CHAPTER 5
DECONTAMINATION
THE MAINTENANCE OF ALIENATION AND SETTLING OUT ZONES

5.1. Decontamination

In the period 1986 - 1989 after the catastrophe the mass decontamination of the settlements on the contaminated Belarussian territories was carried out by special divisions of engineering troops and civil defense. Outside the 30 km zone about 500 settlements were decontaminated, moreover, 60 % of them - 2-3 times. That work included removal of contaminated ground and re-filling by clean ground, dismantling of contaminated installations not being subjected to clean up, asphalting of streets, ways, sidewalks, replacement of roofing. $7,3*10^6$ m^3 of soil was removed and buried, $1,57*10^6$ m^3 of clean ground was re-filled.

As a result, it became possible to achieve some improvement of radiation situation. However, the full decontamination of the settlements, agricultural and industrial objects to create normal life conditions appeared to be unreal because of the fact that necessary scales of work exceeded the possibility of their realization. Since 1989 the scales of decontamination were reduced and the main protection measure was resettlement.

At present, the limited decontamination work on the most important installations of life sustenance and their territories is being implemented.

In first place such socially important installations as children's pre-school institutions, schools, medical and rehabilitation establishments, rest zones and places of people's mass stay, enterprises belonging to the food-processing industry and other industrial installations, local spots of abnormally high contamination in people's residing places are to be decontaminated.

The criteria for intervention are "Temporary control levels of radioactive contamination for adopting decisions on decontamination works", coordinated by the National commission on radiation protection and confirmed by the Chief state sanitary doctor of the Republic of Belarus.

In 1991-1995 the clean up of territories of more than 150 installations (the clean up area amounts to 450 thousand m^2) was carried out and 480 more installations (including industrial enterprise territories) were shown to be subject to decontamination (not taking into account individual farms). The clean up of 390 ventilation systems at 21 enterprises was conducted. Not less than 1300 units of the industrial equipment were discovered to be subject to decontamination. It is planned up to 2000 to complete mainly decontamination of socially important installations, industrial equipment and to begin decontaminating individual farms.

The important directions of work are: prevention of unsanctioned exportation of contaminated materials from the alienated territories, reduction of fire hazard, and radionuclides transition connected to fires, demolition, concealment of buildings in the zones with Cs-137 contamination density over 555 kBq/m^2. For the years 1991-1995 68 settlements have been demolished and about 11 thousand individual farms are subjected to concealment. At the same time the processing and the subsequent use of materials and building constructions with strict radiation control is foreseen.

The normative documents worked out earlier in the USSR for regulation of works with radioactively contaminated waste could not cover all the specificity of problems connected to usage of the decontamination waste of Chernobyl origin. For the purpose of formation of the state normative-legislative base for enterprises dealing with decontamination works and han-

dling the decontamination waste in 1992-1995 on the basis of the national and international experience the complex of normative and organizational-methodical documents (sanitary rules, regulations, methods, instructions) was developed.

In Belarus before the accident there was no industrial base for handling the decontamination waste. There was only one place for radioactively contaminated waste concealment that due to its small volume and placement could not be used for the placement of waste of Chernobyl origin. At present in Belarus on the contaminated areas there is a network of points of decontamination waste concealment. The exploratory works have been carried out, recommendations for the placement of fields for radioactively contaminated waste concealment have been worked out.

With decontamination of installations and demolition of buildings about 26 thousand tons of hard waste is formed per year that require concealment in special storage pits. Besides, with decontamination of industrial equipment up to 20 tons of liquid radioactive waste is formed annually that require processing and subsequent immobilization of the hard residue. To that it is necessary to add the considerable amount of decontamination waste and life activity waste with lower contamination level that was established for hard radioactive waste because they may be dangerous for people and environment due to the large volumes of their accumulation.

Annually on the territory with Cs-137 contamination level over 37 kBq/m^2 in the result of the use of local types of fuel 18 thousand tons of ashes are formed, 12 % of which have Cs-137 contamination level from 970 to 9700 Bq/kg, and 75 % - over 9700 Bq/kg reaching in some cases 500 kBq/kg.

On the sewage installations of the settlements situated on the territories with contamination density over 185 kBq/m^2 more than 30 thousand cubic meters of sewage sediments are formed annually, the level of Cs-137 contamination of which reaches 27-60 kBq/kg. Incidentally, the summarized content of radiocaesium mobile forms in sewage waters makes up 20-45 % that approximately is much higher than in soil.

The high mobility of Cs-137 in sewage waters sediments formed on the contaminated territory may lead to the secondary contamination of environment. The estimation of migration processes in the places of accumulation of radioactive sewage sediments (silt sites, filtration fields, bioponds) shows that radiocaesium can reach subsoil water in concentrations exceeding permissible level for drinking water. According to forecasting estimations this can happen on the filtration fields with sandy beds - in 14 years, in bioponds with the soil protection layer depth up to the level of subsoil waters of 6m - in 30 years, and on the silt sites with natural bottom - in 8 years. Thus, in the places of radioactive sediments of sewage waters accumulation there exists a real danger of subsoil waters contamination in the nearest future.

Due to the absence of the acceptable technological solutions and lack of financing the problems of insulation of the mentioned wastes have not been solved till the present time.

The final stage of the radionuclides contaminated waste handling is their reliable insulation. It is accepted that depending on the activity the concealment must be carried out : in the points of concealment, points of concealment of decontamination waste and materials radioactively contaminated in the result of the Chernobyl NPP catastrophe and places of concealment of the demolition buildings and installations waste on the settled out territories.

At present on the territory of the resettlement zone there are 7 (in Gomel and Mogilev regions) acting points of concealment of decontamination waste done according to the typical projects the volume of each makes up 30-50 thousand m^3. In Brest region due to the absence of the points of concealment 10,4 thousand m^3 decontamination waste are kept on the temporary sites and must be removed to the points of concealment of decontamination waste. Their

construction is conducted in Stolin district and is planned in Luninets district. The unfilled volumes of the points of concealment of decontamination waste make up about 120 thousand m^3 that can provide decontamination works within 1,5-2 years. For decontamination waste concealment for the following period it will be necessary to commission some more points of decontamination waste concealment with the volume up to 120 thousand m^3 that will require additional considerable expenditures.

The serious problem is providing safety of the points of concealment formed in 1986-1989. Their creation was carried out in extreme conditions of the Chernobyl catastrophe consequences without the detailed account of the hydrogeological consequences. The majority of points of concealment do not have engineering protection barriers, some part of them is in the swamps water area, the Pripyat, Sozh and their tributaries bottom lands in places with the high level of subsoil waters standing. Many of them are thawed out periodically that represents potential ecological danger. On the territory of the republic there have been revealed 69 points of decontamination waste concealment, works have been done for their examination and certification. The top priority measures for safety of waste concealment in these points-their covering with a ground layer, fencing on a perimeter, placement of signs of radiation danger have been realized.

The analysis of forms of radionuclides state in the decontamination waste (Fig. 5.1.) has shown the considerable differences of correlation of water-soluble and exchange forms of Sr-90 for different zones of radionuclides fall-out. The tendency was revealed for increase of Sr-90 mobile forms s shares that can lead to the further growth of its migration to the subsoil waters. In this connection on the 11 concealment points that embrace practically all the spectrum of characteristic natural and construction-technological conditions of contamination waste keeping, in 1993-1994 there have been created the system of observation for the processes of radionuclides migration.

Incidentally, there has been registered the increased (10-15 times) Cs-137 and Sr-90 content in the subsoil waters and the protection ground layer under the bottom of concealment points in comparison with control measurements that testifies to the processes of radionuclides migration to the side of water-bearing horizon.

5.2. The maintenance of alienation and settling out zones

The formation of principles and strategy of the maintaining territories contaminated with radionuclides due to the Chernobyl NPP catastrophe, was carried out differentially for the two main regions - zone of alienation and zone of settling out.

The alienation zone is a compact region with an area of about 170 thousand ha. The residing population was evacuated during May, 1986. Since May 1986 the land of the alienation zone has been removed from economic turn-over. The Polessye State Radiational-Ecological Reservation has been established there. The main tasks of the Reservation are: realization of measures on prevention of radionuclides transition to the less contaminated areas, protection of forests from fire, the study the natural-plant complexes state and radiational-ecological monitoring.

The results of the observation allow to conclude that the radioecological situation in the given region is determined not only by the high Cs-137 and Sr-90 contamination density but by the presence of long-lived transuranium isotopes in the ecosystems. That is why the main ter-

ritory of the alienation zone can not be returned to the economic turn-over even in the remote perspective.

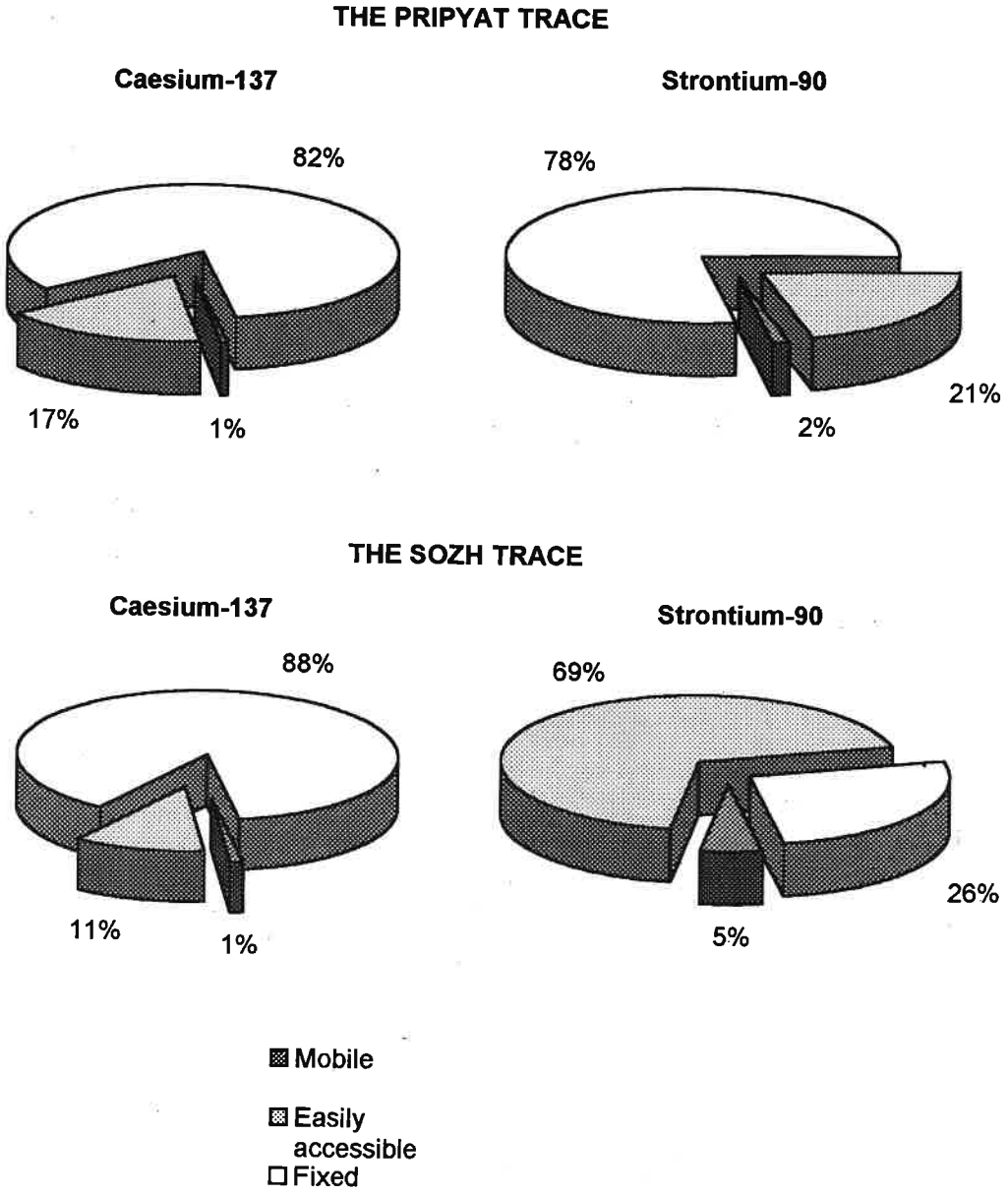

Fig. 5.1. The correlation of forms of radionuclides state in the decontamination waste

The modern state of ecosystems and economic infrastructure of the alienation zone as well as the zone of settling out, is characterized by the degradation processes of the former agricultural lands, meliorative systems, roads, recurring swamping of the territories, bushing of meadows and also by unsanctioned dismantling of buildings and installations. There are cases of unauthorized re-evacuation of the inhabitants and self-inhabiting of the left residential buildings by people, who did not live there earlier. In the forests and on water basins the cases of offendering have been cut short.

For the alienation territory "The concept of the maintaining of alienation and settling out zones" envisages the following activities: creation of scientific fields; control of water regime of the territories under the conditions of terminated use of meliorative systems; approbation of organizational and technical solutions on the economic activity restoration with the use as separate high fertility fields; organization and improvement of the system of counteraction activities as well as establishment of an effective fire service for forest and peatbogs fires; fulfillment of the work deforesting of lands subjected to water and wind erosion.

As opposed to the zone of alienation strictly limited economic activity is conducted on the territory of the zone of settling out connected to the maintaining in the working condition of roads, electric lines, and other objects that are of economic significance.

The agricultural lands of the settling out zone are characterized by heterogeneous soil cover and the fertility level from 16-30 to 55-60 points. The radionuclides soil contamination makes up from 37 to 1480-5400 kBq/m^2 on Cs-137 and from 11 to 222 kBq/m^2 on Sr-90. The plutonium isotopes content is relatively low and is concentrated in the part of the zone adhering to the Chernobyl NPP.

According to the radionuclides contamination density of agricultural lands there have been allocated three groups of lands. The first group is represented by 67 thousand ha of agricultural lands with Cs-137 contamination density less than 555 kBq/m^2 and Sr-90 - less than 74 kBq/m^2. The part of such lands with the prevalence of loamy and sandy loam soils may be included into the agricultural use on the first stage of rehabilitation.

The second group of about 50 thousand ha with Cs-137 contamination density of 555-1480 kBq/m^2 and Sr-90 of 74-111 kBq/m^2 also can be used in the agricultural production but will require large expenditures on reclamation and realization of other agrochemical measures. The lands of this group can be partially developed on the fist stage of rehabilitation for sowings of grain, rapes and feed crops for milk and meat production. The inclusion of the lands into the agricultural turn-over is possible only on the second stage of rehabilitation. Practically in the perspective it is possible to develop only that small part of the territory of settling out where it is necessary to maintain the housing facilities and production infrastructure. The rehabilitation of settled out territories requires state financing as in the first years the net cost of the agricultural production on the recultivated lands will considerably exceed the realization costs even on the soils with high fertility level.

Sandy and loose-sandy loamy soils with the quality index less than 30, lands requiring wood meliorative protection from water and wind erosion and also the lands of the third group with Cs-137 contamination density over 1480 kBq/m^2 and 111 kBq/m^2 on Sr-90 should not be planned for agricultural usage.

Low fertility lands of the settling out zone inadequate for agricultural production are given over to forestry enterprises and are subjected to afforestation.

One of the main problems of maintaining the zones of alienation and settling out is the struggle against forest fires. For this purpose the following measures have been realized: establishment of mineralized borders on quarter rides; plowing around the settled out villages on the perimeter; construction of fire prevention water basins; maintaining roads leading to the most fire dangerous sites of the zone in the working condition; flood of the part of peatmassifs; aviation and ground patrol; creation of fire-chemical stations.

The guarding -regime measures are carried out in the zones of alienation and primary and subsequent settling out (over 555 kBq/m^2) for the purpose of prevention of the unauthorized penetration of citizens, uncontrolled exportation of freights and also to provide the necessary sanitary and fire service state. Providing of these measures is realized by systematic patrol,

control-points functioning on the main cross-roads within the perimeter of the zone boundaries, application of guarding-regime installations and signs.

* * *

Thus, in Belarus there have been realized a large volume of works on decontamination, radioactive waste concealment and settlements accomplishment that made up the considerable part of expenditures on the overcoming of the catastrophe consequences. The crisis state of the economy at present does not allow to realize the protective measures at a full scale. However, decontamination of the settlements will be continued.

The main direction of work is the rehabilitation of the contaminated territories aimed at the gradual return of the population to the former way of life and economic activity. This concerns first of all, the territories where people live now. The process of rehabilitation will require not only new conceptual approaches and concrete solutions but the use of the positive from the accumulated experience as well. The increase of efficiency of decontamination measures requires the creation of improved technologies complex with regard to the whole cycle of handling the decontamination waste.

In the future special attention should be paid to the measures on providing safety for the points of decontamination waste keeping and continue the investigation of radionuclides migration to the subsoil waters for opportune undertaking of corresponding countermeasures up to repeated concealment.

At present the maintaining of the alienation zone territory is possible in the regime of reservation with realization of the necessary sanitary, fire-protection and other measures.

The restoration of the economic activity on the territory of the zones of primary and subsequent settling out requires profound scientific and methodical elaboration determining the priority directions of works in the concrete regions with regard to the whole complex of social and economic factors and optimization of actions according to the "profit - harm" principle.

For the improvement of the maintaining regime of the alienation and settling out the following main problems are being solved in the republic:

- Perfection of the protective-regime measures;
- Development of long-term strategy of rehabilitation of the contaminated territories;
- Perfection of legal base of the economic activity on the territory of the radioactively contaminated zones;
- Providing safety of the historic-architectural monuments, etc.