Going nuclear – again

A comprehensive set of reports on Materials for Energy was issued by Materials UK in December 2007. In the first of a series looking at the reports, Professor George Smith FRS of Oxford University, UK, considers the nuclear position.

On 10 January, the UK Government announced its formal backing for the construction of a new generation of civil nuclear power stations. This had been foreshadowed in the 2007 Energy White Paper, *Meeting the Energy Challenge*, but was in marked contrast to policies proposed in the 2003 Energy White Paper, *Our Energy Future: Creating a Low Carbon Economy*.

With impeccable timing, on 4 December 2007, Materials UK launched a comprehensive set of reports on Materials for Energy. The present article is based largely on the Nuclear Energy Materials Report, by I Cook, C English, P Flewitt and G Smith. The report contains proposals for a research and devopment agenda.

Why did the Government have a change of heart? First, energy security is a concern with the UK facing the prospect of being beholden to unstable or unfriendly states for future supplies. The economics of nuclear power have also changed, due to rising prices of oil and gas. While in terms of technology, there is now a better understanding of the limitations of renewables for the provision of underlying base load electrical power generation, and legal pressures from the EU are threatening to force the closure of the more polluting fossil fuel power generating plants, forcing a reappraisal of the environmental benefits and risks of nuclear power.

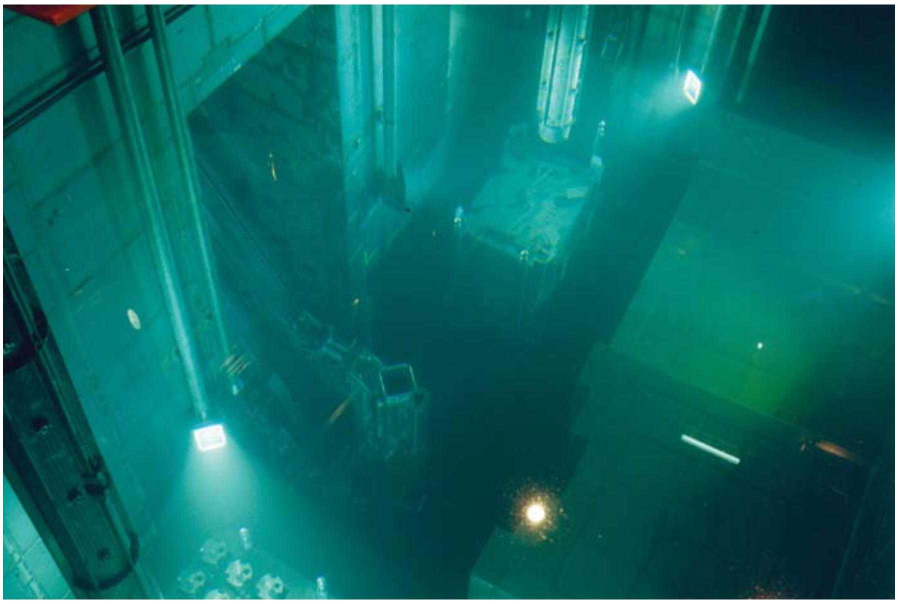
Global picture

It is important to place the UK decision in a worldwide context. At present, the global industry is buoyant. There are 440 commercial power generating nuclear reactors operating in 30 different countries. The total installed capacity is 372,000MWe, which supplies 16% of the world's electricity needs. There are 30 more reactors currently under construction, and 80 plants at various stages of planning and development.

In the UK, the picture has been less favourable. There are currently 19 operational power-generating reactors, which normally produce around 18% of UK electricity. However, no new plants have been commissioned since Sizewell B (1995). The oldest (Magnox) plants are now being decommissioned, and the advanced gas-cooled reactors (AGRs) are next in line to close. The proportion of UK electrical power generated by the nuclear sector will fall to about seven per cent by 2020, and to zero by 2035, unless there is significant life extension of existing AGR stations, and new nuclear plants are constructed. There is a need for urgency in addressing this.

A multi-pronged strategy is required. In the shortest time span (0-5 years), the best that can be hoped for is to find ways to extend the safe operating lifetime of existing AGR plants. In the medium term (5-15 years), new nuclear plants must be constructed based on existing Generation III designs. The leading contenders are Pressurised Water Reactors (PWRs), such as the Westinghouse AP1000 which adopts proven technology and has improved passive safety features.

In the longer term (15-30 years), a new range of sophisticated Generation IV designs is expected to become available including, for example, the modular 'Pebble Bed' reactor being developed in South Africa. These plants are intended to be 'fail safe' in design. Beyond 30 years, there is the dream of nuclear fusion as a virtually limitless source of energy. The experimental ITER fusion reactor, to be built at Cadarache, France, represents the next step on the journey.



Above: The feed pond at the Thorpe reprocessing plant, UK. Image courtesy British Nuclear Group

Future requirements

What are the implications of the new UK energy policy for the materials community? The nuclear manufacturing industry in the UK has been allowed to run down to the point where the key technology will almost certainly have to be imported from abroad. So what role can the R&D community, and UK industry, play? The regulatory regime requires an 'intelligent customer' – a team that understands the full engineering complexity of such a system and is able to take on the responsibilities of ownership, including the ability to deal with any eventuality. There are many areas where scientists and engineers can contribute to a resurgent industry, and to wider global developments in this field. R&D needs –

- Development of materials with enhanced performance in harsh environments.
- Better non-destructive techniques for inspection and monitoring of reactor systems.

- Better understanding of the long term integrity of plants, particularly large welded structures.
- Improved accuracy of plant lifetime prediction and management.
- Research on corrosion and erosion, crack nucleation and growth mechanisms, environmentally assisted cracking, creep-fatigue interactions, and thermal cycling.
- Research on irradiation damage effects on materials, especially at the high energies and high doses expected in future fusion reactors.
- Further studies of long term degradation of waste storage materials, and of the design and construction of waste storage facilities.

On the industrial side, each of the new generation reactors will represent a major construction project, with large employment and investment potential. There will also be the opportunity to restore key engineering manufacturing capabilities where skills have been lost.

There is also a need to develop a clear strategy and an improved infrastructure for waste management and reprocessing. Public acceptance of the proposed new build programme will depend very strongly upon this.

We therefore need to produce a new generation of scientists and engineers who will become the leaders in this field in the next 10-30 years, as well as capture the wisdom and experience of those who have worked in this industry in the last 40 years and are now retired, or close to retirement. A concerted effort is needed to carry out a critical appraisal of the technical information accumulated by their efforts.

Furthermore, the UK programme of nuclear decommissioning needs to take into account the need for materials harvesting. There is literally no substitute for long-term exposed materials from real-life nuclear plants when it comes to assessing degradation mechanisms, and predicting the behaviour of future installations. At present, the remit of the Nuclear Decommissioning Agency seems to be to remove the old reactors and dispose of them at the lowest possible cost. The NDA and others recognise the potential benefits of materials recovery, but there needs to be a modest additional cost element built into the programme to allow key materials to be retrieved for subsequent forensic examination. And, of course, we need a national nuclear laboratory facility, where examination of such irradiated materials can be carried out.

For further information, e-mail: george.smith@materials.ox.ac.uk.

All the reports are available at: http://www.matuk.co.uk/energy.htm.

The next article in this series will appear in June.

Meta4

Meta4 is the new name for the metals and alloys node of the Materials KTN. David Stafford, Sales and Marketing Manager at the National Metals Technology Centre (NAMTEC) provides an overview of its activities

Meta4 provides networking opportunities for UK metals related companies and organisations, encouraging knowledge transfer from the technology sector and science bases to industry, to improve industrial performance and innovation. The new name reflects the broader remit.

The metal and alloys node of the Materials KTN continues to be managed by the National Metals Technology Centre (NAMTEC), UK, and through it companies have access toNAMTEC's wider Technology Transfer Programme. This provides a hub for the support of the advanced engineering, materials and manufacturing communities, and is aimed at identifying the technologies and competencies required to sustain growth. NAMTEC provides a support centre to give companies direct and easy access to a team of technical staff who are able to provide an immediate response to their specific needs and enables companies to access technical support from a range of research and technology providers.

From left to right: Dr Alan Partridge, NAMTEC, Ian Hodges, Timet UK, Dr Malcolm Thomas, Rolls Royce Aerospace; Dr Roger Digby, Airbus

Titanium symposium

The inaugural Meta4 symposium, focusing on titanium, was held in November 2007. Over a hundred delegates attended. The event, which was held in association with the Advanced Manufacturing Park and the Titanium Information Group in Rotherham, UK.

The symposium featured speakers from titanium producers and end users including, TIMET, Airbus, Rolls-Royce, BAE Systems and Boeing. It presented an opportunity to learn about the industry from the perspective of various industry stakeholders.

Chief Executive of NAMTEC Dr Alan Partridge explains, 'We had an overwhelming response and the event provided the chance for regional, national and international titanium manufacturers and their customers to benefit from sharing information and best practice. It is likely that this symposium will become an annual event.'

The programme covered the current status of the titanium market, key factors that will influence the future growth and development, and drivers for the wider introduction of the metal.

Sessions presented the key technical developments that have taken place in the titanium industry and the implications for key market sectors. A similar event on special steels will be held in November.

Forum launch

One of the key developments during the course of 2007 was the establishment of a Special Metals Forum. Stephen Timms, Minister of State for Competitiveness for the Department of Business Enterprise and Regulatory Reform, visited NAMTEC during December 2007 to officially launch the Forum. It brings together the strengths, resources and capabilities of the special metals supply chain – producers, fabricators, component manufacturers and OEM's, as well as research organisations and the wider academic community.

Over 150 delegates, attended the launch, held in Rotherham, UK, which provided the opportunity to meet with other companies within the sector and talk to the Minister.

Partridge noted, 'This is recognition of the important role that special metals play in the UK economy and the role that the Forum will play in driving innovation, training and improved competitiveness within the sector.'

For further information, visit: www.namtec.co.uk.