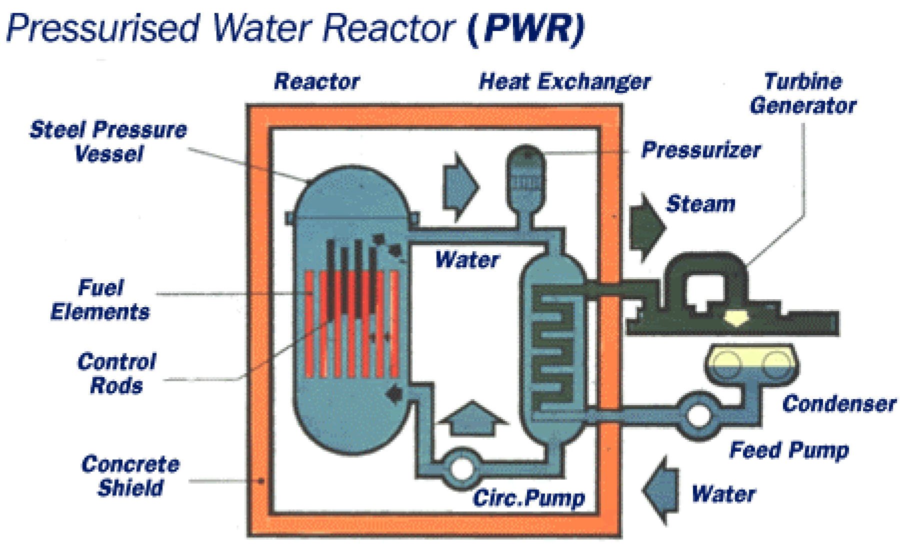
How a PWR power station works

Nuclear Power

Coal, oil and nuclear power stations produce electricity in basically the same way - they use fuel to raise steam to turn a turbine to generate an electric current. In a Pressurised Water Reactor heat from the reactor is transferred to steam generators by a circulating fluid - in this case water, under high pressure. This water not only cools the fuel, but also acts as a moderator to slow down the neutrons released in fission so that they more readily promote further fissions. The action produces steam which powers the turbines which, in turn, generate electricity.



The Reactor

At the heart of the process is a single reactor where the uranium containing fuel is held inside a pressure vessel containing circulating pressurised water. This water has two vital roles to play. First it act as a moderator by slowing down the fast neutrons produced in fission to a speed at which they will split the uranium atoms, to start off - and maintain - a chain reaction and so create heat. Second, it acts as a coolant transferring the heat produced by the fission reactions to the boilers. The core of the reactor contains vertical fuel assemblies and neutron absorbing control rods which can be moved in and out of the core to alter the power levels. The control rods are made from silver-indium-cadmium alloy.

The control rods are normally raised or lowered using electromagnets. In the event of a power failure or the need to shut the reactor down quickly, the supply to the electro-magnets is cut off and the rods drop automatically into the core by gravity, stopping the chain reaction in less than 5 seconds.

The Reactor Pressure Vessel and Primary Pressure Circuit

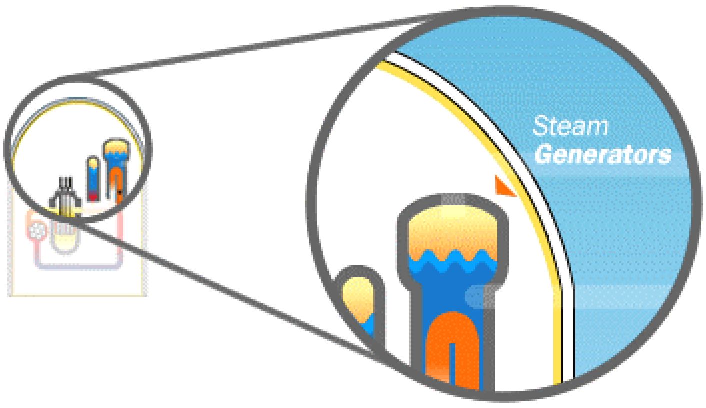
The reactor core, the control rods and the pressurised water are contained in a massive steel reactor pressure vessel over 20cm thick. This pressure vessel is connected by pipes to steam generators, pumps which circulate the water and a pressuriser which controls its pressure. These components form the sealed primary pressure circuit, arranged in loops.

The pressuriser is a vertical tank, partly filled with water, and heated to a temperature above that of the water in the rest of the pressure circuit. This keeps the pressure of the water sufficiently high to ensure that it stays liquid as it flows around the primary circuit. The whole of the primary pressure circuit is located inside a high reactor building or containment made of pre-stressed concrete, lined with steel. This is a major barrier against radiation or the release of radioactivity.

The Steam Generators and the Secondary Circuit

The heat produced in the fuel is carried from the reactor by the primary coolant water and taken to the steam generators which are heat exchangers that work like giant kettles. The hot primary water under high pressure is pumped through the steam generators - each consisting of a large bundle of metal tubes* surrounded by water in a separate secondary circuit. This water is at a lower pressure than in the primary circuit - low enough to allow it to boil and produce steam.

* (Like the electric element in the bottom of a kettle)



Steam from the boiling water is used to drive the two turbines, each of which is mechanically connected to an electrical generator. In the generators, electricity is produced in copper coils, known as stators, by the action of the spinning electromagnet, or rotor.

The Condenser and Third Circuit

The third and final water system is sea water drawn in through a concrete tunnel off shore. The water is passed through drumscreen filters to remove any debris. The sea water is then pumped by the cooling water pump into the condenser where it is used to condense the steam. The now condensed steam (water) can then be returned to the steam generators for re-use.
After the cooling work is finished, the water - its temperature raised by a few degrees Celsius - is returned to the sea.

Refuelling

About every 18 months, approximately one third of the fuel is replaced. To do this the reactor is shut down and depressurised, the reactor vessel head is removed and, one at a time, all fuel assemblies are removed from the core and placed into a crating system in the cooling ponds. A third of the assemblies are removed, the remaining fuel is shuffled, and the new fuel added.

Cooling Ponds

The used fuel assemblies can remain in the storage ponds for as long as necessary. Eventually they will be transported away from the power station for reprocessing or disposal. Storage under water is a safe, efficient and convenient way of cooling the fuel while radiation decays away.