OBSERVATIONS AND RECOMMENDATIONS FROM THE 1st EAN WORKSHOP TO IMPROVE ALARA IMPLEMENTATION DURING DECOMMISSIONING

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Introduction

Optimisation of radiological protection has been shown to be a routine feature during major decommissioning operations in the nuclear industry sector. ALARA is not only considered as a principle but corresponds also to practices that determine important steps during the planning, the operation and feedback evaluation.

The presentations during the workshop described a wide variety of national approaches which depend on the legal requirements, the availability of funds, the industrial ressources and, last but not least, the waste disposal routes in the different European countries. It was also shown that, as far ALARA implementation is concerned, the reality is still far from being ideal everywhere, and that a lot of problems have still to be solved, as developed in the following paragraphs.

Need to develop tools to estimate dose rates in complex and evolving environments and activity levels of large amounts of wastes

Specific tools (devoted software, feedback experience databases, gamma-cameras…) have been developed in many countries to help engineers and decision makers in the assessment of doses arising from decommissioning operations. Two pieces of software, Visiplan, a Belgian product developed by CEN Mol, and PANTHERE RP a French product developed by Electricité de France (EDF), were demonstrated as were BNFL's «ALARP Experience database» and their gamma-camera. But, as it was said by the CEN-Mol representatives, there is still a room for new developments and tools in that area in order to better implement ALARA. At CEN-Mol, «the estimation of dose distributions in complex installations was quickly identified as a challenge, and the assumptions made to simplify the calculation were often too rough to give useful results. Therefore, developments in radiation field modelling and dose uptake estimation were started to help to better evaluate the actual doses of operators working in a complex environment and at different locations. Dose mapping, which is also of the inputs of the dose uptake modelling programme, remains a development area. This is particularly true in low radiation field area, where sources are distributed and where hot spots or main sources are absent or difficult to track» (Massaut et al.). The development and the use of these tools must be adapted, on a case-by-case basis, to the complexity of the plant which has to be dismantled and decommissioned.

Decommissioning produces a large volume of material containing very low levels of radioactivity or only background levels. To process this material, mostly for free release, a variety of approaches are adopted and in number of countries, specialised mobile facilities have been developed (Auler et al.). It was noted that differences could arise in the interpretation of the radioactivity measurements and their sensitivity and that this could lead to problems during transboundary waste transportation or recycling of materials. There was therefore a need for guidance at a European level on the acceptability of metrological procedures and protocols.

Need to develop techniques, models and software to realistically predict and follow-up internal exposures

The assessment of internal exposures is often a crucial point for many decommissioning operations. Several presentations demonstrated that internal exposure is an important contribution to the individual and collective occupational doses (e.g. decommissionings of the SPV Magnox Nuclear Power Station, of the Andujar uranium mill, of the mettalurgy hot cells at CIEMAT, or of the AWE military facilities). The realistic estimation of doses (both internal and external) is the first step of the implementation of ALARA. However the estimation process needs to be soundly based which in turn requires feedback experience from monitor programmes. For internal exposure this poses significant problems. It was concluded there was plenty of scope for the development of techniques, models and software packages to support internal dosimetry and lead to objective advice on the wearing of personnel protective equipment. Indeed this was identified as a potential topic for a future Workshop.

Need to take into account a total risk approach with various trade-offs such as radiological and conventional risks, public and occupational exposure, imposed and voluntary risks, human health and environmental hazards

The total risk approach was a feature of a number of presentations. In the SPV Magnox decommissioning project, «hazard identification, assessment of risk and review of the adequacy of control measures have been ongoing processes. A total risk approach has been taken of which radiological risk has been only one component. Optimisation of risk has required careful consideration of all risks.» (Spooner). It is essential to integrate all non-radiological risks from decommissioning operations, and to take into account the various trade-offs arising from the radioactive wastes alternatives (see Table 1 from Menon, next page).

Table 1. Summary of health risks from 50,000 t of Radioactive Scrap Metal Management Alternatives

Impact Categories	**Recycle/Reuse** (risk per year)	**Dispose and Replace**
Radiological Risks (individual dose < 10µSv/y)	· 10^{-7} to 10^{-6} fatal cancer risk to metal workers and public · 10^{-2} to 10^{-1} population risk per year of practice	· Potential elevated cancer risk to miners
Other Risks · **Accidents (workplace)** · **Accident (transport.)** · **Chemical exposure (smelting)** · **Chemical exposure (coke)**	· ~ 7 fatalities or serious injuries · 10^{-2} fatality risk to workers and public · 10^{-3} fatal cancer risk to workers; 10^{-4} to public · None	· ~ 14 fatalities or serious injuries · 10^{-2} fatality risk to workers and public · 10^{-3} fatal cancer risk to workers; 10^{-4} to public · 1 fatal cancer risk to workers; 10^{-2} to public

Need to develop tools to introduce transparency and coherence in the decision aiding, particularly in the case of the trade offs identified in 3rd recommendation

Formal optimisation is not part of the German regulatory system, nevertheless pragmatic decisions have to be made on the effort put into reducing doses. Cornelius et al. described the approach taken with the VVER reactors at Greifswald and Table 2 summarises the categorisation uses for areas and associated protection measures. When it is possible to be more formalized, cost-benefit analyses - using the so-called alpha-values - are widely used for decommissioning operations throughout Europe. However, there was a consensus that these techniques are not sufficient in themselves for a number of cases in complex situations and do not allow to efficiently take care of trade-offs (see above), total risk approach and other criteria such as social and political considerations. The use of multicriteria analyses seems to be a promising way to deal at the operational level with complex situations (Pauwels et al.), but there would still be problems of how to factor in social and political considerations.

Need to enlarge the International System on Occupational Exposure (ISOE) to plants being decommissioned in order to have available an international database and feedback experience exchange support

During the workshop, several participants voiced a need to rapidly exchange the radiological protection data on decommissioning projects and operation undertaken in Europe. Many organisations have developed their own feedback experience databases. However there would be benefit in promoting this kind of initiative at the international level, for example by encouraging utilities to participate the International System of Occupational Exposure (ISOE) which has been already structured to collect specific data on decommissioning operations.

Need to create an ALARA culture in the non-nuclear sector where there are significant opportunities to improve ALARA

Presentations devoted to decommissioning experiences in the non nuclear sector, showed numerous opportunities for radiological protection optimisation. For example, the decommissioning of medical, scientific and industrial nuclear accelerators (Eggermont et al.) illustrated the large potential for using ALARA tools in that sector (more than 200 accelerators in Europe). The dose levels, the risks of contamination, the activation characteristics, and the waste volumes justify the development of ALARA procedures adapted to this domain. It was recognized that one key point is the absence of «optimisation culture» in the non-nuclear industry. Consequently, the implementation of ALARA procedures and the use of ALARA tools should be promoted by national authorities and European guidances in that field.

Table 2. Catalogue of dose reduction measures during the decommissioning of VVER reactors in Greifswald

Ambient Dose Rate µSv/h	Man-Power man. hours	Expected dose reduction factor	Decontamination of systems before dismantling	Shielding	Pre-dismantling of parts with high doserates	Complete dismantling of components and cutting in specific areas	Total or partly remote controlled dismantling	Training of personnel with mock-ups
>100	> 1000	> 100	yes	yes	yes	yes	yes	yes
		10-100	yes	yes	yes	yes	no	yes
		2-10	yes	yes	yes	no	no	no
10-100	100-1000	100	yes	yes	yes	yes	yes	yes
		10	yes	yes	yes	yes	no	yes
		2-10	yes	yes	yes	no	no	no
5-10	< 100	10	yes/no	no	no	yes	no	no
		< 10	no	no	no	yes	no	no
		-	no	no	no	no	no	no

Need to adopt an uniform system of control in Europe to demonstrate that an acceptable level of risk has been achieved when materials arising from decommissioning are cleared

Janssens presented the EC approach to deriving clearance levels. From the EC point of view, there is really no viable option other than to clear a large volume for reuse of the materials generated by decommissioning (see the mass flows of wastes from the Greifswald site decommissioning as an illustration of this challenge in Table 3). The values recommended by EC are based on an «underlying concept of the risk that remains by clearing those items as being trivial» (individual public dose lower than 10 µSv). From the discussions, «there has to be doubt as to whether or not every country will actually accept those levels, and we have to look at what should be the consequences of what that might be in the European free market . This possible disharmonisation would also put the public opinions in trouble». Another presentation (Menon) advocated for a more probabilistic - and maybe more flexible - approach integrating all types of risks and hasards associated with the decommissioning (see Table 1). The final decision should take into consideration the total health risk, and all the socio-economic impacts. Moreover, «a too much severe regulation could involve inconsistencies between that level of dose and some other human activities that are not yet regulated or that are less drastic from the radiological point of view».

In conclusion, the discussion identified a crucial need to simplify the regulatory background. One proposed solution was to give up the concept of clearance, and use only exemption levels, with corrective factors depending upon the quantity of material that are being considered. There was a strong support for having an «international acceptable level» within the European Community, to allow coherence in low level waste policies. It was recognized that public opinion was a dimension to be taken into account, and policies should be comprehensible. Fundamental to this is getting across the message that for this types of activities «zero ris » is not achievable, and that effort needs to be put into educating the public to understand what the actual risks and possible damages are.

Need for clear criteria to be applied in the radiological aspects of the remediation of contaminated sites and for protocols covering means of demonstrating compliance to the regulator and to the public

This point can be summarized by two questions taken from Mobbs's paper:

- What level of residual risk to future users of the site is acceptable?
- How can it be demonstrated that this level of risk has been achieved?

Robinson et al. suggest that «it would be unreasonable for a regulator to interpret «no danger» in such a way that following de-licensing the levels of radioactivity remaining on the site would be such as to be subject to regulatory control by other radiological legislations. Therefore residual radioactivity should be reduced below appropriate exemption levels defined by relevant UK law. Over and above this requirement it would be prudent to remove all radioactive material where it is simple to do so. As an additional safeguard, when this had not been already achieved, it would seem worthwhile that site remediation continued if necessary to ensure that the annual dose to a member of the public who may use the de-licensed land would not exceed the 20 µSv/year level.»

And a corollary of this question is when to begin the final stage of decommissioning or, in other terms, what can be the strategies for waiting for decay? There was no consensus to answer to this question. Recent experiences showed that different driving forces than radiological protection (eg. social considerations at Transfynnyd, finances at Berkley, environmental and political considerations at Brennilis) do exist. The answer could be: as soon as possible, just now if the ressources are available because the one who has had the benefits of a practice, have also to bear the cost of its giving up. It should be an ethical position not to transfer these burdens to future generations who will not directly benefit from the rest of a practice inherited from the past. However, one must keep in mind that «it is better to finish safe if late than with loss if on time» (Spooner).

Table 3. Waste mass flows and paths from the decommissioning of VVER reactors in Greifswald

Path	Specific activity limit (Bq/g)	Surface contam. limit (Bq/cm^2)	Mass (tons)
Class A. **Unrestricted release of metals**	0.1 (all nuclides)	0.5 (e.g. Co^{60})	511100
Unrestricted release of other residuals	0.2 (Co^{60} equiv.)	0.5 (e.g. Co^{60})	
Class B. **Restricted reuse and utilisation of metal scrap**	1 (all nuclides)	0.5 (e.g. Co^{60})	2500
Release of debris for further use	0.2 (Co^{60} equiv.)	-	
Class C. **Disposal as conventional waste**	2 (e.g. Co^{60})	-	3750
Class D. **Decay storage**	Materials which will surely reach class A, B or C, within 10-15 years due to radioactive decay.		28400
Class E. **Controlled reuse in nuclear facilities**	Materials which can be used in other nuclear facilities		4150
Class F. **Disposal as radioactive waste**	All materials which cannot be classified A to E and which will be orderly removed as radwaste		16500