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Deep Borehole Disposal Concepts for Spent Fuel and HLW

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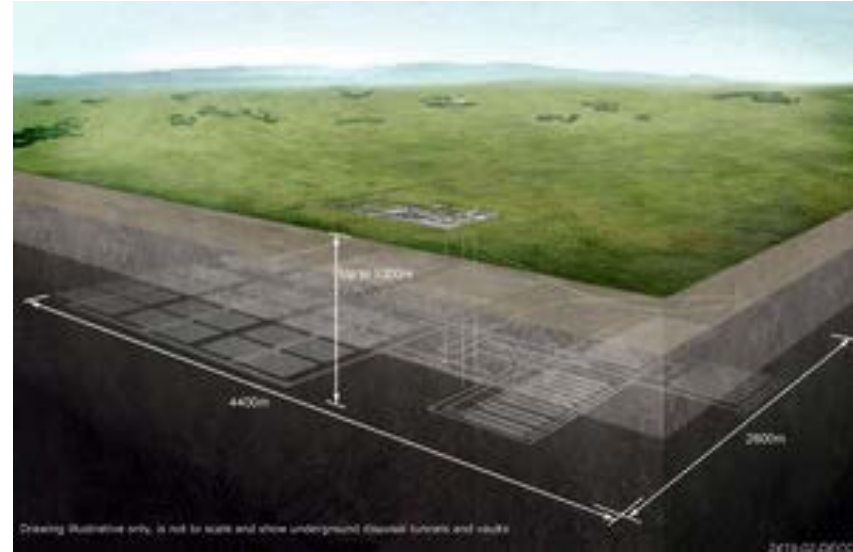
Engineering and Physical Sciences
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**Sandia
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Disposal of spent fuel/HLW in the UK

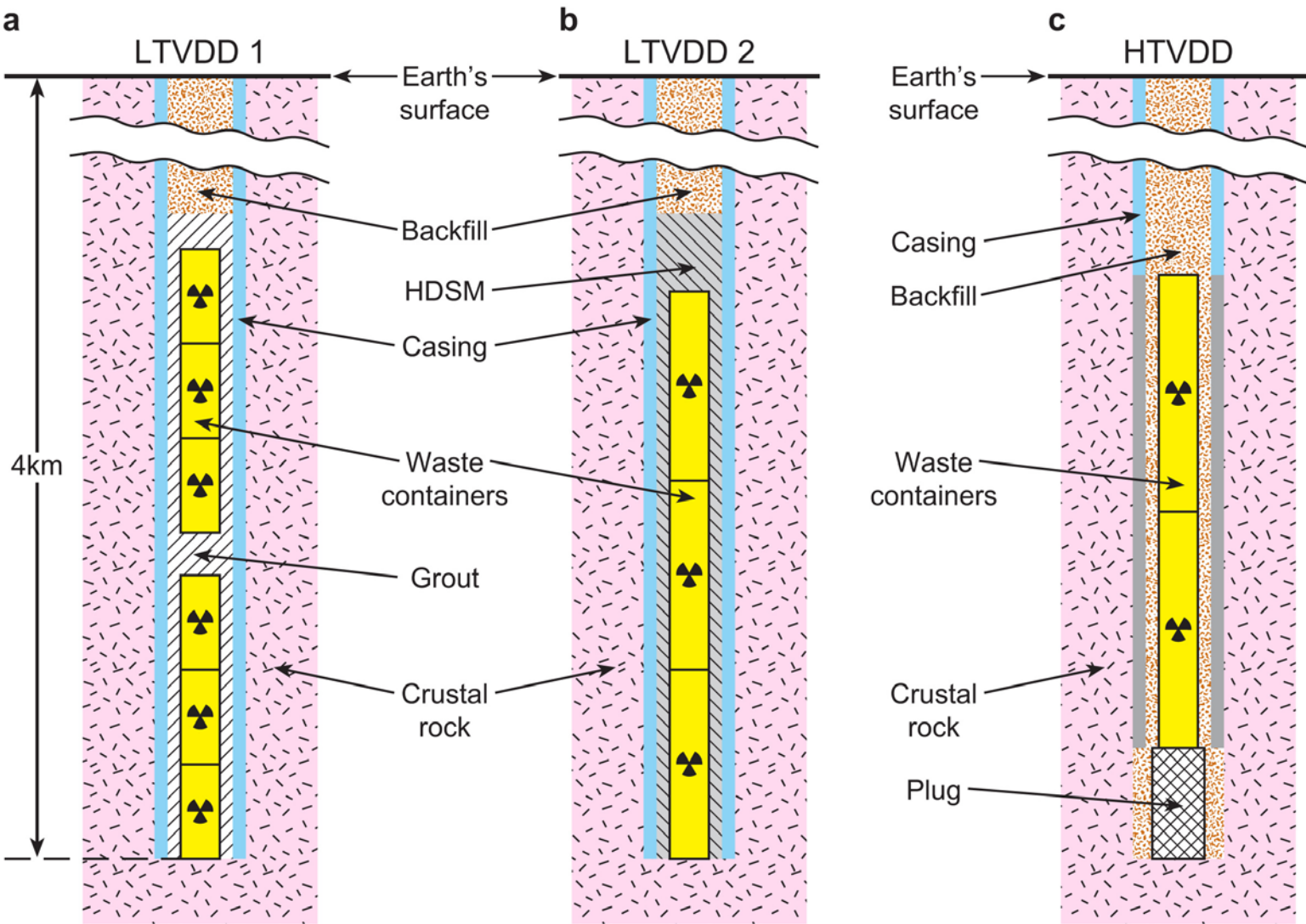
- The current proposal is for **co-disposal** of HLW/spent fuel along with ILW in a single GDF.
- The first containers of vitrified HLW will not enter the GDF until 2075.
- The NDA is keeping a watching brief on developments in DBD.
- In 2016, RWM commissioned a *Review of Alternative Radioactive Waste Management Options*, which includes a section on DBD.





- All the UK's vitrified HLW could be disposed of in as few as **six** 5 km deep boreholes, occupying an area the size of a soccer pitch.
- Spent fuel could be efficiently disposed using consolidated disposal, including spent MOX and fuels with higher burn-ups.
- Direct disposal of Pu could be considered.
- Some waste packages such as the Hanford capsules are particularly suited to disposal by DBD.

DBD variants for different waste packages



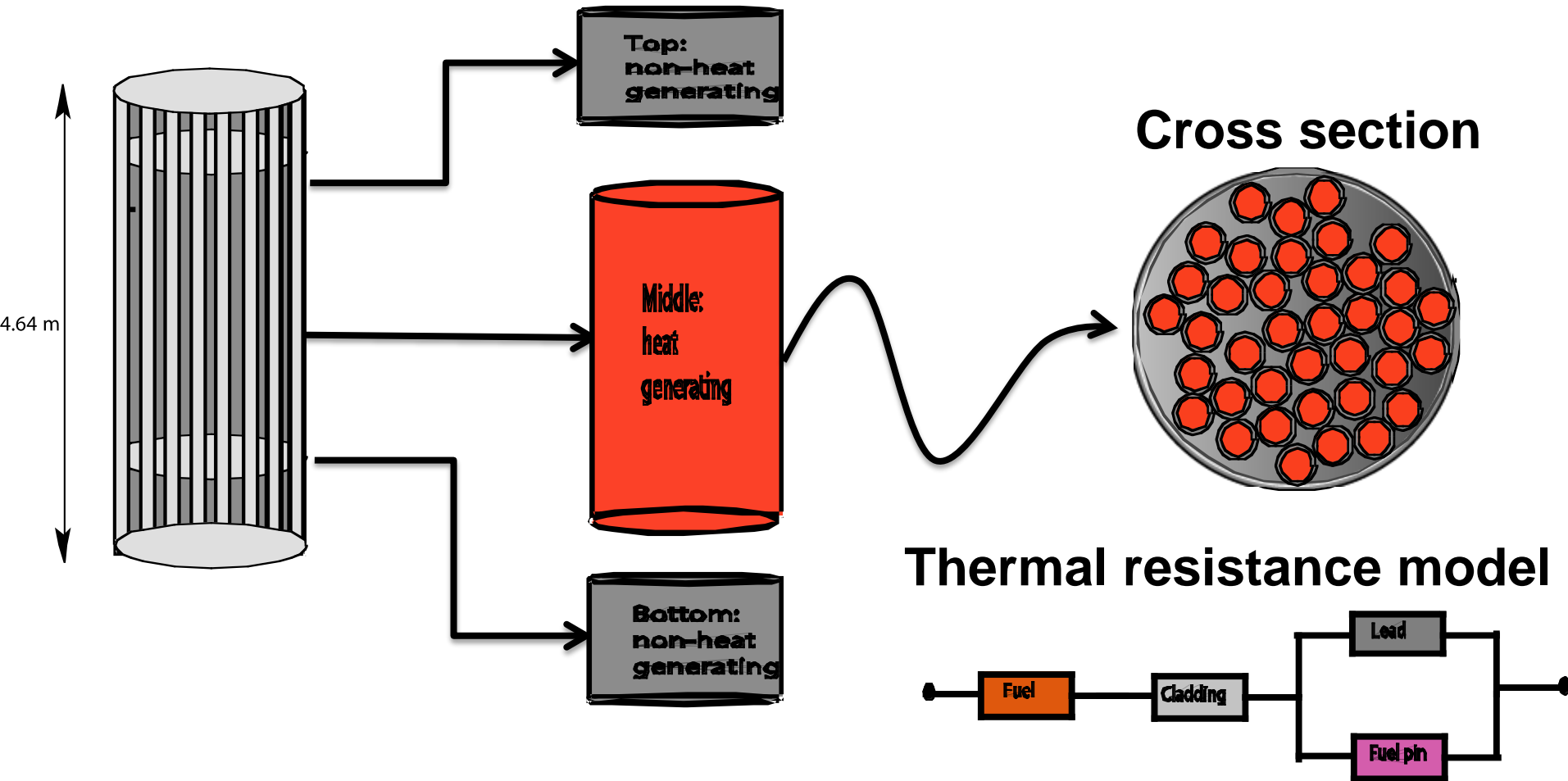


- Why seal the annulus in DBD?
 - Delay ingress of groundwater, which could corrode the disposal container
 - Prevent upward transport of radionuclides
 - Provide mechanical support for stack of containers
 - Significant addition to the DBD safety case

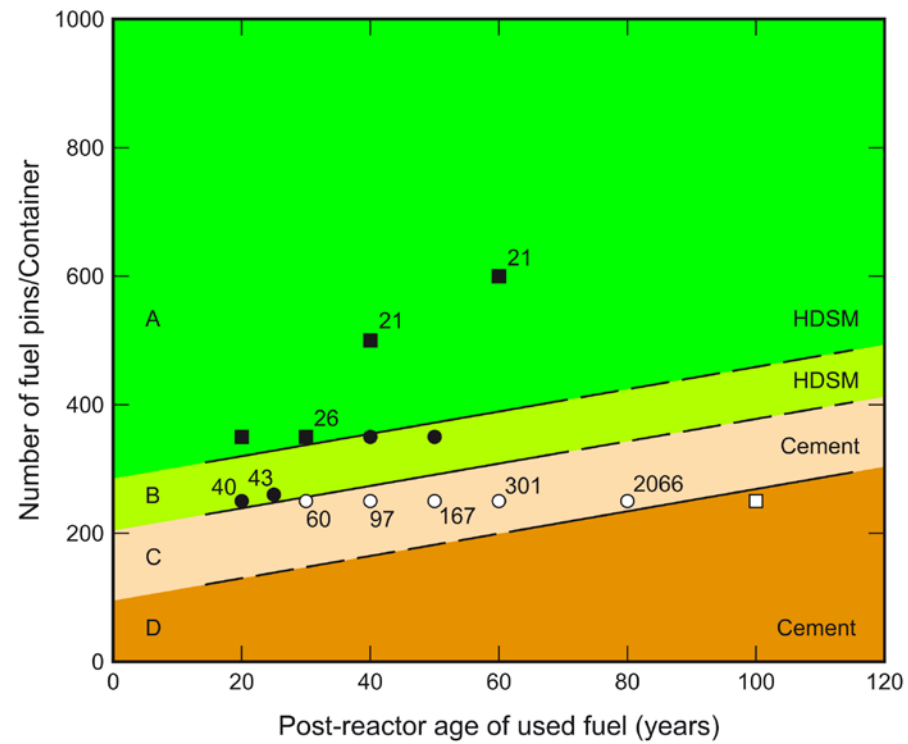
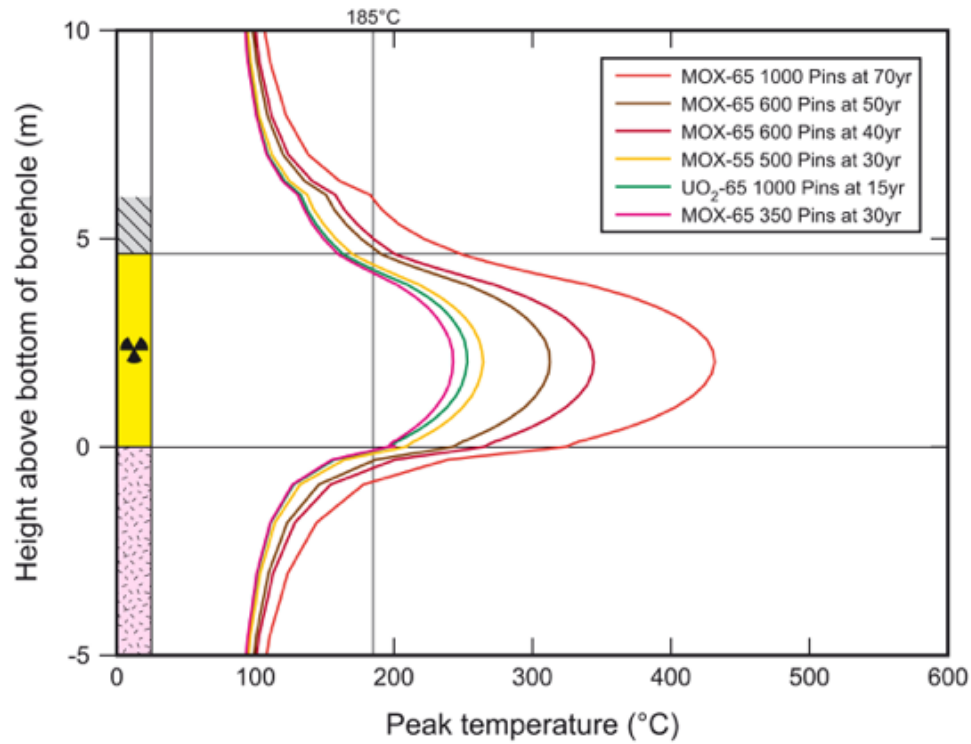


- Consolidated disposal is most efficient –individual fuel pins are packed in containers which are then filled with molten lead. Around 1000 AP1000 fuel pins could be packed in a container.
- Whole assemblies could also be disposed – one per container. Less efficient, but less handling is an advantage.
- Heat flow modeling has been undertaken in order to give information on temperature distribution
- Modeling allows a wide operating envelope to be explored.

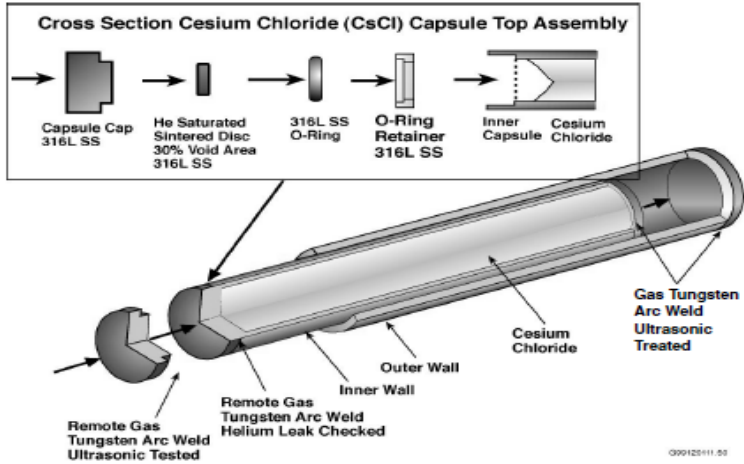
The source term for consolidated pin disposal



Spent Fuel – Consolidated Disposal



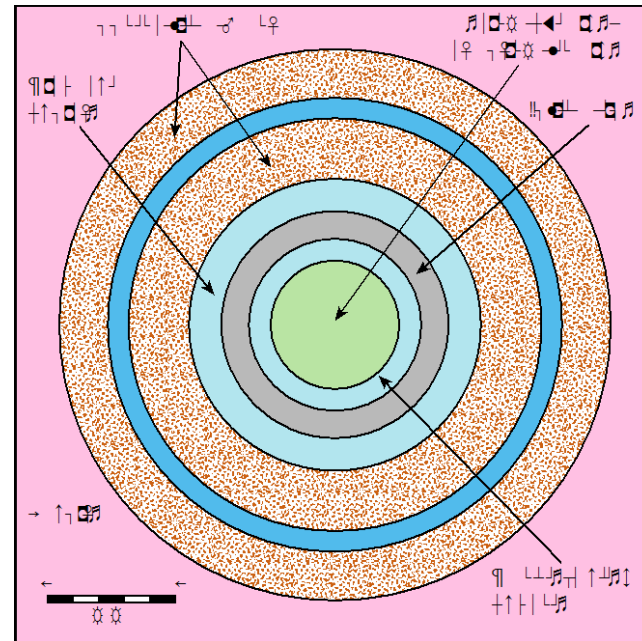
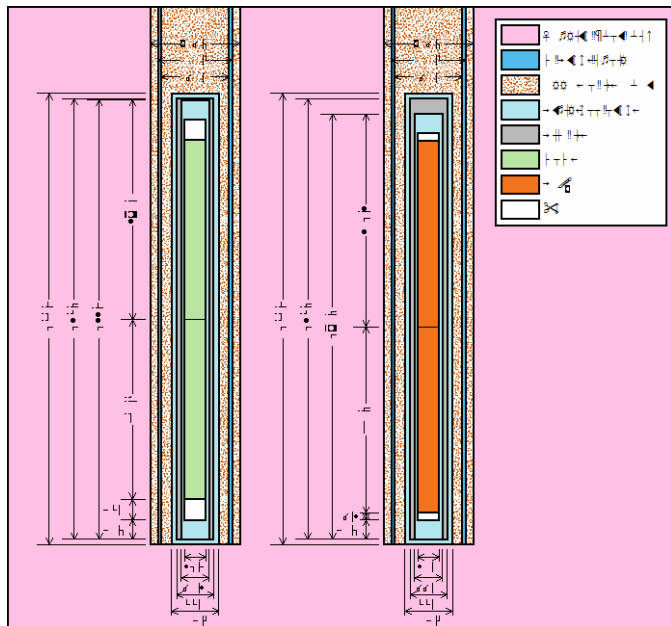
Small waste packages – Hanford capsules



Capsule Dimensions

Length: 0.51 - 0.53 m

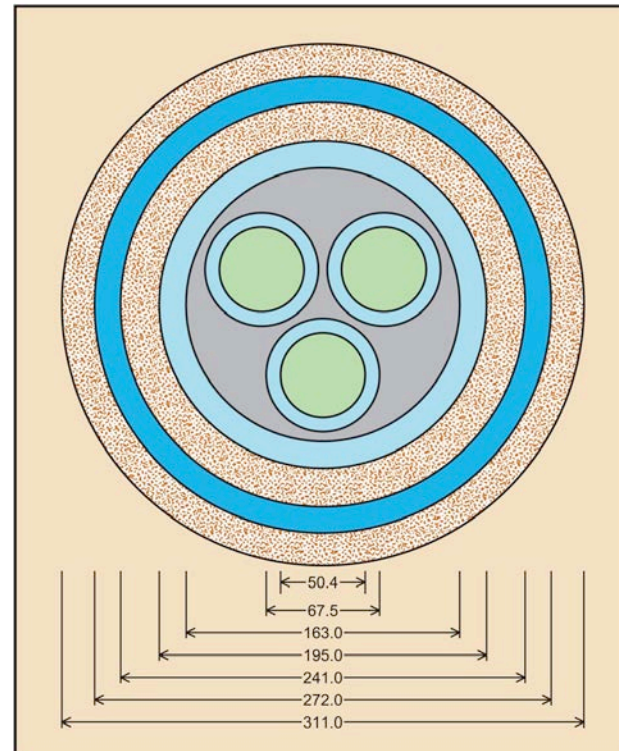
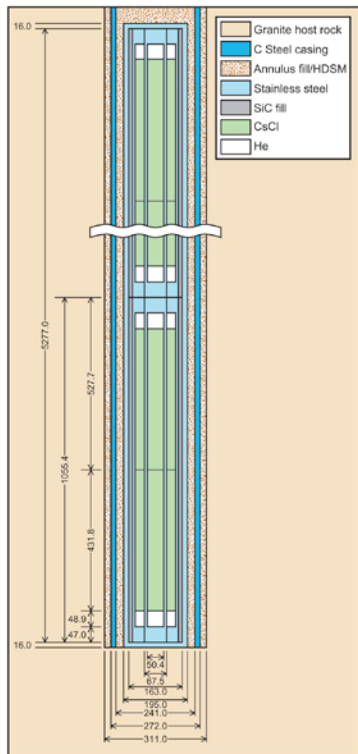
Diameter: 6.7- 8.3 cm



Small waste packages – Hanford capsules



- Alternative, more efficient solution - "triples"
- Entire Hanford capsule inventory could be disposed in a single hole with a 12 ¼ inch diameter disposal zone.



Borehole Seals – key to DBD being used for higher activity wastes



Surface
(Backfill)
Zone

It is vital that the borehole itself does not provide an easier route back to the human environment for any radionuclide bearing fluids than does the surrounding geology.

Seal
Zone

Therefore the borehole above the disposal zone must be sealed (to liquids & gasses)

Sealing &

1. For how long do the seals have to function?

Support



Matrix
(SSM)

2. How good do the seals need to be?

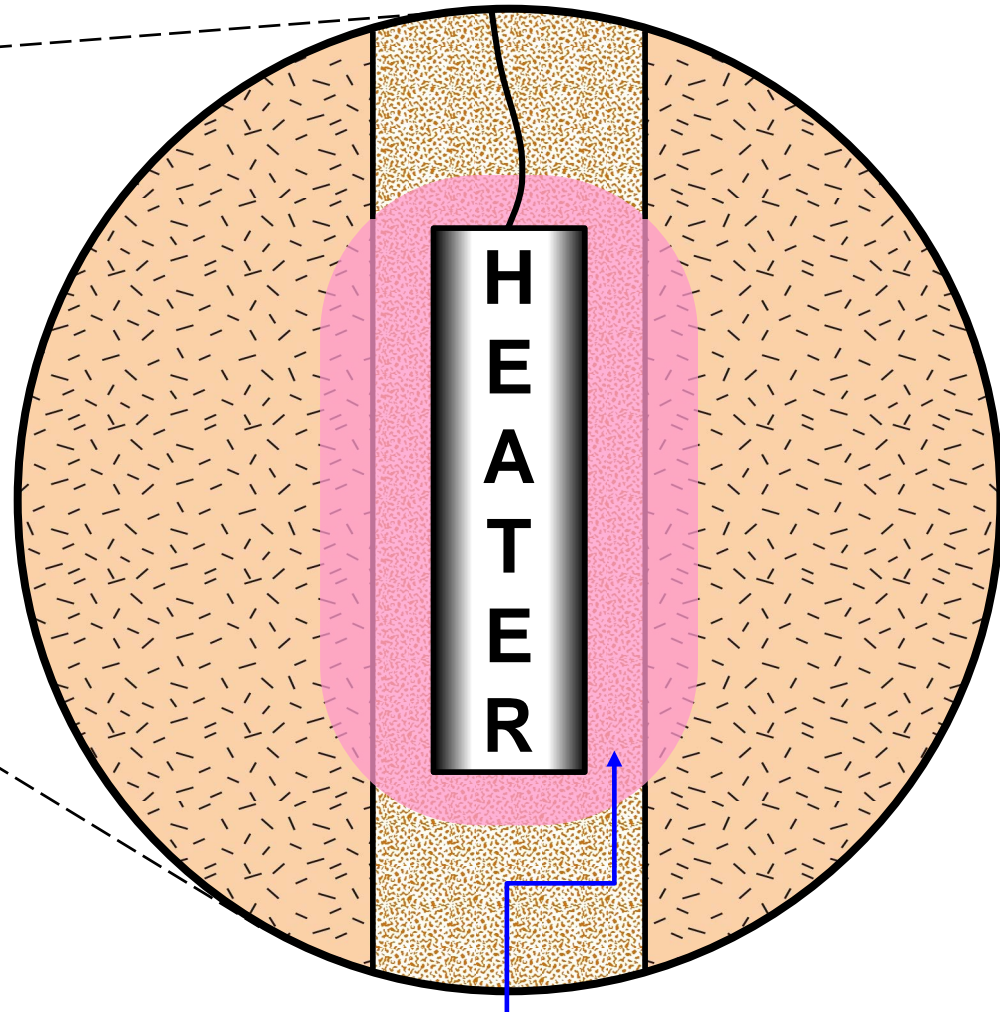
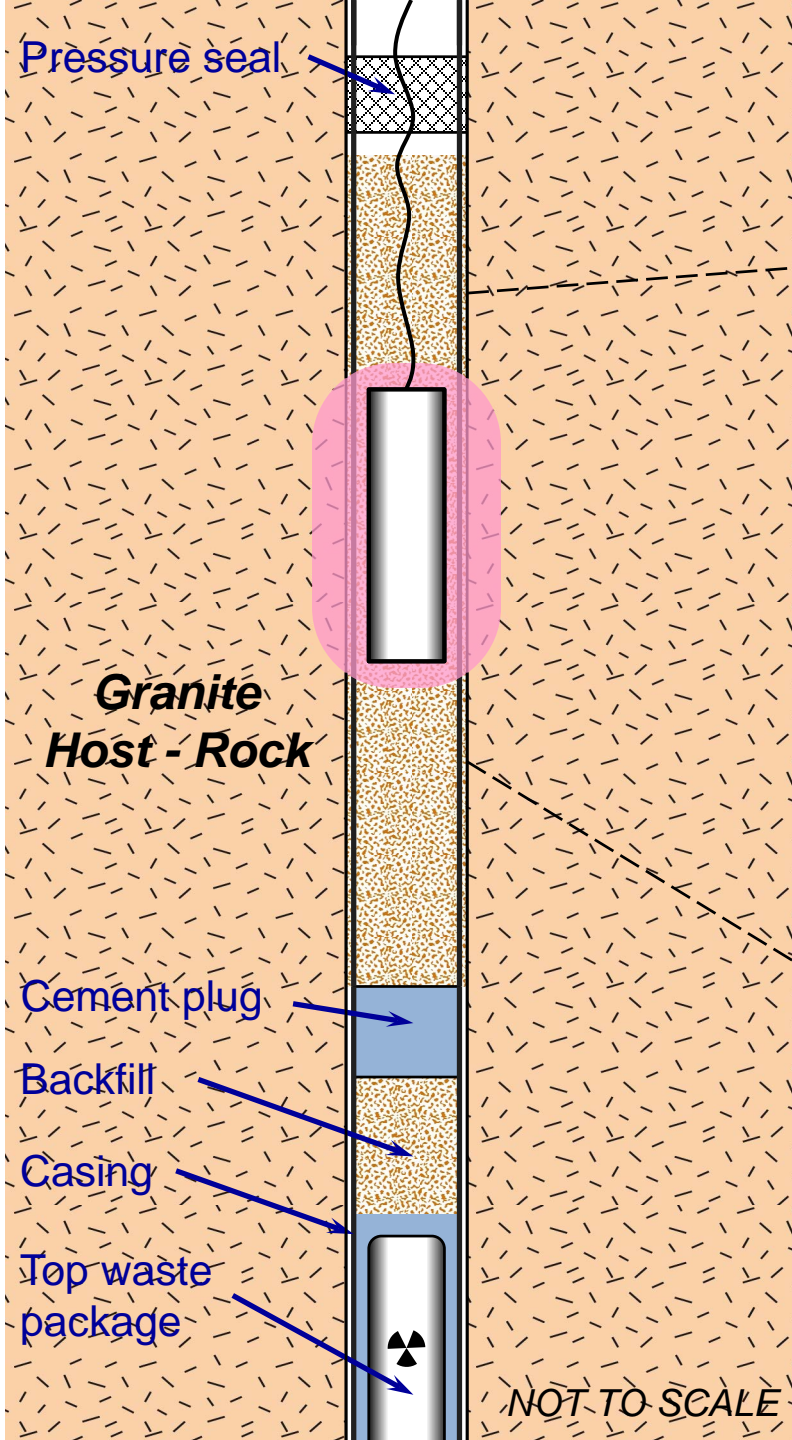
Disposal
Zone



3. Are these criteria achievable and, if so, how ?

“Rock Welding” Engineering Concept

(Under R & D at The University of Sheffield)



Recrystallized granite identical to, & continuous with, host rock

Repeat at intervals above DZ as required



- DBD offers a versatile solution for disposal of higher activity wastes, spent fuel, plutonium and difficult wastes.
- Is less expensive (per tonne of heavy metal disposed) than a mined repository.
- Offers a substantially lower environmental footprint than the co-disposal GDF solution.
- Is at least as safe as a GDF (NWTRB report) and likely to be potentially safer.
- DBD could offer a less centralised solution for high activity waste, reducing the need to transport waste large distances from the waste producers.