17th December 2022

IRPA Feedback on System of Radiation Protection

Introduction

The International Commission on Radiological Protection (ICRP) has embarked on a review and revision of the System of Radiological Protection that will lead to new General Recommendations refining and eventually superseding ICRP *Publication 103* The 2007 Recommendations of ICRP. The first major milestone was open-access publication of the paper 'Keeping the ICRP Recommendations Fit for Purpose'. The aim of this paper is to encourage discussions on which areas of the System might benefit most from review, and to initiate collaborative efforts. ICRP is seeking responses on the ideas in the paper and other areas relating to the review of the System and is organising a series of workshops, the first of which was held virtually in October 2021, to gather feedback. This is an opportunity for open and transparent discussion on the first steps of this multi-year initiative.

The International Radiation Protection Association (IRPA) has set up a Task Group to inform Associate Societies (AS) about this initiative, encouraging them to organise feedback through IRPA and independently, and consolidating views reflecting areas of broad consensus and the spectrum of views of the profession. Feedback was initially obtained from the Associate Societies on areas of the System that might benefit most from review, and early thoughts on directions for improvement of the System. This feedback was consolidated for a presentation at the October 2021 ICRP workshop, representing the spectrum of views received. Following this, a second call for feedback was issued requesting AS to inform in more detail on their three most important issues concerning the revision of the System for Radiation Protection. Later in the year a third call was issued requesting practical examples relating to the System of Radiation Protection, with a final request for comment on the ICRP priorities for the revision just prior to the Vancouver Conference in November 2022. The IRPA feedback has been presented at the North American IRPA Regonal Congress, the Health Physics Society Annual meeting and at the ICRP Symposium. A summary of the various responses, highlighting commonalities in views as well as some individual concerns, is given below.

Response from Associate Societies

17 Associated Societies responded to the call for TG members, with a total of 30 IRPA members nominated to the TG. The initial call for feedback on the ICRP paper received detailed comments from 16 Societies, with 9 Societies providing input to the second call for feedback, 7 responding to the 3rd call and 5 to the final one. Details of the AS that responded are given in Table 1.

AS Providing First Feedback	AS Providing Second Feedback
Australasian Radiation Protection Society	Australasian Radiation Protection Society
Austrian Radiation Protection Society	Austrian Radiation Protection Society
Belgian Association for Radiological Protection	French Radiation Protection Society
Brazilian Radiological Protection Society	Health Physics Society, US
Cameroon Radiological Protection Society	Italian Radiation Protection Association
Dutch Society for Radiation Protection	Japan Health Physics Society
French Radiation Protection Society	Nordic Society For Radiation Protection
German-Swiss Association for Radiation Protection	The Society for Radiological Protection, UK
Ghana Association for Radiation Protection	Spanish Society of Radiological Protection
Health Physics Society, US	**AS providing Third Feedback**
Italian Radiation Protection Association	Australasian Radiation Protection Society
Korean Association for Radiation Protection	Cameroon Radiological Protection Society

Japan Health Physics Society	Dutch Society for Radiation Protection
Nordic Society for Radiation Protection	Japan Health Physics Society
The Society for Radiological Protection, UK	Nordic Society for Radiation Protection
Spanish Society of Radiological Protection	The Society for Radiological Protection, UK
	Spanish Society of Radiological Protection
AS Providing Fourth Feedback	
French Radiation Protection Society	
Dutch Society for Radiation Protection	
Japan Health Physics Society	
Nordic Society for Radiation Protection	
The Society for Radiological Protection, UK	

Table 1: Associate Societies providing feedback

Summary of First Feedback

General Comments – Positives

Most countries were in general approval of the revision and the overall approach (Belgium, Brazil, Cameroon, Dutch, German-Swiss, Ghana, Italy, Spain, UK). Particularly appreciated were the recognition of the need to simplify and clarify the system, the importance of communication, and planned involvement of stakeholders.

The Belgian Society welcomes review of the concept of dose and detriment and also the concept of potential exposure. The Dutch Society agrees to prioritise consistency and clarity.

The Italian Society appreciates to continue in taking into account scientific, ethical and practical aspects all together, and at the same time the consideration to identify how explicit incorporation of the ethical basis of the System would be beneficial.

The UK Society supports linking review to changes in underlying science, including changes to ICRP dose quantities and ICRU operational quantities, and notes an interest in development of ideas concerning revision of effective dose concept. Published work by IRPA and R Coates (Reasonableness, System of Protection & Low Dose Decision-making) is suggested as input to IRPA response.

General Comments – Negatives

The Belgian Society commented on the lack of distinction between occupational and public dose limits and notes that the integration of tools used for protection seems unrelated to problems around defining exposure situations.

The Dutch Society notes that some proposals eg inclusion of non-human biota will lead to increased complexity, so ensuring consistency and clarity may be challenging.

The German-Swiss Society commented that communication with the authorities and public needs attention, and this requires professionalism for dealing with the media. They recommend a Traffic Light model for radiation protection and have concerns over coordinated radon protection and regulation for dose to eye lens along with a request for greater clarity over use of the LNT model, and interpretation of DDREF, ALARA, and detriment.

The Ghanian Society would appreciate access to some of the referenced papers.

The Japanese Society would like more clarity on the use of a public dose limit of 1 mSv only for planned exposure situations, as its relaxation following Fukushima caused communication issues.

The Spanish Society considers it may not be possible to develop and incorporate all suggested changes, with a full consensus, and proposes that prioritising issues might be beneficial.

The UK notes that a wider perspective is needed on who might be considered a Stakeholder and suggests re-evaluation of the tolerability of dose / inferred risks in different exposure situations, with quantitative contextualisation of radiation risks with other risks. They would also like to see more on practical implementation of protection of the environment.

Specific Comments - Background and Purpose

The Spanish Society noted agreement with the stated objectives but consider over-complexity to be one of the issues of current system. The UK Society support the focus on improving clarity and consistency. The US Society welcome open & transparent engagement but note that the rationale behind recommendations must be clear. They also propose that heritable effects should no longer be studied as have been demonstrated to not exist. The Italian Society suggest that understanding the System should be in the context of Practice.

Specific Comments – Objectives and Principles of the System

Regarding the link of detriment to the WHO health definition, the Spanish, Dutch and US Societies are in approval of this. The Spanish Society supports review of the distinction of stochastic & tissue effects and detriment concept but suggest caution in application of age/sex risk differences in the System, particularly with respect to dosimetry. The US Society notes that paediatric sensitivity to cancer should be considered on a case-by-case basis as it is highly dependent on irradiated organs – implications in medicine.

Some Societies (Italian, Belgian, Austrian, Australian) suggest that space exploration examples are not appropriate for the majority of practitioners and objections to inclusion of space references are made throughout. The Australian Society consider tissue reactions should only be tolerated if benefit to irradiated individual and recognise problems in applying WHO health definition & addressing mental health issues.

Several Societies (Spanish, Italian, Brazilian, Australian, French) express support to varying degrees for increased attention to environmental & non-human protection. It is noted that considerations need to be practical though. The Brazilian Society would like consideration of ecosystems & non-human biota to consider sensitivity variations of native species & multi-generational effects The Australian Society recognises the need to consider benefits to environment eg reduction of climate change impact and also notes that sustainability is beyond the skill set of RP experts.

Justification is recognised to be an important issue, that is currently poorly understood or applied in some quarters. The Belgium and French Societies welcome justification according to exposure situation and the Dutch Society would like to see the system based on ethical values. There are some specific recommendations/requests, including that quality of life be included (Spanish Society), clarification over responsibility for justification of biomedical research (Korean Society) and inclusion of non-medical aspects which may vary be sector (Australia Society). Practical examples and communication of ideas are important, particularly in medical sector.

There was strong support from many countries (Belgian, Spanish, UK, US, French, Nordic, Australian) for a holistic approach to optimisation, including issues such as optimisation not meaning minimisation, inclusion of societal /economic factors and the environment, consideration of variations in natural background, setting of a level below which risks are ignored, and provision of guidance and practical examples. The Spanish Society particularly request practical recommendations for optimisation in design phases and suggest that acceptable levels for public exposure from nuclear

could be specified. The Australian Society notes that non-radiological factors should be the responsibility of government not ICRP or RP practitioners.

There is agreement from Belgium, Nordic, French Societies in regard to combining constraints and reference levels, although the Australian Society considers careful differentiating of limits, constraints & reference levels important to prevent tightening controls excessively. The Belgian Society urges caution over having limits only for planned exposures and suggests tolerability of exposure should distinguish between workers and public. The Spanish Society agrees with proposals re dose limits but suggest care to ensure clarity rather than confusion and urge caution in changing values. The French Society suggests considering criteria based on lifetime exposure and both the UK and Spanish Societies support work to broaden application of risk criteria and limits to reflect all exposure situations.

General agreement for review of exposure categories is indicated, with cautious agreement for proposed new categories provided these are clarified well though the Dutch Society has concern over a new category for emergency worker exposures as a difference between workers and public could lead to inconsistency and note that a category for non-human biota may over-complicate things, and should be justified on ethical grounds. The Australian Society would not support dose limits for natural exposures and the Cameroon Society suggest that there is a need to increase number of RAPs to include native species from all continents. Several Societies (Belgian, Ghana, Cameroon, Brazil) have concerns around NORM including potential new exposures (industry/buildings), over-regulation, need to include thoron in radon reference levels, harmonisation of inhalation coefficients, need for better quantification, and a suggestion to encourage re-use of NORM residues as part of optimisation process.

Specific Comments – Overarching Considerations

Several Societies (Spanish, Ghanian, Italian, French, Austrian) are supportive of an increased prominence of ethical issues within the RP System, with a request for examples of application. The French Society note the need to get communication right on issues. The Australian Society is less convinced of the value of incorporating an ethical basis. The UK Society strongly supports use of natural background in risk communication.

Stakeholder engagement is welcomed by the Belgian and Australian Societies but is recognised to carry risks and should be differentiated across exposure situations. The Spanish Society agrees with the co-expertise process but consider intensive work required in this area. The US Society requests transparency in the process of transmitting comments on this review process to ICRP, and for ICRP to make all comments public.

Several Societies (Ghanaian, Spanish) expressed their support for the importance of education, including at undergraduate level. The Belgian Society notes that safety culture & understanding risk have been emphasised by COVID. The French Society would welcome focussed further work in education & training, and the Australian Society that education should include risk theory. The Austrian Society suggests that recognition of programmes may be more cost effective than individual accreditation, and the Australian Society that Accreditation standards are needed for professionals & tools for standardised safety assessment methodologies. The US Society recommends that title protection needs to be considered.

Specific Comments - Dose

Proposal for changes in dose quantities are broadly welcomed, particularly the removal of equivalent dose (mentioned by Spanish, Dutch, Italian, Brazilian, French) and changes to operational dose quantities (Spanish, Italian, French). The Ghanian Society also agrees with the absorbed dose concept. The Spanish, Austrian and Nordic Societies note the potential for confusion and recommended

prudence in adoption and consideration of practical implications. The Spanish Society is also cautious re separation of tissue and stochastic effects. The Dutch and French Societies suggest a new unit for radiation weighted absorbed dose whereas the Brazilian Society suggests organ dose replaces equivalent dose.

Regarding more specific (age/sex) effective dose coefficients, the Ghanian and Nordic Society give unqualified support, whereas several Societies (Austrian, Japanese, Spanish, Dutch, Belgian) agree with the concept in principle but suggest that uncertainties need to be considered to justify the change, and both the French and Italian Societies not the possibility of ethical/practical implications in implementation. The Korean Society requests clarification as to when individual effective dose estimates are required as their use is primarily prospective. They also note that excessively complex calculations hinder regulatory activity.

The Spanish Society supports individual risk quantification in medicine but the Dutch Society queries as to whether individual risk quantification at very low doses should be recommended.

The Spanish Society approve no change to models for ingestion/inhalation as over complex models have added little value and also approve the initiative on emergency dosimetry, as do the Australian Society, who also note the need for injection dose coefficients. The Ghanian Society would find medical dose coefficients useful, but the French Society suggest that varying sets of effective dose coefficients would raise ethical and practical issues. The Dutch also support the intention to minimise requirements to recalculate dose coefficients, and the Australian Society suggests ensuring any altered dose coefficients are made available prior to the publication of new recommendations.

The Belgium Society welcomes inclusion of veterinary guidance, but the Spanish Society notes that application to non-human biota & ecosystems must be kept very simple.

Specific Comments - Effects and Risk

The Australian, Spanish and Dutch Societies support further stratification of Tissue effects including distinguishing between severe and less severe tissue reactions. The Italian Society recognises that there is need for health effects to be reviewed and consider it important to be clear re implementation – examples would be useful in this regard.

Societies are not all agreed re unifying dose limits for workers and public. The Spanish, Italian and Dutch Societies would support this, but the Belgian and French Societies disagree. The Belgium Society also suggests that consideration should be made of small children as well as in utero. The Spanish Society requests a decision on the threshold for cataracts & circulatory effects. The Italian Society suggest consultation on limits with those involved and query the choice of value as well as drawing attention to uncertainties in cardiovascular risks.

There are differing views regarding LNT. The Spanish, Ghanian, and Italian Societies all support use of LNT, the Italian Society noting that it is easy to apply in practical situations, though review of Scientific evidence is agreed to be necessary, and uncertainties need to be considered at low doses, including relating to benefits. The Brazilian Society consider LNT only appropriate for planned exposures, with an optimisation-based system for other exposures, noting that reference levels are often wrongly interpreted as limits. The Australian Society accept LNT as basis but at practical level low dose threshold should be investigated, below which exposures should be out of regulatory control. In contrast, the US Society strongly dispute the use of LNT and the lack of evidence for a threshold model and request that all possible dose response models be tested.

Revision of the DDREF is supported by both the Nordic and French Societies. The Nordic Society also suggests that more clarity is provided regarding interpretation of detriment, and that examples would be useful.

The French and Italian Societies consider that individual response to radiation is important and significant as evidence for differences is compelling. They suggest that this is particularly important for medical applications. The Korean and Australian Societies, however, consider that the difficulties and uncertainties in taking this approach make it impractical for inclusion in the System of Radiation Protection.

The Spanish Society agrees with the conclusions made re heritable effects and that future data should revise such risk estimates but not do away with them; The Australian Society also supports reconsidering heritable risks.

The French Society agrees that radiation weighting factors should be reviewed, but the Spanish Society notes that any developments in radiation weighting factors must clarify not confuse practitioners.

Opinions on changes to the definition of detriment are varied. The Nordic Society supports the inclusion of other late effects than cancer and hereditary effects in the detriment and the French Society notes that other proposed changes in the RPS System will have a considerable effect on detriment so alternative measures should be investigated. The French Society also suggests considering the practical & ethical implications of using radiation detriment for the fetus. The Spanish and Australian Societies are not keen on the development of sex/age specific detriment and effective dose calculations, noting that alternatives to current detriment definitions must be well justified, with limited value in trying to achieve greater specificity at low doses.

Summary of Second Feedback (Three Key Issues)

A smaller number of Societies provided specific feedback on what they saw as the three key issues for revision of the System of Protection. These fell broadly under four headings, as outlined below.

System of Protection

The complexity of the RP system and the resulting challenge to its communication is a big concern for AS and the importance of communicating with the public on radiation and risk is a key issue for three AS. There is also a concern that the RP system has become overly conservative and applications in the regulatory system are even more conservative. To address this, the use of the context of natural background, and its variability, is encourage in order to improve the communication of radiation risk.

A strong ethics basis for the RP System is strongly supported, and it is also suggested that ICRP should consider how the WHO definition of health can be incorporated into the RP System.

There is need for further explanation of ICRP intentions regarding protection of the environment and how and when this should be considered in practice.

Optimisation and Reasonableness

There was very strong support among AS for a holistic approach to optimization (a key issue for 3 AS) and several recommendations that it is stressed that optimisation is not minimisation. It was considered important to promote the use of reasonable caution to avoid undue conservatism. It was further suggested that there is a need for practical recommendations and examples of a holistic approach to optimisation. There is a concern that the LNT approach leads to unreasonable financial burden and efforts at low doses.

There was also suggestion to include non-radiation effects in risk/benefit consideration.

Effective dose/Risk estimation

There is broad support for introducing age and gender specific weighting factors in effective dose calculation, with a view to improving individual risk assessments. This was a key topic for five Associate Societies and was noted as being of particular value in medical exposures. Justification for more refined risk estimates is felt to lie in improved scientific knowledge around aspects such as RBE of different radiation for different effects. Potential for different risk factors for different effects was mentioned.

There was comment from multiple sources on the need to review how risk is defined, due to multiple considerations in definition of detriment. Lethality has been proposed or, by others, cancer incidence – the latter being more stable with time due to improving healthcare. The better consideration of non-cancer effects was also raised. Potential use of DALY/QALY was noted by two AS.

Despite support, ethical and practical difficulties were noted in implementation of individual risk estimates, including the possibility of discrimination in the workplace and potential challenges around dose limits. Uncertainties, particularly at low doses also need to be recognised.

Exposure Situations

The application of the three types of exposure situations was raised as a key issue for two Associate Societies, partly as many exposure scenarios do not fit neatly into one of these, indicating the system requires clarification, and also because it is felt that protection of the individual should be paramount no matter what the exposure situation.

It was proposed that the system of exposure situations might be simplified by applying a broader protection principle and rethinking concepts of limits, reference levels and constraints.

An alternative perspective was provided by one Associated Society who proposed tailoring the System of Protection to the exposure context ie medical/nuclear/natural in order to apply a holistic approach, grouping radiation practices by their common attributes – a subtly different approach to the current exposure situation concept.

Summary of Third Feedback (Practical Examples)

The third set of feedback was more succinct and focussed on specific practical examples that may be of use in illustrating some of the issues and concerns previously raised. It was emphasised by some Societies that the examples may well be seen more as evidence as poor application of the current System, rather than issues with the System itself, but that this should be recognised as evidence of the need for a much less complex System of Radiation Protection, with clear and unambiguous guidance, perhaps on a sector specific basis.

Conservative application of the System of Radiation Protection

A number of practical examples were provided as to how over-conservatism has had an adverse impact on Society. Issues around the management and remediation of contaminated land were raised by both the Australian Society and the UK Society, including excessive expenses to manage or remediate ‘contaminant material’ with a low likelihood of significant exposure; industry favouring justifying very low dose outcomes without a balanced consideration of optimisation and reasonableness; significant unnecessary costs on industry, reaching hundreds of £Ms particularly over decommissioning programmes; and infringement of the increasingly important concept of sustainability, where re-use and recycling of resources is gaining importance. A further impact of over-conservatism can be seen through the overestimation of shielding requirements in both healthcare and the nuclear industry, leading again to both expenditure and lack of sustainability. A

further healthcare example offered by the Australian Society was overuse of lead aprons and dosimetry for nursing staff, and the Dutch Society highlighted similar themed issues, including the example of financial and energy costs of isotope lab requirements if an overly conservative approach is employed, and the impact of a lack of consideration of benefit against risk in medical applications.

Dose quantities and limits

The Dutch Society note that lowering of dose limits for tissue effects without considering their severity has been demonstrated to lead to expensive efforts in dosimetric, legislative and protective measures. They also comment on the confusion arising from using one dosimetric Unit for two different quantities (equivalent and effective dose) and potential ethical issues around gender specific weighting factors due to the issue of gender inclusiveness. The Nordic Society also note issues with 'valuing' different tissue effects, and also stress the importance of quantifying uncertainties in detriment and weighting factors plus providing background to the selection of dose limits. The Spanish Society also distinguish between tissue reactions of varying severity and highlight the problems arising from slightly different approaches to occupational dose limits of different international organisations. The Cameroon Society provided worked examples of how discrepancies between ICRP and UNSCEAR on radon effective dose coefficients leads to high uncertainties in estimates of radiation dose associated with radon in the workplace.

Exposure situations and categories

The Japanese Society is planning a new Task Group to discuss proposals for improvement measures in categorisation of exposure situations, based on the difficulties and challenges encountered during the response to the Fukushima Daiichi Nuclear Power Plant accident in relation to exposure situations. The Dutch Society provided a number of examples showing how some exposure situations do not fit neatly into one of the three categories, with consequent uncertainty in how the situations are managed. These include the impact of a distant nuclear accident on international trade and import of commodities, and NORM processing industries, both of which could be argued as either planned or existing exposure situations, and also unforeseen presence of radioactive material in small, but non-exempted quantities. The impact of public risk perception is seen to play a role in such exposure categorisation and clearer guidance is needed.

Radon

The Cameroon Society provided detailed evidence of how the failure to include thoron in radon dose assessments can lead to significant underestimates of inhalation dose and may lead to bias in radio-epidemiological studies. The Dutch Society also recognise this as an issue and are currently undertaking a debate on the topic.

Priorities for Revision of the System of Protection

Five Societies provided information specifically on the Priorities for revision of the System of Radiation Protection, although the views of practitioners on this can be deduced from previous feedback also. Two of the responding Societies commented on the fact the list of headings provided by ICRP was not helpful in understanding the planned work and more detail was needed to comment fully.

Aspects of tolerability and reasonableness, including a balanced view of risks were mentioned as a priority by all of those responding to this particular request, with two Societies noting that a holistic approach to optimisation was an important topic missed off the priority list. Closely related, and mentioned in multiple responses, was assessment, understanding and impact of uncertainties. Other priority areas mentioned were revision and application of detriment, including mechanisms of biological effects, how to address environmental effects and non-human biota, individual sensitivity,

and communications and ethical issues, the latter being recognised as a component of individual dose estimation. One further priority seen as missing from the list by one Society was the use of Artificial Intelligence in radiation Protection.

Incorporating themes emerging from all sets of feedback, the practitioners' views on priority areas for review are captured in Table 2.

Key Priority Areas (Mentioned by Multiple Societies)
• Tolerability & reasonableness • Impact of uncertainties • Holistic approach to optimisation • Ethics, in medicine but also more generally • Communication • Exposure situations & exposure categories • Application of Justification
Medium Priority Areas (including those considered high priority by a smaller number of Societies)
• Clarity around Radiation Protection of the Environment/Non-human species • Dose coefficients & individual Effective Dose • Non-cancer radiation effects, including cardiovascular disease • Radiation Risk Inference at Low-dose and Low-dose Rate • Detriment & Risk – how these are defined, inclusion of non-radiation effects • Training & Education • NORM
Low Priority Areas (Negative Feedback)
• Space travel

Table 2: Summary of views on priorities for review

Additional important points that were made within this feedback were an observation that the majority of practitioners were more concerned with the transparency and the clarity/explicability of the next ICRP system than with the inclusion of the scientific evolutions and research discoveries; and that the free availability of ICRP publications, particularly in electronic format, were of great help to the radiation protection community.

Concluding Comments

The various sets of feedback provide a good overview of the main issues, and an indication of direction for the ICRP in addressing these issues, including priorities for review. This includes the opinions of a wide range of radiation protection professionals; however, it can be noted that initially the majority of the feedback provided was quite general. Although the third set of feedback provided more detail of experiences in the practical applications of the RP System, more examples of this would be welcome, in particular within the regulatory framework. A similar observed can be made for other international/regional entities addressing the revision. There are often many comments high on general reflections but low on specifics or practical examples of difficulties/challenges encountered. Further work of the TG might usefully focus on further practical experience/examples that members are willing to share and, as ICRP proposals develop, practical exploration and feedback on implementation of these.