

A SHORT STATEMENT

from the **UK ATOMIC ENERGY AUTHORITY**
on **NUCLEAR FUSION**

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BASIC SCIENCE OF FUSION

In a fusion reaction, energy is produced when light atoms are fused together to form heavier atoms. This process takes place in the Sun and stars.

To utilise fusion reactions as an energy source it is necessary to heat a large volume of dilute gas, containing equal parts of deuterium and tritium to temperatures in excess of 100 million degrees – several times hotter than the centre of the Sun. At these temperatures, the gas becomes a plasma. The deuterium and tritium ions in the plasma fuse together to form helium and high speed neutrons, releasing significant amounts of energy. A commercial power station would use the heat generated by the neutrons, slowed down by a blanket of denser material (lithium), to generate electricity.

The plasma must be kept away from material surfaces to avoid it being cooled and contaminated; magnetic fields are used for this purpose. The most promising magnetic confinement systems are toroidal (doughnut shaped) and the most advanced is called the Tokamak. The Joint European Torus (JET) at Culham near Oxford is currently the largest Tokamak in the world.

The fuels used are virtually inexhaustible. Deuterium and tritium are both isotopes of hydrogen. Deuterium is extracted from water and tritium is manufactured from a light metal, lithium, which is found all over the world. One kilogram of fusion fuel produces the same amount of energy as 10,000,000 kilograms of fossil fuel.

CURRENT STATUS OF FUSION RESEARCH

JET has already produced 16 MW of fusion power and is likely to continue operations for the foreseeable future. Its international successor ITER (International Thermonuclear Experimental Reactor) is under construction in the South of France. Funded by a global partnership of China, EU, India, Japan, Korea, Russia and the USA, this will be a power station scale device, roughly twice as big as JET in all dimensions, that should produce over 500 MW of fusion power and confirm that a real fusion power station can be built. Operations on ITER are planned to start in 2018.

In addition to ITER, an international fusion materials radiation facility (IFMIF) is being designed and developed by an international team from Japan and the EU. This will test and characterise materials to be used in a fusion power station and demonstrate their reliability over years of operation. Both these facilities will take ten years to construct and a prototype fusion power station could start construction once results from ITER and IFMIF have been assimilated. If the facilities are built in parallel prototype fusion power stations could be putting electricity into the grid in under 30 years if no major problems arise. Widespread commercial fusion power would follow 10-15 years later. Fusion is therefore not a contributor to any short-term solution to energy needs, but could be a major player in the medium to long term energy mix.

SOCIETAL ISSUES

Some radioactive waste would be created in a fusion power station, from the tiny amount of tritium used as fuel and from the activation of the internal structure by the neutrons. The radioactivity in both cases decays away with a half-life of only 10-12 years and all the components could be recycled within 100 years. Tritium would not need to be transported to a fusion power station once operation had commenced as the necessary amount of fuel could be self-sustained within the reactor.

Any possible misuse of a fusion power station for illicit nuclear proliferation purposes, ie procurement and processing of fissile material, would easily be detected as such a power plant is designed to have no such material (eg plutonium) on site.

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