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ОКП

SCIENTIFIC AND PRODUCTION COMPANY
«DOZA»

PERSONAL GAMMA DOSIMETER
DKG-05D

Operation manual
ФВКМ.412113.005РЭ

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The present Operation Manual contains information on the design, operational principle, technical specifications and instructions necessary for the proper application and safety operation of the product (intended use, maintenance, routine repairs, storage, and transportation), as well as information on decommissioning of the product.

1 DOSIMETER DESCRIPTION AND OPERATION

1.1 Purpose of the dosimeter

The personal gamma dosimeter DKG-05D ФВКМ.412113.005 (thereafter, dosimeter) is produces in accordance with the requirements of ТУ 4362-010-31867313-2007.

The dosimeter is designed to wear it on the personnel clothes. The dosimeter is intended to measure the personal gamma radiation dose equivalent $H_p(10)$ and rate of personal gamma radiation dose equivalent $\dot{H}_p(10)$.

The dosimeter is used together with the US-05 reading device and ZU-1 charging device and independently (for routine, operational, and accidental monitoring of individual doses) as well as a part of the computer-aided dosimetry monitoring system at facilities and organizations, when handling ionizing radiation sources, including nuclear-powered vessels.

1.2 Technical specifications

1.2.1 Measured energy range …….…… 0,05 to 3,0 MeV.

1.2.2 $H_p(10)$ measurement range …..…….. $1 \cdot 10^{-7}$ to 15 Sv.

1.2.3 Rate of $\dot{H}_p(10)$ measurement range ……...……. $1 \cdot 10^{-6}$ to 10 Sv/h.

1.2.4 Relative measurement error no more than:

- $H_p(10)$ ……....……. ± [15 + 10/$H_p(10)$] %;
- Rate of $\dot{H}_p(10)$ …….…….... ± [15 + 40/$\dot{H}_p(10)$] %,

where $H_p(10)$ and $\dot{H}_p(10)$ are a non-dimensional quantitys that are numerically equal to the gamma radiation dose equivalent value in μSv and rate of the personal gamma radiation dose equivalent value in μSv/h.

1.2.5 Energy dependence of sensitivity ……... no more than ±30 %.

1.2.6 Anisotropy of dosimeter sensitivity within ±90° solid angle for ^{137}Cs radiation (0,661 MeV) …… no more than ±35 %.

1.2.7 Operation mode up time ……. no more than 5 min.

1.2.8 Continuous operation time …….. no less than 100 h without accumulator battery re-charge.

1.2.9 Dosimeter reading instability during 8 h of continuous operation is ….. no more than ±5 %.

1.2.10 Rate of $\dot{H}_p(10)$ measurement time is selected automatically depending upon dose rate value:

Subrange:	Measurement time:
- 1 to 7.5 μSv/h	255 s;
- 7,5 to 15 μSv/h	from 256 to 128 s;
- 15 to 30 μSv/h	from 128 to 64 s;
- 30 to 60 μSv/h	from 64 to 32 s;
- 60 to 120 μSv/h	from 32 to 16 s;
- 120 to 240 μSv/h	from 16 to 8 s;
- 0,24 to 0.48 mSv/h	from 8 to 4 s;
- 0,48 to 0.96 mSv/h	from 4 to 2 s;
- 0,96 to 2 mSv/h	from 2 to 1 s;
- above 2 mSv/h	1 s.

1.2.11 Sound and light alarm signals would be switched on:

- in case of accumulator battery voltage below 3,52 V;
- in case of indication limit exceeding above 42,9 Sv for $H_p(10)$ and 42,9 Sv/h for rate of $\dot{H}_p(10)$;
- in case of exceeding the systemic alarm thresholds;
- in case of exceeding of a subrange limits.

1.2.11.1 Sound alarm parameters:

- sound signal frequency in the range of ..... ….. from 1000 to 3000 Hz;
- sound pressure level:
  - at 40 cm distance from the ear ..... ……. no less than 80 dB;
  - at 30 cm distance from the ear ..... ……. no more than 100 dB;

1.2.11.2 Values of factory settings of sound and light alarming are as follows:

- $H_p(10)$ preventive threshold …… 15 mSv;
- $H_p(10)$ accidental threshold ……. 20 mSv;
- rate of $\dot{H}_p(10)$ accidental threshold is 12 μSv/h;
- preventive rate of $\dot{H}_p(10)$ threshold which switches off the alarm is set 1 μSv/h;

Note - Systemic alarm thresholds of 1 μSv/h steps rate of $\dot{H}_p(10)$ and 1 μSv $H_p(10)$ are preset by the consumer, using PC and US-05 at any point of the measurement range.

1.2.12 The dosimeter provides automated recording of $H_p(10)$ and rate of $\dot{H}_p(10)$ into its memory at the fixed time periods. The maximal number of records should not be less than 1900. Time period of archive records is established as follows:

- with 1 second step for periods of 1 to 60 seconds;
- with 1 minute step for periods of 1 minute to 1 hour;
- with 1 hour step for periods of 1 hour to 18 hours.

1.2.13 In case of the uncharged (absent) accumulator batteries, the information recorded in the nonvolatile dosimeter memory would be preserved for 5 years at least.

1.2.14 Electric power supply is provided:

- for the dosimeter – by three accumulator batteries 280 mA/h capacity each with the total voltage 3,6 V;
- for ZU-1 – including feeding adapter of 220 V, 50 Hz;

1.2.15 ZU-1 provides full dosimeter battery charge within …….. no more than 6 hours.

1.2.16 Electric power consumed by the dosimeter together with US-05 and ZU-1 is no more than 50 VA.

1.2.17 The type of climatic design is NF4.2* as per GOST 15150-69.

1.2.18 The values of the environment climatic factors during the operation of the dosimeter and ZU-1 in operating condition are as follows:

- working temperatures:
  - the dosimeter ……..……..... from minus 20 to plus 45°C,
  - ZU-1 ……..…….....……... from 0 to plus 45°C;
- relative humidity limit value ….……..……..…… 98 % at +35 °C;
- atmospheric pressure ranged ……..…….... from 84,0 to 106,7 kPa;
- corrosive agents air concentration corresponds to the type of atmosphere …… I, II, III.

1.2.19 The dosimeter and ZU-1 are resistible to impact of sinusoidal vibration of frequency ranges:

- from 2 to 13,2 Hz with 1 mm shift amplitude,
- from 13,2 to 80 Hz with 0,7 g acceleration.

1.2.20 The dosimeter and ZU-1 are resistible to shocks impact with 5,0 g acceleration and frequency within 40 to 80 times per minute; total number of shocks is no less than 1000.

1.2.21 The dosimeter is resistible to shocks impact in case of the free falling from the height of no more than 750 mm on wooden floor for:

- falling on edges ..... 6 times;
- falling on crossbars ..... 3 times;
- falling on angles ..... 2 times.

1.2.22 On seismic stability, the dosimeter and ZU-1 correspond to the requirements of РД 25 818-87 and НП-031-01 for seismic impact of up to grade 7 of the MKS-64 scale at 30 m height above the ground.

1.2.23 The casing protection degree on IEC 529:1989:

- for the dosimeter …… IP65;
- for US-05 ..…..… IP23;
- for ZU-1 ...……...…… IP20.

1.2.24 By its electromagnetic compatibility the dosimeter and ZU-1 belongs to normal operation elements, important for safety as per group III, criterion of the quality of functioning is A as per GOST P 50746-2000.

The impact of electromagnetic interference does not result in false operation and restart of the dosimeter and ZU-1.

1.2.25 The dosimeter in Hp(10) or rate of Hp(10) measurement mode withstands the short time exposure to 20 Sv/h ambient dose equivalent rate for 5 minutes. At that after 10 minutes of exposure the dosimeter keeps its main relative error of measurement within the margins specified in 1.2.4.

1.2.26 The electric shock protection degree is class III on GOST 12.2.007.0-75 for the dosimeter and class I for ZU-1.

1.2.27 On fire protection properties, the dosimeter and ZU-1 correspond to GOST 12.1.004-91 with fire incidence probability of less than 10^{-6} 1/year.

1.2.28 The dosimeter and ZU-1 are resistible to decontamination agents:

- boric acid (H_3BO_3) – 16 g, sodium thiosulphate ($Na_2S_2O_3 \cdot 5H_2O$) – 10 g, distilled water up to 1 l;
- tri-sodium phosphate or sodium hexametaphosphate – 10 to 20 g/l in water (any synthetic detergents);
- 5 % solution of citric acid in rectified ethyl alcohol – for internal surfaces of electronic parts.

1.2.29 Mass is no more than for:

- the dosimeter including accumulator batteries ……..…..…… 0,1 kg;
- ZU-1……..……..…..……. 0,4 kg.

1.2.30 Overall dimensions are no more than for:

- dosimeter ……..……..…… 96×47×30 mm;
- ZU-1……..…….. 50×65×40 mm.

1.3 Dosimeter components

The dosimeter is a miniature direct reading device with the hermetic casing made of shock-resistant plastic.

The inner side of the dosimeter has the clip to fix it on the operator chest pocket.

The dosimeter is used in the complex with US-05 reader and ZU-1 charger.

Overall and connection dimensions of the dosimeter is given in annex A.

1.4 Dosimeter design and operation

1.4.1 Two silicon detectors are used for the radiation detection (rough and fine ones). Detectors are switched of in a sequence depending upon the measured radiation dose rate. The ionizing radiation flow is transformed into electric pulses in the detector.

Dosimeter operation is controlled by the microprocessor responsible for different functions including the transformation of electric pulses into rate of $\dot{H}_p(10)$ and $H_p(10)$ values, self-test functions, functions of data accumulation and storage for rate of $\dot{H}_p(10)$ and $H_p(10)$ measurements, data exchange with PC, accumulator battery charge control etc. measurement result is displayed in the indicator.

General view of the dosimeter is shown by figure 1.1.

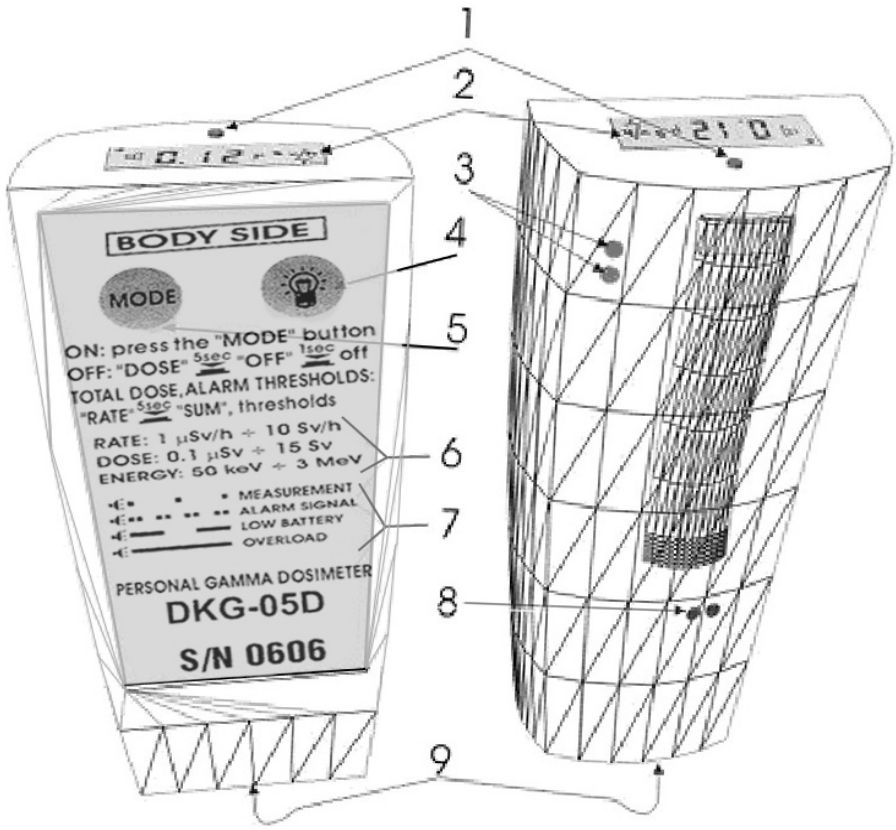


Figure 1.1 - General view of dosimeter

1) red light diode – doubling of sound signals in case of alarm or operation mode change;

2) combined LCD indicator;

3) sound signal source to provide sounds in case of operation mode change, rate of Hp(10) and Hp(10) threshold excess and battery discharge;

4) indicator light button;

5) «MODE» button to switch on/off the power and to change the following dosimeter operational modes:

- rate of $\dot{H}_p(10)$ measurement;
- measurement of single $H_p(10)$ accumulated from the time of the last switching on;
- cumulated $H_p(10)$ measurement;

6) ranges of measured values;

7) list of light and sound signals given at dosimeter operation (operator reference);

8) entrance IR window for PC connection via US-05 reader to preset systemic alarm thresholds for rate of $\dot{H}_p(10)$ and $H_p(10)$, to read measurement results and to adjust/ re-adjust dosimeter operation;

9) contacts of accumulator battery placed on the lower side of the casing.

1.4.2 The dosimeter provides *operational individual monitoring of personnel and sound and light alarming* in case of the rate of $\dot{H}_p(10)$ and $H_p(10)$ preset thresholds exceeding.

Operational individual monitoring of dose consumption for personnel of nuclear industry enterprises and others concerned with operation of power reactor facilities, handling, processing, and transportation of production containing radioactive materials. The dosimeters may be applied in medicine for radiotherapy and diagnostics as well as used by environmental, sanitary, and customs service.

ATTENTION! THE DEVICE SIDE WITHOUT CLIP HAS TO BE PLACED TO THE BODY DIRECTION.

The dosimeter presumes the setting of two levels of $H_p(10)$ thresholds: preventive and accidental presets, which exceeding is dosimeter user distinguished according to the character of the sound signal. If the preventive $H_p(10)$ preset is exceeded, doubled short (100 ms each) *sound tone signals* would occur, whereas the accidental $H_p(10)$ preset or rate of $\dot{H}_p(10)$ threshold are exceeded, tone signals have 250 ms duration each.

Alarm signal occurred in case of the exceeding any threshold would be automatically terminated, if the new rate of $\dot{H}_p(10)$ measured current value is below the threshold value of the alarm preset. This function provides user to automatically stop the alarm signal, if he/she has left the radiation field of dangerous (threshold) rate of $\dot{H}_p(10)$ level. It should be reminded, that $H_p(10)$ and rate of $\dot{H}_p(10)$ measurements are always simultaneous and the display is automatically re-switched to the mode of indication of the exceeded value.

Values of factory settings of *sound and light alarming are as follows:*

- $H_p(10)$ preventive threshold ……. 15 mSv;
- $H_p(10)$ accidental threshold ……. 20 mSv;
- if measured $H_p(10)$ value is above 42,9 μSv, the continuous alarm of 6 seconds duration would be switched on to signalize $H_p(10)$ indication limit excess; in such case maximal possible value of 42,9 μSv would be indicated;
- preventive rate of $\dot{H}_p(10)$ threshold which switches off the alarm is set 1 μSv/h;
- rate of $\dot{H}_p(10)$ accidental threshold is 12 μSv/h;
- if measured rate of $\dot{H}_p(10)$ value is above 42,9 μSv/h, the continuous alarm of 6 seconds duration would be switched on to signalize rate of $\dot{H}_p(10)$ indication limit excess; in such case maximal possible value of 42,9 μSv/h would be indicated;
- when the accumulator battery voltage is below 3,52 V, the blinking battery symbol would be indicated to prevent that the dosimeter will be automatically switched off in few hours because of the complete power discharge; in such case 2 second sound signal would be given each 15 minutes. In case of 3,3 V battery voltage, the switching off signal will be given and the dosimeter will be automatically switched off with the preservation of accumulated information in the memory. In case of dosimeter operation under negative outside temperature around minus 20 °C, the battery discharge symbol can be also indicated for almost charged battery. In such case the automated switching off will occur after 24 hours of continuous operation at least.

Systemic alarm thresholds of 1 μSv/h steps rate of $\dot{H}_p(10)$ and 1 μSv $H_p(10)$ are preset by the consumer, using PC and US-05 at any point of the measurement range.

Rate of $\dot{H}_p(10)$ measurement time is 1 to 255 s. The time of indication renewal is automatically increased for the decreasing dose rate. Each sequential calculation of rate of $\dot{H}_p(10)$ value is accompanied by sound signal of 60 ms duration.

Dosimeter power supply is provided by three accumulator batteries 280 mA/h capacity each with the total voltage 3,6 V. Continuous operation without battery charge is 100 hors for routine operation of the sound signal: less than 1 sound signal of measurement per minute. Battery charge is provided by ZU-1 charger included in the shipment set.

For dosimeter operation in the dosimetry monitoring system together with PC, the data transmission is arranged via US-05 reading device based upon the IR duplex communication channel.

1.5 Marking and sealing

1.5.1 Following marks are placed on the casings of dosimeter components:

- trade mark or the manufacturing plant mark;
- the product design letters;
- serial number as per the manufacturer numeration system;
- year of manufacture;
- instrumentation type approval mark.

1.5.2 The place and technology of marking and font size agree to requirements specified in design documentation.

1.5.3 The dosimeter and ZU-1 must be sealed according to design documentation.

1.6 Packing

1.6.1 The dosimeter shall be packed according to the requirements of category КУ-3 as per GOST 23170-78.

1.6.2 The dosimeter and ZU-1 internal packing is made in conformity with the requirements of GOST 9.014-78 for group III protection way В3-0, packing way ВУ-5.

1.6.3 The packing shall be produced in enclosed ventilated premises with ambient air temperature ranged from + 15 to + 40°C and relative air humidity up to 80 % at temperature 20°C and corrosive agents content in the air not exceeding the one specified for the atmosphere of type I GOST 15150-69.

2 INTENDED USE

2.1 Operational limits

2.1.1 The dosimeter keeps its operational abilities under conditions given by 1.2.

2.2 Preparation for operation

2.2.1 Dosimeter switching on/off

2.2.1.1 Dosimeter switching on is done by single push of the button «MODE». After switching on, the dosimeter will start self-testing mode, when whole electric circuits of the dosimeter are tested including indicator and detectors. In case of electric circuit failure the message **E-(01, 02, 04, 05)** would be indicated and the dosimeter will be automatically switched off. It will also switch off with the sound signal if the battery power voltage is below 3,3 V. If the power voltage is below 3,52 V the dosimeter will switch on but the preventive sound of 3 s duration will occur and battery discharge symbol will be indicated. Such signal will be always given if the voltage is below 3,6 V during the operation.

It should be noted that if the short time (less than 1 s) push is done when switching on the dosimeter, indicator and battery test results will be indicated; the longer push will result to exclusion of these indications to save time for operational mode start. Indicator and battery voltage tests can be also set via dosimeter configuring by the US-05 reading device and PC.

During dosimeter self-testing, sound and light signals will be given (red light diode glow) as well as all segments and symbols of the indicator to give the opportunity of indicator, sound and light workability visualization. At the end of the self-testing battery voltage is displayed and the dosimeter enters to operational measurement mode.

2.2.1.2 Dosimeter switching off is done as follows.

Under dose indication mode, to push and keep the button «MODE» until second sound signal. To release the button after the second sound. «OFF» reading will be indicated. Within next 5 s the button should be pressed and released. The dosimeter will be switched off with long sound. If the button is not pressed within 5 seconds after «OFF» indication, the indication will continue to indicate dose. The consumed electric current under switched on state does not exceed the self-discharge current of the accumulator battery.

2.3 Intended use

2.3.1 Choice of operational mode

The dosimeter is operated in any of three measurement modes with direct indication of measurement results:

- measurement of rate of personal gamma radiation dose equivalent $\dot{H}_p(10)$;
- measurement of single personal gamma radiation dose equivalent $H_p(10)$, the automated EPROM recording is carried out for the accumulated dose at specific time intervals;
- measurement of accumulated personal gamma radiation dose equivalent $H_p(10)$.

Mode selection and other operations are carried out by the button «MODE» push. The command execution is confirmed by the sound. Radiation danger symbol blinking indicated to the measurement in progress.

Under «TOTAL DOSE» mode, the dose accumulated within the whole operational time or from the moment of last erasure (if any) will be indicated.

To call accumulated dose to the indicator, the button should be pressed until the second sound under dose rate measurement mode. After the sound, the button should be released and the message SUM (value of cumulated dose) will be indicated. Upon 3 s the indicator will be back automatically to the rate of $\dot{H}_p(10)$ mode indication.

2.3.2 Dosimeter operation description in the complex with US-05 reading device

US-05 is used to provide duplex data exchange between computer and the dosimeter. PC connected via the COM-port to US-05 inquires it periodically. US-05 converts the electric signal of inquiry into IR pulses. If the dosimeter is inserted in US-05, it receives IR inquiry and sends the light signal of data exchange readiness. US-05 transforms the light response signal into electric signal transmitted to PC via COM-port communication.

The manual ФВКМ.467669.002 contains information on the design, operational principle, technical specifications and instructions about US-05.

2.3.3 Dosimeter operation description with ZU-1 charger

2.3.3.1 As already mentioned in 2.2.1, if the power voltage is below 3,52 V, the preventive sound of 3 s duration, which signal will be repeated each 15 min of the operation and the battery discharge symbol will be indicated.

ATTENTION! IN SUCH CASE, IT IS NECESSARY TO CHARGE THE ACCUMULATOR BATTERY, BECAUSE THE DOSIMETER WILL BE AUTOMATICALLY SWITCHED OFF IN SEVERAL HOURS OF OPERATION, WHEN THE VOLTAGE WILL DECREASE TO 3.3 V.

2.3.3.2 The switching on the device will be only possible after the battery charge.

The accumulator battery charging is provided by ZU-1 charger.

ZU-1 is the steel made casing fixed on the wall and it contains 220 V AC power supply contact sets connected in parallel to the power supply output. To charge the battery, ZU-1 has to be connected to 220 V mains and the dosimeter has to be fixed in ZU-1 contact set. Dosimeter indicator will show the battery voltage and red light diode will operate.

2.3.3.3 Charging process is arranged as follows. Immediately after 5 V application to the charging contact set placed in the dosimeter casing, the processor will stop the measurement and connect the load resistor to the battery poles, where 100 mA current will be applied for 3 s. Upon 3 s under the load, the battery voltage is measured. If the measured voltage is above 3,52 V the forced discharge will be stopped and time-unlimited < 15 mA current charging will be started. In such case the battery is considered to be normally charged and the dosimeter can be operated at any time. If the measured voltage is below or equal to 3.52 V the forced discharge will be continued until the voltage decrease to 3.3 V. thereafter, the normal charging by 90 to 100 mA will be initiated for 12 hours. Three variants of charging light indication are present:

- in case of forced discharge the light diode blinks with 2 Hz frequency,
- under normal charging by 90 to 100 mA the light diode blinks with 1 Hz frequency,
- under permanent charging by 15 mA (storage mode) the light diode is permanently illuminated.

3 MAINTENANCE

3.1 General

3.1.1 Dosimeter maintenance implies periodical visual examination for the purpose of absence of damages and check of operability according to 2.2. No additional requirements to personnel qualification and workplaces are needed.

3.1.2 Basic parameters are checked according to the procedure in section 4.

3.2 Safety measures

3.2.1 Prior to the dosimeter operation commencement one shall study this operating manual.

3.2.2 «Main sanitary rules of radiation safety assurance СП 2.6.1.799-99 (OSPOBR-99)» and «Radiation safety standards СП 2.6.1.758-99 (NRB-99)» requirements shall be observed during the dosimeter maintenance.

4 VERIFICATION

4.1 General

4.1 Verification of the dosimeter is performed by State metrological service authorities or by other authorized bodies, organizations entitled to carry out the verification. The requirements to the organization, procedure of verification and the form of verification results presentation are specified in ПР 50.2.006-94 «State system of uniformity of measurements assurance. Procedure of instrumentation verification».

All newly produced, taken out from repair and operating dosimeters are subject to verification.

Primary verification is carried out when dosimeters are newly produced and after their repair.

Regular verification is performed during dosimeters operation.

Re-verification interval is one year.

4.2 Operations and verification equipment

Operations and equipment shown in table 4.1 should be used while verification tests.

Table 4.1 – Operations and equipment for verification

Operation	No. of item	Verification equipment and their reference technical specifications	Obligatory for	
			Primary calibration	Periodical verification
1. Visual examination	4.5.1	Visually	Yes	Yes
2. Testing	4.5.2		Yes	Yes
3. Assessment of $H_p(10)$ rate of $\dot{H}_p(10)$ measurement relative error	4.5.3	Verification installation or similar with ^{137}Cs sources, which provides exposure to $\dot{H}_n(10)$ within: from 0,1 to 3000 mSv/h with the error of no more than ±5 %. Chronometer C1-2a ТУ 25-1 819.0027-90. Phantom: - cube 30×30×30 cm, tissue equivalent substance	Yes	Yes
4. Results recording	4.6		Yes	Yes
Note – It is permitted to use verification means and equipment newly elaborated or in operation, which are similar or better than these shown in the present verification technique.				

4.3 Safety requirements

When conducting verification, safety requirements of 3.2 and given in documentation on applied verification means and equipment are obligatory.

4.4 Conditions

The following conditions shall be observed during verification:

- ambient temperature ……..……..……..……..……. +(20 ±5) °C;
- air relative humidity ……..……...…… from 30 to 80 %;
- atmospheric pressure ……...…… from 86, 0 to 106,7 kPa;
- natural radiation background ……..……...….. not more than 0,2 μSv·h^{-1}.

4.5 Procedure

4.5.1 Visual examination

Visual examination one should check:

- correspondence of the dosimeter set;
- operational documentation presence;
- absence of defects affecting on dosimeter operation;
- presence of previous verification marks.

4.5.2 Testing

Dosimeter testing is done according to 2.2.1 operations.

4.5.3 Assessment of relative $H_p(10)$ rate of $\dot{H}_p(10)$ measurement error

4.5.3.1 For verification to be performed, the verification installation or similar device which is certified for $\dot{H}_p(10)$ rate of gamma radiation within the error of 5 % in the ranges of 0,1 to 100 mSv/h and 100 to 3000 mSv/h) with ^{137}Cs sources should be used.

Notes

1 To protect the operator caring out verification against the overexposure, information is read using remote video camera or other optical device (for example, binoculars) to exclude the operator exposure to radiation field of the source.

2 Verification test is not performed in the whole range of Hp(10), it is warranted by positive results of Hp(10) verification test in two points and rate of Hp(10) in the whole measurement range.

4.5.3.2 Place the phantom on the verification installation so that the phantom plane is perpendicular to radiation incidence.

When measuring, the dosimeter should be closely placed on the phantom side faced to the radiation source. The dosimeter clip should be faced to the radiation source and the detector center (its projection is marked in the casing – see Annex C) should be on the line which connects the radiation source with the phantom surface center.

4.5.3.3 Perform rate of $\dot{H}_p(10)$ and $H_p(10)$ measurements according 2.2 and 2.3.

4.5.3.4 Relative error assessment under rate of $\dot{H}_p(10)$ measurement mode should be done for rate of $\dot{H}_p(10)$ values of 0,1, 50, 500, 3000 mSv/h.

4.5.3.5 Relative error assessment under $H_p(10)$ measurement mode should be done for $\dot{H}_p(10)$ values from 0,4 to 0,5 mSv/h and from 1 to 1,2 Sv/h. Exposure time should not be less than 200 s.

4.5.3.6 At least, five rate of $\dot{H}_p(10)$ measurements should be done, $\dot{H}_p(10)_i$ for each conditionally true value of personal dose equivalent rate, $\dot{H}_p(10)_{0i}$, according to 4.5.3.4 and personal dose equivalent rate, $\dot{H}_p(10)_j$ for conditionally true value of dose, $\dot{H}_p(10)_{0j}$, according to 4.5.3.5 and average values of measured parameters should be calculated.

4.5.3.7 Minimal and maximal measured values of rate of $\dot{H}_p(10)$ and $H_p(10)$ should be determined.

4.5.3.8 Calculate relative differences (%) by following formulae

$$\delta_{\dot{H}} = 100 \cdot \left[\dot{H}_p(10)_{0i} - \dot{H}_p(10)_{i\min}\right] / \dot{H}_p(10)_{0i} \quad . \quad (4.1)$$

$$\delta_{\dot{H}} = 100 \cdot \left[\dot{H}_p(10)_{0i} - \dot{H}_p(10)_{i\max}\right] / \dot{H}_P(10)_{0i} \quad (4.2)$$

$$\delta_{\mathrm{H}} = 100 \cdot [\mathrm{H}_p(10)_{oj} - \mathrm{H}_p(10)_{j\min}] / \mathrm{H}_p(10)_{oj} \quad (4.3)$$

$$\delta_{\mathrm{H}} = 100 \cdot [\mathrm{H}_p(10)_{oj} - \mathrm{H}_p(10)_{j\max}] / \mathrm{H}_p(10)_{oj} \quad (4.4)$$

4.5.3.9 Verification test results are positive, if no one value of errors in absolute magnitude does exceeded the value given in 1.2.4.

4.6 Recording of results

4.6.1 The dosimeter verification positive results are finalized in accordance with PR 50.2.006-94.

4.6.2 If the verification results are negative, a notification of the dosimeter unserviceability is issued or a respective record is made in the technical documentation and the dosimeter is not permitted to be used.

5 ROUTINE REPAIR

5.1 Possible failures of the dosimeter and their troubleshooting are shown by table 5.1.

Table 5.1- Possible failures of the dosimeter and their troubleshooting

Failure	Possible cause	Troubleshooting
The indicator is not activated when the dosimeter is switched on	Accumulator battery discharged	To charge battery
Arbitrary signs are indicated when the dosimeter is switching on and than switches off dosimeter power supply	Accumulator battery failure	To replace battery
Charging is absent or instable	Bad contact between contact sets of the dosimeter and charger	To recover the contact

5.2 The routine repair of ZU-1 consists in the recovery of damaged cables and connectors. Inner parts of the dosimeter are not repairable and subjected to the replacement in case of their failure.

6 STORAGE

6.1 Prior to its putting into operation the dosimeter should be stored preserved in enclosed warehouses with natural ventilation. The dosimeter is allowed to be kept in unheated premises without artificial control of climatic conditions. The conditions of the storage of the dosimeter packaged by the manufacturer shall conform to 3 (G3) as per GOST 15150:

- ambient air temperature ……... from + 5 to +40 °C;
- air relative humidity ……..…… 80 % at 25 ºC;

It is not permitted that the dosimeter be stored unpreserved and unpackaged.

The storage premises shall be free of dust, vapours of acids and alkali, aggressive gases and other detrimental impurities causing corrosion.

The storage place shall exclude the sun rays direct impact on the packaged dosimeter.

6.2 Shelf life is three years.

7 TRANSPORTATION

7.1 The dosimeter packaged by the manufacturer can be transported by all means of transport for any distance:

- the transportation by railway shall be made in clean box cars;
- when transported by open moto transport the boxes with units shall be covered with the waterproof material;
- when transported by air the boxes with units shall be placed in air-tight heated compartment;
- when transported by water and sea transport the boxes with units shall be placed in a bilge.

7.2 The boxes arrangement and fastening on transport means shall provide their steady position en route, absence of displacement and striking each other.

7.3 The requirements of the inscriptions on the transport packing shall be observed during loading and unloading.

7.4 Transportation conditions are as follows:

- temperature ……..….... from minus 50 to +50 °C;
- humidity ……...…… up to 98 % at +35 °C;
- sinusoidal vibrations …… within frequency range from 10 to 500 Hz with displacement amplitude 0,35 mm below crossover frequency, with acceleration 5,0 g above crossover frequency (group F3 as per GOST 12997-84).

8 UTILIZATION

8.1 On the dosimeter (its component parts) service life full expiry and prior to its taking out for repair it shall be inspected for the matter of radioactive contamination of its surfaces.

8.2 The dosimeter should be decontaminated if the level of the device surfaces (including those accessible for repair) radioactive contamination can be reduced up to allowable values.

8.3 It is allowed that absorbed dose rate at a surface (0,1 m) be used as a criterion of further use of the dosimeter contaminated with unknown gamma-emitting radionuclides.

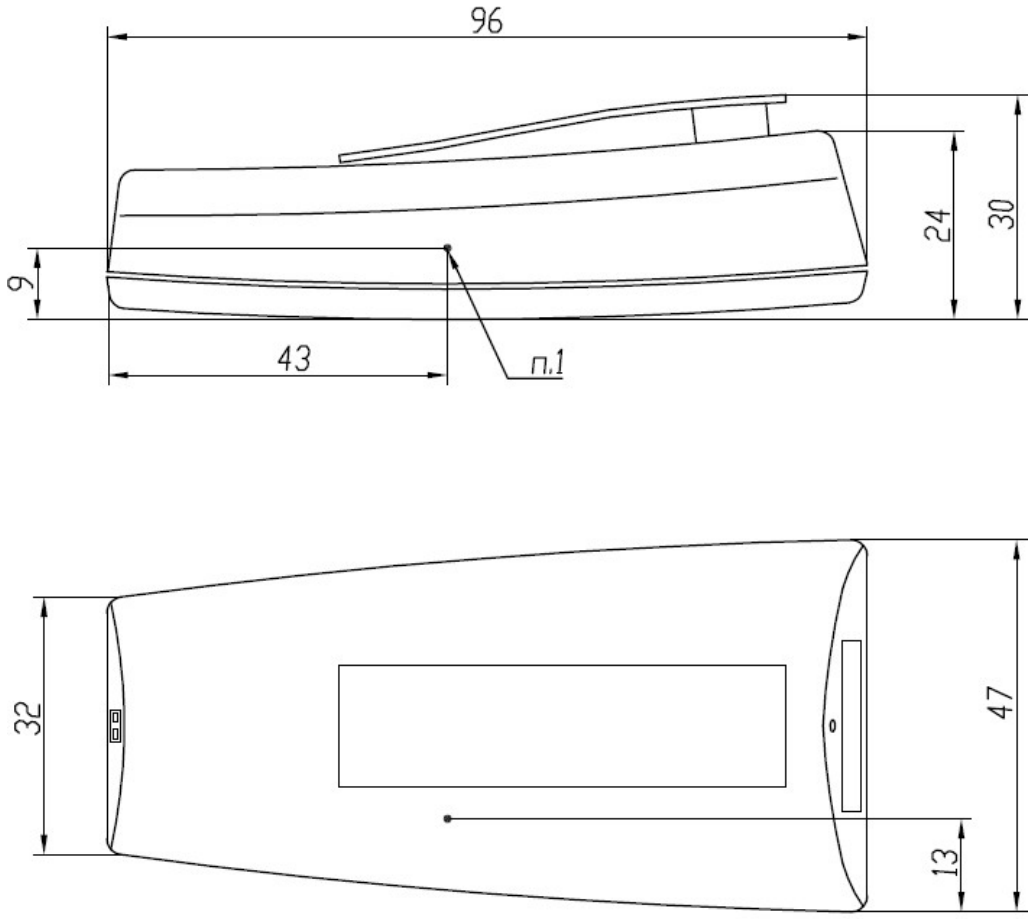
8.4 In case the dose rate is 0,001 mGy/h (1 μSv/h) higher than the background value after decontamination or the radioactive contamination level permissible values have been exceeded the requirements are imposed on the dosimeter as to radioactive wastes (RAW).

8.5 The dosimeter permitted to be used after decontamination is subject to repair if it fails. The unfit for further use dosimeter the surface radioactive contamination level of which does not exceed permissible limits shall be dismantled in order to exclude the possibility of its further use and shall be forwarded to specially separated places of industrial wastes burial.

The dosimeter the service life of which has expired and which is allowed to be used after decontamination is subjected to its technical condition inspection. If its technical condition is satisfactory, the dosimeter is subject to verification and determination of its further operation life.

Annex A
(obligatory)

OVERALL AND CONNECTION DIMENSIONS



1. Dots indicate the detection unit center projection