

**The structure of the nuclear power  
industry with regard to management of  
radioactive waste**

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# 1 Introduction

- 1.1 This note considers the most appropriate organisational structure for the management of radioactive waste in the UK. The approach is to consider the fundamental economic principles that govern organisation and regulatory structure and then apply these to the specifics of management of radioactive waste<sup>1</sup>. Section 2 of the paper begins by discussing market failure and identifies the well established problem that future generations are not present in a current market to trade and make their preferences felt. Government intervention is required as guardian of the interests of future, as yet unborn, generations. Section 2 then outlines the modern approach to regulation. Economists view the asymmetry of information between regulators and regulated as the major regulatory problem. For this reason the regulatory and organisation structure should be designed to elicit as far as is possible information and correct signals and to put in place structures in such a way that the incentives facing the regulated activities coincide with society's objectives.
- 1.2 Section 3 argues that the information problem is most severe between short and long run waste management, that the potential for conflict between social preferences and individual incentives are most severe within a single organisation spanning these two activities and that the benefits of shared expertise are in comparison less important. It proposes the solution of one agency to deal with short run operational management of liabilities (here called the LMA) and another to deal with very long run storage (here called WMO). This seems to offer most hope to provide efficient treatment of these liabilities. The LMA will bring the liabilities together, ensure cost effective short and medium term waste management to minimise these liabilities and be charged with transferring these liabilities where appropriate. A WMO paid under contract according to waste received and managed has every incentive to ensure that transfers to long run management are carried out as planned.

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<sup>1</sup> I should add that the specific suggestions are themselves relatively high level and leave many details still to be addressed.

- 1.3 Section 3 also argues that under current arrangements the property rights structure is not clear. It is suggested that the liability for long-term management should pass to the WMO under a binding contract and that the LMA or the waste producers pay a fee for the transfer of the liability. Finally, to aid the development of policy, it is suggested that it would be helpful to have a small Commission of independent commissioners who are charged with taking an overview of the whole system and providing reviews of current policy.

## **2 The role of government and the regulatory problem**

### *The role of government*

- 2.1 Market failure is used by economists to describe circumstances where unconstrained competition will not lead to an efficient allocation of resources. Probably the most prevalent forms of market failure arise from externalities - a term given to a situation where the choice of one party affects the welfare of another at the given prices in the economy. Congestion is a typical example. If a person decides to use a train rather than a car for a journey then an externality arises because other road users obtain a benefit from the reduction in congestion caused by the decision to take the train. In an unconstrained market the outcome will be that too many car journeys are taken and too few rail journeys.
- 2.2 Management of the radioactive waste suffers from externality problems for at least two separate reasons:
- Poor management of waste may cause a reduction in welfare but the downside consequences may not arise for thousands of years in the future. Many of the well-known efficiency properties of competition, underpinned by an unbiased legal system, arise in a theoretical framework where all parties trade together and enforce these contracts through the legal system. Future generations may

be affected by the quality of waste management but are not present in a current market to trade or use the current legal system to exact damages. For this reason prices will not reflect their preferences and many of the traditional welfare enhancing features of private markets are destroyed. This problem stems from the extremely long-term nature of the waste and government intervention is required as guardian of the interests of future, as yet unborn, generations

- For a company producing waste the cost of failure to apply the highest standards may only fall on the company through legal action in a worst-case scenario. However, in this situation the company may be unable to deal financially with the scale of damages. In an unregulated competitive market such companies may then have dampened incentives to manage the waste efficiently since expenditures that only bring benefits when the company is unviable anyway will appear less attractive than they should be. The incentives may be particularly distorted when companies have limited liability. This problem stems from the combination of the small probability of failure, the sheer scale of damages in a worst-case scenario and limited liability. It suggests that the free market and general legal system alone may be unable to provide efficient incentives.

2.3 These two forms of externality are not exhaustive but are sufficient to show that regulatory intervention by the government is necessary to resolve market failures in waste management.

*The regulatory problem*

- 2.4 An objective of any framework introduced to intervene in the market mechanism is to resolve market failures in as efficient a manner as possible. Economists distinguish between productive efficiency and allocative efficiency.<sup>2</sup> Loosely, the former ensures that the least resources are being used up (i.e. what is produced is done so at the minimum cost) while the latter ensures that the resources are correctly allocated (i.e. the correct outputs are provided). Unfortunately, there is often a conflict between the two. Competitive incentives are good at providing productive efficiency but they are weak at ensuring allocative efficiency. Generally, incentives that work to minimise costs tend to distort allocation in the economy. For example, privatisation of utilities can reduce cost but in an unregulated environment may enhance monopoly profit that distorts outputs and signals sent to the rest of the economy.
- 2.5 The traditional view has been that the public sector is better at determining allocation but poor at minimising costs whereas the private sector is good at reducing costs but does not allocate resources well. The perceived balance between these two problems has changed enormously in the last twenty years. Traditional concerns focused heavily on allocation and tended to favour public sector delivery whereas in the last twenty years the gains to be achieved from ‘incentivisation’ have been a major focus. Initially this appeared as a drive to privatisation of industries but more recently there has been development in the understanding of how to mix public and private activities.
- 2.6 It is now generally agreed by economists that the major barriers to achieving productive and allocative efficiency are informational and political constraints.<sup>3</sup>

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<sup>2</sup> This distinction is standard in the analysis of regulation (see for example Armstrong, Cowan and Vickers, *Regulatory Reform*, MIT Press, 1994.)

<sup>3</sup> See for example Laffont and Tirole’s *A Theory of Incentives in Procurement and Regulation*, MIT Press, 1993.

Putting to one side the political and administrative constraints and focusing purely on the economic aspects, the major problem with any regulatory framework is that those within the regulated organisations have far better information than that available to the regulator. This disparity allows those in the organisations to pursue goals that do not always fully coincide with society's objectives. This is not unique to economic regulation. To use the modern social science terminology, the central issue is the agency relationship.

2.7 In such a framework the social objective should be to structure activities and design the regulatory framework in a way that:

- elicits information and correct signals from the regulated activities and
- puts in place structures in such a way that the incentives facing the regulated activities coincide with society's objectives,

but to do so is far from easy.

2.8 The history of the privatisation programme in the UK has emphasised the conflict between cost minimisation and information problems. There have been two strong lessons from the privatisation programme in the UK.

- One is that the scale of efficiency gain (whether caused by the change in ownership itself or the consequent regulation and competition) has been far larger than most commentators believed possible.
- The other is that the regulatory mechanisms have shown themselves to be far more prey to the problem of information rent than anticipated. By information

rent I mean the ability of regulated companies to use their informational superiority over the regulator to good effect<sup>4</sup>.

- 2.9 These two are closely related. The ability of the old public sector companies to mask such large inefficiency indicates the difficulty that those outside the entity, and sometimes those inside, had in understanding the true position. A natural corollary of this is that regulation of these companies is not easy since the information problem can be as significant a barrier for regulation as it proved in assessing the potential benefits of privatisation. In the absence of the belief in a 'free lunch', it should be recognised that regulation is more costly in efficiency terms than had been initially anticipated but that this is an inevitable side product of enormous efficiency gains. One cannot pick and choose bits of the package.

### *Summary*

- 2.10 The main points that emerge from this abstract discussion of the government's role and consequent regulation are as follows. It is clear that the market mechanism cannot fully determine the management of radioactive waste without some form of government regulation in the market. Of course, this view is well understood. The primary market failure arises because future generations preferences do not enter current prices and the government must act as the guardian of their interests. Economists view the asymmetry of information between regulators and regulated as the major regulatory problem. For this reason the regulatory and organisation structure should be designed to elicit as far as is possible information and correct signals and to put in place structures in such a way that the incentives facing the regulated activities coincide with society's objectives.

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<sup>4</sup> That is good effect for the Organisation's selfish interest, not good in the broader sense.

### 3. Management of Liabilities

3.1 In this section we take these abstract notions from Section 2 and apply them to the treatment of waste management. In turn we consider the treatment of short and medium term waste management, long-term waste management, the contractual relationship between the two and the regulatory structure.

#### *Short and Medium Term Liabilities.*

3.2 It is helpful initially to consider the management of short term and medium term liabilities. We have suggested in the previous section that, in the absence of government intervention, there may be dulled incentives to get the cost-safety trade-off exactly right and it is likely that companies may cut costs at the expense of safety at the margin without supervision. The question is how should the government presence be structured?

3.3 Clearly, the incentives to distort the cost-safety trade-off are strongest where the incentives to minimise costs are strongest. That is, if those producing the waste are given property rights over the decision when and how to do this they will tend to favour cheaper solutions and in particular those solutions that avoid large up front payments even if at the margin there is a greater risk to safety. This suggests that where there is a strong cost minimisation motive, e.g. from a profit motive, behind those generating the waste then they should not have property rights over the decision as to the treatment of waste. As we will see later this does not imply that those producing the waste will not be allowed to treat it but purely that the decision as to who treats the waste and how to do it should not be in their control.

3.4 Since the government, in its most general form, currently holds the final liability for all public sector waste management then an agent of the government is probably better placed to decide on the implementation of short term waste management than a non-

government agency. Countering this argument the entity that produces waste may have stronger incentives to minimise cost. However, since safety is paramount there is an imperative to maximise efficient provision of waste management within a public agency if this is possible. Furthermore, since the government holds all the public sector liability it makes some sense to bring all these together in a single agency since it may be easier to deal with this as a single policy. We can think of this agency as a Liabilities Management Agency (LMA).<sup>5</sup>

3.5 How 'hands-on' should this agency be? Evidence from contracting out of other services has shown that compulsory competitive tendering of well-defined sub components of a state activity can generate large savings. Separating refuse collection from other aspects of local government and separating laundry from other aspects of hospital provision have proved very successful. Cost reductions of 20% are standard as a result of competitive tendering.<sup>6</sup> Furthermore, the savings have been found to be present whether new private operators or the existing ring-fenced providers win the final tender. That is, it is the presence of competition rather than the transfer of the undertaking to the private sector that matters. Dramatic gains of this type are somewhat less obvious for PFI type projects but this may be a measurement issue.<sup>7</sup>

3.6 Therefore it makes little sense for the LMA to be closely involved with the direct operational management of short and medium term waste. The LMA ought to be overseeing proposed approaches to short and medium term waste management and then monitoring the activities of the winners. Those producing the waste may have an advantage in managing their own waste relative to others and are likely to win tenders to do so. The critical point is that those producing the waste are dealing with their own waste only because they have won the right to do so. Specifically, they will have had no property rights over this decision. This sits with the LMA who

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<sup>5</sup> Where possible I have used the terminology that is in current usage although clearly its use in this context may differ from other interpretations of the role of a Liability Management Agency.

<sup>6</sup> For example Donberger and Jensen, *Contracting out by the Public Sector: Theory Evidence Prospects*, *Oxford Review of Economic Policy*, 1997.

have stronger incentives to retain required standards. The LMA will be expected to 'oversee' cost efficient methods of meeting the required safety standards, e.g., possibly setting compulsory competitive tendering rules (CCT), and will be held accountable under this obligation. For this reason it is impossible to ensure that there is no distortion to meet the overall objectives, since whenever there are conflicting objectives one cannot guarantee that the outcome fully reflects social preferences at the expense of 'organisational' preferences. The hope is that a government agency may minimise distortions relative to the situation where those producing the waste also have property rights over the method of dealing with it and the associated liability. In addition, the LMA will be charged with transferring the liabilities where appropriate. Thus the role of the LMA will be to bring the liabilities together and to ensure cost effective waste management to minimise these liabilities.

3.7 There are two tensions at play with the decision to have a single agency dealing with all short and medium term waste management and liabilities.

- On the one hand a single agency can choose between approaches and take a relatively dispassionate view. Furthermore, the skill of dealing with alternative management methods and monitoring will be aggregated together.
- The downside is the information problem. Vesting all this information within a single agency limits the scope for assessment of the agency's performance.

3.8 However, when dealing with short and medium-term treatment it is possible that the information problem may not be so significant since there is limited scope for manipulation between the methods of short term waste management that meet long term safety requirements. It is the trade-off between short-term savings and long run safety where the real information problems exist and become difficult to regulate if they are retained in one organisation.

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<sup>7</sup> See Grout *The Economics of the Private Finance Initiative*, *Oxford Review of Economic Policy*, 1997.

3.9 Note that the arguments provided here can apply equally to privately owned entities as well as publicly owned entities that have a requirement to be cost conscious. It is thus an open question whether the LMA exists purely to deal with all liabilities arising within the public sector (most of the current liabilities) or whether it should have a watching brief over the private and public sector short-term waste management. There are strong arguments for both possibilities. At the margin a pure economic efficiency approach would appear to favour the LMA having a brief to oversee the short-term treatment of all waste. The brief of the LMA would be far more limited than a regulator since it would purely be concerned with the correct treatment of waste and associated liabilities and so would appear to fill a gap that currently exists for both public and private waste producers. On the other hand the main purpose is to bring together all public sector liabilities and bringing private sector activity into the picture may distract from the main brief. I do not have a particular view between these two models.

#### *Long Term Liabilities*

3.10 Section 2 identified a fundamental market failure that arises from the long-term nature of radioactive waste. However, the government intervention in the market to help resolve this market failure requires a very long run duty of care. The government is intervening to represent these future generations in their asymmetric trade with the present generation. But it is this long-term duty of care that makes the regulatory problems associated with long-term management far greater than those associated the short and medium term management. The government can act as representative of future generations but how well its structure for regulation and management of waste can achieve the objective depends on the information flowing to regulators and the organisational objectives of the various parties.

3.11 The set up costs of long-term waste management may be extremely large and the consequences of incorrect decision-making will probably appear so far into the

future that no one alive today or in the next few generations will be affected. Any agency that has cost minimisation of short and medium term management as one of its primary objectives will find that current costs can be reduced by delaying transfer to long term management (or opting for a less efficient long term solution) while any consequent deterioration in benefits will not be readily apparent. That is, there is a natural conflict between the short run cost minimisation and long run waste management.

3.12 I have argued that regulatory bodies will have an informational disadvantage relative to the agency so there is no reason to suppose that the regulators will be able to monitor the position easily if all decisions are vested within the single agency. Indeed, if the regulatory body had enough information to monitor the full functions of a single agency then it is not clear what the agency's role is or why the whole problem could not be solved by centralised dictat. This is of course an unrealistic expectation. Indeed one of the most fundamental changes in the government's role in recent years has come from the realisation that putting activities in the public sector is not always a solution to market failure. Well-structured and regulated private incentives can achieve a better outcome but the trick is to ensure that the correct organisational structure is in place. Creating a single state entity and expecting it to do 'the right thing' is not a solution. The information and incentive problems have to be addressed seriously. Failure to do so may simply replace one market failure with a new set of distortions that again fail to meet the objective.

3.13 Separation of short and medium term waste management from very long run management appears to be the best way to elicit information and the correct signals. It also enables the incentives facing agencies to coincide more closely with society's objectives. An agency made accountable for the efficient treatment of long run waste management has an incentive structure that coincides with long run social preferences in that it has a reduced incentive to distort, delay or minimise long run waste management. In contrast, a single agency with a brief to minimise costs will meet its objectives more easily if it can distort, slow and minimise transfer.

- 3.14 Of course, contractual structures and regulatory rules will be needed to set times for this transfer whatever framework is chosen (see paragraphs 3.18 to 3.29). This immediately causes a transparency problem and need for an incentive scheme that encourages transfer to occur at the correct time while minimising regulatory costs. With a separate agency for management of long run liabilities, call this the Waste Management Organisation (WMO), there is maximum transparency between the two agencies. If the WMO is paid under contract according to waste received and managed it has every incentive to ensure that transfers to long run management are carried out as planned.
- 3.15 Furthermore, the dual system (i.e. separation between, on the one hand, short-and medium-term waste management and, on the other hand, long-term waste management) provides the maximum possibility of correct signals. For example, separation provides the regulator with comfort that the cost of short and medium term management storage and long run management are true economic costs of these activities determined in binding legal negotiations. Again within a single agency there is scope for manipulation of cost structures and accounting procedures. Of course, a regulator can press for detailed internal modelling of cost structures in an effort to resolve some of these problems but as is well documented in utility regulation this is a poor approach unless absolutely necessary and can ossify and distort decision-making.
- 3.16 Of course, there is no solution that delivers a perfect answer and there will be costs that arise as a result of separation into two agencies. The expertise learnt from dealing with competing approaches to short-term management will not be so easily transferred across organisations as within a single organisation. However, by its very nature, long run management lends itself least well to competition. For example, the market size and cost structure may be such that it is inefficient to have two repositories. There could potentially be competition for the franchise to build and manage a single repository but the time scale is unlike any other (far longer than

any PFI type contracts) and lends itself less well to a franchise competition for the whole operation. But there will be scope for contracting out many of the activities within WMO. However, the nature of these contracts is likely to be different from those overseen by the LMA and so the gains from bringing all this expertise with a single agency, instead of having it separated between the LMA and WMO, appear to be small compared to the incentive and informational benefits that arise from different agencies.

- 3.17 In summary, it appears that the information problem is most severe between short and long run management, that the potential for conflict between social preferences and individual incentives are most severe within a single organisation spanning these two activities and that the benefits of shared expertise are in comparison less important. The solution of one agency to deal with short run operational management of liabilities (here called the LMA) and another to deal with very long run storage (here called WMO) seems to offer most hope to provide efficient treatment of these liabilities.

### *Contractual Arrangements*

- 3.18 We have argued on efficiency grounds that there should be a major separation between short-term and long-term management. But, given this separation, what should the contractual arrangements be between the parties? The contractual structure is a fundamental issue. The *raison d'être* of government intervention in this industry is to correct market failure and so the implicit or explicit contractual relationship associated with the 'corrected market' plays a critical role in the delivery of the desired outcome. The current arrangements do not meet this objective.
- 3.19 My understanding is that currently Nirex advises on packaging and, where it is demonstrated that proposals are consistent with foreseen requirements for transport, handling, storage and long term management, prepares a 'comfort letter'. But, since

this is a comfort letter, the parties producing waste cannot discharge their liability. The existence of a potentially almost infinitely lived liability amongst other short-term relationships has significant disadvantages.

3.20 Those producing waste have a short-term profile on the ‘production’ side. For example, a private nuclear plant can last for 25 to 50 years. It provides revenue from sales of electricity during this time and produces waste at the end. Since the managers of the waste only receive a comfort letter their downside financial commitment is long lived. The liability sits with the enterprise for a very long period of time. This is unattractive for investors since unravelling the investment is only possible by passing it on to another investor. On the other hand, the sole party that is charged with the management of long-term liabilities has made some commitment – the comfort letter – but cannot, under current arrangements, hold the liability. This is a poor incentive structure.

3.21 In the jargon of law and economics we have a situation where the property rights are very unclear. The role of property rights plays two roles. One is the obvious contractual commitment. If the existing contractual arrangements continued then the LMA would not be able to genuinely discharge the liabilities. It would be no more than a cosmetic transfer. Similarly, the WMO would not be accountable for the process it is managing since it is only offering comfort letters rather than taking full contractual responsibility for its actions. The other role of property rights stems from the notion of residual rights when situations arise that are not covered clearly in the contract. For radioactive waste-producing technologies to be viable on any scale in the private sector then the private sector will wish to be in a position where residual rights, or in this context residual problems, sit with whoever owns the long term management of radioactive waste. Not unreasonably the private sector will be looking for a ‘buyer beware’ exit mechanism for their radioactive waste. This can only be achieved with a clear property rights structure.

3.22 It is not simply the private sector that feels the need for clear property rights. The public at large have every right to feel uncomfortable with a situation where there are unclear property rights and strong separation between those responsible for long-term waste management and those subject to residual claims.

3.23 Finally, the government's position as ultimate regulator is made hard since those charged with long-term waste management are not fully accountable. Indeed, the WMO's position is difficult since they are not able to sell the very thing (i.e. a trade in management responsibilities and liabilities) that the waste producers value most highly. A situation where the LMA gathered together, managed and then ultimately negotiated and organised the trade of the public sectors liabilities to the WMO is not possible under the current arrangement yet seems the obvious way of dealing with the problem.

3.24 The natural structure would be for:

- The LMA to gather together liabilities, oversee short and medium term waste management and negotiate with the WMO for the termination of these liabilities from the companies.
- provided the waste meets the requirements for long term management specified by the WMO then the liability for long term management passes to the WMO under a binding contract
- the LMA or the waste producers pay a fee to the WMO for the transfer of the liability.

*Regulation of waste management.*

3.25 A detailed regulation structure already exists. Here some high level comments are made which follow from the analysis up to this point in the paper. It is suggested

that the LMA and WMO should be public sector agencies but there are real dangers with placing both the regulatory and operational type functions within these agencies. Operational functions require cost effective management involvement in the oversight of private sector projects. All this should be conducted in an efficient manner. It is dangerous if the same agencies that have close involvement in the operational activities and are assessed in part on cost effective performance in this regard are also responsible for the design of their targets and the assessment of their performance. Also the appropriate safety standards, timing of transfer from short to long term management to phased deep disposal and prices to be levied should not be in the sole control of these agencies.

- 3.26 These abstract arguments suggest that there should be independent bodies that regulate those dealing with operational and financial management of the liabilities. Such regulatory bodies should have the powers to set standards, disallow particular prices and different types of waste management if necessary, and assess the performance of the agencies. Of course, in practice such bodies already exist for many of these functions. In essence, it might be useful to think of two types of regulators - those conducting a safety and environmental regulation and those concerned with economic regulation. The latter is where there may need to be a change in regulation.
- 3.27 In summary, the main practical point here is that economic analysis indicates that these regulators should have clear objectives and their powers should not be devolved to the LMA and WMO.
- 3.28 There remains one further regulatory issue. We have indicated that the problem of eliciting information lies at the heart of modern analysis of regulation and organisation structure. To minimise these problems we have suggested an optimal structure for managing liabilities. But this does not explain how information will be provided to assess and develop overall policy and to inform the general public. To this end it would be helpful to have a small Commission of independent commissioners who

are charged with taking an overview of the whole system and providing reviews of current policy. In one sense they would in part be replicating activities currently undertaken by various government departments and the industry but the main difference in the context of the Commission is that a fully independent body with a non-partisan role would bring them together.

- 3.29 There are many models that could be adopted for the Commission. A sensible one could be to provide powers to take evidence, even powers of seizure of evidence (e.g., as with the OFT), publication of reports and requirement of ministers to respond within a set period (as is the current position with the Better Regulation Task Force). A small, high profile, clearly independent Commission could be instrumental in informing and bolstering public confidence in the chosen policy.

## **4. Conclusion**

- 4.1 It has been argued that

- There should be one agency to deal with short run operational management of liabilities (here called the LMA) and another to deal with very long run management (here called WMO).
- It is suggested that the liability for long-term management should pass to the WMO under a binding contract and that the LMA or the waste producers pay a fee for the transfer of the liability.
- To aid the development of policy it is suggested that it would be helpful to have a small Commission of independent commissioners who are charged with taking an overview of the whole system and providing reviews of current policy.