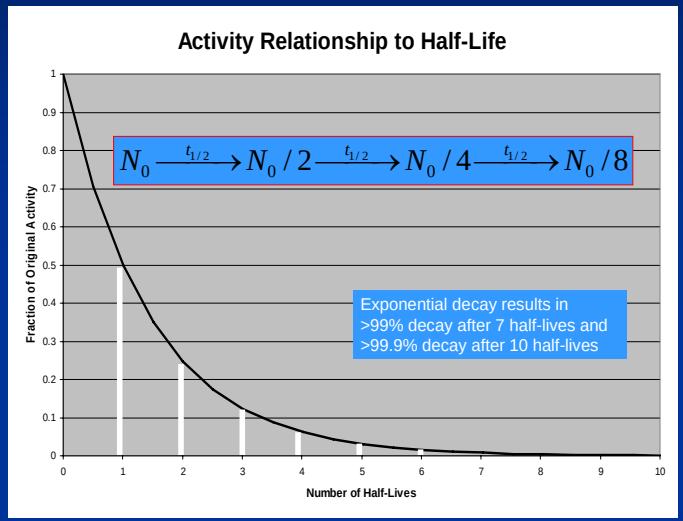
Radioactive Production and Decay of SRE Reactor Gases

Radionuclide Decay and Exposure to Gases and Gas Decay Products

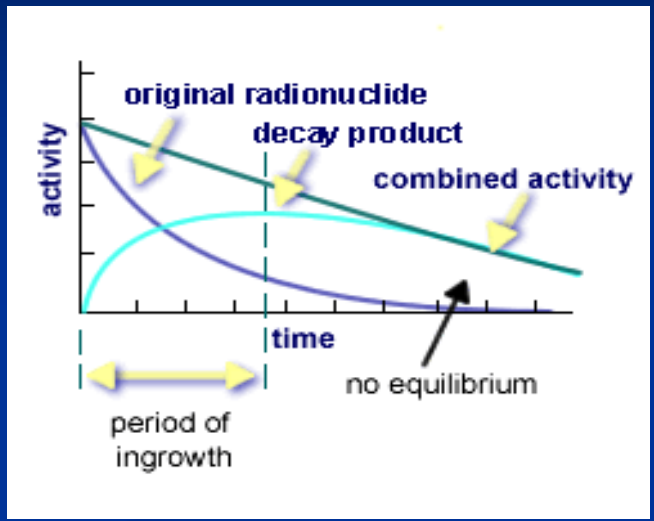
Radionuclide exposure is a function of both released amounts and radioactive decay until the time of exposure.

Some radionuclides decay to other radionuclides but eventually the decay chain ends in a stable (non-radioactive) isotope.

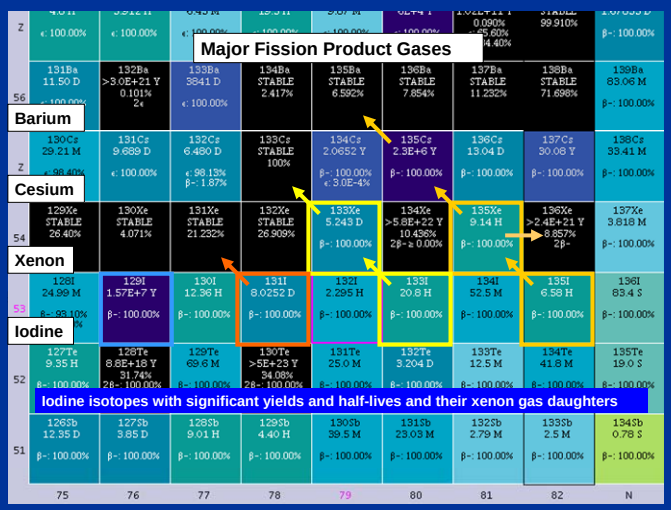
The rate of decay of a radionuclide is a function of its half-life ($T_{½}$).

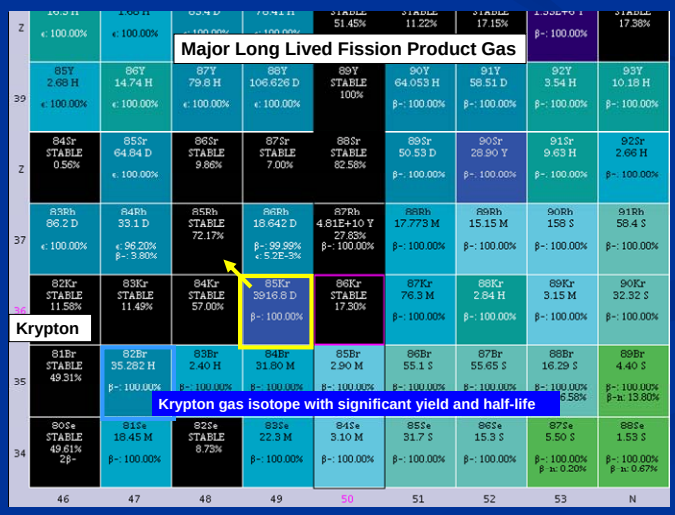


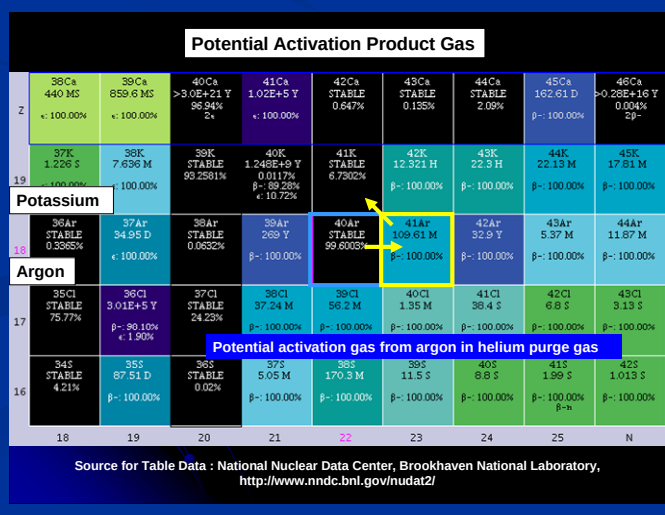
Ingrowth of daughter (D) radionuclides from parent (P) when $T_{½P} < T_{½D}$ and $A_{D0} = 0$



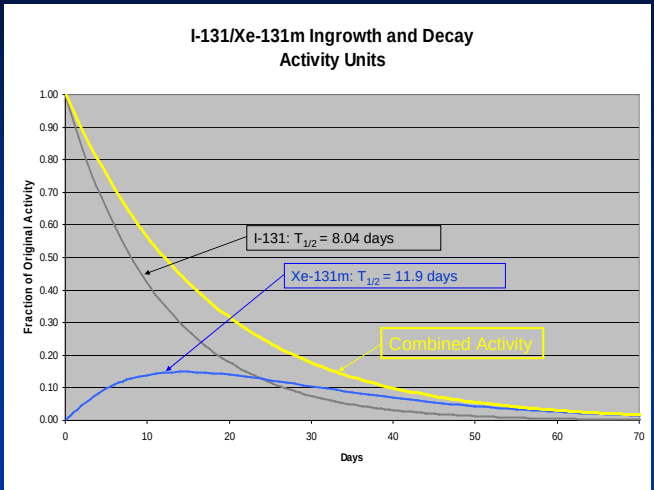
Gases estimated to have been released after the SRE accident were primarily the isotopes of non-reactive noble gases Xenon, Krypton, and Argon identified below.

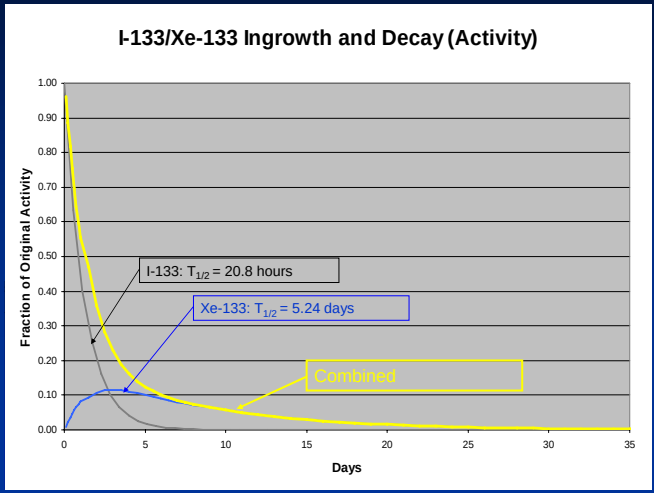


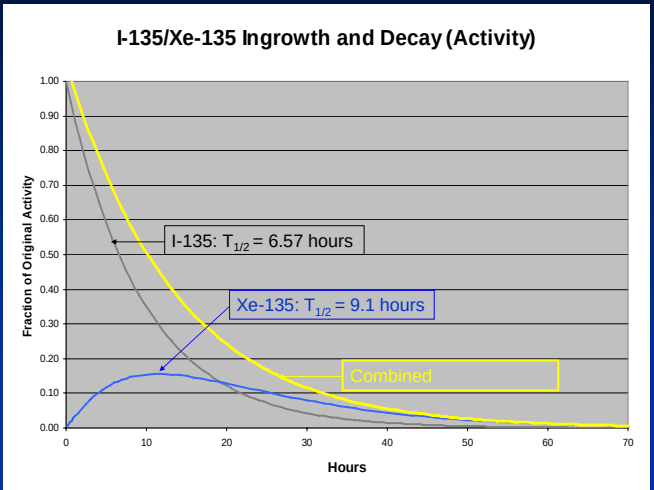


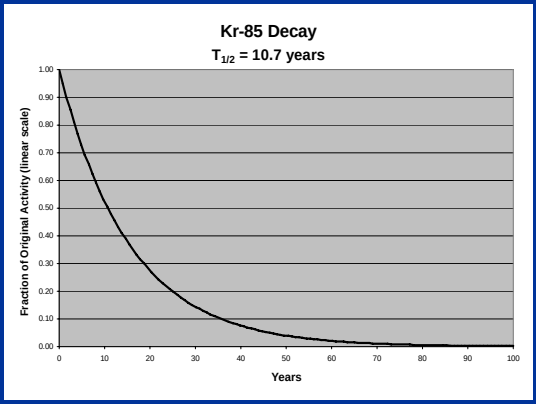


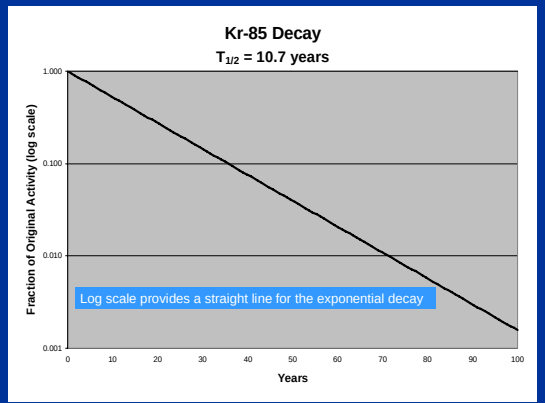
Radioactive Decay of SRE Reactor Inventory and Estimated Releases





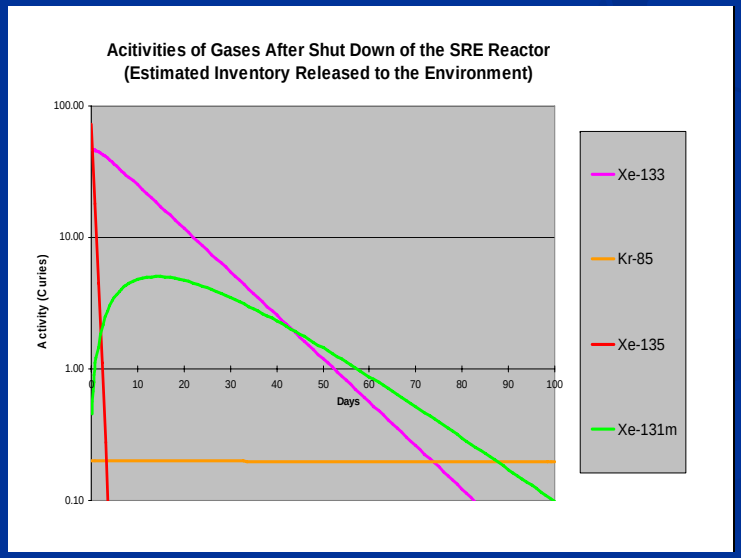


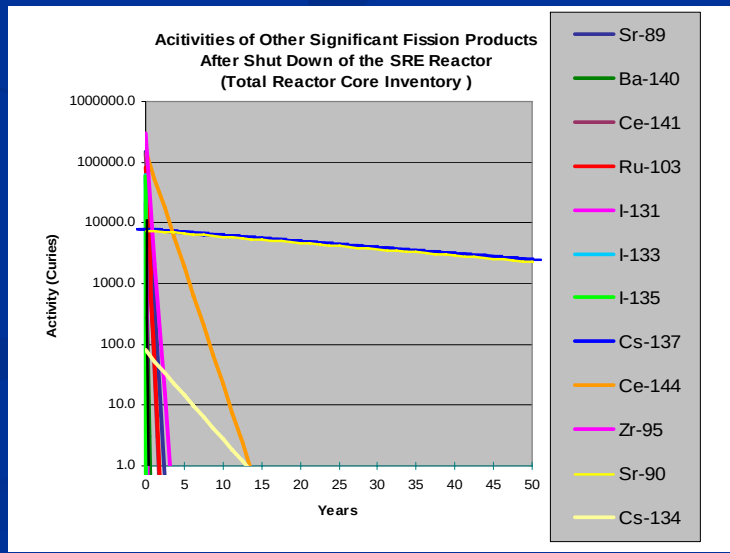




When the exponential decay is plotted on a log scale the plot is linear.

The plots below show the amounts of noble gases estimated to have been released after the SRE accident, the total reactor inventory of other fission products at the time of the accident, and their decay over time.



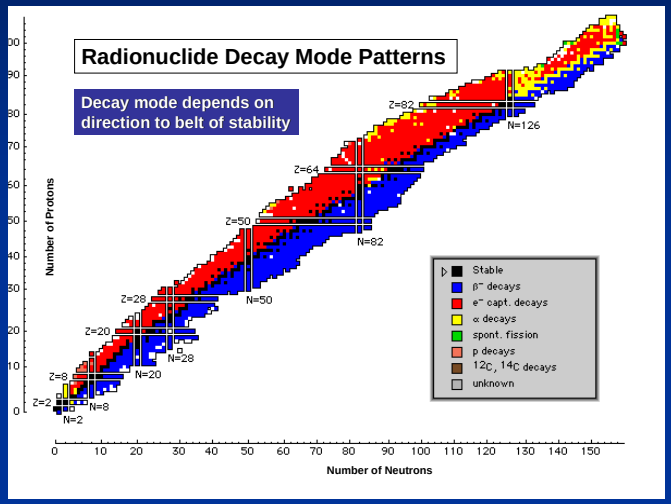


Radioactive Decay and Equilibrium of SRE Reactor Fuels

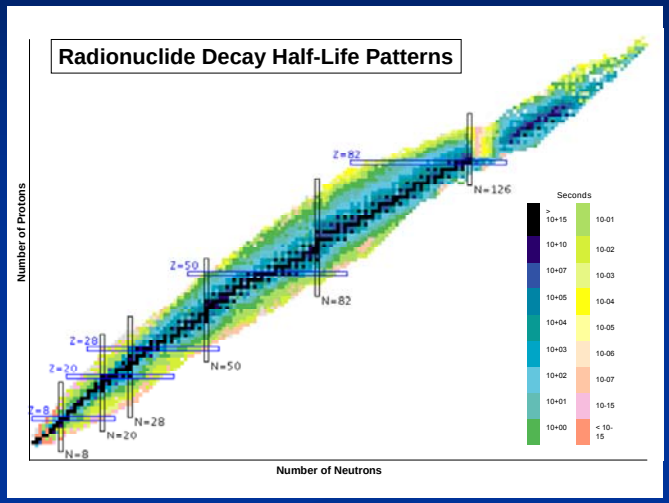
Radioactive Decay

- Due to nuclear instability
- Mode depends on direction to belt of stability. Possible Modes:
  - Alpha decay (α)
  - Beta decay (β-)
  - Positron Decay (β+)
  - Electron capture (EC)
  - Spontaneous Fission

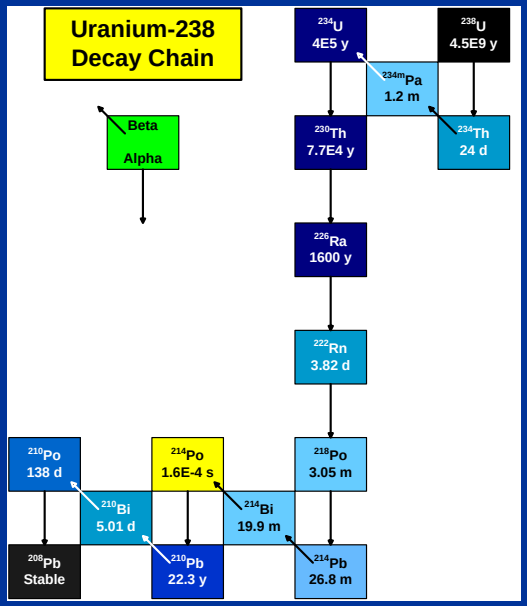
Decay mode depends on direction to belt of stability

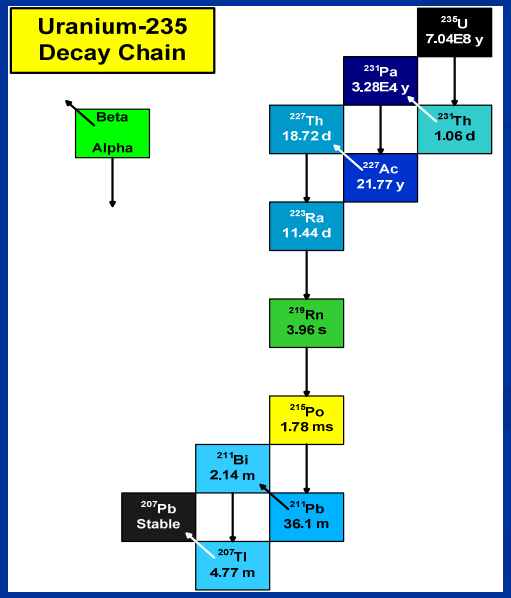


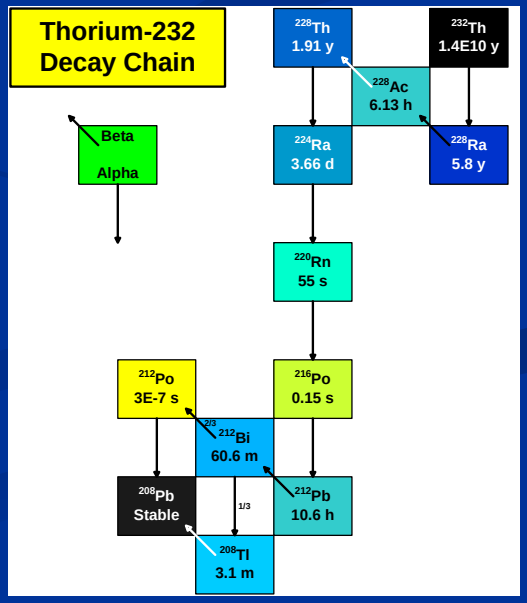
Half-lives are longer as decay moves closer to belt of stability



Decay Chains Associated with SRE Reactor Fuel Elements (Thorium-232 only used in SRE Core II)

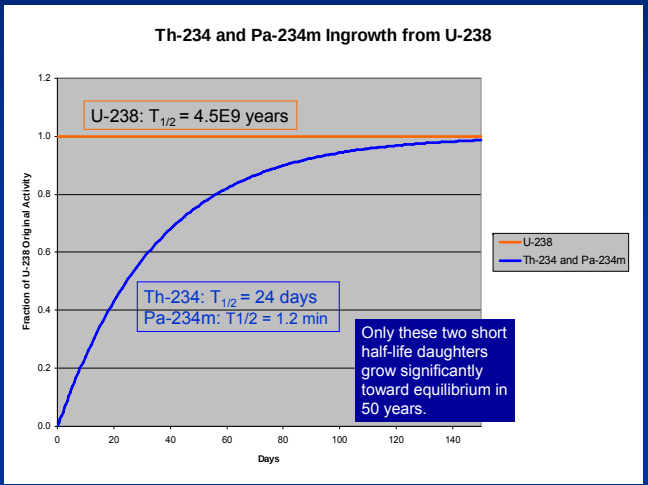




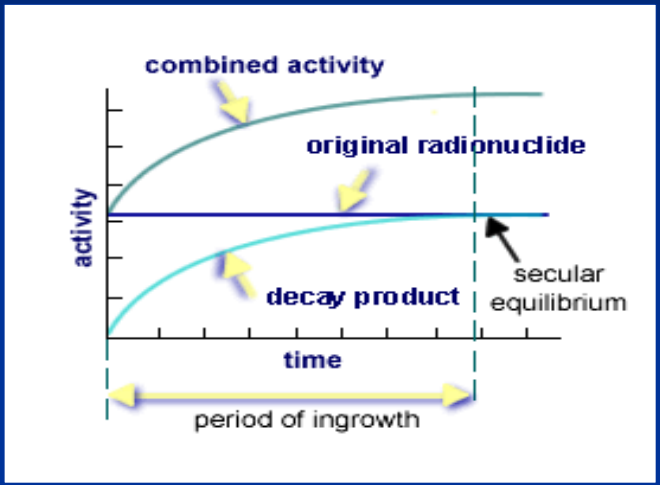


Radioactive Decay and Equilibrium of SRE Reactor Fuels

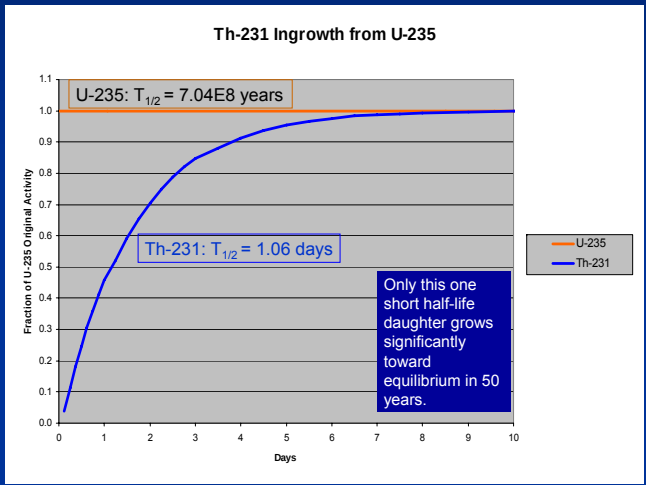
Ingrowth of early decay chain short half-life daughters from U-238



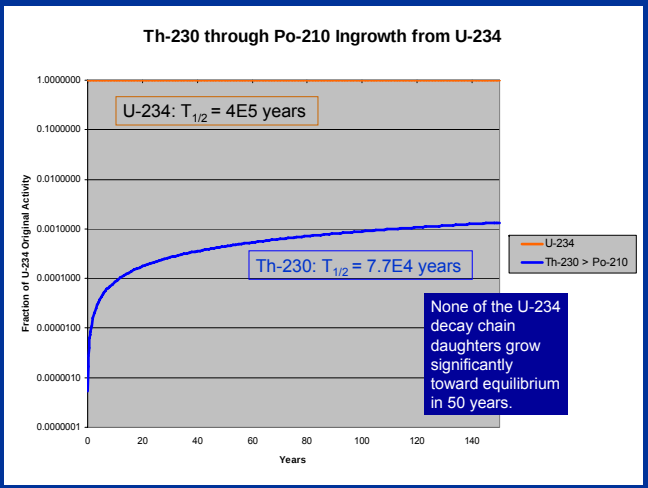
Ingrowth of daughter (D) radionuclides from parent (P) when $T_{½P} >> T_{½D}$ and $A_{D0} = 0$



Ingrowth of early decay chain short half-life daughters from U-235



Ingrowth of long half-life daughters from U-234



The time it takes for the daughter to reach equilibrium with the parent depends on the half-life of the daughter.

Because of the long half-life of intermediate members in the U-238 and U-235 decay chains, equilibrium is only established for early short half-life daughters. All members of the Th-232 decay chain approach early equilibrium.

Ingrowth of decay chain short half-life daughters from Th-232