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ARPS Third Feedback

A contribution to the IRPA Task Group for the review of the system of radiological protection

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This document provides examples of current difficulties encountered by ARPS members in the practical application of radiation protection.

Introduction

The Australasian Radiation Protection Society (ARPS) is represented on, and participating in, the International Radiation Protection Association (IRPA) task group on the review of the system of radiological protection. IRPA called upon the task group to provide feedback on behalf of represented associate societies on two prior occasions. Accordingly, ARPS provided the following two documents:

1. *ARPS Feedback on the ICRP Paper*, 3 October 2021.
2. *ARPS Revised Feedback Focusing on 3 Highest Priorities*, 15 December 2021.

IRPA recently requested a third round of feedback seeking "information on specifics or practical examples of difficulties/challenges encountered in the practical applications related to the most important issues from the second feedback (System of Protection, Optimisation and Reasonableness, Effective dose/Risk estimation, Exposure Situations)."

We note that the ICRP system propagates through IAEA standards and then into national regulations. Examples could be dismissively seen as incorrect applications of the original ICRP system. Therefore, while examples are useful, we would want to re-enforce that it is our opinion that the overriding issue with the current system of protection is its complexity and, because of this, there is a need for more practical guidance.

Consultation

Examples of difficulties in the application of the system of protection are provided below based on feedback from ARPS members. Feedback was primarily received through responses to invitations for input sent to ARPS members, as well as ensuing discussions amongst members of the ARPS executive committee.

Conservative Application of Radiation Protection

A common theme expressed by ARPS members is the formalisation of the conservative application of radiation protection. As stated in the IRPA 'reasonableness' paper (2021) "in practice there is a wide consensus that at low exposure levels typically around 'a few mSv' or less, all we know is that if there is a risk, then it is very small and is equivalent to many risks in situations commonly accepted in society". In spite of this consensus, it is usual that the lower levels become the standard, either through regulation or industry standards for dose limits, dose constraints and applying the ALARA principle. Consequently, it is commonplace for unreasonable efforts to be expended for circumstances where such efforts are not justified when considering the potential effective dose alongside factors such as cost and actual risk. In practice, the good intentions of reasonableness and optimisation can be lost when the legal system requires specific compliance criteria.

The three examples provided by ARPS members are legacy sites, the use of lead aprons in radiology, and shielding calculations for linac bunkers. It is recognised that these examples arise not from stipulations in the current ICRP system of radiological protection, but rather from conservative application of the system by regulators, practitioners and industry with a primary focus on dose minimisation without balancing optimisation and reasonableness.

Legacy Sites

The management and remediation of land contaminated with radioactive material begins with defining what is 'contaminant material'. This determination is often based on applying an annual dose such as 1mSv/y limit, or a 0.3mSv dose constraint to derive measurable parameters such as an activity concentration or associated exposure rate.

The overarching dose limit or dose constraint have a very low associated health risk. Despite this, practitioners frequently apply these values conservatively, for example using worst case exposure rates. The outcome can be highly restrictive, resulting in excessive expenses to manage or remediate 'contaminant material' with a low likelihood of significant exposure. Although such activities on legacy sites are via 'justification' on a case-by-case basis, it is important to recognise that the environmental consultancy industry is risk averse and influenced by public perceptions. Therefore this industry favors justifying very low dose outcomes without a balanced consideration of optimisation and reasonableness.

Lead Aprons

There is a regulatory requirement in some jurisdictions, and an expectation everywhere that nurses must wear lead aprons during procedures that use radiation.

Some jurisdictions also require nurses to have personal monitoring. Most nurses involved are more than 2m from the x-ray tube, and are often outside the exposure room. The radiation monitoring results are almost uniformly below minimum detectable doses. Requiring both a "belt and braces" approach to radiation protection is a common result of conservatism. Provision and maintenance of adequate PPE for a large nursing workgroup has a fairly high cost. The PPE in this situation will reduce radiation exposure to less than MDL, given the mix of roles across multiple shifts. We might even say PPE means the worker has no extra radiation dose.

The inherent outcome of minimal to no radiation dose due to the use of lead aprons is only confirmed by also requiring personal radiation monitoring. That monitoring also has a high cost for a large nursing workgroup. Conservatism in the application of the radiation protection system imposes costs for both the provision and maintenance of PPE, and for personal monitoring. The additional cost does not improve radiation safety for these workers.

Wearing lead aprons also introduces the risk of musculoskeletal injury. The situation seems to arise from a dose minimisation approach to radiation protection, rather than a holistic risk-based approach. Consideration of all risks might prompt the removal of lead aprons as a requirement for nursing roles that do not involve prolonged radiation exposure. The reduced risk of physical injury having a much great benefit than the risk of potentially increased radiation exposure.

Linear accelerator Bunker Shielding Calculations

Shielding assessments are routinely conducted prior to installing linear accelerators. The implications of conducting shielding assessments on a conservative basis compared to a real case basis are substantial. A conservative assessment that overestimates the number of treatments and assumes full radiation output results in overengineered bunkers and can deem existing bunkers unsuitable for new linear accelerators.

Concluding Remarks

We note that the ICRP system of protection is already complex and continues to expand in complexity and specificity. This is resulting in radiation protection publications that are larger and harder to navigate, which are further removed from the practical implementation of the recommendations.

We note that the ICRP risks losing relevance as practitioners turn to more accessible guidance. With this is mind, we suggest an ICRP publication on the system of protection that provides a brief and plain language summary. Additional documentation may provide practical guidance with a far greater emphasis on reasonableness that actively discourages the application of layers of conservatism beyond what is already inherent to the system. ARPS recommends that the system

summary document includes clear guidance for aligning optimisation and reasonableness with radiation protection for low dose exposure situations, and consideration of the use of background radiation levels as a modifying factor on prudent use of an LNT model.

IRPA Task Group on the Review of the System of Radiological Protection

Feedback of Cameroon Radiological Protection Society

a. General comments

The revision of the System of Radiological Protection is welcome to update the 2007 General Recommendations in ICRP 103. Several areas of the System requires more clarity and consistency. Cameroon Radiological Protection Society (CRPS) will focus its feedback on:

- Fundamental principle of application of dose limits (Paragraph 2.6)
- Categories of exposure and exposure situations (Paragraph 2.7)
- Effective dose coefficients (Paragraph 4.4)
- Dose quantities for non-human biota and ecosystems (Paragraph 4.5).

b. Specific comments

Fundamental principle of application of dose limits

- Should consider the existing exposure situation because exposure to natural radiation could reach dose levels higher than 100 $mSv.yr^{-1}$. It is for instance the case of radon exposure indoors.
- Should consider thoron in the definition of radon reference level and regulation. Thoron is neglected in dose assessment. However, many reported studies in the world proved the importance of thoron.

Radon, thoron and thoron progeny measurements were carried out from 2014 to 2017 using radon-thoron discriminative detectors (commercially RADUET) in 450 dwellings and thoron progeny monitors in 350 dwellings of some ore bearing areas of Cameroon. Activity concentrations of thoron range between 20-700 Bq m^{-3} with the geometric mean of 107 Bq m^{-3}. Thoron equilibrium factor ranges between 0.01-0.6 with the arithmetic mean of 0.09 higher than the default value of 0.02 given by UNSCEAR. The average contribution of thoron to the inhalation dose due to radon and thoron exposure is about 40%. For the specific case of the uranium and thorium bearing area of Lolodorf, thoron contribution to effective dose ranged between 3 and 80% with the average value of 53%. Thus, thoron cannot be neglected in dose assessment to avoid biased results in radio-epidemiological studies. In general, only radon is considered in regulation and in the national radon action plan.

In April 2022, IAEA has organized a technical meeting. Considering thoron in regulation on radon exposure was discussed.

References

1. Saïdou*, Shinji Tokonami, Masahiro Hosoda, Ndjana Nkoulou II Joseph Emmanuel, Naofumi Akata, Tchuente Siaka Yvette Flore, Oumar Bobbo Modibo, Bineng Guillaume Samuel, Takoukam Soh Serge Didier (2019). Natural radiation exposure to the public in mining and ore bearing regions of Cameroon. *Radiation Protection Dosimetry*, 1-6, doi:10.1093/rpd/ncz176.
2. Bineng Guillaume Samuel, Saïdou*, Shinji Tokonami, Masahiro Hosoda, Tchuente Siaka Yvette Flore, Hamadou Issa, Takahito Suzuki, Hiromi Kudo (2020). The importance of direct progeny measurements for correct estimation of inhalation dose due to radon and thoron. *Frontiers in Public Health*, Vol. 8, Nº17.

About the reference level only defined for radon, there is a methodology used in Russia taking into account radon and thoron to define a combined reference level. Unfortunately, we do not have references on that.

Categories of exposure and exposure situations

More emphasis should be given to existing exposure situation. Currently it appears as the least important between the three exposure situations. However, existing exposure is the most common situation met in the world without any consideration of country, urban or rural areas.

Effective dose coefficients

- Harmonization of inhalation dose coefficients of radon and thoron published by ICRP and UNSCEAR by using dosimetric and biokinetic models. ICRP and UNSCEAR have worked in the recent years to harmonize their views on the effective dose coefficients of radon and thoron. Unfortunately there is still divergence between the two scientific commissions. Professionals and members of the public are not well protected against harmful effects of radon exposure in case of misunderstanding between ICRP and UNSCEAR. As consequence, the System of Radiological Protection is weakened.
- More effort is required on the uncertainty assessment of dose coefficients. By convention, ICRP has decided to give dose coefficients as reference values, without any uncertainty. However more clarity is welcome on uncertainty in dose coefficients.

It should be mentioned that the conversion factor proposed by UNSCEAR has recently been called into question by the International Commission on Radiological Protection (ICRP), which suggests a correction by a factor of 2 upwards. In 2017, the ICRP published new, higher dose conversion factors for radon, which therefore increased the calculated radiation dose associated with exposure to radon in workplaces. For the calculation of doses following the inhalation of radon and radon progeny in underground mines and in buildings, in most circumstances, the ICRP recommends a dose coefficient of 3 mSv per mJ h m^{-3} (approximately 10 mSv WLM^{-1}). UNSCEAR, however, has confirmed in a report on lung cancer from exposure to radon in 2019 that the evidence reviewed by its experts is compatible with the available data in the Committee's previous assessment of lung cancer risk due to radon. Therefore, UNSCEAR concluded that there is no reason to change its established dose conversion factor and recommends the continued use of the dose conversion factor of 9 nSv per (Bq h m^{-3}) EEC of ^{222}Rn, which corresponds to 1.6 mSv (mJ h m^{-3}) $^{-1}$ for estimating radon exposure levels to a population.

Thus harmonization of points of view between ICRP and UNSCEAR in inhalation dose assessment due to radon and thoron is welcome to strengthen the System of Radiological Protection.

References

1. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Sources and Effects of Ionizing Radiation; United Nations Publication: Vienna, Austria, 2000.

2. International Commission on Radiological Protection (ICRP). Lung Cancer Risk from Radon and Progeny and Statement on Radon; ICRP Publication 115, Part 1; Pergamon Press: Oxford, UK, 2010.

3. International Commission on Radiological Protection (ICRP). Occupational intakes of radionuclides: Part 3; ICRP Publication 137; Pergamon Press: Oxford, UK, 2017.

4. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Report of the UNSCEAR to 66th General Assembly of the United Nations; United Nations Publication: Vienna, Austria, 2019

Dose quantities for non-human biota and ecosystems

Currently there are 12 RAPs typical of marine, aquatic and terrestrial environments. It will be important to increase the number of RAPs to take into account common terrestrial animals met in all continents.

AS_Japan 28.6.2022

The Japan Health Physics Society will establish a TG on exposure situations and categories. This TG will discuss proposals for improvement measures based on the difficulties and challenges encountered during the response to the Fukushima Daiichi Nuclear Power Plant accident.

Feedback from Nordic Society for Radiation Protection (NSFS)

1. Thorough elaboration on uncertainties involved in estimating the total detriment, based on nominal incidence risk, weighted for lethality and life impairment (and including DDREF) is needed, in particular quantification of uncertainties regarding the nominal (organ) risk coefficients based on cancer incidence data. This also involves validation of published dose coefficients.

2. In addition to the introduction of uncertainties, age- and sex-specific radiation and tissue weighting factors ought to be determined, in order to better achieve prudent optimization (in contrast to minimization).

3. The possibility of using QALY or DALY for severity adjustment should be explored, as well as considering using lifetime attributable risk (LAR) or risk of exposure-induced cancer (REIC) as indicators of risk.

4. ICRP give recommendations on dose limits for occupational and public exposure, limits that are often adopted in national legislations. It may be valuable to discuss/describe the foundation for setting the value of dose limits, in particular the limits for effective dose.

5. We support the inclusion of other late effects/endpoints than cancer and hereditary effects in the detriment. How should various endpoints be compared and valued, e.g. induction of cataracts vs cardiovascular disease?

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Mats Isaksson & Håkan Pettersson

NVS: Third feedback - information on specifics or practical examples of difficulties/challenges encountered in practical applications

Introduction

Based on the email sent on May 27th, 2022 by the chair of the TG, the members of the focus group of the Dutch Society for Radiation Protection collected input on specifics regarding, and practical examples of difficulties and challenges in practical applications when looking at the most important issues that have been identified by the TG.

I note that several specifics and examples could be categorized in more than one of the identified issues. The seemingly most appropriate issue has been chosen to categorize the item.

System of Protection

1) The principle that dose limits should be used for preventing tissue reactions to occur, of course deserves wide support. However, the system does not weigh the severity of tissue reactions under consideration against the effects of an eventual decrease in dose limits. The actual dose limit for the lens of the eye is a clear example where the decrease of the dose limit led to an enormous effort in dosimetric, legislative and protective measures. One might discuss whether the costs of these measures and developments outweigh the advantages of preventing small numbers of cataract – that can easily be treated at relatively low cost. In our opinion, ICRP should therefore re-evaluate this principle.
2) In practice RP professionals responsible for low risk applications have limited knowledge of details of the system of RP. When interpreting a 'dose' in mSv (or µSv), they are usually not aware of the differences between equivalent (organ) dose and effective dose. This regularly leads to undesirable misinterpretation of numbers given in mSv. Although E&T programs for RPOs address this topic in an appropriate manner, the use of one unit for different quantities remains highly confusing.
3) Broad support for age and gender specific weighting factors for calculating the effective dose is reported by the TG chair. Apart from the evident increase in complexity of the system, we note that introducing gender specific weighting factors in an era that strongly promotes inclusiveness, will undoubtedly lead to future questions like 'how to cope with gender neutrality?' when these weighting factors are – erroneously – used for individual risk assessments.
4) It is noted that a review of the system and its underlying ethical principles might also be reason for an update of ICRP publication 62 on radiological protection in biomedical research..

Optimization and Reasonableness

1) The statement that the system of RP is overly conservative is sometimes illustrated by the fact that no clinical observable effects have been seen below doses of the order of 100 mSv. Recent research has shown that at even lower doses effects might be observed (e.g. for pediatric CTs). The basic need for the revised recommendations is therefore to give guidance on when the LNT approach stops to be an adequate theory to use as a basis for protection measures. A few examples will illustrate this.
    a) There are doses, and dose rates, so low that it is bad science to use them for epidemiologic purposes, especially when received by millions of people, over decades of time, due to the uncertainties in the data. Yet, this is done regularly, as e.g. the communication on the victims of the Chernobyl accident proves.
    b) In the Netherlands an old guideline for establishing isotope laboratories and calculating / restricting the expected internal exposures due to the application of radioactive substances

in dispersible form is used. This guideline claims to restrict the exposures to an effective committed dose lower than 2 mSv annually. However, it has been shown that due to an overly conservative approach, actual exposures will in general be as low as tens of microSieverts. Relaxation of the requirements for e.g. the ventilation of isotope labs will hardly influence the actual exposures, but might significantly contribute to saving energy / money and therefore to a more sustainable future.

2) For communication purposes, it might be helpful to compare natural radiation levels to levels of planned exposures. Also, on a cellular level, it would be very interesting to compare DNA damage due to natural processes (e.g. cell metabolism) and cell damage caused by very low doses of ionizing radiation. Could we determine a universal dose (rate), below which the contribution of ionizing radiation is negligible, a de facto threshold? Additionally, it is noted that using the LNT hypothesis, an annual effective dose of the order of a few tenths of a mSv (i.e. a fraction of the natural background level) corresponds to an annual risk of 10^{-5} for developing stochastic effects, which is generally considered acceptable for workers.

Effective dose / Risk Estimation

1) When justifying new clinical techniques or methods, in practice the focus is mainly on the disadvantages due to the (possible) extra radiation dose, while the (potential) benefits for patients are often less heavily weighted. We illustrate this with two specific examples:
   a) when tomographic mammography (tomosynthesis) was introduced, the FDA stated in advance that the glandular dose limit set for 2D mammography, should not be exceeded for tomosynthesis;
   b) currently, at the introduction of spectral CT, the discussion often revolves around (approximately) doubling of the dose, overshadowing the potential benefits for the patient.
2) There is a debate going on with respect to the dose conversion coefficient used for radon. Due to time restrictions, we have not been able to work this topic out in detail. However, If required, I offer to forward the request for further elaboration on this topic to the appropriate member of our focus group.

Exposure situations

1) Many exposure scenarios do not neatly fit into one of the three standard types of exposure situations:
   a) The approach towards the radiological situation during and after a **distant** nuclear accident. How should countries located far away from the directly affected country or region approach their radiation-protection strategy targeted at the import of (non-food) commodities, i.e, at the international trade of (non-food) commodities? Obviously, this depends on how such (potential) exposure situations are categorized: planned or existing. Unaffected countries could treat such a scenario as an existing exposure situation, since ‘the situation already exists when a decision on control has to be taken’. However, there could also be strong arguments to base the strategy on a ‘planned situation’, inasmuch as ‘the radiological protection can be planned in advance, before exposures occur, and since the magnitude and extent of the exposures can be reasonably predicted’. Said differently, the import of commodities could introduce new sources of exposure in the unaffected country of which the dosimetric consequences could be assessed largely in advance. There may be sufficient time to plan the protection strategy, especially when such scenarios are worked out in emergency response plans of countries.
   b) The choice for a planned or existing exposure situation may also greatly depend on the public perception of the radiological risks involved as well as on the economic or political

dependence on the affected country or region. Treating this situation strictly as a planned one may reassure the public but could - perhaps unnecessarily - hinder the international trade of commodities with great economic consequences. Clear guidance on these issues could be provided by the ICRP, taking into account the aspect of harmonization.

c) In ICRP Publication 142 (2019), the ICRP categorizes industries involving NORM as existing exposure situations. The key paragraph in this publication is para 35, which mentions that "For most NORM industries, the source **is not deliberately introduced** in the industrial process for its radioactive properties. The process by which NORM in raw materials is concentrated, with changes in physicochemical form resulting in production of radioactive release, residues, and wastes**, is not for the purpose of introducing a new radioactive source; it is incidental although it has to be managed**". Hence the 'intention' of the industrial process seems to be the main reason for considering most NORM processing industries as existing exposure situations. However, one may argue that these industrial processes themselves are known to lead to increased levels of natural radioactivity and thereby to increased levels of exposure. Despite the fact that this is incidental, the situation itself is artificial and protection against these increased levels can well be planned in advance. ICRP could provide stronger arguments to manage industries involving NORM as existing situations, or leave the door open to manage them as a planned exposure situation as well.

2) Somewhat related to the last example is the question how to deal with the unforeseen presence of radioactive material in small, but non-exempted quantities. This radioactivity may be of natural origin (accumulation of 'NORM' in several non-nuclear industries, scrapyards, incineration plants, etc.), but there have also been a number of cases with radioactivity of artificial origin (accumulation of C-14 or C-137 in (biomass) power plants, orphan sources in scrap yards, I-125 in cremators). The question is whether these situations should be considered as planned (or – in the case of NORM – existing) exposure situations, and – if so – to what extend they should be regulated as a 'normal' planned (or existing) exposure situations. Treating these situations as 'normal' exposure situations – depending on national legislation – means that the presence of radioactivity requires authorization, and compliance with (usually complex) general radiation protection requirements. These requirements can be challenging and expensive for companies and might as a consequence lead to undesirable behavior. Given the in general modest risks associated with small quantities of radioactive material, a separate and more graded approach, and/or specific guidance, for unforeseen or potential presence of radioactivity may contribute to a better and more effective radiation protection framework.

Hielke Freerk Boersma, June 28, 2022

- The effect of any external dose exposure should be independent of the age and sex of the irradiated person. The LNT hypothesis should not have different slopes depending on the sex or the age of irradiated person.
- The assessment or quantification of the environmental protection must be elementary, straightforward or almost trivial, and not deviate to much from establishing the characteristics of the object of protection, exposure scenarios, dose and effect relationships, and by defining derived consideration reference levels (DCRLs) indicating absorbed dose rate bands where some detrimental effects could be anticipated for a particular RAP.
- As long as the optimization process is not so complicated and difficult to apply that its practical implementation will be impossible, the SEPR supports the inclusion of other aspects within the optimizations such as societal, environmental, economic, and general wellbeing.
- The SEPR does not agree with statement from your presentation "*One AS proposes that the introduction of a low dose threshold is investigated, e.g., between 1 and 5 mSv, with planned exposures below this threshold subject to no regulatory governance*." On the same subject, our proposal was that "*There is enough information and experience to consider, for example, that the public exposure from radioactivity releases in the liquid and gaseous effluents of nuclear power plants can be considered optimized without any further assessment or consideration if such exposure is less than a few µSv/yr. Work should be done to reach a general consensus on what this value of µSv/yr could be for the most exposed and/or most at-risk person in the exposed population and to reflect it in the new recommendations*".
- The current dose limit for exposed workers of 100 mSv in 5 years has been widely accepted and applied in all cases of occupational exposure and has shown enough flexibility in its application so that any change made to it should be very well justified and its application should bring more benefits than disadvantages. Nevertheless, it should be clarified what is the dose limit to apply in occupational exposure. Currently there are 3 very similar approaches among them: ICRP-103 of 100 mSv in 5 years; International Basic safety Standards of the IAEA of 20 mSv/year averaged over 5 years and European Directive 2013/59 EURATOM that establishes 20 mSv/year, but in special circumstances and for certain exposure situations specified in national legislation, a higher effective dose of up to 50 mSv may be authorized in a single year, provided that the average annual dose over any five consecutive years, including the year for which the limit has been exceeded, does not exceed 20 mSv.
- The SEPR suggests that any change introduced in the definition of new dose quantities should not represent a drastic revolution compared with previous recommendations, since this could be interpreted as a lack of knowledge or security of the experts.
- For tissue reactions, the SEPR strongly supports the distinction between severe tissue reactions with thresholds of occurrence and less severe tissue reactions at lower doses with recovery capacity. Also, it would also be of great interest if finally it is clarified whether or not there is a dose threshold for the formation of cataracts and diseases of the circulatory system. Finally, the SEPR strongly supports that there should be no differences in the dose limit for the public and exposed workers for exposure of the lens of the eyes and the skin.

Overview of Practical Issues in the Implementation of the System of Protection

- Over-conservatism in the clearance regime: There is documented evidence [Coates 1] that an accumulation of multiple conservatisms in the clearance regime has resulted in regulatory-enforced clearance levels (Bq/g) being a factor of between one and two orders of magnitude unnecessarily restrictive. This imposes very significant unnecessary costs on industry, reaching hundreds of £Ms particularly over decommissioning programmes. It also seriously infringes the increasingly important concept of sustainability, where re-use and recycling of resources is gaining importance. Our RP system should be supporting and encouraging the recycling/re-use of materials such as metals and concrete rubble, as is happening in other industries, rather than making the system unnecessarily challenging to implement.

- A similar conservative approach to shielding assessments has been shown [Ambrose] to lead to overly restrictive shield requirements for occupational exposure in the nuclear and healthcare industries. This results in the use of significant additional steel and concrete which imposes a real burden in terms of additional CO_2 releases which impact the climate, together with a significant additional cost burden on future society for decommissioning expenditure.

- Both the above issues stem in part from a lack of proportionality in the application of the ICRP system of protection. In particular there has been a 'one size fits all' approach to dose assessment regimes, both for public and occupational exposure, irrespective of the level of dose (and hence assumed risk). Much international guidance (including ICRP) is framed in the context of avoiding exceeding dose limits, but the same approaches are used for assessments well below these levels. In addition to better proportionality there need to be a wider approach to decision-making that takes account of important non-radiological issues – an 'holistic' approach.

- This lack of proportionality manifests itself also in general decision-making at low doses, especially around the 'few mSv' level and lower. This leads to imbalances which are difficult to explain to normal members of the public – ie a misalignment with what many regard as a 'common sense' approach. An example of this is developed in [Coates 2], comparing the exposures and societal costs resulting from the clearance regime with the personal choice of a holiday in an area of higher natural background (Cornwall).

- Current RP regimes tend to unintentionally support or reinforce a perspective that man-made radiation is particularly dangerous, and certainly much more so than natural radiation. This also stems from a perspective that 'there is no safe level of radiation'. This is perhaps the largest challenge facing the RP profession today, and the current review of the ICRP system of protection must seriously consider how to address this challenge.

- Hence it is important to change the way we make decisions at very low doses – we need an approach that better aligns with what is generally regarded as 'common sense'. I have tried to express this sentiment in [Coates 2] and for example in my presentation to the NKS group in Stockholm.

References

Ambrose; Conservatism versus sustainability; recognising the interconnectivity of ALARA and sustainability (IRPA European Congress, Budapest 2022)

Coates 1; Prudence and conservatism in radiation protection: a case study

Coates 2; The need to review low-dose decision-making in radiation protection

Note: Ambrose, Bryant and Coates are preparing a paper on 'RP and Sustainability' for submission to the upcoming ICRP Vancouver conference.