PART A
Introduction

1. Introduction

1.1 Study purpose and background

Decommissioning and cleanup of the global nuclear legacy represents a massive management, technological and environmental challenge for the UK over the next century. The Nuclear Decommissioning Authority (NDA) will be responsible for a work programme lasting for decades worth billions of pounds and the development of a long-term, diverse, robust and competitive supply chain. The scale of investment required by the UK alone is £56 billion, opening up opportunities for both existing companies and committed new entrants. This is dwarfed by the global market, estimated to be worth £300 billion for reactor decommissioning alone over the next 30 years, providing major opportunities for the UK. However, there is a key issue relating to the existing nuclear supply chain capability and capacity to exploit future global opportunities in nuclear decommissioning.

In addition to nuclear decommissioning, diversification opportunities may also exist in non nuclear sectors such as oil & gas, defence sectors etc; for the existing nuclear industry. However, development of a robust supply chain will need to address both capacity and capability requirements to meet future market demands for nuclear and non nuclear decommissioning work and services. Creating an open and competitive environment will open up greater opportunities for companies at Tier 1, Tier 2 and Tier 3 levels. However, the level of awareness in other industry sectors, especially by Small or Medium Enterprises (SME's) of potential supplier opportunities, understanding of supply chain dynamics and scope for technology/skills transfer is mixed. Furthermore, there is generally lower awareness overall of the greater opportunities offered by the global nuclear decommissioning market, in terms of scale, timing and demand forecasts. This will have implications on the UK's supply chain capability and capacity to exploit the global market place. Companies therefore need to be better informed in order to respond to future opportunities.

DTI and its partners UK Trade and Investment (UKTI) and Scottish Development International (SDI) commissioned this study to review the global nuclear decommissioning market and non-nuclear decommissioning markets (UK only) to assess opportunities for the development of a strong and internationally competitive UK supply industry. A mini-management group steered and managed delivery of the study.

Key objectives for the study were to provide:

- Detailed information to support UK industry to decide which markets to enter
- Guidance on "market entry strategies"
- A world marketing plan
- A SWOT analysis of UK capabilities Vs international capabilities

1.2 Methodology

The study has been carried out using face to face meetings with a range of UK and overseas nuclear industry suppliers and major stakeholders, telephone interviews with nuclear industry suppliers and international desks, internet and literature searches, reviews of information held in Nuclear Industry Association (NIA) databases and company annual reports.

1.3 The UK Nuclear Industry Past, Present and Future

In the 1940's Britain started producing plutonium at Windscale for defence purposes.

In the 1950's an Act of Parliament set up the United Kingdom Atomic Energy Authority (UKAEA) to be responsible for research and development of both civilian and military atomic energy.

In the 1970's BNFL was set up by the government to be responsible for fuel manufacture and the management of spent fuel and radioactive wastes. It went on to reprocess used fuel from overseas.

Responsibility for nuclear weapons passed from UKAEA to the Ministry of Defence; leaving UKAEA to focus on the civilian nuclear industry.

Construction began at Calder Hall in Cumbria in 1953 on the UK's first commercial nuclear power station. Calder Hall was connected to the national grid in 1956, thus becoming the first nuclear power station in the world to provide electricity commercially. The reactors at Calder Hall were a prototype of the Magnox gas cooled reactor. A second prototype Magnox station at Chapelcross in Dumfries and Galloway was switched to the national grid in 1959. These stations have recently closed.

Following these prototype stations, nine further full scale Magnox power stations were built in the UK. Construction of the first of these began in 1957. Four of these stations are still in operation. Five are closed and are being decommissioned.

The Magnox nuclear power stations were the first generation of nuclear reactors to be built in Britain. The stations were constructed between 1956 and 1971 for the Central Electricity Generating Board (CEGB), United Kingdom Atomic Energy Authority (UKAEA) and the South of Scotland Electricity Board (SSEB).

During the early 1970's a new generation of reactors was introduced: the Advanced Gas-cooled Reactors (AGR's). In 1987 construction of Britain's first Pressurised Water Reactor at Sizewell B commenced followed by commissioning of the plant in 1995. Since Sizewell B, no further nuclear reactors have been built or ordered in the UK.

In 1989 the CEGB/SSEB was part-privatised, with National Power and PowerGen created to run the UK's fossil-fuelled power stations, and two newly-formed companies were created to look after the nuclear stations: Nuclear Electric plc and Scottish Nuclear Ltd.

In the 1990's part of UKAEA was privatised as AEA Technology. UKAEA remains responsible for decommissioning many nuclear facilities.

Britain started decommissioning three civilian power stations and four prototype and demonstration reactors operated by UKAEA.

In 1994 the more modern AGRs and the PWR were transferred to British Energy plc, which was subsequently privatised. This left the older Magnox stations to be formed into Magnox Electric plc, a government-owned company.

In 1998 Magnox Electric plc was transferred to BNFL as a wholly owned subsidiary and Magnox Generation was formed, bringing the power stations of Magnox Electric and BNFL together.

In 2001 the UK Government took a decision to create the Nuclear Decommissioning Authority. The NDA was launched on April 1st 2005 and has strategic responsibility for the decommissioning and clean up of all 20 of the UK public sector civil nuclear sites. The NDA was set up by the Government under the Energy Act 2004 and from 1st April 2005 the NDA became responsible for the nuclear facilities currently managed by British Nuclear Group which is now part of British Nuclear Fuels (BNFL) plc and the United Kingdom Atomic Energy Authority (UKAEA).

The UK Government and the devolved administrations for Scotland and Wales are currently considering the options for a UK policy for all forms of radioactive wastes. In September 2001 the UK Government published a consultation paper, 'Managing Radioactive Waste Safely – Proposals

for developing a policy for managing solid radioactive waste in the UK'. A period of public consultation followed until March 2002. In July 2002 the government announced that, following these consultations, a new body, the Committee on Radioactive Waste Management (CoRWM) would be set up. This has the brief of assessing the options for managing solid radioactive waste and recommending to UK ministers the best solution that will achieve long-term protection for people and the environment. It is expected that this should reach a conclusion in 2006. Following this a Government decision on the UK's long term waste disposal strategy and construction of a disposal store will begin.

A programme of decommissioning the Magnox reactors began a number of years ago and closure dates for all of the remaining Magnox reactors have been announced with the last Magnox reactor set to close in 2010, the last AGR in 2023 followed by the last PWR reactor in 2035.

The last Energy White Paper outlined the Government's position on nuclear energy which was no more than to keep the nuclear option open. Subsequently there have been indications that nuclear power should be considered as part of a balanced and diversified energy mix for the UK and to assist in meeting its CO_2 emission reduction targets. There is current optimism that new nuclear plants will be constructed in the UK in the foreseeable future.

1.4 UK Non Nuclear Industries Past, Present and Future

Offshore

The UK oil & gas offshore industry was established over 30 years ago during early exploration and production in the North Sea. Since the 1970's major offshore development has taken place in the North Sea and other regions around the world. The UK's supply industry is now generally recognised to be world class.

The oil & gas industry is heavily regulated by the Health and Safety Executive (HSE) under the provisions of the 1998 Petroleum Act. Within the UK continental shelf (UKCS) area of the North Sea there are currently over 200 offshore platforms that will require decommissioning at some stage. This will include topside and structures, jackets, subsea structures, pipelines etc and possibly drill cuttings.

Decommissioning activity in the North Sea is gathering pace as oil fields become depleted or uneconomic. However, there is currently a drive to extend the working lives of these marginal fields. A UK offshore

decommissioning supply industry is already established, providing a comprehensive range of specialist services, technologies and techniques. However, major decommissioning programmes for offshore platforms over the next 30 years could create supplier capacity issues, requiring future supply chain development. This is major objective of DTI, which is implementing a number of supply chain development initiatives.

Fossil power generation

Fossil fuel based power generation including coal, gas, oil and others has historically accounted for the highest proportion of the UK's energy mix. During the 1970's the UK's policy was for grid connected large mass burn coal fired power stations. Coal power stations were built by larger engineering groups e.g. Babcock, NEI etc and larger construction companies e.g. Bechtel, Foster Wheeler etc. The policy changed with the 'dash for gas' in the late 1980's and 1990's offering cheaper and cleaner energy. Gas fired power stations were smaller and often supplied power to local communities and larger energy consuming sectors such as chemicals and petrochemicals, where some large companies opted for distributed power. There are currently over 40 operational gas fired power stations In the UK.

The UK has a legacy of older fossil power stations (92) that will require decommissioning up to 2036, although there is a major drive to extend the life of these power stations beyond typically 30 years due to security of future energy supplies. However, fossil power plant will have to be decommissioned at some stage in the future.

Although fossil fuels, especially coal, will remain an important part of the UK's energy mix for some time, increasing use of renewables and possible growth in nuclear power will impact on future new build programmes of fossil fuel power stations.

Defence (non nuclear)

The MOD is one of the largest landowners in the United Kingdom and currently spends over £1bn per annum on its estate. The defence estate comprises some 240,000 hectares (ha) in the UK with over 4,000 sites. Sites can be broadly described as "built" (barracks, naval bases, depots, aircraft hangars, etc) or "rural". The built estate covers around 80,000 ha, including more than 45,000 buildings (excluding housing), and it is on this that most expenditure is concentrated. As well as military facilities, the defence estate contains 289 Sites of Special Scientific Interest (SSSIs), 48 special protection areas, and over 650 statutorily protected buildings.

Since the end of the cold war, the MOD has been reducing the size of it's estates and is decommissioning many of its bases, facilities, ships and armaments. It also has a legacy of hazardous waste materials at establishments such as Porton Down, since it was built in 1916. Much of this work is subcontracted out to the specialist contractors in the private sector through the Defence Estates via MOD Contracts:- www.contracts.mod.uk/dc/index.htm

The vision for the defence estate was set out in the MOD publication 'In Trust and on Trust: The Strategy for the Defence Estate', which was published on 7 June 2000. One of the key components of the Strategy is a departmental view on which of its sites are 'core' to delivering its long-term business. Under the Core Sites project, the MOD though its Defence Estates is undertaking a review of existing sites that are core to delivering the UK's defence capability beyond the next 10-15 years. A core sites implementation plan has been developed that will dispose of non-core facilities, some of which have decommissioning requirements. To deliver solutions to defence estate requirements, DE will use the principles of SMART Acquisition through Public Private Partnerships (PPP). Private Finance Initiatives (PFI) such as Project Aquatrine (to provide for MOD's water and wastewater requirements) will continue to be used where appropriate.

Green ship recycling

Ship breaking and scrapping of merchant vessels and warships is an international business, which has historically been undertaken in shipyards around the world, where the UK was a major player during the first half of the last century. In the 1980s and 1990s much of this activity moved to countries such as Taiwan, South Korea and China. Today the bulk of merchant shipbreaking is carried out in India, China, Bangladesh and Pakistan, which jointly account for some 98% of the world market.

In 2003 the EU adopted legislation to accelerate the phase out of the single hull oil tanker and the International Maritime Organisation (www.imo.org) developed similar rules for the worldwide fleet of single hull tankers. This will result in potentially huge numbers of ships destined for scrapping. However, there is currently a global shortage of ship recycling facilities with environmental credentials. Although the UK has about 9% of the merchant tanker fleet, there is limited ship breaking facility capacity available apart from specialist ship breaking and recycling companies such as Able UK in North East England, waste management companies handling hazardous waste and the wider recycling industry.

In 2003 IMO issued guidelines for ship recycling practices to address safety and environmental issues. The concept of a "Green Passport" for ships is included in the guidelines. It is envisaged that this document, containing an inventory of all materials potentially hazardous to human health or the environment, used in the construction of a ship, would accompany the ship throughout its working life. Produced by the shipyard at the construction stage and passed to the purchaser of the vessel, the document would be in a format that would enable any subsequent changes in materials or equipment to be recorded. Successive owners of the ship would maintain the accuracy of the Green Passport and incorporate into it all relevant design and equipment changes, with the final owner delivering it, with the vessel, to the recycling yard.

IMO plan to develop a legally binding and global applicable regulations for ship recycling for international shipping and recycling facilities for implementation by 2008-2009.

Industrial plant

Industrial plant covers a diverse range of facilities covering numerous industry sectors including manufacturing, engineering and processing. The UK's industrial base has undergone major changes over the last 50 years in terms of its size and composition, with manufacturing now accounting for less than 20% of GDP and corresponding growth in the service and knowledge based sectors.

Over the last 50 years industrial plant owners faced limited liability when facilities shutdown, often left to stand derelict or mothballed for decades. Regulation was covered under the Provisions of the Occupiers Liability Act 1957, the Occupiers Liability Act 1984 and the Water Resources Act 1991. Today there is still limited liability and onus on owners to decommission and remove industrial plant, unless there are health and safety issues.

Major regeneration of brown field sites has taken place across the UK over the last ten years, which has driven private and public sector investment. This has created significant opportunities for decommissioning, demolition of buildings and site remediation. A large project may involve managing contractors, usually large civil engineering groups, waste management contractors and providers of specialist services e.g. land remediation.

The UK still has a considerable industrial legacy which offers long term opportunities for decommissioning industrial plants covering hundreds of sites. The existing supply industry is well established with limited capability/ resource gaps and therefore potential for new entrants.

Mining

For the purposes of this study, mining includes coal, minerals and metal extraction.

The Coal Authority has some 200 historic liability sites from the last century including pumping stations, monitoring stations, gas venting sites, contaminated water and settlement lagoons where the UK has a major environmental legacy from decades of inadequate administration or failure to close mines and processing plants with disputed ownership.

Over 40 open cast sites and 8 deep coal mines are still operating in the UK. Many coal mines are also mothballed for possible future commercial activity with owners taking a wait and see approach. Coal mining activity in the UK is currently stagnant or in decline, however the situation could change if the high energy costs and energy security issues remain in the long term.

Mineral and metal extraction is also declining in the UK due to depleting natural resources or increasing costs and environmental regulation. Conversely, other counties are expanding their mining and processing sectors to meet global demand especially from China and India. Around 2400 active mines, quarries and hundreds of mineral processing plants exist today in the UK. These are often large scale developments that may impact on the environment. Early planning for closure is required for land and community care and sites are usually turned to nature conservation, recreational and regeneration.

Overall the mining sector offers long term prospects over the next 30 years, although currently limited. Post site monitoring is likely to become the responsibility of third parties with insurance bonds or special funding. Due to the nature of the mining industry, future requirements will be for demolition, waste management, site rehabilitation, monitoring and continuous maintenance services.

Refineries

In the 1970's the UK had 17 operational plants refining crude oil both from the North Sea and imports into fuel products and feedstock for chemicals, plastics etc. During 1980's and 1990's global refining capacity increased and prices fell, resulting thin profit margins and refinery closures. From a total of UK 17 refineries in 1976, five were decommissioned by 2000.

Today there is a global shortage of refining capacity due to exceptional growth in demand, mainly from China and India. The net result is record fuel prices, which analysts forecast are sustainable above $60 per barrel in the medium term. In the UK most refineries are between 30-40 years old and there are major drives within the industry to extend the life of existing production facilities.

1.5 Policy Objectives of Nuclear D&D (Decommissioning & Dismantling)

A number of countries have been involved in the earliest development of nuclear technology since the 1940s and 1950s. These countries have a wide range of plant and equipment that has now served its purpose and needs to be decommissioned and dismantled. This range includes R&D facilities for chemical processing, uranium and plutonium production, isotope separation, nuclear fuel fabrication, etc; as well as research reactors, critical assemblies, materials research reactors and various designs of experimental and demonstration reactors, including fast breeder reactors, and high temperature reactors with special fuels. The list also includes processing facilities associated with mining uranium and facilities for the treatment and storage of a wide range of radioactive wastes. In addition, some countries have facilities associated specifically with nuclear weapons production and with naval nuclear propulsion systems.

Even though individual facilities may be relatively small, this inventory of historic facilities presents a range of complex nuclear technical challenges compounded, in some cases, by the presence of non-radioactive, hazardous substances such as asbestos and PCBs. The difficulties of dealing with these older facilities are exacerbated by the fact that some original documentation may be difficult to retrieve, and the original designers and staff have retired in most cases. Nevertheless, substantial progress on decommissioning these facilities has already been made and valuable technical experience has been gained on a wide range of technologies.

A new range of challenges opens up as the more modern nuclear power programmes mature and large commercial nuclear power plants approach the end of their useful life by reason of age, economics or change of policy on the use of nuclear power. The scale of such challenges may be judged from the fact that over 440 nuclear power plants have now been constructed and operated worldwide. They include gas-cooled reactors (GCRs), boiling-water reactors (BWRs), pressurised-water reactors (PWRs), pressurised heavy-water reactors (PHWRs) and various types of demonstration plants such as high-temperature reactors (HTRs) and liquid metal cooled fast-breeder reactors (FBRs). Only about 80 of these power plants have been retired from service, including the early demonstration plants. For the most part, these are smaller units and are either being maintained in a safe condition under surveillance after removal of fuel, or are being decommissioned. Some commercial nuclear power plants have been decommissioned and dismantled and in some cases, their sites returned to unrestricted reuse of the site. In addition to power plants, there are

associated nuclear fuel fabrication and irradiated fuel reprocessing facilities, at least parts of which have been, or soon will be, retired from service.

Detailed plans for global decommissioning depend on the circumstances and policies of individual countries. Current thinking, however, generally involves consideration of three main strategies:-

- Immediate decontamination and dismantling
- Safe storage
- Entombment

Any organisation wishing to decommission nuclear power stations and other nuclear facilities must ensure that proposals are consistent with national policy. The national policy on decommissioning in the UK is set out in the 1995 Government White Paper Cm 2919. This has recently been updated by a statement of the UK Government and devolved administrations on "The Decommissioning of the UK Nuclear Industry's Facilities" September 2004.

UK practice varies according to the particular circumstances of a facility. In general, stage 1 decommissioning is carried out promptly following shutdown. The later stages of decommissioning are scheduled in order to reduce the hazards presented by the facility in a progressive and systematic way.

UK operators of commercial reactors are seeking to defer the later stages of decommissioning of their redundant reactors. Following de-fuelling and removal of most plant and facilities external to the bio-shield, the bio-shield will be sealed. For the steel pressure vessel Magnox reactors, the external pressure circuit and steam generators will also be safe stored. The reactor will be allowed to decay for up to 100 years before final dismantling and clearance of the site takes place. This is known as the "safestore" concept. The contents of a safestore should be chemically and physically stable, with appropriate containment, and placed in the store in a manner which minimises the need for safety mechanisms, maintenance, monitoring and human intervention, but also in a manner which facilitates retrieval for final disposal.

The regulatory regime for a safestore is expected to be no different to that for an operational plant. The licensee will have to prepare safety justifications covering all credible faults and ageing. Modifications of systems and structures by licensees, periodic safety reviews and maintenance, care and surveillance, etc, would all be regulated under the standard conditions attached to the nuclear site licence. The environment agencies would expect to see continued adherence to the requirements of authorisations for radioactive waste disposal.

The ultimate aim of decommissioning is to release the site for unrestricted use, although it is recognised this may not be realistic for all sites. Nuclear licensed sites can be delicensed under the Nuclear Installations Act when the HSE is satisfied that there is no danger from ionising radiation on the site. A number of small sites and parts of sites have been delicensed on a case-by-case basis and HSE is developing criteria to use in the future particularly for some of the larger sites.

National policy on the process for decommissioning varies throughout the world. However, the Nuclear Energy Agency, Organisation for Economic Co-Operation and Development has published a report which draws upon a database of fact sheets produced to a standard format by individual member countries. The report is entitled "The Decommissioning and Dismantling of Nuclear facilities: Status, Approaches, Challenges "and can be accessed online from the NEA web site at:- www.nea.fr/html/rwm/wpdd/

1.6 The UK decommissioning supply chain structure

1.6.1 Nuclear

A recent NIA Study has indicated that the supply chain in the UK will consist of three main tiers. Organisations at tier 1 will deliver against contracts awarded by the NDA and will earn fees from delivering agreed Near Term Work Plans (NTWP's). Current tier 1 organisations for the NDA sites are the existing site licensees who hold the M & O contracts for their sites. This situation will change in the future as it is an NDA target to compete at least half the sites by the end of 2008. The supply chain model shows a larger number of tier 1 companies competing for contracts to manage and operate sites and dealing with a reduced number of tier 2 companies which in turn will manage companies lower down the supply chain at tier 3 and below.

All of the major contractors in the UK nuclear supply chain are members of the Nuclear Industry Association (NIA) and links to all of these company web sites (115 currently) can be found on the NIA member's web site home page at www.niauk.org/members

Further details of nuclear industry suppliers can be found on the web sites of the main UK site licensees who publish details of companies who have been awarded contracts for supply of goods and services.

The Foratom web site has a list of 63 UK Companies working in the UK nuclear industry, many with links to their company web sites providing details of their products/services together with contact information. See: – www.foratom.org Click on "links" on the homepage, then "companies" and scroll down to UK.

A survey of a typical cross section of nuclear industry suppliers drawn from a sample of 90 NIA member companies has been undertaken and split in terms of category of supply. The table of results is included in Part C Section 5 of this study and is discussed there.

1.6.2 Non Nuclear

Offshore

Operators of offshore platforms are responsible for decommissioning facilities after final shutdown. These range from majors such as BP, Shell etc and more recently, smaller independent operators. Decommissioning is usually outsourced to tier 1 main contractors who subtract work packages to tier 2 and tier 3 companies supplying a diverse range of services. Operators are members of the United Kingdom Offshore Operators Association (UKOOA). Suppliers are represented by many different types of trade association including the Offshore Contractors Association (tier 1) to various industry and regional organisations. A full list of trade associations is published by the Trade Association Forum www.taforum.org.

Fossil power generation plant

Owners and operators of coal, oil and gas fired power stations have responsibility for end of life decommissioning of facilities. These range from large utility companies, independent generators and large industrial energy consumers with on-site energy production capabilities. Decommissioning is usually managed by a main tier 1 contractor, typically civil engineering groups, who may undertake decommissioning activities themselves and subcontract out work packages to specialist tier 2 and tier 3 suppliers. Operators and owners are represented by a number of trade associations e.g. the Association of Energy Producers www.aepuk.com. Representation of the supply side is more fragmented with companies affiliated to different industry association. Some are also members of the NIA.

Defence (non nuclear)

Decommissioning facilities are managed through the MOD Defence Estates (www.defence-estates.mod.uk). Decommissioning covers many different requirements from simple demolition of buildings to safe removal and treatment of hazardous wastes. Most work is undertaken by sub contractors ranging from large engineering groups to small providers of various services. Procurement will depend on size of contract, where large contracts are usually awarded to main contractors or directly to companies providing the service for small contract. Contract notices are placed on the MOD Contract

Portal www.contracts.mod.uk/dc/index.htm and suppliers have to be approved under MOD through vendor assessment schemes. No single trade association covers decommissioning suppliers, although a number of them are members of the Defence Manufacturers Association, NIA, Civil Engineering Contractors Association and numerous others.

Green ship recycling

Scrapping and recycling of ships is the responsibility of owners. However, ships are often sold on to third parties who then take on the responsibility. In the UK, contracts are awarded to specialist companies such as Able UK to remove equipment, treat hazardous wastes, break up vessels and recycle materials. These companies may subcontract certain activities e.g. waste treatment to other suppliers. However, there are only a few companies with the necessary facilities such as dry docks to undertake the work.

Industrial plant

Decommissioning industrial plants can involve various activities including demolition of building, removal and recycling of equipment, treatment of wastes, land remediation and landscaping. Contracts are usually placed with civil engineering contractors and tier 2 and tier 3 suppliers. Many of these contractors also carry out decommissioning work in other non nuclear sectors and the nuclear industry.

Mining

A decommissioning supply industry for the mining sector is well established with licensed contractors. They provide a range of services in areas such as environmental services, demolition, waste management, land remediation, monitoring and maintenance. Suppliers are members of various industry associations such as the Coal Mine Contractors Association (CMCA), Engineering Construction Industry Association (ECIA) etc.

Refineries

Due to the low refinery decommissioning activity in the UK, there is no dedicated supply industry, although there is routine maintenance and refurbishment work carried out by specialist subcontractors. Actual decommissioning of refineries will be undertaken by contractors working in other sectors e.g. civil, offshore etc.