EVACUATION AND REENTRY POLICY FOR CASES OF GROUND DEPOSITION FOLLOWING NUCLEAR ACCIDENTS

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INTRODUCTION

Evacuation due to ground deposition after a large nuclear accident has to be decided on the basis of dose rate at a given time or of integrated dose over a defined period. This paper describes the rationale underlying the intervention levels used in Argentina, which have the objective of preventing serious non-stochastic effects and of limiting individual risk. The paper also discusses the basis of the levels of remaining ground contamination at which reentry would be permited, used in Argentina.

It should be stressed that, as it is the case in all invervention levels, the overriding principle is that the countermeasure should reduce risk: the risk avoided by the countermeasure should be larger than the risk of the countermeasure itself. The intervention levels, therefore, should be taken as indication for action, subject to judgement based on that overriding principle.

INTERVENTION LEVEL FOR EVACUATION

The main objective of evacuation is to prevent accumulation of doses leading to serious non-stochastic effects or to "unacceptably high" risk of stochastic effects. As non-stochastic effects depend not only on dose but also on the time distribution of dose, the intervention level must reflect the fact that exposure from ground deposition is a function of time.

Several expressions have been proposed to relate the "instantaneous equivalent dose" with an actual dose distribution giving the same magnitude of a non-stochastic effect. A very useful expression for the case of dose rate varying with time is the Walinder modification of the Kirk formula(1)

$$D_e(T) = \int_0^T 0.568\, \dot{D}(t)\, (T-t)^{-0.29}\, dt$$

where: $D_e(T)$ is the "instantaneous equivalent dose" received up to time T; $D(t)$ is the dose rate at time t, and the time is expressed as the number of days. In the case of constant dose rate, the above equation results in the classical Kirk formula

$$D_e = 0.8\, \dot{D}\, T^{0.71}.$$

The time evolution of the dose rate caused by ground contamination will depend on the radionuclide composition released in the accident, but usually for large reactor accidents it could be represented by a power function of the type

$$\dot{D}(t) = D(1)t^{-n},$$

where n is a constant and the time, again, is expressed as a number of units.

For radionuclide compositions considered to be representative of the postulated accidents on which the Argentine emergency plans are based, the value of n can be approximated by 0.55 and, if the time is expressed as number of days, D(1) is close to 90% of D(0). In this case, the Walinder modification of the Kirk formula predicts the following evolution of the accumulated "instantaneous equivalent dose":

TIME	1/4 DAY	1 DAY	1 WEEK	1 MONTH	1 YEAR
D_e	1	3	10.5	24	45

where the dose is normalized to the value of one at six hours. From the above time evolution, it is clear that accumulated actual doses of 0.1 Gy in 1/4 day will correspond to "instantaneous equivalent doses" of about 0.3 Gy in a day and more than 1 Gy in a week, entering from that time in a region of doses leading to serious non-stochastic damage. On the other hand, accumulated actual doses of 0.1 Gy in a day will correspond to D_e of somewhat more than 0.3 Gy in a week and only reach the 1 Gy level in many months.

On this basis, the intervention levels adopted are the following: for projected doses exceeding 0.1 Gy in six hours evacuation is indicated for all involucrated individuals, while for smaller doses but exceeding 0.1 Gy in 24 hours evacuation is indicated for those which are "easy" to evacuate (namely not involving particular evacuation risks). The situation is reevaluated for the remaining individuals at a later time.

In both cases, consideration of the stochastic risk also underlines the intervention levels. A whole-body dose of about 0.1-0.3 Gy corresponds to a stochastic risk (2) of a few times 10^{-3}, which is deemed to justify the countermeasure unless such countermeasure involves larger risk by itself. However, if non-stochastic damage becomes possible after a few days (such as in the case of doses exceeding 0.1 Gy in six hours), then this fact becomes overriding.

RE-ENTRY POLICY

Long after evacuation, when the ground deposit has decayed sufficiently, it has moved down in the groun or has been washed away, a decision is required regarding areas where reentry would be allowed for permanent occupancy. While there is not still a formal policy adopted in Argentina a value of 0.05 Sv in a year of effective dose equivalent is used in planning and assessments.

Such dose would imply a stochastic risk over a lifetime of the order of a few percent. Cost-benefit considerations, with the value of 10^4 $/man Sv used in Argentina, indicates that permanent refusal of re-entrey authorization at doses lower than that indicated above would not be justified. It should be pointed out that effective dose equivalents of that order are due in some cases to natural exposure to indoor radon(3).

BIBLIOGRAPHY

(1) Walinder, G. Radiologisk Katastrofmedicin, F.O.A., Stockholm, 1981.

(2) ICRP Publication 26. 3. ed. Oxford, Pergamon Press, Annals of the ICRP v. 1: N° 3, 1977.

(3) United Nations Scientific Committee on the Effects of Atomic Radiation. 1982 Report to the General Assembly, with annexes. New York, United Nations, 1982. 773 p.