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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: MPC-REPOSITORY INTERFACE ISSUES

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LAS VEGAS, NEVADA
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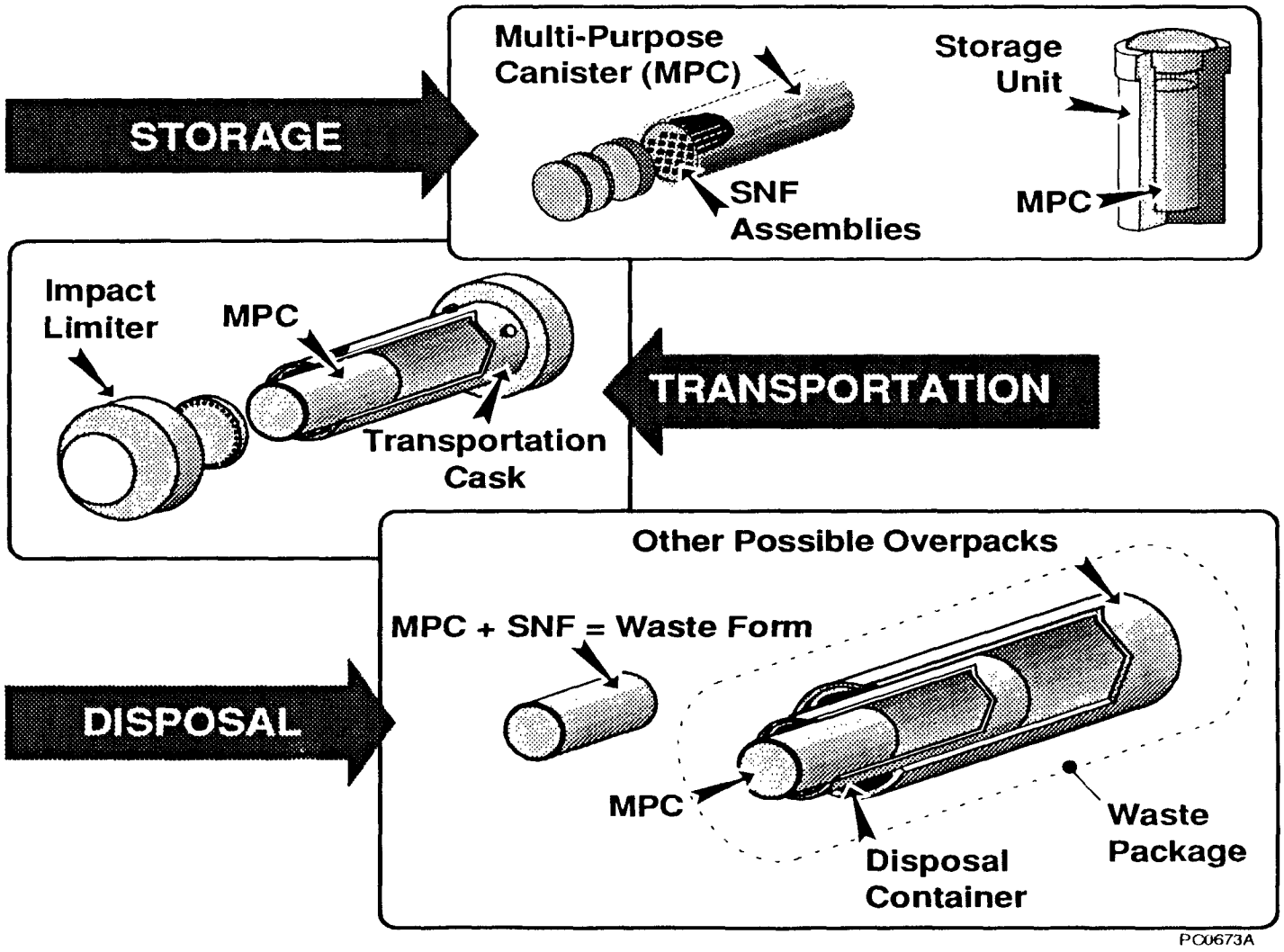
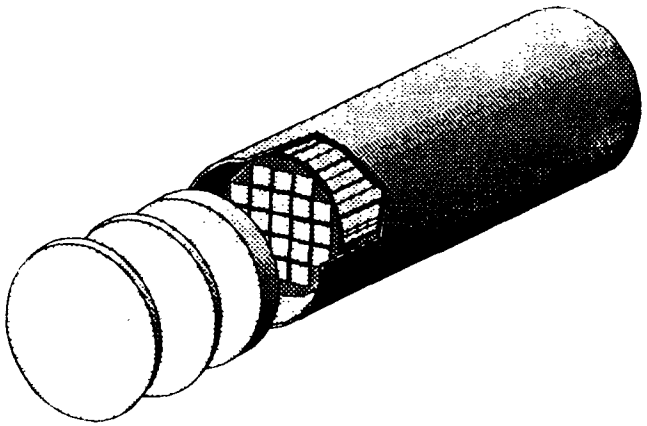
Outline

- Overview of MPC Concept
- Major MPC-MGDS Interface Issues
- MPC Compatibility with 10 CFR Part 60
- Schedule

Multi-Purpose Canister System



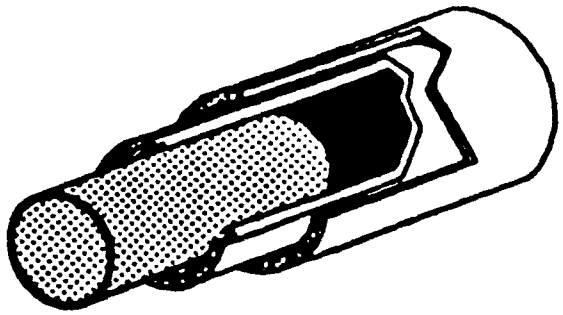
MPC Conceptual Design Configurations



		MPC Reference	
		Large	Small
		21 PWR	12 PWR
		40 BWR	24 BWR
Length	≃	4.9 m (16 ft)	4.9 m (16 ft)
Diameter	≃	1.5 m (5 ft)	1.3 m (4 ft)
Weight (Empty)	≃	18 tonnes (20 tons)	13 tonnes (15 tons)
Weight (including Fuel)	≃	34 tonnes (38 tons)	23 tonnes (25 tons)

Replace — Monday

MPC Waste Package Conceptual Design Configurations



		Large	Small
		21 PWR	12 PWR
		40 BWR	24 BWR
Length	≃	5.7 m (19 ft)	5.7 m (19 ft)
Diameter	≃	1.8 m (6 ft)	1.5 m (5 ft)
Weight (Empty)	≃	31 tonnes (34 tons)	25 tonnes (28 tons)
Weight (including MPC)	≃	65 tonnes (72 tons)	48 tonnes (53 tons)

Major MPC-MGDS Interfaces Issues

- Long-term criticality control
- Thermal loading
- Waste containment
- Repository operations

Long-Term Criticality Control - Requirement

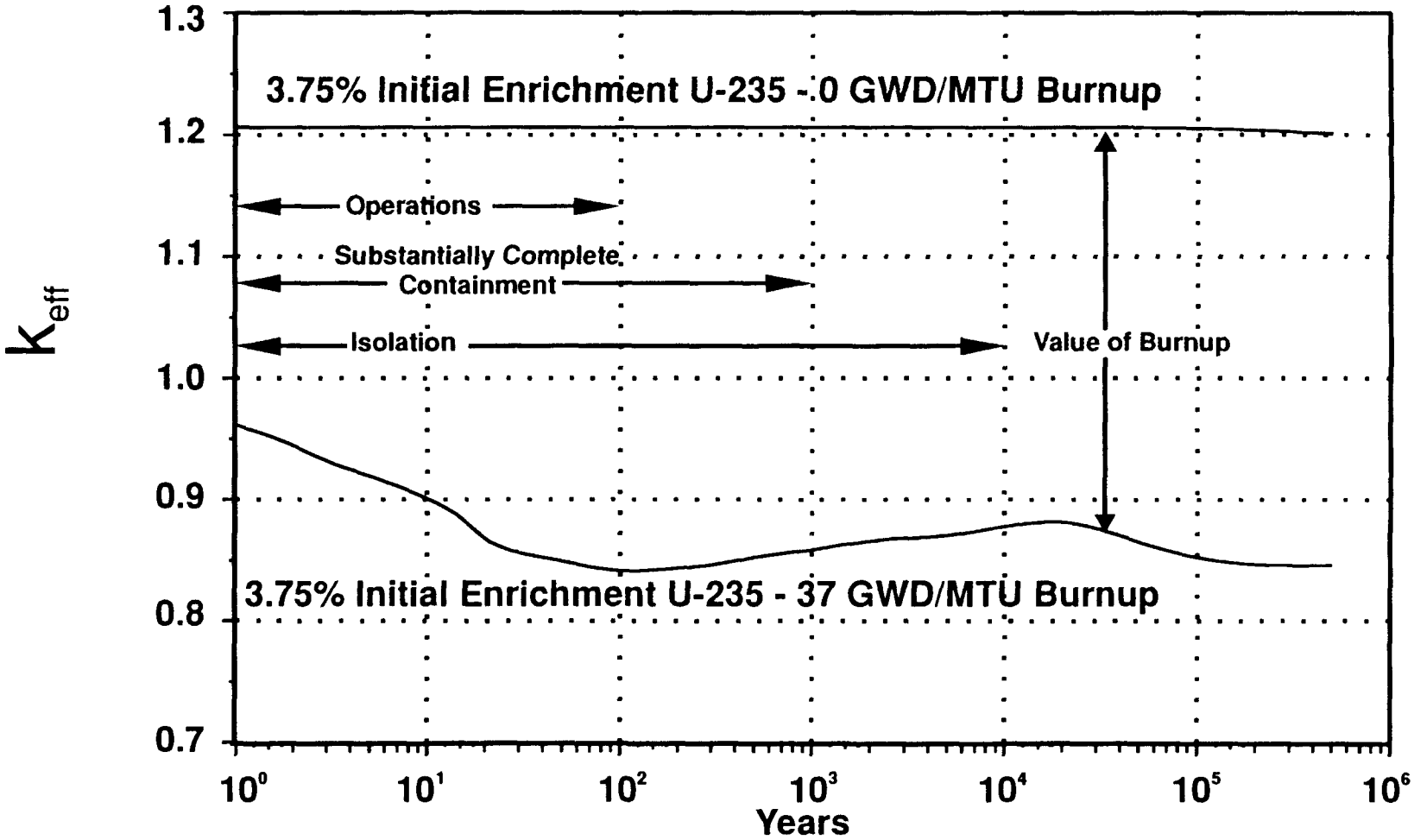
- Title 10 CFR Part 60.131.(b)(7)
  - Control criticality for all repository systems, including isolation
  - Criticality not allowed unless two unlikely, independent, and concurrent or sequential changes occur
  - Criticality safety required under normal and accident conditions
  - k_{eff} must be $\leq$0.95 (a 5% margin below unity), accounting for
    - » bias in the calculational method
    - » uncertainty in the experiments validating the calculational method

Long-Term Criticality Control: Background

- Value of burnup
- Value of neutron absorbers

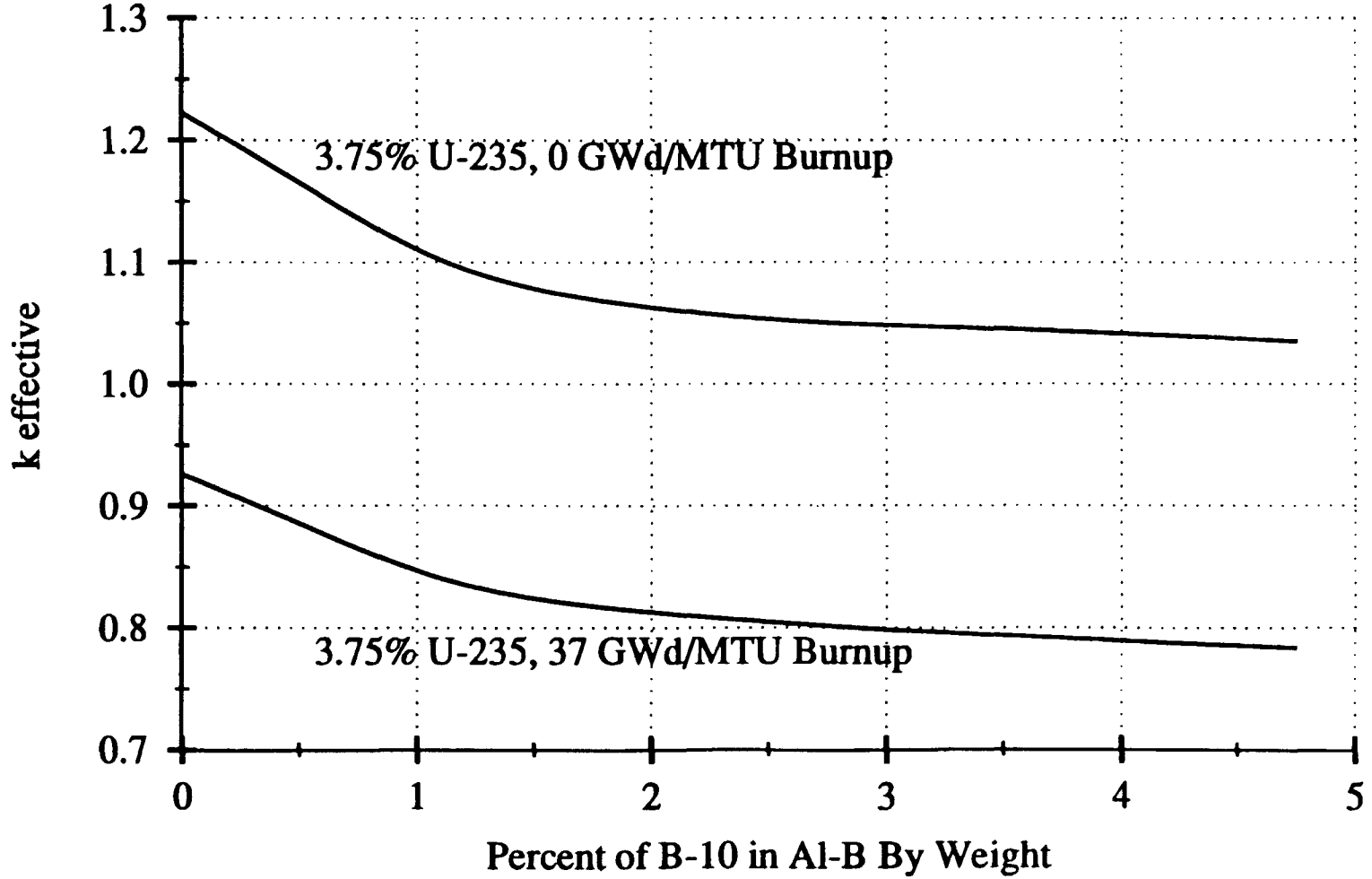
Criticality Control: Value of Burnup

21 PWR Burnup Credit MPC Design
No Additional Neutron Absorbers Added
Fully Moderated, Constant Basket Geometry



Criticality Control: Value of Neutron Absorbers

21 PWR Burnup Credit MPC Design
1.27 cm of Al-B Between Fuel Asseblies
Fully Moderated



MPC/ Long-Term Criticality Control Compatibility Strategy

- Expect to rely on burnup credit and engineered neutron absorbers
  - Perform deterministic and probabilistic analyses, depending on time period
- Uncertainties in results of
  - Amount of burnup credit allowed
  - Long-term basket material testing

MPC/ Long-Term Criticality Control Compatibility Strategy

(Continued)

- Development of contingencies required
  - Allow for opening a portion of MPCs as a planned off-normal event
    - » Moderator displacement filler material
    - » Disposable control rods
    - » Repackaging
  - Allow for insertion of disposable control rods at time of loading
  - Waste stream management (e.g., least reactive fuel first)
  - Allow for MPC design modifications

Thermal Loading

- Thermal loading MPC interface issue with repository is related to power output of the package
- MGDS-requirements document (interface requirement)
  - Assumes that "loaded MPCs emplaced for disposal will have a maximum thermal output of 14.2 kilowatts"
  - Requires that "the MGDS shall provide an emplacement environment...for the MPC with disposal container, such that an emplaced waste package with a thermal output of 14.2 kW will not result in an MPC surface temperature higher than 225°C <TBR>"
  - Also states that "the MPC design is responsible for maintaining the peak SNF cladding temperature below the maximum temperature designed for disposal. To meet this requirement, the peak cladding temperature in a loaded MPC with a power output of 14.2 kW may not exceed 350°C when subjected to an MPC external wall temperature of 225°C"

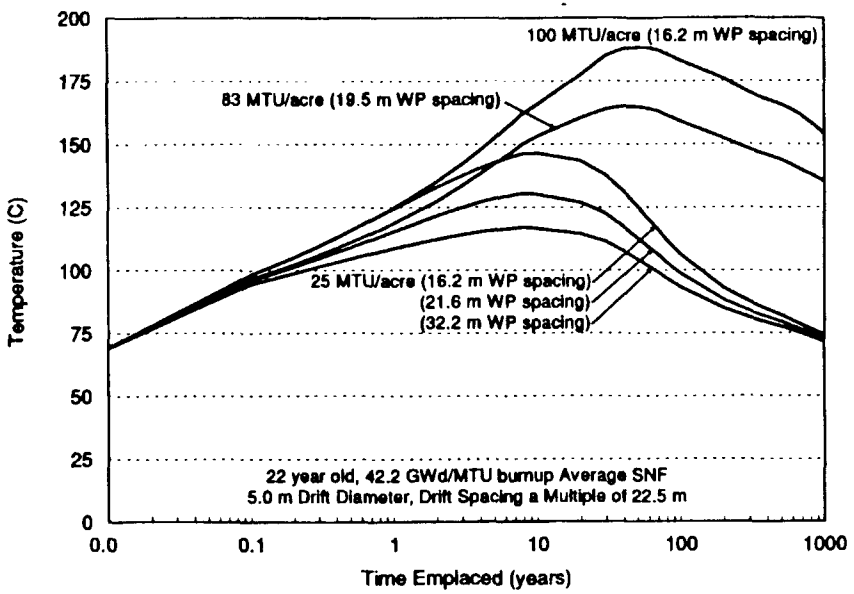
Thermal Loading: Background

- Temperature variation due to drift and package spacing differences
- Peak temperature sensitivity to waste package power output vs repository location
- Impact of aging

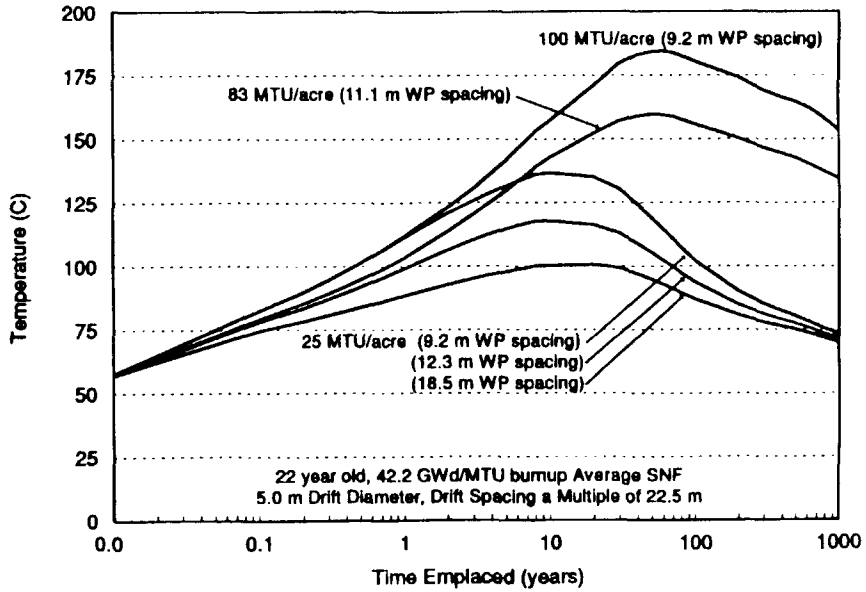
Temperature Variations Due to Drift and Package Spacing Differences

Waste Package Surface Temperatures

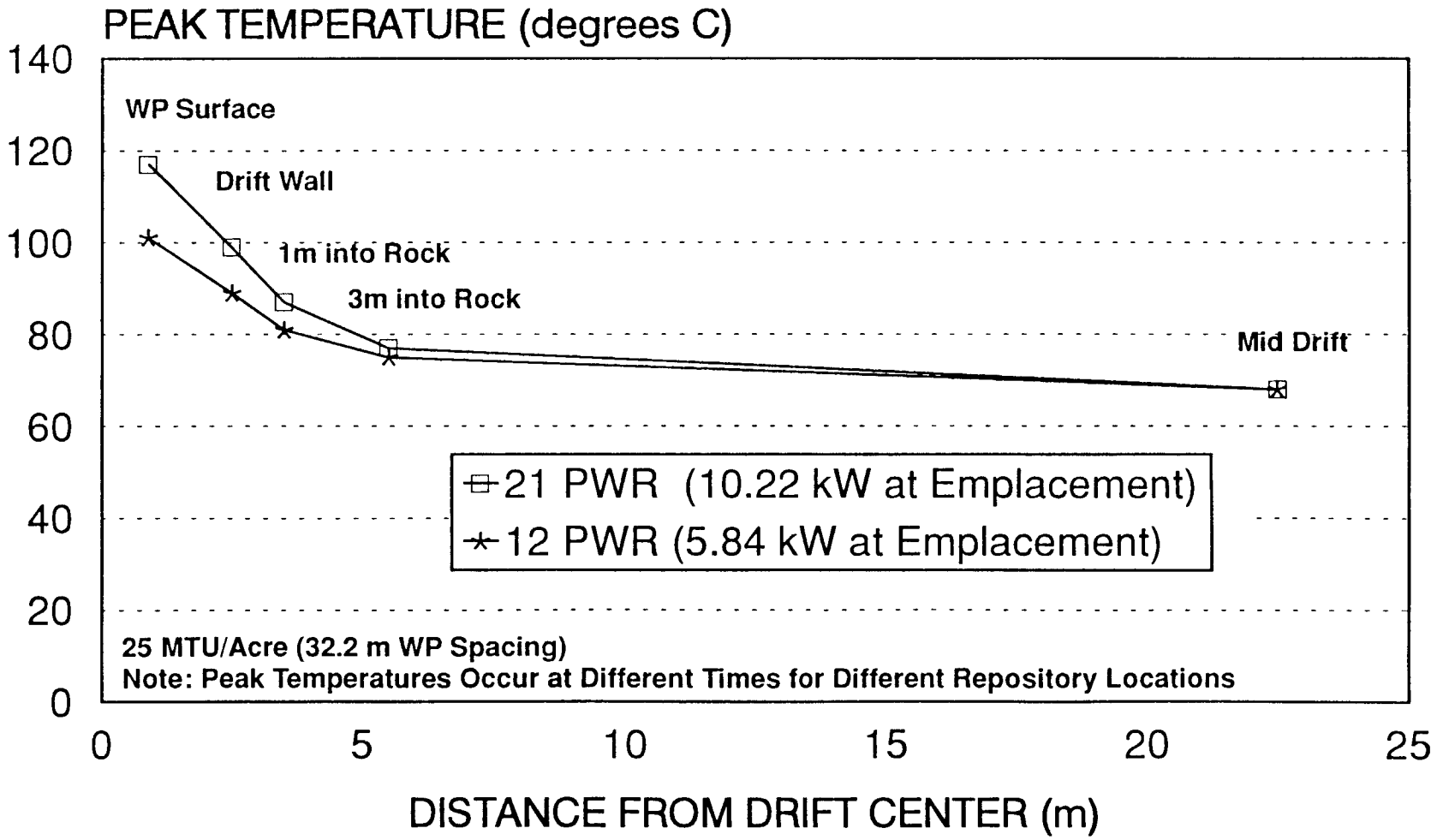
10.22 kW (21 PWR) at Emplacement



5.84 kW at (12 PWR) Emplacement

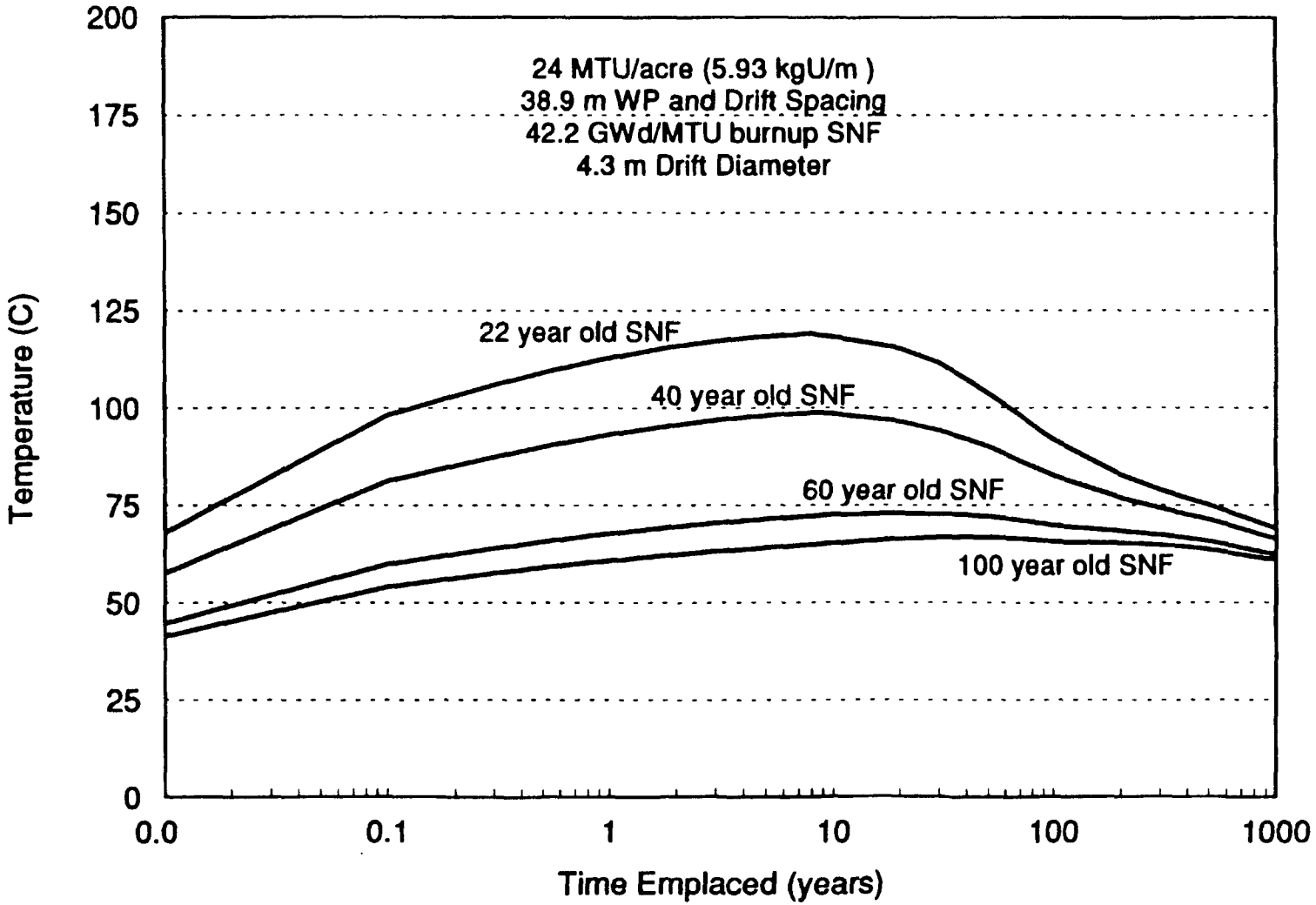


Peak Temperature Sensitivity to WP Power Output vs Repository Location



Impact of Aging

Waste Package Surface Temperatures



MPCRPSI.CDR 125.NWTRB/4-19-95

MPC-Thermal Loading Compatibility Strategy

- High thermal load consistent with MGDS-requirements documents requirements
- Low thermal load may specify lower near-field temperatures
- Options are available to ensure that the MPC is compatible with potential low thermal loading requirements:
  - Waste stream management (e.g. oldest fuel first)
  - Ventilation
  - Selective repository emplacement
    - » Waste package spacing
    - » Utilization of edge effects
    - » Reposition of packages prior to closure
  - Derating/down-sizing
  - Aging

Waste Containment

- 10 CFR 60 states that
  - "Containment within the waste packages will be substantially complete for a period...not less than 300 years nor more than 1,000 years after permanent closure of the geologic repository"
  - "The release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure"
- 10 CFR 60 also invokes EPA standards for radioactivity; currently working to a 10,000 year limited cumulative radionuclide release requirement (Remanded 40 CFR 191)

Waste Containment

(Continued)

- Current design goal is to allow less than 1% waste package failures in the first 1,000 years with a mean waste package lifetime well in excess of 1,000 years

MPC-Waste Containment Compatibility Strategy

- Allocate no quantitative performance to the MPC as a containment barrier. All performance is allocated to the waste package and waste form (excluding the MPC shell)
- Verify that the MPC material does not accelerate deterioration of surrounding disposal container
- Avoids cost risk of designing "expensive" MPC shells now in anticipation of NRC approval at time of MGDS licensing
- After the uncertainty in acceptable materials for containment has been reduced, allocating containment performance to the MPC could become economically desirable

MPC-Repository Operations Compatibilty Strategy

- Interface requirements established in MGDS requirements document on receiving, handling, opening, filler addition, etc.

- Surface facilities handling operations
  - Appropriately sized handling equipment
  - Opening of MPC treated as a planned off-normal occurrence

MPC-Repository Operations Compatibility Strategy

(Continued)

- Subsurface operations (driven by large waste package, with or without an MPC)
  - Horizontal in-drift emplacement mode
  - Rail transport underground
  - Reduced grades underground
  - Appropriately sized equipment for large waste packages

MPC-Repository Operations Compatibility Strategy
(Continued)

- Nevada transportation (driven by large transportation casks, with or without an MPC)
  - Develop a rail line to connect existing rail line to potential repository location at Yucca Mountain
  - Heavy haul truck transport is also an option

MPC Compatibility with 10 CFR Part 60

- NRC approval, when MGDS license issued
- Risk management issue
- MPC 10 CFR Part 60 Design Considerations Technical Report to be submitted concurrently with Parts 71 and 72 Safety Analysis Reports to allow an integrated review by NRC
- Pursuing NRC "letter of no objection" before fabrication

MGDS/MPC Interface Schedule

4/18/1995