

Radiation
Protection
Instruments

Berthold
Technologies



Radiation Protection Instruments

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Introduction

for radiation protection during nuclear emergencies the measurement of

- contamination
- dose and dose rate
- activity

are of special importance. Measurements of these quantities are providing quantitative descriptions of nuclear hazards. Comparison of measured values with legal limits and safety requirements allows for assessments of real situations and their risks. Measurement is anyway indispensable as values of these quantities might vary by many orders of magnitude and because human beings are not capable for sensing ionizing radiation. As a well-known German manufacturer of nuclear instruments with more than 60 years of experience we recommend here the following types of measurements and instruments.

Contamination Measurement

Contamination is activity of one or several radionuclides spread across surfaces and is measured in units of Bq/cm². Surfaces are meant to comprise for instance tables, floors, walls, objects, devices, cloth or skin of hands or feet. Decontamination is usually simple if it is detected at all. Without detection it probably continues to spread out. Contamination can easily be measured with handheld battery operated contamination monitors.

Dose and Dose Rate Monitoring

Dose is a measure for the energy deposit of radiation. Equivalent Dose is a measure of the risk for human beings induced by exposure to ionizing radiation and it is measured in Sievert [Sv]. There is individual dose for measuring doses applied to persons and there is area dose for measuring doses at certain locations. There are also different types of doses for different types of radiations. Usually it is sufficient to consider gamma dose only. Dose rate is measured in Sv/h. Dose is a measure of the effect of radiation on people. Doses are determined with dose meters.

Activity Measurement

Activity is the number of spontaneous nuclear decays per time in a sample of material. Its standard SI unit is the Becquerel [Bq] where one Bq equals one decay per second. It is a measure of the amount of radionuclide(s) in a material emitting ionizing radiation. Activities are measuring sources and they are determined by using activity monitors.

CONTAMINATION MONITORS



SCINT Contamination Monitor LB 124 SCINT for α - and $\beta\gamma$ - measurement

Simultaneous measurement of alpha, beta and gamma contaminations on surfaces, high sensitivity and uniform response, no counting gas necessary because of new scintillation technology, wide temperature range.

Easy handling over function keys, different user profiles (password-protected), numerous software functions (utilities, measurement modes, parameters), large data memory, program download and data transfer to a Pc/printer are possible. Calibration factors for more than 50 nuclides, calibration selectable according to ISO 7503-1 or related to activity on 100 cm² area, protective grid with high transparency.

Detector

Sensitive area	170 cm ²
Entrance window's dimensions	118 x 145 mm
Entrance window's material	6 μ m Plastic metallized (approx. 0.4 mg/cm ²)
Transmission of grating	80%

Efficiency (related to the activity of a source with an area of 100 cm²)

¹⁴ C	11%	(Beta channel)
³⁶ Cl	44%	(Beta channel)
⁶⁰ Co	29%	(Beta channel)
¹³⁷ Cs	43%	(Beta channel)
²³⁹ Pu	18%	(Alpha channel)
²⁴¹ Am	21%	(Alpha channel)
Background	approx. 0.1 cps	(Alpha channel)
Background	approx. 10 cps	(Beta channel)

Gamma sensitivity in external ¹³⁷Cs field with 1 μ Sv/h:

Alpha channel	not detectable
Beta channel	< 100 cps
Spillover	
Alpha to beta channel	< 20 % with ²¹⁰ Po
Spillover	
Beta to alpha channel	< 2 x 10 ⁻⁵ with ⁹⁰ Sr
Measuring range	0 to 5000 cps (Alpha channel)
(dead time < 10 %)	0 to 50000 cps (Beta channel)
Surface response	max. \pm 20 %
uniformity	(α channel with ²⁴¹ Am and $\beta\gamma$ channel with ¹⁴ C point sources)

Instrument

Display	Monochrome LCD 192 x 64 pixels, Electro-luminescence illumination
Radiation Detector	ZnS – Scintillator
Detection of light	Photomultiplier (PMT)
Measurement modes	Alpha and beta measurement simultaneous and separate, ratemeter, scaler-timer-mode

Max. operating time (without illumination)

3.5 Ah Ni-MH rechargeable batteries	> 25 h
7.8 Ah alkaline batteries	> 50 h
Data memory	1000 measured values with date & time
Serial interface	RS232

Dimensions Instrument	240 x 140 x 110 mm
Weight with batteries	1300 g

Temperature range (operation)	-20°C to +40°C
Temperature range (storage)	-40°C to +60°C
External pressure (operation)	500 to 1300hPa
External pressure (storage/transport)	100 to 1300hPa
Relative humidity	0% to 80 % (no condensation)
Protection class	IP 53

CONTAMINATION MONITORS



Gas filled Contamination Monitor LB 124B (Xenon) for $\beta\gamma$ -measurement

Measurement of radioactive contamination on surfaces based on well proven Xenon filled proportional counter technology. High sensitivity for beta particle and for gamma and especially for measurement of photon emitting radionuclides.

Easy handling over function keys, different user profiles (password-protected), numerous software functions (utilities, measurement modes, parameters), large data memory, program download and data transfer to a Pc/printer are possible. Calibration factors for more than 50 nuclides, calibration selectable according to ISO 7503-1 or related to activity on 100 cm² area, protective grid with high transparency.

Detector

Sensitive area	150 cm ²
Entrance window's dimensions	100 x 150 mm
Entrance window's material	10 μ m Titanium (approx. 5 mg/cm ²)
Transmission of grating	80%

Efficiency (related to the activity of a source with an area of 100 cm²)

¹⁴ C	2%
¹⁸ F	17%
³⁶ Cl	24%
⁶⁰ Co	26%
^{99m} Tc	2.6%
¹³¹ I	17%
¹³⁷ Cs	20%
²⁴¹ Am	11%

Background approx. 10 cps

Instrument

Display	Monochrome LCD 192 x 64 pixels, Electro-luminescence illumination
Radiation detector	sealed proportional counter tube with Xenon filling
Measurement modes	Search mode, ratemeter, scaler-timer-mode, clearance mode, half-life

Max. operating time (without illumination)

3.5 Ah Ni-MH rechargeable batteries	> 25 h
7.8 Ah alkaline batteries	> 50 h

Data memory	1000 measured values with date & time
Serial interface	RS232

Dimensions Instrument	240 x 140 x 110 mm
Weight with batteries	1620 g

Temperature range (operation)	-15°C to +50°C
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Temperature range (storage)	-20°C to +70°C
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External pressure (operation)	500 to 1300hPa
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External pressure (storage/transport)	100 to 1300hPa
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Relative humidity	0% to 80 % (no condensation)
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Protection class	IP 64
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DOSE AND DOSE RATE MONITORING



Doserate Monitor LB 123D-H10

The proportional counter probe LB 1236 is used for dose and dose rate measurements. It has been tested and approved by the German Office of Standards (PTB).

Easy handling over softkeys, data memory, bidirectional interface for computer and printer and automatic detector control.

Basic Unit LB 1230

Result display	high-contrast dot-matrix display with 32 x 84 pixels
Operating elements	membrane keypad comprising 1 On/Off button and 4 softkeys
Detector connection	8-pin connector socket Fischer 04
Data output (Option)	FSMA connector, via beam waveguide and beam waveguide interface LB 75306 with D 25 connector
Temperature range	-15°C to 50°C
Dimensions	145 x 170 x 45 mm (H x W x D)
Weight	approx. 800 g (with batteries)
Power supply	3 x IEC-R14 (baby cell) or 3x rechargeable cells Varta NiCd # 5014
Operating life	with R14 > 150 hours

Doserate Probe LB 1236-H10

Dimensions and weight

Max. diameter	50 mm
Length	275 mm
Weight	0.46 kg
Temperature range	-10°C to 60°C
Calibration factor	0.214 μ Sv/h per 1 cps
Measuring range	50 nSv/h to 10 mSv/h
Energy range (\pm 30% relative to ^{137}Cs)	30 keV to 1.3 MeV

COMBINED SYSTEM: CONTAMINATION AND DOSE/DOSE RATE MONITOR



Doserate Monitor LB 123D-H10 and Contamination Probe LB 1231

LB 1231 contains the beta/gamma contamination detector with Xenon fill gas and titanium window. The calibration factors for 25 radionuclides are stored in the instrument. Several free memory locations are available for the customer to enter his or her own calibration factors.

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Energy range (± 30% relative to ¹³⁷ Cs)	30 keV to 1.3 MeV

Contamination Probes LB 1231

Type of radiation	β-γ
Counting gas	Xenon
Type of filling	sealed
Window area	120 x 190 mm ²
Window thickness	5 mg/cm ²

Efficiency (including protection grid with 70% transmission):

¹⁴ C	3.6%
⁹⁰ Sr	30%
²⁴¹ Am	11%

Temperature range	-15°C to 50°C
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Transport Case

Dimensions	180 x 450 x 350 mm (H x W x D)
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ACTIVITY MEASUREMENT



Bequerel-Monitor LB 200

Scintillation measuring system for assessment of gamma activity in foodstuffs, liquids, bulk goods in Bq/l

- Detection limit approx. 20 Bq/l
- small dimensions
- easy and error-free operation
- display of the statistical accuracy for each measuring result
- operated by dry batteries or mains supply

Detector Unit

Radiation detector	NaI(Tl) - crystal (25 mm Ø x 25 mm)
Dimensions	Bottom 95 x 120 mm Height 185 mm (with lead shielding 240 mm)
Weight	approx. 0.8 kg

Measuring Unit

Display	bright transmitted light LCD, 2 x 16 character, 74 x 28 mm
Measuring ranges	0.1 to 999 cps or 1 to 9999 Bq/l
Calibration factor	Preset inside the instrument via code switches, the factors for individual radionuclides are listed in the Operating Manual; manufacturer's setting for ¹³⁷ Cs
Voltage supply	Via 6 V mains adapter or built-in dry batteries (4 x LR 20 Mono)
Operation life time batteries	approx. 80 h
Box casing with combined handle/support	220 x 230 x 70 mm (W x D x H)
Connections for	mains adapter, probe cable, printer or computer

Lead shielding

Wall thickness	15 mm
Height	115 mm
Diameter	120 mm,
Weight	approx. 8 kg

Beaker

Plastic, useful volume 0.5 l

ACTIVITY MEASUREMENT



Activity Monitor LB 2045/LB 742

Modern gamma spectroscopy system for nuclide-specific activity measurements activity in foodstuffs, liquids, bulk goods in Bq/l

- Detection limit approx. 1 Bq/l
- Connection for scintillator probes
- 3 different energy ranges
- Spectrum presentation (1024 channels)
- One or two energy windows
- Nuclide library
- Storage of spectra or ROI data
- Half-life correction
- Weight entry and spillover correction.

Intuitive user guidance: operation via softkeys on the display

Several service functions are available: background measurement, energy calibration and spectrum recording

Measurement/Spectrum

ADC	1024 channels, 7 μ s max. conversion time
Energy ranges	0-256 keV, 0-1024 keV, 0-2048 keV
Energy calibration	non-linear empirical function
Region of interest	max. 2 ROIs
Nuclide library	max. 50 nuclides

Data Acquisition/Computer

Processor	Motorola MC68340 32 bit 16 MHz
Display/Touch panel	Graphical LC display 320 x 240 pixels
Memory	max. 70 spectra or 800 ROI values
Serial interface	RS232

General Specifications

High voltage supply	0-1300 Volt, polarity positive, resolution 12 bit
Power supply (wide-range input)	85-264 VAC, 47-65 Hz
Protection class	IP 54
Temperature range	-5°C to +40°C
Relative humidity	0% to 90% (no condensation)
External dimensions	245 x 145 x 325 mm (W x H x T)
Weight	3.3 kg

SZ 50 U 8S8/2E-X scintillation probe

Detector	NaI crystal 2" x 2", with photomultiplier and voltage divider
Resolution	7.5 % (FWHM) for ^{137}Cs 661 keV
External diameter	65 mm,
Complete cable set	2 m

Shielding LB 7428 A

Lead chamber for 2" probes	
50 mm lead shielding for 0.4 l Marinelli beakers	
Weight	approx. 75 kg



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