BELARUSIAN EXPERIENCE IN THE FIELD OF

RADIATION MONITORING AND RADIATION PROTECTION OF POPULATION

ROLE OF GOVERNMENTAL AND NON-GOVERMENTAL STRUCTURES IN SOLVING THESE PROBLEMS

Project deliverable of the EC SAGE Project

"Strategies and Guidance for establishing a practical radiation protection culture in Europe in case of long-term radioactive contamination after a nuclear accident"

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

INTRODUCTION

The objective of the SAGE Project is to develop strategies and guidance to establish a practical radiation protection culture in Western Europe in case of a nuclear accident or incident with long-term contamination.
Although the conditions in Belarus and in Western Europe are different, the feed back experience of the day-to-day management of the radiological situation by authorities, professionals and population living in the contaminated territories is very useful for the development of a radiation protection culture in case of a long term contamination in Europe.

This deliverable reported the Belarusian experience associated with the practical management of the consequences of the Chernobyl accident over the last 18 years. It aims to draw the lessons from this period as far as the monitoring of the situation and the involvement of the stakeholders are concerned.
The first two parts describe what Russian authorities and then Belarusian ones have implemented to reduce the radiological burden of the population. The historical evolution of laws and countermeasures is presented and criticized. The third and the fourth parts present the contribution of Belarusian and international NGOs in the rehabilitation of living conditions in the affected territories: the participation of the Belrad Institute is detailed, the ETHOS project is summarized and analysed. Finally, the last two parts try to give recommendations for the management of such a situation, especially as far as organisation of health care activities is concerned.

1. ANALYSIS OF SHORT TERM RADIATION PROTECTION MEASURES UNDERTAKEN FOR THE BELARUSIAN POPULATION

1.1. First phase (April-May 1986)

The explosion of the reactor of the 4th energy-block at the Chernobyl NPP occurred on 26th of April 1986. During the first following hours and days after, a specific Governmental Commission was created to propose and supervise emergency rescue works. This Governmental Commission was constituted by different ministries of the former Socialist Soviet Republic of Belarus (eg. Ministry of Medium Engineering Industry, Ministry of Internal Affairs, Ministry of Civil Defence, Ministry of Public Health, Ministry of Forests and Agriculture) and the Central Committee of the Communist Party of Belarus. But, in fact, during the emergency phase, all decisions were principally determined by the Central Committee of the Communist Party of the Soviet Union and the former USSR Government.

The most important goals during the initial emergency period were: to stop the chain reaction, to provide the cooling of the fuel, to reduce emissions of radioactive substances in the environment and to avoid a future development of the catastrophe. The stop of the reactor and the construction of the “Sarcophage” are described in annex 1.

One of the first questions that the Governmental Commission faced to was about the destiny of people living in Pripyat, a town located at a distance of 8 km from the Chernobyl NPP. In the morning of April 26th the population of the city, without any precise information on what happened, was recommended to stay indoors, windows and doors closed. At noon, a permanent control of radiation levels in the city was established. In the evening, the ambient dose rates were measured between 14 and 140 mRoentgen/hour[1] in the Pripyat streets. During the night, the radiation situation worsened and ambient dose rates were measured in the range of 180-600 mR/hour. However, in order to avoid a panic before celebrations of both 1st and 9th of May, authorities only promulgated preventive recommendations without any control of their actual realization. And, because the weather was warm these days, children and adults spent time outdoors on fresh air. On the 27th of April ambient dose rates were still measured in the range of 360-540 mR/hour, reaching the range of 720-1000 mR/hour on the roads near the NPP. Hence, the Governmental Commission decided to evacuate the inhabitants of Pripyat: 1200 buses and 3 special railway trains were routed to Pripyat from Kiev and other nearby cities. The evacuation began at 2 pm on 27 April and took approximately three hours. During this single day, 44 600 people were brought out of the city. The days after, the whole population living in the vicinity of the NPP (< 10 km) was also evacuated.

On 28 and 29 April, the Institute of Nuclear Energy (INE) of the Academy of Sciences of the Belarusian SSR submitted proposals for implementing iodine prophylaxis for the

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1 "Chernobyl: The look through decades". Belarusian Encyclopedia, Editors: J.V.Malashevitch and others, Minsk, 1996, p.319.

entire population and for resettling all people living within a radius of 100 km area around the Chernobyl NPP. But, this proposal was not accepted by the Governmental Commission[2]. Once the evolution of the damaged reactor was considered as being stopped, efforts of the Governmental Commission were redirected to emergency works such as, decontamination, water protection by filtering measures, isolation and burying of the damaged reactor building and blasted elements of concrete.

According to the previously developed and stated "*Plans for eliminating emergency situations*" (PEEs), the following measures were parallelly taken by Ministries and Departments of the Civil Defence as well as by the chemical Subdivisions of the Soviet Army:

1. Fire control of the reactor aiming at reducing radioactive emissions,
2. Radiation monitoring and mapping of the soil contamination and radioactive background (mainly Cs, Sr and Pu),
3. Medical inspection of the population as well as people who intervene to mitigate the accident consequences,
4. Installation of barriers and warning signs into the perimeter where the contamination was in the order of or higher than 100 Ci/km^2,
5. Evacuation of citizens from contaminated zone around 30 kilometres from reactor to safe places. The criterion for evacuation was the 35 BER (Biological Equivalent of Roentgen) dose limit for a life.
6. Control over the herding of cattle and the conduct of agricultural works in the first days in a 100 km radius around the plant,
7. Decontamination of towns and villages by retired soldiers and personnel of the Civil Defence,
8. Radioactive contamination monitoring and washing of the cars and agricultural machines which was used in the vicinity of the plant ("10 km -" and "30 km -" areas) in case of their move to cleaner areas.

The Communist Party and Executive Authorities of the former USSR controlled results of these works: PEEs were constantly corrected depending on how the situation was evolving.

It was not until the 2nd of May that the Ministry of Public Health decided to implement iodine prophylaxis and to resettle people living at a distance of less than 30 km from the Chernobyl NPP. However, only about 170 000 people received iodine prophylaxis instead of the whole inhabitants of the Mogilyov, Gomel, Brest and Minsk districts. During the same month, hundreds of children were brought to cleaner regions of the former USSR (principally to Russia).

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[2] "Rodnik" newspaper, issues no 5, 6 and 7, 1990.

The effective internal and external doses received by the evacuated population due to Cs-137 are presented in Table 1.

Table 1. Average doses of evacuated people[3]

Evacuation stage	Number of towns and villages evacuated	Number of people evacuated	Absorbed ^{131}I Dose to the thyroid (Gy)	Effective dose (mSv)	
				^{137}Cs Internal Dose	^{137}Cs External Dose
May 2-7	50	11,035	1,33	2,1	31,2

At the beginning of May, according to the decision of the Government of Belarus, a Scientific and Technical Commission was created to evaluate radiation contamination and to give suggestion on radioprotection measures, with the following membership: N.A. Borisevich (physicist, President of the Academy of Sciences), Pr. I.N. Nikitchenko (doctor of agricultural sciences), Pr. V.B. Nesterenko, Pr. E.P. Petryayev (chemist), Pr. S.S. Shushkevich (physicist), and Pr. E.F. Konoplya (biologist).

On May 3, Pr. V.B. Nesterenko, in accordance with the Technical Implementation Plan, visited the regions of Belarus affected by the Chernobyl accident together with a group of radiation safety specialists from INE. After this visit, a new letter (dated May 7, 1986) was sent by the director of INE to the Government with proposals for implementing several radiation protection measures:

- To start an iodine prophylaxis,
- To resettle all people living at less than 100 km from the plant,
- To suggest to the Ministry of Public Health to evaluate the safety of local produced foodstuffs in the south of Belarus.

1.2. Second phase (June-December 1986)

1.2.1. Contamination of territories

At the end of May 1986, a first map of Cs-137 deposition in Belarus was made by the INE (figure 1).

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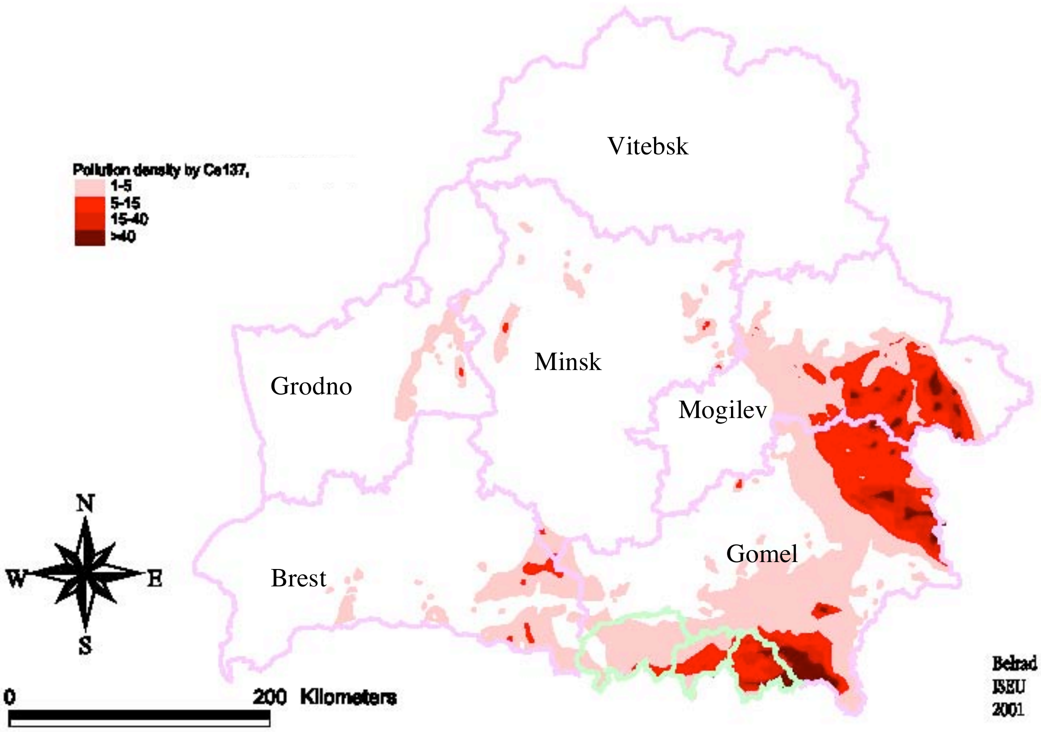
[3] "Chernobyl consequences in Belarus: 17 years after", National report edited by V.E.Shevchuk, V.L. Gurachevsky, Minsk: "Propilei", 2003.-p.54

Figure 1. Distribution of caesium-137 (Ci/km^2) in soil on the territory of the Republic of Belarus on May 1986



As a consequence the population of Southern regions of Belarus (at a distance of 50 to 70 km from the NPP) was additionally resettled from June 5 to June 10, 1986 (based on the criteria of dose rates > 3-5mR/h).

In July 1986, a first zoning was implemented (table 2). The major criterion was the density of contamination in caesium-137.

Table 2. Initial zoning implemented in July 1986

	Level of contamination with Cs-137 (Ci/km^2)	Legal status
1	< 1	No limitations
2	1-5	Zone of selective radiation control
3	5-15	Zone of periodical radiation control
4	15-25	Zone of strict radiation control and subsequent resettlement
5	25-40	Zone of initial resettlement
6	40-100	Zone of timely migration (evacuation)
7	More than 100	Zone of evacuation

By the end of 1986, about 116,000 people from 188 towns and villages (including Pripyat) have been evacuated.

The following table (table 3) present the effective internal and external doses received by the evacuated population due to caesium-137.

Table 3. Average doses of evacuated people[4]

Evacuation stage	Number of towns and villages evacuated	Number of people evacuated	Absorbed ^{131}I Dose to the thyroid (Gy)	Effective dose (mSv)	
				^{137}Cs Internal Dose	^{137}Cs External Dose
June 3-10	28	6,017	1,04	1.6	15,9
August-September	29	7,327	0,66	0,9	20,3

Local authorities initiated a certain number of actions, principally to interrupt the massive departure of the population from the most polluted areas (especially in the Gomel and Mogilyov districts). In order to maintain a certain number of people living in the affected regions, the Council of Ministers of the Belarusian SSR and the Central Committee of the Communist Party of Belarus promulgated several decrees and instructions which proposed financial incentives for people living in areas with a high contamination level (>1480 kBq/m^2, i.e. > 40 Ci/km^2) or, by proposing them resettlements in the same district. For example, the Mogilyov Regional Committee of the Communist Party and the Regional Executive Committee built the “Maysky” settlement in the Cherikov district to resettle here inhabitants of “Chudyany” and “Malinovka”. However, as Maysky was located at a very short distance - 3 to 5 km - from “Chudyany” and “Malinovka” villages, the people continued their agricultural activities on the same plots they had before the resettlement, on soils contaminated at levels from 1480 to 2960 kBq/m^2 (40 to 80 Ci/km^2).

1.2.2. Temporary agricultural recommendations

On June 13, 1986, the Chairman of the State Committee for agricultural production (Gosagroprom) of the USSR, in coordination with the Chief State physician of the USSR, put into force “*Temporary Recommendations for the agricultural production in radio-contaminated territories of the Belarus SSR*”. These permitted to produce agricultural products (even on the lands where dose rates were from 5 to 20 μR/h), to produce radio-contaminated agricultural products and to distribute them over the whole Republic. The local population who lived in that area during the whole year received high external doses (up to 150 mSv) and internal doses by eating local foodstuffs.

4 "Chernobyl consequences in Belarus: 17 years after"; National report edited by V.E.Shevchuk, V.L. Gurachevsky.-Minsk: “Propilei”, 2003.-p.54

The same Chairman of the State Committee for agricultural production and the deputy Chief State physician also put into force "*1986 Recommendations for the use of meat containing radioactive substances from 2.10^{-7} to 1.10^{-6} Ci/kg for production of cooked meats*". This recommendation led to the irresponsible mixing of highly contaminated meat (18000 to 37000 $Bq_{(Cs\text{-}137)}$/kg) in sausages.

On June 24, 1986 the same people promulgated "*Temporary recommendations for the primary processing of wool received from radio-contaminated animals*". But, as there was only one Belarusian factory for wool primary processing in Zhuravichi (Gomel region), all the wool processed here became radioactive. This has been used for sewing clothes and has enlarged the external doses received by people.

On July 23, 1986, the deputy Chairman of Gosagroprom of the USSR, in coordination with the deputy Chief State physician, put into force the "*1986 Temporary recommendations for purchasing, authorizing, storing and using grain and grassy meal of crops gathered on the territory of the RSFSR, the Ukrainian SSR and Belarusian SSR exposed to radio-contamination*". It was not recommended to stop the grain production; on the contrary, it was recommended to feed cattle with radioactive grains, and to make alcohol with them. It led to Cs-137 contamination of the milk and meat and, hence, also contaminated human consumers.

In Summer 1986, soil samples were taken in all southern regions of Belarus by the agrochemical Services of the MAP. In Autumn (September-October), the maps of the radiation deposition on agricultural holdings of the Southern regions of Belarus were drawn. In September 1986, INE submitted the map of deposition (Cs-137 and other radioisotopes) in the Southern regions of the Republic with the approval of both the Academy of Sciences and the Government of Belarus.

At that time, local foodstuffs were transported from Southern regions of Belarus to be monitored in Minsk: at the INE, at the Physics Institute of the Academy of Sciences and, at the Nuclear Physics Department of the Belarusian State University.

1.2.3. Other emergency countermeasures

During this period, other countermeasures were implemented to protect people from the direct influence of radiation. All ministries and departments were involved in the improvement of the radiological situation.

1.2.3.1. The Ministry of Communal Economy

It had to ensure:

- Protection of water sources (annex 2);

For instance, a plan of water protective measures in the area between the Dniepr and the Pripyat was developed to prevent the flow of radioactive substances in the waters of the river Pripyat and its influxes in the cascade of the Dniepr ponds. It included the following list of initial works:

- Blocking of all outputs from melioration system in the Pripyat by deaf barrages;

- Completing of anti-flood barrages erection on main water-flows;
- Erection of filtering barrage with sorbents in the bed of the Braginka and on main melioration channels with the purpose to fix radio nuclides;
- Organization of a systematic control on water contamination in the channels of ameliorative network;
- Searching for efficient sorbent materials;

- Refining and protection of mine-wells for drinking water;
- Organization of dust reduction on highways and streets of cities;
- Timely recycling of everyday wastes, garbage on the streets of cities and villages;
- Cleaning of rain wells;
- Perfection of filter constructions on the fields of drainage waters;
- Construction and organization of locations to bury wastes of decontamination (LBWD).

1.2.3.2. The Ministry of Energy

It had to:

- Ensure electricity supply during rescue emergent works;
- Dismantle electricity lines and electric equipment in the zones of expropriation;
- Ensure electricity supply during the construction of houses for migrants and during all decontamination works.

1.2.3.3. The subdivisions of Belarusian geology

They had to:

- Provide materials for burying the blasted reactor with the aim to decrease radioactive emissions from it;
- Fulfil research works on underground space and underground waters pollution.

1.2.3.4. The State Hydro Meteorological Service of the USSR

Its main tasks were the:

- Monitoring of air, rivers and soils;
- Development of guidance, admonishments and instructions about a radiological monitoring system of the environment;
- Formation of data base about pollution of towns and villages, rivers and lakes;
- Monitoring of the radiation situation in boroughs (radiation back-ground is currently measured on 56 meteorological stations in four radiation-dangerous directions: Smolensk, Ignalin, Chernobyl and Rovno).

1.2.3.5. The Ministry of Health

The Ministry of Health had to implement a first radiological monitoring system. From the first days after the accident, it started to conduct special measures for the protection of the population:

- Control of people's thyroid gland irradiation (250,000 measurements were realized);
- Radiometric control of food products and water;
- Control of internal irradiation of the population (36,000 persons were examined in 1986, 60,000 in 1987);
- Iodine distribution among evacuated population from 30-km zone. All in all, 5,3 million people (1,6 million kids) benefited from iodine (often too late);
- Medical examination of population: more than 100.000 people were examined in May-June from Bragin, Narovlya, Khoiniki districts. To examine the population 25 mobile medical brigades were created: they consisted in 1295 doctors from different institutions of the Ministry of Public Health, 1485 nurses, 140 operators of whole body counters, 210 students of medical institutes, 370 drivers.

In June 1986, a republican list of people suffered from irradiation after the accident at the Chernobyl NPP was established. It was also created a Research Institute of Medicine and Endocrinology with branches in Gomel and Mogilev. Today, it moved to Gomel and was reorganized into Center of Radiation Medicine and Human Ecology. In Minsk, dispensers were opened. A specialized clinic in Aksakovshchina, regional dispensers of endocrinology and other specialized centers (onco-pathology of thyroid gland) were also created.

1.3. Third phase (1987-1988)

1.3.1. Contamination of territories

The Governmental Commission of the USSR on Chernobyl issues (mainly presented by the Ministry of Public Health) did not recommend resettling people in cleaner regions if their accumulated life dose was less than 350 mSv.

On 1st of July 1987, the Government of the USSR declared - based on the MPHS advice - that it was possible to set a lifedose limit of about 500 mSv (250 mSv during the first 25 years after the accident) with the following annual dose distribution (in mSv): 30; 30; 25; 20; 20; 15; 15; 10; 10; 10 and then 5 mSv/year until the 70th year after the accident. At the same time, the Committee for Hydrometeorology of the USSR, MPHS, the Council of Ministers of Belarus, Ukraine and Russia concluded that it was possible for the population living in Mogilyov, Gomel, Bryansk and Kiev regions to live in districts with a territorial contamination higher than 40 Ci/km^2 if they used imported foodstuffs (especially, milk) and if the following "complex activities" were implemented:

- Decontamination in settlements contaminated over 40 Ci/km^2" (soil-layer removal, making asphalt cover in the most contaminated places, changing thatches, etc.) and simultaneously, ploughing and sowing of perennial grass and crops from the cleaner fields surrounded these settlements.
- Implementation of the whole complex special soil-conservation activities on all croplands in 1987 and on all pastures in the zone of about 40 Ci/km^2 in 1987 and 1988. Separation of plots for their urgent grassing for private cows in settlements contaminated over 40 Ci/km^2 (in autumn 1987).
- Completing the recommended soil conservation activities in 1987 on the territories of private farms contaminated under 40 Ci/km^2 and implementation of the intensive soil conservation activities (with application about 20 tons of zeolites per hectare and increased quantities of fertilisers) in settlements contaminated above 40 Ci/km^2.
- Implementation of the complex activities on agricultural holdings contaminated at about 80 Ci/km^2 to decrease the contamination of agricultural products in 1987 and 1988 with the objective to decrease the contamination of all foodstuffs under established norms in 3 or 4 years and to call off restrictions for private agricultural products uses during ten first years.

1.3.2. Agricultural activities

During this period the Government of the USSR in its "*Recommendations to the BSSR, USSR and RSFR*" insisted in the use of foodstuffs contaminated above the standards by mixing them with clean products. On the basis of the recommendations cited above, Gosagroprom of the BSSR in association with the Ministry for Grain Production of the BSSR repeated those decisions (order no. 3c/21C dated June 27, 1987). Consequently, about 1 million tons of radioactive grains were processed and fed at poultry farms and hog-breeding farms. The grain contamination was controlled in 17 districts of the Gomel and Mogilyov regions and Cs-137 concentration levels in grain were estimated between 370 and 3700 Bq/kg.

In March 1988, the Chairman of Gosagroprom put into force the "*Guide for Conducting Agriculture in Conditions of Radioactive Contamination of the Part of the Territory of the RSFSR, the Ukrainian SSR and Belarusian SSR for 1988 to 1990*" (annex 3), submitted by the Inter-departmental Commission[5] of scientific experts in radiology in the agricultural complex, which provided specific guidance for cultivating in radio-contaminated territories from 1 to 80 Ci/km^2. This *Guide* suggested to annually apply 1.5 time increased doses of phosphoric and potassium fertilizers on hayfields and pastures; it recommended to apply 2-3 kg of "double super-phosphate" and 3-4 kg of potassium chloride and sulphate per 100 m^2, as well as lime materials and zeolite

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[5] It consists of experts from Gosagroprom, the institute of Agricultural radiology (Obninsk) and representatives of the Ministries of Agriculture of BSSR and Ukraine SSR. Their goal was to establish transfer coefficients from soil to plants, and recommendations on reconversion of agricultural enterprises.

(200 kg per 100 m^2) in order to reduce the contamination of fruits, vegetables and potatoes in kitchen gardens. It was potentially efficient and could reduce the transfer coefficients of contamination from soil to plants by a factor of 6 to 8. However, about 20% (1.6 million of hectares) of all agricultural holdings were exposed at ^{137}Cs contamination over 1 Ci/km^2. The whole Belarusian budget was not enough for such a countermeasure: these fertilisers were only used in a little number of localities. Between 1986 and 1990, about 257100 hectares of agricultural holdings were totally excluded from the agricultural production market.

The use of local fodder for poultry food was not limited if the chickens were fattened with clean or slightly contaminated fodder 1-1.5 months before slaughter; in the same spirit, cattle- and pig- breeding and fattening were permitted without any constraint on the quality of food if they would be kept indoors and fattened with clean fodder the last 1.5-2 months before their slaughter.

From 1987 to 1990, based on the recommendations cited above and in accordance with the order of the Gomel Agricultural Committee, the officials of enterprises (kolkhozes) sent people to the zone of resettling, where grass and grains were sowed to be used for feeding cattle. During 4 years the situation almost stayed the same. It can be concluded that the "Guide" written by the so-called experts from the inter-Departmental Commission has clearly encouraged to carry out the agricultural production in contaminated territories by all means, neglecting the fact that fattening with contaminated fodder would inevitably cause the contamination of all kinds of products.

1.4. Fourth phase (1989)

On June 24, 1989 at a meeting in the Academy of Sciences Scientific and Technical Commission, several experts[6] were convinced about the acceptability of the concept of a lifetime dose of 350 mSv. However, this point of view was not shared at the international level: some experts - among which the Head of the French Central Service of Protection against Ionizing Radiations[7] - stated that one could accept 700 mSv or even 1 Sv during the life because of the lack of financing for protecting people and providing them clean foodstuffs!

In September 1989, a group of 92 scientists (including 5 Belarusian people) joined that "play" connected with an improper conception of what are the real life conditions in contaminated territories. In a petition addressed to President Gorbachev, they contended that the lifetime dose of 350 mSv, accepted by the National Committee for Radiation

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6 N.A. Borisevich (physicist), Pr. I.N. Nikitchenko (President of the Academy of Sciences, doctor of agricultural sciences), Pr. V.B. Nesterenko, Pr. E.P. Petryayev (chemist), Pr. S.S. Shushkevich (physicist) and Pr. E.F. Konoplya (biologist)

7 SCPRI (Service Central de Protection contre les Rayonnements Ionisants) became OPRI (Office de Protection contre les Rayonnements Ionisants) in 1994. Today, it its competency and personnel are incorporated into IRSN and DGSNR.

Protection (NCRP) of the USSR (in 1989), was based on the long-term examination of the state of the health of Japanese people (survivors from Hiroshima and Nagasaki bombs) as well as people living in the Russian district affected by the accident at the storage of radioactive waste in 1957 (Chelyabinsk). In this petition, authors insisted on the point that the resettlement of inhabitants should be made only if the lifetime dose could exceed 350 mSv (in normal living conditions without any restrictions or countermeasures). Authors said also that this approach was approved by IAEA, WHO, NCARE and UN. However, other scientists, both in Belarus and in Ukraine, totally disagree with this conception: the Academy of Sciences of Belarus rather proposed a lower lifetime dose value of 70 mSv. (Concept of safe life residing on Contaminated territories, approved by the Council of Ministers of BSSR in 1989).

1.5. Fifth phase (since 1990)

The first 1990-1992 programme was financed under the former USSR conditions. From 1993 to 1995 and from 1996 to 2000 the Republican State programmes were implemented. Since, the State programmes for overcoming the catastrophe at the Chernobyl for the period 2001-2005 and the up to 2010 are in use.

In 1991, three laws of the Republic of Belarus were adopted:

- "*About the Social Defence of Citizens Affected by the Accident at the Chernobyl NPP*", proposed on February 22, 1991 and approved on December 11, 1991 (the so-called 1991 Law); (8)
- "*About the Legal Regime of Territories Contaminated by Radiation as a Result of the Catastrophe at the Chernobyl NPP*", 1991; (10)
- "*Radiation Safety of the Population of Belarus*", 1998.

1.5.1. Dose constraints

The laws cited here above fixed the maximum permissible average annual effective radiation public exposure, excluding natural background, at 1 mSv per year. They suggested that this constraint should be reached by using a step-by-step approach: 5 mSv/y in 1991; 3 mSv/y in 1993; 2 mSv/y in 1995; 1 mSv/y in 1998.

In addition, a new zoning (table 4) was also proposed according to the potential doses received by the people and the corresponding contamination density (criteria are given for caesium, strontium and plutonium):

Table 4. Zoning of territories determined by the law of 1991

Zones	Annual dose	Density of contamination (Ci/km^2)		
		Cs-137	Sr-90	Pu-238, 239, 240
Zone of obligatory and immediate resettlement		From 40	From 3	From 0,1
Zone of subsequent resettlement[8]	"The annual dose can exceed 5 mSv"	From 15 till 40	From 2 till 3	From 0,05 till 0,1
Zone with the right to migrate	"The annual dose can exceed 1 mSv"	From 5 till 15	From 0,5 till 2	From 0,02 till 0,05
Zone with periodical radiation control	"The annual dose should not exceed 1 mSv"	From 1 till 5	From 0,15 till 0,5	From 0,01 till 0,02

Then, in 2000, the following basic national regulatory documents in the field of radiation safety and protection of the population were implemented in Belarus:

- *"Norms of radiation safety and protection of the population"* (that give the information on permissible levels of radioactivity contents in environment and human body).
- *"Basic sanitary rules for radiation prevention"* (that give the health norms for people who worked in contaminated territories).

The 17th of May 2001, the Law of the Republic of Belarus "*About the Social Defence of Citizens Affected by the Accident at the Chernobyl NPP*" No 31-1 was updated: "as an index of the assessment of the territory where the living conditions and working conditions of the population do not require any restrictions, the average annual effective radiation exposure must not exceed 1 mSv above the natural and man-caused radiation background[9]".

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[8] Today, in Belarus, more than 28000 persons – including 7000 children – are living in this zone. In Ukraine, all people were resettled from zones with a contamination density > 15 Ci/km^2.

[9] Formally, it means that Chernobyl accident contribution must be less than 1mSv a year.

The Law of 2001 stated that:

- If the average effective radiation exposure of the population exceeds 1 mSv/year above the natural and anthropogenic radiation background radiation protection activities must be undertaken.
- If the average effective radiation exposure of the population is comprised between 0.1 and 1 mSv/year, mitigating activities are not cancelled but they must be adapted to the situation by the Council of Ministers of the Republic of Belarus.
- If the average effective radiation exposure of the population is less than 0.1 mSv/year, specific protective actions are not considered as necessary from the health end environmental viewpoints."

1.5.2. Whole Body Counting

In 1992, the Ministry for Public Health Services (MPHS) of the Republic of Belarus published the "*New Catalogue of dose burdens of the population for 3668 settlements of the Republic*". However, this Catalogue was established using only 10 milk samples and 10 potatoes samples!

At that time, whole body counters[10] (WBCs) were installed in every municipal, regional and republican hospital (table 5). The Belarusian Government accepted the resolution, which obliged all Heads of private and public companies, the Ministers and their Departments to make measurements of all inhabitants of the contaminated regions of Belarus. Unfortunately, the existing WBCs were of low quality at that time: less than one third - about one hundred - of in-service WBC fitted with the State standards of certification. For example, in the Slavgorod district, WBCs did not operate for 3 years, and for 2 years in the Bragin district. Today, these equipments have been out of operating for several years. And because WBCs measurements characterise quite well the efficiency of the radiation protection activities, the lack of data on the internal irradiation of children (Cs-137 contamination) was particularly regrettable at that time.

Table 5. Number of operating WBCs in 1992-2000

	1992	1996	2000	2004
State devices	102	51	30	69
Private/NGOs devices	No data	4	10	11

Such a system of WBCs allows monitoring correctly the whole population and detecting the most contaminated people, especially children. One of the greatest lessons to be

[10] They are spectrometers used to measure human internal irradiation.

learned is also that it is extremely important to have such a measurement system operational before a potential accident in every district.

Indeed, even if some districts are not considered as highly contaminated, it is necessary to monitor their population to identify families who are in critical situations and their roots of contamination (contaminated milk, lots of consumed products from forests...).

2. CONTAMINATION AND CONTROL OF FOODSTUFFS

2.1. Permissible levels of radionuclides in foodstuffs and drinking water

Based on emergency dose limits of 100 mSv during the first year, 50 mSv in 1987, 30 mSv in 1988, 30 mSv in 1989, 5 mSv in 1990 (50% of external dose, 50% of internal dose), MPHS of the USSR approved temporary permissible levels for Cs-137 radionuclide concentrations in foodstuffs and drinking water.

The table 6 hereafter shows these temporary permissible levels (VDU-86, VDU-88, VDU-91), and the republican control levels (RKU-90 and RDU-92, RDU-96, and RDU-99) for Cs-137 concentration in foodstuffs and drinking water.

The annual VDU-88 limits corresponded to an internal dose of 8 mSv/year. RKU-90 accepted by MPHS in August 1990 was calculated in such a way that the internal dose be inferior to 1.7 mSv/year by the intake of contaminated foodstuffs. In Belarus, the RKU-90 was stricter than those accepted at the beginning of 1991 by MPHS of the USSR new temporary permissible levels VDU-91: the calculation was made in such a way that the internal dose be inferior to 1,36 mSv/year.

It is known that the Health Chief-Inspector of MPHS of the Republic of Belarus approved the dose limits for Cs-137 and Sr-90 concentrations in foodstuffs and drinking water (RDU-99) taking into account the annual actual food allowance of inhabitants of the Chernobyl regions (these limits of concentrations were supposed to be compatible with the dose limit of 1 mSv/year). It must be here pointed out that MPHS did not accept (nevertheless of three official appeals made by BELRAD) to fix the permissible concentration of Cs-137 in foodstuffs based on a dose constraint of 0.1 mSv/y. To be coherent with the Law of the Republic of Belarus, the set of permissible levels of radionuclides concentrations in foodstuffs, equivalent to 0.1 mSv/year would have been necessary (see above).

Tableau 6. Temporary Permissible Levels (VDU-86, VDU-88, VDU-91), Republican Control Levels (RDU-90, RDU-96, RDU-99) for Cs-137 concentration in foodstuffs and in drinking water

Foodstuff	VDU -1986	VDU -1988	VDU -1991	RKU -1990	RDU -1992	RDU -1996	RDU -1999
Drinking water	370	18.5	18.5	18.5	18.5	18.5	10
Milk (and whole milk products)	370	370	370	185	111	111	100
Condensed milk	7400	1100	1100	370			200
Butter	7400	1100	370	370	185	185	100
Lactic products, sour cream and curds	3700	370	370	185			50
Meat and meat products:							
beef	3700	2960	740	592	600	600	500
mutton	3700	1850	740	592	600	600	500
pork, poultry, fish and their products	3700	1850	740	592	600	370	180
Vegetable fat	7400	370	185	185	185	185	40
Animal fats, margarine	7400	370	185	185	185	185	100
Potatoes, verdure	3700	740	600	592	370	100	80
Bread and bakery	-	370	370	370	185	74	40
Flour, cereals, sugar	-	370	370	370	370	100	60
Vegetables and edible roots	3700	740	600	185	185	100	100
Fruits	3700	740	600	185	185	100	40
Garden berries	3700	740	600	185	185	100	70
Wild berries (fresh, preserves and jams)	-	-	1480	185	185	185	185
Canned fruit and vegetables, juices, honey	-	740	600	185	185	185	185
Fresh mushrooms	-	-	1480	-	370	370	370
Dried mushrooms, dried fruits	-	11100	7400	3700	3700	3700	2500
Other foodstuffs and food additives	-	-	-	592	370	370	370
Herbs (medicinal plants), tea	-	-	7400	1850			
Infant food (ready for use)	-	1850	185	37			37

Nowadays, according to the MPHS data, the proportion of contaminated foodstuffs has not really decrease. Since 1986, permissible levels have been reduced ten times, when the level of contamination has decreased of 20-25% only.

During last years, 90 contaminations of grain, milk and vegetables were revealed in 28 Belarusian farms. The level of income of the inhabitants of these regions is too small to allow them to buy clean foodstuffs. They are still obliged to feed themselves and their animals with local foodstuffs contaminated with Cs-137, which still contributes to more than 80 % of annual individual dose.

2.2. Organisation of radiation monitoring of foodstuffs

2.2.1. Description of the monitoring system in the former USSR (1986-1990)

During all first months after the accident at the Chernobyl NPP the control of foodstuffs from contaminated zones was conducted at three Institutes (the INE, the Institute of Physics and the Department of nuclear physics of the Belarusian State University). According to the request of INE, a lot of (about 4000) radiometric devices (SRP-68-01) were delivered from Siberia; they came from uranium mines and nuclear enterprises. Radiometers KRP-1, KRVP-3AB, RKP-4SM, SRP-68-01, RUPP, RIS-1 were assembled and produced for military and geological needs mainly. By the middle of June 1986, in order to complete the installation of all centres, the following quantities were still necessary: 502 radiometers DP-100, 639 SRP-68-01 and approximately 300 KRVP devices. But, at the beginning of June there were only 121 DP-100 and 37 SRP-68-01 available.

By the middle of July 1986, mobile radiological labs were created at Gosagroprom and MPHS. Radiometers for controlling foodstuffs were produced at the INE, at the Belarusian State University and at the Institute of Physics. They were distributed to the radiological services and Institutes of the Ministry for Agricultural Production of the Republic.

The mobile laboratories visited all farms in Gomel and Mogilyov regions and specialists from MPHS and Gosagroprom observed that products and animal husbandry were contaminated with Cs-137 and Sr-90. Unfortunately, without knowing the actual size of the accident and, according to trade organisations recommendations, the Regional and Departmental authorities decided to process contaminated products. Therefore, the radiation control services were organised in all 27 companies of meat industry, 127 dairy enterprises, 114 companies of food industry, 61 facilities of the Ministry for grain production, 56 companies of fruits and vegetables industry and also in 1200 collective and state farms. All these places were or have been contaminated. Apart from those cited above, 12 agricultural research institutes, 3 republican, 6 regional and 117 local vet laboratories, 188 stations for meat control, 117 inter-regional laboratories, 6 regional chemical stations, 10 pedigree companies, and 78 poultry farms, were used as places for the implementation of radiation monitoring. The whole radiation monitoring system counted until 2122 places!

In August 1986 the system of radiation monitoring of foodstuffs at Minsk markets was approved.

By October 1986 3077 specialists were trained at the Belarusian State University and the Academy of Sciences of the Republic to work at radiation control centres.

In August 1987 the system of radiation monitoring of foodstuffs, agricultural products and objects of environment in Belarus was approved. Apart from agricultural products, it was also designed to control the contamination of mushrooms, wild berries and herbs.

However, all the outputs and findings in relation with radiation contamination levels of foodstuffs (e.g. maps of contamination) were classified as secret until Spring 1989. At that time, during the first session of the Supreme Soviet of the USSR, it was finally decided to make public all the information connected with the Chernobyl catastrophe thanks to a common initiative of Mr A.D. Sakharov and Belarusian and Ukrainian deputies.

After this too long period of silent, inhabitants of Belarus, Ukraine and Russia became to seriously distrust the information they had received from authorities concerning the size of the accident, the contamination levels of local foodstuffs and as well, the health effects submitted by the State bodies.

2.2.2. Creation of Local Centres of Radiological Control (LCRCs) by Belrad

At that time, the Belarusian writer A. Adamovich, the Chairman of the "Peace Foundation Sakharov", and the famous chess player A. Karpov suggested that Pr Nesterenko should create an Institute for the radiation protection of the population of Belarus (they became co-founders and signed the Statue of Belrad", see hereafters). The first goal of that institute was to inform public about the actual radiation situation, the contamination of foodstuffs and nature gifts and also to train them to simple radiation protection measures.

The Belarusian Institute of Radiation Safety ("BELRAD" Institute) was then created in November 1990. BELRAD Institute suggested in the beginning of 1991 to the Supreme Soviet, the Belarusian Government, and the Chairman of the Regional Executive Committees, to create a network of Local Centres of Radiological Control (LCRCs) of foodstuffs. This suggestion was included into the Law of the Republic of Belarus "*About the Legal Regime of Territories Contaminated by Radiation as a Result of the Catastrophe at the Chernobyl NPP*" with the following statement (§40): "*In the settlements located in radioactive contaminated areas, the State Committee of the Republic of Belarus opens LCRCs, under the supervision of local authorities, for overcoming the consequences of the catastrophe at the Chernobyl NPP when it is necessary, and for the implementation of citizens requirements connected with the testing of foodstuffs and things of general use.*"

At the beginning, the "BELRAD" Institute developed α- β- and γ- dosimeter "Sosna". Its production was organised at the Institute and at the industrial works of Gomel, Borisov and Rechitsa (over 300,000 devices were produced). At the same time, the production of dosimeters RKSB-104 was organised at Minsk industrial works. Having developed and produced over 1000 gamma-radiometers RUG-92, the Institute "BELRAD" promoted the equipping of radiological services of MAP, the Ministry of Forestry, the Belarusian Cooperation Union and LCRC with reliable devices with high

sensitivity range for the monitoring of Cs-137 concentrations in foodstuffs, water and environment.

In the Southern part of Belarus, a network of 370 LCRCs was set up. The first 30 LCRCs were open thanks to the financial support of the Peace Foundation of the USSR (A. Karpov) and the Belarusian Peace Foundation (M. Yegorov). The Chernobyl Committee appointed the “BELRAD” Institute as the head organisation creating and maintaining LCRCs and consulting the population (Letter no397 dated: 14 August 1991). In such centres located at schools and at local administration buildings, the population had the possibility to measure the radionuclide concentrations in foodstuffs and to get objective information about the safety of their use for food. They were also informed about culinary processing (specific recipes) techniques for reducing contamination. BELRAD Institute selected the candidates of local teachers, doctors, nurses, and agronomists in association with the local authorities: they were trained at the BELRAD Institute facilities to become “radiametrist” (they received a qualification certificate). Every month, radiametrists send to the “BELRAD” Institute reports containing results of the radiation control of foodstuffs, nature gifts and animal feeding. The Chernobyl Committee also took part in the system by financially supporting the production of devices for the LCRC and radiametrists’ wages. The first part partly describes the system of LCRCs implemented by “BELRAD”.

2.2.3. Current situation

Today, the Chernobyl Committee does not support any LCRCs. 20 LRCRs are the property of the Research Institute of Radiology. Other 20 LCRCs are operating in Belarus thanks to the financial support of the German Chernobyl initiatives ("Christian Women for Life", "JugendUmweltNetzwerk" (JANUN), "Kinder von Tschernobyl - Hannover", "Tschernobylhilfe-Auschuss im Freudeskreis Polozk", "Bürgerinitiative Hermannsburg", etc). 6 LCRCs are also operated in the Bragin district with the financial support of the Swiss Agency for Development and Cooperation in the framework of the CORE programme. BB-RIR supports too several LCRCs in the Stolyn district.

The radiation monitoring data consist in over 350,000 samples (identified by the surnames of the owners of foodstuffs). According to these data the maps of the radiation contamination of milk, berries, mushrooms, etc have been made.

The contamination density of milk is the paramount risk factor for the health of people, especially children. According to the data coming from LCRCs of the Gomel region and three districts of the Brest region, about 15% of the controlled milk had Cs-137 contaminations above the permissible level of 100 Bq/L. In 2001, 326 settlements had milk with Cs-137 concentrations exceeding the permissible levels. According to the data of MPHS, the Cs-137 activity in milk samples were measures over 50 Bq/L in more than 1100 villages of Belarus (the legal limit for Cs-137 in children’s food is 37 Bq/kg,L).

3. PARTICIPATION OF THE BELRAD NGO INSTITUTE IN OVERCOMING THE CONSEQUENCES OF THE CHERNOBYL ACCIDENT IN BELARUS

3.1. Mapping of territories and creation of LCRCs

Since 1989, the Government of Belarus implied the staff of the non-governmental Institute of Radiation Safety “BELRAD”[11] in the assessment of the radiation situation and in the implementation of radiation protection measures of the population.

In 1989, the complex Commission[12] of the Council of Ministries of Belarus made investigations in the villages of Chudyuny (> 147 Ci/km^2), Malinovka, and Maysky (district of Cherikov, region of Mogilyov). The proposals of the Commission were accepted by the Government, and the inhabitants of those villages were resettled. The same Commission made a complex investigation of the village Veprin (district of Cherikov). According to the results of the work of the Commission, all children were sent for several months to a sanatorium in Russia; then, all inhabitants of the village were also resettled and the village was land-buried.

In 1990 and 1991, the same Commission investigated living conditions in some villages of the district of Narovlya (figure 2) and especially, the possibility for producing foodstuffs containing Cs-137 (in accordance with the RDU-90 Republican permissible level). According to the results of the work of the Commission, 65 villages in which life doses could exceed 350 mSv were identified. The Government took the decision of the additional resettlement of the inhabitants of Narovlya as well as 8 villages of the district.

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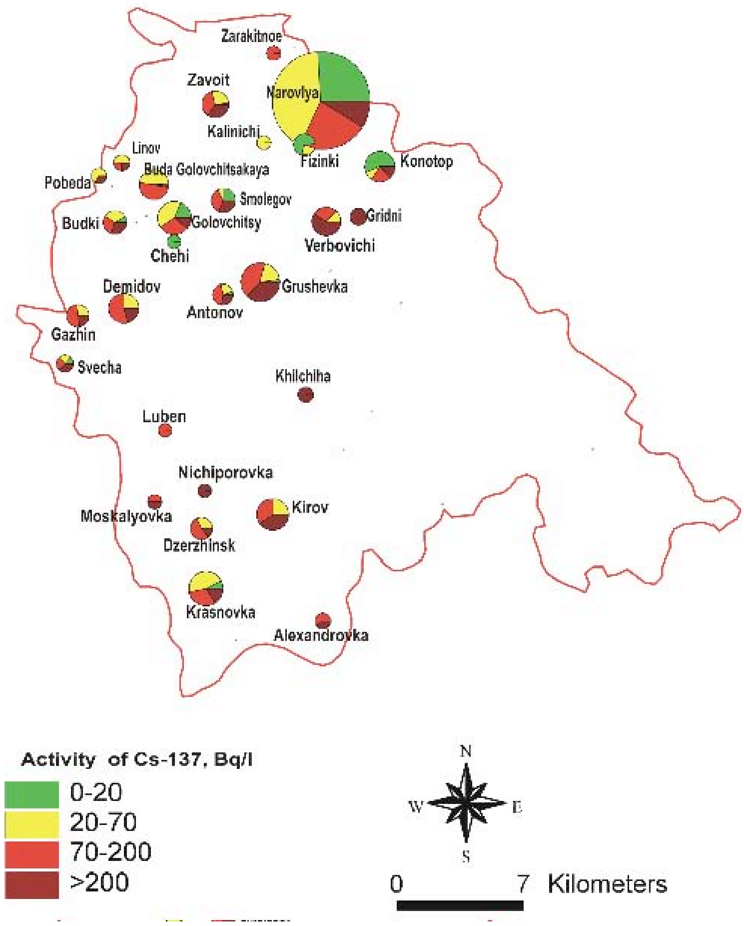
11 From 1989 to 1990, it was called the Scientific and Technical Centre for Radiation Safety.

12 This Commission, chaired by Pr. V.B. Nesterenko, was composed by the Chief of the Radiation Control Center, the Head of radiological services of the Ministry of Agricultural Products, a representative of the Ministry of Water Resources, and representatives of local Government in regions and districts.

Figure 2. Map of the Narovlya district in the Gomel region



In Autumn 1991, the same Commission, on behalf of the Government of Belarus, made the complex investigations of the villages of Olmany, Gorodnaya and other villages of the Stolin district. The Commission worked with local authorities, schools and the whole population. In all these villages, Local Centres for Radiological Control for informing the population were installed and additional radiation protection measures of children were taken (clean foodstuffs at schools, stay twice a year in a sanatorium in clean regions of Belarus, etc.). As a result of that work, a network of 20 LCRCs was organized in the Stolin district, 5 of them being used for implementing the ETHOS project.

3.2. Development of Whole Body measurements

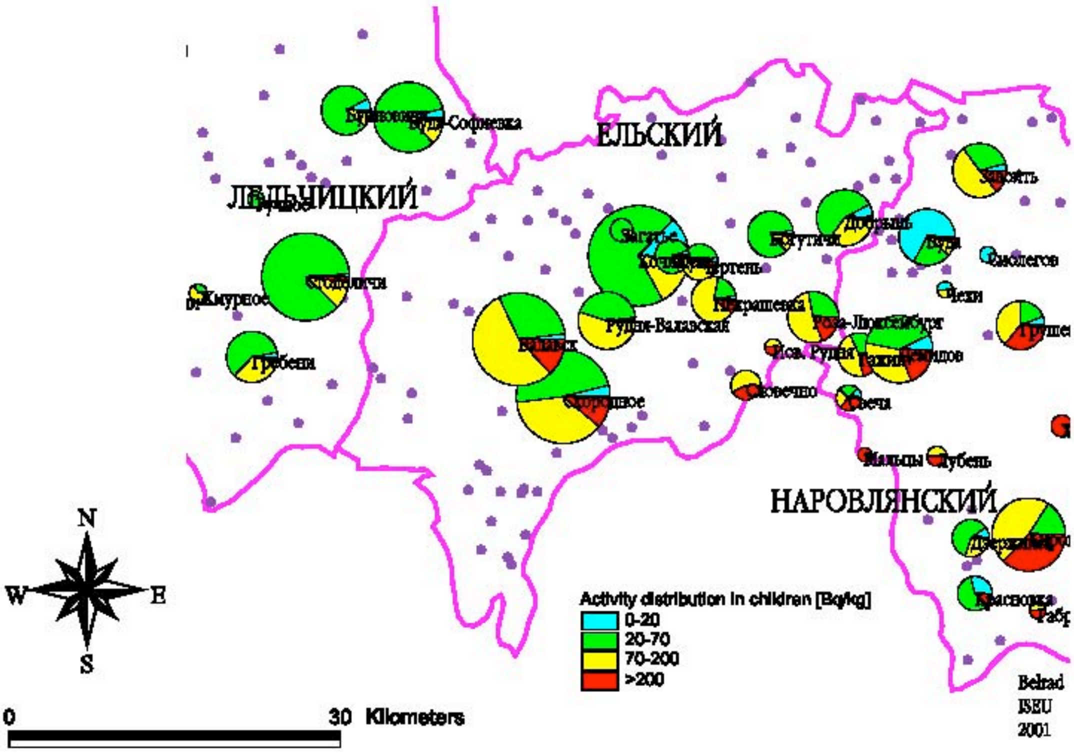
The next fundamental stage of informing the population has consisted in developing the WBC radiation monitoring programme which aims at measuring the Cs-137 accumulation levels in children and in searching possibilities for their minimization. In that respect, since 1995, the BELRAD Institute began to create a net of mobile WBC laboratories. Thanks to the help of the Chernobyl initiatives from Germany, Ireland, Norway, USA and of the World Church Council, 8 mobile laboratories (in vans or

minibuses) were developed: the concept had been presented to the institute by the "Chernobyl Children" Irish Project and the Vienna city Council.

With these mobile WBCs, about 204,000 children were measured from 1996 to 2004, in villages of Gomel, Brest, Mogilyov, Minsk, Grodno and Vitebsk regions (21 districts – figure 3). This program was implemented in association with the Research Centre "Juelich" (in Germany) and financed by the German Ministry for the Preservation of the Environment and Radiation Safety.

These measurements demonstrated that only 10 to 15% of children had internal Cs-137 contamination under 10 Bq/kg. The maximal Cs-137 concentration levels reached 7200 Bq/kg.

Figure 3. Contamination of children



Scientific investigations made by medical staffs and researchers demonstrated that pathological dysfunctions of important organs and systems of children can appear if the Cs-137 accumulation level in the organism was in the order of 30 to 50 Bq/kg. Heart muscle is especially sensitive to the radiation contamination of the organism.[13].

In 1998, 2000 and 2002, MPHS made attempts to create and publish a New Catalogue of the situation. The Ministry for Emergency Situations (MES) - Chernobyl Committee - and the House of Representatives of the National Assembly of Belarus organised a

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13 Pr. Yu.I. Bandazhevsky. Biomedical Effects of Radiocaesium Incorporated into the Organism. Minsk, 2000, page 70.

commission of experts that carried out direct WBCs measurements of 5,000 inhabitants (basically children) in 45 villages declared by MPHS as “safe and clean”. The BELRAD Institute was involved in these investigations: WBCs measurements demonstrated that the actual annual burden doses of the inhabitants of those villages were 6 to 8 times higher than those written in the New Catalogue submitted by MPHS to the Government of Belarus. The results were then reported first at the Parliament Assembly. In April 2000 the results of the work of Commission were reported at the special session of the Chamber of Representatives for the problems of the consequences of the Chernobyl accident. The proposals of the Commission were accepted: at the demand of the Government, MPHS was obliged to revoke the draft of its *Catalogue of Annual doses of the population of Belarus (2000)* and to send it to the Institute for Radiation Medicine and Endocrinology for revision.

The WBC measurements database allowed to draw maps of the children contamination in 12 districts and to adapt the radiation protection in these regions. It is now considered[14] that protective measures should be ensured in such a way that the annual dose received by the critical group should not exceed 0.3 mSv and, that it should be less than 0.1mSv as an average in the whole settlement.

In August 2002, according to the submission of MPHS of the Republic of Belarus, the Decree of the Council of Ministers of the Republic of Belarus (no 1076 dated: 8 August 2002) excluded 146 villages of the Chernobyl regions of the republic from the list of the settlements located in the contaminated area. As a result, 66,000 inhabitants (among which 17,000 children) were deprived of aid for providing them radiation protection (clean meals at schools, cures in sanatoria, etc). The same Decree decreased the radiation status for 71 villages (60,000 inhabitants, among which 13,000 children) that would reduce the financial support given to the population.

Consequently, in 2002 and 2003 together with the French association “Enfants de Tchernobyl - Belarus” the BELRAD Institute implemented the project “Villages oubliés” (*"Forgotten villages"*) and performed WBCs measurements in 20 villages and in the town of Kalinkovichi (38,000 inhabitants). Those measurements demonstrated that all internal doses exceeded 0.3 mSv/year. This was also the case in 17 settlements whose radiation status was decreased (for example, in the settlement Korma - 4,900 inhabitants) where doses of the critical group were comprised between 1.6 and 1.8 mSv/year; and, in the town of Dobrush (20,100 inhabitants) where doses of the critical group were estimated to reach about 0.3 mSv/year.

Therefore, it must be recognized and pointed out that the §3 of the Law of the Republic of Belarus “*About the Social Protection of Citizens, affected by the Accident at the Chernobyl NPP*” (no 31-3 dated to 04.06.2001) is not yet implemented. Everything

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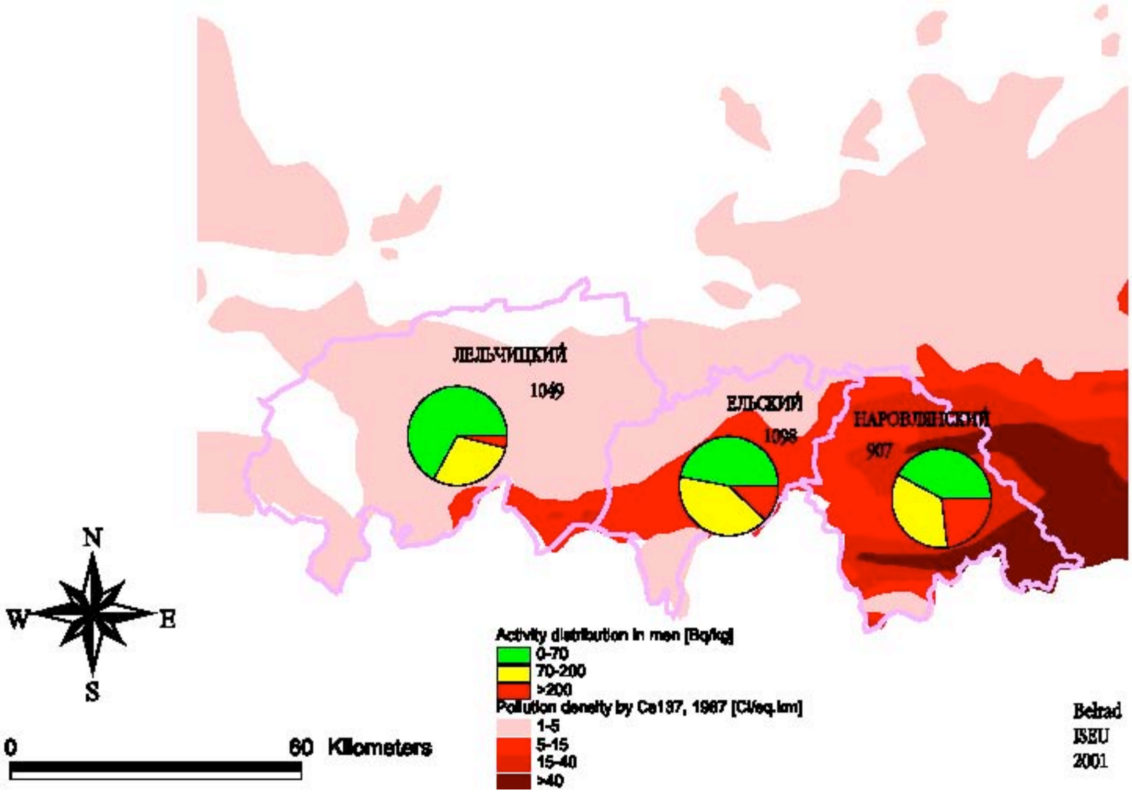
[14] In accordance with the addendum and the modification of the Law of the Republic of Belarus “About the Social Protection of Citizens, affected by the Accident at the Chernobyl NPP” # 31-1 dated to May 17, 2001.

shows that mistakes were made when determining the list of settlements excluded from the "*State list of settlements and objects located in the contaminated area*".

In the same Decree (no 31-3 dated: 4 June 2001) of the Council of Ministers of the Republic of Belarus, MPHS was ordered to prepare, once again, a Catalogue of dose burdens of the population of Belarus. The Republican Scientific and Practical Centre for Radiation Medicine and Human Ecology (RSPC RM&HE) in Gomel prepared a new method for calculating the annual doses of the populations based on the hypothesis that the annual dose burden of the population was proportional with the contamination density of the territory. The members of the BELRAD Institute (Professor V.B. Nesterenko and Professor A.N. Devoyno) were included in the Commission of experts of the National Commission for Radiation Protection for the assessment of the scientific significance of the "*Methods of Determining of Annual Dose Burdens of the Population of Belarus*" proposed by RSPC RM&HE. BELRAD submitted to the experts Committee the results of WBCs measurements performed in 97 villages of the Gomel region, 9 villages of the Mogilyov region and 18 villages of the Brest region. The **K**[15] coefficient values vary from 0 to 354 in Gomel region, from 7 to 95 in Mogilyov region an from 6 to 85 in Brest region (figure 4).

[15] K is the ratio between the mean specific Cs-137 contamination of inhabitants (Bq/kg) and the contamination density of the territory (Ci/km^2). See:V.B. Nesterenko. "Radiation monitoring of inhabiltants and their foodstuffs in the Chernobyl zone of Belarus", Chernobyl accident newsletter no XXV, Minsk, 2004.

Figure 4. Comparison between the mean specific Cs-137 contamination of inhabitants (Bq/kg) and the contamination density of the territory (Ci/km^2)



This shows clearly that the main hypothesis of the authors of the "*Methods of Determining of Annual Dose Burdens of the Population of Belarus*" based of the radiation contamination density of soil has no scientific ground. Therefore, the National Committee for Radiation Protection finally rejected it. A new Catalogue of dose burdens of the population should be made on the basis of calculations of external exposures (from the measurements made in all settlements by the Belarusian State Committee on Hydrometeorology) and internal exposures received by critical groups of inhabitants - 10 to 15 persons - (extrapolated from WBCs measurements).

Moreover, it was revealed a lack of WBCs data in several villages particularly in the Brest and Mogilyov regions. In order to recover some data, BELRAD Institute proposed to the administration of RSPC RM&HE to use its mobile WBCs (not less than twice a year in each settlement). This proposal has not been accepted yet.

The capabilities of the mobile WBCs of the "BELRAD" Institute allow to perform measurements of 55,000 to 60,000 persons a year and to ensure the reliable data of the radionuclide accumulation level in inhabitants. Direct WBCs measurements will reveal the most irradiated groups of people. At the end of the year 2003, more than 200,000 WBC measurements of children had been already performed in schools and kindergartens. High Cs-137 accumulation levels in children were revealed: the highest

child contamination measured is 7000 Bq/kg that corresponds approximately to an annual dose of about 17 mSv!

Information is systematically given to parents, school and regional administrations. The results of WBCs measurements were integrated and published by approbation of parents and children in the information list, submitted to the Government, President's Administration, Ministry for Public Health Services (MPHS), all Governors, the Executive Committees and all LCRCs to inform them and to implement protective measures.

Today, there are still only 8 mobile WBC laboratories available; a number of about 15 would be necessary to efficiently make measurements of the 500,000 children who are still living in the territories affected by the Chernobyl accident.

4. PARTICIPATION OF FRENCH PARTNERS IN THE REHABILITATION OF LIVING CONDITIONS IN THE TERRITORIES AFFECTED BY THE CHERNOBYL ACCIDENT: THE ETHOS PROJECT

4.1. Context and introduction

The post-accidental situation in the territories affected by the Chernobyl accident is characterised by a high degree of complexity. The inhabitants are confronted with a risk that is omnipresent in every facet of their everyday life but they do not know how to cope with it. They have the general feeling to be ignorant and to have lost the control on the simple and traditional situations they used to manage in the past. In such a context, the role of authorities and scientific bodies is pre-eminent. Thus, in the first two chapters, the collective response of governments has appeared as a key element to protect the population and to implement efficient countermeasures. However the situation is so difficult that many proposed actions are not completed or ineffective. This is reinforcing the general feeling among the population to be abandoned and deceived. Next, all realms of the private and social lives are altered. Ethical, social, economic, political, but also aesthetic and symbolic values are more or less seriously depreciated. As a result, the quality of life as a whole is perceived as being irreversibly affected. It is consequently important that rehabilitation programmes start off from the day-to-day actions of the inhabitants. This means to look for all opportunities for improving the daily life and to give those affected the means to act by themselves within the framework of the community. This approach is interrelated and complementary to actions developed by authorities.

The approach proposed during the ETHOS project was based on a strong involvement of the local population in the control of their radiological protection. It was an innovative strategy in order to better cope with the main features of the post-accidental situation. It tried to take into account the complexity of the situation (lots of stakeholders: population, experts, administration) and all the dimensions that contribute to the quality of life (health, environment, economy, education, culture). The problem of living in a contaminated territory was also treated in its global nature. A main goal was to create conditions for the affected populations to enable them to become more autonomous actors in a rehabilitation process embracing the improvement of the local living conditions as well as increasing radiological safety. The recovery of self-confidence and control among the population as well as the restoration of social trust were also key objectives. It aimed besides to give inhabitants and the local community the means to participate and to be involved in the management of their radiological situation. They become active stakeholders and take part in decision-making processes.

4.2. First experience at the local level in the village of Olmany (1996-1999) :

4.2.1. The situation of Olmany in 1996

The first part of the project (ETHOS I: 1996-1999) was implemented in the village of Olmany (Stolyn district, Brest region). Olmany was in a “voluntary relocation zone“ where the estimated average annual individual exposures ranged from 1 to 5 mSv, the

ground caesium contamination ranging between 185 and 555 kBq/m^2. Among the criteria taken into account for the site selection was the location of the settlement in a zone that, according to the Belarusian law, was not dedicated to a complete relocation and where the rehabilitation of the living conditions was therefore necessary. Another was the existing social network including families with children and the clearly expressed willingness of the population to participate in the project.

In 1996, the village of Olmany (1265 inhabitants) was linked to a collective farm of roughly 1800 hectares whose main production was milk, wheat and meat. Problematic contamination levels of privately produced food appeared to be a real concern for both the population (notably the mothers) and the local authorities. Tradition was very deeply rooted in the social organisation, and the population, contrary to other districts more severely affected by previous relocation policies, had a large proportion of young people (369 inhabitants less than 17 years old). Only a few families with very young children left Olmany when the consequences of the accident in their village were officially recognised in 1991. Despite an on-going political debate concerning the possibility of relocating the population of the village there was a firm opposition from most of the inhabitants to leave.

As far as the monitoring system was concerned, some measurements were already performed. Whole body measurements were both performed by the BELRAD institute and by the Stolyn hospital and foodstuffs were measured time to time by State organisations (to make statistics on the radiological situation of the affected territories). Hpwever, there was no harmonization between all these measurements (results were not given in the same units): the population did not receive clear information and was not involved at all in the management of its radiological situation.

4.2.2. The ETHOS approach

During the first mission in July 1996, a series of meetings with the population of Olmany allowed to understand the difficulties and the worries of inhabitants. They asked several questions: “Do you think that we can live here with our children? Are there any risks to our health? Should we leave this area or can we stay?”. Taking into account the difficulties created by the population’s distrust in experts, the research team[16] expressed its ethical position as refusing to make decisions in the place of the people confronted with the contamination while proposing to help those having decided to stay in the village to improve their safety and their quality of life. The population also expressed a feeling of “being treated like guinea-pigs“ by scientists, “without any kind of benefit in return,” and a kind of scepticism about the potential benefit to be expected from the project for their village. This made it necessary for the research team to commit itself to adopt as a main goal the practical improvement of the real local situation in the village of Olmany during the lifetime of the project.

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[16] The ETHOS multidisciplinary team comprises: researchers from Mutadis Consultants, the Compiègne University of Technology, the Paris-Grignon National Institute of Agronomy and CEPN (Centre d’étude sur l’Evaluation de la Protection dans le domaine Nucléaire), researchers needed in specific fields such as sociology or psychology contributing a complementary outlook to the project.

During the first few stays, the ETHOS team also discovered the problems that inhabitants have to face and realized that their position as experts and their knowledge were not so useful. In spite of all the data that they had accumulated on the consequences of the Chernobyl catastrophe, they were unable to bring concrete answers to the inhabitants because they knew nothing of the local situation: the way of life, dietary habits, agricultural methods, social and administrative organisation, available means. They have never envisaged dealing with the problem of rehabilitation in an individual perspective that is to say at the level of a farmer or of a mother.

They also began to work with the population. Radiological measurements were performed systematically in participation with the Olmanians throughout the entire village. Little by little, the villages learnt how to use the instrumentation to measure the radiological risk in their environment by themselves. This co-operation allowed the ETHOS team to appropriate the living conditions of the population.

From the contact established with the population several working groups involving local volunteers were created and dedicated to a specific objective.

- The "young mothers" group aimed at improving the radiological situation of the children in the families. They developed strategies to reduce contamination levels as low as possible taking into account the local situation and the economical constraints that families had to face.
- The "milk" group was constituted by private producers. When the ETHOS project began, the problem posed by the radiological contamination of private milk appeared to be a source of concern. First, milk was an important part of children's diet; however it was generally considered by the inhabitants to be homogeneously contaminated at the scale of the village. Furthermore, the trade of private milk was stopped in Olmany after the accident because of its contamination, which was strongly perturbing the economy of the village. A group of volunteer private producers worked on these problems and identified the ways of reducing the contamination (clean hay and choice of pastures).
- The "meat" group, constituted by private producers aimed at improving the radiological quality of the bovine and porcine meat in order to consume it and to sell it on local markets.
- The "video" group met a dozen of teen-agers. It appeared quickly enough that the youth of the village was not really interested in the ETHOS project. Most of them just felt like leaving the village as soon as possible. They were reluctant to take part in the different groups. It is by chance that some of them get interested in video material brought by a member of the team and that they decided progressively to make a movie on the situation of the village and to address the issue of contamination.
- The "education" group: several teachers became aware that the school brought no practical knowledge to children and did not allow them to evaluate their situation These teachers have also decided to organize excursions with the students so that they could perform measurements themselves and understand the radiological situation of their own village.
- The "ashes" group, led by the forester of Olmany, was worried by the future of contaminated ashes. Measurements of ashes have revealed that the

contamination could reach very high levels. Traditionally, ashes were spread as fertilizers in gardens. The aim of the group was to avoid spreading this contamination in the near environment of habitations.

These working groups have favoured the adoption of prudent and responsible attitudes in the management of day-to-day situations. They provided each individual means to evaluate its personal exposure through measurements of its environment and of foodstuffs.

4.3. Results of ETHOS I

In 1996, at the end of the project, the radiological monitoring system was improved.

- Radiameters were of common use in Olmany and inhabitants were able to measure by themselves the ambient doses rates in their house or in their garden. They were able to identify the safe places for their family.
- A new LCRC had been opened in Olmany and measurements of foodstuffs were daily performed by the dosimetrist of the village.
- WBC measurements were harmonised.

Besides, through their involvement in the working groups, Olmanians have developed means to understand and interpret measurements. They have identified individual or collective actions to improve their radiological situation and have built the basis of a "practical radiological culture".

The direct participation of the population in measurements favoured their involvement in the management of the situation. This point highlighted that affected people should have a direct access to the monitoring equipment. Devices like radiameters have to be available in each village so that each individual who wants to know the quality of its environment or of its private products can measure them.

The situation in Olmany has shown as well that the capability to evaluate its radiological situation did not only rely on measurements and that means to interpret them had to be provided. On an individual point of view, this means that each person should have means to link its measurements to other indicators. These indicators can be other measurements performed by the same person (historical evolution) or by another one (comparison with neighbouring situations or reference situations). These measurements can be liked with other kinds of data like for instance measurements of foodstuffs with whole body measurements. This includes that information should be easily available and understandable (coherence of units for instance).

It is important too that the affected people access independent data from different sources. This can allow for instance to compare the measurements performed by the authorities to those performed by the inhabitants. People can check the legitimacy of countermeasures and work with the authorities if protective actions need to be re-oriented or modified.

4.4. Second experience at the regional level in the Stolyn district (2000-2001):

4.4.1. Extension of the ETHOS approach

The ETHOS project has continued during two years (2000-2001) on the request of the local and national administration who wished to diffuse further the ETHOS approach in other villages of the district of Stolyn. A new co-operation was also signed (ETHOS II): it involved this time Belarus institutes in order to transfer "the French know how" to the national experts. A programme was implemented in 5 villages of the district: Olmany, Belaoucha, Gorodnaya, Terebejov and Rechitsa. The aim was to rely on local professionals supported by the national experts in order that together they spread the cooperation work with the population.

Four networks of local professionals were created at the beginning of the ETHOS II project, in the fields of health, pedagogy, agriculture and radiation measurements. These networks involved some 80 people, mainly professionals such as nurses, physicians, teachers, education officials, kolkhoz managers and radiologists etc. With the support of the ETHOS team, local government and Belarus scientific experts from the Pinsk Regional Centre for Research on Radiological Rehabilitation, the Belarus Research Institute for Geology and Agrochemistry, and the University of Brest, these networks were able to set in place in the 5 localities, practical projects intended to improve the radiological situation relying on volunteers from the local population. By their involvement and participation in the work carried out by these networks, the various stakeholders (authorities, experts, local professionals and local population), each in their own field (farming, teaching, medicine or radiation measurement), have gradually developed a system of co-expertise, combining different approaches and different sources of readings available, leading to a more precise and reliable assessment of the radiological situation in each village. The work carried out in the context of the different networks has also made it possible to develop concepts, practical tools and professional arrangements adapted to life in the contaminated territories and to foster the development of practical radiological culture amongst the populations involved.

4.4.2. International seminar at Stolyn

The ETHOS project ended with an international seminar held on 15 and 16 November 2001 at Stolyn. The seminar was attended by representatives from the Chernobyl Committee of the Soviet Ministers of the Republic of Belarus, authorities from the Stolyn district and the Brest region, managers and professionals from collective farms, inhabitants of the contaminated localities, scientists from the National Academy of Science, representatives of the European Commission, the United Nations Programme for Development and the World Bank, the French ambassador to Belarus, representatives of international non-governmental organisations, European scientists and members of the ETHOS group. The objectives of the seminar were to present the results of the project and to discuss the issues associated with the sustainable rehabilitation of contaminated land and the handling of health problems, which remains a major concern for the population. Indeed the project showed that radiological protection is a goal that cannot be achieved independently of the other aspects of overall

improvement of the living conditions in the territories in which the situation of economic crisis prevails and the health of the population is still degrading. Radiological quality is only meaningful in the context of renewal of quality of life and health care.

The 150 attendees at the seminar backed a declaration recommending that international organisations continue their cooperation with the local and national government authorities and the Belarus scientific institutes in the context of new projects to encourage economic development and radiological rehabilitation of the contaminated territories with due allowance for the experience gained from the ETHOS Project.

5. IMPLICATIONS ON THE HEALTH OF THE POPULATION

It is very important to develop a system of information and education of the population promoting the learning of the scientific and medical recommendations in the field of safety living. It is necessary to study not only the sickness rate of the population in the Chernobyl regions but to implement the necessary radiation protection activities and the treatment of the suffered population. Here, some activities for minimisation of the internal exposure of the population can be listed, for example:

- Resettlement (135,000 persons were resettled);
- Cultivation of pastures and hayfields, agrochemical protective activities in agriculture (about 0.5 ha of pastures and hayfields per cow were cultivated once in 17 years, although it is necessary to do it every 3/4 years);
- Mixed fodder with sorbents and boles in cattle-breeding (the production of mixed fodder with sorbents - Prussian blue - is necessary: 200 to 250 kg per cow);
- Meals for children at schools and kindergartens due to the Chernobyl programme
- Annual stay in clean districts and abroad for health improvement;
- Organisation of the production of food additives and their inclusion in the food allowance for decontamination of the organism from radionuclides and heavy metals:

  Pectin additive: Since 1996, in association with initiatives from Germany, England, France, Italy, USA, Austria, Ireland, Belgium and Switzerland, BELRAD Institute started also the implementation of the programme consisting in WBC measurements associated with the intake of pectin food additives for the decontamination of the organism of children. The Institute "BELRAD" used the scientific innovations of the Ukrainian Centre for Radiation Medicine and the recommendations of the Belarusian Institute for Radiation Medicine of MPHS (2 to 4 times a year, contaminated children follow 21-days cycles of intake of additives of pectin[17] together with vitamins and microelements). In 2000, "BELRAD" received the license from the MPHS of Belarus allowing the institute to produce and to use the food additive (apple drink) named "Vitapect" enriched by 7 vitamins (group B, C, E, β-carotene) and 4 microelements (K, Zn, Se, Ca). According to the task of Chernobyl Committee of Belarus, comparative tests of the efficiency of pectin and vitamin preparations "Medetopect" (France), "Vitapect" (Institute "BELRAD"), Spirulina (Russia) and the vitamin preparation "Vitus-Iod" were carried out at a sanatorium in "Belarus". The groups of children (up to 30 persons in each group) took these preparations two times a day during 21 days. The WBC measurements made before and after the intake of these preparations demonstrated the decrease of the Cs-137 concentration in the children: - 46 to 49% decrease when taking pectins; - 31 to 35% decrease when taking Spirulina; - 23% decrease when taking "Vitus-Iod"; - 18% decrease in the control group (without taking these preparations). Another experiment was implemented at the sanatorium "Serebryanye Klyuchi" in Svetlogorsk (Belarus) under European standards (double blind tests) to test the efficiency of the intake of the "Vitapect" pectin. This demonstrated that during 21 days, there was a 14% decrease of the Cs-137 concentration in children if they tae a placebo preparation, and a 65% decrease if they take "Vitapect".

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[17] First, the French preparation "Medetopect" was used, and then, the Ukrainian "Yablopect".

As a result of the Chernobyl catastrophe the population of Belarus was exposed and is always exposed to the influence of negative factors, the basic of them being radiation-induced morbidity and diseases. All people of the Republic were irradiated to iodine radio-elements during the early period of the accident. About 10,000 people, among which 1800 children, received care because they had developed thyroid cancer.

Among the population living or lived on territories with Cs-137 contamination density over 37 kBq/m^2, it is observed a significant increase of the diseases rate of malignant formations of respiration organs, digestion organs and dairy gland cancer. In these regions genetic dysfunctions, congenital malformations first of all, were significantly established[18].

As for bodily diseases of the affected population, it was also stated significant increases of the diseases rates of cataract, ischemia, respiration system system, urino-genital system, endocrine system, immune system, the stomach ulcer, duodenal ulcer and dysfunctions of metabolism.

The specific anxiety is due to the health of children characterised by an increase of the diseases rate and a decrease of healthy children in the population (from 85% to 20% in the republic and to 6% in Gomel region).

[18] Y.I. Bandazhevsky, Swiss Med. Wkly, 133, 488-490

CONCLUSION

A lot of things have changed since 1986. Global conversions have touched many countries of the world, including Belarus. New states formed on territories of the former USSR, undergo the problems of system transformation from planned to free-market economy. In Belarus, the after-effects of the Chernobyl catastrophe coincided with economic difficulties caused by the breakdown of the USSR and the destruction of social structures. On the way of building a young Belarus State it is necessary to deal with the multitude of socioeconomic problems and to do everything to minimize the consequences of the accident at the Chernobyl NPP. 4% of the national budget is devoted each year to the mitigation of the Chernobyl Catastrophe. Today, new extraordinary situations and crises shocked the world community and Chernobyl is almost completely forgotten. It is necessary to declare that the help from the world community is inadequate and has little efficiency. Remote consequences are still unobvious but the increase of the number of various diseases and of genetic disorders is worrying.

This accident has changed the further development of nuclear energy in the world. It has modified its fundamental image and the public's attitude to it, caused the growth of anti-nuclear motion and demands about shutdown of all NPPs [10]. Till present, people think differently about the Chernobyl catastrophe. International experts often consider the Chernobyl catastrophe only from the point of view of radiation factor pointing at the non-correspondence of dose charges to the accepted levels of interference. The Chernobyl problem is considerably much more complex. It is impossible to underestimate its economic, social and humanitarian aspects, especially on the background of difficulties of the Belarusian transition to free-market economy.

The Belarus experience can allow to draw lessons and to give recommendations for the management of a nuclear accident.

In countries having their NPP and in contiguous countries, systems for monitoring the environment and foodstuffs should be organised beforehand. In all European countries,

- A national system of radiation control of foodstuffs must be organised.
- The national system must be completed by an independent network of local centres of radiation control of foodstuffs (LCRCs).
- A network of fixed and mobile radiological laboratories (including WBCs) should be created to determine the Cs-137 internal contamination (especially for children).
- Reserves of food additives allowing the decontamination of the organism should be constituted in advance.
- A specific guide on specific agro-industrial techniques should be written and distributed in order to inform and help farmers in producing clean agricultural products on slightly contaminated soils (adapted to the local productions).
- A dynamic system of permissible levels of contamination of foodstuffs and agricultural products, which operatively reflects the up to date radiological situation should be envisaged in the laws.

ANNEXES

Annex 1: Shutdown of the reactor and construction of the “Sarcophage”

Pic.1 The destroyed 4th block of Chernobyl NPP.

The attempts were undertaken to reduce the temperature of the reactor by submitting water to the active zone. In order to create barriers on the way of emissions from the blasted energy - block, a decision was taken to isolate it from the environment with various materials. During the period from April 27th to May 10th, 1986, helicopter subdivisions of the army aircraft threw about 5000 tons of various materials on the blasted block (pic. 1), including 40 tons of boron (an efficient absorber of neutrons) and 1800 tons of clay and sand.

At the end of May 1986, two decrees of the Central Committee (CC) of the Communist Party and the Cabinet council of the USSR were administered. They described measures of decontamination of buildings of the Chernobyl NPP, as well as the renascence of energy blocks exploitation 1 and 2.

Pic. 2. "Sarcofage" of the energy bloc 4

The main task was to build the object “Refuge” (“Sarcofage”- pic. 2) of the energy block 4. A powerful organization, US-605, was formed: it included construction enterprises from six areas, administrations of: mechanization, of motor transport, of energy management, of manufacturing-technical supply, of sanitary-everyday service, of working supply (including a canteen), as well as the service of the bases of the habitation of personnel. With the necessity of the respect of demands, of norms and rules of radiation security there was established a seasonal method of the work of personnel during 2 months. The personnel (about 10000 people) on the territory of the NPP worked all day long in 4 changes. In November 1986, the construction of the "Sarcophage" was finished, and US-605 was deconstructed.

The erection of the "Sarcophage" was carried out in a record short term. However even if time and money were won, several problems were ignored. Dozens of tons of nuclear fuel remained under the concrete stratum and doses received by workers were relatively high.

Annex 2: Protection of water sources

Project works and research works were developed as well.

Project works:

- The specification of hydrological characteristics along the Pripyat and the Braginka (expenses, modulation of the speeds of water vertically in water flow, the maximal and minimal levels of water during floods et al.);
- The development of the scheme of dams placement on channels and the Braginka that provide accumulation of flood waters in the area between the Pripyat and the Braginka;
- The development of barrages projects.

Research works:

- Specification of the data about radioactive contamination of soil and water on the left bank of the Pripyat. Separately along the territory with inflow of surface waters into the Pripyat;
- Forecast making of pollution dynamics for a period June-October 1986 and June 1986 - April 1987 (on the whole and on the spectrum of radio nuclides) in air, surface water and soil;
- Researches of silt radioactive contamination in the Braginka, main channels of ameliorative system and into the Pripyat (from pond-cooler of the NPP till mouth);
- The estimation of possible changes of radioactive contamination in time, in annual cycle;
- The estimation of efficiency of applying various sorbents and the development of demands to the parameters of filtering strata (prisms) of sorbents;
- The estimation of the change of radioactive contamination of soil in case of accumulation of flood waters in the drainage-basin of the Braginka and in the area between the Pripyat and the Braginka;
- The calculations of possible volumes of radio nuclides coming into the Pripyat and then to the Dniepr and the cascade of Dniepr pondages due to flood waters from the bottomed-land surface on the territories between the river and anti-flood barrages;
- The estimation of efficiency of measures taken to decrease the radioactive pollution of aqueous objects.

The main difficulty of these works lay on the Ministries of Aqueous Economy. In the basis of the concept of anti radiation water protective measures, as it has already been partially said above, they put the fixation of fallen from outside radio nuclides on the surface of the Pripyat in the places of their prolapse and ensuring, as possible, of minimal carrying out of radioactive substances during the flood in 1987 ith transit waters from Belarusian territory to the cascade of Dniepr pondages, where they took water for drinking purposes in Ukraine.

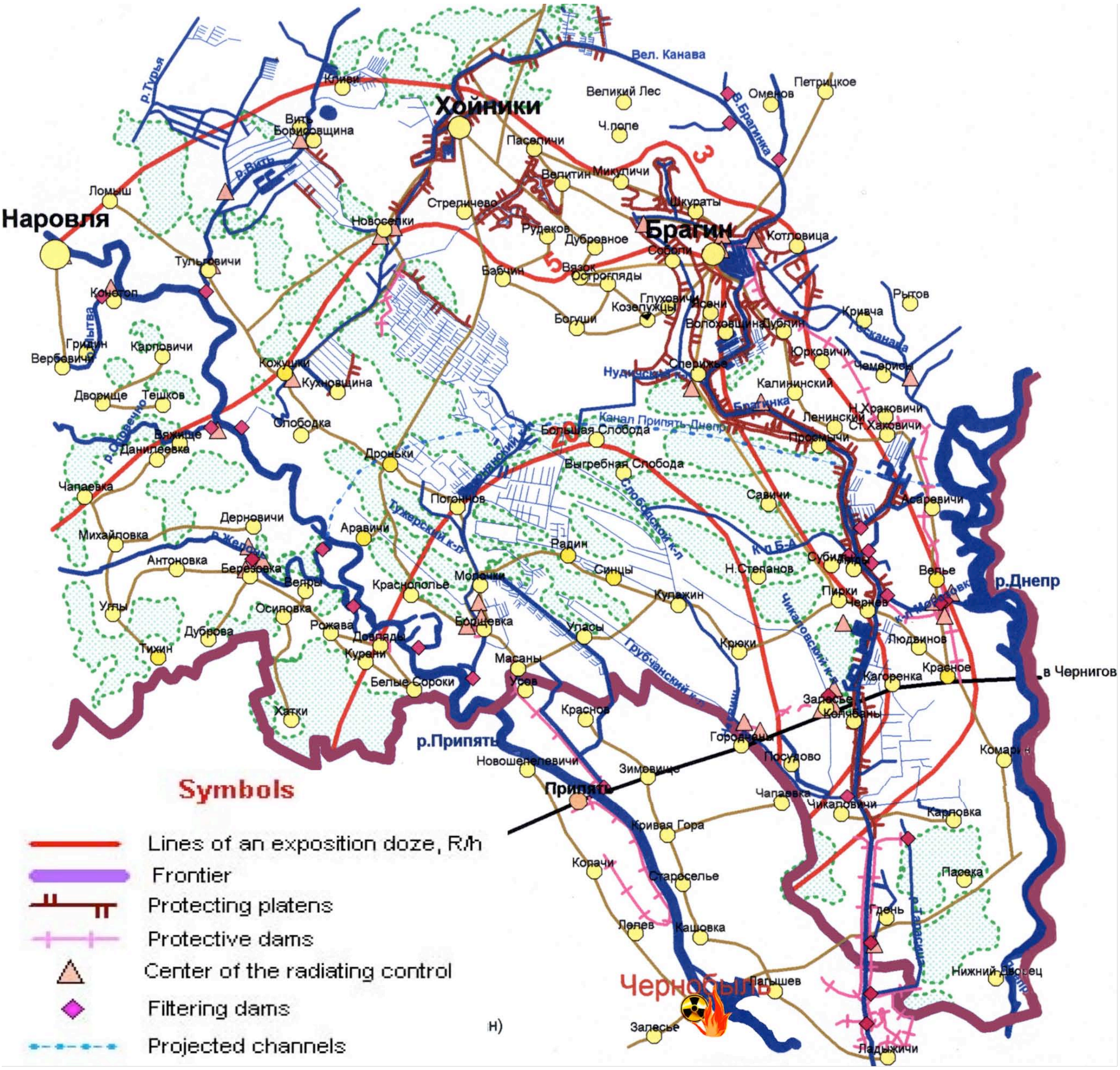
For these purposes, during June - October 1986, they built the following protective constructions (Pic.1):

- Wall barrages 107.2 Km;
- Ground rollers 3.3 km;

- Walls in channel 18;
- Pondages 5;
- Reservoirs for drainage water 14;
- Filtering insertions (with general length of 4.5 km) 47;
- Adsorbent laid (zeolite containing adsorbents) 62.3 m^3

The scheme of anti radiation water protective measures is presented on figure 5.
It is interesting, that on the territory of the Republic of Belarus the adsorbent from zeolite containing substances in filtering insertions of the body of barrages resided under the mixture of stones with ballast. In the course of time it gained water and destructed the body of a barrage. Quite often river waters flowed across the body of a barrage. In Ukraine the sorbent in the barrage body was mounted in removable containers that let replace the sorbent periodically, in 3 - 4 weeks. On the whole, as it was seen from experimental data, these pollutions of floodwaters of the rivers Dniepr and Pripyat in spring 1987, such measures, to a certain extent, played their role, and radio nuclides flow to the cascade of Dniepr pondages was carried out as to minimum. Aside from filtering constructions on the influxes of the Pripyat and ameliorative channels of various levels they created dug ponds and silt traps, that had a purpose to bring down the speeds of erosion in aqueous flood and to decrease the quantity of brought substances, that generally provoked the migration of radio nuclides to the mouth of rivers and channels.

Figure 5. Anti radiation water protective measures in the area between the Pripyat and the Dniepr, carried out in Belarusian SSR in 1986 after the catastrophe at the Chernobyl NPP



Annex 3: Examples of demands for conducting agriculture on polluted lands according to "Guidance for conducting rural economy in conditions of radioactive contamination of the part of the territory of the Russian SFSR, the Ukrainian SSR and the Belarusian SSR for a period 1988-1990"

	Till 15 Ci/km^2 Cs-137	From 15 till 40 Ci/km^2, Cs-137	From 40 till 80 Ci/km^2, Cs-137
Recommendations of crop science conduct and animals breeding in public sector	* Crop science is conducted without limitations; * In summer period it is recommended to keep cattle by the type of «green conveyer»; * Natural mowing lands and pastures are used for feeding cattle on meat, of young animals and milk cows with milk processing in butter.	* Mineral fertilizers are added in recommended doses. Organic fertilizers are added without limitations; * Natural mowing lands and pastures are used for herding of goats, sheep, and horses, milk cows with milk processing on butter.	* Agricultural lands are used under sewage for seeds and technical cultures; * Herding of animals on natural pastures is not allowed; * In case of necessity it is allowed to herd one-year animals, and to process milk only for butter.
The peculiarities of the conduct of personal ancillary economies (PAE)	Production of vegetables, potatoes and gardening is conducted without limitations.	* Growing and feeding meat poultry, pigs and cattle is allowed without limitations; * Herding of cattle is allowed on individual usage pastures with the pollution level till 5 Ci/km^2. In case of such pastures milk is processed only for butter. Private economies in forest are forbidden; * Wild fruits, mushrooms and forest berries, herbs are allowed to collect in all forests, not having exclusionary symbols and inscriptions.	* Growing of vegetables, potatoes on kitchen gardens is decided concretely for every borough; Agricultural production on the territory polluted with ^{137}Cs higher than 80 Ci/km^2 is forbidden. Herding of cattle from individual sector on the pastures is strictly forbidden.

From 40 till 80 Ci/km^2 of Cs-137, all agricultural production without exception is subject to radiation control. Till 15 Ci/km^2, an optional control is carried out. Between 15 and 40 Ci/km^2 of Cs-137, a preventive radiation control is conducted during vegetation and if products are for sale or for processing.

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