THE IMPACT OF THE CHERNOBYL ACCIDENT ON NORWAY

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INTRODUCTION

As the fallout from the atmospheric nuclear weapons tests gradually decreased during the 1970s, the national preparedness and analytical capacity in Norway gradually disintegrated as well. The Chernobyl accident was therefore met without any overall contingency preparedness plan. The affected governmental bodies and other institutions had to improvise their first steps, including information to the public, until necessary coordination had been established. A complicating factor was the change of government during the first days of May 1986, the reasons for this had however nothing to do with the reactor accident.

A great deal of uncertainty prevailed about the accident and its consequences, especially during the first days after the accident. The Ministry of Health and Social Affairs and the Ministry of the Environment in May 1986 both appointed committees to report on the accident and its impacts and on a future preparedness system, although their given terms of reference were not identical. A third committe was appointed in June by the the Ministry of Health and Social Affairs to report on the "information crises" in connection with the accident.

AIR CONCENTRATION AND DEPOSITION ON THE GROUND

The peak concentration of the fallout from the Chernobyl reactor accident was first detected by permanent air monitor stations in the Oslo region in the morning of 28 April 1986. Probably contaminated air of lower concentration had already reached the country during the night. The maximum air concentration, 2-3 Bq Cs-137/m^3, was recorded during 28-29 April. The concentration of total I-131 at the same time was about 19 Bq/m^3. The existing air monitoring stations in other parts of the country had no facilities for immediate evaluation of the activity. It therefore took some time before the air concentrations outside the Oslo region were known, and that was heavily criticized in local newspapers. The air concentrations in the Trondheim region, and probably in other regions as well, had in fact been just as high as in Oslo.

The deposition pattern turned out to be rather complex, due to local precipitation in many areas while the air concentration was high. The deposition mapping was done by measurements of the direct gamma radiation from the ground, and also by soil sampling where four samples from each municipality should represent a mean value of the deposition in that municipality. In some municipalities the mean deposition was higher than 80 kBq/m^2, and certain areas exceeded 200 kBq/m^2. It has been calculated that Norway received about 1200 TBq of Cs-134 and 2300 TBq of Cs-137, corresponding to 6 % of the amount released from the reactor.

ACTION LEVELS

The only action levels put into force in Norway applied to radioactivity in food, concerning food sales only and not consumption of food supplied of one's own. At the earliest stage the levels for all types of food were 300 Bq Cs-137/kg and 1000 Bq I-131/kg. The iodine level remained unchanged, but the levels for radiocaesium were revised in June 1986 to be 370 Bq/kg for milk and baby-food and 600 Bq/kg for all other food, now including both Cs-134 and Cs-137. An increased level of 6000 Bq/kg was applied to reindeer and game meat in November 1986 and to fresh water fish in July 1987. The justification of the increase was that it would only lead to a modest incremental dose to the normal consumer.

FOOD MEASUREMENTS AND ACTIONS TAKEN

The radionuclides of concern in food were Cs-134 and Cs-137, only. All concentrations mentioned below refer to total radiocaesium in fresh food. The concentrations in dairy milk increased from the end of May until the beginning of August 1986 when they started to decrease. The monthly mean value of radiocaesium in milk from any local dairy did not exceed 100 Bq/litre in 1986, and all types of white cheese, butter and casein had negligible contents. Meat from cattle contained in 1986 generally less than 600 Bq/kg, and the content of pork was close to zero.

The number of sheep in Norway is about 2 millions, and during the summer these animals are normally grazing in the mountain fields of which many received considerable amounts of fallout. By their return to the villages in the autumn 1986, only 70 % of the sheep had a body content of radiocaesium below 600 Bq/kg, and 3 % had more than 2000 Bq/kg, some even above 15000 Bq/kg. The others were given a special diet of low activity fodder with certain additives. Within 4-6 weeks, the body content of most of these animals was less than 600 Bq/kg. Similar treatment was given in 1987.

Most of the domesticated and wild reindeer areas in Norway south of the polar circle were heavily contaminated. Some animals had a body content of nearly 90000 Bq/kg in the spring 1987, at the end of the lichen feeding period. The meat from domesticated reindeer from this part of the country will exceed 6000 Bq/kg for several years. Although Northern Norway had very little Chernobyl fallout, the radiocaesium content of its domesticated reindeer nevertheless exceeded 600 Bq/kg already in the autumn 1986. As a consequence, about 85 % of the country's annual production of domesticated reindeer meat would not have been allowed sold, probably for several years, if the action level had not been increased to 6000 Bq/kg. This might have had serious social consequences for the Lapp population and culture.

Cultivated Atlantic salmon and other marine products were very little affected by the Chernobyl fallout. The radiocaesium content of the salmon was below 10 Bq/kg in 1986. Also the content of cultivated fresh water fish was low all the time. The situation for wild fresh water fish was on the other hand less satisfactory, and in July 1986 all sales of such fish from nearly 50 municipalities were forbidden. Trout or char from some lakes in the most heavily contaminated areas exceeded even 50000 Bq/kg at the end of the summer 1986. Great variations were however observed, both among individual fishes, species and lakes. About 25 percent of the Norwegians are engaged in gamefishing in some way during the summer season, and the high radioactivity content in the fish caused a considerable public concern.

The highest radiocaesium concentration found in human milk was 20 Bq/litre in a sample from a woman who lived in the worst contaminated municipality, but most of the samples contained less than 5 Bq/litre. Except from very early lettuce and parsley, the radioactivity in vegetables has been low all over the contry, and the content of cereals has not exceeded 5 Bq/kg. Most of the lake and river waters measured in June 1986 had concentrati ons below 5 Bq/litre. Cistern water could contain as high as 10 kBq/litre in some areas, mainly iodine-131, just after the fallout. The population were recommended not to drink such water for some weeks.

TOTAL EXPOSURE OF THE POPULATION

The estimated individual and collective dose equivalents to the Norwegian population (4 million) the first year after the Chernobyl accident are given in the table below and compared with the background radiation doses. The total collective dose for all years after the accident is expected to be 2900 manSv, compared to 6200 manSv if no action levels had been established.

TABLE. Estimated dose equivalents to the Norwegian population the first year after the Chernobyl accident

Radiation source	Individual dose (mSv) Mean	Range	Collective dose (manSv)
Natural background	1.2		4990
Radon	4.0		16600
Medical X-ray	1.0		4150
Nat. and med. rad. total	6.2	1.0 - 15.0	25740
Inhalation	0.01	0.01 - 0.06	43
External gamma	0.10	0 - 2.3	414
Food	0.16	0 - 31	663
Chernobyl fallout total	0.27		1120

In October 1986 the Directorate of Public Health issued some general dietary guidelines concerning consumption of food of high radiocaesium content. Some preliminary studies indicate that the guidelines have largely been followed. The real individual doses to members of population groups like hunters, anglers, and sheep- and reindeer-breeders are therefore much smaller than those expected if their normal food consumption habits had not been altered. The 31 mSv dose in the table is thus probably too high.

DIFFERENT OTHER IMPACTS

The lack of an efficient governmental information service which could meet the very large demand from the media and the population in the early stage, placed a heavy additional burden on the employees of the involved institutions. Inevitably some contradictory statements were given and obtained major headlines in the media. The rather low action levels, being not only based on radiological, but also on commercial and psychological arguments, were in news media often erroneously referred to as risk levels. It also happened that, on radiological grounds, some experts argued for higher action levels while other experts wanted still lower levels. This lead to a widespread confusion and fear among the population, who developed a serious lack of confidence in the official statements and actions.

People were not adviced to stay indoors during the period of high air concentrations of radioactivity, and the cattle was let out as usual at the end of May without any restrictions. This was also criticized.

The exportation of cultivated Atlantic salmon was stopped by some of the importing countries, until it had been proven that the salmon was not affected by the Chernobyl fallout. 2300 tons of mutton and 550 tons of reindeer meat had to be discarded in 1986, as the content exceeded the action levels. The cost of the special feeding treatment plus the value of the discarded meat was about 150 million NOK or 23 million USD. In 1987 it is expected that such actions will cost about 70 million NOK. The reduction is partly due to the results of intensive research, including the use of an in vivo animal counting technique.

The tourist industry faced a reduction of visitors from certain countries as high as 42 % during the summer of 1986. In 1987 the number of foreign visitors was more like normal again.

CONTINGENCY PREPAREDNESS

The radiation contingency preparedness in Norway was before the accident mainly concentrated on emergency plans and monitoring systems in connection with the two research reactors in Kjeller and Halden. As a part of a nationwide early warning system, a network of ionization chambers has now been connected to the environmental data network system of the Norwegian Institute for Air Research. In September 1986 all main food control laboratories were furnished with modern equipment for gamma spectrometric analysis.

The committees having studied a future contingency preparedness system in Norway in light of the lessons learned from Chernobyl and other possible nuclear accidents, have presented their recommendations. These are now being assessed by the different governmental bodies involved.