«AtomEco SRL»

DOSIMETER-RADIOMETER MKC-01CA1

OPERATION MANUAL

«AtomEco SRL»
Tel: + 50688511540
Email: atomecomail@gmail.com
sales@atom-eco.com
www.atom-eco.com
10901, Costa Rica, Santa Ana. 350 al norte del restaurante Ceviche del Rey

CONTENTS

1 INSTRUMENT DESCRIPTION AND OPERATION

1.1 Purpose and scope of application

1.1.1 Dosimeter-radiometer МКС-01СА1 (hereinafter – the instrument) is intended for measuring of ambient dose equivalent and ambient dose equivalent rate of gamma (x-ray) radiation (hereinafter the dose and dose rate, respectively), for measuring of beta-particles flux density, indication of alpha-particles flux density as well as indicating flow rate of ionizing particles.

When release the instrument is graduated as a dosimeter in ambient dose units for radiation ^{137}Cs.

1.1.2 The instrument allows prompt Survey of contaminated objects or radiation sources, and also control human environment (radiation safety of working places, habitations, territory; evaluation of radioactive contamination of real objects, materials and samples, including banknotes and their packing).

The instrument could be used as:

- individual directly reading dose measuring element, gamma dose rate - (X-ray) radiation, and beta-radiation flux density;
- Survey measuring instrument for gamma- and X-ray radiations for prompt evaluation of radiation situation.

1.1.3 The instrument allows performing:

- measurement of radioactivity using a special algorithm;
- setting of audible alarms thresholds regarding the dose, dose rate, beta- and alpha- particles flux density and flux of ionizing particles;
- setting of intervals and records in the log (inherent memory of the instrument for further reading of changing history by PC)
- Storing the accumulated dose and exposure time in non-volatile memory (when power is turned off or when replacing the battery) for a period exceeding 5 years;
- automatic record of measurements in instrument diary. The capacity of the log is 2 000 records. The view of records is done using PC;
- indication and voice message on the low charge of the power supply elements.

1.1.4 The information is output on the LCD display. The instrument uses a continuous measurement mode and presentation of average value of obtained value on the display with every second change in readings, which is convenient for operational control. In the dose rate measurement mode the instrument sound signaling is automatically switched on to warn the operator about the danger of overexposure when working with radioactive products or in the zone of radioactive contamination.

1.1.5 Instrument settings provide:

- sound messages about instrument switching on and switching off;
- switching on/off sounds ("clicks") corresponding to each act of registering gamma rays, beta or alpha particles by the counter;
- turning on the audible alarms on excess of thresholds set dose rate measurement, beta or alpha particles flux density.
- setting of time slots for record of measurement results in the log (1 min, 5 min, 30 min or off);
- switching on/off the display backlight

1.2 Specifications

1.2.1 The instrument specifications are described in table 1.

Table 1

Parameter description	Value
Dose measuring range, mSv	0,0001 - $1 \cdot 10^3$
Dose rate measuring range, μSv/h	0,1 - $1 \cdot 10^4$
Photons energy range, MeV	0,05 - 3,0
Measuring range of beta-particles flux density (by ^{90}**Sr**+^{90}**Y**), $min^{-1} \cdot cm^{-2}$	5 - $3 \cdot 10^4$
The lower limit of the beta-radiation energy being registered (according to average beta spectrum energy ^{14}**C**), not more than, MeV,	0,05
The threshold of allowable basic relative error for confidence probability 0,95 for all measuring modes, %	±25
Indication range of alpha-particles flux density (for ^{239}**Pu**), $min^{-1} \cdot cm^{-2}$,	10 - $3 \cdot 10^4$
Indication range of ionizing particles flux (for ^{90}**Sr**+^{90}**Y**), min^{-1}	10 - $3 \cdot 10^4$
Self background level: - in **«GAMMA»** mode**,** μSv/h, not more than - in **«BETA»** mode, $min^{-1} \cdot cm^{-2}$, not more than	 0,05 6,00
Operating mode setting time, min, not more than	1
Continuous work time (while measurement at the level of natural radiation background level), not less than, h: - from 2 pcs. AA batteries, or 2 pcs. AA accumulators (with a capacity of more than 2700 mA*h); - by the AC voltage adapter or PC	 Not less than 400 Non limited
Dose rate measuring time, s, not more than: - if the background is less than 0,15 μSv/h - if the background is more than 1 μSv/h	 120 5
Dose rate thresholds setting range, μSv/h	0,01 - $1 \cdot 10^4$
Dose thresholds setting range, μSv	0,01 - $1 \cdot 10^6$
Beta and alpha particles flux density thresholds, $min^{-1} \cdot sm^{-2}$, (with a step of 1,0 $min^{-1} \cdot cm^{-2}$)	5 - $3 \cdot 10^4$
Ionizing particles threshold flux thresholds, min^{-1}, (with a step of 1,0 min^{-1})	5 - $3 \cdot 10^4$
Intervals of voice output of dose rate measurements results, s	Automatic, with intervals 30, 60, 120s or OFF
Sound signaling activated when exceeding the preset the thresholds dose rate, beta- and alpha- particles flux density	On-off signal with 1s interval
Sound messages: - when the instrument power supply is on; - when the instrument power supply is off; - when exceeding the measuring limit of the dose rate, alpha- or beta- flux density; - when exceeding the preset dose threshold	 «Device is ready to operate» « Device is stop off» \«Result overflow» «Dose threshold excess»
Intervals of recording in the log, min	1; 5; 30 or OFF
Log capacity, quantity of records	2 000
The language of display information output	English / Spanish
Operation conditions: - temperature, °C - humidity at 30 °C, %	 From minus 20 up to +50 Up to 75

Overall dimensions, mm	112×65×30
Mass without power supply elements, g, not more than	150

1.3 Measuring procedure

1.3.1 In the instrument the frontal gas-discharge counter «BETA-1» with a thin input gate as a radiation detector is used. Photon flux is converted by detector in electrical sequencing. These signals are formed according to width and amplitude, and then are processed with microprocessor, providing output of measurement results on the display of the instrument.

The readings on the display are hanged automatically with averaging of measurement results by microprocessor. Each next result is processed with microprocessor and the current reading of measurement results, and also statistical measurement error at a time are shown on the display.

1.4 General design data

1.4.1 The overall view of the instrument is given of the Fig.1.

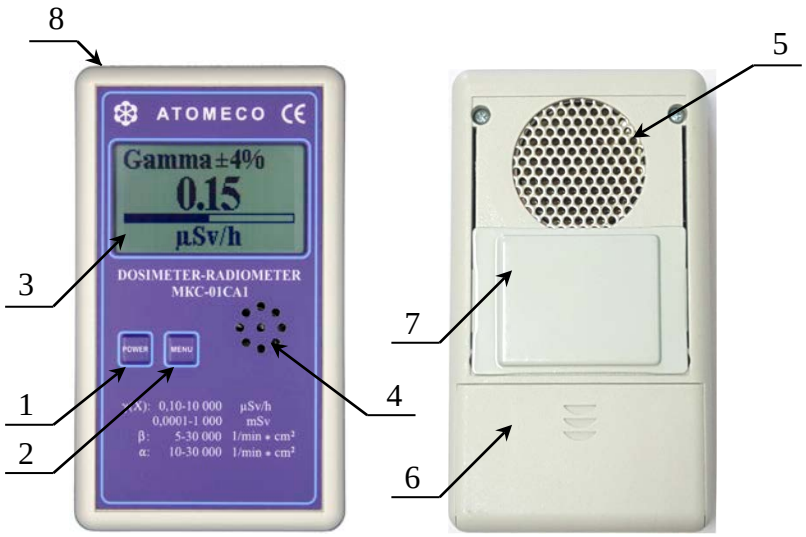


Fig.1. Overall view of the instrument MKC-01CA1

1 - button «**POWER**» - power supply on/off and to change the service parameters of the instrument; 2 – button «**MENU**» - selecting the operation mode; 3 – LCD display; 4 - dynamic; 5 - detector «**BETA-1**» - sensitive window; 6 - cover of the power supply section; 7 - movable compensative filter; 8 - mini USB connector to connect PC or network adapter.

1.4.2 Indication and alarm of the instrument

1.4.2.1 The example of information shown on display is given on the Fig. 2

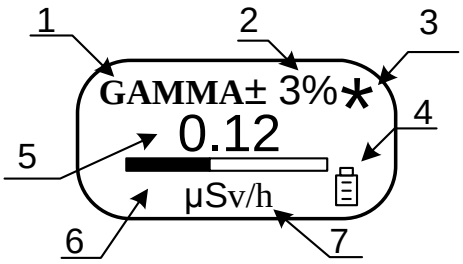


Fig.2. The example of information shown on display

1 – physical magnitude measured (determined by operating mode);

2 – current value of statistic error of the value measured;
3 – radiation rate indicator – blinking symbol «*****»;
4 – battery discharge indicator;
5 – current value of magnitude measured;
6 – analogue scale;
7 – measurement units:
- μSv/h – microsievert/hour;
- mSv/h – millisievert/hour;
- $min^{-1}cm^{-2}$ – $minute^{-1}$ per $centimeter^{-2}$ (the number of particles per minute per centimeter square);
- min^{-1} - $minute^{-1}$ (the number of particles per minute);
- μSv - microsievert;
- mSv - millisievert;
- Sv - Sievert;

1.4.2.2 Alarm on exceeding the preset threshold of dose rate, beta- and alpha- particles flux density or ionizing particles flux – an intermittent audible alarm with an interval 1 s.

1.4.2.3 Alarm on exceeding of preset dose threshold – periodic voice message « **DOSE THRESHOLD EXCESS**».

1.4.2.4 Alarm on overload **–** in the case of excess of dose rate, beta- and alpha- particles flux density upper measurement range – voice message «**RESULT OVERFLOW**».

1.4.2.5 Indication of battery discharge – when battery discharge up to 1.6 V the symbol the symbol «▭» will be shown on display.

1.4.2.6 The display backlight is on automatically by pressing any button of the instrument. Duration of backlight is 30 s.

1.4.3 Operating mode of the instrument

1.4.3.1 To turn on the instrument, press «**POWER**» button.
1.4.3.2 To turn off the instrument, press end hold (more than 2 s) «**POWER**» button.
1.4.3.3 To change the operating mode of the instrument, press «**MENU**» button.
The modes are changed in a circle, according to the scheme given on Fig. 3.

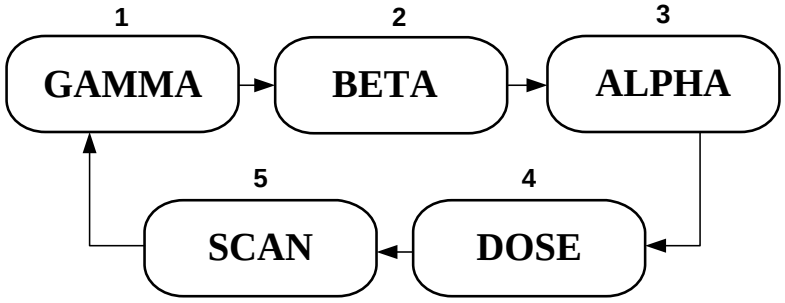


Fig. 3 – Mode change scheme of the instrument

1 - «GAMMA» - dose rate measurement;
2 - «BETA» - beta- particles flux density measurement;
3 - «ALPHA» - alpha- particles flux density measurement;
4 - «DOSE» - integral dose measurement;
5 - «SCAN» - Scan and localization of radioactive sources

1.4.4 Service parameters of instrument

1.4.4.1 Turn on the instrument. The instrument is initially turn on in the «**GAMMA**» mode.
To enter the settings mode, press and hold (more than 2 sec) the «**MENU**» button.
The text «**VOICE …..**» will be shown on the display.

To select a mode, press the «**MENU**» button.
Select the required from the list given in the Fig. 4.

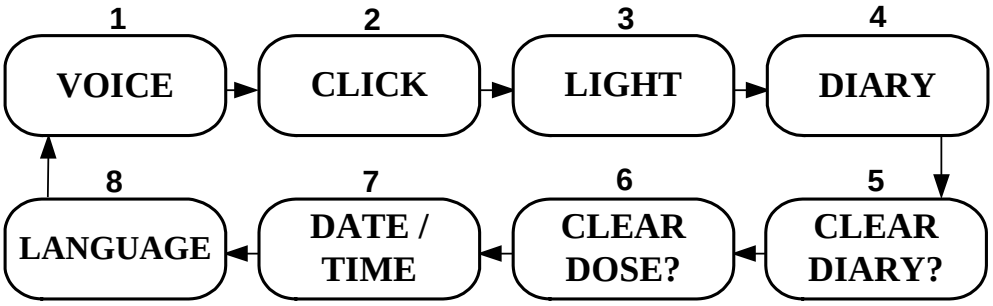


Fig.4. The scheme for changing of alarm settings

To exit from settings mode, press and hold (more than 2 sec) the «**MENU**» button.
The instrument returns to preliminary selected measurement mode.

1.4.4.2 **Voice settings**
Enter the mode «**VOICE».**
Select the interval for voice evaluation of the dose rate measurement result from the list: «**VOICE 30 sec»**, «**VOICE 60 sec»**, «**VOICE 120 sec»** or «**VOICE OFF»**.
Press the «**POWER**» button to change the parameter.

1.4.4.3 **Click settings**
«Click» - audible intensity of radiation.
Enter the mode **«CLICK»**
Select **«CLICK ON»** or **«CLICK OFF».**
Press the «**POWER**» button to change the parameter.

1.4.4.4 **Light settings.**
Light **–** backlight of instrument.
Enter the mode «**LIGHT**»
Select «**LIGHT ON**» or «**LIGHT OFF**».
Press the «**POWER**» button to change the parameter.

1.4.4.5 **Diary settings**
Diary - inherent memory of the instrument for further reading of PC changing history.
Enter the mode «**DIARY**».
Select the interval for automatic recording in the diary from the list: «**DIARY 1 min**», «**DIARY 5 min**», «**DIARY 30 min**» or «**DIARY OFF**»
Press the «**POWER**» button to change the parameter.

Notice! The diary capacity is 2 000 reports.

1.4.4.6 **Clear Diary**
If the diary is full, you must clear it.
Enter the mode «**CLEAR DIARY?**».
Press the «**POWER**» button to clear diary.
Press the «**MENU**» button to skip this mode.

1.4.4.7 **Clear Dose**
Enter the mode «**CLEAR DOSE?**».
Press the «**POWER**» button to clear dose.

Press the «**MENU**» button to skip this mode.

1.4.4.8 **Date & time.**
Enter the mode «**DATE / TIME**».
Press the «**POWER**» button to start change date & time.
The cursor shows the selected parameter.
Press the «**POWER**» button to change selected parameter.
Press the «**MENU**» button to select next parameter.
After the changes are completed, the cursor disappears.

ATTENTION! After replacing the batteries, the set parameter «**DATE / TIME**» are not saved.

1.4.4.9 **Language**
Enter the mode «**LANGUAGE**»
Press the «**POWER**» button to change language.

1.4.4.10 **Setting of alarm thresholds**
Setting of alarm thresholds in any measurement mode is done identically.
Switch on the instrument.
Select the required measurement mode «**GAMMA**», «**BETA**», «**ALPHA**», «**DOSE**» or «**SCAN**» by «**MENU**» button.
Press the «**POWER**» button to enter the threshold setting menu.
Press the «**MENU**» button to start change threshold.
The cursor shows the selected parameter.
Press the «**POWER**» button to change selected parameter.
Press the «**MENU**» button to select next parameter.
After the changes are completed, the cursor is disappears.
Press the «**POWER**» button to return to measurement mode.

2 MEASURING

2.1 Operating limitations and safety measures

2.1.1 To prevent the detector power supply occurrence under the high voltage and malfunction of the chart elements it is forbidden to open the sealed section of the instrument.
2.1.2 Keep clean the power supply section and contacts for power supply connection.
2.1.3 Change on-time the power sources which have been discharged.
2.1.4 In case of radioactive substances occur on the instrument case its background readings can be increased. Check it by measuring the instrument background readings in another place or room.

2.2 Instrument preparation for operation

2.2.1 Instrument preparation for operation with batteries:
- remove the cover of the power supply section (see Fig.1);
- insert the batteries into the instrument observing the polarity;
- close the cover of the power supply section.
- close operating surface of detector by moving the absorbing filter (see Fig.1) into upper position.

2.2.2 Preparation for operation from AC mains:

- connect output connector of power adapter to mini USB connector, located in the upper end of the instrument (see Fig.1);
- switch on adapter mains plug in receptacle with the power of ~ 120 V.

2.2.3 Preparation for operation with PC:

- connect with the cable the connector in the upper end of the instrument and USB port of PC.

2.3 Dose rate measuring

2.3.1 Close the entrance gate of detector, by moving compensative filter (see Fig.1) in the top position.

Switch on instrument. (After activation the instrument will initially be set in dose rate measuring mode «**GAMMA**» will be shown on a display).

2.3.2 To measure radiation background of dose rate in the building or in the open air:

- locate the instrument on a distance of not less than 1 m from the any surface and any surrounding subjects;
- in 2-3 seconds the first averaged value of radiation background dose rate, and also first value of statistic error, approximately ± 90 % will be shown on a display;
- wait until the value of the statistical error is less than 20%;
- fix the measured background value of the dose rate $\dot{H}_{bg}$ in μSv/h.

2.3.3 Measure the investigated object:

- reset previous measurement result. To do this, press the «**MENU**» button until the «**GAMMA**» mode turned again.
- locate the instrument near the investigation object;
- wait until the value of the statistical error is less than 20%;
- fix the measured object+background value of the dose rate $\dot{H}_{\gamma+bg}$ in μSv/h.

2.3.4 Calculate the measured value of the dose rate from the object, by the formula 1

$$\dot{H}_{\gamma} = \dot{H}_{\gamma+bg} - \dot{H}_{bg} \qquad (1)$$

Notice! Each sudden change of the instrument position and/or sudden change of radiation intensity is accompanied by reset of collected information (nullification) and dose rate measuring process starts again.

2.4 Dose measuring

2.4.1 Close the input window of the detector, by moving the compensative filter (Fig.1) in the top position.

Switch on instrument in the «**DOSE**» mode.

NOTE! The instrument measures the integral radiation dose in «**GAMMA**» or «**DOSE**» modes.

In the «**DOSE**» mode the instrument display indicates the total exposure time of the instrument (hours : minutes) and accumulated dose value. The instrument keeps the accumulated dose value after it is switched off (or when the power elements are replaced) in the nonvolatile memory for more than 5 years period.

2.5 Beta-particles flux density measuring from surfaces

2.5.1 Open the entrance gate of detector, by moving compensative filter (see Fig.1) in the bottom position.

- set the mode «**BETA**»;
- place the detector window at 3-5 mm distance directly above the investigation object.
- wait until the value of the statistical error is less than 20%;
- fix the measured object+background value of beta- particles flux density $\Phi_{\beta+bg}$ in $min^{-1}\cdot cm^{-2}$;
- close the entrance gate of detector by moving the compensative filter (see Fig. 1) in the top position;
-reset previous measurement result. To do this, press the «**MODE**» button until the «**BETA**» mode turned again;
- place the detector window at 3-5 mm distance directly above the investigation object;
- wait until the value of the statistical error is less than 20%;
- fix the measured background value of beta- particles flux density Φ_{bg} in $min^{-1}\cdot cm^{-2}$;
- calculate beta particles flux density Φ_{β} in $min^{-1}\cdot cm^{-2}$, by the formula 2

$$\Phi_{\beta} = \Phi_{\beta+bg} - \Phi_{bg} \quad (2)$$

2.6 Alpha-particles flux density evaluation from surfaces

2.6.1 Open the entrance gate of detector, by moving compensative filter (see Fig.1) in the bottom position.
- set the mode «**ALPHA**»;
- place the detector window at 1-2 mm distance directly above the investigation object;
- wait until the value of the statistical error is less than 20%
- fix the measured object+background value of alpha- particles flux density $\Phi_{\alpha+bg}$ in $min^{-1}\cdot cm^{-2}$
- cover the investigation object with a thin paper sheet used for printing on laser or ink printers;
- reset previous measurement result. To do this, press the «**MENU**» button until the «**ALPHA**» mode turned again;
- place the detector window at 1-2 mm distance directly above the investigation object;
- wait until the value of the statistical error is less than 20%
- fix the measured background value of alpha- particles flux density Φ_{bg} in $min^{-1}\cdot cm^{-2}$;
- calculate alpha particles flux density Φ_{α} in $min^{-1}\cdot cm^{-2}$;

$$\Phi_{\alpha} = \Phi_{\alpha+bg} - \Phi_{bg} \quad (2)$$

2.7 Search for radiation sources and objects contaminated with radioactive nuclides

2.7.1 Open the entrance gate of detector, by moving compensative filter (see Fig.1) in the bottom position.
- set the mode «**SCAN**»;
- locate the instrument on a distance of not less than 1 m from the any surface and any surrounding subjects;
- wait until the value of the statistical error is less than 20%
- fix or remember the measured background value;
- reset previous measurement result. To do this, press the «**MENU**» button until the «**SCAN**» mode turned again;
- place the detector window at 1-2 mm distance directly above the investigation object;
- smoothly moving the instrument along the surface of the object to be monitored;

- in the case of a sharp increase in the readings of the instrument by 1.5-2 times or more, stop the movement of the instrument and within 30-40 sec make sure that the readings are constantly increasing;
- moving the instrument in different directions;
- determine the range or objects of radioactive contamination.
- after identifying a contaminated surface or object, take a measurement in «**GAMMA**», «**BETA**» and «**ALPHA**» modes.

2.8 Operation of instrument with PC

2.8.1 - connect the instrument to PC using USB cable;

- turn on the instrument;
- in a few seconds the PC system **(OC Windows XP and higher)** will identify its connection. In the «My computer» the new removable disk will appear. The window will be displayed on the screen of PC (see Fig. 5)

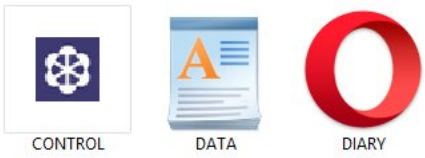


Fig.5 – Monitor window showing removable drive content.

2.8.2 Operation with Control program

2.8.2.1 Run «**Control.exe**» program (file extension may not be displayed and depends on PC settings). This could take several seconds.

The user's program menu will be displayed on the screen (see Fig. 6).

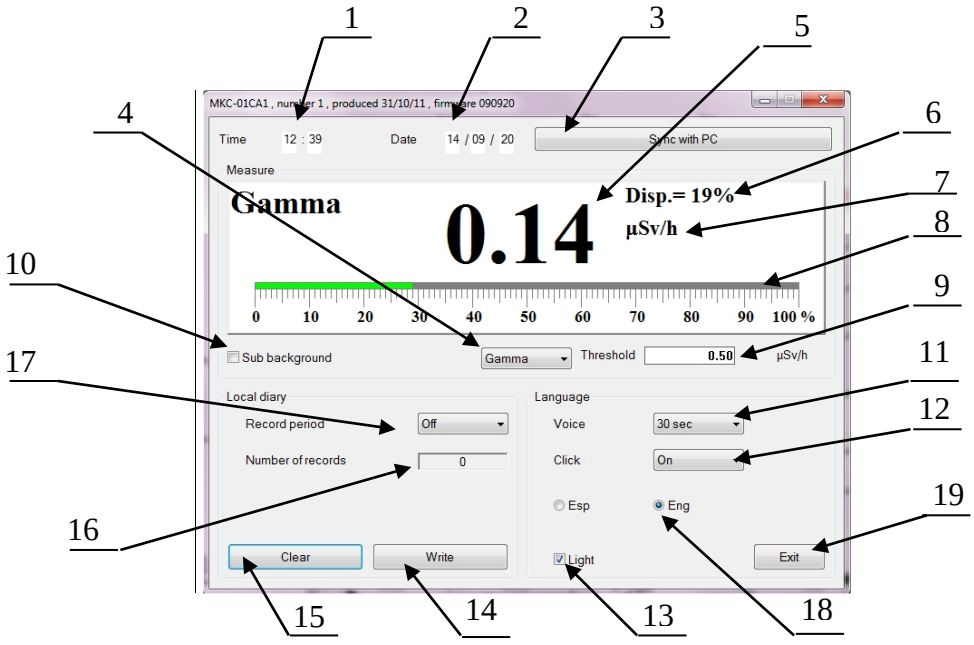


Fig.6. User's program menu

1 – Time setting window; 2 – Date setting window; 3 – Button for automatic set of time & date through PC; 4 – Button for selecting the operating mode of the instrument; 5 – Measuring result; 6 – Measured value statistical error, %; 7 – Unit of measurement; 8 – Analogue scale (progress bar scale); 9 – Alarm threshold set; 10 – Automatic background subtraction with an

indication of the subtracted values; 11 – Button of the selection of intervals of the voice evaluation measurement results; 12 – On/off button for "Clicks"; 13 – On/off button for the device backlight; 14 – Button of a single recording of measurement results in the «Diary» of the instrument; 15 – Button for reset of all records from the «Diary»; 16 – Number of records in the «Diary»; 17 – Button for the selection of intervals of automatic recording of results in the «Diary»; 18 – Menu language select; 19 – Button for finishing of operation with Control.exe; 18 – Menu language select.

2.8.2.2 Set date and time on the instrument. This could be done in both manual or automatic mode by pressing the button 3 (Fig. 6) «Set date & time from PC ». At that time & date set for PC will be set for the instrument.

2.8.2.3 Select the required measurement mode («**GAMMA**», «**DOSE**», «**ALPHA**», «**BETA**» or «**SCAN**»), by pressing the button 4 (Fig.6).

2.8.2.4 For automatic subtraction of the background put a mark in the window 10 (Fig. 6). Subtraction value will be shown in the window close to mark, and measured value – in the window 5 (Fig. 6) will be equal to zero.

NOTE! For correct measurement of background, place the instrument at a distance of 1 m from the surface, walls and floor. Expose the instrument as soon as statistical error will reach not more than 20%.

2.8.2.5 Set the required alarm threshold for selected measuring mode in the window 9 (Fig. 6) and press Enter.

ATTENTION! ALARM THRESHOLD WILL NOT BE CHANGED DURING AUTOMATIC BACKGROUND SUBTRACTION.

2.8.2.6 Set the required time slot for voice accompaniment of measuring results by the button 11 (Fig. 6) (30; 60 or 120 sec).

NOTE! Voice accompaniment of measuring results is done only in «**GAMMA**» measuring mode.

2.8.2.7 To activate audible signals - «clicks», and also the backlight of display put the mark in windows 12 and 13 correspondingly (Fig. 6).

2.8.2.8 Set the required time interval (1; 5 or 30 min) for recording of measuring results in the diary of the instrument by the button 17 (Fig. 6).

2.8.2.9 Additional, single shot record of measuring result in the diary is done by the button 14 (Fig. 6)

2.8.2.10 If maximum allowed number of records has achieved in the measuring diary (2000 records), delete files from the diary by pressing button 15 (Fig. 6). By pressing button the control question «Delete files from diary?» will appear. In the case of approval all records will be removed.

ATTENTION! Removed records are impossible to be restored. Copy the data to PC memory if required.

2.8.2.11 Window 15 (Fig. 6) shows current quantity of records in instrument diary.

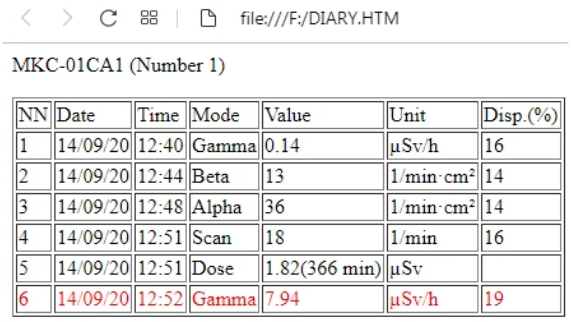
2.8.2.12 To select language of Menu put the mark in window 18 (Fig. 6)

2.8.2.13 To finish work with **Control.exe** please press the button 19 (Fig. 6).

NOTE! BEFORE YOU CLICK "EXIT" ALL SETTINGS ARE STORED IN THE PC RAM. IF THE UNIT POWER WILL BE OFF BEFORE PRESSING THE "EXIT" BUTTON, THEN THE PARAMETERS, SET IN THE USER MENU, WILL NOT BE SAVED!

2.8.3 Browsing of records in the diary.

2.8.3.1 Open the file DIARY.HTM using EXCEL or any Internet-browser. The table will be shown on PC display. Each line corresponds to one record of the diary (see Fig.7).



NN	Date	Time	Mode	Value	Unit	Disp.(%)
1	14/09/20	12:40	Gamma	0.14	µSv/h	16
2	14/09/20	12:44	Beta	13	1/min·cm²	14
3	14/09/20	12:48	Alpha	36	1/min·cm²	14
4	14/09/20	12:51	Scan	18	1/min	16
5	14/09/20	12:51	Dose	1.82(366 min)	µSv	
6	14/09/20	12:52	Gamma	7.94	µSv/h	19

Fig.7. Fragment of diary

The diary displays date, time, operating mode, measured value, measurement unit and measurement dispersion.

The diary records is highlighted in red if the set threshold is exceeded.

2.8.4 Finishing of operation with PC.

2.8.4.1 Turn off the instrument

2.8.4.2 Disconnect USB cable from the instrument and PC

3 MAINTENANCE

3.1 Safety measures

3.1.1 Prior to start working with the instrument the personnel shall study carefully the present operation manual.

3.1.2 It is forbidden to open the instrument or to perform repairs since the high voltage power supply (about 400 V) counter is inserted inside it. Thus for repairs the instrument shall be sent to the manufacturer.

3.2 Maintenance procedure

3.2.1 The instrument maintenance is performed to assure its serviceability during operation and executed by the personnel, working with the instrument, observing safety measures as per item 3.1.

3.2.2 Preventive works, performed during maintenance include the check of completeness, examination of the instrument appearance and check of its operability.

3.2.3 Check of the instrument completeness assumes its compliance with item 5.1.

3.2.4 When examining the instrument appearance make sure that there are no chips and cracks on the instrument case, that inscriptions on controls are clear, and also that the shielding grid and the detector thin input window are integral.

4 CALIBRATION METHODS

Calibration methods are developed in accordance with requirements of RMG 51 - 2002, apply to the personal dosimeter-radiometer MKC-01CA1 and establish methods and means of their initial and periodic calibration.

4.1 Calibration operations

4.1.1 The following operations mentioned in the Table 2 should be done within calibration.

Table 2

№	Name of operation	Operation manual item №	Performing of operation within	
			Initial calibration	Periodic calibration
1	Exterior check	4.5	yes	yes
2	Testing	4.6	yes	yes
3	Determination of basic relative error of the instrument	4.7	yes	yes
4	Determination of the self background level	4.8	yes	no

4.2 Calibration instruments

4.2.1 Calibration instruments given in the Table 3 should be used while calibration performing.

Table 3

Name of verification instrument	Name of standard	Note
Gamma-radiation source ^{137}Cs	ISO 17034	The dose rate generated by the source should be in the range from 0.1 to 9 mSv/h.
Beta-radiation source $^{90}Sr+^{90}Y$	ISO 17034	The beta source area must be larger than the detector area. The beta particle flux density should be at least 15 000 $min^{-1}*cm^{-2}$.
Plumbum box	-	Wall thickness 50 mm. Internal overall dimensions 200x100x50 mm
Note – Other instruments and equipment with the same parameters is possible to be used.		

4.3 Calibration conditions and preparation for calibration

4.3.1 At the time of calibration natural radiation background should be up to 0.25 μSv/h.

At the time of calibration there shouldn't be external ionizing radiation sources, creating the ambient background, exceeding the half of natural background value.

Preparation of calibrated instrument for operation should be done in accordance with requirements mentioned in Operation Manual.

4.4 Safety measures

4.4.1 Persons involved in calibrating the instrument must comply with ISO/IEC 17025-2019 and know the Operation Manual.

4.5. Exterior check

4.5.1 Make sure that there are no chips and cracks on the instrument case, that inscriptions on controls are clear, and shielding grid and the detector thin input window are no broken.

4.6 Testing

4.6.1 While testing of the instrument it is required to check operating of controls and working ability of the instrument in accordance with operation manual.

4.6.2 The test of working ability for the instrument should be performed according to the with p. 2.3 Operation Manual.

If the dose rate value measured at normal conditions is within the range of 0.1 – 0.3 μSv/h, the instrument is serviceable. In other case it is subject to additional inspection or repair with future test.

4.7 Determination of the main relative error and Certificate of calibration

4.7.1 Periodic calibration consists of calculation of basic relative error of the instrument at the definite levels of measured values in the mode of dose rate measurement and beta particles flux density.

All measurements of the same type should be conducted not less than 5 times, and average meaning of the measured value should be calculated according to their results.

During calibration record of information on measured values from the calibrated instrument is made with statistical error of less than ±3% for value of basic measurement errors listed in Operation Manual.

4.7.3 Determination of the main relative error of the instrument for gamma radiation is done in «**GAMMA**» mode according with sources ^{137}**Cs** at three values of dose rate, equal to 0,1; 0,5; 0,8 correspondingly of the value of measurement range maximum limit (1, 5 and 8 mSv/h ±20%).

Calibration in dose measurement mode is not performed. Correspondence to basic relative error of the instrument in dose measurement mode is provided with a calibration in the mode of dose rate measurement and circuit design of the instrument.

4.7.4 Determination of the main relative error of the instrument for the beta radiation is done in «**BETA»** mode according with sources ^{90}**Sr+**^{90}**Y** at one values of particle flux density equal to 0,5 correspondingly of the value of measurement range maximum limit (15 000 $min^{-1}*cm^{-2}$ ±20%).

NOTE The beta source area must be larger than the detector area.

4.7.5 Certificate of calibration

4.7.5.1 Certificate of calibration is issued for calibrated instrument.

Validity of certificate of calibration - 2 year.

4.7.5.2 The instrument which not passed the calibration is subject to adjustment or repair with further verification. If the instrument is impossible to repair the disability certificate for it is issued.

4.8 Determination of the self background level

4.8.1 In the case of initial calibration, and also while calibration after repair, related to replacement of the counter «**BETA-1**», the level of the own background will be calculated. Calculation of the own background level will be done while placement of the instrument in the Plumbum box with walls thickness of not less than 50 mm in «**BETA**» and «**GAMMA**» modes.

5. PASSPORT DATA

5.1 Completeness

Name	Legend	Quantity, units
1 Dosimeter-radiometer MKC – 01 CA1	SNGA.412152.001-01	1
2 Power supply element of AA	-	2
3 Operating manual	SNGA.412152.001-01 Op.m	1
4 Packing box	-	1

Accessories you can buy separately.

Name	Legend	Quantity, units
1 Power supply (adapter)	AC / DC 5 V	1
2 Accumulators type AA (with a capacity of more than 2700 mA*h)	-	2
3 Accumulators Charger	-	1

5.2 Service life and warranty

5.2.1 The average service life of the device is 10 years.

After the specified period, the use of the device may be extended after major repairs performed by the manufacturer (hereinafter referred to as the manufacturer).

The manufacturer's address is specified in clause 5.4 (acceptance certificate). The Seller - **AtomEco SRL» Co Ltd**, whose address is also specified in clause 5.4, is responsible for carrying out major repairs.

5.2.2 The manufacturer guarantees that the device will operate for an average service life, provided that the User complies with the operating, transport and storage rules set out in this operating manual.

5.2.3 The Warranty period of the device is 3 years from the date of initial calibration (when the device is supplied to the Seller directly by the manufacturer). Warranty and post-warranty repair of devices is performed by the Seller -**«AtomEco SRL» Co Ltd**

ATTENTION! CLAIMS ARE NOT ACCEPTED AND WARRANTY REPAIRS ARE NOT CARRIED OUT IF THE CONSUMER IS NEGLIGENT WITH THE DEVICE, WHICH CAUSED DAMAGE TO THE INPUT WINDOW OF THE DETECTOR, INDICATOR OR THE DEVICE BODY.

5.3 Data on precious metals content

5.3.1 There are no precious metals on the printed board in components.

5.4 Acceptance certificate

5.4.1 **Dosimeter-radiometer MKC-01CA1** is registered in the Russian State Register of Measuring Instruments under the number No. 33063-08.
MKC-01CA1 has:
- Russian Certificate of type approval of measuring instruments RU.C.38.002.A No. 31090 with a validity period of 03/07/2023;
- CE Certificate No. OSE - 13-0413 / 02 for compliance with Directive 2006/95 / EC of December 12, 2006 with the safety requirements of electrical equipment for measurement, control and laboratory use;
- CE Certificate No. OSE - 13-0413 / 01 for compliance with Directive 2O04 \ 108 \ EC of December 21, 2004 requirements for electromagnetic compatibility of electrical equipment for measurement and control.

5.4.2 **Dosimeter-radiometer MKC– 01CA1 (**SNGA. 412152.001-01**) serial number** _____ was manufactured and recognized serviceable for operation in Russia by «ATOMPRIBOR» Co Ltd (123060, Russia, Moscow, Raspletina str., 5, bld. 1)

Responsible for acceptance

_____ Papanov S.
(signature) (surname, initials)

_____
(date)

Stamp

Filled by the Seller organization:

_____ **Goussatchenko A**
(signature) (surname, initials)

_____
(date of selling)

Seller:

«AtomEco SRL»
Tel: + 50688511540
Email: atomecomail@gmail.com
sales@atom-eco.com
www.atom-eco.com
10901, Costa Rica, Santa Ana. 350 al norte del restaurante Ceviche del Rey

Appendix A

Operation manual
on identification of radio-contaminated banknotes

This Manual is developed to control banknotes with the help of MKC-01CA1 instrument in accordance with the instructions of Central Bank of Russian Federation dated 04.12.2007 №131-I «On identification, temporary storage, cancel and utilization of radio-contaminated banknotes».

In radioactive decay, isotopes that are well known in nature, such as cesium, potassium, cobalt, iodine, etc. (more than 100 elements in total) emit both gamma rays and beta particles. And only 6 isotopes (strontium, thallium, carbon, etc.) emit only beta particles. In nature, there are no isotopes that emit only gamma rays.

The sensitivity of the BETA-1 detector of the MKC-01CA1 dosimeter to beta- radiation is approximately 50-100 times higher than to gamma- rays. In this regard, the detection and identification of radioactive contamination of banknotes, metal coins, payment cards and other environmental objects is recommended to start with the measurement of beta particle flux density. Moreover, if no radioactive contamination is detected when measuring the beta- particle flux density, then gamma- radioactive contamination is guaranteed to be absent (i.e., in this case there will be no necessity for additional measurements of gamma radiation dose rate for these banknotes).

It is mentioned in Instruction N 131-I that beta particles flux density from the banknotes should not exceed 10 $min^{-1} \cdot cm^{-2}$.

Setting of threshold alarm for beta particles flux density of the instrument MKC-01CA1 and radioactivity survey by mentioned instrument should be done in the following way:

1.1 Activate the instrument in «BETA» measurement mode. Open the working surface of detector by moving the screen to lower position (see Fig.1). In this case the instrument will register mixed gamma and beta radiation.`

1.2 Measure and register in the log the intensity of radiation background Φ_{bg} in the place of banknotes control, for example – on the desktop of operator (see item 2.5 of this Operation Manual).

1.3 Switch over the instrument in the mode of beta radiation threshold setting (see item 1.4.4.10 of this Operation Manual) and set the value of alarm threshold «**Beta threshold XXXXX** $min^{-1} \cdot cm^{-2}$» on the basis of exceeding above the background by $10 min^{-1} cm^{-2}$, i.e. (Φ_{bg} + 10) – according to requirements of Central Bank instruction.

Set beta radiation alarm thresholds are saved in permanent memory of instrument.

It is recommended to repeat mentioned preparation in cash operating units on a daily basis before starting of operation or at least once per several days.

1.4 By smooth moving of instrument along the surface of the banknote surveyed or the package of banknotes, locate the opened working window of detector at a minimum distance from the surface surveyed.

1.5 If readings of instrument will be increased with regard to beta radiation background value intensity Φ_{bg} by $10 min^{-1} cm^{-2}$ and more the audio alarm of exceeding the threshold will be activated. Stop moving the instrument and ensure persistent increase of instrument readings. As soon as the statistical measurement error indicated on the display reaches less than ± 20%, record the measurement results in a log.

1.6 Further measuring of contaminated banknotes identified in the item 2.3 of this Operation Manual should be done in **«GAMMA»** mode, previously moving the movable screen of detector in the upper position.

Note:

1. To accelerate radioactive anomalies survey according to item 1.4 the user can activate additional radiation intensity audio alarm (**“Clic On”**) and identify the most contaminated area of banknotes based on audible “clicks” frequency changing.

2. It is required to remember that, measuring time (time when statistic error will reduce from ± 99% to ± 20%) depends on radiation intensity and could be the value from several seconds (at high radiation intensity) up to 2 minutes in the case of changing at the level of natural radiation background. To accelerate low background changes of contaminated banknotes identified in the items 1.4-1.6 it is recommended either to restart the instrument with **«MENU»** button, or switch it off and activate the instrument by **«POWER»** button.