



# Managing Low Dose Radiation Exposure

A position statement by World Nuclear Association's  
Radiological Protection Working Group

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Produced by: World Nuclear Association  
Published: November 2022

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The Radiological Protection Working Group  
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scientifically-based policies and practices  
supported by industry experience to provide  
sufficient protection to workers, the public and  
the environment.

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## Supporting the current basis of the system of radiological protection

The linear no-threshold (LNT) approach is currently widely accepted by the international radiological protection (RP) community as providing the basis for the system of protection. However, there is not complete agreement on such an approach, with some parties arguing strongly in favour of an alternative approach based around the assumption of a threshold, below which it is proposed that there is no risk (and potentially even hormesis – where low doses of radiation can be protective).

After careful consideration, World Nuclear Association believes that a threshold approach is very difficult to sustain scientifically, and would not provide a sound basis on which to base the RP system. Furthermore, endorsing the threshold approach would put the Association in opposition to all significant international bodies and national regulators, and indeed to most RP practitioners across the world. World Nuclear Association therefore accepts that the LNT-based approach is the best current approach for developing an RP system whilst noting some important context as expressed below.

In accepting the LNT approach, it is important to note that it is only a convenient model on which to base a system of protection and associated regulatory practice. It is not claimed as a scientific hypothesis, and there is no resulting claim that every type of radiation causing any type of cancer is fully linear all the way to almost zero dose. Some types of radiation causing some types of cancer are likely to be more linear than others, and some may even have a threshold. This is why a simple model is necessary for protection purposes – the real science is too confusing and uncertain. For the purposes of a protection system, the LNT basis has greater scientific support and is more appropriate than a threshold-based model. This conclusion is fully supported by a 2020-21 UNSCEAR report<sup>1</sup> that reviewed the latest scientific evidence on risks from radiation.

## Implications of an LNT model

The LNT approach implies that even at low radiation doses there is some residual risk. However, noting the current limitations of the science at low dose, World Nuclear Association suggests that a more accurate statement for low dose would be: *If there is a risk, then indeed it is very small, and well within the range of risk usually accepted in society*. On this basis, the Association argues that there should be a wider perspective to decision-making at low dose, with several factors to be taken into account in order to maintain proportionality.

## Low dose decision-making

Within the RP community there are several definitions of 'low dose'. For the purposes of this discussion, the term 'low-dose' covers radiation doses of a few mSv (or a few mSv/yr), typically equivalent to the basic universal natural background exposure of around 2-5 mSv/yr. This range covers all public planned exposure and the overwhelming majority of occupational exposure within the industry. Importantly it also relates to natural background exposure, which gives an important context for decision-making at this level of exposure.

Given the prevalence of this dose level in practice, and the acceptance of very low risk associated with this level, the processes relating to how decisions on RP measures are made should be reviewed. World Nuclear Association believes there should be a different and wider paradigm that is without excessive conservatism and where decisions are more understandable and relevant to the general public. The Association supports proposals for developing this wider perspective on low dose decision-making<sup>2</sup>, for example drawing on comparisons with individual decisions made regularly on exposure to natural background radiation, where the relevant exposures are in principle controllable. This contrasts with the current situation for industry exposures, where dose levels that are up to two orders of magnitude lower are subject to regulatory measures – resulting in a misunderstanding of radiation risk as well as a misuse of societal resources.

### Reasonableness

One key component of decision-making is the interpretation of ‘reasonable’ in the ALARA (‘as low as reasonably achievable’) optimization principle. This is a topic of much discussion, and it is important that it receives further attention during the current review of the system of protection (see IRPA perspective<sup>3</sup> on this topic). The following aspects of the judgement of reasonableness are worthy of further deliberation.

### Proportionality

Top-level statements in international guidance acknowledge the need for proportionality and the application of a graded approach at low doses. However, there is little evidence of consistent application in practice, particularly by regulatory bodies. It would be helpful for top-tier statements to be strengthened, including such issues as the need to optimize the allocation of resources to reflect the level of risk, to avoid unnecessary conservatism and to attach an appropriate value to society’s resources, whilst respecting the need to engage with relevant stakeholders in decision-making.

World Nuclear Association supports the IRPA considerations<sup>3</sup> (see Appendix) addressing the issue of levels of exposure below which there should be no formal restrictions (sometimes termed ‘below regulatory concern’). This follows on from the general principle of applying fewer resources as exposures become lower. There cannot be a universal dose level since exposure situations are so varied, but the principle that at some dose levels any further regulatory intervention or requirement is unnecessary is worth further consideration. This does not imply that the relevant interested parties cannot take appropriate measures (as illustrated in the IRPA perspective), but rather that the level of risk is so low that further regulatory action is inappropriate.

### All-hazards approach

Optimization should apply to the total risk (and benefits) in any situation – which is often much broader than radiation risk. Indeed, in many industrial settings, radiation is a relatively minor part of the overall hazard, although experience shows that it often receives the greatest regulatory attention. Optimization of only radiation exposure has the potential to increase the overall risk, and also reinforces the view that radiation is a particularly harmful hazard compared to other workplace or public risks.

ICRP statements regarding optimization could be strengthened by applying them to all hazards, although it is recognized that the ICRP's formal area of competence implies that any expansion of the means to achieve this may be beyond its scope. But such a clear top-tier statement could encourage others with the relevant expertise to address this issue. In particular it is essential that regulators have the competency, capacity and willingness to take account of the non-radiation factors in achieving optimization. In those cases where the formal competency of a regulatory body may be limited to radiation issues, the regulator could enter into agreements with other relevant regulatory bodies to help ensure that an all-hazards optimization can be facilitated.

### Sustainability

Sustainability is a wider part of an all-hazards approach and is increasingly recognized as being central to modern decision-making. World Nuclear Association supports the ongoing work within the ICRP to address this topic, including such issues as ecosystem services and resource utilization more generally.

Some aspects of sustainability may relate more to justification (e.g. the value of nuclear electricity generation), some aspects to optimization (e.g. conservative exposure assessments resulting in excessive use of steel/concrete resources in shielding to achieve inappropriately low occupational exposures, thereby also creating excessive burdens for future generations during clean-up activities), and some to low dose decisions more generally (e.g. promoting clearance and recycling of materials through a more balanced, reasonable and less restrictive clearance process). These are all essential considerations which should receive greater attention and emphasis, and eventually become embedded in international guidance and regulatory procedures.

### Public understanding

It is widely recognized that achieving greater public understanding, engagement and awareness of radiation is essential for almost all aspects of radiological protection.

Many consider the RP system to be very complex, nuanced, and difficult to understand outside a quite small cohort of experts. Several aspects of the system can promote a view that radiation is particularly hazardous, including the LNT basis (as it implies that there is no safe level of radiation). The fact that the public dose limit is much lower than any level of natural background radiation can promote the view that man-made radiation is inherently more dangerous than natural radiation, and this can be exacerbated by the strict divisions into categories of exposure, with different rules. World Nuclear Association supports the ICRP intention to review the current approach to limitation of exposure (looking at the concepts of limits, constraints and reference levels) and the categories of exposure, which should lead to a simplified overall approach.

The ICRP has an important role in public education as it is seen as independent. The next set of ICRP recommendations should therefore have an accompanying simple but comprehensive plain-language guide aimed at the wider public. Other organizations and RP professionals should also engage in public education on RP and radiation risk (see for example IRPA's *Practical Guidance for Engagement with the Public on Radiation and Risk*<sup>4</sup>). World Nuclear Association has unbiased

information available, although many will regard this information as being biased. The challenge concerns how to interact with the public to gain its confidence rather than being about simply providing information.

There is a tendency in some authorities to move to requiring very low doses in response to perceived public concern. This is wasteful of resources and is against the principle of proportionality. Indeed, this can be counterproductive as it may serve to fuel radiation phobia – as it implies that if doses have to be extremely low, then radiation at even these levels must be very dangerous. Regulators should ensure that decisions are made on the evidence available and that they imply a balanced and proportionate use of society's resources. Whilst taking account of significant public interest, they should be prepared to robustly defend their decisions through effective communication of reasoned and science-based arguments.

## Other issues

Regarding individual response and genetic susceptibility, World Nuclear Association recognizes that the current system of protection takes account of differences in key groups, including children, adults and during pregnancy. As the science develops further it seems likely that other specific different sensitivities will be identified. In response to this, the ICRP should take account of the need for the system of protection to be practicable and implementable in a reasonable way, without unnecessary complexity.

## Conclusions

World Nuclear Association supports the need for a system of radiological protection (RP) that adequately protects people and the environment whilst allowing the use of beneficial radiation technologies, including nuclear power.

In the current state of scientific knowledge, the RP system should be underpinned by the linear no-threshold (LNT) model. However, at the low doses of real interest and significance (*i.e.* of only a few mSv, up to around 5 mSv/yr or so), the decision-making system must take account of much broader considerations in order to maintain reasonable proportionality and alignment with wider societal decision processes, and so that the public understanding of radiation is effectively enhanced.

The ICRP is leading a review process for the development of the next set of General Recommendations. This process provides an opportunity to address the imbalances in the approach to low dose decision-making, particularly through addressing the concept of 'reasonableness'. This involves ensuring proportionality with the very low risks involved, accepting that radiation is just one of many potential hazards that must be considered (an 'all-hazards' approach), and taking account of the wider considerations of sustainability.

Issues within the current RP system that challenge the ability of the public to understand and accept that RP requirements should be in line with other risk mitigation measures should be addressed. Indeed, some current aspects can even serve to promote radiation phobia. The main challenge is for the system of protection to demonstrate proportionality, simplicity and practicability, without unnecessary complexity and conservatism.

# References

1. Sources, Effects and Risks of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, with Scientific Annexes, Volume III [Scientific Annex C: Biological mechanisms relevant for the inference of cancer risks from low-dose and low-dose-rate radiation](#), United Nations (December 2021)
2. Roger Coates, The need to review low-dose decision-making in radiation protection, *Journal of Radiological Protection*, Volume 42, Number 1, 014001 (12 January 2022)
3. [IRPA Perspective on 'Reasonableness' in the Optimisation of Radiation Protection](#), International Radiation Protection Association (2021)
4. [Practical Guidance for Engagement with the Public on Radiation and Risk](#), International Radiation Protection Association (2020)

# Appendix

## Section 3.7 of *IRPA Perspective on 'Reasonableness' in the Optimisation of Radiation Protection*, International Radiation Protection Association (2021)

### De Minimis Approach

Some consideration has previously been given to the concept of a minimum cut-off, below which no further efforts to address optimisation are necessary. Various proposals for such a threshold have covered the range from 10 $\mu$ Sv/year up to doses around 5-10% of the relevant worker or public dose limit. Whilst this approach is understandable and has some rationale, it is challenging to apply in practice:

- The simple declaration of a fixed 'de minimis' value perhaps carries an imputation that even just above this value it is necessary to undertake optimisation, which could lead to inappropriate and unnecessary action.
- Exposure situations are so varied that a single numerical minimum does not seem realistic and would be likely to lead to an inappropriate 'lowest common denominator' approach. A system of different de-minimis levels appropriate for different types of situations could be more appropriate.
- Experience has shown that even at low doses there are often simple, realistic and inexpensive actions that can still be taken to improve the exposure situation by resulting in greater overall well-being.

Whilst the above considerations identify challenges in applying the de-minimis concept, it is none the less appropriate to consider how the underpinning conceptual value of this approach could be manifested in a more practical way. IRPA therefore encourages authorities and regulatory bodies to have a very careful regard before setting expectations or requirements for optimisation assessments at low doses, unless there are significant and specific reasons for doing so. This approach should apply where exposures are significantly below relevant limits, constraints, or reference levels – which of course would be a matter of judgement and which could benefit from wider consideration. Such a course would align with the concept of a graded approach and support the effective use of society's resources.

However, as noted above, in some low dose situations below any implied de-minimis level there may be appropriate measures that could reasonably be taken by the respective local interested parties: for example, to implement actions arising from safety culture considerations, or from stakeholder engagement where these improve overall confidence and well-being without imposing a disproportionate burden on society's resources, even if there is no significant benefit in direct safety terms. In such cases it would be helpful overtly to recognise the basis on which the decision is made.





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The International Commission on Radiological Protection (ICRP) review of its general recommendations initiated in 2021 presents an opportunity to address imbalances in the radiological protection system. The area of low dose is of particular significance as it covers all public planned exposure as well as the overwhelming majority of occupational exposure. While accepting the linear no threshold model as the basis of the radiological protection system, this position statement argues that decision-making at low doses should be proportional with the very low risks involved, accepting that radiation is just one of many potential hazards that must be considered and taking account of the wider considerations of sustainability. Adopting such an approach will bring socio-economic benefits and make the risks from low dose radiation more understandable to the general public.

This position statement has been produced by the Radiological Protection Working Group (RPWG) of World Nuclear Association. The RPWG advocates scientifically-based policies and practices supported by industry experience to provide sufficient protection to workers, the public and the environment. It channels the global industry's voice on radiological protection questions, as it interfaces with institutions such as the ICRP and the International Atomic Energy Agency's Radiation Safety Standards Committee (RASSC).