4.3.4 Fuel and Control Rods for LWRs

The uranium dioxide fuel in a PWR or BWR is formed into cylindrical pellets that are packed into zircaloy tubes about 3.5 m in length known as fuel rods (figure 1).

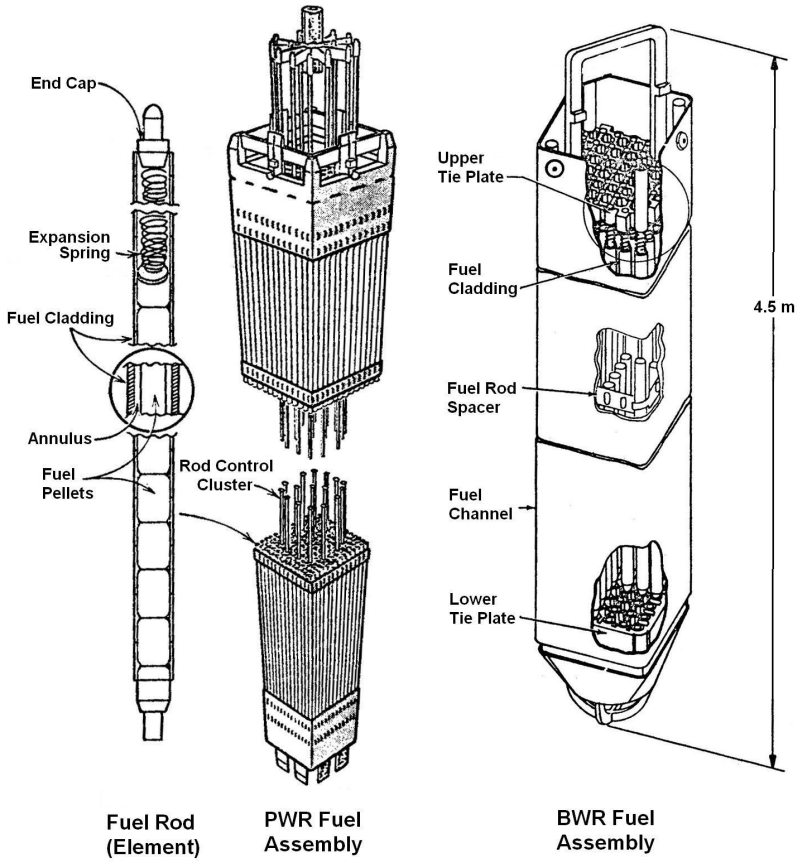

Figure 1: Fuel element and PWR fuel assembly (from Duderstadt and Hamilton 1976) and BWR fuel assembly (from USAEC 1973).

The walls of the fuel tubes are known as *cladding*. In a typical PWR the pellets are 0.97 cm in diameter and the fuel rods have an outside diameter of 1.07 cm; in a typical BWR the corresponding diameters are 1.24 cm and 1.43 cm respectively. Typically the core contains $55,000$ and $47,000$ fuel rods respectively in a PWR and BWR. As will be seen in section 5.3 these dimensions imply cylindrical reactor core dimensions (height and diameter) of about 3.6 m and 4.4 m respectively.

The fuel rods are arranged in *fuel assemblies* or *fuel bundles* as shown in

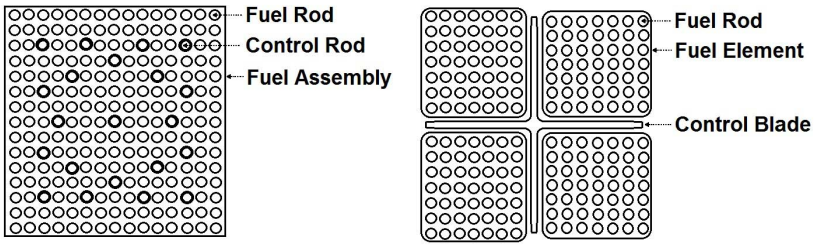

Figure 2: Cross-sections of PWR (left) and BWR (right) fuel assemblies.

figure 1. In a PWR the typical arrangement in a fuel assembly consists of a square cross-sectioned cell (figure 2, left) containing about 200 equally spaced fuel rods interspersed with about 20 circular control rod channels; the coolant in the cell flows in the spaces between these elements. There are about 200 of these assemblies arranged, lattice-like in a PWR core. A BWR core also consists of cells (figure 2, right) each containing about 64 fuel rods arranged in a square channel through which the coolant flows. Four of these cells are grouped together with the rectilinear space between them containing the cruciform-shaped control blade. There are about 180 such groups of four assemblies in a BWR core.

Thus the fuel rods, control rods, moderator, coolant channels, etc. in a reactor are usually arranged in *lattice cells* that are repeated across the cross-section of the core. Consequently there are several structural or material scales within the core and these various scales of inhomogeneity become important in some of the more detailed calculations of the neutron flux within the reactor (see section 3.6.7).