

PROGRAMMABLE DOSIMETER

PM1203M

OPERATING MANUAL

POLIMASTER Ltd.

Minsk 2001



EU/UE

KONFORMITÄTSERKLÄRUNG/
DECLARATION OF CONFORMITY/
DECLARATION DE CONFORMITE/
ДЕКЛАРАЦИЯ СООТВЕТСТВИЯ No 5

We, Wir, Nous, Мы POLIMASTER Ltd.,

112, Bogdanovich str.,

220040 Minsk, Belarus

declare under our sole responsibility that the product
erklären in alleiniger Verantwortung, daß das Produkt
déclarons sous notre seule responsabilité que le produit
заявляем под свою ответственность, что изделие

DOSIMETER PM1203M

to which this declaration relates is in conformity with the following
standard(s) or other normative document(s):

auf das sich diese Erklärung bezieht, mit der/den folgenden
Norm(en) oder normativen Dokument(en) übereinstimmt:

auquel se réfère cette déclaration est conforme à la (aux) norme(s) ou autre(s)
document(s) normative(s):

по этой декларации соответствует следующим стандартам:

EN 55022 B, EN 61000-4-2, EN 61000-4-3, ENV 50204

following the provisions of Directive(s):

Gemäß den Bestimmungen der Richtlinie(n):

conformément aux dispositions de(s) Directive(s):

в соответствии с условиями директивы:

89/336/EEC.

The tests for compliance with stated above standards have been conducted at:

Les épreuves de conformité aux normes, ci-dessus cités ont été faits par:

Die Prüfungen für die Konformität den obengenannten Normen wurden von:

Испытания на соответствие вышеприведённым стандартам проводились:

ARC Seibersdorf research GmbH.

Minsk, February, 2002



A. A. Antonovski
Managing Director

CONTENTS

	Page
<i>1 DESCRIPTION AND OPERATION OF THE DOSIMETER</i>	4
1.1 Application of the dosimeter.....	4
1.2 Delivery kit	5
1.3 Specifications	6
1.4 Design and theory of operation	9
<i>2 USE OF THE DOSIMETER</i>	11
2.1 General guidelines	11
2.2 Safety instructions	11
2.3 Preparation for use	11
2.4 Use of the dosimeter	11
<i>3 MAINTENANCE</i>	21
<i>4 TROUBLESHOOTING</i>	22
<i>5 VERIFICATION TECHNIQUE.....</i>	23
<i>6 STORAGE AND SHIPPING</i>	27
<i>7 WARRANTY</i>	28
<i>ATTACHMENT A</i> Dependence of time of reading stabilization on the DER value.....	29

This Operating Manual combined with the passport is intended to describe the design, operation and use of the programmable dosimeter PM1203M. The Operating Manual includes the general description, specifications of the dosimeter, instructions for its maintenance, as well as some other information necessary for the proper operation of the dosimeter and a full realization of its possibilities.

During manufacturing of the programmable dosimeter PM1203M some changes may be introduced in its electrical scheme, construction and software that do not influence the specifications and metrological parameters and, therefore, may be not specified in this manual.

1 DESCRIPTION AND OPERATION OF THE DOSIMETER

1.1 Application of the dosimeter

The PM1203M programmable dosimeter (hereinafter referred to as the device) is designed to provide:

- continuous measurement of the ambient dose equivalent rate of gamma radiation $\dot{H}^*(10)$ (hereinafter DER);
- measurement of the ambient dose equivalent of gamma radiation $H^*(10)$ (hereinafter DE);
- measurement of the time of the ambient dose equivalent accumulation;
- storage in the memory and transmission to a personal computer of the DER measurement history;
- indication of the time in hours, minutes and seconds, the date and month and year on the digital liquid crystal display.

The PM1203M programmable dosimeter may be used by a variety of specialists (personnel of nuclear facilities, radiological and isotope laboratories, officers of the emergency services, civil defence, fire brigades, police, customs and border services), as well as by a wide range of users to measure the DER and DE of gamma radiation.

1.2 Delivery kit

Table 1.

Item	Type	Quantity	Note
Programmable dosimeter PM1203M	14804920.006-2001	1	
Battery ¹⁾	V357	2	
Operating manual	412118.006-01	1	The present operating manual contains verification technique
IR adapter IR Computer Link ACT-IR220L	426434.008	1	Available as an option
Case for shipping	412915.002-07	1	

Note:

- 1) similar types of batteries are acceptable

1.3 SPECIFICATIONS

1.DER measurement range	0.1 – 2000 $\mu\text{Sv/h}$
2.DER threshold range	0.1 – 1999.99 $\mu\text{Sv/h}$, step is 0.01 $\mu\text{Sv/h}$
3. Maximum permissible intrinsic relative error of DER measurement	$\pm (15 + A_1/\dot{\gamma} + A_2 \cdot \dot{\gamma}) \%$, where $\dot{\gamma}$ – DER value, $\mu\text{Sv/h}$; A_1 – coefficient 1.5 ($\mu\text{Sv/h}$); A_2 – coefficient 0.0025 ($\mu\text{Sv/h}$) ⁻¹
4. DE measurement range	0.01 - 9999 mSv
5. DE threshold range	0.01 – 9999.999 mSv, step is 0.001 mSv
6. Maximum permissible intrinsic relative error of DE measurement	$\pm 20 \%$
7.Coefficient of variation	10 %
8. Range of the dose accumulation time	1 – 9999 h, step is 1 h
9.Maximum permissible additional relative error of measurement: - due to temperature variations from normal to high or low - at limiting values of power voltage - due to humidity variations from normal to high	$\pm 15 \%$ $\pm 10 \%$ $\pm 10 \%$
10.Energy range	0.06 - 1.5 MeV
11.Energy response relative to 0.662 MeV (¹³⁷ Cs) in the energy range: 0.06 - 0.662 MeV 0.662 - 1.5 MeV	$\pm 25 \%$ $\pm 15 \%$
12. DER measurement time, no more than	36 s
13.Response time when DER value is increased more than 10 times, no more than	10 s
14. Instability of readings during 24 hour continuous work, no more than	$\pm 5 \%$
15. Search mode is available	
16. DER measurement start is available	
17. Electronic watch accuracy at normal conditions may be set using digital correction at	$\pm 1 \text{ s}/24 \text{ hours}$
18. Power supply	3 V (two V357 type batteries)
19. Battery discharge warning:	indication of partial and of critical battery discharge
20. Battery lifetime at natural background and audible signals activated for more than 2 min/24 hours, at least	1 year

21. PC communication by infrared interface at a distance	up to 0.2 m
22. Angular response of the device for each energy does not exceed values (in %) presented in Table 2, when the device is rotated in the horizontal plane and values (in %) presented in Table 3 when the device is rotated in the vertical plane	

Table 2

Angle of detection relative to the direction of graduation, °	Angular response, %		
	Energy of gamma radiation, MeV		
	0,059	0,662	1,25
0	0	0	0
30	±5	±15	±10
60	±5	±5	±10
90	±5	±5	±10
120	±15	±5	±10
150	±15	±15	±10
180	±15	±15	±10
-30	-30	±15	±15
-60	-75	±10	±10
-90	-65	±10	±10
-120	-35	±10	±10
-150	-30	±15	±10

Table 3

Angle of detection relative to the direction of graduation, °	Angular response, %		
	Energy of gamma radiation, MeV		
	0,059	0,662	1,25
0	0	0	0
30	-20	±15	±15
60	-50	±15	±15
90	-35	-50	-35
120	-65	±15	±15
150	-30	±15	±15
180	±15	±15	±15
-30	-20	±15	±15
-60	±65	±15	±15
-90	-95	-55	±15
-120	-70	±15	±15
-150	-15	±15	±15

23. Operating conditions: - temperature range - relative humidity - pressure	from -15 to +60 °C with indication on LCD, from -40 to -15 °C without indication, but with the storage of the measuring data in non-volatile memory up to 80% at + 35 °C 84 – 106.7 kPa
24. Dimensions: - PM1203M - PM1203M with the protective screen - PM1203M in the case	125x42x24 mm 125x47x25 mm 180x135x71 mm

<p>25. Weight:</p> <ul style="list-style-type: none"> - PM1203M - PM1203M with the protective screen - PM1203M in the case 412915.002 - PM1203M with the protective screen in the case 	<p>0.09 kg 0.17 kg 0.34 kg 0.42 kg</p>
<p>26. Reliability parameters:</p> <p>average full operating time, no less than</p> <p>average service life, no less than</p> <p>average time of recovery, no more than</p>	<p>10000 h 6 years 60 min</p>

1.4 Design and theory of operation

1.4.1 Design of the device

The device is designed as a monoblock housed in a plastic case. The device uses a Geiger-Muller tube as a radiation detector, which converts gamma radiation quanta to electric pulses that are processed by the microprocessor. The microprocessor controls as well over the display, power supply and electronic watch.

A direction of graduation and the detector geometric center relative to which the factory calibration is performed are shown in Figs. 1a and 1b.

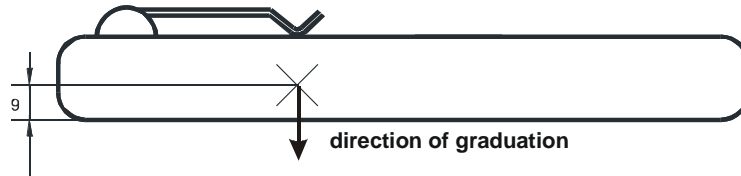


Fig.1 a

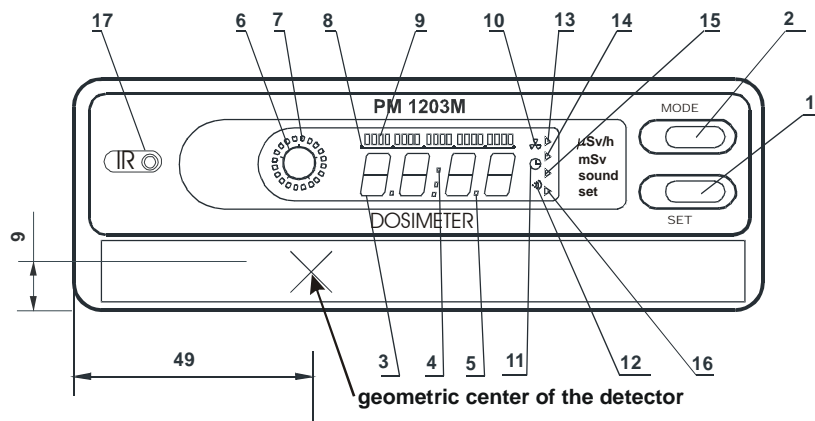


Fig. 1b

The time of reading stabilization is set automatically in inverse dependence on the dose rate level. A dependence of the time of reading stabilization on the DER value is presented in the Table A.1 of the Attachment A.

The device allows setting thresholds of the dose equivalent rate (DER) and dose equivalent (DE) values. An excess of the preset thresholds may be controlled visually (from the display readings), or audibly. The DER and DE measurements are carried out continuously and are independent on a value indicated at the moment on the display.

The following controls are located at the front panel of the device (Fig. 1b).

1 – the “set” button is used to enter the *reference mode* or to exit from it (to check the alarm clock ON time; date and month, year, minutes and seconds), to enter the *set mode* and exit from it, as well as to enter the *data storage mode*, *DER measurement start mode*, *data transmission mode* and to exit from these modes.

2 – the “**mode**” button is used to switch between DER, or DE, or Current Time modes, to set the dose rate audible indication ON/OFF, to change the parameters as well as to start measurements in the DER mode and to store the DER values.

The “**set**” and “**mode**” buttons are used in two ways: pressing (for approx. 1 second) and releasing, or pressing and holding (for approx. 3 or more seconds).

The display has the following indication elements:

- 3 – digital panel;
- 4 – dividing sign “:” (colon);
- 5 – dividing sign “.” (point);
- 6 – circular element;
- 7 – circular analogue scale of DE values;
- 8 – linear element;
- 9 – linear analogue scale of DER values;
- 10 – “dosimeter” sign indicating that the device operates in the *dosimeter mode*;
- 11 – "Current Time mode" sign (“clock” sign);
- 12 – "Alarm clock ON" sign indicating that the alarm clock will sound at the preset time;
- 13 – "DER mode" sign;
- 14 – "DE mode" sign;
- 15 – "Sound ON" sign showing that the dose rate audible indication is set ON;
- 16 – "Set mode" sign;
- 17 – IR data port.

1.4.2 Operation modes

The main operation modes are as follows:

- DER mode;
- DE mode;
- current time mode.

The auxiliary modes of operation are as follows:

- DER measurement start mode;
- DER value storage mode;
- audible DER indication mode;
- data transmission mode;
- alarm clock and calendar reference mode;
- set mode;
- mode of digital adjustment of electronic watch accuracy;
- the mode of indication of the partial and critical battery discharge;
- the mode of indication of the device failure.

2 USE OF THE DOSIMETER

2.1 General guidelines

When purchasing the device it is necessary to check the safety of seals, the delivery kit and the proper operation of the device in all the operation modes.

Protect the device from mechanical damages, shocks. Avoid exposing the device to strong chemicals, organic solvents and open fire.

2.2 Safety instructions

During the device adjustment, checking, repair, maintenance and verification, if the radioactive sources are used, the regulations for work with radioactive materials and other radiation sources, as well as Standards of radiation safety should be followed.

When the device is used within a territory contaminated by radioactive materials, it is recommended to put it in a polyethylene bag to prevent its radioactive contamination.

2.3 Preparation for use

It is necessary to study the present manual before using the device. The device is supplied with the inserted batteries and is ready to operate after it is unpacked.

2.3.1 Checking the device operation

Checking the device operation is performed with the control buttons. To check the device operation it is necessary to perform the operations described in points 2.4.1 – 2.4.9. When the device operates in the DER mode, the LCD should show the natural background value. If the device is operative, the LCD should not display the error messages **Er01 – Er04** (Table 4). If the battery voltage is normal, the LCD should not show the message “**bAt**”.

ATTENTION! *If the device seems to be used under conditions when the DER value is higher than 100 $\mu\text{Sv/h}$, it is recommended to insert new batteries.*

2.4 Use of the dosimeter

The device operates continuously in the **measurement mode** and carries out the 24 hour measurements of the DER, DE, DE accumulation time and indicates the current time on the electronic watch. The DE and DER values are indicated in digital format and also in analogue format - on the corresponding analogue scales that appear on the display, if the DE and DER values exceed 0.1 of the preset thresholds. When the DE and DER values exceed the thresholds, the corresponding scales are completely

displayed. The closeness of the DE and DER current values to their thresholds can be judged from the degree of these scales filling up (Fig. 1b).

2.4.1 Selection of an indicated parameter

The device displays either the measured DE or DER value, or the current time in hours and minutes. Press and release the “**mode**” button to switch between DER, or DE, or Current Time modes. Each pressing of this button changes the values in the sequential order: Current Time - DER - DE - then again Current Time, etc. (see Fig. 2). The corresponding signs appear on the display to inform the user about the indication of either the current time (in hours and minutes), or the DER (in $\mu\text{Sv/h}$) and DE (in mSv) values.

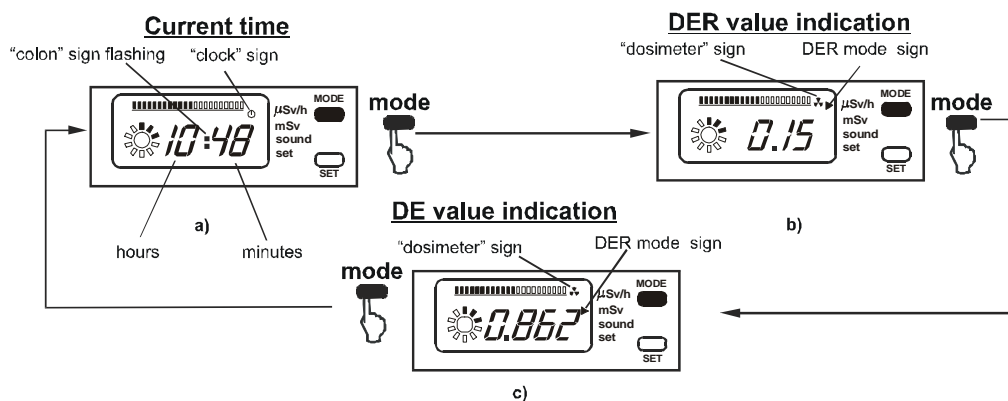


Fig. 2

2.4.2 Dose Rate Audible Indication

Press and hold the “**mode**” button in any of the above mode to set the dose rate audible indication ON; the next value in the order shown in Fig. 2 and the corresponding sign are displayed (Fig. 3). Press the “**mode**” button again to set the sound indication OFF.

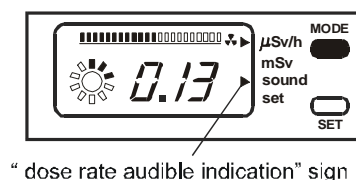


Fig. 3

At natural background, the rate at which the audible tone repeats is 10-20 signals per minute. It will increase with increasing the gamma radiation intensity as a result of, for example, approaching to a radiation source. **This provides a possibility of searching and locating rather intense gamma-radiation sources.**

2.4.3 The mode of indication of the current measured DER value and storage of the DER value

Press and release the “set” button (Fig. 4) to switch from the DER value indication to the DER value storage mode. The display will show the number of an expected reading. To store the current DER value, press the “mode” button. The display will show the next number of an expected reading increased by 1. The indication “rd - -“ means that the memory is full, i.e. 100 readings were stored. To view the stored history it is necessary to use the data transmission mode (see point 2.4.5). The counter of readings may be reset while in the set mode. Then each new reading will be stored in the memory instead of the old one.

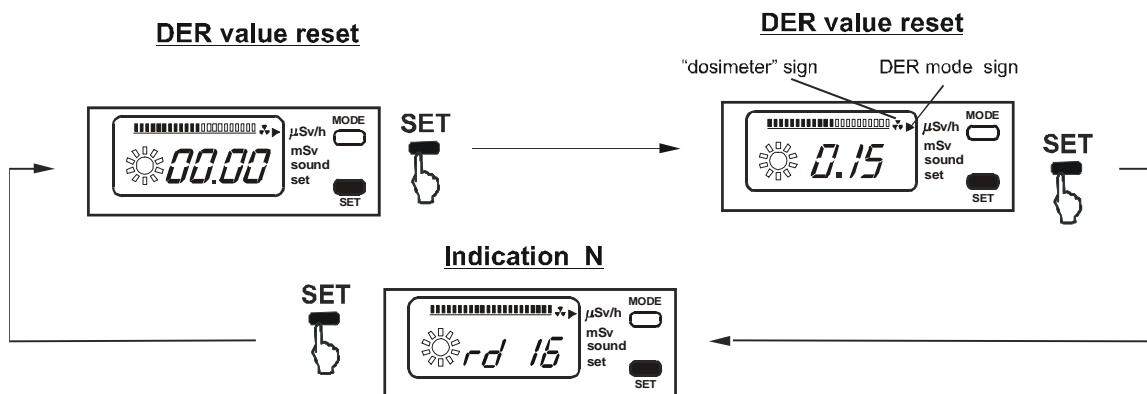


Fig. 4

2.4.4 The DER measurement start mode

Press two times the ”set” button to switch from the DER indication to the DER measurement start mode (Fig.4). The LCD will show not flashing digits 00.00 $\mu\text{Sv/h}$.

To start the DER measurements press the “mode” button. The digits on the LCD will be flashing until the first measured DER value appears. As the device is measuring the DER value, the flashing circular analogue scale is filling in. The flashing circular analogue scale serves to indicate the DER measurement start mode. The empty circular analogue scale corresponds to a statistical error more than 100 %; the completely filled in scale corresponds the statistical error no more than 20 %. To store the measured DER value, use the “mode” button. Press the “set” button to exit from the following modes: beginning of the DER measurement, the DER measurement before the analogue scale is completely filled in, or the mode after the measured value was stored.

The device operation in the DER measurement start mode is as follows:

- 1) switch the device to the state of readiness to starting the DER measurement;
- 2) place the device to a point where the DER value is to be measured;
- 3) press the “mode” button to start the measurement;
- 4) when the circular analogue scale is completely filled in, read the DER value or store it in the device memory using the “mode” button;
- 5) press the “set” button to exit from the DER measurement start mode.

During the DER measurement it is necessary to take into account that the time of stabilization of the DER readings is automatically changed depending on the DER value. An approximate dependence is given in Appendix A.

2.4.5 The mode of indication of the DE and DE accumulation time and the mode of data transmission to PC

Press and release the “set” button to switch from the DE indication mode (Fig.2) to the mode of indication of the time (in hours) during which the DE value was accumulated (see Fig 5). The device will automatically return to the DE indication, if the buttons are left unused for approximately 5 seconds.

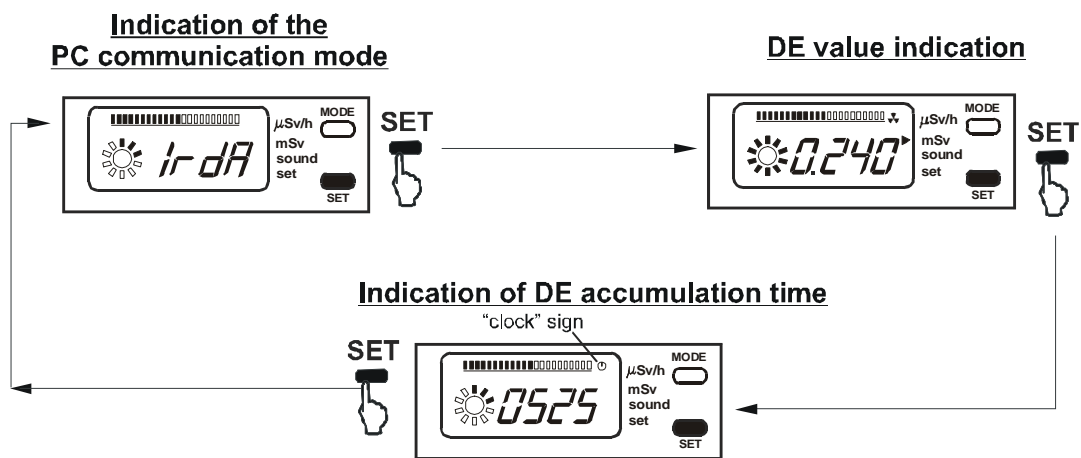


Fig.5

ATTENTION! When batteries are replaced the values of DE and DE accumulation time are stored in the device memory.

Knowledge of the DE accumulation time is of great importance, as the human body is not indifferent whether the irradiation was momentary, or continued for a long period of time.

If the “set” button is pressed while in the mode of indication of the DE accumulation time, the device enters the PC communication mode and the LCD shows the message “IrDA” (Fig.5).

2.4.6 The mode of data transmission to PC

To operate with the device in this mode, an IR adapter (see section 1.2) and an application program PM1203M.EXE supplied on the diskette together with the adapter are to be used.

Minimum requirements to a computer:

- PC 486 or higher;

- 800X600 or higher resolution of a monitor.
- 2 Mb free on the hard disk and an adequate space available for database;
- Windows 9x, NT, ME or 2000.

Connect the cable of the **IR adapter** to a communication port of the personal computer.

To load the application program insert the diskette into the diskette drive. Run the program SETUP.EXE. Following the instructions given in the program, install PM1203M.EXE into the computer. Run the program PM1203M.EXE. An application window PM1203M will appear on the monitor. Select the communication port, which the IR adapter is connected to, and click "OK". If the port is selected erroneously, the message "Port initialization error" will be displayed. Click "OK" and repeat the operation.

For data transmission from dosimeter to PC it is necessary to place dosimeter's IR data port opposite PC's IR data port at a distance of 10-20 cm and select data transmission mode by pressing buttons.

A description of the PC communication mode is given in the help file of the application program.

2.4.7 The mode of indication of the current time, alarm clock and calendar

Switching from the current time indication to the alarm clock and calendar reference mode.

Press and release the "**mode**" button and enter the Current Time mode according to Fig. 2a. Then press the "**set**" button to see sequentially the alarm clock ON time, date and month, year, minutes and seconds in the order shown in Fig. 6.

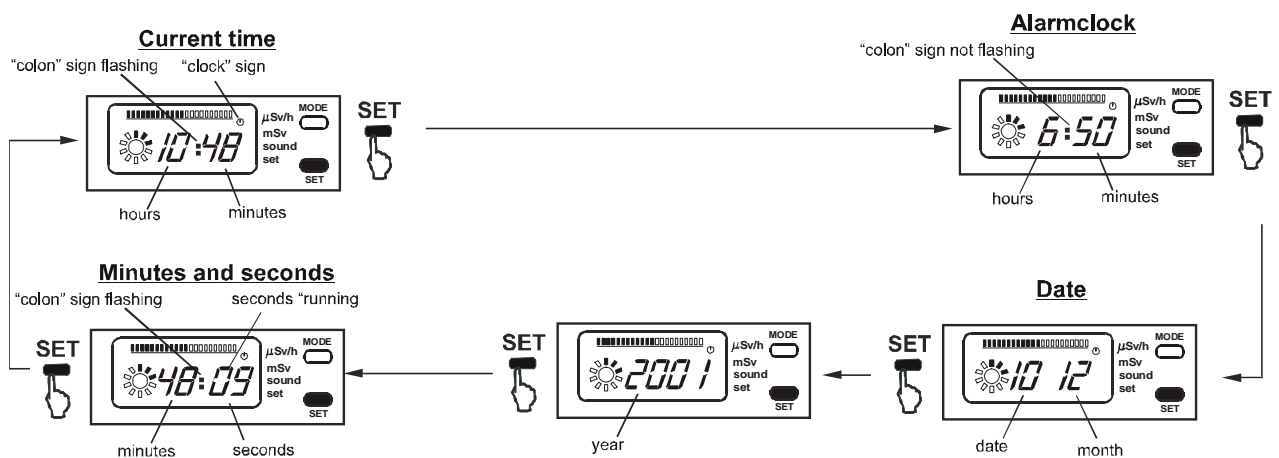


Fig. 6

The display automatically returns to the Current Time mode, if the buttons are left unused for approximately 5 seconds. **Exception:** to exit from the indication of minutes and seconds it is necessary to press and release the “set” button again.

To turn the alarm clock ON, press and release the “mode” button when the alarm clock ON time is displayed; the corresponding sign will be indicated (Fig. 7) (to turn the alarm clock OFF it is necessary to press and release the “mode” button again). The alarm clock signal will sound at the preset time. Press and release the “mode” or “set” buttons to stop the sound signal. If the buttons were not pressed, the signal will sound for 60 seconds.

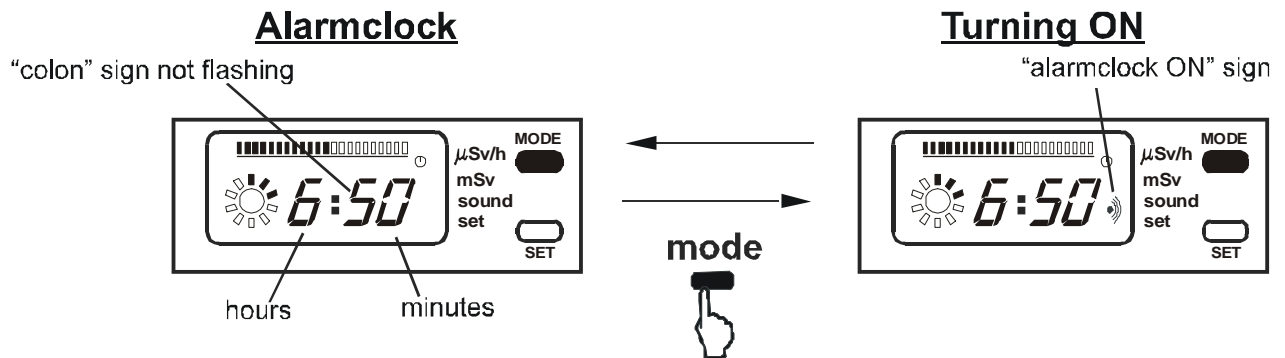


Fig. 7

2.4.8 Set mode

The *set mode* allows setting the hours, minutes, seconds, date, month, year, alarm clock ON time, DER and DE thresholds, and resetting the counter of readings. Press and hold the “set” button to enter this mode. To exit from this mode press and hold this button again, or the device will automatically exit from this mode, if the buttons are left unused for approximately 1 minute. Press and release the “mode” button to change the set parameters.

2.4.8.1 Setting the alarm clock ON time, date, month, year and current time

Press and release the “mode” button to enter the Current Time mode according to Fig. 2. Press and hold the “set” button, the set mode sign will appear and the hours will be flashing on the display. (Fig. 8).

Alarmclock



set mode sign

Fig. 8

Press and release the “**mode**” button to correct the flashing digit by one. For setting the minutes, press and release the “**set**” button. The minutes will be flashing. Each pressing of the “**mode**” button increases the flashing digit by one. Hold this button down to change the minutes rapidly.

Each pressing of the “**set**” button switches between the set parameters in the rotation shown in Fig. 9 (press and release the “**mode**” button to correct the flashing digits).

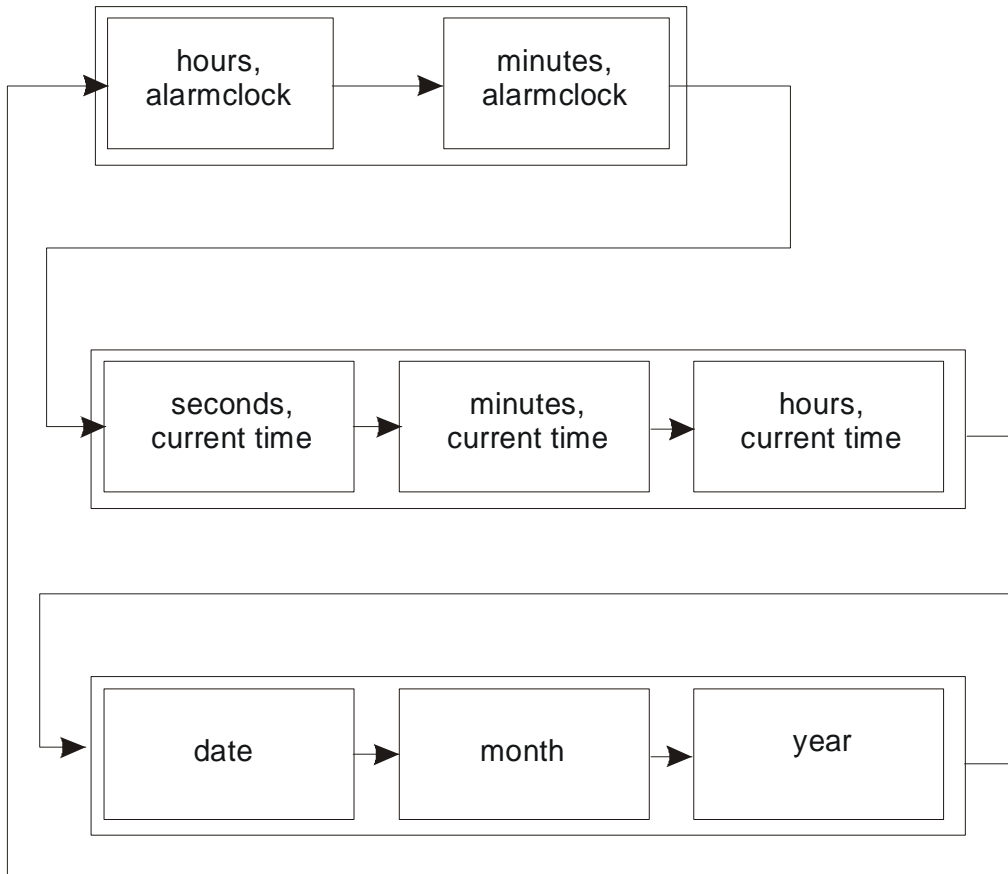


Fig. 9

The device will automatically *exit from the set mode*, if the buttons are left unused for approximately 1 minute, or the user may press and hold the “**set**” button to exit.

2.4.8.2 Setting the DER threshold

The device informs the user about an excess of the preset DER threshold by an audible signal and enters the DER mode, the LCD indicating the completely filled in linear analogue scale. The audible signal will sound until the DER becomes lower than the preset threshold. To stop this signal, press and release the “**set**” or “**mode**” button. If the DER value will subsequently become lower than the preset threshold and then will exceed it, the audible signal will sound again. When the upper limit of the DER measurement of 2400 $\mu\text{Sv/h}$ is exceeded, the LCD will indicate the flashing message “**-HI-**”.

ATTENTION! When the batteries are replaced, the DER threshold is not changed. The user may set it at his own discretion taking into account the relevant Standards or recommendations.

To set DER threshold, press and release the “mode” button and enter the DER mode according to Fig. 2. Press and hold the “set” button to see the preset DER threshold; the two least significant digits (tenths and hundredths of $\mu\text{Sv/h}$) will be flashing, the set mode sign will appear and the filled in linear analogue scale will be indicated (Fig. 10).

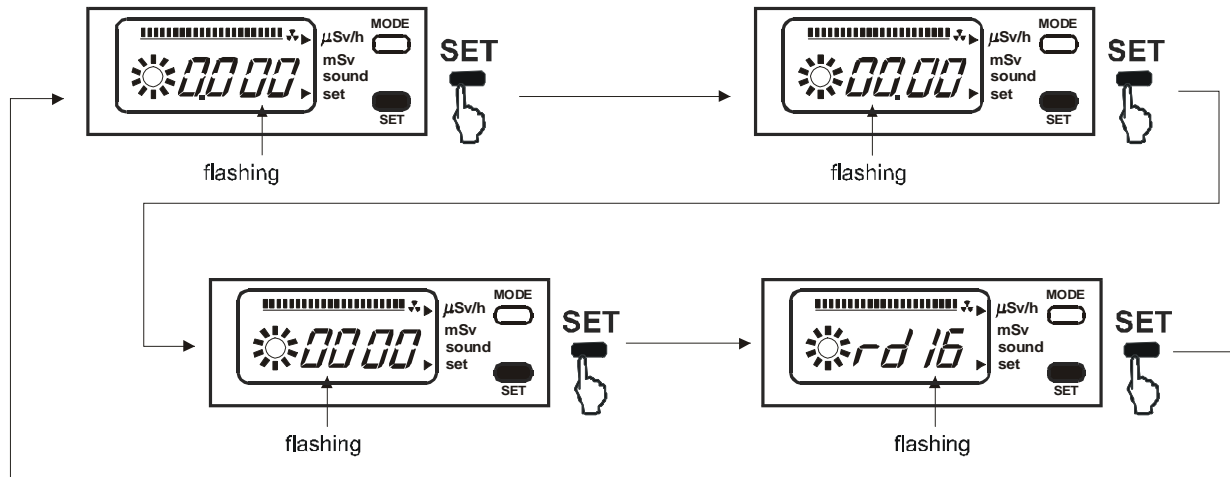


Fig. 10

Press and release the “mode” button to change the value by one.

Press and release the “set” button again to make flashing the first two digits on the display (units and tens of $\mu\text{Sv/h}$). Press and release the “mode” button to change these digits. The next pressing of the “set” button makes flashing the last two digits on the display (hundreds and thousands of $\mu\text{Sv/h}$), which may be changed by pressing the “mode” button. After the next pressing of the “set” button the device will enter the state when the counter of reading may be reset. This may be done by pressing the “mode” button. Press the “mode” button again to cancel the reset of the counter. The device will automatically exit from this mode, if the buttons are left unused for approximately 1 minute, or the user may press and hold the “set” button to exit.

2.4.8.3 Setting the DE threshold

WARNING! When viewing or setting the DE threshold, please remember that the DE threshold changing causes the reset of the accumulated DE value and DE accumulation time.

The user may set the DE threshold at his own discretion taking into account the relevant Standards or recommendations.

The device informs the user about an excess of the preset DE threshold by an audible signal and enters the DE mode, the LCD showing the completely filled in circular analogue scale. To stop this signal, press and release the "set" or "mode" button, the DE measurement will therewith continue.

To set the DE threshold, press and release the "mode" button and enter the DE mode according to Fig. 2. Press and hold the "set" button to see the preset DE threshold; the two digits (hundredths and thousandths of mSv) will be flashing, the set mode sign will appear and the filled in circular analogue scale will be indicated (Fig. 11).

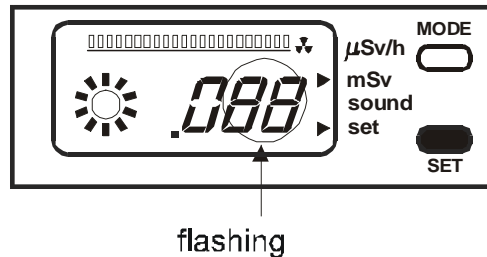


Fig. 11

Every pressing and releasing of the "mode" button will change the value by one.

Press and release the "set" button again to make flashing the first digit after the decimal point (tenths of mSv). Press and release the "mode" button to change this digit. The next pressing of the "set" button makes flashing the two digits (units and tens of mSv). After the next pressing of the "set" button the first two digits will be flashing (hundreds and thousands of mSv) and may be changed by pressing the "mode" button. Press the "set" button again to returns to the indication of flashing hundredths and thousandths of mSv. The device will automatically exit from this mode, if the buttons are left unused for approximately 1 minute, or the user may press and hold the "set" button to exit.

2.4.9 Digital adjustment of the electronic watch accuracy

Press and release the "mode" button and enter the Current Time mode according to Fig. 2. Press several times the "set" button to enter the year indication mode. Press and hold the "set" button to see two flashing digits and the set mode sign. Press and release the "mode" button to set the value that is equal to the weekly deviation (in seconds) of the watch readings from the accurate time. If the watch is fast this value is set with the minus sign. If the watch is slow this value is set without the minus sign. The minus sign is appeared / disappeared when the set value changes from 99 to 00. The device will automatically exit from this mode, if the buttons are left unused for approximately 1 minute, or the user may press and hold the "set" button to exit.

2.4.10 Indication of the partial and critical battery discharge

Measurement of the battery voltage is carried out after replacing the batteries and during operation of the device every minute at 00 seconds.

In the case of the partial battery discharge the LCD will display the message “**bAt**” every 10 seconds and the device will continue its operation.

It is necessary to replace the batteries!

In the case of the critical battery discharge the device discontinues measurements, does not respond to controls and indicates the DE value existing at that moment. In this state the device will save the DE value on the display for no less than 24 hours.

3 MAINTENANCE

Maintenance involves:

- battery replacement in proper time,
- keeping the device clean.

Maintenance is carried out by the user.

The verification of the device is performed by appropriate institutions that are allowed to make these procedures.

ATTENTION! Insert new batteries before sending the device for verification.

3.1 Battery replacement

Take off the plastic cover at the back panel of the device. Remove old batteries. **After approximately 5 minutes** (this time is necessary for discharging the capacitors) put two new batteries observing the polarity indicated on a label at the back panel of the device, and close the cover. Immediately after inserting the batteries all segments will be displayed and the device will enter the DER indication mode.

ATTENTION! All necessary parameters are renewed in the non-volatile memory of the device every 10 minutes. Thus the following information is regained after the battery replacement:

- *the accumulated DE value;*
- *the DE accumulation time;*
- *the DE threshold value;*
- *the DER threshold value;*
- *the value of the counter of readings and the whole history;*
- *the date, month, year, hours, tens of minutes;*
- *a coefficient of accuracy of the watch;*
- *time of the alarm clock turning ON.*

After the battery replacement the user needs to set the accurate time only to return the device into the initial state. The batteries described in the clause 1.3 should be used. Otherwise the specifications of the device can not be guaranteed.

4 TROUBLESHOOTING

Table 4

Problem	Cause	Solution
No indications on the LCD	Batteries discharge Batteries are inserted incorrectly Bad contact between springs and batteries	Replace the batteries Insert the batteries in the proper way Clean and tight spring contacts
The device does not respond to pressing a button, the LCD indicates incorrect symbols	Microprocessor error condition	Remove the batteries and insert them again in 5 minutes
The LCD indicates: “Er01” “Er02” “Er03” “Er04”	Transducer failure Detector failure Registration block failure Memory failure	Send the device for repair

5 VERIFICATION TECHNIQUE

5.1 Introduction

This technique extends to the programmable dosimeters PM1203M, corresponds to the Methodical Instructions 1788 "Radiation-monitoring devices for measuring the exposure dose and exposure dose rate, absorbed dose and absorbed dose rate of photon radiation in air. Verification technique" and establishes the verification technique for dosimeters.

The verification should be carried out by local bodies of the metrological department of the State Standard Committee and by institutions authorized to carry out these works.

The verification of a dosimeter should be carried out when releasing for sale, when releasing from repair and during operation and storage with a time interval of 12 months.

5.2 Operations and measuring instruments

The operations that should be performed during the verification procedure and measuring instruments that should be used are listed in Table 5.

Table 5

Operations	Technique section #	Names of reference and auxiliary measuring instruments and major performances
External examination	5.7.1	-
Testing	5.7.2	-
Determination of metrological data	5.7.3	Dosimetric verification assembly according to Methodical Instructions 2050-90. The maximum certified error of the assembly should be not higher than $\pm 5\%$ at 0.95 confidence level.
"	5.5	Barometer with the least division of 1kPa. Measurement range from 60 to 120 kPa.
"	5.5	Thermometer with the least division of 0.1 °C. Measurement range from 10 to 30 °C.
"	5.5	Hygrometer with measurement range from 30 to 90 %.
"	5.5	Stopwatch with measurement range from 1 to 600 seconds.
"	5.5	Dosimeter DBG-06T. Intrinsic error is $\pm 15\%$ (Other dosimeters providing the required accuracy of measurements may be used).

5.3 Expertise requirements to officers carrying out the verification tests

Persons certified as State Verification Officers are allowed to carry out verification tests and/or to interpret the results obtained.

5.4 Safety requirements

The following safety requirements should be satisfied when verification tests are carried out by officers:

- works involving the use of radioactive sources should be carried out in conformity to requirements cited in "Major health rules for treating radioactive materials and other sources of ionizing radiation" and "Standards of radiation safety", as

well as to instructions for the accident prevention that are in force in the site where verification tests are carried out;

The verification process should be considered as work under special conditions.

5.5 Verification conditions

The following conditions are required for carrying out verification tests:

temperature of the environment, ° C	20 ± 5 ;
relative air humidity, %	up to 80;
atmospheric pressure, kPa	100 ± 4 (750 ± 50 mm Hg);
Background gamma-radiation, $\mu\text{Sv/h}$	$\leq 0,20$.

5.6 Preparation for verification tests

Verification officers should study the Operating Manual of the dosimeter before the verification tests.

5.7 Verification procedure

5.7.1 During the external examination the dosimeter should be tested against the following requirements:

- the delivery kit of the tested dosimeter should be the same as described in the manual;
- the initial or last verification should be recorded in the manual;
- the dosimeter should be marked with clear inscriptions;
- pollution and mechanical damages that may influence the work of the dosimeter should be eliminated.

5.7.2 During testing it is necessary:

- to check the operation of the dosimeter as described in sections 2.3.1 of the manual;
- to set the threshold values as follows:
 - 1) DER threshold value equals to $1999.99 \mu\text{Sv/h}$;
 - 2) DE threshold value equals to 9999.999 mSv

5.7.3 The intrinsic relative errors of the DER and DE measurements should be established during the determination of metrological data.

5.7.3.1 To determine the intrinsic relative error δ of the DER measurements the following operations should be performed:

- 1) enter the DER mode using the “**mode**” button;
- 2) place the dosimeter on a dosimetric verification assembly with a ^{137}Cs gamma radiation source; the graduation direction should coincide with the direction of radiation flow and the longitudinal axis of radiation flow should pass through the geometric center of the detector;

3) calculate the average background value. For this purpose in no less than 360 s take 5 readings of \dot{H}_{bi} at intervals of no less than 30 s and calculate the average background value using an equation:

$$\overline{\dot{H}_b} = \frac{\sum_{i=1}^n \overline{\dot{H}_{bi}}}{n}, \quad (1)$$

where n – the number of measurements and equals to 5.

4) create DER $\dot{H}_{oj} = 3.0 \mu\text{Sv/h}$ at a point of the geometric center of the detector and irradiate the device;

5) in no less than 300 s after the beginning of irradiation, take 5 readings of \dot{H}_{ji} at intervals of no less than 30 s and calculate the average value \dot{H}_j using an equation:

$$\overline{\dot{H}_j} = \frac{1}{n} \sum_{i=1}^n \overline{\dot{H}_{ji}}, \quad (2)$$

where n – the number of measurements at each point and equals to 5.

6) repeat measurements for points where the dose rate value \dot{H}_{oj} is equal to 30.0; 80.0; 300.0; 1600 $\mu\text{Sv/h}$;

7) calculate for each point the relative error of measurements using an equation:

$$Q_j = \left| \frac{\left(\overline{\dot{H}_j} - \overline{\dot{H}_b} \right) - \dot{H}_{oj}}{\dot{H}_{oj}} \right| \times 100 \% \quad (3)$$

8) calculate the confidential limits of the permissible intrinsic error of the DER measurement (in %) using an equation:

$$\delta = 1.1 \sqrt{(Q_o)^2 + (Q_{j\max})^2}, \quad (4)$$

where Q_o – is an error of a standard dosimetric assembly (in %);

$Q_{j\max}$ – is the maximum relative error of measurement (in %), determined from the formula (3).

Compare δ with an acceptable value of δ_{acc} that is calculated using an equation: $\delta_{acc} = \pm(15 + A_1 \dot{H} + A_2 \dot{H}^2) \%$, where \dot{H} – DER value, $\mu\text{Sv/h}$; A_1 – coefficient 1.5 ($\mu\text{Sv/h}$); A_2 – coefficient $0.0025 (\mu\text{Sv/h})^{-1}$. If $\delta > |\delta_{acc}|$, the dosimeter is rejected. If $\delta < |\delta_{acc}|$, the dosimeter is considered to be good.

5.7.3.2 To determine the intrinsic relative error of the DE measurements the following operations should be performed:

- 1) set the maximum values of the DER and DE thresholds and enter the DE mode, resetting the accumulated DE value;
- 2) place the dosimeter on a dosimetric verification assembly with a ^{137}Cs gamma radiation source; the graduation direction should coincide with the direction of radiation flow and the longitudinal axis of radiation flow should pass through the geometric center of the detector;
- 3) read the initial DE value H_{ij} ;
- 4) create DER $\dot{H}_{oj} = 80.0 \mu\text{Sv/h}$ at a point of the geometric center of the detector and irradiate the device during the time period of 1 hour;
- 5) read the final DE value H_{ej} after the end of irradiation;
- 6) calculate the intrinsic relative error of measurement G_j using an equation:

$$G_j = \left| \frac{(H_{ej} - H_{ij}) - \dot{H}_{oj} \cdot T}{\dot{H}_{oj} \cdot T} \right| \times 100 \% ; \quad (5)$$

7) repeat measurements as described in clauses 3-6 for points where the calculated DER value \dot{H}_{oj} is equal to 800.0; 1600 $\mu\text{Sv/h}$;

8) calculate the confidential limits of the permissible intrinsic error of DE measurement δ (in %) using an equation:

$$\delta = 1.1 \sqrt{(G_o)^2 + (G_{j\max})^2} , \quad (6)$$

where G_o – is an error of a standard dosimetric assembly (in %);

$Q_{j\max}$ – is the maximum relative error of measurement (in %), determined from the formula (8).

Compare δ with an acceptable value of $\pm 20 \%$. If $\delta > |20 \%$, the dosimeter is rejected. If $\delta < |20 \%$, the dosimeter is considered to be good.

5.8 Presentation of the verification results

5.8.1 The results of verification are entered in the record.

5.8.2 With good results of the initial verification, a signature and a verification mark of an officer, as well as a stamp of the institution, in which the verification was carried out and the date of verification are put in section 10 (Acceptance Certificate) of the operating manual.

6 STORAGE AND SHIPPING

6.1 Devices in package are to be stored at the air temperature from -15 °C to +50 °C and humidity up to 95% at a temperature of 35 °C.

Devices without package are to be stored at the air temperature from +10 °C to 35 °C and humidity up to 80 % at a temperature of 25 °C.

The storage place should be free of dust, vapours of strong chemicals, aggressive gases and other substances that may cause corrosion.

6.2 Devices in package may be shipped by any kinds of closed transport.

When carried by sea, devices in package should be placed in hermetic plastic bags with silicagel.

When carried by air, devices in package should be placed in hermetic compartments.

When shipping dosimeters, the environmental conditions should be within the following limits:

- air temperature from -50 °C to +50 °C,
- air relative humidity up to 100 % at temperature of 40 °C.

6.3 Devices in package should be arranged and fastened in the transport so that their stable position is ensured and shocks are avoided.

7 WARRANTY

7.1 The manufacturer guarantees that the device meets the requirements of Technical Conditions provided that the customer will observe the guidelines of its use, shipping and storage described in this manual

7.2 The warranty period of use is 18 months since the date of placing the device in service.

7.3 The warranty period of storage is 6 month since the date of acceptance of the device by the officer of the Quality Control Department of the manufacturer.

7.4 Warranty and after-warranty repair is carried out by the manufacturer or the institutions that have a permission of the manufacturer.

7.5 Warranty does not cover the devices:

- without the manual;
- those subjected to the customer service;
- with mechanical damages;
- if the requirements of exploitation and storage were not satisfied;
- after expiration of the warranty period stated in p. 7.2.

7.6 The warranty period of use is prolonged for a period of warranty repair.

7.7 Warranty does not cover the batteries. The claims concerning the batteries quality are not accepted. The batteries replacement is not considered as the warranty repair.

Appendix A

Dependence of the time of reading stabilization on the DER value

Table A.1

DER range, $\mu\text{Sv/h}$	Time of reading stabilization (seconds) at a coefficient of variation		
	30 %	20 %	10 %
0.1 - 0.8	150-100	360-300	1000-600
0.8 – 8	100-10	300-30	600-60
8 – 20	10-3	30-5	60-15
≥ 20	3	5	15

Note: within the range limits the time is in inverse dependence on the DER value