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Note technique

Principles for occupational exposure control*

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ABSTRACT **A major component of the 1990 recommendations of ICRP (ICRP, 1991a) was the revision of the dose limits. But other changes were introduced which necessitated a review of earlier guidance. In particular, ICRP set up a Task Group in 1993 to prepare a report on the principles for the protection of workers. The report was adopted in 1997 and has now been published as ICRP Publication 75 (ICRP, 1997). It is for others to judge the real significance of the guidance provided; what follows are some of the main points.**

One task was to clarify what was meant by the term "occupational exposure" in the context of radiation protection. The conventional definition covers all exposures incurred at work, regardless of source. But this is too broad to be suitable for the purpose of indicating those exposures that should be subject to control under the system of radiological protection for practices, primarily because of the ubiquity of radiation of natural origin. ICRP Publication 60 (ICRP, 1991a) therefore limited the application of this term to those exposures incurred at work as the result of situations that can reasonably be regarded as being the responsibility of the operating management. This necessitated the development of an understanding of what exposures should be excluded and what practices or sources in the workplace should be exempted from control.

Cosmic radiation exposure at ground level is a clear example of what should be excluded. But what exposures from natural sources of radiation should be included within any control system needed further consideration and the report provides a separate section on this (see below). Exposures from sources of artificial radiation in the workplace (unless regarded as medical) should normally be considered as occupational. But there should be provision for exemption of sources from control on the grounds either that they give rise to small individual and collective doses in both normal and accident conditions or that no reasonable control procedures can achieve significant reductions in individual and collective doses.

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An important point to note is that this definition does not relate to where a person is working, whether in a designated area or outside, and not to whether individual doses are assessed.

1. Dose limits

ICRP recommends a limit on effective dose of 20 mSv per year averaged over five years, with the further provision that the effective dose should not exceed 50 mSv in any single year. However, the five year averaging periods adopted may differ from one country to another with some loss of harmonisation. Indeed, as acknowledged in the report, some countries may prefer to continue to operate with an annual limit, which would be 20 mSv.

ICRP Publication 60 does not specify special dose limits for women in general. It does, however, specify a dose objective to be applied to the fetus during the period following declaration of pregnancy. ICRP considers that its advice in Publication 60 has sometimes been interpreted too rigidly and now recommends that the working conditions of a pregnant worker, after declaration of pregnancy, should be such as to make it unlikely that the additional equivalent dose to the conceptus will exceed about 1 mSv during the remainder of the pregnancy. This objective places responsibilities on both the worker and her management; in the case of the former, to declare her pregnancy, and, in the case of the latter, to apply, if necessary, additional controls over pregnant workers to protect the fetus.

2. Dose constraints

Several points on this concept are made in the report. Perhaps the most important is that they should be used in a prospective manner; they are not to be confused with dose limits or investigation levels which are used in a retrospective manner. Some of the other points are noted here.

Dose constraints are to be used in the optimisation process. Both at the design stage of a project and in planning operations, the optimisation principle calls for a prior assessment of individual doses. It is these predicted doses that should be compared with the chosen constraint, the purpose being to limit the range of options being considered. Options predicted to give doses below the constraint should be considered further; those predicted to give doses above would normally be rejected.

As they are part of the optimisation process, they are source-related. The source to which the constraint relates should therefore be specified. It may be a complete job, such as a specified maintenance task, in which case it will be expressed as a single dose. But there may be situations where it would be

appropriate to express it over a given time. The law of diminishing returns applies to the optimisation principle and so it is with dose constraints. They therefore need not be established where the work already results in insignificant doses to the workers involved.

The process of establishing constraints should include, whenever practicable, an assessment of the levels of individual dose presently achieved from particular tasks or operations, identification of any subgroups of workers receiving higher doses and clarification of the driving forces behind those doses. The purpose of the analysis should be to determine the distribution of individual doses that is "reasonably achievable" in the particular circumstances, with a view to setting the constraint in the region of the upper end of the distribution. This process may not be straightforward and care should be taken to avoid inadequately based decisions regarding the selection of the constraint.

3. Operational management

One underlying theme of the report is the role that management should play in the optimisation of protection. This includes the setting at a local level of dose constraints for clearly identified tasks. The report therefore emphasises that the control of radiation exposure should be firmly on the agenda of management and that there should be a firm commitment to protection and safety throughout the organisation.

Proper management can be summarised in a few key words. The first is *policy*, which is used to express the general objectives of an organisation and, in particular, its commitment to protection and safety. These objectives should be written down. The second is *organisation*, which is the establishment of responsibilities and structures. This secures involvement and is sustained by effective communication, the provision of resources and the promotion of competence, for example, through training. The third element is *planning*, which describes the process of implementing the policy. It is concerned with allocating resources to achieve the objectives and decide priorities. The approach to planning operational protection should have the following components:

- a prior radiological evaluation of the operations to identify the routine and reasonably foreseeable potential sources of exposure, to make realistic estimates of the doses and to determine the radiological protection measures needed to satisfy the optimisation principle,

- the establishment of an operational radiological protection programme, commensurate with the degree of hazard, to ensure effective management of the measures needed to satisfy the optimisation principle.

The fourth element is *measuring*, which means the collection of information about the effectiveness of the plans and includes comparison with pre-

determined standards. Particularly important is information on the doses received by workers, over time and from specific tasks. The final elements are *auditing* and *review*. Auditing is the structured process of collecting independent information on the efficiency, effectiveness and reliability of the management system and drawing up plans for corrective action. Reviewing involves making judgements about performance and provides the main feedback loop. Investigation levels would often be involved in the review process. The objective should be to learn from the experience gained. The focus should be on whether the level of protection was optimal, particularly with respect to those receiving the higher doses.

4. Designation of areas

The control of occupational exposure can be simplified and made more effective by the designation of workplaces into two types: controlled and supervised. A controlled area is one in which normal working conditions, including the possible occurrence of minor mishaps, require the workers to follow well-established procedures and practices aimed specifically at controlling exposures. A supervised area is one in which the working conditions are kept under review but special procedures are not normally needed. ICRP Publication 60 notes that the definitions are best based on operational experience and judgement, account being taken both of the expected levels of exposure and of the likely variations. Outside designated areas, the level of protection of workers would be expected to be comparable with that required in public exposure, although the exposures would still be regarded as occupational.

The report indicates that a controlled area should be designated when specific operational procedures are required, because the engineered controls are insufficient, or cannot be relied upon with sufficient confidence, to provide the appropriate level of protection. The procedures can be purely administrative in nature or can relate to specific working practices including the use of protective clothing and equipment. They should be identified in the prior radiological evaluation.

A supervised area should be established only when management considers it necessary to keep the working conditions under review but does not consider it necessary to define operational protection procedures. The review should determine whether the status of the area remains appropriate. It should not, however, be necessary to set up a supervised area around every controlled area.

There are practical advantages in defining the outer boundary of designated areas by reference to predetermined levels of dose rate or contamination. Realistic assumptions should, however, be used, particularly with respect to occupancy, the objective being to avoid the unnecessary designation of areas, the designation of unduly large areas and the need to measure impractically low

levels of dose rate or contamination. Nevertheless, for administrative reasons, managements may wish to specify larger areas than are strictly necessary on the basis of the above definitions, making use of appropriate physical boundaries.

5. Natural radiation

Some exposures to natural sources of radiation such as those in uranium mines have generally been subject to control. There is now a recognition that some incidental exposures to natural radiation are significant enough to warrant attention and that controls may need to be introduced where none was previously deemed necessary.

The exposure of workers to radon in general workplaces is covered in ICRP Publication 65 (ICRP, 1993). The new report also deals with materials with elevated levels of natural radionuclides and cosmic ray exposure in jet aircraft. It suggests that regulatory agencies choose activity concentrations of the parent radionuclides within the range 1-10 Bq g^{-1} to determine whether the exposures from the former should be regarded as occupational. In the case of the latter, the report recommends that aircrew but not business passengers, be treated as occupationally exposed.

6. Monitoring

There is a substantial chapter on this subject and it is essentially this chapter that replaces ICRP Publication 35 (ICRP, 1982). Different types of monitoring are discussed. The first level of subdivision, into routine, task-related and special, relates to the objectives of monitoring. The objectives of the first two are obvious; that of the third is to investigate and provide detailed information in order to elucidate any problems and define future procedures. There is a further level of subdivision into workplace and individual monitoring: the former can be subdivided into external radiation, air contamination and surface contamination monitoring; the latter into external exposure, internal exposure and skin contamination monitoring.

Individual monitoring is taken to mean the making of measurements by equipment worn by workers or measurements of quantities of radioactive materials in or on their bodies and the interpretation of such measurements. The principal objectives of a programme of routine monitoring of individual exposure from external or internal radiation are:

• to obtain an assessment of the (committed) effective dose and, where appropriate, the (committed) equivalent dose in significantly exposed tissues, so as to demonstrate compliance with managerial and regulatory requirements,

- to contribute to the control of operations and the design of facilities,
- in the case of accidental overexposure, to provide valuable information for the initiation and support of any appropriate health surveillance and treatment.

In the case of external radiation, the report notes that it is often convenient to identify three groups in relation to each of the components of exposure:

- those for whom individual monitoring is certainly needed,
- those for whom it is probably needed,
- those for whom it is not needed.

If specific doses are needed to replace this judgement, the report recommends that those individuals liable to exceed an annual effective dose between 5 and 10 mSv should certainly be in the first category, unless their doses can be assessed more conveniently in some other way, *e.g.* aircrew. Groups in which all members are likely to receive an annual effective dose of less than 1 mSv should be in the third category. In the case of internal exposure, the report recommends that individual monitoring should be used routinely only for workers who are employed in areas that are designated as controlled specifically in relation to the control of contamination and in which there are grounds for expecting significant intakes. A number of examples are given where this would normally be the case.

The recording level for individual monitoring now recommended should be derived from the duration of the monitoring period and an annual effective dose of no lower than 1 mSv or an annual equivalent dose of about 10 % of the relevant dose limit. However, in the rare situations where several components of the exposure (such as external and internal exposures of specific organs) contribute significantly to the total dose, it may be appropriate to derive lower recording levels for each component.

In practice, little use is made of recording levels in individual monitoring for external exposure because the measured dose is usually entered directly as a measure of the effective dose. The minimum level of detection should then be used as the recording level with results below that level being deemed to be zero. However, the recording level is useful in defining the low dose requirements of dosemeters.

A major question in the design of the monitoring programme is the length of time that records of the results of assessments of individual doses should be kept. This is already covered in ICRP Publication 60 which indicates that such records should be retained for periods comparable with the expected lifetime of the individual.

7. Other topics

There are three other important topics covered in the report which are not discussed here. The first relates to the control of occupational exposures in accident or emergency situations. In the main, it reiterates material that has already been published by ICRP (ICRP, 1991b). The second relates to the management of overexposed workers and the third to health surveillance of occupationally exposed workers.

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