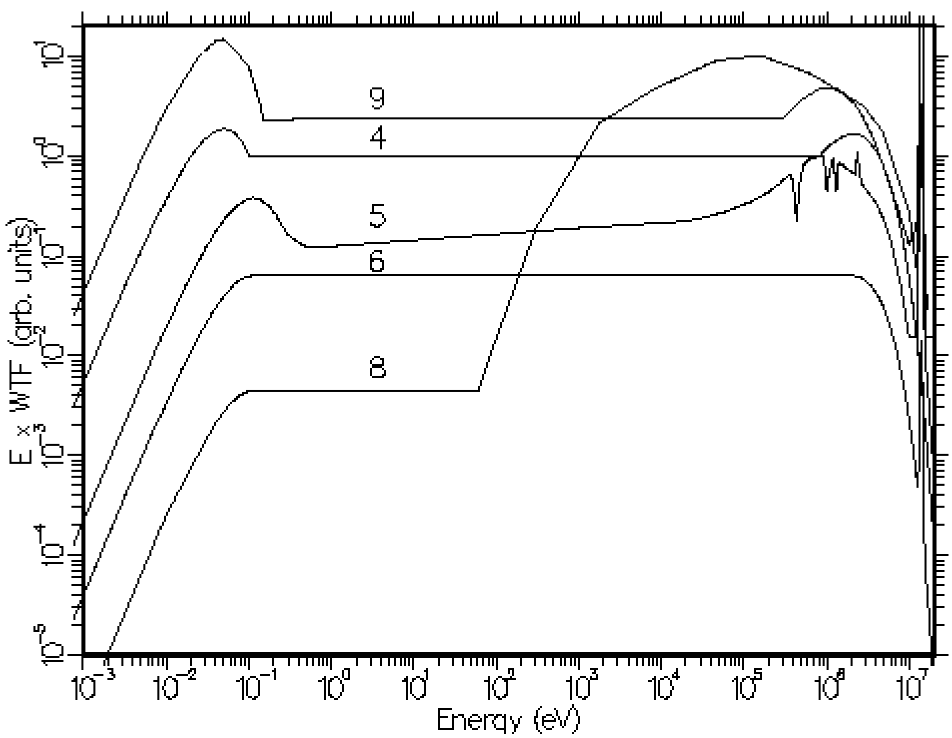
GROUPR:
Weighting Function

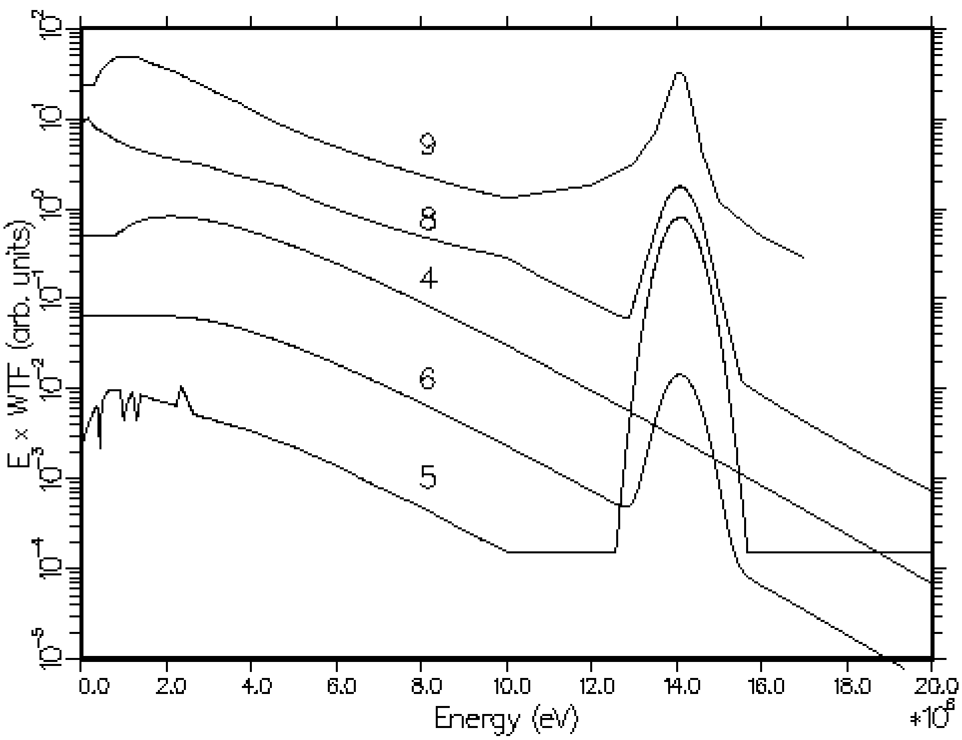
"Wait a minute," you ask, "the purpose of solving the transport equation is to get the flux, but I have to know the flux to compute the multigroup constants!" This conundrum is the source of much of the "art" in using multigroup methods. If you can make a good guess for the shape of the flux (mostly the *intragroup* flux) for the class of problems of interest, you can do very good multigroup calculations with only a few groups. If the flux can change shape between different problems or between different regions of one problem, then you have to use a large number of groups together with some default shape (such as flat weighting). The presence of resonance absorbers in a problem results in complex shapes for the weighting function, which leads to the effects called "self shielding."

As a first example, consider a typical water-moderated critical assembly, such as a power reactor. Neutrons are born at high energies (about 2 MeV) with a characteristic fission spectrum, many of them slow down by collisions with hydrogen nuclei in the water, resulting in a *1/E* shape, and they finally come into equilibrium when they reach thermal energies, resulting in a Maxwellian shape appropriate to the temperature of the system. As shown in the following figure, GROUPR contains several builtin weighting functions that show this combination of shapes:



The curves are plotted as log-log "weight per unit lethargy" or *E*W(E)*, which makes the central *1/E* part of the curve flat. The parameters used to generate the curve for IWT=4 were a thermal temperature of .0253 eV joined to *1/E* at 0.1 eV, and a fission temperature of 1.40 MeV joined to *1/E* at 820.3 keV. Curve #8 is for a fast reactor or fusion blanket.

As a second example, consider a fusion system. The neutrons born in d-T reactions appear as a sharp peak centered near 14 MeV. They then scatter down to lower energies by elastic and inelastic processes, producing a shape in the 1 MeV range very similar to the fission spectrum. If there are few light isotopes around, few neutrons get to thermal energies, and a shape like #8 results. The high-energy shapes of some of GROUPR's built-in weighting functions are shown below:



Here is a brief summary of the built-in weighting functions:

- IWT=2, constant. Used for very fine group structures like the 640-group dosimetry structure.
- IWT=3, 1/*E*. Used for calculating resonance integrals.
- IWT=4, analytic thermal + 1/*E* + fission. Allows the user to adjust the relative amounts of thermal and fission flux.
- IWT=5, mid-life PWR flux spectrum with a fusion peak added. Includes some peaks and dips from oxygen, and some hardening of the 1/*E* shape. Used for EPRI data and for the LANL libraries using the WIMS structure.
- IWT=6, similar to 4, but the breakpoints were chosen to make the curve continuous and a fusion peak was added.
- IWT=7, reserved.
- IWT=8, fast reactor weighting function. It has a fusion peak and an intermediate shape typical of a fast reactor or fusion blanket. A thermal part is provided at low energies for outer regions of systems.

- IWT=9, CLAW weighting function. A typical thermal + 1/*E* + fission + fusion shape used for many years at Los Alamos.
- IWT=10, same at IWT=9, except the thermal part is automatically recalculated to follow a Maxwellian law for the actual temperature.
- IWT=11, VITAMIN-E weighting function. Another thermal + 1/*E* + fission + fusion shape.

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