

## 9. The system of protection: an analysis based on the ICRP proposal

### 9.1. The scope of the RP system

The ICRP proposal (ICRP 2001) states that ‘it is the control of radiation doses that is important, no matter what the source...’ and uses the term *controllable source* to apply when ‘either the source or the resulting exposures are controllable by reasonable means’, cf. Section 2.4. We regard this as a step in the right direction towards making the contours of the RP system more visible. It is also a way of saying that since there is no biological difference between doses (of the same type of radiation) from artificial radio-nuclides and natural radiation sources, they should all, presumably, be covered by the RP system, providing the sources are regarded as ‘controllable’ in the sense just mentioned.

On this point, the ICRP proposal ought to be further developed in order to avoid ambiguity and to define the scope of the RP system in a way that is easily understandable and logical at all times. A concept such as ‘controllable source’ may be useful in itself but does not seem suitable for, say, delineating the protective system; what is physically controllable may change with new technology, and considerations of what is controllable by ‘reasonable means’ will certainly vary with regard to costs, among other things.

We suggest that the RP system should cover, in its concept, all radiation sources. This does not mean that an actual control procedure will automatically be set in motion for all sources. None of us intends, for example, to begin checking our neighbours for the  $K_{40}$  that we all, as humans, have in our bodies. Nor do we think that living trees will have to be checked, although the use of fly ash from wood burning might be, etc. For the system to be meaningful at any given time, the scope of targets for control must be further specified, and regional/national differences may well be observed. However, we mean that the ICRP should play an important role in this context by i) indicating types of sources perceived as directly amenable to control, or for which exposure pathways may be controlled, and ii) recommending that all or at least some of these targets always be controlled. The ICRP could do this by drawing up a positive (including) or a negative (excluding) list of targets, with guidelines for making decisions on previously unidentified types of radiation sources. The lists would be updated when necessary.

The approach outlined above should trigger a system for inventory of radiation sources, not least naturally occurring radioactive material (NORM) and especially technologically enhanced naturally occurring radioactive material (TENORM). This would not only help identify radiation sources that have not been previously controlled on a usual basis, but also enable us to view presently controlled sources in a wider perspective.

The waste streams of, for example, phosphates, petroleum production, water treatment, and mineral processing give rise to considerable radioactivity each year, as illustrated by the following data for the US alone (EPA 1993). The reference gives production rates for these sources in the range of  $10^5$ – $10^9$  t/year and activities in Bq/g in the range of up to 1000–4000 (U+Th+Ra). From coal ash in the US, with (at the time the data was collected) a production of  $6.1 \times 10^7$  tonnes per year and an activity of up to 2 Bq/g according to the EPA, we conclude that there would have been a calculated maximal total activity of upwards of  $10^{14}$  Bq in one year’s time. Other industries with significant radioactive waste streams are, generally speaking, petroleum processing, geothermal plants and paper mills. We do not think *à priori*

that such information would make it necessary—or possible—to control all such sources or control every step in the handling of slightly radioactive products as is the case in the nuclear industry. However, we do think that perhaps radiation doses to workers may sometimes be overlooked in practices not usually identified with radioactivity. Further, many waste streams (and not only obvious candidates such as mine tailings) ought to be seriously studied with regard to population doses and compared with corresponding information about low-activity waste from traditionally regulated radioactive sources. Again, the purpose is not to introduce new bureaucratic procedures for the sake of achieving absolute harmonisation of dose control, since this is not possible in any case. But a protective system that covers, in principle, all radiation sources will oblige us to deliberate over what type of source should be controlled and what should not and, in the latter case, why not. It is important that such deliberations be presented openly, and that many parties in society ('stakeholders' in a wide sense of the word) get the opportunity to participate.

As we have already pointed out, it is not only a matter of which sources should be considered for control at a given time, it is also the 'degree' of control. For some sources there is a need of more stringent and far-reaching control requirements than for others. As regards the RP concept, the starting point should be that all doses and risk aspects that are similar and at the same level also be controlled to the same degree. Deviations from this principle need to be justified and clearly explained, e.g. in case there are 'double' standards with different dose constraints for exposures to TENORM and man-made radioactivity. Further down in this section we will develop some of these thoughts a bit more when we discuss the problem of many 'small doses' and, in particular, the problem of 'unavoidable sources' and the principles behind intervening to reduce doses of all kinds.

## 9.2. Justification

The ICRP proposes that the use of all (controllable) optional sources must be justified, the term 'optional' being used 'when the existence, or the nature, of the source is a matter of choice'. Justification would be the basic requisite for such sources, as it is in the present recommendations (although the proposal uses the term 'endeavour' not 'practice'). However, in this proposal, the ICRP has not seen its own role coming into play until after justification. The next recommendations would therefore 'apply only to justified optional sources and to unavoidable sources'. In the ICRP proposal the latter term applies to sources 'when neither the existence, nor the nature of the source is a matter of choice, but the pathways to man are controllable', thus justification is not relevant in their case.

We strongly support the principle that justification of optional sources should still be the first requirement in radiological protection but we think any international or national RP system should also explicitly include this principle. It is true that certain decisions on justification, especially when taken at a high political level, may not focus on RP aspects. It is essential, though, that such aspects be part of the information that serves as input to decision-making.

It is inherent in any justification of a particular thing that it should 'do more good than harm' in the words of the present ICRP recommendations. However, the focus ought to be more sharply on the whole picture—that is, what can be defined when all the pros and cons have been weighted together, and not on just one aspect such as radiation risks unless, of course, this kind of risk is predominant. Situations in which a qualitative approach in the justification procedure is seen as most appropriate do not preclude the fact that quantitative or semi-quantitative information is also being used. We would like to refer especially to the sometimes neglected task of comparing the risks (and benefits) of alternative solutions to a problem; comparisons of this type may be of special importance as regards justification. In

this context, risk comparisons would usually require quantified information, as discussed in Sections 6 and 7.

Further, it is a fact that there are many practical situations in which justification will focus directly on the radiation risks and on RP, and in which it may also be difficult to separate justification from some form of optimisation. This is another reason for firmly establishing justification in the ICRP's RP system. The previously mentioned CRPPH report (NEA 2000) differentiates between Justification (with a capital J) of, for example, nuclear power as a practice and justifications (with a small j) of protective alternatives or actions on a case-by-case basis. The latter type of justification is often essential to operational radiological protection. The report further states that such justification is becoming increasingly important in making choices that involve stakeholders. Another thing to bear in mind is the interaction between justification (with a small j) and optimisation principles in complex situations where Justification (with a capital J) may have rested more on general socio-political arguments than radiological protection.

Seen from all the angles mentioned, justification as a concept includes many and very different aspects, some of which are certainly not easy to deal with. We think the ICRP should thoroughly analyse these aspects, clearly define its own role, and give guidance when appropriate.

### **9.3. Protection steps one and two**

For each previously justified radiation source, *step one* in the new RP system proposed by the ICRP involves restricting the dose to individuals by means of 'Protective Action Levels', PALs for short. Our understanding is that there should be a guarantee of a minimal health protection standard for the individual, and that PALs should be taken as indications of whether or not it will be necessary to reduce the dose, one way or the other, to make this guarantee valid. We think this has the advantage of making individual protection more visible and perhaps more understandable. However, the concept of PALs needs to be further developed to allow for a complete analysis of its applicability. In the following, we will discuss some of the relevant aspects.

PALs are related to 'bands of concern about individual effective doses in a year', which are described as multiples or fractions of the natural background radiation, the latter typically in the range of 1–10 mSv per year. So far there are no numerical values suggested for PALs but indications of magnitude are given, at least for the various dose intervals (= bands), on a list of typical protective actions that involve public, medical and occupational exposures, see Table 2.3 in Section 2. At the moment we are not quite sure how the PALs concept might be used to allow the RP system to deal with effective doses from a particular source and at the same time take the sum of effective doses to an individual from many sources into consideration if, indeed, the latter aspect is meant by the ICRP to be included in PALs. We believe it is, otherwise the total dose to an individual might become very high before protective action is indicated. Anyway, this needs to be clarified.

The status of PALs will no doubt depend on how they are justified and presented and how they are seen as compared to more formal limit values. We believe there is a need for internationally authoritative recommendations on limit values for the individual, but we have not discussed this any further.

Whether it be limit values or (numerical) PALs that will be used in the future, the criteria for setting such values will have to be transparent and widely acceptable. Using normally

occurring natural background radiation as a reference in accordance with the ICRP proposal would no doubt be of value in risk communication, but it does not seem altogether adequate for individual protection criteria. Any numerical value derived from figures representing background radiation would still include an element of arbitrariness. In spite of the uncertainties in risk quantification, we think the ICRP should reconsider the possibility of also looking at occupational safety standards for risk factors other than ionising radiation as well as take a closer look at the attitudes of the public to various risks encountered in their everyday environments.

With a reference in its proposal to ‘the recognition that there is likely to be some risk to health, even at small doses’, the ICRP sees a ‘moral requirement, for each controllable source, to take all reasonable steps to restrict both the individual doses to levels below the action level and the number of exposed individuals’. This raises the problem of what may be called ‘small doses’. Because this warrants special analysis, we will attempt to discuss it from three angles: the exposed individual; exposed but clearly delimited groups; and ‘large populations’ in the present or as a result of integration of small doses over long periods of time.

The proposal indicates a dose to the individual below which any exposure from unavoidable as well as optional sources should be excluded from the ICRP system of protection. This exposure level, called ‘negligible’, is synonymous with the lowest-exposure band of concern. It is set at ‘ $< 0.01 \times \text{normal}$ ’, which represents a value of around 0.01 mSv per year if the lowest figure in the range of typical natural background is used.

Before proceeding to the actual issue of ‘small doses’, we would like to insert another comment: An exclusion of doses in this context is not likely to be understood as implying an exception to the initial requirement that each optional source be justified, which in any case would remain in place, irrespective of the size of individual exposure doses referable to the source. In its proposal, the ICRP does not discuss ‘small doses’ in connection with justification probably because they had suggested that decision-making in this area was to be outside the scope of their recommendations. When the issue is raised in the proposal, it is raised as part of the first step of dose control, which concerns the individual only.

Our views are as follows: First of all, it should be realised that there is no such thing as a general level of risk acceptance among the general public; instead, there are more or less acceptable ‘risk conditions’. However, we agree that there is a need to indicate a low dose level below which society may legitimately maintain that an individual is adequately protected, and that regions or states may well apply such an individual-related *de minimis* principle to their own citizens. Further, it is desirable that the ICRP indicate what this level might be. We note that the suggested level of around 0.01 mSv per year is also used i.a. in the IAEA Basic Safety Standards, BSS (IAEA 1996). On the other hand, we do not agree with the suggested construction of the protective system on this point, whereby a pre-set individual dose would govern whether or not the number of exposed people may be considered in the RP process. (This is because, in the proposal, such low individual doses (in ‘step one’) are intended to be ‘excluded from the ICRP system of protection’, which in turn would mean that protection ‘step two’ /see below/ is not applicable. However, we have no difficulty with the other BSS requisite for exclusion, that the low individual dose is to be combined with a collective dose not exceeding 1 manSv/y.). How an individual-related *de minimis* principle could be made to fit into the RP system ought thus to be reconsidered—but not the idea behind it. However, we are doubtful of generally excluding even very low doses in medical care, should this be the intention in the ICRP proposal (cf. Section 10).

At this point of our analysis, it is time to look more closely at protection *step number two* in the ICRP proposal. As we understand it, after considering the possible need for individual-oriented Protective Action at doses above the ‘negligible level’, the new ICRP model implies ‘a necessary but less prescriptive’ second step: an optimisation (with regard both to the individual and to exposed groups) to a level of exposure As Low As Reasonably Practicable (ALARP). An exposed group should be, by definition, ‘limited to individuals receiving specified ranges of dose over specified periods of time’. The ‘collective’ and the collective dose, in this context called the ‘group dose’ by the ICRP, would thus be more strictly demarcated (truncated) than the traditional collective population and collective dose.

The proposal also puts less emphasis on collective dose than may be inferred from the present recommendations. It states that the choice in optimisation for example between a number of feasible protection plans would be dependent on judgement rather than on collective dose, since both individuals and groups should be considered. Irrespective of the need, expressed by many, for further development of the present recommendations on optimisation, this new angle would require a special effort on the part of the ICRP.

As regards a fairly limited number of exposed persons such as a workforce or people living close to a radiation source, the situation in terms of optimisation might not be much different from that of today. However, we think the ICRP could give guidance on how to consider parameters such as possible uneven dose distribution—or other inequities within such a group—besides the group dose. As far as the larger (but still delimited) groups in the proposal are concerned, the situation is less clear so far, not least in complex situations of combined concern for individuals ‘with faces’ and exposed groups in which individuals are statistical persons and therefore ‘without faces’. To sum up: in operational radiological protection it is very important that the Commission devote sufficient resources to elaborate on the ‘ALARP optimisation’ and make its intentions highly visible, preferably also by using stylised examples or actual cases. Besides, it should also be clearly stated that dilution is not an acceptable way of reducing doses to individuals.

The other obvious need for clarification concerns the delimitation of exposed groups to be considered in optimising according to the proposal. Taken together, the criteria of specified ranges of dose and specified periods of time indicate as one requirement that there should be a realistic possibility of doing an exposure analysis. Large populations in general as well as populations that span several generations would then probably be excluded. However, the matter of ‘large populations’ could also be seen as an issue in itself, which in actual practice is closely connected with the problem of ‘small doses’. Without presupposing any results, we would have welcomed a proper analysis of this issue in the ICRP proposal. In the following subsection, we will therefore make a superficial attempt to look at it.

#### **9.4. Many small doses: Is a third step needed in the RP system?**

Let the “moral requirement”—as already quoted from the ICRP proposal—be the starting point, that is, for each controllable source, ensuring that all reasonable steps be taken to restrict both individual doses and the number of exposed individuals. One might envision a sliding scale of situations, from groups of exposed individuals with doses not far below PALs to large populations receiving extremely low individual doses, in which case any reference to individual doses and implied individual risks would be meaningless. How far along such a scale would the new concept of ‘group dose’ take us? It would probably vary with the situation, but in any case it will not take us into the range where the individual dose would be ‘negligible’ as has already been pointed out above.

But here we need to change perspective for a moment. In a situation where each individual is presumably adequately protected—or more than that—with regard to radiation exposure, what is the relevance of the total risk? If a carefully made risk assessment based on a population dose indicates a ‘visible’ magnitude of detriment, it would be surprising if people in general and governments in particular were not concerned.

Recognition of legitimate societal concern for the possibility of ‘unnecessary harm’ being done through what has here been called total risk would mean a) Low doses to large populations should not be *à priori* excluded, and b) Where there are calculable or potential exposures to large populations, especially across borders and including future generations, an additional ‘third step’ seems necessary to modify the proposed system.

A third step, when applicable, need not mean the use of a collective dose that is unlimited in time and space, or very formalised mathematical procedures for doing cost-benefit analyses in optimisation. The current ICRP recommendations have been criticised for this, although the criticism is not altogether fair because the recommendations contain nuances that have not always been properly observed. To the extent that there will be further development along the present lines, uncertainties in exposure/dose/risk calculations should be more explicitly discussed for different types of situations as opposed to the advantages of applying simplified models when considering ‘total risk’.

It may not even be necessary to always approach the issue of large populations/small doses in the traditional manner. For example, in a separate project proposal, we have discussed a possible role in this context of a general information database regarding radiation sources and how to find a way of improving already existing information by continuously registering released radioactivity and/or total doses from all sources in the RP system. There is, for example, certain aggregated information available from the UNSCEAR inventories. However, the registration procedure that we envisage should be a national activity.

In principle, the information obtained should be open to public scrutiny, which is thought to be a way of increasing confidence in the RP policy. Although professionals working for the authorities and certain groups in the business community would already have a fairly clear over-all view of radiation sources and exposures in a particular country, the register would be a means of specifying ‘hot spots’ and keeping track of trends. Could it also be used as a tool for specifying certain radiation sources or types of exposure in advance that would not require our ‘third step’ considerations and how could that be explained in order to reach a wide acceptance? What mechanisms for alert would be needed—especially at the international level—if there is a clear trend towards increased releases from a certain type of radiation source that may have been explicitly excluded from ‘the third step’ by one or more countries? We have no clear answers to these or other questions in connection with our register model as a possible means to simplify ‘the third step’ procedure. However, we do think that nations (and perhaps specific regions) should consider setting up an information database like the one we have discussed here, because this would be an end in itself. The ICRP might help advancing the idea.

We believe that the discussion of large populations/small doses must continue in terms of principles as well as practice. To the extent that conceptual differences actually exist between the proposed optimisation by the ICRP (step two in the protection process) and step three in this subsection, these differences ought to be made plain by the ICRP. Either way, the further development and illustration of how to combine quantitative or semi-quantitative information on doses or risks, in optimisation, with ‘judgements’ under various circumstances is a major challenge facing the ICRP.

### 9.5. Reducing exposures that are arising or already in existence

So far we have looked at the radiological protection process mainly in terms of optional sources of radiation. The actual scope of any RP system is summarised in the following quote from the ICRP proposal, also presented in Section 2.4:

‘The most effective action will be applied at the design stage of a new endeavour. However, experience may show that the design precautions were inadequate, or accidents may occur. Existing precautions may sometimes have to be improved. If the source is not optional, additional protective action may have to be applied in the environmental pathways, or to individuals, previously known as intervention.’

The unavoidable sources (as opposed to the optional ones) have been seen in many respects as a major problem, if not *the* major problem, in the implementation of the present ICRP policy. Besides addressing NORM/TENORM (as mentioned in subsection 9.1), in which we would like to include radon in dwellings, we have also noted observations from the Chernobyl accident as illustrated by one of the Swedish case studies (cf. Section 4). Contaminated sites constitute another issue, especially with respect to how far decontamination should be taken and whether the sites should be evacuated or not. As regards improving the safety of existing nuclear plants, the protective principles to be applied would probably in most cases refer to an ‘optional source’ according to the ICRP proposal, illustrated by a situation when certain equipment has to be replaced. In other situations, the source must be regarded as ‘unavoidable’, for example, when extra barriers are introduced to reduce the risk of radioactive substances being released into the environment.

As regards the new proposal, to our knowledge there is as yet no in-depth analysis available from the ICRP of the rather difficult policy issue that has been known as intervention. The proposal itself is – by nature – rather brief and contains few details with regard to how the issue might be addressed. However, it clearly states that ‘protective actions will be different for optional sources and unavoidable sources’ and gives some indications of ‘typical protective actions for unavoidable sources’ as regards the various exposure levels or bands ‘of concern’.

To what extent do conceptual or practical difficulties or both arise when unavoidable sources are compared with optional sources in RP? We do not think there should be conceptual differences but we certainly agree that in actual practice, protective actions and, in many cases, the attainable level of protection to be achieved must differ. We also believe that many exposures from unavoidable sources are national in character, which requires flexibility in the ICRP recommendations or guidelines. A typical expression of this is radon in dwellings in Sweden.

We are not quite sure about the intended use of PALs in connection with unavoidable sources according to the proposal. However, we do not think there ought to be more than one set of ‘minimal health protection standards’ if the credibility of an RP system is to be maintained, and that they must be set in the context of optional sources. Although such standards are expected to allow higher individual exposures than may be achieved after optimisation of an optional source, they might well be seen as unrealistic by decision-makers in certain situations where human beings are exposed to radiation from unavoidable sources, either over the short term or permanently. This could no doubt cause both anxiety and anger among the public but

in any case it would force the decision-makers to produce a plausible explanation of the grounds for their decision and the value judgements on which it was based.

Given our idea of common health protection standards, it should be noted that these standards would not be as formally applicable in the RP system to unavoidable sources as they would be to optional ones. In the spirit of the ICRP proposal, one should start by considering how to reduce the highest existing individual doses by reasonable means, taking social and economic factors into account. If such measures imply that the individual health protection standards will not be met, the next goal would be to get those standards to be met, unless this is judged to be totally unrealistic. Then the same moral requirement as for optional sources would follow to consider an optimisation with regard to both individual exposures and the number of exposed individuals, including the issue of large populations/small doses as outlined above. But again, the focus must be on what is reasonable under the circumstances. For example, drastic intervention in the wake of an accident may be counterproductive when risk information and advice to the population on simple measures for exposure reduction might have been more effective with regard to the general health and well-being of those affected.

For the same reasons, we do not think that the ICRP should give indications of ‘no protective action’ for unavoidable sources that are different from the indications for optional sources at the same dose levels.

To sum up: It should be possible to develop a consistent RP policy for optional and unavoidable sources within one and the same conceptual framework. The difficulties will lie in its practical implementation. The ICRP should be responsible for providing guidance as regards unavoidable sources but will have to analyse more specifically how its role should be played in that context. Besides the traditional approach, it might also be worth while to set up a database of case information containing various national authorities’ decisions on intervention and the value judgements behind them—providing that sufficient data could be made available.

#### **9.6. Public trust in the RP system and the role of risk communication**

The ICRP proposal contains no discussion under this particular headline, although cultivating public confidence in the RP system is bound to be an important underlying issue. It is essential that an RP system be widely accepted and reasonably well understood by all concerned, especially if a concrete and threatening situation should arise. To the extent that a population dose—together with the individual dose—is considered to matter in protective work, certain difficulties will no doubt remain. However, when reality is complex, the RP system must inevitably reflect some of that complexity. Further, we believe there is a connection between understanding and having confidence in an RP system, on the one hand, and understanding radiological risks on the other hand.

In an open process of risk management, communication is an issue at every step of the process, both with regard to risk as such and how the risk problem is being handled. Scientists and civil authorities as well as members of the business community will be involved. Although the RP system cannot be tailor-made in advance to cope with all possible issues involving communication with the public, from a top-down perspective there is a joint responsibility—from the ICRP to national authorities and further to those who actually deal with people’s questions—for considering such difficulties well in advance. This should

include providing distinctly structured presentations of the system and a minimum of (clearly defined) concepts that apply to the system's operation.

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