4.3.3 Boiling water reactors (BWRs)

The concept behind the boiling water reactor (in 2013 there were about 84 of these in commercial operation worldwide) is to avoid the high pressures of PWRs (and thus the associated dangers) by allowing the primary coolant water to boil as it progresses through the reactor core as shown in the schematic of a typical BWR in figure 1.

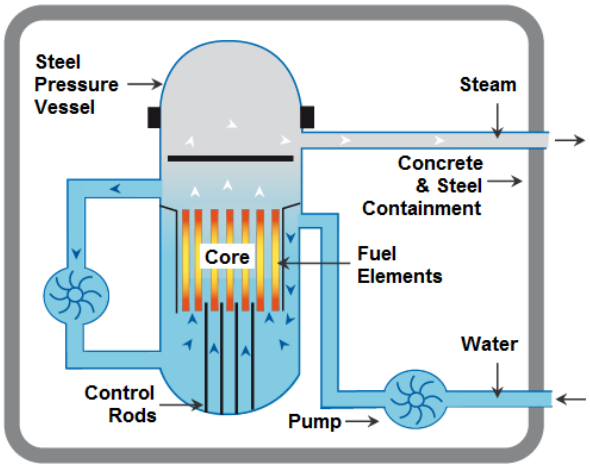

Figure 1: Schematic of a typical BWR. Adapted from WNA (2015b).

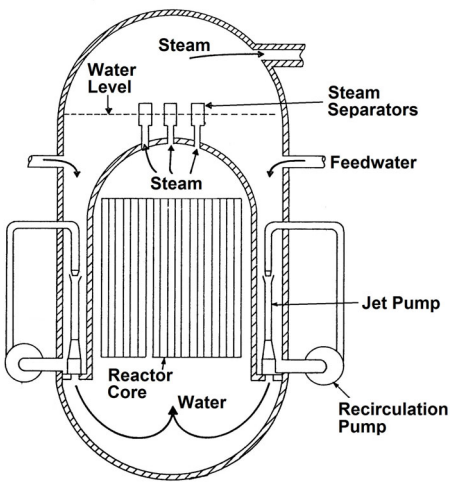

Figure 2: Schematic of the BWR coolant and steam supply systems. Adapted from USAEC (1973).

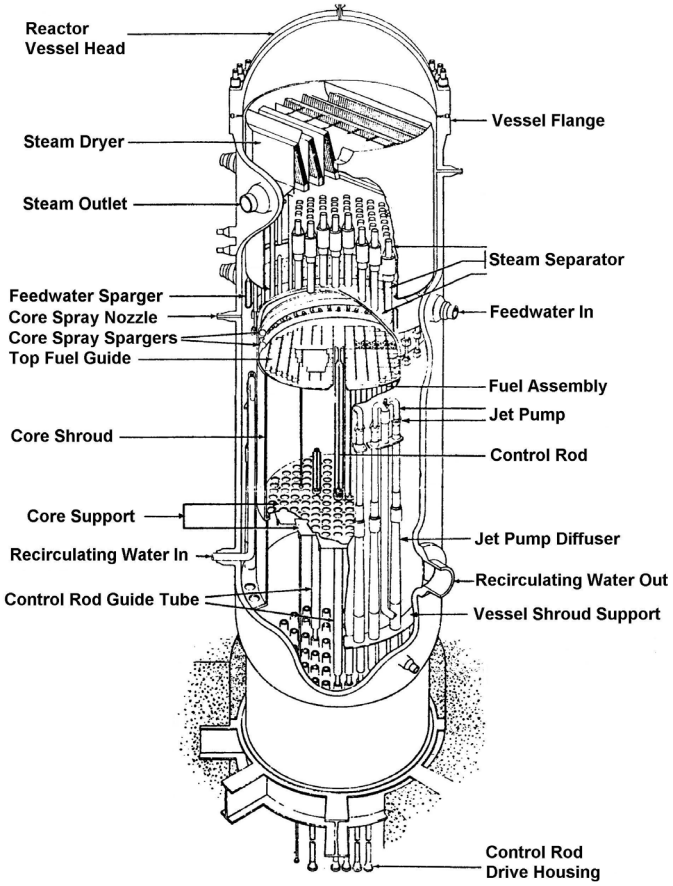

Figure 3: Typical BWR reactor vessel. Adapted from USAEC (1973).

As depicted in figure 2 the steam thus generated is fed directly to the turbines, thus eliminating the secondary coolant loop. Details of the reactor core of a BWR are shown in figure 3. By avoiding the high primary coolant loop pressures, this design reduces the need for the kind of large and costly containment structure deployed around a PWR since a rupture in the primary coolant loop would not lead to such a high build up of pressure inside that secondary containment. Instead General Electric who designed and built the BWRs devised a secondary containment structure that, in the event of a primary coolant loop rupture, would direct the steam down through pipes into a large body of water (known as a suppression pool) where it would be condensed. This would minimize the build up of steam pressure within the secondary containment. The first (or Mark I) suppression pool was toroidal in shape as shown in figure 4.

Later several other pressure suppression configurations were produced. Further comment on the issues associated with primary coolant loop rupture in a

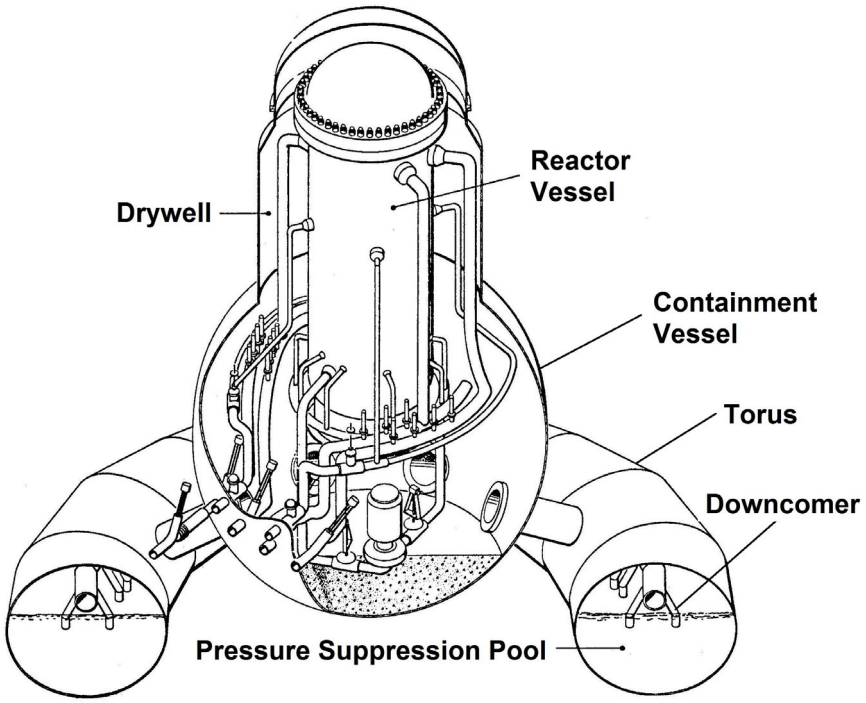

Figure 4: Schematic of the BWR (Mark I) primary containment and pressure suppression systems. Adapted from USAEC (1973).

BWR are delayed until later (section 7.4).

The elimination of the secondary or intermediate coolant loops is advantageous for the thermal efficiency of the unit but it also means increased build-up of radioactivity in the turbines. Other features of the BWR include the effect of the steam/water mixture on the moderator role played by the coolant (see section 7.4 on reactor control).