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Impact of the Revised 10 CFR 835 on the Neutron Dose Rates at LLNL

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1. Introduction

In June 2007, 10 CFR 835 [1] was revised to include new radiation weighting factors for neutrons, updated dosimetric models, and dose terms consistent with the newer ICRP recommendations. A significant aspect of the revised 10 CFR 835 is the adoption of the recommendations outlined in ICRP-60 [2]. The recommended new quantities demand a review of much of the basic data used in protection against exposure to sources of ionizing radiation. The International Commission on Radiation Units and Measurements has defined a number of quantities for use in personnel and area monitoring [3,4,5] including the ambient dose equivalent H*(d) to be used for area monitoring and instrument calibrations. These quantities are used in ICRP-60 and ICRP-74.

This report deals only with the changes in the ambient dose equivalent and ambient dose rate equivalent for neutrons as a result of the implementation of the revised 10 CFR 835. In the report, the terms neutron dose and neutron dose rate will be used for convenience for ambient neutron dose and ambient neutron dose rate unless otherwise stated. This report provides a qualitative and quantitative estimate of how much the neutron dose rates at LLNL will change with the implementation of the revised 10 CFR 835.

2. Executive Summary

Neutron spectra and dose rates from selected locations at the LLNL were measured with a high resolution spectroscopic neutron dose rate system (ROSPEC) as well as with a standard neutron rem meter (a.k.a., a remball). The spectra obtained at these locations compare well with the spectra from the Radiation Calibration Laboratory's (RCL) bare californium source that is currently used to calibrate neutron dose rate instruments. The measurements obtained from the high resolution neutron spectrometer and dose meter ROSPEC and the NRD dose meter compare within the range of ± 25%.

When the new radiation weighting factors are adopted with the implementation of the revised 10 CFR 835, the measured dose rates will increase by up to 22%. The health physicists should consider this increase for any areas that have dose rates near a posting limit, such as near the 100 mrem/hr for a high radiation area, as this increase in measured dose rate may result in some changes to postings and consequent radiological controls.

3. Background

Both the old 10 CFR 835 neutron quality factors and the revised 10 CFR 835 radiation weighting factors for neutrons are energy dependent. However, the energy dependence of the new radiation weighting factors differs somewhat from the energy dependence of the old quality factors. Therefore, it is difficult to predict accurately what will be the impact of the implementation of the revised 10 CFR 835 radiation weighting factors to any neutron field without knowing its spectral characteristics. For the proper determination of the neutron dose

and dose rates it is necessary to measure the energy distribution of the neutrons and to apply the appropriate fluence-to-dose conversion factors.

4. Methodology

We measured the neutron spectra at various locations (as selected by the facility health physicists) with the neutron spectrometer and applied the appropriate fluence-to-dose conversion factors to determine the neutron dose rates. The fluence-to-dose conversion factors based on the old 10 CFR 835 are listed in NCRP-38 [6]. Those used in the revised 10 CFR 835 are published in ICRP-74 [7].

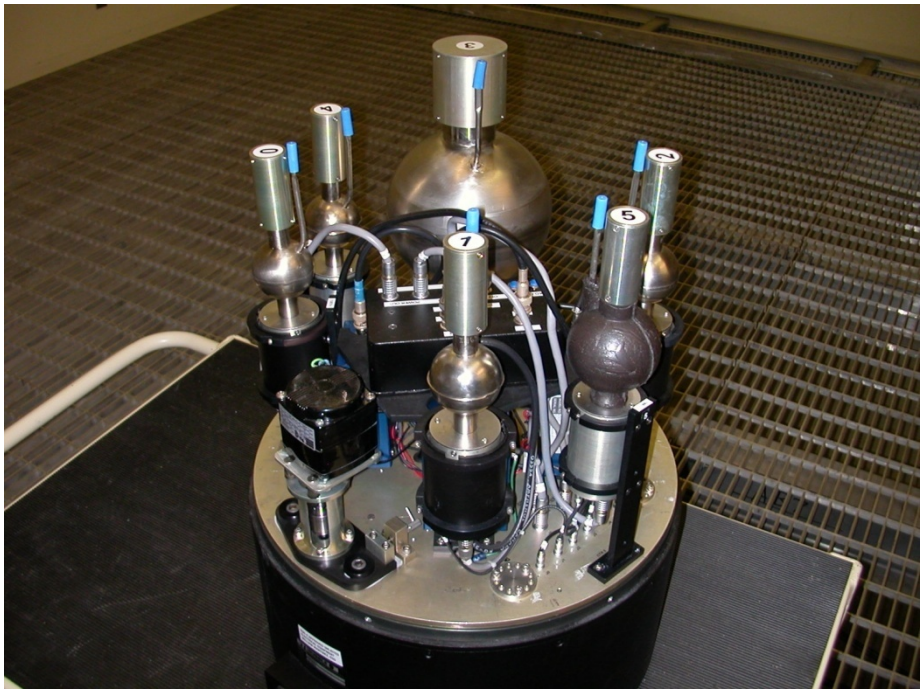
A high resolution neutron spectrometer (ROSPEC) loaned from Los Alamos National Laboratory (LANL) was used to measure and characterize the neutron spectra and neutron dose rates at several locations in LLNL in the energy range of thermal to 4.5 MeV. Dose rate measurements were also performed using a standard neutron rem meter (remball) calibrated at LLNL's Radiation Calibration Lab.

5. Equipment

5.1 ROSPEC

ROSPEC (**RO**tating **SPEC**trometer) is a neutron spectrometer designed to measure neutron energy spectra and to provide accurate neutron dosimetry. The instrument is manufactured by Bubble Technologies Industries (BTI) of Chalk River, Canada. ROSPEC is 16" in diameter and 23.75" high weighing about 50 lbs, and consists of six gas-filled proportional counters. See Figure 1.

Figure 1. ROSPEC



Four of the six counters measure the neutron energy by measuring the energy from recoiling protons in the fill gas (H_2 or P10). The other two counters are filled with ^{3}He and use the (n, p) reaction to measure the neutron energy. Each of the counters is dedicated to a particular neutron energy range covering the range from thermal to 4.5 MeV. The 5-10 MeV region is provided by a generic fission spectra supplied with the ROSPEC. The six neutron counters are mounted on a circular rotating platform with 30 cm diameter which constrains each of the counters to follow the same circular orbit. This allows each of the counters to sample the same neutron field so that spatial variation of the field is averaged. Table 1 details ROSPEC counter parameters.

Table 1. ROSPEC counter parameters

Counter #	Name	Diameter (inches)	Fill Gas	Pressure (atm)	Energy Range (MeV)
0	SP2-1	2	H_2	0.75	0.05 - 0.25
1	SP2-4	2	H_2	4.0	0.15 - 0.70
2	SP2-10	2	H_2	10.0	0.40 - 1.50
3	SP6	6	P10	5.0	1.20 - 4.50
4		2	^{3}He	0.08	$<1x10^{-6}$
5		2	^{3}He	0.5	$1x10^{-6}$ - $1x10^{-2}$

After a measurement is completed and the pulse height distributions are stored in the computer, a software program is used to calculate (unfold or extract) the neutron spectra from pulse height distributions (the recoil proton and nuclear reaction products spectra) from each of the

detectors. The unfolded six spectra are normalized and combined into one neutron spectrum and the neutron fluence is arranged in approximately 57 energy bins. The neutron spectrum together with fluence-to-dose conversion factors (derived from NCRP-38 and ICRP-74) are used to determine the dosimetric quantities (kerma, dose equivalent (NCRP-38), ambient dose equivalent (ICRP-74) and personal dose equivalent (ICRP-74)). The fluence and dose data are displayed for the thermal (E_n < 1 eV), epi-thermal (1 eV < E_n < 50 keV) and fast (50 keV < E_n < 4.5 MeV) regions.

The unfolded neutron spectrum is used to calculate the following dosimetric quantities: kerma, total dose equivalent (H), ambient dose equivalent (H*(10)) and personal dose equivalent (Hp(10,0)). The operational quantities are:

- **H** is the dose equivalent for neutrons as defined in NCRP-38
- **H*(10)** is the ambient dose equivalent as defined in ICRP-74 and ICRP-60 at a point in a radiation field that would be produced by the corresponding expanded and aligned neutron field in the ICRU sphere at a depth of 10 mm on the radius opposing the direction of the aligned field.
- **Hp(10,0)** is the personal dose equivalent as defined in ICRP-74 and ICRP-60 in soft tissue at 10 mm below a specified point on the body at 0 degree between the incident unidirectional neutron field and the direction normal to the surface (in atero-posterior geometry)

The software linearly interpolates the data to determine the appropriate conversion factors at each bin mid-point energy. The energy dependence of the NCRP-38 dose equivalent factors was determined by interpolation of the data given in NCRP-38. The conversion factors for ambient dose equivalent (H*(10)) and personal dose equivalent (Hp(10,0)) were taken from the data listed in ICRP-74. A best fit curve was created through the fluence-to-dose conversion factors and the appropriate conversion factors at each bin's mid-point energy were obtained from the curve. The fluence-to-dose conversion factors used are provided in Appendix A.

The ROSPEC was previously used to successfully characterize the neutron fields at LANL, Savannah River Site (SRS), Pacific Northwest National Laboratory (PNNL), and Brookhaven National Laboratory (BNL) calibration facilities [8-10] and LANL Plutonium and Waste facilities. The ROSPEC is the only commercially available instrument that can fairly accurately measure the neutron doses and dose rates from various neutron fields in the energy range of thermal to 4.5 MeV by applying energy dependent fluence-to dose conversion factors. In fact, various conversion factors based on different recommendations (e.g. NCRP-38, ICRP-26, ICRP-74, etc.) can be used with the same measurement providing a convenient way to compare the impact of different dosimetric models or regulatory revisions to the measured doses and dose rates.

5.2 Calibration of ROSPEC

LLNL used a ROSPEC, serial number 01002, that was re-calibrated by LANL with metrology-grade mono-energetic neutron fields at Physikalisch-Technische Bundesanstalt (PBT) in Germany, the National Physical Laboratory (NPL) in UK and thermal column data collected at the GKSS facility outside Hamburg, Germany. The calibration procedure and the results are

described in more detail in reference [9-12]. Each year LANL performs the ROSPEC calibration in the following manner. LANL measures the neutron spectrum from a NIST traceable ^{252}Cf source and compares it against an MCNP calculated ^{252}Cf spectrum with parameters taken from ISO 8529 to account for any shifts or deviations in the measured neutron energy distribution from the NIST-traceable ^{252}Cf source. Additionally, the strength and the dose rates measured by ROSPEC are compared with the decay corrected dose rates from the source. The ROSPEC, serial number 01002, was last calibrated at LANL on February 26, 2008.

At LLNL we verified ROSPEC calibration with an NRD rem meter calibrated by NIST with bare ^{252}Cf and D_2O-moderated ^{252}Cf sources. We measured the dose rates with both instruments at five distances from a bare ^{252}Cf source and at six distances from a D_2O moderated ^{252}Cf source. Excellent agreement was achieved for bare ^{252}Cf (97.6% - 98.9%) and for D_2O moderated ^{252}Cf (90.6% - 95.5%). The larger difference for D_2O moderated ^{252}Cf is due to the fact that LLNL's D_2O sphere is slightly larger than the NIST D_2O sphere. The results are presented in Table 2.

5.3 NRD neutron rem meter

The standard neutron rem meter was a commercial instrument from Thermo Fisher (formerly Eberline), model NRD consisting of a BF_3 detector in a 9" diameter polyethylene sphere connected to E600 meter from Thermo Fisher (Eberline). The neutron rem meter is shown in Figure 2.

Figure 2. Thermo NRD neutron rem meter

5.4 Calibration of the NRD neutron rem meter

The Thermo NRD rem detector (serial number 725612) coupled with the Thermo E600 counter (serial number 2923) was calibrated in January 2008 at the LLNL's Radiation Calibration Lab with bare ^{252}Cf source using the NCRP-38 neutron fluence-to-dose conversion factors.

6. Measurement results

6.1 ROSPEC measurements results

The locations of the dose rate and spectra measurements were chosen by the facility health physicists and are presented in Figure 3. The dose rate and spectra measurements with ROSPEC and NRD rem meter were taken from April 2 to April 24, 2008. The majority of the measurements at a given location lasted one full day or more, and had accumulated integral dose over 100 mrem, which provided for fair statistical accuracy.

The neutron spectra measured with ROSPEC at the nine locations in LLNL are presented in graphical form in Figures 4 – 8 and in Appendix C for energies from thermal to 4.5 MeV. The representation of the neutron spectra in the figures is standard in the field of neutron physics and radiation protection from neutrons. Neutron energy E, times the fluence rate energy distribution $d\phi/dE$, is plotted on the vertical axis against neutron energy E on the horizontal axis. Energy E is in MeV units and on a log scale. It is conceptually simpler to plot just $d\phi/dE$

on the vertical axis, however, that typically requires a log-log plot for neutrons covering many orders of magnitude on both axes, making details difficult to see. The large range of neutron $d\phi/dE$ stems from its characteristic 1/E dependence when the neutrons slow down in a scattering media. On all ROSPEC neutron energy plots (Figures 4-9 and 12-17 and in Appendix C) the vertical axis is in lethargy units; the lethargy = phi(E)/[ln(E2/E1)], where phi(E) is the neutron fluence in a given bin (in neutrons per cm^2) and E2 and E1 are the upper and lower bin boundary energies. E PHI E on the plots is a shorthand for lethargy because lethargy is often approximated with E*phi(E)/deltaE (i.e. $E*d\phi/dE$). The neutron spectra in Figures 4-9 and 12-17 are not normalized to one source neutron and, therefore, provide indication on the relative strength of the neutron fields at these locations. Figures 12-17 provide more details in the neutron spectra for the same locations in the energy region of 50 keV-4.5 MeV. Appendix B provides tables with detailed numerical data for the measured spectra.

Detailed neutron spectra plots are compiled in Appendix C in the energy region from thermal to 4.5 MeV. The energy plots are for the same locations as in Figures 4-9 and are normalized per one neutron in the following fashion. After the spectra from the six detectors are combined, the number of neutrons in each energy bin of the combined spectra is divided by the total number of neutrons in the combined spectra. Such presentation allows for better visual comparison of spectra taken for different periods of time and from sources with different activities.

There are noticeable similarities and differences in the shape of the neutron energy distribution at the measurement locations.

The integral neutron fluence (in neutrons per cm^2) and neutron fluence rates (in neutrons per cm^2 per second) measured with ROSPEC for all locations are presented in Tables 3-11. The fluence and fluence rates are also presented for the fast neutron region (50 keV-4.5 MeV), epithermal region (1 eV - 50keV) and thermal region (< 1 eV). The dose rates are calculated from the measured spectral fluence using the fluence-to-dose conversion factors listed in Appendix A. For each location three integrated dose and dose rates are given: dose equivalent rate based on the fluence-to-dose conversion factors derived from NCRP-38 (H NCRP-38), ambient dose equivalent rate based on the fluence-to-dose conversion factors from ICRP-74 (H*(10) ICRP-74) and personal dose equivalent rate based on the fluence-to-dose conversion factors from ICRP-74 for personal dose in atero-posterior geometry (Hp(10,0) ICRP-74). Additionally in Tables 3-11 dosimetric data are presented for the three neutron energy regions: 50 keV - 4.5 MeV, epithermal, and thermal.

In Table 12 the dose rates are presented for all locations measured by ROSPEC. The first four columns list the location, the date and the distance from the front surface of the sources. The last two columns provide the dose rates as determined by ROSPEC using the old 10 CFR 835 quality factors (NCRP-38) and the revised 10 CFR 835 radiation weighting factors (ICRP-74, Ambient). There are two measurements for location #2, since some material was moved after the first measurement.

6.2 NRD rem meter measurements results

Table 13 shows the dose rates measured by NRD rem meter for all locations. The first four columns list the location, the date and the distance from the front surface of the sources. The last column provides the dose rates measured by the NRD rem meter calibrated using the old 10 CFR 835 quality factors. Location 7 measurement with the NRD may have been affected by source to detector geometry factors and is treated as an outlier.

7. Discussion

The measurements were aimed to answer several questions:

- What are the neutron spectral distributions in these locations?
- How much do the neutron spectral distributions in these locations affect the corresponding neutron dose rates?
- How well is a standard neutron rem meter suited for area monitoring of the neutron fields in these locations?
- How much will the current neutron dose rates in these locations change when the radiation weighting factors from the revised 10 CFR 835 are implemented?

7.1 Neutron spectral distributions

From the measured neutron spectral distributions presented in Figures 4-10, Figures 12-17 and in Appendix C it is obvious that in Rooms A and D the neutron spectra are harder and resemble that from a bare ^{252}Cf, while in Rooms B and C the neutron spectra are softer and are closer to a spectrum from a D_2O moderated ^{252}Cf. This is exemplified in Figure 9 and Figure 17 where the spectrum from Room B is compared with that from Room D, and also in Figure 10 where the normalized per one neutron spectrum from Room A is compared with the spectrum from Room C. Numerically this can be seen also from Tables 3-11 where the entire neutron fluence is divided into three broad energy regions: thermal, epi-thermal and fast (50 kev – 4.5 MeV) neutrons. As an example, the fluence data from Tables 6 and 9 are presented in Figure 11 on the left side. The contribution of the thermal and epithermal neutrons for Room D, location #7 is only 40% of the total neutron fluence, while for Room B, location 4 it is over 76%. Similar ratios can be derived for all measured locations from the data in Tables 3-11. Details of the neutron spectra in the 50 keV - 4.5 MeV region are provided in Figures 12-16.

7.2 Relationship between the neutron spectral distribution and the corresponding doses and dose rates

Because the radiation weighting factors and the corresponding fluence-to-dose conversion factors are energy dependent, it is obvious that neutrons with different energies will not have the same contribution to the neutron dose. A higher contribution to the total neutron dose is expected from neutrons in the 50 keV – 4.5 MeV region where the conversion factors are greater. This is illustrated in Figure 11 where the fluence distribution and the corresponding doses are shown for two representative locations from both groups of rooms: Rooms A and D and Rooms B and C. In location # 4 (Room B) the fast neutrons are only 23% of the total

number of neutrons, however, they contribute 83% to the total neutron dose. In location #7 (Room D) the fast neutrons are 60% of the total number of neutrons and they contribute 97% of the total dose. Similar relations can be calculated from the data in Tables 3-11 for each of the measured locations with NCRP-38 or ICRP-74 conversion coefficients. The measurements confirm that the neutron dose and dose rate in these locations are caused primarily by neutrons in the 50 keV - 4.5 MeV energy region. Therefore, the neutron spectrum in the 50 keV - 4.5 MeV region is important for the health physicist for a proper evaluation of the radiation hazards and establishing control measures.

7.3 Comparison of measurements with ROSPEC and a standard neutron rem meter

Table 14 provides comparison between the dose rates measured in certain LLNL locations by ROSPEC and a standard NRD neutron rem meter calibrated at the RCL with bare ^{252}Cf. ROSPEC values were determined using the NCRP-38 conversion factors in order to compare them with NRD measured values. The last column in Table 14 provides the ratio of the measured dose rates by ROSPEC and NRD rem meter. This ratio indicates how close the dose rates measured by the NRD rem meter calibrated with bare ^{252}Cf are to the more accurate values measured by the spectroscopic ROSPEC. The ratio has two distinct values for the two groups of rooms as would be expected from the differences in the neutron spectra in these locations. NRD underestimates the dose rates by 20-23% for rooms A and D which have harder neutron spectrum and overestimates the neutron dose rates by up to 21% for rooms B and C, which have more moderated neutrons. Overall, the NRD measurement compares well with a ROSPEC measurement averaging (1.04 ± 0.15) when the uncertainties in the calibration are considered. This is a good agreement considering that 1).these two instruments are based on different operating principles and technologies and 2).that the dose rates available for measurement at these locations were low and provide for poorer counting statistics than higher dose rates would. Overall, these results support a decision to continue to use the RCL's bare ^{252}Cf source for neutron instrument calibration without the need to apply multiple facility-specific correction factors.

7.4 Impacts to the dose rates in the selected LLNL's locations from implementation of the revised 10 CFR 835 radiation weighting factors

ROSPEC provides a very convenient way to assess the ambient dose equivalent rates based on the old 10 CFR 835 quality factors (NCRP-38) and on the revised 10 CFR 835 radiation weighting factors (ICRP-74) for any given neutron spectrum. Table 15 (6^{th} and 7^{th} column) provides the neutron dose rates determined by ROSPEC using NCRP-38 and ICRP-74 conversion factors for all measured locations. The last column shows the difference in percent between the ICRP-74 (new) and NCRP-38 (old) determined dose rates. This indicates the expected increase in the ambient neutron dose equivalent rates when the revised 10 CFR 835 is implemented. Due to the different energy spectra in the two groups of rooms there is slightly different dose rate increases: for rooms B and C (with softer spectra) the increase in the neutron dose rates will be (20.5 – 21.5)%; for rooms A and D (with harder spectra) the increase in the neutron dose rates will be (14.8 – 17.8)%.

8. Conclusion

The neutron fields in the selected LLNL locations fall into two groups based on the configuration of material and associated shielding. One group's spectra are closer to bare ^{252}Cf spectrum and the other group has spectra closer to a D_2O moderated ^{252}Cf spectrum.

The neutron spectra in the selected LLNL's locations are similar enough to allow 1). the use of a simple rem meter (e.g. NRD remball) calibrated with bare ^{252}Cf to measure the neutron dose rates in all locations with an acceptable uncertainty and 2). the use of only one NRD correction/calibration coefficient for all locations with the ambient neutron dose rate equivalent being overestimated by up to 30% for some locations with softer neutron spectrum. Such an approach will allow to avoid the introduction of multiple facility or location specific calibration factors for this area.

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When the revised 10 CFR 835 is implemented the neutron dose rates will increase between 15% and 22% for the selected locations.

9. References

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Figure 3. Measurement locations

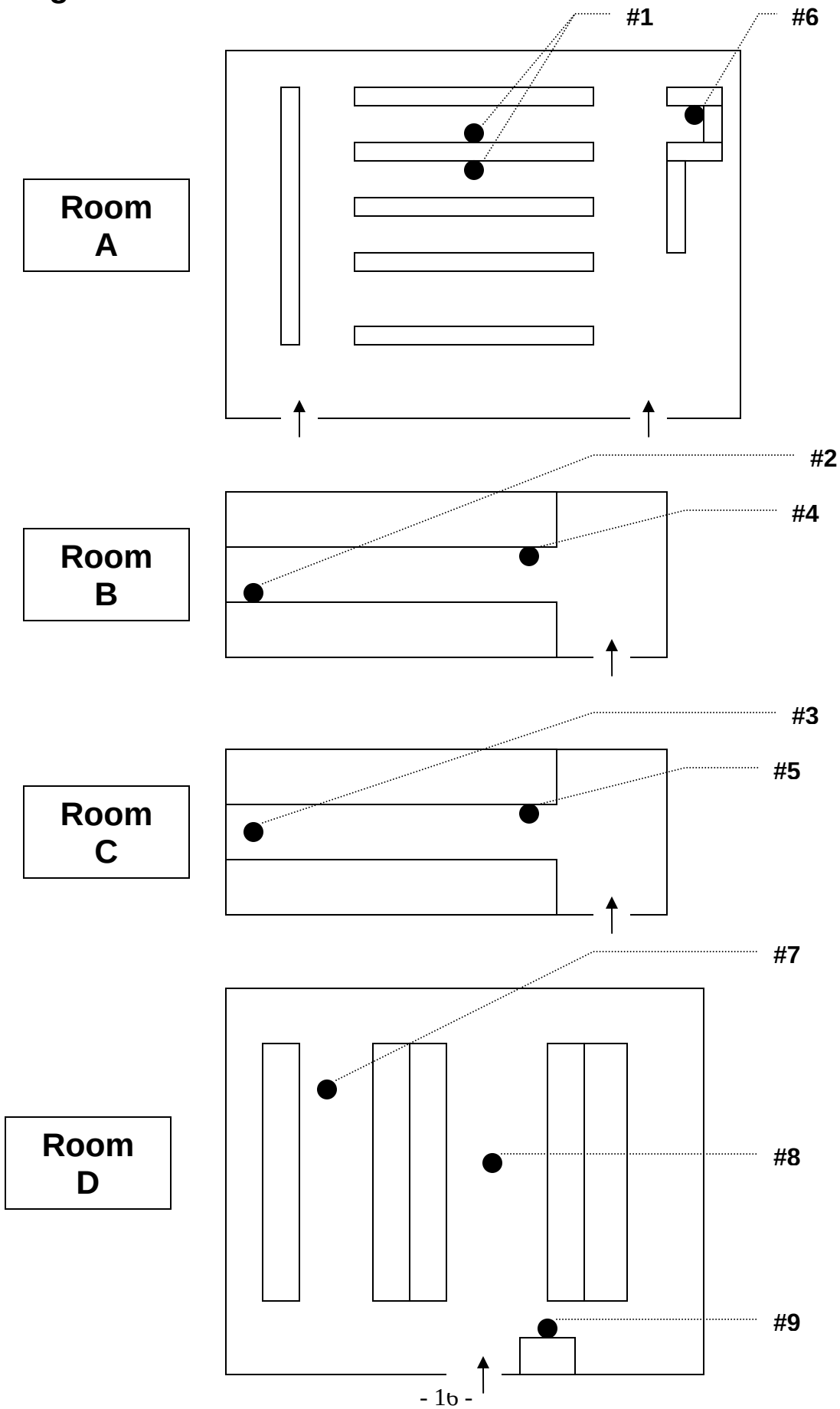
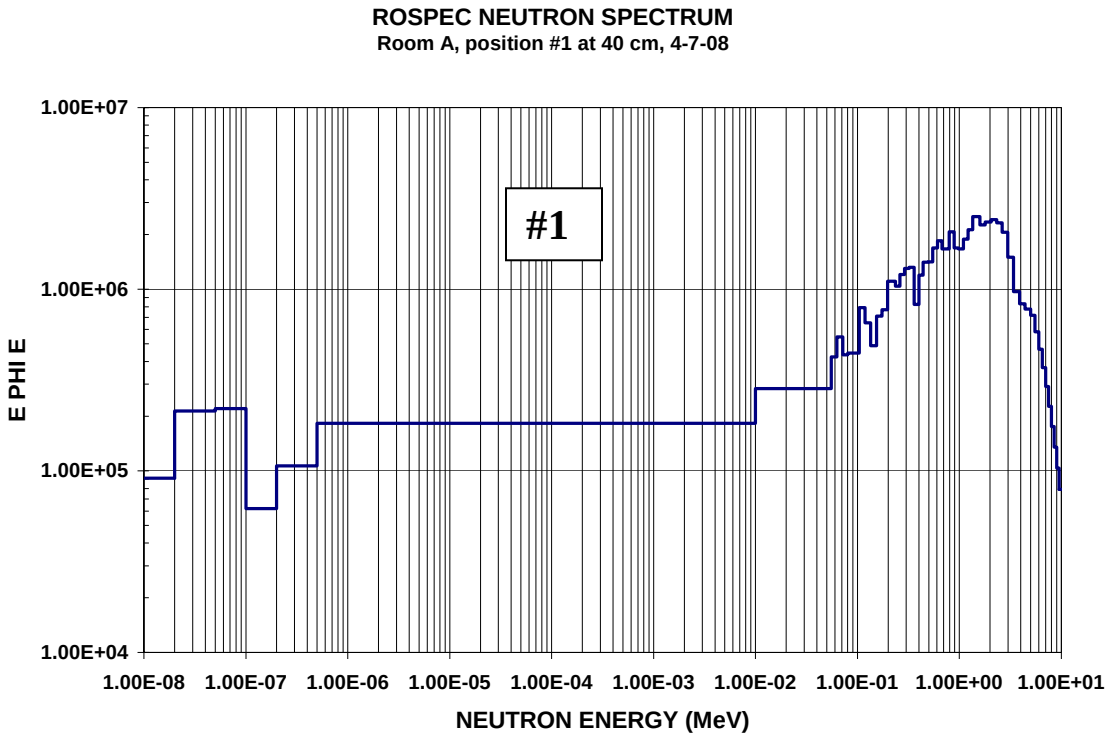


Figure 4. Neutron spectra in room A



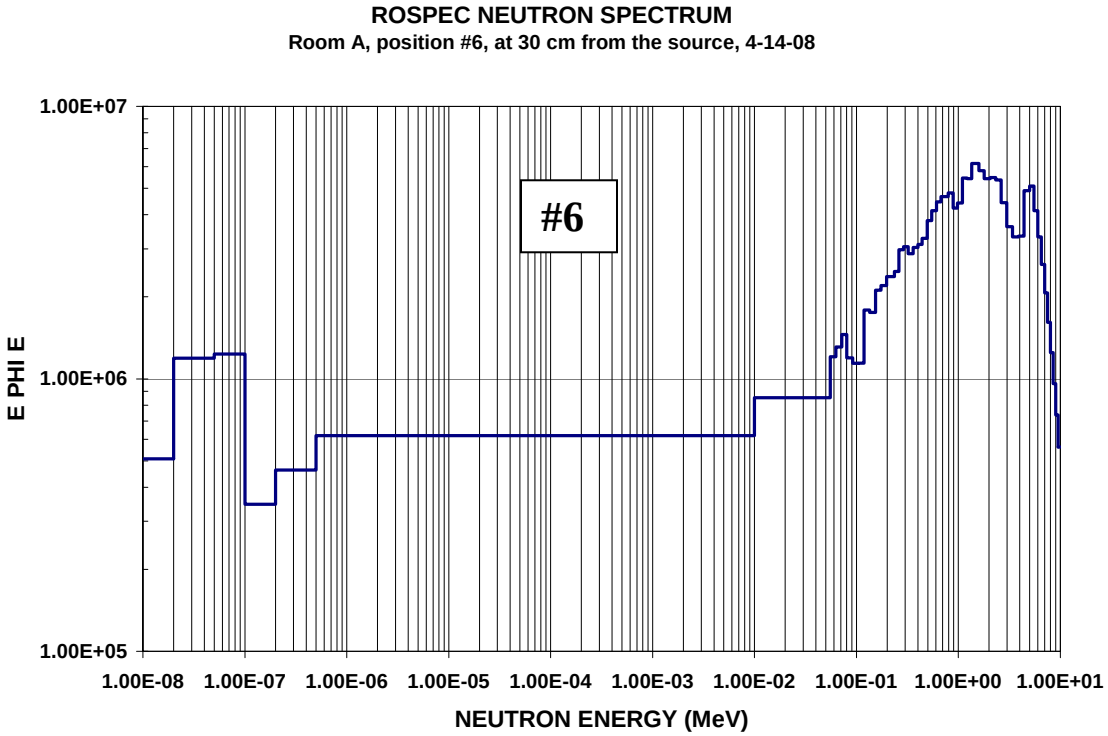
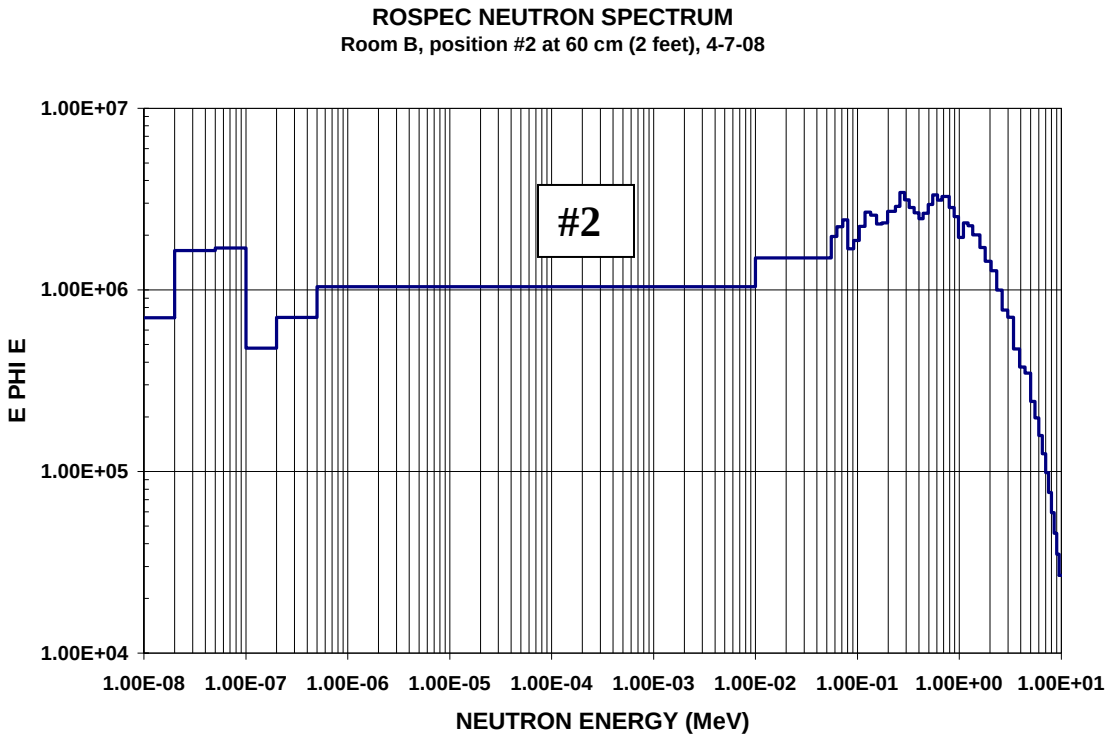


Figure 5. Neutron spectra in room B



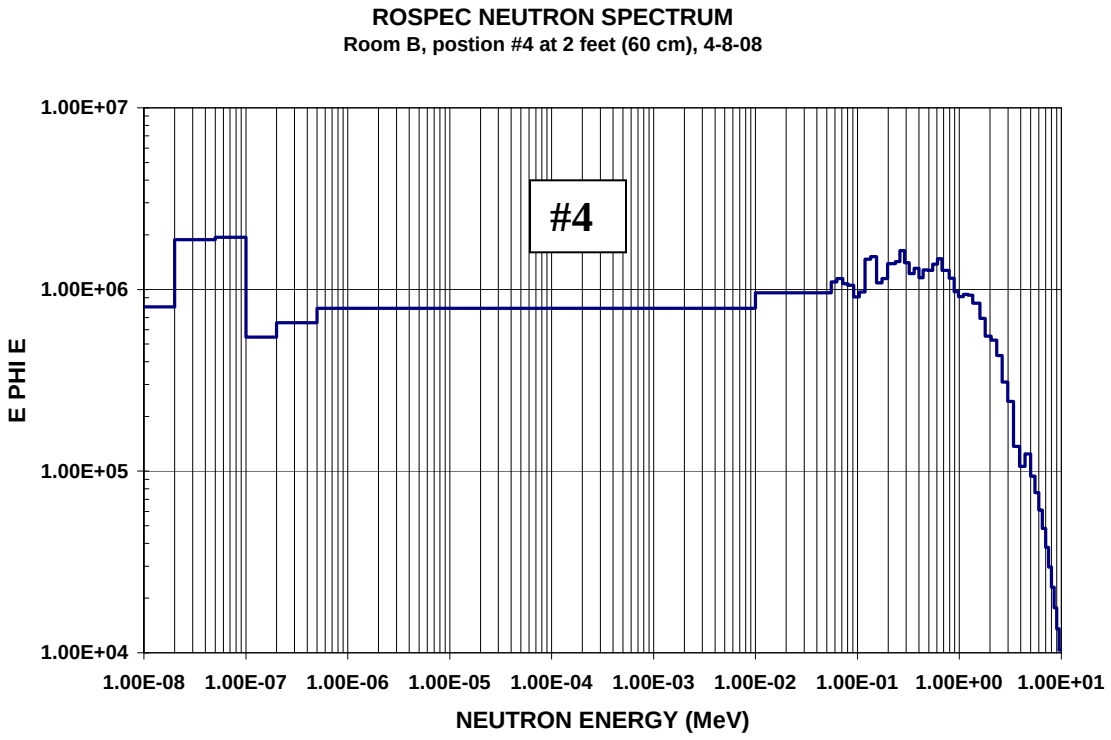
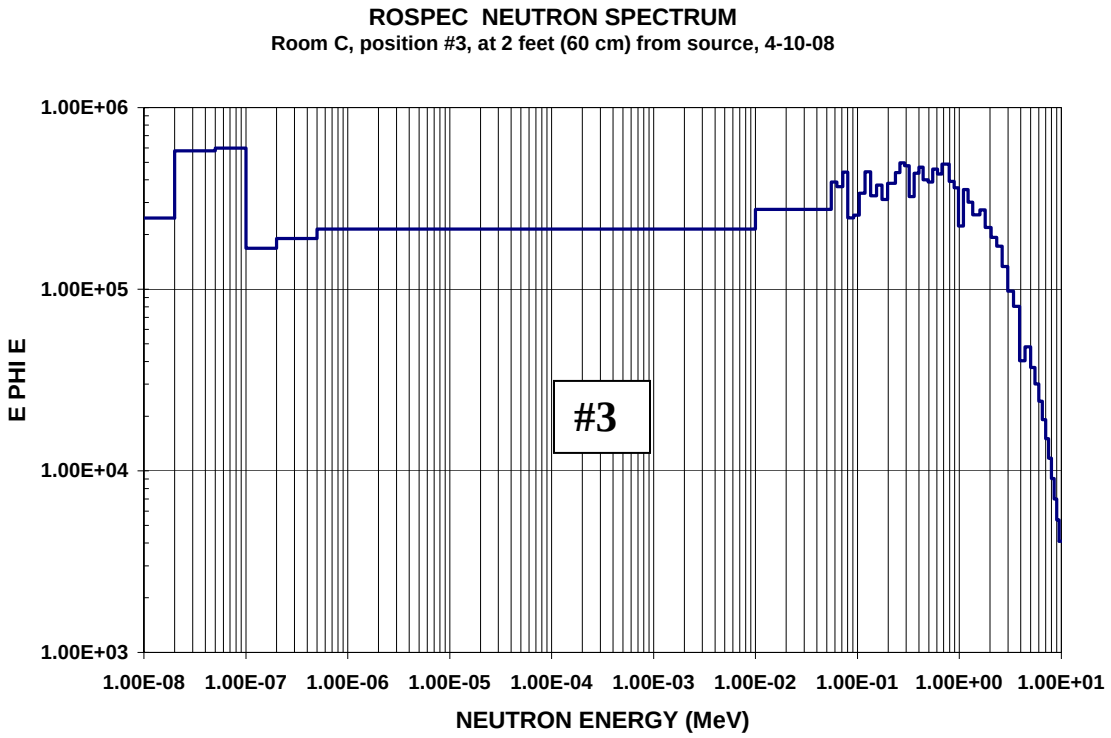


Figure 6. Neutron spectra in room C



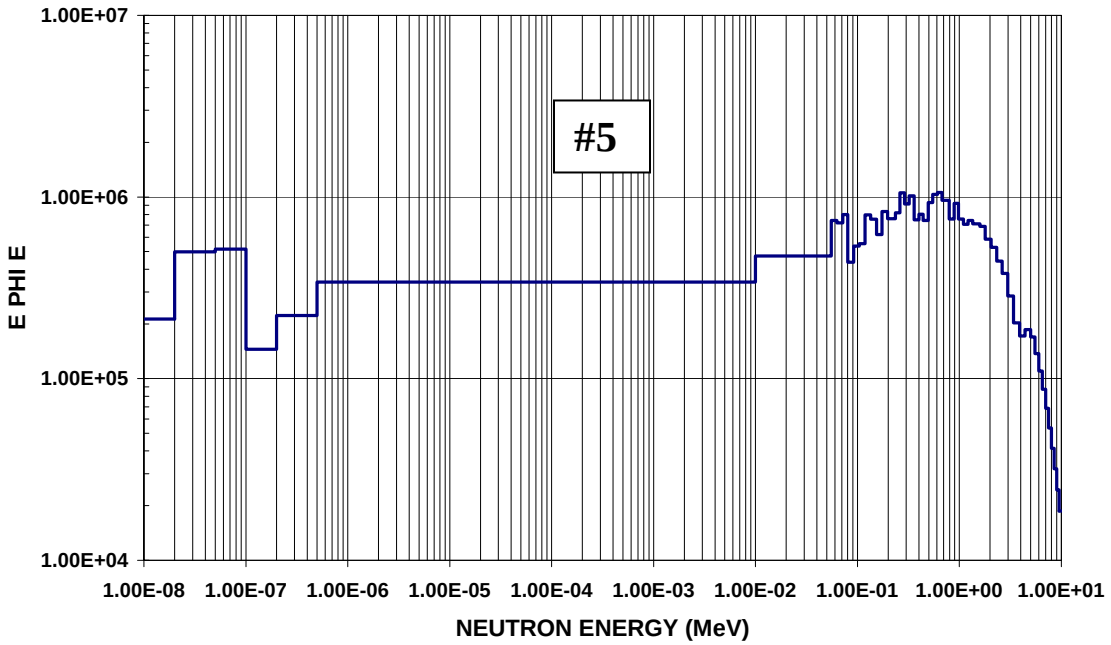
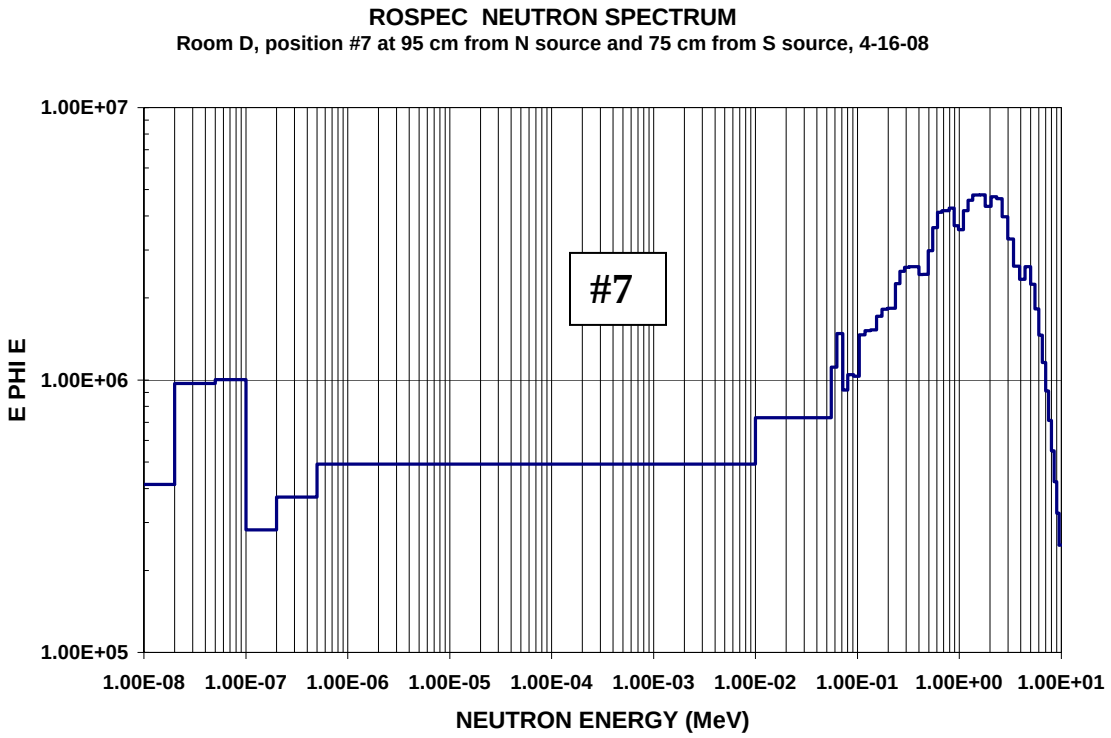


Figure 7. Neutron spectra in room D



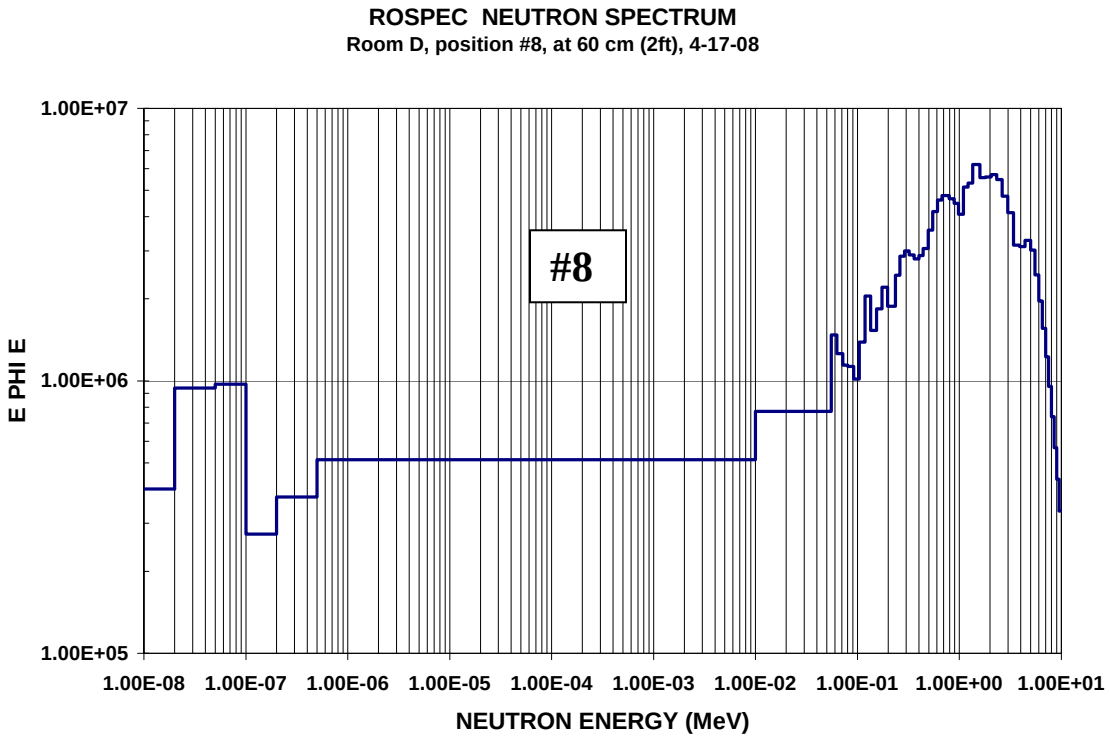


Figure 8. Neutron spectra in room D

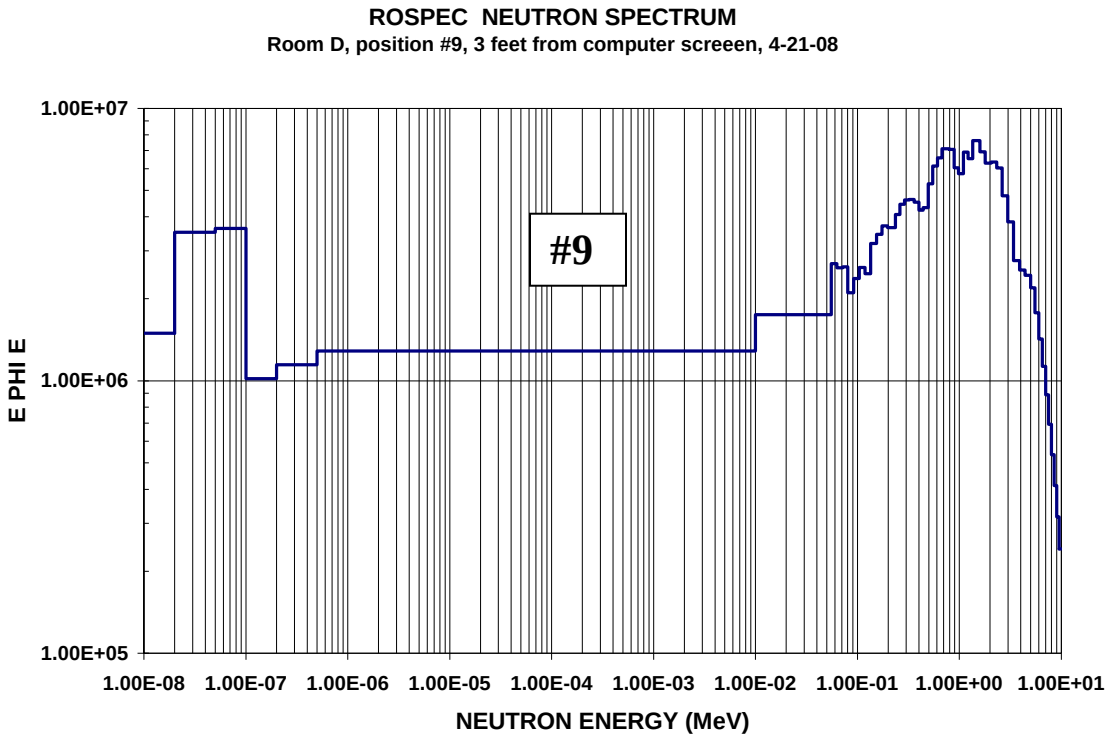
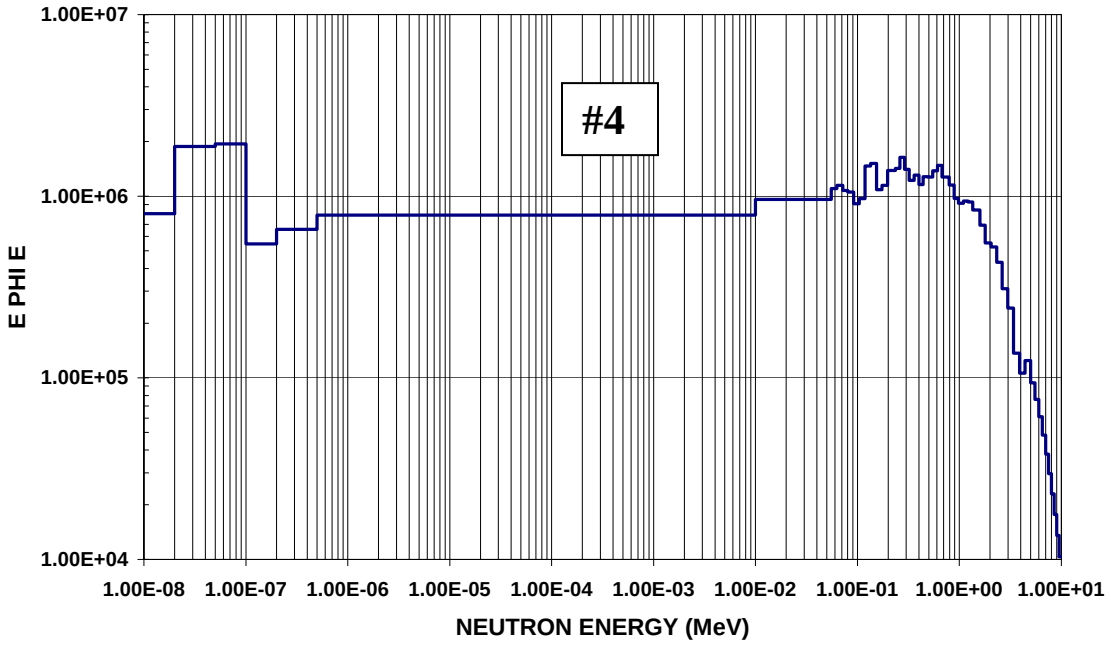


Figure 9. Comparison of neutron spectra

Room B



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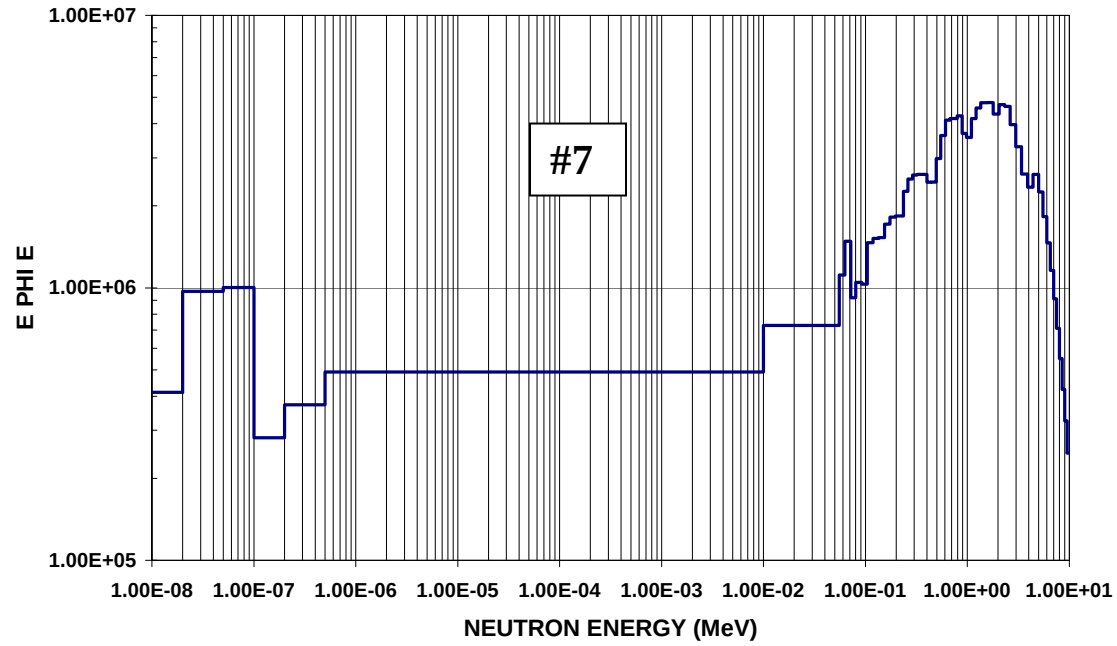


Figure 10. Comparison of normalized neutron spectra

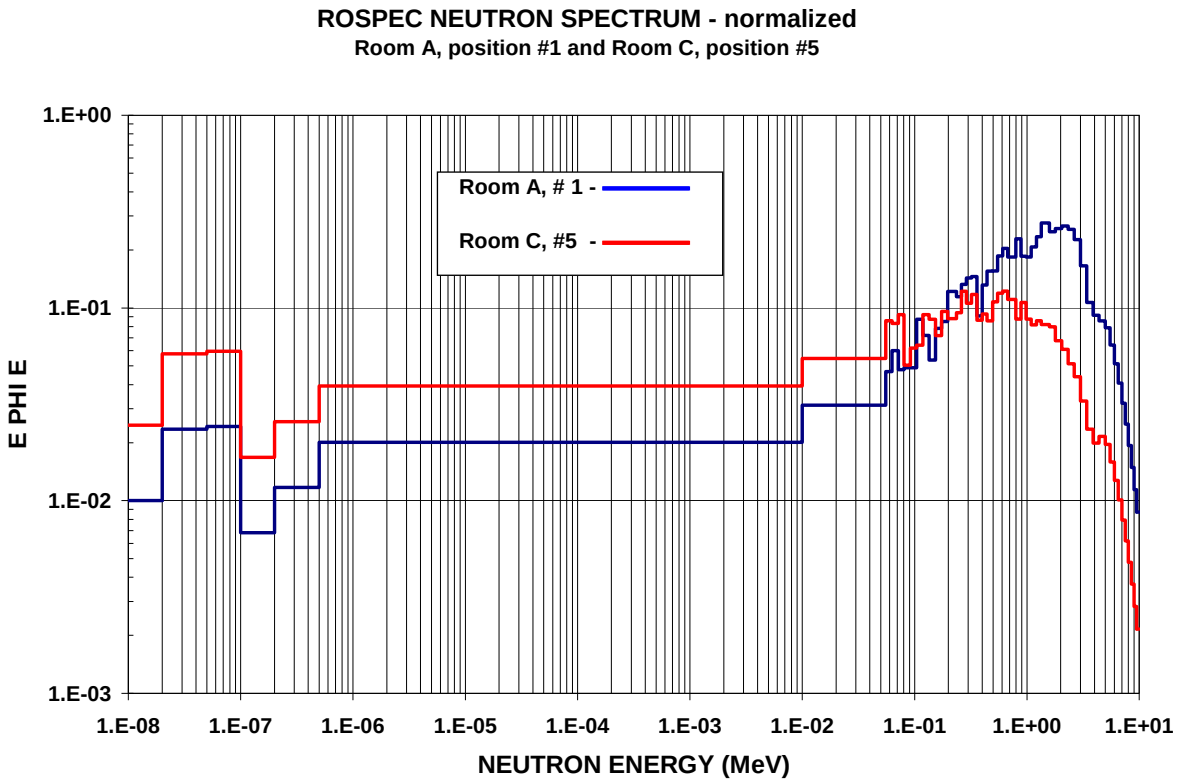
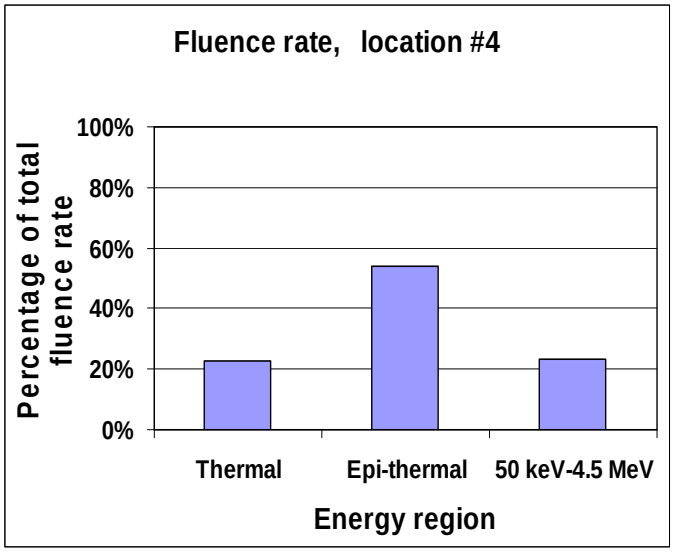
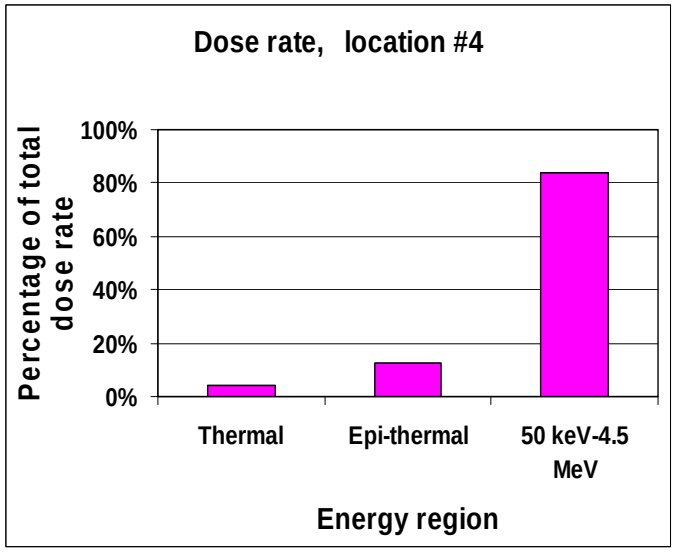


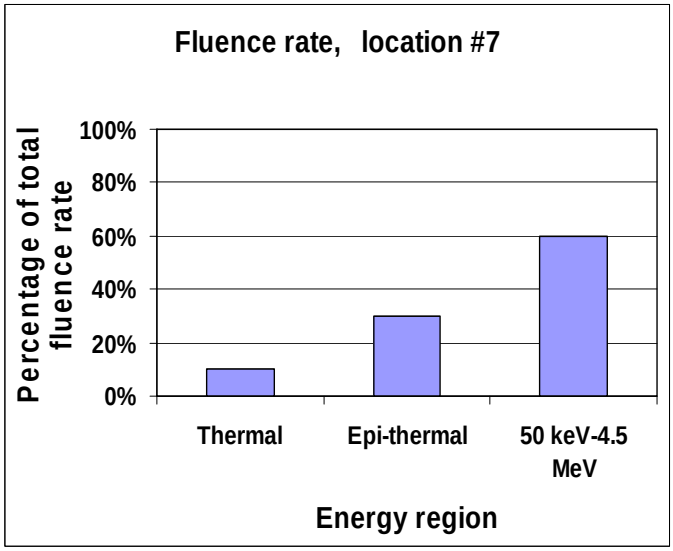
Figure 11. Comparison of the fluence and dose rates

Room B, location #4





Room D, location #7



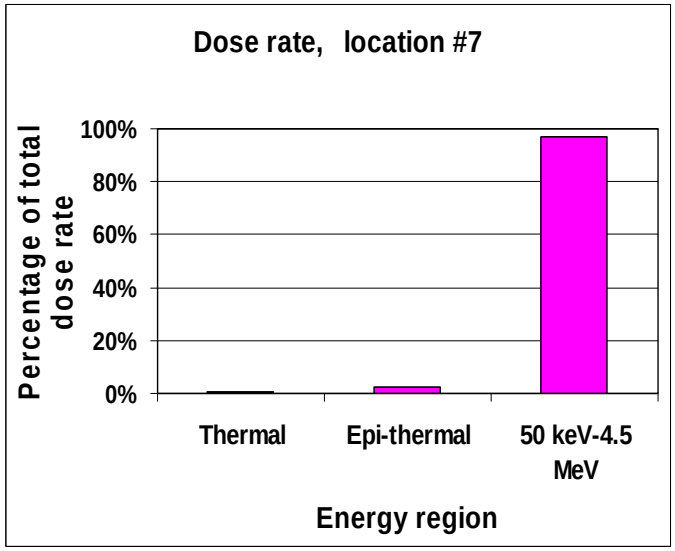
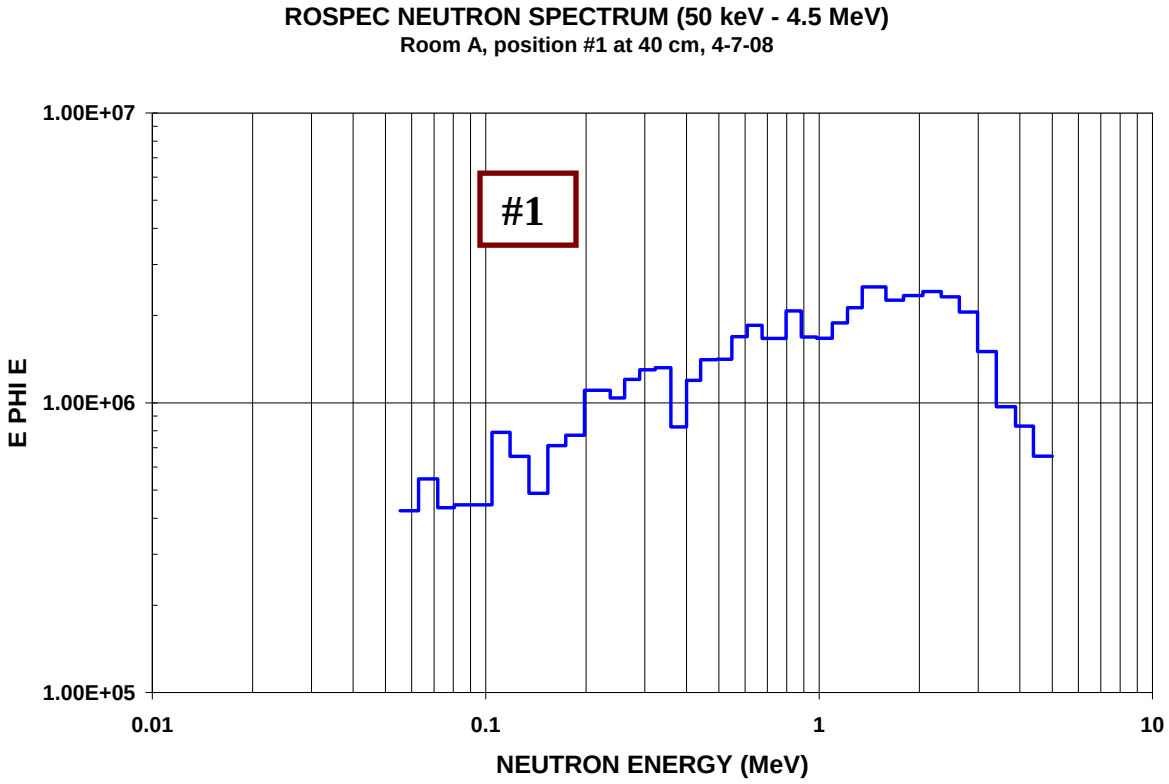


Figure 12. Neutron spectra (50 keV – 4.5 MeV) in room A



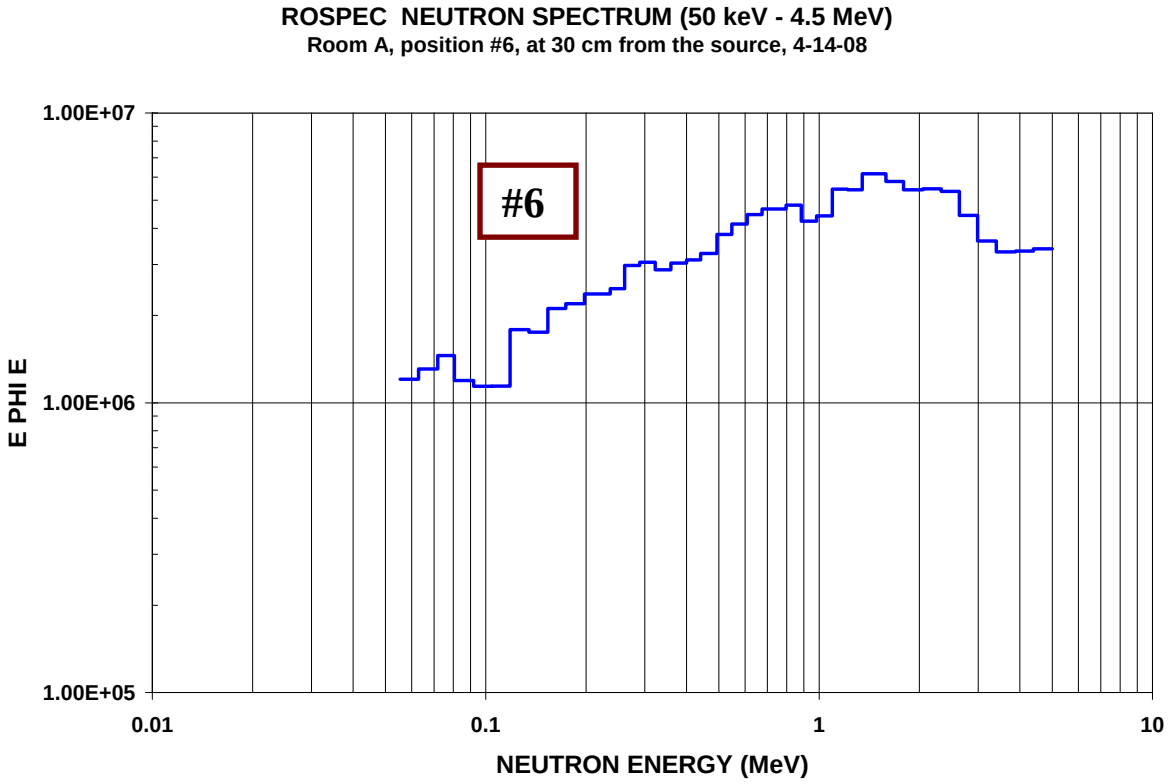
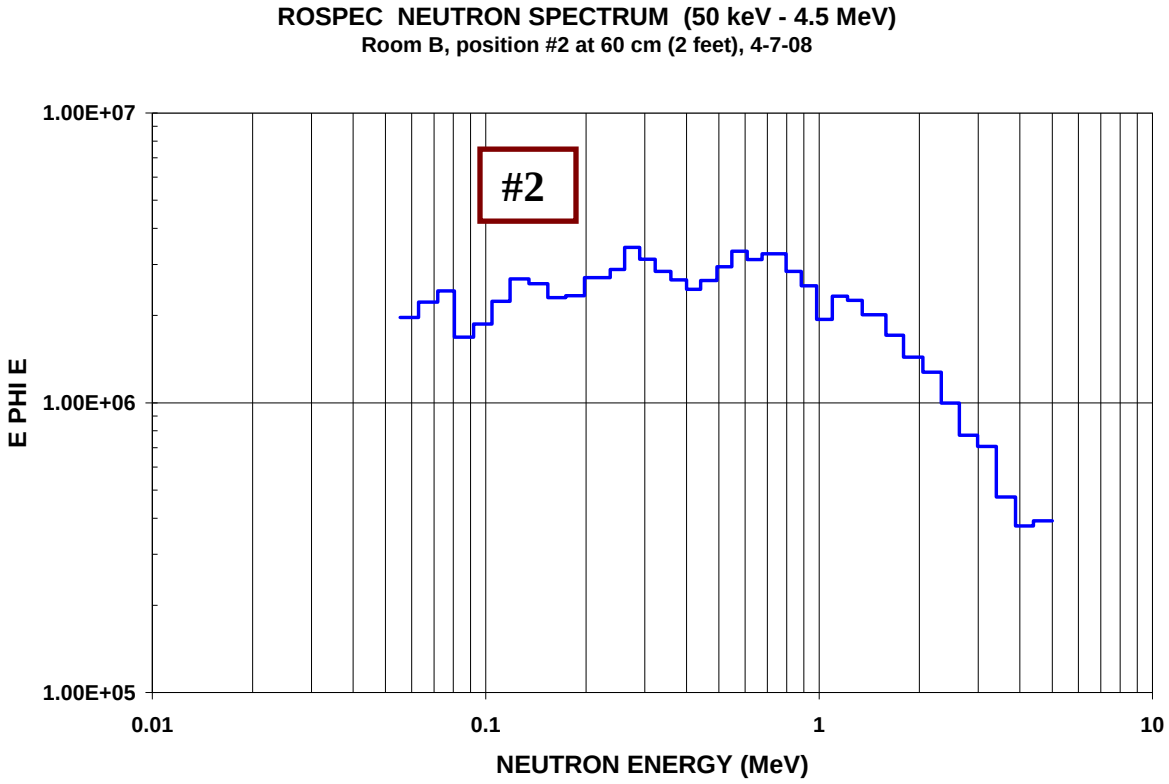


Figure 13. Neutron spectra (50 keV – 4.5 MeV) in room B



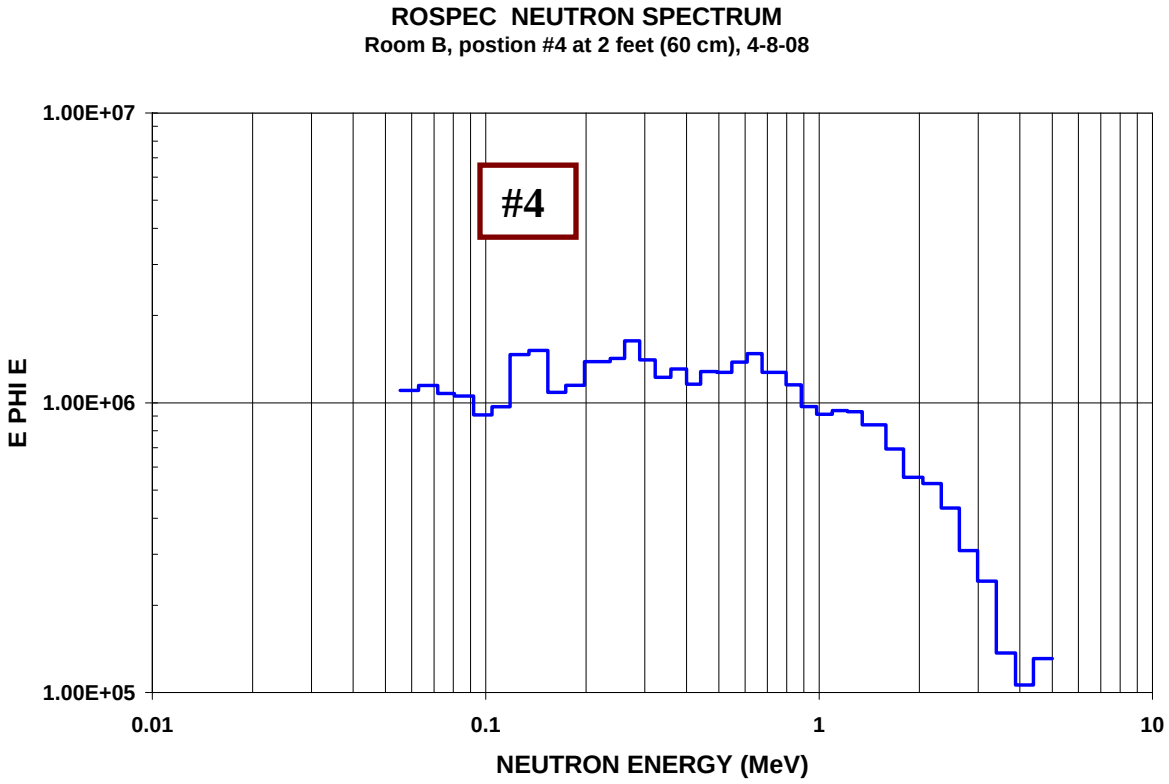
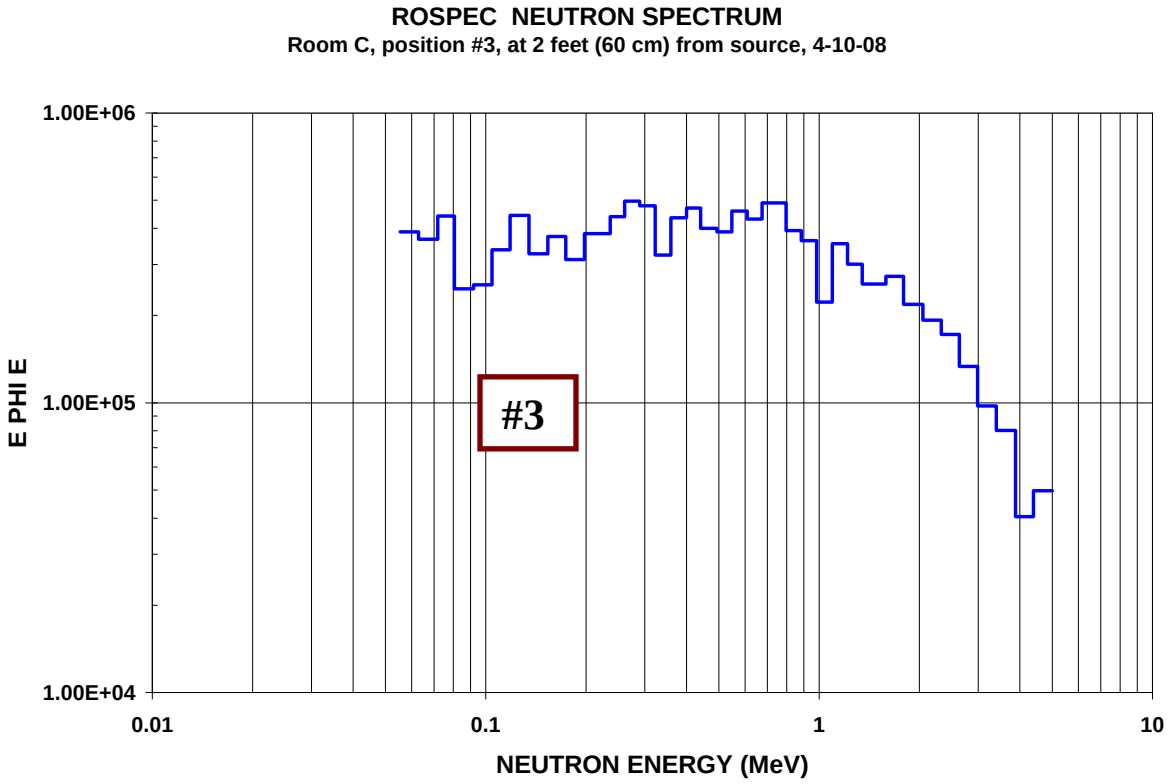


Figure 14. Neutron spectra (50 keV – 4.5 MeV) in room C



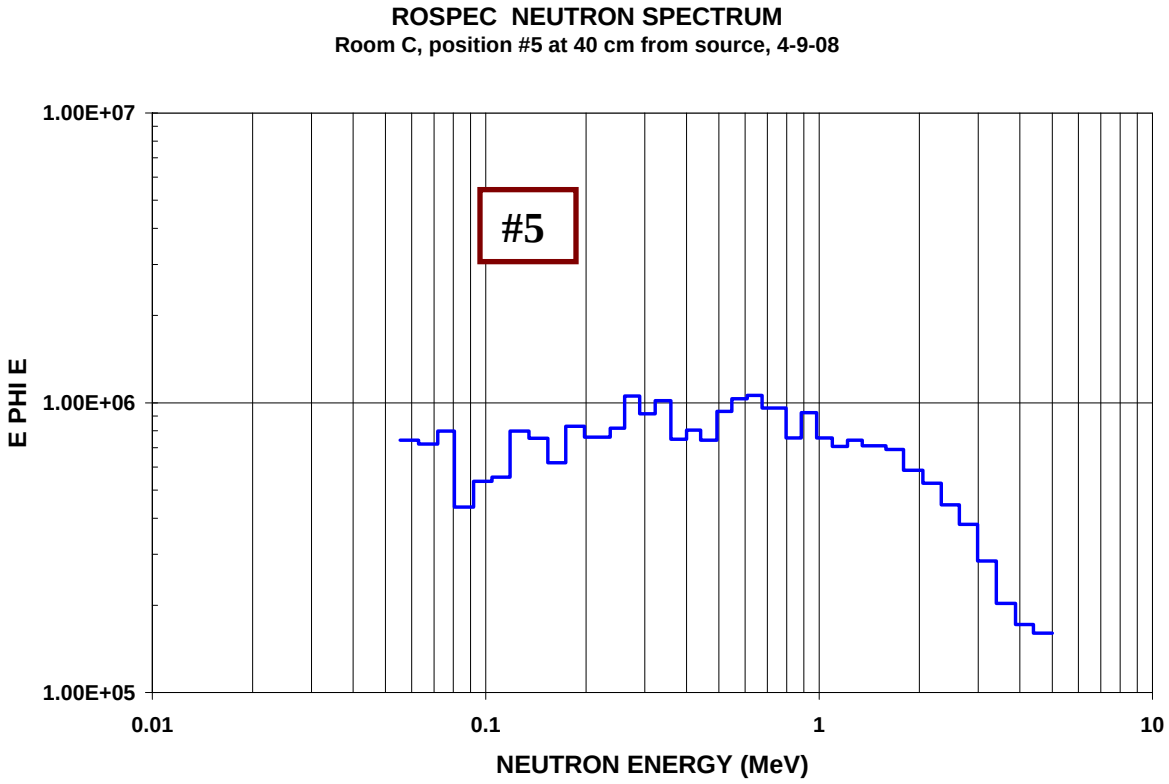
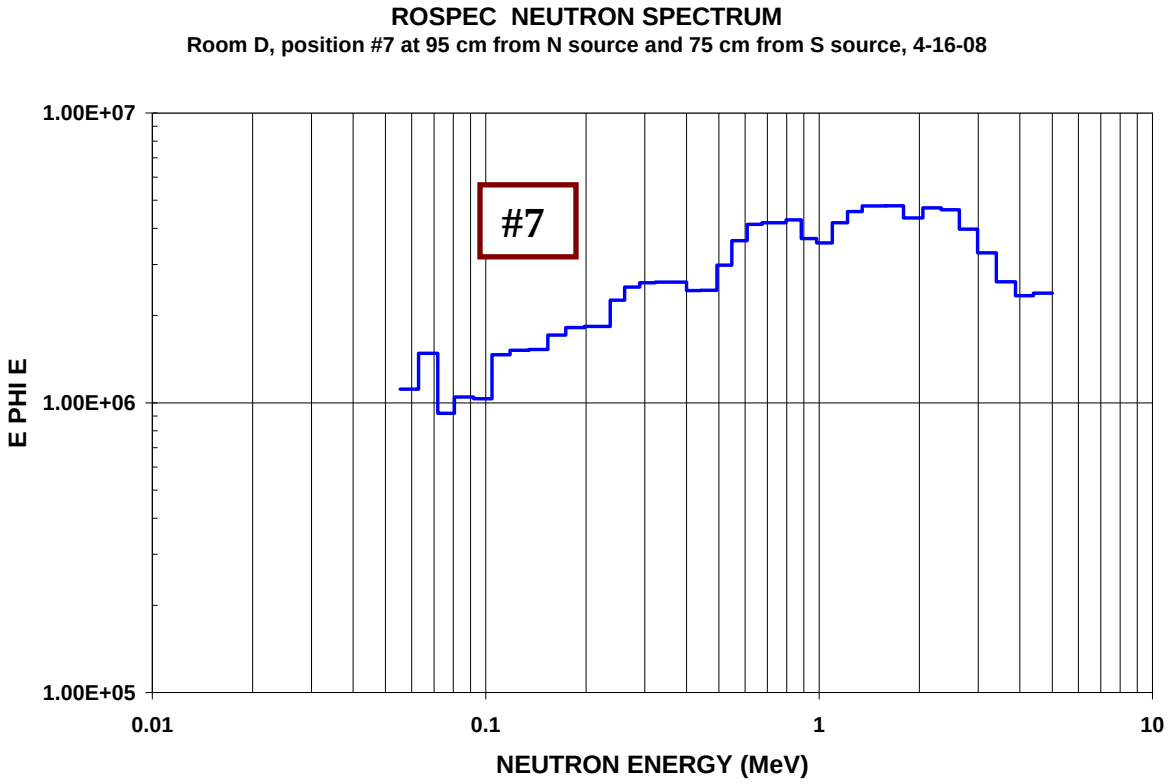


Figure 15. Neutron spectra (50 keV – 4.5 MeV) in room D



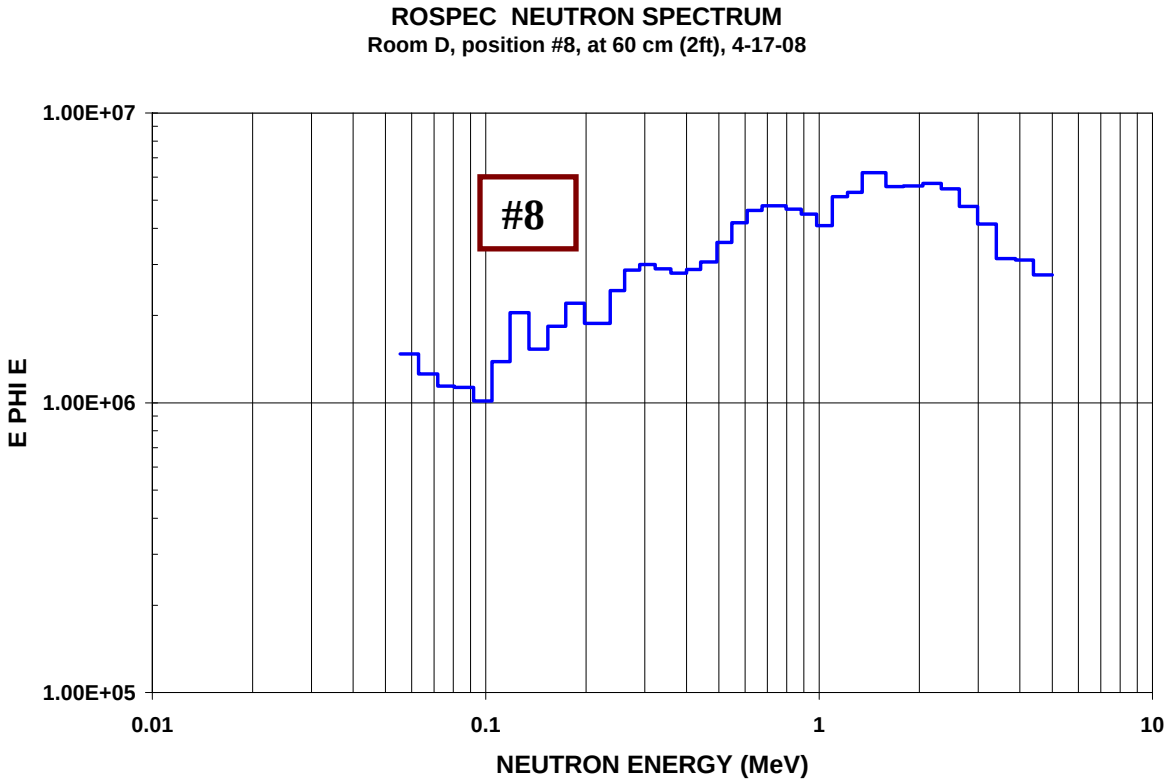


Figure 16. Neutron spectra (50 keV – 4.5 MeV) in room D

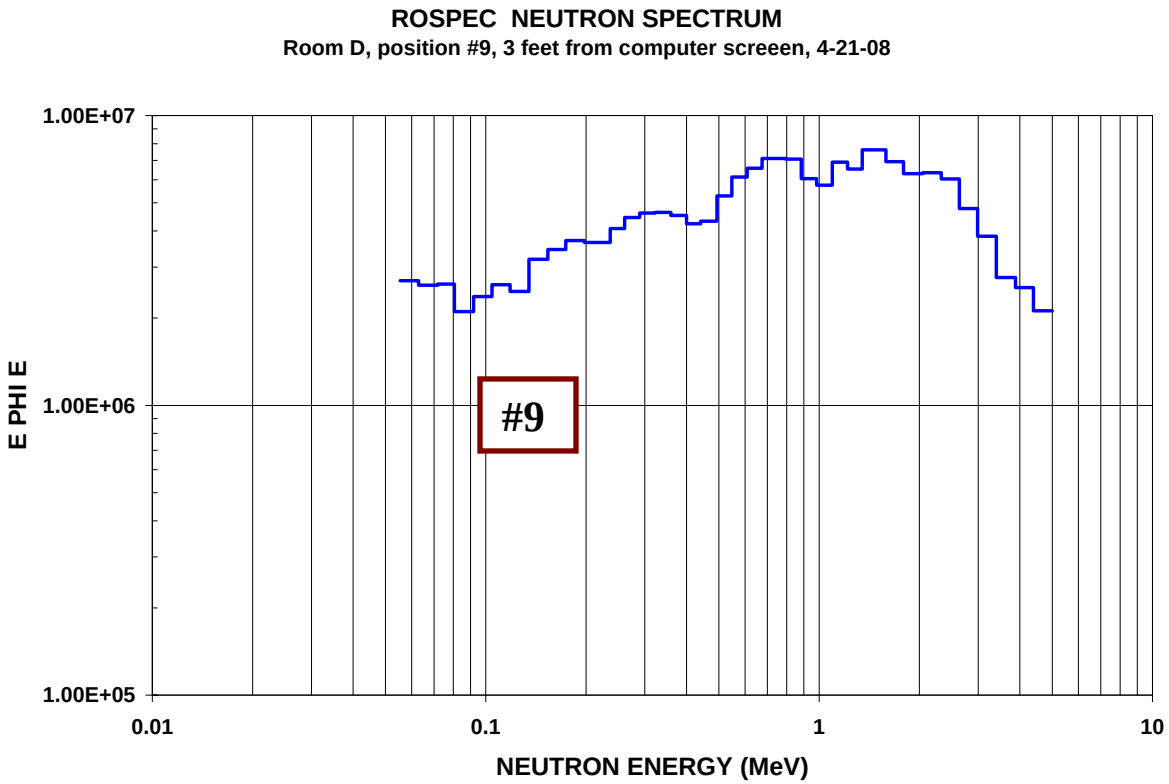
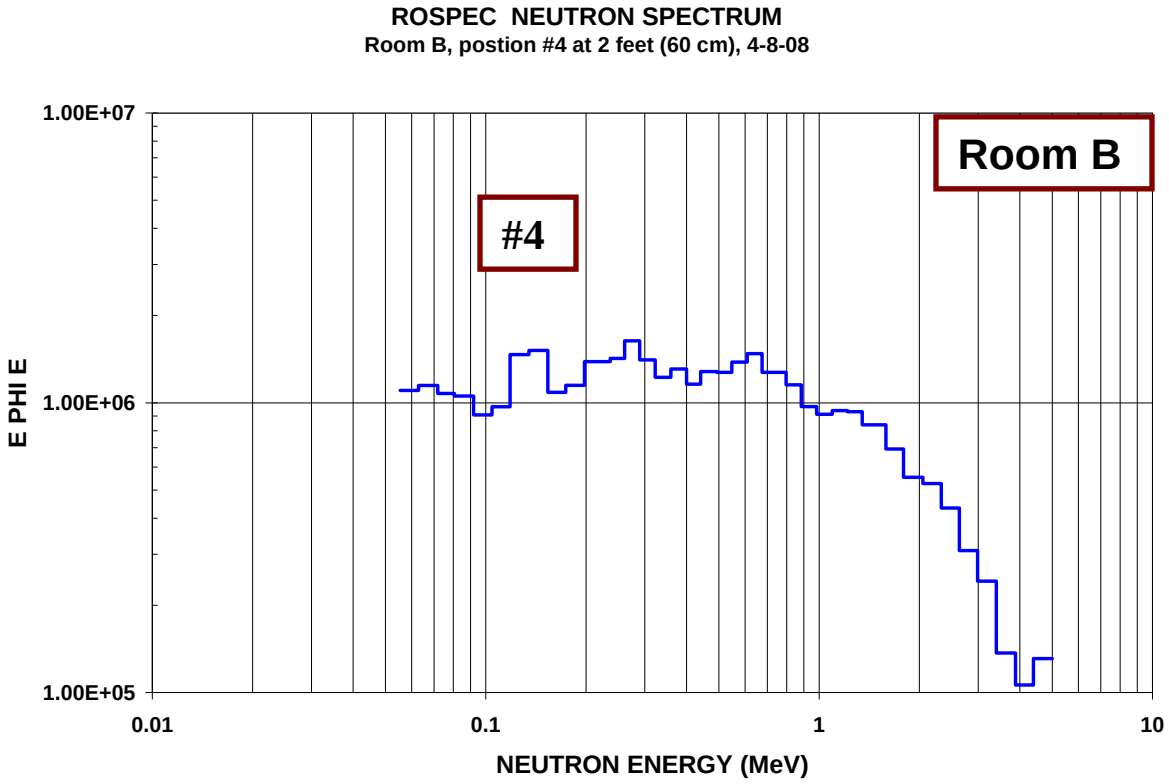


Figure 17. Comparison of neutron spectra (50 keV – 4.5 MeV)



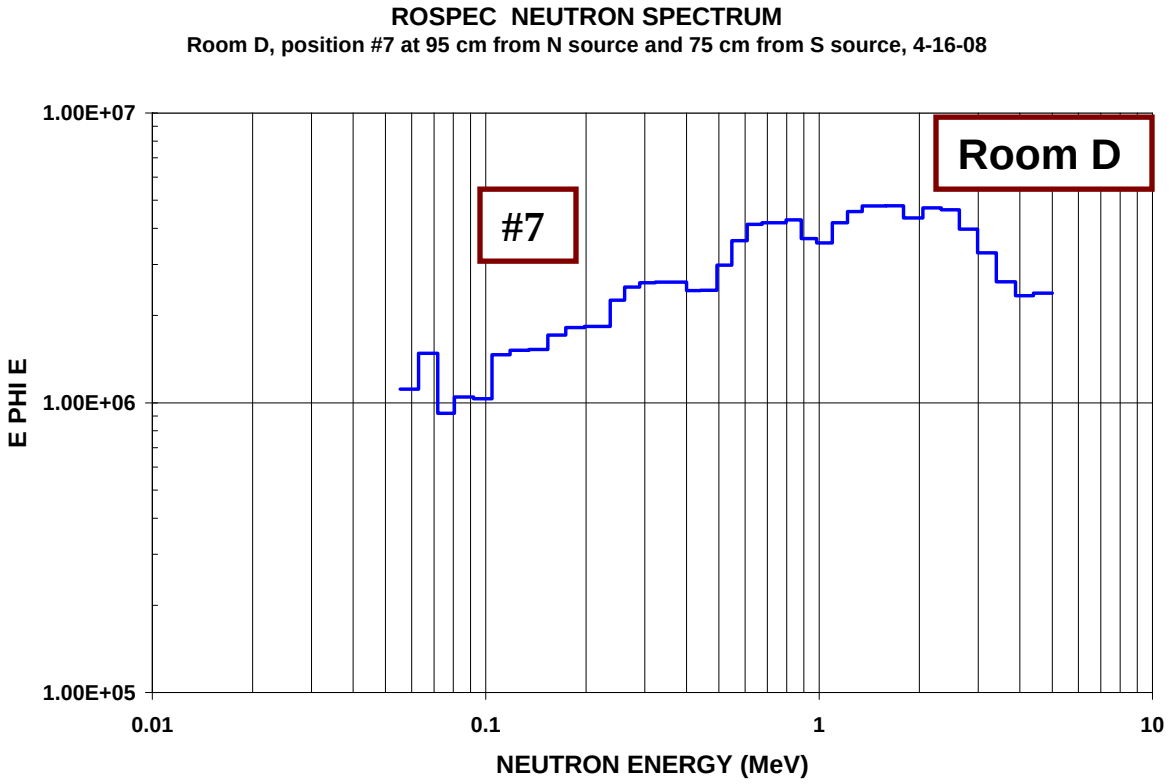


Table 2. Comparison of ROSPEC and NIST calibrated NRD dose rate measurements

Instrument: **Thermo - NRD (s#725627) with E600 meter (s#2442), calibrated by NIST**
Location: **RCL**

10 min exposures

Bare Cf-252		NRD measurements					ROSPEC (mrem/h) 3/10/08	Ratio NRD-NIST/ Rospec
Date	Meters	Exposure (mrem)	Dose rate (mrem/h) 8/22/08	Days since 3/10/08	Dose rate (mrem/h) 3/10/08	Dose rate corrected by NIST*		
8/22/2008	2.0	32.1	192.6	165	216.9	203.9	207.9	**98.1%**
8/21/2008	2.5	22.6	135.6	164	152.6	143.4	145.9	**98.3%**
8/21/2008	3.0	17.3	103.8	164	116.8	109.8	112.5	**97.6%**
8/21/2008	3.5	14.1	84.6	164	95.2	89.5	90.5	**98.9%**
8/21/2008	4.0	11.9	71.4	164	80.3	75.5	76.8	**98.3%**

10 min exposures

Moderated Cf-252		NRD measurements					ROSPEC (mrem/h) 3/10/08	Ratio NRD-NIST/ Rospec
Date	Meters	Exposure (mrem)	Dose rate (mrem/h) - 8/13/08	Days since 3/10/08	Dose rate (mrem/h) 3/10/08	Dose rate corrected by NIST*		
8/13/2008	1.5	16.6	99.6	156	111.4	76.9	84.25	**91.3%**
8/13/2008	2.0	10.4	62.4	156	69.8	48.2	51.99	**92.7%**
8/13/2008	2.5	7.4	44.4	156	49.7	34.3	37.84	**90.6%**
8/13/2008	3.0	5.9	35.4	156	39.6	27.3	29.02	**94.2%**
8/13/2008	3.5	4.8	28.8	156	32.2	22.2	23.97	**92.7%**
8/13/2008	4.0	4.2	25.2	156	28.2	19.5	20.37	**95.5%**

Note*: NIST provided the following calibration coefficients for the above NRD rem meter:
For bare ^{252}Cf - 0.96
For D_2O moderated ^{252}Cf - 0.69
NRD measured dose rates were multiplied by these coefficients

Table 3. Fluence and dosimetric data measured by ROSPEC in room A, location #1

Date: 4/3-7/2008
Measurement time = 318,400 sec.

INTEGRATED FLUENCE = 9.0837E+06 FLUENCE RATE = 2.8529E+01

	INTEGRATED DOSE	DOSE RATE
KERMA	= 1.4502E-02 rads	1.6397E-01 mrads/hr
H NCRP-38	= 1.8170E-01 rem	2.0545E+00 mrem/hr
H*(10) ICRP-74	= 2.1351E-03 Sv	2.4140E+01 uSv/hr
Hp(10,0) ICRP-74	= 2.2126E-03 Sv	2.5017E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	5.95E+06	1.87E+01
Epi-thermal region	2.39E+06	7.51E+00
Thermal region	4.85E+05	1.52E+00
TOTAL	8.82E+06	2.77E+01

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	1.35E-02	1.70E-01	2.02E-03	1.53E-01	1.92E+00	2.28E+01
Epi-thermal region	1.48E-04	3.20E-03	3.04E-05	1.67E-03	3.62E-02	3.44E-01
Thermal region	9.70E-06	4.95E-04	5.14E-06	1.10E-04	5.59E-03	5.81E-02
TOTAL	1.37E-02	1.73E-01	2.05E-03	1.54E-01	1.96E+00	2.32E+01

Table 4. Fluence and dosimetric data measured by ROSPEC in room A, location #6

Date: 4/10-14/2008
Measurement time = 316,600 sec.

INTEGRATED FLUENCE = 2.7965E+07 FLUENCE RATE = 8.8329E+01

	INTEGRATED DOSE	DOSE RATE
KERMA	= 4.4020E-02 rads	5.0054E-01 mrads/hr
H NCRP-38	= 5.2796E-01 rem	6.0034E+00 mrem/hr
H*(10) ICRP-74	= 6.0567E-03 Sv	6.8869E+01 uSv/hr
Hp(10,0) ICRP-74	= 6.2842E-03 Sv	7.1457E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	1.53E+07	4.84E+01
Epi-thermal region	8.01E+06	2.53E+01
Thermal region	2.71E+06	8.56E+00
TOTAL	2.60E+07	8.22E+01

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	3.53E-02	4.41E-01	5.20E-03	4.02E-01	5.01E+00	5.91E+01
Epi-thermal region	4.56E-04	1.06E-02	9.99E-05	5.18E-03	1.20E-01	1.14E+00
Thermal region	5.42E-05	2.76E-03	2.87E-05	6.16E-04	3.14E-02	3.27E-01
TOTAL	3.59E-02	4.54E-01	5.33E-03	4.08E-01	5.16E+00	6.06E+01

Table 5. Fluence and dosimetric data measured by ROSPEC in room B, location #2

Date: 4/7/2008
Measurement time = 23,200 sec.

INTEGRATED FLUENCE = 2.6890E+07 FLUENCE RATE = 1.1591E+03

	INTEGRATED DOSE	DOSE RATE
KERMA	= 1.6073E-02 rads	2.4941E+00 mrads/hr
H NCRP-38	= 2.2400E-01 rem	3.4759E+01 mrem/hr
H*(10) ICRP-74	= 2.7211E-03 Sv	4.2224E+02 uSv/hr
Hp(10,0) ICRP-74	= 2.8152E-03 Sv	4.3685E+02 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	9.57E+06	4.12E+02
Epi-thermal region	1.35E+07	5.83E+02
Thermal region	3.74E+06	1.61E+02
TOTAL	2.68E+07	1.16E+03

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	1.53E-02	2.05E-01	2.54E-03	2.38E+00	3.18E+01	3.94E+02
Epi-thermal region	7.94E-04	1.79E-02	1.70E-04	1.23E-01	2.78E+00	2.64E+01
Thermal region	7.48E-05	3.81E-03	3.96E-05	1.16E-02	5.92E-01	6.15E+00
TOTAL	1.62E-02	2.27E-01	2.75E-03	2.51E+00	3.51E+01	4.27E+02

Table 6. Fluence and dosimetric data measured by ROSPEC in room B, location #4

Date: 4/7-8/2008
Measurement time = 82,400 sec

INTEGRATED FLUENCE = 1.8735E+07 FLUENCE RATE = 2.2736E+02

	INTEGRATED DOSE	DOSE RATE
KERMA	= 7.1931E-03 rads	3.1426E-01 mrads/hr
H NCRP-38	= 1.0472E-01 rem	4.5752E+00 mrem/hr
H*(10) ICRP-74	= 1.2628E-03 Sv	5.5169E+01 uSv/hr
Hp(10,0) ICRP-74	= 1.3100E-03 Sv	5.7232E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	4.40E+06	5.34E+01
Epi-thermal region	1.00E+07	1.22E+02
Thermal region	4.27E+06	5.18E+01
TOTAL	1.87E+07	2.27E+02

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	6.64E-03	8.86E-02	1.11E-03	2.90E-01	3.87E+00	4.85E+01
Epi-thermal region	5.27E-04	1.31E-02	1.23E-04	2.30E-02	5.71E-01	5.38E+00
Thermal region	8.54E-05	4.36E-03	4.53E-05	3.73E-03	1.90E-01	1.98E+00
TOTAL	7.25E-03	1.06E-01	1.28E-03	3.17E-01	4.63E+00	5.59E+01

Table 7. Fluence and dosimetric data measured by ROSPEC in room C, location #3

Date: 4/9-10/2008
Measurement time = 194,700 sec

INTEGRATED FLUENCE = 5.5087E+06 FLUENCE RATE = 6.5894E+01

	INTEGRATED DOSE	DOSE RATE
KERMA	= 2.3995E-03 rads	1.0333E-01 mrads/hr
H NCRP-38	= 3.4328E-02 rem	1.4782E+00 mrem/hr
H*(10) ICRP-74	= 4.1340E-04 Sv	1.7802E+01 uSv/hr
Hp(10,0) ICRP-74	= 4.2854E-04 Sv	1.8454E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	1.42E+06	1.70E+01
Epi-thermal region	2.77E+06	3.31E+01
Thermal region	1.32E+06	1.57E+01
TOTAL	5.50E+06	6.58E+01

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	2.23E-03	2.97E-02	3.69E-04	9.62E-02	1.28E+00	1.59E+01
Epi-thermal region	1.50E-04	3.61E-03	3.42E-05	6.44E-03	1.56E-01	1.47E+00
Thermal region	2.63E-05	1.34E-03	1.39E-05	1.13E-03	5.78E-02	6.01E-01
TOTAL	2.41E-03	3.46E-02	4.17E-04	1.04E-01	1.49E+00	1.80E+01

Table 8. Fluence and dosimetric data measured by ROSPEC in room C, location #5

Date: 4/8-9/2008
Measurement time = 85,500 sec

INTEGRATED FLUENCE = 8.6561E+06 FLUENCE RATE = 1.0124E+02

	INTEGRATED DOSE	DOSE RATE
KERMA	= 5.6019E-03 rads	2.3587E-01 mrads/hr
H NCRP-38	= 7.6282E-02 rem	3.2119E+00 mrem/hr
H*(10) ICRP-74	= 9.1700E-04 Sv	3.8610E+01 uSv/hr
Hp(10,0) ICRP-74	= 9.4962E-04 Sv	3.9984E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	3.08E+06	3.60E+01
Epi-thermal region	4.38E+06	5.13E+01
Thermal region	1.14E+06	1.33E+01
TOTAL	8.60E+06	1.01E+02

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	5.20E-03	6.85E-02	8.44E-04	2.19E-01	2.88E+00	3.55E+01
Epi-thermal region	2.52E-04	5.79E-03	5.48E-05	1.06E-02	2.44E-01	2.31E+00
Thermal region	2.27E-05	1.16E-03	1.20E-05	9.57E-04	4.88E-02	5.07E-01
TOTAL	5.47E-03	7.55E-02	9.11E-04	2.30E-01	3.18E+00	3.84E+01

Table 9. Fluence and dosimetric data measured by ROSPEC in room D, location #7

Date: 4/15-16/2008
Measurement time = 80,700 sec

INTEGRATED FLUENCE = 2.2284E+07 FLUENCE RATE = 2.7614E+02

	INTEGRATED DOSE	DOSE RATE
KERMA	= 3.2601E-02 rads	1.4543E+00 mrads/hr
H NCRP-38	= 4.0341E-01 rem	1.7996E+01 mrem/hr
H*(10) ICRP-74	= 4.7004E-03 Sv	2.0968E+02 uSv/hr
Hp(10,0) ICRP-74	= 4.8722E-03 Sv	2.1735E+02 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	1.28E+07	1.59E+02
Epi-thermal region	6.45E+06	7.99E+01
Thermal region	2.21E+06	2.73E+01
TOTAL	2.15E+07	2.66E+02

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	2.92E-02	3.65E-01	4.32E-03	1.30E+00	1.63E+01	1.93E+02
Epi-thermal region	3.83E-04	8.57E-03	8.14E-05	1.71E-02	3.82E-01	3.63E+00
Thermal region	4.41E-05	2.25E-03	2.34E-05	1.97E-03	1.00E-01	1.04E+00
TOTAL	2.97E-02	3.76E-01	4.43E-03	1.32E+00	1.68E+01	1.98E+02

Table 10. Fluence and dosimetric data measured by ROSPEC in room D, location #8

Date: 4/16-17/2008
Measurement time = 86,400 sec

INTEGRATED FLUENCE = 2.5052E+07 FLUENCE RATE = 2.8996E+02

	INTEGRATED DOSE	DOSE RATE
KERMA	= 3.9608E-02 rads	1.6503E+00 mrads/hr
H NCRP-38	= 4.8564E-01 rem	2.0235E+01 mrem/hr
H*(10) ICRP-74	= 5.6385E-03 Sv	2.3494E+02 uSv/hr
Hp(10,0) ICRP-74	= 5.8454E-03 Sv	2.4356E+02 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	1.51E+07	1.74E+02
Epi-thermal region	6.75E+06	7.81E+01
Thermal region	2.14E+06	2.48E+01
TOTAL	2.40E+07	2.77E+02

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	3.49E-02	4.35E-01	5.14E-03	1.46E+00	1.81E+01	2.14E+02
Epi-thermal region	4.06E-04	8.99E-03	8.54E-05	1.69E-02	3.75E-01	3.56E+00
Thermal region	4.28E-05	2.18E-03	2.27E-05	1.78E-03	9.09E-02	9.45E-01
TOTAL	3.54E-02	4.47E-01	5.25E-03	1.47E+00	1.86E+01	2.19E+02

Table 11. Fluence and dosimetric data measured by ROSPEC in room D, location #9

Date: 4-17-21/2008
Measurement time = 322,500 sec

INTEGRATED FLUENCE = 4.5963E+07 FLUENCE RATE = 1.4252E+02

	INTEGRATED DOSE	DOSE RATE
KERMA	= 4.6253E-02 rads	5.1631E-01 mrads/hr
H NCRP-38	= 6.0041E-01 rem	6.7022E+00 mrem/hr
H*(10) ICRP-74	= 7.0690E-03 Sv	7.8910E+01 uSv/hr
Hp(10,0) ICRP-74	= 7.3232E-03 Sv	8.1747E+01 uSv/hr

	FLUENCE (n cm-2)	FLUENCE RATE (n cm-2 s-1)
50 keV - 4.5 MeV	2.04E+07	6.34E+01
Epi-thermal region	1.68E+07	5.21E+01
Thermal region	7.97E+06	2.47E+01
TOTAL	4.52E+07	1.40E+02

DOSIMETRIC DATA

	KERMA (rads)	NCRP-38 (rem)	H*(10) (Sv)	KERMA (mrads/hr)	NCRP-38 (mrem/hr)	H*(10) (uSv/hr)
50keV - 4.5 MeV	4.27E-02	5.47E-01	6.55E-03	4.76E-01	6.11E+00	7.31E+01
Epi-thermal region	9.40E-04	2.21E-02	2.09E-04	1.05E-02	2.46E-01	2.34E+00
Thermal region	1.59E-04	8.13E-03	8.45E-05	1.78E-03	9.07E-02	9.43E-01
TOTAL	4.38E-02	5.77E-01	6.84E-03	4.88E-01	6.45E+00	7.64E+01

Table 12. Dose rates measured with ROSPEC

Room	Location	Date	Distance from source	ROSPEC - dose rates	
				H - NCRP-38 (mrem/hr)	H*(10) - ICRP-74 Ambient (mrem/hr)
A	1	04/07/08	40 cm	2.05	2.41
A	6	04/14/08	30 cm	6.00	6.89
C	3	04/10/08	60 cm	1.48	1.78
C	5	04/09/08	40 cm	3.21	3.86
B	2	04/07/08	60 cm	34.76	42.22
B	2	04/17/08	60 cm	23.56	28.43
B	4	04/08/08	60 cm	4.57	5.52
D	7	04/16/08	95 cm	18.00	20.97
D	8	04/17/08	60 cm	20.23	23.49
D	9	04/21/08	90 cm	6.70	7.89

Table 13. Dose rates measured with NRD rem meter

Room	Location	Date	Distance from source	RCL NRD dose rate (mrem/hr)
A	1	04/07/08	40 cm	1.69
A	6	04/14/08	30 cm	5.43
C	3	04/10/08	60 cm	1.58
C	5	04/09/08	40 cm	3.50
B	2	04/07/08	60 cm	34.00
B	2	04/15/08	60 cm	24.30
B	4	04/08/08	60 cm	5.75
D	7	04/16/08	95 cm	11.00*
D	8	04/17/08	60 cm	16.85
D	9	04/21/08	90 cm	5.46

* This result may be affected by source to detector geometry factors and is not included in the discussion of the results.

Table 14. Comparison with the current NCRP-38 dose conversion factors

Room	Location	ROSPEC (NCRP-38) mrem/hr	RCL NRD dose rate (mrem/hr)	Ratio ROSPEC /NRD`
A	**1**	2.05	1.69	**1.21**
A	**6**	6.00	5.43	**1.10**
C	**3**	1.48	1.58	**0.94**
C	**5**	3.21	3.50	**0.92**
B	**2**	34.76	34.00	**1.02**
B	**2**	23.56	24.30	**0.97**
B	**4**	4.57	5.75	**0.79**
D	**7**	18.00	11.00*	**1.64***
D	**8**	20.23	16.85	**1.20**
D	**9**	6.70	5.46	**1.23**

ROSPEC / NRD ratio

Rooms:		
B - C	0.79 – 1.02	(#2 NRD measurement may be lower)
A - D	1.1 - 1.23	(except #7, measurement may be not at exact position)

* This result may be affected by source to detector geometry factors and is not included in the discussion of the results.

Table 15. Dosimetric measurements at selected LLNL locations

Room	Location	Date	Distance from source	RCL NRD dose rate (mrem/hr)	ROSPEC - dose rates		Difference ICRP-74/ NCRP-38 (Rospec)
					H - NCRP-38 (mrem/hr)	H*(10) - ICRP-74 Ambient (mrem/hr)	
A	**1**	4/7/2008	40 cm	1.69	2.05	2.41	17.8%
A	**6**	4/14/2008	30 cm	5.43	6.00	6.89	14.8%
C	**3**	4/10/2008	60 cm	1.58	1.48	1.78	20.4%
C	**5**	4/9/2008	40 cm	3.50	3.21	3.86	20.3%
B	**2**	4/7/2008	60 cm	34.00	34.76	42.22	21.5%
B	**2**	4/17/2008	60 cm	24.30	23.56	28.43	20.7%
B	**4**	4/8/2008	60 cm	5.75	4.57	5.52	20.7%
D	**7**	4/16/2008	95 cm	11.00	18.00	20.97	16.5%
D	**8**	4/17/2008	60 cm	16.85	20.23	23.49	16.1%
D	**9**	4/21/2008	90 cm	5.46	6.70	7.89	17.8%

Increase of dose rates determined by ICRP-74 to dose rates determined by NCRP-38

Rooms	Dose rate increase
B - C	**- (20.5 - 21.5)%**
A - D	**- (14.8 - 17.8)%**

Table of neutron fluence-to-dose conversion factors

Table A below contains the fluence-to-dose conversion factors used in the software program to calculate the dosimetric values from the neutron spectra obtained by ROSPEC. The dosimetric quantities used are defined below.

KERMA – is the quotient of dE by dm, where dE is the sum of the initial kinetic energies of all the charged ionizing particles liberated by the neutrons in a volume element of mass dm.

H (NCRP-38) – is the neutron dose as defined in the "old" 10CFR835 using quality factors and fluence-to-dose conversion factors derived from NCRP-38.

H*(10) – is the ambient dose equivalent as defined in ICRP-74 at a point in a radiation field is the dose equivalent that would be produced by the corresponding expanded and aligned neutron field in the ICRU sphere at a depth of 10 mm on the radius opposing the direction of the aligned field.

Hp(10,0) – is the personal dose equivalent as defined in ICRP-74 in soft tissue at 10 mm below a specified point on the body at 0 degree between the incident unidirectional neutron field and the direction normal to the surface (in atero-posterior geometry).

Note: anthropomorphic phantoms of various parts of the body are not yet specified by ICRU with the exception of the human trunk. For the purposes of dosimeter calibration, phantoms have been specified that are taken as surrogates of the human torso. These specified tissue-equivalent phantoms are the ICRU-equivalent sphere (30 cm diameter) and the 30cm x 30cm x 15cm ICRU slab (ICRU Report 47).

APPENDIX A

Table A - The neutron energy is in MeV and the conversion factors are in nanorad per neutron per square centimeter for kerma, nanorems per neutron per square centimeter for H and pico Sieverts per neutron per square centimeter for H*(10) and Hp(10,0).

Energy	Neutron Fluence-to-Dose Conversion Factors			
En	**KERMA**	**H NCRP-38**	**H*(10) ICRP-74**	**Hp(10,0) ICRP-74**
(MeV)	(nrad/n/cm^2)	(nrem/n/cm^2)	(pSv/n/cm^2)	(pSv/n/cm^2)
2.50E-08	0.02	1.02	10.6	11.4
1.00E-07	0.01	1.02	12.9	12.6
1.00E-06	0.003	1.24	13.3	14.4
1.00E-05	0.001	1.24	11.3	13.2
1.00E-04	0.001	1.20	9.4	10.3
0.001	0.011	1.02	7.9	8.78
0.002	0.02	1.01	7.7	8.72
0.005	0.05	1.00	8.0	9.36
0.01	0.10	0.99	10.5	11.2
0.02	0.18	1.70	16.6	17.1
0.03	0.29	2.30	23.7	24.9
0.05	0.41	3.30	41.1	39.0
0.07	0.51	4.30	60.0	59.0
0.10	0.64	6.04	88.0	90.6
0.15	0.82	8.80	132.0	139.0
0.20	0.97	11.50	170.0	180.0
0.25	1.10	14.00	210.0	213.0
0.30	1.22	16.50	233.0	246.0
0.35	1.33	19.00	270.0	268.3
0.40	1.49	21.50	280.0	290.5
0.45	1.65	23.50	310.0	312.8
0.50	1.61	25.72	322.0	335.0
0.55	1.68	27.00	340.0	347.8
0.60	1.76	28.50	350.0	360.5
0.65	1.83	30.50	365.0	373.3
0.70	1.90	32.00	375.0	386.0
0.75	1.97	33.00	385.0	393.0
0.80	2.03	34.00	390.0	400.0
0.85	2.09	35.50	395.0	407.0
0.90	2.16	35.50	400.0	414.0
0.95	2.33	36.00	400.0	418.0
1.00	2.51	36.50	416.0	422.0
1.20	2.46	37.00	425.0	433.0
1.40	2.64	37.00	425.0	435.3
1.60	2.80	36.50	420.0	437.5
1.80	2.95	36.20	420.0	439.8

En	KERMA	H NCRP-38	H*(10) ICRP-74	Hp(10,0) ICRP-74
2.00	3.09	36.00	420.0	442.0
2.20	3.22	35.00	418.0	439.8
2.40	3.34	35.00	416.0	437.6
2.60	3.45	35.00	415.0	435.4
2.80	3.56	35.50	412.0	433.2
3.00	3.69	35.80	412.0	431.0
3.20	3.86	36.00	410.0	429.2
3.40	4.07	36.50	410.0	427.4
3.60	4.23	37.00	410.0	425.6
3.80	4.24	38.00	408.0	423.8
4.00	4.20	39.00	408.0	422.0
4.20	4.20	40.00	408.0	421.6
4.40	4.25	41.00	408.0	421.2
4.60	4.31	42.00	408.0	420.8
4.80	4.38	43.00	405.0	420.4
5.00	4.45	43.48	405.0	420.0
5.50	4.60	42.50	402.0	421.5
6.00	4.75	42.00	400.0	423.0
6.50	4.89	41.00	402.0	427.5
7.00	5.01	40.90	405.0	432.0
8.00	5.25	40.85	409.0	445.0
9.00	5.46	40.85	420.0	461.0
10.00	5.65	40.85	440.0	480.0
11.00	5.82	45.00	460.0	498.5
12.00	5.99	49.00	480.0	517.0
13.00	6.14	52.00	500.0	533.5
14.00	6.29	57.87	520.0	550.0
15.00	6.36	59.00	540.0	564.0
16.00	6.41	60.00	540.0	576.0
17.00	6.47	61.00	562.0	585.5
18.00	6.52	62.00	570.0	595.0
19.00	6.57	62.50	585.0	597.5
20.00	6.62	63.13	600.0	600.0

Tables of neutron fluence distribution (neutron spectra)

The tables below provide detailed data for the measured neutron spectra by ROSPEC. The first columns provide the lower (E1) and upper (E2) energy bin boundaries. The third columns provide the neutron fluence (number of neutrons per cm^2) for the corresponding energy bin. The fourth columns provide the neutron fluence (number of neutrons per cm^2) per MeV, i.e. the fluence is divided by the width of the corresponding energy bin in MeV units. The fifth columns provide the fluence per lethargy, i.e. the fluence divided by ln(E2/E1). The values from these columns are used in the neutron energy plots presented here. The last columns list the average energy per the corresponding bin, i.e. (E2-E1)/2.

Table B-1. Neutron fluence measured by ROSPEC in room A, location # 1

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	1.096E+03	1.096E+12	1.581E+03	1.500E-09
2.000E-09	5.000E-09	7.031E+03	2.344E+12	7.673E+03	3.500E-09
5.000E-09	1.000E-08	2.138E+04	4.277E+12	3.085E+04	7.500E-09
1.000E-08	2.000E-08	6.303E+04	6.303E+12	9.094E+04	1.500E-08
2.000E-08	5.000E-08	1.954E+05	6.513E+12	2.133E+05	3.500E-08
5.000E-08	1.000E-07	1.527E+05	3.055E+12	2.203E+05	7.500E-08
1.000E-07	2.000E-07	4.296E+04	4.296E+11	6.198E+04	1.500E-07
2.000E-07	5.000E-07	9.747E+04	3.249E+11	1.064E+05	3.500E-07
5.000E-07	1.000E-02	1.808E+06	1.808E+08	1.826E+05	5.000E-03
1.000E-02	5.531E-02	4.856E+05	1.072E+07	2.839E+05	3.266E-02
5.531E-02	6.287E-02	5.434E+04	7.188E+06	4.242E+05	5.909E-02
6.287E-02	7.169E-02	7.166E+04	8.125E+06	5.459E+05	6.728E-02
7.169E-02	8.051E-02	5.042E+04	5.716E+06	4.346E+05	7.610E-02
8.051E-02	9.185E-02	5.857E+04	5.165E+06	4.445E+05	8.618E-02
9.185E-02	1.045E-01	5.716E+04	4.536E+06	4.446E+05	9.815E-02
1.045E-01	1.183E-01	9.861E+04	7.115E+06	7.915E+05	1.114E-01
1.183E-01	1.347E-01	8.473E+04	5.173E+06	6.535E+05	1.265E-01
1.347E-01	1.536E-01	6.402E+04	3.387E+06	4.875E+05	1.441E-01
1.536E-01	1.738E-01	8.771E+04	4.350E+06	7.112E+05	1.637E-01
1.738E-01	1.977E-01	9.969E+04	4.164E+06	7.723E+05	1.857E-01
1.977E-01	2.364E-01	1.977E+05	5.107E+06	1.106E+06	2.170E-01
2.364E-01	2.609E-01	1.026E+05	4.181E+06	1.039E+06	2.487E-01
2.609E-01	2.896E-01	1.253E+05	4.377E+06	1.204E+06	2.753E-01
2.896E-01	3.223E-01	1.391E+05	4.251E+06	1.299E+06	3.059E-01
3.223E-01	3.591E-01	1.429E+05	3.881E+06	1.321E+06	3.407E-01
3.591E-01	4.000E-01	8.900E+04	2.176E+06	8.251E+05	3.796E-01
4.000E-01	4.409E-01	1.163E+05	2.844E+06	1.195E+06	4.205E-01
4.409E-01	4.941E-01	1.603E+05	3.015E+06	1.408E+06	4.675E-01
4.941E-01	5.472E-01	1.445E+05	2.717E+06	1.413E+06	5.207E-01
5.472E-01	6.086E-01	1.796E+05	2.928E+06	1.691E+06	5.779E-01
6.086E-01	6.740E-01	1.888E+05	2.885E+06	1.848E+06	6.413E-01
6.740E-01	7.954E-01	2.761E+05	2.275E+06	1.667E+06	7.347E-01
7.954E-01	8.845E-01	2.202E+05	2.471E+06	2.074E+06	8.400E-01
8.845E-01	9.817E-01	1.760E+05	1.810E+06	1.688E+06	9.331E-01
9.817E-01	1.095E+00	1.824E+05	1.609E+06	1.669E+06	1.038E+00
1.095E+00	1.217E+00	1.983E+05	1.632E+06	1.884E+06	1.156E+00
1.217E+00	1.346E+00	2.153E+05	1.661E+06	2.127E+06	1.281E+00
1.346E+00	1.586E+00	4.114E+05	1.715E+06	2.509E+06	1.466E+00

1.586E+00	1.790E+00	2.733E+05	1.340E+06	2.259E+06	1.688E+00
1.790E+00	2.045E+00	3.122E+05	1.224E+06	2.344E+06	1.918E+00
2.045E+00	2.326E+00	3.108E+05	1.108E+06	2.418E+06	2.185E+00
2.326E+00	2.632E+00	2.869E+05	9.375E+05	2.321E+06	2.479E+00
2.632E+00	2.989E+00	2.614E+05	7.322E+05	2.055E+06	2.810E+00
2.989E+00	3.397E+00	1.921E+05	4.709E+05	1.501E+06	3.193E+00
3.397E+00	3.881E+00	1.293E+05	2.668E+05	9.695E+05	3.639E+00
3.881E+00	4.391E+00	1.026E+05	2.012E+05	8.310E+05	4.136E+00
4.391E+00	5.000E+00	1.010E+05	1.659E+05	7.777E+05	4.696E+00
5.000E+00	5.500E+00	6.841E+04	1.368E+05	7.177E+05	5.250E+00
5.500E+00	6.000E+00	5.066E+04	1.013E+05	5.823E+05	5.750E+00
6.000E+00	6.500E+00	3.735E+04	7.471E+04	4.667E+05	6.250E+00
6.500E+00	7.000E+00	2.742E+04	5.483E+04	3.699E+05	6.750E+00
7.000E+00	7.500E+00	2.006E+04	4.013E+04	2.908E+05	7.250E+00
7.500E+00	8.000E+00	1.463E+04	2.926E+04	2.267E+05	7.750E+00
8.000E+00	8.500E+00	1.064E+04	2.128E+04	1.755E+05	8.250E+00
8.500E+00	9.000E+00	7.725E+03	1.545E+04	1.351E+05	8.750E+00
9.000E+00	9.500E+00	5.599E+03	1.120E+04	1.036E+05	9.250E+00
9.500E+00	1.000E+01	4.059E+03	8.118E+03	7.913E+04	9.750E+00

Table B-2. Neutron fluence measured by ROSPEC in room A, location # 6

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	6.125E+03	6.125E+12	8.836E+03	1.500E-09
2.000E-09	5.000E-09	3.930E+04	1.310E+13	4.289E+04	3.500E-09
5.000E-09	1.000E-08	1.195E+05	2.390E+13	1.724E+05	7.500E-09
1.000E-08	2.000E-08	3.523E+05	3.523E+13	5.083E+05	1.500E-08
2.000E-08	5.000E-08	1.092E+06	3.641E+13	1.192E+06	3.500E-08
5.000E-08	1.000E-07	8.537E+05	1.707E+13	1.232E+06	7.500E-08
1.000E-07	2.000E-07	2.401E+05	2.401E+12	3.464E+05	1.500E-07
2.000E-07	5.000E-07	4.242E+05	1.414E+12	4.629E+05	3.500E-07
5.000E-07	1.000E-02	6.126E+06	6.126E+08	6.186E+05	5.000E-03
1.000E-02	5.531E-02	1.457E+06	3.216E+07	8.519E+05	3.266E-02
5.531E-02	6.287E-02	1.543E+05	2.041E+07	1.204E+06	5.909E-02
6.287E-02	7.169E-02	1.717E+05	1.946E+07	1.308E+06	6.728E-02
7.169E-02	8.051E-02	1.688E+05	1.914E+07	1.455E+06	7.610E-02
8.051E-02	9.185E-02	1.573E+05	1.387E+07	1.194E+06	8.618E-02
9.185E-02	1.045E-01	1.463E+05	1.161E+07	1.138E+06	9.815E-02
1.045E-01	1.183E-01	1.421E+05	1.025E+07	1.140E+06	1.114E-01
1.183E-01	1.347E-01	2.317E+05	1.415E+07	1.787E+06	1.265E-01
1.347E-01	1.536E-01	2.299E+05	1.216E+07	1.751E+06	1.441E-01
1.536E-01	1.738E-01	2.607E+05	1.293E+07	2.114E+06	1.637E-01
1.738E-01	1.977E-01	2.837E+05	1.185E+07	2.198E+06	1.857E-01
1.977E-01	2.364E-01	4.247E+05	1.097E+07	2.375E+06	2.170E-01
2.364E-01	2.609E-01	2.445E+05	9.962E+06	2.475E+06	2.487E-01
2.609E-01	2.896E-01	3.098E+05	1.082E+07	2.975E+06	2.753E-01
2.896E-01	3.223E-01	3.273E+05	1.000E+07	3.057E+06	3.059E-01
3.223E-01	3.591E-01	3.111E+05	8.451E+06	2.876E+06	3.407E-01
3.591E-01	4.000E-01	3.275E+05	8.007E+06	3.036E+06	3.796E-01
4.000E-01	4.409E-01	3.031E+05	7.411E+06	3.113E+06	4.205E-01
4.409E-01	4.941E-01	3.733E+05	7.022E+06	3.279E+06	4.675E-01
4.941E-01	5.472E-01	3.889E+05	7.314E+06	3.805E+06	5.207E-01
5.472E-01	6.086E-01	4.401E+05	7.174E+06	4.142E+06	5.779E-01
6.086E-01	6.740E-01	4.554E+05	6.959E+06	4.459E+06	6.413E-01
6.740E-01	7.954E-01	7.728E+05	6.366E+06	4.667E+06	7.347E-01
7.954E-01	8.845E-01	5.103E+05	5.727E+06	4.806E+06	8.400E-01
8.845E-01	9.817E-01	4.413E+05	4.540E+06	4.233E+06	9.331E-01
9.817E-01	1.095E+00	4.827E+05	4.256E+06	4.415E+06	1.038E+00
1.095E+00	1.217E+00	5.737E+05	4.722E+06	5.452E+06	1.156E+00
1.217E+00	1.346E+00	5.495E+05	4.240E+06	5.429E+06	1.281E+00
1.346E+00	1.586E+00	1.011E+06	4.217E+06	6.168E+06	1.466E+00
1.586E+00	1.790E+00	7.025E+05	3.443E+06	5.806E+06	1.688E+00
1.790E+00	2.045E+00	7.226E+05	2.834E+06	5.426E+06	1.918E+00

2.045E+00	2.326E+00	7.035E+05	2.508E+06	5.474E+06	2.185E+00
2.326E+00	2.632E+00	6.633E+05	2.168E+06	5.366E+06	2.479E+00
2.632E+00	2.989E+00	5.635E+05	1.578E+06	4.429E+06	2.810E+00
2.989E+00	3.397E+00	4.632E+05	1.135E+06	3.619E+06	3.193E+00
3.397E+00	3.881E+00	4.422E+05	9.127E+05	3.316E+06	3.639E+00
3.881E+00	4.391E+00	4.119E+05	8.076E+05	3.336E+06	4.136E+00
4.391E+00	5.000E+00	6.362E+05	1.045E+06	4.900E+06	4.696E+00
5.000E+00	5.500E+00	4.861E+05	9.721E+05	5.100E+06	5.250E+00
5.500E+00	6.000E+00	3.600E+05	7.200E+05	4.137E+06	5.750E+00
6.000E+00	6.500E+00	2.654E+05	5.308E+05	3.316E+06	6.250E+00
6.500E+00	7.000E+00	1.948E+05	3.896E+05	2.629E+06	6.750E+00
7.000E+00	7.500E+00	1.426E+05	2.851E+05	2.066E+06	7.250E+00
7.500E+00	8.000E+00	1.039E+05	2.079E+05	1.610E+06	7.750E+00
8.000E+00	8.500E+00	7.561E+04	1.512E+05	1.247E+06	8.250E+00
8.500E+00	9.000E+00	5.489E+04	1.098E+05	9.603E+05	8.750E+00
9.000E+00	9.500E+00	3.978E+04	7.957E+04	7.358E+05	9.250E+00
9.500E+00	1.000E+01	2.884E+04	5.768E+04	5.623E+05	9.750E+00

Table B-3. Neutron fluence measured by ROSPEC in room B, location # 2

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	8.453E+03	8.453E+12	1.219E+04	1.500E-09
2.000E-09	5.000E-09	5.423E+04	1.808E+13	5.919E+04	3.500E-09
5.000E-09	1.000E-08	1.649E+05	3.299E+13	2.380E+05	7.500E-09
1.000E-08	2.000E-08	4.862E+05	4.862E+13	7.015E+05	1.500E-08
2.000E-08	5.000E-08	1.507E+06	5.024E+13	1.645E+06	3.500E-08
5.000E-08	1.000E-07	1.178E+06	2.356E+13	1.700E+06	7.500E-08
1.000E-07	2.000E-07	3.314E+05	3.314E+12	4.781E+05	1.500E-07
2.000E-07	5.000E-07	6.462E+05	2.154E+12	7.053E+05	3.500E-07
5.000E-07	1.000E-02	1.030E+07	1.030E+09	1.040E+06	5.000E-03
1.000E-02	5.531E-02	2.566E+06	5.662E+07	1.500E+06	3.266E-02
5.531E-02	6.287E-02	2.525E+05	3.339E+07	1.971E+06	5.909E-02
6.287E-02	7.169E-02	2.921E+05	3.312E+07	2.225E+06	6.728E-02
7.169E-02	8.051E-02	2.820E+05	3.197E+07	2.430E+06	7.610E-02
8.051E-02	9.185E-02	2.218E+05	1.956E+07	1.683E+06	8.618E-02
9.185E-02	1.045E-01	2.404E+05	1.908E+07	1.870E+06	9.815E-02
1.045E-01	1.183E-01	2.790E+05	2.013E+07	2.239E+06	1.114E-01
1.183E-01	1.347E-01	3.469E+05	2.118E+07	2.675E+06	1.265E-01
1.347E-01	1.536E-01	3.379E+05	1.788E+07	2.574E+06	1.441E-01
1.536E-01	1.738E-01	2.843E+05	1.410E+07	2.305E+06	1.637E-01
1.738E-01	1.977E-01	3.020E+05	1.261E+07	2.340E+06	1.857E-01
1.977E-01	2.364E-01	4.834E+05	1.249E+07	2.703E+06	2.170E-01
2.364E-01	2.609E-01	2.849E+05	1.161E+07	2.884E+06	2.487E-01
2.609E-01	2.896E-01	3.580E+05	1.251E+07	3.439E+06	2.753E-01
2.896E-01	3.223E-01	3.351E+05	1.024E+07	3.130E+06	3.059E-01
3.223E-01	3.591E-01	3.073E+05	8.347E+06	2.841E+06	3.407E-01
3.591E-01	4.000E-01	2.866E+05	7.008E+06	2.657E+06	3.796E-01
4.000E-01	4.409E-01	2.399E+05	5.866E+06	2.465E+06	4.205E-01
4.409E-01	4.941E-01	3.010E+05	5.662E+06	2.644E+06	4.675E-01
4.941E-01	5.472E-01	3.015E+05	5.670E+06	2.950E+06	5.207E-01
5.472E-01	6.086E-01	3.543E+05	5.776E+06	3.335E+06	5.779E-01
6.086E-01	6.740E-01	3.187E+05	4.870E+06	3.121E+06	6.413E-01
6.740E-01	7.954E-01	5.410E+05	4.456E+06	3.267E+06	7.347E-01
7.954E-01	8.845E-01	3.013E+05	3.382E+06	2.838E+06	8.400E-01
8.845E-01	9.817E-01	2.641E+05	2.717E+06	2.533E+06	9.331E-01
9.817E-01	1.095E+00	2.122E+05	1.871E+06	1.941E+06	1.038E+00
1.095E+00	1.217E+00	2.457E+05	2.022E+06	2.335E+06	1.156E+00
1.217E+00	1.346E+00	2.282E+05	1.761E+06	2.254E+06	1.281E+00
1.346E+00	1.586E+00	3.299E+05	1.375E+06	2.012E+06	1.466E+00
1.586E+00	1.790E+00	2.069E+05	1.014E+06	1.710E+06	1.688E+00
1.790E+00	2.045E+00	1.914E+05	7.507E+05	1.437E+06	1.918E+00

2.045E+00	2.326E+00	1.639E+05	5.843E+05	1.275E+06	2.185E+00
2.326E+00	2.632E+00	1.232E+05	4.027E+05	9.968E+05	2.479E+00
2.632E+00	2.989E+00	9.829E+04	2.753E+05	7.726E+05	2.810E+00
2.989E+00	3.397E+00	9.042E+04	2.216E+05	7.065E+05	3.193E+00
3.397E+00	3.881E+00	6.310E+04	1.302E+05	4.732E+05	3.639E+00
3.881E+00	4.391E+00	4.643E+04	9.104E+04	3.761E+05	4.136E+00
4.391E+00	5.000E+00	4.525E+04	7.431E+04	3.485E+05	4.696E+00
5.000E+00	5.500E+00	2.317E+04	4.633E+04	2.431E+05	5.250E+00
5.500E+00	6.000E+00	1.716E+04	3.432E+04	1.972E+05	5.750E+00
6.000E+00	6.500E+00	1.265E+04	2.530E+04	1.580E+05	6.250E+00
6.500E+00	7.000E+00	9.285E+03	1.857E+04	1.253E+05	6.750E+00
7.000E+00	7.500E+00	6.795E+03	1.359E+04	9.849E+04	7.250E+00
7.500E+00	8.000E+00	4.954E+03	9.908E+03	7.676E+04	7.750E+00
8.000E+00	8.500E+00	3.604E+03	7.208E+03	5.944E+04	8.250E+00
8.500E+00	9.000E+00	2.616E+03	5.232E+03	4.577E+04	8.750E+00
9.000E+00	9.500E+00	1.896E+03	3.792E+03	3.507E+04	9.250E+00
9.500E+00	1.000E+01	1.375E+03	2.749E+03	2.680E+04	9.750E+00

Table B-4. Neutron fluence measured by ROSPEC in room B, location # 4

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	9.653E+03	9.653E+12	1.393E+04	1.500E-09
2.000E-09	5.000E-09	6.193E+04	2.064E+13	6.759E+04	3.500E-09
5.000E-09	1.000E-08	1.884E+05	3.767E+13	2.717E+05	7.500E-09
1.000E-08	2.000E-08	5.552E+05	5.552E+13	8.010E+05	1.500E-08
2.000E-08	5.000E-08	1.721E+06	5.737E+13	1.878E+06	3.500E-08
5.000E-08	1.000E-07	1.345E+06	2.691E+13	1.941E+06	7.500E-08
1.000E-07	2.000E-07	3.784E+05	3.784E+12	5.459E+05	1.500E-07
2.000E-07	5.000E-07	6.010E+05	2.003E+12	6.559E+05	3.500E-07
5.000E-07	1.000E-02	7.805E+06	7.806E+08	7.881E+05	5.000E-03
1.000E-02	5.531E-02	1.640E+06	3.620E+07	9.590E+05	3.266E-02
5.531E-02	6.287E-02	1.412E+05	1.868E+07	1.102E+06	5.909E-02
6.287E-02	7.169E-02	1.506E+05	1.707E+07	1.147E+06	6.728E-02
7.169E-02	8.051E-02	1.249E+05	1.416E+07	1.076E+06	7.610E-02
8.051E-02	9.185E-02	1.390E+05	1.226E+07	1.055E+06	8.618E-02
9.185E-02	1.045E-01	1.167E+05	9.263E+06	9.080E+05	9.815E-02
1.045E-01	1.183E-01	1.208E+05	8.716E+06	9.696E+05	1.114E-01
1.183E-01	1.347E-01	1.901E+05	1.161E+07	1.466E+06	1.265E-01
1.347E-01	1.536E-01	1.991E+05	1.053E+07	1.516E+06	1.441E-01
1.536E-01	1.738E-01	1.340E+05	6.649E+06	1.087E+06	1.637E-01
1.738E-01	1.977E-01	1.483E+05	6.193E+06	1.149E+06	1.857E-01
1.977E-01	2.364E-01	2.480E+05	6.407E+06	1.387E+06	2.170E-01
2.364E-01	2.609E-01	1.406E+05	5.728E+06	1.423E+06	2.487E-01
2.609E-01	2.896E-01	1.704E+05	5.950E+06	1.636E+06	2.753E-01
2.896E-01	3.223E-01	1.505E+05	4.600E+06	1.406E+06	3.059E-01
3.223E-01	3.591E-01	1.324E+05	3.596E+06	1.224E+06	3.407E-01
3.591E-01	4.000E-01	1.411E+05	3.449E+06	1.308E+06	3.796E-01
4.000E-01	4.409E-01	1.129E+05	2.759E+06	1.159E+06	4.205E-01
4.409E-01	4.941E-01	1.460E+05	2.745E+06	1.282E+06	4.675E-01
4.941E-01	5.472E-01	1.301E+05	2.446E+06	1.273E+06	5.207E-01
5.472E-01	6.086E-01	1.467E+05	2.392E+06	1.381E+06	5.779E-01
6.086E-01	6.740E-01	1.509E+05	2.306E+06	1.478E+06	6.413E-01
6.740E-01	7.954E-01	2.108E+05	1.736E+06	1.273E+06	7.347E-01
7.954E-01	8.845E-01	1.225E+05	1.375E+06	1.154E+06	8.400E-01
8.845E-01	9.817E-01	1.012E+05	1.042E+06	9.711E+05	9.331E-01
9.817E-01	1.095E+00	9.980E+04	8.801E+05	9.130E+05	1.038E+00
1.095E+00	1.217E+00	9.887E+04	8.138E+05	9.397E+05	1.156E+00
1.217E+00	1.346E+00	9.424E+04	7.272E+05	9.310E+05	1.281E+00
1.346E+00	1.586E+00	1.378E+05	5.744E+05	8.402E+05	1.466E+00
1.586E+00	1.790E+00	8.384E+04	4.110E+05	6.929E+05	1.688E+00

1.790E+00	2.045E+00	7.366E+04	2.889E+05	5.531E+05	1.918E+00
2.045E+00	2.326E+00	6.763E+04	2.411E+05	5.262E+05	2.185E+00
2.326E+00	2.632E+00	5.351E+04	1.749E+05	4.329E+05	2.479E+00
2.632E+00	2.989E+00	3.932E+04	1.101E+05	3.091E+05	2.810E+00
2.989E+00	3.397E+00	3.101E+04	7.601E+04	2.423E+05	3.193E+00
3.397E+00	3.881E+00	1.824E+04	3.765E+04	1.368E+05	3.639E+00
3.881E+00	4.391E+00	1.311E+04	2.570E+04	1.062E+05	4.136E+00
4.391E+00	5.000E+00	1.616E+04	2.654E+04	1.244E+05	4.696E+00
5.000E+00	5.500E+00	8.951E+03	1.790E+04	9.391E+04	5.250E+00
5.500E+00	6.000E+00	6.629E+03	1.326E+04	7.618E+04	5.750E+00
6.000E+00	6.500E+00	4.887E+03	9.775E+03	6.106E+04	6.250E+00
6.500E+00	7.000E+00	3.587E+03	7.174E+03	4.840E+04	6.750E+00
7.000E+00	7.500E+00	2.625E+03	5.250E+03	3.805E+04	7.250E+00
7.500E+00	8.000E+00	1.914E+03	3.828E+03	2.966E+04	7.750E+00
8.000E+00	8.500E+00	1.392E+03	2.785E+03	2.297E+04	8.250E+00
8.500E+00	9.000E+00	1.011E+03	2.021E+03	1.768E+04	8.750E+00
9.000E+00	9.500E+00	7.326E+02	1.465E+03	1.355E+04	9.250E+00
9.500E+00	1.000E+01	5.311E+02	1.062E+03	1.035E+04	9.750E+00

Table B-5. Neutron fluence measured by ROSPEC in room C, location # 3

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	2.974E+03	2.974E+12	4.290E+03	1.500E-09
2.000E-09	5.000E-09	1.908E+04	6.360E+12	2.082E+04	3.500E-09
5.000E-09	1.000E-08	5.803E+04	1.161E+13	8.372E+04	7.500E-09
1.000E-08	2.000E-08	1.711E+05	1.711E+13	2.468E+05	1.500E-08
2.000E-08	5.000E-08	5.303E+05	1.768E+13	5.787E+05	3.500E-08
5.000E-08	1.000E-07	4.145E+05	8.290E+12	5.980E+05	7.500E-08
1.000E-07	2.000E-07	1.166E+05	1.166E+12	1.682E+05	1.500E-07
2.000E-07	5.000E-07	1.739E+05	5.797E+11	1.898E+05	3.500E-07
5.000E-07	1.000E-02	2.121E+06	2.121E+08	2.142E+05	5.000E-03
1.000E-02	5.531E-02	4.708E+05	1.039E+07	2.752E+05	3.266E-02
5.531E-02	6.287E-02	4.979E+04	6.586E+06	3.886E+05	5.909E-02
6.287E-02	7.169E-02	4.810E+04	5.453E+06	3.664E+05	6.728E-02
7.169E-02	8.051E-02	5.118E+04	5.803E+06	4.411E+05	7.610E-02
8.051E-02	9.185E-02	3.256E+04	2.871E+06	2.471E+05	8.618E-02
9.185E-02	1.045E-01	3.282E+04	2.605E+06	2.553E+05	9.815E-02
1.045E-01	1.183E-01	4.205E+04	3.034E+06	3.375E+05	1.114E-01
1.183E-01	1.347E-01	5.746E+04	3.508E+06	4.431E+05	1.265E-01
1.347E-01	1.536E-01	4.287E+04	2.268E+06	3.265E+05	1.441E-01
1.536E-01	1.738E-01	4.620E+04	2.292E+06	3.746E+05	1.637E-01
1.738E-01	1.977E-01	4.028E+04	1.682E+06	3.120E+05	1.857E-01
1.977E-01	2.364E-01	6.849E+04	1.769E+06	3.830E+05	2.170E-01
2.364E-01	2.609E-01	4.329E+04	1.764E+06	4.383E+05	2.487E-01
2.609E-01	2.896E-01	5.163E+04	1.803E+06	4.959E+05	2.753E-01
2.896E-01	3.223E-01	5.125E+04	1.566E+06	4.787E+05	3.059E-01
3.223E-01	3.591E-01	3.495E+04	9.495E+05	3.232E+05	3.407E-01
3.591E-01	4.000E-01	4.691E+04	1.147E+06	4.349E+05	3.796E-01
4.000E-01	4.409E-01	4.571E+04	1.118E+06	4.695E+05	4.205E-01
4.409E-01	4.941E-01	4.556E+04	8.568E+05	4.001E+05	4.675E-01
4.941E-01	5.472E-01	3.971E+04	7.469E+05	3.885E+05	5.207E-01
5.472E-01	6.086E-01	4.869E+04	7.936E+05	4.582E+05	5.779E-01
6.086E-01	6.740E-01	4.399E+04	6.721E+05	4.307E+05	6.413E-01
6.740E-01	7.954E-01	8.094E+04	6.668E+05	4.888E+05	7.347E-01
7.954E-01	8.845E-01	4.165E+04	4.675E+05	3.923E+05	8.400E-01
8.845E-01	9.817E-01	3.775E+04	3.884E+05	3.621E+05	9.331E-01
9.817E-01	1.095E+00	2.431E+04	2.144E+05	2.224E+05	1.038E+00
1.095E+00	1.217E+00	3.719E+04	3.061E+05	3.535E+05	1.156E+00
1.217E+00	1.346E+00	3.046E+04	2.350E+05	3.009E+05	1.281E+00
1.346E+00	1.586E+00	4.207E+04	1.754E+05	2.566E+05	1.466E+00

1.586E+00	1.790E+00	3.305E+04	1.620E+05	2.732E+05	1.688E+00
1.790E+00	2.045E+00	2.910E+04	1.141E+05	2.185E+05	1.918E+00
2.045E+00	2.326E+00	2.477E+04	8.832E+04	1.927E+05	2.185E+00
2.326E+00	2.632E+00	2.129E+04	6.958E+04	1.722E+05	2.479E+00
2.632E+00	2.989E+00	1.699E+04	4.760E+04	1.336E+05	2.810E+00
2.989E+00	3.397E+00	1.248E+04	3.059E+04	9.754E+04	3.193E+00
3.397E+00	3.881E+00	1.071E+04	2.211E+04	8.033E+04	3.639E+00
3.881E+00	4.391E+00	4.990E+03	9.784E+03	4.042E+04	4.136E+00
4.391E+00	5.000E+00	6.255E+03	1.027E+04	4.816E+04	4.696E+00
5.000E+00	5.500E+00	3.538E+03	7.076E+03	3.712E+04	5.250E+00
5.500E+00	6.000E+00	2.620E+03	5.240E+03	3.011E+04	5.750E+00
6.000E+00	6.500E+00	1.932E+03	3.864E+03	2.413E+04	6.250E+00
6.500E+00	7.000E+00	1.418E+03	2.836E+03	1.913E+04	6.750E+00
7.000E+00	7.500E+00	1.038E+03	2.075E+03	1.504E+04	7.250E+00
7.500E+00	8.000E+00	7.565E+02	1.513E+03	1.172E+04	7.750E+00
8.000E+00	8.500E+00	5.503E+02	1.101E+03	9.078E+03	8.250E+00
8.500E+00	9.000E+00	3.995E+02	7.990E+02	6.989E+03	8.750E+00
9.000E+00	9.500E+00	2.896E+02	5.791E+02	5.356E+03	9.250E+00
9.500E+00	1.000E+01	2.099E+02	4.198E+02	4.093E+03	9.750E+00
9.500E+00	1.000E+01	2.099E+02	4.198E+02	4.093E+03	9.750E+00

Table B-6. Neutron fluence measured by ROSPEC in room C, location # 5

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	2.567E+03	2.567E+12	3.704E+03	1.500E-09
2.000E-09	5.000E-09	1.647E+04	5.490E+12	1.798E+04	3.500E-09
5.000E-09	1.000E-08	5.009E+04	1.002E+13	7.227E+04	7.500E-09
1.000E-08	2.000E-08	1.477E+05	1.477E+13	2.130E+05	1.500E-08
2.000E-08	5.000E-08	4.578E+05	1.526E+13	4.996E+05	3.500E-08
5.000E-08	1.000E-07	3.578E+05	7.156E+12	5.162E+05	7.500E-08
1.000E-07	2.000E-07	1.006E+05	1.006E+12	1.452E+05	1.500E-07
2.000E-07	5.000E-07	2.037E+05	6.790E+11	2.223E+05	3.500E-07
5.000E-07	1.000E-02	3.371E+06	3.371E+08	3.404E+05	5.000E-03
1.000E-02	5.531E-02	8.091E+05	1.786E+07	4.730E+05	3.266E-02
5.531E-02	6.287E-02	9.519E+04	1.259E+07	7.431E+05	5.909E-02
6.287E-02	7.169E-02	9.449E+04	1.071E+07	7.198E+05	6.728E-02
7.169E-02	8.051E-02	9.273E+04	1.051E+07	7.992E+05	7.610E-02
8.051E-02	9.185E-02	5.755E+04	5.075E+06	4.367E+05	8.618E-02
9.185E-02	1.045E-01	6.888E+04	5.466E+06	5.358E+05	9.815E-02
1.045E-01	1.183E-01	6.900E+04	4.978E+06	5.538E+05	1.114E-01
1.183E-01	1.347E-01	1.035E+05	6.320E+06	7.983E+05	1.265E-01
1.347E-01	1.536E-01	9.907E+04	5.242E+06	7.545E+05	1.441E-01
1.536E-01	1.738E-01	7.661E+04	3.800E+06	6.212E+05	1.637E-01
1.738E-01	1.977E-01	1.072E+05	4.476E+06	8.302E+05	1.857E-01
1.977E-01	2.364E-01	1.360E+05	3.513E+06	7.604E+05	2.170E-01
2.364E-01	2.609E-01	8.074E+04	3.290E+06	8.175E+05	2.487E-01
2.609E-01	2.896E-01	1.098E+05	3.836E+06	1.055E+06	2.753E-01
2.896E-01	3.223E-01	9.806E+04	2.997E+06	9.160E+05	3.059E-01
3.223E-01	3.591E-01	1.098E+05	2.984E+06	1.016E+06	3.407E-01
3.591E-01	4.000E-01	8.072E+04	1.974E+06	7.484E+05	3.796E-01
4.000E-01	4.409E-01	7.833E+04	1.915E+06	8.045E+05	4.205E-01
4.409E-01	4.941E-01	8.451E+04	1.589E+06	7.422E+05	4.675E-01
4.941E-01	5.472E-01	9.531E+04	1.793E+06	9.325E+05	5.207E-01
5.472E-01	6.086E-01	1.097E+05	1.788E+06	1.032E+06	5.779E-01
6.086E-01	6.740E-01	1.082E+05	1.654E+06	1.060E+06	6.413E-01
6.740E-01	7.954E-01	1.587E+05	1.307E+06	9.583E+05	7.347E-01
7.954E-01	8.845E-01	8.029E+04	9.011E+05	7.562E+05	8.400E-01
8.845E-01	9.817E-01	9.630E+04	9.907E+05	9.236E+05	9.331E-01
9.817E-01	1.095E+00	8.273E+04	7.295E+05	7.568E+05	1.038E+00
1.095E+00	1.217E+00	7.435E+04	6.119E+05	7.066E+05	1.156E+00
1.217E+00	1.346E+00	7.519E+04	5.802E+05	7.428E+05	1.281E+00
1.346E+00	1.586E+00	1.165E+05	4.856E+05	7.104E+05	1.466E+00
1.586E+00	1.790E+00	8.343E+04	4.090E+05	6.896E+05	1.688E+00

1.790E+00	2.045E+00	7.791E+04	3.055E+05	5.850E+05	1.918E+00
2.045E+00	2.326E+00	6.786E+04	2.419E+05	5.279E+05	2.185E+00
2.326E+00	2.632E+00	5.492E+04	1.795E+05	4.443E+05	2.479E+00
2.632E+00	2.989E+00	4.836E+04	1.355E+05	3.802E+05	2.810E+00
2.989E+00	3.397E+00	3.644E+04	8.931E+04	2.847E+05	3.193E+00
3.397E+00	3.881E+00	2.707E+04	5.587E+04	2.030E+05	3.639E+00
3.881E+00	4.391E+00	2.122E+04	4.161E+04	1.719E+05	4.136E+00
4.391E+00	5.000E+00	2.423E+04	3.979E+04	1.866E+05	4.696E+00
5.000E+00	5.500E+00	1.614E+04	3.229E+04	1.694E+05	5.250E+00
5.500E+00	6.000E+00	1.196E+04	2.391E+04	1.374E+05	5.750E+00
6.000E+00	6.500E+00	8.815E+03	1.763E+04	1.101E+05	6.250E+00
6.500E+00	7.000E+00	6.470E+03	1.294E+04	8.731E+04	6.750E+00
7.000E+00	7.500E+00	4.735E+03	9.470E+03	6.863E+04	7.250E+00
7.500E+00	8.000E+00	3.452E+03	6.904E+03	5.349E+04	7.750E+00
8.000E+00	8.500E+00	2.511E+03	5.023E+03	4.142E+04	8.250E+00
8.500E+00	9.000E+00	1.823E+03	3.646E+03	3.189E+04	8.750E+00
9.000E+00	9.500E+00	1.321E+03	2.643E+03	2.444E+04	9.250E+00
9.500E+00	1.000E+01	9.579E+02	1.916E+03	1.868E+04	9.750E+00

Table B-7. Neutron fluence measured by ROSPEC in room D, location # 7

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	4.984E+03	4.984E+12	7.191E+03	1.500E-09
2.000E-09	5.000E-09	3.198E+04	1.066E+13	3.490E+04	3.500E-09
5.000E-09	1.000E-08	9.726E+04	1.945E+13	1.403E+05	7.500E-09
1.000E-08	2.000E-08	2.867E+05	2.867E+13	4.136E+05	1.500E-08
2.000E-08	5.000E-08	8.888E+05	2.963E+13	9.700E+05	3.500E-08
5.000E-08	1.000E-07	6.947E+05	1.389E+13	1.002E+06	7.500E-08
1.000E-07	2.000E-07	1.954E+05	1.954E+12	2.819E+05	1.500E-07
2.000E-07	5.000E-07	3.410E+05	1.137E+12	3.721E+05	3.500E-07
5.000E-07	1.000E-02	4.865E+06	4.865E+08	4.912E+05	5.000E-03
1.000E-02	5.531E-02	1.244E+06	2.744E+07	7.271E+05	3.266E-02
5.531E-02	6.287E-02	1.427E+05	1.888E+07	1.114E+06	5.909E-02
6.287E-02	7.169E-02	1.944E+05	2.204E+07	1.481E+06	6.728E-02
7.169E-02	8.051E-02	1.065E+05	1.208E+07	9.183E+05	7.610E-02
8.051E-02	9.185E-02	1.379E+05	1.216E+07	1.046E+06	8.618E-02
9.185E-02	1.045E-01	1.327E+05	1.053E+07	1.032E+06	9.815E-02
1.045E-01	1.183E-01	1.823E+05	1.315E+07	1.463E+06	1.114E-01
1.183E-01	1.347E-01	1.970E+05	1.202E+07	1.519E+06	1.265E-01
1.347E-01	1.536E-01	2.006E+05	1.061E+07	1.528E+06	1.441E-01
1.536E-01	1.738E-01	2.114E+05	1.049E+07	1.715E+06	1.637E-01
1.738E-01	1.977E-01	2.349E+05	9.812E+06	1.820E+06	1.857E-01
1.977E-01	2.364E-01	3.278E+05	8.469E+06	1.833E+06	2.170E-01
2.364E-01	2.609E-01	2.231E+05	9.092E+06	2.259E+06	2.487E-01
2.609E-01	2.896E-01	2.609E+05	9.112E+06	2.506E+06	2.753E-01
2.896E-01	3.223E-01	2.776E+05	8.485E+06	2.593E+06	3.059E-01
3.223E-01	3.591E-01	2.821E+05	7.662E+06	2.608E+06	3.407E-01
3.591E-01	4.000E-01	2.813E+05	6.877E+06	2.608E+06	3.796E-01
4.000E-01	4.409E-01	2.373E+05	5.803E+06	2.438E+06	4.205E-01
4.409E-01	4.941E-01	2.781E+05	5.231E+06	2.443E+06	4.675E-01
4.941E-01	5.472E-01	3.050E+05	5.736E+06	2.984E+06	5.207E-01
5.472E-01	6.086E-01	3.852E+05	6.279E+06	3.625E+06	5.779E-01
6.086E-01	6.740E-01	4.210E+05	6.433E+06	4.122E+06	6.413E-01
6.740E-01	7.954E-01	6.919E+05	5.700E+06	4.179E+06	7.347E-01
7.954E-01	8.845E-01	4.536E+05	5.091E+06	4.272E+06	8.400E-01
8.845E-01	9.817E-01	3.845E+05	3.956E+06	3.688E+06	9.331E-01
9.817E-01	1.095E+00	3.897E+05	3.436E+06	3.565E+06	1.038E+00
1.095E+00	1.217E+00	4.399E+05	3.620E+06	4.181E+06	1.156E+00
1.217E+00	1.346E+00	4.627E+05	3.570E+06	4.571E+06	1.281E+00
1.346E+00	1.586E+00	7.829E+05	3.264E+06	4.774E+06	1.466E+00

1.586E+00	1.790E+00	5.794E+05	2.840E+06	4.789E+06	1.688E+00
1.790E+00	2.045E+00	5.783E+05	2.268E+06	4.342E+06	1.918E+00
2.045E+00	2.326E+00	6.043E+05	2.154E+06	4.702E+06	2.185E+00
2.326E+00	2.632E+00	5.728E+05	1.872E+06	4.634E+06	2.479E+00
2.632E+00	2.989E+00	5.052E+05	1.415E+06	3.971E+06	2.810E+00
2.989E+00	3.397E+00	4.217E+05	1.034E+06	3.296E+06	3.193E+00
3.397E+00	3.881E+00	3.488E+05	7.199E+05	2.616E+06	3.639E+00
3.881E+00	4.391E+00	2.891E+05	5.669E+05	2.342E+06	4.136E+00
4.391E+00	5.000E+00	3.384E+05	5.557E+05	2.606E+06	4.696E+00
5.000E+00	5.500E+00	2.143E+05	4.285E+05	2.248E+06	5.250E+00
5.500E+00	6.000E+00	1.587E+05	3.174E+05	1.824E+06	5.750E+00
6.000E+00	6.500E+00	1.170E+05	2.340E+05	1.462E+06	6.250E+00
6.500E+00	7.000E+00	8.587E+04	1.717E+05	1.159E+06	6.750E+00
7.000E+00	7.500E+00	6.284E+04	1.257E+05	9.108E+05	7.250E+00
7.500E+00	8.000E+00	4.582E+04	9.163E+04	7.099E+05	7.750E+00
8.000E+00	8.500E+00	3.333E+04	6.666E+04	5.498E+05	8.250E+00
8.500E+00	9.000E+00	2.419E+04	4.839E+04	4.233E+05	8.750E+00
9.000E+00	9.500E+00	1.754E+04	3.507E+04	3.244E+05	9.250E+00
9.500E+00	1.000E+01	1.271E+04	2.543E+04	2.479E+05	9.750E+00

Table B-8. Neutron fluence measured by ROSPEC in room D, location # 8

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	4.836E+03	4.836E+12	6.977E+03	1.500E-09
2.000E-09	5.000E-09	3.103E+04	1.034E+13	3.386E+04	3.500E-09
5.000E-09	1.000E-08	9.437E+04	1.887E+13	1.361E+05	7.500E-09
1.000E-08	2.000E-08	2.782E+05	2.782E+13	4.013E+05	1.500E-08
2.000E-08	5.000E-08	8.624E+05	2.875E+13	9.412E+05	3.500E-08
5.000E-08	1.000E-07	6.741E+05	1.348E+13	9.725E+05	7.500E-08
1.000E-07	2.000E-07	1.896E+05	1.896E+12	2.735E+05	1.500E-07
2.000E-07	5.000E-07	3.433E+05	1.144E+12	3.747E+05	3.500E-07
5.000E-07	1.000E-02	5.083E+06	5.083E+08	5.133E+05	5.000E-03
1.000E-02	5.531E-02	1.321E+06	2.916E+07	7.725E+05	3.266E-02
5.531E-02	6.287E-02	1.888E+05	2.498E+07	1.474E+06	5.909E-02
6.287E-02	7.169E-02	1.650E+05	1.871E+07	1.257E+06	6.728E-02
7.169E-02	8.051E-02	1.324E+05	1.501E+07	1.141E+06	7.610E-02
8.051E-02	9.185E-02	1.490E+05	1.314E+07	1.130E+06	8.618E-02
9.185E-02	1.045E-01	1.305E+05	1.036E+07	1.015E+06	9.815E-02
1.045E-01	1.183E-01	1.727E+05	1.246E+07	1.386E+06	1.114E-01
1.183E-01	1.347E-01	2.651E+05	1.618E+07	2.044E+06	1.265E-01
1.347E-01	1.536E-01	2.009E+05	1.063E+07	1.530E+06	1.441E-01
1.536E-01	1.738E-01	2.268E+05	1.125E+07	1.839E+06	1.637E-01
1.738E-01	1.977E-01	2.848E+05	1.189E+07	2.206E+06	1.857E-01
1.977E-01	2.364E-01	3.360E+05	8.681E+06	1.879E+06	2.170E-01
2.364E-01	2.609E-01	2.408E+05	9.811E+06	2.438E+06	2.487E-01
2.609E-01	2.896E-01	2.986E+05	1.043E+07	2.869E+06	2.753E-01
2.896E-01	3.223E-01	3.211E+05	9.812E+06	2.999E+06	3.059E-01
3.223E-01	3.591E-01	3.135E+05	8.515E+06	2.898E+06	3.407E-01
3.591E-01	4.000E-01	3.018E+05	7.380E+06	2.798E+06	3.796E-01
4.000E-01	4.409E-01	2.808E+05	6.864E+06	2.884E+06	4.205E-01
4.409E-01	4.941E-01	3.483E+05	6.551E+06	3.059E+06	4.675E-01
4.941E-01	5.472E-01	3.655E+05	6.875E+06	3.576E+06	5.207E-01
5.472E-01	6.086E-01	4.440E+05	7.237E+06	4.178E+06	5.779E-01
6.086E-01	6.740E-01	4.708E+05	7.194E+06	4.610E+06	6.413E-01
6.740E-01	7.954E-01	7.929E+05	6.532E+06	4.788E+06	7.347E-01
7.954E-01	8.845E-01	4.943E+05	5.548E+06	4.656E+06	8.400E-01
8.845E-01	9.817E-01	4.670E+05	4.805E+06	4.480E+06	9.331E-01
9.817E-01	1.095E+00	4.465E+05	3.938E+06	4.085E+06	1.038E+00
1.095E+00	1.217E+00	5.410E+05	4.452E+06	5.142E+06	1.156E+00
1.217E+00	1.346E+00	5.387E+05	4.157E+06	5.322E+06	1.281E+00
1.346E+00	1.586E+00	1.021E+06	4.256E+06	6.226E+06	1.466E+00

1.586E+00	1.790E+00	6.735E+05	3.302E+06	5.567E+06	1.688E+00
1.790E+00	2.045E+00	7.455E+05	2.924E+06	5.598E+06	1.918E+00
2.045E+00	2.326E+00	7.346E+05	2.619E+06	5.716E+06	2.185E+00
2.326E+00	2.632E+00	6.769E+05	2.212E+06	5.476E+06	2.479E+00
2.632E+00	2.989E+00	6.053E+05	1.695E+06	4.758E+06	2.810E+00
2.989E+00	3.397E+00	5.299E+05	1.299E+06	4.141E+06	3.193E+00
3.397E+00	3.881E+00	4.196E+05	8.661E+05	3.147E+06	3.639E+00
3.881E+00	4.391E+00	3.837E+05	7.524E+05	3.108E+06	4.136E+00
4.391E+00	5.000E+00	4.253E+05	6.985E+05	3.275E+06	4.696E+00
5.000E+00	5.500E+00	2.877E+05	5.755E+05	3.019E+06	5.250E+00
5.500E+00	6.000E+00	2.131E+05	4.262E+05	2.449E+06	5.750E+00
6.000E+00	6.500E+00	1.571E+05	3.142E+05	1.963E+06	6.250E+00
6.500E+00	7.000E+00	1.153E+05	2.306E+05	1.556E+06	6.750E+00
7.000E+00	7.500E+00	8.439E+04	1.688E+05	1.223E+06	7.250E+00
7.500E+00	8.000E+00	6.153E+04	1.231E+05	9.533E+05	7.750E+00
8.000E+00	8.500E+00	4.476E+04	8.952E+04	7.383E+05	8.250E+00
8.500E+00	9.000E+00	3.249E+04	6.498E+04	5.684E+05	8.750E+00
9.000E+00	9.500E+00	2.355E+04	4.710E+04	4.356E+05	9.250E+00
9.500E+00	1.000E+01	1.707E+04	3.415E+04	3.329E+05	9.750E+00

Table B-9. Neutron fluence measured by ROSPEC in room D, location # 9

E1 (MeV)	E2 (MeV)	Fluence per energy bin	Fluence per MeV	Fluence per lethargy	E average (MeV)
1.000E-09	2.000E-09	1.801E+04	1.801E+13	2.598E+04	1.500E-09
2.000E-09	5.000E-09	1.155E+05	3.852E+13	1.261E+05	3.500E-09
5.000E-09	1.000E-08	3.514E+05	7.029E+13	5.070E+05	7.500E-09
1.000E-08	2.000E-08	1.036E+06	1.036E+14	1.495E+06	1.500E-08
2.000E-08	5.000E-08	3.211E+06	1.070E+14	3.505E+06	3.500E-08
5.000E-08	1.000E-07	2.510E+06	5.020E+13	3.621E+06	7.500E-08
1.000E-07	2.000E-07	7.060E+05	7.060E+12	1.019E+06	1.500E-07
2.000E-07	5.000E-07	1.049E+06	3.497E+12	1.145E+06	3.500E-07
5.000E-07	1.000E-02	1.275E+07	1.275E+09	1.287E+06	5.000E-03
1.000E-02	5.531E-02	2.993E+06	6.605E+07	1.750E+06	3.266E-02
5.531E-02	6.287E-02	3.447E+05	4.560E+07	2.691E+06	5.909E-02
6.287E-02	7.169E-02	3.408E+05	3.864E+07	2.596E+06	6.728E-02
7.169E-02	8.051E-02	3.038E+05	3.445E+07	2.619E+06	7.610E-02
8.051E-02	9.185E-02	2.777E+05	2.449E+07	2.108E+06	8.618E-02
9.185E-02	1.045E-01	3.050E+05	2.421E+07	2.373E+06	9.815E-02
1.045E-01	1.183E-01	3.248E+05	2.343E+07	2.607E+06	1.114E-01
1.183E-01	1.347E-01	3.205E+05	1.957E+07	2.472E+06	1.265E-01
1.347E-01	1.536E-01	4.191E+05	2.217E+07	3.192E+06	1.441E-01
1.536E-01	1.738E-01	4.256E+05	2.111E+07	3.451E+06	1.637E-01
1.738E-01	1.977E-01	4.786E+05	1.999E+07	3.707E+06	1.857E-01
1.977E-01	2.364E-01	6.521E+05	1.685E+07	3.647E+06	2.170E-01
2.364E-01	2.609E-01	4.025E+05	1.640E+07	4.075E+06	2.487E-01
2.609E-01	2.896E-01	4.631E+05	1.618E+07	4.449E+06	2.753E-01
2.896E-01	3.223E-01	4.930E+05	1.507E+07	4.605E+06	3.059E-01
3.223E-01	3.591E-01	5.007E+05	1.360E+07	4.630E+06	3.407E-01
3.591E-01	4.000E-01	4.875E+05	1.192E+07	4.519E+06	3.796E-01
4.000E-01	4.409E-01	4.122E+05	1.008E+07	4.234E+06	4.205E-01
4.409E-01	4.941E-01	4.920E+05	9.253E+06	4.321E+06	4.675E-01
4.941E-01	5.472E-01	5.399E+05	1.015E+07	5.282E+06	5.207E-01
5.472E-01	6.086E-01	6.521E+05	1.063E+07	6.137E+06	5.779E-01
6.086E-01	6.740E-01	6.725E+05	1.028E+07	6.585E+06	6.413E-01
6.740E-01	7.954E-01	1.177E+06	9.697E+06	7.108E+06	7.347E-01
7.954E-01	8.845E-01	7.513E+05	8.432E+06	7.076E+06	8.400E-01
8.845E-01	9.817E-01	6.318E+05	6.500E+06	6.060E+06	9.331E-01
9.817E-01	1.095E+00	6.286E+05	5.543E+06	5.751E+06	1.038E+00
1.095E+00	1.217E+00	7.267E+05	5.981E+06	6.907E+06	1.156E+00
1.217E+00	1.346E+00	6.622E+05	5.110E+06	6.542E+06	1.281E+00
1.346E+00	1.586E+00	1.248E+06	5.202E+06	7.610E+06	1.466E+00
1.586E+00	1.790E+00	8.383E+05	4.109E+06	6.929E+06	1.688E+00

1.790E+00	2.045E+00	8.387E+05	3.289E+06	6.298E+06	1.918E+00
2.045E+00	2.326E+00	8.163E+05	2.910E+06	6.351E+06	2.185E+00
2.326E+00	2.632E+00	7.476E+05	2.443E+06	6.048E+06	2.479E+00
2.632E+00	2.989E+00	6.073E+05	1.701E+06	4.774E+06	2.810E+00
2.989E+00	3.397E+00	4.908E+05	1.203E+06	3.835E+06	3.193E+00
3.397E+00	3.881E+00	3.686E+05	7.608E+05	2.764E+06	3.639E+00
3.881E+00	4.391E+00	3.146E+05	6.169E+05	2.548E+06	4.136E+00
4.391E+00	5.000E+00	3.164E+05	5.197E+05	2.437E+06	4.696E+00
5.000E+00	5.500E+00	2.090E+05	4.180E+05	2.193E+06	5.250E+00
5.500E+00	6.000E+00	1.548E+05	3.096E+05	1.779E+06	5.750E+00
6.000E+00	6.500E+00	1.141E+05	2.283E+05	1.426E+06	6.250E+00
6.500E+00	7.000E+00	8.377E+04	1.675E+05	1.130E+06	6.750E+00
7.000E+00	7.500E+00	6.131E+04	1.226E+05	8.886E+05	7.250E+00
7.500E+00	8.000E+00	4.470E+04	8.939E+04	6.926E+05	7.750E+00
8.000E+00	8.500E+00	3.252E+04	6.503E+04	5.363E+05	8.250E+00
8.500E+00	9.000E+00	2.360E+04	4.721E+04	4.129E+05	8.750E+00
9.000E+00	9.500E+00	1.711E+04	3.422E+04	3.164E+05	9.250E+00
9.500E+00	1.000E+01	1.240E+04	2.481E+04	2.418E+05	9.750E+00

APPENDIX C

Plots of measured neutron spectra normalized per one source neutron

The following plots represent the measured neutron spectra in the energy region from thermal to 4.5 MeV. They are normalized per one neutron in the following fashion. After the spectra from the six detectors are combined, the number of neutrons in each energy bin of the combined spectra is divided by the total number of neutrons in the combined spectra. Therefore, the ordinate axis of the plots represents what fraction of the total lethargy is contained in each energy group. Such presentation allows for better visual comparison of spectra taken for different periods of time and from sources with different activities.

Figure C-1 Neutron spectrum in Room A, position #1

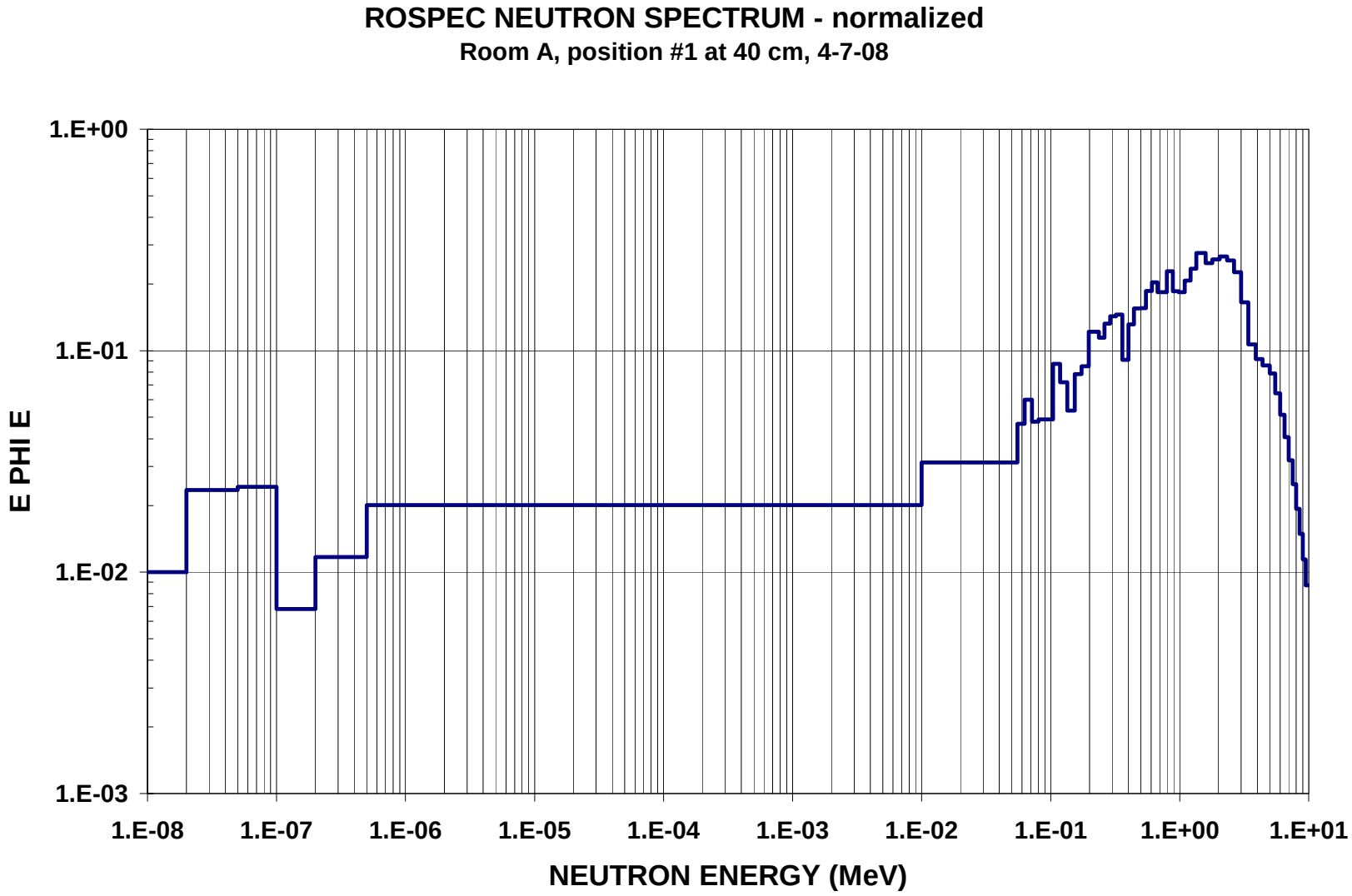


Figure C-2 Neutron spectrum in Room A, position #6

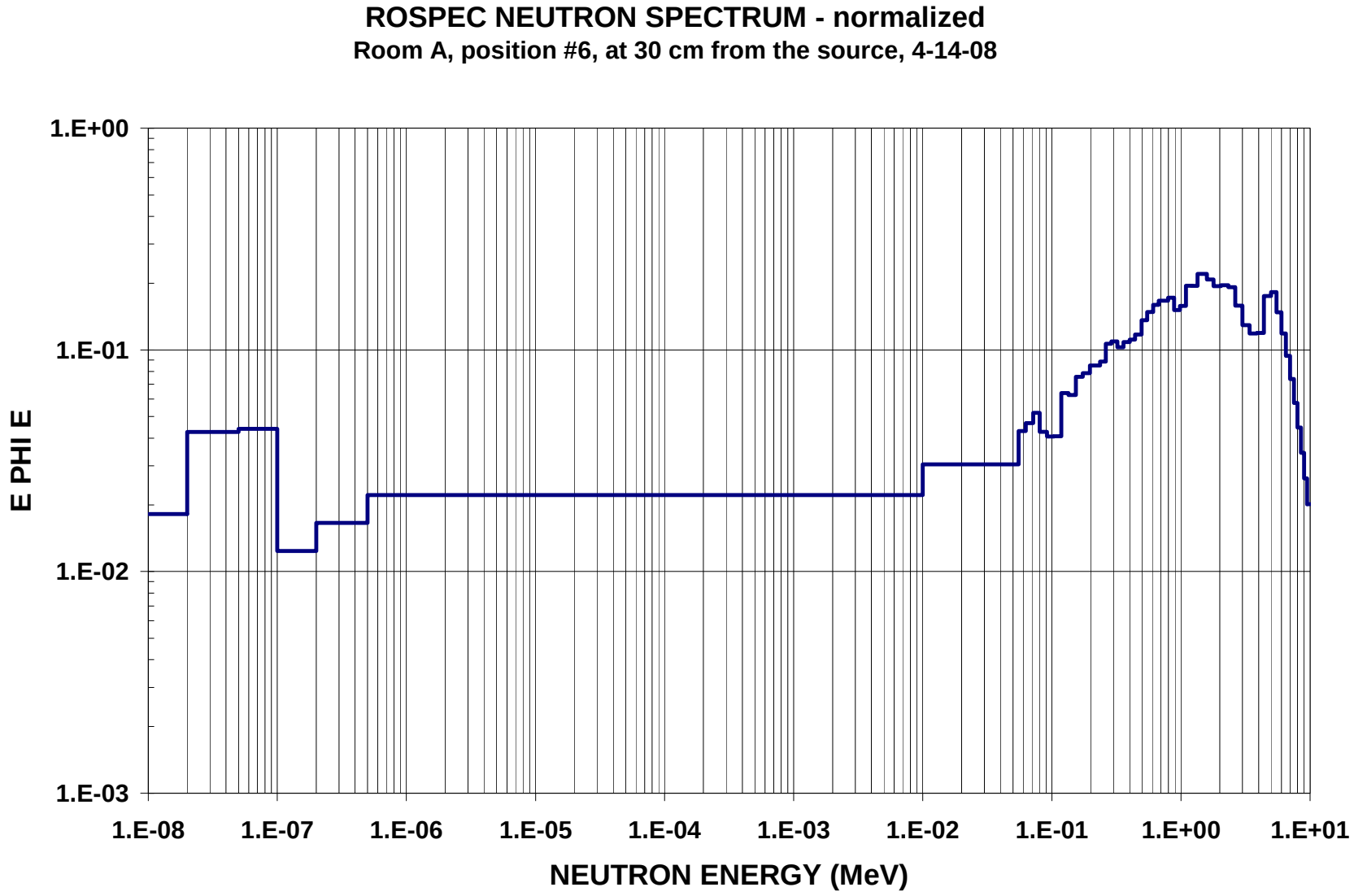


Figure C-3 Neutron spectrum in Room B, position #2

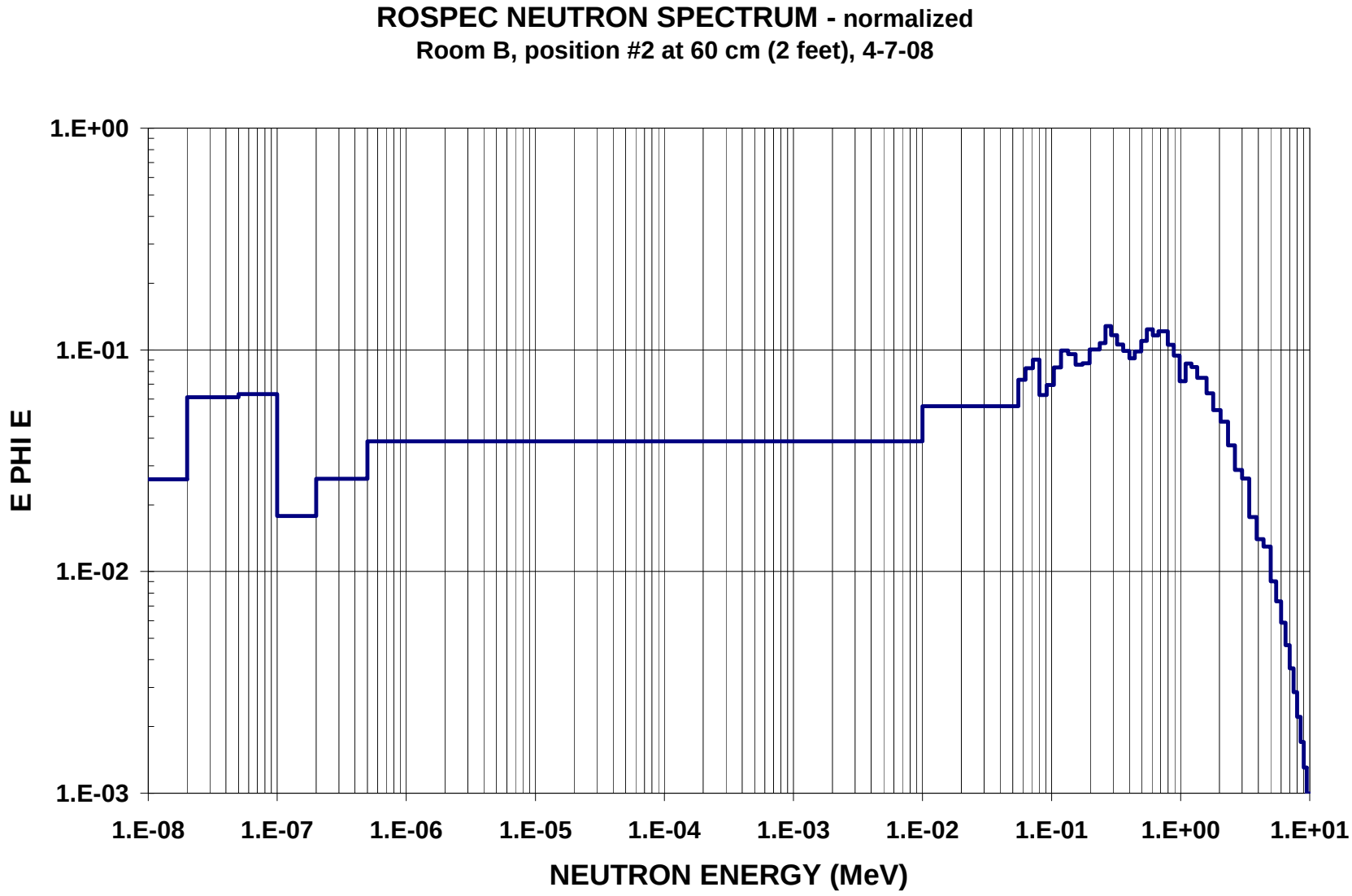


Figure C-4 Neutron spectrum in Room B, position #4

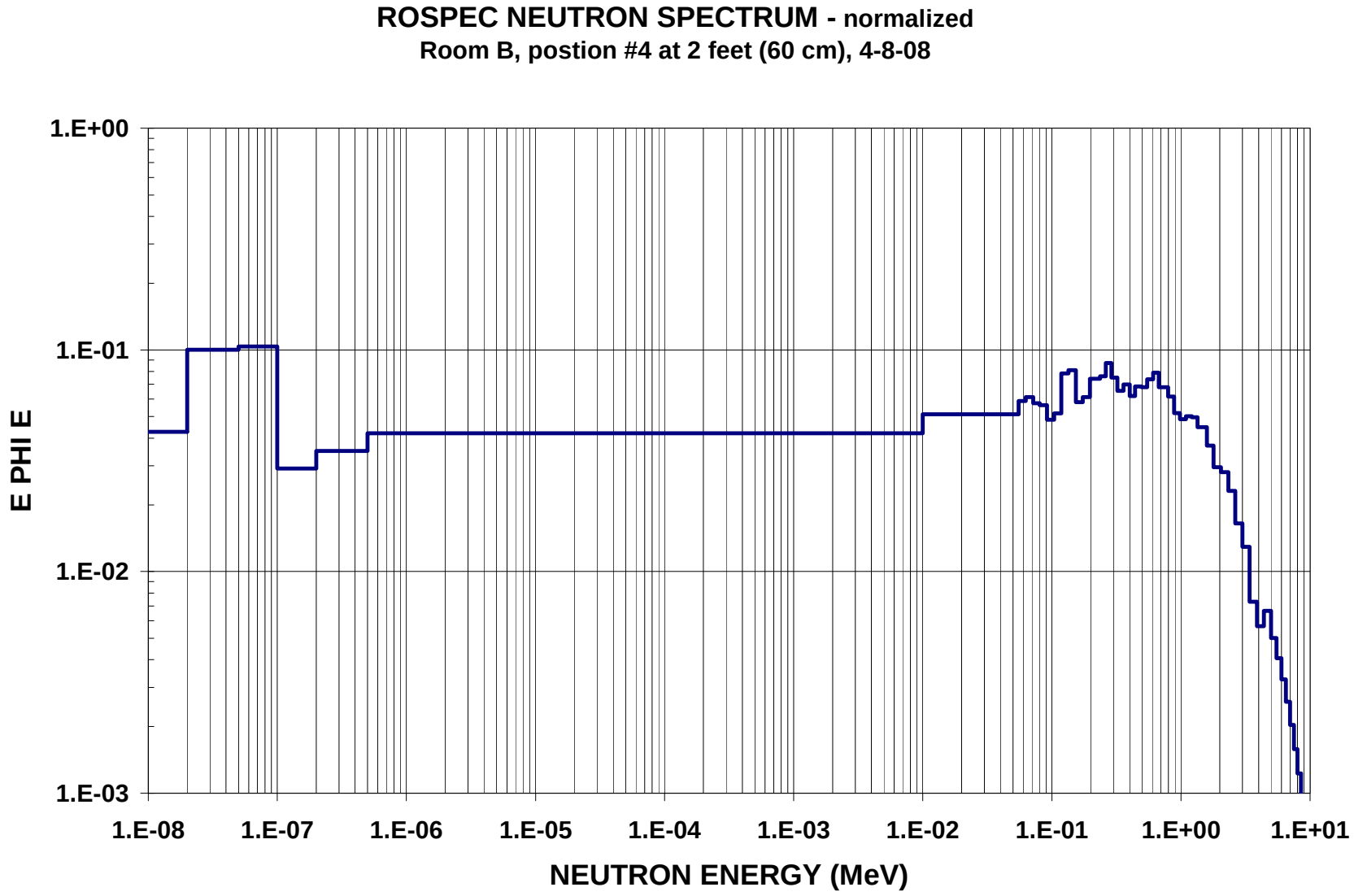


Figure C-5. Neutron spectrum in Room C, position #3

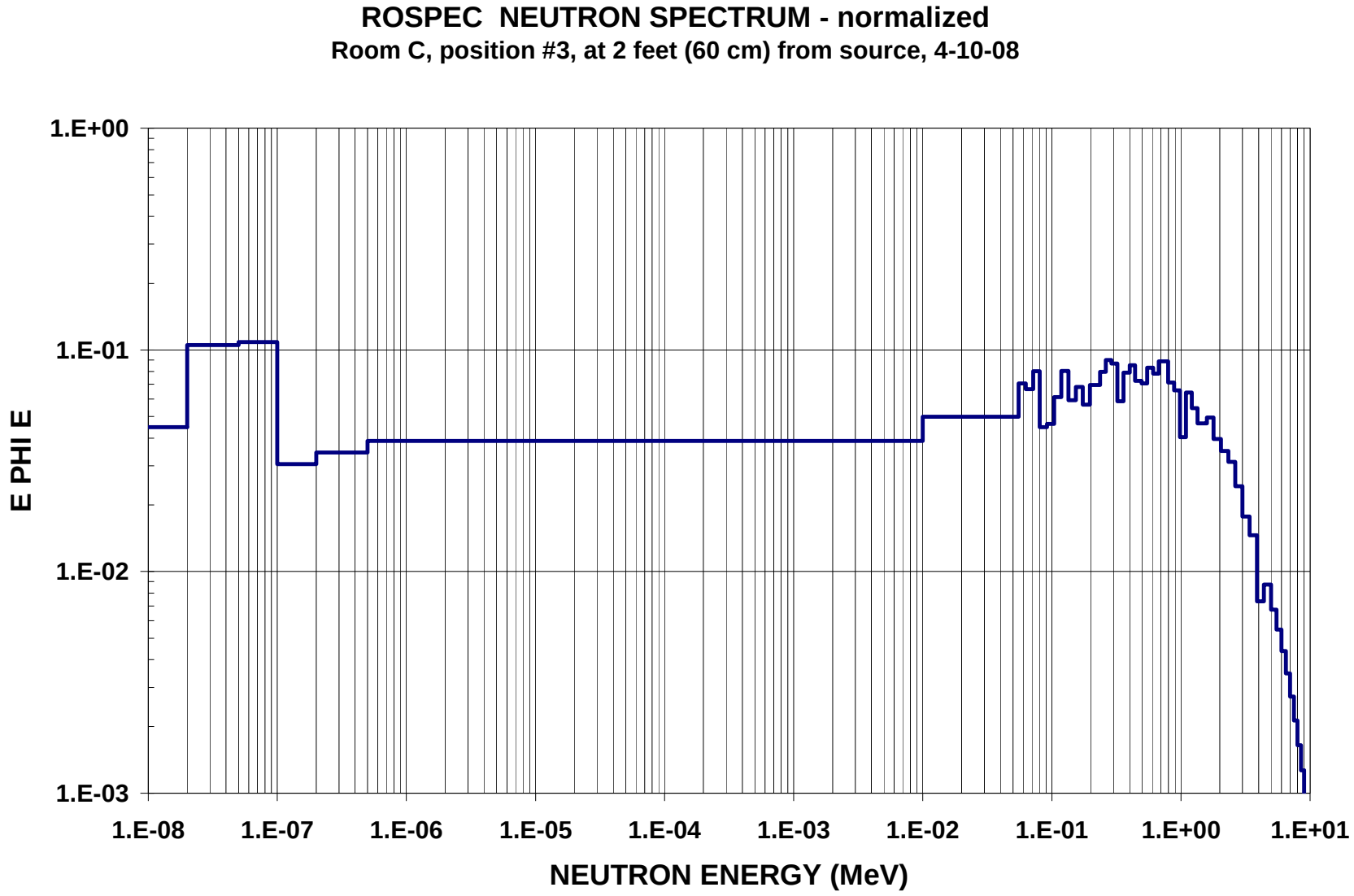


Figure C-6. Neutron spectrum in Room C, position #5

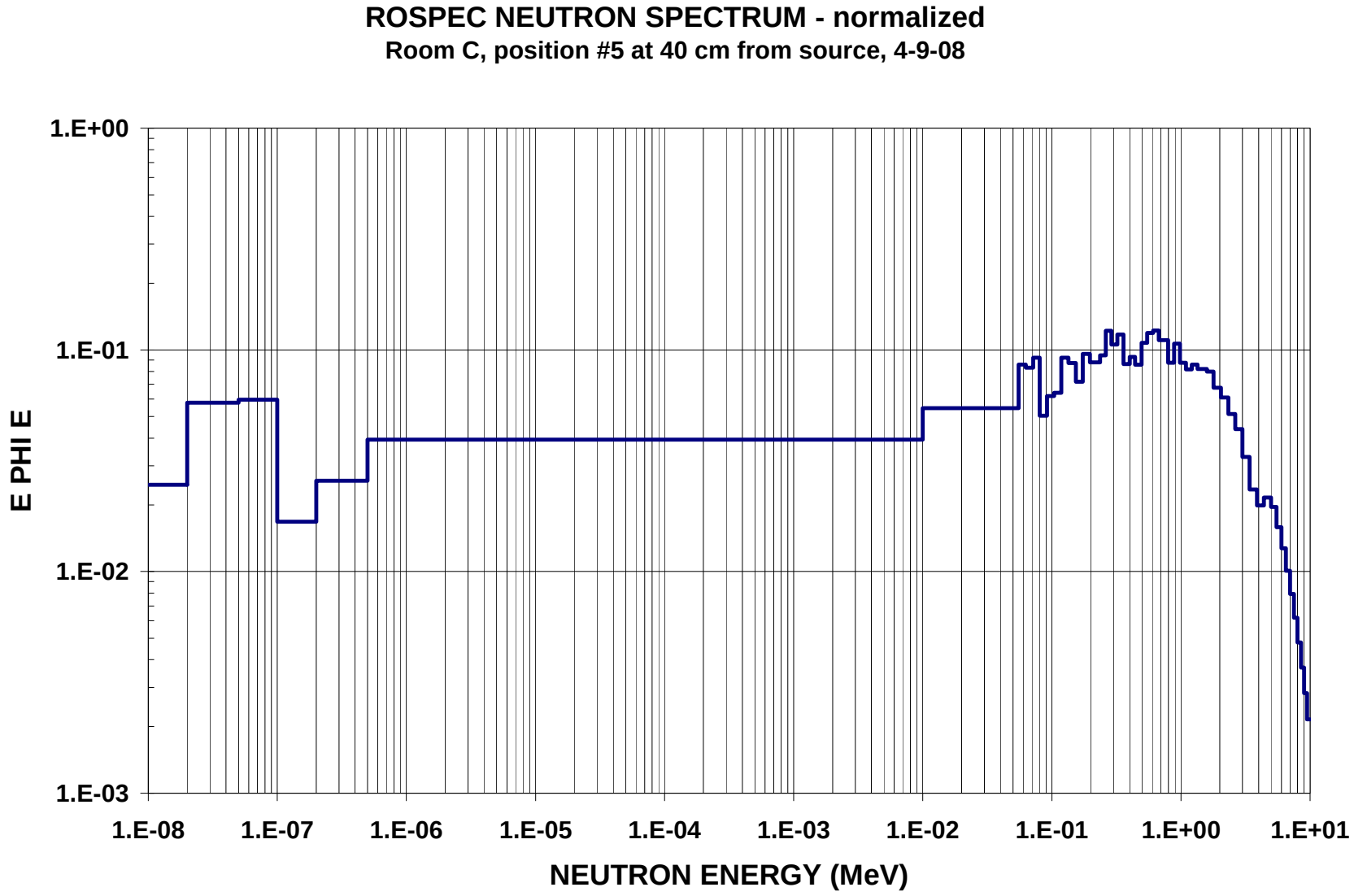


Figure C-7. Neutron spectrum in Room D, position #7

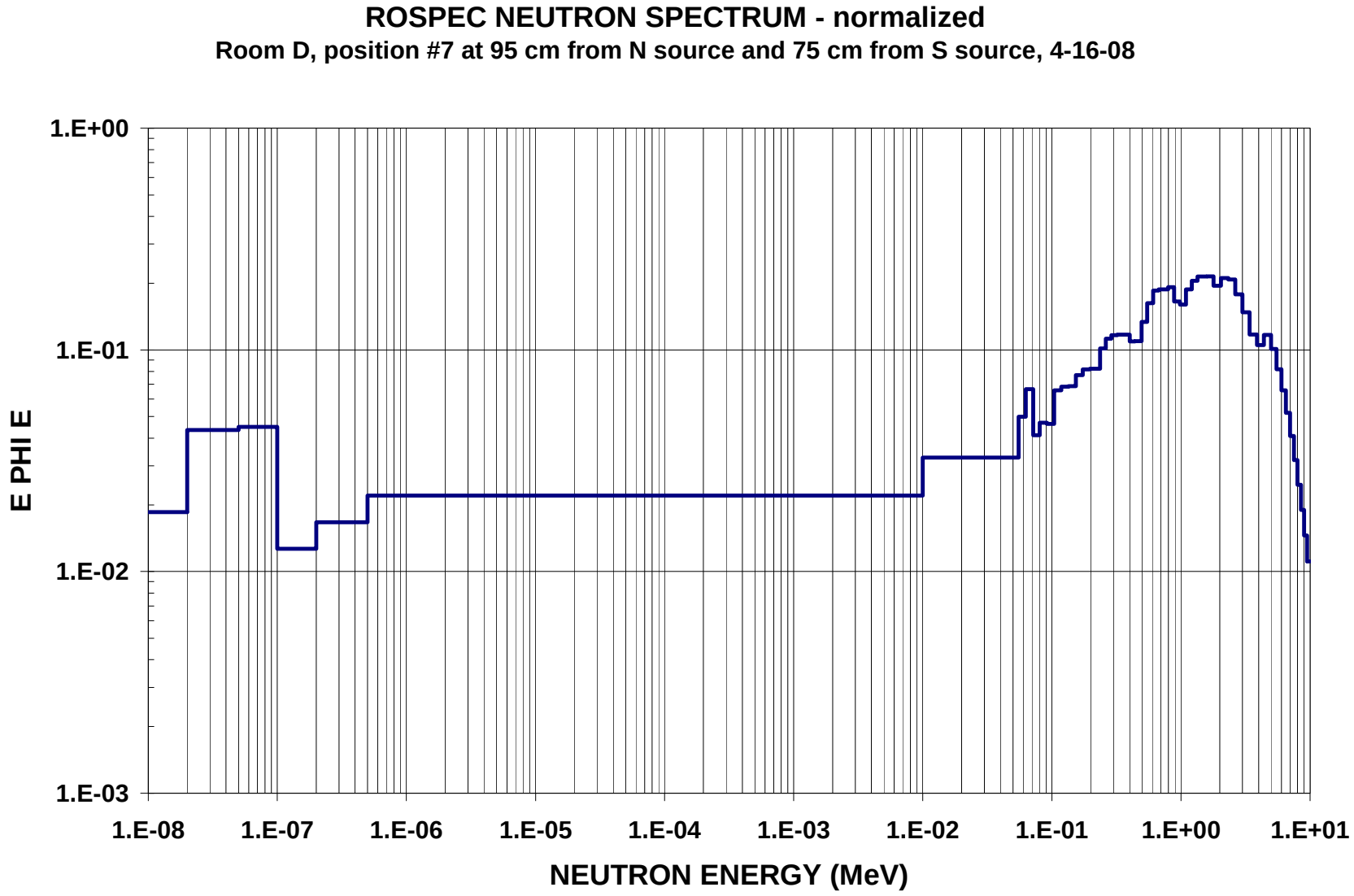


Figure C-8. Neutron spectrum in Room D, position #8

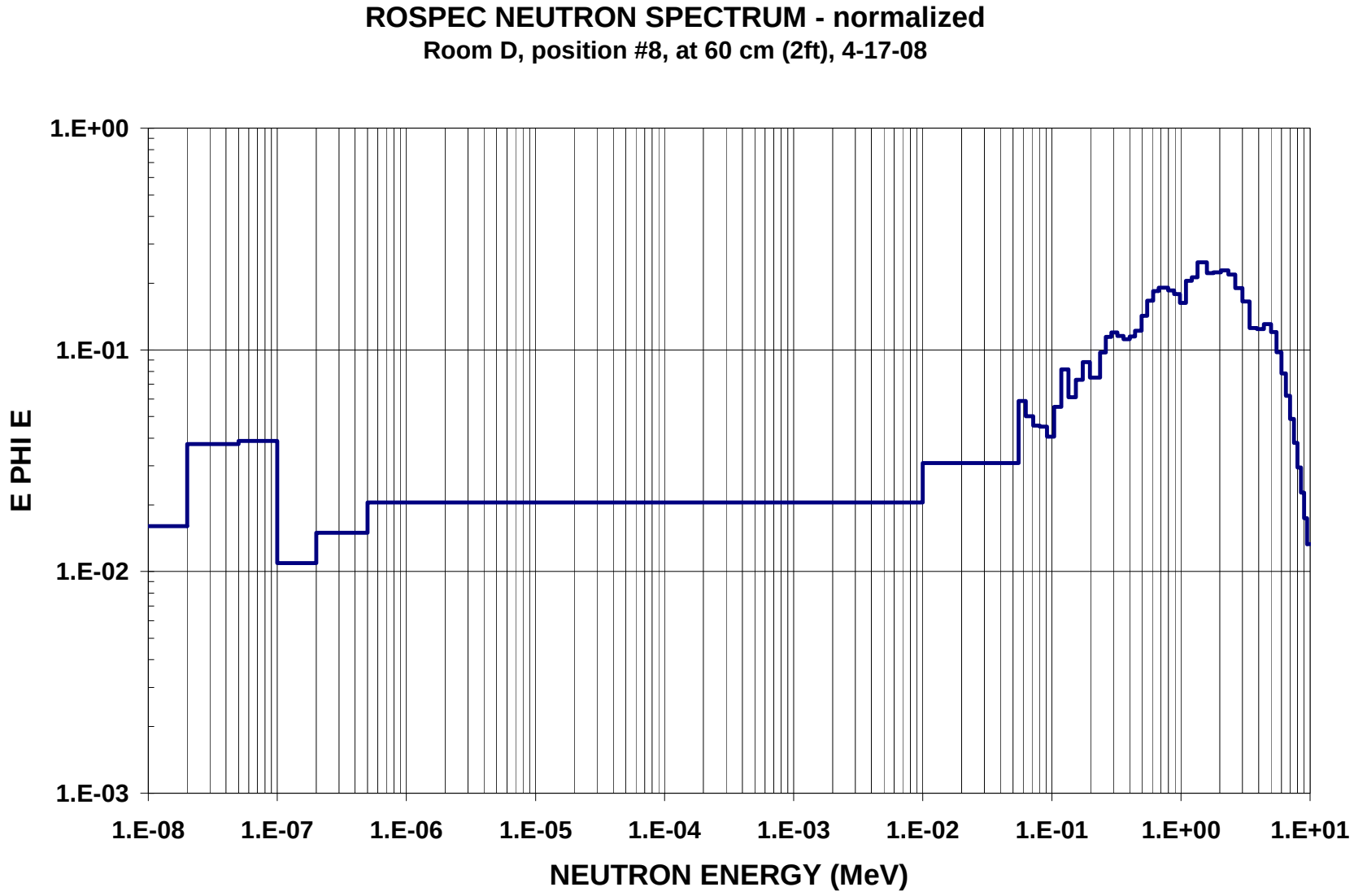


Figure C-9. Neutron spectrum in Room D, position #9