Radioactive Waste – an outstanding problem

A presentation by
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Public Expectation

"there should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future." (Royal Commission on Environmental Pollution, sixth Report, p.131, para 338.)

The first question

Is the ‘deep geological repository’ concept extendable to take spent fuel from new nuclear reactors?

The Nuclear Industry View

"a repository dealing with legacy wastes could readily accommodate the smaller volumes of easier-to-handle wastes from that new generation of nuclear plants"

The Nuclear Industry Association 'Nuclear Future' – Vol.04, N0.1, January 2008

Government View

"….new waste could technically be disposed of in a geological repository and….this would be the best solution for managing waste from any new nuclear power stations.."

THE ROLE OF NUCLEAR POWER IN A LOW CARBON UK ECONOMY, DTI Consultation Document. MAY 2007 Page 24 para 99

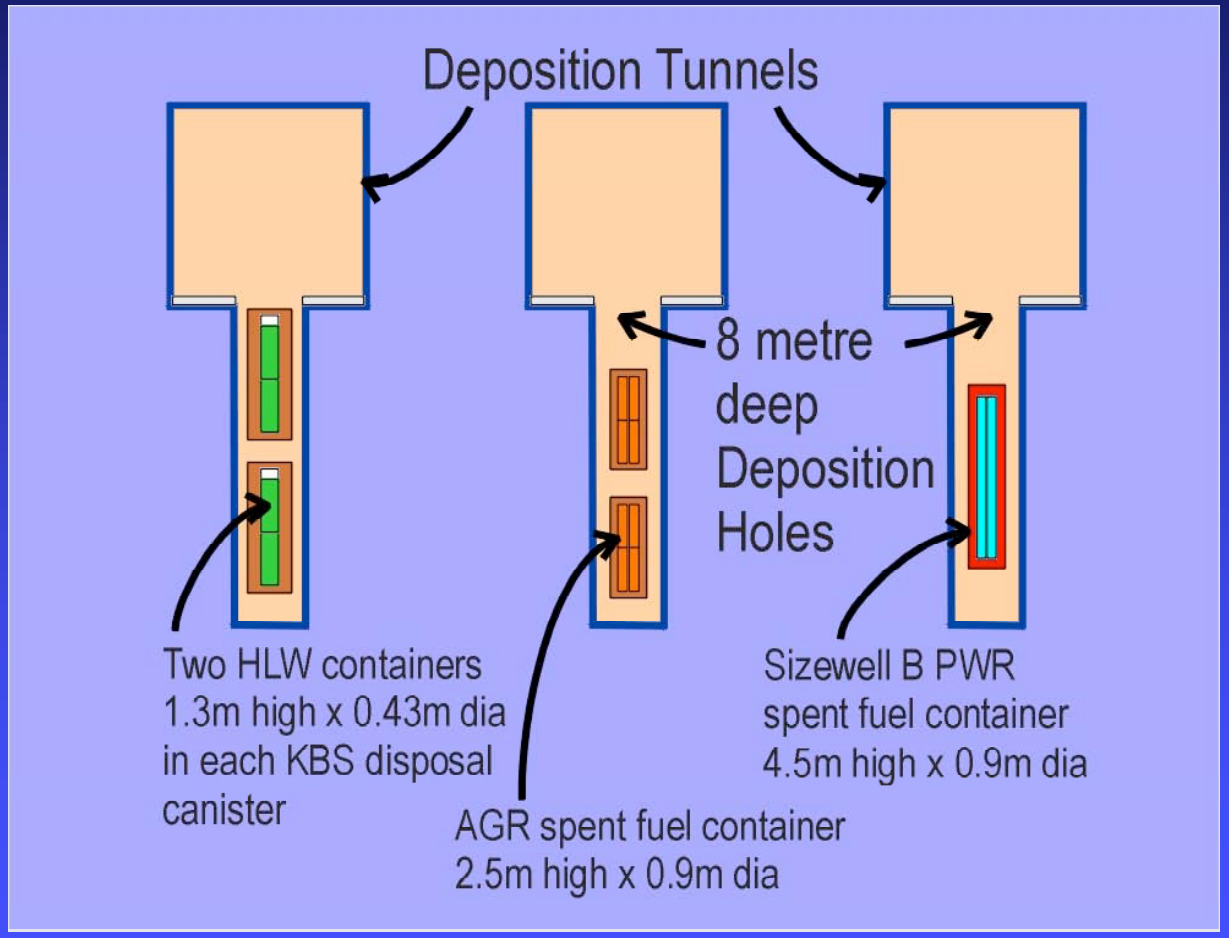
The Government's desire 'to reduce costs for energy companies considering investing in new nuclear' is a strong motivation to put new build waste in the same repository as legacy waste.

NDA/Nirex Advice

"…the impact that new build waste would have on the repository footprint is dependent on the number of disposal canisters required and the heat output associated with the Spent Fuel "

The Gate Process: Preliminary analysis of radioactive waste implications associated with new build reactors.
February 2007 Para 4.1

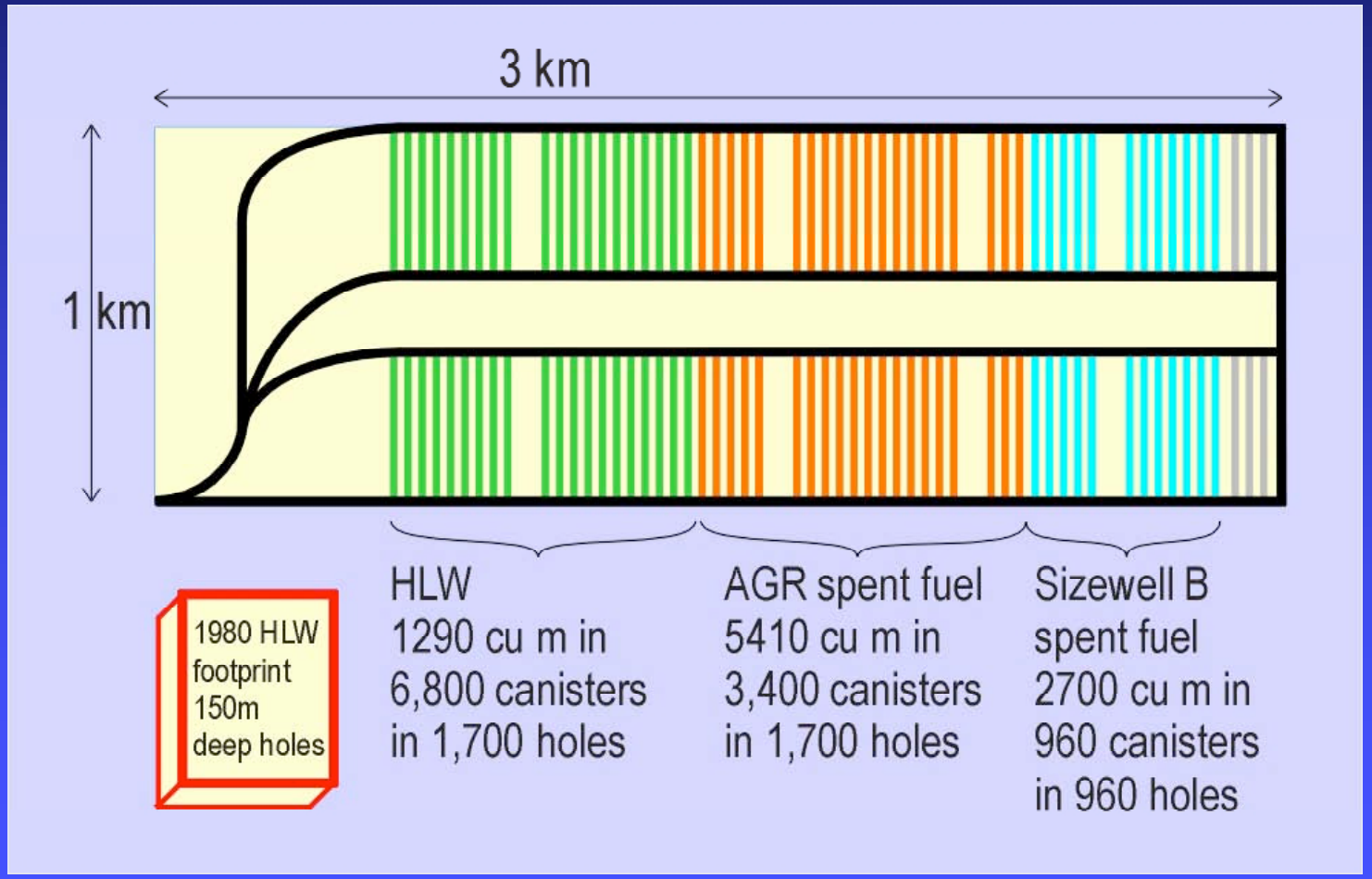
The Reference Repository



The Reference Repository

- Legacy HLW - 1290 cu m in 6,800 canisters in 1,700 holes
- AGR spent fuel - 5410 cu m in 3,400 canisters in 1,700 holes
- Sizewell B spent fuel - 2700 cu m in 960 canisters in 960 deposition holes

The Reference Repository footprint – Legacy waste

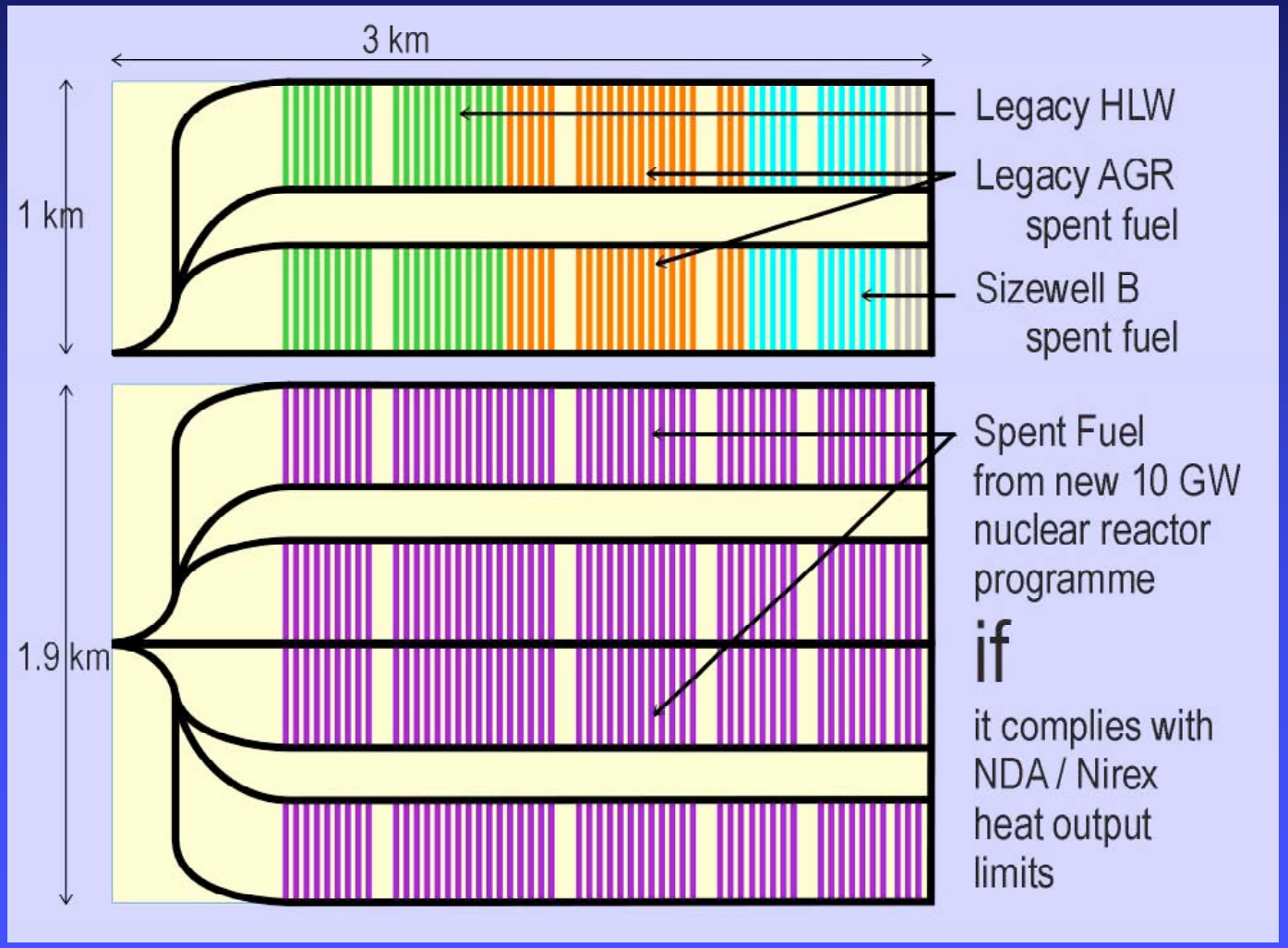


The Reference Repository – All HLW and Spent Fuel

- Legacy Waste – 3 Sq Km +
- Spent fuel from new UK reactors
  31,900 cu m in 7,000 KBS3 canisters in 7,000 deposition holes
  - 5.7 Sq Km

(based on 10 AP1000 reactors operating for 60 years)

A Repository for all HLW & SF



Radioactive Waste - 'Footprints'

ILW/LLW
1 Sq Km

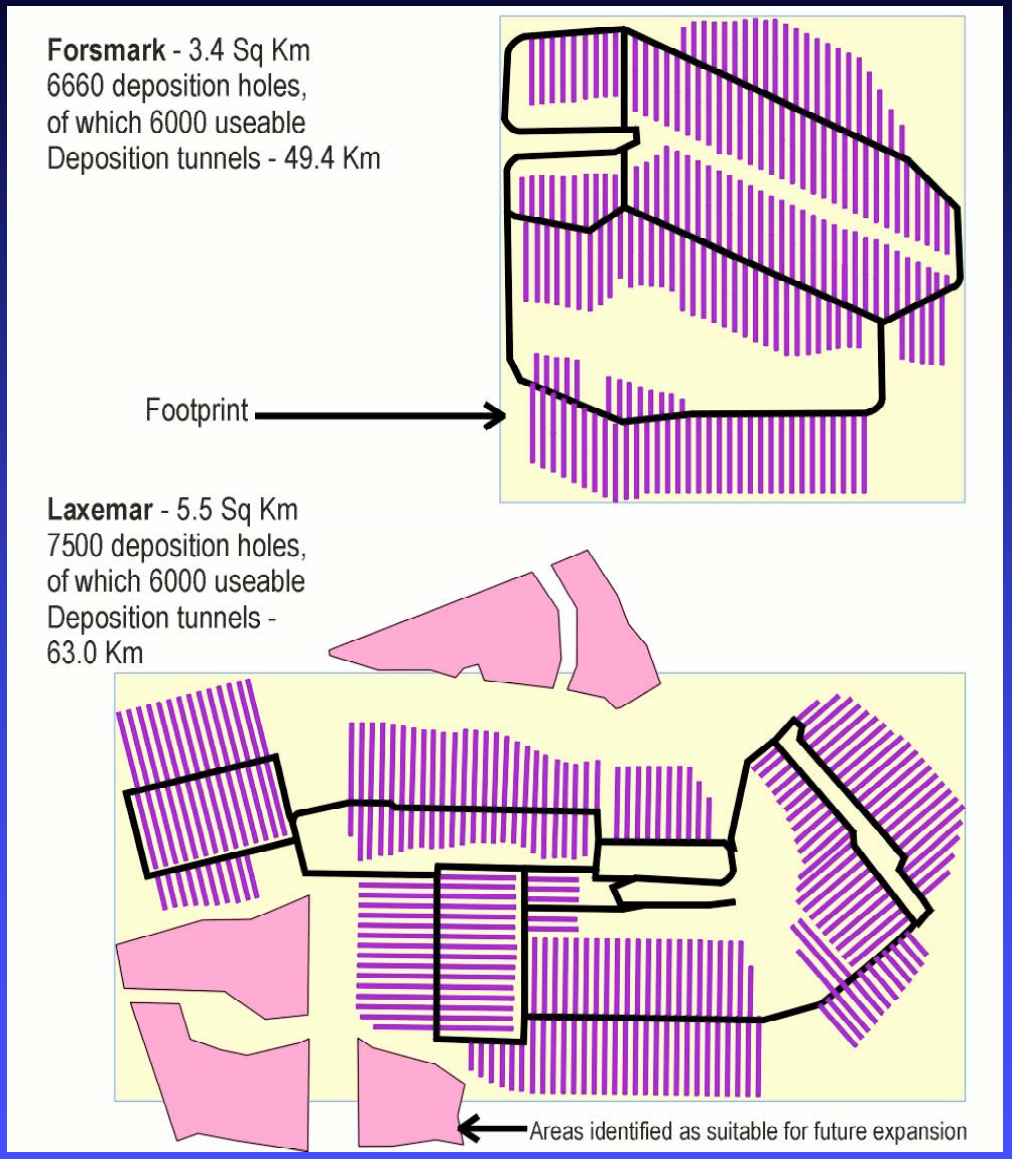
HLW/Spent Fuel
3 Sq Km

Legacy Waste

Albert Hall to same scale

Spent Fuel from a 10 GW Nuclear New-build Programme

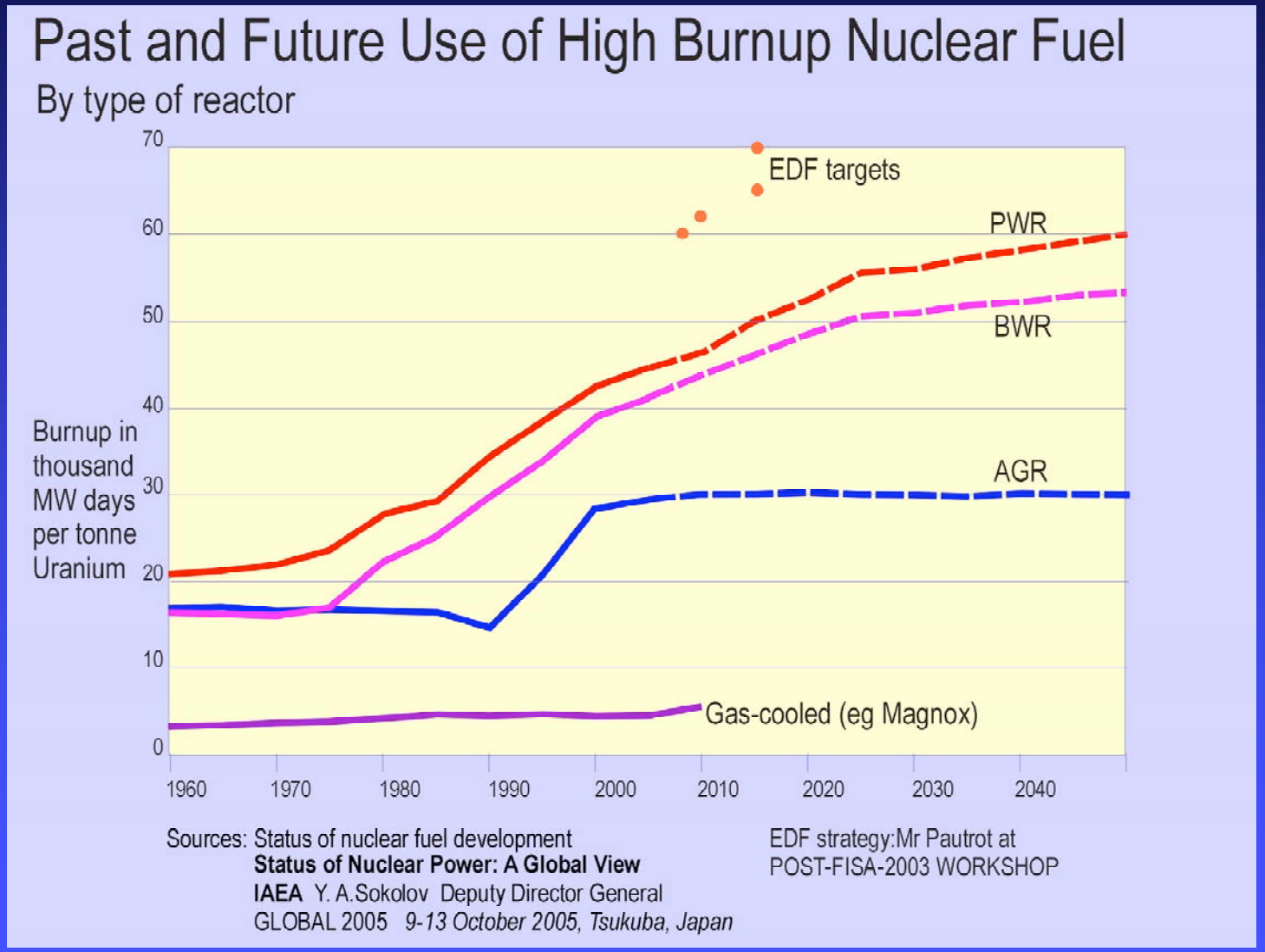
6 Sq Km


Forsmark - 3.4 Sq Km
6660 deposition holes,
of which 6000 useable
Deposition tunnels - 49.4 Km
Footprint
Laxemar - 5.5 Sq Km
7500 deposition holes,
of which 6000 useable
Deposition tunnels -
63.0 Km
Areas identified as suitable for future expansion

Burnup of Spent Fuel

To boost the efficiency of their reactors, operators have progressively enriched the uranium they use as fuel to increase its "burn-up" rate. This is a measure of the amount of electricity extracted from a given amount of fuel, and is expressed in thousand megawatt-days per tonne of uranium (MWd/tU).

Nuclear – gambling with the Future

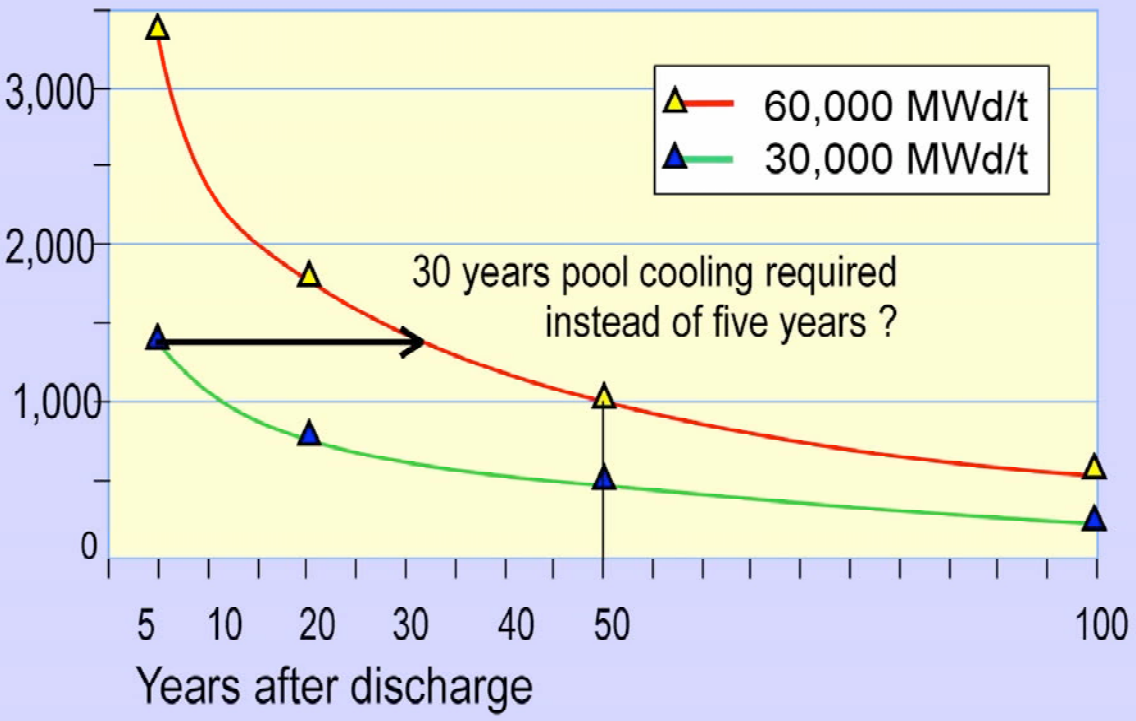


Heat Output of Spent Fuel

"The higher burnup of fuel has a significant impact on the choice of the storage option and on the design of storage systems, due to the increased decay heat, inter-alia, which is roughly proportional to burnup, imposing a higher cooling load to the storage system."

Selection of Away-From-Reactor Facilities for Spent Fuel Storage, A Guidebook. IAEA Tecdoc 1558 Sept 2007, Para 2.1.4. Page 7

Heat output over time



Source: Nuclide Importance to Criticality Safety, Decay Heating, and Source Terms Related to Transport and Interim Storage of High-Burnup LWR Fuel

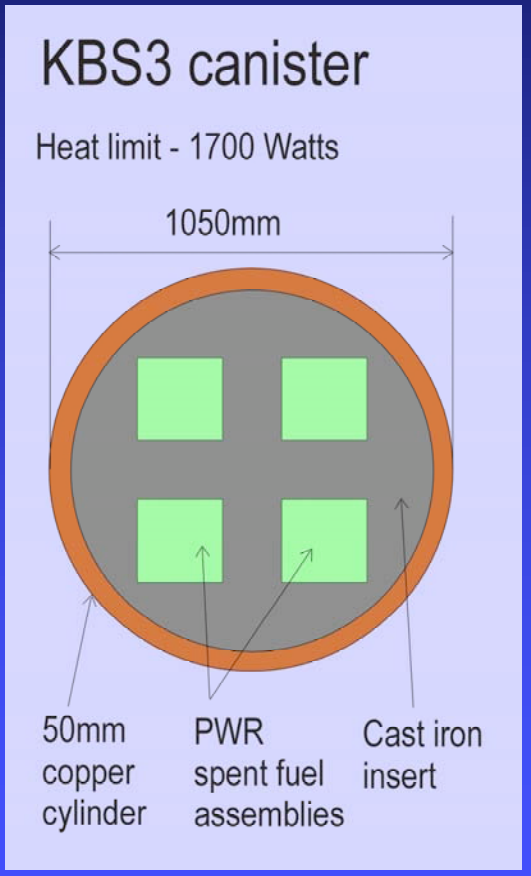
I. C. Gauld and J. C. Ryman, Oak Ridge National Laboratory
U.S. Nuclear Regulatory Commission, December 2000, NRC Job Code W6479

Heat Output and Radioactivity

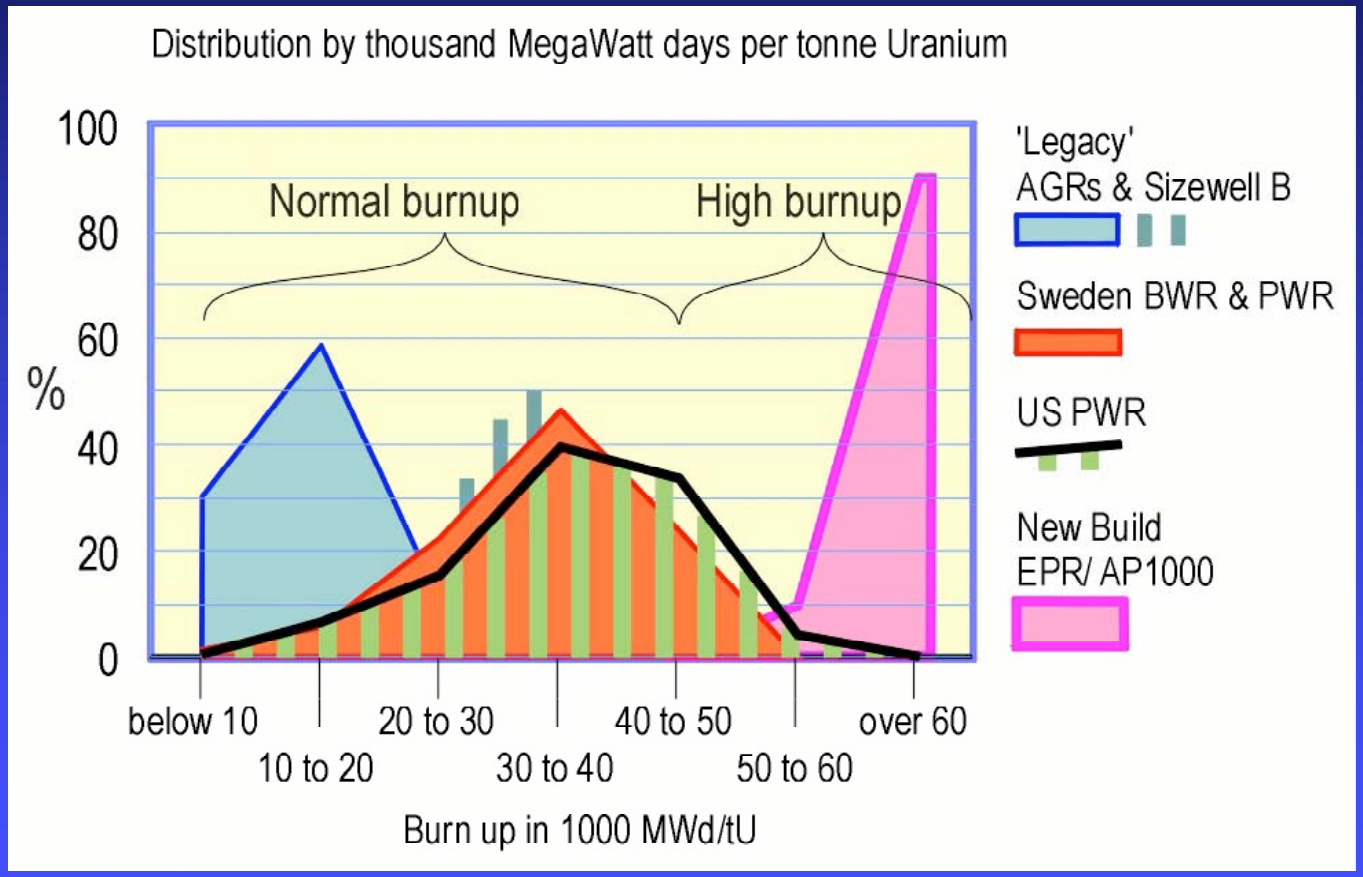
a build-up of heat could cause fractures

- in the containers in an underground storage site or
- in the surrounding rock, and

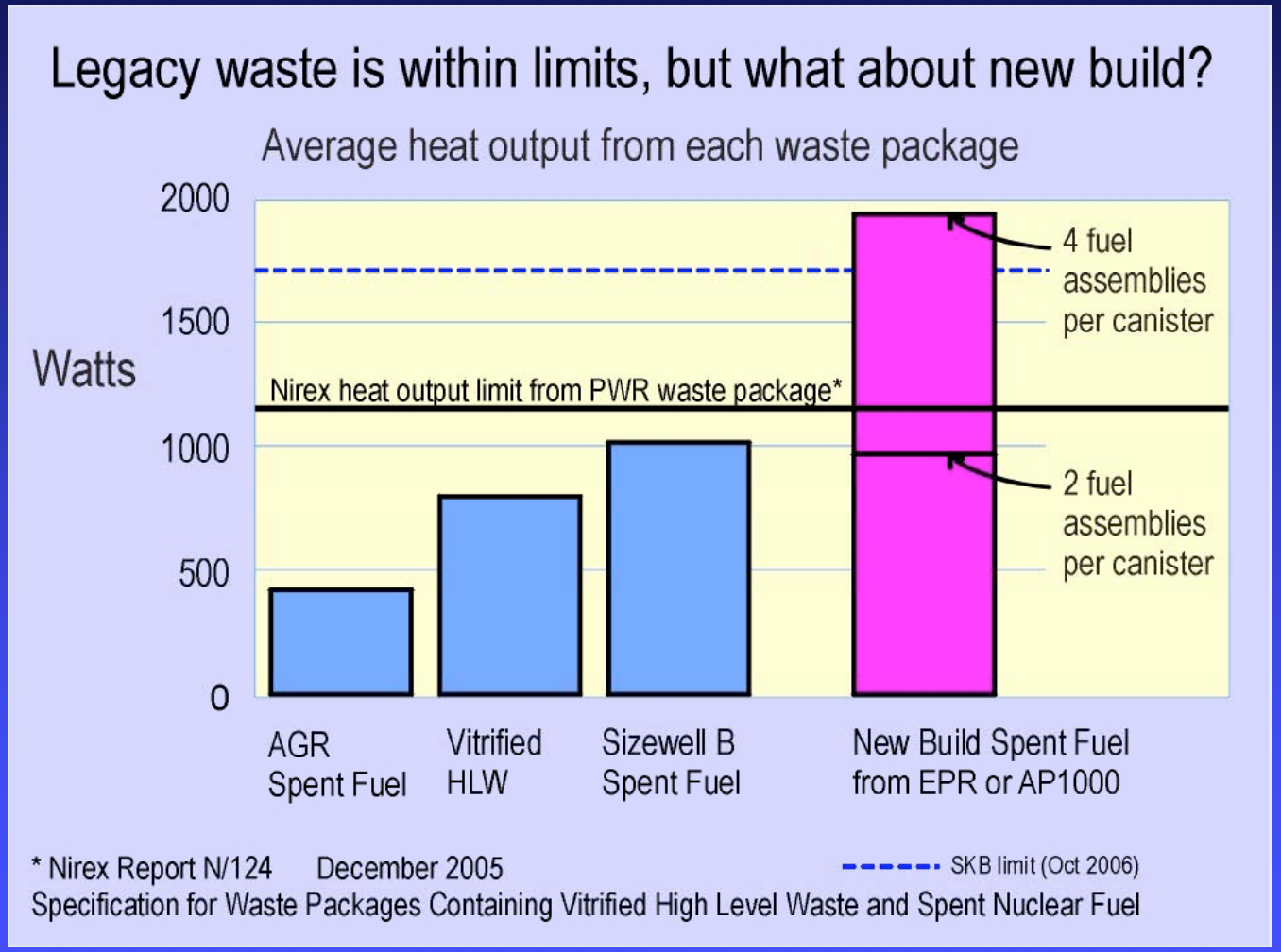
so increase the risk of a leak



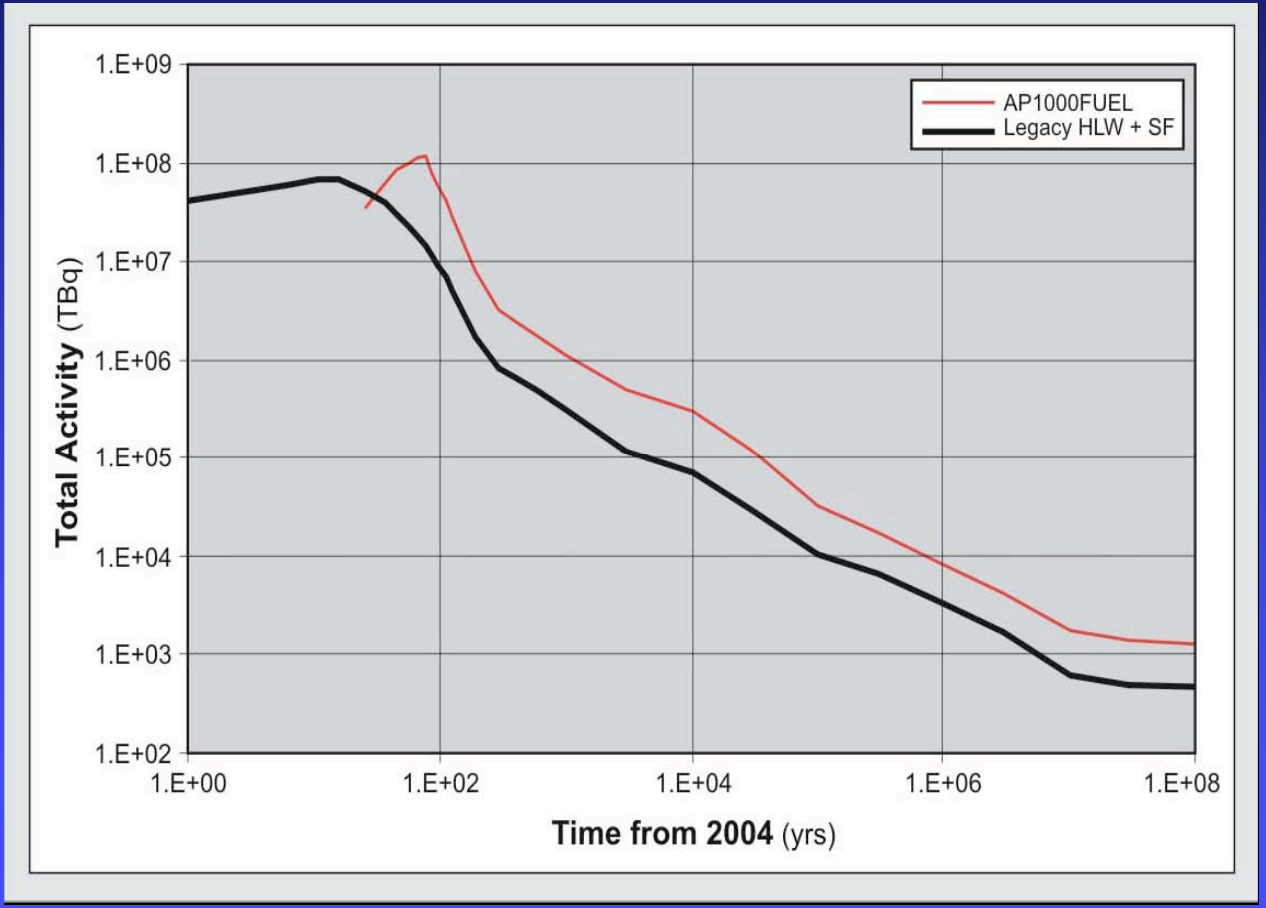
Spent Fuel burnup



Nirex advice on Heat Limits

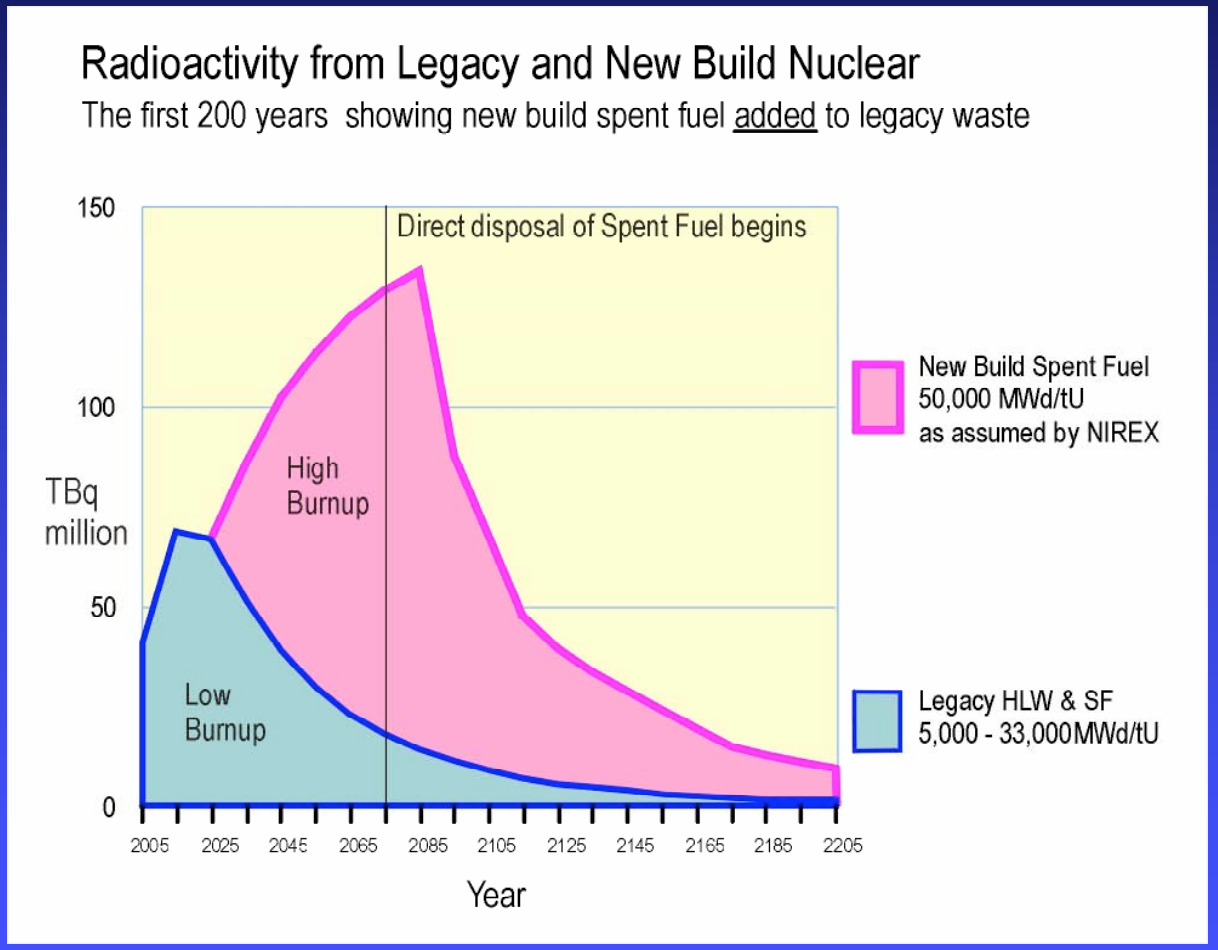


Nirex advice on radioactivity



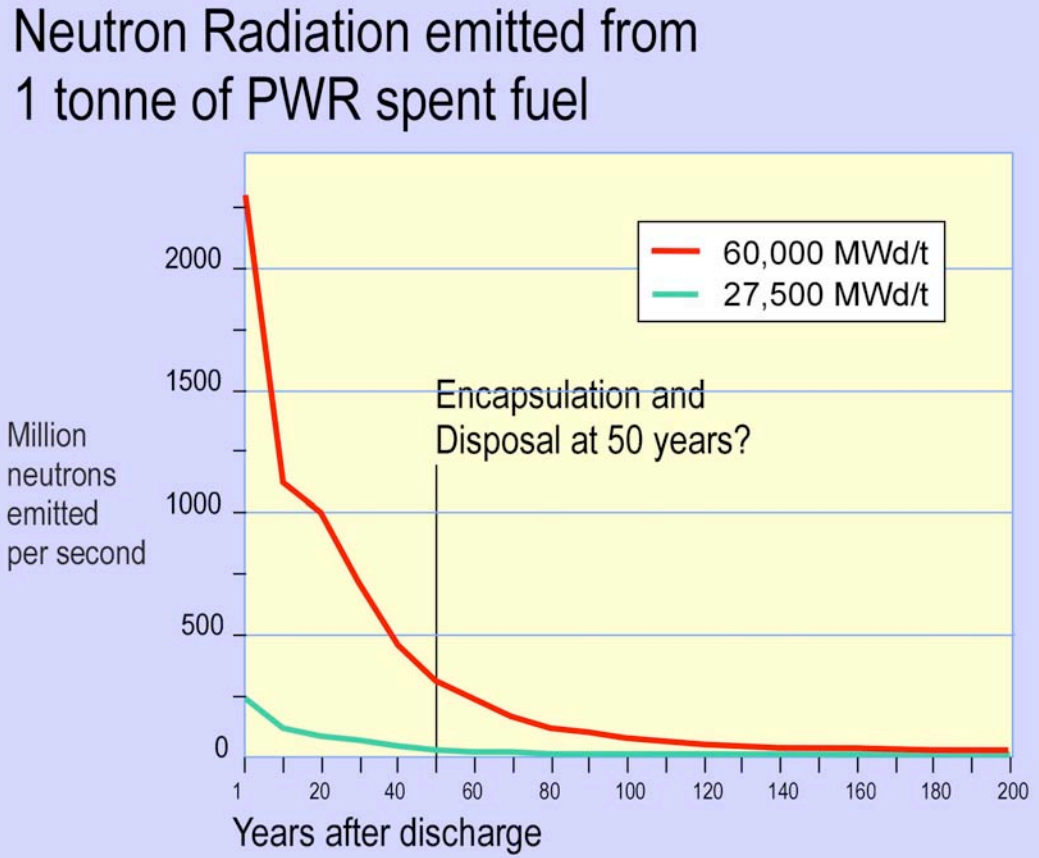
(Logarithmic scale)

Nirex advice on radioactivity, redrawn



Same data on an arithmetic scale

Neutron Shielding – the big challenge



Disposing of High Burnup Spent Fuel after 50 years is the equivalent of direct disposal of 'normal' spent fuel within one year of discharge

Issues of concern 1

- Direct disposal of spent fuel is an unproven concept.
- Swedish repository concept adopted by Nirex was designed for ‘normal’ burnup spent fuel.
- New nuclear reactors will discharge very high burnup spent fuel (over 60,000MWd/tU)
- There is very little experience of spent fuel of 60,000MWd/tU and over
- Materials for its safe containment are still at an experimental stage.
- There is reasonable doubt that a method exists

Paying for Radwaste?

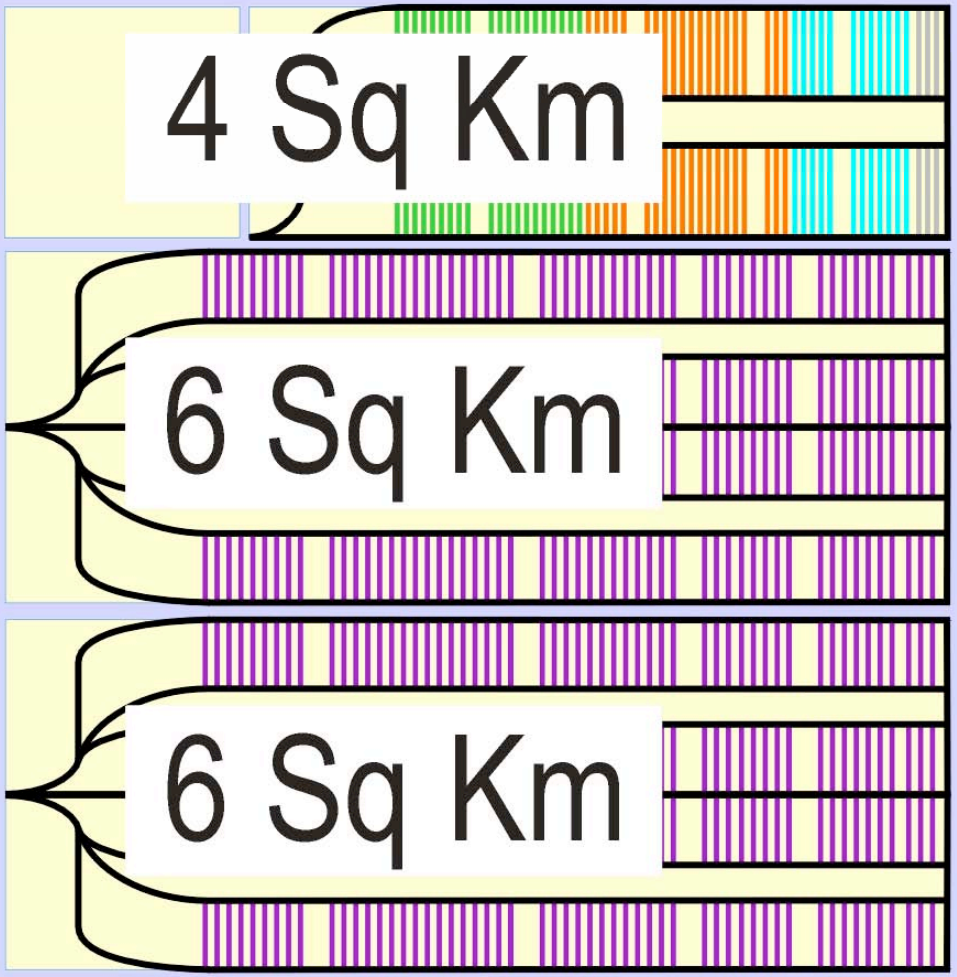
- A mechanism for providing adequate financial resources should be established to cover any future costs, in particular, the costs of decommissioning and also the costs of managing radioactive waste and the spent fuel after storage. **It….should be updated, as necessary.** (Storage of Spent Fuel IAEA Draft Safety Guide February 2008)
- ….the Government's policy (is) to set a fixed unit price for operators of new nuclear power stations for disposal of intermediate level waste and spent fuel (BERR February 2008)

Issues of concern 2

- More demanding at every stage of the nuclear cycle, high burnup spent fuel will increase potential worker and public exposure to radiation.
- It will need many decades additional cooling time, or
- be spaced out more widely in underground repositories, increasing their 'footprint'.
- Much misleading information on repository footprints has already been disseminated.
- In advance of technical and scientific confidence about high burnup spent fuel, any level of disposal charge fixed now would flout IAEA guidance and expose future taxpayers to huge risks

Can a Legacy repository be ‘extended’ to take spent fuel from a new nuclear power programme?

Can UK geology accommodate this?



If it couldn't accommodate this in 1980?

Legacy Waste

Spent Fuel
from a
10 GW
Nuclear New-build
Programme

within NDA/Nirex
heat limits

12 Sq Km