BELVAR

“РАДИАН”

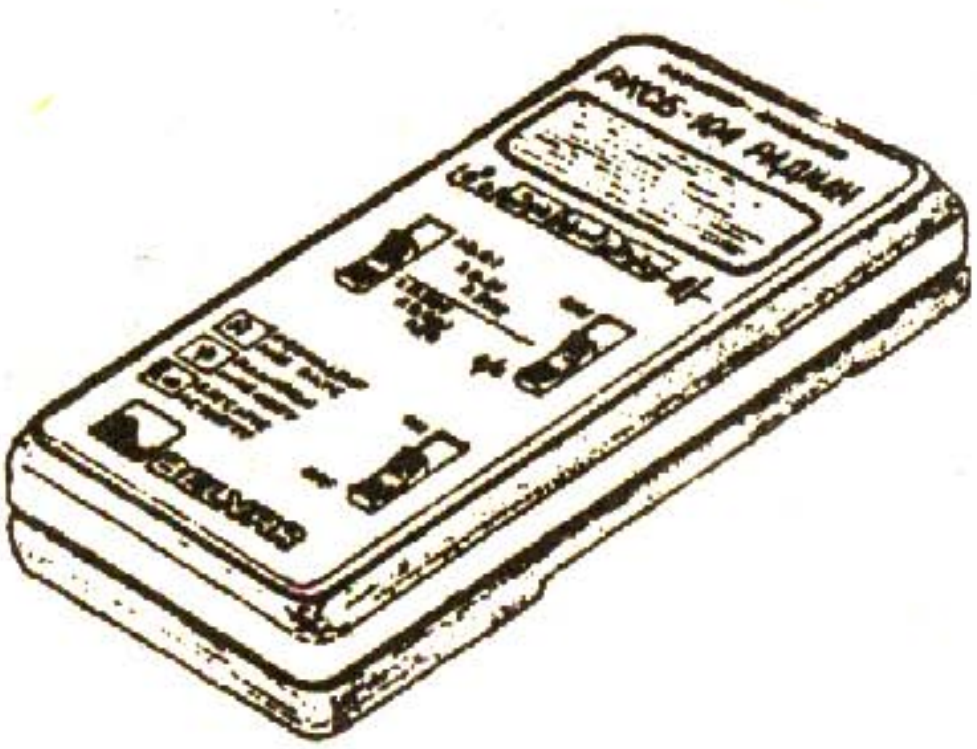
COMBINED

IONIZING RADIATION

MEASURING INSTRUMENT

РКСБ-104

CERTIFICATE



CONTENTS

1. INTRODUCTION

The present Certificate is intended for studying of the operation principle of "РАДИАН" Combined ionizing radiation measuring instrument РКСБ-104 (later on - instrument) and also as Instruction Manual.

2. APPLICATION

2.1. The instrument is an individual dosimeter and radiometer designed for radiation monitoring of terrain, living accommodations and industrial promises and is used to measure the following values·

gamma-radiation field equivalent dose rate;

beta-radiation intensity from radionuclide-contaminated surfaces;

specific radioactivity of caesium-137 as well as to signal an excess of user-set threshold value of gamma-radiation equivalent dose rate by sounding an alarm.

2.2. Design of the Instrument permits connection of external detection units.

3. BASIC SPECIFICATIONS

3.1. Measurement range of field equivalent dose rate of gamma radiation, μSv/h 0.1 - 99.99,
which corresponds to the exposure dose rate of gamma-radiation, μR/h 10 - 9999.

3.2. Measurement range of beta-radiation intensity from surface (for radionuclides strontium-90+ yttrium-90), $1/(s \cdot cm^2)$ 0.1 - 99.99,
which corresponds to intensity $1/(min \cdot cm^2)$ 6-6000.

3.3. Measurement range of specific radioactivity of caesium-137, Bq/kg 2.10^3 - 2.10^6,
which corresponds to specific radioactivity, Ci/kg $5.4 \cdot 10^{-8}$-$5.4 \cdot 10^{-5}$.

3.4. Registered radiation energy ranges, MeV:

beta-radiation 0.5 - 3;

gamma-radiation 0.06 - 1.25.

3.5. Value limits of admissible basic measurement error of field equivalent dose rate of gamma radiation, %:

within the range of from 0.1 to 1 μSv/h ±40;

within the ranges of from 1 to 10 μSv/h and from 10 to 99.99 μSv/h ±25.

3.6. Value limits of admissible basic measurement error of beta-radiation intensity from surface (for radionuclides strontium-90 + yttrium-90), %:

within the range of from 0.1 to 1 $1/(s \cdot cm^2)$ ±60;

within the ranges of from 1 to 10 and from 10 to 99.99 $1/(s.cm^2)$ ±40.

3.7. Value limits of admissible basic measurement error of caesium-137, %:

within the range of from $2 \cdot 10^3$ to $2 \cdot 10^4$ Bq/kg ±60;

within the ranges from 2.10^4 to 2.10^5 and 2.10^5 to 2.10^6 Bq/kg. ±40.

3.8. Energy dependence of instrument readings while measuring:

field equivalent dose rate of gamma- radiation, %,

not worse than +50 -25;

beta-radiation Intensity from surface, %,

not worse than ±150.

3.9. Measurement time of field equivalent dose rate of gamma-radiation does not exceed, s:

within the ranges of from 1 to 10 and from 10 to 99.99 μSv/h (the S3 slide-switch is in the upper position) 28;

within the ranges of from 0.1 to 1 and 1 to 10 μSv/h (the S3 slide-switch is in the lower position) 280.

3.10. Measurement time of beta-radiation intensity from surface (for radionuclides strontium-90+yttrium-90) does not exceed, s:

within the ranges from 1 to 10 and from 10 to 99.99 $1/(s \cdot cm^2)$ (the S3 slide-switch is in the upper position) 18;

within the ranges from 0.1 to 1 and from 1 to 10 $1/(s \cdot cm^2)$ (the S3 slide-switch is in the lower position) 180.

3.11. Measurement time of specific radioactivity of radionuclides caesium-137 does not exceed, s:

within the ranges of from 2.10^4 to 2.10^5 and from $2 \cdot 10^5$ to $2 \cdot 10^6$ Bq/kg (the S3 slide-switch is in the upper position) 40;

within the ranges of from and from $2 \cdot 10^3$ to $2 \cdot 10^4$ Bq/kg (the S3 slide-switch is in the lower position) 400.

3.12. Time of reaching the operating conditions, s, max 10.

3.13. The instrument generates an intermittent audible signal and displays "P" symbol on the indicator panel upon completion of a measurement cycle.

3.14. The instrument provides for setting any out of 31 possible thresholds of signaling operation as to the field equivalent dose rate of gamma-radiation within the range, μSv/h 0.1 - 16.

3.15. Instrument's continuous operation time, h (at least) 12.

3.16. The following conditions are considered to be normal for the Instrument use:

1) ambient air temperature, °C from -10 to 35;

2) relative air humidity at 30 °C, % 75±3; 3) atmospheric pressure, kPa 86-107.

3.17. Admissible complementary measurement error of the instrument, %:

1) upon changes of operating temperature to its limiting operating values (from 20±5°C) ±15;

2) upon changes of relative air humidity up to (75±3) % at a temperature of 30°C ±10.

3.17. The Instrument is powered by the "Korund" battery.

3.18. Instrument's complementary measurement error caused by the battery discharge down to 6.0 V does not exceed, % ±10.

3.19. Instrument's overall dimensions, mm, max:

without package 153x77x39;

with package 166x92x54.

3.20. Instrument's mass, kg, max:

without package 0.35;

with package 0.6.

3.21. Instrument's mean-time-between-failures, h, at least 4000.

3.22. Life expectancy, years, at least 10.

3.23. Admissible and actual values of instrument's basic error (checked during approval tests) are shown in Table 1.

Table 1

Specification	S3 slide-switch position	Measure-ment unit	Tested point	Basic error value, %		Reference source isotope
				Admis-sible	Actual	
1. Basic measurement error of gamma-radiation field equivalent	Upper	μSv/h	60	20	3	Caesium-137
2. Basic measurement error of beta-radiation from surface	Upper	μSv/h	40-60	20	11	Strontium-90 + yttrium-90

signature

Test data 30.04.03

4. COMPLETE SET

4.1. The Complete Set contains the following articles and service forms and records listed in Table 2.

Table 2

Designation	Name	Q-ty	Notes
1. 412152.001	Combined ionizing radiation measuring instrument РКСБ-104	1	In manufacturer's package P.3 and 4 are used as dishes for measurement of radionuclide caesium-137 specific radioactivity
2.	"Korund" battery TY 16-729.060-81	1	
3. 735211.001	Cover	1	
4. 735211.001	Cover	1	
5. 412152.001C	Certificate	1	

Note: The instrument modification numbers of P.1 and details P.3 and 4 are designated by the instrument color and structural styling and are indicated by the manufacturer when released.

5. SAFETY PRECAUTIONS

5.1. After measuring samples it is necessary to deactivate thoroughly dishes by washing them with synthetic detergents.

5.2. While operating with the removed cover be careful and do not damage film filters of gas discharge counters because in switched on state the counters are energized with high voltage (of the order of 400V).

5.3. Sample substances with detected radioactivity and decontamination radioactive waste are subject to burying in places appointed by the sanitary inspection.

6. PRE-OPERATION

6.1. Before operation study thoroughly the instrument's application, its basic specifications and measurement technique.

6.2. Before operating the instrument after its purchase:

1) take the instrument out of the package;
2) make sure by visual inspection of the absence of mechanical damages of the body , covers , liquid-crystal indicator and controls;
3) check the Instrument's completeness - it should comply with that listed in P.4 of the Certificate;
4) check the existence and safety of the manufacturer's seal , the seal should not be damaged;
5) remove the power supply compartment cover (the direction is shown by the arrow on it), take out of the compartment the terminal block for battery connection;
6) open the package and make visual Inspection of the battery; if there are traces of electrolyte or white salt remove them with rags;
7) connect the battery to the terminal block observing the polarity of connection and put them into the compartment. Replace the cover again.

7. OPERATING PROCEDURE

7.1. General

7.1.1. The instrument is в multifunctional meter designed at measuring 3 physical values:

1) gamma-radiation field equivalent dose rate;

2) beta-radiation intensity from surfaces;

3) specific radioactivity of caesium-137 in substances.

7.1.2. The reading device of the instrument is a liquid-crystal indicator, the panel of which displays 4-digit numbers - from 0000 to 9999.

Note. Measurement cycle duration depends upon the measured value and measurement subrange (see. Certificate p.3.5).

7.1.3. To obtain the result of measuring the particular physical value it is necessary to multiply the instrument's reading (or average value of some readings) through by the conversion coefficient indicated for each measured value and for each measurement subrange on the instrument face panel on the right side from the slide-switch S3. The results are in measurement units indicated on the instrument panel below the indicator board. For the consumer's convenience the measured value designation, its measurement units and conversion coefficient values (Table 3) are marked on the face panel with the paint of one color different

Table 3

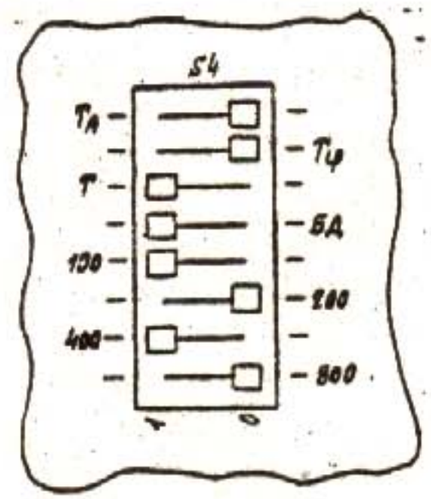
Measured value	Designation	Measurement unit	Conversion coefficient for different measurement ranges	
			Switch S3 is in the upper position	Switch S3 is in the lower position
1. Gamma-radiation field equivalent dose rate	H	μSv/h	0.01	0.001
2. Beta-radiation intensity from surface	Φ	1/(s·cm^2)	0.01	0.001
3. Specific radioactivity if radionuclide caesium-137 in substances	A_m	Bq/kg	200	20

from the color of similar designation accepted for other measured values.

7.2. Measurement of gamma-radiation field equivalent dose rate.

7.2.1. Remove back cover-filter.

7.2.2. Set code-switch sliders to the positions shown in Fig.1.



S4.8 – "0"
S4.7 – "0"
S4.6 – "1"
S4.5 – "1"
S4.4 – "1"
S4.3 – "0"
S4.2 – "1"
S4.1 – "0"

Position of slides S4.1-S4.4 can be random

Fig.1

7.2.3. Replace the cover-filter again.

7.2.4. Set slide-switches S2 and S3 to upper positions

("OPN" and "x0.01
x0.01
x200" correspondingly).

7.2.5. Switch the instrument on by S1 setting it to "ON" position. In (27-28)s the instrument will output intermittent sound signal and the panel of a liquid-crystal indicator will display *"F"* symbol and 4-digit number. To detect gamma-radiation field equivalent dose rate multiply the significant part of this number by the conversion coefficient equal to 0.01

(table 3) and. you will get the result in microSiverts per hour (μSv/h).

Example of gamma-radiation field equivalent dose rate; number 0018 is displayed; its significant part - 18; conversion coefficient - 0.01; the result is 0.18 μSv/h (it corresponds to the exposure dose rate 18 μR/h).

7.2.6. To achieve more precise measurement result (with admissible values of basic measurement error) at values of gamma-radiation field equivalent dose rate less than 10 μSv/h repeat measurement in lower position of S3 slide-switch (other controllers position is not changed). Measurement time will increase up to (270-280)s. Multiply the instrument's readings by the conversion coefficient equal to 0.001 (Table 3) and you will get the result in microSiverts per hour.

In S3 slide-switch lower position the significant part of 4-digit number displayed ON the indicator panel upon completion of a measurement cycle corresponds to multiplied by 10 value of gamma-radiation exposure dose rate in microRentgens per hour.

7.3. Measurement of surface contamination with beta-radiative radionuclides.

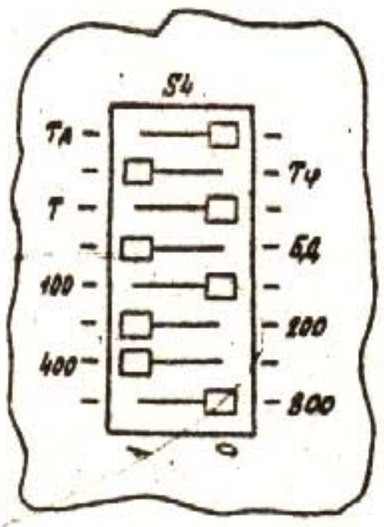
7.3.1. Remove the cover-filter.

7.3.2. Set code switch-sliders to the position shown in fig.2.

7.3.3. Replace the cover-filter again.

7.3.4. Set slide-switches S2 and S3 to upper positions

("OPN" and "xO.01
xO.01
x200" correspondingly).



S4.8 – "0"
S4.7 – "1"
S4.6 – "0"
S4.5 – "1"
S4.4 – "0"
S4.3 – "1"
S4.2 – "1"
S4.1 – "0"

Position of slides S4.1-S4.4 can be random

Fig.2

7.3.5. Carry the instrument to analyzed surface placing plastic package between them or take the instrument away at a distance of 110-120 cm. Switch on the instrument with s1 slide-switch by shifting it to "On" position.

7.3.6. Read background indication of the instrument (φ_b) which will set on the panel approximately in 18s after switching on. Remember or write down its readings.

7.3.7. Switch off the instrument with s1 slide-switch by shifting it to "OFF" position.

7.3.8. Remove back cover-filter and place the instrument over analyzed surface at a distance of not more than 1 cm.

7.3.9. Switch on the instrument with s1 slide-switch. Remember or write down its readings (φ_b) which were set during the intermittent sound signal.

7.3.10. Detect the value of surface contamination with beta-radiative, radionuclides which is characterized by the value of beta-radiation intensity from surface (φ) on the

formula $\varphi = K_1 (\varphi_s - \varphi_b)$ (1)

where φ in beta-radiation intensity from surface in particles per second from square centimetre [$1/(s \cdot cm^2)$ or $s \cdot cm^2$];

K_1 - coefficient equal to 0,01 (Table 3);

φ_s - instrument's readings with removed cover;

φ_b - readings corresponding to external gamma-radiation background.

7.3.11. To achieve more precise measurement result (within admissible values of basic measurement error) at values of beta-radiation intensity from surface less than 10 $1/(s \cdot cm^2)$, i.e. less than 600 B-particles/$(min \cdot cm^2)$ it is necessary to repeat measurement in lower S3 slide-switch position ("0.001

xO.001

x20"). Other controllers' position is not changed. In this case reading difference (φ_s - φ_b) should be multiplied by coefficient 0.001 (Table 3) and you will get the result in particles per second from square centimetre. To get intensity in particles per minute from square centimetre the result should be multiplied by 60. Measurement cycle time is (175-185)s.

7.4. Measurement of radionuclide caesium-137 specific activity.

7.4.1. Remove back cover-filter.

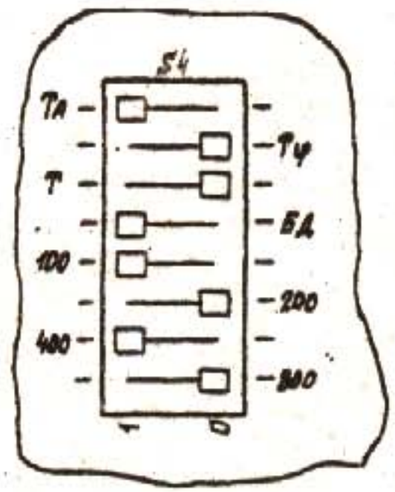
7.4.2. Set code-switch S4 sliders to the positions shown in Fig.3

7.4.3. Set the instrument's controllers: S2 slide-switch - in the upper ("OFF"), and S3 - in the lower position

("x0.001

x0.001

x20")



S4.8 - "1"
S4.7 - "O"
S4.6 - "O"
S4.5 - "1"
S4.4 - "1"
S4.3 - "0"
S4.2 - "1"
S4.1 - "0"

Positions of slides can be random

Fig.3

7.4.4. Till in a measurement dish (instrument's halfcasing) with radiologically "clean" water up to the mark on the interior wall of the dish and put the instrument above the dish as it is shown in Fig.4 .

7.4.5. Switch on the instrument by shifting S1 switch to "ON" position. Take 5 readings of the instrument, that corresponds to instrument's own radiological background (A_{b2} , A_{b2} , A_{b3} , A_{b4} , A_{b5}) and write them down. In order to reduce the overall tine of measurement perform short-term breaks in instruments operation by switching it on/off each time the reding is taken. Switch off the instrument as soon as all the redings are taken.

7.4.6. Calculate the average value of the obtained results (A_b) using the formula (2):

$$A_b = \frac{A_{b1} + A_{b2} + A_{b3} + A_{b4} + A_{b5}}{5}, \quad (2)$$

where A_{b1}, A_{b2}, ... , A_{b5} are separate background reading of the instrument during five measurements.

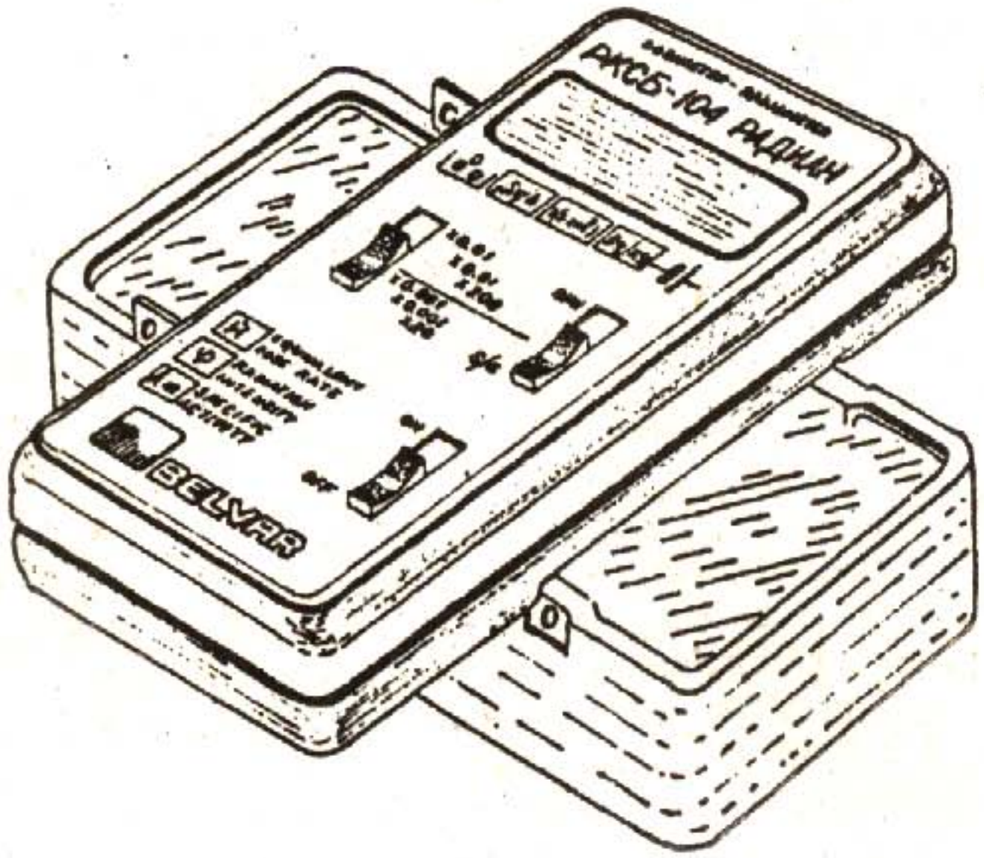


Fig. 4

7.4.7. Empty and dry the dish, pour the solution to be examined into the dish up to the mark.

7.4.8. Put the instrument upon the dish again and switch it on. Take 5 readings of the Instrument (A1 , A2 , A3 , A4 , A5) and write them down. Calculate an arithmetic mean of the readings (A_{mea}) using formula (3).

$$A_{mea} = \frac{A_{b1} + A_{b2} + A_{b3} + A_{b4} + A_{b5}}{5}, \qquad (3)$$

7.4.9. Calculate the specific radioactivity (A_m) of radionuclide caesium-137 in substance (in Bq/kg);

$$A_m = K_2 (A_{mea} - A_b), \qquad (4)$$

where K_2 is the scaling coefficient which equals 20 (T.3). To obtain value of specific radioactivity of radionuclide caesium-137 (in Ci/kg) the result of formula (4) should be multiplied by $2.7 \cdot 10^{-11}$ (1Bq = $2.7 \cdot 10^{-11}$ Ci).

$$A_m = K_2 (A_{mea} - A_b) 2.7 \cdot 10^{-11}, \qquad (5)$$

Note. For measurements of the specific radioactivity of substances with different radionuclide composition (caesium-137 , strontium-90+yttrium-90, etc.) use corresponding scaling coefficient K2 which are determined in research laboratories.

7.4.10. In case of counter overflow, when 4-digit numerals which exceed 9999 are displayed on the screen and are proceeded by sign "+" (for example, "+ 0132" is displayed), specific radioactivity measurement should be repeated with S3 switch in the upper position

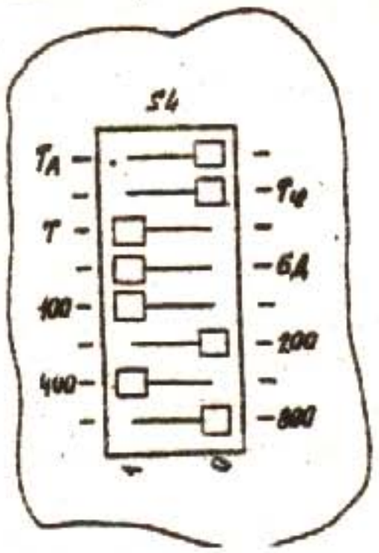
(“x0.01
x0.01
x200"). In this case when calculating value of radionuclide caesium-137 specific radioactivity the scaling coefficient K2=200 (Table 3) should be applied to formula (4).

7.5. Setting of signal response threshold required by the user.

7.5.1. Remove cover-filter.

7.5.2. Set slides S4.5-S4.8 of the code-switch to positions shown in Fig.1.

7.5.3. To set the required signal response threshold. shift slide-switch S3 and code-switch slides S4.1-S4.4 to positions specified in Table 4. Figure 5 gives an example of positions of slides S4.1-S4.4 for threshold value of gamma-radiation field equivalent dose rate of 1.1 μSv/h (110 μR/h).



S4.8 - "0"
S4.7 - "0"
S4.6 - "1"
S4.5 - "1"
S4.4 - "1"
S4.3 - "0"
S4.2 - "1"
S4.1 - "0"

Correspond to the threshold value of 1.1 μSv/h (110 μR/h) with slide-switch S3 in the lower position

Fig.5

7.5.4. Replace the cover-filter. Shift slide-switch S2 to the lower position ("S/B" - "STAND BY") and switch on the instrument. If an excess of the preset

threshold value is detected the instrument responds with a continuous sound signal.

Table 4

Signaling response threshold value, μSv/h (μR/h)	Indicator reading corre-sponding to the threshold	S3 positions	S4 positions			
			S4.1	S4.2	S4.3	S4.4
			800	400	200	100
0.1 (10)	0100	Lower	1	1	1	1
0.2 (20)	0200	– || –	1	1	1	0
0.3 (30)	0300	– || –	1	1	0	1
0.4 (40)	0400	– || –	1	1	0	0
0.5 (50)	0500	– || –	1	0	1	1
0.6 (60)	0600	– || –	1	0	1	0
0.7 (70)	0700	– || –	1	0	0	1
0.8 (80)	0800	– || –	1	0	0	0
0.9 (90)	0900	– || –	0	1	1	1
1.0 (100)	1000	– || –	0	1	1	0
1.1 (110)	1100	– || –	0	1	0	1
1.2 (120)	1200	– || –	0	1	0	0
1.3 (130)	1300	– || –	0	0	1	1
1.4 (140)	1400	– || –	0	0	1	0
1.5 (150)	1500	– || –	0	0	0	1
1.6 (160)	1600	– || –	0	0	0	0
1 (100)	0100	Upper	1	1	1	1
2 (200)	0200	– || –	1	1	1	0
3 (300)	0300	– || –	1	1	0	1

Table 4(continued)

Signaling response threshold value, μSv/h (μR/h)	Indicator reading corre-sponding to the threshold	S3 positions	S4 positions			
			S4.1	S4.2	S4.3	S4.4
			800	400	200	100
4 (400)	0400	Upper	1	1	0	0
5 (500)	0500.	– ‖ –	1	0	1	1
6 (600)	0600	– ‖ –	1	0	1	0
7 (700)	0700	– ‖ –	1	0	0	1
8 (000)	0800	– ‖ –	1	0	0	0
9 (900)	0900	– ‖ –	0	1	1	1
10 (1000)	1000	– ‖ –	0	1	1	0
11 (1100)	1100	– ‖ –	0	1	0	1
12 (1200)	1200	– ‖ –	0	1	0	0
13 (1300)	1300	– ‖ –	0	0	1	1
14 (1400)	1400	– ‖ –	0	0	1	0
15 (1500)	1500	– ‖ –	0	0	0	1
16 (1600)	1600	– ‖ –	0	0	0	0

8. SERVICE INSTRUCTIONS. GENERAL

8.1. Keep the instrument clean, regularly dust it with dry and clean cloth.

8.2. Protect the instrument from shocks and mechanical damage.

8.3. The instrument is equipped with a removable filter-cover 4 which is removed when taking radiometric measurements. To avoid damage remove and replace the cover carefully in compliance with Section 7 of the present manual.

8.4. To avoid contamination of the casing with radionuclides and to protect it from ingress of moisture it is advisable to keep the instrument inside a plastic cover.

8.5. To avoid waste of power supply de-energise the instrument during the idle period.

8.6. The manufacturer does not supply spare power supply sources, they have to be purchased by user on his own. To replace the power supply source proceed as follows:

a) remove cover of power supply compartment by shifting it in the direction shown by the arrow;

b) extract the power block with connected battery and, holding the block, disconnect the battery;

c) connect a fresh battery to the power block as it is specified in Section 6; replace the power block with fresh battery and replace the cover.

8.7. As a result of prolonged operation of the instrument In areas with excessive radio-contamination the instrument can override even if sources of ionizing radiation are not present in the vicinity. In that case the instrument should be decontaminated in the following order:

a) prepare neutral decontamination solution (dissolve 1/3 of tea-spoon of neutral detergent in 0.5 l of lukewarm clean water);

b) remove covers and extract the battery;

c) thoroughly wipe casing, covers and together with the power supply compartment using cloth soaked in the prepared detergent solution.

d) wipe the decontaminated surfaces with dry and clean cloth.

e) assemble the instrument.

9. TROUBLESHOOTING

Probable troubles, their causes and remedies are shown in T.5 .

Table 5

Character (outward manifestation) of trouble, its additional signs	Probable cause	Remedy
1. The instrument is switched on. There are no readings (or they are displayed for short time and disappear) on the indicator.	1.1. "Korund" battery is fully discharged.	1.1. Replace the battery.
2. During measurement in natural radiation background conditions the indicator panel displays "--" .	2.1. Selfdischarge of gas-discharge counters CBM 20.	2.1. Replace in turn one or two counters.
3. In "STAND BY" mode in case of an excess of the preset threshold value the instrument does not respond with sound signal.	3.1. Faulty bell.	3.1. Replace the bell.
4. In digital information on the indicator panel some figure elements are absent.	4.1. Failure of the liquid crystal indicator. 4.2. Failure of the pulse counter.	4.1. Replace the indicator. 4.2. Replace faulty micro-circuit.

10. STORAGE RULES

10.1. The instrument should be stored in manufacturer's package in the storehouses at ambient temperature from 5°C to 40°C and relative humidity up to 80% at temperature up to 25°C.

10.2. Store rooms should be free of dust, acid and alkali vapor, corrosive gas and other harmful impurities causing corrosion.

11. TRANSPORTATION

11.1. The instrument can be shipped by any kind of transportation at temperature from minus 50°C to 50°C.

11.2. Never snip the instrument in unheated non-air-tight aircraft compartments.

11.3. The instrument in the shipping container endures:

abrupt temperature change from minus 50°C to 50°C (3 cycles);

relative air humidity (95±3)% at temperature up to 35°C;

relieved air pressure up to (60±3) kPa;

transport shaking with acceleration of 30 m/s^2 at shocks frequency from 10 to 120 per minute for 2 hours.

6. ACCEPTANCE CERTIFICATE

This is to certify that the combined ionizing radiation measuring instrument PKCB - 104 Serial No 030858 is in full compliance with Specifications and found tit for service.

Date of manufacture 30.04.03

signature

13. PACKING CERTIFICATE

This is to certify that the combined, ionizing radiation measuring instrument PKCB - 104 Serial No 030858 has been packed in accordance with the requirement a of Design Documentation Set.

Date of packing 30.04.03

Packed by

Signature

The instrument accepted after packing

by

signature