SONE

Supporters of Nuclear Energy

Newsletter

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Congratulations.

Adrian Bull of the National Nuclear Laboratory was awarded an MBE in the 2018 New Year's Honours list for his work on the development of public understanding in nuclear research. Adrian is a member of the SONE committee.

A summary of UK nuclear power reactors

(More details can be found at www.world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom.aspx with regular updates at www.world-nuclear-news.org).

Currently the UK has 15 nuclear reactors delivering 8.883 GWe. Their contribution to the national grid is steady but the large fluctuations in the availability of other sources of power can be watched on the website http://www.gridwatch.templar.co.uk/index.php .

The retirement dates of current reactors range from 2023 to 2035. No doubt some of the 40-year lives will be safely extended to 60 years. Nevertheless they will need to be replaced and the current reliance on gas will need to be cut to reduce carbon emissions. The use of coal has already been reduced, and it is not possible to run a grid guaranteeing an energy supply with stable voltage and frequency powered by wind and sunshine alone! This is not a question of price as the media like to suppose. Over-enthusiastic environmentalists have to be reminded that, when the wind does not blow and the sun does not shine, they cannot supply energy, whatever the price. Current UK electricity consumption is 50 GW. While this may be reduced through the use of smart devices and the switch to LED lighting, it will be increased by the electrification of road and rail transport, and heating, too, if we are to be weaned off carbon fuels.

This all adds up to a need for many more fission reactors. Three waves may be foreseen: those large reactors already planned; a new generation of

small modular reactors (SMR) with designs currently in hand for use in the UK; finally, other designs that are also being discussed. The future lies in particular with the development of the SMRs that can be assembled from modular components, manufactured off-site with the advantages of assembly line construction and delivery by conventional transport.

This is a developing story to which we will return in future newsletters.

Large new fission reactors

There could be as many as 13 of these with a maximum combined output of 17.905 GWe.

The construction of the two 1.67 GWe EPR reactors at **Hinkley Point C** continues in spite of criticism by the National Audit Office and others that the contract loads too much of the eventual cost onto the utility bills of future consumers. The construction investment is being made by EDF and China General Nuclear Corporation (CGN), although they estimate that 57% of the construction work will be carried out by UK companies. Nobody suggests that the contracts for further power stations, now being negotiated, should follow the pattern used for Hinkley Point. Completion and connection to the grid is due in early 2026. However, Hinkley has at least broken the ice in the UK and later power stations should be built more cheaply and quickly. Current progress on the HPC site may be seen on EDF's website https://www.edfenergy.com/media_colorbox/3716909/full/en. Concrete for the main basemat is due to be poured in mid 2019.

EDF and CGN also have plans for two similar EPR reactors at **Sizewell C**, but there is no contract or timescale for these yet. There is also a proposal to build two further reactors of 1.15 GWe of the Chinese Hualong One design at **Bradwell B**. UK approval of this design is expected in 2021.

Another new station built is to be built at **Wylfa Newydd** in Anglesea by the Horizon collaboration. It will comprise two 1.38 GWe GE-Hitachi Advanced Boiling Water Reactors (ABWR) of a design that has been built and operated in Japan. Horizon is now owned by the Hitachi. The design was cleared for construction in the UK in December 2017 and a start date of 2019 is foreseen, though a firm contract is yet to be signed. (Horizon also have a further proposal to build two more ABWR units at **Oldbury B**.) It remains to be seen whether the UK Government, or even the Japanese Government, is prepared to contribute to the construction cost. Whatever the end result, there is great

pressure to lower costs.

Some nuclear suppliers are not able to build plants in their home countries because of domestic politics. As a buyer with a good political stability, the UK is in a favourable position. It should not dither. It should exploit this buyer's market without delay.

At **Moorside** in Cumbria NuGen, owned by Toshiba, proposed to build a 3.8 GWe plant to the Westinghouse AP1000 design, which already received UK approval in March 2017. Because of the virtual collapse of the nuclear new build market in the United States, Toshiba is negotiating to sell its interest in NuGen to the Korean Electric Power Corporation. South Korea, too, has problems at home with the acceptance of new nuclear power plants.

This slowdown in the international market for nuclear power plants abroad has two causes: a complete over reaction to the Fukushima accident, and the current low price of natural gas. Reliance on gas should be avoided because of the questionable availability of supplies from Russia and the Middle East, neither of which is secure in the long term. Natural gas, whether burnt or leaked, pollutes the environment, and its price and availability can change in a much shorter time than it takes to construct a power station.

Persuading public opinion, and the politicians who follow it, that the future is nuclear

Here is an essay recently published on Facebook, Twitter, LinkedIn, and ResearchGate:

www.researchgate.net/publication/322804878_To_know_or_not_to_know_the_nuclear_question_(amended)

To know, or not to know: the nuclear question

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Hon. Sec. of Supporters Of Nuclear Energy (SONE)

When humans learnt to use fire, their supremacy on the planet was assured, for a while at least. The advance was not barred by public fear and ignorance. Its adoption was welcomed and general instruction for its safe use was shared widely. However, today, with an increased population and larger economic horizons, we need a new source of energy, one that is more concentrated and

has less impact on the environment.

Fortunately, nature offers such a source. While nuclear energy is a million times denser than fire, its effect on the environment is very small. Unfortunately, few in society have been ready to learn about it, or to appreciate its benign impact on life. They have preferred not to know. The reason for this failure is historical. Like other features of nature, nuclear energy can also be abused, and concern about its use in military conflict has coloured general perceptions of it ever since World War II. Although fear of radioactivity and its radiation is largely unjustified, it became a phobia in the days of the Cold War, when scientific truth was often obscured by official secrecy and public distrust. If humanity is to flourish in the future, we should examine these historical shadows and ensure that our children are not deceived by them. They should know; they should learn about nuclear energy, the part it plays in the natural world, and how it can help their future.

A simple description of the atoms, of which everything is made, is not difficult to follow. These LEGO bricks of matter are all very similar and governed by universal principles: each atom has a tiny nucleus, held at the centre of a cloud of electrons. This nucleus plays no active part in the usual technologies of electronics, lasers and chemistry, where energy is so much lower than nuclear. The biology of life takes place on a far larger scale with great variety and rules shaped locally by evolution.

Nuclear energy can affect life when a nucleus decays, releasing energy as radiation, and such a nucleus is called radioactive. Everything, even our own bodies, contains some natural radioactivity, and nuclear radiation shines on us from space too. If it had been really dangerous, life would have died out aeons ago, when the radiation flux was more intense than it is today. To survive the oxidative damage caused by radiation and oxygen, life has evolved a series of amazingly clever design features and strategies. These include:

- renewal by the cell cycle
- the repair of broken DNA
- apoptosis of errant cells
- and even the birth-and-death cycle that replaces whole individuals.

Each year more details are discovered about how these work and protect

living tissue from low and moderate radiation fluxes.

Marie Curie showed that high radiation doses can be used to cure cancer, and everyone, directly or indirectly, is aware of these health benefits. However, in the 1950s twenty years after Marie Curie's death, draconian limits were introduced for acceptable exposures, in an attempt to appease fears expressed during the Cold War. Large public demonstrations and political confrontations ensured that leaders responded to the general fear of growing stockpiles of nuclear missiles. Limiting acceptable exposures to radiation by international regulation was such a response, although it was a sticking plaster solution that provided little reassurance. Nevertheless, those regulations, though not based on sound evidence, continue in use today. Varying from 1 to 20 milli-sievert per year, they are more cautious by a factor above 1000, compared to the 30,000 milli-sievert dose received by normal tissue in the course of a typical radiotherapy treatment.

The public appeal for radiation safety was answered by requiring that any radiation exposure should be As Low As Reasonably Achievable (ALARA). This was underwritten by the idea that any exposure is harmful, however small and received at whatever rate. This idea, called the LNT model, is not supported by scientific or mathematical evidence, is quite unlike the behaviour of other systems, evolved or designed for self protection, and is at odds with modern radiobiology. But what story does the evidence tell?

At Fukushima the radiation doses were low, even to the workers, and there was no radiation casualty. But, without any knowledge of radiation, the public reaction to the imposed regulations was fear and distrust of the authorities. The result was great personal suffering in Japan, and near-panic and inept changes of energy policy, worldwide.

At Goiania, Brazil in 1987, a radioactive source, activity 50.9 TBq[1] Cs-137 from a disused radiotherapy unit, fell into the hands of the public, who liked the glow it emitted! They decorated themselves and ingested it with their food. In total 249 people were contaminated, over 70 of them internally. Within a few weeks four had died, 28 had surgery and many suffered from mental illness and alcoholism. However, no one died in the following 25 years as a direct result of the radiation. Two children were born normally, one who was already in utero, and another some four years later to a mother who had received 300 MBq, internally.

1 Tbq, a trillion, a million million, radioactive decays per second.

At Chernobyl, too, the fear and stigma of having been irradiated caused despair, family break-up, and mental illness. Hundreds of miles away mothers were frightened into aborting their unborn, and the expectation of many tens of thousands of deaths were raised in the media. However, the final count of deaths that can be linked to radiation, either identifiably or statistically, was 43, as reported by the UN and WHO.

In the public at large, ignorance about radiation and its effects on health is almost total. Few professional engineers or physical scientists are sufficiently informed on the medical side to challenge the entrenched opinion of ICRP, the safety committee sanctioned by the United Nations. The proper loyalty of most professional medics is to the health of their patients, and they are generally reluctant to pursue decades-old disagreements, even where the scientific and medical evidence is quite clear, as it is here. The nuclear industry, anxious for new business, has always stuck close to the regulators. Some safety professionals, who understand the radiobiology, admit that the regulations are quite inappropriate and against the general interest. However, they have jobs and careers that rely on the status quo, and so are reluctant to upset the apple cart, in spite of the large addition to healthcare costs involved. In some jurisdictions, Japan for example, large compensation payments have been made without requiring any evidence of harm from radiation to be shown. In this way the law has discouraged many from speaking about the real issue. These are the reasons that no one has stood up to say the truth – nuclear energy is much safer than fire.

The well rehearsed reaction to the 2011 tsunami in Japan was based on a civil defence policy of public education, but there was no similar provision for a nuclear incident, civil or military. Although the radiation from the reactor accident had no direct impact on health, it did show how a total lack of preparation can lead to near-panic. Fear of a nuclear holocaust was an important weapon during the Cold War. However, such an intense, but vague, apprehension makes actual reactions far worse. Today, panic and a breakdown of public order would be the dominant result of a “dirty bomb”, or even a nuclear strike. Education and public health information could be provided relatively easily as a major improvement in social resilience.

We should look to such education to be broader, more open, and less fearful, not only for the young, but for the wider public too. At the level of public health, nuclear radiation is not difficult to understand: it is only the phobia

(plus those who jealously guard its status) that makes it seem forbidding. If a wide spectrum of opinion makers had a better understanding of the range of future risks – radiation, environment, health, economic resources – the right balance between them would become clearer to everybody in society when decisions are made, and law and order would be preserved. A democracy based on ignorance is open to distrust and collapse.

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