

Radiological Assessments in Support of the UK Review of Exemption Orders for Radioactive Waste

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Abstract. In 2009 and 2010, as part of the better regulation initiative, the Department of Energy and Climate Change (DECC) and the Devolved Administrations consulted on a new exemption orders regime under the Radioactive Substances Act 1993 and the Environmental Permitting regulations (EPR) 2010. The overall aim was to have a simpler set of exemption orders, informed by risk, that are more easily linked to the European Basic Safety Standards Directive.

As part of the work to support the review of the exemption orders, DECC asked HPA to advise on the radiological protection and health related aspects of the proposed regime. HPA performed a number of radiological assessments to ensure that the exclusion and exemption levels for radioactive wastes in the new regime took into account the associated risk to health. These radiological assessments are briefly described.

The results from the HPA's radiological assessments are incorporated into the Exemption Order that came into effect in the autumn of 2011, replacing the previous set of Exemption Orders.

KEY WORDS: exemption, radioactive waste, NORM, radiological assessment

What are exemption orders?

In the UK until recently the Radioactive Substances Act (RSA) 1993¹ radioactive and its predecessor, RSA 1960, regulated the keeping and use of radioactive substances, and the accumulation, storage and disposal of radioactive waste. A 'family' of Exemption Orders had evolved under the Act as a means of reducing regulatory control over radioactive substances and waste for widespread practices where risk to health is trivial. In 2010, in England and Wales, RSA 1993 was subsequently incorporated into the Environmental Permitting (England and Wales) Regulations (2010)². In 2009 and 2010, as part of the better regulation initiative, the UK's Department of Energy and Climate Change (DECC) and the Devolved Administrations consulted on a new exemption orders regime that could be applied under both the RSA 1993 and the Environmental Permitting regulations (EPR) 2010. The overall aim was to have a simpler set of exemption orders, informed by risk, that are more easily linked to the European Basic Safety Standards Directive (BSSD)³.

HPA's contribution to the Review Process

As part of the work to support the review of the exemption orders, DECC asked HPA to advise on radiological protection and health related aspects of the proposed regime. The new regime contains exclusion levels (activity

concentrations below which the waste is not considered to be radioactive) and exemption levels (total activity or activity concentration levels below which a permit or authorisation for radioactive waste disposal is not required). DECC asked HPA to perform a number of radiological assessments to ensure that the exclusion and exemption levels for radioactive wastes in the new regime took into account the associated risk to health. HPA also advised on the use of internationally agreed exemption levels in the new regime.

HPA performed specific radiological assessments to determine suitable exemption levels for large volumes of solid wastes containing naturally occurring radionuclides (NORM); suitable exemption levels for aqueous liquids; suitable exclusion levels for NORM gases and NORM liquids to compliment internationally agreed values for NORM solids; and suitable exclusion levels for non-aqueous liquids.

Exemption levels for NORM waste

HPA was asked by DECC to investigate the amount of NORM waste, with a head of chain concentration of up to 5 Bq g^{-1} that can be disposed of to landfill without exceeding the dose criteria given in Table 1⁴.

Table 1 Dose criteria

Scenario	Dose criterion	Key groups
Operational phase	1 mSv y^{-1}	Landfill worker
Inadvertent intrusion (post-closure)	3 mSv y^{-1}	Member of the public (i.e. resident), construction worker
Inhalation of ^{222}Rn landfill gas (post-closure)	200 Bq m^{-3}	Member of the public (i.e. resident)
Migration with groundwater (post-closure)	0.02 mSv y^{-1}	Member of the public

The exemption levels for solid NORM wastes were derived using the landfill assessment methodology developed by HPA⁵. The exposure scenarios included exposure of landfill workers, and post closure exposure of the public, through migration and inadvertent intrusion. The calculations considered the three natural decay chains (uranium-238, thorium-232 and uranium-235) and a generic landfill site for inert waste, with a capacity of $2.2 \cdot 10^6$ tonnes and a lifetime of 15 years. The radiological capacity of the landfill site was determined for each natural decay chain, considering both the whole chain in secular equilibrium and different segments of the chain. The maximum head of chain or chain segment activity concentration considered in the study was 5 Bq g^{-1} . For a chain in secular equilibrium this corresponds to 5 Bq g^{-1} for each chain member.

It was found that if the sum of the head of chain activity concentrations for the three natural decay chains was 5 Bq g^{-1} or lower, then setting an annual disposal limit of 10 000 t of NORM waste per consignor (assuming three consignors of NORM waste to the site) would ensure that the radiological criteria were met. Larger quantities of waste containing correspondingly lower activity concentrations would also meet the radiological criteria. This corresponds to a generic limit of $5 \cdot 10^{10} \text{ Bq}$ per consignor per year, where the activity concentration assigned to each chain is the head of chain activity concentration, or the maximum activity concentration in the chain, rather than the total activity

in each chain. These results were incorporated directly into the revised Exemption Order and related guidance.

Exemption levels for aqueous liquids

DECC asked HPA to calculate activity concentration values for aqueous liquids that could be used as either exclusion or exemption levels, based on a dose criteria of $10 \mu\text{Sv y}^{-1}$ to individuals representative of those most highly exposed and a collective dose per year of practice of 1 manSv . HPA derived these activity concentration levels using a simplified version of the methodology used by HPA to calculate generalised derived limits of radioactivity in environmental media⁶. The calculations considered generic freshwater exposure pathways (ingestion of drinking water and fish, and external irradiation from contaminated river sediments) and determined radionuclide specific activity concentration levels in aqueous liquids that would meet the radiological criteria. Results were obtained for over 270 radionuclides and these were compared with values for 84 radionuclides based on the UK Environment Agency's Initial radiological assessment methodology⁷ and found to be in good agreement. The quantity of liquid containing these activity concentration levels that could be disposed of to a sewage treatment works was also calculated using a range of models. Although HPA proposed a single radionuclide independent value in its report, later discussions with DECC and the Environment Agencies resulted in the revised Exemption Order containing different allowable quantities for different groups of radionuclides. The radionuclide specific activity concentration levels calculated by HPA are incorporated directly into the revised Exemption Order.

Exclusion levels for NORM liquids and gases

The exclusion levels for NORM liquids were derived using the simplified methodology⁶ discussed above but using a dose criterion of $300 \mu\text{Sv y}^{-1}$ to be consistent with the EC guidance on clearance levels for solids for NORM wastes⁸. DECC also asked HPA to recommend exclusion levels for NORM gases using the dose criterion of $300 \mu\text{Sv y}^{-1}$. Inhalation and external exposure pathways were considered, assuming that an individual is exposed for 8760 hours per year, and using dose coefficients⁹ recommended by the International Commission for Radiological Protection. The derived exclusion levels¹⁰ were incorporated directly into the revised RSA 93 and EPR 2010^{11,12,13}.

Exclusion levels for non-aqueous (relevant) liquids

HPA was asked by DECC to consider whether the EC clearance levels for solids¹⁴ could also be used for exclusion or exemption for non-aqueous liquids, such as solvents, organic liquid scintillants and mercury. The exemption levels for aqueous liquids are not relevant to non-aqueous liquids because they include direct consumption of the liquid (as drinking water) which is not appropriate for non-aqueous liquids. The exposure pathways considered in the assessment were inhalation, ingestion as a contaminant in drinking water, external exposure and contamination of skin following a spill. It was concluded¹⁵ that the EC clearance levels for solids¹⁴ were appropriate for defining exclusion for non-aqueous liquids and other non-potable liquids. This was incorporated in the revised RSA93 and EPR 2010 in the provision for 'relevant' liquids.

Summary

Over the period of the review, HPA has been providing advice on exemption and assistance with aspects of the review programme. The results from HPA's radiological assessments informed the development of the single Exemption

Order which appeared in new legislation^{11, 12, 13, 16, 17} that came into effect in the Autumn of 2011.

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