Memorandum 8

Submission from the Institute of Materials, Minerals & Mining (IOM3)

1. Executive Summary.

1.1 In the short term, in order to build and commission new nuclear power stations, it will be necessary for the UK to import technology and engineering skills from those countries which have continued to invest in nuclear power. To be an intelligent customer for these Generation III nuclear power stations, the UK will need to urgently undertake the training of a new generation of nuclear engineers and scientists AND initiate a knowledge capture exercise which would draw on the UK's wealth of expertise in this sector which was world leading for 40 years. This expertise is retained in archives and, more importantly, by those nuclear scientists and engineers who worked in the industry but have now retired.

1.2 In addition, it is vital, if the economic viability of nuclear power generation is to be increased and the costs of de-commissioning and waste disposal reduced, that forensic examinations are conducted on materials recovered from nuclear power stations being de-commissioned.

1.3 It is also necessary to maintain and enhance the engineering skill base in the following topics: improved materials for hostile environments, non- destructive techniques for inspection and monitoring, better understanding of the long term integrity of large plants, especially large welded structures, improved accuracy of plant lifetime prediction and better understanding of the mechanisms of degradation of the materials deployed in the construction of nuclear power plant and waste storage facilities.

2. The UK's engineering capacity to build a new generation of nuclear power stations and carry out planned de-commissioning of existing nuclear power stations.

2.1 Capacity to build a new generation of nuclear power stations.

The new generation of nuclear power stations will be based on proven technology deployed on existing Generation III designs such as the WestinghouseAP1000 Pressurised Water Reactor (PWR) with its improved passive safety features. In the short term it will be necessary to import this technology in order to design, build and commission new nuclear stations which will replace those scheduled for decommissioning. There is an urgent need to train a new generation of engineers and scientists during the time it will take to build and commission the new nuclear stations.

2.2 Decommissioning of existing nuclear power stations.

The UK has the engineering skills and experience to continue decommissioning existing nuclear power stations. However, current activities could, at a modest extra cost, provide vital information for the design and operation of future nuclear power plants by forensic examination of the materials of the structures being

decommissioned. There is no substitute for information obtained on the degradation mechanisms to which materials are subject in nuclear plants than to study materials that have been harvested from real life installations. Ideally this forensic examination would be carried out in a national nuclear laboratory located close to one of the universities that is conducting research on Generation IV Nuclear Power Systems, eg The Dalton Nuclear Institute at The University of Manchester, or the Universities of Oxford and Birmingham.

3. The value in training a new generation of nuclear engineers versus bringing in expertise from elsewhere.

3.1 It is essential to train a new generation of nuclear engineers if the UK is to be an intelligent customer for the new build nuclear power stations. UK nuclear engineers should also be involved in the research and development of Generation IV nuclear systems such as the Pebble Bed reactor being developed in South Africa and the Fast Breeder reactor where the UK once held a leading position.

3.2 The training of a new generation of nuclear engineers would be assisted by establishing funded secondments/visiting fellowships whereby UK scientists and engineers could work in those countries and companies at the forefront of current and next generation nuclear systems.

3.3 In addition, a Knowledge Capture Programme should be funded to ensure that the explicit and tacit knowledge of those scientists and engineers who worked in the nuclear industry and their research laboratories over the past 40 years is captured and transferred to the new generation of employees. This programme needs to be conducted now. In five years time some of these retired, experienced nuclear engineers may not be with us and their expertise would be lost forever. The Knowledge Capture Programme could be facilitated by a professional institution such as the Institute of Materials, Minerals & Mining (IOM3).

4. The role that engineers will play in shaping the UK's nuclear future and whether nuclear power proves to be economically viable.

4.1 Engineers will play a major role in shaping the UK's nuclear future and improving the economic viability of nuclear power if they can successfully meet the following challenges:

- Develop materials with enhanced performance in the harsh environment of nuclear installations.
- Improve non-destructive techniques for inspection and monitoring of reactor systems both during construction and operation.
- Understand better the long term integrity of complex plants, particularly large welded structures.
- Improve the accuracy of plant lifetime prediction and management.
- Understand better the materials degradation mechanisms in nuclear plants, in particular corrosion and erosion, environmentally assisted cracking, creep-fatigue interactions, thermal cycling, and irradiation damage effects, especially at the high energies and doses which will occur in future fusion reactors.

- Improve the understanding of the long term degradation of nuclear waste storage facilities.

4.2 It is impossible to accurately predict the long term economics of nuclear power. It is, however, clear that improved engineering can significantly reduce costs. For example, it has been calculated that if all the electricity generated by nuclear power in the UK had been produced by modern PWRs, the amount of waste produced would be one tenth of that from the nuclear power stations currently being de-commissioned.

4.3 The biggest nuclear engineering challenge is the creation of commercially viable nuclear fusion reactors. These would use a virtually inexhaustible supply of fuel (derived from water and lithium, which is abundant), and would not directly generate any radioactive waste (the components would become activated, but with suitable choices of materials, could be recycled within a hundred years, leaving no waste requiring long term storage).

The International Tokamak Experimental Reactor (ITER) to be built in France should go a long way to establishing whether fusion power is feasible, although formidable materials and engineering challenges will have to be tackled in parallel to ITER. The UK has held a prominent position in fusion research thanks, in a large part, to the location of the Joint European Torus (JET) at Culham in Oxfordshire. This facility will be decommissioned in the coming decade and the UK's position will decline unless the UK's fusion programme (which is poorly funded compared to programmes in other major European countries) is expanded to allow the UK to contribute to its full potential in support of ITER and in addressing the engineering and material challenges.

A new UK research and development facility would be highly desirable, either building on the UK's own innovative Spherical Tokamak or in support of work on fusion technology and materials (an obvious candidate is an installation which could expose materials to intense fluxes of energetic neutrons).

5. The overlap between nuclear engineers in the power sector and the military.

5.1 The main overlap occurs in the engineering disciplines listed in paragraph 4.1 above, ie non-destructive inspection, corrosion, structural integrity, and safety and reliability engineering, remote handling, and waste disposal techniques.

5.2 There will always be concerns that any expansion of civil nuclear power programmes will increase the risk of leakage of the technology that permits the enrichment of fissile materials to weapons grade levels. There is therefore the utmost need to continue to prevent the leakage of technology, and to control the trading and prevent the theft of materials with bomb making potential.

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