PRE-PLANNED VERSUS UNPLANNED DECISION MAKING IN THE CASE OF ENVIRONMENTAL DECONTAMINATION

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Abstract

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Until a few years ago it was not usual to pre-plan realistic countermeasures directly related to a radiological emergency or a nuclear accident (RENA), mostly because the probability of occurrence of such events was considered to be too low for real concern. The Three Mile Island, Chernobyl and Goiânia accidents, however, changed long accepted views of the decision making community throughout the world. Today, meetings are being held just to discuss how one can go about making decisions to face the problems that may occur in a number of RENAs. The present work will examine several well established scientifically based radiological criteria to be used in decision making processes concerning either radioactive decontamination following a severe RENA, or decommissioning procedures. Such criteria can certainly be used to select pre-planned countermeasures, but can also be helpful as guidance to decision makers when facing a choice of untested and unplanned options. Selected advantages and disadvantages of each criterion based option will be presented and briefly discussed, as, for example, the amount of radioactive waste produced vis-B-vis the risk (concentration or projected dose) level adopted in the decontamination procedures. In addition, non-scientific aspects will be brought into the discussion, because their social, economical, and political implications cannot be ignored by responsible decision makers. Uncertainties associated with both non-scientific aspects and scientifically based environmental and dosimetric models will also be examined for specific cases.

1. INTRODUCTION

There are a variety of criteria that can be used to guide a decontamination procedure or even to decommission a site. However, it is fully recognised today that one should develop radiological criteria with well established scientific basis to be adopted in case of accidents. In the past, meagre attention was given to early preparation to deal with severe radiological emergencies and nuclear accidents (RENAs), because of widespread conviction that such RENAs were unlikely to occur. Mathematical exercises were carried out to prove that the probability of occurrence for any severe RENA was very low. The Three Mile Island, Chernobyl and Goiânia accidents, however, compelled decision makers to review their convictions, mostly because the perception of risk by the public did not coincide with the quantitative risk estimates obtained in mathematical exercises. Furthermore, practical considerations cannot usually be ignored because of political, social, psychological and economical implications that are subjacent to severe RENAs.

Technical aspects, per se, should also be examined with extremely great care because they can modify considerably the results obtained with environmental and dosimetric models in which pre-planned decisions can be taken. Thus, for example, parameters describing the retention of a particular radionuclide in the vegetation, the resuspension factor, or the time

integral used in the models may have significant impact in the numerical results, affecting, ipso facto, the decision making process.

Several options can be considered preliminary to discuss the formation of radiological criteria to be used in decontamination procedures. As a starting point one can consider the following:

- Risk limitation by establishing limit values of concentrations or doses above which the risks to the public are deemed to be unacceptable;
- to select as a goal a risk so low that even if it cannot be achieved, due to practical considerations, by reaching a level close enough the risk for the public can be considered perfectly tolerable;
- to use the best available technology and to make the best effort in the decontamination procedures;
- to continue the decontamination procedures until return to the natural radiation background; and
- a mixture of all options mentioned above depending on practical considerations and not necessarily radiological criteria.

One should understand, however, that there are no universal criterion, because the criteria to be adopted will depend on the type, magnitude and severity of the RENA under consideration.

2. ADVANTAGES AND DISADVANTAGES

It is important to bear in mind that any option incurs advantages and disadvantages which are inherent to its adoption. In so being, the national authority responsible for the decontamination process should carefully analyse each option previous to adoption. Although what follows is not claimed to be a comprehensive analysis of each option, the discussion of some of the advantages and disadvantages may be helpful to the decision making process in the case of a severe RENA.

2.1. Risk limitation

2.1.1. Advantages

Risk limitation can be based on environmental and dosimetric models relatively well accepted by the radiological protection community, and can be defensible from the scientific viewpoint.

2.1.2. Disadvantages

The concept of quantitative risk is not easily accepted by the general public, making this option difficult to defend in public hearings. Thus, when one is presenting to the public concepts like acceptable or unacceptable risk, it is of little value to compare risks in the order of 10^{-2} (1/100), 10^{-4} (1/10,000) or 10^{-6} (1/1,000,000) associated with different human activities. Nuclear and non-nuclear accidents, like Three Mile Island, Bophal, Challenger, Chernobyl, and Goiânia made the public perception of risk estimates become similar to their perception of science fiction. As a matter of fact, the general public became so confused with the low probability of occurrence of severe accidents with self proclaimed accident free

technologies, that they rather prefer to believe in subjective information than in scientific knowledge. Horoscopes, astrological maps and hand reading are examples of non-scientific and non-quantitative perceptions widely accepted by the general public. Even for a significant segment of the community of liberal professionals and scholars, not directly involved with the nuclear sciences, risk perception concerning nuclear accidents does not coincide with that of the nuclear community.

2.2. Very low risk

2.2.1. Advantages

This option avoids the usual discussion that the adopted risk limit is not low enough. It is usually defensible in debates with the scientific community.

2.2.2. Disadvantages

The cost to reach or get close to the low risk goal can easily become prohibitively high. In addition, the absence of a well established and achievable risk limit may imply in the production of an unjustifiable high volume of low level radioactive wastes. As a consequence, the future waste management may become too costly.

2.3. Best technology available

2.3.1. Advantages

It is obvious that if the best technology is timely and easily available it will be used. Thus, it depends on the site and circumstances of the RENA. However, it is important not to postpone the decontamination procedures until the best technology becomes available, to avoid scattering the initial contamination. So, whenever the best technology and the best trained individuals are available this option presents real advantages.

2.3.2. Disadvantages

The best technology or the best individuals to operate the devices and machinery may not be available. The problem of cost should also be taken into proper consideration to avoid unnecessary high decontamination costs in a minor accident.

2.4. Return to radiation background

2.4.1. Advantages

Whenever possible this is the ideal option. It is easily defensible in debates with either the scientific community or the general public.

2.4.2. Disadvantages

It is not always possible to return to the original radiation background. In addition, it is necessary to know the baseline before the accident in order to convince the critics that the background was reached. This is particularly true when one is dealing with accidents involving naturally occurring radionuclides or decommissioning technically enhanced sites.

2.5. Mixture of all options

2.5.1. Advantages

Different criteria can be applied to different problems that occur in decontamination. A selection of an option may depend on the importance of the site or entity to be decontaminated.

2.5.2. Disadvantages

One can be accused of lack of consistency when dealing with different problems. It is not easy to convince scientists and the public that different criteria may be applicable to different problems.

3. PRE-PLANNED CASE STUDY

Although there are a number of pre-planned studies reported in the open literature, one should bear in mind that a RENA seldom occurs in a predicted way.

In the case of nuclear power plants case studies are not only discussed in the licensing procedures, but are also updated as new information become available. As one among many examples, one can mention the United States Nuclear Regulatory Commission (USNRC) revision on safety systems response to loss of coolant and loss of off-site power (1).

4. UNPLANNED CASE STUDY — GOIÂNIA

4.1. Accident characterisation

The Goiânia accident has been fully described and characterised in a series of publications (2–4), however, many known interesting aspects, some of them relevant to decision making remain unpublished (5,6). This workshop may bring to light some new aspects concerning the characterisation of the Goiânia accident.

4.2. Source term characterisation

The source term was a broken teletherapy capsule of ^{137}CsCI with an initial activity of about 59TBq (1375 Ci) (3,4,7). The overall activity recovered in the decontamination procedures, including the remnants of the broken capsule, was estimated to be 49.0 ± 1.7 TBq (1324 ± 51 Ci). The uncertainty reported here represents about 3%, and it is an estimate based on data and information gathered and recorded by the teams involved in recovering the wastes resulted from the decontamination procedures at the time of the accident.

4.3. Control systems

One important aspect to delimit an accident to its initial and unavoidable consequences is to be able to act promptly. Unfortunately, this was not the case in Goiânia. Almost two weeks had elapsed before the accident was discovered mostly due to an unbelievable mixture of common sense and luck. After the discovery of the accident, the actions taken were able to control the already extensive damage to persons and properties.

Today, many things could be said as how one would go about in dealing with the Goiânia accident when it was first discovered. However, the responsibility to make a decision at the right time is something quite different than comment on that decision "a posteriori".

4.4. Decision on decontamination

In the case of Goiânia, one could say that the decision on decontamination had components of several criteria. Thus, a mixture of options can better describe the decision making process on the decontamination of Goiânia.

Reference levels were suggested to be used in the case of the Goiânia accident (3). Figure 1 represents schematically the reference levels with the variation of the natural radiation background in Brazil. The cut off level was to be chosen somewhere between the investigation and the action levels, taking into account the high variation of the natural background. The levels shown in Figure 1 were based on a relative scale, which in turn was reached based on the level of deposition of ^{137}Cs on the soil and the corresponding exposure rate (3,8-11). One of the objectives of the suggested reference levels was to reduce the amount of very low and non-radioactive wastes produced. However, one must again bear in mind that the responsibility for the final decision is different than that involved in making suggestions. The scientific subsidy is quite important for decision makers, but there are many other factors that have to be taken into account by responsible decision makers.

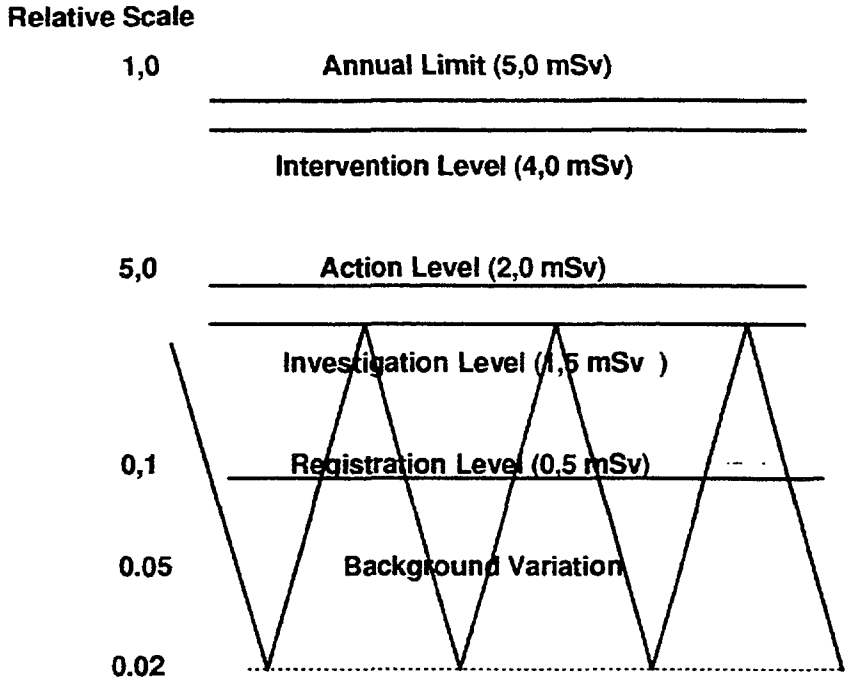

Fig. 1. Reference levels for Goiânia

5. CONCLUDING REMARKS

– Preliminary options to discuss the formation of radiological criteria to be used in decontamination procedures were presented and briefly discussed critically.

- Although one can pre-plan for an accident, the actual cases are mostly unpredictable. However, emergency preparedness should be maintained, because it is helpful even in unplanned cases.
- The Goiânia accident was briefly reviewed as an example of an unplanned case study.
- It was observed that in Goiânia a mixture of options in the decision making process occurred.
- Last, but not least, one concludes that the final decisions should be well subsidised scientifically, however, the responsibility remains with the authority who has the ultimate legal obligation to take decisions.

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