BDPN-07
DETECTING UNIT
OF NEUTRON RADIATION

Operating manual
BICT.418251.002-02 РЭ

CONTENTS

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

The OM contains the following abbreviations:

N_{th} – a numeric value of thermal neutrons flux density, equivalent to N/(cm^2·min)
N_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 the BDPN-07 detecting unit

The BDPN-07 detecting unit of neutron radiation (hereinafter called the detecting unit) is designed to search for neutron radiation sources 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 or the MKS-U multipurpose dosimeter-radiometer ТУ У 22362867.005-2000. 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 the 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 thermal neutrons flux density	N/(cm^2·min)	$10 – 10^5$
2 Measurement range of fast neutrons flux density	N/(cm^2·min)	$50 – 10^5$
3 Basic relative permissible error limit of thermal neutrons flux density measurement at Pu-Be calibration with confidence probability of 0.95	%	$20+200/N_{th}$, where N_{th} is a numeric value of thermal neutrons flux density, equivalent to N/(cm^2·min)
4 Basic relative permissible error limit of fast neutrons flux density measurement at Pu-Be calibration with confidence probability of 0.95	%	$20+500/N_f$, where N_f is a numeric value of fast neutrons flux density, equivalent to N/(cm^2·min)
5 Detected neutrons energy range	eV	$0.025 – 14·10^6$
6 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

Table 1.1 (continued)

Name	Unit of measurement	Standardized value according to the specifications
6 Operating supply voltage of the detecting unit form the external regulated power supply	V	3.30±0.05
7 Useful current of the detecting unit for overall measurement range of neutron flux density, not more than	mA	50
8 Time of operating mode setting and measurement time of the detecting unit, not more than	min	1
9 Unstable readings of the detecting unit during 6-hour continuous operation, not more than	%	5
10 Complementary permissible error limit at measurement, caused by ambient temperature change from minus 25 ^{o}C to 55 ^{o}C	%	5 per each 10 ^{o}C deviation from 20 ^{o}C
11 Dimensions of the detecting unit with the main moderator, not more than	mm	Ø76x195
12 Dimensions of the detecting unit with the protective cap, not more than	mm	Ø76x175
13 Dimensions of the additional moderator, not more than	mm	215x295x270
14 Weight of the detecting unit with the main moderator, not more than *	kg	0.8
15 Weight of the detecting unit with the protective cover, not more than *	kg	0.55
16 Weight of the additional moderator, not more than	kg	8

* - without the telescopic bar clamp 0.125 kg weight.

1.2.2 Use environment.

1.2.2.1 Concerning the resistance to climatic and other environmental factors, the detecting unit meets the requirements outlined below.

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

- air temperature from - 25 ^{o}C to 55 ^{o}C;
- relative humidity up to 100 % at 30 ^{o}C 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.

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 shipping container is resistant to the influence of:

- ambient air temperature from - 40 ^{o}C to 60 ^{o}C;
- relative humidity up to (95 ± 3) % at 35 ^{o}C 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 BICT.418251.002-02 BDPN-07 detecting unit

(with the main moderator) .....1 pc.

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

1.3.3 BICT.716721.001 Protective cap..... 1 pc.

1.3.4 BICT.301539.001 Clamp for fastening to the telescopic bar..... 1 pc.

1.3.5 BICT.418251.002-02 РЭ Operating manual..... 1 copy.

1.3.6 BICT.412915.007 Packing …….....1 pc.

1.4 Design and operation principle of the detecting unit

1.4.1 Design description.

The detecting unit (according to Figure 1) consists of an electronic module (1) and main moderator (2) with the same outer diameters.

1.4.1.1 The electronic module (according to Figure 2) is designed as a compact measuring instrument of cylindrical form. It is constructed as component parts of electric circuit that are combined in multilayer structure. The component parts are secured to the bottom of the metal cup (3) with internal thread through a rubber sealing layer. The multilayer construction consists of the elements located one over another:

- wiring strip (4) with output connector and push-button switch, which forms the signal of calibration factors change in the control panel of the dosimeter depending on the operating mode;
- printed-circuit board of the high voltage former (5);
- printed-circuit board of output signal former with electrostatic screen (6);
- insulator (7);
- detector (8).

To protect the output connector from possible contamination an adjustable plug is provided (not shown).

1.4.1.2 The main moderator (9) is intended for operation of the electronic module in the mode of search for neutron radiation sources. It is made from polyethylene in the form of the cup with an external thread and wall thickness of 2 cm. During assembly the moderator is put on the detector of the electronic module and with the help of the thread it is connected to the external metal cup through the rubber sealing layer (10).

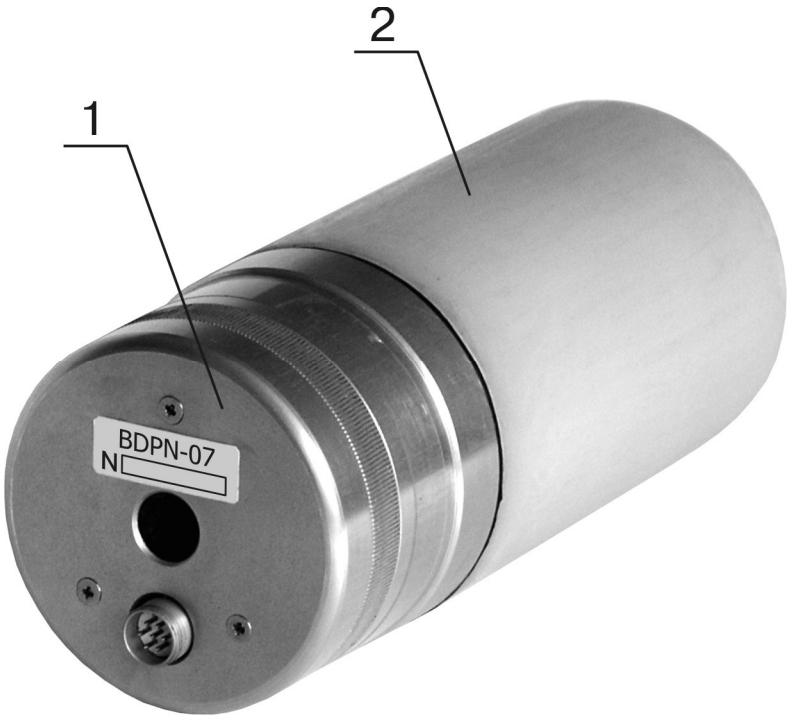

Figure 1

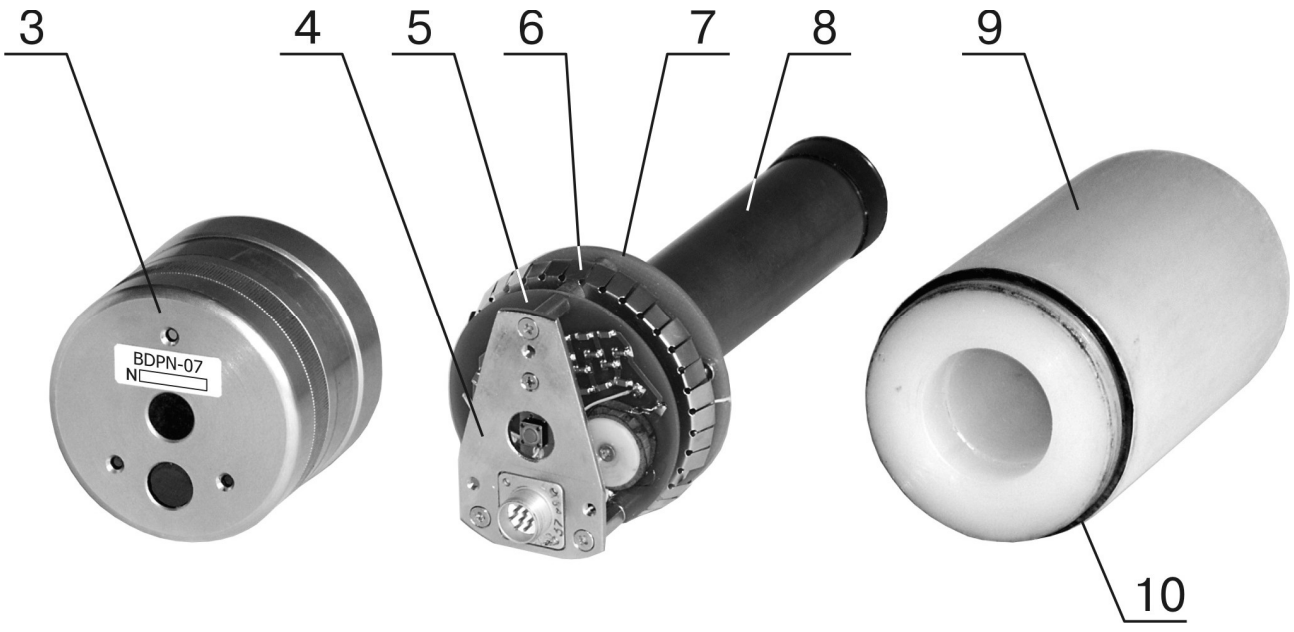

Figure 2

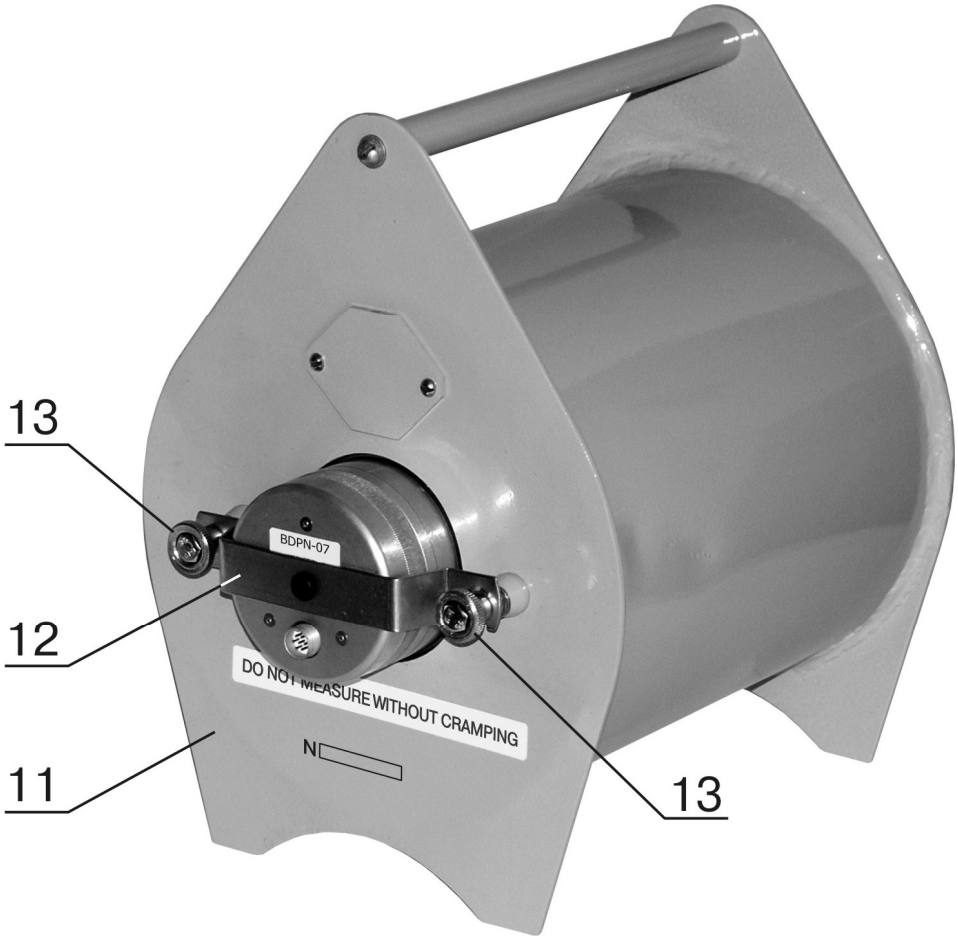

Figure 3

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) the case of cylindrical form (11), the inside of which is limited with cylindrical walls (inner and outer) and two plane side walls, structural elements of which at the same time are the legs and the brackets for fixing the handle for carrying the additional moderator. The inside of the case is filled with paraffin that creates additional layer, 6 cm thick, for the detecting unit. For operation the detecting unit (with the main moderator) is inserted in the central hole of the additional moderator and is cramped (12) with the help of two threaded clamps (13) located on the wall of the case. Simultaneously the cramp presses the bush-button switch of the electronic module, which forms the signal of calibration factors change in the control panel of the dosimeter. The necessity of cramping the detecting unit is indicated with the help of the "DO NOT MEASURE WITHOUT CRAMPING" inscription on the wall of the additional moderator.

1.4.1.4 The protective cap is intended to protect the detector of the electronic module from the impact of external mechanical and climatic factors. Externally it looks like the main moderator and it is constructed as a thin-walled metal cup with the external thread, which through the rubber sealing layer is placed instead of the main moderator after the letter was removed. The outer diameter of the protective cover is bigger, than the diameter of the central hole of the additional moderator, thus excluding the possibility of inserting it into the additional moderator by mistake.

1.4.1.5 The clamp for fastening to the telescopic bar (14) ensures comfortable handling of the 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 (13) in the position with the angle within 0º to 175º between

geometrical axes of the telescopic bar and the detecting unit. The clamp is fixed to the telescopic bar with the help of the bayonet connection.

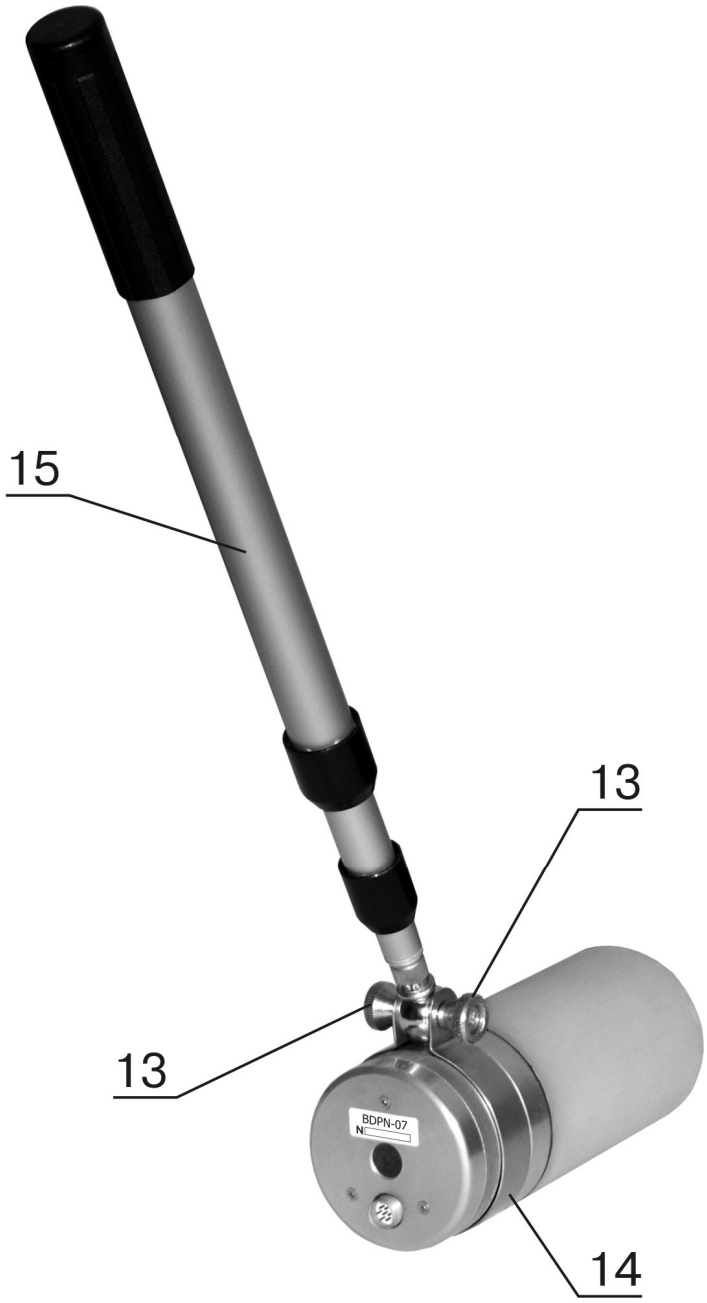

Figure 4

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 that works in the corona discharge mode is used as the detector in the detecting unit. The counter is filled with pressure He-3 gas.

For corona discharge ignition, high voltage of 1500 V is applied to the counter. Voltage is formed with the scheme based on the multivibrator with diode-capacitive voltage multiplier.

Pulses from neutrons on the counter outlet are separated from noise. They are formed according to the amplitude and sent to the detecting unit outlet.

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 В7-21А Digital voltmeter	Measurement range of direct current intensity from 10^{-7} A to 1 A
3 ИПУ-12У2 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 are permitted	

1.6 Labeling and sealing

1.6.1 The case of the detecting unit is marked with engraving according to the design document of the producer enterprise. Labeling contains:

- trademark of the producer enterprise;
- design letter of the detecting unit type;
- serial number according to the numbering system of the manufacturer;
- production date.

Note - Trademark of the producer enterprise and production date can be printed on the individual packing of the detecting unit.

1.6.2 Sealing of the detecting unit is performed by the producer enterprise.

1.6.3 Removal of seals and repeated sealing is performed by the organization in charge of repair of the units.

1.6.4 Labeling of the shipping container contains main (consignee and destination), additional (consigner of goods and origin), and informational (gross and net weight in kg) letterings, as well as handling marks No.1 "Fragile – Handle with care", No.3 "Protect from humidity", No.11 "This side up".

The type of the detecting unit (BDPN-07) and the number of the detecting units in packing box is labeled under the main letterings.

The shipping container with the packed detecting units is sealed by the representative of the Quality Control Department of the producer enterprise.

1.7 Packing

1.7.1 The detecting unit and the maintenance documentation are placed in plastic sachets, which are welded after packing performed. Then they are packed in a special packing bag.

1.7.2 At shipping, the detecting units, which are packed in packing bags, are placed into unitized shipping containers (wooden boxes). Inside surfaces of the walls, bottom and cover of the box should be furnished with corrugated cradboard.

Note - Other types of unitized containers are allowed.

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 voltages hazardous for life.

2.2.1.2 During calibration and testing of the detecting units, if operating with ionizing radiation sources, the radiation safety requirements stated in valid regulatory documents should be met.

2.2.2 Volume and order of external examination.

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 panel of the 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 panel of the 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 panel of the MKS-07 dosimeter.

2.2.3.3 Switch the control panel of the MKS-07 dosimeter on and observe the "10^3/cm^2·min" dimension of quantity and the "n" symbol on the liquid crystal display of the control panel (hereinafter the LCD). 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 Take the detecting unit out of the additional neutron moderator. Remove the main moderator by turning it counterclockwise. Replace it with the protective cap by turning it clockwise.

2.2.3.5 Disconnect the main and additional neutron moderators from the detecting unit and observe "10^3/cm^2·min" dimension of quantity and flashing "n" symbol on the LCD. 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 the Table 2.1.

Table 2.1 - List of possible troubles and troubleshooting

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

2.2.4.2 Troubles during use are registered in Appendix D of this operating manual.

2.2.4.3 At failure to eliminate the troubles presented in the Table 2.1, or at detection of more complicated faults, the detecting unit should be sent for repair to the repair services or to the producer enterprise.

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 three operating modes:

- search for neutron radiation sources;
- measurement of thermal neutrons flux density;
- measurement of fast neutrons flux density.

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

- unpack the detecting unit;
- remove the additional neutron moderator from the detecting unit;
- attach the clamp for the telescopic bar to the detecting unit (according to Figure 4);
- remove the plug form the output connector of the detecting unit;
- connect the detecting unit to the control panel of the MKS-07 dosimeter with the help of the connecting cable;
- attach the telescopic bar to the detecting unit with the help of the bayonet connection;
- set the detecting unit in operating position on the telescopic bar and fix it with threaded clamps;
- set the audio alarm threshold level at the level of not more than $0.005 \cdot 10^3/(cm^2 \cdot min)$;
- 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, flashing of segments of the analog intensity indicator and readings increment on the LCD.

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

- unpack the detecting unit;
- remove the additional neutron moderator from the detecting unit;
- remove the main moderator by turning it counterclockwise. Replace it with the protective cap by turning it clockwise.
- set the clamp on the detecting unit according to Figure 4;
- remove the plug form the output terminal of the detecting unit;
- connect the detecting unit to the control panel of the MKS-07 dosimeter with the help of the connecting cable;
- attach the telescopic bar to the detecting unit with the help of the bayonet connection;
- set the detecting unit in operating position on the telescopic bar 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 panel of the dosimeter. If required to get precise results, measurement should be carried out in the “Start-Stop” or “Precisely” modes 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;
- cramp the electronic module with the help of 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 panel 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;
- read the measurement results from the LCD on the control panel of the dosimeter. If required to get precise results, measurement should be carried out in the “Start-Stop” or “Precisely” modes 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 technical 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.

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

3.1.3.1.2 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, the placement 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 2.2.4.

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:

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

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

- for major repair:

а) non-operating measuring channel;

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

3.1.3.4 Damaged covering repair.

Repair damaged covering of the detecting unit case with the help of the НЦ-1125 enamel. Choose carefully the proper tint to try to match the color of the lacquered covering. Clean the area that should be enameled. Brush on a level layer of paint on the surface.

3.1.3.5 Registration of operations in the performance records table.

Register actual operation hours of the detecting unit in Appendix 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 the 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 basic relative permissible error limit at measurement of thermal neutrons flux density	3.2.4.3
4 Calculation of basic relative permissible error limit at measurement of fast neutrons flux density	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 0.25 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 be completed as described in 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.

Note - The delivery kit completeness is checked only at manufacture.

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 basic 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 for creating 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 should fall at right angle to the detector main axis.

3.2.4.3.3 Connect the detecting unit with the help of the connecting cable to the control panel 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 “Precisely” mode in compliance with the technical specification and the operating manual for the MKS-07 dosimeter.

Register the received readings in the protocol. Calculate the basic 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 limits of basic relative error at measurement of each value of thermal neutrons flux density does not exceed $(20+200/N_{th})$ %, where N_{th} is a numeric value of thermal neutrons flux density in $N/(cm^2 \cdot min)$.

3.2.4.4 Calculation of basic relative error at measurement of fast neutrons flux density.

3.2.4.4.1 Prepare the РЕТУ 12-03-01-03 working standard according to its operating manual for creating 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 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 should fall at right angle to the detector main axis

3.2.4.4.3 Connect the detecting unit with the help of the connecting cable to the control panel 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 З Measure fast neutrons flux density in the “Precisely” mode in compliance with the technical specification and the operating manual for the MKS-07 dosimeter.

Register the received readings in the protocol. Calculate the basic relative error limit of measurement.

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

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

3.2.4.4.10 Repeat the operations according to 3.2.4.4.5 - 3.2.4.4.9 with the neutron radiation source of ИБН-8-7 type placed in the РЕТУ 12-03-01-03 working standard.

3.2.4.4.11 The detecting unit is acknowledged to have passed the testing, if the limits of basic relative error at measurement of each value of thermal neutrons flux density does not exceed $(20+500/N_f)$ %, where N_f is a numeric value of fast neutrons flux density in $N/(cm^2 \cdot min)$.

3.2.4.5 Presentation of verification results.

3.2.4.5.1 Positive results of primary or periodic verification are presented as follows:

1) primary verification is registered in the “Certificate of acceptance” section

2) periodic verification is registered in the issued certificate of the established form, or in the table of Appendix E of this OM.

The results of primary verification of the detecting unit are registered in the Table 3.3.

Table 3.3 – Primary verification of key specifications

Verified specification		Actual value
Name	Standardized value	
Basic relative permissible error limit at measurement of thermal neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+200/N_{th}$, where N_{th} is a numeric value of thermal neutrons flux density in $N/(cm^2 \cdot min)$	
Basic relative permissible error limit at measurement of fast neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+500/N_f$, where N_f is a numeric value of fast neutrons flux density in $N/(cm^2 \cdot min)$	

3.2.4.5.2 The detecting units that do not meet the requirements of the verification procedure are not allowed for manufacture and use, and get the certificate of inadequacy.

4 CERTIFICATE OF ACCEPTANCE

The BDPN-07 detecting unit of neutron radiation with _____ serial number is tested and accepted for use.

Date of manufacture _____

Stamp here Quality Control Department: _____
(signature)

Verification mark here

State Verification Officer: _____
(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, provided that the user observes the operating, shipping and storage conditions described in the ВІСТ.418251.002-02 РЭ operating manual.

6.2 The warranty period of the detecting unit shall terminate and be of no further effect in not less than 18 months after the date of putting it into operation, or after the warranty storage period 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 is terminated, 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.

6.8 Failure of batteries after their warranty terminates is not the basis for claims.

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 Appendix 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. The storage period should not exceed one year. Shipping 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. Temporary closing-down according to the B3-10 protection option is recommended. Silicagel, used during temporary closing-down, is recommended to be placed into fabric bags or paper packages. It is allowed to perform not more than two temporary closing-downs. Before putting in prolonged storage or repeated use, silicagel should be dried. Total time of the detecting unit storage with the account of the repeated closing-down should not exceed 5 years.

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

9 SHIPPING

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

9.2 The detecting units can be shipped by railway, motor, water and air transport. When shipped 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 car, by water transport – in a ship's hold, and by air transport – in pressurized compartments.

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

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

9.5 Canting is forbidden.

10 DISPOSAL

Disposal of the detecting unit is performed as follows: metals are recycled or melted, and plastic parts are dumped.

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.

APPENDIX A

OPERATION REGISTER

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

APPENDIX 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

APPENDIX C

STORAGE

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

APPENDIX 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

APPENDIX 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)
Basic relative permissible error limit at measurement of thermal neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+200/N_{th}$, where N_{th} is a numeric value of thermal neutrons flux density in $N/(cm^2 \cdot min)$						
Basic relative permissible error limit at measurement of fast neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+500/N_f$, where N_f is a numeric value of fast neutrons flux density in $N/(cm^2 \cdot min)$						

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)
Basic relative permissible error limit at measurement of thermal neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+200/N_{th}$, where N_{th} is a numeric value of thermal neutrons flux density in $N/(cm^2 \cdot min)$						
Basic relative permissible error limit at measurement of fast neutrons flux density at Pu-Be calibration with confidence probability of 0.95 %	$20+500/N_f$, where N_f is a numeric value of fast neutrons flux density in $N/(cm^2 \cdot min)$						

APENDIX 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

APPENDIX 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