

## 8.8 Safety aspects

Fuel rods containing uranium oxide are used as a source of fissionable material in nuclear power stations. The fuel must contain around 3-5% of its uranium as uranium-235. Once the fuel rod has been in the reactor core for some time, the percentage of fissionable uranium-235 will become depleted and the rod will need to be replaced.



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Although uranium is naturally radioactive, the activity of the fuel is relatively low prior to it being placed in the reactor. Uranium also decays by emitting alpha particles which are absorbed by the fuel cans that the fuel is packed in. However, the fission products of the reaction are extremely radioactive and produce alpha, beta and gamma radiation. This means that the 'spent' fuel rods need to be handled with extreme care to avoid exposure of workers and to avoid release of radioactive materials into the environment.

(1) *The reactor vessel is composed of thick steel. What radiation will this prevent from escaping?*

(2) *In a pressurised water reactor (PWR), what is the other benefit of using thick steel for the reactor vessel?*

(3) *The reactor vessel is surrounded by steel reinforced, thick concrete walls. What radiation is this designed to stop escaping?*

(4) *The reactor core has an emergency shut-down system which releases the control rods. How does this stop the reactor?*

### Radioactive waste

Radioactive waste is categorised into *high*, *intermediate* and *low* level. *High level radioactive waste* includes the material from spent fuel. It can remain highly radioactive for hundreds of years.

(5) *Spent fuel rods are stored, for some time after they are removed from the reactor, in water ponds. What two functions does this serve?*

In some countries, the spent fuel is 'reprocessed' to extract unused uranium and plutonium. The uranium can then be used in the nuclear reactor.

(6)  *What can the plutonium be used for?*

The long-term solution to disposing of high-level waste is to bury it underground in stable rock formations. The material is often vitrified by mixing it with molten glass prior to burying, to make sure that the radioactive material will not leach out into underground aquifers.

*Intermediate level radioactive waste* consists of materials with low activity and may include casings from reactor components, and chemicals used in reprocessing. Intermediate waste is usually packed in concrete inside steel drums and stored in special waste storage buildings.

*Low level radioactive waste* consists of materials with very low activity, such as laboratory equipment and protective clothing. It can be buried in metal drums in landfill sites.

(7)  *What are the benefits of nuclear power generation over generating energy from i) fossil fuels, ii) solar and wind?*

(8)  *Nuclear power is considered to be very expensive, in the long term. Why do you think this is?*