**Nuclear Power**

**Activity 5: Nuclear Waste Storage Times**

Spent nuclear fuel from U.S. commercial reactors contains primarily of two types of radioactive material: fission products and transuranic elements. The fission products are produced by the splitting of 235U and 239Pu in the reactor. They have atomic masses around 95 and 137. Except for seven isotopes, these nuclides have half-lives less than 100 years. The long-lived fission products have half-lives between 211,000 years and 15.7 million years. The long-lived isotopes of the spent fuel consist of the actinides, including isotopes of uranium, plutonium and the transuranic elements. These isotopes have much longer half-lives.

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| **medium-lived**  **fission products** | |  | **long-lived**  **fission products** | |  | **actinides** | |
| 155Eu | 4.76 y |  | 99Tc | 211,000 y |  | 229Th | 7,340 y |
| 85Kr | 10.76 y |  | 126Sn | 230,000 y |  | 230Th | 75,380 y |
| 133mCd | 14.1 y |  | 79Se | 295,000 y |  | 232Th | 14.05x109 y |
| 90Sr | 28.9 y |  | 93Zr | 1,530,000 y |  | 233U | 159,200 y |
| 137Cs | 30.23 y |  | 135Cs | 2,300,000 y |  | 235U | 704x106 y |
| 121mSn | 43.9 y |  | 107Pd | 6,500,000 y |  | 236U | 2.35x107 y |
| 151Sm | 90 y |  | 129I | 15,700,000 y |  | 238U | 4.47x109 y |
|  |  |  |  |  |  | 239Pu | 24,000 y |
|  |  |  |  |  |  | 240Pu | 6,563 y |
|  |  |  |  |  |  | 247Cm | 1.56x107 y |
|  |  |  |  |  |  | 261Cf | 900 y |

Decay of a radioactive isotope is described by:



where N is the number of radioactive isotopes remaining, N0 the number of radioactive isotopes originally present, λ the decay constant and t the time since the system started. The decay constant is related to the half-life by the following expression:



1. Using this information, determine the optimum storage time for the different classes of waste.
2. How might this information be used to determine national nuclear policy?