BDPN-07
DETECTING UNIT
OF NEUTRON RADIATION

Operating manual
BICT.418251.028-02 HE

CONTENTS

This operating manual (the OM) is intended to inform the user about the principles of operation, rules of application, maintenance, storage and transportation of the BDPN-07 detecting unit of neutron radiation.

The OM contains the following abbreviations:

F_{th} – a numeric value of thermal neutrons flux density, equivalent to N/(cm^2·min)
F_f – a numeric value of fast neutrons flux density, equivalent to N/(cm^2·min)
LCD – digital liquid crystal display.

1 DESCRIPTION AND OPERATION

1.1 Purpose of use of BDPN-07 detecting unit

BDPN-07 detecting unit of neutron radiation (hereinafter referred to as the detecting unit) is designed to search for neutron radiation sources, measure the equivalent dose rate of neutron radiation, and measure flux density of thermal and fast neutrons.

The detecting unit comes with the MKS-07 "POSHUK" search dosimeter-radiometer ТУ У 22362867.003-99. The detecting unit can also be used as a part of computer-aided systems of radiation control.

1.2 Technical specifications

1.2.1 Key specifications are presented in Table 1.1.

Table 1.1 - Key specifications of the detecting unit

Name	Unit of measurement	Standardized value according to the specifications
1 Measurement range of equivalent dose rate of neutron radiation	μSv/h	$0.1 – 10.0 \cdot 10^4$
2 Main relative permissible error limit when measuring the equivalent dose rate of neutron radiation	%	15+2/M, where M is a dimensionless quantity numerically equal to the value of neutron radiation dose rate measured in μSv/h
3 Measurement range of thermal neutrons flux density	N/(cm^2·min)	$10 – 10^5$
4 Measurement range of fast neutrons flux density	N/(cm^2·min)	$50 – 10^5$
5 Main relative permissible error limit of thermal neutrons flux density measurement at Pu-Be calibration with confidence probability of 0.95	%	$20+200/F_{th}$, where F_{th} is a dimensionless quantity numerically equal to the value of thermal neutrons flux density measured in N/(cm^2·min)
6 Main relative permissible error limit of fast neutrons flux density measurement at Pu-Be calibration with confidence probability of 0.95	%	$20+500/F_f$, where F_f is a dimensionless quantity numerically equal to the value of fast neutrons flux density measured in N/(cm^2·min)

Table 1.1 (continued)

Name	Unit of measurement	Standardized value according to the specifications
7 Detected neutrons energy range	eV	$0.025 – 14 \cdot 10^6$
8 Maximum gamma radiation exposure dose rate that does not introduce complementary error at measurement of neutrons flux density, not more than	μR/hour	10^4
9 Supply voltage of the detecting unit	V	4.8±0.6
10 Useful current of the detecting unit for overall measurement range of neutron flux density, not more than	mA	50
11 Time of operating mode setting and measurement time of the detecting unit, not more than	min	1
12 Unstable readings of the detecting unit during 6-hour continuous operation, not more than	%	5
13 Complementary permissible error limit at measurement, caused by ambient temperature change from minus 25 ºC to 55 ºC	%	5 per each 10 ºC deviation from 20 ºC
14 Dimensions of the detecting unit with the main moderator, not more than	mm	Ø76x195
15 Dimensions of the detecting unit without the main moderator, not more than	mm	Ø76x176
16 Dimensions of the additional moderator, not more than	mm	215x295x270
17 Weight of the detecting unit with the main moderator, not more than *	kg	0.8
18 Weight of the detecting unit unit without the main moderator, not more than *	kg	0.55
19 Weight of the additional moderator, not more than	kg	8
* - without the telescopic tube clamp of 0.125 kg weight.		

1.2.2 Use environment.

1.2.2.1 Regarding the resistance to climatic and other environmental factors, the detecting unit meets the requirements of C1 group according to the recommendations of GOST 12997-84 standard with the additions outlined below.

1.2.2.2 The detecting unit is resistant to the influence of the following climatic factors:

- air temperature from - 25 ºC to 55 ºC;
- relative humidity up to 100 % at 30 ºC temperature, non-condensing;
- atmospheric pressure from 84 kPa to 106.7 kPa.

No requirements to other climatic factors.

1.2.2.3 The detecting unit is resistant to sinusoidal vibrations under N1 group according to the recommendations of GOST 12997-84 standard.

1.2.2.4 The detecting unit is resistant to shocks with the following parameters:

- shock pulse duration – from 5 ms to 10 ms;
- number of shocks - 1000±10;
- maximum shock acceleration – 100 m/s^2.

1.2.2.5 The detecting unit in transport container is resistant to the influence of:

- ambient air temperature from - 40 ºC to 60 ºC;
- relative humidity up to (95 ± 3) % at 35 ºC temperature;
- shocks with acceleration of 98 m/s^2, shock pulse duration of 16 ms, and number of shocks – 1000±10.

1.2.2.6 The detecting unit is resistant to the influence of magnetostatic fields or alternating magnetic fields (50 Hz ±1 Hz) with 400 A/m voltage.

1.2.2.7 The detecting unit is resistant to the influence of gamma radiation with exposure dose rate up to 1.0 Sv/hour during 5 min.

1.3 Delivery kit of the detecting unit

The delivery kit of the detecting unit consists of units and maintenance documentation, given below.

1.3.1 BDPN-07 detecting unit

BICT.418251.028-02 (with the main moderator) .....1 pc.

1.3.2 Additional moderator BICT.301111.002.....1 pc.

1.3.3 Clamp for fastening to the telescopic tube BICT.301539.002.....1 pc.

1.3.4 Operating manual BICT.418251.028-02 HE.....1 copy.

1.3.5 Packing BICT.412915.043 …….....1 pc.

1.4 Design and operation principle of the detecting unit

1.4.1 Design description.

Depending on the operatimg mode, the design of the detecting unit has the following configurations and consists of:

- to search for sources of neutron radiation - (according to Figure 1) - the electronic module (1) with a removable main moderator (2) of cylindrical shape, which are connected by a threaded connection;

- to measure the thermal neutron flux density - (according to Figure 2) - only of the electronic module (the removable main moderator is removed at that).

- to measure the fast neutron flux density - (according to Figure 3) - the electronic module with a removable main moderator attached, which are mounted together in the hole of the additional moderator (3).

1.4.1.1 The electronic module (according to Figure 2) is designed as a compact measuring instrument that has a combined cylindrical shape with an external thread (3) to connect the main moderator. A neutron radiation detector is located in the elongated cylindrical part (4) of the module's body. The rest of the electronic part of the module is located in a part (5) with a larger diameter, on the end surface of which there are the output connector (6), the rubber membrane (7) in the central hole, behind which is the button switch for changing the calibration factors. The body parts are made of aluminum alloy.

1.4.1.2 The main moderator is intended for operation of the electronic module in the mode of search for neutron radiation sources. It is made from polyethylene in the shape of the cup with an external thread and wall thickness of about 2 cm. It is mounted on the part of the electronic module where the neutron radiation detector is located.

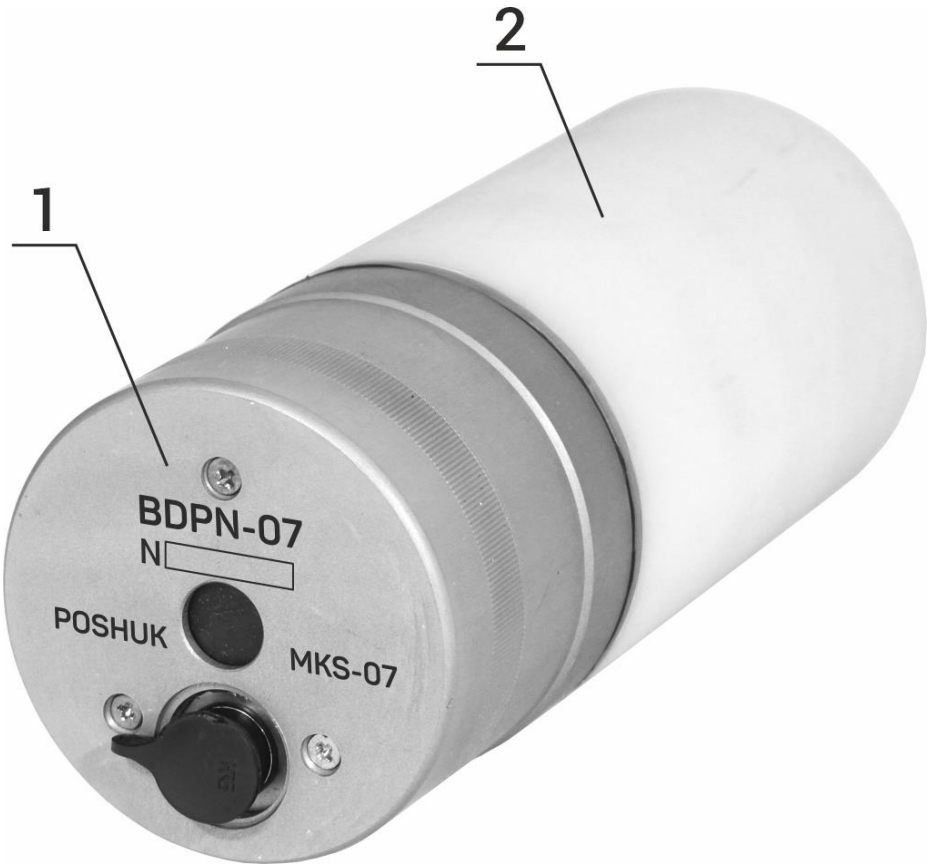

Figure 1

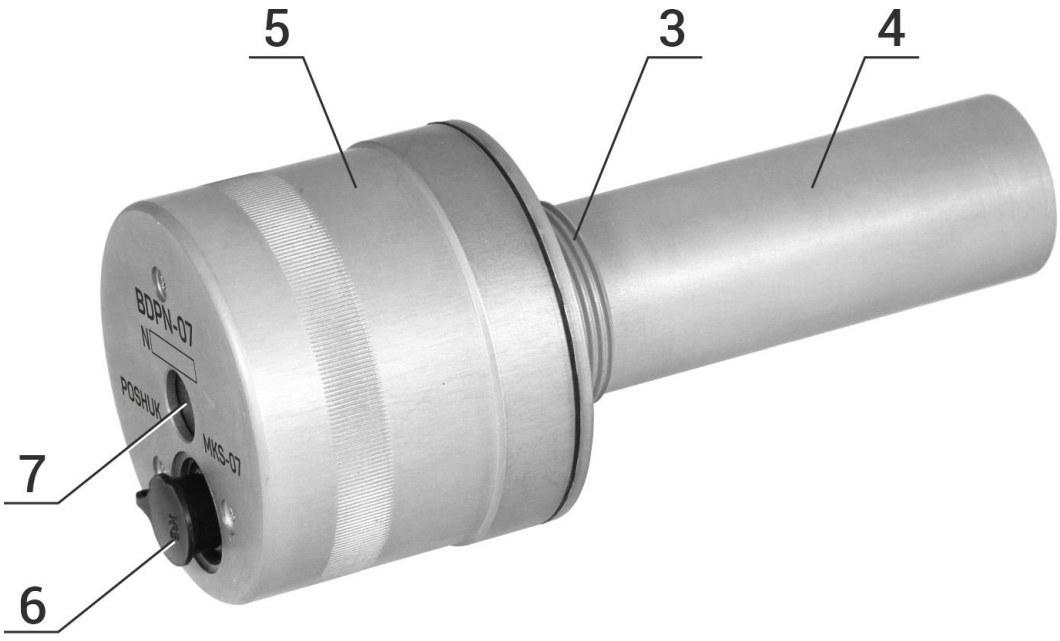

Figure 2

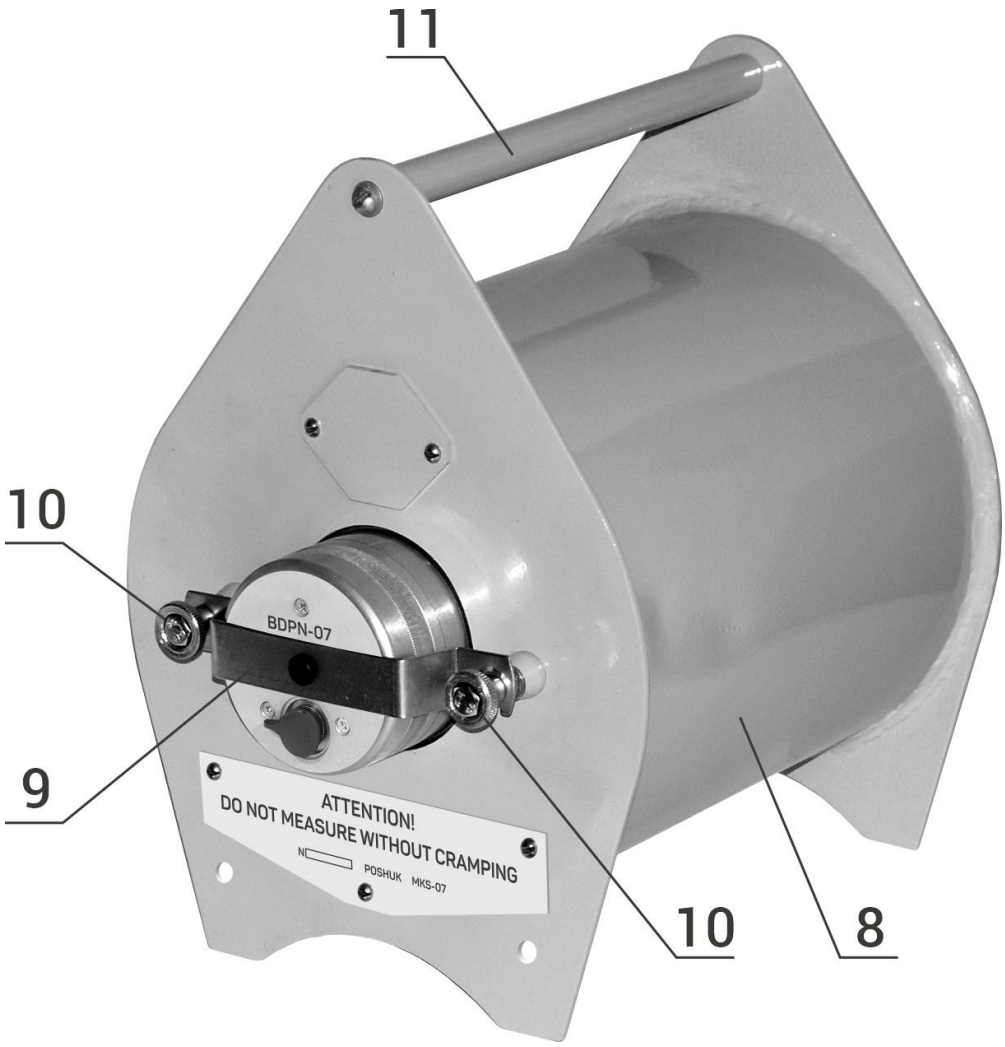

Figure 3

1.4.1.3 The additional moderator is intended for operation in the mode of fast neutrons flux density measurement. It is (according to Figure 3) a cylindrical container (8) with a central blind hole. The inner space of the container is filled with paraffin, which forms an additional 6 cm thick shell. To operate, the electronic module with the connected main moderator is mounted in the central hole of the additional moderator and is cramped by a bracket (9) with two threaded clamps (10).

Simultaneously, the cramp presses the push-button switch of the electronic module through the rubber membrane, which generates a signal of calibration factors change in the control unit of MKS-07 "POSHUK" dosimeter. The inscription “DO NOT MEASURE WITHOUT CRAMPOING” reminds about the need of cramping the detecting unit on the wall of the additional moderator. To move the detecting unit in this configuration, the design of the additional moderator provides a carrying handle (11).

1.4.1.4 The clamp (12) for fastening to the telescopic tube (13) from the kit of MKS-07 "POSHUK" search dosimeter-radiometer ensures comfortable handling of the detecting unit in hard-to-reach places during operation in the modes of searching for neutron radiation sources and measurement of thermal neutrons flux density.

It is installed (according to Figure 4) on the cylindrical part of the electronic module and is fixed with two threaded clamps (14) in the position with the angle within 0º to 175º between

geometrical axes of the telescopic tube and the detecting unit. The clamp is fixed to the telescopic tube with the help of a thread connection.

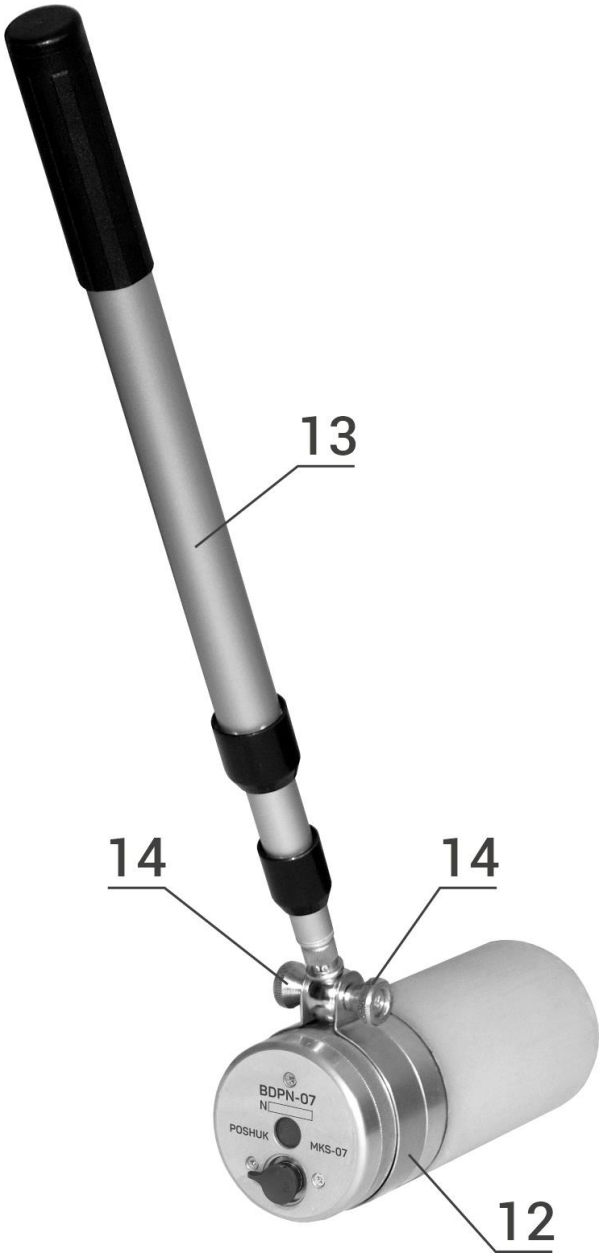

Figure 4

1.4.2 Operation principle of the detecting unit.

Operation of the detecting unit is based on the method of transformation of neutron radiation into the voltage pulse train on the detector's outlet.

The counter of CHM-56 type (or similar) that works in the corona discharge mode is used as the detector in the detecting unit. The meter is filled under pressure with He-3 gas.

For corona discharge ignition, high voltage is applied to the counter. Voltage is generated by a converter with a diode-capacitive voltage multiplier controlled by a microcontroller.

The pulses from neutrons on the counter outlet are cut off from the noise. They are generated by the amplitude and fed to the output of the detecting unit.

1.5 Measuring instruments, tools and equipment

1.5.1 The list of measuring instruments, tools and equipment necessary for control, setting and current repair of the detecting unit is presented in the Table 1.2.

Table 1.2 - List of measuring instruments, tools and equipment

Name	Standardized document or main technical requirements
1 MKS-07 "POSHUK" search dosimeter-radiometer	ТУ У 22362867.003-99
2 Digital voltmeter	Measurement range of direct current intensity from 10^{-7} A to 1 A
3 DC power source	Output voltage - from 0 V to 30 V. Output current - from 0 A to 2.5 A
4 РЕТУ 12-03-01-03 working standard with neutron radiation sources of ИБН-8 type	Thermal neutrons flux density range from 10 to 100000 N/(cm^2·min); Fast neutrons flux density range from 50 to 100000 N/(cm^2·min);
Note - Other measuring instruments that satisfy the specified accuracy can be used	

1.6 Labeling and sealing

1.6.1 Labeling of the detecting unit is performed by engraving in accordance with GOST 26828-86 standard and drawings of the manufacturer. Labeling contains:

- detecting unit index;
- serial number according to the numbering system of the manufacturer;

Note - Trademark of the manufacturer is applied to the packing (original bag).

1.6.2 Sealing of the detecting unit according to the drawings is carried out by the manufacturer.

1.6.3 Removal of seals and repeated sealing of the detecting unit during repair works is performed by the organization in charge of repair.

1.6.4 Labeling of the transport container is done according to GOST 14192-96 standard.

Transport containers with packed detecting units are sealed with the stamp's imprint of the responsible organization.

1.7 Packing

1.7.1 The detecting unit (the electronic module with the attached additional moderator, the clamp for fastening to the telescopic tube, the additional moderator) and operating documentation (operating manual) are placed in plastic film covers, then in the package (original bag). The original bag is a service part of the product and is used to move the kit consisting of the above parts to places where the presence of neutron radiation is examined.

1.7.2 When transported to the consumer, the filled original bags are placed in transport containers. The type of the transport container is determined by the contract, and the manufacturer does not standardize it. Inside surfaces of the walls, bottom and cover of the transport container should be furnished with corrugated cradboard in accordance with GOST 7376-89 standard.

2 PROPER USE

2.1 Operating limitations

2.1.1 The detecting unit is a complex electronic-physical device that should be competently serviced.

2.1.2 Study this document before you start using the detecting unit. All requirements stated in the technical documents for the detecting unit should be precisely met.

2.1.3 The detecting unit should operate under conditions that do not fall outside the use requirements outlined in section 1.2.2.

2.2 Preparation of the detecting unit for operation

2.2.1 Safety measures.

2.2.1.1 The detecting unit contains no external parts exposed to life-threatening electrical voltages.

2.2.1.2 During calibration and testing of the detecting units, if operating with ionizing radiation sources, the radiation safety requirements stated in the valid regulatory document "Radiation safety standards of Ukraine" (NRBU-97). State hygienic standards DGN 6.6.1-6.5.001-98 should be met.

2.2.2 Volume and order of external examination.

2.2.2.1 Before using the detecting unit, unpack it and check if the delivery kit is complete. Examine for mechanical damage.

2.2.2.2 Before using the detecting unit that was on temporary closing-down, re-activate it and check its operability.

2.2.2.3 Register the re-activation and putting the detecting unit in operation in the corresponding sections of the OM.

2.2.3 Guidelines on switching on and testing the detecting unit with description of testing procedure of the detecting unit in operation.

2.2.3.1 Prepare the MKS-07 “POSHUK” search dosimeter-radiometer (hereinafter the MKS-07 dosimeter) for operation. Do the following:

- take the control unit of MKS-07 dosimeter out of the packing case;
- connect the connecting cable (included in the dosimeter’s kit) to the corresponding inlet of the control unit of MKS-07 dosimeter.

2.2.3.2 Prepare the detecting unit for operation. Do the following:

- unpack the detecting unit equipped with the main and additional moderators;
- cramp the electronic module with the help of two threaded clamps (according to Figure 3);
- remove the plug from the output connector of the detecting unit;
- connect the detecting unit, equipped with the main and additional moderators, to the cable, which has already been connected with one end to the control unit of the MKS-07 dosimeter.

2.2.3.3 Switch on the control unit of the MKS-07 dosimeter and observe the “$10^3/cm^2 \cdot min$” unit of measurement and the “n” symbol on the liquid crystal display (hereinafter the LCD) of the control unit. Even if there is no neutron radiation source, readings from 0.001 to 0.002 can be observed on the LCD because of personal background of the neutron counter used.

2.2.3.4 For a period of not more than one second, press the SCALE button of the MKS-07 dosimeter’s control unit twice and make sure that the unit changes from “$10^3/cm^2 \cdot min$” to “μSv/h”. Press the SCALE button twive once again and make sure that the unit changes from “μSv/h” to “$10^3/cm^2 \cdot min$”.

2.2.3.5 Take the detecting unit out of the additional neutron moderator. Remove the main moderator.

Observe the unit "$10^3/cm^2 \cdot min$" and the flashing "n" symbol on the LCD. At the same time, even if there is no neutron radiation source, readings from 0.001 to 0.002 can be observed on the LCD because of personal background of the neutron counter used.

2.2.4 List of possible troubles and troubleshooting.

2.2.4.1 The list of possible troubles and troubleshooting is presented in Table 2.1.

Table 2.1 - List of possible troubles and troubleshooting

Trouble	Probable cause	Troubleshooting
1 The control unit of the MKS-07 dosimeter does not identify the detecting unit	The cable between the detecting unit and the control unit of the dosimeter is damaged	Replace the cable
2 The control unit of the MKS-07 dosimeter identifies the detecting unit, but at presence of neutron radiation source, no measurement results are displayed	The detecting unit is out of order	Send the detecting unit for repair

2.2.4.2 Troubles during use are registered in the Table of Annex D of this operating manual.

2.2.4.3 At failure to eliminate the troubles presented in Table 2.1, or if more complicated faults arise, the detecting unit should be sent for repair to the repair services or to the manufacturer.

2.3 Use of the detecting unit

2.3.1 Safety measures during use of the detecting unit.

2.3.1.1 Safety measures during use of the detecting unit fully comply with the requirements presented in section 2.2.1 of the OM.

2.3.1.2 Direct use of the detecting unit is not dangerous for the maintenance personnel and is environmentally friendly.

2.3.2 Operation procedure of the detecting unit.

The detecting unit can be used in four operating modes:

- search for the neutron radiation sources;
- measurement of the thermal neutrons flux density;
- measurement of the fast neutrons flux density;
- measurement of the equivalent dose rate of neutron radiation

2.3.2.1 To search for neutron radiation sources, do the following:

- unpack the detecting unit;
- attach the clamp for the telescopic tube to the electronic module (with the main moderator connected) and connect the telescopic tube (according to Figure 4);
- remove the plug form the output connector of the detecting unit;
- connect the detecting unit to the control unit of MKS-07 dosimeter with the help of the connecting cable;
- set the detecting unit on the telescopic tube to the working position and fix it with threaded clamps;
- with quick (for a time not exceeding one second) double presses of the SCALE button of the MKS-07 dosimeter control unit, set the necessary measurement units of measurement results;
- set the required threshold level of sound alarm triggering on the MKS-07 dosimeter's control unit);
- place the detecting unit at the minimum distance from the object to be examined.

- search for neutron radiation source using audio alarm of the MKS-07 dosimeter, illumination of the segments of the analog intensity indicator and the readings increment on the LCD.

2.3.2.2 To measure thermal neutrons flux density, do the following:

- unpack the detecting unit;
- remove the main moderator from the electronic module.
- set the clamp to the electronic module and connect the telescopic tube (according to Figure 4);
- remove the plug form the output terminal of the detecting unit;
- connect the detecting unit to the control unit of MKS-07 dosimeter with the help of the connecting cable;
- set the detecting unit on the telescopic tube to the working position and fix it with threaded clamps;
- place the detecting unit at the minimum distance from the object to be examined;
- read the measurement results from the LCD on the control unit of the dosimeter. If required to get precise results, measurement should be carried out in the "Precise" mode in compliance with the technical specifications and the operating manual for the MKS-07 dosimeter.

2.3.2.3 To measure fast neutrons flux density, do the following:

- unpack the detecting unit;
- install the electronic module (with the main moderator connected) in the additional moderator and fix it with a bracket with threaded clamps;
- remove the plug form the output connector of the detecting unit;
- connect the detecting unit, equipped with the main and additional neutron moderators, to the control unit of the MKS-07 dosimeter with the help of the connecting cable;
- place the detecting unit at the minimum distance from the object to be examined;
- if the measurement results are displayed in "μSv/h", set the dimension of the measurement results as "10^3/cm^2·min". To do this, for a time not exceeding one second, press the SCALE button of the MKS-07 dosimeter control unit twice;
- read the measurement results from the LCD on the control unit of the dosimeter. If required to get precise results, measurement should be carried out in the "Precise" mode in compliance with the technical specifications and the operating manual for the MKS-07 dosimeter.

2.3.2.4 To measure equivalent dose rate of newutron radiation, do the following:

- unpack the detecting unit;
- install the electronic modukle (with the main moderator connected) in the additional moderator and fix it with a clamp with threaded clamps;
- remove the plug form the output connector of the detecting unit;
- connect the detecting unit, equipped with the main and additional neutron moderators, to the control unit of the MKS-07 dosimeter with the help of the connecting cable;
- place the detecting unit at the minimum distance from the object to be examined;
- if the measurement results are displayed in "10^3/cm^2·min", set the dimension of the measurement results as "μSv/h". To do this, for a time not exceeding one second, press the SCALE button of the MKS-07 dosimeter control unit twice;
- read the measurement results from the LCD on the control unit of the dosimeter. If required to get precise results, measurement should be carried out in the "Precise" mode in compliance with the technical specifications and the operating manual for the MKS-07 dosimeter.

3 MAINTENANCE

3.1 Technical maintenance of the detecting unit

3.1.1 General instructions.

The list of operations during technical maintenance (hereinafter the TM) of the detecting unit, order and peculiarities of operational phases are given in the Table 3.1.

Table 3.1 - List of operations during maintenance

List of operations	Maintenance type			OM item No.
	during		during long-term storage	
	everyday use	periodical use (annually)		
External examination	-	+	+	3.1.3.1
Delivery kit completeness check	-	-	+	3.1.3.2 3.1.3.3
Operability check	+	+	+	
Damaged covering repair	-	+	+	3.1.3.4
Verification	-	+	+	3.2
Registration of operations in the performance records table	-	+	-	3.1.3.5
Note – "+" symbol means the operation is applicable during this maintenance type, "-" symbol means the operation is not applicable				

3.1.2 Safety measures.

Safety measures during maintenance fully comply with safety measures presented in section 2.2.1 of the OM.

3.1.3 Maintenance procedure of the detecting unit.

3.1.3.1 External examination.

3.1.3.1.1 External examination of the detecting unit should be performed in the following order:

a) check the condition of the detecting unit surface, integrity of seals, absence of scratches, traces of corrosion, and surface damage;

b) check the condition of the connector in the cable connection point.

3.1.3.1.2 Clean the metal parts of the detecting unit with the oiled cloth after operation in the rain or after special treatment (deactivation).

3.1.3.1.3 Deactivation of the case surface and component parts of the detecting unit is performed if required.

Deactivate the surface of the component parts of the detecting unit by cleaning it with decontamination solution.

Boric acid (H_3BO_3 12÷16 g/l) is recommended to be used as the decontamination solution. The following decontamination solutions are also permitted:

- 5 % solution of citric acid in ethyl alcohol C_2H_5OH (96 % concentration);
- boric acid – 16 g/l, $Na_2S_2O_3 \cdot 5H_2O$ – 1 % solution;
- standard synthetic detergents.

Expenditure rate of the decontamination solution during deactivation of the detecting unit surface is 0.2 l. Use cotton gloves, surgical gloves and sheeting during deactivation.

To deactivate, wipe thoroughly the contaminated areas of the detecting unit surface with a cloth moistened with decontamination solution, then with a cloth moistened with warm water and wipe dry.

Notes

1 Before deactivating the detecting unit, put on cotton gloves and rubber (surgical) gloves, observing safety requirements for operation with chemical solutions.

2 Deactivation of the detecting unit can be done according to the procedure established at the object of use for ionizing radiation measuring instruments.

3.1.3.2 Delivery kit completeness check.

Check if the delivery kit of the detecting unit is complete according to section 1.3 of the OM. Check the technical condition of the component parts of the detecting unit, and the presence of the maintenance documentation.

3.1.3.3 Operability check of the detecting unit.

3.1.3.3.1 Operability check of the detecting unit in the process of its use is performed according to 2.2.3.

3.1.3.3.2 The procedure of pre-repair fault detection and rejection.

Use the following criteria to evaluate the necessity of sending the detecting unit for repair and type of repair:

- for mid-life repair:

a) deviation of parameters from control values during periodical verificaiton of the detecting unit;

b) minor defects of the connector that do not affect its hermiticity and correct readings of measurement results;

- for major repair:

a) non-operating measuring channel;

b) mechanical damages that affected the detecting unit case or the connector.

3.1.3.4 Registration of operations in the performance records table.

Register actual operation hours of the detecting unit in Annex A of the OM.

3.2 Verification of the detecting unit

The detecting units should be tested after manufacture, repair and during use (periodical testing at least once a year).

3.2.1 Verification operations.

During testing, the operations presented in Table 3.2 should be performed.

Table 3.2 - Verification operations

Operation name	Verification procedure No.
1 External examination	3.2. 4.1
2 Testing	3.2. 4.2
3 Calculation of the main relative permissible error limit at measurement of thermal neutrons flux density	3.2.4.3
4 Calculation of the main relative permissible error limit at measurement of fast neutrons flux density and equivalent dose rate of neutron radiation	3.2.4.4

3.2.2 Verification facilities.

The following measuring instruments and equipment should be used during testing:

- ТУ У 22362867.003-99 MKS-07 “POSHUK” search dosimeter-radiometer;
- РЕТУ 12-03-01-03 working standard;
- MB-4M aspirated psychrometer;
- M-67 control aneroid barometer;

Usage of other measurement equipment that meets the specified accuracy is allowed.

3.2.3 Verification conditions.

Verification should be carried out in compliance with the following conditions:

- ambient air temperature in the range of (20±5) ^{o}C;
- relative air humidity in the range of (65±15) %;
- atmospheric pressure from 84 kPa to 106.7 kPa;
- natural background level of gamma radiation, not more than 0.30 μSv/h;

3.2.4 Verification procedure.

3.2.4.1 External examination.

During external examination the detecting unit should meet the following requirements:

- the delivery kit should meet section 1.3 of the OM;
- labeling should be accurate;
- QCD seals should not be violated;
- the detecting unit should be free from mechanical damage that may affect its performance.

3.2.4.2 Testing.

The detecting unit should be tested according to section 2.2.3 of the operating manual.

3.2.4.3 Calculation of the main relative error at measurement of thermal neutrons flux density.

3.2.4.3.1 Prepare the РЕТУ 12-03-01-03 working standard according to its operating manual to creating the thermal neutrons flux.

3.2.4.3.2 Fix the detecting unit with the removed main and additional neutron moderators and attached protection cap in the УКПН-1М carriage holder, which is included into the kit of РЕТУ 12-03-01-03 working standard, so that the mechanical center of thermal neutrons beam coincides with the detector center. The detector center is the mechanical center of the main axis of the detecting unit. The neutron flux must fall perpendicular to the main axis of the detector.

3.2.4.3.3 Connect the detecting unit with the help of the connecting cable to the control unit of the MKS-07 dosimeter and switch on the dosimeter according to its operating manual.

3.2.4.3.4 Place the neutron radiation source of ИБН-8-1 type into the РЕТУ 12-03-01-03 working standard.

3.2.4.3.5 Place the УКПН-1М carriage with the detecting unit in a position, where the distance between the neutron radiation source and the detecting unit center is 2.0 m.

3.2.4.3.6 Measure thermal neutrons flux density in the “Precise” mode in compliance with the technical specification and the operating manual for the MKS-07 dosimeter.

Register the received readings in the report. Calculate the main relative error limit of measurement.

3.2.4.3.7 Repeat the operations according to 3.2.4.3.6 for the distance between the neutron radiation source and the detecting unit center of 1.0 m.

3.2.4.3.8 Repeat the operations according to 3.2.4.3.6 for the distance between the neutron radiation source and the detecting unit center of 0.75 m.

3.2.4.3.9 Repeat the operations according to 3.2.4.3.6 for the distance between the neutron radiation source and the detecting unit center of 0.5 m.

3.2.4.3.10 Repeat the operations according to 3.2.4.3.5 - 3.2.4.3.9 with the neutron radiation source of ИБН-8-7 type placed in the РЕТУ 12-03-01-03 working standard.

3.2.4.3.11 The detecting unit is acknowledged to have passed the testing, if the limit of the main relative error at measurement of each value of thermal neutrons flux density does not exceed $(20+200/F_{th})$ %, where F_{th} – a dimensionless quantity numerically equal to the value of the thermal neutrons flux density measured in $N/(cm^2 \cdot min)$.

3.2.4.4 Calculation of the main relative error at measurement of fast neutrons flux density and equivalent dose rate of neutron radiation.

3.2.4.4.1 Prepare the РЕТУ 12-03-01-03 working standard according to its operating manual to create the fast neutrons flux.

3.2.4.4.2 Fix the detecting unit with the attached main and additional neutron moderators and the locking cramp clutched with the help of the threaded clamps in the УКПН-1М carriage holder, so that the mechanical center of the fast neutrons beam coincides with the detector center. The detector center is the mechanical center of the main axis of the detecting unit. The neutron flux must fall perpendicular to the main axis of the detector.

3.2.4.4.3 Connect the detecting unit with the help of the connecting cable to the control unit of the MKS-07 dosimeter and switch on the dosimeter according to its operating manual.

3.2.4.4.4 Place the neutron radiation source of ИБН-8-1 type into the РЕТУ 12-03-01-03 working standard.

3.2.4.4.5 Place the УКПН-1М carriage with the detecting unit in a position, where the distance between the neutron radiation source and the detecting unit center is 2.0 m.

3.2.4.4.6 If necessary, quickly (for a time not exceeding one second) double press the SCALE button of the MKS-07 dosimeter control unit, and set the measurement unit of the measurement results as "$10^3/cm^2 \cdot min$".

3.2.4.4.7 Measure fast neutrons flux density in the "Precise" mode in compliance with the technical specification and the operating manual for the MKS-07 dosimeter.

Register the received readings in the report. Calculate the main relative error limit of measurement.

3.2.4.4.8 Quickly (for a time not exceeding one second) double press the SCALE button of the MKS-07 dosimeter control unit, and set the measurement unit of the measurement results as "μSv/h".

3.2.4.4.9 Measure the equivalent dose rate of neutron radiation dose in "Precise" mode according to the technical specification and operating manual for the MKS-07 dosimeter.

Record the result in the report. Calculate the limit of the main relative measurement error.

3.2.4.4.10 Repeat the operations according to 3.2.4.4.6 … 3.2.4.4.9 for the distance between the neutron radiation source and the detecting unit center of 1.0 m.

3.2.4.4.11 Repeat the operations according to 3.2.4.4.6 … 3.2.4.4.9 for the distance between the neutron radiation source and the detecting unit center of 0.75 m.

3.2.4.3.12 Repeat the operations according to 3.2.4.4.6 … 3.2.4.4.9 for the distance between the neutron radiation source and the detecting unit center of 0.5 m.

3.2.4.4.13 Repeat the operations according to 3.2.4.4.5 - 3.2.4.4.12 with the neutron radiation source of ИБН-8-7 type placed in the РЕТУ 12-03-01-03 working standard.

3.2.4.4.14 The detecting unit is acknowledged to have passed the testing, if:

- the limit of the main relative error at measurement of each value of thermal neutrons flux density does not exceed $(20+500/F_f)$ %, where F_f – a dimensionless quantity numerically equal to the value of the fast neutrons flux density measured in $N/(cm^2 \cdot min)$.

- the limit of the main relative error at measurement of the equivalent dose rate of neutron radiation does not exceed (15+2/M)%, where M – a dimensionless quantity, numerically equal to the value of neutron radiation dose rate measured in μSv/h.

3.2.4.5 Presentation of verification results.

3.2.4.5.1 Satisfactory verification results are presented as follows:

1) in the"Certificate of acceptance"section;

2) by issuance of a calibration certificate of the established form or registration in the table of Annex D hereto.

3.2.4.5.2 The detection units that do not meet the requirements of the verification procedure shall not be allowed for use and get a certificate of inadequancy.

4 CERTIFICATE OF ACCEPTANCE

The BDPN-07 detecting unit of neutron radiation with _____ serial number has been accepted for use and calibrated.

Date of issue _____

Stamp here Quality Control Department: _____
(signature)

5 PACKING CERTIFICATE

The BDPN-07 detecting unit of neutron radiation with _____ serial number is packed at the PE “SPPE “Sparing-Vist Center” enterprise in accordance with the requirements stated in section 1.7.

Date of packing _____

Stamp here Packed by: _____
(signature)

Packed product accepted by: _____
(signature)

6 WARRANTY

6.1 The manufacturer warrants that the detecting unit meets the technical requirements, if the user observes the operating, transportation and storage terms described in the BICT.418251.028-02 HE operating manual.

6.2 The warranty period of the detecting unit shall terminate and be of no further effect in 24 months after the date of putting it into operation or after the warranty period of storage terminates.

6.3 The warranty period of storage of the detecting unit is 6 months after the manufacture date.

6.4 The warranty period of use is prolonged for the time when the detecting unit has been under warranty repair.

6.5 After the warranty period terminates, the repair of the detecting unit is performed under separate contracts.

6.6 Warranty and post-warranty repair is done only by the producer enterprise.

6.7 If the mechanical damage is detected or the seals are removed, the repair is done at the customer’s expense.

7 REPAIR

7.1 In case of failure or troubles during the warranty period of the detecting unit, the user should draw up a statement about the necessity of repair and deliver the detecting unit to the manufacturer at the address:

PE “SPPE “Sparing-Vist Center”
33 Volodymyr Velyky Str.,
Lviv 79026, Ukraine
Tel.: (+38032) 242 15 15,
Fax: (+38032) 242 20 15.

7.2 All claims are registered in the Table 7.1

Table 7.1

Date of failure	Claim summary	Action taken	Note

7.3 Information about repair of the detecting unit is registered in the table of the Annex F of the Operating Manual.

8 STORAGE AND PUTTING IN PROLONGED STORAGE

8.1 Before putting in operation, the detecting unit should be stored in the packing of the producer enterprise in storehouses under special conditions (1 (L) in accordance with GOST 15150-69 standard). The storage period should not exceed one year. Transportation time is included in the storage period of the device.

8.2 If necessary to prolong the storage period, or if the storage conditions are harsher than stated in section 8.1, the consumer should temporarily close the detecting unit down in accordance with GOST 9.014-78 standard. The consumer chooses the temporary closing-down option.

8.3 Additional information on storage, check during storage and maintenance of the detecting unit is registered in Annexes B, C, G of the OM.

9 TRANSPORTATION

9.1 The detecting units should be transported under the conditions similar to those presented in 1.2.2.5 of the OM.

9.2 The detecting units can be transported by railway, motor, water and air transport. When transported by railway transport, the detecting units should be placed in a box car. When carried by motor transport, they should be placed in a closed body or van, by water transport – in a ship’s hold, and by air transport – in pressurized compartments.

9.3 During transportion of the detecting units, observe handling marks inscribed on the transport containers.

9.4 Total transportion time of the detecting units in packing of the producer enterprise should not exceed one month.

9.5 Canting of the detecting units is forbidden.

10 DISPOSAL

Disposal of the detecting unit is performed according to DSTU 4462.3.01:2006, DSTU 4462.3.02:2006, the Laws of Ukraine "On Environmental Protection" and "On Waste".

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

The detecting unit should be disassembled in accordance with the procedure established by the user enterprise.

ANNEX A

OPERATION REGISTER

Date	Purpose for operation	Time of switching on	Time of switching off	Operation duration

ANNEX B
PUTTING IN PROLONGED STORAGE AND REMOVAL FROM STORAGE

Date of putting in prolonged storage	Storage method	Date of removal from prolonged storage	Name of the enterprise in charge of putting in, or removing of the device from prolonged storage	Date, position and signature of the responsible official

ANNEX C

STORAGE

Date		Storage conditions	Position, name and signature of the responsible official
of placing in storage	of removing from storage		

ANNEX D

TROUBLE RECORD DURING USE

Date and time of trouble Operating mode	Type (external manifestation) of trouble	Cause of trouble, number of operation hours of the failed element	Action taken and claim note	Position, name and signature of the person responsible for solving the problem	Note

ANNEX E

PERIODIC VERIFICATION OF KEY SPECIFICATIONS

Verified specification		Verification date					
Name	Value according to the technical requirements	20		20		20	
		Actual value	Measured by (position, signature)	Actual value	Measured by (position, signature)	Actual value	Measured by (position, signature)
Main relative permissible error limit when measuring the equivalent dose rate of neutron radiation	15+2/M, where M is a dimensionless quantity numerically equal to the value of neutron radiation dose rate measured in μSv/h						
Main relative permissible error limit at measurement of thermal neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+200/F_{th}$, where F_{th} is a dimensionless quantity numerically equal to the value of thermal neutrons flux density measured in $N/(cm^2 \cdot min)$						
Main relative permissible error limit at measurement of fast neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+500/F_f$, where F_f is a dimensionless quantity numerically equal to the value of fast neutrons flux density measured in $N/(cm^2 \cdot min)$						

ANNEX F

REPAIR

Name and type of the component part	Reason for repair	Date		Name of the repair organization	Number of hours worked before repair	Type of repair	Name of repair	Position, name and signature of the responsible official	
		of arriving for repair	of repair completion					who performed the repair	who accepted after repair

ANNEX G

VERIFICATION AND INSPECTION RESULTS

Date	Type of verification or inspection	Result of verification or inspection	Position, name and signature of the person responsible for verification	Note