10 September 2001

## ENERGY POLICY REVIEW – UKAEA SUBMISSION

Please find attached UKAEA's submission to the Energy Policy Review. UKAEA has two distinct areas of responsibility, and the submission is presented in two parts to reflect each of our key missions:

- The decommissioning of redundant nuclear facilities and the environmental restoration of our nuclear licensed sites; and
- The UK's contribution to the international programme of fusion energy research.

# FUSION POWER

**Submission by the United Kingdom Atomic Energy Authority to the Energy Policy Review**

**10 September 2001**

## Introduction

The attached submission has been produced by the UKAEA working with the EURATOM Fusion association. The essence of the submission is that:

- Fusion power is environmentally friendly, does not produce long lived radioactivity nor does it produce greenhouse gases.

- The process has been established at an experimental level and to date powers of some 16MW have been achieved on JET at Culham. Extension to continuous power generation and commercial scale requires research into the practical development of the concept rather than the concept itself.

- The cost of such power is likely to be comparable with that from other environmentally responsible sources of power generation.

- Worldwide co-operation would facilitate development of this environmentally friendly source of power by the middle of this century.

## Submission

This statement is submitted by the EURATOM-UKAEA Fusion Association. The UKAEA is responsible for the implementation of the UK research and development programme on magnetic confinement fusion, and on behalf of Europe operates JET, which is the world's leading fusion experiment.

1. The Energy Policy Review is a review of “the strategic issues surrounding energy policy for Great Britain . . .within the context of meeting the challenge of global warming, while ensuring secure, diverse and reliable energy supplies at a competitive price”. The timeframe under consideration is to 2050.

2. In this submission we say why developing electricity generation using fusion - the process that powers the sun - should be an important element of a sustainable energy strategy.

3. With increasing concern over the environmental effects of energy use and production, ever-expanding world energy requirements, and a need to guarantee security of supply for the future, it is vital to have a wide-ranging energy strategy given top priority by government and backed-up by sufficient resources. This should include:

- optimising the use of present technologies to minimise environmental impact;
- improvements in existing energy technologies, particularly in reducing emissions and improving efficiency of energy production and use; and
- development and introduction of a range of new energy technologies providing the options necessary to allow a gradual move to a radically different energy supply system and market.

Fusion and most renewables can contribute to the third category, and it is important that they are developed to their full potential.

4. Fusion can realistically be foreseen as making an important contribution to the above objectives because of (a) the abundance of its fuel supplies, (b) its significant safety and environmental advantages, and (c) progress developing the technology of fusion power in the last decade. These factors are summarised in the following paragraphs.

5. The fuels for fusion – deuterium and lithium – have widespread and abundant distribution at low cost.

6. Fusion power stations will have only limited stocks of energy that could drive accidents. It has been shown that the worst possible accident driven by in-plant energies would result in only very small hazards to the public. The consequences of an accident initiated, for example, by a very large earthquake would be small compared to the direct consequences of the earthquake itself.

7. Fusion power stations will make no contribution to global warming as greenhouse gases are not produced.

8. Fusion power stations will make no use of uranium, plutonium or other fissile materials. Although there is activation of the machine structure during the plant operations, this is sufficiently short lived that almost all the materials in a fusion power plant could be recycled at the end of the plant life. There is not a large waste burden for future generations.

9. Estimates of the cost of electricity from fusion power stations suggest that it should be acceptable in a future energy market, particularly one in which environmental concerns become increasingly important. The estimates are similar to those for clean coal (emission–abated coal power stations) and renewables (ignoring costs of energy storage for renewables). Unlike many renewables, fusion power would not be intermittent, nor be restricted to certain geographical locations.

10. There has been great scientific and technological progress in developing fusion over the last decade. Fusion power has been produced at levels up to sixteen MegaWatts. Improved designs of the burning-plasma core of a fusion power plant are being researched, such as more compact - and therefore possibly cheaper – systems led by UK scientists. In addition, prototypes of most of the components of a fusion power plant have been produced and successfully tested individually at close to the necessary conditions. The integration of all the required elements into

reliable power plants is required, however, before we can be certain first of fusion's technical feasibility and later its economic feasibility.

11. No major breakthroughs are needed. These have already occurred. Further development can be envisaged broadly in two stages: firstly, the integration of the various elements in a device approaching power station size, together with testing of materials in conditions as typical as possible of a power plant; and secondly, the build-up of reliability in operation to confirm economic feasibility.

12. Fusion development has been undertaken as an international effort, by Europe, Russia, Japan, USA, and a number of other countries. Taking fusion forward to commercialisation, as sketched in the preceding paragraph, requires continued international collaboration. With the present sequential approach, commercialisation should be possible by 2050, and much earlier if the key steps are undertaken in parallel. The latter is within the capacity of the international fusion community if co-ordination is increased and focused solely on key deliverables linked to demonstrating the feasibility of fusion. This in turn requires sufficient political will and strong project management, with a remit to produce the electricity generating systems for the energy industries and utilities which will eventually manufacture and operate fusion power stations.

# NUCLEAR DECOMMISSIONING – THE WAGR DEMONSTRATION PROJECT

**Submission by the United Kingdom Atomic Energy Authority to the Energy Policy Review**

**10 September 2001**

1. The United Kingdom Atomic Energy Authority (UKAEA) pioneered the development of nuclear power in the UK. Today, UKAEA is pioneering the decommissioning of redundant nuclear facilities, and the environmental restoration of our sites for the benefit of future generations. UKAEA's nuclear licensed sites are located at Dounreay in Scotland, Windscale in Cumbria, Harwell in Oxfordshire and Winfrith in Dorset.

2. UKAEA no longer has a role in the development and promotion of nuclear fission, since our focus is now on the restoration of the sites that were historically used for this purpose. UKAEA has no corporate view on the prospects for or merits of future nuclear generation. However, our experience may be valuable in establishing the practical issues involved in reactor decommissioning, and demonstrating that they can be successfully addressed.

3. UKAEA maximises the contribution of private sector contractors to the decommissioning of its liabilities. UKAEA carries out the planning and project management, but uses decommissioning contractors to implement the work. By placing contracts through competitive tender, this policy encourages the introduction of new techniques to decommissioning and increases value for money for the tax-payer.

4. UKAEA's mission has a number of nationally important benefits:

   - The safe management and dismantling of old nuclear plant at minimum cost. This process will become increasingly important to the environment and the community as more nuclear facilities reach the end of their lives;

   - The decommissioning work stimulates jobs, business opportunities and valuable skills, in many cases in isolated communities;

   - UK contractors can improve their competitive position in overseas markets through developing skills and experience on UKAEA decommissioning projects.

5. To date, six of UKAEA's research reactors have been completely removed, nine are in safe care and maintenance and a further four are currently being decommissioned. In addition UKAEA has dismantled three plutonium handling plants and nine other major facilities.

6. The decommissioning of UKAEA's prototype Advanced Gas-cooled Reactor at Windscale is directly relevant to commercial power reactors.

7. The Windscale AGR (WAGR) was a 110MW(t) reactor, designed as a prototype for the family of commercial-scale AGR's that now provide base-load electricity generation across the UK. It began operations in 1962 and successfully exported power to the grid until it was shut down in 1981.

8. The fuel was removed from the reactor soon after shut-down. After defuelling, commercial reactor operators would in general expect to defer further decommissioning for several decades. This approach allows radioactivity to decay to low levels while the reactor is kept under care and maintenance, minimising the radiation dose to workers during the eventual dismantling of the reactor, and reducing the need for expensive remote handling techniques to be deployed.

9. However, UKAEA undertook early decommissioning of WAGR, as one of a number of European demonstration projects, designed to show that power reactors can be decommissioned safely and completely. The £80 million decommissioning cost is funded jointly by the Department of Trade and Industry and the nuclear industry. BNFL Magnox is the prime contractor for the project.

10. To date, Project WAGR has successfully delivered its technical objectives. In the early 1990s the top biological shield was removed and a remote dismantling machine, that will take apart the reactor core, installed in place of the refuelling machine.

11. In 1995, the four heat exchangers (or boilers) were removed through the reactor dome. The190 tonne heat exchangers were lifted out whole using one the largest cranes in Europe. Each was then transported six miles by road to the low-level waste site at Drigg.

12. The next step - now underway - is to remove the reactor core and pressure vessel. This is being done in a series of carefully planned campaigns using the remote dismantling machine. Equipped with cutting, grabbing and lifting tools, the machine is removing sections of the core and transferring them to waste boxes for grouting and storage. The low-level waste is transferred to Drigg for disposal. The intermediate level waste is packaged and retained in a purpose designed store at Windscale awaiting a decision on a national waste repository.

13. Removal of the reactor and pressure vessel is planned to be completed by 2007, after which a decision will be taken on the future of the residual building structure and the famous "golf-ball" dome which is all that will remain.

14. If new nuclear build is to be considered, it is important for the nuclear industry to demonstrate today that it can safely remove what it built in the past. Project WAGR is demonstrating that a power reactor can be decommissioned safely, cost effectively and with minimum risk to the environment, using equipment which is readily available today.