Spent Fuel Storage at Sizewell

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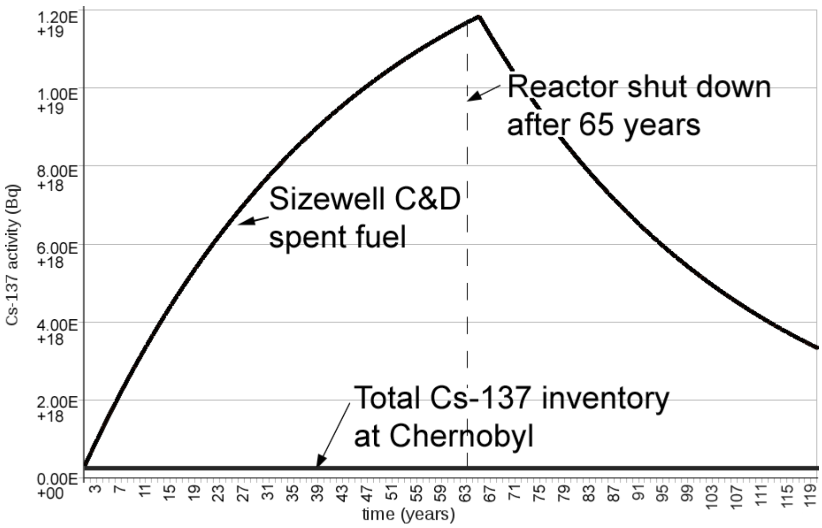
Over a period of 3-4 years the fuel from a nuclear reactor is taken out and placed in spent fuel ponds. Therefore after this period there is more spent fuel in the fuel ponds than in the reactor core. Fuel from Sizewell A is sent for processing at Sellafield, but the fuel from Sizewell B and the proposed Sizewell C&D will be kept on-site at Sizewell until at least 2130[1].

About Spent Fuel

'Burning' the fuel in the reactor results in it becoming over a million times more radioactive than fresh fuel. It is so radioactive that standing next to spent fuel will cause death in minutes. The radioactive decay of the spent fuel also produces a large amount of heat. If the fuel is not effectively cooled it can heat up to a point where the fuel rods can catch fire.

Spent fuel still contains a significant amount of fissile material including plutonium-239 and uranium-235. It is therefore possible for 'renewed criticality' – i.e. the fission process restarts after the fuel has been removed from the reactor. This produces large amounts of heat. To counteract this, special care has to be taken when storing fuel. It has to be stored with adequate space around it, and neutron absorbers must be placed around the spent fuel. Since these fissile isotopes have long half lives the possibility of 'renewed criticality' does not decrease significantly while in storage.

Amount of Spent Fuel



Over the lifetime of Sizewell B about 1400 tonnes of spent fuel will accumulate. Sizewell C&D will add a further 3500 tonnes[2]. The proposed new reactors will use 'high burnup' fuel which means that more electricity can be generated from the same volume of fuel in the reactor. However, this will make the fuel from Sizewell C&D more radioactive and 'hotter' than the fuel from Sizewell B.

The crucial thing about the fuel is not the actual volume of mass of fuel, but the amount of radioactivity contained within it. One of the most dangerous isotopes in the spent fuel is Caesium 137 (Cs-137). It is this isotope which is used to determine evacuation areas in the event of a nuclear accident.

The International Atomic Energy Agency sets its "operational criteria for evacuation" at 1MBq per square meter[3]. Using this criteria, the amount of Cs-137 that will be stored at Sizewell C&D ($1x10^{19}$Bq) would be theoretically enough to contaminate an area 40 times that of the UK[4]. Whilst it is extremely unlikely that an incident involving the spent fuel at Sizewell will release all the Cs-137, or that it would be distributed evenly, at Chernobyl only 30% of the $2.8x10^{17}$Bq of Cs-137 was released and this was enough to result in an exclusion zone of $2{,}600Km^2$. Note that if Sizewell C&D go ahead they will contain over 100 times the Cs-137 released by Chernobyl.

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1 Spent Fuel Management – EDF Energy Perspective,EDF Energy March 2012 (http://www.nuleaf.org.uk/nuleaf/documents/Nuleaf_presentation_09032012_final.pdf)

2 Sizewell B calculated (http://www.plux.co.uk/spent-fuel-at-sizewell/). EDF give a figure of 3600 tonnes (http://hinkleypoint.edfenergyconsultation.info/Preferred_Proposal_Documents/Environmental%20Appraisal/Volume_2/V2%20C06%20Spent%20Fuel%20and%20Radioactive%20Waste%20Management.pdf) which is slightlyy higher than our calculated value of 3500 tonnes (http://www.plux.co.uk/3500-tonnes-of-spent-fuel-may-be-produced-by-sizewell-c/)

3 IAEA says Fukushima fallout warrants more evacuation, New Scientist, 2011 (http://www.newscientist.com/article/dn20324-iaea-says-fukushima-fallout-warrants-more-evacuation.html)

4 http://www.plux.co.uk/cs-137-inventories-in-spent-fuel/

Storing Spent Fuel

Initially the large quantities of heat generated by the spent fuel means that it has to be stored under water in spent fuel ponds. The water also provides protection from the intense radiation.

After at least 5 years in the cooling ponds the type of fuel used at Sizewell B can, in theory, be transferred to 'dry cask' storage (although this has not yet been done at Sizewell B) These casks are naturally air cooled and do not require a water supply or pumps to operate and are considered to be a much safer way of storing the fuel than leaving it in ponds. There is a plan to start moving fuel from Sizewell B out of the spent fuel ponds and into dry storage in the near future.

The “high burnup” fuel from Sizewell C&D would produce too much heat for dry storage and so it is currently planned to keep the fuel in the ponds until at least 2130[5].

Unlike the fuel in the reactor, the spent fuel ponds are not protected by a strong 'containment building' in the UK. However, in Germany such containment buildings have been compulsory since the 1970s due to the threat of terrorist attack. In Germany, The fuel is moved from the fuel ponds to dry storage after 5 years.

Even if technology is developed which enables the new type of fuel to be placed in dry storage in the future there is not sufficient space in the current Sizewell site plans to allow for this[6].

Accidents and Terrorism

If water is lost from the ponds the radiation levels in the building will rise dramatically, which can make any remedial work on the fuel pond very difficult. When there is not sufficient water in the fuel pond the fuel can heat up to a point where the fuel rods rupture. At higher temperatures the fuel rods can burn in air or when in contact with water[7]. When they react with water the fuel rods produce hydrogen gas which is explosive when mixed with air. Such fires could be self sustaining and result in large releases of radioactive material including Cs-137. A 1997 report by the Nuclear Regulatory Commission in the US concluded that the consequences of such a fire involving 400T of spent fuel could include: 54,000 to143,000 extra cancer deaths, 2000 to 7000 Km^2 of agricultural land contaminated and condemned, and economic costs due to evacuation of between $117 to 566 billion[8].

The fuel ponds at Sizewell C&D would hold nine times this amount of spent fuel.

- The water could be lost via a leak such as the one that almost led to disaster at Sizewell A in 2007[9].
- If power is lost to the water pumps at the fuel pond the water can heat up to boiling point. Eventually the fuel rods would be exposed which could result in a fire. This almost happened at Fukushima[10].
- A terrorist attack could damage the fuel pond – bunker buster type bombs are not necessarily high technology and in fact the GBU-28 bunker buster is an artillery gun barrel packed with explosives[11]. More sophisticated weapons have also been sold around the world and could fall into the hands of terrorists.

If Sizewell C&D are built the risk of an incident at the spent fuel ponds will remain for at least the next 117 years.

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5 Spent Fuel Management – EDF Energy Perspective,EDF Energy March 2012 (http://www.nuleaf.org.uk/nuleaf/documents/Nuleaf_presentation_09032012_final.pd

6 Sizewell B dry fuel store is to be 110m by 50m (*www.british-energy.com/opendocument.php?did=1063*). The new station will have to store 2.5 times the amount of fuel and will therefore require a building at least 2.5 times that of the Sizewell B dry cask store.

7 See the report by the US National Academies which was commissioned by the US congress (http://www.nap.edu/catalog.php?record_id=11263#toc)

8 Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States, Alvarez et al, 2003 (http://www.ips-dc.org/files/2987/reducing-the-hazards-from-stored-spent-nuclear-fuel.pdf)

9 Sizewell nuclear disaster averted by dirty laundry, says official report, Guardian 2009 (http://www.guardian.co.uk/environment/2009/jun/11/nuclear-waste-nuclearpower)

10 See Wikipedia (http://en.wikipedia.org/wiki/Fukushima_Daiichi_units_4,_5_and_6#Spent_fuel_pool)

11 Guided Bomb Unit-28 (GBU-28), Federation of American Scientists (http://www.fas.org/man/dod-101/sys/smart/gbu-28.htm)