Some of the statements of the International Committee on Nuclear Technology (ILK) about the impacts of the Chernobyl accident after twenty years

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Abstract

In January, 2006, the International Committee on Nuclear Technology – ILK -published a statement on the aftermath of the Chernobyl radiation accident. This accident induced a very heavy ground contamination mainly covering irregularly an area of ~ 4000 km^2. This central area is still "an exclusion area". Although the entire northern hemisphere was concerned, only territories of the former Soviet Union and small areas of the remaining Europe experienced significant contamination. A total area of 11,000 km^2 was contaminated with $^{134/137}$Cs, levels exceeding 555 kBq/m^2. The contamination in the medium Nordic latitudes resulting from the atomic bomb fallout ranged between 1.5 and 5 kBq/m^2. The "prohibited area" (4,300 km^2) is officially uninhabited, and its critical nuclides include ^{137}Cs, ^{90}Sr and also ^{239}Pu. Beyond the prohibited area, the critical radionuclides are only ^{137}Cs and ^{90}Sr. An area of about 30 km^2 was also contaminated with ^{90}Sr levels exceeding 10 kBq/m^2. The evacuees of this zone received average doses estimated at approximately 20 mSv. This is comparable to the typical dose received by a patient undergoing a medical computer tomography (CT) examination of the torso. The number of fatalities which have been and will be attributable to the Chernobyl accident has been estimated to lie around 4,000, including deaths from acute radiation syndrome, thyroid cancers in children and cancers in the population. An attempt to reduce thyroid doses by the administration of stable iodine to block radioactive uptake by the thyroid was made. Infant thyroid doses generally ranged from 1 to 20 mGy in Europe. Leukemia cases increased two years after the accident, but they are not clearly related to the accident. Solid cancers have not been observed. There is an association between cataracts and exposure to radiation from the Chernobyl accident above a threshold of 250 mGy. The food chains accounted for approximately 50% of the total dose received by the populations of the affected zones, and even up to 70% in the zones where poor soils prevail. Twenty years after the accident, exposures of populations are mainly due to the consumption of agricultural food contaminated by ^{137}Cs. Soil contamination with ^{137}Cs and ^{90}Sr may still be present. The regional average levels of ^{137}Cs in the diet of European Union citizens, by the end of 1990, approached pre-accident levels (EC 1994). The remaining physical risks of today are: a) the possibility of the collapse of the sarcophagus, b) the contamination of natural waters and aquatic ecosystems by runoff of ^{137}Cs and ^{90}Sr. In the 30 km zone, the experts also fear contamination of the groundwater by ^{241}Am, a decay product of plutonium.

It is the Editor's of HJNM suggestion that since olives, olive oil and sugar contain none of the above elements in a stable state they will not contain the same elements in a radioactive state and may therefore be preferred for consumption in case of a nuclear accident.

Keywords: Nuclear accident – Cancer risks – Contamination zone – Food contamination – Remaining risks

In January, 2006, the International Committee on Nuclear Technology – ILK published a statement on *Regulatory and management approaches for the control of environmental residues containing naturally occuring radioactive material (NORM):* Proceedings of a technical meeting held in Vienna, 6-10 December 2004, IAEA-TECDOC-1484. May I try to copy from the above paper some important facts. This accident induced an enormous release of radioactive materials into the environment, producing a very heavy ground contamination mainly covering irregularly an area of ~ 4000 km^2. This central area is still "an exclusion area" today. The doses received by the firemen and liquidators of the first phase after the accident ranged from a few hundred mSv to more than 10 Sv. Although the entire northern hemisphere was concerned, only territories of the former Soviet Union and small areas of the remaining Europe experienced significant contamination. A total area of 11,000 km^2 was contaminated with $^{134/137}$Cs, levels exceeding 555 kBq/m^2. In comparison: The contamination in the medium Nordic latitudes resulting from the atomic bomb fallout ranged between 1.5 and 5 kBq/m^2.

The "prohibited area" (4,300 km^2) includes a circular area with a radius of 30 km. This zone is officially uninhabited, and its critical nuclides include ^{137}Cs, ^{90}Sr and also ^{239}Pu. It is not clear whether a return to the 30 km exclusion zone will ever be possible nor whether it would be feasible to utilize this land in other ways such as grazing for stud animals or hydroponic farming. There are, however, a small number of generally elderly residents who have returned to that area with unofficial tolerance. Beyond the prohibited area, the critical radionuclides are only ^{137}Cs and ^{90}Sr. An area of about 30 km^2 was also contaminated with ^{90}Sr levels exceeding 10 kBq/m^2. The evacuees of this zone received average doses estimated at approximately 20 mSv. This is comparable to the typical dose received by a patient undergoing a medical computer tomography (CT) examination of the torso. We may also refer for comparison, that the dose limit for professional exposed workers under controlled conditions is normally 20 mSv per year. Also that: the average natural radiation exposure = 2.4 mSv/a (1-10 Sv), the X-ray of the lower back = 2 mSv, the scintigram of the thyroid = 1 mSv and the transatlantic flight Frankfurt-New York-Frankfurt = 0.1 mSv.

The number of fatalities which have been and will be attributable to the Chernobyl accident has been estimated to lie around 4,000, including deaths from acute radiation syndrome, thyroid cancers in children and cancers in the popula-

tion. An attempt to reduce thyroid doses by the administration of stable iodine to block radioactive uptake by the thyroid was made (Mettler 1992), but its success was doubtful because it came too late. For dosimetry, ^{131}I was the main contributor to the dose, via ingestion of milk. Infant thyroid doses generally ranged from 1 to 20 mGy in Europe, from 0.1 to 5 mGy in Asia, and were about 0.1 mGy in North America. Adult thyroid doses were lower by a factor of about 5 (UNSCEAR 1988). In Belarus, Ukraine and Russia, a total of approximately 3,000 cases of thyroid cancers were registered and treated to date; nine of these died. Outside the former Soviet Union, thyroid cancer incidence cannot be linked to the Chernobyl accident.

Although the number of leukemia cases increased two years after the accident, there is no evidence showing that this increase was more pronounced in areas that were most affected by the accident. In Ukraine, Belarus, Russia, Finland, Sweden and Greece there is a slight tendency for an increase in rates of childhood leukemia. However, there was no association between the extent of contamination and the increase in occurrence (WHO 2005).

Solid cancers in workers or in residents of contaminated areas have not been observed till now (WHO 2005).

According to estimates, the radiation-related increase of total cancer morbidity (incidence) and mortality (death) rates above the spontaneous level could be 1%-1.5% for low and 4%-6% for highly contaminated areas. This would result in about 2,000 predicted radiation-induced deaths among liquidators, about 1,500 among evacuees of highly contaminated areas and 4,600 in other contaminated areas. This evaluation does not take into account any uncertainty ranges in dose and risk factors. Such an increase would be very difficult to detect epidemiologically.

For children and liquidators, the studies clearly show an association between cataracts and exposure to radiation from the Chernobyl accident above a threshold of 250 mGy. The results observed here are compared to recent studies on astronauts and on patients having had CT scans.

A study of prenatally exposed children shows mental disorders and diseases of the nervous system which could be due to radiation or to the stress of the mothers who belonged to the group of evacuated and relocated persons.

For populations living in "contaminated territories" (6,400,000 people) annual estimated received doses were lower than 1 mSv for two thirds of the population and ranged between 1 to 10 mSv for the other third comparable to natural background radiation which reaches a few mSv per year worldwide. An analysis of effective doses mainly from ^{137}Cs and ^{131}I received by the population shows that three periods can be defined: a) The first year, which corresponds to the period with the largest received doses amounting to approx. 30% of the total accumulated doses. b) The second period corresponding to 1987-1991, during which the irradiation is only related to the ingestion of ^{134}Cs and ^{137}Cs and has been controlled and limited. c) The third period after 1991 is of comparable nature but with a lower level of protection because of increasing carelessness. The ^{137}Cs content in the human body today follows the natural rate of decrease in the environment, related to ^{137}Cs half-life of 30 years.

As late as 1991, the resettling criteria were still being discussed and applied (e.g. 555 or l,480 kBq/m^2 or 5 mSv per year). In comparison: The natural background radiation in Europe amounts to about 2.4 mSv per year. Add to this another 1 mSv per year on average from medical applications. Today, territories where populations receive an accident- related dose under 1 mSv per year are declared as a "zone permitting normal life".

The food chains accounted for approximately 50% of the total dose received by the populations of the affected zones, and even up to 70% in the zones where poor soils prevail. This confirms the importance of a well adapted agriculture. Later soil treatments reduced uptake of radiocaesium. The procedures applied can involve deep ploughing (dilution in soil), application of nitrogen, potassium fertilisers and lime (dilution of Cs in the plant).

There is a continuous, if slow, reduction in the level of ^{137}Cs activity in agricultural soil. However, 20 years after the accident, exposures of populations are mainly due to the consumption of agricultural food contaminated by ^{137}Cs. Since July 1986, the dose rate from external irradiation in some areas has decreased by a factor of 40, and in some places, it is less than 1 per cent of its original value. Nevertheless, soil contamination with ^{137}Cs and ^{90}Sr is still high. Restrictions on the use of land are still necessary in the more contaminated regions in Belarus, Ukraine and Russia. In these areas, no lifting of restrictions is likely in the foreseeable future. The uptake of plutonium from soil to plant in the prohibited area (4,300 km^2) constitutes a small health hazard for the population, because transfer rates from soil to plant and plant to man are very low.

In Germany, some milk in parts of Bavaria was converted into milk powder. The regional average levels of ^{137}Cs in the diet of European Union citizens, which was a source of exposure after the early phase of the accident, have been falling so that, by the end of 1990, they approached pre-accident levels (EC 1994).

In 1986, the EC imposed a ban on the import of food containing more than 370 Bq/kg of radiocaesium for milk products and 600 Bq/kg for any other food, regardless of the quantity consumed in the average European diet (EC 1986). Even twenty years on, the values for mushrooms (1,000 Bq/kg), milk, and forest berries, as well as for the meat of wild boar, elk and sheep are still high in heavily exposed areas, particularly in the contaminated zones of the former Soviet Union.

In 1990, forest workers in Russia were estimated to have received a dose up to three times higher than others living in the same area (IAEA 1994). Harvesting trees for pulp production may be a viable strategy for decontaminating forests (Holm 1995).

In the "exclusion zone" it was noticed: increased mortality of coniferous plants, soil invertebrates and mammals, chronic radiation syndrome in mammals and birds. Beyond the exclusion zone, no acute radiation-induced effects on animals and plants exposed to a cumulative dose of less than 0.3 Gy during the first month after the accident have been reported.

Before slaughtering, a supply of clean fodder was provided to animals. A more rational use of pastures was carried out. The net result of these measures was a reduction of the contamination of food by a factor of 2 to 15. The agro-alimentary transformations, such as the transformation of milk into cheese, can reduce the activity of ^{137}Cs and ^{90}Sr by a factor of 50. The majority of activity remains in the whey. Austria issued advice not to feed fresh grass to cows for a short period in May 1986. Restrictions on slaughter and consumption of sheep and reindeer are also still in force in some Nordic countries.

The remaining physical risks of today are: a) the possibility of the collapse of the sarcophagus, b) the contamination of natural waters and aquatic ecosystems by runoff of ^{137}Cs and ^{90}Sr. The average annual activity of ^{137}Cs in the water of the Pripiat river and the lake serving as a water reservoir for the above-mentioned cities has stabilized at around 0.1 to 0.2 Bq/l and is only ten times higher than the measurement levels recorded before the accident (IAEA 2005b). The hydro-geologic studies of the contamination of subsoil waters in the zone of exclusion show that ^{90}Sr is the most critical radionuclide, which could contaminate drinking water in the next 100 years above the currently acceptable limits, because it has penetrated deeper layers of soil more quickly than caesium.

Lastly, in the 30 km zone, the experts also fear contamination of the groundwater by ^{241}Am, a decay product of plutonium. As this radionuclide migrates into deeper layers of earth more quickly than plutonium (Smith and Beresford, 2005), this problem is to be monitored over the very long term.

The physiological effect of a radiation accident: "radiophobia" is very important to maintain normal life of the population affected by even small doses of radiation.

The Editor of the Hell J Nucl Med adds:

Important conclusive remarks from the above statement may be the following: a) The Chernobyl accident was much worse for the environment than the atomic bomb in Japan. b) After 20 years there are some measures still taken for recovery of both the food chain and the contamination of water. c) Some of these measures will last for many more years d) Thyroid cancers in children may be at least partly prevented by the early intake of stable iodine.

A practical advice

A practical and simple means of totally avoiding food contaminated by stable caesium, strontium or stable iodine is to know which food does not metabolize at all and does not contain either of these elements and also does not contain potassium, whose metabolism is similar to caesium. Olives, olive oil and sugar contain none of the above elements. In case of a nuclear accident, if we consume olives, olive oil and sugar and also vitamin plus mineral pills, stored dried bread and stored water, we will have a radiation free meal.

Bibliography

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The Editor