Respondent Details	
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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	Given the uncertainty in timing of the future availability of commercially viable fast reactors, and the hazard associated with storage of the current substantial plutonium stock pile, it is clear that a coherent long term strategy and R&D plan are required to support a future decision on how to manage plutonium stocks. However, in my opinion, the substantial uncertainties associated with both the option to reuse or direct immobilisation-disposal, do not enable a preliminary policy view to be taken at the present time.
Q2	Do you agree that the Government has got to the point where a strategic sift of the options can be taken?
Response	The high level options identified are broadly correct, but it is not clear that sufficient data or depth of analysis if available to make a strategic sift at this point. In my opinion, the following points should be addressed. Reuse as fuel. - A clear strategy for management and storage of spent MOX fuel, arising from any decision to reuse, is required – particularly if a deep burn approach is to be employed to extract maximum value from the fuel. The current Japanese nuclear emergency highlights the hazards associated with storage of substantial quantities of spent (MOX) fuel. - The case for re-use or disposal must consider the overall environmental impact from generation of fission products and actinide breeding, arising from burning of MOX, and the disposal of these radionuclides in the form of spent fuel, *versus* direct disposal of plutonium in an engineered wasteform. Disposal. - Although technologies required for immobilisation of plutonium are less mature than that those for the reuse option, it is likely that these could be developed and deployed within a decade given appropriate resource, vision and co-ordination of R&D. Without a long term strategy and commitment to such an R&D programme it is doubtful that the necessary enabling outputs will be delivered in the timescale required. Given the diminishing skills base and facilities required to pursue this option it is vital that Government, through NDA and Research Councils, makes a commitment to support R&D in this area as a matter of urgency.

	Irrespective of whether the bulk of the stockpile is to be reused as MOX fuel, the necessary R&D will be required to support immobilisation of a significant fraction of the stockpile (at least 5%) which is unsuitable for manufacture and would be expensive and hazardous to recondition. - The analysis states "should un-irradiated low specification MOX pellets be considered as a suitable form for disposal, the technology to make the pellets is well developed". In my opinion so called "low specification MOX" is a dangerous diversion in consideration of the high level options for the management of the plutonium stockpile. **Low spec MOX is <u>not</u> a material engineered to be fit for the purpose of direct disposal** – although this approach would convert plutonium oxide powder into a monolithic ceramic (which is preferable to safeguard against environmental dispersion). However, the resulting product dilutes the plutonium in a matrix which is far less durable than other engineered wasteform materials based on titanium or zirconium oxides and without the enhanced criticality safeguard associated with the addition of neutron poisons. It is difficult to see any set of circumstances in which plutonium disposal in the form of so called "low specification MOX" could be preferable to disposal in an engineered and fit for purpose material, except in the case of an available and under utilised MOX fuel plant with a proven track record of throughput. Even if such a plant were available, it could easily be adapted to immobilise plutonium in an engineered ceramic wasteform by essentially the same process as fuel manufacture. Thus, in any circumstance where low specification MOX is considered a potential option for disposal, the option to produce an engineered wasteform will always be competitive and preferable in terms of overall environmental impact. - The analysis states "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". This is a valid and important concern and highlights the need for a purposeful strategy to undertake the required R&D to demonstrate long term stability of wasteforms as a matter of urgency – such that this knowledge will be available at the time it is required in the future. - The analysis states "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". I am not convinced that this is necessarily the case. At the present time plutonium oxide must be stored in a configuration which safeguards against criticality. Although plutonium would be diluted in a wasteform, compared to the free oxide, hot or cold isostatic pressing would afford ceramics close to theoretical density – i.e. only a few percent of enclosed porosity. In comparison, cans containing loose plutonium oxide grains could comprise 50% porosity (or more). Thus, dilution will be off set partially, by a substantial increase in package density (normalised to Pu content). Furthermore, Pu would be combined with neutron poisons (e.g. Gd, Hf) in a wasteform which would allow more efficient packing in a given volume, based on criticality considerations, compared to loose powder. If Hot Isostatic Pressing (HIP) were selected

	as a wasteform packaging process, then the size of the product packages could be optimised to be accommodated within the existing stores. Therefore, it is not clear, from the analysis presented, that the issue of new storage facilities is pivotal to the decision for early or late (i.e. near or far term) immobilisation. Even if a new store were required, the enhanced criticality safeguards and proliferation resistance assured by an engineered wasteform could mean that such a store would be smaller and less expensive to construct and operate compared to the existing waste store. If reuse of the existing store for immobilised plutonium is assumed, then there are two possible immobilisation options – either near / early or far / late term – both of which require an immobilisation plant and a packaging plant. In both cases it is likely that a packaging plant would be required to pack the waste packages produced by HIP into larger containers for final disposal (due to the maximum size of waste package volume produced by this technology). As time goes on, the cost and hazard associated with the immobilisation option increases due to the ingrowth of americium. The immobilisation process, involving loose plutonium oxide powder, is clearly much more hazardous than the packaging process which involves a monolithic packaged product. Therefore, there is a clear safety and cost incentive to immobilise early rather than late. In contrast, because the packaging plant will operate in the period running up to repository emplacement, irrespective of the choice of late or early immobilisation, the cost and hazard are unlikely to be much different, because the americium ingrowth is the same in both scenarios. In my opinion, therefore, it is not clear that an immobilisation process should wait until the GDF is available. Certainly, this is not true in the case of any plutonium declared as waste, since to do so would prolong the hazard and risk associated with ongoing storage of material which has no beneficial end use.
Q3	Are the conditions that a preferred option must in due course meet, the right ones?
Response	Broadly, the conditions as set out in the published analysis are correct. However, the principle of inter-generational equity should be specifically identified: that is, the sum of all other factors are equal, the option that leads to earliest reduction of the existing stockpile should be pursued, to reduce the burden on future generations. With respect to the issue that an option “must be achievable and deliverable” this must be considered in parallel with a supporting R&D strategy. Options which may not appear feasible now, might become feasible with a dedicated period of intensive R&D. Engagement with the academic sector is key to addressing this issue. With respect to the issue that “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”, I further emphasise the need to consider this in parallel with a supporting R&D strategy. I do not believe that the required fundamental and enabling scientific knowledge to support an appraisal of cost effectiveness or likelihood of success is currently available. For example, to qualify the long term performance of a waste package with respect to stability against self

	induced radiation damage from Pu alpha decay – a decade long research programme is needed to build the required fundamental scientific understanding of relevant mechanisms. Therefore, it is vital that Government invest in the scientific knowledge and skill base **now** to provide the necessary supporting data to support future decision making, regarding facilities, in a timely fashion.
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	Setting out "strategic direction" now is essential to minimise the hazard and security risks associated with indefinite storage of the plutonium stockpile. However, I am not convinced that sufficient data are available to enable a preliminary policy view to be stated at this point.
Q5	Is there any other evidence government should consider in coming to a preliminary view?
Response	Please refer to detailed answers to Q3 and Q7.
Q6	Has the Government selected the right preliminary view?
Response	It is difficult to be certain that Government has selected the right preliminary view based on the analysis presented in the consultation document. In my opinion, the current uncertainties regarding income from energy generation, cost of a new fuel processing plant, cost of spent fuel storage facilities, and cost of final geological disposal, mean that we cannot be sure that reuse is the best option available. Furthermore, I do not see a convincing strategy in place for management of the spent fuel arising from MOX reuse or a convincing appraisal of the overall environmental impact of reuse (arising from the resulting fission product and minor actinide inventory) compared to direct disposal in an engineered wasteform. In my opinion the published analysis that MOX reuse will lead to "creating a proliferation resistant waste-form" is misleading. The term wasteform should be reserved for materials which are engineered for the immobilisation and disposal. MOX fuel is designed for burning in reactors and nothing more – it is **not** a material designed for the purpose of disposal. Given the substantial current uncertainties associated with both the option for reuse and direct immobilisation-disposal, my opinion is that Government policy should be to pursue both options in parallel for an initial period of 3-5 years, to address the underlying uncertainties, before taking a view on a preferred option. In my view, a commitment and strategy to resolve the underlying scientific and economic uncertainties associated with re-use or disposal options is more important than a preliminary policy view on a preferred option.
Q7	Are there any other high level options that the Government should consider

	for long-term management of plutonium?
Response	In the analysis of Chapter 4, relating to foreign owned plutonium, the analysis does not identify a potential revenue generating opportunity. Foreign customers may not wish to convert their separated plutonium stock into MOX fuel for reuse but would likely not want to accept the return of unconditioned plutonium since this would carry storage cost, security and safety issues similar to those of current concern in the UK. The cost to foreign customers of constructing their own bespoke immobilisation plant to immobilise small quantities of plutonium would be disproportionately high. Therefore, the opportunity is for the UK to immobilise foreign owned plutonium stocks, alongside UK owned material, in a passively safe and proliferation resistant engineered wasteform, prior to return to the customer for interim storage and final disposal. The revenue generated by this service would partially off-set the cost of the required immobilisation and packaging facility and would carry the added benefit of reducing the quantity of foreign owned plutonium stored in the UK, within an earlier time frame.