Comments on Technology Options for Transmutation Systems

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Overview of Reactions

- The technology development roadmap is generally OK because it allows for a range of options of technologies to be explored, while focusing on the most promising ones.

  But there are omissions:

  - Reactor options
  - Non-steel materials

Overview of Reactions (Cont'd.)

- The tradeoff studies in year 1 are short on a clear statement of ATW performance indicators or the need for their development. That leaves the process too subjective.

  Need to consider indicators for:

  - TRU transmuted per $
  - TRU transmuted per year
  - Waste characteristics and impact on repository design
  - Proliferation issues
  - Technology development payoffs

- Does not address the impact of the defense waste on the repository performance.

Need to Focus on Approaches to Cost Reduction

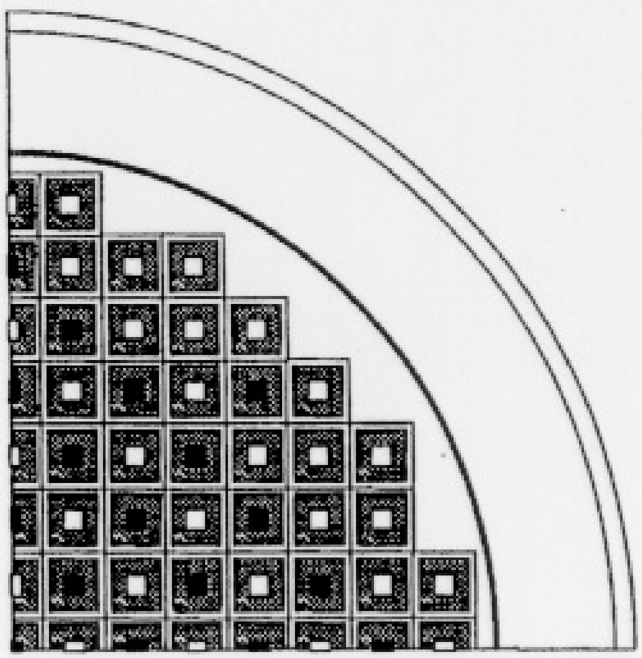
The cost of the plant can be minimized if fewer major components can be eliminated

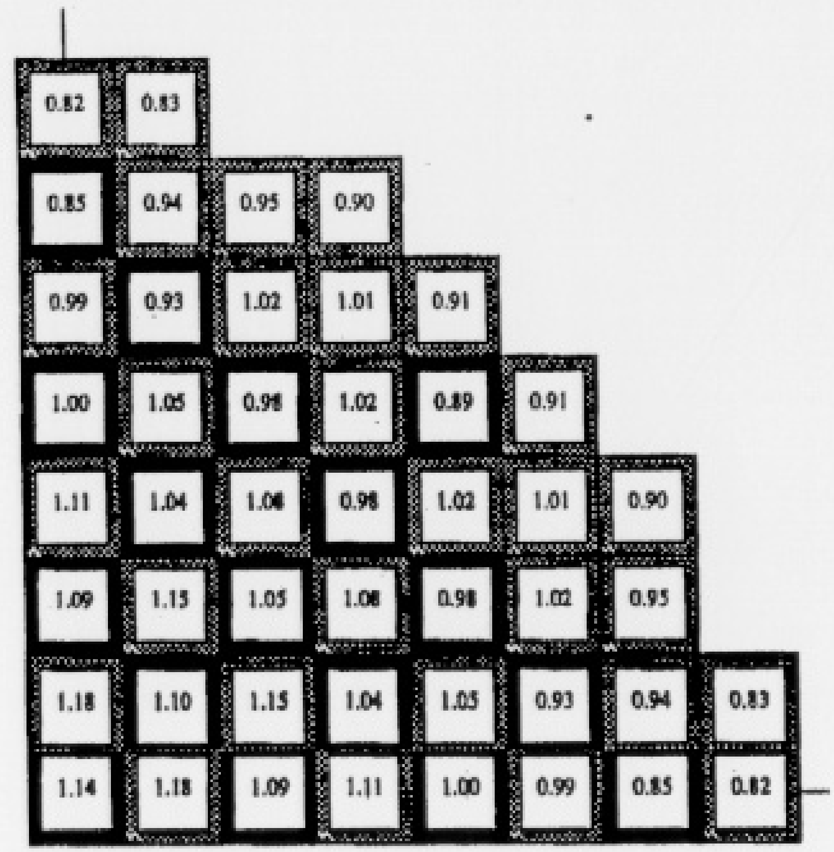
- ⇨ A Critical burner eliminates the need for the accelerator
- ⇨ Pb–Bi eliminates the need for an intermediate loop
- ⇨ A passively safe system reduces the cost of the containment
  - Eliminate the reactivity due to void
  - Maintain negative doppler reactivity coefficient
  - Provide passive cooling for operating and decay powers

Core Arrangement and Power Distribution

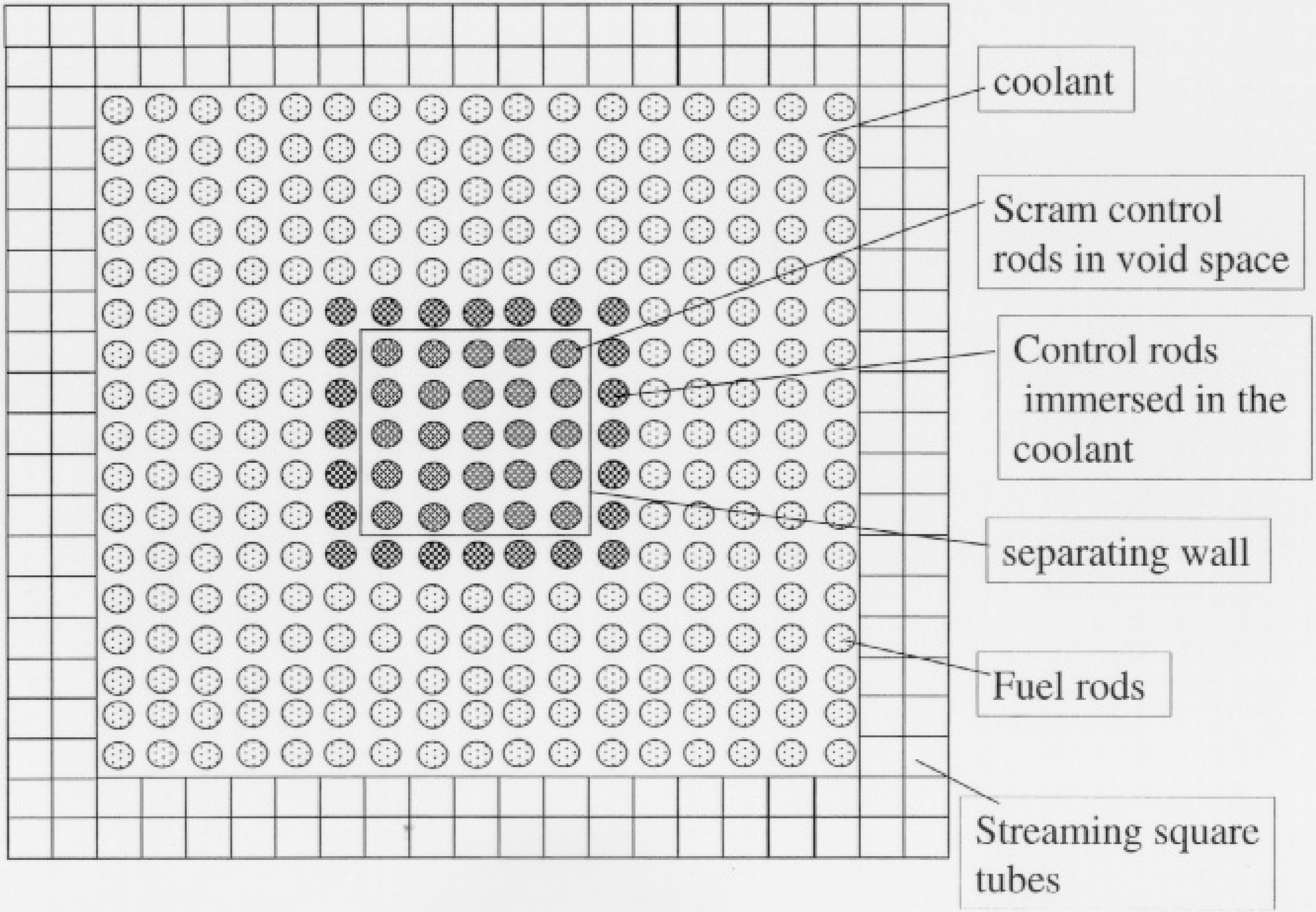
Fuel assemblies
Control assemblies

Core with streaming FAs
Total number of FAs 157
FAs with control 53
Fuel assembly pitch 263.55 mm
Equivalent core OD 3.73 m
Core Barrel thickness 2 cm
Downcomer thickness 0.5 m





A Schematic of a Fuel Assembly



Reactivity performance of the fresh core (uniform enrichment)

Case (CRDs are 84.5cm in the core)	k_{eff}±0.001
Reference case (core-average coolant density =10.25g/cm^3)	0.999
Core-average coolant density =8g/cm^3	0.992
Core-average coolant density =6g/cm^3	0.988
4 FAs voided*	0.998
Worth of central control assembly	0.005Δk/k
1 central FA voided** (for fully withdrawn CRDs in central FA)	1.002
1 central FA fully flooded –all peripherial streaming tubes (152) flooded	0.996
Entire central void region with CRDs 84.5cm in the core in central FA flooded	0.998

* Partially voided central 50% of 4 fuel assemblies in the core central region

** Partially voided central 50% of 1 central fuel assembly (CRDs from this assembly withdrawn)

Reactivity performance of the fresh core (uniform enrichment)-continued

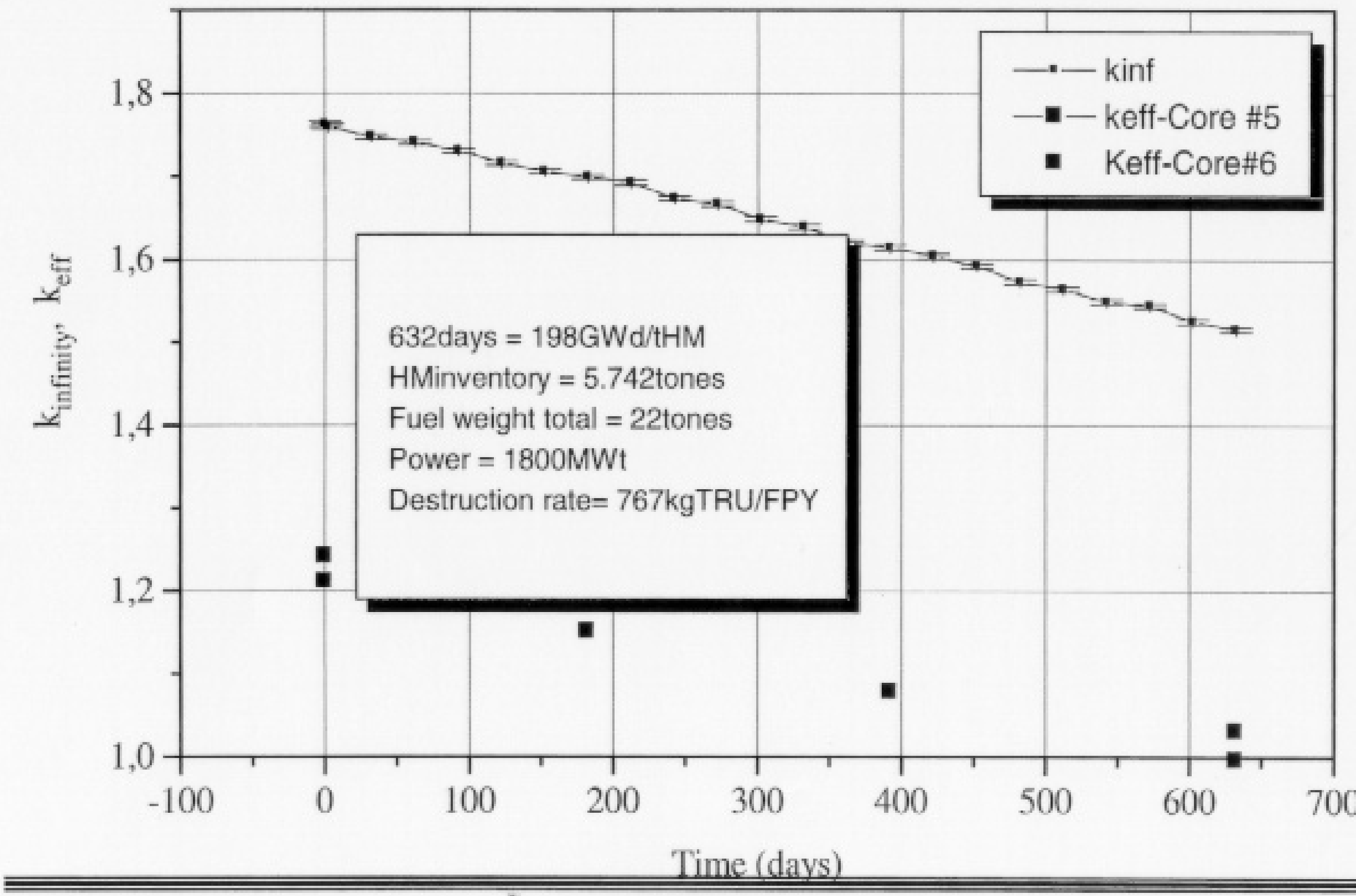
Case (CRDs are fully withdrawn)	K_{eff}±0.001
CRDs from the central fuel assembly fully withdrawn	1.004
All CRDs fully withdrawn - burnup=0GWd/tHM -coolant density=10.25g/cm^3	1.241
All CRDs fully withdrawn - burnup=198GWd/tHM$^+$-coolant density=10.25g/cm^3	1.031
All CRDs fully withdrawn - burnup=198GWd/tHM$^+$- 4 FAs voided*	1.032
All CRDs fully withdrawn - burnup=198GWd/tHM$^+$-coolant density=8g/cm^3	1.031

* Partially voided central 50% of 4 fuel assemblies in the core central region

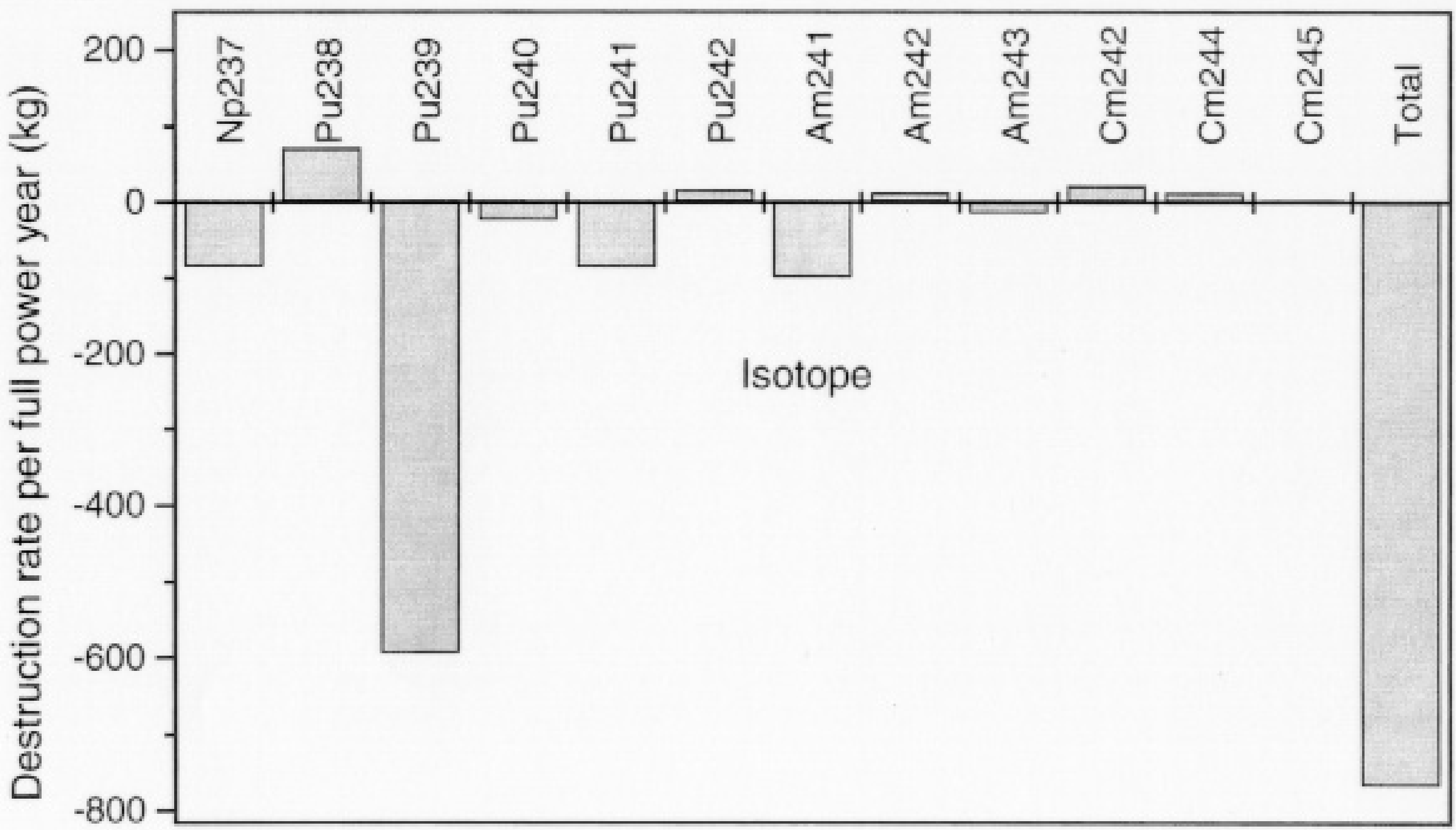
** Partially voided central 50% of 1 central fuel assembly (CRDs from this assembly withdrawn)

+ 198 GWd corresponds to 632 full power days of exposure, tHM is metric tons of heavy metal

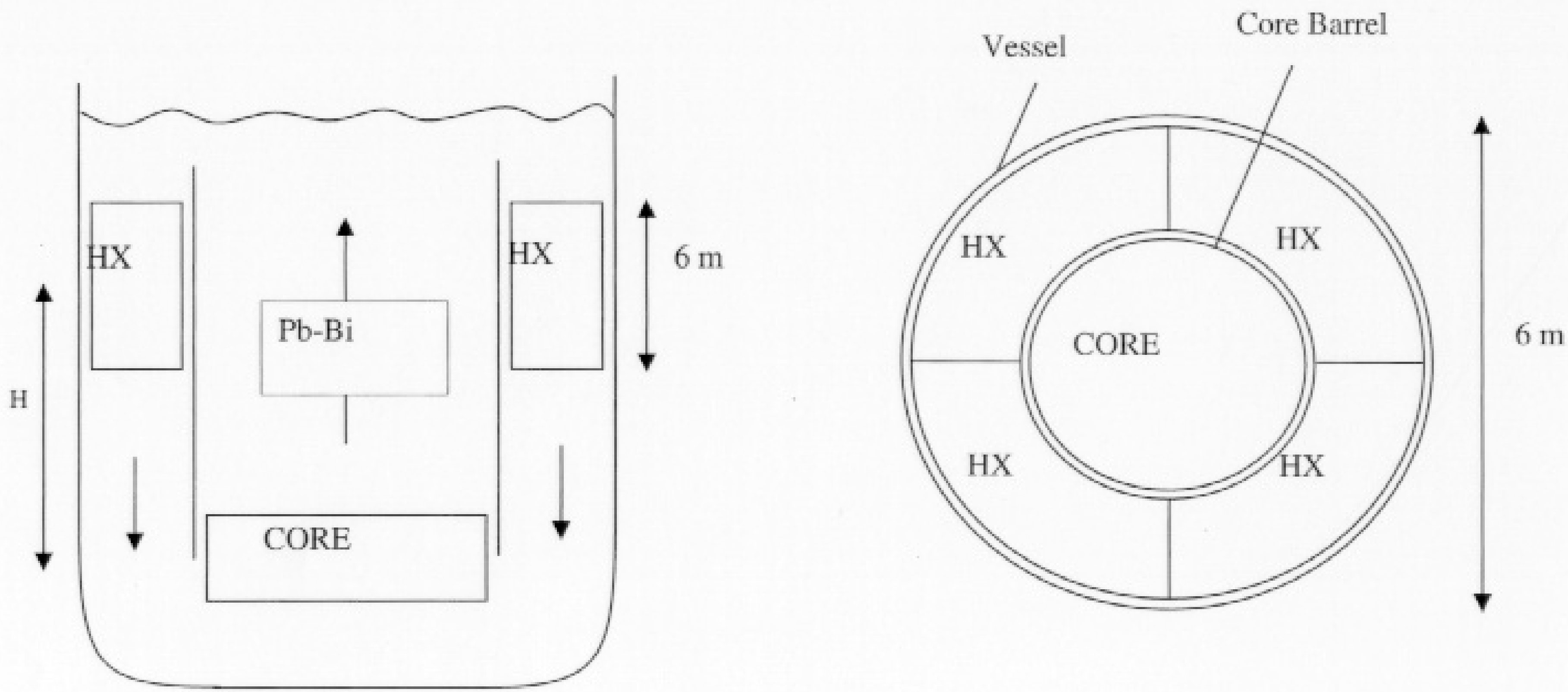
Reactivity Decline with Burnup



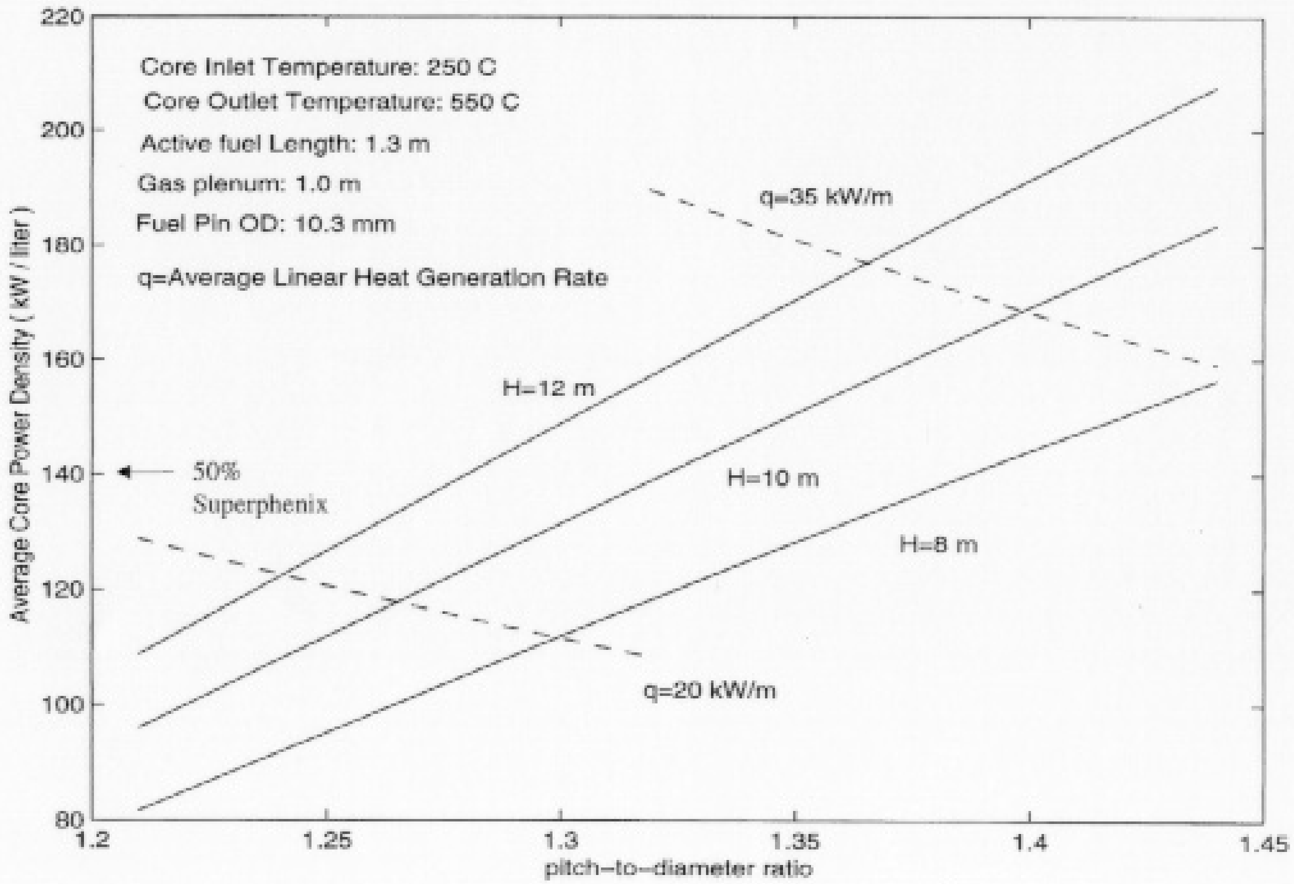
Actinide Burning Rates in the 1800 MWth Reactor



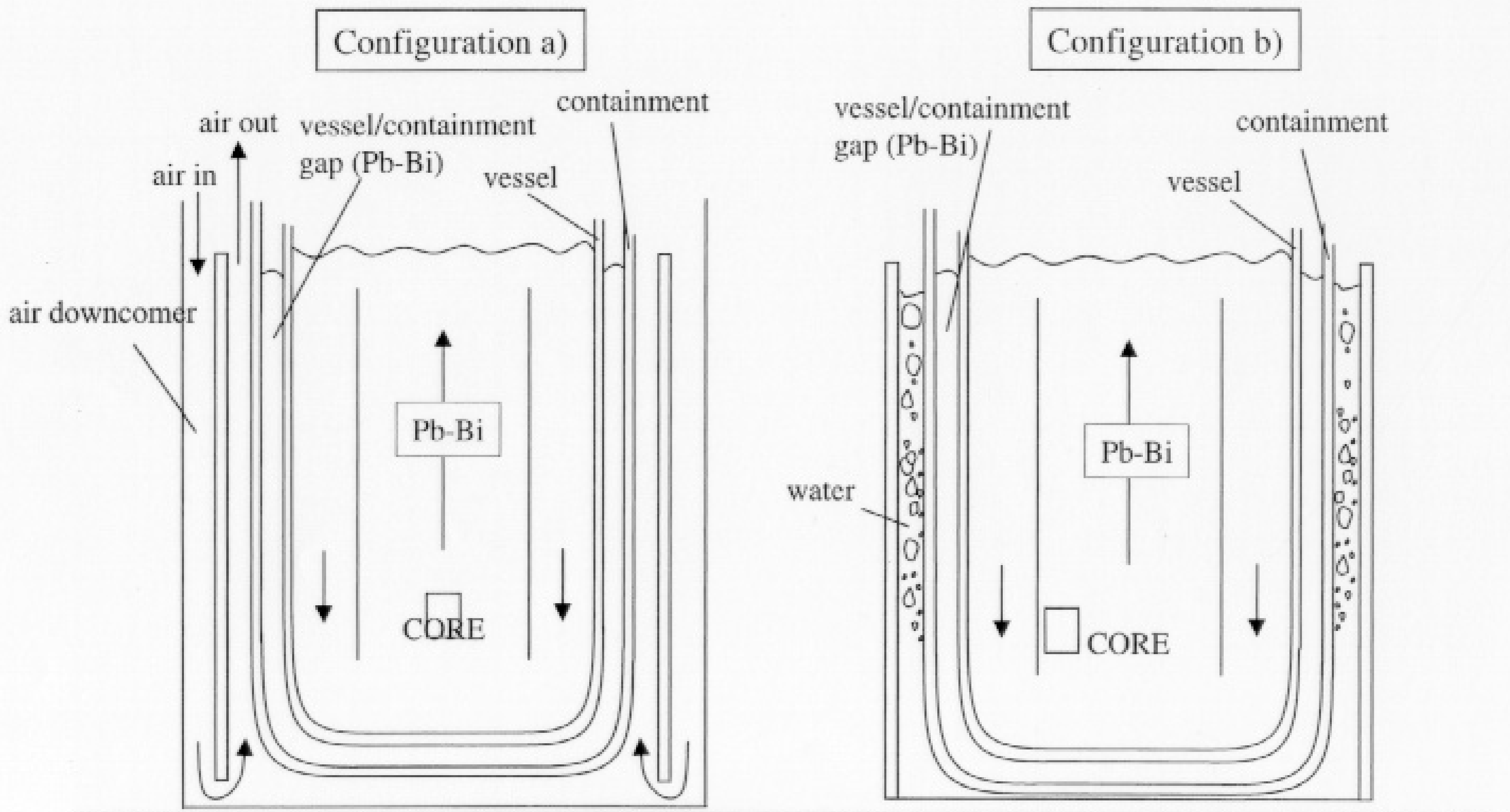
Pool Reactor Arrangement



Single Phase Natural Convection Operating Range



Decay Heat Removal Options



The materials development effort is not broad enough

- ⇨ **High reliance for Pb-Bi on one approach: the oxide layer formation for ferritic steels**
- ⇨ **Ceramic materials are not investigated**
  - ❖ **Coating metals with ceramics**
  - ❖ **Ceramic-metal compounds**
- ⇨ **Use of Nb-Zr alloys may be promising**

Does not address the 1995 recommendation of National Academy Study

The use of LWRs for actinide burning is not investigated, but it is the major candidate emerging from the National Academy Study of 1992-95.

- ➪ **One recycle in LWRs may reduce the number of ATWs needed**
- ➪ **Use of PWRs with the fuel and nonfertile blanket further reduces the Pu in spent fuel**