Risk Management for Legacy Sites and Wastes: Implications for Proportionate Risk Management and a Graded Approach to Risk Assessment

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Outline

- A little history of optimisation
- Update on ethics
- Examples of attempts at achieving optimisation through analysis of options
- Some recent experience:
  - Sellafield, legacy wastes/fuel particles on beach
  - LLWR, LLW disposal facility
  - Little Forest
  - Andreeva Bay
- Key results from NEA Expert Group on Legacy Management
  - Proportionate risk management
  - Graded approach to assessment
- Some suggestions and questions for EAN 😊
Optimisation is tricky

This figure from Aston 2014, Thesis on “Regulation of Sellafield discharges in context of sustainable development”

… we are looking for balance, not the best as seen from one perspective;

… it’s not just a technical issue…

Figure 4 Diagram illustrating the balanced interpretation of Sustainable Development as a scale

EAN WS #18: ALARA for decommissioning and site remediation
Was Dr Ashton being smart?

“In recent years, there has been an increasing emphasis on the quantitative assessment of risk following exposure to radiation. {…} It has generally been assumed that this trend will contribute to the formulation of policy and standards in the field of radiation protection. **The difficulties of achieving this contribution have, perhaps, been underestimated because the problem has been seen too often as an exercise in science rather than as a combined operation involving, in addition, the skills of management, government and sociology.**

- Dunster and McLean (IRPA, Brighton, 1970)
Another perspective on have we been getting it right!

“Despite its wide scope, the Health and Safety at Work Act, 1974, is written as though the only problems is worker protection. As matters have developed, the real issue is about protection of workers, the public and the environment from the consequences of industrial technology, and about the risks we need to take, or ought to tolerate, in the interests of creating wealth and happiness. We are in as great a confusion as in 1974. Why does government choose to deal separately with the harms done by processes, by products and by wastes, when industry can neither see them as separate, nor so deal with them?”

Near quote from former director of the HSE (1999) essentially calling for a holistic policy and regulatory approach

NB: Holistic approach to risk highlighted at EAN 1997!!
ICRP on optimisation.. a reminder

- Justification
- Dose limitation
- Optimisation

Use of effective dose for all kinds of exposure

Nominal risk coefficients which, not for individuals but on average, allow you to address deontological and utilitarian components of an ethically base system of protection.

Since ICRP 26 (1977)

ICRP 138 (2018), reminds/updates ethical foundations

- Beneficence and non-maleficence
- Prudence
- Justice
- Dignity
Example application: Holistic and balanced?

Best Practical Environmental Option for L/ILW management in the UK, 1986.

Attributes evaluated for a range of logistical dynamic strategies.

Weighted from 4 societal perspectives!
Example: remediation of a NORM site

Options

On site solutions

1 - Long term Storage
   1a - All waste on B1/B2
   1b - Past wastes on B1/B2, other waste on site landfill

2 - Storage for disposal
   2a - All waste on B1/B2
   2b - Past wastes on B1/B2, other waste on site landfill

3 - After treatment storage for disposal
   3a - Past waste extracted, all wastes treated and placed on B1/B2
   3a1 - Basic treatment
   3a2 - Basic treatment + uranium extraction
   3a3 - Basic treatment + uranium extraction + removal of fission / activation products

3b - Past waste extracted, all wastes treated and placed on site landfill
   3b1 - Basic treatment
   3b2 - Basic treatment + uranium extraction
   3b3 - Basic treatment + uranium extraction + removal of fission / activation products

Off site solutions

4 - Disposal off site of all wastes after screening and treatment
   4a - Basic treatment
   4b - Basic treatment + uranium extraction
   4c - Basic treatment + uranium extraction + removal of fission / activation products

Mixed on / off site solutions

5 - On site storage or storage for disposal of existing waste in B1/B2, new waste being sent off site
   5a - Storage of existing waste on B1/B2, future waste disposed off site
   5b - Storage for disposal of existing waste on B1/B2, future waste disposed off site

15 Options
43 attributes organised in 7 main groups

- Group A: Health and Safety
- Group B: Environmental impact
- Group C: Environmental policy
- Group D: Technical aspects
- Group E: Socio-economical aspects
- Group F: Stakeholders
- Group G: Financial aspects
Sum over all attributes and weightings, for each weighting set

In this example, all groups favoured option 1a or 2a (Everyone actually impacted said, “Leave it where it is!”)

Helps you to organise the information. Results are only a guide to your thinking.
US NRC on using collective dose

- US NCRP’s Guidance on Collective Dose
  [https://www.ncrppublications.org/Reports/121](https://www.ncrppublications.org/Reports/121)

- NRC’s dollar per person-rem guidance, this is draft awaiting for the Commission to approve, but the technical basis is in described within.

- NRC information on back-fitting and regulatory analysis.
  [https://www.nrc.gov/about-nrc/regulatory/crgr/related-info.html](https://www.nrc.gov/about-nrc/regulatory/crgr/related-info.html)

- Information on **dose truncation** used in severe accident analyses.  [https://www.nrc.gov/about-nrc/regulatory/research/soar/soarca-health-effects.html](https://www.nrc.gov/about-nrc/regulatory/research/soar/soarca-health-effects.html)

- NCRP committee discussing the differences in risk management approaches used by the EPA and NRC in cleaning up radioactively contaminated sites.  **The EPA approach applies to chemicals too.**  [http://www.ncrppublications.org/Reports/146](http://www.ncrppublications.org/Reports/146)

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EAN WS #18: ALARA for decommissioning and site remediation
## Sellafield: history of operations

<table>
<thead>
<tr>
<th>1940s/50s</th>
<th>1960s/70s</th>
<th>1980s</th>
<th>1990s</th>
<th>2000s</th>
<th>2010s</th>
<th>EAN WS #18: ALARA for decommissioning and site remediation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear build begins</td>
<td>Waste stored safely – pending treatment</td>
<td>Main expansion of site</td>
<td>Commercialisation of reprocessing — Thorp comes online</td>
<td>NDA formed</td>
<td>Decision taken to end Thorp reprocessing</td>
<td></td>
</tr>
<tr>
<td>Initially a military programme</td>
<td>Storage capacity extended incrementally</td>
<td>Major waste treatment focus</td>
<td>Waste arising from processes treated in ‘real time’</td>
<td>Stop start progress in Decommissioning</td>
<td>Vitrification of all overseas Highly Active Waste complete</td>
<td></td>
</tr>
<tr>
<td>Later civil programme begins</td>
<td>Coarse segregation of waste arising from process</td>
<td>Environmental impact substantially reduced</td>
<td>Product waste forms compatible with disposal concepts</td>
<td>Calder Hall ceased generating power after 47 years in operation</td>
<td>Decommissioning gathering pace</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnox reprocessing starts</td>
<td></td>
<td></td>
<td></td>
<td>First sludge exports from FGMSP</td>
<td></td>
</tr>
</tbody>
</table>
EAN WS #18: ALARA for decommissioning and site remediation
NDA Risk Management Framework

Finding balance:
Act before you know how to or
Delay until after something dramatic has done wrong?
Focus on hazard reduction!
Adaptability of regulation!

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Fuel particles Sellafield beach

Optimising, not just dose, also probability of exposure, i.e. risk!
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LLWR Near surface disposal, near Sellafield, UK then
Requirement to use best practical means “to minimise waste generated on site and ensure radiological impacts are ALARA”

Q2: Can you do both at once?
NEA answer “the minimisation of one detrimental impact is always likely to result in something else detrimental not being minimised.” NEA report 7305
Asbestos is the highest risk – exceeds the guidance level for the site, but..... regulatory legal advice is accept the waste ... 

Little Forest Legacy Site, Sydney

LLW disposal from 1960 to 1968

Encroachment of the Sydney suburbs.

Major hazard beryllium.

But managed as a nuclear legacy...
Spent fuel stores in NW Russia
Progress at Andreeva Bay
SF store remediation

2004
- Unsatisfactory condition of SNF and RAW storage facility
- Lack of sufficient information on radiation and health conditions
- Inadequate coordination between the regulator, operator and the emergency medical response

2014
- The then upcoming SNF extraction was the most demanding part of the remediation
- **Required enhancement of regulatory process, rules and guidance, regulatory adaptability!**

2017
- First major SNF recovery and shipment to Mayak for reprocessing

Regulatory guidance on management of residual VLLW, to be managed under rules for hazardous waste management with overlay of RP issues.
In English at StrålevernRapport • 2008:7
see www.dsa.no
RAW classification system has also suffered certain changes. The Federal Law «On the Radioactive Waste Management …» established new RW classification system according to which all radioactive wastes are divided into two groups: special and removable. Resolution of the Government of the Russian Federation №1069 specifies the criteria used to define waste as special or removable. According to the resolution, RW can be defined as special RW if it meets the following criteria:

- collective effective dose for the whole period of RW potential hazard and the risk of potential exposure associated with operations on RW removal are greater than the collective effective dose for the whole period of RW potential hazard and the risk of potential exposure associated with in situ disposal of such waste;

- costs of RW removal (including the costs for RW discharge, processing, conditioning, transportation to the disposal site and disposal itself) are greater than the aggregate possible damage inflicted to the environment in case of such waste disposal in situ and the costs for the RW disposal in situ (including the costs associated with transition of the RW storage facility to RW disposal facility, its operation and closure, as well as safety provision for the whole period of RW potential hazard);

- RW disposal facility and its sanitary-protection zone are located outside the borders of settlements, designated conservation areas, coastal buffer zones and water conservation zones, as well as other exclusive and protected areas established under the Russian legislation.

In short, by Russian law, if the collective dose and other things add up to more if you move the waste, then leave it where it is. Holistic and clear…?
Key remarks from NEA EGLM

• Legacies may present mixed radiation exposure situations as well as other non-radiation related hazards that do not fit readily into existing management and regulatory arrangements.

• In developing an effective and efficient regulatory framework, it is of particular interest to achieve a balance between:
  o the need for regulatory flexibility that allows easy adaptation of the regulations to a wide variety of prevailing and evolving circumstances and technology, and
  o the need to include appropriately precise and detailed requirements and criteria that provide clarity to and confidence in the safety standards, and that facilitate demonstration that the standards are being met.
Proportionate risk management

• An holistic approach to management and regulation of the hazards and risks is warranted in order to achieve proportionate risk management and overall optimisation.

• This implies the need to consider chemical and other hazards alongside the radiological, adopting proportionate health, safety and risk management strategies and applying corresponding regulatory requirements based on common protection objectives.
Graded approach to risk assessment

An important corollary is that assessment methods should be graded, so as to support and promote proportionate approaches to demonstrating or confirming regulatory compliance in line with the common protection objectives.

(Don’t sweat the small stuff...)

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Linked up strategic thinking

- Strategies for management and regulation of legacies should take account of strategies for radioactive waste management, and vice versa. This is especially important for legacies which involve large volumes of contaminated wastes, which incorporate old disposal facilities, or which have contamination in underground structures, for which in situ disposal may be an appropriate management option.
It is not all bad news!

- It is broadly necessary, and of long-term advantage, to involve all stakeholders in the process to manage and resolve legacy sites as soon as the legacy has been recognised.
- It should be expected that a staged process is likely to be needed since (except in trivial cases) it will not be possible to achieve an appropriate end-state in one step.
- The Case Studies and Site Visits show that there has been significant practical progress to resolve the issues mentioned above, including the scope for avoiding development of a legacy altogether. This experience is of potential relevance at other sites.
Preliminary Framework

• A Preliminary Framework is presented in the report for the design of a process for a logical progression of activities leading to selection and achievement of an appropriate end-state.

• However, arrangement of the interactions among relevant organisations and interested parties is a complex and dynamic activity in itself. Recommendations have therefore been provided to support the testing and extension of the Preliminary Framework into an effective and sustainable guiding instrument.

• Scope implies reaching out from radiation protection community to the OECD Environment Directorate, the United Nations Environment Programme and the World Health Organisation and to chemical regulators, to share experiences to work cooperatively and develop guidance on holistic optimisation.