U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: CONCEPT OF REPOSITORY OPERATION-SUBSURFACE

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PRESENTER'S TITLE
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LAS VEGAS, NEVADA
APRIL 19-20, 1995

Overview

- Current concept of operations (subsurface) and its compatibiity with
  - Waste isolation and thermal managment strategies
  - Drift monitoring, retrieval
  - Reasonably available technology needs
- Use of ventilation during preclosure period
- Alternative concepts considered
- Drift monitoring and maintenance after emplacement
- Summary

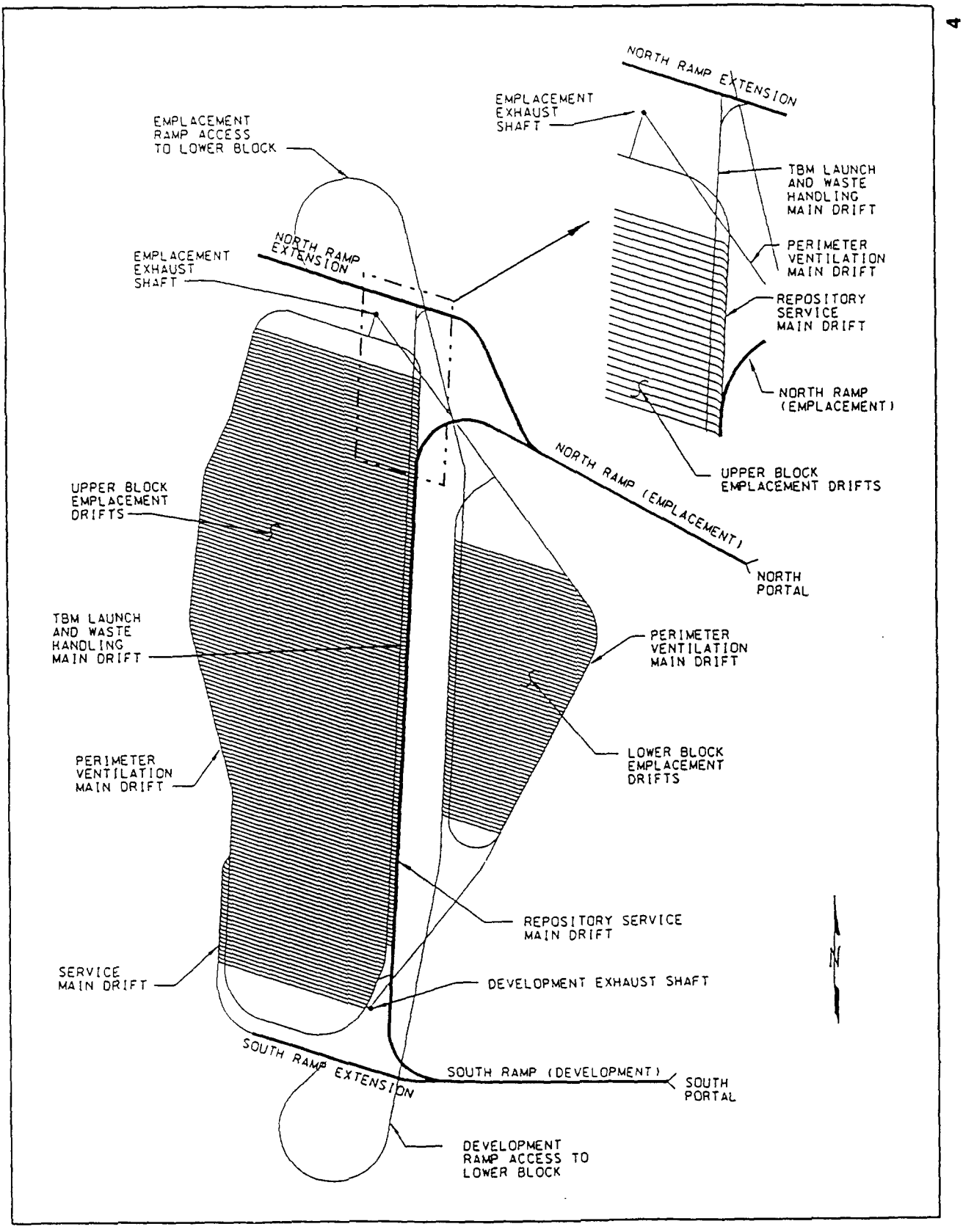
Key Concepts for Subsurface Operation

- Integrated rail transport will be used for subsurface transport of waste packages
- Waste packages will be emplaced in-drift in a horizontal mode
- Individual waste packages will not be shielded to personnel limits

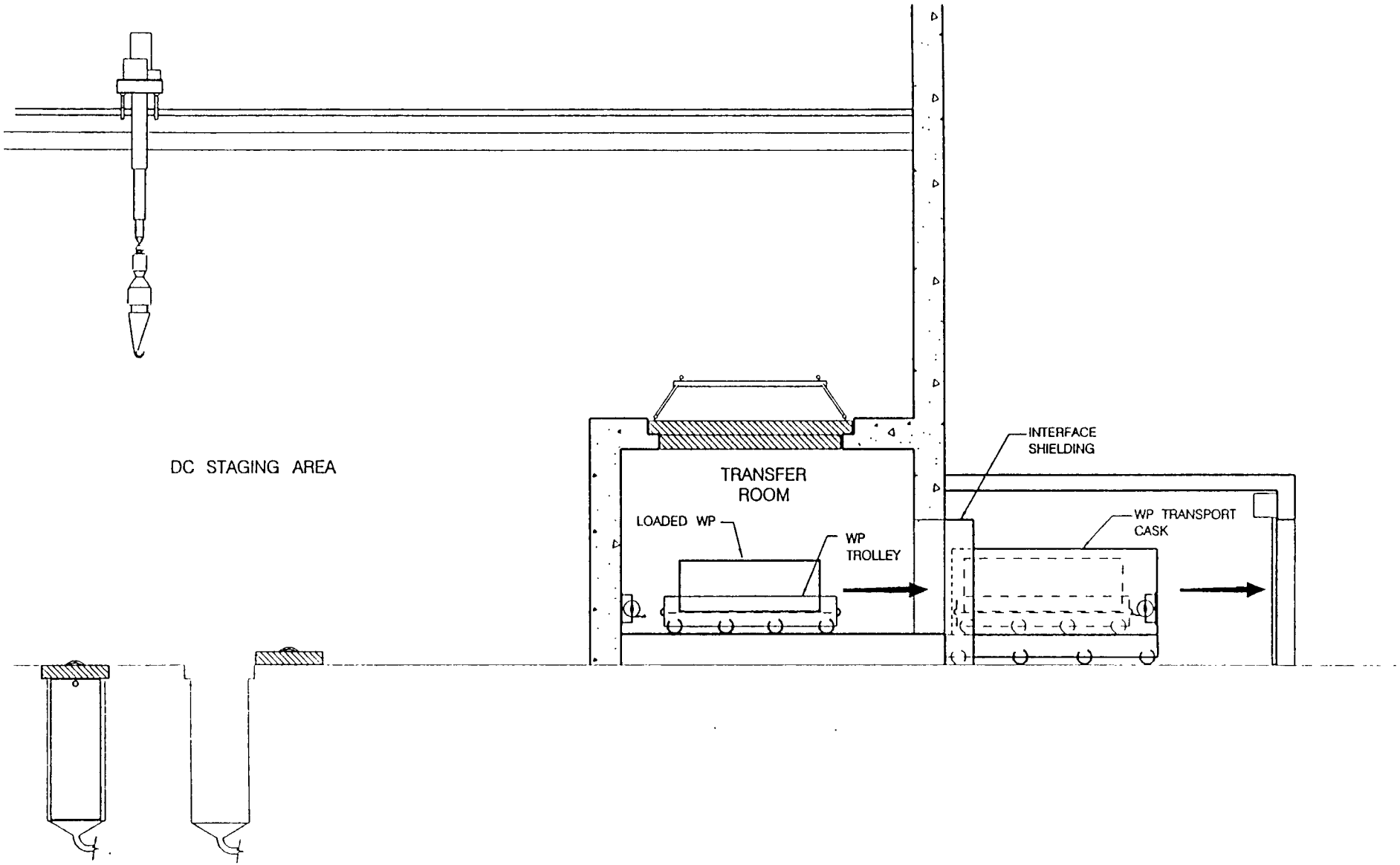
Key Concepts for Subsurface Operation

(Continued)

- Remote handling and robotics will be used, where applicable, to achieve the concept of as low as reasonably achievable (ALARA)
- No human entry will be allowed in an emplacement drift while waste packages are present
- Repository will be designed for a retrievability period of up to 100 years
- Backfill options will be maintained

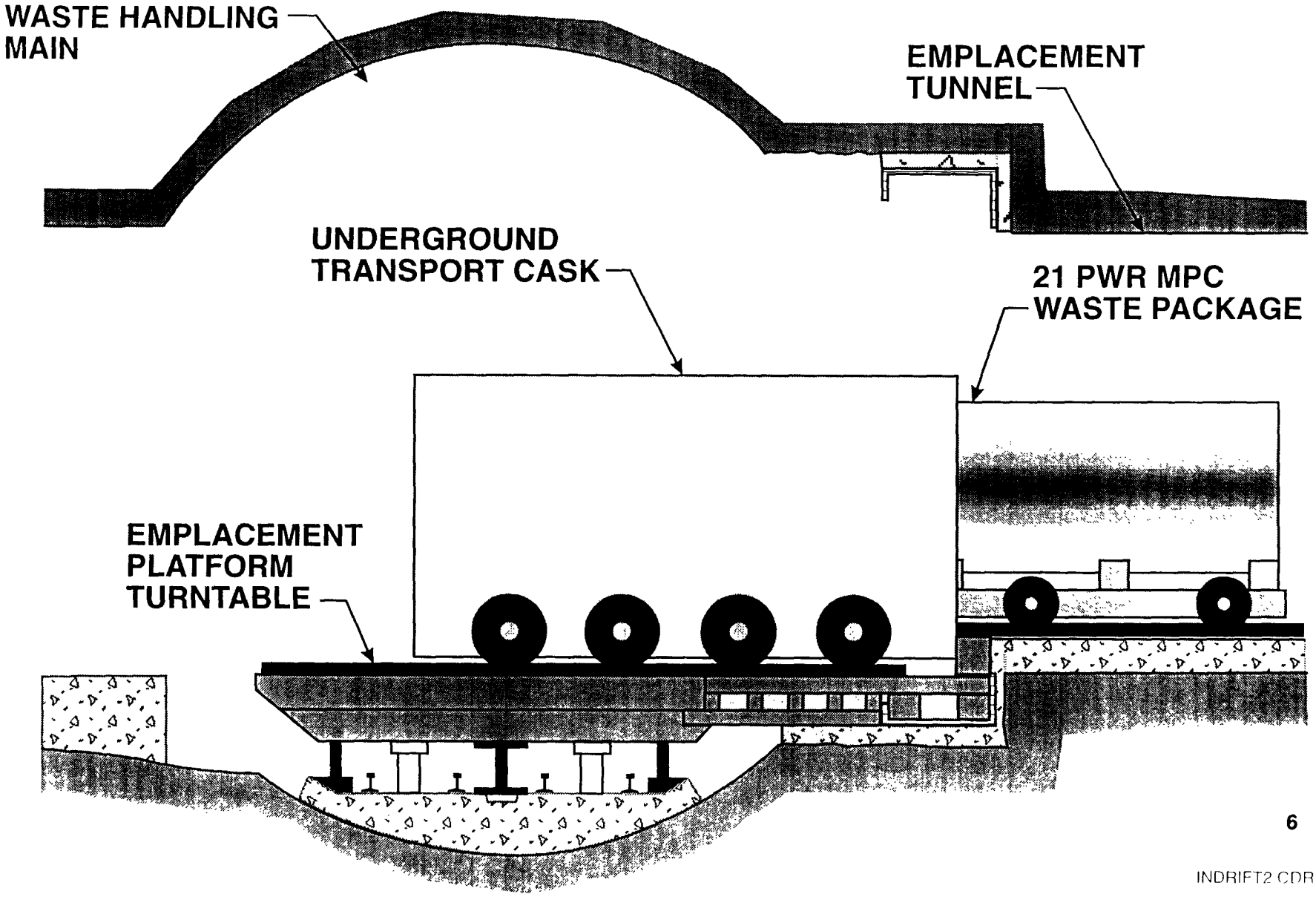


Conceptual Repository Subsurface Facilities Layout

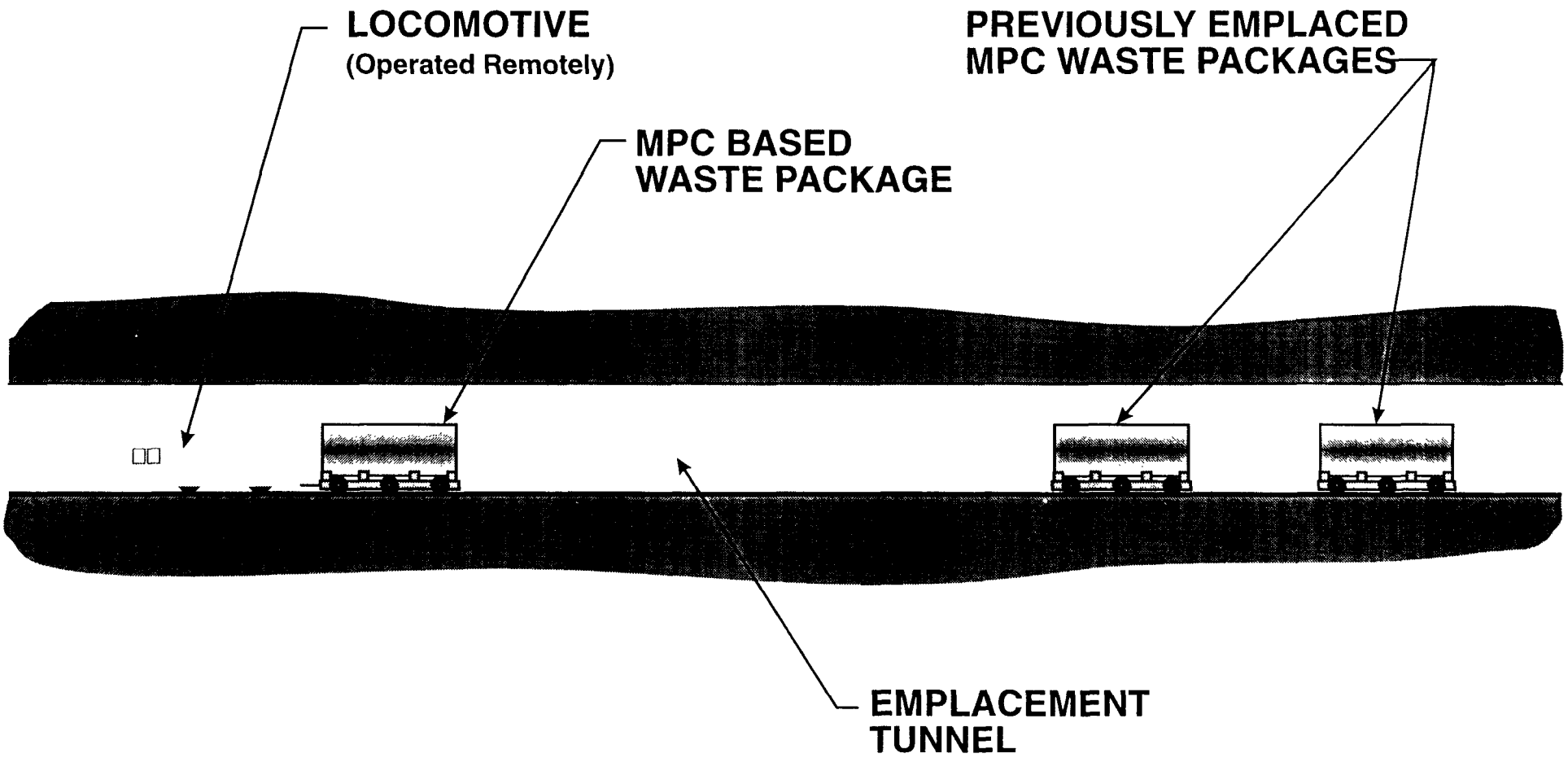


WASTE PACKAGE TRANSPORT CASK LOADING

Offloading MPC-Based Waste Package Into End of Emplacement Tunnel



Underground Locomotive Moving Waste Package to Emplacement Location



Compatibility with Current Thermal Management Strategy

The following design and operational concepts are being evaluated to maintain flexibility with respect to the thermal management strategy:

- **Waste acceptance strategy for emplacement**
- **Arrangement of drifts and waste package spacing**
- **Utilization of "edge effect"**
- **Re-positioning of waste packages prior to closure**
- **Aging of selected waste packages at the repository**
- **Ventilation of emplacement drifts**

Compatibility with Current Thermal Management Strategy

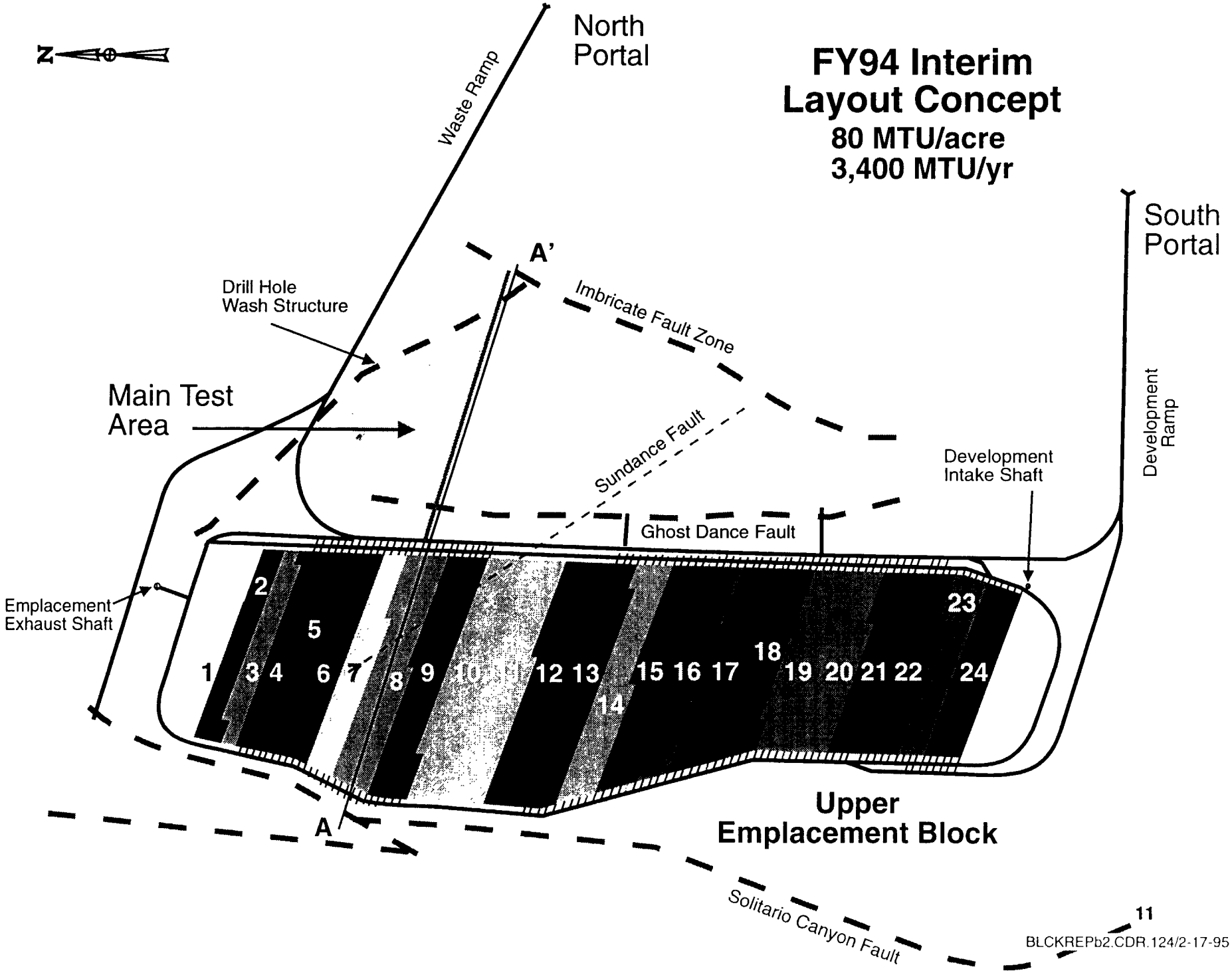
Waste acceptance strategy for emplacement

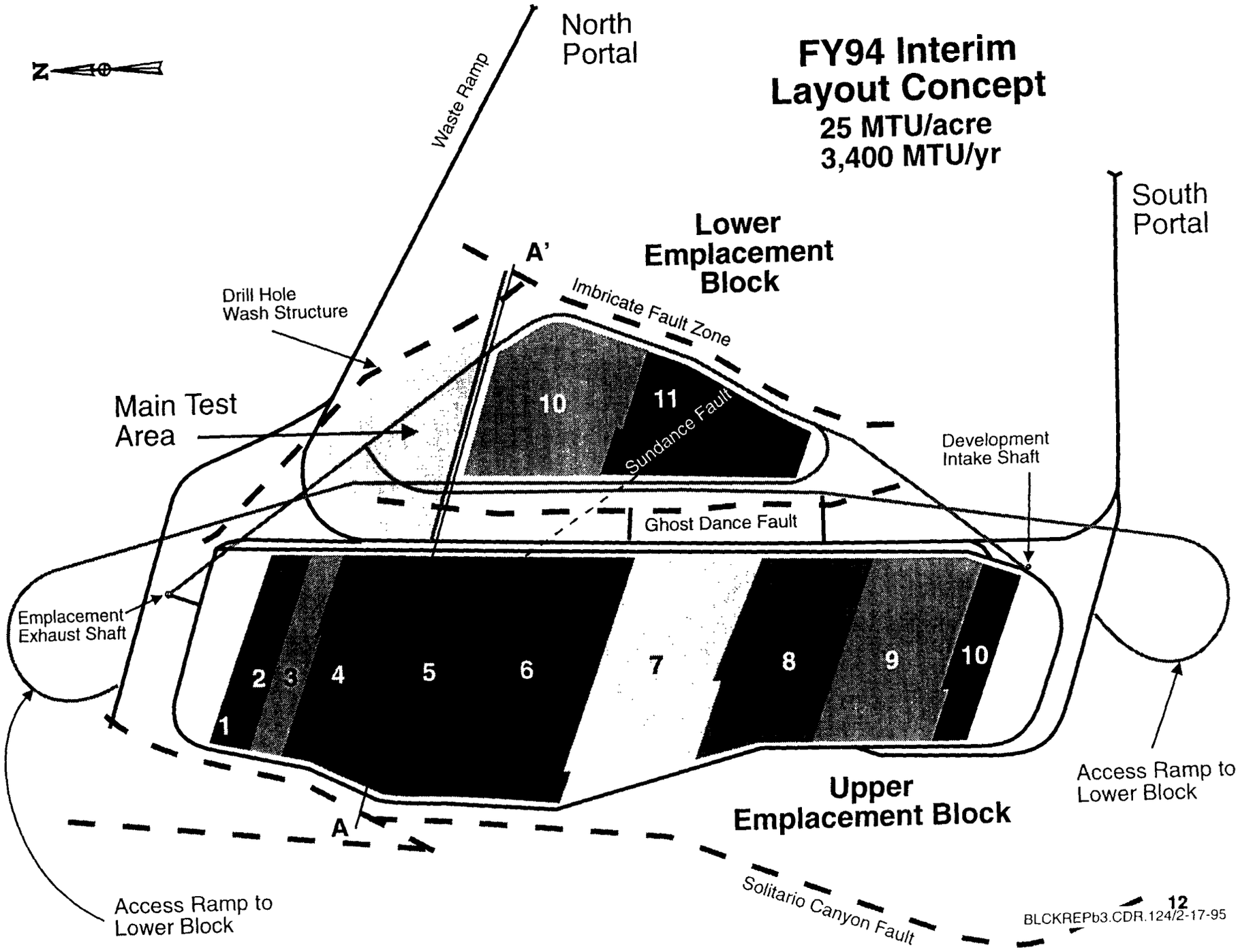
- Oldest fuel first (OFF) vs. youngest fuel first, at least 10 years (YFF + 10)
  - OFF total heat output 68.3 mW
  - YFF (+10) total heat ouput 85.6 mW
  - A 17.3 mW difference in emplaced heat

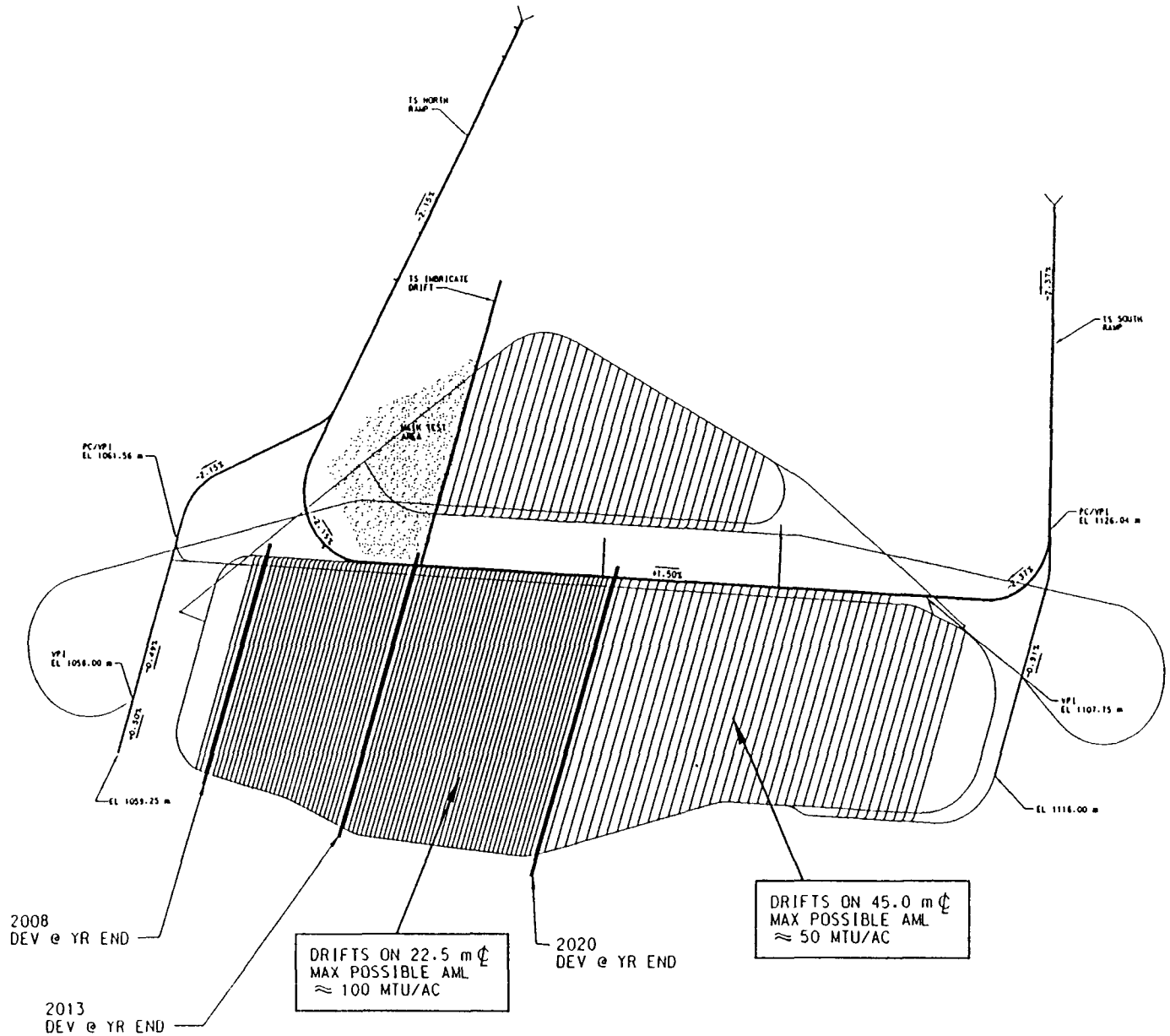
Compatibility with Current Thermal Management Strategy

Waste acceptance strategy for emplacement

- Current waste emplacement rate is 70,000 MTU emplaced in 23 years
- Flexibility of thermal strategy can be increased by lowering the emplacement rate and by providing lag storage facility


N
North Portal
Waste Ramp
FY94 Interim Layout Concept
80 MTU/acre
3,400 MTU/yr
South Portal
A'
Drill Hole Wash Structure
Imbricate Fault Zone
Main Test Area
Sundance Fault
Development Ramp
Development Intake Shaft
Ghost Dance Fault
Emplacement Exhaust Shaft
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
A
Upper Emplacement Block
Solitario Canyon Fault
11
BLCKREPb2.CDR.124/2-17-95


N
North Portal
Waste Ramp
FY94 Interim Layout Concept
25 MTU/acre
3,400 MTU/yr
South Portal
Lower Emplacement Block
A'
Drill Hole Wash Structure
Imbricate Fault Zone
Main Test Area
10
11
Sundance Fault
Development Intake Shaft
Ghost Dance Fault
Emplacement Exhaust Shaft
1
2
3
4
5
6
7
8
9
10
Upper Emplacement Block
A
Access Ramp to Lower Block
Access Ramp to Lower Block
Solitario Canyon Fault
BLCKREPb3.CDR.124/2-17-95



850 MTU/YR EMPLACEMENT RATE @ 25 MTU/AC 2 TBM OPERATION

DRIFT LAYOUT WITH CHANGE IN SPACING MID-BLOCK
INTERIM ESF/REPOSITORY CONCEPTUAL LAYOUT, OPTION 1
(WITHOUT CALICO HILLS DRIFTS)

PAGE OF		FEB 17,1995
DRAWN: R CHESTNEY	DESIGNED: D McKENZIE	SSRM-SK141g.DGN

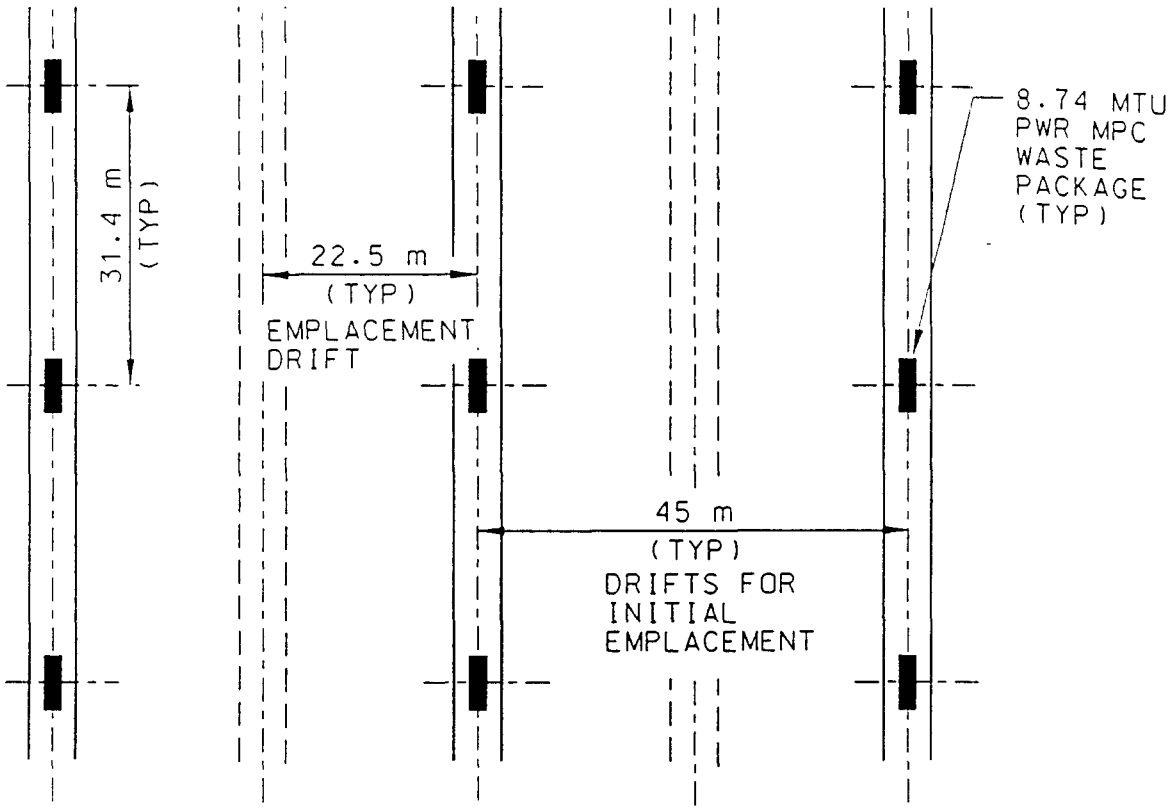
CONCEPTUAL

reggie //rmp/repos/mine/ogv/ssrm-sk141g.dg

Compatibility with Current Thermal Management Strategy

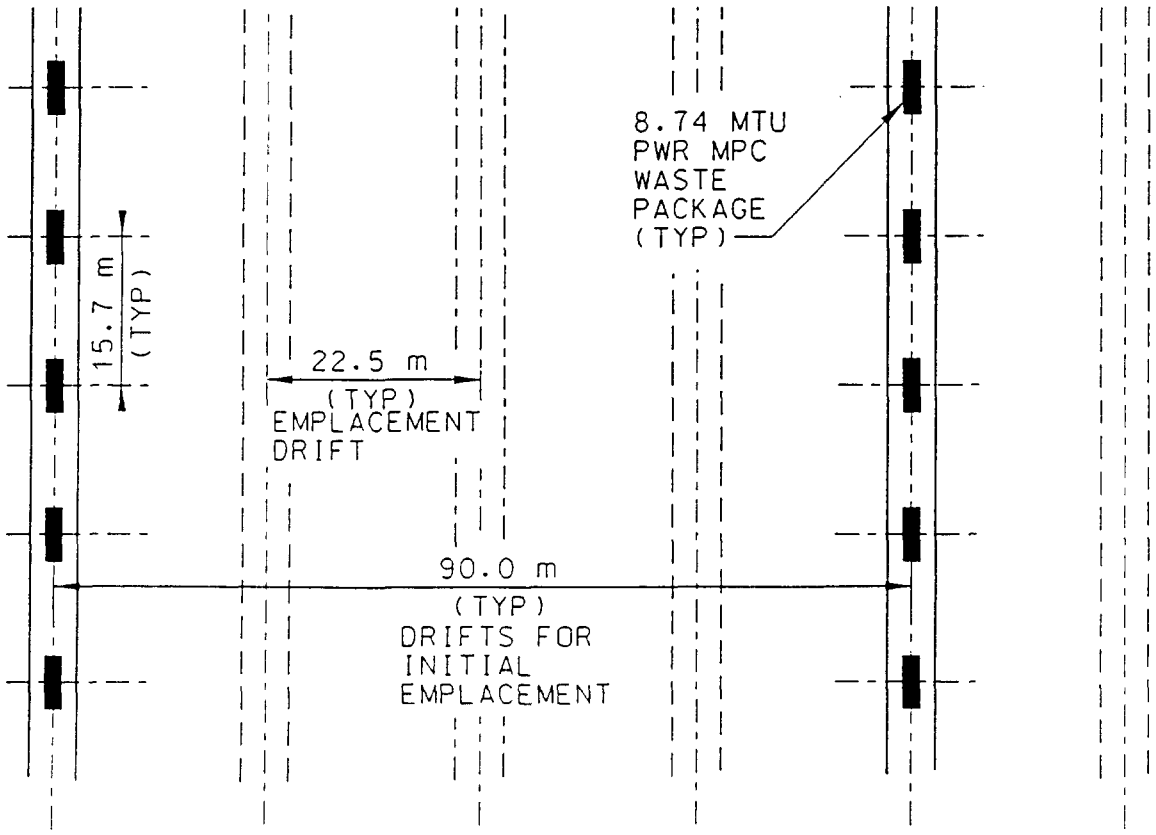
Arrangement of drifts and waste package spacing:

- **Many combinations of waste package and drift spacing can lead to same areal thermal loading**
- **Various arrangements will lead to different thermal near-term regimes for the same areal load**



MINIMAL DISTURBANCE EMPLACEMENT PATTERN

SCALE 1 : 800



LOCALIZED DISTURBANCE EMPLACEMENT PATTERN

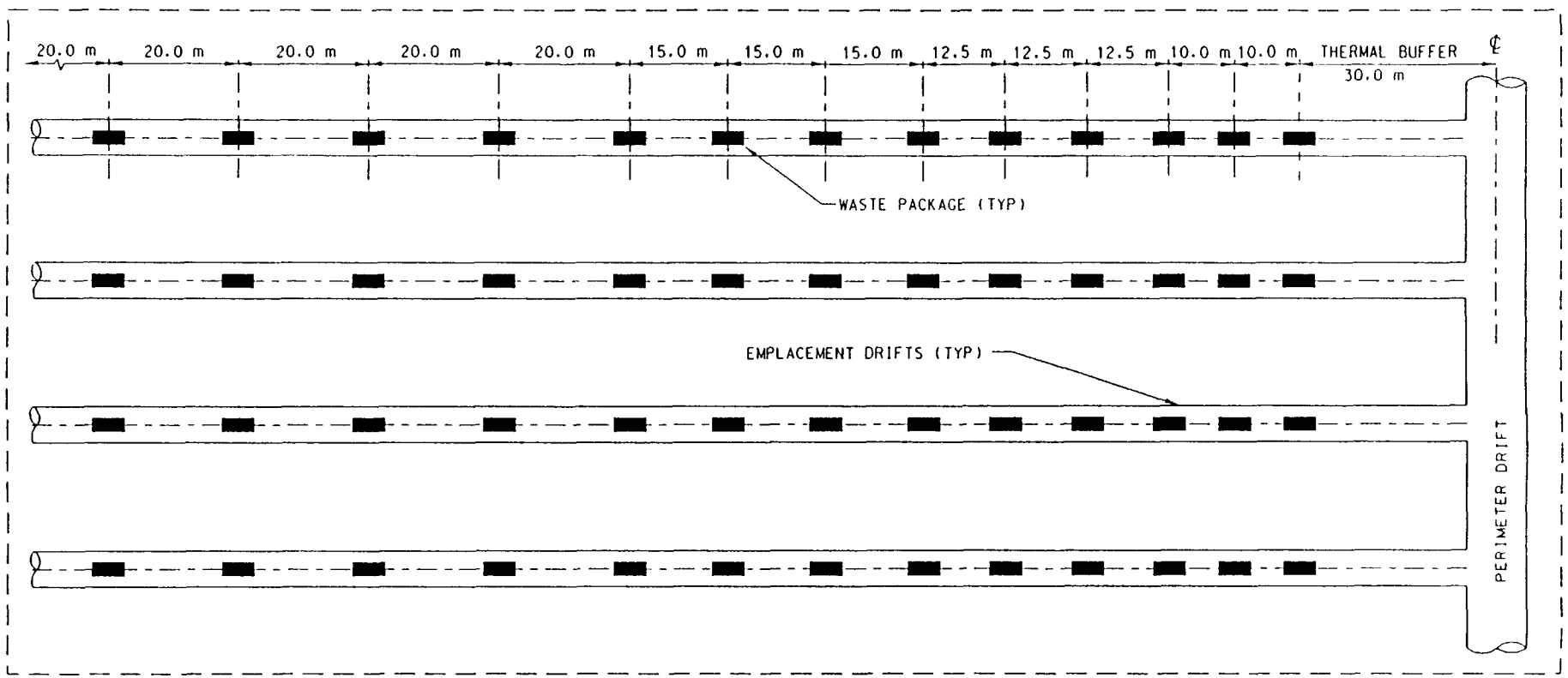
SCALE 1 : 800

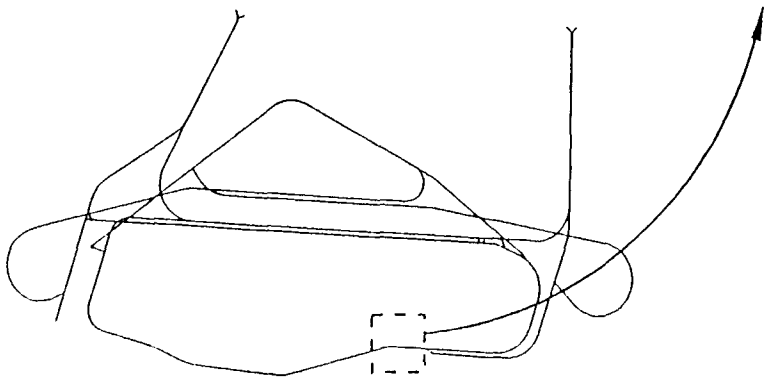
/rep/repss/mine/dgn/ssrm-sk265.dgn

Compatibility with Current Thermal Management Strategy

Utilization of "Edge Effect"

- Repository edge will shed heat at a higher rate due to boundary condition
- Take advantage of this phenomenon to emplace waste packages at higher density to achieve the desired thermal load





PACKAGE SPACING STRATEGY TO UTILIZE THE EDGE EFFECT

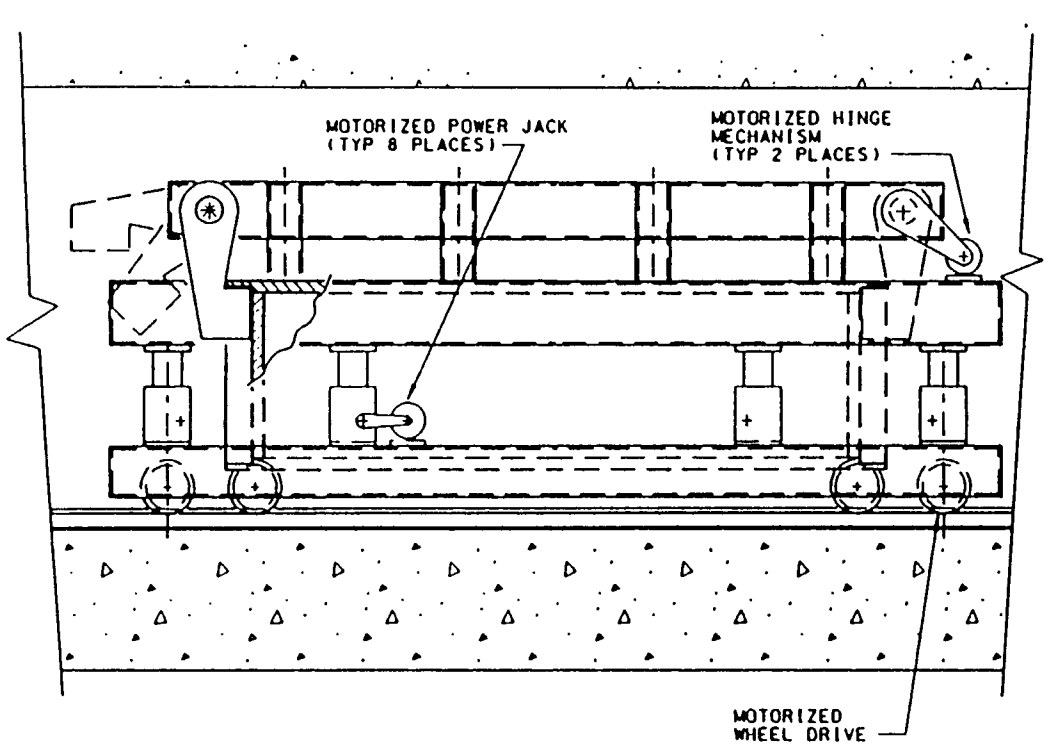
NOT TO SCALE

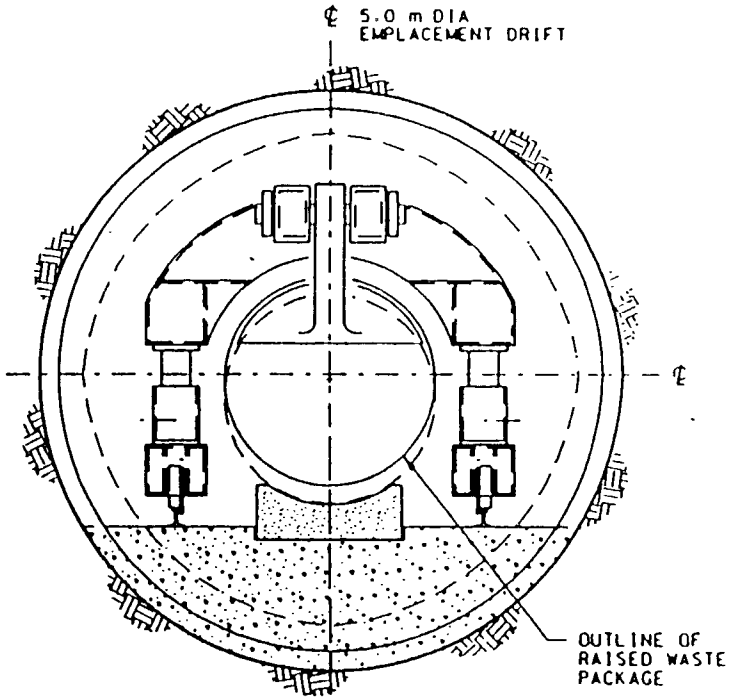
/rep/repss/mine/dgrv5srm-sk235.dgn

Compatibility with Current Thermal Management Strategy

Re-positioning of waste packages

- **Adjust thermal loading any time before closure**
- **Smooth out uneven localized thermal loads**





GANTRY CONCEPT 'ROTATING HINGE DESIGN' FOR TRANSPORT/ EMPLACEMENT OF WASTE PACKAGE

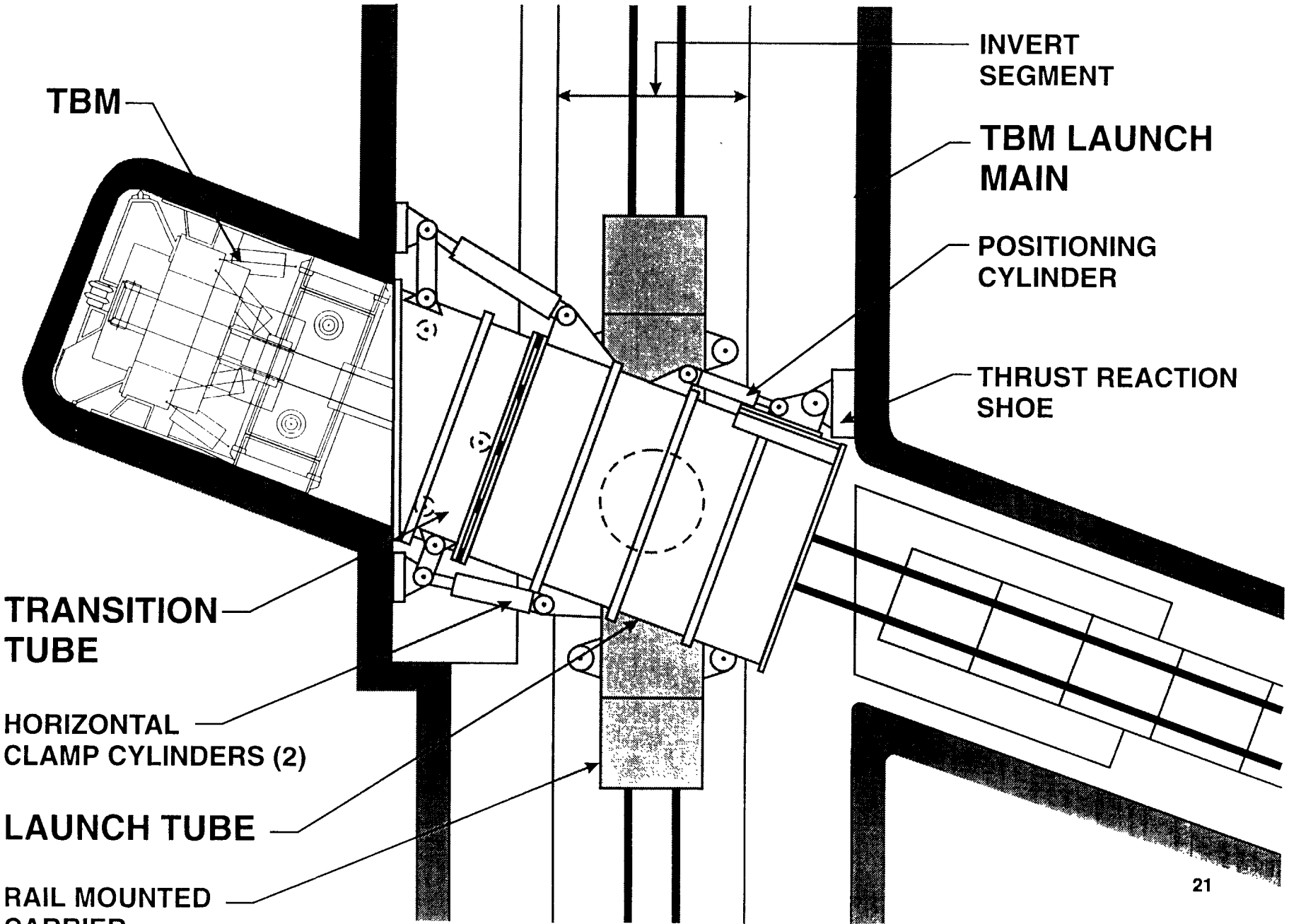
WASTE PACKAGE 66 METRIC TONS (1.8 m DIA x 5.7 m LONG)

/rep/repss/mine/dgn/asrm-sk266.dgn

Compatibility with Reasonably Available Technology

- The following current concepts of operation are considered to be compatible with reasonably available technology :
  - Excavation system using TBM and mechanical excavation of shafts
  - Transportation of waste package using rail system
  - Emplacement of waste packages using rail cart or gantry system

MECHANIZED TBM LAUNCH CONCEPT



LNCHCONC CDR.124/4-5-94

Compatibility with Reasonably Available Technology

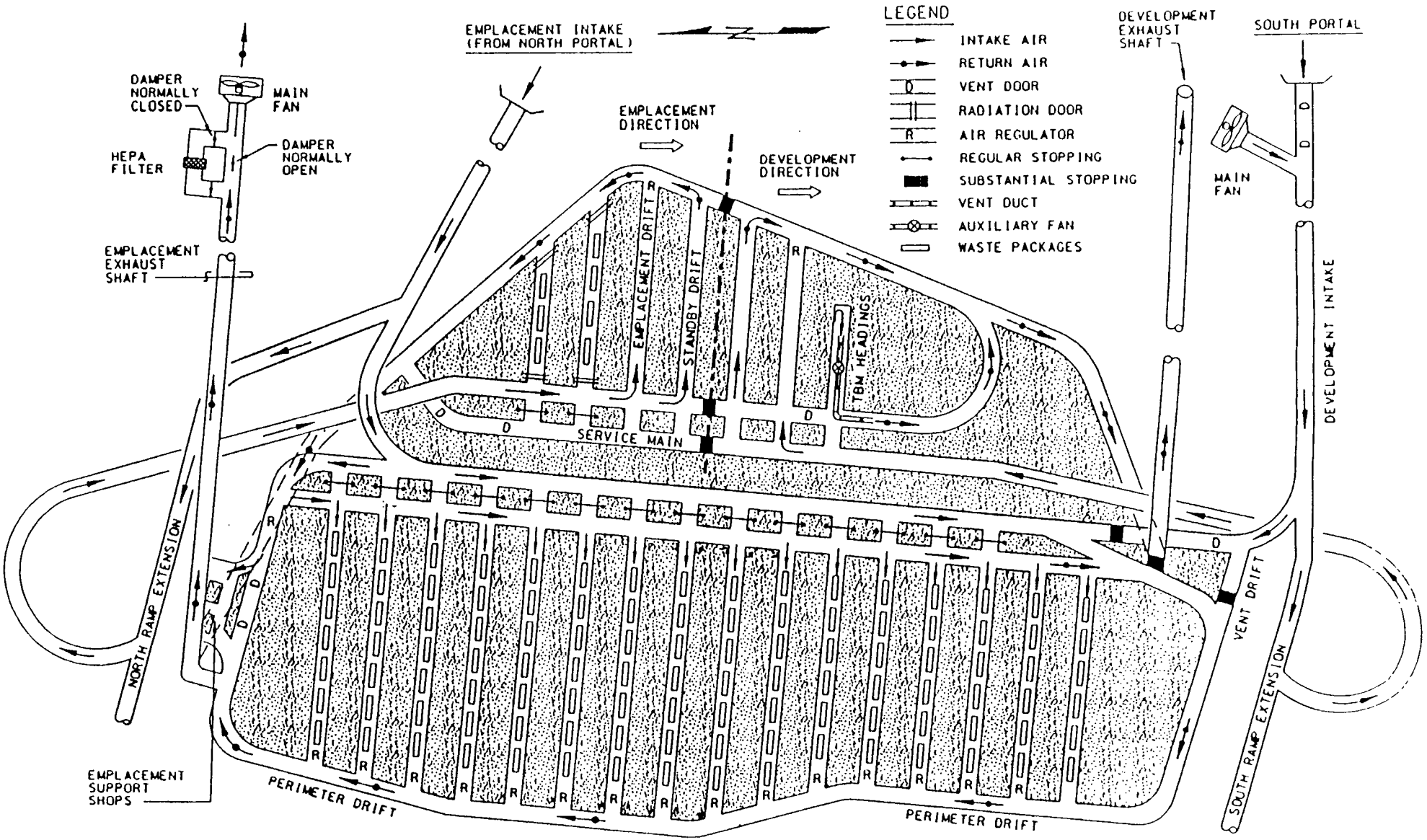
- Concepts requiring further evaluation for compatibility with reasonably available technology :
  - Emplacement drift maintainability for 100-year retrievability period
  - Retrieval equipment
  - Cooling during retrieval
  - Recovery from accident events
  - Backfill system
  - Remote handling and application of robotics
  - Monitoring

Compatibility of Current Concepts with Retrieval

- Option for retrievability is integral in all concepts being considered
- Emplacement method and drift orientation (level, straight) should facilitate retrievability
- Emplacement drifts are oriented favorably with joint system to promote stability and are planned to be supported robustly
- Backfill (if used) will be emplaced only at closure
- Access drifts, shafts, and ramps are all away from emplacement area for accessibility during retrieval

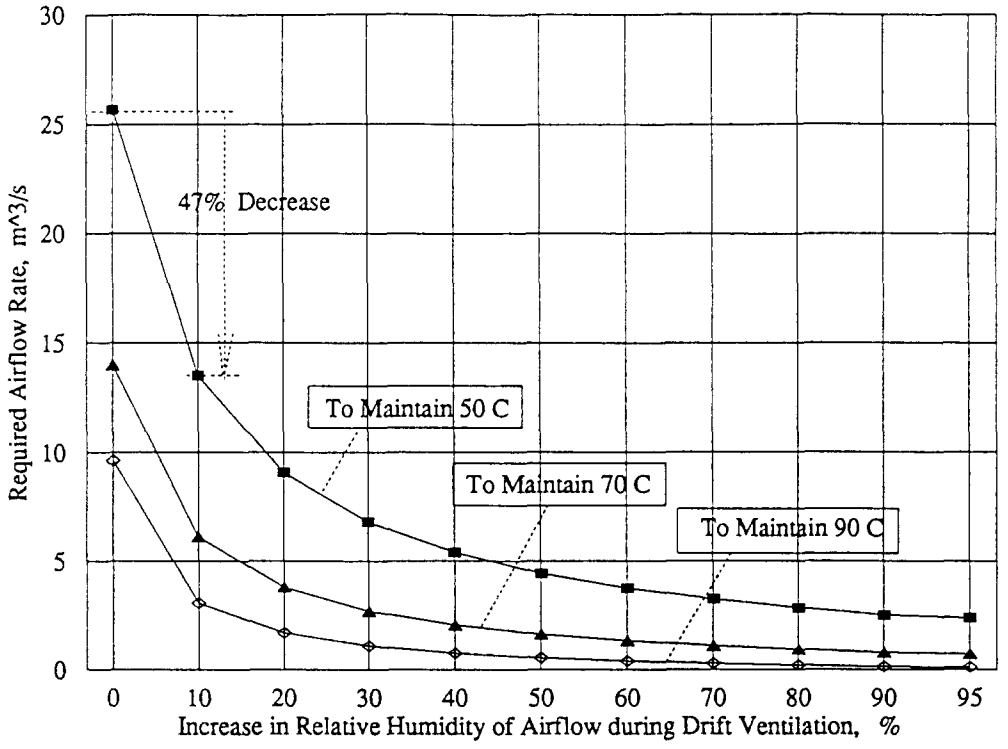
Use of Ventilation During Preclosure Period

- Ventilation can be used during emplacement and caretaker period of time to meet various thermal strategies
  - Remove heat and moisture
  - Maintain a target drift surface/air temperature
  - Smooth out "hot spots" during preclosure period

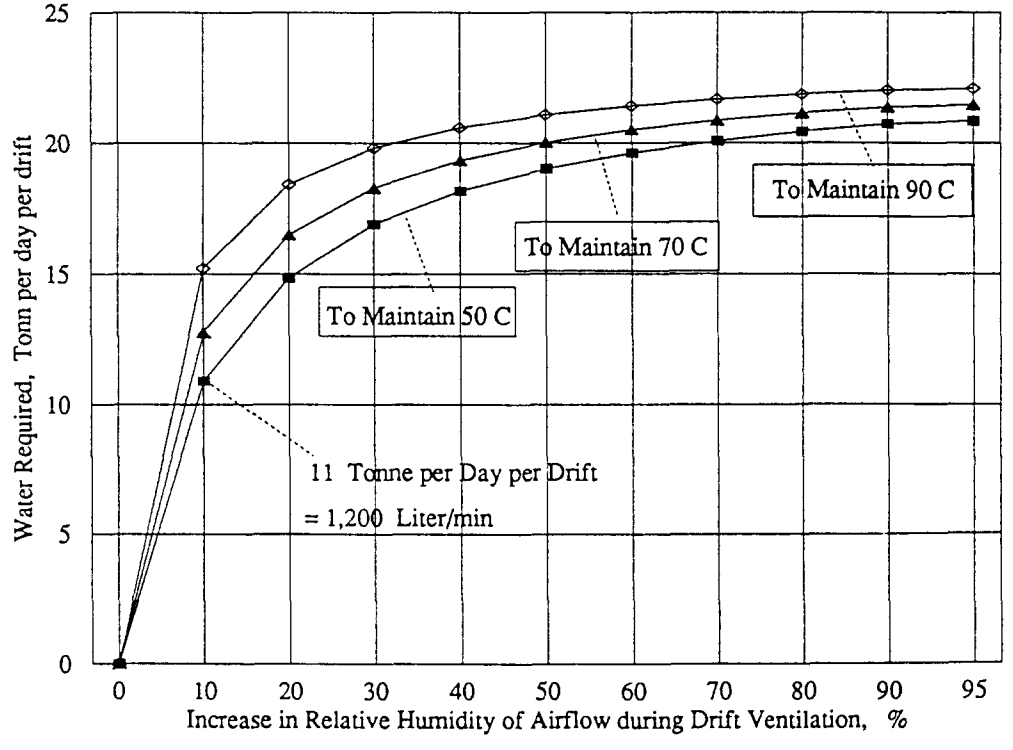


AIRFLOW DIAGRAM OF CONTINUOUS EMPLACEMENT DRIFT COOLING
NOT TO SCALE

Effect of Water Vapor on Airflow for Drift Temperature Control



Water Supply Needed to Reduce Airflow for Drift Temperature Control



Maintain Emplacement Drift Temp. at 90 °C by Continuous Ventilation*

Year	(YFF/+10) Air Quantity m^3/s	(kcfm)	(YFF/+10) Additional Shafts (8 m Diam)	(OFF) Air Quantity m^3/s	(kcfm)	(OFF) Additional Shafts (8 m Diam)
2010	128	(272)	-	127	(270)	-
2015	343	(727)	2 shafts	253	(537)	-
2017	467	(990)	-	346	(734)	2 shafts
2033	1,159	(2,456)	-	998	(2,115)	-
2133	317	(762)	-	287	(609)	-

TOTAL # OF ADD. AIR SHAFTS: **2** (for YFF) **2** (for OFF)

* Based on 100 MTU/Acre

Alternative Concepts of Operations Considered to Date

- Vertical emplacement in boreholes of MPC-based 12- and 21-PWR waste packages
  - Thermal analyses and systems study indicated the unfeasibility of emplacing large waste packages in boreholes
- Sub-surface waste package transportation system
  - Trucks and crawler mounted transport vehicles were considered. With development of <3% grade repository layout, integrated rail system was the preferred method
- Many options of excavation methods using tunnel boring machine are under consideration

Drift Maintenance and Monitoring Concepts

- Emplacement drifts are oriented favorably with respect to joint sets and excavated at less than 30 percent extraction ratio to promote stability
- Drifts support system through retrievability period is being evaluated in FY95
- Remote handling may be used to perform routine monitoring activities during the preclosure period (planned for FY96)

Summary

- Current concepts of operation are geared towards maintaining flexibility to meet the evolving thermal and waste isolation strategies
- Various methods such as emplacement mode, waste package spacing, relocation options, and others are being evaluated for maintaining operational flexibility
- Reasonably available technology is being evaluated for construction, operation, and closure
- Alternatives are being evaluated for all major design features, and few have been closed to date