# MKS-07 "POSHUK"

# SEARCH GAMMA, BETA RADIATION DOSIMETER-RADIOMETER

Technical Description and Operating Manual
BICT.412129.003-02 TO

**Dear user,**

You had chosen well if purchased a device of ECOTEST trademark manufactured by the "Sparing-Vist Center". The unit will reliably operate during many years. Should you have any questions concerning its use, please, contact our managers by telephone **+38 (032) 242-15-15**, fax **+38 (032) 242-20-15** or **e-mail sales@ecotest.ua**.

We would greatly appreciate to receive your comments on its operation. The device is under 24-month (free of charge) guarantee maintenance.

Best regards,

International Sales Department.

CONTENTS

## 1 GENERAL GUIDELINES

1.1 Technical description and operating manual (hereinafter referred to as the OM) is intended to inform the user about the principles of operation and rules of application of MKS-07 “POSHUK” search gamma, beta dosimeter-radiometer. The manual contains all information necessary for proper operation of the dosimeter and full implementation of its technical possibilities.

1.2 The OM contains the following abbreviations:

DE - ambient dose equivalent H*(10) of photon ionizing radiation;

DER - ambient dose equivalent rate H*(10) of photon ionizing radiation.

## 2 PURPOSE OF USE

The MKS-07 “POSHUK” search gamma, beta dosimeter-radiometer (hereinafter referred to as the dosimeter) is designed to measure ambient dose equivalent (DE) and ambient dose equivalent rate (DER) of gamma and X-ray radiation (hereinafter referred to as photon ionizing radiation), and surface beta particles flux density.

The dosimeter is intended for dosimetry and radiometry control at industrial enterprises, nuclear power plants, and research establishments. The unit can be used to monitor radiation contamination of residential premises, buildings and structures, the adjacent territory, household items, clothing, the surface of the soil in homesteads, and vehicles.

## 3 TECHNICAL SPECIFICATIONS

3.1 Specifications are presented in the Table 3.1

Table 3.1 – Specifications of the dosimeter

| Name | Unit of measurement | Standardized values according to the specification |
|---|---|---|
| 1 | 2 | 3 |
| Measurement range of photon ionizing radiation DER | μSv/h | $0.1 – 2.0 \cdot 10^6$ |
| Main relative permissible error limit of DER measurement with 0.95 % confidence probability:<br>- in precise measurement mode<br>- in search mode | % | $15 + \frac{2}{\dot{H}^*(10)}$<br>$25 + \frac{2}{\dot{H}^*(10)}$,<br>where $\dot{H}^*(10)$ – is a numeric value of measured DER in μSv/h |
| Measurement range of photon ionizing radiation DE | mSv | 0.001 - 9999 |
| Main relative permissible error limit of DE measurement (DER from 0.1 to $1.0 \cdot 10^4$ μSv/h) with 0.95 % confidence probability | % | ±15 |
| Energy range of detected photon ionizing radiation | MeV | 0.05 – 3.00 |
| Anisotropy of gamma radiation detecting units at 0.66 MeV for:<br>- remote detecting unit (gamma-quantum incidence at 30 to 150° angles relative to the main area of the detectors location), not more than<br>- built-in detecting unit, not more than<br>**Note.** Anisotropy charts for the remote detecting unit from $^{137}Cs$, $^{60}Co$, $^{241}Am$ isotopes are presented in the Annex A | % | ±80<br>±40 |

Table 3.1 (continued)

| 1 | 2 | 3 |
|---|---|---|
| Energy dependence of the dosimeter readings at photon ionizing radiation DER and DE measurement within the preset energy range, not more than | % | ±25 |
| Measurement range of surface beta particles flux density | part./(cm$^2$·min) | $5 – 10^5$ |
| Main relative permissible error limit of surface beta particles flux density measurement with 0.95 % confidence probability:<br><br>- in precise measurement mode;<br><br>- in search mode | % | $15 + \frac{200}{\phi_\beta}$,<br><br>$25 + \frac{200}{\phi_\beta}$,<br><br>where $\phi_\beta$ is a numeric value of measured surface flux density in part./(cm$^2$·min) |
| Energy range of detected beta particles | MeV | 0.15 – 3.00 |
| Operating supply voltage of the dosimeter from the rechargeable storage battery (four AA batteries) | V | 4.8 |
| Additional relative permissible error limit during measurement caused by supply voltage variations from 5.2 to 4.2 V | % | ±5 |
| Additional relative permissible error limit during measurement caused by ambient air temperature variations from -25 to +55 ºC | % per each 10 ºC deviation from 20 ºC | ±5 |
| Time of operating mode setting, not more than | min | 2 |
| Battery life (rechargeable battery of 2700 мAh capacity) at natural background radiation and switched off display backlight, not less than | hours | 400 |
| Unstable readings of the dosimeter during 6 hours of continuous operation, not more than | % | ±10 |

Table 3.1 (continued)

| 1 | 2 | 3 |
|---|---|---|
| Communication interface with the detecting units | | RS-485 |
| Dimensions of the dosimeter's control panel, not more than | mm | 96×35×148 |
| Dimensions of the remote detecting unit of gamma radiation, not more than | mm | 98×38×231 |
| Dimensions of the remote detecting unit of beta particles, not more than | mm | 108×46×171 |
| Weight of the dosimeter's control panel, not more than | kg | 0.4 |
| Weight of gamma radiation remote detecting unit, not more than | kg | 0.5 |
| Weight of beta radiation remote detecting unit, not more than | kg | 0.5 |

3.1.1 Threshold level values of DER and beta particles flux density in the entire operating measurement range are programmed in the dosimeter.

The discreteness of DER threshold level programming is 0.01 μSv/h. The discreteness of threshold level programming of surface beta particles flux density is $0.01\times10^3$ part./($cm^2\cdot$min).

3.1.2 The dosimeter allows automatic subtraction of gamma background when surface beta particles flux density is measured.

3.1.3 The dosimeter allows performing measurement with results averaging time from 1 to 99 min in the precise mode.

3.1.4 The dosimeter allows setting results averaging time from 1 to 99 min in the mode of precision measurement.

3.1.5 The dosimeter sends a single-tone audio signal at detecting gamma quantum or beta particle, and a two-tone audio alarm if the programmed DER or beta particles flux density threshold level is exceeded.

3.1.6 The dosimeter allows saving up to 4096 measurement results of photon ionizing radiation DER or beta particles flux density in the nonvolatile memory, and up to 999 numbers of the studied objects, as well as independent self-recording of dose accumulation history with a 15-minute time interval of photon ionizing DE entries.

3.1.7 The dosimeter allows alternate indication of the history of photon ionizing DER measurements or beta particles flux density on the LCD together with the numbers of the studied objects; and data transmission to the PC database through the infrared port.

3.1.8 LCD is tested when the dosimeter switches on.

3.1.9 The dosimeter displays the fact of DER exceeding the upper limit of measurement range ($1.0 \times 10^4$ μSv/h) during DE measurement.

3.1.10 The dosimeter displays the battery status.

3.1.11 The dosimeter constantly monitors the status of the detectors and in case of their failure gives out the corresponding message.

3.1.12 Mean time to failure – not less than 6000 h.

3.1.13 Average resource of the dosimeter until the first major repair – not less than 10000 h, average life until the first major repair – not less than 6 years.

3.1.14 The dosimeter ensures safe operation under the following conditions:

- temperature from minus 25 to +55 ºC;
- relative humidity up to 100 % at 30 ºC;
- atmospheric pressure from 66 to 106.7 kPa.

3.1.15 The dosimeter is resistant to sinusoidal vibrations according to N1 group of GOST 12997-84 standard.

3.1.16 The dosimeter endures shocks with the following parameters:

- shock pulse duration – from 5 to 6 ms;
- pulse rate – from 40 to 180 per minute;
- number of shocks – 1000±10;
- maximum shock acceleration – 50 $m/s^2$.

3.1.17 The dosimeter endures exposure to constant or alternating magnetic fields of 40 A/m.

3.1.18 The dosimeter in transport container endures:

- environmental temperature from minus 50 to +55 ºC;
- relative humidity up to 95 % at 35 ºC;
- shocks with acceleration of 30 $m/s^2$ and frequency from 10 to 120 shocks per minute (number of shocks - 15000).

3.1.19 The dosimeter endures exposure to photon ionizing radiation with exposure dose rate corresponding to ambient dose equivalent rate up to 200 Sv/h during 5 min or 2.0 Sv/h during 500 min.

3.1.20 The ingress protection rating – is IP51 according to DSTU EN 60529:2018 standard.

## 4 DELIVERY KIT

4.1 The delivery kit consists of units and maintenance documentation presented in the Table 4.1

Table 4.1 - Delivery kit of the dosimeter

| Type | Item | Quantity | Note |
|---|---|---|---|
| BICT.468382.002-02 | Control panel | 1 | |
| BICT.467979.002-02 | BDBG-07 gamma radiation detecting unit | 1 | |
| BICT.467979.003-02 | BDIB-07 beta particles detecting unit | 1 | |
| BICT.304592.001 | Telescopic tube | 1 | |
| BICT.686423.001 | Connecting cable | 1 | |
| BICT.412129.003-02 ТО | Technical description and operating manual | 1 | |
| BICT.412129.003-02 ФО | Logbook | 1 | |
| BICT.412915.036 | Packing box | 1 | |
| | AA type NiMH battery of of 2700 mA·hr capacity (Varta) | 4 | Analogues permitted |
| | Purchased battery charger | 1 | Model is not specified |
| | Swivel holders for detecting units | 2 | Included in the units' kit |

## 5 DESIGN AND PRINCIPLES OF OPERATION

5.1 Overview

5.1.1 The dosimeter kit includes the control panel with a built-in gamma detector used to measure the operator's dose, and remote detecting units of gamma radiation and beta particles.

5.1.2 The control panel serves to perform:

- controlling operating modes of the dosimeter;
- measurement of photon ionizing radiation DE;
- indication of measurement results on the LCD;
- sound alarm;
- saving measurement results in the nonvolatile memory;
- transferring measurement results via IR port to the PC;
- power supply of the detecting units.

5.1.3 The control panel uses the energy-compensated Geiger-Muller counter to measure photon ionizing radiation DE.

5.1.4 The detecting units measure gamma DER, beta particles flux density and provide ready measurement results to the control panel via RS-485 interface.

5.1.5 The BDBG-07 gamma detecting unit consists of two measuring channels – high-sensitive and low-sensitive, which are built based on the energy-compensated Geiger-Muller counters.

5.1.6 The BDIB-07 detecting unit of beta particles is designed on the basis of the scintillation detector.

5.1.7 The dosimeter is controlled with the help of the ON, SCALE, DOSE, THRESHOLD, PRECISELY and MEMORY buttons.

5.1.8 Measurement results are displayed on the LCD.

5.1.9 The dosimeter operates from the storage battery consisting of four AA NiMH batteries. The storage battery is charged from the purchased charger included in the delivery kit.

5.2 Design description

5.2.1 The dosimeter consists of:

- control panel;
- BDBG-07 remote detecting unit of gamma radiation;
- BDIB-07 remote detecting unit of beta particles;
- connecting cable
- telescopic tube;
- swivel holders for detecting units.

5.2.2 The control panel of the dosimeter (Figure 1) is designed as a rectangular parallelepiped with a slant in the upper part and rounded corners on the sides. The control panel includes the case consisting of the base (1), the frame (2) and the cover (3), and other component parts located inside. The main unit in the control panel is the printed circuit board of digital information processing with the energy-compensated Geiger-Muller counter. The cover (3) contains the metrology label - "+" symbol (4), which marks the mechanical center of the Geiger-Muller counter. The display board is fastened to the digital processing board in the top part by the two plates and screws. The LCD (5) is located on the display board. Four light-emitting diodes are used for the LCD backlight. The digital processing and display circuits make up a separate crucial component of the control panel that is screwed to the case with four screws. The battery compartment with the contact system and four nickel-metal hydride AA batteries (NiMH) is located in the middle part of the control panel. The battery compartment is closed by the screwed lid. The HR10A connector (plug) used for cable communication with remote detecting units is located in the lower part of the case. A protective cap is used to protect the connector. Two panels (6, 7), six control keys of the dosimeter, and two special screws (8), used for fastening of the device to the waist-belt, are placed in the top part of the control panel. The IR port window (9) is located on the cover under the panel with the control keys.

The component parts of the case are screwed together by four screws. Rubber gaskets and polyethylene terephthalate films are used to protect the plug connectors, the battery compartment and the control panel from dust and humidity.

**Note**. You may use other types of connectors and dust caps that do not impair the IP degree of protection of the control panel and the detecting units.

5.2.3 The remote detecting unit of gamma radiation BDBG-07 (hereinafter the BDBG-07 unit) is designed as a rectangular parallelepiped with side slants and rounded corners (Figure 2, 3).

The BDBG-07 unit consists of a body formed by a cover (2) and a base (1), as well as other components placed inside it.

To measure gamma radiation, energy-compensated Geiger-Muller counters are used in the detecting unit, which are located behind the cover (2). There is a metrological mark – the "+" symbol (3) on the cover (2), which marks the mechanical center of the counters.

In the lower part of the base, the connector (plug) HR-10A (4) is fixed, which is used for communication with the dosimeter’s control panel by means of a cable.

A spring (5) is fixed in the upper part of the BDBG-07 unit, which fastens the BDBG-07 unit to the belt. In the middle part, a U-shaped swivel bracket (127) is attached to the BDBG-07 unit with two butterfly screws (6). A holder (8) is attached to it, to which a telescopic tube is fixed (Fig. 4).


Figure 1 – Control panel

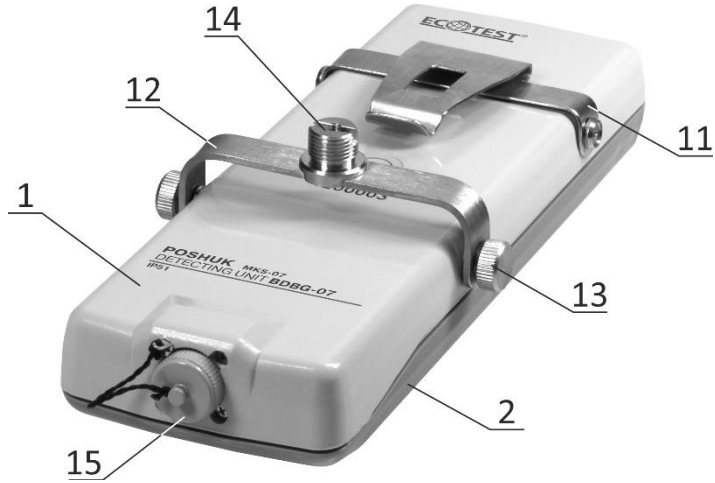


Figure 2 - BDBG-07 unit
(top view)

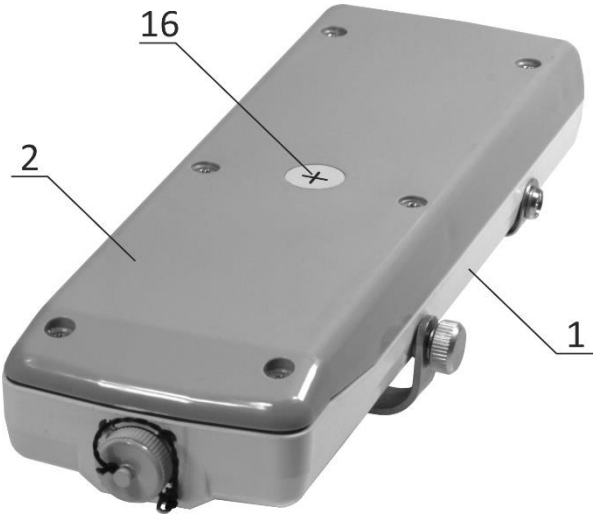


Figure 3 – BDBG-07 unit
(bottom view)

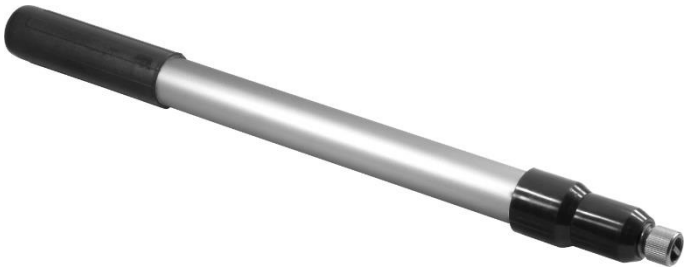

Figure 4 – Telescopic tube

5.2.4 The remote detecting unit of beta particles BDIB-07 (hereinafter referred to as the BDIB-07 unit) is designed as a rectangular parallelepiped with side slants and rounded corners (Figure 5, 6).

The BDIB-07 detecting unit includes the case consisting of the base (1) and the cover (2), and other component parts located inside. In the lower part of the base, the connector (plug) HR-10A (3) is fixed, which is used for communication with the dosimeter's control panel using a cable. A detector window (4) measuring 50 mm × 72 mm is provided in the cover (2), behind which the beta particle detector is located.

The beta particle detector is built on the basis of a 50 mm × 70 mm plastic scintillator. Light pulses from the scintillator are registered by two silicon photomultipliers.

To protect the detector from dust and moisture, a transparent polyethylene terephthalate film is used, which is placed between 2 protective grids.

In the non-working state, the detector window is covered by a removable filter panel (5). The filter panel is fixed in the cover by two fasteners, one of which is movable. The filter panel is removed when working with the BDIB-07 unit by pressing the latch down.

In the middle part, a U-shaped swivel bracket (6) is attached to the BDIB-07 unit with two butterfly screws (7). A holder (8) is attached to it, to which a telescopic tube is attached (Fig. 4).


Figure 5 – BDIB-07 unit
(top view)


Figure 6 – BDIB-07 unit
(bottom view)

5.3 Basic operation of the dosimeter

5.3.1 The dosimeter is switched on by pressing ON and holding it down for 4 s. This turns on the control panel and starts testing the dosimeter's LCD. As soon as the LCD is tested, the dosimeter begins measuring photon ionizing radiation DE. DE is measured by counting a total number of pulses from the output of the energy-compensated Geiger-Muller counter built-in the control panel.

DE is measured and measurement results are saved in the nonvolatile memory continuously and irrespective of the dosimeter's mode and the type of the detecting unit connected to the control panel. DE measurement results are displayed on the LCD of the dosimeter only when you press the DOSE button.

5.3.2 If one of the detecting units is connected to the control panel, the latter feeds voltage to the detecting unit and switches to the measurement mode of photon ionizing radiation DER or surface beta particles flux density (depending on the connected detecting unit). In this mode, the control panel sends queries to the detecting unit and the detecting unit measures and transmits measurement results to the control panel. RS-485 interface is used for exchange between the control panel and the detecting unit. Measurement results are displayed on the LCD of the dosimeter and can be saved in its nonvolatile memory.

5.3.3 Content of the dosimeter's nonvolatile memory can be transferred to a PC via the IR port. The control panel uses the IrDA-transceiver for this purpose. The PC controls the communication process.

## 6 LABELING AND SEALING

6.1 The trademark, the name, the symbol of the unit, IP51 ingress protection rating and the approval pattern of the measuring instrument are inscribed on the control panel of the dosimeter.

The cases of the detecting units contain the trademark, the name, the symbol and IP51 ingress protection rating.

6.2 The factory serial number and the date of manufacture are inscribed in the bottom of the control panel case and the middle and top parts of the detecting units' cases.

6.3 Sealing is done by the manufacturer using N1 paste in the pockets for fastening elements. Special film seals may be also used: in the bottom part of the control panel case under the storage battery so that the seal covers the pockets for the fastening screw head, and in the detecting units – between the base and the cover.

6.4 Removal of the seals and repeated sealing is done by the manufacturer after repair and verification testing.

## 7 GENERAL INSTRUCTIONS FOR USE

7.1 Check if the delivery kit is complete before putting the dosimeter into operation. Inspect for mechanical damage.

7.2 Before using the dosimeter that was put in prolonged storage, remove it from storage and check its operability.

7.3 Register the removal from storage and putting the dosimeter in operation in the logbook.

## 8 SAFETY MEASURES

8.1 The dosimeter complies with the requirements of DSTU 7237:2011 in terms of protection from electric shock of Class III safety according to DSTU EN 61010-1:2014 standard.

A special protection jacket is used to protect from accidental contact with conductive parts. The ingress protection rating is IP51 according to DSTU EN 60529:2018 standard.

8.2 The dosimeter belongs to fire safety equipment in compliance with GOST 12.1.004-91 and GOST 12.2.007.0-75.

8.3 You should comply with the local radiation safety requirements while working with ionizing radiation sources.

In case of contamination, the dosimeter should be deactivated. Wipe its surface by a gauze tampon moistened by the standard decontaminating agent.

## 9 PREPARATION FOR OPERATION

9.1 Preparation of the dosimeter for operation

9.2 Study the operating manual and the control buttons before putting the dosimeter in operation.

9.3 Open the battery compartment of the control panel with the help of a screw driver. Make sure the four batteries are inserted, the connections are reliable, and there is no leakage of salts after the long-term storage of the dosimeter. In case there is a salt leakage, remove the batteries. Clean them if possible, or replace if not. Insert the batteries and close the lid.

9.4 If the battery needs to be recharged, which is indicated by the battery discharge symbol on the LCD (all four battery symbol segments are blinking), remove the batteries from the battery compartment and recharge them using the charger. The recharge procedure is described in the guidelines included in the charger kit.

Insert the charged batteries into the battery compartment observing the polarity and close the lid.

**Note. The storage batteries should be recharged only after the low battery symbol appears on the LCD of the dosimeter.**

9.5 Connect the necessary remote detecting unit to the dosimeter with the help of the connecting cable through the X1 connector in the lower front part of the control panel of the dosimeter.

## 10 OPERATION PROCEDURE

10.1 The dosimeter operates within the following modes:

- switching the dosimeter on/off;
- switching display backlight on/off;
- switching signaling of the detected gamma quanta or beta particles on/off;
- photon ionizing radiation DER measurement in search and precise modes;
- beta particles flux density measurement in search and precise modes;
- audio alarm threshold levels viewing and programming;
- viewing photon ionizing radiation DE measurement result;
- viewing and setting measurement results averaging time for precise mode, and viewing statistical error of measurement results;
- recording measurement results and characteristics of the studied objects in the nonvolatile memory;
- viewing measurement results history on the personal LCD;
- communication of the measurements history to the PC through the infrared port of data exchange (IRDA).

**Note.** The type of the remote detecting unit is identified automatically after being connected to the dosimeter. The dosimeter enters the measurement mode of the corresponding physical units (photon ionizing radiation DER or beta particles flux density).

10.2 **Switching the dosimeter on/off**

10.2.1 Press shortly the ON button and hold it for 4 s to switch the dosimeter on. Self-testing of the LCD, which takes place for about 5 s, shows that the dosimeter is on. As soon as testing is finished, the dosimeter starts measuring photon ionizing radiation DE and switches to the search mode of measurement of photon ionizing radiation DER or surface beta particles flux density (depending on the type of the connected remote detecting unit).

If no detecting units are connected to the control panel, the LCD of the dosimeter will display "----"characters and the dosimeter will measure only photon-ionizing radiation DE.

10.2.2 Press the ON button once again and hold it pressed for 4 s to switch the dosimeter off.

10.3 **Switching display backlight on/off**

10.3.1 Press shortly the SCALE button to switch the display backlight on for 8 s. The display backlight is switched off automatically in 8 s.

10.3.2. To activate continuous display backlight hold the SCALE button pressed for 4 s. Its repeated blinking will point to activation of continuous display backlight.

10.3.3 Press shortly the SCALE button once again to switch the display backlight off.

10.4 **Switching signaling of gamma quanta or beta particles detection on/off**

10.4.1 Audio signaling of detected gamma quanta or beta particles (depending on the type of the connected remote detecting unit) is switched on automatically after the dosimeter is turned on. Every detected gamma quantum or beta particle is followed by a short audio signal.

10.4.2 Press shortly the ON button to switch audio signaling off.

10.4.3 Press shortly the ON button once again to switch audio signaling on.

10.4.4 Signaling of the detected gamma quanta or beta particles is used to search for sources of ionizing radiation. When you approach a source of ionizing radiation, the number of detected gamma quanta and beta particles increase along with the number of short beeps. At a certain distance from the source the intermittent beeps will merge into a continuous audio signal – you will not be able to continue searching.

To continue, press shortly the PRECISELY button (dosimeter should work in the search mode). The dosimeter begins signaling not all detected gamma quanta or beta particles, but only every $n^{th}$.

The n number (a signaling divider) is generated so that at a current intensity of ionizing radiation intermittent beeps are produced about once per second. You can continue approaching the source of ionizing radiation.

If ionizing radiation intensity is changed, you may press the PRECISELY button, i.e. recount the signaling divider an unlimited number of times. To reset the divider (n = 1, each registered gamma quantum or beta particle is accompanied by a short audio signal), you must disable and enable signaling by shortly pressing ON.

10.5 **Measurement of photon ionizing radiation DER in search and precise modes**

10.5.1 To measure photon ionizing radiation DER in search or precise modes, connect the BDBG-07 remote unit with the help of the connecting cable to the control panel of the dosimeter.

10.5.2 Switch the dosimeter on. It will operate in the search mode. Place the BDBG-07 unit with its metrological label "+" toward an examined object. In this mode, the dosimeter's LCD will display the following:

- symbol of photon ionizing radiation DER measurement - "γ" (1);
- DER measurement results (2);
- DER measurement result dimension (3);
- battery status symbol (4);
- indicator of instantaneous DER value (5).


Figure 7 – LCD of the dosimeter
(photon ionizing radiation DER measurement in search mode)

Measurement results in the search mode are updated every 2 seconds.

A twenty-segment indicator of instantaneous DER value is intended for fast evaluation of photon ionizing radiation intensity. Integration time during measurement of instantaneous DER value and data update time on the instantaneous value indicator is 500 ms.

An instant DER value is displayed in pseudo-logarithmic scale. The first segment of the indicator is highlighted when DER exceeds 0.09 mSv/h. The higher photon ionizing radiation DER, the more segments are highlighted from left to right. If all segments of the indicator are highlighted, DER is equal to 1.5 Sv/h.

In the search mode, each gamma quantum is followed by a short audio signal, while exceeding of the threshold level is followed by a two-tone audio alarm and periodic blinking of the LCD digits.

The arithmetic average of five last measurements should be considered as the DER measurement result in the search mode.

10.5.3 Press and hold down the PRECISELY button in the search mode to switch to the mode of precision measurement. The digits will blink several times (in about 4 s). Then release the PRECISELY button.

In this mode, the dosimeter's LCD will display the following:

- symbol of photon ionizing radiation DER measurement - "γ" (1);
- current averaging results and DER measurement results (2);
- unit of DER measurement result (3);
- battery status symbol (4);
- indicator of averaging time (5).


Figure 8 – LCD of the dosimeter
(Photon ionizing radiation DER measurement in precise mode)

Current averaging results in the precision measurement mode are updated each 30 seconds. Averaging time can be programmed in the range from 1 to 99 minutes. Averaging time is set equal to 1 min after switching the dosimeter on. Information about viewing and change of averaging time is provided in OM 10.9.

The averaging time indicator shows which part of the specified averaging time has already passed. If the first two and the last segments are highlighted it is indicative of the averaging start, if all segments are highlighted – averaging time completion.

You may forcibly restart the process of averaging. Simply shortly press the PRECISELY button that will reset the previous averaged value and start the new averaging interval.

In the precise mode, each gamma quantum is followed by a short audio signal, while exceeding of the threshold level is followed by a two-tone audio alarm and periodic blinking of the LCD digits.

To exit the mode of precise measurement press the PRECISELY button and hold it down until multiple blinking of digits (in about 4 seconds).

10.6 **Measurement of surface beta particles flux density in search and precise modes**

10.6.1 Connect the BDIB-07 detecting unit with the help of the connecting cable to the control panel of the dosimeter to measure surface beta particles flux density (hereinafter referred to as surface flux density) in the search and precise modes of measurement.

10.6.2 Switch the dosimeter on. It will operate in the search mode. Remove the panel filter from the window and place the BDIB-07 unit so that its window is located in parallel to and at a minimum distance from the surface to be inspected.

**Important!** To consider gamma background in measurement results of surface beta particles flux density you should measure gamma background and save it for further automatic subtraction. Information about measurement and saving of gamma background is provided in OM 10.6.4.

In the mode of surface flux density measurement, the dosimeter's LCD displays the following:

- symbol of surface flux density measurement - "β" (1);
- symbol of gamma background saved for automatic subtraction - blinking "γ" symbol (2);
- surface flux density measurement results (3);
- "$10^3$/cm$^2$·min" unit of measurement (4);
- battery status symbol (5);
- indicator of instantaneous value of photon ionizing radiation intensity and beta particles flux (6).

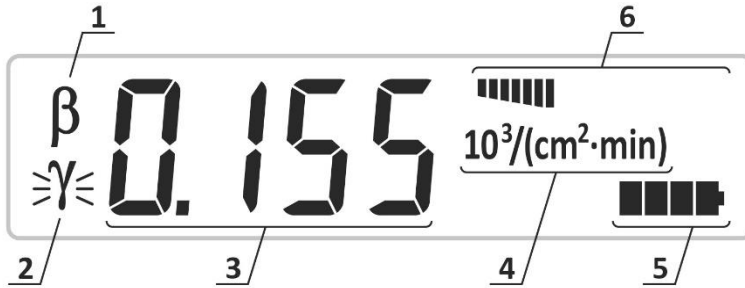


Figure 9 – LCD of the dosimeter
(Surface beta particles flux density measurement in precise mode)

Measurement results in the search mode are updated every 2 seconds.

A twenty-segment indicator of instantaneous DER value is intended for fast evaluation of photon ionizing radiation intensity and beta particles flux density. Integration time during measurement of instantaneous value of photon ionizing radiation intensity and beta particles flux density, as well as data update time on the instantaneous value indicator is 500 ms.

The instant intensity value is displayed in pseudo-logarithmic scale.

In the search mode, each registered gamma quantum or beta particle is followed by a short audio signal, while exceeding of the threshold level is followed by a two-tone audio alarm and periodic blinking of the LCD digits.

The arithmetic average of five last measurements should be considered as the surface flux density measurement result in the search mode.

10.6.3 Press and hold down the PRECISELY button in the search mode to switch to the mode of precise measurement. The digits will blink several times (in about 4 s). Then release the PRECISELY button.

In this mode, the dosimeter's LCD displays the following:

- symbol of surface flux density measurement - "β" (1);
- symbol of gamma background saved for automatic subtraction - blinking "γ" symbol (2);
- current averaging results and surface flux density measurement results (3);
- "$10^3$/cm$^2$·min" unit of measurement (4);
- battery status symbol (5);
- indicator of averaging time (6).

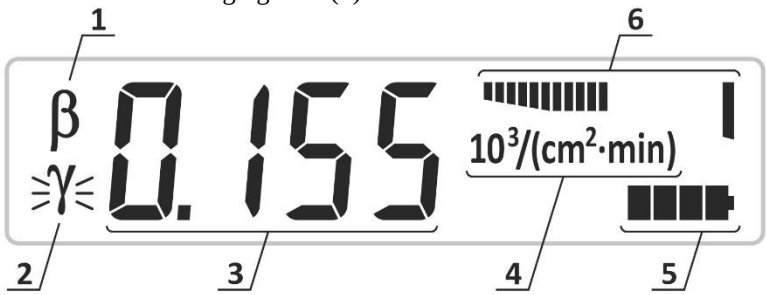


Figure 10 – LCD of the dosimeter
(Surface beta particles flux density measurement in precise mode)

Current averaging results in the precise measurement mode are updated each 30 seconds. Averaging time can be programmed in the range from 1 to 99 minutes. Averaging time is set equal to 1 min after switching the dosimeter on. Information about indication and change of averaging time is provided in OM 10.9.

The averaging time indicator shows, which part of the specified averaging time has already passed. If the first two segments and the last one are highlighted it is indicative of the averaging start, if all segments are highlighted – averaging time completion.

You may forcibly restart the process of averaging. Simply shortly press the PRECISELY button that will reset the previous averaged value and start the new averaging interval.

In the precise mode, each registered gamma quantum or beta particle is followed by a short audio signal, while exceeding of the threshold level is followed by a two-tone audio alarm and periodic blinking of the LCD digits.

To exit the mode of precise measurement press the PRECISELY button and hold it down until multiple blinking of digits (in about 4 seconds).

10.6.4 Measurement of gamma background and saving it for further automatic subtraction in the mode of surface beta particles flux density measurement

To measure gamma background and save it, perform the following operations in the mode of precise measurement of surface flux density:

- place the detecting unit with the closed panel filter so that its window is located in parallel to and at a minimum distance from the surface to be inspected;
- shortly press the PRECISELY button to restart the averaging process;
- wait for the precise measurement completion;
- save the measurement result by pressing DOSE and hold it down for at least 2 seconds.

A blinking "γ" symbol means that gamma background value has been recorded in the memory (see (2) Fig. 10).

Then you can open the beta detector window and perform measurement of surface flux density. Gamma background will be automatically subtracted in the search, and precise mode.

**Note.** Measure and save gamma background of each new object when you change the object of study.

10.7 **Viewing and programming of audio alarm threshold levels**

10.7.1 You can view and program audio alarm threshold level in the search mode of the dosimeter's operation. Press the THRESHOLD button to view the threshold. The LCD will display the current value of the threshold level as long as THRESHOLD is held down, but not longer than 2 s.

Hold the button down for more than 2 s. This resets the previously programmed threshold level, and the dosimeter enters the mode of new threshold level programming, which is indicated by the blinking low-order digit on the LCD. Release the TRESHOLD button as soon as the low-order digit starts blinking.

The digit is blinking to indicate that its value can be programmed. Set the required value with the help of the THRESHOLD button. The value changes per unit due to short presses and releases of THRESHOLD. If you press THRESHOLD and hold it down, the value will be automatically changing, which is stopped after you release the button.

A short press of the MODE button records the value of the blinking digit. It stops blinking and you can change the value of the next digit, which starts blinking. Programming of other digits is done likewise.

After all values are set, a short press of the PRECISELY button saves the new threshold level value in the memory. It is indicated by triple blinking of its new value on the LCD and dosimeter's entering the search mode.

10.8 **Indication of photon ionizing radiation DE measurement**

10.8.1 DE measurement is performed continuously and irrespective of the selected mode of measurement and the type of the connected remote detecting unit.

10.8.2 You can view DE measurement result in the search mode of the dosimeter's operation. Press the DOSE button to view DE measurement result. The LCD will be displaying the current DE value, "γ" symbol and DE measurement units "mSv" as long as DOSE is held down. If DOSE is held down less than 2 s, simply release to return to the search mode.

Hold the button down for more than 2 s. The dosimeter will switch to the mode of continuous display of DE measurement result, which is indicated by triple blinking of DE on the LCD. Then you can release the DOSE. The dosimeter will remain in the mode of continuous display of DE measurement result.

To return to the search mode press DOSE again and hold it down for 2 s until DE measurement result blinks three times.

10.8.3 If a decimal point is blinking when DE measurement result is displayed, this indicates that DER exceeded the upper limit of measurement range ($1.0 \cdot 10^4$ μSv/h) during DE measurement.

10.8.4 To reset the DE measurement result press the MEMORY button and hold it down for 5 s until "clr" symbols appear on the LCD. Then release the MEMORY button and confirm resetting by a short press of the THRESHOLD button. A successful resetting of DE measurement result will be indicated by its triple blinking on the LCD of the dosimeter.

While "clr" characters are displayed on the LCD, you may cancel resetting DE measurement result. Shortly press the PRECISELY button for this purpose. The "clr" characters will disappear from the LCD of the dosimeter.

10.9 **Viewing and setting measurement results averaging time for precise mode, and viewing statistical error of measurement result**

10.9.1 You can view and set measurement results averaging time for the precise mode, and view statistical error of measurement result from the precise mode of the dosimeter's operation. Press and hold down the THRESHOLD button to view the averaging time and the statistical error. In this mode, the dosimeter's LCD displays the following:

- averaging time in minutes (1) – non-blinking digits;
- statistical error in percentage (2) - blinking digits.

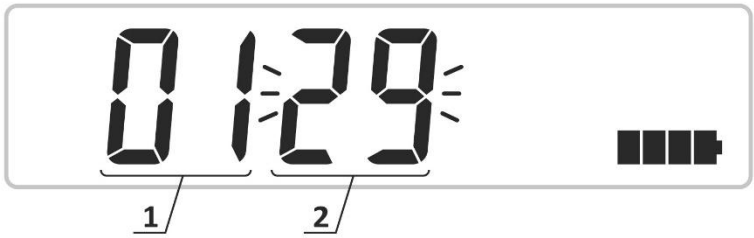


Figure 11 - LCD of the dosimeter
(Viewing and setting measurement results averaging time for precise mode, and viewing statistical error of measurement result)

**Notes**

1 When switched on, averaging time is equal to 1 min.

2 While the statistical error exceeds 99 %, the LCD of the dosimeter displays it in "пп" symbols.

To change averaging time, hold the THRESHOLD button down more than 4 s. The value of averaging time will be 1 min and will automatically increase by 1 min. When you get the desired value, release the THRESHOLD button.

10.10 **Saving measurement results and numbers of the studied objects in the nonvolatile memory**

Saving measurement results and numbers of the studied objects in the nonvolatile memory can be done in the mode of precise measurement.

10.10.1 Press shortly the MEMORY button to record the precise measurement result and the number of the corresponding object in the nonvolatile memory.

The “P” symbol and three digits that stand for the number of the object of measurement appear on the LCD, and the low-order digit is blinking. Correct the number of the object with the help of the THRESHOLD and PRECISELY buttons if necessary. Shortly press the THRESHOLD button to change the blinking digit of the object number per unit. To correct the next digit, press shortly the PRECISELY button, and the latter starts blinking.

Press shortly the MEMORY button to record the measurement result and the number of the corresponding object in the memory. A typical “traveling wave” on the analogue indicator in the top right corner of the LCD indicates that the result has been recorded.

**Notes**

1 After switching to the precise mode, the measurement result and the number of studied object can be recorded only after at least one averaging time interval is finished. At least one precise measurement must be performed.

2 After saving the measurement result and the number of the studied object, the next saving is possible only after the next averaging time interval is finished. You have to wait for the next measurement result. It is impossible to save the same measurement result several times.

3 Recording of the measurement result and the number of the studied object when measuring surface beta particles flux density is possible only after the previous measurement and recording of gamma background value of the object (blinking "□" symbol on the LCD) in accordance with OM 10.6.4.

4 The nonvolatile memory of the dosimeter is arranged as a "ring". When the memory is full the next record of measurement result and object number will clear the oldest measurement result and the number of studied object.

10.11 **Measurement history viewing on the LCD**

The dosimeter's LCD has a feature to display measurement results and numbers of corresponding objects saved in the nonvolatile memory.

Measurement results and numbers of objects are displayed in the search mode of measurement.

10.11.1 Press shortly the MEMORY button to enter the mode of measurement history viewing. The LCD displays the following in this mode:

- measurement result (1);
- indicator of conventional position of this measurement result in the dosimeter's memory (3);
- battery status symbol (2).


Figure 12 – LCD of the dosimeter
(Measurement history viewing, measurement result display)

Press shortly the MEMORY button to shift to the next measurement result saved in the memory. The conventional position of measurement result in the memory is displayed with the help of the medium segment of the indicator (3). The extreme right position of this segment corresponds to the last measurement result recorded in the memory. The extreme left – to the first one.

Press shortly the PRECISELY button to switch on the LCD between the display of measurement result and corresponding object number. "P" symbol that appears before the three-digit object number is an attribute of the object number.


Figure 13 – LCD of the dosimeter
(Measurement history viewing, measurement result display)

Press the MEMORY button and hold it down for not less than 2 s, to exit the mode of the measurement history viewing.

10.12 **Transmission of measurement history data into the PC through infrared port of data exchange (IRDA)**

The measurement history data can be communicated to the PC only in the search mode of the dosimeter operation. The PC should be equipped with a special purpose infrared port and a custom software should be installed.

Before data transmission from the dosimeter, the user should follow the required steps in accordance with the user's manual to launch the program on the PC and make it ready to read data through the infrared port.

To transmit, the switched on control panel of the dosimeter should be located opposite the infrared port adapter so that the window of the infrared port of the control panel is parallel to the window of the adapter at a maximum distance of 30 cm. Data transmission to the PC is performed automatically during 1...30 s (depending on the volume of stored information). Audio signaling and corresponding information displayed on the PC monitor indicate that transmission has been successful.

**Note.** After the data is transmitted to the PC, the dosimeter’s nonvolatile memory is cleared.

## 11 TROUBLESHOOTING

11.1 Troubleshooting is presented in the Table 11.1

Table 11.1 - Troubleshooting

| Trouble | Probable cause | Troubleshooting | Note |
|---|---|---|---|
| 1 No readings on the LCD when the dosimeter is switched on | 1 Storage battery discharged<br>2 No contact between the batteries | 1 Recharge the storage battery<br>2 Remove and clean the batteries (replace if necessary) | |
| 2 The LCD displays "----" symbols | 1 The remote detecting unit not connected to the control panel<br>2 Broken conductor in the cable of the remote detecting unit | 1 Connect the remote detecting unit to the control panel<br>2Find and remove the break | |
| 3 The LCD displays "ErXX" symbols, where XX is an error code | Remote detecting unit failure | 1 Send the dosimeter for repair to the enterprise producer | |

11.2 Repair works are conducted by the enterprise producer at the address:

**PE "SPPE "Sparing-Vist Center"**
**33 V. Velykoho Str., Lviv 9026, Ukraine**
**Tel: (+38 032) 242-15-15, Fax: (+38 032) 242-20-15**
**E-mail: sales@ecotest.ua.**

## 12 VERIFICATION

12.1 The devices are subject to verification during operation (periodic verification at least once a year) and after repair. The verification is carried out according to the methods determined by the laws and regulations of the central executive body, which ensures the formation of state policy in the field of metrology and metrological activity, or by national standards.

12.2 Presentation of the verification results

12.2.1 Satisfactory results of periodic verification and verification after repair are evidenced by the issuance of a certificate of verification of a legally regulated measuring equipment.

12.2.2 If, as a result of verification, the device is recognized as unfit for use, it gets an unserviceability certificate.

## 13 TRANSPORTATION AND STORAGE RULES

13.1 Transportation

13.1.1 Transportation conditions comply with GOST 15150-69 standard.

13.1.1.1 The detecting units in the transport container of the producer enterprise can be transported by railway, motor, water and air transport at any distances provided the following conditions are satisfied (group 4 (Ж2) of GOST 15150-69):

- by railway transport – in a dry box car;
- by air transport – in pressurized compartments;
- by water transport – in a ship's hold;
- by motor transport – in a closed car.

13.1.2 The dosimeters in the transport container should be placed and fastened to ensure their stable position and to avoid shocks.

13.1.3 Not more than five dosimeters may be shipped in the transport container of the producer enterprise. Stacking of the dosimeters should be vertical.

13.2 Storage

13.2.1 The dosimeters in packing should be stored indoors with an ambient air temperature from 5 to 40 °C and relative humidity up to 80 % at the temperature of 25 °C.

13.2.2 The dosimeters without packing should be stored indoors with an ambient air temperature from 10 to 35 $^0$C and relative humidity up to 80 % at the temperature of 25 °C.

13.2.3 The composition of dust, acid and alkali vapors, aggressive gases and other harmful admixtures that may cause corrosion in the buildings where the dosimeters are stored, should not exceed the composition of corrosion elements for the atmosphere of the 1 type (according to GOST 15150-69).

13.2.4 The location of the dosimeters in the storehouses should ensure their free displacement and access to them.

13.2.5 The distance between the walls, the floor of the storehouses and the dosimeters should be not less than 1 m. The distance between the heating gadgets of the storehouses and the devices should be not less than 0.5 m.

## 14 DISPOSAL

Disposal of the dosimeter shall be carried out in compliance with the Laws of Ukraine “On Environmental Protection” and “On Waste” with observance of the methods and rules approved in the established order: metals are processed (melted), plastic details are dumped.

Disposal of the dosimeters is not dangerous for the service personnel, and is environmentally friendly.

**Note.** In the case of the dosimeter contamination with liquids or solids containing radionuclides, and the impossibility of its complete deactivation, it should be disposed of as solid radioactive waste according to valid radiation safety standards.

# ANNEX A

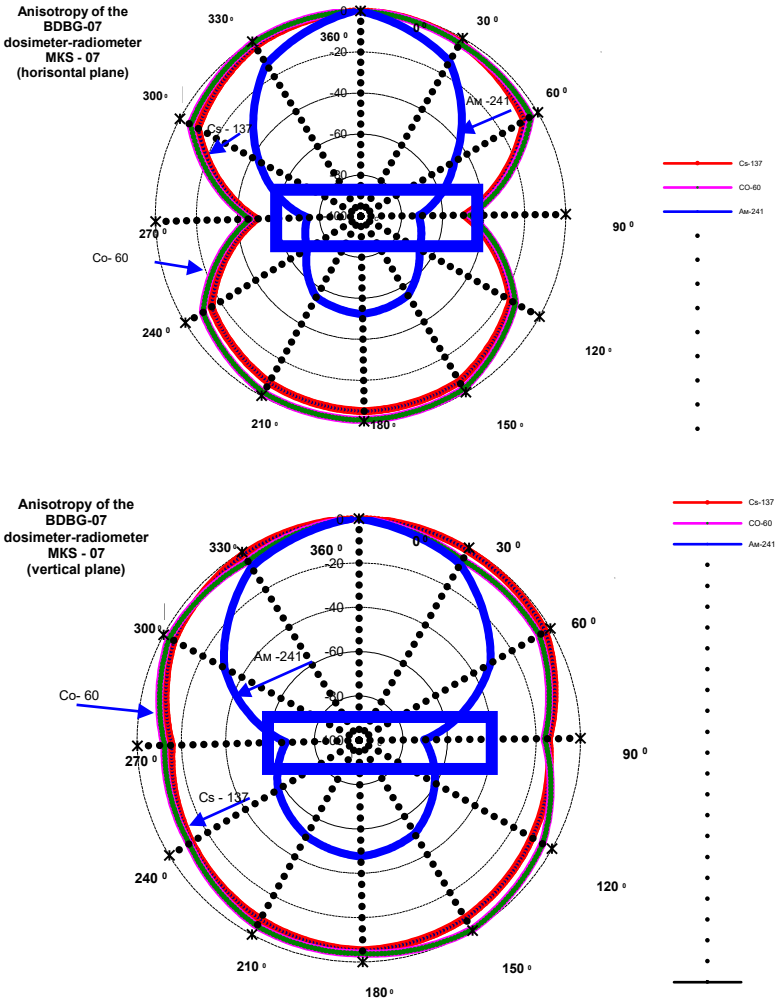


Figure A.1