"Controllable Dose" - Results and Proposals from Discussions within the German-Swiss Radiation Protection Association (FS)

Hans H. Brunner
Past President, FS, German-Swiss Radiation Protection Association
CH-8006 Zurich, Switzerland

1. ACTIONS OF THE FS

When the FS received a first copy of the Clarke paper (1) in September 1998, it quickly recognized the relevance of this proposal in the ongoing discussions as a possible way towards an exit from the dead end into which the battle with LNT-model opponents might lead (2). Therefore a German translation (4) was published both in our journal StrahlenschutzPRAXIS and on our web page and distributed together with the English original to all Board members and chairpersons of FS Working Groups and other interested members for detailed analysis and discussion. Several Working Groups and individual members have analyzed the proposal in great detail and depth and have elaborated comments and proposals (5) and in one case even provided a modified and expanded version of the proposal (6) (see 6. below). The Swiss members discussed the proposal in January 2000 at a seminar with Prof. Clarke, organized by the Federal Commission for Radiation Protection (EKS). A discussion of this material with the Board and WG chairpersons is planned for February 2000. A summary will then be presented at IRPA 10 in May. Following the discussions in Hiroshima the FS intends to closely follow the further developments of the proposal and as far as feasible to collaborate and to keep the ball thrown by Roger Clarke rolling towards its goal.

The FS does not intend or attempt to develop a formal unified opinion at this stage. This summary of January 2000 is a snapshot from ongoing discussions and shows highlights and the spread of opinions in a subjective selection and presentation by the author. Both the deadline for submission of the paper and the available space do not allow to present all views and arguments in the desirable detail.

2. GENERAL REACTIONS AND IMPRESSIONS

The author's general impression from all these discussions and comments is that a majority of those who really tried to understand and analyze the proposal reached mainly positive conclusions, but also detected a number of problems, flaws and weaknesses for which they proposed interesting and constructive solutions. There seem to be relatively few who started with a rather negative or conservative attitude or who got fixed to some problem of wording or translating and thus reached rather negative conclusions or even declared that there was no need for a new concept. As always, the attitudes of the "silent majority" which does not dare or want to comment, are difficult to estimate.

Some comments and arguments from German members have to be judged on the background of the special German regulatory and practical situation (still based on ICRP 26, implementation of ICRP 60 / new EC regulations has only started; no provisions for enhanced natural radiation; large problems with residues from uranium mining ) which in many respects differs from that in Switzerland where regulations have been changed according to ICRP 60 and BSS already man years ago (1994).

Terminology

Many readers seem to have difficulties in understanding parts of the text and of the reasoning. This may in part be caused by the German translation (see 6. for proposed improvements in terminology) and - ceterum censeo... - points once more to a general problem - the adequate translation of special or new terms such as "constraint" from English into other major languages -, which leads both to difficulties and to misinterpretations when ICRP recommendations or IAEA standards are translated or are implemented into regulations in other languages. ICRP has members from all major languages and should propose adequate translations of its terminology into the main languages.

Structure of the Proposal

The original Clark paper is too compact and rather difficult to understand (6). There should be a clear separation of:

- problems of the existing radiation protection concept
- misunderstandings in interpretation and application
- different approaches for solutions
- the new concept
- explanations and application of the new concept.

It may also be necessary to discuss separately the new concept in contrast to the present separation of
planned protection and intervention, and the derivation of uniform criteria for individual dose for all applications.

**Collective Dose**

The abolition of collective dose is generally welcomed, but there remains a need for a "group dose" or "team dose" for planning and special purposes, such as comparing the radiation protection efficiency of specific tasks.

### 3. RESULTS OF ANALYSES

The following summary is mainly drawn from a study in which the FS Working Group on Waste Management (AKE) has summarized several in-depth analyses by individuals and groups (5). Additional opinions and comments will be mentioned both here and in 4. and 5.

The Clarke paper is welcomed as an important step in view of further development of the existing protection criteria.

#### 3.1. Dose Levels

- The four levels - action level, investigation level, constraint, trivial level - should be further characterized in an expanded version of the figure given by Clarke (see Table 1) with the following items:
  - Name / value in mSv/yr / multiple or fraction of average natural exposure / associated fatal risk (with further explanations) / relation to present criteria and practices / function or application.
  - The main comparison should be realistic and made between the levels and the unavoidable average natural radiation exposure. The secondary relation to risk levels is based on a linear dose-effect-relation without lower threshold, but should mainly be used for comparison of risks at higher dose levels with other accepted risks. Both relations together form a basis for the justification of the four dose levels (this justification is different from the justification of new practices).
  - Dose-rate effects must also be considered (medical and occupational areas) and one should show, that the application of the dose levels sufficiently covers short-time high dose-rates.
  - Column 5 of Table 1 shows the present criteria and relevant types of application / practices.
  - Columns 2 - 5 could be visualized for better acceptance.

#### 3.2. Function or Application of the Dose Levels

- In the last column of Table 1 the function or application of the four dose levels is briefly described.
- For the action level, text and examples should explain, that such doses can only be accepted when the exposed individual has a direct benefit (occupational or medical exposure) or if a reduction of the dose should considerably impair the life-style (intervention, unplanned exposure). In the region 3 to 30 mSv/a optimization is required.
- The region below the investigation level, 3 mSv/a, is in the lower part of the natural exposure. Optimization is indicated, if it is practicable or if there is no benefit for individuals.
- The region below the constraint of 0.3 mSv/a is in the 1-10 percent region of natural exposure and represents additional exposures which are not detectable in the fluctuation of natural exposures. Optimization is not necessary, the single source is already optimized.
- In the trivial region no radiological protection is necessary.
- These applications should be explained in the text with good examples.
- The application of a trivial risk should not allow a release of activity after dilution.

#### 3.3. Justification and Optimization

- The application of the justification of categories of practices and the optimization of individual doses should be explained more clearly. Justification is a fundamental principle and must be maintained, as it is also a part of the European legislation and is important for dealing with residues.
- The abolition of the Collective Dose for use in optimization is welcomed, (also in the majority of other comments from FS members and groups, but some problems, such as cut-off doses, are seen in connection with residue problems). Collective dose is not used in the German or Swiss legislation. On the other hand it is still useful to apply a collective dose for well defined groups of persons with individual doses in the range of a few mSv for the optimization of specific operations, but this should better be called "group dose" or "team dose". In the optimization of operations one should be careful to include the entire relevant chain of operations (it does make little sense to optimize only the conditioning of waste when considerably higher doses occur during final storage of that waste).

#### 3.4. Trivial Dose
- The concept of controllable dose is based on a limitation of the individual dose, and it is explained, that, if the risk from a source for an individual is trivial, then the total risk from this source is trivial and the source is controllable. This reasoning must be extended to the region of non-trivial doses (professional exposures above 1 mSv/a), and for this the term "sufficiently protected" must be explained. This is closely connected to the question of justification of higher doses for professionally exposed persons. It can be done using two additional arguments:

a) For higher doses, above 10 mSv/a, one should argue with risks, i.e. suggestion of a risk which is also accepted for other professional categories or for the public from other effects of civilization.

b) For doses below 10 mSv/a one should argue with natural radiation exposure, because the assignment of risks will become more problematic and questionable. It is proposed to allow for the total of all groups of persons (or at least for the public and for the professionally exposed persons) a radiation exposure from man-made activities whose average value of ca. 0.3 mSv/a (public) is in the region of the average variation of natural exposures, and which has a similar distribution of values as the natural exposure. In its upper part (> about 1 mSv/a) one would find the major part of the professionally exposed persons and of those parts of the public who are involuntarily exposed.

This split argumentation has the advantage, that the probabilistic risk notion only needs to be used for a small group of persons, while for most of the public and of the professionally exposed persons the arguments are based on the natural exposure and its distribution of values.

Both arguments have in common, that they make radiation protection a part of a broader system of protection by comparison with other risks of civilization and, by comparing with natural exposures, by a link to other concepts of protection (e.g. limitation of concentrations of heavy metals in water). Thus radiation protection would move away from its singular point-of-view, which might improve general acceptance.

(In another discussion group seriously different views regarding the statement "if the most exposed individual is sufficiently protected, then everyone else is also sufficiently protected..." (1) and its consequences could not be united and prevented a joint opinion.)

3.5. Summary of the AKE Study:

It should be clearly demonstrated, that the proposed dose levels
• are derived from the level and distribution (variation) of the natural radiation exposures and from comparisons with accepted risk levels,
• are compatible to the state of knowledge on detrimental health effects of ionizing radiation, and
• are no new inventions but a further development of existing recommendations.

It is extremely important to present the developed concept of "controllable dose" to the public in an accessible and understandable way. Also in view of acceptability the central arguments should be presented in the following order:
• Natural radiological situation (level, distribution),
• Generally accepted risk levels, and
• Radiation protection as part of a concept for protection from damaging effects of human activities on a wide basis.

4. COMMENTS FROM SWITZERLAND

This is a short review of comments made by Swiss members, mainly during the EKS seminar with Prof. Clarke:

- The abolition of the unrestricted collective dose is welcomed, but well defined "group doses" with a suitable cut-off and presenting the distribution in space and time remain a useful tool for radiation protection for evaluation of options or for demonstrating state and trends in protection.
- Some legal limits are needed where the individuals have no freedom of choice, but only for precisely measurable quantities. The present limit for the public of 1 mSv/yr could not be abolished without loss of credibility, but it should be interpreted as a guidance level, not a legal limit. A constraint of 0.3 mSv should not become a legal limit because it could make radiation protection unreasonable in specific situations.
- Guidance levels are useful indicators of the order of magnitude of risks.
- Exclusion (of exposures), exemption (of practices) and clearance (of materials) must be clearly defined and properly applied.
- Action levels and investigation levels are already used in applied protection, but set at fractions of legal limits with the aim to avoid violation of limits.
- Make criteria transparent, inform the public and – during development – test understanding of new concepts on members of the public.
- The distinction between practices and interventions is a weak point of the present system, both optimization and intervention reduce doses, but there are no "negative doses".
A scale of benefits should be developed for comparison with the scale of levels.
- ALARP (as low as reasonably practicable) could be expressed as "do what you can" (DWYC).
- Distinguish between normal and accidental situations and between occupationally exposed persons, patients and members of the public.
- In view of all the problems in understanding the risk notions and the controversies about the LNT-model, would it not be better to completely avoid to use magnitudes of risks as arguments?
- What is "safe" or "unsafe"? A limit is set by convention, not by an absolute magnitude of risk. What is allowed by law or by habit is considered "safe", thus it is "unsafe" to violate a legal limit of exposure, but it is "safe" to exceed an action level and take the prescribed action.
- If the dose to the most exposed individual is calculated in the usual conservative manner, cumulating all kind of rather improbable extreme assumptions, one could again reach a situation where a lot of money is spent for a hypothetical case. Therefore either some reasonable statistical concept should be involved when calculating hypothetical cases, or one should rigorously stick to real situations.
- There are some fears, that a new concept could lower the actual high standard of radiation protection, especially in such fields as decommissioning and waste disposal, and that trivial levels could be misused by intentional dilution of wastes or contaminated foodstuffs.

5. OTHER COMMENTS, PROBLEMS AND PROPOSALS
The following is a collection of comments and proposals from different groups and members of the FS. Lack of space does not allow to present detailed reasoning.

5.1. General Comments, Advantages, Disadvantages
- Some comments criticize the timing and fear negative influence from the discussion of new concepts on the ongoing implementation process of the new EU regulations. But such fundamental discussions on the international level must start one phase and at least a decennium ahead of the national regulation processes.
- One group (dealing with applied radiation protection) sees no need to replace present concepts because the new proposal does not seem to be more simple or to have more advantages.

5.2. Definition, Terminology
- The adequate translation of "controllable" should express the possibility to measure a dose rather than the necessity to take action above the level (a proposal is made by Krüger, see 6.).
- Missing: a description of what is controllable and what is not.
- The concept should not add a new dose quantity to the too many already existing ones, but it should reduce these quantities to the minimum number needed for application.

5.3. Sources, Individuals, Levels, Limits,
- The principles of the proposal for a single source are no longer valid for the total effects of several sources or of several practices, and for the same source the external and internal exposures may vary by several orders of magnitude depending on different scenarios.
- How shall "non-controllable" sources be considered?
- Do we need the "most exposed individual" which may be difficult to define, or would "any exposed individual" be sufficient?
- Should we use one single investigation level for all practices or different ones for different practices? If only one is used, optimization will be required.
- A critical discussion of the present policy of using limits, action levels, guidance and working levels is welcomed. But experience shows that experts, authorities and courts tend to interpret derived levels as legal limits (especially if the term "limit" is not properly defined and then translated as "legal limit" or "Grenzwert", as is happened with the surface contamination level of fuel transports). Different interpretations may lead to different conclusions and consequences which may deviate from the original purpose of a derived level.

5.4. Comparisons (Risk, Natural Exposures)
- How can the benefit of an individual from a source be defined? Is it a benefit to have a job? Does an expert from a supervising authority also have to tolerate a higher risk? How can the one who benefits from a practice (e.g. the stockholder of a power company) be included in the group of individuals who have to accept higher risks?
- The net benefit of a source would have to comprise its entire duration of use which again would need assumptions and abstractions, so the procedures might become more complicated instead more simple.
- One comment is critical regarding the comparison with fatal risks for the three lower levels which all lie in the region of doses from natural exposures.
- Some comments equalize the application of the same concept to different areas of practices with equalizing the
exposures from these practices and think that it would be difficult or impossible to compare benefits and risks.
- A risk level of $10^{-5}$ might mean for Germany that 1/3 of the drinking water would be unsuitable because of its Radon content.
- Use the general principle that no job is without some risks that are higher than those of the general public.

5.5. Concept, Application
- Is the Clarke proposal only complementary to existing concepts or is it a fundamental change (looking at one specific source in place of the total of many possible and sometimes also unrecognized sources)?
- The proposal applies to many different exposure types and applications, but the one with the highest values is not included: intervention. (A possible solution might be the one chosen in the Swiss regulations (Art. 121 StSV): lifesaving actions may be commanded, if the expected dose is below 250 mSv, for other actions the dose limit for emergency personnel is 50 mSv. Compare to the situation of firemen or rescue teams).
- The "possible solution" section of the proposal contains contradictory dose levels for the public, and one cannot recognize a reasonable philosophy for limiting the doses to all different members of the population (children, adults, workers, intervention teams).
- It seems difficult to express in simple general rules the various ways to respect the dose levels as shown in the examples (but see 6.).
- Thanks to the single action level there is no more need to maintain the worker categories A and B (special EU and German problem, does not exist in the Swiss regulations).
- The "triviality principle" of the proposal must become a fundamental principle.
- The table proposed by Clarke seems plausible. It would have to become the international standard and to be modified periodically according to the state of knowledge. From this, clear rules for the various practical situations should be derived (see 6.).
- For setting a "tolerance" or "trivial" level there are two possibilities:
  a) < 3 mSv/yr, because the average natural exposure is between 1-3 mSv/a without discernible difference of risk,
  b) < 0.3 mSv/yr net dose (ambient dose subtracted), but difficulty to determine such a net dose.

5.6. Supervision, Monitoring
- Which control instrument or procedure would allow to detect significant cumulations of doses to an individuum or group?
- A special problem is the progress of measurement techniques towards lower limits of detection, which provokes a trend to lower legal limits! But a feasible measurement is not always a reasonable measurement! -> The requirement for measuring instruments: "lower limit of detection divided by legal limit $\ll 1$" should become one of the criteria in the table.

5.7. Acceptance, Positioning of Radiation Protection
- The proposal may lead to better acceptance by the public.
- Legal limits are necessary for acceptance by the public.
- Radiation protection should be put into a general frame, and decision making should consider all effects and consequences, not only the radiological ones.
- The AKI working group agrees with Clark's aim to improve acceptance and avoid misinterpretations by more transparency and by a clear reference to individual risks. They especially welcome a single limit as upper threshold which shall not be exceeded, and action levels below that limit. But they give the proposal only little chance to contribute to an improvement. Intervals in place of limits are unrealistic from a legal view. The irrational public discussions on many health risks show that clear boundaries between dangerous and harmless are requested and that the public does not accept other, more differentiated solutions. The basic problem, the acceptance of risk evaluations, is only semantically shifted to the definition of controllable doses in Clarke's proposal, but also here one finds the notion of "reasonably" whose interpretation has not succeeded in public discussions.

6. A STEP TOWARDS IMPLEMENTATION
Several comments mention problems of the future implementation of the proposal. One member, F.W. Krüger, went one step ahead and remodeled and expanded the Clarke paper with excellent definitions and explanations in a fashion which shows quite clearly how the proposal could be implemented in regulations and in protection practice (6). Krüger also proposes valuable solutions or more precise wording for a number topics mentioned in the AKE study (3. and (5)) and in other comments (4.,5.). Some parts of Krüger's text deal with specific German problems of the present German regulations such as the lack of regulations for exposures from
natural sources, these aspects are omitted in this summary. He also splits Clarke's figure into three tables (tables 2–4).

6.1. Definitions
Krüger uses "controllable radiation exposure" (German: *beeinflussbare Strahlenexposition*) instead of "controllable dose", with "controllable" in the sense of 'susceptible to influence' (the German translation of "control" has a much more restricted meaning of supervision). Controllable exposure allows a unified determination of the region of applicability and comprises everything that is regulated by the new EU regulations. The same protection principles apply to all controllable exposures, and it is an open list which can be subdivided more finely or can be expanded.

"Controllable dose" is called "Kenndosis" = "characteristic dose" (or simply "dose") and is the highest effective dose of a person from a controllable exposure, all exposure paths and protective actions taken into account.

"Justified doses" (German: "gerechtfertige Dosen") is the general term for the four levels (action level, investigation level, constraint, trivial level).

6.2. The New Concept
- For all controllable exposures the characteristic doses must be restricted by suitable means to reasonably attainable values, the justified doses, which depend upon the individual benefit for the exposed persons. (Table 2)
- Protection measures are related to the magnitude of the justified dose. (Table 3)
- There is a range of discretion for fixing justified doses.
- The precautions and measures for restriction of the characteristic doses must be monitored and supervised by suitable (differentiated) procedures. If there are indications for violation of protection or for exceeding justified doses, the causes have to be determined, evaluated and if necessary eliminated.

6.3. Explanations
- Justification becomes the fundamental principle of radiation protection.
- Justified doses are not determined by automatism or mathematical formula. A measure of discretion is available which allows to take various factors into consideration, also social and psychological ones and interests of the "stakeholders".
- The requirements of optimization are included. Also when high benefit would justify high doses, the reasonably feasible protection measures must be applied. Justified doses are only acceptable when protective measures have been taken, and these measures must be more comprehensive the higher the doses are.
- Monitoring can comprise assessment of the following quantities:
  - ambient dose or dose-rate
  - activity concentration of radioactive substances in air, water or other samples
  - surface contamination
  - individual exposures (external and internal)
  - other mechanical, electrical or thermal parameters.
- Monitoring follows the same principles for all quantities. There will be several levels for each quantity, the violation of which requires recording, reporting, investigation or restrictive (corrective) actions. Thus the monitoring of dosimetric parameters is not only concentrated on "limits" as dividers between "acceptable" and "unacceptable".

6.4. The Principles of the New System of Protection
- Justification: Doses caused by controllable radiation exposures must be justified by individual benefits.
- Optimization: The real exposures (characteristic doses) must also below justified doses be kept as low as feasible by protective measures which correspond to the exposure level and the state of science and technology.
- Supervision, Monitoring: the observance of the justified doses authorized for a practice and the exposed group of persons and the functioning of the protective measures must be supervised.
- Action: In case of violations of protective measures or justified doses, the causes must be determined, evaluated and if necessary eliminated.

6.5. Comments:
- The system uses the same scientific and technical bases and knowledge as the present one.
- No new or farther reaching radiobiological or technical knowledge is involved.
- No changes in applied radiation protection are necessary.
- The present level of protection remains unchanged (table 4)
- Radiation protection is relieved from theoretical and systematic burdens.
- The system returns to principles which already now are used in practical protection.

6.6. Advantages:
- Radiation protection follows the same principles in all areas of application, also intervention and natural exposures.
- The importance of disputed risk estimates is reduced, they are only tools for setting justified doses, but the main argument is individual benefit.
- The explanation of protective measures does not need to rely on scientifically uncertain or impossible statements (LNT, detriments of low doses, hormesis)
- Decisions on protective measures which involve discretion are recognized as such and need not hide under a disguise of science.

7. HOW TO CONTINUE?

Our experiences have clearly shown that it will not be sufficient to continue to discuss just the new concept. Such discussions tend to remain somewhat in the clouds and academic. If we want to promote the new concept among radiation protection experts, regulators and interested members of the public, it will be necessary to show very early how the concept could be implemented both in legislation and in the field and how it is able to deal with specific problems. Krüger has made a first interesting attempt, but it relates in many parts to the specific German situation and would have to be "internationalized" and translated into English.

Therefore, once ICRP decides to go ahead with the development of the proposal, the International Organizations - or in a first phase ICRP Committee 4 - should in parallel develop a first draft of new Basic Safety Standards. When the drafts of a new ICRP recommendation and of new BSS will be ready for discussion, IRPA should once more provide the services for a wide consultation among the Associate Societies and the radiation protection community as it was done with the draft of ICRP Publication 60 in 1989.

Acknowledgments:
FS Officers and Board members, chairpersons and members of FS Working Groups AKE, AKD, AKI, AKP, AKR, AKU, AKURA

REFERENCES
1. Clarke, R.: "Controllable Dose", August 1998 (as distributed by IRPA)

A Limerick by Rupprecht Maushart:

Once that question in Didcot arose
they all there were struck dumb, I suppose.
And their spirits were low,
until Roger said: Ohhh,
let's just call it Controllable Dose.
<table>
<thead>
<tr>
<th>Dose Level</th>
<th>Multiple / Fraction of average natural Expos.</th>
<th>Fatal risk $a^{-1}$</th>
<th>Name of Dose Level</th>
<th>Present Criteria</th>
<th>Function / Handling of Dose Level</th>
</tr>
</thead>
</table>
| ca. 30     | 10                                          | ca. 10^{-3}         | Action Level      | • Limit for workers (20/50 mSv/a)  
• Upper action level for Radon concentration  
• Intervention level for resettlement / evacuation (100/30 mSv)  
• CT-scan | • Related to individuum  
• Dose should not exceed this level  
• Acceptance only if benefit for individuum or if dose reduction difficult with considerable impairment of lifestyle |
| ca. 3      | 1                                           | ca. 10^{-4}         | Investigation Level | • Average natural exposure (2.4 mSv/a)  
• Lower action level for Radon concentration  
• Dose limit for public (1 mSv/a)  
• Lower level for simple actions after accident (10 mSv)  
• Simple X-ray diagnostics (some mSv)  
• Average profess. exposure (ca. 2 mSv/a) | • Related to individuum  
• Optimization especially when practicable and when no benefit for individuum |
| ca. 0.3    | 0.1                                         | ca. 10^{-5}         | Constraint        | • Maximum dose level for single source  
• Average variation of natural exposure (without Radon) | • Related to single source  
• Maximum dose for individual without direct benefit  
• Optimization already at source |
| ca. 0.03   | 0.01                                        | ca. 10^{-6}         | Trivial Dose with trivial risk | • Exemption level  
• Clearance level | • Related to individuum  
• No necessity for protective measures |

Table 1: Concept of Controllable Dose (from AKE study (5))
Three Tables from Krüger (6):

<table>
<thead>
<tr>
<th>Individual Benefit</th>
<th>Justified Dose</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not given or recognizable</td>
<td>0.03 mSv/a</td>
<td>Exempted materials or products</td>
</tr>
<tr>
<td>Exists indirectly, no individual benefit in specific case</td>
<td>0.3 mSv/a</td>
<td>Population near NPP under normal operation</td>
</tr>
<tr>
<td>Individual benefit exists</td>
<td>3 mSv/a</td>
<td>Medical diagnostics, prevention of stochastic effects</td>
</tr>
<tr>
<td>High individual benefit</td>
<td>30 mSv/a</td>
<td>Radiation worker; living in a house with Radon daughters</td>
</tr>
<tr>
<td>Extremely high benefit</td>
<td>&gt; 30 mSv/a</td>
<td>Avoiding resettlements after accident, lifesaving rescue or medical procedure</td>
</tr>
</tbody>
</table>

Table 2: Individual benefit justifies different doses

<table>
<thead>
<tr>
<th>Justified Dose</th>
<th>Protection Requirements</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03 mSv/a</td>
<td>No special protection measures</td>
<td></td>
</tr>
<tr>
<td>0.3 mSv/a</td>
<td>Protection measures at the source</td>
<td>Retention of effluents</td>
</tr>
<tr>
<td>3 mSv/a</td>
<td>Protection by measures at the source and/or simple organizational and technical measures</td>
<td>Ventilation in Radon houses; after accidents: iodine tablets, sheltering</td>
</tr>
<tr>
<td>&gt; 30 mSv/a</td>
<td>Protection by a coordinated system of organizational and technical measures</td>
<td>Protection of professionally exposed persons; evacuation after accidents</td>
</tr>
</tbody>
</table>

Table 3: Protection requirements for different justified doses

<table>
<thead>
<tr>
<th>Fatal Risk</th>
<th>Dose mSv</th>
<th>Proposed System</th>
<th>Present Criteria</th>
</tr>
</thead>
</table>
| 10^{-3}    | 30       | Dose should not exceed this level. Approach only when benefit for individual or dose difficult to reduce or avoid. | • Dose limit for workers  
• Upper level for Radon actions  
• Intervention level for resettlement  
• CT-scan |
| 10^{-4}    | 3        | It may be necessary to reduce the dose, especially when no benefit for the individual exists. | • Lower intervention level for sheltering  
• Lower Radon action level  
• Average natural background  
• Level for diagnostics |
| 10^{-5}    | 0.3      | Maximum dose for individuum without direct benefit from the single source.      | • Maximum constraint for single source  
• Variation of natural background (without Radon) |
| 10^{-6}    | 0.03     | Trivial risk for individuum                                                     | • Exemption level  
• Clearance level |

Table 4: Comparison of present and new criteria