MINISTRY OF FORESTRY OF THE REPUBLIC OF BELARUS

State Enterprise for Protection and Forest Monitoring "Bellesozaschita"

BELARUSIAN FORESTRY DEVELOPMENT PROJECT
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10th STAGE REPORT

Final report
"Develop the methodology to forecast the Cs-137 contamination of wood, determine the possibility of harvesting timber that will meet the required sanitary standards. Develop the methodology of radiation inspection of forest fund"
for the Contract **№ BFDP/GEF/SSS/16/34/ - 03/16**
dated May 18, 2016 г.

Project Activity 3.4: Development of a system of support for decision-making concerning forest management in radioactive contamination areas, prompt informing about the radioactive conditions in the territory of the forest fund

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Abbreviations

NRA	Normative Regulatory Act
TNRA	Technical Normative Regulatory Act
TCEP	Technical Code of Established Practice
Forestry Enterprise	State Forestry Enterprise
SFPA	State Forestry Production Association
MoF	Ministry of Forestry
^{137}Cs	Cesium-137 radionuclide
GRI	Gamma-Radiation Intensity (gamma radiation dose rate)
I Zone	Radioactive contamination zone with soil contamination density of Cesium-137 37-185 kBq / m^2 (1-5 Ci/km^2)
II Zone	Zone of radioactive contamination with soil contamination density of Cesium-137 185-555 kBq / m^2 (5-15 Ci/km^2)
III Zone	Zone of radioactive contamination with soil contamination density of Cesium-137 555-1480 kBq / m^2 (15-40 Ci/km^2)
IV Zone	Zone of radioactive contamination with soil contamination density of Cesium-137 1480 kBq / m^2 and more (40 Ci/km^2 and more)
RPL/Forestry-2001	Republican Permissible Levels of Cesium-137 content in wood, wood products and wood materials, other non-food forest products
RPL-99	Republican Permissible Levels of Cesium-137 and Strontium-90 radionuclides content in food products and drinking water
IS "RadFor"	Information System "Radioactive contamination of forests. RadFor"
IS "RadForView"	Information system "Radioactive contamination of forests. RadForView" (peripheral version for Forestry Enterprises)
TFC	Type of forest conditions (conditions of soil fertility and moisture)
COT	Coefficient of Cesium-137 transfer from soil to plants

Executive Summary

The final report is presented on 81 pages, contains 15 tables, 36 figures, 10 boxes

1. The subject of the study is forest fund areas exposed to radioactive contamination as a result of the Chernobyl disaster, the system of forest management, protective measures, radioactive contamination control, and information on the radiation conditions in the forests. As of 01.01.2018, the forest fund of the Ministry of Forestry of the Republic of Belarus (hereinafter - the Ministry of Forestry) in zones of radioactive contamination is 1356.3 thousand hectares or 16.1% of the total forest area.

Table 1 - Distribution of the territory of the Ministry of Forestry by radioactive contamination zones (as of 01.01.2018)

№	SFPA name	Forest fund area, thousand ha		Including in each radioactive contamination zone, thousand ha			
		Total	In zones	1 - 5 Ci/km^2	5 - 15 Ci/km^2	15 - 40 Ci/km^2	40 Ci/km^2 and >
1	Brest	1256,4	83,6	81,2	2,4	0	0
			6,65%	6,46%	0,19%		
2	Vitebsk	1656,9	0,1	0,1	0	0	0
			0,01%	0,01%			
3	Gomel	1861,1	816,1	548,1	196,8	70,6	0,6
			43,85%	29,45%	10,57%	3,79%	0,03%
4	Grodno	910,5	25,6	25,5	0,1	0	0
			2,81%	2,80%	0,01%		
5	Minsk	1505,2	30,9	30,7	0,2	0	0
			2,05%	2,04%	0,01%		
6	Mogilev	1226,9	400,0	263,1	90,5	46,0	0,4
			32,60%	21,44%	7,38%	3,75%	0,03%
Total		**8417,0**	**1356,3**	**948,7**	**290,0**	**116,6**	**1,0**
			16,11%	**11,27%**	**3,45%**	**1,39%**	**0,01%**

2. The purpose of the work is rational planning of forest management and forest use, maintenance of the promptness of decision-making in forest management in the territories of radioactive contamination. To achieve this goal, the following works were performed:

– Updating of the regulatory framework taking into account changes in the radiation conditions and in the legislative framework,

– Optimizing the collection and transmission of information on radiation conditions indicators in forests with the use of geoinformation technologies,

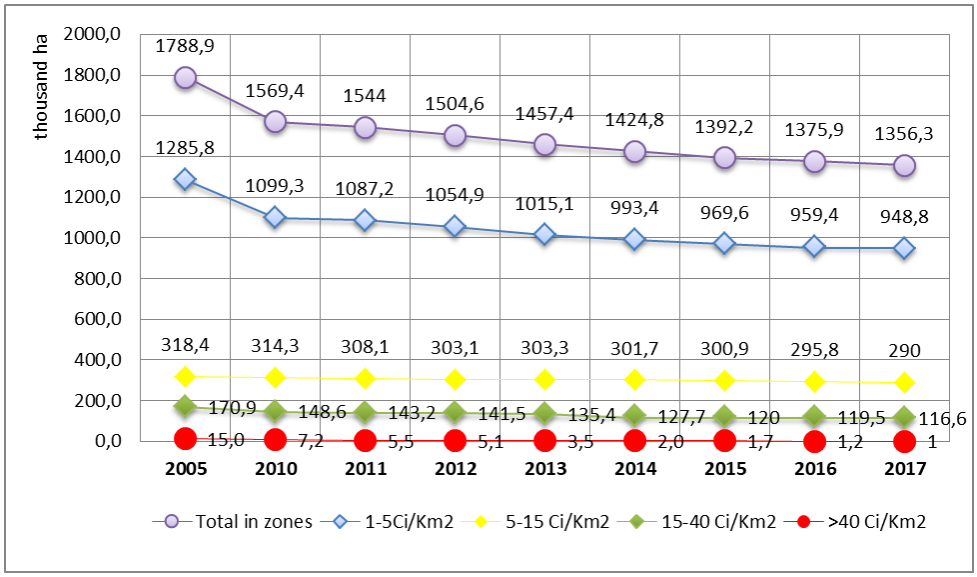
– Improving methods for radiation inspection, for forecast of changes in the radiation conditions in forests: soil contamination density with cesium- 137 and the content of Cesium-137 in wood.

3. The analysis of the paragraphs of technical normative legal acts and of the results of radiation inspections to justify the need to amend the technical codes of established practice TCEP 239-2010 “Radiation Control. Inspection of cutting areas. Order of organization” (hereinafter – TCEP 239-2010) and TCEP 240-2010 “Radiation control. Inspection of forest fund lands. Order of organization” (hereinafter – TCEP 240-2010).

4. Amendments to TCEP 240-2010 regarding the determining the homogeneous of radioactive contamination of forest compartments and the requirements for the selection of forest compartment for an inspection to clarify the radiation conditions are developed. The main share of forest compartments (70% of the forest fund area) is in radioactive contamination zones and it belongs to zone I with cesium 137 soil contamination density (hereinafter - soil contamination

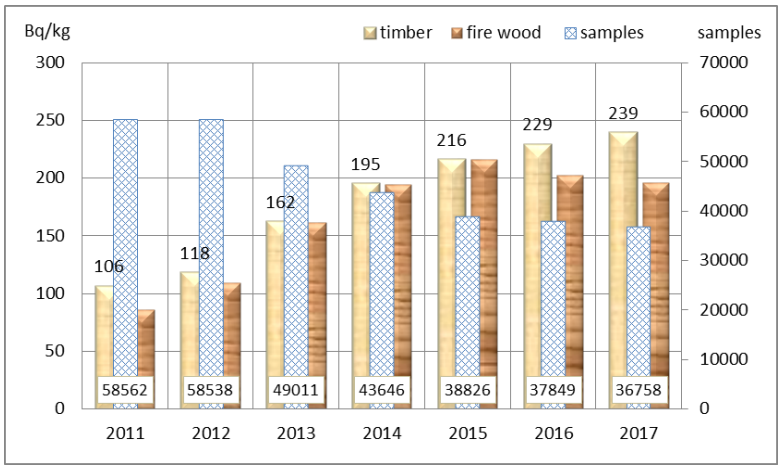
density) from 37 to 185 kBq / m^2 (from 1 to 5 Ci / km^2). Forest compartments in zone I are considered uniform in radioactive contamination because the ratio of the maximum and minimum values of gamma radiation intensity (hereinafter - GRI) within the compartment on average does not exceed 1.36 times with an allowable 3.3. When preparing a radiation inspection plan heterogeneity of radioactive contamination and soil contamination density in adjacent forest areas, as well as the content of Cesium-137 in wood should be taken into account. Amendment No. 1 to TCEP 240-2010 is developed. It is agreed with the SFPAs and approved by the Resolution of the Ministry of Forestry of 24.10.2016, No. 24. It was included into the State register with No. 2012 of November 25, 2016 and enacted on 01/04/2017. In 2017 the efficiency of application of Amendment No. 1 to TCEP 240-2010 was checked. The share of forest compartments that "moved" to a zone with a lower soil contamination density increased in comparison with previous years: on average, in the Forestry Enterprises of Gomel SFPA - from 40 to 71.1%, Mogilev - from 72 to 84.9%. Annually, as a result of the radiation inspection the area of radioactive contamination decreases by an average of 2.2%.

Figure 1 - Change in the radioactive contamination area of the forest fund of the Ministry of Forestry



5. Amendments to TCEP 239-2010 are developed with the aim of optimizing the radiation inspection of cutting areas. This optimization consists of the transition from an inspection of each cutting site in forest compartments with a soil contamination density of 2-5 Ci / km^2 to an inspection of one specially selected cutting area in the forestry, transition to opportunity of using the content of Cesium-137 in wood to confirm the radiation safety of all wood batches shipped from other cutting areas in this forestry. The developed amendments can be applied in 32 from 41 Forestry Enterprises with forest fund territories with a soil contamination density of 2-5 Ci / km^2. Amendment No. 2 to TCEP 239-2010 is developed. It is agreed with the SFPAs and approved by the Resolution of the Ministry of Forestry of 4.11.2016, No. 29. It was included into the State register with No. 2013 of November 25, 2016 and enacted on 01/04/2017. In 2017 the efficiency of application of Amendment No. 2 to TCEP 239-2010 was checked. The number of controlled samples of wood decreased by 1100 samples. From 2014 to 2017 in connection with the optimization of work on the radiation inspection of cutting areas in zone I the radiation control of wood decreased by 25%. By introducing amendments to TCEP 239-2010 a certain parity between the volumes of control (the number of measurements) and the necessary to obtain results to confirm the radiation safety of the timber batches is achieved.

Figure 2 - The average content of Cesium-137 in controlled wood



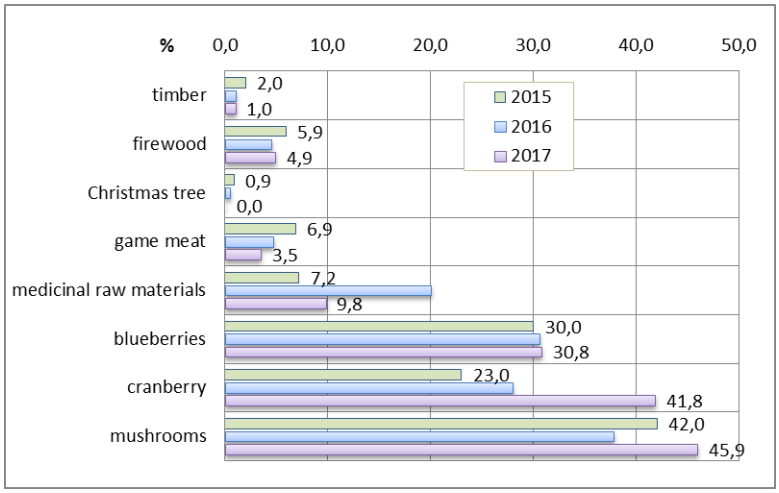
6. The analysis of the paragraphs of the existing normative regulatory acts in the field of forestry management, of the legal regime in the territories of radioactive contamination, of indicators of the radiation conditions is done to justify the need to amend The Forest Management Rules in the territories exposed to radioactive contamination as a result of the Chernobyl disaster (hereinafter – Rules for Forest Management Organization), Rules for radioactive contamination control in the system of the Ministry of Forestry (hereinafter - the Rules for Radioactive Contamination Control).

7. There are positive changes in the forest fund as decrease of: the area of radioactive contamination for the period from 2009 to 2016 by 12.4%, by 19.6% - in zone III with a soil contamination density of 15-40 Ci / km^2, in IV (40 Ci / km^2 and more) - up to 1.2 thousand hectares; forest area with a high dose rate (more than 0.68 μSv / h); specific activity of Cesium-137 in forest products. It allows to optimize protective measures, change the requirements for forest management. Currently, restrictions in forest use in zones of radioactive contamination are related to the prohibition on the production and sale of forest products with radionuclide content exceeding the republican permissible levels, as well as they are related to the need to comply with the requirements set by consumers of wood fuels. Limitations due to the potential possibility of exceeding the annual average radiation dose of 1 mSv are practically minimized and exist in the territories constituting 0.8% of the total forest area of the Ministry of Forestry. On that basis the changes were made in the zoning of territories, in the regulation of forestry activities and forest use, in the requirements for the radiation survey of the logging site, in the provision of information that confirms the radiation safety of the forest products, and in informing. The Forest Management Rules in the territories exposed to radioactive contamination as a result of the Chernobyl disaster were developed and put into force. It was approved by the Decree of the Ministry of Forestry No. 86, dated December 27, 2016, published on the National Legal Internet Portal 07.02.2017, 8/31754. The application in practice of the new Forest Management Rules will ensure compliance with radiation safety standards in the implementation of forest management measures, forest use: do not exceed the average annual radiation dose limit, obtain forest products with a content of radionuclides not exceeding permissible levels. The volume of protective measures will decrease in connection with the reduction of the forest fund territories in the III and IV zones, the possibilities of forest use and estimated cutting area in the third zone will increase.

8. The Rules for radioactive contamination control in the system of the Ministry of Forestry were approved on 03.02.2017 by the order of the Ministry of Forestry No. 36. The Rules for radioactive contamination control define objects, controlled parameters, volumes, frequency and procedure for radioactive contamination control in the system of the Ministry of Forestry taking into account the radiation condition on the territory of the forest fund, previously obtained data

on control of radioactive contamination and the specifics of production technologies, and other factors. The Forestry Enterprises with the territories of the forest fund in zones of radioactive contamination created the Radiation Control Schemes based on The Rules for Radioactive Contamination Control. Radiation control departments (hereinafter referred to as RDC) carry out the control in accordance with the TNRA with the established frequency, ensure the storage of control results in databases, prepare and submit documents and reports on the results of work. The application of the new Rules for Radioactive Contamination Control in practice ensures the receipt of objective information on the radiation conditions in the territory of the forest fund for making decisions on the implementation of forest management, which in its turn ensures the supply to the consumer of normatively "clean" forest products - products containing radionuclides not exceeding permissible levels.

Figure 3 - The share of controlled forest products exceeding the permissible levels



9. Modern technologies of data storage and processing are used to support decision making in forest management in zones of radioactive contamination, for prompt provision of information on monitoring results to the RCD. Since 2010, the Radiation Control Service of the Ministry of Forestry applies a distributed Information System “Radioactive contamination of forests. RadFor” (hereinafter – IS “RadFor”) and peripheral version IS “RadForView” for the Forestry Enterprises. The IS “RadForView” provides processing of the results of the radiation inspection included in the IS databases, obtaining Act of the Radiation Inspection of the Cutting Area, the results of the control of radioactive contamination of forest fund lands based on IS, cartographic materials. In the IS “RadFor” consolidated information on the entire territory of the Forestry Fund of the Ministry of Forestry in the zones of radioactive contamination of 45 "contaminated" Forestry Enterprises is created, the results of the control of radioactive contamination of forest fund lands are updated. Update according to the forest inventory data, monitoring and analysis of the results of the radiation survey, improvement of functions on a systematic basis and update versions for Forestry Enterprises are carried out in IS.

10. A complex of works on optimization of "RadFor" and "RadForView" for collection and transmission of information on radiation conditions indicators in forests was carried out. A scheme was developed for introducing to the permission documents the results of the radiation survey of cutting areas such as: Cesium-137 soil contamination density, Cesium-137 specific activity in wood, № of Act of the Radiation Inspection of the Cutting Area, ways of interaction between the "Forest use" and "RadForview" to create a subroutine that provides automatic filling of data.

11. Additional functions of the "RadFor" IS have been developed: (i) presentation of summary information in the "Radiation conditions" databases on radioactive contamination of the forest fund territory of SFPAs with a forecast of changes in the radiation conditions at a set date; (ii) visualization of the forecast of the change in the soil contamination density in forest compartments on a given date on the digital thematic maps of the forestries; (iii) presentation of

detailed and summary information on the forecast of changes in the radiation conditions with the possibility of performing a visual comparison analysis in the "RadFor" and "RadForview" IS. Updated versions of "RadForview" IS with the inclusion of new functions were transferred to the Forestry Enterprises, they are used to prepare radiation inspection plans, to develop information materials. Training seminars were conducted with the specialists of the radiation monitoring service of the Gomel and Mogilev SFPAs for the application of new functions.

12. The reporting forms of the IS "RadFor" containing information on the radiation conditions indicators have been systematized, and new forms of reports have been developed.

– Report "Results of wood radiation control by radioactive contamination zones" for the prompt receipt of information on levels of Cesium-137 in wood in the forest fund in each radioactive contamination zone of forestries, Forestry Enterprises and SFPSs. The report is formed on the basis of the results of the radiation survey of cutting areas included in the database "Forest Products". The application of the report on the content of Cesium-137 in wood by zones in forestries allows the rapid identification of forestries in which it is possible to optimize the conduct of the radiation inspection of cutting areas. The optimization consists of reducing the number of inspected cutting areas, if the content of Cesium-137 in wood in the forestry within the last three years did not exceed 200 Bq / kg.

– "Universal" report for prompt receipt of information on radioactive contamination of all types of controlled forest products in accordance with specified parameters. This type of report is called universal, as it covers all types of forest products and most of the radiation condition indicators. The report is formed on the basis of the results of the radiation survey of cutting areas, radiometric measurements of mushrooms and berries sampled in forest compartments and at monitoring sites for studying long-term contamination of forest food products with Cesium-137, game, honey, and samples from batches of manufactured wood products - sawn timber, wood chips, fuel pellets. These results are contained in the database "Forest Products". With the help of a universal report, information on the content of Cesium-137 in forest products (coefficients of Cesium-137 transfer from soil to plants) can be obtained promptly with a certain density of soil contamination in a certain period of time for forestry, Forestry Enterprise, SPFA, and the Ministry of Forestry. The reporting information is used to estimate the levels of Cesium-137 in wood, other types of forest products in various regions at present, and also it allows to calculate the forecast of changes in these levels based on the values of transfer coefficients and taking into account the decrease in radioactivity due to the radioactive decay of Cesium-137. Information on indicators of the radiation situation, obtained with the help of a universal report, can be used, both in making managerial decisions on emerging current issues, and in developing information materials for forestry workers and the public.

13. Information on the radiation conditions at the territory of the forest fund of the Forestry Enterprises from 1995 to the present was collected, summarized and analyzed. A review of the existing forms of information was prepared and new formats for providing information on the results of the radiation survey of the forest fund and radiation monitoring of forest products were developed.

14. Informing about the radiation conditions in forests is one of the activities of the radiation monitoring service, and it is carried out with the aim of observing radiation protection measures. Information materials on the radiation situation in forests and changes that have occurred after the Chernobyl disaster were created on the basis of the results of radioactive contamination control entered into databases and with using the functions of the RadFor, RadForView, and standard office programs. Forms of information materials (thematic leaflets) were developed for further distribution in Forestry Enterprises, forestries, booklets, brochures, on official web-sites of Forestry Enterprises. The information was presented taking into account the target audience - for specialists of forestry, public, consumers of forest products. The radiologists (workers of RCDs) were given the procedure for developing information materials to ensure promptness. Information was provided on the radiation conditions and the rules of forest use in the zones of

radioactive contamination on the territory of the forest fund in each "contaminated" Forestry Enterprise in the form of a compilation (brochure).

15. An algorithm for calculating the predicted values of the specific activity of Cesium-137 in wood (firewood) in felling areas planned for felling was developed to determine the possibility of harvesting wood that meets the requirements of hygienic standards, in which permissible levels of Cesium-137 are established (RPL / Forestry-2001), as well as the requirements for the level of Cesium-137 in wood fuels (technical specifications for fuel chips - 300 Bq / kg, control level for boiler rooms with a capacity of more than 0.1 MW - 200 Bq / kg). Calculations are based on the laws of radioactive decay, on intensity of Cs-137 transition from the soil into wood (hereinafter - COT) depending on the type of forest conditions (hereinafter - TFC). In calculating the radiation condition indicators systematized in IS "RadFor" databases the following data is used: the density of soil contamination with Cs-137, Cs-137 specific activity in wood by species in different TFC and COT. Sequential selection schemes are created for selection of COT values to forecast a level of Cs-137 content in the wood.

16. Proposals on the radiation inspection of the logging fund were developed. They are aimed at clarifying the methods for determining radiation condition indicators in forests and for detailing the objects of radiation survey using accumulated information on the behavior of radionuclides in forest ecosystems. More accurate methods of radiation inspection are advisable to use in the Forestry Enterprises when examining forest compartments assigned to the zone III (15-40 Ci / km^2), in which the most likely to produce wood exceeding the permissible levels of Cesium-137 (740 and 1480 Bq / kg). Additional GRI measurements, sampling of soils in subcompartments intended for main felling (ripe and ripening stands), selection of bark samples from model trees for preliminary assessment of the content of ^{137}Cs in wood are suggested. The proposed method allows to determine the possibility of harvesting normatively "clean" wood and to plan the carrying out of cuttings.

17. Proposals on the procedure for preparing and introducing information on the radiation conditions (including in the form of cartographic materials) and their changes in forest management plans were developed. The blocks of information on radioactive contamination of the forest fund (density of soil contamination and content of Cesium-137 in timber) were developed for the preparation of forest management plans by the example of Narovlay special Forestry Enterprise and Yelsk Forestry Enterprise of Gomel SFPA and Krasnopolie Forestry Enterprise of Mogilev SFPA for the beginning and the end of the revision period and period of their sales. The databases with the results of the radiation survey of the forest fund lands "Radiation conditions" and "Forest products" and the functions of the IS "RadFor" and RadForView" were used in the preparation of information on changes in levels and areas of radioactive contamination of forest fund, on content of Cesium-137 in wood and its compliance with the requirements of permissible levels of RPL / Forestry-2001. Information on changes in the radiation conditions during the revision period is primarily intended for the most "contaminated" Forestry Enterprises with forest fund in zone III and wood with cesium-137 content exceeding the levels from RPL / Forestry-2001. In Gomel SFPA these are Vetka, Narovlya and Chechersk special Forestry Enterprises, Yelsk, Gomel, Khoyniki Forestry Enterprises; and in Mogilev SFPA these are Krasnopolie, Kostyukovichi, Cherikov Forestry Enterprises. The application of updated information on radiation condition indicators is aimed at the timely use of the estimated cutting area, maintenance of the state of forests in radioactive contamination zones in accordance with sanitary requirements.

1. Introduction

1. After more than 30 years after the Chernobyl disaster, the problems associated with the need to implement a set of protective measures in the management of forestry remain relevant. In the Republic of Belarus, the territory of the forest fund, referred to the zones of radioactive contamination, is 1632.0 thousand hectares or 17.1% of the total area. The main share of radionuclides contaminated forests is managed by the Ministry of Forestry (83.1%), the territory of the forest fund of 45 forestries is classified as contamination zones in an area of 1356.3 thousand hectares, including the zone I with soil contamination density of Cesium-137 (further - the density of pollution) from 1 to 5 Ci / km^2 - 948.7 thousand hectares (69.9% of the polluted area), zone II (from 5 to 15 Ci / km^2) - 290 thousand hectares (21%), zone III (from 15 to 40 Ci / km^2) - 116.6 thousand hectares (9%) and zone IV (40 Ci / km^2 and more) - 1.0 thousand hectares (0.1%).
2. The system of forest management in the areas of radioactive contamination should ensure for effective organization of forest management activities for a long time and forest use, provided that the norms of radiation safety are met - the average annual dose limit should not be exceeded by 1 mSivert (hereinafter – mSv), the permissible levels of Cesium-137 content in the batchbatches of forest products are not exceeded. To fulfill these conditions, the work is carried out within the allocated radioactive contamination zones with mandatory radiation control, restrictions are imposed on certain activities.
3. The managerial decisions on organizations of certain measures are made only on the basis of updated and reliable results of radioactive contamination monitoring. To do this, it is necessary to ensure the prompt exchange, transmission and provision of the results of the radiation survey of forest fund lands, cutting areas, forest products that are contained in the databases of the distributed information system “Radioactive contamination of forests. RadFor” (hereinafter - IS “RadFor”) and the peripheral version for the forestries IS “RadForView”.
4. Currently, plans for the development of forestry in forestries with forest fund areas in radioactive contamination zones do not contain information on changes in the radiation situation during the audit period, which leads to the restriction of certain activities. For rational planning of forest use in zones of radioactive contamination, it is necessary to develop forecasts of changes in the radiation situation (pollution density, Cesium-137 content in wood) based on the results of the radiation survey, the main pattern of radioactive contamination of forest biogeocenoses.
5. When cutting forests in zones of radioactive contamination, the permit contains information on the results of the radiation survey of cutting areas, which are currently being entered manually. To ensure the promptness of logging tickets, to avoid possible mistakes, it is necessary to develop system of the information input through the interaction of two systems - the automatic workplace “ForestUse" and the IS "RadFor", and the mutual exchange of radiation conditions and assessment characteristics.
6. The indicators of the radiation situation contained in the RadFor databases are used to support decision making in the management of forestry in the areas of radioactive contamination, the formation of documents - the Radiation Examination Report, the Statement of Radioactive Contamination of Forest Lands, and Reporting Materials. At the same time, in addition to the standard forms of reports, to ensure the prompt solution of current tasks, it is necessary to develop a format for universal reports - a report on the given parameters. To provide updated and timely information on the radiation situation in the forest fund for various groups of users: forestry specialists, the public, wood users, we should also make maximum use of the resource and capabilities of the IS "RadFor".
7. Since the new Forest Code was developed and since the introduction of new normative legal acts, it is necessary to harmonize the statements of the NRA and TNRA in the field of forest management, radiation survey. In addition, some statements should be revised taking into

account positive changes in the radiation situation, a significant amount of data and experience gained.

8. Currently, the radiation survey of logging sites is allowed only after they have been withdrawn, which can lead to unjustified labor costs if, after they are withdrawn, the permissible levels of Cesium-137 in wood are exceeded. In order to exclude such cases and make optimal decisions on the need for logging, it is necessary to estimate the levels of Cesium-137 in wood prior to harvesting. Accumulated objective information on the radioactive contamination of each forest compartment, types of forest conditions and forest types, plantations, as well as the updated functions of the IS "RadFor", create prerequisites for the development of new approaches to the radiation survey of the forest fund.

9. Taking into account existing problems and possibilities for their resolution, a set of actions has been carried out in the following key areas: updating of the regulatory framework in the field of forest management; improving the system of collecting, transmitting and reporting information on radiation health indicators in forests using the IS "RadFor"; forecasts of the radiation situation changes in the planning of forestry activities, forest use and new methods of radiation survey of the logging site.

2. Updating the regulatory framework in the field of forest management in the territories of radioactive contamination

10. Within the system of the Ministry of Forestry of the Republic of Belarus during the implementation of activities in the territories of radioactive contamination one is guided by the normative legal acts and technical normative legal acts (hereinafter - NRA and TNRA), that ensure compliance with the legal regime of the territories contaminated as a result of the Chernobyl nuclear disaster and with the radiation safety requirements. The NRA includes the Rules for forest management in zones of radioactive contamination, the Rules for the Control of Radioactive Contamination in the System of the Ministry of Forestry, and TNRA includes 6 technical codes of established practice (hereinafter - TCEP).

11. To comply with radiation safety standards, radioactive contamination is monitored, the requirements for which are established taking into account the radiation situation on the territory of the forest fund, as well as data previously obtained on radioactive contamination and the using of harvested forest products. Positive changes in the radiation situation caused by the radioactive decay of radionuclides over time, the accumulated experience of work provide an opportunity to review and optimize the requirements for forest management, radiation monitoring established in the NPA and TNPA. In addition, the statements of NRA and TNRA should be brought into line with the norms of the Forest Code and new regulations.

12. We made analysis of the current NRA and TNRA, the results of the radiation survey, the radiation situation, and developed reasons for the amendment of the technical codes of the established practice of TCEP 240-2010 “Radiation control. Inspection of forest fund lands. Order of organization” and TCEP 239-2010 “Radiation Control. Inspection of cutting areas. Order of organization”, and of the Rules for forest management in zones of radioactive contamination, Rules for controlling radioactive contamination in the system of the Ministry of Forestry. As a result of the work done, changes in the TCEP and new versions of the Rules were developed and approved.

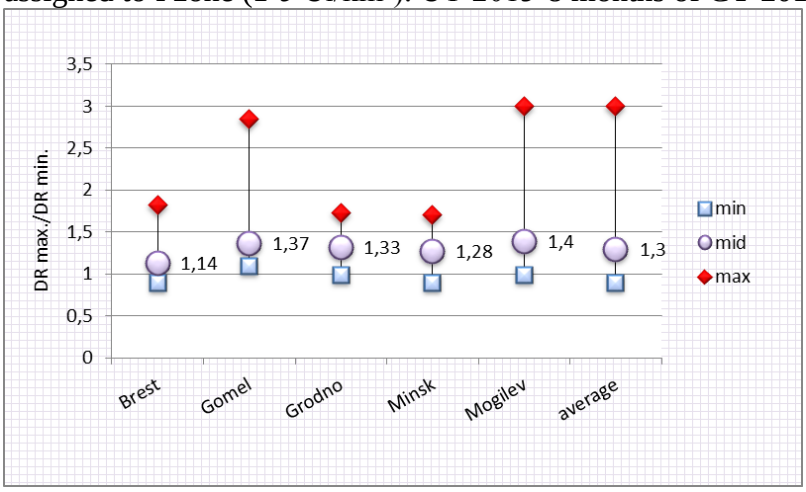
2.1 Development of amendments to TCEP 240-2010 “Radiation control. Inspection of forest fund lands. Order of organization”

2.1.1 Analysis of the radiation inspection results. Justification of the amendments

1. To substantiate the amendments to TCEP 240-2010 the analysis of the results of radiation survey of forest compartment in the area of radioactive contamination of forest fund of the Ministry of Forestry over the past three years was carried out. 2292 forest compartments were analyzed. The main share of forest compartments - 70% of the forest fund in the areas of

radioactive contamination - belongs to the zone with periodical radiation control with the density of soil contamination with Cesium-137 from 37 to 185 kBq/m^2 (1 to 5 Ci/km^2, zone I). Optimization of the radiation survey in the zone I will lead to a reduction in work while maintaining the objectivity of the data. Analysis of the results of the radiation survey showed that the differences in dose rate (hereinafter – DR) values within the forest compartment in zone I (the ratio of the maximum DR to the minimum) do not exceed the value at which a compartment can be attributed to different zones. Values of DR max/DR min proportion obtained in CY 2013-2015 during the radiation survey of forest districts belonging to zones 1-5 Ci/km² in general do not exceed 1.3 at an acceptable 3.3 times. Thus, forest compartments in zone I should be considered homogeneous by radioactive contamination, which makes it possible to amend the process of checking their homogeneity by performing DR measurements along the perimeter of forest compartments in zone I (Figure 4).

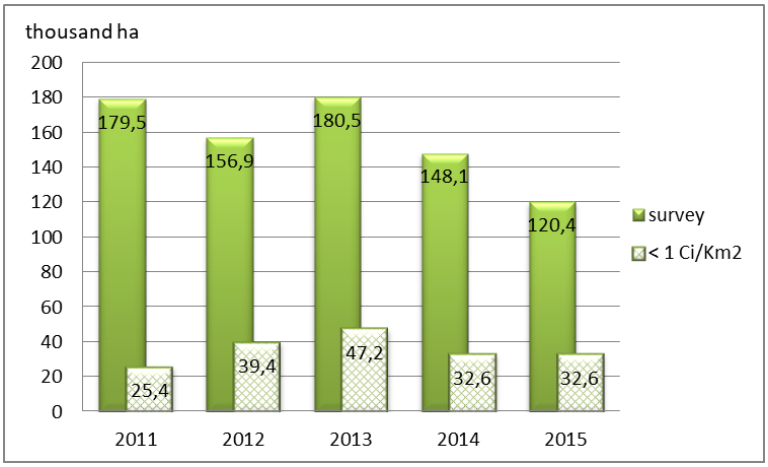
Figure 4 - DR max/DR min proportion during the radiation inspection of forest compartments assigned to I zone (1-5 Ci/km²). CY 2013-8 months of CY 2015



The source: IS "RadFor", CY 2013-2016

14. The analysis of the effectiveness of radiation survey was carried out, which results in specifying of the radiation situation, the area of radioactive contamination reduces and therefore reduces the amount of protective measures. With an annual survey of the area from 120 to 180 thousand Ha of contaminated areas it appears from 25 to 47 thousand ha, or from 14% to 27% of the examined area (Figure 5).

Figure 5 - The results of radiation inspection of the territory of the forest fund. CY 2011-2015.



2. After annual inspections of forest fund (an area of 120 to 180 thousand hectares) from 25 to 47 thousand ha or from 14 to 27% of the entire surveyed area "come out" of the radioactive contamination zones. There is a transition of forest compartments from zones with a greater soil

contamination density into zones of lower density. In 2014-2015, the proportion of the forest compartments surveyed which “moved” to zones with a lower soil contamination density was 67% on average in the Ministry of Forestry.

3. In accordance with TCEP 240-2010 the radiation inspection plan of the forest fund includes those forest compartments for which it is established that due to the radioactive decay of Cesium-137 there has been a change in the soil contamination density to the values at which the forest compartment should be attributed to another zone of radioactive contamination. The predicted value of the soil contamination density is established on the basis of the "Radiation conditions" database of the information system “Radioactive contamination of forests. RadFor” (hereinafter – “RadFor” IS). In order to ensure a higher efficiency of the results of the radiation survey, it is necessary to additionally take into account the following factors when preparing the list of compartments for the survey: the accuracy and reliability of the previous survey, the soil density of contamination which is close to the values of 0.95, 4.95, 14.95 Ci / km^2, density of soil contamination in adjacent forest areas. When selecting compartments for an inspection it is necessary to use the information on the levels of Cesium-137 in wood from the “Forest Products” database of the “RadFor” IS and the correspondence between specific activity and soil contamination density.

2.1.2 Preparation and implementation of Amendment №1 to TCEP 240-2010

4. On the basis of the results of the analysis, proposals are developed to amend the TCEP 240-2010. The requirement to determine the homogeneity of radioactive contamination of forest areas classified in Zone I by measuring the dose rate of DR at its perimeter is canceled. The requirements for the selection of forest compartments for a survey to clarify the radiation situation are added: "When preparing a radiation inspection plan, the heterogeneity of radioactive contamination, soil contamination density in adjacent forest areas and content of Cesium-137 in wood are taken into account.”

5. Amendment №1 to TCEP 240-2010 (02080) “Radiation control. Inspection of forest fund lands. Order of organization” is developed in accordance with the requirements for the development of technical codes in the system of the Ministry of Forestry TCEP 1.5-2004 (04100), agreed with SFPAs, adopted by the Decree of the Ministry of Forestry No. 24, dated 24.10.2016 (National Register of Legal Acts of the Republic of Belarus, No. 2012, dated 25.11. 2016), put into effect in 01.04.2017.

6. At the workshop the justification for the need to amend the TCEP and the procedure for applying Amendment No. 1 to TCEP 240-2010 and visual materials were presented to the experts of the radiation control service of the Ministry of Forestry. For the radiation control service materials have been developed for the selection of forest compartments in preparation of plans for the radiation survey of forest fund lands and for monitoring the results of the survey during the year.

7. Selection of forest compartments is made to clarify the radiation conditions when developing plans for inspection of forest fund lands. To choose the forest compartments it is suggested to carry out a more detailed analysis of the factors, which include the following characteristics: area and configuration; inspection year; actual soil contamination density (Ci / km^2) according to the previous inspection results; the predicted (calculated) value of the soil contamination density at the date of the proposed inspection (Ci / km^2), the assessment sub-compartment number and the coordinates of the soil sampling points; radiation conditions and the forecast of their change in neighboring compartments; Cesium-137 content in wood in the surveyed compartment and in forest areas adjacent to it. All listed characteristics are included in a specially developed table for the plan preparation to a radiation inspection of forest fund lands (Table 2).

Table 2 - Selection of forest compartments for radiation inspection in order to clarify the radiation conditions in 2018

Forestry	Forest compartment (FC)		Radiation conditions in FC, inspection period and soil contamination density (SCD), Ci/km^2					Radiation conditions in FCs along the border with the inspected FC			Cesium-137 content in wood (avg.), Bq/kg
	№	Area, ha	Inspection year	Actual SCD	SCD, forecast for 01.06. 2018	SCD 2018	Sub compart. №, location	FC №, SCD forecast	FC №, SCD forecast	FC №, SCD forecast	

Data from the "Radiation conditions" and "Forest Products" databases of the IS "RadForView" were used to complete the table. To obtain predicted values of contamination density, the function of the soil contamination density calculating by a set date is used in the report generator of the "Radiation conditions" database. The date should correspond approximately to the month and year of a planned inspection, for example, 01.06.2018. As a result, the calculated values of the soil contamination density in the forest compartment and the color of the radioactive contamination zones are indicated in the "Forecasted decrease of Cesium-137 soil contamination density" window which provides visualization of the selection results. The use of filters to sort forest compartments by the density of contamination makes it possible to arrange the data in ascending order and to show forest compartments which may be included in the plan for specifying the radiation conditions.

2.1.3 Effectiveness of the evaluation of the radiation inspection results in 2017

8. In 2017 a radiation survey of forest fund lands was carried out on the area of 98,600 hectares. The forest fund of the Ministry of Forestry in the radioactive contamination zones decreased by 19.6 thousand hectares (1.4%) in comparison with 2016 and currently makes up 1356.3 thousand hectares (16.11% of the total area). The largest part (69.9%) of the territories of radioactive contamination of the forest fund is attributed to the I zone with soil contamination density of Cesium-137 from 1 to 5 Ci / km^2 and II zone (5-15 Ci / km^2) (21.4%), to the III (15-40 Ci / km^2) and IV (40 Ci / km^2 and more) zones. The radiation survey is conducted in accordance with the requirements of TCEP 240-2010 "Radiation control. Inspection of forest fund lands. Order of organization" and Amendment No. 1 to it.

9. The results of the radiation survey of 2017 were analyzed based on the developed report forms for assessing the effectiveness of the work (Table 3). Criterion for the effectiveness of the work on the examination of the radiation conditions is an indicator of the share (%) of forest compartments in which according to the survey results the soil contamination density decreased to values at which the forest compartment may be classified as less polluted, from all those surveyed in the year.

Table 3 - Results of the radiation inspection of forest compartments (FC) in 2017

Forestry Enterprise	Inspected FC	FC “moved” to a zone with a lower soil contamination density		FC “came out” of the I zone, less than 1 Ci/km^2		FC “came out” of the III zone	
	Total	pcs.	%	pcs.	%	pcs.	%
Luninets	50	33	66,0%	17	34,0%		
Pinsk	2	2	100,0%	2	100,0%		
Polessie	10	7	70,0%	2	20,0%		
Stolin	66	42	63,6%	8	12,1%		
Brest SFPA	**128**	**84**	**65,6%**	**29**	**22,7%**		

Forestry Enterprise	Inspected FC	FC "moved" to a zone with a lower soil contamination density		FC "came out" of the I zone, less than 1 Ci/km^2		FC "came out" of the III zone	
	Total	pcs.	%	pcs.	%	pcs.	%
Buda-Koshelevo	47	45	95,7%	16	34,0%	11	23,4%
Vasilevichi	42	7	16,7%	6	14,3%		
Vetka	70	41	71,4%	0	0,0%	21	30,0%
Gomel	49	30	61,2%	11	22,4%	7	14,3%
Elsk	38	32	84,2%	4	10,5%		
Zhitkovichi	25	19	76,0%	3	12,0%		
Kalinkovichi	32	16	50,0%	10	31,3%		
Komarin	30	10	33,3%	0	0,0%		
Lelchitsy	24	7	29,2%	3	12,5%		
Loev	5	0	0,0%	0	0,0%		
Miloshevichi	37	19	51,4%	5	13,5%		
Mozyr	34	32	94,1%	11	32,4%		
Narovlya	27	26	96,3%	0	0,0%		33,3%
Rogachev	82	82	100,0%	58	70,7%		
Rechitsa	46	39	84,8%	18	39,1%		
Khoiniki	34	30	88,2%	0	0,0%		
Chechersk	34	30	88,2%	0	0,0%	1	2,9%
Gomel SFPA	**660**	**469**	**71,1%**	**146**	**22,1%**	**49**	**7,4%**
Ivye	12	7	58,3%	3	25,0%		
Novogrudok	4	4	100,0%	2	50,0%		
Grodno SFPA	**16**	**11**	**68,8%**	**5**	**31,3%**		
Berezino	14	11	78,6%	4	28,6%		
Volozhin	1	1	100,0%	0	0,0%		
Starobin	2	0	0,0%	0	0,0%		
Minsk SFPA	**17**	**12**	**70,6%**	**4**	**23,5%**		
Belynichi	23	22	95,7%	6	26,1%		
Byhov	73	66	90,4%	18	24,7%		
Gorki	1	1	100,0%	1	100,0%		
Klimovichi	28	7	25,0%	3	10,7%		
Klichev	32	32	100,0%	26	81,3%		
Kostyukovichi	19	8	42,1%	1	5,3%		
Krasnopolye	27	25	92,6%	0	0,0%	1	3,7%
Mogilev	41	41	100,0%	15	36,6%		
Chausy	32	30	93,8%	3	9,4%		
Cherikov	41	37	90,2%	12	29,3%	3	7,3%
Mogilev SFPA	**317**	**269**	**84,9%**	**85**	**26,8%**	**4**	**1,3%**
Total, Ministry of Forestry	1138	845	74,3,0%	269	23,6%	53	4,7%

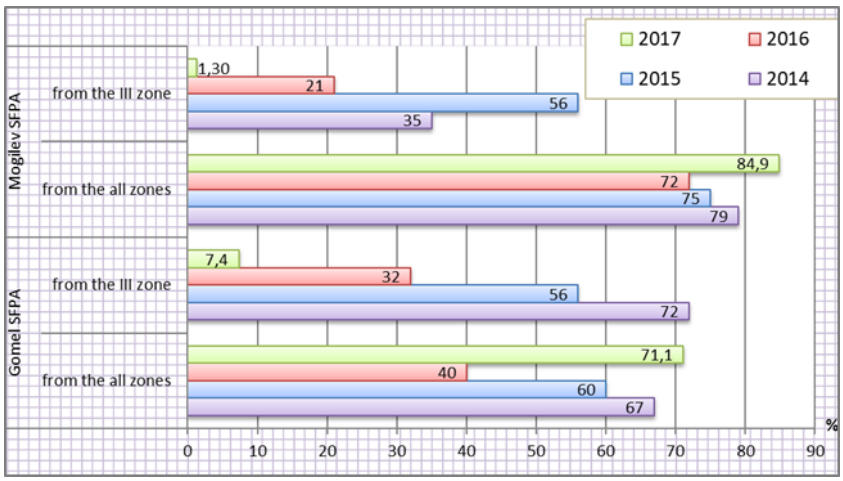
10. As a result of the examination of the radiation conditions 74.3% of all the surveyed forest compartments "moved" to a zone with a lower soil contamination density, while in the Forestry Enterprises of Mogilev SFPA the effectiveness of the radiation inspection (confirming the predicted soil contamination density values for a year) is 84.9%, for Brest SFPA - 65.6%.

11. According to the results of the inspection the share of forest compartments that "moved" from the I radioactive contamination zone (mean pollution density less than 1 Ci / km^2) is 23.6%

of the surveyed territory, “moved” from zone II to I - 46.7%, from III to II - 4.7%. On average in the Ministry of Forestry a quarter (25.7%) of the surveyed forest compartments did not “move” to a zone with a lower soil contamination density, but in most cases (~ 90%) a decrease in the soil contamination density is found in comparison with the previous radiation survey.

12. As a result of the work carried out and consideration of effectiveness and compliance with the requirements of regulatory documents for conducting a radiation inspection of forest fund lands in seminars with specialists of the radiation control service, in 2017 the forest compartments share that “moved” to a zone with a lower soil contamination density increased in comparison with previous years: on average in the Forestry Enterprises of Gomel SFPA from 40 to 71.1%, Mogilev - from 72 to 84.9%. An analysis of the 2017 survey results was carried out for all forestries of 37 Forestry Enterprises.

Figure 6 - Forest compartments share that “moved” to a zone with a lower soil contamination density. Gomel and Mogilev SFPAs, 2014-2017.



The plan for the radiation inspection of the forest fund lands for 2018 was prepared taking into account all the requirements of Amendment No. 1 to TCEP 240-2010 for the selection of forest compartments, in which the forest compartment should be assigned to a zone of lower density according to the calculated predicted soil contamination density. During the year, as the results of the radiation survey are received, the RDC specialists evaluate them: comparing actual and predicted values of contamination density.

2.2 Development of proposals to amend TCEP 239-2010 "Radiation Control. Inspection of cutting areas. Order of organization"

2.2.1 Analysis of the radiation inspection results. Justification of the amendments

13. Analysis of the radiation survey results of the cutting areas in the zone I in forest compartments with a soil contamination density from 74 to 185 kBq / m^2 (2-5 Ci / km^2) for the period from 2013 to 2015 was conducted to justify the advisability of amendments to TCEP 239-2010 “Radiation control. Inspection of cutting areas. The order of organization” (hereinafter - TCEP 239-2010). 75,607 results of the radiometric measurements of wood (commercial timber, firewood) sampling at the cutting areas with a density of 2-5 Ci / km^2 were analyzed in 47 Forestry Enterprises.

14. When comparing the values of the Cesium-137 specific activity in wood with a level of 200 Bq / kg it was found that throughout I zone (from 1 to 5 Ci / km^2) 10.7% of the samples measured exceeds this level. 17 % of the samples measured in the area with a soil contamination density of 2 to 5 Ci / km^2 exceeds the level of 200 Bq/kg (it is a value when currently there are no restrictions on the use of “contaminated” wood, including as wood fuel). There were no cases of excess of 200 Bq / kg of Cesium-137 in wood in 14 of 41 Forestry Enterprises with forest fund areas with a density of 2 to 5 Ci / km^2. The average specific activity values are in the range

from 41 to 141 Bq / kg. In the territory of 27 Forestry Enterprises the content of Cesium-137 in wood may exceed 200 Bq / kg (in 14 Forestry Enterprises the specific weight of wood with a level of more than 200 Bq / kg with an average Cesium-137 specific activity of 76 to 116 Bq / kg does not exceed 10%). With such values of Cesium-137 activity in wood, it is not necessary to conduct a radiation survey of each cutting area in forest compartments with a soil contamination density of 2 to 5 Ci / km2, and a transition to a selective inspection similar to the procedure from Amendment No. 1 to TCEP 239-2010 is possible.

15. In 2014, a radiation inspection of cutting areas with a soil contamination density of 1 to 2 Ci / km^2 was optimized as a result of the enactment of the Amendments to TCEP 239-2010. The experience of implementation of Amendment No. 1 to TCEP 239-2010, data on levels of Cesium-137 content in wood and the patterns of radionuclide transition to wood in various types of forest conditions, the possibility of processing data for the purpose of predicting the harvesting of wood with a Cesium-137 content not exceeding permissible levels allow to expand the optimization of the radiation inspection of the forest fund with soil contamination density of 2-5 Ci / km^2 and, in general, in the Ist zone. The territory of the forest fund referred to the 1st zone is 70% of all contaminated areas including 30% of territories with soil contamination density of 2-5 Ci / km^2.

16. On the basis of the result analysis of the wood radiation control and the presence of timber with Cesium-137 content not exceeding the level of 200 Bq / kg a distribution of Forestry Enterprises was prepared where it is possible to optimize the procedure of radiation inspection of cutting areas with soil contamination density of 2 to 5 Ci / km^2.

17. In addition to Cesium-137 content in wood, the number of forestries in each Forestry Enterprise where the Cesium-137 content in wood does not exceed 200 Bq / kg at a density of 2-5 Ci / km^2 was determined. The forest fund of 127 out of 223 forestries in 27 Forestry Enterprises is contaminated with Cesium-137 with a density of 2-5 Ci / km^2, in 91 (72 %) of 127 forestries the content of Cesium-137 in wood exceeds 200 Bq / kg.

18. This analysis of the results of radiation inspections of cutting areas, levels of Cesium-137 in wood in the territory of forestries allows to define Forestry Enterprises for optimization of works at a density of 2-5 Ci / km^2. Out of 41 Forestry Enterprises with 2-5 Ci / km^2 optimization is possible in 14 Forestry Enterprises throughout the whole territory, in 7 Forestry Enterprises it is possible in the majority of forestries (more than 75%), in 11 Forestry Enterprises - 50% and in 9 Forestry Enterprises the optimization will not be applicable in the near future.

Table 4 - Forestry Enterprises on whose territory it is possible to optimize radiation inspection of cutting areas in 2-5 Ci/km^2

It is possible to optimize radiation inspection of cutting areas in 2-5 Ci/km^2:			
throughout the whole territory in 14 Forestry Enterprises:	in the majority of forestries in 7 Forestry Enterprises:	throughout the 50% of the territory in 11 Forestry Enterprises:	optimization will not be applicable in the near future in 9 Forestry Enterprises:
Vasilevichi	Rechitsa	Cherikov	Vetka
Buda-Koshelevo	Chausy	Khoiniki	Yelsk
Belynichi	Zhlobin	Lelchitsy	Komarin
Berezino	Klimovichi	Polessky	Narovlia
Ivie	Klichev	Luninets	Chechersk
Gorki	Mozyr	Rogachev	Krasnopolye
Zhitkovichi	Bykhov	Gomel	Stolin
Starobin		Loev	Milashevichi
Krupki		Kostiukovichi	Volozhin
Logoisk		Mogilev	
Svetlogorsk		Kalinkovichi	
Novogrudok			
Dzyatlava			
Molodechno			

On the territory of 32 Forestry Enterprises it will be possible to implement the new requirements for radiation inspection of cutting areas with a density of 2-5 Ci / km^2.

2.2.2 Preparation of proposals, implementation of Amendment No. 2 to TCEP 239-2010

19. Based on the results of the analysis, proposals were developed to amend the TCEP 239-2010 with the aim of optimizing the radiation survey of cutting areas. The optimization consists of the transition from a radiation survey of each cutting area in forest compartments with a soil contamination density of 74 to 185 kBq / m^2 (2-5 Ci / km^2) to a survey of one specially selected cutting area in the forestry, the possibility of using Cesium-137 content values in the wood for confirmation radiation safety of all batches of timber shipped from other cutting areas. The folowing proposals were made:

– In the forest compartments with a soil contamination density of 74 to 185 kBq / m^2, the scope and frequency of the radiation inspection are established taking into account the Cesium-137 levels in the wood. If the content of Cesium-137 did not exceed 200 Bq / kg during the last three years in wood harvested on the territory of the forestry in forest compartments with a soil contamination density of 74 to 185 kBq / m^2, a radiation inspection is carried out in accordance with this technical code and additional requirements to the selection of the cutting area, given in Appendix M of the Amendment No. 1 to TCEP 239-2010.

– The results of the radiation inspection of a specially selected cutting area (Appendix M) are used throughout the year to fill out the radiation safety marks, the radiation safety certificates for shipped timber from the compartments of the forestry with a soil contamination density of 74 to 185 kBq / m^2.

– In the felling license for cuttings in forest compartments with a soil contamination density of 74 to 185 kBq / m^2, the number and date of the Act of the Radiation Inspection of the specially selected cutting area are entered.

20. The radiation inspection in a specially selected cutting area in the IB subzone (2-5 Ci/km^2) will be subject to the same requirements as in the zone 1-2 Ci/km^2 (described in Annex M to Amendment № 1 to TCEP 239-2010).

– For a radiation survey it is necessary to select a cutting area from the areas with the highest possible level of Cesium-137 content in the wood of different species, assigned to the cutting on the territory of the forestry during the current year. For this:

– From the territory of the forest area of forest blocks with contamination density from 37 to 74 kBq / m² a compartment (compartments) with a maximum density of contamination is (are) selected;

– In the compartment selected a cutting area (areas) with the maximum number of wood species in the forest conditions where there are the highest rates of transition of Cesium-137 into the timber set is (are) selected;

– Coefficients of Cesium-137 transition into the wood are determined for each forestry on the basis of radiation survey results for the past 3 years from the database "Forest products" of the information system "Radioactive contamination of forests. RadForView".

– Radiation survey is carried out after demarcation of a cutting area before and during the cutting.

– Scope and frequency of radiation survey are set in the rules (schemes) of control of radioactive contamination in forests and forestry sites of the organization that conducts the tests.

– Under the current legislation requirements for the implementation of control of radioactive contamination are established taking into account the radiation situation on the territory of the raw material zones, contamination control data previously obtained, the specifics of the production technology, and other factors (Regulations on radioactive pollution control system, adopted by the Council of Ministers on May 4, 2015 No. 372).

21. Amendment №2 to TCEP 239-2010 (02080) "Radiation Control. Inspection of cutting areas. Order of organization" was developed in accordance with the requirements for the development of technical codes in the system of the Ministry of ForestryTCEP 1.5-2004

(04100), agreed with SFPAs, adopted by the Decree of the Ministry of Forestry No. 29, dated 4.11.2016 (National Register of Legal Acts of the Republic of Belarus, No. 2013, dated 25.11.2016), put into effect in 01.04.2017.

22. Requirements and application procedure of Amendment №2 to TCEP 239-2010 were presented at seminars of radiation control service. Auxiliary visual materials were developed. To substantiate the application of Amendment No. 2 to TCEP 239-2010 the analysis of results of the radiation inspection of cutting areas in previous years is carried out in Forestry Enterprises. Types of forest conditions were determined in which the maximum levels of Cesium-137 are established in wood. The procedure for the justification of the implementation of Amendment No. 2 to TCEP 239-2010, for the registration of the results of radiation control of wood, and the introduction of additions to the Radiation Control Scheme of a Forestry Enterprise were provided.

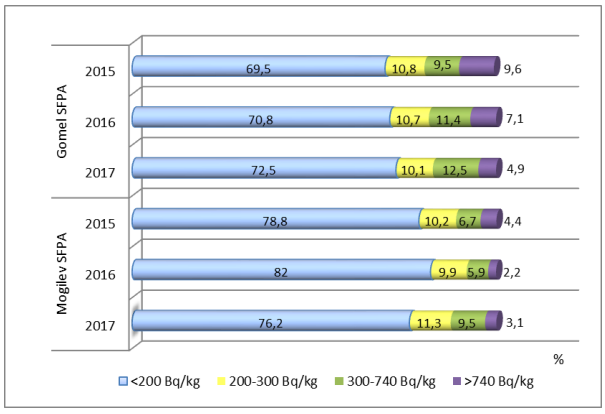
23. Application of Amendment No. 2 to TCEP 239-2010 in the Forestry Enterprises will reduce the costs of radiation inspection in cutting areas with a soil contamination density of Cesium-137 from 2 to 5 Ci / km^2 as a result of the transition from total to selective inspection with a maximum using the results of radiation control of wood obtained in previous years.

2.2.3 Application results of Amendment №2 to TCEP 239-2010

24. In 2017, the results implementation of Amendment No. 2 to TCEP 239-2010 for the cutting areas inspection in the Forestry Enterprises were analyzed. In total, during the year 2017, 6527 cutting areas were inspected on the territory of the radioactive contamination of the forest fund. 34096 samples of industrial wood and firewood were measured. In 20 forestry enterprises out of 45 "contaminated", Cesium-137 content in wood does not exceed 200 Bq / kg and it can be used as wood fuel, deliver to boiler plants with the capacity of 0.1 MW and more.

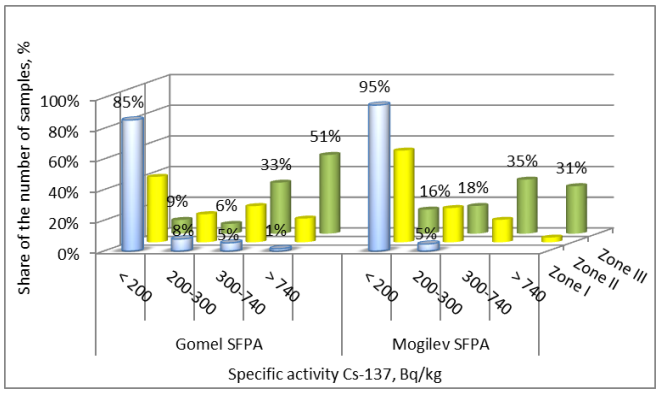
25. In most of the samples of timber controlled (industrial wood and firewood) in the total volume the cesium-137 content does not exceed the values of 200 Bq / kg and in 2017 it was 72.5% in Gomel and 76.2% in Mogilev SFPA (Figure 7).

Figure 7 − Share of wood samples with different contents of Cesium-137 in Gomel and Mogilev SFPAs. CY 2015 - 2017



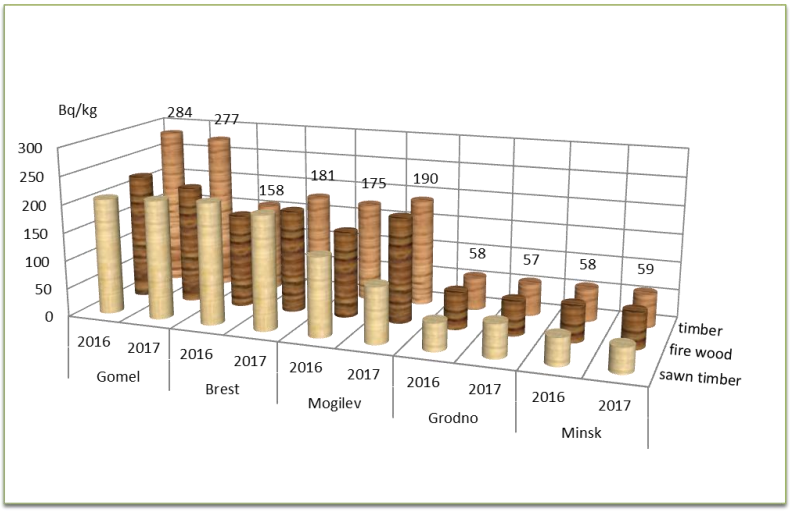
26. The main share of wood with a Cesium-137 content less than 200 Bq / kg is typical for the territories classified as zone I (1-5 Ci / km^2). While in the Forestry Enterprises of Gomel SFPA the possibility of wood obtaining with specific activity up to 200 Bq / kg is less than in the Forestry Enterprises of Mogilev SFPA. In the forest fund of the Forestry Enterprises of Gomel SFPA the proportion of wood samples with a Cesium-137 content of less than 200 Bq / kg is 89% in the I zone (1-5 Ci / km^2), in the Mogilev region it is 95%. It confirms the possibility of application of the Amendment No. 2 to TCEP 239 -2010 on a significant territory.

Figure 8 − Wood. The proportion of samples with different content of Cesium-137 in contaminated zones. Gomel and Mogilev SFPAs, CY 2016



27. Optimization of radiation survey of cutting areas leads to a reduction in control scope. From 2014 to 2017 the radiation control of wood fell by 25% due to a decrease in the scope of radiation survey of cutting areas in the territories in the zone I. With the implementation of Amendments to TCEP 239-2010 certain parity between the scope of control (the number of measurements) and the results obtained to confirm the radiation safety of the timber batches was achieved (Figure 9).

Figure 9 − The average content of Cesium-137 in wood. CY 2016-2017



28. Further measures to optimize the radiation survey of cutting areas are limited by the requirements for the level of Cesium-137 in wood fuel (200 Bq / kg, 300 Bq / kg). In 2016-2017 the average values of the specific activity of Cesium-137 in Gomel SFPA were close to 300 Bq / kg, in Mogilev and Brest – 200 Bq / kg.

2.3 Elaboration of Forest Management Rules in the territories exposed to radioactive contamination

2.3.1 Changes in radiation conditions

29. Forest Management Rules in the radioactive contamination zones (2009) have been developed in a new version due to changes in the radiation conditions, the adoption of new legislative acts − the Forest Code (2015), the Regulations on the Radioactive Contamination Control System (2015), Regulations on the control of radioactive contamination (2016). The rules were given a new title in accordance with the title established in the Forest Code, the Forest Management Rules in the territories exposed to radioactive contamination as a result of the Chernobyl disaster (hereinafter – Forest Management Rules).

30. From 2009 to 2016 there were changes in the radiation situation on the territory of the forest fund. The area of radioactive contamination of the forest fund has decreased by 12.4%, including in the zone III by 19.6%, in the zone IV – up to 1.2 thousand hectares. The dose rate does not exceed 0.68 mcSv /h for a significant part (95%) of the contaminated area and the dose of external irradiation of workers does not exceed the established average annual limit. The content of Cs137 radionuclide in wood, industrial wood and firewood is reduced. With an annual refinement of the radiation situation in the territory of radioactive contamination of the forestry fund of the Ministry of Forestry, an average area reduction of 2.2% per year is established, which is due to a decrease in density of soil contamination with Cesium-137 as a result of radioactive decay, redistribution of the radionuclide in forest ecosystem components.

31. As the density of soil contamination with Cesium-137 decreases, the Gamma-Radiation Intensity (hereinafter – GRI) decreases. Within the last six years, Gamma-Radiation Intensity on the territory of the forest fund in the zones of radioactive contamination decreased on average by 2.2% per year. Gamma-Radiation Intensity is an important indicator, since during forest management activities at Gamma-Radiation Intensity more than 0.68 mcSv/ h work duration restrictions are introduced to prevent the formation of a dose of external irradiation to a person exceeding the established annual average limit of 1 mSv. With the time, Gamma-Radiation Intensity in the forest fund areas decreases with the same contamination density (Fig. 10).

In 2016, according to the results of the radiation survey of the forest fund, Gamma-Radiation Intensity exceeds the values of 0.68 mcSv / h in areas with a contamination density of 20 Ci / km² and more and observed in 10 Forestry Enterprises of the MoF on the area of 70.7 thousand hectares or 5.1% of the total "Contaminated Area" (Fig. 11).

Figure 10 – The dose rate of gamma radiation on the territory of the forest fund at a different density of soil contamination with Cesium-137

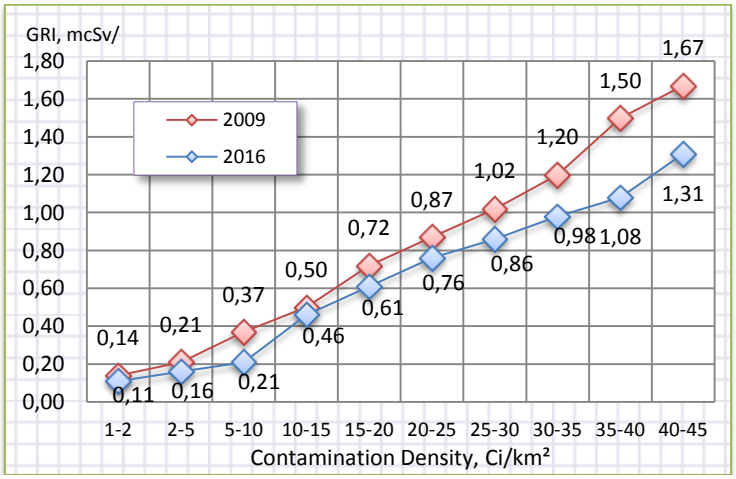
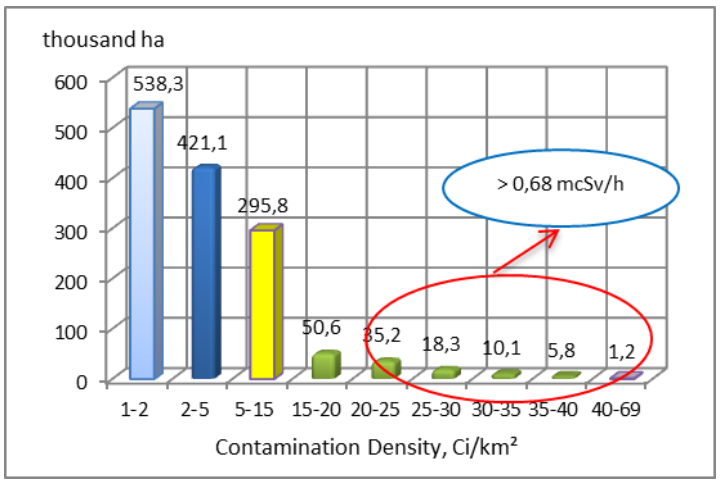


Figure 11 – The territory of radioactive contamination at a different density of contamination, MoF, CY 2016

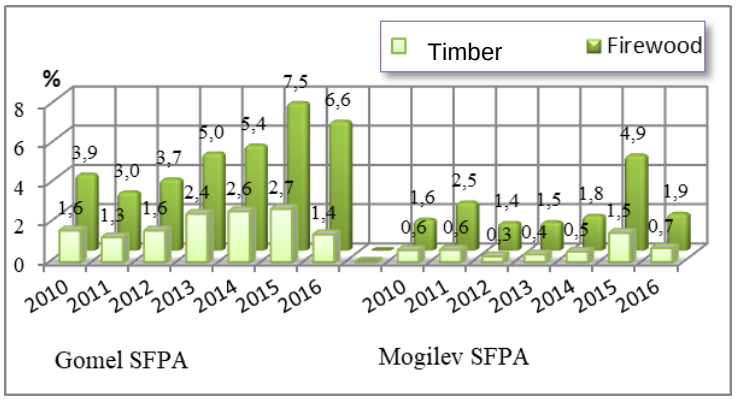


32. Restrictions on the implementation of forest management activities, forest use in zones of radioactive contamination due to potential possibility of exceeding the annual average irradiation dose of 1 mSv are practically minimized and exist in the territories constituting 0.8% of the total forest area of the MoF. If there is a need to carry out work in these areas (the density of pollution is more than 20 Ci / km² and GRI is more than 0.68 mcSv / h), individual dosimetric control is carried out, compliance with the standards is ensured by the regulation of the work time within the year.

33. Restrictions on forest use in zones of radioactive contamination are related to the prohibition on the production and sale of forest products with excess of the Republican permissible levels of radionuclide content (RPL / Forestry-2001, RPL-99) and the need to meet the requirements set by wood fuel consumers.

34. Exceeding the permissible levels of Cesium-137 content in wood is annually established on the territories of radioactive contamination of the forest fund in 10-12 Forestry Enterprises of Gomel and Mogilev SFPAs. The highest proportion of wood samples exceeding the RPL / Forestry 2001 was established in the Forestry Enterprises of Gomel SFPA, in firewood, the content of Cesium-137 in 2015 exceeded 7.5% (Figure2).

Figure 12 – Industrial timber and firewood with cesium-137 content exceeding RPL/Forestry-2001. Gomel, Mogilev SFPA, CY 2010 – 2016



35. Cesium-137 wood contamination is caused by the root intake of the radionuclide from the soil and is in proportion to the contamination density. The level of pollution is influenced by other factors, including regional differences in the conditions of growth of tree plantations. If the content of Cesium-137 does not exceed 300 Bq / kg in the forest fund of the Forestry Enterprises of Mogilev SFPA in the zone I, the cases of excess of 740 Bq / kg (the standard for firewood) are recorded in the forestry of Gomel SFPA. The bulk of samples with excess of RPL / Forestry-2001 refers to zone III, at the same time, in this zone it is possible to produce wood with cesium-137 activity not exceeding 300 and 200 Bq / kg.

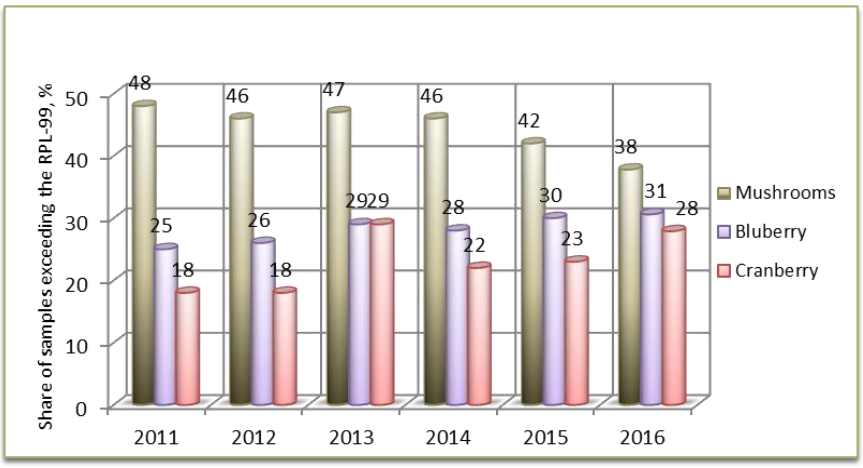
36. A comparison of the results of the radiation survey of cutting areas, radiometric measurements shows that the content of Cesium-137 in wood gradually decreases. The dynamics of activity reduction is quite conservative, for example, at a density of 1 to 5 Ci / km², the average values for the last 6 years have practically not changed, and they are within the accepted error of the measurement results.

Figure 13 – Change in the content of Cesium-137 in pine in I-III zones on the territory of the forest fund of Gomel SFPA, CY 2010-2016

Source: IS «RadFor»

37. The highest values of specific activity of Cesium-137 and the proportion of samples exceeding the permissible levels of RPL-99 are established for wild mushrooms, berries, and game' meat throughout the forest fund with a pollution density of 1 Ci / km² and more.

Figure 14 – Exceeding the permissible level of Cesium-137 content in mushrooms and berries, MoF, CY 2011-2016



Source: Report of "Bellesozaschita" Institution

Comparison of the average for SFPA and maximum levels of Cesium-137 in mushrooms shows that these indicators remain the highest in Gomel Forestry Enterprises (985 Bq / kg – average and 23895 Bq / kg – maximum) and Brest SFPA (560 Bq / kg and 22828 Bq / kg). The decrease in activity of Cesium-137 in wild berries and mushrooms occurs mainly due to natural processes

– radioactive decay and, as a consequence, a decrease in activity of Cesium-137 in the soil, forest cover, mycelium.

2.3.2 Development of proposals to amend the Forest Management Rules

38. On the basis of an analysis of the radiation conditions in the forest fund areas classified as radioactive contamination zones in the established order, positive changes have been established: a decrease in the proportion of forests with a high soil contamination density of Cesium-137 (more than 15 Ci / km^2), a decrease in forest areas with a high dose rate (more than 0.68 μSv / h), a decrease in specific activity of Cesium-137 in forest products, which allows to optimize protective measures and change the requirements for forest management.

39. In drafting the new version of Forest Management Rules it is proposed to make changes in the zoning of territories, in the regulation of forestry activities and forest use, in the requirements for the radiation survey of the cutting areas and the provision of information that confirms the radiation safety of the forest products, and in informing.

40. When developing the Forest Management Rules, the norms of legislation in the field of the legal regime of territories exposed to radioactive contamination as a result of the Chernobyl catastrophe, the norms of legislation in use, protection and reproduction of forests are taken into account. The Forest Code contains requirements for areas of radioactive contamination, which are also proposed to be reflected in the Rules. This is clause 7 of Article 41: Forest land plots referred to radioactive contamination zones may be provided for forest use after the forestry legal entities control the radioactive contamination and determine the feasibility of forest management taking into account the requirements for ensuring radiation safety.

41. It is also proposed to add the requirement set out in paragraph 15 of the Regulation on the Control of Radioactive Contamination (2016): "The sale of products manufactured in the territory of radioactive contamination is carried out under the condition of mandatory control of its radioactive contamination and the availability of a document confirming the compliance of radionuclide content in such products to the republican permissible levels issued by the organization, which is granted the right to conduct the control of radioactive contamination in the manner prescribed by the licensing legislation".

42. It is proposed to leave the chapters of the Regulations on the Protection of Forests Against Fire, Pests and Forest Diseases unchanged.

2.3.3 Regulatory actions for forest management activities, forest use in the areas of radioactive contamination

43. The Rules for the Regulatory actions for forest management activities and forest use in zones of radioactive contamination establish the zoning of forest fund territories, taking into account the density of soil contamination with Cesium-137. The division of zone I with the pollution density from 37 to 185 kBq / m² (from 1 to 5 Ci / km²) was abolished for sub-zones IA (from 1 to 2 Ci / km²) and IB (from 2 to 5 Ci / km²). The subzones were singled out for more detailed regulation of forestry activities. At the same time, in respect to the main types of work - reforestation and afforestation, logging, diversion and inspection of logging areas - restrictions on subzones are not introduced. In the zone I, the content of Cesium-137 in wood meets the requirements of the republican permissible levels, the specific weight of wood with a Cs-137 activity of less than 200 Bq / kg is 95% in Mogilev SFPA and 85% in Gomel SFPA; average values of specific activity of Cs-137 are in range from 75 to 272 Bq / kg.

44. The results of monitoring of the radioactive contamination, levels of Cesium-137 in forest products: in wood for CY 2016, in the rest of forest products - for the last three years were used to make decisions on amending the Rules of forest management (Table 5).

45. The obtained results show that the application of the regulatory actions for forest management established in the Forest Management Rules in the zones of radioactive contamination (2009) ensured compliance with radiation safety standards and the supply of normatively "clean" products. When harvesting wood in the zones I-III, the content of Cesium-

137 in industrial wood in most cases (99%) corresponds to RPL/ Forestry-2001, in the zone I the average Cesium-137 content in Christmas Trees was 228 Bq / kg, which is less than the permissible level (1850 Bq / kg). The content of Cesium-137 insoft resine (barrios), which within the last three years was harvested in very limited quantities, mainly in Narovlyansky Special Forestry, did not exceed 93 Bq / kg while the norm is 1850 Bq / kg. This allows expanding the harvesting of barrois on the territory of the zone III. Limitations in the preparation of moss, the collection of forest cover are fully justified, since the activity of the radionuclide in these species reaches significant levels (more than 7,000 Bq / kg).

46. Harvesting of tree juices and the placement of hives and apiaries in zones I-II confirmed the possibility of obtaining birch juice and honey with Cesium-137 content below the permissible levels (370 Bq / kg, 3700 Bq / kg), while the average values of the specific activity of Cesium -137 is much less than admissible. When mowing and pasturing of cattle in the zone I, the requirements for the safe use of green mass, hay for feeding animals are observed. To collect wild berries and mushrooms in a group with an average accumulation of Cesium-137, restrictions in collection at a density of not more than 2 Ci / km² should be left in the new Rules as well.

47. Forest management and forest use planning is carried out within the allocated radioactive contamination zones using the results of radiation monitoring. When conducting forestry in the territories exposed to radioactive contamination, the following regulatory actions shall be observed (table 5)

Table 5 - Regulatory actions for forestry management in the areas of the radioactive contamination ("+" – allowed, "-" – prohibited)

No.	Forest management activities	Zone			
		I	II	III	IV
1.	Reforestation, afforestation				
1.1.	Creation of permanent forest seed base objects (forest seed plantations, plots)	+	+	+	-
1.2.	Forest plants' seeds harvesting	+	+	+	-
1.3.	Creation of permanent and temporary forest nurseries	+	+	-	-
1.4.	Growing planting stock of forest plants in nurseries	+	+	-	-
1.5.	Promoting natural regeneration of forests	+	+	+	-
1.6.	Reforestation, afforestation, creation of forest crops	+	+	+	+
2.	Forest protection				
2.1.	Forest fire protection	+	+	+	+
2.2.	Fire protection of forests and construction of reservoirs	+	+	+	+
2.3.	Protection of forests from pests and diseases	+	+	+	+
3.	Felling				
3.1.	Felling of the main use	+	+	+	-
3.2.	Intermediate felling	+	+	+	-
3.3.	Other felling	+	+	+	+
4.	Barrois and secondary forest resources harvesting				
4.1.	Barrois, spruce resin harvesting	+	+	+	-
4.2.	Christmas Tree trees harvesting	+	-	-	-
4.3.	Lime liber, willow and fir bark harvesting	+			
4.4.	Stubs and roots harvesting for fuel, branchwood harvesting for processing flour	-	-	-	-
5.	Minor forest use				
5.1.	Wood juices harvesting	+	+	-	-
5.2.	Hives and apiaries placing	+	+	-	-
5.3.	Wild berries, nuts and fruit harvesting*	+	-	-	-

5.4.	Mushrooms picking:				
5.4.1	Weak- and middle-accumulating Cesium-137 *	+	-	-	-
5.4.2	Strongly accumulating Cesium-137	-	-	-	-
5.5.	Collection of plants and their parts used as medicinal raw materials *	+	-	-	-
5.6.	Mowing and grazing (herbage)	+	-	-	-
5.7.	Moss, forest cover and fallen leaves harvesting	-	-	-	-
6.	Forest management of the territory of the forest fund	+	+	+	+
7.	Control of radioactive contamination of the forest fund territory	+	+	+	+
8.	Road construction	+	+	+	+

*is permitted in the forest compartments with the contamination density up to 74 kBq/m² (up to 2 Ci/km²)

2.3.4 Special aspects of marking-cut a logging site and felling

48. One of the distinguishing features in the marking of logging sites in areas of radioactive contamination is to conduct the radiation survey, which determines the possibility of carrying out felling subject to compliance with radiation safety standards. At the logging site, radiation characteristics should be established as follows: Cesium-137 soil contamination density, Gamma-Radiation Intensity, Cesium-137 content in wood according to species and categories of technical suitability (industrial and firewood).

49. In the zone I, the radiation inspection of the felling areas is carried out after their marking, if the content of Cesium-137 in the wood harvested on the territory of the forestry did not exceed the permissible levels within the last three years. Prior to the beginning of felling, selection of model trees is carried out, during the felling - sampling of wood from model trees. In other cases in the zone I, the radiation survey of cutting areas is carried out prior to their marking. In the zones II - IV, the radiation survey of felling areas is carried out before they are marked.

50. A new requirement has been introduced in the Rules. If demarcation of cutting areas is not carried out, but wood that can be used (sold) is harvested, a radiation survey of the cutting areas is carried out after demarcation or radiation control of wood batches can be carried out. That is, if it is not possible to survey the logging site, radiation control of already harvested wood is allowed. In this case, the requirement of mandatory radiation monitoring and obtaining information on the content of Cesium-137 in wood is observed. At the same time, a comparison of the results of radiation monitoring of wood sampled from model trees during the radiation survey of the logging site and from the batch shows that in the overwhelming majority of cases, the content of Cesium-137 in the model tree wood is higher than in the harvested batches.

51. This suggests that the methodology for sampling wood from model trees characterized by the ability to accumulate radionuclides to the greatest extent provides evidence of the safe use of all wood harvested from the cutting area by the radiation factor.

52. Felling of the main use in the zone III is carried out by the Forestry Enterprises on the basis of the permission of the Ministry of Forestry after providing a justification for the necessity of their holding. This norm was introduced with a view to confirming the silvicultural and economic feasibility of carrying out felling of forests under conditions of high radioactive contamination. The practice of felling in the zone III showed the possibility of developing the allowable cut and harvesting of normatively "clean" industrial wood. When cutting in this zone, up to 55% of firewood in Gomel and up to 28% in Mogilev SFPA does not meet the requirements of RPL/ Forestry-2001 and remain on the felling areas.

2.3.5 Special aspects of harvesting and storage of forest food products

53. Radiation control of products of minor forest use in the zones of radioactive contamination is carried out prior to the beginning or during the harvesting of them
54. Mushrooms picking in the zones of radioactive contamination is carried out taking into account the following features: weakly and medium accumulating Cesium-137 mushrooms (autumnal mushroom, parasol mushroom, puff-balls, champignon, chanterelle, boletus, birch-boletus, blewits) are allowed to be picked in the forest quarters with a pollution density up to 74 kBq / m² (up to 2 Ci / km²). Highly accumulating Cesium-137 mushrooms (woody milkcap, bay boletus, annulated boletus, ugly milk- cap, gypsy mushroom, sharp agaric, russula) are allowed to pick in forest compartments with a soil contamination density up to 37 kBq / m² (up to 1 Ci / km²).

55. Harvesting of wild berries, fruits, nuts, plants and their parts used as medicinal raw materials is allowed in forest quarters with a pollution density up to 74 kBq / m² (up to 2 Ci / km²).
56. Wood juices harvesting, hives and apiaries placing are permitted in zones I-II only.

2.3.6 Forest products radiation clearance confirmation

57. The batches of forest products received for processing into production areas from forest quarters in radioactive contamination zones are accompanied by a document certifying the content of radionuclides. The accompanying documents shall be put and filled with a stamp of the radiation safety mark in form 1 or 2 in accordance with Annex 2 to the Forest Management Rules.
58. After the processing of forest products, the batches of manufactured products are subjected to radiation control at a frequency established in radiation monitoring schemes, a test report is issued. The test report is submitted to the forestry subdivisions, which are responsible for the shipment of the finished products.
59. Each batch of the finished products is supported with the radiation safety mark put and filled or a radiation safety passport is provided in accordance with the Annex 3 to the Rules.
60. Registration of the radiation safety passport, filling of the mark stamp on the shipped products is carried out on the basis of the report of the radiation inspection of the cutting area or the test report.
61. When shipping batches of forest products from the storage sites, the radiation safety passport shall be drawn up on the basis of the values of the activity of Cesium-137 indicated in the radiation safety marks. At the same time, the maximum value of the specific activity of Cesium-137 in the shipment batch and the corresponding number of the radiation inspection certificate for the logging site (test report) are indicated in the radiation safety passport. The specific activity of Cesium-137 in wood is indicated with the addition of the value of the estimated uncertainty or measurement error.
62. On the supporting documents, for each batch of forest products shipped directly from the harvesting sites (industrial wood, firewood, products of secondary forest use: birch juice, mushrooms, berries, etc.), a radiation safety mark is filled in and radiation safety passport is issued if necessary.
63. In the Appendix to the Forest Management Rules, new forms of radiation safety marks are given. In the mark (Form 1) in the column "The content of Cesium-137 in the product is", the value of the specific activity and the value of the error in the measurement results should be given, which are summed up. The measured value + error shall not exceed the permissible level. The Forest Management Rules contain a new mark for confirming the radiation safety of wood (Form 2), which is filled in if the 137Cs content in the batch of wood exceeds 200 Bq / kg. Radiation safety mark does not contain values of cesium-137 activity; these values are given in the Radiation Examination Report or the test protocol.

Box 1 − Radiation safety mark

Form 1

MINISTRY OF FORESTRY OF THE REPUBLIC OF BELARUS
_____SFPA,_____FORESTRY ENTERPRISE
_____FORESTRY

THE PRODUCTS ARE CHECKED
FOR THE RADIOACTIV CONTAMINATION

The content of Cesium-137 in the products makes _____+_____ Bq/kg,
while the permissible level is _____ Bq/kg.
Test protocol (Radiation Inspection Act)
No _____ dated «___» _____ _____

Signature _____ (Name, Surname)

Form 2

MINISTRY OF FORESTRY OF THE REPUBLIC OF BELARUS
_____ SFPA, _____ FORESTRY ENTERPRISE
_____ FORESTRY

CESIUM-137 CONTENT IN THE WOOD
DOES NOT EXCEED 200 BQ/KG

Radiation Inspection Act (Test protocol)
No _____dated «____» _____ _____

The batches of wood, on the accompanying documents to which the stamp of form 2 is placed, can be used without restrictions on the radiation factor. The stamp form 2 is simplified, when filling in, only the number and date of the radiation inspection act (test protocol) is entered.

64. The new forest management regulations in the territories affected by radioactive contamination as a result of the Chernobyl catastrophe have optimized the requirements for forest management, taking into account changes in the radiation situation in forests, practical experience in monitoring of radioactive contamination of the forest fund, forest products, and also the requirements established by the legislation in CY 2012-2016:

- the zoning of territories has been optimized (subzones excluded), the actions in forestry activities and forest management are regulated;
- when making decisions on the implementation of forest management, the results of monitoring of radioactive contamination for the previous period are used to the fullest extent, radiation control from batch of harvested wood is allowed, unless the harvesting area is marked;
- it is not necessary to develop special regulations for cuttings in the zone III. The forms of documents confirming the radiation safety of batches of timber shipped are simplified;
- the volume of the document was reduced from 50 to 20 pages, the number of applications from 11 to 3.

65. The Rules in the new edition were reviewed and agreed with SFPAs, the Ministry of Emergency Situations of the Republic of Belarus, the Ministry of Health of Belarus, the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, the Office of the

President of Belarus, the State Inspection for Protection of animal and plant life of the President of the Republic of Belarus, and approved by the Decree of the Ministry of Forestry of the Republic of Belarus as of December 27, 2016 No. 86, and published on the National Legal Internet Portal 07.02.2017, 8/31754.

2.4 Development of the Rules of radioactive contamination control

2.4.1 Radioactive contamination control requirements

66. The functioning of the radioactive contamination control system in the forest fund is regulated by the Ministry of Forestry. Control of radioactive contamination is carried out on the basis of Rules of radioactive contamination control. The requirements for monitoring of radioactive contamination were established taking into account the radiation situation on the territory of the forest fund, previously obtained data on the control of radioactive contamination, the specifics of production technologies and other factors.

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2.4.2 Justification and amendment of the Rules of radioactive contamination control

67. In 2015-2016, different new NRAs has been put into effect in the Republic of Belarus, defining the requirements for the organization and control of radioactive contamination in connection with the Chernobyl nuclear disaster at the current stage, the responsibility of departments and organizations for the implementation of radiation control of products produced and sold, the need for updating the Forest Management Rules in the zones of radioactive contamination at the departmental level.

68. Rules of radioactive contamination control in the system of the Ministry of Forestry of the Republic of Belarus (hereinafter referred to as the Rules of control) establish the procedure for the organization and control of radioactive contamination on the territory of the forestry fund of the Ministry of Forestry. The Rules of control were developed on the basis of the requirements established in the NRA, as well as taking into account the capabilities of the information resources created in previous years with databases on radioactive contamination of the forest fund and forest products.

69. The legal norms of the Rules supplement and detail the basic requirements for the organization of a radioactive contamination monitoring system, the interaction of the constituent entities thereof and the provision of information on the results of the control of radioactive contamination set forth in the Regulations on the Control of Radioactive Contamination, the Regulations on the Radioactive Contamination Control System, the Legislation On the Legal Regime of territories exposed to radioactive contamination as a result of the Chernobyl catastrophe, and radiation safety.

70. The Rules of control define objects, controlled parameters, volumes, frequency and procedure for monitoring of the radioactive contamination in the system of the Ministry of Forestry, taking into account the radiation situation in the forest fund, previously obtained data on radioactive contamination control, the specifics of production technologies and other factors.

2.4.3 Radiation Control Schemes in a Forestry Enterprise

71. The Rules established that the control of radioactive contamination at the production level is carried out by the Forestry Enterprises on the basis of the Radiation Control Schemes.

72. The Forestry Enterprises with the forest fund in the zones of radioactive contamination, develop Radiation Control Schemes. The scheme is adopted by the director of the Forestry Enterprise and is subject to agreement with the main department of radiation control of the Ministry of Forestry - the state institution for the protection and monitoring of forests ”Bellesozaschita”.

73. Radiation Control Schemes of the Forestry Enterprises contain a list of objects for radioactive contamination monitoring; list of controlled parameters; volumes of control; technical normative regulatory acts establishing requirements for objects of control of radioactive contamination; list of measuring instruments used and methods of their implementation; list of officials responsible for ensuring control of radioactive contamination and carrying out such control, as well as detailed requirements for the periodicity of control of radioactive contamination of forest fund areas, forest fund plots, forest products and products of its processing, forestry facilities and workplaces.
74. Forestry Enterprises with forest fund that are not referred to radioactively contaminated zones carry out radiation control of the batches of food products (wood juices, wild berries and mushrooms, game meat, honey) in accredited radiation monitoring units in the established order. The requirement for radiation control of food products is included in the documents regulating production control.

2.4.4 Presentation of information on the monitoring results

75. The results of the forest products control are provided by the Forestry Enterprises until the 1st day of the month following the reported one in the format of IS "RadForView". The Forestry Enterprises of Gomel and Mogilev SFPA provide results to the radiation control departments of Gomel and Mogilev Forestry Enterprises, the Forestry Enterprises of Brest, Grodno and Minsk SFPAs − to the "Bellesozaschita" Institution. Radiation control departments of Gomel and Mogilev Forestry Enterprises provide summary results on the SFPA to the "Bellesozaschita" institution until the 5th day of the month following the reported one.
76. The results of the control of the radioactive contamination of the forest fund lands of the Forestry Enterprises are submitted to the "Bellesozaschita" within the terms established in the work plan for the year. The institution "Bellesozaschita" summarizes, systemizes and analyzes the results of the control of radioactive contamination of the forest fund, forest products for the reporting year and provides an analytical report to the Ministry of Forestry.
77. Rules of radioactive contamination control in the system of the Ministry of Forestry of the Republic of Belarus were approved on 03.12.2017 by the Order of the Ministry of Forestry No. 36. The rules are reviewed and coordinated with the SFPAs. The order approving the Rules and the Rules themselves are coordinated with the Ministry of Health of the Republic of Belarus and the Ministry for Emergency Situations of the Republic of Belarus
78. During the year 2017, all the Forestry Enterprises developed Radiation Control Schemes based on the Rules of radioactive contamination control, reviewed and agreed with the "Bellezaschita" Institution, approved and put into operation in the Forestry Enterprises.

3. Improvement of the system for collection and transmission of information on radiation condition indicators in forests

3.1 Synthesis and analysis of reporting forms of IS "RadFor"

3.1.1 Arrangement of reporting forms from databases of IS "RadFor"

79. During the reporting period arrangement of reporting forms of databases "Radiation situation" and "Forest Products" of IS "RadFor" and its version of "RadForview" was carried out. The reports provide detailed and generalized in different degree information by:
- Forest compartments. This detailed information characterizes the forest compartments by dose rates, soil contamination density, the date of the radiation inspection, and the area of radioactive contamination;
- Forest enterprises in the context of forestries. This information characterizes the area, the degree of contamination (assignment to a particular contaminated area) and rank in accordance with contamination level among forestries of separate Forestry Enterprise;

- SFPAs in the context of Forestry Enterprises. This information characterizes the area, the degree of contamination (assignment to a particular contaminated area) and rank in accordance with contamination level among Forestry Enterprises of separate SFPA;
- The Ministry of Forestry in the context of SFPA. This information characterizes the area, the degree of contamination (assignment to a particular area of contamination).

80. Database “Radiation conditions” (hereinafter referred as to DB “Radiation conditions”) represents 6 reporting forms:
- “The results of radioactive contamination control of forest lands”;
- “List of density of Cesium-137 contamination”;
- “The projected decline of contamination density of Cesium-137 on a given date”;
- “The projected time of decrease contamination density of Cesium-137”;
- “Distribution of territory into areas of radioactive contamination (at present and forecast)”;
- “Distribution of Forestry Enterprises on severity of radioactive contamination”.

81. Reporting forms created in DB “Radiation conditions” with comments are provided in:
- “Results of the control of the forest fund radioactive contamination” report is presented as a list of forest compartments with display indicators of the radiation situation in each, the date of its examination. The report is the basis for classification of forest compartment to zones of radioactive contamination;;
- “Report of Cesium-137 contamination density within the range…”. List of compartments numbers in the standard range in the zones of radioactive contamination is used to update the thematic maps of forestries, colored by zones of radioactive contamination;
- “Report on forecasted decline of contamination density of Cesium-137 on a given date”. After setting the date, two types of statements can be opened depending on the task: “Determination of the density of Cesium-137 contamination at a given date” and “Predicted reduction in the soil contamination density and calculation of the specific activity of wood for the main forest-forming species”;
- The “Forecasted time to reduce the density of Cesium-137 contamination” statement provides a definition of the date of compartment exit from the radioactive contamination zone, or the transition from zone to zone according to a given value of soil contamination density;
- Report “Distribution of the territory into areas of radioactive contamination” is created using the DB “Radiation Situation” and reflects the situation on a period of report creation. The report reflects the distribution of the forestry area into the zones of radioactive contamination by forest enterprises in the context of forestries, by SFPA in the context of Forestry Enterprises, by the Ministry of Forestry in the context of SFPA;
- The forecast report “Distribution of forest fund territory by radioactive contamination zones” presents the distribution of forest fund areas on a given date for forestries of Forestry Enterprises, for Forestry Enterprises of SFPAs, for SFPAs of the Ministry of Forestry;
- Report “Distribution of Forestry Enterprises on severity of radioactive contamination” is created out of DB “Radiation Situation” on the period of report creation − “Distribution of Forestry Enterprises of the Ministry of Forestry according to severity of radioactive contamination”, “Distribution of Forestry Enterprises ..... of SFPA by severity of radioactive contamination”, “Distribution of forestries ..... of Forestry Enterprise by severity of radioactive contamination”. Reports are generated in automatic and semi-automatic mode.

82. From the database “Forest Products” the following form of the report can be generated:
- Act of Radiation Inspection of Cutting Areas” for the main forest use and areas for intermediate felling. It is developed for the peripheral version of “RadForView” and it can be generated not only automatically, but with the direct participation of the operator.
- "The results of radiation monitoring of timber in zones of radioactive contamination" for forestries of Forestry Enterprises, for Forestry Enterprises of SFPAs;

- "The results of radiometric measurements of objects of control in forestry". The report can be generated by the forestries, Forestry Enterprises and SFPAs and submitted for a specified period of time.

3.1.2 IS “RadFor” function, formation of a database of assessment descriptions, proposals for the development of an algorithm that provides links to other databases

83. IS “RadFor” includes the storage technologies, display and presentation of information on radioactive contamination of forest fund, forest products, the dose rate of gamma radiation, cartographic materials from the quarterly distribution of zones of radioactive contamination and the list of requirements to conduct works in contaminated areas aimed at improving radiation protection of forest workers.

84. Information system “RadForview” is introduced in Brest, Gomel, Grodno, Minsk and Mogilev SFPE and provides the following feature set: the collection, combining and processing of information on the results of radiometric measurements; obtaining reference information by compartments and quarters (parts of compartment) from the database; automatic coloration of the territory of a compartment depending on the soil contamination density of Cesium-137; selection of objects on the map and searching information on it in the database; issuance for printing a graphical and text information; scrolling the map in any direction and zoom, exporting of maps in a graphical format suitable for further processing.

85. The features allows for: pursuing a common policy in the sphere of effective forest management, subject to radiation safety standards; applying modern methods and tools for collecting and analyzing information; organizing interaction between suppliers and consumers of information geographically distant from each other; organizing background information on forest condition and leading it to the cartographic basis; carrying out an initial analysis of the results of radiation monitoring for the preparation of decision-making; providing the information resulting from the analysis of the database to the organizations, ministries and departments involved.

86. All IS “RadFor” functions and its peripheral version “RadForview” are systematized and presented in the report tables. Description and analysis of the functions of the databases "Radiation situation" and "Forest products" are presented in Tables 6 and 7.

Table 6 - Functions of “Radiation Situation” DB, IS “RadFor”

Functions	**Characteristics and analysis**
Database "Radiation conditions" of the Information system “RadFor”	
Maintaining a "Radiation situation" DB IS “RadFor”: adding the results of a radiation survey; updating of the database as a result of the basic forest management.	The main direction of using these functions is updating the database as a result of a radiation survey of forest compartments and conducting a basic forest inventory.
Adding and updating of data on radiation survey of forest areas in “RadForView” program in window for editing of the information.	Allows for entering the information on the results of radiation situation (the dose rate of gamma radiation, density of soil contamination with Cesium-137, radiation survey date).
Information exchange between programs RadForview and RadFor users The "export data" function is designed for RadForview and RadFor programs, and has no fundamental differences.	The function provides the collection, exchange and updating of data by unloading one program from the databases and then loading them into another program. This increases the speed of data exchange and prevents their distortion.
Comparative analysis of the new results data of radiation survey in the DB “Radiation conditions” of the version “RadFor” is provided with the functions: - collection and presentation of information; - color display of different records of the same fields; - visualization of the representation of the coloration of radioactive contamination zones.	New results of the inspection of radiation conditions are loaded in the double fields of the "Import Data" window. If there is a mismatch, the values are highlighted in red. Fields that control the coloring of contamination zones are created. Non-coincidence of the color of the cell during the analysis indicates a change in the radiation situation.
Replacement of data in the DB “Radiation conditions”: -replace all information with a button within the selected fields of the database; - selective replacement of data on the results of radiation survey of the forest compartments.	The system allows for making selective data replacement. Function of review and selective replacement of the information in the database "RS", received by e-mail, makes it possible to accept or reject the results of the survey entirely all or for one compartment.
Information of the “Radiation Situation” DB presentation. Data search and selection. Providing information about the compartment or compartment group radiation situation on the search criteria.	The information can be represented by a common table, individual database fragments (compartment, group of compartments) by setting parameters in the "Search" window, report forms of the established sample.
Download selected data from DB “Radiation conditions” in Excel format.	Allows you to obtain more detailed information on the selection of data
Presentation of information, a block of the decision support system (hereinafter - DSS): Regulation of forestry activities; Prediction of specific activity; Forecasting the change in the radiation conditions in compartments with a cesium-137 contamination density of 1 and more Ci / km^2.	Excerpts from normative documentation on the use of forests in zones of radioactive contamination are posted; Forecasting the activity of forest products in certain regions (annex to the program); Calculation of the forecast of changes in the radiation conditions is presented in the report windows.

The calculation of the projected decrease in the density of soil contamination with Cesium-137 - on the specified date. Predictive values of the specific activity of the wood for the main forest-forming species.	Allows to determine the value of soil contamination density on the date for which the forecast will be calculated. The function is realized by entering the forecast date and the conversion coefficient of Cesium-137 from the soil into the wood.
Visual presentation of the results of the forecast of changes in the radiation situation on a given date in the "Projections of Cesium-137 contamination density decline".	The function allows to quickly determine the compartments that can move from zone to zone, when drawing up radiation inspection plans and developing projection maps.
Presentation of the forecast for changes in the radiation situation on a given date by the digital maps of forestry with the coloring in the zones of radioactive contamination with Cesium-137	The presented map provides comprehensive information on the assignment of compartments to radioactive contamination zones, their location and configuration.
Calculation of the predicted date for the reduction of soil contamination density, Cesium-137 in forest compartments to the established level.	The result is opened in the statement “Determination of the date for a given value of the density of contamination with Cesium-137”.

Table 7 - Functions of the database “Forest Products” of the IS “RadFor”

Functions	**Characteristics and analysis**
Data adding, editing and moving into another compartment in the "Edit information in forestry" window	Accumulation of data on the results of a survey of products with reference to a specific compartment number.
Creation of the output document "Act of Radiation Survey in the cutting areas." Filling of individual act cells in the automatic mode. Filling the conclusion of the "Act" from the guidelines as may be selected.	The function allows to quickly and error-freely make a “Radiation inspection report and print it out”.
Carrying out of data export and import from "Forest Products" DB. Data import of “Forest Products” DB for updating of the united DB of RadFor Program.	It is carried out by creating the "View" download folder and is used in two ways: updating your own database and databases of other users.
Installing filters in all graphs of accounts of database "Forest Products" (data sorting). The function provides data sorting, which makes it possible to identify errors in the introduction of information and also provides operational information.	The function provides data sorting. Data search and selection functions are carried out through the "Search" window of the “Forest Products” database. Search criteria can be set for any database field.
Downloading the selected data in the Excel format.	Allows to process the data for obtaining graphs and tables.
Presentation of reports of a standard pattern with printing and the possibility of uploading to Excel for further development.	Reports are generated from the "Report Creation" window of the "Forest Products" DB and through the "Reports" main menu of the "RadFor" program and its version of "RadForView".

87. One of the major IS “RadFor” blocks is working with digital maps. Inclusion of the library of programs for work with digital maps MapX into the system allows for automation of

the creation of user's digital maps of forest areas on the existing topographic base. This allows for displaying the information in a more understandable form, as maps are more informative than charts and graphs and their interpretation is more evident and fast compared with the tables, especially with such complex and lengthy, as the radioactive contamination tables with details on the types of products and stand out.

88. It is very important that the MapX is based on the same mapping technologies that are used in other MapInfo products and are already extensively used in this survey. In addition, the user can work with active map, for example:

- Visual selection. Using standard tools, you can select items that will fall into a rectangle, a circle and an arbitrary polygon;
- Layers management. There are features that allow for operating with layers of geographic information, assign ways of displaying objects and the formation of signatures to change the map scale, control the visibility of layers, to determine the order of display and scaling effect for layers of map objects and labels.

89. As a topographic base the digital topographic maps in MapInfo format can be used for any territory. Digital topographic maps are of multi-layers organization and layers management software that allows for quickly adding or removing the layers required.

90. In order to implement the following additional functions are defined in the framework of the existing system:

- Automatic coloring of the compartment territory depending on the density of soil contamination with Cesium-137;
- Marking of objects on the map and search for information on it in the database;
- Receipt of reference information concerning the compartments and allotments from database;
- Printout of graphic and text information;
- Scrolling the map in any direction;
- Zoom;
- Export maps in a graphical format suitable for further processing.

91. The information system "RadFor" has a unit for storing assessment descriptions (hereinafter - TD), that are used to fill the database "Forest products" and drafting of output reports (radiation survey of the Act of Radiation Survey in the cutting areas). At this stage, the completion and updating of the database is associated with functional difficulties that require the intervention of specialists - programmers to convert data from a forest inventory program to IS "RadFor". Such a system of IS filling with data is neither economic nor operational. Using the TD data while manual entry into the database leads to errors, due to the inefficient time management at their elimination. Therefore it is necessary to reform the system of filling the DB "Assessment escription" of IS "RadFor".

92. As a solution to the problem it is proposed to create a converter or to bring the IS "RadFor" databases and forest management programs to a common format, from which the assessment descriptions would be downloaded.

93. IS "RadFor" can be reorganized into a more convenient form for the user. It is proposed to add a function block, filled with relevant assessment descriptions associated with digital maps of forest compartments, through which it is possible to get information about the forest through the highlighted allotment on the map. In addition the availability of such a unit would help to establish a lock for a possible error when filling the "Forest products" DB line by an operator.

94. The program operates through the algorithm providing coloring of forest compartments on digital maps in the zones of radioactive contamination, in case of changing the density of soil contamination in the database "Radiation situation", it is also possible to calculate the forecasted density of soil contamination on a given date in the statements, and to display a thematic map. The algorithm, which allows for calculating the value of the specific activity of a particular timber species typical for the site conditions for the current and future periods (forecast). In order to make the calculations a special software module is used that is manually filled with pre-

calculated values of the coefficients of transition of Cesium-137 from the soil into the timber. Such a system is not sufficiently improved.

95. In this regard it is possible to offer the development of the following algorithm interaction between assessment descriptions and other databases. It is proposed to create a separate module, which connects the table of calculated coefficient values of transition for all main tree species with soil contamination density and assessment descriptions via digital forestry maps. Built in module table should associate the individual elements such as type of forest-forming species and type of forest conditions (hereinafter - TFC) (assessment descriptions); soil contamination density (DB "Radiation conditions"), the rate of transfer factor for selected forest-forming species and TFC and digital thematic map. Linking these elements and setting a date for the calculation of the forecast make it possible to get quickly the calculated predicted value of the specific activity in wood on the specified date. Such integration will help to address issues related to the planning and implementation of forest management activities on the territories of radioactive contamination of the forest fund of the Republic of Belarus more effectively.

3.2 Development of schemes for introducing information on indicators of the radiation conditions at cutting areas in permitting documents

96. The goal of service is to optimize forest use in the territory of radioactively contaminated areas of the forest fund through the enhancement of operational information about the radiation conditions in forests, the use of the updated information on the levels of radionuclide content in the components of forest biogeocenosis, forest products.

97. To achieve the goal the following objectives are fulfilled:

- The scheme for entering data on the radiation conditions into the felling license is developed;
- The system of creation of a felling license in the program complex (PrC) «Forest use» (FU) is analyzed.;
- Possible ways of interaction between automatic workplace “Forest use” (hereinafter – AWP “Forest use”) and IS “RadForview” are identified to make suggestions about creating a sub-program provides automatic filling of the radiation characteristics of the cutting area;
- The scheme for entering the information on Cs-137 contamination density of soils, specific activity of Cs-137 in wood, number of act on radiation inspection from DB IS “RadFor” into the felling licenses;
- The suggestions about creating a sub-program of AWP ”Forest use” (FU) for preparing the felling licenses were made. The options for program complex "FU" reorganization are outlined to provide interaction between AWP “Forest use” and IS “RadForview”. The first option is to add the fields contain information on radiation conditions into the database “Forest fund”. The second option is to create a new database – “Radiation conditions”. Information exchange is suggested to conduct through export and import data on radiation conditions from IS “RadFor” into AWP “Forest use”.

3.2.1 Scheme for data input on the radiation conditions into the felling license

98. Harvester tickets entitle to carry out of felling and export of timber. It is filled in by forestry specialists in Forestry Enterprises with AWP “Forest use”. Information is entered in felling licenses from the database PrC (Program complex) “Forest use” automatically, and radiation inspection data are entered manually from the act of radiation inspection cutting areas created with “RadForview”. When filling a felling license manually inaccuracies are possible, working time is not used rationally. To minimize the influence of the human factor, it is advisable to automate the input of information directly from the databases of the “Forest use” AWP.

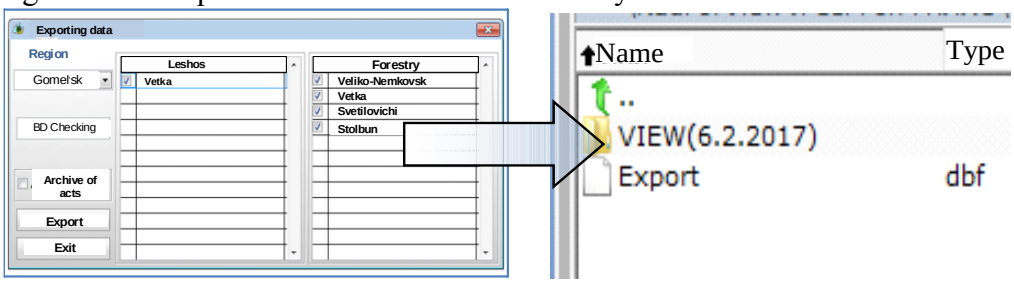
99. Input of information on the radiation factor in felling licenses is proposed to conduct by stages.

Export data;

The accumulation and storage of the results of radiation inspection of the cutting areas is carried out in the database "Forest Products" IS “RadForview”. Information on the density of soil contamination with Cesium-137 at cutting areas and the specific activity of Cesium-137 in wood is introduced into the appropriate fields in the window "Editing of the information in a forestry";

The unloading of information on the radiation conditions in the cutting area is carried out by carrying out data export from the software version of the RadForview IC. The exported data folder "VIEW (___ .___. 201_)" is located in the "Export" program folder, specially created for receiving the upload folders.

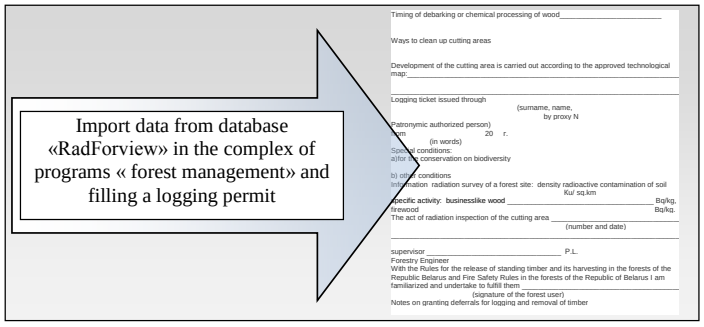
Figure 15 − Export data from the Information System “RadForview”.



The source: IS “RadForview”.

Import data into the program complex “Forest use”. Import data in the PrC “Forest use’» to fill in the radiation inspection results of the cutting area to felling licenses in the automatic mode.

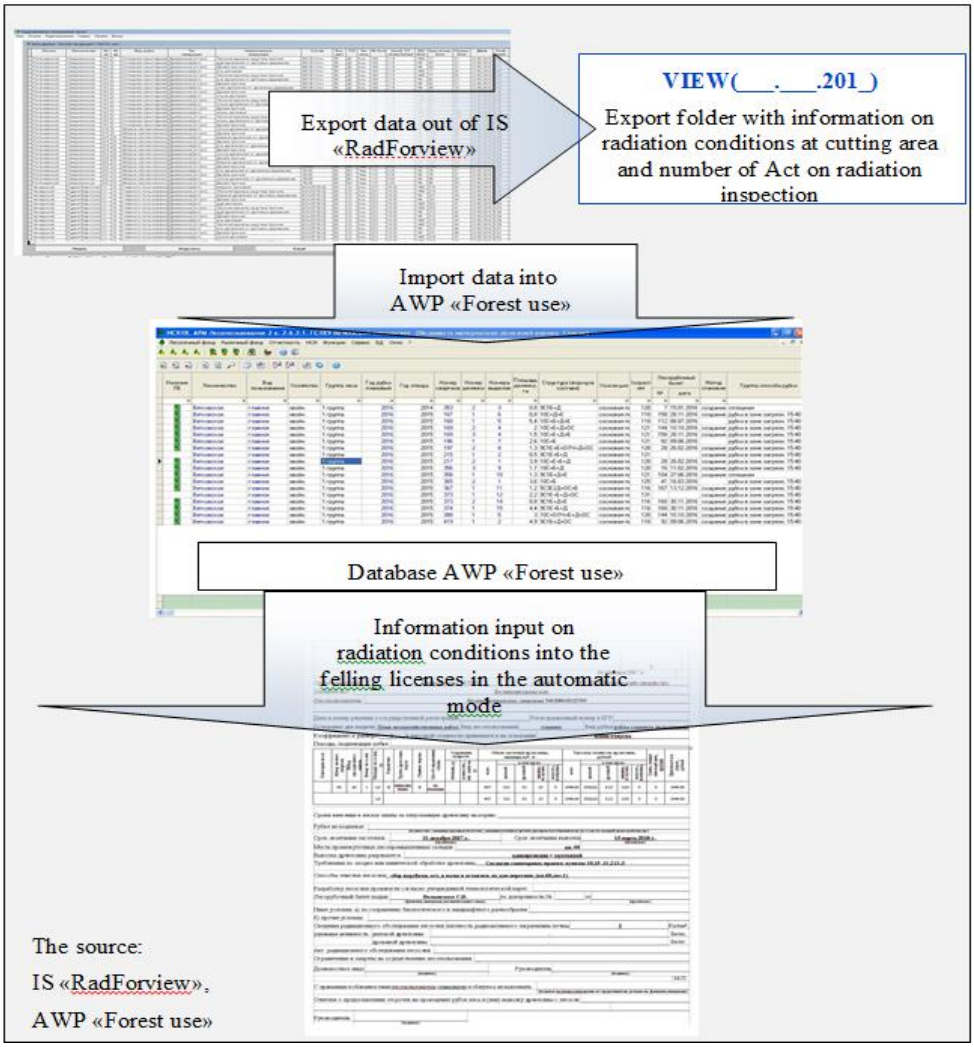
Box 2 - Import data to fill the felling license



100. With this method of the data occurrence on soil contamination density and specific activity of Cesium-137 in wood at the cutting area in the felling license mistakes in filling the document are excludes, and time for its preparation is reduced. Addition of information on the radiation conditions at the cutting areas out of the IS ”RadForview” into PrC AWP “Forest use” is appropriate and technically feasible.

101. Scheme for data input on soil contamination density of Cesium-137, specific activity of Cesium-137 in wood by species and categories of technical suitability, number of act on radiation inspection into permitting documents for forest use, and data occurrence on the radiation conditions is shown at the Scheme (Box 3).

Box 3 - Scheme for information input on soil contamination density of Cesium-137, specific activity of Cs-137 in wood by species and categories of technical suitability into the felling licenses



3.2.2 Proposals of subprogram development for the automated working place "Forest use"

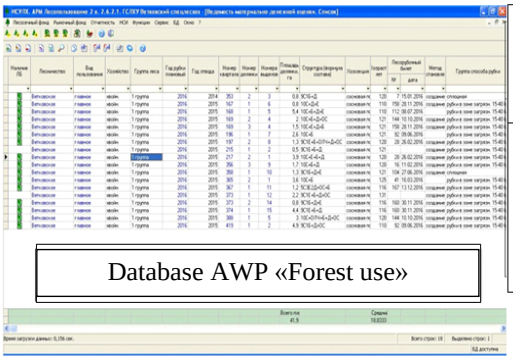
102. To improve the operational information on the radiation conditions in forests it is proposed to develop algorithm for databases interaction between PrC AWP "Forest use" and IS "RadForview". Interaction between two programs can be achieved by creation of a separate module or new fields in the database AWP, and ensuring data import out of IS "RadForview" into AWP "Forest use".

103. It is necessary to develop the conditions for import into the PrC "Forest use" data on the radiation conditions at cutting areas. To accomplish this task two options for the amendment to program complex are proposed.

Option I.

104. Creation new fields in the database AWP "Forest use" for automatic download through data import on soil contamination density of Cesium-137 (Ci/km^2), specific activity of Cs-137 in wood (Bq/kg), № of Act on radiation inspection out of IS "RadForview" (Figure 16).

Figure 16 − Window of the DB AWP “Forest use” with the sample of new fields to fill the information on the radiation characteristic.



Soil cont. density, Ci/km^2	Activity in wood, Bq/kg	№ of Act

Option II.

105. Creation of a separate module which allows importing more extensive information – the entire database with the ability to use data on the user's choice.

106. In selecting any option for amendment to the program complex AWP “Forest use” the information loading scheme remains the same and contains the same steps:

Export data on radiation conditions out of the Information System “RadForview”;

Import data into the program complex “Forest use”.

107. The options for the software integration of information system “Radioactive contamination of forests. RadForview” and AWP “Forest use” are offered. Its implementation will provide reduction of work load during the filling in felling licenses, validity of data on soil contamination density of Cesium-137, specific activity of Cs-137 in wood, № of Act on radiation inspection of cutting areas.

108. For the data import it is necessary to develop and apply of the converter to ensure integration in information exchange within the software.

109. The technical specification was developed for the announcement of the competition to render the programming services. Subject of procurement – the integration of information system “Radioactive contamination of forests. RadForview” and AWP “Forest use”.

3.3 Development of an information block to provide operational information on the radiation conditions, predictions of its change

110. For the well-timed planning and implementation of forest management measures a function is developed to enlarge representation of the radiation condition changes on the territory of the forest fund of the Ministry of Forestry in the context of the SFPAs and Forestry Enterprises.

111. All data on radioactive contamination in forests are included in the "Radiation conditions" database, which is an integral part of the information system "Radioactive contamination of forests. RadFor".

112. One of the functional subsystems of the RadFor program is the report generator due to which it is possible to determine the predicted time for reducing the soil contamination density of Cesium-137 at a given density in the territory of any forestry department. Or vice versa determine the density of soil contamination at a given date setting a forecast date. The calculation is carried out according to the formula:

$t = \lg(N_0/N)/0.023$ (years), where

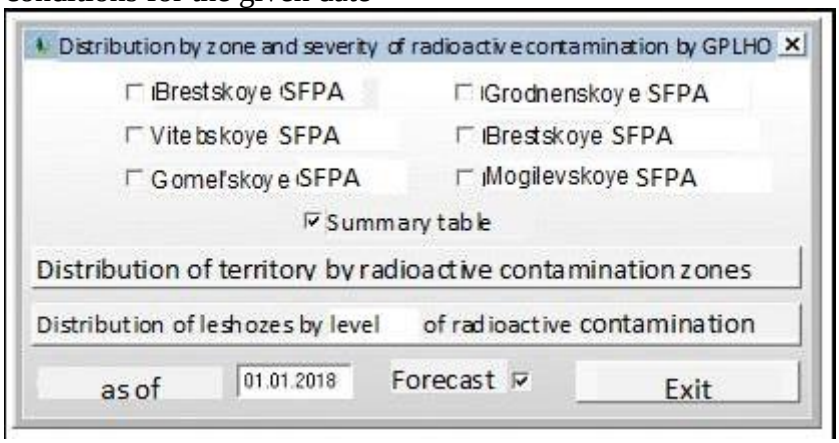
N_0 – contamination density of the soil layer 0-20 cm with Cesium-137, Ci / km^2 (currently);

N – intended density of soil contamination, at which the planned forest management measures can be carried out, Ci / km^2;

0,023 – constant number.

113. The function of the report generator is implemented in the window “Division by zones and severity of radioactive contamination in SFPAs” and is represented by the position “Forecast” (Figure 2). To form the report, set the criteria for its formation: enter the date of the forecast; select the report type; check the box in the “Forecast” position; select the button “Division of territory by radioactive contamination zones”.

Figure 17 − Window “Division by zones and severity of radioactive contamination in SFPAs” with the calculating function and the presentation of the forecast changes in the radiation conditions for the given date



The source: IS “RadFor”

As a result, a report form will be generated in the "Report Designer" window as a forecast for the given date (Figure 18).

Figure 18 − “Report Designer” window. Division of the forest fund territory of the Ministry of Forestry of the Republic of Belarus by radioactive contamination zones in SFPAs. Forecast of changes in the radiation conditions for the given date.

№	Name of GPLHO	total area, Thous. hec.	Total contaminated, Thous. hec. %	Cesium-137 soil contamination by zones, Thous. hec.			
				1 zone	2 zone	3 zone	4 zone
				1 -5 Ci/km²	5 -15 Ci/km²	15 -40 Ci/km²	40 and more Ci/km²
1	Brestskoye	1252.7	74.9 5.98%	72.8 5.81%	2.1 0,17%	0.0	0.0
2	Vitebskoye	1575.0	0.0	0.0	0.0	0.0	0.0
3	Gomel'skoye	1853.9	785.0 42.34%	529.0 28.53%	191.7 10.34%	63.9 3.45%	0.5 0.03%
4	Grodnenskoye	909.6	18.7 2.06%	18.5 2.03%	0.1 0.01%	0.0	0.0
5	Minskoye	1497.9	29.2 1.95%	29.0 1.94%	0.2 0.01%	0.0	0.0
6	Mogilevskoye	1217.7	390.5 32.07%	258.0 21.19%	91.7 7.53%	40.1 3.29%	0.7 0.06%
	Itog	8306.8	1298.3 15.63%	907.3 10.92%	285.8 3.44%	104.0 1.25%	1.2 0,01%

The source: IS "RadFor"

114. This report is an enlarged form of presentation of the change in the division of the territory of the forest fund by zones of radioactive contamination on the given date. It represents the total area of the radioactive contamination in the forest fund by zones of radioactive contamination by SFPAs (in thousand hectares). Thus, it is possible to obtain the predicted values of the level of radioactive contamination for any date for SFPAs and the Forestry

Enterprises. A similar function for calculating the forecast for the given date is developed for the Forestry Enterprises with a representation of the forecast indicators in the forestry departments.

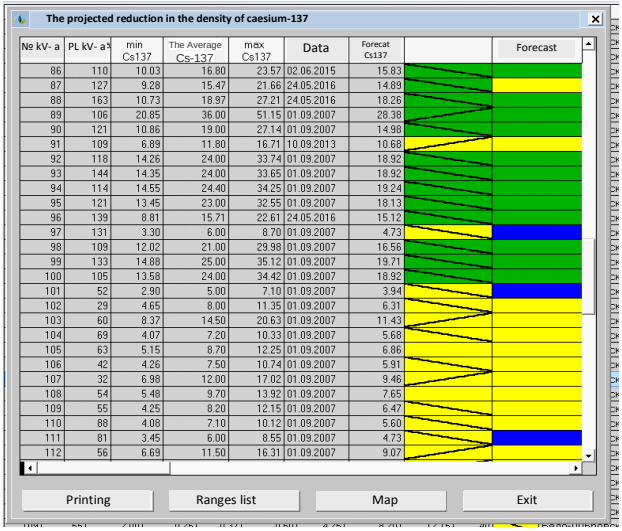
3.3.1 Development of the function of presenting forecast indicators

115. For the presentation of predictive indicators of changes in soil contamination density, functions of more detailed calculations and representations have been developed that can be more effective in the planning of works to specifying of radiation conditions. The most convenient form of presenting forecasted indicators of radiation condition changes is specification by forest compartments with visualization of calculated indicators in the program report. Such a function is necessary for the analysis and identification of forest compartments where it is necessary to clarify the radiation conditions.

116. Since the content of Cesium-137 in forest products directly depends on the density of soil contamination in forest compartments, it is extremely important to estimate the density of soil contamination timely and as precise as possible. It will provide timely clarification of the radiation conditions and a more rational planning of forest management in the areas of radioactive contamination.

117. The function for calculating the forecast of the soil contamination density for each forest compartment of the chosen Forestry Enterprise is developed and presented in the "Report creation" window of the DB "Radiation conditions" in a user-friendly form (Figure 19). Using the "Print" button a window opens with a cell to determine the date on which a calculation of the forecast of the soil contamination density in forest compartments is to be obtained.

Figure 19 – "Report creation" window to set the forecast date in DB "Radiation conditions"



The source: IS "RadFor"

118. The information on the chosen forestry is reflected: forest compartment number, forest compartment area, soil contamination density value, radiation inspection date, soil contamination density forecast (Ci / km2) for the given date, color fields for visualization of contamination zones. For the convenience of the operator, a better and faster receipt of the forecast results, special fields are developed to display the density of soil contamination in the color version. The cells of the fields are painted in colors corresponding to zones of radioactive contamination:

- not colored – soil contamination density less than 37 kBq / m^2 (less than 1 Ci / km^2);
- colored in blue – soil contamination density is 37-74 kBq / m^2 (1 - 2 Ci / km^2);
- dark blue – 37-185 kBq / m^2 (1 - 5 Ci / km^2) – I zone;
- yellow – 185-555 kBq / m^2 (5 – 15 Ci / km^2) – II zone;
- green – 555-1480 kBq / m^2 (15-40 Ci / km^2) – III zone;
- red – 1480 kBq / m^2 (40 Ci / km^2) and more – IV zone.

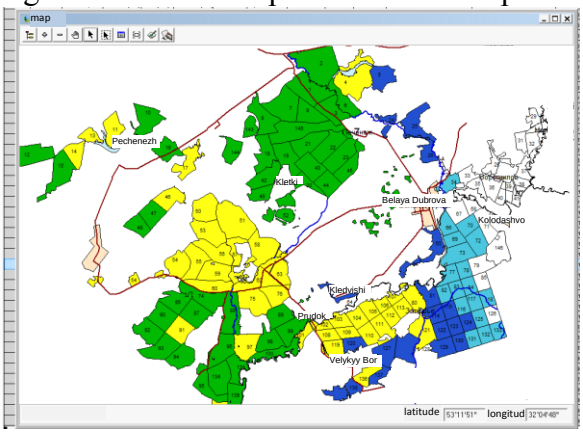
119. The colors of radioactive contamination zones are determined by the Forest Management Rules. It is used in the preparation of information materials for stands, posters, recommendations, collections, in the development of maps of forestries and Forestry Enterprises for mapping the assignment of forest compartments to radioactive contamination zones. In the IS “RadFor” the colors of radioactive contamination zones are used to visualize the soil contamination density of forest compartments in the "Radiation conditions" database and when presenting digital thematic maps with colored radioactive contamination zones.

120. In the “Forecasted reduction of the soil contamination density of Cesium-137” window the special filter is developed. It allows to sort the calculated soil contamination density values in ascending order. Thus, you can see a sorted list of all compartments that will be assigned to another zone of radioactive contamination.

121. For a more detailed analysis of the forecast of the radiation condition changes the function of representing digital maps with the coloration of radioactive contamination zones is developed. The map can be represented at the current time and at the forecast date.

122. Usability of this function consists in a one-time representation of the density of soil pollution and the location of the forest compartment on the forestry department map relative to other forest compartments, as well as roads, settlements and other geographic objects with reference to the grid.

Figure 20 − The “Maps” window for representing the digital maps of the forestry departments.



The source: IS "RadFor"

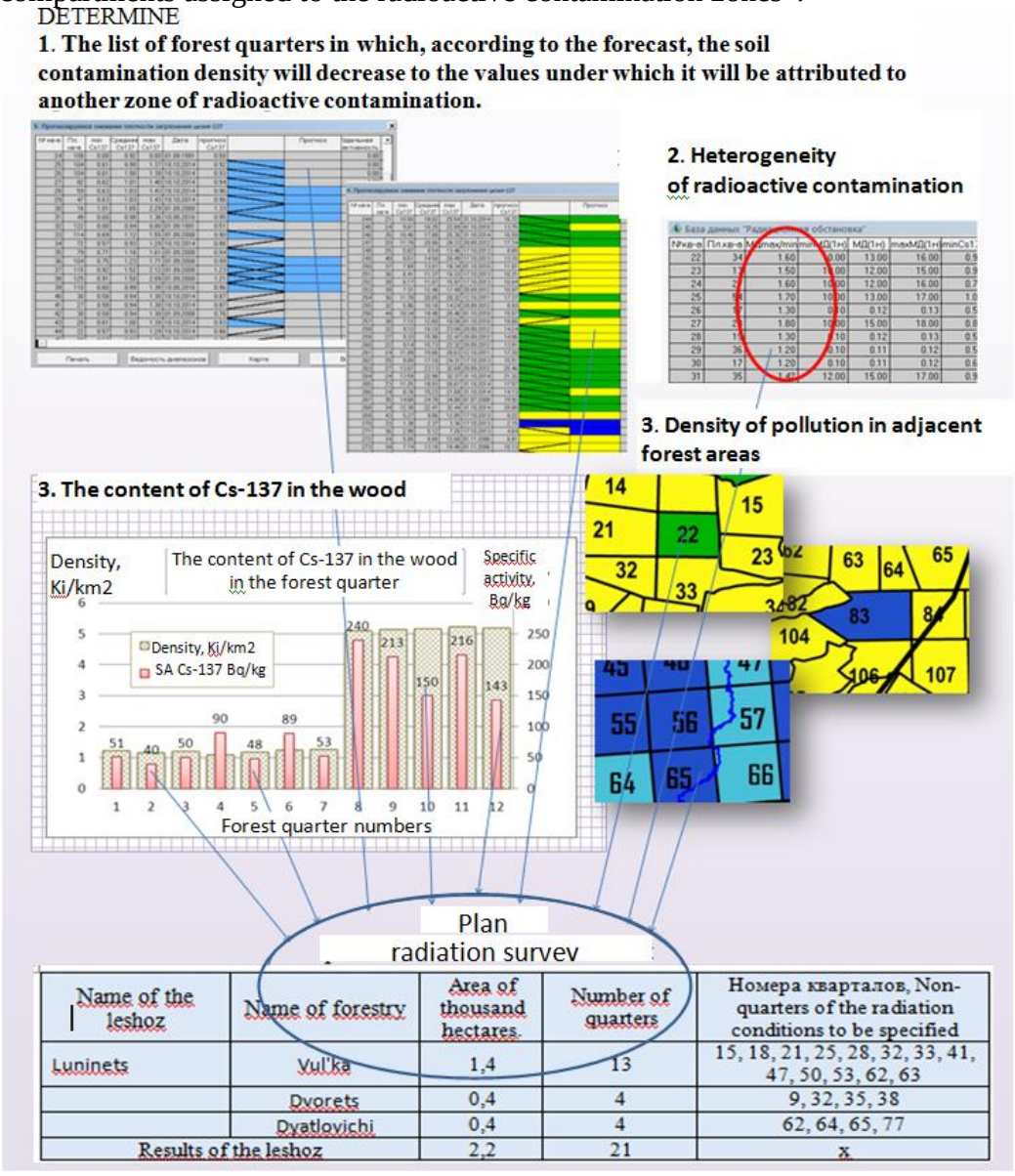
123. For the radiation characteristic it is important to estimate the homogeneity of the radioactive contamination of neighboring forest compartments, comparing contamination densities. This factor is taken into account when choosing forest compartments to clarify the radiation conditions. The configuration, the relative positions of the quarters and their location on the map along with the forecast of changes in soil contamination density of Cesium-137 provides a more qualitative analysis in the preparation of the list of forest compartments for inclusion in the plan of specifying the radiation conditions. An assessment of the probability that the forest compartment can be assigned to another zone or out of the radioactive contamination zone is carried out in more detail.

124. In accordance with the list of forest compartments proposed to clarify the radiation conditions the on-site inspection of forest compartments is carried out in accordance with TCEP 240-2010 to obtain the actual gamma radiation dose rate and the soil contamination density of Cesium-137. The results of radiometric measurements are entered in the DB "Radiation conditions" of the “RadFor” Information System for the use of actual data in the work that means the implementation of forest management in radioactive contamination zones while observing radiation safety standards.

125. To help workers of the radiation control service methodical recommendations are developed: leaflets “Scheme for planning the specifying of the radiation conditions in the forest compartments assigned to the radioactive contamination zones” (Box 4) and “Scheme for the

organization of radiation inspection in the forest compartments assigned to the radioactive contamination zones".

Box 4 − The leaflet "Scheme for planning the specifying of the radiation conditions in the forest compartments assigned to the radioactive contamination zones".



Name of the leshoz	Name of forestry	Area of thousand hectares	Number of quarters	Номера кварталов, Non-quarters of the radiation conditions to be specified
Luninets	Vul'ka	1,4	13	15, 18, 21, 25, 28, 32, 33, 41, 47, 50, 53, 62, 63
	Dvorets	0,4	4	9, 32, 35, 38
	Dyatlovichi	0,4	4	62, 64, 65, 77
Results of the leshoz		2,2	21	x

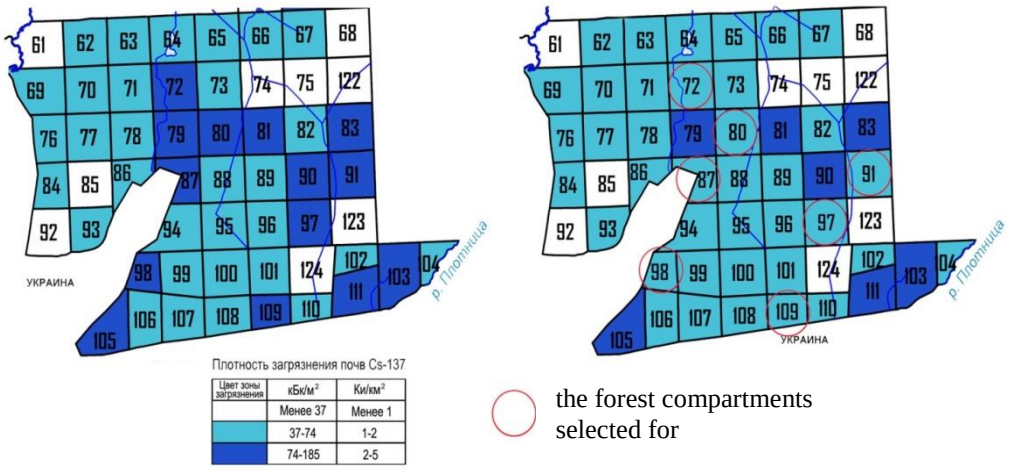
126. In zones of radioactive contamination, the special system of forest management is organized, ensuring safe working conditions and obtaining normatively clean forest products. To do this, it is necessary to timely clarify the radiation situation in the radioactive contamination zones, use the results of the forecast during the survey planning, including only those forest compartments where positive changes are expected: the forest compartment will "come out" of the zone or move to a zone with a lower soil contamination density..

127. The forest compartment moving into the zone with a soil contamination density from 1 to 5 Ci / km^2 can significantly facilitate the radiation inspection of the logging sites and save time and money during preparatory work for cutting areas demarcation.
128. If contamination density is from 1 to 5 Ci / km^2 radiation inspection is carried out after cutting areas demarcation if the Cesium-137 content in harvested wood in the territory of forestry department has not exceeding the permissible levels for the past three years. Prior to the beginning of cutting selection of model trees is carried out, during cutting - sampling of wood from model trees. In the I zone the radiation inspection of the felling areas may be carried out in a smaller scope (1 felling area in the forestry department during the year), if at a contamination density of 37 to 74 kBq / m^2 or 74 to 185 kBq / m^2 the Cesium-137 content in the wood does not exceed 200 Bq / kg.

3.3.2 Planning for clarifying of the radiation conditions on the territory of the forest fund

129. In 2017 through the new functions of the Information System "RadFor" the analysis of the forecast indicators of the change in the soil contamination density for June 2017 was done. Selection of forest compartments to clarify the radiation situation was made for the forest fund of the Ministry of Forestry.
130. The selection of forest areas to clarify the radiation conditions and prepare the schedule was carried out in stages:
Stage 1. Obtaining predicted values of soil contamination density for the given date.
Stage 2. Analysis of forecasted values of soil contamination density in the selection of compartments to clarify the radiation situation.
Stage 3. Listing of the forest compartments selected to clarify the radiation conditions in 2017.
131. The analysis of the probability of changing the radiation situation was carried out using the function of visualizing the soil contamination density in color fields. For the analysis the colored map-scheme of radioactive contamination of forest compartments of Vetka forestry in the forecast for the given date was also used.

Figure 21 − Fragments of Miloshevichi Forestry of Miloshevichi Forestry Enterprise maps-schemes with the forest compartments selected to clarify the radiation conditions.



For January 1, 2017 Forecast for June, 2017
The source: Information system “RadForview”.

132. On the map, the location of the compartments chosen to specify the radiation situation was determined. Their location in relation to other "polluted" compartments has been analyzed and the likelihood of the transition of the planned for the inspection the forest compartments to another zone of radioactive contamination is estimated.

133. Based on the predicted values of Cesium-137 soil contamination density in the forest fund sites in 2017, calculated using the IS "RadFor" functions and the cartographic materials, the forest compartments list was prepared to clarify the radiation conditions in 2017 in 45 Forestry Enterprises, 144 forestry departments, 1131 forest compartments on the total area of 98.3 thousand hectares.

3.3.3 Analysis of the forecast accuracy

134. In April-May, 2017 in accordance with the schedule to clarify the radiation situation the inspection of forest areas was carried out in 8 Forestry Enterprises in accordance with the requirements of TCEP 240-2010 "Radiation control. Inspection of forest lands. Order of organization", Amendment No 2 to TCEP 240-2010. Measurements of the Gamma-Radiation Intensity at the soil sampling sites (the test sites of 30-50 x 30-50 m) in the forest compartment, selection of soil samples (with forest litter) and field layer (live ground cover) with a special sampler to a depth of 20 cm were carried out.

135. The content of Cesium-137 in the selected soil samples was measured and the density of soil contamination with Cesium-137 was determined. The results of radiometric measurements were included in the Information System "RadForview" for the further coordination and approval of the statements "Results of the control of the radioactive contamination of the forest fund lands". After approval, the statements turn to the document confirming the soil contamination density in the forest compartments (at the date of the survey) and its reference to the radioactive contamination zones. The values of soil contamination density of Cesium-137 are used in filling the felling licenses, operating process charts, planting plans.

136. The results of the forest compartments inspection conducted in April-May 2017 were compared with the values of the soil contamination density of the previous radiation survey and with the changes forecast for June 2017 for: Vetka, Komarin, Miloshevichi, Mozyr, Khoiniki Forestry Enterprises of Gomel SFPA and Bykhov, Klimovichi, Chaussy, Cherikov Forestry Enterprises of Mogilev SFPA.

Table 8 - The results of a survey of forest compartments on the example of Rogachev Forestry Enterprise of Gomel SFPA. April-May 2017

Forestry	Forest compartment No	Soil contamination density, Ci/km^2		
		For 01.01.2017	Forecast for June, 2017	The results of the inspection, June, 2017
Rogachev Forestry Enterprise				
Drutsk	52	1,35	1,25	0,91
	86	1,10	1,01	0,92
	172	1,17	0,94	0,59
	187	1,24	1,00	0,94
	189	1,23	0,99	0,49
Koshara	132	1,03	0,95	0,93
	137	1,0	0,92	0,62

137. The results of the radiation survey of the forest compartments and the soil contamination density were compared with predicted values. The analysis shows that in April-May 2017 the validity of the adopted method was confirmed in 72 (81.8%) out of the 88 inspected forest areas. As a result of the survey the soil contamination density declines to the values at which the forest compartment:

- 1 - "leaves" from the radioactive contamination zones (soil contamination density is less than 37 kBq/m^2 or 1 Ci/km^2 (0.95). Protective measures are no longer being implemented on the forest compartment territory, forest management measures and forest use are carried out without restrictions on the radiation factor;

- 2 - "passes" to the contamination density range from 37 to 74 kBq/m^2 (1-2 Ci/km^2), in which selective radiation inspections of felling areas are allowed;
- 3 - "passes" from II zone to I to the contamination density range from 74 to 185 kBq / m^2 (2-5 Ci/km^2), in which selective radiation survey of felling areas is allowed;
- 4 - "passes" from the III zone to II, in which the carrying out of logging does not require special permits, cutting areas are included in the calculated felling rate.

138. Up to 30% of the surveyed forest compartments "came out" of the radioactive contamination zones, in 26% of the surveyed forest compartments the soil contamination density does not exceed 2 Ci / km2, in 9 % - 5 Ci / km2, 17% of the surveyed forest compartments moved from the III zone (15-40 Ci / km2) in II (5-15 Ci / km2). In 7 of 12 surveyed Forestry departments the predicted values of the soil contamination density of Cesium-137 were confirmed in full (100%). As a result of the clarification of the radiation situation in the beginning of 2017, the Drutsk and Koshara Forestry of Rogachev Forestry Enterprise "came out" of the "contaminated" areas.

139. The functions of the "RadFor" information system provide the calculation of the predicted levels of the soil contamination density of Cesium-137 in forest compartments based on the results of the radiation survey of the forest fund of the Ministry of Forestry and the law of radioactive decay. The level of surface activity of Cesium-137 in soil (soil contamination density) changes with time in accordance with the Cesium-137 half-life period equal to 30 years.

140. Obtaining operational information on decrease of the radioactive contamination level in the forest fund is necessary for the rational planning of forest management, forest use, and timely decisions on clarifying the radiation conditions and obtaining actual values of soil contamination density in forest areas.

141. As a result of the annual radiation survey a decrease in forest fund areas in radioactive contamination zones, changes in division by zones in each Forestry enterprise, forestry department were found. . The urgency of information on the soil contamination density in forest compartments ensures compliance with the regulation of the forestry activities, the optimization of work on the radiation survey of felling areas, control of radioactive contamination.

142. It is proposed to develop a block based on the IS "RadFor" for promptly obtaining information on the predicted values of the specific activity of Cesium-137 in wood of the main forest-forming species on the given date using the existing databases of the results of the radiation survey of logging areas, taking into account the characteristics of the radioactive contamination of trees in various types of forests and types of forest growing conditions. It will provide a more rational approach to forest management planning in the Forestry Enterprises in the territories of radioactive contamination of the forest fund.

3.4 Development of schemes and formats to present results of the radiation inspection, radiation control of forest products

3.4.1 Directions for providing information on the results of radiation inspection

143. The results of the radiation inspection and the radiation control first of all are used at the professional stage for the preparation of official documents: Statements of the results of radioactive contamination control of forest territories, Acts of radiation inspection of cutting sites, test reports. These documents are intended to make decisions on forest management, forest use, and use of forest products taking into account the requirements for the permissible level of Cs-137.

144. The logger’s ticket contains: "Information on the radiation inspection of the cutting area" - the density of radioactive contamination of the soil, the specific activity of Cs-137 in commercial and regular wood; "Act of Radiation Examination of the Cutting Area" with the number and the date of the Act. The results of the radiation survey: the density of soil contamination with Cs-137 and the dose rate are put to the technological map and the forest cultures management plan. The forest management plan contains a map-scheme of forestry,

colored by zones of radioactive contamination in forest areas, forest management activities are set taking into account the radioactive contamination zone.

145. Thus, all necessary information on the radiation situation in each forestry, forestry zone and forest district, is provided for forest management in the territories assigned to the zones of radioactive contamination in order to ensure compliance with norms and rules for radiation safety, to prevent the spread of radionuclides beyond the "contaminated" territory.

146. At the level of work on the forest fund sites in the areas of radioactive contamination: protection and maintenance of the forest, fire protection measures, reforestation, main and secondary felling, other felling; forestry workers are provided with information on the dose rate and density of pollution of the forest quarters on the territory of works. These data is provided: in the results of radioactive contamination control of the forest fund and forestry, and in the of forest cultures management plans, in the technological map, in the map of the forestry scheme, in the information stand.

147. For consumers of forest products harvested in forestries and forest fund in radioactive contamination zones, information on the content of 137Cs as well as compliance with the permissible levels stated in hygiene regulations (RPL/Forestry-2001, RPL-99) is provided in accompanying documents - passports and stamps of radiation safety. Information for consumers and wood processors is provided on the information stands, official web-sites of forestries in the Internet in the section "Radiation Control".

148. At the population level, when visiting forests contaminated with radionuclides, information is provided on the belonging of forest quarters to the radioactive contamination zone on warning and prohibitory signs. Signs are installed: in I and II zones - on roads, before entering the zone, roads' exits; in the III and IV zones - on roads, roads' exits and on the borders of forest areas located near populated areas (Box 5). More detailed information is available at information stands in the forestries, forest areas, on the official websites of forestries in the Internet in the section "Radiation control".

Box 5 - Warning sign of radiation hazard, information stand in forestry

Sign of radiation hazard in the forest

Sign in the 1st zone of radioactive contamination:

"Collecting of mushrooms and berries is only allowed with mandatory radiometric control"

Information stand in forestries and forestries' departments contains: map-scheme of radioactive contamination, standards of permissible values of Cs-137 in forest products, operational information on the results of radiation monitoring, recommendations for forest use

149. In addition to the above-mentioned directions for providing information on the radiation situation in forests, information can also be provided upon the request of the Ministry of Health for the assessment of radiation doses to the population, of the Department for the Elimination of the Consequences of the Chernobyl Disaster and of the Ministry of Emergency Situations on the results of control of radioactive contamination, communication with a justified need.

150. In accordance with the Regulations of the Radioactive Contamination Control System, the Ministry of Forestry provides control over the radioactive contamination of the forest fund, forest products, the systematization, compilation and updating of information on the results of monitoring of radioactive contamination; If necessary, the information of the results of the control of radioactive contamination is exchanged for free.

151. Information of the results of control of radioactive contamination is provided taking into account the "target audience", the end user of this information. It can be provided in the format of documents of normative legal and technical normative legal acts, analytical and informational materials on a given topic, presented in an accessible form for the general public (Table 9).

Table 9 - Forms of presenting the results of radiation monitoring

Executors. Information Consumers	**Forms of providing information of the results of radiation monitoring**	**The source of information**
Specialists of radiation monitoring service	Bulletin of the results of control of radioactive contamination of forest fund lands Acts of radiation survey of harvesting areas Test reports	A preliminary radiation survey sheet, a sample passport, an act of sampling, a working journal, IS “RadFor”, IS "RadForView"
Forestry	Logger’s ticket	Checklist of control

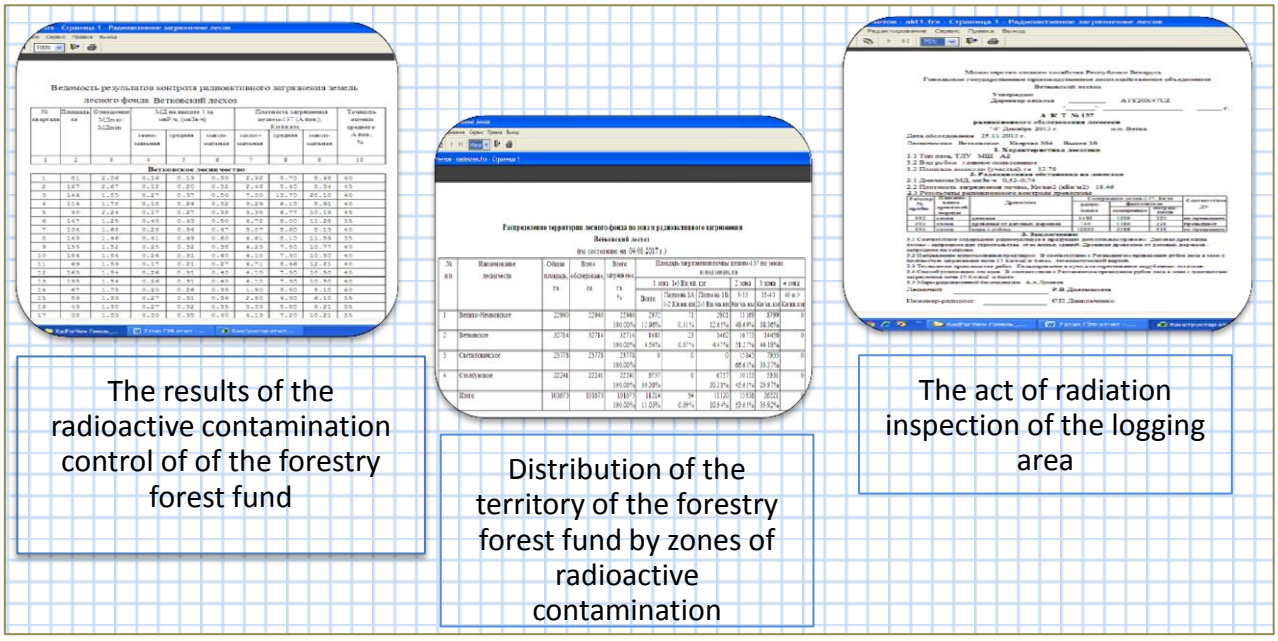
specialists	Technological map Forest Crops Project Forest management project	results Acts of radiation survey of forest logging areas
Forestry Specialists	Technological map Warning and prohibitory signs of radiation hazard Information stand "Radiation control" in forestries Forestry website Leaflets, posters, brochures	The results of the control lists, IS "RadForView", cartographic and analytical materials from IS “RadFor”
Forest products consumers	Radiation Safety Passport Radiation Safety Stamp Information stand, forestry website	Acts of radiation inspection of logging areas, test reports
Population	Warning and prohibitory signs of radiation hazard Information stand "Radiation control" in the forestry Forestry website, SFPA Leaflets, posters, brochures	Lists of control results, cartographic and analytical materials from the IS “RadFor”
Ministry of Health	List of the unified republican dosimetric register (necessary information for the assessment of radiation doses of the population)	Report of the results of individual dosimetry control

152. Considering the requirements required for the provision of information, it is necessary to have updated information of the results of radioactive contamination monitoring, which are obtained from authorized radiation monitoring units, a set of tools for their systematization and generalization for efficient representation. The Ministry of Forestry for this purpose uses an information system "Radioactive contamination of forests. RadFor” (IS “RadFor”), and the peripheral version for forestries IS “RadForView”.

3.4.2 Development of forms for providing results of control of radioactive contamination. Information for forestry specialists.

153. Operative receipt of forms with the results of radioactive contamination control - Bulletins of the results of the radioactive contamination control, Acts of radiation survey of logging areas - is provided by the use of the functions of the IS "RadForview" - the forms are filled in automatically using the database of the current radiation survey (box 6).

Box 6 - Documents of the results of radioactive contamination control taken from the IS ”RadForview”



The results of the radioactive contamination control of of the forestry forest fund

Distribution of the territory of the forestry forest fund by zones of radioactive contamination

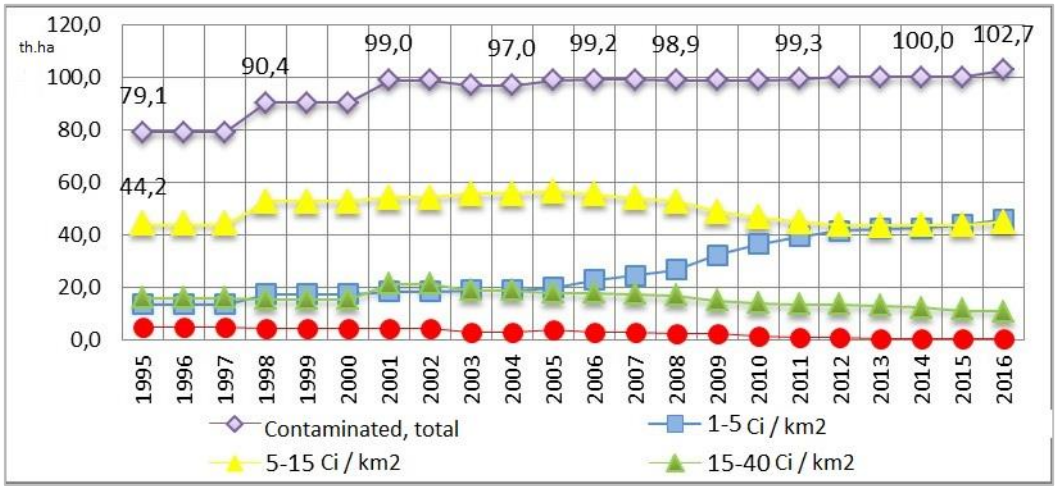
The act of radiation inspection of the logging area

154. For the input of information in the loggers tickets, an algorithm for interaction of the databases of the "Forest Use" software complex with the databases of the IS "RadForview" has been developed (GEF Stage 3 Report). The interaction of these two programs can be achieved by creating a separate module, or by adding new fields in the automatic workplace database and by ensuring the import of information from the IS “RadForview” into the Forest Use Management Program. The implementation of this scheme will ensure the automatic input of the required information.

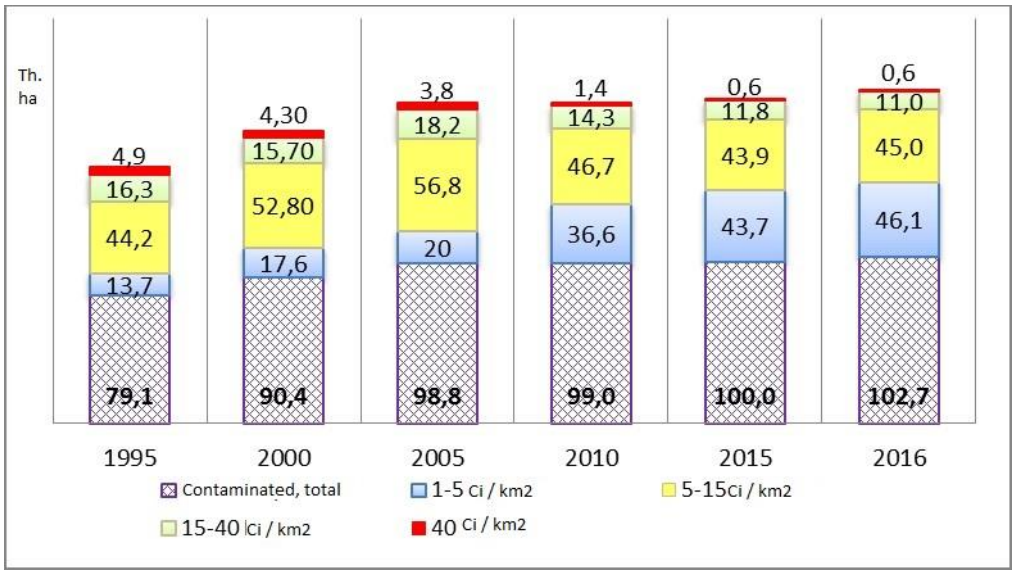
155. For employees of forestries directly working in the territories of radioactive contamination, compliance with the requirements of the legal regime in the "contaminated" areas is ensured by the regulation of forestry activities, the system for controlling radioactive contamination. For regulation, the information is used on the density of pollution and dose rate in forest quarters, which is available to all forestry and forestry workers. To reduce the possible tensions in connection with work on "contaminated" areas, to objectively assess potential hazards, workers should have sufficient information about the current radiation situation, positive changes and measures taken to improve it.

156. In order to represent the dynamic changes of the situation in the "contaminated" territory of the forest fund for the post-accident period, the actual reduction of the area and levels of radioactive contamination in the forestry and forest territory, data were collected on the distribution of the territory by radioactive contamination zones for 47 forestries during the period from 1995 to 01.01.2017. Based on these data, it is possible for each forestry to present changes in the radiation situation in the form of graphic histogram. Information can be submitted for each year, beginning from 1993, for the last 10-15 years. It is advisable to provide information with a frequency of every five years, since within one year of noticeable changes (reducing the density of pollution) does not occur. Variants of visualization of changes in the radiation situation are given for Checherski Special Forestry Enterprise (Figure 22)

Figure 22 - Changes of the territory of the forest fund in radioactive contamination zones from 1995 to 2016. Chechersk Special Forestry Enterprise (visualization options - A, B)



A.



B.

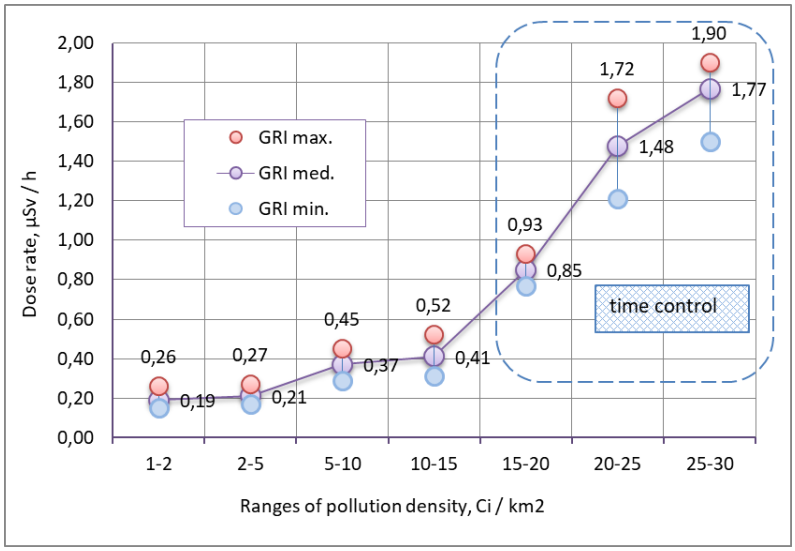
Source: Radioactive Contamination Results Sheets, IS “RadFor”

157. Changes of forests areas in contaminated zones occur due to: objective reasons (Cs-137 radioactive decay) and subjective ones (change in area as a result of land transfer to the forest fund of forestries from other departments, reorganization of forestries territories). Thus , in 2000, more than 1.5 million hectares of former agricultural lands were transferred to the forestry fund of the Ministry of Forestry, about 250,000 hectares of which were attributed to radioactive contamination zones. As a result, after the radiation survey of the transferred lands, the area of forests in the zones increased. Such acceptance and transfer processes are still ongoing. So, in

2016, 5600 hectares of lands polluted with radionuclides, were transferred to the forestry fund of the Ministry of Forestry (Vetkovsky, Checherski Special Forestry Enterprises).

158. In addition to information on changes of Cs-137 contamination levels in forest quarters, workers should be provided with information on the dose rate of gamma radiation at which they work and the processes of reducing it, as the density of contamination decreases in the further period after the accident.

Figure 23 - Dose rate on the territory of the forest fund for different soil contamination density of Cs-137. Nisimkovichi Forestry of Chechersk Special Forestry Enterprise



Source: Radioactive Contamination Results Sheets, IS “RadFor”

159. Knowledge of GRI values at work sites (in forest traversing, planting of forest crops, logging) for employees is no less important than the density of pollution, because this indicator is directly related to the formation of radiation doses. At GRI values of more than 0.68 µSv/h, measures are taken to reduce its impact by regulating (shortening) the time spent in "contaminated" areas, installing household facilities in the logging areas (guest houses for rest and meal) with the lowest GRI.

160. For provision of graphical information on the dose rate in the territory of the forestry, the radiologist engineer is offered a step-by-step procedure for its preparation with the IS “Radforview”.

161. For workers of forest areas with territories contaminated with radionuclides of Chernobyl accident it is also very important to know how the situation will change in the foreseeable future and in the long term. Modern possibilities of available data processing allow predicting changes in levels of radioactive contamination of the forest fund. This information can be presented in tabular form and on maps of forestry schemes.

162. Information for employees of the radiation situation in the forest fund of the forestries, of the changes occurred after the Chernobyl accident, as well as of the predictions of changes in radioactive contamination can be presented in the form of leaflets on information stands. For the engineers-radiologists of forestries, schemes for the formation of information for the preparation of leaflets have been developed.

An example of a scheme for preparing information for a flyer "Changes in the radiation conditions on the territory of the forest fund of _____ Forestry Enterprise"

№	**Actions using software technologies**
A card-scheme by IS”RadFor”.	
1	With the "Geoinformation System" block of the IS “RadFor” generate a map with the coloring of forest areas by zones of radioactive contamination

2	Open map layers. Selecting the name of the layer put a checkmark "Visible Layer" for all selected layers.
3	Select in the menu bar "Save map layers". Layers will be saved in the program folder "ExportMap"
4	In Mapinfo, open the map and make settings for the layers. Export the window to the Photoshop format. Issue a map and save it in the picture format (bmp, jpg)
Obtaining information of the distribution of the territory of the forest fund for zones of radioactive contamination by the IS “RadFor”	
1	The distribution of the territory of the forest fund in the zones of radioactive contamination for the current year can be obtained from the menu "Reports" in the programs "RadFor" or "RadForView". The distribution of the territory of the forest fund for the zones of radioactive contamination over the past years can be obtained from the "Reports" menu of the ”RadFor”. After loading the data from the "Archive" menu (Select year and click "Download").
2	Select areas by zones of radioactive contamination to compose a diagram by years
3	Using the proposed diagram template for the selected data, compose a graph
Use map and schedule for the composing of leaflets	

Information for consumers of forest products

163. For consumers of forest products, primarily wood, the most important is its compliance with the requirements, including the levels of radionuclides in wood. The forestries supplying timber harvested in the territories in the zones of radionuclide pollution inform consumers about the organization of radiation control for compliance with the republican permissible levels, the sold batches are accompanied by documents confirming radiation safety.

164. In accordance with the current legislation, the sale of products produced in the territories of radioactive contamination is carried out under the condition of mandatory control of its radioactive contamination and the availability of a document confirming the compliance of the radionuclide content in such products with the republican permissible levels issued by the organization which, in the manner prescribed by the licensing legislation, is authorized to control radioactive contamination (Article 29 of the Law on Legal Regime areas exposed to radioactive contamination after the Chernobyl accident).

165. In case if the wood is purchased for further processing, the production of various types of products, wood processors must be informed of the control of Cs-137 content in finished products. This is due to the fact that the permissible levels are set taking into account the purposes of use of wood. Thus, timber for round building with a permissible level of Cs-137 of 1480 Bq / kg can be produced for the construction of walls of living buildings (norm 740 Bq / kg), wood fuel (fuel granules, fuel chips) with an allowable content of Cs-137 of 200 Bq / kg (for boilers> 0.1 MW), 300 Bq / kg (chips), 740 Bq / kg (RPL / Forestry-2001).

166. On the issues of safe use of wood fuels and the prevention of the formation of high activity fly ash, which require special treatment, the necessary measures are taken in the forestries. For example, wood chips with level of less than 300 Bq / kg are used for boilers of private houses; fuel chips, and wood fuel with a level of less than 200 Bq / kg are supplied to boiler plants with a capacity of 0.1 MW. To ensure a differentiated approach in the selling of wood fuel the information on wood consumers is systematized, and the areas, forest fund plots where it is possible to obtain wood with a content of Cs-137, not exceeding permissible levels, are defined.

167. The experience of forestries in this field should be recommended to consumers of wood, because in accordance with the Regulations on the Control of Radioactive Pollution, all organizations and individual entrepreneurs which procure, process, use and sell local fuels, including fuel chips, wood processing waste, are to provide control of radioactive contamination of fuel and ash waste.

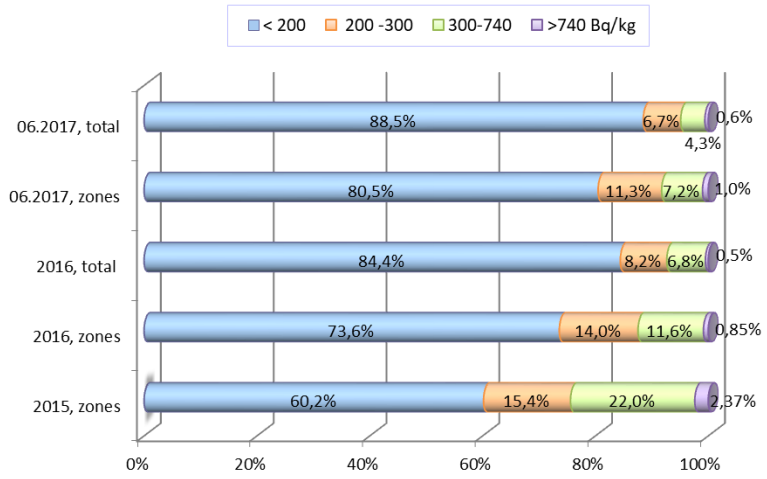
168. It’s also advisable to provide information on the levels of Cs-137 in wood in the forest fund of forestries for consumers in order to assess the possibilities of obtaining normatively clean wood and to determine the fields for its further use. In order to do this, in each "contaminated" forestry information about the results of radiation monitoring of forest products, levels of Cs-137 in wood is provided on the information stand.
169. For more vivid presentation of the information of the actual content of Cs-137 in the timber on the territory of the forestry and of the requirements for permissible levels, additional options for processing the results of radiation monitoring of wood are suggested (using the example of Lelchytsy Forestry Enterprise).
170. The results of the radiation examination of the forest fund, radiometric measurements of wood from 2015 to the present time (as of 01.06.2017) have been processed, the specific weight of wood in the total control volume not exceeding the levels set for wood fuel.

Table 10 - Information of the content of Cs-137Cs in wood, radioactive contamination of the forest fund of Lelchitsy forestry. 2015 - 01/06/2017.

Content of Cs-137 in wood, Bq / kg	2015	2016	01.06.2017
	Part of measured samples of wood,%		
< 200	60,17	73,60	80,48
200 -300	15,42	13,96	11,27
300-740	22,03	11,59	7,24
>740	2,37	0,85	1,01
Average value of specific activity, Bq / kg			
Wood (all)	223	178	154
Commercial wood	260	187	168
Firewood	198	172	146
The maximum value of specific activity, Bq / kg			
Commercial wood	1070	789	1111
Firewood	920	1305	962
Forest area, thousands hectares			
Total	114,6	121,1	121,1
In contaminated areas	68,6	71,5	71,5
% of total area	59,9	59,04	59,03

171. Most of the wood (80.5%) in the radioactive contamination area of Lelchitsy forestry does not exceed 200 Bq / kg and can be used without restrictions. Considering that in 40% of the territory not belonging to pollution zones, the activity of Cs-137 in wood is also less than 200 Bq / kg, the proportion of wood with the safest level increases to 88.5%. The positiveness of this information is complemented by an increase in the proportion of wood with the level of less than 200 Bq / kg over time.

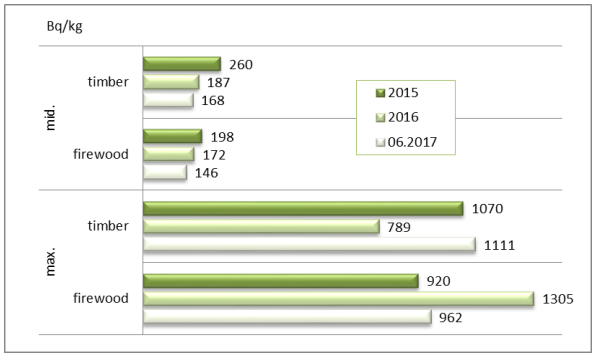
Figure 24 - The proportion of wood with a content of Cs-137, not exceeding 200, 300 and 740 Bq/kg, in pollution zones and throughout the forest fund of Lelchitsy Forestry Enterprise



Source: IS ”RadFor”, IS ”RadForView”

172. Information of the content of Cs-137 in wood (average and the maximum for the forestry) can also be represented by the categories of technical suitability - commercial and firewood at different soil contamination densities of Cs-137 (by zones) over the past few years.

Figure 25 - Content of Cs-137 in wood. Lelchitsy Forestry Enterprise, 2015-06.2017



Source: IS ”RadFor”, IS ”RadForView”

173. The preparation of information of wood contamination with Cs-137 on the territory of the forestry by radiology engineers is carried out using the capabilities of the IS "RadForView" and standard office software. For example, an additional type of report is provided in the IS for reporting data on wood at different pollution densities in the territory of each forestry. Receipt of this type of report is carried out in the database "Forest Products" of IS "RadForView".

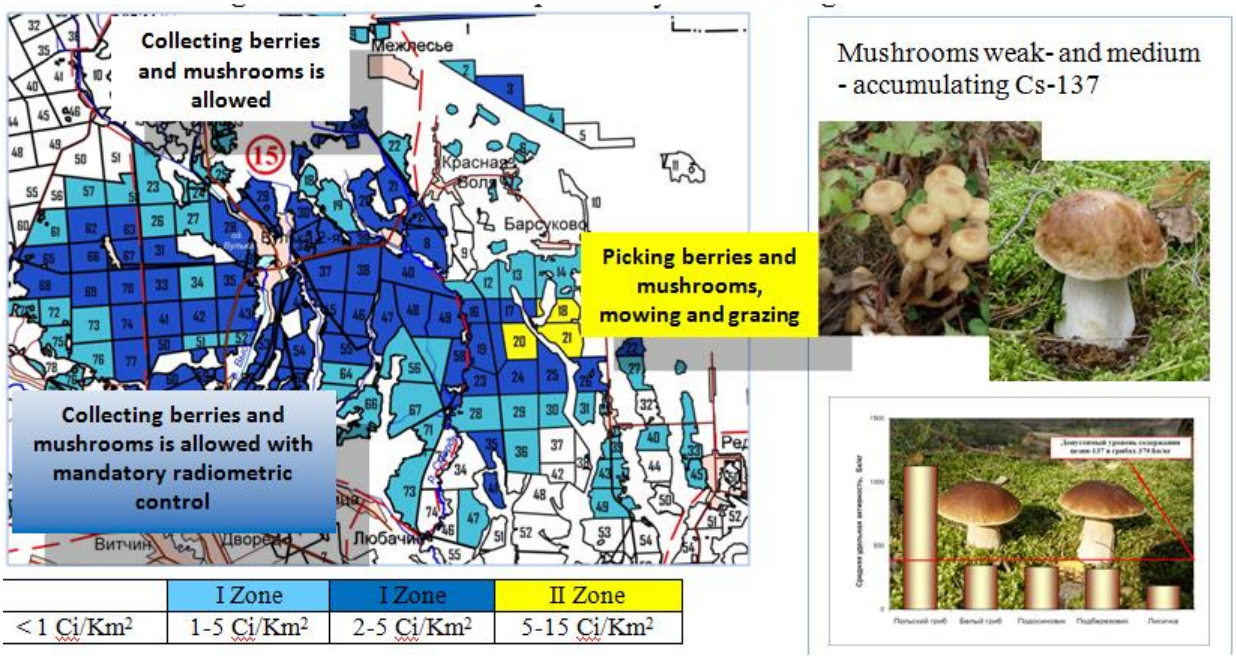
174. For consumers of forest products (wood) two types of leaflets have been developed for placement on information stands of forestries. If necessary, the information can be submitted to consumers directly as well as via the Internet.

175. When visiting forests, people should follow the rules for the use of forests established in the Forest Code (art. 44). In case if the forest fund sites are assigned to radioactive contamination zones, to be aware of the restrictions established in the Law on the Legal Regime of Territories that have been exposed to radioactive contamination after the Chernobyl accident. Depending on the density of contamination the following prohibitions are introduced: (i) collection of wild plants and (or) parts thereof; (ii) hunting, fishing in primary and subsequent resettlement zones (40 Ci/km^2 and more, 15-40 Ci/km^2); (iii) the production (procurement) of products, the content of radionuclides in which exceeds the republican permissible levels (in all contaminated zones).

176. The population should be provided with general information (on the consequences of the Chernobyl accident, levels of radioactive contamination, control system, republican permissible

levels) and private more targeted information about the territories near settlements where people most often collect mushrooms and berries, hunt, rest. For this purpose, it is convenient to use maps of the forestries with the coloring of the forest blocks for the density of pollution.

Box 7 - Presenting of information on the possibility of collecting berries and mushrooms



177. In addition to the information of forest areas in which it is recommended to harvest berries and mushrooms, the population should be aware of the types of berries and mushrooms with the lowest radionuclide content and levels of activity in the areas where collection is planned. For this purpose, the specialists of the radiation monitoring service analyze the results of radiation monitoring of berries and mushrooms by species, by year, comparison with the permissible levels of radionuclide content of Cs-137.

178. New versions of information materials for the population have been prepared; they can be placed on information stands of forest protection, forestries, submitted to schools, other educational institutions, and executive authorities.

179. To provide information of the content of radionuclides in wildlife products, compliance with permissible levels on the hunting territory, the results of radiometric measurements by types of hunting animals are analyzed by year, using the database "Forest Products" of the IS "RadForView" and the functions of the information system. For the engineers - radiologists a scheme for the preparation of information of the results of radiation monitoring of wildlife products is provided.

180. Generalized information of the use of forests in forest fund in the zones of radioactive contamination of a certain forestry can be presented in the form of a brochure "You are going to the forest ..." with the addition of specific information on levels of radionuclide contamination of forest lands and forest products. In the preparation of such a brochure all new formats for reporting information on the results of radiation monitoring in the forestry and forest districts can be used. Content and an approximate layout of the memo-brochure "You are going to the forest ..." are prepared.

3.4.3 Samples of thematic leaflets

181. New formats for thematic leaflets have been developed with the information of the results of control of radioactive contamination, predictions of changes in the radiation situation in the forest fund, Cs-137 content in forest products and compliance with hygiene standards. Thematic leaflets and the procedure for their development by radiologist engineers were presented.

Figure 26 - An example of a thematic leaflet on changing the radiation situation.

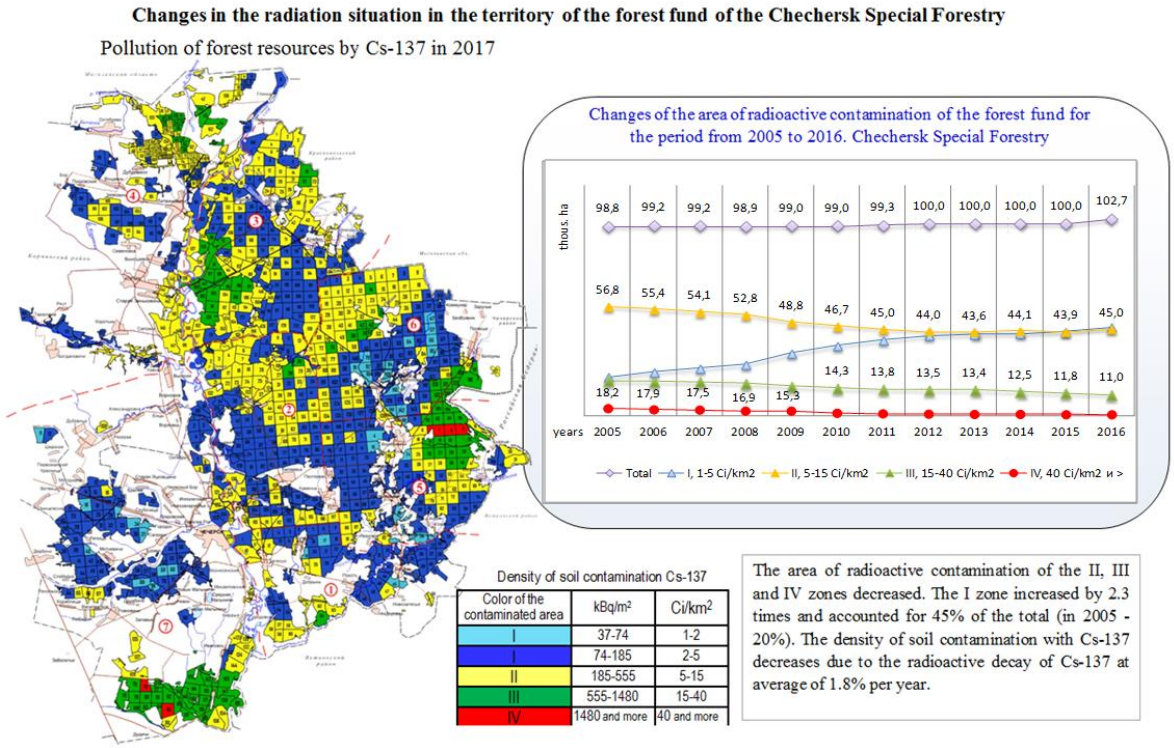
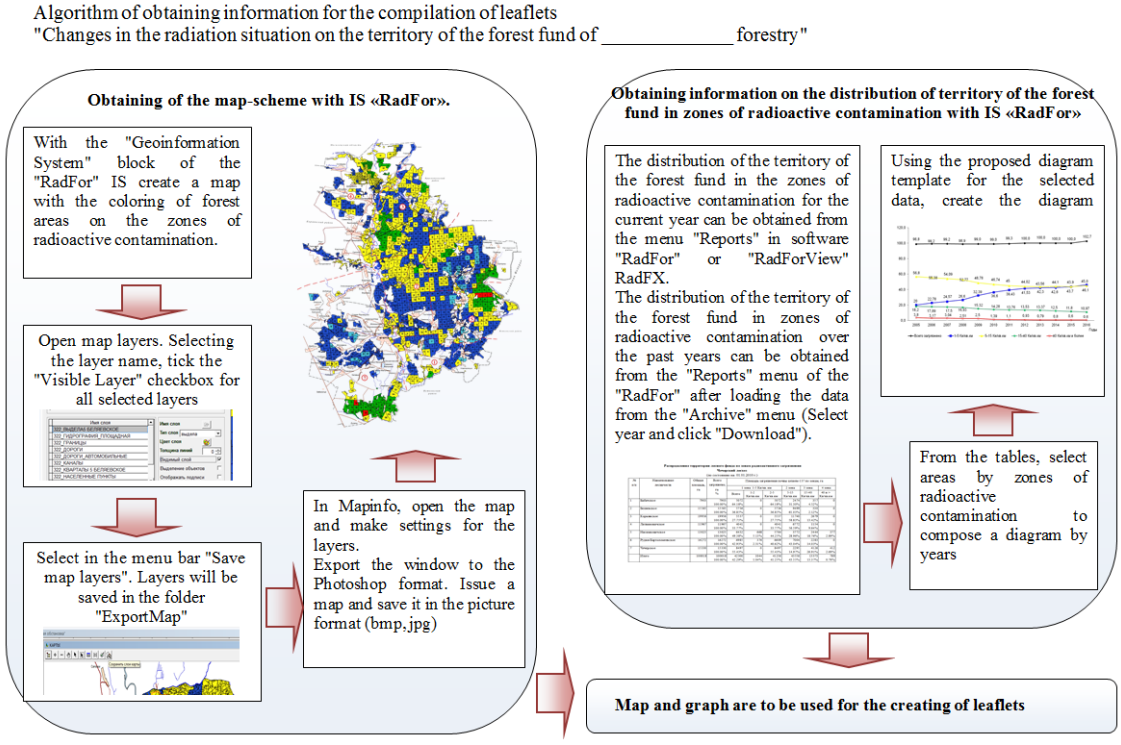


Figure 27 - An example of a scheme for obtaining information for the compilation of leaflets.



3.5 Enhance the system of data collection and communication of information on indices of radioactive conditions, forming of the reports by preset parameters

182. Control of radioactive contamination of the forest fund is carried out by specialists from the radiation control departments of the forestry sector. The results of radiation control are entered and stored for Forestry Enterprises in the databases "Radiation conditions" and "Forest products" of the IS "RadForView", which is the peripheral version of the IS "RadFor". The

results are used for the subsequent prompt receipt of reporting and other information, for the transmission of current radiation inspection data for generalization and systematization.

183. From the databases of IS "RadFor" it is possible to obtain reports on the specified date (period) for forestries of Forestry Enterprises, for Forestry Enterprises of State Forestry Production Associations (hereinafter - SFPA), for SFPAs of the Ministry of Forestry of the Republic of Belarus (hereinafter - the Ministry of Forestry): distribution by zones and severity of radioactive contamination; a list of soil contamination densities; predicted reduction in soil contamination density; predicted time to reduction of soil contamination density; results of radiometric measurements of forestry control objects. On the basis of IS "RadFor" databases following documents can be formed: "List of results of radioactive contamination control of forest fund in forestry", "Act of radiation inspection of the cutting area".

184. The most significant indicator of the radiation conditions is a soil contamination density with Cesium-137, which requires special attention to compliance with the requirements for organization a radiation inspection of forest compartments and objectivity of the results. A form of a report to monitor the implementation of the work plan and inspection results received during the year was developed. Specific indicator (% from all inspected in the year) of the forest compartments, where soil contamination density according to the inspection results decreased to values at which a forest compartment could be attributed to the zone with a lower soil contamination density is chosen as a criteria for the effectiveness of the work on the clarification of the radiation conditions.

185. The analysis of the effectiveness of the radiation inspection of forest fund lands in 2017 was carried out. The forest fund of the Ministry of Forestry in the radioactive contamination zones decreased by 19.6 thousand hectares (1.4%) in comparison with 2016 and currently makes up 1356.3 thousand hectares (16.11% of the total area). The largest part (69.9%) of the forest fund territories of radioactive contamination is attributed to the I zone with soil contamination density with Cesium-137 from 1 to 5 Ci / km2 and II zone - 5-15 Ci / km2 (21.4%), the rest to III (15-40 Ci / km2) and IV zone (40 Ci / km2 and more). As a result of the radiation conditions study 74.3% of all the inspected forest compartments “have moved” to a zone with a lower soil contamination density. In the Forestry Enterprises of Mogilev SFPA the effectiveness of the radiation inspection (confirming the predicted values of the soil contamination density for the year) is 84.9%, in Gomel SFPA – 71.1%, in Brest SFPA - 65.6%. A form of the report "Results of wood radiation control by radioactive contamination zones" was developed to promptly obtain information on Cesium-137 levels in wood in the forest fund in each radioactive contamination zone of the forestries, Forestry Enterprises and SFPAs in general. The report is formed on the basis of the radiation inspection results of cutting areas included in the database "Forest Products". The application of the report on the content of Cesium-137 in wood by zones of radioactive contamination in forestries allows the rapid identification of forest compartments where it is possible to optimize organization of the radiation inspection of cutting areas. The optimization consists in reducing the number of inspected cutting areas, if the content of Cesium-137 in wood in the forestry area has not exceeded 200 Bq / kg during the last three years.

186. A form of the report was developed for prompt receipt of information on radioactive contamination of all types of controlled forest products in accordance with specified parameters. This kind of report should be recognized as universal, since it covers all types of forest products, most of the indicators of radiation situation. It is a universal report for the prompt receipt of information on radioactive contamination of all types of controlled forest products. The report is formed on the basis of the results of the radiation inspection of cutting areas, radiometric measurements of mushrooms and berries sampled in forest compartments and at test sites for studying long-term Cesium-137 contamination of forest food products, game, honey, and samples from batches of manufactured products from wood - lumber, wood chips, fuel pellets. These results are contained in the database "Forest Products". With the help of the universal report information on the Cesium-137 content in forest products (and on coefficients of Cesium-137 transfer from soil to plants) for a certain soil contamination density and in a certain period of

time for a forestry, a Forestry Enterprise, SFPAs, and for the Ministry of Forestry can be obtained promptly. Information from the report is used to estimate the Cesium-137 levels in wood and other types of forest products in different regions at present. Based on the values of coefficients of Cesium-137 transfer it allows to calculate the forecast of changes in these levels taking into account the decrease in radioactivity due to the radioactive decay of Cesium-137. Information on indicators of the radiation conditions obtained with the help of the universal report can be used in making managerial decisions on emerging current issues and in developing information materials for forestry workers and the public.

187. Proposals were developed to ensure the speedy transmission and exchange of data on radiation indicators between the radiation control departments of the Forestry Enterprises (IS "RadForView") and the Enterprise ”Bellesozaschita” (IS "RadFor") by setting a "client-server" connection type, assigning IP addresses to each client, creating the function of updating the database "On Demand" in the information system "RadFor".

3.5.1 Forms of providing reporting information on the radiation conditions in the territory of the forest fund

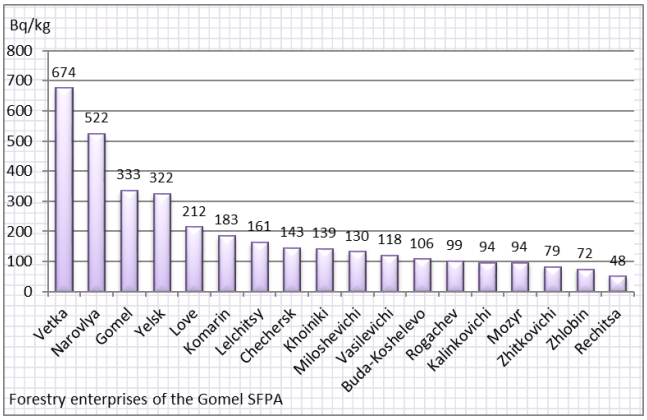
188. In the Forestry Enterprises the results of a radiation inspection and radiometric measurements of the radiation control objects are entered in the "Radiation conditions" database and the "Forest Products" database of the IS "RadForView": the soil contamination density values in kBq/m2 (Ci/km2), dose rate in μSv/h, specific activity of Cesium-137 in Bq/kg. The databases also include all the necessary characteristics of the control objects of a Forestry Enterprise, a forestry: "Radiation conditions" database – forest compartment number, its area, settlement, village council, district; "Forest products" database - forest compartment number, sub compartment department number, type of felling, type and name of products, stand composition, age, type of forest conditions, type of forest.

189. From the "Radiation conditions" database of the IS "RadFor" it is possible to obtain on a set date (period) the following types of reports for a Forestry Enterprise by forestries, for SFPAs - by Forestry Enterprises, for the Ministry of Forestry - by SFPAs: distribution by zones and severity of radioactive contamination; a list of the soil contamination density with Cesium-137 in a range; predicted decrease of soil contamination densities; predicted time of decrease of soil contamination densities. Based on the "Radiation conditions" database a document "Statement of the results of the radioactive contamination control of the forest fund lands" is formed which is used after approval to assign a territory to radioactive contamination zones and in the planning of forest management activities and forest use. The zones of radioactive contamination include territories with a soil contamination density of Cesium-137 1 Ci/km2 and more.

190. The following types of reports can be obtained from the "Forest Products" database of the IS "RadFor": results of radiometric measurements of the control objects in a Forestry Enterprise by forestries, in SFPA - by Forestry Enterprises, in the Ministry of Forestry - by SFPAs. On the basis of the "Radiation conditions" database in Forestry Enterprises a document "Act of the Radiation Inspection of Cutting Area" is formed. It is a basis for a decision on the possibility of cutting, harvesting wood and the directions of its use.

191. Reports on the radiation control of forest products are used to track and control the conducting of the required scope of work of RCDs, to analyze Cesium-137 levels in products by types, in the territory of each Forestry Enterprise, SFPA in the current period and in comparison with previous years. This allows to determine the potential of the Forestry Enterprises in sales of certain types of products, to estimate the existing limitations in their supply at the present stage and perspectives in the future. Based on the data of the report, the average Cesium-137 levels in timber (industrial wood) in 2017 are shown on the example of Forestry Enterprises of Gomel SFPA (Figure 28).

Figure 28 - Average Cesium-137 content in timber in Forestry Enterprises of Gomel SFPA in 2017.



The source - the report for 2017, IS "RadForView"

192. The results of radiometric measurements of wood are used to optimize work in the radiation inspection of cutting areas. If for long time in a forestry of a Forestry Enterprise the Cesium-137 content in wood has not exceed the permissible levels, then it is enough to conduct an inspection of not all but only one specially selected cutting area to confirm the safety of timber use in this forestry. For the selection of such cutting area and the preparation of the report the "Forest Products" database of the IS "RadFor" is used, the functions of which allow to find the maximum levels of Cesium-137 in wood for the previous 3 years in the forestry and to decide on the possibility of optimizing the radiation inspection of cutting areas.

193. Act of the radiation inspection of the cutting area (Figure 29) is one of the main documents for making decisions on the conduct of felling and the use of wood. It contains all the necessary data on the cutting area. From the indicators of the radiation conditions in the cutting area, it includes the following: dose rate (GRI), soil contamination density, as well as the results of radiation control of wood - the Cesium-137 content in each tree species planned for cutting according to the categories of technical suitability (industrial wood and firewood).

Figure 29 – Fragment of the Act of the radiation inspection of the cutting area (part of Act for the entry of the radiation conditions data)

2. Radiation conditions at the cutting area

2.1 Dose rate range, µSv/h (µR/h) 0,48 - 0,57

2.2 soil contamination density, kBq/m^2 (Ci/km^2) 514 (13,9)

2.3 Results of wood radiation control

Registration number of the sample	Wood species	Wood	Cesium-137 content, Bq/kg			Compliance with RPL
			RPL	Compliance with		
				measured	error	
318	pine	Industrial wood (timber)	1480	520	104	does not exceed
319	pine	Fuelwood from timber tree	740	551	110	does not exceed
320	pine	Fuelwood from firewood tree	740	430	86	does not exceed

The source - archive of acts for 2017 from the IS «RadForView»

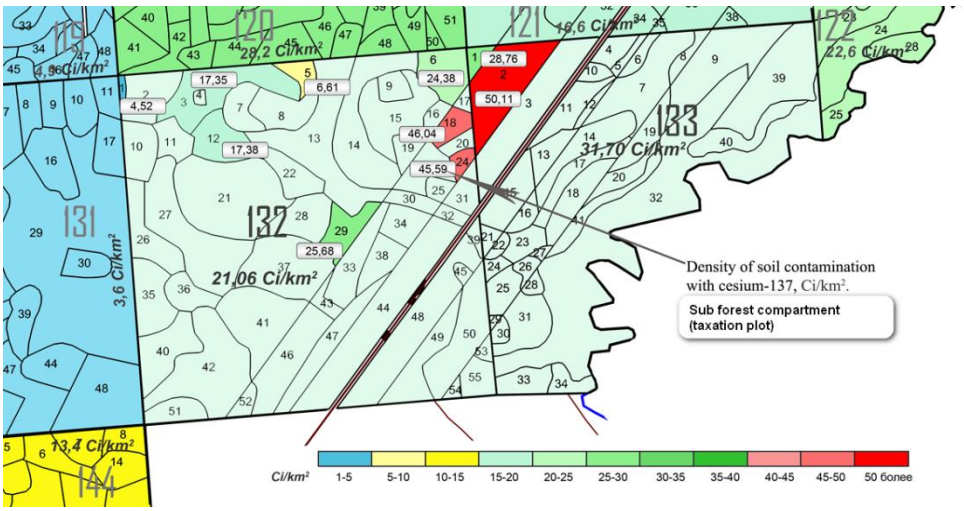
194. The previously developed and currently used types and forms of reports mainly ensure the collection, transmission and processing of information on the results of radioactive contamination control, provide obtaining the necessary documents. At the same time, as information on the radioactive contamination of the forest fund, on changes in the radiation environment due to Cesium-137 decay accumulates, new requirements are being developed for a radiation inspection, which requires the maximum use of all previously obtained information. So, for the application of Amendments No. 1 and No. 2 to the technical code TCEP 239-2010 "Radiation Control. Inspection of cutting areas. Order of organization (01.04.2017)" it is necessary to have information about the Cesium-137 content in wood by species in different

types of forest conditions (hereinafter - TFC) at a certain soil contamination density in the territory of each forestry within the last three years. The application of Amendment No. 1 to the technical code TCEP 240-2010 "Radiation control. Inspection of forest fund lands. Order of organization" (01.04.2017) requires information on the soil contamination density and the location of soil sampling during the previous inspection. Also, the soil contamination density in adjacent forest compartments and the level of Cesium-137 specific activity in wood are needed. This requires improving existing types of reports, developing new ones to ensure the prompt receipt of summary data, data for certain (specified) conditions.

3.5.2 Elaboration of proposals on improving the effectiveness of the results of forest lands radiation inspection

195. The most significant indicator of the radiation conditions is a soil contamination density since in the forest biogeocenosis the Cesium-137 reserve in soil with forest litter and live ground cover is from 94.8% in bilberry pine forest (in type of forest conditions A3B3) to 98.8% in bracken pine forest (in type of forest conditions B2). The spatial distribution of Cesium-137 activity in forest soils is heterogeneous including within the forest compartment. During the radiation inspection of sub compartments in forest compartments in the III zone of Rudnya-Bartolomeevka forestry of Chechersk special Forestry Enterprise a significant difference in the soil contamination density in sub compartments is found out. The values of soil contamination density in sub compartments differ from the mean contamination density in the forest compartment by 2 or more times (Figure 30)

Figure 30 - Map fragment Rudnya-Bartolomeevka forestry of Chechersk special Forestry Enterprise. Cesium-137 soil contamination density in sub compartments of forest compartments 132 and 133 in 2017.



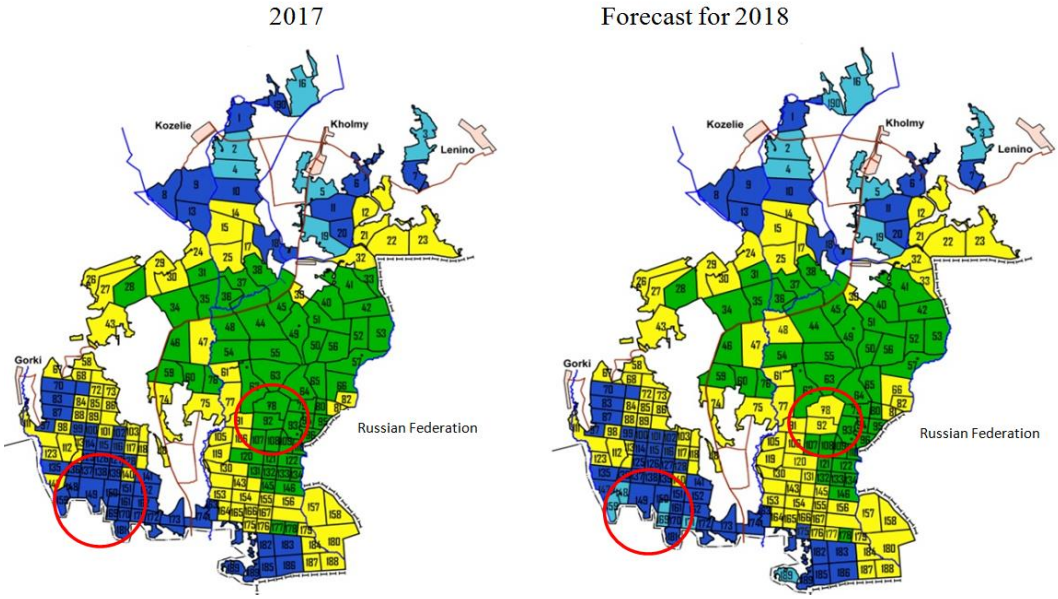
196. Radioactive contamination features of forest soils and spatial heterogeneity of contamination within a forest compartment are taken into account in the technical requirements for the forest fund lands inspection. To determine the reliable value of the soil contamination density in the forest compartment it is necessary to ensure compliance with the established requirements, to have all the data from the previous survey of the forest compartment: contamination density, dose rate, soil sampling location, and data for forest areas bordering on it. To obtain the most reliable results of the radiation inspection, to confirm the decrease in the density of contamination due to radioactive decay and the “transition” of forest compartments from zones with a higher density of contamination to a zone with lower one it is necessary to make full use of the "Radiation conditions" database of the IS "RadFor". For the radiation control service of the industry the materials are developed for the forest compartment selection in the process of plans preparation for the radiation inspection of forest fund lands for 2018 and

for monitoring the results of the inspections during the year. The effectiveness of the results of the radiation survey in 2017 was analyzed..

197. Selection of forest compartments is made to clarify the radiation conditions when developing plans for inspection of forest fund lands. To choose the forest compartments it is suggested to carry out a more detailed analysis of the factors, which include the following characteristics: area and configuration; inspection year; actual soil contamination density (Ci / km2) according to the previous inspection results; the predicted (calculated) value of the soil contamination density at the date of the proposed inspection (Ci / km2), the assessment plot (sub compartment) number and the coordinates of the soil sampling points; radiation conditions and the forecast of their change in neighboring compartments; Cesium-137 content in wood in the surveyed compartment and in forest areas adjacent to it.

198. For the selection of forest compartments for radiation inspection it is also possible to use the forestry maps with coloring on the radioactive contamination zones at the current moment and in the forecast for a set date, which can be presented in the form of digital maps in the "Forecasted decrease of Cesium-137 soil contamination density" window of the IS "RadForView" (Figure 31).

Figure 31 - Forestry maps with coloring on the radioactive contamination zones at the current moment and in the forecast for a set date.



The source - IS “RadFor”

The location of forest compartments relative to each other on the maps allows comparing their coloring and quickly obtaining information on the need to clarify the radiation conditions. Also, it allows establishing the numbers of forest compartments bordering the selected for the inspection compartments. For example, the probability of the forest compartment “transition” from III to the II zone is greater if the adjacent compartments are assigned to zone II.

199. Data on the Cesium-137 content in wood is selected from the "Forest Products" database of the IS "RadForView". The "Search" function is used for selection. After entering the necessary parameters for each forest compartment selected for the inspection the average value of the specific activity of Cesium-137 in wood is determined to estimate the compliance of contamination density and specific activity values. In the Forestry Enterprises the results are added to the table and sent as proposals to SFPA for inclusion in the plan for the radiation inspection of forest fund lands for a year.

3.5.3 Development of proposals to ensure the promptness of the processing and transmission of radiation indicators, new forms of reports

200. To quickly obtain information on Cesium-137 levels in wood in each radioactive contamination zone of the forestries, Forestry Enterprises and SFPAs a new report form is developed by reorganizing the "Create a report" window in the IS "RadFor". The report is formed on the basis of the results of the radiation survey of cutting areas included in the "Forest Products" database.

201. After setting the required parameters a report "Results of wood radiation control by radioactive contamination zones" is generated. The report presents the minimum, average and maximum values for the specific activity of Cesium-137 in timber (industrial wood) and fuelwood, the number of samples measured, including samples exceeding permissible levels of Cesium-137 in wood (RPL/FORESTRY-2001, timber - 1480 Bq / kg, firewood - 740 Bq / kg), as well as the levels set for fuel chips - 300 Bq/kg. The report on the Cesium-137 content in wood by zones of radioactive contamination is presented in Table 11 using the example of several Forestry Enterprises of Mogilev SFPA for 2017.

Table 11 - Report window "Results of wood radiation control by radioactive contamination zones" by Forestry Enterprises

№	Forestry Enterprise name	Permissible level	I zone 1-5 Ci/km^2				II zone 5-15 Ci/km^2				III zone 15-40 Ci/km^2			
			Industrial wood (timber)		Fuelwood		Industrial wood (timber)		Fuelwood		Industrial wood (timber)		Fuelwood	
			740	1480	740	300	740	1480	740	300	740	1480	740	300
	Mogilev	Total, pcs.		202	262			4	5					
		Above the RPL, pcs., %												
		Average Bq/kg		89	93			187	190					
		Min		38	41			137	148					
		Max		211	218			218	222					
	Chausy	Total, pcs.		206	291			42	66					
		Above the RPL, pcs., %												
		Average Bq/kg		111	114			272	271					
		Min		55	52			134	137					
		Max		214	218			421	427					
	Cherikov	Total, pcs.		582	809	38		276	452			61	39	
		Above the RPL, pcs., %						1	10					
								0,4	22					
		Average Bq/kg		76	69	90		214	185			197	201	
		Min		18	18	18		18	18			108	119	
		Max		361	302	142		1258	1382			411	423	
	Total in SFPA	Total, pcs.		2316	3264	38		1111	1693			326	452	
		Above the RPL, pcs., %						4	64			40	184	
								0,4	38			12,27	40,71	
		Average Bq/kg		111	109	90		236	299			589	606	
		Min		18	18	18		18	18			108	67	
		Max		367	382	142		2180	2094			2014	2010	

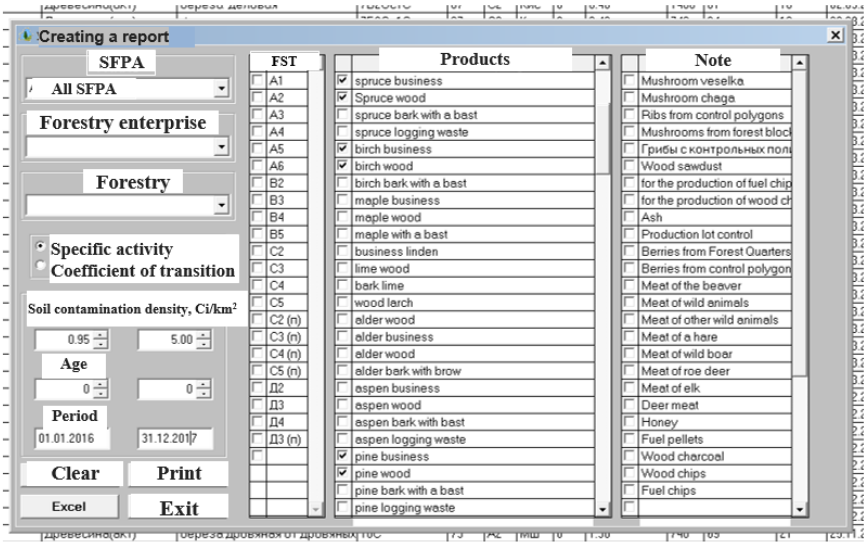
202. The application of the report on the Cesium-137 content in wood by zones of radioactive contamination in forestries of a Forestry Enterprise allows the rapid identification of forestries where the radiation survey of cutting areas can be optimized. The optimization consists in reducing the number of inspected cutting areas if the content of Cesium-137 in wood in the forestry has not exceeded 200 Bq / kg during the last three years.

203. To quickly obtain information on the radiation conditions (specific activity of Cesium-137 and coefficient of Cesium-137 transfer) for all types of forest products a report format is

developed as a universal report with set parameters. Forest products, in addition to industrial wood (timber) and fuelwood, include minor forest products - wild berries and mushrooms; game; medicinal technical raw materials. It should also be considered that the RCD specialists of Forestry Enterprises control the Cesium-137 content in other control objects, for example, in ash (ash waste), selected in the boiler rooms of the forestries, fuel chips, honey. In order to obtain information on all types of products at the first stage the detailed directories for the "Forest Products" database are developed, the form of the creation window of IS "RadFor" universal report is reorganized.

204. In the "Universal report" window an additional "Note" field was developed, in which all product names with details are listed. Wild berries and mushrooms by biological species with access to the sampling site (monitoring sites or forest compartments), wild animals by species.

Figure 32 - "Universal report" window of the IS "RadFor"



The source - IS ”RadFor”

205. A universal report can be generated for all forestries of a Forestry Enterprise and for Forestry Enterprises of a SFPA, for SFPAs of the Ministry of Forestry. With its help it is possible to obtain information on the Cesium-137 content in forest products or on coefficients of Cesium-137 transfer from soil to plants (hereinafter – COT) at a certain density of soil contamination and in a certain period of time. Reporting information is used to assess the existing values of Cesium-137 in wood in various regions, and to forecast their future changes, taking into account the reduction of radioactive contamination of the forest fund. Tables 12 and 13 show the results of a universal report on the content of Cesium-137 and COT (average for SFPA) in timber and fuelwood of birch, spruce and pine in the radioactive contamination zones during 2016-2017.

Table 12 - Example of a universal report. The content of Cesium-137 in birch, spruce and pine wood in zones of radioactive contamination in SFPAs. 2016-2017.

Ministry of Forestry (01.01.2016-31.12.2017)												
	Birch timber		**Birch fuelwood**		**Spruce timber**		**Spruce fuelwood**		Pine timber		Pine fuelwood	
	Number of samples	**Cs-137 content (avg.) Bq/kg**	**Number of samples**	**Cs-137 content (avg.) Bq/kg**	**Number of samples**	**Cs-137 content (avg.) Bq/kg**	**Number of samples**	**Cs-137 content (avg.) Bq/kg**	Number of samples	Cs-137 content (avg.) Bq/kg	Number of samples	Cs-137 content (avg.) Bq/kg
Brest SFPA												
	106	142	345	181	12	118	30	167	449	178	575	195
Gomel SFPA												
	1850	118	3866	123	689	113	946	115	4190	161	6914	162

Grodno SFPA												
	57	55	113	68	57	58	103	69	46	68	103	76
Minsk SFPA												
	111	56	221	66	87	68	172	77	134	74	260	84
Mogilev SFPA												
	1241	110	1778	107	1291	110	1563	108	1548	104	2062	104
Total	3365	113	6323	119	2136	108	2814	108	6367	146	9914	149

Table 13 - Example of a universal report. Coefficients of Cesium-137 transfer from soil to birch, spruce and pine in zones of radioactive contamination in SFPAs. 2016-2017

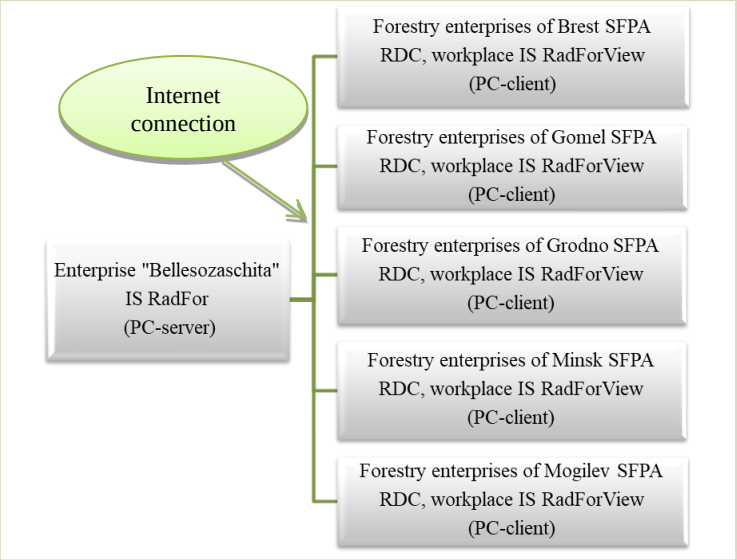
Ministry of Forestry (01.01.2016-31.12.2017)												
	Birch timber		**Birch fuelwood**		**Spruce timber**		**Spruce fuelwood**		**Pine timber**		**Pine fuelwood**	
	Number of samples	**COT (avg.) x 10^{-3} m^2/kg**	**Number of samples**	**COT (avg.) x 10^{-3} m^2/kg**	**Number of samples**	**COT (avg.) x 10^{-3} m^2/kg**	**Number of samples**	**COT (avg.) x 10^{-3} m^2/kg**	**Number of samples**	**COT (avg.) x 10^{-3} m^2/kg**	**Number of samples**	**COT (avg.) x 10^{-3} m^2/kg**
Brest SFPA												
	106	2,21	345	2,65	12	2,27	30	2,43	449	2,54	575	2,76
Gomel SFPA												
	1850	1,31	3866	1,46	689	0,96	946	0,98	4190	1,97	6914	1,98
Grodno SFPA												
	57	1,24	113	1,57	57	1,27	103	1,53	46	1,57	103	1,74
Minsk SFPA												
	111	0,88	221	1,00	87	0,99	172	1,14	134	1,18	260	1,33
Mogilev SFPA												
	1241	1,15	1778	1,11	1291	1,16	1563	1,13	1548	1,09	2062	1,08
Total	3365	1,26	6323	1,41	2136	1,09	2814	1,11	6367	1,78	9914	1,82

206. Proposals to optimize the exchange of information on the radiation situation indicators were made. At the present stage, the information exchange between the main computer of the IS "RadFor" and the peripheral version IS "RadForView" for the Forestry Enterprise is carried out through the data export and import. After the data is exported from the "RadForView" the "View" folder is sent by e-mail followed by the import of data into the integrated databases of the IS "RadFor" for analysis and approval. Thus, the information is collected in 7 stages:

- Data export and folder design (name and archive);
- Downloading and sending a data archive with e-mail;
- Download data to PC from e-mail;
- Unzipping the archive of data and extracting data from the archive;
- Data import;
- Data analysis;
- Entering data into the system. Updating of IS "RadFor" databases.

207. This form of information exchange is reliable, but still not the fastest. Taking into account developing technologies it is possible to simplify the process of forming a database, and as a result to receive up-to-date information at any time without waiting for the reporting period to come. There will also be the possibility of a constant and detailed analysis of information as required, of requests, and opportunity to prepare of interim reports. One of the ways to solve the issue of rapid data transfer is to create a function for updating the databases of the IS "RadFor" "On Demand". The proposed spatial structure of the network is presented in Box 8.

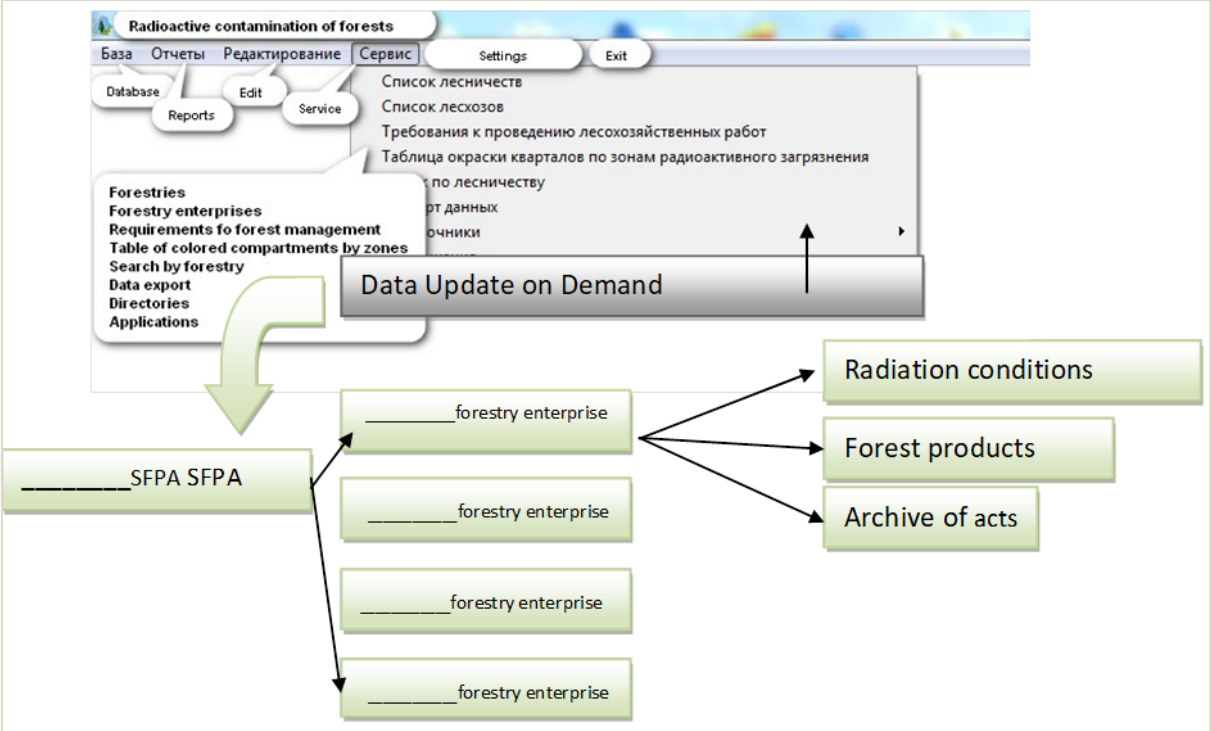
Box 8 - Proposed spatial structure of the network of IS "RadFor" with the “client-server” connection type



208. In the Enterprise “Bellesozaschita” a computer-server is needed with the IS "RadFor" for the possibility of remote client-server type connection (box 8). Such a data exchange structure will require 100% of the access of the RCD engineers of the Forestry Enterprises to the Internet with the further procedure of assigning them static IP addresses. Based on this a table of IP addresses of all the radiation control departments is formed which will later provide client-server communication.

209. In order to accomplish this task, it is suggested to create a new tab "Database Update on Demand" in the "Tools" menu tab. The "Database Update on Demand" model will contain a list of Forestry Enterprises. A pre-assigned static IP address will be set for each name. When you click on any Forestry Enterprise, a list of databases will open to select the information we want to obtain (radiation conditions, forest products, archive of acts) (box 9). After selecting the necessary items, the specialist is connected to the PC. As a result, the necessary information according to the pre-registered paths to the databases of the IS "RadForView" is loaded into the database analysis model. Updating the version and database of the IS "RadForView" is proposed to be carried out in a similar way. If you want to update the databases, the file will be laid out in the pre-defined area (the shared folder for clients) of the entire main database.

Box 9 - Example of the "Update on Demand" model content



As a result of the work new forms of reports on the radiation conditions in the territories of radioactive contamination of the forest fund are obtained through the expansion of the functions of the information system "Radioactive contamination of forests. RadFor" (IS "RadFor") and a peripheral version for the Forestry Enterprises the IS "RadForView". The developed forms of reports provide prompt information about the radiation conditions at the set parameters: the content of Cesium-137 in forest products by species, by zones or density of radioactive contamination (in the range), in a certain period of time for forestry, Forestry Enterprise, SFPA, Ministry of Forestry.

4 Improvement of methods of radiation inspection, forecasting changes in radiation condition indicators in forests

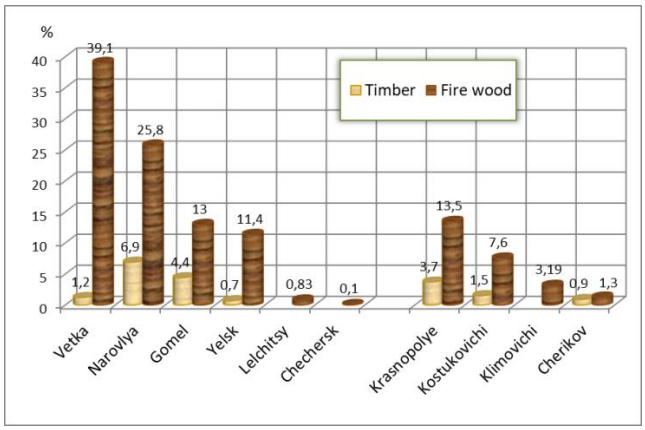
4.1 Methodology for predicting levels of cesium-137 in wood, determining the possibility of harvesting wood that matches the hygienic standards

210. Currently, the radiation survey of cutting areas is allowed only after the demarcation, which can lead to unjustified labor costs if after it the permissible levels of cesium-137 in wood are exceeded. The permissible levels of cesium-137 in wood - 740 Bq / kg for wood fuel and 1480 Bq / kg for industrial timber - are established in the hygienic norm of GN 2.6.1.10-1-01-2001 "Republican permissible levels of cesium-137 in wood, products from wood and wood materials and other non-food products of forestry (RPL / Forestry-2001). In addition to the RPL / Forestry-2001, requirements for wood fuel are set for the level of cesium-137 content by consumers. In accordance with TY BY 100145188.003-2009 "Fuel Chip" (Ministry of Energy) it is established that the content of cesium-137 should not exceed 300 Bq / kg. This level is also

established for firewood used in boilerhouses of Forestry Enterprises. When selling wood fuel (wood, chips, fuel pellets) to boilerhouses with the capacity of 0.1 MW and more, a control level of 200 Bq / kg is applied in Forestry Enterprises, with the exception of 5 Forestry Enterprises: Vetka, Narovla, Chechersk, Yelsk and Krasnopolie.

211. In 27 Forestry Enterprises out of 45 "contaminated" (60%) firewood can be used as wood fuel, fuel chips, including 20 Forestry Enterprises, to supply boiler plants with a capacity of 0.1 MW or more. Exceeding the permissible levels of cesium-137 in wood in 2017 was established on the territory of the forest fund in zones of radioactive contamination of 11 Forestry Enterprises of Gomel SFPA (6), Mogilev (4) and Brest (1, Luninets Forestry Enterprise, 2 samples of firewood).

Figure 33 – Exceeding the permissible levels in industrial wood, firewood



212. In the Forestry Enterprises to the greatest extent exposed to radioactive contamination, in order to exclude cases of logging of trees exceeding the permissible levels and to make optimal decisions on the need for logging, it is necessary to estimate the levels of cesium-137 in wood prior to harvesting.

213. The accumulated objective information on the radioactive contamination of each forest compartment, tree species in types of forest conditions, forest types, plantations, as well as the updated functions of the "RadFor" IS, can be used to predict the radiation conditions, determine the possibility of harvesting wood with a certain level the content of cesium-137 in the territory of radioactive contamination of the forest fund.

214. It was proposed to determine the forecast levels of cesium-137 in wood (firewood) on the basis of the results of control the radioactive contamination of forest fund lands, the radiation survey of cutting areas, radiometric measurements of cesium-137 in wood obtained in previous years (3 years or more). Since 2009, information on the results of the radiation survey of cutting areas, 137Cs in wood (timber and firewood) is stored and systematized in the databases of the IS “RadFor” and “RadForView”.

215. Forecasted levels of cesium-137 in wood are determined for each tree species and types of forest conditions (hereinafter referred to as TFC) using the cesium-137 coefficients of transfer from soil to wood (hereinafter referred to as COT), soil contamination density of cesium-137 in forest compartment, updated with the account of radioactive decay at the planned dates of the cutting.

216. The determination of the predicted levels of cesium-137 in wood is carried out in the planning of cuttings for a year, drawing up plans for the demarcation of cutting areas. When determining the predicted levels of cesium-137 in wood, the results of monitoring the radioactive contamination of the forest fund from the databases of the IS “RadForView”, an updated version for the current year, are used.

217. The results of the radiation survey of forest compartments are given and approved in the Statements of the results of the control of radioactive contamination of forest fund lands, the radiation survey of cutting areas - Acts of radiation inspection of cutting areas.

218. Calculations of predicted levels of cesium-137 in wood are carried out using the average value of the COT for the territory of a forestry, forest compartment (assessment department). The value of the COT is established by means of its sequential refinement to exclude "anomalous" COT (which exceed the average COT for the forestry by 1.5 times).

219. In determining the COT for a particular tree species, the assessment characteristics of the felling areas of the forest fund provided for the felling of the main and intermediate use, and other felling, used in the Forest management plan of the Forestry Enterprise (forest management plan) are used.

220. Determination of the forecast levels of cesium-137 in wood (firewood) is carried out by specialists from radiation control departments accredited in accordance with the ISO / IEC 17025 standard in the field of testing, based on the results of monitoring the radioactive contamination of the forest fund, obtained during a radiation survey in accordance with the technical codes of established practice.

221. To calculate the predicted levels of 137Cs in firewood, the following formula is used:

$$\text{Activity}_{p.}\ (\text{Bq/kg}) = \text{SCD}\ (\text{kBq/m}^2) \times \text{COT}\ (\text{n}\times10^{-3},\ \text{m}^2/\text{kg}),$$ where:

$\text{Activity}_{p.}$ – specific activity (predicted level) of cesium-137 in wood, (Bq / kg);

SCD – density of soil contamination with cesium-137 at the date of cutting, (kBq / m^2);

COT – coefficient of transition of cesium-137 from soil to trees (n × 10^{-3}, m^2 / kg), calculated for cutting area planned for felling.

222. This algorithm is designed to calculate the predicted levels of 137Cs in wood and is based on a conservative approach on the persistence of transition coefficients at a remote stage after the Chernobyl accident, and also takes into account differences in radionuclide migration in different types of forest conditions.

223. The predicted value of 137Cs soil contamination density in the forest compartment for a certain year is determined in the RadFor IS ("Radiation situation" DB / Report / Predicted reduction of cesium-137 contamination density / print / date / print).

224. Sampling data was used to verify the actual and predicted values of cesium-137 content in wood in cutting areas in forest compartments in the previous three years (2014-2016) and in 2017 using the example of Vetka and Narovlya special Forestry Enterprises and Yelsk Forestry Enterprise. The cutting areas with the largest amount of the results of the radiation survey, the specific activity of cesium-137 in the wood within the forest compartment (from 10 to 30 cutting areas in one compartment) were analyzed.

Table 14 – Actual and predicted values of cesium-137 content in wood at cutting areas in forest compartments

Forestry	**№ FQ**	**PD Ci/km², RadFor**	**$PD_{pred.}$, Ci/km² 2017 y.**	**Tree spec.**	**TFC**	**$CT_{calcul.}$ nx10^{-3}**	**SA_{pred}, Bq/kg**	**$CT_{fact.}$ 2017 y.**	**$SA_{fact.}$, Bq/kg 2017 y.**
Vetka Special Forestry Enterprise									
Veliko-Nemkovsk	49	14,50	12,51	Pine	A2	0,64	296	1,06	569
	60	13,00	10,73	Pine	A2/B2	1,25	496	0,79	380
	61	9,95	9,22	Pine	A2/B2	1,95	665	1,09	400
							665	1,02	378
							665	1,40	516
							665	2,29	843
Vetka	308	13,75	13,41	Pine	A2	1,09	541	1,19	607
							541	1,15	586
Yelsk Forestry Enterprise									
Valavsk	12	4,40	3,91	Pine	B3	1,54	223	1,24	203
	16	2,30	2,04	Pine	A2	7,54	569	5,90	510
	19	4,30	3,82	Pine	A2	0,88	124	0,88	140
							124	2,04	325
Narovlia Special Forestry Enterprise									

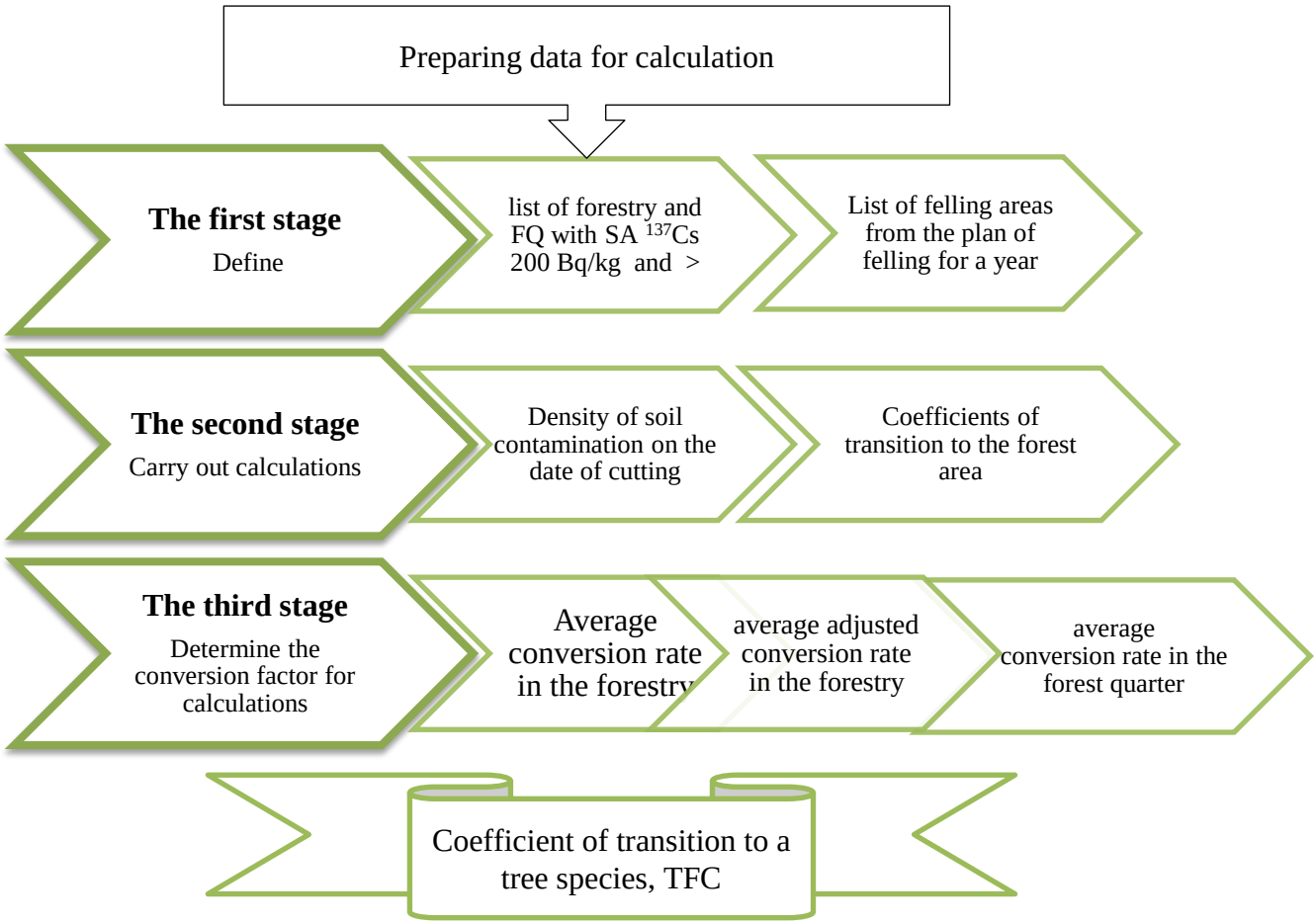
Kirovsk	5	9,40	7,76	Pine	A2	3,32	953	3,62	1260
							953	3,38	1176
Narovlia	7	7,30	6,19	Pine	A2	1,63	373	1,41	381
							373	1,14	310
							373	1,66	449
							373	1,52	410

The average absolute deviation of the actual and predicted values of cesium-137 in wood in the forestries: Veliko-Nemkovsk - 45.1%, Vetka - 9.3%, Valavsk - 23.7%, Kirov - 21.7%, Narovlya – 12.1%.

225. A scheme is developed for calculating the predicted level of cesium-137 in wood. The scheme shows a systematic approach for calculating the predicted level of cesium-137 in wood, which includes three stages. Each stage contains mandatory conditions for implementation, following which the most reliable value of the COT is determined, and as the final result - the forecast level of cesium-137 content in wood for each tree species.

Box 10 - Scheme of the calculation of the forecast level of ^{137}Cs in wood

CALCULATION OF FORECAST LEVEL OF ^{137}CS IN WOOD



TFC	The values of CT in wood (medium for forestry) n×10^{-3} м^2 / kg					
	Pine	Spruce	Oak	Birch	Alder	Aspen
_____forestry						
A2						
A3						

B2						
B3						
C2						

Calculation of the predicted value of the content cesium-137 in wood

$$SA\ (Bq/kg) = PD\ (kBq/m^2) \times CT\ (n \times 10^{-3}\ м^2/kg)$$

4.2 Development of methods for the radiation inspection of the cutting areas. Determining of the radiation conditions in forests with a forecast of changes in the territory of the forest fund in zones of radioactive contamination

226. The purpose of updating the methods of radiation survey is to obtain "targeted" information on the radiation situation that allows expanding the opportunities for development of the territory of the felling site in radioactive contamination zones while observing the norms and rules for ensuring radiation safety. At the same time, it is necessary to make maximum use of the results of radiation monitoring obtained in previous years, the technologies for their processing and calculating forecasts of changes in the radiation situation.

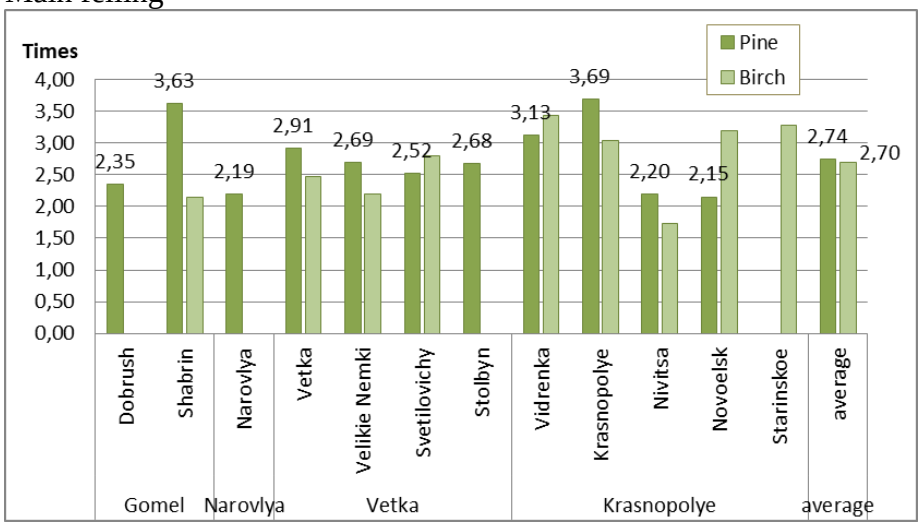
227. More specific (accurate) information should be available in cases where its absence can lead to unreasonable labor, material costs for preparatory work before the felling operations - demarcation of cutting areas, radiation inspection of felling sites - deterioration of working conditions related to the presence of an employee in the territory with high ionizing radiation (gamma radiation dose rate = 0.68 microSv / h and more). These costs should be considered unreasonable if, as a result of the work carried out, it is established that the content of 137Cs in wood exceeds the permissible levels (RPL/Forestry-2001) and it is not subject to sale.

228. The use of more precise methods of radiation survey is aimed at: 1 - excluding the possibility of obtaining wood exceeding the permissible levels - 740 Bq / kg and 1480 Bq / kg (RPL/Forestry-2001); 2 - not to exceed the average annual dose limit for workers exposure, unjustified location in a territory with high gamma radiation dose rate. To solve the first problem, it is necessary to determine with sufficient accuracy the possible level of 137Cs in wood, for the calculation of which it is necessary to know the values of soil 137Cs contamination density in the forest compartment (assessment subcompartments), 137Cs specific activity in wood in the forest compartment (forestry unit), assessment characteristics of the felling site planned for cutting. Currently, for the forest compartment, the average density of contamination is established, indicating the range - from the minimum to the maximum - within it.

229. Taking into account the multiplicity of factors affecting the level of 137Cs in the wood, the decision to develop the calculated cut in zone III, where the 137Cs content may exceed the permissible levels, is appropriate, it is advisable to conduct a preliminary assessment of the wood contamination. For the preliminary estimation, the predicted level of 137Cs content is determined, primarily using the databases and functions of the IS "RadFor", and then, for clarification, calculations are made using data on 137Cs content in the bark and correlation coefficients. During the radiation survey of felling sites in Zone III over the last 5-7 years, a significant amount of information has been accumulated on the content of 137Cs in bark samples taken from trees of various species in mature forest stands and stands approaching maturity.

230. On the basis of the databases "RadFor IS" for the period of CY2013-2016 an analysis of the results of the radiation survey of felling sites in zone III (15-40 Ci / km²) was conducted in the Forestry Enterprises of Gomel, Mogilev SFPAs to determine the ratio of the specific activity of 137Cs in wood with bark and separately the bark. It is established that in the areas of various Forestry Enterprises for pine (TFC A2B2) the average ratio of the specific activity of 137Cs in the bark to the activity of 137Cs in wood with bark (SAcortex/SAwood) makes 2.74 times, for birch 2.7 times. There are differences in values, both between the Forestry Enterprises, and between the forestry units in the Forestry Enterprise.

Figure 34 - Specific activity in the bark and in wood covered with bark ratio. CY 2013-2016. Main felling



231. To obtain more detailed information on radioactive contamination of the forest fund, methods for a more precise radiation survey were developed. The methods are based on the norms established in the existing technical normative legal acts: TCEP 240-2010 "Radiation control. Inspection of forest fund lands. Order of organization", TCEP 239-2010 "Radiation control. Survey of felling sites. Order of conduct" and Amendments to them.

232. This procedure for a more precise radiation survey of the forest fund is used to establish the levels of radioactive contamination with 137Cs in the forest compartment, assessment areas with mature forest stands and stands approaching maturity for a preliminary assessment of the possibility of harvesting wood that meets the requirements of the RPL.

233. The provisions for a more precise radiation survey are recommended for use in Forestry Enterprises with forest fund areas in zone III with soil contamination density with Cesium-137 15-40 Ci/km², Cesium-137 in wood (industrial and firewood) exceeding permissible levels of RPL/Forestry-2001, mature forest stands and stands approaching maturity.

234. The general provisions include:

Radiation survey of forest fund lands is carried out:

- in forest compartments with a soil contamination density with Cesium-137 from 555 to 1480 kBq/m² (15-40 Ci/km²);
- in assessment subcompartments with mature forest stands and stands approaching maturity;
- in forest compartments with soil contamination density with Cesium-137 up to 555 kBq/m² (15 Ci/km²), if the results of the radiation survey of felling sites in previous years the exceeding of the permissible levels of cesium-137 (RPL/Forestry-2001) was found.

235. Preliminary inspection of the forest compartment.

To determine the homogeneity of the radioactive contamination of the forest compartment, gamma radiation dose rate is measured at a height of 1 m from the soil surface in at least twenty points evenly distributed along the perimeter of the compartment at a distance of at least 10 m from the compartment clearances. To determine the homogeneity of radioactive contamination of the assessment subcompartment, gamma radiation dose rate measurements are made at a

height of 1 m from the soil surface in at least ten control points equally spaced throughout the site.

236. Soil Sampling.

For sampling of instant soil samples with forest leaf litter and live soil cover in the forest compartment and in subcompartment a test site of 30-50 x 30-50 meters is selected:

- with a value of gamma radiation dose rate that does not differ from the average value of gamma radiation dose rate in the forest zone, the subcompartment by more than 10%;
- at a distance of 30 meters or more from roads, edges, glades, felling sites and other areas that are not covered with forest;
- with an even relief, which excludes the possibility of soil soil loss.

At the corners of the test site, sampling of soil with forest leaf litter and live soil cover is carried out. At the sampling points of instant samples, measurement of the dose rate at a height of 1 m from the soil surface is carried out.

Instant samples are sampled by sampling equipment to a depth of 20 cm. The sampling equipment should be well sharpened, without any damage to the cutting end (bends, cracks, etc.). After sampling, the sampling equipment shall be completely filled with soil with a forest leaf litter and a live soil cover.

237. Sampling of model trees for inspection of cutting areas.

Model trees shall meet the following criteria:

- characterize the cut down part of the stand;
- cover the industrial category of technical feasibility;
- the diameter of the model trees of each species of the industrial category should be approximately the same at the locations of the sampling of the bark samples;
- instantaneous bark samples are selected separately with cortex sampling equipment timbers at the lower end (in the bottom-end point), two samples from 10 model industrial trees;
- the number of instantaneous samples of tbark should be the same for each tree;
- samples of bark are combined into a total sample. The volume of the total bark sample should be at least 0.5 dm^3;
- after selecting each instant sample, the sampling equipment is cleaned, wiped with rags, then with cotton wool soaked with spirit.

238. Radiometric measurements of selected soil samples, bark are carried out in a radiation control unit accredited for technical competence, with the right to control radioactive contamination. The results of measurements are used to determine the predicted level of 137Cs content in wood, compliance with RPL/Forestry-2001 requirements.

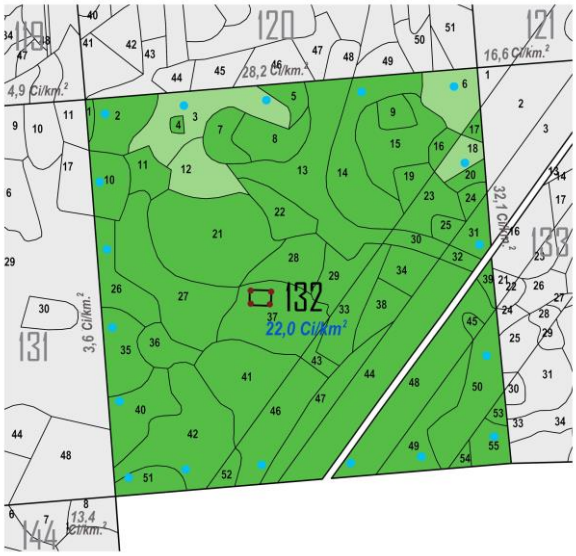
239. The determination of the 137Cs content in wood is carried out using contamination density values in the assessment subcompartments of the 137Cs COTs calculated using the "RadFor" IS as well as using the 137Cs specific activity in the bark and the correlation coefficient (137Cs content in the cortex / 137Cs content in wood). The obtained values are compared with each other, with the values obtained from the previous survey of felling sites in forest compartments. The most reliable values are established and compared with the permissible levels. The results are used to prepare a preliminary estimate of the content of Cesium-137 in wood, compliance with the requirements of RPL/Forestry-2001.

Table 15 - Prepare a preliminary estimate of the content of Cesium-137 in wood

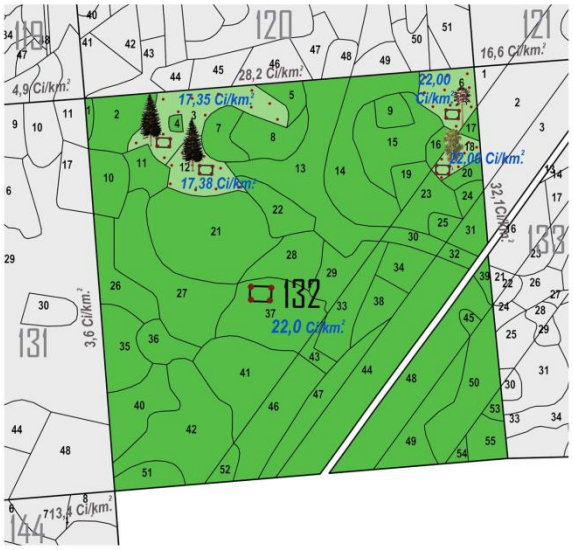
Number of the compartment	**Number of the subcompartment**	**Contamination Density, κBq/m^2**	**^{137}Cs activity in wood, Bq/kg**	**Probability of excess,%**	
				740 Bq/kg	**1480 Bq/kg**

Schematically objects of radiation survey (the points of measurement of gamma radiation dose rate, sampling of soil and cortex) are presented on the example of the forest compartments of the Chechersk Special Forestry Enterprise.

Figure 35 - Inspection design. Rudnya-Bartolomeevskoye Forestry, Chechersk Special Forestry Enterprise



Forest Compartment Survey + forest subcompartment survey



Legend	
●	Points of gamma radiation power measurement in the forest compartment
●	Points of gamma radiation power measurement in the assessment subcompartment
▭	Sites for soil sampling
🌲	Model trees for bark sampling

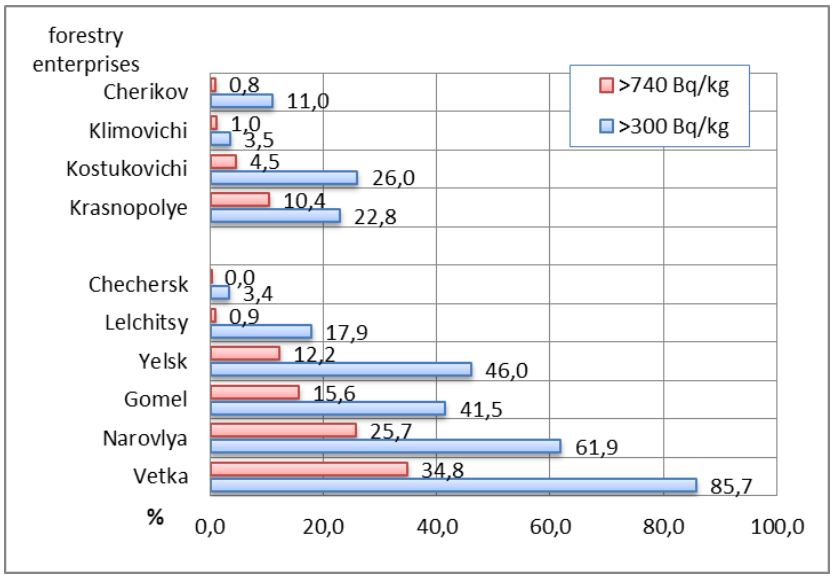
4.2.1 Development of radiation survey methodology for the cutting areas

240. Current methods of radiological inspection of cutting areas provide full information on the levels of cesium-137 in wood. The survey is carried out throughout the territory in radioactive contamination zones; a selective survey is allowed in cases where wood contains less than 200 Bq / kg . At the same time, the law prohibits the procurement of products exceeding the permissible levels. For wood these are the requirements of RPL / Forestry-2001: 740 Bq / kg and 180 Bq / kg. Specific weight of controlled wood with an average permissible level over the Ministry of Forestry is less than 6%, the number of Forestry Enterprises in which there is such timber is 11-12, in these Forestry Enterprises the share of samples with excess of RPL / Forestry-2001 ranges from 1 to 35% (34.8% in Vetka Special Forestry Enterprise). Provided that the permissible levels will not decrease and the cesium-137 content in wood gradually decreases, it is possible to proceed to further optimization of the radiation survey of the

cutting areas, in which radiation safety standards will also be ensured - harvesting of normatively "clean" wood.

241. In 45 "contaminated" Forestry Enterprises in most forestries (83%, 190 of 229 forestries), wood meets the requirements of RPL / Forestry-2001, and over time this situation will change in the direction of increasing the number of such forestries. The analysis of the results of the radiation survey of cutting areas in the Forestry Enterprises is conducted, where the content of cesium-137 in wood exceeded the permissible level of 740 Bq / kg during 2015-2017. It has been established that the proportion of wood samples exceeding the RPL / Forestry-2001 does not exceed 35% (Vetka Special Forestry Enterprise), and in some Forestry Enterprises it is less than 3-4%.

Figure 36 - Share of wood samples with exceedings of 300 Bq / kg and 740 Bq / kg, %



242. Thus, the whole complex of works on radiation survey of cutting areas, including applying methods for clarifying the density of soil contamination in sub compartment and determining a preliminary assessment of the content of cesium-137 in wood, will need to be carried out in 11-12 Forestry Enterprises (39-42 forestries).

243. In the future, it is proposed to determine the scope of the radiation survey of cutting areas, first of all, taking into account the levels of cesium-137 in wood and differentiate the approaches based on the characteristic - compliance with the permissible level of 740 Bq / kg (measured value with the addition of error, the measurement result does not exceed 740 Bq / kg).

244. If in forestry (Forestry Enterprise) the exceeding of permissible levels (740 Bq / kg) over the past three years was established, a preliminary assessment of the cesium-137 content in wood and compliance with permissible levels of RPL / Forestry-2001 is carried out. If it is established that the probability of exceeding the permissible level is more than 70% based on the results of the preliminary assessment, then to determine the possible level of cesium-137 in wood, the density of contamination in the cutting area will be estimated, and the bark will be selected.

245. If within the last three years the content of cesium-137 in wood did not exceed the permissible levels to confirm the radiation safety of timber harvested in the forestry, a radiation survey of one (two) specially selected cutting areas is carried out. The results of the radiation survey are used for the shipment of timber from all logging areas within a year.

246. If the content of cesium-137 in wood did not exceed 200 Bq / kg in the territory of the forestry (Forestry Enterprise) for the last three years to determine the specific activity of cesium-137 in wood, radiation control is carried out from the batch of timber harvested in forest compartments with the largest density of contamination. The results of radiation control are used when shipping timber from all cutting areas within a year.

4.3 Development of formats for reporting data on radioactive contamination on the territory of the forest fund and forecasting changes for forest management plans of Forestry Enterprises

247. The analysis of existing requirements for forest management, preparation of forest management plans, taking into account restrictions in forest management in radioactive contamination zones, summarizing and analysis of data on the radiation situation and content of 137Cs in wood in the most "contaminated" Forestry Enterprises and the forecasting of their changes are carried out. In the I zone with soil contamination density of Cesium-137 from 1 to 5 Ci / km2 and in the II zone - from 5 to 15 Ci / km2 - the field forest assessment works are performed by traditional methods. During forest management in the forest area classified as zone III with soil contamination density from 15 to 40 Ci / km2 (with the exception of the areas of mature forest planned for logging for main felling) and IV zone with soil contamination density 40 Ci / km2 and more the state of forests is determined using the technology of analytical and measurement interpretation of aerial or space imagery, and in the absence of images - using the technology of updating the assessment characteristics using the data of the previous forest assessment.

248. Levels of radioactive contamination of forest fund sites and the assignment of forest areas to the zones are taken into account when forest management plans for a 10-year period are done and the designation of forest management activities and forest use are carried out. The regulation of forest management established in The Rules for Forest Management Conduction in the territories exposed to radioactive contamination as a result of the Chernobyl disaster ensures compliance with norms and rules for radiation safety. Information on the radiation situation in the form of a map-schemes of Forestry Enterprises forests with the coloring of forest compartments by zones of radioactive contamination is provided in the forest management plans.

249. Radiation inspection of forest compartments is systematically carried out and the severity of the radioactive contamination of each Forestry Enterprises is determined to obtain updated information on the radiation conditions in the territory of the forest fund. The Forestry Enterprises classified as the most "contaminated" ones are those which include forest fund areas in the III zone with a soil contamination density of 137Cs from 555 to 1480 kBq / m2 (15 to 40 Ci / km2) and wood exceeding RPL/FORESTRY-2001. In Gomel SFPA these are Vetka, Narovlya and Chechersk special Forestry Enterprises, Yelsk, Gomel, Khoyniky Forestry Enterprises. In Mogilev SFPA these are Krasnopolie, Kostyukovichy, Cherikov Forestry Enterprises.

250. The results of the radiation inspection of cutting areas, levels of Cesium-137 in wood in the territory of the third zone have been summarized and analyzed. When calculating the possible volumes of industrial wood with a Cesium-137 content not exceeding the permissible level, it was established that it is possible to procure normatively "clean" timber: in Vetka Special Forestry - 66% of the stock of ripewood in the III zone, Chechersk - 77%, Gomel - 84% , Krasnopolie - 67%, Kostyukovichi - 100%.

251. Proposals on the procedure for preparing and entering information on the radiation condition and its changes in the forest management plans, including the cartographic materials, were developed. Databases "Radiation conditions" and "Forest products" of IS “RadFor”, “RadForView” with the results of the radiation inspection are used for the preparation of information on changes in levels and area of radioactive contamination of forest fund lands, 137Cs content in wood and its compliance with RPL/FORESTRY-2001 requirements.

252. Preliminary assessment of the 137Cs content in wood provides a differentiated approach to the development of the allowable cut, optimization of the logging operations at the stage of preparation of the forest management plans. The results of the radiation inspection of logging areas in forestries of Narovlya Special and Yelsk Forestry Enterprises of Gomel SFPA and Krasnopolie Forestry Enterprise of Mogilev SFPA have been analyzed, the coefficients of 137Cs transition from soil to wood in various types of forest conditions (hereinafter – TFC) have been clarified, the soil contamination densities were calculated when the Cs-137 content in wood does

not exceed the permissible levels (normatively "clean" wood). The levels established for wood fuel have been calculated.

253. Blocks of information on radioactive contamination of the territory of the forest fund (137Cs soil contamination density and 137Cs wood content) were developed for the preparation of forest management plans for Narovlya Special Forestry Enterprise and Yelsk Forestry Enterprise of Gomel SFPA and Krasnopolie Forestry Enterprise of Mogilev SFPA at the beginning and the end of the revision period, and for the period of their implementation. These Forestry Enterprises are chosen as an example for demonstrating the proposed ways of providing information on the radiation conditions and their changes during the forest management period. In these Forestry Enterprises:

- the territory of the forest fund is contaminated with radionuclides at significant areas (100% – Narovlya Special Forestry Enterprise and Krasnopolie Forestry Enterprise, 86% – Yelsk Forestry Enterprise);
- high gradient of soil contamination density of 137Cs – from 1 to 40 Ci / km2;
- content of 137Cs in wood exceeds the permissible levels at the cutting areas (mature tree stands assigned to the commercial felling) with a soil contamination density of less than 15 Ci / km2;
- there are areas with anomalous coefficient of Cesium-137 transfer from soil to wood (hereinafter – COT) (1,5-2 times more than the average value of the COT for a certain species and TFC in the forestry area).

254. Further similar blocks of information on the radioactive contamination of the forest fund (soil contamination density of 137Cs, 137Cs content in wood) are proposed to be used in the forest management plans for Forestry Enterprises of Gomel and Mogilev SFPAs for a new audit period. The basic forest management of the Forestry Enterprises of Gomel SFPA was carried out in 2010-2011, Mogilev - 2011-2012 and the development of new plans for these Forestry Enterprises is planned between 2021 and 2024. By the time of their development, the amount of data on the results of the radiation inspection of forest fund, radiometric measurements of wood will have increased, which will allow to reflect in the forest management plans the most updated information on the radioactive contamination of the forest fund and more accurately predict changes in radiation situation.

Conclusions and suggestions

255. In the territories of radioactive contamination, rational planning of forest management in compliance with the norms and rules of radiation safety is possible provided that the updated and objective information on the levels of contamination with radionuclides as a result of radiation control is promptly received. The use of protective measures throughout the post-accident period prevents the receipt of additional radiation doses by forestry workers and ensures the delivery of normatively "clean" forest products to the consumer.

256. Potential risks and scope of protective measures are reduced while distance from the Chernobyl disaster and decrease of levels and the area of radioactive contamination. Currently, restrictions in forest use in zones of radioactive contamination are related to the prohibitions on the production and sale of forest products with excess of the republican permissible levels of radionuclide content, as well as the need to meet the requirements set by consumers of wood fuel. Limitations in connection with the potential possibility of exceeding the annual average radiation dose of 1 mSv are practically minimized, and they exist in the territories constituting 0.8% of the total forest area of the Ministry of Forestry.

257. In view of the changes in the radiation conditions, the regulatory framework has been updated. To optimize the work on the territory of the forest fund, new approaches to forest management and monitoring of radioactive contamination in the system of the Ministry of Forestry have been developed and introduced into practice. Forest Management Rules in the territories exposed to radioactive contamination as a result of the Chernobyl disaster, Rules for control of radioactive contamination in the system of the Ministry of Forestry, Amendment No. 1 to TCEP 240-2010, Amendment No. 2 to TCEP 239-2010 have been developed and put into effect. The application in of new NRAs and TNRA, Forest Management Rules ensures observance of radiation safety standards in the implementation of forest management measures, forest management: do not exceed the average annual dose limit of irradiation, obtain forest products with radionuclide content not exceeding permissible levels. The scope of protective measures is decreasing in connection with the reduction of the forest fund territories in the III and IV zones, the possibilities of forest management and the development of the allowable cutting area in the third zone will increase.

258. The application of the new Rules of control ensures that objective information is obtained about the radiation situation in the forest fund for decision-making on the implementation of forest management. The system for recording radiation survey data, radiometric measurements of forest products established in the Control Rules ensures the prompt presentation of the results of monitoring radioactive contamination, optimizes the methods of operation of the radiation monitoring service of the industry. The application of the Control Rules will make it possible to exclude the possibility of implementing controlled products with a content of radionuclides exceeding the permissible levels, to ensure the delivery of normatively "clean" forest products to the consumer.

259. Practical application of Amendment No. 2 to TCEP 239-2010 resulted in a decrease in the number of surveyed cutting areas at a soil contamination density of 2 to 5 Ci / km2 while maintaining the objectivity of information on the content of cesium-137 in wood to confirm radiation safety (compliance with acceptable levels) products. Application the Amendment №1 to TCEP 240-2010 increased the efficiency of conducting a radiation survey of forest fund lands. in 2017, as a result of clarifying the radiation conditions, the proportion of forest compartments that moved to a zone with a lower soil contamination density increased in comparison with previous years in the Forestry Enterprises of Gomel SFPA from 40 to 71.1%, Mogilev - from 72 to 84.9%.

260. The Forestry Enterprises use modern technologies for storing and processing data using the peripheral version of the “RadForView” IS, which is part of the distributed IS “RadFor”. This ensures the storage and processing of the results of the radiation survey, the promptness of obtaining documents - Acts for the Radiation Inspection of Cutting Lines, Statements of the

Results of the Control of Radioactive Contamination of Forest Fund Lands, Cartographic Materials, and Reports.

It is proposed to:

261. Develop subprograms in the AWP “Forest use” to prepare and execute a felling license. Two variants of the reorganization of the “Forest use” program complex are proposed to ensure the interaction of the “RadForview” IS with the “Forest use” AWP. 1st option is the fields addition into the database “Felling-area resources” containing information about the radiation conditions. Option 2 - creating a new database – “Radiation conditions”. Information exchange is proposed to be carried out through the export and import of data on the radiation conditions from the IS “RadForview” in the AWP “Forest use”.

262. When developing forest management plans, use information on radioactive contamination of territories and wood during the revision period with a forecast of its change. For Forestry Enterprises with forest fund areas in the third zone, in determining the size of the estimated cutting area in this zone, not only the density of soil contamination with cesium-137, but also the levels of cesium-137 in wood and their compliance with the requirements of radiation safety standards - RPL / Forestry -2001, should be taken into account.

263. Optimize the methods of radiation survey of cutting areas, at the same time using the results of radiation control obtained in previous years and the technologies for their processing and calculating forecasts of changes in the radiation conditions. Differentiate the approaches to the survey taking into account the levels of cesium-137 in wood, compliance with the permissible level - 740 Bq / kg (the measured value with the addition of the error of the measurement result does not exceed 740 Bq / kg). To strengthen the survey requirements in those areas where levels of cesium-137 wood contamination may exceed RPL / Forestry-2001, to weaken - where these levels are smaller than RPL and go to radiation control of harvested batches - where these levels are significantly less (<200 Bq / kg) .

264. Develop in the ”RadFor” IS the function of updating the databases “On Demand”, install a computer server in “Bellezaschita” Institution for the possibility of remote connection by the type "client-server" to optimize the process of information exchange on the results of radiation control, the formation of databases IS “RadFor” and the possibility of obtaining up-to-date information in any period of time during the reporting period.