SOME COMMENTS ON NRC'S PROPOSED RULE FOR YUCCA MOUNTAIN

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Abstract

On Monday February 22, 1999, the Nuclear Regulatory Commission, issued its proposed rule, 10 CFR Part 19 et al. regarding "Disposal of High-Level Radioactive Wastes in a Proposed Geological Repository at Yucca Mountain, Nevada". NRC's suggested standard for a repository in Yucca Mountain contains a dose value and a critical group description. The choice of a critical group for discussing events in the distant future involves some philosophical problems, since the concept was defined by ICRP for operational installations. It is also worth while to discuss more in detail who the standard is meant to protect considering that a health based standard must refer to health of individuals, of which some live in a distant future.

Background

In many countries, there is intensive work being conducted in siting and designing waste repositories. There is an increasing need to discuss, develop and finally formulate the fundamental standards or criteria for protection of public health and the environment.

The Swedish Radiation Protection Institute participates in many ways in this international process. One example is the International Symposium on Radioactive Waste Disposal, Health and Environmental Criteria and Standards, organized in Stockholm 1998 jointly by the Swedish Radiation Protection Institute and the US Environmental Protection Agency.

IAEA's safety series [Ref. 1] contains general ethical and technical principles for waste management. Similar formulations can be found by other international bodies such as the OECD's Nuclear Energy Agency [Ref. 2]. Such principles may be a starting point for development and formulation of criteria and standards internationally.

The principles have also served as guidelines for the preparation of the so called Waste Convention[Ref. 3]. Also other international guidelines such as the Rio Declaration on Environment and Development, and international conventions, such as OSPAR [Ref. 4] and Espoo [Ref. 5] supply an international foundation for formulation of HLW criteria and standards.

However, there are several constraints in comparing criteria and standards for high level waste internationally. In NRC's proposed standard, the highest individual dose is the main criterion. In Sweden, also other formal requirements must be observed for the safety reporting and repository design, promulgated by the Swedish Nuclear Power Inspectorate. In addition to this, SSI requires protection of the environment as a separate criterion.

There is an obvious benefit in the discussion internationally among regulators of such issues as protection philosophy and the principles behind criteria and standards, but it must be recognized that regulation of protection in the final analysis is a political act. Regulators are close to their governments. These will not be swayed by arguments among regulators alone. Another problem is the legal structure, language and tradition, which would make it prohibitively difficult to make a complete comparison of the different national regulations "true" impact.

Legal standards and scientific bases

However, the scientific bases in connection with criteria and standards can and should be discussed internationally. Such a discussion prepares the regulators in each country so that common principles and both real and apparent differences in different countries can be explained.

In order to comments on the NRC's proposed standard the author goes one step further than discussing the common points of departure in Sweden and the US. In discussing the scientific bases for the NRC standard , the author must try to separate the natural science component from the legal one. In this connection the reader is advised that the author has only superficial knowledge of the American legal system, and the reader will have to judge whether such a separation is possible at all, and if it is, whether it has been successfully achieved.

Technical Bases for Yucca Mountain Standards

The US Congress gave a mandate to the US Academy of Sciences, NAS, reproduced in the National Research Council's publication [Ref. 6]

The US Energy Policy Act 1992 directed NAS (through the National Research Council) to assist EPA by investigating, among other things

- "whether a health based standard based upon doses to individual members of the public …will provide a reasonable standard for protection of the health and safety of the general public", and

- "Whether it is possible to make scientifically supportable predictions of the probability that the repository's engineered or geological barriers will be breached as a result of human intrusion over a period of 10 000 years".

The first question is related to the use of radiation dose, and effects of dose on health, as possible criterion for acceptability of a repository in Yucca Mountain. Even if the question is answered by yes, as it was, it raises a number of new questions as to what kind of exposure scenario should be used in a standard. This is discussed in the next sections. The second question has to do with problems that will inevitably influence any reference to people living in a distant future.

The study of the National Research Council deals with many other issues from the earth sciences to describe the evolution of the engineered barriers and the geological transport of radionuclides in a hypothetical outflow from the repository, but the comments presented here are restricted to the areas mentioned in the two questions above.

Possible roles of collective dose in a standard

The collective dose (specified in mansievert) is the average radiation dose in a group, multiplied by the number of members of the group. Thus, the group may consist of personnel at a facility, a regional collective or the global collective. The collective dose can be used for various purposes:

OPTIMIZATION

Plans for radiation protection measures at facilities where work involving radiation is carried out is often the result of an optimization, i.e. various alternatives have been compared with each other and the proposal which, with reasonable cost and effort, leads to the lowest collective dose, is selected. This could be done if two designs were to be compared. However, although the term "site" is very broad it has been the author's impression that both Congress and the National research Council in the study assumed that the repository design was essentially the one DOE had suggested for Yucca Mountain.

LIMITATION OF THE TOTAL DETRIMENT.

Regulating the total detriment from an activity, require that the quantity can be determined. That would be possible if the so-called linear hypothesis is accepted and the collective dose is known. There are several problems however connected with such a procedure, however, both scientific and philosophical. One technical problem is to calculate the collective dose from a repository, since the assessment may be carried out for millions or billions of years. If a cut-off in time is given the problem becomes easier, but then the philosophical justification for the cut-off becomes a problem instead. There may be valid arguments in the field of jurisprudence, such as pointing to the fact that very few other structures have to be guaranteed to be safe for a period longer than a few hundred years. It is clear that a thorough discussion of such arguments will lead outside the scope of this work.

Another problem arises in the assessment of a reasonable or acceptable total detriment. Ideally, the detriment is part of the balance for total effects of nuclear power production, and should have been decided as an input in the initial decision to start nuclear power production. Even in that case, the initial decision would have an underlying assumption that the total detriment would be a meaningful concept in the decision, for instance if total detriments from alternative modes of production were known. Taken in an absolute way, it is difficult set criteria for the total detriment calculated from the collective dose.

Another way of using collective dose is the one used in the old US standard, 40 CFR 191, which applies to the Waste Isolation Pilot Plant. In this standard, the author understands, a collective dose limit is based on what DOE might reasonable be expected to meet, at that site. Such a standard can be seen as an example of good performance, which the regulator would expect the implementor to meet. Using such a standard, the authority accepts the

burden of defending the quality of the assessment made, that produced the collective dose limit.

LIMITATION OF FUTURE GLOBAL MEAN INDIVIDUAL DOSE

In previous comments from 1977 to Swedish regulations for releases from nuclear power plants, estimates were made of the global average dose to individuals after 500 years after the construction of the last nuclear power plant, based on certain assumptions. The estimate led to the requirement on a collective dose constraint for the general public (the global collective) of 5 mansievert per year and GW of installed electrical capacity. Note that the prospect of a 500 year period of nuclear power production in Sweden is no longer realistic. This was foreseen in the comments by assuming periodic reviews.

This type of estimate intends to limit the mean individual dose to a certain value which is established as the goal. In Sweden, the goal has been to limit the global mean to 1 mSv/year, but it should be emphasized that any system of sources that generate a large enough collective dose, will lead to an arbitrarily high global mean individual dose at some time in the future. The argument that a small dose can be disregarded is not valid here because the dose is not seen in isolation. The problem is the addition of many small components to the individual dose. This effect - of addition - would also permit the use of a linear dose-effect relationship in radiation protection regulation, even if a threshold were believed to exist. All dose generators would then share the risk that an individual were to exceed the threshold as a result of a sum of many small doses, all below the threshold.

Individual dose and critical group

ICRP explains that persons in the critical group may be real or hypothetical. A hypothetical group may be compared to a real group with respect to dose from a operational nuclear facility. Also, a hypothetical group may be described using existing real practices. A hypothetical group does not rely on speculation alone. It may, at any time, be verified or discarded, by practical investigations. Also, the choice of a group evens out the odd case of extremes.

However, for the calculation of the dose to a person in the distant future, there is no particular use of defining a group. There are differences in the behavior of real people, but it is not obvious what differences should be assumed in individual behavior or habits in the far future.

The changing society and biosphere

The National Research Council concluded that the answer was ”no” to the question above,

> “Whether it is possible to make scientifically supportable predictions of the probability that the repository's engineered or geological barriers will be breached as a result of human intrusion over a period of 10 000 years”.

The National Research Council does not believe that either regulators nor implementers may predict the distant future. There is a problem arising when the same uncertainty is applied to the critical group. How can this group be known when the intruding team is unknowable? The author assumes that the National Research Council does not make a distinction between the two groups. They are both unknowable in terms of habits, surrounding society etc . Then how can doses be calculated to this group, conservatively or otherwise? The most simple answer is that is cannot be done.

Another alternative is presented by the author earlier in a letter to the Nuclear Regulatory Commission [Ref. 7]:

> *We do not know the distant future in any respect, but we can design protection as it is used in society today. It is not an expression of neglect regarding the protection of individuals or society in the future. We simply acknowledge that we cannot know the society and we cannot know even (distant) future individual's need of protection, should it be different from our own. We can give them the best protection as it is seen today, using for example realistic but cautious assumptions . This is the purpose of our reference population, it is not a guess of what will be in the future.*

This is a set of assumptions which may solve the problem about the future, and it may - or may not - lie within the margin for the Commission's interpretation of its own regulations.

THE NEAREST FUTURE

Although we don't know the future, we may at least claim to know the nearest future. The future which is considered reasonable to include using today's parameters is different in different legal circumstances.

Many references may be found both to a rapidly and slowly changing society. For the purpose of regulating a nuclear waste repository, it may be valuable to find the maximum time span for which society makes plans in other fields. One example is offered by China, who in 1898 leased the New Territories to Britain for 99 years under the terms of the Peking (Beijing) Convention, which expired at midnight June 30, 1997, ending 156 years of British Colonial Rule.

The Swedish HLW standard assumes that doses to real people may be modeled up to 1 000 years. After this, a dose calculations serves mainly as barrier system performance indicators. The choice in the Swedish standard of 1 000 years can therefore not be compared with the Nuclear Regulatory Commission's standard of 10 000 years. The Swedish standard is unbounded in time, in principle, and therefore closer to the National Research Council's suggestion of using "peak risk, whenever it occurs" [Ref. 6, p 119].

Strict interpretation of the critical group

People and society may belong to a performance assessment reference. It is not known to the author how this concept is perceived by the law in the US. Taken quite literally from the Proposed Rule, the critical group consists of subsistence farmers in Nye County. They

would have a history, and a natural assumption would be that the history of the farmers consists of other subsistence farmers. This assumption implies that no material would be exported outside the farmed land and that, consequently, there might be a build-up of contaminants from the repository during thousands of years.

The natural way of avoiding the above more rigid interpretations would be to formulate the standard in a more general language. It would then be up to the implementer to choose the scenario used for demonstrating compliance, and the regulator to decide whether it has been achieved.

References

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2. OECD/NEA, "Collective Opinion" Concerning the Environmental and Ethical Principles of Geological Final Disposal, OECD-NEA 1995.

3. Joint Convention on the Safety of Spent Nuclear Fuel and on the Safety of Radioactive Waste Management, IAEA 1998

4. The Convention for the Protection of the Marine Environment in the Northeast Atlantic, 1994.

5. Convention of Environmental Impact Assessment in a Transboundary Context, 1991.

6. National Research Council, Technical Basis for Yucca Mountain Standard, National Academy press, Washington 1995.

7. Mikael Jensen, Personal comments Personal Comments on NRC's Proposed Rule for Yucca Mountain, Submitted to the US Nuclear Regulatory Commission, May, 1999.