

## Technical Note No. 296

### US Calibration of Neutron Dose Rate Meter LB 6411

Dr. Alfred Klett 13 April 2005

#### **Introduction**

For the neutron monitor LB 6411 there is for the US a special calibration available. This calibration meets NRC 10 CFR 20.1004 for neutron dose equivalent monitoring. The measured dose quantity is indicated in rem or mrem respectively dose rates are indicated in rem/h or mrem/h.

#### **Calibration Factor**

The calibration factor was determined at neutron energy 1 MeV. The value of the calibration factor is

0.119 mrem/h per cps.

This value was calculated using the measured fluence response of the LB 6411 at neutron energy 1 MeV and the fluence to dose equivalent conversion factor as specified in document NRC CFR 20.1004 at the same neutron energy 1 MeV. The response at other neutron energies varies according to the fluence response of the neutron dose rate probe LB 6411 and the conversion factors as a function of energy. Details are shown below in table 1 and in figure 1.

#### **Specifications**

Measured quantity:	Neutron dose equivalent in rem or mrem and/or neutron dose equivalent rate in rem/h or mrem/h according to NRC 10 CFR 20.1004
Measuring range:	0.003 mrem/h up to 10 rem/h 0.01 mrem up to 100 rem
Lowest indicated non-zero value:	0.001 mrem/h 0.01 mrem
Fluence Response:	1.12 cm <sup>2</sup> (at 1 MeV)
Sensitivity:	30.2 counts per $\mu$ rem
Gamma Sensitivity:	< 4 mrem/h at 1 rem/h $\gamma$ dose rate ( <sup>137</sup> Cs)
Energy dependent response:	< $\pm$ 25% between 100 keV and 10 MeV neutron energy

**Usage within handheld system LB 123**

For usage of the US calibration software version V3.03US is required for the data logger LB 1230.

**Usage within stationary system LB 111**

For usage of the US calibration within system LB 111 input of the correct calibration factor is required.

**Relative Response as a Function of Neutron Energy**

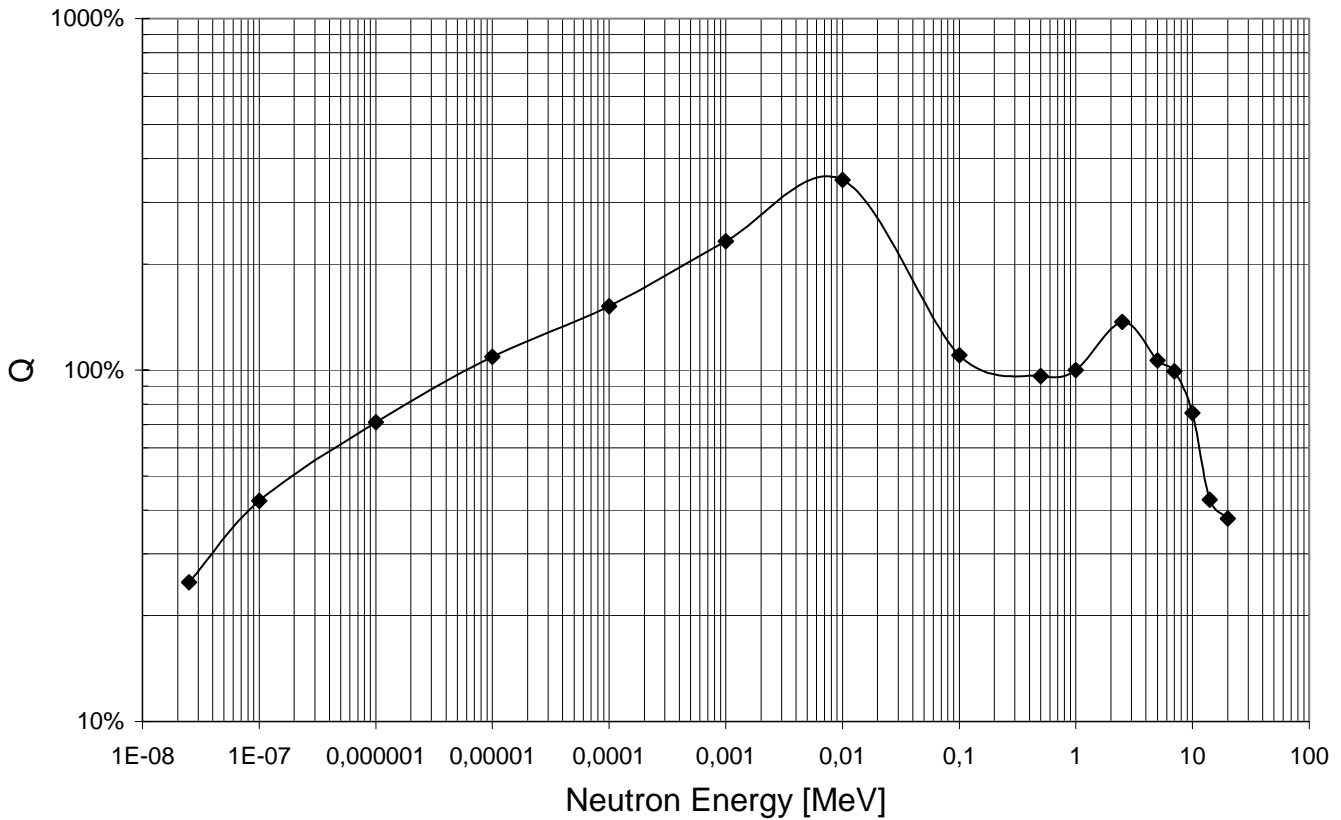


Figure 1: LB 6411's Response to Neutron Dose Rate (NRC 10 CFR 20.1004)

Table 1: LB 6411's Response to Neutron Dose Rate (NRC 10 CFR 20.1004)

Neutron Energy	Conversion Factor			Calibration Factor			Relative q
	R	C <sub>1</sub>	C <sub>2</sub>	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	
[MeV]	[cm <sup>2</sup> ]	[n/(cm <sup>2</sup> rem)]	[rem cm <sup>2</sup> /n]	[counts/μrem]	[μrem/count]	[μrem/(h*cps)]	
2,50E-08	7,67E-03	9,80E+08	1,02E-09	7,52E+00	1,33E-01	4,79E+02	24,9%
1,00E-07	1,31E-02	9,80E+08	1,02E-09	1,28E+01	7,79E-02	2,80E+02	42,5%
1,00E-06	2,65E-02	8,10E+08	1,23E-09	2,15E+01	4,66E-02	1,68E+02	71,0%
1,00E-05	4,07E-02	8,10E+08	1,23E-09	3,30E+01	3,03E-02	1,09E+02	109,0%
1,00E-04	5,46E-02	8,40E+08	1,19E-09	4,59E+01	2,18E-02	7,85E+01	151,7%
1,00E-03	7,18E-02	9,80E+08	1,02E-09	7,04E+01	1,42E-02	5,12E+01	232,7%
1,00E-02	1,04E-01	1,01E+09	9,90E-10	1,05E+02	9,52E-03	3,43E+01	347,4%
1,00E-01	1,96E-01	1,70E+08	5,88E-09	3,33E+01	3,00E-02	1,08E+02	110,2%
5,00E-01	7,45E-01	3,90E+07	2,56E-08	2,91E+01	3,44E-02	1,24E+02	96,1%
<b>1,00E+00</b>	<b>1,12E+00</b>	<b>2,70E+07</b>	<b>3,70E-08</b>	<b>3,02E+01</b>	<b>3,31E-02</b>	<b>1,19E+02</b>	<b>100,0%</b>
2,50E+00	1,43E+00	2,90E+07	3,45E-08	4,15E+01	2,41E-02	8,68E+01	137,1%
5,00E+00	1,40E+00	2,30E+07	4,35E-08	3,22E+01	3,11E-02	1,12E+02	106,5%
7,00E+00	1,25E+00	2,40E+07	4,17E-08	3,00E+01	3,33E-02	1,20E+02	99,2%
1,00E+01	9,50E-01	2,40E+07	4,17E-08	2,28E+01	4,39E-02	1,58E+02	75,4%
1,40E+01	7,61E-01	1,70E+07	5,88E-08	1,29E+01	7,73E-02	2,78E+02	42,8%
2,00E+01	7,15E-01	1,60E+07	6,25E-08	1,14E+01	8,74E-02	3,15E+02	37,8%

C<sub>1</sub> , C<sub>2</sub> fluence-to-dose factors and quality factor Q according to NRC 10 CFR 20.1004  
 N<sub>1</sub> , N<sub>2</sub> and N<sub>3</sub> calibration factors according to NRC 10 CFR 20.1004 (reference energy 1 MeV)  
 q response over required response NRC 10 CFR 20.1004 (1 MeV), R fluence response LB 6411

## References

- [1] **NRC Regulations, Title 10, Code of Federal Regulations, § 20.1004 Units of radiation dose.**  
 U.S. Nuclear Regulatory Commission, <http://www.nrc.gov>
- [2] **The New Remcounter LB6411: Measurement of Neutron Ambient Dose Equivalent H\*(10) according to ICRP60 with High Sensitivity**  
 Klett, Alfred and Burgkhardt, Bertram  
*IEEE Transactions on Nuclear Science, Vol. 44, No.3, pp. 757-759, June 1997*
- [3] **The Neutron Fluence and H\*(10) Response of the New LB6411 Rem Counter**  
 Burgkhardt, B., G. Fieg, A. Klett, A. Plewnia, B.R.L. Siebert  
*Neutron Dosimetry, Proceedings of the Eighth Symposium, Paris, November 13-17 1995, Radiation Protection Dosimetry Vol. 70, Nos. 1-4, (1997), pp. 361-364*