National Scientific Center
"Institute of Metrology"

UA.TR. 113-0347-19

Ministry of Economic Development and Trade of Ukraine
CCSB "Metrology"
NSC "Institute of Metrology"

TYPE EXAMINATION CERTIFICATE

Issued to:	Private Enterprise "Scientific and Production Private Enterprise "Sparing-Vist Center", 33 Volodymyra Velykoho St., Lviv, 79026, Ukraine; USREOU code 22362867
In accordance with:	Annex 1, section "Metrological requirements" Module B (type examination) of the Technical Regulation of Legally Regulated Measurement Instruments, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 94 of January 13, 2016.
Type of measurement instrument:	DKG-21Personal Gamma Radiation Dosimeter
Type designation:	DKG-21
Date of issue:	March 27, 2019 **Valid until:** March 26, 2029
Number of pages:	10
Reference Number:	113-0347-19
Number of designated authority:	UA.TR. 113

This certificate is issued on the basis of the results of studying the measuring instrument technical design document. This certificate ensures the conformity of measuring instrument type to applicable requirements of the Technical Regulation.

The conformity of the measuring equipment supplied to Ukrainian market and/or commissioned in Ukraine to the type described in this certificate and to the applicable requirements of the Technical Regulation shall be approved by carrying out one of the conformity assessment procedures given in the modules following module B in accordance with the requirements of Technical Regulation.

Director of conformity assessment body **(signature)** **P. I. Neyezhmakov** **(initials, family name)**

Seal

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Certificate history

Certificate version number	Date	Substantial changes
UA.TR. 113-0347-19	March 27, 2019	Primary certificate

Requirements

The approved type of measuring instrument meets the requirements of the following documents: Technical Regulation of Legally Regulated Measurement Instruments, approved by the Resolution of the Cabinet of Ministers of Ukraine No. 94 of January 13, 2016.

Applied standards:

DSTU 7215:2011 "Personal electronic X-ray and gamma radiation dosimeters. Classification and general technical requirements".

GOST 27451-87 “Ionizing radiation measuring means. General specifications.”

GOST 14254-96 (IEC 529-89) “Degrees of protection provided by enclosures (IP code)”.

DSTU EN 61010-1:2014 (EN 61010-1:2014, IDT) “Safety requirements for Electrical Equipment for Measurement, Control, and Laboratory Use. Part 1: General Requirements".

1 Description of the measuring instrument type

1.1 Design

DKG-21 personal gamma radiation dosimeter comes in two modifications: DKG-21 and DKG-21M (hereinafter referred to as the dosimeters), which differ in overall dimensions, weight and ingress protection level shown in Table 1.

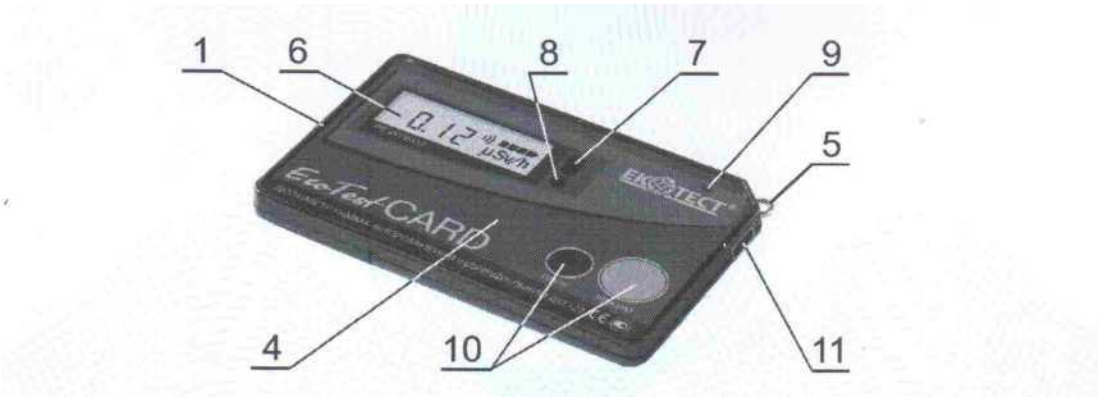
Table 1 — Dimensions, weight and degree of shell protection of DKG-21 and DKG-21M dosimeters

Name	Unit of measurement	Value
Overall dimensions without a clip (length x width x thickness): - for DKG-21, no more; - for DKG-2IM, no more	mm	 90x55x10 98x58x18
Weight without packaging: - for DKG-21, no more; - for DKG-21M, no more	kg	 0.08 0.14
Ingress protection rating: - for DKG-21; - for DKG-21M	-	 IP 31 IP 54

Dosimeters are presented as monoblocks (Figures 1, 2, 3) and consists of gamma radiation detector, printed circuit board with anode voltage formation, digital processing, control and indication circuits, infrared port of data exchange, and a battery. Gamma radiation detector transforms gamma quanta into a sequence of voltage pulses; the number of pulses is proportional to the intensity of recorded radiation.

The circuit of anode voltage formation, digital processing, control and indication features:

- scaling and linearization of the counting response of the detector;
- measuring individual dose equivalent rate by measurement of the average pulse frequency coming from the detector output;
- measuring individual dose equivalent by measurement of the total amount of pulses coming from the detector output;
- real time measurement;
- formation and stabilization of the detector anode voltage;
- control of the dosimeter operating modes;
- measurement results indication.



- Fig. 1 - DKG-21 dosimeter front view.

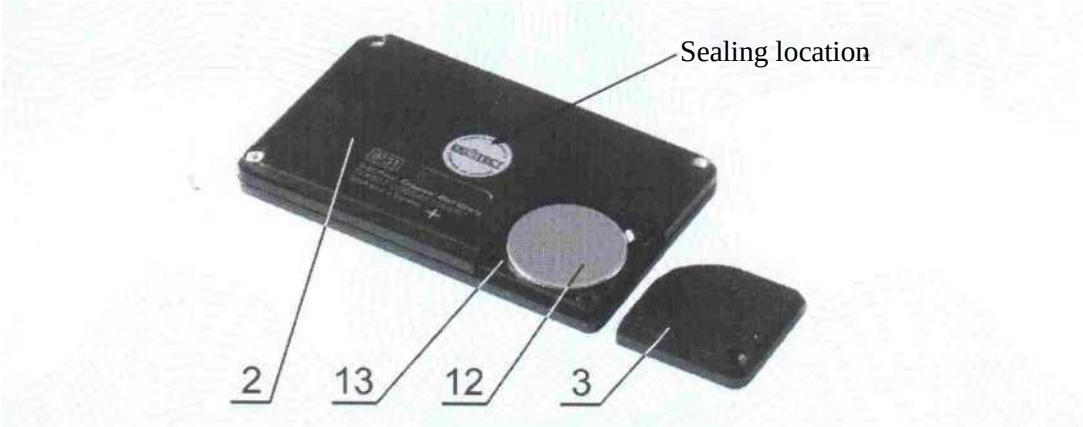


Fig. 2 - DKG-21 dosimeter rear view.

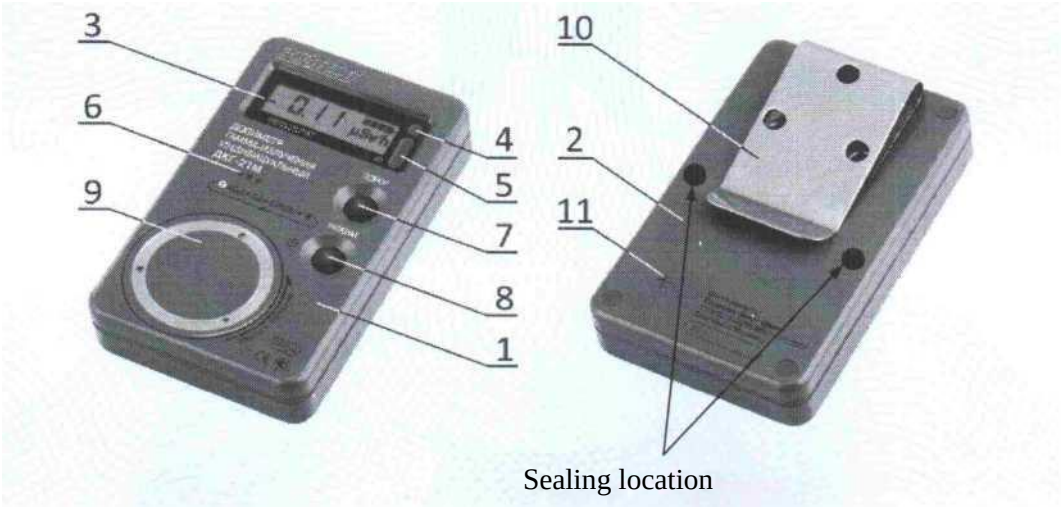


Fig. 3 - Dosimeter DKG-21M.

DKG-21 dosimeter is powered by rechargeable 3.7 V lithium-ion battery of nominal capacity 120 mAh. Dosimeter DKG-21M is powered by 3.0 V lithium cell CR 2450 (Panasonic) of nominal capacity 560 mAh. Dosimeter DKG-21 is designed as a monoblock in a flat rectangular plastic casing (Fig. 1) consisting of the front (1) and rear (2) covers, the battery compartment lid (3), the film front panel (4) and the metal ring (5) used to attach a strap.

The transparent window with LCD (6) behind it is located in the left upper corner of the front panel. Two smaller windows for the optical system of the infrared port (7) and the light-emitting diode indicator (8) are located next to this window. Two membrane control keys (10) with corresponding inscriptions are located in the right lower corner of the front panel. Charger connector (11) is located on the right lateral side of the casing.

The printed circuit board lies within the body, where all elements of the electric circuit, with an exception of the loudspeaker and the battery, are located. The loudspeaker is located in a cylindrical sound chamber, done as a construct of the upper cover. The loudspeaker is mechanically fastened and electrically connected with the circuit by three spring contacts, located on the printed circuit board.

The components of the device and the printed circuit board are fastened with five screws. The battery (12) is inserted into the battery compartment (13), and fastened to the circuit by two spring contacts. The inscriptions that specify the polarity of the battery connection are placed at the bottom of the battery compartment. The mechanical center of the detector is marked by "+" symbol on the back cover (Figure 2).

To charge the battery connect he battery charger to industrial network (100 - 240) V with frequency (50 - 60) Hz. To do this, plug the jack (1) of the charger (2) into the dosimeter slot (3) according to Figure 4.

Fig. 4 - Connecting the charger to the dosimeter DKG-21.

DKG-21M dosimeter is designed as a monoblock in a flat rectangular plastic casing (Fig. 4) consisting of the front (1) and back (2) covers.

Three transparent windows are positioned on the upper part of the front panel. The LCD (3), the light-emitting diode indicator (4), as well as the optical system of the infrared port (5) are placed behind the windows.

Three acoustic holes (6) of the loudspeaker alongside the THRESHOLD (7) and MODE (8) control buttons are located in the middle of the front panel. The battery compartment, which is closed with the sealed lid (9), is located at the bottom of the front panel.

The clip (10) is on the back cover to fasten the dosimeter to clothes. The mechanical center (11) of the detector "+" is also inscribed there.

v

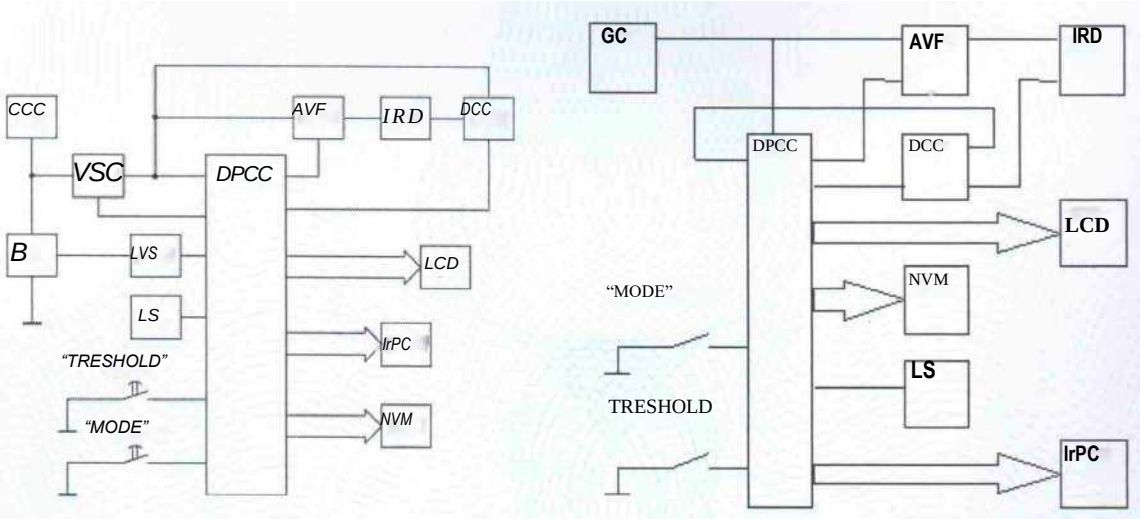


Fig. 5 - Block diagram of the dosimeter DKG-21 Fig. 6 - Block diagram of the dosimeter DKG-21M.

The dosimeter consists of a rechargeable battery (B) for DKG-21, galvanic cell (GC) for DKG-21M, indication and charging control circuit (CCC), voltage stabilizing circuit (VSC), buttons MODE and THRESHOLD, digital processing and control circuit (DPCC), anode voltage former for ionizing radiation detector (AVF), detector control circuit (DCC), nonvolatile memory (NVM), infrared port circuit (IrPC), loudspeaker (LS) and LCD.

MODE and THRESHOLD buttons are used to turn on the dosimeter, to set the respective operating mode and to program the threshold levels of the sound signaling.

CCC is implemented on a specialized chip and provides charging of the B, as well as indication of the charging process and its completion. Additional elements provide CCC protection against overvoltage and pulse noise.

VSC is implemented on the base of the pulse voltage converter with an additional linear voltage stabilizer (LVS) and provides stable voltages for powering all the dosimeter components.

DPCC is implemented on the base of special processor and serves for the dosimeter operating modes control, anode voltage former control, digital processing of pulse sequences from the ionizing radiation detector, generation of LCD control signals, as well as for indications of measurement modes.

AVF is built as a single-kick multivibrator with the transformer voltage multiplication and the subsequent asymmetric diode-capacitive voltage multiplier and serves to form an anode voltage of -500 V required for the ionizing radiation detector performance. DCC is realized on the base of a number of switching and normalizing elements and serves to normalize the "dead time" of the detector.

NVM is based on EEPROM and serves to record the history of doses and time.

Piezoacoustic transducer, which serves for audible alarm if the programmed DER or DE threshold levels have been exceeded and when the alarm clock goes off, was used as the LS.

The ionizing radiation detector (IRD) is an energy-compensated Geiger-Mueller type gas-discharge counter M05βγ. It is intended for gamma radiation detection, parameters of which are measured by the dosimeter.

1.2 Primary transducer

The principle of the primary transducer operation is based on the interaction of gamma quanta with electric field in a gas-discharge Geiger-Mueller counter producing pulses, the number of which is proportional to the intensity of recorded gamma radiation.

1.3 Measurement results processing

1.3.1 Technical means

The digital processing and control circuit (DPCC), implemented on the basis of a special processor, serves for digital processing of pulse sequences from the ionizing radiation detector.

1.3.2 Software

The dosimeter uses a microcontroller that allows blocking access permanently to embedded software by irreversibly erasing security bits during programming. This guarantees the protection of embedded software from unauthorized interference.

A brief description of the software is presented in Table 2.

Table 2 - Brief description of the dosimeter software

Measuring instrument software (name)	Software version number	Functional checksum (for software identification)
DKG-21 dosimeter	v.40	BAA1
DKG-21M dosimeter	v.40	3B2E

1.4 Display of measurement results

The measurement results are displayed on the digital LCD (Fig. 1 and 3).

1.5 Additional equipment and functions that are not subject to the requirements of the Technical Regulation

NA.

1.6 Technical documentation

-TU U 33.2-22362867-010:2007 "DKG-21 Personal Gamma Radiation Dosimeter";

- BICT.412118.031 HE "Personal gamma radiation dosimeter DKG-21. Operating manual";
- BICT. 412118.023-03 HE "DKG-21M Personal Gamma Radiation Dosimeter. Operating manual".

The hard copy of technical documentation is kept in File 113-0347-19.

2 Technical data

2.1 Technical parameters

Personal gamma radiation dosimeter DKG-21 is designed to measure individual dose equivalent $H_p(10)$ (hereinafter referred to as DE), the individual dose equivalent rate $\dot{H}_p(10)$ (hereinafter referred to as DER) of gamma radiation and to maintain an automated database for personnel radiation burden as a part of the automated system of individual dosimetric control ASIDK-21, and comes in the following modifications: DKG-21 and DKG-21M (hereinafter referred to as the dosimeters).

Dosimeters can be used as stand-alone devices, as well as included in the automated system of individual dosimetric control ASIDK-21 at enterprises and in facilities that deal with sources of gamma radiation.

The main metrological and technical characteristics of personal gamma radiation dosimeters DKG-21 and DKG-21M are given in Table 3.

Table 3 — Basic metrological and technical specifications of dosimeters

Name	Unit of measurement	Value
1	2	3
Gamma radiation DER measurement range	Sv/h	from $1 \cdot 10^{-7}$ to 1.0
Main relative permissible error limit of DER measurement in the range from $1 \cdot 10^{-6}$ Sv/h to 1.0 Sv/h with a confidence probability of 0.95: - in the DER range from $1 \cdot 10^{-6}$ Sv/h to $1 \cdot 10^{-5}$ Sv/h (inclusive); - in the DER range from $1 \cdot 10^{-5}$ Sv/h to 1.0 Sv/h	%	 20 15
Gamma radiation DE measurement range in the DER range from $1 \cdot 10^{-7}$ Sv/h to 1.0 Sv/h	Sv	from $1 \cdot 10^{-6}$ to 9.999
Main relative permissible error limit of DE measurement in the DER range from $1 \cdot 10^{-6}$ Sv/h to 1.0 Sv/h and in DE range from $1 \cdot 10^{-5}$ Sv/h to 9.999 Sv/h with a confidence probability of 0.95:	%	15
The range of registered gamma radiation energies	MeV	from 0.05 to 6.0
Energy dependence at DER and DE gamma radiation measurement in the energy range from 0.05 MeV to 1.25 MeV relative to 0.662 MeV energy, not more than	%	±25
Anisotropy at gamma quantum incidence at solid angle of ± 60° relative to the main measurement direction (perpendicular to the front panel of the dosimeter): - for radionuclides ^{137}Cs and ^{60}Co, no more - for radionuclide ^{241}Am, no more	%	 25 85
Complementary permissible relative error limit of gamma radiation DE and DER measurement caused by ambient temperature change from -20 °C to +50 °C	% for every 10 °C deviation from 20 °C	5
Instability of readings during 8 hours of continuous operation, no more	%	5
Time of operating mode setting at DER measurement in the range: - from $1 \cdot 10^{-6}$ Sv/h to $5 \cdot 10^{-6}$ Sv/h (inclusive), no more; - from $5 \cdot 10^{-6}$ Sv/h to $2 \cdot 10^{-5}$ Sv/h (inclusive), no more; - from $2 \cdot 10^{-5}$ Sv/h to 1.0 Sv/h (inclusive), no more;	min	 30 5 3
Continuous operation when powered from new batteries or from fully-charged rechargeable batteries under normal background radiation and LCD off: - for DKG-21, no less; - for DKG-21M, no less	hour	 800 4000
Operating DC supply voltage: - for DKG-21; - for DKG-21M	V	 3.7 3
Power supply voltage: - for DKG-21 – from 120 mAh lithium-ion rechargeable battery; - for DKG-21M – from lithium cell 560 mAh	V	 from 3.2 to 4.2 from 2.4 to 3.2
Average time to failure, no less	hour	6000
Average availability factor, not less	-	0.999

Continuation of Table 3

1	2	3
Mean overhaul period, not less	hour	10000
Average service life (with battery replacements), no less	year	10
Average shelf life (with battery replacement), no less	year	10
Environmental conditions: - temperature; - relative humidity at temperature 35 °C; - atmospheric pressure	 °C % kPa	 from -20 to +50 95 ±3 from 84 to 106.7
Class of external electromagnetic conditions in accordance with the Technical Regulations	-	E2
Class of external mechanical conditions in accordance with the Technical Regulations	-	M1

The dosimeters delivery kit is given in Tables 4 and 5.

Table 4 - Dosimeters DKG-21 delivery kit

Marking	Name	Quantity
BICT.412118.030	DKG-21 personal gamma radiation dosimeter	1
LIR2450 (EEMB Battery)	Rechargeable battery*	1
The model is not specified	Charger**	1
The model is not specified	Case***	1
BICT.321342.014	Cardboard box	1
BICT.412118.031 HE	Operating manual	1

* - Can be replaced with batteries of similar characteristics from other manufacturers that ensure safety, quality and reliability.
** - Micro-USB connector; voltage - 5 V, current - 0.5 A.
*** - Supplied at customer's request.

Table 4 - Dosimeters DKG-21M delivery kit

Marking	Name	Number
BICT.412118.023-03	DKG-21M personal gamma radiation dosimeter	1
CR 2450 (Panasonic)	Galvanic cell*	1
BICT.412915.018	Packaging	1
BICT.303658.001	Screwdriver	1
BICT.412118.023-03 HE	Operating manual	1

* - Can be replaced with batteries of similar characteristics from other manufacturers that ensure safety, quality and reliability.

3 Interfaces and compatible external devices

3.1 Interfaces

The wireless infrared interface (IrDA) can be used to transfer user's dose history from the dosimeter to a personal computer.

3.2 Compatible external devices

USB/IrDA infrared port adapter with software on a CD comes in a separate order.

4 Production, commissioning and usage requirements

4.1 Production requirements

According to the sections 2, 3, 4 of TU U 33.2-22362867-010:2007 (File No.113-0347-19).

4.2 Commissioning requirements

According to the Operating Manual BICT.412118.031 HE and BICT. 412118.023-03 HE (File No.113-0347-19).

4.3 Usage requirements

In accordance with section 6 of TU U 33.2-22362867-010:2007 and the Operating Manuals BICT.412118.031 HE and BICT. 412118.023-03 HE (File No.113-0347-19).

5 Surveillance of devices in operation

5.1 Surveillance documentation

The surveillance documentation is provided by the manufacturer in the technical documentation according to File No.113-0347-19.

Metrological surveillance of legally regulated measuring instruments in operation is performed according to the verification methods given in the Operating Manuals BICT.412118.031 HE and BICT. 412118.023-03 HE, or other documents in accordance with the current legislation of Ukraine.

Verification interval - no more than 1 year.

State market supervision - in accordance with the Law of Ukraine on State Market Supervision dated 10.02.2016.

5.2 Hardware and software identification

Is conducted at the dosimeters production stage according to the information given in the manufacturer's technical documentation and at operation on the basis of the marking on dosimeters casing and in the operating documentation.

6 Hardware and software protection means

Protection against interference is provided by back covers of casing.

The DKG-21 dosimeter is sealed with a label on the back cover (Figure 2). The DKG-21M dosimeter is sealed with a seal in the recess (13) of the back cover (Fig. 3).

7 Labeling and inscriptions

Labeling on the dosimeter housing meets the requirements of section 1.3 of TU U 33.2-22362867-010:2007 and contains the following data (Fig. 1, 2 and 3).

Inscriptions on the front panel of the dosimeter:

- full name of the dosimeter;
- trademark;
- mark of the legally regulated measuring instrument in accordance with the Technical Regulation of the legally regulated measuring instruments;
- conformity mark according to the Resolution of the Cabinet of Ministers of Ukraine No.1184 of December 30, 2015 and the identification number of the authorized conformity assessment body (when assessing the products conformity).

Inscriptions on the rear panel of the dosimeter:

- "Made in Ukraine";
- manufacturer’s name;
- mark of these TUs;
- dosimeter serial number according to the manufacturer numbering system;
- Ingress protection rating - IP 31 (for DKG-21) and IP54 (for DKG-21M) in accordance with GOST 14254;
- mechanical center of the detector;
- month and year of manufacturing according to the manufacturer’s system.

8 Drawings

Hard copy of design documentation BICT.412118.023ГЧ and BICT.754313.001 are kept in the File 113-0347-19.

Additional Information:

Test Reports.

1 Report of conformity assessment to the Technical regulation of the legally regulated measuring instruments of CCSB "Metrology" NSC "Institute of Metrology" No. 6/0347.П.546.B/03-19 of March 22, 2019, accreditation certificate No. 2H524 of August 1, 2016, expires January 29, 2020.

2 Report No. 19-03/10 dated February 1, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of the operating temperature limits in accordance with the requirements of sections 1.2.5 and 1.2.15 of technical specifications TU U 33.2-22362867-010:2007 of the Separated Subdivision (SS) “Testing Center (TC) LORTA”, accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

3 Report No. 19-04/10 dated February 6, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of moisture in accordance with the requirements of sections 1.2.5 and 1.2.15 of technical specifications TU U 33.2-22362867-010:2007 of SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019

4 Report No. 19-05/10 dated February 11, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of sinusoidal vibrations in accordance with the requirements of sections 1.2.16 of technical specifications TU U 33.2-22362867-010:2007 of SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

5 Report No. 19-06/10 dated February 11, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of shocks in accordance with the requirements of sections 1.2.17 of technical specifications TU U 33.2-22362867-010:2007 of SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

6 Report No. 19-07/10 dated February 12, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of environmental and mechanical factors of limiting conditions during transportation in accordance with the requirements of sections 1.2.18 of technical specifications TU U 33.2-22362867-010:2007 of SS "TC LORTA", accreditation certificate of NAAU No.2H042 dated July 14, 2014, expires July 13, 2019.

7 Report No. 19-08/10 dated January 14, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with resistance to impact of constant and alternating magnetic field of (50 ± 1) Hz frequency in accordance with the requirements of sections 1.2.19 of technical specifications TU U 33.2-22362867-010:2007 of SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

8 Report No. 19-09/10 dated February 20, 2019 verifying the compliance of personal gamma radiation dosimeters DKG-21 and DKG-21M with the safety requirements in accordance to GOST 14254-96 SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

9 Report No. 19-10/10 dated February 20, 2019 of personal gamma radiation dosimeters DKG-21 and DKG-21M testing for compliance with safety requirements in accordance to DSTU EN 61010-1:2014 SS "TC LORTA", accreditation certificate of NAAU No. 2H042 dated July 14, 2014, expires July 13, 2019.

10 Test Report, report id.: SPA-20070504-R1 in compliance with EN61326:1997 A1/A2/A3 Emission: Class A&B, Immunity: Up to industrial locations EN60601-1-2:2001, EN61000-4-2 EN61000-4-3, EN61000-4-8, at BICON EMC-laboratories.

DKPP (State Classifier of Goods and Services) products code - 26.51.41.