RADIOMETRIC UNIT UDI-1B: RADIOIODINE MONITOR

User Manual
FVKM.412123.006RE
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This user manual contains information on design, principle of operation, characteristics of the product and instructions essential for correct and safe use of this product (intended use, maintenance, servicing, storage and transportation), as well as information regarding the utilization of the product.

1 DESCRIPTION AND OPERATION OF THE PRODUCT

1.1 Product functionality
Radiometric unit UDI-1B: radioiodine monitor FVKM.412123.006 (hereinafter – monitor) is intended for continuous measurements (monitoring) of the volumetric activity of gamma-emitting radioactive $^{131}$I as well as $^{132}$I, $^{133}$I and $^{135}$I in the workplace air, in ventilation systems, pipes, chambers etc., at the of radiochemical production facilities, in nuclear power engineering and industry.

Monitor is able to transfer data to communication channels and to provide the access to the processed information via communication lines based on Ethernet IEEE 802.3 (protocol TCP/IP) and RS-485 (under ModBUS protocol) interfaces and can be operated both in an off-line mode and as a part of automated systems, complexes and installations for radiation monitoring.

Monitor measures volumetric activity of the iodine radionuclides using simultaneously two methods of measurement data processing, namely: accumulation mode (i.e. within the specified time) and method of observation (i.e. instantaneous values). The type of measured values for displaying at the liquid crystal display (LCD) can be set up using the “Configurator” software. The LCD of the monitor allows simultaneous indication of two measured activity values by any of the above-mentioned methods and for the nuclides selected by the user by means of the “Configurator” software.

Monitor can be installed in a stationary position or used as a mobile measurement device in combination with the unit BN-01.

1.2 Technical characteristics

1.2.1 Energy range of detected gamma photons .................150 to 3000 keV.
1.2.2 Measurement range of volumetric activity of the iodine radionuclides:
- by accumulation method within 6 hours ......................... from 0.1 to 1.0·10$^5$ Bq/m$^3$;
- by observation method .............................................. 3.7 to 3.7·10$^5$ Bq/m$^3$.
1.2.3 Limits of allowable basic relative error of measurement of iodine radionuclides volumetric activity ...................................................... ±30 %.
1.2.4 Warm-up time ......................................................... not more than 15 min.
1.2.5 Continuous operation time .............................................. not less than 24 h.
1.2.6 Instability of readings during 24 hours of continuous operation ...... not more than ±15 %.
1.2.7 Monitor provides transfer of information to the external information channels and access to the processed information via communication lines based on Ethernet IEEE 802.3 (protocol TCP/IP (UDP), RS-485 (protocol ModBUS (RTU mode):
- self-testing codes;
- current measurement information;
- status of parameters;
- date and time;
- signal about opening/closing of the “dry contact” when the corresponding threshold is exceeded.

Adjustment, operability testing and calibration of the monitor are performed by means of the “Configurator” software via RS-232 interface.

1.2.8 Monitor maintain operability under conditions of background gamma radiation with the ambient equivalent dose rate .............................................. not more than 10 µSv·h$^{-1}$. 

FVKM.412123.006RE
1.2.9 Monitor intrinsic background activity indications ……………. not more than 3.7 Bq/m³.
1.2.10 Air flow rate through the trap ……………………………………….. from 20 to 40 l/min.
1.2.11 Limits of permissible basic relative measurement error of the air flow rate ……. ±10%.
1.2.12 Power supply of the monitor is performed from AC mains with voltage $220_{-22}^{+22}$ V, frequency $50_{-2.5}^{+2.5}$ Hz.

1.2.13 Power consumption:
- without pump unit ………………………………………………………… 75 VA;
- with pump unit BN-01 ………………………………………………………… 300 VA.

1.2.14 Operating conditions:
- operating temperature range ………………………………… minus 10 to +50 °C;
- relative humidity …………………………………………………………… 98 % at +35 °C;
- atmospheric pressure …………………………………………………… 84.0 to 106.7 kPa;
- content of the corrosive agents in the ambient air corresponds to the values in table 1.1.

### Table 1.1

<table>
<thead>
<tr>
<th>Type of atmosphere</th>
<th>Content of the corrosive agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>Description</td>
</tr>
<tr>
<td>I</td>
<td>Relatively clean</td>
</tr>
<tr>
<td>II</td>
<td>Industrial</td>
</tr>
<tr>
<td>III</td>
<td>Maritime</td>
</tr>
</tbody>
</table>

Limits of complementary measurement error of volumetric activity of iodine radionuclides:
- due to deviation of the ambient air temperature from normal value ………………… ±10 %;
- under increased relative humidity up to 98% at +35°C ……………………………. ±10 %.

1.2.15 Monitor withstands sinusoidal vibrations in the frequency range from 10 to 55 Hz with displacement amplitude 0.35 mm.

Limits of complementary activity measurement error under conditions with vibration …. ±5 %.

1.2.16 Monitor is stable against seismic impacts with magnitude 7 according to the MSK-64 scale, being installed on the building structures of the industrial site at 70 to 30 m relative to the grade level.

After the seismic impact with the above mentioned parameters monitors are operable within the limits stated in sections 1.2.3, 1.2.7 during the whole life cycle under specified operation conditions.

1.2.17 Degree of protection provided by casings against ingress of solid items and water - IP65.

1.2.18 Monitor withstands the electromagnetic interference of the 3 grade according to IEC 1000-4-8-93, IEC 1000-4-9-93, IEC 61000-4-2-95, IEC 61000-4-3:2006, IEC 61000-4-4:2004, IEC 61000-4-5-95, IEC 61000-4-6-96, IEC 61000-4-11:2004, IEC 61000-4-12-95, IEC 61000-4-13:2002, IEC 61000-4-14-99, IEC 61000-4-28-99.


1.2.20 By its protection against electric shock monitor complies with the IEC 61010-1:2001.

1.2.21 Monitor is a fire-safe products with fire probability of no more than $10^6$ year⁻¹.
1.2.22 Monitor withstands the exposure to decontaminating solutions:
1) boric acid \((H_3BO_3) – 16\text{ g}\), sodium thiosulfate \((Na_2S_2O_3·5H_2O) – 10\text{ g}\), distilled water – up to 1 liter;
2) trisodium phosphate or sodium hexametaphosphate (any detergent) – 10 - 20 g/l water solution;
3) 5 % citric acid solution in rectified alcohol – for connectors and contacts.

1.2.23 Weight …………………………………………………………………………………………………………………………………………………… 35 kg.

1.2.24 Overall dimensions ……………………………………………………………………………………………………………………………… 448×323×479 mm.

1.2.25 Mean time before failure ………………………………………………………………………………………………………………………… not less than 10000 hours.

1.2.26 Mean life time …………………………………………………………………………………………………………………………………………… not less than 10 years.

1.3 Configuration
1.3.1 Monitor is a complete unit, both functionally and structurally.

The following items come with the monitor:
- power cord;
- cable for connection to PC using “RS-232” connector;
- “Configurator” software (hereinafter - “Configurator” software) intended for current control of the monitor and, when necessary, adjustment and calibration of the monitor from PC;
- check source, placed in the holder and intended for testing of operability of the monitor and monitoring of the energy calibration;
- installation kits, consumables, spare parts and accessories.

1.4 Design and operation
1.4.1 The monitor is comprised of the following parts: main (measuring) and compensatory detector units, vortex flow meter, sorption trap, analog-digital converter and processor module.

The front panel of monitor contains: four-lined liquid crystal display (LCD) for displaying information, single colour indicators of red, yellow, and green colour, siren and siren cut-off button. Interpretation of indications of the iodine monitor monitor is provided in the Appendix A.

On the left side panel (Figure 1.1) (in case monitor is viewed from its front panel) power supply and interface sockets are placed as well as connector for the alarm unit (AU) and outlets of dry contact. Sorption trap with inlet manifold for the monitored air is placed on the top cover of monitor. The outlet air manifold is on the right side panel.

The connection layout, wiring diagram, outline drawing are presented in the Appendices B, C and D.

1.4.2 Monitor can operate with pump unit BN-01, on which it is installed. The pump unit BN-01 is connected to the monitor by the transitional hose for junction of air lines. The air outlet of the monitor is connected to the air inlet of the pump unit BN-01. The pump unit BN-01 is powered from the monitor; the power cord is connected to the “TO PUMP” electric outlet located on the left side panel.

1.4.3 When pumping through a sorption trap of the air from ventilation system of by means of external pump unit, the radioactive iodine isotopes \((^{131}I, ^{132}I, ^{133}I \text{ and } ^{135}I)\) from the air are absorbed by the sorbent. Scintillation detector is placed under the trap inside the lead shielding. Gamma photons emitted by radioactive iodine on sorbent pass through the detector and cause scintillations (flashes of light), which are then transformed by the photoelectric receptor to the electric pulses. These pulses are sent to one of two inputs of 1024 channel analog-digital converter (ADC) and then to the processor that produces spectral information related to gamma photons emitted by radionuclides.
With the purpose of decreasing measurement error due to external radiation background, monitor is equipped with additional compensatory channel; detectors of the main measuring channel and compensatory channel are placed inside identical lead shielding. The residual gamma background, which is not absorbed in the shielding is measured by the compensatory detector connected to the second input of the ADC. When performing the calculations, the background detector counts are subtracted. The air flow rate is measured using the built-in vortex flow meter.

When operating the monitor, the sorbent is gradually poisoned mainly by stable iodine isotopes, so it should be timely replaced. The sorbent resource is determined by the manufacturer.

1.4.4 The resulting spectra and data on the air flow rate and volume are processed by the processor. Results are displayed at the LCD in accordance with the settings made in the “Configurator” software. The setting up process is described in the User Manual FVKM.001005-07 34 01.

After that measured values are compared with threshold settings determined by the user at the phase of adjusting the monitor. If the warning threshold (first level) is exceeded, the yellow light signal and audible signal are triggered; red light signal and audible signal are triggered when the emergency threshold (second level) is exceeded. Audible alarm can be cut off by pushing button “MUTE”.

LCD displays information on numerical values of the measured quantities (volumetric activities and activities on a sorption trap) for respective radionuclides. The list of displayed parameters is set up using the «Configurator» software. For each radionuclide two thresholds can be set: warning (first level) and emergency (second level). If a threshold is exceeded, symbol I or II (depending on the exceeded threshold) is displayed on the LCD prior the value of the volumetric activity. Alarm signals are dubbed to the alarm unit BAS (if it is connected). Besides activities of the iodine radionuclides listed above, the total activity of all four radionuclides is calculated. Its value is not displayed at the LCD, but is available via interfaces in the “Configurator” software.

To control external devices, monitor has the dry contact representing a relay transfer contact. To control the dry contact four thresholds are also provided for each of the radioiodine isotopes. If the threshold is exceeded, the dry contact is switched.

1.4.5 Measured values are recorded in non-volatile memory, forming the archive of measurements, which can be read out using the “Configurator” software or upper level radiation monitoring system (RMS) software based on ModBUS interface. Total memory size ensures storage of more than 3000 measurements.
1.5 Marking and sealing
1.5.1 A nameplate with the following information is attached to the monitor casing:
- trademark and name of the manufacturer;
- reference designation of the monitor;
- works number of the monitor according to the manufacturer numeration system;
- sign of approval of the measurement instrument;
- voltage, current and frequency of the AC power supply;
- degree of ingress protection against solid items and water provided by casings;
- made in Russia.
1.5.2 Method of marking and place on the monitor where it is made shall comply with the design documentation.
1.5.3 Monitor is sealed in accordance with the design documentation.

1.6 Packing
1.6.1 The monitor package complies with the design documentation and provides protection against ingress of atmospheric precipitations and aerosols, splashes of water, dust, sand, solar ultraviolet radiation and limits the ingress of water vapour and gases.

2 INTENDED USE

2.1 Operational limitations

ATTENTION! FOR ENSURING CORRECT AND FAILURE-FREE OPERATION DURING PREPARATION FOR USE AND OPERATION OF THE MONITOR LIMITATIONS AND RECOMMENDATIONS STATED BELOW SHOULD BE FOLLOWED.

2.1.1 Monitor can be operated with pumping devices providing air flow rate 20 - 40 l/min.
2.1.2 Monitor cannot be used with gas sampling systems where the suction is less than 20 kPa. Maximum allowable pressure differential during blowing is 10 kPa. If blowing is carried out under pressure exceeding 10 kPa, cut-off of the monitor should be provided by means of the stop valve and blowing of the air line through the bypass;
2.1.3 For ensuring correct measurements it is necessary to provide damping means necessary during switching the sampling on/off, opening and closing of valves. It is necessary to install between the sampling (pumping) device and the monitor a receiver, a diaphragm, a filter, etc. to smooth the pressure pulsations during operation of pumps. Minimum volume of the receiver is 1/5 of the air volume pumped during 1 minute;
2.1.4 For correct operation of the monitor measures should be taken to prevent entrance of radioactive aerosols, not containing radioiodine, into the sorption trap. Additional external device with AFA-type filters shall be used with the purpose of protecting the sorption trap from contamination by aerosols.

In case of absence of the above-mentioned sorption trap protection measurement results of volumetric activity of $^{132}$I cannot be considered reliable due to possibility of concentration on the AFA-type filter of aerosols with $^{137}$Cs and detection of gamma photons of $^{137}$Cs with energies close to that of $^{132}$I.

2.1.5 The following is not allowed during operation:
- use of the monitor at medium (6 – 35 kV) and high (above 35 kV) voltage electric substation;
- use of the monitor as parts of high power electric installations;
- connection of the monitor to the circuit of signal earth;
- use of mobile phones within 10 meters of the monitor.
2.2 Preparation of the product for use

2.2.1 Preparation for operation in off-line mode:
1) place monitor in the intended location;
2) connect monitor to the pumping device; if the pump unit BN-01 manufactured by the SPC “Doza” is used, utilize for this purpose a hose FVKM.302645.006 from the BN-01 delivery kit;
3) connect monitor to AC mains 220 V (50 Hz); connect the pump unit BN-01 (if it is used) to the “TO PUMP” electric outlet using the power cord FVKM.685631.138 from the BN-01 delivery kit;
4) switch the power on by power on/off switch, if the pump unit is used, it will be switched on simultaneously with monitor.

2.2.2 Preparation for use of the monitor as part of the radiation monitoring system:
1) place monitor in the intended location;
2) connect monitor to the pumping device; if the pump unit BN-01 manufactured by the SPC “Doza” is used, utilize for this purpose a hose FVKM.302645.006 from the BN-01 delivery kit;
3) connect monitor to AC mains 220 V (50 Hz); connect the pump unit BN-01 (if it is used) to the “TO PUMP” electric outlet using the power cord FVKM.685631.138 from the BN-01 delivery kit;
4) connect monitor to the information network via “RS-485” or “Ethernet” socket;
5) switch the power on by power on/off switch, if the pump unit is used, it will be switched on simultaneously with monitor.

2.3 Use of a product

2.3.1 After power-on the built-in software is loaded. The software data set (configuration and settings) is located in the non-volatile memory, so no additional preparation for operation is needed after loading.

The program tests main modules of the monitor. After completion of the test command to switch on the pump is generated. After 20 seconds of pumping the flow rate is measured. If the flow rate is within the specified range, the system is concluded to be operable and the program proceeds to the operating mode.

2.3.2 Every 20 seconds the current air flow rate and the pumped air volume (since the monitor was switched on) are measured. At the same time the spectrum is processed by ADC. The time is determined by the real time clock independent of power supply.

Monitor measures volumetric activities of $^{131}$I, $^{132}$I, $^{133}$I and $^{135}$I. There are two calculation methods of volumetric activity: method of observation and accumulation method, monitor performs simultaneous calculations by these methods. Those methods differ by intervals of accumulation of spectrometric data and, as a result, by sensitivity.

2.3.3 The “observation” algorithm is used for calculation of the volumetric activity in the range of $3,7 \text{ to } 3,7 \times 10^5$ Bq/m$^3$ and is characterized by short measurement time intervals. The time interval of the spectra accumulation, measurement, calculation and update of indications on the LCD is within a range of 20 seconds to 10 minutes depending on current volumetric activity of iodine radionuclides.

Volumetric activity values measured in accordance with this algorithm are accessible for reading from corresponding registers and displayed on the LCD.

2.3.4 Accumulation algorithm is used for calculation of volumetric activity in the range of $1.0 \text{ to } 10^5$ Bq/m$^3$ and is characterized by long measurement time intervals; time of spectra accumulation is up to 40 minutes (depends upon current volumetric activity of iodine radionuclides).

2.3.5 Monitor does not require any actions of personnel during its operation. Measurement results and status of the monitor modules are displayed on the LCD and, if the monitor is used as part of a radiation monitoring system, are transferred to the external information network.
If the cartridge with sorbent is required to be replaced, monitor displays the message on LCD and sends it to the information network. Monitor operation with the cartridge to be replaced is possible at least within one hour. Types of cartridges with sorbent and procedure for their replacement are described in section 3.3.1.

2.3.6 The monitor energy calibration shall be carried to provide the operability, the operability also shall be tested by measuring count rate from the check source included in the delivery kit. Both procedures are performed simultaneously in automatic mode when the check source is placed into the monitor standard place.

Performing these steps is necessary during calibration, first switching on in-situ (at the intended operation location) and after long-term switched-off state of the monitor. In all other cases necessity of performing energy calibration and operability test procedures is determined by the built-in software; the operator is warned about that by message “CLB” displayed on the LCD.

To perform energy calibration and operability test:
1) remove check source insert and put the check source on its place (see Figures 2.1 and 2.2);
2) switch on the monitor;
3) record count rates displayed at the LCD: \( n_1 \) for the 511 keV peak and \( n_2 \) for the 1274 keV peak (s\(^{-1}\));
4) repeat step 3) five times, determine average values \( n_{\text{reg}1} \) – count rate at 511 keV peak, and \( n_{\text{reg}2} \) – count rate at 1274 keV peak;
5) take out the check source, turn it around its axis by 180º and put it again in the holder to the standard place;
6) repeat steps 2) - 4), determine average values \( n_{\text{reg}1} \) and \( n_{\text{reg}2} \);

A message “Remove the source” appears when the energy calibration procedure is complete.

After the count rate is measured, the check source expected count rates (s\(^{-1}\)) for corresponding peaks shall be calculated for the moment of measurement

\[
n_{\text{exp}1,2} = n_{1,2} \cdot e^{-0.6934/T_{1/2}},
\]

where \( n_1, n_2 \) - are the check source count rates of monitor from the previous calibration certificate, s\(^{-1}\),
\( n_1 \) - is a count rate at 511 keV peak, \( n_2 \) - is a count rate at 1274 keV peak;
\( t \) – is a time interval (years) since the last calibration;
\( T_{1/2} = 2.6 \) years is the half-life of \(^{22}\)Na.
Monitor shall be considered to have passed the operability test by the check source count rate if the following conditions are fulfilled

\[
\frac{n_{\text{reg}1,2} - n_{\text{exp}1,2}}{n_{\text{exp}1,2}} \cdot 100 \leq 15\% \quad (2.2)
\]

or

\[
\frac{n'_{\text{reg}1,2} - n_{\text{exp}1,2}}{n_{\text{exp}1,2}} \cdot 100 \leq 15\% \quad (2.3)
\]

Otherwise an unscheduled calibration of the monitor shall be carried out.

### 2.4 Adjustment

Parameters of the monitor can be changed by means of “Configurator” software. A list of parameters available for displaying and editing using the "Configurator" is presented in Appendix F. In order to change parameters monitor shall be connected to PC by the communication cable. The cable shall be connected to RS-232 socket of the monitor and to serial port of the computer.

The software shall be installed at the computer according to “Configurator” software User Manual FVKM.001005-07 34 01.

### 3 MAINTENANCE

#### 3.1 General notes

Maintenance is performed with the purpose of ensuring operability of the monitor during the whole service life.

#### 3.2 Safety precautions

3.2.1 Before beginning to work with the monitor familiarize yourself with this User Manual.  
3.2.2 During all operations with the monitor it is necessary to follow occupational and radiation safety requirements of current safety instructions in the company (facility).  
3.2.3 Technical personnel with basic computer skills and skills of working with radiometric equipment are permitted to perform maintenance of the monitor.  
3.2.4 During operation of the monitor special attention shall be paid to power cord condition – in this place dangerous voltage can be present.  
3.2.5 All cable connections and disconnections should be performed with the power supply cut off. When using the monitor as part of measurement information complexes, systems and installations “hot” connection of cables is allowed (without switching the monitor off). At that connection should be provided of the protective ground to corresponding terminals at the monitor and the signal receiving device.  
3.2.6 Removal of the used cartridge with sorbent shall be carried out using gloves. For protection of the respiratory tract maintenance staff shall use breathing masks.  

**ATTENTION! DURING PREPARATION OF THE MONITOR FOR USE AND DURING OPERATION REQUIREMENTS OF THE SECTION 2.1 SHOULD BE STRICTLY FOLLOWED.**

#### 3.3 Maintenance routine

Maintenance is carried out during regular operation of monitor; it includes timely replacement of sorbent containing cartridge, general inspection, dust and dirt cleaning (decontamination).
3.3.1 Replacement of cartridge with sorbent

Depending on the delivery set, monitor can use two types of cartridges with sorbent: FVKM.305152.001 – standard cartridge and FVKM.305152.012 – single-layer cartridge.

Cartridge with sorbent has to be replaced when the message about sorbent contamination appears on LCD of monitor or on the network information server when monitor is used as part of radiation monitoring system. However, during continuous operation of monitor, standard cartridge should be changed at least once in three months.

A single-layer cartridge is recommended when high concentrations of radioiodine is present in the pumped air, as a result of accidental discharge, etc., in this case a single-layer cartridge must be changed at least once a week, regardless whether a message about sorbent contamination is present or not on LCD of monitor or on the network information server.

3.3.2 General inspection of monitor

General inspection of the monitor is performed for timely identification and elimination of factors which may affect the operability and safety of monitor.

General inspection is made each time when the sorption trap is replaced.

In the course of general inspection condition of cables, controls, reliability of the monitor fastening (when using in stationary locations) are checked visually.

3.3.3 Decontamination

3.3.3.1 The monitor is decontaminated in accordance with current decontamination schedules and procedures of the company (facility). External surfaces, cartridge after removal of the spent filter material, and sorption trap compartment in the monitor are decontaminated using decontaminating solutions 1) and 2) as per 1.2.23. After cleaning of surfaces using cloth moisten with decontaminating solution it is necessary to wipe surfaces using cloth moisten with distilled water and then dry using filter paper.

3.3.3.2 Cable connectors are decontaminated using solution 3) of the 1.2.23: additional treatment with distilled water and drying with filter paper are not required.

3.3.3.3 If required, the LCD and other components are cleaned of dust and dirt with clean cloth.
4 CALIBRATION ROUTINE

4.1 General requirements
Calibration of monitor is performed in accordance with the IEC 61453:2007.

4.2 Preliminary arrangements
4.2.1 Operations that should be performed during calibration are listed in the table 4.1.

Table 4.1 – List of calibration operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>External examination</td>
<td>4.5.1</td>
</tr>
<tr>
<td>Testing</td>
<td>4.5.2</td>
</tr>
<tr>
<td>Calibration of the monitor</td>
<td>4.5.3</td>
</tr>
<tr>
<td>Measurement of the intrinsic background volumetric activity</td>
<td>4.5.4</td>
</tr>
<tr>
<td>Determination of the basic relative measurement error of the volumetric activity of gamma-emitting iodine radionuclides</td>
<td>4.5.5</td>
</tr>
<tr>
<td>Determination of the count rate from check source</td>
<td>4.5.6</td>
</tr>
<tr>
<td>Processing of the measurement results</td>
<td>4.6</td>
</tr>
</tbody>
</table>

4.2.2 Primary and auxiliary tools and equipment necessary for calibration are presented in the table 4.2.

Table 4.2 – Primary and auxiliary tools and equipment for calibration

<table>
<thead>
<tr>
<th>Item</th>
<th>Name and type (designation) of primary or auxiliary calibration tool, document that regulates technical requirements and/or metrological and main technical characteristics of the calibration tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5.3, 4.5.5</td>
<td>Sealed radioactive reference sources of photon radiation OSGI-R with $^{137}$Cs and $^{60}$Co – working standards of 2 grade, activity 6000 Bq, uncertainty $\pm 6%$</td>
</tr>
<tr>
<td>4.5.5</td>
<td>Sealed radioactive reference source of photon radiation OSGI-R with $^{137}$Cs – working standard of 2 grade, activity 1000 Bq, uncertainty $\pm 6%$</td>
</tr>
<tr>
<td>4.5.5</td>
<td>Gas meter type SGB G4-1. Limits for measurement error $\pm 1.5%$ at flow rate in the range 0.4 to 6 m$^3$/h.</td>
</tr>
<tr>
<td>4.5.3, 4.5.6</td>
<td>Check source OISN-22-9 from the monitor delivery kit</td>
</tr>
<tr>
<td>4.5.2</td>
<td>PC with installed “Configurator” software FVKM.001005-07</td>
</tr>
<tr>
<td>4.5.2, 4.5.5</td>
<td>Pump unit BN-01 or other pumping unit, providing air flow rate in the range 20 to 60 l/min.</td>
</tr>
<tr>
<td>4.5.4</td>
<td>Sorption trap with fresh filter material</td>
</tr>
<tr>
<td>4.5.5</td>
<td>Hose for connecting the gas meter</td>
</tr>
<tr>
<td>4.5.5</td>
<td>Stop-watch Accuracy rating 2</td>
</tr>
</tbody>
</table>

Note - It is allowed to use other tools and equipment with similar characteristics ensuring determination of metrological characteristics of detectors with required precision.

4.3 Safety precautions
It is necessary to follow safety requirements described in section 3.2 and in documentation accompanying calibration tools and equipment.
4.4 Conditions
4.4.1 The following normal operating conditions shall be met during calibration:
- air temperature .......................................................... + (20 ± 5) °C;
- relative air humidity .................................................. from 30 to 80 %;
- atmospheric pressure .................................................. 86.0 to 106.7 kPa;
- natural radiation background ........................................ not more than 0.2 μSv·h⁻¹;
- AC mains voltage ....................................................... (220 ± 4.4) V;
- AC mains frequency .................................................... (50 ± 0.5) Hz.

During calibration the air flow rate through the sorption trap when using the pump unit BN-01 shall be within the range of 20 to 40 l/min.

Prior to performing calibration procedures the monitor shall be hold in switched state for at least 15 min.

4.4.2 Operations carried out with calibration tools and with the monitor shall comply with instructions specified in correspondent operational documentation.

4.4.3 Prior to calibration prepare OSGI-R source (¹³⁷Cs, activity 1000 Bq) for measurements as follows:
1) calculate activity of each source as of date of calibration by the formula

\[ A_0 = A_{\text{cert}} \cdot e^{-0.693 \cdot T_{1/2}/t} \]  \hspace{1cm} (4.1)

where \( A_{\text{cert}} \) – activity of the source from the last calibration certificate, Bq,
\( t \) – time passed since the last calibration of the OSGI-R, years,
\( T_{1/2} = 30.17 \) years – half-life of ¹³⁷Cs;

2) ensure the possibility of fixing sources in the center of the sorption trap.

4.4.4 In order to carry out calibration in addition prepare OSGI-R sources ¹³⁷Cs and ⁶⁰Co with activity 6000 Bq and calculate their activity as of date of calibration by the formula (4.1), where \( T_{1/2} = 30.17 \) years – half-life of ¹³⁷Cs; \( T_{1/2} = 5.273 \) years is a half-life of ⁶⁰Co; \( A_{\text{cert}} \) is a certified activity of the source, Bq.

4.4.5 Prepare the monitor for calibration as follows:
1) place monitor in the intended location;
2) connect monitor to the pump unit BN-01 using a hose FVKM.302645.006 from the BN-01 delivery kit;
3) connect the pump unit BN-01 with the “TO PUMP” electric outlet of the monitor using the power cord from the pump unit set;
   Note – When the OSGI-R activity in the sorption trap is measured without pumping, the pump unit BN-01 shall be disconnected from the “TO PUMP” outlet.
4) connect the monitor with the personal computer using communication cable;
5) install the “Configurator” software to the computer.

4.4.6 Prior to switching on and performing calibration the monitor shall be kept under conditions specified in 4.4.1 for at least 4 hours.

4.5 Procedure
4.5.1 External examination
Items to be checked during external examination:
- proper completeness;
- availability of operational documentation and the “Configurator” software User Manual;
- absence of defects which could affect the monitor operation.
Results of the external examination are considered positive in case that: monitor arrived for calibration in proper completeness, defects are absent, which can affect the operability of the monitor.

4.5.2 Testing of the monitor
For testing connect the monitor to the external pumping unit; this shall result in updating of the indications on LCD.

Monitor is considered operable if it successfully passed the self-testing procedure.

4.5.3 Calibration of the monitor
Perform energy and detection efficiency calibration of the monitor.

4.5.3.1 Energy calibration of the monitor is performed as follows:
- place the check source to the standard place;
- switch on the monitor;
- wait until the message “REMOVE THE SOURCE” appear at the LCD on completion of the calibration procedure;
- read energy calibration coefficient by means of the “Configurator” software.

4.5.3.2 Detection efficiency calibration of the monitor is performed as follows:
- remove the check source and install the insert, put the sorption trap with OSGI-R source \(^{137}\text{Cs}^{+\text{60}}\text{Co}\) fixed in the center of its lid, to the standard place in the monitor;
- in the “Configurator” software in the “Calibration” tab enter the data for the OSGI-R source \(^{137}\text{Cs}^{+\text{60}}\text{Co}\) according to certificate and current date;
- switch on the monitor without the air pumping and perform measurements using the efficiency calibration mode;
- wait until the calculated by the “Configurator” software efficiency coefficient appear after completion of the calibration procedure;
- record the results of the “Configurator” software calculations into the non-volatile memory of monitor by pushing the button “TRANSFER TO DEVICE”.

4.5.4 Monitor background measurement is performed as follows:
1) prepare monitor for use in the mode of activity measurement without pumping, install the sorption trap filled with the fresh filtering material into the standard place, switch on the monitor;
   Note – It is permitted to measure the background activity without the sorption trap.
2) in 15 minutes record values of the \(^{132}\text{I}\) activity on the filter (Bq) from respective boxes of the “Measurements” tab of the “Configurator” software;
3) repeat step 2) ten times.
   Note – The measurement result of the background activity obtained with fresh sorption trap is numerically equal to the monitor background activity.

4.5.5 For determination of the basic relative measurement error of the gamma-emitting iodine radionuclides volumetric activity it is necessary to determine relative measurement errors of the air flow rate and of activity in the sorption trap (on the filter).

4.5.5.1 Relative error of the air flow rate measurement is determined as follows:
1) prepare monitor for joint operation with the pump unit BN-01, connect monitor inlet pipe to the gas meter outlet pipe using the connection hose with proper diameter;
2) prepare and zero the stop watch;
3) record the initial reading of the gas meter;
4) switch on monitor;
5) after short beep start measuring simultaneously the time of pumping by stopwatch, the volume – by gas meter, the flow rate – by monitor, after the next short beep register and record the following:
- the pumped air volume value by gas meter data (m$^3$),
- stop watch readings (min),
- the values of the flow rate in l/min, shown in boxes “Average rate of the flow, l/min” and “Average accumulative rate of the flow, l/min” of the “Measurement” section of the “Configurator” software;

6) repeat step 5) ten times.

4.5.2.5 The basic relative measurement error of activity in the sorption trap (on the filter) is determined by the measuring channel of $^{132}$I using OSGI-$^{137}$Cs, using the “Configurator” software (methods of observation and accumulation). For this purpose proceed as follows:

1) prepare monitor for activity measurement without pumping;
2) put the trap with OSGI-$^{137}$Cs to the monitor standard place;
3) switch on monitor and after second short beep register the result of measurement by observation method located in the “Activity of $^{132}$I on the filter, Bq” box of the “Measurement” tab;
4) wait until the results appear in the box “Accumulated activity of $^{132}$I on the filter, Bq” of the “Measurements” tab of the “Configurator” software, record measurement result by accumulation method, switch the monitor off;
5) repeat steps 3) to 4) ten times.

4.5.6 Perform determination of the count rate from the check source as follows:
1) place check source in the holder to the standard place;
2) switch on monitor without air pumping, in the mode of the check source measurement;
3) record count rates $n_1$ and $n_2$ (s$^{-1}$), which are displayed on the LCD;
4) repeat step 3) five times, define the average values $n_1$ – count rates at the peak 511 keV, and $n_2$ – count rates at the peak 1274 keV;
5) take away the check source, install the insert.

4.6 Processing of results

4.6.1 Calculation of average value of the monitor intrinsic background

Calculate the average value of the monitor background activity by all iodine radionuclides detected by the monitor by the following formula

$$A_{bgr} = \frac{1}{10} \cdot \sum_{i=1}^{10} A_{bgr\ ij},$$

where $A_{bgr\ ij}$ – measured as per 4.5.4 background activity values of the monitor, Bq,

- $i$ – serial number of measurement;
- $j$ – atomic mass of iodine radionuclide ($j = 131, 132, 133, 135$).

Note – Monitor background activity is expressed in the volumetric activity units to commensurate it with values measured by the monitor, so the activity measured by the detector is normalized for the unit of the pumped air volume.

4.6.2 Calculate the basic measurement error of the air flow rate as follows:
1) calculate the average value of the air flow rate (l/min) by the formula

$$V_0 = \frac{\sum_{i=1}^{10} (V_{0i} / \tau_i)}{10},$$

where $V_{0i}$ – is a value of the pumped air volume by the gas meter data, m$^3$, within the sampling time $\tau_i$ measured by stop watch, min;

- $i$ – serial number of measurement.
2) calculate average values of the air flow rate (l/min) measured by the flow meter of the monitor according to “observation” and “accumulation” method:

\[
v_{\text{obs}, \text{acc}} = \frac{1}{10} \sum_{i=1}^{10} v_{i, \text{obs}, \text{acc}},
\]

where \(v_{\text{obs}}\) and \(v_{\text{acc}}\) – values registered in the “Configurator” software dialog boxes “Average flow rate, l/min” and “Average accumulative flow rate, l/min;

i – serial number of measurement;

3) determine the basic error of the flow rate measurement by the observation method and separately by accumulation method in percents by the following formula

\[
\delta v_{\text{obs}, \text{acc}} = \frac{v_{\text{obs}, \text{acc}} - v_0}{v_0} \cdot 100,
\]

4.6.3 Calculate basic relative measurement error of the volumetric activity of gamma-emitting iodine radionuclides as follows:

1) calculate an arithmetic average value of the registered radiation measured activity (Bq) for observation method and accumulation method using the data obtained as per 4.5.5.2 by the following formula

\[
A_{\text{obs}, \text{acc}} = \frac{1}{10} \sum_{i=1}^{10} A_{i, \text{obs}, \text{acc}},
\]

where i – serial number of measurement;

2) calculate basic relative measurement errors of the volumetric activity in percents by the observation and accumulation methods by the following formula

\[
\delta A_{\text{vol}} = 1.1 \cdot \sqrt{\left(\frac{A_0 - K \cdot A_{\text{obs}, \text{acc}}}{A_0} \cdot 100\right)^2 + \delta A_0^2 + \delta v_{\text{obs}, \text{acc}}^2},
\]

where \(A_0\) – calculated activity as per 4.4.3 of \(^{137}\text{Cs}\) in a sorption trap, Bq;

K - is a factor for conversion of the conventional \(^{132}\text{I}\) source registered by the monitor into activity to the activity of \(^{137}\text{Cs}\) measured in the \(^{132}\text{I}\) channel, the factor is calculated by the formula

\[
\eta = \frac{1.08}{0.85} = 1.27
\]

4.6.4 The results of calibration are considered positive if:

- average value of the monitor background activity does not exceed 3.7 Bq/m²;
- relative measurement error of the air flow rate for observation and accumulation methods does not exceed ±10 %;
- relative measurement error of the volumetric activity by the observation and accumulation methods does not exceed ±30 %.

FVKM.412123.006RE 18
5 ROUTINE REPAIRS

5.1 Routine repairs include restoration of damaged cables and connectors. Replacement of individual modules and blocks is carried out in accordance with the Service Manual FVKM.412123.006RO.

6 STORAGE

6.1 Prior to putting into operation monitor shall be stored in a heated warehouse with natural ventilation:
- in manufacturer’s package – at ambient temperatures from +5 to +40 °C and relative humidity up to 80 % at +25 °C;
- unpacked – at ambient temperatures from +10 to +35 °C and relative humidity up to 80 % at +25 °C.

6.2 The storage location should be free of dust, chemical vapours, aggressive gases and other substances that may cause corrosion. The storage location shall exclude exposure of the monitor to the direct rays of sunlight.

7 TRANSPORTATION

7.1 Monitor in the original manufacturer’s package can be transported by all means of transport at any distance:
- transportation by railway shall be carried out in clean boxcars;
- when transported by open motor transport boxes shall be covered by the water-proof material;
- when transported by air the boxes with monitor shall be placed in air-tight heated compartment;
- when transported by water and sea transport the boxes with monitor shall be placed in the hold.

7.2 Arrangement and fastening of the boxes on transport means shall provide their steady position en route, absence of displacement and striking each other.

7.3 The requirements of the inscriptions on the transport packing shall be observed during loading and unloading. During loading and unloading monitor shall not be exposed to precipitations.

7.4 Transportation conditions are as follows:
- temperature ………………………………………………………………… from minus 50 to +50 °C provided that gradual temperature stabilization after unloading is ensured to temperature in the range from 5 to 40 °C followed by keeping under normal conditions during 24 hours;
- humidity ………………………………………………………………… up to 98 % at +35 °C;
- sinusoidal vibrations ……………………………………… within frequency range from 10 to 55 Hz with displacement amplitude 0.35 mm.
8 DISPOSAL

8.1 On full expiry of the product (its component parts) service life and also prior to its dispatching for repair or calibration it shall be inspected for possible radioactive contamination of its surfaces. Criteria for decision making on decontamination and further use shall comply with obligatory requirements of national standards.

8.2 Decontamination shall be attempted in cases when the monitor surfaces contamination (including surfaces accessible during repair) can be reduced below allowable limits.

In case the radioactive contamination exceeds allowable limits, requirements set forth for the radioactive wastes become applicable to the monitor.

8.3 Monitor accepted for operation after decontamination is subject for repair or replacement in case of failure. Monitor not suitable for operation, with radioactive contamination levels below permissible limits, should be dismantled to prevent further use and transferred to a special site for disposal of industrial wastes.

8.4 Monitor with expired lifetime, accepted for use after decontamination, shall undergo technical inspection. If the technical condition of a detector is satisfactory, an extended operation term of the product shall be determined.
If volumetric activity of certain iodine radionuclide is too low for its analysis or if the monitor did not have enough time to achieve sufficient statistics (typical for this radionuclide photo peak is not clear in the gamma spectrum), zero measurement result and calculated value of the measurement uncertainty are displayed on the LCD.
Appendix B
(Obligatory)

WIRING DIAGRAM
Appendix C  
(obligatory)

**CONNECTION LAYOUT**

3. Cable 3 (4x0.5, length up to 20 m)

<table>
<thead>
<tr>
<th>Cable socket</th>
<th>Contacts condition</th>
<th>Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X50</td>
<td>normally open</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>switching</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>normally closed</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>not connected</td>
<td>4</td>
</tr>
</tbody>
</table>

the type of connector or communication panel is specified at the design stage

1. Output elements positional designations correspond to FKVM.412123.001E4
2. Types of cables are defined by the operation conditions.
3. Unmentioned length of cables is specified at the design stage.

---

1. Cable 1: FKVM.685631.211 Supply cable (PVS 3x0.5)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>~230 V</td>
<td>1</td>
</tr>
<tr>
<td>~230 V</td>
<td>2</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
</tr>
</tbody>
</table>

   Cable socket: SNK.P027-PH.700S

2. Cable 2: FKVM.665631.138 Supply cable for the pump unit (PVC 3x0.5)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>~230 V</td>
<td>1</td>
</tr>
<tr>
<td>~230 V</td>
<td>2</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
</tr>
</tbody>
</table>

   Cable socket: SNK.P027-PH.700S

---

相关图像未显示。
4. Cable 4: Cable ALARM UNIT (cable 7x0,14 shielded, length up to 20 m)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Cont.</th>
<th>Wire Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-5V</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>yellow</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>red</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>screen</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>button</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>common</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>screen</td>
<td></td>
</tr>
</tbody>
</table>

5. Cable 5: Interface cable Ethernet (IEEE 802.3)
4x2x0,5 SFTP, length up to 100m

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Cont.</th>
<th>Wire Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>TXT</td>
<td>1</td>
<td>white-and-orange</td>
</tr>
<tr>
<td>RX2</td>
<td>3</td>
<td>white-and-green</td>
</tr>
<tr>
<td>RX2</td>
<td>6</td>
<td>green</td>
</tr>
<tr>
<td>CTS</td>
<td>1</td>
<td>blue</td>
</tr>
<tr>
<td>RTS</td>
<td>7</td>
<td>brown</td>
</tr>
</tbody>
</table>

6. Cable 6: FKVM.68563:086-01 Personal computer communication cable RS-232
(cable 7x0,14 shielded, length 4,5 m)

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Cont.</th>
<th>Wire Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTS</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TXD</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>RXD</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>DTR</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>GND</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>DSR</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>RTS</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

The type of connector or communication panel is specified at the design stage.
Soldering of the cable interface Ethernet (IEEE 802.3) 4-2-0.5 SFTP

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Wire color</th>
<th>Cont.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX1</td>
<td>white-and-orange</td>
<td>1</td>
</tr>
<tr>
<td>TX2</td>
<td>orange</td>
<td>2</td>
</tr>
<tr>
<td>RX1</td>
<td>white-and-green</td>
<td>3</td>
</tr>
<tr>
<td>GND</td>
<td>shield</td>
<td>4</td>
</tr>
<tr>
<td>not wired</td>
<td>white-and-blue</td>
<td>5</td>
</tr>
<tr>
<td>RX2</td>
<td>green</td>
<td>6</td>
</tr>
<tr>
<td>GND</td>
<td>shield</td>
<td>7</td>
</tr>
<tr>
<td>not wired</td>
<td>blue</td>
<td>8</td>
</tr>
<tr>
<td>not wired</td>
<td>white-and-brown</td>
<td>9</td>
</tr>
<tr>
<td>not wired</td>
<td>brown</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cont.</th>
<th>Wire color</th>
<th>Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>white-and-orange</td>
<td>TX1</td>
</tr>
<tr>
<td>2</td>
<td>orange</td>
<td>TX2</td>
</tr>
<tr>
<td>3</td>
<td>white-and-green</td>
<td>RX1</td>
</tr>
<tr>
<td>4</td>
<td>blue</td>
<td>not wired</td>
</tr>
<tr>
<td>5</td>
<td>white-and-blue</td>
<td>not wired</td>
</tr>
<tr>
<td>6</td>
<td>green</td>
<td>RX2</td>
</tr>
<tr>
<td>7</td>
<td>white-and-brown</td>
<td>not wired</td>
</tr>
<tr>
<td>8</td>
<td>brown</td>
<td>not wired</td>
</tr>
</tbody>
</table>

If unshielded socket RJ-45 is used, do not use contacts 4, 7 GND of the cable socket DNC-BS-1(2)-10/14-R12-1-V
Appendix E
( obligatory )

LIST OF CONSUMABLES FOR MONITOR OPERATION

E.1 Cartridge with sorbent.
Standard cartridge with sorbent FVKM.305152.001 has to be replaced at least once every three months. In normal operation of monitor the average cartridge consumption rate is not more than 5 cartridges for 6 months, during an emergency operation the expected consumption is one cartridge per hour.

Note – In emergency it is recommended to use single-layer cartridges FVKM.305152.012. The recommended consumption rate one cartridge per hour.

Since the shelf life of cartridges is 6 months, the best choice is to have a set of 10 cartridges: 5 pcs for normal operation and 5 pcs for emergency situation, in order to replace the emergency reserve cartridges with new ones every six months and use the replaced cartridges for routine monitoring.

E.2 PVC hose, inner diameter of 10 mm × 1 m.
E.3 silicon oil – one flask 12 ml.
E.4 Coarse calico - 1 m².
Appendix F
(Obligatory)

LIST OF PARAMETERS ACCESSIBLE FOR DISPLAYING AND EDITING USING THE “CONFIGURATOR” SOFTWARE

The list of pages (tabs) available for configuring:
- Common;
- Special;
- Measurement options;
- Measurements;
- Special options of measurements;
- Alarms;
- Calibration;
- Spectra;
- Network;

Note – Tabs “Service”, “Calibration” and “Special measurement settings” are displayed only when the program is switched into expanded access mode. Those tabs are hidden by default.

“Common” tab
This tab contains general information about the monitor and includes the following parameters:
- **Serial number** – serial number (works number) of the connected monitor.
- **Current time** – date, month, year and time, minutes and seconds of the reading.
- **Firmware version** – version of the monitor’s built-in software.
- **Device version** – hardware platform version of the connected monitor.
- **Life, h** – total operating time of the monitor (in hours) from putting into operation.
- **Device status** – number, which represents the operability or failure of the monitor and its interpretation bit–by–bit. The revealed malfunctions are automatically checked by “ticks” and highlighted by yellow colour.
- **Work mode** – service parameter that describes current state of the monitor. In the normal working mode the “0” is displayed in the field for this parameter.

“Special” tab
This tab appears only after the program is switched into expanded access mode. The tab includes the following parameters:
- **Project build mode** – service parameter describing the method of compilation of the built-in software of the monitor.
- **Service functions** – service parameter, which characterizes the service functions used and their interpretation bit–by–bit.
- **Send spectra via UDP** – service parameter controlling the transfer of spectral information from the monitor to the external information network and its interpretation bit–by–bit.

“Measurement options” tab
This tab allows controlling of the measurement process and setting up working modes and indication of the monitor. The tab includes the following parameters:
- **Monitored nuclides** – in this field radionuclides \(1^{31}\text{I}, 1^{32}\text{I}, 1^{33}\text{I}, 1^{35}\text{I} \) and \(1^{23}\text{I} \) are to be selected (checked), for which the monitor have to perform measurements of volumetric activity or activity on the sorbent trap.
The volumetric activity and activity on the sorbent trap for radionuclides, which were not selected as measured nuclides are equated to zero by the monitor.

In the expanded access mode the decimal equivalent of this bit set is shown in separate string.

**Priority Nuclide** – in this field the priority nuclide have to be selected (checked), which means the nuclide, which uncertainty minimization criterion determines the moment of starting calculation for all selected radionuclides.

In the expanded access mode the decimal equivalent of this bit set is shown in separate line.

**Displayed nuclide. First line** – in this field the parameter has to be selected, which will be indicated in the first information line on the LCD of the monitor.

Note – On the four-line LCD of the monitor the first and the second lines are assigned for indication of working mode and the state of the monitor, the third and the fourth lines – for displaying of the measured values. The third and the fourth lines are called “information lines”.

In the expanded access mode the integer decimal equivalent of this bit set is shown in separate line.

**Displayed nuclide. Second line** – in this field the parameter has to be selected, which will be indicated in the second information line on the LCD of the monitor.

In the expanded access mode the integer decimal equivalent of this bit set is shown in separate line.

**Minimal measurement time for monitoring method (20s..600s)** – in this field the minimum time interval can be specified for measurement duration and updating of readings on the LCD of the monitor.

---

### “Measurements” tab

This tab displays the results of measurements performed by the monitor. The tab includes the following parameters:

**Volumetric activities, Bq/m$^3$** – in this group of parameters the values of volumetric activity of radionuclides ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I) are displayed, as measured by the monitor using “observation” method, as well as total volumetric activity of radioiodine nuclides, measured using the same method.

**Filter Activities, Bq** – in this group of parameters values of radionuclide activity are displayed ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I), measured on the sorbent trap of the monitor using the “observation” method, as well as total volumetric activity of radioiodine nuclides, measured on the sorbent trap using the same method.

**Volumetric Storage Activities, Bq/m$^3$** – in this group of parameters the values of volumetric activity of radionuclides ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I) are displayed, as measured by the monitor using “accumulation” method.

**Filter Storage Activities, Bq** – in this group of parameters values of radionuclide activity are displayed ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I), measured on the sorbent trap of the monitor using the “accumulation” method.

If the radionuclide was not selected as “measured nuclide”, its volumetric activity and activity on filter displayed in the fields described above will be equated to zero.

**Average flow rate, l/min** – average value of the air flow rate through the sorbent trap of the monitor measured using “observation” method.

**Average storage flow rate, l/min** – average value of the air flow rate through the sorbent trap for measurements using “accumulation” method.

**Instantaneous flow rate, l/min** – instantaneous value of the air flow rate through the sorbent trap of the monitor.
Flow, l (per measure) – value of the air volume, pumped through the sorbent trap of the monitor during one measurement using the “observation” method.

Storage Flow, l (per measure) – value of the air volume, pumped through the sorbent trap of the monitor during one measurement using the “accumulation” method.

Special options of measurements:
This tab appears only after the program is switched into expanded access mode. Parameters shown in this tab are internal parameters of the monitor. Their values can be changed only with participation of the personnel trained at the factory of manufacturer – SPC “Doza”.

“Alarms” tab
This tab represents values of the Warning and Alarm thresholds set for the monitor. The tab includes the following parameters:

Volumetric activity warning thresholds – this group of parameters includes values of volumetric activity of radionuclides ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I), as well as value of total volume activity of radioiodine nuclides corresponding to thresholds of the first level (warning).

Volumetric activity alarm thresholds – this group of parameters includes values of volumetric activity of radionuclides ($^{131}$I, $^{132}$I, $^{133}$I, $^{135}$I, $^{123}$I), as well as value of total volume activity of radioiodine nuclides corresponding to thresholds of the first level (alarm).

Volumetric activity alarm thresholds for dry contacts – values of total volume activity of radioiodine nuclides, which corresponds to closing/opening of the output “dry contact”.

Minimal allowed flow rate, l/min – value of the minimum allowable air flow rate through sorbent trap corresponding to the range of normal operability of the monitor.

Maximal allowed flow rate, l/min – value of the maximum allowable air flow rate through the sorbent trap corresponding to the range of normal operability of the monitor.

“Calibration” tab
This tab appears only after the program is switched into expanded access mode. The tab includes the following parameters:

Main detector energy calibration factor (EnergyA) – value of the coefficient A of the “energy – channel” function for the main detector.

Main detector energy calibration factor (EnergyB) – value of the coefficient B of the “energy – channel” function for the main detector.

Background detector energy calibration factor (EnergyA) – value of the coefficient B of the “energy – channel” function for the background detector.

Background detector energy calibration factor (EnergyB) – value of the coefficient B of the “energy – channel” function for the background detector.

Efficiency calibration factor A – value of the coefficient A of detection efficiency for gamma-radiation of radionuclide $^{132}$I.

Efficiency calibration factor B – value of the coefficient B of detection efficiency for gamma-radiation of radionuclide $^{132}$I.

Digital discriminator threshold A – service parameter necessary for controlling the threshold of digital discriminator of the ADC.

Digital discriminator threshold B – service parameter necessary for controlling the threshold of digital discriminator of the ADC.

Efficiency calibration factor for low-energy region – service parameter used in the monitor adjusted for measurement of $^{132}$I.
**Low-energy region edge** – service parameter used in the monitor adjusted for measurement of $^{132}$I.

**“Spectra” tab**
This tab represents energy spectra of the main and background channels in the “Observation” and “Accumulation” modes. Principles of working with spectra are described in the User Manual for the “Configurator” software.

**“Network” tab**
This tab represents network parameters of the monitor and contains the following:

**ETHERNET options:**
- **Device IP address** – IP address of the monitor.
- **Server IP address** – IP address of the automated distribution of data.

**ModBUS options:**
- **Device ModBUS address** – net address, provided that the monitor supports the ModBUS protocol.
- **ModBUS rate** – data exchange rate (bps), provided that the monitor supports the ModBUS protocol.
- **ModBUS port number (default 0)** – COM–port number to which the monitor is connected.