

MANAGEMENT OF THE UK'S PLUTONIUM STOCKS

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

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1 Executive Summary

- 1.1 The UK is currently storing a significant quantity of civil plutonium. There has not been a clear policy for its long-term management. In view of the security concerns and proliferation sensitivities associated with plutonium, the UK Government therefore published, for public scrutiny and consultation, its proposed preliminary policy on the long-term management of the UK's civil plutonium.

- 1.2 The consultation document made it clear that, although there remain many issues to be resolved before any policy could be implemented, the UK Government believed that there was sufficient information available to make a high-level judgement as to the right strategic policy option for plutonium management. The Government therefore proposed adopting a preferred solution, or preliminary policy view, for plutonium and then taking forward work to progressively address the practical issues of implementation. That approach is to pursue reuse of plutonium as mixed oxide fuel (MOX). This would mean converting the vast majority of UK civil separated plutonium into fuel for use in civil nuclear reactors. Any remaining plutonium whose condition is such that it cannot be converted into MOX, will be immobilised and treated as waste for disposal.

- 1.3 Having considered all responses received during the consultation period the UK Government has concluded that it has identified the right preliminary view. Accordingly, the Government confirms this as the preferred policy. While the UK Government believes it has sufficient information to set out a direction, it is not yet sufficient to make a specific decision to proceed with procuring a new MOX plant. The Government is now commencing the next phase of work, which will provide the information required to make such a decision. Only when the Government is confident that its preferred option could be implemented safely and securely, that is affordable, deliverable, and offers value for money, will it be in a position to proceed with a new MOX plant. If we cannot establish a means of implementation that satisfies these conditions then the way forward may need to be revised.

- 1.4 The Government is therefore not closing off alternatives. 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 and secure storage will need to continue for some decades until all the Plutonium has been processed. However, rather than continuing to pursue all options with equal vigour, the Government is now prioritising work on reuse, with the intention of demonstrating whether, and if so, how the obstacles to its implementation can be overcome.

- 1.5 The Government believes that there is benefit in setting out now the preferred way forward for future plutonium management. It demonstrates to the international community that the UK Government recognises the security and non-proliferation sensitivities of plutonium and is seeking to develop a long-term strategy for managing this material. Indicating a preferred solution now will help with the Nuclear Decommissioning Authority's (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.
- 1.6 Implementing the policy will take time and, any specific decision to procure a new plant would be a significant investment. Within Government the project will therefore be under the scrutiny of the new Major Projects Authority (MPA). This is a partnership between the Cabinet Office and HM Treasury and will oversee and direct the effective management of all large-scale projects that are funded and delivered by central government. This will mean a staged approvals process to ensure value for money. Affordability will also have to be determined through the Spending Review process in the normal way.
- 1.7 The Government has concluded that converting the plutonium into MOX is the most credible and technologically mature option for reuse. However, the Government remains open to any alternative proposals that offer better value to the taxpayer.
- 1.8 The consultation document also addressed foreign-owned plutonium stored in the UK. Having considered all the responses, the UK government has concluded that overseas owners of plutonium stored in the UK could, subject to commercial terms that are acceptable to UK Government, have their plutonium managed in line with this policy. In addition, subject to compliance with inter-governmental agreements and commercial arrangements that are acceptable to UK Government, the UK is prepared to take ownership of overseas plutonium stored in the UK after which it would be treated in line with this policy.

2 Introduction

Why we consulted

- 2.1 The UK is currently storing a significant quantity of plutonium¹ for which there is currently no clear policy for its long-term management. The existing plutonium management plans are for it to be continuously stored in specially constructed facilities that afford both security and safety - but this is far from the ideal long-term option because it requires continued active management.
- 2.2 Continued storage does not lead to a reduction in the quantity of stored plutonium. Indeed, radioactive decay may make it more complex and costly to handle in future. Long-term continued storage of plutonium leaves a burden of security risks and proliferation sensitivities for future generations to manage. In this context, it would be preferable to have the plutonium put permanently beyond reach via its final disposal in a geological disposal facility, either directly as a waste in an immobilised form or after its reuse as MOX fuel.
- 2.3 The UK Government therefore published, for public scrutiny and consultation, its proposed preliminary policy on the long-term management of the UK's plutonium recognising that, in view of threats from terrorism and proliferation sensitivities, it has a responsibility to develop a long-term vision for its future handling.

About the consultation

- 2.4 106 responses were received to the consultation. These came from a wide range of respondents including individual members of the public, companies involved in the energy industry, Non-Governmental Organisations (NGO's) including local campaigning groups and local authorities.
- 2.5 All responses have been published on the Department's [website](#).

Format of Government response

- 2.6 This UK Government response is organised into sections which generally follow the numbering of the consultation questions. The exception is question 7 which, for logical reasons, is better considered earlier. In the response we set out the questions asked, a short paragraph on the topic, a summary of the key themes identified in the responses, and the UK Government's response to these. This is then followed by a UK Government conclusion to that question.

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

- 2.7 Occasionally, where it is appropriate to do so, responses are treated under a different question from the one under which they were made.
- 2.8 While all responses have been considered, this document does not attempt to set out the UK Government's response to every single point raised in response to the consultation; instead, it concentrates on the key themes which arose from the consultation and the issues considered by the Department.
- 2.9 Annex 1 contains the full list of consultation questions for reference. Annex 2 provides a list of the individuals and organisations who responded to the consultation.

3 Responses to the specific questions

Fast Reactors

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?

- 3.1 The consultation paper described how in the 1960's it was thought that nuclear power in the form of fast reactors² could offer a solution to fossil fuels running out. This led to the UK stockpiling plutonium in order to fuel them. Despite having been in development for many years and having some success in generating electricity, the UK abandoned almost all research into fast reactors in 1994 due to the realisation that they would not be commercially viable in the foreseeable future.
- 3.2 The UK Government judged that there was no guarantee that commercial fast reactors will be available for several decades and so considered that it was not a realistic strategy to wait for them to become a commercial reality before deciding what to do with the plutonium.

Responses

- 3.3 Many respondents agreed that the UK Government should not wait for fast reactor technology to become commercially available before taking a decision on how to manage plutonium stocks. Some who took this line said that nevertheless the UK Government should continue to monitor or be involved in research into fast reactor technology. Some respondents disagreed and argued that the UK should not rule out developments in fast reactor technology or should engage with it more actively. Some argued that the plutonium was a UK energy resource which should be exploited, and that failing to do so would lead to a bigger burden in the future than retaining the plutonium stocks. Some respondents said that although a long-term strategy was needed it was too soon to exclude or commit to any option at this stage. A few respondents disagreed with the question arguing that it was biased towards reuse.

²A 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>

Government response

- 3.4 Fast reactors may, at some point in the future, offer a potential solution for plutonium management. While significant resources have been spent developing fast reactor technology there is still considerable work to be carried out before they could become commercially viable. We are, therefore still potentially decades away from deploying a fast reactor solution for plutonium management.
- 3.5 There are serious nuclear security risks associated with the storage of the UK's plutonium and significant measures are put in place to ensure it can continue to be managed safely and securely. However the increasing global threat of terrorism, and the desire of the international community to manage stocks of fissile materials means the UK Government no longer believes that it is acceptable to store such quantities of plutonium without having a deliverable policy in place for its long-term management. Keeping our plutonium in long-term storage until commercial fast reactors become available, before deciding what to do, is therefore not a realistic strategy.
- 3.6 By adopting a preferred policy to take forward, the UK Government will be addressing the need to manage our plutonium. This does not mean that fast reactors have been ruled out completely. The adoption of a policy option for plutonium management is not the end of this matter. It will necessarily take several years to reach the point where UK Government is satisfied that it has sufficient information for it to be able to take a final decision on reusing separated plutonium through MOX. Even if such a decision is taken there will be many decades on top of that until all the plutonium has been dealt with. Should fast reactors become commercially available or significant other advances be made during that period there will be the opportunity to consider again whether such technology could be employed.
- 3.7 The UK Government is not currently engaged in developing fast reactor technology but will nonetheless maintain a watching brief on developments of such technology.

Government's conclusion

- 3.8 *The UK Government's conclusion is that there is a need to address now the serious nuclear security risks and proliferation sensitivities posed by our plutonium accumulations. Waiting for fast reactors to become commercially available could mean leaving a legacy of security risks and proliferation sensitivities for future generations to manage on an ongoing basis. UK Government believes that it has a responsibility to decide on a policy for long-term plutonium management now and take it forward. Should fast reactors (or*

other disposition options) become commercially available in the future, there will be an opportunity to consider their merits at that time.

Credible options

Q7 Are there any other high level options that the UK Government should consider for long-term management of plutonium?³

- 3.9 The consultation paper set out three high level credible options that could be used for long-term plutonium management. These high level options emerged from earlier work that the Nuclear Decommissioning Authority (NDA) had completed in support of the UK Government's intention to identify a long-term solution for plutonium management. Through the consultation process we asked for evidence of any other high level options that we had not already considered.
- 3.10 The consultation paper set out the main characteristics of the three high level options including plant, costs, skills and technical maturity. The UK Government acknowledged that there were limitations to the work that had been done to date but also thought that the available facts provided enough information to undertake a strategic sift and subsequently propose a preliminary policy view. Significant further information would be required before a final policy on plutonium management could be taken and implemented. The section on next steps describes the processes to get to an implemented final policy.
- 3.11 In summary the high level options are:-
- a. Reuse as fuel.
 - Requires the plutonium to be converted into Mixed Oxide (MOX) fuel for use in a nuclear reactor. Conversion of the UK's plutonium would require construction of a new MOX plant and associated facilities, regulatory consents for the use of MOX fuel in new reactors and a range of other permissioning activities including fuel vendor licences.
 - b. Immobilisation and direct disposal as waste.
 - An immobilisation technology would be employed to produce a stable plutonium-containing material that would be suitable for geological disposal. This would require the development of a

³ The order of consultation questions has been changed because it is more appropriate to consider this question within the scope of the existing options.

suitable facility to manage and immobilise the large volumes of plutonium.

c. Continued long-term storage.

- This option would see plutonium remain in secure storage until the end of the Sellafield site decommissioning programme, assuming the UK's plutonium was consolidated on one site. In this option 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.

Responses

3.12 Many respondents considered that the UK Government had correctly identified the three high-level options and said that they thought there were no others which were viable. A few people believed that all facilities in relation to plutonium production should be shut down and decommissioned immediately.

3.13 Other options for plutonium management proposed by respondents were:-

- Use of metallic fuel in Light Water Reactors (LWR)
- Using fusion neutron sources to transmute plutonium
- Use small modern sodium-cooled reactors to consume plutonium as a metal fuel.
- Immobilisation of plutonium via the low-spec MOX route, using the existing Sellafield MOX plant.
- Use thorium / plutonium fuels
- Use Inert Matrix Fuel (IMF)
- Construct a Pebble bed reactor at Sellafield
- Deliver reuse via spare MOX fabrication capacity in overseas facilities.

Government response

3.14 We recognise the widespread support for the three existing credible options which were developed out of the work undertaken by the NDA and which resulted in the publication of their credible options paper. This paper was used to underpin the consultation and during the preceding study, the NDA considered earlier many advanced fuel and reactor concepts, including many of those proposed above, when arriving at their list of credible options. Central to the selection of credible options was the requirement that a disposition method for UK plutonium would need to be deployable within 25 years for an option to be considered credible. All of the above proposed options were again considered at high level by the NDA to inform this response paper.

3.15 Many of the proposals suggested involve technologies that are still conceptual or which are not commercially available. Fission–fusion reactors and metal-

fuelled LWR reactors are examples of proposals that are still conceptual. Accelerator Driven Subcritical Reactors and thorium and Inert Matrix Fuel reactors have yet to be proven commercially.

3.16 Proposals on:-

- Use of metallic fuel in Light Water Reactors (LWR)
- Using fusion neutron sources to transmute plutonium
- Small modern sodium-cooled reactors
- Use of thorium based fuel
- Inert Matrix Fuel
- Pebble bed reactors

3.17 For the above options our view is that taking them forward as a solution for plutonium management in the UK would mean that the UK Government would have to pioneer the technology. Given the existence of the proven MOX option, the Government does not need to bear such development risk. The Government remains open to such options if a commercial partner was prepared to bear the risk and if they can demonstrate a credible plan to deliver a solution within similar timeframes. Otherwise, the Government is concerned that there would be no guarantee of success and the risk is that, as with Fast Reactors, another 10 years or more would pass without any steps along the road to finding a viable solution to our plutonium problem.

3.18 None of these technologies has produced electricity on an industrial scale, some have not been built on a pilot scale and some are conceptual.

3.19 These technologies are unlikely to be of interest to utility companies and so there is little likelihood of these technologies becoming a commercially available option for plutonium management for several decades.

3.20 Proposal on

- Immobilisation of plutonium via the low-spec MOX route

3.21 The NDA are aware that papers have been written on immobilisation of plutonium as low specification MOX and the option itself has been considered in their credible options study. The NDA completed an assessment of how much throughput the Sellafield MOX Plant (SMP) could achieve to deliver a disposal MOX option. It showed that early assumptions in these papers on the capacity of SMP have turned out to be incorrect and that this option does not appear to offer any advantages over the other options under consideration. The NDA assessment formed the basis of the statements made in section 6.7 of the Consultation paper about low specification MOX.

3.22 The NDA also considered the thorium fuel cycle in their earlier study. NDA's position was that mixed thorium–plutonium oxide fuels as a disposition method for UK plutonium is not likely to be a commercially available technology in the next 25 years. They concluded that the technology is innovative, although technically immature and currently not of interest to the utilities as its use would represent significant financial investment and risk, without notable benefits.

3.23 Proposal on

- Use of spare capacity in overseas facilities

3.24 A suggestion to use MOX fabrication facilities overseas has been considered earlier and dismissed for security as well as practical reasons. Such an option would involve making several shipments of separated plutonium each year, for about 30 years. While each individual shipment could be undertaken safely and securely, there would still be significant risks to be assessed and managed. Regularised shipments of plutonium overseas could make these risks intolerable. In addition to the significant costs for each shipment and significant costs associated with using an overseas MOX facility for such a long period, there would be practical difficulties with using overseas facilities to make UK MOX for such a long period. There may also be the need to provide and fund state-of-the-art plutonium storage facilities overseas.

Government's conclusion

3.25 *UK Government welcomed the suggestions posed by respondents but nonetheless has concluded that the credible options described in the consultation paper, i.e. reuse as fuel, immobilisation and disposal as waste and continued storage are the only credible options that can be implemented within the desired timescale (of 25 years) to deliver a solution for plutonium management. While other options for managing plutonium may become readily available in the future, they do not yet exist commercially and are therefore not truly credible options that can be employed now. If however a proposal was to be made that exposed the UK Government to minimum risk and cost, e.g. where industry accepted the developmental risks required to make a proposal credible within a timeframe comparable to that of producing MOX, Government would be willing to consider such a proposal. Similarly, if an alternative option becomes available in the future, as far as it is possible UK Government will be able to consider its merits at that time.*

Taking a strategic sift of options

Q2 Do you agree that the UK Government has got to the point where a strategic sift of the options can be taken?

3.26 The consultation paper set out what was known about the three options but recognised that there was still a lot of work to be done before UK Government reached the point where it could make a final decision and commit to significant spending. UK Government did however believe that it had reached a point where it was reasonable to take a strategic sift of the options.

Responses

3.27 Many respondents agreed with the UK Government that it was time to make a strategic sift of the options. Some respondents said that such a sift was overdue. Some said that it was welcome that UK Government was now focusing on legacy nuclear as well as new build. Others thought that sufficient work had been done identifying the options and that the momentum should be maintained to taking the work forward. Some considered that the data and analysis available or published was not deep enough to justify such a policy shift. In particular, some respondents thought there was a lack of information on the costs of the different options, and a lack of information on the existing MOX plant and why it has not been as successful as anticipated. Some respondents suggested a published study on the costs of the three options, or a re-run consultation with more evidence presented. Other respondents thought that it was not clear enough how the proposal fitted in with UK energy policy.

Government response

3.28 To gather all the information on all the options so that they can be fully compared on a like-for-like basis would require significant resource and would take many years as we would need allow time for suitable disposal technologies to be developed and reach a more mature level.

3.29 The sift of the options was taken by looking at the options across different criteria. What we provided and published in the consultation paper was a comparison of the key points for the options based on the evidence available.

3.30 The costs of the options will continue to be refined, for example, as a result of commercial discussions with suppliers and customers. Furthermore, the different options begin at different points and fall across different lengths of time and the options themselves vary in their level of maturity. However, our best current estimates show that costs of procuring and operating the necessary facilities for the reuse option, including disposal, are comparable with the estimated costs of procuring and operating the necessary facilities for the

immobilisation option, including disposal. While these costs will continue to move and develop over time, the current estimates for the discounted costs of each of these options is around £3bn. For reuse these costs should be reduced by sales of the resulting MOX fuel, although the quantum cannot be predicted with accuracy at this time and would ultimately have to be negotiated with the reactor operators. For comparison, the current estimate for the discounted costs of the long-term storage option is around £2bn. The Government and NDA will work intensively to refine these costs over the next phase of this work.

3.31 The main difference between these two options is the maturity of the underlying technology that they rely on. Despite the failure of the Sellafield MOX plant to produce fuel at the designed throughput, it has nonetheless safely manufactured MOX fuel which has been successfully burned in reactors. In addition, the Areva plant in France has safely managed a similar amount of plutonium to that which the UK has stored. By comparison, there is not the same degree of maturity for an immobilisation option, unless we consider the use of cementation, which would mean around 200,000 tonnes of cemented waste to be disposed.

3.32 At this point in the programme, there is no additional relevant information that could be published either as a separate document or via a re-run of the consultation. We believe that we have enough information available to allow UK Government to take a strategic view of the way forward now. However taking a strategic sift of the options now does not mean we will proceed to implementation without obtaining any further evidence. The sift allows us to focus efforts and resources on the option that looks to be the most promising in terms of being able to deliver a solution. We will have to gather sufficient evidence to be satisfied that our proposal remains credible and is in line with Treasury Green Book rules before we can decide on implementing a solution.

Government's Conclusion

3.33 *The UK Government's conclusion is that there is a balance to be drawn between deferring the need to decide on a way forward in order to gather all the necessary information, and showing resolve to address the problem and take forward a solution with the available information. We believe that there is enough information available to take a strategic view of our options and to proceed with progressive implementation of our policy now, recognising that if the obstacles and problems we know about cannot be overcome then we might need to pause or revert to some other option. A final decision on the implementation of the policy can only be taken forward in accordance with Treasury Green Book Rules.*

Conditions for implementing an option

Q3 Are the conditions that a preferred option must in due course meet the right ones?

3.34 The consultation paper set out conditions that an option must satisfy before a final decision can be taken. These were:-

- 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 national security objectives; and
- It must demonstrate that it provides value for money and is of overall benefit to the UK.

Responses

3.35 Most respondents agreed that the conditions are sensible, wide ranging and appropriate. Some suggested additional conditions including, a long-term view of the value of Plutonium as an energy source, being capable of inspiring public confidence or being of economic benefit to the UK in terms of the job creation and development of advanced technologies that could bring revenue to the UK. A few disagreed for various reasons including; the conditions assume storage of spent fuel rather than reprocessing, because options should only be evaluated by standards of overall benefit to the UK in terms of jobs, investment, creativity, and skills and capabilities. Others thought the conditions were not appropriate because the respondents were against the use of MOX fuel in the UK.

Government response

3.36 The conditions that a preferred option must meet in due course would apply equally to any option that was employed for long-term plutonium management. UK Government accepts that the option for plutonium management must be capable of inspiring public confidence, particularly in light of the experience of the existing Sellafield MOX plant. Equally, to inspire public confidence it has to be shown that an option is safe, secure and meets environmental requirements as well as delivering a cost effective solution for plutonium management.

Government's Conclusion

3.37 *UK Government has concluded that the conditions described in the consultation paper can be evenly applied across all options. We believe that these conditions are appropriate and relevant and that they should be satisfied before a final option can be implemented. However, additional benefits can be seen*

within different options, such as the benefit to the UK from investment and jobs. These additional benefits should be considered as part of the implementation process, but are not seen as a prerequisite for an option.

3.38 *We are not suggesting that they will be the only conditions applied as all options will of course have to satisfy all regulatory requirements including those, where relevant, relating to Justification, planning and licensing. With the launch of the Major Projects Authority⁴ there will be significant scrutiny of this project as it progresses to ensure that it will deliver what it promises. This will help build public confidence that the procurement of any new facilities will be properly scrutinised before being agreed.*

Setting a strategic direction

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?

3.39 The consultation paper noted that setting a direction of travel affords more certainty than simply waiting to see what the future may bring. It helps the NDA with its future planning for plutonium management and allows research to be focused on relevant areas.

Responses

3.40 Most respondents agreed that it was right to take a preliminary view and to set out a direction now. Where respondents did not think the UK Government was right this tended to be because they disagreed with the choice made (see Q6). There was no support for the UK Government not attending to the issue. Some thought that the UK Government should take a preliminary view but that it does not currently have the necessary data to make the right choice.

Government Response

3.41 UK Government believes that setting out a policy will allow effort and resources to be focused more appropriately on the path that has the best prospect of delivering a successful outcome. Setting a policy on plutonium management does not mean we will proceed without regard to other options, or that the UK Government is committed to a procurement of suitable facilities at this stage. There remain many hurdles to cross before plutonium policy can be

⁴ <http://www.cabinetoffice.gov.uk/news/government-launches-major-projects-authority>

implemented and the Next Steps section describes what UK Government will be doing to take this policy forward.

- 3.42 Without a clear direction of travel, it would be difficult to hold meaningful commercial discussions with possible suppliers or new build operators. It will be through these discussions that we would gather further evidence that our chosen path can deliver the success that we require and, at what cost. While much of the information we will gather will be commercially confidential, there will be points as we go forward where the evidence gathered will require approval initially through an outline business case and then through a full business case before we can proceed.
- 3.43 In the consultation paper, the preliminary policy view was based on the maturity and availability of a solution and the ability to deliver that solution, while not unnecessarily foreclosing other potential future options.

Government's Conclusion

- 3.44 *Taking a decision to set out a direction affords more certainty than simply waiting to see what the future may bring. Setting a direction 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. Taking a decision, even a preliminary one, requires balancing significant uncertainties. Nonetheless, in light of the points set out in the consultation paper the UK Government took the preliminary policy view that the best prospect of delivering a long-term solution for plutonium management was through reuse as MOX fuel. UK Government considers that its preliminary view, as set out in the consultation paper was principally the right view and that it is now the right time to set a clear policy and direction of travel for long-term plutonium management. UK Government accepts that further work will be required to assess the evidence to support this policy before it can take a final decision on implementation.*

Other evidence

<p>Q5 Is there any other evidence the UK Government should consider in coming to a preliminary view?</p>

- 3.45 In coming to a preliminary view, the UK Government took account of the relevant information known about the options. However it was right to ask in a consultation whether there was other evidence, perhaps that we were not aware of, that we should consider.

Responses

3.46 Some respondents thought that the UK Government had considered all relevant information. Some respondents thought that the full radiological and health impact, including dose estimates of different options needed to be considered, others thought that future energy supplies should be considered. Some respondents thought that the impact of the options on the design of a Geological Disposal Facility (GDF), including its footprint, period of operation and safety case should be considered. Some suggested that any other evidence could be captured through a public consultation on a generic sustainability assessment of the reuse option and why it is preferable to immobilisation and disposal.

Government response

3.47 With regard to the health impact of options for plutonium management, all of the credible options would at some point involve plutonium handling and therefore all options have dose implications for workers. Both the reuse and immobilisation as waste options have roughly the same dose implications for workers but continued long-term storage may cause additional doses. This would be due to continued safeguards, monitoring requirements and periodic repackaging or package reviews with increasing dose rates per mass of material over the next 20-60+ years due to americium in-growth in the plutonium.

3.48 Taking forward a policy of reuse will have to be shown to be capable of meeting health, safety and environmental requirements and will require the practice to be Justified as required by the "Justification of Practices Involving Ionising Radiation Regulations". This involves an assessment of the benefits and health detriment of any type of practice that can lead to radiation exposure to a person.

3.49 The UK's plutonium is a significant energy resource that could be used to generate electricity. However in the 2008 Nuclear White Paper⁵, the previous administration concluded that there were sufficient high-grade uranium ores available to meet future global demand. UK Government therefore does not consider our plutonium as a necessary resource to ensure security of supply.

⁵ <http://www.berr.gov.uk/files/file43006.pdf>

- 3.50 All the options will have an impact on a GDF as all options will ultimately lead to disposal. The actual impact on a GDF will depend on various factors including the conditions associated with disposal packages such as how hot packages are permitted to be at the time of disposal, the space packages take up in the repository and the volumes of immobilised material to be disposed. These are all challenges that need to be addressed and for which work streams are being developed.
- 3.51 The purpose of the consultation was to set out for public scrutiny, UK Government's proposals for plutonium management, including its preliminary policy, in order to capture any relevant evidence that should be taken into consideration. UK Government does not consider it necessary to consult again at this point in the process in order to capture evidence relating to the sustainability of the MOX option.

Government's Conclusion

3.52 *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 an intrinsically secure waste-form that is consistent with existing plans to dispose of spent fuel in the UK. The UK Government considers that it has sufficient information to be able to make a preliminary policy decision on pursuing the reuse option. However further information as set out in the Next Steps chapter would be required before this policy could be finalised and a decision made on implementation. In addition, the successful implementation of a reuse policy will require various regulatory processes including Justification and planning to be completed. Such regulatory processes will allow opportunities for stakeholder engagement as these points in the process are reached.*

Preliminary Policy view

Q6 Has the UK Government selected the right preliminary view?
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3.53 In the consultation paper the UK Government said that the primary grounds for selecting reuse as MOX as its preliminary policy view were the maturity of the technology, the ability to use the inherent energy resource of the Plutonium, it creates a proliferation resistant waste form and the estimated costs are similar to disposal.

Responses

3.54 Some respondents agreed that the UK Government had selected the right preliminary view. Some thought that this should now be backed up by a fully evidenced commitment to the chosen option. Others disagreed. Some thought that storage was currently the only option in the absence of a current solution employing disposal. Some thought that disposal was a better option than MOX and that MOX in the long-term would create a bigger waste problem. Some thought that it was too soon to make a decision and that UK Government should pursue MOX and disposal in parallel for 3–5 years. Some thought that MOX had been a failure in the UK and there was no reason to think that it would be any better this time. Some thought that the proposed option risked increasing proliferation and terrorism. Some thought that a subsidy would be needed for the price of MOX or, more generally, that more clarity was needed on the economics of the project.

Government response

3.55 Long-term plutonium management will rely on storage of plutonium until alternative strategies can be implemented, whether that be immobilisation and disposal as a waste, reuse as MOX fuel or some other method. The first two of these are both credible options for plutonium management and are of comparable net cost. It is not possible to get a consensus on the best option for managing plutonium as some would prefer that it was disposed of as waste and others that it be used as a fuel to utilise its valuable energy resource. Of the two options, reuse via MOX is a mature solution that has been demonstrated commercially. Immobilisation technologies to manage the bulk of the UK's plutonium are, in general, less mature but do exist in the form of cementation and ceramic waste forms, including low specification MOX. Both the immobilisation and reuse options will require the procurement of plants to deal with the plutonium, will have dose implications for workers and create significant volumes of waste for disposal.

3.56 Further work will continue on both the reuse and disposal options as in the event that reuse is chosen as the final disposal policy, we expect there will be a small volume of plutonium that cannot be reused and will have to be dealt with as a waste. The research work on disposal will be geared towards managing small amounts of plutonium rather than the large scale industrial processes that would be required if we had to deal with the bulk of the plutonium through this route. However the work on small scale immobilisation could be useful in exploring the viability of managing the bulk of the plutonium through an immobilisation option.

3.57 UK Government believes that the reuse as MOX creates a waste form with higher overall degree of intrinsic security than the immobilisation option. Although reuse as MOX will initially create un-irradiated MOX fuel, in this form

it has a degree of intrinsic security equivalent to that achieved by an immobilisation option. Both of these forms make our plutonium less attractive to terrorists. Irradiation of MOX fuel takes the intrinsic security to a higher level again as it becomes highly radioactive and therefore self protecting and consequently even less attractive to terrorists.

- 3.58 While it is true that there will be security risks associated with MOX fuel being transported to reactor sites, the risk of theft or attack are minimal and can be managed. It is important to remember that all options for plutonium management involve managing risks associated with terrorism and the appropriate levels of security will be applied.
- 3.59 All options to manage plutonium involve spending public money. Reuse as MOX in nuclear reactors would be a route for putting the plutonium beyond reach rather than a commercial operation in its own right. The value of the fuel to reactor operators is significantly less than the cost of its manufacture, though the revenue gained will help to relieve the burden of the expensive nuclear legacy to the taxpayer.

Government Conclusion

- 3.60 *The UK Government has concluded that principally the right preliminary view was selected in the consultation paper and that to manage the vast majority of our separated plutonium in the long-term, the best prospect of success lies with the "reuse as MOX" option. This option should therefore be taken forward as the principal policy for long-term plutonium management.*
- 3.61 *This option is technologically mature, which makes the reuse option both achievable and deliverable. 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. This makes use of the valuable energy resource contained in the plutonium; a single gram of recycled plutonium in MOX fuel will produce as much electricity as one ton of oil.*
- 3.62 *The UK Government is satisfied that lessons learned from the Sellafield MOX plant can be applied to a new MOX plant and that overseas experience gives confidence that any new MOX plant will be successful.*
- 3.63 *In addition to providing the best prospect of success, the reuse option would start to tackle the nuclear legacy and provide an ultimate resolution to a serious nuclear security issue.*

- 3.64 *However, before this policy can be implemented the UK Government will require significantly more detailed information on the market for the use of MOX fuel and the availability of reactors in which it can be burned. This will ensure that the plant will be affordable and provide value for money. Other information will focus on detailing the costs and timescales to procure a new MOX plant and any associated facilities, and the best procurement model that represents the lowest risk to UK Government. The subsequent Justification process will also ensure that this option meets health, safety and environmental requirements.*
- 3.65 *Whilst the MOX option is the most technologically mature and accessible option, we will continue to consider emerging reuse options if they are deemed to be credible within the timescales set out for implementation.*

4 Events in Japan

- 4.1 Following the recent earthquake and tsunami in Japan and their impact on the Fukushima nuclear site, the Secretary of State for Energy and Climate Change asked Mike Weightman, the chief nuclear inspector and head of the Health and Safety Executive's Nuclear Directorate, for a report on the implications of the unprecedented events in Japan and to identify lessons to be learnt for the UK nuclear industry. An interim report was published in May and the final report was released on October 11th 2011.
- 4.2 Soon after the events in Japan had unfolded, UK Government considered what impact these events might have on the consultation and whether or not the consultation period should be extended. Our view was that it would not be realistic to continue consulting until after the final report from the independent regulator had been published.
- 4.3 The majority of respondents who commented on events in Japan did not do so until the last week of the consultation period. Some of those respondents suggested that the consultation process be halted, until the full effects of the events in Japan were understood.
- 4.4 However, UK Government had already decided that the consultation would continue as planned because the reasons for consulting on plutonium management were to allow associated serious nuclear security risks and proliferation sensitivities to be addressed. These reasons have not changed as a result of events in Japan and our intention, which is to implement a policy that will reduce volumes of separated plutonium by putting it beyond reach, is still valid. The events in Japan might impact the implementation of a policy for managing plutonium, but it should be recognised that the consultation was only the beginning of the long-term plutonium management process. Implementing a policy for plutonium management is not something that can happen overnight. It is a process that will realistically take many years and which will require many various regulatory consents, including those relating to safety and the environment before we can proceed. There will, therefore, be time and opportunity for any significant relevant facts that might emerge to be considered as part of the longer term process.
- 4.5 However we are aware from Mike Weightman's report that there was no evidence to suggest that the presence of MOX fuel in reactor unit 3 significantly contributed to the health impact of the accident on or off the site.

- 4.6 Nonetheless if it is shown that the events in Japan have significant relevance to our proposals on plutonium management we will of course take the relevant facts into account.

5 Statement of Government's policy on plutonium management.

- 5.1 The UK Government has concluded that for nuclear security reasons the preferred policy for managing the vast majority of UK civil separated plutonium is reuse and it therefore should be converted to MOX fuel for use in civil nuclear reactors. Any remaining plutonium whose condition is such that it cannot be converted into MOX will be immobilised and treated as waste for disposal.
- 5.2 While the UK Government believes it has sufficient information to set out a direction, it is not yet sufficient to make a specific decision to proceed with procuring a new MOX plant. The Government is now commencing the next phase of work, which will provide the information required to make such a decision.
- 5.3 To underpin the policy, further work will initially be focused on:-
- Further understanding the obstacles such a policy position might face with the intention of demonstrating whether, and if so, how the obstacles can be overcome;
 - Developing the requirements for implementation of reuse including consideration of procuring services or facilities, including a suitable MOX plant for reuse of plutonium, which can be delivered with minimum risk to UK Government;
 - Gaining further understanding of the market for MOX fuel and commercial arrangements;
 - Exploring the benefits and health detriment with a view to Justification, as per the "Justification of Practices Involving Ionising Radiation Regulations", of the practice for manufacturing, using and disposing of spent MOX or other plutonium based fuel;
 - Establishing the planning, licensing and permissioning requirements; and
 - The development of a delivery programme.
- 5.4 Implementation of this policy would then require the procurement of suitable facilities to manufacture MOX fuel and the availability of suitable reactors in which the MOX can be burned. Implementation would therefore be subject to at least the following conditions:-
- There being a high confidence that the capability to manufacture MOX fuel can be successfully procured;
 - There being availability of suitable reactors in which the use of MOX can be licensed and that acceptable commercial arrangements are in place;

- The chosen policy can meet health, safety and environmental requirements; and
 - The option is affordable and represents value for money.
- 5.5 This work will provide the necessary information to take the policy forward in line with Treasury Green Book Rules and will be required before UK Government can procure MOX fabrication facilities. Only when the Government is confident that its preferred option could be implemented safely and securely, that it is affordable, deliverable, and offers value for money, will it be in a position to proceed with a new MOX plant. If we cannot establish a means of implementation that satisfies these conditions then the way forward may need to be revised.
- 5.6 Setting out a policy for plutonium management sets a clear direction of travel, enabling UK Government to have essential commercial discussions with possible suppliers or new build operators. It will be through these discussions that we would gather further evidence that our chosen path delivers the outcomes that we require.
- 5.7 At this point in time the UK Government has not decided whether or not to hold a further public consultation on taking forward plutonium management. Implementation of this policy requires a range of regulatory and permissioning processes to be undertaken prior to final implementation and therefore UK Government anticipates that there will be an opportunity for stakeholders to put forward their views as part of these processes.

6 Other plutonium in the UK

- 6.1 In the consultation paper we noted that the UK is currently storing around 28 tonnes of foreign-owned plutonium and that in accordance with contracts and inter-governmental agreements reprocessing customers are required to demonstrate an acceptable end use before their plutonium can be returned to them.
- 6.2 The UK Government's preferred policy on long-term management of the UK's plutonium is that it should be reused as MOX fuel. This policy provides an option whereby overseas customers could opt to have their plutonium converted into MOX fuel in the UK in the facilities that will be used to convert UK-owned plutonium into MOX, if it suited their requirements.
- 6.3 In the consultation paper we said that the UK would be open to consider the merits of taking over ownership of that foreign plutonium and to manage it 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.

Policy **Statement on overseas plutonium**

- 6.4 The UK Government has concluded that overseas owners of plutonium stored in the UK could, subject to commercial terms that are acceptable to the UK Government, have that plutonium managed in line with this policy. In addition, subject to compliance with inter-governmental agreements and acceptable commercial arrangements, the UK is prepared to take ownership of overseas plutonium stored in the UK after which it would be treated in line with this policy.
- 6.5 For each instance where there is a proposal for the UK to take title to overseas plutonium, the NDA will be required to demonstrate to the UK Government that there is an overall benefit to the UK in doing so.

7 Next steps

- 7.1 The consultation was the beginning of the process to take forward the policy on long-term plutonium management. The next steps towards implementation will see further information being gathered by the UK Government and NDA through detailed commercial discussions on the market for MOX fuel and the availability of reactors in which it can be burned. Other discussions will focus on detailing the costs and timescales for procuring services or facilities, including a suitable MOX plant, which can be delivered at minimum risk to UK Government.
- 7.2 Further workstreams will take forward the requirements for the Justification of the whole MOX path from fabrication, through use to disposal, which will be required before UK Government can commit to spending significant capital on procuring a new MOX fabrication plant.
- 7.3 We anticipate that an initial data gathering process would take about a year, which would be used to determine whether enough assurances can be provided that there is benefit to proceeding with the Justification process, which itself could easily take several years. UK Government would have to be satisfied that MOX fabrication and use could be Justified before we would consider taking the process to the point where UK Government would procure new MOX fabrication facilities.
- 7.4 In parallel with these processes the NDA will continue supporting work on small scale immobilisation, to deal with an expected small amount of plutonium that cannot be managed through reuse.
- 7.5 Procurement of new MOX facilities will follow the Treasury Green Book Rules and will be supported by the necessary evidence and business case to satisfy UK Government that this is the right thing to do.
- 7.6 We will continue to monitor the emergence of other technologies which could be considered as credible reuse options within appropriate timescales.
- 7.7 The project to manage the UK's plutonium is considered to be a Major Project and as such will be scrutinised by the new Major Projects Authority (MPA)⁶. This is a partnership between the Cabinet Office and HM Treasury and will oversee and direct the effective management of all large-scale projects that are

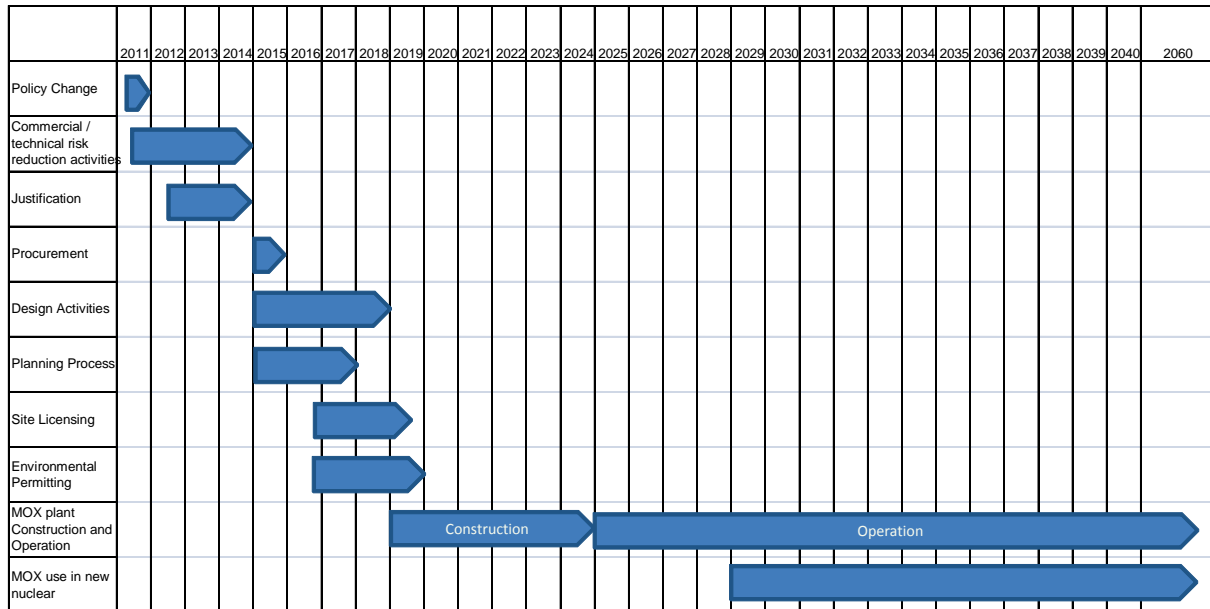
⁶ <http://www.cabinetoffice.gov.uk/news/government-launches-major-projects-authority>

funded and delivered by central government. The MPA will scrutinise projects, ensure accountability and inform the Treasury's decisions on whether to approve projects.

Illustrative Timeline

7.8 An illustrative timeline for taking forward the management of plutonium is shown below. Implementing a reuse option will be taken forward in a way that does not impact on the delivery of new nuclear power stations and therefore the time to first use of MOX fuel in new build can only be estimated.

Overall illustrative timeline for Plutonium management in the UK



ANNEX 1

Consultation Questions

- 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?

ANNEX 2

List of respondents

Allerdale Borough Council
Professor Wade Allison
AMEC
Areva
Balogh, Steve
Dr Frank Barnaby and Shaun Burnie
Emeritus Prof Kieth Barnham
Micheal Baron MBE
Blackwater Against New Nuclear
Britain's energy coast
British Pugwash Group
Cambridge Nuclear Energy Centre
J Chanay
COMARE
Copeland Borough Council
CORE
CoRWM
Roland Cremer
Felicity Crowley
Cumbria County Council
Ian Currie
Dounreay Site Restoration Ltd
EDF
ENBW
Environmentalists for Nuclear Energy
Richard Garnsey
GE Hitachi
Brian Gerrard
Chris Gifford
GKN
GMB
Greenpeace
Neville Grundy
Health Protection Agency
Richard Herbert
David Horsley
Sioned Huws
Isle of Man Government
Jacobs Engineering
Andrew Jeapes
T L Jones
John Kapp
Peter Krebs
Martin Lack
Lightbridge Corporation
David Lord
Dr David Lowry
Peter MacFarlane

Peter Manning
Christopher Mathieson
Ministry of Defence
National Nuclear Laboratory
New Build Nuclear Consulting Ltd
Nuclear Free Local Authorities
Nuclear Industries Association
Nuclear Information Service
Nuclear Institute
Nuclear Liabilities Fund Ltd
NuGen
NuLeAF
Dr William Nuttall
Office For Nuclear Regulation
Parents Concerned About Hinkley
Jill Perry
Mr Phalford
Prospect
Radiation Free Lakeland
Frances Rand
Chris Reed
Peter Rigg
Linda Rogers
Rolls Royce PLC
Royal Academy of Engineering
Pat Sanchez
Science Council for Global Initiatives
Sellafield Trade Unions
SEPA
SERA (Greater Manchester)
Peter Sharpe
Shetland Council
Barrie Skelcher
Smith School of Enterprise and the Environment
Jonathan Squire
Karen Stewart
Richard Strange
Rae Street
Supporters of Nuclear Energy
Gareth Rhys Thomas
ThorEA
Tokomak Solutions
Unite Union
University of Sheffield
US Friends of the Earth
Duncan Webster
West Cumbria and North Lakes Friends of the Earth
Westinghouse Electric Company
John Wilkins
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