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# Existing Exposure Situations: Intervention in Practice

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## Introduction

This paper describes some recent HPA experiences in dealing with radioactive contamination issues where the levels of existing exposure have ranged from quite significant to levels that are low but nevertheless of some concern to those exposed. One of the examples relates to the common situation of remediation of a contaminated site where the emphasis may be largely on optimising future exposures rather than the true existing ones, but there are common themes, notably the perception of contamination of premises, and the consequences of the way in which regulations define "radioactive" material.

## Case 1: Intervention to reduce radon and other exposure pathways

In this situation there was very definitely existing exposure arising from past practices and the levels of exposures meant that intervention was judged appropriate.

The location concerned is utilised for small scale commercial and industrial activities with multiple employers involved. Some of the site buildings are more than one hundred years old. The site is not in a designated "radon affected area" within the UK and it was only by chance that tests were done that identified elevated radon gas levels. The maximum (time averaged) concentration measured in one room in a particular building was about 40,000 Bq.m-3. In the regularly occupied areas radon levels were between a few hundred and several thousand Bq.m-3.

Initial detection of radon was by polyallyl diglycol carbonate (PADC) dosemeters and follow up work included more investigations elsewhere on the site and attempts to try to establish the possible causes of the high levels. A gamma radiation survey quickly identified that there was significant contamination by radium-226 residues caused by historic work involving radium luminised aircraft components. That work pre-dated modern UK controls on radioactive substances and the existence of the contamination appeared to be unknown to the current site users. In common with similar locations there was evidence of burial of wastes in external areas, substantial contamination underneath some internal floors, and superficial but largely fixed contamination within rooms (the building had undergone modifications and re-decoration since the original contaminating practices). It was suspected that one of the sub-floor radium deposits was the cause of the significantly raised radon levels within the building, since there was some correlation between gamma radiation readings and radon levels.

The initial radiation protection advice provided was aimed at dealing with the highest radon levels encountered. The room at 40,000 Bq.m-3 was not an immediate problem due to low occupancy but there were a few rooms with high occupancy and radon levels around 2500 Bq.m-3, which was related to an annual dose rate of about 15 mSv.y-1. There were only a small number of workers exposed and the decision was taken to move them promptly as this could be done easily.

There were a larger group of workers in a zone with levels around 800 Bq.m-3 (corresponding to about 5 mSv.y-1) and the building owner was recommended to reduce radon levels in this area within six months.

Another initial step taken was to suspend access to an external area that contained a substantial amount of buried radium. This area was being used for recreational purposes by site

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workers, e.g. during lunch breaks. Whole body gamma dose rates were in places up to 10 µSv per hour. Occupancy was relatively low with annual external gamma doses unlikely to exceed 1 mSv y-1 but the conditions would nevertheless demand designation as a controlled area under the UK worker protection regulations, which would have proved problematic. This external area also had several fruit trees and samples of the fruit tested showed raised levels of polonium-210.

It was clear that normal approaches to the treatment of high radon levels (i.e. sub-floor sumps providing a positive pressure differential between the air above ground and the soil gas) might not solve the radon problem alone. Some but not necessarily all of the elevated radon was definitely attributable to the man-made radium contamination and the fact that this was distributed non-uniformly, with its location and full extent not known prior to excavation, meant that the best location for sumps could not be determined. The building was unusually shaped and the pattern of radon gas movement in above ground areas was not understood. There was even some concern that if disadvantageously placed sumps might modify the movement of soil gas in a way that could increase radon levels in some areas unexpectedly. Accordingly, the building owner embarked on a program of removal of radium contamination beginning with the identifiable deposit that was associated with the rooms with very high radon levels. After removal of as much contamination as was practicable and fitting of a sump the radon levels in this part of the building have been successfully reduced right down to around 100 Bq.m-3. Further testing in the building has continued and there are still areas with radon levels of several hundred Bq m-3 with the likelihood of at least one further radium deposit that may require removal.

This was a relatively unusual recent case of radium contamination as the site appeared to have had no remediation of the original radium contamination at all. Many situations that HPA lately has been involved in have already had at least one campaign of remediation, including some of those described later. It is fairly unusual now to find quite so high radon levels associated with radium contamination in a building in the UK. In the case of this site this must reflect a substantial radium inventory and the peculiarities of the emanation rates and soil gas transport aspects, since other sites with substantial levels of radium-226 buried under solid floors have not shown high indoor radon levels. It is also relatively unusual to consider intervening against the direct gamma dose rate pathway on these sites and to see the potential operation of a (minor) food pathway arising from radium residues.

Optimisation in the broad sense is clearly a significant operational factor for a site like this, indeed worker dose limitation is an issue with the higher high radon levels. Formal cost benefit analysis (CBA) approaches are not applied, partly because it is not possible while removing the radium contamination to judge exact how much must be removed to secure a given reduction to the radon level. The cost of the specialist radium decontamination work including radioactive waste disposal is a significant factor here and decision making although aimed primarily at reducing radon exposures is in some ways similar to the approach taken to the change of use of contaminated buildings (Case 3).

## Case 2: Concerns caused by even low levels of residual contamination

This example refers to a series of locations investigated by HPA over the period 2008-2010. It was not known initially if the premises were currently contaminated or if so at what levels. but if they were then their current occupancy would have implied they were definitely "existing exposure" situations.

The initial prompt for this work was raised about possible historic radium contamination in two historic laboratory buildings at Manchester University. These centred on (but were not exclusively related to) the work of Ernest Rutherford who was at Manchester from 1907-1919. In respect of this location HPA undertook a retrospective dose assessment for the more recent occupants of the buildings. The HPA report has been published by the University on its own web site along with other related investigation reports. The radiological assessment did not find evidence of significant exposure of building occupants but it nevertheless represented a considerable effort in seeking to allay concerns of those who had been (and still are) in the relevant buildings.

The investigations at Manchester prompted questions about where else Rutherford and other earlier researchers had worked with radium and other radioactive materials and this led to a request to HPA to survey parts of the Old Cavendish Laboratory building at Cambridge University, where Rutherford worked between 1919 and his death in 1937. There were also concerns raised about where the powerful radium sources that Rutherford secured for his work came from and where they actually ended up, as records of this were very limited so long after the events. This led to requests to HPA to investigate a number of sites in London where radium was known to have been sold in the earlier years of the twentieth century.

The university buildings at Manchester and Cambridge had already been subject to decontamination (sometimes in several stages) although the records were relatively limited meaning that there were few records of historic contamination levels, and this made the retrospective dose assessment for Manchester a difficult task. Where HPA actually undertook monitoring (at Cambridge) only trivial contamination was identified, typically small spots or patches with only kBq levels of radium-226. An interesting feature when planning this survey was the need to consider the possibility of contamination by separated lead-210 (formally referred to as "Radium D"), thorium-230 (formally "ionium") and actinium-227. All these had been purified by those undertaking early nuclear chemical research. One of the survey methods was collection of dust samples from inside buildings and radiochemical assay of polonium-210, this serving as a "marker" for lead-210.

The venues investigated in London comprised a varied assortment of commercial and office locations. Some showed no radium contamination, but several showed detectable but still low level traces on or under floors. In no case was intervention anywhere near warranted on the basis of the contamination found. (It is not possible to state that these residues are completely outside the scope of the current UK legislation for radioactive substances, which is an interesting issue from the point of view of long term management: details of these recent HPA surveys may prove hard to find in another hundred years time!) Many of these buildings in London had undergone substantial internal modification and refurbishment over the years and it likely possible that greater contamination had been present at some stage but it was inadvertently removed over time.

In all these cases where contamination

was detected there was an existing exposure situation albeit the levels were so low as not to warrant intervention. What is significant is the power of even reports of contamination or suspicion of contamination to cause concern to building occupants: here the "intervention" was of the form of monitoring to provide public reassurance that the premises were safe, so effectively to rule out existing exposure to residues. As will be described later the very existence of "contamination" whatever the risk level exercises a powerful influence on perceptions and is a significant influence on decision making. Another feature of these scenarios is the difficulty of maintaining usable records of past practices including previous contamination levels. This is not new but is a continuing theme in this part of radiation protection.

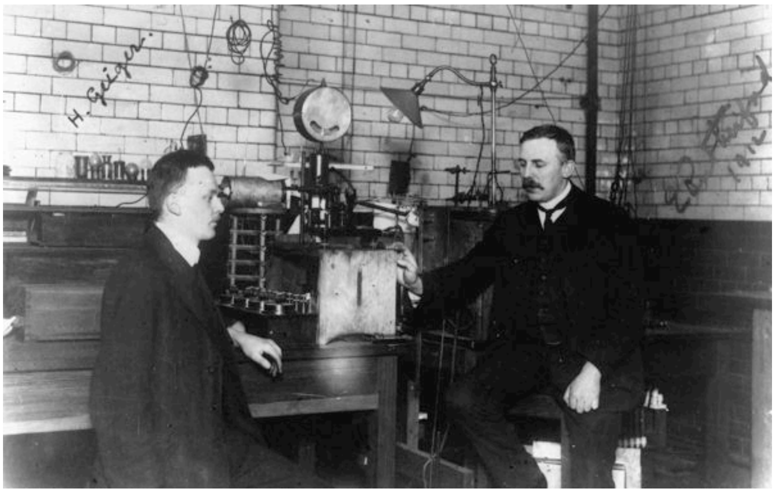

Figure 1 – Ernest Rutherford (right) and Hans Geiger in the laboratory of M. Rutherford at Manchester University, about 1908 (credit: Rex Features).

### Case 3: Remediation of a thorium contaminated site

This third example is the common one of "full" remediation of a contaminated site where we are moving from a largely disused premises, where occupancy is by now low (and so "existing" exposures limited) to complete re-development. Unlike Case 1, the main driver here is not reduction of existing exposures but the desire to redevelop the site for commercial reasons. This and the likely high cost of radioactive decontamination point to high value end-use for the site, such as domestic dwellings or commercial/office use, or a mixture of these. These applications will typically be characterised by high occupancy so the exposure to any residual contamination (after remediation) will be higher than were the site to be used for lower value applications such as simple storage space or, say, car parking.

The optimisation we are seeking is of the future exposure of future site occupants. As we cannot measure such exposure in advance we must predict future exposure based on measurable levels of residual contamination and so determine what "end point" is appropriate when planning the decontamination work, and against which we will demonstrate success by measurement before new buildings are erected. This requirement is well known to those who work in this area.

The site was in London and had been used for manufacture of gas mantles containing thorium oxide. There was easily detectable but relatively minor contamination of the above ground building structures which were to be completely removed (an interesting feature was the desire for extensive salvage and re-cycling of some of the building materials). This contamination required the usual worker radiation protection measures including "controlled area" working and the use of respiratory protective equipment. As is often the case there were much more significant radioactive deposits below ground arising from past disposal practices, again undertaken prior to modern UK regulations. These were the primary source of radioactive wastes requiring disposal from the site.

Key questions were, what would be the decontamination end point, how would that be verified, and what if any area averaging of results would be acceptable when demonstrating that the end point was met? In fact the chosen end point for this site had already been agreed between the owner and the environmental regulator as 0.1 Bq.g-1 to be applied above a "local background" level (which was nominally taken as 0.03 Bq g-1 in this case). The 0.1 Bq.g-1 figure applied to thorium-232 in equilibrium with all its decay products and had been originally derived from consideration of a predicted fatal cancer risk rate to future site occupants of 10-6 per year. (Some assessments suggest the excess risk rate for an incremental level of 0.1 Bq.g-1 of thorium-232 in soil may be several times higher that this.) It was clearly going to be a challenging end point to achieve and verifying it required not only use of gamma radiation surveys but also a detailed grid of soil samples that were assayed by gamma spectrometry. There was no need to employ area averaging arguments in this particular case, although clearly gamma surveys inevitably provide for some area averaging in the monitoring process, unlike discrete sampling.

The project has been a success in that the desired end point was achieved and verified, but this does not mean that it was necessarily the radiologically optimised solution. What is now considered here is what alternative end point might have been possible. Intuitively, the question might be how much higher could the end point have been set? An incremental level much below 0.1 Bq.g-1 would stray into the normal variability of the natural level of thorium in soils and attempting to pursue an ultra-low end-point could lead to an exponential increase in waste volumes and costs and, in addition, a much more difficult and expensive final survey.

HPA advice on determination of end points for change of use of a contaminated site like this one is that where there may be future public exposure a constraint on predicted future doses of 300 μSv per year should be applied. This sets a minimum standard of remediation which can be regarded as acceptable.

Below this constraint the remediation should be optimised so that predicted future exposures will be as low as reasonably achievable. A separate reference level of 20 µSv per year (which relates to an excess risk rate of the order of 10-6.y-1) is described. Below this the requirement for optimisation can be considerably relaxed but this is not intended as the automatic level that all remediation strategies should aim for and it is definitely not the boundary between "acceptable" and "unacceptable" risk.

The methodology and results in report NRPB-W36 can be used to determine that the following thorium-232 chain concentrations would correspond to the 300 and 20 µSv per year levels for a range of physical distributions of the residual contamination. In all these cases it is the residential housing scenario that is being considered, as this tends to be the most sensitive, and it was relevant in this particular situation (see table 1).

On this basis it would have been possible to consider an end point for thorium-232 in soil rather higher than the chosen 0.1 Bq.g-1, perhaps allowing area averaging against one lower value with a second higher threshold of maybe 1 Bq.g-1 for "peak" concentration as determined by discrete samples. Secondary thresholds applicable to small areas could be useful in some situations of non-uniform contamination, and they can be radiologically justified.

For the widespread contamination scenario the thorium-232 concentration corresponding to the 20 µSv per year level is very low (a few tens of Bq.kg-1). This is definitely within the variability of normal levels of thorium in many soils and building materials. This shows how for natural radionuclides (but especially thorium and radium) attempts to "achieve" very low residual risk targets are likely to be impracticable on grounds of inability to detect the additional man-made contamination above the normal background, while they are certainly unlikely to represent optimisation of protection.

## Discussion

Cases 1 and 3 above present different examples of intervention to deal with radioactive contamination. In Case 1 the intervention was in a true existing exposure situation caused by historic residues whereas in Case 3 it is mainly future exposure to residues that is important. However, the two scenarios share a common theme that once a decision is taken to intervene, i.e. carry out decontamination actions, the question of how far should these actions be pursued becomes most important. In Case 1 it could be argued that only limited decontamination would be required to suppress the radon levels but judging this would present problems because of the difficulty of predicting radon levels after remediation. In addition given the disruption involved the marginal cost of removing more contamination could be relatively small so there was in that case a strong incentive to treat the situation as a "full" decontamination exercise. That would, for example, facilitate future changes to use of the affected premises: by not leaving significant contamination behind there would be no concern about the need to re-visit and undertake further remediation in future.

Thus the setting of end-points for site decontamination is important both to intervention in existing exposures to historic residues and to changes of use of contaminated sites. The ALARA method would suggest that end points would have upper bounds (related to dose constraints or even limits) but otherwise consider the balance between implied future doses (minus the reduction in any existing does) against the costs expended to reduce those. That alone is a difficult judgement partly because of the difficulty of predicting future doses and or predicting the costs of remediation before it begins. However, in practice further factors are significant in the selection of the remediation end point and one of the most significant of these is the definition of "radioactive substance" for the purpose of regulatory control.

Current UK regulations for radioactive substances activities including waste disposal set a concentration threshold for application of the regulations to practices involving solid radioactive materials. The thresholds for each radionuclide or decay chain are derived from RP-122. The UK regulations do not seek to require permitting for in-situ contamination above this level but they would, unless an exemption applied, require permitting for disposal of radioactive wastes arisings. Thus, while contamination remains undisturbed these regulations do not require action, but any deliberate radioactive decontamination or just wastes produced from building modification work can come into the scope of the regulations. Disposal of such wastes may fall within exemption provisions but these are not unconditional, all that is avoided is the requirement for a formal permit. This means that when planning decontamination there is often a strong desire for decision makers to achieve a result which implies no future regulatory burden, and that makes the regulatory reference level a strong candidate to become the chosen decontamination end-point.

In the case of the thorium-232 decay chain the preceding W36 results show that the UK threshold value of 0.5 Bq.g-1 if applied as an end-point for uniform widespread contamination implies future doses to site occupants above 300 µSv per year for some scenarios. That would not be compatible with the HPA advice and so supports the decision to use a lower end point in the Case 3 scenario. The corresponding threshold for cobalt-60 in the UK regulations is 0.1 Bq.g-1 and for the uniformly contaminated uncovered ground/housing scenario in NRPB-W36 implies a dose rate of about 90 µSv per year. This seems comfortably below the HPA recommended constraint for a change of use of contaminated land whilst not being excessively low. More extreme

| Distribution of contamination | Uniform (no cover) | Uniform (covered) | Uniform (covered, disturbed)) | Patchy (covered) | Patchy (covered) | Patchy (covered, disturbed) |
|---|---|---|---|---|---|---|
| Bq/g for 300 microSv/y | 0.25 | 1.11 | 0.62 | 1.22 | 2.00 | 1,79 |
| Bg/g for 20 microSv/y | 0.017 | 0.074 | 0.041 | 0.081 | 0.133 | 0.120 |

Table 1 – Activity of the thorium-232 chain necessary to receive an annual dose of 20 mSv or 300 mSv for a range of distribution of the contamination.

cases are the regulatory thresholds for radionuclides such as tritium and carbon-14 which are in the UK respectively 100 and 10 Bq.g-1. These if applied as end points are likely to imply much lower dose rates and their use could distort optimisation, especially if the even lower value for carbon-14 of 1 Bq.g-1 in the IAEA publication RS-G-1.7 is applied. But at least these tritium and carbon-14 values are more sensible than the previous threshold of 0.4 Bq.g-1 that would have been considered for these radionuclides prior to the UK's adoption in its regulations of a new exemption and exclusion regime.

### Conclusions

There is clearly a role for optimisation of radiation protection in relation to decontamination whether this is to reduce existing doses or to restrict (predicted) future doses. The significant direct financial costs of remediation and waste disposal surely support this assertion.

When considering extensive remediation work other non-radiological risks are not often considered but perhaps ought to be, for example movement of large volumes of contaminated soils to landfill sites imply transport risks.

However, as usual in ALARA situations there are other factors that impinge on decision making: the psychological perception of contamination (including where residues may be forgotten and then re-discovered long after the original contaminating practices) can be a significant factor and may prompt expensive attempts to remove "all" contamination, or to remove it down to very low levels, which will clearly lead to verification issues with NORM and may be simply impractical for widespread contamination by radionuclides such as cobalt-60 which can be detected at extremely low levels.

The regulatory thresholds for "radioactive material" are attractive as end-points for very practical and logical reasons. However, since they tend to be derived from concepts of exclusion and clearance based on very low nominal risk rates they can "drag" the decision making process to what should be the lower end of the range of doses relevant to optimisation of protection. Related to this is the need to recognise that low risk rate criteria such as 10 or 20 µSv per year are not automatically suitable for deriving end-points as targets for decontamination. They may be practical for some scenarios but the cost of applying them in others could be that remediation is not undertaken because it is just too expensive or disruptive. In some cases complete regulatory clearance may not be practicable and managing radioactive residues in-situ should be considered.

However, even if the concept of optimisation is fully embraced in remediation work there are considerable problems in its application including considering how to apply quantitative techniques such as cost benefit analysis. As well as the question of how to cost radiation detriments (which for residual contamination may be delivered over long times) there are significant uncertainties peculiar to these scenarios. One is that despite the best preliminary surveys the extent of remediation required or even practicable cannot always be determined before physical processes such as excavation are begun. Another is the difficulty of predicting future exposures to residual contamination. With gamma emitters this may appear relatively easy but for radon arising from radium residues this is certainly more difficult.

### References

1. Mobbs S F, Barraclough I M, McDonnell C E, Morrey M, Cooper J R and Fry F A. *Radiological protection objectives for land contaminated with radionuclides*. Docs NRPB, Vol. 9 No. 2 (1998) http://www.hpa.org.uk/Publications/Radiation/NPRBArchive/DocumentsOfTheNRPB/
2. European Union. *Practical use of the concepts of clearance and exemption: Guidance on general clearance levels for practices*. RP122 Part I (2000)
3. European Union. *Application of the concepts of exemption and clearance to natural radiation sources*. RP122 Part II (2002).
4. IAEA. *Application of the concepts of exclusion, exemption and clearance*. Safety Guide RS- G-1.7 (2004).
5. Oatway W B and Mobbs S F. *Methodology for estimating the doses to members of the public from the future use of land previously contaminated with radioactivity*. NRPB-W36 (2003) ISBN 0 85951 508 7 http://www.hpa.org.uk/Publications/Radiation/NPRBArchive/NRPBWSeriesReports/
6. Jones K A, Oatway W B, Haylock R G E, Holmes S and Simmonds J R: *Assessment of the possible risks of radiation induced health effects from contamination at the University of Manchester*. Report RPD-EA-5-2010 http://www.manchester.ac.uk/rutherfordreview/media/corporate/theuniversityofmanchester/content/files/rutherfordreview/finalreports/HPA-final-radiation-report.pdf

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## Experience from a High Radiation Area in Norway

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In 1988, very high levels of radon were detected in a kindergarden in Kinsarvik, a village by the Hardanger Fjord at the west coast of Norway. In 1996-97, an extensive radon measurement and mitigation project was carried out. The radon measurement revealed that most buildings in this area had very high or extremely high radon concentrations.

### Radon measurements and mitigation 1996-1997

When the seriousness of the problem was recognized, a mitigation project was initiated. It was organized with a steering group of local political leaders and representatives of the public. A working group with representatives from the local administration and health personnel, in addition to various radon experts, was set up. In the first phase of the project, measurements were carried out in most dwellings in the area.

About 60 % of the alpha track detectors were overexposed, and had to be analyzed by a special procedure. Annual average radon concentrations up to 56,000 Bq.m-3 were found, and the mean radon concentration was 4,340 Bq.m-3!

Published values of radiation doses to the population ranged from 3.6 to 920 mSv.year-1, with a mean value of 72 mSv.year-1! These dose estimates values were calculated based on the ICRP risk-based approach developed in ICRP 65 in the calculation of effective dose (Sundal et al, 2007).

Measurements had to be carried out in all four seasons due to extreme and unusual seasonal variations. Normally, radon concentrations in dwellings are highest in the cold winter season. In Kinsarvik, the radon concentrations are highest in summer in the lower part of the residential area, and highest in winter in the upper part. This is due to the particular geological conditions, with highly permeable masses covered by more fine-grained sediments (Sundal et al 2008).

A pilot project for radon reduction techniques were performed in 3 of the most severely affected houses. Radon levels were reduced in these houses, but were still too high. Mitigation plans were developed for 96 houses, and in the period 1999-2003 economic compensation for the mitigations were made available.

## Stakeholders

The major stakeholders include national and local authorities, the public (homeowners, workers) and local industry and employers. Furthermore, primary health care workers and teachers could be important as secondary informants on radon health risks and how the risk can be reduced.

## Response of the public

Despite intense communication and information efforts, most homeowners did not act to mitigate their homes. Interest and anxiety varied considerably. Many compared their radon values with other houses nearby, or with the very worst affected in the area. Hence, levels of a few thousand Bq.m-3 could be perceived as moderate levels in relation to this. Many, especially elderly persons, did not believe in the health risks, and referred to the fact that people have inhabited these areas for centuries. Anxiety was, however, clearly age dependent, and parents were particularly concerned with their children's health.
Recently, new radon measurements have been carried out, and the result shows no significant overall reductions when compared with the measurements made approximately 15 years ago (see Fig 1 below). This is of course a serious concern, and in the new National Radon Strategy (2009) areas with extremely high radon levels have been given special attention.

## Exposure situations

High radon concentrations affect all types of buildings in the area: dwellings, school, kindergarden, workplaces, health care institutions, shops and other public buildings. Even the outdoor radon concentrations are exceptionally high, and could even exceed an annual average of 200 Bq.m-3 (Jensen et al, 2006). Children are being exposed to high levels both at home and at school, and it may be assumed that a large fraction of local workers have their homes in the affected area. This raises the question of whether it is reasonable to view the radon problem in the area as separate exposure situations depending on whether the building in question is a home, a school or a workplace.

## Some lessons learned

It is essential that the local authorities and the public are involved in the planning and implementation of the radon reduction projects.

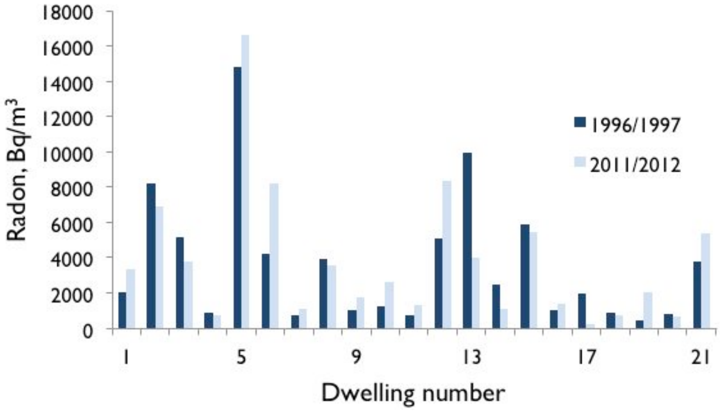

Figure 1 – Annual mean radon concentrations in dwellings 1996/97 compared with 2011/12.

Figure 2 – Kinsarvik is located at the mouth of the Sørfjorden and the Eidfjorden where it branches from the Hardangerfjord, county of Hordaland, Norway.

In many cases it was technically difficult to achieve indoor radon levels below the action limit at the time (200 Bq.m-3). In such cases, the efforts were perceived as unsuccessful, even when radon was reduced by more than 70-90 %. Homeowners were therefore in some cases reluctant to carry out the mitigation. It is therefore important to encourage any reduction of radon.

It is important to encourage mitigation shortly after information and measurement campaigns. If not, it seems that the motivation to mitigate decreases with time.

Most primary health care workers have limited knowledge on radon risks and the synergy with smoking. In areas where such high radon levels occur, it is particularly important that correct advice on both smoking and radon is given by the primary health services. Some individuals have been exposed to high radiation doses, and need detailed advice regarding their situation.

## References

1. Jensen C L, Sundal A V, Ånestad K, *Radon concentrations in outdoor air. Presentation of results from radon measurements in outdoor air in six selected Norwegian areas.* StrålevernRapport 2006:20. Østerås: Norwegian Radiation protection Authority, 2006 (In Norwegian)
2. *Strategy for reduction of radon exposure in Norway* (2009) http://www.nrpa.no/dav/000c3a1385.pdf
3. Sundal A V, Jensen C L, Ånestad K, Strand T. *Anomalously high radon concentrations in dwellings located on permeable glacial sediments*. J Radiol Prot. 2007; 27:287-98
4. Sundal A V, Valen V, Soldal O, Strand, T. *The influence of meteorological parameters on soil radon levels in permeable glacial sediments.* The Science of the total environment 2008; 389(2-3):418-28.

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# Health Economics Evaluation of Radon Intervention Strategies in Ireland

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## Introduction

A health economics evaluation was undertaken of different radon intervention strategies, which might be applied in Ireland. The aim of health economics in general is to assist decision makers in achieving the best public health outcomes from finite resources. The aim of this work was to indentify the most cost effective radon interventions in an Irish context and was undertaken in support of the development of a National Radon Control Strategy.

This evaluation was undertaken using cost-effectiveness analysis, a tool widely used by health economists. For each radon intervention considered, the analysis compares the economic cost of the intervention against the effectiveness of the measure. In this analysis the effectiveness of an intervention is measured in terms of quality adjusted life years gained (QALY) as a result of the intervention. The QALY is widely used by health economists to compare the beneficial effect per unit cost for a wide range of different health interventions (vaccination, health screening, road traffic measures, etc). The QALY has the advantage of combining in a single measure both premature mortality and morbidity/ quality of life. The cost effectiveness model used in this analysis is based on that described by Gray et al, [2009] and the World Health Organisation [WHO, 2009].

## The cost-effectiveness model

The cost-effectiveness model estimates the lifetime risk of fatal lung cancer before and after preventive measures to reduce radon level using Irish demographic and cancer incidence data and the radon risk estimates obtained from the European pooling study [Darby et al. 2005, 2006]. These lifetime risks are used to calculate life years gained, which are further adjusted using age specific and sex specific normative weights to calculate QALYs gained. The model estimates the cost of each intervention, which can then be combined with the QALY values to calculate a cost effectiveness ratio (€/QALY) for each intervention.

Direct costs incurred or saved by homeowners, government and the health service have been included. There costs include: the costs associated with education/ awareness programmes to encourage householders to test radon levels in their homes, the measurement/ survey costs associated with identifying high radon levels in existing homes, remediation of existing homes (both capital and running costs), the cost of preventive measures in new homes, the cost of standby sumps and health service costs. In common with other similar evaluations, all future costs and benefits are discounted to account both the economic value of deferred spending together with societal preference to defer costs and to enjoy the benefits as soon as possible. Discounting has been applied using the guidelines issued by the Department of Public Expenditure and Reform [DPER, 2011]

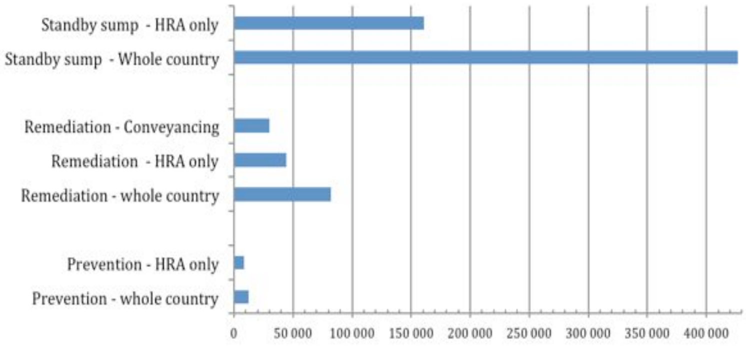

Figure 1 – Cost effectiveness of radon interventions (in €/QALY).

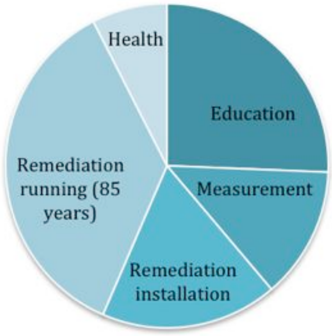

Figure 2 – Cost per QALY for remediation in high radon areas broken down by key elements of cost.

Euro per QALY values were modelled for: prevention incorporated in new homes at the time of construction, remediation (where a standby sump was not present in the house) and remediation by activation of a standby sump. For each intervention the cost effectiveness was modelled for two scenarios the first assuming the intervention was targeted at the whole country and the second that the intervention was targeted at high radon areas (HRA) only. The effect on cost effectiveness of different strategies to promote radon measurement was also modelled. The strategies considered included: public education programmes; requiring the exchange of information on radon between vendor and purchaser when a house is sold and remediation programmes undertaken by local authorities. This analysis was also be used to examine the impact of cost effectiveness on a range of other factors such as average radon level, smoking status and choice of reference level, etc. The key results are summarised in Figure 1.

A number of clear trends emerge from this analysis. Of all of the scenarios considered radon prevention in new houses appears to be the most cost effective. Awareness raising and remediation programmes for existing houses are more likely to be cost effective in high radon areas, while as currently implemented the cost effectiveness of standby sumps appears to be poor.

The poor cost effectiveness associated with standby sumps is due primarily to the fact that only a very small proportion of houses with standby sumps are actually tested and an even smaller proportion of those remediated. Hence despite the relatively low unit cost of installing a sump in a new house, the ratio of sumps installed to house remediated is very large and hence the normalised cost is high.

For each scenario the cost per QALY gained as a result of the intervention was broken down by cost type (direct cost of the remedial measure, health service costs, education/ awareness and radon survey). This breakdown is useful is suggesting where improvements in cost effectiveness can be gained. As can be seen from Figure 2, for example, measures which improve the uptake rates of awareness programmes may have a significant impact on cost effectiveness (given the relatively high cost of education and awareness programmes when normalised to QALY gained). Similarly considering the proportion of the overall cost per QALY accounted for by running costs, the fan wattage is likely to have a significant impact on cost effectiveness.

The principal reason for the relatively low normalised cost of radon prevention when compared to remediation is that prevention is applied to all houses in the target area, while remediation is applied only to houses with radon concentrations above the National Reference Level, which in Ireland is 200 Bq/m$^3$. Prevention, therefore, results in an average reduction in radon concentrations across the whole housing stock, while remediation only results in a reduction in radon concentrations in houses, which initially had concentration in excess of the reference level. Because of the lognormal distribution of radon levels in houses, the majority of houses in all parts of the country have concentrations below the reference level and as a result the majority of radon attributable lung cancers are caused by exposure to radon at concentrations below the reference level.

## Conclusions

A number of clear trend and general conclusions emerge from the cost effectiveness analysis, which are summarised below. It should be noted that these are based on Irish conditions (average radon level, demographics, costs etc) and so may not be exactly the same in other countries.

- In general the incorporation of prevention into new buildings at the time of construction is significantly more cost effective than identifying existing homes with high radon levels and remediating them.
- It is cost effective to include basic preventive measures in all new homes and not just those in high radon areas.
- The total costs associated with remediation of existing housing are dominated by the cost of education and testing programmes. It is clear that it is expensive to find homes and to persuade owners to act. The lifetime costs associated with active remediation systems are also high. The hierarchy of costs associated with remediation can be summarized as follows:

  Education and testing > lifetime running > installation of remedial measure.
- The cost effectiveness of awareness & remediation programmes is significantly better in high radon areas. This points to the need for careful targeting of radon awareness campaigns.
- Cost effectiveness of awareness and remediation campaigns is dependent on test uptake and remediation rates. There is a need, therefore, to adopt strategies which improve these rates. The cost effectiveness ratio for social housing programmes, for example, tend to be relatively good because such programmes have generally close to 100% uptake. Other strategies, which may improve uptake rates, include grant aiding or subsidising either testing or remediation, linking of radon testing to conveyancing and measures to support householder decision making throughout the

In many cases it was technically difficult to achieve indoor radon levels below the action limit at the time (200 $Bq/m^3$). In such cases, the efforts were perceived as unsuccessful, even when radon was reduced by more than 70-90 %. Homeowners were therefore in some cases reluctant to carry out the mitigation. It is therefore important to encourage any reductions of radon.
It is important to encourage mitigation shortly after information and measurement campaigns. If not, it seems that the motivation to mitigate decreases with time.

Most primary health care workers have limited knowledge on radon risks and the synergy with smoking. In areas where such high radon levels occur, it is particularly important that correct advice on both smoking and radon is given by the primary health services. Some individuals have been exposed to high radiation doses, and need detailed advice regarding their situations.

## References

1. DEPR, 2011. http://per.gov.ie/project-discount-inflation-rates
2. Gray A., Read S., McGale P. and Darby S., 2009. *Lung cancer deaths from indoor radon and the cost effectiveness and potential of policies to reduce them*. British Medical Journal, BMJ 2009;338:a3110 doi:10.1136/bmj.a3110.
3. *WHO Handbook on Indoor Radon – A Public Health Perspective*. http://whqlibdoc.who.int/publications/2009/9789241547673_eng.pdf.

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# Stakeholders Input to the Development of the National Radon Control Strategy for Ireland

Stephanie LONG
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Presented at the European ALARA Network Workshop, Dublin 4-6 September 2012

## Introduction

In November 2011 the Irish Government announced the establishment of an inter-agency group tasked with developing a National Radon Control Strategy for Ireland. This group comprises representatives from those state agencies that have a role in radon control. The role of the inter-agency group and the work programme used to develop the draft Strategy was outlined in a previous newsletter by David Fenton (RPII). The work of the inter-agency group was carried out in close consultation with stakeholders. This consultation was critical to ensure that the input of the public and key stakeholders is captured; that the Strategy is developed in as open and transparent a way as possible and to ensure that the Strategy recommendations are practical to implement. Stakeholder consultation was divided into three phases between January 2012 and March 2013. These are described below.

## Phase I Consultation

Seven groups of key stakeholders were identified:

1. Radon measurement and remediation companies
2. Organizations related to the construction industry
3. Local authority building control staff
4. Employer and employee groups
5. Government agencies and public bodies with a specific interest in radon
6. Representative bodies for health professionals
7. Staff of the RPII
8. The general public

A tailored questionnaire was designed for each of these groups and these were distributed by email. The topics addressed in the questionnaire included awareness and testing rates, radon prevention in new buildings, building regulations, workplaces, measurement services, remediation services, the role of other public bodies and the role of health professionals.

There was an excellent response to this consultation with over 1,000 comments received from more than 160 individuals and representative bodies. Responses were reviewed, categorised and themes identified. These results were then combined with the output of a number of recent consultations with members of the public and local authorities:

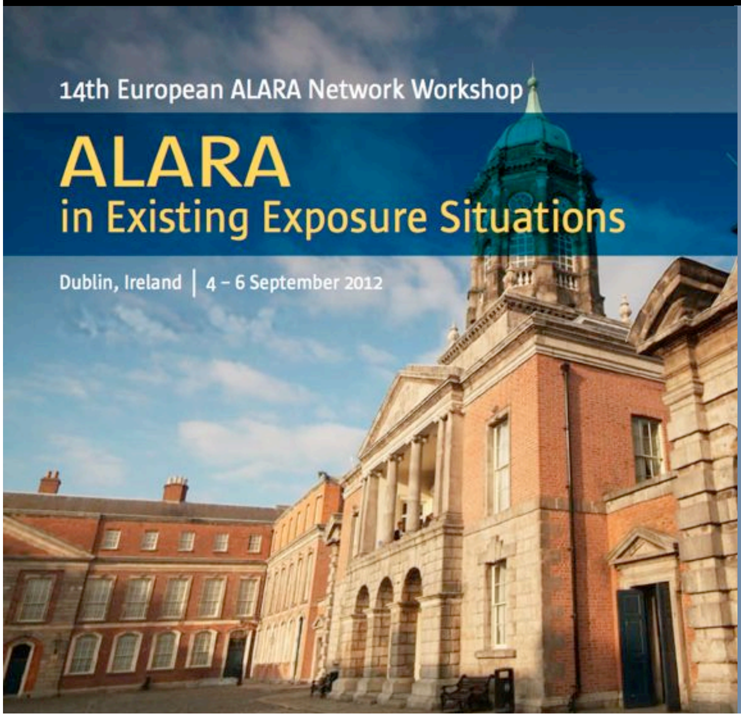
- Qualitative research with focus groups in High Radon Areas to explore homeowners' awareness of radon gas and barriers to getting their homes tested.
- A survey of RPII customers in to determine radon remediation methods and costs.
- A survey of RPII customers to determine radon remediation rates.
- A survey of local authorities regarding their approach to radon.

The output from all of these consultations helped put shape on the draft Strategy and fed directly into the initial discussions of the inter-agency group. Specific issues were identified for further exploration with key stakeholders in Phase 2 of the consultation.

## Phase 2 Consultation

During Phase 2 meetings were held with representatives from 32 government agencies, departments, employee representative bodies and measurement and remediation companies to further explore a wide range of issues identified during Phase 1.
Examples of the topics discussed include:

- Training in radon preventive and remedial measures for undergraduates, site staff and professional staff
- Proposed improvements in radon preventive measures for new buildings
- Including radon during property transactions (sales and rental)
- The need for registration of remediation contractors
- The need for some type of validation scheme for radon testing services



The last European ALARA Network took place in Dublin's Castle (Ireland) from 4 to 6 September 2012.

The topic was "ALARA in Existing Exposure Situations" and the workshop consist of presentations intended to highlight the main issues, and a significant part of the programme will be devoted to discussions within working groups. From these discussions, participants will be expected to produce recommendations on ALARA in existing exposure situations addressed to relevant local, national and international stakeholders.

Slides and papers presented during the Workshop are now available on EAN website (http://www.eu-alara.net/).

The output from these consultations helped inform the final draft Strategy document.

### Phase 3 Consultation

The final phase of stakeholder consultation is a full public consultation on the draft Strategy. This consultation was launched by the Minister of State at the Department of Environment, Community and Local Government at the annual National Radon Forum in January 2013. The document was published on the Department of Environment, Community and Local Government website, a press release was issued and an email regarding this sent to over 500 stakeholders. This final consultation will end on 1st March 2013 and the output will be used to finalise the draft Strategy for submission to Government at the end of 2013.

### Conclusion

The RPII is confident that this 14-month consultation process will result in a National Radon Control Strategy that reflects the experience and opinions of all key stakeholders and is practical to implement. Ultimately this means that the overall objective of the National Radon Control Strategy to reduce the number of radon related lung cancers in Ireland will be met as efficiently and effectively as possible.

* * *

## ALARA in Existing Exposure Situations Summary and Recommendations from 14th EAN Workshop in Dublin

Peter Shaw
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Pascal Croüail
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### Workshop objectives ans programme

The concept of "*existing exposure situations*" was introduced by ICRP in Publication No. 103 (2007), and is defined as exposure situations that already exist when a decision on control has to be taken. Examples include radon in homes, aircrew exposure to cosmic radiation, remediation of historically contaminated land, and post-emergency situations.

Optimisation is the key radiation protection principle for existing exposure situations, although it is not always clear how to apply this in practice. Consequently, the aim of the 14th EAN workshop was to focus on how the ALARA principle can be applied to the whole range of existing exposure situations, considering the wider principles and strategies that might be adopted, as well as specific methods for implementing ALARA in practice.

The Workshop was officially opened by Mr Fergus O'Dowd, Minister of State at the Department of Communications, Energy and Natural Resources and the Environment, Community and Local Government. There were 66 participants from 17 different countries, with half the programme devoted to presentations, and half to Working Group discussions based on the following topic areas:

- ALARA challenges and practicalities at the national and regional level
- Considerations in choosing dose reference levels
- Economic and technical factors, and endpoints of optimisation
- Societal factors and stakeholder engagement

On the final day, the reports from the four working groups were presented and discussed, and form the workshop conclusions and recommendations. These, plus individual presentations (slides and papers), are available to download from the EAN website (http://www.eu-alara.net/).

Some key themes and issues did emerge from the workshop, and these are also summarised below.

### Themes and issues arising

#### *Characteristics of existing exposure*

### *situations*

The basic definition of existing exposure situations is simple: they already exist when a decision on control has to be taken. However, such situations are diverse – from radon in homes to post-nuclear emergencies – and a theme to emerge from the scene-setting presentations was how to define some common characteristics. It is clear that they encompass natural and man-made sources, public and occupational exposures, and also a very wide range of radiation doses: from small fractions of mSv/y in some site remediation case studies, to several hundred mSv/y (or more) in some radon studies. Furthermore, often there are broad individual dose *distributions*, which become an important factor when considering reference levels.

From an EAN perspective, an important question is the potential for optimisation, which clearly varies according to the type of existing exposure situation. For example, there is very little scope for restricting cosmic ray exposures to aircrew. On the other hand, there is clearly a huge scope for reducing exposures to radon, both in the home and the workplace.

Another feature of existing exposure situations, which emerged repeatedly throughout the workshop, is the wide range of stakeholders involved. This includes a range of actors and decision-makers, many of which are outside the traditional radiation protection community. For example, there is often a need for a wider governmental involvement, with equally important roles for the media and other communicators. There is also an emphasis on individuals being able to reduce their own radiation exposures, for example through radon remediation measures at home, or through modifying living habits in contaminated areas. However, it was clear from a number of presentations that such "self-help" protection actions cannot be forced on people, and, in fact, actions are required at all levels to achieve optimisation. Indeed, a significant conclusion from the workshop was that traditional mechanisms of control, such as regulation (ie as applied to planned exposure situations), may be of limited value in the context of existing exposure situations. If so, alternative frameworks, which can be supported by local actors, need to be considered.

### *When should they be treated as planned exposure situations?*

Although the focus of this Workshop was on existing exposure situations, inevitably this raised the question of the relationship with planned exposure situations. ICRP has recommended that some existing exposure situations should (for the purposes of control) be treated the same as planned exposure situations. This would include occupational exposures to radon, whereby gas concentrations cannot be reduced below the reference level (e.g. in specific workplaces or activities, such as underground workplaces or spas), and the system of control for planned exposures should be applied. Subsequently, in the international BSS, similar proposals have been made for NORM industries, based

From left to right: Pascal Croüail (CEPN, EAN), Stephane Calepene (European Commission), Jacques Lochard (CEPN, ICRP), Edouard Lazo (OECD-NEA), Peter Shaw (HPA, EAN), Mr. Fergus O'Dowd (Minister of State, Irish Government), Ann McGarry (RPII), Christopher Clement (ICRP Scientific Secretary), Professor Ian McAulay (Trinity College, Dublin), Fernand Vermeersch (SCK•CEN, EAN), at the14th European ALARA Workshop, Dublin, September 2012.

either on occupational dose (typically 1 mSv/y) or activity concentration (typically 1 Bq/g for U-238/Th-232).

The above approaches provide a basis for differentiating widespread (or "natural") exposures from those that might be considered high enough to warrant further attention. Equally importantly, they are also based on practical considerations of which existing exposures might be amenable to control, ie through a regulatory system. However, there is potential for confusion here with the concepts of exclusion and exemption, especially for NORM industries and NORM in building materials, where such concepts have traditionally played an important role. Thus, clarification from ICRP on the relationship between these different concepts would be useful.

### *Implementation of ICRP103*

The ICRP system of exposure situations has been incorporated into the (interim) IAEA and (draft) European Basic Safety Standards. Presentations at the Workshop suggested that there are already differences in interpreting how the requirements for existing exposure situations should be implemented. A key example is radon in homes, for which the approach is very similar to that used currently for Action Levels. This is not simply a question of terminology: remedial action is required above action levels, but optimisation is required above and below reference levels. While it is easy to view this trend as a dilution of the ALARA principle, it is important to consider the wider context and history of the radon problem. Although there are some notable success stories (as several presentations highlighted), the overall impact in terms of dose reduction has been very low. This is true even in Ireland where a very impressive campaign to tackle radon has been mounted.

In practice, we may need to accept that there are limitations on what can be enforced and achieved, even though (in most cases) radon exposures can effectively be reduced. It was noted at the start of the workshop that existing exposures may be characterised as not requiring urgent action. However, what emerged from the workshop is that there is a need for action now, but we must accept that success will require time. In the case of radon, this requires a focus on prevention (for new buildings), and a prioritised campaign for existing buildings based on what can reasonably be achieved, even if it does not (yet) fully embrace optimisation in all cases.

### *Stakeholder engagement*

This has been a recurring theme at many previous EAN workshops, and is especially relevant for existing exposure situations, for example where home owners are exposed to radon, or where populations are exposed as a result of past events or practices. Several presentation stressed the need for stakeholder engagement at all levels throughout the decision making process. For example, it is important to engage at the emergency planning stage, and not just after an accident has occurred.

Increasingly the question is how such engagement should be conducted, and there was particular emphasis on treating individuals, their cultures and traditions with dignity and respect; exploring shared ethics and values; and "decoding" and optimising two-way communications.

### *"Soft boundaries"*

It was stated at the start of the workshop that dose reference levels were intended to be "soft boundaries", within the optimisation process. The workshop highlighted a number of ways in which this message can be lost in translating ICRP recommendations into practice. The most obvious error is to misinterpret reference levels as limits: however, even if this is avoided it is inevitable that such levels will introduce something of a step-change in the approach to protection. The workshop also highlighted problems with setting unattainable reference levels, and the practical difficulties in verifying compliance, especially where the levels are low.

### *Other issues*

There is not space here to describe all the topics and issues arising from the workshop. Papers and presentations are available on the EAN website, and these include: legacy sites (including heterogeneous contamination and probabilistic exposures, using consistent soil contamination criteria); cosmic rays (exposure of aircrew and ALARA options); post-emergency situations (managing the transition to an existing exposure situation, setting coherent reference levels for foodstuffs and other commodities); and radon (applying health economics to the problem, and dealing, as a priority, with areas with very high radon gas concentrations).

## Workshop conclusions and recommandations

A large number of suggestions and recommendations were made by the working groups, and the full presentations are available on the EAN website. Given below is a short selection from these.

### *WG1: ALARA challenges and practicalities at the national and regional level*

- There is a role for national, regional and site-specific reference levels, depending on the circumstances. National Radon Action Plans require a national reference level set by governments. However, it may be appropriate to also define regional reference levels (for example where radon gas concentrations are very atypical of the whole country), provided that engagement with local authorities and communities takes place. Site-specific reference levels may be more appropriate for legacy sites, although it needs to be ensured that they fit within an overall national framework.

- When establishing a protection strategy for existing exposure situations, the means by which optimisation can be enforced and/or encouraged should be considered. Regulation offers a more direct means of control, but requires significant regulatory resources, and is clearly not applicable to situations such as radon in existing homes where optimisation will rely on encouragement and assistance. Risk communication and public awareness are important components and should be supported by public health organisations as well as the radiation protection community.

### *WG2: Considerations in choosing dose reference levels*

- The factors to consider when choosing reference levels are the same as those required for the ALARA process as a whole, ie the benefits and detriments, and the associated economic and societal factors. However, there needs to be an even stronger emphasis on practicality and realism about the improvements that might be achieved.

- Reference levels should primarily be established in terms of (actual or expected) effective dose, but when applying these in practice it may be useful to use derived levels, eg in terms of activity concentration. It is possible to set reference levels in terms of risk (ie for potential exposures), but it remains unclear how these would be used in practice.
- The following dose reference levels are suggested:
  - For legacy sites (past practices): 1 mSv/a
  - For radon: 10 mSv/a[1]
  - Post-nuclear emergency:
  - medium term: the lower end of 1 - 20 mSv/a
  - longer-term: 1 mSv/a
  - Air-crew: Between 5 and 10 mSv /a (1 mSv/a for pregnant workers).

### *WG3: Economic and technical factors; and endpoints of optimisation*

- Before any numerical criteria (either reference levels or end-points) are set, there is a need to characterise existing exposure situations. This should include questions such as "who is exposed?" and "who has a responsibility for taking action?" It should also address the inherent uncertainties, for example in terms of the doses received, and the effectiveness of remedial measures.
- Existing exposure situations can involve a complex decision-making process: tools such as cost-benefit (or cost-effective) analysis can provide structure, clarity and rationality to support this process. It is therefore recommended that use of CBA (including the cost of the man-Sv) and other decision-aiding tools, be considered further.
- Optimisation is not minimisation: ALARA must have an end-point, which should be, as far as practicable, below the reference level. However, the actual end-point will differ on a case-by-case basis, and cannot be pre-determined at the start of the process. As an example, in the long term after a nuclear emergency, the levels of exposure should tend towards those in normal situations but it must be recognized that a complete return to "normality" (i.e. as in prior to the accident) will probably not be achievable.

### *WG4: Societal factors and stakeholder engagement*

- Engaging with stakeholders is essential in optimising protection in existing exposure situations. It is important to be proactive in identifying stakeholders at an early stage, and some may need support (e.g. financial, technical, etc.) to effectively participate.
- Stakeholder engagement should start at the emergency preparedness stage, not fatre an accident has already occurred.
- The objectives and "rules of engagement" should be agreed at the start, and management of expectations is important throughout the process. Stakeholders need to know the extent to which their views and concerns can influence decisions, and be aware that engagement does not always equal consensus. Stakeholders will have different levels of 'stake' in a given situation, and the distinction between this and any wider agendas should be recognised.
- It is essential to build trust to encourage engagement: in many cases the active and willing participation of different stakeholders is required (eg radon in homes, post-emergency situations).
- It is important to assess stakeholder feedback and to learn lessons from this.

## Building ALARA as a Tool for Effective Risk Communication

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Presented at the European ALARA Network Workshop, Dublin 4-6 September 2012

An important part of the management of radiation risk is risk communication, which is required for all (existing, planned and emergency) exposure situations.

The communication procedures applied are crucial for the successful implementation of the required protective actions, especially persons who are at risk. Effective communication may also reassure individuals who are not directly at risk facilitating relief efforts. Furthermore, it is important for organizations involved to build up public trust and confidence.

The special characteristics of existing exposure situations should be considered when relative risk communication procedures are developed. In order to encourage a proactive role in decision making for the public, the dissemination of reliable information regarding the potential health risks and the means available for reducing the exposures as low as reasonably achievable is necessary.

The risk communication process can be described using the Shannon - Weaver communication model, which includes the following elements:

- A source: The initiator that puts the model into action. It is an individual or group that has a specific reason (message) to begin the communication process.
- An encoder: It takes the message that the source of information wants to sent, and puts it into a suitable format for later interpretation.
- A channel: It is the route that the message (verbal, written, electronic, etc) travels on.
- A message: The information, idea or concept that is communicated from one end of the model to the other.
- A decoder: It is where the message is decoded or interpreted from its original form into one that the receiver understands.
- A receiver: A second party at the end of the channel which receives the decoded message.

In many cases the message does not reach the receiver in the original form due to the existence of noise. Noise may be an interference or distortion which alters the initial message either partially or fully. It can be physical (a sound) or semantic, for example if the vocabulary used in the message is not appropriate for the recipient. However, the potential effects of noise on the message can be prevented or limited by putting in place an appropriate feedback mechanism. Feedback should inform the source whether the message has been received, and most importantly, if it has been interpreted accurately.

However, since risk communication is considered as a two-way, interactive and long term process, where the and long term process, where the public and risk communicators are engaged in a dialog, rather than acting as senders and receivers, it is expected to be also strongly facilitated by ALARA culture. ALARA culture is a reference framework, a state of mind and attitude which encourages an individual and/or an organization to act in a responsible way in order to manage radiation risks and giving radiation protection the priority it should have. Additionally, it is characterized by risk awareness, balanced judgment of risks and benefit, and the capability to develop and use skills and tools for risk assessment and management, and for balancing of resources and economic and social considerations.

The practical implementation of radiation protection is relatively complex in the case of existing exposure situations: it involves new stakeholders for which the first step is to be informed about radiation risk and ALARA philosophy. Therefore, elements contributing to ALARA culture, such as attitudes and behaviors, education and training, engagement and participation of stakeholders, dissemination of information and lessons learnt, should always be taken into account when risk communication strategies regarding existing exposure situations are developed and applied.

### References

1. Economides S, Hardeman F, Nuccetelli C, Risica S, Schieber C, Schmitt-Hannig A, Vermeersch F, Development and Dissemination of ALARA culture, IRPA 13 International Congress, Glasgow, 2012.
2. European ALARA Network Workshop, Experience and new Developments in Implementing ALARA in Occupational, Patient and Public Exposures, Prague, Czech Republic, 12-15 September 2006.
3. International Atomic Energy Agency, Communication with the Public in a Nuclear or Radiological Emergency, IAEA, Vienna, 2012.
4. International Atomic Energy Agency, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3 (Interim), IAEA, Vienna, 2011.
5. Shannon, C. E. A Mathematical Theory of Communication, The Bell System Technical Journal, Vol. 27, pp. 379-423, 623-656, July, October, 1948.
6. Bradbury, J. A. Risk communication in environmental restoration programs. Risk Analysis, 14(3), 357-363, 1994.

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## ALARA NEWS

### 15th European ALARA and Xth EUTERP Workshop

The next workshop is planned to be a joint EAN and EUTERP Workshop focused on “ALARA through Education and Training”. The workshop will take place at Rovinj, Croatia (Istria peninsula) from 5th to 7th May 2014.

### 50th anniversary of the Belgian Association of Radioprotection

The Belgian Association on Radiological Protection BVS-ABR will organize an international symposium to celebrate its 50th anniversary from 8 to 10 April 2013 in Brussels. The symposium is entitled “Challenges for Radiological Protection for the next 50 years”.

First announcment and call for abstracts can be found on http://www.bvsabr.be/50Y

### CODIRPA – Nuclear Post-Accidental Phase Managment

Under ministerial mandate, between 2005 and 2012, the French Autorité de Sûreté Nucléaire (ASN) formed a steering committe to establish a national protocol for the management of a nuclear incident or radiological emergency (CODIRPA). The committee included operators, expert bodies (IRSN, InVS), associations and elected bodies.The elements of the first national protocol have been established, which relates to nuclear incidents involving radioactive releases of short duration (less than 24 hours). A new feature is that this protocol covers the entire post-accident phase. The document is available on the ASN website http://www.asn.fr/index.php/Bas-de-page/Sujet-Connexes/Gestion-post-accidentelle/Comite-directeur-gestion-de-phase-post-accidentelle/Elements-de-doctrine-pour-la-gestion-post-accidentelle-d-un-accident-nucleaire-5-octobre-2012 .

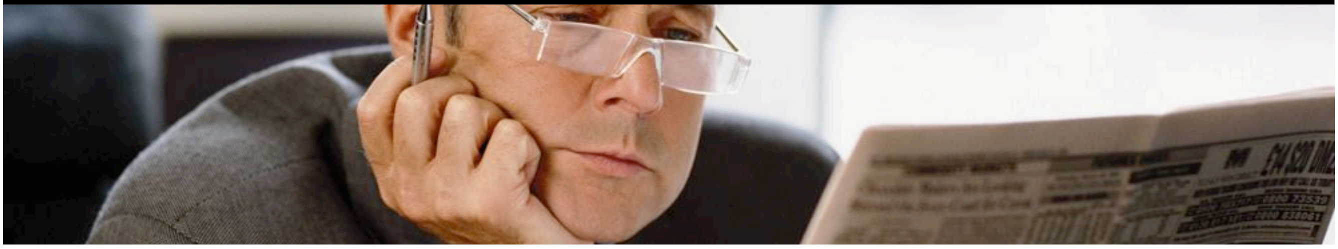
## FAQ ALARA

On the ORPNET webpage, IAEA proposes a list of frequently asked questions (FAQs) which intends to provide information to radiation protection specialists so that they can answer quickly and correctly the most frequently asked questions. The ALARA Newsletter proposes in each issue a selection of these FAQs.

### Are there different levels of sophistication of the procedures according to different levels of individual or collective dose?

The ALARA approach applies regardless of the level of exposure. Nonetheless, the time-scale and the sophistication of the procedures should be aligned with the type and quantities of individual and collective doses at the site. Dosimetric criteria (individual and/or collective dose levels and/or dose rate and/or the frequency of a task, etc.) are often taken into account in deciding on how formalize the procedures.

Reference: http://www-ns.iaea.org/tech-areas/communication-networks/norp/faq.asp?fq=27



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