Nuclear Decommissioning Authority

Version 1

Optimising the number and location of: Interim Intermediate Level Waste (ILW) storage facilities on Magnox Limited and EDF Energy sites and FED Treatment (Dissolution) Facilities in Magnox Limited

Preferred Option
For Comment

November 2013

Ref: 20492158

Executive Summary

Intermediate Level Waste (ILW) is radioactive waste that exceeds the upper limit for Low Level Waste (LLW) but which does not require heat-generation to be taken into account in its management. On reactor sites, ILW includes ion exchange resins, sludges, and contaminated or activated redundant components. It is proposed that these wastes will be retrieved from current storage locations, processed, and packaged for interim storage until a waste disposal route becomes available.

Fuel Element Debris (FED) consists of the "splitters" or "lugs" removed from magnox fuel elements before the spent fuel is (or was) sent to Sellafield for reprocessing. At a number of Magnox Limited (hereafter known as 'Magnox') sites, through treatment with acid, a dissolution process is to be applied to the FED to produce a significantly lower volume of non-reactive waste for subsequent management along with the other types of ILW as described above.

It is currently proposed that these waste management activities are undertaken on the sites at which the wastes arose. However, following wide public consultation, the Nuclear Decommissioning Authority (NDA) published its strategy in 2011 which said:

> "…*we will investigate opportunities to share waste management infrastructure across the estate and with other waste producers where we can see benefit*."

Magnox has reviewed the case for consolidating the interim storage of packaged ILW on Magnox sites. Although EDF Energy requirements for interim storage of packaged ILW have been taken into account, the study does not address optimisation of EDF Energy storage.

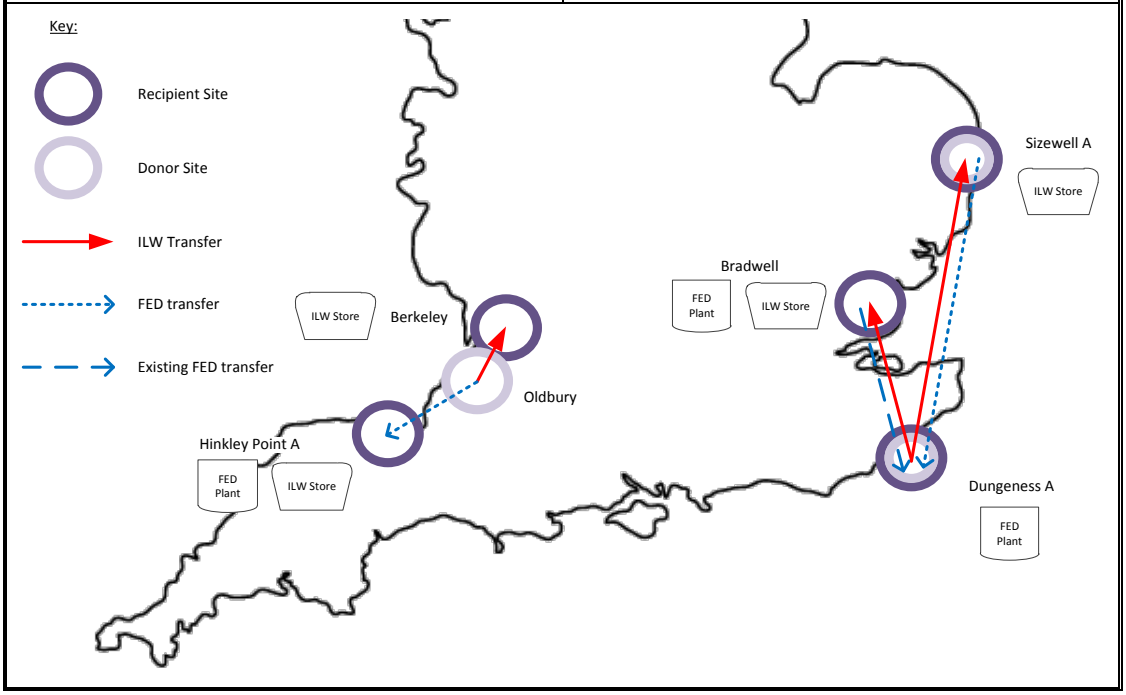
Magnox has also reviewed the case for treatment of Magnox FED through the use of shared facilities, or for treatment of FED at a site other than the site of origin.

These studies have been undertaken following the NDA's Strategy Management System (SMS). Within this system the development of an individual strategy is managed in distinct stages. In Stage A, by applying screening criteria, the initial long-list of options is distilled into a short-list of options that can credibly deliver the required objectives. In Stage B further work is then undertaken to identify the preferred option(s). In this case, separate Stage A papers were produced for interim storage of packaged ILW and for FED treatment. However, it is now considered better to combine Stage B into a single paper (this document), so that stakeholders and decision-makers can see the overall impact of both aspects on individual sites in one document.

For both studies the approach has been to first identify a preferred alternative option (i.e. if the current plan was not adopted, what would be the preferred option?), and then to compare the preferred alternative option to the existing plan to determine the final preferred option. This has been carried out taking into account stakeholder feedback provided at two workshops (in February and July 2013) and during the public engagement on the two Stage A papers in May – June 2013.

Based on this assessment the following option for those Magnox wastes in scope is preferred:

FED Treatment	ILW Interim Storage
Treatment of FED from Hinkley Point A and Oldbury at one new plant at Hinkley Point A, and treatment of FED from Sizewell A at the existing carbonic plant at Dungeness A.	Oldbury ILW transfers to Berkeley, and Dungeness A ILW transfers to Bradwell and if necessary Sizewell A.



This proposal:

- Makes best use of existing facilities and avoids unnecessary construction.
- Ensures that there is a balance of development across the sites.
- Reduces overall environmental impact.
- Reduces costs by approximately £90M whilst maintaining the highest safety and environmental standards.
- Does not significantly disadvantage any site as regards the timing of Care and Maintenance (C&M) entry.
- Provides opportunities for future consolidation of ILW package interim storage with EDF Energy.

Overall, it is considered that the advantages of the preferred integrated solution (relating to reduced construction) outweigh the disadvantages (such as the transport of some radioactive waste on public roads), especially when potential mitigations are taken into account. The preferred option reflects a strategy of minimising new construction and making the best use of assets. Stakeholder feedback has been taken into account within these studies by proposing waste transfers on a regional basis only.

The review does not consider FED treatment technology (i.e. whether to build a carbonic or nitric acid based plant) or whether dissolution is the appropriate management solution for FED, both of which have been subject to separate Best Practicable Environmental Option (BPEO) assessments at the relevant Magnox sites. The choice of acid is not considered to affect the conclusions of the review but, for the purposes of the project, Magnox has made an assumption that any new FED treatment plant would be nitric acid based. Magnox has made a commitment to review experience of operating the Bradwell dissolution facility, which will use nitric acid, before making a decision on the appropriate acid choice for any new FED treatment plant.

A number of factors could affect the NDA's ability to implement the preliminary preferred option. For example, the new Parent Body for Magnox and Research Sites Restoration Limited (RSRL), which will be selected in March 2014 following the conclusion of the current competition process, could bring forward alternative proposals for managing ILW and FED. Any alternative plans would be subject to NDA assessment and approval of a business, as well as regulatory and stakeholder engagement.

There are a also a number of uncertainties, such as those relating to waste volumes, which could affect the ability to implement the preferred option exactly as described in this paper. Our preferred approach would be to pursue the underlying strategy: i.e. to make best use of facilities on a regional basis. Should new opportunities arise as a result of revised estimates of waste arisings, for example, then there would be further assessment of the options and appropriate engagement with relevant stakeholders.

The NDA and Magnox will continue to engage with and involve their stakeholders as the project progresses.

1 Introduction

1.1 Purpose

Intermediate Level Waste (ILW) is radioactive waste that exceeds the upper limit for Low Level Waste (LLW) but which does not require heat-generation to be taken into account in its management. On reactor sites, ILW includes ion exchange resins, sludges, and contaminated or activated redundant components. It is proposed that these wastes will be retrieved from current storage locations, processed, and packaged for interim storage until a waste disposal route becomes available.

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It is currently proposed that these waste management activities are undertaken on the sites at which the wastes arose. However, following wide public consultation, the Nuclear Decommissioning Authority (NDA) published its strategy in 2011 [Ref. 1] which said:

> "…*we will investigate opportunities to share waste management infrastructure across the estate and with other waste producers where we can see benefit*."

Magnox has reviewed the case for consolidating the interim storage of packaged ILW on Magnox sites. Although EDF Energy requirements for interim storage of packaged ILW have been taken into account, the study does not address optimisation of EDF Energy storage.

Magnox has also reviewed the case for treatment of Magnox FED through the use of shared facilities, or for treatment of FED at a site other than the site of origin.

These studies were undertaken following the NDA's Strategy Management System (SMS)[1]. Within this system the development of an individual strategy is managed in distinct stages. In Stage A the initial long-list of options is distilled into a short-list that can credibly deliver the objective by applying screening criteria. In Stage B further work is then undertaken to identify the preferred option(s).

This document summarises Stage B both for interim storage of packaged ILW and for FED treatment. After Stage A [Refs. 2 and 3], for both aspects the question has been asked, if the baseline was not adopted, what would be the preferred option?

[1] This work utilises NDA's Value Framework process [Ref. 4]. In addition, the studies also address the Environment Agency's (EA's) optimisation (Best Available Techniques (BAT)) requirements under the Environmental Permitting Regulations. As such, the studies take account of the Nuclear Industry Code of Practice (NICoP) on BAT [Ref. 5].

This preferred alternative option is then compared to the baseline to determine the final preferred option[2]. This document summarises these final two steps in the process.

1.2 Assumptions and Data

There are two main assumptions that have been made in the studies:

- It has been assumed that any new dissolution plant would be a nitric-acid plant based upon the Bradwell design. However, the effect of changing this assumption is considered within this paper.

- Based in part on stakeholder feedback, the assumption has been made that most transfers of FED or packaged ILW would be made by rail. The exceptions to this are transfers between Oldbury and Berkeley, because these sites share a railhead near Berkeley, and transfers to Hinkley Point A, because of the location of the railhead at Hinkley Point A within Bridgwater. In these cases, the assumption has remained that transport would be by road.

As the studies have progressed, some of the underlying technical information has been slightly revised. Aside from the Sizewell A inventory change discussed below, these changes are not considered to be significant. This is because they do not have the potential to affect the studies' principal conclusions. Therefore, the revisions to technical information have not been reflected in the data provided in this paper. All data presented in this paper are the same as that presented to stakeholders at a workshop in July 2013, with the exception that:

- The mass of Sizewell A FED has been revised from 134 tonnes to 84 tonnes, based on the use of a more accurate calculation method, and the radioactive inventory of the Sizewell A FED has also been reduced.

- The percentage changes in background concentrations of nitrates as a result of effluent discharges have been revised using additional background data obtained since July.

In the case of the changes to the Sizewell A inventory, these have only been reflected in the information provided on timescale to process Sizewell A FED and the public doses from aqueous discharges. The changes are not reflected in other data presented here, although the main effect would be to reduce the impacts associated with transport of the FED elsewhere.

[2] Appendix A addresses how the Value Framework attributes have been addressed in the process.

2 FED Treatment

2.1 Background

As mentioned above, Fuel Element Debris (FED) consists of the splitters or lugs[3] removed from Magnox fuel elements before the spent fuel is (or was) sent to Sellafield for reprocessing. The fuel casing, including the splitters and lugs used in Magnox reactors, are a magnesium alloy. Although the specific alloy used is non-oxidising (from which the Magnox reactors derive their name, "MAGnesium Non-OXidising" metal), magnesium is inherently a reactive metal.

The current plan for FED is for each site to manage its own wastes on its own site. For each of the three sites within the scope of this study, treatment by dissolution was identified as the preferred approach within site-specific Best Practicable Environment Option (BPEO) studies. In each case, the preferred option was found to be robust within the sensitivity analyses undertaken.

Through treatment with acid, FED dissolution produces a non-reactive waste, reducing the solid waste volume by about 95%. The majority of the radioactivity is retained in residues and within the effluent abatement system, to be managed along with other ILW wastes at the site.

The reduction in solid waste volumes has the knock-on effect of reducing the size of store required for interim storage of packaged ILW, although the FED treatment process does lead to some aqueous discharges of radioactive and non-radioactive by-products to the environment. All such discharges have to be both minimised and authorised under the Environmental Permitting Regulations (England and Wales) (as amended) 2010 (EPR2010).

2.2 Scope

This study only considers which sites are the best locations to treat FED by dissolution and does not consider the type of any new dissolution plant.

The FED in scope is that currently stored at Hinkley Point A, Oldbury, and Sizewell A (Figure 1). Bradwell site FED is not included in the scope of the study because Bradwell is well-advanced in implementing dissolution of its own FED on its own site in line with its accelerated Care & Maintenance (C&M) programme[4].

[3] Essentially "fins" that optimised heat transfer from the in-reactor fuel elements during generation.

[4] Bradwell site is also not considered as a recipient site as it would require the site continuing to undertake operations after its planned entry into C&M. Further, whilst the short-term impacts of discharges have been deemed to be acceptable (and the relevant permit obtained), the Bradwell site is sub-optimal in terms of longer term environmental impacts, as would occur if Bradwell was used as a shared plant. For this reason, the Environment Agency has stated that the continued use of the Bradwell site in this way would require strong justification.

Dungeness A has recently completed the dissolution of its own FED in the existing dissolution plant there. Dungeness A is considered to be a potential location for the treatment of FED within the scope of this study.

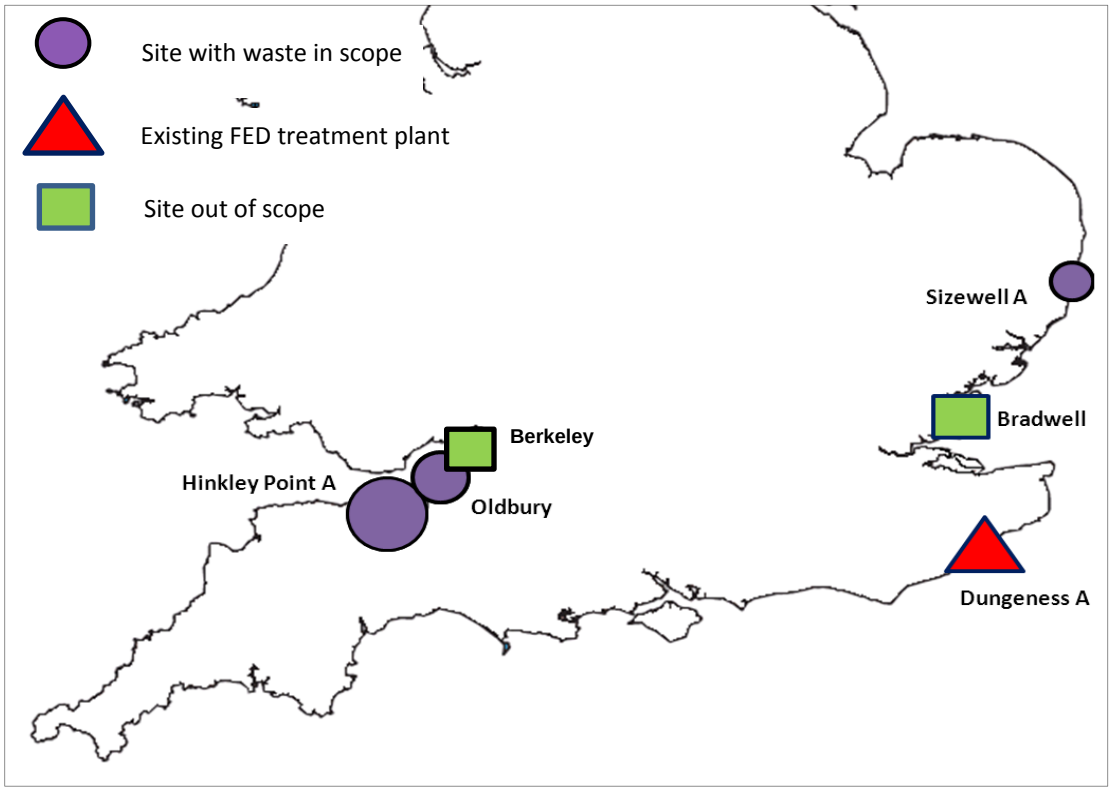


Figure 1: Summary of Sites and FED Waste Considered to be in Scope[5]

The baseline plan for the remaining sites with a significant amount of Magnox FED waste, namely Berkeley, Hunterston A and Trawsfynydd, is packaging for long-term storage and disposal without the prior application of dissolution. In general dissolution is not considered to be an appropriate treatment for FED at these sites due to progress already made in the construction of interim waste storage facilities and, in the case of Berkeley and Hunterston A, because much of the FED is mixed or contaminated with other waste types thereby making dissolution technically difficult. As such these sites were not considered as potential locations for the treatment of FED.

Other nuclear operators either do not generate FED in the first instance (e.g. EDF Energy), or else the FED that they hold is unlikely to be suitable for treatment by dissolution (e.g. Sellafield). Therefore, no FED generated or held by other operators falls within the scope of this study.

[5] The amount of FED at each site is given in Appendix F.

2.3 Case for Review

The baseline plan for the Magnox FED at all of the sites in scope is treatment of the FED by a process of dissolution at the site of origin. However, within the Higher Activity Waste section of NDA Strategy (2011) [Ref. 1], the NDA has committed to investigate opportunities to share waste management infrastructure across the estate. Further to this, support for the investigation of consolidation and / or alternative locations for waste management has been expressed previously by the Environment Agency (EA), particularly in relation to dissolution of FED material.

The implementation of alternative approaches to FED treatment has the potential to offer a number of safety and environmental benefits:

- Consolidation of facilities would result in reduced facility construction works, reduced use of materials, and reduced volumes of waste generated from decommissioning and plant demolition.
- With fewer plants being built the risks associated with construction and demolition to both people and the environment would be reduced.
- Whilst the coastal water environments at the sites considered are all suitable for the receipt of the aqueous discharges associated with dissolution, some environments may be considered better suited than others.

Implementation of alternative approaches could have an impact on the effect of both non-radioactive and radioactive aqueous discharges. Whilst the total volume and amount of activity which would be treated across the company would not change, it is recognised that the level and duration of aqueous discharges across the affected sites would be altered. As noted above, this change could in principle represent an overall environmental benefit.

The implementation of a shared facility approach could also offer significant economic benefits in terms of reducing overall lifetime plan costs which would be achieved principally through a reduction in design, construction, commissioning and decommissioning costs.

2.4 Credible Options Assessment

2.4.1 Long-List of Options

A long-list of 14 options was initially generated within five high level categories:

- Baseline option – each site has its own treatment plant.
- Regional options – transfers may happen between sites on a regional basis (south-west or south-east).
- Consolidation of lower volume FED sites only (i.e. Oldbury and Sizewell A FED processed at the same location).

- Minimisation of future plants (if not in categories above) – two new plants.
- Minimisation of future plants – one new plant.

Most of these options involve the construction and use of new plants that do not yet exist, these being located at one or more of the Hinkley Point A, Oldbury, Sizewell A and Dungeness A sites. In some options FED from Sizewell A would be transferred for processing at the existing dissolution plant at Dungeness A.

These 14 options were discussed at a stakeholder meeting on 12th - 13th February 2013[6] [Ref. 6]. Stakeholders were given the opportunity to add further options, resulting in the addition of one further option to the list: Hinkley Point A constructing its own new plant for treating its own FED and the construction of a new plant at Dungeness A for treating FED from Sizewell A and Oldbury.

The full long-list of 15 FED treatment options is given in Appendix B.

2.4.2 Screening

The screening of the options to reduce the long-list of options to a shortlist of credible options to be taken forward for more detailed assessment took place by means of an Options Assessment Panel (OAP) on 13th March 2013. The screening meeting involved radioactive waste management consultants, radiological safety experts, an industrial safety expert and environmental specialists. The approach to the screening exercise was to eliminate long-list options that on balance are clearly sub-optimal on those safety and environmental issues which were identified as most important to stakeholders during the February 2013 workshop [Ref. 6].

For each factor information on the relative performance of the long-list options was provided to the OAP. This allowed the OAP to rate the performance of each long-list option against each factor as being (relatively) good, average or sub-optimal. By inspection, it was then possible to determine which long-list options should be rated overall as sub-optimal on the safety and environmental issues of most importance to stakeholders [see Ref. 2].

It was found that six long-list options were clearly sub-optimal to the other nine options, and that this was robust in the sensitivity analysis. The sub-optimal options screened out all would involve transferring Hinkley Point A FED to other locations. In summary, this was because Hinkley Point A has the largest mass of FED of any of the three sites in scope, and the receiving environment for aqueous discharges at Hinkley Point is relatively good. It is therefore considered appropriate to leave that FED at the site of origin and to process it there.

[6] Stakeholders at this meeting included Site Stakeholder Group / Local Community Liaison Council members; representatives from local authorities; the regulators, the NDA and also the industry.

2.4.3 Credible Options List

The remaining options are given in Table 1. In this table each row represents one possible option and the final four columns show potential host sites. For example, in Option C[7] there is a new treatment plant at Hinkley Point A which would be used to treat FED from that site and also from Oldbury, and another new treatment plant at Sizewell A. Option H is the same as regards Hinkley Point A and Oldbury, but in this option Sizewell A FED would be transferred to Dungeness A for processing at the existing treatment plant there.

The baseline option of each site treating its own FED remains (Option A), and one option remains that involves all FED in scope being treated at a single location (Option I). In between these, there are a number of options that variously include elements of regional and cross-regional transfer; low volume consolidation; and use of the existing plant at Dungeness A.

[7] Note that for simplicity the options have been re-numbered and therefore no longer reflect the option ID numbers in the long-list of options.

Table 1: FED Credible Options List.

Option ID	Option ID in Long List	Option Type	Number of Locations	Number of New Plants	Dissolution Facility Host Sites			
					Hinkley Point A	Oldbury	Sizewell A	Dungeness A
A	1	Baseline	Three	Three	Hinkley Point A FED	Oldbury FED	Sizewell A FED	N/A
B	2e	Regional	Three	Two	Hinkley Point A FED	Oldbury FED		Sizewell A FED (using existing plant)
C	2c	Regional	Two	Two	Hinkley Point A FED Oldbury FED		Sizewell A FED	
D	4b	Cross-regional	Two	Two	Hinkley Point A FED Sizewell A FED	Oldbury FED		
E	3c	Cross-regional	Two	Two	Hinkley Point A FED			Sizewell A FED & Oldbury FED (using new plant)
F	3a	Cross-regional	Two	Two	Hinkley Point A FED	Oldbury FED Sizewell A FED		
G	3b	Cross-regional	Two	Two	Hinkley Point A FED		Sizewell A FED Oldbury FED	
H	2b	Regional	Two	One	Hinkley Point A FED Oldbury FED			Sizewell A FED (using existing plant)
I	5a	Cross-regional	One	One	Hinkley Point A FED Oldbury FED Sizewell A FED			

2.5 Down-Selection of Options to Identify Preferred Alternative to the Baseline

2.5.1 Selection of the Preferred Alternative

Magnox undertook a process of "paired comparisons" to reduce the remaining list of non-baseline options. The process of paired comparison involved reviewing all the factors for pairs of options one at a time. The initial objective was to reduce the options list to a single option involving one location; a single option involving two locations; and a single option involving three locations. These three options were then compared to obtain the preferred alternative for subsequent comparison to the baseline.

The same OAP used for the long-list screening exercise described earlier was asked to review whether differences in the performance of the options against each factor were significant, such that they should act as discriminators in selection of the preferred option. This process not only took into account differences between options, but also the absolute magnitude of the impacts. After considering all factors in this manner, the OAP were then asked to conclude for each pair comparison which option was preferred overall.

In addition to the factors used for the screening exercise, other factors relating to cost and practicability were considered, taking account of the NDA Value Framework Process (Appendix A). These included: schedule; implementation risk; time to start of FED processing; time to end of FED processing; and costs.

Excluding the baseline, there was only a single option remaining involving three locations and only a single option remaining involving one location. Therefore the paired comparison exercise focused upon the two locations options. Option H was the preferred option involving two locations. All other options involving two locations would require additional construction with significant additional costs (~£30M), more disturbance, more risk to workers etc., for which complete mitigation would not be possible. It was not considered that there was any benefit in other two location options that would override this, and those other options also carried additional disbenefits of their own, such as being more likely to affect local ecology through construction or emissions.

The remaining non-baseline options were therefore:

- Option B (three locations): Hinkley Point A FED treated at Hinkley Point A, Oldbury FED treated at Oldbury and Sizewell A FED treated at Dungeness A;
- Option H (two locations): Oldbury FED and Hinkley Point A FED treated at Hinkley Point A and Sizewell A FED treated at Dungeness A; and
- Option I (one location): all FED treated at Hinkley Point A.

A paired comparison of the remaining three non-baseline options was then undertaken using the same comparison methodology. Based on these comparisons, Option H and Option I were both preferred over Option B. This was for similar reasons to why Option H was preferred as discussed above. However, it was considered that on balance there was relatively little difference overall between Option H and Option I. Neither of these options would involve the construction of additional dissolution plants beyond that required at Hinkley Point A (required in all remaining options), the difference being whether Sizewell A FED would be processed at Hinkley Point A or else processed using the existing plant at Dungeness A.

The three remaining non-baseline options (B, H and I) were presented to stakeholders at a meeting on 18th - 19th July 2013[8] [Ref. 7]. Most of the issues discussed above were also noted by stakeholders. However, the additional points shown in Table 2 were made.

Table 2: FED Treatment Stakeholder Feedback.

View Expressed	Supports:
Use of the established / proven technology at Dungeness A was viewed favourably.	Option B or Option H
Use of the Dungeness A plant for processing FED from elsewhere is already happening, so already has degree of local acceptance and will result in continued employment (considered important to local stakeholders).	Option B or Option H
Public acceptability is important – this was considered to favour Option B in that it only involves transfer within a region, as does Option H, but unlike in Option H the option only uses rail for the transfer of FED.	Option B and to a lesser degree Option H
More plants, particularly if based on different technologies, provide greater operational flexibility.	Option B (three plants) and to a lesser degree Option H (two plants).
There are no alternative transport routes in / out of Hinkley Point A: lorries would have to go through Bridgwater whether rail or road is used (as railhead is located in Bridgwater).	Option B
With regard to lorry deliveries / collections, some stakeholders considered there to be a difference in the impact between construction / demolition lorries and lorries transporting radioactive waste, regarding the former as worse in terms of potential for disturbance – this supports options which involve the least construction.	Option H or Option I

[8] Stakeholders at this meeting included Site Stakeholder Group / Local Community Liaison Council members; representatives from local authorities; the regulators, the NDA and also the industry.

View Expressed	Supports:
Although in general cost was not viewed as an over-riding issue, it was accepted that sensible use of public money was important.	Option H or Option I

When the additional points made by stakeholders at the July workshop were taken into account, it became clear that the overall preferred alternative option would be Option H: Oldbury FED processed at Hinkley Point A and Sizewell A FED processed at Dungeness A.

2.5.2 Comparison of the Preferred Alternative to Other Credible Options

As shown in Table 3, across a range of factors Option H performs well in comparison to all of the other credible options that were taken through at Stage A.

Table 3: Performance of the Preferred Alternative (FED Option H) within the Credible Options (Excluding the Baseline)[9]

	Attribute	Best	Worst	Option H
Construction & Demolition	Amount of construction and demolition (years)	~ 2	~ 4	~ 2
	Material resource use – unrecoverable materials (tonnes)	~ 390	~ 780	~ 390
	Number of lorries to transport construction / demolition materials	~ 150	~ 300	~ 150
	Total one-way HGV-kms	~7,500	~15,000	~7,500
Transport – Collection / Delivery of Radioactive Materials[10]	Number of lorries to transfer wastes by road	0	~130	~70
	Total one-way HGV-kms	0	~ 34,000	~ 6,500
Aqueous Discharges	Nitrates discharge to the environment (weighted average % change at affected sites)	~ 0.04	~ 0.76	~ 0.04
	Public individual dose summed across sites (micro-Sv)	6.7	14	7.3
	Public collective dose (man-milliSv)	0.82	0.95	0.95
Cost	Cost (£M)	~ 85	~ 120	~ 90

[9] "Best" and "Worst" do not relate to a single option for all attributes but instead show the best or worst impact for each attribute separately under consideration.

[10] Note that these figures do not include the transfers required between the sites and railheads necessary to load and unload trains (as these are short distance journeys).

Option H is the best performing of all the credible options on construction and demolition related factors. This is because Option H would involve no further construction of dissolution plants beyond those already agreed in Stage A i.e. at Hinkley Point A.

Considering the factors associated with the transfers of radioactive waste Option H performs fairly well. Whilst not the best performing of the credible options on the number of transfers by road required, it would only require a relatively small number of HGV kilometres. This is principally because all transfers would occur within regions. Option H also makes best use of the good rail access between Sizewell A and Dungeness A, and the number of packages being transferred by road to Hinkley Point A is limited.

In respect of aqueous discharges the performance of Option H varies across the factors considered. On nitrates Option H is the best performing of the credible options, although no option would result in a significant impact in this regard. On total dose to the most exposed individual summed across sites involved in the option, Option H is close to the best credible option, though the doses in all cases are very small. On collective dose from aqueous discharges, there is little variation between the options and all doses are very small.

Finally, it is noted that Option H, whilst not offering the maximum cost reduction, offers a significant cost reduction which is greater than the majority of the other credible options.

2.6 Comparison to the Baseline

For the comparison of the preferred alternative to the baseline (see Figure 2), it is recognised that the assessment can be resolved by answering two independent questions:

1. Is it better to process the FED from Oldbury in a new plant at Oldbury, or in the new plant at Hinkley Point A which would have already processed the FED from Hinkley Point A?

2. Is it better to process the FED from Sizewell A at a new plant at Sizewell, or in the existing carbonic acid plant at Dungeness A?

Technical information which supports answering these two questions is given in Appendix C. In Appendix C it is stated by factor whether the baseline or the alternative option is preferred. However, as neither option is preferred on all factors, it is necessary to determine which factors are most important to the overall decision.

<table>
<tr><th>Baseline Option</th><th>Alternative Option – Option H[11]</th></tr>
<tr><td rowspan="2">1) Hinkley Point A

2) Oldbury

3) Sizewell A

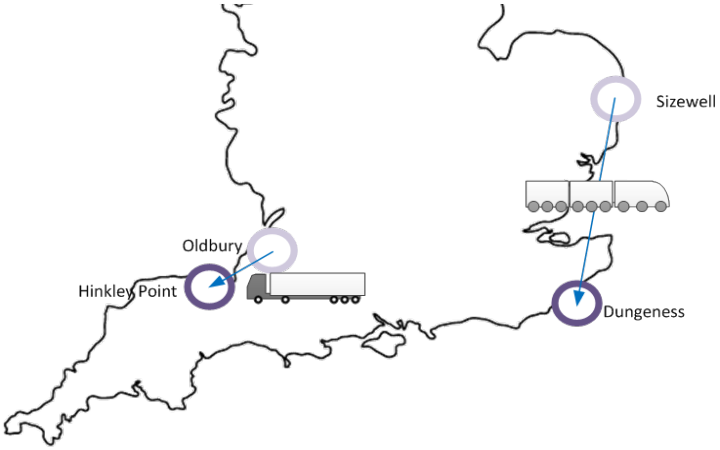
i.e. each site has its own new FED treatment plant to process its own FED.</td><td> 
</td></tr>
<tr><td>1) Hinkley Point A (Oldbury)
2) Dungeness A (carbonic) (Sizewell A)</td></tr>
</table>

Figure 2: Baseline vs. Alternative.

The discussion below summarises the issues which may discriminate between the two options in each of the two questions given above, specifically in terms of amount of construction, the impact of discharges and emissions, overall transport, transport of radioactive wastes specifically, and cost.

Is it better to process the FED from Oldbury in a new plant at Oldbury, or in the new plant at Hinkley Point A which would have already been built to process the FED from Hinkley Point A?

The baseline would require a new plant being built at Oldbury, which would involve construction and demolition (C&D) with associated disturbance (directly and from lorry deliveries / collections). Such impacts can be managed in line with best practice schemes for C&D activities to reduce impacts as far as is reasonably practicable, but cannot be completely mitigated against. The alternative to the baseline avoids building a new plant, resulting in lower resource use and reduced risk to workers associated with construction, demolition and movement of materials.

There are differences with regard to public doses as a result of authorised aqueous discharges between processing Oldbury's FED at Oldbury versus processing that FED at Hinkley Point A:

[11] Those sites in bold type are recipient sites, those sites in brackets (e.g. Oldbury in Option H) are donor sites.

Table 4: Public doses as a result of permitted aqueous discharges.

	Processing Oldbury FED at Oldbury	Processing Oldbury FED at Hinkley Point A
Total dose to most exposed individual at site of processing	~ 7 micro-Sv	~ 0.3 micro-Sv
Public collective dose (UK)	0.04 man-mSv	0.04 man-mSv

Given that these doses would be incurred over a number of years and that the average background dose rate to individuals in the UK is about 2,700 micro-Sv per year, none of these doses are considered large enough to be significant in discriminating between the options.

Assuming a nitric-acid based plant is built, processing Oldbury FED at Oldbury would result in a change to background nitrate concentrations of about 0.7% for 2.5 years, whereas processing the Oldbury FED at Hinkley Point A would involve a 0.04% change for the same period. This favours processing FED at Hinkley Point A, though the issue is not considered to be significant.

Oldbury and Hinkley Point A are not particularly sensitive locations to the mono-nitrogen oxide (NO_x) emissions that dissolution using nitric acid generates, so again this issue does not help distinguish between these two options.

A benefit of the alternative option for Oldbury is that it would eliminate the need for about 150 lorries for construction and demolition, and would also eliminate the need for delivery of consumables (for example, acid and neutralising media), replacing these with about 70 lorries for collection of FED. Hinkley Point A, however, would see an additional 70 lorries for deliveries of FED, plus a few deliveries per week for consumables over the circa 2.5 years processing period. During the review stakeholders have expressed concern about the cumulative impacts with Hinkley Point C construction traffic, as well as general concerns about traffic impacts in Bridgwater, Cannington and on the C182. However, the additional vehicle movements at Hinkley Point A would occur several years after the expected peak (around 2016) in Hinkley Point C construction traffic. As such, and given the small increase in vehicle numbers in relative terms, this is not considered to be a significant detriment for the alternative.

Transport of Oldbury FED to Hinkley Point A does introduce the potential for one off (to any one person) non-trivial public individual doses[12] due to use of road transport. However, there are a number of ways that this public dose could potentially be addressed, possible measures including increased shielding to vehicles, timing of transports to avoid peak hours as far as practicable and use of vehicle escorts.

[12] The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Here, non-trivial would be one-off doses of the order of a few hundred micro-Sv to one or more individuals. To give this context, the dose received by an individual on a return flight to the USA ~140 micro-Sv, the dose from a CT scan to the head is 1,400 micro-Sv, whilst the average annual radon dose to people in Cornwall is 7,800 micro-Sv.

Avoiding a new plant at Oldbury would result in significant cost reductions (ca. £30M) compared to the baseline.

Overall, and taking into account that its main disadvantages (relating to transport) can be mitigated / managed, treatment at Hinkley Point A is preferred. This is primarily on the basis of avoiding unnecessary construction, making best use of what would be an existing asset at Hinkley Point A, and avoiding significant expense.

Is it better to process the FED from Sizewell A at a new plant at Sizewell, or in the existing carbonic acid plant at Dungeness A?

The arguments against constructing a new plant at Sizewell A are similar to those against constructing a new plant at Oldbury: i.e. there are significant benefits in avoiding construction in terms of disturbance, resource use, worker safety etc.

There would be differences with regard to public doses as a result of authorised aqueous discharges between processing Sizewell A's FED at Sizewell versus processing that FED at Dungeness A:

Table 5: Public doses as a result of permitted aqueous discharges.

	Processing Sizewell A FED at Sizewell	Processing Sizewell A FED at Dungeness A
Total dose to the most exposed individual at site of processing	<0.1 micro-Sv	<1.0 micro-Sv
Public collective dose (UK)	~0.02 man-mSv	~0.1 man-mSv

However, these doses are all considered to be too small to influence the choice of preferred location for processing Sizewell A FED.

Assuming that a new plant would be nitric-acid based, processing Sizewell A FED at Sizewell would result in a change to background nitrate concentrations of about 1.7% for 1.5 years, whereas processing the Sizewell A FED at Dungeness A would involve no nitrates discharges (because the plant uses carbonic acid). Furthermore, operating a dissolution plant at Sizewell A may require additional mitigation, and / or more complex aerial dispersion modelling to demonstrate acceptable impacts, compared to operating a similar plant elsewhere. This is due to the relatively near-by presence of NO_x sensitive plant species at Sizewell A. Therefore discharges and emissions factors favour processing at Dungeness A, though these issues are not considered to be significant.

There would not be a large difference in overall lorry numbers between these two options. The baseline would involve construction and demolition of a new FED treatment plant (about 150 lorries), plus a few lorries per week for consumables over the processing period of about 1.5 years, at Sizewell A. The alternative would involve fewer than 60 lorries[13] to transfer FED to the railhead at Leiston, and likewise fewer than 60 lorries at Dungeness A to transfer the FED from the railhead on to site. The alternative would also involve a few deliveries of consumables per month over the processing period of about 8 years at Dungeness.

In general reducing the amount of construction by sharing facilities leads to the transfer of radioactive waste, at least in part on public roads, and therefore would introduce the potential for public dose from transport. However, in this case the potential for non-trivial public dose would be minimal due to the use of rail for almost the entire journey. Therefore, this issue is not a significant detriment for the alternative option in this case.

Although processing Sizewell A FED at Dungeness A would be slower than the baseline, it is expected to meet the current programme requirements at Sizewell A for passivation of FED and will not interfere with plans for Dungeness A plans to enter into Care and Maintenance in 2027. Therefore processing time is not regarded as a significant detriment for the alternative[14].

Building a new dissolution plant at Sizewell A would result in significant additional cost over and above using the existing plant at Dungeness A (ca. £30M).

Taking all the arguments together it is considered that treatment of Sizewell A FED at Dungeness A is preferred. This is primarily on the basis of avoiding unnecessary construction, making best use of an existing asset at Dungeness A, and avoiding significant expense, with no significant detriment incurred.

2.7 Sensitivity Analysis

There are three types of assumption that have been made in this options assessment:

1. High level assumptions in estimating the relative performance of the options (for example the design of any new plant and the mode of transport for packaged FED).

2. Detailed assumptions in estimating the relative performance of the options (e.g. amount of construction materials that can be transported on each HGV; distances travelled; process throughput rates etc.).

3. Go / no-go assumptions: e.g. that Magnox can obtain the necessary permissions, or that the packaged FED is all transportable.

[13] See Section 1.2.

[14] There is also an on-going study to investigate the feasibility of enhancing the throughput of the Dungeness A plant.

Magnox believes that its assumption that rail would be used for most transfers is robust. This is because use of rail where practicable is preferred NDA strategy; it is the stakeholder preference; it limits the potential for public dose from radioactive waste transport; and an initial feasibility study undertaken for this study was positive.

It is not proposed to discuss the impact of each detailed assumption here. However, it is worth addressing some of them briefly, specifically those relating to design of new plant (acid choice) and the mass of FED requiring treatment by dissolution. The go / no-go assumptions are also briefly discussed below.

Design of New Plant (Acid Choice)

The principal effect of changing the assumption on acid choice from nitric acid to carbonic acid would be the removal of nitrates discharges and NO_x emissions from the assessment.

In all credible options the impact of nitrates aqueous discharges is minimal: all percentage changes are less than 2% and there is no threat to compliance with water quality standards as a result of dissolution at any site (considered under the implementation risk attribute). Therefore the preferred option does not change if nitrates discharges are removed from the analysis.

The only locations with NO_x sensitive plant species are Sizewell and Dungeness. However, the NO_x issue was not a significant part of the overall argument for not constructing new dissolution plants at those locations. Therefore the preferred option does not change if NO_x emissions are removed from the analysis.

Mass of FED Requiring Processing

This study has been based on the current best estimates of the amounts of FED stored at Hinkley Point A, Oldbury and Sizewell A requiring treatment by dissolution. Whilst every effort is made to ensure that estimates of radioactive waste inventories are accurate, uncertainties are inherent, including uncertainties in the mass of waste being stored. That said, it is not considered plausible that this study is in error in assuming that there is significantly more FED present at Hinkley Point A than at either Oldbury or Sizewell A.

The possibility of disposal of some FED as LLW is currently being explored. If this waste management route was used, it would reduce the amount of FED requiring treatment by dissolution. The amount of FED that could and should be managed in this way has not yet been determined, but it is thought likely that this would only reinforce the current position that the largest single source of FED requiring treatment by dissolution is at Hinkley Point A. This would also reinforce the conclusion that new plants beyond that required for Hinkley Point A FED should not be constructed. However, if there was a significant change in the mass of FED to be processed by dissolution then the impacts on the findings of this study would be considered.

Go / no-go assumptions

The key go / no-go assumption is that the FED currently stored at Oldbury or Sizewell A is transportable.

At time of writing approximately 20 tonnes FED is being transferred from Bradwell to Dungeness A for dissolution (the subject of a previous agreement with Kent County Council, the Environment Agency and local stakeholders). One of the main reasons for that transfer was as a trial, including a trial of the feasibility of transport. Though the formal review of that trial has yet to be undertaken, transfers have taken place. Therefore, it is known to be the case that at least some of the FED is transportable. At the time of writing, development of a transport container for use with higher activity FED is underway.

In summary there is sufficient confidence that this assumption is robust and further underpinning work is underway to improve this level of confidence.

3 Interim ILW Storage

3.1 Background

Interim storage of packaged ILW at all of the Magnox and EDF Energy sites in scope involves the retrieval, packaging and storage of ILW waste in purpose-built storage facilities (taking due account of both regulatory and NDA guidance) until final disposal in the proposed Geological Disposal Facility (GDF). However, there are some company (Magnox and EDF Energy) and site-specific differences in the plans at a more detailed level:

- At most Magnox sites, the packaging strategy is to use Ductile Cast Iron Containers (DCICs).
- At Trawsfynydd and Hunterston A sites, the packaging strategy is to encapsulate ILW (primarily using cement grout) within three cubic metre ($3m^3$) stainless steel containers or other packages.
- At most EDF Energy sites the current packaging strategy is to produce encapsulated packages in 500 litre stainless steel containers.
- At EDF Energy's Sizewell B site, the use of DCICs is proposed for ILW resins.

In all cases it is currently proposed that all of the packaged ILW is to be held on site in purpose-built interim storage facilities. However, the differences in packaging approaches affect ILW storage facility designs, how the packages are handled and transported, and influence the credible interim storage options that are available in this study. In particular, where adjacent A and B sites have different waste packaging strategies, co-location of waste in the same storage building is unlikely to be practicable or optimal.

3.2 Scope

The initial scope of this study was Magnox and EDF Energy operational ILW within England and Wales. However, only those EDF Energy 'B' Station sites that are co-located with Magnox sites have been included within the study (see Figure 3)[15].

In addition, this study primarily addresses optimising the interim storage of packaged ILW on Magnox sites. This is because, in general, Magnox sites have more ILW than adjacent EDF Energy sites, and those wastes require management sooner. Adjacent EDF Energy sites have only been considered as a factor in determining the preferred locations for storage facilities for the Magnox sites.

[15] The Scottish sites of Chapelcross, Hunterston A & B and Torness are the subject of a separate study [Intermediate Level Waste Storage Solutions: Central and Southern Scotland, Preferred Option, NDA, April 2013]. Heysham I and II and Hartlepool are also excluded from this study due to location and packaging strategies.

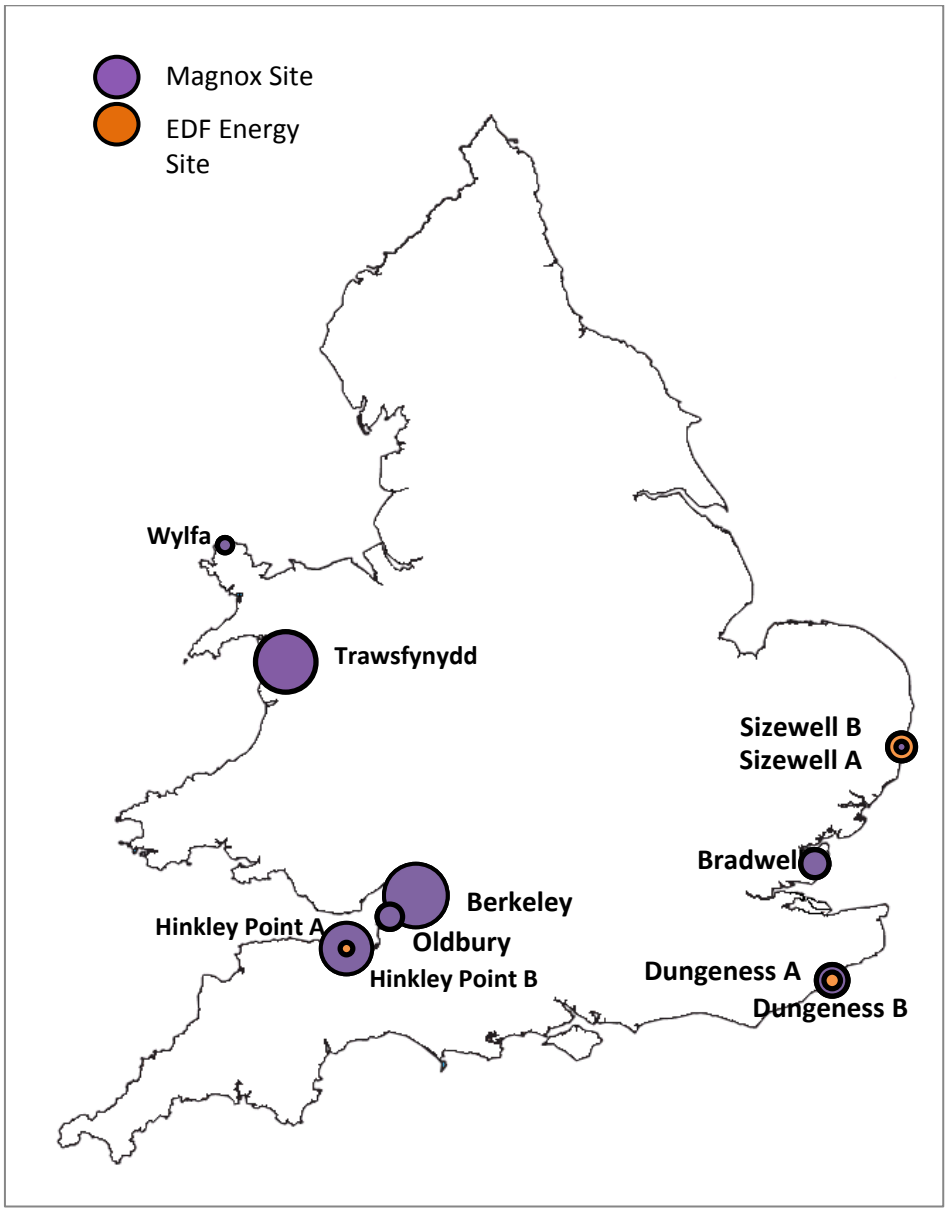


Figure 3: Summary of Intermediate Level Waste[16] Considered in Scope.

This study only considers which sites are the best locations to store ILW and does not consider the choice of type of package or store. The scope does not include ILW which will be generated during the Final Site Clearance (FSC) period as the plan is that this will be dispatched directly to the GDF at the time of arising.

[16] The size of the circles on the diagram broadly reflects the volume of waste on each site. Package numbers for Magnox sites are given in Appendix F.

For Magnox sites, it is assumed that Berkeley and Bradwell have interim ILW storage facilities that will be used to store their own wastes (the Bradwell store is already constructed, and Berkeley's store is currently under construction). It is assumed for this study that these stores may also be available to store wastes from other sites (to utilise their spare capacity[17]). All other Magnox sites were, at least in the initial stages of this study, potential donor sites and most were potential recipient sites.

The question of where best to store Wylfa's waste has been decoupled from the assessments described later in this paper. This is because:

- There are only a small number of packages at Wylfa, and the number of packages may reduce as alternative waste management opportunities are pursued.
- Wylfa will be the last Magnox site to retrieve and package its ILW.
- In principle the DCICs could be sent to any appropriate site with a storage facility where spare capacity exists, or else potentially stored within the reactor Safestore building.

It was therefore decided that the storage location for the Wylfa waste packages will be decided nearer the time packages are created. For Trawsfynydd, in none of the options did storage of packaged ILW from any location other than Wylfa feature. Therefore the store at Trawsfynydd is also not considered further in the assessments.

3.3 Case for Review

Within the Higher Activity Waste section of the NDA Strategy (2011) [Ref. 1], the NDA has made a commitment to:

> *"…explore opportunities to share current and planned storage assets to improve value for money, reduce the environmental impact of new store build and impact on decommissioning timescales"*

The consolidation of operational ILW interim storage across the Magnox and potentially EDF Energy sites offers a significant opportunity of this nature.

[17] ILW stores are designed before ILW is retrieved and packaged. There is therefore uncertainty about the number of packages that the store will need to accommodate and a contingency is built into the design of the store for the event that more packages than estimated are generated. In practice, package numbers have reduced from the estimates used at store design stage. In part this is because, so far, the original volumes have been found to be over-estimated, and in part because of the efforts made during implementation (e.g. by enhanced waste segregation) to minimise the ILW requiring packaging. Current best estimate package numbers for Bradwell and Berkeley indicate these stores will have significant spare capacity.

The implementation of a shared interim storage approach has the potential to offer significant benefits in terms of both safety and the environment. Consolidation of waste storage would avoid the need to build some of the planned new interim storage facilities. Reduced store construction could avoid use of a significant amount of materials (concrete, steel, metal cladding), and result in a reduction in plant items such as craneage and ventilation systems. This in turn would reduce transport disturbance and worker risk associated with construction.

Fewer interim storage facilities being built would mean fewer facilities to maintain during the operational phase, reducing for example, the amount of cladding potentially requiring replacement. During the store decommissioning phase, there would be a reduction in the amount of material requiring waste management and fewer sites being disturbed.

However, consolidated storage would have the disadvantage of increased transport of radioactive packages.

The implementation of a shared interim storage approach could offer significant economic benefits in terms of overall programme cost reductions. Any reduction is likely to be achieved principally through a reduction in design, construction, commissioning and decommissioning costs.

3.4 Credible Options Assessment

3.4.1 Long List of Options

A long-list of options was developed, with options grouped into three categories:

- Baseline – each site has its own interim ILW storage facility for its own waste only.
- Regional options – some storage facilities are shared (with wastes remaining in either the south-west or the south-east).
- Minimisation of future stores (if not included in regional) – the number of stores is minimised with sub-options considering three, four, five, etc. interim ILW storage facilities.

The full long-list of options is given in Appendix D. These options were discussed at the stakeholder meeting on 12th - 13th February 2013 [Ref. 6][18]. Stakeholders were given the opportunity to add further options and a number of suggestions were made. The main issue raised related to a preference that adjacent Magnox and EDF Energy sites should share storage facilities if possible.

[18] Stakeholders at this meeting included Site Stakeholder Group / Local Community Liaison Council members; representatives from local authorities; regulators, industry (Magnox and EDF), and the NDA.

As noted earlier in this paper, in the first instance the study addresses optimising the interim storage of packaged ILW on Magnox sites only. This is because, in general, Magnox sites have more ILW than adjacent EDF Energy sites and those wastes require management sooner. Also as noted above, in general EDF Energy sites have different packaging strategies from the A sites, with most EDF Energy sites adopting a strategy of ILW encapsulation and interim storage in over-packs[19]. The exception is at Sizewell, where both the A and B sites have a packaging strategy at least in part based on use of DCICs, and Sizewell B will have more packaged ILW to interim store than Sizewell A. The potential opportunity to co-locate the storage of packaged ILW from Magnox and EDF Energy sites is therefore addressed as a qualitative consideration in the assessments of Magnox storage options below.

3.4.2 Screening

The screening of the options to reduce the long-list of options to a short-list of credible options to be taken forward for more detailed assessment took place by means of an Options Assessment Panel (OAP) on 13th March 2013. The approach to the screening exercise was as described in Section 2.4.2 for FED, which was to eliminate long-list options which, on balance, were considered to be clearly sub-optimal on those safety and environmental issues identified as most important to stakeholders during the workshop of 12th - 13th February 2013 [Ref. 6].

It was found that seven long-list options[20] were clearly sub-optimal to the other options, and that this was robust in the sensitivity analysis. The options screened out all would involve Hinkley Point A packages being transferred for storage elsewhere. Fundamentally, this is because Hinkley Point A has the largest number of waste packages of any potential donor sites. The transfer of Hinkley Point A wastes to another location would therefore result in relatively high disturbance to local stakeholders and, relative to other options under consideration, increased public dose from transport. Therefore these options were screened out.

3.4.3 Credible Options List

The outcome of the screening assessment identifies the credible options list in Table 6 to be taken forward for more detailed assessment. This leaves eight options for assessment in Stage B. In Table 6 each row represents one possible option and each column is a potential host site. For example, in Option 4c there is a store at Berkeley (for Berkeley, Oldbury), at Hinkley Point A (for Hinkley Point A and some Dungeness A waste packages) and also a store at Bradwell (for Bradwell, Sizewell A and some Dungeness A waste packages).

[19] An initial feasibility study identified significant technical difficulties with storing EDF Energy encapsulated packages in Magnox DCIC interim storage facilities. In addition, encapsulated EDF Energy waste packages will not be transportable on public highways until a Standard Waste Transport Container is available.

[20] At Stage A, there were variants in which Wylfa has its own store or it does not.

Table 6: Credible Options List for Magnox Waste Packages.

ID.	ILW STORAGE SITES					
	BERKELEY	**HINKLEY POINT A**	**OLDBURY**	**BRADWELL**	**DUNGENESS A**	**SIZEWELL A**
7a	Berkeley	Hinkley Point A	Oldbury	Bradwell	Dungeness A	Sizewell A
6c	Berkeley	Hinkley Point A	Oldbury	Bradwell Dungeness A		Sizewell A Dungeness A
6b	Berkeley	Hinkley Point A	Oldbury	Bradwell Sizewell A	Dungeness A	
6a	Berkeley Oldbury	Hinkley Point A		Bradwell	Dungeness A	Sizewell A
5f	Berkeley Dungeness A	Hinkley Point A	Oldbury	Bradwell Sizewell A Dungeness A		
5b	Berkeley Oldbury	Hinkley Point A		Bradwell Dungeness A		Sizewell A Dungeness A
5a	Berkeley Oldbury	Hinkley Point A		Bradwell Sizewell A	Dungeness A	
4c	Berkeley Oldbury	Hinkley Point A Dungeness A		Bradwell Sizewell A Dungeness A		

3.5 Down-Selection of Options to Identify Preferred Alternative to the Baseline

3.5.1 Selection of the Preferred Alternative

No further reduction in the number of options was presented to stakeholders at the meeting of 18th – 19th July 2013 [Ref. 7]. Therefore, at the meeting stakeholders were presented with the credible options list (excluding the baseline), and associated data on lorry deliveries / collections etc. Views were then sought on preferences and arguments that favour or do not favour certain options or stores. Through syndicate-based discussions, a number of clear points were made [Ref. 7], shown in Table 7.

Table 7: ILW Storage Stakeholder Feedback.

View Expressed	Supports:
In general, it was thought that, if transfers were going to happen, then Oldbury sending ILW packages for storage in the Berkeley ILW storage facility was the most sensible transfer to make as the sites are located close together. In addition, the Oldbury ILW packages would fit in the spare capacity of the Berkeley store. It was also thought that this may be publically acceptable (although different local authorities are involved at each site).	No store at Oldbury.
Two groups expressed a view that Dungeness A ILW packages may be suitable for transport and interim storage at another site. This was largely because of the availability of rail transport at Dungeness.	No store at Dungeness A.
The ability to share ILW storage facilities with EDF Energy was seen as important (i.e. single store for A and B sites' ILW packages).	A store at Sizewell A or Dungeness A (or both)[21].
Potentially regionally based solutions would be more publically acceptable and that these options represent the smallest change from the baseline.	No transfers between the south-west and the south-east.

Based on these views, ILW storage options not involving the transfer of ILW packages from Oldbury for storage at Berkeley have been removed from further consideration as possible alternatives to the baseline. This is because this is generally accepted to represent the minimum for any consolidation option. Option 4c has also been removed as this would involve the transfer of some packages from Dungeness A to Hinkley Point A (i.e. not within the same region).

The options remaining are then Options 5a, 5b and 6a. These options differ only in whether or not there is an ILW storage facility at Sizewell A, Dungeness A, or both.

On balance it is Magnox's view that Option 5b is preferred to the other two options. This is primarily because the option maximises use of the existing asset by using the spare capacity at Bradwell. Otherwise, there would be additional storage capacity created elsewhere, with its own spare capacity, which it is not necessary to create.

[21] The ILW store at Hinkley Point A would be able to accommodate packages from Hinkley Point B, if the B site changed strategy to the use of DCICs, in all remaining options.

Based on current package number estimates, not all of the Dungeness A packages can be stored at Bradwell, and there would be an excess for storage elsewhere, along with the need to store Sizewell A packages. It is considered to be better to construct this additional storage at Sizewell. This is because it would then leave open the opportunity of sharing ILW storage with Sizewell B, this being the only EDF Energy B site currently intending to use a similar waste management packaging strategy to Magnox (at least for some of its wastes). This would also avoid the need to construct on the ecologically sensitive Dungeness A site.

All remaining options enable spare capacity in the store at Hinkley Point A to potentially be used to accommodate packages from Hinkley Point B should EDF Energy change its ILW packaging strategy at that site. Only Dungeness B packages would not form part of a consolidated approach, though this can be reviewed in the future if, for example, the EDF Energy packaging strategy for Dungeness B wastes was to change.

Should there be a significant change in the quantities of packaged ILW for interim storage or in the spare capacity available within existing interim storage facilities, then the conclusions of this study will be reviewed with appropriate stakeholder and regulatory engagement at that time.

3.5.2 Comparison of the Preferred Alternative to Other Credible Options

As can be seen in Table 8, across a range of factors Option 5b has a middling performance.

Those credible options which perform relatively well on factors related to construction and demolition perform relatively poorly on factors relating to transport of waste packages. Fundamentally this is because to avoid construction of stores, more waste transfers would be required. Conversely those options which perform relatively well on factors related to transport of waste packages perform relatively poorly on the factors relating to construction and demolition. This is because avoiding transport of waste packages would result in more stores needing to be built.

Therefore Option 5b performs in the middle on all factors because it does not involve the largest amount of construction and demolition and it does not involve the largest amount of waste package transfers. This is also reflected in the cost reduction offered by Option 5b which is in the middle of the range of credible option costs.

Table 8: Performance of the Preferred Alternative (ILW Option 5b) within the Credible Options (Excluding the Baseline)[22].

	Attribute	Best	Worst	Option 5b
Construction & Demolition	Amount of construction and demolition (years)	~ 1	~ 3	~ 2
	Material resource use – unrecoverable materials (tonnes)	~ 2,170	~ 8,250	~ 4,610
	Number of lorries to transport construction and demolition materials	~ 310	~ 870	~ 520
	Total one-way HGV-kms	~15,500	~ 44,000	~ 26,000
Transport – Collection / Delivery of Radioactive Materials[23]	Number of lorries to transfer ILW packages by road	0	~ 150	~ 100
	Total one-way HGV kms	0	~ 22,000	~ 2,000
Cost	Cost (£M)	~ 60	~ 100	~ 80

3.6 Comparison to the Baseline

For the comparison of the preferred alternative to the baseline (see Figure 4), the assessment can be resolved by answering two independent questions:

1. Is it better to build a store at Dungeness for ILW from Dungeness A, or transport the ILW from Dungeness A to stores at Bradwell and Sizewell A?

2. Is it better to build a store at Oldbury for ILW from Oldbury, or transport the ILW from Oldbury to the existing store at Berkeley?

Technical information which supports answering these two questions is given in Appendix E. In Appendix E it is stated by factor whether the baseline or the alternative option is preferred. However, as neither option is preferred on all factors, it is necessary to determine which factors are most important to the overall decision.

[22] "Best" and "Worst" do not relate to a single option for all attributes but instead show the best or worst impact for each attribute separately under consideration.

[23] Note that these figures do not include the transfers required between the sites and railheads necessary to load and unload trains (as these are short distance journeys).

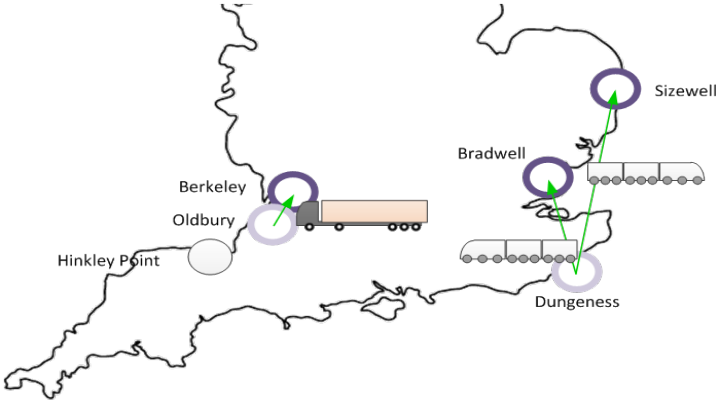
Baseline Option	Alternative Option – Option 5b[24]
1) Berkeley **2) Bradwell** **3) Dungeness A** **4) Hinkley Point A** **5) Oldbury** **6) Sizewell A**	
i.e. each site has its own interim storage facility for its own ILW	**1) Berkeley** (Oldbury) **2) Bradwell** (Dungeness A) **3) Hinkley Point A** **4) Sizewell** (Dungeness A)

Figure 4: Baseline vs. Alternative.

The discussion below summarises the issues which may discriminate between the two options in each of the two questions given above, specifically in terms of amount of construction, overall transport, transport of radioactive wastes specifically, and cost.

Is it better to build a store at Oldbury for packaged ILW from Oldbury, or transport the packaged ILW from Oldbury to the existing store at Berkeley?

In the baseline strategy a new store would be built at Oldbury, with its own spare capacity, when there is sufficient spare capacity at Berkeley that could be used to accommodate the packaged ILW from Oldbury.

The baseline would involve the disturbance associated with construction and demolition (C&D), both directly and from lorry deliveries / collections. Such impacts can be managed in line with best practice schemes for C&D activities to reduce impacts as far as is reasonably practicable, e.g. hours of working, but cannot be completely mitigated against. The alternative option involves no such impacts.

The baseline option would see around 260 lorry movements near Oldbury for construction and demolition. The alternative option replaces these with about 100 lorries collecting ILW packages from Oldbury and delivering them to Berkeley. Though these vehicles would have to pass through Berkeley town centre, these movements would take place over a number of years and the impact in terms of disturbance would be small.

[24] Those sites in bold type are recipient sites, those sites in brackets (e.g. Oldbury in Option 5b) are donor sites.

The transfer of ILW packages between Oldbury and Berkeley introduces the potential for increased public dose when compared to the baseline. However, given the length of the journey and the nature of the roads between these two sites, it is considered that there is limited potential for non-trivial dose to individual members of the public.

A new store at Oldbury results in significant additional cost over and above using the existing Berkeley store (ca. £15M).

On balance, storage at Berkeley is preferred. This is primarily on the basis of avoiding unnecessary construction at Oldbury, making best use of the asset at Berkeley, and avoiding significant expense, with no significant detriment incurred.

Is it better to build a store at Dungeness for packaged ILW from Dungeness A, or transport the packaged ILW from Dungeness A to stores at Bradwell and Sizewell A?

The main arguments in favour of each option are as discussed above in relation to Oldbury and Berkeley. In this case though, a new store at Dungeness would require construction on or near on-site ecologically sensitive and designated land. Any construction would be undertaken sympathetically, and be subject to appropriate ecological surveys and mitigation measures, but the avoidance of construction at Dungeness has this extra aspect that avoidance of construction at other sites does not.

The 300 lorry deliveries / collections associated with construction in the baseline option would be on roads near Dungeness, with its vulnerable road users (e.g. in and around Lydd). The alternative would incur around 100 lorry deliveries / collections near Bradwell with its own relatively poor local roads. However, the reduction at Dungeness is significantly greater than the increase at Bradwell, and therefore the alternative is preferred on this issue.

As noted earlier, in general reducing the amount of construction by sharing facilities leads to the transfer of radioactive waste, at least in part on public roads, and therefore introduces the potential for increased public dose from transport. However, the potential for non-trivial public dose in this case is minimal due to the use of rail. Therefore, this issue is not considered to be a significant detriment for the alternative option.

Storage at Bradwell / Sizewell A would foreclose the opportunity for Magnox and EDF Energy to co-store ILW packages at Dungeness. However, it is considered that given the small volume of waste residing at Dungeness B and that this waste is not due to be packaged for almost a decade, further opportunities may exist in the future for the co-storage of this waste and therefore foreclosure of this particular opportunity is tolerable.

A new store at Dungeness would result in significant additional cost over and above the alternative (ca. £15M).

On balance, storage at Bradwell / Sizewell A is preferred. This is primarily on the basis of avoiding unnecessary construction at Dungeness A, making best use of the asset at Bradwell, and avoiding significant expense, with no significant detriment incurred.

3.7 Sensitivity analysis

There are three types of assumptions that have been made in this options assessment:

1. High level assumptions in assessing the relative performance of the options (for example, mode of transport for packaged ILW).

2. Detailed assumptions in estimating the relative performance of the options (for example, the amount of construction materials that can be transported on each HGV; distances travelled; and package numbers).

3. Go / no-go assumptions: e.g. that Magnox can get the necessary permissions, or that all of the packaged ILW is transportable.

Magnox believes that its assumption that rail would be used for most transfers is robust, for reasons given earlier in this paper. As regards detailed assumptions, it is not proposed to assess the impact of each assumption here. However, it is worth addressing the effect that significant increases or decreases in package numbers would have. The go / no-go assumptions are also briefly discussed below.

Package numbers

If package numbers at one or more sites significantly increase, this can only affect the feasibility of storing all Oldbury packages within the Berkeley store, as even with the base case assumption Dungeness packages do not all fit within the Bradwell store and some would be transferred for storage at Sizewell A (which store is not yet built or even designed).

If there were to be a significant excess of packages from Oldbury after the Berkeley ILW storage facility was full, then the interim storage strategy for Oldbury would require proper review with further stakeholder engagement. If there were to be only a few excess packages, then the possibility of storing these at Hinkley Point A or in the Oldbury reactor Safestore would be investigated (with appropriate stakeholder engagement).

If package numbers at one or more sites significantly decrease, then there would be additional spare capacity at Berkeley and / or Bradwell after implementing the preferred strategy. The equity aspect of the preferred integrated option for the south-east (discussed in Section 4) would be less significant if no Dungeness packages were transferred to Sizewell for storage, but it is not considered that this would alter the overall preference.

Go / no-go assumptions

The key go / no-go assumption is that the packaged ILW is transportable. If none was transportable (at the time transport would be required) then clearly inter-site transfers as envisaged here would not be feasible and there would be no option other than to continue with the baseline (though potentially with A and B sites sharing storage facilities). If only part were to be transportable, then the effect on this study would depend on the proportion that is not transportable and the site(s) affected. In principle, it may still be possible to adopt at least part of the preferred option.

4 Integrated Solution

4.1 The Preferred Integrated Solution

The preferred integrated solution (Option H for FED Treatment and Option 5b for ILW storage) is illustrated below in Figure 5.

FED Treatment Option H	ILW Interim Storage Option 5b
Treatment of FED from Hinkley Point A and Oldbury at one new plant at Hinkley Point A, and treatment of FED from Sizewell A at the existing carbonic plant at Dungeness A.	Oldbury ILW transfers to Berkeley, and Dungeness A ILW transfers to Bradwell and if necessary Sizewell A.

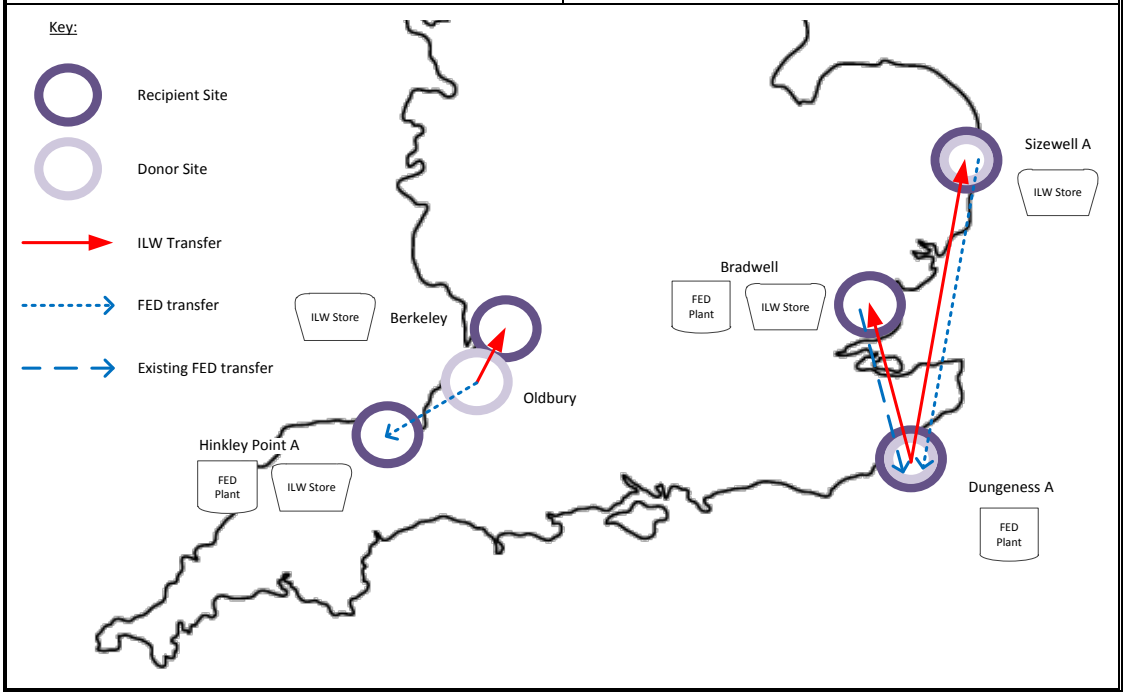


Figure 5: Preferred Integrated Solution.

4.2 What Would It Mean for Individual Sites?

At individual sites the key impacts are described below (in addition to further information on the baseline versus the alternative presented site-by-site in Appendix F):

- Berkeley – an additional circa 100 lorries in total would deliver packaged ILW from Oldbury over a period of up to 7 years.

- Bradwell – an additional circa 100 lorries in total would transport packaged ILW from the railhead at Southminster to site over a period of up to 3.5 years.

- Dungeness A – potentially after a short period of plant "down-time", the existing FED plant would continue operation for about 8 years (with associated deliveries of liquid carbon dioxide and other consumables) to process FED from Sizewell A. Transfers of FED into the site and ILW away from the site would use the railhead at the end of the approach road. There would be no store at Dungeness A (removing all associated safety and environmental impacts from construction and demolition, including the movement of ~300 lorries of construction / demolition materials).

- Hinkley Point A – a FED plant would be constructed for processing the FED from Hinkley Point A. The plant would operate for a period of about 5 years (with associated deliveries of acid and other consumables). This plant would then be operated for a further ~2.5 years to process the FED from Oldbury, which would be delivered using about 70 lorries in total (in addition there would be a small number of lorries per week delivering acid and other consumables over the ~2.5 year period). An interim ILW storage facility would also be constructed as originally proposed in the baseline, over about a year.[25]

- Oldbury – there would be no FED plant required at Oldbury (removing the need for about 150 lorries of construction / demolition materials and lorries associated with consumables) with FED being transported to Hinkley Point A over a period of about ~2.5 years (using about 70 lorries in total). No ILW interim storage facility would be required (removing the need for about 270 lorries of construction / demolition materials), with packages transferred to Berkeley over a period of about 7 years (using about 100 lorries in total).

- Sizewell A – there would be no FED plant required at Sizewell A (removing the need for about 150 lorries of construction / demolition materials) with FED being transported away from site via the railhead at Leiston using about 60 lorries in total. An interim storage facility for ILW would still be constructed, possibly slightly larger than originally proposed in the baseline to accommodate some packages from Dungeness A if required. ILW Packages from Dungeness A would be transported via the railhead at Leiston, with about 20 lorries required to complete the journey to site.

[25] It should be noted that at this stage no proposal is made regarding the storage location of the secondary treatment wastes which would be generated at Hinkley Point A by treatment of the Oldbury FED. In part this is because there is uncertainty regarding the number of ILW packages which would be created.

4.3 Discussion

Various benefits of the preferred integrated solution are discussed below, many of which reflect stakeholder views as expressed at workshops, in meetings and in letters received in response to the Stage A papers.

The preferred integrated option utilises the expected spare capacity in the Berkeley and Bradwell ILW storage facilities, allows spare capacity in the store at Hinkley Point A to be potentially used to accommodate packages from Hinkley Point B should EDF Energy change its ILW packaging strategy, and allows for a store at Sizewell A to also accommodate DCICs from Sizewell B. The preferred integrated option also makes best use of FED treatment assets, in that the Dungeness A plant already exists, and the Hinkley Point A dissolution plant will exist in all credible options.

Taking into account the existing transfer of Bradwell FED to Dungeness A, the transfer of Sizewell A FED to Dungeness A for treatment along with Dungeness ILW packages being sent to Bradwell and Sizewell A for interim storage could be seen as an equitable solution in the south-east of the country[26].

The preferred integrated option involves no single site being over-burdened with development (construction). Considering Magnox sites, there would be no construction in the south-west beyond the minimum[27], and there would be only one construction project in the south-east, that being a new (albeit larger than baseline) store at Sizewell A.

Should the Sizewell A store also be used for Sizewell B resins, only two stores would be required at Sizewell rather than three (Sizewell B would still require a store for its encapsulated packages). At Dungeness, one store would be constructed (on the B site, for encapsulated packages) rather than two.

In addition, the preferred integrated option spreads the burden of importing wastes. In this option five out of six sites would receive waste from elsewhere, no site would receive material from more than one other site, and no site would host more than one consolidation opportunity:

- Hinkley Point A only receives FED from Oldbury;
- Berkeley only receives ILW packages from Oldbury;
- Dungeness A only receives FED from Sizewell A;
- Bradwell only receives ILW from Dungeness A; and

[26] Though stakeholders noted at the meeting in July 2013 that there were various ways in which “equity” could be measured, including by means of community benefit.

[27] Stores are already built or required at Berkeley and Hinkley Point A, and a FED plant would be required for Hinkley Point A.

- Sizewell A only receives ILW from Dungeness A.

Reduced facility construction associated with the preferred option has the potential to save the tax payer approximately £90M.

The above benefits do not come without some detriments. For example, unless an alternative and better means of transport can be found and shown to be practicable, treatment of Oldbury FED at Hinkley Point A would require the transport of around 70 consignments of FED by road (plus delivery of consumables). The impact of these vehicle movements on traffic flows, and on the level of disturbance to the local community, would be very small, because the percentage increase would be very small. These vehicle movements would also occur some years after the expected peak in Hinkley Point C construction traffic.

There would also be potential for some public dose from FED transport. However, Magnox would be required to minimise this, possible measures including increased shielding to vehicles, timing of transports to avoid peak hours as far as practicable, and use of vehicle escorts. Similar considerations apply to the transfer of Oldbury packaged ILW to Berkeley, which would involve about 100 deliveries.

Sizewell A FED would not be transferred for processing at Dungeness A for a number of years. Alhough Dungeness A is currently processing some FED from Bradwell under an existing agreement, under current plans the Dungeness A plant would cease operation until commencing processing Sizewell A FED. During this period, in line with Magnox's arrangements the plant will be maintained to ensure the asset is fit for any future use.

5 Stakeholder Engagement

The process thus far has provided stakeholders with several opportunities to input into the assessment. An initial workshop was held in February 2013 [Ref. 6] which helped to inform the selection of credible options presented in the two Stage A papers. Stakeholders were then invited to comment on the papers in May / June 2013 and 57 responses were received. Comments made influenced the stakeholder engagement plans from that stage forward, and resulted in a number of additional technical studies being commissioned. Where a view was expressed, it was generally supportive of the credible options list proposed.

Stage B, the identification of preferred options, was also informed by a stakeholder meeting (July 2013, [Ref. 7]), ultimately resulting in this Stage B paper. Some responses received on publication of the Stage A papers expressed a view that there had been insufficient stakeholder engagement prior to issue of the Stage A papers. Therefore, stakeholder engagement on some of the content of this Stage B paper commenced prior to publication; this included presentations to local authorities, and to SSG / LCLC chairs.

Appendix G provides a list of stakeholder engagements undertaken up to the time of writing. Regarding future stakeholder engagement, a communications plan has been developed. This plan details a variety of engagement activities including public drop-in centres local to the affected sites, presentations at SSG / LCLC meetings, and meetings with local authorities at both district and county levels. Finally, most if not all of the individual aspects of the preferred option (e.g. transferring packaged ILW from Oldbury to Berkeley) will require planning applications and statutory public consultations would be required as part of the determination process in each case.

6 Delivery

Following a decision by the NDA to proceed with some or all of the elements of the preferred option, Magnox will proceed to an implementation phase following normal processes. These will include:

- Produce LC35 submissions to gain any required ONR agreements to the changes proposed.
- Change control to amend Magnox lifetime plans.
- Develop Best Available Techniques (BAT) cases (analogous to this paper) to support the revised strategies for FED and interim storage, as required under Environmental Permitting Regulations (England and Wales) (as amended) 2010 (EPR2010).
- Produce detailed optimisation cases required to meet the BAT requirements under EPR2010, and to meet ALARP requirements under site license conditions.
- For FED, undertake more detailed assessments of the environmental impact of radioactive and chemical aqueous discharges, and request amendment to site permits if necessary.
- Develop the designs and safety cases for facilities not yet available.
- Develop the detailed plans and logistics for how the proposals would be implemented, including those for transport and buffer storage.
- Produce documentation required to support planning applications, including any associated Environmental Statements required under Town and Country Planning (Environmental Impact Assessment) Regulations 2011.
- Undertake Regulation 13 assessments under Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations (1999) (as amended).
- Complete any necessary development and certification of containers for the transport of the waste between sites.

7 Conclusion

The case for consolidating the treatment of Magnox FED treatment and ILW interim storage has been assessed. Based on this assessment the following option is preferred:

FED Treatment	ILW Interim Storage
Treatment of FED from Hinkley Point A and Oldbury at one new plant at Hinkley Point A, and treatment of FED from Sizewell A at the existing carbonic plant at Dungeness A.	Oldbury ILW transfers to Berkeley, and Dungeness A ILW transfers to Bradwell and if necessary Sizewell A.

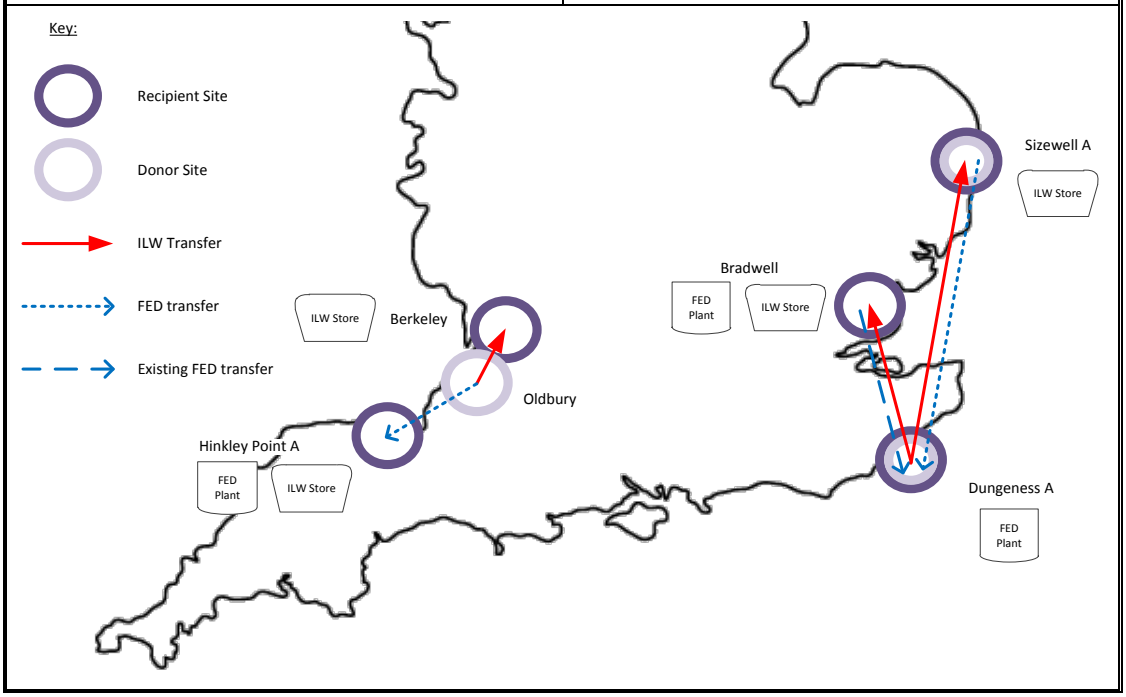


Figure 6: Preferred Integrated Solution.

This proposal:

- Makes best use of existing facilities and avoids unnecessary construction.
- Ensures that there is a balance of development across the sites.
- Reduces overall environmental impact.
- Reduces costs by approximately £90M whilst maintaining the highest safety and environmental standards.
- Does not significantly disadvantage any site as regards the timing of Care and Maintenance (C&M) entry.

- Provides opportunities for future consolidation of ILW package interim storage with EDF Energy.

Overall, it is considered that the advantages of the preferred integrated solution (relating to reduced construction) outweigh the disadvantages (such as the transport of some radioactive waste on public roads), especially when potential mitigations are taken into account.

The preferred option reflects a strategy of minimising new construction, thereby making the best use of assets (ILW stores and FED treatment plants). Stakeholder feedback is recognised within this strategy by giving priority to waste transfers on a regional basis.

There are a number of uncertainties, such as those relating to waste volumes, which could affect the ability to implement the preferred option exactly as described in this paper. However, the underlying strategy - i.e. making best use of facilities on a regional basis only - would continue to be applied as far as possible.

Magnox will continue to engage with and involve its stakeholders as the project progresses.

8 References

1. NDA (2011), NDA Strategy, Effective from April 2011. March 2011.

2. Optimising the Number and Location of FED Treatment (Dissolution) Facilities in Magnox Limited - Credible Options (Stage A). Issue 1. May 2013.

3. Optimising the Number and Location of Interim ILW Storage Facilities on Magnox Limited and EDF Energy Sites in England and Wales - Credible Options (Stage A). Issue 1. May 2013.

4. EGG08, NDA Guidance for the Production of Business Cases, Rev 7, January 2010.

5. Nuclear Industry Safety Directors Forum (December 2010). Best Available Techniques (BAT) for the Management of the Generation and Disposal of Radioactive Wastes - A Nuclear Industry Code of Practice. Issue 1.

6. Waste Optimisation - Report on a Workshop Held at the Radisson Edwardian Blu Hotel, Euston 12th - 13th February 2013. Workshop Report.

7. FED Treatment and ILW Interim Storage Optimisation - Report on a Workshop Held 18th - 19th July 2013.

Appendix A – Value Framework Attributes

The attributes which were used to perform the option screening are consistent with the NDA Value Framework process [Ref. 4]. The table below provides a summary of the high-level Value Framework attributes and shows at which stage of the project these attributes were considered.

Value Framework Attribute	Used in Stage A?	Used in Stage B?	Specific Attributes
Safety	✓	✓	Public dose Worker dose Public conventional safety Worker conventional safety
Environment	✓	✓	Material use Carbon dioxide emissions Disturbance Aqueous discharges Aerial discharges
Hazard Reduction	×	✓	Time to start / end of FED treatment.
Security	×	×	Security is not considered to differentiate between any of the options as each of the sites have suitable security arrangements that ensure that the site is protected against foreseeable security threats (including during transport).
Socio-economic	×	✓	N/A – this has been addressed in this paper through discussions about continued use of existing plant, continued employment, equity and community benefit.
Cost	×	✓	Lifetime cost

Appendix B – FED Treatment Long-List of Options[28]

Option	Recipient Site			
	Hinkley Point A	Oldbury	Sizewell A	Dungeness A
BASELINE				
1	Hinkley Point A FED	Oldbury FED	Sizewell A FED	N/A
REGIONAL				
2a	Hinkley Point A FED Oldbury FED		Sizewell A FED	
2b	Hinkley Point A FED Oldbury FED			Sizewell A FED (using existing carbonic plant)
2c		Oldbury FED Hinkley Point A FED	Sizewell A FED	
2d		Oldbury FED Hinkley Point A FED		Sizewell A FED (using existing carbonic plant)
2e	Hinkley Point A FED	Oldbury FED		Sizewell A FED (using existing carbonic plant)
CONSOLIDATION OF LOWER VOLUME FED SITES				
3a	Hinkley Point A FED	Oldbury FED Sizewell A FED		
3b	Hinkley Point A FED		Sizewell A FED Oldbury FED	
3c[29]	Hinkley Point A FED			Sizewell A FED & Oldbury FED (using new nitric plant)
MINIMISATION OF FUTURE PLANT: TWO NEW PLANTS				
4a		Oldbury FED	Sizewell A FED Hinkley Point A FED	
4b	Hinkley Point A FED Sizewell A FED	Oldbury FED		
MINIMISATION OF FUTURE PLANT: ONE NEW PLANT				
5a	Hinkley Point A FED Oldbury FED			

[28] Each row represents one possible option and each column is a potential host site e.g. in Option 2c there is a dissolution facility at Oldbury (for FED from Oldbury and Hinkley Point A) and also a facility at Sizewell A (for Sizewell A's own FED).

[29] Additional option introduced following the workshop of 12th – 13th February 2013.

Option	Recipient Site			
	Hinkley Point A	Oldbury	Sizewell A	Dungeness A
	Sizewell A FED			
5b		Oldbury FED Hinkley Point A FED Sizewell A FED		
5c			Sizewell A FED Hinkley Point A FED Oldbury FED	
5d				Hinkley Point A FED (new nitric plant) Oldbury FED (new nitric plant) Sizewell A FED (new nitric plant)

NB After screening to produce the credible options list, the option numbering system was amended; see Table 1 in the main text.

Appendix C – FED Optimisation: Baseline versus Alternative

Consolidated FED Treatment – Difference between Processing Sizewell A FED at Sizewell A or Sizewell A FED at Dungeness A

Attributes	Impacts of Treatment of Sizewell A's FED at Sizewell A (BASELINE)	Impacts of Treatment of Sizewell A's FED at Dungeness A (OPTION H)	Favours	Explanation / Context
Public Conventional Safety – Transport of Radioactive Waste and Construction & Demolition Materials	Risk of 1 in 6,500 of a fatality (from transport of construction and demolition materials for a plant at Sizewell).	Risk of 1 in 93,500 of a fatality (from transport of FED to Dungeness).	Alternative	The risk is spread across a large population and would not be experienced by any single person.
Public Individual Dose – Transport of Radioactive Waste	N/A – there is no transport of radioactive waste.	Road transport of radioactive waste to and from nearby railheads. The remainder of the journey is by rail. Minimal opportunity for non-trivial dose to a member of the public.	Baseline	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Here non-trivial would be one-off doses of the order of a few hundred micro-Sv to one or more individuals. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Public Collective Dose – Transport of Radioactive Waste	N/A – there is no transport of radioactive waste.	Minimal opportunity for significant public collective dose from transport.	Baseline	Total UK annual dose due to background radiation is ~162 man-Sv / yr.
Total Public Individual Dose – Radioactive Discharges	~ 0.07 micro-Sv per year for about 1.5 years.	~ 0.09 micro-Sv per year for about 8 years.	Baseline	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Total Public Collective Dose – Radioactive Discharges	~0.02 man-milliSv (1 in 1,000,000 risk).	~0.1 man-milliSv (1 in 200,000 risk).	Baseline	The risk (of one or more fatalities) is spread across a large population and would not be experienced by any single person. Total UK annual dose due to background radiation is ~162,000 man-milliSv / yr.

Attributes	Impacts of Treatment of Sizewell A's FED at Sizewell A (BASELINE)	Impacts of Treatment of Sizewell A's FED at Dungeness A (OPTION H)	Favours	Explanation / Context
Disturbance Caused Directly by On-Site Construction & Demolition Activities	~ 2 years disturbance from C&D to residential properties close to Sizewell A (~250m from site boundary).	No additional construction.	Alternative	Construction at Sizewell A would occur in the context of other site decommissioning activities.
Disturbance Caused by Lorry Deliveries / Collections (Total)	~ 150 lorries making deliveries / collections (from construction and demolition of a plant at Sizewell). In addition, there would be a few lorries per week delivering consumables to Sizewell A during the operations period (about 1.5 years).	~ 60 lorries making deliveries / collections (for transport of FED) to and from the railheads at both ends of the journey. In addition, there would be a few lorries per month delivering consumables to Dungeness during the operations period (about 8 years).	Alternative	Decommissioning sites typically have a few tens of HGV deliveries per day.
Nitrates Discharge to the Environment (% change)	1.7% for about 1.5 yrs at Sizewell.	No nitrates discharge from use of existing carbonic plant.	Alternative	Additional nitrates discharges would not threaten compliance with relevant European water quality standards.
Environmental Sensitivity (NO_x)	Sizewell A has plant species sensitive to NO_x emissions.	No NO_x emissions at sensitive sites.	Alternative	Emissions would be mitigated to meet relevant air quality standards.
Environmental Sensitivity (Other / Conventional)	There is no direct use of sensitive land for construction.	There is no direct use of sensitive land for construction.	Neutral	"Sensitive land" means on-site land that it is designated and / or contains protected species, or is close to such land.
Materials Use (Unrecoverable Materials)	390 tonnes for a plant at Sizewell A.	No additional construction required.	Alternative	The Eiffel Tower weighs 7,300 metric tonnes (iron).
CO_2 Emissions (Use of Construction Materials / Transport of Construction & Demolition Materials and of Radioactive Waste)	3,290 tonnes CO_2 from construction of a plant at Sizewell A and associated transport.	~ 0.5 tonnes CO_2 from transport of FED, to and from the railheads (does not include CO_2 from rail transport).	Alternative	The UK total CO_2 emissions equivalent for 2008 was 628.3 million tonnes.

Attributes	Impacts of Treatment of Sizewell A's FED at Sizewell A (BASELINE)	Impacts of Treatment of Sizewell A's FED at Dungeness A (OPTION H)	Favours	Explanation / Context
Worker Conventional Safety – Construction & Demolition and Transport of Associated Material	1 in 270 risk of a worker fatality (1 new plant).	There is no new plant required under this option, so minimal / no risk.	Alternative	The risk is spread across the population of workers.
Worker Collective Dose – Transport of Radioactive Waste	N/A - there is no transport of radioactive waste.	~ 3 man-milliSv (~ 1 in 6,700 risk of a fatality).	Baseline	The risk is spread across the population of workers.
Implementation Risk	Levels of nitrates discharged would not present an implementation risk relating to the Environmental Quality Standards (EQS) at Sizewell.	No nitrates would be discharged as the process uses carbonic acid.	Neutral	"Implementation risk" means risk of constraints on throughput due to risk of causing non-compliance with relevant European water quality standards.
Schedule (C&M Entry)	There would be no impact on schedule.	There would be no impact on schedule.	Baseline	Delays to planned C&M entry could incur significant cost per year.
Time to Start of FED Treatment	March 2018	January 2018	Neutral	Sizewell A planned C&M entry date is 2027. Dungeness A planned C&M entry date is 2027.
Time to End of FED Treatment	September 2019	December 2025	Baseline	Sizewell A planned C&M entry date is 2027. Dungeness A planned C&M entry date is 2027.
Costs	~£40M	~£10M	Alternative	The total plan costs for Magnox for 2013/14 is £722M.

Consolidated FED Treatment – Difference between Processing Oldbury FED at Oldbury or Oldbury FED at Hinkley Point A

Attributes	Impacts of Treatment of Oldbury's FED at Oldbury (BASELINE)	Impacts of Treatment of Oldbury's FED at Hinkley Point A (OPTION H)	Favours	Explanation / Context
Public Conventional Safety – Transport of Radioactive Waste and Construction & Demolition Materials	Risk of 1 in 6,500 of a fatality (from transport of construction and demolition materials for a plant at Oldbury).	Risk of 1 in 8,000 of public fatality (from transport of FED).	Alternative	The risk is spread across a large population and would not be experienced by any single person.
Public Individual Dose – Transport of Radioactive Waste	N/A - there is no transport of radioactive waste.	Potential for non-trivial public individual dose from transport of radioactive waste on motorways and other multi-lane roads from Oldbury to Hinkley Point A.	Baseline	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Here non-trivial would be one-off doses of the order of a few hundred micro-Sv to one or more individuals. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Public Collective Dose – Transport of Radioactive Waste	N/A – there is no transport of radioactive waste.	Estimated to be 0.6 man-milliSv arising from Oldbury to Hinkley Point A transfers (risk of about 1 in 33,000).	Baseline	The risk is spread across a large population and would not be experienced by any single person. Total UK annual dose due to background radiation is ~162,000 man-milliSv / yr.
Total Public Individual Dose – Radioactive Discharges	~ 3.0 micro-Sv per year for about 2.5 years.	~ 0.1 micro-Sv per year for about 2.5 years.	Alternative	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Total Public Collective Dose – Radioactive Discharges	0.04 man-milliSv (1 in 500,000 risk).	0.04 man-milliSv (1 in 500,000 risk of a fatality).	Neutral	The risk is spread across a large population and would not be experienced by any single person. Total UK annual dose due to background radiation is ~162,000 man-milliSv / yr.

Attributes	Impacts of Treatment of Oldbury's FED at Oldbury (BASELINE)	Impacts of Treatment of Oldbury's FED at Hinkley Point A (OPTION H)	Favours	Explanation / Context
Disturbance Caused Directly by On-Site Construction & Demolition Activities	~ 2 years disturbance from C&D to residential properties close to Oldbury (~ 500m from site boundary).	No additional construction at Hinkley Point A.	Alternative	Construction at Oldbury would occur in the context of other site decommissioning activities.
Disturbance Caused by Lorry Deliveries / Collections (Total)	~ 150 lorries making deliveries / collections (from construction and demolition of a plant at Oldbury). In addition, there would be a few lorries per week delivering consumables to Oldbury during the operations period (2.5 years).	~ 70 lorries making deliveries / collections (from transport of FED). In addition, there would be a few lorries per week delivering consumables to Hinkley Point A during the operations period (2.5 years).	Alternative	Decommissioning sites typically have a few tens of HGV deliveries per day.
Nitrates Discharge to the Environment (% change)	0.7% for 2.5 yrs at Oldbury.	0.04% for 2.5 yrs at Hinkley.	Alternative	Additional nitrates discharges would not threaten compliance with relevant European water quality standards.
Environmental Sensitivity (NO_x)	Oldbury site not sensitivity to NO_x emissions.	Hinkley Point A site not sensitive to NO_x emissions.	Neutral	Emissions would be mitigated to meet relevant air quality standards.
Environmental Sensitivity (Other / Conventional)	There is no direct use of sensitive land for construction at Oldbury.	There is no direct use of sensitive land for construction at Hinkley Point A.	Neutral	"Sensitive land" means on-site land that it is designated and / or contains protected species, or is close to such land.
Materials Use (Unrecoverable Materials)	~ 390 tonnes for construction of a plant at Oldbury.	No additional construction required as plant would already exist for purposes of processing FED from Hinkley Point A.	Alternative	The Eiffel Tower weighs 7,300 metric tonnes (iron).

Attributes	Impacts of Treatment of Oldbury's FED at Oldbury (BASELINE)	Impacts of Treatment of Oldbury's FED at Hinkley Point A (OPTION H)	Favours	Explanation / Context
CO_2 Emissions / Energy Use (Use of Construction Materials / Transport of Construction & Demolition Materials / Transport of Radioactive Waste)	~ 3,290 tonnes CO_2 for construction of a plant at Oldbury and associated transport.	~ 11.6 tonnes of CO_2 from transport of radioactive material.	Alternative	The UK total CO_2 emissions equivalent for 2008 was 628.3 million tonnes.
Worker Conventional Safety – Construction & Demolition and Transport of Associated Material	~ 1 in 270 risk of a worker fatality (1 new plant).	There is no new plant required under this option, so minimal / no risk.	Alternative	The risk is spread across the population of workers.
Worker Collective Dose – Transport of Radioactive Waste	N/A – there is no transport of FED.	7 man-milliSv (~1 in 2,900 risk of a fatality).	Baseline	The risk is spread across the population of workers.
Implementation Risk	Levels of nitrates discharged at Oldbury would not present an implementation risk relating to the Environmental Quality Standards (EQS) at Oldbury.	Levels of nitrates discharged would not present an implementation risk relating to the Environmental Quality Standards (EQS) at Hinkley.	Neutral	"Implementation risk" means risk of constraints on throughput due to risk of causing non-compliance with relevant European water quality standards.
Schedule (C&M Entry)	There would be no impact on schedule.	There would be no impact on schedule.	Neutral	Delays to planned C&M entry could incur significant cost per year.
Time to Start of FED Treatment	April 2020	April 2020	Neutral	Oldbury C&M planned entry date is 2027. Hinkley Point A planned C&M entry date is 2025.
Time to End of FED Treatment	June 2024	October 2022	Alternative	Oldbury C&M planned entry date is 2027. Hinkley Point A planned C&M entry date is 2025.
Costs	~ £37M	~ £7M	Alternative	The total plan costs for Magnox for 2013/14 is £722M.

Appendix D – Long List of Options – ILW Storage

This scenario involves EDF Energy remaining on their existing strategy and storing their waste separately.

OPTION	RECIPIENT LOCATION							
	BERKELEY	HINKLEY PT A	OLDBURY	BRADWELL	DUNGENESS A	SIZEWELL A	TRAWSFYNYDD	WYLFA
8a	Berkeley	Hinkley Point A	Oldbury	Bradwell	Dungeness A	Sizewell A	Trawsfynydd	Wylfa
Regional								
4a	Berkeley Oldbury, Hinkley Point A			Bradwell Sizewell A	Dungeness A		Trawsfynydd Wylfa	
4b	Berkeley Oldbury, Hinkley Point A			Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd Wylfa	
5a	Berkeley Oldbury	Hinkley Point A		Bradwell Sizewell A	Dungeness A		Trawsfynydd Wylfa	
5b	Berkeley Oldbury	Hinkley Point A		Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd Wylfa	
5c	Berkeley Oldbury, Hinkley Point A			Bradwell	Dungeness A	Sizewell A	Trawsfynydd Wylfa	
5d	Berkeley Oldbury, Hinkley Point A			Bradwell Sizewell A	Dungeness A		Trawsfynydd	Wylfa

OPTION	RECIPIENT LOCATION							
	BERKELEY	HINKLEY PT A	OLDBURY	BRADWELL	DUNGENESS A	SIZEWELL A	TRAWSFYNYDD	WYLFA
5e	Berkeley Oldbury, Hinkley Point A			Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd	Wylfa
6a	Berkeley Oldbury	Hinkley Point A		Bradwell	Dungeness A	Sizewell A	Trawsfynydd Wylfa	
6b	Berkeley	Hinkley Point A	Oldbury	Bradwell Sizewell A	Dungeness A		Trawsfynydd Wylfa	
6c	Berkeley	Hinkley Point A	Oldbury	Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd Wylfa	
6d	Berkeley Oldbury	Hinkley Point A		Bradwell Sizewell A	Dungeness A		Trawsfynydd	Wylfa
6e	Berkeley Oldbury	Hinkley Point A		Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd	Wylfa
6f	Berkeley Oldbury, Hinkley Point A			Bradwell	Dungeness A	Sizewell A	Trawsfynydd	Wylfa
7a	Berkeley	Hinkley Point A	Oldbury	Bradwell	Dungeness A	Sizewell A	Trawsfynydd Wylfa	
7b	Berkeley Oldbury	Hinkley Point A		Bradwell	Dungeness A	Sizewell A	Trawsfynydd	Wylfa
7c	Berkeley	Hinkley Point A	Oldbury	Bradwell Dungeness A		Sizewell A Dungeness A	Trawsfynydd	Wylfa

OPTION	RECIPIENT LOCATION							
	BERKELEY	HINKLEY PT A	OLDBURY	BRADWELL	DUNGENESS A	SIZEWELL A	TRAWSFYNYDD	WYLFA
7d	Berkeley	Hinkley Point A	Oldbury	Bradwell Sizewell A	Dungeness A		Trawsfynydd	Wylfa
Minimisation of Future Stores								
3a	Berkeley Oldbury, Hinkley Point A, Dungeness A			Bradwell Sizewell A, Dungeness A			Trawsfynydd Wylfa	
4c	Berkeley Oldbury	Hinkley Point A Dungeness A		Bradwell Sizewell A, Dungeness A			Trawsfynydd Wylfa	
5f	Berkeley Dungeness A	Hinkley Point A	Oldbury	Bradwell Sizewell A, Dungeness A			Trawsfynydd Wylfa	
6g	Berkeley Dungeness A	Hinkley Point A	Oldbury	Bradwell Sizewell A, Dungeness A			Trawsfynydd	Wylfa

Appendix E – Interim ILW Storage Optimisation: Baseline versus Alternative

Consolidated ILW Storage – Difference between Consigning ILW from Dungeness A to Sizewell A / Bradwell or Building a Store at Dungeness A

Attributes	Impacts of New Interim Storage Facilities at Dungeness A for host site ILW only (BASELINE)	Impacts of Transfer of Dungeness A's ILW to Sizewell A and Bradwell (OPTION 5b)[30]	Favours	Explanation / Context
Public Conventional Safety – Transport of Radioactive Waste and Construction & Demolition Materials	Risk of ~ 1 in 3,100 of a fatality (from transport of C&D materials for ILW stores at Sizewell A and Dungeness A).	Risk of ~ 1 in 11,400 of a fatality (from transport of C&D materials for a store at Sizewell A and transport of Dungeness packages).	Alternative	The risk is spread across a large population and would not be experienced by any single person.
Public Individual Dose – Transport of Radioactive Waste	N/A - there is no transport of radioactive waste.	Road transport of radioactive waste to and from nearby railheads. The remainder of the journey is by rail. Minimal opportunity for non-trivial dose to a member of the public.	Baseline	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Here non-trivial would be one-off doses of the order of a few hundred micro-Sv to one or more individuals. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Public Collective Dose – Transport of Radioactive Waste	N/A – there is no transport of radioactive waste.	Minimal opportunity for significant public collective dose from transport.	Baseline	Total UK annual dose due to background radiation is ~ 162,000 man-milliSv / yr.

[30] This column includes the impacts of building a larger than baseline store at Sizewell A (i.e. the extra construction and demolition required).

Attributes	Impacts of New Interim Storage Facilities at Dungeness A for host site ILW only (BASELINE)	Impacts of Transfer of Dungeness A's ILW to Sizewell A and Bradwell (OPTION 5b)[30]	Favours	Explanation / Context
Disturbance Caused Directly by on-site Construction & Demolition Activities	~ 1 year disturbance from C&D to residential properties at Dungeness A (~50m from site boundary) and similarly for Sizewell A.	No disturbance for construction at Dungeness A. The store is built at Bradwell. The extra construction / demolition required at Sizewell in this option would be carried out in same general timescales as in the baseline.	Alternative	Construction at Dungeness A would occur in the context of other site decommissioning activities.
Disturbance Caused by Lorry Deliveries / Collections (Total)	~ 300 lorries making deliveries / collections (for C&D of the store at Dungeness A).	~ 120 lorries making deliveries / collections of ILW packages to and from the railheads at both ends of the journey plus an extra ~ 30 lorries delivering / collecting extra construction / demolition materials for a larger Sizewell A store.	Alternative	Decommissioning sites typically have a few tens of HGV deliveries per day.
Environmental Sensitivity	Potential for direct use of / impacts on sensitive land for construction at Dungeness A (there is a SSSI within the site licence boundary).	There is no direct use of sensitive land for construction.	Alternative	"Sensitive land" means on-site land that it is designated and / or contains protected species, or is close to such land.
Materials Use (Unrecoverable Materials)	~ 3,050 tonnes (for store at Dungeness A).	There would be no new store built at Dungeness A for this option. However, a larger store would be required at Sizewell A requiring an extra ~ 430 tonnes.	Alternative	The Eiffel Tower weighs 7,300 metric tonnes (iron).

Attributes	Impacts of New Interim Storage Facilities at Dungeness A for host site ILW only (BASELINE)	Impacts of Transfer of Dungeness A's ILW to Sizewell A and Bradwell (OPTION 5b)[30]	Favours	Explanation / Context
CO_2 Emissions / Energy Use (Use of Construction Materials / Transport of Construction Materials / Transport of Radioactive Waste)	~ 3,960 tonnes (for store at Dungeness A).	There would be no new store built at Dungeness A for this option. However, a larger store would be required at Sizewell resulting in an additional ~ 150 tonnes for the larger store at Sizewell A. There would also be ~ 40 tonnes associated with transport of packages from Dungeness A to Bradwell and Sizewell A.	Alternative	The UK total CO_2 emissions equivalent for 2008 was 628.3 million tonnes.
Worker Conventional Safety – Construction & Demolition and Transport of Associated Materials	~ 1 in 1,030 risk of a worker fatality for construction / demolition of a store at Dungeness A.	There would be no new store built at Dungeness A for this option. However, a larger store would be required at Sizewell – the risk of a worker fatality from this additional C&D is ~1 in 7,300.	Alternative	The risk is spread across the population of workers.
Worker Collective Dose – Transport of Radioactive Waste	0	22 man-milliSv (1 in 900 risk).	Baseline	The risk is spread across the population of workers.
Cost (£M)	~ £18M	~ £3M	Alternative	The total plan costs for Magnox for 2013/14 is £722M.

Consolidated ILW Storage – Difference between Consigning ILW from Oldbury to Berkeley or Building a Store at Oldbury

Attributes	Impacts of New Interim Storage Facilities at Oldbury for host site ILW only (BASELINE)	Impacts of Transfer of Oldbury's ILW to Berkeley (OPTION 5b)	Favours	Explanation / Context
Public Conventional Safety – Transport of Radioactive Waste and Construction & Demolition Materials	Risk of ~ 1 in 3,600 of a fatality (from transport of C&D materials for a store at Oldbury).	Risk of ~ 1 in 13,200 of a fatality (from transport of ILW packages to Berkeley).	Alternative	The risk is spread across a large population and would not be experienced by any single person.
Public Individual Dose – Transport of Radioactive Waste	N/A - there is no transport of radioactive waste.	Limited potential for non-trivial public individual dose from the transport of radioactive waste on minor roads from Oldbury to Berkeley.	Baseline	The IAEA consider that a dose rate of a few tens of micro-Sv per year is trivial. Here non-trivial would be one-off doses of the order of a few hundred micro-Sv to one or more individuals. Average annual dose to any single person in the UK is 2,700 microSv / yr.
Public Collective Dose – Transport of Radioactive Waste	N/A – there is no transport of radioactive waste.	0.21 man-milliSv (1 in 95,000 risk of a fatality).	Baseline	The risk (of one or more fatalities) is spread across a large population and would not be experienced by any single person. Total UK annual dose due to background radiation is ~162,000 man-milliSv / yr.
Disturbance Caused Directly by On-site Construction & Demolition Activities	~ 1 year disturbance from C&D to residential properties at Oldbury (~ 500m from site boundary).	No further construction required in this option.	Alternative	Construction at Oldbury would occur in the context of other site decommissioning activities.
Disturbance Caused by Lorry Deliveries / Collections (Total)	~ 270 lorries making deliveries / collections (for C&D of the store at Oldbury).	~ 100 lorries making deliveries / collections (for transfer of the Oldbury packaged ILW to the Berkeley store).	Alternative	Decommissioning sites typically have a few tens of HGV deliveries per day.
Environmental Sensitivity	There is no direct use of sensitive land for construction.	There is no direct use of sensitive land for construction.	Neutral	"Sensitive land" means on-site land that it is designated and / or contains protected species, or is close to such land.

Attributes	Impacts of New Interim Storage Facilities at Oldbury for host site ILW only (BASELINE)	Impacts of Transfer of Oldbury's ILW to Berkeley (OPTION 5b)	Favours	Explanation / Context
Materials Use (Unrecoverable Materials)	~ 3,020 tonnes for construction of a store at Oldbury.	No further construction required in this option.	Alternative	The Eiffel Tower weighs 7,300 metric tonnes (iron).
CO_2 Emissions / Energy Use (Use of Construction Materials / Transport of Construction & Demolition Materials / Transport of Radioactive Waste)	~ 3,610 tonnes for construction of a store at Oldbury.	~ 4 tonnes for transport of packages from Oldbury to Berkeley.	Alternative	The UK total CO_2 emissions equivalent for 2008 was 628.3 million tonnes.
Worker Conventional Safety – Construction & Demolition and Transport of Associated Material	~ 1 in 1,160 risk of a worker fatality for construction of a store at Oldbury.	No further construction required in this option.	Alternative	The risk is spread across the population of workers.
Worker Collective Dose – Transport of Radioactive Waste	0	14 man-milliSv (~1 in 1400 risk).	Baseline	The risk is spread across the population of workers.
Cost (£M)	~ £15.5M	~ £0.5M	Alternative	The total plan costs for Magnox for 2013/14 is £722M.

Appendix F – Site Impacts: Baseline versus Alternative

Berkeley: ILW Storage

Issue	In the baseline: Impacts of interim storage of Berkeley ILW packages only in the Berkeley ILW store.	In the preferred alternative: Impacts of interim storage of Berkeley and Oldbury ILW packages in the Berkeley ILW store.
Construction	ILW storage facility almost constructed.	ILW storage facility almost constructed. No store extension required.
Waste transport route	N/A	Lorries by road (along A38) from Oldbury to Berkeley.
HGVs	N/A	~100 lorries delivering Oldbury ILW packages.
Package numbers	Interim storage of 641 Type VI and 250 MOSAIK®s.	As in the baseline, plus the interim storage of an extra 63 Type VI and 79 MOSAIK®s.
C&M	Planned C&M entry is 2021.	Some ILW packages would be received after the Berkeley site has entered C&M.
Opportunity for co-storage with B site	N/A	N/A

Bradwell: ILW Storage

Issue	In the baseline: Impacts of interim storage of Bradwell ILW packages only in the Bradwell ILW store.	In the preferred alternative: Impacts of interim storage of Bradwell and most Dungeness A ILW packages in the Bradwell ILW store.
Construction	ILW storage facility already constructed.	ILW storage facility already constructed. No store extension required.
Waste transport route	N/A	Rail from Dungeness to Southminster (Bradwell), then by road to site.
HGVs	N/A	~100 lorries delivering Dungeness A ILW packages from the railhead (Southminster).
Package numbers	Interim storage of 60 Type VI and 113 MOSAIK®s.	Interim storage of an extra 9 Type VI and 174 MOSAIK®s.
C&M	Planned C&M entry is 2015.	Some ILW packages would be delivered after the Bradwell site has entered C&M.
Opportunity for co-storage with B site	N/A	N/A

Dungeness A: ILW Storage

Issue	In the baseline: Impacts of interim storage of Dungeness A ILW packages in a Dungeness A ILW store.	In the preferred alternative: Impacts of transporting Dungeness A ILW packages for interim storage at Bradwell and Sizewell A.
Construction	New ILW storage facility required on / near on-site ecologically sensitive land.	No ILW storage facility required.
Waste transport route	N/A	Rail from Dungeness to Southminster (Bradwell) & Leiston (Sizewell), and then by road to sites.
HGVs	~300 lorries delivering / collecting construction and demolition materials.	~120 lorries collecting Dungeness A ILW packages for transport to the railhead (at the end of the approach road).
Package numbers	Interim storage of 18 Type VI and 201 MOSAIK®s.	No interim storage at Dungeness A.
C&M	Planned C&M is 2027.	As baseline.
Opportunity for co-storage with B site	Opportunity for shared storage (if EDF Energy change packaging strategy for Dungeness B).	Forecloses opportunity for shared storage at Dungeness.

Dungeness A: FED Treatment

Issue	In the baseline: The current FED treatment plant at Dungeness A would cease operation.	In the preferred alternative: Impacts of processing Sizewell A FED using the Dungeness A dissolution plant.
Construction	N/A	Minimal: existing FED treatment plant used.
Waste transport route	N/A	By train from Leiston (Sizewell) to Dungeness, and then by road to site.
HGVs	N/A	~60 lorries delivering Sizewell FED from the railhead (at the end of the approach road). In addition, there would be a few lorries per month delivering consumables.
Operations	N/A	Continued operation of Dungeness A plant to process 84 tonnes of FED.
Chemical emissions (NO_x)	N/A	No NO_x emissions.
Chemical discharges (nitrates)	N/A	No nitrates discharges.
Radioactive discharges	N/A	Dose rate of 0.09 micro-Sv per year (for about 8 years).

Hinkley Point A: ILW Storage

Issue	In the baseline: Impacts of interim storage of Hinkley Point A ILW packages in the Hinkley Point A ILW store.	In the preferred alternative: As the baseline.
Construction	New ILW storage facility required.	As the baseline.
Waste transport route	N/A	As the baseline.
HGVs	~300 lorries delivering / collecting construction and demolition materials.	As the baseline.
Package numbers	Interim storage of 81 Type VI and 503 MOSAIK®s.	As the baseline.
C&M	Planned C&M entry is 2025.	As the baseline.
Opportunity for co-storage with B site	Opportunity for shared storage (if EDF Energy change packaging strategy at Hinkley Point B).	As the baseline.

Hinkley Point A: FED Treatment

Issue	In the baseline: Impacts of processing Hinkley Point A FED using the Hinkley Point A dissolution plant.	In the preferred alternative: Impacts of processing Hinkley Point A and Oldbury FED using the Hinkley Point A dissolution plant.
Construction	New FED treatment plant required.	Same plant as in the baseline.
Waste transport route	N/A	Lorries by road (along A38, M5 to C182) from Oldbury to Hinkley Point A.
HGVs	~150 lorries delivering / collecting construction and demolition materials. In addition, there would be a few lorries per week delivering consumables for the dissolution process during the operations period (5 years).	Same as the baseline for construction and demolition, plus ~70 lorries delivering Oldbury FED. The delivery of consumables for the dissolution process would continue during the extra additional operations period (2.5 years).
Operations	Processing 297 tonnes of FED over about 5 years.	As in the baseline, then processing an extra 144 tonnes of FED over about 2.5 years.
Chemical emissions (NO_x)	NO_x emissions for about 5 years, but no NO_x sensitive plant species in proximity.	As in the baseline, then NO_x emissions for a further ~2.5 years, but no NO_x sensitive plant species in proximity.
Chemical discharges (nitrates)	0.04% change in background nitrates levels for about 5 years. No threat to "good" water quality status.	As in the baseline, then 0.04% change in background nitrates levels for a further 2.5 years. No threat to "good" water quality status.
Radioactive discharges	1.3 micro-Sv per year for about 5 years.	As in the baseline, then 0.1 micro-Sv per year for a further 2.5 years.

Oldbury: ILW Storage

Issue	In the baseline: Impacts of interim storage of Oldbury ILW packages in an Oldbury ILW store.	In the preferred alternative: Impacts of transporting Oldbury ILW packages for interim storage at Berkeley.
Construction	New ILW storage facility required.	No ILW storage facility required.
Waste transport route	N/A	Lorries by road (along A38) from Oldbury to Berkeley.
HGVs	~270 lorries delivering / collecting construction and demolition material.	~100 lorries collecting Oldbury ILW packages for transport to Berkeley.
Package numbers	Interim storage of 63 Type VI and 79 MOSAIK®s.	No interim storage at Oldbury.
C&M	Planned C&M entry is 2027.	As in the baseline.
Opportunity for co-storage with B site	N/A	N/A

Oldbury: FED Treatment

Issue	In the baseline: Impact of processing Oldbury FED using an Oldbury dissolution plant.	In the preferred alternative: Impact of transport Oldbury FED for processing at Hinkley Point A.
Construction	New FED treatment plant required.	No plant required.
Waste transport route	N/A	Lorries by road (A38 and M5) from Oldbury to Hinkley Point A.
HGVs	~150 lorries delivering / collecting construction and demolition material. In addition, there would be a few lorries per week delivering consumables for the dissolution process during the operations period (2.5 years).	~70 lorries collecting Oldbury FED for transport to Hinkley Point A.
Operations	Processing 144 tonnes of FED over about 2.5 years.	No FED processing.
Chemical emissions (NO_x)	NO_x emissions, but no NO_x sensitive plant species in proximity.	No chemical emissions.
Chemical discharges (nitrates)	0.65% change in background nitrates levels for about 2.5 years. No threat to “good” water quality status.	No chemical discharges.
Radioactive discharges	2.9 micro-Sv per year for about 2.5 years.	No radioactive discharges.

Sizewell A: ILW Storage

Issue	In the baseline: Impacts of interim storage of Sizewell A ILW packages only in the Sizewell A ILW store.	In the preferred alternative: Impacts of interim storage of Sizewell A and some Dungeness A ILW packages in the Sizewell A ILW store.
Construction	New ILW storage facility required.	New larger ILW storage facility required.
Waste transport route	N/A	Rail from Dungeness to the railhead nr Leiston (Sizewell) and then by road to site.
HGVs	~190 lorries delivering / collecting construction and demolition materials.	As in the baseline, plus an extra ~30 lorries delivering / collecting extra construction & demolition materials. ~20 lorries delivering Dungeness A ILW packages from the railhead (nr Leiston).
Package numbers	Interim storage of 16 Type VI and 12 MOSAIK®s.	As in the baseline, plus the interim storage of an extra 9 Type VI and 27 MOSAIK®s.
C&M	Planned C&M entry is 2027.	As in the baseline.
Opportunity for co-storage with B site	Opportunity for shared storage (Sizewell B has some resins packaged in MOSAIKs®).	Opportunity for shared storage (Sizewell B has some resins packaged in MOSAIKs®).

Sizewell A: FED Treatment

Issue	In the baseline: Impacts of processing Sizewell A FED using a Sizewell A dissolution plant.	In the preferred alternative: Impacts of transporting Sizewell A FED for processing using the Dungeness A dissolution plant.
Construction	New FED treatment plant required.	No FED treatment plant required.
Waste transport route	N/A	Road to railhead, and then by train from Leiston (Sizewell) to Dungeness.
HGVs	~150 lorries delivering / collecting construction and demolition materials. In addition, there would be a few lorries per week delivering consumables during the operations period (1.5 years).	~60 lorries collecting Sizewell A FED for transport to the railhead (on the edge of Leiston).
Operations	Processing of 84 tonnes of FED over about 1.5 years.	No FED processing.
Chemical emissions (NO_x)	Presence of NO_x sensitive plant species, additional mitigation / abatement / argument may be required.	No chemical emissions.
Chemical discharges (nitrates)	1.7% change in background nitrates levels for about 1.5 years. No threat to “good” water quality status.	No chemical discharges.
Radioactive discharges	0.07 micro-Sv per year for about 1.5 years.	No radioactive discharges.

Appendix G – Schedule of Stakeholder Engagements

The following schedule records all of the significant engagements which have been made with external stakeholders prior to publication of this paper[31].

Date	Stakeholders
24th October 2012	NuLeAF - Local Authorities
29th & 30th October 2012	SSG/LCLC representatives
5th December 2012	SSG/LCLC Chairs
9th January 2013	SSG/LCLC Chairs and Vice-Chairs; NuLeAF - Local Authorities; Office for Nuclear Regulation; Environment Agency
17th January 2013	Environment Agency
6th February 2013	SSG/LCLC Chairs and Vice-Chairs; NuLeAF - Local Authorities; Office for Nuclear Regulation; Environment Agency
12th February 2013	1st Stakeholder Workshop (Day 1) ▪ SSG/LCLC Chairs and Vice-Chairs from: Berkeley, Bradwell, Dungeness A, Hinkley Point A, Oldbury, Sizewell A, Trawsfynydd, Wylfa. ▪ Local Authority representatives from: South Gloucestershire CC, Essex CC, Kent CC, Somerset CC, Suffolk CC, Isle of Anglesey CC. ▪ Environment Agency.
13th February 2013	1st Stakeholder Workshop (Day 2) ▪ SSG/LCLC Chairs and Vice-Chairs from: Bradwell, Dungeness A, Hinkley Point A, Oldbury, Sizewell A. ▪ Local Authority representatives from: South Gloucestershire CC, Essex CC, Kent CC, Somerset CC, Suffolk CC. ▪ Environment Agency.
28th February 2013	SSG/LCLC Chairs and Vice-Chairs NuLeAF - Local Authorities Office for Nuclear Regulation Environment Agency
7th March 2013	Sizewell SSG
12th March 2013	NuLeAF - Radioactive Waste Management and Spatial Planning Meeting
18th March 2013	Hinkley Point SSG Sub-group
24th April 2013	Oldbury SSG

[31] NDA and EDF Energy are not considered to be external stakeholders for the purposes of this project.

Date	Stakeholders
30th April 2013	Berkeley SSG
9th May 2013	Sizewell Public Meeting
15th May 2013	Bradwell LCLC Meeting
16th May 2013	Dungeness SSG Meeting
17th May 2013	Hinkley Point SSG Meeting
28th May 2013	Bradwell Village Public Meeting
29th May 2013	Mersea Island Public Meeting
4th June 2013	Special Dungeness SSG Meeting
7th June 2013	Environment Agency Meeting
28th June 2013	Hinkley Point SSG Meeting
17th July 2013	Office for Nuclear Regulation (Radioactive Materials Transport Team (RMTT))
18th & 19th July 2013	2nd Stakeholder Workshop ▪ SSG/LCLC Chairs and Vice-Chairs from: Berkeley, Bradwell, Dungeness A, Hinkley Point A, Oldbury, Sizewell A. ▪ Local Authority representatives from: South Gloucestershire CC, Essex CC, Kent CC, Somerset CC, Suffolk CC. ▪ Environment Agency. ▪ Office for Nuclear Regulation (both Strategy & RMTT).
15th August 2013	Environment Agency Meeting
3rd September 2013	SSG/LCLC Chairs
17th September 2013	Somerset County Council and West Somerset & Sedgemoor District Council Officers
19th September 2013	Gloucester County Council, Stroud District Council and Berkeley SSG Chair
24th September 2013	Somerset Nuclear Energy Group Meeting
25th September 2013	Dungeness, Bradwell and Sizewell SSG/LCLC Chairs. Kent, Essex and Suffolk Coastal County Council Officers.
30th September 2013	Environment Agency Meeting
4th October 2013	Environment Agency Meeting
16th October 2013	South Gloucestershire Council Meeting
21st-22nd October	NDA National Stakeholder Event
29th October	Office Nuclear Regulation meeting
25th November	Hinkley Point A SSG meeting
16th October	Meeting with South Gloucestershire Council

Date	Stakeholders
31st October	Stroud District Council (Environment Committee)
1st November	Hinkley Point Drop-in Centre (Cannington)
4th November	Sedgemoor District Council Meeting
5th November	Bradwell Drop-In Centre (Bradwell village)
6th November	Bradwell Drop-In Centre (Mersea Island)

Glossary

BAT	Best Available Techniques
C&D	Construction and Demolition
C&M	Care and Maintenance
CO_2	Carbon Dioxide
DCICs	Ductile Cast Iron Containers
EA	Environment Agency
EPR2010	Environmental Permitting (England and Wales) (as amended) Regulations 2010
FED	Fuel Element Debris
FSC	Final Site Clearance
GDF	Geological Disposal Facility
HGV	Heavy Goods Vehicle
IAEA	International Atomic Energy Agency
ILW	Intermediate Level Waste
LCLC	Local Community Liaison Council
NDA	Nuclear Decommissioning Authority
NICoP	Nuclear Industry Code of Practice
NO_x	NO_x is a generic term for mono-nitrogen oxides
OAP	Options Assessment Panel
ONR	Office for Nuclear Regulation
RMTT	Radioactive Materials Transport Team (within ONR)
SSG	Site Stakeholder Group