



## CoRWM Position Paper: Transport Considerations

25 October 2018

This Position Paper reflects the Committee on Radioactive Waste Management (CoRWM) current position on the safety, security and environmental protection aspects of the transport of radioactive materials as part of the overall evaluation process of higher activity waste storage and disposal. It is designed to respond to consultation replies such as ‘*waste from power stations should not be transported but stored on site*’, and ‘*transport of waste would introduce uncontrollable hazards*’. The paper will be updated and revised as more information becomes available.

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### 1. Introduction

Transport of radioactive materials, waste and spent fuel has been a significant concern for stakeholders for the decades since the nuclear power programme began in the UK. For radioactive waste, the position of transport was extensively examined in the work that led up to CoRWM’s 2006 “Managing Radioactive Waste Safely: CoRWM’s Recommendations to Government” (CoRWM Document 700). Since 2006, a great deal more data has been generated on safety, security and environmental aspects associated with the transport of radioactive materials. This has confirmed rather than questioned CoRWM’s conclusions. This paper summarises the views given in CoRWM Document 700 and introduces some of the evidence and analyses which have been published in the intervening years.

### 2. Transport in CoRWM’s Recommendations to Government

Transport features prominently in CoRWM’s Recommendations to Government (Document 700), and in particular transport appears in the Committee’s Recommendation 2:

**Recommendation 2:** (Page 11) *A robust programme of interim storage must play an integral part in the long-term management strategy. The uncertainties surrounding the implementation of geological disposal, including social and ethical concerns, lead CoRWM to recommend a continued commitment to the safe and secure management of wastes that is robust against the risk of delay or failure in the repository programme. Due regard should be paid to:*

- i. reviewing and ensuring security, particularly against terrorist attacks;*
- ii. ensuring the longevity of the stores themselves;*
- iii. prompt immobilisation of waste leading to passively safe waste forms;*
- iv. minimising the need for re-packaging of the wastes;*
- v. the implications for transport of wastes.*

The transport of radioactive wastes is an important issue. In particular, the ‘double movement’ of radioactive waste should be avoided as far as possible. This is the movement of radioactive waste to centralised interim stores, followed by a second phase of transport to disposal facilities at a later date.

Typically, the mention of transport emphasises stakeholder views, and bring out such points as:

- i. *'many people said that the transport of radioactive waste should be minimised' (Para 17, page 71)*
- ii. *'in view of the importance that many people attach to minimising the transport of radioactive material, CoRWM did consider local near surface repositories for reactor decommissioning waste' (Para 19 page 71)*
- iii. *'Current site storage options all score better than their associated centralised options. The largest contributor to this difference is the security criterion, reflecting a judgement that transporting waste to a central location creates a greater risk of terrorist attack' (Para 21 page 82).*
- iv. *'It was acknowledged that preferences for some form of on-site disposal were driven by a desire to reduce the transport of waste. Members realised that what was not known was the balance of opinion between willingness to accept a local shallow disposal facility and willingness to accept transport of waste away from the site' (Page 89)*
- v. *the need to achieve passive safety and the desirability of avoiding unnecessary transport of wastes (Para 19, page 99)*

Overall, the stakeholder attitude to transport is summarised in Para 19 of the section on 'Location of Stores':

*Most of those participants in CoRWM's PSE process who commented on the transport issue argued that the transport of radioactive materials should be minimised or avoided altogether<sup>1</sup>. The key concern appeared to be the vulnerability of waste transport to terrorism, together with concerns about safety, the environment, and the impact on particular communities of moving the waste from one site to another. For the most part, respondents argued against the movement of any wastes, but some respondents thought that the transport of some materials, such as spent nuclear fuel, to improved interim storage facilities was justified even if the transport of large quantities of relatively low hazard waste (such as decommissioning arisings) was not. Some respondents expressed the view that there is a danger in over emphasising the problems associated with transport.*

## **Security**

The security concerns mentioned in Point 3 above, were commented on in the section on security issues (Para 22 et seq, Page 127). As the position is quite complex it is worthwhile to include the whole security issues section:

*Many of the security specialists considered that there is a significant vulnerability to terrorist attack and misappropriation during transport. The type of material being moved influences the desirability or otherwise of transporting it. Highly radioactive material, such as spent nuclear fuel and HLW, is regarded by some members of the public and stakeholders as an attractive target for terrorists, although the robustness of the transport packages, the form in which the waste exists, the dispersibility of the radioactivity, the utility of the waste to terrorists, and the level of security arrangements, are all elements for assessment in respect of the potential dangers represented by transport. Less radioactive material may pose a lower health risk but is generally far larger in volume and would therefore involve higher levels of transport.*

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<sup>1</sup> Committee on Radioactive Waste Management, "Briefing paper for CoRWM's Holistic Assessment, document" 1691 (pages 12, 16 and 49), April 2006.

*When assessing the options in terms of the vulnerability to attack during transport, the security specialists did not distinguish between the waste streams. Although they did make this distinction when they assessed the options in terms of vulnerability after emplacement, they found little difference across the waste streams because, in their view, the political impact of any attack on a store, or during transport, regardless of the relative activity of, or hazard posed by, the material involved "would be huge even if there were not a significant dispersal of activity."<sup>10</sup>*

*However, when assessing the options in terms of misappropriation, the specialists judged that spent nuclear fuel, plutonium and highly enriched uranium would be much more attractive to terrorists than any of the other materials. In the MCDA<sup>2</sup>, the local storage options with enhanced protection were judged to be the best performing storage options against the criteria as a whole for the higher activity wastes such as HLW, spent nuclear fuel, plutonium and ILW. This is because of the high weight given to security and the high importance that the security specialists gave to the transport risks associated with the central options.<sup>143</sup> No other criterion discriminated between the storage options to the same extent.*

*The evaluation of the actual terrorist risk associated with the movement of radioactive materials is complicated. While avoiding transport is a principle that is generally subscribed to, it is only one of the factors that need to be considered. It is also important to consider the potential impact on communities of retaining waste on existing sites.*

It is significant that the summary concludes that, while transport is per se undesirable, it is only one factor to consider when judging the future management of radioactive waste. As security is the factor examined, the weighting behind final decisions is unlikely to be wholly disclosed in the public domain.

Overall, the position to this point is that 'stakeholders generally dislike the transport of radioactive materials of any sort, and this transport also has security implications which must be considered'.

### **Environment and Loss of Amenity**

Additionally, environmental impacts and loss of amenity are addressed (Para 27, Page 128):<sup>4</sup>

*Several participants in CoRWM's process identified environmental impacts as additional reasons why transport should be minimised<sup>5</sup>.<sup>11</sup> The site specific environmental and amenity issues could not be assessed in the absence of a specific site but will clearly be important considerations when the environmental impact of any new stores is being assessed.*

This makes it clear that, while transport may have environmental and amenity effects, these cannot be addressed generically. They can only be addressed for a known site, with a known transport plan.

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<sup>2</sup> Multi-Criteria Decision Analysis – for background see Chapter 11 of CoRWM Doc 700, July 2006

<sup>3</sup> 14 Catalyze Limited, "CoRWM MCDA Decision Conference, March 2006", Catalyze report: COR006, document 1716.2, May 2006.

<sup>4</sup> Page 128

<sup>5</sup> 11 Committee on Radioactive Waste Management, "Briefing paper for CoRWM's Holistic Assessment, document" 1691 (pages 12, 16 and 49), April 2006.

## Safety Aspects of Transport

The only treatment of the safety aspects of transport was in the Section on 'Safety Issues' (Page 27):

*The safety specialists assessed the implications of transporting all the waste in the CoRWM inventory to a centralised location in terms of the risk from radiation, including accidents, and the non-radiation risk due to accidents. Studies show that the probability of a theoretical death being caused by radiation during transport is four times less than the probability of a death due to transport itself<sup>6</sup>. The specialists concluded that transport issues were much less important than the ability of the options to withstand events such as the loss of institutional control<sup>13</sup>. The environmental specialists drew similar conclusions.*

Clearly the effects on safety should be a key driver for minimising transport. Section 3 examines the analysis on which the conclusions of Document 700 are based and gives information on work and statistics which have become available since 2006.

### 3. Safety Effects of Transportation of Radioactive Materials

The Integrated Decision Management (IDM) review of transport risk and detriment referred to above,<sup>7</sup> starts with the comment that transport is viewed as a key variable, and is 'consistently identified as a significant concern, but currently without meaningful statistics to underwrite this'. The paper's section on transport is reproduced in Appendix 1.

Understandably, the paper is dominated by studies which were current at its date of publication (2005). With this limitation, it concludes that:

*The then-current British Nuclear Fuels Limited (BNFL) business case would involve 820,000 miles of spent fuel and waste rail travel, and would be predicted to cause 0.44 statistical deaths from transport accidents. For the same case, Nirex estimated 0.57 statistical deaths, with an additional 0.14 theoretical deaths due to public radiation dose.*

This infers that detriment from the transport of radioactive waste is dominated by conventional risks (collision, derailment etc.). Little detriment is driven by the nature of the radioactive material being transported. It should be noted that the CoRWM assumed that materials currently classified as waste will be conditioned to LoC (then 'Letter of Comfort', now 'Letter of Compliance'<sup>7</sup>) standards prior to invoking one or other of the options under consideration. This meant that none of the options would need to involve any additional transport of unconditioned radioactive materials.

In 2003, Nirex had carried out a Generic Transport Safety Assessment (GTSA). The GTSA was 'a safety assessment of a generic transport operation for the movement of intermediate-level and certain low-level radioactive wastes to a future radioactive waste phased disposal facility in the United Kingdom'. Two transport scenarios were addressed: The first maximised rail transport; while the second assumed packages were transported by road if they were within the weight limits of unrestricted transport by Heavy Goods Vehicles (HGV). Packages above these limits were transported by rail. The GTSA found that the dominant risks to the public were conventional (non-radiological). Greater risk was generated due to movement of materials during the construction of a Geological Disposal Facility (GDF), and during a worker's daily commute rather than by the movement of Intermediate Level Waste (ILW) to the repository.

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<sup>6</sup> 12 Integrated Decision Management Limited, "Background discussion paper: Option assessment criterion – Safety", IDM report 21/1, June 2005.

<sup>7</sup> Conditioned to the extent of being in a form suitable for disposal in a GDF

The predicted radiation doses to the public were very small:  $0.9 \times 10^{-2}$  to  $2.1 \times 10^{-2}$  man-Sv per year for maximum rail use, and  $1.9 \times 10^{-2}$  to  $3.1 \times 10^{-2}$  man-Sv per year when road and rail were used. With an average UK public dose of 2.7 mSv per annum<sup>8</sup>, these predicted doses are less than the dose received by a single member of the UK public.

CoRWM also commissioned a study on transport risk by the National Nuclear Laboratory (NNL)<sup>9</sup>, which was then peer reviewed by Nirex<sup>10</sup>. These sought:

*‘to obtain an understanding of the magnitude of the transportation that would be required to transfer the waste from the reactor sites to a national repository and the risks that would be avoided if this transport did not occur’.*

There were detailed disagreements between the two reports, but they agreed that:

*“It can be concluded that the transport of radioactive waste from the reactor sites to a national repository has been analysed by Nirex and the results demonstrate that the radiological risks are negligible, but the non-radiological risks dominate”.*

The general conclusions are supported by a body of work by regulators and others, on the detriment caused by radioactive material transport. References are provided in Appendix 2. A uniform finding is that the proportion of radioactive material movements arising from the nuclear fuel cycle is very low. While around 500,000 packages containing radioactive material per year<sup>11</sup> are moved by road alone<sup>12</sup>, the estimates for transport from the nuclear fuel cycle are much lower. In one estimate, 25,000 packages in 3,000 consignments per year were transport by road, and about 1,500 packages in 750 consignments were transported by rail<sup>13</sup>.

All of this supports the general conclusions that:

- The detriment from incidents involving the transport of radioactive materials is predominantly from the conventional effects of transport accidents.
- The individual radiation doses to the public from radioactive materials transport are extremely low, and the collective dose from projected transport programmes is vanishingly small in comparison to natural radiation.

It must, of course, always be borne in mind that the current risk and detriment level for radioactive materials transport is underpinned by a strict, and strictly observed, regulatory regime. Any divergence from this state would certainly invalidate the observations made in this study.

#### **4. Environment and loss of amenity**

As previously emphasised, CoRWM Document 700 has many references to the importance placed by stakeholders on radioactive materials transport. Also, several participants in CoRWM’s process identified environmental impacts as additional reasons why transport

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<sup>8</sup> <https://www.gov.uk/government/publications/ionising-radiation-dose-comparisons/ionising-radiation-dose-comparisons>

<sup>9</sup> Reduction in Transport Risk, NNC Limited, CoRWM Document No: 622, September 2004

<sup>10</sup> Review of CoRWM Document No. 622, Reduction in Transport Risk, Nirex, March 2005

<sup>11</sup> Most of these are packages containing materials destined for industrial, research and especially medical uses.

<sup>12</sup> Radiological impact of road and rail transport in UK, S J Watson, W B Oatway, A L Jones, A S Hughes, National Radiological Protection Board, NRPB-W66, 2005

<sup>13</sup> Survey into the Radiological Impact of the Normal Transport of Radioactive Material in the UK by Road and Rail, A L Jones, T Cabianca, Public Health England, 2017

should be minimised<sup>14</sup>. The numbers of movements mentioned in Section 3 are small in comparison to the overall number of national transport movements. While the overall transport impact may be small, there is a need to take specific sites and routes into account during any process moving towards the establishment of a GDF.

This must include all the planning considerations usual for a major infrastructure scheme, and environmental and amenity aspects will need to be addressed during the planning phase of any GDF.

## **5. CoRWM Current Stance**

This report reviews CoRWM's previous work on transport, as well as examining more recent developments. It supports a view that the standards and regulations applied to radioactive material transport have been adequate to ensure an operation where any detriment suffered is very largely due to the conventional risks of transport, with very little which can be attributed to the actual materials being transported.

Concerns have been raised about security which must be taken on board by the relevant authorities. However, there is currently little evidence that the transport of radioactive waste to a GDF would pose challenges outside the envelope of activities already undertaken for many decades.

It is of course true that '*with all other things being equal*', transport is an activity which should be minimised, if only to reduce resource use. However, there is clearly a need to prioritise this minimisation against other attributes and resource uses of any radioactive waste management scheme. This must be done proportionately and with a clear evaluation of changes in other attributes.

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<sup>14</sup> 11 Committee on Radioactive Waste Management, "Briefing paper for CoRWM's Holistic Assessment, document" 1691 (pages 12, 16 and 49), April 2006.

## Appendix 1. Section on Transport from Background discussion paper<sup>15</sup>: Option assessment criterion – Safety

### Transport

As evidenced by the importance given to it in the CoRWM consultation material<sup>16</sup> and in the nomination of 'Proximity' as a separate criterion for the Discussion Papers, transport is likely to be a major perceived difference between options. There has been no major transport incident leading to a release of radioactivity in the West, so the available statistics relate to routine operations. Routine transport risks consist of conventional transport accidents (collisions, derailments etc. for road and rail), while the major radiological component is from direct radiation from the transport flask to people near it – generally termed 'shine'. Most if not all studies of routine transport risk and detriment have been dominated by conventional accidents<sup>17</sup>.

The scale of the detriment can be judged from the previously mentioned work of the Spent Fuel Management Options Working Group of the BNFL National Stakeholder Dialogue<sup>18</sup>. This shows that the entire transport operation for the then BNFL Business Case totalled 2,000 journeys involving 820,000 miles of rail travel, with a predicted detriment of 0.44 statistical deaths. For comparison, figures derived from Nirex estimates<sup>19</sup> give an estimate of 0.57 statistical deaths, with an additional 0.14 theoretical deaths due to public radiation dose.

In direct contrast to the availability of statistics, the concerns expressed about the transport of radioactive materials centre on the possible effects of transport accidents giving a significant release of radioactive material. Perhaps the most useful study was the consideration by the Spent Fuel Management Options Working Group of the BNFL National Stakeholder Dialogue<sup>20</sup>.

However, it is worth repeating at this point that the CoRWM assumption is that materials currently classified as waste will be conditioned to LoC standards prior to invoking one or other of the options under consideration. None of the options would need to involve any additional transport of unconditioned radioactive materials. If this is so, these materials would have a Hazard Potential which is very much lower (many orders of magnitude) than, for example, plutonium dioxide powder, spent Magnox fuel, or Highly Active Liquor (HAL). Additional clarity is needed on the storage forms for materials which may be designated as waste. As an example, the Plutonium Working Group<sup>21</sup> of the BNFL National Stakeholder Dialogue agreed that the storage of plutonium as plutonium oxide powder was not a viable option for planning periods over 25 years.

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<sup>15</sup> Integrated Decision Management Limited, "Background discussion paper: Option assessment criterion – Safety", IDM report 21/1, June 2005

<sup>16</sup> CoRWM Second Consultation Document, 4<sup>th</sup> April – 27<sup>th</sup> June 2005

<sup>17</sup> See, for example, 'Assessment of the case for allowing BNFL to return radioactive waste to overseas reprocessing customers via ILW substitution, IDM for BNFL, January 2004

<sup>18</sup> Spent Fuel Management Options Working Group Report, July 1992, at [www.the-environment-council.org.uk](http://www.the-environment-council.org.uk)

<sup>19</sup> 'Assessment of the case for allowing BNFL to return radioactive waste to overseas reprocessing customers via ILW substitution, IDM for BNFL, January 2004, Appendix 2

<sup>20</sup> Spent Fuel Management Options Working Group Report, July 2002, at [www.the-environment-council.org.uk](http://www.the-environment-council.org.uk)

<sup>21</sup> Plutonium Working Group Report, March 2003 at [www.the-environment-council.org.uk](http://www.the-environment-council.org.uk)

## **Appendix 2. Example Studies on radioactive material transport**

Survey into the Radiological Impact of the Normal Transport of Radioactive Material in the UK by Road and Rail, A L Jones, T Cabianca, Public Health England, 2017

Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK – 2011 Review, M P Harvey and A L Jones, HPA Centre for Radiation, Chemical and Environmental Hazards, 2012

Radiological Consequence Resulting from Accidents and Incidents involving the Transport of Radioactive Materials in the UK – 2009 Review, M P Harvey, HPA Centre for Radiation, Chemical and Environmental Hazards, 2010

Radiological Consequence Resulting from Accidents and Incidents involving the Transport of Radioactive Materials in the UK – 2007 Review, M P Harvey, J S Hughes, HPA Radiation Protection Division, 2009

Review of Events involving the transport of Radioactive Materials in the UK, from 1958 to 2004, and their Radiological Consequences, J S Hughes, D Roberts and S J Watson, HPE Radiation Protection Division 2006

Radiological impact of road and rail transport in UK, S J Watson, W B Oatway, A L Jones, A S Hughes, National Radiological Protection Board, NRPB-W66, 2005

Statistics on the Transport of Radioactive Materials and Statistical Analyses, 2003,  
[https://ec.europa.eu/energy/sites/ener/files/documents/20131018\\_trm\\_statistics.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/20131018_trm_statistics.pdf)