

APPLICATION OF INTERVENTION LEVELS IN SWEDEN AFTER CHERNOBYL

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PURPOSE OF INTERVENTION LEVELS

The International Commission on Radiological Protection, ICRP, has stated that the purpose of intervention in case of an accident should be that the reduction in detriment achieved by the countermeasure should more than outbalance the detriment carried by the countermeasure itself (1). This has later been elaborated into three goals for intervention (2): a) avoid serious nonstochastic effects; b) achieve a positive net benefit to the individuals involved by limiting the risk from stochastic effects; and c) limit as far as reasonably practicable the overall incidence of stochastic effects.

Item b) has been criticised as lacking clarity and is likely to be revised in the review process started by the ICRP after the Chernobyl accident. In general, however, the three goals have been accepted as a basis for international recommendations about countermeasures following an accident.

A large number of factors influence the achievement of the three goals a), b) and c) following a reactor accident, e. g. the time pattern of the releases, the condition of the reactor, the number of people and domestic animals affected by a decision, the sheltering capacity of buildings, the time of the day or year, the weather and traffic conditions and so on. In the case of the consequences of the Chernobyl accident in Sweden, nonstochastic effects were never possible so the only goals applicable for countermeasures were a) and b), both related to stochastic effects. The international recommendations recognise the many factors relevant to the decision in such a case and suggest a decision aiding tool in the form of a range of individual radiation doses, within which an intervention level of dose (IL) should be chosen for the particular situation at hand. The simplest expression of this dose range is for the countermeasures of sheltering and control of foodstuffs, for which the range is an effective dose equivalent of 5 to 50 millisievert (mSv). In the case of foodstuffs this applies to the first year after the accident. With the aid of suitable conversion factors, an intervention level of dose can be converted to a derived intervention level (DIL) for e. g. an initial external radiation dose equivalent rate from ground contamination, or an activity concentration in food (3).

INTERPLAY BETWEEN RADIATION PROTECTION AND NATIONAL POLITICS

In the initial phase of the Chernobyl accident, the recommendations about the range of individual doses were explained to the Swedish minister of the environment and energy, who represented the government. She was told that the radiation protection authority

was at liberty to aim for an intervention level of dose within this range. A low intervention level of dose would entail costs of many millions of US dollars but would give the population the information that the radiation risks were taken very seriously.

The response from the minister was very unequivocal. She would back up any decisions that were in line with the traditionally strong concern for environmental contamination in Swedish politics, even at the expense of considerable costs to the government budget. This meant that in the following, the authority aimed for the lower limit of the range of individual dose when deciding upon countermeasures and derived intervention levels.

EXAMPLES OF COUNTERMEASURES

The attached table contains a list of several countermeasures discussed following the Chernobyl accident. The purpose of the countermeasure is given as well as various factors entering into the decisions about its application. The experiences after the countermeasure was instituted are reported, including the dose savings and their estimated costs.

DISCUSSION AND CONCLUSIONS

The table shows that many decisions on countermeasures were based on scarce information about radiation doses. The need for countermeasures that can be simply explained conflicts with the desire to adapt decisions to radiological conditions. It was difficult to adjust decisions to such factors as sex, age, status of health and geographical conditions even though this would have been desirable according to the ICRP recommendations.

The conclusion is therefore that preestablished intervention levels tend to focus interest on the individual radiation doses and hamper the consideration of other factors which are important for the achievement of the goals b) and c) give above. Nevertheless, the discussion of the role of intervention levels in relation to other factors has an important didactic role in the emergency organisation.

REFERENCES

1. Recommendations of the International Commission on Radiological Protection. ICRP Publication 26, Annals of the ICRP, 1 (3), Pergamon Press, Oxford (1977).
2. Protection of the public in the event of major radiation accidents: principles for planning. ICRP Publication 40, Annals of the ICRP, 14 (2), Pergamon Press, Oxford (1984).
3. Derived intervention levels for application in controlling radiation doses to the public in the event of a nuclear accident or radiological emergency: principles, procedures and data. Safety Series No. 81, IAEA, Vienna (1986).

<u>Countermeasure</u>	<u>Factors entering the decision</u>	<u>Implementation and result</u>
<u>Recommendation to stay indoors to secure time for consideration of further counter-measures</u>	- o respiratory protection - o expected additional ground contamination next few days - o holidays coming up - o monitoring still incomplete - o IL 5 mSv in one day - o DIL 0.15 mSv/h from ground contamination	DIL was never reached but one measurement late one night indicated the possibility. Before next morning this measurement was shown to be erroneous.
<u>Recommendation not to take iodine tablets to avoid adverse reactions</u>	- o pharmacy sales were booming - o the public was concerned about the lack of tablets - o maximum thyroid dose estimated to be less than 5 mSv - o lower limit of dose range for IL of 50 mSv was not explicitly quoted	Recommendation widely published. Typical reaction from the public: We still want to buy tablets to keep in case the situation improves. Later enquiry showed less than 1% took iodine pills, 10% considered buying pills but most of these refrained from buying.
<u>Recommendation not to travel closer to Chernobyl than 100 km and not to abstain from travelling to areas more distant than 500 km to avoid possible exposures without being overcautious</u>	- o very little was known about radiation doses near Chernobyl - o exposure times would in general be less than a few weeks - o additional information might become available about radiation doses - o assuming inverse proportionality to distance, first week doses would be 5 mSv and 1 mSv, respectively: no IL was quoted	Travellers generally more cautious than the spirit of the recommendation. Later information showed doses at distances above 100 km to be no higher than the highest doses in Sweden.
<u>Recommendation not to drink rainwater and eat fresh leafy vegetables to avoid ingestion of shortlived radionuclides</u>	- o high activity levels reported in rainwater - o very few leafy vegetables were exposed since growing season had not started - o countermeasure was very inexpensive and thus considered to keep radiation doses as low as reasonably achievable; no IL was quoted	Countermeasure criticized for having increased public concern unnecessarily, particularly for vegetables with small annual consumption, such as parsley.

Countermeasure

Recommendation not to let cattle graze outdoors to decrease iodine levels in milk and later iodine and cesium levels in milk and meat

Recommendation not to market food with elevated cesium content to limit individual effective dose equivalents

Recommendation for special protection for farm and other workers to ensure protection when working with air fillers, hay slaughter, leaf raking, ash handling etc.

Factors entering the decision

- o grazing season was just about to start
- o costs could rapidly rise to millions of US dollars per week
- o measure judged to be very efficient with respect to iodine, and later necessary to ensure compliance with DIL for cesium in milk
- o IL for I-131 was 50 mSv to infant thyroid
- o DIL for I-131 was 10 kBq/sqm ground area or 3 kBq for the grass collected from 1 sqm
- o DIL for cesium was to be derived from special test farm experiments
- o implications for Sweden's large international food trade
- o IL 5 mSv in first year, 1 mSv following years
- o DIL 200 000 Bq Cs-137 with other nuclides additional, as intake in the first year; 40 000 Bq following years
- o DIL 300 Bq/kg for all foods in the first year; changed to apply to basic foods only in the following years with DIL for other foods being 1500 Bq/kg
- o large groups exposed who were not transnational radiation workers
- o Implementation the responsibility of the occupational health authority which had little experience of radiation
- o LI 5 mSv first year
- o DIL 0.02 mSv/h at 1 m distance from the source

Implementation and result

Very extensive measurements led to a gradual lifting of the recommendation. Iodine was replaced by cesium as the main problem after about 2 weeks. The recommendation was lifted from the last parts of the country after about two months. Thyroid doses were less than 5 mSv. About 100 manSv were averted at a cost of several hundred thousand US dollars per manSv, but cost estimates have large uncertainties because of the difficulty to account for the costs saved due to absence of decreased milk consumption.

Initially strong public adherence to DIL for activity concentration in food. After about a year more understanding of the significance of annual intake limitation. Some 10% changed their food habits significantly and body burdens of cesium as a mean for Sweden were one-third of those predicted. Effective dose equivalents were less than 1 mSv first year but may for special groups reach 5 mSv following year. About 500 manSv were averted first year at a cost of about a hundred thousand dollars per manSv.

Extensive inquiries to the occupational health authority. Respiratory protection and work planning were main measures. Studies of farmers revealed no elevated internal contamination with cesium in spite of outdoor work without special precautions in areas with ground contamination of about 100 kBq/sqm.