

## QUADRO

### Gamma –, beta- and alpha - spectrometer – radiometer

#### APPLICATION

Gamma-, beta- and alpha – spectrometer QUADRO is designed for measuring energy distribution of gamma- and beta - radiation, identification of gamma-emitting radionuclides, as well as for measuring specific and volumetric activity of natural radionuclides  $^{226}\text{Ra}$ ,  $^{232}\text{Th}$ ,  $^{40}\text{K}$ ,  $^{222}\text{Rn}$  and technogenic radionuclides ( $^{137}\text{Cs}$ ,  $^{134}\text{Cs}$ ,  $^{60}\text{Co}$ ,  $^{99\text{m}}\text{Tc}$ ,  $^{90}\text{Sr}$  and etc.) in soil samples, rocks, vegetation, water, food, wood, building materials, chemical industry materials, alloys, scrap metal and other technological products. Also it is used for measuring gross specific activity of beta- and alpha-emitting radionuclides in water.

#### METHODS OF MEASUREMENTS (MM):

"Methodology for measuring the activity (specific activity) of radionuclides in samples of environmental objects and products of enterprises on spectrometer-radiometers using the ASW2 software."

#### METROLOGICAL AND TECHNICAL SPECIFICATIONS

Description	Value
Type of detectors: <ul style="list-style-type: none"> <li>- BDEG-63-63</li> <li>- BDEG-80-80 (or other sizes)</li> <li>- BDEG-150-100</li> <li>- BDEG-50-50-CS (or other sizes)</li> <li>- BDEG-38-38-LB (or other sizes)</li> <li>- BDEB-70-10</li> <li>- BDA-70-1</li> </ul>	NaI(Tl) Ø63x63mm NaI(Tl) Ø80x80mm NaI(Tl) Ø150x100mm CsI(Tl) Ø50x50mm LaBr <sub>3</sub> (Ce) Ø38x38mm Polystyrene Ø70x10mm ZnS(Ag) Ø70x1mm
Energy range, keV <ul style="list-style-type: none"> <li>- for gamma radiation</li> <li>- for beta radiation</li> <li>- for alpha radiation</li> </ul>	40-3000 65-4000 1500-10000
Relative energy resolution on the line 661,7 keV, measuring with radionuclide source $^{137}\text{Cs}$ , %, no more than <ul style="list-style-type: none"> <li>- for BDEG-63-63</li> <li>- for BDEG-80-80</li> <li>- for BDEG-150-100</li> <li>- for BDEG-50-50-CS</li> <li>- for BDEG-38-38-LB</li> </ul>	8 8,5 12 9 3,5
Relative energy resolution on the conversion electron line 624 keV of radionuclide $^{137}\text{Cs}$ , %, no more than <ul style="list-style-type: none"> <li>- for BDEB-70-10</li> </ul>	15
Integral nonlinearity in the gamma energy range from 40 to 3000 keV,%, not more then	1
Integral nonlinearity in the beta energy range from 65 to 4000 keV,%, not more then	2

Detection sensitivity for beta radiation of radionuclide $^{90}\text{Sr}$ - $^{90}\text{Y}$ for the thin source located at 3 mm from the end surface of the detector within the working range of 550-2300 keV , cps/Bq, no less than - for BDEB-70-10	0,15
Detection sensitivity for alpha radiation of radionuclide $^{239}\text{Pu}$ for the thin source located at 3mm from the end surface of the detector, cps/Bq, no less than - for BDA-70-1	0,3
Maximum throughput, cps, no less than	$5 \cdot 10^4$
Minimum measurable activity of the radionuclide $^{137}\text{Cs}$ at the ambient dose rate of no more than 0,2 $\mu\text{Sv/h}$ on the protection chamber surface and measurement time of 1 hour, Bq, not more than - for BDEG-63-63 - for BDEG-80-80 - for BDEG-150-100	3 2 2
Minimum measurable activity of the radionuclide $^{90}\text{Sr}$ at the ambient dose rate of no more than 0,2 $\mu\text{Sv/h}$ on the protection chamber surface and measurement time of 3 hour, Bq, not more - for BDEB-70-10	1
Minimum measurable activity of the radionuclide $^{239}\text{Pu}$ at the ambient dose rate of no more than 0,2 $\mu\text{Sv/h}$ on the protection chamber surface and measurement time of 3 hour, Bq, no more - for BDA-70-1	0,01
Measuring range of activity for $^{137}\text{Cs}$ , Bq - for BDEG-63-63 - for BDEG-80-80 - for BDEG-150-100 The measuring range can be extended in case of sample concentrating or impoverishment.	$5 - 6 \cdot 10^7$ $3 - 6 \cdot 10^7$ $2 - 6 \cdot 10^7$
Measuring range of activity for $^{90}\text{Sr}$ , Bq - for BDEB-70-10 The measuring range can be extended in case of sample concentrating or impoverishment.	$0,25 - 2 \cdot 10^6$
Permissible basic relative error for measuring activities does not exceed (P=0,95)	10%
Measuring range of activity for $^{239}\text{Pu}$ in a thin source, Bq - for BDA-70-1	$0,05 - 1,5 \cdot 10^5$
Measuring range of gross specific activity of alpha radiating radionuclide in water, Bq/kg - for BDA-70-1 Permissible basic relative error for measuring activities does not exceed 50% (P=0,95).	0,05 - 400
Instability of spectrometer indications (energy conversion characteristic) for 24 hours of a continuous operation, %, not more	$\pm 1$
Operation conditions: <ul style="list-style-type: none"> <li>ambient air temperature, <math>^{\circ}\text{C}</math></li> <li>relative air humidity, %</li> <li>atmospheric pressure in the range of, kPa</li> <li>intensity of magnetic fields of the permanent and variable grid frequencies, A/m</li> </ul>	from +10 to +40 up to 80 from 84 to 106,7  up to 40

## OVERALL DIMENSIONS AND WEIGHTS

No	Name of element	Diameter, mm	Height, mm	Width, mm	Length, mm	Weight, kg
1	BDEG-63-63	90	250	-	-	2,4
2	BDEG-80-80	105	275	-	-	3,5
3	BDEG-150-100	195	340	-	-	9,9
4	BDEB-70-10	90	210	-	-	1,8
5	BDA-70-1	90	210			1,5
6	MCA	-	55	155	200	0,46
7	Power supply	-	35	65	130	0,4
8	Lead chamber for gamma detectors	318	580	425	-	240
9	Lead chamber for beta detectors	210	390	430	-	80
10	Chamber for alpha detectors	210	390	430	-	15

## COMPLETE SET

- multichannel, also can be embedded to detector ;
- spectrometric detectors of gamma – radiation based on crystal NaI(Tl): BDEG-63-63 (A) (BDEG-80-80, BDEG-150-100, character 'A'-embedded MCA);
- spectrometric detectors of gamma – radiation based on crystal CsI(Tl): BDEG-50-50-CS (BDEG - 40-40-CS, BDEG-25-25-CS);
- spectrometric detectors of gamma – radiation based on crystal LaBr<sub>3</sub>(Ce): BDEG-38-38-LB (BDEG-25-25-LB, BDEG-51-51-LB, BDEG-76-76-LB);
- spectrometric detectors of beta – radiation based on plastic scintillator (polysterene) : BDEB-70-10;
- radiometric detectors of beta – radiation – radiation based on plastic scintillator (polysterene): BDB-70-1;
- radiometric detectors of alpha – radiation based on ZnS(Ag): BDA-70-1;
- low-background protective chambers for gamma detector, beta detectors and alpha detectors
- beakers and vessels for measurements;
- software for spectrometric analysis ASW2.