Committee on the Problems of the Consequences of the Accident at the Chernobyl NPP, Republic of Belarus

15 YEARS AFTER CHERNOBYL CATASTROPHE : CONSEQUENCES IN THE REPUBLIC OF BELARUS AND THEIR OVERCOMING

NATIONAL REPORT

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National report is aimed to promote dissemination of objective information on the situation after the Chernobyl catastrophe in the Republic of Belarus.

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"…In case of Chernobyl, the victims live in three countries: Belarus, Ukraine and Russia Federation. The exact number of them may never be known. But three million children require physical treatment and not until 2016, at the earliest, will we know the full number of those likely to develop serious medical conditions. The most vulnerable victims were, in fact, young children and babies unborn at the moment when the reactor exploded. Their adulthood – now fast approaching – is likely to be blighted by that moment, as their childhood has been. Many will die prematurely. Are we to let them live, and die, believing the world indifferent to their plight?…"

Kofi A. Annan
Secretary-General of the United Nations
(CHERNOBYL: a continuing catastrophe.
United Nations. New York and Geneva, 2000)

Not everybody can imagine a real scale of the catastrophe the consequences, which have been experienced by Belarus so far. Many people, particularly abroad, think of Chernobyl accident as an event of the past. However, it continues, having devastating impact on all spheres of vital activities in our country. Still worse is that no one can be sure that the most dreadful consequences for human health and environment have gone by, regardless of the fifteen years which have past after the explosion that destroyed the nuclear reactor at the Chernobyl nuclear power plant in the neighboring Ukraine.

Breakdown of the reactor was the reason of the tragedy that still brings death, sufferings and misery. The consequences of the catastrophe both for the population and the economy of Belarus can hardly be measured.

Multiple abnormalities in the state of health are registered in the contaminated territories. These abnormalities are caused both by radiation and other reasons, first of all, by low living standards. There are medical manifestations of hard stresses to population. They have undoubtedly revealed the relation between radiation impact and unprecedented growth of malignant neoplasms of thyroid gland of Belarusian children.

"Chernobyl" regions of Belarus are characterized by distorted demographic structure. Thus, more than 135 thousand people were relocated and at least 200 thousand people became forced migrants who left the contaminated regions unorganized. Youth, intelligentsia and skilled specialists were actively leaving the area and are doing the same now. In some most affected regions old aged people constitute 70% of population, thus three times exceeding similar figure for the republic as a whole.

The President and the Government of the Republic of Belarus still give the utmost priority to the consequences of Chernobyl catastrophe. This is proved by adoption of the new State Program of the Republic of Belarus on Overcoming the Consequences of the

Catastrophe at the Chernobyl Nuclear Power Plant in 2001-2005 and for a period of up to 2010.

A lot has changed since 1986. Global changes affected many countries of the world, including Belarus. New states that emerged at the territory of the former USSR go through the system transformation, turning from planned to market economy. In Belarus the consequences of the Chernobyl disaster concurred with economic difficulties caused by the disintegration of the USSR, breakdown of precious state and social structures. Constructing a young Belarusian state, we have to solve many economic and social problems and, to add, do everything to minimize the consequences of the accident at Chernobyl nuclear power station. The scope of post-Chernobyl problems greatly exceeds available opportunities, though the funds assigned to eliminate the consequences of the disaster amount to 6% of the state budget expenditures. Against the background of new emergency situations and crises that shocked world community, Chernobyl is almost forgotten and one has to certify that the assistance by the world community is not consistent with the scope of current problems and is ineffective.

Besides fields and forests contaminated for many long years, deserted villages and deprived people devoid of their own hearths, distrust of our fellow citizens to official sources of information is another sorrowful heritage of Chernobyl. It has become obvious that inadequate information causes damage not less than radiation impact. The present report is aimed to provide objective situation of the consequences of Chernobyl catastrophe in the Republic of Belarus, what has been and is to be done. Our goal is to draw attention to post-Chernobyl problems and remind that the victims of this tragic disaster still need assistance.

Chairman of Committee
on the Problems of the Consequences
of the Accident at the Chernobyl NPP **V.G. Tsalko**

CHAPTER 1

RADIOACTIVE CONTAMINATION OF BELARUS

Radioactive contamination of the environment in the territory of Belarus began just after the explosion of the reactor. Peculiarities of weather conditions during April 26 to May 10, 1986 as well as composition and dynamics of emergency release of radioactive substances caused a compound nature of republican territory contamination.

Analyzing radioactive contamination of European territory with caesium-37 shows that the territory of Belarus accounts for minimum 34% of Chernobyl fall-outs of this radionuclide in the European continent and according to some other estimates, this share amounts to 70%. Contamination of the territory of Belarus with caesium-137 with the density of above 37 kBq/m^2 constituted 23% of the total area of the republic (5% for the Ukraine and 0.6% for Russia). Regarding the large scale and weight of the consequences of the catastrophe at Chernobyl nuclear power station, in July, 1990 the Supreme Soviet of Belarus declared the territory of the republic the zone of ecological disaster.

Radiation monitoring of the environment objects in the Republic of Belarus is performed by State Committee of Hydrometeorology, Ministry of Food and Agriculture, Ministry of Forestry, Ministry of Housing and Communal Services, institutes of the National Academy of Sciences of Belarus, Manufacturing Association "Belarusgeologiya", Belgiprovodkhoz, Polesskiy State Radio-Ecological Reserve. To determine the behavior of radionuclides in different ecosystems and develop forecasts, fundamental research studies are underway in the republic.

Regarding the specificity of radioactive contamination of some regions, their landscape geochemical features and other factors, a network of continuous monitoring of environment (Fig. 1.1) has been established in the republic, including 181 reference sites and 19 landscape geochemical grounds.

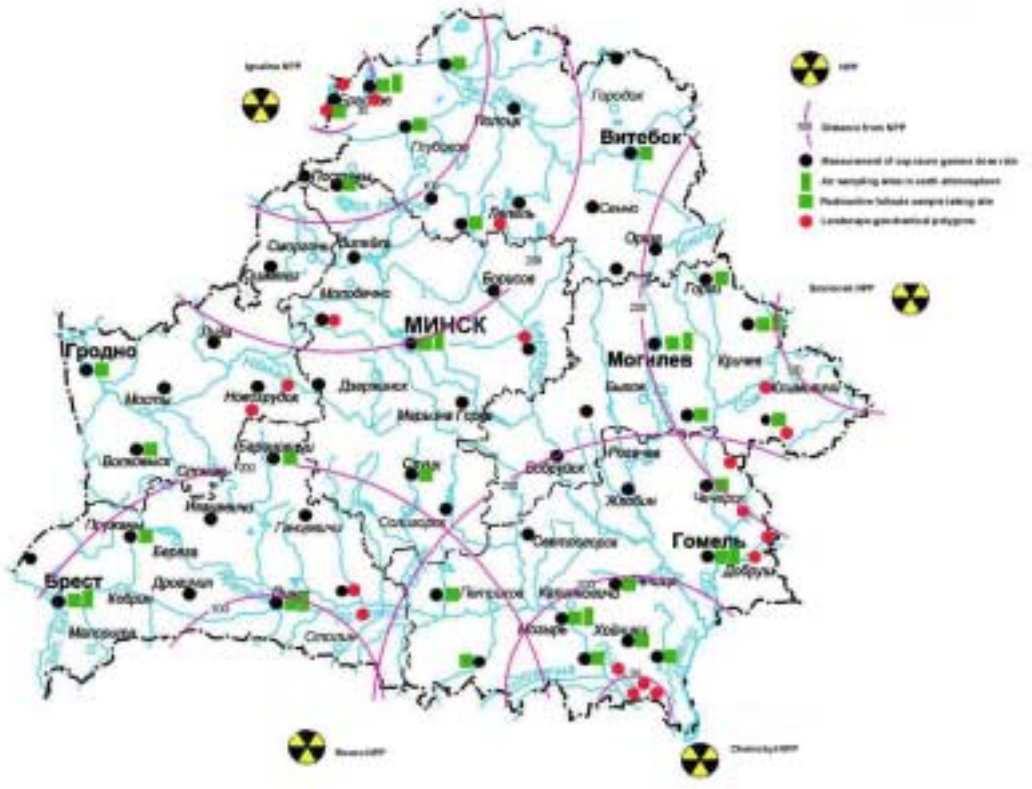


Fig. 1.1. System of radio-ecological control and monitoring of environment

1.1. Contamination of Belarus with radioactive iodine

During the first period after the catastrophe considerable growth of gamma-radiation exposure dose was registered almost in the whole territory of Belarus. The amount of available experimental data on measurements of iodine-131 activity in fall-outs is limited, which required development of special procedures to remodel radioactive contamination with iodine (Fig. 1.2).

The largest levels of iodine-131 fall-out were registered in the near zone of Chernobyl nuclear power station, namely in Bragin, Khoiniki and Narovlya districts of Gomel region, where its content in the soil was 37,000 kBq/m^2 and more. In Chechersk, Korma, Bouda-Koshelyovo and Dobroush districts contamination levels reached 18,500 kBq/m^2.

Such south-west areas as Elsk, Lelchitsy, Zhitkovichi, Petrikov districts of Gomel region as well as Pinsk, Louninets and Stolin distrcits of Brest region were exposed to extensive contamination.

High contamination levels were registered to the north of Gomel and Mogilev regions. In Vetka district of Gomel region iodine-131 content in soil reached 20,000 kBq/m^2. In Mogilev region the highest contamination was recorded in Cherikov and Krasnopolye districts (5,550-11,100 kBq/m2).

Territory contamination with iodine-131 caused high radiation doses of thyroid gland ("iodine attack"), which resulted later on in considerable growth of its pathology, particularly with the children.

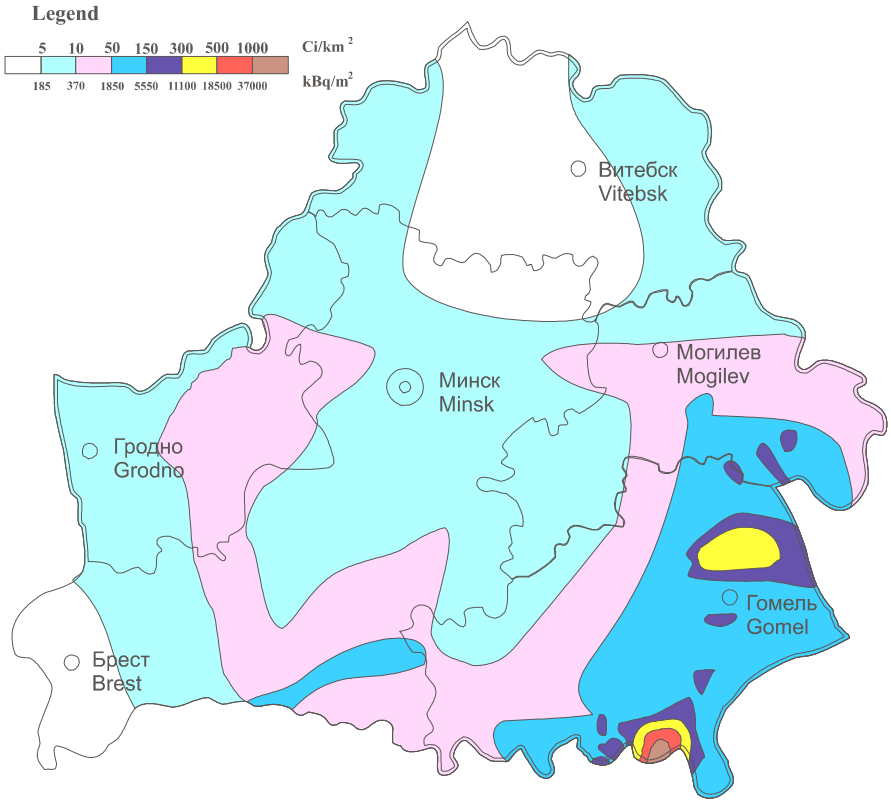


Fig. 1.2 Remodeling of iodine-131 distribution in soil in the territory of the Republic of Belarus as of 10.05.1986

1.2. Contamination of Belarus with caesium-137

After the accident at Chernobyl nuclear power station soil contamination with caesium-137 (^{137}Cs) exceeded 10 kBq/m^2 (0.3 Ci/km^2) at 136.5 thousand km^2 (66%) of Belarusian territory. Contamination is of non-uniform, spot-like nature. Analyzing the charts of caesium-137 contamination of Belarusian territory (Fig. 1.3) allows to distinguish several main areas. First of all, this is the near zone of Chernobyl nuclear power station that includes 30-km zone around the plants. Contamination levels of soil with caesium-137 in this territory are extremely high, maximum values at some points exceeded 37,000 kBq/m^2 (1,000 Ci/km^2). At the same time contamination levels at some places do not exceed 185 kBq/m^2 (5 Ci/km^2).

Part of contamination is called north-western track. It includes south and south-west of Gomel region, central areas of Brest, Grodno and Minsk regions. Contamination level in the track is considerably lower than in the near Chernobyl zone.

The third spot is to the north of Gomel region and central part of Mogilev region.

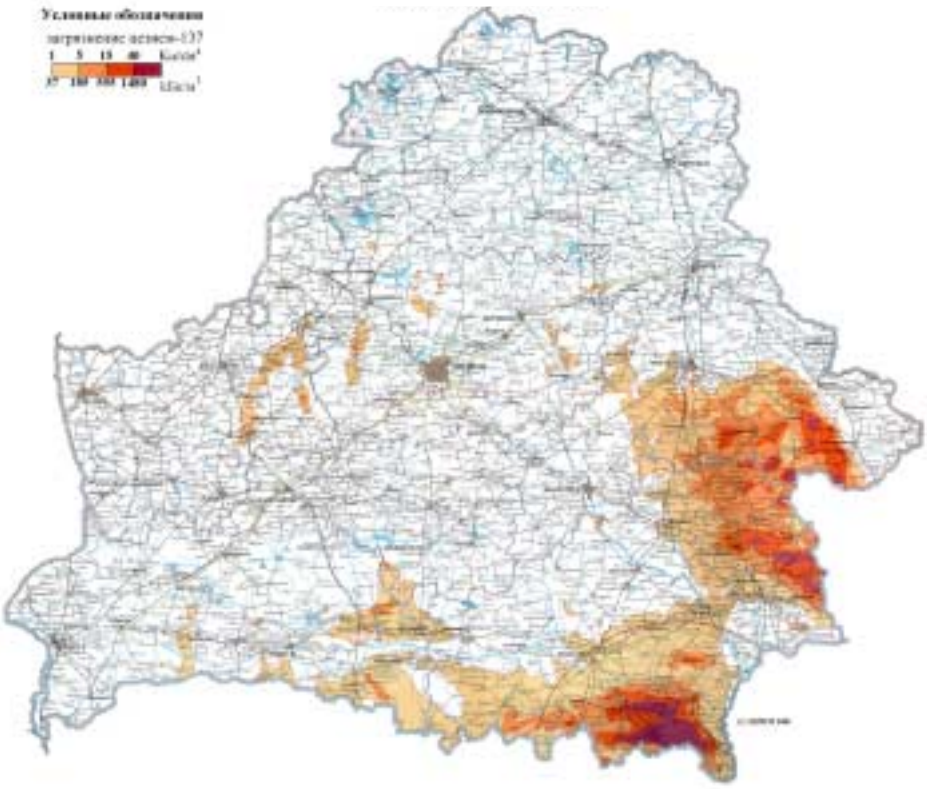


Fig. 1.3. Contamination chart of the territory of Belarus with caesium-137 as of 2001.

Non-uniformity of contamination can be observed even within one settlement. So, in the settlement of Kolybanj of Bragin district, Gomel region, contamination levels vary from 170 kBq/m^2 (4.6 Ci/km^2) to 2,400 kBq/m^2 (65 /km^2).

The highest soil contamination with caesium-137 in the near Chernobyl nuclear power station zone is detected in the settlement of Kryuki of Bragin district, 59,200 kBq/m^2 (1,600 Ci/km^2), and that in the remote zone (local spot at 250 km from Chernobyl nuclear power

station) – in the settlement of Choudyany of Cherikov district, Mogilev region, 59,000 kBq/m^2 (1,595 Ci/km^2).

Caesium-137 soil contamination of above 37 kBq/m^2 (1 Ci/km^2) was detected in Brest region in the territory of 6 districts. Mainly contamination levels range from 37 to 185 kBq/m^2 (1 to 5 Ci/km^2) and only at some places they reach 400 kBq/m^2 (10 Ci/km^2). The highest level is registered in the settlement of Barsoukovo of Louninets district – 780 kBq/m^2 (21 Ci/km^2).

In some settlements of Grodno and Minsk regions and 4 settlements of Vitebsk region caesium-137 content amounted to 37 kBq/m^2 (1 Ci/km^2). The highest levels are recorded in the territory of Volozhin district of Minsk region where soil contamination with caesium-137 in some places exceeds 185 kBq/m^2 (5 Ci/km^2). After Chernobyl disaster soil contamination with caesium-137 exceeded 10 kBq/m^2 at 137 thousand km^2 (66%) of the territory of Belarus, at some places pre-fault soil contamination with radionuclide constituted 1.5 to 3.7 kBq/m^2.

In accordance with Article 4 of the Law of the Republic of Belarus "On legal regulations of the territories exposed to radioactive contamination as a result of the catastrophe at Chernobyl nuclear power station", the zones of radioactive contamination include the territories where the density of soil contamination with caesium-137 is 37 kBq/m^2 (1 Ci/km^2) and more, that of strontium-90 – 5.5 kBq/m^2 (0.15 Ci/km^2) and more, plutonium-238,-239, 240 – 0.37kBq /m^2 (0.01 Ci/km^2) and more. Assumed zoning is used when planning and taking measures to minimize the consequences of the catastrophe at Chernobyl nuclear power station and to ensure radiation safety of the population.

1.3. Contamination of the territory of Belarus with strontium-90

Contamination of the republic territory with strontium-90 (^{90}Sr) has more local nature, compared with caesium-137 (Fig. 1.4).

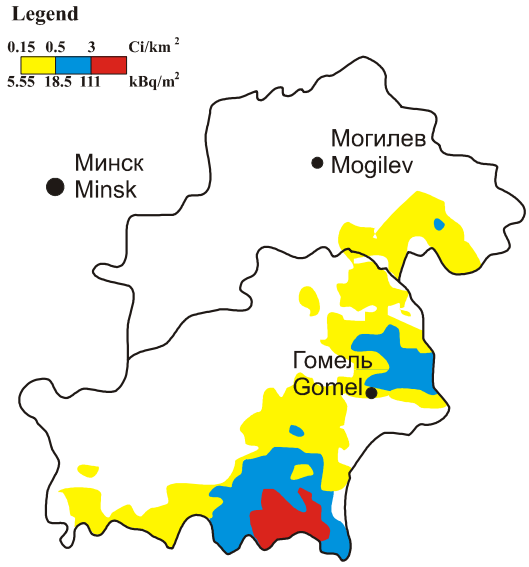


Fig. 1.4. Contamination of Gomel and Mogilev regions with strontium-90 as of 2001

Soil contamination with this radionuclide of above 5.5 kBq/m^2 (0.15 Ci/km^2) are detected at an area of 21.1 thousand km^2, which is 10% of the republic territory. The highest strontium-90 levels were registered within 30-km zone of Chernobyl nuclear power station and they reached 1,800 kBq/m^2 (48.6 Ci/km^2) in Khoiniki district of Gomel region. The highest strontium-90 activity in soil in the remote zone was detected at 250-km distance in

Cherikov district of Mogilev region and it amounted to 29 kBq/m^2 (0.78 Ci/km^2) as well as to the north of Gomel region, Vetka district, - 137 kBq/m^2 (3.7 Ci/km^2).

1.4. Contamination of the territory of Belarus with plutonium isotopes

Soil contamination with isotopes of plutonium-238,-239,-240 (^{238,239,240}Pu) with density of above 0.37 kBq/m^2 (Fig. 1.5) covers about 4.0 thousand km^2 or almost 2% of the republic territory. These territories are mostly located in Gomel region (Bragin, Narovlya, Khoiniki, Rechitsa, Dobroush and Loevsk districts) and Cherikov district of Mogilev region. Plutonium isotope contamination with high density is typical for 30-km zone of Chernobyl nuclear power station. The highest levels are observed in Khoiniki district, above 111 kBq/m^2.

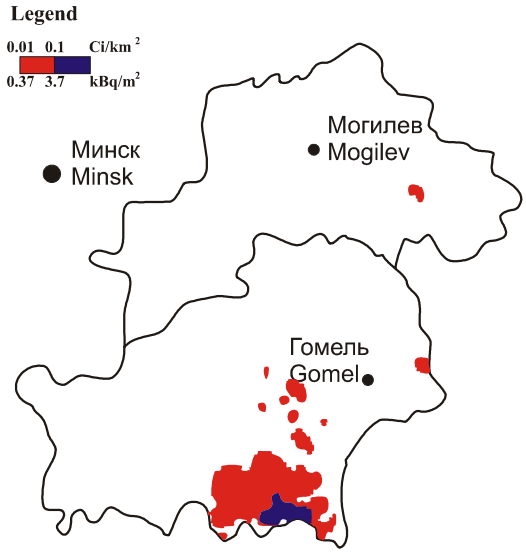


Fig. 1.5. Plutonium contamination of Gomel and Mogilev regions as of 2001

1.5. Problem of americium-241

As a result of beta-decay of 241Pu, americium-241 (^{241}Am) is being formed in radioactively contaminated territories in the mounts comparable with that of major α-sources. Since ^{241}Am by radiotoxity is close to α-isotopes of plutonium, the problem of estimating consequences of its accumulation has become topical.

At present americium-241 contributes 50% to total alpha-activity. The growth of alpha-activity of soils contaminated with transuranium isotopes due to americium-241 will continue till 2060 and its contribution will be 66%. Plutonium isotope contribution will be as follows: ^{238}Pu – 7,1%, ^{239}Pu – 10,5%, ^{240}Pu – 16%. In 100 years after the accident at Chernobyl nuclear power station, in 2086, total soil α-activity in the contaminated territories of the Republic of Belarus will be 2.4 times of that during initial post-fault period. Reduction of soil α-activity of americium-241 to 3.7 kBq/m^2 is expected after the year of 2400.

Nowadays, zoning the territory of Belarus contaminated with radionuclides is based on the data on the content of ^{137}Cs, ^{90}Sr and isotopes of plutonium ^{238,239,240}Pu in the soil. Results of calculations made on the basis of measurements of ^{238,239,240}Pu and ^{241}Am content in the soil show that regarding americium-241 contribution to soil contamination, the amount of settlements related to the zone contaminated with transuranium elements increases. The obtained results indicate the gravity of the problems that can arise due to ^{241}Am activity growth. Their solution requires investigation of the role of ^{241}Am when forming dose loads on population.

CHAPTER 2

RADIO-ECOLOGICAL SITUATION IN BELARUS

2.1. Forms and peculiarities of radionuclide behavior in soils

Physico-chemical state of radionuclides in soil and first of all the amount of their mobile forms are the determining factor of radiocaesium and radiostrontium migration in soil profile and by biological chains for many decades. In time the ratio of easy dissoluble and unexchangeable forms changes and these changes have their own peculiar features in different landscapes, biocenoses and genetic horizons of soils.

During the first post-fault period (1986-1989) 70-95% of caesium-137 and 50-70% of strontium-90 were contained in upper 0-5 cm soil layer, "fixed" unexchangeable forms dominating. ^{90}Sr state in soils differed in somewhat higher content of mobile forms.

Later there were changes in the ratio of easy dissoluble and fixed forms of radionuclides. To add, beginning from 1991-93 to present, higher content of mobile radionuclide forms has been observed in 5-10-cm soil layer. This trend is more evident for radiostrontium.

At present the percentage of caesium mobile forms in sod-podzol soils amounts to about 10%, that of strontium – 70%; in peat soils – 15% and 50%, respectively. Major amount of ^{90}Sr for sod-podzol soil is in the most mobile forms, i.e., water-soluble and exchangeable ones, for peat-gley soil – in acid-soluble ones.

The content of americium and plutonium mobile forms in soils does not exceed 12.5% and 9.5%, respectively. As a rule, the percentage of mobile americium is higher than that of plutonium. In general, in time there are no express tendencies for the content of transuranium-element mobile forms to change. As far as $^{239,\ 240}$Pu and ^{241}Am mobile form content is concerned, the soils may be arranged as follows: sod-podzol (4.7 and 8.8%), sod (2.5 and 4.1%) and peat (1.2 and 1.9%).

Results of radionuclide migration studies indicate the change of average annual rate of ^{137}Cs migration in typical soils of Belarus. This change becomes most apparent in peat soils where annual rate of ^{137}Cs distribution median displacement decreased in 1989-1998on average 2.5-3 times. Observed dynamics of ^{137}Cs migration behavior in peat soils is the evidence of compound nature of ^{137}Cs interaction with soil complex. The obtained data shows that half-refinement time of upper, 0-5 cm thick peat soil layer of ^{137}Cs exceeds on average 10 years, whereas in sod soils it can last 1.5-2 times longer. Thus, ^{137}Cs will still be considerably active in the root-inhabited layer of soils for a long time.

2.2. Active particles in soils

Availability of particles with high specific activity was a characteristic feature of "Chernobyl" fall-outs. These particles can be divided into two types: fuel or "hot" particles (aggregates of micron and submicron sizes) that are characterized by alpha-, beta- and gamma-radiation, and active particles of condensation origin that are the products of radionuclides sorption at various aerosols.

During the period past from the accident, the amount of active particles decreased in mineral soils by2-3 orders of magnitude and in organogenic ones by 1-4 orders of magnitude (Fig. 2.1). At present the amount of active particles per 1 m^2 constitutes $5.0\cdot10^2$–$5.0\cdot10^3$ in mineral soils and $1.0\cdot10^2$–$1.0\cdot10^4$ in organogenic ones. In soils of one and the same genesis the rate of particle dissolution at the plots more remote from Chernobyl nuclear power station

is higher than that of the near regions. One should emphasize that particle dissolution rate in organogenic soils is higher that that of particles discovered in mineral soils at the same distance from Chernobyl nuclear power station.

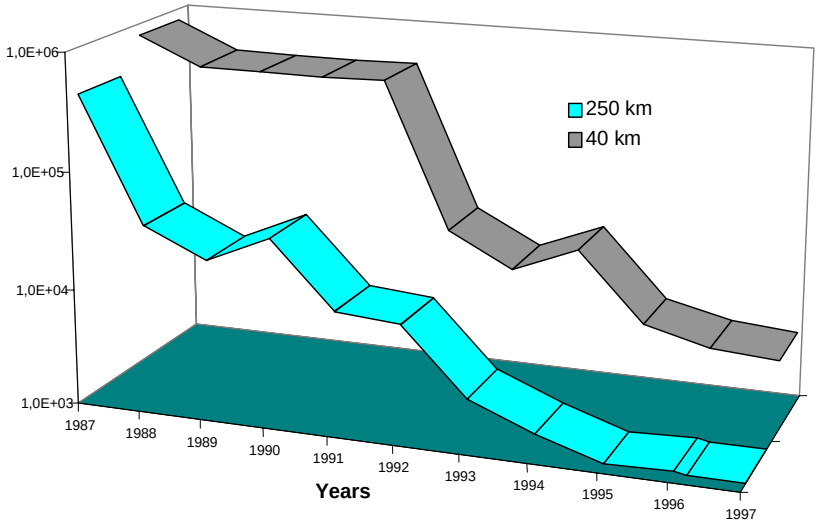


Fig. 1.2. Active particle content in soils at different distance from Chernobyl nuclear power station

Studying active particle distribution by the depth of soil profiles has shown that their main quantity is concentrated in the upper (0-3 cm) soil horizon. The depth of soil layer occurrence increasing, appreciable decrease of particle radio-activity and their quantity is observed. Thus, small vertical migration of particles is observed as a result of their re-distribution within 10-15 cm from soil surface. In deeper layers active particles in any soils were not detected.

Comparing the results obtained during long-term investigations shows that beta-activity of active particles decreases (on average) 1.2-1.5 times a year. To add, decrease rate of particle beta-activity is higher in soils with higher acidity and high content of organic fraction.

Mobility of americium being part of particle composition is considerably higher in general than that of plutonium: americium can account for 50% in potentially mobile forms and plutonium – 30%, plutonium portion in tightly bound state being higher than its portion in mobile state in particles detected at different distance from Chernobyl nuclear power plants.

Lifetime of active particles in the environment is defined, first of all, by the following factors: the nature of particles formation (nature of fall-outs in the territory under study – fuel, condensation or mixed one) and characteristics of soils (soil acidity, moisture, humus content, mineral fraction composition). Particles decaying in the soil can lead to formation of radionuclides in potentially mobile form.

2.3. Radio-activity of surface air

Radiation monitoring of free air shows that exposure rate of gamma-radiation (exposure rate) decreased considerably, compared to 1986, mainly due to natural decomposition of radionuclides at all survey points (Fig. 2.2). So, e.g., exposure rate level in Bragin decreased 470 times, compared to 1986, in Mozyr and Slavgorod – 80 times and in Pinsk – 70 times. Reduction level of exposure rates depends on isotope composition of fall-outs.

The highest levels in 2000 were registered in the town of Bragin, 99 μR/hr, and in the town of Narovlya, 79 μR/hr. In the remaining territory, as a rule, gamma-radiation exposure rate does not exceed 20 μR/hr. In regional towns average annual level in 2000 amounted to 10 to 15 μR/hr.

Data analysis shows that seasonal change in gamma-radiation exposure rate is registered for the settlements of south spot, namely Bragin, Khoiniki and Narovlya. In the remaining spots where gamma-radiation exposure rate is comparable with pre-fault level, express seasonal changes in exposure rates are not observed.

Long-term investigations of radioactive contamination of surface air and radionuclide transport by air, particularly mechanism of its formation in alienation zone and adjoining regions showed that in 2000 in settlements adjoining the re-settlement zone (Khoiniki, Bragin and Babchin) average annual air concentrations of man-caused radionuclides amounted to 110, 40 and 135 μBq/m^3 for ^{137}Cs and 210, 79 and 67 nBq/m^3 for ^{239,240}Pu, respectively. In the re-settlement zone (the settlement of Masany) it was 350 μBq/m^3 for ^{137}Cs and 790 nBq/m^3 for ^{239,249}Pu.

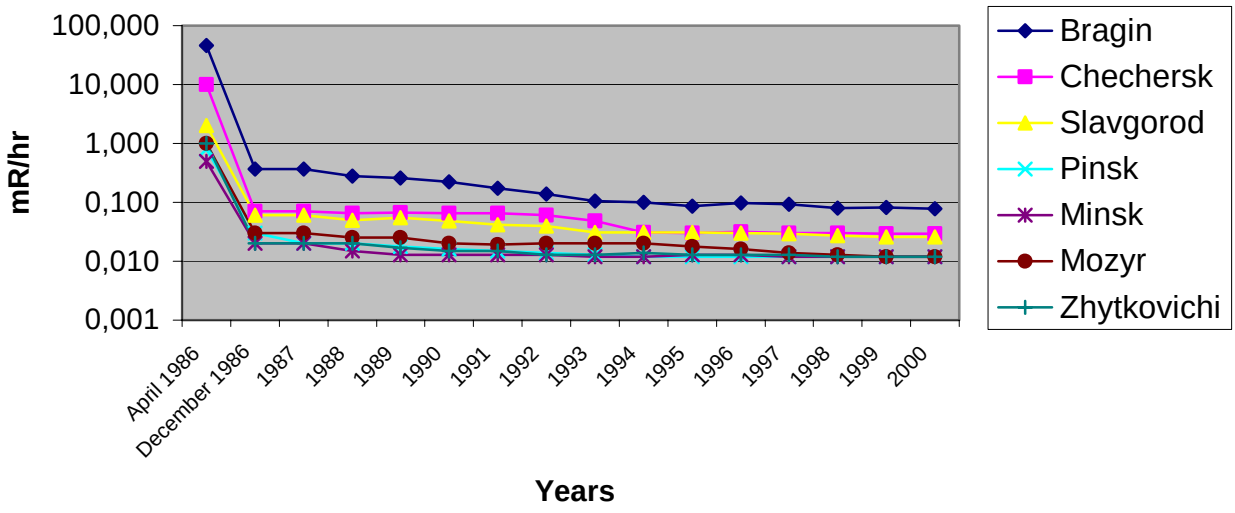


Fig.2.2. Dynamics of exposure rate according to data of radiation monitoring network of State Committee for hydrometeorology of the Republic of Belarus

The conducted research of plutonium isotope re-suspension from underlying surface of soil have revealed that radioactive air contamination with transuranium elements in the re-settlement zone and adjoining areas is determined by both dust content in the air and its specific activity. Average dust concentration in the re-settlement zone due to general termination of agricultural activities is the same and amounts on average to 25 μg/m^3. Intensive agricultural activities in the regions adjoining the re-settlement zone (Khoiniki, Bragin and Narovlya districts) causes considerable local growth of dust content in the air (more than 1 mg/m^3) during springtime. This leads to the fact that in the regions with lower transuranium elements contamination of soil surface local plutonium concentration in the air during agricultural works exceeds that of ^{239,240}Pu in the most contaminated places of re-

settlement zone, reaching 10 μBq/m^3. In the direct vicinity of dusting sources (agricultural machinery, motor vehicles) ^{239,240}Pu content in the air reaches 17 mBq/m^3.

2.4. Radioactive contamination of river systems

Surface waters are the main factor determining radionuclide migration in ecosystem. Estimating transit role of rivers that are major carriers of radionuclides, including transboundary transport, is very important. In watercourses and running reservoirs radionuclide concentration decreases and in stagnant tanks, closed lakes, pond and reservoirs with lowered shape of the bottom radionuclide accumulation is detected in bottom sediments.

The data of radioactive monitoring of water objects indicates that radiation situation at the rivers of Dnieper-Sozh and Priepyat basin has been stabilized; average annual caesium-137 concentrations decreased significantly during the observation period of 1987-2000 in large and medium rivers. Excess republican allowable levels (RAL-96, 99) of caesium-137 and strontium-90 in the river water were not detected. However, caesium-137 concentration in surface waters is closely related to the amount of river water flow, which is indicated by caesium-137 concentration growth in some rivers the water content of which in 2000 was below the average longstanding values (Fig. 2.3).

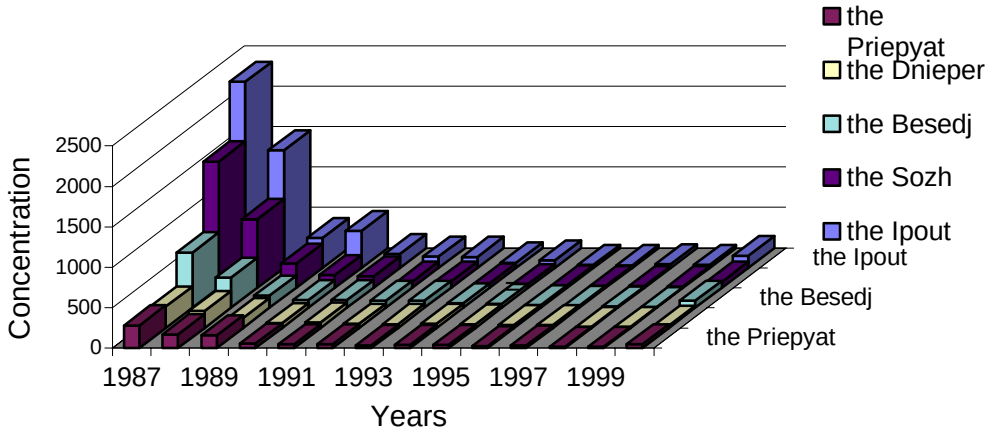


Fig. 2.3. Dynamics of average annual caesium-137 concentrations in the rivers of Belarus (Bq/m^3) in 1987-2000

Analyzing data on caesium-137 content during spring tide of 1999 in the basin of the river Priepyat (the town of Mozyr) showed that caesium-137 concentration in soluble form had remained at the level of average concentration values for the given station in previous years (1996-1998). However, concentrations of this radionuclide at suspensions greatly increased, which indicates its wash-out and transport with solid material from river basin with flood waters.

At present, there is an express tendency of lower caesium-137 carry-over by rivers (Fig. 2.4).

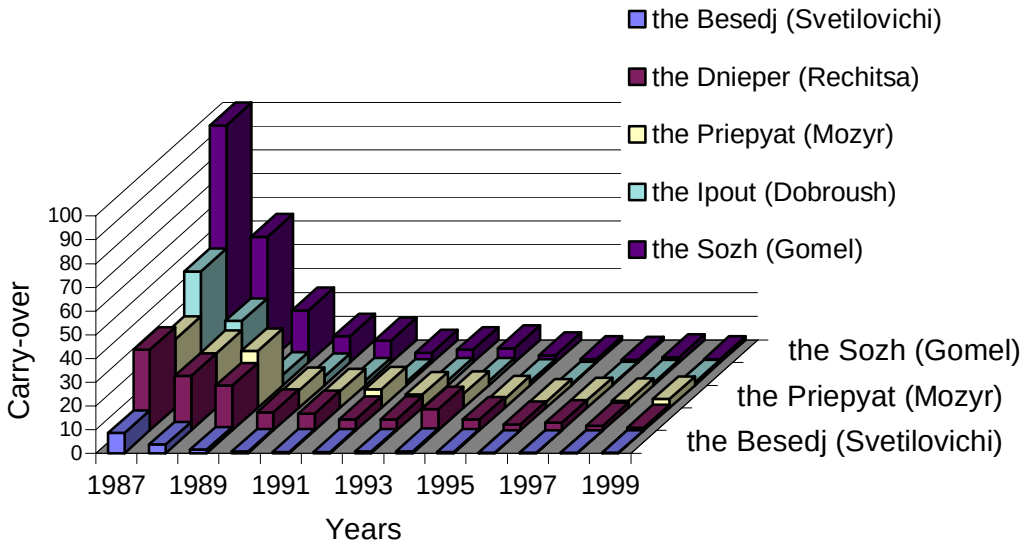


Fig. 2.4. Dynamics of annual caesium-137 carry-over (10^{11} Bq) by the rivers of Belarus in 1987-1999

Total caesium-137 carry-over by the rivers of Belarus in 1987-1999 was as follows: the river Sozh (Gomel) – $2.4 \cdot 10^{13}$ Bq, the river Dnieper (Rechitsa) – $1.7 \cdot 10^{13}$ Bq, the river Priepyat (Mozyr) – $1.3 \cdot 10^{13}$ Bq, the river Ipout (Dobroush) – $0.91 \cdot 10^{13}$ Bq and the river Besedj (the village of Svetilovichi) – $0.19 \cdot 10^{13}$ Bq.

Out of total activity of caesium-137 carried over by each river during 12 years (1987-1999), 85% are carried over by the Ipout during 2 years, 81% - by the Sozh, the Besedj and the Priepyat during 3, 4 and 6 years, respectively, and 71% - by the Dnieper during 9 years. Comparing caesium-137 carry-over in 1987-1999 at closing stations of the rivers Dnieper and Priepyat within the Ukraine and at hydrological stations of Belarus shows that only 26% of total caesium–137 carry-over were formed in 30-km zone of Chernobyl nuclear power station. Thus, contribution of large catchment areas with low radioactive contamination has greater influence in the formation of river flow on secondary river contamination than surface wash-out from highly contaminated territories with relatively small catchment areas.

Much attention is being paid now to studies of radiation state of small rivers in the most contaminated districts of Gomel and Mogilev regions that are tributaries of the Priepyat (the rivers Braginka, Nesvich and Slovechna) and the Sozh (the rivers Liepa and Senna).

After a number of years there is a reduction of radioactivity of water mass. The dissolved portion of ^{90}Sr is an exception, which is typical for the near Chernobyl zone.

As follows from many years' data of studying ^{137}Cs and ^{90}Sr content in water (in dissolved and suspension states), bottom sediments and aqueous biota, bottom sediments and aqueous biota (Fig. 2.5 and 2.6) are main contributors to total radioactivity of surface water systems. The tendency of lower activity of bottom sediments and biota in time is insignificant.

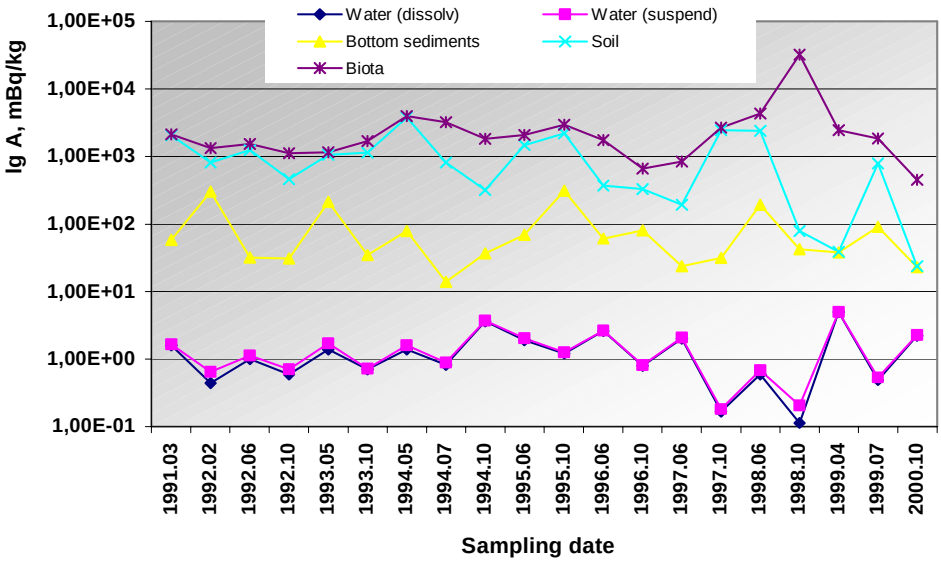


Fig. 2.5. ^{90}Sr content dynamics in water system components

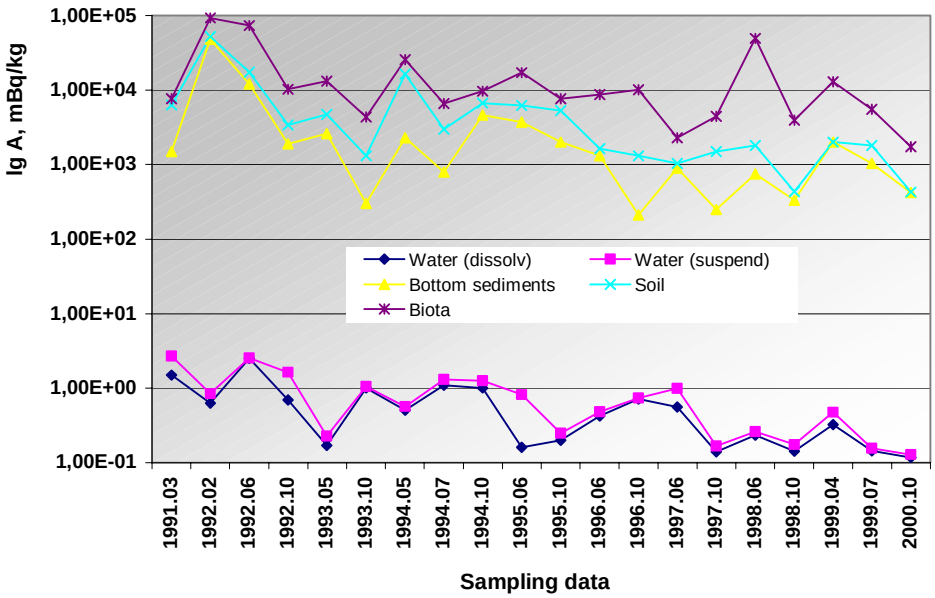


Fig. 2.6. ^{137}Cs content dynamics in water system components of the river Braginka (the village of Gdenj)

During spring floods, summer and fall tides radionuclides migration in open water systems occurs in both dissolved state and in the forms sorbed on organic and mineral particles.

In small rivers there is a tendency of lower flow of radionuclides after a number of years, excluding ^{90}Sr in dissolved state for the near Chernobyl zone.

As follows from ^{137}Cs and ^{90}Sr concentration ratio for closing stations of the rivers Braginka and Senna, since 1992-1993 ^{90}Sr content has started exceeding that of ^{137}Cs. This phenomenon is typical for surface watercourses close to the near Chernobyl zone and is explained by the growth of migration properties of ^{90}Sr due to liberation from active particles.

2.5. Radiation situation of lacustrine ecosystems

Lacustrine reservoirs located in the contaminated territories are noted for high concentrations of water dissolved ^{137}Cs and ^{90}Sr and large stock of radionuclides in bottom sediments. Being an object of fishery, lacustrine reservoirs play an important role in forming radiation doses of population by food chains.

^{137}Cs concentration in the lakes situated in the territory of Gomel and Mogilev regions (Fig. 2.7) varied mainly from 0.2 to 7.2 Bq/l (for 0-20 cm water layer). Single radioactive fall-outs to lake waters as well as subsequent ^{137}Cs and ^{90}Sr carry-over from catchment area are the source of radiocaesium and radiostrontium, which is proved by close relation of radionuclide stock at water catchment and in lake water mass.

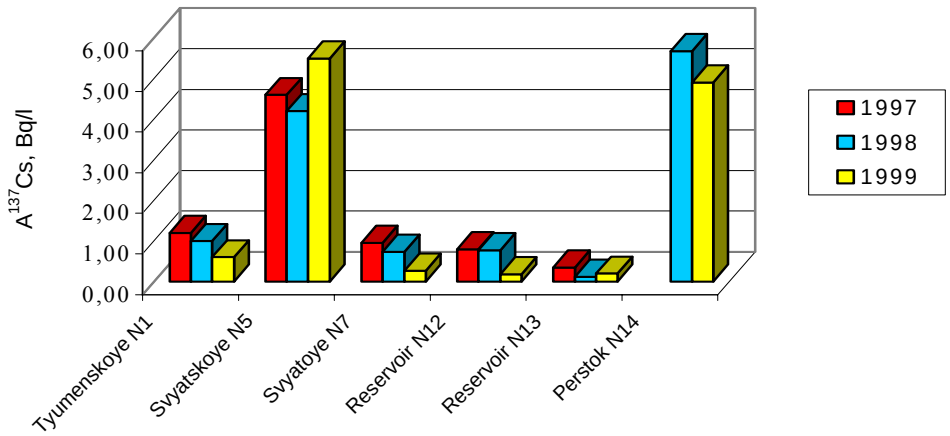


Fig. 2.7. Dynamics of average annual ^{137}Cs activity in lake waters

The majority of lakes are characterized by permanent ^{137}Cs concentration decrease in water mass (sorption on suspended matter and bottom sedimentation). The capability of lakes to self-purify that is manifested in suspended matter sedimentation led to considerable accumulation of radioactivity in bottom sediments (up to 1,556 kBq/m^2) as a result of which the latter are a major source of lake-water secondary contamination.

Long-term radio-ecological monitoring of the lakes shows that after single radionuclide fall-out onto the lake surface and their catchment area there is an abrupt reduction of radioactivity within the first 3-4 years mainly due to radionuclide decay with half-life of up to 1 year, then there is a dynamic equilibrium between radionuclide content in water, soil and different specimens of biota.

In stratified lakes caesium concentration in water in summer increases from the surface to the bottom; in shallow lakes due to continuous mixing caesium is uniformly distributed in water mass. So, in the stratified lakes Cvyatskoye (territory contamination level

 is about 550 kBq/m^2) and Rislavskoye (contamination level – up to 1,480 kBq/m^2) caesium concentration in surface water is 6.2 and 13.2 Bq/l, in bottom water – 8.6 and 19.3 Bq/l, respectively. In the shallow lake Revoucheye (contamination level – up to 700 kBq/m^2) it is 3.0-3.6 Bq/l. Bottom sediments of the reservoirs can contain more than 90% of caesium-137 of its total stock in all components and 70-90% of strontium-90. Suspension fraction in total caesium-137 balance is maximum 2.4% and that of strontium-90 – maximum 1.8%. Filtered water contains maximum 0.17% of total caesium-137 stock in all components and strontium portion can increase to 21%.

Aquatic life contribution to total radioactivity of lacustrine ecosystems is insignificant and does not exceed 0.023% by ^{137}Cs and 0.014% by ^{90}Sr. Macrophytes (large-leaved reed mace and water thyme) as well as community of lower biofouling algae with predominant species of cladoforum and edogonium that form the largest areas of obliteration play dominating role in ^{137}Cs and ^{90}Sr radionuclide accumulation among species constituting aquatic phytocenoses. Seasonal effect on radionuclide content is revealed in different parts of water plants. To add, radionuclide accumulation in vegetative organisms is proportional to the content of macro analogs of these nuclides in the plants.

2.6. Radiation state of underground waters

Underground water is a major source of portable and auxiliary water supply. One can state by the results of surveys that radionuclide concentration in it does not exceed republican allowable levels (10 Bq/l). At the same time one should note that radiation state of subterranean waters during 15 post-Chernobyl years was characterized by higher levels of activity, by one-two orders of magnitude, compared to pre-fault radiation background (0.007 Bq/l).

Subterranean waters feeding area of which have, first of all, higher density of top-soil contamination, namely the basins of the rivers Braginka and Nesvich, are mostly subject to radioactive contamination. In general, during the last 5 years there has been a stable subterranean water contamination level set as a result of dynamic equilibrium of various factors, when staking a well at watershed: ^{137}Cs – 0.02÷0.07; ^{90}Sr – about 0.02 Bq/l; in littoral zone - ^{137}Cs – 0.02÷0.05; ^{90}Sr – 0.03÷0.20 Bq/l. Cyclic fluctuations of radionuclide content in subterranean water of river basins are caused by the effect of seasonal floods, growth or reduction of aeration zone and radionuclide wash-out from upper active layer, deeper front of surface contamination distribution, etc. To add, amplitudes of caesium-137 specific activity fluctuations are greatly higher than those of strontium-90. Major portion of caesium-137 gets into underground waters by filtration through aeration zone as well as with surface water flow during flood and post-flood periods. Surface flow in flood period has greater effect on underground water contamination with strontium-90.

Dynamics of radioactive contamination of underground waters by years is given in Fig. 2.8.

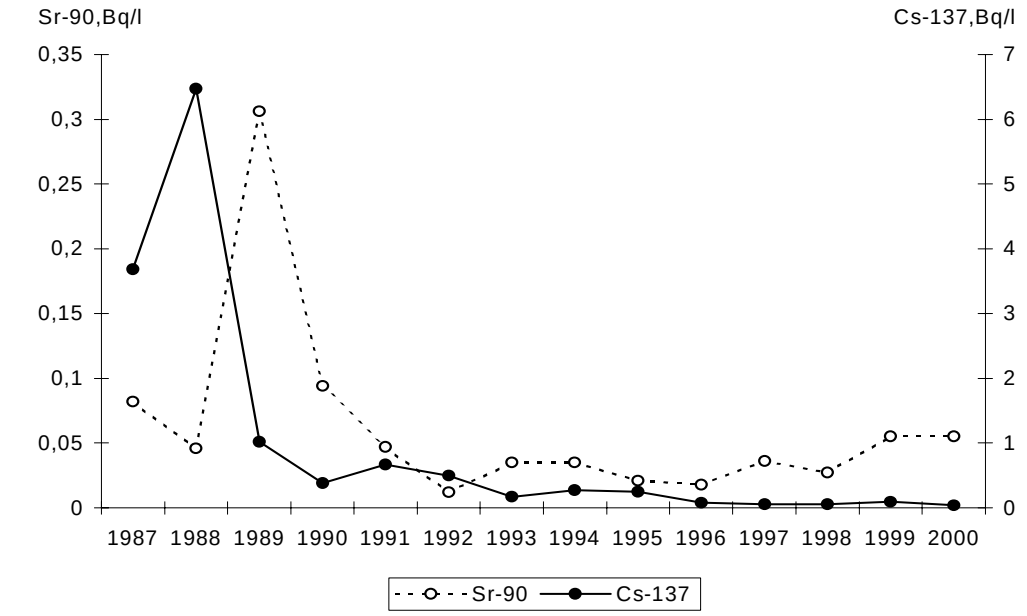


Fig. 2.8. Changes in strontium-90 and caesium-137 specific activity in subterranean waters of the basin of the river Besedj

2.7. Radioactive contamination of plant communities

As a result of the accident at Chernobyl nuclear power station, about 1.7 million hectares of woods or about 23% of forests of the republic were in radioactive contamination zone.

Table 2.1

Radioactive contamination of forests of Belarus

Radioactive contamination zones by 137Cs, kBq/m2	Conifers, thousand hectares		Hard-leaved species, thousand hectares		Soft-leaved species, thousand hectares			
	Total	Incl. pine-trees	Total	Incl. oak	total	Incl. birch	Incl. aspen	Incl. alder-tree
37–185	762,8	691,8	73,2	67,0	180,7	170,1	18,4	91,5
185–555	188,8	170,2	19,1	17,6	71,7	43,7	5,4	22,3
555–1480	90,1	80,6	9,0	8,3	34,0	20.8	2,8	10,2
More than 1480	24,5	21,1	2,1	2,1	9.2	5,7	0,8	2,5
Total	1066,2	963,7	103,4	95,0	395,6	240,3	27,4	126,5

During the first days after the accident about 80% of all radioactive fall-outs on forest areas were detained by overhead parts of wood plants and about 20% settled onto the top-soil. Beginning from 1988, there has been a higher root inflow of 137Cs and 90Sr radionuclides to overhead phytomass alongside continuing self-cleaning of the tops and reduction of plant contamination from the air.

At present, depending on the age and thickness of afforestation, wood species and growing conditions, the overhead part accounts for 5-7% of radionuclides. Surveys indicate a continuing accumulation of radionuclides in the wood of major forest-forming species.

Forecasts show that forest contamination will increase and root inflow will be a major mechanism of radionuclide transit to wood tier. In the near 10 years overhead phytomass of 30-year old pine forests, in particular, will accumulated 10-15% of the total 137Cs stock in woodlands.

Accumulation of 90Sr and 137Cs in forest ecosystems is the lowest for upper wood tier and the highest for live over-top soil, undergrowth and underwood occupying intermediate position. Bilberry with allowable radiocaesium content can be stocked at 137Cs contamination density of up to 50 kBq/m2, wild strawberry – 137 kBq/m2. Bilberry and strawberry leaves with allowable 137Cs content (1,850 Bq/kg) can be stored up at soil contamination density of 120 and 545 kBq/m2, respectively.

Depending on soil and landscaping conditions, moisture level, species peculiarities and other factors, herbaceous plants accumulate radionuclides in different ways. According to the capability of accumulating 137Cs in overground mass, herbaceous plants can be arranged as follows (KA – dose buildup factors): Ericaceae (KA = 0.341), sedge species (0.089), Gramineae (0.069), Compositae (0.037), buckwheat (0.026), legumes (0.021), blooming sally (0.014), John's-wood (0.012), Cruciferae (0.011). As revealed, caesium and strontium radionuclide migration from soil to meadow vegetation on peat-gley soils is 1.5-2 times lower in low-level meadows both in Gramineae group and motley grass than in floodplain meadows with mineral soils.

Comparative assessment of caesium and strontium radionuclide accumulation in meadow vegetation of natural cenoses during the last period showed the tendency of the ratio of these isotopes accumulation to shift towards strontium.

In ascending order of average KA values by 137Cs for phytocenoses, their ecotopes form a series: beds with automorphic sand soils – 0.035, drained meadow-bog complexes – 0.048, beds with automorphic loamy-sand soils – 0.057, waterless meadows with automorphic sand soils – 0.142, floodplain meadows – 0.304, all forests – 2.026, including pine woods – 2.401.

As shown by the studies of radionuclide migration in soil and vegetation complex, depending on plant root system structure, average factors of 137Cs buildup by the plants with tap root system amount to 0.030, fibrous system – 0.036. The highest value of dose buildup factors is discovered with the plants of a conditionally distinguished group, i.e., creeping-root species; it constitutes 0.146.

Monitoring of natural plant population indicates that vegetation complexes in general are relatively resistant to radioactive effect. Majority of plant kingdom specimens in the contaminated territories did not undergo major changes. Regardless of visible disturbances at population and cenosis level due to accumulation of mutation burden (chromosomal aberrations) in genomes, one can not exclude the possibility of changes in phytocenoses to occur towards predominance of the most radio-resistant species. There is a number of other abnormalities: reduction of seed germinating capacity, change of photosynthesis, protein synthesis, etc.

2.8. Consequences of radioactive contamination of biotope for animal world

Radio-ecological and radio-biological surveys of fauna objects allowed to determine a number of differently directed changes. In particular, at one of many checkpoints at the river Priepyat caesium-137 content slightly decreased in muscular tissue of all species of fish under study. At the same time predatory fish, namely perch and pike, and representatives of non-predatory species of fish, namely red-eye and crucian carp in the lake of Perstok (Polesskiy State Radio-Ecological Reserve), displayed higher content of this radionuclide. In 2000 radio-caesium content in muscles of roach, silver bream, crucian and tench did not change, compared to 1999.

As far specimens of land fauna are concerned, biotopic conditions have great importance in accumulating radionuclides. The highest amount of radio-caesium among birds being a subject of sports hunting is detected with dry open-area inhabitants, i.e. partridge. Garganey teal and mallard duck accumulated the highest amount of radionuclides from among the birds composing littoral water complex, and shoveler – the lowest one.

Radionuclide content with ungulate mammals inhabiting the most contaminated areas still remain at high level, the dynamics mainly being determined by climatic peculiarities of the current year and depending on season. So, hunt and game ungulate animals display higher organ and tissue contamination during summer and fall due to high gamma-emitters' content in the plants constituting their forage resources.

Predatory mammals (wolf and fox) as a final link of trophy chain are characterized by the highest levels of radionuclide content reaching 50 and 47 kBq/kg for the wolf and fox, respectively, and exceeding that of herbivores 12 times.

At permanent inflow of radionuclides to the organism of vertebrates, they are accumulated in different organs and tissues. If one arranges the latter by descending of their activity, the following row will be obtained: muscular tissue, kidneys, heart, spleen, liver, lungs and bone tissue. Wild animals are ascertained to experience high dose loads in Polesskiy radio-ecological reserve, which can influence on functional state of the orgamisms and, hence, their homeostasis.

Manifestation of negative radiation effects with the animals is characterized particularly by low haemopoiesis rate, availability of pathological changes of different level in hemolymph and weakened state of posterity.

One can suppose that in the near years there will be no considerable decrease in radionuclide content in wild animals in general. At the same time existing marked difference in radionuclide content in the animals of different systemic and ecological groups as well as individual variability in their accumulation will grow.

A number of animal species forming zoocenosis of alienation zone (Fig. 2.9) undergo changes by years.

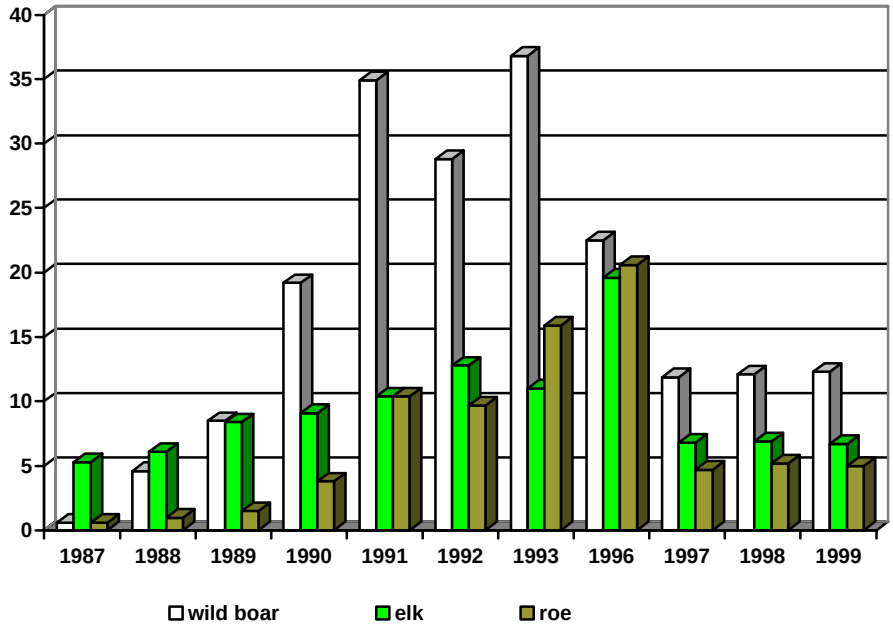


Fig. 2.9. Dynamics of numbers (species/1000 hectares) of major game animals in the territory of Polesskiy State Radio-Ecological Reserve

When studying enthomofauna in contamination zone, a wide set of potential disease carriers has been defined. Considerable total level of their numbers creates real opportunity of infections and invasions, conditions for pathogenes of rabbit-fever, tick-borne encephalitis and California fevers to occur in the territory of alienation and re-settlement zones even during unfavorable dry years. In the years of excess moisture the numbers of insects increase. Performed studies allow to make a conclusion that in the near years better epidemiological situation in the accident zone of Chernobyl nuclear power station should not be expected.

CHAPTER 3

MEDICAL AFTER-EFFECTS OF CHERNOBYL CATASTROPHE

Extensive contamination of the territory and lots of people exposed to the effect of radiation and non-radiation factors of Chernobyl catastrophe demanded organization of a system to evaluate the state of victims' health, development of diagnosis, treatment and rehabilitation procedures (Fig. 3.1).

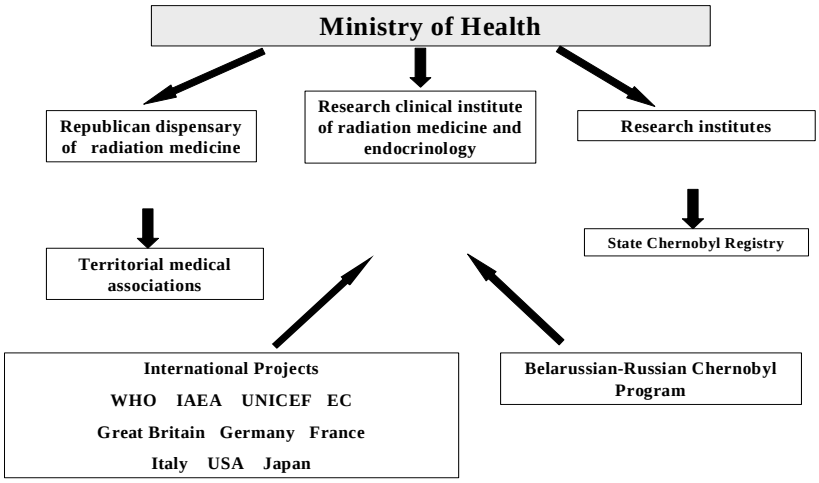


Fig. 3.1. Organizational chart of evaluation of the state of health

Evaluating the state of health of the main categories of victims (Table 3.1.) is made by analyzing the results of clinical examination of 1.6 million people, including 344 thousand children, the data received by the State Registry of people suffered from Chernobyl catastrophe (180,000 people) and the results of surveys made by research institutions of the Ministry of Health under state programs and international projects.

Table 3.1 Main categories of victims of the accident at Chernobyl nuclear power station

Categories of victims
Participants of elimination of the consequences of the accident in 1986-1987
Participants of elimination of the consequences of the accident in 1988-1990
Evacuees
Re-settlers
Residents of the contaminated territories
Children born by irradiated parents

The state of population health is affected by a set of factors of radiation and non-radiation nature (Table 3.2) causing the change of the main tendencies of morbidity.

Table 3.2 Major factors of Chernobyl catastrophe, affecting the health

Radiation factors	*Non-radiation factors*
External and internal irradiation: dose-forming radionuclides of iodine, caesium, strontium, transuranium elements	Social, economic factors; stress; risk perception

As a result of Chernobyl catastrophe, radio-iodine (iodine-131, first of all) was a major source of population irradiation that mainly affected thyroid gland. Children and teenagers, especially children under 7 were the most irradiated residents of Belarus. The results of direct measurements in 1986 showed that about 30% of children under 2 took doses of above 1 Gy. In the most contaminated rural settlements average radiation dose of thyroid gland of younger children reached 3 Gy and more. Cumulative radiation dose of Belarus residents during "iodine" period amounted to more than 500 thousand people-Gy. Table 3.3. shows cumulative radiation doses of thyroid gland for residents of various regions of Belarus.

Table 3.3 Distribution of cumulative radiation doses of thyroid gland for residents of regions of the Republic of Belarus

Region	Cumulative radiation dose of thyroid gland, 103 people-Gy			
	0–6 years	7–17 years	Above 17 years	Total
Brest	35.0	19.2	46.5	100.7
Vitebsk	0.5	0.3	0.9	1.7
Gomel	96.6	53.7	151.0	301.3
Grodno	16.4	9.0	24.0	49.4
Minsk	23.0	12.6	32.7	68.3
Mogilev	9.9	5.4	16.3	31.6
For the republic	181.4	100.2	271.4	553

Thyroid gland exposure still continues after the iodine period, though in much less doses due to external and internal effect of radioactive caesium. During post-fault period cumulative radiation dose of thyroid gland amounted to more than 21 thousand people-Gy due to radiocaesium with the residents of the republic.

Continuing radiation impact on the residents of Belarus at present that is by more than 90% caused by long-lived caesium radionuclides forms external and internal radiation doses different in value and contribution, depending on radio-ecological conditions and contamination of territories with caesium-137. During post-fault period external radiation dose of population decreased mainly as a result of physical decay and deepening of radionuclides into the soil. At present average annual external radiation dose of 1 mSv and more is formed mostly due to caesium-137 in the territories with contamination density above 20 Ci/km^2. In contrast to stable tendency of external radiation dose to decrease in all territories of radioactive contamination, there is no express movement of internal radiation dose to fall. According to long-term observations over radionuclide content in the human body by using human radiation counters during the last 10-12 years, median values of specific radiocaesium activity in the dwellers' organism remained almost unchanged for those settlements where internal radiation doses amounted to 0.1-0.2 mSv/year in 1989-1990. To add, the diversity of individual values relative to average content of radiocaesium in the organism of the dwellers of one and the same settlement is characterized by sufficiently wide range that reaches several dozens of times. As an example of the latter, Fig. 3.2 shows

sufficiently wide distribution of the number of measured values of incorporated radiocaesium in the organism of Khoiniki town-dwellers, plotted against the results of more than 6,000 measurements with human radiation counters. Median value of incorporated activity for the dwellers of Khoiniki amounted to 59 Bq/kg, which corresponds to internal radiation dose of 0.15 mSv/year.

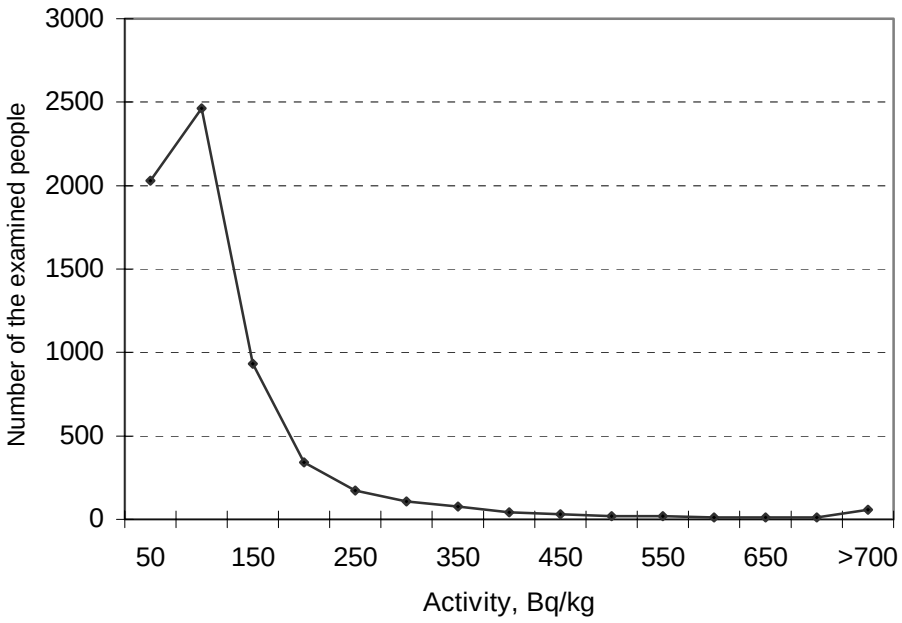


Fig. 3.2. Distribution by specific radiocaesium activity in the organism of dwellers of Khoiniki, examined with human radiation counters in 1998

Decrease of incorporated activity median values was more noticeable (1.5-2.5 times) for the dwellers of the settlements where internal radiation doses amounted to 0.4-0.5 mSv/year in 1989-1990. To further limit internal radiation doses, in 1999 new republican allowable levels (RAL-99) of caesium-137 and strontium-90 radionuclide content in foodstuffs and portable water came into effect. Table 3.4 gives RAL-99 values for primary products.

Table 3.4 Basic critical values of RAL-99

For caesium-137	
Description of the product	Bq/kg, Bq/l
Portable water	10
Milk and dairy products	100
Meat and meat products, including	
Beef, mutton and products made of them Pork, poultry and products made of them	500 180
Potato	80
Bread and bakery products	40
Vegetables and edible roots	100
Specialty children's foodstuffs ready for usage	37
For strontium-90	

Portable water	0.37
Milk and whole dairy products	3.7
Bread and bakery products	3.7
Potato	3.7
Specialty children's foodstuffs ready for usage	1.85

Population of the republic received about half cumulative radiation dose during the first year and about 80% within the first five years. To add, at the accident the children under 7 received about 15% of total cumulative dose, at the age of 7 to 17 – about 10%, and grown-ups – about 70% of cumulative dose. Almost 5% of the cumulative dose accounts for those born after the accident.

As a result of iodine radionuclide impact at the early stage of the accident and insufficient effectiveness of measures to protect thyroid gland, they have started registering morbidity growth of thyroid cancer, and among children in particular, in Belarus since 1990. Compared to pre-fault period, after Chernobyl accident occurrence of thyroid cancer increased 33.6 times among children and 2.7 to 7 times among grown-ups, depending of the age group (Table 3.5).

Table 3.5 Occurrence of thyroid cancer, depending on the age at the time of operation

Age group, years old	Years	
	1972–1985	1986–2000
0-18	29	975
19-34	227	1158
35-49	341	2334
50-64	461	2002
65 and more	404	1035
Total:	1472	7504

The highest occurrence of thyroid cancer is detected with the dwellers of Gomel and Brest regions.

Unprecedented morbidity growth of thyroid cancer required a decision-making on better organization of medical assistance to that category of people. To this end, Republican research working center of thyroid gland tumors, rehabilitation ward at the clinic of Research Clinical Institute of radiation medicine and endocrinology, radio-iodine treatment department at Gomel regional oncologic dispensary were put into operation and close cooperation with clinic of nuclear medicine of Wurtzburg University (Germany) was established. Treating patients with thyroid cancer includes surgical operation (total thyroidectomy with cervical dissection), radiotherapy to ablate thyroid tissue remnants and treat metastases, suppressive therapy by L-thyroxin and subsequent rehabilitation. Comprehensive treatment allowed to reach mortality level of 0.3% for children and teenagers diseased of thyroid cancer.

Average annual indices of leucosis morbidity of children population of all six Belarus regions remain stable within the whole post-fault period. There were noted tendencies of higher leucosis morbidity with persons of middle age, however, it is impossible to reveal the relation with radiation factor impact for a while yet.

Morbidity of persons that had eliminated the consequences of the accident in 1986-1987 proved to be higher, compared to the population of the same age that did not pass clinical examination. The differences are especially high in morbidity of diseases of endocrine system, systems of blood circulation and digestion, ischemic heart disease and neoplasms (Fig. 3.3). They mark acute polymorbidity in this category of victims. Available epidemiological and radiation information does not allow to define the role of radiation factor in differences of morbidity rates.

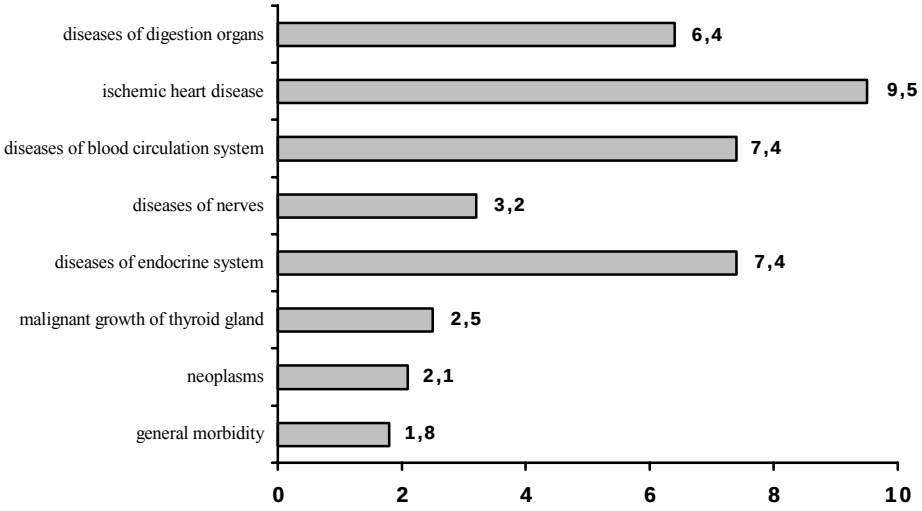


Fig. 3.3. Multiplicity of excess morbidity of liquidators of consequences of the accident in 1986-1987, compared to morbidity of Belarus population not subject to special clinical examination

The level of primary disablement of the liquidators of the consequences of the accident exceeds that of adult population of the republic 1.6 times (114.3 and 71.6 per 10,000 people, respectively). Major reasons of primary disablement are diseases of blood circulation system and neoplasms. Death rate of the liquidators of the consequences of the accident remained lower, compared to the mortality of adult population.

The population residing in the territories contaminated with radionuclides accounts for higher morbidity with diseases of nervous and endocrine system and malignant growths of thyroid gland, compared with that not passing special clinical examination (Fig. 3.4).

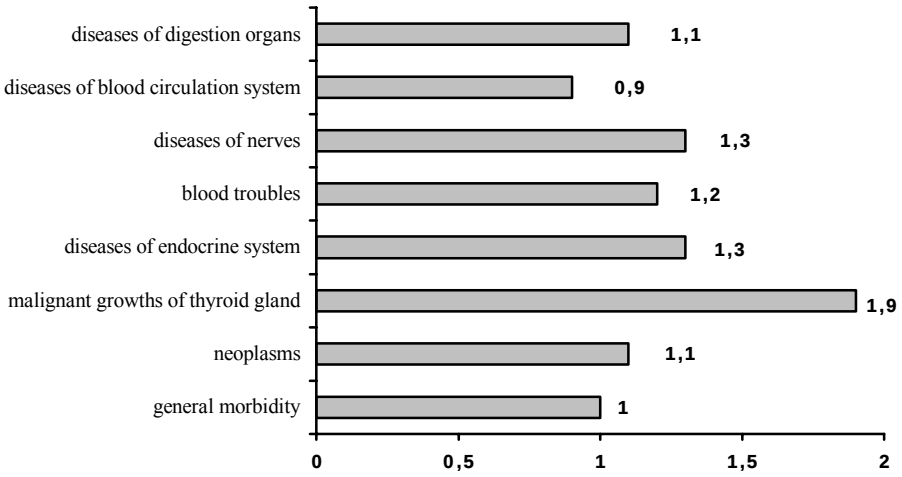


Fig. 3.4. Multiplicity of excess morbidity of population residing in the contaminated territories, compared to that of Belarus population not subject to special clinical examination

One should note that higher morbidity rates registered during special clinical examination of population and liquidators of the consequences of the accident can be related both to radiation and non-radiation factors of Chernobyl catastrophe and so-called «screening» effect. To determine the role of radiation factor in the change of the state of victims' health, long-term radiation and epidemiological studies should be made that have been already partially carried out in the territory of Belarus under national and international programs.

The population of Belarus residing in the territories with caesium-137 contamination density of above 555 kBq/m^2 is noted for established growth rate of some congenital defects of growth, compared to pre-fault period (Fig. 3.5).

The rate of unstable indicators (dicentric chromosomes, rings) of radiation impacts is considerably high with the dwellers of Gomel regions, compared to the ones of groups from the city of Minsk. Frequency of polyploid and aneuploid cells has also greatly increased, which indicates biologically effective influence on hereditary mechanism of blood lymphocytes of mutageneous factors of radiation origin.

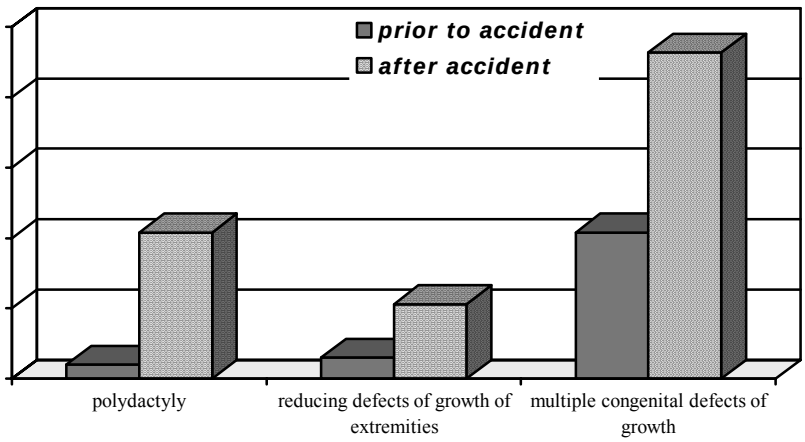


Fig. 3.5. Rate of some congenital defects of growth of Belarusian population residing in the territories with caesium-137 contamination density of above 555 kBq/m2

On the basis of the results of examinations of both new-born children and children of school age, one can make a conclusion that according to intensity rate of mutation process in somatic cells children born in 1986-1988 were exposed to more efficient impact of ionizing radiation on the genome. Consequently, the specified category should be attributed to the group of higher genetic risk.

The observed growth impairments of intrauterine maturity with the population of Belarus should be regarded a consequence of composite negative effects on reproductive function. Physical mutagens (radionuclides), chemical embryotoxins and unbalanced nutrition are probably most significant of these factors. However, such conclusion requires additional large-scale research.

In general, a system of dynamic observation effective in the republic over the victims of the catastrophe at Chernobyl nuclear power station, including annual medical examinations, allows to reveal diseases and timely conduct necessary medical and rehabilitation measures, which contributes to preservation of victims' health.

CHAPTER 4

SOCIAL AND ECONOMIC DAMAGE. STATE POLICY ON OVERCOMING THE CONSEQUENCES OF CATASTROPHE AT CHERNOBYL NUCLEAR POWER PLANT IN BELARUS

4.1. Economic consequences

Chernobyl catastrophe exerted influence on all spheres of human activities: production, culture, science, economics, etc. Agricultural turnover lost 2.64 thousand square kilometers of agricultural land. 54 collective and state farms were liquidated, nine processing factories of the agroindustrial complex were closed. Areas under crop and total yield of crops diminished sharply and livestock considerably decreased.

Volumes of using forest, mineral, raw material and other resources are greatly reduced. Contamination zone covered 132 deposits of various mineral and raw material resources, including 47% of molding sand, 19% of mortar and silicate sand and 91% of glass-making sand of the republic; 20% of industrial supply of chalk, 13% of loam stock for brick production, 40% of refractory clay, 65% of building stone supply and 16% of cement raw material.

22 fields of mineral, raw material resources are taken out of development the reserves of which constitute almost 5 million m^3 of mortar sand, gravel-sand materials and clays, 7.7 million tons of chalk and 13.5 million tons of peat. The territory of Pripyat oil-and-gas bearing region the resources of which are valued at 52.2 million tons of oil is excluded from the plans of exploration work.

Forestry suffered great losses. About a quarter of forests of Belarus, i.e., 17.3 thousand square kilometers, were exposed to radioactive contamination. At present annual losses of timber resources exceed 2 million m^3 and by 2010 they will reach 3.5 million m^3. In Gomel and Mogilev regions where 51.6 and 36.4% of total woodlands are contaminated with radionuclides wood logging in the territory with caesium-137 contamination density of 137,555 kBq/m2 and more is completely terminated.

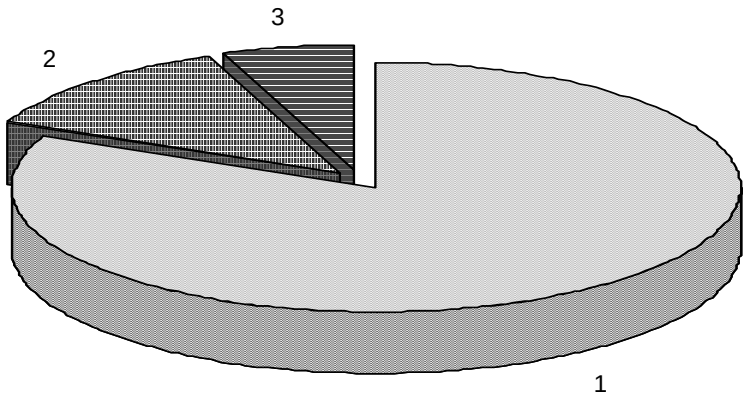
Contamination zone accounts for about 340 industrial enterprises operation conditions of which have greatly deteriorated. As a result of re-settlement of the dwellers of the most affected districts, the activities of some industrial enterprises and establishments of social sector have been terminated. The remaining ones incur heavy losses and continue to sustain losses from decline in the volume of output, insufficient self-repayment of funds invested in buildings, constructions, equipment and reclamation works. Fuel, raw stock and materials account for significant losses.

Economic crisis made radioactive contaminated territories face extremely difficult social and economic conditions. They sharply display general features of the crisis: decline in production, outflow of population from the regions, lack of consumer sector development, low level of satisfaction of needs in social amenities and medical care of population.

Under such conditions neither rapid self-recovery of the affected territories nor direct restoration of the objects of the national economy are possible. One may speak only about long-term process of rehabilitation that implies stage-by-stage commissioning of the lost potential to national economic sector as safe conditions for living and development of those industries the activities of which are possible under radioactive contamination without any damage to the health of people are created.

The damage caused by Chernobyl catastrophe to the republic is valued at 235 billion US dollars, counting on 30-year period of its negotiation, which is 32 budgets of the republic in 1985. It includes losses related to deterioration of health, damages caused to industry and social sector, agriculture, construction complex, transport and communications, housing and communal services, contamination of mineral and raw material, land, water, forest and other resources as well as costs related to measures undertaken to eliminate and minimize the consequences of the catastrophe and ensure safe conditions of population activities. Fig. 4.1 and Table 4.1 show the composition of economic damage to the Republic of Belarus by Chernobyl nuclear power station by types of losses and objects of national economy.

Inputs related to support of production operation and realization of protective measures account for the largest share (81.6%) in the composition of total damages in 1986-2015, which amounts to 191.7 billion US dollars. About 30.0 billion US dollars (12.6%) fall to the share of direct and indirect losses. Loss of profit is valued at 13.7 billion US dollars (5.8%). Direct losses include the cost of the constituent part of republic national wealth removed from usage: capital and revolving production assets, objects of social infrastructure, housing and natural resources.



1 – Additional inputs related to support of production operation and realization of protective measures, 191.7 billion US dollars.
2 – Direct and indirect losses, 29.6 billion US dollars.
3 – Loss of profit, 13.7 billion US dollars

Fig. 4.1. Composition of damage caused to the Republic of Belarus as a result of catastrophe at Chernobyl nuclear power station during the period of up to 2015

Indirect losses include those caused by the effect of economic and social factors (living conditions, state of population health) that initiated malfunction or termination of production, decrease in labor productivity, higher cost and difficulties in supply of other objects of public, cooperative and private property as well as losses from migration of population from the affected districts.

Loss of profit stated in value terms is composed of decline in the volume of output, work and service content in the contaminated territories, cost of unusable produce due to radioactive contamination, additional expenses to pay off deficient products, costs to restore

the lost quality of the produce, losses from contract termination, cancellation of projects, freezing of credits, payment of penalties, fines, forfeits, etc.

Additional inputs are expenses to negotiate the consequences of the accident and ensure standard performance of various industries of the national economy in radioactive contamination zones, including creation of safe conditions of population activities. They also include expenses to indemnify the consequences of negative factor impacts, cost of additional resources attracted to pay losses and loss of profit, expenditures for the works on decontamination and radiation monitoring.

Performed assessment of the damage is not final since cause-and-effect relations reflecting the impact of radioactive territory contamination on various spheres of human activities are enough intricate. Science has no complete and definite information on medical and biological, social and ecological consequences of Chernobyl catastrophe.

Table 4.1 Sectorial composition of social and economic damage of the Republic of Belarus, caused by the accident at Chernobyl nuclear power station (billion US dollars)

Sector of national economy	Years				
	1986-1990	1991-1995	1996-2000	2001-2015	1986-2015
Population health	4,05	16,77	18,13	54,32	93,27
Agroindustrial complex	18,3	20,0	15,6	18,1	72,0
Forestry	0,58	0,68	0,70	2,15	4,11
Industry	0,06	0,13	0,11	0,33	0,63
Construction complex	0,15	1,25	0,32	0,96	2,68
Mineral, raw material and water resources	2,00	0,12	0,15	0,40	2,67
Transport and communications	0,93	1,20	0,36	0,90	3,39
Social sector	2,84	5,45	2,96	6,45	17,70
Decontamination of contaminated territories	0,04	4,19	22,48	10,12	36,83
Radio-ecological monitoring	0,05	0,21	0,19	1,27	1,72
Total	29,00	50,00	61,00	95,00	235,00

4.2. Activities by the Government at the initial stage of negotiation of consequences of the accident

Government commission of the USSR Council of Ministers and USSR Ministry of Health managed undertaking of protective actions and elimination of consequences of the accident at Chernobyl nuclear power station in April-May, 1986. First, a decision was made to evacuate population from the zone where exposure rate exceeded 25 mR/hr (the level observed in the territory of 10-km radius from Chernobyl nuclear power station). In fact, evacuation of population started on May 1 in Belarusian part of the zone (in the beginning only children and pregnant women). Then, they made a decision to decrease dose limit to 5 mR/hr, which approximately corresponded to a zone of 30-km radius. Altogether, 50 villages (11,035 people) were evacuated on May 1-4 from Bragin, Khoiniki and Narovlya districts. From 2nd to 9th of June additionally 28 villages (6,017 people) were re-settled and in late August – 29 (7,327 people). Thus, within a year 24.7 thousand citizens from 107 most suffered settlements were evacuated from Belarusian zone.

Among other decisions that were made at the USSR ministries and departments as well as by the Government Commission that determined undertaking of actions in Belarus, the following should be mentioned. On May 3, 1986 the National Committee for radiation protection of the USSR set temporary rates of iodine content in portable water and other foodstuffs that were revised by the USSR Ministry of Health on May 6 and 30, 1986. On 12th of May, 1986 a limiting radiation dose of 500 mSv/year for population was introduced and for children under 14, pregnant women and nursing mothers it constituted 100 mSv/year. In 10 days (May 22, 1986) a limiting radiation dose of 100 mSv/year was fixed for the whole population. The USSR Ministry of Health approved temporary allowable contamination levels for premises, transport facilities, clothes, skin, etc. that were lowered on October 26, 1986. Iodine preventive measures for re-settlers from the suffered regions were taken for the first time on the 2nd of May (they were not applied to other categories of citizens). In July 1986 the National Committee for radiation protection developed "Procedures of calculating the level of external and internal irradiation of the population residing in the territories contaminated with radioactive products of emergency releases of Chernobyl nuclear power station". These facts indicate only indeterminacy and complexity of decision-making at local levels in radioactively contaminated regions as well as the existing sluggishness and insufficient developmental work on normative documents by former union bodies.

In the most contaminated territories engineer and civil defense forces performed large-scale decontamination of the settlements. Outside 30-km zone about 500 settlements were decontaminated, 60% of them 2-3 times. As a result, they managed to somehow mitigate radiation situation. However, total decontamination of the settlements, agricultural and industrial facilities to arrange standard conditions for activities proved to be unreal due to the fact that the required work content greatly exceeded the opportunities to accomplish it.

During May 5 to December 9, 1986, Belarusian Government developed and approved 32 normative documents aimed to carrying out of protective measures. On 12th of May, 1986, the Ministry of Health and Gosagroprom of BSSR determined "Temporary norms of permissible radioactive substance content in portable water, foodstuffs and forage".

One should note that at the time of the accident there was neither regulatory base nor experience on carrying out the works under such circumstances. In this respect, regarding the scope of damage and tasks that were to be solved, Government Commission headed first by V.G. Evtoukh, Deputy Chairman of The Council of Ministers, and then by A.T. Kichkailo was formed to control the respective works. The commission was assigned to undertake a whole set of measures to protect the population found itself in the territory contaminated with radionuclides. The decisions by the commission became the foundation to start forming regulatory and legal base of actions in elimination of the consequences of the accident.

First post-fault days are characterized both by intensive work on elimination of the consequences of the accident at the station itself, which involved dozens of thousand of people from all over the former USSR, including Belarus, and by evacuation, intensive departure of dwellers from the settlements of the suffered districts of Gomel region, primarily from Bragin, Khoiniki and Narovlya districts. That required the solution of a number of problem which the republic had not faced before. On May 8, 1986 The Council of Ministers passed a resolution No. 131 "On the terms of labor remuneration and material security of the employees of enterprises and organizations of Chernobyl nuclear power station zone" by which the heads of enterprise and organization were given the right to pay the workers directly involved in the elimination of the consequences of the accident at Chernobyl nuclear power station at higher (up to 100%) base wage rates. Indemnities, free food, trip to a new place of residence and living were set for persons evacuated from Chernobyl zone. The families that lost the breadwinner due to the catastrophe at Chernobyl nuclear power station received lump-sum payment and got privileged pensions. Persons suffered from the

catastrophe were provided with free holiday vouchers to undergo treatment and health improvement.

Regarding the fact that many children lived in the contaminated territories, on May 23, 1986, The Council of Ministers and Belarusian Board of trade unions passed resolution No. 153 "On measures in organization of summer holidays and health improvement of children and teenagers of Gomel region in 1986" that determined the order of health improvement of pregnant women, mothers with children under 3, children of preschool and school age of Bragin, Khoiniki abd Narovlya districts in the territories of other regions. Allotment of vouchers was envisaged for other suffered districts too. Brest and Mogilev regional executive committees were assigned to secure health improvement and recreation of children and teenagers, pregnant women at recreation centers of their regions. They solved the problems of transportation, food supply, accommodation, medical and consumer services for people coming for health improvement.

By mid-June, 1986, an issue of accommodating thousands of people at a new place came up due to mass evacuation. In this respect on June 11, 1986, Central Committee of the Communist Party of Belarus and The Council of Ministers passed resolution No. 172 "On employment assistance and provision with housing and social amenities for the population of Gomel region evacuated from the zone of Chernobyl nuclear power station". In June, 1986 regional party and executive committees were assigned to as follows:

- temporary accommodate people evacuated from dangerous areas of the accident at Chernobyl nuclear power station, provide food, medical, trade and consumer services;
- assist evacuated citizens in employment by giving them a regular work in accordance with their profession and qualification in collective and state farms and other agricultural enterprises as well as in establishments and organizations.

When necessary, issues of training of these workers for new professions and organization of their studies had to be solved, their average wages and salaries at former place of employment being retained during training period.

Ministry of agricultural construction, Belselstroy and Glavpolesyevodstroy were prescribed to provide said citizens with living quarters in apartment houses of different departmental affiliation at the latest October, 1986. A program was set to construct apartment houses, objects of public amenities, trade and communal services in the settlements of Gomel region that were fixed for evacuated population residence. All in all, 3,970 houses of farmstead type were to be constructed, for which 90 million rubles were allocated. Factory-made wooden houses of 180 thousand m^2 and sets of timber parts for house construction with walls of local materials worth 70 thousand m^2 that were obtained by the republic from the union reserve were handed over to Gomel regional executive committee.

Regional executive committees and BSSR Gosagroprom were assigned to guarantee as follows:

- provision of homestead lands and rendering assistance in their tillage to people evacuated to rural settlements;
- sale of cows, allotment of cattle pasturing and mowing areas and, when necessary, forage at the costs of the farms to evacuated persons.

A number of resolutions by the Council of Ministers touched upon the issues related to indemnities to people suffered from the catastrophe at Chernobyl nuclear power station. Organizationally this problem was developed in the Resolution No. 194-13 by the Council of Ministers dated of June 26, 1986 "On reparation of property damage to population evacuated from the settlements of alienation zone of Chernobyl nuclear power station". This resolution set entitlement payments for household property, fruit and berry plantations and crops, uninsured agricultural animals, buildings (apartment houses, garden houses, summer cottages,

garages and farm buildings). State bank was allowed to grant interest-free loans to evacuated persons for household needs. Nutrition of evacuated children in infant schools was to be provided according to sanitation norms.

Mothers with children of preschool age found themselves in the most difficult situation, for during the first post-fault period in most cases they were evacuated and stayed in health improvement establishments together with children to be socially protected. Thereupon, on 13th of August, 1986 the Council of Ministers passed decree No. 645-pc according to which an average salary and unbroken employment record were retained from the date of tie-up due to the accident to the date of return home or receipt of dwelling premises and employment in other regions for the woman-workers having children of preschool age that were evacuated from the zone of Chernobyl nuclear power station and accommodated in health-centers of trade unions, health improvement establishments of ministries and departments or other places of temporary habitation. By October 1, 1986 regional executive committees, ministries and departments, directors of enterprises, organizations and institutions were assigned to guarantee employment of these women and provide places in infant schools for their children out of turn.

At the same time analysis of radiation situation showed that it was necessary to carry out additional re-settlement of people. On 26th of August, 1986 Central Committee of the Communist Party of Belarus and the Council of Ministers passed joint resolution No. 266-17 "On additional measures in employment assistance, provision of dwelling and social amenities for the population evacuated from the settlements owing to the accident at Chernobyl nuclear power station and reparation of property damages to it". As a primary task, Gomel regional executive committee was assigned to ensure evacuation from 29 settlements in August-September, 1986. Regional committees and regional executive committees were to provide temporary accommodation of the evacuated people, arrange food, medical, trade and consumer services and ministries and departments were to guarantee their employment by October 1, 1986. Orders were made to develop documentation, perform works in timely completion of construction of living quarters and objects of public amenities for the re-settlers. Entitlement payments were fixed for fruit and berry plantations and uninsured agricultural animals. Lump-sum payment for a laborer and members of his family, property delivery payment and payments of salary for the days of collection for leaving to and getting settled at a new place of residence were introduced.

Completing evacuation of population from the most affected settlements that was paid much attention to in May-August, 1986, allowed to face the problems of other contaminated territories where hundred thousands of people resided. In this aspect, on 28th of August, 1986 the Council of Ministers adopted resolution No. 267-18 "On better financial position of population residing in settlements with limited consumption of locally manufactured agricultural products owing to the accident at Chernobyl nuclear power station". This resolution envisaged payment of 30-ruble monthly monetary allowance per each member of the family, free support of children in infant schools and food in 116 settlements. Damage caused to the dwellers' property owing to decontamination works were to be indemnified completely. Ministries and departments were assigned to ensure the supply of milk, meat and other foodstuffs, systematic inspection of portable water, agricultural produce of local manufacture and private subsidiary plots as well as the products brought from other regions. To prevent contaminated milk and dairy products from being consumed, until September 1, 1986 regional executive committees and Gosagroprom were charged to organize stabling of cows from citizens' individual farms in these settlements and supply sufficient amount of clean forage to these farms.

Later on, prior to the adoption of the Law "On social protection of citizens suffered from the catastrophe at Chernobyl nuclear power station" the Council of Ministers repeatedly

addressed both the issues related to social protection of the suffered population and those matters of settlement attribution to this or that contamination zone, followed by re-settlement or fixing of relevant benefits to the citizens. So, on 19th of August, 1987 they adopted resolution No. 273-20 "On additional actions to safeguard health of population and improve economic activities in the districts of Gomel and Mogilev regions exposed to radioactive contamination". Decree N 339 dated of July 12, 1989 envisaged re-settlement of the dwellers from 52 settlements exposed to radioactive contamination as a result of the accident at Chernobyl nuclear power station in which decontamination and soil-conservation works did not ensure the required limit of individual radiation dose in the course of life, fixed by USSR Ministry of Health. On 28th of December, 1989 decree No. 578p approved the list of settlements in which consumption of milk and, if necessary, other foodstuffs of local manufacture and individual subsidiary farms was partially restricted; the dwellers of these settlements were to receive monetary allowances worth 15 rubles monthly per each member of the family.

A number of resolutions and decrees by the Council of Ministers were aimed to improve remuneration of labor for the works in the contaminated territory. So, decree N 486 dated of 21st of June 1986 permitted the heads of enterprises and organizations to pay the workers involved in the works in the settlements of Gomel regions (68 settlements) at higher by 100% base wage rates (piece-rates) and position salary scales for a period until decontamination of the appropriate territories was completed. To add, in said regions a number of other benefits envisaged in resolution No. 665-195 dated of June 5, 1986 by the Council of Ministers were introduced. Decree No. 545p dated of July 8, 1986 by the Council of Ministers made it possible to pay persons employed in the settlements of Gomel region (146 settlements) at higher, by 75 to 100% base wage rates (piece-rates) and position salary scales. The issues of labor remuneration for the work executed in the contaminated territories in 1986 were reflected in other decrees by the Council of Ministers, namely No. 786pc dated of October 2, 1986, No. 907pc dated of November 25, 1986, No. 300 dated of July 4, 1990, etc.

One should note that many regulatory documents published in Belarus were mainly based on similar documents adopted by the USSR Council of Ministers and in some cases union resolutions only were in effect. First of all, one should mention the decisions by union authorities, concerning the issues of social protection of persons who participated in elimination of the consequences of the accident at Chernobyl nuclear power station or who were involved in the works at the station itself. They include such resolutions by the Council of Ministers as No. 1497-378 dated of December, 1987 "On terms of payment and benefits for the workers involved in operation of Chernobyl nuclear power station and elimination of the consequences of the accident in re-settlement zone"; N 325 dated of March 31, 1990 "On actions to improve medical care and social security of persons involved in the works on elimination of the consequences of the accident at Chernobyl nuclear power station".

In 1987 National Committee for radiation protection approved the Norms of radiation safety NRS-76/87 that allowed the Ministry of Health to determine dose limits for population that received high radiation doses as a result of the accident. In 1987 a limiting level of 20 mSv was introduced and in 1988 and 1989 it constituted 25 mSv. Thus, the highest total dose that peoples residing in the contaminated territory could receive during 4 incomplete years (44 months) amounted to 175 mSv. Thereby, primary task was to prevent deterministic effects.

They considered it expedient to distinguish the following radioactive contamination zones:

- Permanent re-settlement zone of where minimal exposure rates on the 15th day after May 6, 1986 exceeded 20 mR/hr (0.2 mGy/hr). To add, if annual dose was above 0.1 Gy, the dwellers of this territory were re-settled.
- Temporary re-settlement zone to which the return of population after evacuation was possible. In the given territory exposure dose ranged from 5 to 20 mR/hr.
- Monitoring zone with exposure dose from 2 to 5 mR/hr (0.2-0.5 mGy/hr). Pregnant women and children were temporary evacuated from this zone for 2-3 months. Besides, systematic radiation monitoring, foodstuffs, water and forage checkup were conducted in this zone.

To limit internal radiation doses, temporary allowable levels (TAL-88) of foodstuffs and water contamination with caesium isotopes came into effect.

In the first post-fault years the Council of Ministers passed several dozens of resolutions and decrees on the matters related to elimination of the consequences of the accident at Chernobyl nuclear power station. Nevertheless, it became more and more obvious that it was impossible to cope with the whole package of problems without express state program for elimination of the consequences of this catastrophe and without appropriate legislation. As a result, in 1990-1991 there was an intensive work on preparation and adoption of Laws "On social protection of people suffered from the catastrophe at Chernobyl nuclear power station" and "On legal regulations of the territories exposed to radioactive contamination as a result of the catastrophe at Chernobyl nuclear power station".

4.3. Activities of the Government, legislative authorities and the President of the Republic of Belarus during rehabilitation period of negotiation of the consequences of Chernobyl catastrophe

Experience of works carried out during the initial period dictated the necessity of systemic solution of the problems of the consequences of Chernobyl accident. On 22nd of May, 1989, Central Committee of the Communist Party of Belarus and the BSSR Council of Ministers passed a resolution on the elaboration of State Program of negotiation of the consequences of the accident at Chernobyl nuclear power station in Belarusian SSR for 1990-1995 and up to the year of 2000. Such program was developed in July, 1989 and approved by XI-th session of the Supreme Soviet of BSSR. The same session declared the republic a zone of national ecological disaster. Finally, the Program was adopted by XII-th session of the Supreme Soviet in October, 1989. The following measures formed its basis:

- carrying out actions on maximum reduction of radioactive irradiation dose;
- securing safety of human health by medical preventive measures, health improvement, social security and re-settlement from the settlements in which safe habitation criteria are not guaranteed;
- creating conditions of activities safe for human health in the regions exposed to radioactive contamination;
- increasing living standards of population of these regions;
- research study of the problems related to radioactive impact on human being, ecosystems, etc.

In April 1990 the USSR Supreme Soviet approved State Union-Republican Program of urgent measures on elimination of the consequences of the accident at Chernobyl nuclear power station. However, after the dissolution of the Soviet Union the Republic of Belarus remained alone facing the whole set of Chernobyl problems.

On July 28, 1992 the Presidium of the BSSR Supreme Soviet approved State Program on negotiation of the consequences of the catastrophe at Chernobyl nuclear power station in the Republic of Belarus for 1993-1995 and for a period of up to 2000. At present State Program on negotiation of the consequences of the catastrophe at Chernobyl nuclear power station in the Republic of Belarus for 2001-2005 and for a period of up to 2010 is approved. This indicates that the importance of Chernobyl problems for Belarus will remain at the state level for long.

Laws "On social protection of people suffered from the catastrophe at Chernobyl nuclear power station" and "On legal regulations of the territories exposed to radioactive contamination as a result of the catastrophe at Chernobyl nuclear power station" were adopted by the Supreme Soviet of the Republic of Belarus in 1991.

The Law "On social protection of people suffered from the catastrophe at Chernobyl nuclear power station" determined protection of rights and interests of people who had participated in elimination of the consequences of the catastrophe, had been re-settled and had moved to a new place of residence from radioactive contamination territories, who lived at that moment in the specified territories, as well as of persons who had participated in elimination of or had suffered from the accidents and their consequences at other nuclear works of civil or military purpose or as a result of testing, military exercises and other works related to nuclear plants, including nuclear weapons.

The Law of the Republic of Belarus "On legal regulations of the territories exposed to radioactive contamination as a result of the catastrophe at Chernobyl nuclear power station" defines legal regulations of the territories of the Republic of Belarus exposed to radioactive contamination because of Chernobyl accident and is aimed at reducing radioactive impact on population and ecological systems, carrying out nature-recovery and protection measures, efficiently using natural, economic and scientific potential of these territories. Legislation determines the notions of national, radiation and ecological disaster, radioactive contamination territories, radiationally dangerous lands, alienation lands, lands of limited economic usage, etc. In accordance with Article 4 of the Law, depending on radioactive contamination of soils with radionuclides and average annual effective dose, the territory of the Republic of Belarus is divided into zones (Table 4.2).

Table 4.2 Zoning of the territory of the Republic of Belarus according to radioactive contamination and dose loads on population

Zone description	Equivalent dose, mSv/year	Contamination density, kBq/m^2 (Curie/km^2)		
		Cs-137	Sr-90	Pu-238, -239, -240
Habitation zone with periodic radiation checkup	< 1	37–185 *(1–5)*	5,55–18,5	0,37–0,74
Zone with the right to re-settlement	> 1, but < 5	185–555 *(5–15)*	18,5–74	0,74–1,85
Zone of subsequent re-settlement	> 5	555–1480 *(15–40)*	74–111	1,85–3,7
Zone of priority re-settlement	> 5	> 1480 *(>40)*	> 111	> 3,7
Evacuation (alienation) zone	Territory around Chernobyl nuclear power station which the population was evacuated from in 1986			

In 1998 National Assembly passed the Law "On radiation safety of population". This Law was aimed at improving the system of radiation safety in the republic, its transition to the principles and procedures of radiation monitoring meeting international standards and recommendations.

Selecting and implementing public policy in negotiating the consequences of Chernobyl catastrophe are pursued with direct participation of the President of the Republic of Belarus. Activities by the President and his Administration are based on supervision over implementation of Chernobyl legislation and State programs on minimization of the consequences of Chernobyl catastrophe. It includes regular (minimum twice a year) working trips of the President to the republic regions contaminated with radionuclides and in situ consideration of the problems concerning social protection of the suffered population, elaboration of specific measures to realize instructions by the President, time of execution, officials responsible for execution, forms of supervision and so on being specified. According to the results of the trips to the affected districts (12 trips since 1995) a substantial number of protocol instructions were made to adjust the actions by the state authorities and executive committees in minimizing the consequences of the catastrophe.

When necessary, according to the results of the President's stay in Chernobyl zone, the President issues decrees and edicts, and initiates resolutions of the Government or other regulatory documents of state public authorities, local executive and administrative bodies. When carrying out the instructions of the President, the work on negotiating the consequences of the catastrophe gets additional impetus and becomes more dynamic and purposeful.

In 1991 State Committee of the Republic of Belarus for the problems of elimination of the consequences of the catastrophe at Chernobyl nuclear power station was formed by the resolution of the Supreme Soviet in the republic; it was re-organized in 1994 to form the Ministry of emergency situations and protection of population against consequences of the catastrophe at Chernobyl nuclear power station, in 1995 – Ministry of emergency situations and in 1998 – Committee for the problems of the consequences of the catastrophe at Chernobyl nuclear power station attached to the Ministry of emergency situations of the Republic of Belarus (Chernobyl Committee). The main objectives of the Chernobyl Committee are to pursue public policy in protecting population against the consequences of the catastrophe at Chernobyl nuclear power station, ensuring public supervision over preservation and use of the territories exposed to radioactive contamination. Being a public customer, Chernobyl Committee organize and coordinate the fulfillment of the State Program of the Republic of Belarus on negotiation of the consequences of the catastrophe at Chernobyl nuclear power station.

Inputs to Chernobyl program account for major portion of the republican budget: in 1991 – 16.8%, 1992 – 12.6%, 1993 – 9.6%, 1994 – 6.9%, 1995 – 7.3%, 1996 – 10.9%, 1997 – 9.9%, 1998 – 8.9%, 1999 – 8.7%, 2000 – 6.6%. Annually 30-50% of these funds are spent for social protection of the suffered population.

Emergency tax introduced in 1992 is one of sources financing the objectives of the State Program. Before 1994 it amounted to 18% of wage fund of all enterprises located in the territory of Belarus (excluding collective and state farms and farmer's businesses). However, these funds covered only 65-70% of budget expenditures on elimination of the consequences of the catastrophe. The remaining 30-35% of the needs were financed from the republican budget. The Government had to reduce emergency tax to 12% in 1994 and to 4% in 1998.

Regardless of the actions undertaken by the state, the funds assigned from the budget to overcome the consequences of Chernobyl catastrophe are not sufficient. All attempts to attract monetary funds of enterprises, local budgets and extrabudgetary funds as well as foreign investors were a failure. Crisis in the national economy growing and economy

reforming rate decreasing, these potential sources of finance of protection and rehabilitation measures become less and less workable.

This is explained, first of all, by extremely low profitability of most enterprises located in radioactive contamination districts. As a result, many enterprises do not possess necessary financial resources to fulfill even the most urgent output programs, including reproduction of capital assets and revolving funds and as a result, they possess no funds to finance protective and rehabilitation measures. The same reason limits financial capacities of local budgets. Moreover, as a rule, the budgets of regions and districts suffered from Chernobyl catastrophe are based on subsidies. They do not have sufficient assets to finance essentially necessary arrangements in health protection and public education and timely pay wages to people employed in these fields.

Acute deficit of financial resources allocated to minimize and overcome negative consequences of the catastrophe adversely affects the volumes and rates of carrying out protective and rehabilitation measures. So, in 1991-1995 budgetary and other expenditures on negotiation and minimization of the consequences of the catastrophe at Chernobyl nuclear power station amounted on average to less than 15% of total sum of social and economic damages falling at that 5-year period. The following five years (1996-2000) saw no improvement too.

Nevertheless, due to the efforts by public authorities, lawmakers, scientists and experts, solution of some vital problems was a success. They include as follows.

- Regulatory and legal base is elaborated almost for all aspects of negotiation of the consequences of the accident.
- Large amount of protective measures in agroindustrial complex is being realized, which allows to exercise control over the production of agricultural produce. A system of radiation control and monitoring has been developed and reliably functions.
- A set of measures is carried out to improve medical care and population state of health is being monitored in the districts contaminated with radionuclides.
- A system of social protection of all categories of the suffered population is in effect.

Tremendous efforts were aimed at reducing radiation risk to human health, developing normal conditions of activities both for re-settlers and those who had to go on living under radioactive contamination. About 135 thousand people from 470 settlements (295, 174 and 2 in Gomel, Mogilev and Brest regions, respectively) were re-settled from the most contaminated territories to clean districts of the republic.

Since 1986 they have built 64,836 apartments and houses of homestead type or 4,519.4 thousand m^2 of housing area for the re-settlers, including 239 communities (more than 50 houses in each) with the required infrastructure in clean districts of the republic. At the same time the problem of settlement development for the re-settlers was solved. During this period they constructed comprehensive schools for 44,072 pupils, infant schools for 18470 children, dispensary and out-patients' establishments for 20,922 visits per shift and hospitals with 4,160 beds.

To provide the population residing in the districts contaminated with radionuclides with fuel, 1,898 km of gas pipelines were laid in the republic. To improve living conditions of the population in the contaminated territories, 1,847 km of water lines, 521 km of sewer system and 21,907 km of motor road were constructed, bath-houses for 1,792 persons were put into operation, improvement of settlements, livestock farms, machinery farms and other objects was made.

At present, capital investments are directed, first of all, to construct habitation for the re-settlers and the disabled as well as to hold personnel in the contaminated districts, develop settlements for the re-settlers, undertake protective measures, construct rehabilitation and

health improvement centers and objects of public health care in accordance with the President's program "Children of Belarus". Construction of objects to ensure living standards of population that meet radiation safety norms retains its importance. It includes the construction of water and gas supply networks, sewer systems and portable water treatment plants. To solve these tasks, 144 artesian wells should be drilled, about 1,300 km of water lines must be laid, 42 water intake facilities, 480 km of gas branch lines and 2,780 km of distribution gas pipeline networks are to be put into operation.

* * *

Reparation of social and economic damage caused to the Republic of Belarus by Chernobyl catastrophe will last hundreds of years. All these years our national economy, social and other vital spheres of public activities will be marked with Chernobyl tragedy. Year in and year out, the country will experience great deficiency in production output and amounts of revenues, and its citizens will incur losses caused by deterioration of their health and social status.

Chapter 5

SOCIAL PROTECTION AND MEDICAL SERVICING OF SUFFERED POPULATION

5.1. Social Protection of Citizens-Victims of Chernobyl Catastrophe

Measures of social protection of the citizens who have suffered from Chernobyl catastrophe have been undertaken by the Government of the Republic literally since the first days after the accident. In the classified form they found their reflection in the Law passed in February 1991 "On Social Protection of Citizens-Victims from Chernobyl Catastrophe", where for the first time the legal status of the citizens who have suffered from the accident, the volume and types of privileges and compensations granted to them were legally established.

As of 1.01.2001 the Republic had (Fig. 5.1):

- citizens sick with radiation illness, invalids, in relation to whom the causal connection has been established of their physical inability with Chernobyl catastrophe – 9343 persons;
- participants of liquidation of the consequences of Chernobyl catastrophe in 1986-1987 in the evacuation zone – 70.371 persons;
- participants of liquidation of consequences of Chernobyl catastrophe in 1988-1989 in the evacuation zone, in 1986-1987 – in zones of first-order resettling and subsequent resettling – 37,439 persons;
- those living in the contaminated territories – 1571 thousand persons;
- those who have left the contaminated territories – over 135 thousand persons.

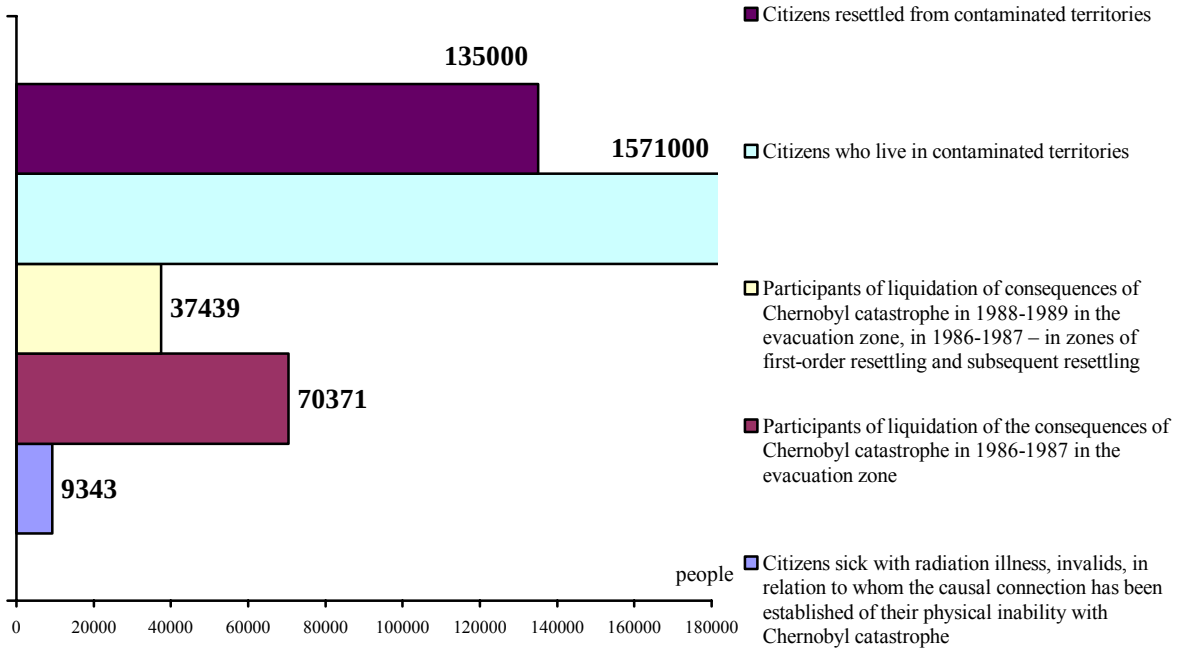


Fig. 5.1. Main categories of citizens covered by the Law of the Republic of Belarus "On Social Protection of Citizens Who Have Suffered from Chernobyl Catastrophe"

Not the most numerous, but the most damaged group is made up by those who has fallen ill and suffered from radiation illness caused by consequences of Chernobyl catastrophe, and also invalids in relation to whom the causal connection has been established of their physical inability with the Chernobyl accident. Among them are also children with detected diseases of blood-forming organs (acute leukoses), thyroid gland (adenoma, cancer) and malignant tumors. When granting privileges and compensations, children-invalids are equated to the first group invalids.

Privileges and compensations established for the given category of citizens are directed first of all at compensation of damage to the health obtained as a result of participation in activities of liquidation of the consequences of the accident, residence and works in the territory, contaminated with radionuclides. They receive lumpsum compensations of damage to the health, and annually – also some material assistance for health rehabilitation.

Chernobyl invalids and those persons equated to them have the right to receive free medicines, to make and repair tooth prostheses free of charge. When they retire or change job, they preserve the right to use the medical institutions where they had been treated when at work. If a single invalid needs care, he or she is reimbursed the expenses on a nurse. Once a year they are granted a free tour to a sanatorium are paid the cost thereof if this right has not been realised. In such cases those who work receive a hospital leaf for the whole period of treatment at sanatoriums and special medical institutions. Chernobyl invalids are provided vacation when they want, besides, they receive additional 14 calendar days of vacation every year with preservation of the average wage.

A series of privileges are directed at rendering of economic support to the invalids and persons equated to them. Namely, liberation from payment of a part of the income tax, gratuitous obtaining of their flats into private ownership in the houses of the state housing fund, 50-percent payment for housing, public utilities, gas, electricity, free travel to the place of treatment, prophylactic, out-patient or clinical examination, free travel in the urban public and suburban transport, and also – once a year to any point of the Republic. At presence of the respective medical indications they are preferentially granted special automobiles.

Privileges are envisaged directed at improvement of housing conditions of invalids. Among them are the right of out of turn, within one year, provision of housing to those who require improvement of dwelling conditions, and also to have additional dwelling floor area as a separate room, first-order entrance into the housing or housing-construction co-operatives, granting of a land plot and purchase of building materials. The right is envisaged to obtain a loan on building or acquisition of personal apartment houses or joining a co-operative, in this case 50 percent of the loan obtained for building or acquisition of an apartment house, or co-operative housing construction is repaid at the expense of the state budget. Chernobyl invalids have the right to enter out-of-competition universities, secondary special educational institutions, technical training colleges, and courses of vocational training, in all the cases they are granted hostel places for the time of study; their scholarship is 50 percent higher. Children of invalids have priority when placed to children's preschool institutions, summer camps and sanatorium type institutions, and a kept there free of charge.

At definition of privileges and compensations to citizens who took part in liquidation of consequences of Chernobyl catastrophe in 1986-1987 years in the evacuation zone, or who were busy during this period in the works on the station itself, they took into consideration, that these people were directed and worked on liquidation of the consequences of the accident during the most tense period in the places, most heavily contaminated with radionuclides, that their health was exposed to the largest risk, that in many aspects it was thanks to them that a huge scope of works of neutralisation of the blown-up reactor, evacuation of the population and material values, building, decontamination has been timely made. In this connection the

privileges for these participants of liquidation of the consequences of the accident, both by their volume, and by their significance, are not in fact different from the privileges established for invalids. A little smaller privileges are granted to them on transportation services, provision of housing, loans, pensions. At the same time the privileges granted to the remaining participants of liquidation of the consequences of the accident, namely, to those who worked in the evacuation zone or at the station in 1988-1989, in the zone of first-order resettling and subsequent resettling in 1986-1987 are rather small. They have the first-order right to obtain a land plot for building of an apartment house, to enter a housing or housing-construction co-operative; privileges when entering higher, secondary special educational institutions and technical training colleges, courses for vocational training with granting of a hostel in all cases and obtaining of increased by 50 % scholarship, etc.

The legislation has equated the rights of citizens evacuated and resettled from zones of evacuation (alienation), of first-order resettling and subsequent resettling, and also those who independently left these zones after the accident. The directivity of privileges and compensations granted to them is clearly seen: first of all, to indemnify the material damage suffered, to provide a possibility to move to another residence under the least possible losses, to get quickly accommodated in the new habitation, to get employed. The given category of citizens has the right at resettlement to terminate operatively, without observance of any terms envisaged by the current legislation, their employment contracts, and in the new habitation to be first-order employed. In this case they preserve their continuous employment record for 4 months.

Among the compensatory disbursements are the following:

- dismissal pays at a rate of four monthly average wages at termination of the employment contract;
- lump sum allowances at a rate of a monthly official wage (basic wage rate) and 1/4 of the allowance per each resettled family member of the worker;
- monetary compensations for the property lost in connection with resettlement (or obtaining into ownership of other equivalent property): constructions, household articles which cannot be taken to the new habitation owing to radioactive contamination, insured agricultural animals subject to enforced slaughter, fruit-and-berry plantings; expenses on development of the land plot of gardening partnership and pre-house land plot, accumulated fees at housing-construction (housing co-operatives).

In the full volume expenses are compensated connected with resettling and transportation of property. The citizens resettled from these territories are granted, instead of the left apartment houses and constructions owned by them as property, are provided with apartment houses (flats) in the new habitation. In this case they are paid no monetary compensation for the lost apartment houses and constructions. If the size of compensation for the lost apartment house and constructions exceeds the cost of the house or flat, provided into private ownership the difference in the costs is paid out to these citizens.

Taking into consideration, that alongside with the organized resettlement of citizens from zones of radioactive contamination, they move very often by their own, measures are envisaged directed at provision housing to them in the new habitation.

Among other privileges: redemption of land tax payment during three years at resettlement into the countryside, first-order provision with permits for sanatorium treatment and rest, extraordinary provision of places in children's preschool institutions, specialized children's institutions of medical and sanatorium type, health-improving camps, usage of vacation in comfortable time, obtaining of additional vacation for the period of 14 calendar days without preservation of wages.

Accordingly, at departure from cleaner zones, the volume of submitted privileges is also decreased.

Children and teenagers who lived earlier in evacuation zones, in the areas of initial and subsequent resettling, in the zone with the right for resettling, when they move to the new habitation, have the right to get charge-free sanatorium treatment and health-improvement, charge-free receipt of medicines. In case a child directed to medical or sanatorium treatment, needs to be accompanied by an adult or parents, they are paid travel expenses and granted a medical leave for the whole period of stay with the sick child on the way and during treatment.

The following circumstance is important. At present, resettlement has been over of citizens from the zone of first-order resettling, and there is no problem of mandatory, forced resettling of citizens from the zone of subsequent resettling. In connection with the fact that dwelling settlements in this zone will continue to exist, measures have been taken directed at decrease in them of unfavorable consequences of Chernobyl accident. These measures may be conditionally subdivided into 2 groups: those of medical and economic nature. Thus, the citizens living in the zone of subsequent resettling, are provided with medicines free of charge, with permits to sanatorium treatment and health improvement (children may take advantage of this right for the period of up to 2 months).

Children are kept free of charge at children's preschool institutions, health-improving camps, are granyed free nourishment at schools, technical training colleges and schools.

Mothers who are away from work because of taking care after children-invalids are paid monthly allowances, the parents have the right of free return travel with the sick child to the place of treatment and back. During the period of care after the child, including sanatorium treatment, one of the parents is given a sick leaf at a rate of 100 percent of the wage. Those living and working in the polluted zones have increased annual paid vacation (from 30 to 44 calendar days, besides the additional vacation provided for work under severe working conditions), when granting thereof they are also paid material aid for health improvement.

Those who live in the zone above 1 Ci/km^2 (37 kBq/m^2) enjoy the preferential right to enter higher, secondary special educational institutions, technical training colleges and courses for vocational education with granting in all cases of a hostel during the whole period of study. The scholarship to them is increased by 50 percent.

The citizens who live in the territories of radioactive contamination are paid monthly allowance to each member of the family. A fixed additional payment is appointed also to those working (including persons directed for temporary employment and on business trips), disabled pensioners, citizens receiving allowances, scholarships.

Certain privileges are granted to persons working in the evacuation zone (including those temporarily directed and sent on business); they have a 35-hour working week, increased paid vacation, increased per diem, charge-free hot meals three times per day.

The legislation stipulates the order of military service in the territory of radioactive contamination. Deployment of military units in zones of evacuation, first-order and subsequent resettling is prohibited. The citizens recruited from the zones of first-order and subsequent resettling, and also from the zone with the right of resettling are sent for passage of the regular military service to military units, entities to the position, where their radiation irradiation during the service is eliminated. Those who take their military service in the zones of resettling are granted, on expiration of 12 months of service, a vacation of 14 calendar days, and the remaining servicemen – an additional paid vacation.

5.2. System of medical support, health improvement and sanatorium and rest-house treatment

During all the 15 years that elapsed after Chernobyl catastrophe, in the Republic of Belarus they are implementing a complex of measures and actions for health preservation of the damaged population.

With the aim to ensure constant control over the condition of health of two million persons who have been recognized to have suffered from Chernobyl accident, in the Republic special prophylactic examination is carried out of the given category of citizens, a special system of medical support of the damaged population has been enacted, including extraordinary servicing at preventive institutions and drugstores, charge-free delivery of medicines upon prescriptions of doctors, supplying with food-stuffs under increased rates when on treatment, etc. Solution of these problems is implemented by territorial preventive institutions, and also with the help of specialized mobile medical crews and medical staff who are working in the contaminated territories by means of temporary camps.

With the purpose to staff the institutions of public health located in the contaminated territories with medical personnel, they have enacted the contract form of employment of medical workers, and also started the medical institute in the City of Gomel. They are also widely using the method of targeted acceptance of students into medical institutes of the Republic.

Rendering of consulting and specialized medical help, its scientific and methodical support are executed by the specially established Scientific and Research Clinical Institute of Radiation Medicine and Endocrinology having its affiliates in Gomel and Vitebsk.

For those who suffered from Chernobyl accident, they have opened the Republican Specialized Dispensary in the City of Minsk, a specialized clinic in the settlement of Aksakovschina, strengthened endocrinological services of the Oblasts. On the basis of the Minsk Medical Institute and Minsk City Oncologic Dispensary they have launched the Republican Center of thyroid gland oncopathology, in the 9th hospital they have launched a department of marrow transplantation.

In connection with the growth of oncologic diseases during the post-Chernobyl period, in sanatorium institutions of the Republic they have opened departments for rehabilitation of such patients including the one for rehabilitation of children suffering from oncologic diseases in the "Ostroshitsky Gorodok" children's sanatorium.

Since 1993 in the Republic they have launched the State Register of persons who have suffered from Chernobyl catastrophe. The Register comprises medical information about more than 267 thousand persons, among them:

- invalids whose diseases are connected with the consequences of Chernobyl catastrophe;
- persons who were taking part in liquidation of the consequences Chernobyl accident;
- those evacuated or those who independently left the evacuation zone after the accident on the Chernobyl Power Plant;
- those living or working in the zones of first-order and subsequent resettling, and also those resettled from these zones or who left them independently after the accident;
- children born from the above persons;
- those living or working in zones with the right of resettling and with a periodic radiation monitoring, and also inhabitants of dwelling settlements, where the average equivalent radiation dose exceeds 1 mSv/year.

Pursuant to the Law of the Republic of Belarus "On Social Protection of Citizens who Suffered from the Chernobyl Catastrophe" (hereinafter – the Law) in the Republic about 500 thousand persons, including more than 400 thousand children, have the right to have charge-free sanatorium treatment or health improvement. The information on the number and

structure of the population who are having right to receive charge-free sanatorium treatment or health improvement is given in Fig. 5.2. The annual growth of the number of invalids is observed whose diseases are connected with the consequences of the accident on the Chernobyl Power Plant.

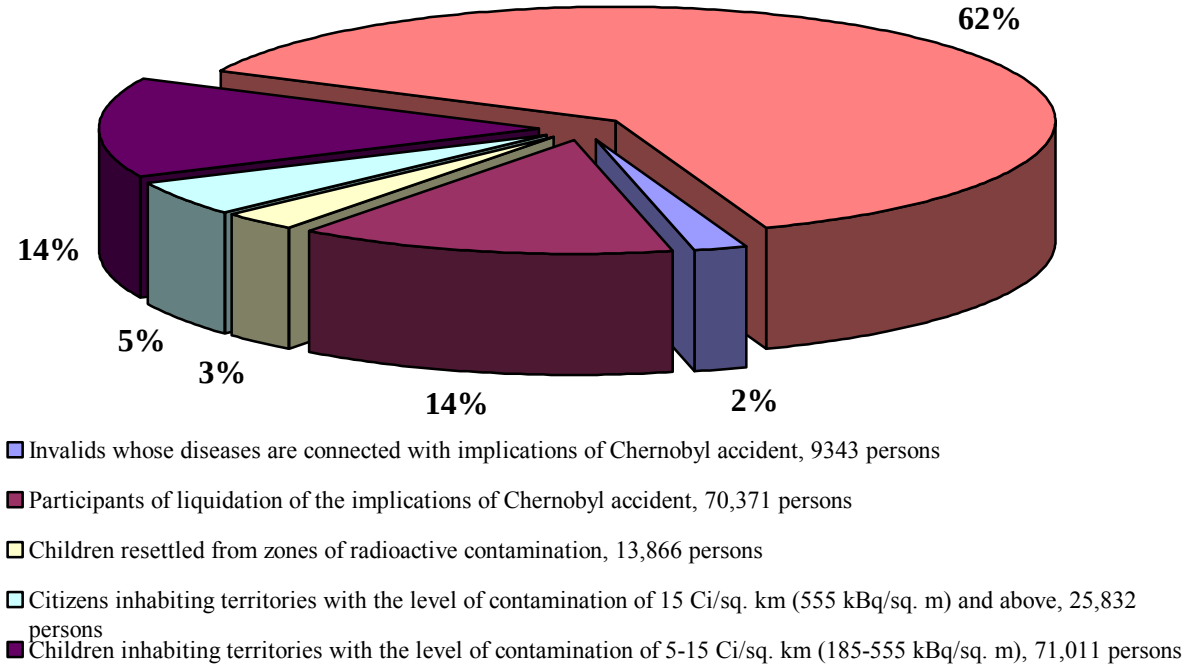


Fig. 5.2. Structure of the population having the right to receive charge-free health improvement pursuant to the Law of the Republic of Belarus "On Social Protection of Citizens who Suffered from Chernobyl catastrophe" in 2001

According to the Law, the children living in the territories with the level of radioactive contamination of 5 Ci/km^2 (185 kBq/m^2) and higher, have the right to receive annual charge-free health improvement for the period of up to 2 months; children of preschool age and children-invalids are directed to health resorts accompanied by one of the parents, children of school age usually go to health improvement or sanatorium treatment in organized groups accompanied by their teachers. With account of the aforesaid, in order to fulfill the Law completely more than 700 thousand permits to sanatorium and health improvement institutions are needed every year. Practically during several last years the allocated financing allowed to pay for not more that 300 thousand permits (Fig. 5.3). Because of limited assets, the Committee on Problems of Consequences of Chernobyl Catastrophe together with the Republican Center on health improvement and sanatorium treatment of the population have determined priority directions of their usage – health improvement of invalids whose diseases are connected with consequences of Chernobyl accident, and children living in locations with the level of radioactive contamination of 5 Ci/km^2 (185 kBq/m^2) and higher.

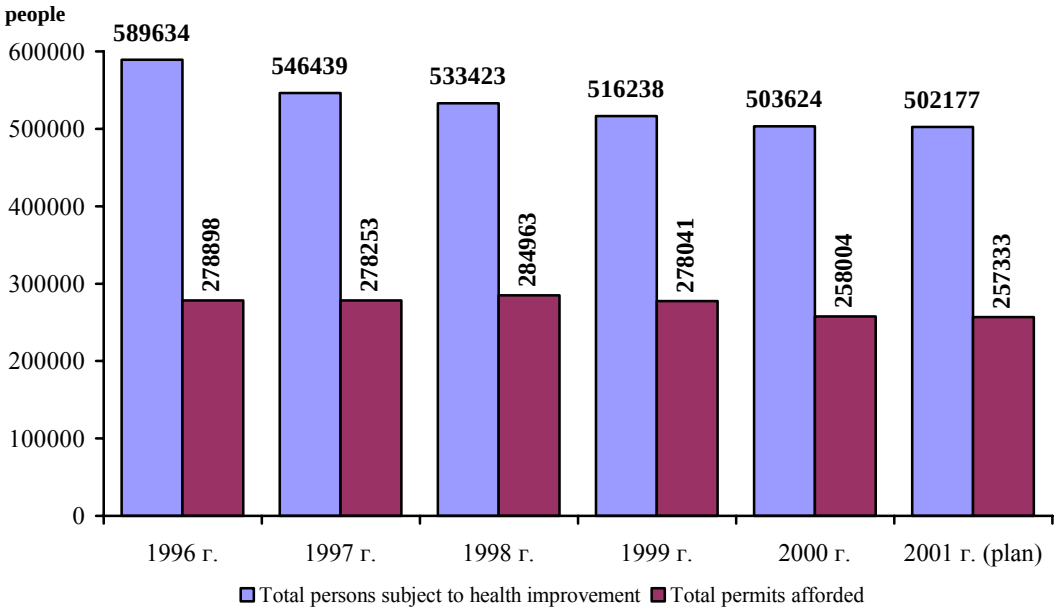


Fig. 5.3. Health improvement and sanatorium treatment of the suffered population in 1996-2000

Optimization of planning of sanatorium treatment and health improvement of the damaged population is implemented with account of the following factors:

- expediency of sanatorium treatment and health improvement of population at health resorts located in the territory of the respective Oblast (except the most damaged by the accident on the Chernobyl Power Plant Mogilyov and Gomel Oblasts);
- minimizations of expensive agreements with sanatorium institutions of the countries of CIS by direction into them only under medical indications;
- first-order granting of permits to children and adolescents who have not undergone health improvement through charitable organizations;
- priority financing of health resorts which have conditions necessary for full-scale sanatorium treatment and health improvement of children, including those formed as organized groups (children's rehabilitation-improving centers of the Committee on Problems of Consequences of Chernobyl Catastrophe, children's sanatoriums and the children's санаторно-improving complexes), where in the first order children are directed who are living in the territories with the level of radioactive contamination of 5 Ci/km^2 (185 kBq/m^2) and higher.

One shouldn't avoid mentioning the help rendered to Belarus in health improvement of children by foreign countries due to which annually about 50 thousand children leave abroad to have their rest. Nevertheless, the main problem of organization of health improvement and sanatorium treatment of children, and namely they are taking the leading place in the structure of population damaged by Chernobyl accident, is the lack of children's sanatorium institutions.

The children damaged by the consequences of Chernobyl catastrophe are taken in Belarus by 7 children's sanatoriums and 2 departments for children in sanatorium institutions with a total capacity of 1760 places, 6 children's rehabilitation and mproving centers (capacity – 1440 places) and 3 children's sanatorium complexes (capacity – 860 places). Parents with children are received by 3 sanatoriums (with the total capacity of 350 children's places).

Thus, during a year a total of about 62 thousand children may be directed to children's health resorts. The overwhelming majority of children is directed to adult sanatoriums and improvement institutions which does not allow to hold their proper sanatorium treatment.

It is necessary to mention that, despite all economic complexities, the President and the Government of the Republic of Belarus are permanently searching ways of solution of problems of children protection, including those who suffered from Chernobyl catastrophe. Thus, in 1998-2000 within the framework of the presidential program "Children of Belarus" the subprogram "Children of Chernobyl" was executed. During the latter a lot of additional measures of medical protection, social-psychological rehabilitation and health improvement of children, building and renovation of preventive institutions for children who have suffered from the accident have been implemented.

The Committee on Problems of Consequences of Chernobyl Catastrophe has created and develops a network of rehabilitation and health-improving centers for children and adolescents damaged by Chernobyl catastrophe (Children's Rehabilitation and Health Improvement Center - CRHIC). They are located in all the Oblasts of the Republic, including clean locations of the Oblasts most heavily damaged by the accident on the Chernobyl Power Plant – Gomel, Mogilyov and Brest ones. The Centers receive parents with children of preschool age, and also children of all ages in the form of organized groups accompanied by teachers. The total capacity of six operating CRHICs is 1440 places. Three Centers with the general designed capacity of 1250 places are under building and renovation.

Alongside with climatotherapy, balanced diet, sports and physical culture, educational and upbringing work, and cultural activities in the Centers conditions have been created for affection of natural factors and physical methods (sources of potable mineral water, inhalation equipment, ward of speleotherapy, phytobar, sauna, basin, ward of physical culture therapy, exercise room, wards of needle- and reflexotherapy, magnet therapy, photarium) which are improving functions of the most vulnerable organs and systems for radionuclides. In connection with deficit of medical personnel in damaged regions, diagnostic departments have been equipped with ultrasound examination devices, ECG, spirography, and also laboratory departments have been established. At the Centers they are launching psychological services, their task being improvement of the mood of the child, formation and strengthening of his or her faith in success of treatment and health improvement. Among them are the department of social-psychological rehabilitation at the "Zhdanovichi" CRHIC created within the framework of the "UNESCO-Chernobyl" Program. A similar department is being established at the "Svitanok" CRHIC.

Let's give a brief characteristic of the operating and built children's rehabilitation and health-improving centers of the Committee for Chernobyl.

Republican unitary enterprise (RUE) "Zhdanovichi" Children's rehabilitation and health-improving center

The "Zhdanovichi" children's rehabilitation and health-improving center was founded on December 4, 1995, and is a versatile sanatorium entity with capacity of 250 places for children of all ages, including children of preschool age with parents.

The "Zhdanovichi" Center is located on the coast of the Minsk Sea, 10 km away from Minsk, in a resort zone.

All the children who undergo the course of health improvement at the "Zhdanovichi" CRHIC receive a course of massage, they go to the swimming-pool, physiotherapeutic

procedures, they are given stomatology help. The complex of medical measures includes phytotherapy, medical physical culture, electro-chromophototherapy, inhalation of medicinal substances and highly dispersive aerosol of marine salt, paraffin-ozocerite applications, water treatment.

With the purpose of examination they undergo and SICh-diagnostics. If necessary, children are inspected at the Republican Dispensary of Radiation Medicine.

Great attention is given to physical exercises, including medical physical culture. The Center is equipped with sporting and tourist stock. There is a well-equipped beach.

Simultaneously with treatment the schoolboys have their studies, for which purpose they have 8 well-equipped classrooms. For holding of upbringing and cultural-mass activities, rooms are equipped for circle activities, there is a club, equipped with all the necessary equipment.

On the basis of the "Zhdanovichi" children's rehabilitation and health-improving center a department has been established for social-psychological rehabilitation of those who has suffered after Chernobyl catastrophe. The activities are continued of equipping it with special equipment (computers, video equipment, sporting equipment, toys). Together with the faculties of the medical institute they are designing and introducing the most progressive methods of psychological assistance.

"Lesnaya Polyana" Children's rehabilitation and health-improving center RUE

The "Lesnaya Polyana" children's rehabilitation and health-improving center was created on May 29, 1995, and is located in the Smorgonsky District of the Grodno Oblast and may house 200 children of school age simultaneously.

In the Center, which is located on the picturesque coast of the Viliya river, in the pine forest, has unique capabilities for natural health improvement.

In the health resort they are running ultrasonic investigations, functional diagnostics, there are conditions for valuable sanatorium therapy (diet therapy, medical physical culture, electro- and chromophototherapy, medical baths and douches, underwater massage). They have a sauna, sporting hall, a cosy phytobar.

A lot of attention is given to education of schoolboys. The school for 108 places is under construction. Seven educational classes, rooms for circle activity, educational-sporting gym are available at present. There is also a library.

"Praleska" Children's rehabilitation and health-improving center RUE

The "Praleska" children's rehabilitation and health-improving center is the largest of all rehabilitation and health-improving centers of the Committee for Chernobyl (450 places). The center was opened of April 7, 1998, is located on the picturesque coast of the Dnieper river, 14 kilometers from the town of Zhlobin of the Gomel Oblast. The Center receives children of school age in organized groups, since 2000 the department for health improvement of organized groups of

children of preschool age is in operation.

The Center is equipped with modern diagnostic equipment: a clinical analyzer, ultrasound examination apparatus, electrocardiographs. The wards of KVCh-therapy, medical physical culture, speleotherapy, thermotherapy, massage are available, medical bath hall, underwater douche-massage, cabinet of psychological rehabilitation, sauna with a swimming-pool, and a summer swimming-pool are present. In the Center there are several medical professionals: the ophthalmologist, LOR, endocrinologist, psychologist. Since 1993 two wells of mineral water are operating. 16 classes for training children, rooms for circle activities are equipped. The Center is equipped with sporting and tourist stock, the beach is well-equipped.

A favourable climate, natural factors, procedures, well-balanced nourishment, sporting games, excursions, walks, constant stay in the nature create magnificent conditions for health improvement and treatment.

The Center directs its activities at introduction of effective methods and means of personal medical rehabilitation and health improvement with the purpose of optimization of operation of the human body, training of adaptive mechanisms, increase of resistance to operating ecological, biological and psycho-social risk factors.

"Ptich" Children's rehabilitation and health-improving center RUE

The "Ptich" children's rehabilitation and health-improving center is located in the Petrikov District of the Gomel Oblast in a pine forest, on the coast of the river Ptich. The Center started its operation since February 1, 1994.

The well of mineral water of the type "Mirgorodskaya" acts in the territory, the sapropels are used from the Dikoye Lake (town of Rogachov). In the Center the natural factors for health improvement of children and adolescents are widely used. All the children have a capability to take a course of massage, they receive phytococktails.

In the "Ptich" CRHIC there are 10 types of treatment, the ultrasonic diagnostics is made by a highly qualified specialist, physiotherapy and electro- and chromophototherapy are used, the inhalations and paraffin-ozocerite applications are widely applied, medical douches and baths are used. A stomatology ward is operating where all the children undergo inspection and sanation.

Every year about 1400 children and adolescents pass the course of health improvement at the CRHIC, where they have fine capabilities for rest and entertainment. There is a comfortable videohall, three game rooms which are aesthetically designed and equipped with toys and board games.

Great attention is given to education of schoolboys. In the "Ptich" CRHIC there are specially equipped classes for holding lessons. A gym has been equipped for training in physical culture, and also grounds for sporting games in the fresh air.

"Svitanok" Children's rehabilitation and health-improving center RUE

The "Svitanok" children's rehabilitation and health-improving center was opened on May 29, 1995, it is located 40 kilometers from the ancient city of Pinsk in the Brest Oblast. The territory of the Center is surrounded with a pine wood, the ancient Pogost Lake is adjacent. The dwelling block has capacity of 220 places. The Center is intended for health

improvement of mothers with children below 6 years of age and children of junior school age who arrive in organized groups.

The medical block is equipped with the modern medical equipment. The diagnostic department has a cabinet of ultrasonic diagnostics, a lab of functional diagnostics, a cabinet of radiological examination, a medical department (balneary with different types of baths, underwater douche-massage, cabinet of medical douches, swimming-pool), a physiotherapeutic department (cabinet of photoradiotherapy, electrodream, chromophototherapy, magnet therapy). In the health resort the preference is given to non-medicamental methods of treatment, a phytobar is operating, where they select tinctures of vitamin-containing and special herbs consolidating the immune system and boosting the protective functions of the organism.

They are permanently holding physical culture lessons, sporting competitions. Meals are served 6 times per day, they are well-balanced, especially fit for strengthening of nonspecific stability of the organism. The rations include products of beekeeping, pectins, bifido-containing lactic products, etc. The leisure is nicely organized, there is a stadium, playlands, the beach is nicely equipped, in summer they operate a boat station. Conditions have been created for music- and choreotherapy.

Now on the basis of the Center the works are underway of organization of the department of social-psychological rehabilitation, the main direction of its activities will be the problems of psychology of the family.

"Sidelniki" Children's rehabilitation and health-improving center RUE

The "Sidelniki" rehabilitation and health-improving center was created on December 27, 1996, has capacity for 240 children, in 2000 the department for children of preschool age was organized, the Center is located on the coast of the river Pripyats, in the Mozyrsky District of the Gomel Oblast, it has 2 sources of mineral water for balneology and for drinking. In 1996 the new medical block was commissioned with departments of fangotherapy, balneary, two swimming-pools with mineral water and saunas, medical baths and douche installations, massage, etc. cabinets have been launched into operation.

With the diagnostic purpose on the basis of the Center they run ultrasonic diagnostics, electrocardiography, spirometry and spirography, clinical analyses are carried out. A complex of treating and health-improving measures with usage of diet therapy, medical physical culture, electro- and chromophototherapy, inhalation, fangotherapy, halotherapy, underwater and dry manual massage was implemented. In the Center a sauna and a swimming-pool work.

They give meals 6 times per day, they are balanced, specially fit for strengthening of nonspecific immunity of the organism. They give products of beekeeping, pectins, bifido-containing lactic products, etc., which are included into the rations.

In the "Sidelniki" CRHIC 22 types of treatment are used, phytotherapy, massage, terrain cure and medical physical culture, water treatment (swimming-pool, baths, douches) are widely applied.

For schoolboys they hold training in a separate building of school. There are a discohall, a club, a gymnasium, workshops, a library, game rooms.

5.3. Centers of social-psychological rehabilitation

The accident on the Chernobyl Power Plant has exerted influence not only on the ecological situation in the environment of Belarus and conditions of health of the population, but also on the mentality of the people, that has found reflection in the mental conditions, social assumptions and in the respective behavioral preferences. Their originality is traced during the long-lived period of post-accident process. In this case, if the radio ecological conditions and the conditions of health of the population depend, in the greater degree, directly on the level of contamination with radionuclides of the territory, the changes in mentality are greatly under the influence of information processes, measures and actions taken, including the humanitarian help.

At the initial stage after the accident, it was found out, that for some part of the population high mental stress was characteristic, while another one acquired assumptions to ignore the radiation hazard. It has predetermined the necessity of paying urgent attention to psychological consequences of Chernobyl accident. Later, under the influence of mass media and not always adequate actions of officials, the population got into bewilderment, which was replaced by growth of the so-called dependant moods. Lately, we have been watching a sluggish process of gradual escaping out of such condition. However, for the present there is no high activity of the inhabitants in search of an independent escape out of the situation by increase of business activity. In this case one should take into account that psychological consequences of the accident are essentially influencing by the crisis in social and economic spheres of the life in Belarus.

For comprehension of the consequences of the accident in the space of mental peculiarities of the population of Belarus, it was necessary to embrace different attitudes and assumptions towards various spheres of life, including the state of health of the people and self-assessment of the health.

The researches conducted in one of the most damaged areas by the consequences of Chernobyl accident – the Narovlya District of the Gomel Oblast – have shown, that the most powerful factors decreasing the adaptive potential of individuals and groups in such regions, are the following five main determinants:

- incessant rise of prices and decrease, caused thereby, of the material well-being of large groups of people;
- preserved high scale of radiation risk;
- feeling of injustice of social and economic order of the modern society, in which the degree of a social protection of the population is belittled;
- unsatisfactory health services;
- caused by Chernobyl accident impairment of health of the population.

As a result of interaction of these factors, the four following types of adaptation-desadaptation behavior are formed:

The first type of social adaptation is embodied in full adaptation of an individual or a social group (family, territorial, professional, etc.) to the conditions and features of the post-accident development also is characterized by active-initiative effect on the ambient social environment, on other people, on the whole set of conditions of everyday life. Such type of adaptive policy of behavior is observed in approximately one third of the population – 32 %.

A much more widespread is the second type of life strategy which is embodied in the policy of an incomplete, partial fitness to extreme post-Chernobyl living environment and may be described as a passive accommodation. A distinctive feature of this type of incomplete, passive accommodation consists in an atomised self-closing of a personality into a narrow channel of daily family-household interests, in aiming to keep in a stable state of their relative social-psychological equilibrium with the closest natural and social environment, in accustoming to living conditions, broken to the inferior side, in the extreme situation of post-accident social environment (43 %).

A considerably smaller specific weight in the structure of the population of the region is taken by the third type of social adaptation, the representatives of which suppose, that they have faster failed to adapt to the extreme situation of living in the zone of increased radiation risk, than have adapted to it. The external manifestation of this biotic policy is embodied in the fact that its followers aim to ensure their existence only at the expense of the help from the government, charitable funds and organizations, express their discontent with everything happening around. To this type of biotic policy belong less than 10 % of the total population.

The smallest, but requiring increased social support, group of the population is made up by those persons, who are characterised by long-lived (almost for 15 years) and steady disability to adapt themselves to sharply worsened unfavorable ecological, economic, social-psychological living conditions in the zone of increased radiological risk and to formulate in them any adaptive biotic strategy. These are the people, whose daily style of life is determined by desadaptational strategy of behavior and which should be attributed to the most devastating, fourth type of behavior – the desadaptation one. Their specific weight in the total population makes (by self-rating of respondents) 5.9 %.

Distribution of the population into different levels of adaptability to extreme post-accident conditions indicates that the priority directions of social policy of the district, Oblast and Republican levels of bodies of state power and management should be the following: 1) establishment of conditions for maintenance of maximum secure living of the inhabitants in extreme social and ecologic conditions which have arisen after Chernobyl accident, increase of their adaptivity to complicated living environment; 2) social and psychological rehabilitation of the damaged population; 3) improvement of physical, mental and moral health; 4) increase of the level of material well-being of citizens, development of a social infrastructure in the region; 5) effective social protection and help to the citizens damaged by Chernobyl accident.

For solution of the respective circle of problems in the Republic, pursuant to the government agreement in the Program "UNESCO-Chernoby", we have created centers of social-psychological rehabilitation. The operational schedule of creation of communal rehabilitation centers for the damaged population as a result of the accident on the Chernobyl Power Plant in settlement Streshin and in settlement Aksakovschina was signed by Commission of the United Nations for Education, Science and Culture (UNESCO) and the Government of the Republic of Belarus on 21.12.1992 and 04.02.1993. The minutes and the appendix to the Operational Schedule about creation of one more center in settlement Pershai and conditions of transfer of funds, were signed accordingly on 04.02. and 07.07.1993.

By the Order of the Ministry of Education of the Republic of Belarus of 5.10.93 No. 298 they have approved the temporary regulations on a center of social-psychological rehabilitation of the population damaged by Chernobyl catastrophe, agreed with the Ministry of Public Health, Ministry of Finance, GosChernobyl Committee and State Committee for Labour, according to which the center is under subordination to the department of education of the District Executice Committee, is financed at the expense of the assets allocated from the the Republican budget to the GoscomChernoby, and the scientific-methodical help and coordination of the activity of center are rendered by the Ministry of Education.

Now, the financing of maintenance of the centers, as well as financing of the works held earlier on repair and renovation of rooms of the centers, is made by the Committee on Problems of Consequences of Chernobyl Catastrophe at the Ministry for Emergency Situations at the expense of the assets of the state budget intended for liquidation of the consequences of the accident.

In the Committee on Problems of Consequences of the Accident on the Chernobyl Power Plant the activity is underway to ensure the operation of the centers, their physical and organizational integrity, to integrate the newly-created centers into the present state system of maintenance of rehabilitation of the population damaged by the consequences of Chernobyl catastrophe.

The centers are executing a considerable activity of rendering assistance to the damaged population – strengthening of spiritual and mental health, strengthening of families, psychological support of children, removal of psychological stress. For the years of their activity the centers became the main organizers of realization of mass measures, holidays, cultural and sporting life of the settlements. The psychologists of the centers regularly carry out interrogations and polling of the population of the settlements, and build their activity, outgoing from the responds of the population. Each visitor has a capability to receive psychological help in solution of his or her personal and family problems.

With account of the gained experience in work with the population, one of the most important functions of the centers should become rendering information to the population on consequences of the accident on the Chernobyl Power Plant and on radiation safety, holding of works on educating the population to the new radio ecological culture.

Chapter 6

AGROINDUSTRIAL PRODUCTION IN CONDITIONS OF RADIOACTIVE CONTAMINATION

6.1. Radiation situation in agricultural lands

In Belarus under radioactive contamination with density higher than 37 kBq/m^2 of cesium-137 occurred more than 1.8 million hectares of agricultural land, that makes 20.8 % of the total area, of which 265 thousand hectares with the density of contamination with cesium-137 of more than 1480 kBq/m^2, by strontium-90 – 111 kBq/m^2, by plutonium – more than 3.7 kBq/m^2, were eliminated from agricultural circulation.

Now agricultural production in Belarus is run on 1296.8 thousand ha of lands contaminated with cesium-137 with density over 37 kBq/m^2. Special complexity is made by running agricultural production on lands with density of cesium-137 fallout of 185-1480 kBq/m^2 (366 th. ha), and also of strontium-90 with density of 6-111 kBq/m^2 in the area of 458 thousand ha.

The main areas of contaminated agricultural lands are concentrated in Gomel (740.6 thousand ha or 57.1 %) and Mogilyov (338.7 thousand ha or 26.1 %) Oblasts. In the Brest, Grodno, Minsk and Vitebsk Oblasts their share in the general area of contaminated lands in the Republic makes accordingly 7.4, 4.3, 5.0 and 0.1 %.

The goverment has launched the system of radiation monitoring of soils. The situation with contamination of agricultural lands is periodically updated. During the post-accident period a total of 14.6 thousand ha of previously withdrawn land was returned back into circulation.

6.2. Behavior of radionuclides in soil and their transition into crop products

Vertical migration in soil of cesium-137 and strontium-90 goes very slowly. On untilled lands all the stock of radionuclides is concentrated practically in the top layer of humus horizons (Fig. 6.1). The depth of migration of radionuclides depends substantially on the structure of organic and mineral components of soils and of the mode of moistening. In peat soils radionuclides migrate 5-10 cm deeper than in mineral soils. Considerable distinctions in depth of migration of radionuclides are marked at changing the degree of soil moistening.

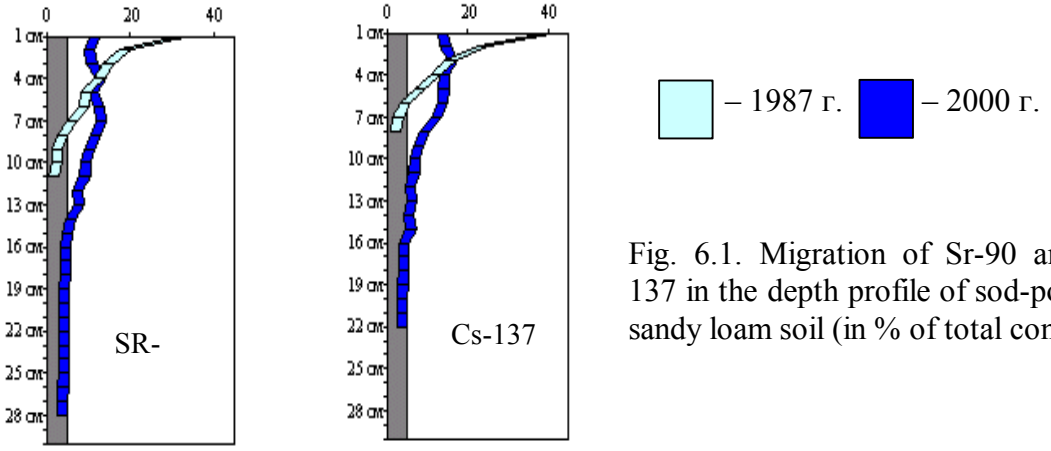


Fig. 6.1. Migration of Sr-90 and Cs-137 in the depth profile of sod-podzolic sandy loam soil (in % of total content)

On arable soils radionuclides are distributed rather uniformly along the whole depth of the tilled layer. In the immediate future, self-cleaning of the rooting layer (solum) of soils through vertical migration of radionuclides will be unsignificant.

Secondary horizontal reallocating of radionuclides is connected with the processes of water and wind erosion. Depending on the intensity of erosive processes, the content of radionuclides in the arable layer on lower relief elements may increase to 75 % (Table 6.1).

Table 6.1 Density change of contamination in arable horizon of sod-podzolic soils by cesium-137 under effect of water erosion on sloping lands of the Vetka District

Soil outwash, t/ha per year	Density of contamination, kBq/m^2		Increase of density of contamination, %
	Outwash zone	Accumulation zone	
Less than 5.0 t/ha	466* 196-736	529 222-870	13 0-18
5.1-10.0 t/ha	481 192-596	618 263-707	28 17-35
10.1-20.0 t/ha	351 144-555	614 207-1236	75 25-127

* Numerator – the average value, denominator – range of change.

The character of usage of sloping lands is essentially changing the intensity of horizontal migration of radionuclides. No solid effluents on permanent crops of perennial grasses was established. In grain-grass crop rotations the density of soil contamination in the outwash zone is increased by 20-25 %, under row crops – to 76 %.

As a protective measure, a system of land-protection crop rotations and special soil processing techniques with periodic deep (to 40 cm) mouldboardless loosening of the plough foot. It allows to reduce loss of humus and the scale of secondary soil contamination.

Accessibility of radionuclides to plants and the level of contamination of products depend on the strength of fixing of cesium-137 and strontium-90 in soil. For the period from 1987 to 2000 the share of fixed fraction of cesium-137 increased almost 3-fold and makes now 83-98 % of the gross content. For strontium-90. on the contrary, the dominance of accessible to plants forms is characteristic, the share being 57-81 % of the gross content and tends to increase over time.

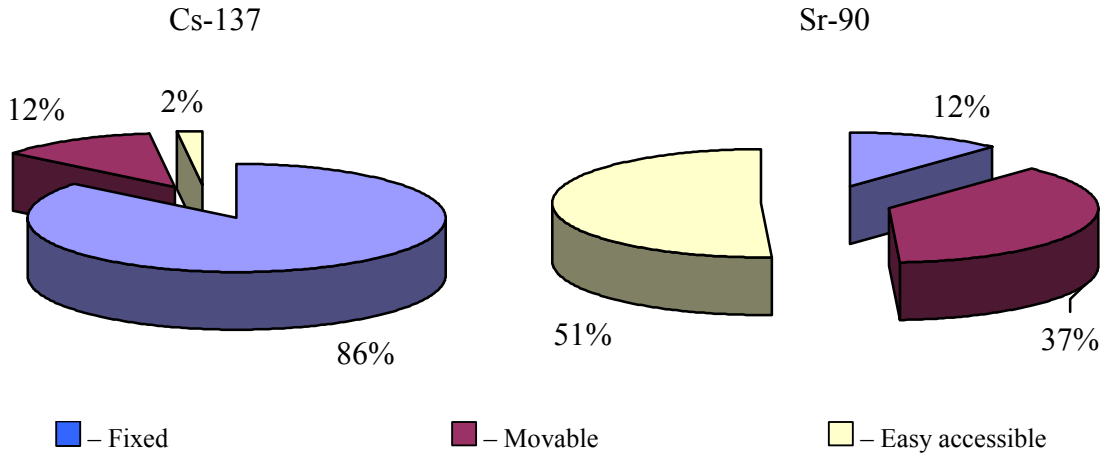


Fig. 6.2. Forms of presence of radionuclides in sod-podzolic sandy loam soil (Narovlya District, 1998)

Conversion factors of radionuclides from soil into plants also change with time accordingly. Transition of cesium-137 into agricultural crops during the post-accident period has decreased by the order of magnitude (Fig. 6.3), whereas the biological accessibility of strontium-90 practically is not reducing (Fig. 6.4).

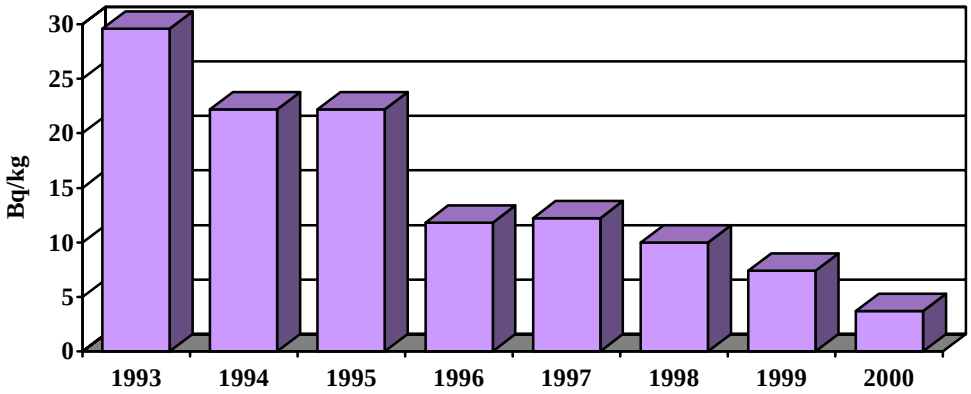


Fig. 6.3. Dynamics of Cs-137 content in barley grain in sod-podzolic sandy loam soils of the Mogilyov Oblast at the density of contamination of 370 kBq/m^2

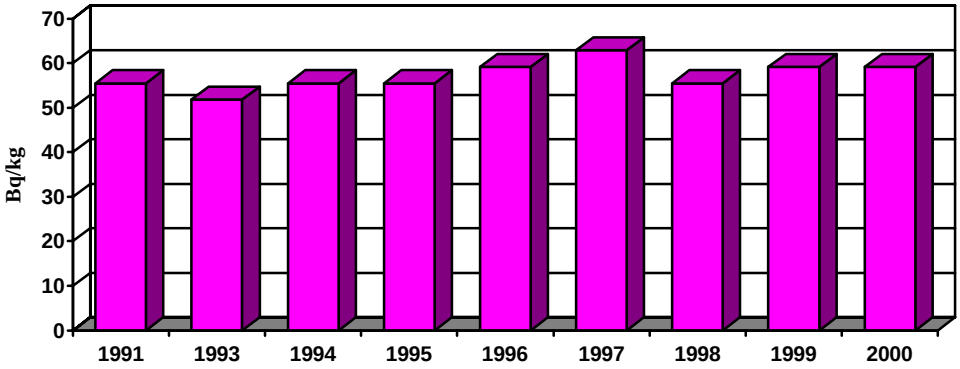


Fig. 6.4. Dynamics of Sr-90 content in barley grain in sod-podzolic sandy loam soils of the Mogilyov Oblast at the density of contamination of 37 kBq/m^2

In order to forecast contamination of agricultural products, it is necessary periodically to update the conversion factors of radionuclides from soil into the crop.

The content of radionuclides in agricultural products depends not only on the density of contamination, but also on the type of soils, degree of their moistening, granulometric composition and agrochemical properties and biological features of cultivated crops.

All this makes it difficult enough to forecast the content of radionuclides in the crop products.

Parameters of soil fertility render essential influence on accumulation of radionuclides in all agricultural crops. At increase of humus content in soil from 1 to 3.5 %, transition of radionuclides into plants is reduced by 1.5-2 times, and in the process of increase of the content in soil of potassium metabolic forms from low (less than 100 mg K_2O per kg of soil) to optimal (200-300 mg/kg) and change of soil reaction from acid (pH 4.5-5.0) to neutral (pH 6.5-7.0) – by 2-3 times (Figs. 6.5, 6.6, 6.7).

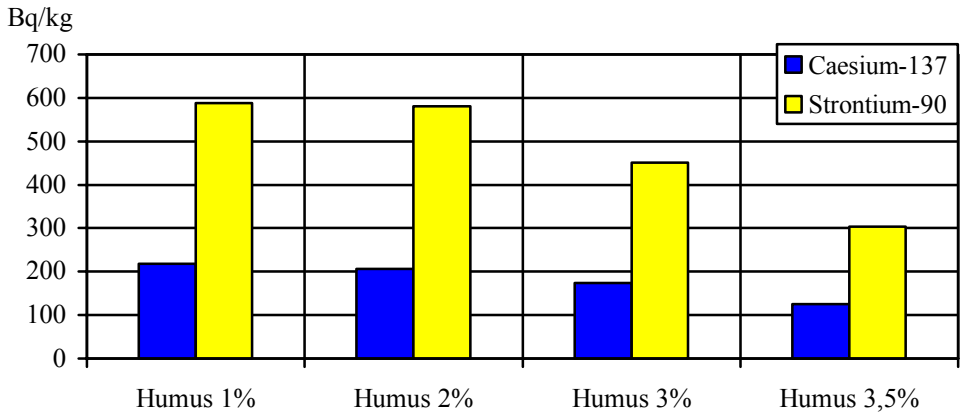


Fig. 6.5. Accumulation of radionuclides in hay of perennial cereal grasses versus the content of humus at density of soil contamination of 37 kBq/m^2

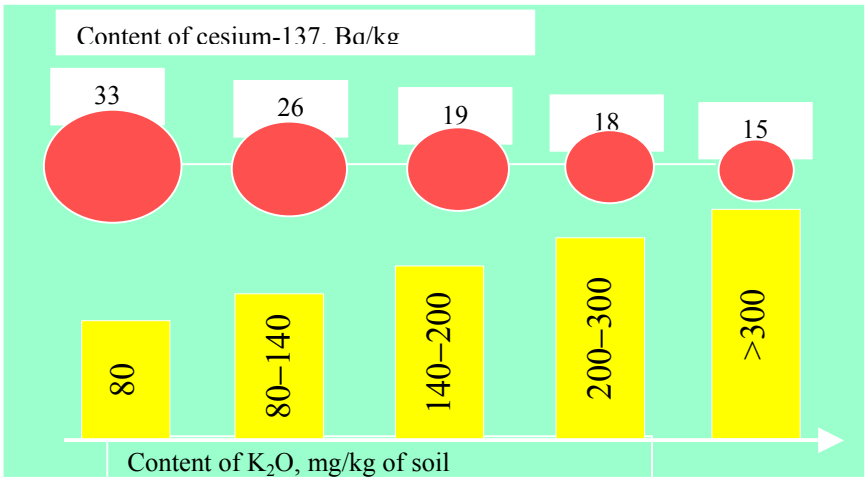


Fig. 6.6. Accumulation of cesium-137 in barley grain versus the content of metabolic potassium in sod-podzolic sandy loam soils at density of contamination of 370 kBq/m^2

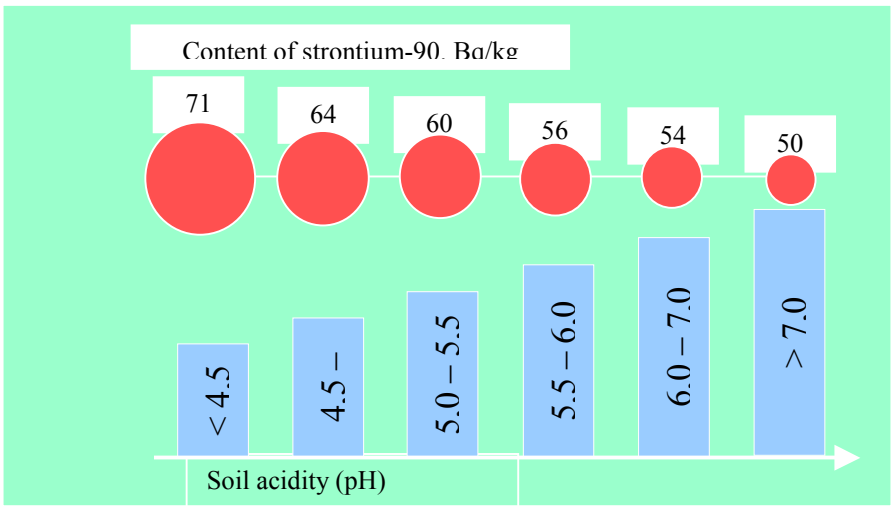


Fig. 6.7. Accumulation of strontium-90 in barley grain versus the acidity level of sod-podzolic sandy loam soils at density of contamination of 37 kBq/m^2

The minimum transition of cesium-137 and strontium-90 into plants is observed at achievement of optimal parameters of agrochemical properties of soils.

Arrival of radionuclides into cultures is essentially dependent on granulometric composition of soils. On sandy soils transition of radionuclides into plants is approximately twice as high as on loams, especially in case soils have a deficit of metabolic potassium (Fig. 6.8).

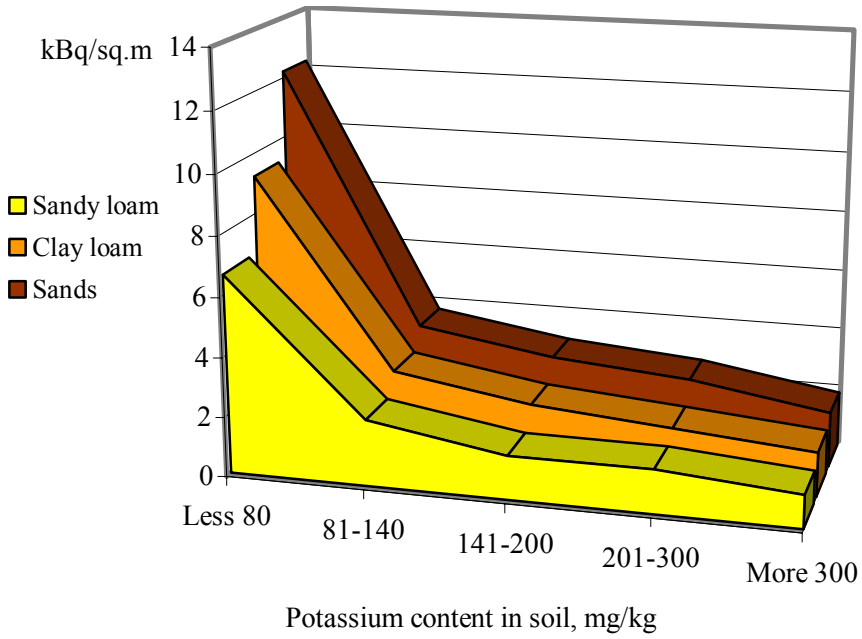


Fig. 6.8. Content of Cs-137 in oat grain in sod-podzolic soils of various granulometric composition versus the content of metabolic potassium in them

A great influence on accumulation of radionuclides in agricultural crops is caused by the mode of soil moistening (Fig. 6.9). On over-moistened sand soils dominating in Belarusian Polesje high scale of contamination of grass forages is observed even at rather low density of soil contamination with radionuclides. At the same time on improved areas of sites(segments) loess and moraine loams, more representative for the Mogilyov and Minsk Oblasts, it is possible to obtain products with the permissible content of cesium-137 at contamination density of up to 740-1110 kBq/m^2.

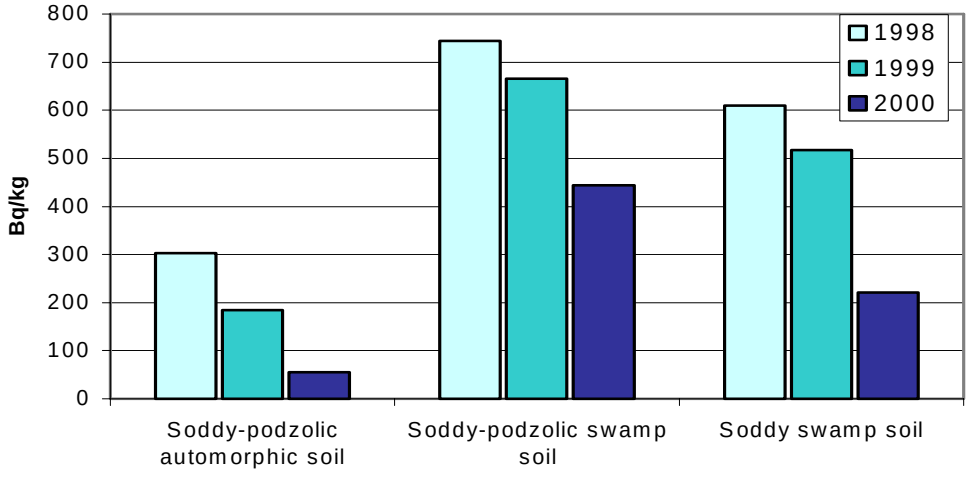


Fig. 6.9. Accumulation of cesium-137 in hay of perennial cereal grasses on soils of various moistening modes at density of contamination being 370 kBq/m^2

Transition of radionuclides from soil into vegetative products strongly depends also from biological peculiarities of cultivated agricultural crops. At a similar density of contamination, accumulation of cesium-137 in the grain of winter rye in 10 times lower than in seeds of summer rape, and 24 times lower compared with the grain of lupine. Multiple differences are observed in concern of accumulation of strontium-90 between grain cereals and pulse crops. Sort differences in accumulation of radionuclides are also significant though less notable. For example, various sorts of summer rape differ by 2-3 times in the content of cesium-137, by 4 times in strontium-90. which should be also taken into account in agricultural production on contaminated lands.

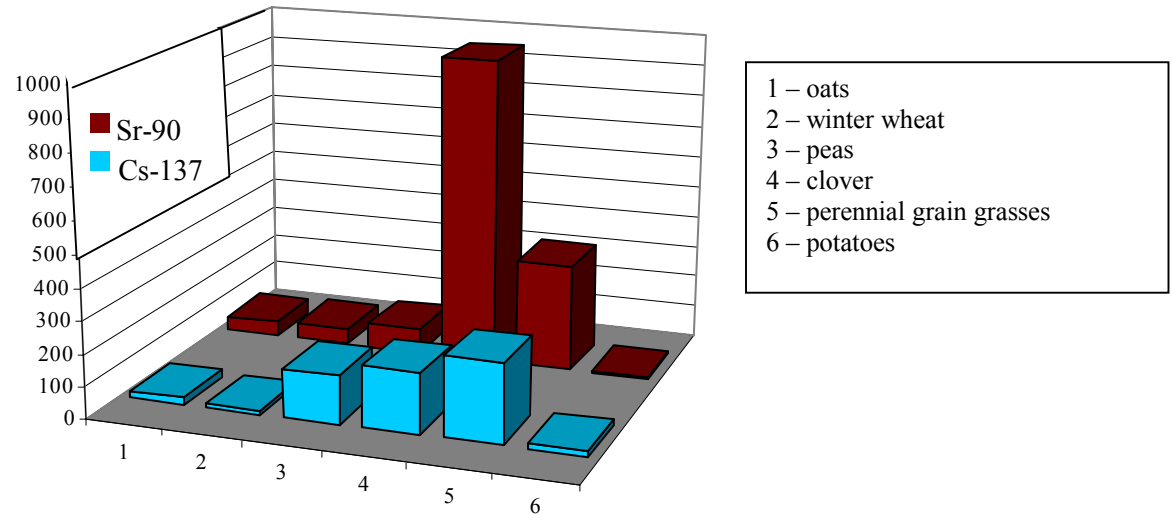


Fig. 6.10. Arrival of radionuclides into field crops at density of contamination of sod-podzolic sandy loam soils with cesium-137 – 370 kBq/m^2, strontium-90 – 37 kBq/m^2

6.3. Methods to limit arrival of radionuclides into plants

Obtaining of products with the content of radionuclides within the limits of allowed levels is the main problem of running of the agricultural production on contaminated lands. With this purpose a complex of special protective measures allowing to drop the concentration of radionuclides in agricultural products has been designed.

Selection of cultures. By the degree of accumulation of radiocesium in dry matter of plants, the following descending succession has been established: forbs of boggy meadows, green lupine mass, perennial cereal grasses, green rape mass, clover, peas, tare, oat straw, green mass of corn, oat grain, barley, potatoes, fodder beet, grain winter rye and wheat. By the content of strontium-90. accordingly: green mass of clover, lupine, peas, rape, tare, perennial cereal grasses, straw of barley, green mass of winter rye, fodder beet, green mass of corn, oat straw, winter rye, grain of barley, oat, winter rye, potatoes.

The established regularities of arrival of radionuclides into products of various cultures make a theoretical basis for placement of cultures in the fields and formation of the structure of crops and specialization of crop growing. The Republic counts about 100

thousand hectares of arable soils contaminated with strontium-90 to the density of 11-37 kBq/m^2, where they periodically observe cases of obtaining crop products with the content of radionuclides above the allowed levels. In 12 thousand hectares of fodder lands with the density of contamination above 37 kBq/m^2, they observe the increased content of strontium-90 in all kinds of rough forages, which are unsuitable for production of whole milk and may be fed to cattle only for production of raw milk and partially for meat thickening. In the area of more than 18 thousand hectares production of food grain and potatoes is impossible.

In this connection typical schedules of crop rotation have been designed depending on the level and nature of soil contamination with radionuclides. Selection of cultures and sorts with minimum accumulation of radionuclides is the most accessible means to decrease the arrival of radionuclides from soil into the crop.

Soil cultivation. Deep ameliorative tillage which reduces the arrival of radionuclides into plants by 5-10 times in conditions of Belarus had a restricted application because of dominance of weak humus soil horizons. After deep tillage later cultivation is made in such a way as to touch above the stopped up contaminated layer.

In overpacked eroded and temporarily exuberantly humidified soils it is necessary to apply periodic deep loosening or fissuring.

In haylands and pastures, where after radionuclide fall-out the contaminated root mat was tilled down, at subsequent meadow formation tillage is forbidden. It is necessary to make surperson milling and rolling down together with grass sowing or renovation of herbage by seeding grasses into the root mat. Root and surperson improvement of meadow lands is an efficient measure allowing to cut at least twice the arrival of radionuclides from soil into perennial grasses.

Liming of acidic soils. Introduction of lime (calx) is an effective way to decrease arrival of strontium-90 from soil into plants. Depending on the initial acidity degree of soils, liming ensures a decrease of arrival of radionuclides into crops by 1.5-3 times.

Minimum accumulation of radionuclides in crop products is observed at optimal parameters of soil acidity (pH), which for sod-podzolic soils make: for clay and loamy soils – 6.0-6.7; for sandy loams – 5.8-6.2; for sands – 5.6-5.8. In peat-marshy and mineral soils of haylands and pastures the optimal parameters of pH make accordingly 5.0-5.3 and 5.8-6.2.

Doses of lime are differentiated by soil types, their granulometric composition, acidity value and density of contamination with cesium-137 and strontium-90.

Fertilizers. Introduction of organic fertilizers reduces transition of radionuclides from soil into plants down to 30 %. In contaminated soils it is necessary to use all kinds of organic fertilizers, which ensure crop increase which is paying back all the expenses on application thereof.

Depositing of increased doses of potash fertilizers into soils poorly supplied with metabolic potassium reduces the transition into plants of cesium-137 by 2 times, and of strontium-90 – by 1.5 times. The efficiency of potash fertilizers is notably increased at the background of application of organic fertilizers and liming (Figs. 6.11, 6.12.).

Depositing of potash fertilizers is differentiated depending on the type of soils, of the content of metabolic potassium in them, and on the density of contamination with radionuclides. In lands with high content of mobile forms of potassium, it is expedient to deposit minimum doses of fertilizers for support of an optimal potassium regime in soils.

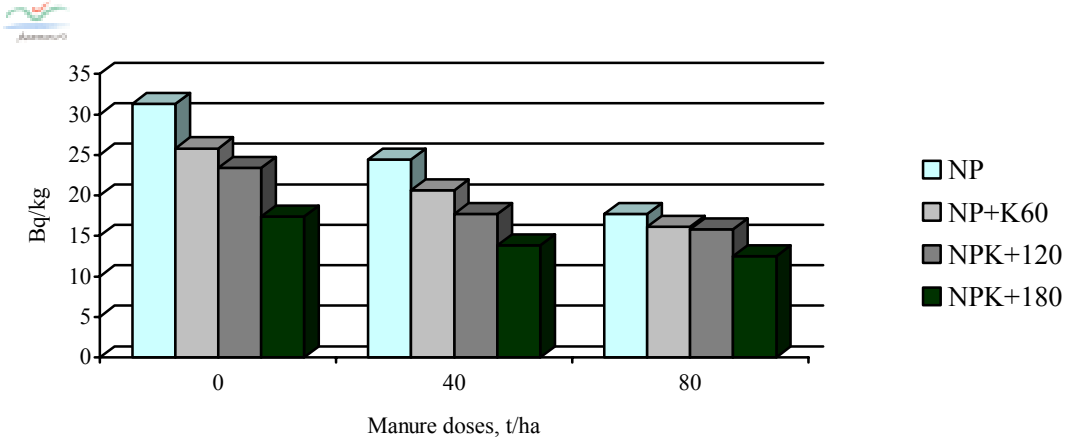


Fig. 6.11. Effect of increasing doses of potash and organic fertilizers on the content of Cs-137 in green mass of corn at density of soil pollution of 370 kBq/m^2

Reduction of arrival of radionuclides from soil into vegetative products is also promoted by phosphoric fertilizers, especially in soils with the low content of mobile phosphates.

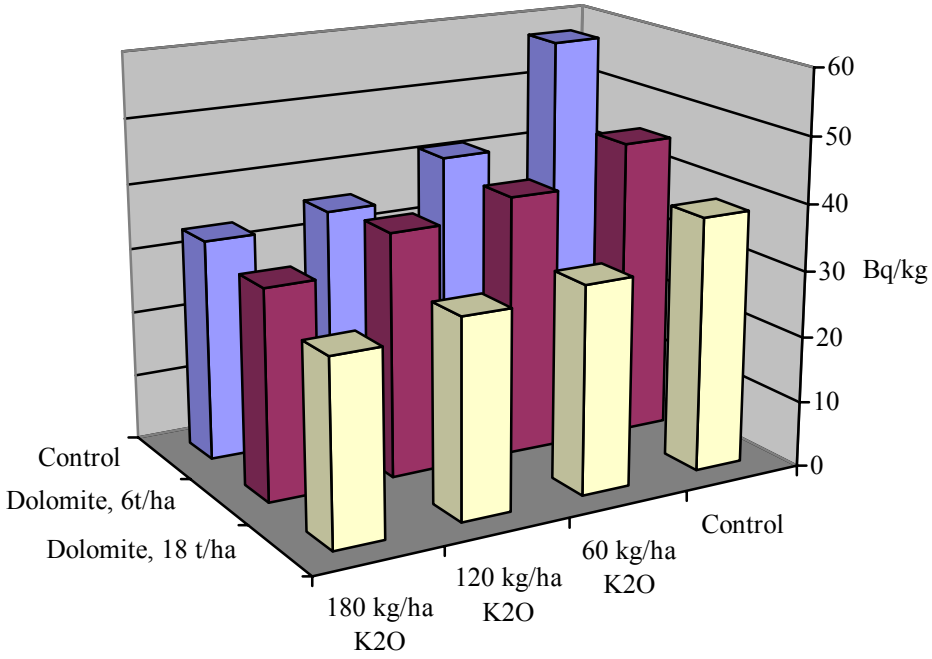


Fig. 6.12. Accumulation of strontium-90 in barley grain versus doses of dolomitic meal and potash fertilizers at density of soil contamination of 37 kBq/m^2

An important role is played by regulation of nitrogen feeding of plants. At lack of accessible nitrogen in soil, the crop is reduced, and the concentration of radionuclides in products is increased a little. On the other hand, high doses of azotic fertilizers boost accumulation of radionuclides in plants. For optimization of doses of azotic fertilizers, it is necessary to hold soil and vegetative diagnostics.

Rather effective from the point of view of decreasing contamination of the crops with radionuclides and nitrates are the newly-designed forms of slow-acting fertilizers. At the Grodno "Azot" PA they have mastered production of new grades of carbamide and ammonium sulphate. Their application allows to lower accumulation of cesium and strontium in plants by 10-30 % and to get a crop surplus 30-50 % higher than when using standard fertilizers. In cereal crops and crops of perennial cereal grasses application of preparations is effective based on associated strains of nitrogen-binding bacterias; it allows to save 20-40 kg of nitrogen of mineral fertilizers per hectare of crops and to lower contamination of the crop down to 25-50 %.

Microfertilizers are also promoting decrease of arrival of radionuclides into agricultural crops. Especially effective is non-root dressing with manganese sulphate of perennial grasses on limed soils, which allows to drop the accumulation of radionuclides in the green stern and hay by 30-40 %.

Plant protection. Measures of chemical plant protection against pests, illnesses and weeds also result in decrease of accumulation of radionuclides in products. The integrated system of plant protection allows an up to 40 % decrease transition of radionuclides into crop products at the expense of crop surplus (Fig. 6.13).

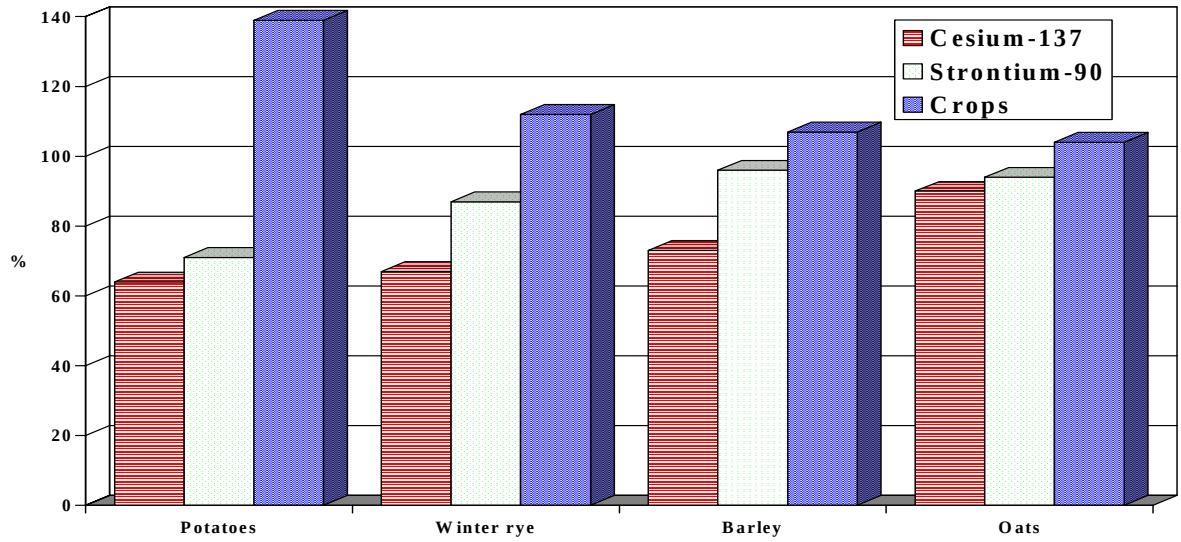


Fig. 6.13. Effect of an integrated system of plant protection on accumulation of radionuclides by crops of main agricultural cultures (in percentage to the control, 100 % – without any protection)

For grains and potatoes it is expedient, under the conditions of radiological soil contamination, to include into the technology of protection of mineral salts (potassium chloride, calcium nitrate), and also of growth stimulators of the humic nature (peat oxidate, oxi- and hydrohumates). This method reduces consumption of pesticides by 30-40 % at the same efficiency of their affection and is further reducing transition of radionuclides into the crops.

Regulation of a water regime. Drainage of overmoistened lands is an important method of decreasing of the content of radionuclides in agricultural crops. For the majority of peat and mineral bogged soils the minimum absorption of radionuclides by plants is reached at the level of groundwaters being 90-120 cm from the soil surperson. The rise of groundwaters, for example as a result of mulfunction of the drainage network, up to 35-50 cm from the soil surperson results in increase of accumulation of radionuclides by up to 5-20 times.

6.4. Management of cattle breeding. Rations and technologies of forage usage

The scale and degree of radioactive contamination of the territory with radionuclides determine the difficulties of management of cattle breeding. In order to prevent production of milk and meat with the content of cesium-137 and strontium-90 above the allowed levels, it is necessary to account for regularities of transition of these radionuclides from forages into milk and meat of horned cattle, sheep, pigs and poultry.

The parameters have been established of transition of radionuclides from forages into cattle-breeding products. The transition factor of cesium-137 from diurnal rations into milk makes an average of 0.01, and of strontium-90 – 0.0014 Bq/l/Bq/rat. Transition of radionuclides into meat of large horned cattle is characterized by factors 0.04 and 0.0008 Bq/kg/Bq/rat., accordingly. The transition factors of radiocesium from diurnal rations into meat of pigs and sheep makes 0.25 and 0.15 Bq/kg/Bq/rat., accordingly. The total content of radiocesium in the ration for obtaining of the whole milk should not exceed 10 kBq per day, of strontium-90 – 2.6 kBq, and when producing raw milk for further making butter –37 and 13 kBq, accordingly. When producing beef, the total contamination of the diurnal ration with radiocesium should not exceed 15 kBq.

It is recommended to use technological division of forages depending on the degree of their contamination with radionuclides when obtaining different products – whole milk, raw milk, meat. For facilitation of practical usage of recommendations, the normatives have been calculated of limiting content of radionuclides in particular forages for large horned cattle on the basis of standard feeding rations (Table 6.2).

Table 6.2 Allowed content of radionuclides in forages for large horned cattle (Bq/kg)

Products	Cesium-137			Strontium-90	
	Whole milk	Raw milk	Meat	Whole milk	Raw milk
Hay	1300	1850	1300	260	1300
Straw	330	900	700	185	900
Haylage	500	900	500	100	500
Silage	240	600	240	50	250
Root and tuber crops	160	600	300	37	185
Grains	180	600	480	100	500
Green mass	165	600	240	37	185

With the purpose of obtaining of normatively clean meat, a particular schedule of raising nurselings and fattening of large horned cattle is used. At the first stage of fatteningit is possible to feed nurselings with grassy and rough forages with the increased content of radionuclides. Subsequently, the final fattening is carried out, which includes feeding animals during 2-3 months before slaughtering with clean forages or with forages with low content of radiocesium (corn silo or green mass of corn and concentrates).

A separated depasturing of milking cows, fattening nurselings and forage making are carried out on the basis of forecasts of contamination of forage crops depending on the density of soil contamination.

6.5. Forecast of contamination of agricultural products

The forecast of contamination of agricultural products allows to plan the placement of cultures among the lands of crop rotations in view of the final target of usage of resulting products (as food-stuffs, fodder, for industrial processing, etc.). The forecasting is based on transition factors of radionuclides into crops of various cultures, on the results of radiological and agrochemical examination of soils. The forecast is important also in connection with periodic revision of the Republican Maximum Allowed Norms of the content of radionuclides in food products. So, at pasturing of the cows on natural pastures, the whole milk for direct use in nutrition by cesium-137 may be obtained at the following density of soil contamination: on loams – 300-370 kBq/m^2, sandy loams – 220-300 kBq/m^2, sands -110-220 kBq/m^2. Usage of peat soils for these purposes is excluded. Under a higher density of contamination, it is possible to pasture cattle only for production of raw milk and fattening for meat. On cultural pastures the allowed level of density of soil contamination with cesium-137 for pasturing of milking herd is essentially increased (Table 6.3.).

Table 6.3 Limits of density of soil contamination with cesium-137 for production of forages (meat and milk according to RDU-99) depending on the degree of soil improvement (kBq/m^2)

Products, culture	Soddy-podzolic soils, kBq/m^2			Peat soils
	Loamy soils	Sandy loams	Sands	
Whole milk				
Oats grain	630-1070	444-888	405-700	
Oats straw	666-1480	405-1480	405-1180	-
Barley straw	1480	960-1480	850-1480	-
Clover hay	925-1480	925-1480	925-1480	-
Hay of grain grasses	740-1480	555-1480	555-1480	148-405
Hay of natural grasses	480-740	405-700	222-370	37-111
Corn green mass	1480	1035-1370	740-960	
Green clover	555-1370	555-1260	555-960	-
Final fattening				
Green clover	925-1480	925-1480	815-1405	-
Green perennial gramen	630-1480	444-1405	444-1330	148-370
Natural pastures	405-480	185-330	185-330	37-111

The forecast of the content of radionuclides in agricultural crops with account of peculiarities of each field and cattle-breeding farm has been carried out for all the farms of eleven most contaminated districts. Based thereon, projects of protective measures envisaging decrease of arrival of radionuclides into alimentary products by 1.8-2.0 times have been designed. Analysis of the projects has shown that production of forages in the polluted zone for milking herd and obtaining of whole milk with the permissible content of radionuclides is possible on 86.6 % of arable lands, 75.4 % of improved haymakings and pastures and 36.3 % of natural meadow lands. On the remaining area of agricultural lands it is possible at present to produce fodder only for production of meat and raw milk. It underlines a leading role of improved soils in decrease of accumulation of radionuclides in products.

In cases when cattle is depastured on natural fodder lands, where obtaining milk and meats under the permissible content of cesium-137 is impossible because of high content of

radionuclides in the fodder, rather efficient is introduction into the ration of animal of cesium-binding preparations made on the basis of Prussian blue. Application of ferrocyanides together with mixed fodder during 40 day in doses from 1.0 to 6.0 grams per head at the content of radiocesium in the diurnal ration of 37 kBq allows to lower by 4.5-6.8 times the concentration of radionuclides in the muscle tissue of animals which are fattened for meat.

In the Republic they have launched production of mixed fodder with ferrocyanide intended mainly for large horned cattle in the private sector, where they are using more often natural fodder pastures for cattle fattening. This method allows to lower the content of radiocesium in milk by 2-5 times.

6.6. Efficiency of protective measures

In the process of taking protective measures in the territories contaminated with redionuclides during the post-accident period, we may single out two stages: the first phase – 1986-1991, and the second one – from 1992 till the present time.

At the first stage, all the heavily contaminated lands were withdrawn from use, where production of agricultural products with the permissible content of radionuclides was impossible. The cultures accumulating high quantities of radionuclides were excluded from crop rotation, liming of acid soils was conducted everywhere, increased doses of phosphoric and potash fertilizers were brought in. In the majority of waterlogged segments drainage and tillage of sod were made, and also grassing and regrassing of haymakings and pastures was conducted.

Starting since 1992, the second stage of oriented in detail counter-measures in agriculture has been underway with account of peculiarities of each field and each cattle-breeding farm. Methods are used of reduction of contamination of crop products at the expense of regulation of mineral nourishment, application of bacterial preparations and new forms of fertilizers. In cattle breeding they envisage technological department of forages depending on the degree of their contamination with radionuclides, normalising of rations with usage of fodder additives which lower the content of radionuclides in milk.

The conducted protective measures have allowed to lower by 10 times in the average the arrival of radiocesium into agricultural products. As a result, the production of milk with an excess above the permissible content of radiocesium in the public sector has decreased from 524.6 thousand tons (13.8 %) in 1986 to 1.4 thousand tons (0.5 %) in 2000 (Fig. 6.14).

The amount of contaminated meat decreased accordingly from 22.1 thousand tons (4.3 %) to several tons. The volume of contaminated grain non-conforming to the Republican standards in 2000 made 900 tons, of potatoes – 10 tons.

The arrival of radiostrontium into food products during the post-accident period decreased twice. However, the accessibility for the plants of strontium-90 remains high, with the tendency to increase even more.

Thus, the comparatively high efficiency of wide-scale protective agricultural measures is obvious. However, the problem of secure habitation of the population and production of high-quality food-stuffs is still far from its solution. The main reason is that the agriculture has not received the sufficient resources for overcoming of the consequences of the accident. Despite the considerable volume of the executed works (three cycles of liming of acid soils have been conducted, mineral and organic fertilizers are annually introduced, fodder lands are meliorated), it is required to neutralize increased acidity and to improve potassium mode in the half area of meadow lands and 20 % of arable land. Regulation is necessary of water treatment and surperson improvement of waterlogged and low-productive pastures and haymakings, where predominantly the cattle of personal pre-house land plots is fattened.

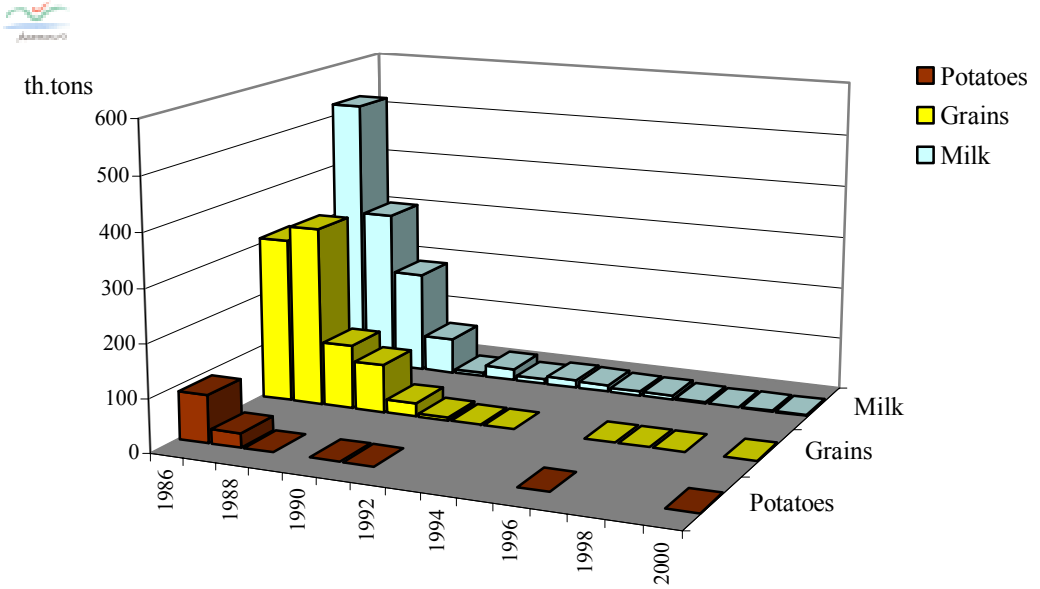


Fig. 6.14. Dynamics of production of agricultural products with excess of the established standards of the content of radionuclides for the period of 1986-2000

Programs have been designed of running agricultural production for the farms of the eleven most contaminated regions envisaging decrease by 1.8-2.0 times of arrival of radionuclides into the alimentary chain. The Committee on Problems of Consequences of Chernobyl Catastrophe has been executing lately priority financing of agricultural protective measures. However, in connection with the economic crisis the total amount of financing did not cover the demand. For example, the works of liming of acid soils during the last three years made less than 70 % from the demanded volume, the works of grassing and degrassing of haymakings and pastures of the public sector have been fulfilled by 79 %, the demand in the main dose of mineral fertilizers is covered by 84 %, in the additional dose – by 93 %.

It has resulted in underharvesting of agricultural crops, decrease of soil fertility and increase of the tendency of increase of transition of radionuclides into crops and cattle-breeding products.

In the zone of radioactive contamination there are great areas of waterlogged and temporarily overhumidified soils, which make 37 % from all the area of agricultural lands. Approximately two thirds of waterlogged lands have been drained during the latest thirty years, however a considerable share of the drainage network requires renovation and repair. A more and more acute is the problem of secondary waterlogging of already drained lands. Under the present deficit of investments on renovation of the drainage network, during the nearest years considerable areas of drained lands may become waterlogged, and the transition of radionuclides into the grass fodder, milk and meat will increase manyfold. Maintenance of the drainage network in the contaminated lands in proper operation has priority value and should be under the state control.

A special concern is caused by the quality of food-stuffs produced in the private sector. During the last 4 years, a total of 780 dwelling settlements periodically marked cases of production of milk with the content of radionuclides above the permissible norms of the RDU-99.

In the public sector a considerable proportion of forages is made with an excess of the allowed levels of the content of cesium-137. Basically (up to 80 %), the contamination of forage crops is observed on soils with the density of contamination with cesium-137 of more

than 555 kBq/m^2. On low-fertility, waterlogged and peat soils contamination of grass forages over the established limits is possible also under smaller contamination densities.

The economic crisis has aggravated the consequences of Chernobyl accident in Belarus. Even under the permissible content of radionuclides, the agricultural products have lately become noncompetitive more often. The crisis phenomena have shown themselves to the greater degree in the contaminated territories. In connection with alienation of lands and sharp drop of productivity in the most damaged regions, the production volume of grains, potatoes and green forages has decreased. Production of milk and meat in damaged regions has decreased to the greater degree. For example, in the Narovlya District was twice as great as in the whole of Belarus. The main reason is outflow of personnel and also reduction of the governmental help to the farms of the contaminated area. Difficult financial conditions of the farms and a mismatch of prices that have caused unprofitability of cattle-breeding products, became a reason of decrease of the count of cows and pigs even in the private sector.

* * *

At present, the economic efficiency is important of protective measures directed at reduction of arrival of radionuclides into food products, under decrease of the cost price and improvement of quality of finished agricultural products.

With the purpose of reduction of dosage loads on the population and production of competitive products, the study is underway of economic and technological aspects of cultivation of contaminated lands of industrial crops – rape and sunflower, modernisation and extension of available processing facilities for oil-yielding crops, potatoes and grain into starch and spirit. Solution of these problems requires extension of international cooperation and attraction of investments.

Chapter 7

DECONTAMINATION AND WASTE HANDLING

During the years that has elapsed after the accident of the Chernobyl Nuclear Power Plant, Belarus has implemented widescale measures directed at minimization of its ecological implications. Decrease of the level of radioactive contamination of objects by implementation of well-justified decontamination measures is one of the main methods of radiation protection.

During the period from 1986 to 1989 massive decontamination was held of dwelling settlements by forces of engineer troops and civil defence. Outside the 30-km zone about 500 settlements were decontaminated. During the decontamination process they made soil cutting-off and removal, filling in of contaminated sites with clean ground, screening of contaminated surpersons with film polymer coatings, asphalting of roads, streets, sidewalks, replacement of roofs, fences, destruction of anomalously contaminated constructions. The decontamination wastes (DWs) formed as a result of decontamination activities were buried in the vicinity of the sites of their formation. As a result of fulfilment of decontamination activities, it was only possible to achieve a slight softening of the radiation situation. Safe conditions for habitation in the contaminated territories could be created only under complete decontamination including total removal of the ground, vegetation and other radiation sources. However, such approach to decontamination of contaminated territories was unreal because of huge volumes of work, variety of contaminated objects and impossibility to ensure future habitation of the population owing to removal of the fertile soil layer, vegetation, etc. A negative consequence of decontamination in 1986-1989 was creation in Belarus of more than 80 burial sites of DWs (Fig. 7.1) established without any account of geological and hydrological conditions when selecting areas to locate them. Volumes of decontamination activities got decreased during the subsequent years both in Belarus, and in the Ukraine and Russia.

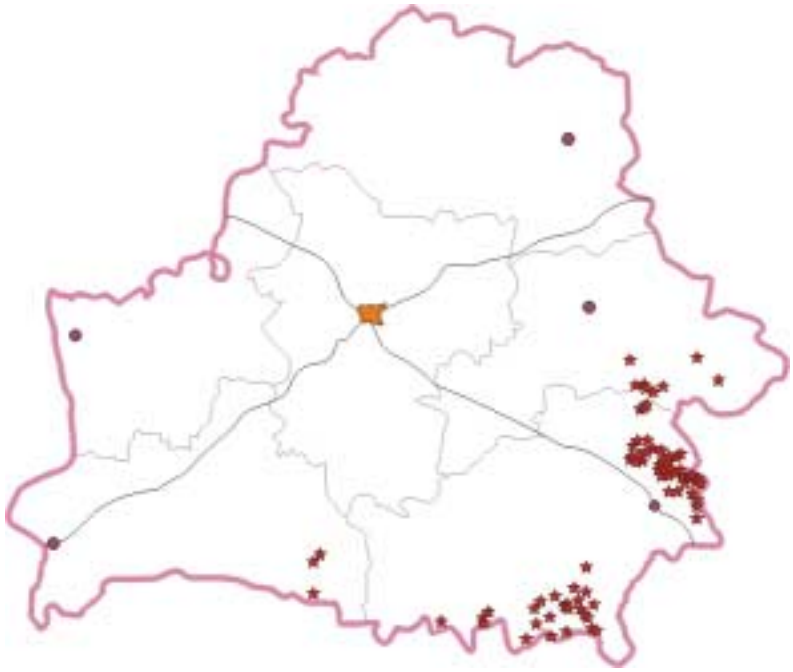


Fig. 7.1. Placement of burial sites of decontamination wastes in the territory of the RB

Starting since 1991, according to the altered strategy of decontamination activities, in settlements they are running decontamination of local sites only, which have increased radioactive contamination and are most important for habitation. The contamination levels in the territory of the sites subject to decontamination are characterized by the values of the power of exposure dose from 35 to 150 μR/h. Surpersons of equipment at industrial enterprises (vent systems, etc.) are contaminated to 10.000 beta-particles / (cm^2 · min.) under the power of exposure dose equal to 50-1500 μR/h.

From the organizational point of view, of great importance was establishment of Goskomchernobyl (State Committee for Chernobyl Implications) in Belarus and creation of its subordinate state-owned specialized enterprises (SSE) for running of decontamination activities. For decision-making about decontamination, reference levels of radioactive contamination were established.

Since 1991 in Belarus decontamination of the territory of more than 300 sites has been conducted, the total area of clearing has exceeded 1 mln. sq. m. At industrial enterprises more than 550 ventillation systems have been decontaminated of the total area of more than 87 th. sq. m. There are still about 650 sites (without account of personal land plots of inhabitants) and at least 1300 units of equipment awaiting decontamination. In the nearest coming years it is planned to complete decontamination of socially significant sites and industrial equipment, and after that to start decontamination of individual land plots.

The estimation of decontamination efficiency in local sites demonstrates that the observed decrease of the dose power varies from 1.25 times for indoor objects to 2 times – outdoors. The decontamination effect preserves over time. The coefficient of dose reduction as a result of external irradiation after decontamination activities conducted for different groups of population made 1.22 – 1.36.

In the practice of activities of SSE for decontamination of territories of settlements, they use mainly removal of contaminated soil, and for cleaning of the equipment of industrial enterprises they use liquid chemical methods.

The nomenclature and the amount of wastes contaminated with radionuclides, formed annually in the contaminated territories of Belarus, are given in Table 7.1.

Table 7.1 Nomenclature and amount of annually formed wastes, contaminated with radionuclides

Nomenclature of DWs	Volume, kg	%
Solid wastes	$2.6 \cdot 10^7$	35.1
Liquid wastes	$2 \cdot 10^4$	0.03
Wastes after fuel burning	$1.8 \cdot 10^7$	24.3
Precipitations of sewages	$3.0 \cdot 10^7$	40.5

With the purpose of creation of the all-national normative-legal base for enterprises engaged in activities of decontamination and waste treatment, they enacted in 1998 the Temporary Sanitary Regulations of treating decontamination wastes formed as a result of activities of overcoming the consequences of Chernobyl catastrophe (SPOOD-98) which are currently the basic state regulatory document on decontamination wastes treatment and burial. It gives a classification of decontamination wastes (DWs) and burial sites. The lower contamination border of ^{137}Cs at which isolation of DWs is required, is established at the level of 0.96 kBq/kg by specific activity and of 20 beta-particles / (cm^2 · min.) of surperson contamination.

In order to decrease capital expenses on building and transportation, it is envisaged to make burials of DWs by several technologies:

- in burial sites of wastes from destruction (BSWD) of buildings and structures – for DWs with specific activity from 0.96 kBq/kg to 9.6 kBq/kg;
- in burial sites of DWs of the second category (BSDWs-II) – for volumetric DWs with specific activity in the range from 0.96 kBq/kg to 96 kBq/kg and thin-wall DWs with the level of surperson contamination of more than 50 beta-particles/cm · min.;
- in burial sites of DWs of the first category (BSDWs-I) – for DWs with specific activity of more than 96 kBq/kg.

Into a special class sites have been included of wasteburial from decontamination operations fulfilled in 1986-1989 (BSDWs-III), since they were created without any projects.

Apart from solid and liquid radioactive wastes, covered by provisions of the SPOOD-98, annually in the territory with the level of contamination with cesium-137 higher than 37 kBq/sq. m, as a result of usage of local fuel about 18 thousand tons of ash is formed, of which 12 % have the level of radioactive contamination with cesium-137 from 970 to 9700 Bq/kg, and 75 % – more than 9700 Bq/kg, reaching in certain cases 500 kBq/kg. With the purpose of preventing uncontrolled secondary transfer of radioactive contamination, it is suggested to launch a centralized planning-regular system of collection and burial of radioactive ash wastes with account of radio ecological conditions in a particular region and economic capabilities of dwelling-municipal services of regions and cities.

The level of radioactive contamination with cesium-137 of precipitations of sewages (POS), formed at purification facilities of urban settlements located in the territories with the density of contamination of more than 185 kBq/sq. m, reaches 27-60 kBq/kg. The general content of mobile forms of radiocesium in sewages makes 20-45 % which is approximately an order of magnitude higher than in soil. During operation time of purification facilities they become "accumulators" of activity in the layer of slime and adjacent areas of soil. In percolation (filtration) and in bioponds the active slime, contaminated with radionuclides, is insulated from the external world by a layer of water, the activity of which does not exceed the background values. From the point of view of external irradiation these areas during operation periods do not introduce any threat. What concerns slime platforms, they may be dangerous for operators and should remain under permanent control of the services of radiation safety.

Thus, in the places of accumulation of radioactive deposits of sewages, there is an actual threat of contamination of groundwaters in the near future.

Improvement of technological process schemes of purification facilities and usage of modern physicochemical treatment techniques of sewages and their precipitations allows to increase the extraction degree of radionuclides. In this case it is suggested to arrange the process layouts of purification facilities in such a way as to keep the level of accumulation of radionuclides in precipitations within the established limits, at which special methods of treating radioactive deposits and their burial in specially equipped depots are required. Storage of sewage precipitations, contaminated with radionuclides, is organized in places of their formation with application of protective barriers made on the basis of raw materials and cheap production wastes possessing sorbtion-catalytic properties (tripoli powder, phosphogypsum, etc.)

Before the accident, Belarus had no industrial facilities for treatment of decontamination wastes. There was a single burial site of radioactive wastes (RAWs) which could not be utilised for burial of Chernobyl wastes because of its small volume and location. Now in Belarus a network of burial sites of waste of a decontamination is created in the contaminated territories. Prospecting works have been executed, recommendations have been given on placement of sites for burial of the RAWs.

The technologies of treatment of solid DWs are dictated by their physicochemical properties. Treatment of DWs of mineral origin (ground, crushed stone, concrete, etc.) is added up to their collection), if necessary – to temporary storage and transportation from places of formation to burial sites. Building materials, contaminated beyond the established norms, window and door units, slate are brought, before burial, into condition eliminating their unauthorized usage.

Reduction of the volume of solid radioactive wastes is achieved by their compaction. This operation is made directly at burial sites by means of a heavy general purpose full-track tractor. Multiple passages of a heavy tractor over loose wastes (ground, wooden elements of various structures) result in their compaction. Thus, for wooden wastes the compaction degree by the above method makes ~1.5, and for grounds ~1.2.

Application of such technology of volume reduction of wastes like incineration has not received broad spread in connection with a necessity to build a special installation and complicated subsequent operations to treat the resulting ash. At the same time the volume of wastes in relation to which the technology of incineration may be potentially applied is huge. These wastes are represented with timber.

Belarus has been widely using the technology of treating timber wastes formed as a result of disassembly of constructions in contaminated territories. For example, slicing of logs into boards with subsequent usage of internal boards and burial of the outside ones. In this case the equipment is used intended for wood industry. A certain negative aspect of this technology is the necessity to take additional measures on maintenance of radiation safety of the workers, first of all to prevent inhalation receipt of radionuclides together with the dust formed.

Liquid radioactive wastes (LRAWs), formed at decontamination of the equipment of industrial enterprises, is characterized by the average specific activity of 3.7 kBq/l and by a complex chemical composition. The specificity of these wastes is determined by application of surfactants and complexing substances for their decontamination. A feature of LRAWs is also a high content of salt and suspended particles. The refining complex created for the Goskomchenobyl's specialized enterprise is intended for compacting of liquid and solid radioactive waste having low specific radioactivity with their subsequent immobilization in a cement matrix. The main technological processes when treating LRAWs are removal of surperson-active agents by means of vacuum flotation and concentrating of solutions through evaporation.

Burial of solid DWs is made, according to the SPOOD-98, into burial sites of decontamination wastes (BSDWs) of different categories and into burial sites of wastes from destruction (BSWD) of buildings and structures depending on the level of specific activity or surperson contamination with DWs, and also on the way of their formation. Burial sites are categorized, by their engineering design, into three categories: first (BSDWs-I), second (BSDWs-II) and third (BSDWs-III).

A BSDWs-I is a special, engineering facility, built to the project and intended for burial of DWs with rather high activity (over 96 kBq/kg), ensuring their reliable isolation through usage of special engineering protective barriers.

A BSDWs-II is an engineering facility built to the project and intended for pre-surperson burial of DWs with specific activity from 0.96 kBq/kg to 96 kBq/kg, preventing propagation of radionuclides from DWs into the environment through usage of simplest clay shields.

All the BSDWs-III were created during the initial post-accident period (1986-1989) pre-surperson sites for storage of DWs built, as a rule, without any projects and with no account of hydro-geological conditions.

The BSWDs represent pre-surperson shelters of simplified type for burial of wastes after demolishing of buildings and structures in places of their formation. Unlike BSDWs, for BSWD no permanent monitoring was ever envisaged over their conditions and environmental impact.

The SPOOD-98 envisages a possibility of compact burial in BSDWs-II of solid decontamination wastes of RAWs category with the contamination level of 9.6-96 kBq/kg or 10-6 Ci/kg, and of temporary storage of concrete blocks of cement-bound wastes with specific activity of up to 9600 kBq/kg, and also of fragments of ventilation systems and production equipment with the surperson contamination level above 50 beta-particles / ($cm^2 \cdot$ min.). In BSWD they bury only wastes from demolishion of buildings and structures with specific activity of up to 9.6 kBq/kg remaining after department of the following group of DWs, which is delivered for burial to BSDWs-II: the DWs obtained from roofs (slate, bitumen felt, roofing iron), and also DWs in the form of wooden elements having thickness of 20 mm (wall facing materials, fencing, plywood), wiping-out cloth, polyethylene film, filtering materials, elements of ventilation systems and other production equipment with the level of surperson contamination over 50 beta-particles / ($cm^2 \cdot$ min.); ground and others free-flowing (loose) DWs, volumetric wooden DWs in which specific activity of ^{137}Cs is over 9.6 kBq/kg ($2.6 \cdot 10^{-7}$ Ci/kg).

A possibility of burial in BSDWs-II of DWs with specific activity of up to 96 kBq/kg was confirmed by forecasting estimations of contamination of groundwaters in the location of BSDWs-II. Thecalculation results made under the most conservative (pessimistic) assumptions concerning the conditions of storage and outwashing of radionuclides from the volumes of DWs for the maximum possible reserve of their activity, at full absence (destruction) of engineering protective barriers, demonstrate, that even in this case the concentrations of radionuclides of ^{137}Cs in the aquifer will not exceed the values of RDU-99 (allowed exposure limit) for potable water. The content of ^{90}Sr in groundwaters in the vicinity to BSDWs-II may exceed the limiting values of RDU-99, but during further dispersion its concentration is reduced, and outside the sanitary protective zone (500 m) decreases by the order of magnitude below the RDU. The presence of a protective barrier results, under other most pessimistic conditions, in a decrease of ^{90}Sr concentration in groundwater to the values below RDU at the distnace of 200 m.

By today, a total of 82 BSDWs-III have been identified? investigated and improved, and 9 BSDWs-II have been constructed. For every BSDWs we have defined the volumes of wastes and the areas covered by them, and also the values of the average and maximum specific activity of DWs by ^{137}Cs, ^{90}Sr and $^{239,240}Pu$ have been determined. Besides, we have established the power of natural protective barriers between the bottoms of burial sites and the ground-water level. The generalized characteristics of the inspected BSDWs-II and BSDWs-III are given in Table 7.2.

Table 7.2. Basic characteristics of burial sites of decontamination wastes

Type of BSDWs	Quan-tity	Volume of DWs, m^3	Average/max. value of DWs specific activity			Activity stock of radionuclides in DWs		
			^{137}Cs, Bq/kg	^{90}Sr, Bq/kg	$^{239,240}Pu$, Bq/kg	^{137}Cs, Bq	^{90}Sr, Bq	$^{239,240}Pu$, Bq
BSDWs-II	9	$8,3\times10^4$	$\frac{2,0\times10^4}{4,1\times10^4}$	30–100	0.2–2,5	$1,3\times10^{12}$	$1,6\times10^{10}$	$1,8\times10^8$
BSDWs-III	82	$3,3\times10^5$	$\frac{1,4\times10^4}{1,1\times10^5}$	40–900	0.2–20.0	$2,2\times10^{12}$	$1,9\times10^{11}$	$3,0\times10^9$

"Khatki" bio burial site	1	$3,8\times10^{3}$	$2,4\times10^{5}$			$4,5\times10^{11}$	$1,5\times10^{11}$	

A complex of researches is underway to assess the radioecological safety of BSDWs-III. In 11 most typical of them the system of monitoring of the content of radionuclides in groundwaters is operating in their location sites. The measured values of specific activity of groundwaters by ^{137}Cs and ^{90}Sr stay within the limits of 10-530 and 5-150 Bq/m3 accordingly, that is much lower than the allowed levels of the content of radionuclides in potable water. Analysis of calculated results of a long-termed forecast of migration of radionuclides into groundwaters for BSDWs-III has shown that the period of potential threat of burial sites covers the range of 240-370 years. Migration of cesium-137 from the depots is limited to the aeration zone in the presence of protective barriers, or to the mixing region of radioactive contamination with groundwaters directly under the depots in case of their flooding. In connection with the greater mobility of ^{90}Sr, its concentrations in groundwaters directly under the depots may reach (0.02÷7.5) x 104 Bq/m3, and at the distance of 100 m from the depots – 0÷1 x 104 Bq/m3 (Fig. 7.2). For the depots that have been studied the estimated sizes of the zone of their affection where the content of radionuclides in groundwaters may exceed the allowed levels, do not exceed 330 m.

At present, a project has been finalised of renovation of the "Khatki" biological burial site with the aim to improve its empty part pursuant to the requirements moved by the SPOOD-98 towards BSDWs-I, and after fulfillment of the respective safety assessment, modernisation of this site is planned for burial of DWs with rather high activity.

Analysis of the existing and currently used methods of treating DWs, of the state of technical base of the SSE, demonstrates the necessity of further scientific researches and application works in the direction of development of technologies of treating ash wastes and precipitations of sewages. Further scientific and normative support is needed for decontamination of pre-house land plots. Search should be continued of solutions of the problem of soil cleaning from radionuclides.

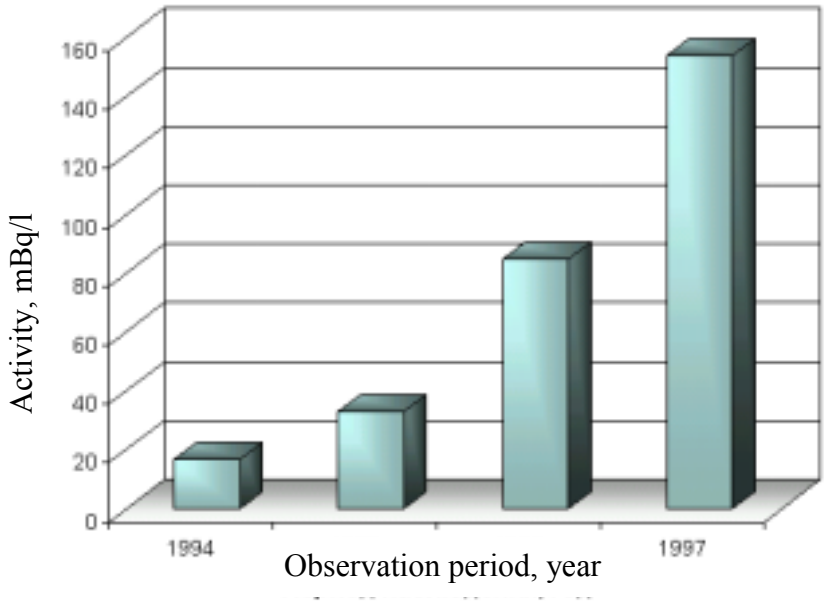


Fig. 7.2. The content of ^{90}Sr in groundwaters in the location of BSDWs-III "Dudichi" (Sozh track of radionuclides fall-out)

Chapter 8

MAINTENANCE OF EVACUATION (ALIENATION) AND RESETTLING ZONES

Designing of principles and policy of maintenance of the territories where human habitation proved to be impossible due to high radioactive contamination was implemented differently for the two main regions – zone of evacuation (alienation) and zone of resettling.

Photo 1. Resettled village of Rechki (Vetka District)

The Belarusian sector of the evacuation (alienation) zone of the Chernobyl Nuclear Power Plant represents a compact territory having the area of 1.7 thousand sq. km. The population who have lived here (24.7 thousand persons) were evacuated in 1986. At the same time the lands in this territory were withdrawn from economic use. In 1988 the Polesje State Radiation-Ecological Reserve (PSRER) of the Committee For Issues of Chernobyl Consequences was established here. Initially, its area made 1.313 thousand sq. km. Now, after adding to it in 1993 of a portion of the adjacent resettled territory, its area now makes 2.154 thousand sq. km. With account of the reserve treatment established here, it looks expedient to view the given territory within the framework of the unified approach based on the point of view of its maintenance.

In the territory of the PSRER a total of 130.000 Ci of cesium-137 (30 percent of fallout in the territory of Belarus), 12,000 Ci of strontium-90 (73 percent), 400 Ci of isotopes of plutonium-238, 239, 240 (97 percent) are concentrated. The density of soil contamination reaches 1350 Ci/sq. km of cesium-137, 70 Ci/sq. km of strontium-90. 5 Ci/sq. km of isotopes of plutonium and americium-241. In connection with the presence in ecosystems of significant amounts of long-lived isotopes of plutonium and americium, the main territory of the reserve wouldn't be returned into economic use even in the very distant perspective.

Pursuant to the Concept of Maintenance of Alienation and Resettling Zones (1993), the primary goals of the PSRER are: implementation of measures to prevent transfer of radionuclides to less contaminated territories; protection of forests and former farmland against fires; guarding of the reserve territory; maintenance of natural development of the whole diversity of the living nature; study of the state of the natural and vegetative complexes; implementation of radiation-ecological monitoring; realization of scientific researches over a broad spectrum of problems connected with radioactive contamination of ecosystems and removal of anthropogenous loads; fulfilment of activities of reforestation of lands which are subject to water and wind erosion; designing of technologies of land rehabilitation and use contaminated with radionuclides.

The current condition of ecosystems and economic infrastructure of the above territory, as well as of the territory of the resettling zone, is characterized by processes of degradation of former agricultural lands, amelioration systems, road network, repeated waterlogging of lands, including that connected with the necessity of maintenance in the flooding condition of a considerable share of peat bogs and bushing of meadows.

In connection with sharp removal of anthropogenous loading on the territory and the richness of flora here, as a matter of fact, the ideal conditions have formed for recovery of the fauna. More than 40 species of mammals, 70 species of birds, 25 species of fishes live here. According to preliminary data, more than 40 species of animals are considered rare or vanishing. The tendency is observed of increase of their number.

Now in the Polesje State Radiation-Ecological Reserve the implementation of the project is near the end of launching of fire-prevention system in the territory, including the system of fire-prevention gaps, vistas and water pools, roads of fire-prevention purpose and observation towers. A section of the system of automated detection of fire centers has been realised. The experimental base has been created. In settlement Massany of Khoiniki District which is the closest to the Chernobyl Power Plant an observation station for bioclimatic researches and monitoring of the dynamics of radiation conditions was established and now operates on the permanent basis. In the reserve the introduction of the aurochs from the Belaya Vezha reserve was performed, and the herd includes already 26 animals.

Experimental activities are held here on usage of contaminated timber, breeding of horses in highly contaminated territory, cultivation of crops. For this purpose 700 hectares of agricultural lands have been returned into experimental circulation. Works are underway of planting forests, later the issue will be considered of expansion of restricted use of timber resources outside the evacuation (alienation) zone.

Unlike the evacuation (alienation) zone, in the territory of the resettling zone (4.8 th. sq. km together with the 0.45 thousand sq. km, included into the PSRER) strictly limited economic activities are implemented connected with maintenance in operation of road network, power lines and other objects having economic value.

Former agricultural lands of the resettling zone are characterized by a rather inhomogeneous soil cover and the level of fertility in the range from 16 to 60 points. The soil contamination makes from 37 to 5400 kBq/sq. m of cesium-137 and from 11 to 222 kBq/sq. m of strontium-90. The content of plutonium isotopes is rather insignificant here by the density of contamination with radionuclides, and according to the Concept of Maintenance of Alienation and Resettling Zones, 3 categories of lands have been identified here. The first group is made up by 67 thousand hectares of former farmland with the density of contamination with cesium-137 of less than 555 kBq/sq. m and by strontium-90 of less than 74 kBq/sq.m. Part of these lands, first of all those with dominance of loamy and sandy loam soils may be considered as an object of rehabilitation in the nearest perspective under the condition of economic feasibility.

The second group of lands with the area of approximately 50 thousand hectares, with the density of contamination with cesium-137 of 555-1480 kBq/sq. m and by strontium-90 of 74-111 kBq/sq. m may also be considered for possible return into agrarian circulation, as the lands with such density of contamination were withdrawn from use, as a rule, due to economic feasibility because they were surrounded by heavier contaminated lands. The above lands may be used for crops grain, rape and forage crops for production of meat and raw milk.

Lands with sandy and loose sandy loam soils with the quality class below 30. lands requiring forest and ameliorative protection from water and wind erosion, and also lands with density of contamination with cesium-137 of more than 1480 kBq/sq. m and by strontium-90 of more than 111 kBq/sq. m are inexpedient to be considered as possible rehabilitation sites in the closest perspective.

Low-fertility lands of the resettling zone, unsuitable for agricultural production, should be viewed for possible reforestation.

In the territory of the resettling zone quite relevant is the problem of ensuring its fire safety which is solved within the framework of conventional measures, but in view of the specificity connected with an essentially smaller capability of operative attraction of forces and means. The emphasis here is made on effectiveness of detection of combustion pockets through increase of the intensity of airpatrolling of the territory, imposing of the given task on special detachments of interior forces who are executing the automobile patrolling.

Photo 2. The Polesje State Radiation-Ecological Reserve, Maidan natural boundary. Entrance into the 30-km zone

In the territories of evacuation (alienation) and resettling zones a special legal treatment has been launched with the purpose of preventing unauthorized infiltration into them of citizens and transportation means, uncontrolled exportation of freights, suppression of facts of poaching, gathering of "forest gifts". The protection-treatment measures are ensured by running of automobile patrolling, operation of a system of check-points, application of cordon structures, warning signs.

Chapter 9

SCIENTIFIC MAINTENANCE OF THE SOLUTION OF PROBLEMS OF OVERCOMING THE CHERNOBYL DISASTER.

The disaster on the Chernobyl Nuclear Power Plant (CNPP) has put before the state a series of the most complicated ecological, medical, agricultural, economical, social, legal, demographic and other problems. All scientists, available in the Republic, and specialists of the applicable profile were attracted in their solution.

Primary goal of scientific and research works was an assessment of the radiological situation and development of urgent measures and proposals for the Governmental commission on problems of consequences of the Chernobyl disaster with the purpose of a decrease of negative influencing of irradiation on an organism of the man. Scientists from the National Academy of Sciences of Belarus, Ministry of Public Health, Gosagroprom, Ministry of Education and other institutions of Belarus took part in the solution of these problems.

The outcomes of the conducted researches have been laid in the fundamentals of acceptance of the government solutions, including on relocation of the inhabitants of damaged locales, on building of new housing, on standards of a radiation safety etc.

However, it was apparent, that for removal of consequences of emergency, the realization of not only urgent prime measures was necessary, but also the acceptance of the long - term justified scientific measures. The Program of complex researches on problems of liquidation of consequences of the Chernobyl disaster was developed and approved.

It is necessary to note, that for the moment of the emergency in the Republic there were practically no scientific collectives specializing on these directions. Such researches were massed predominantly in Russia.

The government had in the urgent order to create specialized scientific entities, to organize training of personnel. Institute of radiobiology and Institute of radioecological problems of the Academy of sciences of Belarus (Minsk), Research institute of radiation medicine (Minsk; now - Research clinical institute of radiation medicine and endocrinology of the Ministry of Public Health of the Republic of Belarus), Vitebsk, Gomel and Mogilyov affiliates of the scientific and research institute of radiation medicine of the Ministry of Public Health of the Republic, Byelorussian scientific and research institute of agricultural radiology (Gomel) of the Ministry of agricultural production (Minselkhozprod) of the Republic (now - Republican scientific and research unitary enterprise, RSRUE "Institute of radiology" of ComChernobyl) were created in the Republic. Practically all scientific entities and higher educational institutions which had the relevant specialists and logistics, were connected to the solution of the arisen problems, in particular, Institute of nuclear power engineering of the Academy of sciences, Byelorussian state university, Byelorussian research institute of soil science and agrochemistry, Byelorussian scientific and research institute of hematology and blood transfusion, Institute of oncology and medical radiology and many others. The majority of scientific collectives have been solving problems, facing them, on a voluntary basis.

Subsequently, the Complex program of scientific researches on overcoming consequences of the accident on the CNPP in Belarus was designed on the basis of this inter-republican program. Simultaneously, the program of monitoring and forecasting of radiation situation in the Republic was created and approved.

In the total of fulfilment of the indicated programs, the complex estimation of radiation - ecological conditions in the Republic was given, the primary outcomes about influencing of a turned out situation at functional systems of an organism, morbidity of the population were obtained, the complex medical and preventive actions were conducted, a

series of the guidelines on management of an agriculture in the contaminated territories, rational management of nature was prepared, the ways of a decontamination and clearing of radionuclides of objects of an environment were offered, the primary forecast of dynamics of radiological contamination of the territory of Belarus for the proximate years was given.

The obtained outcomes have formed the basis for realization of protective measures, designing of the concept of residing of the population on the radioactive contaminated territories, approving of the standards of the contents of radionuclides in food and potable water, the prohibition or limitations of a number of kinds of economic activities in polluted territories etc. Developed proposals have been utilised for working out the State programs of overcoming of consequences of the Chernobyl disaster for 1990 - 1995, 1996 - 2000 and 2001 - 2005.

9.1. Totals of executed scientific researches and primary goals for the period of 2001 - 2005.

At present in the Republic there are own staff and scientific schools on all major directions, bound with problems of impact of irradiation on the man and environment. The main part of researches is performed in frameworks of the unit of scientific maintenance of the State program on overcoming consequences of the disaster on the Chernobyl NPP. In a concentrated view it is possible to formulate the totals of scientific researches executed for precursor period, as follows.

- It is established, that the radiation - ecological situation in Belarus remains complicated. Alongside with remaining impurity of ecosystems with the long - lived radionuclides - cesium - 137, strontium - 90 and transuranium elements, last years mark increase of disintegration of fuel fragments with a liberation of energy of migration - mobile radionuclides, ascending of the mobile forms of strontium - 90, which are actively actuated in food chains. It stipulates multiplicity of paths of irradiation of the population, creates a risk for its health, imposes limitations on management of the nature and habitability of the people.

- The estimation to negative impact of ionizing radiation and influencing of formed ecological conditions on functions of major systems of an organism was given: endocrine, cardiovascular, immune and genesial. A number of ways of decreasing post - radiation violations was offered.

- The features of forest ecosystems, for which a large number of trophic and simbiotic connections is characteristic, were detected and evaluated. The sharp sensitivity of system elements to comparatively small on intensity technogenetic impurities was noted. The methods of forest recovery and its usage in conditions of radiological contamination of the territory were developed.

- The biomedical researches showed violation of metabolic processes and functions of major systems of an organism; an aggravation of symptoms of health of the population, both evacuated, and living on the contaminated territories; increase of a general somatic morbidity. The distant carcinogenic effect of radiation effect (a thyroid gland cancer) was established.

- The designed and implemented know-hows of management of an agriculture in conditions of radiological contamination have allowed to lower a level of contamination of agricultural commodity.

- Dynamics was estimated and the forecast of radiological contamination of different systematic and ecological groups of animals, and also fauna complexes, was given. On the basis of the detected legitimacies the guidelines on usage hunting - trade animals, fishery and fish-breeding, preventing of nature-focal infections and invasions, were worked out.

- The designed and realised measures on overcoming consequences of the disaster on the Chernobyl NPP have allowed to lower a predictable irradiation dose of the population and to initiate the solution of problems of an aftertreatment of the contaminated territories in a full volume, that implies the recovery of economical and social life of suffered regions and demands long - lived and volumetric activity with participation of scientists of different specialities.

As a result of fulfilment of the scientific unit of the State program, only for the period of 1996 - 2000, 24 proposals to Government were prepared;: 10 concepts, 60 know-hows, 63 techniques, 152 methodical guidelines, 43 medical drugs and 66 normative - technical documents (rules, THAT, GOSTs) were designed; the passports on 92 points of dumping of waste of a decontamination were compounded, 48 inventor's certificates and patents for the inventions were obtained, 11 scientific conferences were conducted, 741 scientific articles were published.

The obtained results have allowed to essentially lower dose loads, to improve medical maintenance of the suffered population; to forecast development of radiation - ecological conditions and biomedical consequences of the disaster on the CNPP; to implement the most effective equipment and know-hows; to provide the public awareness; to conduct operating correction of priority directions and financing of the State program.

However, a series of actual problems remains unsolved. In particular, there are no reliable enough criteria of the distant forecast of behavior of radionuclides in separate ecosystems and their influencing on living organisms; values of dose loads require refinement and epidemiological estimations; the problems of preventive measures of the distant biomedical consequences and genetic damages at a chronic exposure by small doses require fundamental exploration; the finding - out of mechanisms of the change of radiosensitivity is necessary at combined and cross impact of radiation and other factors, creation on this basis of means of a decrease of upbuilding of radionuclides in an organism, development of effective systems of social and economic development of the regions which have exposed to radiological contamination. There is also a number of other relevant important tasks which have arisen with the change of behavior of radionuclides in an environment.

The impurity of farmland demands constant attention and efforts for maintenance of production of agricultural commodity with the contents of radionuclides in tolerance limits, including over - profiling of economy facilities and applying of the applicable know-hows of management of an agriculture, that conducts to the additional expenses. Problems of obtaining of clean commodity in a private sector, limitation of usage by the population of the contaminated secondary commodity of a forest are of acute nature.

The destructive tendencies in all spheres of habitability of the people, which appeared as a result of the accident on Chernobyl NPP, demand the solution of the problems of social

adaptation and social - psychological support of the population living in the territory, contaminated by radionuclides. For a large group of the population living in these territories, there is an additional risk of a decrease of a level of health, increase of a morbidity is marked here. The control of radiation situation in the regions, contaminated by radionuclides, requires the constant attention.

The analysis of medical consequences of the Chernobyl accident, their dynamics and forecast testify that the problem of minimization of these consequences and increases of efficiency of a medical care to the persons who have been exposed to the radiation impact, not only saves the urgency, but also becomes the most relevant for the proximate years.

The priority directions of scientific - practical activities for the proximate and distant outlook are determined by the above said. The pattern of researches on scientific section of the State program of overcoming of consequences of the disaster on the Chernobyl NPP for the years of 2001 - 2005 is shown on the Drawing 9.1.

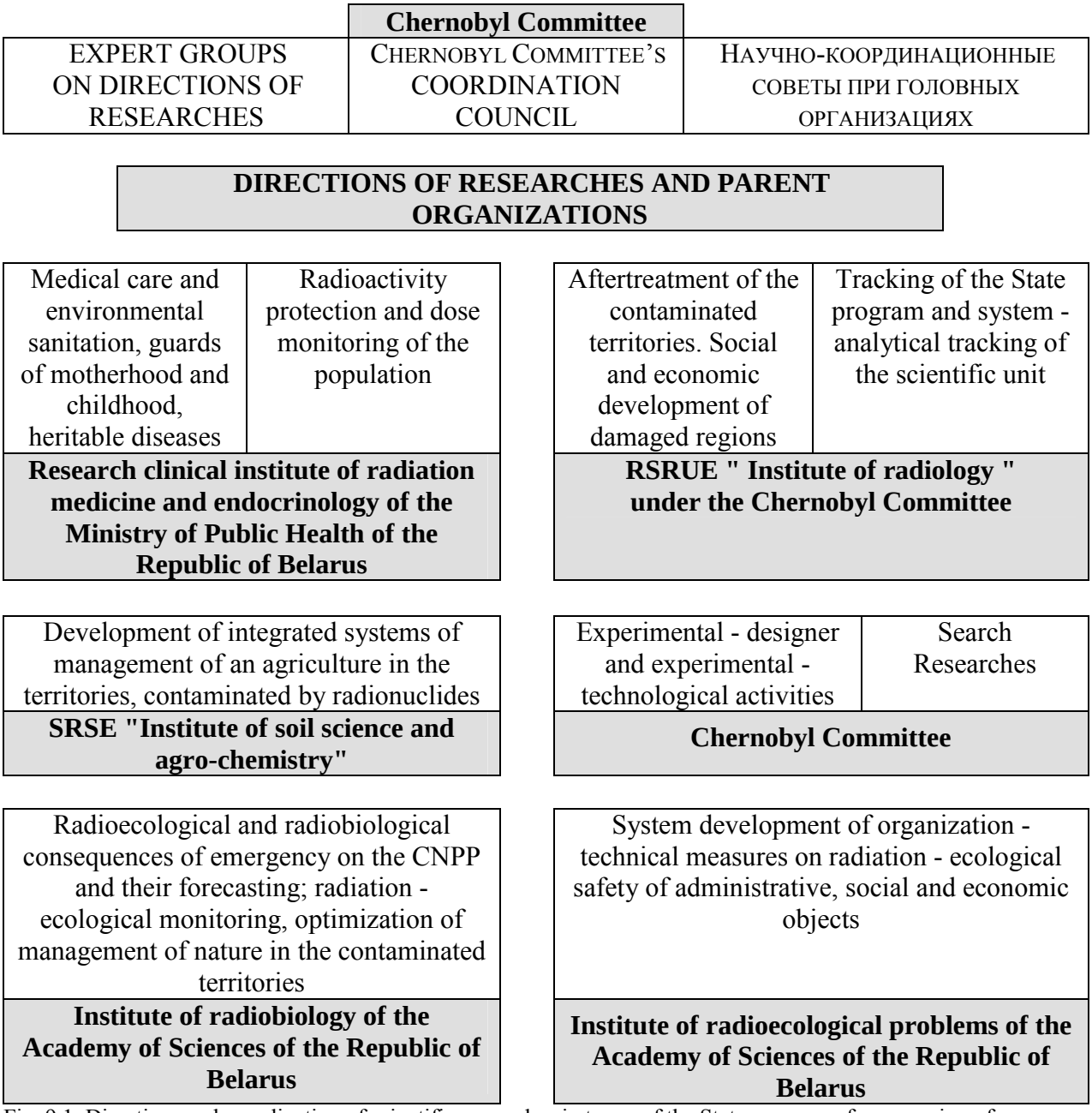


Fig. 9.1. Directions and coordination of scientific researches in terms of the State program of overcoming of consequences of the disaster on the Chernobyl NPP

Being by the indispensable tool of the justified planning and implementation of measures, the section of scientific maintenance mirrors the unitized construction of the State program and arms it with unified methodological, information, organizational approaches and criteria. At the same time, the researches, directly aimed at the application of achievements of science to a national economic complex, have the special significance and priority.

9.2. Solution of problems of an aftertreatment of the contaminated territories

The special subsection of scientific maintenance of the State program is directed at the solution of problems of an aftertreatment of the suffered locales. This problem has a complex nature and requires generalizing and systematic analysis of outcomes of researches on all other directions.

In outcome of the Chernobyl accident in the contaminated territories, except for a straight line of losses in the national economy, there were changes in the number and demographic structure of the population, the accumulated intellectual and vocational potential was lost, the collectives having a long-term history were broken down, the economical parameters were decreased. The population migration has rendered negative effect on formation of employment of the population in the contaminated regions, that was expressed in mass outflow of able-bodied population, first of all of qualified personnel, and as a consequence - in deterioration of a manpower as a whole. In 2 - 3 years after the emergency, the problem of shortage of the specialists in regions, mainly, of doctors, teachers, has appeared. To the greatest degree lack of a manpower experiences the agrarian sector, where there is a deficit not only of highly qualified specialists, but also of workers of mass occupations completed in a certain measure at the expense of persons of a pension age.

In this connection, the recovery of normal habitability of damaged locales needs working out of the special (specific) programs of their social and economic development in view of natural - territorial living conditions of the population, radio ecology of the man and environment, demography, medicine, sociology and psychology, economics and economic activities in a situation conditioned by radiological contamination. In opinion of the majority of the scientists and specialists, the essence of an aftertreatment of the contaminated territories consists in this issue.

The methodical approaches to the solution of problems of an aftertreatment are elaborated and perfected by RSRUE “ Institute of radiology ” (Gomel), together with other entities, on the basis of the analysis of outcomes of scientific researches being executed in the field of agricultural radiology, medicine, radiobiology, the forestries etc.

The preliminary minings in this direction were executed in 1994 - 95 on an example of Chechersky district. From 1996 till 1999, the comprehensive complex plans of rehabilitational measures for the most contaminated Gomel districts (Braginsky, Vetkovsky, Narovljansky and Khojniksky) and Mogilyov districts (Klimovichsky, Kostjukovichsky, Krasnopolsky, Bykhovsky, Cherikovsky and Slavgorodsky), and also for Stolinsky district of the Brest region, were designed. In the program of an aftertreatment for each particular district, on the basis of the comprehensive analysis of medical, radiation - hygienic, social and economic, demographic and social - psychological problems, the mechanisms of refurbishment works in an economic, social sphere of activity of rehabilitated regions and realization of indispensable retaliation for a decrease of collective and personal doses, have been substantiated. By results of the analysis of an economical condition of each of districts, the sizes of financing for recovery of economic activities during five years' period were determined. In the table 9.1 the pattern of costs for all studied districts is adduced.

The table 9.1. Pattern of costs on rehabilitational measures, %

Measures	Mogilyov region (6 districts)	Vetkovsky district	Braginsky district	Khojniksky district	Narovljansky district	Stolinsky district
Maintenance of a private sector окультуренными by pastures and mixed fodders with sorbent	0,37	1,2	0,03	0,09	0,92	2,79
Cardinal improvement of fodder fields	1,69	3,5	0,16	0,05	0,64	0,17
Depositing of mineral fertilizers	27,5	13,5	13	14	19	29
Engineering of an agriculture	42,4	41,1	58	39	27	26
Public health services, education and culture	9,7	4,2	5	2	4,4	11
Housing for the specialists and settlers	4,7	-	4	8	6	2,5
Utility service of the population	13,7	36,5	19	37	41	28
Forestry	-	-	0,14	0,15	0,84	0,44

These outcomes demonstrate, that the rehabilitational measures should be of individual character, conditioned by particular features of habitability of a settlement, facilities, district, etc. Nevertheless, in all contaminated locales, the main fraction in pattern of indispensable costs is made of measures on engineering of an agriculture, depositing of mineral fertilizers and utility service of the population. As the consequent, "frontal" solution of problems of an aftertreatment requires enormous costs, therefore looking up for new paths, steep scientific - methodical developments, determining priority directions of activities in particular locales in view of all complex social and economic factors and optimization of operatings by a principle " efficiency - costs ", is necessary.

The further researches were directed on ranking of settlements by value of radiological contamination of territory and agricultural commodity, and also, of dose loads on the living population, that allows optimally to plan indispensable retaliation for each settlement and to execute their target financing. Thus, the social and economic level of a settlement, demographic structure of the population, psychosomatic condition and psychological perception by the inhabitants of spent measures have been considered.

The essential attention was retracted to town-planning measures, first of all - planning organization of territories, as to the steadiest element of the development in space and time. The offered territorial - planning approach has allowed to determine conditions and priorities of an aftertreatment at a level of settlements, that also can become the adjusting factor at distribution of the investments.

It is doubtless, that the social and economic development of the contaminated territories is impossible without recovery of an agricultural production (this sector has suffered most as a result of the emergency on CNPP and the situation in it was aggravated as a result of general economical decay). In a complex of problems being solved, the tasks of a radiation aftertreatment of an agroindustrial sphere are the most important and are in direct intercoupling with all aspects of a rehabilitation. Thus, the registration of an economic feasibility of this or that branch of production is necessary, as well as the search of the most prepared and expedient sources and mechanisms of raising the efficiency of this economy production.

The wood complex stays an important component of the economical operation of locales. For the solution of rehabilitational problems, a regional model of optimal forest usage and a model of rational social and economic development of a wood complex in the contaminated territories have been designed.

In view of it, the versions of the scripts of an aftertreatment of the subjects of managing for three main types of damaged districts are offered.

For such a district, as Stolinsky of the Brest region, characterized by high labor activity of the population, at creation of agrarian financial and industrial groups (FIG), reallocating a considerable fraction of ground and means of production for the benefit of the farmers and partnerships of personal part-time farms (PPF) is expedient. Behind the reformed facilities, there is a specialization on those branches, where they are in a condition to realise intensive know-hows.

For such districts, as Lelchicky of the Gomel region, at reforming of weak facilities the priority in pattern of relations of production " collective farm - farmer - partnership PPF " also should be given to the latter. The processing of milk for remote territories is more expedient for conducting on mini - butter & cheese producing works, operating on the basis of strong facilities with a lactic specialization. To the majority of the reformed facilities, it is more expedient, within the framework of agrarian FIGs, to specialize on meat cattle breeding (at weak grain base - only on up-growing of large horned cattle). Fattening up of cattle should be conducted in facilities with "clean" fodder base. The creation of mini-plants on processing of commodity of a forest (mushrooms, berries) is perspective for such regions.

In such districts as Chechersky of the Gomel region, it is offered to create two intereconomic formations, a core of each of them will be one-two economically developed facilities with more fertile agricultural farmlands and developed lactic and plants growing production. Re-specialization of the facilities, adjacent to a base one, within the framework of cooperation, should be plotted by a principle of mutually advantageous addition. For the remaining weak farms, circumferential facilities are expedient: reorganization, specialization within the framework of agrarian FIGs on meat cattle breeding, creation of a social and economic infrastructure for farming development on farms, engaging of staff, formation within the framework of agrarian FIGs of specialized subdivisions on fulfilment of plants growing and cattle-breeding activities.

During researches, a series of prime problems has come to light, the solution of which can determine the prospects for the development of the contaminated locales.

Conditioning for formation of effective economic patterns, quality updating of know-hows boosting competitive strength of the produced commodity now is required. It is necessary to change a system of the taxation for development of small - sized business, enterprise and commercial activity, effective utilization of the available capital funds and creation of new workstations, that, in turn, requires legislative changes. Therefore, the main problem in a near future is perfecting normative - legal base in the field of overcoming of consequences of the disaster on the CNPP.

It is important to note, that restructuring of production, introduction of non-polluting know-hows, creation of new jobs, housing construction, improvement of health services and measures of prophylactics of diseases, formation of radio - ecological competent behavior are the fundamentals for softening effect of principle factors of risk and as a consequent - for a solution of a problem of a social - psychological aftertreatment of the population.

The outcomes of the conducted researches have allowed to work out the conceptual approaches to the solution of problems of an aftertreatment of the population and territories damaged as a result of the disaster on the Chernobyl NPP, which have been utilised at developing the Concept of the State program of the Republic of Belarus on overcoming consequences of the disaster on the Chernobyl NPP for 2001-2005 years and for the period till the year 2010.

9.3. State scientific and technological programs

A series of the State scientific and technological programs (SSTP), funded through link of the State Committee of the Republic of Belarus on science and know-hows, is directed on designing of devices and creation of techniques.

From 1997 till 2000, the SSTP " To elaborate and to introduce methods and hardware means for maintenance of radiation and ecological safety " (" Radio ecology "), has been performed. The program was the prolongation of the SSTP 18.02p, which had been executed in the period from 1990 till 1995. The main purpose of the program - technical and methodical maintenance of a system of ecological monitoring and radiation safety in the Republic. Within the framework of the program, the following basic outcomes have been obtained.

An intellectual power - level detector of a dose of a gamma-radiation, meter - warning indicator of dose rate of X - ray and gamma - radiation, transport radiation screen monitor of the control after unauthorized moving of nuclear materials, gamma - beta spectrometer, portative multifunction radiometer - dosimeter, digital personal dosimeter of X-ray and gamma-radiation, search portative radiometer for detection of nuclear materials have been designed and put on production. A small-sized forward-indication screen monitor of a radon in air, radiometer of a radon in air with the electrostatic chamber have been created and prepared for production.

The prototypes of a computer citometer for diagnostic of diseases of a thyroid gland and ultrasonic echo-sinusoscope for diagnostic of diseases of genyantrums of the man have been created.

A technique of probe preparing and concentrating of radionuclides of cesium and strontium from water, technique of a sampling of sewages, solid domestic and street waste for definition of the contents of radionuclides in them, technique of probe preparing of sewages for the radiochemical analysis of strontium - 90, have been designed and matched with the State Standards, a calibration complex for check of clinical dosimeters, sorbents for selective allocation of strontium - 90 and cesium - 137 from water and milk, have been created and introduced.

Based upon the tasks of the program, which have been executed, in 1999 only the " Atomtech " research - and - production firm has manufactured about 1,5 thousand radiation control meters. All devices have passed certification, are delivered for export, and will be used in the Republic of Belarus as import replacing commodity.

At present, the fulfilment of the " Radiation safety " SSTP, which has been included in addition to the State Program of overcoming of consequences of the disaster on the Chernobyl NPP for 2001 - 2005, started as one of its sections. Its purpose is the creation of hardware - methodical base for problem solving, defined by the Law of the Republic of Belarus " On a radiation safety of the population ".

The tasks, arising during implementation of the indicated Law, have the special significance for Belarus. They are actual for all population of the Republic on the extension of the boundless future. The decrease of pernicious general effect of irradiation on the population is also possible on paths of minimization of dose loads from natural and techno-genetic sources, and at medical irradiation as well. The activities in this direction can appear more effectively, as the decrease of Chernobyl components of a radiation dose with each year is reached by the more and more expensive price.

In frameworks the " Radiation safety " SSTP, the solution of the following problems is planned.

1. Development of methods and creation of instrumentation for a decrease of dose loads at x-ray and radial diagnostic and therapy.

The creation of means of measurements of personal radiation doses of the patients is supposed at medical x-ray diagnostic irradiation. The created till now X-ray dosimeters are intended for a radiation monitoring of the attendants, manufacturing and living accommodations. Means of measurements, indispensable for the control of characteristics of exploited X-ray equipments, are lacking as well.

The conducted examination of vehicles of diagnostic radiology has shown, that the know-how of examination of the patients and image processing used in Belarus, does not allow to receive values of the input doses stowed in advised by the IAEA values. The park of X-ray apparatuses of the Republic of Belarus includes about 2600 complete sets, and among them the installations with an effective life more than 15 years make 32 %. In this connection, the realization of scientific and research measures on improvement of the quality of the installations and auxiliary equipment is supposed, with the purpose of a decrease of radial loads at realization of x-ray diagnostic examinations.

2. Development of methodical and metrology base and creation of means of measurements for maintenance of a radiation safety:

- At medical irradiation of the population;
- At the treatment of natural and techno - genetic sources of ionizing radiation and radioactive waste.

In this direction a lot of activities, aimed at creating of reference methods and checking of radiometric and dose metering apparatuses, is planned. Thus, the radon chamber for definition of the basic metrology characteristics of means of measurements of a radon and its derived products of disintegration till now misses in the Republic.

3. Creation of instrumentation of a new generation of a radiation-monitoring system:

- of personal radiation doses;
- at production of foodstuff, potable water and consumer goods;
- of techno - genetic radiation pollution of the environment.

In the Republic a number of devices, indispensable for the control of natural radionuclides, in particular their contents in potable water (alpha - beta-gamma-radiometer), contents of a radon, measurement of the contents of cesium - 137 without a sampling in conditions of pipeline lines of meat-processing factories etc., is lacking.

The creation of an expert beta - gamma of the meter of radiations of the man for the analysis of upbuilding strontium - 90 for the population of the Republic is planned.

4. Development of new methods of construction of electronic - physical instrumentation for maintenance of a radiation safety and decrease of dose loads on the population, and also methods of protection of the population at radiation emergencies.

5. Retrofit of means of measurements and diagnostic in view of the new requirements to a radiation safety.

The fulfilment of the indicated SSTP will serve as the relevant reason of transition on principles and radiation-monitoring system adequate to the international standards and the guidelines, will essentially extend hardware - methodical base for problem solving of overcoming of consequences of the Chernobyl disaster.

Chapter 10

INTERNATIONAL CHERNOBYL COOPERATION

The state policy of the Republic of Belarus in the field of softening and overcoming of consequences of the Chernobyl disaster is being built based upon the fact of an admission of their long term. Today, as before, it is apparent, that contributing of the foreign states is necessary for Belarus, as the available resources do not allow in a sufficient measure to fund priority directions of an aftertreatment of the population and territories damaged in outcome of the Chernobyl disaster.

More than three years was required that the world has learned about true scales of the tragedy which has overtaken the Byelorussian people. All this time because of privacy, limitation of the information and absence of the official appeals to international community the problems of rendering of contributing to three most damaged states remained outside of an orb of fissile international cooperation.

10.1. Cooperation with the United Nations

Belarus (then BSSR), was the first of the United Nations members which has stated about the necessity of international contributing for analysis and overcoming of consequences of the Chernobyl disaster in eve of its third anniversary - on April 12, 1989 on the 44-th session of the EEC of the United Nations. On February 20, 1990, BSSR officially has addressed the international community for contributing and help. The applicable Appeal of the Presidium of the Supreme Council of BSSR was lead up to the item of information of the United Nations, other international organizations, governments and parliaments of foreign countries and mass media.

For the first time the Chernobyl problematics was widely and comprehensively reviewed on the session of the General assembly of the United Nations (GA of the United Nations) only in 1990, when, on behalf of 119 co-authors - states - members of the United Nations, the Resolution 45/190 from December 21, 1990 " International cooperation in the field of softening and overcoming of consequences of emergency on the Chernobyl nuclear power plant " was adopted by the consensus, called subsequently by " the resolution of a humanism, mercy and solidarity ".

In an operating part of the Resolution it was offered to the General Secretary of the United Nations:

- to elaborate the program of coordination of activity, which will be implemented by the bodies, organizations and programs of a system of the United Nations on attenuation and overcoming of consequences of the Chernobyl disaster;
- to assign a function of coordination to one of the assistants of the General Secretary;
- to found a target working group for urging activity of a system of the United Nations Organization in this field and its overseeing;
- to address with an appeal to introduce voluntary fees for a reinforcement of resources of the regular budget used by bodies and entities of the United Nations Organization for implementation of activity, aimed at attenuation of consequences of the Chernobyl disaster.

To bodies, specialized entities and programs of a system of the United Nations, the request was addressed « at consideration of a problem about probable technical and diverse specialized help to the most damaged regions, specially in the Byelorussian Soviet Socialist

 Republic, Ukrainian Soviet Socialist Republic and Russian Soviet Federative Socialist Republic, to allow for the unprecedented nature of a radiation - ecological disaster and extraordinary situation which was adding up in these regions as a result of long - term effect of anthropogenous irradiation on present and future generations “.

Subsequently “ the Chernobyl resolutions “ were adopted on 46, 47, 48, 50, 52 and 54 sessions of the GA of the United Nations.

In adding up to the present time under aegis of the United Nations to a system of international cooperation there are following coordination structures: the co-ordinator of the United Nations on international Chernobyl cooperation (in a rank of the assistant of the General Secretary of the United Nations), Interoffice target group on Chernobyl and Quadrilateral co-ordinating committee of the United Nations.

In the performance of point 1 (b) of the Resolution 45/190 the General Assembly of January 15, 1991, the General Secretary of the United Nations Javier Perez de Cuellar has appointed his assistant Margareth Joan Ensti as the Co-ordinator of the United Nations on international Chernobyl cooperation. Further this position sequentially took: Josef Verner Read, Jan Aliasson, Peter Hansen, Jasushi Akashi, Sergio Viejra de Mello. After assigning S. de Mello by the Head of transient management in Eastern Timore (the autumn of 1999), it was Carolin Makaski who temporarily executed the duties of the Co-ordinator of the United Nations on international Chernobyl cooperation. Since December 8, 2000 the assistant of the General Secretary of the United Nations on humanitarian problems and Co-ordinator of the United Nations on international Chernobyl cooperation is Kenzo Oshima.

Certainly, such often replacements of the Co-ordinator of the United Nations on international Chernobyl cooperation could have an effect on productivity of undertaken efforts by Belarus in this area.

In point 1 (c) of the resolution 45/190 from January 14, 1991 the General Assembly has invoked the General Secretary “ to found target working group for urging activity of a system of the United Nations [in connection with the consequences of the catastrophe on the Chernobyl nuclear power plant] and overseeing it “. The Interoffice target group was created in April, 1991, and its first sitting was held on May 24, 1991.

With the purpose of increase of an introducing role of the United Nations at implementation of the programs and projects on minimization of consequences of the Chernobyl disaster in May, 1993, the Quadrilateral co-ordinating committee of the United Nations on Chernobyl in a composition of the Co-ordinator of the United Nations on international Chernobyl cooperation and ministers of Belarus, Ukraine and Russia engaging problems of Chernobyl, was formed.

Pursuant to rules of a number of the resolutions the GA of the United Nations, the Department on coordination of humanitarian activity of the United Nations (DCHA of the United Nations), created pursuant to the resolution of General Assembly of the United Nations 46/182 (former title - the Department on humanitarian problems), represents itself as Secretariat of Quadrilateral co-ordinating committee of the United Nations on Chernobyl and Interoffice target group on Chernobyl. In reality the Chernobyl Secretariat of the United Nations in Geneva is represented by one employee of a category L (temporary adviser).

Both coordination mechanisms have the advisory - information status. Thus the Quadrilateral committee serves for the coordination of multilateral policy on the basis of national priorities, and the Interoffice target group is a body for implementation of matched policy into practical operatings of Secretariats of intergovernmental organizations. Unfortunately, the substantial mechanism of fulfilment of the above mentioned “ Chernobyl “ resolutions is not designed till now on the part of the United Nations.

All these years planned - programmatic approach was mostly employed on an international arena, i.e. collecting and generalizing of the design proposals in priority areas requiring external contributing, for the subsequent submission to potential donors.

On the basis of lists of need in the help, introduced by the USSR, BSSR, USSR and RSFSR governments in March, 1991, for the first time " a consolidating Plan of the United Nations on international cooperation with the purpose of softening consequences of emergency on Chernobyl NPP " was drawn up. Schedule included 131 design proposals from 3 most damaged republics and the USSR, in particular from Belarus - 21 (cost of 45 500 000 US dollars), thus the republic also participated in developing 45 joint project proposals.

The consolidating plan was submitted on the Conference under the declaration of fees (New York, September 20, 1991). Initially the forecast concerning outlooks of success of the conference was unfavourable. M. Ensti, the first Co-ordinator of the United Nations on international Chernobyl cooperation, has to the extreme clearly formulated the main unfavorable factors: "... Large period from the moment of emergency; the considerable events, which have taken place for this time, specially war in the Persian Gulf and current critical development of a situation in relation to curds; a mutable political situation in USSR and republics and contradictory views of different sources on real scales and effect of the emergency ".

The conference was finished by a full collapse - on " a consolidating Plan of the United Nations on international cooperation with the purpose of softening consequences of the emergency on Chernobyl NPP ", estimated in 646 500 000 US dollars, less than 1 000 000 US dollars was collected. As of January 17, 1992, it was announced about the fees in amount of 1 086 807,59 US dollars, and it was obtained - 669 857,59 US dollars. The largest fee in amount of 500 000 US dollars - practically half of all the announced sum - was made by Chechoslovakia. The USSR has made a fee in amount of 5 000 000 foreign currency roubles, Belarus, Ukraine, Russia - 2 000 000 roubles each.

In 1993 the inventory control of a consolidating Plan of the United Nations was conducted. The republic of Belarus has presented 41 projects on the following directions: " Health ", " Economical aftertreatment ", " Social - psychological aftertreatment ", " Food and agriculture ", " Monitoring and environmental sanitation ", " Lessons of Chernobyl emergency " for the sum of 114 557 000 US dollars.

In 1997 the " Interoffice program of international contributing to territories damaged from the Chernobyl disaster " (the so - called " Blue Book ") on the totals of a visit in Belarus, Russia and Ukraine of a special evaluation mission of the United Nations for detection of particular requirements in external support for minimization of consequences of the Chernobyl tragedy, was designed. 13 national project proposals for the sum of 22 342 500 US dollars have been entered in the " Blue Book " from Belarus.

On November 25, 1997, the special international sitting on problems of the Chernobyl disaster was held in Headquarters of the United Nations, on which the " Blue Book " was submitted to attention of the potential donors. As a whole, the sitting was poured out only in exchange of judgements, not having given any financial outcomes.

On March 26, 1998, the Second international sitting under the declaration of voluntary fees on the projects of a Chernobyl directivity entered in the " Blue Book ", was held in Geneva. Outcomes of engaging of financial assets were more than modest. In total, it was announced about the allocation of 1 500 000 US dollars (at an overall costs of the projects which are included in the " Blue Book ", equal to 90 million US dollars), i.e. less than 2 per cent from the asked sum. Thus, from the obtained 1 500 000 US dollars, 1000000 US dollars - a target fee of USA on implementation of the Ukrainian projects.

In 1999, under the totals of a visit of S. de Mello, the Assistant of the General Secretary of the United Nations, in Belarus, Ukraine and Russia, the Appeal of the United

Nations of 1999 on international Chernobyl cooperation being as a matter of fact audit " of the Interoffice program of international contributing to territories, damaged from the Chernobyl disaster " in the part of allocation of the most priority projects, was prepared by the DCHA from among all design proposals. The Appeal of 1999 on international Chernobyl cooperation included 9 projects (on 3 from each state) for the sum of 9 510 000 US dollars (1,3 % from the initial cost of the " Blue Book "). The Appeal included the following design proposals from Belarus: " Retrofit of Braginsky district hospital (Gomel region) ", " Creation of a network of children's rehabilitational centers, in clean areas of Belarus ", " Radioecological recovery of separate districts in the Gomel region for conditioning steady development of damaged territories. Decontamination of places of the regular stay of children and adults of Gomel region ". On two of these projects the activity is actively conducted. So, together with IAEA, the project " Rehabilitation of territories suffered from the Chernobyl disaster " will be executed, and German charitable organization Diakonie, through DCHA, has financed the activities on implementation of the project, aimed at creation of a center of a social - psychological aftertreatment for the mothers with children, on the basis of one of children's rehabilitation - improving centers - CRIC " Svitanok " in the Brest region.

The role of the United Nations in the organization, coordination and development of international Chernobyl cooperation is extremely relevant. And though this role is far from being always marked by definite outcomes, the republic of Belarus considers invaluable the preservation of a Chernobyl problematics in the agenda of this influential international organization.

The republic in every possible way aims to develop cooperation with the United Nations and its subdivisions. For this purpose there are good fundamentals, joint operating running times, successful projects and programs. The cooperation with the United Nations is under construction on the basis of indicated priority directions with the Republic of Belarus:

- overcoming of medical consequences of the radiation disaster, decreasing of general risk to health of the population, children and liquidators of the emergency.
- a decrease of unfavorable ecological, economical and social - psychological consequences of the disaster.
- recovery of normal conditions of life and economic activities in the territories, contaminated by radionuclides.

Within the framework of these priorities the activity on informing of the world community on negative consequences of the Chernobyl disaster, looking up of the donors and investors for rendering assistance in implementation of the joint programs and projects is conducted.

10.2. Interaction with structural subdivisions of the United Nations and other international organizations

Chernobyl Committee coordinates a fulfilment of the Chernobyl projects of technical cooperation with International agency on an atomic energy (IAEA), aimed at rehabilitation of the suffered population and territories. In 2000, through link of technical cooperation with IAEA, three projects for the sum of about 2 000 000 US dollars were executed. Within the framework of the projects of IAEA, namely BYE/9/006 " Rehabilitation of territories damaged in outcome of the Chernobyl disaster ", BYE/5/004 " Production of food oil from rape seeds, grown on the contaminated territories ", RER/9/059 " Decreasing of doses of external irradiation of the inhabitants of the contaminated territories " are equipped with the modern equipment of the lab of radiological control of Polessky radiation - ecological reserve and Khojniksky cheese producing plant, the specialists are trained, the production equipment

for production of food rape-seed oil on " Pripjat " fodder plant of Mozyrsky district is mounted. It would be desirable to call the latter of the mentioned projects of IAEA as the project " of new quality ", which can essentially contribute to a solution of a problem of economical revival of damaged locales.

Addressing to history, it is necessary to note, that in 1989, after the addressing of the former USSR government, the IAEA has acted as the organizer of the International Chernobyl project, the purpose of which was an estimation of the concept, existing in country, of secure residing of the population in the territory which has exposed to radiological contamination as a result of emergency on Chernobyl NPP and efficiency of measures, undertaken after the emergency. In the second half of 1990 50 scientific missions worked in three damaged republics, in a structure of which more than 200 scientists from 25 countries of the world were included. The outcomes of researches were debated on the international conference in Vienna in May, 1991. In 1991 the IAEA has published the technical report " Evaluation of radiation consequences and protective measures ", maps of the contaminated locales, conclusions and concludings on fulfilment of this project, which were ambiguously perceived by the scientists of miscellaneous countries.

In the subsequent years, under aegis of the IAEA, a series of conferences on discussing problems of a radiation safety and of Chernobyl emergency was held. The international conference " A Decade after Chernobyl: an estimation of consequences of emergency " (April, 1996) became the most significant of them. The participants from many countries of the world have discussed consequences of emergency for health of the population, environment, social and economical development of the damaged states, necessity of acceptance of long-time measures for overcoming its consequences.

Within the framework of the Program of technical cooperation of the IAEA the projects aimed at a decrease of influencing of the radiation factor in different orbs, were executed: " Berlin azure ", " Stations of radiation monitoring ", " Retaliation in an agriculture ", " Research of migration of radionuclides in the contaminated soils ", " New know-hows of dumping of radioactive timber ", " Cultivation of rape on the grounds, contaminated by radionuclides ", " Production of biolubrications from rape seeds, grown on the contaminated territories ", " Creation of the lab of secondary standards ", " Harmonization of procedures of radiation measurements ». For the period from 1990 to 1998 the technical assistance of the IAEA to the Republic of Belarus has compounded over two million US dollars, the modern equipment has been obtained, the national staff has been trained, the technical reports have been prepared.

In the meantime, the official Chernobyl programs of cooperation with the Organization of the United Nations on education, science and culture (UNESCO) are missing. However, by negotiations it was possible to solve the problem on allocation of about 100000 US dollars on fulfilment of the projects, aimed at rendering assistance to children suffered from Chernobyl.

UNESCO was by one of the first entities of the United Nations which have responded in due time on a call for help to states, suffered from the Chernobyl disaster.

Under the proposal of the Republic of Belarus the Executive Council of UNESCO on its 135 session (October, 1990) has considered and has made a decision, in which the Council:

> " … asks the General director, in the course of development of a Draft program and budget on 1992-1993, to start with expediency of actuation in it of the special project, aimed at the development of international cooperation on contributing in the fields of the competence of UNESCO to liquidation of consequences of the emergency on Chernobyl NPP, meaning implementation of this project, mainly, on the basis of self-financing

 … sends an appeal to states - members, international organizations, national and individual entities to prolong in every possible way to encourage international cooperation in liquidation of consequences of emergency on Chernobyl NPP… “.

On the twenty sixth session (October, 1991) the General conference has confirmed urgency and relevance of the solution adopted by the Executive Council of UNESCO on its 135 session. In the resolution 13.5 the directives were updated and the solution on implementation of drafts of the program “ UNESCO - CHERNOBYL “ was accepted, within the framework of the approved programs and budget for the years 1992 - 1993 by sectors of education, science, the cultures and communications, and the proposals on the necessity of acceptance of measures on strengthening inside the Secretariat of UNESCO of the mechanism on coordination of an implementation of the program “ UNESCO - CHERNOBYL “ were brought in.

Originally the program contained approximately 70 proposals on the projects, which were prepared after consultings with competent authorities of damaged republics (April - June 1990) in cooperation with the applicable sectors of the Organization and were designed for implementation pursuant to principles, defined by the Executive Council.

In total 82 projects were envisaged within the framework of the program, about 30 projects were being executed. More than 9 000 000 US dollars were mobilized. However, according to the estimates of the international experts, 3 742 000 US dollars were allocated directly on implementation of the projects. The program was finished by December 31, 1997.

The project № 64 “ Creation of centers of a social - psychological aftertreatment “ became one of the most significant for Belarus within the framework of the evocative program, pursuant to which in Belarus the indicated centers in settlements Aksakovshtchina (Minsk region, Minsk area), Pershai (Volzhinsky district, Minsk region), Streshin (Zhlobinsky district, Gomel region) were created. The creation of these centers became possible due to the considerable financial contribution of German charitable organizations “ Diakonie “ and “ Caritas “, and also on the part of the government of Canada, Children's fund of the United Nations (UNICEF) and of Chernobyl trust fund of the United Nations. Each of the centers has the specialization of its own. The successful implementation of the project on creation of centers of a social - psychological aftertreatment has found the prolongation in 2000 and support of the DCHA of the United Nations. On base of the CRIC “ Zhdanovichi “the department of a social - psychological rehabilitation of children passing environmental sanitation in center was created in 1999 - 2000, and in 2001 on the base of the CRIC “ Svitanok “ the activity on creation of the center of a social - psychological aftertreatment for the mothers with children was started. It is thought, that these are only the first steps in creation of a professional republican system of a psychological aftertreatment of damaged children and adult population of Belarus.

The projects on equipping the clinic of Research clinical institute of radiation medicine and endocrinology “ Aksakovshtchina “, sporting halls of schools of damaged areas were also executed. Within the framework of the same program the assistance was rendered in creation of radioecological institute (successfully operating now as the International ecological university named after A. D. Sakharov) in studying of foreign languages by the specialists engaged in dealing with the problems of consequences of the Chernobyl disaster, and also in organization of international conferences and workshops.

During the exploratory visit to three damaged republics (June, 1991), the mission of Children's fund of the United Nations (UNICEF) has established orbs, requiring priority and external contributing: a psychological aftertreatment of victims of the Chernobyl disaster;

delivery of vitally indispensable drugs, vitamins and medical equipment; the analysis of a condition of health of children and women.

For treatment of disorders caused by unsufficiency of iodine for children, living in the damaged regions of three republics, UNICEF has submitted ultrasonic instrumentation for their treatment and capsules with iodine containing drugs.

In 2000, on the part of Children's fund of the United Nations, the support to children's rehabilitation - improving centers of ComChernobyl, centers of a system of the Ministry of education, structural subdivisions of the Ministry of Public Health and non-governmental organizations, as the humanitarian assistance, for the sum of about 100 000 US dollars which included a school fitting, sporting stock, ware, toys, refrigerators, was rendered.

The consolidating plan of the UNICEF operatings for the years 2000-2001, being the establishing document of activity of this organization in Belarus, among other directions, contains a Chernobyl component. Thus the strengthening of systems of a primary medical care to the women and children in regions damaged from Chernobyl emergency is supposed. The realization of educational seminars for the specialists of a system of the Ministry of Public Health is scheduled on issues of the integrated approach on protection of health of the women and children, system development of monitoring of a condition of health of children and women in damaged regions and other measures.

The gravity of Chernobyl consequences for health of the population was marked in the resolution of 87-th session of the executive Committee of World-wide Organization of public health Services (CART) adopted on January 24, 1991. In the report of the General director of the CART, Khiroshi Nakadzima, introduced on this session, is pointed out, that " … during the last two years it became abundantly clear, that the effect of Chernobyl emergency is considerably more composite, than it was originally supposed... Others, the earlier not suspected consequences began to gain all increasing value … "

On May 1, 1991, the World-wide Assembly of the CART, in the resolution WHA 44.36, has officially approved a creation of the International program on decreasing medical consequences of the Chernobyl disaster (IFEKA). The program was counted on some decades and has joined together efforts of the three most damaged states, the CART and a number of other countries and organizations in the solution of the medical problems which have arisen after the emergency.

For fulfilment of an initial (pilot) phase of the Program counted for three years, the CART allotted about 20 000 000 dollars of extra-budgetary means. These means were formed, mainly, at the expense of the financial contribution in IFEKA of the government of Japan. The financial help to the program have also been rendered by Czechia and Slovakia (total sum of 500 000 bucks), Finland and Switzerland.

The first phase of IFEKA included five pilot projects, within the framework of which the separate diseases of a thyroid gland for children, leukoses and similar diseases of a blood, damage of a brain owing to prenatal irradiation, management of the epidemiological registers were studied. The researches spent within the framework of the program, enveloped medical consequences called both by direct effect of irradiation, and by the factors of not radiation nature, such as an intensive psychological stress called by an evacuation, and possible injury for health as a result of radioactive fall outs.

For rendering of material and technical support on fulfilment of a pilot phase of IFEKA, the CART has bought and has delivered in three states the equipment for realization of indispensable researches, reagents and reactants. The trainings of 200 specialists in scientific and clinical foreign entities were organized and conducted.

IFEKA has considerably contributed to improvement of diagnostic and therapeutic capabilities of three damaged states. Outcomes of fulfilment of a pilot phase of the program

simultaneously demonstrate the necessity of prolongation of researches, maintenance and updating of the epidemiological registers, the role of which increases with flow by time, elapsed from the moment of the emergency, and approach of the distant consequences of the Chernobyl disaster.

After Chernobyl disaster the program of a radioactivity protection of the European Commission (1985-1989) has been exposed to revision. 10 international projects for an estimation and forecasting of the proximate consequences of emergency were organized. Soon after a beginning of the third program of this cycle, the European Commission formed the separate budget for financing of Chernobyl researches. With this purpose, for the period from 1991 to 1995 the Commission has submitted the sum in 20 000 000 ECU, which subsequently has been increased up to 30 000 000 as a result of participation in these researches of other european organizations. Thus, the first step to the fulfilment of actual research and pilot projects (16 in total) was made in the field of radio ecology, radiation medicine, of onco-epidemiological monitoring of consequences of emergency, biological dosimetry, policy of a decontamination, and also substantiation of retaliation received in case of nuclear emergencies. In researches, the official basis for which became the Agreement on international cooperation on problems, bound with consequences of emergency on Chernobyl NPP, between Commission of European Communities, State Chernobyl Committee of the Republic of Belarus, State Chernobyl Committee of Russian Federation and MinChernobyl of Ukraine signed on June 23, 1992 in Bruxelles, shared about 80 exploratory groups of the Western Europe and 120 exploratory groups of the three damaged republics.

The totals of cooperation of scientific countries of Europe, Belarus, Russia and Ukraine were discussed on the First international conference of Commission of European Communities, Belarus, Russian Federation and Ukraine on radiological consequences of the Chernobyl emergency (Minsk, Belarus, March 18-22, 1996).

Having achieved considerable result in frameworks of the above mentioned 16 scientific projects, the European Commission in 1996 adopted a decision to initiate with activity with the population living in contaminated territories. The applicable EU project " ETOS " has a title " Quality improvement in the life in damaged territories ". Its main idea is reduced to a necessity of fissile entrainment of the population in control of radiological risk, education of a new radiological culture.

The cooperation with European Union under the program of Technical contributing to the new independent states and Mongolia (TASIS) continues. The regional Program TASIS - 93 " Rendering of assistance to locales damaged from the Chernobyl emergency " included 5 projects:

- "Training of medical staff engaged in treatment of a thyroid gland cancer";
- "Definition and implementation of measures on improvement of usage of the contaminated forestry wastes";
- "Definition and implementation of measures on improvement of production and packaging of iodinated salt";
- "Definition of measures on improvement and support of information means of the population in locales damaged from the Chernobyl disaster";
- "Creation of the Agency of economical development of the Gomel region".

The Project on creation of the Gomel regional economic development agency (GREDA) became one of the most perspective projects of the TASIS program. The agency was formed with the purposes of improvement of an economical climate in damaged locales under the initiatives of Chernobyl Committee and at participation of the Gomel regional

executive committee. GREDA is unique for Belarus by formation combining in its activities a potential of private business and a capability of the regional executive authority.

The agency has already executed a series of projects, from which it is possible to outline such as " Development of production of Seybit fertilizing mixtures " (cost of the project is 10 000 US dollars), " Training of the chiefs of a miscellaneous control link to modern methods of management of agricultural production on an example of the Czech republic " (about 100 specialists was trained during 1999 - 2000), " Economical rehabilitation of a poultry - farm of the " Bolsheviksky Pobeda " collective farm of Khoyniksky district " (cost of the project is 50 000 US dollars).

Only under the last project (" Economical rehabilitation of a poultry farm of the " Bolsheviksky Pobeda " collective farm of Khoyniksky district ") the farm has received gratuitous technical assistance from Czechia as the equipment for production of mixed fodders, which was mounted, was put into operation and allows the facilities to have substantial profit.

By the order of Chernobyl Committee, the Gomel regional agency of economical development has designed the business - plans on development of cattle breeding, poultry-farming, gardening, other agricultural and industrial subjects.

In 1996 Belarus has joined the Central European Initiative (CEI), - a regional association created in 1989 by countries of the Dunaj - Adriatic subregion with the purpose of cooperation in the field of renovation of political and economical patterns in Europe, organization of flexible and pragmatic regional cooperation. In two years after joining the CEI - the definite readiness was outlined among its countries to support the Republic of Belarus in the field of minimization of consequences of the emergency on CNPP. So, at support of the CEI Fund of confidence, the European Bank of Reconstruction and Development and the National educational fund of the Czech Republic, the implementation of the first Chernobyl project - Byelorussian - Czech educational program for the managerial personnel of an agriculture from damaged regions of the Gomel region began in May, 1998 and is successfully prolonged in the meantime. The first grade level passed in May, October and November, 1998 on the basis of the Czech " Farmtech " corporation (Tabor, Czech Republic). The training was directed on the specialists, bound with operation of agricultural firms, problems of reforming and organization of control in this area, motivation of the workers, practice of activity in conditions of the transient economics.

These were only the first steps in cooperation with the CEI. In the further activity will be concentrated on advance of the credit projects, grants, humanitarian help and training of personnel.

Within years, elapsed after the emergency, the problems of minimization of consequences of the Chernobyl disaster have been decided in tight interplay of three most damaged countries - Belarus, Ukraine and Russia. The scientists and specialists of the three countries are the participants of the joint international programs and projects, co-ordinating committees on different problems of recovery of the contaminated locales and aftertreatment of the damaged population. In view of changing conditions the programs of joint actions of Belarus and Russia are designed and staticized, the audit of the available bilateral and trilateral arrangements and agreements is conducted, the steps on their implementation into life are scheduled.

The Program of joint cooperation on overcoming consequences of the Chernobyl disaster within the framework of the Union of Belarus and Russia for 1998-2000 years serves as a vivid example to it. The joint cooperation of the specialists of two damaged countries is concentrated on formation of the pattern and contents of the normative - methodical documents, analysis of radiological contamination of territories, development of the

normative documents on environmental sanitation and aftertreatment of the damaged population, in-depth analysis of a morbidity by a thyroid gland cancer of the population of the Gomel region of Belarus. The considerable resources are allocated on building and rigging of 2 objects of medicine in Belarus - Grodno plant of medicines and Gomel special dispanser.

Only for 2000, as a whole on the Republic, the republican bodies of administration of government and their subordinated organizations executed more than 30 international projects of a Chernobyl directivity with total amount of financing of activities for the sum about 4 millions US dollars including delivery of the equipment, training of the specialists, realization of seminars and consultations, realization of particular applied and research works. The sum of attracted means is cited without the registration of the humanitarian help and spent means for improving of children's health.

10.3. Outlook of international Chernobyl cooperation

The end of the 20th century has flashed the contradictory tendency in the field of organization of international Chernobyl cooperation: from a heightened interest to a problem to the attempt of its full denying. The first issue is confirmed by realization of a significant amount of international negotiations on a Chernobyl problems. In 2000 only the Chernobyl Committee conducted more than 80 of them. The interest is exhibited on the part of the representatives of international organizations, private initiatives, public charitable funds, diplomats of all ranks, journalists of known global TV- and radio - companies. On the other hand, the report of Scientific committee of the United Nations on operating nuclear irradiation has reduced consequences of the Chernobyl disaster to alone - cancer of a thyroid gland.

In environment of the potential donors the term " a syndrome of a fatigue ", the fatigue from the inquiries about the help, which are distributed not ceasing from damaged countries during 15 years after Chernobyl, even more often began to be used. The main reason of such a situation is seen from the fact that the support of countries damaged from the Chernobyl disaster, has basically been implemented under the slogan of the humanitarian help rendered for overcoming of consequences of extraordinary situations.

The Chernobyl subjects step-by-step leave an orb of attention of an international public, are displaced from the agenda of international organizations by other cares, bound with global issues of our time, widescale natural disasters and humanitarian crises. Despite of commonly recognized unprecedented nature of Chernobyl consequences, after the lapse of 15 years after debacle this slogan has settled itself, and the new momentum is necessary to international Chernobyl cooperation.

It is necessary to state, that the governments of the richest countries of a world, and specially " of nuclear Europe " up till now have not turned by a face to countries damaged from Chernobyl. Practical absence of the applicable intergovernmental agreements, programs and projects testify about it.

The analysis of ten years' period of international Chernobyl cooperation demonstrates, that the planned - programmatic approach used since 1991 for looking up of external financing with the purposes of the solution of the most acute after-Chernobyl problems, has appeared not effective enough. It is probably connected with the fact that rigid, the fast becoming outdated programs do not respond to varying priorities of the potential donors. The joint developing of the project proposals with the foreign associates appears to be perspective.

Yes, Chernobyl is probably forgotten by many, but not by the one who daily tests for to itself hardships of Chernobyl burden. The fact of residing almost two million people in the contaminated territories of Belarus still demands both targeted activity of state bodies, and

appreciable contributing on the part of international community, as the indispensable for the solution of available problems resources multiply surpass capabilities of the country. The development of new approaches to development of international Chernobyl cooperation - one of the most actual problems of the state, as the future of Belarus in many respects depends on it.

Many organizations - donors frequently carry out artificial separation of the project proposals of a Chernobyl directivity, presented by Belarus, on humanitarian and economical ones, i.e. requiring of the investments in a manufacturing sphere. Thus is overlooked, that Chernobyl - not only the ecological, but also social - psychological, and economical problem. Tasks facing Belarus require a comprehensive approach.

Can be that the most dangerous and terrible for the people living in contaminated regions, are not a level of a background radiation and contents of radionuclides in food, but the feeling of a hopelessness and absence of a sense of confidence in tomorrow. To change a situation to the best, the realization of a complete combination of all rehabilitational measures is necessary, starting from education of new ecological culture of residing in the contaminated territories, fissile information and propaganda activity in this direction and finishing an economical aftertreatment of the damaged territories.

The considerable potential of the development of international Chernobyl cooperation is laid up in interplay with foreign non-governmental charitable organizations. The humanitarian help to the requiring people and health improving of the population who is included in of group of risk, still introduce the powerful contribution to overcoming problems of Chernobyl. In this direction there is also a number of the unused capabilities. Returning owing to active and noble activity of our foreign associates, it is necessary to recognize, that in a number of cases the help is sputtered, not always reaching up those for whom it is vitally indispensable. A problem on creation of the coordination mechanism in this connection is acutely put, which could adequately and reasonably consider concerns of the damaged population, charitable organizations, civil society and state.

By invoking to cooperation and suggesting to look on a Chernobyl problematics under different angles of view, we act for a new policy in interaction with organizations and countries - donors. Alongside with humanitarian and scientific cooperation, we are prepared to develop such new forms, as:

- the interest-free long-term credits for investment in economics of damaged locales and development of their manufacturing and social infrastructure;
- delivery of the equipment under particular present production with delay of payment or payment by made commodity;
- creation of joint productions, and, thus, of new jobs, in settlements for the re - settlers and in damaged areas;
- an intrusion of new know-hows for processing of the commodity received in a territory, contaminated by radionuclides.

After the lapse of fifteen difficult after - Chernobyl years, when in the Republic of Belarus the statutiry - normative base on a Chernobyl problem has been created, when serious scientific outcomes have already been produced and the steadfast matched and integrated analysis of an after - Chernobyl situation is prolonged, we transfer to a rehabilitation stage of overcoming of consequences of the disaster, during which the vital needs of the present generation of people should be satisfied, without decreasing such a capability for the future generations. In this connection we estimate help of international community in overcoming of the Chernobyl consequences as the relevant and indispensable reason for transition of damaged locales and country as a whole to a steady development.

Chapter 11

RADIOECOLOGICAL EDUCATION. INFORMING AND ENLIGHTENMENT OF THE POPULATION.

The problems of preparation of the specialists on radio ecology and radiation safety, and also enlightenment of the damaged population, are extremely important for the Republic, which had no of the applicable educational institutions up to the Chernobyl disaster. Their significance is conditioned:

- by long - term nature of consequences of the emergency on the CNPP for the Republic of Belarus;
- by necessity of a reliable radiation monitoring for all spheres of the national economy, including both export and import of raw and materials from the contaminated regions;
- by maintenance of a radiation safety when handling ionizing radiation sources;
- by presence of the operational NPP near to the boundaries of the Republic.

The considerable activity is done on organization of radioecological education, including enlightenment of the population, to the present time. Since 1989, by the solution of Ministry of education and the sciences, special courses on a radiation safety for all contingents of trained personnel (at schools, secondary and secondary special, higher educational institutions) were introduced. The Republican scientific - educational and information center on a radiation safety and radioecological education (RSEIC), as a parent organization, executes the improvement of professional skills and retraining of staff of a network of a radiation monitoring and specialists engaged in activities on overcoming of consequences of the emergency on the CNPP. The preparation of the top qualification specialists is conducted by the International Ecological University (IEU) named after A. D. Sakharov In some higher educational institutions, for example, in the Byelorussian agricultural academy, the faculties, specializing on the given direction, are opened. In other high schools, the faculties of an ecological profile ensuring teaching of general disciplines of a radioecological directivity, are created. The faculty of an ecology of the Byelorussian state polytechnic academy, the faculty of radiation medicine and ecology in Minsk state medical institute and others, are among them.

11.1. Training of personnel in a Chernobyl Committee system. RSEIC

The improvement of professional skills and retraining of the specialists of a network of a radiation monitoring of the Republic and workers engaged in implementation of measures on overcoming of consequences of the emergency on the CNPP, including the representatives of the bodies of state and local control, ministries and offices, is conducted in the Chernobyl Committee RSEIC on the following specialities:

- Radiation safety;
- Radiometry and dosimetry;
- Consequences of the emergency on the CNPP;
- Social protection of the citizens damaged as a result of the emergency on the Chernobyl NPP;
- Decontamination of the contaminated territories and objects;
- Activity of the representatives of administration of zones;
- Mass media activities on elucidating problems of consequences of the emergency on the CNPP in the Republic of Belarus;
- Training and retraining of the operators of meters of radiation of the man.

During this activity for the time of existence of the center, more than 3600 specialists of a system of Chernobyl Committee, Ministry of forestry, Ministry of housing and municipal services, Ministry of trade, Goskomgidromet, Gossanepidemnadzor, Byelorussian railway, Belstandart, Belcoopsoyuz, MASS-MEDIA have passed training.

For maintenance of the educational process, educational textbooks and the manuals, methodical, information and visual materials are prepared and published by the RSEIC specialists. The computer database " STAFF " taking into account requirements of the Republic in the specialists on a radiation monitoring and overcoming of consequences of debacle on CNPP, is conducted. With the purpose of optimization of process of retraining of staff and organization of wide scale research of a degree of training of the population and specialists in the field of radio ecology and radiation safety, the pilot version of the database for complex radioecological testing by means of the Internet is created.

The important area of the RSEIC activity is an issue of the information bulletins on Chernobyl subjects. 75 bulletins with elucidating of the most urgent questions of a radiation safety and problems of consequences of the Chernobyl disaster have been published.

In 1998 the RSEIC has come in the IEU pattern on the rights of a faculty, that has allowed in a definite measure to aggregate intellectual and material resources of the Ministry of education and Chernobyl Committee for the solution of problems of overcoming of consequences of the disaster on the CNPP.

The Republican research unitary enterprise " Institute of radiology " (Gomel), subordinated to Chernobyl Committee, conducts training and improvement of professional skills of the chiefs and specialists of agricultural enterprises, arranged on the territories which have been exposed to radiological contamination after the emergency on the CNPP. 463 chiefs and specialists of an agriculture have passed training in 1999-2000.

The institute of a radiation safety " Belrad " prepares radio metrists for local centers of a radiation monitoring created pursuant to the Law of the Republic of Belarus " On a legal regime of territories, exposed to radiological contamination as a result of the emergency on Chernobyl NPP " 164 radio metrists have been prepared by the order of Chernobyl Committee.

Pursuant to the solution of the Council of Ministers №17/1416-45 from March 3, 1994 " About distribution of the documents and information on nuclear and the radiation safety in the Republic of Belarus ", the RSEIC, IEU and RSRUE " Institute of radiology ", represent Belarus in an International nuclear intelligence system (INIS) of the IAEA. The system provides the specialists with the information on the publications on a radiation safety and usage of an atomic energy in the peace purposes. The database of a system INIS contains more than 2 million records about the literary references. It is distributed on compact discs, other information carriers, and also through the Internet. The Byelorussian department submitted the data about more than 2150 publications in the republican editions (articles, books, materials of conferences, patents) to the INIS database, that allows to operatively inform the world scientific community on directions and outcomes of researches of the Byelorussian scientists.

11.2. International Ecological University, named after A. D. Sakharov

International college on radio ecology, named after A. D. Sakharov, was opened on the basis of the Byelorussian state university, by the Decree of the Council of Ministers of the Republic of Belarus from January 20, 1992, pursuant to the initiatives of 1-st International congress of memory of A. D. Sakharov " The world, progress, human rights " and the program " Chernobyl ", supervised by the United Nations Organization. In 1994 it transformed into an independent institute, and in 1999, in the International Ecological

University (IEU), named after A. D. Sakharov. At present, preparation of the students is conducted on two specialities: radio ecology; radiation and ecological medicine. An annual set of the students is about 100 persons.

At the University the highly qualified scientific and pedagogical staff, including 22 doctors of sciences, 48 candidates of sciences, is massed. The industrial practice of the students is carried out on a field station in Khojniki (Gomel region), arranged in immediate proximity from a zone of alienation. The contacts of the university are arranged with universities and research centers of Great Britain, Germany, Sweden, France, the USA, and also Russia, Ukraine, other countries of CIS on early cancer diagnostic, radiation biophysics and biochemistry, radiation immunology, molecular endocrinology, molecular tokens of radiation effect, geographic information systems (GIS) in radio ecology, creation of devices for radiation monitoring.

In 1999 - 2000, the IEU has executed activity on the national project of technical cooperation with the IAEA - BYE/9/007 " Perfecting of training of personnel on a radioactivity protection and safety of wastes ", aimed at perfecting formation of the professionals and improvement of professional skills in the field of a radioactivity protection, nuclear technologies and their secure applying. The lectures and practical occupations were conducted by the leading scientists of the Republic and specialists of the IAEA. After termination of the course, the participants have received the certificates of the IAEA.

This experience has shown, that the RSEIC, included in the IEU structure, is capable to represent itself as a training center on rendering of assistance to the Secretariat of the IAEA in a matter of organization and realization of post - graduate educational courses and specialized educational measures in the field of a radioactivity protection, nuclear safety and handling of wastes.

11.3. Preparation and improvement of professional skills of staff in other ministries and offices

To meet the needs of the Ministry of an agriculture and food in the highly qualified specialists, since 1994 in the Byelorussian agricultural academy (Gorky town of the Mogilyov region), there has been started the preparation of the students by a speciality " Radio ecology " with a specialization " Agricultural radio ecology ". The indicated specialists are trained for professional manufacturing - technological, organizational - administrative and research activity in the field of agricultural radio ecology and ecology.

At the Byelorussian agrarian - technical university (Minsk), at the faculty " Safety of habitability ", the courses of retraining and improvement of professional skills of the specialists of a network of a radiation monitoring of the Ministry of an agriculture and food have been opened since January, 1990, for dosimetric stations and laboratories of meat and milk producing enterprises and food industry firms, processing enterprises, fruit and vegetable bases, veterinary and agrochemical labs, collective farms, state farms, agricultural enterprises. 1802 specialists have been prepared in the period from 1996 till 2000.

11.4. Supply with information of the public and activity with the population

The Regulation on the control of radiological contamination from the Chernobyl disaster in the Republic of Belarus determines a system of the collecting and distribution of the objective information on radiation situation (fig. 11.1). According to the indicated Regulation, the citizens and the public organizations of the Republic have the right to well-timed obtaining of full and reliable information on Chernobyl problems, which is

concentrated by Chernobyl Committee from entities and organizations executing the control, supervision and researches in this area.

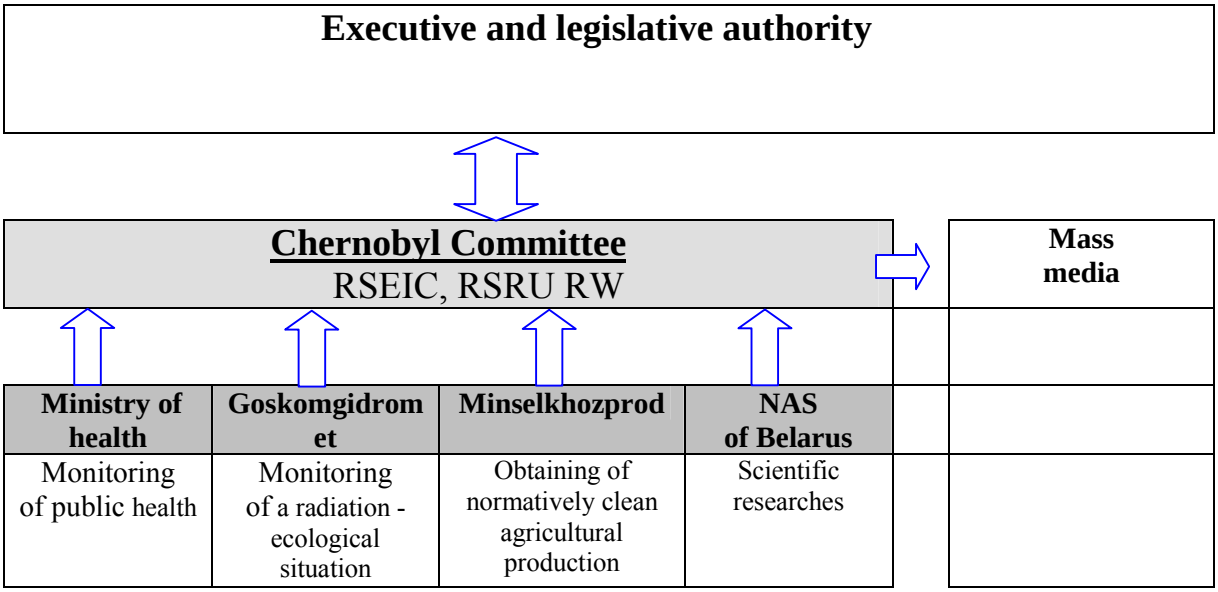


Fig. 11.1. The basic information flows

Primary goal of a supply with information is the broad explanatory activity, delivery to the population of damaged regions of the off-the-shelf scientific - practical conclusions and guidelines on a radioactivity protection, adequate information on measures spent for maintenance of normal conditions of habitability. Within the framework of this activity, the following measures are implemented:

- Conducting of press conferences of the Chernobyl Committee management,
- Regular issue of telecasts on a Chernobyl problematics,
- Issue of a weekly radio transmission " Chernobyl measurement ",
- The publication in central mass media of materials prepared by the leading Chernobyl Committee specialists,
- Issuing of the newspaper "The Ecological bulletin " and the magazine " Native nature ",
- Special issues of the newspapers in regions damaged from the emergency on the CNPP,
- Holding of conferences, seminars, meetings, exhibitions, expositions, trips of the specialists and journalists in damaged regions,
- Issuing of the monographies, reference books, encyclopedias, collections, bulletins, brochures, memorandums and other materials on Chernobyl problems.

Change of a way of life, formation of a new ecological culture is a destiny of all mankind. But by virtue of the accomplished Chernobyl disaster for Belarus, exposed to its consequences, this process has gained nature of a top priority.

With the purpose of an improvement of work with the population of the damaged regions, the IEU has initiated with creation of modern techniques of information impact, which are being probed in Khojniksky district of the Gomel region with broad engaging of the teachers and students of the university during their industrial practice.

The experience obtained during fulfilment of the international projects (" ETOS " etc.) merits the most steadfast attention. The ETOS project of the European Commission " Quality improvement of the life in damaged territories " outgoes from the necessity of an active entrainment of the population in control of radiological risk, education of a new radiological culture. The international experts together with national authorities come to a conclusion:

nobody can solve problems of secure residing of the people, if people are not attracted to this process. The approach, used in the project, has received an ambiguous estimation on the part of the Byelorussian specialists, though, as a matter of fact, the activity is built on a recently widely used in the USSR system of belonging to a circle activity or on organization of " clubs by interests ". As a model, Olmany village of Stolinsky district of the Brest region was selected. The group of the French experts together with the population, on the exclusively voluntary basis, has created working groups: " The Young mums ", " Clean milk ", " Clean meat ", " Ashes, " School ", " Video " (for the youth). By joint efforts, acquainting with the essence of existing problems in the village, the people search for paths of their solution.

The project " ETOS - 2 ", being a logical prolongation of the project " ETOS - 1 ",is now being executed. During its implementation the attempt at a new quality level is undertaken to spread the experience with the local residents and authorities to others 5 villages of Stolinsky district. The implementation of the project is exercised jointly with the Byelorussian scientific institutes, and also with specialists of the region. The project step-by-step conquers ever more supporters; it becomes more understandable to the people on places, where the hazard lies hidden now, how to operate risks, where the state resources allocated for overcoming of consequences of the Chernobyl emergency are spent to. The executives deem to consider that the approach used by them for activity with authorities and the damaged population, is padding in relation to measures undertaken by the state, and it allows to optimize consumption of state resources. The strategy of propagation of the experience of the " ETOS " project on other contaminated locales of the Republic will be submitted during an international seminar, which will complete the project " ETOS -2 ", in November, 2001.

Two Chernobyl projects of the TASIS program, which were started in 1995-1996 years and were renewed in 1999, correlate with the " ETOS ". Project. Both projects are directed on rendering of information support to the people living in contaminated territories. One of the projects is invoked to consolidate an information center Chernobyl Committee and 3 operational centers of UNESCO on a social - psychological aftertreatment by the modern equipment and to give them a new function - informing of the population on consequences of the Chernobyl disaster and ways of a selfdefence from their negative influencing. The other project - " the Solution of problems of clearing of the contaminated territories and secondary medical effects " is aimed at developing of information materials for five damaged settlements of the Brest and Gomel regions, and also envisages a delivery of audiovisual means.

11.5. Concept of education and enlightenment of the population on issues of a radiation safety and radio ecology

The " Concept of radioecological education in the Republic of Belarus ", designed by the IEU, RSEIC and Chernobyl Committee specialists and approved by the National commission on a radioactivity protection and by the Ministry of education, is directed on the solution of a complete set of problems of radioecological education, including enlightenment of the population The basic thesis of the concept are shown below .

- The radioecological education is the constituent of all education system and is directed on formation of modern knowledge indispensable for adequate perception of the broad range of problems, bound with the impact of irradiation on an environment and the man, radiation safety and hygiene, usage of nuclear technologies in the national economy. It encompasses practically all population of the Republic of Belarus.
- The contents of radioecological education are unified for each level of a general education and is being built in view of the applicable volume of the basic naturallyscientific knowledge.

- In secondary, secondary special and higher educational institutions, the course of the fundamentals of a radiation safety represents itself as a mandatory independent subject.
- Teacher, doctors, MASS-MEDIA employees are encompassed by the activity on retraining and improvement of professional skills in the field of a radiation safety.
- The systematic activity on enlightenment and informing of the population deploys on the basis of reference - information cabinets on a radiation safety and hygiene organized in regional centers, large settlements of the contaminated regions of the Republic. The mass media, network of the state radiation and sanitary-hygienic control, local centers of a radiation monitoring, educational institutions, centers of a medical aftertreatment and environmental sanitations, other republican services actively join this activity.
- The general management of a system of radioecological education is executed jointly by the Ministry of education and Chernobyl Committee.

Within the framework of activities on implementation of the concept in 2001, the Ministry of education together with Chernobyl Committee updates the program of an educational course of a radiation safety for schools of the radiation monitored zones, the new tutorials and manuals are elaborated.

* * *

Thus, for a short period of time, in the Republic of Belarus, a system of radioecological education with training levels from the schoolboys up to the specialists in the field of a radiation safety is created, and it successfully operates in the present moment. This system, at the applicable level of financing, is capable to completely ensure the republic with the staff for the solution of the problems, bound with a radiation safety and overcoming of consequences of the Chernobyl disaster.

The activity on informing and enlightenment of the population on the issues of consequences of the disaster on the CNPP and measures of their overcoming is conducted. In the given moment this activity is not always capable to satisfy information famine of a public and requires to be put on a qualitatively new level. This problem is in a field of view of the bodies of administration of government; the pilot activities on its solution are conducted.

CHAPTER 12

PRESERVATION OF A HISTORICAL AND CULTURAL HERITAGE

The Chernobyl disaster has created a substantial threat of the irrevocable loss of historical and cultural values of the Byelorussian Polesje - unique on the features of locale of the Republic. Here, near the villages of Berdyzh of Chechersky district and Yurovichi of Kalinkovichsky district of the Gomel region, the most ancient stands of the primitive man in the territory of Belarus have been detected. In the II millennium before the new era, the Grensk culture, the most ancient monuments of which are - the Borovka village of Bykhovsky district and the Zhuravel village of Cherikovsky district, started to take shape on the rivers of Dnieper and Sozh. In the process of melting of a glacier, the tribes of this culture advanced north-up, mastering new places. The anthropogenous tracks of activity of our ancestors have been being found out literally at every step, therefore it is quite justified to call this locale as an archeological museum in the open - air. The geographic position of this land facilitated to preservation of ancient traditions in a peasant household activities, which existed in Europe in the pre-Christian period, and have vanished or have nearly vanished on the European continent.

Photo 1. Byelorussian Polesje. The shore of the Pripjats river close to the town of Narovlja.

Alongside with archeological monuments, a great number of monuments of the architecture and wood architecture is situated here. Considering, that a tree is a rather ephemeral material, these monuments refer to a later period. Due to traditions passed from generation to generation, monuments of wood architecture giving the notion about a high scale of culture of our ancestors have been kept well - preserved up to now. This feature is found out both in subjects of a peasant household activities, and in a folk art.

Photo 2. The Middle-Ages monument - the stone-peasant woman (the village of Danilovichi of Lelchitsky district. It associates with a legend about a mum with a daughter, and serves as a place of worship up till now. Inhabitants of the neighborhood consider it protecting them from misfortunes.

The song - folklore heritage represents a special value of the locale. Still today in the villages of Lelchitsky, Jelsky, Khojniksky, Narovljansky, Braginsky, Kormjansky, Vetkovsky, Buda - Koshelevsky, Chechersky districts of the Gomel region, Klimovichsky, Kostjukovichsky, Cherikovsky, Slavgorodsky, Krasnopolsky districts of the Mogilyov region, the people of elder generation sing age-old ceremonial and life songs in cases, eligible to it, saving its unusual rich and original voice culture.

After the disaster, the huts and ancient constructions, and the monuments of ethnography in resettled villages together with them, literally grow with bushes, shatter of decay on eyes and go to ruin. The problems exist as well in the territories of a radiation monitoring. The migratory processes, disappearance of many villages, influence of the age factor, result in sharp reduction of that part of the population, which by itself is a direct bearer of material and spiritual culture. This process is aggravated and can become irreversible.

Photo 3. “ Oberega ” (Abjarega) in the village of Nadtochajevka of Narovljansky district. According to the ancient Polesje tradition, the cross was placed at the crossroads in the beginning of a village

On saving and preservation of the historical - cultural heritage of damaged locales, the activity of the State historical - cultural expedition, created by the order of the Council of Ministers № 110 from 26.03.91, in the performance of the Decree of the Supreme Council from 19.07.90 " About measures on acceleration of implementation of the State program on overcoming of consequences of the emergency on the Chernobyl NPP ”, was directed.

Due to the fact, that during the first four years elapsed after the emergency, the analysis and saving of a cultural heritage of the locale was almost not conducted, a lot of things have been irrevocably lost. At the end of 1990, the commissions on examination of a condition of monuments were created, and the measures on preservation of a historical and cultural heritage in settlements, which were subject to resettlement, and in the zone of a permanent radiation monitoring, were worked out by Gomel and Mogilyov regional executive committees. 28 areas of activity, envisaged for the years of 1991 - 95, were determined. From the end of

Photo 4. The outcomes of the expedition assembly of materials in Narovljansky district.

1991, the activity has gained the all - republican nature, its financing, by a decision of the government, was implemented at the expense of means, which were allocated on overcoming of consequences of the Chernobyl disaster.

Thus, although behind the schedule, the organizational, financial and scientific - methodical base for preservation of a historical and cultural heritage was created. The main form of work - research expeditions with participation of the specialists of the interested organizations. The expedition cooperates with the Ministry of culture, Ministry on extraordinary situations, institutes of an art criticism, ethnography and folklore, linguistics, history of the National Academy of Sciences of Belarus, scientific and research institutes of city designing and building and " Belprojektrestavratsija ", Gomel and Mogilyov universities and Local Lore museums, Byelorussian state museum of the national architecture and household activities, manufacturing - creative association " Belvideocenter ", Byelorussian public partnership of guards of monuments, departments of culture of executive committees.

The prior task of the historical - cultural expedition was creating of a data bank about monuments. At the first stage of activity of the expedition, 362 archaeological monuments of the neolithic times, bronze and iron centuries, early feudalism (stands, ancient settlements, towns and tumulus gravestones), 1283 monuments to a history, bound with events of the past and famous fellow - countrymen, 97 monuments of the architecture, including 18 monuments of the palace and park architecture, 67 - wood architecture, 750 age-old icons and valuable books, 118 folklore collectives, 16 state and 79 public museums, 437 libraries, 795 national foremen and skilled craftsmen, 70 savers of oral national creativity, were registered in 10 regions of the Gomel region (Braginsky, Buda - Koshelevsky, Vetkovsky, Dobrushsky, Jelsky, Kormjansky, Lelchitsky, Narovljansky, Khojniksky, Chechersky districts of the Gomel region, and six districts of the Mogilyov region (Bykhovsky, Kostjukovichsky, Klimovichsky, Krasnopolsky, Slavgorodsky, Cherikovsky), which have most suffered and where there was a necessity in resettlement.

In activity with archeological monuments, a basic direction of the activity - the research of their condition, precise fixing on terrain and topographic maps. As a result of archeological expeditions, the total research of Bykhovsky, Kostjukovichsky, Klimovichsky, Krasnopolsky and Slavgorodsky districts was conducted for fixing and detection of new archaeological monuments. Dozens of new monuments, which have been not registered in the official state registry, were detected, the scientific - reference manuals were published. The activity on warning of possible destruction of monuments during forest planting, agricultural, building and others land arranging measures was conducted. The documentation about monuments with the guidelines on their preservation was sent in district government bodies. With each year, the monuments grow with bushes and become hardly accessible to research. However, fixed on topography, they serve a material for subsequent investigation phases, considerably supplementing an archeological map of Belarus and enlarging notions about a history of our state.

The similar activity on fixing, development of the projects of the guarded zones, was conducted concerning monuments of the architecture of districts of the Gomel region. The condition of a monument of wood architecture of the XIX century - a church in the village of Vylevo of Dobrushsky district of the Gomel region - was studied, the project of its restoration, in view of its possible transfer to Terekhovka town settlement was compounded. The projects of schematic measurement plans of monuments of wood architecture in the village of Doudichy of Chechersky district, in the village of Krupets of Dobrushsky district, in in the village of Kouleshovka of Klimovichsky district, in the in the village of Gavrilenka and in the village of Kanichi of Kostjukovichsky district, were executed. Activities on preservation of monuments in a zone of resettlement, in particular, of the church in the village of Samotevichy of Kostjukovichsky district, palace and park ensemble in the village of

Demjanky of Dobrushsky district, practically were not started. Monuments in a zone of residing are in the better situation there. The church in the town of Slavgorod, the town hall in the town of Chechersk, were restored at the expense of state grantings and means of the local budget. The monuments in the village of Miloslavichy and in the village of Zabycannje of Klimovichsky district, in the Borisovshtchina village of Khojniksky region, the castle and synagogue in the town of Bykhov, the palace and park ensemble in the town of Narovlja, require urgent help. Since 1991, at participation of institutes of linguistics, art criticism, ethnography and folklore of the National Academy of Sciences of Belarus, the scientific program on research and fixing of folklore - ethnographic heritage in the suffered districts, features of the language and spiritual culture of the population of Polesje area, have been implemented. As a result of folklore ethnographic and linguistic expeditions, 3,5 thousand products of oral national creativity have been fixed and prepared for printing, the scientific collection " The Chernobyl people speak " has been published, about 2000 valuable subjects of art and national culture have been collected in the zone of relocation, their decontamination and placement in the Chernobyl department of a Museum of ancient Byelorussian culture of the NAS of Belarus have been conducted. For 5 years of activity of expedition, the considerable ethnographic fund of monuments, reflecting the centuries-old Eastern Slavonic tradition, has been accumulated, moreover, together with archeological discoveries, this collection can pretend for development of a new concept of the process of formation of an ethnos in an aspect angle of the today's status of our independent state. The data bank, compounded for the elapsed period in respect of monuments of a Chernobyl zone, testifies about the existence here of the richest layer of traditional national culture and confirms a hypothesis about its remote roots.

Photo 5. The symbol of Polesje - a stork, the bird of hope.

Conclusions

The totals of implementation of the state programs demonstrate, that the problem of overcoming of consequences of the Chernobyl disaster is of objectively long - term nature, and there is not enough means, allocated from the republican budget, for its solution in the near future. On overcoming of damage, estimated in 32 average annual budgets, about one and a half was directed for last ten years. The overseen tendency of a decrease of volumes of financing reduces capabilities of realization of protective and rehabilitational measures.

Meanwhile, recently such radioecological problems, as increase of movability of strontium - 90, transition of plutonium - 241 in americium - 241, having large radiological hazard, disintegration of "ardent" fragments with a liberation of energy of radionuclides joining in food chains, have begun to be exhibited. For all that, about 70 % of a collective dose is reshaped at the expense of the entry of radionuclides in an organism with food. There is still an acute problem of obtaining of "clean" foodstuff in personal subsidiary farms of the Gomel, Mogilyov and Brest regions, where the excess of radionuclides is permanently determined in samples of milk and milk products, meat, vegetables, potatoes. All this, in its turn, leads to additional doses of internal irradiation.

The doses received by the population, alongside with a psychological stress and other unfavorable kinds of the effect, determine an aggravation of symptoms of health of the population of damaged regions, specially of children. As the outcomes of researches demonstrate, the long - lived radiactive irradiation by small doses increases the sensitivity of an organism to the impact of other unfavorable factors (lead, nitrates etc.). For all that, all people living on the contaminated territories are themselves a group of heightened risk apart from " liquidators " and the evacuated population.

It is asserted by some researchers, that the radiation dose obtained by an organism during a long - lived period of time, results in essentially more strong destruction, than the same dose obtained for a shorter period (the so-called Petko effect).

It is necessary to note, that it was traditionally accepted to attribute radiation - induced oncologic diseases in the main radiological medical consequences. However, during the last years ever more data occur about the radiation conditionality of a lot of not oncologic diseases. The numerous data testify on grave infringements of a condition of health for the liquidators the evacuated persons and people living in contaminated territories. For all that, the increase of parameters of a morbidity is being marked practically on all main classes of illnesses of the systems of blood circulation, breathing, digestion, endocrine, nervous, genitourinary and other systems.

The authentic establishment of interrelation between the radiation factor, radiation dose and morbidity is extremely difficult. The unprecedented growth of cases of a morbidity of a thyroid gland for children of Belarus testifies that our knowledge of possible radiological consequences of nuclear damages is insufficient. Thus the World health organization has recognized the presence of the radiation conditioned pathology concerning a thyroid gland cancer in Belarus only in November, 1995. On an example of a thyroid gland cancer it became clear, that the hazards of originating of illnesses and a death rate at the radiation impact are undervalued, specially at a chronic exposure in small doses. By modern estimations, the latent period for the development of radiation - induced malignant neoplasms makes approximately 10 years. It means, that after 1996, the population of our country, which has exposed to radioactive irradiation in outcome of the Chernobyl emergency, has entered a period of more intensive development of negative consequences of irradiation. It's vague still, how much time it is required to prove a radiation genesis of diverse pathologies, and also to conduct an impartial assessment of risk factors probably irrelevant directly with a radiation

 effect. But if we continue to passively wait, losing precious time, the health of many generations can appear under threat.

The realities of life speak about the necessity of strengthening of scientific maintenance of rehabilitational measures and the development of new perspective directions and approaches. Chronic insufficient financing requires developing of a legible prioritization, models of effective concentration of resources. A fundamental problem is the usage of Chernobyl experience with the purpose of definition of factors of radiation risk in the area of " small doses " for acceptance of the optimal administrative solutions, aimed at the minimization of medical consequences of the disaster.

Estimations of the Chernobyl disaster are rather ambiguous till now as for us in the country, and abroad. International experts frequently esteem the Chernobyl disaster only from the point of view of the radiation factor, indicating on mismatch of dose loads to adopted levels of interference. The Chernobyl problem is much more complicated. It is impossible to underrate its economical, social and humanitarian aspects, specially on a background of difficulties of transition of Belarus to market economy.

The report of Scientific committee of the United Nations on operating nuclear irradiation to the General assembly of the United Nations, favoured in May this year, on 49-th session of SCDAR, namely appendix J " Levels of irradiation and consequences of the Chernobyl emergency ", serves as a vivid example of the prejudiced attitude to consequences of the Chernobyl disaster. Grounded on the arbitrary selected data, on the separate publications, which in their number practically did not include activities of the Byelorussian scientists, the report treats the after - Chernobyl situation in three damaged states incompletely and pretentiously.

Unfortunately, many attempted and attempt to unscrpulously acquire to themselves both political and financial capital on a human trouble. We stand for the objectivity, but against false sensations, for the comprehensive scientific analysis, but against thoughtless expenditure of money under the aegis of " science vividness ". Many approaches have already been revised, still a lot should be reconsidered. Nobody is insured from errors, and we together study to correct them. It is possible to guess, that the descendants will attribute our errors with comprehension and will not forgive only one - inattention and inactivity.