Regulation, proportionality and discharges of radioactive waste

Bob Morley
LLW Repository Ltd

Co-authors

Gregg Butler
Professor of Science in Sustainable Development and Dalton Nuclear Institute, University of Manchester
Director: Integrated Decision Management Ltd
and
Grace McGlynn
Director: Integrated Decision Management Ltd

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Where to start?

Well – how about looking at the total public dose detriment of the UK nuclear industry??

- The UK has 24 Magnox reactors at 10 sites, all scheduled to be shut by 2011, 14 AGR reactors at 6 sites and one PWR
- It has two reprocessing plants at Sellafield and a fully functioning weapons industry
- The highest critical group dose in the country is that from Sellafield, at 0.22mSv or 220 microsieverts
- The TOTAL annual public dose committed by the entire nuclear industry is …… **6.3 man sieverts**

UK Nuclear Industry Public Detriment

- 6.3 man sieverts implies 0.4 fatalities at some time in the future
- It is, however, instructive to look at the level of individual risk at which this detriment will be delivered
- Taking Sellafield as the dominant example, we looked at the dose distribution to individuals

- Note that the highest critical group dose in the country (0.22mSv) means that NO member of the public is exposed to a risk of more than 1 in 100,000 per annum

UK Nuclear Industry Public Detriment

Collective doses are predominantly delivered at very low levels, as illustrated by the typical Sellafield discharge scenario[1] seen below

Individual dose range (microSv per annum)					
<0.015	0.015-0.15	0.15-1.5	1.5-10	>10	Total
3500 95.8%	110 2.9%	17 0.5%	20 0.5%	12 0.3%	3700

The bulk of the dose is delivered between 0.0015 and 0.000015 microsieverts per annum (or 0.015 – 1.5 nanosieverts), corresponding to an annual risk between one in ten billion and one in 1000 billion.

1. BNFL National Stakeholder Dialogue, Spent Fuel Management Options Working Group Report, Appendix 10.

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

UK Nuclear Industry Public Detriment

So – we have a dose of 6.3 man sieverts which converts to a detriment of 0.4 theoretical deaths suffered by individuals almost entirely at risk levels in the sub-1 in 10 billion range, and in no case above one in 100,000

How do we weight this detriment into the overall scheme of nuclear operations?

…….and we need to – because……

UK Nuclear Industry Cleanup

- The cleanup of the UK civil nuclear sites has been entrusted to the Nuclear Decommissioning Authority
- A £70B (and rising?) public liability – huge incentive to achieve a balance and optimise spend
- Public spend means it really *is* a choice between risk reduction, discharge abatement, health provision, education and transport schemes!
- Budget limitations mean that money spent on ALARA of discharges will not be spent on hazard potential reduction

  So balancing dose reduction with other factors is actually ***important***

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Comparisons and Problems

• Comparisons of different detriments are possible using ‘lives’ or ‘money’
• There is great controversy on values used, and on whether this is ethical – but a steady increase is evident in the use of detriment valuation to guide regulatory and policy decision making
•Nowhere is this clearer than in the provision of healthcare – where the realisation that resources are finite has led to a crucial role for these methodologies
•Therefore – why not use them in energy and nuclear site cleanup policy assessment?

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Dose comparisons in UK

Annual collective UK doses in 2005 (HPA-RPD, 2005)

- Natural background radiation 131,100 man Sv
- Medical, occupational, fallout 25,035 man Sv
- NORM industries 53 man Sv
- Nuclear Industry 50 man Sv
  (0.032% of total)

Dose comparisons in different areas – UK doses due to use of Natural Gas

- Householders – average 4 uSv/yr
- Commercial – average 19 uSv/yr
- Critical Group – ‘few tens of’ uSv/yr

- Critical group of same order as annual radioactive discharges from Sellafield
- Collective doses over four times entire UK nuclear industry
- BUT is exempt from registration/authorisation!

Dose comparisons in different areas – UK doses related to NHS activities

- Public doses – persons *unknowingly* sitting next to patient on a bus – up to 300 uSv (more than maximum *fully disclosed* dose from all Sellafield operations)
- Sewage treatment workers receive up to 238 uSv/yr
- Public doses up to 180 uSv/yr from NHS sewage outfall
- Construction of I-131 holding tanks in new London hospital – cost £0.5M, sewage worker reduction would have been 180 uSv/yr, hospital workers would have received 1500 uSv/yr.
  BPM questioned – tanks bypassed – spend wasted

UK Nuclear Industry Cleanup

- When we examine the cost of dose reduction, we find that spends of >£10M per statistical life are commonplace (compared to the £1M or so used in other policy areas like transport and health), and this measure of proportionality is given little attention.

- Disproportionate attention given to ‘reducing discharges’ no matter how trivial the environmental consequences (e.g. UK application of OSPAR very different from France)

Current application of 'Risk Based Regulation'

- The methodologies – BPEO and BPM – are supposed to adequately deal with the dilemmas posed
- **But the methodologies used do not!!**
- And the result is…….at Sellafield:

  - Several LETP's planned between now and 2020.
  - Cost - up to £500M (capital only).
  - Extra waste generated (primary and secondary) - unquantified in most cases but very large.

  - £Millions spent in sampling and analysis of specific nuclides per per microsievert critical group dose saved

Getting money for cleanup

So BPEO and BPM are being applied without any method of assuring value for money, and hence proportionality

Government, especially Treasury, needs to be assured of Value for Money

It generally does this by Cost Benefit Analysis

This is widely used and generally accepted in fields such as Health (NICE), Road Traffic (DfT), but not in the nuclear area – though methodologies do exist

Getting money for cleanup

Total absence of CBA in the nuclear area has weakened the NDA's ability to justify its spending plans, especially in comparison to other potential expenditures which produce defined benefits or avoid defined detriments

This has been reflected in the results of spending reviews. Without a meaningful way of weighting the importance of nuclear site cleanup against other uses of public money – there is a growing risk that the real importance of cleanup could be discovered only after the event.

Getting money for cleanup

The worth of nuclear site cleanup must be related to the reduction in the actual and potential doses from normal operations and in accident situations, to public and workforce. Any method of assessing this must give at least a relative importance to dose – both individual

It is conceptually difficult to value critical group dose – and this has generally not been attempted, but can be inferred retrospectively.

A meaningful measure must surely integrate dose over time and the population affected – collective dose!!

Key problem

- The key problem is that detriment is delivered at very small doses to very many people over very long times
- This has led to it being used out of context as a stick to beat the nuclear industry with
- The response from the industry and from ICRP has been to undermine Collective Dose as a measure of public detriment – without putting anything else in its place
- This absence of an integrative measure means that proportionality could only ever be achieved by accident – and recent experience shows little sign of this particular accident ever happening

Valuation or Weighting of Societal Dose and Detriment

- There is actually nothing wrong with collective detriment valuation that cannot be vastly improved by concentrating on the higher doses
- There are two ways of doing this
  1. Disregard low doses – i.e. put in a de minimis dose
  2. Calculate collective dose as at present – but vary the valuation of that dose according to the dose, and therefore the risks.

Valuation or Weighting of Societal Dose and Detriment

- Ignoring low doses is compatible with recent HPA-RPS advice (2006) that:

‘ … discharges giving rise to per caput doses of less than a few nanosieverts per year of discharge can be regarded as trivial. Higher annual per caput doses, up to say a few microsieverts per year of discharge can be considered trivial, but may require some consideration of alternative discharge options, particularly if at the higher end of the range.

- The Environment Agency has also begun to report ‘average per caput’ doses (a few nanosieverts per year of Sizewell B discharges, for example) – and class these as trivial

- So the argument of ‘less worth at low risk’ seems to be gaining ground, but towards *undermining* the collective measure rather than *improving* it

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Methodology – Dose Valuation

The developing ‘low dose is trivial’ view does remove some of the problems of the value of societal dose – but creates others.

A cut-off below which ‘value = zero’ is difficult to defend – and in practice, de minimis values (e.g. 10μSv/a) have been stated in policy but never applied

Also, as almost all of collective doses are low, this tends to remove ‘societal dose’ as a discriminator – which is counter-intuitive to most philosophical views.

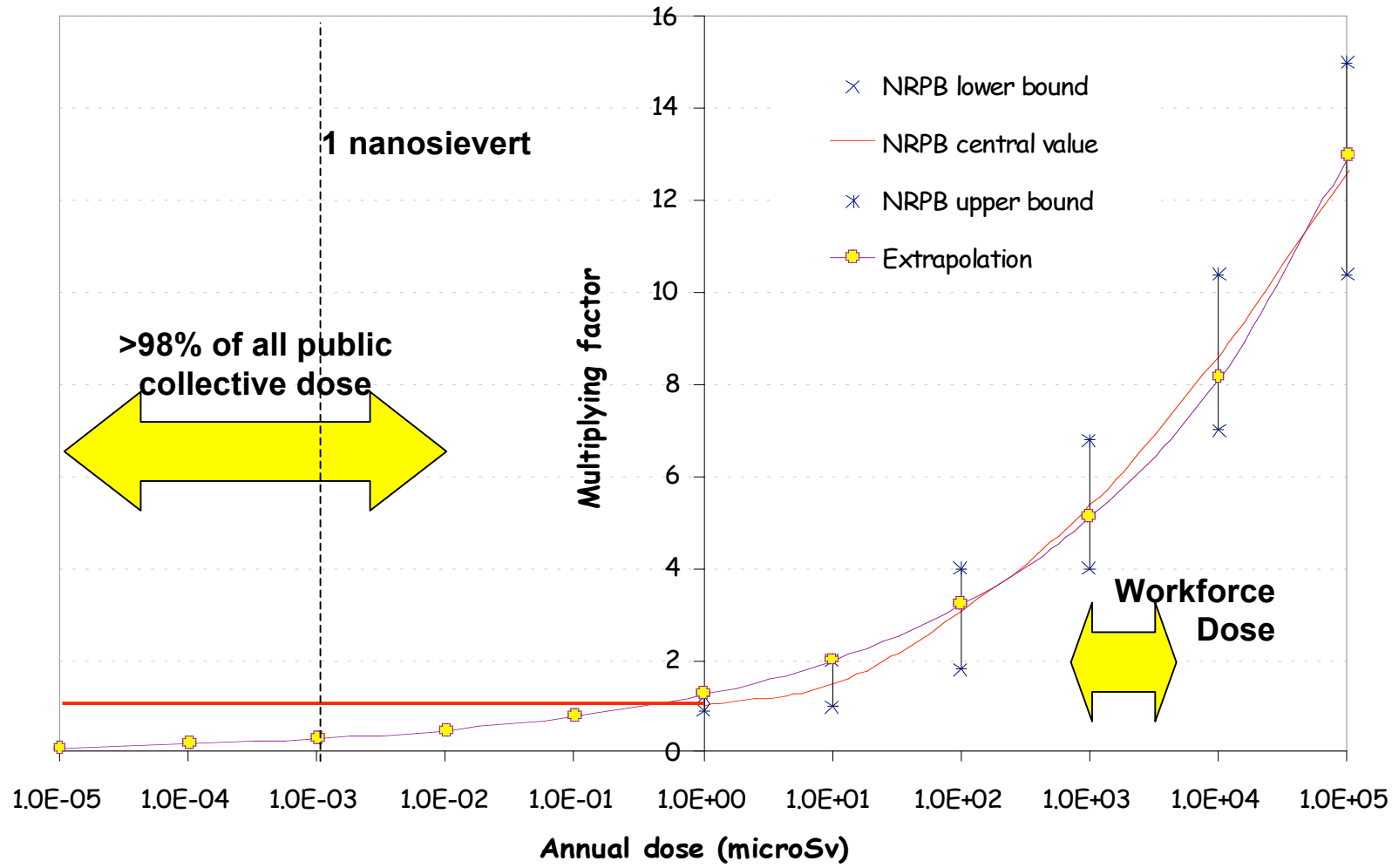
Surely it is more transparent and defensible to maintain collective dose, but to concentrate its value at the higher risks where it is most significant?

Methodology – Dose Valuation

A function has been derived which continuously increases the ‘value of spend to save a statistical life’ with increasing risk - applying a greater value to higher doses, and less value to lower doses caused to wider populations

This can accord a weight or value to collective dose which is concentrated where the effects may become significant

Methodology – Dose Valuation



IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Methodology – Dose Valuation

• This method reduces the valuation of collective dose at the current doses, but can be arranged to increase the valuation at higher doses in the region of the highest critical groups

• It may also make possible comparisons between worker and public doses: this balance is included in legislation and regulation but has never been attempted in practice

Why this is important

• Work in support of the NDA's Prioritisation Procedure examined the detriment of 'business as usual' discharges from legacy ponds and silos, using the ExternE methodology (an extensive EU-funded project examining the external costs of power generation and transport for valuing detriments.

•This demonstrated that radioactive discharges contribute less than 1% of the overall detriment – with the bulk being the environmental detriment of the power generation required to run pumps, heating and lighting in the plants

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Why this is important

- Preoccupation with discharge reductions and doses at trivial levels precludes a balanced approach to the regulation of nuclear site cleanup - the existing regulatory regime has given no safeguard against disproportionate use of resources on the reduction of discharges
- This makes it difficult to justify spend on cleanup against other Government Expenditure –increasing the vulnerability of the NDA budget to arbitrary spending cuts
- The development and application of a proper methodology in this area would be a major step in allowing the NDA to demonstrate Value for Money

Conclusions

•If site cleanup is REALLY important, it deserves to be judged and measured by a methodology, not by articles of faith - a transparent methodology would give real advantages, and could be done

•Risk-based dose valuation offers a solution to ensure holistic, proportionate spend

•Society would have much to gain by adding a meaningful onus on Regulators to assess and prove reasonableness, and to audit the results.

IDM integrated decision management

MANCHESTER 1824

LLW Repository Ltd

Conclusions

- None of these measures could gain acceptance without much improved communication of real risks to the public.

- The money that could be saved by the resulting acceptance of more realistic decision making would dwarf the cost of such a scheme.