Nuclear Business Unit

Nuclear Industry Guidance on Qualitative Risk Assessment for Land Contamination, including Radioactive Contamination

SoBRA / RSC MEETING – 21st December 2011

Nick Hesketh & Mike Pearl - Babcock International Group plc
Hugh Richards – Magnox Ltd

Background

- NDA's site licensee companies (SLCs) identified a requirement to develop a more consistent approach to risk assessments for radioactive and non-radioactive land contamination.
  - Approach for assessing risks to human health and other receptors differs for radioactive and non-radioactive contamination.
  - NDA has difficulty comparing the relative risk significance of different areas of potential contamination across its portfolio and prioritise the funding of risk mitigation measures.
- Hugh Richards (Magnox Ltd) prepared a specification for work to address this, to be funded through the NDA Direct Research Portfolio
- Contract awarded to a team led by UKAEA Ltd (now part of Babcock International Group plc)

Project Team

Babcock International Group

- Mike Pearl & Nick Hesketh

Nottingham University

- Paul Nathanail

Quintessa

- James Penfold, Russell Walke, Alan Paulley & Alex Bond

Customer Organisations

- NDA – funders via Direct Research Portfolio
- Nuclear Industry Group for Land Quality (NIGLQ)
  - Formerly known as [Nuclear] Inter-Industry Group on Contaminated Land & Site Restoration Issues (IIG-CL)
  - Sponsoring body for publication of guidance
- Nuclear Waste Research Forum (NWRF)
- Land Quality R&D Working Group
  - Reports to both NIGLQ and NWRF

Aims

- Development of methodology for **qualitative** assessment of risks from (potential) land contamination (both radioactive and non-radioactive)
  - Subject of this presentation.

- Development of guidance on application of **tiered assessment of radiological risks** from land contamination, in a similar manner to CLR11 and SAFEGROUNDS main guidance.
  - Still a “work in progress”.

Starting-points for QLRA guidance

- Aimed at experienced land quality risk assessment practitioners, primarily in nuclear industry
- Be consistent with guidance on tiered risk assessment:
  - Greenleaves II, CLR-11 & SAFEGROUNDS LMGv2
- Build on existing “national” QLRA guidance
  - CIRIA C552, 2001: Contaminated land risk assessment
  - Defence Estates PG01/07, 2007: Land Quality Assessment guide
  - EA/NHBC/CIEH R&D66:2008: Safe development of housing on land affected by contamination
- Consider QLRA methodologies already being used for Magnox sites (based on Defence Estates PG01/07).

Approach to Developing the QLRA Guidance - 1

- Initial Experts Workshop – 4th February 2010 (Mike Pearl, Paul Nathanail & Nick Hesketh)
- Industry Workshop – 26th February 2010
- Industry Workshop – 6th May 2010
- Beta testing of methodology using information from Magnox sites and Dounreay

Approach to Developing the QLRA Guidance - 2

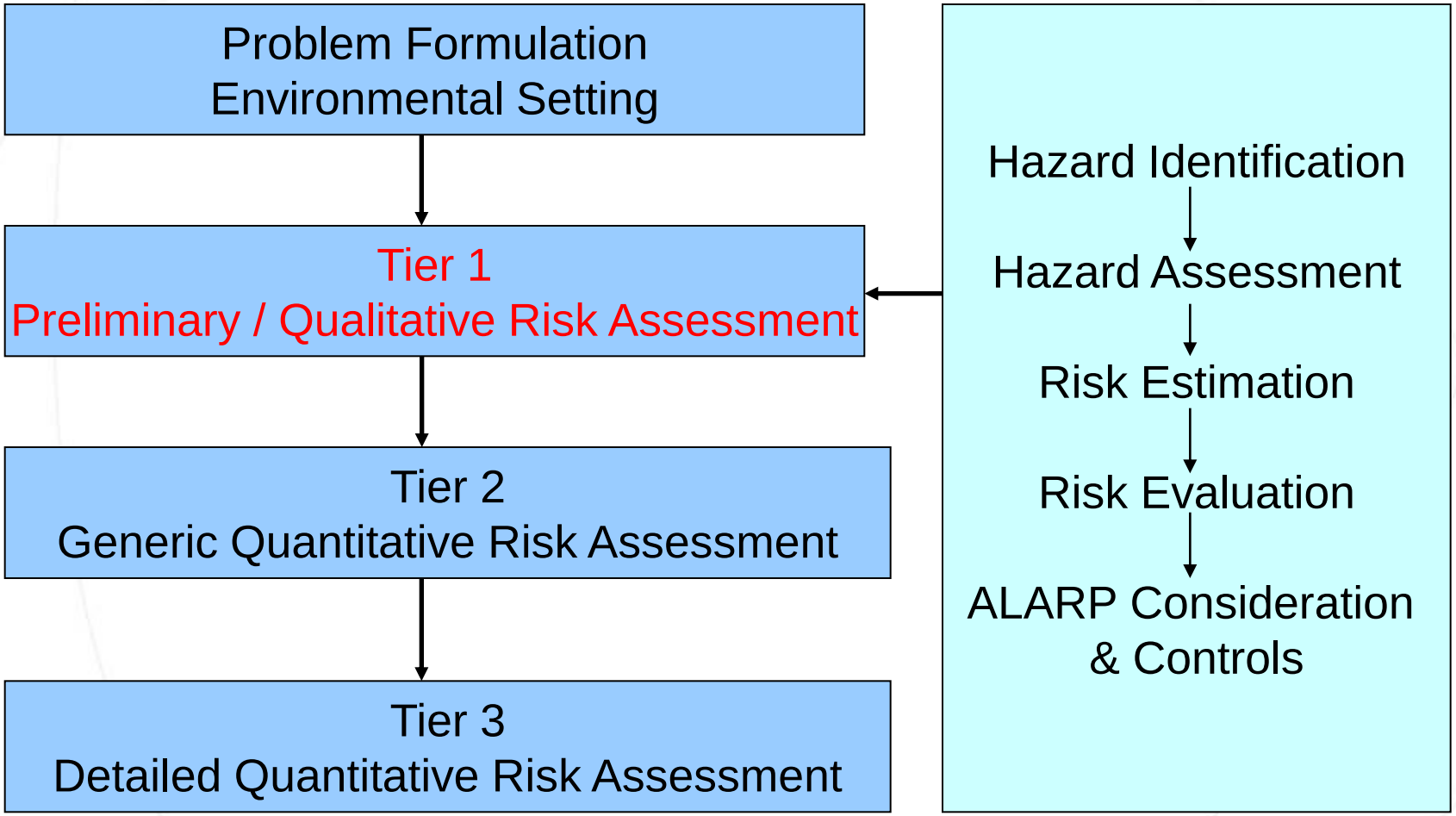
- Several cycles of review during 2010
- UKAEA version made available to nuclear industry, Dec ‘10
- Trialled in QLRA studies on some NDA sites
- Weaknesses identified by users
- Further consultation with Regulators (Aug ’11)
- Review by SoBRA members (Sept/Oct ’11)
- Final “tweaking”
  - Input from SAGTA and NIGLQ (Dec ’11)
- Publication as NIGLQ Industry Guidance (19 Dec ’11)
- Launch at RSC/SoBRA conference (21 Dec ’11)
- Dissemination using SAFEGROUNDS website (Jan ’12)

The QLRA Guidance

Scope of Application

- Primarily for assessing risks to a variety of receptors (people, environment, property & “compliance boundaries”) from land contamination in its current state.
- May be used for assessing a planned future condition.
- NOT intended for assessing risks associated with undertaking planned work that may affect or be affected by land contamination.

Context within Tiered Risk Assessment Framework



Main components of the guidance

- Guidance on pre-assessment stage (setting the context & objectives, collating information on site setting, etc)
- Guidance on developing conceptual site model(s) appropriate to QLRA (check-list approach)
- “Greenleaves II” framework translated for land contamination:
  - Descriptors for Severity of Potential Consequence (i.e. if a pollutant linkage exists)
  - Descriptors for Likelihood of Potential Consequence (i.e. likelihood that pollutant linkage exists or will develop over the timescale being assessed)
  - Matrix of descriptors of Significance of Risk (Severity x Likelihood)
  - Descriptors of Confidence in Assessed Significance of Risk
- Guidance on next steps following different outcomes of QLRA

“Greenleaves II” framework applied to land contamination

- **Hazard Assessment**
  - What is the context?
  - What pollutant linkages (S-P-R) could be present?
  - What could the effects be on the receptors?
  - What mitigations are already in place?
- **Risk Estimation** - predict the magnitude and probability of the possible consequences arising from the hazard at the receptor via the various pathways. What degree of harm to the receptors might result, and how likely is it?
- **Risk Evaluation** - Does the situation pose an unacceptable level of risk under the given context? Is there a need for a risk reduction management action?
- **Uncertainties** - identify uncertainties and information gaps. How do the uncertainties impact on the assessment? How can they be reduced?

Practical Application

- Guidance recommends tabular presentation of QLRA
- Up to 22 defined column headings, including
  - APC Ref No. & description
  - Conceptual Site Model (several columns)
  - Severity of Potential Consequence(s)
  - Likelihood of Potential Consequence(s)
  - Significance of Risk
  - Confidence in Assessed Significance of Risk
  - ALARP considerations for nuclear sites
  - Criteria for review/reassessment of the QLRA
- Prompts user to document rationale for each step
- No prescribed template
- Worked examples to be developed

Significance of Risk

Significance of Risk = Potential Severity of Consequence x Likelihood of Consequence Occurring

Potential Severity of Consequence

Receptors

- Radiation dose to public
- Radiation dose to on-site “general employees”
- Radiation dose to on-site “employees working with ionising radiation”
- Harm to humans from non-radioactive contamination
- Harm to flora and fauna
- Harm to property (excluding buildings)
- Harm to buildings
- Pollution of the water environment
- Contamination crossing a compliance boundary

Potential Severity of Consequence

- Negligible
- Mild
- Moderate
- Severe

- In general, “Severe” = “consequence that could not unreasonably be expected to lead to formal regulatory action (e.g. “Part 2A” determination) or other legal action by a regulator or affected party”

The Meaning of “Severe” for Human Health (non-rad)

- Initial (Dec 2010) version of QLRA guidance: Like DE PG01/07 (i.e. “Severe” = actual “Significant Harm”)
  - Difficult to apply in practice (e.g. suspected asbestos in soil)
- CIRIA 552 & R&D66:2008 – “concentrations likely to result in significant harm”
  - problems with using “concentrations” (e.g. asbestos, NAPL)
  - “likely to result” (what does it mean?)
- Our solution:
  - “levels that could reasonably be construed as indicative of SPOSH”, <u>if exposure occurs</u>
  - gives quite a bit of flexibility in interpretation (context-specific)
  - amenable to amendment if statutory guidance criteria for SPOSH change

The Meaning of “Severe” for Pollution of Water Environment (incl. CW)

- Initial (Dec 2010) version of QLRA guidance: based on magnitudes of concentrations with respect to relevant WQS
  - Problematic because sensitivity of receptor was not considered
- R&D66:2008 - based on EA pollution incident categories
- Our solution:
  - “Severe” equivalent to EA 2011 Common Incident Classification Scheme (CICS) category 1 or 2 incident for surface water quality or potable abstraction
  - “Severe” equivalent to significant pollution of groundwater as might be determined under Part 2A of EPA90
  - plus footnote on SEPA criteria for entry of contaminants to groundwater (WAT-PS-10-01), and EA document Groundwater Protection: Principles and Practice (published 2012)

The Meaning of “Severe” for Radiological Dose (to public)

- No precedents
- Difficulty of different regimes:
  - 0.01-0.02 mSv/yr Basic Safety Objective *“de minimis”* risk
  - 0.3 mSv/yr HPA guidance for Planning context
  - 1 mSv/yr legal limit for planned exposures (IRR99)
  - 3 mSv/yr criterion for Part 2A determination of radioactively contaminated land (‘intervention’ criterion)
- Our solution: “Severe” means more than of the order of 1 mSv/yr

The Meaning of “Severe” for other receptors

- Compliance boundaries:
  - assessors invited to define their own severity criteria
- Other receptors:
  - same approach as for human health (i.e. “levels that could reasonably be construed as indicative of SPOSH”, if exposure occurs)

The Meaning of “Negligible” Consequence

- Human health (non-rad): Contaminants in soil or other media at levels that could not lead to “significant harm”
- Pollution of water: What a regulator would typically regard as a potentially discernible but inconsequential effect
- Radiological dose (public): Less than of order 0.01 mSv/yr, if exposure occurs (i.e. $<10^{-6}$/yr, meeting BSO)

Likelihood of Consequence Occurring

- CIRIA 552 & R&D66:2008: Qualitative descriptors, including attempt to consider short/long term
  - Too open to subjective interpretation?
- DE PG01/07: Quantitative ranges
  - 0-4% defined as “nil chance”
- IPCC 2011: Quantitative ranges
  - Overlapping ranges
- Our solution: Quantitative ranges, to relate specifically to the stated timescale of the assessment
  - Extra category of “extremely unlikely”

Likelihood of Consequence Occurring

Likelihood Descriptor	Probability of Occurrence*
Very Likely / Certain	More than 95%
Likely	45 to 95%
Unlikely	5 to 44%
Very Unlikely	Less than 5%
Extremely Unlikely	Much less than 1%
No pollutant Linkage	Zero

*i.e. probability of occurrence within the time-frame(s) defined for the risk assessment (i.e. ‘short term’ and/or ‘long term’)

Matrix for Significance of Risk

	Likelihood of Consequence Occurring	Very Likely / Certain	Likely	Unlikely	Very Unlikely	Extremely Unlikely	No Pollutant Linkage
Potential Consequence	Severe	Very High	Very High	High	Medium	Low	None[#]
	Moderate	High	High	Medium	Low	Very Low	
	Mild	Medium	Medium	Low	Very Low	Trivial	
	Negligible	Low	Very Low	Very Low	Trivial	Trivial	

[#] If there is no pollutant linkage, then the severity of (hypothetical) consequence does not need to be assessed, and the 'significance of risk' is 'none'

Features of Significance Matrix

- Broadly similar to predecessors (CIRIA 552, DE PR/01/07, R&D66:2008)
- Not quite as “symmetrical” as some predecessors – for a reason
- “Medium” used rather than “Moderate”
  - “Moderate” is more appropriate as a severity descriptor
- Avoidance of “on the fence” descriptors in predecessors (e.g. “Medium/Low”)

Applying the Methodology: General Principles - 1

- Situations with limited characterisation / large uncertainties
  - What is the worst credible severity of consequence, if a pollutant linkage is present?
  - What is the likelihood of such consequence?
  - What is the resulting qualitative significance of the risk?
  - What is the confidence in the assessment?
  - Do either the significance of the risk or the uncertainties in the assessment mean that more information is needed before deciding on the next step(s) in managing/assesssing the risk?

Applying the Methodology: General Principles - 2

- Situations where there is already good information available
  - What is the actual or most likely severity of consequence?
  - What is the likelihood of such consequence? (It may be 100%)
  - What is the resulting qualitative significance of the risk?
  - What (if any) is/are the next step(s) in managing the risk?

QLRA input to Risk Management - 1

QLRA Output – Significance of Risk (Trivial to Very High)

For radioactive land contamination on licensed sites, also require:

- Contaminated Land Safety Case, including ALARP demonstration (risks to people)
- Compliance with Licence Conditions (e.g. LC34) – land contamination considered as “nuclear matter” “contained” in the ground – requirement to detect any further “escape”
- Demonstration to EA/SEPA of BAT/BPM (minimise radioactive discharges/wastes from managing land)

Other considerations:

- Social, political and economic

QLRA input to Risk Management - 2

- QLRA Guidance does not prescribe actions to be taken following the identification of risk.

- QLRA Guidance does identify potentially “unacceptable” and “not unacceptable” risks.

Acceptability of qualitatively assessed risks to Industry

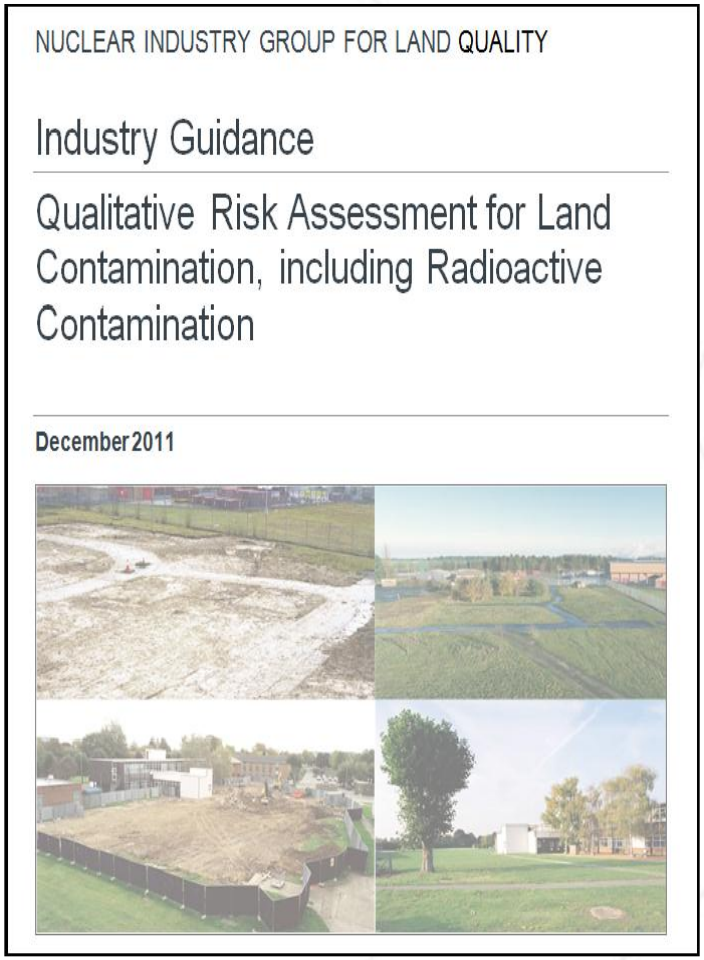
- Very High and High Significance Risks – “unacceptable”
- Low, Very Low and Trivial Significance Risks – “not unacceptable”, tending to “acceptable” at “Trivial” level
- Medium Significance Risks – “not unacceptable” in immediate term but “not acceptable” in the long term

Anticipated benefits of using this methodology

- Improved consistency of QLRA across a portfolio of sites (e.g. NDA estate)
- Basis for prioritisation of resources; especially for intrusive characterisation
- More robust basis for stopping at qualitative Tier 1 of risk assessment process for low risk areas
- More robust basis for bypassing Tiers 2 & 3 for high-risk areas (i.e. where “unacceptable risks” clearly identified at Tier 1)

The Future

- Guidance to be applied at NDA sites (especially 10 Magnox sites)
- Further review by regulators
- Feedback from users
  - by 1 Nov 2012, please
- Consider any implications of new Part 2A Statutory Guidance
- Revision in early 2013.
- Potential review/adoption by CL:AIRE?



trusted to deliver ™