PERSONAL DOSIMETER-RADIOMETER МКС-03СА

OPERATION MANUAL
СНЖА.412152.003 РЭ

Registered in State register of instrumentation under № 33063-08.
Approval certificate of instrumentation type RU.C.38.002.A № 31090

Status O_1

CONTENTS

1. INSTRUMENT DESCRIPTION AND OPERATION

1.1 Purpose and scope of application

1.1.1 Personal dosimeter-radiometer MKC-03CA (hereinafter – the instrument) intended for measuring of the ambient dose equivalent and ambient dose equivalent rate of gamma (x-ray) radiation (hereinafter the dose and dose rate, respectively), for measuring of beta-particles flux density, for measuring of specific activity of radio nuclides in samples of food products and other objects in the environment, indication of alpha-particles flux density as well as indicating flow rate of ionizing particles.

When release the instrument is calibrated in units of ambient dose equivalent by radiation ^{137}**Cs**.

1.1.2 The instrument assures current search of contaminated objects or sources of X-ray radiation as well as to control the human environment (radiation safety of work places, housing, environment, assessment of radioactive contamination of objects and materials, including bank notes and their packages).

The instrument can be used as:

- an individual expressly indicative meter of the dose and the dose rate of gamma (X-ray) radiation;
- a survey meter of the gamma (X-ray) radiation dose rate for immediate evaluation of radiation environment.

1.1.3 The instrument software allows performing:

- Measurement of radioactivity using a special algorithm;
- Installation and change of sound signaling thresholds by dose, dose rate, beta-and alpha-particles flux density, ionizing particles flux density;
- Installation of log records intervals (in the internal instrument memory for subsequent reading of measurements history by the personal computer hereinafter the PC))
- Storing the accumulated dose and exposure time in non-volatile memory (when power is turned off or when replacing the battery) for a period exceeding 5 years;
- Indication when the battery is discharged.

1.1.4 The information is displayed on the alphanumeric LCD display.

The instrument uses a continuous measurement mode and presentation of average value of obtained value on the display with every second change in readings, which is convenient for operational control. In the dose rate measurement mode the instrument sound signaling is automatically switched on to warn the operator about the danger of overexposure when working with radioactive products or in the zone of radioactive contamination.

1.1.5 Instrument settings provide:

- sound messages about instrument switching on and switching off;
- switching on/off sounds ("clicks") corresponding to each act of registering gamma rays, beta-or alpha-particles by the counter;
- inclusion of the audio signals on exceeding preset thresholds of measurement of dose, dose rate, beta-and alpha-particles flux density;
- switching on/off the display backlight.

1.2 Specifications

The instrument had specifications described in table 1.

Table 1

Parameter description	Value
Dose measuring range, mSv	from $1 \cdot 10^{-4}$ to $1 \cdot 10^{3}$
Dose rate measuring range, μSv/h	from 0,1 to $1 \cdot 10^{4}$
Photons energy range, MeV	from 0,05 to 3,0
Measuring range of beta-particles flux density (by ^{90}**Sr** + ^{90}**Y**), $min^{-1} \cdot sm^{-2}$	from 3 to $3 \cdot 10^{4}$
The lower limit of the beta-radiation energy being registered (by average energy of beta-spectrum ^{14}**C**), not more than, MeV	0,05
The limit of permissible basic relative error in the confidence 0,95, %	±25
Indication range of alpha-particles flux density (by ^{239}**Pu**), ($min^{-1} \cdot sm^{-2}$)	from 10 to $3 \cdot 10^{4}$
Indication range of ionization particles flux (for ^{90}**Sr**+^{90}**Y**), min^{-1}	from 10 to $3 \cdot 10^{4}$
The range of the measurements of specific activity of samples with the density of 0.5 to 1.5 g/cm^3 : - for ^{90}**Sr**+^{90}**Y**, Bq / kg; - for ^{137}**Cs**	 100 to $2 \cdot 10^{5}$ 50 to $2 \cdot 10^{5}$
Natural background level: - in "**GAMMA**" mode, μSv/h, not more than - in "**BETA**" mode, $min^{-1} \cdot sm^{-2}$, not more than	 0,06 6,00
Operating mode setting time, min, not more than	1
Continuous operation time period (when measuring at the level of the natural radioactive background), hour: - by 2 batteries of AA "DURACELL" type - by AC 220V, 50 Hz (by voltage adapter)	 Not less than 400 Not limited
Dose rate measuring time, s, not more than: - when the background is 0,15 μSv/h - when the background is more than 1 μSv/h	 20 3
Time measurements of beta particles flux density (excluding the background measurement time), s, not more than - when beta particles flux density is less than 5 $min^{-1}sm^{-2}$ - when beta particles flux density is more than 100 $min^{-1}sm^{-2}$	 20 3
Dose rate thresholds setting range, μSv/h (with 0,1 μSv/h step)	from 0,1 to 10^{4}
Dose thresholds setting range, mSv (with 0,001 mSv step)	from $1 \cdot 10^{-4}$ to 10^{3}
Beta-particles flux density thresholds setting range, $min^{-1} \cdot sm^{-2}$ ($1,0\ min^{-1} \cdot sm^{-2}$ step)	from 5 to 30000
Speech output of dose rate measuring result	Automatic with intervals 30s, 60s or 120s. Single-staged, at any time
Sound signaling activated when exceeding the preset the thresholds dose rate and alpha- or beta-particles flux density	On-off signal with 1 s interval
Sound messages: - when the instrument power supply is on; - when the instrument power supply is off; - when exceeding the measuring limit of the dose rate, alpha- or beta- flux density;	"Instrument is ready for operation" "Instrument is off" "Result exceeds the measuring limit"

- when exceeding the preset dose threshold	"Dose threshold exceeding"
Intervals of records in the log, min	1; 5; 30 or OFF
Log capacity, number of records	2000
Language	Russian/English
Operation conditions: - temperature, ºC - humidity at 30 ºC	 from minus 20 up to+50 °C up to 75 %
Overall dimensions, mm	150×75×30
Mass, g, not more than	360

1.3 Measuring procedure

In the instrument an end-plate gas-discharging counter "**BETA-5**" is applied as an irradiation detector. The detector converts the photons flux into electrical signals sequence. These signals are generated by the duration and amplitude, and then are processed by the microprocessor, which assures indication of the measurements results on the graphic liquid-crystal display.

In the measurement process readings on the display are changed automatically with every second averaging of measurements results by microprocessor and counting of measurement statistics error in the confidence interval 0.95. In this case, the display shows the current value of the measured physical value in appropriate units of measurement, statistical error of measurement at the moment, as ell as preset signaling threshold of measured value (which determines the maximum value of the analog scale), serial number of the current record of measurements results in the journal of measurements (hereinafter – the journal), time, date and day of week.

1.4 General design data

1.4.1 General appearance of the instrument МКС-03СА is presented on the Fig. 1.

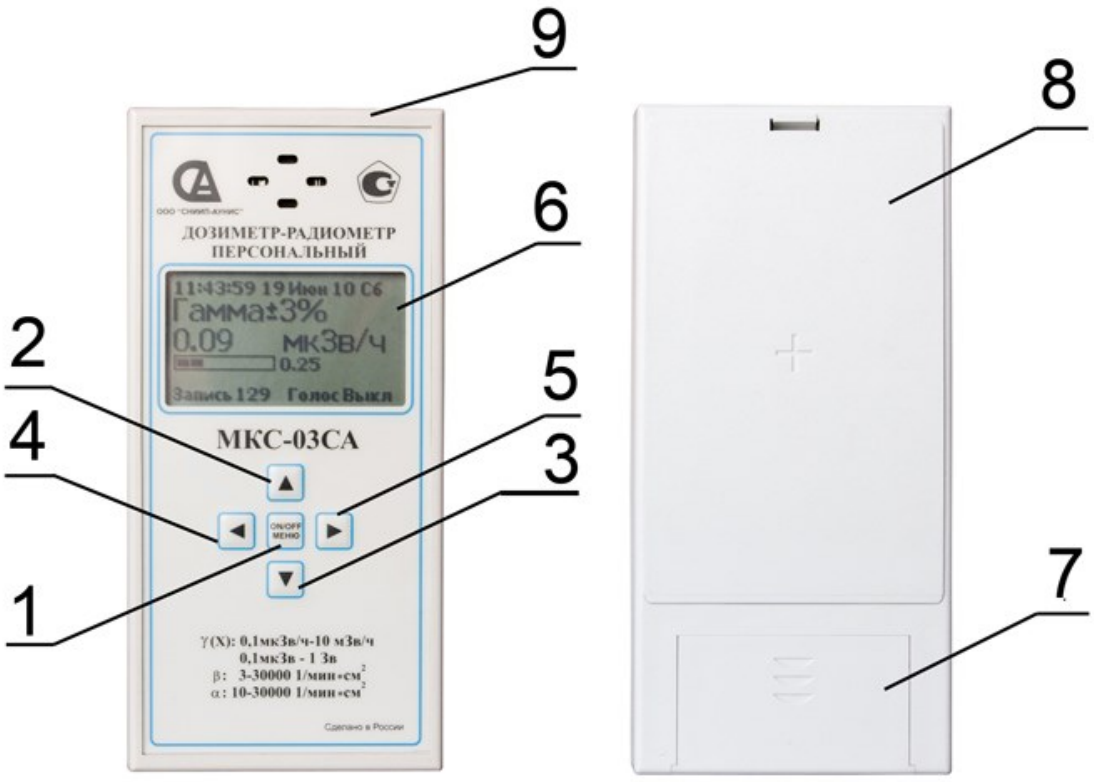


Fig. 1 General appearance of the instrument МКС-03СА

1 – button "**ON/OFF"** – On/Off of the instrument;

2-3 – buttons for selecting the operation mode (in "**MENU**" mode buttons ▲ or ▼ provide switching of service settings);

4 – a button of single logging of measurements results);

5 – buttons for setting the service parameters of the instrument. For short single pushing of the button in the measurements: - in the "Gamma" mode – switch-on of the speech sound of the current measurement result. For short single pushing of the button in the measurements in modes "ALPHA", "BETA" and "SEARCH" - reset of the current measurement result. A single long-term (more than 2 sec.) pushing of the button in the "SEARCH" mode transmits the device into mode of the measurements of specific activity of samples, while in the lower central part of the display symbol Σ is switched on. When you press a button for the second time long, the device switches to its original working condition, and the symbol Σ on the screen is off;

6 – liquid-crystal display;

7 – an cover of the power supply section;

8 – an absorbing detector's screen;

9 – mini USB connector for connection to PC or AC adapter.

1.4.2 Indication and signaling of the instrument

1.4.2.1 The example of information shown on the display is presented on the Fig. 2

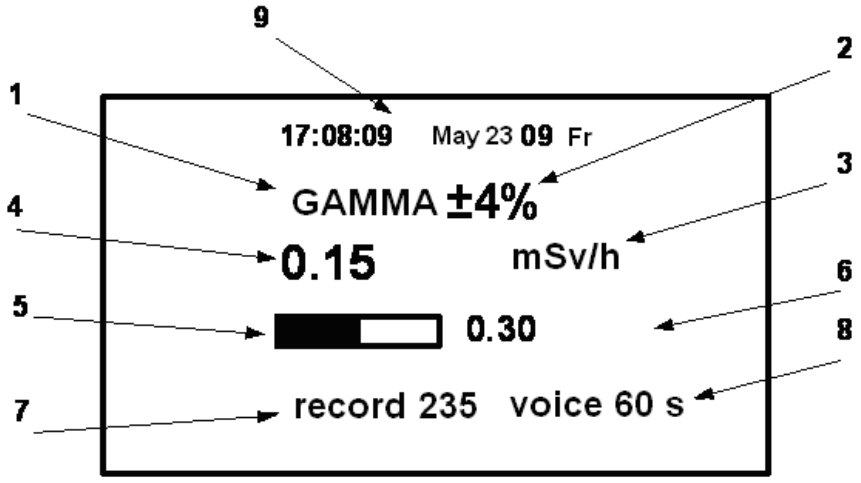


Fig. 2. The example of information shown on the display
1 - the physical value being measured (defined by the operation mode);
2 - the current value of statistic error of the value being measured;
3 - the dimension of the value being measured;
4 - the current threshold value of the measured value;
5 - analogue scale;
6 - the preset threshold value of the measured value;
7 - the account number in the log;

8 - the frequency of sound measurements;
9 - the current time, date, day of week.
The following units are used:
- μSv/h - microsieverts per hour;
- mSv/h - millisievert per hour;
- Sv/h - sievert per hour;
- Min^{-1} cm^{-2} - minute in the minus first degree per one centimeter in the minus second degree;
- μSv - microsieverts;
- mSv - millisievert;
- Sv - sievert;
- Min^{-1} – minute in the minus first degree.

The information is displayed in the language chosen by the user (in Russian or English).

1.4.2.2 Signaling of exceeding the preset threshold of dose rate, beta-particles flux density and ionizing particles flux – sound signal;

1.4.2.3 Signaling of exceeding the limit of dose measurement – periodic, voice message "Exceeding the threshold dose"

1.4.2.4 Signaling of overload – in exceeding the upper limit of dose rate measurement – voice message "The result is above the measurement limit".

1.4.2.5 Indication of battery discharge - when battery discharge up to 1.6 V the symbol "▭" appears on the display

1.4.2.6 Display backlight turns on automatically when you press any button on the instrument. Duration of backlight is 30 s.

1.4.3 The instrument has a special mode of recording measurements in the log. Log capacity is 2000 records. Records review can be carried out manually or using a personal computer.

1.5.General information on instrument operation

1.5.1 The instrument is turned on by short-term pressing (less than 1 s) of button «**ON / OFF**». The instrument is turned off by long pressing (more than 2 s) of button «**ON / OFF**».

1.5.2 The choice of modes of instrument operation is made by short-term pressing (less than 1 s) or button ▼ or ▲. Modes vary cyclically according to the scheme shown in Fig. 3.

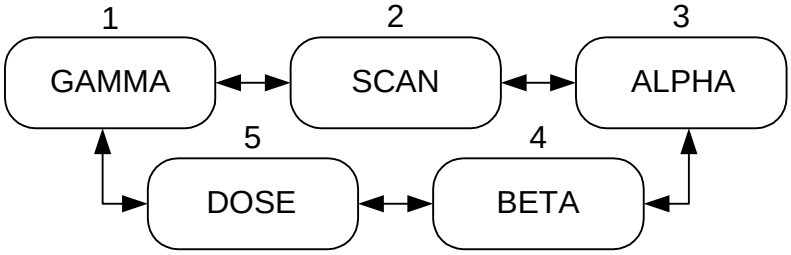


Fig. 3. Scheme of switching operation modes of the instrument
1 - «GAMMA» - dose rate measurement;
2 - «SEARCH» - search and localization of radioactive radiation sources;
3 - «ALPHA» - indication of alpha particles flux density;
4 - «BETA» - measurement of beta-particles flux density;
5 - «DOSE» - dose measurement.

1.5.3 Setting of instrument parameters

Parameters are set in the "**MENU**" of the instrument.

- Turn on the instrument, p. 1.5.1. The instrument is initially in the "GAMMA" dose rate measurements mode,
- Go to "**MENU**" settings by short-term pressing (less than 1 s) of button «**ON / OFF**». The display shows instrument "**MENU**" (the entrance to instrument "**MENU**" can be done from any measurement mode);

- Select parameter necessary for setting by buttons ▲ or ▼ (selected parameter is displayed in a frame on the screen). Set the value of selected parameter by buttons ◄ or ► buttons in accordance with p. 1.5.5.

1.5.4 Service parameters of instrument "MENU":

- "**Voice**" - sounding measurements results through preset time-interval (30s, 60s, 120s or off);
- "**Clicks**" – sound signaling which records the intensity of radioactive radiation (on / off);
- "**Backlight**" - set display backlight (on / off);
- "**Log**" - set time interval of recording measurement results in log (1 min, 5 min, 30 min or off);
- "**Log viewing**" - entries view in the measurement log;
- "**Gt**" - a threshold of gamma radiation dose rate;
- "**At**" - a threshold of alpha particles destiny flux;
- "**Bt**" - a threshold of beta-particles destiny flux;
- "**Dt**" - a threshold of dose;
- "**St**" - a threshold of ionizing particles flux at search of radioactive anomalies;
- "**Reset dose**" - reset of accumulated dose;
- "**Clear diary**" – delete entries in the measurement log;
- "**Date**" - current date of measurement;
- "**Time**" - current time of measurement;
- "**Language**" - the language of messages output to the display is Russian / English.

Exit the "**MENU**" by short-term pressing (less than 1 s) of button «**ON / OFF**», in this case the instrument returns to measurement mode.

1.5.5 Parameters setting

To set parameters switch on the instrument according to p. 1.5.1, 1.5.3.

1.5.5.1 Voice dubbing of dose rate measurements results and their evaluation

Select the parameter "Voice" using buttons ▲ or ▼ (highlight a rectangular frame). Set desired parameter setting – 30 s, 60 s, 120 s or off using buttons ◄ or ►. Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the measurement mode.

Note - In the dose rate measurement mode short-term press the button ► provides a single voice message of current measurements result and their evaluation.

1.5.5.2 Turning on of audio signals recording the intensity of radiation

Select the parameter "**Clicks**" using buttons ▲ or ▼ (highlight a rectangular frame). Set desired parameter setting – on or off using buttons ◄ or ►. Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the measurement mode.

1.5.5.3 Backlight turn on / off

Backlight turning on / off is made like in p. 1.5.5.2.

1.5.5.4 Setting the recording interval of measurements result in the log.

Select the parameter "**Log**" using buttons ▲ or ▼ (highlight a rectangular frame). Set desired parameter setting – 1 min, 5 min, 30 min or off using buttons ◄ or ►. Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the measurement mode.

WARNING! LOG'S ENTRY IS MADE IN CURRENT MEASUREMENT MODE. SPECIAL LOG ENTRY CAN BE MADE IN ANY MEASUREMENT MODE USING BUTTON ◄ .

1.5.5.5 Log viewing

Select the parameter "**Log viewing**" using buttons ▲ or ▼ (highlight a rectangular frame). View records of measurements results using buttons ◄ or ►, see fig.4.

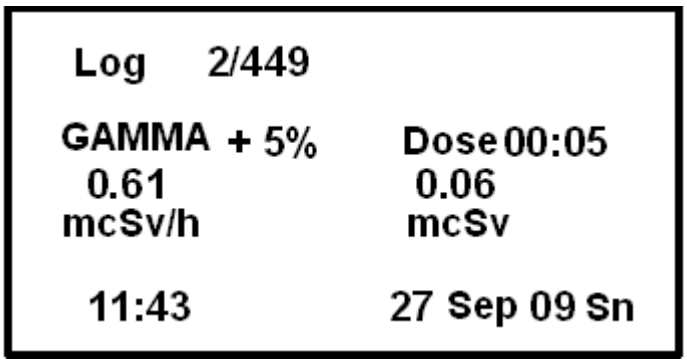


Fig4. Record example of dose rate and accumulated dose measurements results

Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the "**MENU**" mode**.** Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.6 Setting dose rate signaling thresholds

Select the parameter "**Gt**" - **"Threshold of gamma radiation dose rate"** using buttons ▲ or ▼ (highlight a rectangular frame). Switch to set numerical values of the parameter by short-term pressing of buttons ◄ or ► (less than 1 s). Select with cursor the number's category or its dimensions using buttons ◄ or ►. Set the numerical value of each selected category and its dimension using buttons ◄ or ►. Go to the next category by buttons ◄ or ►.

Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the "**MENU**" mode**.** Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.7 Setting beta-particles flux density signaling thresholds

Setting beta-particles flux density signaling thresholds **("Bt")** is made accordance to p. 1.5.5.6.

1.5.5.8 Setting alpha-particles flux density signaling thresholds

Setting alpha-particles flux density signaling thresholds "**At**" is made accordance to p. 1.5.5.6.

1.5.5.9 Setting integral dose signaling thresholds

Setting integral dose signaling thresholds **"Dt"** is made accordance to p. 1.5.5.6.

1.5.5.10 Setting ionizing particles flux signaling thresholds

Setting ionizing particles flux signaling thresholds **"St"** is made accordance to p. 1.5.5.6.

1.5.5.11 Reset of accumulated dose

Select the parameter "**Dose reset**" using buttons ▲ or ▼ (highlight a rectangular frame). Switch to dose reset mode by short-term pressing of buttons ◄ or ► (less than 1 s). When the message- **"Do you with to reset dose?"** is shown on the screen reset the dose by short-term pressing of the button «**ON/OFF**» (less than 1 s). Pressing of any other button will cancel dose reset. When you reset the dose the screen menu screen displays the option **"Dose reset dose of 0.00 mSv".**

Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.12 Delete log entries

Select the parameter "**Clear log**" using buttons ▲ or ▼ (highlight a rectangular frame). Switch to clear log mode by short-term pressing of buttons ◄ or ► (less than 1 s). When the message **"Clear log?"** is shown on the screen, delete log entries by short-term pressing of the button "**ON/OFF"** (less than 1 s). Pressing of any other button will cancel dose deleting.

Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.13 Date setting

Select the parameter "**Date**" using buttons ▲ or ▼ (highlight a rectangular frame). Switch to date setting mode by short-term pressing of buttons ◄ or ► (less than 1 s). Set a numerical value using buttons ◄ or ►.

Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the "**MENU**" mode**.** Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.14 Time setting

Select the parameter "**Time**" using buttons ▲ or ▼ (highlight a rectangular frame). Switch to time setting mode by short-term pressing of buttons ◄ or ► (less than 1 s). Set a numerical value using buttons ◄ or ►.

Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the "**MENU**" mode**.** Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

1.5.5.15 Choice of text messages language

Select the parameter "**Language**" using buttons ▲ or ▼ (highlight a rectangular frame). Choose necessary language of text messages Russian/English by short-term pressing of buttons ◄ or ► (less than 1 s).

Press the button «**ON/OFF**» (less than 1 s) to move the instrument in the "**MENU**" mode**.** Press the button «**ON/OFF**» twice for a short moment (less than 1 s) to move the instrument in the measurement mode.

2. MEASURING

2.1 Operating limitations and safety measures

2.1.1 To prevent the detector power supply occurrence under the high voltage and malfunction of the chart elements it is forbidden to open the sealed section of the instrument.

2.1.2 Keep clean the power supply section and contacts for power supply connection.

2.1.3 Change on-time the power sources which have been discharged.

2.1.4 In case of radioactive substances occur on the instrument case its back-ground readings can be increased. Check it by measuring the instrument background readings in another place or room.

2.1.5 By class of people's protection from electric shock the instrument belongs to Class III by GOST 12.2.007.0-75.

2.2 Instrument preparation for operation

2.2.1 Instrument preparation for operation with replaceable batteries:

- remove the cover of the power supply section (see fig. 1);
- set the power supply elements taking into account the polarity;
- set the cover of the power supply section at its place;
- cover the working surface of the detector with absorbing barrier (fig.1).

2.2.2 Instrument preparation for operation from AC mains:

- connect the output connector of power adapter to the USB connector, located in the upper end of the instrument (see Fig. 1);
- turn on the power cord into the mains outlet voltage ~220 V.

2.2.3 Prepare the instrument for use with a PC connecting them with USB cable.

2.3 Dose rate measuring

2.3.1 To measure the background radiation dose in the room or in the open air perform the following:

- switch the instrument power supply on by p. 1.5.1. Once the instrument has been switched on, it is set initially in the dose rate measuring mode: ("**GAMMA**" is indicated on the display);
- place the instrument at not less than 1 m distance from the floor (ground) surface and any other nearby objects.
- in 2-3 seconds the first averaged dose rate value of the natural radiation background and the fist statistic error value, ±90% approximately will be displayed;

- to define the dose rate precisely it is essential to fix the display readings at that the statistic error will be decreased and achieved the value close to 20 percentage

- keep in mind that each rapid displacement of the instrument or rapid change of the radiation activity leads to reset of the accumulated information (nullification) and the process starts again.

2.4 Dose measuring

The instrument measures the integral radiation dose as soon as the instrument is switched on only in modes "**GAMMA**" or "**DOSE**".

2.4.1 Switch the instrument power supply on by p. 1.5.1. In accordance with p. 1.5.2 switch on "**DOSE**" mode using buttons ▲ or ▼.

In the "**DOSE**" mode the instrument display indicates the total exposure time of the instrument (hours : minutes) and accumulated dose value. The instrument keeps the total exposure time of the instrument and the accumulated dose value after it is switched off (or when the power elements are replaced) in the nonvolatile memory for more than 5 years period.

2.5 Beta-particles flux density measuring from surfaces

2.5.1 To measure the beta-particles flux density from the surface being surveyed, per-form the following:

- open the input window of the detector (Fig. 1);
- switch the instrument power supply on by p. 1.5.1;
- set the mode "**BETA**" in accordance with p. 1.5.2;
- place the detector input window at (3-5) mm distance directly under the surface to be surveyed. As soon as the statistic error has achieved less than 20%, register the average value of the display $\mathbf{\Phi}_{\beta+\phi\gamma}$, in units of measurement: $min^{-1}sm^{-2}$;
- put absorbing barrier on detector's working surface (Fig. 1). Place the dosimeter at not less than 1 m distance from the tested surface;
- as soon as the statistic error has achieved less than 20%, register the background reading of the display $\mathbf{\Phi}_{\phi\gamma}$, ($min^{-1}sm^{-2}$);
- calculate the beta-particles flux density $\mathbf{\Phi}_{\beta}$, ($min^{-1}sm^{-2}$), by the formula

$$\mathbf{\Phi}_{\beta} = \mathbf{\Phi}_{\beta+\phi\gamma} - \mathbf{\Phi}_{\phi\gamma} \qquad (1)$$

2.6 Alpha-particles flux density evaluation from surfaces

2.6.1 To evaluate the alpha-particles flux density from the surface to be surveyed, perform the following:

- open the input window of the detector;
- follow step of p. 1.5.3 , set the mode "**ALPHA**";
- place the detector backside directly under the surface to be surveyed in such a way as the distance between the detector input window and the surface to be monitored shall be minimum: not more than (1-2) mm;
- as soon as the statistic error has achieved less than 20%, register the readings of the display $\mathbf{\Phi}_{\alpha+\phi}$ in units of measurement: $min^{-1}sm^{-2}$;
- cover the surface to be surveyed with a thin sheet of paper, for example used for printing in modern printers;
- repeat the measuring procedure, by placing the input window of the detector directly under the surface to be surveyed in the same geometry, as when evaluating $\mathbf{\Phi}_{\alpha+\phi}$. As soon as the statistic error has achieved less than 20%, register the average reading of the display $\mathbf{\Phi}_{\phi}$ **,** $min^{-1}sm^{-2}$;
- determine alpha-particles flux density with contamination surface $\mathbf{\Phi}_{\alpha}$**,** $min^{-1}sm^{-2}$ by formula

$$\mathbf{\Phi}_{\alpha} = \mathbf{\Phi}_{\alpha+\phi} - \mathbf{\Phi}_{\phi} \qquad (2)$$

2.7 Survey of radioactive radiation sources, items and objects, contaminated with radioactive nuclides

2.7.1 Survey of radioactive anomalies shall be performed after the instrument has been prepared for operation in accordance with paragraph 2.2

- open the input window of the detector (figure 1);
- switch the instrument power supply on by p.1.5.1.
- in accordance with p. 1.5.2 switch on **"SCAN"** mode by buttons ▲ or ▼.

Smoothly moving the instrument along the surface of the object to be monitored, it shall be placed at the minimum distance from the surface to be surveyed.

In case of notable increase in the instrument readings in (1,5-2) times and more, suspend moving the instrument and during (30-40)s make sure that the readings are increasing steady.

Than moving the instrument in different directions, determine the range of the radioactive contamination and in this range detect objects, contaminated with radioactive nuclides.

Evaluate the photon radiation dose rate level at the distance as requested by an operator from the radiation source in accordance with p. 2.3.

2.8 Survey and monitoring of objects or samples contaminated with radioactive nuclides.

2.8.1 Survey and monitoring of objects or samples for contamination with radioactive nuclides is performed in order to detect separate objects (for example, building materials, banknotes etc.) and samples (of soil, agricultural production etc.), contaminated with radionuclides. The result of this activity shall be separation of objects subjected to monitoring or types of production in accordance with established reference levels of radioactive contamination for different radionuclides.

Related to the mentioned activity measurements shall consider specificity and physical characteristics of objected subjected to monitoring, as well as tasks, arisen when organizing such a monitoring. In view of this for each object and type of monitoring the procedure and/or recommendations shall be developed additionally on how to organize the detection and monitoring of objects, contaminated with radioactive nuclides and how to remove them from application followed by disposal at special areas. These documents are subjected to obligatory agreement with Federal authorities on technical regulation and metrology, Federal agency of health protection and social development, Federal agency on atomic energy and other organizations – if appropriate (for example, Federal agency on agriculture etc.).

3. INSTRUMENT WORK WITH PERSONAL COMPUTER (PC).

3.1 Instrument connection to a PC

- Connect the instrument to a PC via a USB cable.

- Turn on the instrument (see p. 1.5.1)

- A few seconds after switching the device on the PC system (Windows XP and above) will find its connection. In the "My Computer" section a new removable drive will appear. On the PC monitor a widow will appear (Figure 5).

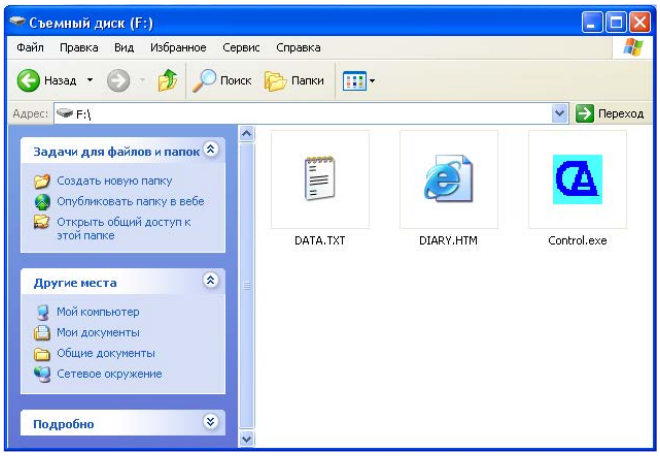
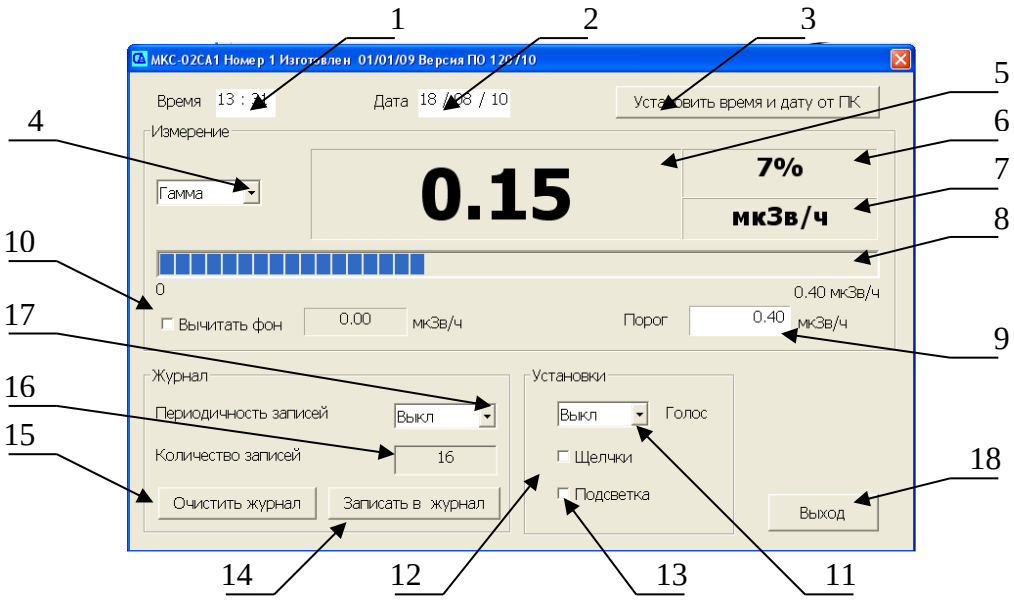


Figure 5. Monitor window displaying the content of the removable drive

3.2 Working with user program Control

3.2.1 Run Control.exe (The file extension could not be displayed and depends on the PC configuration). It may take a few seconds.

The screen will display a user menu bar (see Fig. 6).



1 - Window of time settings, 2 - Window of date settings; 3 – Button of automatic setup of the date and time from the PC, 4 - Mode button of the device 5 - Results of measurements, 6 - Statistical margin of error for the measured value, in percent; 7 – Unit f measurement; 8 - Analog scale (the scale of the progress bar); 9 – Installed signaling threshold; 10 - Automatic background subtraction with an indication of the subtracted values; 11 – Button of the selection of intervals of the measurement results speech sound; 12 - On/off button for "Clicks"; 13 - On/off button for the device backlight; 14 - Button of a single recording of measurement results in the device "Register", 15 – Button for the removal of all entries from the "Register", 16 - Number of entries in the "Register "; 17 - Button for the selection of intervals of automatic recording of results in the "Register", 18 - Button for the completion of program Control.exe.

Fig. 6. User menu

3.2.2 Set the date and time on the device. This can be done both manually and automatically by pressing 3 (Fig. 6) "Set the date and time from the PC." The time and date, installed on the PC, will be installed on the device.

3.2.3 Select the desired measurement mode ("**GAMMA**", "**DOSE**", "**ALPHA**", "**BETA**" or "**SEARCH**") by pressing 4 (Fig. 6).

3.2.4 For automatic subtraction of the background put a tick in box 10 (Fig. 6). The subtracted value will be displayed in the window next to the tick, and the measured value in box 5 (Fig. 6) becomes equal to zero.

NOTE! For a correct measurement of the background, place the device at a distance of 1 meter from the surface of the walls and floor. Expose the instrument to achieve the statistical margin of error of not more than 10%.

3.2.5 Set the desired signaling threshold for the selected measurement mode in window 9 (Fig. 6) and press Enter. At the same time under the right analog scale will be the same value as in box 9.

WARNING! WITH AUTOMATIC SUBTRACTING BACKGROUND THE SIGNALING THRESHOLD DOES NOT CHANGE.

3.2.6 Set the desired interval (30, 60 or 120 sec) of the periodicity of the speech sound of measurement results with button 11 (Fig. 6).

NOTE! The speech sound of the measurement results carried out only in the measurement mode "**GAMMA**".

3.2.7 To enable the audio signals - "clicks", as well as the backlight place a tick in box 12 and 13, respectively (Figure 6).

3.2.8 Set the desired interval (1, 5 or 30 minutes) of the periodicity of automatic recording of measurement results into the device register with button 17 (Figure 6).

3.2.9 Additional single measurement result is recorded in the device register with button 14 (Figure 6).

3.2.10 In case of the maximum number of entries in the measurement register (2000 records), clear the history by pressing button 15 (Figure 6). After pressing button "Clear register" a check request to delete records "Clear register?" will appear. In case of confirmation, all entries will be deleted.

WARNING! DELETED RECORDS ARE NOT FOR RECOVERY. IF NECESSARY, PRE-COPY THE DATA IN THE PC MEMORY.

3.2.11 Window 15 (Figure 6) shows the current number of entries in the device.

NOTE: BEFORE YOU CLICK "EXIT" ALL SETTINGS ARE STORED IN THE PC RAM. IF THE UNIT POWER WILL BE OFF BEFORE PRESSING THE "EXIT" BUTTON, THEN THE PARAMETERS, SET IN THE USER MENU, WILL NOT BE SAVED!

3.2 Viewing the register of measurements

3.2.1 Connect the device to a PC using the supplied USB cable. After 1-5 seconds the PC operating system (Windows XP and above) will find it. In "My computers" section a new removable drive will appear. You will see the register file - «DIARY.HTM» see Fig. 7.

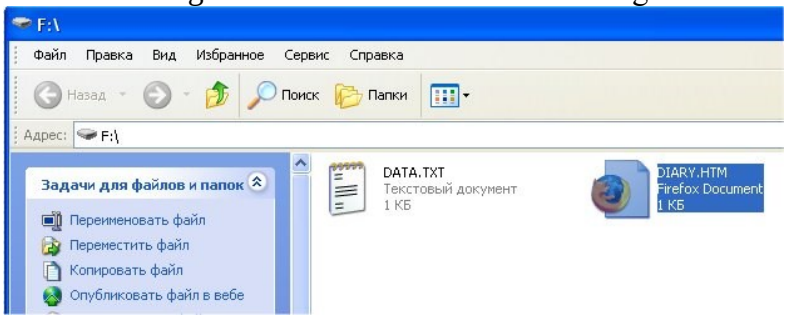
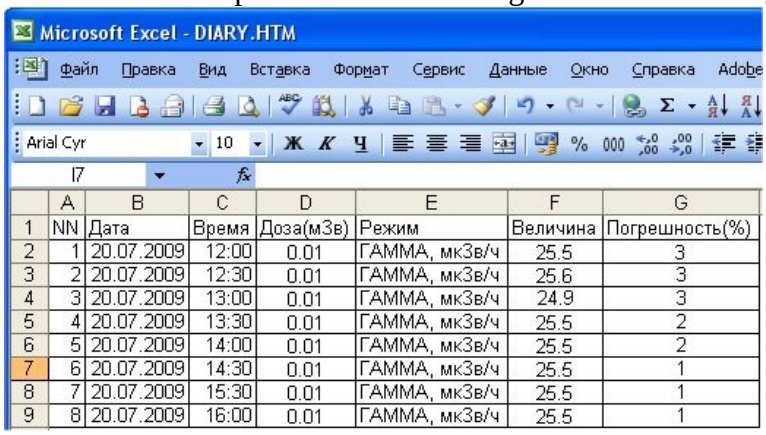


Fig. 7. A fragment of the history of recording dose rate measurements in the register

This file is available only for reading. Open the file using EXCEL. The PC screen displays a table where each row represents one of the register entries. see Fig. 8.



	A	B	C	D	E	F	G
1	NN	Дата	Время	Доза(мЗв)	Режим	Величина	Погрешность(%)
2	1	20.07.2009	12:00	0.01	ГАММА, мкЗв/ч	25.5	3
3	2	20.07.2009	12:30	0.01	ГАММА, мкЗв/ч	25.6	3
4	3	20.07.2009	13:00	0.01	ГАММА, мкЗв/ч	24.9	3
5	4	20.07.2009	13:30	0.01	ГАММА, мкЗв/ч	25.5	2
6	5	20.07.2009	14:00	0.01	ГАММА, мкЗв/ч	25.5	2
7	6	20.07.2009	14:30	0.01	ГАММА, мкЗв/ч	25.5	1
8	7	20.07.2009	15:30	0.01	ГАММА, мкЗв/ч	25.5	1
9	8	20.07.2009	16:00	0.01	ГАММА, мкЗв/ч	25.5	1

Fig. 8. A fragment of recording of the history of dose rate measurements in the register.

Conduct the necessary review of records in the measurements register.

3.3. Finishing of operations with PC

- Power off the instrument (see 1.4.3)

- Disconnect the USB cable from the instrument

NOTE: If there is no connection with the instrument the message will appear on a PC monitor, see Fig. 10.

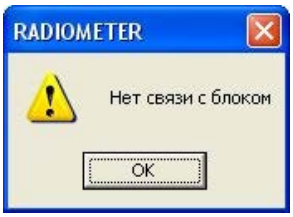


Fig. 10 The dialog box

4. MAINTENANCE

4.1 Safety measures

4.1.1 Prior to start working with the instrument the personnel shall study carefully the present operation manual.

4.1.2 It is forbidden to open the instrument or to perform repairs since the high voltage power supply (about 400 V) counter is inserted inside it. Thus for repairs the instrument shall be sent to the manufacturer.

4.1.3 Control source of beta radiation that is included in instrument's delivery set is located in a plastic bag. The control source is safe to work because its total activity of ^{90}**Sr** + ^{90}**Y** radionuclides is significantly (approximately 100 times) less than the lower limit of the regulation referred to in the table of Annex П-4 НРБ-99/2009. In accordance with НРБ-99/2009 such sources are exempt from regulation.

WARNING! KEEP THE STICKER ON THE CONTROL SOURCE. DO NOT BREAK THE AIRTIGHTNESS OF CONTROL SOURCE. WHEN THE AIRTIGHTNESS OF CONTROL SOURCE IS BROKEN, CONTACT LOCAL AUTHORITIES OF STATE SANITARY INSPECTION.

4.2 Maintenance procedure

4.2.1 The instrument maintenance is performed to assure its serviceability during operation and executed by the personnel, working with the instrument, observing safety measures as per paragraph 4.1.

4.2.2 Preventive works, performed during maintenance includes the check of completeness, examination of the instrument appearance and check of its operability.

4.2.3 Check of the instrument completeness assumes its compliance with paragraph.6.1.

4.2.4 When examining the instrument appearance make sure that there are no chips and cracks on the instrument case that inscriptions on controls are clear, and also that the shielding grid and the detector thin input window are integral.

5. CALIBRATION METHODS

Calibration methods are developed in accordance with requirements of RMG 51 - 2002, apply to the personal dosimeter-radiometer MKC-03CA and establish methods and means of their initial and periodic calibration.

5.1 Calibration operations

The following operations as shown in Table 2 should be carried out at calibration.

Table 2

Operation name	Number of points the user guide	Operations at	
		initial calibration	periodic calibration
1. Visual inspection	5.5.1	yes	yes
2. Testing	5.5.2	yes	yes
3. Determination of instrument basic error	5.6.2 5.6.3	yes	yes
4. Determination of natural background	5.6.1	yes	no
5. Determination of instrument readings from control source	5.6.4	yes	yes

5.2 Calibration instruments

The following calibration instruments, specified in the Table 3, should be applied during calibration.

Table 3

Name of calibration instrument	Symbol	Symbol of standard	Note
Calibration dosimeter gamma radiation instrument	CDGRI-1M	GOST 8.081-2000	Working standard I or II level, sources: ^{137}Cs
Beta-particles source $^{90}Sr+^{90}Y$	5CO	TU 95.477-83	Working standard II level 5CO133
Control source	СНЖА.41215 2.003 ПС		
Note – other instruments and equipment with the same parameters can be also used.			

Additional calibration means are protective lead blocks the type BS – 50 dimension 100x100x50 mm to determine the proper background of dosimeters in the lead shielding.

5.3 Calibration terms and preparation to it

Normal conditions in accordance with GOST 27451 under the natural background radiation up to 0.25 mSv/h shall be maintained during calibration.

During calibration there should not be extraneous sources of ionizing radiation creating the external background that is more than half value of the natural background.

Preparation of calibrated instrument to work should be carried out in accordance with requirements set out in the relevant section of the dosimeter user guide.

5.4 Safety requirements

Persons engaged in instrument's calibration should be trained and certified as calibrators and should be familiar with the instrument manual SNZHA.412152.003 RE.

All works with sources of ionizing radiation should be conducted in accordance with set safety requirements: "Main sanitary rules of radiation safety OSPORB-99", "Radiation Safety Standards RSS-99/2009", "Inter-sectoral regulations on labor protection (safety) for operation of electrical installations" LPO RM - 016 - 2001 (RD 153 - 34.0 – 03.150 - 00), "Rules of technical operation of electrical installations", approved by the Ministry of Energy of the Russian Federation No. 6 of 13.01.03.

5.5 Calibrations

5.5.1 Visual inspection

During visual inspection of instrument state make sure that there are no chips or cracks on the instrument, inscriptions at controls are clearly seen as well as protective grid and thin input window of the detector are safe.

5.5.2 Testing

When testing the instrument operation of controls should be checked in accordance with the manual and the instrument should be tested.

5.5.2.1 Inspection of the instrument that has no control sources should be done in accordance with p. 2.8 СНЖА.412152.003 РЭ.

If the resulting value of the dose rate measured in normal conditions lies in the range from 0.1 to 0.3 mSv/h, the instrument is suitable for use. Otherwise it is subject to additional inspection or repair.

5.5.2.2 Inspection of the instrument that has a control source should be done in the following order:

- Turn the unit into the "**BETA**" mode and place it in the area of upcoming measurements;
- When statistical error is not more than ±10%, record background readings of the instrument by open detector $N_{ф}$, particles per minute in a square centimeter;
- Place the control source under the center of the detector's input window;
- When statistical error is not more than ±5%, record total readings of the instrument from the control source together with the background $N_{к+ф}$, particles per minute in a square centimeter;
- Remove the control source and place it on a regular place of storage;
- Determine the value of instrument readings from the reference source, $N_{к}$, particles per minute in a square centimeter, according to the formula

$$N_{к} = N_{к+ф} - N_{ф} \qquad (3)$$

- Compare the measured value $N_{к}$ with the value $N_{ко}$ given in the instrument calibration certificate according to the formula

$$\delta = \left| \frac{N_{к} - N_{ко}}{N_{ко}} \right| 100 \qquad (4)$$

If the resulting value δ is within ±20% then the instrument is suitable for use. Otherwise it is subject to additional inspection or repair and subsequent calibration.

5.6 Definition of the basic error

Periodic calibration is to determine the basic relative error of the instrument at certain levels of measured values in the dose rate and beta-particles flux density measurement mode.

All measurements of the same type should be conducted at least five times and the average measured value should be determined by their results.

During calibration record of information on measured values from the calibrated instrument is made with statistical error of less than ±3% for value of basic measurement errors listed in РЭ of this product.

5.6.1 Determining the level of natural background.

During initial calibration as well as at calibration after repairs involving replacement of the counter "BETA-5" the level of natural background is determined. Determining the level of natural background is made by placing the instrument in a lead shield with a wall thickness not less than 50 mm in "**BETA**" and "**GAMMA**" modes.

5.6.2 Determining the basic relative error by gamma-radiation.

Determining the basic relative error by gamma-radiation is made in the "**GAMMA**" mode by MI 1788-87 methods for calibration gamma units with ^{137}**Cs** sources at three values of the dose rate that are 0.1, 0.5, 0.8 respectively of the upper limit of the measuring range;

Calibration in the dose measurement mode is not carried out. Compliance with the basic relative error in the dose measurement mode is provided by instrument calibration in the dose rate measurement mode and instrument schematics.

5.6.3 Determining the basic relative error by beta-radiation.

Determining the basic relative error by beta-radiation is made in the "**BETA**" mode according to methods of GOST 8.040-84 for exemplary source of ^{90}**Sr +**^{90}**Y** type 5SO133-working standard II digit.

5.6.4 Documenting calibration results.

Certificate of calibration is issued for calibrated instrument.

Validity of certificate of calibration:

- one year, if there is no controlling source in the instrument delivery set;
- two years, if there is controlling source in the instrument delivery set (as evidence of calibration the value of instrument reading from the controlling source in "**BETA**" and "**GAMMA**" modes with an open counter window shall be added).

The instrument that has not passed the calibration is subject to regulation or repair with subsequent submission for calibration. If it is impossible to repair the instrument a notice of unfitness shall be issued.

6.1 Completeness

Completeness of the instrument is shown in the Table 4.

Table 4

Name	Symbol	Quantity, pc.
1 Dosimeter-radiometer МКС – 03 СА	СНЖА.412152.003	1
2 Power supply element of AA “DURACELL”	LR6	2
3 Control source ^{90}**Sr+**^{90}**Y***	-	1
4 Operation manual	СНЖА.412152.003 РЭ	1
5 Calibration certificate	-	1
6 Packing box	-	1
7 The power supply (adapter) *	AC – 220 – S – 3 - 500	1
8 Connection cable, 1.8 m *	USB2.0 A/mini B 5P	1
9 Petri dish*	Standard, 90×14 mm	10
* Delivery of products according to paragraphs 3, 7- 9 is performed by additional requirement of the Consumer		

6.2 Service life, storage and warranty

6.2.1 The average time of instrument storage is 6 years.

6.2.2 The average lifetime of the instrument is 10 years.

Upon expiry of the specified period, the instrument application can be prolonged provided it has been subjected to the heavy overhaul to be performed by the enterprise-manufacturer (hereinafter – Manufacturer).

The Manufacturer's address is given in sec. 4.4 (acceptance certificate).

6.2.2 The Manufacturer warrants that the instrument is operating during the average service period provided the User observes operation, transportation and storage regulations established in this operation manual.

The warranty period of the instrument storage is 6 months of the date of the instrument acceptance (refer to acceptance certificate).

The warranty period of the instrument operation is 24 months of the date of the primary calibration (when the instrument is delivered to the User directly by the Manufacturer) or of the date of purchase (when the instrument is sold through the trade network).

The time period when the instrument has been under the warranty repairs is not included in the preset warranty period.

ATTENTION! CLAIMS ARE NOT ACCEPTED AND THE WARRANTY REPAIRS DO NOT COVER INSTRUMENTS THAT HAVE BEEN SUBJECTED TO NEGLIGENCE CAUSING DAMAGE TO THE DETECTOR INPUT WINDOW, INDICATOR, CASE, AND WHICH SEALS HAVE BEEN DISTURBED OR ABSENT THAT.

6.3 Data on precious and ferrous metals content

6.3.1 There are no precious metals on the printed board in components.

6.4 Utilization

6.4.1 At the end of the average lifetime of the instrument supplied power sources that are not suitable for further use should be treated as radioactive waste, written off and surrender to the burial in consultation with local authorities of State Sanitary Inspection (e.g. to regional offices or special plants of NPO "Radon" or other authorized organizations).

A copy of the acceptance certificate for disposal of sources is transmitted to bodies of State Sanitary Inspection and bodies of internal affairs.

6.5 Acceptance certificate

6.5.1 Dosimeter-radiometer МКС– 03СА serial number _____ was manufactured and accepted in accordance with specifications ТУ 4362-003-42741182-2010 (СНЖА.412152.003 ТУ) and recognized serviceable for operation.

Responsible for acceptance

_____ _____

(signature) (surname, initials)

_____

(date)

Head of the enterprise

_____ N.N.Vonsolvskiy

(signature)

Stamp

Appendix A

METHODOLOGY

of rapid radiometric determination of specific activity of
beta-emitting radionuclides in samples of food products
with a dosimeter-radiometer MKC-03CA

1 Purpose and Scope

1.1 This methodology is designed for rapid radiometric determination of the specific activity of radionuclides in samples of foods for beta-radiation using a dosimeter-radiometer MKC-03CA (the dosimeter).

1.2 The methodology is intended for the use with the specified device, adjusted, and tested in accordance with its technical documentation, with the use of standard plastic Petri dishes, with the volume of 75 ml. (See Fig. 10).

Figure 10. The general form of a plastic Petri dish.

3 The methodology is used for measuring samples with a specific activity of 100 to 2 • 10^5Bk/kg.

1.4 The methodology is used for measuring the specific activity of environmental samples with a density of 0.5 to 1.5 g/cm^3.

1.5 The calibration of the dosimeter is made for a plastic Petri dish with a nominal sample volume of 75 ml using the working standard of the second class simulant of bulk samples with a density of 1 g/$sm^{3\ for}$ radionuclides $^{90}Sr+^{90}Y$ (predominant in the affected areas after radiation accidents), certified in the Federal State Unitary Enterprise "VNIIFTRI." The manufacturer can produce a gradation of the dosimeter for various radionuclides and samples of different densities for an additional contract with the consumer.

2 Sampling and preparation for measurements

2.1 Sampling is produced from a homogeneous batch of products in quantities of 200 up to 500 g. The samples, selected for the study, are packed in a dry, clear of radiation packaging (cellophane, polyethylene, parchment, glass or plastic bowl).

2.2 Samples of foods are subject to processing, identical to the one, applied to them in the first stage of cooking.

Root vegetables are washed in running water. Inedible cabbage leaves are removed. Food greens, berries, fruits are washed in running water. Meat and fish are cleaned, the fish scales and entrails are removed, the layer of wax is removed from cheese. Prepared foods are ground with a grinder, grater, etc.

Samples of flour, tomato paste, sour cream, mustard and other finely ground materials are mixed in their containers, and then shifted into a Petri dish. Preparations of liquid samples are prepared immediately before measurement.

Solid fats, meat, etc. are placed on a cutting board and using a knife or scalpel a sample of cylindrical shape with dimensions corresponding to the diameter and depth of a Petri dish is cut.

To obtain more precise information about the content of radioactive substances it is recommended to prepare three identical density preparations from one sample, paying attention to the fact that the thickness of the substance, placed in the Petri dish, was identical.

The prepared sample is sealed with a tamper, the surface layer is leveled at 1-2 mm from the edges of the Petri dish, supplied with the MKC-03CA, covered with a thin plastic film (the recommended film thickness is of not more than 50 mm, see figure 11).

Weigh the prepared sample m, kg, net weight of the petri dish.

NOTE: The weighing is produced with the accuracy of up to ± 0,001 kg.

Figure 11: General view of a Petri dish with a sample

After sample preparation, you can begin to measure the specific beta activity of preparations, using the dosimeter.

NOTE: In order to obtain statistically reliable results, the time measurements of the sample is 30 min.

3 Radiometric determination of the specific activity of beta-emitting radionuclides in samples

3.1. Measurements:

- Remove the screen from the back side of the device;
- Switch on and set the operating mode "SEARCH";
- Switch the device mode measurements of total flux with a long push of button ▶, while in the lower right corner of the device display symbol Σ will be shown.
- Place the device on the desktop, so that the prepared sample was at least 1 m from the device. Perform one measurement of the background **Ff**, min^{-1}. Upon reaching the statistical error of 2% secure the device readings (the background measurement time can be up to 30 min);
- Place the device directly on the cup with the prepared sample (see fig. 12.), so that the middle of the detector window was located over the center of the cup. By pressing button ▶ reset the readings. Perform measurement of the flux density of beta-particles from the surface of the prepared sample $\mathbf{F_{\beta+f}}$, min^{-1}. Upon reaching the statistical error of ± 2% secure readings (time of the sample measurement can reach up to 30 min);

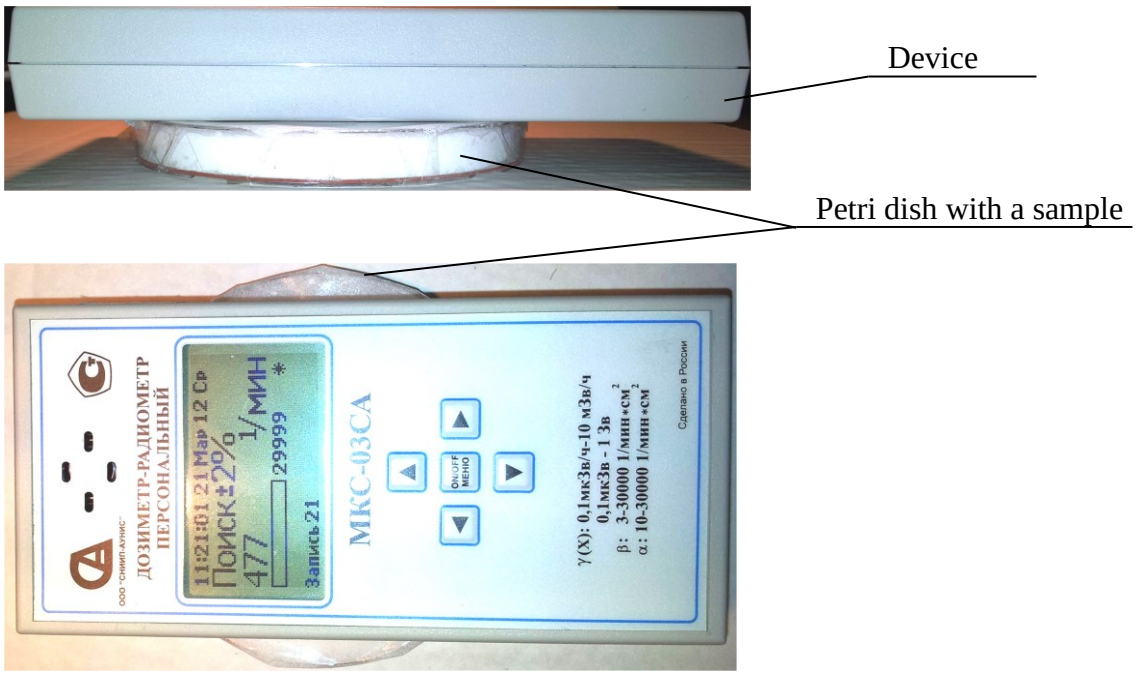


Figure 12. The position of the device and the controlled sample during the measurement.

NOTE: The current value of the statistical error is displayed in the upper right corner of the display. With the accumulation of pulses the measurement error decreases.

- Calculate the value of the measured total specific beta-activity of the sample A_Σ, Bq/kg, according to formula 5:

$$A_\Sigma = 3{,}2\frac{\left(\Phi_{\beta+\phi} - \Phi_\phi\right)}{m}, \qquad (5)$$

where - m, the mass of the sample, kg.

3,2 - sensitivity coefficient, Bq · min.

- Compare the obtained value of the specific activity of the sample with the local norms of the content of radionuclides.

3.2 Correction for the content of ^{40}**К** in the controlled samples.

This Methodology provides the possibility to take into account the contribution of ^{40}**К** natural activity to the total specific activity of the sample. Accounting for this factor is required when the measured specific activity is close to the regulated allowable level of contamination, as well as in controlling products and samples that are characterized with the high content of ^{40}**К**, which is important when deciding on the grading of the product.

The value of the measured specific activity of sample A, Bq/kg, with a correction that takes into account the contribution of ^{40}**К**, is determined by formula 6:

$$A = A_\Sigma - A_к, \qquad (6)$$

where $A_к$ - specific activity of ^{40}**К** in the measured sample, Bq / kg (the value from the reference table or radiological handbook).

3.3 Measurement results processing

3.3.1 In implementing the recommendations of this methodology the error in determining the specific activity of the sample is limited with the main error of the dosimeter and amounts to:

- Not more than ± 50%, at levels from the bottom of the measurement range up to triply exceeded one, which is the range of 100 to 300 Bq/kg;
- Not more than ± 30%, in the rest of the measurement range.

NOTE: The given values of the basic relative error are regulated for normal measurement conditions.

3.3.2 In the event of exposure to the dosimeter with climatic, electromagnetic, mechanical and other destabilizing factors, beyond the normal laboratory conditions, there are additional errors, the limit values are given in the manual for the dosimeter.

Table 5

The stable potassium and ^{40}К content in basic foods*

Product group	The content of stable potassium, g/kg	Average specific activity of ^{40}К, Bq/kg
Milk	1.50	44.40
Meat, Beef	3.45	102.12
Poultry	3.50	103.60
Eggs	1.50	44.40
Cheese	2.00	59.20
Fish	3.00	88.80
Corn, barley	4.55	134.68
Flour	2.50	74.00
Grits, oatmeal	3.00	88.80
Pasta	1.90	56.24
Bread, rye	2.10	62.16
Potatoes	5.70	168.72
Vegetables	2.90	85.84
Fruit	2.60	76.96
Mushrooms	4.50	135.00
Tea	25.00	740.00
Coffee	1.60	480.00
Berries	3.75	111.00

* The data are taken from "Methodology of rapid determination of the volumetric and specific activity of beta-emitting radionuclides in water, food, vegetation and soil by the "direct" measurement of "thick samples", approved by the Deputy Chairman of USSR Gosstandart D.I. Mehanikov, Deputy Chairman of the State Agricultural Committee of the USSR N.M. Zaichenko and Ch. Medical Officer of the USSR P.N. Burgasov.