2.3.4 Delayed neutrons and emissions

Another important feature of nuclear fission is that although almost all of the neutrons are produced essentially instantaneously, a small fraction (about 0.7%) are delayed and emerge up to about 80 *sec* after the fission event. Most of these *delayed neutrons* occur because some fission products, known as *delayed-neutron precursors*, produced by the event undergo radioactive decay and, in one or more stages of that decay, emit a neutron. One of the most common of these post-fission decays occurs when the fission product ^{87}Br decays, though there are many fission products each having several stages of decay so that delay times may range from 0.6 to 80 *sec*. However, for the purposes of modeling simplification these precursors are usually divided into a small number of groups (often 6) with similar properties.

These delayed neutrons play a crucial role in the control of a nuclear reactor. As will be described later in sections 3.9 and 4.3.6, a nuclear reactor would be very difficult to control without these delayed neutrons since a slight excess in the neutron population would grow exponentially in a matter of milliseconds (in a thermal reactor). Because of the delay times mentioned above, the delayed neutrons increase this response time by several orders of magnitude and make reactor control quite manageable as described in section 4.3.6.