Fission in MF10 (Arjan Koning and Andrej Trkov, IAEA)

Background

In nuclear physics, and in the ENDF-6 format, fission is often associated with the combination of 1/ incident neutrons, 2/ actinide targets. If both these conditions are satisfied, then the LFI flag at the top of an ENDF-6 file is set to 1. This has many consequences, such as:

The fission cross section is expected to be present in MF3/MT18

Fission resonance widths are expected in MF2/MT151

Nubar and other fission quantities are expected in MF1/MT452-458

A PFNS is expected in MF5/MT18

+ covariances for all this in MF31-35.

In other words, one sets LFI=1 if one really deals with a neutron reaction on an actinide. For example, the TENDL library considers a material an 'actinide' if A >= 215, which is a safe point between the obvious non-actinide Bi-209 and the first important actinide Th-232.

However, there are other examples of fission, such as sub-actinide fission. It is estimated that neutron-induced fission of Bi-209 at an incident energy of 200 MeV may have a cross section of about 150 mb, yet we obviously do not want to declare Bi-209 as fissile or fissionable, in the ENDF-6 sense. If we take 200 MeV as the maximum energy of a conventional ENDF-6 file, then we can state that ENDF-6 files are (more) complete if for the material range between W and Bi the cross section is stored somewhere, since the cross section is non-negligible.

For incident photons and charged-particles there is, in the ENDF-6 sense, no distinction between sub-actinides and actinides. We obviously never want to, or can not, give the information listed above, like nubar etc. that is required for neutron-actinide fission.

For these reasons, it is recommended to store all fission cross sections which are NOT for neutron-induced reactions on an actinide, in MF10.

Below are the proposed changes for the ENDF-6 manual.

ENDF-6 manual updates

10.2 Formats

IZAP 1000 x Z + A for the product nucleus, or -1 for fission

10.3 Procedures

Sub-actinide and non-neutron induced fission

Fission cross sections can be given in File 10, MT18, if the projectile is not a neutron or if the target is not an actinide. This avoids specifying all mandatory information in an ENDF-6 file, like fission resonance widths, average number of fission neutrons, prompt fission neutron spectrum, etc. when LFI=1, which is used in the normal case of a neutron and an actinide.

In this case, File 3, MT18 should not be used.

For MF10, MT 18, one must set IZAP = -1 and NS =1. Also the corresponding data in File 8 must be set.

40.6 Sub-actinide and non-neutron induced fission

Covariance data for sub-actinide and non-neutron induced fission can be given analogously to the other reaction channels in File 40.