**NUCLEAR INDUSTRY ASSOCIATION RESPONSE TO CONSULTATION ON MANAGING RADIOACTIVE SUBSTANCES AND NUCLEAR DECOMMISSIONING**

The Nuclear Industry Association (NIA) welcomes the chance to respond to the Government's consultation on UK policy proposals for managing radioactive substances and nuclear decommissioning.

The NIA is the trade association and representative body for the civil nuclear industry in the UK. We represent around 270 companies operating across all aspects of the nuclear fuel cycle, including the current and prospective operators of nuclear power stations, international designers, and vendors of nuclear reactors, and those engaged in decommissioning, waste management and nuclear liabilities management. Members also include nuclear equipment suppliers, engineering and construction firms, nuclear research organisations, and legal, financial and consultancy companies.

Many of our members will have made their own, detailed response to this consultation. The focus of this submission is therefore on industry-wide matters, illustrating our recommendations and arguments with specific case studies where appropriate.

**Executive Summary**

The NIA agrees with and takes as our starting point the consultation's statement that "we are clear that we must strive to keep the creation of radioactive waste to a minimum. We must strive to find the most cost effective and sustainable solutions for its long-term safe management. We must strive to reduce the burden for future generations of managing the radioactive waste that has already accumulated or has yet to be generated, for example, through nuclear decommissioning and clean-up activities."

Since we share these goals of minimising waste, ensuring cost effective and sustainable solutions, and minimising the burden on future generations, we support the following high-level steps:

- Aggressive application of the waste hierarchy with a clear mandate from the Government to the NDA to seek out and implement solutions that reduce waste volumes and drive down waste classifications as far as possible. This saves money and improves efficiency.
    - We have cited the example of a re-characterisation solution applied by ANTECH to just 1,810 drums of Intermediate Level Waste plutonium-contaminated materials. ANTECH's re-measurement found that more than 95% of the drums were in fact Low Level Waste or below, generating an estimated £9 million of savings. This is the kind of solution we should apply.
- Implementation of the consultation's recommendation of near-surface disposal of appropriate ILW, rather than its consignment to the GDF, because the GDF is the most highly-engineered solution and thus less likely to be cost-effective for ILW under a risk-informed decision making framework.
    - Establishment of a policy principle to minimise the volumes of waste going to GDF, as it is the most highly-engineered disposal solution and thus at the very bottom of the waste hierarchy.
- Enhanced collaboration with other countries on shared solutions to waste, because it is highly unlikely to be sustainable or cost-effective for every country that has generated nuclear waste to develop all the capabilities necessary to treat, store and dispose of waste themselves.

    - Specialisation of countries in the treatment and disposal of certain kinds of waste is much more likely to be efficient and sustainable, so the transfer or exchange of waste should be allowed pragmatically.

    - The “Self-sufficiency” principle alone should not be sufficient to deny authorisation for trans-frontier shipment of waste.

- Establishment of an overall policy preference for the re-use of nuclear materials where possible

    - In-principle support for the reprocessing of spent fuel, and thus its preservation from geological disposal as long as practical. Ideally, reprocessing should be pursued to extract the maximum possible clean energy from nuclear materials and to minimise volumes consigned to a GDF, but we appreciate the challenges that would emerge in practice. The UK Government should encourage viable proposals for reprocessing, cognisant of the lessons of past experience.

    - Special categorisation of uranium within nuclear materials policy to reflect its lower hazard, lower proliferation risk, and high potential for further productive use.

        - A formal policy to re-use the public stockpile of uranium wherever possible in nuclear or non-nuclear applications. It is noted that while there is an opportunity for re-use some uranium stocks through further enrichment, there will still be residues that may ultimately require disposal and so a pragmatic management solution remains a priority.

    - Renewed pursuit of the re-use of plutonium through a dedicated programme to support the deployment of plutonium-burning reactors, or the use of the plutonium in MOX fuel for any viable reactor type: funding, costs, risks and rewards should be shared between the NDA and the private sector under a clearly defined framework reflecting the particular considerations at work.

        - Any programme will likely take years to reach fruition, but procrastination makes it harder to reuse the plutonium effectively. Since re-use is the policy, re-use should be pursued actively to implementation.

**<u>Part I</u>**

1. **Do you agree with the proposal to require the application of a risk-informed approach as a decision-making framework for the management of all solid radioactive waste? Please provide the reasoning behind your response.**

Yes, we agree with the proposal because a realistic and comprehensive appraisal of the risks presented by solid radioactive waste is more likely to produce sustainable and cost-effective solutions. A more rigid framework is likely to result in excessively conservative management, treatment and storage solutions that cost more.

In particular, we support the department’s assessment that a risk-informed approach will lead to “increasing the diversity of technologies, options and infrastructure” for waste management.

A risk-informed approach will need swift implementation in a strategy that can guide the operational priorities and procurement strategies of those organisations responsible for waste management to maximise the benefits of more proportionate solutions.

We do think that the UK should reflect in international guidance and establish a *de minimis* radiation does level below which regulatory burdens are considerably less. We point to the example of the IAEA, which has stated that a dose below 0.01 mSv per year should be "below regulatory concern", because a risk-based framework should be designed to prevent the expenditure of effort and resource to demonstrate reduction of already *de minimis* risks.

2. **Do you agree that application of the waste hierarchy should be an explicit policy requirement for the management of all solid radioactive waste where practicable? Please provide the reasoning behind your response.**

We strongly support the application of the waste hierarchy as an explicit policy requirement because solutions applied further up the hierarchy more effectively support our ultimate goals of minimising waste, minimising cost, and minimising the burden on future generations.

As the consultation references, solutions such as additional characterisation and segregation enable the minimisation of wastes.

To take one example, the Universal Drum and Segregation System (UDASS) developed by ANTECH, a UK SME, was applied to 1,810 drums of Plutonium Contaminated Materials (PCM) classified as ILW. The UDASS found that just more than 95% of the drums were in fact LLW. Of those LLW drums, more than 85% were themselves Low-Assay LLW or Very Low Level Waste. The LLWR Site radiological inventory and radiological hazard was reduced by a factor of 10. The project is also projected to achieve more than £9 million in the lifetime costs of managing the waste. The project thus minimised waste, minimised cost, and minimised the management burden of future generations, which are three key goals of waste management policy. In addition, this project examined less than 5% of ILW drums held across the NDA estate, so the potential savings yet to be realised are much higher still, likely over £100 million.

Requiring the application of the waste hierarchy should help drive the rigorous and comprehensive adoption of solutions like this across our radioactive waste inventory. In particular, the Government should ensure that the UK has enough waste characterisation capacity to capture the substantial efficiencies and savings offered by these solutions.

The application of the hierarchy should help facilitate more creative solutions to allow re-use of materials.

To take a further example, plutonium in the UK's stockpile absorbs neutrons over time and decays to become americium. The presence of americium makes it more difficult to re-use the plutonium as fuel. However, the americium can be removed and used to power batteries for spacecraft.[1] Its extraction in turn purifies the plutonium and facilitates its re-use as fuel. This separation allows the re-use of both materials rather than their collective consignment for disposal.

3. **Do you agree with the proposed amendment to current policies on geological disposal to allow disposal of ILW in near surface facilities? Please provide the reasoning behind your response.**

We strongly support the proposed amendment to current policies to allow near surface disposal of ILW. Again, the GDF is the most highly engineered solution, so it should be a last resort, given its

[1] National Nuclear Laboratory, "UK Space Agency and National Nuclear Laboratory to collaborate on world's first space battery powered by British fuel" (2022): https://www.nnl.co.uk/2022/12/uk-space-agency-and-national-nuclear-laboratory-to-collaborate-on-worlds-first-space-battery-powered-by-british-fuel/. Accessed 23 May 2023.

comparative implications for cost. The net savings for near surface disposal estimated by the NDA and cited in the consultation document further strengthen this case.

The Government should also mandate the re-characterisation of all ILW in which there is low confidence in the initial classification. This should create a clearer picture of what ILW can go to near surface disposal as opposed to geological disposal and may reveal further inventory to be only LLW or below, which may not even require near surface disposal. This would further support the aims of minimising waste, minimising cost, and minimising the burden on future generations.

4. **Do you agree with the proposed policy framework for the development of near surface disposal facilities by the NDA for the disposal of less hazardous ILW? Please provide the reasoning behind your response.**

Yes, we agree with the policy framework proposed. It follows a robust and familiar structure for the establishment of a new nuclear facility. It is probably wise not to designate the project as a National Significant Infrastructure Project, as the NSIP system has not achieved the swiftness and decisiveness initially envisaged and is already slow ad overcapacity.

5. **Do you agree that the policy of the UK Government and devolved administrations should promote the use of on-site disposal of radioactively contaminated waste from the decommissioning of nuclear sites, subject to environmental permits? Please provide the reasoning behind your response.**

We believe that the policy should enable the use of on-site disposal where appropriate under a risk-informed approach. We should exploit natural attenuation to our advantage and not do more than we need to do. As noted in the consultation document, on-site disposal solutions can be more sustainable, because they do not involve as much excavation, packaging, transportation and construction of additional facilities for storage and disposal, all of which can themselves consume resources and create more carbon emissions.

UK policy should be careful to ensure that the application of the waste hierarchy, which is a strong guiding principle, does not unduly conflict with the potential for on-site disposal. The application of the waste hierarchy could encourage early intervention to extract, treat and attempt to recycle materials from the sites in question, rather than employ on-site disposal. There should be careful consideration in these instances to balance considerations of cost, risk, and sustainability to ensure the appropriate solution.

6. **Are there any further improvements that we might consider in relation to the proposed update of the nuclear decommissioning and clean-up policy? Please provide the reasoning behind your response.**

We support the framework outlined and would simply stress that the updated policy be swiftly and rigorously reflected in the strategies and operational practices of the public bodies responsible for decommissioning.

In particular, we support the proposal that the first use for which land hosting publicly owned nuclear facilities should be considered is national infrastructure and believe that the deployment of further nuclear power plants on these sites should be a key objective of national policy. However, we believe that within the context of the nuclear new build programme itself, that publicly owned and privately owned sites should be evaluated on a level playing field. Given the ambition to deploy 24 GW of nuclear for on-grid electricity, and the demands of industrial decarbonisation, it is possible in any case that all of these sites would need to be utilised for additional nuclear capacity.

In addition, we believe that maximising "the wider socio-economic and environmental benefits of decommissioning and clean-up" will require the revision of the policy on the import and export of nuclear materials. We outline our suggestions in more detail below, but it should be recognised that the UK has world-leading expertise in nuclear decommissioning that could be applied to projects abroad. To realise the full benefits of this expertise, there should be more provision for the well-regulated, pragmatic trans-frontier shipment of waste.

7. **Do you agree with our proposed updates to the policy statement on the management of spent fuel? Please provide the reasoning behind your response.**

We generally support the proposed updates but believe the statement should recognise that in the interests of circularity and the maximisation of clean energy production for materials not yet designated as waste, that ideally spent fuel should be reprocessed.

The statement could be adjusted to say, "*The UK Government supports in principle the reprocessing of nuclear fuel to ensure circularity and to maximise clean energy production, recognising the need for any renewed reprocessing to demonstrate value for money.* The UK Government is continuing to support the advanced nuclear sector through investments in research facilities and programmes *and would consider supporting the commercialisation of new reprocessing techniques if brought forward by industry.*

8. **Do you agree with our proposed policy statement on the management of uranium? Please provide the reasoning behind your response.**

We generally agree but believe that the policy statement should define a clear policy preference for the re-use of uranium where viable, in a similar way to the policy on plutonium. While not all plutonium is suitable for re-use, UK policy overall is still to re-use plutonium: likewise, not all uranium may be suitable for re-use, but UK policy should still reflect that overall ambition.

In particular, the statement should specify that UK policy for the UK Government-owned inventory of uranium is for re-use wherever possible.

Furthermore, the statement should indicative a special categorisation of uranium within nuclear materials given that it has comparatively low radioactivity overall, poses significantly less proliferation risk than separated plutonium, and still has a number of beneficial energy and non-energy potential re-use options.

**<u>Part II</u>**

1. **Do you think that the draft policy statements on radioactive sources accurately reflects existing practice and regulation? Please provide the reasoning behind your response.**

Yes, we believe the statements do reflect existing practice and regulation accurately.

2. **Do you have any suggestions on how to improve this chapter on radioactive sources? Please provide the reasoning behind your response.**

We would propose that chapter recognise that international standards can and will evolve: the ICRP with UK participation is actively examining issues in this area, and the chapter should reflect that the UK will follow evolving international best practice wherever possible.

3. **Do you think that the draft policy statement on radioactive liquid and gaseous discharges accurately reflects existing policy, practice and regulation? Please provide the reasoning behind your response.**

Yes, we believe it reflects the current situation, although we would ask for explicit clarification on whether or not it is the Department's view that the waste hierarchy applies to liquid or aqueous wastes. We would also welcome a specific examination of the consequences of its application beyond solid radioactive wastes before any policy to apply the hierarchy explicitly to new classes of waste is adopted.

4. **Do you have any suggestions on how to improve this chapter on radioactive liquid and gaseous discharges? Please provide the reasoning behind your response.**

We do not have significant suggestions for improvement, but there may be merit in aligning the England and Wales dose levels defining the threshold for optimisation with those in Scotland and Northern Ireland. The IAEA, as noted above, defines doses below 0.01 mSv per year as being "below regulatory concern", and we certainly strongly recommend the adoption of a *de minimis* threshold below which regulatory burdens are significantly lessened.

5. **The solid radioactive waste policy set out above includes existing policy and policies that would be implemented if the proposals in Part 1 are taken forward. Do you agree that the policy statement captures all relevant policy on managing solid radioactive waste?**

Yes, we believe it captures the relevant policy on managing solid radioactive waste. In particular, we support the strong emphasis on the waste hierarchy and the preference for early solutions, as this is the best approach to minimise waste, cost and the burden on future generations.

6. **Do you have any suggestions for how this chapter on managing solid radioactive waste could be improved? Please provide the reasoning behind your response.**

We believe that there should be an explicit policy requirement added to take all practical and proportionate steps to minimise the volumes of material consigned to geological disposal. The volume of material committed is one of the variables affecting the cost of such a facility, so policy should be set to ensure cost effectiveness.

We are also not comfortable with a GDF being designed with *no* plans for retrievability in mind. It is possible that significant advances in reprocessing and fast neutron reactors take place in the coming years, and at the very least before a GDF would become operational. However, it is possible that we will be in a position of committing materials to a GDF that still have significant energy potential. There could be a defined window, perhaps 100 years, in which materials could be retrieved. If this is found to significantly increase costs of a GDF, however, it should not be considered.

We believe the expectations set on the NDA in paragraph 8.55 to support new initiatives, research and development and international collaboration will require the revision of the policy on the import and export of radioactive substances. We outline specific proposals later on, but it is extremely unlikely that good practice internationally in cost-effective and sustainable waste management will involve every single country that has generated radioactive waste developing the capabilities and facilities to manage all of its waste itself.

7. **The nuclear decommissioning policy set out above includes existing policy and policies that would be implemented if the proposals in Part I are taken forward. Do you agree that the policy statement captures all relevant policy on nuclear decommissioning?**

Yes, we agree that the statement captures relevant policy, and we want to stress our support for a number of the items contained therein.

Decommissioning should be carried out as soon as reasonably practicable, especially to facilitate the efficient use of sites for nuclear new build. It is important that decommissioning approaches take account of the needs of local communities and socio-economic factors, given the importance of nuclear skills and workers to the prosperity of local economies.

We would also observe that the use of Funded Decommissioning Programmes for nuclear new build is an example of best practice that should be adopted across the energy sector.

8. **Do you have any suggestions for how this chapter on nuclear decommissioning could be improved? Please provide the reasoning behind your response.**

We would simply note that in the interests of minimising the costs of decommissioning, that the Government should follow the Public Accounts Committee's recommendation in their report of May 2022 to review the investment strategy of the Nuclear Liabilities Fund (NLF). The NLF has delivered very poor returns in recent years, constrained by an excessively conservative investment strategy. Given the long-term nature of decommissioning programmes and liabilities reduces investment exposure to short-term fluctuations, the NLF should be more aggressively invested to generate higher returns and lower taxpayer costs for decommissioning. We note that of the 20% of the NLF assets invested more aggressively, they have generated returns of around 6.2% per year. If applied to the whole fund, the NLF would double in value to around £30 billion in 12 years, more than the £23.5 billion estimated 100-year cost of decommissioning the stations which hit covers.

9. **Do you think this chapter on the import and export of radioactive substances accurately reflects existing policy, practice and the regulatory framework? Please provide the reasoning behind your response.**

Yes, we believe this chapter reflects the existing situation.

10. **Do you have any suggestions on how to improve this chapter on the import and export of radioactive substances? Please provide the reasoning behind your response.**

We understand the intent behind the principles that radioactive waste should be managed in the country in which it was generated and as close to the point of generation as possible. However, these principles will prevent the most cost effective and sustainable approaches to decommissioning. It does not make sense for the Netherlands or Slovenia, for instance, which have each connected a single reactor to their electricity grids, to develop the same capabilities as the UK, which has connected 45 reactors to the grid over its history. If Romania, Bulgaria, Slovakia, Hungary and Czechia, and indeed all 32 countries worldwide, built separate Geological Disposal Facilities, there would be a massive redundancy, underutilisation, wasted resource and wasted effort.

Given that many nuclear facilities and capabilities require capital intensive upfront investment, the best approach will be for nuclear nations to collaborate to identify the most efficient ways to meet their shared needs. The consultation document identifies a number of pragmatic examples of this, such as the shipping of UK metallic waste to Sweden for smelting. This pragmatic approach should be extended and systematised wherever possible.

Countries could consider exchanging radiologically equivalent waste volumes for treatment and storage, especially since the return of treated waste consumes extra resources and can create additional carbon emissions from transportation.

Since the UK has some of the most advanced decommissioning capabilities in the world, it will sacrifice economic value if it insists on a strict application of the self-sufficiency principle.

To give an example, Tradebe Inutec, the nuclear site licensee at Winfrith, proposed to take some Low Level Waste from an overseas nuclear fleet, for incineration at its Dorset and Fawley processing facilities and disposal at UK LA-LLW landfill sites. The incineration process reduces radioactivity by 85%, and the contract would have been worth several million in total over 10 years. That would have supported 70 jobs and valuable decommissioning skills which are also used in the UK, while having no material impact on the UK's stock of waste. During discussions the Environment Agency, however, indicated that it would refuse permission for the shipment on the grounds that foreign States should manage their own waste.

The chapter should therefore be modified at least to say that the import of waste for disposal as well as treatment, where it has no material impact on the UK, should be allowed even if it does not align with the general principle of self-sufficiency.

The UK should provide clear guidance on what it believes to constitute a material impact and be willing to apply this principle flexibly to achieve efficient cooperation with partner nations.

Simply put, not everybody should do everything on decommissioning. Instead, we should specialise, taking advantage of our expertise to win contracts, create jobs, and preserve skills vital for the progress of our own decommissioning programmes.

11. **Do you agree that the policy covers everything you would expect it to regarding managing spent fuel and uranium? We are not currently seeking views on plutonium management policy.**

It is not satisfactory to separate the question of plutonium management from managing spent fuel and uranium, because the option of reprocessing spent fuel involves the creation of separated plutonium. The merits of reprocessing cannot be properly evaluated without an idea of what the solution is for the reuse of plutonium. Moreover, the blending of plutonium from reprocessing with uranium, reprocessed or otherwise, to create MOX fuel is one of the plausible ways to re-use plutonium, so it is important to have a coherent general framework to address all three questions. We would therefore expect to see plutonium evaluated and addressed alongside spent fuel and uranium.

12. **Do you have any suggestions for how the policy statements on managing spent fuel and uranium could be improved? Please provide the reasoning behind your response.**

*Spent Fuel*

In our answers to Part II above, we set out proposed wording on spent fuel and further proposals on the use of uranium. Overall, UK policy should express a clear preference that nuclear materials should be re-used, unless there is no viable route to do so.

The policy should express a preference for spent fuel reprocessing, subject to a stringent test of economic viability and value for money, given the UK's past experience.

*Uranium*

The policy should express a preference for the re-use of uranium as well, in particular the re-use of the Government's own inventory.

Since the UK owns 110,000 tonnes of uranium[2], it would be particularly wasteful not to attempt to re-use that, especially given the UK's ambitions for expanded nuclear deployment and the growing demand for resource circularity and sustainability.

The policy should also treat uranium in a special category within nuclear materials, given, as noted previously, its lower radioactivity, its lower proliferation risk, and the wide range of nuclear and non-nuclear uses for which it could be employed. Uranium can be re-enriched into traditional nuclear fuel, but even depleted uranium could be used for other applications such as stable hydrogen storage.

Given these characteristics, the highly engineered disposal in the GDF seems unlikely to be the most cost effective and sustainable solution for uranium, especially if the waste hierarchy is rigorously applied.

Instead, the UK Government should work creatively with the private sector to find re-use pathways for uranium, including by making the Government stockpile accessible at reasonable commercial terms.

In that vein, we agree with the proposal to allow the NDA to take ownership of overseas-owned uranium, and that the NDA should also be allowed to take ownership of uranium that arises from UK processing.

The document does note that Urenco's facility at Capenhurst cannot currently enrich reprocessed uranium, but we stress that Urenco does have this capability at its facility in the Netherlands and that it would be possible to have this capability at Capenhurst, subject to the usual commercial considerations. There is no insuperable technical or physical impediment.

*Plutonium*

Lastly, the UK should renew its pursuit of plutonium re-use with a vigour that matches the risk the Government has identified. The consultation document itself says "The safe, secure management and ultimate disposition of separated plutonium produced from spent fuel reprocessing is one of the most significant and complex challenges the UK faces in managing its nuclear legacy." If that is the Government's view, and if the Government's policy is to reuse plutonium, it is time to develop a pathway to re-use through to implementation.

This effort should progress further than the last attempt approximately 10-15 years ago, because over time, radioactive decay presents addition obstacles to efficient reuse the plutonium.

The UK Government must be an active sponsor of solution, rather than a passive observer, by establishing a dedicated programme that is charged not with evaluating whether or not solutions are viable but with selecting a viable solution for implementation. The UK Government has the policy levers to achieve a viable solution, with active interest and cooperation from the private sector.

The dedicate programme should involve the sharing of funding, costs, risks and rewards between the UK Government, either directly or through the NDA, and the private sector under a clearly defined framework that takes account of the following considerations:

*Practical Difficulties and Considerations*

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[2]Nuclear Decommissioning Authority and Department for Business, Energy and Industrial Strategy, *2022 UK Radioactive Material Inventory* (2023): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1134901/2022_Materials_Report_-_010223.pdf. Accessed 15 May 2023.

- The UK's plutonium stock varies in age and quality: extracting it will involve costs, and it is highly unlikely that the entire inventory will be usable as fuel.

- The size of the inventory and the maturity of "burner" reactor technologies means that it is unlikely that a significant reduction in inventories could be made in the immediate future.

- It is therefore certain that significant projects to re-package and store the waste in the next 20 years, which involve "front-loaded" capital expenditure, must continue to completion.

- Given the size of the inventory, it is still a strong possibility that further capital investments would need to be made in storage in subsequent decades.

- It is therefore true that a large proportion of the estimated £8.5 billion liability is not current cash expenditure that could be saved by implementing "burner" reactor technologies or MOX fuel solutions.

- It is unlikely that the development and construction of a "burner" reactor design, with a MOX fuel fabrication plant as well, could "pay for itself" purely through saving on management, storage and disposal costs of plutonium.

- The burning of plutonium itself will create waste streams that need to be managed and stored, with some inventory which will need geological disposal.

- The proliferation concerns inherent in the use of plutonium mean that any entity that operates a "burner" reactor or runs a MOX fuel fabrication facility must be properly skilled and competent to handle such a sensitive material. It is not a simple task to build an organisation capable of being licensed in this way.

- A successful "burner" reactor design would also likely need an additional supply of plutonium beyond the 140 tonnes currently stored, which would involve a change in UK spent fuel reprocessing policy. A "self-sustaining" reactor design could of course make use of the stockpile for a longer period of time.

- Past UK efforts to both reprocess spent fuel (at THORP in particular) and to fabricate MOX fuel (at the Sellafield MOX Plant in particular) encountered very substantial commercial challenges in the course of operations, and great care would have to be taken to incorporate lessons from that experience in future endeavours.

*Benefits*

- Re-using the plutonium as fuel is fundamentally the best solution because it eliminates a security and proliferation concern, adheres to the waste hierarchy in re-using materials before resorting to highly engineered disposal, and could generate very significant amounts of sovereign clean energy, in keeping with the UK's energy security and net zero objectives.

- The UK's inventory of 140 tonnes of plutonium would be enough to support, for example, around 1,500 tonnes of MOX fuel at 4-5% Plutonium composition, making allowances for the quality and usability of the inventory. The UK certainly has enough uranium stockpiled to blend with this plutonium.

    - For perspective, the 6 GW UK nuclear fleet uses less than 150 tonnes of traditional, enriched uranium fuel per year to provide around 15% of the country's electricity and

save 15 million tonnes of emissions. At current carbon prices, 15 million tonnes of emission are worth approximately £900 million, and carbon prices are forecast to escalate sharply over the next 15 years. The current fleet also displaces around 8-9 billion cubic metres of gas use per year, from less than 150 tonnes of fuel.

- Although new storage facilities for plutonium are necessary in any case, burning the plutonium long term will reduce the current and capital outlays necessary by 2120, when the NDA's latest business plan aims to have "all plutonium reused or disposed"[3]. A fleet of "burner" reactors should be able to go through the current inventory decades before then.

    - To take an example, Newcleo is developing a 200 MWe Lead-Cooled Fast Neutron Reactor capable of utilising MOX fuel in either a "burner" or self-sustaining configuration that would consume the following amount of plutonium per year:

| Reactor configuration | Initial Core | Reload frequency/amount | Fuel needs per yr (not including first core) |
|---|---|---|---|
| LFR-AS-200 Burner | 8tHM (U+Pu) @30% Pu = 2.4T Pu | ½ core every 18 months | 2.6tHM (U+Pu)/yr @30% Pu = 0.78T Pu/yr |
| LFR-AS-200 Self Sustaining | 11.4tHM (U+Pu) @19% Pu = 2.1T Pu | 1/5 core every 16 months | 1.7tHM (U+Pu)/yr @19% Pu = 0.32T Pu/yr |

    - For illustration, Newcleo estimates that the UK's 140-tonne plutonium inventory could support up to 430 years of operation in a self-sustaining configuration, or around 175-180 years in a "burner" configuration. Newcleo's ambition is to deploy up to 4 GW of capacity, or 20 reactors, so even under the most conservative deployment estimates, such a fleet would consume the stockpile long before the 2120 deadline.

    - Assuming 90% reactor availability, the plutonium would then support up to 678 TWh of clean electricity production, displacing 267 million tonnes of CO2 emissions versus gas-fired generation, the equivalent of 141 billion cubic metres of gas.

- MOX fuel is not an experimental solution. MOX incorporating plutonium has been proven to work reliably in Light Water Reactors from years of experience, particularly in the French reactor fleet.[4]

    - The Melox facility operated by ORANO produces around 150 tonnes of MOX fuel per year, and MOX fuel generates about 10% of nuclear electricity in France[5], or about 30 TWh. That production would displace nearly 12 million tonnes of CO2 emissions per year, compared to gas-fired generation.

    - The UK also successfully fabricated and utilised MOX fuel for the advanced, sodium-cooled reactors deployed at Dounreay.

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[3] Nuclear Decommissioning Authority, *Nuclear Decommissioning Authority: Business Plan 2023 to 2026* (2023): https://www.gov.uk/government/publications/nuclear-decommissioning-authority-business-plan-2023-to-2026/nuclear-decommissioning-authority-business-plan-2023-to-2026. Accessed 24 May 2023.
[4] ORANO, "MOX, Recycling Nuclear Energy": https://www.orano.group/country/china/en/our-stories/mox-recycling-nuclear-energy. Accessed 24 May 2023.
[5] *Ibid.*

- MOX fabrication provided hundreds of skilled jobs and sustained valuable fuel cycle skills, while the plant was operational in the UK.

    - Again, though, it must be acknowledged that the Sellafield MOX plant was not a commercial success, and that care would have to be taken to learn the lessons and avoid repetition of the same mistakes.

    - The Melox facility operated by ORANO is much more likely to provide a useful model for future facilities, and care should also be taken to learn lessons from the French experience in this area.

- The operation of "burner" reactors and a future MOX plant could restore the skills, which the consultation document recognises have particular value for the UK and would create significant social value through jobs in construction and operation of reactors which are estimated to have at least a 60-year lifespan. This supports the ambition to maximise "the wider socio-economic and environmental benefits of decommissioning and clean-up".

    - Newcleo estimates that fuel fabrication alone would support 100 full-time equivalent positions per year initial, rising to 160 as more reactors were deployed, requiring more fuel.

*Considerations of Programme Design*

- The UK Government and bodies owned by the UK Government are responsible for the creation of the plutonium stockpile, so the UK Government must be the primary sponsor of any solution.

- The UK Government and UK taxpayer will continue to be responsible for management and storage costs of the plutonium and for the costs of ultimate disposal, so the UK Government should contribute funding given its interest in saving long-term costs.

- The UK Government has identified the plutonium stockpile as a proliferation risk, so the UK Government should contribute funding based on the value it puts on eliminating that security concern.

- The UK Government is the ultimate owner of nuclear materials that have massive clean energy potential. The generation of clean energy produces very significant social benefits from emissions reduction and energy security that only the Government can properly "price in". The UK Government should contribute funding based on the value it assigns to using the stockpile to reduce emissions and reduce fossil fuel imports.

- The UK has lost jobs and capabilities from the ending of commercial reprocessing and the closure of the MOX fuel fabrication facility, as well as other advanced fuel facilities. The use of the plutonium has the potential to restore these in part or in full.

- The UK Government controls the regulatory access necessary to proceed with a viable programme to utilise the plutonium, so it must offer such access as part of this programme.

- The UK Government should provide as much information as possible as early as possible on previous work done on plutonium utilisation and on the state of the inventory, to ensure swift and efficient working.

- The success of “burner” reactors and MOX fuel fabrication holds huge promise for the owners and operators of those facilities, so the private sector should contribute funding on the basis of that potential.

- Given the likelihood of these rewards and the past empirical difficulties in fabricating MOX fuel and deploying advanced reactors, the private sector should contribute funding based on acceptance of a share of those development risks.

- The private sector must produce licensable organisations as well as licensable reactor designs for the plutonium to be properly utilised and should therefore contribute funding based on an acceptance of its responsibilities.

- The private sector should have confidence in its own scientific expertise, engineering skill and project capabilities, and should contribute funding based on that confidence of success.

The NIA is happy to engage further with the Government on this subject and provide further reflections distinct from the overall consultation, if that would be helpful.

**CONCLUSION**

This policy “refresh and reset” is a crucial opportunity to set a framework to minimise decommissioning costs, minimise waste, minimise the burden on future generations, and maximise the socio-economic value of those programmes.

To do this, the policy framework should insist on a few simple but essential parameters:

- Aggressive application of the waste hierarchy, driving solutions that cut waste volumes, cut radioactivity and drive down waste classifications as far as possible.

- Minimisation of waste volumes consigned for GDF disposal, to incentivise rigorous application of the waste hierarchy and early management solutions. Near-surface disposal of appropriate ILW is an excellent step in the right direction.

- International collaboration and pragmatic acceptance of import and export of radioactive waste, rather than rigid application of the self-sufficiency principle. The UK can capture a huge amount of economic value from its expertise in waste management and decommissioning, and the specialisation of different countries in different capabilities in much more likely to be the most cost effective and sustainable solution to decommissioning worldwide.

- Clear policy preference for the re-use of all nuclear materials, including the following:

    - In-principle preference for spent fuel reprocessing, and preservation of spent fuel from geological disposal as long as practical, subject to the practical considerations.

    - Special categorisation of uranium given its lower radioactivity, lower proliferation risk, and high potential for productive re-use.

    - Initiation of a programme charged with identifying a viable solution for plutonium re-use, rather than evaluating if solutions are viable, and set up on the basis of cost and risk-sharing between the private sector and Government. Plutonium re-use is the right policy, and it should be implemented.

***Further Information***

The NIA is happy to provide more context or any clarifications desired on the content of our response and to ask our members where appropriate for additional information that may be useful.

Please contact Lincoln Hill, Director of Policy and External Affairs for the NIA, at @lincoln.hill@niauk.org to do this.