Guidance for the Environment Agencies' Assessment of Best Practicable Environmental Option Studies at Nuclear Sites

 February 2004

This document has been developed jointly by the Environment Agency and the Scottish Environment Protection Agency.

Note:

Queries about the content of this document should be made to the Environment Agency's Radioactive Substances Regulation Process Management Group or to the Radioactive Substances Policy Unit in the Scottish Environment Protection Agency.

Preface

This Guidance has been produced by the Environment Agency for England and Wales in collaboration with the Scottish Environment Protection Agency (SEPA). The Guidance is primarily intended to support the Agencies' assessment of BPEO studies relating to the authorisation of radioactive waste disposal at nuclear sites.

Although Agency staff may discuss their requirements with operators at the start of the BPEO process, the flexibility of the BPEO concept allows for the application of a range of approaches at the detailed level, depending on the context in which the study is made. Agency staff will not generally specify the precise approach to be followed by the operator, but will assess the way in which a BPEO study has been conducted, and the methodology that has been applied, for adequacy. Typical components of such a regulatory assessment include:

- The validity of the process and methodology;
- The competence of the team carrying out the study;
- The data used and any explicit or implicit assumptions that have been made;
- The extent of any associated stakeholder input or consultation;
- The documentation of the results.

The Guidance is structured accordingly. It first sets out the key principles underpinning the BPEO process and its role in decision making. The appropriate treatment of generic issues such as stakeholder input, uncertainty and costs are then discussed.

It may not be appropriate for Agency staff to conduct independent detailed checks on the calculations and data underpinning a BPEO study. The Agencies will more usually scrutinise the analytical framework and supporting data that has been used, together with the factors that give confidence in its appropriate application. These include the experience of those that have carried out the analysis, the quality management arrangements that have been applied, and the extent of stakeholder involvement and review. Submissions should provide a transparent account of the logic, justify assumptions, and provide sufficient information to confirm the validity of data used in support of the study. These features are pre-requisites for the effective use of a BPEO study in support of a proposal and, therefore, in informing decision making.

BPEO studies intended to support decision making generally conform to the same basic principles, and a typical framework is given below. This model has proved useful in the past for undertaking and assessing BPEO studies and is consistent with most of the alternatives approaches described in the literature, but it is not meant to define an 'ideal' programme. It is used in subsequent Sections of this Guidance to provide a structure for discussion on key issues in the design and application of multi-attribute methods in the BPEO context.

- Definition of purpose and scope;
- Identification of options;
- Screening;
- Selecting attributes;
- Option analysis;
- Weighting factors;
- Identification of the BPEO;
- Integration into decision making.

Inevitably, generic Guidance has to address issues and cover steps that are required in complex situations but are perhaps less significant in simpler ones. In detailed application of the Guidance, it has to be borne in mind that each BPEO study is unique and the general methodology needs to be tailored to a specific purpose and audience. In general, the larger the scope and reach, the better defined and more formal the stages should be. In a smaller study, they may be implicit or merged together, provided that this is made clear.

In order to help Agency staff to prioritise their efforts in assessing BPEO studies submitted on behalf of site operators, key assessment criteria from each Section are summarised in a final discussion.

Document Status

This Guidance has been developed through a consultative process within the Agencies. It is supported by a R&D Technical Report that describes the outcome of activities undertaken to identify the main concepts and ideas that underpin implementation of the BPEO approach and its practical use as input to regulatory decision making.

Contents

1 INTRODUCTION

1.1 Overview

The application of the concept of Best Practicable Environmental Option (BPEO) forms one aspect of the regulatory response of the Environment Agencies (the Environment Agency and the Scottish Environment Protection Agency (SEPA) – collectively "the Agencies") to the optimisation principle formulated by the International Commission on Radiological Protection (ICRP). This principle seeks radiation doses to people that are "as low as reasonably achievable" (ALARA), economic and social factors being taken into account. It is incorporated into European law through the 1996 Basic Safety Standards Directive. Other aspects of the Agencies' regulatory response to the ALARA principle include the application of: minimisation of waste creation; constraints on doses to members of the public; numerical limits on levels of discharge and disposal of radioactive waste; and the application of the concept of Best Practicable Means (BPM). These other aspects are not considered further in this document, except incidentally, but instead are discussed separately in other documentation, either already issued or in due course to be issued.

The application of BPEO to radioactive waste management is not new, but has been a regulatory requirement of the Agencies and their predecessor bodies for many years. For example, *Radioactive Waste Management - The National Strategy*, issued by the Department of the Environment in July 1984 stated: "In discussing with waste producers how best to deal with particular types of waste, what the RCI [Radiochemical Inspectorate, responsible at the time for regulation under the Radioactive Substances Act] seeks to achieve is the best practicable environmental option in each case." However, this document marks the first time that specific guidance has been issued by the Agencies on the application of BPEO to radioactive waste management.

The BPEO concept has gained currency in the United Kingdom as a result of the work of the Royal Commission on Environmental Pollution (RCEP). RCEP provided the following definition of BPEO in its Twelfth Report (RCEP, 1988):

> *"… the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term."*

This definition provides the basis for this Guidance.

A BPEO study is a particular example of the more general process of options appraisal. An options appraisal is an appraisal carried out by any person or organisation of a range of possible options for achieving a specified objective. A BPEO study is a particular form of options appraisal in which, given that waste creation has already been minimised, the waste disposal option is sought that achieves the minimum impact on the environment of the waste that is nevertheless created.

Regulatory context

The 1995 Environment Act requires the Government to give guidance on statutory objectives that it is appropriate for the Agencies to pursue when discharging their regulatory functions. In accordance with this requirement, and taking account of the Environment Agency's responsibilities that exist by virtue of the Radioactive Substances Act 1993 (RSA93), draft guidance for England was issued by DETR (now Defra) to that Agency in October 2000 on the Regulation of Radioactive Discharges into the Environment from Nuclear Sites. Similar draft guidance for Wales was subsequently issued by the Welsh Assembly Government to the Environment Agency. Guidance from the Scottish Executive to SEPA is expected in due course.

The Defra and Welsh Assembly Government Statutory Guidance is intended to supersede relevant parts of existing guidance, specifically paragraphs 63 to 73 of the 1995 White Paper Cm 2919, *Review of Radioactive Waste Management Policy*. It incorporates a statement of general policy principles, drawing on the same underlying considerations as those applied more generally to UK environmental policy, as well as highlighting specific pollution control principles that are more explicitly relevant to the regulation of aerial and liquid discharges of radioactive waste.

Paragraph 14 of both the English and the Welsh draft guidance (also paragraph 25 of the accompanying Explanatory Document) establishes an obligation on the Environment Agency to

ensure that proper consideration is given to the identification and evaluation of alternatives, in order to ensure that the BPEO is chosen, before authorisations can be granted. This supplements and reinforces current regulatory practice whereby nuclear site operators may be required (under Conditions attached to existing authorisations) to review waste management strategies on a regular basis in order to demonstrate that they represent the BPEO. Moreover, although the Statutory Guidance issued by Defra and the Welsh Assembly Government strictly applies only to the Environment Agency, SEPA shares the Environment Agency's interest in the use of BPEO in the management of radioactive waste and, more specifically, in the authorisation of radioactive waste discharges and disposals, both for continuing operations and for decommissioning projects.

Responsibilities in relation to nuclear sites

The direct statutory responsibility of the Agencies in relation to the management of radioactive waste on nuclear sites is in granting authorisations for discharges and disposals under RSA93, subject to appropriate limitations and conditions. In addition, the Agencies are consulted on other aspects of radioactive waste management on sites licensed under the Nuclear Installations Act 1965, for which regulatory responsibility rests with the Nuclear Installations Inspectorate (NII), part of the Nuclear Safety Directorate of the Health and Safety Executive (HSE). Consistency between the Agencies' approach to application of the BPEO concept and the approaches followed by other regulators is important, not least because there is a general strategic requirement to undertake options appraisal as a basis for justifying wider decisions relating to nuclear sites. It is in general inappropriate wholly to separate waste disposal considerations from other aspects of waste management, particularly in the context of strategic planning for decommissioning, dismantling and site restoration.

Purpose of this guidance

In the light of the above, and taking account of the specific requirements emerging from new statutory guidance, this BPEO Guidance has been developed to provide Environment Agency and SEPA staff with a framework for assessing BPEO studies submitted by site operators in relation to authorisation under RSA93. It is anticipated that such studies will be produced as part of the support for proposed waste management and disposal strategies, both for continuing operations and decommissioning projects. Whereas the Guidance presented here is necessarily focused on the conduct of BPEO studies in relation to waste discharge and disposal, the way in which it has been developed reflects the need for continuing liaison between the Agencies and NII on areas of common interest.

1.2 Relationship to Other Guidance and Concepts

BPEO studies have previously been undertaken (both by site operators and the Agencies) in relation to limitations and conditions attached to existing authorisations under RSA93. However, unlike the situation that exists in relation to processes regulated under Integrated Pollution Control (IPC) (for which the E1 Technical Guidance Note was developed by the Agencies), there has hitherto been no single standard methodology or guidance to Agency staff or operators on application of the BPEO concept to radioactive waste management. Studies relating to RSA93 authorisation have typically been considered on a case-by-case basis, with limited indication of overall expectations for how they should be assessed. It is appropriate to reflect on how the concept has been interpreted and presented in other regulatory contexts as well as in statutory requirements.

IPC and IPPC

The IPC regulations, and the primary legislation from which they were derived, were able to invoke the concept of BPEO as a result of the work of the RCEP. The Royal Commission has extended the application of BPEO principles to a range of fields and increased its scope beyond simple consideration of the most appropriate medium into which polluting discharges should be released. However, within IPC, use of the BPEO concept has remained focused on a largely technical demonstration of cost-effectiveness in relation to measures of environmental harm from alternative waste treatment and discharge strategies.

BPEO terminology is not widely used in Europe outside the UK. Thus the requirement under IPC to adopt BATNEEC 'having regard for the BPEO' is replaced in the Pollution Prevention and Control (PPC) Regulations, which stem from a European Directive, by the requirement to demonstrate that Best Available Techniques (BAT) are used to prevent and minimise pollution from an installation. Although no longer defined as a methodology for identifying the BPEO, the IPPC regulatory guidance on the assessment methodology for demonstrating BAT, currently being developed as Horizontal Guidance Note H1, follows a broadly similar approach to that used in the E1 BPEO Guidance Note that it is designed to supersede.

BPEO and BPM

By contrast, the interpretation of BPEO in the context of radioactive waste management (e.g. as in the Glossary definition within the 1995 White Paper Cm2919) has traditionally been taken to involve a wide-ranging, strategic exploration of the balance between environmental impacts, occupational risks and social factors, in addition to cost. The draft Statutory Guidance in relation to the authorisation of radioactive waste disposal under RSA93 identifies BPEO as one of the primary principles that the regulator should pursue. This indicates that consideration of the BPEO continues to be seen as part of a waste strategy (see below), rather than, for example, a detailed cost-benefit evaluation.

Integrated Waste Strategy

Indeed, the inclusion in the Statutory Guidance of consideration of both BPEO and BPM in the authorisation of radioactive waste disposal points towards an interpretation of BPEO that is concerned with identifying and justifying a preferred ('best practicable') overall management approach, taking account of a broad range of strategic considerations. Whilst the precise boundaries that define the scope of any particular BPEO study will depend on the context of the authorisation under consideration, use of the concept in relation to RSA93 authorisation is concerned with a broad evaluation of waste strategies. This is different from BPM, which relates to optimisation of the selected option from the perspective of radiological protection, and is concerned with the detailed refinement of design and operational conditions. An integrated waste strategy is an outline overall plan, taking into account environmental principles, that can be applied consistently to all actual and potential sources of waste, both radioactive and non-radioactive, within the scope of the strategy. The scope may extend to the whole of a complex nuclear site or even to multiple sites. A BPEO study may be needed to identify an optimised strategy. Such a strategy is considered to include the following elements:

- How the creation of waste is prevented or minimised.
- How the unnecessary introduction of waste into the environment is avoided.
- How the presumption for "concentrate and contain" is applied in practice.
- How the segregation and categorisation of wastes is undertaken and dilution avoided where practicable.
- How the strategic management of radioactive wastes is undertaken.
- How it is ensured that radioactive wastes are safely disposed of, at appropriate times and in appropriate ways.
- How progressive reductions in discharge limits and discharges will be achieved and how any exceptional case needing increases in limits is handled.
- When and how more detailed or project-specific BPEO studies are undertaken.
- When and how BPM studies are undertaken.
- How monitoring of radioactive waste and the environment is undertaken.

In developing an integrated waste strategy on a large scale, there is a need to look across different sources of waste to identify common aspects and synergies capable of leading to a reduced environmental impact overall.

1.3 Purpose of the BPEO Guidance

Use by Agency staff

The Guidance is written in the form of a handbook for the Agencies to assist them in assessing BPEO studies submitted by site operators. It is not intended as a detailed instruction manual for how to implement a BPEO study. Nevertheless, it is anticipated that the discussion of methods for BPEO assessments will provide a framework that is suitable for use not only by regulators but also by site operators and consultants in developing an understanding of the Agencies' views. For instance, it may prove useful as a starting point in Agency/operator discussions at early stages in the process of conducting an authorisation review.

Operators may present BPEO studies in support of decisions on radioactive waste management that span regulatory remits. Although this Guidance is designed for Agency assessors principally in the context of authorisation under RSA93, it is recognised that they may also be taken into account in other contexts and by other regulatory bodies.

Basic principles

As the BPEO concept has been developed in the UK, it has generally been applied to decisions where a strategic choice between different approaches to managing environmental impact is required. An element of stakeholder input to the process, coupled with transparency regarding data and assumptions, are also generally considered integral to the BPEO concept, which is particularly suited to exploring the impact of different perspectives on the eventual decision. The practical implications of these defining characteristics are discussed in the Guidance.

In practice, very few decisions are made solely on the basis of a BPEO study. A BPEO study informs consideration of the balance between the various factors that need to be taken into

consideration, and helps reveal the key issues and assumptions, but in general does not define the solution.

Guidelines – not prescriptions

The use of multi-attribute methods is not exclusive to BPEO studies; they are applied in a wide range of environmental, safety and economic decision-making contexts. Their application does not define a BPEO study, and different multi-attribute methods may be appropriate in different BPEO studies. Although a number of sources of information on such methods are included here, this Guidance does not provide detailed advice on the selection or application of such methods. It does, however, set out a framework by which Agency staff might judge the appropriateness of the method that has been used and its application in the context of a particular BPEO study. The overall aim is to be definitive about expectations, without being prescriptive about the particular manner in which those expectations are satisfied.

2 KEY PRINCIPLES

2.1 Characteristics of BPEO Studies

BPEO as a Framework Concept

BPEO studies are characterised not by the use of a specific methodology for identifying or comparing options, but by the purpose of the study and the way in which the chosen methodologies are applied.

The key characteristics of BPEO studies identified and advocated by RCEP are generally regarded as definitive, and include the following:

Key characteristics of a BPEO study:

- The process is essentially strategic – it is geared towards identifying a preferred overall strategy from the perspective of the environment as a whole, as opposed to detailed optimisation of the selected scheme.
- A structured and systematic process is used to identify and compare strategic options. The presumption is that a BPEO study will generally be an open and transparent process, documented to make explicit the reasoning, data and assumptions.
- Alternatives should be evaluated in terms of their projected implications for environmental quality. Consideration also needs to be given to questions of practicability (including financial costs and/or benefits, as well as wider social and economic considerations), as well as the overall strategic objectives, in order to reflect the wider context in which the decision is being taken.
- The process should involve consideration of environmental effects in both the short term and the long term, requiring consideration to be given to the relative importance of different indicators of environmental performance (e.g. short-lived versus persistent pollutants).
- Effects on the environment are not necessarily restricted to direct emissions of pollutants to land, air and water from the process (or activity) itself; life cycle considerations (such as energy demand) may also have a part to play in the decision process.
- There is an accent on consultation as an integral part of the study process – an informed study of alternatives necessarily involves taking into account the values and perspectives of a range of stakeholders.

2.2 Interpretation of Principles in relation to RSA93 Authorisations

Strategic decisions

BPEO studies are particularly relevant to strategic decision-making, involving choices between alternative management options. The fundamental comparison relates to the performance of environmental options, but the process should provide a holistic appraisal of factors associated with the practicability of implementing strategic alternatives. The word 'strategic' implies a wide regulatory interest, including environment agencies, HSE and planning authorities. In practice, within the context of RSA93 authorisation, BPEO studies will typically relate to medium to long-term considerations such as site waste management planning, decommissioning and site restoration.

The aim of a BPEO study is to ensure that the rationale behind a strategic decision, involving technical, scientific and more qualitative judgements (including their consistency with the over-riding principles of precautionary action and sustainable development), is made visible. A BPEO study may be required to inform the operator's or the regulator's decision-making; however, it is rarely the sole criterion for making the choice.

Decision context

BPEO studies are generally commissioned where there is a perceived need or possibility for environmental improvement, or the need to meet environmental objectives. Such studies assist the identification of a preferred option that manages the potential environmental detriment in the most effective and practicable way.

Wherever possible, BPEO studies should be undertaken at the planning stage. However, it may be appropriate to use a BPEO study to validate a conclusion that has previously been reached via a different route. This will be acceptable, providing that the way in which the study is undertaken

and presented makes such a context transparent. Regulators will still need to assess the outcome to confirm that studies have been comprehensive and that the conclusions are robust.

It is possible that larger-scale programmes (such as the development of a site decommissioning plan) may require a hierarchy of BPEO studies to be undertaken on a site-wide basis. There may be a hierarchical relationship between one BPEO study and another, which has an influence on the overall decision context. Issues need to be addressed in a structured and holistic way, with coordination to enable decisions to be made in a logical order.

Transparency through a structured evaluation process

The particular value of BPEO studies comes from their focus on a structured process that identifies key discriminators between strategic options and reveals the key issues to be taken into account in the decision process. The methods used in BPEO studies usually support quantification, but the emphasis within the study itself will usually be on the qualitative analysis and related arguments.

It is important to recognise and make explicit the uncertainties within an analysis, and not to give a false impression of precision. The necessary level of detail for a BPEO study is that required to achieve discrimination between options. A greater level of detail may be required for subsequent cost/benefit or optimisation work.

It is in the nature of strategic evaluation that the methodologies used need to be flexible. At the same time, however, the fact that such methodologies cannot be prescribed in advance implies that the way in which the studies are conducted needs to be open and transparent, if the result is to secure public confidence.

Consideration of effects

Given the strategic nature of the BPEO process and the absence of a legally-tested definition in the regulatory context, it is not surprising that operators seek guidance on the scope of the impacts that they should be taken into account. For instance, the RCEP definition can be interpreted as requiring that complete plant life cycle and a full range of environmental impacts should be taken into account. In practice, however, different studies have historically drawn the line in different places, for instance in the extent to which deterministic or probabilistic health effects are included. Guidance for assessors regarding the selection of attributes as a basis for options evaluation is given in Section 8 below.

Stakeholder inputs

At the core of a BPEO study is the evaluation of identified candidate options against a range of performance measures to inform judgements about the preferred option. Such an approach favours the adoption of a basic technique of multi-attribute analysis. Stakeholders may express their values and perspectives through a number of the attributes under consideration. The extent to which particular attributes are important to stakeholders may differ from one application to another depending on the context within which the BPEO study is set.

A comprehensive appraisal of options against a range of attributes can provide the basis for a systematic evaluation of the comparative performance of options. However, different groups will typically attach varying levels of importance to different measures of performance. As quantitative analysis alone cannot provide a substitute for the decision-making process involved in identifying a preferred option there must be an emphasis on the participative nature of the BPEO procedure.

3 BPEO STUDY FRAMEWORK

As noted in Section 2, BPEO studies intended to support strategic decision making generally conform to the same basic principles. A typical framework for the implementation of those principles is described below and illustrated graphically in Figure 3.1.

The model is not intended to define an 'ideal' programme; however, it has proved useful in the past for designing and assessing BPEO studies and is consistent with most of the alternatives in the literature. It is used in subsequent Sections of this Guidance to provide a structure for discussion of issues associated with the design and application of multi-attribute methods in the BPEO context.

Framework for Implementation of BPEO Studies

- **Definition of purpose and scope**

The purpose of the study is defined and the methodology selected. Key assumptions are identified. An initial estimate is made of the level of detail required and a corresponding project plan drawn up. The extent of stakeholder participation is decided. Stakeholders may wish to comment on every aspect of the framework and at more than one stage. The regulators are advised of the proposed scope and other aspects of the study and may wish to comment.

- **Identification of options**

A broad list of options is drawn up and characterised in sufficient depth for initial screening.

- **Screening**

Decisions are made regarding the principles to be applied in deciding the criteria for screening out options from further consideration, and then the criteria themselves are defined. The criteria are applied in order to select a short list of options from the initial broad list of alternatives.

- **Selection of attributes**

The principles to be applied in deciding the attributes against which options are to be compared need to be decided, and then the attributes themselves.

- **Options analysis**

Each option on the short list is evaluated against each attribute. The results of the evaluation are recorded either as a ranking (e.g. best to worst) or a numerical 'score'.

- **Weighting factors**

Weightings may be applied to each attribute to reflect its relative importance in establishing a preferred option. If used as part of the analysis, weightings need to be systematically derived and justified. Alternative weighting sets can be used to test the sensitivity of the conclusions to different perceptions of relative importance (e.g. in order to reflect the perspectives of different stakeholder groups).

- **Identification of the BPEO**

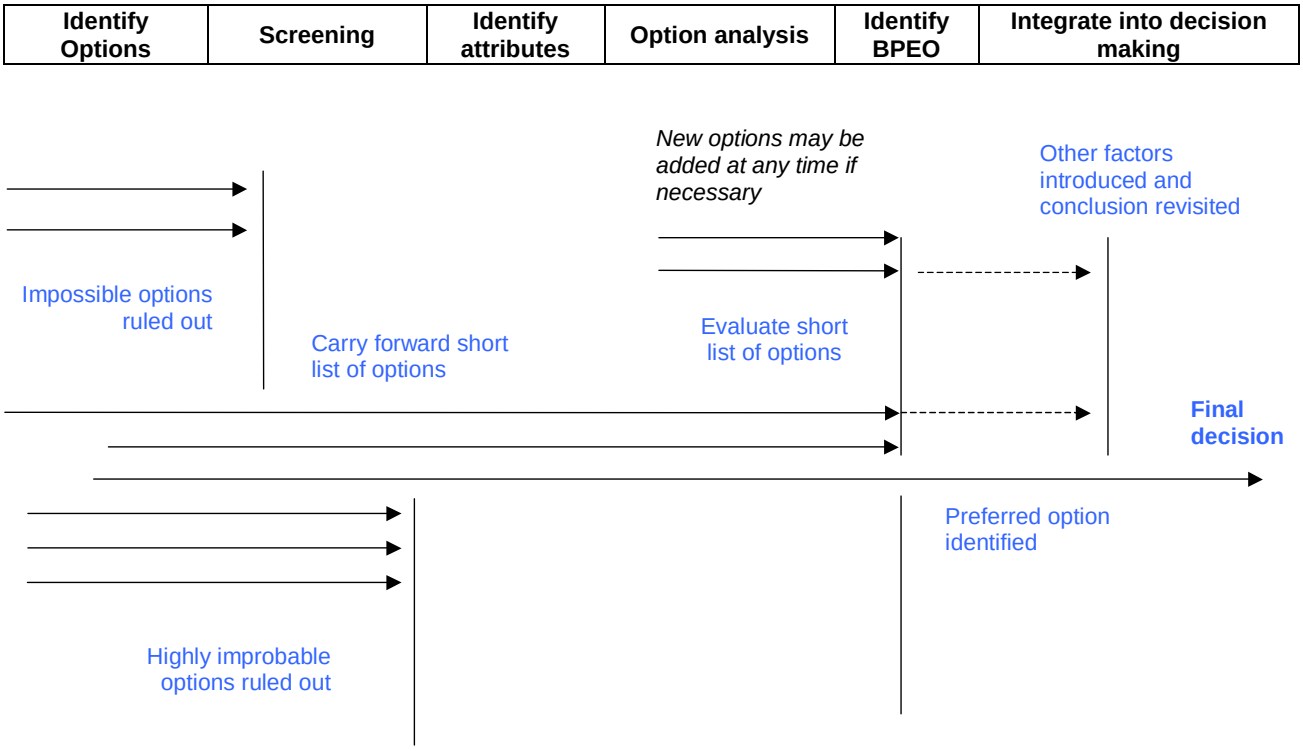
A 'logic flowchart' based on the results of option analysis and application of weighting factors identifies the BPEO. If a numerical scoring system is used, the top scoring option may be the starting point, but the conclusion may still be that this is not the BPEO.

- **Integration into decision making**

Identification of the BPEO is an important input to strategic decision making. In practice, however, few decisions are made solely on the basis of such a study. The selection and approval of a preferred option may be modified by other factors that are not taken directly into account in the BPEO study. These other factors may include political considerations or the results of more detailed safety, economic and technical optimisation studies.

In what follows, consideration is given first to some general themes representing important considerations that need to be taken account throughout a BPEO study. Subsequently, in Sections 5-11, individual steps in the process are considered in turn.

Figure 3.1 **Illustration of Typical BPEO Study Framework**



4 GENERAL THEMES IN BPEO STUDIES

4.1 Stakeholder Participation

One of the key differentiators between a BPEO study and a general multi-attribute analysis is that the BPEO process should be designed to facilitate stakeholder input. Indeed one reason for carrying out a BPEO study, irrespective of whether it is required for regulatory purposes, is that it includes features that make it a useful tool for capturing stakeholder views. The format for stakeholder interaction within the BPEO study should be designed to emphasise collaborative working. An associated communications programme should be implemented that clearly defines the purpose and scope of the BPEO study and identifies any limitations on its scope. Care should be taken to avoid using the study for purposes for which it is not intended.

Determining the required extent of participation

The Agencies expect that stakeholder participation in the BPEO process will be proportionate to the technical and societal significance of the decision. However, the principle of participation does not necessarily mean that all potential stakeholders need to be involved in every BPEO study. The extent of involvement will depend on, amongst other factors, the following considerations:

Factors determining the extent of stakeholder participation

- The technical and societal significance of the decision.
- The information that stakeholders can bring to the process.
- The extent to which sensitivity analysis to examine the effect of different perspectives is to be included.
- The extent to which stakeholder 'ownership' of the process is an objective.

It should be evident that stakeholder involvement and consultation requirements have been thought through and the objectives defined at an early stage in the process. Although consultation implies that there is some information available to consult on, it is generally more effective to obtain and use stakeholder input when communication has started early in the process. For example, it may be appropriate to seek comments on the proposed scope of the study, or the identification of issues of concern that may be represented as attributes at a later stage in the study.

Evidence of stakeholder inputs

An effective vehicle for obtaining stakeholder input is a 'stakeholder panel' – which may be internal or a mix of internal and external stakeholders – that contributes at key stages in the process, such as in study design, identification of options and analysis of options against attributes. Assessors of a BPEO study should look for evidence about the role and composition of the panel; a BPEO study should be a team activity.

'BPEO Workshops' bring stakeholders together for one or more facilitated events, typically to review the selection of attributes, rankings or scores and weightings. Assessors should look for evidence that stakeholders' views have been systematically elicited and recorded as part of the options identification and screening processes, attribute selection, and the comparison of options against those attributes. Assessors will not be able to judge the accuracy of the records, so they should look for evidence that those involved have reviewed and agreed the record.

Use of stakeholder inputs within a BPEO study

Untested assumptions about the views of stakeholders within a sensitivity analysis cannot be assumed to be reliable. Equally, it should not be assumed without substantiation that the views of individuals are representative of the general view of the stakeholder group or constituency from which they are drawn.

Stakeholder input and views are not a basis in themselves for selecting the BPEO. They provide information and insight to support the decision making process, but the responsibility remains with the operator. There is no obligation on the part of those carrying out the study to reflect the views of any particular stakeholder, providing their position and the grounds for rejecting it have been properly recorded.

It is not easy to constrain stakeholder input to BPEO studies, and significant information or stakeholder views that are not directly linked to the analysis in question often emerge. Participants, especially those not familiar with the BPEO processes, may get frustrated if their

concerns are not acknowledged and a good, well organised process will have a mechanism for recording and sorting these issues and taking them forward by some other means.

Community involvement in decision making generally and, where relevant, in BPEO studies is desirable in principle, but the legitimacy of representative government must also be recognised. Care needs to be taken in design to avoid potential conflict, because stakeholders' views are normally integrated into the process whilst the policies of local and national government are more likely to be treated as constraints or factored into eventual decision making.

4.2 Public Consultation

Many projects where a BPEO study has been commissioned involve consultation with the local community and other stakeholders, either by the operator or as part of the Agencies' consultations, e.g. on draft authorisations. Consultation with stakeholders by the operator and the Agencies should be co-ordinated to facilitate involvement, but the distinction between operator and regulator must be maintained.

Regulators are likely to look more favourably on BPEO studies that have been exposed in the public domain and have thus been subjected to stakeholder and elements of peer review.

Consultation not a substitute for effective stakeholder input

Although there may be occasions where public meetings are held to identify key attributes and concerns, these are not generally intended to feed directly into a BPEO study. Such meetings, and any consultations that the Agencies may choose to carry out as part of their assessment, do not replace the need for effective stakeholder inputs within the BPEO process. Internal BPEO studies may however be a prelude to a broader consultative process undertaken by the operator, guiding the identification and evaluation of key issues. Alternatively, and particularly where the main considerations are technical rather than societal, consultation may focus simply on the outcome of the BPEO process.

4.3 Public Acceptability

There is no requirement to include public acceptability explicitly as one of the factors to be taken into account in a BPEO study. However, the acceptability of the proposed course of action to stakeholders, including the local community, is potentially an important element in many decisions for which a BPEO study is undertaken.

Problems with subjective views of acceptability

The acceptability of options to different stakeholder groups should not constrain the initial identification of options. It may sometimes act as a screening criterion (Section 7) but, by contrast with criteria such as legality, there is often no clear-cut distinction. Where it is included explicitly, it is more often applied as part of the final decision logic.

Some past BPEO studies have included stakeholder acceptability explicitly as an attribute against which to compare strategic options. This is however not generally recommended, for the following reasons:

- It is preferable to identify the underlying factors on which acceptability depends through consultative processes, so that they can be effectively incorporated into the BPEO study as attributes or into the subsequent decision process.
- Some attributes used in the options analysis (e.g. safety or environmental performance attributes) may well be major factors in determining stakeholder acceptability. If public acceptability is also used as a measure of performance, there is the danger of 'double counting' particular issues.
- Other factors that contribute to public acceptability may be complex and not generally amenable to condensing into an attribute. Such factors are better addressed qualitatively outside the multi-attribute analysis.
- Comparing the effect of different attribute weighting sets is the usual means for testing the sensitivity of the results to different stakeholder perspectives, and already provides a mechanism for gaining insight into the importance of attitudes.
- The aim of the BPEO study is to identify the best option from a broad environmental perspective to inform the final decision. There may be valid reasons lying wholly outside this perspective why stakeholders might prefer an option, but these should be taken account of outside the core BPEO study.

4.4 Policy and Regulatory Constraints

There is no requirement to include consistency with Government policy explicitly in a BPEO study. However, especially where radioactive waste is concerned, it is likely to be an important element in many decisions for which a BPEO study is prepared.

Treatment of policy considerations in BPEO studies

Consistency with policy, which is taken to include international conventions such as OSPAR, should not limit the initial identification of potential options. It may be appropriate to translate clear policy constraints into screening criteria as part of the BPEO process or to apply them as part of the final decision logic. If it is decided that policy issues are to be included, a clear explanation should be provided on how such issues have been used.

The use of Government policy as a screening criterion will generally be more appropriate where the application of the policy to the circumstances is clear, when taking unrealistic options forward may be at the expense of more practical ones, or where the cost of analysis is high. Nevertheless, assessors should be receptive to the possibility that an unconstrained study, in which restrictions imposed by current policy are effectively disregarded, can be sometimes be helpful in guiding future policy development. Such an approach may reveal sound scientific arguments that can play a role in reviewing the policy itself. Agencies themselves sometimes need to examine the potential implications of policy where its application is unclear or under challenge.

Screening options through regulatory considerations

Regulatory constraints are generally not a factor in identifying candidate options but it will usually be appropriate to take them into account at the screening stage. Nevertheless, non-compliant options may sometimes be taken forward, for example in situations where likely future developments in the regulatory framework could affect the conclusion. Assessors of BPEO studies should look for clarity, transparency and consistency.

Agency-sponsored BPEO studies and assessments of operators' BPEO studies would be expected to follow statutory guidance, but they should set out transparently how this has been done.

4.5 Cost Considerations

Cost considerations should not constrain the initial identification of strategic options. 'Grossly disproportionate cost' may be used as a screening criterion in some studies, in which case both the definition of the chosen criterion and the cost data that are used need to be clearly identified. Under some circumstances, political or societal considerations within environmental decisions may have an influence on the interpretation of 'grossly disproportionate cost'.

Fit-for-purpose use of cost data

More usually, cost is included as part of the multi-attribute analysis of options. Cost data can be very expensive and time-consuming to assemble, and a detailed breakdown is not normally required as part of a strategic BPEO study. In most cases a ranking will be all that is initially required, perhaps on the basis of estimated high/medium/low costs, until the options have been narrowed down to a short list. The work put into refining cost estimates, and the level of detail to which they are presented, need not be any greater than is fit for purpose, providing that the estimates are shown to be consistently conservative. Cost engineering information could be used more explicitly as part of a parallel cost-benefit analysis. It can be beneficial to examine the comparative performance of options both with and without accounting for costs.

Just as the analysis of beneficial or detrimental environmental impact should cover the full life cycle, so should the cost data used where it discriminates between options – including, where appropriate, operating and decommissioning costs.

In considering future costs and financial benefits within the attribute framework, it can be relevant to take into account the timescales over which costs are incurred. As a general rule, it will be appropriate to evaluate sensitivity to cost calculations with and without discounting in order to assess its possible importance to the identification of the BPEO. Discounting may be taken into account in the eventual decision logic, providing that it is done transparently and any related assumptions are set out clearly in the submission.

The key point from the assessor's perspective is that costs used in the BPEO study should be substantiated and verifiable and that the methodologies used to produce them should be transparent. Cost data should be independently verified if they play a significant part in the

selection of a preferred option. On major projects where costs play a pivotal role in the decision, the Agencies may choose to commission their own cost studies.

4.6 Uncertainty

Uncertainty has to be addressed in any BPEO study and assessors will look for a clear statement setting out the way in which different sources of uncertainty have been dealt with, and for transparent and realistic treatment of its implications within the analysis.

Within the framework of a BPEO study, areas where uncertainty has generally to be taken explicitly into account include the following:

Sources of uncertainty in BPEO studies

- Uncertainty regarding the most appropriate scope and framework of attributes, rankings and weightings that will genuinely indicate the most practicable choice from a range of environmental options.
- Uncertainty regarding the validity of models and data, including statistical variability, used to compare options.
- Uncertainty concerning the validity of assumptions embedded within the analysis, including assumptions about future developments in regulatory and policy frameworks etc.
- Project risks, including uncertainty about costs, practicality and timescales.

Management of uncertainty within the BPEO study

The appropriate approach for dealing uncertainty will differ according to the source, and will also vary from BPEO study to study.

For example, the development of a clear statement of objectives, and transparent explanations of the logic underpinning assumptions and data selection are required in order to address uncertainty about the scope and framework of a study. Assumptions that might have a significant impact on the conclusions have to be made explicit and be supported, including the reasons for the degree of confidence expressed in those assumptions.

Other areas of uncertainty are more appropriately integrated explicitly within the analytical framework of the BPEO studies. Assessors would normally expect to see supported, conservative, estimates of the uncertainty associated with numerical data and sensitivity analyses that evaluate the potential impact of such uncertainties on the eventual conclusions. In some BPEO studies, this may involve a direct analysis of the sensitivity of the overall study to uncertainties in the ranking or score attached to each attribute for each option. Alternatively, additional rankings or scores may be included for each option as measures of the significance of uncertainty associated with primary attributes defined within the BPEO study.

'Project risk' in this context is the possibility that a particular strategy may not meet expectations in terms of performance, cost and time to implementation. It is a valid consideration in evaluating the practicality of an option and can sometimes be separated out from other areas of uncertainty. It may be appropriate to apply project risk as a screening criterion within the BPEO process or to use it as part of the final decision logic. Assessors will look for clear identification of the main components of project risk and how they relate to other attributes in a BPEO study.

Consideration of project risk is intimately linked to consideration of uncertainty about cost data. Uncertainty about cost estimates contributes directly to project risk, but in reality most areas of project risk have cost impacts. Care needs to be taken to ensure that the study only includes each form of uncertainty once.

Sometimes, uncertainty may be so significant that it can be applied as a screening factor to exclude options from more detailed analysis. An example might be where an option depends on technological advances that have only a remote likelihood of becoming practical within a realistic timescale. Alternatively, the impact of some sources of uncertainty – for example, in respect of future changes to government policy – may be so important and far-reaching that a decision is taken to address them within the scope of the study. This might involve adopting a reference set of study assumptions or by explicitly excluding a particular area of uncertainty from the study.

BPEO studies are generally snap-shots of the ranking of options at a particular point in time. However, they may identify a need for further work or monitoring in order to validate assumptions or confirm that the conclusions remain valid as more information becomes available. In such

cases, submissions will need to explain how information will be obtained and interpreted, and what arrangements have been made to revisit the study and the decision. Assessors may, of course, require such work even if it is not included in the submission.

5 DEFINITION OF PURPOSE AND SCOPE

Establishing foundations for BPEO studies

An essential focus is provided for a BPEO study by establishing, at the outset, a clear statement of its purpose, scope and objectives. Definition of the overall objective is also critical to securing stakeholder support for the results of the options identification and analysis. In the context of radioactive waste disposal, decisions may range from choices relating to particular aspects of waste treatment (e.g. "What do I do with the liquid effluent when decommissioning facility X?") to strategic planning on a site-wide basis (e.g. "What is the preferred option for dealing with low level wastes associated with contaminated land?").

Other factors involved in defining the purpose of a BPEO study include

- The nature of the problem that is being addressed – major uncertainties and assumptions should be identified, if possible, at an early stage as a prelude to more detailed analysis;
- The wider context in which the decision is being made – helping to clarify what is within and what is outside the scope of the study;
- The constraints (e.g. resources, regulations etc.) on decision making.

Assessors will look for a clear statement of purpose and for an explanation of the logic by which this is translated into a definition of the extent of the plant, process or contaminated material to be covered in the study. The assumptions that define the shape and scope of the study should be identified, while recognising that these may evolve as assumptions are tested within an iterative and consultative process.

Boundaries for the study

It is important that the scope of a BPEO study is matched to its purpose. The scope obviously needs to be bounded, but must include those issues that are important to discriminating between options to select the BPEO. Amongst other things, decisions have to be made in terms of:

- The extent of the plant, process or contaminated material covered by the study;
- The scope of the study in terms of plant life cycle and timescale.

Context and timing

Decisions on particular radioactive waste issues will typically form part of a hierarchy of strategic considerations, and may involve a corresponding hierarchy of BPEO studies and stakeholder consultation activities. Development of a BPEO study to guide strategy development will normally be seen as an activity to be undertaken alongside general planning, environmental impact assessment, safety and decommissioning studies.

The context of the BPEO and the decision it is intended to support should be described in submissions. Supplementary information may discuss how the problem relates to other aspects of waste management on the site.

For example, a site decommissioning plan may set out overall strategic objectives, within which more detailed plans are developed for waste discharge and disposal associated with individual waste streams, the decommissioning of particular plants and remediation programmes for defined areas. This may require development of a number of separate, but related, BPEO studies. Assessors will look for evidence in submissions that issues are being addressed in a structured and holistic way, and that individual BPEO studies are being coordinated within the sequence of activities such that decisions can be made in a logical order.

As part of defining the objectives of a BPEO study, it is reasonable to expect consideration to be given to the detailed methodology that is to be used, together with the extent and format of any stakeholder involvement in the process. Sometimes (e.g. for more technical problems), the range of stakeholders with a direct interest in the outcome may be quite small; in other cases, particularly where the decision has wider implications, there may be a wide interest in the outcome of the decision process. Typically, within a co-ordinated strategic programme, one would expect to find some consistency in BPEO study methods, stakeholder involvement, assumptions and data.

Stakeholder input to study scope

The operator should initiate the study and define the objectives. Early discussions with regulators and stakeholders on the purpose and scope will normally be advantageous. Early involvement of the Agencies, or other regulators, must not compromise independence or prejudice future regulatory decisions, but may be necessary to clarify regulatory expectations in respect of the BPEO study.

6 IDENTIFICATION OF OPTIONS

The BPEO study begins with the identification of a broad list of strategic options that are potentially capable of addressing the defined study objectives. The degree of detail to which options are specified and the range of options that need to be taken into account will vary according to the particular problem under consideration. Nevertheless, a diverse range of alternatives helps to provide confidence that the identification of a preferred solution has been identified on the basis of a process that was sufficiently comprehensive and transparent.

Innovation and imagination

Options should not be unreasonably restricted; imaginative and innovative thinking is to be encouraged. In practice, options are likely to be defined on the basis of currently available, or foreseeable, technological alternatives; however, it may be appropriate to consider untried or less familiar solutions. A systematic approach to options identification, which breaks down strategic alternatives according to fundamental issues and choices, can help to ensure that a comprehensive range of candidate solutions is taken into account.

Even if novel ideas are rejected at an early stage in the analysis, on the basis of preliminary screening (Section 7), the fact that they were taken into account at all can help to demonstrate that the selection of a preferred option was based on a suitable, comprehensive BPEO study. An overall approach to the study that involves a measure of iteration in the identification and comparison of options will allow candidate solutions to reviewed and, if necessary, modified, or provide scope for new alternatives to be added at a later stage in the study (see Figure 3.1).

The introduction of new options at later stages of a study is more common where stakeholder input comes only after initial screening, and new alternatives are suggested. It will usually be preferable to enable stakeholders to make an input during the option identification stage, rather than as a result of consultation on the final outcome of the study. Stakeholder input to option identification is important to help ensure that identification is unconstrained by preconceptions and to engender a sense of shared 'ownership' in the process.

Focus on strategic alternatives – not optimisation

Options need to be characterised in sufficient depth for initial screening. BPEO studies can be made more difficult if a very large number of detailed options are considered. The level of detail to which options are described and the extent of differentiation between variations will be dependent on the context in which the study is being made. It should be borne in mind, however, that the BPEO concept is designed to discriminate between alternative approaches at a reasonably high level. Optimisation of the chosen approach then follows, typically as part of a BPM analysis.

7 SCREENING

It is normally convenient to restrict the detailed evaluation of options by means of a structured screening process, based on clearly defined criteria, in order to arrive at a manageable number of alternatives. Screening criteria are special types of attributes that represent basic expectations in relation to the practicability of proposed options. Where possible, stakeholders should be enabled to contribute to the selection of screening criteria.

Screening may be undertaken in a single step, or it may involve a more iterative approach. For example, options that fail to meet basic screening criteria (e.g. in terms of legal compliance or consistency with international treaty obligations) can be eliminated first; the remainder may then be characterised in more detail before a second screening exercise is undertaken to confirm the short list. This could involve, for example, consideration of whether the options satisfy minimum criteria for acceptance associated with any of the selected attributes (Section 8). Whether undertaken in one or two steps, only those options that can be clearly and unambiguously identified as being incompatible with the agreed screening criteria should be excluded.

Characterising strategic options in sufficient detail to allow them to be compared with screening criteria may involve, for example, a HazOp assessment, or research and literature reviews.

From the assessor's point of view, it is important that evidence is provided in submissions to make the logic of the screening process transparent and substantiate the judgements that are made. It is equally important that screening criteria and the reasons for their selection should be clearly recorded for review. Where options have been screened out assessors would expect to see clear reasons for their exclusion.

8 SELECTION OF ATTRIBUTES

The core of a BPEO study is an analysis of the performance of candidate options against a comprehensive set of performance measures, or attributes, corresponding to the range of factors that are deemed relevant to the identification of a preferred solution. In order to be effective, the attributes used in a BPEO study will have the following characteristics:

- they should provide a true measure of performance by reflecting all relevant environmental and practicability criteria used in the decision process;
- they must be quantifiable, even if only via a simple scoring scheme or ranking process;
- they should, as far as possible, be independent of one another;
- they should reflect considerations at similar levels of detail.

The principles to be applied in deciding the attributes against which options are to be compared are decided first, then the attributes themselves. Assessors will look for evidence that the principles used in generating a comprehensive list of performance attributes have been made transparent.

Determining a comprehensive and manageable list of attributes

The decision process that a BPEO study is designed to inform will generally focus on those areas where the impact of different options is sufficiently different to influence the eventual choice. Nevertheless, there may be circumstances in which it is beneficial to include attributes that are recognised as being of fundamental interest and importance, even if they do not discriminate significantly between options. It is important that the list of attributes should be sufficiently comprehensive to identify all relevant factors that differentiate between options while at the same time not being so large that the study becomes diffuse and unmanageable. Consequently, care is required in selecting the number of attributes; if the overall number used in a BPEO study becomes too large (more than a few tens), it can be very difficult to manage and present conclusions.

A systematic approach to the selection of attributes, with clear explanations for choices that have been made, can help to ensure that all potentially important issues have been taken into account and dealt with appropriately. For example, a hierarchical grouping of attributes can provide a useful simplification by aggregating several related measures of performance under a single high-level heading. Alternatively, a top-down approach, starting from fundamental attribute groups, can help to confirm that comprehensive consideration is given to all relevant factors.

Assessors will look for transparency in the presentation of component attributes and information on the way options have been ranked or scored against them, as well as the approach taken to deriving the rank or score of the aggregated attribute from its components.

Generic guidance on attribute selection

The BPEO concept is designed to provide an integrated picture of the environmental impacts, within the defined overall scope of the study. Although, for the purposes of RSA93 authorisation, the overall radiological impacts of waste discharge and disposal will be of central interest, submissions will normally be expected to cover a range of other environmental impacts, including non-radioactive contaminants and energy use.

It is for the operator to decide on, and justify, a detailed set of performance attributes that (a) reflect all relevant measures of environmental impact and practicability in the context of a particular study, and (b) have the power to discriminate between options. It is not unusual for additional attributes to be incorporated, or their definition to be refined, during in the course of a study in order to improve discrimination or to take account of emerging impacts. Early consideration of stakeholder views on attribute selection can be a helpful way of ensuring that a comprehensive range of interests is represented in the choice of attributes.

The BPEO framework described in this Guidance is not intended to define a prescriptive checklist of environmental impacts and other relevant attributes. As a general rule, however, it can be expected that the ‘top-tier’ list of complementary factors that need to be considered as a part of the comprehensive evaluation of management options will comprise:

- environmental impact;
- technical performance and practicability;
- health and safety;
- social, economic and security considerations;
- cost.

Such fundamental considerations will be generally valid for any environmental options comparison study, and represent the minimum basis on which it would be reasonable to attach relative weightings as an expression of the values associated with different aspects of performance. For illustration, some examples of attributes used in past BPEO studies concerned with radioactive waste management are given below. Some of the original detailed attributes have been aggregated: for example, indirect environmental impact might include both energy and other resource use.

Examples of Attribute Selection in BPEO Studies

- **Actual and perceived impact on health and safety**
  - Radiation dose to critical groups from projected discharges and collective dose to the population as a whole
  - Potential dose to critical groups from accidental releases
  - Individual and collective occupational exposures for radiation workers
  - Occupational risks from other industrial hazards
- **Impacts on natural, physical and built environments**
  - Impact on marine ecosystems and habitat
  - Impact on terrestrial ecosystems and habitat
  - Long-term contaminant residues
  - Non-radioactive waste arisings
  - Nuisance (noise, odour, visual impact)
  - Indirect impacts (e.g. global warming)
- **Technical performance and practicability**
  - Aggregated project risk
  - Requirements for technical development
  - Timescale to implementation
  - Flexibility
  - Impacts on site operability
- **Social and economic impacts / quality of life**
  - Nuisance (noise, odour, visual impact)
  - Residual restrictions on access following remedial actions
  - Positive/negative effects on local economy
- **Costs**
  - Indicative lifetime cost (construction, operation, decommissioning)

Use of 'stakeholder acceptability' as an attribute

As noted previously (Section 4.3) it will not normally be appropriate to include stakeholder acceptability as an explicit attribute against which to compare options. Various technical attributes that are already used in the options analysis (e.g. measures of safety or environmental performance, or cost) are likely to be among the factors that determine stakeholder acceptability. Comparing the effect of different attribute weighting sets (Section 10) then provides a means for testing the sensitivity of the study outcome to different stakeholder perspectives, and acts as a mechanism for gaining insight into the importance of attitudes.

Other factors that may contribute to public acceptability are complex and are often not amenable to condensing into a single quasi-technical attribute that can be readily and objectively assessed. Consultative processes are the preferred means of identifying the underlying criteria on which acceptability depends, so that they can be effectively incorporated into the BPEO study itself or otherwise, more qualitatively, into the related decision process. There may be valid reasons, unrelated to environmental performance or practicability, why stakeholders might not prefer an option, but these should be taken into account outside the core BPEO study.

9 OPTION ANALYSIS

The process of options analysis requires the performance of each option on the short list to be assessed against each attribute. The results of the evaluation are recorded either as a ranking (e.g. best to worst) or a numerical 'score' (usually on the basis of a semi-quantitative study on a simple integer scale, or high/medium/low). Depending on the attribute concerned, ranking or scoring may lie anywhere in the range from entirely objective to entirely subjective. Attention needs to be given to providing a ranking or scoring procedure that is straightforward to apply and transparent to external audiences.

The aim should be to undertake an objective study of each option/attribute combination, distinct from the subjective importance that might be attached to that attribute according to different perspectives. It is an important aim that all stakeholders whose views might inform the decision process should be able to agree on the chosen attributes. It is also an aim that, if possible, they should consent to how performance is evaluated against those attributes. Although this may not always be achievable in practice, assessors will look for unambiguous arguments and relevant supporting material (impact studies, cost engineering studies) in support of the ranking, or scores, that have been determined. Divergences between stakeholders are most likely to arise in the different weightings (Section 10) they might attach to attributes in establishing an order of preference.

Records of the reasoning that underpins the analysis

Whether the evaluation of an option against an attribute is recorded as a ranking or a score, there will almost always be a mix of qualitative and quantitative reasoning to underpin the evaluation. The degree of quantification depends on the nature of the problem. Many key attributes (e.g. health impacts of radioactive discharges) are quantifiable but difficulties may be experienced with 'softer' issues such as the degree of technical flexibility associated with different options. Within an iterative approach to a BPEO study, it may be appropriate to begin considering attributes in a qualitative manner, seeking to make them more quantified only at a later stage.

Where they are used, numerical scores should be demonstrably objective and represent a consensus view of the range from very good (highest score) to very poor (lowest score). If consensus cannot be reached, alternative viewpoints should be preserved within the study and considered as part of the sensitivity analysis. It should at least be possible for an external reviewer to understand how the scoring was derived.

Focus on BPEO as a tool to reveal issues, rather than as an end in itself

There is a considerable literature dedicated to multi-attribute methods and the derivation of scores (and weightings), but many of the published approaches are likely to be too complex for application in a typical BPEO study. The evaluation of options should be based on a structured, credible methodology, where the aim is not so much to identify an 'optimum' solution as to make explicit the assumptions, facts and logic behind the identification of the preferred option. For example, extensive exercises to elicit 'indifference curves' or (for instance) 'willingness to pay' valuations on different detriments have not generally proved necessary to clarify and discriminate between options.

The Agencies' view is that the choice of method lies with the operator provided that this decision is made transparent and justified in the submission. The operator should have the flexibility to determine the most appropriate balance between the advantages and disadvantages of alternative approaches.

10 SENSITIVITY ANALYSIS AND WEIGHTING FACTORS

Different perspectives on the relative importance of different attributes (e.g. timescale to implementation versus cost, or residual contamination) can, in principle, be taken into account by attaching different levels of importance, or 'weighting', to those attributes in determining the aggregate performance of each option. Assessors will look for clarity in the treatment of weightings, to provide assurance that they have not skewed the overall conclusions of the study.

Where used, weightings need to be systematically derived and justified as part of the overall submission. Use of weightings implies that the results of the BPEO study will be expressed in terms of an aggregate score based on summing the results for each option over all (weighted) attributes. Even where a sophisticated approach is adopted to weighting in order to identify an 'optimum' solution, the conclusions that are derived from the aggregated scores may be rather less important to the final decision than the reasoning used in identifying key discriminating factors between options. This is consistent with the primary aim of BPEO studies, which is to reveal systematically the arguments, assumptions, issues and preferences that underpin decisions about a proposed course of action.

Difficulties with formalised weighting approaches

Attribute weightings are essentially subjective. It is important to examine the sensitivity of the outcome of a BPEO study to the choice of those weightings. One of the ways of doing this is by considering the implications of extreme combinations of weighting factors.

Stakeholders will have differing views on the relative importance of attributes. The literature contains many alternative approaches to the elicitation of weightings from stakeholders, but most of these are likely to be too complex for typical BPEO applications. Some would also usually be ruled out because of the excessive demands they make on stakeholders' time. Rather than attempting to determine how different groups would assign relative weights to different measures of performance, it may be more practicable simply to carry out a sensitivity analysis as identified above. It may sometimes be appropriate for mechanisms of stakeholder involvement to be used to explore the particular views of key groups of stakeholders. There is, however, a balance to be struck, and weightings should not simply reflect the subjective judgement of a small group of people.

Exploring the significance of uncertainties through sensitivity analysis

In addition to considering the potential sensitivity of the studies conclusions to alternative views on the weighting of attributes, it will usually be important to consider the sensitivity of the overall study to a wider range of potential uncertainties. For example, exploration of the effects of changes to basic assumptions that have been adopted in defining the scope of the study (Section 5), or in undertaking the options analysis (Section 9), can give an indication of the overall robustness of the BPEO study.

As a general rule, numerical sensitivity analysis should not normally take precedence over providing robust justification of assumptions and more qualitative arguments that influence the conclusions of the BPEO study.

11 INTEGRATION INTO DECISION MAKING

A BPEO study may be initiated by a nuclear site operator who wishes to understand the environmental implications of decision making in the following areas:

- application for authorisation under RSA93,
- the development of strategies to support continued operation and/or decommissioning, or
- the development of new practices or the major modification of existing practices

The outcome of a BPEO study is an important input to decision making. The final decision may be influenced by other factors known at the time or emerging subsequently. More detailed studies will normally be carried out subsequent to the BPEO study. Such studies may be informed by the work undertaken within the BPEO study. A final decision cannot be made until these additional studies have been completed.

Identification of the BPEO

This Guidance has consistently stressed that the value of multi-attribute methods within the BPEO framework is to provide the basis for a systematic qualitative comparison of options, rather than implying that quantitative study alone is sufficient as a basis for determining the preferred option. The ranking of options on the basis of aggregate (weighted) scores alone is rarely satisfactory as a basis for decision making. If a numerical scoring system is used, the top scoring option may be the starting point for identification of a preferred strategy, but the conclusion may still be that it is not the BPEO.

12 PRESENTATION OF BPEO STUDIES

The flexibility of the BPEO concept allows for the application of a range of different approaches at the detailed level, depending on the context in which the BPEO study is made. This Guidance does not specify a precise approach to be followed. It draws out the key considerations associated with the design and implementation of BPEO studies, that will be taken into account in a regulatory assessment of the adequacy of the particular methodologies that may be used by individual operators.

The preceding discussion has highlighted some of the key themes associated with the design and implementation of BPEO studies, and the expectations of the Agencies for how they should be undertaken. Components of the regulatory assessment include:

- The validity of the process and methodology;
- The competence of the team carrying out the BPEO study;
- The data used and those significant judgements, whether explicit or implicit, that have affected the outcome of the BPEO study;
- The extent of any associated stakeholder input or consultation;
- The documentation of the results.

General Expectations

Factors that lend confidence to the appropriate application of the analytical framework of BPEO studies include: the experience of those that have carried out the study, the quality management arrangements that have been applied, and the extent of stakeholder involvement and review. Well-written submissions that provide a transparent account of the logic, explain assumptions, and provide sufficient information to confirm the validity of data used in support of the study, are also key factors for the effective use of a BPEO study as a part of the decision-making process.

Assessors will expect BPEO documentation to include a clear description of how the BPEO study was developed and undertaken, including key decisions, dates and information sources. The composition and competence of the project team that carried out the study should be recorded, and stakeholder inputs to the process – as well as their effects on the outcome of the study – should be clearly identified. The operator's approach to monitoring the validity of assumptions made in the study against unfolding reality, and the implications of this for strategic planning outcomes, should be described.

Assessment Criteria Checklist

The detailed guidance presented in this document establishes and develops some key overall principles that affect the way in which individual BPEO studies can be tailored to meet specific requirements. However, it is also possible to identify a number of general considerations that assessors will expect to see taken into account in the presentation of all BPEO studies. The checklist presented below is not exhaustive, and should not be seen as substitute for a more detailed reading of the Guidance. Nevertheless, it is presented here as a simple summary of some of the main criteria for regulatory assessment of BPEO studies.

Criteria for BPEO Assessments

- **General**
  - Evidence for consideration of stakeholder involvement and consultation requirements
  - Records of stakeholder inputs at different stages of the study
  - Evidence of stakeholder verification of their inputs to the study
- **Definition of purpose and scope**
  - Clear statement of objectives and logical translation into study scope
  - Explanation for the way in which policy/regulatory and other constraints are factored into the BPEO study
  - Logical structuring and consistency in individual BPEO studies undertaken as part of site-wide strategic process
- **Identification of options**
  - Evidence for a systematic, comprehensive identification of candidate options
  - Records of (and reasons for) any options introduced at later stages in the study
- **Screening**
  - Clear explanation for choices of screening criteria, including relevant stakeholder inputs
  - Evidence of the logic applied in the screening process

Presentations of Studies

- **Selection of attributes**
  - Evidence of principles used to generate a comprehensive list of study attributes
  - Transparency in the presentation and description of study attributes
  - Records of (and reasons for) any attributes introduced at later stages in the study
- **Options analysis**
  - Clear explanation of the 'scoring' scheme used in the analysis
  - Description and explanation of judgements made in the analysis
  - Logic underpinning assumptions and data selection, including:
    - > Unambiguous supporting material for study of the projected impacts of options
    - > Substantiated evidence of assumptions relating to cost data
    - > Clear explanation of any assumptions regarding cost discounting
  - Evidence for systematic and realistic consideration of the implications of uncertainty
- **Use of weighting factors**
  - Overall clarity in the explanation and treatment of weightings within the BPEO study
- **Identification of the BPEO and integration into decision making**
  - Evidence of qualitative reasoning used to interpret the results of the options analysis
  - Systematic presentation of arguments, including factors outside the scope of the BPEO study, leading to identification of a preferred option

13 GLOSSARY

Attribute	In this document, a quality, property, or performance measure of an option that enables different options to be scored or ranked in relation to one another. Depending on the attribute concerned, the scoring or ranking process may lie anywhere in the range from entirely objective to entirely subjective. Different attributes are not normally commensurable with one another in any direct way and hence a subjective weighting factor must be applied to each attribute if an overall scoring or ranking of options is to be obtained.
BPEO	Best Practicable Environmental Option. *"… the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conservation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as in the short term."* (Royal Commission on Environmental Pollution, Twelfth Report, 1988.)
BPEO Assessment	An assessment carried out by a body such as one of the Environment Agencies of a BPEO study carried out by a body such as a nuclear site operator.
BPEO Study	A study carried out, usually by or on behalf of a nuclear site operator, of the BPEO with respect to some aspect of radioactive waste disposal. The term *BPEO Study* refers to the whole process, including any external consultation stages.
BPM	Best Practicable Means. *"…a term used by the **EA** and **SEPA** in authorisations issued under the Radioactive Substances Act. Essentially, it requires operators to take all reasonably practicable measures in the design and operational management of their facilities to minimise discharges and disposals of radioactive waste, so as to achieve a high standard of protection for the public and the environment. BPM is applied to such aspects as minimising waste creation, abating discharges, and monitoring plant, discharges and the environment. It takes account of such factors as the availability and cost of relevant measures, operator safety and the benefits of reduced discharges and disposals. If the operator is using BPM, radiation risks to the public and the environment will be ALARA."* (Managing the Nuclear Legacy - A strategy for action, Cm 5552, July 2002.)
Environmental Principles	Environmental principles aim towards desired environmental outcomes. In practice, they are a combination of International agreements, UK Government policy and the Agencies' own policy choices.
Integrated Waste Strategy	An integrated waste strategy is an outline plan, taking into account environmental principles, that can be applied consistently to all actual and potential sources of waste, both radioactive and non-radioactive, within the scope of the strategy. The scope may extend to the whole of a complex nuclear site or even to multiple sites. A BPEO study may be needed to identify a suitable strategy.
Multi-attribute Analysis	An analysis of different options in terms of multiple attributes they possess.
Option	In this document, a potential means of achieving a specified objective.
Options Appraisal	An appraisal carried out by any person or organisation of a range of possible options for achieving a specified objective. A BPEO study is a particular form of options appraisal in which, given that waste creation has already been minimised, the waste disposal option is sought that achieves the minimum impact on the environment of the waste that is nevertheless created.
Project Risk	The possibility that a particular strategy may not meet expectations in terms of performance, cost and time to implementation.
Ranking	Placing options in order from highest to lowest against a particular attribute.
RSA93	Radioactive Substances Act 1993.
Scoring	Placing a numerical value on an option in relation to a particular attribute.
Screening Criterion	A criterion used to exclude one or more proposed options from further consideration. As such, it is a special type of attribute that represents basic expectations in relation to the practicability of proposed options. Such a criterion is likely to be based on unfeasibility, violation of legal, policy

	or regulatory constraints, or manifestly inferior performance against important attributes, and to be brought into play to reduce the amount of subsequent work.
Stakeholder	Any person or organisation that considers it has an interest in the BPEO study concerned. Although the relevant nuclear site operator, the regulators and Government departments are stakeholders, in this document the term is reserved for persons or organisations other than these.
Uncertainty	In this document, lack of definite information on a matter relevant to a BPEO study.
Weighting Factor	A factor applied to each attribute of an option so as to obtain an overall scoring or ranking for that option. Weighting factors are essentially subjective.

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