DEPARTMENT OF ENERGY & CLIMATE CHANGE

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

December 2010

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Chapter 1: Introduction

Executive Summary

Aim of the consultation

1.1 This consultation follows the publication of the "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" in March 2010 (the "March consultation").

1.2 This consultation document sets out:

- the Government Response to the March consultation;
- the key changes that have been made as a result of the consultation;
- an updated methodology for further consultation.

1.3 We are seeking responses to the three questions contained in this consultation. The responses will assist the Government in developing a finalised methodology for pricing the transfer of title to and liability for intermediate level waste (ILW) and spent fuel from a new nuclear operator to the Government (the "Waste Transfer Pricing Methodology").

Government response to the March consultation

1.4 The March consultation sought responses to six questions. Chapter 2 summarises the views expressed and the Government's response. A range of views was expressed. Many responses were broadly supportive of the Government proposals but raised comments or concerns about specific points, for example some responses expressed the view that the consultation was too conservative in its approach to uncertainty around waste disposal costs. Other responses were critical of the proposals, for example concerns were raised that the proposals exposed the taxpayer to unacceptable risks and represented a subsidy to new nuclear power.

1.5 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[1]. The Government acknowledges that the approach to risk and uncertainty set out in the March consultation is conservative but, given the level of uncertainty around estimates of disposal costs, believes that such conservatism is necessary to ensure the taxpayer is protected.

[1] 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

1.6 Question 1 concerned the proposal that operators of new nuclear power should have the option to defer setting their Waste Transfer Price for a specified Deferral Period. The Government agrees with those respondents who said that it would be preferable to set a Final Price when there is more certainty over disposal costs. Hence the Government's view, set out in more detail in Section 3.2, is that the Deferral Period for a new nuclear power station should be extended from 10 years, as proposed in the March consultation, to 30 years after start of generation.

1.7 Question 2 concerned the proposal that the Schedule for the Government to take title to and liability for an operator's waste should be brought forward ("Early Transfer") and set in relation to predicted end of the decommissioning of the new nuclear power station. The Government's view is that it is better placed than operators to manage long-term cost risks and hence regards the proposals in the consultation for the Early Transfer of waste, together with sufficient monies to cover all additional costs incurred by Government ahead of disposal, to be an important part of the framework to protect the taxpayer. The Government is satisfied that the lump sum payment to recompense Government for the additional costs arising from Early Transfer can be calculated with sufficient accuracy to minimise any risk to the taxpayer.

1.8 Question 3 sought views on whether the proposed methodology struck the right balance between protecting the taxpayer and facilitating new nuclear build. The Government's view is that the March consultation set out a clear approach in the event that the Managing Radioactive Waste (MRWS) process proceeds broadly as currently expected, but accepts that more clarity is needed around how the Price would be set if things did not go according to current expectations, and this is addressed in the revised methodology set out in Chapter 3.

1.9 Question 4 concerned the proposed approach to determining an operator's contribution to the Fixed Costs of constructing a Geological Disposal Facility (GDF). Having considered the responses to this question the Government does not intend to revise the proposals set out in the March consultation, that the Waste Transfer Price should include a contribution to the Fixed Costs of a GDF. The Government regards this as consistent with its policy that new nuclear operators should pay their full share of waste disposal costs. A new nuclear operator's contribution to the Fixed Costs of a GDF should be calculated in proportion to the operator's share of total Variable Costs.

1.10 Question 5 sought views on the proposed units to be used for setting a Price. The Government is pleased to note general agreement to its proposal for the unit for ILW to be the cubic metre of packaged waste. On spent fuel, this is clearly a finely balanced argument, but there appear to be fewer risks in using a simple volumetric unit, such as £/tU, rather than the unit proposed in the March consultation, which was p/kWh. This would also have the benefit of consistency with the current National Inventory.

1.11 Question 6 concerned the updated estimates of decommissioning, waste management and waste disposal for a new nuclear power station. The Government regards the estimates set out in the consultation as forming a benchmark against which to assess the estimates produced by operators,

however it will expect operators to produce their own estimates and will subject those estimates to close scrutiny.

Waste Transfer Pricing Methodology

1.12 Chapter 3 sets out the revised Waste Transfer Pricing Methodology and comments are sought on this in this consultation. The key principles underpinning the Waste Transfer Pricing Methodology 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 Final Price they will be expected to pay the Government for the provision of a waste disposal service.
- The Final Price charged by Government for the provision of a waste disposal service 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 Final Price should be set in relation to actual cost data, to ensure that 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 Final Price should be deferred for a specified Deferral Period, provided that in certain circumstances it will be possible for the final 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.

Proposed changes following the March consultation

1.13 There are two significant changes proposed to the methodology set out in the March consultation and the Government is seeking views specifically on these two changes in this further consultation.

1.14 The March consultation said that in seeking a deferral the operator would be accepting the risk that a Price set at a later date could be higher than the Price on offer at the outset, if estimated costs escalate sufficiently in the intervening period. Having considered the responses to the consultation, the Government's view is that it will be difficult for an operator to accept such a risk, given that there is very little the operator can do to manage and mitigate it. In contrast, the Government does have capacity to manage risks around waste disposal costs, as these costs will be heavily influenced by the manner in which the Government implements geological disposal. Therefore the Government's view is that it is reasonable for nuclear operators to have some certainty over their maximum exposure to these risks from the outset.

1.15 The Government therefore proposes to specify a maximum Final Price the operator would be expected to pay (the "Cap"). The Cap (which will be indexed for inflation) will reflect the Government's current analysis of risk and uncertainty and will be set at a level where the Government has a very high level of confidence that actual costs will be lower than the Cap. The Government recognises that, in setting a Cap, the small residual risk that actual cost might exceed the Cap will lie with the Government. Hence in return for setting a Cap the Government will charge the operator an appropriate fee (the "Risk Fee") and incorporate this into the Final Price.

1.16 The Cap will be set by the Secretary of State, having regard to a cost modeling process to derive estimates of the costs of waste disposal taking into account the level of uncertainty around the estimation of those costs. Section 4.2 sets out a worked example for how a Cap would be calculated using this Methodology. It assumes, for the purposes of illustration, that the Cap is set at the 99th percentile (P_{99}) from the distribution derived in the cost modelling process, i.e. at the level where it is estimated that there is a 99% probability that actual cost will be below the Cap and a 1% probability that actual cost will exceed the Cap.

1.17 The second proposed change is that the Deferral Period should last for 30 years after start of generation. The Government's view is that a 30-year Deferral Period should enable the Final Price to be set when the site for a GDF is known. This will allow a Site Specific Cost Estimate to be prepared, based on a good deal of actual cost data and with only a small amount of residual uncertainty. The current planning assumption is that GDF Site Selection will be in around 2025.

1.18 In the event that GDF Site Selection has not taken place by the end of the Deferral Period, a Default Pricing Mechanism will be used to determine the Final Price. In practice, given that uncertainty may not have been reduced significantly it is considered likely that the Default Price will be at or near the level of the Cap.

1.19 An operator can request that their Final Price be fixed during the Deferral Period. In this case the level of the Final Price will be at the discretion of the Secretary of State, having regard to a cost modelling process that takes account of uncertainty around cost estimation. An operator can opt at any time to fix their Final Price at the level of the Cap.

Description of the Waste Transfer Pricing Methodology

1.20 The Final Price should be set at a level over and above expected costs and include a Risk Premium to compensate the taxpayer for accepting the risk of subsequent cost escalation. The Government proposes that the Final Price should be set in accordance with the Cost Estimating Methodology set out in Chapter 3.

1.21 The purpose of the Cost Estimating Methodology is to set out clearly how waste disposal costs will be estimated and uncertainty in those estimates handled. The manner in which costs are estimated, and the analysis of risk and uncertainty around current cost estimates, is consistent with the approach set out in Chapter 3 of the March Consultation. The Cost Estimating Methodology will generate a distribution of estimated costs and a conservative cost estimate (the "Pricing Cost

Estimate") will be set at P_{95} of this distribution, i.e. set at a level where there is expected to be a 95% probability that actual cost will be lower than estimated cost and a 5% probability that actual cost will be higher than estimated cost.

1.22 The Final Price set at the end of the Deferral Period will be set according to the formula:

Final Price = Pricing Cost Estimate + Risk Fee

1.23 This is subject to two exceptions:

- The Final Price cannot be higher than the Cap;
- In the event that the Final Price is set before GDF Site Selection, it will be determined through the Default Pricing Mechanism.

1.24 The Expected Price is the Government's projection of the level of the Final 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 Final Price.

1.25 It is expected that by the end of the Deferral Period the Cost Estimating Methodology will be applied to a Site Specific Cost Estimate. However it will not be possible to produce such an estimate until after GDF Site Selection. Therefore in the interim, and for the purposes of deriving an Expected Price, a simplified Cost Estimating Methodology needs to be applied using NDA's current cost estimates, which have been derived with regard to a reference case. Section 4.3 of this consultation sets out a worked example of how an Expected Price would be calculated prior to GDF Site Selection using this Methodology.

Updated worked examples

1.26 Chapter 4 provides updated worked examples for several aspects of the revised Waste Transfer Pricing Methodology. 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.

1.27 Moreover, it is proposed that the 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 wastes (i.e. the Variable Costs as defined in the Cost Estimating Methodology). 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).

1.28 Section 4.5 sets out how the illustrative figures derived here might translate into a waste disposal liability for a new nuclear operator[2], both on the Assumed Disposal Date (which is 2130 in the worked examples) and on the Transfer Date (which is assumed to be 2080 in the worked examples.)

1.29 It also provides an illustration of how these figures might translate into annual payments into an operator's independent Fund, 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 and, given the long timescales involved, even small variations in assumed fund performance can have a very large impact on the estimated level of payment into the Fund. Therefore the example figures given here are for illustrative purposes only. Table 2 summarises theses illustrative figures.

Indicative waste disposal liability for a new nuclear power station	Final Price = Expected Price	Final Price = Cap
Total liability on Assumed Disposal Date of 2130 (£)	670m	1104m
Total liability on Transfer Date of 2080 (£)	226m	372m
Liability expressed in as annual fund payment (£/MWh)	0.20 – 0.43	0.33 – 0.71

Table 2: indicative waste disposal liability for a new nuclear power station, as derived in Section 4.5 (constant September 2008 money values).

[2] The figures in this consultation assume a generic 1.35GW PWR operating for 40 years.

Background

Introduction

1.30 This section sets out the background to the proposals in this consultation. It is provided here for information only.

Previous consultations

1.31 The "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" was published on 25 March 2010[3].

1.32 This consultation followed the publication of three pre-consultation discussion papers during autumn 2008 and spring 2009[4]. These papers informed discussions with stakeholders during the pre-consultation process in order to refine the proposed fixed unit price methodology for this consultation.

1.33 Having considered the responses to the March consultation the Government has concluded that a number of changes need to be made to the proposed methodology, which is now termed the Waste Transfer Pricing Methodology. The Government is seeking views on these changes through this further consultation

The Energy Act 2008

1.34 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[5]. The Act requires operators of new nuclear power stations to have a Funded Decommissioning Programme (FDP) approved by the Secretary of State for Energy and Climate Change, in place before construction of a new nuclear power station begins and to comply with this programme thereafter.

1.35 On 18 October 2010 the Nuclear Decommissioning and Waste Handling (Designated Technical Matters) Order 2010 was laid before Parliament, to be followed by the Decommissioning and Waste Handling (Finance and Fees) Regulations 2010. The Order and the Regulations together complete the statutory framework for the financing of nuclear waste and decommissioning[6].

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[3] http://www.decc.gov.uk/en/content/cms/consultations/nuc_waste_cost/nuc_waste_cost.aspx

[4] These discussion papers are available at: http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/waste_costs/waste_costs.aspx

[5] Energy Act 2008 http://www.legislation.gov.uk/ukpga/2008/32/pdfs/ukpga_20080032_en.pdf

[6] The Order and Regulations, together with the "Government response to the consultation on the financing arrangements for nuclear decommissioning and waste handling regulations 2010" can be found at http://www.decc.gov.uk/en/content/cms/consultations/nuc_dec_fin/nuc_dec_fin.aspx

Funded Decommissioning Programme Guidance

1.36 Alongside this consultation the Government is also publishing a Consultation on Revised Funded Decommissioning Programme Guidance[7]. This Guidance will assist operators in understanding their obligations under the Energy Act, and what is required for an approvable FDP. This follows an earlier consultation in 2008 on draft FDP Guidance[8].

Geological disposal

1.37 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 White Paper published in June 2008[9]. 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."*

1.38 The Government has given responsibility for planning and implementing geological disposal to the Nuclear Decommissioning Authority (NDA), so as to enable 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 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 NDA into the 'NDA's delivery organisation' for the GDF.

1.39 In July 2010 NDA published "Geological Disposal: steps towards Implementation"[10], a report which describes the preparatory work that 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 NDA believe will be required for successful implementation of geological disposal. It also explains how the various activities and outputs of NDA's work programme are designed to achieve a safe, secure, sustainable and publicly acceptable outcome.

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[7] http://www.decc.gov.uk/en/content/cms/consultations/rev_fdp_guide/rev_fdp_guide.aspx

[8] The 2008 Consultation, and the Government Response, can be found at http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/consultations/page44784.html

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

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

Responding to the consultation document

1.40 We want to hear from members of the public, industry, financial and other institutions that may be involved in the financing of new nuclear power stations, non-governmental organisations and any other organisation or body with an interest.

1.41 When responding please state whether you are responding as an individual or representing the views of an organisation. If you are responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how you assembled the views of members.

How to respond

1.42 A response form is included at Annex A.

1.43 The closing date for responses is **8 March 2011**. Email responses are preferred. Please send your response to the consultation mailbox: decomguidance@decc.gsi.gov.uk

1.44 Alternatively, please send hard copy responses by post to:

Waste Transfer Pricing Methodology consultation
Office for Nuclear Development
Department of Energy and Climate Change
3 Whitehall Place
London
SW1A 2AW

Additional copies

1.45 You may make copies of this document without seeking permission. An electronic version can be downloaded from DECC's website at: http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/new/waste_costs/waste_costs.aspx

1.46 Further hard copies of the consultation document may be obtained from:

Publications Orderline, ADMAIL, 528, London SW1W 8YT
Tel: 0845-015 0010
Fax: 0845-015 0020
Minicom: 0845-015 0030

Confidentiality and data protection

1.47 Your response may be made public by the Government. If you do not want all or part of your response or name made public, please identify the information which you do not wish to be disclosed. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

1.48 You should be aware that information provided in response to the consultation, including personal information, may be subject to publication or disclosure in access to information regimes (primarily the Freedom of Information Act 2000 (FOIA), the Data Protection Act 1998 (DPA) and the Environmental Information Regulations 2004).

1.49 If you want information that you have provided to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals with, amongst other things, obligations of confidence.

1.50 In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances.

1.51 The Department will process your personal data in accordance with the DPA and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

Help with queries

1.52 A copy of the consultation code of practice criteria is set out at Annex C.

1.53 Please direct any queries about the consultation to our consultation mailbox: decomguidance@decc.gsi.gov.uk or in writing to the above address.

1.54 If you have any comments or complaints about the way the consultation has been conducted (as opposed to comments about the issues which are the subject of the consultation), these should be sent to the DECC Consultation Co-ordinator:

DECC Consultation Co-ordinator
3 Whitehall Place
London
SW1A 2AW
Email: consultation.coordinator@decc.gsi.gov.uk

Next steps

1.55 The finalised approach on the issues covered by the consultation will be issued in 2011.

Complete list of consultation questions

1.56 This consultation focuses on the consultation questions listed below. When considering responses to this consultation, the Government will give greater weight to responses that are based on argument and evidence, rather than simple expressions of support or opposition.

1.57 When answering these questions please explain and give reasons for your answers.

Consultation questions	
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?
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?
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.

Chapter 2: Government Response to the "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"

2.1 Introduction

2.1.1 The March consultation document aimed to inform stakeholders and the wider public of:

- Changes to the Government's policy framework for setting a fixed unit price as a result of feedback from stakeholders during the pre-consultation process.
- The main stages of the proposed methodology to set a fixed unit price and worked examples of how it would be calculated using this methodology.
- The Government's updated estimates of decommissioning, waste management and waste disposal costs.

2.1.2 The consultation sought responses to six questions contained in the consultation document. The deadline for responses was 18 June 2010. A total of 41 formal written responses were received. A list of those who responded to the consultation is set out in Annex E and the responses are available on the DECC website[11]. The Cabinet Office Code of Practice on Consultation 2008[12] applied to this consultation.

2.1.3 This chapter sets out the Government's response to the views expressed in that consultation. It is organised into sections on the six questions posed in the consultation document, each of which sets out a summary of the comments received followed by the Government's response. In many cases the views expressed in the consultation have informed the revised proposals set out in Chapter 3.

[11] http://www.decc.gov.uk/en/content/cms/consultations/waste_trans/waste_trans.aspx
[12] http://www.berr.gov.uk/files/file47158.pdf

2.2 Comments received during the Consultation and the Government's response

Consultation Question 1:

Do you agree or disagree that prospective operators of new nuclear power stations should be given the option to defer the setting of their fixed unit price? If so, do you agree that this deferral should be limited to 10 years after the power station has commenced operation? Do you have any comments on the way the Government proposes to determine an expected fixed unit price (eFUP) as the basis for an operator's interim provision in the event that they choose to defer the setting of their fixed unit price?

Summary of comments

2.2.1 Some respondents agreed with the proposal, on the basis that deferring the setting of a fixed unit price would enable there to be greater certainty over waste disposal costs at the point that a price was finally set. For example, it was noted that deferral would provide an opportunity to find a site for a GDF, and also resolve wider uncertainties, for example whether a second GDF might be needed.

2.2.2 However others disagreed with the proposal. Many argued that setting a price before costs were certain meant that the taxpayer would be taking on an unacceptable risk. Some took the view that this would represent a subsidy to the new nuclear operator and it was argued that the only acceptable approach would be for operators to pay the costs of disposal at the point their waste was disposed of. Some respondents argued that deferral was simply a mechanism to reduce costs for operators to encourage investment, and that if operators had to pay full costs it would make new nuclear uneconomic.

2.2.3 A number of respondents argued that it is simply not possible to estimate disposal costs with any confidence, and some were sceptical that a period of deferral would have any significant effect, arguing that uncertainties would continue long into the future. Some expressed doubts over whether geological disposal could ever be safely achieved and it was thus argued that costs and risks were likely to extend well beyond the expected date of disposal, either because the waste would never be emplaced in a GDF, or because, once emplaced, the waste might have to be retrieved due to leakage or other contamination.

2.2.4 Among those who agreed in principle with deferral there was a range of views over the length of the Deferral Period. Many respondents agreed that it should be limited, to ensure that the operator was able to ensure sufficient funds were available to meet its liability. However, while some supported a fixed 10-year Deferral Period, others argued that this was too short and inflexible. It was noted that under the 40-year reactor life assumption upon which the worked examples in the consultation were based, a 10-year Deferral Period implied a period of 30 years after fixing for the operator to ensure there were sufficient monies in their independent fund. Several respondents argued that a 60-year reactor life was more likely, on the basis that 60 years is the design lifetime of the two reactor designs going through the Generic Design Assessment process. Hence a Deferral Period of 30 years was proposed, as

this would still leave 30 years after the price was fixed for fund sufficiency to be assured.

2.2.5 A number of responses suggested that the length of the Deferral Period should be linked to progress in the MRWS process (such as the selection of a site for a GDF, or first waste emplacement), as this would be the primary means by which greater cost certainty would be achieved.

2.2.6 There was also a range of views on whether operators should have the option to fix a price before the end of the Deferral Period. Several respondents argued that the option to fix at the outset was important, on the basis that an operator might prefer to take a higher price early to reduce cost risk. A number of respondents argued that it should be possible for an operator to opt to fix their price during the Deferral Period, for example at a Quinquennial Review. However the alternative argument was also made that, given the benefits of deferral, deferral should be a requirement rather than an option.

2.2.7 A few responses commented on the way in which the eFUP would be determined, noting for example that care should be taken that the eFUP was not set at a low level such that if a much higher price were set later the operator might face difficulties in meeting increased liabilities.

Government's response

2.2.8 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[13].

2.2.9 The Government agrees with those respondents who said that it would be preferable to set a Final Price when there is more certainty over disposal costs. The Government also agrees that this greater certainty will come as progress is made in MRWS and hence accepts that a Deferral Period of 10 years might be insufficient to achieve this greater certainty.

2.2.10 However the Government notes that there was widespread support for the proposal that the Deferral Period should be limited, to mitigate the risk that there might be a shortfall in the operator's fund, should the price when finally set be higher than the Expected Price on which the operator's interim provision had been based. Therefore the Government does not favour an unlimited Deferral Period.

2.2.11 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 Price is set, the longer the period of uncertainty over the size of the operator's final waste disposal liability, and therefore the greater the risk that the operator fails to make prudent provision for their liability.

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[13] 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

The Government's view, set out in more detail in Chapter 3, is that the right balance is for there to be a Deferral Period of 30 years after the start of generation. On NDA's current indicative timetable, First Waste Emplacement in a GDF is envisaged as taking place in around 2040. Therefore a Deferral Period of 30 years should mean that the Final Price is set when there is a high degree of certainty over actual disposal costs.

2.2.12 The Government accepts however that there is a risk that progress in MRWS might be slower than currently anticipated and hence that significant cost uncertainty might remain even at the end of a 30-year Deferral Period. The Government also accepts that operators will wish at the outset to have a degree of cost certainty in order to seek financing. The Government's proposals in this regard are set out in Chapter 3.

Consultation Question 2:

Do you agree or disagree with the proposal that the Schedule for the Government to take title to and liability for an operator's waste should be set in relation to the predicted end of the decommissioning of the nuclear power station? Do you have any comments on the way the Government proposes to recoup the additional costs it will incur in this case?

Summary of comments

2.2.13 Some respondents were in favour of this proposal, agreeing with the argument in the consultation that the Government was better placed than the operator to manage cost risks over such long periods. It was noted for example that several decades could elapse between the end of decommissioning and final waste disposal and that over such long timescales the financial health of operators could not be guaranteed.

2.2.14 Others disagreed with this proposal, arguing that operators should remain liable for their waste until it can be disposed of. It was argued that in taking liability before disposal more risk was being transferred from operators to Government. Some further argued that this risk transfer represented a subsidy to the operator.

2.2.15 One of the risks identified in some responses was that extended storage might be required beyond the expected date of disposal and this was an additional cost risk that would borne by Government under these proposals. Some respondents emphasised the need to make progress in the implementation of geological disposal to mitigate this risk. However this risk was a particular concern for those respondents who expressed doubt over whether a GDF capable of taking new build wastes would ever be built. Those who were sceptical about the achievability of geological disposal raised consequent long-term cost risks, included remediating contamination and the possible need to repackage failed fuel or retrieve waste from a GDF.

2.2.16 A number of respondents said that it could not be certain that an operator would remain solvent and able to meet its liabilities for the long time periods involved. Some saw this as a reason to support the proposal for Early Transfer, as long as sufficient funds were transferred to Government to manage the wastes pending disposal, while others saw this as increasing the risk that long-term costs would fall to the taxpayer.

2.2.17 With regard to the proposals for the Government to recoup the additional costs arising from Early Transfer, some respondents agreed that waste management costs should be well understood by the Transfer Date, while others envisaged ongoing uncertainty over costs, which would cast doubt over whether sufficient funds could be provided by the operator to protect the taxpayer. Concern was expressed that Early Transfer implied use of shared facilities between legacy and new build, which could mean costs that should properly fall to new nuclear operators would be borne by Government in its management of legacy wastes. This was considered a benefit to new build that could again represent a subsidy.

2.2.18 Some respondents sought more detail on how the lump sum payment would be calculated. In particular, clarification was sought on how the "time value of money" would be handled, as the way in which long term costs were discounted would have a significant effect on the amount an operator had to pay into its fund.

Government's response

2.2.19 The Government agrees with those respondents who identified risks around the ability of energy companies to meet liabilities in the very long term, particularly after the end of electricity generation when revenues have ceased. It is for this reason that prospective operators are required to have secure arrangements in place to ensure the financing of decommissioning, waste management and waste disposal before construction of a new nuclear power station begins. This framework will ensure that monies set aside by operators for these purposes are available even in the event of the insolvency of the operator.

2.2.20 The Government remains of the view that it is better placed than operators to manage long-term cost risks and hence regards the Early Transfer of waste, together with sufficient monies to cover all additional costs incurred by Government ahead of disposal, to be an important part of the framework to protect the taxpayer.

2.2.21 The Government accepts that Early Transfer represents the transfer of a cost risk to Government, but believes that by the time title to and liability for the waste from a new nuclear power station transfers to Government, there should be a high level of certainty over the costs to be incurred. Therefore the Government is satisfied that the lump sum payment to recompense Government for the additional costs arising from Early Transfer can be calculated with sufficient accuracy to minimise any risk to the taxpayer.

2.2.22 With regard to the question of whether a GDF for waste from new nuclear power stations will ever be built, the Government is committed to the implementation of geological disposal for the disposal of legacy wastes and considers that it is technically feasible and desirable to dispose of waste from new nuclear power stations in the same facilities. The draft Nuclear National Policy Statement[14] sets out the reasoning behind the Government's view that it is satisfied (i) that geological

[14] See Annex B of the Nuclear NPS, available at https://www.energynpsconsultation.decc.gov.uk/docs/AnnexestoEN-6-RevisedDraftNuclearNPS%28VolumeII%29-October2010.pdf

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.

2.2.23 The Government's view is that it is too early to establish the extent of possible sharing of waste storage and processing facilities between existing and new nuclear operators. Prospective new build operators and NDA have identified options for managing the spent fuel that will arise from new nuclear power stations[15]. The Government expects that systems and methods for both legacy and new build waste streams will be considered in parallel, not in isolation to each other. This will enable best practice to be shared across the legacy and new build estates to deliver the optimum management process and exploit synergies that may exist. The Government believes that it will be possible to ensure that costs are apportioned correctly in the event of any sharing of facilities between legacy and new build and does not consider that such arrangements would constitute a subsidy to new build.

2.2.24 The Government accepts that, due to the long time horizons involved, the way in which the "time value of money" is handled will have a very significant effect on the amount operators will have to pay, and the amount the Government will receive in payment at the Transfer Date. The Government's view remains that the applicable discount rate should be set near the Transfer Date and should be set in relation to the rates of return on long-term investments in Government securities and similar assets.

[15] http://www.nda.gov.uk/documents/loader.cfm?csModule=security/getfile&pageid=42986

Consultation Question 3:

Do you agree or disagree that the proposed methodology to determine a fixed unit price strikes the right balance in protecting the taxpayer, by taking a prudent and conservative approach to cost estimation, and facilitating new nuclear build by providing certainty to operators? What are your reasons?

Summary of comments

2.2.25 Some respondents said that that there was insufficient information provided to form a view and argued that there were many uncertainties that had not been considered. Uncertainties that were cited included the cost of community benefits associated with a GDF and costs arising from accidents, terrorist incidents or possible compensation claims. Some respondents were also sceptical about whether the geological disposal of new build spent fuel would prove feasible, in which case long term waste management costs would be impossible to estimate accurately.

2.2.26 It was argued that in the face of such uncertainty this was a speculative exercise which lacked credibility. Some cited massive cost escalation in other nuclear projects as evidence that the risk premium in the methodology was unlikely to be sufficient. Others argued that the purpose of the methodology was to enable new nuclear operators to avoid paying the true cost of waste disposal. A number of respondents took the view that if operators were not prepared to accept the cost risks around waste disposal then they should not proceed with building new nuclear power stations.

2.2.27 Other respondents took an alternative view and regarded the methodology as highly conservative in its approach to risk. Some commented that the methodology allowed for very high levels of uncertainty such that it was in effect an upper bound cost estimate, and in doing so would mean charging the operator a very high price in return for cost certainty. Some agreed that such a conservative approach was appropriate given the level of uncertainty over costs and the benefit of cost certainty to the operator. However others were concerned that the approach was excessively conservative, arguing that the illustrative prices given in the worked examples were overcautious and implied a significant profit to Government, so that in effect that new build operators would be subsidising legacy waste disposal.

2.2.28 A number of responses highlighted the extent to which the cost risks were substantially within the Government's control, given that the Government is responsible for the delivery of geological disposal, and argued that the operators would have very little ability to influence disposal costs. Some noted that the provision in the methodology for the Price, if deferred, to be higher in the future than a Price set at the outset, might provide a perverse incentive for Government either not to control costs or to delay progress in building a GDF. It was noted that under deferral the operator was bearing the risk of increases in costs largely determined by Government, and that this could create problems for prospective investors in new nuclear.

2.2.29 A number of respondents expressed concern over the extent to which the financial modelling in the worked examples envisaged that the operator's provisions for waste disposal costs would rely on investment performance assumptions, for example

growth in investments in the stock market, in order to ensure sufficient funds were available. Some saw the availability of monies to pay the fixed unit price as being over-dependent on investment performance and perceived this to be a further risk to the taxpayer.

Government's response

2.2.30 The Government recognises that there is substantial uncertainty over waste disposal costs, but does not accept that this means that a price setting methodology is not possible. The consultation set out in detail the risks and uncertainties that have been identified and proposals for how those risks should be taken into account in the methodology. The Government agrees with those respondents who argued that the approach to risk and uncertainty set out in the consultation is very conservative, but believes that such conservatism is necessary to ensure the taxpayer is protected.

2.2.31 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. However the Government does not expect considerations relating to this pricing framework to have a significant impact on the pace or manner in which it makes progress with the implementation of geological disposal. As stated above, the Government is committed to the implementation of geological disposal for the disposal of legacy wastes. The need for the Government to dispose of the legacy inventory gives a strong incentive for the Government to seek to control disposal costs.

2.2.32 The Government has considered the argument made by several respondents that the methodology does not take sufficient account of wider risks and uncertainties and hence is likely to underestimate disposal costs.

2.2.33 The Government's view is that the Consultation set out a clear approach in the event that MRWS process proceeds broadly as currently expected. However the Government accepts that the Consultation did not address sufficiently how the Price would be set in the event that the MRWS process did not proceed as currently anticipated. An updated methodology, which takes this into account, is set out in Chapter 3.

2.2.34 The Government does not accept the argument that there is an unacceptable risk to the taxpayer in allowing operators to assume some investment growth in the independent funds that they are required to set up to accumulate monies to pay their waste and decommissioning liabilities. Over the many decades in which these funds are expected to operate, the Government considers it reasonable for an operator to plan on the basis that real terms growth in investments will be achieved. However it is important to note that the risks around fund performance lie with the operator not the Government. The investment assumptions set at the outset are not fixed and will need to be reviewed every five years at each Quinquennial Review of the operator's FDP. In the event that the operator's independent Fund had not grown as expected, the operator would be required to take corrective action to top-up the Fund.

Consultation Question 4:

Do you agree or disagree with the proposed approach to determining an operator's contribution to the fixed costs of constructing a geological disposal facility? What are your reasons?

Summary of comments

2.2.35 A number of responses acknowledged the difficulty of determining the appropriate share of GDF fixed costs to be borne by operators of new nuclear power stations. There was some support for the proposed approach, in which a new nuclear operator's share of GDF fixed costs is set in proportion to its share of variable costs. However it was noted that there would be practical challenges in determining this, as it depends on assumptions around waste volumes for both legacy and new build and these were both uncertain. However some responses were critical of this approach, arguing that it did not take account of other considerations, such as the higher radioactivity of new build wastes when compared to legacy wastes.

2.2.36 Some respondents favoured limiting new build's contribution to the fixed costs of a GDF to those additional fixed costs incurred directly on behalf of new build, arguing that new build contributions to costs that would otherwise fall to legacy wastes constituted a new build subsidy of legacy costs. In contrast, others took the view that any arrangement in which new build paid only marginal costs would not be acceptable.

2.2.37 The scope of costs included within the "fixed cost" total also attracted comment. Several responses stressed the importance of including the cost of community benefits associated with a GDF within the total. Some also argued that all GDF development and design costs incurred to date should also be included in the total.

2.2.38 A number of respondents also addressed the issue of a possible second GDF. Some were pleased to see that the possibility had been acknowledged, and supported the deferral of the setting of a fixed unit price to allow time for certainty on this issue. Others argued that the consultation was premature in assuming co-disposal of legacy and new build wastes in the same GDF, arguing for example that this might not be accepted by the GDF's host community. It was suggested that a dedicated GDF for new build wastes was one way of demonstrating no subsidy.

Government's response

2.2.39 Having considered the responses to this question the Government's does not intend to revise the proposals set out in the consultation, that the Waste Transfer Price should include a contribution to the fixed costs of a GDF. The Government regards this as consistent with its policy that new nuclear operators should pay their full share of waste disposal costs, and does not accept the argument that the price charged to new nuclear operators should be set in regard solely to the marginal costs of waste disposal. The Government also confirms that a new nuclear operator's contribution to the fixed costs of a GDF should be calculated in relation to the use the operator makes of the facility, and that the best proxy for this is the operator's share of total variable costs.

2.2.40 The Government accepts that there is some uncertainty over this calculation as the inventories of both legacy and new build wastes will remain uncertain. Therefore, and as set out in the consultation, these inventories will need to be estimated and these estimates might be revised over time. In light of the finding that unit costs fall gradually as the size of the new build fleet increases, the methodology should employ a conservative estimate of the likely size of the new build fleet.

2.2.41 With regard to the possibility that a second GDF might be needed, the March consultation discussed two different risks that a second GDF might be needed. The first of these is the risk that co-location of spent fuel/HLW and ILW/LLW does not prove feasible and this is taken into account in the Contingency Allowance as risk A2 (see Annex C of the March consultation for more detail). The second is the risk that a second GDF might be needed if there were capacity constraints at the site of the first GDF, for example if the new build fleet is large. The Government's view remains that the methodology should proceed on the presumption of co-disposal, but retain the flexibility to revise that assumption at a later date if there were reasons to consider that there was a significant risk that a second GDF might be needed.

2.2.42 The methodology uses simple cost definitions. Fixed Costs are all costs incurred from a specified start date to first waste emplacement and all costs incurred after last waste emplacement to a specified end date. Variable Costs are all those costs incurred during the period of waste emplacement. This means it includes overheads and maintenance and refurbishment costs, which in other circumstances might sometimes be called fixed costs. More detail on these definitions can be found in the Cost Estimating Methodology set out in Chapter 3.

2.2.43 The starting point for the calculation of the Fixed Costs is expected to be at or around the time that the first price is requested by a prospective new nuclear operator. It therefore excludes all design and other costs incurred before that point. The consultation noted that there are categories of possible costs excluded from the current cost estimate but which might need to be added in later, such as the cost of community benefits associated with a GDF and the need to maintain institutional control for the facility post closure. To the extent that such costs are incurred or expected to be incurred as part of the GDF project, a new nuclear power station operator will be expected to pay their full share of these costs.

Consultation Question 5:

Do you agree or disagree with the proposal that the units to be used for the fixed unit price are pence per kWh for spent fuel and cubic metres of packaged intermediate level waste? What are your reasons?

Summary of comments

2.2.44 With regard to ILW, there was general agreement among those respondents who commented that the proposed unit, the cubic metre of packaged waste, was an appropriate unit.

2.2.45 With regard to spent fuel, the consultation proposed that the price be levied in terms of pence per kilowatt-hour generated (p/kWh), with a quantity based unit such as pounds per tonne of uranium (£/tU) being the most viable alternative. There was some support for each of these units.

2.2.46 Those respondents who supported an output unit such p/kWh noted for example that it reflected heat loading, which is a key consideration in the safe disposal of spent fuel. The simplicity and transparency of this unit were also noted, though some respondents said that more detail was required on how this would operate in practice.

2.2.47 Those respondents who favoured a volumetric unit such as £/tU argued that although heat loading was significant, it was just one of a number of factors affecting costs and p/kWh was too far removed from actual costs. It was noted that a simple volume measure was consistent with reporting of existing materials in the National Inventory. It was also argued that a volumetric unit would create an incentive to minimise disposal volumes and some concern was raised that moving away from a volumetric unit for spent fuel risked weakening that incentive.

2.2.48 A number of respondents disagreed with these proposals, on the basis that they did not agree with the policy to set a fixed unit price and did not consider it possible to set a fixed unit price at a level that would protect the taxpayer and avoid the risk of subsidy.

2.2.49 Several respondents expressed concern that operators might not be able to make up any shortfall in funds in the event of a significant decrease in electricity prices. There was concern that in setting the price in relation to electrical output this proposal appeared to link waste and decommissioning funding to the operator's financial performance.

Government's response

2.2.50 The Government is pleased to note general agreement to its proposal for the unit for ILW to be the cubic metre of packaged waste. On spent fuel, the Government notes the range of opinions expressed and recognises that this is clearly a finely balanced argument.

2.2.51 As set out above, the Government is proposing an extended Deferral Period, to enable uncertainty to be reduced and the Final Price to be set in relation to more robust cost data. This should also enable uncertainty over the disposal concept to be resolved, and hence the Government expects the Final Price to be set in relation to a known, specified disposal concept, which is expected to include a specified disposal canister. The question of which unit to use applies only to Prices set before the disposal canister is confirmed.

2.2.52 Although there is uncertainty over the specification of the final disposal canister, all concepts currently under consideration assume the packaging of spent fuel assemblies in some form of container for emplacement in a GDF. The current NDA reference case assumes a copper canister containing four fuel assemblies. Some assumptions are then required, in order to convert the estimated cost into either of the two units under consideration (p/kWh or £/tU). The conversion from £/canister to £/tU is a simple one – a copper canister is assumed to contain 2.06tU. However the conversion from £/canister to p/kWh requires a more complex calculation, in which a given quantity of spent fuel is assumed to give rise to a given output of electricity.

2.2.53 The Government's view is that the risks introduced by this conversion process need to be considered alongside the benefits identified for each unit. Having considered the responses to the consultation, the clear benefit, of simplicity and resilience to change, represented by a simple output unit such as p/kWh have the potential to be outweighed by the uncertainties around the conversion from a cost estimate per canister.

2.2.54 On balance therefore there seem to be fewer risks in using a simple volumetric unit, and here would also be the benefit of consistency with the current National Inventory. Therefore the Government's view is that the better unit to be applied when determining the Price for spent fuel, under conditions where the disposal canister is not known, appears to be £/tU.

2.2.55 With regard to concern that a fall in electricity prices might lead to a shortfall in funds, under the Energy Act 2008 operators are required to have an FDP agreed by the Secretary of State in place before construction of the power station can begin and to comply with the plan thereafter. The FDP will set out how the operator will ensure that secure funds are available to meet their liabilities as they fall due, and will explain how any shortfall in the operator's independent Fund will be handled.

Consultation Question 6:

Do the cost estimates set out in this chapter provide a credible range of estimates of the likely costs for decommissioning, waste management and waste disposal for a new nuclear power station?

Summary of comments

2.2.56 Many respondents commented on the degree to which the figures published in the consultation were substantially higher than those published in the 2007 Consultation on the Future of Nuclear Power, in many cases arguing that this demonstrated the unreliability of estimates of nuclear costs. Some respondents concluded that the estimates lacked credibility given the current high level of uncertainty.

2.2.57 Other respondents did consider the estimates to be credible, albeit covering a wide range. Some regarded such a wide range as necessarily conservative, while others considered the high-end figures as being at the extreme upper end. Several respondents commented that there should be opportunities in future for costs to be reduced, for example through technical advances or shared facilities.

2.2.58 A number of respondents commented that the scope of the estimates was unclear. There was some comment on the range of uncertainties, in particular uncertainty over the way in which spent fuel would be managed in the long term, covering issues such as the manner and location of spent fuel storage and encapsulation. Some suggested that important potential costs appeared to be excluded, in particular costs over the very long term such as possible compensation for health impacts or mitigating flood risks arising from climate change.

2.2.59 In general, the wide range of values and generic nature of the estimates led many to conclude that these estimates were of limited value and that much more work would be needed to establish the robustness of cost estimates relating to specific proposals.

Government's response

2.2.60 The Government acknowledges the concerns over the substantial increases in cost estimates between 2007 and 2010. At the time the 2007 estimates were published, it was acknowledged that further work was needed to establish costs and the range of likely uncertainty in those cost estimates. Substantial work has been carried out since 2007 and this has identified that some of the high-level assumptions underpinning the 2007 estimates should be revised. These revised assumptions were explained in the consultation and the Government regards the updated estimates as credible and more robust than those published in 2007.

2.2.61 The Government remains of the view that it is important to be cautious in estimating costs in view of the considerable uncertainties in a number of areas. The Government regards the estimates set out in the consultation as forming a benchmark against which to assess the estimates produced by operators, however it will expect operators to produce their own estimates and will subject those estimates to close scrutiny.

Chapter 3: The Waste Transfer Pricing Methodology

3.1 Introduction

3.1.1 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.

3.1.2 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 "Final Price"). The Final 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.

3.1.3 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 2008 requires operators to make prudent funding arrangements for their waste and decommissioning liabilities. The Government's view is that in order for an operator to be able to make prudent financial 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.

3.1.4 Equally, the Government intends that the Final Price, although set 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 Final Price will be set at a level over and above estimated costs and include a risk premium (the "Risk Premium") to compensate the taxpayer for taking on the risk of subsequent cost escalation.

3.1.5 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. In responses to the 2007 Consultation on the Future of Nuclear Power, and subsequently, energy companies have indicated that they would be prepared to pay a significant Risk Premium, over and above the

expected costs of disposing of waste, in return for having the certainty of a fixed upper price.

3.1.6 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.

3.1.7 It is against this background that the Government has developed the Waste Transfer Pricing Methodology set out here. 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 Final Price they will be expected to pay the Government for the provision of a waste disposal service.
- The Final Price charged by Government for the provision of a waste disposal service 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 Final Price should be set in relation to actual cost data, to ensure that 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 Final Price should be deferred for a specified Deferral Period, provided that in certain circumstances it will be possible for the final 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.

3.1.8 Having considered the responses to the March consultation the Government has concluded that a number of changes need to be made to the methodology set out in that consultation. The Government is seeking views on these changes through this further consultation. This chapter sets out the two main changes, which to a considerable extent flow from comments received in the March consultation as discussed in Chapter 2. This chapter also sets out the revised Waste Transfer Pricing Methodology. Much of the methodology and underpinning analysis is carried forward from the March consultation. Chapter 4 contains some worked examples to illustrate the working of this Methodology.

3.2 Changes to the Methodology following the March consultation

3.2.1 There are two significant proposed changes to the methodology set out in the March consultation and the Government is seeking views specifically on these two changes in this further consultation:

- the Final Price should be subject to a Cap, and in return a Risk Fee should be charged;
- the Deferral Period should be set at 30 years after start of generation.

3.2.2 A number of other, more limited, changes and refinements have been made and hence this consultation also seeks views on the revised Methodology as a whole.

Setting a Cap and charging a Risk Fee

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?

3.2.3 As set out in Chapter 2, the Government's view is that the March consultation set out a clear approach in the event that the MRWS process proceeds broadly as currently expected. For clarity, and taking into account the Government's intention (set out below) to specify a Deferral Period of 30 years, the Government's expectation is that the Final Price for an operator will be set after First Waste Emplacement in a GDF, which is currently anticipated to take place in around 2040. This price will be based on a conservative estimate of disposal costs (the "Pricing Cost Estimate"), which in turn will be based in large part on actual disposal cost data, and will include a Risk Premium to compensate the taxpayer for taking on the risk of subsequent cost escalation.

3.2.4 However the Government accepts that the March consultation did not examine in sufficient detail what would happen if things did not go according to current expectations. There are broadly two scenarios of particular concern:

- that uncertainty over waste disposal costs has not been significantly reduced by the end of the Deferral Period;
- that uncertainty over disposal costs has been reduced by the end of the Deferral Period, but estimated disposal costs are very much higher than currently anticipated.

3.2.5 With regard to the first scenario, the Government is committed to the implementation of geological disposal. The Government is satisfied that it is technically achievable and that a site will be found for a GDF. As stated in Chapter 2, the Government has set out its reasons, together with supporting evidence, in the draft Nuclear National Policy Statement and accompanying material.

3.2.6 However the Government accepts that there is a residual risk that delays in the implementation of geological disposal might mean that it will not be possible to achieve a high level of confidence over disposal costs by the end of the Deferral Period. The proposed extension of the Deferral Period to thirty years after start of generation (i.e. around 2048 for the first new nuclear reactor) means that the Government regards this risk as small. However it is possible that at the end of the Deferral Period it will be necessary to set a Final Price when there remains significant uncertainty over waste disposal costs.

3.2.7 The second scenario is that at the end of the Deferral Period geological disposal is being successfully implemented, but the cost is very much higher than currently estimated. The March consultation set out a highly conservative analysis of risk and uncertainty and the Government does not intend to revise this analysis significantly following the consultation. However the Government accepts that there is a small residual risk that costs could exceed even the very conservative, risk-adjusted estimates derived through this analysis. In this case, a Pricing Cost Estimate produced at the end of the Deferral Period could be higher than that derived at the outset.

3.2.8 The March consultation said that in seeking a deferral the operator would be accepting the risk that a Price set at a later date could be higher than the Price on offer at the outset, if estimated costs escalate sufficiently in the intervening period. Having considered the responses to the consultation, the Government's view is that it will be difficult for an operator to accept such a risk, given that there is very little the operator can do to manage and mitigate it. In contrast, the Government does have capacity to manage risks around waste disposal costs, as these costs will be heavily influenced by the manner in which the Government implements geological disposal. Therefore the Government's view is that it is reasonable for nuclear operators to have some certainty over their maximum exposure to these risks from the outset.

3.2.9 The Government therefore proposes to specify a maximum Final Price the operator would be expected to pay (the "Cap"). The Cap (which will be indexed for inflation) will reflect the Government's current analysis of risk and uncertainty and will be set at a level where the Government has a very high level of confidence that actual costs will be lower than the Cap. The Government recognises that, in setting a Cap, the small residual risk that actual cost might exceed the Cap will lie with the Government. Hence in return for setting a Cap the Government will charge the operator an appropriate fee (the "Risk Fee") and incorporate this into the Final Price. This means that the Final Price will be calculated as a Pricing Cost Estimate *plus* the Risk Fee (subject to the proviso that the Final Price cannot exceed the Cap).

3.2.10 Hence the Government would be accepting a small risk that actual cost could exceed the Cap and would charge appropriately for so doing. The Government intends this Risk Fee to be determined on a commercial basis, and more detail on how this Risk Fee might be determined is set out below.

Extended Deferral Period

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?

3.2.11 The purpose of deferring the setting of the Final Price is to enable uncertainty over waste disposal costs to be reduced. As stated in Chapter 2, the Government believes that the Deferral Period should be limited, to ensure operators are able to make prudent provisional for their waste disposal liability. However the Government accepts that a Deferral Period of only 10 years after start of generation, as proposed in the March consultation, might not be sufficient to allow uncertainty to be significantly reduced. Therefore the Government proposes a Deferral Period of 30 years, hence the Government expects the Final Price to be set after considerable progress has been made in the implementation of geological disposal.

3.2.12 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[16]:

- Preparatory Studies
- Surface Based Investigations
- Construction and Underground Based Investigations
- Operation
- Closure

3.2.13 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.

3.2.14 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 ("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.

[16] 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

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 the underground environment where disposal is planned has been reached, and when regulators give permission for construction of the GDF to proceed.

3.2.15 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.

3.2.16 The Government's view is that a 30 year Deferral Period should enable the Final 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.

3.2.17 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.

3.2.18 The Government's view is that following GDF Site Selection it will be possible for the body responsible for constructing and operating the GDF to produce a Site-Specific Cost Estimate that takes due account of risk and uncertainty. Therefore, although the Government's preference is for the Final Price to be set after First Waste Emplacement, it is expected to be possible to set a Final Price at the end of the Deferral Period in the manner envisaged in this Methodology before First Waste Emplacement, as long as GDF Site Selection has taken place. However, given that the cost data available in these circumstances will be more uncertain, the Final Price would probably include a larger Risk Premium than would be necessary if the Price were being set following First Waste Emplacement.

3.2.19 In the event that GDF Site Selection has not taken place by the end of the Deferral Period, a mechanism is required to determine the Final Price in these circumstances (a "Default Pricing Mechanism"). In this case, the level of the Final Price will be set at the discretion of the Secretary of State, having regard to such cost modelling as is available at the time. However the Cap will still apply, hence the Default Price will not be higher than the Cap. In practice, given that uncertainty may not have been reduced significantly it is considered likely that the Default Price will be at or near the level of the Cap.

3.2.20 An operator can request that their Final Price be fixed during the Deferral Period. In this case the level of the Final 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 Final Price cannot be higher than the Cap, and an operator can opt at any time to fix their Final Price at the level of the Cap.

3.3 Description of the Waste Transfer Pricing Methodology

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.

Summary of the Waste Transfer Pricing Methodology

3.3.1 This section provides a summary of the key points of the Waste Transfer Pricing Methodology. The remainder of this Chapter then sets out a more detailed description of the Methodology.

3.3.2 The Final 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. The Government intends that the Price should be set in accordance with the Cost Estimating Methodology set out below, in which the best available estimate of waste disposal costs is adjusted to take due account of risk and uncertainty.

3.3.3 The Cost Estimating Methodology will generate a distribution of estimated costs. A Pricing Cost Estimate will be drawn from this distribution and the Final Price should be set in direct relation to this Pricing Cost Estimate. 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.

3.3.4 The Government proposes that the Pricing Cost Estimate be set at P_{95} of the distribution derived in the Cost Estimating Methodology, 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.

3.3.5 The analysis set out in the March consultation showed that a Pricing Cost Estimate derived now would be very much higher than the current best estimate of disposal costs (as set out by NDA in their 2007/08 Annual Report and Accounts), 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.

3.3.6 Therefore the Government's view is that the setting of the Final 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 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.

3.3.7 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 Final 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. 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 added onto the Final Price, i.e. it is in addition to the Risk Premium[17].

3.3.8 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 a projection of the expected level of the Final Price when it comes to be set at the end of the Deferral Period (an "Expected Price"). The Expected Price will be reviewed at five-year intervals (the "Quinquennial Review") during the Deferral Period. The proposed way in which the Expected Price will be determined is set out below and views are sought in particular on this matter in this consultation.

3.3.9 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.

3.3.10 Therefore the Government expects that the Final 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 Cost Estimating 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.

3.3.11 It is envisaged that a detailed Cost Estimating Methodology, based on the summary below, will be set out in the Waste Contract agreed between the operator and the Secretary of State alongside the Secretary of State's approval of the operator's FDP. In this Contract the Government would expect to commit to a transparent application of the Cost Estimating 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 Final Price would be set. This is expected to include provisions for transparency and independent scrutiny of the Government's cost estimates, and a Dispute Resolution procedure

[17] For clarity, the distinction between the Risk Premium and the Risk Fee is as follows:
- the Risk Premium compensates Government for accepting the risk of cost escalation after the Final Price has been set;
- the Risk Fee compensates Government for accepting, at the outset, the risk that actual cost might exceed the Cap.

involving independent experts to resolve disagreements arising from the application of the Cost Estimating Methodology, except in cases where the Default Pricing Mechanism applies (as set out below).

3.3.12 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.

3.3.13 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.

3.3.14 The Government's view therefore is that it will be possible to set a Final 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 Final Price were to be set after First Waste Emplacement. Hence, a Final Price set in these circumstances is likely to include a larger Risk Premium than a Final Price set after First Waste Emplacement.

3.3.15 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 GDF Site Selection. In this case it will not be possible to set a Final Price in relation to a Site Specific Cost Estimate and a Default Pricing Mechanism will apply. In these circumstances the level of the Final 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 Final Price would be at or near the level of the Cap.

3.3.16 An operator can request that their Final Price be fixed during the Deferral Period. In this case the level of the Final 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 Final Price cannot be higher than the Cap, and an operator can opt at any time to fix their Final Price at the level of the Cap.

3.3.17 The Cap will be set at a level that reflects the Government's current analysis of risk and uncertainty around waste disposal costs. The level of the Cap will be determined by the Secretary of State, having regard to the application of the Cost Estimating Methodology described below, and will not be subject to Dispute Resolution. 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 proposed way in which the Risk Fee will be calculated is set out below and views are sought in particular on this matter in this consultation.

3.3.18 Alongside the Final Price the Government will also provide the operator with an Assumed Disposal Date. This is the Government's best estimate of the date on which disposal of the operator's waste will begin. An Assumed Disposal Date is required as it will determine the duration of interim storage of waste pending disposal for which the operator will be required to make financial provision. It will also determine the extent to which the Final Price is subject to discounting if the date on which title to and liability for the operator's waste transfers to Government (the "Transfer Date") is, as currently anticipated, some years before the Assumed Disposal Date.

3.3.19 The Assumed Disposal Date will be determined alongside the Final Price, and an Expected Assumed Disposal Date will be provided to the operator alongside an Expected Price. In the event that the Final Price is set before GDF Site Selection, the Default Pricing Mechanism will also determine the Assumed Disposal Date.

Cost Estimating Methodology

3.3.20 The purpose of the Cost Estimating Methodology is to set out clearly how waste disposal costs will be estimated and uncertainty in those estimates handled. The manner in which costs are estimated, and the analysis of risk and uncertainty around current cost estimates, is consistent with the approach set out in Chapter 3 of the March Consultation.

3.3.21 The Cost Estimating Methodology will generate a distribution of expected costs from which the Pricing Cost Estimate will be drawn. It is expected that by the end of the Deferral Period the Cost Estimating Methodology will be applied to a Site Specific Cost Estimate. However it will not be possible to produce such an estimate until after GDF Site Selection. Therefore in the interim, and for the purposes of deriving an Expected Price prior to GDF Site Selection, a simplified Cost Estimating Methodology needs to be applied using NDA's current cost estimates, which have been derived with regard to a reference case.

3.3.22 This section first of all sets out a summary of the Cost Estimating Methodology. It then describes how this Methodology will be applied in setting the Final Price and the Expected Price. Finally this section sets out how this Methodology is applied in the cost modelling process that will inform the setting of the Cap and the Risk Fee.

3.3.23 As set out above, it is expected that a detailed Cost Estimating Methodology, based on the summary below, 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.

Estimating waste disposal costs

3.3.24 The Cost Estimating Methodology will use data produced by the body responsible for building and operating a GDF. This is currently NDA's RWMD.

3.3.25 The Cost Estimating 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.

3.3.26 The Methodology defines Fixed Costs as 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.

3.3.27 The Methodology defines Variable Costs as all GDF costs incurred during the period of waste emplacement. This means it includes overheads and maintenance and refurbishment costs, which in other circumstances might sometimes be called fixed costs.

3.3.28 The Methodology derives estimates of these two costs per unit of ILW or spent fuel. Adding the Variable Costs per unit to the Fixed Costs per unit 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.

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

Allocation of Variable Costs per unit ILW/spent fuel

3.3.30 To derive an estimate of the Variable Costs per unit, the Methodology currently takes an estimate of the total GDF Variable Costs for a specified period and divides it by the number of units expected to be disposed of in that period.

3.3.31 It might be possible that a more detailed approach to the apportionment of Variable Costs per unit will be developed over time, and the Government would expect that the Waste Contract between the operator and the Government regarding the Cost Estimating Methodology to include the flexibility to refine this calculation over time if it is appropriate to do so.

Allocation of Fixed Costs per unit ILW/spent fuel

3.3.32 As set out in the March consultation the Government considers that a new nuclear operator's full share of waste disposal costs should include a contribution towards the Fixed Costs of building a GDF that will take both legacy and new build wastes. This contribution will be calculated as part of the Cost Estimating Methodology.

3.3.33 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 build operator's share of the Fixed Costs of a GDF is calculated in proportion to its share of estimated total Variable Costs.

3.3.34 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.

3.3.35 As set out above, the Cost Estimating 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. Annex D of the March consultation sets out an inventory for a generic PWR. This inventory was used in the worked examples in the March consultation and has also been used in the worked examples in Chapter 4 of this consultation.

3.3.36 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 of the March consultation also gave the legacy inventory that has been assumed for the worked examples.

3.3.37 In addition, an estimate of the total inventory of new build wastes to be emplaced in a GDF is required, which requires an assumption around 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. The March consultation explained that 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 Cost Estimating Methodology will make a conservative estimate of the likely size of the new build fleet.

3.3.38 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 March consultation acknowledged 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 co-disposal. 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.

3.3.39 As set out in the March consultation, the Government proposes to proceed on a presumption of the co-disposal of legacy and new build waste, 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 proposal set out here for a longer, 30-year Deferral Period.

Financing Charge

3.3.40 As set out in the March consultation, 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.

3.3.41 The Final 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 emplacement of legacy wastes will take priority.

3.3.42 The issue of the "late payment" of the contribution to the Fixed Costs of a GDF was discussed in the March consultation, which proposed that a "Financing Charge" should be applied on the share of Fixed Costs included in the Final 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.

3.3.43 In this case a GDF would be built many decades later, as it would not need to be ready until the waste from new build operators 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 build 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 Final Price would be due to be paid).

3.3.44 Having considered this question further during the consultation, the Government has concluded that a Financing Charge should be applied in the Cost Estimating Methodology based on the "virtual GDF" approach, i.e. 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.

Handling uncertainty in cost estimates

3.3.45 The Cost Estimating Methodology needs to allow for risk and uncertainty around the cost estimates produced by NDA. As set out in the March consultation, in the absence of a GDF site or confirmed disposal concept the current level of uncertainty is very high. Over time uncertainty is expected to be reduced, particularly following GDF Site Selection, at which point a Site Specific Cost Estimate can be produced.

3.3.46 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. It should enable production of a cost distribution from which a Pricing Cost Estimate (and hence an appropriate Risk Premium) can be derived. It is expected that by the time a Final Price is to be set at the end of the Deferral Period, there should be a high degree of confidence in estimates of GDF costs.

3.3.47 In the absence of a Site Specific Cost Estimate, a simplified approach is required to derive an expected Pricing Cost Estimate for the purposes of determining an Expected Price and a Cap. More detail on how this will be handled in set out in the relevant sections below

"Units" conversion

3.3.48 The Cost Estimating 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, Final Price, Cap and Risk Fee for the disposal of ILW.

3.3.49 For spent fuel, NDA's cost modelling estimates costs with reference to the KBS-3 copper canister. However, and as set out in the March consultation, 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, Final Price, Cap and Risk Fee for the disposal of spent fuel. Therefore, the last stage of the Cost Estimating Methodology for spent fuel will be the conversion of the cost per unit from whichever unit is used in NDA's cost modelling to an appropriate unit for spent fuel.

3.3.50 This issue was discussed in the March consultation and the Government's response is set out in relation to Consultation Question 5 in Chapter 2. This states that the Government's view is that the appropriate unit for spent fuel is likely to be £/tU. However this is a finely balanced question and this issue will be considered further in light of responses to this consultation.

Determination of the Final Price

3.3.51 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 Final Price will be set in relation to a Site Specific Cost Estimate, incorporating a large amount of actual cost data.

3.3.52 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. The Government's view is that it will be possible to set a Final 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 Final Price were to be set after First Waste Emplacement. Hence, a Final Price set in these circumstances is likely to include a larger Risk Premium than a Final Price set after First Waste Emplacement.

3.3.53 In the event that the end of the Deferral Period falls before GDF Site Selection it will not be possible to set a Final Price in relation to a Site Specific Cost Estimate and the Default Pricing Mechanism, set out below, will apply.

Estimating waste disposal costs

3.3.54 By the end of the Deferral Period the Government expects there to be a Site Specific Cost Estimate. Applying the Cost Estimating Methodology to this Site Specific Cost Estimate should enable estimates of Total Costs per unit of ILW and spent fuel to be derived.

Handling uncertainty in cost estimates

3.3.55 The Site Specific Cost Estimate 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 cost distribution from which a Pricing Cost Estimate (and hence an appropriate Risk Premium) can be derived. The Pricing Cost Estimate will be set at P_{95} from the distribution.

3.3.56 It is expected that at the end of the Deferral Period, there should be a high degree of confidence in estimates of GDF costs. Therefore the distribution of estimated costs derived in this way 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.

Setting the Final Price

3.3.57 The Final Price set at the end of the Deferral Period will be set according to the formula:

Final Price = Pricing Cost Estimate + Risk Fee

3.3.58 This is subject to two exceptions:

- the Final Price cannot be higher than the Cap;
- in the event that the Final Price is set before GDF Site Selection, it will be determined through the Default Pricing Mechanism set out below.

3.3.59 As set out above, the Pricing Cost Estimate will be equal to P_{95} on the distribution derived from the Cost Estimating Methodology. The Risk Fee and the Cap will be set at the outset (and indexed for inflation). 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 Final Price. Therefore the Government envisages that the Waste Contract will include Dispute Resolution procedures, including reference to independent third party experts.

3.3.60 An operator can request that their Final Price be fixed during the Deferral Period. In this case the level of the Final Price will be at the discretion of the Secretary of State (and therefore will not be subject to Dispute Resolution), 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 Final Price cannot be higher than the Cap, and an operator can opt at any time to fix their Final Price at the level of the Cap.

Default Pricing Mechanism

3.3.61 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 Final Price in relation to a Site Specific Cost Estimate and a Default Pricing Mechanism will apply.

3.3.62 In these circumstances the level of the Final 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 Final Price would be at or near the level of the Cap.

3.3.63 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 Final Price is subject to discounting if the Transfer Date is, as currently anticipated, some years before the Assumed Disposal Date.

3.3.64 The Default Date will be determined by the Secretary of State alongside the Cap. This is likely to be the current best estimate of the 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.

Determination of the Expected Price

3.3.65 The Expected Price is the Government's projection of the level of the Final 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 Final Price. Section 4.3 of this consultation sets out a worked example of how an Expected Price would be calculated prior to GDF Site Selection using this Methodology. The proposed way in which the Expected Price will be determined is set out below and views are sought in particular on this matter in this consultation.

Estimating waste disposal costs

3.3.66 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.

3.3.67 A Site Specific Cost Estimate cannot be produced until after GDF Site Selection. In the interim, the Cost Estimating Methodology will be used to derive estimates of waste disposal costs based on cost data provided by NDA that reflects the most up-to-date assumptions and information available at the time. For the setting of the first Expected Price the best available waste disposal cost estimate is the current best estimate derived by NDA for their reference scenario[18].

Handling uncertainty in cost estimates

3.3.68 After GDF Site Selection 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 cost distribution from which a Pricing Cost Estimate can be derived.

3.3.69 Before GDF Site Selection it will not be possible to produce a Site Specific Cost Estimate from which a Pricing Cost Estimate can be derived. Hence at this stage the derivation of a projected Pricing Cost Estimate will require a simplified

[18] The NDA's reference scenario was used as the basis of the detailed cost estimated that underpins the NDA's current best estimate of GDF costs included in its Annual Report and Accounts 2007/08, that included bottom up estimates with costs and prices included from tender information, quotations, relevant industry data and current salary levels. For more detail see Section 11 of "Geological Disposal: Steps towards Implementation"

application of the Cost Estimating Methodology and this simplified application will be used at each review of the Expected Price prior to GDF Site Selection.

3.3.70 As set out above, the Risk Premium is defined as the gap between the Pricing Cost Estimate (which is P_{95} on the 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

3.3.71 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.

3.3.72 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.

3.3.73 The March consultation set out 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"[19]. This needs to be allowed for through a suitable uplift, which can be derived through 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[20].

3.3.74 When an Expected Price is first requested by 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 at each Quinquennial Review prior to GDF Site Selection.

3.3.75 The derivation of the appropriate level for the Optimism Bias adjustment has not been carried out for this consultation. For the worked examples in the March consultation and also in this consultation 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.

[19] 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

[20] 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

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

3.3.77 The Risk Premium represents the level of contingency that the Government will require, over and above the Best Cost Estimate, at the time the Final Price is set to compensate the taxpayer for taking on the risk of subsequent cost escalation. This will need to be proportionate to the level of risk being assumed by the Government in fixing the Final Price ahead of the actual date of waste disposal. The purpose of deferring the setting of the Final 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:

- 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 Final 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.

3.3.78 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 A sets out how the projected Risk Premium has been derived for the worked example in Section 4.3.

3.3.79 Therefore for the purposes of setting the Expected Price prior to GDF Site Selection, the projected Pricing Cost Estimate is calculated as:

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

3.3.80 The level of this expected Pricing Cost Estimate will be updated at each Quinquennial Review. This will require updated base cost estimates from NDA, an updated Optimism Bias assessment and an updated projected Risk Premium. The review, and if necessary revision, of the Expected Price 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 Contract expected to be agreed between the Government and the operator.

3.3.81 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 this point it will no longer be necessary to use the approach outlined here to derive a projected Pricing Cost Estimate.

Setting the Expected Price

3.3.82 The Expected Price will be set according to the formula:

Expected Price = Projected Pricing Cost Estimate + Risk Fee

3.3.83 This is subject to the proviso that the Expected Price cannot be higher than the Cap. The Pricing Cost Estimate will be determined as set out above. The Risk Fee and the Cap will be set at the outset (and indexed for inflation).

3.3.84 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 Final 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

Determining the Cap and Risk Fee

3.3.85 The Cap will be determined by the Secretary of State at the outset and the Government will guarantee that the Final Price will not be higher than the Cap. In return for this guarantee the Final Price will include a Risk Fee. The Cap and the Risk Fee will be indexed for inflation. 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.

3.3.86 It is important to note that the level of the Cap will be determined by the Secretary of State. Therefore the determination of the Cap will be a two-stage process:

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

3.3.87 The cost modelling process set out here is an application of the Cost Estimating Methodology in the specific circumstances that will apply when determining the level of the Cap. The March consultation set out an analysis of risk and uncertainty around current estimates of waste disposal costs and proposed how these should be handled. Having considered responses to the consultation the Government does not intend to change the analysis of risk and uncertainty set out in the March consultation. Therefore the analysis set out here is consistent with

the analysis set out in Section 3.3 of the March consultation, which was illustrated with a worked example in Section 4.2 of the March consultation.

3.3.88 Section 4.2 of this consultation has a worked example of how a Cap and Risk Fee would be calculated using this Methodology.

Estimating Waste Disposal Costs

3.3.89 This cost modelling process will use NDA's latest estimates of waste disposal costs for ILW and spent fuel. 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.

3.3.90 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.

3.3.91 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.

3.3.92 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.

3.3.93 These figures, which were detailed in Annex A of the March consultation, were used for the worked examples set out in Sections 4.2 and 4.3 of the March consultation and are used again for the worked example in Section 4.2 of this consultation. These scenarios 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. Hence the costs estimates set out in the worked example in Section 4.2 should be considered illustrative.

3.3.94 In line with the Cost Estimating Methodology, this cost modelling determines estimates of Variable Costs per unit and a contribution to GDF Fixed Costs per unit (including a Financing Charge). It then combines these two figures to derive an estimate of Total Costs per unit.

Handling uncertainty in cost estimates

3.3.95 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. 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 to adjust for uncertainty in current estimated costs.

3.3.96 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 the worked example each scenario has been considered equally probable. However this assumption could change over time. This cost modelling process then uses Monte Carlo methods[21] in order to determine a distribution of estimated disposal costs.

3.3.97 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 these are handled through an "Optimism Bias" adjustment, following the methodology set out in HM Treasury "Green Book" guidance (see above).

3.3.98 When a prospective new nuclear operator requests an Expected Price the Government will undertake an exercise to determine the appropriate level of the Optimism Bias adjustment, taking into account Treasury guidance, and this analysis will also be used in this cost modelling process.

3.3.99 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.

[21] Monte Carlo simulation is a mathematical technique that can be used to allow for risk and uncertainty in quantitative analysis and decision-making. See Annex B of the March consultation for a description of how Monte Carlo methods have been used in this methodology.

3.3.100 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.

3.3.101 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. This distribution is then combined with the distribution derived earlier in the cost modelling process for waste disposal costs, to produce a risk-adjusted distribution for Total Costs per unit.

3.3.102 Annex C of the March consultation had a worked example of how a Contingency Allowance distribution would be calculated. The figures given are illustrative, and it is proposed that an exercise similar to that shown in Annex C of the March consultation 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.

Setting the Cap

3.3.103 The Secretary of State will then set the level of the Cap, having regard to the risk-adjusted cost distribution derived in this way. The worked example in Section 4.2, for the purposes of illustration, assumes that the Cap is set at the level of 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.

Setting the Risk Fee

3.3.104 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 the consequence to Government in the event actual cost exceeds the Cap. The proposed way in which the Risk Fee will be calculated is set out below and views are sought in particular on this matter in this consultation.

3.3.105 It is proposed that the Risk Fee is set in relation to the following formula.

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

3.3.106 Hence the Risk Fee will depend on the level of the Cap relative to the overall distribution for estimated unit costs. For example, if the Cap is set at P_{99} of that distribution, the Probability of actual cost exceeding the Cap should be 1%.

3.3.107 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 the worked example in Section 4.2 of this consultation 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.

3.3.108 It is also proposed that a suitable Mark-up over cost will be added, as compensation to Government for undertaking this transaction. It is proposed that this Mark-up be set at 50%. Finally, for simplicity it is proposed that the Risk Fee be "rounded up" to the nearest £1k/tU for spent fuel, and nearest £0.1k/m^3 for ILW.

Setting the Assumed Disposal Date

3.3.109 As set out above, 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 Final Price will be discounted if the Transfer Date precedes the Assumed Disposal Date.

3.3.110 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 emplacement schedule and waste inventory. It is considered likely that a new build 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 Chapter 4 assume that the same Assumed Disposal Date for ILW and spent fuel.

3.3.111 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. A final Assumed Disposal Date will be agreed at the same time as the Final Price is set.

Setting the Transfer Date

3.3.112 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. 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 (perhaps owing to an extension in the life of the power station).

3.3.113 The rationale for this proposal was set out in Section 3.2 of the March consultation. The Government response to views expressed on this proposal is set out in relation to Consultation Question 2 in Chapter 2.

3.3.114 As set out in the March consultation, it is the Government's policy that operators 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 its 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 final 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.

Discounting and escalation

3.3.115 The Final 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 Final 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 Final Price to reflect his time difference.

3.3.116 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 between the Government and the operator. The Government will provide the operator with an estimated long-term discount rate to enable prudent provision to be made.

3.3.117 The worked examples in the March consultation, for the purpose of illustration, applied 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. The updated figures in Section 4.5 of this consultation also assume a discount rate of 2.2%.

3.3.118 Once the Cap, Risk Fee, Expected Price and then Final 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 between the Government and the operator.

Dispute Resolution

3.3.119 In entering into a Waste Contract with the Government regarding the terms on which the Government would agree to take title to and liability for the operator's waste, it is expected that the operator would want assurance from the Government on how their Final Price and other key variables will be determined. The Government's expects that the Expected Price and Final Price will be determined through a transparent application of the Cost Estimating Methodology set out above.

3.3.120 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, 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.

3.3.121 The Government envisages these procedures being available to resolve disputes over the level of the Expected Price and the Final 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 Final Price and Assumed Disposal Date under the Default Pricing Mechanism, i.e. in the event that the Deferral Period ends before GDF Site Selection.

Chapter 4: Updated Worked Examples

4.1 Introduction

4.1.1 Chapter 4 in the March consultation contained three worked examples. The numbers given there were illustrative, but provided an example of how the methodology set out in the March consultation could work in practice. This section provides updated worked examples for two aspects of the revised Waste Transfer Pricing Methodology:

- Section 4.2 has a worked example of how a Cap and a Risk Fee would be calculated using this Methodology.
- Section 4.3 has a worked example of how an Expected Price would be calculated using this Methodology, prior to GDF Site Selection.

4.1.2 In addition, Section 4.4 compares the illustrative figures derived in the worked examples with current estimated costs. Section 4.5 then translates the illustrative figures derived in the worked examples into an estimated waste disposal liability and an annual payment into the operator's independent Fund, expressed in £/MWh.

4.1.3 As with the figures in the March 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.

4.1.4 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.

4.2 A worked example of how a Cap and Risk Fee would be calculated using this Methodology

4.2.1 This worked example largely reproduces the worked example set out in Section 4.2 of the March consultation. There are two notable changes:

- The Optimism Bias uplift is applied at a different stage. In this worked example it is applied once a distribution of estimated Total Unit Costs has been derived, whereas in the March consultation it was applied separately to the estimates of Variable Costs and Fixed Costs. This change has been made to make clearer the distinction in the Cost Estimating Methodology between the estimation of waste disposal costs and the adjustment of those cost estimates for uncertainty. It has no effect on the values derived.
- In line with the proposal that the Final Price for spent fuel should be set in terms of £/tU, this conversion is made towards the end of the worked example.

4.2.2 In line with the Methodology set out in Chapter 3, this worked example follows three broad stages in the setting of a Cap and a Risk Fee:

- estimate waste disposal costs;
- adjust for uncertainty in estimated costs;
- determine the Cap and Risk Fee.

Estimate waste disposal costs

4.2.3 As set out in Section 3.3, the Parametric Cost Model devised by NDA will be used to provide estimates of the costs of waste disposal in a GDF. When the Government models waste disposal costs in order to set a Cap, 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**).

4.2.4 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 were listed in Annex A of the March consultation. For simplicity, in this worked example all the scenarios are assumed to be equally probable.

4.2.5 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.

Allocate Variable Costs per unit of ILW/spent fuel

4.2.6 For each scenario the Parametric Cost Model has provided an estimate for Variable Costs per unit of ILW and spent fuel (**Step 2**). The Parametric Cost Model 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.

4.2.7 The adjusted 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 (**Step 3)**.

Allocate GDF Fixed Costs per unit of ILW/spent fuel

4.2.8 For each scenario the Parametric Cost Model also provides an estimate for the total Fixed Costs of a GDF (**Step 4**). They will then be combined by Monte Carlo methods to produce a distribution for estimated Fixed Costs (**Step 5**).

4.2.9 As set out in Section 3.3, 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.

4.2.10 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 3 with estimates of the relevant waste inventories.

4.2.11 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 legacy and new build wastes might not be feasible in the event that the new nuclear fleet is very large (**Step 6**). As set out in Chapter 3, the current assumption is the co-disposal of legacy and new build waste, but the Methodology retains the flexibility to revise this at a later date when setting a Cap for subsequent reactors if there were reasons to consider that there was a significant risk that a second GDF might be needed.

4.2.12 The calculation of an overall waste inventory requires an estimate of the legacy waste inventory 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 7**). Annex D of the March consultation set out how the assumed waste inventories used in these worked examples have been derived. For this worked example, it has been conservatively estimated that the new build fleet will consist of four reactors.

4.2.13 Once a total waste inventory has been determined, it can be combined with the Variable Costs per unit estimates from Step 3 to calculate total Variable Costs (V_T) and a new build operator's share of total Variable Costs (V_N/V_T). This fraction is then applied to the distribution of GDF Fixed Costs from Step 5 to give a distribution for a new build operator's contribution to GDF Fixed Costs (**Step 8**).

4.2.14 As discussed in Chapter 3, in order to reflect the time value of money, a Financing Charge is added to the distribution of a new build operator's contribution to GDF Fixed Costs at this stage. This adjusted distribution is then divided by the new build operator's waste inventory from Step 7 to give a distribution for GDF Fixed Costs per unit of ILW or spent fuel (**Step 9**).

4.2.15 The distribution for Variable Costs per unit derived at Step 3 is then combined with the distribution for Fixed Costs per unit derived at Step 9 to produce a distribution of Total Costs per unit (**Step 10**).

Summary of Methodology	Assumption for worked example
Steps 1-2: 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.	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 A of the March consultation 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 3: No assumptions required. See Annex B of the March consultation for a brief description of how Monte Carlo calculations are produced in this Methodology.	
Step 4-5: as for Steps 1-3	See Steps 1-3.
Step 6: The cost modelling will assume the co-disposal of legacy and new build waste, but the Methodology retains the flexibility to revise this at a later date for subsequent reactors if there were reasons to consider that there was a significant risk that a second GDF might be needed.	This worked example assumes the co-disposal of legacy and new build waste.
Step 7: The estimated legacy waste inventory will be based on latest figures from NDA. A predicted waste inventory for a new nuclear power station will be estimated in light of the specific characteristics of the station under consideration. The cost modelling will also make a	Annex D of the March consultation set out how the waste inventories used in these worked examples have been derived. The estimated legacy waste inventory used in the worked example is: • 10,659 canisters of HLW/spent fuel; • 390,000m^3 of ILW.

conservative estimate of the likely size of the new build fleet. As discussed above 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 size is a cautious assumption.	A predicted waste inventory for a generic 1.35GW PWR is used: • 500 canisters of spent fuel (i.e. 2000 fuel assemblies, 1030 tU[22]); • 2000 m^3 of ILW. The worked example assumes a fleet of 4 new reactors.
Step 8: A new build operator's share of the Fixed Costs of a GDF will be allocated in proportion to its share of Variable Costs.	As for the Methodology.
Step 9: The Financing Charge will be applied on the basis of the "virtual GDF" approach. An interest rate consistent with Treasury guidance will be applied, and the indicative GDF spend profile will be based on NDA's most up-to-date cost estimates. The distribution for the Fixed Cost contribution is then divided by the assumed waste inventory from Step 7 to produce a Fixed Cost contribution per unit.	The Financing Charge has been calculated using a real interest rate of 2.2% and an indicative GDF spend profile based on latest cost estimates[23]. The effect of this approach is to uplift the value of the new build operator's contribution to the Fixed Costs of a GDF by around 38% compared to the case with no Financing Charge.
Step 10: No assumptions involved.	N/A.

[22] The copper canister has an assumed capacity of 4 PWR spent fuel bundles, or 2.06 tU.
[23] There is a cost profile on page 36 of the NDA 2007/08 Annual Report and Accounts http://www.nda.gov.uk/documents/upload/Annual-Report-and-Accounts-2007-2008.pdf.

CAP/RISK FEE WORKED EXAMPLE
(NB all figures in constant September 2008 money and undiscounted)

Step 1
Nine scenarios have been used for this worked example. They are set out in Annex A of the March consultation.

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;
- ILW unit Variable Costs in the range £9.17-12.29 per m^3.

Step 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;
- 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 4
For the nine scenarios considered here, the Parametric Cost Model estimates the Fixed Costs of a GDF to be in the range £4401-5015m.

Step 5
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 6
This worked example assumes the co-disposal of legacy and new build waste in a single GDF.

Step 7
The estimated legacy waste inventory is:

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

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

- spent fuel inventory of 500 canisters;
- ILW inventory of 2000 m^3.

This worked example assumes a new build fleet of four reactors.

Step 8
For the scenarios considered in Step 1:

- Total legacy Variable Costs (combining the unit Variable Costs from Step 3 with the inventory from Step 7) are in the range £7816-11203m;
- V_N - total Variable Costs for a new build operator (combining the unit Variable Costs from Step 3 with the inventory from Step 7) - is in the range £217-325m (of which around 92% are related to spent fuel);
- V_T - total Variable Costs (legacy Variable Costs plus the Variable Costs for four new build reactors) - is in the range £8684–12503m.

Therefore V_N/V_T - the new nuclear reactor's share of total Variable Costs (and therefore their share of GDF Fixed Costs) - is in the range 2.5–2.6%.

Applying this to the distribution for Fixed Costs determined in Step 5 gives a distribution for a new build 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 9
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.

Allocating these costs to spent fuel and ILW in proportion to their share of Variable Costs and dividing by the inventory from Step 7 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;
- 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 10
Combining the distributions for estimated Variable Costs per unit from Step 3 and for estimated Fixed Costs per unit from Step 9 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[24];
- 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.

[24] It can be seen that the maximum of the distribution for Total Costs per unit spent fuel at Step 10 is slightly less than the sum of the maxima for the distributions of Variable Costs per unit at Step 3 and Fixed Costs per unit at Step 10. 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

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

4.2.17 In-Model Risks are addressed here by adjusting the estimates of Total Costs per unit for each scenario for "Optimism Bias," which is defined as the "demonstrated, systematic tendency for project appraisers to be overly optimistic" (**Step 11**). 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, as set out in Section 3.3, 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.

4.2.18 As explained above, 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. The way in which a Contingency Allowance will be calculated is described in Section 3.3. Annex C of the March consultation sets out how the values for the Contingency Allowance used in this worked example have been calculated.

4.2.19 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 distribution derived under Step 11 to give a final cost distribution (**Step 12**).

Summary of Methodology	Assumption for worked example
Step 11 When an Expected Price is first requested by a prospective operator the Government will undertake an exercise to determine the appropriate level of the Optimism Bias adjustment for In-Model Risks, calculated in line with Treasury guidance. This analysis will also be used in the cost modelling process that informs the setting of the Cap and Risk Fee.	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.

Step 12: 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	The derivation of the Contingency Allowance for this worked example is set out at Annex C of the March consultation. The Contingency Allowance for the worked example is based on the following distributions: • for spent fuel per canister, a minimum of £-133.3k, P_{50} of £99.3k and maximum of £704.9k; • for ILW per m^3, a minimum of £-3.0k, P_{50} of £0.3k and a maximum of £19.5k.

CAP/RISK FEE WORKED EXAMPLE (continued)

Step 11
Uplifting the distributions derived at Step 10 for Optimism Bias gives the following distributions:

- for spent fuel a distribution for Total Costs per canister with a minimum of £1115.2k, a P_{50} of £1181.8k and a maximum of £1554.6k;
- 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 12
The adjustment for contingency costs is based on the following distributions:

- For spent fuel per canister, a minimum of £-133.3k, P_{50} of £99.3k and a maximum of £704.9k;
- For ILW per m^3, a minimum of £-3.0k, P_{50} of £0.3k and a maximum of £19.5k.

Combining the contingency distributions with those derived in Step 12, using Monte Carlo techniques, gives final Total Costs distributions as follows:

- For spent fuel per canister, a minimum of £1023.0k, P_{50} of £1320.2k and a maximum of £2253.3k;
- For ILW per m^3, a minimum of £23.4k, P_{50} of £27.7k and a maximum of £50.9k.

Determine the Cap

4.2.20 The cost estimates are expressed in terms of the units used by the Parametric Cost Model to calculate costs, i.e. copper canisters for spent fuel and m^3 for ILW. The distribution of costs derived in Step 12 can be converted into a number of possible alternative units (**Step 13**). As set out in Section 3.3, it is proposed that the units to be used for setting the Cap for spent fuel will be £/tU. It is currently assumed that the capacity of a canister is four PWR fuel assemblies, or 2.06tU.

4.2.21 The Secretary of State will then set the Cap, having regard to the risk-adjusted cost distribution derived in this Methodology (**Step 14**). 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 12.

4.2.22 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.

Summary of Methodology	Assumption for worked example
Step 13: The distribution for spent fuel costs will be converted from £/canister to £/tU.	It is assumed that each canister holds 4 PWR spent fuel assemblies, equating to 2.06tU.
Step 14: 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. Once set the Cap will be indexed for inflation.	For this worked example, it is assumed that the Cap is set as equivalent to P_{99} from the cost distribution derived at Step 12. The worked examples in this 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.

CAP/RISK FEE WORKED EXAMPLE (continued)

Step 13
This worked example converts the distribution for spent fuel derived at Step 12 from £/canister to £/tU, giving a final cost distribution as follows:

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

Step 14
For this worked example it is assumed that the Cap is equivalent to P99 from the distributions derived in Step 12, which gives:

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

Determine the Risk Fee

4.2.23 As set out above, it is proposed that the Risk Fee is calculated (**Step 15**) as:

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

4.2.24 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%.

4.2.25 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.

4.2.26 It is also proposed that a suitable Mark-up over cost will be added, as compensation to Government for undertaking this transaction. It is proposed that this Mark-up be set at 50%. Finally, for simplicity it is proposed that the Risk Fee be "rounded up" to the nearest £1k/tU for spent fuel, and nearest £0.1k/m^3 for ILW.

Summary of Methodology	Assumption for worked example
Step 15: The Risk Fee will be calculated as Risk Fee = (Probability x Cost Consequence) + Mark-up	The Cap is assumed to be set at P_{99} of the distribution derived at Step 12. 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%.

CAP/RISK FEE WORKED EXAMPLE (continued)

Step 15
For these illustrative figures, the Cap has been set at the level of P_{99} from the distribution, which means 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 per canister;
- 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

4.3 A worked example of how an Expected Price would be calculated prior to GDF Site Selection

4.3.1 The Expected Price will be the Government's projection of the Final Price at the time it is eventually set at the end of the Deferral Period. This section sets out a worked example of how an Expected Price would be determined prior to GDF Site Selection. Following GDF Site Selection it is expected that the Expected Price will be determined through a full application of the Cost Estimating Methodology set out in Section 3.3, using a Site Specific Cost Estimate.

4.3.2 In line with the Methodology set out in Section 3.3, this worked example follows three broad stages in the setting of an Expected Price:

- estimate waste disposal costs;
- adjust for uncertainty in estimated costs;
- determine the Expected Price, which is the projected Pricing Cost Estimate plus the Risk Fee.

Estimate waste disposal costs

4.3.3 The Cost Estimating Methodology will use data produced by the body responsible for building and operating a GDF. This is currently NDA's RWMD.

4.3.4 The Methodology derives estimates of Variable Costs per unit of ILW and spent fuel and total Fixed Costs for a GDF (**Step 1**).

4.3.5 The Fixed Costs of a GDF are allocated per unit of ILW or spent fuel in line with the Cost Estimating Methodology, as described in the worked example in Section 4.2.

4.3.6 This requires an assumption around the co-disposal, or otherwise, of legacy and new build wastes (**Step 2**). It also requires estimates regarding the total inventory of waste to be disposed of in a GDF, which requires assumptions around the legacy inventory, the inventory for a single new nuclear power station and the size of the new build fleet (**Step 3**).

4.3.7 This allows the calculation of the new build operator's share of GDF Fixed Costs, to which the Financing Charge is added (**Step 4**). This is then allocated to spent fuel and ILW per unit, in proportion to their share of total Variable Costs (**Step 5**). Combining the Variable Costs and Fixed Costs estimates per unit gives Total Costs estimates per unit (**Step 6**)

Summary of Methodology	Assumption for worked example
Step 1: Each time an Expected Price is to be set, or reviewed, prior to GDF Site Selection, NDA will provide their current best estimate of the Variable Costs per unit of ILW and spent fuel and Fixed Costs of a GDF.	Estimated costs have been drawn from NDA's current best estimate.
Step 2: The cost modelling will assume the co-disposal of legacy and new build waste 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.
Step 3: The estimated legacy waste inventory will be based on latest figures from NDA. A predicted waste inventory for a new nuclear power station will be estimated in light of the specific characteristics of the station under consideration. An estimate will be made of the likely size of the new build fleet at the end of the Deferral period.	Annex D of the March consultation set out how the waste inventories used in these worked examples have been derived. The estimated legacy waste inventory used in the worked example is: • 10,659 canisters of HLW/spent fuel; • 390,000m^3 of ILW. A predicted waste inventory for a generic 1.35GW PWR is used: • 500 canisters of spent fuel (i.e. 2000 fuel bundles, 1030 tU); • 2000 m^3 of ILW. The worked example assumes a new build fleet of ten reactors.

Step 4: A new build operator's share of the fixed costs of a GDF will be allocated in proportion to its share of variable costs. The Financing Charge will be applied on the basis of the "virtual GDF" approach. An interest rate consistent with Treasury guidance will be applied, and the indicative GDF spend profile will be based on NDA's most up-to-date cost estimates.	As for the Methodology. The Financing Charge 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 build operator's contribution to the Fixed Costs of a GDF by around 38% compared to the case with no Financing Charge.
Step 5: The estimated Fixed Cost contribution is divided by the assumed waste inventory from Step 3 to produce a Fixed Cost contribution per unit.	As for the Methodology.
Step 6: No assumptions involved.	N/A.

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

Step 1
The NDA current best estimates of Variable Costs per unit are:

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

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

Step 2
This worked example assumes the co-disposal of legacy and new build waste.

Step 3
The estimated legacy waste inventory is:

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

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

- spent fuel inventory of 500 canisters;
- ILW inventory of 2000 m^3.

This worked example assumes a new build fleet of ten reactors.

Step 4
This gives:

- total legacy Variable Costs (combining the estimated unit Variable Costs with the assumed inventory) of £7751.6m;
- V_N - Variable Costs for one new nuclear reactor of £217.2m;
- V_T – total Variable Costs (legacy Variable Costs plus the Variable Costs for ten new nuclear reactors) of £9923.6m.

Therefore V_N / V_T - the new nuclear reactor's share of total Variable Costs (and therefore their share of GDF Fixed Costs) – is 2.19%, or £96.3m. Adding in a Financing Charge of 38% gives a total Fixed Costs contribution of £132.9m.

Step 5
Allocating to spent fuel and ILW in proportion to their share of Variable Costs:

- spent fuel Fixed Costs contribution of £243.7k per canister;
- ILW Fixed Costs contribution of £5.5k per m^3.

Step 6
Combining the Variable Costs and Fixed Costs estimates per unit gives a Total Costs estimate per unit as follows:

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

Adjust for uncertainty in estimated costs

4.3.8 As set out in Section 3.3, when there is a Site Specific Cost Estimate following GDF Site Selection this will include a robust 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.

4.3.9 In the absence of a Site Specific Cost Estimate the results of such an exercise must be approximated in the way set out in Section 3.3, on the basis that:

Pricing Cost Estimate = Best Cost Estimate + Risk Premium

4.3.10 The projected Best Cost Estimate is derived by adjusting the NDA current best estimate for Optimism Bias. 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. For the purposes of illustration it is assumed for this worked example that the Optimism Bias uplift will be set at 66%. This uplift is applied to the Total Costs per unit derived in Step 6 (**Step 7**). The level of the Optimism Bias adjustment will be reviewed at each Quinquennial Review prior to GDF Site Selection.

4.3.11 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 8**). 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 A.

4.3.12 The projected Pricing Cost Estimate is then derived by adding the projected Best Cost Estimate and the projected Risk Premium (**Step 9**).

Summary of Methodology	**Assumption for worked example**
Step 7: Each time an Expected Price is first requested by a prospective operator, or reviewed at a Quinquennial Review prior to GDF Site Selection, the Government will undertake an exercise to determine the appropriate level of the Optimism Bias, in line with Treasury guidance.	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.
Step 8: When an Expected Price is first requested by a prospective operator, or reviewed at a Quinquennial Review prior to GDF Site Selection, the Government will undertake an exercise to determine a projected value for the Risk Premium. This projected Risk Premium will take the form of a percentage uplift on estimated cost.	This worked example assumes the follows illustrative values for the projected Risk Premium: • for spent fuel a projected Risk Premium of 15.5%; for ILW a projected Risk Premium of 7%. The derivation of these figures is set out at Annex A.
Step 9: No assumptions involved.	N/A.

EXPECTED PRICE WORKED EXAMPLE (continued)

Step 7
The projected Best Cost Estimate is derived by adjusting the NDA current best estimate 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 £1065.7k per canister;
- ILW Best Cost Estimate of £24.1k per m^3.

Step 8
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%;
- for ILW a projected Risk Premium of 7%.

The derivation of these figures is set out at Annex A

Applying these uplifts to the Best Cost Estimates gives:

- spent fuel projected Risk Premium of £165.2k per canister;
- ILW projected risk premium of £1.7k per m^3.

Step 9
Combining the projected Best Cost Estimate with the projected Risk Premium gives:

- spent fuel projected Pricing Cost Estimate of £1230.9k per canister;
- ILW projected Pricing Cost Estimate of £25.8k per m^3.

Determine the Expected Price

4.3.13 The cost estimates are expressed in terms of the units used by the Parametric Cost Model to calculate costs, i.e. copper canisters for spent fuel and m^3 for ILW. The Pricing Cost Estimates derived at Step 9 can be converted into a number of possible alternative units (**Step 10**). As set out in Section 3.3, it is proposed that the unit to be used for spent fuel is £/tU. It is currently assumed that the capacity of a canister is four PWR fuel assemblies, or 2.06tU.

4.3.14 The Expected Price is calculated by adding together the projected Pricing Cost Estimate and the projected Risk Fee (**Step 11**). This worked example uses the illustrative values for a Risk Fee derived in Section 4.2.

4.3.15 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.

Summary of Methodology	Assumption for worked example
Step 10: The Pricing Cost Estimate for spent fuel will be converted from £/canister to £/tU.	It is assumed that each canister holds 4 PWR spent fuel assemblies, equating to 2.06tU.
Step 11: The Expected Price is calculated by adding together the projected Pricing Cost Estimate and the projected Risk Fee.	As for the Methodology.

EXPECTED PRICE WORKED EXAMPLE (continued)

Step 10
This worked example converts the value for spent fuel derived at Step 9 to £/tU, giving:

- a spent fuel projected Pricing Cost Estimate of £597.5k/tU.

Step 11
Using the illustrative figures for the Risk Fee from the worked example in Section 4.2, i.e. £2k/tU spent fuel and £0.1k per m^3 ILW, gives:

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

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

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

- Comparing the Expected Price / Cap and the current Total Costs estimate per unit shows the escalation in the cost of a GDF that would be required before actual costs exceed the Expected Price / Cap. The current best Total Costs estimate is derived at Step 6 of the worked example in Section 4.3.
- Comparing the Expected Price / Cap and the 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 1 of the worked example in Section 4.3.

	Variable Cost	Total Cost	Expected Price	Cap
Spent fuel (£/tU)[25]	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.

4.4.2 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.

4.4.3 Moreover, the proposed 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 that currently expected.

[25] The cost estimates per tU of spent fuel have been derived by dividing the cost per canister figures from Section 4.3 by 2.06.

4.5 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

4.5.1 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 was explained in Annex D of the March consultation. The assumed inventory is:

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

4.5.2 The worked examples in this Chapter 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.

4.5.3 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 Final Price is set at the level of the illustrative Expected Price.
- A waste disposal liability for an operator in the event that their Final Price is set at the level of the illustrative Cap

4.5.4 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 March consultation, this section assumes a Transfer Date of 2080[26]. Therefore to reflect this timing difference the Final Price will be subject to discounting.

4.5.5 The worked examples in the March consultation, for the purpose of illustration, applied 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 returns at that time on long-term investments in Government securities and similar assets. The Government will provide the operator with an estimated long-term discount rate to enable prudent provision to be made.

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

4.5.6 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	Final Price = Expected Price	Final 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

4.5.7 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).

4.5.8 In line with the approach set out in the March 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[27] has been estimated at 10,600GWh/year, or 424,000GWh over the 40-year life of the station.

4.5.9 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.

4.5.10 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.

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

4.5.11 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. It is impossible to project fund performance over the very long timescales involved here. Moreover, 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.

4.5.12 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 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, in the absence of revenues from the nuclear power station, it is likely to be more difficult for an operator to make up any shortfall.

4.5.13 For the purposes of illustration, the figures in this section assume different investment strategies during and after generation. The assumptions here are consistent with those in Section 5.5 of the March consultation. 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).

4.5.14 As set out above, it should be noted that all calculations in this consultation are in "real" money, i.e. they disregard inflation. All money values in this consultation are expressed in constant September 2008 money and are undiscounted except where indicated. When a Final 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)*	***Final Price = Expected Price*** *(2080 target fund value = £226m)*	**Final 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).

Annex A: Derivation of the projected Risk Premium for Section 4.3

1. The Final 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 Final 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 Final Price is set at the end of the Deferral Period.

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

3. 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. Section 4.3 sets out a worked example for how an Expected Price would be calculated before GDF Site Selection. This Annex sets out how the projected Risk Premium in that worked example was calculated.

4. 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[28], 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 6.

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 6: indicative uncertainty ranges for different estimate classifications.

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

5. 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 it is considered to provide a reasonable starting point for this exercise to derive a projected Risk Premium.

6. 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 not possible to produce a distribution from which a P95 value can be derived, a simplified approach has been adopted to determine a P95 value, as set out below:

   - P50 = (Minimum + (4 x Most Likely) + Maximum) / 6;
   - P95 = P50 + ((Maximum - P50) / 5 x 4.5) (i.e. 45% of the difference between P50 and Maximum).

GDF Fixed Costs

7. 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%.

8. This gives a projected Risk Premium for Fixed Costs of 3.65%, as derived in Table 7 below.

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 7: derivation of Fixed Costs projected Risk Premium.

Variable Costs

9. 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 Final 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.

10. 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%.

11. This gives the following figures, as derived in Tables 8 and 9:

    - 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 8: 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 9: derivation of ILW Variable Costs projected Risk Premium.

Projected Risk Premium

12. For both spent fuel and ILW, the figures derived in the worked example 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 B: Response form for the consultation document

You may respond to this consultation by email or by post.

Respondent Details	
Name:	
Organisation:	
Address:	
Town/ City:	
County/ Postcode:	
Telephone:	
E-mail:	
Fax:	

Please return by 8 March 2011 to:
Waste Transfer Pricing Methodology consultation Office for Nuclear Development Department of Energy and Climate Change 3 Whitehall Place London SW1A 2AW You can also submit this form by email: decomguidance@decc.gsi.gov.uk

Tick this box if you are requesting non-disclosure of your response. ☐

No.	**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?
Response	

No.	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?
Response	
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.
Response	

Please select the category below which best describes who you are responding on behalf of.

	Business representative organisation/trade body
	Central Government
	Charity or social enterprise
	Individual
	Large business (over 250 staff)
	Legal representative
	Local Government
	Medium business (50 to 250 staff)
	Micro business (up to 9 staff)
	Small business (10 to 49 staff)
	Trade union or staff association
	Other (please describe):

Thank you for taking the time to let us have your views. The Government does not intend to acknowledge receipt of individual responses unless you tick the box. ☐

Annex C: The Consultation Code of Practice Criteria

The seven consultation criteria

Criterion 1 **When to consult**

Formal consultation should take place at a stage when there is scope to influence the policy outcome.

Criterion 2 **Duration of consultation**

Consultation should normally last for at least 12 weeks with consideration given to longer timescales when feasible and sensible.

Criterion 3 **Clarity of scope and impact**

Consultation documents should be clear about the consultation process, what is being proposed, the scope to influence and the expected costs and benefits of the proposals.

Criterion 4 **Clarity of scope and impact**

Consultation exercises should be designed to be accessible to, and clearly targeted at, those people the exercise is intended to reach.

Criterion 5 **The burden of consultation**

Keeping the burden of consultation to a minimum is essential if consultations are to be effective and if consultees' buy-in to the process is to be obtained.

Criterion 6 **Responsiveness of consultation exercises**

Consultation responses should be analysed carefully and clear feedback should be provided to participants following the consultation.

Criterion 7 **Capacity to consult**

Officials running consultations should seek guidance on how to run an effective consultation exercise and share what they have learned from the experience.

The code of practice can be accessed at www.berr.gov.uk/files/file47158.pdf

Annex D: Glossary

Assumed Disposal Date – the Government's best estimate of the date on which disposal of the operator's waste will begin. The Assumed Disposal Date will determine the duration of interim storage of waste pending disposal for which the operator will be required to make financial provision. It will also determine the extent to which the Final Price is subject to discounting if the Transfer Date is, as currently anticipated, some years before the Assumed Disposal Date.

Cap – the maximum level of the Final 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 existing and "committed" 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.

Committed waste – radioactive waste that will arise in future from the operation or decommissioning of existing nuclear facilities.

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. Annex C of the March consultation set out how the Contingency Allowance in the worked example in Section 4.2 of this consultation was derived.

Cost Estimating Methodology – the manner in which waste disposal costs will be estimated and uncertainty in those estimates handled.

Decommissioning –

(a) Decommissioning begins when the reactor is shut down with no intention of further use for the purpose of generating electricity.

(b) 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.

(c) Decommissioning ends when all station buildings and facilities have been removed and the site has been returned to an end state which has been 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 Final 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 Final Price is set. The consultation proposes that this deferral should be set at 30 years after the nuclear power station has commenced operation. However an operator can request that their Final Price be fixed during the Deferral Period. In this case the level of the Final Price will be at the discretion of the Secretary of State, having regard to a cost modelling process that takes account of uncertainty around cost estimation. An operator can opt at any time to fix their Final Price at the level of the Cap.

Dispute Resolution – a procedure, or procedures, set out in the Waste Contract that is expected to be agreed between the Government and the operator, by which disputes will be resolved.

Early Transfer – when title and liability for an operator's waste transfers to the Government before the estimated availability of a GDF.

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

Expected fixed unit price (eFUP) – this term was defined in the March consultation as "the basis for an operator's interim provision in the event that they choose to defer the setting of their fixed unit price. This will be the Government's best estimate of the level of the fixed unit price at the time it is eventually set, i.e. at the end of the Deferral Period".

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 Government and will represent the Government's best estimate of the level of the Final Price when it is set at the end of the Deferral Period.

Final Price – the price that will be charged by Government to an operator of a new nuclear power station for the Government to take title to and liability for their ILW and spent fuel. It will be set at the end of the Deferral Period

Financing Charge – the charge that would be applied to the 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 build 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) – 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. These include 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.

Fixed unit price – the March consultation set out proposals that the Government would set a fixed price for operators of new nuclear power stations for disposal of their ILW and spent fuel, and a schedule for the Government to take title to and liability for these materials.

Funded Decommissioning Programme (FDP) – the programme that any operator of a new nuclear power station will need to have approved by the Secretary of State 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.

Generic Design Assessment – the generic assessment being undertaken by the Health and Safety Executive and the Environment Agency of the suitability of new reactor designs for use in the UK.

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 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 LW and spent fuel.

In-Model Risks – risks that 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.

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.

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 simulation – 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[29], 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. These can relate either to the assumptions that NDA has made when using the Model to estimate waste disposal costs, or to the additional assumptions that DECC has made in order to use Parametric Cost Model data to estimate 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 the Cost Estimating Methodology. This consultation proposes that he Pricing Cost Estimate 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.

[29] 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 set out in Section 2 of the Radioactive Substances Act 1993.

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 – the charge that will be included in the Final Price to reflect the risk being assumed by the Government in setting a Cap at the outset.

Risk Premium – the premium over and above expected costs that will be included in the Final Price to compensate the taxpayer for taking on the risk of subsequent cost escalation.

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 the operator's responsibility for managing the waste pending disposal will transfer to the Government.

Variable Costs (of a GDF) – all GDF costs incurred during the period of waste emplacement. This means it includes overheads and maintenance and refurbishment costs, which in other circumstances might sometimes be called fixed costs. This 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 Final 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 Final 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.

Annex E: List of those who responded to the March consultation

There were 41 written responses to the March consultation. One of the respondents requested non-disclosure of their response. The other respondents are listed below, in alphabetical order.

1	Blackwater Against New Nuclear
2	Booth, Philip
3	Bradwell for Renewable Energy (BRARE)
4	Centrica
5	Communities Against Nuclear Expansion (CANE)
6	Copeland Borough Council
7	Cumbria County Council
8	EDF Energy
9	Energy Fair
10	Environment Agency
11	Foreman, Peter
12	GE Healthcare
13	Gifford, Christopher
14	Greater Manchester SERA
15	Greenpeace
16	Hawkes, Ian
17	Horizon Nuclear Power
18	Jones, Brian
19	Low Level Waste Repository Ltd
20	Lowry, David
21	Ministry of Defence, Defence Nuclear Safety Regulator
22	Norris, Bryan
23	Nuclear Decommissioning Authority (NDA)
24	Nuclear Free Local Authorities
25	Nuclear Industry Association (NIA)
26	Nuclear Legacy Advisory Forum (NuLeaf)
27	Nuvia Limited
28	People Against Wylfa B

29 Reed, Chris

30 Richards, Hugh

31 Rogers, Linda

32 Scottish Environment Protection Agency (SEPA)

33 Scottish Power

34 Shepperdine Against Nuclear Energy

35 Shut Down Sizewell Campaign

36 SSE

37 Suffolk Coastal Green Party

38 Welsh Assembly Government

39 West Cumbria and North Lakes Friends of the Earth

40 Western, Rachel

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