DEPARTMENT OF ENERGY & CLIMATE CHANGE

Waste Transfer Pricing Methodology for the disposal of higher activity waste from new nuclear power stations

December 2011

Contents

Introduction

Executive Summary

1. This document follows the publication of the "Consultation on an updated Waste Transfer Pricing Methodology for the disposal of higher activity wastes from new nuclear power stations" which was published in December 2010.

2. This document sets out:
   - the final Waste Transfer Pricing Methodology (Section 1);
   - two worked examples to illustrate how the Waste Transfer Pricing Methodology will work in practice (Section 2); and
   - the Government Response to the Consultation (Section 3).

The Waste Transfer Pricing Methodology

3. Section 1 sets out the Waste Transfer Pricing Methodology. The purpose of the Methodology is to set out how the Waste Transfer Price will be determined. This Methodology will form the basis of more detailed provisions to be set out in the Waste Contract that will be agreed between the Government and the Operator.

4. The key principles underpinning this framework are that:
   - The Government's objective is to ensure the safe disposal of intermediate level waste ("**ILW**") and spent fuel from new nuclear power stations without cost to the taxpayer and to facilitate investment through providing cost certainty. The Government is not seeking to make profits over and above a level consistent with being compensated for the level of risk assumed, but does expect Operators to meet their full share of waste disposal costs.
   - Prospective new nuclear Operators should be provided with certainty over the maximum Waste Transfer Price they will be expected to pay the Government for the provision of a waste disposal service.
   - The Waste Transfer Price should be set at a level over and above expected costs and include a Risk Premium to compensate the taxpayer for taking on the risk of subsequent cost escalation.
   - Where possible the Waste Transfer Price should be set in relation to actual cost data, to ensure that any Risk Premium is proportionate and properly reflects the financial risks being assumed by the Government. Therefore, in order to enable greater certainty over expected costs, the setting of the Waste Transfer Price should be deferred for a specified Deferral Period, provided that in certain circumstances it will be possible for the Waste Transfer Price to be set before the end of the Deferral Period.
   - During the Deferral Period the Operator must make prudent provision for their waste disposal liabilities, based on an Expected Price provided by the Government.

5. The Government's view is that the setting of the Waste Transfer Price should be deferred for a 30 year Deferral Period to enable uncertainty over costs to be reduced. During the Deferral Period the Operator will be required to make prudent

provision for their estimated waste disposal liability. To enable them to do this, the Government will provide the Operator with an Expected Price, which will be the Government's projection of the expected level of the Waste Transfer Price when it is set at the end of the Deferral Period. The Expected Price will be reviewed at five-year intervals during the Deferral Period.

6. In order to provide Operators with certainty over the maximum amount they will be expected to pay for waste disposal the Government will, at the outset, set a Cap on the level of the Waste Transfer Price. The Cap will be set at a level where the Government has a very high level of confidence that the actual cost will not exceed the Cap. However the Government accepts that, in setting a Cap, the residual risk that the actual cost might exceed the Cap is being borne by the Government. Therefore the Government will charge an appropriate Risk Fee for this risk transfer.

7. Hence for clarity, the Waste Transfer Price will include two separate risk allowances:

- The Risk Premium is the premium over and above expected costs that will be included in the Waste Transfer Price to reflect the risk being assumed by the Government, when the Waste Transfer Price is set at the end of the Deferral Period, that actual costs might be higher than the Waste Transfer Price.
- The Risk Fee is an additional element included in the Waste Transfer Price to reflect the small residual risk being assumed by the Government, when the Cap is set at the outset, that actual costs might be higher than the Cap.

8. The Waste Transfer Pricing Methodology will use estimated cost data produced by the body responsible for building and operating a Geological Disposal Facility ("**GDF**"), which is the Nuclear Decommissioning Authority ("**NDA**"). The current level of uncertainty over GDF costs is high, in the absence of a confirmed site or design for a GDF. However this uncertainty is expected to reduce as progress is made in the implementation of geological disposal.

9. The Government's view is that a 30 year Deferral Period should enable the Waste Transfer Price to be set after the GDF is operational, at which point there should be a great deal of actual cost data available and only a small amount of residual uncertainty. The Site Specific Cost Estimate that will be produced following GDF Site Selection will incorporate an assessment of risk and uncertainty. This assessment will be transparent and will be made in line with good industry practice. This will enable the production of a Risk Adjusted Cost Distribution. For the purposes of setting a Waste Transfer Price and an Expected Price after GDF Site Selection, a "**Pricing Cost Estimate**" will be drawn from this distribution and this will determine the level of the Price.

10. The Government's view is that it is not possible to produce a robust line-by-line assessment of risk and uncertainty in relation to GDF costs prior to GDF Site Selection, as some of the biggest risks relate to the programme as a whole, such as uncertainty over site and design. Therefore, prior to GDF Site Selection an Interim Approach will be used to derive a projected Pricing Cost Estimate for the purposes of setting an Expected Price.

11. The Waste Transfer Price set at the end of the Deferral Period will be set according to the formula:

Waste Transfer Price = Pricing Cost Estimate + Risk Fee

12. This is subject to two exceptions:

- The Waste Transfer Price cannot be higher than the Cap;
- In the event that the end of the Deferral Period falls before GDF Site Selection, the Waste Transfer Price will be determined through the Default Pricing Mechanism.

Updated Worked Examples

13. Section 2 contains two worked examples. These two worked examples relate to the two scenarios that are applicable at the time when the Waste Contract is first agreed between the Operator and the Secretary of State:

- Worked Example 1: setting an Expected Price prior to GDF Site Selection;
- Worked Example 2: setting a Cap and a Risk Fee.

14. In addition Section 2 compares the illustrative figures derived in the worked examples with current estimated costs and translates the illustrative figures into indicative waste disposal liabilities for a new nuclear power station. As with the figures in the consultation, the figures given here are for the purposes of illustration and should not be taken as representing the level of the Cap, Risk Fee or Expected Price that will actually be set for an Operator of a new nuclear power station.

15. The worked examples show that the proposed approach to setting a Cap, which takes a conservative approach to risk and uncertainty and applies probabilistic cost modelling, results in a Cap that is three times the current best estimate of waste disposal costs. Moreover, it is proposed that the Waste Transfer Price paid by new nuclear Operators includes a contribution to the Fixed Costs of the GDF. This represents a benefit to the taxpayer, as these are costs that will need to be incurred anyway in order to dispose of legacy wastes. Hence there is only a risk to the taxpayer if costs escalate to the extent that the Cap is insufficient to pay the additional disposal costs for new build waste (i.e. the Variable Costs). The Cap derived here represents five times the current Variable Costs estimate. In other words, the taxpayer would not be out of pocket (compared with no new build at all) even if waste disposal costs were five times greater than that currently expected. Table 1 summarises these figures.

	Variable Cost Estimate	Total Cost Estimate	Cap
Spent fuel (£/tU)	193k	312k	978k
ILW (£/m^3)	9.0k	14.5k	48.4k

Table 1: comparing the illustrative values derived for the Cap with current best estimates of waste disposal costs (constant September 2008 money values).

16. Section 2 sets out how the illustrative figures derived here might translate into a waste disposal liability for a new nuclear Operator[1]. It also provides an illustration of how these figures might be expressed as a cost per unit of electricity generated (£/MWh). This calculation depends on the assumptions made around the investment performance of the Operator's independent Fund. Given the long timescales involved, even small variations in assumed Fund performance can have a large impact on the estimated level of payment into the Fund. Therefore the figures given here are for illustrative purposes only. Table 2 summarises theses illustrative figures.

	Waste Transfer Price = Expected Price	Waste Transfer Price = Cap
Indicative waste disposal liability for a new nuclear power station expressed in £/MWh	0.20 – 0.43	0.33 – 0.71

Table 2: indicative waste disposal liability for a new nuclear power station expressed as a cost per unit of electricity generated (constant September 2008 money values).

[1] The figures in the worked examples assume a generic 1.35GW PWR operating for 40 years.

The Government's response to the Consultation

17. The consultation sought responses to three questions. Section 3 summarises the views expressed and the Government's response.

18. Question 1 concerned the proposal that the level of the Waste Transfer Price should be subject to a Cap and that in return for setting a Cap the Government should charge a Risk Fee. Having considered the views set out in the consultation, the Government remains satisfied that setting a Cap on the Waste Transfer Price is appropriate and that in return for setting a Cap a Risk Fee should be charged. The Government does not agree that taking title to radioactive waste, including spent fuel, for a fixed price is a subsidy to new nuclear power, provided that the price properly reflects any financial risks or liabilities assumed by the state.

19. The Government's view is that it is necessary to take a highly conservative view of risk and uncertainty when setting the Cap. Therefore the Government does not agree that the approach set out in the consultation will result in a Cap being set at an unreasonably high level.

20. Question 2 concerned the proposal that the Deferral Period should be 30 years after the start of electricity production, in order to enable uncertainty over waste disposal costs to be reduced. The Government is pleased to note the level of support for a 30 year Deferral Period, and agrees that the 30 year Deferral Period should not give rise to the risk that an Operator does not have the monies available to meet their liabilities. The Government will expect the Operator, through their Funded Decommissioning Programme ("**FDP**"), to demonstrate that monies will be available to meet their liabilities as and when they fall due.

21. The Government is persuaded that a modest degree of flexibility in the operation of the proposed 30 year Deferral Period could be necessary to ensure fair outcomes for Operators, particularly as new nuclear power stations are likely to begin operating at different times and hence would reach the 30 year cut-off point at different times.

22. Question 3 sought comments on the updated Waste Transfer Pricing Methodology and in particular on the proposed approach to setting an Expected Price and a Risk Fee. The Government acknowledges that the cost modelling set out in the consultation was complex and has considered how it can be set out more clearly. The final Methodology in Section 1 and the worked examples in Section 2 follow the same overall approach as the corresponding sections of the consultation, but they have been reworked to improve clarity.

23. A number of broader risks and uncertainties were identified that respondents argued had not been sufficiently taken into account in the proposed Methodology. The Government recognises that there is substantial uncertainty over waste disposal costs but does not agree that the Methodology takes insufficient account of risk and uncertainty. The Methodology identifies a range of risks and uncertainties and describes how they are taken into consideration.

24. With regard to the calculation of the Risk Fee, the Government is satisfied that the approach set out in the consultation is appropriate. With regard to the setting of the Cap, the Government believes it is appropriate for the Secretary of State to have discretion over the level of the Cap. The Cap will be set at the outset and included in the Waste Contract. The Operator will be able to decide whether it wishes to enter into a Waste Contract with a Cap at the level offered.

Background

Previous consultations

25. The "Consultation on an updated Waste Transfer Pricing Methodology for the disposal of higher activity waste from new nuclear power stations" was published on 8 December 2010. It followed the earlier, related consultation on "a Methodology to Determine a Fixed Unit Price for Waste Disposal and Updated Cost Estimates for Nuclear Decommissioning, Waste Management and Waste Disposal", which was published on 25 March 2010[2].

26. Having considered the responses to the March 2010 consultation the Government has concluded that a number of changes need to be made to the proposed Waste Transfer Pricing Methodology and the Government sought views on these changes through the December 2010 consultation.

The Energy Act 2008

27. The Government's policy is that Operators of new nuclear power stations must have arrangements in place to meet the full costs of decommissioning and their full share of waste management and disposal costs. This policy is being implemented through a framework created by the Energy Act 2008[3] (Energy Act). The Energy Act requires Operators of new nuclear power stations to have an FDP approved by the Secretary of State in place before construction of a new nuclear power station begins and to comply with this programme thereafter.

Funded Decommissioning Programme Guidance

28. Alongside the December 2010 consultation the Government also published a Consultation on Revised FDP Guidance[4]. This Guidance will assist Operators in understanding their obligations under the Energy Act 2008, and what is required for an approvable FDP. This follows an earlier consultation in 2008 on draft FDP Guidance[5]. The Government Response to the FDP Guidance consultation is being published alongside this consultation response[6].

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[2] http://www.decc.gov.uk/en/content/cms/consultations/nuc_waste_cost/nuc_waste_cost.aspx
[3] Energy Act 2008 http://www.legislation.gov.uk/ukpga/2008/32/pdfs/ukpga_20080032_en.pdf
[4] http://www.decc.gov.uk/en/content/cms/consultations/rev_fdp_guide/rev_fdp_guide.aspx
[5] The 2008 Consultation, and the Government Response, can be found at http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/consultations/page44784.html
[6] http://www.decc.gov.uk/en/content/cms/meeting_energy/nuclear/new/waste_costs/waste_costs.aspx

Geological disposal

29. Geological disposal is the way higher activity waste will be managed in the long term. This will be preceded by safe and secure interim storage until a GDF can receive waste. A framework to implement this policy was set out in the Managing Radioactive Waste Safely ("**MRWS**") White Paper published in June 2008[7]. This gave the following explanation of what is meant by "geological disposal":

> *"Geological disposal involves isolating radioactive waste deep inside a suitable rock formation to ensure that no harmful quantities of radioactivity ever reach the surface environment. It is a multi-barrier approach, based on placing wastes deep underground, protected from disruption by man-made or natural events. Geological disposal is internationally recognised as the preferred approach for the long-term management of higher activity radioactive waste."*

30. The Government has given responsibility for planning and implementing geological disposal to the NDA, so as to enable the NDA to take an integrated view across the waste management chain, with both long and short-term issues addressed in planning and strategy development. Since then the NDA's Radioactive Waste Management Directorate ("**RWMD**") has been established, incorporating resources from the former United Kingdom Nirex Ltd, which will develop into an effective delivery organisation to implement geological disposal. It is envisaged that RWMD will evolve under the NDA into the 'NDA's delivery organisation' for the GDF.

31. In July 2010 the NDA published "Geological Disposal: steps towards Implementation"[8], a report which describes the preparatory work that the NDA has undertaken so far, including the planning of its future work programme and the management arrangements to deliver it. This report provides information, for a wide range of interested parties, on the steps the NDA believe will be required for successful implementation of geological disposal. It also explains how the various activities and outputs of the NDA's work programme are designed to achieve a safe, secure, sustainable and publicly acceptable outcome.

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[7] The MRWS White Paper is available at http://mrws.decc.gov.uk/.

[8] http://www.nda.gov.uk/documents/upload/Geological-Disposal-Steps-Towards-Implementation-March-2010.pdf

Section 1: The Waste Transfer Pricing Methodology

Introduction

1.1 Geological disposal is the way in which higher activity waste will be managed in the long term. The Government expects to dispose of spent fuel and ILW from new nuclear power stations in the same GDF that will be constructed for the disposal of legacy waste.

1.2 Operators of new nuclear power stations are required to have an FDP approved by the Secretary of State before nuclear-related construction can begin. Alongside the approval of an Operator's FDP, the Government will expect to enter into a contract with the Operator regarding the terms on which the Government will take title to and liability for the Operator's spent fuel and ILW (the "**Waste Contract**"). In particular, this agreement will need to set out how the price that will be charged for this waste transfer will be determined (the "**Waste Transfer Price**"). The Waste Transfer Price will be set at a level consistent with the Government's policy that Operators of new nuclear power stations should meet their full share of waste management costs.

1.3 Alongside the Waste Transfer Price the Government will also provide the Operator with the Government's best estimate of the date on which disposal of the Operator's waste will begin (the "**Assumed Disposal Date**").

1.4 The purpose of the Waste Transfer Pricing Methodology is to explain how the Waste Transfer Price and the Assumed Disposal Date will be determined. This Methodology will form the basis of more detailed provisions to be set out in the Waste Contract that will be agreed between the Government and the Operator.

1.5 The Government's policy is that there should be no subsidy for new nuclear power. The Government does not consider that taking title to radioactive waste, including spent fuel, for a fixed price is a subsidy to new nuclear power, provided that the price properly reflects any financial risks or liabilities assumed by the state. The Government's approach to taking title to and liability for ILW and spent fuel will be subject to ensuring compliance with EU State Aid law.

Key elements of the Methodology

1.6 The key principles underpinning this framework are that:

- The Government's objective is to ensure the safe disposal of ILW and spent fuel from new nuclear power stations without cost to the taxpayer and to facilitate investment through providing cost certainty. The Government is not seeking to make profits over and above a level consistent with being compensated for the level of risk assumed, but does expect Operators to meet their full share of waste disposal costs.
- Prospective new nuclear Operators should be provided with certainty over the maximum Waste Transfer Price they will be expected to pay the Government for the provision of a waste disposal service.
- The Waste Transfer Price charged by Government should be set at a level over and above expected costs and include a Risk Premium to compensate the taxpayer for taking on the risk of subsequent cost escalation.
- Where possible the Waste Transfer Price should be set in relation to actual cost data, to ensure that any Risk Premium is proportionate and properly reflects the financial risks being assumed by the Government. Therefore in order to enable greater certainty over expected costs, the setting of the Waste Transfer Price should be deferred for a specified Deferral Period, provided that in certain circumstances it will be possible for the Waste Transfer Price to be set before the end of the Deferral Period.
- During the Deferral Period the Operator must make prudent provision for their waste disposal liabilities, based on an Expected Price provided by the Government.

1.7 It is expected that the disposal of spent fuel and ILW from a new nuclear power station will take place many years after the end of electricity generation at that station. The Energy Act requires Operators to make prudent provision for their waste and decommissioning liabilities in their FDP. The Government's view is that in order for an Operator to be able to make prudent provision they need certainty over their waste disposal liabilities during the operational life of their power station, as it is during this period that they will be able to set aside funds from operating revenue. Therefore the Government does not think it practical for the Waste Transfer Price to remain uncertain until the point of disposal.

1.8 Equally, the Government intends that setting the Waste Transfer Price many years before the expected date of waste disposal should not mean that the taxpayer takes on a financial risk without being appropriately compensated. Therefore the Waste Transfer Price will be set at a level over and above estimated costs and include a **Risk Premium** to compensate the taxpayer for taking on the risk of subsequent cost escalation. This Methodology sets out how the Waste Transfer Price will be determined

1.9 A Waste Transfer Price set now would be very much higher than the current best estimate of disposal costs, i.e. there would be a very large Risk Premium. This would be necessary in order to protect the taxpayer, given the current high level of uncertainty.

1.10 Therefore the Government's view is that the setting of the Waste Transfer Price should be deferred until uncertainty over costs can be reduced. The length of the **Deferral Period** needs to balance two competing considerations. Firstly, that the longer the Deferral Period, the less uncertainty there should be over costs. Secondly, that the later the Price is set, the greater the risk that there is insufficient time for an Operator to make up any shortfall in their Fund to ensure prudent provision for their waste disposal liability. The Government's view is that the right balance is for there to be a Deferral Period of 30 years after the start of generation. However the Government considers that there should be a degree of flexibility in the operation of the Deferral Period and more detail on this is set out in the section below on the Deferral Period.

1.11 During the Deferral Period the Operator will be required to make prudent provision for their estimated waste disposal liability. To enable an Operator to do this, the Government will provide the Operator with an **Expected Price**, which will be the Government's projection of the expected level of the Waste Transfer Price when it comes to be set at the end of the Deferral Period. The Expected Price will be reviewed at five-year intervals (the "**Quinquennial Review**") during the Deferral Period. This Methodology also sets out how the Expected Price will be determined.

1.12 The Government recognises that it is likely to be the monopoly supplier of a GDF service and that new nuclear Operators will have very little ability to influence waste disposal costs. Hence proceeding to invest in a new nuclear power station in the face of uncertainty over waste disposal costs represents a significant cost risk to a prospective nuclear Operator that they can do little to manage or mitigate. The Government's view is that this uncertainty will present difficulties for prospective Operators in seeking financing for investment, and that potential investors in new nuclear power stations need clarity over the maximum amount they will be expected to pay for waste disposal in order to be able to take investment decisions and seek financing.

1.13 In order to provide Operators with certainty over the maximum amount they will be expected to pay for waste disposal the Government will, at the outset, set a **Cap** on the level of the Waste Transfer Price. The Cap will be set at a level where the Government has a very high level of confidence that actual cost will not exceed the Cap. However the Government accepts that, in setting a Cap, the residual risk that actual cost might exceed the Cap is being borne by the Government. Therefore the Government will charge an appropriate **Risk Fee** for this risk transfer.

1.14 The Risk Fee will be set at a level that properly reflects the risk being assumed by the Government in setting a Cap. The Risk Fee will be included in the Waste Transfer Price and is in addition to the Risk Premium. This Methodology also sets out how the Cap and Risk Fee will be determined.

1.15 Hence, for clarity, the Waste Transfer Price will include two separate risk allowances:

- The Risk Premium is the premium over and above expected costs that will be included in the Waste Transfer Price to reflect the risk being assumed by the Government, when the Waste Transfer Price is set at the end of the Deferral Period, that actual costs might be higher than the Waste Transfer Price.
- The Risk Fee is an additional element included in the Waste Transfer Price to reflect the small residual risk being assumed by the Government when the Cap is set at the outset, that actual costs might be higher than the Cap.

1.16 An Operator can request that their Waste Transfer Price be fixed during the Deferral Period. In this case, following a cost modelling process that derives estimates of the costs of waste disposal and takes into account the level of uncertainty around the estimation of those costs, the Secretary of State will offer the Operator a Waste Transfer Price; the level of this offer will be at the discretion of the Secretary of State. In the event that the Operator decides not to accept this offer, the Waste Contract will proceed as before with the Waste Transfer Price being set at the end of the Deferral Period. However this would be subject to the proviso that the Waste Transfer Price cannot be higher than the Cap, and an Operator can opt at any time to fix their Waste Transfer Price at the level of the Cap.

1.17 It is also necessary to consider the scenario, albeit unlikely in the Government's view, in which progress in the implementation of geological disposal is very much slower than currently anticipated and hence the end of the Deferral Period falls before a site has been identified for a GDF ("**GDF Site Selection**"). In these circumstances the **Default Pricing Mechanism** will apply, in which the level of the Waste Transfer Price will be set by the Secretary of State, having regard to such cost modelling as would be available at the time. The Default Price would still be subject to the Cap. Given that in these circumstances the level of uncertainty over costs is likely to be high, it is considered likely that the Waste Transfer Price would be at or near the level of the Cap. More information on the Default Pricing Mechanism is set out below.

1.18 Once an Operator has been provided with an Assumed Disposal Date, they will be able to make financial provision in their FDP on the basis that their waste will be disposed of on that date, i.e. the Assumed Disposal Date determines the duration of interim storage of waste pending disposal for which the Operator will be required to make financial provision. The Assumed Disposal Date will be determined alongside the Waste Transfer Price and an **Expected Assumed Disposal Date** will be provided to the Operator alongside an Expected Price. In the event that the Waste Transfer Price is set before GDF Site Selection, the **Default Pricing Mechanism** will also determine the Assumed Disposal Date.

1.19 The Waste Contract will also provide for the setting of the date on which title to and liability for an Operator's ILW and spent fuel will transfer from the Operator to Government (the "**Transfer Date**"). The Transfer Date will be aligned with the Operator's decommissioning timetable. In the event that the Transfer Date is earlier than the Assumed Disposal Date ("**Early Transfer**") then the Government would need to be compensated for the additional waste management costs it would incur.

1.20 The Waste Contract for a new nuclear power station will be based on the clear presumption that the ILW and spent fuel from that station will be disposed of in the GDF to be built by the Government. However it is acknowledged that over the long period covered by a Waste Contract it is possible that acceptable alternative approaches to the long term management of the power station's higher activity waste might become available. The Waste Contract will not prevent the Operator from making use of an alternative route, as long as all necessary regulatory and other permissions (including approval for any necessary Modification to the Operator's FDP) have been obtained.

1.21 It is envisaged that a more detailed Methodology, based on the framework set out here, will form part of the Waste Contract agreed between the Operator and the Secretary of State. In the Waste Contract the Government would expect to commit to a transparent application of the Methodology throughout the process: from the setting of the Expected Price, through each Quinquennial Review until the end of the Deferral Period, at which point the Waste Transfer Price would be set. This is expected to include provisions for transparency and external scrutiny of the Government's cost estimates, and a Dispute Resolution procedure involving independent experts to resolve disagreements arising from the application of the Methodology, except in cases where the Default Pricing Mechanism applies.

The Waste Transfer Pricing Methodology

1.22 There are three stages to the Waste Transfer Pricing Methodology framework:

- estimate GDF costs and derive Base Unit Cost Estimates;
- adjust these cost estimates for risk and uncertainty;
- set the Price.

1.23 This section sets out how GDF costs will be estimated and how those cost estimates will be used to derive a Unit Cost Estimate for the disposal of new build ILW and spent fuel. This section then sets out how uncertainty around those cost estimates will be handled, in order to set a Waste Transfer Price.

1.24 There are four scenarios in which this framework can be applied. In each scenario the same three stage process will be followed, though with some differences in the application of the framework under each scenario. These four scenarios are:

(1) To set the **Waste Transfer Price at the end of the Deferral Period** (as long as GDF site Selection has taken place);

(2) To set the **Expected Price after GDF Site Selection**;

(3) To set the **Expected Price prior to GDF Site Selection**; and

(4) To set the **Cap and Risk Fee** at the outset.

1.25 Section 2 contains two worked examples to illustrate the operation of this Methodology in the two scenarios that are applicable at the time that the Waste Contract is first agreed between the Government and an Operator:

- Worked Example 1 relates to Scenario (3), setting the Expected Price prior to GDF Site Selection; and
- Worked Example 2 relates to Scenario (4), setting the Cap and Risk Fee at the outset.

1.26 In order to set out clearly how the Methodology will operate, it has been broken down into a series of 16 steps. These steps are detailed in this section. The steps will apply in each of the four scenarios set out above and these 16 steps also form the basis of the worked examples in Section 2.

1.27 The Waste Transfer Pricing Methodology also envisages a fifth scenario, which is when a Waste Transfer Price has to be set at the end of the Deferral Period but when GDF Site Selection has not taken place. In this scenario the Default Pricing Mechanism applies. More information on the Default Pricing Mechanism is also set out in this section.

1.28 Figure 1 summarises how the Methodology operates in these five scenarios.

FRAMEWORK	(1) WASTE TRANSFER PRICE (set at end of Deferral Period)	(2) EXPECTED PRICE (after GDF site selection)	(3) EXPECTED PRICE (before GDF site selection)	(4) CAP & RISK FEE (set at the outset)	(5) DEFAULT PRICE (set at end of Deferral Period)
Estimate GDF costs and derive a Base Unit Cost Estimate	**Site Specific Base Cost Estimate**	**Site Specific Base Cost Estimate**	**Generic Base Cost Estimate** (reference scenario)	**Generic Base Cost Estimates** (range of scenarios)	Applies if there is no **Site Specific Cost Estimate** at the end of the **Deferral Period**
Adjust for risk and uncertainty	Produce **Risk Adjusted Cost Distribution**, based on a transparent assessment of risk and uncertainty in line with good industry practice **Pricing Cost Estimate** = P_{95} from distribution	Produce **Risk Adjusted Cost Distribution**, based on a transparent assessment of risk and uncertainty in line with good industry practice **Pricing Cost Estimate** = P_{95} from distribution	**Interim Approach** to adjusting for risk and uncertainty prior to GDF Site Selection to derive a **Projected Pricing Cost Estimate**	Produce **Risk Adjusted Cost Distribution**, derived by uplifting **Base Cost Estimates** for **Optimism Bias**, adding **Contingency Allowance** and combining by **Monte Carlo methods**	In this case the level of the **Waste Transfer Price** will be set by the Secretary of State (subject to the Cap) having regard to such cost modelling as would be available at the time
Set Price	**Waste Transfer Price** = **Pricing Cost Estimate** + **Risk Fee** **Dispute Resolution** applies	**Expected Price** = **Pricing Cost Estimate** + **Risk Fee** **Dispute Resolution** applies	**Expected Price** = **Projected Pricing Cost Estimate** + **Risk Fee** **Dispute Resolution** applies	Secretary of State sets **Cap & Risk Fee** Worked example has **Cap** at P_{99} from the distribution **Dispute Resolution** does not apply	It is considered likely that the **Waste Transfer Price** would be at or near the level of the **Cap** **Dispute Resolution** does not apply
			Worked Example 1	**Worked Example 2**	

Figure 1: application of the Waste Transfer Pricing Methodology in five scenarios

Estimate GDF costs and derive a Base Unit Cost Estimate

Estimate GDF Fixed and Variable Costs

1.29 The Methodology will use estimated cost data produced by the body responsible for building and operating a GDF. The MRWS White Paper confirmed that NDA is responsible for planning and implementing geological disposal in the UK. To implement geological disposal NDA has set up the RWMD.

1.30 NDA has defined a number of phases in its programme of work for successful implementation of a GDF that run from its initial planning through to its closure and beyond[9]:

a. Preparatory Studies;

b. Surface Based Investigations;

c. Construction and Underground Based Investigations;

d. Operation;

e. Closure.

1.31 As each phase progresses more information will become available and the level of confidence around waste disposal cost estimates will steadily increase. The current phase of work is Preparatory Studies, and the planning assumption is that this phase will be around five years in duration. The planning assumption is that the second phase, Surface Based Investigations, will be around ten years in duration.

1.32 The Construction and Underground Based Investigations phase will begin once the Government has decided on a preferred site for a GDF in accordance with the MRWS process. This point is termed here "GDF Site Selection". NDA's current planning assumption is that this will be in around 2025. At this time decisions can be made about the disposal concept and the engineering design will have been developed sufficiently to allow a robust cost estimate (the "**Site-Specific Cost Estimate**") to be produced. However at this point there will still be significant risk and uncertainty associated with implementing the programme. This uncertainty should steadily reduce over time as various intermediate milestones are reached, for example when regulators give permission for construction of the GDF to proceed and when the underground environment where disposal is planned has been reached.

[9] See Chapter 7 of NDA publication "Geological Disposal: Steps towards Implementation" at http://www.nda.gov.uk/documents/upload/Geological-Disposal-Steps-Towards-Implementation-March-2010.pdf

1.33 The next phase is GDF Operation and the current planning assumption is that this will begin in around 2040, when the GDF operator has obtained all the relevant permissions and authorisations to receive and emplace waste at the GDF. This point is termed here as "**First Waste Emplacement**". By this point the upfront costs of constructing the GDF will be known and actual data relating to the costs of emplacing waste in the GDF will start to become available.

1.34 At the current early stage in the implementation of geological disposal there is not yet a site or a confirmed design for a GDF. Therefore NDA's current cost estimate is based on a reference design and a series of underpinning assumptions. RWMD has developed the Disposal System Specification (DSS) to provide a clear definition of the requirements on the disposal system (i.e. what are the waste packages, transport system and GDF required to do). It forms an important input to the development of cost-effective engineering designs and assessment of their fitness for purpose. The DSS is currently generic but will be tailored to a specific site once a site has been identified.

1.35 In March 2011 NDA published a suite of documents providing detail on the DSS as part of the generic "Disposal System Safety Case" that shows how NDA can have confidence in the safety of a GDF, based on its knowledge of the scientific and engineering principles that underpin geological disposal and the existing experience of managing radioactive wastes both in the UK and abroad[10].

1.36 The DSS provides the basis of the estimate of the cost of a GDF produced by RWMD. This **Generic Base Cost Estimate** includes construction and operation of facilities both above and below ground, together with preparatory activities including R&D and site investigation.

1.37 However, the cost estimate does not include elements relating to the interim storage of waste pending disposal, the packaging of waste for disposal or the transport of the waste from the storage site to the GDF. For Operators of new nuclear power stations these costs must be provided for separately in their FDP and they do not fall within the scope of the Waste Transfer Price.

1.38 Under the Methodology, the cost estimates prepared by NDA will be reviewed and updated at each Quinquennial Review during the Deferral Period. Over time the level of detail and robustness of these cost estimates is expected to increase and the level of uncertainty over estimated costs will be reduced. In particular, following GDF Site Selection a Site Specific Cost Estimate will be produced, which will over time incorporate increasing amounts of actual cost data.

[10] http://www.nda.gov.uk/aboutus/geological-disposal/rwmd-work/dssc/

1.39 For the purposes of setting a Cap and Risk Fee at the outset, it is necessary to consider a range of possible scenarios for the implementation of geological disposal in order for the uncertainties around possible waste disposal costs to be fully taken into account. The Methodology does this by drawing estimates of the costs of these scenarios, relating in particular to different possible geological environments, from the Parametric Cost Model developed by NDA. Annex B has more information about the Parametric Cost Model.

1.40 The Methodology identifies two different categories of GDF cost:

- **Fixed Costs**, such as the site selection and investigation programme and the construction of the surface facilities, access shafts and access drift. These are considered to be predominantly fixed costs as they are largely unrelated to the volume of waste being emplaced.
- **Variable Costs**, such as the construction of underground deposition tunnels for spent fuel and underground disposal vaults for ILW. These are considered to be variable costs as they vary with the volume of waste being emplaced.

1.41 The distinction between the two categories of costs is important because the Waste Transfer Price is set in relation to an estimate of the Variable Costs of disposing of an Operator's waste plus a contribution to the Fixed Costs of the GDF. This Methodology sets out how the contribution to the Fixed Costs will be determined, based in particular on assumptions around the total inventory of waste to be disposed of in a GDF.

1.42 As the GDF project progresses the definitions of Fixed and Variable Costs contained in the Waste Contract are expected to be refined in light of more detailed cost and design information. However for the purposes of the worked examples set out in Section 2, the following simple definitions are used:

- Fixed Costs are all GDF costs incurred from a specified starting point until First Waste Emplacement and all costs incurred after Last Waste Emplacement to a specified end point.
- Variable Costs are all GDF costs incurred during the period of waste emplacement. This means it includes overheads and maintenance and replacement costs, which in other circumstances might sometimes be called fixed costs.

1.43 There is a further consideration. The Government considers that it would be technically possible and desirable to dispose of both new and legacy waste in the same geological disposal facilities. However the size of the new build programme and the specification of the site chosen for a GDF will have an impact on the feasibility of the co-disposal of all wastes in a single GDF. In the event that a second GDF were needed as a result of the new build programme becoming very large, this would imply a significantly greater total cost, although such cost would be spread over a larger nuclear programme.

1.44 The Government proposes to proceed on a presumption of a single GDF, but the Methodology retains the flexibility to revise this at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed. This flexibility is enhanced by the provision for a longer, 30-year Deferral Period.

1.45 There are four steps of the Waste Transfer Pricing Methodology relating to the estimation of GDF Fixed and Variable Costs and these are summarised below.

Estimate GDF Fixed Costs and GDF Variable Costs
Step 1: Cost estimate data will be provided by the body responsible for building and operating a GDF. This is currently NDA's RWMD.
Step 2: NDA will provide their current best estimate of the Variable Costs per unit of ILW and spent fuel.
Step 3: NDA will provide their current best estimate of the Fixed Costs of a GDF.
Step 4: An estimate will be made of whether one or more than one GDFs might be needed. The current assumption is for a single GDF but the Methodology retains the flexibility to revise this at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed.

Derivation of Unit Cost Estimates

1.46 Further assumptions will be needed to translate the GDF cost estimates produced by NDA into an estimate of the cost of disposing of a unit of new build ILW or spent fuel. In particular, and in line with the Government's policy that new nuclear Operators should meet their full share of waste management and disposal costs, the Waste Transfer Price will include a contribution to the Fixed Costs of the GDF.

1.47 This section sets out the key principles by which waste disposal costs for new build wastes will be estimated, drawing on GDF cost estimate data. It is expected that a more detailed procedure, consistent with these principles, will be set out in the Waste Contract that will be agreed between the Operator and the Secretary of State alongside the Secretary of State's approval of the Operator's FDP.

1.48 The Methodology derives estimates of GDF Variable Costs and GDF Fixed Costs per unit of ILW or spent fuel. Adding these two figures together gives Total Costs per unit. The Methodology will use the units used by NDA for cost estimation. Currently these are:

- Cubic metres (m^3) of packaged volume for ILW.
- Disposal canisters for spent fuel. The current NDA reference case is the KBS-3 copper canister, containing four PWR fuel assemblies.

1.49 These units are subject to change and the units applied in the Methodology will also change as required in order to remain consistent with NDA's assumptions and cost modelling.

1.50 The Government's view is that an Operator's contribution to the Fixed Costs of a GDF should be in proportion to the use it makes of the GDF's capacity. The best way of measuring this is considered to be through estimates of its share of total Variable Costs, as this takes into account both the quantity and the nature of the wastes emplaced. Therefore in this Methodology a new nuclear Operator's share of the Fixed Costs of a GDF is calculated in proportion to its share of estimated total Variable Costs.

1.51 Hence the share of the Fixed Costs of a GDF to be allocated to a single new nuclear power station is V_N/V_T, where:

- V_N is the estimated Variable Costs of disposing of the ILW and spent fuel from the new nuclear power station in a GDF; and
- V_T is the estimated total Variable Costs of a GDF, incorporating the disposal of both legacy and new build wastes.

1.52 As set out above, the Methodology provides an estimate of the Variable Costs per unit of spent fuel and ILW. The total Variable Costs for a single new nuclear power station (V_N) can be calculated with reference to an assumed inventory. The worked examples in Section 2 are based on an assumed inventory for a generic PWR and the derivation of this assumed inventory is set out in Annex D.

1.53 However further assumptions are required to calculate the estimated total Variable Costs of a GDF (V_T). Firstly an estimate of the inventory of legacy wastes to be emplaced in a GDF is required. Annex D also has the legacy inventory that has been assumed for the worked examples.

1.54 In addition, an estimate of the total inventory of new build wastes to be emplaced in a GDF is required, which requires an assumption of how many new nuclear power stations will be built. This is uncertain, as it will be for energy companies to build new nuclear power stations. Total Costs per unit fall gradually as the size of the new build fleet increases, as the Fixed Costs are shared across an increasing number of units, and therefore the Methodology will make a conservative estimate of the likely size of the new build fleet.

Financing Charge

1.55 As a general principle the Government considers it necessary for the payment made by an Operator in relation to the Waste Transfer Price to reflect the "time value of money", i.e. that the value of money is affected by when it is paid, based on the principle that a sum of money paid today is more valuable than the certainty of receiving the same sum at a later date.

1.56 The Waste Transfer Price will include a component relating to the Variable Costs of waste disposal and a contribution to the Fixed Costs of a GDF. The Variable Costs are assumed to be incurred immediately before emplacement. This is because it is expected that underground tunnels and vaults will only be excavated in response to demand. In contrast, most of the Fixed Costs of a GDF will be incurred many years before the emplacement of new build wastes in a GDF because it is currently assumed that emplacement of legacy wastes will take priority.

1.57 A "Financing Charge" will be applied on the share of GDF Fixed Costs included in the Waste Transfer Price, based on the approach that might be taken in the theoretical case that the Government were constructing a GDF to a timescale driven by the needs of new build Operators, described as the "virtual GDF" approach.

1.58 In this case a GDF would be built many decades later, as it would not need to be ready until the waste from the new nuclear Operator was ready for disposal. It is assumed that under this scenario the theoretical GDF would follow the existing GDF cost profile, but with all Fixed Costs incurred later so that it would open at the point that new build wastes were due for disposal, with interest charges applied to a new nuclear Operator's contribution to the Fixed Costs on this basis. In other words, rather than applying the interest charge for many decades, it would only be applied for the few years between construction and first emplacement of waste (when the Waste Transfer Price would be due to be paid).

"Units" conversion

1.59 The Methodology will calculate unit waste disposal costs with reference to whichever "unit" is used in NDA's cost modelling. For ILW, NDA's cost modelling uses £/m^3 and this is considered the appropriate unit for the purposes of setting an Expected Price, Waste Transfer Price, Cap and Risk Fee for the disposal of ILW.

1.60 For spent fuel, NDA's cost modelling estimates costs with reference to the KBS-3 copper canister. However this is merely an assumption at this stage and the canister specification is liable to change in the future. This uncertainty means that £/copper canister is not considered an appropriate unit for setting an Expected Price, Waste Transfer Price, Cap and Risk Fee for the disposal of spent fuel. Therefore the Methodology for spent fuel will convert the cost per unit from whichever unit is used in NDA's cost modelling to an appropriate unit for spent fuel. The Government's view is that the appropriate unit for spent fuel is £/tU.

1.61 There are nine steps of the Waste Transfer Pricing Methodology relating to the derivation of the contribution to GDF Fixed Costs per unit of new build wastes and the calculation of a Total Costs estimate per unit and these are summarised below.

Derive contribution to GDF Fixed Costs and calculate total Unit Cost Estimates
Step 5: The legacy waste inventory will be estimated based on latest figures from NDA.
Step 6: The new build waste inventory will be estimated. This will be based on: • a predicted waste inventory for a new nuclear power station, in light of the specific characteristics of the station under consideration; and • an estimate of the likely size of the new nuclear fleet at the end of the Deferral Period.
Step 7: The estimated legacy and new build inventories are combined to give an estimated total GDF waste inventory.
Step 8: A new nuclear Operator's share of total GDF Variable Costs will be calculated according to the formula (V_N/V_T), where (V_N) is the Operator's total Variable Costs and (V_T) is total GDF Variable Costs.
Step 9: A new nuclear Operator's share of the Fixed Costs of a GDF will be allocated in proportion to its share of total Variable Costs.
Step 10: The Financing Charge uplift will be applied on the basis of the "virtual GDF" approach. An interest rate consistent with Treasury guidance will be used and the indicative GDF spend profile will be based on NDA's most up-to-date cost estimates.
Step 11: The uplifted Fixed Cost contribution is then apportioned to the Operator's spent fuel and ILW inventory in proportion to each waste stream's share of the Operator's total Variable Cost (V_N) and then allocated per unit of spent fuel and ILW to produce a Fixed Cost contribution per unit.
Step 12: The Variable Costs per unit estimate from Step 2 is then combined with the Fixed Costs contribution per unit derived at Step 11 to produce a Total Costs estimate per unit.
Step 13: The cost estimate per canister of spent fuel is converted to £/tU.

Adjust cost estimates for risk and uncertainty

1.62 The Waste Transfer Price charged by Government should be set at a level over and above expected costs and include a Risk Premium to compensate the taxpayer for taking on the risk of subsequent cost escalation.

1.63 The current level of uncertainty over GDF costs is high, in the absence of a confirmed site or design for a GDF. However this uncertainty is expected to reduce as progress is made in the implementation of geological disposal.

1.64 The Government's view is that a 30 year Deferral Period should enable the Waste Transfer Price to be set after First Waste Emplacement, when there should be a great deal of actual cost data and only a small amount of residual uncertainty.

1.65 The Site Specific Cost Estimate that will be produced following GDF Site Selection will incorporate an assessment of risk and uncertainty. This assessment will be transparent and will be made in line with good industry practice. This will enable the production of a **Risk Adjusted Cost Distribution**.

1.66 For the purposes of setting a Waste Transfer Price and an Expected Price after GDF Site Selection, a "**Pricing Cost Estimate**" will be drawn from this distribution and this will determine the level of the Price.

1.67 The Pricing Cost Estimate will be set at P_{95} from the distribution, i.e. set at a level where there is expected to be a 95% chance that actual cost will be lower than estimated cost and a 5% chance that actual cost will be higher than estimated cost. The Government considers the Risk Premium to be the difference between the Pricing Cost Estimate and the Best Cost Estimate at the time the distribution is derived.

1.68 At present there is a Generic Base Cost Estimate produced by NDA in relation to a reference case. The Government's view is that it is not possible to produce a robust line-by-line assessment of risk and uncertainty in relation to GDF costs prior to GDF Site Selection, as some of the biggest risks relate to the programme as a whole, such as uncertainty over site and design. Therefore prior to GDF Site Selection it will not be possible to produce a Risk Adjusted Cost Distribution for the purposes of setting an Expected Price. Hence the **Interim Approach** set out in **Annex A** will be used to derive a Projected Pricing Cost Estimate for the purposes of setting an Expected Price prior to GDF Site Selection.

1.69 The cost modelling process applied for the purposes of determining a Cap and Risk Fee will estimate waste disposal costs in line with this Methodology but apply a very conservative approach to risk and uncertainty to ensure that the Cap is set at a level where there is a very high level of confidence that actual cost will be lower than the Cap. More detail on how a Risk Adjusted Cost Distribution will be derived for the purposes of setting a Cap is set out in **Annex B**.

1.70 There are two steps of the Waste Transfer Pricing Methodology relating to the adjustment of estimated costs for risk and uncertainty. These are summarised below.

Adjust for Risk and Uncertainty

Step 14: The Base Unit Cost Estimates derived in the Methodology will be adjusted for risk and uncertainty:

- Following GDF Site Selection this will be through a transparent assessment of risk and uncertainty relating to a Site Specific Cost Estimate in line with good industry practice. This will result in a Risk Adjusted Cost Distribution for the cost per unit of ILW and spent fuel.
- For the purposes of setting an Expected Price prior to GDF Site Selection the Interim Approach will be applied, as set out in Annex A.
- For the purposes of setting a Cap and Risk Fee at the outset a Risk Adjusted Cost Distribution will be produced according to the process set out in Annex B.

Step 15: Following the exercise to uplift the cost estimates for risk and uncertainty a Pricing Cost Estimate will be derived.

- Following GDF Site Selection the Pricing Cost Estimate will be set at the value of P_{95} from the Risk Adjusted Cost Distribution.
- For the purposes of setting an Expected Price prior to GDF Site Selection the Interim Approach will derive a Projected Pricing Cost Estimate, as set out in Annex A.

Setting the Price

1.71 The Waste Transfer Price set at the end of the Deferral Period will be set according to the formula:

Waste Transfer Price = Pricing Cost Estimate + Risk Fee

1.72 This is subject to two exceptions:

- The Waste Transfer Price cannot be higher than the Cap;
- in the event that the end of the Deferral Period falls before GDF Site Selection, the Waste Transfer Price will be determined through the Default Pricing Mechanism set out below.

1.73 The Expected Price is the Government's projection of the level of the Waste Transfer Price when it is set at the end of the Deferral Period. The level of the Expected Price will be reviewed, and if necessary revised, at each Quinquennial Review to ensure that it remains an up-to-date projection of the level of the Waste Transfer Price.

1.74 As set out above, the Government's current expectation is that by the end of the Deferral Period the GDF should be in its operational phase. This means that disposal costs will be estimated through a Site Specific Cost Estimate, incorporating a considerable amount of actual cost data. However the

Government accepts there is a risk that progress in MRWS might be slower than currently anticipated. In this case there might continue to be significant uncertainty over disposal costs even at the end of the Deferral Period and the Waste Transfer Pricing Methodology needs to specify what would happen in these circumstances.

1.75 The Government notes that NDA's current indicative timetable suggests that First Waste Emplacement in a GDF is likely to take place in around 2040. Hence the Government's current expectation is that the end of the Deferral Period, which will be around 2048 for the first new nuclear power stations, should fall after First Waste Emplacement in a GDF.   Therefore the Government expects that the Waste Transfer Price will be set in relation to a Site Specific Cost Estimate, incorporating a large amount of actual cost data. This means that the level of uncertainty over waste disposal costs at the end of the Deferral Period should be low, and therefore the distribution of estimated costs derived from the Methodology should be narrow. Hence, although the Pricing Cost Estimate will be set at P_{95} from the distribution, the Risk Premium should be small, and the potential surplus to Government (in 95% of cases) or shortfall (in 5% of cases) should also be small.

1.76 The Government notes however that NDA's current indicative GDF timetable is subject to change, as the timing of the implementation of geological disposal is dependent on the voluntarism and partnership approach under the MRWS process. Therefore it is possible that progress might be slower than currently anticipated, and hence First Waste Emplacement might not have taken place by the end of the Deferral Period.

1.77 The key milestone in the implementation of geological disposal prior to First Waste Emplacement is GDF Site Selection, which in NDA's current indicative timetable is estimated to be in around 2025. GDF Site Selection is an important milestone from the perspective of cost estimation as this will resolve some of the biggest current uncertainties, which arise because the final geological environment and GDF design will not be known until a GDF site has been selected. Following GDF Site Selection it will be possible to produce a Site Specific Cost Estimate of waste disposal costs, incorporating a more detailed and comprehensive assessment of risk and uncertainty than is possible in the absence of a GDF site.

1.78 The Government's view therefore is that it will be possible to set a Waste Transfer Price based on a Site Specific Cost Estimate if the end of the Deferral Period falls after GDF Site Selection but before First Waste Emplacement. However there will be greater uncertainty over costs in this case than there would be if the Waste Transfer Price were to be set after First Waste Emplacement. Hence, a Waste Transfer Price set in these circumstances is likely to include a larger Risk Premium than a Waste Transfer Price set after First Waste Emplacement.

1.79 In the event that GDF Site Selection has not taken place by the end of the Deferral Period the Default Pricing Mechanism will apply (see below).

1.80 It is recognised that, due to the specific technical issues involved, there may be scope for disputes between the Government and the Operator over the application of this Methodology in determining the level of the Waste Transfer Price and the Expected Price. Therefore the Government envisages that the Waste Contract will include Dispute Resolution procedures, including reference to independent third party experts.

1.81 An Operator can request that their Waste Transfer Price be fixed during the Deferral Period. In this case, following a cost modelling process that derives estimates of the costs of waste disposal and takes into account the level of uncertainty around the estimation of those costs, the Secretary of State will offer the Operator a Waste Transfer Price; the level of this offer will be at the discretion of the Secretary of State. In the event that the Operator decides not to accept this offer, the Waste Contact will proceed as before with the Waste Transfer Price being set at the end of the Deferral Period. However this would be subject to the proviso that the Waste Transfer Price cannot be higher than the Cap, and an Operator can opt at any time to fix their Waste Transfer Price at the level of the Cap.

Setting the Cap and Risk Fee

1.82 The Cap and the Risk Fee will be determined at the outset and will be contained in the Waste Contract agreed between the Operator and the Government. The Cap will be set at a level that reflects the Government's current analysis of risk and uncertainty around waste disposal costs and gives a very high level of confidence that actual cost will not exceed the Cap.

1.83 Once the Cap has been set the Government will guarantee that the Waste Transfer Price will not be higher than the Cap. In return for this guarantee the Waste Transfer Price will include a Risk Fee. The Cap and the Risk Fee will be indexed for inflation.

1.84 It is important to note that the level of the Cap will be determined by the Secretary of State prior to the agreement of the Waste Contract and the derivation of the Cap will not be subject to Dispute Resolution. Therefore the determination of the Cap will be a two-stage process:

- a cost modelling process, in line with this Methodology, to derive estimates of the costs of waste disposal, taking into account the level of uncertainty around the estimation of those costs; and
- determination of the Cap by the Secretary of State, in which he would have regard to the cost estimates derived from this modelling.

1.85 The level of the Risk Fee will be set in relation to the size of the risk being accepted by the Government in setting a Cap, and an assessment of the likely consequence to Government of that risk materialising. Hence the higher the Cap the smaller the Risk Fee, and vice versa. The Risk Fee will be set in relation to the following formula:

Risk Fee = (Probability x Cost Consequence) + Mark-up

1.86 Hence the Risk Fee will depend on the level of the Cap relative to the Risk Adjusted Cost Distribution. For example, if the Cap is set at P_{99} of that distribution, the Probability of actual cost exceeding the Cap should be 1%.

1.87 It is difficult to quantify precisely the Cost Consequence in the unlikely event that actual costs were to exceed the Cap. Due to the way it is calculated, the distribution derived in this Methodology, as described in Annex B and illustrated in Worked Example 2, has a maximum value, but in reality there may be scenarios in which the outturn could be higher than this derived maximum. However, within the 1% of cases where actual cost could exceed the Cap, there will be cases in which actual cost is only marginally higher than the Cap. The proposed approach, which is considered conservative, is to treat the *maximum derived cost* from the distribution as a proxy for the *average actual cost* for all cases where actual cost exceeds the Cap.

1.88 It is also proposed that a suitable mark-up over cost will be added, as compensation to Government for undertaking this transaction. The level of mark-up will be determined by the Secretary of State. For the purposes of illustration in Worked Example 2 this mark-up is set at 50%.

1.89 Given that the Risk Fee is compensation for the Government accepting a risk at the point the Contract is signed, the Operator will be obliged to pay the Risk Fee even in the event that the Operator ultimately withdraws from the Waste Contract due to the availability of an alternative disposal route for their waste. Hence the Risk Fee would be payable on termination of the Waste Contract.

1.90 Worked Example 2 illustrates how a Cap and Risk Fee would be calculated.

1.91 Setting the Price is the last step in the Waste Transfer Pricing Methodology and is summarised below.

Set the Price

Step 16: The Waste Transfer Price will be set as Pricing Cost Estimate plus Risk Fee. This is subject to two exceptions:

- the Waste Transfer Price cannot be higher than the Cap; and
- in the event that the end of the Deferral Period falls before GDF Site Selection, the Waste Transfer Price will be determined through the Default Pricing Mechanism.

The Expected Price will be the Government's projection of the level of the Waste Transfer Price when it is set at the end of the Deferral Period.

The Cap will be determined by the Secretary of State at the outset, having regard to a cost modelling process in line with this Methodology.

The Risk Fee will be calculated as Risk Fee = (Probability x Cost Consequence) + Mark-up. The level of the Mark-up will be determined by the Secretary of State.

The Default Pricing Mechanism

1.92 It is necessary to consider the scenario, albeit unlikely in the Government's view, in which progress in the implementation of geological disposal is very much slower than currently anticipated and hence the end of the Deferral Period falls before GDF Site Selection. In this case it will not be possible to set a Waste Transfer Price in relation to a Site Specific Cost Estimate and the Default Pricing Mechanism will apply.

1.93 In these circumstances the level of the Waste Transfer Price will be set by the Secretary of State, having regard to such cost modelling as would be available at the time, and would not be subject to Dispute Resolution, though it would still be subject to the Cap. Given that in these circumstances the level of uncertainty over costs is likely to be high, it is considered likely that the Waste Transfer Price would be at or near the level of the Cap.

1.94 The Government recognises that Operators will wish to have clarity over the operation of the Default Pricing Mechanism and the circumstances in which it will apply. Therefore the Government would expect the Waste Contract to:

- Specify the trigger mechanism for moving a Default Price, which would be where there was no reasonable prospect of a site for a GDF being identified by the end of the Deferral Period. The trigger mechanism would be subject to Dispute Resolution.
- Provide that the Secretary of State will set out how that Default Price has been determined and the Operator would be entitled to make representations with regard to the derivation of the Default Price.
- Provide that the Deferral Period could be extended for a limited period if there were reasonable grounds to believe that GDF Site Selection would be achieved during that time (see the section below on the Deferral Period for more detail on this).

1.95 The Default Pricing Mechanism also needs to specify the Assumed Disposal Date that will apply (the "**Default Date**"), as it will determine the duration of interim storage of waste pending disposal for which the Operator will be required to make financial provision. The Assumed Disposal Date will also determine the extent to which the Waste Transfer Price is subject to discounting if the Transfer Date is, as currently anticipated, some years before the Assumed Disposal Date.

1.96 The Default Date will be determined by the Secretary of State alongside the Cap and will be set out in the Waste Contract. The Default Date is likely to be based on the estimated availability of a GDF for the disposal of new build wastes, based on current estimates of the likely timetable for the implementation of geological disposal, GDF emplacement rates and the inventory of materials for disposal.

1.97 It is possible that at a Quinquennial Review of the Expected Price during the Deferral Period, it might be concluded that GDF Site Selection is unlikely to take place before the end of the Deferral Period. This would mean that it would not be expected to be possible to set the Waste Transfer Price using a

Site Specific Cost Estimate and instead the Default Pricing Mechanism would be expected to apply. In this scenario, the Secretary of State will also determine the Expected Price and this will not be subject to Dispute Resolution, though it will be subject to the Cap. In practice, given the high level of uncertainty likely to apply in this scenario, it is considered likely that the Expected Price will be set at or near the level of the Cap, and the Operator would be required to make prudent provision on this basis.

1.98 The trigger mechanism for applying the Default Pricing Mechanism to the setting of the Expected Price, which would be where there was no reasonable prospect of a site for a GDF being identified by the end of the Deferral Period, would be set out in the Waste Contract and would be subject to Dispute Resolution.

1.99 It is acknowledged that over the long period covered by a Waste Contract it is conceivable that there might be a change to the Government's policy that geological disposal is the way in which higher activity waste will be managed in the long term. One consequence of such a change would be that it would no longer be appropriate for the Default Pricing Mechanism to be triggered as a result of GDF Site Selection not being achieved. In this situation an alternative approach to determining the Waste Transfer Price would need to be devised, consistent with the key principles set out in paragraph 1.6. The Waste Contract will retain the flexibility to accommodate this scenario.

Other elements of the Methodology

Assumed Disposal Date

1.100 The Assumed Disposal Date is the Government's best estimate of the date on which disposal of the Operator's waste will begin. The Assumed Disposal Date will be determined with regard to an estimated GDF emplacement schedule and waste inventory.

1.101 The Assumed Disposal Date is required as it will determine the duration of interim storage prior to disposal for which Operators must make financial provision. It will also determine how the Waste Transfer Price will be discounted if the Transfer Date precedes the Assumed Disposal Date.

1.102 It is considered likely that a new nuclear Operator's spent fuel and ILW will have different Assumed Disposal Dates. The current assumption is that the disposal of new build spent fuel will begin after the completion of the disposal of legacy HLW/spent fuel (though this assumption will be subject to review). In contrast it is considered likely that the disposal of new build ILW will be able to begin somewhat earlier, perhaps on or near the Transfer Date, i.e. in parallel with the disposal of legacy wastes. However for simplicity, the worked examples in Section 2 assume the same Assumed Disposal Date for ILW and spent fuel.

1.103 An Expected Assumed Disposal Date will be provided to the Operator alongside an Expected Price and this date will be reviewed, together with the Expected Price, at each Quinquennial Review. The Assumed Disposal Date will be set at the same time as the Waste Transfer Price is set.

1.104 The Government accepts that deferring the setting of the Assumed Disposal Date might be problematic for Operators who will need to plan for the long term management of their ILW and spent fuel and the Government would be prepared to discuss with the Operator whether there should be some bounding dates set out in the Waste Transfer Contract. The Government is committed to optimising the implementation of geological disposal process wherever possible, to look for ways to do things in the most efficient, timely way whilst taking account of safety, security and the views of a local community. The Government will work with new nuclear Operators on the optimisation of the GDF project and as the programme moves forward, aspects such as the geology, the design of a facility, the inventory of waste to be disposed and the timing of waste arisings will become more defined and thus the scope for optimisation will become clearer.

Transfer Date

1.105 The Transfer Date (the date on which title and liability for the Operator's waste transfers to Government) will be aligned to the Operator's decommissioning timetable. The Government's current expectation is that the Transfer Date will be at or near the point that the decommissioning of the Operator's power station has been otherwise completed, in order to enable the Operator to be in a position to be released from its site licence obligations. The intention is for the Transfer Date to be agreed between the Operator and the Government in the Waste Contract, but that it will be subject to revision in future if, for example, the completion of decommissioning is anticipated to be later than envisaged at the time the Transfer Date was agreed.

1.106 It is the Government's policy that Operators of new nuclear power stations will meet their full share of waste management costs. The Government would therefore need to be compensated for the waste management costs that it would incur under these arrangements. The Government proposes to recover these additional costs through the existing requirement for an Operator to estimate all waste management costs in their FDP and to make provision for these costs in their independent Fund. This would ensure that there were sufficient monies to pay for waste management costs arising after the Transfer Date. These monies would transfer to the Government as a Lump Sum Payment at the same time as title to and liability for the waste is transferred. One purpose of the Government providing the Operator with an Assumed Disposal Date (in addition to the Transfer Date) is so that the Operator knows the expected time period over which the Government will be responsible for maintaining their waste in interim storage prior to disposal.

Deferral Period

1.107 The Government's view is that the setting of the Waste Transfer Price should be deferred until uncertainty over costs can be reduced. The length of the Deferral Period needs to balance two competing considerations. Firstly, that the longer the Deferral Period, the less the uncertainty there should be over costs. Secondly, that the later the Waste Transfer Price is set, the greater the risk that there is insufficient time for an Operator to make up any shortfall in their Fund to ensure prudent provision for their waste disposal liability. The Government's view is that the right balance is for there to be a Deferral Period of 30 years after the start of generation.

1.108 However a 30 year Deferral Period should not give rise to the risk that an Operator does not have the monies available to meet their liabilities. An Operator will be required, in its FDP, to make prudent provision for its waste disposal liability from the outset. Deferring the setting of the Waste Transfer Price does not enable an Operator to defer making financial provision. The Government will expect an Operator, through its FDP, to demonstrate that monies will be available to meet its liabilities as and when they fall due.

1.109 The Government's view is that where possible the Waste Transfer Price should be set in relation to actual cost data and sees positive benefits in an extended Deferral Period. Therefore the Government's preference would be for the Waste Transfer Price to be set at the end of the Deferral Period, and that any request to set a Waste Transfer Price "early" at a level below the Cap should be at the discretion of the Secretary of State.

1.110 However the Government considers that a modest degree of flexibility in the operation of the 30 year Deferral Period is likely to be necessary to ensure fair outcomes for Operators, particularly as new nuclear power stations are likely to begin operating at different times and hence would reach a 30 year cut-off point at different times.

1.111 For example the Government might consider it appropriate for Operators of a tranche of nuclear power stations (such as those beginning operation within a specified period) to have a joint "price-setting date", which would imply some limited variation in the length of each power station's Deferral Period.

1.112 Also, with regard to the Default Pricing Mechanism, which is triggered if GDF Site Selection has not occurred by the end of the Deferral Period, it is possible to envisage a scenario where GDF Site Selection is significantly later than currently anticipated and hence has not taken place by the end of the Deferral Period, but is nonetheless imminent by that point. An inflexible Deferral Period would mean that an Operator's Waste Transfer Price would be set in accordance with the Default Pricing Mechanism, whereas a short extension to the Deferral Period would enable the Waste Transfer Price to be set based on a Site Specific Cost Estimate. The Government recognises that this could be an undesirable outcome, hence would envisage the Waste Contract between the Operator and the Government containing provisions allowing for a short (perhaps up to five year) extension to the Deferral Period if there were good reason to believe that GDF Site Selection was going to occur in that period.

1.113 The Government would envisage this flexibility being accommodated in the Waste Contract. Any such flexibility would be conditional on the Secretary of State being satisfied that the Operator was making prudent provision for its waste disposal liabilities in its FDP.

1.114 As set out at paragraph 16 above, an Operator can request that their Waste Transfer Price be fixed during the Deferral Period. In this case the level of the Waste Transfer Price will be at the discretion of the Secretary of State, having regard to a cost modelling process that derives estimates of the costs of waste disposal and takes into account the level of uncertainty around the estimation of those costs. This would be subject to the proviso that the Waste Transfer Price cannot be higher than the Cap, and an Operator can opt at any time to fix their Waste Transfer Price at the level of the Cap.

Discounting and escalation

1.115 The Waste Transfer Price will be the price applicable on the Assumed Disposal Date. As set out above, the Transfer Date, particularly for spent fuel, is likely to fall some years ahead of the Assumed Disposal Date and in this case the Waste Transfer Price would be paid before it fell due. It is therefore considered necessary to adjust the payment made by the Operator to reflect this early payment. This will be done through the application of an appropriate discount rate to the Waste Transfer Price to reflect this time difference.

1.116 This discount rate will not be fixed at the outset. Rather it will be determined nearer the Transfer Date and set in relation to the rates of returns at that time on long-term investments in Government securities and similar assets. It is expected that the manner in which the discount rate will be determined will be set out in the Waste Contract. The Government will provide the Operator with an estimated long-term discount rate to enable prudent provision to be made.

1.117 The worked examples in Section 2, for the purpose of illustration, apply a real discount rate of 2.2% per annum, as this is consistent with the long-term discount rate applied to legacy liabilities in NDA's Annual Report and Accounts.

1.118 Once the Cap, Risk Fee, Expected Price and Waste Transfer Price have been set they will be indexed for inflation. It is expected that the manner in which this indexing will be carried out will be specified in the Waste Contract.

Dispute Resolution

1.119 In entering into a Waste Contract with the Government it is expected that the Operator would want assurance from the Government on how their Waste Transfer Price and other key variables will be determined. The Government's expects that the Expected Price and Waste Transfer Price will be determined through a transparent application of this Methodology.

1.120 It is recognised that, due to the specific technical issues involved, there may be scope for disputes between the Government and an Operator over the application of this Methodology, for example around assessments of risk and uncertainty, and over the scope of costs to be included in the cost estimates. Therefore the Government envisages that the Waste Contract will include Dispute Resolution procedures, including reference to independent third party experts.

1.121 The Government envisages these procedures being available to resolve disputes over the level of the Expected Price and the Waste Transfer Price, and also with regard to other considerations, such as the Assumed Disposal Date and the application of discounting and escalation for inflation. The Government does not intend Dispute Resolution procedures to apply in relation to the setting of the Cap and Risk Fee, nor to the setting of the Waste Transfer Price and Assumed Disposal Date under the Default Pricing Mechanism. However Dispute Resolution would apply in relation to the trigger mechanism for the Default Pricing Mechanism.

Equal treatment of different Operators

1.122 The Government intends that this Methodology will apply equally to all Operators of new nuclear power stations. However the Government does not consider that this necessarily means that a single Cap or Waste Transfer Price should apply to all Operators. The Cap and Waste Transfer Price for each Operator will be based on the most up-to-date cost estimates available at the time together with an analysis of the level of uncertainty around those cost estimates. Therefore the level of the Cap or Waste Transfer Price could vary depending on when they are set.

1.123 The Government would expect variation in the Cap or Waste Transfer Price provided to different Operators to be objectively justified. Once a Cap has been set for the first Operator the Cap for subsequent Operators will take account of how the first Cap was determined, with any differences being explained.

1.124 During the Deferral Period the level of the Expected Price provided by Government to an Operator will be subject to Quinquennial Reviews, in which estimates of GDF costs are updated and subject to independent scrutiny and review. The Government sees potential benefits in there being a single cost estimation and review process applicable to all Operators subject to an Expected Price and would expect to consider, in consultation with the Operators, whether this could be achieved.

1.125 Also, and as set out above, the Government might consider it appropriate for Operators of a tranche of nuclear power stations (for example those that begin operation within a specified period) to have a joint "price-setting date". This would mean that different Operators might have slightly different Deferral Periods, in order that all Operators in that tranche might be provided with the same Waste Transfer Price.

Publication of the Waste Contract

1.126 The Secretary of State, mindful of the public interest in these arrangements, would expect to publish as much of the Waste Contract as possible once it has been agreed, except for material of a sensitive nature, for example material that is commercially confidential or may have security sensitivities.

Annexes to Section 1

Annex A: Interim Approach for deriving a Projected Pricing Cost Estimate prior to GDF Site Selection

A.1 Under this Methodology, the Waste Transfer Price is expected to be set after GDF Site Selection. At this point there will be a Site Specific Cost Estimate, incorporating an assessment of risk and uncertainty. This assessment will be transparent and will be made in line with good industry practice. This will enable the production of a Risk Adjusted Cost Distribution from which a Pricing Cost Estimate can be derived.

A.2 However, before GDF Site Selection it will not be possible to produce a Site Specific Cost Estimate. Therefore in order to derive an Expected Price prior to GDF Site Selection it is necessary to apply an Interim Approach, which will derive a Projected Pricing Cost Estimate.

A.3 This Annex sets out the Interim Approach that will be used to set the Expected Price at the time the Waste Contract is agreed between the Operator and the Secretary of State. It is expected that the GDF cost estimate produced by NDA will develop over time, including in the period prior to GDF Site Selection, and these developments will be reflected in the revised cost estimation process at each Quinquennial Review. As the process of selecting a site for a GDF proceeds and more detailed information becomes available, this Interim Approach will be refined and improved to ensure that it produces a Projected Pricing Cost Estimate that reflects the best available information.

A.4 As set out in paragraph 1.67 above, the Risk Premium is defined as the gap between the Pricing Cost Estimate (which is P_{95} on the Risk Adjusted Cost Distribution) and the Best Cost Estimate at the time the distribution of estimated costs is derived, i.e.:

Pricing Cost Estimate = Best Cost Estimate + Risk Premium

A.5 Therefore a projected value for the Pricing Cost Estimate can be derived using a projected value for the Best Cost Estimate and a projected value for the Risk Premium.

Derivation of the Best Cost Estimate

A.6 The best available waste disposal cost estimate is the current best estimate derived by NDA for their reference scenario. This is a single value base estimate rather than a distribution, as a detailed line-by-line assessment of the risks and uncertainties around this estimate cannot meaningfully be produced at this stage, in the absence of a site and final design for a GDF.

A.7 The Government's view that this estimate is likely to be subject to "Optimism Bias". Optimism Bias is defined as the "demonstrated, systematic, tendency for project appraisers to be overly optimistic"[11]. This needs to be allowed for through a suitable uplift, which can be derived by applying HM Treasury's Green Book Guidance. The Green Book offers guidance on possible Optimism Bias factors, based on an analysis of historic cost out-turns versus the original cost estimates for a range of public sector projects, including nuclear projects[12].

A.8 When the Government is first requested to set an Expected Price for a prospective Operator the Government will undertake an exercise to determine the appropriate level of the Optimism Bias adjustment in this case, taking into account Treasury guidance, and this exercise will be repeated as required at subsequent Quinquennial Reviews.

A.9 The derivation of the appropriate level for the Optimism Bias adjustment has not yet been carried out. For the worked examples in Section 2 a figure has been drawn from Treasury guidance to illustrate the impact of the Optimism Bias adjustment. In Green Book terms, a GDF can be categorised as a "non-standard civil engineering project" with a "recommended adjustment range" of 6-66%. In the early stages of a project Green Book advice is always to start with the upper bound. Therefore the worked examples use 66% as an illustrative Optimism Bias adjustment.

A.10 The Optimism Bias uplift will give an adjusted base estimate, which is considered to be a reasonable projection for the Best Cost Estimate at the end of the Deferral Period.

Derivation of the projected Risk Premium

A.11 The Risk Premium represents the level of contingency that the Government will require over and above the Best Cost Estimate, at the time the Waste Transfer Price is set, to compensate the taxpayer for taking on the risk of subsequent cost escalation.

A.12 The Risk Premium should be proportionate to the level of risk being assumed by the Government in fixing the Waste Transfer Price ahead of the actual date of waste disposal. The purpose of deferring the setting of the Waste Transfer Price is to reduce uncertainty over estimated costs and by the end of the Deferral Period the level of uncertainty should be low. In particular, on the assumption that First Waste Emplacement has taken place by the end of the Deferral Period:

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[11] The HM Treasury Supplementary Green Book Guidance on Optimism Bias is available at http://www.hm-treasury.gov.uk/green_book_guidance_optimism_bias.htm.

[12] This analysis was set out in a 2002 report for HM Treasury by Mott MacDonald, available on http://www.exner.com.au/News/images/3-Review%20of%20Large%20Public%20Procurement%20in%20the%20UK.pdf.

- Most Fixed Costs will have been incurred in full and thus will not be subject to any uncertainty. The only uncertainty will be around those Fixed Costs incurred after Last Waste Emplacement (which are estimated to be around 10% of total estimated Fixed Costs).
- There will be some uncertainty over the Variable Costs of waste emplacement, but this should be limited as actual data will be available on the costs of many underground operations. The main remaining uncertainty will stem from the extended period there will be between the setting of the Waste Transfer Price and the disposal of new build wastes and the consequent risk that new or unexpected costs could emerge. Some allowance should be made for this risk, although this should to some extent be offset by the opportunities to reduce costs that should arise as a result of learning over time.

A.13 When an Expected Price is first requested by a prospective Operator the Government will undertake an exercise to determine a projected value for the Risk Premium that will be applied in setting an Expected Price prior to GDF Site Selection. This projected Risk Premium is expected to take the form of a percentage uplift on estimated cost. Annex E sets out how the Projected Risk Premium has been derived for Worked Example 1.

Derivation of the projected Pricing Cost Estimate

A.14 For the purposes of setting the Expected Price under this approach, the Projected Pricing Cost Estimate is calculated as:

Projected Pricing Cost Estimate = NDA base estimate + Optimism Bias uplift + projected Risk Premium

A.15 The level of this Projected Pricing Cost Estimate will be updated at each Quinquennial Review at which this approach is applied.

A.16 As set out above, as the process of selecting a site for a GDF proceeds and more detailed information becomes available, this Interim Approach will be refined and improved to ensure that it produces a Projected Pricing Cost Estimate that reflects the best available information. The review and, if necessary, revision of the Expected Price at each Quinquennial Review will be conducted in a transparent manner and in the event of a disagreement it will be subject to the agreed Dispute Resolution procedures set out in the Waste Contract.

A.17 Once GDF Site Selection has taken place it is expected that a detailed engineering cost estimating exercise will be possible, from which a Site Specific Cost Estimate will be derived. At that point it will no longer be necessary to use the Interim Approach set out here.

Annex B: derivation of a Risk Adjusted Cost Distribution for the purposes of setting a Cap

B1. The cost modelling process applied for the purposes of determining a Cap and Risk Fee will estimate waste disposal costs in line with the Methodology set out in Section 1. However it will apply a very conservative approach to risk and uncertainty to ensure that the Cap is set at a level where there is a very high level of confidence that actual cost will be lower than the Cap. This Annex sets out how a Risk Adjusted Cost Distribution will be derived for the purposes of setting a Cap.

Estimate GDF costs and derive a Base Unit Cost Estimate

B2. The cost of a GDF is uncertain. It is influenced by many different factors, including the inventory of waste, timings of waste arisings, the geology at the site in question and the detailed design of a GDF.

B3. The Cap will be set at a level where there is a very high level of confidence that actual costs will be below the Cap. Therefore it is necessary to take account of a wide range of risks and uncertainties when modelling the possible costs of a GDF for the purpose of setting a Cap.

B4. In order to do so a number of scenarios will be developed. NDA, at the request of DECC, has developed a range of scenarios for geological disposal which differ, for example in geology or inventory, from the scenario used to develop NDA's current best estimate. The impact on cost of these various scenarios can then be taken into account and used to derive a Risk Adjusted Cost Distribution.

B5. NDA has developed a "Parametric Cost Model" to enable the costs of a GDF for higher activity wastes to be estimated despite the current level of uncertainty. The Parametric Cost Model generates updated cost estimates for geological disposal. It allows the key parameters that impact on the construction and operating costs of a GDF in the UK to be varied. The Parametric Cost Model uses as its basis the detailed cost estimate that underpins NDA's current best estimate included in its 2007/08 Annual Report and Accounts. The detailed cost estimate resulted from a rigorous process in 2007/08 that included bottom up estimates with costs and prices included from tender information, quotations, relevant industry data and current salary levels.

B6. The output from the Parametric Cost Model results from a set of assumptions being selected and, as a consequence, the cost estimates it produces depend on the assumptions used. A range of parameters can be varied to examine the cost impact from changing those parameters. For example, the Parametric Cost Model can vary parameters such as rock type, depth of repository and waste inventories, to reflect their impact on costs. The Parametric Cost Model can also estimate the cost for disposing of a specified amount of ILW and spent fuel in a GDF.

B7. The Parametric Cost Model has been used to identify the cost impact of the different disposal scenarios. These figures, which are set out in Annex C, have been used in Worked Example 2. These scenarios are illustrative and will continue to be refined over time. The estimates for each scenario are derived from the Parametric Cost Model, which is also subject to review and refinement in the future. Consequently the costs estimates set out in Annex C should be considered illustrative only.

B8. This cost data from the Parametric Cost Model can then be used to derive a contribution to GDF Fixed Costs and calculate total Unit Cost Estimates, in line with the Methodology set out in Section 1.

Adjust for risk and uncertainty

B9. Three distinct sets of risks arise from the use of the Parametric Cost Model to estimate waste disposal costs for new build ILW and spent fuel. These risks need to be taken into account in this cost modelling process, in order derive a Risk Adjusted Cost Distribution for the purposes of setting a Cap and a Risk Fee.

B10. The first set of risks arises because a site for a GDF has not yet been identified. Therefore the geological environment in which the GDF will be built is uncertain. Geology has a significant cost impact, therefore to accommodate this risk this cost modelling process will consider a variety of geological scenarios and their associated costs. A probability is then assigned to each scenario to enable a distribution of estimated waste disposal costs to be derived. For simplicity, in Worked Example 2 each scenario has been considered equally probable. This cost modelling process then uses Monte Carlo methods[13] in order to determine a distribution of estimated disposal costs.

B11. The second set of risks relate to the possibility that the Parametric Cost Model does not correctly calculate the costs of a specific disposal scenario. This includes such things as the consequences of delays, the possibility that costs for the assumed activities and their duration, scope and timing may be different in practice, or that some activities, and their associated costs, have not been included in the Parametric Cost Model's estimate. These have been defined as "**In-Model Risks**" and the cost estimates need to be adjusted for these risks. In this cost modelling In-Model Risks are handled through an "Optimism Bias" adjustment, following the methodology set out in HM Treasury "Green Book" guidance. Annex A provides more information on Optimism Bias. The exercise to determine the appropriate level of the Optimism Bias adjustment for the purposes of setting an initial Expected Price will also be used in this cost modelling process.

[13] Monte Carlo simulation is a mathematical technique that can be used to allow for risk and uncertainty in quantitative analysis and decision-making.

B12. The third set of risks relate to wider uncertainties. In the absence of a site for a GDF, NDA has made a number of assumptions when using the Parametric Cost Model to estimate waste disposal costs. For example NDA's estimates are based on an assumed disposal concept (which for spent fuel is the Swedish KBS-3 concept). In addition, DECC has made some further assumptions in order to use Parametric Cost Model data to estimate the costs of disposing of new build wastes. For example it is assumed that no additional Fixed Costs are incurred as a result of including new build wastes in a GDF designed and built for the disposal of legacy wastes.

B13. If any of these assumptions do not occur in practice then the accuracy of the Parametric Cost Model output used in this cost modelling is likely to be affected. These have been defined as "**Out-Of-Model Risks**" and are handled in this cost modelling by a **Contingency Allowance**.

B14. The calculation of the Contingency Allowance is inherently difficult. The approach taken in this cost modelling process is to identify a set of risks together with an assessment of the consequence and probability of each risk occurring. These assessments are then combined by Monte Carlo methods to determine a distribution for the Contingency Allowance.

B15. Annex F sets out how the Contingency Allowance distribution used in Worked Example 2 has been calculated. The figures given are illustrative, and it is proposed that an exercise similar to that shown in Annex F would be carried out using latest available information each time the Secretary of State was considering the level of the Cap to be provided to a prospective new nuclear Operator.

Deriving the Risk Adjusted Cost Distribution

B16. The Risk Adjusted Cost Distribution is then derived as follows:

- The total Unit Cost estimates for each scenario, derived from the Parametric Cost Model, are combined by Monte Carlo methods to produce a distribution of total Unit Cost for ILW and spent fuel.
- These distributions are then uniformly uplifted by Optimism Bias, to account for In-Model Risks.
- This uplifted distribution is then combined, by Monte Carlo methods, with the Contingency Allowance distribution, to allow for Out-of-Model Risks.

B17. The Secretary of State will then set the level of the Cap, having regard to the Risk Adjusted Cost Distribution derived in this way. Worked Example 2, for the purposes of illustration, assumes that the Cap is set at P_{99} from that distribution, i.e. at the level where it is estimated that there is a 99% chance that actual cost be below the Cap, and a 1% chance that actual cost will exceed of the Cap.

Section 2: Updated Worked Examples

Introduction

2.1 The December consultation contained two worked examples. The numbers given there were illustrative, but provided an example of how the Methodology set out in the consultation could work in practice. This section provides updated worked examples. The figures used here are the same as those used in the consultation, but to improve clarity the presentation of these worked examples has been revised in some areas. For example the "steps" applied here are consistent with the steps set out in Section 1.

2.2 The two worked examples in this section relate to the two scenarios that are applicable at the time when the Waste Contract is first agreed between the Operator and the Secretary of State.

- Worked Example 1: setting an Expected Price prior to GDF Site Selection; and
- Worked Example 2: setting a Cap and a Risk Fee.

2.3 In addition this section compares the illustrative figures derived in the worked examples with current estimates of GDF costs.

2.4 As with the figures in the consultation, the figures given here are for the purposes of illustration and should not be taken as representing the level of the Cap, Risk Fee or Expected Price that will actually be set for an Operator of a new nuclear power station.

2.5 It should be noted that all calculations in this consultation are in "real" money, i.e. they disregard inflation. All money values in these worked examples are expressed in constant September 2008 money and are undiscounted except where indicated.

Worked Example 1: setting an Expected Price prior to GDF Site Selection

2.6 The Expected Price will be the Government's projection of the Waste Transfer Price at the time it is eventually set at the end of the Deferral Period. Following GDF Site Selection the Expected Price will be set in relation to a Site Specific Cost Estimate and will incorporate a transparent assessment of risk and uncertainty, in line with good industry practice. Prior to GDF Site Selection an Interim Approach is required, as described in **Annex A**. This section sets out a worked example of how an Expected Price would be determined prior to GDF Site Selection, following the Interim Approach.

2.7 In line with the Methodology set out in Section 1, this worked example follows 16 steps in order to derive illustrative values for an Expected Price prior to GDF Site Selection.

Estimate GDF Fixed Costs and GDF Variable costs

2.8 The Methodology will use data produced by the body responsible for building and operating a GDF. This is currently NDA's RWMD. In order for RWMD to produce an estimate of GDF costs before GDF Site Selection a number of assumptions are required, relating in particular to GDF design and geological environment (**Step 1**). This will be a projection of the likely design and geology based on current knowledge.

2.9 At present these assumptions will be those of the "reference case" used by RWMD to produce an estimate of GDF costs for NDA's Annual Report and Accounts. These assumptions are for a GDF to be constructed in hard rock according to the KBS-3 disposal concept (for HLW/spent fuel) and immobilisation in grout disposal concept (for ILW/LLW).

2.10 RWMD will provide estimates of Variable Costs per unit of ILW and spent fuel (**Step 2**). RWMD uses the copper canister as the unit for estimating the costs of spent fuel disposal and packaged volume in m^3 for estimating the costs of ILW disposal. However later in this worked example the figures for spent fuel have been converted into £/tU.

2.11 RWMD will also provide estimates for the Fixed Costs of a GDF (**Step 3**). These need to be allocated per unit of ILW or spent fuel in line with the approach set out in Section 1.

2.12 To estimate the total waste inventory for a GDF it is necessary to decide how to handle the uncertainty around the size of the new build fleet, and in particular whether the co-disposal of all legacy and new build wastes in a single GDF might not be feasible in the event that the new nuclear fleet is very large (**Step 4**). As set out in Section 1 the current assumption is for a single GDF, but the Methodology retains the flexibility to revise this at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed.

Estimate GDF Fixed Costs and GDF Variable Costs	**Assumption for Worked Example 1**
Step 1 Cost estimate data will be provided by the body responsible for building and operating a GDF. This is currently NDA's RWMD.	In order for RWMD to produce an estimate of GDF costs before GDF Site Selection a number of assumptions are required, relating in particular to GDF design and geological environment. This will be a projection of the likely design and geology based on current knowledge. The assumptions are those used for the "reference case" used by RWMD to produce an estimate of GDF costs for NDA's Annual Report and Accounts. These assumptions are for a GDF to be constructed in hard rock according to the KBS-3 disposal concept (for HLW/spent fuel) and immobilisation in grout disposal concept (for ILW/LLW).
Step 2: NDA will provide their current best estimate of the Variable Costs per unit of ILW and spent fuel.	Estimated costs have been drawn from NDA's current best estimate. These figures are set out in Annex D.
Step 3: NDA will provide their current best estimate of the Fixed Costs of a GDF.	Estimated costs have been drawn from NDA's current best estimate. These figures are set out in Annex D.
Step 4: An estimate will be made of whether one or more than one GDFs might be needed. The current assumption is for a single GDF but the Methodology retains the flexibility to revise this at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed.	As for the Methodology.

WORKED EXAMPLE 1
(NB all figures in constant September 2008 money and undiscounted)

Step 1
It is assumed that the GDF will be constructed in hard rock according to the KBS-3 disposal concept (for HLW/spent fuel) and immobilisation in grout disposal concept (for ILW/LLW).

Step 2
The NDA current best estimates of Variable Costs per unit are:

- spent fuel Variable Costs estimate of £398.3k per canister; and
- ILW Variable Costs estimate of £8.99k per m^3.

Step 3
The NDA current best estimate for the total Fixed Costs of a GDF is £4401m.

Step 4
This worked example assumes a single GDF.

Derive contribution to GDF Fixed Costs and calculate total Unit Cost Estimates

2.13 A new nuclear Operator’s share of the Fixed Costs of a GDF is allocated in proportion to its share of estimated total Variable Costs. Hence the share of the Fixed Costs of a GDF to be allocated to a single new nuclear power station is V_N/V_T, where:

- V_N is the estimated Variable Costs of disposing of the ILW and spent fuel from one new nuclear power station in a GDF; and
- V_T is the estimated total Variable Costs of a GDF, incorporating the disposal of both legacy and new build wastes.

2.14 For this calculation it is necessary to estimate both the Operator’s total Variable Costs (V_N) and also the total Variable Costs for a GDF as a whole (V_T). These figures are derived by combining the Variable Costs per unit distributions from Step 2 with estimates of the relevant waste inventories.

2.15 The calculation of an overall waste inventory requires an estimate of the legacy waste inventory (**Step 5**) and an estimate of the new build inventory, which in turn requires an estimate of the waste inventory from a typical new nuclear power station and an estimate of the number of new nuclear power stations **(Step 6**). Annex D sets out how the assumed waste inventories used in these worked examples have been derived. For this worked example, it has been estimated that the new build fleet will consist of ten reactors.

2.16 A total waste inventory can then be determined (**Step 7**). The inventory estimates produced at Steps 5-7 can be combined with the Variable Costs per unit estimates from Step 2 to calculate an Operator’s total Variable Costs (V_N), total GDF Variable Costs (V_T) and a new nuclear Operator’s share of total Variable Costs (V_N/V_T) (**Step 8**). This fraction is then applied to the estimate of GDF Fixed Costs from Step 3 to give a new nuclear Operator's contribution to GDF Fixed Costs (**Step 9**).

2.17 As set out in Section 1, in order to reflect the time value of money, a Financing Charge uplift is added to the Operator's contribution to GDF Fixed Costs at this stage (**Step 10**). This uplifted contribution is then apportioned to the Operator's spent fuel and ILW inventory in proportion to each waste stream's share of the Operator's total variable cost (V_N) and then allocated per unit of spent fuel and ILW (**Step 11**).

2.18 The Variable Costs per unit estimate from Step 2 is then combined with the Fixed Costs contribution per unit derived at Step 11 to produce a Total Costs estimate per unit (**Step 12**). For spent fuel this estimate is then converted from £/canister to £/tU (**Step 13**).

Derive contribution to GDF Fixed Costs and calculate total Unit Cost Estimates	**Assumption for Worked Example 1**
Step 5: The legacy waste inventory will be estimated based on latest figures from NDA.	The estimated legacy waste inventory used in the worked example is: • 10,659 canisters of HLW/spent fuel; and • 390,000m^3 of ILW. Annex D sets out how this inventory has been derived.
Step 6: The new build waste inventory will be estimated. This will be based on • A predicted waste inventory for a new nuclear power station, in light of the specific characteristics of the station under consideration. • An estimate of the likely size of the new nuclear fleet at the end of the Deferral Period.	A predicted waste inventory for a generic 1.35GW PWR is used: • 500 canisters of spent fuel (i.e. 2000 fuel assemblies, 1030 tU); and • 2,000 m^3 of ILW. The worked example assumes a new build fleet of ten reactors.
Step 7: The estimated legacy and new build inventories are combined to give an estimated total GDF waste inventory.	The total predicted GDF inventory is therefore: • 15,659 canisters of HLW/spent fuel; and • 410,000m^3 of ILW.

Step 8: A new nuclear Operator's share of total GDF Variable Costs will be calculated according to the formula (V_N/V_T), where (V_N) is the Operator's total Variable Costs and (V_T) is total GDF Variable Costs.	As for the Methodology.
Step 9: A new nuclear Operator's share of the Fixed Costs of a GDF will be allocated in proportion to its share of total Variable Costs.	As for the Methodology.
Step 10: The Financing Charge uplift will be applied on the basis of the "virtual GDF" approach. An interest rate consistent with Treasury guidance will be used and the indicative GDF spend profile will be based on NDA's most up-to-date cost estimates.	The Financing Charge uplift has been calculated using a real interest rate of 2.2% and an indicative GDF spend profile based on latest cost estimates. The effect of this approach is to uplift the value of the new nuclear Operator's contribution to the Fixed Costs of a GDF by around 38% compared to the case with no Financing Charge.
Step 11: The uplifted Fixed Cost contribution is then apportioned to the Operator's spent fuel and ILW inventory in proportion to each waste stream's share of the Operator's total Variable Cost (V_N) and then allocated per unit of spent fuel and ILW to produce a Fixed Cost contribution per unit.	As for the Methodology.
Step 12: The Variable Costs per unit estimate from Step 2 is then combined with the Fixed Costs contribution per unit derived at Step 11 to produce a Total Costs estimate per unit.	As for the Methodology.
Step 13: The cost estimate per canister of spent fuel is converted to £/tU.	It is assumed that each canister holds 4 PWR spent fuel assemblies, equating to 2.06tU.

WORKED EXAMPLE 1 (continued)

Step 5
The estimated legacy waste inventory is:

- spent fuel/HLW inventory of 10,659 canisters; and
- ILW inventory of 390,000 m^3.

Step 6
The estimated waste inventory for a single new nuclear power station is:

- spent fuel inventory of 500 canisters; and
- ILW inventory of 2,000 m^3.

This worked example assumes a new build fleet of ten power stations. Therefore the total estimated new build waste inventory is:

- spent fuel inventory of 5,000 canisters; and
- ILW inventory of 20,000 m^3.

Step 7
Therefore the estimated total GDF waste inventory is:

- spent fuel/HLW inventory of 15,659 canisters; and
- ILW inventory of 410,000 m^3.

Step 8
Combining the Variable Cost estimates from Step 2 with the inventory figures from Steps 5-7 gives:

- total legacy Variable Costs of £7751.6m;
- Variable Costs for one new nuclear power station (V_N) of £217.2m; and
- total Variable Costs (legacy Variable Costs plus the Variable Costs for ten new nuclear power stations) (V_T) of £9923.6m.

Step 9
The new nuclear power station's share of total Variable Costs is V_N / V_T, i.e. 217.2/9923.6 = 2.188% = £96.3m.

Therefore its share of GDF Fixed Costs is 2.188% of £4401m = £96.3m.

Step 10
Applying a Financing Charge uplift of 38% gives a total Fixed Costs contribution of £132.9m.

Step 11
For a new nuclear power station:

- spent fuel Variable Costs are (500 x 0.3983) = £199.15m;
- ILW Variable Costs are (2000 x 0.00899) = £17.98m; and
- Hence total Variable Costs are £217.13m.

Allocating the total Fixed Costs contribution from Step 10 to each unit of spent fuel and ILW in proportion to each waste stream's share of Variable Costs gives:

- Spent fuel Fixed Costs contribution of (199.15/217.13) x £132.9m = £121.89m. Dividing by 500 canisters gives £243.7k per canister.
- ILW Fixed Costs contribution of (17.98/217.13) x £132.9m = £11.01m. Dividing by 2,000m^3 gives £5.5k per m^3.

Step 12
Combining the Variable Costs estimate per unit from Step 2 with the Fixed Costs estimates per unit from Step 11 gives a Total Costs estimate per unit as follows:

- Spent fuel Total Costs estimate of £642.0k per canister; and
- ILW Total Costs estimate of £14.5k per m^3.

Step 13
This worked example converts the value for spent fuel to £/tU, on the assumption that each canister contains 2.06tU. This gives:

- a spent fuel Total Costs estimate of £311.7k/tU.

Adjust for uncertainty in estimated costs

2.19 As set out in Section 1, when there is a Site Specific Cost Estimate following GDF Site Selection this will incorporate an assessment of risk and uncertainty, resulting in a distribution of estimated costs from which the Pricing Cost Estimate can be derived, representing P_{95} from that distribution. In the absence of a Site Specific Cost Estimate the results of such an exercise must be approximated in the way set out in Annex A, on the basis that:

Pricing Cost Estimate = Best Cost Estimate + Risk Premium

2.20 The projected Best Cost Estimate is derived by adjusting the Total Costs per unit derived in Step 13 for Optimism Bias (**Step 14a**). For the purposes of illustration the level of the Optimism Bias adjustment in this worked example has been set at the upper end of the range recommended in Treasury's Green Book Guidance, which is 66%. However this figure is illustrative and when a prospective Operator requests an Expected Price the Government will consider the appropriate level of the Optimism Bias adjustment, taking into account Treasury guidance. The level of the Optimism Bias adjustment will be reviewed at each Quinquennial Review prior to GDF Site Selection.

2.21 When an Expected Price is first requested by a prospective Operator the Government will also undertake an exercise to determine a projected value for the Risk Premium that will be applied in setting an Expected Price (**Step 14b**). This projected Risk Premium will take the form of a percentage uplift on estimated cost. The level of the projected Risk Premium will be reviewed at each Quinquennial Review prior to GDF Site Selection. This worked example assumes a projected Risk Premium of 15.5% for spent fuel and 7% for ILW. The derivation of these figures is set out in Annex E. The projected Pricing Cost Estimate is then derived by adding the projected Best Cost Estimate and the projected Risk Premium (**Step 15**).

Adjust for Risk and Uncertainty	Assumption for Worked Example 1
Step 14: The Base Unit Cost Estimates derived in the Methodology will be adjusted for risk and uncertainty. • For the purposes of setting an Expected Price prior to GDF Site Selection the Interim Process will be applied, as set out in Annex A.	As set out in Annex A, in line with the Interim Approach to be used for setting an Expected Price prior to GDF Site Selection that there will be two adjustments for risk and uncertainty: **A An Optimism Bias uplift, to derive a Best Cost Estimate**. The level of the Optimism Bias adjustment in this worked example is 66%. In Green Book terms, a GDF can be categorised as a "non-standard civil engineering project" with a "recommended adjustment range" of 6-66%. In the early stages of a project Green Book advice is always to start with the upper bound. **B a Projected Risk Premium.** This will take the form of a percentage uplift on the Best Cost Estimate. This worked example assumes the following illustrative values for the projected Risk Premium: • for spent fuel a projected Risk Premium of 15.5%; and for ILW a projected Risk Premium of 7%. The derivation of these figures is set out at Annex E.

Step 15: Following the exercise to uplift the cost estimates for risk and uncertainty a Pricing Cost Estimate will be derived. • For the purposes of setting an Expected Price prior to GDF Site Selection the Interim Approach will derive a Projected Pricing Cost Estimate, as set out in Annex A.	As set out in Annex A, in line with the Interim Approach to be used for setting an Expected Price prior to GDF Site Selection: Projected Pricing Cost Estimate = NDA Base Estimate + Optimism Bias uplift + Projected Risk Premium

WORKED EXAMPLE 1 (continued)

Step 14a

The projected Best Cost Estimate is derived by adjusting the Total Costs estimates per unit derived at Steps 12-13 for Optimism Bias. For the purposes of illustration, it is assumed that the Optimism Bias uplift will be set at 66%. This gives:

- spent fuel Best Cost Estimate of £517.4/tU; and
- ILW Best Cost Estimate of £24.1k per m^3.

Step 14b

At the end of the Deferral Period it is assumed that the Fixed Costs prior to First Waste Emplacement are known but that some contingency is required to allow for uncertainty in Variable Costs and for uncertainty in those Fixed Costs due to be incurred after Last Waste Emplacement.

This worked example assumes the follows illustrative values for the projected Risk Premium:

- for spent fuel a projected Risk Premium of 15.5%; and
- for ILW a projected Risk Premium of 7%.

The derivation of these figures is set out at Annex E.

Applying these uplifts to the Best Cost Estimates gives:

- spent fuel projected Risk Premium of £80.1k/tU; and
- ILW projected risk premium of £1.7k per m^3.

Step 15

Combining the projected Best Cost Estimate with the projected Risk Premium gives:

- spent fuel projected Pricing Cost Estimate of £597.5k per canister; and
- ILW projected Pricing Cost Estimate of £25.8k per m^3.

Determine the Expected Price

2.22 The Expected Price is calculated by adding together the projected Pricing Cost Estimate and the Risk Fee (**Step 16**). This worked example uses the illustrative values for a Risk Fee derived in Worked Example 2 below.

2.23 All values in this worked example are in constant September 2008 money values. However once an Expected Price has been determined it will be indexed for inflation.

Set the Price	**Assumption for Worked Example 1**
Step 16: The Waste Transfer Price will be set at Pricing Cost Estimate plus Risk Fee. This is subject to two exceptions: • the Waste Transfer Price cannot be higher than the Cap; and • in the event that the end of the Deferral Period falls before GDF Site Selection, the Waste Transfer Price will be determined through the Default Pricing Mechanism. The Expected Price will be the Government's projection of the level of the Waste Transfer Price when it is set at the end of the Deferral Period.	The Expected Price is calculated by adding together the projected Pricing Cost Estimate and the Risk Fee. This worked example uses the illustrative values for a Risk Fee derived in Worked Example 2 below.

WORKED EXAMPLE 1 (continued)

Step 16
Using the illustrative figures for the Risk Fee from Worked Example 2, i.e. £2k/tU spent fuel and £0.1k per m^3 ILW, gives:

- a spent fuel Expected Price of £599.5k/tU; and
- an ILW Expected Price of £25.9k per m^3.

Worked Example 2: setting a Cap and Risk Fee

2.24 This worked example follows the approach set out in **Annex B**, which describes how a Risk Adjusted Cost Distribution will be derived for the purposes of setting a Cap. This worked example is consistent with the worked example set out in Section 4.2 of the December 2010 consultation. However, as with Worked Example 1, the presentation has been slightly revised to improve clarity.

2.25 This Worked Example also follows the 16 steps set out in the description of the Waste Transfer Pricing Methodology in Section 1.

2.26 It is important to note that Worked Example 2 takes a much more conservative approach to risk and uncertainty than Worked Example 1. This is because Worked Example 1 is an illustration of how an Expected Price would be derived. The Expected Price is the Government's best estimate of the level of the Waste Price at the end of the Deferral Period. The Expected Price will be reviewed over time and increased, or reduced, where appropriate.

2.27 In contrast, Worked Example 2 is an illustration of how a Cap would be derived. The Cap will be set at a level where the Government has a very high level of confidence that actual cost will not exceed the Cap. Once the Cap has been set for an Operator it cannot be revised (though it will be indexed for inflation). Therefore the approach to assessing risk and uncertainty when determining the Cap is necessarily conservative. In setting a Cap at a level that protects the taxpayer by ensuring that the risk of costs exceeding the Cap is very small, the Government considers it appropriate to ensure that the Cap is high enough even in very pessimistic scenarios.

Estimate GDF Fixed Costs and GDF Variable Costs

2.28 As set out in Annex B, when the Government models waste disposal costs for the purposes of setting a Cap, the Parametric Cost Model devised by NDA will be used to provide estimates of the costs of a GDF. A number of scenarios will be considered, varying the main factors that impact on cost, such as geology, GDF layout, depth and waste inventory, and the probability of each of these scenarios will also be considered (**Step 1**).

2.29 An exercise to determine GDF scenarios, estimate the costs of those scenarios and consider the probability of those scenarios will need to be undertaken each time the Secretary of State considers the level of the Cap to be provided to a prospective new nuclear Operator. For this worked example nine scenarios have been used. These are listed in **Annex C**. For simplicity, in this worked example all the scenarios are assumed to be equally probable.

2.30 The estimates for each scenario are derived from the Parametric Cost Model, which is subject to review and refinement in the future. Hence the cost estimates and assumed probabilities given here are illustrative and subject to change.

2.31 For each scenario the Parametric Cost Model has provided an estimate for Variable Costs per unit of ILW and spent fuel (**Step 2**). The estimates for each scenario will then be combined by Monte Carlo methods, using the probability for each scenario assigned in Step 1, to produce a distribution for estimated Variable Costs per unit.

2.32 For each scenario the Parametric Cost Model also provides an estimate for the total Fixed Costs of a GDF (**Step 3**). They will then also be combined by Monte Carlo methods to produce a distribution for estimated Fixed Costs.

2.33 An assumption is required as to whether there will be one or more than one GDFs (**Step 4)**.

Estimate GDF Fixed Costs and GDF Variable costs	**Assumption for Worked Example 2**
Step 1 Cost estimate data will be provided by the body responsible for building and operating a GDF. This is currently NDA's RWMD.	DECC has asked NDA to provide base cost estimates for a number of scenarios from the Parametric Cost Model. Nine of these scenarios were used to generate the figures in this worked example. These scenarios seek to establish the cost impact of varying the assumed waste inventory, geology, depth and GDF layout. See Annex C for more on these scenarios. The key driver of cost variability is the geological environment assumed, and in this case all geological environments have been assumed to be equally likely. This is a reasonable assumption as the location of a GDF is not yet known.
Step 2: NDA will provide their current best estimate of the Variable Costs per unit of ILW and spent fuel.	The Variable Cost estimates for each scenario used in this worked example are set out in Annex C. The values for each scenario have then been combined by Monte Carlo methods.
Step 3: NDA will provide their current best estimate of the Fixed Costs of a GDF.	The Fixed Cost estimates for each scenario used in this worked example are set out in Annex C. The values for each scenario have then been combined by Monte Carlo methods.

Step 4: An estimate will be made of whether one or more than one GDFs might be needed. The current assumption is for a single GDF but the Methodology retains the flexibility to revise this at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed.	This worked example assumes a single GDF.

WORKED EXAMPLE 2
(NB all figures in constant September 2008 money and undiscounted)

Step 1
Nine scenarios have been used for this worked example, as set out in Annex C. All scenarios are assumed to be equally likely.

Step 2
For the nine scenarios, the Parametric Cost Model's estimates are:

- spent fuel unit Variable Costs in the range £398.3-601.4k per canister; and
- ILW unit Variable Costs in the range £9.17-12.29 per m^3.

Combining the appropriate values for each scenario by Monte Carlo methods:

- spent fuel unit Variable Costs distribution with a minimum of £398.3k, a P_{50} of £429.3k and a maximum of £601.4k; and
- ILW unit Variable Costs distribution with a minimum of £9.2 k, a P_{50} of £9.6k and a maximum of £12.3k.

Step 3
For the nine scenarios considered here, the Parametric Cost Model estimates the Fixed Costs of a GDF to be in the range £4401-5015m.

Combining the values for each scenario by Monte Carlo methods gives a distribution for GDF Fixed Costs with a minimum of £4401m, a P_{50} of £4408m and a maximum of £5015m.

Step 4
This worked example assumes a single GDF.

Derive contribution to GDF Fixed Costs and calculate total Unit Cost Estimates

2.34 A new build Operator's share of the Fixed Costs of a GDF is allocated in proportion to its share of estimated total Variable Costs. Hence the share of the Fixed Costs of a GDF to be allocated to a single new nuclear power station is V_N/V_T, where:

- V_N is the estimated Variable Costs of disposing of the ILW and spent fuel from one new nuclear power station in a GDF; and
- V_T is the estimated total Variable Costs of a GDF, incorporating the disposal of both legacy and new build wastes.

2.35 These need to be allocated per unit of ILW or spent fuel in line with the approach set out in Annex A and illustrated in Steps 5-13 of Worked Example 1.

2.36 This requires estimates regarding the total inventory of waste to be disposed of in a GDF, which requires assumptions around the legacy inventory **(Step 5),** the inventory for a single new nuclear power station and the size of the new build fleet **(Step 6).**

2.37 Once these waste inventory estimates have been determined (**Step 7**), they can be combined with the distribution for Variable Costs per unit from Step 2 to calculate distributions for an Operator's total Variable Costs (V_N), total GDF Variable Costs (V_T) and the Operator's share of total Variable Costs (V_N/V_T) (**Step 8**).

2.38 This fraction is then applied to the distribution for GDF Fixed Costs from Step 3 to give a distribution for the Operator's contribution to GDF Fixed Costs (**Step 9**), to which the Financing Charge uplift is added (**Step 10**). This uplifted distribution is apportioned to the Operator's spent fuel and ILW inventory in proportion to each waste stream's share of the Operator's total Variable Cost (V_N) and then allocated per unit of spent fuel and ILW (**Step 11**).

2.39 The distribution for Variable Costs per unit from Step 2 is then combined with the distribution for Fixed Costs contribution per unit derived at Step 11 to produce a distribution for Total Costs per unit (**Step 12**). For spent fuel this distribution is then converted from £/canister to £/tU (**Step 13**).

Derive contribution to GDF Fixed Costs and calculate total Unit Cost Estimates	Assumption for Worked Example 2
Step 5: The legacy waste inventory will be estimated based on latest figures from NDA.	The estimated legacy waste inventory used in the worked example is: • 10,659 canisters of HLW/spent fuel; and • 390,000m^3 of ILW. Annex D sets out how this inventory has been derived.
Step 6: The new build waste inventory will be estimated. This will be based on • A predicted waste inventory for a new nuclear power station, in light of the specific characteristics of the station under consideration. • An estimate of the likely size of the new nuclear fleet at the end of the Deferral period.	A predicted waste inventory for a generic 1.35GW PWR is used: • 500 canisters of spent fuel (i.e. 2000 fuel assemblies, 1030 tU); and • 2,000 m^3 of ILW. Total Costs per unit fall gradually as the size of the new build fleet rises. Therefore a conservative estimate of the size of the new build fleet is a cautious assumption. This worked example assumes a new build fleet of four reactors.
Step 7: The estimated legacy and new build inventories are combined to give an estimated total GDF waste inventory.	The total predicted GDF inventory is therefore: • 12,659 canisters of HLW/spent fuel; and • 398,000m^3 of ILW.
Step 8: A new nuclear Operator's share of total GDF Variable Costs will be calculated according to the formula (V_N/V_T), where (V_N) is the Operator's total Variable Costs and (V_T) is total GDF Variable Costs.	As for the Methodology. Given that this calculation relates to a distribution of GDF Variable Costs, the result will be a distribution for a new nuclear Operator's share of those Costs.
Step 9: A new nuclear Operator's share of the Fixed Costs of a GDF will be	As for the Methodology. This will again lead to a distribution rather than a single

allocated in proportion to its share of total Variable Costs.	value.
Step 10: The Financing Charge uplift will be applied on the basis of the "virtual GDF" approach. An interest rate consistent with Treasury guidance will be used, and the indicative GDF spend profile will be based on NDA's most up-to-date cost estimates.	The Financing Charge uplift has been calculated using a real interest rate of 2.2% and an indicative GDF spend profile based on latest cost estimates. The effect of this approach is to uplift the value of the new nuclear Operator's contribution to the Fixed Costs of a GDF by around 38% compared to the case with no Financing Charge.
Step 11: The uplifted Fixed Cost contribution is apportioned to the Operator's spent fuel and ILW inventory in proportion to each waste stream's share of the Operator's total Variable Cost (V_N) and then allocated per unit of spent fuel and ILW to produce a Fixed Cost contribution per unit.	As for the Methodology. This will again lead to a distribution rather than a single value.
Step 12: The Variable Costs per unit estimate from Step 2 is then combined with the Fixed Costs contribution per unit derived at Step 11 to produce a Total Costs estimate per unit.	As for the Methodology. This will again lead to a distribution rather than a single value.
Step 13: The cost estimate per canister of spent fuel is converted to £/tU.	It is assumed that each canister holds 4 PWR spent fuel assemblies, equating to 2.06tU.

WORKED EXAMPLE 2 (continued)

Step 5
The estimated legacy waste inventory is:

- spent fuel/HLW inventory of 10,659 canisters; and
- ILW inventory of 390,000 m^3.

Step 6
The estimated waste inventory for a single new nuclear power station is:

- spent fuel inventory of 500 canisters; and
- ILW inventory of 2,000 m^3.

This worked example assumes a new build fleet of four power stations. Therefore the total estimated new build waste inventory is:

- spent fuel inventory of 2,000 canisters; and
- ILW inventory of 8,000 m^3.

Step 7
Therefore the estimated total GDF waste inventory is:

- spent fuel/HLW inventory of 12,659 canisters; and
- ILW inventory of 398,000 m^3.

Step 8
Combining the Variable Cost distribution from Step 2 with the inventory figures from Steps 5-7 gives:

- total legacy Variable Costs in the range £7816-11203m;
- Variable Costs for one new nuclear reactor (V_N) in the range £217-325m; and
- total Variable Costs (V_T), i.e. legacy Variable Costs plus the Variable Costs for four new nuclear reactors, in the range £8684–12503m.

Step 9
The new nuclear power station's share of total Variable Costs (V_N / V_T), and therefore their share of GDF Fixed Costs, is in the range (217.2/8684) – (325/12503) = 2.5-2.6%.

Applying this to the distribution for Fixed Costs determined in Step 3 gives a distribution for a new nuclear Operator's share of Fixed Costs with a minimum of £108.6m, a P_{50} of £111.5m and a maximum of £132.7m.

Step 10
Adding in the Financing Charge uplift of 38% gives an adjusted distribution with a minimum of £149.9m, a P_{50} of £153.9m and a maximum of £183.1m.

Step 11
Allocating these costs to spent fuel and ILW in proportion to their share of Variable Costs and dividing by the inventory from Step 6 gives:

- for spent fuel a distribution for Fixed Costs per canister with a minimum of £273.4k, a P_{50} of £282.5k and a maximum of £339.8k; and
- for ILW a distribution for Fixed Costs per m^3 with a minimum of £6.2k, a P_{50} of £6.4k and a maximum of £6.8k.

Step 12
Combining the distributions for estimated Variable Costs per unit from Step 2 and for estimated Fixed Costs per unit from Step 11 gives the following distributions for estimated Total Costs per unit:

- for spent fuel a distribution for Total Costs per canister with a minimum of £671.7k, a P_{50} of £711.8k and a maximum of £936.5k[14]; and
- for ILW a distribution for Total Costs per m^3 with a minimum of £15.4k, a P_{50} of £16.0k and a maximum of £19.1k.

Step 13
This worked example converts the value for spent fuel to £/tU, on the assumption that each canister contains 2.06tU. This gives a distribution for Total Costs per tU with a minimum of £326.1k, a P_{50} of £345.5k and a maximum of £454.6k;

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[14] It can be seen that the maximum of the distribution for Total Costs per unit spent fuel at Step 12 is slightly less than the sum of the maxima for the distributions of Variable Costs per unit at Step 2 and Fixed Costs per unit at Step 11. This is because the distributions are derived in relation to given scenarios. The maximum of the Variable Costs per unit occurs in Scenario 9, whereas the maximum of the Fixed Costs per unit occurs in Scenario 7 (as the lower cost per unit ILW in Scenario 7 means that each unit of spent fuel bears a higher share of the GDF Fixed Costs).

Adjust for uncertainty in estimated costs

2.40 The cost estimates derived from the Parametric Cost Model need to be adjusted for both In-Model and Out-of-Model Risks.

2.41 As set out in Annex B, In-Model Risks are addressed here by adjusting the distributions for Total Costs per unit for each scenario for Optimism Bias, (**Step 14a**). The level of the Optimism Bias adjustment in this worked example has been set at the upper end of the range recommended in Treasury's Green Book Guidance. However this figure is illustrative and when a prospective Operator requests an Expected Price the Government will consider the appropriate level of the Optimism Bias adjustment, taking into account Treasury guidance. This analysis will also be used in the cost modelling process that informs the setting of the Cap and Risk Fee.

2.42 As explained in Annex B, in addition to the In-Model Risks there is a second set of uncertainties that fall outside the scope of the Parametric Cost Model. Hence this worked example has a further Contingency Allowance to allow for these Out-of-Model Risks (**Step 14b**). The way in which a Contingency Allowance will be calculated is described in Annex B. Annex F sets out how the values for the Contingency Allowance used in this worked example have been calculated.

2.43 The Contingency Allowance is in the form of a distribution rather than a single value and is combined using Monte Carlo methods with the cost distributions derived under Step 14a to give a final cost distribution (**Step 15**).

Adjust for Risk and Uncertainty	Assumption for Worked Example 2
Step 14: The Base Unit Cost Estimates derived in the Methodology will be adjusted for risk and uncertainty. For the purposes of setting a Cap and Risk Fee at the outset a Risk Adjusted Cost Distribution will be produced according to the process set out in Annex B.	As set out in Annex B, there will be two adjustments for risk and uncertainty: **a) An Optimism Bias uplift, to allow for In-Model Risks**. The level of the Optimism Bias adjustment in this worked example is 66%. In Green Book terms, a GDF can be categorised as a "non-standard civil engineering project" with a "recommended adjustment range" of 6-66%. In the early stages of a project, Green Book advice is always to start with the upper bound. **b) A Contingency Allowance, to allow for Out-of-Model Risks**. The derivation of the Contingency Allowance for this worked example is set out at Annex F. The Contingency Allowance for this worked example is based on the following distributions: • for spent fuel per tU, a minimum of £-64.7k, P_{50} of £48.2 and maximum of £342.2k; • for ILW per m^3, a minimum of £-3.0k, P_{50} of £0.3k and a maximum of £19.5k.
Step 15: Following the exercise to uplift the cost estimates for risk and uncertainty, a Pricing Cost Estimate will be derived.	N/A. The Methodology does not derive a Pricing Cost Estimate when applied for the purposes of setting a Cap.

WORKED EXAMPLE 2 (continued)

Step 14a
Uplifting the distributions derived at Steps 12-13 for Optimism Bias gives the following distributions:

- for spent fuel a distribution for Total Costs per tU with a minimum of £541.4k, a P_{50} of £573.7k and a maximum of £754.7k;

- for ILW a distribution for Total Costs per m^3 with a minimum of £25.7k, a P_{50} of £26.7k and a maximum of £31.8k.

Step 14b
The Contingency Allowance is based on the following distributions:

- for spent fuel per tU, a minimum of £-64.7k, P_{50} of £48.2k and maximum of £342.2k;

- For ILW per m^3, a minimum of £-3.0k, P_{50} of £0.3k and a maximum of £19.5k.

Combining the Contingency Allowance distributions with those derived in Step 14a, using Monte Carlo methods, gives final Risk Adjusted Cost Distributions as follows:

- For spent fuel per tU, a minimum of £496.6k, P_{50} of £640.9k and a maximum of £1093.8k;

- For ILW per m^3, a minimum of £23.4k, P_{50} of £27.7k and a maximum of £50.9k.

Step 15

Not applicable. The Methodology does not derive a Pricing Cost Estimate when applied for the purposes of setting a Cap.

Determine the Cap and Risk Fee

2.44 The Secretary of State will then set the Cap, having regard to the Risk-Adjusted Cost Distribution derived in this Methodology (**Step 16**). In setting the Cap he will consider whether in his view the figure determined by this cost modelling provides appropriate protection for the taxpayer. For example, this might include consideration of whether the cost modelling has taken sufficient account of the need for protection against the risk of cost escalation and other uncertainties. For this worked example, it is assumed that the Cap is set as equivalent to P_{99} from the cost distribution derived at Step 14.

2.45 All values in this worked example are in constant September 2008 money values. However once a Cap has been set it will be indexed for inflation.

2.46 As set out above, it is proposed that the Risk Fee is calculated as:

Risk Fee = (Probability x Cost Consequence) + Mark-up

2.47 Hence the Risk Fee will depend on the level of the Cap relative to the overall distribution for estimated unit costs. In this worked example the Cap is set at P_{99} of that distribution, hence the Probability of actual cost exceeding the Cap is 1%.

2.48 It is difficult to quantify precisely the Cost Consequence in the unlikely event that actual cost exceeds the Cap. Due to the way it is calculated, the distribution derived in this worked example has a maximum value, but in practice there may be scenarios in which the actual cost could be higher than this derived maximum. However, within the 1% of cases where actual cost could exceed the Cap there will be cases in which actual cost is only marginally higher than the Cap (i.e. well below the derived maximum). The proposed approach, which is considered conservative, is to treat the *maximum derived cost* from the distribution as a proxy for the *average actual cost* for all cases where actual cost exceeds the Cap.

2.49 It is also proposed that a suitable Mark-up over cost will be added, as compensation to the Government for undertaking this transaction. The level of this Mark-up will be determined by the Secretary of State. For this worked example the Mark-up has been set at 50%. Finally, for simplicity, in this worked example the Risk Fee has been "rounded up" to the nearest £1k/tU for spent fuel and the nearest £0.1k/m^3 for ILW.

Set the Price	Assumption for Worked Example 2
Step 16: The Cap will be determined by the Secretary of State, having regard to a cost modelling process in line with this Methodology. The Risk Fee will be calculated as Risk Fee = (Probability x Cost Consequence) + Mark-up. The level of the Mark-up will be determined by the Secretary of State	**Setting the Cap** When an Operator of a new nuclear power station requests a Waste Transfer Price, the level of the Cap will be determined by the Secretary of State. He will consider whether in his view the figure determined by this cost modelling provides sufficient protection for the taxpayer. For this worked example, it is assumed that the Cap is set as equivalent to P_{99} from the cost distribution derived at Step 14. Once set, the Cap will be indexed for inflation. The worked examples in this document are in “real” money, i.e. they disregard inflation. All money values in the worked examples are expressed in constant September 2008 money and are undiscounted except where indicated. **Setting the Risk Fee** The Cap is assumed to be set at P_{99} of the distribution derived at Step 14. Therefore the Probability is 1%. The Cost Consequence is calculated on the basis that the maximum derived cost from the distribution is a proxy for the average actual cost for all cases where actual cost exceeds the Cap. The Mark-up is assumed to be 50%.

WORKED EXAMPLE 2 (continued)

Step 16
For this worked example it is assumed that the Cap is equivalent to P_{99} from the distributions derived in Step 14, which gives:

- For spent fuel, a Cap of £978k/tU;
- For ILW, a Cap of £48.4k/m^3.

For these illustrative figures, the Cap has been set at the level of P_{99} from the distribution, which means that there is considered to be a 1% probability that actual cost could exceed the Cap.

The average cost consequence for the 1% of cases where actual cost could exceed the Cap is calculated here as:

- Per tU of spent fuel, £1094k - £978k, which is £116k/tU;
- For ILW, £50.9k – £48.4k,which is £2.5k per m^3

This gives the following illustrative figures for the Risk Fee:

- For spent fuel, (1% of £116k) + 50% = £1.8k, rounded up to £2k/tU
- For ILW, (1% of £2.5k + 50%) = £0.04k, rounded up to £0.1k/m^3

Comparing the illustrative figures derived in the worked examples with current estimated costs

2.50 Table 3 compares the illustrative values for the Expected Price and the Cap from the worked examples with NDA's current best estimates:

- Comparing the Expected Price and the Cap with the current Total Unit Costs Estimate shows the escalation in GDF costs that would be required before actual costs exceed the Expected Price or the Cap. The current best Total Costs estimates are derived at Steps 12-13 of Worked Example 1.
- Comparing the Expected Price and the Cap with the current Variable Costs estimate per unit shows the escalation in GDF costs that would be required before the marginal costs of disposing of new build wastes exceeds the Expected Price / Cap. The current best estimate of Variable Costs can be found at Step 2 of Worked Example 1.

	Variable Cost	Total Cost	Expected Price	Cap
Spent fuel (£/tU)[15]	193k	312k	600k	978k
ILW (£/m^3)	9.0k	14.5k	25.9k	48.4k

Table 3: comparing the illustrative figures derived in the worked examples with current estimated costs.

2.51 It can be seen that the proposed approach to setting a Cap, which takes a conservative approach to risk and uncertainty and applies probabilistic cost modelling, results in a Cap that is three times the current best estimate of waste disposal costs.

2.52 Moreover, the Waste Transfer Price paid by new nuclear Operators includes a contribution to the Fixed Costs of the GDF which represents a benefit to the taxpayer, as these are costs that will need to be incurred anyway in order to dispose of legacy wastes. Hence there is only a risk to the taxpayer if costs escalate to the extent that the Cap is insufficient to pay the additional disposal costs for new build wastes (i.e. the Variable Costs). The Cap derived here represents five times the current Variable Costs estimate, In other words, the taxpayer would not be out of pocket (compared with no new build at all) even if waste disposal costs were five times greater than those currently expected.

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[15] The Variable Cost estimate per tU of spent fuel has been derived by dividing the cost per canister figure from Step 2 of Worked Example 1 by 2.06.

Translating the illustrative figures derived in the worked examples into an estimated waste disposal liability and an estimated annual Fund payment

Estimated waste disposal liability

2.53 The worked examples are based on an assumed inventory of ILW and spent fuel for a generic PWR operating for 40 years. The derivation of this inventory is set out in Annex D. The assumed inventory is:

- spent fuel: 500 canisters or 1030tU;
- ILW: 2000m^3.

2.54 The worked examples in this Section give the following figures:

- For spent fuel, a current Total Costs best estimate of £312k/tU, an Expected Price of £600k/tU and a Cap of £978k/tU.
- For ILW, a current Total Costs best estimate of £14.5k/m^3, an Expected Price of £25.9k/m^3 and a Cap of £48.4k/m^3.

2.55 Combining these figures with the assumed inventory it is possible to calculate:

- A current best estimate of the cost of disposing of the spent fuel and ILW from a new nuclear power station (including a contribution to the Fixed Costs of a GDF);
- A waste disposal liability for an Operator in the event that their Waste Transfer Price is set at the level of the illustrative Expected Price and
- A waste disposal liability for an Operator in the event that their Waste Transfer Price is set at the level of the illustrative Cap.

2.56 The Cap and Expected Price are set in relation to an Assumed Disposal Date of 2130. However it is currently expected that the Transfer Date will be before the Assumed Disposal Date and, in line with the worked examples in the consultation, this section assumes a Transfer Date of 2080[16]. Therefore to reflect this timing difference, the Waste Transfer Price will be subject to discounting.

2.57 The worked examples, for the purpose of illustration, apply a discount rate of 2.2% per annum, as this is consistent with the long-term discount rate applied to legacy liabilities in NDA's Annual Report and Accounts. It is important to note that this discount rate will not be fixed at the outset. Rather it will be determined nearer the Transfer Date and set in relation to the rates of return at that time on long-term investments in Government securities and similar assets. The Government will provide the Operator

[16] This is based on the assumption of a power station beginning operation in 2020, with an operational lifetime of 40 years and a 20-year decommissioning period.

with an estimated long-term discount rate to enable prudent provision to be made.

2.58 Table 4 below summarises the estimated waste disposal figures for a single new nuclear power station at the Assumed Disposal Date of 2130 and Transfer Date of 2080.

	Current best estimate	**Waste Transfer Price = Expected Price**	**Waste Transfer Price = Cap**
Estimated waste disposal liability at the Assumed Disposal Date (2130)	£350m	£670m	£1104m
Discounted value at the Transfer Date (2080)	£118m	£226m	£372m

Table 4: estimated waste disposal liability for a single new nuclear power station on the Assumed Disposal Date and Transfer Date (all values in constant September 2008 money).

Estimated annual Fund payment

2.59 This section provides an illustration of how the illustrative waste disposal liabilities set out here might translate into annual payments into an Operator's independent Fund, expressed as a cost per unit of electricity generated (£/MWh).

2.60 In line with the approach set out in the March 2010 consultation, the figures in Table 4 can be translated into an illustrative annual fund payment, calculated as a figure in £/MWh. For this exercise the total output of a generic PWR[17] has been estimated at 10,600GWh/year, or 424,000GWh over the 40-year life of the station.

2.61 These figures are for illustrative purposes only. The Operator will be responsible for making good any shortfall or risk of shortfall in the accumulated monies held by their independent Fund, in order to ensure that the Fund is sufficient to meet their waste and decommissioning liabilities. The Nuclear Liabilities Financing Assurance Board (NLFAB) will advise the Secretary of State on the financial arrangements that an Operator submits for approval and will provide advice to the Secretary of State on the regular reviews and ongoing scrutiny of funding arrangements.

[17] This is an estimate based on a generic 1.35GW(e) PWR with a load factor of 90%.

2.62 The monies in the Fund will be accumulated through a combination of payments by the Operator and growth of investments. Therefore in order to estimate the level of payments that will be required by an Operator it is necessary to estimate not only costs, but also the impact of the investment performance of the Fund over its lifetime.

2.63 The performance of an Operator's independent Fund will depend on a number of factors, including the Fund's investment strategy and the performance of the economy over time. Given the long timeframes involved, even small variations in assumed fund performance can have a very large impact on the estimated level of payments into the Fund. It will be for the Operator to propose an investment strategy for their Fund, and this will be approved by the Secretary of State as part of the FDP approval process.

2.64 It is considered likely that the investment strategy of an Operator's independent Fund will change after the end of generation. During the operational life of the power station, a Fund might pursue a relatively aggressive investment strategy aiming to maximise Fund growth, in the knowledge that in the event of poor investment returns, the power station would be generating revenues from which any shortfall in the Fund could be made up. In contrast, after the end of generation it is likely that a more cautious investment strategy will be pursued while the Fund is drawn down to pay decommissioning, waste management and waste disposal costs. This is because it is likely to be more difficult for an Operator to make up any shortfall in the absence of revenues from the nuclear power station.

2.65 For the purpose of illustration, the figures in this Section assume different investment strategies during and after generation. Three possible real annual growth rates are considered for the Fund during generation: 3.5%, 2.2% and 1%. Two, more conservative, real annual growth rates are considered for the Fund after end of generation; 1% or 0% (a 0% real annual growth rate would mean that the Fund grows only in line with inflation).

2.66 As set out above, it should be noted that all calculations in this document are in "real" money, i.e. they disregard inflation. All money values in this document are expressed in constant September 2008 money and are undiscounted except where indicated. When a Waste Transfer Price, Expected Price, Cap and Risk Fee are set, their values will be indexed for inflation. When an Operator set out the investment strategy for its independent Fund, the Fund will be expected to recognise and address the risks associated with its investment strategy, including inflation risk.

Fund growth assumption		Annual fund payment in £/MWh	
During generation (2020-2059)	***After end of generation*** *(2060-2079)*	***Waste Transfer Price = Expected Price*** *(2080 target fund value = £226m)*	**Waste Transfer Price = Cap** *(2080 target fund value = £372m)*
3.5%	1%	0.20	0.33
2.2%	1%	0.27	0.45
1%	1%	0.35	0.58
3.5%	0%	0.24	0.40
2.2%	0%	0.33	0.54
1%	0%	0.43	0.71

Table 5: illustrative annual fund payment to cover waste disposal costs, expressed as a figure per MWh (all values in constant September 2008 money).

Annexes to Section 2

Annex C: cost data provided by NDA

Generic Base Cost Estimate

C1. To assist with planning at this early stage of GDF implementation, NDA has developed a reference case programme. This programme provides both a basis for planning and a framework for formal and transparent control of significant changes to the programme as it evolves.

C2. The reference case programme is based on locating the facility in a higher strength host rock, since NDA has access to reliable and detailed information on what would be entailed in developing the facility in such rock from the former UK Nirex programme. It assumes a depth of disposal of 650m below ground level, since that allows NDA to use the information that was previously generated by Nirex for developing a facility at this depth. In such a "co-located" disposal facility there would be two distinct excavated disposal areas, one for ILW and LLW, and the other for HLW and spent fuel. The disposal operators would share surface facilities, access tunnels, construction support and security provision. By making assumptions such as this, NDA has developed a reference conceptual design for a GDF which provides the basis for estimations of timings and costs of the various activities that would be carried out to implement a GDF.

C3. The Generic Base Cost Estimate provided by NDA for Worked Example 1 is based on a detailed cost estimate of the reference case programme. This underpins the NDA's current best estimate included in its 2007/08 Annual Report and Accounts. The detailed cost estimate resulted from a rigorous process in 2007/08 that included bottom up estimates with costs and prices included from tender information, quotations, relevant industry data and current salary levels.

C4. As stated in NDA's Annual Report and Accounts 2007/08 the current best estimate within the range of potential costs for a GDF is £12.2 billion undiscounted. This figure covers both the Fixed Costs of a GDF and the Variable Costs of the disposal of legacy waste, which is all known waste that currently exists and waste arising from current facilities and therefore does not include any provision for new build waste or a number of other potential wastes.

Additional data from the Parametric Cost Model

C5. NDA has also developed a Parametric Cost Model to generate updated estimates of the costs of geological disposal. It allows the key parameters that impact on the construction and operating costs of a GDF in the UK to be varied.

C6. The Parametric Cost Model uses as its basis the detailed cost estimate that underpins NDA's current best estimate included in its 2007/08 Annual Report and Accounts.

C7. The output from the Parametric Cost Model results from a series of assumptions being selected and, as a consequence, the cost estimates it produces depend on the assumptions used. A range of parameters can be varied to examine the cost impact from changing the parameters. For example, the Parametric Cost Model can vary parameters such as rock type, depth and waste inventories, to reflect their impact on costs. The Parametric Cost Model can also estimate the cost for disposing of a specified amount of ILW and spent fuel in a GDF.

C8. In order to enable waste disposal costs for ILW and spent fuel from new nuclear power stations to be estimated, NDA, at the request of DECC, has developed a range of scenarios for geological disposal which differ – for example in geology or inventory – from the scenario used to develop NDA's current best estimate, and these have been used in the Parametric Cost Model to identify the cost impact of these scenarios.

C9. The nine scenarios that have been used in the development of this paper are listed in Table 6, together with the "base scenario," which is the reference case programme from which the other estimates are derived.

Scenario	Geology/depth	Legacy wastes?	Legacy U and Pu?	New build wastes?	Restricted footprint?	Variable Cost		Fixed Cost
						Canister of spent fuel (£k)	m^3 ILW (£k)	£m
Base	Strong rock 650m	Yes	No	No	No	398.3	8.99	4,401
1	Strong rock 650m	Yes	No	Yes	No	398.3	9.55	4,401
2	Strong rock 650m	Yes	Yes	Yes	No	398.3	9.17	4,401
3	Strong rock 650m	Yes	Yes	Yes	Yes	407.8	9.17	4,401
4	Evaporite 650m	Yes	No	Yes	No	429.3	9.95	4,408
5	Evaporite 650m	Yes	Yes	Yes	No	429.3	9.56	4,408
6	Evaporite 650m	Yes	Yes	Yes	Yes	438.9	9.56	4,408
7	Low strength 500m	Yes	No	Yes	No	596.6	11.54	5,015
8	Low strength 500m	Yes	Yes	Yes	No	596.6	12.29	5,015
9	Low strength 500m	Yes	Yes	Yes	Yes	601.4	12.29	5,015

Table 6: the scenarios and their cost implications.

Annex D: derivation of the illustrative waste inventories

Legacy inventories

D1. The inventory assumed in these worked examples is the scenario that underpins the estimate in NDA's 2007/08 Annual Report and Accounts. This inventory was based on that given in the 2007 Consultation "Managing Radioactive Waste Safely"[18] and is set out in Table 7 below.

Waste/material	Inventory Packaged Volume (m3)	Inventory (tonnes)	Number of disposal units/canisters
LLW	37,200		
ILW	353,000		
Sub-total (LLW/ILW)	390,200		
HLW	1,290		3,291
PWR Spent Fuel		1,200	572
AGR Spent Fuel		7,000[19]	6,796
Sub-total (HLW/spent fuel)			10,659

Table 7: Summary of legacy inventory assumed in the worked examples.

D2. This inventory is subject to change over time. For example, the inventory set out in the 2008 MRWS White Paper was slightly different to that given above. In the future, there are other materials – Plutonium, Highly Enriched Uranium and Depleted Uranium – which might require disposal in a GDF. If these materials were included in the inventory for disposal that would significantly increase volumes and the total cost of disposing of legacy wastes.

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[18] MRWS White Paper page 12.

[19] The inventory given in the 2007 MRWS Consultation was based on 3,500 canisters of AGR spent fuel, but this value was considered to be a more appropriate figure when this exercise was undertaken by NDA.

New build inventories

D3. These are derived from the inventories set out in the Disposability Assessment reports on the EPR[20] and AP-1000[21] designs produced by NDA as part of the Generic Design Assessment process. On the basis of these inventories an assumed inventory for a generic PWR operating for 40 years has been derived. This section summarises how these generic inventories of waste have been calculated.

EPR

D4. The EPR has a rated thermal power of 4500MW and an electrical power output of approximately 1600-1660MW(e) depending on site-specific factors. For this exercise the electrical power output of an EPR is assumed to be 1630MW(e).

D5. Spent fuel arisings: the GDA Disposability Assessment for the EPR assumes that over a 60 year operating life an EPR would generate 3600 spent fuel assemblies, i.e. 900 disposal canisters. This equates to an average of 60 assemblies a year, or 36.8 assemblies per GW per year.

D6. ILW arisings: the GDA Disposability Assessment for the EPR assumes that over a 60 year operating life an EPR would generate:

- 1647-3201m^3 packaged operational ILW[22], which equates to 37.5-53.4m^3 per year.
- 449.3m^3 decommissioning ILW.

AP-1000

D7. The AP-1000 has a rated thermal power of 3400MW and an electrical power output of 1117-1154MW(e) depending on site-specific factors. For this exercise the electrical power output of an AP-1000 is assumed to be 1135MW(e).

D8. Spent fuel arisings: the GDA Disposability Assessment for the AP-1000 assumes that over a 60 year operating life an AP-1000 would generate 2560 spent fuel assemblies, i.e. 640 disposal canisters. This equates to an average of 42.7 assemblies a year, or 37.6 assemblies per GW per year.

D9. ILW arisings: the GDA Disposability Assessment for the AP-1000 assumes that over a 60 year operating life an AP-1000 would generate:

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[20] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-Disposability-Assessment-for-Wastes-and-Spent-Fuel-arising-from-Operation-of-the-EPWR.pdf

[21] http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf

[22] The Disposability Assessment included a reference case, which calculated an operational ILW volume of 3201m^3 and two variant cases. Variant 1 calculated an operational ILW volume of 1647m^3, Variant 2 calculated an operational ILW volume of 2285m^3.

- 3237.8m^3 packaged operational ILW, which equates to 54m^3 per year;
- 212.1m^3 decommissioning ILW.

Generic PWR

D10. We have assumed a generic PWR with an electrical power output of 1.35GW(e) operating for 40 years.

D11. Spent fuel arisings: we have assumed that this generic PWR produces 37 assemblies per GW per year, which equates to 50 assemblies per year, i.e. 2000 assemblies, or 500 canisters, over a 40 year operating life.

D12. ILW arisings: we have assumed that this generic PWR produces 40m^3 of operational ILW per year, which equates to 1600m^3 over a 40 year operating life. We have further assumed that the generic PWR produces 400m^3 of decommissioning ILW. This gives a total of 2000m^3 of packaged ILW for disposal.

Annex E: derivation of the Projected Risk Premium for Worked Example 1

E1. The Waste Transfer Price will include a Risk Premium, representing the level of contingency that the Government will require, over and above the Best Cost Estimate, at the time the Waste Transfer Price is set to compensate the taxpayer for accepting the risk of subsequent cost escalation. Therefore the Expected Price needs to incorporate a Projected Risk Premium, i.e. an estimate of the level of the Risk Premium when the Waste Transfer Price is set at the end of the Deferral Period.

E2. The Projected Risk Premium will need to be proportionate to the level of risk expected to be assumed by the Government in fixing the Waste Transfer Price ahead of the actual date of waste disposal. The purpose of deferring the setting of the Waste Transfer Price is to reduce uncertainty over estimated costs and by the end of the Deferral Period the level of uncertainty should be low.

E3. When an Expected Price is first requested by a prospective Operator the Government will undertake an exercise to determine a projected value for the Risk Premium that will be applied in setting an Expected Price prior to GDF Site Selection. This projected Risk Premium is expected to take the form of a percentage uplift on estimated cost. Worked Example 1 illustrates how an Expected Price would be calculated before GDF Site Selection. This Annex sets out how the Projected Risk Premium in Worked Example 1 was calculated.

E4. It should be noted that this exercise applies only in relation to the Interim Approach described in Annex A. Once there is a Site Specific Cost Estimate the Interim Approach, and hence this exercise, will no longer be needed.

E5. This exercise calculates the projected Risk Premium through assessing the likely level of residual uncertainty in several different classes of costs. This analysis broadly follows the approach set out in NDA's cost estimating guidance PCP09[23], which identifies four classes of estimates and provides suggested values for an appropriate contingency at various project stages. The values used in this exercise are set out in Table 8.

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[23] NDA Project Controls Framework Document PCP-M, available at http://www.nda.gov.uk/documents/upload/PCP-M-Project-Controls-Framework-Document-Rev1.pdf

Estimate classification	Indicative uncertainty range
Class A Detailed	-5% to +10%
Class B Intermediate	-10% to +20%
Class C Preliminary	-10% to +30%
Class D Planning	-10% to +40%

Table 8: indicative uncertainty ranges for different estimate classifications.

E6. It is acknowledged that this NDA Guidance was not drafted for this purpose and it is not a perfect fit. In particular the time horizons in the Waste Transfer Pricing Methodology are much longer than envisaged in PCP09. However the NDA Guidance is considered to provide a reasonable starting point for this exercise to derive a projected Risk Premium.

E7. As a range of values is given for the indicative uncertainty range, a formula is required to determine the appropriate level of the projected Risk Premium. As it is not possible to produce a distribution from which a P_{95} value can be derived, a simplified approach has been adopted to determine a P_{95} value, as set out below:

- P_{50} = (Minimum + (4 x Most Likely) + Maximum) / 6;
- P_{95} = P_{50} + ((Maximum - P_{50}) / 5 x 4.5) (i.e. 45% of the difference between P_{50} and Maximum).

GDF Fixed Costs

E8. For this worked example it is assumed that most Fixed Costs will have been incurred in full by the end of the Deferral Period. Hence these costs will not be subject to any "estimating uncertainty". The only uncertainty will be around estimates of those Fixed Costs to be incurred after Last Waste Emplacement (which are estimated to be around 10% of total estimated Fixed Costs). Hence:

- Fixed Costs prior to First Waste Emplacement are known and therefore not subject to any uncertainty, i.e. 90% of the Fixed Costs estimate is subject to 0% estimating uncertainty;
- There is considerable uncertainty over the Fixed Costs following Last Waste Emplacement, equating to estimating class D, i.e. 10% of the Fixed Costs estimate is subject to estimating uncertainty in the range -10/+40%.

E9. This gives a projected Risk Premium for Fixed Costs of 3.65%, as derived in Table 9.

Estimate Class Split	Estimate Class	Minimum		Most Likely	Maximum		P50	P95
90%	N/A	0%	90	90	+0%	90	90.00	90.00
0%	A	-5%	0	0	+10%	0	0	0
0%	B	-10%	0	0	+20%	0	0	0
0%	C	-10%	0	0	+30%	0	0	0
10%	D	-10%	9	10	+40%	14	10.5	13.65
Total	(90.00 + 13.65) – 100 = 3.65%							

Table 9: derivation of Fixed Costs projected Risk Premium.

Variable Costs

E10. Some of the Variable Costs of waste emplacement should be subject to limited estimating uncertainty, as underground operations are assumed to be underway by the end of the Deferral Period. This means that actual data will be available on the costs of many waste disposal activities. The main estimating uncertainties will stem from the extended period there will be between the setting of the Waste Transfer Price and the disposal of new build wastes and the consequent risk that new or unexpected costs could emerge. Some allowance should be made for this risk, although this should to some extent be offset by the opportunities to reduce costs that should arise as a result of learning over time.

E11. It is currently envisaged that ILW emplacement will begin first. NDA's planning assumptions lead to first emplacement of HLW/spent fuel in 2075. Therefore there should be significantly less uncertainty over ILW disposal costs than over spent fuel disposal costs. However even for spent fuel, although emplacement is not expected to have begun by the end of the Deferral Period there will be actual cost data for many of the operating costs of the GDF, which are captured within the Variable Costs estimate. This worked example assumes:

- There is a high degree of confidence over Variable Costs relating to ILW disposal, equating to estimating Class A, i.e.100% of the ILW Variable Costs estimate is subject to estimating uncertainty in the range -5/+10%.
- There are varying degrees of confidence over the Variable Costs relating to spent fuel disposal. It is assumed that 50% of the spent fuel Variable Costs will be subject to uncertainty equivalent to estimating Class B. i.e. subject to estimating uncertainty in the range -10/+20%, and 50% of the spent fuel will be subject to uncertainty equivalent to Class C, i.e. with estimating uncertainty in the range -10/+30%.

E12.This gives the following figures, as derived in Tables 10 and 11:

- Projected Risk Premium for spent fuel Variable Costs is 22.75%;
- Projected Risk Premium for ILW Variable Costs is 9.08%.

Estimate Class Split	Estimate Class	Minimum		Most Likely	Maximum		P50	P95
0%	N/A	0%	0	0	+0%	0	0	0
0%	A	-5%	0	0	+10%	0	0	0
50%	B	-10%	45	50	+20%	60	50.83	59.08
50%	C	-10%	45	50	+30%	65	51.67	63.67
0%	D	-10%	0	0	+40%	0	0	0
Total	(59.08 + 63.67) – 100 = 22.75%							

Table 10: derivation of spent fuel Variable Costs projected Risk Premium.

Estimate Class Split	Estimate Class	Minimum		Most Likely	Maximum		P50	P95
0%	N/A	0%	0	0	+0%	0	0	0
100%	A	-5%	95	100	+10%	110	100.83	109.08
0%	B	-10%	0	0	+20%	0	0	0
0%	C	-10%	0	0	+30%	0	0	0
0%	D	-10%	0	0	+40%	0	0	0
Total	109.08 – 100 = 9.08%							

Table 11: derivation of ILW Variable Costs projected Risk Premium.

Projected Risk Premium

E13.For both spent fuel and ILW, the figures derived in Worked Example 1 have Variable Costs as 62% of total costs and Fixed Costs as 38% of total costs, therefore:

- the projected Risk Premium for spent fuel is (0.62 x 22.75%) + (0.38 x 3.65%) = 15.49%;
- the projected Risk Premium for ILW is (0.62 x 9.08%) + (0.38 x 3.65%) = 7.02%.

Annex F: derivation of the Contingency Allowance for Worked Example 2

F1. As set out in Annex B, the derivation of a Risk Adjusted Cost Distribution for the purposes of setting a Cap requires a Contingency Allowance to adjust for Out-of-Model Risks.

F2. This Annex, which reproduces the analysis set out in Annex C of the March 2010 consultation, describes the six risks that have been considered when deriving the Contingency Allowance for inclusion in Worked Example 2. It should be noted that this calculation is also a worked example. This is not necessarily a definitive list of the risks that will be taken into account when determining a Contingency Allowance for the purposes of setting a Cap. It is anticipated that an exercise to determine a Contingency Allowance will be carried out, following a process similar to this one, each time an Operator requests a Cap.

F3. The Risks have been classified into two groups:

- Group A Risks relate to the possibility that the fundamental assumptions underpinning the Parametric Cost Model's estimation of waste disposal costs do not correspond to the final outcome.
- Group B Risks relate to the possibility that the assumptions made in applying the Parametric Cost Model to the estimation of new build disposal costs do not correspond to the final outcome.

Group A Risks

F4. Like all cost models, the Parametric Cost Model is based on a number of underlying assumptions. This group of risks considers the possibility that some of the key assumptions do not reflect what actually happens when a GDF is built and operated. Three key assumptions have been identified and taken into account in the calculation of the Contingency Allowance.

F5. It should be noted that the risks around these assumptions apply equally to estimates of disposal costs for new build and legacy material. Hence a new build Operator's share of the allowance for these risks is determined in line with the apportionment of Fixed Costs.

A1: Risk that the KBS-3 disposal concept (for HLW/spent fuel) and immobilisation in grout disposal concept (for ILW/LLW) are not adopted

Description of the risk

F6. The Parametric Cost Model assumes that a GDF will be built according to the KBS-3 concept for HLW/spent fuel disposal and the immobilisation in grout concept for ILW/LLW disposal. The choice of disposal concept fundamentally affects GDF design and therefore cost and the Parametric Cost Model's assumptions are subject to change. The Committee on Radioactive Waste Management (CORWM) for example has noted that there are a number of possible disposal concepts and has recommended that NDA avoid giving the impression that it prefers one concept or design[24].

F7. It should be noted that this risk relates only to scenarios where a *fundamentally* different disposal concept is adopted. Smaller design modifications, such as those that might be implemented in response to specific operational issues at the site of a GDF, would be regarded as project uncertainties, and thus would be an In-Model Risk.

Consequence

F8. It is difficult to estimate the cost impact of applying a different disposal concept. It is not necessarily the case that this would increase costs. Indeed, a key driver for the adoption of a different disposal concept might be to reduce expected costs.

F9. NDA has carried out some limited, high-level analysis of the cost impact of adopting different disposal concepts for the disposal of spent fuel. It has considered ten alternative concepts[25] and examined their potential cost impact by flexing those parameters of the Parametric Cost Model that are expected to be affected. In taking account of different disposal concepts the Parametric Cost Model only flexes the construction costs associated with the excavation size and underground layout and does not alter the cost of the emplacement equipment or backfill material. On the basis of this exercise they found that the changes in disposal concept that they examined implied a relatively modest variation in cost. Some concepts were found to imply higher costs than the KBS-3 concept assumed in the Parametric Cost Model, while others implied lower costs.

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[24] CoRWM July 2009 report on geological disposal, e.g. paragraph 12.54: available at http://www.corwm.org.uk/.

[25] The ten concepts considered are drawn from the paper "Geological Disposal Options for High-Level Waste and Spent Fuel". This paper examined a total of 12 different concepts, of which two ("hydraulic cage" and "very deep boreholes") were excluded on the basis that there was no data on which to estimate the likely costs of adopting these concepts.
http://www.nda.gov.uk/loader.cfm?csModule=security/getfile&pageid=20941

F10. In order to quantify the consequence of this risk, this exercise has drawn on NDA's work but recognises that it was a limited, high level analysis. Therefore a pragmatic approach has been adopted, in which this risk is allowed for through a 3-point estimate, derived on the basis of a proportion of estimated costs. This distribution assumes that the range of possible consequences for this risk is to vary costs by +/-10%, with the most likely outcome being disposal costs at the level predicted by the Parametric Cost Model (i.e. a triangular distribution with a minimum of -10%, mode of 0% and maximum of +10% of estimated costs).

F11. Although the analysis from NDA on the cost impact of adopting different disposal concepts has been focused on spent fuel, the same distribution is also used in this exercise to estimate the consequence of this risk for the cost of disposing of ILW.

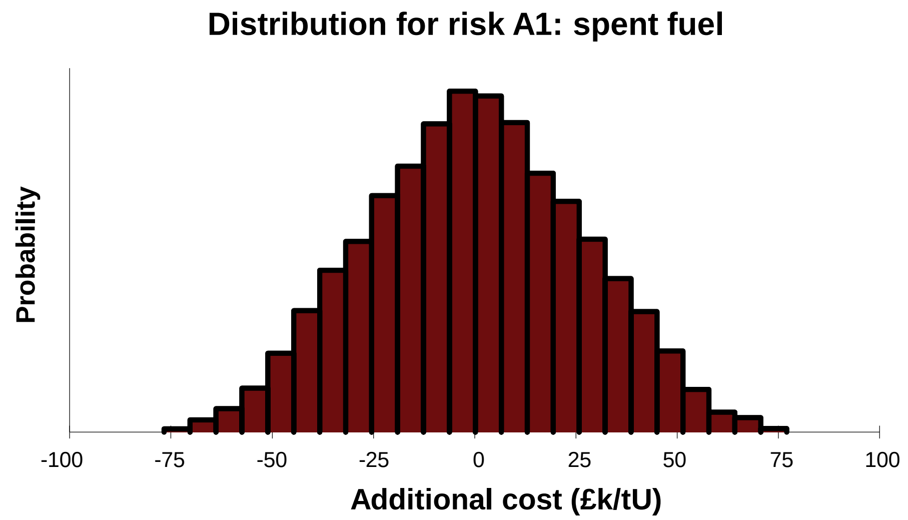
F12. The cost estimate to which this uncertainty is applied is derived earlier in the calculation. These figures are obtained from Step 14a of the Methodology as applied in Worked Example 2, which is where the estimated costs from the Parametric Cost Model for each scenario have been uplifted for Optimism Bias and then combined by Monte Carlo methods to produce a distribution.

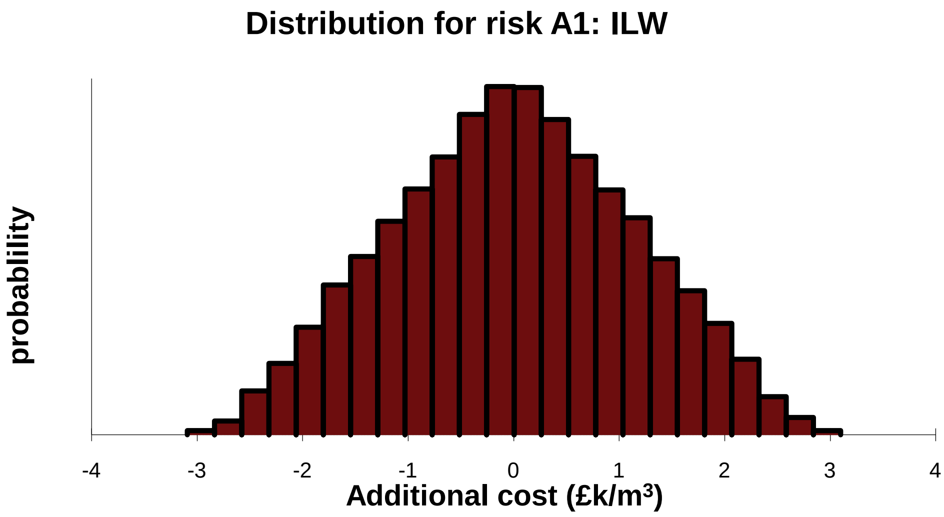
F13. In Worked Example 2 this has the following distributions for total unit costs:

- for spent fuel a distribution for Total Costs per tU with a minimum of £541.4k, a P_{50} of £573.7k and a maximum of £754.7k;
- for ILW a distribution for Total Costs per m^3 with a minimum of £25.7k, a P_{50} of £26.7k and a maximum of £31.8k.

F14. Hence to derive a distribution for the cost implications of this risk, these cost distribution is combined by Monte Carlo methods with the triangular distribution from paragraph F10 above. This gives the following distributions:

- for spent fuel a distribution per tU with a minimum of £-74.1k, a P_{50} of £0.1k and a maximum of £73.3k;
- for ILW a distribution per m^3 unit with a minimum of £-3.1k, a P_{50} of £0k and a maximum of £3.1k.





A2: Risk that it is not possible to build a single GDF for the disposal of both HLW/spent fuel and ILW ("co-location")

Description of the risk

F15. The MRWS White Paper said that it would be possible to build more than one GDF, for example one for ILW/LLW and one for HLW/spent fuel, and that this could be necessary if the geology at potential sites was not suitable for a "co-located" GDF. However the MRWS White Paper also said that "the Government sees no case for having separate facilities if one facility can be developed to provide suitable, safe containment for the Baseline Inventory"[26].

F16. However this will remain uncertain until a safety case can be made for a co-located facility at a specified site. This is another issue discussed in CoRWM's 2009 report on geological disposal[27].

F17. It should be note that this risk is different to the risk that a second GDF might be needed due to the volume of waste for disposal in the case that the new build fleet is very large. This risk is handled at Step 4 of the Methodology.

[26] MRWS White Paper page 29
[27] CORWM report on geological disposal see paragraphs 12.30 to12.39

Consequence

F18. If co-location is not possible, two GDFs would have to be built, with two sets of Fixed Costs. It is possible that a simple doubling of the Fixed Cost estimate from the Parametric Cost Model might overstate total cost in this scenario, as the cost of each GDF in this scenario might be somewhat lower than the cost of a single GDF for all wastes. NDA has estimated the cost of two separate GDFs for ILW/LLW and HLW/spent fuel using the Parametric Cost Model and found that the reduction in the Fixed Costs is very small (in the order of 1-2%). There may however also be some reduction in costs in building a second GDF as a result of learning from experience.

F19. Therefore it has been assumed for this exercise that the cost impact of not being able to implement co-location would be that two GDFs would be built, each of them having Fixed Costs of 95% of a co-located GDF. The costs of both GDFs must be shared between new build and legacy material. As each GDF now only contains a single category of waste we can apportion between the two simply on the basis of quantity.

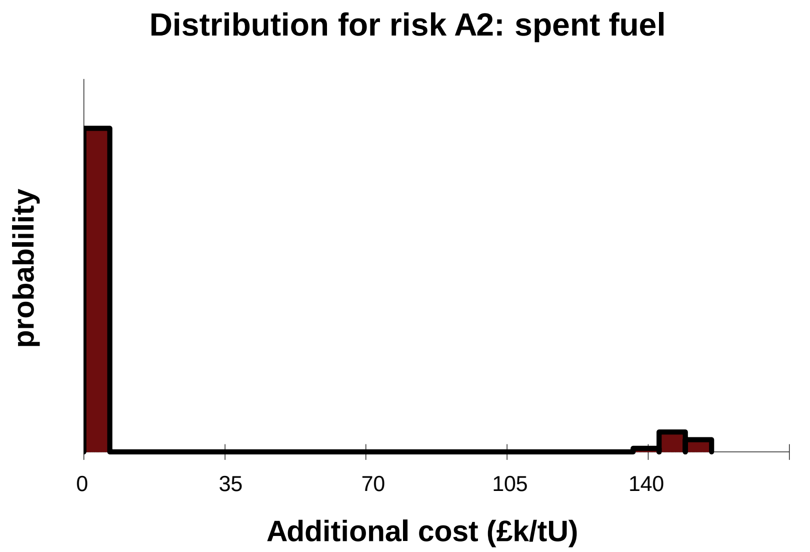
F20. Worked Example 2 includes assumptions on both the legacy inventory and the assumed inventory of spent fuel from a new nuclear power station. The derivation of these assumptions is set out in Annex D. On the basis of those assumptions:

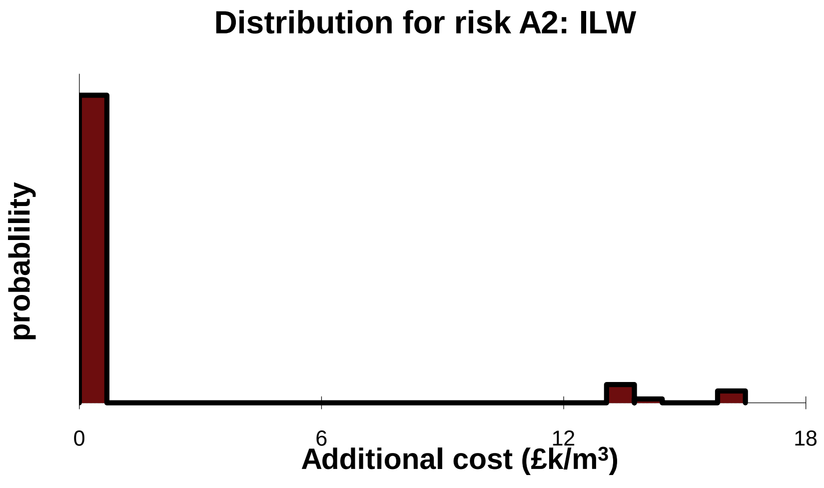
- A new nuclear Operator's share of the Fixed Costs of a dedicated HLW/SF GDF would be 4% (based on a generic spent fuel inventory of 500 disposal canisters per reactor, an assumed new build fleet of four power stations and an estimated legacy inventory of 10,659 canisters).
- A new nuclear Operator's share of the Fixed Costs of a dedicated LLW/ILW GDF would be 0.5% (based on a generic ILW inventory of 2,000m^3 per reactor, an assumed new build fleet of four power stations and an estimated legacy inventory of 390,000m^3).

F21. This contribution to the Fixed Costs can then be apportioned on a per unit basis and the additional cost that would result can be calculated. The consequence of this risk, per unit of spent fuel or ILW, is therefore the Fixed Cost contribution per unit based on two dedicated GDFs, less the Fixed Cost per unit based on a co-located GDF. It should be noted that this is not a single number, as the estimate of costs per unit is in both cases a distribution (because it has been derived through combining by Monte Carlo methods the cost estimates for each disposal scenario).

F22. In the absence of any information that permits an accurate estimate of the probability of this scenario, in this exercise a probability of 10% has been assigned to this risk. However this risk is different in kind from A1. This is a discrete event that is assumed to occur 10% of the time. Therefore the distributions associated with the risk for spent fuel and ILW each have simply two discrete values: the additional cost as calculated above, or zero. These distributions do not, in any meaningful sense, have a mean, as can be seen from the charts shown below[28]. This gives the following distributions:

- for spent fuel a distribution per tU with a minimum of £0 and a maximum of £151.2k;
- for ILW a distribution per m^3 with a minimum of £0 and a maximum of £16.5k.





[28] It can be seen from the charts that there are three distinct values at the right hand side. This is because there is uncertainty over the Fixed Costs of a GDF and this depends in particular on the geological environment in which it is constructed. A GDF built in soft rock would have higher Fixed Costs than a GDF built in hard rock or evaporites, and thus the cost impact of this risk varies according to the geology assumed.

A3: Risk that the GDF is not closed immediately after last waste emplacement

Description of the risk

F23. This subject was also discussed in the MRWS White Paper, which said that "closure at the earliest opportunity once facility waste operations cease provides greater safety, greater security from terrorist attack, and minimises the burdens of cost, effort and worker radiation dose transferred to future generations". However it also said that "Government's view is that the decision about whether or not to keep a geological disposal facility (or vaults within it) open once facility waste operations cease can be made at a later date"[29].

F24. There are two reasons in particular why immediate closure might not be adopted:

(i) to allow for the possible retrieval of waste materials (perhaps due to concern over the performance of a GDF);

(ii) a care and maintenance period, perhaps whilst the performance of the facility is subject to extended monitoring.

Consequence

(i) Possible retrieval of waste

F25. In the case of waste from new nuclear power stations, no disposal is envisaged until a GDF has been open for a substantial period of time (on the basis of NDA's current planning assumptions this could be 90 years). This should be a sufficient time period for any substantial problems to be identified. Only in the absence of such problems would emplacement of new build wastes take place. If such problems were encountered there might be a delay in the final disposal of new build wastes, hence requiring an extension to the period of interim storage, but this risk is covered by Risk B2 below. Therefore we do not consider that there should be an element of the Contingency Allowance relating to possible retrieval costs.

(ii) Care and maintenance period

F26. The current assumption is that a GDF will be backfilled as soon as possible, but it is not inconceivable that circumstances may require backfilling to be deferred. Maintaining an open facility will incur care and maintenance costs.

F27. It is assumed that a care and maintenance period would only be adopted in order to able to confirm that the GDF is performing as expected. As indicated in the above discussion around possible retrieval of waste, it is assumed that the longer a GDF operates without problems being identified, the less likely it is that problems will subsequently arise necessitating either long term monitoring or retrieval.

F28. One of the factors that will determine the operational life of a GDF is the volume of new build wastes to be disposed of within it. Therefore the materiality of this risk varies with the size of the new build fleet. The larger the new build fleet, the longer the operational life of a GDF and therefore the less likely it is considered to be that

[29] See MRWS White Paper page 28.

a care and maintenance period would be required between last waste emplacement and final closure.

F29. Worked Example 2 assumes a fleet of four new nuclear reactors, as this is considered a conservative assumption for the purposes of calculating a Cap. In this case it is considered necessary to take account of the risk that a care and maintenance period might be needed.

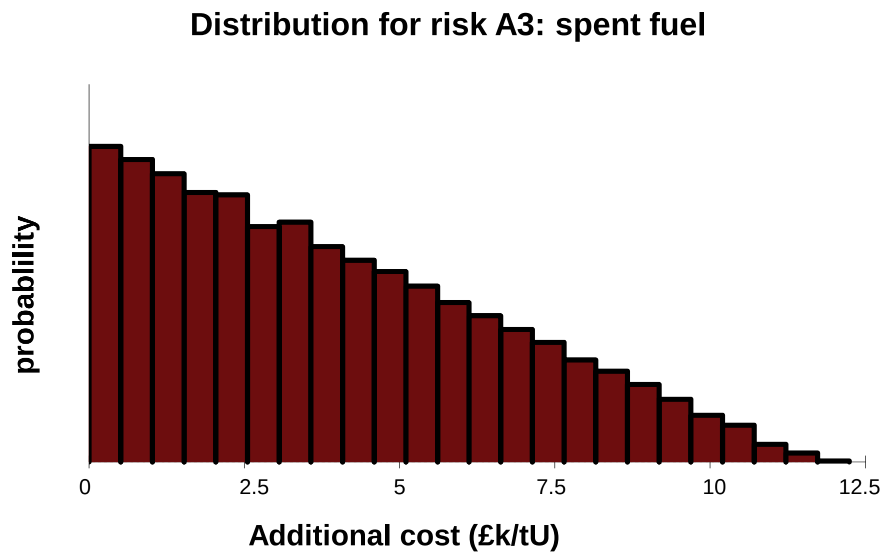
F30. Using the Parametric Cost Model NDA has estimated the cost impact of a 50 year care and maintenance period. It estimated that the costs would be of the order of £10m per year. Beyond this point costs are likely to escalate because of the need for major refurbishments. In deriving an allowance for this it is assumed that care and maintenance beyond 50 years is unnecessary. This period should have been sufficient to demonstrate satisfactory performance.

F31. If costs are apportioned in the same way as the Fixed Costs of a GDF are apportioned in this Methodology (i.e. in proportion to share of total Variable Costs) the estimated annual cost of £10m over 50 years translates to a total additional cost of £24.0k per canister of new build spent fuel, which is £11.7k/tU, and £0.5k per m^3 of ILW.

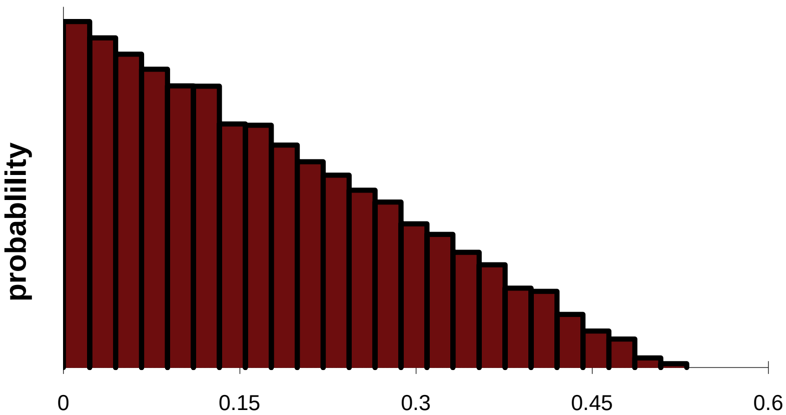
F32. In order to derive a distribution of estimated costs for this exercise it is assumed that the minimum and the mode coincide at zero years – this is chosen to reflect the fact that monitoring the facility through its operational life might provide sufficient confidence that its performance is satisfactory to permit backfilling. The maximum duration is taken to be 50 years in accordance with the argument above.

F33. This gives the following distributions for this risk:

- for spent fuel a distribution per tU with a minimum of £0k, a P_{50} of £3.8k and a maximum of £11.7k.
- for ILW a distribution per m^3 with a minimum of £0k, a P_{50} of £0.2k and a maximum of £0.5k.



Distribution for risk A3: ILW



Group B Risks

F34. A number of assumptions have been made in order to use the Parametric Cost Model to estimate the costs of disposing of new build ILW and spent fuel in a GDF. This group of risks considers the consequences if some or all of these assumptions do not correspond to the actual outcome when new build waste is emplaced in a GDF.

F35. It should be noted that, in contrast to the risks in Group A, these risks apply solely to the estimation of waste disposal costs for new build. Hence the contingencies identified here are to be borne by new build alone and not shared with legacy.

B1: Risk that emplacing new build wastes in the same GDF as legacy leads to additional Fixed Costs

Description of the risk

F36. The Methodology set out in Section 1 assumes that the emplacement of new build wastes in a GDF, which has been designed and built for the disposal of legacy wastes, does not entail any additional Fixed Costs. However there are a number of scenarios in which the addition of new build wastes to the existing inventory of waste materials for disposal might lead to additional Fixed Costs:

(i) There is a risk that, as a result of the lifetime of a GDF being extended significantly to accommodate new build wastes, some of the shared facilities might need replacement or refurbishment, over and above the routine maintenance factored into the Parametric Cost Model's cost estimates.

(ii) It is possible that the design of a GDF might be amended to reflect the larger inventory implied by the inclusion of new build wastes. These changes might be to increase either GDF throughput or GDF lifetime, and might imply greater Fixed Costs.

(iii) There is a risk that, as a result of the new build fleet being large, the total waste inventory might lead to a second GDF being required.

Consequence

F37. The materiality of these risks depends on the size of the new build fleet. If there is only a small number of new nuclear power stations then these risks are considered negligible, but they become significant in the event the new build fleet is large.

F38. However as the new build fleet grows larger so does the contribution made by new build Operators to GDF Fixed Costs through the Waste Transfer Price. For example, the calculations in the worked examples show that a considerable proportion of the Waste Transfer Price is calculated with reference to the contribution to GDF Fixed Costs and each new nuclear power station would be contributing a substantial amount towards GDF Fixed Costs. It seems a reasonable assumption that any additional costs that result from risks (i) and (ii) materialising will be more than offset by the additional funds provided by new nuclear Operators to pay towards the Fixed Costs of the GDF.

F39. This is not necessarily the case for risk (iii) but, as set out in Section 1 the current assumption is a single GDF for the disposal of all legacy and new build wastes (however the Methodology retains the flexibility to revise this assumption at a later date if needed).

F40. Therefore it is not proposed to include an element relating to risk B1 in the Contingency Allowance.

B2: Risk that an inaccurate date is set for the start of new build waste emplacement

Description of the risk

F41. As set out in Section 1, in order for the Operator to estimate and make prudent provision in their FDP for waste management costs the Operator will need to know the expected time period over which they must make prudent provision for interim storage costs. Therefore the Government will provide the Operator with an "Assumed Disposal Date". In the event that a GDF were not available at the Assumed Disposal Date, the Government would bear the cost of continued interim storage.

F42. NDA's current planning assumptions are that a GDF will be operational in 2040, legacy spent fuel/HLW disposal is estimated to begin in 2075 and be completed by around 2130 for the assumed inventory set out in Annex D. At this point it is expected that the disposal of new build spent fuel would begin (it is possible that the disposal of new build ILW could begin earlier). However these dates are based on assumptions (for example around the duration of the site selection and construction phases, and on the rate of waste emplacement in the GDF once it is operational) and are subject to considerable uncertainty.

Consequence

F43. If disposal facilities are not available on the Assumed Disposal Date, the Government will face additional interim storage costs and, in the event that disposal is delayed substantially, there might also be costs relating to the rebuilding of interim stores and repackaging of wastes.

F44. However a delay to the disposal of new build wastes implies that the expenditure on the Variable Costs associated with disposing of those wastes would also be delayed. This would serve to reduce the "net present value" of those costs to the Government at the Assumed Disposal Date, due the effect of discounting.

F45. As an example, take the case where at the Assumed Disposal Date the Government expects the Variable Cost of disposing of a canister of spent fuel to be £1m. If disposal is delayed, then the net present value of the liability the Government faces is reduced. At a discount rate of 2.2% (which is the required discount rate for NDA's liabilities), for each year of delay the net present value of the Government's liability for disposing of the canister would be reduced by £22k.

F46. This is likely to be substantially higher than the additional costs being incurred in this case; the current estimate of maintaining an interim store is in the region of perhaps £4-6k per canister per year. In the event of an extended delay it seems a reasonable assumption that cumulative impact of discounting on disposal costs would more than offset the additional costs around refurbishment of interim stores and possible repackaging.

F47. Therefore, although there would be extra costs to the Government resulting from an extended period of interim storage prior to final disposal, it is expected that the monies provided by the Waste Transfer Price should be sufficient to meet these additional costs without the need to include an extra element in the Contingency Allowance specifically to address Risk B2.

B3: Risk that the GDF cannot operate optimally during emplacement of new build spent fuel

Description of the risk

F48. The estimation of the Variable Costs of disposal for spent fuel from new nuclear power stations relies on two key assumptions around the operation of a GDF:

- that each disposal canister is filled to its maximum capacity of four fuel assemblies;
- that a GDF is able to emplace the disposal canisters at the same rate (200 per year) that has been assumed for the disposal of legacy wastes.

F49. It is on this basis that it is assumed that the spent fuel inventory used in the worked examples, which is 2000 fuel assemblies (based on a generic 1.35 GW PWR operating for 40 years), is translated to 500 disposal canisters, and disposal of this inventory is assumed to take two and a half years.

F50. However this assumes that all the new build spent fuel is ready for disposal at the allotted time. The assessments of the disposability of new build spent fuel carried out as part of the Generic Design Assessment have found that if all new build spent fuel were to be subject to the maximum burn-up considered, which is 65GWd/tU, then the spent fuel might need around 100 years of cooling in interim storage before it could be disposed of in a GDF (assuming the KBS-3 copper canister, subject to the current assumed surface temperature constraint and filled with the maximum four spent fuel assemblies)[30].

F51. As set out above, the current best estimate of when spent fuel from a new nuclear power station can begin to be emplaced in a GDF is 2130. For a reactor that starts operating in 2020 and operates for 40 years this means its spent fuel will be due for disposal 70 years after end of generation. In this case the reactor's total spent fuel inventory would have been subject to an average of 90 years cooling, and the fuel discharged at end of generation would have been cooled for 70 years at the point of disposal, whereas that produced at the start of generation would already have been cooled for 110 years.

Consequence

F52. This risk is related to the heat output of the disposal canister at the point of disposal, so applies only to spent fuel and not to ILW.

F53. The finding in NDA's disposability assessments was based on some very conservative assumptions. In particular it assumed that all fuel assembles are subject to the maximum burn up, whereas in practice there will be some variation in burn up across the inventory of spent fuel from a new nuclear power station, and the average burn up will be lower than the maximum possible. This would reduce the cooling time required – and as an example NDA also calculated that for spent fuel with an average burn up of 50GWd/tU, a cooling period of around 75 years would be required. There is also mitigating action that could be taken to reduce the heat load of a given spent fuel canister, such as mixing hotter and cooler fuel assemblies in each canister.

F54. However the Contingency Allowance should consider the risk that at the scheduled point of disposal some of a new nuclear Operator's spent fuel is too "hot" for disposal in accordance with the assumptions made in this Methodology. In this case the GDF operator would have the choice either of delaying disposal to allow further cooling in interim storage, or putting fewer assemblies in each canister to allow disposal to continue as scheduled.

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[30] The Summary Disposability Assessment for the AP-1000 page 5.
http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-DA-for-Wastes-and-SF-arising-from-Operation-of-APPWR-October-2009.pdf.
Summary Disposability Assessment for the EPR page 6.
http://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-Disposability-Assessment-for-Wastes-and-Spent-Fuel-arising-from-Operation-of-the-EPWR.pdf

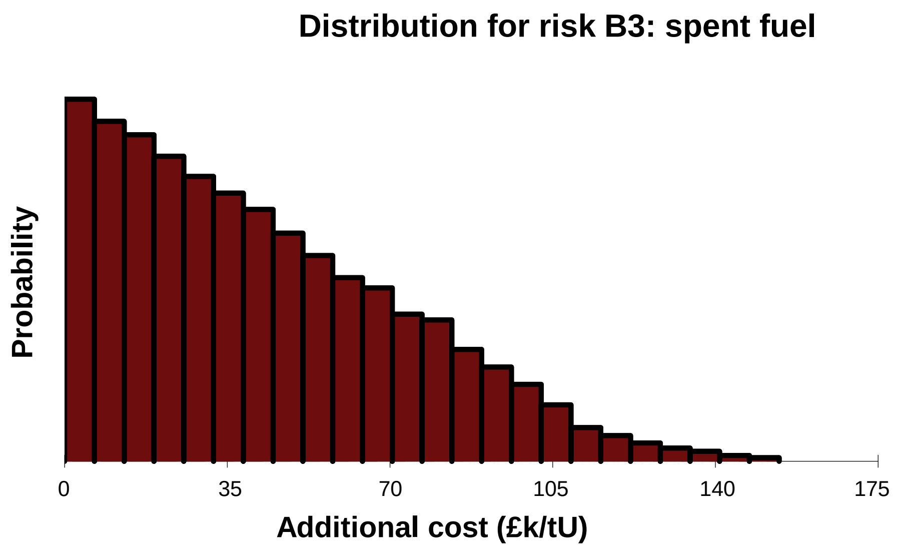
F55. This worked example assumes that the GDF operator would prefer to continue with disposal at the maximum throughput rate, rather than to reduce throughput or put the GDF into care and maintenance while the spent fuel was subject to further cooling. This would entail filling some canisters with fewer than the maximum four assemblies, and therefore more canisters would be required. On the basis of NDA's findings it has been calculated that around 20% more canisters might be needed in this case[31], which would translate into an uplift of 20% in the Total Unit Cost Estimate derived in this Methodology.

F56. Therefore for this risk, the worst case is a 20% uplift in unit cost. For this exercise it is assumed that the minimum cost and the mode coincide at zero – this is chosen to reflect the fact that the NDA finding that 100 years cooling might be required is based on some very conservative assumptions.

F57. As with other risks in this exercise the cost estimate to which this uncertainty is applied is derived from Step 14a in Worked Example 2, which has a distribution for the costs per tU of spent fuel with a minimum of £541.4k, a P_{50} of £573.7k and a maximum of £754.7k.

F58. This gives the following distribution for this risk:

- for spent fuel a distribution per tU with a minimum of £0k, a P_{50} of £41.7k and a maximum of £148.4k.

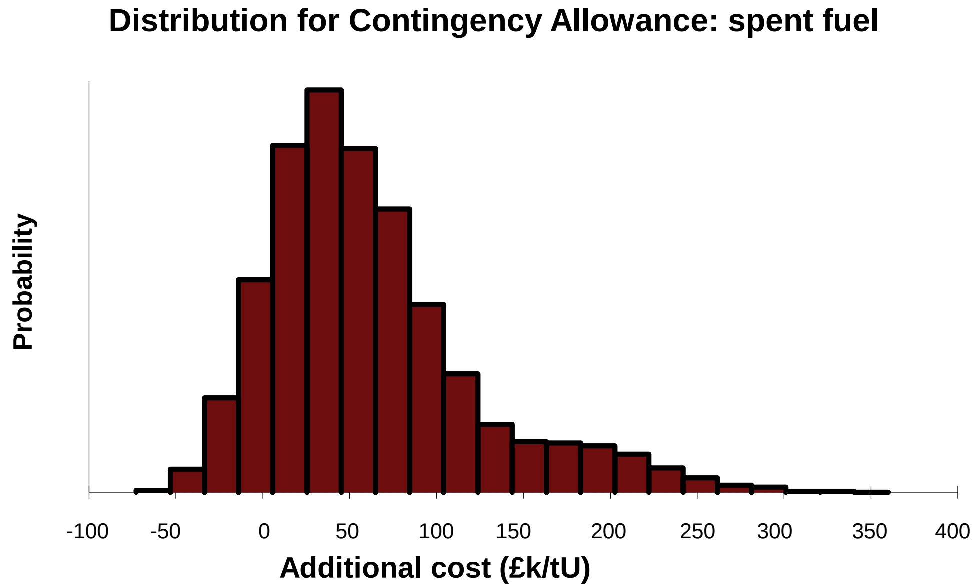


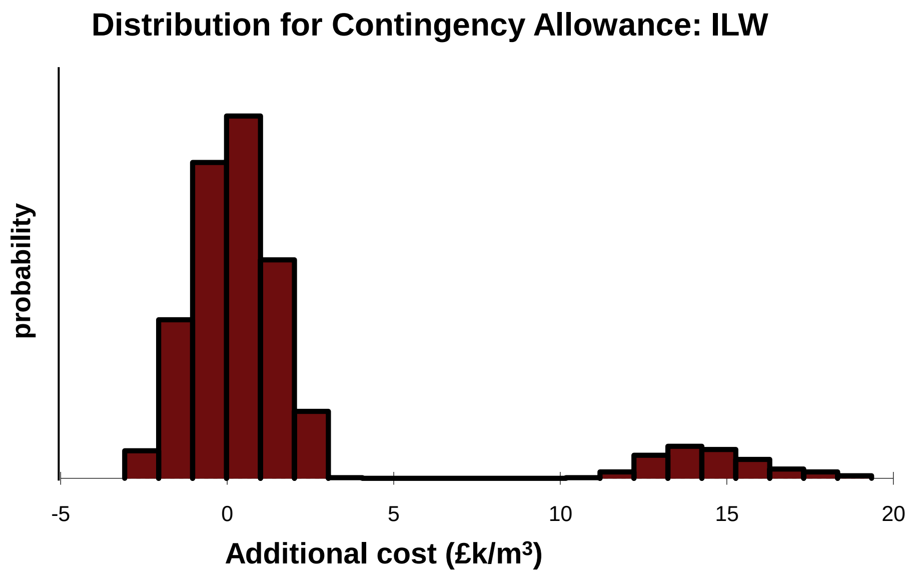
[31] This calculation is based on the assumption that not all fuel assemblies will have reached 65 GWd/tU burn up. In particular, some fuel from the first and last discharges will have been subject to burn-up substantially lower than the others. It is assumed that therefore one of these assemblies could be disposed of in a canister containing three assemblies of higher burn up fuel. Therefore some canisters would still be disposable while holding four assemblies.

Overall contingency distributions

F59. These are derived by combining the various distributions derived above by Monte Carlo methods to give a single distribution. For this worked example this gives the following distributions for the Contingency Allowance:

- for spent fuel a distribution per tU with a minimum of £-64.7k, P_{50} of £48.2k and maximum of £342.2k;
- for ILW a distribution per m^3 with a minimum of £-3.0k, P_{50} of £0.3k and a maximum of £19.5k.[32]





[32] It can be seen that the distribution for ILW is "bi-modal", i.e. it has two distinct peaks. This is because of the effect of risk A2, which is bi-modal and is the largest element in the overall ILW contingency distribution. The distribution for spent fuel is not bi-modal. This is because although risk A2 is also important for spent fuel, Risk B3, which does not apply to ILW, is comparable in scale and has a "smoothing" effect on the overall spent fuel distribution.

Section 3: The Government Response to the Consultation on an updated Waste Transfer Pricing Methodology

Introduction

3.1 The consultation document published in December 2010 set out:

- the Government Response to the March 2010 consultation;
- the key changes that had been made as a result of the March 2010 consultation; and
- an updated Methodology for further consultation.

3.2 The December 2010 consultation sought responses to three questions contained in the consultation document. The deadline for responses was 8 March 2011. A total of 34 written responses were received. A list of those who responded to the consultation is set out in Annex G and the responses are available on the DECC website[33]. In addition to written responses, views were also provided in a consultation event held in London on 22 February 2011. The Cabinet Office Code of Practice on Consultation 2008[34] applied to this consultation.

3.3 This section sets out the Government's response to the views expressed in the consultation. It is organised into sections on the three questions posed in the consultation document, each of which sets out a summary of the comments received followed by the Government's response. The views expressed in the consultation have been taken into account in the final proposals set out in Section 1.

[33] http://www.decc.gov.uk/en/content/cms/meeting_energy/nuclear/new/waste_costs/waste_costs.aspx.

[34] http://www.berr.gov.uk/files/file47158.pdf

Comments received during the Consultation and the Government's response

Consultation Question 1:

Do you agree or disagree that the level of the Waste Transfer Price should be subject to a Cap and that in return for setting a Cap the Government should charge a Risk Fee? What are your reasons?

Summary of comments

3.4 Some respondents agreed with the proposal to set a Cap on the level of the Waste Transfer Price. Several respondents considered that this was appropriate given that Operators of new nuclear power stations would have very limited scope to manage the cost risks around waste disposal and hence clarity on maximum cost was necessary to seek financing.

3.5 However other respondents did not agree with the proposal to set a Cap. It was argued that this exposed the taxpayer to unacceptable levels of risk. Some responses referred to the very long timescales involved, arguing that it was not possible to adequately incorporate risk and uncertainty into cost estimates. Others disagreed with the view in the consultation that the Government could manage the risks around waste disposal costs. Given that the Government had accepted that there was no guarantee that the Cap would not be exceeded, a number of responses considered that, in transferring risk from the Operator to the taxpayer, the Cap represents a subsidy to new nuclear power. Those opposed to setting a Cap argued that Operators' liability for their waste disposal costs should not be limited and their price should not be set until disposal has taken place.

3.6 Several responses argued that the approach set out in the consultation for deriving a Cap was too conservative, resulting in the Cap being set at an unreasonably high level. Some suggested that technological change would be likely to lead to reduced costs. However other responses pointed to factors that might lead to the Cap being set too low, pointing for example to the history of overspends on UK nuclear projects.

3.7 A number of responses favoured setting the Cap based on very conservative assumptions, agreeing with the consultation that the Cap should be set at a level where the Government has a very high level of confidence that costs will not exceed the Cap. There were some comments on the manner by which the illustrative value for the Cap had been determined. For example it was argued that there were problems in using a "P_{99}" figure, as this relied on a value from the extreme of a cost distribution, which is very sensitive to the underlying assumptions.

3.8 A number of responses agreed with the proposal that in return for setting a Cap the Government should charge a Risk Fee. Several respondents suggested that this was important to protect the taxpayer and maintain public confidence. It was argued that it was important that the Risk Fee was robustly determined and large enough to ensure taxpayer protection. Some responses however were critical of the proposal to charge a Risk Fee. It was argued that the high level of the Cap already provided sufficient taxpayer protection and the additional Risk Fee was unnecessary. It was also suggested that a Risk Fee could not be rationally determined.

The Government's response

3.9 Having considered the views set out in the consultation, the Government remains satisfied that setting a Cap on the Waste Transfer Price is appropriate and that in return for setting a Cap a Risk Fee should be charged. The Government does not agree that taking title to radioactive waste, including spent fuel, for a fixed price is a subsidy to new nuclear power, provided that the price properly reflects any financial risks or liabilities assumed by the state[35].

3.10 The Government accepts that in setting a Cap at the outset the residual risk that actual cost might exceed the Cap is being borne by the Government. Therefore the Government will charge an appropriate Risk Fee for this risk transfer. The Risk Fee will be set at a level that properly reflects the risk being assumed by the Government in setting a Cap. The Government notes that many responses supported the proposal to set a Risk Fee. The Government considers that the rationale for a Risk Fee is clear and does not agree with those respondents who argued that it was unnecessary.

3.11 The Government recognises that there is a high level of uncertainty over waste disposal costs, particularly given the very long timescales involved, but does not accept that it is impossible to make adequate allowance for this uncertainty in setting a Cap. The Government's view is that it is necessary to take a highly conservative view of risk and uncertainty. Hence the Government does not agree that the approach set out in the consultation will result in a Cap being set at an unreasonably high level.

3.12 The Cap will be set at a level where the Government has a very high level of confidence that actual cost will not exceed the Cap. Therefore the approach to assessing risk and uncertainty when determining the Cap is necessarily conservative. The Government acknowledges that using very high percentile values means that the derived values depend to a large extent on the assessment of high impact, low probability risks. However in setting a Cap at a level that protects the taxpayer by ensuring that the risk of costs exceeding the Cap is very small, the Government considers it appropriate to ensure that the Cap is high enough even in very pessimistic scenarios.

3.13 It should be stressed that the Government expects the Waste Transfer Price paid by Operators to be based on actual cost data and considers it highly unlikely that the Cap will need to be applied. The Cap exists to provide certainty to Operators as to their maximum liability. The Government accepts that the illustrative values for the Cap set out in the consultation were based on highly conservative assessments of risk and uncertainty, but does not regard that as unreasonable given that this is for the purposes of setting a Cap, not a Price.

[35] For more on the Government's policy that there should be no subsidy for new nuclear power, see the Written Ministerial Statement from 18 October 2010: http://www.decc.gov.uk/en/content/cms/news/en_statement/en_statement.aspx

Consultation Question 2:

Do you agree or disagree that the Deferral Period should be 30 years after start of electricity generation, in order to enable uncertainty over waste disposal costs to be reduced? What are your reasons?

Summary of comments

3.14 The proposal in the consultation to extend the Deferral Period from 10 years to 30 years was welcomed by many respondents. Some respondents agreed with the consultation that that the length of the Deferral Period had to balance the competing considerations of, on the one hand enabling uncertainty over disposal costs to be reduced, while on the other hand providing sufficient time during the operational life of the power station for the Operator to make prudent provision for their liabilities. Many responses considered that 30 years struck the right balance.

3.15 However some argued that, in the light of the operational lifetimes achieved by nuclear power stations so far, a 30 year Deferral Period was too long and introduced additional risks. There was concern that this might not allow enough time for the Operator to make up any shortfall in their independent Fund once the price had been fixed, increasing the risk of insufficient financial provision by Operators. A few responses were concerned that the proposal appeared to enable a new nuclear Operator to defer making financial provision for their liabilities.

3.16 A number of respondents suggested that there should be some flexibility around the duration of the Deferral Period. The option for an Operator to fix their price before the end of the Deferral Period was welcomed by some, but it was suggested that this should not be at the Secretary of State's discretion but rather that, following GDF Site Selection, it should be possible to set the Waste Transfer Price at any time following the procedure proposed to apply at the end of the Deferral Period, including recourse to Dispute Resolution.

3.17 There was some concern that a fixed Deferral Period meant that the price for different Operators could vary significantly depending on when their Deferral Period ended. It was suggested that, given the linkage to the current indicative timeline for the implementation of geological disposal through the MRWS process, the end of the Deferral Period should be linked to milestones in MRWS.

3.18 However other respondents argued that the Government was relying too heavily on progress in MRWS and suggested that deferring the setting of the Waste Transfer Price was a gamble that increased the risk to the taxpayer. It was suggested that a 30 year Deferral Period was unlikely to significantly improve the quality of the cost estimates and that considerable uncertainty would persist throughout the operational life of the GDF and beyond.

The Government's response

3.19 The Government is pleased to note the level of support for a 30 year Deferral Period and accepts that the framework has to accommodate risks arising from the proposal to set a Deferral Period.

3.20 The Government agrees that it is important to ensure that the 30 year Deferral Period does not give rise to risks that Operators do not have the monies available to meet their liabilities. It is important to note that Operators will be required to make prudent provision for their waste disposal liability from the outset and the deferring of the setting of the Waste Transfer Price does not enable the Operator to defer making financial provision. The Government will expect the Operators, through their FDP, to demonstrate that monies will be available to meet their liabilities as and when they fall due.

3.21 The consultation on draft FDP Guidance set out that the Government's view, based on experience to date, is that 40 years remains a prudent reactor life assumption, meaning that a 30 year Deferral Period should provide sufficient time for an Operator to make up any shortfall in their independent Fund following the setting of their Waste Transfer Price. However regardless of the reactor lifetime assumed, in order for an FDP to be approvable as representing prudent provision it would need to contain robust mechanisms to ensure that there would be sufficient funds to meet the costs of decommissioning, waste management and waste disposal in the event that the power station did not achieve its anticipated lifetime. This would need to include addressing risks around fund insufficiency with regard to waste disposal liabilities.

3.22 The Government's view is that, where possible, the Waste Transfer Price should be set in relation to actual cost data and sees positive benefits in an extended Deferral Period. Therefore the Government's preference would be for the Waste Transfer Price to be set at the end of the Deferral Period and any request to set a Waste Transfer Price early at a level below the Cap should be at the discretion of the Secretary of State.

3.23 However the Government is persuaded that a modest degree of flexibility in the operation of the proposed 30 year Deferral Period could be necessary to ensure fair outcomes for Operators, particularly as new nuclear power stations are likely to begin operating at different times and hence would reach a 30 year cut-off point at different times.

3.24 For example the Government might consider it appropriate for Operators of a tranche of nuclear power stations (such as those beginning operation within a specified period) to have a joint "price-setting date", which would imply some limited variation in the length of each power station's Deferral Period.

3.25 Also, with regard to the Default Pricing Mechanism, which is triggered if GDF Site Selection has not occurred by the end of the Deferral Period, it is possible to envisage a scenario where GDF Site Selection is significantly later than currently anticipated and hence has not taken place by the end of the Deferral Period, but is nonetheless imminent by that point. An inflexible Deferral Period would mean that the Operator's Waste Transfer Price would be in accordance with the Default Pricing Mechanism, whereas a short extension to the Deferral Period would enable the

Waste Transfer Price to be set based on a Site Specific Cost Estimate. The Government recognises that this could be an undesirable outcome, hence would envisage the Waste Contract between the Operator and the Government containing provisions allowing for a short extension (perhaps up to five years) to the Deferral Period if there were good reason to believe that GDF Site Selection was going to occur in that period.

3.26 The Government would envisage this flexibility being accommodated in the Waste Contract. Any flexibility would be conditional on the Secretary of State being satisfied that the Operator was making prudent provision for its waste disposal liabilities in its FDP.

3.27 The Government's view is that the Deferral Period should enable the level of uncertainty over waste disposal costs to be reduced substantially. If the implementation of geological disposal follows NDA's current indicative timetable then by the end of the Deferral Period for the first new nuclear Operator, in around 2048, the GDF should be in its operational phase. Therefore the costs of constructing the GDF will be known and there should be a good deal of actual cost data regarding the operation of the facility. The Government accepts that there will be residual cost uncertainty, but considers that this uncertainty will be limited.

Consultation Question 3:

Do you have any comments on the updated Waste Transfer Pricing Methodology? Comments are sought in particular on the proposed approach to setting an Expected Price and a Risk Fee.

Comments relating to the cost modelling

Summary of comments

3.28 Many respondents commented on the cost modelling set out in the consultation. Some were concerned that it was not sufficiently transparent and argued that it was difficult to form a view on the basis of the information provided. Further information was sought, particularly on the derivation of cost estimates by NDA and the underpinning analysis of risk and uncertainty. It was suggested that there should be a firm commitment from the Government to improve the quality of cost modelling during the Deferral Period.

3.29 The consultation envisaged that the Waste Contract between the Government and an Operator would include provisions for transparency and independent scrutiny of the Government's cost estimates. The responses from prospective new nuclear operators in particular sought more information around how these provisions would operate in practice.

3.30 A number of responses commented on the extent to which the proposed methodology relied on drawing high percentile values, such as P_{95} and P_{99}, from cost distributions derived following an assessment of risk and uncertainty. It was suggested that there are risks in using values drawn from the extreme end of a distribution as these carry the greatest uncertainty from the underpinning analysis.

3.31 Several responses were concerned that the Methodology was overly conservative. Some commented that there appeared to be multiple overlapping risk factors, leading to concern that there may be double counting of risks. However other responses favoured a very conservative approach given the current high level of uncertainty over estimated costs, with some responses supporting the proposal to include a significant "Optimism Bias" uplift.

3.32 Concern was also expressed over the "simplified application" of the Methodology for the purposes of setting an Expected Price prior to GDF Site Selection. It was suggested that even prior to GDF Site Selection it should be possible for GDF cost estimates to continue to be developed and incorporate a detailed assessment of risk and uncertainty.

The Government's response

3.33 The Government acknowledges that the cost modelling set out in the consultation was complex and has considered how it can be set out more clearly. The final Methodology in Section 1 and the worked examples in Section 2 follow the same overall approach as the corresponding sections of the consultation, but they have been reworked to improve clarity.

3.34 The worked examples in the consultation drew on detailed cost estimates provided by NDA of the costs of waste disposal. The high level figures derived from the cost modelling were set out in the March 2010 consultation and are reproduced in Annex C. NDA's cost modelling is highly detailed and is not suitable for publication. The Government does not consider that it is necessary to provide highly detailed cost information in order to seek views on how this cost information should be used to set a Waste Transfer Price using the proposed Methodology. However the Government recognises that Operators will want to understand and review in detail the cost estimates from which their Waste Transfer Price will be determined and would expect the Waste Contract to set out provisions for external scrutiny.

3.35 The Government will set the Cap at a level where there is a very high degree of confidence that actual cost will be below the Cap. Therefore in setting a Cap the analysis of risk and uncertainty in these cost estimates needs to be highly conservative. It is for this reason that the cost modelling employed to set a Cap, which is described in more detail in Annex B, applies several different uplifts for risk and uncertainty. Uncertainty over geological environment is accounted for by considering a range of scenarios. In-Model Risks are allowed for using an Optimism Bias uplift and Out-of-Model Risks are allowed for through a Contingency Allowance.

3.36 The Government does not consider that this approach leads to double counting of risks, and does not regard the possibility of the double-counting of risks to be a justification to set a lower Cap. As set out in the consultation the illustrative figures derived for a Cap are three times current cost estimates. The Government accepts the approach taken to derive these figures as highly conservative, but considers this appropriate in order to ensure the taxpayer is protected.

3.37 In contrast, in order to set an Expected Price, the Government has to project forward to the circumstances that are expected to apply at the end of the Deferral Period. The Expected Price will be reviewed and if necessary updated every five years to reflect latest cost estimates. The Government's view is that NDA's current estimates are likely to be subject to Optimism Bias hence the estimates are adjusted for this. However by the end of the Deferral Period it is expected that the GDF will be in its operational phase, therefore uncertainty over costs will be lower and hence the Waste Transfer Price will only need to incorporate a modest Risk Premium. The consultation proposed an Interim Approach to estimating this Risk Premium, which will only apply until there is a Site Specific Cost Estimate. More detail on the Interim Approach is provided in Annex A.

3.38 The Government's view is that there are limits to the extent to which a detailed, line-by-line assessment of risk and uncertainty around cost estimates can usefully be attempted prior to GDF Site Selection and for this reason intends to employ the Interim Approach during this period. However the Government will expect that the GDF cost estimate produced by NDA will continue to be developed over time, including in the period prior to GDF Site Selection, and these developments will be reflected in the revised cost estimation process at each Quinquennial Review.

Comments on the handling of risk and uncertainty in the methodology

Summary of comments

3.39 A number of broader risks and uncertainties were identified that respondents argued had not been sufficiently taken into account in the proposed Methodology. For example it was suggested that there was a risk that some economic assumptions, such as the expectation of real terms growth in investments over the long term, might not hold over the extended time periods covered by a Waste Contract.

3.40 Others argued that the Methodology did not sufficiently address the risk that a second GDF might be needed, or more broadly that the implications of uncertainty over the size of the new build fleet were not properly examined. It was also suggested that the proposal to set the price for spent fuel in £/tU did not take sufficient account of the higher level of radioactivity expected in new build spent fuel in comparison with legacy spent fuel.

3.41 Some responses argued that the Methodology did not address uncertainty over whether and when geological disposal would be implemented. Some respondents pointed to historic delays in nuclear projects and it was suggested that this was a particular concern if, due to delays in the availability of a GDF, the Government was responsible for an extended period of interim storage prior to disposal.

3.42 Several responses addressed those risks that were considered to be within the Government's control rather than the Operator. It was suggested that there needed to be incentives on the Government to ensure cost effective and timely delivery of GDF. It was also suggested that the costs of encapsulating spent fuel for disposal were largely determined by the Government and that, like GDF costs, there was little the Operator could do to influence these costs. It was therefore suggested that encapsulation costs should come within the scope of the Waste Transfer Price.

The Government's response

3.43 The Government recognises that there is substantial uncertainty over waste disposal costs but does not agree that the Methodology takes insufficient account of risk and uncertainty. The Methodology identifies a range of risks and uncertainties and describes how they are taken into account.

3.44 Although the Government acknowledges that the long time frames involved in this Methodology present challenges, the Government believes it is reasonable to allow Operators to assume real terms investment growth in the monies held in their independent Funds to meet their waste disposal liabilities. However the risk around Fund performance lies with the Operator, not the Government, and if their Funds do not grow as expected the Operator would be required to take corrective action to top-up their Fund.

3.45 The risk that a second GDF might be needed is addressed in the Methodology. It is accepted that the size of the new build programme and the specification of the site chosen for a GDF will have an impact on the feasibility of the co-disposal of legacy and new build wastes. The Government intends to proceed on the presumption of the co-disposal of legacy and new build wastes but this assumption can be revised at a later date and the Expected Price would be adjusted accordingly. The Contingency Allowance derived in the worked example for the setting of a Cap takes into account the risk that a second GDF might be needed in the event that it is not possible to build a single GDF for the disposal of both HLW/spent fuel and ILW/LLW (see risk A2 in Annex F).

3.46 The question of the correct unit to be used for setting a price for spent fuel was discussed at length in both the March and December 2010 consultations. The Government remains of the view that £/tU is the appropriate unit. The Government accepts that spent fuel from new nuclear power stations is likely to be hotter than legacy spent fuel. In the event that this has a cost implication then the Expected Price will adjust accordingly over time. The Contingency Allowance derived in the worked example for the setting of a Cap takes this risk into account (see risk B3 in Annex F).

3.47 The Government is committed to the implementation of geological disposal and, as set out in the Nuclear National Policy Statement, the Government is satisfied (i) that geological disposal is technically achievable, (ii) that a site for a GDF will be identified and (iii) that waste can be kept in safe, secure and environmentally acceptable interim storage until it can be disposed of[36].

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[36] Nuclear National Policy Statement page 17: http://www.decc.gov.uk/en/content/cms/meeting_energy/consents_planning/nps_en_infra/nps_en_infra.aspx

3.48 However the Government accepts that there is uncertainty over the timing of the implementation of geological disposal. When the Waste Transfer Price is set for an Operator the Government will also set an Assumed Disposal Date, which will be the Government's best estimate of the date on which the disposal of the Operator's waste will begin. If disposal facilities are not available on the Assumed Disposal Date, the Government will face additional interim storage costs and, in the event that disposal is delayed substantially, there might also be costs relating to the rebuilding of interim stores and repackaging of wastes. However a delay to the disposal of new build wastes implies that the expenditure on the Variable Costs associated with disposing of those wastes would also be delayed. This would serve to reduce the "real value" of those costs to the Government at the Assumed Disposal Date due to the effect of discounting, which should offset the increase in interim storage costs. The illustrative Contingency Allowance calculation, for the purposes of Worked Example 2 on the setting of a Cap, considers this risk in more detail (see risk B2 in Annex F).

3.49 The Government accepts that deferring the setting of the Assumed Disposal Date might be problematic for Operators who will need to plan for the long term management of their ILW and spent fuel and the Government would be prepared to discuss with the Operator whether there should be some bounding dates set out in the Waste Contract. The Government is committed to optimising the implementation of the geological disposal process wherever possible, to look for ways to do things in the most efficient, timely way whilst taking account of safety, security and the views of a local community. The Government will work with new nuclear Operators on the optimisation of the GDF project and as the programme moves forward aspects such as the geology, the design of a facility, the inventory of waste to be disposed and the timing of waste arisings will become better defined and thus the scope for optimisation will become clearer.

3.50 With regard to the costs of encapsulation (or other suitable spent fuel pre-disposal treatment), the Government remains of the view that the scope of the Waste Transfer Price should not be extended to include encapsulation. The Government believes that Operators should be responsible for ensuring spent fuel is disposable in the GDF and should make provision for this in their FDP. In the Base Case this requires the encapsulation of their spent fuel, either directly or by a third party under contract to the Operator. The Government recognises that the specification of encapsulation is dependent on the design and operational requirements of the GDF and, as set out above, the Government will work with new build Operators to ensure these are optimised in light of the requirements of both legacy and new build Operators.

Comments on the broader framework

Summary of comments

3.51 Some respondents stressed the effect that the handling of discounting and escalation could have over an Operator's liabilities. It was noted that the consultation envisaged that a discount rate would not be set at the outset, and it was argued that it would be necessary for the mechanism by which the discount rate would eventually be set to be contained in the Waste Contract.

3.52 A few responses also commented on the way in which the Risk Fee was proposed to be calculated. Some suggested that the proposed "mark-up" needed justification and the proposal to "round up" the Risk Fee was queried. In contrast others favoured a much higher Risk Fee in order to protect the taxpayer. Some responses commented that it was not clear whether the values for the mark up were a firm proposal or for the purposes of illustration.

3.53 A number of responses raised questions about what would happen if a new nuclear Operator were unable to pay their Waste Transfer Price. A few responses noted that the consultation envisaged that in most cases a Dispute Resolution procedure would apply in the event of disputes between an Operator and the Government, for example over the level of the Expected Price. However the consultation proposed that the Secretary of State would retain the final say in the setting of the Cap, the Waste Transfer Price under the Default Pricing Mechanism and the early setting of the Waste Transfer Price (i.e. during the Deferral Period). Some argued that the Secretary of State's discretion should be reduced and the scope of Dispute Resolution extended, although the opposite argument was also made.

3.54 Prospective new nuclear Operators raised the issue of how different Operators would be treated. It was suggested that the Government commit to equal treatment of Operators, extending perhaps to a single Cap, Risk Fee and Deferral Period, and a standard Waste Contract, to prevent different arrangements applying to different Operators simply as a result of their power stations beginning operations at different times. It was also suggested that the Government should commit to equality of treatment between legacy and new build wastes, and that Government and new build Operators should co-operate to optimise GDF for new build wastes and make progress on GDF development.

3.55 It was also pointed out that the consultation did not refer to the separate DECC consultation on Management of the UK's plutonium stocks[37], which suggested that new nuclear power stations might use mixed oxide (Mox) fuel. It was argued that the consultation should be re-run with figures for Mox fuel disposal.

3.56 Several responses raised the issue of transparency more broadly and sought public disclosure of Waste Contracts between the Government and new nuclear Operators. It was suggested that there should be the opportunity for public comment on proposed Waste Contracts.

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[37] http://www.decc.gov.uk/en/content/cms/consultations/plutonium/plutonium.aspx

The Government's response

3.57 The Government recognises that the discount rates applied to the level of the Waste Transfer Price if the Transfer Date falls before the Assumed Disposal Date could have a significant impact of the level of an Operator's financial provision for its waste disposal liabilities. Given the long time frames involved the Government does not intend for this discount rate to be fixed at the outset, but rather it will be determined nearer the Transfer Date and set in relation to the rates of returns at that time on long-term investments in Government securities and similar assets. It is expected that the manner in which the discount rate will be determined will be set out in the Waste Contract between the Government and the Operator.

3.58 With regard to the calculation of the Risk Fee, having considered responses to the consultation, the Government is satisfied that it is the right approach to base the Risk Fee on the formula:

Risk Fee = (Probability x cost consequence) + mark up

3.59 The purpose of the "mark up" is, as set out in the consultation, to compensate the Government for entering into the transaction. The level of the mark up will be determined by the Secretary of State at the point at which the Cap and Risk Fee are determined. Worked Example 2 in Section 2 sets the mark up at an illustrative 50%.

3.60 Given that the Risk Fee is compensation for the Government accepting a risk at the point the Contract is signed, the Government has concluded that in the event that the Operator ultimately withdrew from the Waste Contract due to the availability of an alternative disposal route for their waste, the Risk Fee would nonetheless be payable.

3.61 With regard to the perceived risk that an Operator might be unable to pay their Waste Transfer Price, the Energy Act 2008 requires any prospective Operator of a new nuclear power station to have an FDP approved by the Secretary of State before construction begins and to comply with that programme thereafter. The Operator must satisfy the Secretary of State that effective and transparent arrangements are in place to ensure that the Operator will meet its obligations to discharge its liabilities, including waste disposal liabilities, in full.

3.62 The Government believes it is appropriate for the Secretary of State to have discretion over the level of the Cap. The Cap will be set at the outset and included in the Waste Contract. The Operator will be able to decide whether it wishes to enter into a contract with a Cap at the level offered.

3.63 The Waste Contract will include an agreement that the Waste Transfer Price will be set at the end of the Deferral Period. Should the Operator seek a Waste Transfer Price before the end of the Deferral Period the Government considers it reasonable for that Price to at the discretion of the Secretary of State (subject to the Cap).

3.64 The consultation also proposed that the level of the Waste Transfer Price, when set under the Default Pricing Mechanism, should be at the discretion of the Secretary of State. The Government remains of the view that this is appropriate. The Default Pricing Mechanism will only be applied in circumstances where no site for a GDF has been identified and hence when there will be substantial uncertainty over estimated costs. In these circumstances the Government's view remains that the Waste Transfer Price should be set by the Secretary of State, having regard to such cost modelling as is available at the time, subject to the proviso that the Waste Transfer Price cannot be higher than the Cap.

3.65 However the Government recognises the concern that this might in theory give Government an incentive to invoke the Default Pricing Mechanism in order to set a higher price than otherwise might be set. In order to address this concern the Government would expect the Waste Contract to:

- Specify the trigger mechanism for moving to the Default Pricing Mechanism, which would be where there was no reasonable prospect of a site for a GDF being identified by the end of the Deferral Period, and that the trigger mechanism would be subject to Dispute Resolution.
- Provide that the Secretary of State will set out how that Default Price has been determined and the Operator would be entitled to make representations with regard to the derivation of the Default Price.
- As set out above, provide that the Deferral Period could be extended for a limited period if there were reasonable grounds to believe that GDF Site Selection would be achieved during that time.

3.66 The Government accepts that it is reasonable for all Operators to expect to be treated equally. However the Government does not consider that this means that a single Cap or Waste Transfer Price should apply to all Operators. The Cap and Waste Transfer Price for each Operator will be based on the most up-to-date cost estimates available at the time, together with an analysis of the level of uncertainty around those cost estimates. Therefore the level of the Cap or Waste Transfer Price could vary depending on when they are set. However the Government would expect variation in the Cap or Waste Transfer Price provided to different Operators to be objectively justified. Once a Cap has been set for the first Operator later Caps should take account of how the first Cap was determined, with differences being explained.

3.67 With regard to the possible use of Mox fuel, the Waste Contract, including an Expected Price and a Cap, agreed with the Operator at the outset will cover only the disposal of spent uranium oxide fuel. Were an Operator to secure approval for the use of Mox fuel in the future, the disposal of that spent fuel would be subject to a new contract.

3.68 The Government recognises the level of public interest in these arrangements and would expect, where possible, to publish details of the agreements reached between the Government and prospective nuclear Operators.

Annex G: List of those who responded to the consultation

There were 34 written responses to the consultation. One respondent requested non-disclosure of their response. The other respondents are listed in alphabetical order.

1	Allison, Wade
2	Attwater, Katy
3	Barkham, Hazel
4	Blackwater Against New Nuclear Group (BANNG)
5	Chanay, J.
6	Copeland Borough Council
7	Cumbria County Council
8	EDF Energy
9	Environmentalists for Nuclear Energy
10	Gerrard, Brian
11	Gifford, Christopher
12	Grahame, Lesley
13	Greater Manchester SERA
14	Greenpeace
15	Horizon Nuclear Power
16	Kick Nuclear
17	L2 Business Consulting Ltd
18	Manson, P.
19	Ministry of Defence, Defence Nuclear Safety Regulator
20	Northern Ireland Environment Agency
21	Nuclear Free Local Authorities
22	Nuclear Industry Association (NIA)
23	Nuclear Legacy Advisory Forum (NuLeAF)
24	NuGeneration Limited
25	Oldbury Site Stakeholder Group
26	Saibene, Ornella
27	Scientists for Global Responsibility
28	Sedgemoor District Council and West Somerset Council
29	Shut Down Sizewell Campaign
30	Smith, Zoe
31	South West Against Nuclear
32	Viesnick, D.
33	Welsh Assembly Government

Glossary

Assumed Disposal Date – the Government's best estimate of the date on which disposal of the Operator's waste will begin.

Cap – the maximum level of the Waste Transfer Price that can be set for an Operator at the end of the Deferral Period. The Cap, which will be indexed for inflation, will be set by the Government at the outset.

Co-disposal – disposal of new build waste in the same facility as legacy waste.

Co-location – disposal of HLW/spent fuel and ILW in a combined GDF in which there are separate parts of the facility for the various types of waste.

Contingency Allowance – the cost modelling that will underpin the setting of the Cap will include an adjustment for Out-of-Model Risks and this will take the form of a Contingency Allowance calculated through an exercise to identify a set of risks, together with an assessment of the consequence and probability of each risk occurring.

Decommissioning – means dismantling the station and remediating the site including waste management but not including waste disposal to a condition agreed with the regulators and the planning authority.

Default Date – the Assumed Disposal Date that will be set if the Default Pricing Mechanism applies.

Default Pricing Mechanism – the mechanism by which an Operator's Waste Transfer Price and Assumed Disposal Date will be determined in the event that GDF Site Selection has not taken place by the end of the Deferral Period.

Deferral Period – the specified period before the Operator's Waste Transfer Price is expected to be set.

Dispute Resolution – a procedure, or procedures, set out in the Waste Contract, by which disputes will be resolved.

Early Transfer – means a situation where the Transfer Date (on which the Operator's responsibility for the waste transfers to the Government) precedes the Assumed Disposal Date.

Expected Assumed Disposal Date – the Assumed Disposal Date that will be determined, and then reviewed, alongside the Expected Price.

Expected Price – the basis for an Operator's interim provision for their waste disposal liabilities during the Deferral Period. The Expected Price will be set by the Government and will represent the Government's best estimate of the level of the Waste Transfer Price when it is set at the end of the Deferral Period.

Financing Charge – an uplift to be applied to a new nuclear Operator's estimated contribution to the Fixed Costs of a GDF based on the approach that might be taken in the theoretical case that the Government were constructing a GDF to a timescale driven by the needs of new nuclear Operators.

First Waste Emplacement – the beginning of the "GDF Operation" phase, once the GDF operator has obtained all the relevant permissions and authorisations to receive and emplace waste at the GDF. The current planning assumption is that this will be in around 2040.

Fixed Costs (of a GDF) – includes the site selection and investigation programme and the construction of the surface facilities, access shafts and access drift. These are considered to be predominantly fixed costs as they are largely unrelated to the volume of waste being emplaced.

Fund – means a trust or other vehicle constituted for the purpose of accumulating, managing and investing monies obtained from the Operator for the purpose of the Objective and includes, as the context permits or requires, any person who is a member of, or is responsible for the governance and/or management of that entity.

Funded Decommissioning Programme (FDP) – means the programme that any Operator of a new nuclear power station will need to have approved by the Secretary of State pursuant to the Energy Act before construction begins and to comply with thereafter.

GDF Site Selection – the point at which the Government has decided on a preferred site for a GDF in accordance with the MRWS process. This will mark the beginning of the Construction and Underground Based Investigations phase of the MRWS process. The current planning assumption is that this will be in around 2025.

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

Higher activity waste – includes the following categories of radioactive waste: high level waste (HLW), ILW and a small fraction of low level waste (LLW) with a concentration of specific radionuclides. On the assumption of no reprocessing of spent fuel, higher activity wastes from new nuclear power stations will be ILW and spent fuel.

In-Model Risks – risks that relate to the possibility that the NDA's Parametric Cost Model does not correctly calculate the costs of a specific disposal scenario.

Interim storage – storage of radioactive waste prior to implementing a final management step, such as geological disposal.

Intermediate level waste (ILW) – radioactive wastes exceeding the upper activity boundaries for LLW but which do not need heat to be taken into account in the design of storage or disposal facilities.

Last Waste Emplacement – the end of the "GDF Operation" phase, when all wastes have been disposed in the GDF.

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

Low level waste (LLW) – defined as "radioactive waste having a radioactive content not exceeding four gigabecquerels per tonne (GBq/te) of alpha or 12 GBq/te of beta/gamma activity".

Managing Radioactive Waste Safely (MRWS) – a phrase covering the whole process of public consultation, work by the Committee on Radioactive Waste Management (CoRWM), and subsequent actions by the Government, to identify and implement the option, or combination of options, for the long term management of the UK's higher activity radioactive waste.

Monte Carlo methods – a mathematical technique that can be used to allow for risk and uncertainty in quantitative analysis and decision-making.

Nuclear Decommissioning Authority (NDA) – NDA is the implementing organisation responsible for planning and delivering the GDF.

Operator – the legal person who holds a licence under the Nuclear Installations Act 1965 in relation to the site to which an FDP relates, or who has applied for such a licence in relation to such a site.

Optimism Bias – the approach set out in HM Treasury "Green Book" guidance[38], to be used in assessing risk where a comprehensive assessment is not possible.

Out-of-Model Risks – risks relating to the accuracy of NDA's Parametric Cost model output when it is used to model the costs of disposing of new build wastes.

Parametric Cost Model – a model developed by NDA to generate updated estimates of the costs of geological disposal.

Pricing Cost Estimate – this will be drawn from the distribution of estimated costs derived in this Methodology. The Pricing Cost Estimate is to be set at P_{95} of that distribution, i.e.at a level where there is expected to be a 95% chance that actual cost will be lower than estimated cost and a 5% chance that actual cost will be higher than estimated cost.

[38] The Green Book is an HM Treasury publication that presents the techniques and issues that should be considered when carrying out assessments of new policies, programmes and projects. The HM Treasury Supplementary Green Book Guidance on optimism bias is available at http://www.hm-treasury.gov.uk/d/5(3).pdf

Quinquennial Review – a review each five years. In this case this will be a review of the level of the Expected Price, Assumed Disposal Date and other important variables, such as discount and inflation rates, and may result in one or more of these being revised.

Radioactive waste – has the meaning given by the Environmental Permitting (England and Wales) Regulations 2010.

Radioactive Waste Management Directorate (RWMD) – a directorate of NDA, incorporating resources from the former United Kingdom Nirex Ltd, which will develop into an effective delivery organisation to implement geological disposal. It is envisaged that RWMD will evolve under NDA into 'NDA's delivery organisation' for the GDF.

Risk Fee – an additional element included in the Waste Transfer Price to reflect the small residual risk being assumed by the Government when the Cap is set at the outset, that actual costs might be higher than the Cap.

Risk Premium – the premium over and above expected costs that will be included in the Waste Transfer Price to reflect the risk being assumed by the Government, when the Waste Transfer Price is set at the end of the Deferral Period, that actual costs might be higher than the Waste Transfer Price.

Site Specific Cost Estimate – following GDF Site Selection it will be possible to produce a Site Specific Cost Estimate of waste disposal costs, incorporating a more detailed and comprehensive assessment of risk and uncertainty than is possible in the absence of a GDF site.

Spent fuel – fuel that has been used in a nuclear reactor and for which there is no further use as fuel.

Time value of money – the principle that a sum of money paid today is more valuable than the certainty of receiving the same sum at a later date.

Transfer Date – the date upon which title to and liability for an Operator's ILW and spent fuel will transfer to the Government.

Variable Costs (of a GDF) – includes the construction of underground deposition tunnels for spent fuel and underground disposal vaults for ILW. These are considered to be variable costs as they vary with the volume of waste being emplaced.

Virtual GDF – the theoretical case that the Government were constructing a GDF to a timescale driven by the needs of new build Operators. This concept is used in determining the extent to which the element of the Waste Transfer Price comprising a contribution to the Fixed Costs of a GDF should be subject to a Financing Charge.

Voluntarism – an approach in which communities "express an interest" in participating in the process that would ultimately provide the site for a GDF. Initially a community would be expressing an interest in finding out more about what hosting such a facility would involve. In the latter stages, there would be more detailed discussion of plans and potential impacts.

Waste Contract – alongside the approval of an Operator's FDP, the Government will expect to enter into a Contract with the Operator regarding the terms on which the Government will take title to and liability for the Operator's spent fuel and ILW. In particular, this agreement will need to set out how the Waste Transfer Price will be determined.

Waste disposal liabilities – the liability to pay the sum charged to the Operator by the Government in connection with an approved FDP in relation to the disposal by the Government of higher activity waste produced on the relevant site.

Waste Transfer Price – the price paid by an Operator of a new nuclear power station in return for the Government taking title to and liability for their ILW and spent fuel.

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