**Ministry of Russian Federation
on Civil Defence, Emergencies and Elimination
of Conseguences of Natural Disasters
(EMERCOM of Russia)**

CHERNOBYL ACCIDENT: TEN YEARS ON

Problems and Results of Elimination of the Conseguences of the Accident in Russia

Russian National Report

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S.K. Shoigu, Minister of Russian Federation on Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters

PREFACE

Ten years have past since the accident at the Chernobyl Nuclear Power Plant. From the very first day, this event drew the attention of the world community. The citizens of the USSR learned about it a few days later. Mass media gave a brief information only on April 28, 1986. The scale of thecatastrophe and measures taken for the elimination of the consequences

were partly secret, and on the whole hardly available for the population. Several years later, an avalanche of alarming information about the consequences of the accident fell on the population. In 1991, a Law of the Russian Federation "On the Social Protection of the Population Affected by Radiation Resulted from the Accident at the Chernobyl NPP" was adopted, and a special body of state control, the State Committee, now transformed into EMERCOM of Russia, was organized. On the basis of the Law, the State Program on Protection of the Population of the Russian Federation against the Impact of the Consequences of the Chernobyl Catastrophe for 1992 to 1995 and for the interval up to 2000 was developed. In addition, two special programs are implemented: "Children of Chernobyl" and "Dwelling for Liquidators"

The State Program incorporates a wide range of measures for the social protection of the affected population, development of health services on the contaminated territories and providing special medical aid, environmental monitoring and exposure doses, activities for reducing radiation commitments, including measures taken in farming and forestry, sanitary restrictions, social and psychological and economic rehabilitation of the population and territories.

Since 1994, the Government of the Russian Federation charged the EMERCOM of Russia with coordination of activities on overcoming the consequences of the Chernobyl Accident. The following bodies take part in the implementation of the State Program: Ministry of Health and Ministry of Agriculture, the State Committee on Sanitary and Epidemiological Surveillance, Federal Service of Russia on Forest Economy, the Russian Federal Service for Hydrometeorology and Environmental Monitoring, Ministry of Education, and others. Partly, this work is carried out by the local administration at the expense of the State program.Inspite of the difficult economic situation, the Russian Government allocated large funds. In 1992–1995, the Government spent 9 trillion roubles for the works on overcoming the consequences of the accident, and, in accordance with the Law, 5 trillion roubles were paid as compensations (the total sum exceeds 3 billion dollars).

During ten years, a lot of events took place. Unfortunately, fatal natural and man-made disasters, like earthquakes in Armenia and Neftegorsk, and During ten years, a lot of events took place. Unfortunately, fatal natural and man-made disasters, like earthquakes in Armenia and Neftegorsk, and the railway crash near Ufa, took lives of dozens of thousand people. But unlike other emergency situations, the problem of the Chernobyl people — "liquidators", evacuated and resettled population, and the residents of the contaminated territories — became a part of our life.

The topic of this official report of EMERCOM of Russia prepared by the leading Russian experts is the assessment of the consequences of the Chernobyl Catastrophe ten years later, what has been done during these years, our understanding of the modern situation and further prospects for overcoming the consequences of the Chernobyl Catastrophe.

Minister of the EMERCOM of Russia S.K. Shoigu

INTRODUCTION

The accident at the Chernobyl nuclear power plant occurred on April 26, 1986 was a major technogeneous and humanitarian catastrophe of the Twentieth century. Radioactive contamination affected the territories of 19 subjects of the Russian Federation1 with a total population of over 30 million people. The area of these territories contaminated with Cs-137 densities above 37 kBq m-2 was more than 56 thousand km2 (Fig. 1), about 3 million people live in the contamination zone.

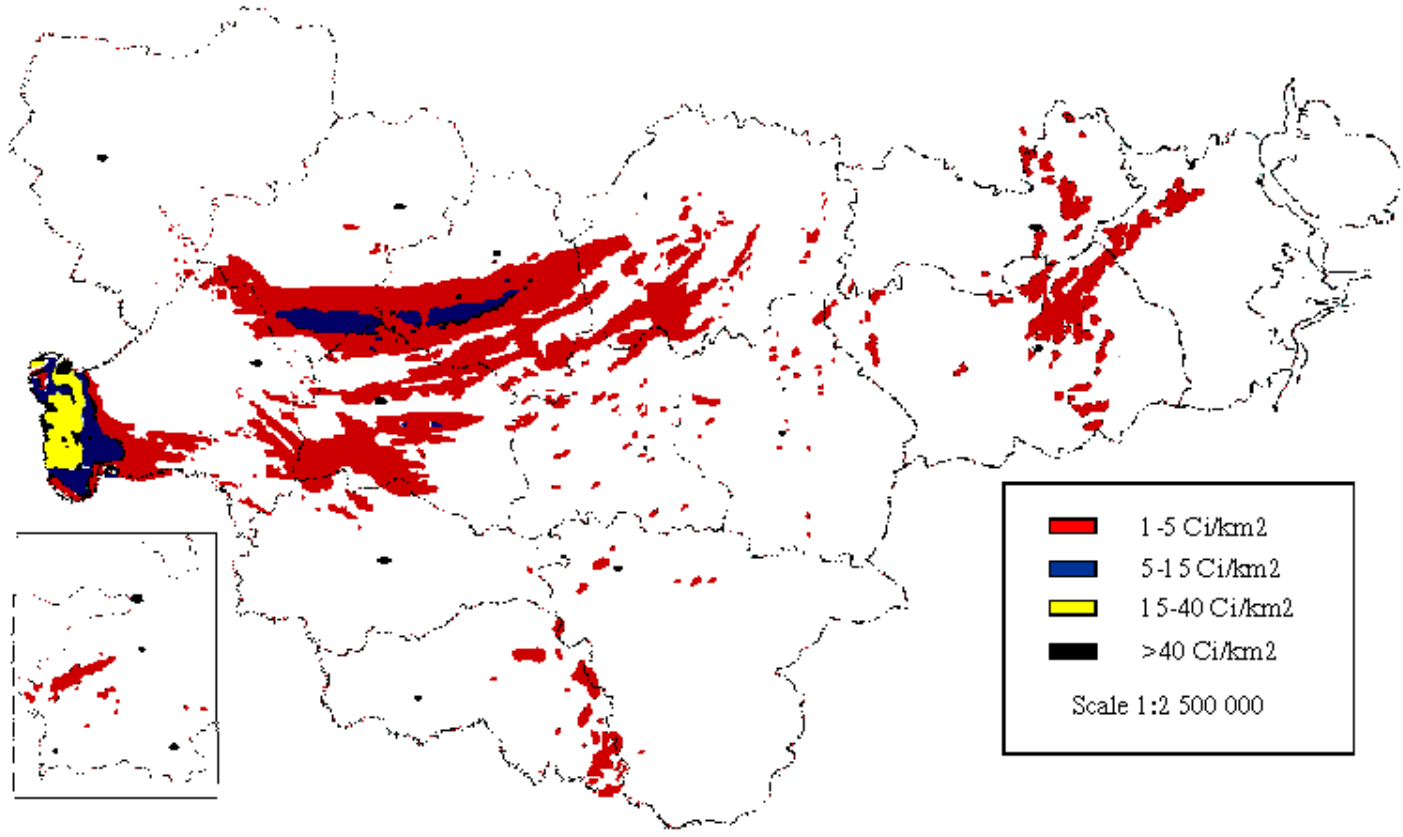

Fig. 1. Map of caesium-137 contamination density with the margin > 1 Ci/km2 of the territory of the European part of Russia

Radiation monitoring of the territories started from the very first day after the accident. The first maps of radioactive contamination were obtained by May 10 (I-131, Cs-137). Over 6 million square kilometres have been examined. Aerial gamma-radiation surveys and ground investigations have allowed to prepare and publish contamination maps of the European part of Russia contaminated with Cs-137, Sr-90, and Pu-239 (1:500,000 scale) and Cs-137 (1:2,500,000 scale). By now, information on radioactive contamination levels in more than 12,000 settlements located in 23 administrative subjects of the Russian Federation is available.

Immediately after the accident, hundreds of thousands of citizens of the USSR were involved in emergency actions and clean-up operations, including 200,000 people from Russia.

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1. RETROSPECTIVE OF PROTECTIVE AND REHABILITATION MEASURES

1.1. Strategy of Post-Accident Activities

In 1986–1988. Measures for the radiation protection of the population were taken as soon as contaminated sites were revealed. They included various restrictions, clean-up operations, resettlement of residents. When more accurate information on the radiation situation was obtained, the zone of control was extended and the scale of countermeasures was increased (see Table 1). At the initial stage, the major activities were carried out in the so-called "zone of stringent control" limited by an isoline of 555 kBq·m-2 (about 100,000 inhabitants). It was believed that, with such a zone boundary, the dose limit of 100 mSv would not be exceeded during the first year. Later the following restrictions upon admissible doses of exposure to population were accepted: 30 mSv for the 2nd year and 25 mSv for the 3rd one. They provided a significant reduction in doses of exposure to population but disturbed the habitual way of life.

Table 1.

Dates of intervention decisions and types of criteria used

	Date	Criteria	Population or territories affected
1.	06 May 86	I(131) in foodstuff	~150 ths people
2.	12 May 86	100 mSv/year	~100 ths people
3.	15 May 86	Dose rate (1,3,5,20 mP/hour)	<100 ths people
4.	16 May 86	Total activity in foodstuff	<100 ths people
5.	30 May 86	Total activity in foodstuff	2 m. people
6.	30 May 86	Dose rate and concentration in foodstuff	<700 ths sg.km
7.	12 Jun 86	Dose rate	<50 ths people
8.	22 Aug 86a	Cs(137) in the soil	0.2 ths people
9.	22 Aug 86a	Cs(137) in the soil (15 Ci/km2)	78.7 ths people
10.	24 Oct 86	Dose rate and surface contamination	<50 ths people
11.	23 Apr 87	30 mSv/year	78.7 ths people
12.	29 Jul 87	Dose rate and surface contamination	<50 ths people
13.	12 Aug 87	Cs(137) in the soil and social factors(15 Ci/km2)	+17.9 ths people
14.	15 Dec 87	Cs(134) Cs(137) in foodstuffs	1.5 m. people

15.	23 May 88	Cs(134) è Cs(137) in the soil andfoodstuffs	10 ths sg.km
16.	18 Jul 88	25 mSv/year	96 ths people
17.	19 Jul 88	Dose rate and surface contamination	<50 ths people
18.	13 Sep 88	Cs(137) in the soil and social factors(15 Ci/km2)	+6.0 ths people
19.	06 Oct 88	Cs(134) Cs(137) in foodstuffs	2 m. people
20.	22 Nov 88	350 mSv	
21.	24 May 89 è 05 Oct 89	350 mSv	4.7 ths people
22.	20 Oct 89	AD	100 ths people
23.	30 Dec 89	Cs in the soil(15 Ci/km2) and social factors	+0.7 ths people
24.	26 Jan 90	Cs in the milk	200 ths people
25.	16 Mar 90	350 mSv	+2.3 ths people
26.	11 May 90	part/min cm2	>10 ths people
27.	28 Sep 90	Cs in the soil 1,5,10,15,30 Ci/km2	259.6 ths people
28.	22 Jan 91	Cs(137) in foodstuffs	3 m. people
29.	11 Mar 91	Cs in the milk	+75 ths people
30.	19 Feb 91	Cs(134) and Cs(137) in the soil and foodstuffs	35 ths sg.km
31.	08 Apr 91	1 and 5 mSv/year	
32.	15 May 91	Cs in the soil 1,5,10,15,40 Ci/km2,LAD	
33.	28 Dec 91	Cs in the soil and social factors(	2.3 m. people
34.	25 Feb 92	Cs in the soil and social factors(	+0.2 m. people
35.	18 Jun 92	Cs in the soil, LAD	
36.	01 Oct 92	AD see 33 and 34 (State program)	3 m. people
37.	25 Dec 92	AD see 33 and 34 (Territory)	8 ths sg.km
38.	05 Apr 92	Cs in the soil and social factors(	+0.1 m. people
39.	21 Jul 93	Cs(137) in foodstuffs	3 m. people
40.	25 Apr 95	Cs in the soil and social factors(	+70 ths people
41.	17 Jul 95	1,5,20 mSv/year	~50-100 ths people

Sanitary restriction on doses (annual and during the life time), content of radioactive materials in ffoodstuff, contamination of surfaces and territories

Departmental recommendations and instructions for farming and forestry

Administrative(Govermental) decisions on lists of localities, where the measures were taken, including State programs

Legislative decisions on the population protection

Scientific concept on the population protection

In 1988–1990. Some changes in the society and understanding of the negative effect of numerous restrictions upon vital activities of residents of contaminated areas induced an attempt of passing to the period of rehabilitation on the basis of total lifetime extra dose limit equal to 350 mSv. This concept gave rise to a sharp discussion in such a dynamically changing society as the Soviet Union of that period. So the USSR Government was forced to appeal to the IAEA to organise an independent examination. The results of the International Chernobyl Project that confirmed the sufficiency of protective measures being taken could not change the tendency towards the aggravation of the situation. Responsible organizations (NCRP USSR, WHO, the IAEA, and others) focused on radiological problems and could not properly assess social social, psycological, and political factors.

At the beginning of 1991, a new concept of living in contaminated territories was accepted that established the new intervention level, namely, extra exposure dose above 1 mSv/year. It was used in the Law of the Russian Federation "On the Social Protection of the Population Affected by Radiation Resulted from the Accident at the Chernobyl NPP" adopted in 1991. The law which is still in force (though it has been slightly modified) defines the privileges and compensations on the basis of the concept of zoning territories in accordance with the contamination level. Under intense political pressure, the zoning concept was supplemented, along with the dose criterion, with an extra one, namely, the density of soil contamination with Cs- 137. An isoline of 37 kBq·m-2 was taken as the lower limit defining the boundaries of contaminated zones.

So, the measures implemented during the first years after the accident were primarily protective in nature and oriented mostly to prevention of extra exposure of the population. The experience of those years demonstrated that efficient measures for alleviation of Chernobyl catastrophe effects could be realised with the proviso that the complete set of the problems of contaminated regions, including investment, ecological, economic, and other problems would be considered at the state level. The first attempt of that kind made in 1988 was a program of work in the Bryansk Region. In 1990, the State Program, incorporating some urgent measures for the years 1990–1992, was adopted. The law passed in 1991 forced some amendments to the Program. Since 1992, the work has been performed pursuant to "The Unified State Program on Protection of the Population of the Russian Federation against Consequences of the Chernobyl Catastrophe for Years 1992–1995 and for the Period up to the Year 2000". Additionally, a number of special programs (e.g., "Children of Chernobyl" and "Dwelling for Liquidators") are being realised. Within a number of tasks on population protection and rehabilitation of territories, the program is being realised differently in various contaminated zones (see Table 2).

Table 2.

Restrictive zoning of Russia territories contaminated due to Chernobyl accident, in accordence with the Law of the RF

Residence zone with privileged social-	Zone of residence with the right to leave	Resettlement zone. (Territories outside	30-km zone (territories, from

economic status (Territories outside the 30-km zone, resettlement zone, and zone of residence with the right to leave). Density of soil contamination with caesium is 37 to 185 kBg/m2		(Territories outside the 30-km zone, resettlement zone). Density of soil contamination with caesium is 185 to 555 kBg/m2		the 30-km zone). Density of soil contamination with caesium is more than 555 kBg/m2		which the population was evacuated or resettled). Density of soil contamination with caesium is more than 555 kBg/m2	
localities	inhabit., thous	localities	inhabit., thous	localities	inhabit., thous	localities	inhabit., thous
6594	2249	802	347	279	91	17	-

The State Program is aimed at reduction of negative medical, social, and psychological effects down to minimum possible level on the basis of general rise in life standards, leading development of the network of public health institutions, improvement of the ecological situation in general, andcompensation of economic damage (see Fig. 2).

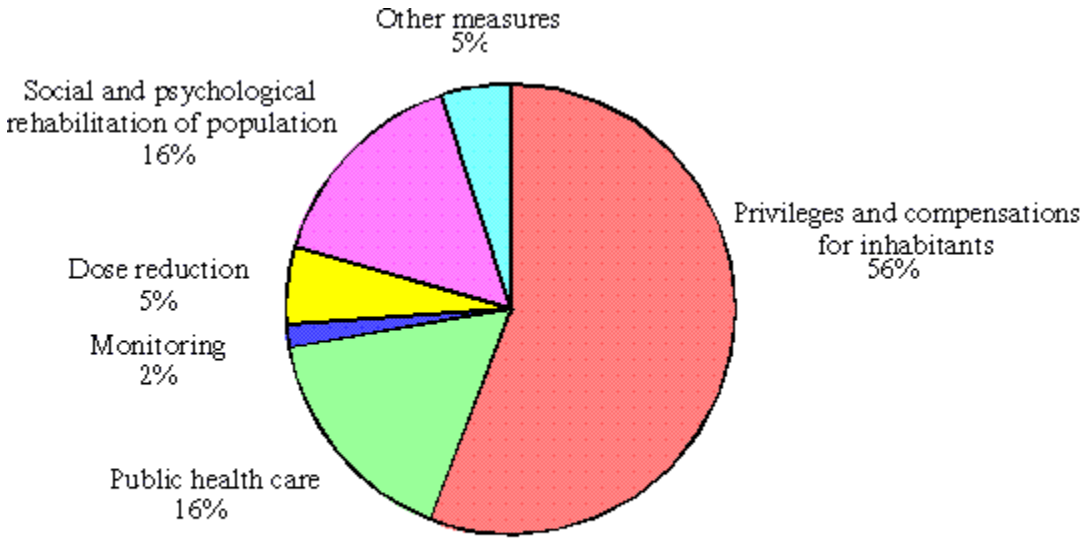

Fig. 2. Structure of expenses for the State Program in 1992-1995 (actually spent over 14 trillion roubles in prices as of 1995)

Co-ordination of work on overcoming the Chernobyl accident consequences is currently entrusted to the Ministry of Russian Federation for Civil Defence, Emergencies, and Elimination of Consequences of Natural Disasters. The following institutions are also involved: the Ministry of Health, the Ministry of Agriculture, the State Committee on Sanitary and Epidemiological Surveillance, the Federal Service on Forest Economy, the Russian Federal Service for Hydrometeorology and Environmental Monitoring, the Ministry of Education and other departments. A certain part of the work is performed directly by local authorities at the expense of the State Program resources.

1.2. Measures for Reducing Population Exposure Doses in 1986-1995

From the very first days of the Chernobyl accident, the following efforts to reduce population exposure doses were made: resettlement, decontamination and burial of radioactive waste, restriction of access and cessation of economic activity, special measures in agriculture and forest economy, restriction of consumption of contaminated foodstuffs, etc.

A farmer from Uvel'e wrote on the gate of his home before leaving for the Kaluga region: "Forgive us, Paternal Home, for leaing you!"

Resettlement. At the initial stage, decisions on countermeasures were made primarily on the basis of precluding acute radiation impact on the population and doses in excess over the limits in force. In conformity with the mentioned criteria, mass evacuation in the Russian territory was not performed, though 4 inhabited localities (186 inhabitants) were resettled in the autumn of 1986. The measures for preclusion of thyroid overexposure (including iodine prophylaxis) turned out to be of low efficiency because of untimely accomplishment.

Large-scale resettlement of the population from the Bryansk Region of the Russian Federation started in 1989 in view of the predicted exceeding of the total lifetime dose and later this measure was applied to inhabitants of the resettlement zone. For a certain part of the this zone, the notion of obligatory resettlement was introduced. Additionally, the right of voluntary departure was granted to inhabitants of the so-called “residence zone with right to leave” (contamination with Cs-137 above 185 kBq·m-2). As a result of these measures, nearly 50,000 people were resettled or voluntarily left contaminated territories in Russia (see Fig. 3). Some part of the population refused to leave their homes.

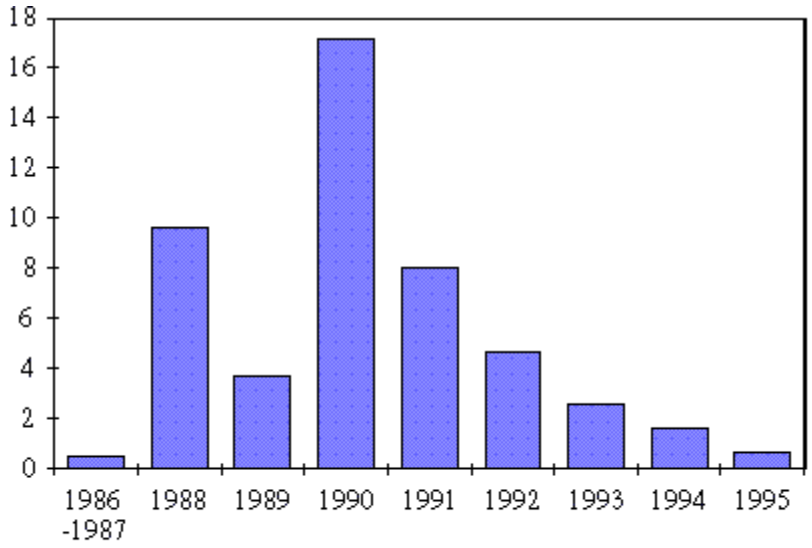

Fig. 3. Variation in resettlement of population from the localities in the Bryansk Region, suffered from the radioactive contamination, thousands of people

The decisions on resettlement were made under intense pressure of public opinion and legislative bodies. From today's viewpoint one can affirm that under conditions when resettlement could not be avoided because of social and psychological reasons, it would be worthwhile just to provide people with opportunities to leave contaminated territories.

Decontamination of territories, buildings, and structures and burial of waste. The work started at the end of May, 1986. It involved subdivisions of chemical troops of Ministry of Defence of the USSR and those of civil defence. The work on decontamination was accomplished mainly within the "zone of stringent control" (contamination with Cs-137 was above 555 kBq·m-2). In total, 472 inhabited localities in western districts of the Bryansk Region have been decontaminated since the accident. At 50 localities, decontamination was performed twice and at 6, thrice. Dozens of thousand cubic meters of ground and other waste have been buried. As a rule, the burial was effected in special trenches with clay "cut-offs" and a clay bed beyond natural low places. Places with low level of ground waters were chosen for such burials.

In 1986–1987, decontamination enabled improvement of the radiation situation by multiple dose rate reduction in some frequently visited areas in contaminated inhabited localities. By 1989, complete decontamination had practically exhausted itself as a protective measure.

During 1990–1995 the character of work changed. Clean-up operations were carried out in local areas in settlements, farms, production sites. These operatons were accompanied by construction of new temporary storage facilities and re-equipment of those constructed earlier, burial of objects of small economic value with high levels of radioactive contamination (or fire-hazardous, or presenting other kinds of danger).

Protective measures in agriculture and forest economy. Practically all known protective measures were used in the post-accident period. Incontaminated territories, some measures aimed at partial substitution of agricultural products and types of animal husbandry were taken.

Areas under a number of products were reduced, forestry was restricted, and sheep breeding was curtailed.

In 1986–1994, in the four most contaminated regions in Russia (Bryansk, Kaluga, Orel and Tula Regions) the liming of acid soils was performed over an area of 1,334.8 thousand ha, elevated doses of fertilisers were deposited over 1,526.5 thousand ha, significant improvement of meadows and pastures covered 130.9 thousand ha. The maximum volume of work was accomplished in the Bryansk Region. Practically everywhere, nourishment rations for domestic animals were determined on the basis of actual contamination of forage components. Since 1994, ferrocene-containing compounds allowing to reduce milk contamination by a factor of 2-4 have been widely adopted in the Bryansk Region as well as the final fattening of cattle with "clean" forage and monitoring of vital body content of Cs-137.

These measures allowed avoiding contamination of plant-growing production above the existing norms everywhere, except in the most contaminated areas in the Bryansk and Kaluga Regions. During a few past years, production of goods with elevated Cs-137 content has been practically terminated. In the south-west districts of the Bryansk Region, the excess over the existing norms in main kinds of the farming production has been reduced many times (see Fig. 4).

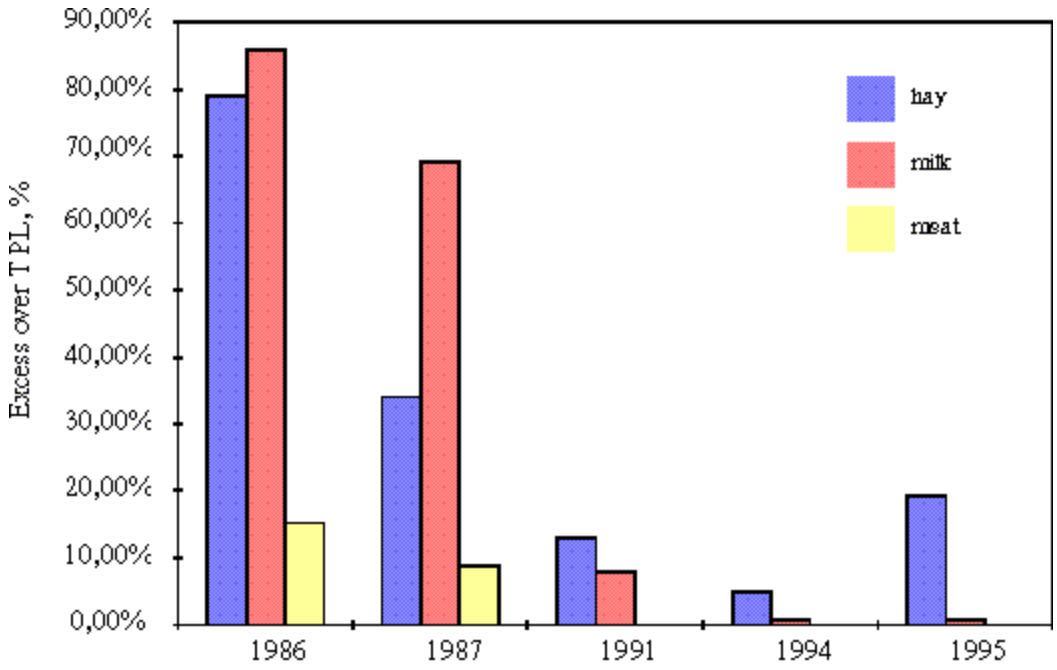

Fig. 4. Farming grading in the Bryansk Region (south-eastern districts)

Measures were developed and implemented to provide safety activities in agriculture and forestry, including means for personal protection and dosimetric control.

To restrict penetration of radionuclides into organisms of inhabitants, temporary permissible levels (TPLs) of content of radioactive substances infoodstuffs were introduced.

The practical implementation of such restrictions is related to the system of obligatory control effected by producers and sanitary services. Annual size of such control sampling amounts only in the Bryansk Region to 100,000 measurements). Any inhabitant can obtain information about the radionuclide content in foodstuff. If production does not correspond to the Temporal Permissible Level (see Fig. 5), it is reprocessed or recycled. Besides there are numerous restrictions on gathering mushrooms, berries, medicinal herbs, on hay procurement in forests, etc.

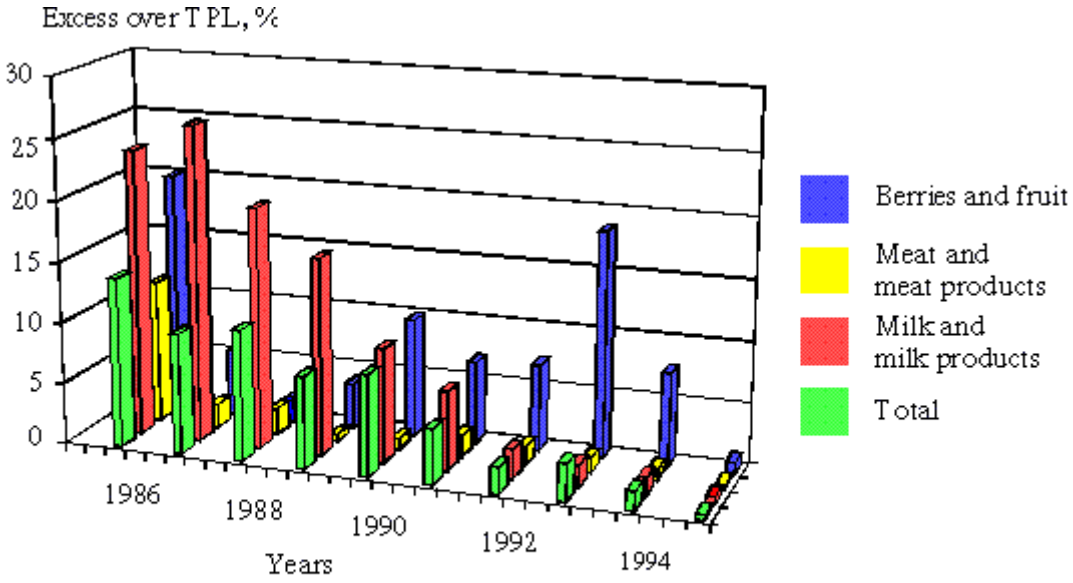

Fig. 5. Variation in the excess over temporary permissible level (TPL) for several kinds of farming production in the Bryansk Region

The efficiency of the set of restrictions turned out to be sufficiently high. In 1986, the average dose of internal exposure within the "zone of stringent control" (above 555 kBq m-2) did not exceed 15 mSv, in 1989 some doses of internal exposure to 95% of inhabitants of this zone were under 2.5 mSv and those in 1994, under 1 mSv.

For inhabitants involved in agriculture, recommendations on management of personal plots, procedures for reprocessing of production, mushrooms and berries, maintenance of domestic animals, hygienic measures were offered. In most contaminated regions, lime and potassium fertilisers were applied at personal plots. Local authorities were repeatedly recommended allocating cultivated pastures for pasturing private cattle. However, for a number of reasons, some of those recommendations were not implemented. As a result, milk, one of the principal ration components, was often contaminated above the existing norms. At present, ferrocene-containing compounds for cows are extensively applied as they are free of charge.

Measures on improvement of inhabited localities implemented in contaminated territories also add up to dose reduction. These were gasification, construction and improvement of roads, construction of projects of housing and communal services, improvement of streets and recreation zones, construction and repair of water supply and sewer systems.

Some other implemeted measures have resulted, directly or indirectly, in reduction of exposure doses or considered as protective ones by the public. Sanitation of children (e.g., organised trips to sanatoria and recreation camps) started in 1986, soon after the accident. People were paid numerous compensations and granted privileges. In contaminated regions, some measures to reduce exposure doses resulting from medical treatment of residents were taken. The implemented protective measures provided considerable reduction of exposure dose (see Fig. 6).

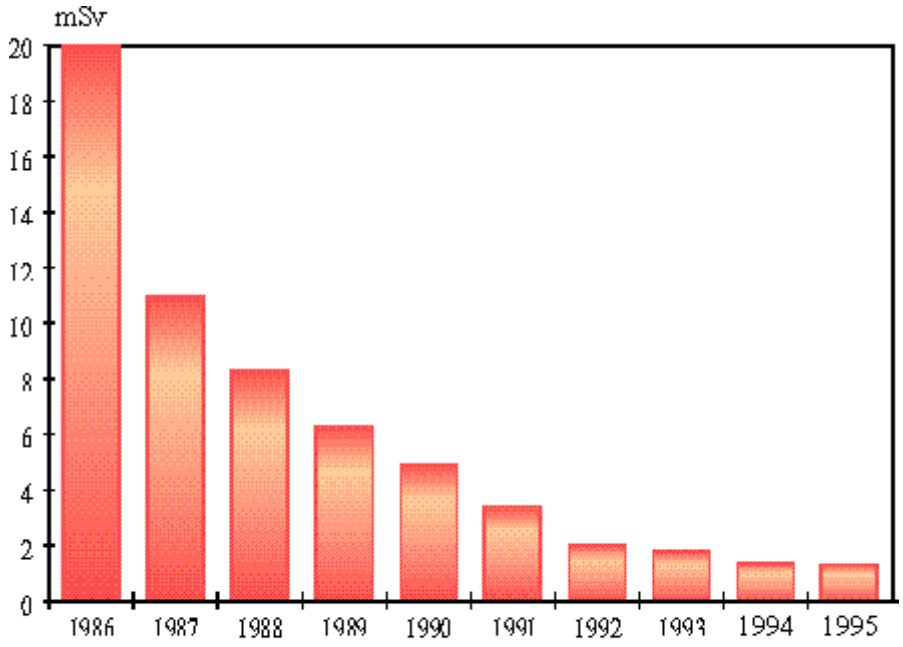

Fig. 6. Variation in the average annual exposure doses
for the population in the contaminated zone of 15 to 40 Ci/km2

1.3. Health Protection Measures

At the initial stage, primarily research medical programs or mass screening (condition of thyroids in children, etc.) were applied to the population in most contaminated territories. With time, even increasing attention was paid to development of local medical facilities and rendering specialised medical aid.

During the years following the accident, regional and local medical institutions were equipped with diagnostic apparatus and medicinal preparations or the budget resources for such purchases were provided. Some measures were taken to attract necessary medical personnel. During the period of 1992–1995, a number of hospitals (750 beds in total) and clinics (up to 4,585 visits per shift in total) were built and put into operation.

Much attention has been paid to protection of the health of those people who took part in emergency actions and clean-up operations (liquidators). The All-Russian Centre of Ecological Medicine has been created in St. Petersburg. It became the leading organisation rendering medical aid to the liquidators. The Centre is equipped with modern facilities and capable of rendering high-quality medical aid to more than 1,500 patients per year. In 1992–1995, over 8

thousand people were examined and treated at the Centre. Ten interdepartmental experts committees have been created that deal with issues of cause of illnesses, disability, and mortality of people exposed. Four centres for social and psychological rehabilitation were created in the Bryansk, Orel, and Tula Regions to render legal, social, and psychological aid to all age groups of suffered people.

To provide registration of people exposed in result of the Chernobyl accident, the Russian National Medical Dosimetric Register (RNMDR) (see Fig. 7) was created. The number of people registered in RNMDR is 435 thousands, including 152 thousand "liquidators". The fact of being included in the Register implies regular clinical examination. There are three levels of observation in RNMDR: the State level, Regional level, and District level.

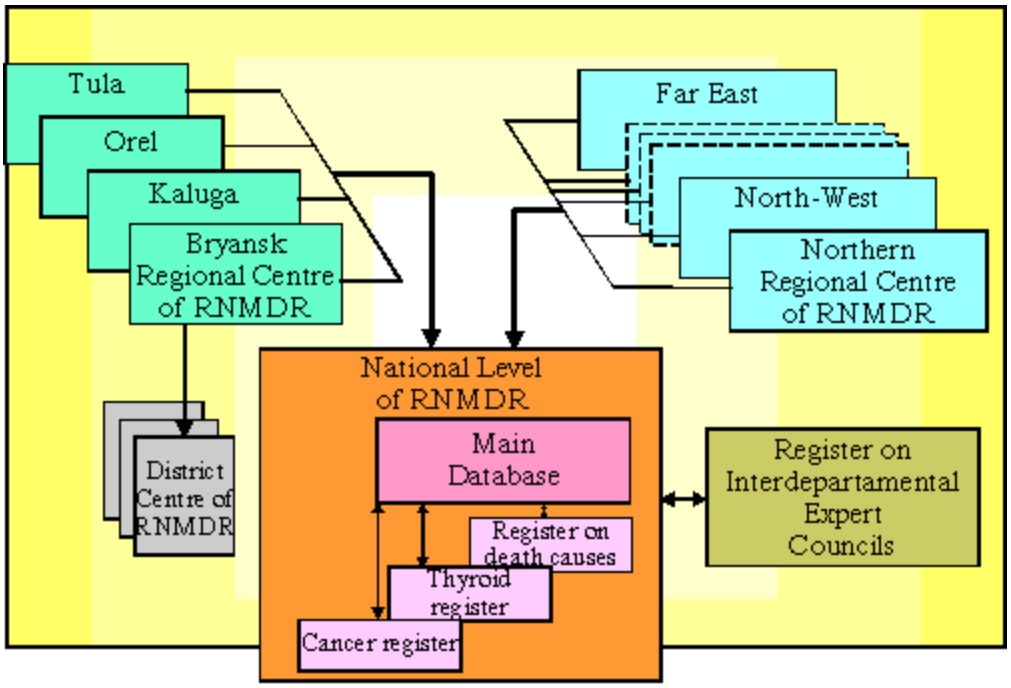

Fig. 7. Russian National Medical Dosimetric Register

In recent years, 25 leading specialised scientific research institutes pertaining to the RF Ministry of Health and Medical Industry and the Russian Academy of Medical Sciences have been involved in the medical observations.

For contaminated regions, special food programs are being conducted that envisage production of food with curative and radioprotective properties.

1.4. Social Protection of Population and Economic Rehabilitation of Territories

Since 1991, particular attention has been paid to social protection of people exposed and to economic rehabilitation of territories affected by the accident. "Liquidators" and the population of affected territories have been granted (though with zone differentiation) a wide set of privileges and compensations (free medicines, free medical aid, earlier retirement, annual paid

extra holiday, tax privileges, etc.). Additionally, a large volume of work on housing construction (over 2 million square meters). Projects in public health care, and social and industrial activities have been carried in contaminated territories.

In the period of 1992–1995, in contaminated regions houses of a total floor space of 1,200 thousand m2, general education schools for 15.5 thousand pupils, pre-school institutions for 3,000 children, club houses and recreation centres (3,500 places), gas pipelines (over 1,500 km), roads (over 500 km), were constructed.

Some economic privileges, including tax ones, have been granted to enterprises in the mentioned zones. A number of regions have been provided the possibility of obtaining credits on easy terms.

1.5. Scientific Support of the Work

Since 1986, hundreds of scientific institutions have been involved in research to overcome consequences of the Chernobyl accident. The scientific work was carried out and co-ordinated by the following scientific centers: Taifun PA, Institute of Applied Geophysics, and Institute of Global Climate and Ecology (environmental monitoring); Scientific Research Institute of Radiation Hygiene (St. Petersburg) and State Research Center "Institute of Biophysics" (assessments of radiation-hygienic situation and exposure doses for population); Medical Radiological Scientific Center of Russian Academy of Medical Sciences (health inspection of hundreds of thousand people included in the Register, All-Russian Scientific Research Institute of Agricultural Radiology and Agroecology (development of the scientific basis for agricultural and industrial production at the contaminated territories); Institute of Evolution Ecology and Morphology of Animals (radioecology problems); Russian Scientific Center "Kurchatov Institute" (physic, chemical, and technical consequences of the Accident and development of new monitoring facilities); Nuclear Safety Institute of Russian Academy of Sciences (problems of information and analytic support of the works); Institute of Economic of Russian Academy of Sciences and All-Russian Scientific Institute of Civil Defence and Emergencies (problems of economic rehabilitation). The solution of the scientific problems has resulted in development of numerous recommendations, technologies, devices, and facilities that have been used in the work on overcoming of accident consequences. A considerable part of the research efforts are to be continued. The Scientific Council of the Russian Academy of Sciences and EMERCOM of Russia on consequences of the Accident (headed by Prof. S.T. Belyaev, academician of RAS) and Russian Scientific Committee on Radiation Protection (headed by Prof. A.F. Tsyb, academician of RAMS) carry out the general co-ordination of works.

1.6. Measures Involving Other Countries and International Organisations

In the first years, overcoming of the Chernobyl catastrophe consequences was carried out by the Soviet Union quite independently, practically without participation of other countries. Exclusions were provided by the help in treatment of acute radiation sickness and some humanitarian programs. After establishment of the International Chernobyl Project, conducted under the aegis of IAEA, in which about 200 independent scientists from 23 countries and international organisations took part (1990) and the special resolution of the United Nations General

Assembly on the Chernobyl problem (45/190 of December 21, 1990), international contacts on Chernobyl affairs were given real impetus. Cooperation between CEC and CIS countries was of significant interest and efficiency. In the framework of this co-operation, 16 scientific research projects were implemented. Scientific co-operation of such a scale, when research projects involve about 200 laboratories and institutes results in a radical change of the research level in such fields as behaviour of radioactive substances in the environment, risk analysis and its control, exposure doses and their impacts. The public favoured the practical Russian-German measurement program. A lot of useful results have been obtained in joint projects with the USA and France.

The World Health Organisation (IPHECA), UNESCO, and other international organisations considerably contributed to the elimination of the consequences of the Accident. Work was started on application of the Chernobyl experience to get ready to the situations of emergency at nuclear power sites. In 1995 a major international training called "Polyarnye Zori-95" took place. It was organised by the RF Ministry for Situations of Emergency in cooperation with the UN DHA.

2. TODAY'S SITUATION

The establishment of the "Unified State Program on Protection of the Population of the Russian Federation against Consequences of the Chernobyl Catastrophe for Years 1992–1995 and for the Period up to the Year 2000" has allowed noticeable reductions in the Chernobyl accident effects, though the today's situation is still far from being satisfactory.

2.1. Radiation and Hygienic Situation

By now, about 100,000 people are receiving radiation exposures with doses above 1 mSv/year and in 4 settlements the average doses of extra exposure exceed 5 mSv/year. In large territories, cases of radioactive contamination of milk, mushrooms, and berries above TPLs were reported. The worsening of the economic situation caused an increase of portion of home-made production, mushrooms and berries in rations of inhabitants. For these reasons, an increase in doses of internal exposure is being observed at a number of locations.

2.2. Radioecological Consequences

Agriculture. In Russia radioactive contamination affected 2,955,000 ha of agricultural lands, including 171,000 ha with densities above 555 kBq·m-2. Some natural processes and the countermeasures performed enabled reduction of the quantity of production that had to be destroyed.

However, deterioration of the economic situation in the country conditioned a drop in the scale of special agricultural measures in 1993–1994, which, in its turn, gave rise to an increase in radiocaesium content in plant-growing products and forage. For example, in Novozybkov district in the Bryansk Region the level of hay and forage contamination in 1994 increased in average by a factor of 1.5 as compared to 1992.

Rehabilitation of fodder lands in flood plains is still a challenging problem, because there is virtually no possibility of applying conventional technologies in water-protecting zones. In arid years, these lands are the principal source of fodder for a lot of farms. In 1994–95 in the Bryansk Region the following Cs-137 concentrations were measured in foodstuffs in the private sector of economy: milk — 3 kBq/l, meat of domestic animals — 7 kBq/kg.

Forestry. The most severe contamination of forest resources is observed in the Bryansk (228.5 thousand ha), Kaluga (159 thousand ha), Tula (107.6 thousand ha), and Orel (93 thousand ha) Regions, which effect over 30% of the total forestry in these regions. In general, meeting the proper technology and restrictions in the course of procurement enables obtaining normal contents of radionuclides in lumber and timber. An exception is provided by procurement of firewood and coniferous flour rich in vitamins, which had been a real industry in these regions. The economic activity has been ceased in more than 59 thousand ha of forests. As a result, the sanitary condition deteriorated and the fire danger became more serious. In the Bryansk Region alone, 10 thousand ha of dry woods have been revealed in the mentioned zones. Another deplorable example is the fact of the first detection of tularemia pathogene in the Bryansk Region. The caesium content in meat of wild animals, mushrooms and berries often exceeds the accepted permissible levels by several times and has no indicated tendency to being reduced.

Rivers and lakes. Contamination of waters and bottom depositions presents practically no hazard to water consumption in all rivers and water reservoirs. An exception is provided by several lakes, including the Kozhanovskoye Lake (the stock of caesium is about 0.3 PBq at a water surface of 6.5 km2). Content of Cs-137 in fish from the lake exceeds the permissible levels by several times.

2.3. Demographic Situation

In general, the demographic situation in the regions affected by the accident reflects the dramatic tendencies characteristic of today's Russia — death rate rise and birth rate decrease and, as a result, natural depopulation (see Fig. 8 and Table 3). There were short periods (e.g., 1992–1993) when, owing to some measures of social protection, slightly better birth and death rates were reported in the zones of radioactive contamination. However, some estimates suggest that, in the case of a pessimistic scenario of social and economic development of Russia, the demographic situation in most contaminated regions will worsen at a higher rate as compared to Russia as a whole.

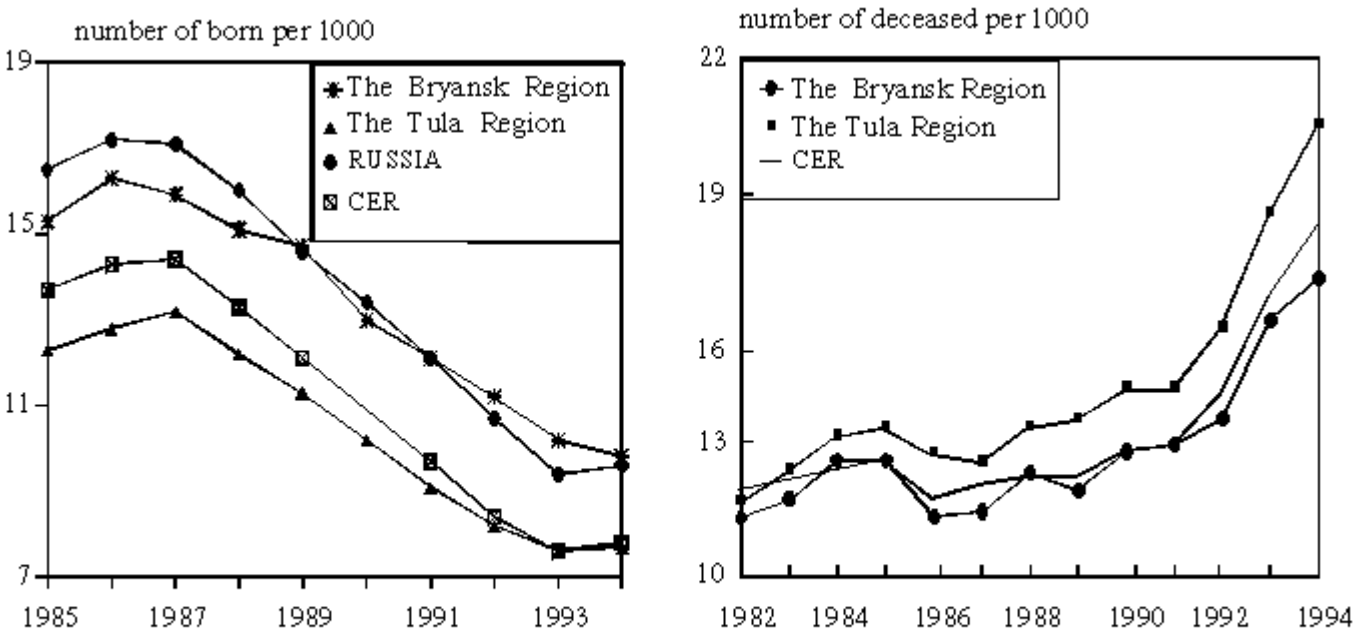

Fig. 8. Dynamics of birth-rate and total mortality in the most contaminated regions and in the whole Russia (crude indexes). CER - Central Economical Region

Table 3.

Crude indexes of birth-rate and mortality in tested and reference territories

TERRITORY	Percentage of rural population,(%)	Birth-rate index per 1000			Total mortality index per 1000		
	1994	1992	1993	1994	1992	1993	1994
ZR	53	13.1	12.3	11.2	15.1	18.4	19.8
ZVR	51	10.2	9.4	9.5	15.1	17.9	19.5
Bryansk Region	32	11.2	10.2	9.8	13.7	15.9	16.9
Tula Region	19	8.2	7.7	7.6	15.8	18.4	20.5
CER	17	8.4	7.6	7.8	14.3	16.6	18.2
Russia	27	10.7	9.4	9.6	12.2	14.5	15.7

For the time being, most anxious inhabitants (mainly families with children and working-age people) have left the contaminated regions. Since 1993, a positive migration balance has been observed in the contaminated regions, primarily due to arrival of new inhabitants at towns and major settlements (see Fig 9).

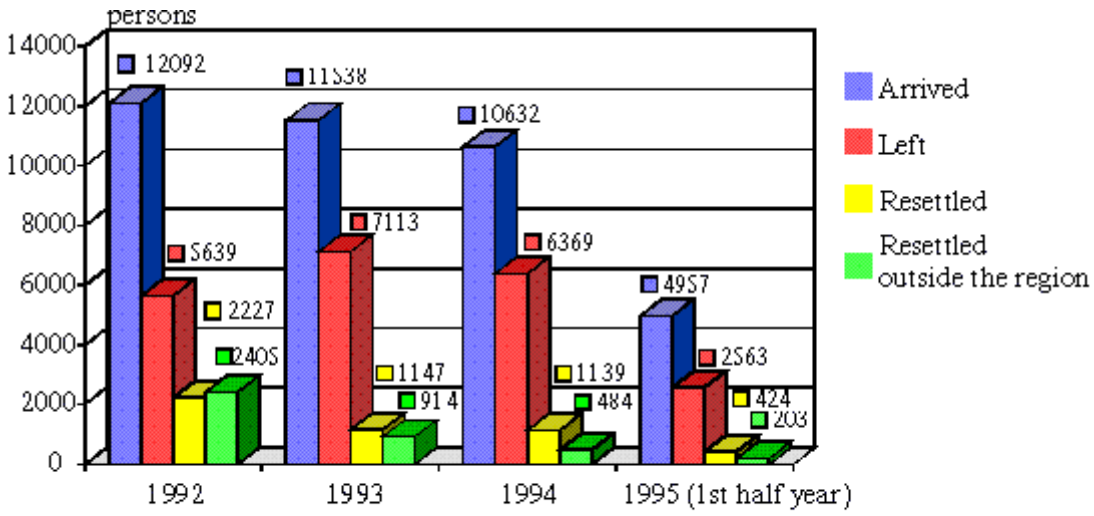

Fig. 9. Migration of the population of the Bryansk Region (resettlement zone and zone with the right of resettlement)

2.4. Population Health Status in Contaminated Territories

The most probable consequence of radiation impact is the risk of malignant neoplasms (in the first place, thyroid tumours in children and teenagers in the Bryansk Region). In connection with the expectations, annual medical examinations including ultrasonic investigation of thyroid were organised for all children in contaminated territories. By now, in the Bryansk (Fig. 10) and Kaluga Regions 62 cases (as of 1.12.95) of thyroid cancer were revealed in those who were children and teenagers at the time of the accident, which is dozens times higher than the common level.

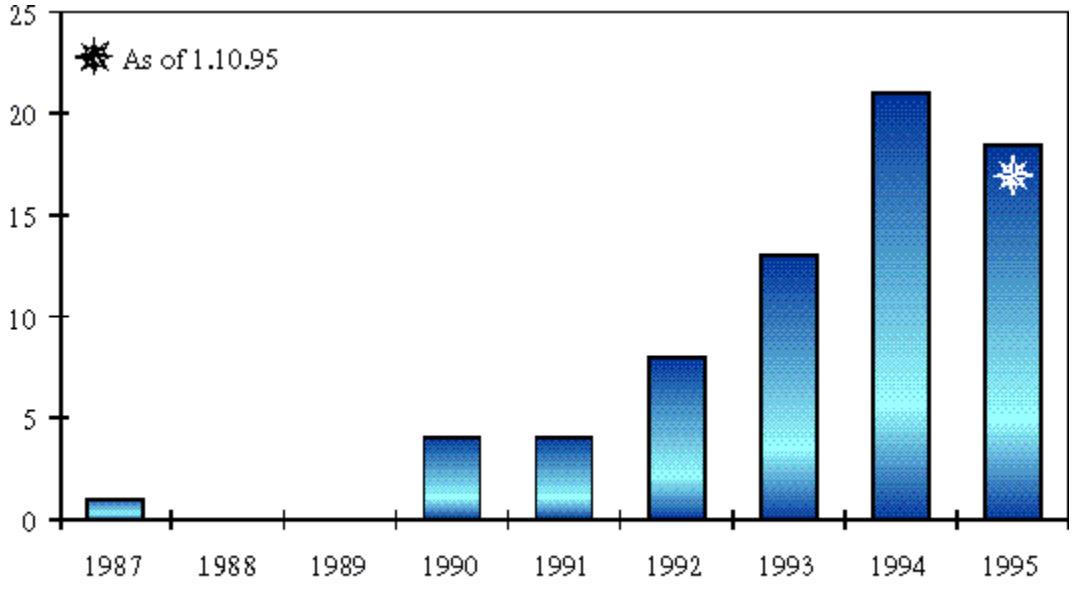

Fig. 10. Cases of thyroid cancer among children in the Bryansk Region

According to some predictions, an "epidemic" of leukaemia, other oncological diseases and genetic disorders was not expected even in most contaminated regions. The investigations showed that, as of 1995, there was no detectable growth of leukaemia, solid tumours, and genetic disorders in population affected by radiation.

The total morbidity rate and its structure at the given stage, both qualitatively and quantitatively, do not differ from the processes in Russia as a whole. However, local medical and scientific institutions have revealed certain disorders in health, namely, an increase in the rate of ischemia, diabetes, stomach ulcer, some symptoms of depression of immune system functioning. As for children, a rise of both total and primary morbidity of endocrine system and blood diseases, congenital abnormalities of development, and diseases of digestion organs was observed. A stable growth in the rate of mental disorders was emphasised.

Observations performed by RNMDR institutions have also revealed unfavourable tendencies in dynamics of some classes of general somatic diseases in children and adults in contaminated territories.

A significant role in the reduction of an organism's adaptive capabilities is played by a high level of stress among population in contaminated territories. Permanent psychoemotional stresses, enhanced fear of radiation, passive anticipation of assistance, and disappointment if such assistance is not rendered give rise to unfavourable changes in health. The psychological distress that manifests itself in a rise of the number of neurotic stress disorders or psychosomatic symptoms is characteristic of population in contaminated territories.

Monitoring of the social and psychological situation being conducted in contaminated areas has provided information on some tendencies. At the beginning of the economic reforms (up to 1993), an evident compensating influence of the Federal Program upon population was seen. The negative tendencies typical for Russia as a whole manifested themselves here with a certain delay and in less explicit forms. In some characteristics (internal strain, etc.), the situation in zones with privileged status and the right for resettlement turned out to be more satisfactory than in reference zones. Continuing deterioration of life standards and reduction in the amount of financing have gradually levelled these positive features. Negative tendencies have not experienced noticeable changes either. As previously, people evaluate their health, contamination of the environment, and information available as being much worse in contamination zone, than in uncontaminated territories.

2.5. Economic Situation

Nowadays the economic situation in contaminated territories is deplorable. In first post-accident years (to be more precise, until 1993) it was sufficiently stable due to centralised financing within state programs. Beginning from 1994, lowering in the number of live-stock and amount of meat procured has been observed in the public sector of national economy. A similar situation takes place in plant growing where the volume of production of main agricultural cultures has decreased by a factor of 1.5–2 in recent years because of drop in productivity and reduction in cultivated areas. These circumstances may be related to the overall decline of agricultural production in Russia. However, the results of some investigations showed both a lower income

in contaminated territories, as compared to uncontaminated ones, and a relationship between low income and the general contamination rank of a region as a whole. The lowest income per capita are characteristic of contaminated areas in the Bryansk Region.

2.6. Problems of Liquidators

Observations performed within the National Register have revealed a number of unfavourable tendencies in dynamics of some classes of general somatic diseases in "liquidators". According to the data of RNMDR, the average dose of external exposure of the liquidators was 12 cGy. More then 40% of the "liquidators" have got doses of 10 to 25 cGy. The average time of work in the radiation zone was approximately two months. For several classes of diseases, the morbidity for "liquidators" of 1986 is different at a statistically significant level from corresponding indices for the dose group 0–5 cGy consisting of "liquidators" of 1988. Taking into account a set of factors of both radiation and nonradiation nature, we can conclude that liquidators who worked in 1986–1987 are the group of enhanced risk.

An analysis of main disease classes that were considered by expert committees to establish causal dependence of diseases, physical disability, and mortality indicates that diseases of circulatory system, nervous system, sense organs, digestive organs, as well as mental disorders and oncological diseases, are the most frequent subjects the experts deal with. With such health troubles, "liquidators" turn out to be more vulnerable in other spheres of life. The more so, if we take into consideration that the social privileges granted to them by the government are not provided in full measure. Of particular acuteness is the issue of providing housing to all "liquidators". To solve the problem a special federal program named "Dwelling for Liquidators" was developed and approved in 1995.

2.7. Analysis and Generalisation of Consequences of the Chernobyl Accident

For the past 10 years, an immense experience in overcoming the accident consequences in a number of practical directions pertaining to various fields of science and engineering (medicine, agriculture, environmental protection, work with population, etc.) has been gained.

To use this experience, the State Program incorporates a major information project, namely, the "Chernobyl" (see Fig. 11) administrative information system with the central bank of generalised data (see Fig. 12) at the Nuclear Safety Institute of the Russian Academy of Sciences (NSI RAS, Moscow), in which the evidence on radiohygienic, ecological, sociopsychological, and economic aspects of the accident is being accumulated. In this information system, acquisition and systemisation of data is accompanied by development and operation of information systems on the problem as well as systems for decision-making support and training systems, which were tested in the following practical games and headquaters exercises: Russian-French practical game "St. Peterburg—93", headquaters exercises of EMERCOM of Russia in November, 1994, command and headquaters exercises "Polyarnye Zori — 95" (EMERCOM of Russia and DHA UN). When preparing the practical game "Polyarnye Zori — 95", the Chernobyl experience was widely used.

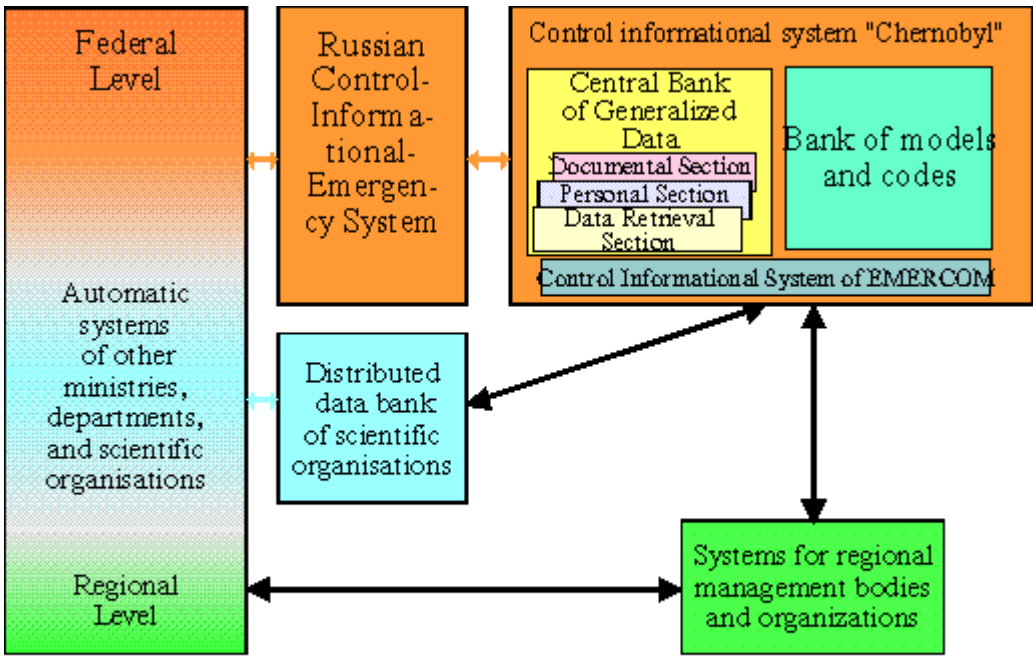

Fig. 11. Informational system «Chernobyl»

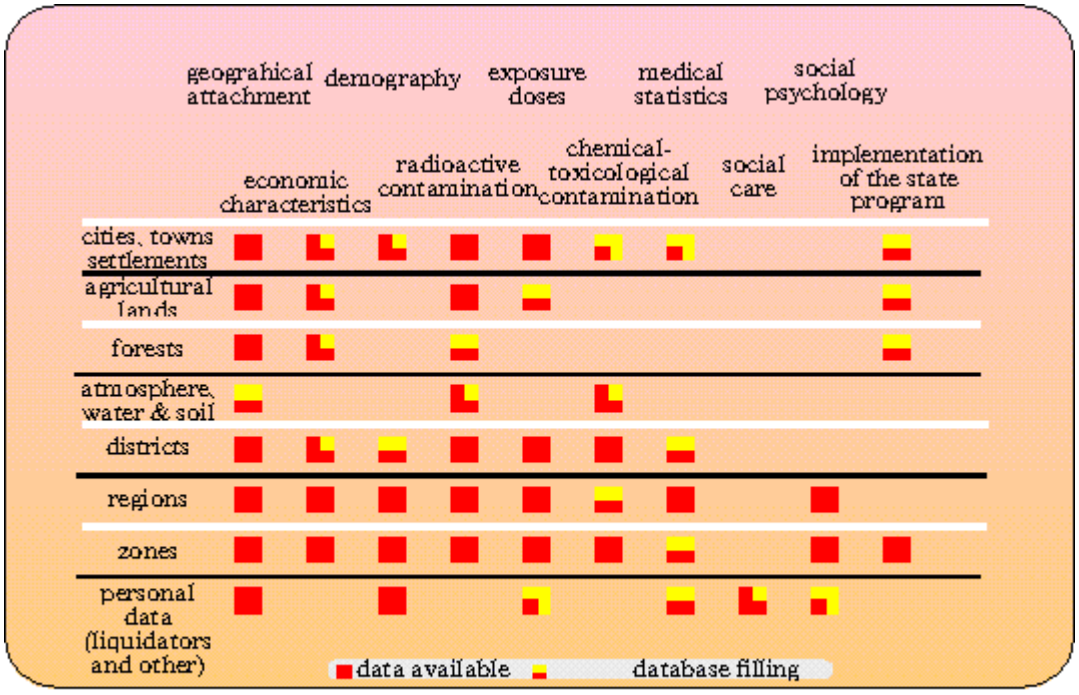

Fig. 12. Current Filling State of the Central Data Bnk - 1995

3. RESULTS AND PROSPECTS

The establibshment of the variety of protective measures outlined above has allowed significant reduction in doses of exposure to population living in territories contaminated as a result of the Chernobyl Accident and the exposure dose for the entire population of the Russian Federation. For the time being, a deplorable economic situation in the country does not allow implementation in full scale of the contemplated plans for elimination the consequnces of the accident. However, implementation of the State Program will be continued.

On the eve of the 10th anniversary of the Chernobyl catastrophe it is important to evaluate the problem status and outlook for overcoming consequences of the Chernobyl accident throughout the territory of Russia.

The results of the accomplished work can be summarised as follows:

1. A great volume of work on refinement of the information concerning the radiation situation, ecological, medicodemographic, economic, and social characteristics of territories and contingents affected has been executed. At present, the situation at the contaminated territiries can be reliably predicted.
2. The work on population protection has been accomplished, including some measures concerning agriculture, forest economy, sanitary protection, decontamination, improvement of inhabited localities involved. At the same time, some programs on improvement of medical services to population, rendering special medical aid, and social protection of the citizens suffered from the accident have been launched.
3. Owing to natural processes and the efforts taken, noticeable improvement in the radiation situation has been achieved in all the territories having significant radioactive contamination. In weakly affected areas of the Belgorod, Voronezh, Kursk, Lipetsk, Leningrad, Novgorod, Penza, Ryazan', Tambov, and Ulyanovsk Regions, as well as Mordovia and Chuvashia republics, the situation may be considered normal.
4. In Russia, the Federal Law "On Radiation Safety of Population" has been passed that establishes permissible limits for exposure doses in the territory of the Russian Federation. In particular, the average annual effective dose for population equals 1 mSv.
5. The National Committee on Radiation Protection has adopted the "Concept of radiation, medical, social protection and rehabilitation of population of the Russian Federation affected by emergency exposure. (NCRP, 1995) which creates scientific grounds for the work on rehabilitation at the phase of reconstruction and envisages alteration of principles laid into foundation of zoning of suffered territories and measures to be taken. The concept includes zoning territories and exposure doses with boundary values of 1, 5 and 20 mSv/yr (see Fig. 15). Simultaneously, notions of "an exposed person" and "a suffered person" are introduced (see Fig. 16).

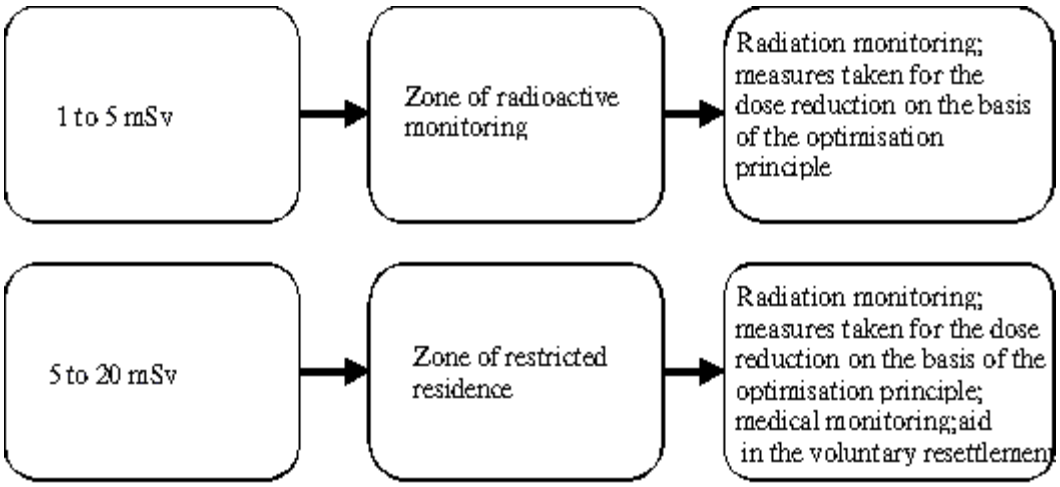

Fig. 15. Concept of RNCRP-95
Territory zoning in accordance with annual effective dose due to radioactive contamination

Exposed population	Acute exposure dose exceeding 50 mSv or accumulated effective dose of chronic exposure exceeding 70 mSv
Population suffered from radiation exposure	Persons with deterministic effects or other diseases in cases when causality with exposure is determined

In addition, the following groups of population are included in the National Register:

Children, who got a whole body dose of more than 10 mSv in the embryonic period
Adults and children, who got an absorbed dose on the thyroid gland of more than 0.5 Gy and 0.2 Gy, respectively;
Children of the exposed parents burn after the accident
Persons evacuated or resettled from the radioactive contaminated zone, regardless of the absorbed doses

Fig. 16. Concept of RNCRP-95
Radiation, medical and social protection of exposed population

6. Groups at enhanced risk have been identified, namely, the cohort of "liquidators" who worked in- 1986–1987 and children in the most contaminated districts of the Bryansk, Kaluga, Orel, and Tula Regions. Prolonged medical observation should be provided for these population categories.

It seems to be expedient to highlight two groups of tasks, (1) long-term measures of practical and scientific nature, and (2) top-priority tasks to be accomplished within the nearest few years.

Among the problems that will require some efforts of the government both prior to 2000 and further are:

1. Providing medical aid to "liquidators" and the affected population. This problem will still remain in 10 and 20 years. However, the effects related to thyroid should be separated from other diseases. In the nearest years, radiation-induced thyroid cancers will peak. Simultaneously, with the issues of medical aid, the task of social protection of the mentioned contingent, including "liquidators", will have to be dealt with.
2. The radiohygienic situation in southwestern districts of the Bryansk Region necessitates continuation of measures aimed at radiation, medical, and social protection and rehabilitation of population as well as that of agricultural lands and forests. About 50,000 people live at rural inhabited localities in these territories. The town of Novozybkov (45 ths. people) is located in the immediate vicinity of such territories.
3. In vast territories where the radiation situation has already been normalised, or will be normalised, in the next few years, some measures aimed at socio-economic and socio-psychologic rehabilitation should be performed.
4. Scientific studies in a number of principal directions should be continued. They are significant for overcoming the effects of the Chernobyl accident as well as for providing adequate response to possible radiation incidents in the future:
    - epidemiology of radiation-induced pathologies in "liquidators" and the population;
    - radioecology in what concerns long-term observation of the radioecological testing grounds created;
    - complex analysis of the problems related to overcoming the accident consequences and creation of systems integrating the accumulated experience;
    - sociology and psychology concerning the development of methods for social and psychological rehabilitation of groups of people affected.

On problems of years 1996-2000. The Law on Radiation Safety, and the "Concept of Radiation, Medical, Social Protection and Rehabilitation of Population of the Russian Federation Affected by Emergency Exposure" (adopted in 1995) provide the legal and scientific basis for bringing them to conformity with the "Law on Social Protection of the Population Affected by Radiation in Result of the Accident at the Chernobyl Nuclear Power Plant". The gained experience brings out clearly that it is rather problematic to reduce the scale of program realisation in a very short time from 57,000 square kilometres defined by an isoline of the Cs-137 contamination density equal to 37 kBq·m-2 down to rather limited territories where extra exposure doses exceed 1 mSv/year. A negative response of the population and local authorities may aggravate severe social consequences of the catastrophe. Transient phase (4–5 years) enabling a smooth and "adequately perceived" withdrawal of regions from the sphere covered by the State Program on overcoming consequences of the accident is of great significance.