Letter to the Editor

Fissible: A Proposed New Term in Nuclear Engineering

We believe a new word is needed in the nuclear engineering vocabulary. We hereby define the term "fissible" and provide justification for its use.

The need arises in the void between the words "fissile" and "fissionable." Fissile is a precise word describing nuclei that can be made to support a thermal neutron chain reaction. Reference 1 provides the following definition:

> **fissile nuclide:** A *nuclide* capable of undergoing *fission* by interaction with *slow neutrons*, provided the effective neutron production cross section, $\overline{\nu\sigma f}$, exceeds the effective absorption cross section $\overline{\sigma_a}$.

The term "fissionable" is sometimes used to refer to nuclides in a general sense, although some of them can support a self-sustaining chain reaction and some cannot, which leads to confusion.

A number of reports have been published providing critical mass data for special actinide elements that lack the properties of a fissile nuclide by definition but nonetheless are capable of supporting a fast-neutron chain reaction.[2-6] In addition, Ref. 6 provides subcritical control limits for several actinide elements that fail to meet the definition of a fissile nuclide. These are simply referred to in Ref. 6 as nonfissile nuclides. We therefore propose the term "fissible," as defined below, to describe the nonfissile nuclides capable of supporting a fast-neutron chain reaction.

Proposed New Definition:

> **fissible nuclide:** A nuclide that cannot support a slow-neutron chain reaction but is only capable of a fast-neutron chain reaction, provided that the effective fast-neutron production cross section $\overline{\nu\sigma f}$ exceeds the "effective" fast-neutron removal cross section.

Many of the synthetic actinides have the above-described property. It would simplify matters in criticality control and safeguards studies to have a single term that can be used to refer unambiguously to these special nuclides.

The following examples of each category of nuclei may serve to further illustrate the cases and the need:

1. Fissile: ^{235}U is a classic example; it has a finite fast-critical mass and an even smaller critical mass at thermal neutron energies.

2. Fissible: ^{240}Pu is a fission threshold isotope, having little or no fission cross section below the threshold at ~200 keV. Although it is criticality safe at thermal energies, it has a finite metal critical mass of only ~19 kg in a steel reflected spherical assembly.[4]

3. Fissionable: ^{238}U is a good example of a fissionable isotope. It fissions at energies above ~1 MeV but is incapable of a self-sustaining chain reaction at any mass under any conditions of reflection.

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