REGULATORY POLICY INSTITUTE

The Regulation of Radioactive Waste Management in the UK

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Introduction

Substantial quantities of radioactive waste exist in the UK largely as a result of the activities of government agencies or government owned companies since the 1940s. Additional large quantities of waste are also 'pre-committed' in the sense that they will be generated as a result of the operation and decommissioning of pre-existing power stations. Whilst a considerable amount of this waste is 'low level' and has a relatively short potentially harmful life, significant amounts will be potentially harmful for very long periods of time, in some cases hundreds of thousands of years.

This raises important and difficult questions concerning how trade-offs between both the levels and distribution of costs and environmental quality/safety associated with different waste management decisions should be addressed, particularly since many of those affected by these decisions are not yet alive. In key respects, the arrangements that are currently in place have failed to adequately address these trade-offs, in that thus far they have not been able to generate a publicly acceptable way of addressing key issues. Most notably, in 1997 the Secretary of State refused to grant Nirex planning permission for the development of a Rock Characterisation Facility at its planned site for an underground radioactive waste repository on the grounds of scientific justification and public acceptability.

This paper is concerned with how the institutional arrangements for dealing with issues surrounding radioactive waste management can best be developed. When considering issues of regulatory design it is important to understand the factors that influence the structure and conduct of regulatory regimes more generally. Any proposals made, or any arrangements put in place, in the context of radioactive waste management will be subject to the influence of these factors, and good regulatory design should take this into account at the outset. Otherwise, there is a strong risk that the achievement of public policy objectives will be compromised later, in circumstances where more attention to the robustness of regulatory design in relation to predictable pressures and influences which may have unwanted effects could have led to better outcomes.

In section 1, we focus on those factors that at other times and in other industries have been shown to influence regulatory developments. We highlight these factors and the potential for regulatory failure that can be expected to be associated with them. In section 2, we consider ways in which institutional arrangements can be made more robust to the anticipated influences by considering a range of idealised regulatory structures and roles. On the basis of this discussion, we turn to consider Radioactive Waste Management (RWM) issues more specifically in section 3, and evaluate the extent to which current arrangements can be expected to be robust to the potential for regulatory failures. In section 4 we propose a potential way forward that seeks to address the main source of failures identified. Appendix 1 provides a detailed description of the various institutions currently involved in the regulation of radioactive waste in the UK, and Appendices 2 & 3 map the current statutory and institutional framework respectively.

Executive Summary

The substantial quantities of radioactive waste which exist in the UK largely as a result of the activities of government agencies or government owned companies since the 1940s, raise important and difficult questions concerning how trade-offs between both the levels and distribution of costs and environmental quality/safety associated with different waste management decisions.

This paper is concerned with how the institutional arrangements for dealing with issues surrounding radioactive waste management can best be developed. Our main focus is on those factors that at other times and in other industries have been shown to influence regulatory developments.

The Development of Regulatory Frameworks

- When considering issues of regulatory design it is important to understand the factors that influence the structure and conduct of regulatory regimes more generally. Regulatory structures and institutions come in many different shapes and sizes, but these differences are not arbitrary: they are shaped by, and in turn shape, a variety of economic, political, legal, and social factors. Broadly, the explanations that have been provided as to why these structures emerge and develop, can be grouped under four headings:

    - market failure,
    - pressures for redistribution of economic resources, and
    - institutional factors, and
    - public or specialist opinion

- The '*efficiency hypothesis*' is a traditional way of thinking about issues relating to regulatory design. Under this approach, the first step is to hypothesise a highly decentralised, atomistic economic system in which all co-ordination is achieved via market transactions, and then to consider its possible inefficiencies (usually described as market failures). Centralisation of decision making and the emergence of regulatory structures and institutions can then be explained as mechanisms for promoting more efficient outcomes when the market fails (ie: market failure). The 'efficiency hypothesis' therefore argues that regulatory structures and institutions evolve according to their success or failure in promoting economic efficiency.

- Four sets of problems that can give rise to market failures are: *Pure monopoly; Imperfect competition; Externalities* (uncompensated third-party effects); and *Informational problems*. Of these, the most relevant to Radioactive Waste Management (RWM), in our view, include the problems associated with externalities and informational problems.

Sources of Regulatory Failure

- The main sources of regulatory failure can be grouped under three broad headings: *distributional factors; institutional factors;* and, *public opinion*. However, information conditions are also of considerable importance and can significantly influence the extent to which these factors are likely to give rise to regulatory failures.

- The susceptibility of regulation to distributional pressures is well documented, and in its extreme form may give rise to *regulatory capture.* More generally, however, a balance will be struck between competing interests, leading to a redistribution of payoffs. The extent of regulatory failure arising from distributional pressures will depend on a range of factors including the strength of those pressures, differences in effective leverage, the visibility and concentration of the costs and benefits of alternative courses of action and more generally on the robustness of regulatory and government institutions. The low visibility and considerable temporal dispersion of effects of many RWM activities indicates that such issues may be prone to regulatory failures as a result of distributional factors.

- A further set of factors that shape regulatory developments are 'institutional' in nature. Institutional explanations tend to emphasise the influence that organisational norms, procedures and cultures can have on regulatory developments. In RWM, the problem of the 'relational closeness' of experts within regulatory authorities and regulated companies, is likely to contribute to concerns that experts within the relevant institutions are 'closer' to those they are regulating than those they are supposed to be acting on behalf of. There may be tendencies to develop consensus views on how things can be done, particularly in conditions of uncertainty, which can provide psychological comfort and/or facilitate coordination. There may also be associated tendencies to 'not notice' information that is inconsistent with existing beliefs and interests.

- The potential impact of public opinion raises a range of concerns under conditions of uncertainty given that well recognised biases may emerge. For example, heavy publicity given to low probability outcomes, in circumstances when risk assessment is difficult, has been shown to give rise to over-estimation of risks. Similarly, new and 'dramatic' information may give rise to excessive volatility of perceptions of risk. If the policy making process responds readily to shifting opinion, this may give rise to knee-jerk reactions that can lead to considerable inefficiencies.

- Limited information impinges on regulatory issues in a number of highly complex ways, particularly in relation to evaluating future benefits and costs of a decision. Thus, when markets fail and the relevant policy questions concern effects on future generations, explicit or implicit views will have to be taken on a range of factors in order to evaluate benefits and costs.

- Problems of limited information and potential regulatory failure are amplified where differences of belief exist, and when information asymmetries exist

between regulators and organisations, or between regulators and those that they act on behalf of.

Addressing Regulatory Failure: Regulatory Roles and Structures

- The term 'regulation' embraces a range of activities. The questions of how best to conduct each activity, and of how best then to co-ordinate the various activities, are therefore fundamental to good regulatory design.

- Some of the activities and roles that are covered by the term 'regulation', and which regulators are involved in, include:

  - Take major economic or social decisions
  - Make rules
  - Set standards
  - Monitor and enforce compliance with rules and standards
  - Advise and inform
  - Adjudicate
  - Represent, bargain and negotiate
  - Disturb unsatisfactory equilibria ('prodding')
  - Format information flows

- The institutional structures of regulation are often highly complex, as institutional structures tend to evolve in order to accommodate required responses to new policy issues which emerge over time. Where institutions rely on statute, opportunities for substantial institutional change may occur only periodically, being constrained by legislative capacity and timetables. These points are illustrated by the development of many of the main regulatory institutions in the UK.

- Behind the complexity of actual institutions, however, lie a number of 'models' or 'ideal types' of regulatory institution, which include:

  - Departmental regulation
  - The public corporation
  - Sectoral regulators (eg: Ofcom for the broadcasting and telecommunications sectors)
  - Focused regulators (eg: Environment Agency)
  - Self regulation

- The difference between these 'ideal types' or 'models' of regulatory institution provides a useful framework for considering how potential regulatory decisions might best be 'insulated' from particular sources of influence by means of separation or unbundling from:

  (a) the political process
  (b) commercial decision making
  (c) other types of regulatory activity

- Recognition of these influences on decision making can help address the potential for regulatory failure. Thus, one form of structural response to the potential for regulatory failure is to develop arrangements that seek to 'insulate' decision making from day to day public opinion or interest group pressures, by separating relevant decision making from the more direct influences of the political process and commercial decision making. Thus, decision making by independent regulatory authorities with well defined mandates is likely to be more robust to these pressures than decision making by government departments or self-regulators.

- A second form of structural response to potential regulatory failures is to seek to recognise the underlying tensions and trade-offs in explicit ways within decision-making processes. For example, arrangements can seek to bring 'public opinion' within the decision making process in a more formal and ongoing manner, and thus provide a clear forum for a wide representation of views. This approach recognises that whilst the undoubted biases in public opinion that exist are a source of problems, diversity of view is also a potential strength in dealing with difficult and complex issues. It can be noted that markets function better than central planning precisely because they work with, and thrive on, such diversity, making best use of available information and providing strong incentives for the discovery of new information.

- Relevant tensions may also be more directly addressed through the design of regulatory roles and objectives. In particular, when markets fail it is frequently possible to identify groups who suffer most, such as future generations. Regulators may seek to "represent" these interests and bargain or negotiate on their behalf (for example, regulators as consumer champions) as a means of addressing what would otherwise be a mismatch in economic/political power. This approach can be underpinned by primary legislative duties to a particular interest group (eg Utilities Act duties on Ofgem to protect consumers). Where regulators act as 'advocates' in this way, emphasising particular dimensions of relevant trade-offs, it is important that there is a clear adjudicator between the regulator and the regulated company in cases of dispute. Indeed, it can be noted that the existence of a credible adjudicator is an important factor in enabling regulators to 'represent' particular groups in this way.

- The role of an adjudicator highlights the way in which addressing the potential for regulatory failures through on the one hand seeking to separate decisions from political and commercial pressures and on the other seeking to develop the involvement and representation of different interests in decision making processes can be complementary approaches. That is, an adjudicator can provide a open forum within which representations are made, including by other regulators acting as advocates. Thus, some regulatory activity is geared towards highlighting and better articulating aspects of relevant trade-offs that may otherwise be under-represented, whilst other regulatory activity is geared towards determining how appropriate trade-offs should be balanced in a context that is 'insulated' from direct political and commercial involvement.

- In order to address institutional problems that may be associated with the relational closeness of regulators and those they regulate, arrangements can be developed that ensure that processes are 'prodded' or 'disturbed' in order to counteract these tendencies. This may include activities such as raising awkward questions, funding alternative research and more generally encouraging market participants to think about different approaches. In addition to this, regulators may actively seek to generate new forms of transparency, representation and accountability, which may include efforts to make activities more easily 'auditable' by the regulator and/or by third parties. Such activity can change the information conditions against which views are formed and decisions are made, as well as more generally enhancing credibility.

Evaluating the Current RWM Regulatory Regime

- Under the current RWM arrangements, there is a lack of a coherent approach to sources of long lived radioactive waste, with in particular Nirex charged with responsibilities for Intermediate level and some low level waste, whereas responsibility for high level waste lies with DEFRA. There would seem to be significant benefits in waste management issues associated with different sources of long-lived waste being dealt with within the same set of institutional arrangements to address potentially negative effects associated with non-compatibility and concerns that opportunist behaviour may take place at a later date (for example, that an ILW waste repository if built may be considered a convenient location for HLW at that stage).

- Whilst the current institutional arrangements provide a clear basis for independent regulatory scrutiny of the short and medium term effects of storage, packaging and conditioning decisions, they do not provide for scrutiny in relation to the longer-term issues, in particular: the determination of long term strategies and approaches, and the assessment of the implications of these approaches for operational decisions in the short term.

- The primary role in relation to strategic decisions is played by Nirex, which is owned by the waste producers. Given the very substantial information and incentive problems associated with these issues, and conditions conducive to the development of institutional biases, industry self-regulation of this kind is highly unlikely to provide a robust basis for developing a long term strategy. In our view, there is a very strong case for an independent body to be charged with developing long term strategic options.

- The evaluation of the implications that potential long term approaches should have for current packaging and conditioning standards is also primarily dealt with through self-regulation, by Nirex, in a highly non-transparent manner. Nirex issue letters of comfort to waste producers where proposed approaches are considered compatible with long term strategic factors, but is currently not permitted (by its owners, the waste producers) to routinely provide this material to the Nuclear Installations Inspectorate (NII) and the Environment Agency (EA) – the independent regulators who have responsibility for regulating the activities of the

waste producers. In our view, there is a very strong case for the assessment of packaging and conditioning standards to be carried out by an independent body.

- The development and evaluation of long-term strategic options, and the assessment of the implications that potential long term approaches should have for current packaging and conditioning standards could be subsumed within a single independent body - a form of independent Nirex – or they could be unbundled to some extent. For example, assessments in relation to packaging and conditioning standards could be undertaken by the NII and/or the EA. However, important considerations in relation to unbundling will include potential conflicts between short and long term regulatory considerations, the relatively limited availability of relevant expertise, and, given the costs associated with relevant research, the costs of duplication.

- Under the current institutional arrangements there is a lack of a clear forum where the many difficult trade-offs associated with major RWM decisions can be openly presented and developed, with subsequent adjudication. Thus, it was only in the context of the local authority planning inquiry concerning the planned Rock Characterisation Facility at Sellafield that there was a clear public forum within which the plans for deep disposal were scrutinised and adjudicated upon.

- More generally, the current institutional arrangements lack coherent adjudicatory arrangements in relation to regulatory decisions concerning different aspects of radioactive waste management. Both the Environment Agency and the NII have legislative mandates that are geared to them representing particular interests (environment and health & safety), with cost considerations acting as secondary constraints. However, where regulators act as representatives or 'advocates' in this way, emphasising particular dimensions of relevant trade-offs, it is important that there is a clear adjudicator between competing views in cases of dispute. A common adjudicator in relation to appeals to regulatory decisions could provide for an open forum within which licence and authorisation disputes could be heard, and a more coherent framework within which subsequent regulatory decisions are made.

- Factors such as the relatively small size of the relevant expert community, the background of secrecy within the industry, and the low level of public trust more generally, are likely to contribute to ongoing concerns that experts within the relevant institutions are 'closer' to those they are regulating than those they are supposed to be acting on behalf of. In our view a set of arrangements that does not provide for substantial and visible scrutiny or 'prodding' on a regular basis can be expected to generate decisions that are considerably more likely to be subjected to unwanted political influence on a more erratic basis.

Developing a Way Forward

- In our view, the robustness of current institutional arrangements could be significantly enhanced, through the introduction of a new independent body which could:

- provide for open hearings, and subsequently clear recommendations to the Secretary of State, on major issues associated with the long term RWM;
- publish submissions, analysis and conclusions associated with these recommendations;
- have powers to adjudicate in relation to disputes over regulatory decisions in relation to radioactive waste management issues;
- fund reviews, ask awkward questions and otherwise disturb or 'prod' the various actors, including regulatory bodies and those charged with the development of long term strategies;
- develop and 'format' regulatory arrangements for RWM, including through the generation of new forms of transparency and representation, over time.

- The Competition Commission would appear to provide a particularly useful model upon which a new body or organisation could be developed. The Competition Commission is a focused regulatory organisation in that, in practice, it deals with problems or potential problems associated with the existence of market power. It receives submissions from interested parties on the matters of concern, and it publishes reports setting out facts, analysis, the views of parties making submissions, its own views, and its final conclusions.

- The arrangements relating to the decision-making power of the Competition Commission are interesting in that, in effect, they imply a substantial delegation of high-level regulatory decision making to a specialist Commission, but with reserve powers retained to deal with what might be judged to be particularly sensitive cases. Given the political sensitivity of major RWM issues, this form of substantial – but partial – delegation, would appear to provide a useful model for long term RWM issues.

- The introduction of a new Commission of the form described is of course not the only potential way of addressing the various regulatory challenges that have been highlighted in the area of RWM. It does, however, in our view, provide a useful way of thinking about how these issues may be resolved by recognising, and indeed emphasising, the differing roles currently played by existing institutions. A Commission can be understood as providing a means by which major trade-offs between cost and environmental quality/safety in relation to RWM issues can be made through an open and adequately scrutinized process.

Section 1
The Development of Regulatory Frameworks

1.1 Introduction

Regulatory structures and institutions come in many different shapes and sizes, but these differences are not arbitrary: they are shaped by, and in turn shape, a variety of economic, political, legal, and social factors. Broadly speaking, the explanations that have been provided as to why these structures emerge and develop in the ways that they do, can be grouped under four headings:

- market failure,
- pressures for redistribution of economic resources, and
- institutional factors, and
- public or specialist opinion

Each of these groupings will be discussed in what follows, but they will be considered in slightly different ways. Market failures provide a rationale for the development of a regulatory response to the problems of radioactive waste management. That is, they explain why a Government seeking to promote economic efficiency, defined in a broad sense (see below), should not and will not simply 'leave matters to the market'. The efficiency objective is a general one and, other things equal, is not particularly controversial. In contrast, the influences of distributional factors, institutional factors and opinion are likely to be much more controversial (i.e. provoke much greater conflict between different stakeholder groups), and to be the source of failures in regulatory design (i.e. failures of public policy to resolve underlying trade-offs in effective ways).

The impact of these general influences in any particular circumstance is highly dependent on prevailing information conditions. The second part of the section highlights some the ways in which problems of limited information have been found to affect regulatory outcomes, highlighting those factors of most relevance to RWM issues.

1.2 Efficiency as a driver of regulation

The concept of efficiency

The term 'efficiency' has a number of possible meanings, even when used in a technical sense. In what follows, however, the term is used in one and only one way: efficiency is measured as the total benefits less the total costs associated with particular activities or outcomes.

Three points should be emphasised concerning this usage:

- It abstracts from distributional issues: all costs and benefits are added together with no attention paid as to which groups gain and which groups lose.

- It includes *all* parties affected by the activities of interest. In the case of RWM, this means, for example, that it encompasses the interests of future generations.

- It includes all benefits and costs, including benefits and costs that are not taken into account by transacting parties (i.e. what in economics are *called external effects*).

The "efficiency hypothesis"

A traditional way of thinking about the issues is first to hypothesise a highly decentralised, atomistic economic system in which all co-ordination is achieved via market transactions, and then to consider its possible inefficiencies (usually described as market failures). Centralisation of decision making and the emergence of regulatory structures and institutions (other than the generic institutions required to support trade) can then be explained as mechanisms for promoting more efficient outcomes when the market fails (see Grout 2001[1]).

The most familiar examples of this type of analysis concern the case for state intervention in resource allocation decisions. Whenever there is a significant market failure – such as environmental damages arising from undefined property rights and absent markets – it is natural to ask whether public policy can improve matters. If a view is taken that it can, the chosen mechanism for intervention will often be "institutional", for example an agency to control prices or environmental emissions. The *public interest theory of regulation* is based on this type of approach (see Noll, 1989).[2]

The institutional response to market failure need not, however, be a governmental one. Both the existence and, more ambitiously, the structures of companies and other forms of productive organisation can be explained by similar factors. Coase (1937), in a classic article, explained the existence of firms in terms of their ability to economise on transactions costs as compared with markets.

Later writers (Alchian and Demsetz, 1972; Williamson, 1975) have followed a similar market failure approach, differing from Coase and from each other largely in relation to the particular market failure or set of market failures that they emphasise most in accounting for the development of complex organisations. Thus Williamson has

[1] Grout, P.A *"Financial Issues in the Management of Radioactive Liabilities"*, UK Nirex Ltd internal paper submitted to the Cabinet Office, 14 June 2001

[2] It is not inevitable that the "solution" will be institutional in the sense in which the latter word is used here. It is conceptually possible to envisage purely private enforcement of anti-trust law through the courts, or cases where the environmental problem could be dealt with via the creation of new property rights that, once established and allocated could be also be enforced through the courts.

emphasised contractual problems when one side at the bargaining table can behave *opportunistically* because the bargaining partner has already made investments that are specific to the particular business relationship.

By way of background, four sets of problems that can give rise to market failures can be noted, of which the third and fourth are particularly relevant to RWM issues:

- Pure monopoly.
- Imperfect competition.
- Externalities (uncompensated third-party effects).
- Informational problems, which may be divided into problems connected with the production of information (e.g. R&D) and the distribution/use of information (e.g. *differential* or *asymmetric* information as between interested parties).

In a US context, Spulber (1989), following Breyer (1982), has pointed out that different types of policy institution can be matched to the different categories of market failure.[3] Thus:

Pure monopoly:	*Federal and state regulatory commissions.*
Imperfect competition:	*Anti-trust policy and law.*
Externalities:	*Environmental Protection Agency.* *Nuclear Regulatory Commission.*
Information:	*Food and Drug Administration.* *Federal Aviation Authority (safety aspects).* *Consumer Product Safety Commission.* *Occupational Safety and Health Administration.*

A similar list can be drawn up for the UK energy sector, although in this case the lack of a clear pattern of association between market inefficiencies and institutional responsibilities can be noted:

Pure monopoly:	*Ofgem.* *Competition Commission (disputes and appeals).*
Imperfect competition:	*Department of Trade and Industry.* *Office of Fair Trading.* *Competition Commission.* *Ofgem.*
Externalities:	*Environment Agency.* *Energy Efficiency Programmes in various institutions.*
Information:	*Office of Fair Trading.* *Ofgem.*

[3] Spulber does not distinguish pure monopoly and imperfect competition, and refers to "internalities" rather than to information problems.

Energy Efficiency Programmes in various institutions.

The notion that regulatory structures and institutions evolve according to their success or failure in promoting economic efficiency – what can be called the *efficiency hypothesis* – is a powerful tool in explaining changing patterns of economic organisation over very long periods. It is, however, clear (and demonstrated by substantial empirical evidence) that, at any one point in time, it is unlikely that institutional structures are such as to ensure that economic outcomes are fully efficient. We turn now to consider three central explanations that have been provided for why this may be the case: distributional factors; institutional factors; and opinion.

1.3 Key Sources of Regulatory Failure

(i) Distributional influences on regulation

If it were ever the case that a particular form of economic organisation reached a state of economic efficiency (i.e. there exist no alternatives that would yield a higher aggregate net benefit), the resulting arrangements would be vulnerable to disturbance as a result of pressures to redistribute economic resources from one interest group to another (Yarrow, 1996). Thus, set of arrangements A might be more efficient than B, but B may nevertheless be the observed outcome because it is substantially superior for a particular interest group that wields disproportionate influence in the development of policy (e.g. a relevant ministry).

The reason for the vulnerability of efficient arrangements to disturbance by interest group pressures is that it is usually the case that perturbations from efficient arrangements have *much* larger effects on the distribution of resources than upon efficiency itself. Consider, for example, the net social benefits (the measure of efficiency) arising from the taxation of a particular type of pollutant that causes significant environmental damage. At low tax rates, increases in the tax rate will tend to increase efficiency, since it will encourage the adoption of relatively low cost methods of reducing pollution. As the tax rate continues to increase, however, there will come a point where efficiency starts to fall, because the polluter has tax incentives to engage in abatement activities even though their costs start to exceed the benefits of lower pollution.

At the point of maximum efficiency, modest changes in the tax rate have little or no effect on efficiency (the rate of change of efficiency with the tax rate is zero, and the effects of perturbations in the tax rate are of "second order").

On the other hand, the rates of change of the payoffs of interest groups involved (e.g. the regulated company, those affected by the pollution) with respect to the tax rate are not zero, even though, taken together, they are self cancelling. An increase in the tax rate will benefit those affected by pollution, but at the same time, it will damage the company by an almost equal amount. That is, when regulatory arrangements are efficient, the interest groups involved will tend to engage in a zero-sum game to achieve perturbations in decisions that increase their own payoffs at the expense of others.

Since the efficiency costs of small perturbations are very low, governments or regulators who attach even relatively small weights to factors other than efficiency when making decisions (e.g. to tax revenues, electoral prospects, etc.) can be expected to respond to these pressures. This expectation is strongly supported by available evidence: in case study after case study, covering a very wide range of different types of regulatory intervention, the public interest theory of regulation is found not to fit the facts. Rather, regulatory policy responds, in ways that vary across circumstances, to the pressures of one or more interest group

The extent of the regulatory failures arising from interest group pressures will depend upon a range of factors including the strength of those pressures, differences in effective leverage that can be exerted by the different groups, the 'visibility' and concentration of the costs and benefits of alternative courses of action, and the general shape of government or regulatory objectives and institutions. In extreme cases, *regulatory capture* can occur, whereby one group comes to exert an unchallenged influence on policy making. More generally, a balance will be struck, leading to a redistribution of payoffs that correlates with the degree of influence/power exerted.

To illustrate, consider a decision about where to site a new waste disposal facility. A is the preferred (efficient) location, but B is not far behind. Residents in each location can be expected to be strongly opposed to the siting of the facility in their area, and decision makers may be faced with a classic dilemma: the benefits of the facility may be widely spread, whereas at least some of the costs will be highly localised/concentrated. That is, benefits are diffuse and largely unnoticed, the costs are concentrated and highly visible.

Clearly, it is quite possible that, if the interest groups opposed to location A can exert stronger leverage (e.g. their votes may be more valuable on account of being in a marginal constituency), it might be decided to locate the facility at B, even though total social net benefits are lower. If opposition in both places is strong, the project may be delayed or abandoned, even if this will lead to higher costs in the future. Delay can be viewed as one of those 'marginal' adjustments that does not have very much of an impact on efficiency and, although repeated delay may lead to much more substantial efficiency losses, future generations on whom higher costs may fall do not constitute one of the more powerful of the interest groups. This last point is of some significance since, although there has been considerable economic debate about possible "short-termist" biases in markets, it has usually not been noticed that regulatory economics points to the possibility of strong, short-term bias in public policy, particularly in relation to decisions that affect the distribution of costs and benefits over relatively long time horizons.

(ii) Institutional Factors

A further set of factors that shape regulatory developments are 'institutional' in nature. Institutional explanations tend to emphasise the influence that organisational norms, procedures and cultures can have on regulatory developments. A particular concern associated with this influence is that it may result in 'drift' away from the initial objectives of the regulatory intervention, and that such drift can be extremely difficult to control. In the extreme, drift of this kind may be associated with

regulatory capture and have significant distributional effects of the kind discussed above.

A related concept that has clear potential relevance to radioactive waste management issues is that of 'relational distance'. The central argument is that the closer a regulatory body is to a regulated firm in terms of experience, outlook and class – the smaller the 'relational distance' – and the greater the frequency of contact between regulator and regulatee, the greater the possibility that cooperative arrangements and some form of regulatory capture will result. This suggests that, in the absence of counteracting pressures, radioactive waste management arrangements may be prone to the development of shared understandings among relevant expert communities that may drift away from legislative objectives and more general public interest considerations.

(iii) Public opinion.

Another set of factors that can have a major impact on institutional development falls under the general heading of "public opinion". The recognition of the importance of these factors has a distinguished pedigree: David Hume ascribed export restrictions to the "ignorant view that what is considered useful and valuable should be retained"; Adam Smith believed that the intensity of public feeling about "the means of subsistence" meant that governments had to yield to public prejudices in the conduct of agricultural policy; Dicey held that there exists a "close dependence of legislation … upon the varying currents of public opinion"; Keynes, in full rhetorical flow, claimed great influence for the ideas (both right and wrong) of economists and political philosophers; and Milton Friedman, in comparing the policies pursued by India and Japan in the post-war period, stressed "the importance of the climate of opinion, which determines the unthinking preconceptions of most people and their leaders, their conditioned reflexes to one course of action or another." More recently, in assessing the conduct of financial regulation in the UK, Charles Goodhart has argued that public regulation "… often represents a reaction, sometimes an over-hasty reaction, to some scandal which public opinion has put on the political agenda."

In some cases, the force of public opinion is based upon a well established set of values (e.g. the treatment of animals). Changes in opinion then tend to occur relatively slowly. In other cases, opinion is based upon a set of beliefs about relationships between actions and consequences and, in an uncertain world, these can change dramatically over short periods of time (e.g. the health consequences of eating beef).

In particular, heavy publicity given to particular, low probability outcomes can, in circumstances where risk assessment is difficult, give rise to biases towards over-estimation of the risks. Many different sets of beliefs can be "data consistent", and, if events occur that draw the attention of the public to certain possible linkages (focal points for beliefs), those linkages may become common-sense wisdom about a particular issue, even though quite different linkages are, on detailed examination of the evidence, much more likely. Social dynamics tend to reinforce these tendencies, in that members of given groups and societies will tend to seek out 'common understandings' of events and major choices.

New and 'dramatic' information, reinforced by social interaction, can, therefore, lead to excessive volatility in perceptions of risk, and this can be a source of regulatory failure if the policy-making process responds readily to the shifting tides of opinion. On the other hand, it can also be noted that sluggishness to adapt to new information and excess volatility can co-exist in some circumstances, in the sense that different interest groups may react very differently to the same information. Such differences in response can be a stabilising factor in the policy process.

At this point, the influence of opinion can interact with distributional factors. Again because of complexity, uncertainty and limited information, it is all too easy for particular interest groups to develop beliefs about the world that are favourable to their own interests. That is, from among a set of alternative hypotheses, each of which may be true, it is much more comfortable to believe in one that, if correct, has favourable implications than one which, if correct, has unfavourable implications for the relevant individual or group. These issues are discussed further below.

1.4 The Impact of Limited Information

Limited information impinges on regulatory issues in a number of highly complex ways. To get some perspective on the linkages, consider first the standard decision-theory framework in which actions are viewed as leading to consequences and the payoff from each consequence is evaluated (the valuation stage):

Action → *consequences* → *payoffs (costs and benefits)*

Working backwards, it is clear that there is a problem of evaluating benefits and costs (an evaluation that is required in order to make operational the concept of economic efficiency). Call this *valuation* uncertainty. The difficulties are usually particularly important where environmental matters are concerned. Here, economic externalities are major sources of market failure. Definitionally, certain costs and/or benefits are not taken into account by transacting parties, and values are not therefore reflected in market prices. Valuation of costs and benefits therefore has to be made on the basis of less direct evidence and more subtle techniques, and there is usually considerable uncertainty as a result, since a whole range of factors can be expected to affect payoffs. These include preferences, incomes and the prices/values of substitutable and complementary products/services.[4]

Thus, where markets fail and the relevant policy questions concern effects on future generations, explicit or implicit views will necessarily have to be taken on issues such as expected economic growth (i.e. future income levels), possible changes in relative prices, and the preferences of future generations, in order to evaluate benefits and costs. The difficulties are obvious.

The mappings between actions and consequences are also subject to uncertainty, to an extent that varies considerably with circumstances. This can be referred to as

[4] The negative payoff (cost) associated with a source of noise nuisance will depend, among other things, on the price of double glazing. More generally, all factors that affect the costs of actions that can mitigate the externality will affect the value of the externality.

consequence uncertainty or, in contexts such as RWM, *scientific uncertainty*. Flicking a light switch has a set of well defined 'local' consequences: the light will go on, the light will not go on, the bulb will blow, an electric shock will be imparted. Although the outcome is probabilistic, most people have a good sight (or believe they have a good sight) of the mapping from the action to the possible consequences, including the risks involved. The 'non-local' consequences of the action are, however, much cloudier. Extra power will be generated, but from where and using which technologies?

In a well functioning market system, lack of information about such non-local consequences is not a major issue: all that needs to be known, for efficient decisions to be made, are the relevant prices, since prices 'value' these consequences for the electricity consumer in the hypothetical example.

Where externalities exist, however, this valuation route is foreclosed. The mappings between actions and consequences have to be directly assessed, with all their attendant uncertainties. Was extra carbon dioxide emitted as a result of the extra electricity consumption? What are the expected effects of the waste gas on the physics and chemistry of the atmosphere? And, what are the consequences of these effects, in all their detail, for inhabitants of the earth at different locations and in different times?

Beliefs, differences in beliefs and asymmetric information

In considering the mappings between actions, consequences and payoffs, decision theory takes account of uncertainties by assuming that it is possible to identify consequences and assign probabilities to their occurrence, contingent on a particular action being taken. The relevant probability distributions define *beliefs*.

It is possible that all people involved a particular decision will have roughly the same beliefs. That is, although the perceived links between actions, consequences, and payoffs are probabilistic, there is consensus or near consensus as to possible outcomes and the probability to be attached to each. Betting on a spin of a roulette wheel is an illustration of this type of situation.

More typically, however, there will exist differences in beliefs. In economics, this is analysed in terms of problems caused by *asymmetric information*, which is viewed as a source of market failure (see Grout 2001). For example, if sellers of used cars have better information about quality than buyers, buyers will infer that cars offered for sale are of lower quality than average (for the model and age). This depresses second-hand values, reduces the number of cars offered for sale (if I have a high quality car, I will be less inclined to sell), and therefore depresses activity in the market.

Asymmetric information and regulatory failure

Asymmetric information is also a potential source of regulatory failure. The point is often made that regulated firms will have more information about the trade-offs that they face than the relevant regulator, and that this necessarily serves as a constraint on the effectiveness of regulation. To illustrate, a regulated monopoly may know that it could easily reduce costs by, say, 10%, but the regulator may not have this

information. The monopoly will then have incentives to act in inefficient ways, so as to prevent discovery of the information by the regulator, and thereby prevent subsequent regulatory action (e.g. lower prices) based on such discovery.

The point is certainly valid but, in our view, it has been overemphasised in much of the more theoretical economics literature on regulation, at least relative to other consequences of limited information. It is not immediately obvious that a regulated company will generally have more information than a regulator. The latter may take wider perspectives and may be able to obtain information (via statutory powers, for example) not available to a single, regulated firm. Regulated firms may not have good information about certain of their own trade-offs because, in the absence of regulation, there is little or no incentive for them to spend resources on acquiring such information. Thus, if a monopolist is required to price on a cost of service basis, there is little incentive for it even to discover the cost reduction options that might be available.

An informational asymmetry that has received less theoretical attention, but that we would suggest may be of considerable importance in the context of RWM issues, is that between regulators (and other public bodies) and those affected by their actions (other than regulated firms). It is in the presence of significant asymmetries of this kind that there is greatest potential for regulatory failures to result from 'drift' and/or 'capture', given the difficulties posed for accountability. Furthermore, to the extent that this asymmetry results in lower confidence in regulatory arrangements, it may result in those arrangements being more susceptible to regulatory failures, such as 'knee-jerk' reactions, associated with public opinion. Thus, informational asymmetries can provide conditions that are conducive to unwanted influences affecting regulatory outcomes.

Responses to problems of Asymmetric Information

Market failures associated with asymmetric information typically give rise to a particular type or style of regulation, in which the emphasis is placed on disclosure of information. The activities of the Financial Services Authority in retail financial markets or of the fair trading division of the Office of Fair Trading are good examples (see also the tables linking market failures to regulatory institutions shown above). A similar approach is frequently adopted when the informational asymmetry of concern is between a regulator and one or more of its relevant constituents, with significant importance placed on 'transparency'.

However, the extent to which information disclosure can be expected to address the kind of problems identified above is influenced and complicated by a number of factors. Where significant asymmetries exist, there may be difficulties associated with the less informed parties determining what information could be made available, and would be of use. Furthermore, as was indicated above, where the interests of less informed parties differ from those with better access to information, it may not be the case that relevant forms of information have been generated. These considerations suggest that information flows and, more generally transparency, may often be better thought of as requiring active development rather than simply 'disclosure'.

Even if one sets aside these issues, however, the extent to which information disclosure can be expected to mitigate against regulatory failures depends to a significant extent on the credibility of information flows. Consider the used car sales example referred to above. The underlying asymmetric information problem stems not simply from the fact that the seller holds better information concerning the quality of the car, but also because of the difficulties of credibly disclosing this information given the incentives that the seller may face to increase the buyer's perception of quality and as a result the price they are willing to pay. As noted above, this can have the effect of depressing market activity that is to the detriment of sellers and buyers. In a regulatory context, this could take the form of the ability of a regulator to take welfare enhancing actions being limited as a result of difficulties it faces in credibly demonstrating that its actions do indeed adequately reflect public interest concerns. Thus, welfare enhancing regulatory activity may be depressed as a result of credibility issues.

A typical market response to failures of this kind is the generation of signalling devices that serve to increase credibility in the 'quality' of an underlying good, and/or in the organisation providing that good. Thus, for example, in the used car market sellers may use warranties, and may also invest in ways that seek to develop confidence in their commitment to those warranties, and more generally to 'high quality' cars, over time (advertising and investment in car showrooms have been interpreted in this light). The importance attributed to a 'full service record' can also be understood in terms of signalling. In this case, the generation of the signal is linked to a view of 'good practice' for car owners (servicing at defined regular intervals), and to a network of verification (dealer garages). In this way, the generation of the signal can result in modified behaviour that, in addition to providing a means of information provision, can actually result in an improvement in underlying 'quality'[5].

Whilst the development of this type of response can be expected to be considerably more difficult in relation to RWM issues, the general principle underlying signalling devices is of some relevance.

Where relevant information is complex, and as a result significant expertise may be required to appropriately interpret it – as is the case with many RWM issues - credibility issues are likely to be particularly important. An important consideration here is the available quantity and 'independence' of relevant expertise. This impacts both on the potential for securing a credible second opinion, and more generally, on the extent to which competition in the supply of relevant information can be expected to generate credible information flows.

Beliefs and perceptions

In a number of regulatory situations, informational problems are less to do with obvious asymmetries (which is not to say that asymmetries are unimportant) than with a general lack of information by regulatees and regulators alike. In such circumstances a key first requirement may be to develop an institutional structure and set of incentives conducive to discovery of information on all sides (i.e. it is not just a

[5] In the absence of the signalling mechanism incentives to provide quality were inefficiently low.

question of getting one party to reveal something that is already known, but not shared with others).

This point is important because beliefs (views on the consequences of actions, including the values of costs and benefits, and on the probabilities of consequences) may differ among parties even though they have access to much the same information. That is, beliefs may differ because of differences in perceptions.

Differences in perceptions do not, in and of themselves, give rise to either market or regulatory failure. Rather, they are a potential source of strength on both counts. Where there is consensus in beliefs, there may be muted incentives to discover new information. Where there are differences in beliefs, there will tend to be a greater stimulus to discovery because there will be a form of competition between the various parties.

On the other hand, it is known that there exist systematic biases in risk perceptions. There is a tendency, for example, for the likelihoods of low probability events to be over-estimated, and in some cases for likelihoods of higher probability events to be under-estimated. Publicity for high profile events or possibilities also tends to lead to over-estimation of probabilities: *"Typically the events themselves rather than the frequency statistics are publicized. We learn that a number of people have recently been killed by a tornado, but we are not given a sense of the frequency of these events, other than the fact that coverage of tornado victims occurs much more often than coverage of asthma victims"* (Viscusi, Vernon and Harrington, 1995).

Thus, in focusing on unusual events precisely because they are unusual, media coverage may bias perceptions towards affording them a higher probability of occurrence than is warranted on more objective evidence. Other factors that have been shown to significantly influence perceptions of the seriousness of risks include the potential for catastrophe, time lags associated with the generation of harm, the voluntariness with which the risk is undertaken, and the degree of personal control over the potential extent or probability of damage.

It is also known that there are psychological tendencies to ignore or 'not notice' information that is inconsistent with existing beliefs. In decision theory, this is referred to as "Bayesian conservatism": prior beliefs are afforded more weight relative to new information than is justified by the relevant mathematics. In psychology, there is a parallel literature in terms of self deception, and the process can obviously be reinforced by social factors where groups come to share common beliefs. It can be noted that the potential for Bayesian conservatism, if not addressed, may actually feed into a lack of public trust, and thus further exacerbate the kinds of problems highlighted above.

Biases are also linked to phenomena that involve the blurring of facts/information and values. Where established beliefs are associated with a given pattern of conduct, or with views on particular decisions that are firmly held, those beliefs may, over time, shift in ways that tend to reinforce the conduct or view. For example, if someone has decided that costly action must be taken to mitigate an identified risk (because the value placed on the damages that would occur if the risk eventuated are high), there

can be a tendency for the probability of the event to be exaggerated (strengthening the initial conclusion). In this way, ambiguity and its psychological costs can be reduced.

1.5 Summary: Challenges for regulatory design

It is clear from the above overview that regulatory design in an area such as RWM has to confront a number of very substantial challenges. We have highlighted problems associated with limited information, because we think these are key and provide conditions that are particularly conducive to the emergence of regulatory failures. In particular, we have emphasised problems associated with:

- Informational asymmetries between regulators and the organisations they regulate - may limit the extent to which regulators can achieve defined objectives;
- Informational asymmetries between regulators and those they act on behalf of – can provide conditions to conducive regulatory 'drift' and 'capture', particularly when relevant information is complex and expertise is scarce; may be associated with credibility problems;
- A lack of information in general - conducive to recognised biases in perception of risks.

Given these information conditions, there is a significant danger that factors other than efficiency considerations will be to the fore in driving regulation, and that these factors will give rise to regulatory failure. The interaction of interest group payoffs, the potential for institutional drift and public opinion can be expected to lead to pressures that cannot easily be offset. The main issues that are likely to be of relevance to RWM issues are summarised in Table 1.1 below.

Some of the ways in which potential sources of regulatory failure can be addressed are discussed in section 2, however it is useful here to highlight two high level principles that can be helpful in developing ways forward.

- By definition, actions that increase efficiency have the potential to make all stakeholder groups better off. There is scope, therefore, for ancillary redistributions of resources that mitigate the adverse payoffs to particular groups, consequent on the relevant actions. This is easier said than done, and it does not adequately address future generations issues, but the use of 'compensatory measures' (in a wide sense, and not just including financial compensation) could be developed in the UK to a much greater extent than it is now. In management jargon, there should be at least some attempt to find 'win-win' outcomes.

- In relation to beliefs, perceptions, and public opinion, while the undoubted biases that exist are a source of problems, it can also be recognised that diversity of view is also a potential strength in dealing with difficult and complex issues. Markets function better than central planning precisely because they work with, and thrive on, such diversity, making best use of available information and providing strong incentives for the discovery of new information. The informational properties of markets cannot be replicated in a regulatory context, but policy design can potentially draw on lessons from the ways in which market processes reflect and respond to diversity of views and beliefs.

Table 1.1: Summary of key sources of regulatory failure of relevance to RWM

	Key Issues of relevance to Radioactive Waste Management
Distributional Factors	- Extent of regulatory failure will depend on a range of factors including the strength of interest group pressures, differences in effective leverage, the visibility and concentration of the costs and benefits of alternative courses of action and more generally on the robustness of regulatory and government institutions. - The low visibility and considerable temporal dispersion of effects of many RWM activities indicates that such issues may be prone to regulatory failures as a result of distributional factors, including short-termism.
Opinion	- Heavy publicity given to low probability outcomes, in circumstances when risk assessment is difficult, has been shown to give rise to over-estimation of risks. - New and 'dramatic' information may give rise to excessive volatility of perceptions of risk - If the policy making process responds readily to shifting opinion, this may give rise to knee-jerk reactions that can lead to considerable inefficiencies - Likelihood of knee-jerk reactions greater where there is a low level of trust in institutions
Institutional Factors	- Organisational norms, procedures and cultures may result in 'drift' away from initial objectives. - The closer a regulatory body is to a regulated firm in terms of experience, outlook and class – the smaller the 'relational distance' – and the greater the frequency of contact between regulator and regulatee, the more likely that cooperative arrangements and some form of regulatory capture will result. - This suggests that radioactive waste management arrangements are likely to be prone to the development of shared understandings between the expert communities (within both regulatory and regulated bodies) that may drift away from legislative objectives and more general public interest considerations.

Section 2
Addressing Regulatory Failure: Regulatory Roles and Structures

2.1 Introduction

In section 1, we presented some mappings between different types of market failure and regulatory institutions charged with addressing them, in both the US and UK. It is apparent that there are significant differences among the relevant institutions in the ways in which they operate and interact with market participants and other public bodies. These variations result in part from differences in the nature of the underlying problems that require to be addressed. They also arise, however, from differences in the *means* chosen to tackle the problems.

On close analysis, the term 'regulation' embraces a range of activities. Thus, major regulatory bodies, such as the Environment Agency or Ofgem, can be viewed as multi-activity organisations (in effect, they encompass a range of different 'businesses'). Each activity may require specific skills and, to be most effective, a particular organisational style or culture. The questions of how best to conduct each activity, and of how best then to co-ordinate the various activities, are therefore fundamental to good regulatory design.

As indicated by the discussion in the previous section, in complex cases such as RWM, it is unlikely that questions of regulatory design can be quickly and simply answered in a robust manner. A central argument in this report is that in considering questions of regulatory design, there are significant benefits in taking account of those influences that can be expected to result in regulatory failures. In this section, we consider first, a range of 'stylized' regulatory roles, and then a range of 'ideal types' or models of regulatory arrangements, in order to identify ways in which these roles and arrangements are likely to be susceptible to, or provide for robustness against, regulatory failures. Although each is highly simplified, they nevertheless provide a framework for further discussion of possible ways forward in regard to RWM issues, and provide a basis to highlight those regulatory activities and structures that are likely to most adequately address the significant potential for regulatory failure that has been identified.

2.2 What do regulators do?

Before exploring ‘ideal types’ of regulatory structures, it is necessary first to be more explicit about some of the activities or roles that are covered by the term ‘regulation’. Some of the most important are set out below, and, as should be clear from the discussion, there can be overlaps and linkages among these activities.

Take major economic or strategic decisions

This is an executive activity. By and large, the drift of public policy has been away from decision making by regulation, and toward decision making by market participants. The shift is most vividly illustrated by utility privatisation, a process in

which major decisions (e.g. investment) were unbundled from other aspects of regulation. Decision making authority was transferred to the private sector, whilst much of the 'non-executive' regulation was moved from government departments to sectoral agencies (Oftel, Ofgas, Ofwat, etc.). Previously, executive activities had been bundled with other aspects of regulation in public corporations.

It is, however, sometimes appropriate for resource allocation decisions to be made by regulation. In allocating rights to use parts of the radio-spectrum, the UK government relied on an auction process to determine the outcome. However, the prior (highly important) decisions concerning the quantity of spectrum sold and the number of licences issued (i.e. how the available quantity is divided) were regulatory decisions.

Make rules

Rulemaking is a legislative activity, and may be delegated to regulators by a political legislature such as Parliament in the UK or Congress in the US. The establishment of rules can be viewed as a form of *ex ante* intervention in markets, in which the intention is to eliminate certain forms of unwanted conduct, by defining and prohibiting them in advance.

Rulemaking is also a characteristic of certain types of self-regulation: a professional or industry body may have a rule book to which its members are required to comply. Sanctions for non compliance with the rules will, of course, be rather different according to whether the relevant powers are or are not statutory, and this will be one of the factors that influences the choice between statutory and non-statutory approaches.

In Britain, one of the most familiar types of rule making occurs in licensing regimes. Statute may require that a licence is needed to undertake a specified activity and that the licence is issued by a designated regulatory agency. The agency is frequently given powers to modify licences, subject to appeal, which is a form of rule making. If all relevant licences are constrained to be identical, the regulator can, in effect, make "market" rules. If licences can differ as between different types of organisation, then the rulemaking powers will allow the regulator to "micro-manage" market conduct to a greater degree. An example of the latter is provided by telecoms licences: BT licence, which sets rules governing its conduct, is different from that of other operators. Similarly, policy at both the UK and EC level, places great stress on the proposition that companies with significant market power should be constrained by more stringent licence conditions than firms without such market power.

Set standards

Standard setting is another of the major types of regulatory activity. Standards may be very general in nature, or may be much more specific, and may be determined by government agencies or by self-regulation.

An example of a general standard is the prohibition of anti-competitive behaviour contained in competition law. No precise definition of anti-competitive behaviour is set out, and a practice such as price discrimination may be held to be pro-competitive in one context and anti-competitive in another context. Rather, the legislation relies

on the specification of a very broad standard of behaviour – conduct should not be anti-competitive – which is then given greater precision, *ex post*, through decisions reached in particular cases (case law). The competition authorities are the institutions given responsibility for determining whether or not the standard has been breached (a form of adjudication), and therefore for providing this greater precision.

The creation of more specific standards typically involves the establishment of greater precision at the outset (*ex ante*). For example, a minimum level of some measurable quality, or a particular way of doing things (such as use of a particular technology) may be specified. The greater the precision, the closer a standard becomes to a rule. Indeed, standards and rules can be regarded as ranges within a single continuum.

Monitor and enforce compliance with rules and standards

Monitoring and enforcement of given rules and standards are, in terms of resources allocated, major activities for many regulatory institutions. In a wide range of circumstances they are distinct from the activities of making rules and setting standards. Although it is good regulatory practice for monitoring and compliance issues to be considered when rules or standards are set, in such circumstances it is not necessary for these distinct activities to be entrusted to the same organisation (although, in practice, they frequently are).

There are, however, also circumstances where monitoring and enforcement are not clearly distinguishable from standard setting. As discussed in the previous sub-section, a standard of conduct that is specified in very general terms may only gain precision when it comes to be enforced, since it is only then that the boundary between acceptable and unacceptable conduct comes to be defined. There is then no clear distinction between setting and enforcing the standard.

Advise and inform

The provision of advice and information to government, customers and industry is an important aspect of the work of many regulatory agencies, not just those established with these activities specifically in mind. Advice to industry may include more formal processes such as the publication of guidance as well as more informal communication. Where government generally acts on the advice of a particular agency, the distinction between advice and other regulatory activities tends to break down. For example, successive governments have, much more often than not, acted on the advice of the Competition Commission in relation to merger decisions.

Adjudicate

Adjudication is a quasi-judicial activity, and it can take many forms. For example:

- Mergers policy is, at root, an exercise in adjudication. In the UK, a proposed acquisition or amalgamation is referred to the Competition Commission, which is then required, under current law, to recommend whether the transaction should be allowed to proceed, with the Secretary of State for Trade and Industry making the final decision (which, in most cases, is to accept the Competition Commission's

recommendation). Under EC law, the decision rests with the European Commission, subject to appeal, and there are proposals to shift the UK arrangements in this direction.

Merger policy is interesting, however, in that the CC can make recommendations that a merger should be allowed to proceed if certain "remedial" actions are taken, such as divestiture of some businesses or parts of businesses. To the extent that the CC is active in developing remedies, its conduct is shifted somewhat to that of a decision maker. Thus, there have been criticisms of both the CC and European Commission to the effect that mergers policy, which is chiefly intended to be a component of competition policy, has tended to take on some of the characteristics of industrial policy, as when a merger that would lead toward duopoly is subject to conditions that, in effect, are intended to create a "third force" in the market.

- Certain forms of utility regulation are adjudicatory in nature. When Oftel was established, it was required to promote not only the interests of consumers and competition, but also, among other things, research and development and the international competitiveness of UK firms supply telecoms services and equipment. The underlying notion was that the regulator should "balance off" or adjudicate between consumer and producer interests.

  More generally, it can be argued that a regulator governed by public interest duties (such as the Competition Commission – see above) will be heavily involved in adjudication, since decisions will need to take account of the impact of particular outcomes on each of a set of different interest groups. Price review decisions taken by utility regulators may also take this form, as when regulator receives submissions from the various interest groups, including consumers, and then strikes a balance between them in setting prices. US utility regulation has often been viewed in this way. It can be noted that, once the adjudication is made, the outcome is implemented in the form of a rule (in the UK, a modified licence condition). The rule is the means of achieving the desired outcome.

- In the UK energy sector, Ofgem has powers to accept or reject proposed modifications of codes governing conduct in relation to the use of networks and to the short-term balancing of supply and demand. In theory, this is a form of adjudication, in that the actual proposals to change rules are made by other parties. In practice, however, the process shades in to the types of rulemaking to be found in the US: since the interests of different parties frequently come in to conflict, there tends to be a steady stream of proposed modifications, which differ in their effects as a result of the differences in interests. By selecting among the available alternatives, the regulator may be able to achieve outcomes close to those that would have occurred if simple rulemaking authority had been granted to the agency.

- Where a public institution acts as an appeals body in respect of decisions made by some other agency, it will act in adjudicatory mode. The Competition Commission serves this function, both in relation to disputed licence conditions proposed by utility regulators and in relation to decisions of the Office of Fair

Trading. The Secretary of State serves this function in relation to a range of planning and environmental discharge decisions.

Represent, bargain and negotiate

When markets fail, it is frequently possible to identify groups who suffer most. For example: when there is monopoly customers tend to be hit hardest; environmental pollution may adversely affect specific localities or future generations; asymmetric information in financial markets may disadvantage customers. Regulators may, therefore, seek to "represent" these interests and to bargain or negotiate on their behalf.

This regulatory activity is illustrated by developments in utility sectors. Over the years since utility privatisation, there has been a gradual shift in the implied role of industry regulators, away from that of an adjudicator among the claims of different interest groups and toward that of an institution whose primary duties lie to a particular interest group, consumers. For the energy sector, this shift is formally encapsulated in the Utilities Act 2000.

There is a certain underlying logic in this shift. Sectoral regulation was established because of a mismatch of economic power between the demand side of markets (large numbers of relatively small customers) and the supply side (monopolised). Thus, rather than adjudicating between customers and suppliers, the regulator may act as the representative of consumers, by, in effect, acting on their behalf.

This is not to say that the interests of producers will, under this approach, be neglected. If the regulator acted in ways that damaged investment or incentives for quality, for example by setting price controls that were too stringent, consumers would suffer in the longer term. However, these supply side considerations are secondary, in the sense that they act as constraints on regulatory actions, rather than as ends in themselves.

This representational function of regulation is much more apparent in the UK than in the US, in that regulators have tended to describe themselves as consumer watchdogs or consumer champions. Rather than the semi-judicial rate hearings of the US, much of the day-to-day activity of the regulatory agencies is concerned with interactions with the regulated firms. In effect, the regulator *bargains* with firms on behalf of customers.

There is, however, now a fundamental tension in the development of utility regulation in the UK energy and communications sectors (there is much less of an issue in water), comparable to the tension in US Regulatory Commission identified by Spulber (see above). Deregulation of retail markets means that the rationale for the bargaining approach – with Ofgem and Oftel acting as consumer watchdogs for millions of small customers – is disappearing in these parts of the relevant sectors. At least at the retail level, these bodies should increasingly be acting as competition authorities rather than as bargainers (although the rationale for the bargaining approach continues in relation to the supply of transportation networks, at least in energy).

Policy developments have reflected this shift in so far as it is specified that the protection of consumers should be achieved via the promotion of competition, where this is feasible. Sectoral regulators have also been given concurrent powers, alongside the Director General of Fair Trading, in relation to the application of the Competition Act in their sectors. The result of these conflicting trends is that nowadays sectoral regulators are required to undertake a mix of activities that differ quite considerably in relation to the skills required and to the institutional cultures that are most effective.

Disturbing unsatisfactory equilibria ('prodding')

The purpose of all regulation is to influence behaviour and, in a broad sense, its aim is to undermine market outcomes that are judged unsatisfactory for one reason or another. In most cases, the public policy intervention will be made with a view to achieving perceived, alternative outcomes. Thus, a regulator might specify the maximum prices that can be set by a monopoly, or some environmental standard that must be reached.

On the other hand, there can be cases where intervention is less clear about the end that it has in mind. A dominant firm may be prohibited from engaging in undue price discrimination, but the competition law decision in such a case is unlikely to be very prescriptive as to how the firm should in fact set prices. That is, a particular equilibrium is declared unacceptable, and is consequently disturbed, but the competition authorities do not typically seek to specify the equilibrium that should replace it.

The relative lack of prescription in competition policy is closely related to the view that competition is a *process*, rather than a defined state of the world, and that the aim is to improve this process rather than to achieve particular outcomes (although the focus on process may be driven by beliefs that improvements in process will lead on to favourable outcomes, such as consumer benefits in the case of competition).

Similar approaches and activities can be detected in other situations where regulators are pro-active in seeking to reform arrangements/processes that are viewed as leading to unsatisfactory outcomes (whilst being non-prescriptive as to what improved outcomes may look like). Thus, regulators may act as "prodders", raising awkward questions, funding alternative research, and encouraging market participants to think about different ways of going about their business. There can be tendencies for industries to develop consensus views on how things can be done since, particularly in conditions of uncertainty, such consensus can serve a variety of functions, including providing psychological comfort and facilitating co-ordination among different individuals and groups. There is also a tendency, discussed earlier, for beliefs to be influenced by interests, such that evidence that is inconsistent with interests and existing beliefs may be prone to neglect. By breaking, or at least challenging, these patterns, regulators may stimulate a process of search that, over time, leads to the discovery of superior outcomes.

Formatting information flows

Regulators may seek to 'format' information flows, actively seeking to generate new forms of transparency, representation and accountability (Ofwat has been particularly

active in this area). This may include requiring certain market participants to produce various types of information in specified forms and efforts more generally to make activities more easily 'auditable' by regulators and/or third parties. Formatting activities may also include attempts to better specify relationships and information flows with other regulators or with government. Formatting activity can change the information conditions against which views are formed and decisions are made, and can be understood as designed to improve the economic process, rather than to achieve any particular outcome.

2.3 'Ideal types' of regulatory structure

The institutional structures of regulation are often highly complex. New policy issues emerge continuously over time, and institutional structures tend to evolve in order to accommodate required responses. Where, however, institutions rely on statute, opportunities for substantial institutional change may occur only periodically, being constrained by legislative capacity and timetables. As a result, new responsibilities and powers are often grafted on to existing institutions, even where the latter may have been established for quite different purposes. In addition, flexibility in the interpretation of their duties may allow established institutions to change shape, even in the absence of legislation.

These points are illustrated by the development of many of the main regulatory institutions in the UK. Thus, the Monopolies Commission was initially established with a relatively modest remit a little over fifty years ago. Subsequently its powers and duties have been broadened in a step by step process that has spanned the decades since. Among the areas of activity added have been: complex monopoly, mergers, efficiency audits of nationalised industries, adjudicating on disputed utility licence modifications, and appeals against decisions of the OFT. Some of these were natural extensions of the Commission's competition policy work (e.g. mergers). Others (efficiency audits, utility licence modifications) were not, and emerged simply because the Commission was a convenient, existing institution to which the new activities could be attached.

Behind the complexity of actual institutions, however, lie a number of 'models' or 'ideal types' of regulatory institution. These models can be of interest when major structural reforms are in contemplation, since more radical reform affords opportunities to 'tidy up' regulatory structures, by establishing a clearer allocation of regulatory activities that more effectively addresses the issues and problems that public policy has identified. We therefore now briefly outline a number of these models, with a view to considering their possible relevance to approaches to the regulation of RWM.

Departmental regulation

Much regulation is handled directly by Government departments, and this arrangement can be considered to lie at one end of a spectrum of possibilities defined by ***the degree of integration*** of regulation with day-to-day political activities. Departmental regulation implies a high degree of integration, although there is some limited scope for variation in the organisational arrangements. For example, specific

regulatory functions may be hived off into particular units, or advisory bodies and committees may be appointed.

Whatever the precise arrangements, regulatory activity is almost inevitably politicised. In practice, what this means is that extraneous political agendas are likely to intrude into the regulatory process. Regulatory outcomes can, therefore, be particularly sensitive to shifts in the political influence of interest groups and to shifts in public opinion. Where there are difficult and complex issues to resolve, the credibility of policy and confidence in the regulatory process are likely to be low.

The public corporation

The public corporation represents a step towards the separation or unbundling of regulation from day-to-day political activity, but an integration of regulation with commercial decision making. In blueprint form, the directors were expected to act as "high custodians of the public interest", implying that public policy objectives were not at all closely defined. More specifically, although many public corporations are often linked with industries with 'naturally monopolistic' or 'network' elements (communications, energy, transport, water), their remits are by no means limited to the correction of the relevant market failures. This is perhaps most transparent in the pre-privatisation Water Authorities, many of whose responsibilities were subsequently transferred to the Environment Agency.

In practice, in the UK the intended separation of the regulatory and commercial functions of public corporations from short-term political influences was constantly subject to erosion. In part this may have been due to the lack of clarity in objectives, but the main factor is most likely to have been the commercial dependence of the corporations on the public finances. Whatever the precise causes, public corporations came to suffer from similar weaknesses to those of departmental regulation.

Sectoral regulators

The pure sectoral regulator model is characterised by the delegation of all regulatory issues in a particular sector to a single, ‘independent’ regulatory agency. Commercial decision making and regulation are unbundled, and both are de-politicised in comparison with the public corporation type of arrangement. The proposed establishment of a single authority (Ofcom) to handle most regulatory issues in electronic communications (telecoms and broadcasting) is a near approximation to this approach.

The model can be varied somewhat according to the precise extent of the independence granted to the authority and the lines of accountability that are established. Thus, some (politically sensitive) decisions may be reserved for the supervising ministry, and the authority may be accountable to the ministry, to parliament, to the judicial process, or to some mix of these, depending upon the precise activity involved. Alternatively, politicians may seek to influence the conduct of the authority by retaining the power to give guidance on issues of public importance.

The partial de-politicisation of regulation reduces the influence of distributional (interest group) pressures on decisions, and therefore tends to reduce the risk of extensive regulatory failure on this count. On the other hand, the bundling of a potentially wide range of disparate regulatory activities within in a single organisation (activity bundling) may, by reducing focus and transparency in relation to the resolution of relevant trade offs, render regulation less effective. Accountability and monitoring of regulatory performance are also more difficult when a single organisation is asked to pursue a range of potentially conflicting aims. The Ofcom proposals have been criticised by some commentators on this basis.

Focused regulators

Whereas the pure form of sectoral regulation bundles a range of potentially disparate public policy objectives and defines jurisdictional limits in terms of industries and markets, focused regulators have a more limited set of objectives, often defined by a particular type of market failure. Jurisdictions are not necessarily defined by industry or market boundaries, although in some cases they may be. As in the case of sectoral regulation, there is separation of regulatory tasks from commercial decision making.

Examples of this type of structure abound, and they include:

- The Environment Agency, which is concerned with a variety of externality problems across the economy. Similarly, the Health and Safety Executive focuses on health and safety issues.
- The competition authorities (OFT and Competition Commission), which focus on market failures associated with monopoly power across the economy.
- Ofgem, Oftel and Ofwat, which, in their original forms, were chiefly focused on the extreme monopoly issues to be found in the relevant sectors

The constraints imposed by narrower sets of duties tend to make these types of organisations somewhat less vulnerable to regulatory failures arising from distributional (interest group) pressures and swings in public opinion. Narrower duties also tend to reduce the incentives for political interference, and hence help to sustain independence. This in turn helps underpin the credibility of the organisations concerned.

These are, however, matters of degree, and recent tendencies to extend the range of duties of agencies such as Ofgem (in the Utilities Act) and Oftel (in the proposals to replace it with Ofcom, which will become responsible for activities currently undertaken by broadcasting authorities such as the ITC) indicate that the stability of focused arrangements cannot be taken for granted.

Self regulation

Self regulation can be viewed as the structural form that achieves the greatest degree of separation of regulatory activities from the political process. On the other hand, compared with sectoral or focused arrangements, it represents a move back to the integration/bundling of regulation with commercial decision making.

The main advantage of self regulation is flexibility. As market conditions change, the ability of regulatory arrangements to adapt efficiently is not constrained by the time lags and barriers to change that characterise structures that rely upon statutory underpinnings. The main disadvantage is the vulnerability to interest group capture. Precisely because regulatory activities are undertaken by organisations with commercial interests, commercial agendas may intrude into regulatory agendas. Since this danger is so transparent, self regulatory bodies may have difficulties in establishing credibility and public confidence.

2.4 Discussion

Highlighting a range of stylised regulatory roles and structures provides a useful framework for considering how potential regulatory failures might be addressed. A number of the points made in relation to structure can be summarised in a matrix linking the structure of regulation to the degree of separation/bundling of particular regulatory activities from: (a) the political process, (b) commercial decision making, and (c) other types of regulatory activity. This is illustrated below:

Regulatory Structures: Summary Matrix

	Separation from:		
Type:	*Political Process*	*Commerce*	*Other regulation*
Departmental	No	Yes	No
Public corporation	Limited	No	No
Sectoral Regulator	Yes	Yes	No
Focused Regulator	Yes	Yes	Yes
Self regulation	Yes	No	Optional

The matrix emphasises the potential for addressing regulatory failures by seeking to 'insulate' decision-making from particular sources of influence by means of separation or unbundling. Thus, one response to concerns of unwanted political influence (whether as a result of pressures from public opinion or particular interests) is to seek to 'insulate' relevant decision-making from these pressures. Sectoral regulators, focused regulators and self-regulation are likely to provide a greater degree of separation from direct political influence than either departmental regulation or public corporations.

Similarly, one response to the potential for regulatory failures associated with the redistribution of resources in favour of commercial interests, is to generate an institutional structure that has a relatively high degree of separation between regulatory and commercial decision making. Public corporations and self regulation are likely to perform poorly in this respect relative to departmental, sectoral or focused regulation.

Since independent regulators – whether focused or sectoral – provide a relatively high degree of separation from both the political process and commercial decision making, the use of such institutions can provide a structural way of seeking to address concerns of unwanted influences and associated regulatory failures. However, the extent to which this will be likely to actually provide 'insulation' from unwanted

effects will depend on a number of related factors including the magnitude and visibility of the impact of relevant decisions, the degree of public trust and legitimacy that these institutions enjoy, and their susceptibility to distributional influences and regulatory 'drift' or 'capture'.

A second form of structural response to potential regulatory failures is to seek to recognise the underlying tensions and trade-offs in explicit ways within decision-making processes. For example, arrangements can seek to bring 'public opinion' and other pressures within the decision making process in a more formal and ongoing manner, and thus provide a clear forum for a wide representation of views. This approach recognises that whilst the undoubted biases in public opinion that exist are a source of problems, diversity of view is also a potential strength in dealing with difficult and complex issues. It can be noted that markets function better than central planning precisely because they work with, and thrive on, such diversity, making best use of available information and providing strong incentives for the discovery of new information.

Following such an approach, relevant tensions may also be directly addressed through the design of regulatory objectives. In particular, as was argued above, when markets fail it is frequently possible to identify groups who suffer most, such as future generations. Regulators may seek to "represent" these interests and bargain or negotiate on their behalf (for example, regulators as consumer champions) as a means of addressing what would otherwise be a mismatch in economic/political power. This approach can be underpinned by primary legislative duties to a particular interest group (eg Utilities Act duties on Ofgem to protect consumers).

Where regulators act as 'advocates' in this way, emphasising particular dimensions of relevant trade-offs, it is important that there is a clear adjudicator between competing views in cases of dispute. Indeed, it can be noted that the existence of a credible adjudicator is an important factor in enabling regulators to 'represent' particular groups in this way.

The role of an adjudicator highlights the way in which addressing the potential for regulatory failures through on the one hand seeking to separate decisions from political and commercial pressures and on the other seeking to develop the involvement and representation of different interests in decision making processes can be complementary approaches. That is, an adjudicator can provide a open forum within which representations are made, including by other regulators acting as advocates. Thus, some regulatory activity may be geared towards highlighting and better articulating aspects of relevant trade-offs that may otherwise be under-represented, whilst other regulatory activity is geared towards determining how appropriate trade-offs should be balanced in a context that is 'insulated' from direct political and commercial involvement.

Institutional problems, such as those related to relational closeness of regulators and those they regulate, raise a different set of challenges. We have highlighted the ways that institutions be developed to ensure that processes are 'prodded' or 'disturbed' in order to counteract problematic tendencies. As described above this may include activities such as raising awkward questions, funding alternative research/reviews and more generally encouraging market participants to think about different approaches.

In addition to this, we have highlighted the fact that regulators may actively seek to generate new forms of transparency, representation and accountability, which may include efforts to make activities more easily 'auditable' by the regulator and/or by third parties. Such activity can change the information conditions against which views are formed and decisions are made, as well as more generally enhancing credibility.

Section 3
The Current RWM Regulatory Regime

3.1 Introduction

In this section we assess the extent to which the current institutional arrangements for radioactive waste management can be expected to adequately address the various 'challenges' that have been identified. In order to do this, it is first necessary to be more explicit about the manner in, and extent to, which various regulatory failures can be expected to impact on the various activities that constitute RWM. As was indicated earlier, a particularly important consideration here is the information conditions that characterise particular activities - including the complexity of relevant information – and how these conditions interact with the incentives faced by different parties. The current institutional arrangements can then be evaluated in the light of information conditions, incentives and expected sources of 'failure'.

3.2 Key Sources of Regulatory Failure in RWM

Physical Problems

The underlying *physical* problems of concern in RWM arise from the potential harm that may result from the decay of radioactive substances over what can be thousands or in some cases millions of years. The potential for some form of catastrophic nuclear incident raises particularly serious concerns.

Economic Problems

The primary *economic* problem of concern relates to the potential for significant inefficiencies to arise, as a result of 'market failure', in the absence of some form of regulatory intervention. In particular, the actions of parties engaged in waste management may significantly affect the welfare of other parties in ways that are not mediated by a market and are uncompensated - this is most obviously, and significantly, the case in relation to future generations. Given these 'external' effects, those engaged in waste management can be expected to face 'private' incentives to provide a level of quality/safety that is 'too low' in social terms (that is, when all effects are taken into account), and thus avoid the costs of higher quality/safety. It can be noted that this incentive problem can be expected to arise in relation to all aspects of waste management where cost/quality trade-offs are important including the generation, design and choice of strategic options and operational decisions concerning the materials and methods used in conditioning and packaging processes.

The importance of these incentives for cost reduction is likely to be dulled by the fact that much waste management activity is conducted by publicly owned organisations (although greater private sector involvement could be expected to 'sharpen' incentives). However, the incentive effects of externality problems can manifest themselves in a variety of ways. For example, particular types of project may be more desirable to employees when considered in terms of future career prospects. It can be noted that the current block on the development of new nuclear power stations in the absence of a 'solution' in relation to waste issues, creates an incentive on those with significant professional investment in the industry to find such a solution. This

factor may impact on attitudes towards different approaches to waste management, making those that promise 'problem closure' more attractive.

Regulatory Problems

In this report we are primarily concerned with the key *regulatory* problems that are likely to be faced in seeking to address market failure. One important factor that was highlighted in section x is the extent to which a regulatory body can adequately monitor the behavior of those engaged in waste management activities: that is, the importance of asymmetries of information between a regulator and the companies that it regulates. As we indicated in section 1.4, in our view the importance of this kind of informational asymmetry is often over-stated relative to other information problems. For example, in RWM activities regulators can scrutinise the activities of those they regulate in a range of comprehensive ways including physical inspection, auditing of records and procedures, unpacking a sample of materials for detailed testing, and so on.

An important related source of concern here, however, is the potential for asymmetries in expertise, given the complexities of some of the activities involved in RWM. It will be important, therefore, that any institution charged with regulating RWM activities has access to sufficient levels of expertise to address this potential for asymmetry and its associated problems. However, the importance of expertise generates a additional source of informational asymmetry that may cause concern, that is, an asymmetry between those with relevant expertise (whether within a regulatory body or not) and those without it, which most importantly includes those that the regulatory authority will be expected to act on behalf of.

In section 1 above, we highlighted two influences (that have been found to be important in explaining a wide range of regulatory developments in empirical studies) that are likely to be important in this context, and mutually reinforcing: distributional and institutional factors. The problematic incentives that the existence of significant externalities has been shown to generate, are not only a source of 'failure' in the absence of regulation – that is, a source of market failure - but can also be expected to gives rise to pressures to influence the behavior of regulatory institutions put in place to address this market failure. The susceptibility of regulation to distributional pressures is well documented, and in its extreme form may give rise to *regulatory capture.*

With RWM matters, this potential for the impact of distributional factors is likely to be reinforced by the 'relational closeness' of experts within regulatory authorities and regulated companies. In particular, factors such as the relatively small size of the relevant expert community, the background of secrecy within the industry, and the low level of public trust, are likely to contribute to concerns that experts within the relevant regulatory authorities are 'closer' to those they are regulating than those they are supposed to be acting on behalf of.

As noted above, the potential for this kind of failure can be understood as related to the existence of a significant informational asymmetry between experts involved in RWM activities and those affected by their actions, however, it is also significantly exacerbated by conditions of uncertainty more generally. As previously discussed,

the general level of uncertainty associated with RWM activities raises particular difficulties associated with swings and biases in public opinion that are likely to make overcoming low public trust in a robust manner particularly difficult, and as a result leave RWM issues susceptible to political intervention.

Having said this, not all aspects of RWM are likely to be equally susceptible to regulatory failures. In particular, it is in relation to the medium and long term effects of waste management activities that the potential for regulatory failures is likely to be at its greatest, given the extent of uncertainties and complexities (and related importance of expertise) when dealing with longer time scales, and the low visibility and considerable temporal dispersion that may be associated. Given this, we concentrate in what follows on regulatory issues associated with the following two broadly defined sets of activities:

- long term strategy(ies) for RWM (for example, long term storage/disposal decisions)
- the implications of this long term view for short term operational approaches (for example, the compatibility of conditioning and packaging decisions)

We now turn to consider the current institutional arrangements in the context of these remarks.

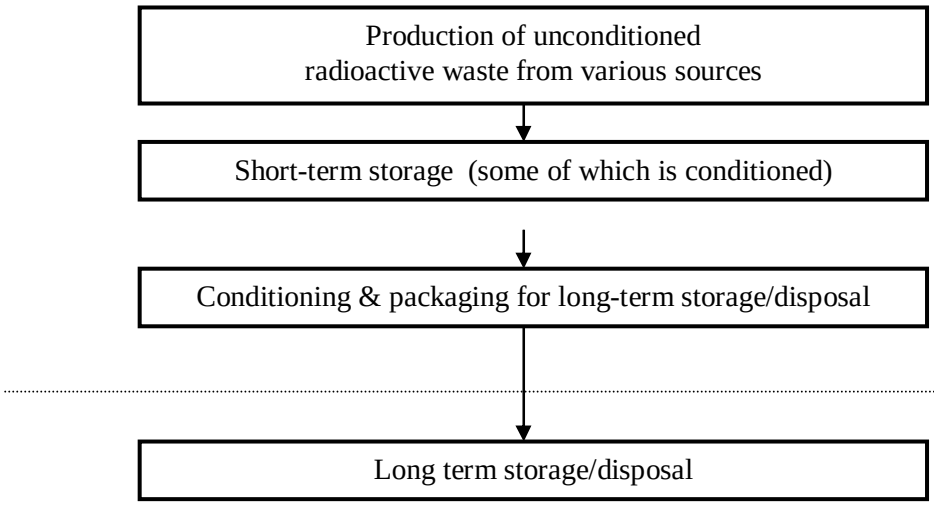
3.3 The Radioactive Waste Storage/Disposal Process & Current Inventory

The radioactive waste considered in this report is the result of a number of different activities and processes, each of which generates a different type and composition of radioactive waste, which has implications for the type of storage/disposal facilities that are required. The primary sources of radioactive waste in the UK are nuclear power generation; defence and other sources such as the waste that results from hospitals and research. Broadly, these processes result in three different types of solid radioactive waste, which are classified in the UK as follows:

- *High level waste (HLW):* which is highly radioactive and heat generating and is primarily generated from the reprocessing of spent nuclear fuel.
- *Intermediate level waste (ILW):* which has an 'intermediate' level of radioactivity and is sourced from decommissioned nuclear power facilities, medicine, research and the military.
- *Low level waste (LLW):* which is classified as being 'slightly' radioactive and results from the operation and decommissioning of nuclear facilities.

One of the major differences between the different classifications of radioactive waste, apart from the degree of radioactivity, is the time in which this waste will need to be adequately stored away from any potential exposure to humans – estimates of which range from between 50 years to thousands of years. Chart 3.1 below provides a highly simplified account of the basic steps involved in radioactive waste management.

Chart 3.1 The process of radioactive waste conditioning and disposal



Current inventory of radioactive waste

The most recent inventory of the stocks of radioactive waste in the UK was undertaken in 1998, and the total volume of wastes in store at that time was recorded as 80,740 cubic metres, with a total estimated radioactivity level estimated at 50,000,000 TBq*6. The composition of this waste, and estimated radioactivity levels are shown in table 3.1 below.

Solid Radioctive Waste Inventory as at April 1998 **Table 3.1**

	Total Waste (m^3)	% of Total Waste	Radioactivity (TBq)
High Level Waste			
- Conditioned Waste	234	0.29%	
- Unconditioned Waste	1,566	1.94%	
Total HLW	1,800	2.23%	44,000,000
Intermediate Level Waste			
- Conditioned Waste	8,326	10.31%	
- Unconditioned Waste	62,624	77.57%	
Total ILW	70,950	87.89%	4,900,000
Low Level Waste			
- Conditioned/Unconditioned Waste	7,980	9.88%	9
Total Radioactive Waste	**80,730**	**100%**	**48,900,009**

1. This is based on an estimate provided by Nirex of total ILW
Source: Radioactiove wastes in the UK: A summary of the 1998 Inventory, Nirex July 1999

[6] TBq is equivalent to 1 million million becquerels. A becquerel is the basic unit of radioactivity.

3.4 Current Statutory and Institutional Arrangements for RWM

The current statutory and institutional arrangements that regulate the production, transportation, conditioning, and storage/disposal of radioactive substances in the UK are discussed briefly below. Appendix 1 to this report provides more detail regarding the international treaties and legislative framework which apply to the management of radioactive waste, as well as discussing the legislative mandate, structure and operational responsibilities of each of the institutions that are involved in the RWM process in greater detail.

International treaties and conventions

The UK is a member of the two principal international organisations with an interest in radioactive substances which are the OECD Nuclear Energy Agency (NEA) and the United Nations International Atomic Energy Agency (IAEA).

The standards and principles established by international organisations such as the IAEA and the NEA have resulted in a certain standardisation of the rules and regulations governing the design, operation and maintenance of nuclear installations in the UK, and elsewhere in the world. In 1998 the UK was a signatory to the OSPAR (Commission for the Protection of the Marine Environment of the North-East Atlantic) Strategy which relates to discharges of radioactive substances in the marine environment

At the European level, the UK is bound by legislation set down under the Euratom Treaty relating to radioactive substances. The Euratom Treaty does not however include any specific requirements regarding radioactive waste storage or disposal facilities, which remain the responsibility of individual EU Member States.
There are, however, four principal EC Council Directives/Regulations which come under the general legislative framework of the Euratom Treaty and apply in relation to the nuclear sector and radioactive substances and are binding on the UK and other member states.

Primary UK Legislation in relation to Radioactive Activities

There are five pieces of primary legislation that govern the radioactive waste sector in the UK. Each article of legislation has been enacted with a specific focus, with two relating primarily to environmental issues (Radioactive Waste Substances Act (1993) and Environment Agency Act (1995)) and three with a predominantly safety focus (Health and Safety at Work Act (1974); Nuclear Installations Act 1965 (as amended) and Ionising Radiations Regulations 1999).

Each Act introduces specific regulations and procedures to address its specific focus, and empowers a particular regulatory body to regulate and supervise the radioactive waste sector toward this end. The roles and responsibilities of each of the institutions charged with regulating one or more of the activities involved in management of radioactive waste management under each of these Acts are discussed briefly below.

Roles of relevant institutions

The Department of Trade & Industry

The Department of Trade & Industry (DTI) is involved in the development and implementation of civil nuclear policy. The DTI's Nuclear Industries Directorate role in the nuclear sector is a varied one, encompassing industry ownership and supervision, and regulatory activities to protect the public and international safety and technical assistance.

The Department for Environment, Food & Rural Affairs

The overall departmental responsibility for radioactive waste management lies with the Department of Environment, Food & Rural Affairs (DEFRA) in England and with the devolved administrations. The Radioactive Substances Division (RAS) within DEFRA is responsible for DEFRA's environment interests in nuclear and radioactive matters encompassing radioactive waste management policy and legislation; environmental radioactivity, including radioactive discharges, contaminated land and radon in the home; response to overseas radiological emergencies; and research.

Radioactive Waste Management Advisory Committee

The Radioactive Waste Management Advisory Committee (RWMAC) provides advice to Ministers, and DEFRA, on the major technical and environmental implications concerning the development and implementation of an overall policy for all aspects of the management of civil radioactive waste. The programme of work of the RWMAC is typically commissioned by Ministers, however, the RWMAC also responds to consultations on relevant issues.

Health & Safety Commission

The Health & Safety Commission (HSC) has overall statutory responsibility for ensuring that there is an adequate framework for regulation of safety at nuclear sites in the UK, and is responsible for advising the Secretary of State on policy and operational safety matters relating to the nuclear industry. The HSC is in turn advised by the Nuclear Safety Advisory Committee (NuSAC).

Nuclear Safety Advisory Committee (NuSAC)

The Nuclear Safety Advisory Committee (NuSAC) is responsible for advising the HSC, and when appropriate the Secretary of State, on major issues affecting the safety of nuclear installations and to advise the HSC on the adequacy and balance of its nuclear safety research programme, specifically in the areas of the design, siting, operation, maintenance and decommissioning of nuclear sites.

NuSAC comprises an independent Chairman and up to 20 other members. Of these, four members are nominated by the TUC, four by the CBI and the remaining 12 are independent.

Health & Safety Executive Nuclear Safety Directorate and HM Nuclear Installations Inspectorate

The HSE's Nuclear Safety Directorate (NSD) is responsible for issuing nuclear site licences and day-to-day regulation for radioactive sites in the UK. NSD seeks to keep up and improve safety standards at licensed nuclear installations through its licensing powers and by assessing safety cases and inspecting sites for licence compliance.

The operational arm of the NSD is HM Nuclear Installations Inspectorate (NII) which is responsible for administering nuclear site licences on the part of the HSE. A dedicated NII site inspector with full powers under the relevant legislation and is typically on site at each licensed nuclear facility. Since 1997, the NII is also responsible for the supervision of sites operated by the Ministry of Defence. NII site inspectors aim to identify those areas which are critical to safety and where it may wish to become more closely involved. The NII can require a licensee to change organisational structure if it feels that a site licence condition is unlikely to be met.

The NII also prepares a review of each nuclear operator's overall decommissioning strategy every five years, known as quinquennial reviews. These reviews are undertaken to ensure that the arrangements in place for decommissioning nuclear power stations are adequate and in line with Government policy.

The Environment Agency

The Environment Agency is a non-departmental public body with specific powers and duties conferred upon it to meet the legal duty to protect and improve the environment. The Environment Agency is responsible under the Radioactive Substances Act 1993, and the Environment Act 1995, for the registration and authorisation of undertakings that use, store or dispose of radioactive materials.

An important point of note here is that where radioactive waste is *stored* on a site which is licensed by the NII, under the provisions of the Nuclear Installations Act 1965 (as amended), it is the HSE rather the Environment Agency which has the statutory powers to regulate storage on that site. However, the Environment Agency is responsible for regulating *disposals* of all forms of radioactive waste on or from the sites that are regulated by the HSE.

This means that in the absence of planned disposals, the Environment Agency does not have any statutory powers to regulate the radioactive waste on NII licensed sites.

The process for authorisation for disposal of radioactive waste, or for a variation of an authorisation, is increasingly occurring through a public consultation process. In 1999, for example, the Agency conducted a public consultation in regard to the application for authorisation of the disposal of radioactive wastes at AWE sites at Aldermaston and Burghfield. Similarly, the Agency recently held public consultations in relation to BNFL's applications for authorisation of radioactive waste disposals from six operational, and two decommissioned Magnox power stations.

Once an authorisation for disposal has been approved, or an undertaking is registered with the Agency as conducting radioactive activities, then Environment Agency site inspectors are responsible for the on-going compliance with the terms of the authorisations granted.

UK Nirex Ltd

UK Nirex Ltd (Nirex) was established in 1985 by the nuclear industry body, with the agreement of the Government, with the objective of developing facilities for the disposal of solid intermediate level and low level radioactive wastes. Nirex is owned jointly by British Nuclear Fuels plc, Magnox Electric plc, UK Atomic Energy Authority, British Energy Generation Ltd and British Energy Generation (UK) Ltd, with the UK government also owning a 'golden' share.

At the present time, Nirex's principal role is to advise producers of radioactive waste on how they should package the waste, and as such sets the standards for radioactive waste packaging. Where the packaging of radioactive waste is consistent with Nirex specifications, safety assessments and packaging principles, Nirex provides a letter of comfort to the waste producer. This letter of comfort is then typically presented to the HSE in order to comply with the terms of the licence relating to the storage and packaging of radioactive waste. Nirex is also responsible for producing an updated public inventory of the quantities and types of radioactive waste that currently exist in the UK.

3.5 Evaluating the current arrangements

Having briefly set out the basic responsibilities of the main institutions involved in RWM issues, we now highlight a number of apparent weaknesses of the current arrangements in the light of the arguments put forward in earlier sections.

The lack of a coherent approach to all sources of long-lived radioactive waste

At present, responsibilities for long-lived radioactive waste management issues are divided, with in particular Nirex charged with responsibilities for Intermediate level and some low level waste, whereas responsibility for high level waste remains with DEFRA. There would seem to be significant benefits in waste management issues associated with different sources of long-lived waste being dealt with within the same set of institutional arrangements. For example, there may be substantial cost implications if the compatibility of different approaches in relation to the long term management of different kinds of waste are not taken into account. Not explicitly taking account of issues raised by the future management of HLW in current decisions in relation to ILW may also give rise to concerns that opportunist behavior make take place at a later date, if, for instance, an ILW waste repository were built (for example, this may be considered a convenient location for HLW at that stage).

In what follows whilst we direct our comments primarily to the arrangements that are currently in place in relation to ILW, the institutional issues raised have relevance for the development of coherent set of arrangements in relation to all sources of long-lived waste.

The problematic nature of the distinction between storage and disposal

The current distinction made between 'storage' and 'disposal' is, in our view, not a useful one in the context of radioactive waste that has the potential to cause harm over

very long periods of time – in some cases several thousands of years. In particular, the use of the term 'disposal' implies that 'problem closure' can be achieved in the relatively short term, for example, at the point in time when a repository is closed. In our view, the relevant timescale for considering radioactive waste management activities should be driven by the physical potential for harm, not by a particular project.

The distinction between 'storage' and 'disposal' also raises a number of more specific institutional problems given the current legislative mandates of the Environment Agency and the NII. In particular, the Environment Agency has no legislative basis for direct involvement in decisions concerning the storage of waste on sites that are licensed by the NII – it's only means of involvement is through a memorandum of understanding between the two agencies. The Environment Agency only has a clearly defined basis for involvement when there is a specific proposal to dispose of waste. Since at present there are no specific proposals for the disposal of intermediate or high level wastes, the Environment Agency has no direct basis for regulating the potential long term impacts of current conditioning, packaging and storage practices.

A lack of regulatory scrutiny in relation to long term RWM issues

Under the present institutional arrangements there is only a limited basis for regulatory scrutiny of long-term radioactive waste management issues. In particular, there is limited independent regulatory involvement in issues concerned with:

- long-term strategy(ies) for RWM (for example, long term storage/disposal decisions), and;
- the implications of long term views for short term operational approaches (for example, the compatibility of conditioning and packaging decisions with longer term options).

Under the present institutional arrangements, both of these sets of issues are primarily dealt with by Nirex, which is owned by the industry. Thus, the regulatory issues associated with both these sets of issues are currently dealt with primarily through self-regulation.

As was highlighted earlier, given the very substantial externality problems associated with RWM issues, the are good reasons to expect that the private incentives of those engaged in waste management activities, if left unchecked, would result in levels of quality/safety that are 'too low' when considered in social terms. Given its proximity to commercial decision-making, self-regulation is likely to provide a very poor basis upon which to address these incentive problems.

More generally, given these incentive problems, and conditions conducive to the development of institutional biases, it is highly unlikely that self-regulatory arrangements of this kind are likely to be able to generate sufficient trust to avoid a potentially damaging exposure to political factors over time, and as a result such arrangements are unlikely to provide a robust basis for developing a long term strategy.

The degree of the current reliance on self-regulation is to some extent a factor of the ways in which the legislative duties of the NII and the Environment Agency are set out, and given this, the fact that there is not a specific disposal option being taken forward at present. Under the current institutional arrangements, a specific disposal site would need a licence from the NII, and the act of disposal would need to be authorised by the Environment Agency. Under the basic model, the regulatory bodies would place conditions on, and monitor the compliance of, the waste disposal company. The disposal company would interpret these conditions in order to determine its 'entry' standards – that is, what conditions waste should comply with in order that it can enter the facility. Compliance with these entry standards (which would include packaging and conditioning requirements) could then be made a part of the licensing and authorisation process by the NII and the EA .

Given this basic institutional structure, one might say that the current reliance on self-regulation is a short-term problem that would be addressed were there a specific disposal project. In our view this is not the case, and rather there are more fundamental problems with the current arrangements. In particular, whilst this institutional structure provides a clear basis for independent regulatory scrutiny of the short and medium term effects of storage, packaging and conditioning decisions, it does not provide for scrutiny in relation to the longer-term issues highlighted above: the determination of long term strategies and approaches, and the assessment of the implications of these decisions for operational decisions in the short term.

Thus, in terms of long term strategies, the NII and the EA would be in a position to evaluate a particular option in terms of its likely short to medium term effects, but this is a different matter to evaluating a long-term option in terms of its potential long-term effects, and against potential alternatives. In our view there would be significant benefits to be gained from an independent body being charged with this evaluative role.

However, an independent role is likely to be important not simply in terms of the evaluation of alternatives put forward by others, but also in the development of potential alternatives. In particular, private incentives can be expected to influence what might be considered desirable lines of inquiry (for example, in favour of options that are 'lower cost' and/or promise 'problem closure'). This 'market failure' – associated with the underproduction of relevant research - could be addressed by charging an independent body with a research role in relation to long term strategic options.

The evaluation of the implications that potential long term approaches should have for current packaging and conditioning standards is also primarily dealt with through self-regulation, by Nirex, in a highly non-transparent manner. Nirex issue letters of comfort to waste producers where proposed approaches are considered compatible with long term strategic factors, but is currently not permitted (by its owners, the waste producers) to provide this material to the NII and the Environment Agency – the independent regulators who have responsibility for regulating the activities of the waste producers. In our view, there is a very strong case for the assessment of packaging and conditioning standards to be carried out by an independent body.

The development and evaluation of long-term strategic options, and the assessment of the implications that potential long term approaches should have for current packaging and conditioning standards could be subsumed within a single independent body - a form of independent Nirex – or they could be unbundled to some extent. For example, assessments in relation to packaging and conditioning standards could be undertaken by the NII and/or the EA. However, important considerations in relation to unbundling will include potential conflicts between short and long term regulatory considerations, the relatively limited availability of relevant expertise, and, given the costs associated with relevant research, the costs of duplication.

The lack of an adjudicator, and forum for presentation of issues

In our view, under the current institutional arrangements there is a lack of a clear forum where the many difficult trade-offs associated with major RWM decisions can be openly presented and developed, with subsequent adjudication. Thus, it was only in the context of the local authority planning inquiry concerning the planned Rock Characterisation Facility at Sellafield that there was a clear public forum within which the plans for deep disposal were scrutinised and adjudicated upon.

There are, of course, a number of advisory and oversight bodies associated with RWM issues including RWMAC, Parliamentary Select Committees, and other bodies such as the Royal Commission on Environmental Pollution. However, none of these bodies would appear to adequately address this role. In particular, questions can be raised in relation to the following factors:

- the level of expertise of the body,
- the level of financial and/or technical support that they are provided with;
- the availability of resources to fund alternative perspectives or to research different options presented to them;
- the extent to which they provide an open and transparent forum;
- the extent to which issues are considered in a coherent manner over time (as opposed to a more ad hoc consideration);
- the level of perceived independence from particular interests;
- the powers they have to generate information flows from the various parties involved.
- the status of their recommendations.

More generally, the current institutional arrangements lack coherent adjudicatory arrangements in relation to regulatory decisions concerning different aspects of radioactive waste management. Both the Environment Agency and the NII have legislative mandates that are geared to them representing particular interests (environment and health & safety), with cost considerations acting as secondary constraints. However, where regulators act as representatives or 'advocates' in this way, emphasising particular dimensions of relevant trade-offs, it is important that there is a clear adjudicator between competing views in cases of dispute. Indeed, as we highlighted in section 2, the existence of a credible adjudicator is an important factor in enabling regulators to more fully 'represent' particular groups in this way.

The appeals process in relation to NII site licence decisions is currently managed within the HSE and has been used on only a very small number of occasions. Environment Agency authorisation decisions are subject to an appeal to the Secretary of State, which may introduce unwanted political factors into the decision making process through what is typically a largely non-transparent process. A common adjudicator in relation to appeals to regulatory decisions could provide for an open forum within which licence and authorisation disputes could be heard, and a more coherent framework within which subsequent regulatory decisions are made.

Limited basis of on-going 'prodding' at present

Factors such as the relatively small size of the relevant expert community, the background of secrecy within the industry, and the low level of public trust more generally, are likely to contribute to ongoing concerns that experts within the relevant institutions are 'closer' to those they are regulating than those they are supposed to be acting on behalf of. Whilst existing oversight and advisory bodies can be expected to provide some basis for 'prodding' or disturbance those engaged in RWM activities (including those within regulatory bodies), the extent to which they appear able to adequately address this role is limited by the factors highlighted in the above section.

In particular, it will be important that a 'prodding' organisation is perceived as independent, has sufficient expertise and technical support to be able to ask awkward questions in an effective manner, has sufficient resources to be able to fund alternative perspectives, and powers to generate appropriate information flows. In our view a set of arrangements that does not provide for substantial and visible scrutiny or 'prodding' on a regular basis can be expected to generate decisions that are considerably more likely to be subjected to unwanted political influence on a more erratic basis.

In the next section, we discuss a possible way forward for the regulation of RWM in the UK in light of these comments.

Section 4
Developing a Way Forward

In Section 3, we highlighted a range of weaknesses associated with the current institutional arrangements concerned with RWM issues. A central weakness concerned the problematic level of self-regulation at present through the activities of Nirex, and we emphasized that this could be addressed through charging an independent body (or bodies), with the development and evaluation of long term strategic options, and the assessment of the implications that long-term factors should have on packaging and conditioning standards. In this section, we focus on a potential response to the other main institutional weaknesses that were identified: the lack of an adjudicator; the lack of a clear forum for the presentation and assessment of issues; and, the limited basis for ongoing 'prodding' at present.

In our view, these factors could be addressed, and the robustness of current institutional arrangements significantly enhanced, through the introduction of a new independent body which could:

- provide for open hearings, and subsequently clear recommendations to the Secretary of State, on major issues associated with the long term RWM
- publish submissions, analysis and conclusions associated with these recommendations;
- have powers to adjudicate in relation to disputes over regulatory decisions in relation to radioactive waste management issues;
- fund alternative research/reviews, ask awkward questions and otherwise disturb or 'prod' the various actors, including regulatory bodies and those charged with the development of long term strategies;
- develop new forms of transparency and representation over time.

In the remainder of this section we discuss a possible form that such a body may take, by considering the example of the Competition Commission in the UK (formerly the Monopolies and Mergers Commission), because we judge that it may represent a set of arrangements reasonably close to a possible way forward in relation to the regulation of RWM.

4.1 The Competition Commission

The Competition Commission is a 'focused' regulatory organisation in that, in practice, it deals with problems or potential problems associated with the existence of market power. It receives submissions from interested parties on the matters of concern, and it publishes reports setting out facts, analysis, the views of parties making submissions, its own views, and its final conclusions.

Two of the Commission's activities that are of particular relevance in the current context are:

- Investigations of proposed mergers.
- Reports on disputed licence modifications in utility sectors.

In each case, the Commission is not necessarily the final arbiter. In the case of mergers, a recommendation is made to the Secretary of State, who is responsible for the final decision as to whether the merger will or will not be allowed to proceed. In utilities cases, the Commission's report goes back to the relevant regulator (Ofgem, Oftel, Ofwat) who is then required to act, taking the recommendations of the Commission into account.

In practice, much more often than not, the Commission is determinative: in that its recommendations are acted upon. One reason for this is that the Commission undertakes detailed, extensive fact finding and analysis of complex issues, and publishes its reports. With the relevant information in the public domain, politicians and regulators are not easily able to set aside the recommendations. Indeed, in the Government's latest proposals for the reform of competition policy, it is now envisaged that the role and powers of the Secretary of State in mergers cases will be largely abolished.

The arrangements are interesting in that, in effect, they imply a substantial delegation of high-level regulatory decision making to a specialist Commission, but with reserve powers retained to deal with what might be judged to be particularly sensitive cases. In terms of the stylised types of regulatory institutions set out in section 2 above, the Commission achieves:

- Substantial, but not complete, separation from the political process.
- Separation from commercial decision making.
- Substantial, but again not complete, separation from other types of regulatory activity (in reaching its judgments, the Commission is in principle, currently able to take into account issues such as environmental impacts, although in practice it is market power considerations that dominate).

Another feature of the arrangements is that matters are referred to the Commission by other parties (the Director General of Fair Trading, the Secretary of State for Trade and Industry). This, however, is not a necessary feature of the regulatory model. It would be possible to envisage such a Commission being given powers to instigate investigations itself in certain cases, as well as acting on matters referred to it. Thus, it would not represent a major change if the Commission had the capacity itself to initiate monopoly and complex monopoly investigations (the change would be more radical, and more problematic, if such powers were granted in relation to mergers or utility licence modifications, since this would imply substantial duplication of the work of utility regulators).

Similarly, the regulatory model would not be radically altered if bodies other than the Secretary of State and the utility regulators had an ability to refer matters to the Commission. Implicitly, this already happens to some extent. If a regulator such as Ofgem or Oftel proposes a licence modification, the company concerned can, in effect, trigger a reference to the Commission by declining to agree (unless the regulator decides to withdraw the proposed modification).

If the model were transposed into a situation such as the regulation of RWM, it is possible to envisage the relevant Commission both initiating its own investigations and reviews (allowing it to pursue a pro-active role) and receiving referrals from other parties, including referrals when there are disputes concerning the regulatory decisions of other agencies (e.g. in respect of standards for the treatment and handling of wastes). These other agencies could include self-regulatory organisations.

Traditionally, Competition Members have not been appointed solely on the basis of narrow technical expertise in the relevant matters. Rather, appointments have been based on broader competencies, in part because of a desire to reflect a range of backgrounds and experiences. This is now changing, with greater emphasis being placed on technical skills in the assessment of competition and market power. Either approach is compatible within the broad framework of the model.

Finally, it can be noted that there has recently been a strong push toward increasing the openness and transparency of the Commission's procedures. Much more information is now published, including via the Internet, during the course of the investigations themselves, and ahead of final reports. Open hearings have also been introduced, in which different interested parties can put their views and listen to the views of others. These proceedings are recorded and published.

As well as promoting better and more informed decision making, by ensuring that relevant information and viewpoints are fully taken into account, such developments serve the further purpose of increasing the legitimacy and authority of the process, which in turn helps sustain the separation from day to day political influences.

4.2 Closing Remarks

The introduction of a new Commission of the form described is of course not the only potential way of addressing the various regulatory challenges that have been highlighted. It does, however, in our view, provide a useful way of thinking about how these issues may be resolved by recognising, and indeed emphasising, the differing roles currently played by existing institutions.

We have emphasised the difficult and substantial trade-offs associated with long-term RWM decisions, and a range of influences that can be expected to distort those decisions, if left un-addressed. We have highlighted the way in which charging institutions with primary duties to represent particular interests – in particular, the Environment Agency, the NII and an independent form of Nirex - can provide a counter-balance to other pressures including those driven by cost.

Cost issues are of course very important. However, given the incentive conditions that have been described, in our view, exposure to liabilities associated with waste management decisions is highly unlikely to generate desirable ‘private’ trade-offs, except in relation to well-defined and credibly monitorable contract performance. Indeed, it is the very fact that potential ‘outcomes’ cannot be expected to be efficiently taken into account in private decisions in the presence of very significant externalities that provides a central rationale for the regulation of RWM activities.

Therefore, as a key part of the regulatory process, we would envisage those responsible for liabilities management 'representing' cost considerations. However, major decisions concerning trade-offs – as with ultimate liabilities that arise as a result of those decisions - would be public. The role of the Commission in this respect can be understood as ensuring that major trade-offs between cost and environmental quality/safety are made through an open and adequately scrutinized process.

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Appendix 1
Institutional Mapping of Current Regulatory Framework

This appendix discusses the current regulatory arrangements that govern the production, transportation, storage and disposal of radioactive substances in the United Kingdom. In each case, we have examined the statutory and legal authority of each of the regulatory bodies involved in the management of radioactive waste; the institutional structure of the bodies and any published guidelines or procedures that detail the powers and responsibilities of the regulatory body, and how these are interpreted in practice. Appendix 2 attached the current legislative framework for the regulation of radioactive waste, and Appendix 3 maps the current responsibilities of the various agencies involved in the management of radioactive waste.

A1.1 International Treaties and Conventions

The UK is a member of the two principal international organisations with an interest in radioactive substances which are the OECD Nuclear Energy Agency (NEA) and the United Nations International Atomic Energy Agency (IAEA). The standards and principles established by international organisations such as the IAEA and the NEA have resulted in a certain standardisation of the rules and regulations governing the design, operation and maintenance of nuclear installations in the UK, and elsewhere in the world.

The IAEA

The IAEA is a specialised agency within the United Nations system and is an inter-governmental forum established in 1956 to promote scientific and technical cooperation in the nuclear field. The IAEA's principal function is the promotion of the safe use of radioactive substances through a series of published safety standard documents setting down best practice in the fields of nuclear energy production, radioactive waste management, radioactive materials transport safety and radiation protection. The current membership of the IAEA is 132 member states.

In 1997, the UK was a signatory to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management which was negotiated under the auspices of the IAEA. The Convention's primary objective is to achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management, and it will not come into force until 25 States have ratified, of which 15 must have 'an operational nuclear power plant'. The UK is expected to ratify the Convention shortly.

The NEA

The NEA is a specialised agency within the OECD whose mission is to assist its member countries in maintaining and further developing the scientific, technological

and legal bases required for the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes. The membership of the NEA is currently 27 countries, which together account for some 85% of the worlds production of nuclear energy.

In addition to the above, in 1998 the UK agreed to the OSPAR (Commission for the Protection of the Marine Environment of the North-East Atlantic) Strategy for Radioactive Substances which requires that, by the year 2020 discharges of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.

Euratom Treaty

At the European level, the UK is bound by legislation set down under the Euratom Treaty relating to radioactive substances. The Euratom Treaty was first established in the 1950's and the UK became a signatory of the Treaty on its joining the European Union in 1972.

The Euratom Treaty contains provisions relating to the radiological protection of the work force and the public; the supply of uranium for the developing nuclear power sector; the safeguarding of this fissile material and general aspects such as research and dissemination of information. Under the Euratom treaty the European Commission (EC) acquired the status of a supranational regulatory authority in three areas: radiological protection, supply of nuclear fissile materials and nuclear safeguards.

The EC therefore has some regulatory oversight in relation to the operation of all facilities handling radioactive substances, including nuclear power plants and radioactive waste stores and disposal facilities. In all these facilities, certain EU-wide norms of limiting radiation exposure must be respected pursuant to the Euratom Treaty.

The Euratom Treaty does not however provide any specific guidance in relation to the operational safety of nuclear power plants, or specific requirements regarding radioactive waste storage or disposal facilities. These aspects of nuclear industry regulation have become the responsibility of individual EU Member States, and no specific criteria or norms have been established which would apply during either design or operation of these facilities.

EC Council Directives and Regulations

There are four principal EC Council Directives/Regulations which apply in relation to the nuclear sector and radioactive substances. These legislative instruments are binding on the UK and all member states. The three directives/regulations discussed below come under the general legislative framework of the Euratom Treaty and relate to the following:

- *Council Directive 92/3/Euratom* relates to the supervision and control of shipments of radioactive waste between Member States and into and out of the Community

- *Council Regulation (Euratom) No 1493/93* relates to shipments of radioactive substances between Member States

- *Council Directive 96/29/Euratom* details the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.

In addition to the above, *Council Directive 97/11/EC* recognises the 'special' nature of the nuclear sector and requires nuclear installations to produce an environmental impact assessments. Other EC directives/regulations in relation to the environment are also applicable to the nuclear sector.

A1.2 Primary Legislation in the UK relating to Radioactive Activities

There are five pieces of primary legislation that govern the radioactive waste sector in the UK, which are:

- Radioactive Waste Substances Act (1993)
- Environment Agency Act (1995)
- Health and Safety at Work Act (1974)
- Nuclear Installations Act 1965 (as amended)
- Ionising Radiations Regulations 1999

Each of the pieces of legislation listed above have been enacted with a specific focus, the first two relating primarily to environmental issues and the latter three with a safety focus. Consequently, each Act introduces specific regulations and procedures to address its specific focus, and empowers a particular regulatory body to regulate and supervise the radioactive waste sector toward this end.

Radioactive Substances Act 1993

The primary purposes of the Radioactive Substances Act 1993 (RSA93) is to protect the environment from radioactive pollution by controlling the use of radioactive materials and in particular the accumulation and disposal of radioactive waste.

The RSA93 controls the storage, use and disposal of radioactive substances in both open and closed sources including mobile radioactive apparatus and applies to Crown premises but does not cover the navy, army, air force or the Secretary of State for Defence. The 1993 Act consolidated the Radioactive Substances Act 1960 and the Environment Protection Act 1990

The RSA93 originally empowered the Minister for Agriculture, Fisheries and Food[7] to appoint a Chief Inspector to ensure that the terms of the Act are complied with, although this power has subsequently ceased pursuant to the Environment Act (1995). The Environment Act 1995 designated the Chief Inspector in England & Wales to be the Environment Agency and the Scottish Environmental Protection Authority in Scotland. The Secretary of State also has significant powers under the Radioactive Substances Act, some of which were also amended in 1995 with the passing of the Environment Act.

The provisions of the RSA93 require any undertaking which uses radioactive substances to be registered with the Chief Inspector (the Environment Agency). In regard to the accumulation and disposal of radioactive waste, the RSA93 requires that any undertaking involved in such activities must be authorised by the Chief Inspector and the appropriate Minister to do so.

The powers given to the Secretary of State in the RSA93 include:

- the authority to direct the Chief Inspector, or to determine directly, certain applications for registrations or authorisations under the Act. In exercising these powers, the Secretary of State has the power to have a local inquiry held in relation to the application

- to restrict the knowledge of particular applications on the grounds of national security

- to hear appeals against a decision of the Chief Inspector relating to a refusal of an application for registration; any limitations or conditions attached to registration; the variation of a registration or the cancellation of a registration

- the Secretary of State is also empowered to provide facilities for the disposal or accumulation of radioactive waste, if it is felt that adequate facilities are not available for such a purpose. This is subject to consultation with the local authority in an area where the radioactive waste would be situated. Additionally, the Secretary of State is empowered to dispose of radioactive waste on any premises if it felt that the premises are unoccupied, or that for any other reason it is unlikely that the waste will be lawfully disposed of without the Secretary of State's intervention

The Environment Act 1995

The primary purpose of the Environment Act 1995 (EA95) is the establishment of the Environment Agency (in England & Wales) and the Scottish Environment Protection Authority. The Environment Agency is established under the EA95 as a non-departmental public body, with specific duties and powers.

The EA95 establishes a board to govern the activities of the Environment Agency, which could comprise up to 15 members. Membership of the Board is determined by

[7] The functions of the Minister for Agriculture, Fisheries and Food in this capacity ceased to be exercisable under the Food Standards Act 1999.

the Secretary of State for the Environment, the National Assembly of Wales and the Minister of Agriculture, Fisheries and Food.

In relation to radioactive substances, as noted earlier, the introduction of EA95 allowed for the transfer of the functions of the chief inspector for England & Wales under the Radioactive Substances Act 1993 to the Environment Agency. In addition, the Environment Act also transfers particular functions of the Secretary of State to the Environment Agency, including the powers of the Secretary of State under the Radioactive Substances Act to dispose of radioactive waste if it is felt that adequate facilities are not available for accumulation or disposal (see above).

In addition to these specific powers, the EA95 also details the principal aim and objectives of the Environment Agency, which could also have implications for the management and disposal of radioactive substances. The principal aim of the Environment Agency under the Act is:

"It shall be the principal aim of the Agency..in discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of achieving sustainable development.."

The specific objectives of the Agency are not detailed in the Act, however, it is noted that *"Ministers shall from time to time give guidance to the Agency with respect to objectives which they consider appropriate for the Agency to pursue"*. The guidance provided by Ministers must include guidance with respect to the principal aim of the Environment Agency of achieving sustainable development.

The EA95 confers specific "pollution control powers" and "pollution control functions" on the Environment Agency which shall be exercisable for the purpose of preventing or minimising, or remedying or mitigating the effects of, pollution of the environment. These pollution control powers/functions are presumably exercisable in relation to radioactive activities and radioactive waste, as it is specifically noted in EA95 that these powers are conferred on the Environment Agency under the provisions of the Radioactive Substances Act.

Health and Safety at Work etc Act 1974

The Health and Safety at Work etc Act 1974 (HSWA) places general duties on all employers toward their employees and other persons to take reasonable care of their own health and safety, and the health and safety of other members of the public that may be affected by what they do, or omit to do.

The HWSA establishes two bodies responsible for implementing the provisions of the Act. The Health and Safety Commission (HSC) is created to comprise of between six and nine representatives of both industry and local authorities, and is charged with developing policies in the health and safety field, and for making new proposals for new health and safety regulations to the relevant Minister.

The Health and Safety Executive (HSE) was also created under the HWSA as a separate statutory body appointed by the HSC. The HSE is responsible for enforcing legal requirements and the directions given by the HSC, and provides advisory

services to both the industry and the HSC. The HSE comprises the major Inspectorates in the health and safety field, including the Nuclear Safety Directorate.

Apart from being subject to the broad provisions of the HWSA relating to the safety of employees working at nuclear installations, the nuclear industry is also subject to the HWSA in the requirement that all risks to health from the use, storage, or transport of "articles" and "substances" must be minimised. Thus, to satisfy these requirements all reasonably practicable precautions must be taken in the handling of any substance likely to cause a risk to health.

Nuclear Installations Act 1965 (as amended)

The Nuclear Installations Act 1965 (NIA) reinforces the obligations imposed on employers under the HWSA to ensure the safety of their workers and the broader public. The NIA requires any site which has a nuclear plant on it to be granted a license by the HSE, and in practice this licensing function is carried out by the HSE's Nuclear Safety Directorate.

The NIA enables the HSE to attach specific conditions to nuclear site licences, and a set of standard conditions have been incorporated into all nuclear site licences granted since 1990. The specific licence conditions are included to ensure that a licensee pays specific attention to particular areas of activity to ensure the safe operation of the nuclear site. Some licence conditions impose specific duties on licensees, whilst others require the licence to develop and implement adequate safety arrangements to deal with the risks associated with a nuclear site.

Ionising Radiations Regulations 1999

The Ionising Radiations Regulations 1999 further enforce the general obligations imposed under the HWSA and are a set of regulations designed to protect workers in all industries, and the general public, against exposure to ionising radiation. The regulations specify limits on the dose of exposure for both employees and members of the public

A1.3 Ministerial and Departmental Responsibilities in the UK

Under the statutory framework discussed above, the responsibility for the various radioactive activities in the UK is allocated to a number of Ministers, and government departments. The respective responsibilities of Ministers are as follows:

<u>Secretary of State for Trade and Industry</u>

The Secretary of State for Trade & Industry is responsible for nuclear safety at licensed sites, which is regulated by the Health and Safety Commission and the Health and Safety Executive. The Secretary of State for Trade & Industry is also responsible for co-ordinating a framework for nuclear emergency plans, and for the UK's involvement in international work in the nuclear area.

Secretary of State for the Environment, Food & Rural Affairs

The Secretary of State for the Environment, Food & Rural Affairs has overall responsibility for the safe transport of nuclear material in Great Britain, although different regulatory bodies assume responsibility for different modes of transport. In England, the Secretary of State for the Environment, Food & Rural Affairs is also responsible for the discharge, disposal, and except on licensed sites, storage and use of radioactive material and these functions are regulated by the Environment Agency.

Secretary of State for Defence

The Secretary of State for Defence is responsible for safety at defence-related nuclear sites.

National Assembly for Wales

In Wales, the National Assembly for Wales is responsible for the discharge, disposal, and except on licensed sites, storage and use of radioactive material, and like in England these functions are performed by the Environment Agency. The National Assembly is also responsible for the safety of radiation levels in food.

Scottish Executive

In Scotland, the Scottish Executive is responsible for the discharge, disposal, and except on licensed sites, storage and use of radioactive material, and these responsibilities are regulated by the Scottish Environment Protection Agency. The Scottish Executive is also responsible for the safety of radiation levels in food.

Secretary of State for Northern Ireland and the Northern Ireland Executive Committee

The Secretary of State for Northern Ireland is responsible for the co-ordination of nuclear emergency planning and the safe transport of radioactive materials on land. Whilst the
Northern Ireland Executive Committee is responsible for the discharge, disposal, storage and use of radioactive material, and the safety of radiation levels in food.

The Department of Trade & Industry

As noted above, the Secretary of State for Trade and Industry is the UK government sponsor and part owner of the civil nuclear industry and as such the Department of Trade & Industry is involved in the development and implementation of civil nuclear policy. The Secretary of State for Trade and Industry is therefore accountable for nuclear safety at nuclear power stations and other licensed civil nuclear sites in the UK, although as discussed below these responsibilities are often delegated to a number of other agencies or authorities.

The Department of Trade & Industry's Nuclear Industries Directorate (NID) is the relevant section of the DTI's activities in regard to the nuclear industry. The role of the DTI(NID) in the nuclear sector is a varied one, encompassing industry ownership

and supervision, and regulatory activities to protect the public and international safety and technical assistance.

The Department for Environment, Food & Rural Affairs

The overall departmental responsibility for radioactive waste management lies with the Department of Environment, Food & Rural Affairs (DEFRA) in England and with the devolved administrations. DEFRA was established in June 2001 and brings together environmental responsibilities from the former Ministry of Agriculture, Fisheries and Food and the former Department of the Environment, Transport and the Regions

The Radioactive Substances Division (RAS) within DEFRA is responsible for DEFRA's environment interests in nuclear and radioactive matters encompassing radioactive waste management policy and legislation; environmental radioactivity, including radioactive discharges, contaminated land and radon in the home; response to overseas radiological emergencies; and research.

A1.4 Regulatory Bodies, Agencies, Commissions and Committees

Radioactive Waste Management Advisory Committee

The Radioactive Waste Management Advisory Committee (RWMAC) was established in 1978 to offer independent advice to Ministers, and DEFRA, on the major technical and environmental implications concerning the development and implementation of an overall policy for all aspects of the management of civil radioactive waste.

The RWMAC is an independent body with a membership drawn from a diverse range of backgrounds and specialisms. The programme of work of the RWMAC is typically commissioned by Ministers, however, the RWMAC also responds to consultations on relevant issues. The RWMAC's advice to Ministers is published, either in individual reports or in the context of the RWMAC Annual Report.

Health & Safety Commission

As noted in the previous section the Health & Safety Commission (HSC) has overall statutory responsibility for ensuring that there is an adequate framework for regulation of safety at nuclear sites in the UK. The funding for both the HSC and the HSE is provided by the Department of Transport Local Government and the Regions which is the ministerial department responsible for health and safety policies.

The HSC is responsible for advising the Secretary of State on policy and operational safety matters relating to the nuclear industry. The HSC is in turn advised by advised by the Nuclear Safety Advisory Committee (NuSAC). The Health and Safety Commission is accountable to the Secretary of State for Trade and Industry for their nuclear safety work.

Nuclear Safety Advisory Committee (NuSAC)

The Nuclear Safety Advisory Committee (NuSAC) was initially established in 1960 under the Nuclear Installations (Licensing and Insurance) and is responsible for advising the HSC, and when appropriate the Secretary of State, on major issues affecting the safety of nuclear installations and to advise the HSC on the adequacy and balance of its nuclear safety research programme.

The specific areas which NuSAC advises the HSC include the design, siting, operation, maintenance and decommissioning of nuclear sites which are referred to it or which it considers require attention. The NuSAC has established a sub committee on research provides independent advice, on behalf of NuSAC, to the HSC on all aspects of research related to subjects within NuSAC's remit.

NuSAC comprises an independent Chairman and up to 20 other members. Of these, four members are nominated by the TUC, four by the CBI and the remaining 12 are independent.

Health & Safety Executive

The HSE is the statutory body responsible for the licensing and day-to-day regulation of work-related health and safety issues in the UK. As noted above, under the Nuclear Installations Act 1965 (NIA), a site cannot have nuclear plant on it unless the user has been granted a site licence by the Health and Safety Executive (HSE).

In issuing licences the HSE sets out a series of licence conditions that cover all the arrangements for managing safety, including response to accidents, leaks and spillages of radioactive materials, emergency planning arrangements, and all aspects of transport of radioactive material on the sites. The responsibility for the regulation of the conditioning and storage of intermediate level radioactive waste on licensed nuclear sites also lies with the HSE.

The HSE's Nuclear Safety Directorate (NSD) is responsible for issuing nuclear site licences. The NSD, acting on behalf of the HSE, has since 1990 set out a set of 36 standard conditions that attach to each nuclear site licence, which remain in force throughout the life of a nuclear installation and cover, construction, commissioning, operation and decommissioning. The operational arm of the NSD is HM Nuclear Installations Inspectorate (NII) which administers the nuclear site licences on the part of the HSE.

Like the HSC, the HSE is also accountable to the Secretary of State for Trade and Industry in relation to their nuclear safety work.

The Nuclear Safety Directorate and HM Nuclear Installations Inspectorate

The licensing and day-to-day regulation functions of the HSE are carried out by the Health and Safety Executive's Nuclear Safety Directorate (NSD). The NSD acts for the HSE specifically, and are independent of any Government Department responsible for the UK nuclear power programme. NSD is responsible for setting the safety standards to be used on nuclear sites in the UK.

The NSD, acting for HSE, sets out in conditions attached to a site licence the general safety requirements to deal with the risks on a nuclear site. Licensees comply with these in different ways; such as presenting a safety case to meet a stage in the plant's life, or through introducing specific arrangements and procedures to meet a licence condition. Guidance is also set out in the safety assessment principles, which NSD has developed for its own use, and made available to the public.

NSD seeks to keep up and improve safety standards at licensed nuclear installations through its licensing powers by assessing safety cases and inspecting sites for licence compliance. NSD consists of four divisions which deal with:

- British Energy plc (British Energy Generation (UK) Ltd and British Energy Generation Ltd);
- British Nuclear Fuels and Magnox Electric;
- UKAEA, Defence and other sites
- Nuclear Safety Research and Strategy

HM Nuclear Installations Inspectorate

The Nuclear Installations Inspectorate (NII), is the operational branch of the NSD and is responsible for administering nuclear site licences on the part of the HSE. The NII is organised, under the Chief Inspector of Nuclear Installations, on a Branch basis, each with a Deputy Chief Inspector. The Inspectors at each Branch are engineers and scientists and have powers to implement and enforce the relevant legislation including the right to information. A dedicated site inspector with full powers under the HSWA is typically on site at each licensed nuclear facility.
Since 1997, the NII is also responsible for the supervision of sites operated by the Ministry of Defence.

The NII aims to identify those areas which are critical to safety and where it may wish to become more closely involved. Once these areas are identified the NII may choose to examine closely the details presented and possibly undertake its own check calculations. The NII can also require a licensee to change organisational structure if it feels that a site licence condition is unlikely to be met. It also needs to be satisfied that arrangements are in place to deal with an emergency at a power station, should it occur.

The NII also prepares a review of each nuclear operator's overall decommissioning strategy every five years. These reviews are known as quinquennial reviews and are carried out to ensure that the arrangements in place for decommissioning nuclear power stations are adequate and in line with Government policy.

The Environment Agency

As noted above, the Environment Agency ("the Agency") was created by the Environment Act 1995 with the legal duty to protect and improve the environment throughout England & Wales and so contribute to sustainable development.[8]

The Agency is accountable to the Secretary of State for Environment, Food & Rural Affairs for its work in England, and to the National Assembly for Wales for its work in Wales. The Scottish Environment Protection Agency is accountable to the Scottish Executive.

The Agency is a non-departmental public body with specific powers and duties conferred upon it to meet the legal duty to protect and improve the environment. The funding for the Agency is derived primarily from charges that it levies, with the remainder being funded by the Government through various departments.

Structure of the Agency

The Agency is governed by a Board of up to 15 members, who are directly responsible to Ministers for all aspects of the Agency's performance and for meeting the legal duties conferred upon the Agency. The Board comprises a Chairman and Chief Executive, the appointment of which need to receive the approval of the Secretary of State. The Agency employees some 9,500 staff that work in 26 area offices, with each office consisting of a general manager and area manager who are empowered to make decisions for that area.

The Environment Act designated that regional advisory committees and these are established and maintained by the Agency covering the areas of environmental protection, flood defence and fisheries. These advisory committees comprise business representatives and local authority members with a Chairman appointed by the Secretary of State. The Agency is statutorily obliged to consult the advisory committee as to any proposals relating to how the Agency carries out its functions in that region, and to consider any representations made by the Agency by the advisory committee.

The Agency's Regulation of Radioactive Activities

As noted above, the Environment Agency is responsible under the Radioactive Substances Act 1993, and the Environment Act 1995, for the registration and authorisation of undertakings that use, store or dispose of radioactive materials.

The process for authorisation for disposal of radioactive waste, or for a variation of an authorisation, is increasingly occurring through a public consultation process. In 1999, for example, the Agency conducted a public consultation in regard to the application for authorisation of the disposal of radioactive wastes at AWE sites at Aldermaston and Burghfield. Similarly, the Agency recently held public

[8] Sustainable development is defined by the Agency to mean "meeting the needs of today without harming future generations"

consultations in relation to BNFL's applications for authorisation of radioactive waste disposals from six operational, and two decommissioned Magnox power stations.

To register to keep and use radioactive materials an undertaking is required to provide the following information:

- the intended location (municipality)

- the purposes for which the radioactive sources are to be kept (ie: medical, academic)

- disclose the type and amount of radioactive matter that is being accumulated or disposed

- where the sources will be stored when not in use

When applying for an authorisation to accumulate and dispose of radioactive wastes additional questions are asked in relation to:

- the form in which the radioactive waste will be when disposed. That is, whether the waste will be in the form of gas or mist; aqueous waste; organic liquid waste; very low level solid waste; or solid waste.

Once an authorisation for disposal has been approved, or an undertaking is registered with the Agency as conducting radioactive activities, then Environment Agency site inspectors are responsible for the on-going compliance with the terms of the authorisations granted.

Other Bodies – UK Nirex Ltd

UK Nirex Ltd (Nirex) was established in 1985 by the nuclear industry body, with the agreement of the Government, with the objective of developing facilities for the disposal of solid intermediate level and low level radioactive wastes. Nirex is owned jointly by British Nuclear Fuels plc, Magnox Electric plc, UK Atomic Energy Authority, British Energy Generation Ltd and British Energy Generation (UK) Ltd, with the UK government also owning a 'golden' share.

At the present time, Nirex's principal role is to advise producers of radioactive waste on how they should package the waste, and as such sets the standards for radioactive waste packaging. Where the packaging of radioactive waste is consistent with Nirex specifications, safety assessments and packaging principles, Nirex provides a letter of comfort to the waste producer. This letter of comfort is then typically presented to the HSE in order to comply with the terms of the licence relating to the storage and packaging of radioactive waste.

Nirex is also responsible for producing an updated public inventory of the quantities and types of radioactive waste that currently exist in the UK.