THE APPLICATION OF THE WASTE HIERARCHY TO THE DECOMMISSIONING OF THE UK'S CIVILIAN NUCLEAR LIABILITIES

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ABSTRACT

On the 1st of April 2005 the United Kingdom's Nuclear Decommissioning Authority will become responsible for the enormous task of decommissioning the UK's civilian nuclear liabilities. The success of the NDA in delivering its key objectives of safer, cheaper and faster decommissioning will be dependent on a wide range factors. It is self-evident, however, that the development of robust waste management practices by those charged with decommissioning liability will be at the heart of the NDA's business. In addition, the implementation of rigorous waste minimisation techniques throughout decommissioning will deliver tangible environmental benefits as well as better value for money and release funds to accelerate the decommissioning programme.

There are mixed views as to whether waste minimisation can be achieved during decommissioning. There are those that argue that the radioactive inventory already exists, that the amount of radioactivity cannot be minimised and that the focus of activities should be focussed on waste management rather than waste minimisation. Others argue that the management and decommissioning of the UK's civilian nuclear liability will generate significant volumes of additional radioactive waste and it is in this area where the opportunities for waste minimisation can be realised.

In the United Kingdom the principle of the waste hierarchy has been developed to encourage everyone who has the potential to create waste to adopt a systematic approach to the minimisation and management of waste. The waste hierarchy has been one of the key tools in establishing the National Waste Strategy for Scotland and has been successfully adopted by organisations throughout the UK.

This paper will describe the waste hierarchy and examine the arguments for its application during the decommissioning of the UK's civilian nuclear liabilities. It will conclude that the development of a systematic approach to waste management and waste minimisation will result in environmental benefits and improved business performance. Ultimately the application of the waste hierarchy will assist the NDA in achieving its goals of safer, faster and cheaper decommissioning.

INTRODUCTION TO THE WASTE HIERARCHY

The waste hierarchy concept has been around for a number of years. It has been used to inform waste management policy making at a number of levels ranging from national and international strategies through to plant based operational philosophies. The Organisation for Economic Collaboration and Development (OECD) have been looking at principles associated with waste prevention and minimisation since 1995 and have concluded that

> *Although the concept of waste prevention is broadly accepted, it is now apparent that ever-growing waste amounts, waste diversity, and associated risks, are heightening the need for governments to vigorously pursue waste prevention as an essential component of strategy for a sustainable future.*

The UK Government and Devolved Administrations have acknowledged the challenges on our society from waste production. In the recently published National Waste Strategy for Scotland the Minister responsible for the environment stated that

> *Every year in Scotland we bury millions of pounds, squandering valuable resources and contaminating the environment on which we all depend. Waste is just that – a squandering of wealth, material resource and energy. It is for this reason that tackling waste is at the heart of the Scottish Executive's approach to sustainable development.*

International bodies and Governments are expending efforts to limit the generation of waste and to reduce the amount that will eventually require disposal. Some countries have used the waste hierarchy and implemented aggressive measures to help them achieve challenging targets. Despite this commitment, however, OECD reports that the amount of waste being created and requiring disposal is on the increase.

SO WHAT IS THE WASTE HIERARCHY?

The waste hierarchy is a systematic approach to preventing, minimising and managing wastes. In the majority of cases the definition of waste includes energy. A number of organisations have developed models for the waste hierarchy. These vary in their complexity and are often adapted to match the context in which the application is set.

Two examples are provided below:

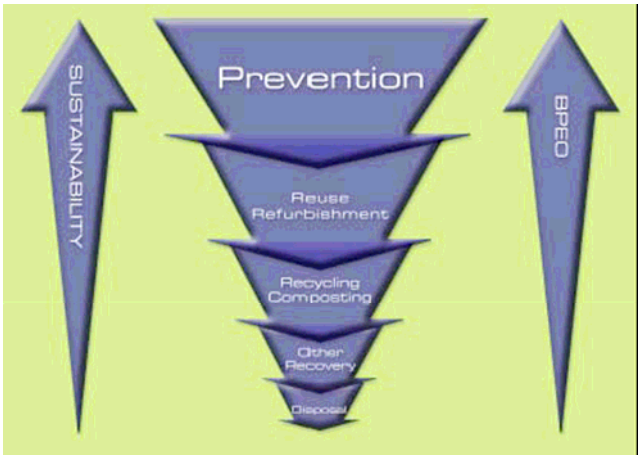

Fig. 1. Waste Hierarchy Model Taken From the Scottish National Waste Strategy.

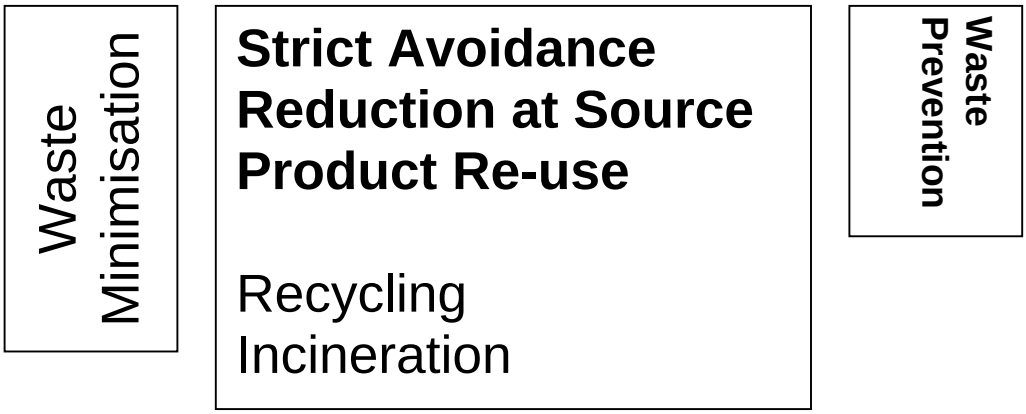

Fig. 2. OECD Waste Prevention and Minimisation Model.

DEFINITION OF THE SEQUENTIAL PRINCIPLES THAT CONSTITUTE THE WASTE HIERARCHY

The definitions of the sequential principles constituting the waste hierarchy are best explained used a simple example - taking a drink of water.

Elimination/Strict Avoidance. The activity that gives rise to the generation of waste is avoided. In the case of our example this could mean not having a drink of water! In reality it would mean drinking directly from the tap or water fountain.

Reduction at Source. The amount of waste generated to support an activity is reduced as part of the manufacturing/generating process. For our example this could mean putting the water in the bigger bottles or using larger glasses to serve it in.

Reuse/Refurbishment. Waste is collected, refurbished and reintroduced in the supply chain. For a drink of water this would relate to the large bottles used in office water coolers that are collected, cleaned and refilled.

Recycling. Waste is collected, treated and reintroduced as a 'raw' material to the manufacturing process. In our example this would be bottles that are collected, crushed and reformed into new bottles.

Other Recovery Value is recovered from wastes that may not result in materials re-entering the supply chains. For our example this could involve recovering energy from a plastic bottles in a waste-to-energy process.

Conditioning. Waste is treated to make more efficient use of disposal routes. Some mineral waters now come in bottles that can easily be crushed so that they take up less space in waste receptacles.

Disposal. Waste is directly disposed of without treatment. For our example this would be throwing an empty water bottle in the bin.

THE WASTE HIERARCHY AND NUCLEAR DECOMMISSIONING

The UK's civilian nuclear liability is diverse and complex – the result of over 50 years of research, power generation and chemical reprocessing. Standards and expectations have changed enormously since the first nuclear plants were constructed and operated. The challenge of decommission, the liability and the associated remediation of the sites is, therefore, significant.

Managing these wastes will represent one of the most significant costs in discharging the UK's nuclear liability. The number and range of waste streams present within the UK civilian liability is considerable. Decommissioning and site remediation will result in the construction of new facilities to manage the wastes that will arise from discharging the liabilities. These will present additional waste streams and associated challenges.

When the UK Nuclear Decommissioning Authority is formed in April 2005 contracts to decommissioning civilian sites will be progressively competed. The contracts will reward operators who are able to set and meet challenging decommissioning targets. The message is simple. Successful decommissioning will be dependent on good waste management. If contractors can't manage their wastes they won't be able to meet to their decommissioning targets. If they don't meet their decommissioning targets they won't make any money.

There appear to be two schools of thought in the UK related to the application of the waste hierarchy to nuclear decommissioning. Some argue that the radioactivity associated with the liability already exists, that opportunities to prevent and minimise radioactive waste are limited and that the focus of activities should be on the lower end of the hierarchy (recycle, recover, condition, dispose). There are others who acknowledge that decommissioning has the potential to generate significant quantities of secondary radioactive wastes and that the focus should be on the upper end of the hierarchy.

BENEFITS OF APPLICATION OF THE WASTE HIERARCHY

There are a number of benefits to be achieved from applying the waste hierarchy to civilian nuclear decommissioning projects in the UK. These are briefly summarised below:

Operational and business needs. As stated above good waste management is good for business. Waste prevention and waste minimisation can improve an operator's competitive edge by driving down capital and operating costs. If you don't build it or use it then it doesn't need to be decommissioned or disposed of. Money saved from waste prevention and minimisation can be spent earning profit on meeting targets within programmes.

Customer requirements. The NDA will look for the best value for the money for the British taxpayer when selecting prospective contractors to operate its sites. Waste management facilities in the UK are also limited. Preventing and minimising waste will not only allow NDA funds to be spent more effectively on individual sites but will reduce the need to invest in new or expanded waste management facilities.

Regulatory requirements. A plethora of regulations is in place that is relevant to nuclear decommissioning programmes. Waste management features prominently. There

is an expectation by UK regulators that the accumulation of waste on nuclear sites will be minimised and that best practicable means will be used to minimise the volume and activity created and disposed of.

International and Government policy. Numerous international treaties exist that have been developed and implemented to protect both global and local environments. Many of these are enshrined in Government policy to which operators of nuclear plants are expected to comply.

Community Expectations. Communities are becoming increasingly aware of environmental issues. Scotland's National Waste Strategy, which promoted the waste hierarchy, involved extensive engagement with communities over municipal and some industrial wastes. Radioactive waste was excluded from the strategy. There is an opportunity to align waste prevention and minimisation practices more closely with those developed for conventional wastes.

SUCCESSFUL APPLICATION OF WASTE HIERARCHY BY NUCLEAR OPERATORS IN THE UK AND INTERNATIONALLY

Many examples exist where the waste hierarchy has been successfully applied. Three examples are provided below. These examples demonstrate where benefits have been achieved at different levels within the hierarchy – elimination/prevention, recycling and conditioning.

Cost Savings of DOE's Return on Investment Programme. In 1999 the US Department of Energy published the results of study on it Return on Investment programme that it had commissioned from Oak Ridge National Laboratory. DoE had considered that it was not receiving significant cost benefits from the programme and the purpose of the study was to determine the programme should be continued. The main finding of the study was that Return on Investment initiatives delivered significant benefits across the lifecycle of the projects. In particular, a project that involved a relatively minor modification to an evaporator resulted in the elimination of approximately 370m^3 of liquid waste and a saving of $22 million. What was interesting in this case was that the individual who held the budget for managing the evaporator did not realise any of the financial benefit from the modification and could not, therefore, make money available to instigate the necessary changes. The organisation as a whole benefited from the savings achieved over the process life cycle.

Many organisations do not achieve the real benefits of applying the waste hierarchy because of artificial barriers that are created for business purposes. The review of DoE's Return on Investment programme identified that by looking at the waste hierarchy and waste management in a holistic manner across the business real benefits can be achieved.

Recycling of Metals. Decommissioning on redundant facilities in Sweden resulted in the accumulation of large volumes of waste metals at nuclear plants. The majority of this metal was either free from radioactive contamination or contaminated to a low enough level for it to be exempt from requiring disposal under radioactive waste legislation. Studsvik, the operator of the sites, negotiated recycling opportunities with local scrap metal merchants and other members of the supply chain. Protocols were developed to ensure that the safety, environmental and commercial interests of all parties, including the

public, were protected at all stages in the process. The result was that valuable material was reintroduced in to the market place and disposal costs avoided.

Recycling of waste from nuclear facilities is a contentious issue. The supply chain and general public perceive commercial and safety implications from recycling. However, decommissioning will require the use of large amounts of metal for both new build and disposal concepts. Recycling nuclear waste back into the nuclear programme could alleviate public and commercial concerns. After all it is argued that to complete the recycle loop an organisation has to use recycled goods.

Super-compaction of Low Level Waste. Disposal capacity at the UK's national low-level radioactive waste repository at Drigg in the northwest of England is finite. Current estimates indicate that it has the capacity to take operational wastes from nuclear plants in the UK for a further 50 years. The impact on Drigg of decommissioning the UK's liabilities has yet to be fully understood. To maximise disposal capacity at Drigg the site operator requires that, where practicable all wastes are to be super-compacted. A number of sites in the UK have built plants for this purpose. However, most waste is super-compacted at Sellafield, which is adjacent to Drigg.

The most effective use of waste streams can be achieved by good conditioning of waste. Those plants that condition their wastes closest to the point of generation are able to benefit from efficiencies in waste handling, transportation and disposal.

CONCLUSIONS

Decommissioning of the UK's civilian nuclear liabilities present many challenges in the field of both radioactive and non-radioactive waste management. One of the most significant costs associated with decommissioning will be the management of these wastes. The waste hierarchy offers a systematic approach to waste management that encourages waste generators to challenge their waste creating operations throughout the lifecycle of their processes. Rigorous application of the waste hierarchy can deliver tangible benefits to the organisation, its employees, the public and the wider environment.

REFERENCES

Towards Indicators for Waste Prevention. OECD (Environmental Policy Committee). Sept 2004. ENV/EPOC/WGWPR/SE(2004)1/FINAL.
http://appli1.oecd.org/olis/2004doc.nsf/43bb6130e5e86e5fc12569fa005d004c/ef50b13775e7c9dac1256f20002e7eb4/$FILE/JT00170442.PDF

Strategic Waste Prevention. User Manual. OECD (Environmental Policy Committee). August 2000. ENV/EPOC/PPC(2000)5/FINAL.
http://www.olis.oecd.org/olis/2000doc.nsf/4f7adc214b91a685c12569fa005d0ee7/c12568d1006e03f7c125692e004f054a/$FILE/00081387.PDF

National Waste Plan 2003. National Waste Strategy Scotland. Scottish Environment Protection Agency, Scottish Executive. 2003.
http://www.sepa.org.uk/pdf/nws/guidance/national_plan_2003.pdf

Assessment of Cost Savings of DOE's Return-on-Investment Program. K L Yuracko, B Tonn, M Morris. Oak Ridge National Laboratory 1999. ORNL/TM-1999/155. http://www.ornl.gov/~webworks/cpr/rpt/104182.pdf

Conditions for Acceptance at Drigg. British Nuclear Fuels.