Nuclear fusion and radioactive waste regulation: CoRWM members visit the Culham Centre for Fusion Energy

By Claire Corkhill

> Fusion will be ready when the world needs it.

This is what Ian Chapman, CEO of the UK Atomic Energy Authority (UKAEA), tells us in his introductory talk. With COP26 having just finished, it's hard to argue that society does not need it now. In light of this, and following the recent publication of the UK government's Fusion Strategy, which outlines the UK's ambition to become a fusion industry superpower, members of the Committee on Radioactive Waste Management were delighted to visit the Culham Centre for Fusion Energy (CCFE) to learn how plans are progressing to implement and regulate this revolutionary new technology.

Located near the Harwell Campus in Oxfordshire, the CCFE has been quietly developing fusion energy for decades. Hiding behind giant doors several metres thick, CoRWM members were shown a peek of the JET – Joint European Torus – reactor, which is the world's first deuterium-tritium powered fusion reactor, operational since 1983. Only this fleeting glimpse was possible because JET is currently engaged in a programme of deuterium-fusion experiments, testing the fuel for its successor, ITER – the International Thermonuclear Experimental Reactor. ITER – meaning 'the way' in Latin – is currently under construction in France and will be the first fusion device to produce net energy. Its cousin, STEP (Spherical Tokamak for Energy Production), will be a prototype for the UK's first energy-generating fusion reactor, due to be operational in 2040.

Rapid progress in the development of the technology, and the government's ambitious fusion strategy, have led to the publication of a public consultation, Towards fusion energy: proposals for a regulatory framework, to which CoRWM have provided input. One of the key areas of CoRWM's interest is the regulation of radioactive waste arising from fusion energy, and its management and disposal, which is detailed in the recently published CoRWM briefing paper, led by member Professor Neil Hyatt. Although nuclear fusion does not produce long lived fission products and actinides, neutron capture by the fusion reactor structural materials and components forms short, moderate and some long lived activation products. In addition to tritium emissions and contaminated materials, it is clear that there will be a need to manage radioactive materials and wastes produced by neutron activation, within regulatory controls, over the whole life cycle of a fusion reactor.

With this in mind, CoRWM members talked with the CCFE Fusion Safety Authority during the tour of the site. We saw the MAST (Mega Amp Spherical Tokamak)

machine and learned the importance of reactor component design and materials selection in the minimisation of radioactive waste. The safety team explained that changes can be made to the materials used in the front wall, blanket, divertor and vacuum vessel, but that does not take away the fact that these may require management as low level waste, or otherwise as low-risk intermediate level waste, at the end of reactor life.

Innovation was at the heart of the visit. We were introduced to novel robots capable of entering the harsh reactor environment, thus reducing radiological risk to personnel. Hot cells (pictured) and state-of-the-art analytical equipment, housed in the Materials Research Facility, that will be used to support development of fusion reactor materials of the future, were demonstrated. The STEP siting process, which received a wide range of submissions, is a first-of-a-kind, making the giant leap from experimental physics to operational energy infrastructure. And, refreshingly, regulation of the technology, including its longer-lived radioactive waste, is already being carefully considered, even though the first energy-producing reactor won't be operational for another 20+ years.

In our work, CoRWM will endeavour to ensure that the innovations in fusion power, and the resulting radioactive waste it generates, will be duly considered, regulated and safely managed into the future. We look forward to seeing the leaps in progress on our next visit.

On the left: the JET (Joint European Torus) fusion reactor at the Culham Centre for Fusion Energy
On the right: The operation of hot-cells in the Materials Research Facility at Culham, showing equipment used to prepare activated fusion reactor materials for microscopy.