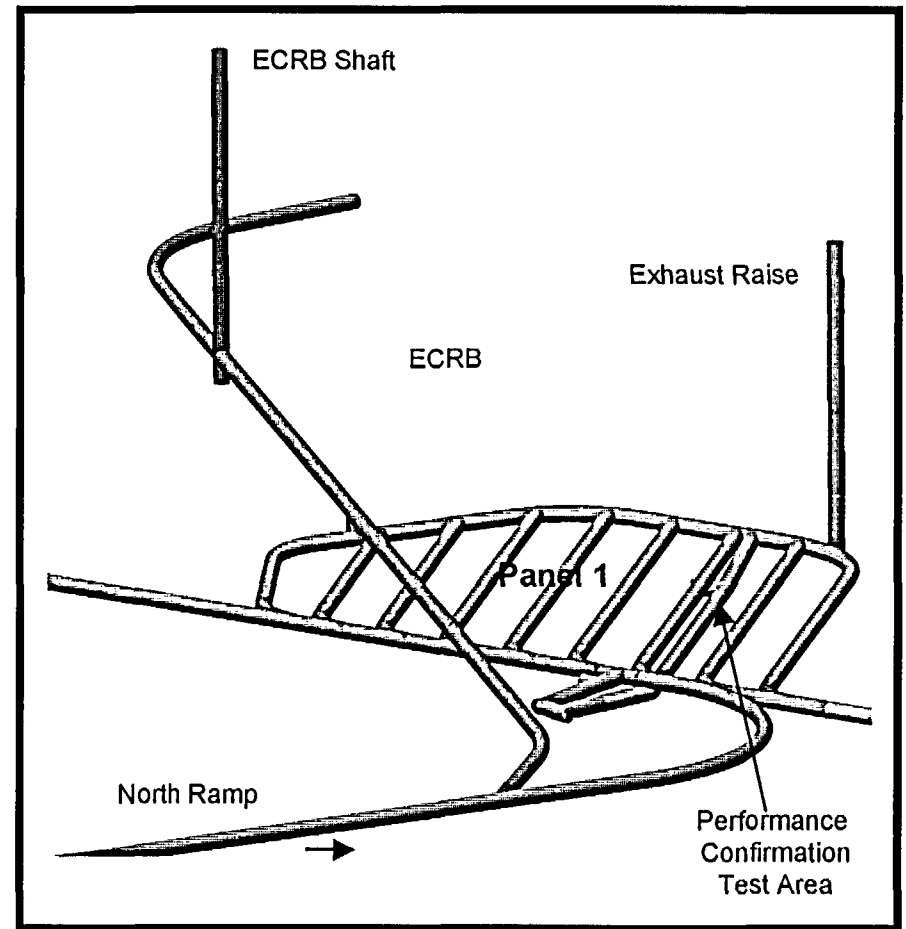


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# Panel 1

- Panel 1 consists of eight emplacement drifts
- Approximately 4,100 m (13,000 ft) of useable emplacement drift
- Panel 1 is located approximately half in the lower lithophysal and half in the middle non-lithophysal
- Panel 1 will be ventilated using the North Ramp and the exhaust raise
- A portion of Panel 1 will be used as a test area for performance confirmation

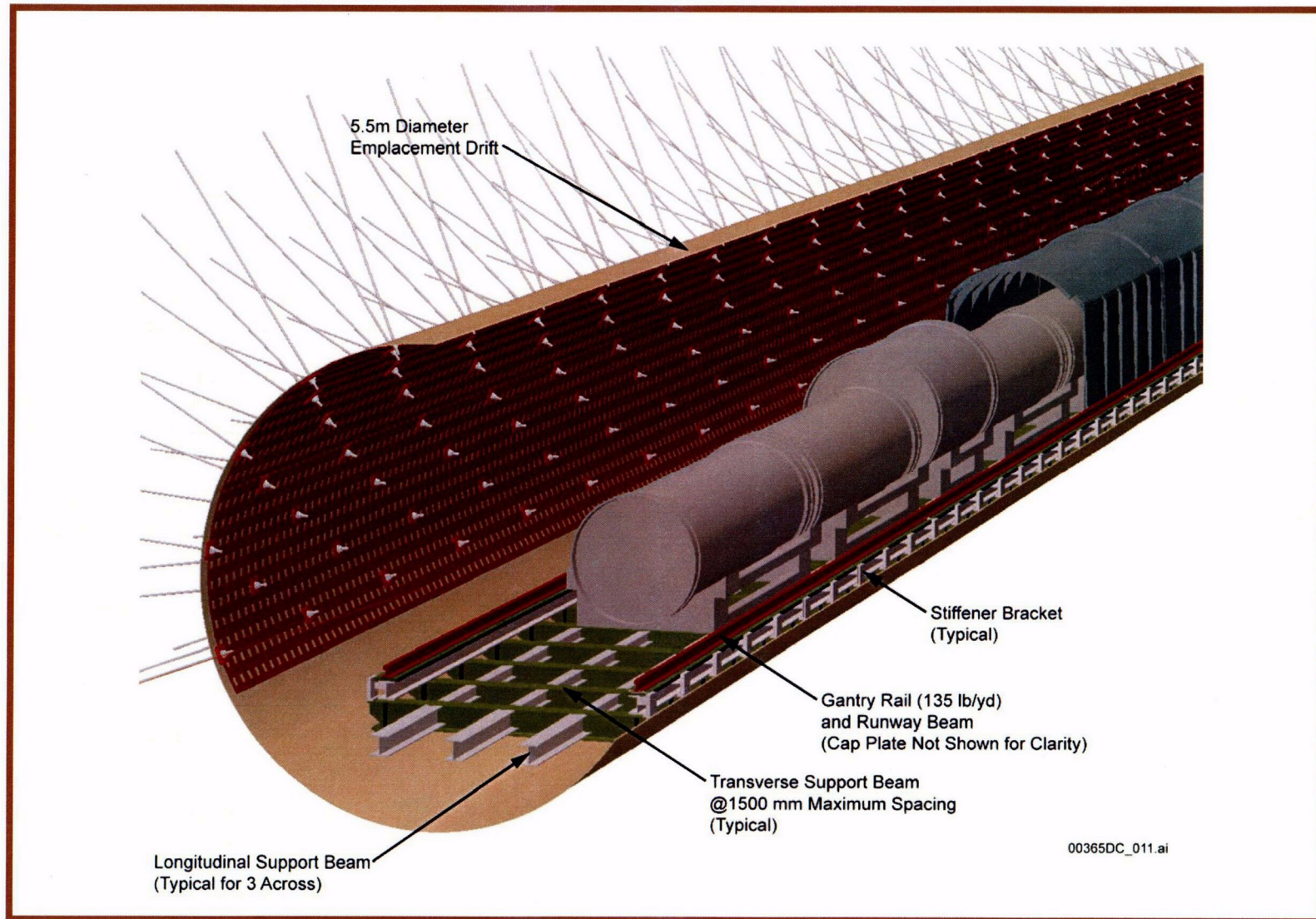


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# Emplacement Drift Isometric

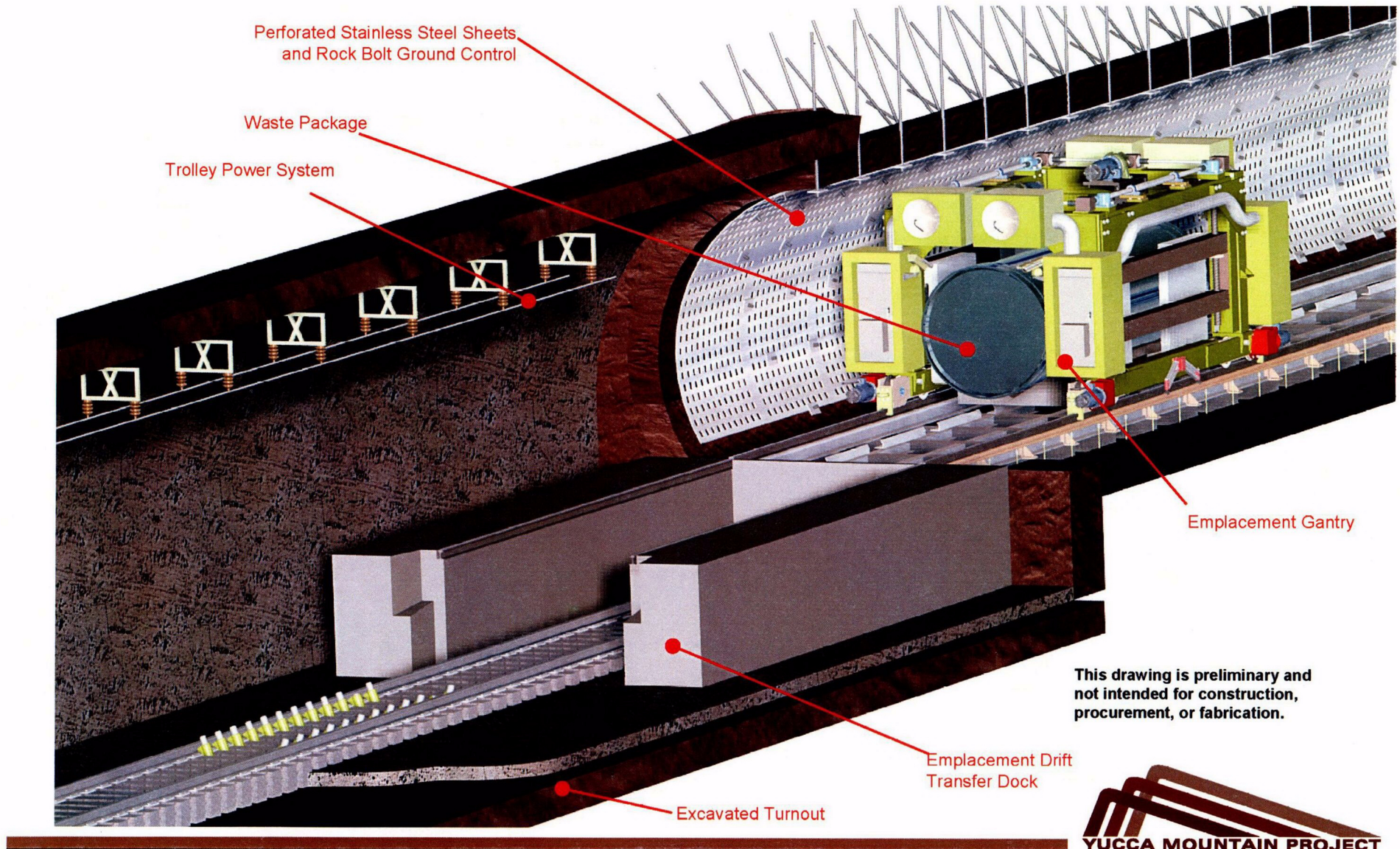


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**YUCCA MOUNTAIN PROJECT**



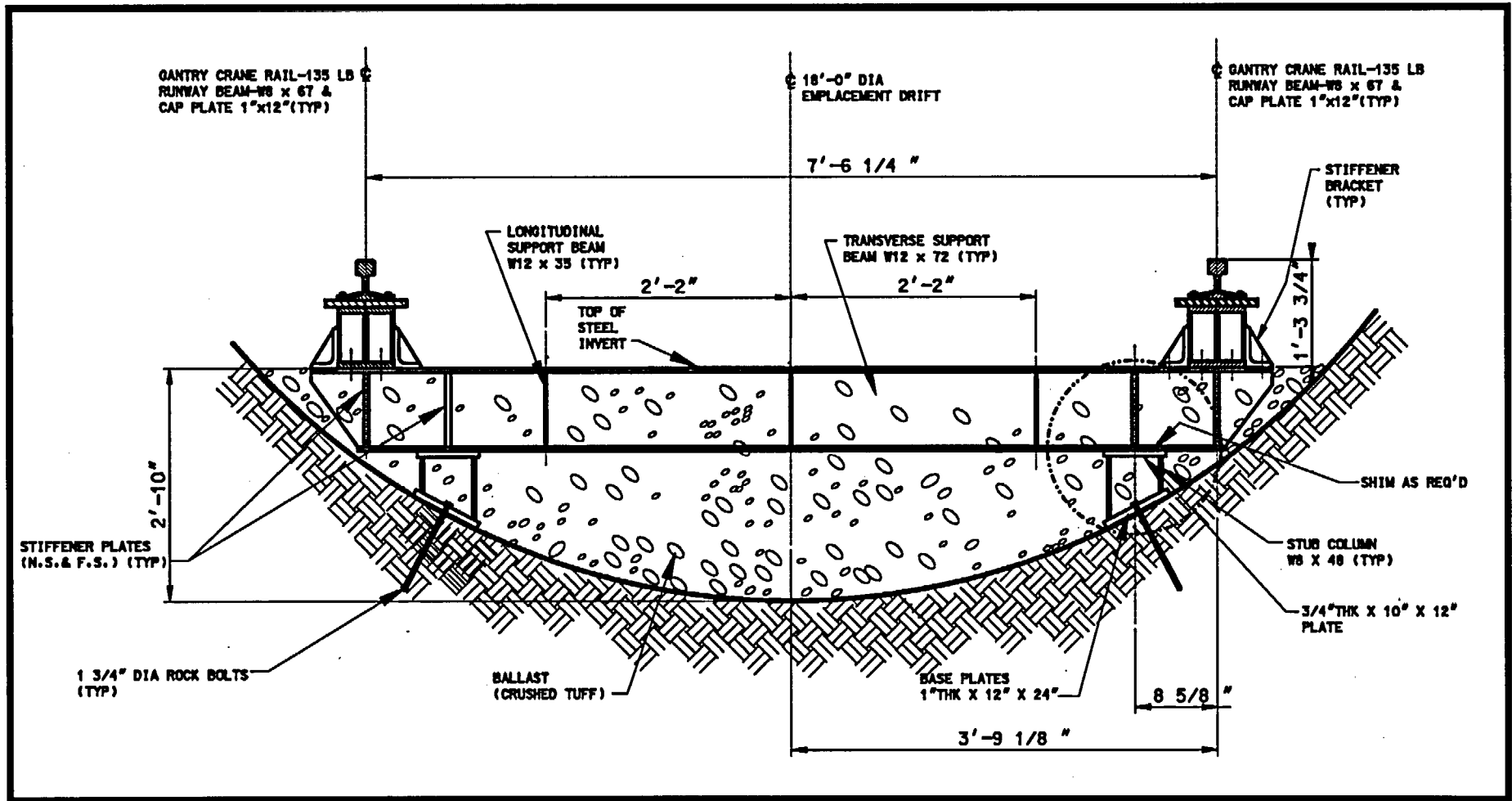
# Emplacement Drift Entrance



**YUCCA MOUNTAIN PROJECT**

CO9

# Emplacement Drift Invert



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# Emplacement Drift Invert

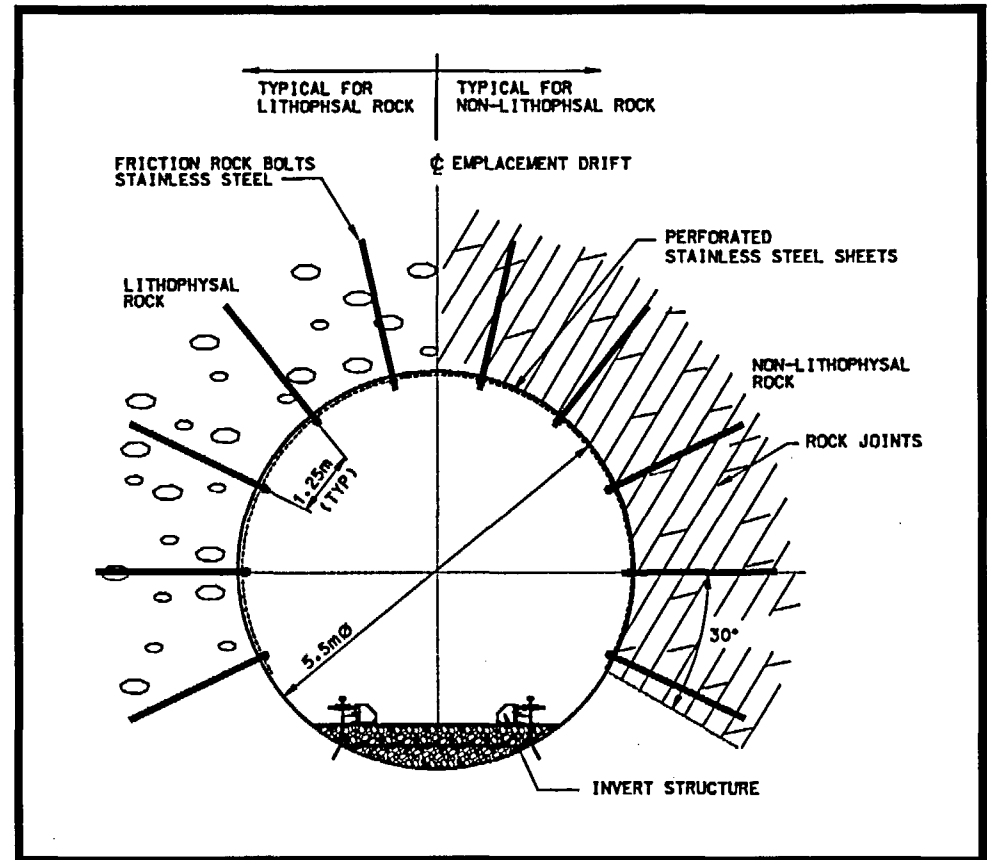
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- **Emplacement drift invert includes steel structure and ballast material**
- **Carbon steel invert structure**
  - Supports emplacement gantry rail system
  - Supports waste packages and drip shields during the preclosure period
- **Ballast material**
  - Crushed tuff, well graded from 2 inch minus to no more than 5 percent fines, compacted to 95 percent of its maximum dry density
  - Provides an engineered barrier to diffuse the potential radionuclide flow from the waste packages
  - Supports waste packages and drip shields during the postclosure period



# Ground Support for Emplacement Drifts

- Friction rock bolts 3 m long, spaced at 1.25 m
- Thin (3 mm thick) perforated sheets, installed in a 240° arc around the drift periphery along entire drift length
- Bolts and sheets made of stainless steel to ensure their longevity
- Suitable for various ground conditions
- Capable of preventing rock fall



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# Ground Support for Non-Emplacement Openings

- Access and exhaust mains; ramps

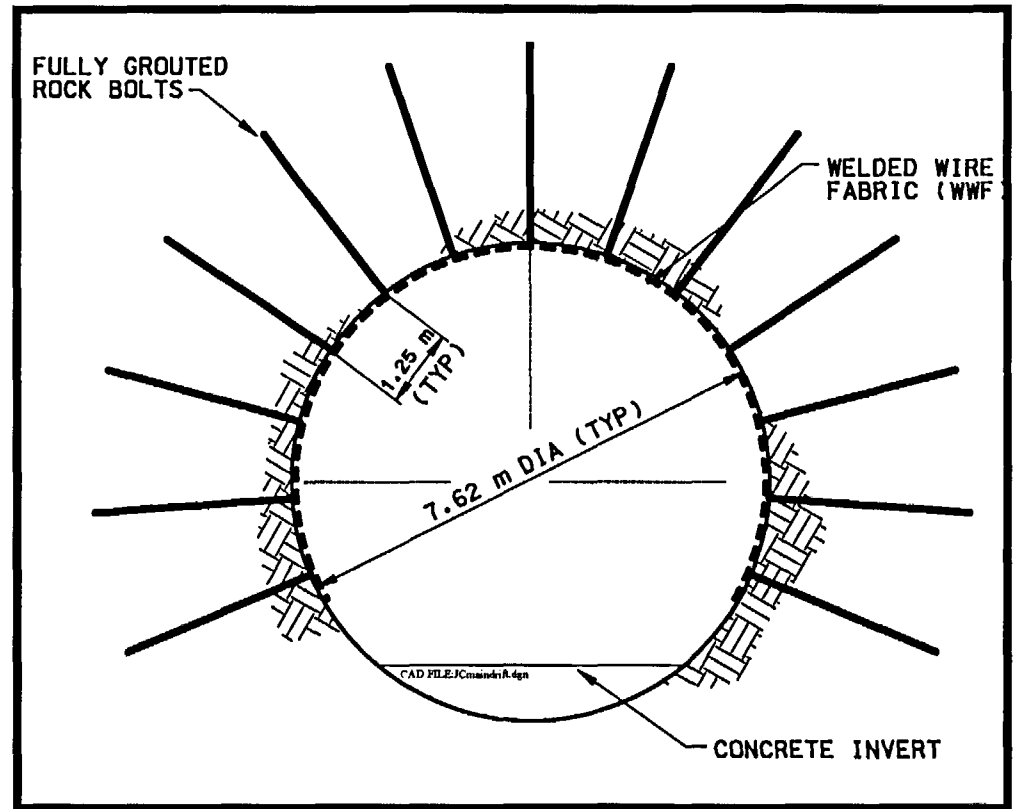
- Fully grouted rock bolts, typically spaced at 1.25 m
- Welded wire fabric installed from springline to springline or below springline for raveling control
- Materials made of carbon steel

- Turnouts and intersections

- Fully grouted rock bolts
- Wire mesh
- Shotcrete (100 mm thick)
- Lattice girders if required in wide spans

- Shafts

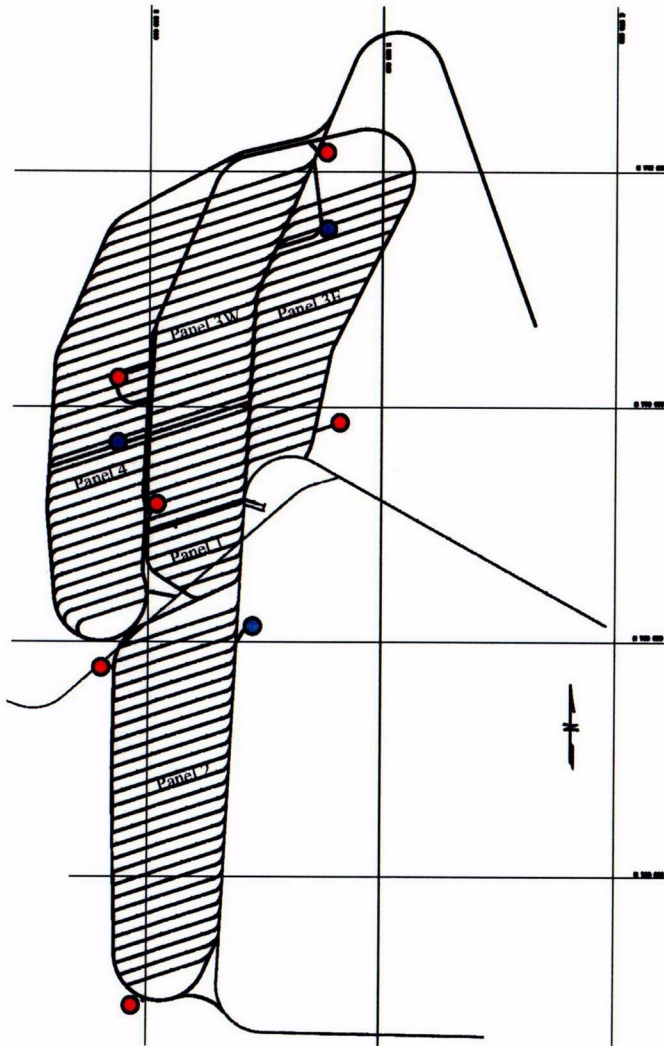
- Rock bolts
- Shotcrete or concrete (100 mm thick)



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



# Forced Ventilation



- **Main Intakes:**
  - 3 shafts and 3 ramps
  - Total intake airflow rate: 1,700  $\text{m}^3/\text{s}$  at 15  $\text{m}^3/\text{s}$  per emplacement drift (includes leakage)
- **Main Exhausts:**
  - 6 shafts or raises
  - Total exhaust airflow rate: 1,900  $\text{m}^3/\text{s}$  at 17  $\text{m}^3/\text{s}$  per emplacement drift (includes leakage)
- — Intake shaft
- — Exhaust shaft or raise

## Notes:

Exhaust airflow greater than intake airflow to account for thermal expansion of air.

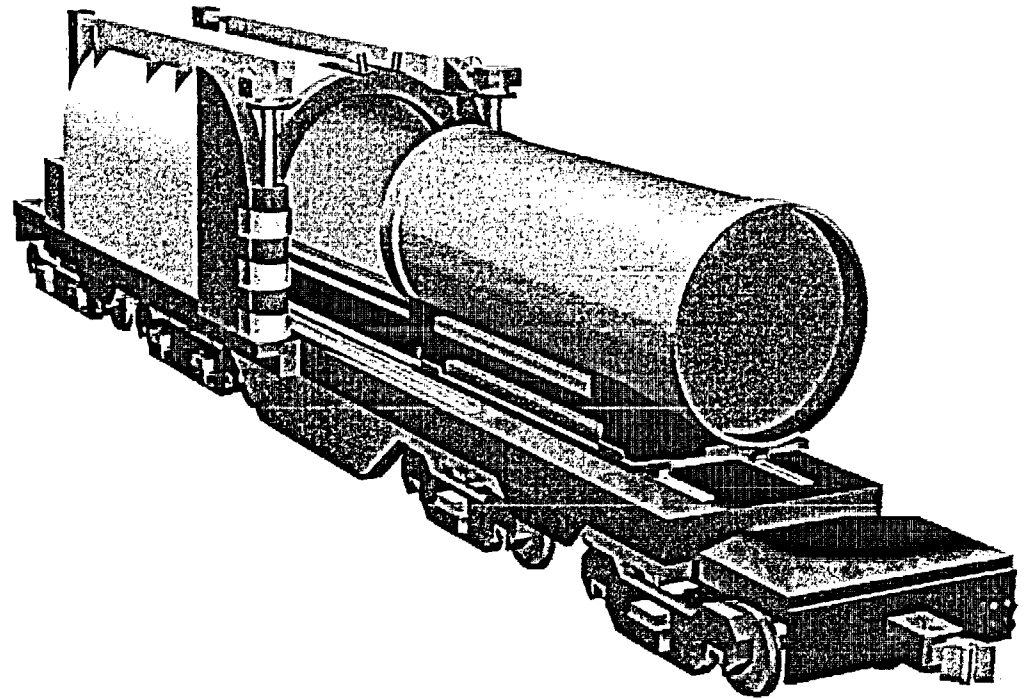
Estimated airflow rates are for emplacement drifts only.

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# Waste Package Transporter

- Transports individual waste package on pallets from the surface facilities to the emplacement drifts
- Weight:
  - 350 tons loaded
  - 265 tons unloaded
- 5.0 mph maximum operating speed
- Two locomotives move transporter underground, one backs transporter into drift
- All manual and remote control operations are through the transport locomotives



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