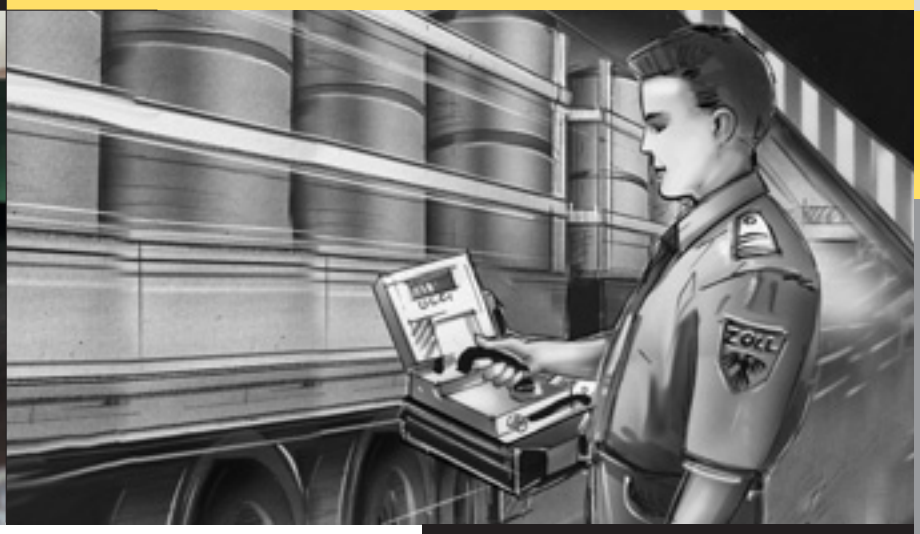
RADIATION PROTECTION

Neutron Survey Meter
LB 6414



BERTHOLD
TECHNOLOGIES

Neutron Survey Meter
LB 6414

The LB 6414 is a new portable neutron survey meter with extremely high sensitivity. The energy dependent response of the instrument was maximized for fission neutrons. There are several interesting applications amongst which is the search for plutonium.

Pu sample found 1994 in Tengen/Germany (Picture: Landesanstalt für Umweltschutz Baden-Württemberg)

- Search for illicit trafficking plutonium
- Search for plutonium contaminations
- Measurement of ^{240}Pu equivalent mass
- Nuclear waste inspection
- Measurement of ^{252}Cf and other neutron sources
- Monitoring of neutron radiation field intensities

Neutron Detection Some applications in neutron detection require extremely sensitive instruments rather than flat energy response. In these cases the LB 6414 neutron survey meter is superior to the conventional rem-counters, which have relatively low efficiencies.

Plutonium Detection Plutonium is extremely dangerous and hard to detect over larger distances. The α-particles, γ's and X-rays which are emitted by plutonium isotopes could easily be shielded by the material itself or by surroundings. Beside of a few γ-rays the only penetrating radiation emitted by plutonium samples are neutrons from spontaneous fission of the even numbered plutonium isotopes, especially from ^{240}Pu. Thus a neutron detector which has maximum sensitivity for fission neutrons would provide an excellent tool for the detection of plutonium, even through shieldings.

Plutonium is usually a mixture of many plutonium isotopes. Reactor plutonium is relatively "dirty" with for example 75% ^{239}Pu, 20% ^{240}Pu and 5% other isotopes. Weapons plutonium has a higher purity of typically 94% ^{239}Pu with only 6% ^{240}Pu. In the presence of 1 kg of plutonium the LB 6414 survey meter would respond with the counting rates specified in the table 1, depending on the distance and type of material.

Distance	Weapons Plutonium	Reactor Plutonium
0.1 m	1160 cps	5176 cps
1 m	11.6 cps	51.8 cps
3 m	1.29 cps	5.75 cps
background	0.06 cps	

Table 1.: Response to 1 kg of plutonium

Measuring Time	Weapons Plutonium	Reactor Plutonium
1 s	303 g	67 g
10 s	47 g	10 g
100 s	12 g	2.6 g

Table 2.: Detection limits for plutonium at 1 m distance

The minimum detectable amounts of material within specified measuring times, distance and type of material are shown in table 2. The values were calculated with a confidendence level of 95% according to the German standard DIN 25482 with a background counting rate of 0.06 cps.

Thus the instrument is ideally suited for the search of illicit trafficking plutonium at the borders of countries, in airports or in special nuclear facilities. There might also be applications for other organizations like, for instance, police, civil defense or military.

Plutonium Contaminations At close distances the neutron survey meter LB 6414 is capable of monitoring even smaller amounts of plutonium. This enables this instrument for the search and localization of plutonium contaminations for instance in glove boxes, in pipes or elsewhere in plutonium processing facilities. Regions with relatively high plutonium concentrations can easily be identified. This is even true in the presence of shielding surrounding materials, because neutrons are strongly penetrating.

Neutron Dose Rate Monitoring As the LB 6414 is extremely sensitive it would sometimes also be useful in neutron dose rate monitoring. Especially in applications, where there is more need for high sensitivity than for flat energy response. For instance in measuring low neutron radiation levels with constant neutron energy spectrum it would be favourable to determine a user-specific calibration factor once and then benefit from good counting statistics.

Data Acquisition and Measurement The Universal Monitor UMo LB 1230 acquires the data from the neutron probe LB 6414 and provides easy-to-use data analysis, display of measured values, alarm indications, data storage, parameter setting and communication and service functions. The software uses sophisticated algorithms for the detection of changes in the observed counting rates. Therefore the instrument has excellent characteristics for the search for radiation sources.

Qualification The Neutron Survey Meter LB 6414 succesfully participated in the Illicit Trafficking Radiation Detection Assessment Program (ITRAP) performed by the Austrian Research Center in Seibersdorf from 1998-2000. The laboratory and field test clearly showed that the LB 6414 meets the IAEA minimum handhelds requirements for the use at border crossings.

Technical Data
LB 6414

Neutron Survey Meter LB 6414

Neutron detector:	^{3}He proportional counter tube in PE moderator	
Electronics:	Integrated preamplifier, discriminator and hv-supply	
Fluence response:	26.4 cm^2 for fission neutrons 10.7 cm^2 for Am-Be	
Detection limit: (distance 1 m)	75 g weapon´s plutonium in 5 s (confidence level 95%)	
Neutron energy range:	Optimized for 10 keV to 1000 keV	
^{240}Pu equivalent mass response:	0.2 cps per g of ^{240}Pu at 1 m distance	
Ambient dose equivalent response to H*(10):	27 counts/nSv or 0.13 µSv/h per cps	**for Am-Be**
	68 counts/nSv or 0.05 µSv/h per cps	**for Cf-252**
Directional response:	100% at normal incidence, 78% sideways, 60% frontal **for Am-Be**	
Dimensions probe:	310 mm x 180 mm x 130 mm (Length x Width x Height)	
Weight of probe:	3850 g	
Typical background rate:	0.06 cps	
Intrinsic detector background:	< 0.006 cps at total neutron flux $\phi_n < 2 \times 10^{-4}$ cm^{-2} s^{-1}	

Universal Monitor UMo LB 1230

Display:	High contrast dot-matrix display with switchable background illumination
Control:	Membrane keypad with 5 keys
Alarm:	Switchable audio with adjustable threshold
Data output:	FSMA connector for optical fibre connection to optional interface LB 75306 with D 25 connector (RS232)
Memory:	More than 200 measured values with time and date
Power supply:	3 x IEC-R14 (baby cell) batteries or 3 x rechargeable NiCd cells Varta #5014
Connection to detector:	Fischer 8-pin socket 04, spiral cable LB 75576
Maximum operating time:	> 150 h with R 14
Dimensions:	170 mm x 145 mm x 45 mm (Length x Width x Height)
Weight:	Approximately 800 g with batteries

System

Temperatur range:	-15° C to 50° C
Options:	Transport case, printer, RS232 interface LB 75306

BERTHOLD TECHNOLOGIES

ISO 9001 BERTHOLD Quality you can trust

BERTHOLD TECHNOLOGIES GmbH & Co. KG · P.O. Box 100 163 · 75312 Bad Wildbad, Germany
Phone +49 7081 177-0 · Fax +49 7081 177-100 · nuclear@Berthold.com · www.Berthold.com

LB 6414 · 10-2004.1000 · Id. 33250PR2 · Rev. 01 · 04-2004