

## Summary of SFRP-IRPA workshops on the reasonableness in the practical implementation of the ALARA principle

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Received: 24 June 2019 / Accepted: 19 September 2019

**Abstract** – The practical implementation of the principle of optimisation of radiological protection (i.e., ALARA principle) was the subject of two workshops organised in Paris (France) in February 2017 and October 2018 at the initiative of SFRP within the framework of IRPA. The article summarizes the discussions and conclusions of these two workshops. The search for reasonableness was examined in three sectors: nuclear industry, medical practices and existing exposure situations. In all sectors, the optimisation remains a challenge and experience shows that this is implemented through a deliberative process to achieve a reasonable compromise with all informed parties. This issue was further investigated by three working groups – one for each sector – on the basis of cases studies. It emerges that, in complement to the use of classical tools such as cost-benefit analysis, the implementation of the optimisation principle implies a clear identification of the challenges to be met in order to achieve the best protection in the prevailing circumstances. These challenges may be specific to a type of exposure situation and in some cases to a given situation. The process should also well identify the relevant stakeholders and decision-makers to be involved and determine how they will be involved. A proactive process including development of awareness, empowerment and/or training may be needed. This reflexion deserves to be further developed.

**Keywords:** reasonable / radiological protection / optimisation / ALARA

### 1 Introduction

The optimisation principle, known as “As low as reasonable and achievable” (ALARA), is the cornerstone of the radiological protection system (ICRP, 2007) and is a major issue continuously addressed by SFRP in *Radioprotection* (Schneider *et al.*, 2017; Bourguignon *et al.*, 2017; Yeung, 2019).

Two workshops were organised at the initiative of SFRP within the framework of IRPA on the practical implementation of the ALARA principle. This initiative was launched following a request from IRPA related to the evolution of the radiological protection system. The two workshops were

held in Paris in February 2017 and October 2018 respectively. They each gathered about 30 participants – experts, regulators, operators – from several countries and international organisations (IRPA, ICRP, NEA, WHO, EAN).

The objective of the 1st workshop was to share feedback experience of the current ALARA approach in different sectors (nuclear, medical, radon, contaminated sites, post-accident situations) and more specifically to challenge the role of the tools helping the decision-making process, the stakeholder involvement as well as the ethical and societal values that allow for a reasonable end to the optimisation process.

In the nuclear sector, the collective doses of workers have been significantly reduced since the implementation of ICRP 60 (ICRP, 1991), but vigilance is still necessary to cope with the disparities in the distribution of individual doses as well as with a more difficult economic situation.

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Vis-à-vis the public, there is a tendency to minimisation of the impact (discharges) instead of optimisation of radiological protection, in a context of increasing societal and environmental considerations.

In the medical sector, the primary objective of exposure is the quality of diagnosis or treatment and it should be achievable by further optimising exposures of patients, and in some cases of health professionals. Emphasis is placed on the justification of the medical act with a shared responsibility of the referrer and the practitioner. The continuous evolution of technologies on the one hand, and the involvement of patients and stakeholders (medical staff, hospital managers, manufacturers...) on the other hand, remain key challenges.

In situations involving radium (contaminated sites) or radon, or in post-accident situations, the control of exposure is made through the pathway of exposure rather than on the source. The individual behaviours may affect the level of exposure and the quality of life may be more at stake than the dose. The result of the optimisation process depends on the actual situation. In that case, taking into account societal and ethical considerations is crucial.

In all sectors, the optimisation remains a challenge. Experience shows that it is implemented through a deliberative process to achieve a reasonable compromise with all informed parties. A synthesis of this 1st workshop has been previously published (Schneider *et al.*, 2017).

After this first round, there was a wish to go further. A second workshop was organised in October 2018 in Paris, focusing on practical cases. Three series of cases studies were presented, related to the same three sectors explored during the first workshop: nuclear industry, medical practices and existing exposure situations. They intend to illustrate how the search for reasonableness in the practical implementation of the ALARA principle can be done by involving stakeholders.

## 2 Case-studies in the 3 sectors: nuclear, medical and existing exposure situations

In the nuclear sector, the French operator EDF and one of its subcontractors Comex/ONET presented together the building of an efficient relationship between them, with strong interfaces. This has led to a continuous reduction of the radiological exposure received by workers for the replacement of the heating system of pressurizer in the French Nuclear Power Plants (NPPs). In this sector, dialogue and engagement are often formalised by contracts, in written procedures and ALARA programmes that engage the hierarchy from bottom to top. This was also illustrated in the Spanish presentation related to the mobilisation of all concerned personnel to improve dosimetric performances in the NPP of Cofrentes. The third case-study was related to the UK experience in the implementation in the UK nuclear sector of the ALARP concept (As low as reasonably practicable) developed more generally for all hazards. It showed, with several examples, how non-prescriptive regulation can set the tone in the quest for reasonableness and how, in some cases, conservatism may lead to the minimisation of the exposure instead of adaptation of optimised solutions. Finally, it also called for improving the dialogue and understanding of radiation hazard between operators and regulators.

In the medical sector, two successful collaborative processes to optimise doses due to medical imaging were presented. The first one was related to a dedicated team of multi-disciplinary experts traveling from hospital to hospital in the Province of Quebec (Canada) to outreach radiological protection (RP) culture and consequently lead to global dosimetric improvement. The second one showed how in Greece, thanks to the involvement of the whole staff in the CT department of the public hospital of Konstantopoulos, a more accurate strategy was elaborated for an effective improvement of the implementation of the optimisation process. The questions on how to assess the involvement of individuals (e.g., practitioners) in ALARA and how to ensure the sustainability of such an involvement remain unsolved. Dose reduction in the medical field is achieved mainly with innovative instrumentation including software advances: an algorithm to optimise image in aortic CT angiography by balancing noise and signal in exposure was presented by the Italian representatives. It was reported that emulation between manufacturers drives the design of devices contributing to exposure reduction.

In existing exposure situations, ethical and societal considerations are the most at stake because local stakeholders (i.e., members of the public, professionals, health authorities etc.), are usually not aware of radioactivity and radiological protection while they are the key stakeholders and even the decision-makers in the optimisation process. In such situations, the optimisation process is done on a case-by-case basis, depending on the circumstances. The first case-study of the workshop was about the radium action plan to manage the radiological legacy of the Swiss watch industry. Traces of radium were found in dwellings of former employees working at home. The selection of the reference level was a key point to determine the magnitude of the remediation, with the regulatory authority successfully taking the lead. The training of remediation workers was also crucial. The second case-study was related to the challenges in the Czech Republic to reach a better matching between the radon national action plan and the energy saving policy in order to achieve a better indoor air quality in dwellings and buildings with public interest. In the third case-study, the Belgian RP authority presented their approach in order to set a reasonable criterion for the management of drinking water, making a better compromise between protection of consumer and cost, and ensuring societal confidence in the control of water. For these different situations, four key questions that shaped the dialogue between RP experts and the local stakeholders could be identified:

- the numerical values (of exposure) and their meaning(s);
- the importance of economic factors;
- the ownership of both the responsibilities and the leadership in the process;
- the link of the radiation protection initiatives with the overall quality of life, taking into account societal and ethical considerations.

A specific case-study related to non-ionizing radiation (NIR) was also presented, showing the difficulties in implementing the optimisation principle in a context of diversity of NIR sources, the uncertainties about their effects, the high sensitivity of some people to NIR and the controversy about leukaemia clusters.

### 3 Discussion

#### 3.1 About reasonableness

Three working groups (WGs) were formed to further investigate the issue of implementing optimisation process with the involvement of stakeholders. At the end of the discussion, the three of them were in agreement with the conclusions of the first workshop (Schneider *et al.*, 2017) and the following additional points were emphasized.

#### 3.2 In the nuclear sector

The WG dealing with the nuclear sector advocated a holistic approach to optimising hazards as a whole, not just the dose, in a process of continuous improvement. Such an approach should find a balance between the different hazards, by relying on multi-expertise teams (experts on conventional, environmental and radiological risks). The focus on the radiological risk may indeed lead, in some cases, to inequities in protection by giving too much weight to the radiation risk in comparison to other hazards. Adequate guidelines are needed for the evaluation and the risk management in a multi-hazards context.

For the protection of workers, the real implementation of good practices agreed at the international level is considered as a proof of the application of ALARA. A cost-benefit analysis and the use of multi-criteria tools can help present a reasoned argument, especially at low doses, for which further reduction in exposure is not ALARA. The application of ALARA also includes the need to establish teams of experts, procedures and meetings as well as the development of a RP culture at all levels. All types of personnel should be involved: hierarchy, inside and outside-workers, but also authorities. Education and training is needed, even for the regulator. Feedback experience from both the operator and the subcontractors is useful. Sharing responsibilities between the operator and the subcontractors is not obvious and a clear partnership should be established. The commitment of the operator is essential. The concept of “intelligent customer” introduced by the IAEA (IAEA, 2011) can be useful: the operator has responsibilities in embedding RP culture throughout the whole subcontracting chain. ALARA should also be implemented using a graded approach commensurate with the level of the risk.

Public perception of radiation risk associated with nuclear power is more critical since the Fukushima accident. For the operators, proving that the public exposure induces a very low risk can be very expensive. Such a consideration is important when setting dose criteria for public exposure. These criteria also can depend on the context (country, exposure situation). Authorities require the application of the best available techniques at all stages. This has resulted in a systematic search of minimisation of the risk regarding sources, discharges and waste beyond ALARA, while NPPs are already designed and operated in order to produce extremely low releases, which can be considered as ALARA. In some cases, the good balance between public protection and worker’s protection may require a trade-off (e.g., when the reactor containment needs to be vented to provide better working conditions inside).

#### 3.3 In the medical sector

In the medical sector, according to the corresponding WG, the key elements to achieve reasonableness are education, training and development of RP culture. It is not always easy, however, to involve the patients. Working with patient associations may be useful. The concept ALADA (As low as diagnostically achievable) in the use of the equipment (search for the optimised image) was encouraged until a proper balance between a cost-benefit analysis and the quality management system demonstrates that new and more optimised equipment is needed. Occupational exposures in medical sector are generally low except for some practices (e.g., interventional radiology and surgery or radio-pharmacy). In some cases, the application of the dose limit to the lens of the eye may be a challenge. Multidisciplinary and equitable approaches were also recommended. A focus on medical ethics has also been emphasized for medical training.

Several suggestions were also made to IRPA in order to improve the dissemination of knowledge:

- creation of a dedicated page on the IRPA website with links to the websites of other organisations (WHO, IAEA/RPOP, IOMP, ICRP/C3);
- translation and promotion of guidelines;
- elaboration and dissemination of pedagogic leaflets notably for patients;
- promotion of specific physician’s training;
- proposition of lectures presenting case-studies in medical conferences;
- proposition of articles in scientific journals showing efforts and improvements.

#### 3.4 In existing exposure situations

As pointed out by the corresponding WG, the scope of existing exposure situations is diverse and some are controversial situations (e.g., contaminated sites). Whatever the case, the WG emphasized the need to reach a kind of acceptance of the situation by the public and hence the importance of organising the dialogue. There is, in most of the cases, an underlying fear of radiation by the public. That fear is generally stronger toward anthropogenic sources (including radium used for its radioactive purpose) than toward natural ones (e.g., radon).

Messages should be clear and straightforward. The situation may evolve and that should be explained to better anticipate the evolution. The role of authorities is crucial to establish or restore confidence. Sometimes, an empowerment of the stakeholders is needed, by providing them with sufficient information and skills to be able to take informed decisions. This is particularly needed when people are involved in their own protection (self-help protection), e.g., against radon exposure or in post-accident situations. For the later case, information and preparation in “peace time” can be helpful at time of crisis.

In case of pollution, there is no “acceptable” level of radiation exposure: from the point of view of members of the public, the radioactivity is unwelcomed and should be deleted. However, zero risk does not exist and the total clean-up of the site is often unfeasible. The quantitative approach is the

preferred approach of experts, while most of the time the public better understands qualitative or comparative arguments. Experience shows that it may be preferable to organise a deliberation reaching an agreement on what is reasonable. Comparison with other risks may be helpful but it can also be tricky. For instance, when the situation is controversial, such comparison may be seen as making trivial the radiological risk vs the other risks.

Thresholds are often wrongly seen as a border between safe and dangerous. The value of 1 mSv/y is used as a reference level in many cases for public exposure while it is the low end of the range recommended by ICRP for existing exposure situations (1–20 mSv/y). Such value is a reference level but in practice, it is rather used as an action level. It is expressed in effective dose while this concept is not meant to reflect individual risk.

In existing exposure situations, what is at stake is to achieve or recover a good quality of life. The optimisation principle may then be called ALAQA (As low as qualitatively achievable). It can be achieved using a flexible approach. Authorities should be clear about what the ground rules are: what they will do or will not do, what resources are available and how they will be allocated. It was finally pointed out that in this approach the question of who pays is crucial.

### 3.5 Other considerations

The workshop discussions were focused around the different sectors – nuclear, medical and existing exposures and it is clear that there are real specific lessons from each individual sector. Moreover, there are several important common themes emerging which are worthy of further interest.

In particular, there are similarities between occupational exposure and medical exposure. In the medical field, the employees are broadly knowledgeable about radiation, and the key aspects of the ALARA process are very strongly aligned with the key attributes of a (radiation) safety culture for them and for their patients, and as such are likely to be more embedded within the organisation:

- engaging with all parties involved in the exposure;
- implementing appropriate education and training;
- maintaining a work environment allowing openness and challenge;
- learning and sharing from experiences;
- arousing strong commitment of the management;
- developing an integrated management system to provide a framework for consideration of ALARA.

In addition, there is a recognition of the need to focus on the highest exposure situations (taking consideration of both individual and collective dose) by giving specific focused attention to these key areas, such as for instance major engineering interventions in a nuclear facility, CT and therapy doses in medical exposure.

By contrast, if the public is central to the ALARA processes the dynamics can be very different, in particular when the presence of the radioactive source is disturbing or controversial. In such cases, the mainly interested parties are unlikely to have a good understanding of radiation (at least at the start of any process), and often, the situations take place in a

“high stress” environment with a lack of trust between the parties. Thus, there is a need to be much more focused on the process of working together, including moving towards an enhanced and shared understanding of radiation risk and radiation environment, within the context of other risks and concerns associated with the situation. There is a growing experience of stakeholder engagement which can serve to successfully address these challenges. Indeed, in some situations where longer-term ongoing action is necessary, there is evidence that working together to develop a “societal RP culture” can be very helpful.

However, in some public exposure situations, including for example environmental discharge, there is evidence of an emphasis on minimisation rather than true optimisation. There is concern that the concept of “reasonableness” has been lost or not considered helpful in the decision-making process, with a reluctance to give any meaningful weight to economic factors and an over-emphasis on “as low as” rather than on “reasonable”.

The workshops have shown a growing recognition of the need to consider more values than “value for money” considerations for society. The need for a debate, including how to ensure a balance between the ethical values of dignity (ensuring stakeholder engagement), prudence (ensuring appropriate safety) and beneficence (broadly interpreted as ensuring best use of resources for society) is becoming recognised. It is interesting to note that previous considerations of cost benefit analysis, with an “alpha value” defining the monetary value of a man-Sv, were aimed to address this factor. Whilst cost-benefit analysis can still play a role, experience has shown that it is not usually a dominant input to the overall judgement of what is “reasonable”. Delivering a broader approach including the objective of reasonable value for money is still a challenge.

There is a wide acceptance that optimisation of exposure is a process requiring judgement, and that there is no single formula leading to an outcome. There are some proposals suggesting that there should be minimum thresholds, below which there would be no requirement for consideration of optimisation. This approach is not currently widely supported, with most experts believing that we should always be trying to be “reasonable”, and indeed be seen to be “reasonable”. However, there is a widespread concern over what seems like a trend to delivering “ever lower doses”. There is a need to be a wider acceptance from all interested parties that there should be a focus on the higher doses, whilst ensuring a proportionate consideration of less significant exposures. For the lowest occupational and medical exposures, this should focus on developing and supporting an effective safety culture across all hazards. For public exposures, there is no substitute for careful and empathetic engagement with all relevant stakeholders, but which also recognises the need for appropriate allocation of society’s resources.

## 4 Conclusions/perspectives

The second workshop (SFRP, 2018) confirmed and refined the conclusion of the first one (SFRP, 2017) on the basis of practical case-studies: in all sectors, the optimisation remains a challenge and experience shows that it is

implemented through a deliberative process to achieve a reasonable compromise with all informed parties. Each case is a particular case.

In the light of the reflections carried out within the three WGs, it seems possible to interpret the "R" of the acronym ALARA, i.e. the term *reasonable*, in a dedicated way according to the situation. In the nuclear sector, where reasonableness is notably a matter of good balance between the protection against several hazards, R may become H as Holistically. In the medical sector, where the capability to carry out the good image for a proper diagnosis is still a challenge for the optimisation of patient exposure, the R of ALARA may become D as diagnostically. In existing exposure situations such as radon exposure, legacy sites or post-accident situations, the R may become Q as Qualitatively in order to illustrate the importance to maintain or recover a decent quality of life for all individuals in the prevailing circumstances. However, while such interpretations may be helpful in some specific situations, they cannot replace the concept of *reasonableness* which is the common driving factor in all situations.

It emerges from the reflexions during the two workshops that, in complement to the use of classical tools such as cost-benefit analysis, the implementation of the optimisation principle implies a clear identification of the challenges to be met in order to achieve the best protection in the prevailing circumstances. These challenges may be specific to a type of exposure situations and in some cases to a given situation. The process should also well identify the relevant stakeholders and decision-makers to be involved in the optimisation process, and determine how they will be involved. A proactive process including development of awareness, empowerment and/or training may be needed. This reflexion deserves to be further developed.

The summary of the two workshops is intended to be disseminated throughout IRPA societies, as well as through congress communications and articles. In addition, a workshop on the issue of reasonableness gathering the main international

organisations in charge of radiological protection (ICRP, IAEA, WHO, NEA...) is envisaged in Paris in the next months.

*Acknowledgements.* The authors would like to thank all participants of the two workshops in Paris in 2017 and 2018 for their contribution during the workshop and for the elaboration of this article.

## References

- Bourguignon M, Bérard P, Bertho JM, Farah J, Mercat C, Radioprotection Editorial Board. 2017. Radioprotection; what's next? *Radioprotection* 52(1): 21–28.
- IAEA. 2011. Workforce planning for new nuclear power programmes. IAEA Nuclear Energy Series N°. NG-T-3.10, Vienna.
- ICRP. 1991. 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. *Ann. ICRP* 21 (1–3).
- ICRP. 2007. The 2007 recommendations of the International Commission on Radiological Protection. ICRP Publication 103. *Ann. ICRP* 37(2–4).
- Schneider T, Lecomte JF, Schieber C, Andresz S, Chambrette V, Le Guen B, Vaillant L. 2017. Synthesis of reflections and conclusions of the SFRP-IRPA workshop on the reasonableness in the practical implementation of the ALARA principle. *Radioprotection* 52(4): 259–263.
- SFRP. 2017. Link to the 1<sup>st</sup> workshop on the SFRP website: <https://www.sfrp.asso.fr/manifestations/manifestations/irpa-workshop-on-reasonableness-in-the-implementation-on-the-alara-principle.html,9,38,0,0,2823>.
- SFRP. 2018. Link to the 2<sup>nd</sup> workshop on the SFRP website: <https://www.sfrp.asso.fr/manifestations/manifestations/irpa-workshop-on-reasonableness-in-the-implementation-on-the-alara-principle.html,9,38,0,0,3102>.
- Yeung AWK. 2019. The “As low as reasonably achievable” (ALARA) principle: a brief historical overview and a bibliometric analysis of the most cited publications. *Radioprotection* 54(2): 103–109.

**Cite this article as:** Lecomte J-F, Bannon A, Billarand Y, Bryant P, Cantone M-C, Coates R, Croft J, Jean-François S, Le Guen B, Schieber C, Schneider T. 2019. Summary of SFRP-IRPA workshops on the reasonableness in the practical implementation of the ALARA principle. *Radioprotection* 54(4): 277–281