Report on the implementation of ICRP Recommendations by NEA member states

A document to support discussions at the 3rd NEA/ICRP forum, Prague, October 2006

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Summary

With the exception of the United States, NEA member states have all implemented the Recommendations in the ICRP 1990 Recommendations in *Publication 60*.

Basically, the member states have not encountered major difficulties with those Recommendations. Some problems have been identified, though, and these are discussed below.

The US position does not seem to reflect primarily any major difficulty with the specific contents of those Recommendations. Most US regulations are based on *Publication 26* from 1977, and apparently the potential benefit of full alignment with the Recommendations of *Publication 60* was perceived as not sufficient to outweigh the extra time and cost of revising federal regulations.

The main implementation problem encountered with the 1990 Recommendations concerns ***constraints***. In the first place, this word is not easily translated into other languages, and conveys an unintended feeling of absolute restriction. In the second place, the possible concurrent use of constraints for open-ended planning purposes and as a retrospective regulatory tool that was implied to some extent in *Publication 60* and in the 2004 version of the draft next Recommendations is rejected as not feasible and in conflict with the development of the concept that has taken place outside ICRP after 1990.

Another problem area concerns ***dose averaging over 5-year periods***. This was foreseen primarily for occupational exposures where ICRP had been under the impression that a direct change from an annual dose limit of 50 mSv to an annual limit of 20 mSv could cause an undue burden for operators. The option of averaging doses, such that 50 mSv would still be tolerable in a single year as long as the average over 5 years was 20 mSv or less, was intended to permit some flexibility. However, in reality very few operators appear actually to have needed this flexibility, and some regulators have baulked at the perceived administrative complication of keeping track of doses under a system of dose averaging.

Dose averaging is the lesser of these two problems, since it has been easy to adopt the system recommended in *Publication 60* without actually implementing dose averaging. Therefore, the fact that the proposed next Recommendations of ICRP continue to recommend dose averaging has met with little discussion; probably most regulators are prepared to continue to accept this as a very theoretical option and those who have already abstained from dose averaging in the ICRP sense will continue to abstain, yet will feel that they are adopting the system as proposed in the next Recommendations.

In contrast, the difficulties surrounding the concept of constraints has been the subject of continued debate, and the efforts of ICRP in its draft next Recommendations to pinpoint the role of constraints is the subject of many consultation comments received by ICRP during its 2006 consultation process.

The scope of the ICRP Recommendations as outlined in the 1990 Recommendations does not seem to have been a problem per se. In *Publication 60*, ICRP pointed out that detailed advice on exemption was provided by, e.g., NEA and IAEA. This state of affairs seems to have met with general approval. While there have been some heated debates about exemption levels in those organisations, there is no indication that the position of ICRP has been regarded as problematic. However, in the draft next Recommendations, some generic exclusion and exemption levels of activity / activity concentration are proposed. This has met with limited enthusiasm, and ICRP is likely to focus even more on conceptual issues in the final version of the next Recommendations.

Introduction

Topic of the report. The Nuclear Energy Agency has requested this report, summarising member states' experience with the implementation process of the general recommendations of ICRP. The purpose of the report is to support discussions at the 3rd NEA/ICRP Forum in Prague in October 2006.

The focus of the report is on experience of the implementation of concepts and recommendations that were new in the ICRP 1990 Recommendations in ICRP Publication 60, as compared to the previous (1977) Recommendations in ICRP Publication 26. To the extent feasible within the time-frame and resources available for the production of the report, it intends to show whether national regulations are consistent with ICRP Publication 60 or not, and whether there have been any areas that proved more problematical.

In the perspective of these observations, comments received by ICRP during public consultation on its updated, 2006, draft Recommendations ('RP06') are analysed with a view to whether the draft next Recommendations appear to have addressed problems that existed with the current Recommendations, and whether the solutions proposed seem to be adequate.

Method of data collection. Concerning past experience of implementation of the ICRP 1990 Recommendations the author relied primarily on his experience as Scientific Secretary of ICRP for 10 years, interacting with CRPPH, IAEA, the European Commission, and national regulators in many countries, and before that as a senior national regulator, national technical representative to the European Council's Atomic Questions Group at the time of the adoption of the current European Basic Safety Standards Directive, and a member of the IAEA Commission on Safety Standards. Furthermore, several national regulators were interviewed over the telephone.

A recent survey of the experience of implementation of the International Basic Safety Standards, conducted by IAEA, provided very useful additional material since those standards are based directly on the ICRP 1990 Recommendations.

Finally, the comments received in response to the public consultation, in the summer of 2006, by ICRP on its most recent draft of its next Recommendations were analysed. These responses show, of course, how the efforts of ICRP to update its Recommendations and rectify any previous problems are perceived, but also reflect indirectly what users of the ICRP 1990 Recommendations regarded as important, positive or negative.

Structure of this report. The next section of this report explains how nowadays, the fundamental Recommendations of ICRP are usually adopted by international and regional organisations before they are adopted into national legislation. This has some bearing on the present report. Then, a survey conducted by IAEA on problems with implementation of the International Basic Safety Standards is presented, highlighting comments that really refer to the ICRP 1990 Recommendations. Thereafter, comments received by ICRP during their 2006 consultation on the draft next Recommendations are presented. Based on these results, a discussion follows where past problems (or otherwise) and proposed new solutions are mentioned, focusing mainly on selected topics: dose constraints; scope/exclusion/exemption; LNT; collective dose; hereditary risk; practices/intervention; and dose limits (the order of topics reflects the number of consultation comments received on these topics in the draft next Recommendations). Finally, a conclusion is provided.

The role of ICRP Recommendations in relation to international and regional standards

As such, the Recommendations of ICRP are precisely that: non-binding Recommendations produced by an advisory non-governmental organisation. The enormous importance and leverage of the Recommendations of ICRP derive from the fact that they are adopted almost universally into national legislation. They are not adopted verbatim, because the ICRP Recommendations are written in discursive fashion, but in essence all actual Recommendations are transformed into legal text.

In the early days of ICRP, this transformation was made almost entirely as individual efforts in each nation. However, after the Second World War, the role of international and regional organisations has increased enormously. These organisations, including OECD/NEA, often adopt ICRP Recommendations into their own standards and norms, either 'wholesale' or in terms of some specific topic. They often adapt ICRP texts into a format more suitable for direct regulatory implementation. Often, the international/regional organisations endorse ICRP Recommendations by recommending that their member states adopt such standards and norms; sometimes, such standards and norms are binding by default for the member states concerned. These mechanisms have increased the knowledge about and penetration of ICRP Recommendations world-wide and contribute materially to the uniformity of radiological protection regulations all over the world.

Two such cases are of particular relevance to the present report, viz. the International Basic Safety Standards (BSS) of the United Nations organisations, and the Basic Safety Standards Directive of the European Union. Both of these are comprehensive in the sense that they cover most or all of the aspects of the ICRP 1990 Recommendations provided in ICRP *Publication 60*. Both of them are indited in such a style that they could be used directly as national regulations

International BSS. For practical purposes in the context of the present report, these can be regarded as offered to all countries in the world. Member states of the UN agencies are encouraged to make adopt them nationally as binding regulations, and many developing countries in particular have elected to include the BSS verbatim into their national legislation. This contributes of course to uniformity of regulations and helps to ensure an up-to-date national legislation.

The International Atomic Energy Agency (IAEA), which is often regarded as 'hosting' the International BSS on behalf of the UN agencies involved, recently conducted a survey to investigate whether implementation of the International BSS had caused any particular problems and concerns. Since the International BSS is based explicitly on the Recommendations of ICRP, much of the response to their survey could equally well be regarded as comments on the utility (or otherwise) of the 1990 ICRP Recommendations. IAEA has kindly provided us with full access to the results of their survey, which has proved very useful and allowed us to avoid duplication of efforts. .

European BSS These are binding for the Member States of the European Union, in the sense that all Member States are obliged to have legislation which is at least as strict as that of the Directive. There is a fairly rigorous process in place to ensure that national legislation really does comply with this requirement.

For the purpose of the present report, it is of particular importance that both drafting and implementation of the European BSS and other European standards and norms within

radiological protection are discussed in the so-called Article 31 Group of Experts (which is dominated by senior regulators). Therefore, any implementation problems are discovered at an early stage and usually handled in a similar manner by all European Union Member States.

Flexibility vs. uniformity. In a strictly legal sense, any country is always free to decide whether to adopt all or part of any ICRP Recommendations into its regulatory system. In this sense, countries enjoy total flexibility. However, when the standards and norms, based on ICRP material, of international and regional bodies are taken into account, the picture is different.

From the above, it is evident that the Member States of the European Union must use regulations which comply with the European BSS and therefore indirectly with the ICRP 1990 Recommendations, although the detailed regulations are up to the individual Member States. Thus, the degree of flexibility is limited, and there is a high degree of uniformity although by no means an absolute harmonisation. Other countries enjoy greater flexibility in theory, but if they have adopted the International BSS (and/or other relevant international documents, such as the ILO No. 114 Convention), they have relinquished that flexibility in favour of uniformity. Due to the 'Model Project' of IAEA, this applies to most developing countries, although some developing countries still lack an appropriate regulatory system (or the resources to verify compliance). Many of the industrialised countries, having had a regulatory system for radiation in place for a long time, have abstained from adopting formally the International BSS, but nevertheless have adopted the ICRP 1990 Recommendations in their own national regulatory systems.

The main exception: USA. The United States have not adopted the ICRP 1990 Recommendations and have not adopted formally the International BSS (although the federal regulatory authorities state that they use the International BSS and adhere to it when possible). Instead, regulations are based mostly on the ICRP 1977 Recommendations in *Publication 26.* Some norms are based on the ICRP 1959 Recommendations in *Publication 2.*

The US position does not seem to reflect primarily any major difficulty with the specific contents of those Recommendations. *Publication 60* emerged at a time when significant time and effort had just been spent on updating federal radiological protection regulations (10CFR20), and apparently the potential benefit of including the Recommendations of *Publication 60* was perceived as not sufficient to outweigh the extra time and cost of revising 10CFR20.

The major genuine difference between USA and other countries is that the limits on effective dose remain at the 1977 values of 50 (occupational) and 5 (public) rather than 20 and 1 mSv. Other aspects of newer ICRP Recommendations and guidance, such as the concepts of practices and interventions and the wider interpretation of optimisation of protection, are used at least de facto; dose constraints are not used formally by the regulators but operators use them for purposes of optimisation. According to staff at the US Nuclear Regulatory Commission, implementing *Publication 60* probably would not cause serious problems for the US nuclear industry.

The IAEA Survey concerning the International Basic Safety Standards

The Survey generated responses from 17 countries, including 9 of the 28 NEA countries and 4 from countries that are not NEA members but do participate in ISOE. In summary, the responses on some topics of particular interest here were as follows:

Topic	NEA member states	Other ISOE members	Other countries
Scope	'BSS needs numbers for natural and bulk materials'	'BSS needs numbers for natural and bulk materials'	
Practice/intervent.	'insufficient advice on interventions'		
Justification	'administrative difficulties with consumer products' 'need practical advice'		
Optimisation	'involve stakeholders'		'not well understood'
Dose constraints	'will develop nation-al guidance after next ICRP recs' 'used only by operators'		
Limits	'limit for fetus can cause discrimination; need advice on how to verify fetus dose' '20 mSv/a preferable to 100 mSv/5 a' 'difficult to verify public dose limit'		'limit for fetus not well understood'

A general conclusion from the survey responses is that the International BSS is regarded as useful and satisfactory. None of the respondents mentioned any problems with LNT, hereditary risks, or dosimetric concepts as used in support of the International BSS. The area that attracted the most requests for updating concerned the scope of radiological protection, where additional advice concerning exemption and clearance of bulk and natural materials is desired.

Consultation comments received by ICRP

ICRP invited comments on the 2006 draft version of its next Recommendations between 6 June and 15 September. On 22 September, 213 different entries had been logged, comprising 707 pages of text. It is not useful to separate these on NEA and non-NEA countries, since comments have come from many different sources (government ministries, national regulators, professional bodies, NGOs, individual experts, and individual concerned members of the public) and some persons have provided more than one entry. However, as a general, qualitative observation, the majority by far of the comments come from NEA countries.

The bar chart on the next page provides an indication of how frequently a number of different topics attracted comments in the consultation replies. A few comments simply endorse the treatment of a topic in the draft text, but by and large people make comments when they want to see something changed, so if there are many comments on a topic, then many respondents would prefer an alternative wording in the next ICRP Recommendations.

When discussing these results, several caveats must be mentioned. In the first place, the bar chart is not an exhaustive compilation of all topics where comments were received. It represents an arbitrary choice of topics that were assumed to be of particular interest from an NEA perspective. There were also comments on several other topics, not mentioned in the bar chart. (The most frequent of those concerned radiological protection in medicine, where respondents lamented the fact that the building block [ICRP report or annex] on this topic was not yet available, and tended to regard the treatment of the topic in the draft as too cursory).

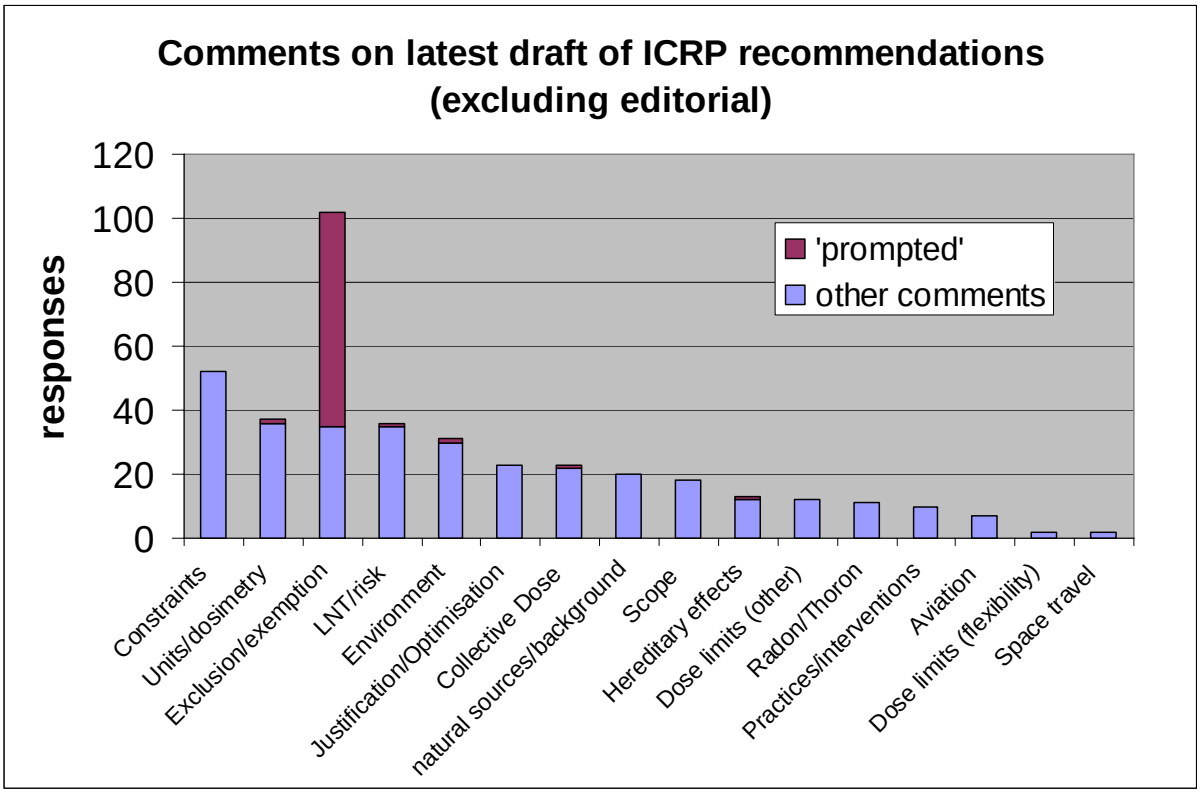
As already indicated, comments come from many sources and some persons have commented more than once. Furthermore, in some cases several persons have sent in a comment copied from somebody else. This is particularly evident for exclusion and exemption, where at least one of the comments provided also includes a copy of the exhortation from an NGO to its supporters to replicate and send in that comment. Such repeated comments are interesting in that they show that many persons share an opinion, but comments that were undoubtedly ‘prompted’ have been colour-coded in the diagram to permit them to be evaluated separately, if desired, from comments which appear to have been drafted by the individual contributor.

Another important caveat is that the number of comments received on a particular topic does not automatically indicate the importance of that topic or the quality of the comment. For instance, there were very few comments on aviation but those comments (‘discuss aviation more prominently’) appear well founded and will probably generate an amendment to the draft. Conversely, many of the comments on exemption, to the effect that there should be no exemptions at all, reflect misunderstandings and may necessitate editorial changes but hardly any change of the factual content.

Also, the distinction between ‘editorial’ comments and ‘topical’ ones is blurred. In any case, some editorial comments are very important.

Thus, the bar chart presentation of the ‘popularity’ of different topics is included to provide a reference frame for comparison with how *Publication 60* was perceived by the users.

In terms of raw numbers, the topic addressed most frequently concerned exclusion and/or exemption. However, more than half of these comments were almost identical, very brief, and clearly prompted. If one counts the number of apparently different comments, this topic comes third after the topics of constraints and units/dosimetry.



The comments on those two topics are very different. Consultation on the 2004 draft version of the next Recommendations had indicated that better explanations were required for constraints. The present comments as represented in the bar chart above can be summarised as ‘better, but still not clear enough’. In contrast, many responders indicate that they are basically happy with units and dosimetry parts of the draft, but wish to submit comments that are either of a semi-editorial nature, identifying errors in equations etc., or explicit suggestions concerning some particular aspect (for instance, the choice of 2 for DDREF).

The scope of radiological protection is usually understood in terms of exclusion and exemption. However, there were also some comments on other aspects of scope; these are displayed separately above.

ICRP *Publication 60* recommended that dose limits be lowered, and at the same time introduced a system of 5-year averaging of effective doses to provide increased flexibility. Comments on the latter aspect of dose limits are displayed separately above.

The next section of this report provides further discussion of the nature of the various comments.

Discussion: Dose and risk constraints

The 1990 ICRP Recommendations. The concept of constraints on optimisation was introduced in *Publication 60*. Constraints were defined as source-related, reflecting that radiation is usually best controlled at source (and for public exposure, this is usually the only option).

However, they referred to individual dose (or risk). The effect of applying a dose constraint was that in some optimisation cases, the protection option causing the minimum collective effective dose might not be acceptable even under the boundary condition that all individual doses must be lower than the pertinent dose limit. Instead, a somewhat higher collective dose would be tolerated in order to keep individual doses not just below the dose limit, but below the dose constraint. This appears to reflect a shift in values away from the very utilitarian approach of *Publication 26* towards more attention to the individual.

Constraints were described as prospective tools that were not intended as regulatory limits. However, in the chapter on implementation of ICRP Recommendations, *Publication 60* also envisaged the possibility of sometimes using constraints for retrospective compliance testing. Possibly, this was a reflection of the fact that during the internal discussions that led to the 1990 Recommendations, ICRP had contemplated abolishing the public dose limit entirely (since in reality it is not a limit but a reference level for regulators only).

Implementation problems. There were thus three different, and possibly not quite compatible, aspects of constraints. There was little practical advice on how to select and use dose constraints, and even less on risk constraints. The radiological protection community accepted constraints as a new tool, but significant development took place outside ICRP (primarily at NEA and IAEA). As a result, the possibility of any retrospective use of constraints was rejected entirely.

The IAEA survey on implementation of the International BSS indicated that responders expect ICRP to provide more guidance on constraints, which could then be used to develop national guidance on this topic.

The draft next Recommendations. In the development of the draft, the possibility of abolishing the public dose limit had again been considered. Discussions with the prospective users of ICRP Recommendations showed that this would not be welcome, and the public dose limit remained unchanged. However, dose constraints were described as ‘the most fundamental level of protection … for the most highly exposed individuals from a single source’.

This has generated numerous critical comments. The wording is perceived as again ‘drifting’ towards a possible use of dose constraints for retrospective compliance testing. While it may be true, responders say, that the dose constraint is the first tool used to restrict doses to the most highly exposed individuals, it is not a ‘fundamental’ level of protection.

Discussion: Scope; exclusion/exemption

The 1990 ICRP Recommendations. These established in a brief section that exposures that are unamenable to control should be excluded. They mentioned very briefly that for practical reasons, any regulatory system should permit exemption of trivial sources and noted that detailed advice was available from other sources such as NEA and IAEA.

Implementation problems. The 1990 Recommendations as such do not seem to have caused any problems, and it appears that users of the Recommendations agreed that applied regulatory advice such as exemption levels should be provided by international and regional organisations rather than by ICRP. IAEA and other organisations concerned have certainly experienced long and sometimes heated debates about the appropriate levels for various types of material, but these debates can not reasonably be regarded as critical of the 1990 ICRP Recommendations.

The IAEA Survey on implementation of the International BSS showed that there is much demand for additional guidance in the BSS, particularly for bulk rather than moderate quantities and for naturally radioactive materials.

The draft next Recommendations. There are two types of consultation comment on this topic. One kind of comment, mainly from protection experts, criticises the fact that the draft includes some 'generic' exclusion and exemption levels. Given that detailed advice is provided by other organisations, and that ICRP endorses the advice of those organisations, the levels given in the draft are regarded as potentially confusing.

A different type of comment, forwarded by some NGOs and several of their members, suspects that exemption will be misused by the nuclear industry to get rid of nuclear waste.

Discussion: Dose response patterns - LNT

The 1990 ICRP Recommendations. The harmful effects considered were cancer and hereditary effects, and these and the actual dose-response model remained the same as in the 1977 Recommendations. However, the probability of detriment per unit dose was much higher in the 1990 Recommendations.

Implementation problems. In general, the increased nominal probability of detriment was perceived as adequate, and no obvious implementation problems surfaced. The IAEA Survey on implementation of the International BSS did not cover this topic.

The draft next Recommendations. These include minor modifications to the nominal detriment per unit dose for cancer and hereditary effects. The existence and, in principle, importance of 'new' mechanisms, such as genomic instability and bystander effects, as well as non-cancer disease, are all acknowledged. However, the Recommendations state that current knowledge is insufficient for quantitative risk assessments.

Most respondents appear to agree in general with this, but there is an enormous range from those who consider that there is a threshold below which there are no adverse effects to those who believe that low-dose radiation is much more dangerous per unit dose. A number of comments would have preferred to see a some kind of quantitative risk estimate for non-cancer disease.

Discussion: Collective dose

The 1990 ICRP Recommendations. Collective dose was treated in much the same way as in the 1977 Recommendations.

Implementation problems. No particular implementation problems have been observed. The IAEA Survey on implementation of the International BSS did not cover this topic.

The draft next Recommendations. The 2004 version of the draft had included many caveats and essentially advised against any use of collective dose. In response to massive criticism of this, the 2006 version is less extreme and admits that collective dose is useful, but emphasises that it should also be disaggregated into components, and includes many warnings against possible misuse of the collective dose.

There were a number of consultation comments to the effect that the 2006 draft is still too negative and that collective dose is an important tool in practical optimisation. There were doubts about the practicability of disaggregation of public collective doses. Some comments criticised the fact that the draft discusses the possibility of giving different weights to high and low doses or to present-time and far future doses.

Discussion: Hereditary risk

The 1990 ICRP Recommendations. While the 1977 Recommendations had only considered genetic effects over the first two generations, the 1990 Recommendations included an infinite integral of all generations. In addition, it paid attention to multifactorial diseases, which had not been considered earlier.

Implementation problems. While the theoretical background of the 1990 estimate was very different from that of the 1977 estimate, the numerical value was only about twice the size of the previous estimate, which meant that it still remained a smaller component of the risk of detrimental effects than cancer. Therefore, it may not be so surprising that no particular implementation problems were observed. The IAEA Survey on implementation of the International BSS did not cover this topic.

The draft next Recommendations. Here, ICRP proposes to revert to projecting genetic risk over two generations only, because of the many unrealistic assumptions surrounding an infinite integral over all generations. Multifactorials are still included, but their contribution is assessed to be smaller than assumed in 1990. Therefore, the genetic risk estimate is now much smaller than in 1990.

The number of comments on this topic is relatively small, but those who do comment are highly critical. While admitting that an infinite estimate would be unscientific, responders feel that the choice of only two generations is also difficult to defend scientifically.

Discussion: Practices and interventions

The 1990 ICRP Recommendations. These concepts were introduced in the 1990 Recommendations.

Implementation problems. The concepts were welcomed initially, but some problems have been identified. Interventions in and immediately after emergencies differ in a number of ways from interventions against moderate levels of pre-existing radiation. What begins as an intervention may turn into a practice, and it is not always obvious when this happens. The IAEA Survey on implementation of the International BSS concluded that more guidance is needed on interventions.

The draft next Recommendations. The concepts have now been amended to comprise planned, existing, and emergency situations. Consultation comments are guardedly positive but note that there are still obscurities, e.g. concerning optimisation below intervention levels.

Discussion: Dose limits

The 1990 ICRP Recommendations. These (a) reduced the dose limits and (b) introduced the possibility of averaging doses over 5-year periods to retain some flexibility.

Implementation problems. Before the 1990 Recommendations were adopted, concerns were voiced in particular from the mining industry that the lower dose limits could become problematic. However, upon implementation no such problems seem to have emerged.

From the United States, who have not adopted the 1990 Recommendations, it has sometimes been claimed that some medical staff and some of the staff involved in non-destructive testing would not be able to comply with the lower dose limits. This however now appears somewhat unconvincing, given that it has proven possible in all other countries to operate to the 1990 limits. From Germany, couriers are cited as a problem, since some of them spend considerably more time in aircraft than pilots or cabin personnel, and sometimes in private aircraft operating above commercial aviation altitudes.

At the time of the adoption of the 1990 Recommendations, the nuclear industry appears to have regarded the option of flexibility as very important, but subsequent experience is that this option has been used only very rarely. In some countries, legal tradition precludes averaging in the manner envisaged in the 1990 Recommendations, but much the same flexibility is achieved by regulators accepting advance applications for permission to exceed the limit on annual average dose on condition of a much lower dose the following year.

The draft next Recommendations. These propose that the same dose limits and flexibility as in the 1990 Recommendations be retained unchanged. Consultation comments essentially endorse the decision to retain the current dose limits. A number of comments state that the option of averaging doses over 5-year periods is no longer necessary and only creates administrative hassle. A single comment from one nuclear installation argues that on the contrary that flexibility is important (although to the best of the author's knowledge, that installation has never actually utilised the option of dose averaging).

Discussion: Other topics

Units, dosimetry. These do not seem to have caused major problems and the many comments received in the current consultation are of a technical / editorial nature only.

Protection of the environment. In the 1990 Recommendations, this was regarded as a sufficient side effect of protection of man. The draft next Recommendations claim that non-human species need protection in their own right but indicate that a system to demonstrate that this is achieved still needs to be developed. Most of the consultation comments on this topic suggest that it is therefore too early to include anything about protection of the environment into the present draft Recommendations.

Justification; optimisation. Already the 1990 Recommendations stressed that justification is a political exercise where radiological considerations are an important, but

rarely overriding, input. The 2004 version of the next Recommendations emphasised the same point to an extent that could be misconstrued as disparaging justification; most of the comments on justification in the current consultation express satisfaction with the improved treatment of justification in the 2006 version. Optimisation is not fundamentally different in the draft next Recommendations than in 1990; consultation comments focus primarily on the use of dose constraints and of collective dose in optimisation (as described above). A few comments suggest that additional advice is needed on the involvement of stakeholders in optimisation.

Natural background radiation. The draft next Recommendations state more clearly than the 1990 Recommendations that in principle, the same protection standards apply to any radiation situation regardless of the source. This seems to be accepted; most of the comments on this topic are of a technical / editorial nature.

Radon / thoron. This topic was not covered in any detail in the 1990 Recommendations, but *Publication 65* in 1993 provided a comprehensive philosophy which is still retained in the draft next Recommendations. Most consultation comments concern either risk estimation for residential radon (estimates are more reliable and higher than earlier), or the confounding caused by thoron (because of which radon risk may be somewhat underestimated), or the exclusion level proposed (the need for this is called in question).

Aviation; space flight. The 1990 Recommendations indicated that doses incurred in aviation should be treated as occupational exposure. A number of comments on the draft next Recommendations point out that this topic seems to have been omitted and should be reinstated to avoid any confusion. A few comments note that ICRP is also working on radiological protection in space flight, and suggest that the next Recommendations should include some reference to this topic too.

Conclusions

A first observation is that users were relatively happy with the 1990 ICRP Recommendations. The most obvious change compared to the 1977 Recommendations, the reduction of the dose limits, had generated some concern at first but in practical application, the new limits do not seem to have caused any genuine serious problems.

Dose and risk constraints were not well developed in the 1990 Recommendations. They constitute the main problem area with the draft next Recommendations. The word 'constraint' is not easily translated into other languages, and conveys an unintended feeling of absolute restriction. Constraints are useful for open-ended planning purposes but should not be used simultaneously as a retrospective measure of compliance.

The treatment of the scope of radiological protection, and the concepts of exclusion and exemption, in the 1990 ICRP Recommendations did not cause any problems or concerns. There seems to be broad agreement that much detailed advice is required but should be provided by other organisations, as also indicated by ICRP. Consultation comments advise against providing exclusion or exemption levels in the next Recommendations. Some editorial amendments may be necessary to clarify that exemption will not provide a short-cut for non-optimised waste disposal.

The use of the linear, no-threshold dose-response model seems to be acceptable at least for practical purposes for all but a small number of respondents.

Additional advice may be needed on the disaggregation of collective dose (although recent reports in the open literature illustrate the feasibility of such disaggregation). If different components of collective doses are to be given different weights, the ethical and practical aspects may need to be explored.

The estimate of genetic risk was increased in 1990, partly due to inclusion of all future generations rather than just 2 as in the 1977 Recommendations. However, the draft next Recommendations revert to 2 generations only. Because of the many assumptions needed, there are good scientific reasons not to include all future generations. However, since the inclusion of all generations had not caused any obvious implementation problems, reverting to 2 generations may be unnecessarily drastic. Extension to some 5 or 10 generations would have demonstrated how the risk rapidly falls asymptotically and could have helped to avoid the impression that ICRP tries to downplay genetic risk.

The substitution of planned/emergency/existing situations for practices and interventions may turn out to solve some of the difficulties experienced with the latter terms, but additional guidance is probably required.

The continued use of the same dose limits as in the 1990 Recommendations is endorsed in the consultation on the next Recommendations. The option of flexibility by dose averaging seems to have found little use; on the other hand keeping it as an option should not create any particular problem since it is perfectly possible for an enterprise (or a regulator / country) to abstain from averaging.