DEPARTMENT OF ENERGY & CLIMATE CHANGE

MANAGEMENT OF THE UK'S PLUTONIUM STOCKS

A consultation on the long-term management of UK owned separated civil plutonium

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Executive summary

Context

1. This paper is about the management of UK owned civil plutonium, of which the UK has accumulated significant quantities. In the 1950s plutonium separation was carried out for defence purposes. In the 1960s when it was thought that fossil fuels would run out, this plutonium was made available as fuel for fast reactors. This is because it was thought that fast reactors would in due course offer a potential energy solution, and so to make sufficient plutonium available for fast reactors the amount of accumulated plutonium was increased by reprocessing spent fuel. Eventually however, in 1994 the UK abandoned almost all research into fast reactors due to the realisation that they would not be commercially viable in the foreseeable future. The plutonium we accumulated still remains and at the moment is stored in facilities designed to meet high standards of safety and security, but there are currently no final plans on how it should be managed in the long-term.
2. The 2010 Review Conference of the Non-Proliferation Treaty, held in May 2010, reached agreement on a number of recommendations that include those relating to the management of fissile material. This was the first time for ten years that the international community had made and agreed such a statement. These specific recommendations recognise and reaffirm the security and non-proliferation sensitivities of plutonium and other fissile material and provide a strong, updated, basis to develop further the UK's long term strategy for this material. In taking this forward, the UK Government wants to do so in a way which engages stakeholder groups and the public, and balances the need for action with the need to ensure that the correct provisions are put in place.
3. The UK Government is now publishing, for public scrutiny and consultation, its proposed approach to the long-term management of plutonium. This proposed approach recognises that, in view of the non-proliferation and security concerns in relation to plutonium, it has a duty to develop a long-term vision for its future handling.

Current situation

4. The UK is currently storing about 112 tonnes of civil separated plutonium. This amount includes about 28 tonnes of material belonging to overseas customers. The plutonium stored in the UK has been derived largely from nuclear fuel reprocessing activities that have been ongoing at Sellafield since

the 1950's with the bulk of the UK's material owned by the Nuclear Decommissioning Authority (NDA) and a smaller amount by British Energy (a part of EdF Energy).

5. There are currently no final plans on how the plutonium should be managed in the long-term, but existing arrangements are based on what is in effect a default strategy, which is that the plutonium will be stored in specialised storage facilities that afford its security and safety for the foreseeable future.

Options for plutonium

6. Storage remains an option for managing the UK's plutonium as the technology is in use now and additional facilities can continue to be constructed as required to provide secure and safe storage into the future.
7. Continued long term storage would still require permanent disposal at a future date but would also leave a burden of security risks and proliferation sensitivities for future generations to manage on a continuing basis. Nonetheless, storage provides a safe and secure solution while alternative strategies are developed that can address the long term security risks and proliferation sensitivities of the plutonium by converting it to a form that could be disposed and put beyond reach.
8. Putting plutonium beyond reach can be achieved in two principal ways: (a) through disposal as an immobilised waste or (b) through reuse in the form of mixed oxide nuclear fuel (MOX) which, after use as fuel in nuclear reactors, leaves spent fuel in a state where it can be prepared for permanent disposal. The disposal of immobilised plutonium or irradiated MOX fuel has yet to be demonstrated in practice but plans are in hand for higher activity radioactive wastes and materials that may be declared a waste in the future, including spent fuel, uranium and plutonium.
9. There are various technologies that might be used to immobilise plutonium, prior to its disposal. However there is currently no immobilisation technology that can reasonably and reliably be used to manage all of the plutonium; existing techniques such as cementation are only currently realistic for incorporation of small amounts of plutonium per package whilst most other techniques have yet to move beyond the laboratory scale. What the UK Government understands is that in general the technologies that would realistically need to be pursued, for the quantity of civil plutonium in the UK, are less mature than that of a reuse option. In addition to the uncertainties associated with the treatment of plutonium to immobilise it, this option may necessitate significant costs in extending the size of a geological disposal facility necessary to receive the immobilised material. In particular this might be the case for cementation where only low incorporation rates are currently

permitted and so there could be around 200,000 tonnes of cemented waste for disposal.

10. Reusing plutonium as MOX fuel is a more mature option. For this reason it was adopted by the US and Russia as the method which will be used to manage their excess weapon grade plutonium under the Plutonium Management and Disposition Agreement that they both signed.

11. The manufacture of MOX fuel has been conducted in France with reactors in France capable of using the fuel, and to a limited extent elsewhere in Europe and Japan.

12. UK experience has, however, been much less successful: the Sellafield MOX plant has produced a small fraction of its original target with around 15 tonnes, as completed fuel assemblies, produced in its 9 years of operation against an original target of 560 tonnes over an expected 10 year operational life. The operational efficiency of this existing plant is improving as the UK knowledge base increases, however, any new MOX plant will be developed in light of the design and operational lessons drawn from these differing experiences overseas and in the UK.

13. MOX fuel has value. This can be used to offset the costs of converting the plutonium into MOX. However, the UK Government’s current expectation is that, at current uranium prices, the value of the fuel generated is significantly less than the costs of its manufacture: in other words, for the foreseeable future, manufacture of MOX is primarily a route for consuming plutonium stocks rather than a commercial operation in its own right.

Preliminary Policy View

14. Although there remain many practical issues to be resolved before any policy could be implemented, the UK Government believes that there is sufficient information available now to make a high level judgement as to the right strategic policy option for plutonium management. Rather than continuing to pursue all options with equal vigour, this consultation document proposes adopting a preferred solution, or preliminary policy view, for plutonium and then taking forward work to progressively address the practical issues of implementation. This does not mean that work on alternative options will cease, only that the Government’s focus would shift to the preferred option.

15. Storage of plutonium is an option that is available and being implemented now, but its continued long term storage has significant problems and, in particular, leaves a burden for future generations to manage, on a continuing basis, the security risks and proliferation sensitivities. Managing plutonium in

the long term requires tough decisions to be taken and storage is an option that avoids having to take those tough decisions now, but only in the knowledge that at some point in the future a decision will have to be taken because sites on which plutonium is stored will have to be decommissioned. Very long-term storage is less well understood and would require the NDA to spend money on ongoing storage facilities and on research into how ageing and radioactive decay processes may affect plutonium and its long-term storage.

16. The reuse as MOX option would require significant expenditure and construction of a major new plant but, it is based on proven mature technology that could be deployed on a reasonable timescale. Reuse as MOX reduces the burden of having stored separated plutonium for future generations. It also addresses, in part, the security concerns relating to possible terrorist activity by making the plutonium less attractive, and proliferation sensitivities associated with storing separated plutonium. A final disposal route, including a change to the baseline inventory for a Geological Disposal Facility (GDF), for the spent MOX fuel is required, alongside existing spent fuel disposal requirements. Disposing of spent MOX will have some impact on the GDF footprint though it would be less than an immobilisation option as we would not be disposing of both bulk immobilised plutonium and spent fuel from new build.

17. We know that immobilisation technologies are still at an early stage of development and that there is no guarantee that they will deliver a successful solution that is capable of managing the bulk of the plutonium. Even if the technology was available now, an immobilisation option would incur significant costs in developing, constructing and operating an immobilisation plant and associated stores. It may, particularly with respect to cementation, also incur a potentially significant extension of the required volume of a geological disposal facility.

18. The UK Government's view, set out for public scrutiny and consultation, is that based on these considerations and on the further analysis set out in this document, the information it has is at a sufficient level to at least set out a direction and take a reasoned preliminary policy view on how plutonium might best be managed in the long-term.

19. The UK Government believes that there is benefit in taking such a decision to set out a direction now for future plutonium management as it affords greater certainty than simply waiting to see what the future may bring. It demonstrates to the international community that the UK Government recognises the security and non-proliferation sensitivities of plutonium and is prepared to develop a long term strategy for managing this material. Setting a direction now will help with the NDA's future planning for plutonium and

allow research to be more focused on relevant areas. It will also allow the UK Government to be more focused on an option that presents the best prospect for success.

20. The UK Government's preliminary policy view is that proceeding on the basis that reusing plutonium either in the UK or overseas in the form of MOX fuel offers the best prospect to deliver a solution for long-term plutonium management.

21. This preliminary view will be conditional in that it will have to be tested to show that it is affordable, deliverable and offers value for money, taking into account safety and security requirements, before the UK Government will be in any position to take a final view. Work is ongoing on both the reuse and immobilisation options in support of this. While the UK Government believes it has sufficient information to set out a direction and take a preliminary policy view, it is not yet sufficient to make a commitment to proceed with a new MOX plant. As well as being open to the prospect that other credible options develop and are more attractive, the UK Government would have to be sure that reusing the plutonium would continue to represent the best prospect for long-term plutonium management.

22. For those reasons further ongoing work on the reuse option is necessary to be sure that such a direction can indeed be taken forward. If the conditions above cannot be satisfied, then the option may need to be amended or abandoned. The UK Government is not closing off alternatives, particularly because disposal options will need to be worked up in any case, to deal with an expected small percentage of waste plutonium from the existing inventory that would not be re-usable.

The way forward

23. This consultation marks the beginning of the UK Government's plan to develop a policy for plutonium management. It is where the UK Government sets out a direction of travel and takes a preliminary view on plutonium policy to be tested. Data will be gathered, including through this consultation, in order to develop and test the reuse option up to the point at which it can be regarded as credible for implementation or is shown to be clearly undesirable compared with other options.

24. Only when the UK Government is confident that it has a preferred option that could be implemented safely and securely, that it is affordable and offers value for money will it be in a position to take a final decision.

Consultation Questions

This document sets out the UK Government's proposed approach to the longer term management of the UK's plutonium stocks for public scrutiny and consultation. Comments on any aspect of this issue are welcome, but the key questions posed in this consultation are:

Q.1. Do you agree that it is not realistic for the UK Government to wait until fast breeder reactor technology is commercially available before taking a decision on how to manage plutonium stocks?

Q.2. Do you agree that the UK Government has got to the point where a strategic sift of the options can be taken?

Q.3. Are the conditions that a preferred option must in due course meet, the right ones?

Q.4. Is the UK Government doing the right thing by taking a preliminary policy view and setting out a strategic direction in this area now?

Q.5. Is there any other evidence government should consider in coming to a preliminary view?

Q.6. Has the UK Government selected the right preliminary view?

Q.7. Are there any other high level options that the UK Government should consider for long-term management of plutonium?

Details of the Consultation

How to respond

When responding please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

Responses should be submitted, preferably by e-mail, to:

Plutonium Consultation
Nuclear Policy Unit
Department of Energy and Climate Change
3 Whitehall Place
London
SW1A 2AW
Email: plutonium@decc.gsi.gov.uk

This consultation runs from 07 February 2011. **Closing date for responses is 10 May 2011.**

Additional copies

You may make copies of this document without seeking permission. Further printed copies of the consultation document can be requested at the above address

Other versions of the document in Braille, Welsh, other languages or CD are available on request

Confidentiality & Data Protection

Information provided in response to this consultation, including personal information, may be subject to publication or release to other parties or to disclosure in accordance with the access to information regimes (these are primarily the Freedom of Information Act 2000 (FOIA), the Data Protection Act 1998 (DPA) and the Environmental Information Regulations 2004). If you want information, including personal data that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

We will summarise all responses and place this summary on our website at www.decc.gov.uk/en/content/cms/consultations/ . This summary will include a list of names or organisations that responded but not people's personal names, addresses or other contact details

Help with queries

Questions about the policy issues raised in the document can be addressed to:

Plutonium Consultation
3rd Floor, Area C/D
Nuclear Policy Unit
Department of Energy and Climate Change
3 Whitehall Place
London
SW1A 2AW

Email: plutonium@decc.gsi.gov.uk

This consultation has been carried out in accordance with the Government's Code of Practice on consultation, which can be found here:

http://www.bis.gov.uk/files/file47158.pdf

If you have any complaints about the consultation process (as opposed to comments about the issues which are the subject of the consultation) please address them to:

DECC Consultation Co-ordinator
Area 6A
Department of Energy and Climate Change
3 Whitehall Place
London
SW1A 2AW

Email: consultation.coordinator@decc.gsi.gov.uk

Chapter 1

Introduction

1.1. Plutonium[1], chemical symbol Pu, is a metallic element which is atomic number 94 in the periodic table. The plutonium in the UK was derived from the reprocessing of irradiated nuclear fuel. These reprocessing activities have been ongoing at Sellafield since the 1950s and have resulted in the UK accumulating around 112 tonnes (metal weight) of separated plutonium, which is stored as an oxide powder. This is made up of about 84 tonnes which are UK owned and 28 tonnes which are foreign owned. The amount of material that is owned by the UK is expected to grow to around 100 tonnes when existing reprocessing operations for UK civil nuclear fuel have concluded.

1.2. In the 1950s plutonium separation was carried out primarily for defence purposes. In the 1960s it was thought that because fossil fuels would run out, nuclear power in the form of fast reactors[2] could offer a solution. However fast reactors need plutonium to start up and so to make plutonium available for fast reactors, surplus plutonium from the defence programme was re-classed as civilian and stored for future use. Recovery of plutonium from reprocessing of spent fuel from the UK's civil reactors added to the stockpile. At the same time, plutonium was thought to be valuable because the increasing number of reactors in the world fed an expectation that uranium would become rare and expensive

1.3. In 1994 the UK abandoned almost all research into fast reactors due to the realisation that fast reactors would not be commercially viable in the foreseeable future. Although progress has been made in demonstrating fast reactor technology, the fast reactors that exist today are either prototype power reactors or research and development reactors and, as yet, are not commercial power generating operations.

1.4. Despite this, and the accompanying realisation that uranium was not going to become rare and expensive, reprocessing operations continued. They continued because Magnox fuel had to be reprocessed for technical

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[1]. Further background information on plutonium can be found at http://www.world-nuclear.org/info/inf15.html

[2]A type of nuclear reactor that could increase the efficiency of existing uranium resources and offer the ability to burn the actinides which would otherwise form part of high-level nuclear wastes. http://www.world-nuclear.org/info/inf98.html

reasons[3] and because of existing commercial contracts with both overseas and UK reactor operators to reprocess other spent fuel through THORP.

1.5. The current plutonium management plans allow for its continued storage in specially constructed facilities that afford both security and safety. Nonetheless continued long term storage is not an easy or inexpensive option. A new modern state of the art storage facility to supplement and progressively replace the existing ones has just been built at the cost of several hundred million pounds. Over a period of time plutonium is expected to be transferred to this new facility, but further facilities will still be required in order to store all the plutonium because the remaining older stores will come to the end of their design life. If the UK Government continued with long term storage, the storage facilities recently completed, which have a design life of 50 to 100 years, will require ongoing refurbishment or replacement in the future.

1.6. Continuing storage, while safe and secure, does not lead to a reduction in the quantity of stored plutonium. Long term continued storage of plutonium leaves a burden for future generations to manage and, in the context of the threats from terrorism and proliferation sensitivities, it would be preferable to put the plutonium in a form that makes it unattractive to proliferators and terrorists while waiting to place it permanently beyond reach via its final disposal in a geological disposal facility, either directly or after use as MOX fuel.

1.7. The UK Government is now publishing, for public scrutiny and consultation, its proposed approach to the long-term management of the UK's plutonium. This proposed approach recognises that, in view of the non-proliferation and security concerns in relation to plutonium, it has a duty to develop a long-term vision for its future handling.

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[3] The cladding on Magnox fuel is a magnesium alloy that degrades in a relatively short period of time. Reprocessing the Magnox spent fuel was and continues to be necessary as there is currently no alternative means to deal with it. The NDA are however working on alternative plans for this fuel.

Chapter 2

Plutonium management and the 2010 NPT Review Conference

2.1. In determining the policy for the management of the UK's accumulated plutonium the UK Government attaches importance to taking fully into account the threat of proliferation and terrorism. Policy on this issue needs to form part of an overall coherent vision of how, globally, the UK Government can manage expanded access to nuclear power without risking further proliferation of nuclear weapons.

2.2. The 2010 Review Conference of the Non-Proliferation Treaty, held in May 2010, reached agreement on a number of recommendations that include those relating to the management of fissile material. This was the first time for ten years that the international community had made and agreed such a statement. These specific recommendations recognise and reaffirm the security and non-proliferation sensitivities of plutonium and other fissile material and provide a strong, updated, basis to develop further the UK's long term strategy for this material.

2.3. The UK Government's proposed approach to plutonium management recognises that, in view of the non-proliferation and security concerns in relation to plutonium, it has a duty to develop a long-term vision for its future handling in a way that acknowledges these security and non-proliferation risks. In taking this forward, the UK Government wants to do so in a way which engages stakeholder groups and the public, and balances the need for action with the need to ensure that the correct provisions are put in place.

2.4. Demonstrating leadership and effectiveness in the UK in facing up to the issues of plutonium management will be important to ensuring that other countries also take their responsibilities in this area seriously.

Chapter 3

The High Level Options

Fast Reactors

3.1. The UK began accumulating its civil plutonium in the 1960s to use as fuel in fast reactors as a potential energy solution if fossil fuels became scarce.

3.2. Fast reactors represented an potential energy solution because they are capable of burning many of the long-lived actinides that would otherwise form the major source of long-lived radioactivity in spent fuel from a normal thermal reactor. A fast reactor can also be used to create new fuel from natural uranium, that could be recovered, vastly enhancing the sustainability of nuclear power.

3.3. While fast reactors have been in development for many years and have successfully generated electricity there is no guarantee that commercial fast reactors will be available. Fast reactor technology has for decades been described as being "about 30 years away". Hence waiting for them to become a commercial reality before deciding what to do with the plutonium is not a realistic strategy. Nonetheless, until the plutonium has been put beyond reach, the UK Government will still have the ability to reassess such an opportunity.

Question

Q1 Do you agree that it is not realistic for the UK Government to wait until fast breeder reactor technology is commercially available before taking a decision on how to manage plutonium stocks?

Credible Options

3.4. The decision to abandon almost all research into fast reactors left a question of what to do with the plutonium and so over the past eight years a considerable amount of effort has been expended by industry, stakeholders and the Government in assessing the principal options for the UK's civil plutonium; some of the key events that took place over those years are described in Annex A. The Royal Society in particular has long called for Government to decide on a strategy for UK plutonium that would better address the security risks and proliferation sensitivities than ongoing storage. The UK Government has discussed these issues with the Royal Society and welcomed their views on the high level options for long-term plutonium management.

3.5. Following its formation in 2005, the NDA began considering what to do with the UK's civil separated plutonium in the long-term. Since that time, Government and the NDA have worked together to consider the issues around plutonium management. In 2007 the NDA were tasked by the UK Government to determine credible options for managing this material in the long-term. In January 2009 the paper "NDA Plutonium Topic Strategy; Credible Options Summary" [4] was published. The purpose of the paper was to define credible options for plutonium management in order to narrow the options being examined and to allow focus on those that have greatest chance of being achieved on a foreseeable timescale. The paper included conclusions from NDA technical workshops[5] and from papers on plutonium options that had been published for comment by the NDA[6].The NDA have issued an updated version of this paper[7] which now includes the option of reusing the UKs plutonium in new nuclear reactors in the UK. While the NDA have a responsibility for ensuring that safe and secure plutonium management continues, it is the Government's responsibility to decide on the policy for long-term plutonium management.

3.6. The high level options to emerge from the work carried out by the NDA are:

a. Reuse as fuel. This would see the material contributing to fuel stocks for new or existing reactors and ultimately being disposed of as spent fuel.

b. Immobilisation and direct disposal as waste.

c. Continued long term storage.

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[4] http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Summary-January-2009.pdf

[5] http://www.nda.gov.uk/news/events/pu-technical-workshop.cfm

[6] http://www.nda.gov.uk/documents/upload/Plutonium-Options-for-Comment-August-2008.pdf

[7] http://www.nda.gov.uk/strategy/nuclearmaterials/plutonium/index.cfm

The Reuse As Fuel Option

Plant

3.7. The reuse as fuel option involves converting the plutonium into Mixed Oxide (MOX) fuel for use in a nuclear reactor. The manufacture of MOX fuel is a mature process that relies on technology that is already in commercial use today.

3.8. In simple terms MOX fuel is produced by mixing together plutonium oxide and uranium oxide in the appropriate ratio and pressing them into small pellets followed by a sintering process. The resultant ceramic pellets are then put into fuel rods which in turn are combined to form fuel assemblies. It is these fuel assemblies that are used to power nuclear reactors. The rods and assemblies are physically identical to those for standard uranium fuel.

3.9. Successful commercial MOX manufacturing is demonstrated by AREVA's plant in France which, with a licensed capacity of 195 tonnes of MOX fuel per annum, has produced 140 tonnes of MOX fuel per annum over the last few years. The UK's own Sellafield MOX Plant (SMP), which was built and justified to manage plutonium from overseas reprocessing contracts only, has by comparison only achieved low throughputs, largely due to its complex design and operating regime. Nonetheless MOX fuel from SMP has been successfully irradiated in European reactors.

3.10. Taking into consideration SMP's existing obligations and its low plant throughput, it would not have sufficient remaining design life for it to be used to convert the entire UK stockpile of plutonium into MOX fuel.

3.11. This means that a strategy to reuse plutonium as MOX fuel either in the UK or overseas would require a new MOX fabrication plant. Any such plant would need to build on the lessons from SMP and use UK and overseas operating experience to ensure that suitable throughputs could be achieved. There would of course be regulatory requirements, such as Justification, that a new plant would have to satisfy.

Cost

3.12. While there is uncertainty over the cost of a reuse option, it does employ proven technology and a successful plant is already operating. The lifetime undiscounted cost of building and operating ,over roughly 30 years, a plant in the UK can only be described in approximate figures, but nonetheless, from NDA data could be expected to be around £5 - £6bn. In discounted[8] cost terms an estimate could be around £3bn. However, because the resulting MOX fuel will have a value that could be in excess of £2bn on an undiscounted basis (circa £1bn discounted), although these figures cannot be predicted with accuracy at this time, it could to some extent, offset the cost of its manufacture. That said it is unlikely that the value of the fuel will reach a point where it covers the full cost of its manufacture. It is not possible to more accurately predict what the value of the MOX fuel would be as prices would ultimately have to be negotiated with the reactor operators, and this in turn will be influenced by the price of natural and enriched uranium through market supply and demand.

3.13. MOX fuel will need to be disposed of after use. This presents, to some degree, greater challenges compared to uranium oxide spent fuel and will need to be addressed in due course. As with other new build spent fuel the UK Government would expect the costs of ultimate disposal of spent MOX fuel to be borne by the commercial nuclear operators, and this would be reflected in the value of the MOX as fuel. Under an immobilisation option, disposal costs for plutonium would be borne by the taxpayer.

Demand for MOX fuel

3.14. Our present expectation is that, at current uranium prices, the value of the fuel generated is significantly less than the costs of its manufacture: in other words, at current prices, manufacture of MOX is primarily a route for consuming plutonium stocks rather than a commercial operation in its own right.

3.15. On this basis, there may be no commercial demand for commencing the manufacture of MOX. However, if made available at a suitable price the UK Government believes that there is likely to be demand for MOX fuel. Additional costs of disposal, and of handling, mean that MOX fuel may have to be valued at a discount to ordinary uranium based fuel, dependent on the uranium price at the time. It is technically possible to use MOX fuel in a number of reactor types. Reactors currently operating in France are capable of using the fuel and, to a limited extent, this is also the case elsewhere in Europe and Japan. Modern third generation reactors such as the EPR and AP1000 are technically capable of using MOX fuel. Although Sizewell B is technically able to use MOX fuel, in general the existing nuclear plants in the UK would not be suitable, although designs currently being considered for future nuclear power stations would be. If this option is to be pursued, there

[8] Discounting is a method used to convert future costs to present values using a discount rate. http://www.hm-treasury.gov.uk/d/green_book_complete.pdf

will need to be work done on the practical issues associated with implementation including exploration of the commercial aspects of MOX fuel use.

Skills

3.16. The UK currently has specialist technical, fuel-related skills associated with MOX fabrication which, in many cases, have been developed through years of experience and research activities. If reuse of MOX is the best option for plutonium management this decision should be taken in sufficient time to ensure that we are to be able to retain and make best use of these skills.

Technical Maturity of the Option

3.17. The technology used in the fabrication of MOX fuel is mature and has been proven to work, a fact supported by the successful operation of the AREVA plant in France. While the UK's existing MOX plant at Sellafield has only achieved low throughputs, largely due to its complex design and operating regime, it has still successfully produced MOX fuel that has been used in reactors overseas. Reuse of plutonium as MOX has been adopted by the US and Russia as the method used to manage their excess weapon grade plutonium under the Plutonium Management and Disposition Agreement that was updated and signed in April 2010.

3.18. The final part of a reuse option would be disposal of spent MOX fuel. After the MOX fuel comes out of the reactor it is assumed that it will, after a suitable cooling period, be disposed of in a geological disposal facility. In that respect, decisions on the specifics of UK material packaging for the disposal of spent fuel are still at an early stage and so the technical requirements of spent MOX disposal can be considered and factored into facility and packaging design decisions.

Other aspects of the reuse option

3.19. The reuse option is the only option available that can make use of the significant energy potential contained within the UK's accumulated plutonium. To put this in context, if all our plutonium was converted to MOX fuel it would be about enough to power two reactors for about 60 years utilising a 40% MOX Core.

3.20. Unlike the immobilisation and disposal option, reusing plutonium as MOX fuel is not influenced by the timing of a Geological Disposal Facility as the spent MOX fuel, like other commercial fuels, will need to be cooled in managed facilities before it can be disposed, although spent MOX fuel will be hotter and may need to be cooled longer before disposal. It is not envisaged that use of MOX fuel would create significant additional spent fuel storage requirements as the spent MOX fuel would replace spent uranium oxide fuel that would otherwise be produced.

3.21. Reusing the plutonium as MOX fuel does not foreclose future possibilities for the plutonium to the same extent as some immobilisation options. Spent MOX fuel will still have a valuable energy content that could potentially be recovered if, for example, fast reactors were to become a commercial reality.

3.22. A new MOX plant would have to operate for about 30 years to convert the UK's plutonium to MOX fuel.

Disposal Option

Technical Maturity of the Option

3.23. In general the technologies that would realistically need to be pursued for immobilisation of the quantity of plutonium in the civil UK stockpile are less mature than that of the reuse option. We have no view of what the process might eventually be or indeed the standards to which it might have to operate.

3.24. The purpose of an immobilisation technology would be to produce a stable plutonium containing material that, alongside the engineered and natural barriers in a geological disposal facility, ensures that plutonium is not dispersed into the environment in significant quantities over the timescales necessary for its radioactivity to decay to safe levels. It should also make the material unattractive to terrorists because of the difficulty in recovering plutonium in a useable form. Immobilisation technologies may therefore also include a radiation hazard, e.g. through incorporation of other radioactive wastes, to further reduce its attractiveness to terrorists.

3.25. There are marked differences in maturity between the different immobilisation methods. For example, should un-irradiated low specification MOX pellets be considered as a suitable form for disposal, the technology to make the pellets is well developed. Similarly, for the incorporation of very small quantities only, immobilisation in cement has already been used. The UK Government's current assumption is the rate at which plutonium can be incorporated within cement, currently around 0.05%, is too low and inefficient to make cementation viable for immobilising the bulk of the UK's plutonium. It would produce such a large volume of packaged waste as to place unrealistic demands on manufacturing and interim storage and could be a significant factor in determining the footprint of a GDF, though the overall impact would depend on a range of factors including actual incorporation rate, site and the concept design selected for a geological disposal facility

3.26. If these technologies are not considered suitable then the options of ceramic waste forms, potentially via Hot Isostatic Pressing (HIP) or immobilisation in glass (vitrification) could be considered.

3.27. The NDA are currently supporting the development of research for the HIP process as a technology for potential use with plutonium residues, as part of the Sellafield decommissioning programme. Although this application is not identical to bulk plutonium immobilisation the process parameters would be very similar. Inactive research and development with materials that simulate the behaviour of plutonium is largely complete and some active work using very small samples is in progress.

3.28. Immobilisation in glass has been considered overseas but with limited success. However the UK has undertaken theoretical work on the different glass formulations for the immobilisation of plutonium. The formulations required are significantly different to those currently used in the existing UK vitrification process for high level waste. Only a limited amount of inactive laboratory work has been undertaken in support of the theoretical work.

3.29. In terms of international programmes, the NDA has talked with US research laboratories which have previously undertaken extensive research into plutonium immobilisation in glass using vitrification technology. There is also a programme of work taking place in Russia.

3.30. It is clear that regardless of the method used for immobilisation there is still a considerable amount of work to be done to underpin the ultimate disposal of the material. Work on the direct disposal of immobilised plutonium is not mature, particularly since not all of the potential technologies involved are developed enough to allow us a clear view of the type and long-term stability of the waste-forms that might be produced.

Plant

3.31. There is no existing plant available for converting all the plutonium to an immobilised disposal form. A new plant would be required and would be determined by the technology chosen.

3.32. Although it may be possible to adapt the existing SMP to produce some low specification MOX it has existing commitments and in any case there would not be enough remaining plant design life to allow all the plutonium to be managed in this way. If immobilisation as low specification MOX was determined as the way forward, it would still be necessary to construct new facilities.

3.33. Disposal as an immobilised waste also presents an additional implementation problem. When plutonium is immobilised the resulting form has a larger volume. Just how much larger depends on the chosen technology. Immobilised plutonium would still have to be stored in suitably secure facilities prior to its eventual disposal in a geological disposal facility. It would therefore seem unwise to build any plant to convert the plutonium into an immobilised waste until the GDF was available. To do otherwise would require the building of additional storage facilities to hold the large volumes of immobilised plutonium waste, although this may be required if improved security and proliferation resistance is required as a priority.

Skills

3.34. Retaining some key skills required for plutonium disposition may become difficult if too much time passes before immobilisation technologies can be employed. As with the MOX option, this is an argument for taking a decision on plutonium management strategy sooner rather than later.

Costs

3.35. We estimate that, from NDA data, an immobilisation and disposal option will have undiscounted lifetime costs of around £5 - £7bn. In discounted cost terms an estimate could be around £2 - £3bn. However, the costs to immobilise and dispose of the bulk of the plutonium can vary considerably and will ultimately depend on the technology employed. For example, if immobilisation as low specification MOX was chosen then we would need to consider the costs of a new MOX plant, its operating costs and costs of storage for the material produced. If we chose for example a HIP process, or a similar technology that has yet to be designed and proven on a commercial scale, then there are huge uncertainties regarding the costs of such a plant but we expect that the lifetime costs would be similar to a low specification MOX route.

Continued Long Term Storage

3.36. The current policy of continued storage, means storage until the end of the site decommissioning programmes which are currently assumed to be 2078 for Dounreay and 2120 for Sellafield (the two sites with stocks of separated plutonium). However it is likely that the plutonium would be consolidated at one site at the earliest opportunity for security and cost reasons. There is no provision for any ongoing storage beyond these timescales, nor are there plans in place for ultimate treatment solutions should that point be reached.

3.37. Whilst plutonium can be stored safely, both now and long into the future there is an ongoing cost associated with this option. The construction of the new stores to date have cost several hundreds of millions of pounds but, as they are not designed to hold the full plutonium inventory, it is likely that additional store modules will need to be added in 20-30 years time, at similar cost, as the remaining existing stores reach the end of their design life. The new store has a design life of between 50 and 100 years and ultimately will itself need to be replaced if no decision is made as to the final disposition route for plutonium.

3.38. Costs for continued long term storage are not limited to the storage facilities themselves. As well as significant security costs for supervision monitoring and guarding of separated plutonium, very long-term storage is not yet well understood and would require spending on research into how the ageing and radioactive decay processes may affect plutonium in long-term storage. Also the cans in which the plutonium is contained have a finite design life. This means that there is a likely need for the periodic repackaging into new cans and potential heat treatment of the plutonium to retain the product quality.

3.39. Whilst storage of plutonium is an option that is available and being implemented now its continued long term storage is not an easy low cost option. It does not lead to a reduction in the volume of plutonium in storage nor does it address terrorist threats and proliferation sensitivities by putting the plutonium beyond reach. Continued long term storage leaves the legacy of separated plutonium for future generations to manage and, because of the need to manage the plutonium before the end of the site decommissioning program, only defers the need to take a decision- although potentially enabling new or more cost effective options to be developed. Ultimately, because a final solution to deal with the plutonium will still have to be found, any costs associated with continued long term storage will be in addition to the final treatment costs. In total we expect that, from the NDA data, managing the plutonium in this way would have an undiscounted lifetime (about 110 years) cost of about £8 billion. In discounted cost terms over this long period an estimated value would be around £1 - £1.5bn

<u>Delivery Of The Options</u>

3.40. The majority of the material is currently stored on the Sellafield site, with about two tonnes (by plutonium metal weight) stored in a form mixed with uranium oxide at Dounreay. The appropriate vehicle for delivering the options depends upon which option is chosen, who has the appropriate skills base and when it is to be delivered.

3.41. In every case delivery would need to take place on a nuclear licensed site by operators regulated by the Health and Safety Executive Nuclear Directorate.

3.42. In the case of continued long term storage it seems unlikely, certainly for the foreseeable future, that this solution would be delivered by anyone except the Site Licence Companies (SLC) on the sites where the material is currently stored.

3.43. For both the reuse as MOX and disposal as immobilised waste options, it would be necessary to procure the construction of appropriate plant, or enter into other appropriate commercial arrangements such as toll processing (in which the risks of the plant not being available on time and on budget are to some extent borne by the operator, but reflected in the price per tonne processed). How that would fit in with current site arrangements has yet to be decided. Consideration would need to be given to whether the skills and experience of a new company would deliver better value for money and risk management than might be offered by the existing site licence companies and their parent bodies.

3.44. A particular factor that impacts on the delivery and timing of all options is the radioactive decay of plutonium to americium. In general, the longer plutonium is stored, the more americium is produced. Americium is more challenging from a dose and heat perspective and so, over time, the presence of increasing amounts of americium makes the plutonium more complex and costly to handle. It is therefore in our interest to decide what to do with the plutonium sooner rather than later, as waiting too long could restrict available options and increase the costs of implementation.

Chapter 4

Other plutonium in the UK

4.1. Whilst the purpose of this consultation is to take forward a strategy for UK owned civil separated plutonium it should be recognised that although the NDA owns the bulk of the material, British Energy [9]owns a proportion. For historical reasons, whilst title to the plutonium rests with British Energy, the financial liability effectively rests with the UK Government. Ideally management of this plutonium would be optimised with the management of the NDA owned plutonium as a UK wide solution, subject to appropriate agreement with British Energy.

4.2. In addition, the strategy we pursue for civil plutonium could potentially offer a solution for any plutonium that the Ministry of Defence (MoD) deems to be surplus to its requirements. Should the MOD decide to declare some of its plutonium as surplus they may wish to have it assigned as civil material for peaceful use and have it managed alongside and via the same ultimate route as current civil material. However for a reuse option it is likely that any such plutonium from MoD sources will require significant pre-treatment to remove unwanted chemical contaminants.

4.3. The UK is currently storing around 28 tonnes of foreign owned plutonium. In accordance with contracts and inter-governmental agreements all reprocessing customers are required to demonstrate an acceptable end use before their plutonium can be returned to them. The customers could opt to have it converted into MOX fuel in the UK however, the material will remain in safe and secure storage in the UK pending their decision on its management route. At all times whilst the material is in the UK this plutonium is not the property of NDA and the customers bear ultimate responsibility for its disposition.

4.4. A finalised policy for the long term management of the UK's plutonium may provide an avenue for some foreign owners of plutonium stored in the UK to pursue if it suited their requirements. Should the UK decide to adopt a policy of reusing plutonium, foreign owners may seek to contract for their plutonium to be converted to MOX fuel for reuse, or since reuse would be an acceptable end use for plutonium, the UK would be open to consider the merits of taking over ownership of that foreign plutonium and to manage it

[9] British Energy delisted from the London Stock Exchange on 3 February 2009 and is now part of EDF Energy

with existing UK plutonium; any such change in ownership would need to be in compliance with inter-governmental agreements and subject to conclusion of acceptable commercial arrangements. For clarity, this does not include waste products from reprocessing which would be returned to the original owner of the fuel.

Chapter 5

Limitations of work done to date

5.1. In the near term the only available option for plutonium management is ongoing storage and this will continue to play a large part in our strategy whilst long-term options are developed. Implementing a final policy for long-term plutonium management will take time. Whatever option is chosen it will have to be safe, secure, affordable, deliverable and offer value for money.

5.2. Although there is uncertainty around the precise costs and deliverability of the options at this stage, the UK Government believes that the available facts provide enough information to propose a preliminary policy view in this paper. In taking a preliminary view the UK Government will set out its direction to develop a strategy that offers the best prospect of delivering an effective long-term plutonium management solution. These uncertainties mean we will not absolutely close off alternatives while issues remain to be resolved.

5.3. Before any final decisions can be taken UK Government will work to ensure that its preliminary policy view satisfies certain conditions, namely that:-

- It must be achievable and deliverable; there is little point pursuing an option that has little guarantee of success.
- It must be shown to be capable of meeting health, safety and environmental requirements as well as meeting non-proliferation and security objectives.
- It must demonstrate that it provides value for money and is of overall benefit to the UK.

5.4. The UK Government will not take a final decision to pursue new facilities until it is satisfied that it can do so in a way that is cost-effective and with sufficient certainty of success in achieving its key aims, particularly in nuclear security and low carbon energy policy.

Question
Q2 Do you agree that we have got to the point where a strategic sift of the options can be taken?
Q3 Are the conditions that a preferred option must in due course meet the right ones?

Chapter 6

Taking a preliminary policy view

6.1. The NDA's Credible Options Summary paper [10] presented the UK Government with three high level options to consider. It is for UK Government to take policy decisions on the long-term future of the UK's plutonium.

6.2. Of the three high level options in the NDA paper, storage offers a safe and secure interim position for plutonium management but does not offer a long-term use or route to dispose of these stocks of fissile nuclear material.

6.3. For these reasons the UK Government needs to consider the realistic options beyond continued long term storage in order to set strategic direction towards a final, proliferation sensitive and cost-effective solution.

6.4. This leaves two remaining high level options for consideration:

- immobilise and dispose as a waste, or
- reuse as MOX fuel followed by disposal of the spent fuel produced

6.5. The UK Government considers that setting a strategic direction and taking a preliminary policy view of the most likely long-term solution will give us the best prospect of achieving a final solution that is practicable, affordable and which offers value for money.

6.6. The UK Government's preliminary policy view is based on the maturity and availability of a solution and the ability to deliver a solution, while not taking a view that would unnecessarily foreclose other potential future options.

6.7. To help reach a preliminary policy view on an option that is more likely to deliver a successful solution, the UK Government compared the two high level options of immobilisation and reuse against the following criteria.

- Availability.

[10] Original Paper http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Summary-January-2009.pdf.

Revised Paper http://www.nda.gov.uk/strategy/nuclearmaterials/plutonium/index.cfm

Immobilisation on the scale required to deal with all the accumulated plutonium in general relies on research and development progressing sufficiently to deliver a solution than can be employed. Cementation is available now but is not credible for the quantities that would need to be dealt with. The possibility of manufacturing low specification MOX pellets as an immobilisation solution is one that, in principle, can be delivered on a reasonable timeframe. This will need further investigation but it is unrealistic to suggest that such a total solution can be delivered using existing plant.

Reusing the plutonium as MOX fuel, like a low specification MOX solution for immobilisation relies on existing proven technology and uses processes that have already been demonstrated to work at the required scale. However, whilst it is unrealistic to suggest that a full reuse option could be delivered using the existing plant, a solution using a new facility could be delivered on a reasonable timeframe.

- Cost

The work done so far on the cost of the immobilisation option is not certain and only gives an indication of anticipated costs. Whether it turns out to be economical is ultimately dependent on viable immobilisation services becoming available, accompanied by reliable cost information.

For the reuse option it is also true to say that the work to date on cost has a degree of uncertainty. While recycling as MOX fuel can be delivered, the cost of this option will depend on factors such as the price of MOX fuel compared to uranium fuel in future. Overall, estimated discounted costs of the two options are similar. However, the uncertainty associated with costs of the reuse option is lower.

- Engineering challenge

Implementing an immobilisation option based on low specification MOX is of a similar challenge to reuse, however beyond a low specification MOX option other possible immobilisation options potentially pose a significant engineering challenge. The underlying technology to immobilise approximately 100 tonnes of plutonium in a way that would facilitate direct geological disposal has yet to be developed beyond the laboratory scale. The challenges are unknown and there is no guarantee that such a process could really deliver. Whilst it could be argued that cementation is available, at current regulatory approved incorporation rates it would generate such a large volume of packaged waste for disposal, that it could be a significant factor that determines the footprint of a GDF. Though the overall impact would depend on a range of factors including incorporation rate, site and the concept design. Other potential immobilisation techniques such a hot isostatic pressing would not generate the same large volumes of waste as cementation.

The engineering challenge to deliver a reuse option is not insignificant either. The main challenge would be to deliver a MOX fabrication plant that can produce fuel at a viable rate. While the UK's existing MOX fabrication facility has only achieved low throughputs, largely due to its complex design and operating regime, the challenge to build and operate a successful MOX fabrication plant has clearly been met internationally.

- Practicability

Without further development most options to immobilise plutonium for disposal are not currently viable. At this point in time, cementation and immobilisation as low specification MOX are the only possible options but, as described earlier, cementation would produce too great a volume of packaged waste to make it practical and a low specification MOX solution requires further investigation but it is unrealistic to suggest that such a low specification MOX solution can be delivered using existing plant

The technology that a reuse option relies on is available today, and offers a solution that is, subject to satisfying regulatory requirements, capable of being put into practice.

- Proliferation resistance

The form of any chosen immobilisation option would determine the level of security required for storage of the material produced. This would include an assessment of how difficult it would be to return the plutonium to a useable form.

Spent MOX fuel offers a high degree of proliferation resistance as it is highly radioactive. While this also makes the spent MOX fuel more difficult to handle, package and store than plutonium powder, the nuclear industry has and continues to routinely deal safely and securely with such highly active spent nuclear fuel in reactor de-fuelling, transport and storage situations.

Recycling plutonium as MOX fuel consumes roughly one-third of the plutonium and significantly degrades the isotopic composition of the remaining plutonium, which makes it a great deal less attractive for weapons use. Significantly, the US and Russia have already chosen the MOX fuel path to degrade their excess weapons-grade plutonium in the framework of the US-Russia Strategic Arms Reduction Treaty (START) disarmament programme.

- Safety and hazard

The potential risks posed by an immobilisation option are less well known but any option taken forward to implementation will be scrutinised by independent regulators in accordance with their requirements to ensure optimum protection of people and society from risks to safety, security and the environment.

The recycling of plutonium as MOX fuel in reactors is a practice that already exists. MOX is used in various nuclear power stations in Europe and so the risks posed by a recycling option are readily understood.

- Security

The levels of protection required will be determined by the form in which the plutonium is immobilised. Once an option has been chosen the security regulator will be responsible for ensuring that appropriate security levels are maintained.

- Technical maturity

Low specification MOX and immobilisation by incorporation in cement are mature immobilisation technologies. Immobilisation in cement would, based on the current assumption see the plutonium incorporated at a rate of about 0.05%, leading to about 200,000 tonnes of cemented waste to be stored then disposed in a geological disposal facility. Having to dispose of such large volumes of cemented waste would be one of the factors that would influence the footprint of a GDF. Immobilisation technologies such as Hot Isostatic Pressing (HIP) are currently only in the research and development stage and are not expected to mature for at least 10 years. The uncertainty of success and the costs of development are real problems for these immobilisation options that have to be addressed.

The technology required to deliver a reuse solution as MOX fuel already exists commercially and has been used successfully to provide MOX fuel for nuclear reactors around the world.

Preliminary View

6.8. Taking a decision, even a preliminary one, at this stage requires balancing significant uncertainties. Nonetheless, in light of the points set out above the UK Government is proposing to take the preliminary policy view that the best prospect of delivering a long-term solution for plutonium management is through a reuse as MOX fuel option either in the UK or overseas. The primary grounds for this decision are that MOX fuel fabrication is a proven and available technology that offers greater certainty of success, whilst allowing use of the inherent energy resource of the plutonium, creating a proliferation resistant waste-form that is consistent with existing plans to dispose of spent fuel in the UK, and that the costs of disposing of plutonium by this route are of similar estimated costs to direct disposal.

6.9. Taking such a decision to set out a direction now affords more certainty than simply waiting to see what the future may bring. Setting a direction now will help with the NDA's future planning for plutonium management and allow research to be more focused on relevant areas. It will also allow UK Government to be more focused on an option that presents the best prospect for success

6.10. This does not mean that reuse as MOX fuel has been selected as the final option. It is only, subject to this consultation, the UK Government's preliminary policy view, based on the current state of knowledge. Further ongoing work is necessary before we can be comfortable that such an option can in fact deliver a suitable solution for plutonium management, efficiently, effectively and at reasonable cost. In addition, further work on comparing the options is required to satisfy the requirements set out in the Treasury Green Book[11], particularly on addressing issues that may have a material impact on the successful implementation of a strategy. These must be considered before a case for committing significant funds can be made.

Work still to be done

6.11. Further work will be required to classify the existing separated plutonium to determine how much of it is immediately reusable, how much

[11] http://www.hm-treasury.gov.uk/data_greenbook_index.htm

might need additional chemical processes to remove impurities and how much is not suitable for reuse and should be considered as a waste. The NDA will continue to support research on suitable immobilisation and disposal technologies for plutonium and spent MOX fuel. These immobilisation technologies will at least be required to deal with the expected small amount of plutonium that will have to be considered as a waste. This work will be factored into later decision making, allowing the preferred option to be reconsidered if new developments change the balance of the argument in the future.

6.12. The UK Government, together with the NDA, are continuing to gather sufficient detailed information to understand the requirements of the reuse option to allow a more robust comparison to be made with the immobilisation option. The UK Government will also need to understand the preparedness and willingness of new build operators to use MOX fuel in their reactors. We will need to better understand how much the reuse as MOX option will cost to deliver and have a better appreciation of how those costs may vary over time. We will also have to show that the option we eventually select is affordable and offers value for money.

6.13. It will be necessary to consider how a new MOX plant might be delivered. What guarantees there will be on the delivery of a reuse as MOX option and who should bear the risks, what such a plant will cost to build and operate. All of this information will be required to determine the cost effectiveness of the reuse option before any final decision can be taken. It may be that UK Government can only consider a reuse scenario where the risks from the costs of construction and successful operation of a new MOX fabrication plant are, at least in part, borne by private industry.

Question

Q4 Is the UK Government doing the right thing by taking a preliminary policy view and setting out a strategic direction in this area now?

Q5 Is there any other evidence government should consider in coming to a preliminary view?

Q6 Has the UK Government selected the right preliminary view?

Chapter 7

Path to final decision

7.1. Taking a preliminary policy view that reuse as MOX fuel offers the most likely solution for a long-term plutonium strategy in no way commits the UK Government to going down this path. The UK Government will not take a final decision until it is satisfied that it can and that it is right to do so.

7.2. While the NDA have identified high level credible options, it is for UK Government to set policy for the long-term future of the UK's plutonium.

7.3. Of the three high level options in the NDA paper, continued storage offers a safe interim position for plutonium management but does not offer a long-term use or route to dispose of the stock of plutonium.

7.4. Ruling out continued long term storage leaves two high level options. The UK Government recognises that continued development of waste management options and advances in technology, or breakthroughs in research, mean that the availability and desirability of options may change.

7.5. This consultation conveys UK Government's plan to develop a final strategy for plutonium management. It is where the UK Government sets out a direction of travel and takes a preliminary view on plutonium policy to be tested. Data will then be gathered in order to develop and test the reuse option up to the point at which it can be regarded as credible for implementation or is shown to be clearly undesirable compared with other options. We will establish arrangements for commissioning the required work and scrutinising the results. This will involve working closely with the NDA and looking at the opportunities for using MOX fuel in new UK reactors. We will determine whether the cost of managing the plutonium in this way offers value for money and what other facilities would be required to implement this strategy.

7.6. The work that the NDA will continue to support on immobilisation technologies will promote a better understanding of, amongst other things, the costs, the engineering challenge and the practicability of the immobilisation option in order to enable a comparison of value for money.

7.7. We expect that this will take time to complete as we have to be assured that the final option will provide value for money and that there is sufficient certainty of success in achieving our key aims. As more detailed and reliable information becomes available, it may be necessary to reconsider the merits of the credible options against each other.

7.8. When the UK Government is confident that it has a preferred option that could be implemented, that it is affordable and offers value for money, it will be in a position to take a final decision.

Next steps

7.9. Subject to the results of this consultation the UK Government will work with the NDA to identify sufficient further information to satisfy the conditions set out in section 5.3 for moving to a final decision on long-term plutonium management. Ongoing work on plutonium immobilisation will be factored into a final decision. This will allow the UK Government to consider whether new developments change the balance of the argument.

7.10. The Government will continue to investigate the issues identified for further work, and will consider any further evidence identified, alongside responses to the consultation. We will then publish a policy document in the summer, responding to the consultation, and updating the Government’s position.

Question
Q7 Are there any other high level options that the UK Government should consider for long-term management of plutonium?

Glossary

Actinide

Any of a series of radioactive elements that have an atomic number of between 89 and 103.

Americium

Americium is a transuranic element of the actinide series. It is a radioactive metal with silvery-white appearance. Its most common isotopes are Am 241 and Am 243.

Decommissioning

The process whereby a nuclear facility, at the end of its economic life, is taken permanently out of service. The term "site clean-up" is sometimes used to describe the work undertaken to make the site available for other purposes.

Disposal

In the context of solid waste, disposal is the emplacement of waste in a suitable facility without intent to retrieve it at a later date; retrieval may be possible but, if intended, the appropriate term is storage.

Environmental Impact Assessment (EIA)

A legal requirement under EU Directive 85/337/EEC (as amended) for certain types of project, including various categories of radioactive waste management project. It requires information on the environmental impacts of a project proposal to be submitted by the developer and evaluated by the relevant competent authority (the planning authority, HSE or other regulators concerned).

Fast reactor

A fast reactor is a type of nuclear reactor in which the fission reaction is sustained by fast neutrons. Fast reactors are capable of burning many of the long-lived actinides that would otherwise form the major source of long-lived radioactivity in spent fuel from a normal thermal reactor. A fast reactor can also be used to create new fuel, that could be recovered, vastly enhancing the sustainability of nuclear power

Geological disposal

A long term management option involving the emplacement of radioactive waste in an engineered underground geological disposal facility or repository, where the geology (rock structure) provides a barrier against the escape of radioactivity and there is no intention to retrieve the waste once the facility is closed.

Half-life

The time taken for the activity of a given amount of a radioactive substance to decay to half of its initial value. Each radionuclide has a unique half-life.

Health and Safety Executive (HSE)

A statutory body whose role is the enforcement of work related health and safety law. HSE is the licensing authority for nuclear installations. The Nuclear Directorate of HSE exercises this delegated authority through the Nuclear Installations Inspectorate (NII) who are responsible for regulating the nuclear, radiological and industrial safety of UK nuclear installations under the Nuclear Installations Act 1965.

High Level Waste (HLW)

Radioactive wastes in which the temperature may rise significantly as a result of their radioactivity, so this factor has to be taken into account in the design of storage or disposal facilities.

Hot Isostatic pressing (HIP)

Is a technique that is used widely around the world to produce high quality ceramics. It is a technology that is relatively new to nuclear waste applications. It works by the simultaneous application of pressure and temperature to a waste to produce a superior quality waste form (e.g. low porosity).

Intermediate level waste (ILW)

Radioactive wastes exceeding the upper activity boundaries for LLW but which do not need heat to be taken into account in the design of storage or disposal facilities.

Irradiated Fuel

Nuclear fuel that has been irradiated in a nuclear reactor.

Justification

Means Justification of Practices Involving Ionising Radiation – This is the first of the three stages of radiological protection recommended by the ICRP, the other stages being Optimisation and Limitation. Justification involves assessing the benefits and detriments of any type of practice than can lead to radiation exposure to a person. To be Justified the benefits of such a practice must outweigh the detriments. Only Justified practices may be permitted, or exempted from permitting. To obtain a permit an applicant must also demonstrate that the practice has been optimized (that is the radiation exposure must be as low as reasonably practicable) and it must also be below any relevant dose limit

Legacy Waste

Radioactive waste which already exists or whose arising is committed in future by the operation of an existing nuclear power plant.

Magnox

A type of nuclear power reactor which was designed and is still in use in the United Kingdom. The name is derived from the fuel rod cladding and is short for **Mag**nesium **n**on-**ox**idising

Ministry of Defence (MoD)

MOX

MOX fuel is a blend of oxides of plutonium and natural uranium, reprocessed uranium, or depleted uranium. It typically contains between 5 and 8% plutonium oxide and performs in a similar way to low-enriched uranium oxide fuel.

New build

New build of a nuclear power station.

Non-Governmental Organisations (NGOs)

In its broadest sense, a non-governmental organisation is one that is not directly part of the structure of Government.

Non-proliferation

The prevention of the spread of the number of countries possessing nuclear weapons

Nuclear Decommissioning Authority (NDA)

The NDA is the implementing organisation, responsible for planning and delivering a geological disposal facility. The NDA was set up on 1 April 2005, under the

Energy Act 2004. It is a non-departmental public body with designated responsibility for managing the liabilities at specific sites. These sites are operated under contract by site licensee companies (initially British Nuclear Group Sellafield Limited, Magnox Electric Limited, Springfields Fuels Limited and UK Atomic Energy Authority). The NDA has a statutory requirement under the Energy Act 2004, to publish and consult on its Strategy and Annual Plans, which have to be agreed by the Secretary of State and Scottish Ministers.

Nuclear waste

A general term for the radioactive waste produced by those industries involved with nuclear energy and nuclear weapons' production.

Plutonium

A radioactive element occurring in very small quantities in uranium ores but mainly produced artificially, including for use in nuclear fuel, by neutron bombardment of uranium.

Pressurised Water Reactor (PWR)

Reactor type using ordinary water under high pressure as coolant and neutron moderator. PWRs are widely used throughout the world for electricity generation. The Sizewell B reactor in Suffolk is of this design.

Radioactive decay

The process by which radioactive material loses activity, e.g. alpha activity naturally. The rate at which atoms disintegrate is measured in Becquerels.

Radioactive material

Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity.

Radioactive waste

Any material contaminated by or incorporating radioactivity above certain thresholds defined in legislation, and for which no further use is envisaged, is known as radioactive waste.

Radioactivity

Atoms undergoing spontaneous random disintegration, usually accompanied by the emission of radiation.

Radionuclide

A term which refers to a radioactive form of an element, for example, carbon-14 and caesium-137.

Repository

A permanent disposal facility for radioactive wastes.

Reprocessing

A physical or chemical separation operation, the purpose of which is to extract uranium or plutonium for re-use from spent nuclear fuel.

Sizewell B

A PWR nuclear power plant in Suffolk, operated by British Energy.

Sellafield MOX plant (SMP)

A plant based in Sellafield that fabricates MOX fuel for overseas customers using their own plutonium recovered from their spent fuel.

Spent fuel (Spent nuclear fuel)

Used fuel assemblies removed from a nuclear power plant reactor after several years use and treated either as radioactive waste or via reprocessing as a source of further fuel.

Stakeholders

In the context of this document, people or organisations, having a particular interest in plutonium management, examples being the non-Governmental organisations and local communities and authorities.

Storage

The emplacement of waste in a suitable facility with the intent to retrieve it at a later date.

Toll processing

Arrangement in which a firm which has a specialized equipment, processes raw materials or semi-finished goods for another firm

THORP

The Thermal Oxide Reprocessing Plant based in Sellafield that reprocesses spent fuel to separate and recover reusable fissile materials from waste.

Uranium

A heavy, naturally occurring and weakly radioactive element, commercially extracted from uranium ores. By nuclear fission (the nucleus splitting into two or more nuclei and releasing energy) it is used as a fuel in nuclear reactors to generate heat.

Annex A

Some of the key events looking at plutonium management.

March 2003. BNFL stakeholder Dialogue final report on plutonium.

The aim of the stakeholder dialogue was to: "*inform BNFL's decision-making process about the improvement of their environmental performance in the context of their overall development*"

http://www.the-environment-council.org.uk/index.php?option=com_content&task=view&id=90&Itemid=135

July 2007. NDA Uranium and Plutonium: Macro-Economic Study.

This study provided an economic analysis of potential future disposition options for the UK's significant stock of nuclear materials.

http://www.nda.gov.uk/documents/upload/Uranium-and-Plutonium-Macro-Economic-Study-June-2007.pdf

June 2008. Plutonium Disposition Technical Meeting.

The workshop formed part of the NDA's continuing work to compile an options paper for Government on the future management of the UK's civil nuclear plutonium.

http://www.nda.gov.uk/news/events/pu-technical-workshop.cfm

August 2008. NDA options for comment paper.

The NDA published this paper seeking comments on credible options for plutonium management.

http://www.nda.gov.uk/documents/upload/Plutonium-Options-for-Comment-August-2008.pdf

October and November 2008. Plutonium Options Stakeholder Workshops.

These workshops were held by the NDA to provide an opportunity for stakeholders to come together to review the responses to their Plutonium Strategy Options Paper.

http://www.nda.gov.uk/documents/upload/Plutonium-Options-Stakeholder-Workshops-Report-October-and-November-2008.pdf

January 2009. NDA Credible Options Summary.

With this paper the NDA completed their work to provide an options paper for plutonium management for Government.

http://www.nda.gov.uk/documents/upload/NDA-Plutonium-Topic-Strategy-Credible-Options-Summary-January-2009.pdf

May 2009. DECC meeting on plutonium.

DECC held a meeting with some stakeholders where we sought views on how the UK should manage its plutonium accumulation and to use these views to inform this consultation process. A transcript and summary report for this meeting can be found on the following web page.

http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/plutonium/plutonium.aspx

DECC pre-consultation discussion paper

As a result of the feedback we received from our meeting with stakeholders we decided to publish two discussion documents ahead of the consultation.

http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/plutonium/plutonium.aspx

Annex B

Consultation questions and response form

Response form for the consultation on the long-term management of UK owned separated civil plutonium.

You may respond to this consultation by e-mail or post.

Respondent Details	
Name:	
Organisation:	
Address:	
Town / City	
County / Postcode	
Telephone	
E-mail:	

Tick this box if you are requesting non-disclosure of your response. ☐

Please respond by 10 May 2011

Plutonium Consultation
3rd Floor, Area C/D
Nuclear Policy Unit
Department of Energy and Climate Change
3 Whitehall Place
London
SW1A 2AW

Email: plutonium@decc.gsi.gov.uk

Please select the category below which best describes who you are responding on behalf of.

☐	Business representative organisation/trade body
☐	Central Government
☐	Charity or social enterprise
☐	Individual
☐	Large business (over 250 staff)
☐	Legal representative
☐	Local Government
☐	Medium business (50 to 250 staff)
☐	Micro business (up to 9 staff)
☐	Small business (10 to 49 staff)
☐	Trade union or staff association
☐	Other (please describe):

Thank you for taking the time to let us have your views.

The Government does not intend to acknowledge receipt of individual responses unless you tick the box. ☐

The consultation document sets out the Government's proposed approach to the longer term management of the UK's plutonium stocks for public scrutiny and consultation. Comments on any aspect of this issue are welcome, but the key questions posed in this consultation are:

No	Question
Q1	Do you agree that it is not realistic for the Government to wait until fast breeder reactor technology is commercially available before taking a decision on how to manage plutonium stocks?
Response	
Q2	Do you agree that the Government has got to the point where a strategic sift of the options can be taken?
Response	
Q3	Are the conditions that a preferred option must in due course meet, the right ones?
Response	
Q4	Is the Government doing the right thing by taking a preliminary policy view and setting out a strategic direction in this area now?

Response	
Q5	Is there any other evidence government should consider in coming to a preliminary view?
Response	
Q6	Has the Government selected the right preliminary view?
Response	
Q7	Are there any other high level options that the Government should consider for long-term management of plutonium?
Response	

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