Long-term Risks for Nuclear Weapons Proliferation from Repositories for Final Disposal of Spent Nuclear Fuel

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An attempt to update a series of papers written in the mid to late 1990s

- Swahn, Johan 1995. "Retrievability and Safeguards Concerns Regarding Plutonium in Geological Repositories". Paper presented at the NATO Advanced Research Workshop on "Disposal of Weapons Plutonium: Approaches and Prospects", St. Petersburg, 14-17 May, 1995. Published on pp. 9-22 in Merz, E. ed., *Disposal of Weapons Plutonium: Approaches and Perspectives*, Kluwer.
- Swahn Johan 1997. "The Importance of the Retrievability of Nuclear Waste for the Implementation of Safeguard Regimes for Geologic Repositories". Paper presented at "IAEA Symposium on International Safeguards", 13-17 October, Vienna, Austria (IAEA-SM-351/29).
- Swahn Johan 1998. "Safeguard and Retrievability Issues for Spent Fuel Repositories". Paper presented at the Eighth International High-Level Radioactive Waste Management Conference, May 11-14 1998, Las Vegas, Nevada. Published as pp. 729-731 in the meeting proceedings.
- In addition to results from thesis work:

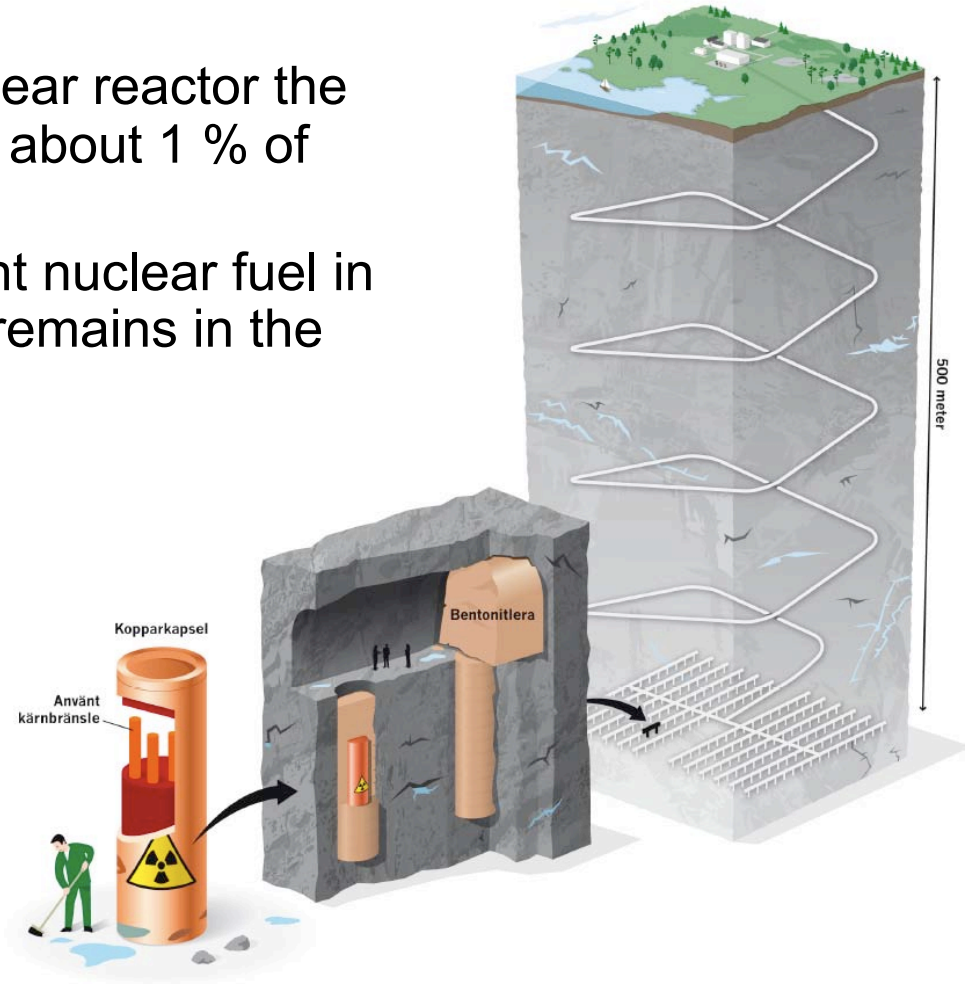
  Swahn, Johan 1992. The Long-term Nuclear Explosives Predicament: The Final Disposal of Militarily Usable Fissile Material in Nuclear Waste from Nuclear Power and from the Elimination of Nuclear Weapons. Institute of Physical resource Theory. Chalmers University of Technology/Göteborg University. Göteborg.

Overview: Nuclear non-proliferations risks from spent nuclear fuel in final repositories

- In direct disposal of spent nuclear fuel the plutonium remains in the waste.
- Plutonium in spent nuclear fuel is of reactor-grade quality but is usable in nuclear explosives. The plutonium in the spent nuclear fuel can be used for the construction of nuclear weapons for over 100 000 years.
- After the first thousand years the radiation from the spent fuel has decreased considerably making retrieval and plutonium extraction easier. The plutonium decay characteristics also make it easier to use the plutonium in weapons with time.
- The nuclear proliferation risks make long-term monitoring (safeguards) necessary for mined repositories containing spent nuclear fuel (such as the Swedish KBS method). Monitoring has to continued in one form or another for over 100 000 years.
- The discussion of the desirability of retrievability almost always ignores this issue, as it complicates the issue in a negative way for proponents of mined repository methods.
- There may be better alternatives that avoid long-term monitoring.

Plutonium in repositories for spent nuclear fuel

- After removal from the nuclear reactor the spent nuclear fuel contains about 1 % of plutonium.
- With direct disposal of spent nuclear fuel in a repository the plutonium remains in the waste.



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Reactor-grade plutonium is usable in nuclear weapons

- There is a myth that plutonium from civil nuclear reactors can not be used in nuclear weapons.
- In reality so called reactor-grade plutonium can be used in nuclear weapons even though a weapons designer would prefer plutonium from weapons-dedicated plutonium production.
- Reactor-grade plutonium gives somewhat bigger radiation protection problems and problems with heat generation in the plutonium.

A plutonium nuclear weapon

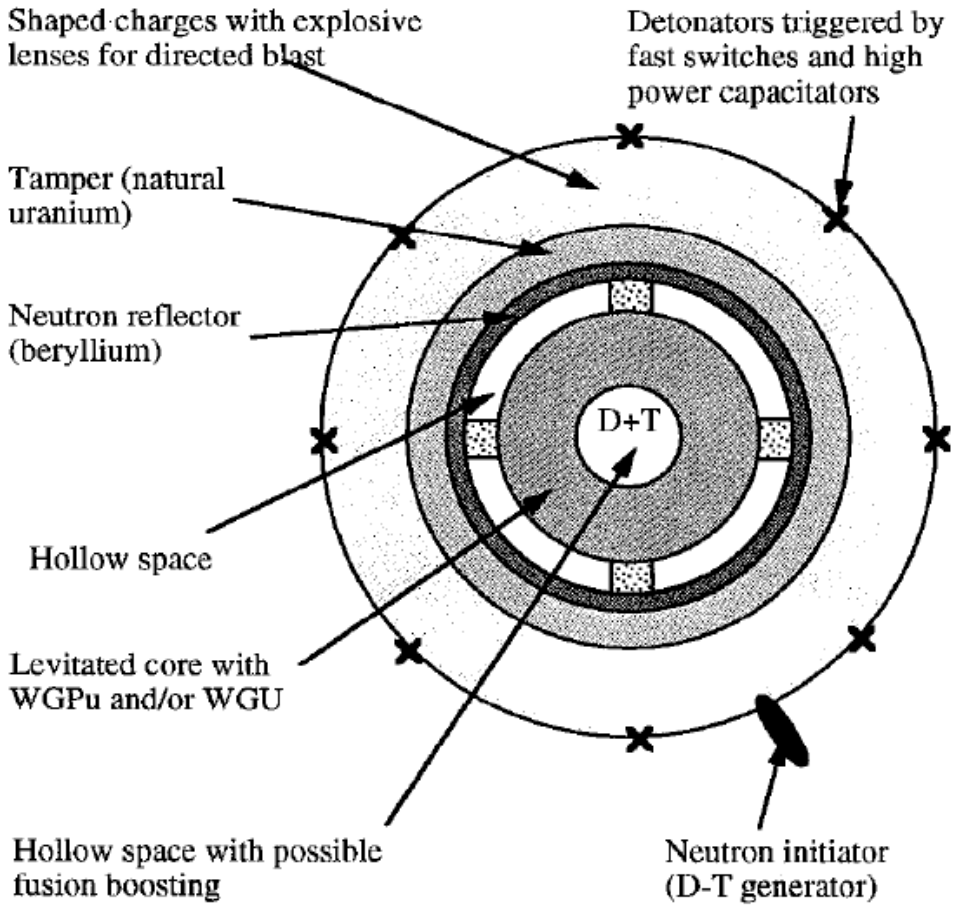

Figure 3.2. Schematic description of a nuclear explosive of the implosion type

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- The number of spontaneous fission neutrons in reactor-grade plutonium is high implosion speeds for a reliable weapon system. The technology for this is much available than in the 1940s.

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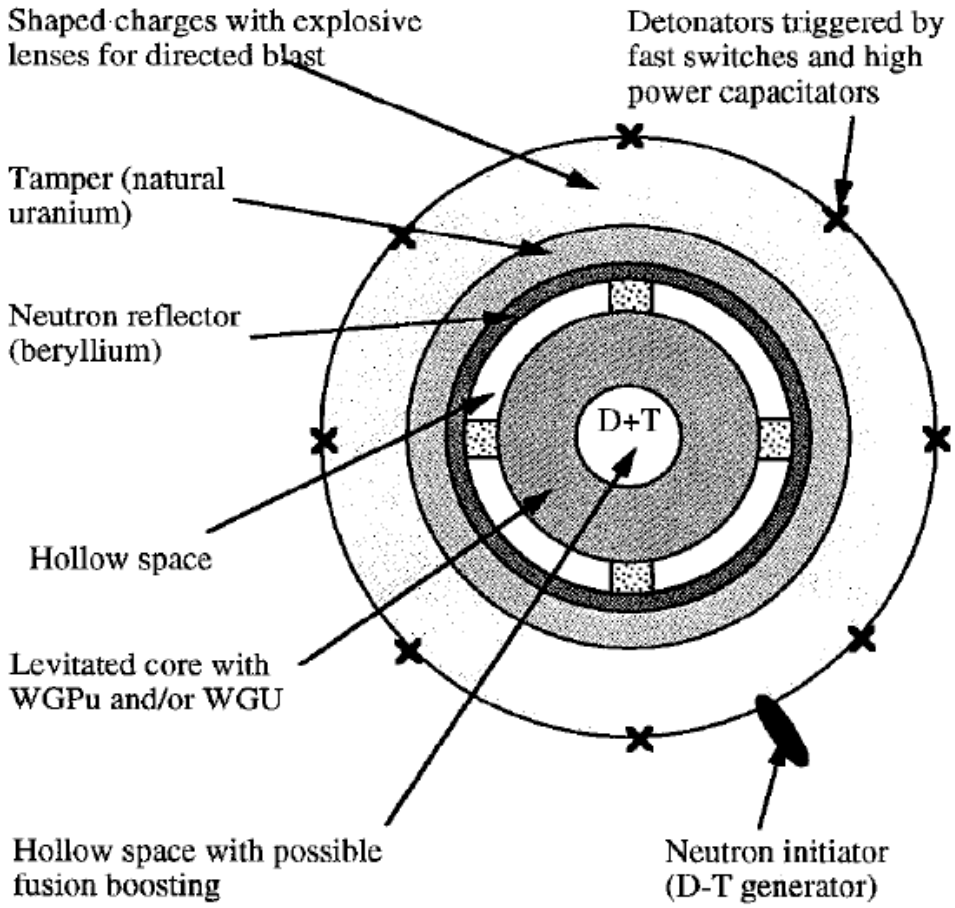

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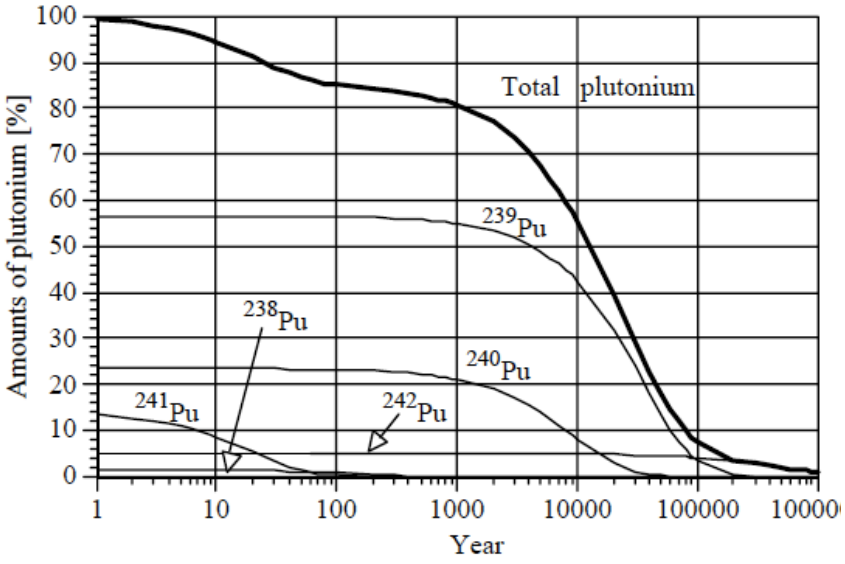
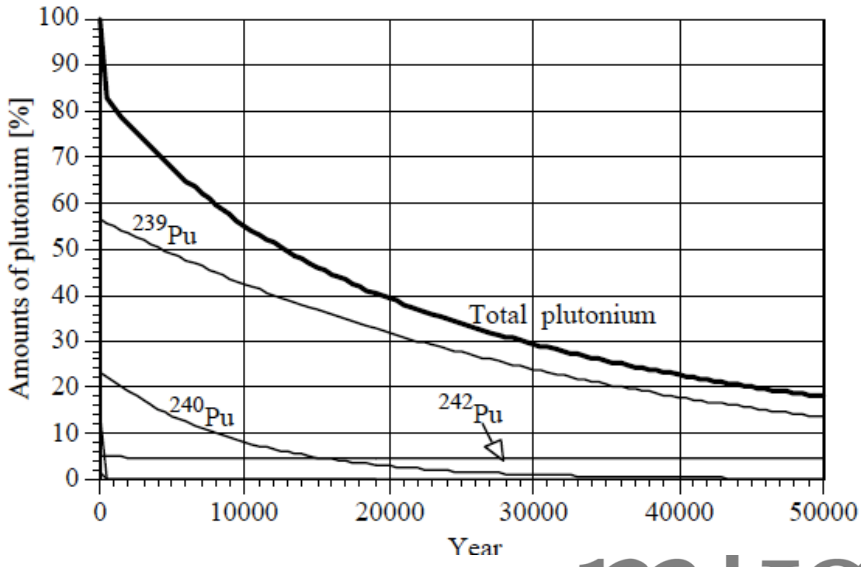
- Reactor-grade plutonium gives somewhat bigger radiation protection problems and problems with heat generation in the plutonium.
- The number of spontaneous fission neutrons in reactor-grade plutonium is high implosion speeds for a reliable weapon system. The technology for this is much available than in the 1940s.
- Even a low-tech plutonium device will give at least a few kilotons of yield.

Plutonium in a repository remains for over 100 000 years

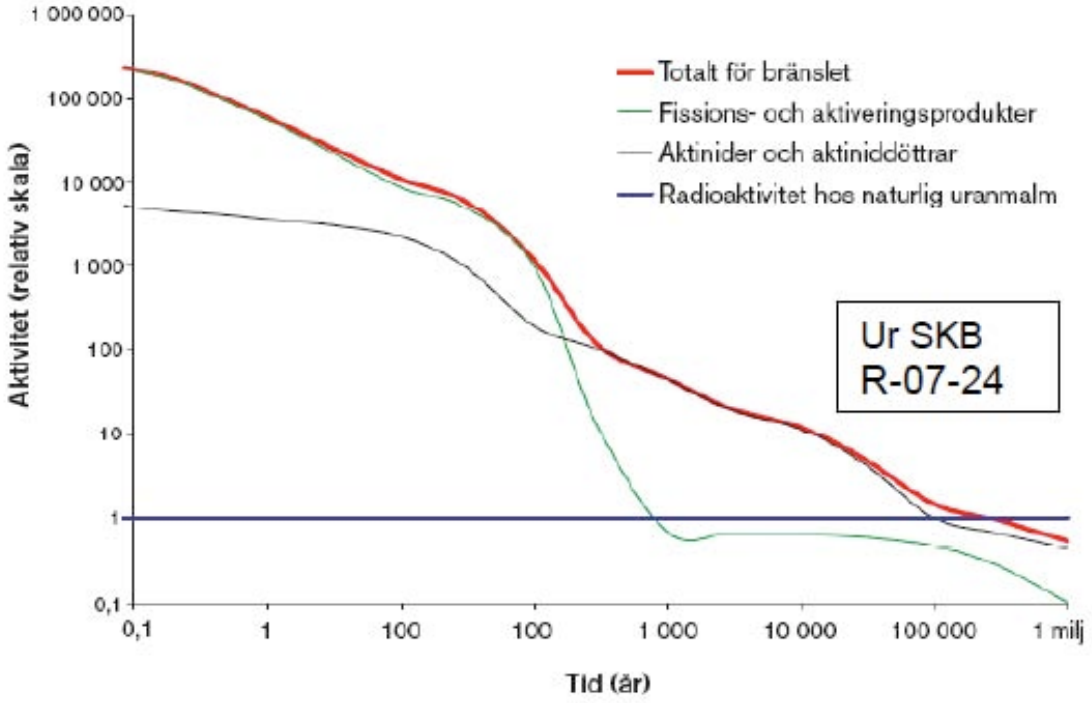
- The half-life of plutonium-239 is 24 000 years. Plutonium remains in the repository even after 100 000 years (≈ 6%).
- Each ton of spent fuel contains about 10 kg of plutonium (≈ 1%)
- One nuclear explosive uses 2-5 kg of plutonium
- A Swedish repository is planned for up to 12 000 tons of spent fuel ≈ 120 tons of plutonium ≈ 24 000-60 000 nuclear explosives





Plutonium in a repository becomes easier to retrieve after the first thousand years

- The “radiation protection” making retrievability and plutonium extraction is much reduced after the first thousand years allowing simplified radiation protection.



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Plutonium in a repository becomes easier to use in weapons with time

- Heat and radiation from the plutonium decreases with time making the construction of a nuclear weapon easier

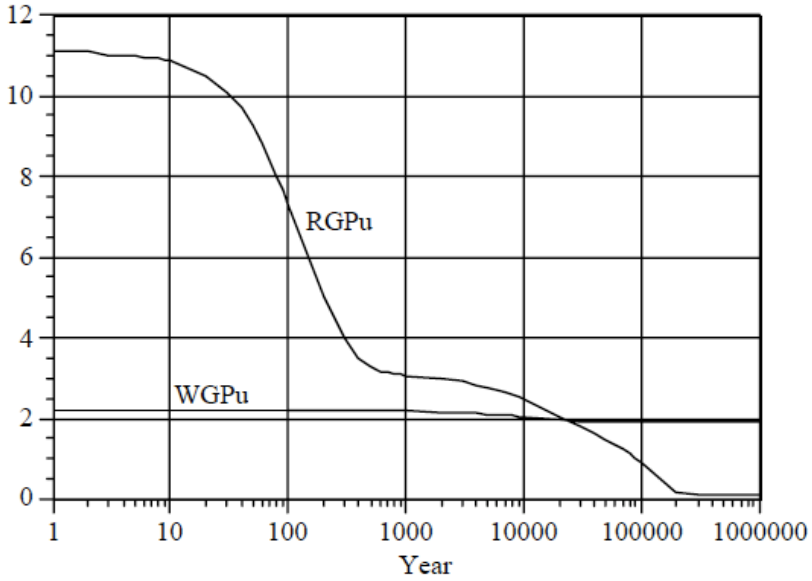


Figure 6.8a. Heat production in plutonium

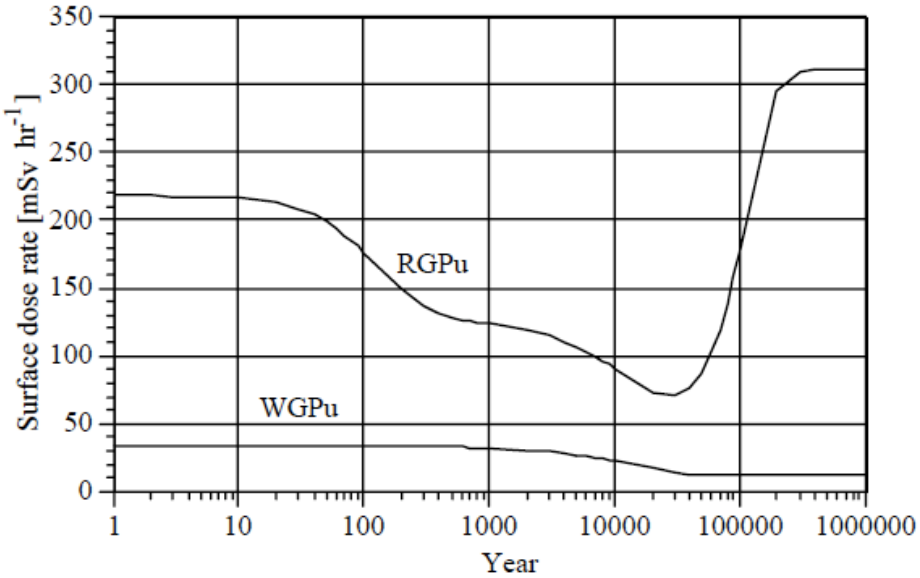


Figure 6.12. Surface dose rates from a 1 kg sphere of plutonium

The spontaneous neutron issue does not change with time

- The spontaneous neutron background in the plutonium does not decrease with time. The same technology criteria for nuclear weapons design due to this issue thus remains.

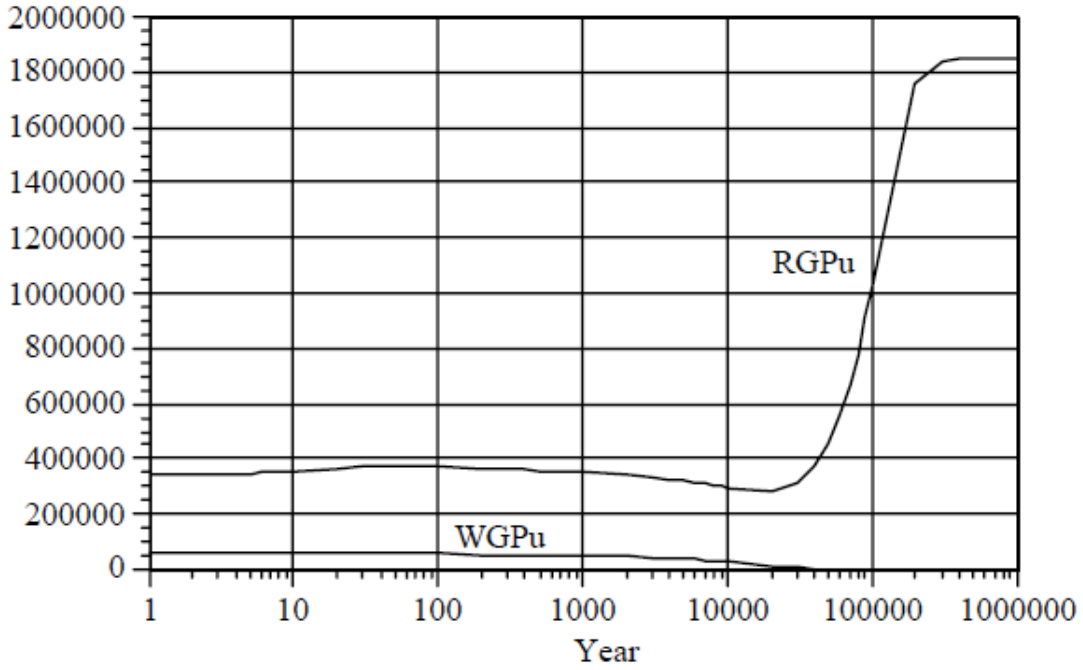
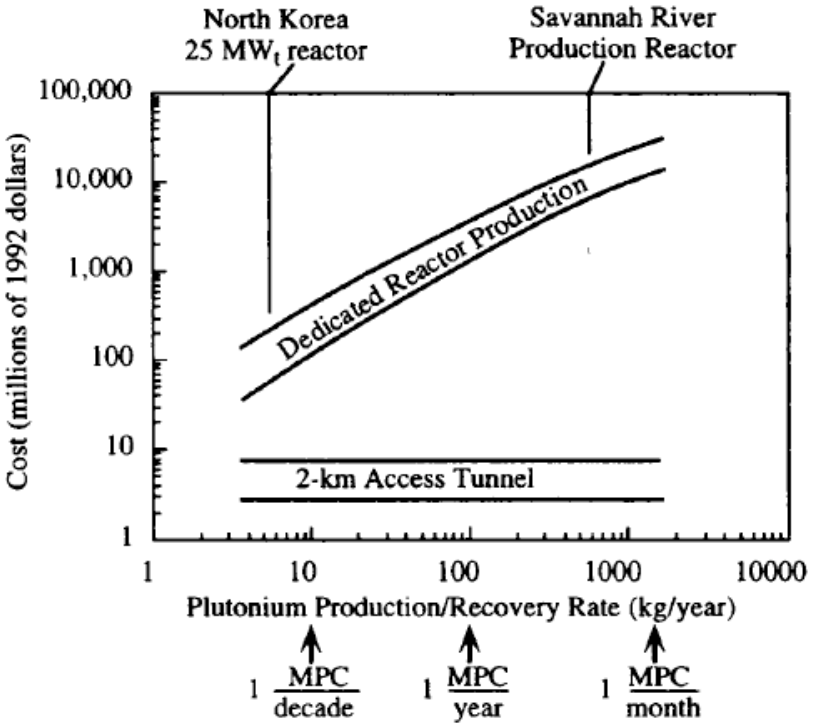


Figure 6.9a. Spontaneous neutron production from spontaneous fission in plutonium

The need for long-term monitoring (safeguards) for mined spent fuel repositories

- The nuclear proliferation risks make long-term monitoring (safeguards) necessary for mined repositories containing spent nuclear fuel (such as the Swedish KBS method). Monitoring has to continued in one form or another for over 100 000 years.



Source: Peterson 1996

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The need for long-term monitoring (safeguards) for mined spent fuel repositories

- The nuclear proliferation risks make long-term monitoring (safeguards) necessary for mined repositories containing spent nuclear fuel (such as the Swedish KBS method) is necessary after closure of the repository.
- The official IAEA stand is that monitoring of closed repositories for spent nuclear fuel has to be continued as long as there is an international system for safeguards (physical protection) in place (SAGOR and ASTOR projects)
- Monitoring has to continued in one form or another for over 100 000 years depending on the societal development on the surface above the closed repository.

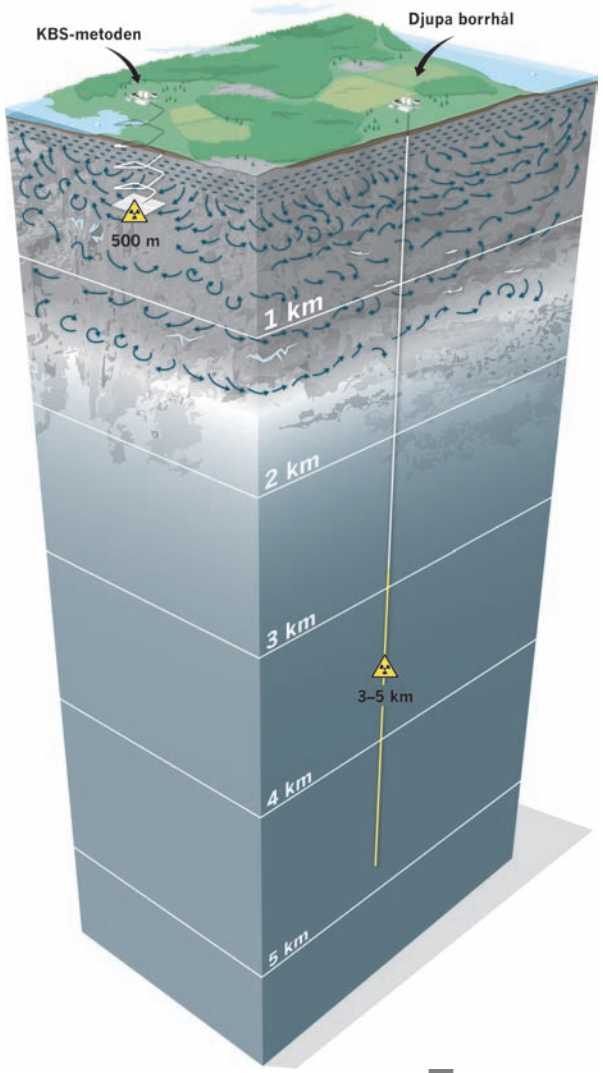
Need for long-term monitoring complicates the desirability of retrievability

- The discussion of the desirability of retrievability almost always ignores the issue of the need for long-term monitoring, as it complicates the issue in a negative way for proponents of mined repository methods.
- Long-term monitoring implies a burden on future generations, something that is undesirable for the sustainability of a waste management solution for spent nuclear fuel.

Alternatives that may avoid long-term monitoring

- Very deep boreholes
- Transmutation using renewable energy in a post-nuclear world
- A combination of the two ?

[If there is a a future long-term nuclear world the plutonium is used as fuel reactors and is not a long-term nuclear proliferation risk. However, such an energy future instead has an inherent nuclear proliferation risk.]



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Summary

- There are long-term nuclear proliferation risks when disposing of spent nuclear fuel in mined repositories.
- Mined repositories for spent nuclear fuel disposal need monitoring for safeguards for an indeterminate future.
- Long-term monitoring needs for mined repositories are problematic for claimed benefits of retrievability.
- There may be nuclear waste management methods that better deal with this issue.

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