LIQUIDATION AND MINIMIZATION OF THE CHERNOBYL ACCIDENT CONSEQUENCES IN BYELORUSSIA

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ABSTRACT

The main part of the European territory of the former USSR contaminated after the Chernobyl accident belongs to Byelorussia. Twenty-three percent of its territory has been contaminated above 87.0 kBq/sq.m. Measurements undertaken have shown that the density of radioactive contamination is very different, the compositions of radionuclides and isotopes also differ in various contaminated regions. The protective measures taken in the republic were not sufficient, adequate and done in time due to several reasons. The paper describes some effects of the Chernobyl accident on economic, health and social situation in the republic. The experience in protective actions got in the five years after the accident in agricultural, industrial and social activities allow to formulate some results and conclusions on the post-accident situation in the republic.

RADIOLOGICAL CONSEQUENCES OF THE ACCIDENT

Nuclear accident at the Chernobyl NPP is the greatest catastrophe of the 20th century.The establishment of the regime of secrecy, the fear of panic, the ignoring of the experts offers and recommendations has led to about five-year period of keeping back the information about the real consequences of the accident from the public. Only in May 1989 the decision was taken to make the information about the accident accessible. In May 1990 the maps of Cs-137 contamination of the republic's territory were published in the newspapers.

The figures and the data characterizing the scale of the damages in the republic were put in different reports and publications many times (1-4). Below there are some of them. Five regions from the total six in the republic were subjected to radioactive contamination. About 70% of the total radioactive releases have fallen down on Byelorussia. Twenty-three percent of the total territory of the republic (46.500 sq.km) is contaminated to such an extent that it is difficult to carry on with the industrial, economic and social activities on it. (Compare: in the Ukraine it is 4.7% of its total area, in the Russian Federation - 0.25%) It is impossible to produce clean products on 18% of the agricultural territories. Fifty-three towns and 3711 villages are situated in the contaminated areas.

The urgent evacuation of the population from the near vicinity of NPP - 30 km evacuation zone- was carried out without precise information about the real situation in it. The verification of the radiological situation has led to additional evacuation of the population from three districts of Gomel region. In June 1986 the Academy of Science and Byelorussian State Hydrometeorological organization presented to the Government the first map of radioisotopes contamination of the Mogilev region and the proposals for taking necessary measures to protect the population of 50 settlements in Cherikov, Slavgorod, Krasnopolsk, Kostukovichi and Bychov districts. But only in January 1990 the population of some villages was relocated from those districts where the contamination level was from 3.34-5.55 MBq/sq.m.

It is natural that the main efforts of the country just after the accident were focused on the localization of the accident object, namely Unit 4 of the Chernobyl NPP, the NPP's site and the vicinities around it. In spite of the vast capacities of the superpower, which used to be the former USSR, it was extremely difficult to solve that problem in a short time. The unprecedented scale of the accident, which at that time was not fully understood, the inability of the Government structures to organize full-scale emergency work, lack of well-developed technical actions and appropriate equipment caused difficulties in carrying out the rescue and postaccident work at the NPP site. The above deficiencies were compensated by the enthusiasm of the personnel involved in emergency work and by drawing of huge resources from each corner of the former USSR. The whole country participated in that work. Practically, such regime of work was maintained during the whole 1986.

As soon as the main problems of the damaged Unit 4 localization, the construction of the sarcophagus, the cleaning of the NPP site and some equipment were solved, the problem of the accident consequences moved from the near vicinity of the NPP to the territories located quite far away from it. The sharp problem was to prevent the "in a valley" wash-out of radionuclides from the contaminated territories in spring to the rivers Dnieper, Pripjat and their tributaries which supply water for huge Ukrainian territories from North to South, including Kiev, the capital of the Ukraine, with 3.5 million inhabitants. To prevent that wash-out and protect millions of people from radioactive contamination of water, including drinking water, in 1986-1987 the specialized organization of Byelorussia and the Ukraine have designed, and the military engineering troops have constructed, 87 special filtration cross-pieces for the reclamation channels, 26 filtration dams on the rivers and 27 blank protective dams. Their total length was about 43 km. To intensify sedimentation of radionuclides in water fine fraction zeolites were periodically spread over some water bodies. At the second stage of the fulfillment of these protective measures special soil dams were built up along the banks of the rivers together with filtration trenches filled with peat as a sorbent. At the third stage filtration dams of gravel and zeolites were made up on many rivers.

According to the data of Civil Defence System that constructed those dams and other barriers to prevent the spreading of radionuclides with surface waters, those measures allowed to decrease the concentration of Sr in water 15 times, Cs - 35 times, fine particles - 350-450 times. After passing all these dams the water became practically clean. According to the other data there was no need to construct those dams and spreading zeolites since the main part of radionuclides was

present in water in a particle form and they were transferred to the bottom by the sedimentation process, anyway.

Gradually the problem of radiation protection of the population affected by the Chernobyl fall-out was becoming a matter of more and more concern. Some specialists believed that the governmental organizations did not pay appropriate attention to the problem of radiation protection of the population in time. If it is so, now it is difficult to say why. Was it because of the lack of precise information? Was it because of the lack of sufficient resources and technical means? Was it because of the fear of panic? It seems that all these reasons influenced the decision makers at that time. One example can illustrate the indecision, non-readiness and non-competence of the authorities. The administration of potassium iodide which was the most important and time-urgent measure to prevent thyroid gland exposures by I-131, especially to children, was not done in time, and therefore was practically useless.

Only in October 1989 the State Program on the Liquidation of the Chernobyl Accident Consequences was worked out and adopted. In 1990 State Chernobyl Committees in the three affected republics were established to coordinate and control the activities dealing with the implementation of the above program. By that time the problem of the Chernobyl accident consequences had become the subject of great public concern, of intensive discussions in the mass media. That time coincided with significant changes in social and political situation in the country which was called "perestroika". Social, technical, medical and scientific aspects of the Chernobyl problem assumed political coloring, especially in the affected areas. To a certain extent it influenced the nature of the adopted Chernobyl program. The program is based on the concept that "... living on the contaminated territory is dangerous for the health of existing and future generations and is accompanied by sharp worsening of psycho-emotional state of the population, therefore maximum decreasing of the dose rate for these people is needed".

According to the program the liquidation of the Chernobyl accident consequences on Byelorussian territory should be done in 3 stages.

- The first stage. Implementation of the emergency measures (1990 -1992)
  - relocation of the people from the territories with the contamination level higher than 5.42 MBq/sq.m;
  - providing financial privilege for the population living on the territories contaminated higher than 37 kBq/sq.m;
  - providing the people with clean food products;
  - stopping agricultural activities on the territories with the contamination level higher than 5.42 MBq/sq.m;
  - providing appropriate medical care for the population living on the contaminated territories; etc.
- The second stage. Implementation of the urgent measures (1993-1995)
  - creation of appropriate social and living conditions for the people in the zone of permanent control (37-185 kBq/sq.m);
  - creation of the necessary infrastructure in the relocated zones;
  - construction of medical service facilities, improvement of medical care of the population;
  - environment protection measures;
  - scientific research and radioecological monitoring to support normal living conditions of the population;
  - construction of disposal facilities for radioactive wastes.
- The third stage. Other measures (1996-2000)

This stage will be defined later when the results of the first two stages are more clear.

It was planned that the fund necessary for the implementation of the program will be provided by central All-Union budget. And it was so till 1992. However in 1992 since the USSR does not exist any more the program should be financed from the resources of the republic, or if it is not possible it should be substantially reduced. In 1991 3.7 billion roubles were spent for this program. In 1992 17 billion roubles are requested for the program, and about 6.5 billion roubles are expected from the Russian Federation.

AGRICULTURAL ASPECTS OF THE ACCIDENT CONSEQUENCES

According to the radiological survey of 01.01.91 1430 sq.km of agricultural land are contaminated by Cs-137 higher than 0.55 MBq/sq.m, 250 sq.km - higher than 1.48 MBq/sq.m. It should be pointed out that during the last five years 26.190 sq.km of arable land were lost for use. This associates with the loss of agricultural products for about 405 mill.rbls and the same amount for the loss of production facilities.

In 1986 temporarily increased limits for radionuclides concentration in food products were adopted in the USSR. Later those limits were decreased (Table I). During May-August 1986 the consumption of some products, for example milk, was restricted in 93 districts (from the total 117) because of high concentration of radionuclides in them.

The main task of agricultural activities in the contaminated zone is to produce food-stuffs with the contents of

TABLE I

Permitted Levels of Radionuclides Content in Food Products and Drinking Water (Bq/kg or BQ/l)

Food products	1986	1988	1990
Drinking water	3.7 E-4	1.8 E-5	1.8 E-4
Milk and milk products	3.7 E-4	3.7 E-5	1.8 E-5
Dry milk	3.7 E-3	1.8 E-3	3.7 E-4
Butter, concentr.milk	1.8 E-2	1.1 E-3	3.7 E-4
Pork, meat	3.7 E-3	1.8 E-3	5.9 E-4
Beef	3.7 E-3	2.9 E-3	5.9 E-4
Potatoes	3.7 E-3	7.4 E-4	5.9 E-4
Vegetables	3.7 E-3	7.4 E-4	5.9 E-4
Bread, sugar	1.8 E-3	3.7 E-4	1.8 E-4
Baby food	-	3.7 E-4	3.7 E-5

radionuclides not exceeding the permitted level, to develop technologies, which could allow to reduce contamination level in agricultural products and ensure radiological protection of the working personnel.

To implement this task various measures have been undertaken. The regime of the land use was changed for the territories contaminated by Cs-137 higher than 0,55-1,48 MBq/sq.m and Sr-90 - 0,11 MBq/sq.m. First of all, it is applied to deep ploughing, optimization of the soil acidity, optimal selection of fertilizers, the use of herbicides and weed-killers.

The problem is not to look for the proper way of clean food production on the contaminated territories, as the specialists know how to do it. The thing is that the republic does not have all the necessary resources to fulfil the task. It is due to the lack of necessary equipment and techniques, appropriate fertilizers, herbicides, weed-killers and the capacities for their production. Of course, there are a lot of problems for further investigation and justification, but even the known ones could not be solved because of the above mentioned reasons.

The further use of the contaminated territories deals with plenty of factors including self-cleaning processes in the soil, determined by the half-life of radionuclides and their migration. The velocity of Cs and Sr vertical migration in the soil is very low almost in all of its kinds excluding wet peat one. In untreated soils 90-95% of radionuclides are located in the top 5 cm layer. In plough-soils they are spread in the processed layer. The level of plant contamination depends much on the composition of the soil, the form of radionuclides in it and the type of the plant. It is possible to reduce transposition of radionuclides from the soil to the plants by means of proper selection of a plant type. The form and the state of radionuclides in the soil is an important and interesting subject of investigation since it can greatly influence the practical recommendations for agricultural activities on the contaminated territories.

Another problem is stock-breeding on the affected territories. It is possible to produce clean meat if animals could be transferred to clean products feeding for the period from 45 to 90 days after grazing them on the contaminated land. However, it is not clear yet how the received radiation dose would influence the health of the animals and could lower their resistance to various diseases. Besides the specialists do not consider stock-breeding on the territories contaminated higher than 0.55 MBq/sq.m to be reasonable. It is necessary to go on with the investigations, to collect more data and to develop new technologies for stock-breeding in such conditions.

The existing information shows that the Chernobyl catastrophe has caused great damage to agricultural production of the republic. The use of new special technologies has not allowed yet to solve all serious problems dealing with agricultural activities on the radioactively contaminated territories.

MEDICAL ASPECTS OF THE CHERNOBYL ACCIDENT CONSEQUENCES

Great number of people from the three republics was involved in the sphere of radiation exposure and radiation effects due to the Chernobyl accident. Radiation effects are characterized by two time periods. The first one deals with radiation effects of short-lived radioisotopes from the Chernobyl fall-outs. The specific feature of the second one is the long-term influence of long-lived radionuclides which will be felt during the lifetime of several generations. Radiation effects and their medical-biological influence on the people are different for these two periods, and it should be kept in mind while analyzing the medical aspects of radiation exposures of Chernobyl origin. In the first case it is a matter of short-time local thyroid gland exposure with a relatively high dose. In the second case it is long-time exposure practically of the whole body with a relatively low dose.

Taking into account the unprecedented scale of the accident and its specific features the Government of the USSR at the recommendation of the National Committee on Radiation Protection adopted and authorized the dose limit for the population of 0.1 Sv during the first year after the accident. In the next years up till 1990 new reduced dose limits were adopted - first of 0.03 Sv, then of 0.025 Sv. So the authorized summary dose limit for the critical group of population in the four years after the accident should not exceed 173 mSv. Those dose limits did define the protective measures which were recommended by Ministry of Health and National Committee on Radiation Protection. Based on a number of direct and indirect measurements it was estimated that real doses for the population in the zone of permanent control (0.55-1.48 MBq/sq.m) was 77 mSv for the first year after the accident, and for the period 1987-1989 it was 23 mSv that is less than was expected. At the same time it is quite obvious that even keeping in mind all the protective measures undertaken the radiation exposure of the population has become chronicle. The circumstances demand the development of the allowed dose limit concept, the realization of which could ensure the population safety and return to its traditional style of life.

As a criteria of defining the safe living conditions for the population a total dose limit collected during the whole life was proposed as a risk factor of distant stohastic effects. On the accurate analyses of domestic and foreign experience in the field of radiation exposure effects for different dose rates, the dose of 0.35 Sv was recommended as a total one of internal and external exposure for the 70 years of life period. This concept of 0.35 Sv life-time dose was adopted in the Russian Federation. However, the specialists in Byelorussia and the Ukraine decided that the life-time dose limit should not exceed 0.07 Sv above natural background irradiation, and this concept was adopted in the republics.

Based on this concept the law on legal regime of the contaminated territories was adopted. According to this law the territories are divided into several zones depending on the contamination level and expected radiation effects on the people. (See Table II).

In 1991 Ministry of Health and the Institute of Radiation Medicine worked out a catalogue of radiation doses for the population of 1194 settlements located on the territories with the contamination level higher that 0.18 MBq/sq.m. The dose assessment methods include the analysis of certain food products and the measurement of radiation level in the settlements. The catalogue has a tabular form and includes information on the number of inhabitants in each settlement, the level of contamination by each isotope (Cs-137, Sr-90, Pu-239, Pu-240), the dose of external exposure, the dose of internal exposure and the average total dose per person for one year. These estimated data allowed to verify the hazard level for the people living on the contaminated territories and the zones from which the people should be relocated. Of course, the

TABLE II

Zones of Radioactive Contamination

Zone of radioactive contamination	Contamination level Cs-137 Sr-90 Pu-391 MBq/sq.m kBq/sq.m kBq/sq.m			Estimate Dose mSv/year
Evacuation zone	30 km zone			-
Zone of urgent relocation	>1,48	>111	>3,7	-
Zone of subsequent relocation	0.55--1.48	74-111	1.8-3.7	>5
Zone of voluntary relocation	0.18--0.55	18-74	0.74-1.8	>1
Zone of periodical radiation control	0.04-	5-18	0.37-0.74	<1

decision on additional protective measures or on the relocation should have been made, so to say, "already yesterday". However to do this it is necessary to dispose of huge resources which are not available now. The economic situation in the whole country and in the republic is very complicated. In this connection the latest data on health conditions and on radiation effects of the Chernobyl accident consequences seem to cause a lot of trouble. A matter of particular anxiety is the increase of a number of children thyroid gland cancer. In the period from 1981 to 1985 only 7 cases of children thyroid gland cancer were registered, moreover, not a single one was registered in Gomel and Mogilev regions. Since 1986 till 1990 already 45 of such cases were registered and for today this figure has increased to 105 cases. Fifty eight of them, that is more than the half, occurred in Gomel region where there were no cases of thyroid gland cancer at all till 1986.

According to cancer data base, established in the republic 18 years ago, the cancer rate is permanently increasing in the last ten years. Since 1979 till 1990 it raised for 49%. The considerable increase after the accident is mainly due to thyroid gland cancer and leucaemia. In the last couple of years the health situation in the republic became worse in general. More cases of cardiovascular disorders, psychological disorders, digestive organs disorders, cold and flu diseases are observed. As one of the reasons for this increase we can mention the broader investigation of the health condition of the population especially in the contaminated and relocated areas. Another reason for the worsening of the people's health can be psychological tension and stresses, anxiety and uncertainty dealing with ecological and economic situation in the republic which is definitely very hard.

CONCLUSIONS

The accident at Unit 4 of the Chernobyl Nuclear Power Plant in the scale of its consequences goes far beyond the frame of ordinary industrial accidents. The reasons and the associated technical features of the accident are more or less clear to the specialists now. But social, psychological and medical effects are definitely broader and more complicated, and plenty of time and efforts are needed for their study and better comprehension. However, we are aware today that these consequences have already greatly influenced the social and economic situation in the affected regions, and in Byelorussia they acquired the scale of national catastrophe.

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