

Response to Comments Received during the Consultation on Proposed HPA Advice on Radiological Protection Objectives for the Land-based Disposal of Solid Radioactive Waste

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ABSTRACT

In 2008 HPA published a consultation document on its proposal for revised advice on radiological protection objectives for the land-based disposal of solid radioactive waste (HPA, 2008). Views were sought on all aspects of the advice but specific questions were also given for the respondents to consider. A stakeholder workshop was held on 18 April 2008 as part of the consultation process. These comments were used to assist HPA in the development of its advice.

This document summarizes the main comments received during the consultation period and HPA's response to them. The revised advice is published in a separate document (HPA, 2009).

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1 INTRODUCTION

One of the functions of the Health Protection Agency (HPA) is the provision of information and advice on protection of the community (or any part of the community) from risks connected with radiation. This function is inherited from one of the HPA's predecessor organisations (the National Radiological Protection Board (NRPB)). HPA's role is an advisory one and it is not a regulator of radioactive waste.

In 1992, the National Radiological Protection Board (NRPB) – now the Radiation Protection Division of the Health Protection Agency – published advice on the radiological protection objectives for the land-based disposal of solid radioactive wastes (NRPB, 1992). HPA decided that it was necessary to update the advice for two main reasons. First, the previous advice was based on recommendations from the International Commission on Radiological Protection (ICRP) which has recently updated its recommendations (ICRP, 2007). Second, there have been a number of recent policy reviews by the UK Government and others looking at the options for radioactive waste disposal.

HPA asked operators and potential developers of radioactive waste facilities and interested government bodies, consultants and individuals for their views on the update of the advice in August 2007. Four sets of written comments were received and meetings were held with the Environment Agency, the Scottish Environment Protection Agency and the Nuclear Decommissioning Authority. The expressed views were taken into account in the development of the consultation document. HPA published the consultation document on the advice on radiological protection objectives for the land-based disposal of solid radioactive waste on its website on 3 March 2008 for a 3 month period (HPA, 2008). Views were sought on all aspects of the advice but specific questions were also given for the respondents to consider. A stakeholder workshop with 28 participants was held on 18 April 2008 as part of the consultation process and the discussions are summarised in (Jones et al, 2008).

Sections 2 to 11 detail the main comments received in response to Questions 1 to 10 in the consultation document, including comments made at the stakeholder workshop; HPA's response to them is summarised in italics. Section 12 details all other points made and HPA's response to them.

HPA would like to thank all those who attended the workshop and responded to the consultation. Their comments have been used to assist HPA in the development of its advice (HPA, 2009).

2 QUESTION 1: EXPOSURE PATHWAYS

Question 1: HPA has categorised the exposure routes that should be assessed into three broad types: natural processes, natural events and inadvertent human intrusion. Are there other categories of exposure routes which HPA should consider?

The main comments were:

- It was not useful to distinguish between processes and events. *This is reflected in the advice document, for example the risk criteria applies to processes and events.*
- Greater clarification was required on the definition of inadvertent human intrusion. In particular there were a number of comments that intrusion into the plume of radioactive contamination in the geosphere formed by the radionuclides gradually migrating from the waste disposal facility should be considered as part of natural processes and events. *Additional text has been added to give more examples of inadvertent human intrusion. The advice has been amended so that intrusion into the plume of contamination is considered to be part of processes and events.*
- Those who commented on naïve intrusion agreed that this is covered by the concept of inadvertent intrusion and does not need separate consideration. *HPA agrees with this and has not given naïve intrusion separate consideration.*
- One comment was as follows. 'It may not in all cases be appropriate to categorise climate change effects as examples of natural processes.' It concluded, 'To avoid difficulties such as these, we suggest two exposure route categories: "processes and events" and "inadvertent human intrusion"'. *HPA has amended the advice document so that it refers to processes and events rather than natural processes and events.*

3 QUESTION 2: MEASURE OF HEALTH IMPACT

Question 2: What measures of health impact(s) should HPA consider for assessing the radiological impact of repositories post-closure: dose, detriment-adjusted risk or fatal cancer risk?

The main comments were:

- There was general agreement from the workshop participants that detriment adjusted risk should be used as a measure of health impact. All respondents who addressed this question specifically agreed with the use of detriment adjusted risk. One respondent stated that 'The ICRP's response to heterogeneity is to employ assumptions. Most are individually questionable and when taken together, as they must be, they are simply not acceptable as a system of radiation protection. The upshot is that "dose" is an effectively meaningless term yet the industry's regulators have no other terms with which to assess and quantify risks'. *This statement has been passed on as a comment for HPA's consultation on the application of the ICRP's 2007 recommendations to the UK. In its advice HPA uses both dose and detriment-adjusted risk as measures of health impact for radiological protection purposes.*

- There were several comments saying that an explanation of detriment for a non-technical audience should be provided. *The advice document explains that detriment is a concept used to quantify the harmful health effects of radiation exposure in different parts of the body.*
- Three respondents commented that it was not appropriate to consider the uncertainties in the dose coefficients as the dose coefficients and dose-risk factors are "reference" in nature. One respondent stated that 'full account of uncertainties in exposures and in the dose coefficients should be taken'. One respondent commented that 'this aspect of HPA's advice requires amplification'. *Additional text on the treatment of uncertainties generally and in relation to dose coefficients has been provided. The advice explains that because the dose coefficients are calculated using defined models and radiation and tissue weighting factors, for the purposes of regulatory control, they are used as point values and are not regarded as subject to uncertainty. However knowledge of the magnitude of uncertainties can be a useful input to decisions on the optimisation of protection.*

4 QUESTION 3: RISK CONSTRAINT

Question 3: HPA has proposed a risk constraint of 1 in 100,000 per year for natural processes and events. Do you agree with this value? If not, why not? Should the risk constraint be set for a single facility or for all disposal facilities affecting the same exposure group at the same time?

The main comments were:

- The term 'risk constraint' was not appropriate as it could be interpreted as a regulatory limit and it implies that the assessed risk of the disposal facility can be estimated with a good degree of precision. At the stakeholder workshop there were discussions about whether the methodologies and the assessments were reliable enough to be used for comparison against the risk constraint and whether a genuine evaluation of compliance against the risk constraint could be made. *HPA has decided to continue using the term 'risk constraint' as this term has been used within the international community for number of years. Both HPA (then NRPB) and ICRP have used the concept of risk constraint in previous documents. ICRP 81 para 77 softens the concept of the constraint being treated as a limit. It states that 'evaluating whether there is compliance with the constraints requires a judgement. The dose/risk constraint should be considered as reference values for the time periods farther into the future...transgressions of constraints do not necessarily oblige rejection of a proposed safety case, merely because their value is estimated to be exceeded.'* *HPA has added additional text to the advice document to this effect. In addition HPA notes that constraints are used to protect the current generation. The general philosophy is to protect future generations to the same level of protection and therefore constraints should also be used to protect future*

generations. Regarding the reliability of assessments of radiological dose and risk it should be noted these assessments are just one of the factors to be considered in the assessment of the safety of a disposal facility. The radiological assessment needs to be suitably comprehensive, clear and transparent and to describe how the uncertainties are addressed.

- All those who commented on the risk value of 1 in 100 000 per year, about half the respondents, felt that it was an appropriate value.
- One respondent commented that ‘If we design the facility to meet a 10^{-6} criterion immediately, we will not have factored in the element of increasing uncertainty over time. I suggest that the risk be “Present-valued” from a million years hence, back to the present, and that it be calculated what level of risk today, meaning at closure, equates to a level of 10^{-6} in a million years time, and the “isolation facility” is then built to that standard. Graphically this can be visualized as a long tunnel with a flared mouth or bell (like a Tibetan trumpet or alphorn), narrowing gradually to a risk level of 10^{-6} at the far end (the “mouthpiece” end). Naturally this requires a much higher standard of protection at the outset, ie a much lower level of risk.’ *HPA considers that the risk criterion applies over all time so the facility is designed to meet it at all times in the future, not just at closure. Hence no change is needed. Whilst it is true that uncertainties in the assessment increase over time it is not true that they will always result in an increased level of risk to future generations.*
- The consultation document stated that exposure to radon gas should be treated separately for both natural processes and events and human intrusion. There were several comments saying that radon should not be treated separately. *HPA has taken account of these comments in its advice. The amended advice does not require exposure to radon gas to be treated separately but does state ‘where radon is a significant contributor to the estimated doses the assumptions made in the assessments for radon should be clearly stated. The doses and risks estimated for radon should also be presented separately so the contribution of radon gas can be clearly seen and understood.’*
- There were several responses to the question of whether the risk constraint should be set for a single facility or for all disposal facilities affecting the same exposure group at the same time. One respondent commented as follows. ‘Risk constraint should be set for “a waste disposal facility, or group of waste disposal facilities, which can be optimised as an integral whole in terms of radioactive waste disposal.”’ The comment continued: ‘The site-related dose constraint of 0.5 mSv/ year set out in Cm 2919 which applies to the aggregate exposure from a number of sources with contiguous boundaries at a single location, irrespective of whether different sources on the site are owned or operated by the same or by different organisations would apply also and could be relevant at complex sites such as those with more than one nuclear power station. In particular, this value would be applied in the case of exposures from multiple facilities affecting the same exposure group at the same time for which it is not practicable to apply the principle of optimisation in an integrated manner.’ Another respondent stated: ‘The constraint must be on a single facility with dose

limit applying to the collective of facilities. We believe that the risk constraint should apply to a single and entire facility. In the event of collocation of (say) ILW and HLW in a single repository the risk constraint should still apply to the whole repository. If several but discrete facilities potentially affect the same critical group, then each facility would be subject to the risk constraint and members of the critical group would be subject to the limit.' A third respondent commented: 'The risk constraint of 1 in 100,000 per year is reasonable and should apply to the sum of the risks from two or more disposal facilities if these risks are to the same hypothetical person.' *There are greater uncertainties associated with estimating the exposures from the disposal of solid radioactive waste as opposed to the disposal of gaseous or liquid radioactive waste due to the longer timescales involved. Therefore HPA has decided it is not appropriate to have two risk constraints, one for a disposal facility and one for a site, which are different by approximately only a factor of two, as this implies an undue level of precision. The advice recommends that the risk constraint applies to the risks from a single facility. However, consideration should also be given to the sum of the risks from any other existing or planned disposal facilities that also affect the same exposure group at the same time.*

5 QUESTION 4: DETERMINISTIC DOSES

Question 4: Is the HPA proposal^{*} the best way to deal with prevention of doses giving deterministic health effects from natural events? If not, what would be a better approach?

The main comments were:

- The majority of respondents were in favour of this approach but three commented that they did not think that it was useful. One respondent stated: 'We do not think that this is meaningful because there will be a high level of unquantifiable uncertainty associated with any assessment of probability of these events. We suggest this is omitted from the final guidance.' Another commented: 'HPA's proposal is not entirely clear, and neither is it clear what the effect of the proposal would be, as the uncertainties around the natural events that might cause deterministic effects are very large in terms of their likelihood and their magnitude. We suggest that a numerical treatment of these scenarios is difficult to justify for deep or surface facilities. For geological disposal in particular this proposal would have little practical effect, as it is very difficult to envisage a natural event affecting a geological disposal facility that could result in deterministic effects to people.'

HPA decided that for near surface facilities a numerical criterion for protection against deterministic effects was not needed. The advice states that 'For near surface disposal

^{*} The total probability of a person receiving a dose above 0.1 Sv as a result of naturally occurring events should not exceed 1 in 1 000 000 per year

facilities the HPA guideline dose range for inadvertent human intrusion (annual dose of around 3 mSv to 20 mSv) will ensure that the doses from inadvertent human intrusion are well below the level that could give rise to severe deterministic effects. HPA does not expect that any processes and events could lead to higher doses than those estimated for inadvertent intrusion directly into the waste. Therefore HPA expects that, for the types of waste that are suitable for disposal into near surface facilities, processes and events affecting the disposal facility are unlikely to give rise to severe deterministic injuries. Hence, it is not necessary to set specific numerical criterion for deterministic doses for near surface facilities'. For geological disposal facilities the numerical criterion is not an effective way of preventing deterministic doses as the estimates of probability of occurrence are not very reliable. The advice recommends that for geological disposal facilities the likelihood of deterministic effects arising should be one of the factors considered in the optimisation study.

6 QUESTION 5: DOSE GUIDANCE LEVELS FOR INADVERTENT HUMAN INTRUSION

Question 5: HPA is proposing dose based criteria for calculations of inadvertent human intrusion into near surface disposal facilities. HPA propose a dose guidance level of 20 mSv is used for short term exposure and an annual dose guidance level of 3 mSv of per year for exposures lasting more than 5 years. What dose criteria do you think should apply to exposures that last more than a few weeks but less than 5 years: 20 mSv total dose, the 3 mSv annual dose or another value?

The main comments were:

- All of the respondents who commented on the use of the dose criteria for inadvertent intrusion into near surface facilities agreed with the approach. However one respondent commented: 'We feel that further thought needs to be given to how this approach would fit into the current framework for regulating disposal facilities and the potential usability and implications of such an approach. Human intrusion cannot be ruled out over very long periods and HPA, together with regulators and policy makers as appropriate, should give consideration to how such an approach would influence the siting, design, authorisation and operation of existing and new surface disposal facilities.'
- Two respondents agreed with the proposed guidance levels. Two other respondents suggested a range rather than two specific levels and proposed a range of around 3 mSv y⁻¹ to around 30 mSv y⁻¹. A fifth respondent commented: 'I would favour 10 mSv for exposure over a period of less than a year and 3 mSv per year for exposures over a year or more'. Another respondent commented, 'We consider that the HPA's own consultation document summarises the much better scientific case that exists for setting the lower value at 1 mSv for all exposures lasting for more than one year. In accordance with a suggestion of the ICRP, we suggest that for the simplicity of communication and to facilitate wider stakeholder understanding the figure defining the upper bound be set at

10 mSv.' A further respondent commented: 'Broadly I am sure [the organisation] would agree with the HPA approach (justification, optimisation and limitation) but I think an ordinary member of the public will wonder why the public dose limit is set at 1mSv py but optimisation in emergencies will probably mean no action if dose is not expected to exceed 10mSv py and possibly no action up to 100mSv (and in the case of "inadvertent intrusion" into a repository a tolerable dose of 3 mSv py "should be applied".' *HPA has adopted a range of guidance levels, based on the guidance levels given in the consultative document. Therefore HPA advice recommends an annual dose guidance range of around 3 mSv to 20 mSv related to the exposure of an individual representative of the more highly exposed individuals in the population following inadvertent intrusion. The reasons are outlined in the advice document.*

- There were several comments that the statement in the consultation document that 'the probability of intrusion can be assumed to be zero during both the active and passive institutional control periods' could not be assumed to be correct for the passive institutional control period. *The HPA advice has been amended accordingly.*

7 QUESTION 6: HUMAN INTRUSION INTO GEOLOGICAL DISPOSAL FACILITIES

Question 6: HPA is proposing different approaches for deep geological and near surface disposal facilities for inadvertent human intrusion. For deep geological facilities it is proposed that no dose guidance level is set but 'stylised scenarios' are used to explore the likely consequences. Do you have any comments on this proposed approach?

The main comments were:

- In general, respondents agreed with the proposal to treat inadvertent human intrusion into deep geological and near surface disposal facilities differently.
- There is a need to clarify the distinction between "deep geological" and "near surface", taking into account those facilities located at intermediate depths (tens to a couple of hundred metres) and ensuring that no disposal facility falls between the two. *Text has been added to the advice document saying that 'The depth at which a waste disposal facility would be defined as a near-surface disposal facility or a geological facility cannot be defined in exact terms nor it is helpful as it will depend on the circumstances of the specific disposal facility. The facility should be assumed to be a near-surface one unless the developer can demonstrate that the safety assessment for processes and events depends on the very long term containment of the waste in the geosphere.'*
- Whilst there was general support for not setting a dose guidance level for deep geological facilities, the concept of and reasons for "stylised scenarios" require clarification. *In the advice document examples of reference scenarios have been added. The HPA is also considering whether additional guidance*

on scenarios and reference assumptions for exposures arising through human intrusion, in a separate document, would be useful.

8 QUESTION 7: LOWER GUIDANCE LEVEL

Question 7: Is the concept of a lower guidance level useful? If so do you agree that it should be set at 1 in 1,000,000 per year? If not, why not?

The main comments were:

- Many of the respondents agreed that the concept of a lower guidance level is useful. Two respondents suggested that more clarity is required on the meaning of the lower guidance level whilst three respondents disliked the term "lower guidance level". Some of the attendees at the stakeholder workshop felt that there was no practical difference between the 1 in 100 000 and 1 in 1 000 000 risk values and that the use of two values therefore gives a misleading impression of what can be achieved and by implication that it does not make sense to allow a lower level of effort to be expended for lower risks. *Following discussions both internally and with the environment agencies it was decided that a numerical lower guidance level would not be specified but that the need for the level of effort expended to be proportionate to the level of risk would be stressed.*
- Many respondents agreed with setting the level at 1 in 1 000 000 y^{-1} . Two respondents stated that the lower guidance level should not be used as a trigger to change or relax the scope or thoroughness of optimisation with another pointing out that the environment agencies would not relax the optimisation requirement if a lower dose can be easily achieved. *HPA agrees that optimisation is a constant requirement and has redrafted the text to reflect this.*

9 QUESTION 8: COLLECTIVE DOSE

Question 8: Is collective dose a useful concept for assessing the disposal options for long-lived waste: a) for the first 500 years post closure? b) for the very long term? If not, why not?

The main comments were:

- The majority of respondents felt that collective dose was not a useful concept, mostly citing the large uncertainties involved. The minority thought it might be a useful concept in eg, comparison of options and for optimisation purposes.
- Some respondents felt that a dose-matrix approach might be useful especially for assessing impact to specific populations (eg the local community) at specific

times. The point was made that the size of the affected population is as important as the magnitude of individual risk.

- Views on the 500 year limit tended to be that it was too precise a limit and that it was not helpful since there should be little or no migration of the radionuclides in the first 500 years and hence no human exposure.

For collective doses resulting from discharges during the operational and active institutional control phases HPA recommends that the collective dose should be truncated at 500 years. For collective doses resulting from the disposed waste in the post active institutional control phases a specific truncation time is not given as it will be dependent on the disposed waste and type of facility. However it is not advisable to consider the very long term collective dose to members of the public in view of the large uncertainties. These uncertainties effectively make any comparison meaningless. HPA advises that collective doses should only be calculated for times where they can be used as a useful discriminator between the different waste management options. This is likely to be of the order of several hundred years post closure.

10 QUESTION 9: OTHER SAFETY INDICATORS

Question 9: a) Are there any other safety indicators that could be usefully considered?
b) If so how might they be applied?

The main comments were:

- The majority of respondents felt that other safety indicators could be useful, although the term "safety indicator" was questioned with one respondent suggesting the term "health protection indicator" as an alternative. Such indicators should be supplementary to dose and risk rather than a substitute.
- Of these respondents, some thought that specifying other indicators was beyond the remit of HPA and others said any supplementary indicators must be consistent with the requirements of the environment agencies document 'Guidance on Requirements for Authorisation'.
- A small number of respondents felt that other indicators were not of use.

HPA has decided that its advice would refer to dose and risk as a means of evaluating the safety of a disposal facility in radiological protection terms. However the advice document does state that 'there are many other radiological protection indicators that might usefully be considered besides dose and risk including, for example, radionuclide flux, radionuclide travel times and environmental concentrations, as well as consideration of natural analogues. They should not be seen as alternatives to dose and risk, but rather as supplementary indicators of radiological protection.'

11 QUESTION 10: ASSESSING DOSES AND RISKS

Question 10: Do you agree in general with the proposed approaches for assessing doses and risks?

The comments in response to this question were varied and although the majority of respondents agreed generally with the proposed approaches there were a number of specific comments. These include:

- Several respondents felt that HPA's guidance should address uncertainties. *The advice document now includes a section on the treatment of uncertainties.*
- There were two comments on the statement in the consultation document that the period specified for active control of a small near surface facility may be significantly less than for a deep geological facility. Both respondents made the point that this might be the case but the opposite could also be argued. *The text in the advice document has been amended to say 'This time period could vary from a few years to centuries depending on a number of factors such as public acceptability, the level of hazard posed by the waste and the likelihood of intrusion into the waste.'*
- Two of the respondents felt that the statement that generally the characteristics of potentially exposed groups or individuals in the future should be defined based upon present-day techniques might be too prescriptive. *The following text was added to the advice document. 'In addition to assuming that the hypothetical representative person behaves in a similar way to present day people in that region account needs to be taken of the impacts of climatic changes. Thus, for example, the hypothetical representative person may also be defined based on human behaviour and habits within climatically analogous regions of the World'.*

12 QUESTION 11: ANY OTHER COMMENTS

Question 11: Do you have any other comments on the proposals in this document?

Some of the comments received did not relate to the specific questions or to proposals in the document and are given below.

- 'Your consultation document depends crucially on advisory recommendations promulgated by the International Commission on Radiological Protection which are scientifically invalid insofar as they are extended to some of the exposures associated with waste.' This respondent later states: 'The ICRP's response to heterogeneity is to employ assumptions. Most are individually questionable and when taken together, as they must be, they are simply not acceptable as a system of radiation protection. The upshot is that "dose" is an effectively meaningless term yet the industry's regulators have no other terms with which to

assess and quantify risks. Reassurances about "trivial doses" are revealed as empty.' *This is beyond the scope of this advice document and has been passed on as a comment relating to the consultation document describing HPA's proposed advice on the application of ICRP's 2007 recommendations to the UK, published in August 2008. It will be addressed as part of that consultation.*

- 'Furthermore, in view of the substantial durations planned for interim (ie surface) storage, under current proposals (in the order of centuries), and in view of the CoRWM Report's stress on the importance of Loss of Institutional Control as a "critical issue" in their rejection of long-term interim storage of existing wastes in the first place, failure to conduct a comprehensive "features, events and processes" analysis of surface facilities, prior to the generation of new wastes, will inevitably result in far higher levels of risk to the next few generations.' This respondent later states: 'If the HPA is committed, as it states, to treat all future generations equally, then it should ensure it is not discriminating against near future generations by failing to extend to them the protection of a comprehensive "features, events, and processes" Analysis. If that means it has to revise its "neutrality" towards nuclear power, then so be it.' *HPA disagrees that protection of future generations to the same level as current ones means that HPA cannot have a neutral position on the issue of nuclear power generation and its waste. The advice relates to the disposal of radioactive waste not to the justification of new nuclear power stations. HPA agrees with the ICRP statement that 'waste management and disposal operations are an integral part of the practice of generating the waste. It is wrong to regard them as a free-standing practice, needing its own justification. The waste management and disposal operations should therefore be included in the assessment of the justification of the practice generating the waste.'*
- 'For example there is an argument in Government that a Repository should not be marked*, as it would encourage human intrusion. On the basis of the Equality of Generations, which includes the equality of rights of affected generations, the HPA must specifically reject this view.' *Whilst HPA agrees with the concept of equality of generations the effectiveness of a marker is more of an anthropological or archaeological question than a radiation protection one and therefore HPA does not wish to comment.*
- 'In particular this response highlights the fact that the 'barriers' referred to by ICRP 81 are not actually present in the designs for a burial facility that are put forward by the industry. (This is due to the need to provide a pathway for gas release.) Given that the barriers will not be in place there will be a route for contaminated water to reach crops and drinking water supplies – this means that it is important to have a reliable methodology for predicting contamination levels. In fact the approaches to this calculation that are applied by the nuclear industry can be up to 100 million times out. These technical and scientific realities are not referred to within the HPA Consultation document. Given the fact that the

* UK Government Response to IAEA Questions on National Response to IAEA Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management,

Government are due to publish a White Paper in which local Communities are invited to 'Volunteer' to put forward their neighbourhoods as locations for a Nuclear Waste Burial Site - it is imperative that the HPA takes full cognizance of the difficulties to be expected in actually reaching the targets that they set out. If the HPA do not do this – it would be very easy for the Nuclear Industry – or the Government – to imply that these standards had been met – although it was very clear that it was not the case.' *HPA argues that it is the responsibility of the developer of the disposal facility to make a sufficiently robust safety assessment case.*

13 REFERENCES

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