

Derivation and Application of Intervention Levels and Remediation Targets for Contaminated Land

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Radioactive and Chemical Contamination on Nuclear and
Defence Sites: Best Practice in Land and Waste Management

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Abstract

Management of contaminated land on nuclear and defence sites is complex due to the differing requirements of regulatory regimes which apply in various circumstances and at different times during a site's lifetime. There are inconsistencies between regimes, and between the approaches and expectations of different regulators. This presentation summarises the requirements of the main regulatory regimes which apply to the management of radiological and non-radiological contamination on and adjacent to nuclear sites. It then reviews the differing requirements for the derivation of intervention levels and remediation targets under each regime, highlighting gaps and inconsistencies between regimes and between different parts of the UK. A facilitated discussion after the presentation will give delegates the opportunity to share experience, comment on concerns and make suggestions for improvements which will be fed back to the NDA by SAFESPUR, for use in discussions with regulators with the objective of developing consistency and clarity in land management requirements.

Principal Regulatory Regimes

Type of site	Status	Type of contamination	NIA	Radio-active substances regime	Part 2A	Water pollution	Planning	PPC	Energy Act
Nuclear licensed sites	Operational	Radioactive	✓	(✓)		(*)	(✓)		
		Non-Radioactive			✓	(✓)	(✓)	(✓)	
	To be delicensed	Radioactive	✓	(✓)		(*)	(✓)		
		Non-Radioactive			✓	(✓)	(✓)	(✓)	
Non-nuclear licensed sites	No change of use proposed	Radioactive		(✓)	✓	(*)			(✓)
		Non-Radioactive			✓	(✓)		(✓)	(✓)
	Change of use proposed	Radioactive		(✓)		(*)	✓		(✓)
		Non-Radioactive				(✓)	✓	(✓)	(✓)

Key

- () Regime relevant but other regimes take precedence for derivation of intervention levels & remediation targets
- * Due to be extended to cover radioactive contamination in future

Nuclear Installations Act

- Only applies on nuclear licensed sites
- Only applies to radioactive contamination
- HSE Safety Assessment Principles (SAPs) include requirement to assess and protect the environment, but remediation is only considered in terms of managing risks to human health
- On operational sites:
 - Contaminated land must be managed in accordance with a Safety Case
 - Any requirement for remediation is risk based. Risk criteria which apply will depend on circumstances
- For delicensing:
 - HSE's "no danger" criterion (individual risk of death from use of land for *any reasonably foreseeable purpose* $<10^{-6}$ per year) must be met ("multifunctional use")
 - HSE expects this will be demonstrated by application of IAEA exclusion and exemption levels, which list activity concentrations (Bq/g) for various radionuclides

Radioactive Substances Regime

- Covers radioactive contamination only
- Applies to solids, liquids and gases
- Where they apply, Nuclear Installations Act and Part 2A take precedence over radioactive substances regime for the derivation of intervention levels and remediation targets
- Radioactive Substances Act Schedule 1 and Exemption Order limits are no longer accepted as remedial targets by regulators
- In setting remedial targets, planning authorities and developers are expected to take account of HPA advice (which implements ICRP recommendations). This only addresses risks to humans:

Situation	Typical example	Intervention level	Remediation target
Intervention	Land in current state, no change of use	Projected lifetime exposure >1Sv (>10-20 mSv per year)	Justified in terms of future exposures
Practice	Redevelopment	Not applicable	Risk $\leq 10^{-5}$ per year (equivalent to ≤ 0.3 mSv per year), or less if ALARA. Remediation unlikely to be justified if risk $< 10^{-6}$ per year (equivalent to ~ 20 μ Sv per year)

Pollution Prevention and Control Regime

- Only applies to facilities holding a Part A PPC Authorisation or Environmental Permit
- Covers non-radioactive contamination only
- On surrender of permit, site must be returned to state of contamination which existed at time permit was issued
- Could be more onerous than “suitable for use” standard if site was previously uncontaminated

Part 2A Contaminated Land Regime

- Applies to land in current use, including any new use for which planning permission is not required or has already been granted
- Implements “suitable for use” approach
- Minimum standard of remediation is that which ensures land no longer meets Part 2A definition of “contaminated land”, but derogation is permitted on grounds of
 - Reasonableness (which includes cost and benefit), practicability, effectiveness or durability, except for
 - Radiological contamination in England & Wales, when derogation is permitted when remedial action is not justified or optimised
- No requirement to remediate any pollution which does not form part of a significant pollutant linkage
- Applies differently to non-radioactive and radioactive contamination

Part 2A – Non-Radioactive Contamination

- Applies both on and off nuclear licensed sites
- Covers harm to
 - Human health
 - Water environment
 - Ecological systems with statutory designation (e.g. SSSIs)
 - Crops and livestock
 - Domestic animals
 - Wild animals where subject to shooting or fishing rights
 - Buildings and scheduled ancient monuments
- Applies when specific criteria for harm or significant potential for significant harm (SPOSH) are met
- In the case of water pollution, only applies where contamination is continuing to enter water. Does not apply to historical water pollution
- In Scotland, the definition of “contaminated land” was changed in 2006 to introduce a test of significance for water contamination. This change has not yet been implemented in England & Wales.

Part 2A – Radioactive Contamination

- Does not apply on nuclear licensed sites
- Applies only to contamination in excess of background
- Would apply to land contaminated as a result of a nuclear accident where remediation could not be secured under another regime
- Differences:
 - Does not apply to risks from radon gas in England & Wales¹
 - Only applies to control of risks to human health in England & Wales, whereas in Scotland the regime also applies to non-human receptors and water environment
 - In Scotland, radiological Part 2A regime applies to all non-human (ecological) receptors, whereas non-radiological Part 2A regime applies only to ecological receptors with statutory designation (e.g. SSSIs)
- Dose constraints given for definitions of harm and SPOH/SPOSH, except in the case of water contamination (Scotland only) where assessment is risk based

Part 2A – Radioactive Contamination

Definitions of “harm” (E&W) and “significant harm” (S)

Lasting exposure criterion constituting harm/significant harm		England & Wales	Scotland
Human beings	Effective dose	>3mSv per year	>3mSv per year
	Equivalent dose to lens of eye	>15mSv per year	>15mSv per year
	Equivalent dose to skin	>50mSv per year	>50mSv per year
Terrestrial biota or plants		Regime does not apply	>40μGy per hour
Aquatic biota or plants		Regime does not apply	>400μGy per hour
Water environment		Regime does not apply	Concentrations of radionuclides that <i>if a receptor was present</i> would result in harm to man or to non-human species (i.e. pollutant linkage to receptor not necessary)

- Dose constraints for human exposure constituting harm/significant harm are same in England, Wales and Scotland

Part 2A – Radioactive Contamination

Definitions of SPOH (E&W) & SPOSH (S)

Lasting exposure criterion constituting SPOH/SPOSH		England & Wales	Scotland
Human beings	Potential total effective dose	Potential effective dose x probability of exposure >3mSv per year	>100mSv per year or Potential effective dose x probability of exposure >3mSv per year
	Potential equivalent dose to lens of eye		Potential equivalent dose x probability of exposure >15mSv per year
	Dose to skin		Actual dose >10Gy in 1 hour or Potential equivalent dose x probability of exposure >50mSv per year
Terrestrial biota or plants	On balance of probabilities it is more likely than not that potential dose ..	N/A	>40µGy per hour
Aquatic biota or plants		N/A	>400µGy per hour
Water environment		N/A	Substance ... more likely than not to enter water environment and would result in significant pollution

Water Pollution Legislation

- England & Wales
 - Water Resources Act 1991
 - Groundwater Regulations 1998
 - Environmental Damage Regulations 2009
- Scotland
 - Controlled Activities Regulations (CAR)
- Apply to historical water contamination (i.e. no current pollutant linkage from land to water)
- Do not apply if contamination results from an authorised discharge
- Currently applies only to non-radiological contamination, but will be extended to radiological contamination when Groundwater Daughter Directive is fully implemented
 - England & Wales – new Groundwater Regulations expected Autumn 2009
 - Scotland – new Groundwater and Priority Substances Regulations expected Autumn 2009
- Will only be applied to require remediation if Part 2A does not apply
- Derivation of remedial targets based on risk assessment – implements “suitable for use” approach

Planning Regime

- Implements “suitable for use” approach
- Applies when land is developed to ensure it is suitable for its intended future use
- Defines “contamination” in broadest sense, to include any contamination above background levels
- Remedial requirements based on risk assessment
- As a minimum, after development, the land should not be capable of being determined as “contaminated land” under Part 2A

Energy Act

- Applies to radioactive and non-radioactive contamination resulting from an accident at a nuclear site
- Only applies off nuclear licensed sites (since remediation on a nuclear licensed site would be regulated under Nuclear Installations Act)
- Only used to designate land for clean-up – standards applicable in other regimes would be applied to derive intervention levels and remediation targets

Assessment of Risks



Risk Assessment Framework

- Model Procedures for the Management of Land Contamination (CLR11)
 - Consistent framework recognised by all UK regulators
 - Applicable across range of non-regulatory and regulatory contexts, including Planning Regime, Part 2A and voluntary remediation
 - Comprises 3 components applied iteratively:
 - Tiered risk assessment to evaluate source-pathway-receptor linkages
 - Options appraisal
 - Implementation
- Available risk assessment guidance
 - Human health toxicological assessment of contaminants in soil (EA 2009 – replaces CLR9)
 - Hydrogeological risk assessment – Remedial Targets Methodology (EA, SEPA & NIEHS 2006 – replaces P20 & SEPA 2001 guidance)
 - RCLEA methodology for assessing radiological risks to human health (Defra 2006)
 - HPA advice on estimating doses to members of the public (NRPB-W36, 2003)
 - Impact assessment of ionising radiation on wildlife (EA 2003)
 - Habitats assessment for radioactive substances (EA 2009)
 - Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) methodology (Beresford 2007)
 - Ecological risk assessment (EA et al. 2008)
 - Archaeological risk assessment (EA & English Heritage 2005)
 - Assessment of risks to buildings, building materials and services (EA 2001)

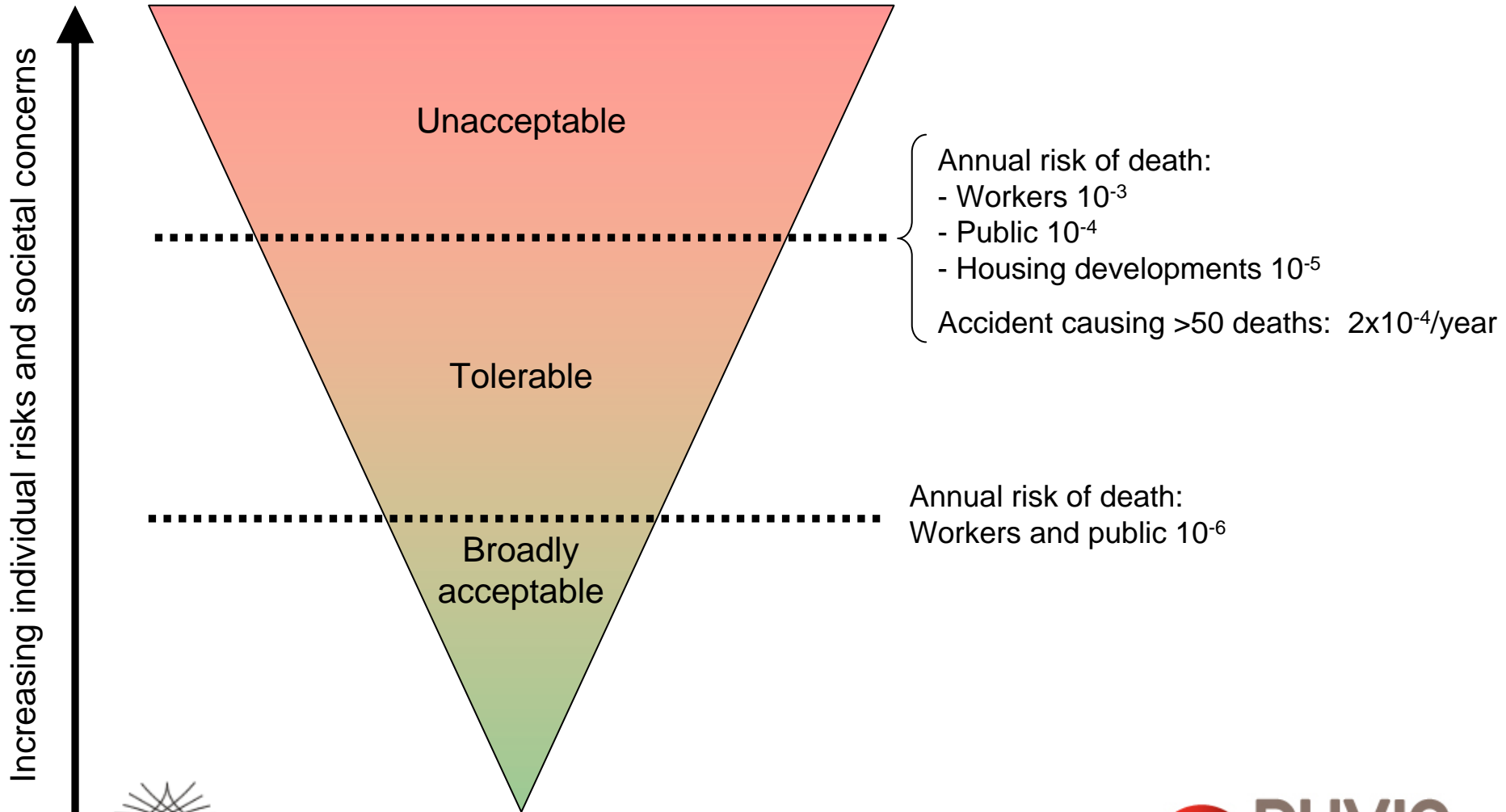


Risk Assessment Models

- CLEA model v1.04 (Excel)
 - Deterministic model for generic or site-specific assessment of human health risks from non-radioactive contaminants
 - Can be used to derive SGVs for use in *screening* assessments
- RCLEA model v2 (Excel) (CLR15)
 - Deterministic model for generic or site-specific assessment of human health risks from radioactive contaminants (complements CLEA)
 - Can be used to derive RSGVs for use in *screening* assessments in England & Wales (use with caution in Scotland since model does not account for risks to non-human species or water environment)
- Hydrogeological risk assessment using EA Remedial Targets Methodology
 - EA Remedial Targets Worksheet v3.1 (Excel)
 - Deterministic. Calculates soil remedial targets at Level 1, 2 or 3, and Level 3 groundwater remedial targets
 - ConSim
 - Probabilistic. Level 1, 2 and 3 assessments for soils, Level 2 and 3 assessments for groundwater, and combined soil and groundwater analyses
- ERICA assessment tool v1.0 May 2009
 - Deterministic (Tier 1 and 2) and probabilistic (Tier 3) model for assessment of environmental risks from ionising contaminants
- Numerous other models are available !

Assessing Significance of Risks

HSE Tolerability of Risk Framework



Comparison of Regimes



Management of Non-Radioactive Contamination

Key Issues

- High degree of consistency between different regulatory regimes
- All require remediation to “suitable for use” standard using risk-based criteria
- Main gaps and inconsistencies:
 - Scope of Part 2A is narrower than planning regime, since it only applies to specified receptors
 - Under Part 2A, minimum standard of remediation is such that land is no longer “contaminated land”, with derogation permitted from this standard. No such constraints apply under planning regime
 - Non-aqueous phase liquid (NAPL) contamination in water is regarded as historical contamination under Part 2A in England and Wales, so remediation cannot be enforced. This is not the case in Scotland
 - No regime addresses risks to receptors which are not covered by Part 2A (e.g. ecological or archaeological receptors without Statutory designation) unless the land is developed under planning system

Management of Radioactive Contamination on Non-Nuclear Licensed Sites - Key Issues

- Regimes reasonably consistent, requiring remediation to “suitable for use” standard using risk-based criteria
- Main gaps and inconsistencies:
 - No regime currently addresses historical water contamination by radiological contaminants (expected to change when Groundwater Daughter Directive is implemented)
 - Unless land is developed, Part 2A in England and Wales does not address risks to any non-human receptors. This is not the case in Scotland
 - No regime addresses contamination below Part 2A levels on land which is not scheduled for redevelopment

Management of Radioactive Contamination on Nuclear Licensed Sites – Key Issues

- Much less consistency in requirements for managing radioactive contamination
- Key gaps and inconsistencies:
 - Not clear whether SAPs address risks to any receptor other than human health, so unless land is developed, uncertain whether remediation would be enforced to protect non-human receptors and water environment from radiological contamination
 - HSE delicensing criteria based solely on risk to human health, whereas Part 2A in Scotland applies to non-human receptors and water environment.
Theoretically possible (although unlikely) that, on delicensing, a site could be designated as “contaminated land” under Part 2A

Management of Radioactive Contamination on Nuclear Licensed Sites – Delicensing Criteria

Radioactive contamination	Non-radioactive contamination
<p>Nuclear Installations Act specifies human health risk RT $<10^{-6}/\text{yr}$ ($<10\mu\text{Sv}/\text{yr}$) for any future use (“multifunctionality”)</p> <p>For comparison, on a non-licensed site, HPA advice would require RT $10^{-5}/\text{yr}$ (0.3mSv/yr) for current or intended future use (practice situation) i.e. “suitable for use” approach, and states that remediation unlikely to be justified if risk $<10^{-6}/\text{yr}$ ($<20\mu\text{Sv}/\text{yr}$)</p>	<p>Either Part 2A or planning regime will apply “suitable for use” approach. In both cases, RT risk based depending on context, but from TOR framework a risk as high as 10^{-5} or 10^{-4} may be acceptable</p>

- Delicensing criterion requires clean-up for multifunctional use, and risk target is significantly lower than would apply in any other circumstances
 - Delicensing criterion said to represent “no danger” - this implies that higher criteria used in planning regime may entail “danger” !!
- HSE expects compliance with delicensing criterion will be demonstrated by application of IAEA exclusion and exemption levels for soils, but this
 - Extends use of these levels beyond their stated limitations
 - Presupposes a “dig and dump” remedial solution which may not be optimised or justified
 - Conflicts with other HSE guidance requiring a risk management approach which also addresses risks to non-human receptors

Summary



A Dog's Breakfast !



Discussion



Discussion

- Instances where issues have arisen, and how these have been resolved
- Any scenarios / issues not mentioned
- Any other concerns / issues
- Suggestions for improvements (to be fed back to NDA via SAFESPUR)

Thank you

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