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FOR POINT ISOTROPIC SOURCE

— MOLYBDENUM, TIN, LANTHANUM, GADOLINIUM, TUNGSTEN, LEAD AND URANIUM —

January 1988

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Data Library of Gamma-Ray Buildup Factors for
Point Isotropic Source

— Molybdenum, Tin, Lanthanum, Gadolinium,
Tungsten, Lead and Uranium —

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Gamma-ray buildup factors for a point isotropic source have been calculated as a function of atomic number of heavy elements and source energies over an energy range from 0.015 MeV to 15 MeV, for penetration depths up to 40 mfp, by the PALLAS-PL,SP-Br code. These data include the contribution of bremsstrahlung, annihilation radiation and fluorescence X-ray. The calculated absorbed-dose, exposure and dose-equivalent buildup factors are tabulated for molybdenum, tin, tungsten, lead and uranium, which are practical interest shield materials, lanthanum and gadolinium which are important materials for obtaining buildup factors by interpolation with the atomic number.

In the case of high atomic number materials, inclusion of bremsstrahlung source has great influence on the buildup factors for high source energies and that of fluorescence X-ray gives spectacular effects on those for low energies close to the K edge of attenuation cross section. Furthermore, the geometrical-progression (G-P) parameters have been determined for these buildup factors in order to obtain the values of buildup factors at arbitrary distances and energies.

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Keywords : Gamma-Ray Buildup Factor, Absorbed-dose, Exposure, Dose-equivalent, PALLAS Code, Molybdenum, Tin, Lanthanum, Cadolinium, Tungsten, Lead, Uranium, Bremsstrahlung, Annihilation Radiation, Fluorescence X-ray, G-P Fitting Parameter

点等方線源に対するガンマ線ビルドアップ係数
データライブラー
—モリブデン, スズ, ランタン, ガドリニウム,
タングステン, 鉛及びウラン—

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(1987年12月16日受理)

重い元素の点等方線源に対するガンマ線ビルドアップ係数をPALLAS-PL, SP-Brコードにより, 原子番号及び0.015 MeVから15 MeVまでの入射エネルギーの関数として, 透過距離40 mfpまで計算した。これらのデータには制動輻射線, 消滅放射線及び蛍光X線の寄与を含めた。遮蔽物質として実用的関心のあるモリブデン, スズ, タングステン, 鉛, ウラン, 並びにビルドアップ係数の原子番号での内挿で重要なランタン及びガドリニウムに対する吸収線量, 照射線量及び線量当量のビルドアップ係数の計算値を数表にした。

原子番号の大きい物質の場合, 制動輻射の寄与を加えることは高い入射エネルギーのビルドアップ係数に大きな影響を与え, 蛍光X線の寄与を加えることはKエッジに近い低い入射エネルギーのビルドアップ係数に顕著な効果をもたらす。さらに, 任意の距離及び入射エネルギーでのビルドアップ係数の値を算出するために, これらのビルドアップ係数にフィットする幾何級数法(G-P法) 内挿式のパラメータを決定した。

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1. Introduction

In spite of development of sophisticated computational schemes, the point kernel integration method is very often useful in gamma-ray shielding design, because the calculation is simple for three dimensional problem and usually gives tolerable accuracy. The reliance of this method is influenced by the accuracy of gamma-ray attenuation coefficients and buildup factors for shielding materials.

Goldstein and Wilkin's buildup factor data¹ which were calculated with the moments method, have been used for nearly 30 years. However, in the case of high atomic number (Z) material and high energy gamma rays, the values of buildup factors disagree with those calculated by other methods. For instance, Butueva et al.² observed the moments method values for lead have deviated about 70 % from those of S_N method in energy range of 6 and 8 MeV about 15 mean-free-path(mfp). They have further corroborated this fact by means of Monte Carlo calculation. Shure³ indicated a correlation of such differences in the case of lead with the trends in the gamma-ray attenuation cross section. Natarajan et al.⁴ confirmed these disagreements were concerned with the calculation considering the Compton scattering process alone. They calculated buildup factor data using ASFIT code⁵ for tin, tungsten, lead and uranium, and observed the systematic trends of deviations from the Goldstein-Wilkin's values. Based on the magnitude of deviations they confirmed that the weight function used by Goldstein and Wilkins is not appropriate for the cases where the gamma-ray attenuation cross section contains a trough and the incident source energies lies above the trough. Further, they indicated the lead data calculated by the modified moments method^{6,7}, developed with respect to the deep penetration problem, was adequate to deal with

this situation as well. The lead data of PALLAS⁸, excluding bremsstrahlung, were in good agreement with the results of ASFIT and the modified moments method⁴, except above 15 mfp in the 10 MeV source energy.

This report furnishes buildup factor data for high Z materials with the PALLAS-PL,SP-Br code⁹⁻¹², including the contribution of secondary gamma-ray source, bremsstrahlung, annihilation radiation and fluorescence X-ray. The values of absorbed dose, exposure and dose-equivalent buildup factors are tabulated for molybdenum, tin, lanthanum, gadolinium, tungsten and uranium, with lead reported in Refs.8, 11 and 12.

The G-P (Geometrical Progression) parameters¹³⁻¹⁵ are fitted to those buildup factors in order to obtain the values of buildup factors at arbitrary distances and energies. The values of five parameters are listed in tables.

2. Calculation of gamma-ray buildup factors

The gamma-ray buildup factors for a point isotropic source have been calculated by the PALLAS-PL,SP-Br code⁸⁻¹². The source energy was from 0.015 MeV, (in the case of lead and uranium medium, from 0.03 MeV), to 15 MeV. Buildup factors corresponding to 16 source-detector distances were picked up from the photon transport calculation in the sphere of 45-mfp-thick medium of each materials for each source energy.

The calculations were made using the photon cross section data taken from Hubbell's(NBS29)¹⁶ and Storm and Israel's(DLC-15)¹⁷ compilations. The items of cross section used for each material are as follows.

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Source energy	Low	High and Intermediated
Library Name	J2391.GXDLC.DATA	J2391.GXSECLIC.DATA
Molybdenum	DLC-15	DLC-15
Tin	DLC-15 ($E_0 \leq 0.6$ MeV)	NBS29 ($0.8\text{MeV} \leq E_0$)
Lanthanum	DLC-15	DLC-15
Gadolinium	DLC-15	DLC-15
Tungsten	DLC-15	DLC-15
Lead	DLC-15 ($E_0 \leq 0.3$ MeV)	NBS29 ($0.4\text{MeV} \leq E_0$)
Uranium	DLC-15 ($E_0 \leq 1$ MeV)	NBS29 ($1.5\text{MeV} \leq E_0$)

The photon cross section data from DLC-15 compilation are listed in Table 1.1 - 1.7 with the dose rate conversion factors used for buildup factors. Figure 1 shows the total cross section of several materials from DLC-15. As response functions, the mass energy absorption coefficients of medium materials, air and tissue were used for absorbed dose, exposure and dose-equivalent buildup factors, respectively.

In these calculations, the effects of bremsstrahlung in the high source energy and K-shell fluorescences with different transition energies in the source energy close to the K edge of attenuation in each materials were included. It was pointed out that there were large differences between buildup factors including a single K-shell fluorescence with average transition energy ¹² and these including some K-shell fluorescences with different energies in deep penetration, because of the differences of the total cross sections corresponding to the fluorescence energies below the K-edge energy. The energies and intensities of 4 fluorescences ($K_{\alpha 2}$, $K_{\alpha 1}$, $K_{\beta 1}$, $K_{\beta 2}$) used in this calculation are tabulated in table 2.

3. Parameter Fitting to the G-P Approximation

As the buildup factors are needed at arbitrary source energy and source-detector distance in shielding calculation, the buildup factors have been represented by parameterized forms. The G-P approximation method is the one of these formula for point source buildup factor and is represented by

$$Br(E_0, X) = 1 + (B - 1) * (K^X - 1) / (K - 1) \quad \dots(1)$$

where Br is the buildup factor at source energy (E_0) and X source-detector distance in mean-free-path of the medium, B is the value of the buildup factor of 1 mfp depending on E_0 and K represents the photon dose multiplication per unit mfp penetration depending on E_0 and X . If K equals unity, the equation is expressed as follows.

$$Br(E_0, X) = 1 + (B - 1) * X \quad \dots(1)'$$

The parameter K is represented by

$$K = c * X^a + d * f(X / X_k) \quad \dots(2)$$

$$f(y) = \{\tanh(y - 2) - \tanh(-2)\} / \{1 - \tanh(-2)\}$$

where a , c , d and X_k are the fitting parameters depending on the source energy.

The G-P parameters in this report were obtained by the least square fitting code, GPFIT.

4. Results and Discussion

The values of absorbed dose, exposure and dose-equivalent buildup factors for molybdenum, tin, lanthanum, gadolinium, tungsten, lead and uranium are listed in Tables 3.1 - 3.7. These values include the effects of bremsstrahlung in high source energy and of fluorescence in the source energy close to the K edge of attenuation cross section in each materials.

The lead exposure buildup factors⁸, excluding the contribution of bremsstrahlung, are compared with the results of modified moments method and the ASFIT⁴ in Figure 2. Deviations of the PALLAS results from those of the ASFIT were within 10 % for all cases in the 3-10 MeV energy range up to 20 mfp depth, except for 15 and 20 mfp depths in the 10 MeV source energy. The deviations from the modified moments method are almost the same as those from the ASFIT.

The values of the buildup factors are gently varying with increasing the atomic number. As typical examples, the exposure buildup factors are shown for the atomic number from 8 to 92 at distances of 1, 5, 10, 20 and 40 mfp in Figure 3. In the 1 MeV case, the value of the buildup factors are dominant in low Z material. On the other hand, in the 10 MeV case, they show on increasing curves in high Z material range. The curves for 3 MeV case are flat. These of lanthanum and gadolinium are effective for the purpose of the interpolation of buildup factors with atomic number.

Moreover, in order to obtain the value of buildup factor at arbitrary distance and energy from the PALLAS's results the values of the G-P parameters were determined for all buildup factors. The results are given in Tables 4.1 - 4.7. These tables include the 5 parameters of G-P approximation (B, c, a, X_k and d), maximum

deviation of fitted data to original buildup factors, source-detector distance where the maximum deviation appears and root mean square of fitted data to original ones for each source energy. Maximum deviations in parameter fitting to the G-P approximation are below 20 % for all buildup factors of 7 materials. The G-P parameters are smoothly changed over the energy except in K-shell edge energy. It is possible to interpolate the G-P parameter in source energy or atomic number.

5. Conclusion

Gamma-ray buildup factors for point isotropic source in medium of high-Z material as a function of source energies have been obtained over an energy range from 0.015 MeV to 15 MeV for penetration depths up to 40 mfp. Furthermore the G-P parameter to those buildup factors have been determined within 20 % in maximum deviations. Using these G-P parameters, the buildup factors in medium of arbitrary atomic number will be calculated in gamma-ray shielding calculation.

Acknowledgement

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Table 1.1 Photon cross section and dose rate conversion factor
for molybdenum

42 - MO MAT=1420 A= 95.94

E (MEV)	TOT UNIT #	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.01	8.230E+1	8.223E+1		8.223E+1	8.223E+1	3.960E-1	3.073E-1
0.012	4.966E+1	4.946E+1		4.947E+1	4.947E+1	2.401E-1	1.718E-1
0.013	3.974E+1	3.957E+1		3.957E+1	3.957E+1	1.927E-1	1.331E-1
0.014	3.232E+1	3.218E+1		3.219E+1	3.219E+1	1.572E-1	1.050E-1
0.015	2.664E+1	2.655E+1		2.656E+1	2.656E+1	1.301E-1	8.428E-2
0.017	1.891E+1	1.879E+1		1.879E+1	1.879E+1	9.226E-2	5.677E-2
0.018	1.616E+1	1.604E+1		1.605E+1	1.605E+1	7.886E-2	4.739E-2
0.02	1.208E+1	1.199E+1		1.199E+1	1.199E+1	5.905E-2	3.398E-2
0.02001	8.107E+1	8.097E+1	6.899E+1	8.098E+1	3.428E+1	5.897E-2	3.398E-2
0.03	2.741E+1	2.730E+1	2.326E+1	2.731E+1	1.683E+1	1.940E-2	9.822E-3
0.04	1.254E+1	1.243E+1	1.059E+1	1.244E+1	8.861E+0	9.829E-3	4.440E-3
0.05	6.710E+0	6.591E+0	5.615E+0	6.603E+0	5.084E+0	5.800E-3	2.694E-3
0.06	4.063E+0	3.942E+0	3.359E+0	3.955E+0	3.196E+0	4.537E-3	2.024E-3
0.08	1.834E+0	1.714E+0	1.460E+0	1.730E+0	1.485E+0	3.339E-3	1.613E-3
0.1	1.009E+0	8.913E-1	7.594E-1	9.093E-1	8.089E-1	2.830E-3	1.553E-3
0.15	3.829E-1	2.718E-1	2.316E-1	2.930E-1	2.723E-1	2.530E-3	1.659E-3
0.2	2.203E-1	1.168E-1	9.947E-2	1.399E-1	1.330E-1	2.505E-3	1.779E-3
0.3	1.280E-1	3.634E-2	3.096E-2	6.145E-2	6.007E-2	2.530E-3	1.911E-3
0.4	9.874E-2	1.651E-2	1.407E-2	4.237E-2	4.187E-2	2.463E-3	1.958E-3
0.5	8.449E-2	9.164E-3	7.808E-3	3.515E-2	3.496E-2	2.340E-3	1.964E-3
0.6	7.617E-2	5.869E-3	5.000E-3	3.179E-2	3.168E-2	2.270E-3	1.958E-3
0.8	6.465E-2	3.013E-3	2.567E-3	2.831E-2	2.827E-2	2.100E-3	1.918E-3
1	5.736E-2	1.871E-3	1.594E-3	2.635E-2	2.633E-2	1.980E-3	1.845E-3
1.5	4.662E-2	8.662E-4	7.380E-4	2.341E-2	2.341E-2	1.755E-3	1.686E-3
2	4.130E-2	5.348E-4	4.556E-4	2.209E-2	2.208E-2	1.604E-3	1.553E-3
3	3.652E-2	2.869E-4	2.444E-4	2.170E-2	2.170E-2	1.397E-3	1.361E-3
4	3.484E-2	1.921E-4	1.636E-4	2.250E-2	2.250E-2	1.258E-3	1.234E-3
5	3.429E-2	1.444E-4	1.230E-4	2.363E-2	2.363E-2	1.160E-3	1.155E-3
6	3.426E-2	1.136E-4	9.680E-5	2.490E-2	2.490E-2	1.093E-3	1.083E-3
8	3.504E-2	7.972E-5	6.792E-5	2.733E-2	2.733E-2	1.004E-3	1.009E-3
10	3.615E-2	6.164E-5	5.252E-5	2.958E-2	2.958E-2	9.543E-4	9.623E-4
15	3.933E-2	3.842E-5	3.273E-5	3.445E-2	3.445E-2	8.867E-4	8.953E-4
20	4.234E-2	2.812E-5	2.396E-5	3.837E-2	3.837E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.2 Photon cross section and dose rate conversion factor
for tin

50 - SN MAT=1500 A=118.69

E (MEV)	TOT UNIT #	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.01	1.340E+2	1.340E+2		1.340E+2	1.340E+2	3.960E-1	3.073E-1
0.012	8.149E+1	8.127E+1		8.128E+1	8.128E+1	2.401E-1	1.718E-1
0.013	6.545E+1	6.527E+1		6.527E+1	6.527E+1	1.927E-1	1.331E-1
0.014	5.341E+1	5.327E+1		5.328E+1	5.328E+1	1.572E-1	1.050E-1
0.015	4.417E+1	4.409E+1		4.410E+1	4.410E+1	1.301E-1	8.428E-2
0.017	3.128E+1	3.115E+1		3.116E+1	3.116E+1	9.226E-2	5.677E-2
0.02	1.993E+1	1.984E+1		1.984E+1	1.984E+1	5.905E-2	3.398E-2
0.0292	7.052E+0	6.951E+0		6.959E+0	6.959E+0	2.089E-2	1.067E-2
0.02921	4.328E+1	4.318E+1	3.623E+1	4.319E+1	1.558E+1	2.087E-2	1.066E-2
0.03	4.003E+1	3.993E+1	3.350E+1	3.994E+1	1.507E+1	1.940E-2	9.822E-3
0.04	1.888E+1	1.877E+1	1.575E+1	1.878E+1	1.000E+1	9.829E-3	4.440E-3
0.05	1.031E+1	1.020E+1	8.557E+0	1.021E+1	6.402E+0	5.800E-3	2.694E-3
0.06	6.304E+0	6.190E+0	5.194E+0	6.203E+0	4.273E+0	4.537E-3	2.024E-3
0.08	2.869E+0	2.755E+0	2.312E+0	2.771E+0	2.124E+0	3.339E-3	1.613E-3
0.1	1.568E+0	1.456E+0	1.222E+0	1.473E+0	1.198E+0	2.830E-3	1.553E-3
0.15	5.612E-1	4.551E-1	3.819E-1	4.755E-1	4.175E-1	2.530E-3	1.659E-3
0.2	2.978E-1	1.989E-1	1.669E-1	2.212E-1	2.015E-1	2.505E-3	1.779E-3
0.3	1.512E-1	6.343E-2	5.321E-2	8.758E-2	8.301E-2	2.530E-3	1.911E-3
0.4	1.081E-1	2.897E-2	2.431E-2	5.384E-2	5.196E-2	2.463E-3	1.958E-3
0.5	8.885E-2	1.629E-2	1.367E-2	4.130E-2	4.029E-2	2.340E-3	1.964E-3
0.6	7.794E-2	1.045E-2	8.770E-3	3.537E-2	3.471E-2	2.270E-3	1.958E-3
0.8	6.474E-2	5.378E-3	4.513E-3	2.973E-2	2.907E-2	2.100E-3	1.918E-3
1	5.664E-2	3.364E-3	2.822E-3	2.691E-2	2.603E-2	1.980E-3	1.845E-3
1.5	4.576E-2	1.548E-3	1.298E-3	2.331E-2	2.262E-2	1.755E-3	1.686E-3
2	4.069E-2	9.488E-4	7.961E-4	2.194E-2	2.099E-2	1.604E-3	1.553E-3
3	3.653E-2	5.059E-4	4.244E-4	2.187E-2	2.041E-2	1.397E-3	1.361E-3
4	3.545E-2	3.374E-4	2.831E-4	2.313E-2	2.114E-2	1.258E-3	1.234E-3
5	3.531E-2	2.527E-4	2.120E-4	2.465E-2	2.212E-2	1.160E-3	1.155E-3
6	3.566E-2	1.974E-4	1.656E-4	2.616E-2	2.308E-2	1.093E-3	1.088E-3
8	3.692E-2	1.380E-4	1.158E-4	2.910E-2	2.490E-2	1.004E-3	1.009E-3
10	3.852E-2	1.066E-4	8.940E-5	3.181E-2	2.644E-2	9.543E-4	9.623E-4
15	4.249E-2	6.698E-5	5.619E-5	3.746E-2	2.924E-2	8.867E-4	8.953E-4
20	4.612E-2	4.846E-5	4.066E-5	4.203E-2	3.035E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.3 Photon cross section and dose rate conversion factor
for lanthanum

57 - LA MAT=1570 A=138.90

E (MEV)	TOT UNIT #	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E. ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.01	1.921E+2	1.921E+2		1.921E+2	1.921E+2	3.960E-1	3.073E-1
0.012	1.179E+2	1.177E+2		1.177E+2	1.177E+2	2.401E-1	1.718E-1
0.013	9.509E+1	9.490E+1		9.491E+1	9.491E+1	1.927E-1	1.331E-1
0.014	7.790E+1	7.777E+1		7.777E+1	7.777E+1	1.572E-1	1.050E-1
0.015	6.468E+1	6.461E+1		6.461E+1	6.461E+1	1.301E-1	8.428E-2
0.017	4.594E+1	4.581E+1		4.581E+1	4.581E+1	9.226E-2	5.677E-2
0.02	2.940E+1	2.931E+1		2.932E+1	2.932E+1	5.905E-2	3.398E-2
0.03	9.549E+0	9.452E+0		9.460E+0	9.460E+0	1.940E-2	9.822E-3
0.03892	4.742E+0	4.640E+0		4.649E+0	4.649E+0	1.048E-2	4.788E-3
0.03893	2.707E+1	2.697E+1	2.239E+1	2.698E+1	9.375E+0	1.048E-2	4.785E-3
0.04	2.538E+1	2.528E+1	2.098E+1	2.529E+1	9.245E+0	9.829E-3	4.440E-3
0.05	1.398E+1	1.388E+1	1.152E+1	1.389E+1	6.819E+0	5.800E-3	2.694E-3
0.06	8.651E+0	8.542E+0	7.090E+0	8.554E+0	4.956E+0	4.537E-3	2.024E-3
0.08	3.994E+0	3.885E+0	3.225E+0	3.900E+0	2.664E+0	3.339E-3	1.613E-3
0.1	2.181E+0	2.073E+0	1.720E+0	2.089E+0	1.565E+0	2.830E-3	1.553E-3
0.15	7.657E-1	6.634E-1	5.506E-1	6.833E-1	5.706E-1	2.530E-3	1.659E-3
0.2	3.889E-1	2.931E-1	2.433E-1	3.148E-1	2.775E-1	2.505E-3	1.779E-3
0.3	1.808E-1	9.583E-2	7.954E-2	1.194E-1	1.111E-1	2.530E-3	1.911E-3
0.4	1.214E-1	4.423E-2	3.671E-2	6.847E-2	6.565E-2	2.463E-3	1.958E-3
0.5	9.591E-2	2.524E-2	2.095E-2	4.960E-2	4.830E-2	2.340E-3	1.964E-3
0.6	8.152E-2	1.604E-2	1.332E-2	4.032E-2	3.963E-2	2.270E-3	1.958E-3
0.8	6.595E-2	8.282E-3	6.874E-3	3.204E-2	3.178E-2	2.100E-3	1.918E-3
1	5.724E-2	5.203E-3	4.319E-3	2.818E-2	2.805E-2	1.980E-3	1.845E-3
1.5	4.564E-2	2.389E-3	1.983E-3	2.367E-2	2.363E-2	1.755E-3	1.686E-3
2	4.066E-2	1.457E-3	1.209E-3	2.218E-2	2.216E-2	1.604E-3	1.553E-3
3	3.698E-2	7.718E-4	6.406E-4	2.231E-2	2.230E-2	1.397E-3	1.361E-3
4	3.619E-2	5.073E-4	4.211E-4	2.383E-2	2.383E-2	1.258E-3	1.234E-3
5	3.645E-2	3.794E-4	3.149E-4	2.561E-2	2.561E-2	1.160E-3	1.155E-3
6	3.694E-2	2.992E-4	2.483E-4	2.733E-2	2.733E-2	1.093E-3	1.088E-3
8	3.863E-2	2.094E-4	1.738E-4	3.068E-2	3.068E-2	1.004E-3	1.009E-3
10	4.044E-2	1.617E-4	1.342E-4	3.359E-2	3.359E-2	9.543E-4	9.623E-4
15	4.502E-2	1.002E-4	8.313E-5	3.987E-2	3.987E-2	8.867E-4	8.953E-4
20	4.919E-2	7.241E-5	6.010E-5	4.504E-2	4.504E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.4 Photon cross section and dose rate conversion factor
for gadolinium

64 - GD MAT=1640 A=157.30

E (MEV) UNIT	TOT (A)	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.01	2.628E+2	2.627E+2		2.627E+2	2.627E+2	3.960E-1	3.073E-1
0.012	1.625E+2	1.623E+2		1.623E+2	1.623E+2	2.401E-1	1.718E-1
0.013	1.316E+2	1.314E+2		1.314E+2	1.314E+2	1.927E-1	1.331E-1
0.014	1.081E+2	1.080E+2		1.080E+2	1.080E+2	1.572E-1	1.050E-1
0.015	9.007E+1	9.000E+1		9.001E+1	9.001E+1	1.301E-1	8.428E-2
0.017	6.430E+1	6.417E+1		6.418E+1	6.418E+1	9.226E-2	5.677E-2
0.02	4.144E+1	4.136E+1		4.137E+1	4.137E+1	5.905E-2	3.398E-2
0.03	1.365E+1	1.356E+1		1.357E+1	1.357E+1	1.940E-2	9.822E-3
0.04	6.190E+0	6.090E+0		6.099E+0	6.099E+0	9.829E-3	4.440E-3
0.05	3.398E+0	3.294E+0		3.305E+0	3.305E+0	5.800E-3	2.694E-3
0.05024	3.359E+0	3.255E+0		3.267E+0	3.267E+0	5.800E-3	2.694E-3
0.05025	1.810E+1	1.800E+1	1.472E+1	1.801E+1	6.139E+0	5.800E-3	2.694E-3
0.06	1.140E+1	1.130E+1	9.242E+0	1.131E+1	5.068E+0	4.537E-3	2.024E-3
0.08	5.354E+0	5.247E+0	4.292E+0	5.262E+0	3.087E+0	3.339E-3	1.613E-3
0.1	2.948E+0	2.842E+0	2.325E+0	2.859E+0	1.916E+0	2.830E-3	1.553E-3
0.15	1.039E+0	9.383E-1	7.676E-1	9.581E-1	7.513E-1	2.530E-3	1.659E-3
0.2	5.125E-1	4.175E-1	3.415E-1	4.390E-1	3.697E-1	2.505E-3	1.779E-3
0.3	2.237E-1	1.394E-1	1.140E-1	1.628E-1	1.475E-1	2.530E-3	1.911E-3
0.4	1.409E-1	6.473E-2	5.295E-2	8.878E-2	8.342E-2	2.463E-3	1.958E-3
0.5	1.074E-1	3.727E-2	3.048E-2	6.143E-2	5.894E-2	2.340E-3	1.964E-3
0.6	8.897E-2	2.386E-2	1.952E-2	4.795E-2	4.665E-2	2.270E-3	1.958E-3
0.8	6.944E-2	1.237E-2	1.012E-2	3.593E-2	3.543E-2	2.100E-3	1.918E-3
1	5.944E-2	7.737E-3	6.329E-3	3.053E-2	3.026E-2	1.980E-3	1.845E-3
1.5	4.682E-2	3.581E-3	2.929E-3	2.473E-2	2.465E-2	1.755E-3	1.686E-3
2	4.159E-2	2.183E-3	1.786E-3	2.298E-2	2.294E-2	1.604E-3	1.553E-3
3	3.822E-2	1.145E-3	9.367E-4	2.328E-2	2.327E-2	1.397E-3	1.361E-3
4	3.771E-2	7.468E-4	6.109E-4	2.503E-2	2.502E-2	1.258E-3	1.234E-3
5	3.817E-2	5.553E-4	4.554E-4	2.707E-2	2.706E-2	1.160E-3	1.155E-3
6	3.885E-2	4.366E-4	3.572E-4	2.898E-2	2.898E-2	1.093E-3	1.088E-3
8	4.079E-2	3.053E-4	2.497E-4	3.260E-2	3.260E-2	1.004E-3	1.009E-3
10	4.290E-2	2.352E-4	1.924E-4	3.588E-2	3.588E-2	9.543E-4	9.623E-4
15	4.806E-2	1.452E-4	1.187E-4	4.278E-2	4.278E-2	8.867E-4	8.953E-4
20	5.272E-2	1.046E-4	8.553E-5	4.838E-2	4.838E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.5 Photon cross section and dose rate conversion factor
for tungsten

74 - W MAT=1740 A=183.90

E (MEV)	TOT UNIT #	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.01	9.014E+1	9.009E+1		9.009E+1	9.009E+1	3.960E-1	3.073E-1
0.01153	1.645E+2	1.645E+2		1.645E+2	1.645E+2	2.672E-1	1.946E-1
0.01154	2.304E+2	2.303E+2		2.303E+2	2.303E+2	2.671E-1	1.940E-1
0.01209	2.028E+2	2.028E+2		2.028E+2	2.028E+2	2.348E-1	1.677E-1
0.0121	2.333E+2	2.333E+2		2.333E+2	2.333E+2	2.347E-1	1.673E-1
0.015	1.344E+2	1.343E+2		1.343E+2	1.343E+2	1.301E-1	8.428E-2
0.02	6.297E+1	6.290E+1		6.291E+1	6.291E+1	5.905E-2	3.398E-2
0.03	2.122E+1	2.113E+1		2.114E+1	2.114E+1	1.940E-2	9.822E-3
0.04	9.726E+0	9.631E+0		9.641E+0	9.641E+0	9.829E-3	4.440E-3
0.05	5.341E+0	5.242E+0		5.252E+0	5.252E+0	5.800E-3	2.694E-3
0.06	3.240E+0	3.138E+0		3.151E+0	3.151E+0	4.537E-3	2.024E-3
0.06952	2.200E+0	2.097E+0		2.110E+0	2.110E+0	3.720E-3	1.802E-3
0.06953	1.078E+1	1.068E+1	8.576E+0	1.069E+1	3.617E+0	3.719E-3	1.802E-3
0.08	7.540E+0	7.437E+0	5.972E+0	7.451E+0	3.163E+0	3.339E-3	1.613E-3
0.1	4.230E+0	4.128E+0	3.315E+0	4.144E+0	2.241E+0	2.830E-3	1.553E-3
0.15	1.501E+0	1.402E+0	1.126E+0	1.422E+0	9.892E-1	2.530E-3	1.659E-3
0.2	7.351E-1	6.421E-1	5.156E-1	6.634E-1	5.160E-1	2.505E-3	1.779E-3
0.3	2.994E-1	2.165E-1	1.739E-1	2.396E-1	2.062E-1	2.530E-3	1.911E-3
0.4	1.785E-1	1.032E-1	8.286E-2	1.270E-1	1.152E-1	2.463E-3	1.958E-3
0.5	1.287E-1	5.962E-2	4.788E-2	8.354E-2	7.797E-2	2.340E-3	1.964E-3
0.6	1.029E-1	3.866E-2	3.104E-2	6.247E-2	5.952E-2	2.270E-3	1.958E-3
0.8	7.705E-2	2.038E-2	1.636E-2	4.367E-2	4.249E-2	2.100E-3	1.918E-3
1	6.355E-2	1.278E-2	1.026E-2	3.528E-2	3.469E-2	1.980E-3	1.845E-3
1.5	4.887E-2	5.864E-3	4.709E-3	2.689E-2	2.669E-2	1.755E-3	1.686E-3
2	4.324E-2	3.538E-3	2.841E-3	2.449E-2	2.443E-2	1.604E-3	1.553E-3
3	4.005E-2	1.854E-3	1.489E-3	2.475E-2	2.472E-2	1.397E-3	1.361E-3
4	3.988E-2	1.219E-3	9.786E-4	2.679E-2	2.678E-2	1.258E-3	1.234E-3
5	4.064E-2	9.009E-4	7.234E-4	2.914E-2	2.913E-2	1.160E-3	1.155E-3
6	4.162E-2	7.076E-4	5.682E-4	3.137E-2	3.137E-2	1.093E-3	1.088E-3
8	4.393E-2	4.914E-4	3.946E-4	3.543E-2	3.543E-2	1.004E-3	1.009E-3
10	4.653E-2	3.735E-4	2.999E-4	3.916E-2	3.916E-2	9.543E-4	9.623E-4
15	5.232E-2	2.293E-4	1.841E-4	4.674E-2	4.674E-2	8.867E-4	8.953E-4
20	5.766E-2	1.667E-4	1.339E-4	5.308E-2	5.308E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.6 Photon cross section and dose rate conversion factor
for lead

82 - PB MAT=1820 A=207.20

E (MEV)	TOT UNIT *	PHOTO ELECTRIC	K X-RAY PRODUCT	MASS E TRANSFER	MASS E ABSORP.	TISSUE RESPONSE (B)	AIR RESPONSE (C)
(A)	(A)	(A)	(A)	(A)	(A)		
0.0131	1.591E+2	1.590E+2		1.590E+2	1.590E+2	1.887E-1	1.298E-1
0.015	1.070E+2	1.070E+2		1.070E+2	1.070E+2	1.301E-1	8.428E-2
0.0152	1.044E+2	1.044E+2		1.044E+2	1.044E+2	1.254E-1	8.428E-2
0.01521	1.457E+2	1.456E+2		1.456E+2	1.456E+2	1.252E-1	8.428E-2
0.0159	1.518E+2	1.517E+2		1.517E+2	1.517E+2	1.109E-1	8.428E-2
0.01591	1.518E+2	1.517E+2		1.517E+2	1.517E+2	1.107E-1	8.428E-2
0.02	8.292E+1	8.285E+1		8.286E+1	8.286E+1	5.905E-2	3.398E-2
0.03	2.854E+1	2.846E+1		2.847E+1	2.847E+1	1.940E-2	9.822E-3
0.04	1.326E+1	1.317E+1		1.318E+1	1.318E+1	9.829E-3	4.440E-3
0.05	7.247E+0	7.151E+0		7.162E+0	7.162E+0	5.800E-3	2.694E-3
0.06	4.459E+0	4.360E+0		4.373E+0	4.373E+0	4.537E-3	2.024E-3
0.08	2.077E+0	1.977E+0		1.991E+0	1.991E+0	3.339E-3	1.613E-3
0.088	1.629E+0	1.529E+0		1.544E+0	1.544E+0	3.111E-3	1.587E-3
0.0881	7.309E+0	7.209E+0	5.681E+0	7.224E+0	2.495E+0	3.111E-3	1.587E-3
0.1	5.332E+0	5.233E+0	4.123E+0	5.249E+0	2.229E+0	2.830E-3	1.553E-3
0.15	1.919E+0	1.823E+0	1.436E+0	1.842E+0	1.141E+0	2.530E-3	1.659E-3
0.2	9.401E-1	8.488E-1	6.689E-1	8.698E-1	6.256E-1	2.505E-3	1.779E-3
0.3	3.750E-1	2.936E-1	2.314E-1	3.163E-1	2.599E-1	2.530E-3	1.911E-3
0.4	2.154E-1	1.416E-1	1.116E-1	1.649E-1	1.446E-1	2.463E-3	1.958E-3
0.5	1.503E-1	8.256E-2	6.506E-2	1.061E-1	9.648E-2	2.340E-3	1.964E-3
0.6	1.172E-1	5.407E-2	4.261E-2	7.750E-2	7.227E-2	2.270E-3	1.958E-3
0.8	8.419E-2	2.866E-2	2.259E-2	5.157E-2	4.951E-2	2.100E-3	1.918E-3
1	6.805E-2	1.805E-2	1.423E-2	4.020E-2	3.916E-2	1.980E-3	1.845E-3
1.5	5.063E-2	8.285E-3	6.529E-3	2.904E-2	2.872E-2	1.755E-3	1.686E-3
2	4.480E-2	4.971E-3	3.917E-3	2.591E-2	2.576E-2	1.604E-3	1.553E-3
3	4.142E-2	2.581E-3	2.034E-3	2.595E-2	2.590E-2	1.397E-3	1.361E-3
4	4.145E-2	1.709E-3	1.347E-3	2.815E-2	2.813E-2	1.258E-3	1.234E-3
5	4.237E-2	1.265E-3	9.965E-4	3.067E-2	3.066E-2	1.160E-3	1.155E-3
6	4.342E-2	9.768E-4	7.697E-4	3.296E-2	3.295E-2	1.093E-3	1.088E-3
8	4.579E-2	6.744E-4	5.314E-4	3.714E-2	3.713E-2	1.004E-3	1.009E-3
10	4.846E-2	5.204E-4	4.100E-4	4.097E-2	4.097E-2	9.543E-4	9.623E-4
15	5.468E-2	3.169E-4	2.497E-4	4.897E-2	4.897E-2	8.867E-4	8.953E-4
20	6.067E-2	2.297E-4	1.810E-4	5.598E-2	5.598E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 1.7 Photon cross section and dose rate conversion factor
for uranium

92 - U MAT=1928 A=238.03

E (MEV) UNIT #	TOT (A)	PHOTO ELECTRIC (A)	K X-RAY PRODUCT (A)	MASS E TRANSFER (A)	MASS E ABSORP. (A)	TISSUE RESPONSE (B)	AIR RESPONSE (C)
0.015	5.977E+1	5.971E+1		5.971E+1	5.971E+1	1.301E-1	8.428E-2
0.01716	4.256E+1	4.250E+1		4.251E+1	4.251E+1	8.977E-2	5.501E-2
0.01717	1.025E+2	1.025E+2		1.025E+2	1.025E+2	8.975E-2	5.491E-2
0.02	6.812E+1	6.806E+1		6.806E+1	6.806E+1	5.905E-2	3.398E-2
0.02094	6.003E+1	5.996E+1		5.997E+1	5.997E+1	5.200E-2	3.398E-2
0.02095	8.508E+1	8.501E+1		8.501E+1	8.501E+1	5.199E-2	3.398E-2
0.02175	7.723E+1	7.716E+1		7.717E+1	7.717E+1	4.685E-2	2.628E-2
0.02176	8.887E+1	8.880E+1		8.881E+1	8.881E+1	4.684E-2	2.625E-2
0.04	1.848E+1	1.839E+1		1.840E+1	1.840E+1	9.829E-3	4.440E-3
0.05	1.026E+1	1.017E+1		1.018E+1	1.018E+1	5.800E-3	2.694E-3
0.06	6.318E+0	6.224E+0		6.236E+0	6.236E+0	4.537E-3	2.024E-3
0.08	2.955E+0	2.859E+0		2.873E+0	2.873E+0	3.339E-3	1.613E-3
0.1	1.664E+0	1.569E+0		1.584E+0	1.584E+0	2.830E-3	1.553E-3
0.1155	1.156E+0	1.060E+0		1.077E+0	1.031E+0	2.720E-3	1.590E-3
0.1156	4.650E+0	4.554E+0	3.493E+0	4.571E+0	1.651E+0	2.719E-3	1.590E-3
0.15	2.474E+0	2.381E+0	1.826E+0	2.399E+0	1.223E+0	2.530E-3	1.659E-3
0.2	1.225E+0	1.136E+0	8.713E-1	1.156E+0	7.364E-1	2.505E-3	1.779E-3
0.3	4.840E-1	4.048E-1	3.105E-1	4.270E-1	3.258E-1	2.530E-3	1.911E-3
0.4	2.715E-1	1.996E-1	1.531E-1	2.225E-1	1.855E-1	2.463E-3	1.958E-3
0.5	1.839E-1	1.179E-1	9.043E-2	1.408E-1	1.234E-1	2.340E-3	1.964E-3
0.6	1.394E-1	7.792E-2	5.977E-2	1.008E-1	9.118E-2	2.270E-3	1.958E-3
0.8	9.589E-2	4.174E-2	3.202E-2	6.411E-2	6.032E-2	2.100E-3	1.918E-3
1	7.539E-2	2.656E-2	2.038E-2	4.820E-2	4.622E-2	1.980E-3	1.845E-3
1.5	5.381E-2	1.212E-2	9.295E-3	3.251E-2	3.190E-2	1.755E-3	1.686E-3
2	4.691E-2	7.286E-3	5.589E-3	2.815E-2	2.787E-2	1.604E-3	1.553E-3
3	4.344E-2	3.744E-3	2.872E-3	2.770E-2	2.760E-2	1.397E-3	1.361E-3
4	4.341E-2	2.449E-3	1.878E-3	2.987E-2	2.983E-2	1.258E-3	1.234E-3
5	4.439E-2	1.811E-3	1.389E-3	3.246E-2	3.244E-2	1.160E-3	1.155E-3
6	4.530E-2	1.409E-3	1.081E-3	3.465E-2	3.464E-2	1.093E-3	1.088E-3
8	4.810E-2	9.690E-4	7.432E-4	3.923E-2	3.922E-2	1.004E-3	1.009E-3
10	5.061E-2	7.463E-4	5.725E-4	4.297E-2	4.297E-2	9.543E-4	9.623E-4
15	5.733E-2	4.529E-4	3.474E-4	5.151E-2	5.151E-2	8.867E-4	8.953E-4
20	6.358E-2	3.264E-4	2.503E-4	5.876E-2	5.876E-2	8.600E-4	8.681E-4

¥ UNIT (A) : CM**2 / G
 (B) : (MREM/HR) / (PHOTONS*MEV/CM**2/SEC)
 (C) : (MR/HR) / (PHOTONS*MEV/CM**2/SEC)

Table 2 Energies and intensity of 4 fluorescence X-ray for several materials

Z	element	$K_{\alpha 2}$	$K_{\alpha 1}$	$K_{\beta 1'}$	$K_{\beta 2'}$	ω_k
42	Mo	a) 17.3743	17.47934	19.60	19.97	0.764
		b) 52.5	(100)	25.9	4.1	
50	Sn	25.0440	25.2713	28.48	29.11	0.859
		53.4	(100)	28.2	5.5	
57	La	33.0341	33.4418	37.8	38.7	0.906
		54.4	(100)	29.7	7.3	
64	Gd	42.3089	42.9962	48.7	50.0	0.934
		55.6	(100)	30.8	8.9	
74	W	57.9817	59.3182	67.2	69.1	0.957
		57.6	(100)	33.8	8.6	
82	Pb	72.804	74.969	84.769	87.3	0.968
		59.3	(100)	33.8	10.2	
92	U	94.665	98.439	110.991	114.5	0.976
		61.9	(100)	33.6	12.3	

a) fluorescence energy (keV)

b) relative intensity

ω_k : K-fluorescence yield

Source: Table of Isotopes ,seventh edition (1987)

edited by C.M.Lederer and V.S.Shirley

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Table 3.1 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick molybdenum

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK MOLYBDENUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.25	1.27	1.33	1.37	1.40	1.34	1.38	1.42	1.44	1.52
1.0	1.47	1.48	1.55	1.62	1.67	1.62	1.72	1.86	1.92	2.07
2.0	1.84	1.81	1.89	2.00	2.12	2.11	2.38	2.80	3.02	3.37
3.0	2.25	2.14	2.21	2.38	2.55	2.57	3.02	3.72	4.14	4.74
4.0	2.76	2.52	2.59	2.79	3.03	3.08	3.68	4.64	5.25	6.13
5.0	3.39	2.97	3.02	3.26	3.57	3.64	4.40	5.61	6.41	7.57
6.0	4.18	3.49	3.51	3.80	4.18	4.28	5.20	6.69	7.67	9.16
7.0	5.16	4.11	4.08	4.41	4.85	4.98	6.05	7.82	8.99	1.09E1
8.0	6.38	4.81	4.77	5.07	5.59	5.73	6.96	9.02	1.04E1	1.26E1
10.0	9.72	6.56	6.23	6.60	7.25	7.40	8.94	1.16E1	1.33E1	1.65E1
15.0	2.75E1	1.38E1	1.19E1	1.18E1	1.26E1	1.26E1	1.48E1	1.91E1	2.17E1	2.79E1
20.0	7.59E1	2.76E1	2.14E1	1.92E1	1.99E1	1.90E1	2.15E1	2.75E1	3.09E1	4.10E1
25.0	2.03E2	5.30E1	3.65E1	2.93E1	2.90E1	2.66E1	2.88E1	3.65E1	4.06E1	5.57E1
30.0	5.27E2	9.83E1	5.97E1	4.24E1	4.02E1	3.53E1	3.66E1	4.59E1	5.07E1	7.16E1
35.0	1.33E3	1.78E2	9.44E1	5.92E1	5.36E1	4.51E1	4.99E1	5.58E1	6.12E1	8.87E1
40.0	3.30E3	3.13E2	1.45E2	7.99E1	6.93E1	5.57E1	5.34E1	6.59E1	7.19E1	1.06E2
R(MFP)	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.06
0.5	1.60	1.65	1.72	2.35	2.10	1.65	1.33	1.13	1.07	1.02
1.0	2.19	2.28	2.32	3.19	2.69	1.87	1.42	1.16	1.09	1.03
2.0	3.59	3.70	3.67	4.45	3.49	2.16	1.53	1.19	1.10	1.04
3.0	5.06	5.18	5.02	5.69	4.22	2.42	1.63	1.22	1.12	1.05
4.0	6.55	6.68	6.34	6.79	4.85	2.63	1.72	1.25	1.13	1.06
5.0	8.08	8.24	7.69	7.91	5.45	2.81	1.80	1.28	1.15	1.07
6.0	9.77	9.97	9.13	9.17	6.10	3.00	1.88	1.30	1.16	1.08
7.0	1.16E1	1.18E1	1.07E1	1.04E1	6.68	3.17	1.94	1.32	1.17	1.08
8.0	1.35E1	1.37E1	1.23E1	1.16E1	7.25	3.32	2.00	1.34	1.18	1.09
10.0	1.75E1	1.80E1	1.57E1	1.40E1	8.38	3.60	2.10	1.37	1.20	1.09
15.0	2.96E1	3.05E1	2.53E1	2.04E1	1.10E1	4.16	2.31	1.43	1.23	1.11
20.0	4.32E1	4.49E1	3.61E1	2.66E1	1.32E1	4.57	2.45	1.47	1.26	1.12
25.0	5.80E1	6.11E1	4.78E1	3.26E1	1.53E1	4.89	2.57	1.51	1.27	1.13
30.0	7.40E1	7.88E1	6.01E1	3.85E1	1.71E1	5.17	2.67	1.53	1.29	1.14
35.0	9.10E1	9.79E1	7.31E1	4.41E1	1.87E1	5.42	2.77	1.56	1.30	1.15
40.0	1.09E2	1.18E2	8.64E1	4.96E1	2.02E1	5.63	2.85	1.58	1.31	1.15
R(MFP)	0.05	0.04	0.035	0.03	0.028	0.026	0.024	0.022	0.021	0.02
0.5	1.31	1.31	1.31	1.29	1.29	1.28	1.27	1.26	1.26	1.01
1.0	1.38	1.49	1.53	1.55	1.56	1.57	1.57	1.56	1.56	1.01
2.0	1.40	1.66	1.89	2.11	2.22	2.33	2.42	2.48	2.51	1.02
3.0	1.40	1.73	2.19	2.84	3.21	3.60	3.99	4.33	4.50	1.02
4.0	1.39	1.77	2.50	3.93	4.87	5.95	7.16	8.36	8.99	1.02
5.0	1.40	1.79	2.84	5.61	7.70	1.04E1	1.37E1	1.73E1	1.93E1	1.02
6.0	1.40	1.80	3.20	8.16	1.25E1	1.87E1	2.69E1	3.67E1	4.24E1	1.03
7.0	1.40	1.80	3.62	1.21E1	2.05E1	3.32E1	5.07E1	7.28E1	8.70E1	1.03
8.0	1.40	1.81	4.15	1.78E1	3.23E1	5.74E1	9.52E1	1.47E2	1.81E2	1.03
10.0	1.41	1.82	5.39	3.80E1	8.41E1	1.79E2	3.46E2	6.13E2	8.06E2	1.03
15.0	1.41	1.82	1.26E1	3.26E2	1.10E3	3.46E3	9.53E3	2.33E4	3.55E4	1.04
20.0	1.42	1.84	4.03E1	3.60E3	1.76E4	7.74E4	2.91E5	9.55E5	1.67E6	1.05
25.0	1.43	1.84	1.53E2	4.58E4	3.19E5	1.92E6	9.59E6	4.12E7	8.19E7	1.05
30.0	1.44	1.85	6.28E2	6.21E5	6.24E6	5.14E7	3.36E8	1.86E9	4.16E9	1.06
35.0	1.44	1.85	2.64E3	8.69E6	1.27E8	1.44E9	1.24E10	8.72E10	2.18E11	1.06
40.0	1.45	1.85	1.13E4	1.23E8	2.64E9	4.17E10	4.73E11	4.22E12	1.18E13	1.06
R(MFP)	0.015	ENERGY (MEV)								
0.5	1.00									
1.0	1.01									
2.0	1.01									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.02									
15.0	1.02									
20.0	1.02									
25.0	1.02									
30.0	1.03									
35.0	1.03									
40.0	1.03									

Table 3.1 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK MOLYBDENUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.33	1.32	1.32	1.32	1.29	1.29	1.29	1.28	1.28	1.29
1.0	1.64	1.58	1.57	1.57	1.54	1.58	1.62	1.62	1.62	1.63
2.0	2.21	2.02	1.98	2.01	2.04	2.04	2.18	2.34	2.40	2.47
3.0	2.89	2.49	2.41	2.45	2.51	2.54	2.78	3.07	3.19	3.34
4.0	3.73	3.04	2.90	2.93	3.03	3.09	3.40	3.82	4.00	4.25
5.0	4.79	3.68	3.45	3.49	3.61	3.69	4.09	4.61	4.86	5.20
6.0	6.12	4.44	4.10	4.12	4.27	4.37	4.84	5.47	5.78	6.25
7.0	7.78	5.32	4.83	4.82	4.99	5.11	5.65	6.39	6.75	7.36
8.0	9.84	6.34	5.65	5.59	5.78	5.91	6.50	7.36	7.77	8.53
10.0	1.56E1	8.88	7.64	7.38	7.57	7.67	8.36	9.43	9.92	1.1E1
15.0	4.63E1	1.94E1	1.51E1	1.35E1	1.34E1	1.31E1	1.38E1	1.54E1	1.60E1	1.84E1
20.0	1.31E2	3.98E1	2.77E1	2.22E1	2.11E1	1.99E1	2.00E1	2.20E1	2.26E1	2.69E1
25.0	3.54E2	7.77E1	4.78E1	3.41E1	3.10E1	2.80E1	2.68E1	2.92E1	2.96E1	3.64E1
30.0	9.24E2	1.46E2	7.88E1	4.97E1	4.31E1	3.72E1	3.41E1	3.67E1	3.69E1	4.67E1
35.0	2.35E3	2.65E2	1.25E2	6.95E1	5.76E1	4.75E1	4.17E1	4.45E1	4.44E1	5.76E1
40.0	5.83E3	4.69E2	1.94E2	9.42E1	7.45E1	5.87E1	4.96E1	5.25E1	5.21E1	6.90E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.06
0.5	1.30	1.29	1.29	1.59	1.48	1.31	1.18	1.08	1.05	1.02
1.0	1.65	1.63	1.60	2.01	1.79	1.46	1.25	1.11	1.07	1.03
2.0	2.49	2.42	2.32	2.68	2.23	1.67	1.35	1.15	1.09	1.04
3.0	3.37	3.24	3.05	3.35	2.65	1.85	1.43	1.18	1.10	1.05
4.0	4.27	4.10	3.77	3.97	3.02	2.00	1.51	1.20	1.12	1.06
5.0	5.23	5.01	4.53	4.61	3.39	2.14	1.58	1.23	1.13	1.07
6.0	6.27	6.01	5.34	5.29	3.76	2.27	1.64	1.25	1.14	1.07
7.0	7.37	7.07	6.19	5.95	4.11	2.39	1.69	1.27	1.15	1.08
8.0	8.54	8.19	7.09	6.62	4.45	2.50	1.74	1.29	1.16	1.08
10.0	1.11E1	1.06E1	8.99	7.99	5.12	2.71	1.83	1.32	1.18	1.09
15.0	1.83E1	1.77E1	1.43E1	1.15E1	6.63	3.11	2.00	1.37	1.21	1.11
20.0	2.66E1	2.59E1	2.02E1	1.49E1	7.97	3.42	2.12	1.41	1.24	1.12
25.0	3.55E1	3.50E1	2.67E1	1.82E1	9.17	3.66	2.22	1.44	1.25	1.13
30.0	4.52E1	4.50E1	3.35E1	2.14E1	1.03E1	3.87	2.31	1.47	1.27	1.14
35.0	5.54E1	5.57E1	4.06E1	2.46E1	1.12E1	4.06	2.39	1.49	1.28	1.14
40.0	6.61E1	6.69E1	4.79E1	2.76E1	1.21E1	4.22	2.46	1.51	1.29	1.15
R(MFP)	ENERGY (MEV)									
	0.05	0.04	0.035	0.03	0.028	0.026	0.024	0.022	0.021	0.02
0.5	2.66	2.82	2.68	2.45	2.32	2.17	2.03	1.89	1.82	1.01
1.0	3.06	3.83	3.91	3.76	3.59	3.38	3.16	2.90	2.78	1.01
2.0	3.12	4.83	5.86	6.59	6.66	6.58	6.38	6.02	5.82	1.02
3.0	3.06	5.23	7.52	1.03E1	1.12E1	1.19E1	1.23E1	1.23E1	1.22E1	1.02
4.0	3.02	5.42	9.19	1.58E1	1.89E1	2.18E1	2.44E1	2.59E1	2.65E1	1.02
5.0	3.02	5.53	1.10E1	2.43E1	3.20E1	4.05E1	4.91E1	5.61E1	5.92E1	1.02
6.0	3.02	5.57	1.29E1	3.72E1	5.42E1	7.52E1	9.91E1	1.22E2	1.33E2	1.03
7.0	3.01	5.58	1.52E1	5.70E1	9.13E1	1.36E2	1.89E2	2.44E2	2.75E2	1.03
8.0	3.02	5.61	1.80E1	8.57E1	1.46E2	2.38E2	3.57E2	4.94E2	5.74E2	1.03
10.0	3.01	5.62	2.47E1	1.87E2	3.83E2	7.44E2	1.30E3	2.07E3	2.56E3	1.03
15.0	3.00	5.63	6.31E1	1.62E3	5.03E3	1.44E4	3.58E4	7.83E4	1.13E5	1.04
20.0	3.02	5.69	2.10E2	1.77E4	7.96E4	3.19E5	1.09E6	3.20E6	5.27E6	1.05
25.0	3.04	5.72	8.09E2	2.24E5	1.43E6	7.88E6	3.56E7	1.37E8	2.57E8	1.05
30.0	3.06	5.74	3.32E3	3.04E6	2.80E7	2.10E8	1.24E9	6.17E9	1.30E10	1.06
35.0	3.07	5.73	1.40E4	4.25E7	5.68E8	5.87E9	4.56E10	2.88E11	6.80E11	1.06
40.0	3.09	5.72	5.98E4	6.02E8	1.18E10	1.70E11	1.74E12	1.39E13	3.65E13	1.06
R(MFP)	ENERGY (MEV)									
	0.015									
0.5	1.00									
1.0	1.01									
2.0	1.01									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.02									
15.0	1.02									
20.0	1.02									
25.0	1.02									
30.0	1.03									
35.0	1.03									
40.0	1.03									

Table 3.1 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK MOLYBDENUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.39	1.39	1.38	1.37	1.37	1.32	1.32	1.32	1.31	1.32
1.0	1.75	1.69	1.66	1.65	1.66	1.60	1.63	1.67	1.68	1.70
2.0	2.40	2.18	2.11	2.12	2.16	2.12	2.27	2.44	2.54	2.62
3.0	3.14	2.69	2.57	2.58	2.67	2.65	2.90	3.22	3.42	3.59
4.0	4.07	3.29	3.10	3.10	3.23	3.22	3.56	4.01	4.31	4.58
5.0	5.25	4.00	3.70	3.69	3.85	3.85	4.27	4.85	5.24	5.63
6.0	6.72	4.84	4.40	4.36	4.56	4.56	5.07	5.77	6.25	6.78
7.0	8.56	5.81	5.20	5.11	5.35	5.34	5.92	6.74	7.31	8.00
8.0	1.09E1	6.94	6.09	5.94	6.20	6.18	6.81	7.77	8.42	9.28
10.0	1.72E1	9.75	8.25	7.85	8.14	8.03	8.77	9.97	1.08E1	1.21E1
15.0	5.14E1	2.15E1	1.64E1	1.44E1	1.44E1	1.38E1	1.45E1	1.63E1	1.74E1	2.02E1
20.0	1.45E2	4.41E1	3.02E1	2.38E1	2.29E1	2.10E1	2.11E1	2.34E1	2.47E1	2.96E1
25.0	3.94E2	8.63E1	5.21E1	3.65E1	3.36E1	2.94E1	2.83E1	3.10E1	3.24E1	4.00E1
30.0	1.03E3	1.62E2	8.61E1	5.33E1	4.68E1	3.91E1	3.60E1	3.90E1	4.04E1	5.14E1
35.0	2.62E3	2.95E2	1.37E2	7.47E1	6.25E1	5.00E1	4.41E1	4.73E1	4.87E1	6.35E1
40.0	6.51E3	5.22E2	2.12E2	1.01E2	8.09E1	6.19E1	5.24E1	5.58E1	5.71E1	7.60E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.06
0.5	1.33	1.32	1.32	1.62	1.50	1.33	1.19	1.09	1.05	1.02
1.0	1.72	1.68	1.65	2.07	1.82	1.49	1.27	1.12	1.07	1.03
2.0	2.64	2.54	2.43	2.78	2.29	1.70	1.37	1.15	1.09	1.04
3.0	3.62	3.43	3.22	3.48	2.72	1.89	1.45	1.18	1.10	1.05
4.0	4.61	4.35	4.00	4.13	3.10	2.04	1.53	1.21	1.12	1.06
5.0	5.66	5.33	4.81	4.80	3.48	2.19	1.60	1.24	1.13	1.07
6.0	6.81	6.41	5.68	5.52	3.86	2.32	1.66	1.26	1.14	1.07
7.0	8.02	7.55	6.60	6.20	4.22	2.45	1.72	1.28	1.16	1.08
8.0	9.31	8.75	7.57	6.91	4.57	2.56	1.77	1.30	1.17	1.08
10.0	1.21E1	1.14E1	9.61	8.34	5.26	2.77	1.86	1.33	1.18	1.09
15.0	2.01E1	1.90E1	1.53E1	1.20E1	6.82	3.19	2.03	1.38	1.22	1.11
20.0	2.92E1	2.78E1	2.17E1	1.56E1	8.20	3.50	2.16	1.42	1.24	1.12
25.0	3.91E1	3.77E1	2.87E1	1.90E1	9.44	3.75	2.26	1.45	1.26	1.13
30.0	4.97E1	4.85E1	3.60E1	2.24E1	1.06E1	3.97	2.35	1.48	1.27	1.14
35.0	6.11E1	6.00E1	4.36E1	2.57E1	1.16E1	4.16	2.43	1.50	1.28	1.14
40.0	7.28E1	7.22E1	5.15E1	2.89E1	1.25E1	4.32	2.51	1.52	1.29	1.15
R(MFP)	ENERGY (MEV)									
	0.05	0.04	0.035	0.03	0.028	0.026	0.024	0.022	0.021	0.02
0.5	2.28	2.36	2.32	2.21	2.13	2.03	1.93	1.82	1.77	1.01
1.0	2.59	3.12	3.30	3.31	3.22	3.09	2.94	2.76	2.67	1.01
2.0	2.64	3.87	4.84	5.69	5.85	5.90	5.84	5.64	5.53	1.02
3.0	2.59	4.18	6.15	8.81	9.79	1.06E1	1.12E1	1.14E1	1.15E1	1.02
4.0	2.57	4.33	7.48	1.35E1	1.64E1	1.93E1	2.21E1	2.41E1	2.49E1	1.02
5.0	2.56	4.41	8.93	2.06E1	2.77E1	3.57E1	4.44E1	5.21E1	5.58E1	1.02
6.0	2.56	4.45	1.05E1	3.15E1	4.68E1	6.64E1	8.96E1	1.13E2	1.25E2	1.03
7.0	2.56	4.46	1.24E1	4.83E1	7.88E1	1.20E2	1.71E2	2.26E2	2.59E2	1.03
8.0	2.57	4.48	1.46E1	7.26E1	1.26E2	2.10E2	3.23E2	4.58E2	5.41E2	1.03
10.0	2.56	4.50	2.00E1	1.59E2	3.32E2	6.58E2	1.18E3	1.92E3	2.41E3	1.03
15.0	2.55	4.51	5.15E1	1.39E3	4.40E3	1.28E4	3.26E4	7.31E4	1.06E5	1.04
20.0	2.57	4.56	1.72E2	1.54E4	7.02E4	2.87E5	9.95E5	3.00E6	5.01E6	1.05
25.0	2.58	4.59	6.64E2	1.95E5	1.27E6	7.13E6	3.28E7	1.30E8	2.46E8	1.05
30.0	2.60	4.60	2.73E3	2.65E6	2.49E7	1.91E8	1.15E9	5.84E9	1.25E10	1.06
35.0	2.61	4.60	1.15E4	3.71E7	5.07E8	5.35E9	4.24E10	2.74E11	6.54E11	1.06
40.0	2.63	4.58	4.92E4	5.27E8	1.05E10	1.55E11	1.62E12	1.33E13	3.53E13	1.06
R(MFP)	ENERGY (MEV)									
	0.015									
0.5	1.00									
1.0	1.01									
2.0	1.01									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.02									
15.0	1.02									
20.0	1.02									
25.0	1.02									
30.0	1.03									
35.0	1.03									
40.0	1.03									

Table 3.2 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick tin

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK TIN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.27	1.30	1.35	1.39	1.42	1.34	1.38	1.42	1.43	1.48
1.0	1.49	1.52	1.56	1.62	1.67	1.58	1.69	1.82	1.87	1.96
2.0	1.87	1.85	1.89	1.98	2.07	2.00	2.27	2.65	2.83	3.04
3.0	2.32	2.21	2.22	2.34	2.48	2.42	2.84	3.45	3.77	4.10
4.0	2.91	2.65	2.62	2.76	2.95	2.89	3.45	4.26	4.69	5.14
5.0	3.68	3.18	3.08	3.24	3.48	3.42	4.12	5.12	5.65	6.19
6.0	4.68	3.82	3.63	3.80	4.09	4.02	4.87	6.06	6.68	7.33
7.0	5.98	4.59	4.26	4.43	4.77	4.68	5.68	7.06	7.75	8.52
8.0	7.66	5.50	4.99	5.14	5.52	5.39	6.54	8.10	8.86	9.74
10.0	1.26E1	7.87	6.79	6.83	7.25	7.00	8.43	1.04E1	1.12E1	1.23E1
15.0	4.38E1	1.89E1	1.41E1	1.30E1	1.31E1	1.21E1	1.41E1	1.68E1	1.76E1	1.95E1
20.0	1.49E2	4.35E1	2.79E1	2.27E1	2.15E1	1.87E1	2.08E1	2.39E1	2.44E1	2.74E1
25.0	4.89E2	9.67E1	5.25E1	3.72E1	3.28E1	2.68E1	2.83E1	3.16E1	3.15E1	3.57E1
30.0	1.56E3	2.08E2	9.52E1	5.83E1	4.77E1	3.63E1	3.65E1	3.96E1	3.87E1	4.45E1
35.0	4.84E3	4.38E2	1.68E2	8.80E1	6.66E1	4.73E1	4.53E1	4.79E1	4.60E1	5.35E1
40.0	1.47E4	8.97E2	2.87E2	1.29E2	8.99E1	5.97E1	5.46E1	5.65E1	5.35E1	6.26E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	2.11	2.14	2.13	2.04	1.75	1.39	1.11	1.10	1.09	1.35
1.0	2.92	2.93	2.81	2.60	2.09	1.50	1.17	1.12	1.11	1.40
2.0	4.21	4.11	3.81	3.36	2.51	1.64	1.26	1.15	1.14	1.41
3.0	5.51	5.28	4.79	4.05	2.87	1.77	1.32	1.18	1.15	1.42
4.0	6.73	6.36	5.65	4.64	3.16	1.87	1.38	1.19	1.17	1.43
5.0	8.02	7.49	6.53	5.21	3.44	1.96	1.42	1.21	1.18	1.44
6.0	9.47	8.74	7.49	5.83	3.72	2.04	1.46	1.22	1.19	1.45
7.0	1.09E1	9.94	8.39	6.39	3.97	2.12	1.49	1.24	1.20	1.46
8.0	1.23E1	1.12E1	9.31	6.95	4.21	2.19	1.52	1.25	1.21	1.46
10.0	1.54E1	1.37E1	1.12E1	8.04	4.67	2.31	1.58	1.26	1.22	1.48
15.0	2.36E1	2.05E1	1.59E1	1.06E1	5.64	2.54	1.68	1.30	1.25	1.50
20.0	3.23E1	2.72E1	2.04E1	1.28E1	6.44	2.70	1.75	1.32	1.27	1.52
25.0	4.13E1	3.40E1	2.47E1	1.49E1	7.12	2.83	1.81	1.34	1.28	1.54
30.0	5.07E1	4.10E1	2.88E1	1.68E1	7.72	2.94	1.85	1.36	1.30	1.55
35.0	6.02E1	4.79E1	3.27E1	1.85E1	8.25	3.04	1.89	1.37	1.31	1.57
40.0	7.00E1	5.50E1	3.64E1	2.02E1	8.72	3.13	1.93	1.38	1.32	1.58
R(MFP)	ENERGY (MEV)									
	0.07	0.06	0.055	0.05	0.045	0.04	0.035	0.03	0.029	0.02
0.5	1.38	1.38	1.38	1.38	1.37	1.36	1.36	1.35	1.01	1.00
1.0	1.49	1.56	1.61	1.64	1.68	1.70	1.75	1.76	1.02	1.01
2.0	1.52	1.70	1.86	2.05	2.28	2.51	2.81	3.04	1.02	1.01
3.0	1.51	1.73	1.99	2.37	2.96	3.69	4.68	5.66	1.03	1.01
4.0	1.51	1.74	2.07	2.69	3.84	5.62	8.33	1.15E1	1.03	1.01
5.0	1.51	1.74	2.13	3.02	5.05	8.87	1.56E1	2.46E1	1.04	1.01
6.0	1.52	1.74	2.17	3.38	6.70	1.43E1	2.97E1	5.38E1	1.04	1.01
7.0	1.52	1.73	2.21	3.80	9.08	2.32E1	5.45E1	1.10E2	1.04	1.02
8.0	1.53	1.73	2.25	4.33	1.22E1	3.66E1	9.89E1	2.26E2	1.05	1.02
10.0	1.54	1.72	2.34	5.59	2.24E1	9.32E1	3.38E2	9.82E2	1.05	1.02
15.0	1.55	1.71	2.62	1.26E1	1.29E2	1.18E3	8.09E3	4.09E4	1.06	1.02
20.0	1.57	1.71	2.88	3.78E1	9.96E2	1.83E4	2.20E5	1.83E6	1.07	1.03
25.0	1.58	1.71	3.20	1.32E2	8.80E3	3.24E5	6.60E6	8.65E7	1.08	1.03
30.0	1.59	1.72	3.64	4.93E2	8.16E4	6.13E6	2.12E8	4.25E9	1.08	1.03
35.0	1.60	1.72	4.26	1.90E3	7.72E5	1.20E8	7.13E9	2.17E11	1.09	1.03
40.0	1.61	1.73	5.14	7.47E3	7.39E6	2.39E9	2.47E11	1.14E13	1.10	1.04
R(MFP)	ENERGY (MEV)									
	0.015									
0.5	1.00									
1.0	1.00									
2.0	1.00									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.01									
25.0	1.01									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.2 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK TIN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.33	1.32	1.32	1.32	1.31	1.27	1.28	1.28	1.26	1.26
1.0	1.65	1.57	1.55	1.54	1.54	1.50	1.53	1.57	1.56	1.55
2.0	2.27	2.03	1.96	1.95	1.97	1.94	2.06	2.20	2.22	2.23
3.0	3.05	2.55	2.40	2.39	2.42	2.40	2.61	2.83	2.88	2.90
4.0	4.08	3.17	2.92	2.88	2.93	2.91	3.19	3.48	3.55	3.57
5.0	5.43	3.94	3.53	3.44	3.50	3.49	3.82	4.17	4.25	4.27
6.0	7.21	4.86	4.24	4.10	4.16	4.14	4.53	4.92	4.99	5.01
7.0	9.51	5.96	5.07	4.84	4.89	4.85	5.29	5.72	5.76	5.79
8.0	1.25E1	7.28	6.02	5.67	5.70	5.62	6.10	6.55	6.56	6.59
10.0	2.14E1	1.07E1	8.39	7.65	7.57	7.35	7.86	8.33	8.24	8.29
15.0	7.81E1	2.69E1	1.81E1	1.49E1	1.39E1	1.28E1	1.31E1	1.34E1	1.28E1	1.29E1
20.0	2.71E2	6.35E1	3.66E1	2.64E1	2.30E1	1.99E1	1.93E1	1.90E1	1.76E1	1.80E1
25.0	8.98E2	1.43E2	6.98E1	4.38E1	3.53E1	2.86E1	2.63E1	2.50E1	2.26E1	2.34E1
30.0	2.88E3	3.11E2	1.28E2	6.90E1	5.14E1	3.89E1	3.40E1	3.13E1	2.78E1	2.91E1
35.0	8.97E3	6.57E2	2.26E2	1.05E2	7.20E1	5.07E1	4.22E1	3.78E1	3.30E1	3.49E1
40.0	2.73E4	1.35E3	3.89E2	1.54E2	9.74E1	6.41E1	5.07E1	4.45E1	3.83E1	4.07E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	1.58	1.55	1.51	1.46	1.34	1.20	1.06	1.09	1.11	1.69
1.0	2.03	1.96	1.86	1.75	1.54	1.28	1.11	1.12	1.14	1.79
2.0	2.78	2.61	2.42	2.18	1.80	1.40	1.17	1.14	1.16	1.79
3.0	3.54	3.27	2.96	2.58	2.03	1.49	1.23	1.16	1.17	1.79
4.0	4.30	3.91	3.47	2.93	2.23	1.57	1.27	1.18	1.19	1.80
5.0	5.09	4.58	3.99	3.29	2.42	1.65	1.31	1.20	1.20	1.81
6.0	5.95	5.29	4.53	3.64	2.60	1.71	1.34	1.21	1.21	1.83
7.0	6.80	5.98	5.05	3.97	2.76	1.77	1.37	1.22	1.22	1.84
8.0	7.68	6.70	5.58	4.31	2.92	1.83	1.40	1.23	1.23	1.85
10.0	9.52	8.19	6.65	4.96	3.22	1.93	1.45	1.25	1.24	1.86
15.0	1.44E1	1.20E1	9.33	6.46	3.87	2.11	1.54	1.28	1.27	1.90
20.0	1.96E1	1.59E1	1.19E1	7.80	4.40	2.24	1.60	1.31	1.29	1.92
25.0	2.50E1	1.98E1	1.44E1	9.03	4.86	2.35	1.65	1.33	1.30	1.95
30.0	3.06E1	2.38E1	1.68E1	1.02E1	5.26	2.44	1.70	1.34	1.32	1.96
35.0	3.63E1	2.78E1	1.90E1	1.12E1	5.61	2.53	1.73	1.35	1.33	1.98
40.0	4.21E1	3.18E1	2.12E1	1.22E1	5.94	2.61	1.77	1.37	1.34	2.00
R(MFP)	ENERGY (MEV)									
	0.07	0.06	0.055	0.05	0.045	0.04	0.035	0.03	0.029	0.02
0.5	1.96	2.25	2.34	2.40	2.36	2.28	2.08	1.86	1.01	1.00
1.0	2.22	2.83	3.12	3.40	3.50	3.23	2.86	1.02	1.01	
2.0	2.28	3.28	3.99	4.91	5.69	6.39	6.41	5.98	1.02	1.01
3.0	2.25	3.38	4.43	6.12	8.17	1.06E1	1.20E1	1.24E1	1.03	1.01
4.0	2.23	3.38	4.70	7.29	1.14E1	1.75E1	2.29E1	2.66E1	1.03	1.01
5.0	2.23	3.37	4.90	8.54	1.58E1	2.91E1	4.45E1	5.86E1	1.04	1.01
6.0	2.24	3.35	5.04	9.86	2.18E1	4.84E1	8.67E1	1.30E2	1.04	1.01
7.0	2.24	3.32	5.17	1.14E1	3.05E1	7.99E1	1.61E2	2.66E2	1.04	1.02
8.0	2.24	3.31	5.30	1.33E1	4.17E1	1.28E2	2.93E2	5.49E2	1.05	1.02
10.0	2.25	3.28	5.59	1.80E1	7.88E1	3.28E2	1.00E3	2.39E3	1.05	1.02
15.0	2.28	3.23	6.52	4.37E1	4.61E2	4.15E3	2.40E4	9.92E4	1.06	1.02
20.0	2.30	3.20	7.41	1.36E2	3.57E3	6.41E4	6.49E5	4.43E6	1.07	1.03
25.0	2.32	3.19	8.49	4.81E2	3.15E4	1.13E6	1.94E7	2.08E8	1.08	1.03
30.0	2.34	3.20	10.00	1.80E3	2.92E5	2.13E7	6.19E8	1.02E10	1.08	1.03
35.0	2.36	3.20	1.21E1	6.96E3	2.76E6	4.17E8	2.08E10	5.19E11	1.09	1.03
40.0	2.37	3.21	1.52E1	2.73E4	2.64E7	8.30E9	7.20E11	2.73E13	1.10	1.04
R(MFP)	ENERGY (MEV)									
	0.015									
0.5	1.00									
1.0	1.00									
2.0	1.00									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.01									
25.0	1.01									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.2 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK TIN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.39	1.38	1.37	1.36	1.36	1.30	1.30	1.30	1.29	1.28
1.0	1.76	1.67	1.63	1.61	1.61	1.54	1.57	1.61	1.61	1.60
2.0	2.45	2.17	2.07	2.05	2.07	2.01	2.13	2.28	2.33	2.33
3.0	3.31	2.74	2.55	2.51	2.56	2.48	2.70	2.94	3.05	3.06
4.0	4.44	3.43	3.11	3.03	3.10	3.02	3.30	3.62	3.76	3.79
5.0	5.94	4.27	3.77	3.63	3.72	3.61	3.97	4.35	4.51	4.54
6.0	7.90	5.28	4.54	4.32	4.42	4.29	4.70	5.13	5.31	5.35
7.0	1.05E1	6.50	5.43	5.11	5.21	5.03	5.49	5.96	6.14	6.18
8.0	1.38E1	7.95	6.47	6.00	6.07	5.83	6.34	6.83	7.01	7.05
10.0	2.37E1	1.18E1	9.04	8.11	8.09	7.64	8.18	8.70	8.81	8.88
15.0	8.65E1	2.97E1	1.96E1	1.58E1	1.49E1	1.34E1	1.37E1	1.40E1	1.37E1	1.39E1
20.0	3.00E2	7.02E1	3.97E1	2.82E1	2.47E1	2.08E1	2.02E1	1.99E1	1.90E1	1.94E1
25.0	9.97E2	1.59E2	7.59E1	4.67E1	3.80E1	2.99E1	2.75E1	2.62E1	2.44E1	2.52E1
30.0	3.20E3	3.45E2	1.39E2	7.37E1	5.55E1	4.06E1	3.55E1	3.28E1	2.99E1	3.14E1
35.0	9.97E3	7.29E2	2.46E2	1.12E2	7.77E1	5.31E1	4.41E1	3.97E1	3.56E1	3.76E1
40.0	3.03E4	1.50E3	4.24E2	1.64E2	1.05E2	6.71E1	5.31E1	4.67E1	4.13E1	4.40E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	1.63	1.59	1.54	1.48	1.36	1.21	1.07	1.10	1.11	1.63
1.0	2.13	2.03	1.93	1.79	1.56	1.30	1.11	1.12	1.14	1.72
2.0	2.94	2.73	2.52	2.24	1.83	1.41	1.18	1.15	1.16	1.72
3.0	3.77	3.43	3.10	2.65	2.06	1.51	1.24	1.17	1.18	1.73
4.0	4.59	4.11	3.63	3.02	2.26	1.59	1.28	1.19	1.19	1.74
5.0	5.45	4.82	4.18	3.38	2.46	1.67	1.32	1.21	1.20	1.75
6.0	6.37	5.57	4.75	3.75	2.64	1.74	1.36	1.22	1.21	1.76
7.0	7.30	6.31	5.31	4.09	2.81	1.80	1.39	1.23	1.22	1.77
8.0	8.25	7.07	5.87	4.44	2.97	1.85	1.42	1.24	1.23	1.78
10.0	1.02E1	8.64	7.00	5.11	3.28	1.95	1.46	1.26	1.24	1.80
15.0	1.56E1	1.27E1	9.84	6.67	3.94	2.14	1.55	1.29	1.27	1.83
20.0	2.12E1	1.68E1	1.26E1	8.06	4.48	2.27	1.62	1.32	1.29	1.86
25.0	2.70E1	2.10E1	1.52E1	9.32	4.95	2.38	1.67	1.34	1.31	1.88
30.0	3.31E1	2.52E1	1.77E1	1.06E1	5.36	2.48	1.72	1.35	1.32	1.89
35.0	3.93E1	2.95E1	2.01E1	1.16E1	5.72	2.56	1.75	1.37	1.33	1.91
40.0	4.56E1	3.38E1	2.24E1	1.26E1	6.05	2.64	1.79	1.38	1.34	1.92
R(MFP)	ENERGY (MEV)									
	0.07	0.06	0.055	0.05	0.045	0.04	0.035	0.03	0.029	0.02
0.5	1.84	2.05	2.14	2.23	2.17	2.08	1.97	1.82	1.01	1.00
1.0	2.07	2.54	2.82	3.10	3.16	3.12	3.00	2.77	1.02	1.01
2.0	2.12	2.92	3.57	4.42	5.05	5.58	5.84	5.74	1.02	1.01
3.0	2.10	3.01	3.95	5.49	7.20	9.17	1.09E1	1.18E1	1.03	1.01
4.0	2.09	3.01	4.18	6.53	1.00E1	1.50E1	2.07E1	2.54E1	1.03	1.01
5.0	2.09	3.01	4.36	7.63	1.39E1	2.49E1	4.01E1	5.59E1	1.04	1.01
6.0	2.09	2.99	4.49	8.81	1.91E1	4.15E2	7.80E1	1.24E2	1.04	1.01
7.0	2.09	2.97	4.60	1.02E1	2.67E1	6.85E1	1.45E2	2.54E2	1.04	1.02
8.0	2.10	2.95	4.72	1.19E1	3.65E1	1.10E2	2.64E2	5.24E2	1.05	1.02
10.0	2.11	2.93	4.98	1.61E1	6.90E1	2.82E2	9.06E2	2.28E3	1.05	1.02
15.0	2.14	2.89	5.81	3.93E1	4.08E2	3.59E3	2.18E4	9.51E4	1.06	1.02
20.0	2.16	2.87	6.60	1.23E2	3.17E3	5.59E4	5.93E5	4.26E6	1.07	1.03
25.0	2.17	2.86	7.56	4.34E2	2.80E4	9.88E5	1.78E7	2.01E8	1.08	1.03
30.0	2.19	2.86	8.90	1.63E3	2.60E5	1.87E7	5.70E8	9.91E9	1.08	1.03
35.0	2.20	2.87	1.08E1	6.30E3	2.46E6	3.67E8	1.92E10	5.06E11	1.09	1.03
40.0	2.22	2.88	1.35E1	2.47E4	2.35E7	7.29E9	6.66E11	2.66E13	1.10	1.04
R(MFP)	ENERGY (MEV)									
	0.015									
0.5	1.00									
1.0	1.00									
2.0	1.00									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.01									
25.0	1.01									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.3 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick lanthanum

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK LANTHANUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.28	1.31	1.36	1.41	1.44	1.36	1.41	1.44	1.44	1.48
1.0	1.50	1.52	1.56	1.63	1.67	1.59	1.70	1.83	1.87	1.93
2.0	1.90	1.85	1.87	1.96	2.05	1.98	2.24	2.63	2.79	2.93
3.0	2.38	2.23	2.21	2.32	2.45	2.38	2.79	3.39	3.65	3.87
4.0	3.03	2.69	2.62	2.73	2.91	2.85	3.38	4.15	4.51	4.78
5.0	3.91	3.27	3.11	3.22	3.45	3.37	4.03	4.97	5.38	5.70
6.0	5.08	3.98	3.69	3.78	4.06	3.97	4.76	5.86	6.32	6.69
7.0	6.65	4.85	4.38	4.43	4.76	4.64	5.55	6.80	7.29	7.71
8.0	8.73	5.91	5.18	5.16	5.53	5.37	6.39	7.79	8.29	8.76
10.0	1.52E1	8.76	7.22	6.93	7.37	7.04	8.25	9.89	1.04E1	1.09E1
15.0	6.04E1	2.31E1	1.62E1	1.37E1	1.39E1	1.26E1	1.39E1	1.59E1	1.59E1	1.69E1
20.0	2.35E2	5.89E1	3.46E1	2.50E1	2.39E1	2.01E1	2.06E1	2.25E1	2.18E1	2.32E1
25.0	8.83E2	1.46E2	7.12E1	4.31E1	3.85E1	2.98E1	2.84E1	2.95E1	2.77E1	2.99E1
30.0	3.22E3	3.49E2	1.41E2	7.10E1	5.89E1	4.18E1	3.70E1	3.69E1	3.36E1	3.67E1
35.0	1.14E4	8.15E2	2.73E2	1.13E2	8.67E1	5.64E1	4.63E1	4.46E1	3.97E1	4.37E1
40.0	3.96E4	1.86E3	5.12E2	1.74E2	1.24E2	7.37E1	5.62E1	5.25E1	4.57E1	5.07E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.07
0.5	1.52	1.51	1.93	1.81	1.54	1.26	1.13	1.38	1.41	1.42
1.0	1.98	1.93	2.44	2.19	1.75	1.33	1.17	1.46	1.60	1.68
2.0	2.96	2.78	3.13	2.67	2.00	1.42	1.23	1.48	1.73	2.00
3.0	3.87	3.54	3.76	3.10	2.21	1.50	1.27	1.49	1.75	2.18
4.0	4.72	4.23	4.30	3.44	2.38	1.56	1.31	1.50	1.76	2.32
5.0	5.57	4.92	4.84	3.77	2.54	1.61	1.34	1.51	1.76	2.43
6.0	6.47	5.64	5.41	4.11	2.69	1.66	1.36	1.52	1.75	2.52
7.0	7.39	6.37	5.93	4.41	2.83	1.70	1.38	1.53	1.75	2.61
8.0	8.32	7.11	6.44	4.71	2.96	1.74	1.40	1.54	1.75	2.72
10.0	1.03E1	8.59	7.46	5.27	3.20	1.81	1.44	1.55	1.74	2.96
15.0	1.53E1	1.22E1	9.87	6.52	3.68	1.94	1.50	1.58	1.74	3.70
20.0	2.03E1	1.58E1	1.21E1	7.55	4.06	2.04	1.54	1.61	1.75	4.81
25.0	2.54E1	1.93E1	1.40E1	8.46	4.38	2.11	1.58	1.62	1.76	6.76
30.0	3.05E1	2.28E1	1.58E1	9.29	4.66	2.17	1.61	1.64	1.77	1.02E1
35.0	3.57E1	2.62E1	1.75E1	1.00E1	4.91	2.23	1.63	1.65	1.78	1.65E1
40.0	4.07E1	2.95E1	1.90E1	1.07E1	5.13	2.28	1.66	1.66	1.78	2.81E1
R(MFP)	ENERGY (MEV)									
	0.06	0.055	0.05	0.048	0.046	0.044	0.042	0.04	0.039	0.038
0.5	1.41	1.41	1.40	1.40	1.41	1.40	1.40	1.40	1.41	1.02
1.0	1.74	1.77	1.80	1.82	1.83	1.84	1.86	1.86	1.88	1.02
2.0	2.34	2.56	2.78	2.88	3.00	3.09	3.19	3.27	3.36	1.03
3.0	2.97	3.58	4.29	4.64	5.02	5.39	5.77	6.11	6.38	1.04
4.0	3.75	5.09	6.90	7.84	8.88	9.99	1.12E1	1.23E1	1.31E1	1.04
5.0	4.76	7.41	1.15E1	1.38E1	1.64E1	1.94E1	2.27E1	2.60E1	2.83E1	1.05
6.0	6.08	1.09E1	1.96E1	2.47E1	3.10E1	3.84E1	4.69E1	5.59E1	6.19E1	1.05
7.0	7.91	1.64E1	3.34E1	4.36E1	5.74E1	7.24E1	9.22E1	1.12E2	1.27E2	1.06
8.0	1.03E1	2.44E1	5.45E1	7.49E1	1.03E2	1.36E2	1.80E2	2.28E2	2.61E2	1.06
10.0	1.78E1	5.32E1	1.52E2	2.30E2	3.44E2	4.93E2	7.07E2	9.59E2	1.14E3	1.07
15.0	8.63E1	4.82E2	2.36E3	4.37E3	7.90E3	1.36E4	2.33E4	3.72E4	4.77E4	1.08
20.0	5.60E2	5.58E3	4.41E4	9.75E4	2.08E5	4.24E5	8.45E5	1.57E6	2.15E6	1.09
25.0	4.12E3	7.31E4	9.27E5	2.43E6	6.04E6	1.44E7	3.30E7	7.03E7	1.03E8	1.10
30.0	3.17E4	1.01E6	2.08E7	6.48E7	1.88E8	5.19E8	1.36E9	3.30E9	5.11E9	1.11
35.0	2.48E5	1.42E7	4.83E8	1.79E9	6.09E9	1.96E10	5.86E10	1.61E11	2.64E11	1.12
40.0	1.97E6	2.03E8	1.14E10	5.07E10	2.03E11	7.60E11	2.60E12	8.08E12	1.40E13	1.13
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.01	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.02	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.00							
5.0	1.03	1.01	1.00							
6.0	1.03	1.01	1.00							
7.0	1.03	1.01	1.01							
8.0	1.03	1.01	1.01							
10.0	1.04	1.01	1.01							
15.0	1.04	1.02	1.01							
20.0	1.05	1.02	1.01							
25.0	1.06	1.02	1.01							
30.0	1.06	1.02	1.01							
35.0	1.06	1.02	1.01							
40.0	1.07	1.02	1.01							

Table 3.3 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK LANTHANUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.34	1.32	1.32	1.31	1.31	1.26	1.27	1.27	1.25	1.24
1.0	1.66	1.58	1.54	1.53	1.52	1.47	1.50	1.54	1.52	1.50
2.0	2.31	2.04	1.95	1.92	1.93	1.88	2.00	2.12	2.13	2.10
3.0	3.16	2.60	2.41	2.35	2.37	2.32	2.51	2.69	2.71	2.67
4.0	4.32	3.29	2.96	2.84	2.87	2.82	3.06	3.29	3.30	3.24
5.0	5.90	4.15	3.62	3.42	3.45	3.38	3.66	3.92	3.92	3.83
6.0	8.02	5.21	4.40	4.08	4.11	4.02	4.33	4.61	4.57	4.45
7.0	1.09E1	6.51	5.32	4.84	4.86	4.72	5.05	5.33	5.24	5.09
8.0	1.47E1	8.10	6.41	5.71	5.71	5.50	5.83	6.08	5.93	5.76
10.0	2.66E1	1.24E1	9.20	7.81	7.69	7.27	7.52	7.69	7.36	7.13
15.0	1.11E2	3.44E1	2.15E1	1.58E1	1.48E1	1.31E1	1.26E1	1.22E1	1.12E1	1.08E1
20.0	4.39E2	8.99E1	4.71E1	2.94E1	2.57E1	2.11E1	1.88E1	1.72E1	1.51E1	1.48E1
25.0	1.66E3	2.25E2	9.83E1	5.13E1	4.16E1	3.14E1	2.58E1	2.25E1	1.92E1	1.90E1
30.0	6.09E3	5.44E2	1.97E2	8.51E1	6.39E1	4.42E1	3.36E1	2.81E1	2.33E1	2.33E1
35.0	2.17E4	1.28E3	3.82E2	1.36E2	9.44E1	5.96E1	4.20E1	3.39E1	2.74E1	2.76E1
40.0	7.53E4	2.91E3	7.20E2	2.10E2	1.35E2	7.79E1	5.10E1	3.98E1	3.15E1	3.20E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.07
0.5	1.23	1.21	1.42	1.37	1.26	1.14	1.06	1.39	1.69	1.85
1.0	1.49	1.43	1.69	1.58	1.39	1.19	1.09	1.47	2.00	2.38
2.0	2.05	1.90	2.09	1.87	1.56	1.27	1.14	1.48	2.21	3.02
3.0	2.57	2.33	2.46	2.13	1.71	1.33	1.17	1.49	2.25	3.39
4.0	3.08	2.73	2.80	2.35	1.83	1.38	1.20	1.50	2.25	3.65
5.0	3.60	3.15	3.14	2.57	1.95	1.43	1.23	1.51	2.24	3.88
6.0	4.14	3.58	3.47	2.78	2.06	1.47	1.25	1.52	2.23	4.07
7.0	4.70	4.02	3.79	2.97	2.15	1.50	1.27	1.53	2.22	4.25
8.0	5.27	4.46	4.10	3.17	2.25	1.54	1.29	1.54	2.22	4.46
10.0	6.44	5.34	4.72	3.53	2.42	1.59	1.32	1.56	2.21	4.94
15.0	9.43	7.48	6.17	4.32	2.76	1.71	1.38	1.59	2.20	6.46
20.0	1.25E1	9.61	7.50	4.99	3.05	1.79	1.42	1.61	2.20	8.72
25.0	1.55E1	1.17E1	8.70	5.58	3.28	1.85	1.45	1.62	2.21	1.27E1
30.0	1.86E1	1.38E1	9.80	6.12	3.48	1.91	1.47	1.64	2.22	1.98E1
35.0	2.17E1	1.59E1	1.08E1	6.60	3.67	1.96	1.50	1.65	2.23	3.26E1
40.0	2.48E1	1.78E1	1.18E1	7.06	3.83	2.01	1.52	1.66	2.24	5.63E1
R(MFP)	ENERGY (MEV)									
	0.06	0.055	0.05	0.048	0.046	0.044	0.042	0.04	0.039	0.038
0.5	2.02	2.04	2.05	2.01	1.98	1.94	1.91	1.86	1.82	1.02
1.0	2.85	2.98	3.08	3.05	3.02	2.97	2.92	2.85	2.78	1.02
2.0	4.36	4.99	5.64	5.74	5.84	5.89	5.92	5.89	5.77	1.03
3.0	5.96	7.62	9.60	1.02E1	1.08E1	1.13E1	1.17E1	1.20E1	1.19E1	1.04
4.0	7.92	1.15E1	1.64E1	1.82E1	2.02E1	2.20E1	2.39E1	2.53E1	2.55E1	1.04
5.0	1.05E1	1.74E1	2.85E1	3.33E1	3.86E1	4.41E1	4.97E1	5.49E1	5.63E1	1.05
6.0	1.38E1	2.65E1	4.95E1	6.08E1	7.40E1	8.85E1	1.04E2	1.19E2	1.24E2	1.05
7.0	1.84E1	4.04E1	8.56E1	1.09E2	1.38E2	1.68E2	2.06E2	2.41E2	2.56E2	1.06
8.0	2.44E1	6.11E1	1.41E2	1.87E2	2.49E2	3.16E2	4.03E2	4.89E2	5.28E2	1.06
10.0	4.33E1	1.35E2	3.96E2	5.78E2	8.36E2	1.15E3	1.59E3	2.06E3	2.30E3	1.07
15.0	2.16E2	1.24E3	6.16E3	1.10E4	1.92E4	3.19E4	5.22E4	8.01E4	9.65E4	1.08
20.0	1.41E3	1.43E4	1.15E5	2.46E5	5.05E5	9.90E5	1.90E6	3.38E6	4.36E6	1.09
25.0	1.04E4	1.87E5	2.42E6	6.12E6	1.47E7	3.35E7	7.39E7	1.51E8	2.08E8	1.10
30.0	8.00E4	2.59E6	5.43E7	1.63E8	4.55E8	1.21E9	3.05E9	7.08E9	1.03E10	1.11
35.0	6.27E5	3.65E7	1.26E9	4.52E9	1.48E10	4.56E10	1.31E11	3.45E11	5.33E11	1.12
40.0	4.96E6	5.20E8	2.98E10	1.28E11	4.92E11	1.77E12	5.83E12	1.74E13	2.83E13	1.13
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.01	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.02	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.00							
5.0	1.03	1.01	1.00							
6.0	1.03	1.01	1.00							
7.0	1.03	1.01	1.01							
8.0	1.03	1.01	1.01							
10.0	1.04	1.01	1.01							
15.0	1.04	1.02	1.01							
20.0	1.05	1.02	1.01							
25.0	1.06	1.02	1.01							
30.0	1.06	1.02	1.01							
35.0	1.06	1.02	1.01							
40.0	1.07	1.02	1.01							

Table 3.3 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK LANTHANUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.40	1.38	1.37	1.36	1.35	1.29	1.29	1.29	1.27	1.26
1.0	1.77	1.67	1.62	1.59	1.59	1.51	1.54	1.57	1.57	1.54
2.0	2.48	2.18	2.06	2.01	2.03	1.94	2.05	2.18	2.22	2.18
3.0	3.43	2.79	2.56	2.46	2.50	2.39	2.58	2.78	2.85	2.80
4.0	4.71	3.55	3.15	2.98	3.03	2.91	3.16	3.40	3.48	3.41
5.0	6.45	4.49	3.86	3.59	3.65	3.49	3.78	4.06	4.13	4.04
6.0	8.79	5.66	4.70	4.29	4.36	4.15	4.48	4.78	4.83	4.70
7.0	1.19E1	7.09	5.70	5.10	5.17	4.89	5.23	5.53	5.54	5.39
8.0	1.62E1	8.85	6.88	6.02	6.07	5.69	6.03	6.31	6.28	6.10
10.0	2.93E1	1.36E1	9.90	8.25	8.20	7.54	7.80	7.98	7.81	7.57
15.0	1.23E2	3.78E1	2.32E1	1.68E1	1.58E1	1.36E1	1.31E1	1.27E1	1.19E1	1.15E1
20.0	4.86E2	9.92E1	5.11E1	3.13E1	2.76E1	2.19E1	1.95E1	1.79E1	1.61E1	1.57E1
25.0	1.85E3	2.49E2	1.07E2	5.46E1	4.47E1	3.27E1	2.68E1	2.35E1	2.05E1	2.02E1
30.0	6.76E3	6.02E2	2.14E2	9.07E1	6.88E1	4.60E1	3.49E1	2.93E1	2.49E1	2.48E1
35.0	2.41E4	1.41E3	4.16E2	1.45E2	1.02E2	6.22E1	4.38E1	3.53E1	2.93E1	2.95E1
40.0	8.36E4	3.23E3	7.84E2	2.24E2	1.45E2	8.13E1	5.31E1	4.15E1	3.37E1	3.42E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.07
0.5	1.25	1.23	1.45	1.38	1.27	1.14	1.07	1.44	1.70	1.82
1.0	1.53	1.46	1.74	1.61	1.41	1.20	1.11	1.53	2.01	2.34
2.0	2.13	1.96	2.16	1.91	1.58	1.28	1.15	1.55	2.22	2.95
3.0	2.70	2.41	2.55	2.17	1.73	1.34	1.19	1.55	2.26	3.32
4.0	3.24	2.83	2.90	2.40	1.85	1.39	1.22	1.56	2.26	3.58
5.0	3.80	3.27	3.25	2.63	1.97	1.44	1.25	1.58	2.25	3.81
6.0	4.38	3.72	3.60	2.84	2.08	1.48	1.27	1.59	2.25	4.00
7.0	4.97	4.18	3.94	3.04	2.18	1.52	1.29	1.60	2.23	4.19
8.0	5.58	4.64	4.27	3.24	2.28	1.55	1.31	1.61	2.23	4.40
10.0	6.83	5.56	4.92	3.61	2.45	1.61	1.34	1.62	2.22	4.89
15.0	1.00E1	7.81	6.44	4.42	2.80	1.72	1.40	1.65	2.21	6.43
20.0	1.33E1	1.00E1	7.83	5.11	3.09	1.81	1.44	1.68	2.21	8.71
25.0	1.66E1	1.22E1	9.08	5.72	3.32	1.87	1.47	1.69	2.22	1.27E1
30.0	1.99E1	1.44E1	1.02E1	6.27	3.53	1.93	1.50	1.71	2.23	1.99E1
35.0	2.32E1	1.66E1	1.13E1	6.76	3.72	1.98	1.52	1.72	2.24	3.29E1
40.0	2.65E1	1.87E1	1.23E1	7.23	3.88	2.03	1.54	1.74	2.25	5.69E1
R(MFP)	ENERGY (MEV)									
	0.06	0.055	0.05	0.048	0.046	0.044	0.042	0.04	0.039	0.038
0.5	1.95	1.98	2.01	1.97	1.94	1.90	1.86	1.81	1.78	1.02
1.0	2.71	2.87	3.01	2.97	2.93	2.87	2.81	2.74	2.69	1.02
2.0	4.12	4.78	5.48	5.56	5.62	5.65	5.65	5.59	5.53	1.03
3.0	5.61	7.27	9.31	9.82	1.03E1	1.08E1	1.11E1	1.13E1	1.13E1	1.04
4.0	7.45	1.10E1	1.59E1	1.76E1	1.93E1	2.10E1	2.26E1	2.39E1	2.43E1	1.04
5.0	9.86	1.66E1	2.76E1	3.21E1	3.70E1	4.20E1	4.71E1	5.16E1	5.35E1	1.05
6.0	1.30E1	2.53E1	4.81E1	5.88E1	7.10E1	8.44E1	9.87E1	1.12E2	1.18E2	1.05
7.0	1.74E1	3.87E1	8.33E1	1.05E2	1.33E2	1.60E2	1.95E2	2.27E2	2.44E2	1.06
8.0	2.30E1	5.85E1	1.37E2	1.82E2	2.40E2	3.02E2	3.83E2	4.61E2	5.03E2	1.06
10.0	4.10E1	1.30E2	3.87E2	5.61E2	8.06E2	1.10E3	1.51E3	1.95E3	2.20E3	1.07
15.0	2.08E2	1.20E3	6.09E3	1.08E4	1.87E4	3.08E4	5.00E4	7.61E4	9.25E4	1.08
20.0	1.36E3	1.40E4	1.15E5	2.43E5	4.95E5	9.62E5	1.83E6	3.22E6	4.20E6	1.09
25.0	1.01E4	1.84E5	2.42E6	6.09E6	1.45E7	3.28E7	7.16E7	1.45E8	2.01E8	1.10
30.0	7.75E4	2.55E6	5.45E7	1.63E8	4.51E8	1.19E9	2.97E9	6.83E9	1.01E10	1.11
35.0	6.07E5	3.60E7	1.27E9	4.52E9	1.47E10	4.50E10	1.28E11	3.34E11	5.21E11	1.12
40.0	4.81E6	5.13E8	3.00E10	1.28E11	4.90E11	1.75E12	5.72E12	1.69E13	2.78E13	1.12
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.01	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.02	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.00							
5.0	1.03	1.01	1.00							
6.0	1.03	1.01	1.00							
7.0	1.03	1.01	1.01							
8.0	1.03	1.01	1.01							
10.0	1.04	1.01	1.01							
15.0	1.04	1.02	1.01							
20.0	1.05	1.02	1.01							
25.0	1.06	1.02	1.01							
30.0	1.06	1.02	1.01							
35.0	1.06	1.02	1.01							
40.0	1.07	1.02	1.01							

Table 3.4 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick gadolinium

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK GADOLINIUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.30	1.33	1.37	1.42	1.45	1.37	1.42	1.45	1.44	1.45
1.0	1.52	1.54	1.57	1.63	1.67	1.57	1.68	1.81	1.83	1.85
2.0	1.93	1.88	1.88	1.94	2.03	1.92	2.17	2.53	2.65	2.70
3.0	2.46	2.28	2.23	2.30	2.41	2.29	2.67	3.20	3.40	3.47
4.0	3.18	2.79	2.65	2.71	2.86	2.73	3.22	3.88	4.13	4.18
5.0	4.17	3.42	3.16	3.18	3.38	3.22	3.82	4.60	4.87	4.90
6.0	5.51	4.21	3.76	3.74	3.97	3.78	4.49	5.38	5.66	5.66
7.0	7.33	5.18	4.48	4.38	4.64	4.41	5.22	6.20	6.47	6.43
8.0	9.79	6.38	5.33	5.11	5.40	5.10	6.00	7.05	7.29	7.21
10.0	1.76E1	9.68	7.52	6.89	7.20	6.69	7.71	8.83	8.97	8.80
15.0	7.67E1	2.72E1	1.74E1	1.38E1	1.37E1	1.20E1	1.29E1	1.38E1	1.33E1	1.29E1
20.0	3.26E2	7.41E1	3.88E1	2.60E1	2.41E1	1.94E1	1.92E1	1.92E1	1.78E1	1.72E1
25.0	1.34E3	1.96E2	8.35E1	4.63E1	3.96E1	2.93E1	2.65E1	2.48E1	2.22E1	2.15E1
30.0	5.33E3	5.04E2	1.74E2	7.91E1	6.21E1	4.18E1	3.47E1	3.06E1	2.65E1	2.59E1
35.0	2.07E4	1.26E3	3.53E2	1.31E2	9.38E1	5.75E1	4.38E1	3.66E1	3.09E1	3.03E1
40.0	7.82E4	3.08E3	6.98E2	2.09E2	1.37E2	7.64E1	5.35E1	4.26E1	3.52E1	3.46E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	1.47	1.43	1.40	1.62	1.57	1.42	1.37	1.44	1.45	1.44
1.0	1.86	1.76	1.67	1.89	1.73	1.47	1.42	1.64	1.71	1.77
2.0	2.67	2.42	2.19	2.20	1.91	1.53	1.46	1.80	2.02	2.31
3.0	3.36	2.96	2.60	2.46	2.06	1.59	1.49	1.84	2.19	2.79
4.0	3.98	3.43	2.95	2.67	2.18	1.64	1.52	1.85	2.31	3.31
5.0	4.60	3.90	3.29	2.86	2.29	1.69	1.55	1.86	2.41	3.91
6.0	5.24	4.38	3.62	3.05	2.39	1.72	1.57	1.86	2.48	4.61
7.0	5.87	4.86	3.96	3.22	2.49	1.76	1.59	1.85	2.56	5.50
8.0	6.51	5.33	4.28	3.39	2.58	1.79	1.60	1.85	2.64	6.67
10.0	7.79	6.26	4.92	3.70	2.73	1.84	1.63	1.85	2.81	9.74
15.0	1.09E1	8.37	6.30	4.34	3.05	1.95	1.69	1.85	3.38	3.20E1
20.0	1.39E1	1.04E1	7.62	4.88	3.30	2.02	1.73	1.85	4.02	1.38E2
25.0	1.67E1	1.22E1	8.83	5.33	3.50	2.09	1.76	1.86	4.97	6.70E2
30.0	1.95E1	1.40E1	9.97	5.73	3.68	2.14	1.78	1.87	6.49	3.43E3
35.0	2.22E1	1.57E1	1.10E1	6.09	3.85	2.20	1.80	1.88	8.93	1.80E4
40.0	2.42E1	1.74E1	1.21E1	6.42	3.99	2.24	1.82	1.89	1.30E1	9.60E4
R(MFP)	ENERGY (MEV)									
	0.075	0.07	0.065	0.06	0.058	0.056	0.054	0.052	0.051	0.05
0.5	1.44	1.44	1.44	1.43	1.43	1.44	1.44	1.44	1.45	1.02
1.0	1.81	1.84	1.86	1.87	1.89	1.91	1.93	1.94	1.95	1.03
2.0	2.48	2.67	2.86	3.03	3.14	3.25	3.35	3.44	3.50	1.04
3.0	3.22	3.75	4.34	4.97	5.31	5.68	6.04	6.37	6.58	1.05
4.0	4.16	5.31	6.78	8.53	9.47	1.05E1	1.16E1	1.26E1	1.32E1	1.06
5.0	5.41	7.69	1.09E1	1.53E1	1.76E1	2.03E1	2.31E1	2.60E1	2.78E1	1.07
6.0	7.08	1.13E1	1.80E1	2.78E1	3.33E1	3.98E1	4.70E1	5.46E1	5.92E1	1.07
7.0	9.47	1.68E1	2.96E1	4.97E1	6.18E1	7.45E1	9.11E1	1.10E2	1.19E2	1.08
8.0	1.26E1	2.49E1	4.75E1	8.66E1	1.11E2	1.39E2	1.75E2	2.17E2	2.39E2	1.09
10.0	2.30E1	5.40E1	1.25E2	2.73E2	3.75E2	4.97E2	6.67E2	8.76E2	9.91E2	1.10
15.0	1.28E2	4.86E2	1.72E3	5.58E3	8.83E3	1.34E4	2.06E4	3.08E4	3.71E4	1.12
20.0	9.39E2	5.61E3	2.91E4	1.34E5	2.39E5	4.12E5	7.09E5	1.19E6	1.52E6	1.13
25.0	7.75E3	7.27E4	5.54E5	3.57E6	7.17E6	1.38E7	2.65E7	4.93E7	6.65E7	1.15
30.0	6.66E4	9.87E5	1.12E7	1.01E8	2.29E8	4.93E8	1.05E9	2.16E9	3.06E9	1.16
35.0	5.83E5	1.37E7	2.32E8	2.98E9	7.59E9	1.83E10	4.33E10	9.84E10	1.47E11	1.17
40.0	5.16E6	1.91E8	4.88E9	8.95E10	2.58E11	7.00E11	1.84E12	4.63E12	7.24E12	1.18
R(MFP)	ENERGY (MEV)									
	0.04	0.03	0.02	0.015						
0.5	1.01	1.01	1.00	1.00						
1.0	1.02	1.01	1.00	1.00						
2.0	1.02	1.01	1.00	1.00						
3.0	1.03	1.01	1.01	1.00						
4.0	1.03	1.02	1.01	1.00						
5.0	1.04	1.02	1.01	1.00						
6.0	1.04	1.02	1.01	1.00						
7.0	1.04	1.02	1.01	1.00						
8.0	1.05	1.02	1.01	1.00						
10.0	1.05	1.02	1.01	1.00						
15.0	1.06	1.03	1.01	1.01						
20.0	1.07	1.04	1.01	1.01						
25.0	1.08	1.04	1.01	1.01						
30.0	1.09	1.04	1.01	1.01						
35.0	1.09	1.04	1.02	1.01						
40.0	1.10	1.05	1.02	1.01						

Table 3.4 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK GADOLINIUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.34	1.32	1.31	1.30	1.29	1.25	1.25	1.25	1.05	1.21
1.0	1.67	1.57	1.53	1.50	1.49	1.43	1.46	1.50	1.07	1.45
2.0	2.35	2.05	1.93	1.88	1.87	1.81	1.91	2.02	1.10	1.94
3.0	3.28	2.65	2.41	2.30	2.29	2.21	2.38	2.52	1.12	2.40
4.0	4.58	3.39	2.97	2.78	2.77	2.67	2.88	3.04	3.00	2.85
5.0	6.36	4.33	3.65	3.34	3.32	3.20	3.43	3.59	3.51	3.31
6.0	8.79	5.50	4.46	3.99	3.95	3.79	4.04	4.18	4.05	3.79
7.0	1.21E1	6.96	5.43	4.73	4.67	4.45	4.70	4.79	4.60	4.27
8.0	1.67E1	8.76	6.58	5.59	5.45	5.18	5.41	5.43	5.16	4.77
10.0	3.12E1	1.38E1	9.56	7.69	7.40	6.85	6.96	6.77	6.30	5.77
15.0	1.42E2	4.06E1	2.31E1	1.59E1	1.44E1	1.25E1	1.16E1	1.05E1	9.23	8.35
20.0	6.13E2	1.13E2	5.29E1	3.04E1	2.55E1	2.03E1	1.73E1	1.45E1	1.22E1	1.10E1
25.0	2.54E3	3.04E2	1.15E2	5.49E1	4.23E1	3.07E1	2.39E1	1.86E1	1.52E1	1.38E1
30.0	1.02E4	7.85E2	2.43E2	9.43E1	6.66E1	4.40E1	3.13E1	2.30E1	1.82E1	1.65E1
35.0	3.94E4	1.97E3	4.94E2	1.56E2	1.01E2	6.05E1	3.94E1	2.74E1	2.11E1	1.93E1
40.0	1.50E5	4.83E3	9.80E2	2.51E2	1.48E2	8.05E1	4.81E1	3.19E1	2.40E1	2.20E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	1.21	1.18	1.16	1.29	1.21	1.14	1.14	1.41	1.51	1.64
1.0	1.42	1.36	1.31	1.45	1.30	1.18	1.17	1.60	1.82	2.12
2.0	1.88	1.72	1.61	1.65	1.42	1.23	1.20	1.75	2.18	2.90
3.0	2.28	2.04	1.86	1.82	1.52	1.28	1.23	1.79	2.38	3.61
4.0	2.66	2.33	2.07	1.97	1.60	1.32	1.25	1.80	2.52	4.37
5.0	3.04	2.62	2.29	2.10	1.68	1.35	1.27	1.81	2.63	5.27
6.0	3.43	2.92	2.50	2.23	1.74	1.38	1.29	1.81	2.72	6.33
7.0	3.82	3.22	2.71	2.35	1.81	1.40	1.30	1.81	2.81	7.69
8.0	4.21	3.51	2.92	2.46	1.87	1.42	1.32	1.81	2.91	9.45
10.0	5.00	4.08	3.33	2.68	1.97	1.46	1.34	1.80	3.13	1.42E1
15.0	6.90	5.39	4.21	3.12	2.19	1.54	1.38	1.80	3.82	4.84E1
20.0	8.72	6.63	5.06	3.49	2.35	1.60	1.41	1.81	4.61	2.11E2
25.0	1.05E1	7.79	5.86	3.80	2.49	1.64	1.44	1.81	5.78	1.04E3
30.0	1.22E1	8.92	6.60	4.08	2.61	1.68	1.46	1.82	7.64	5.31E3
35.0	1.39E1	1.00E1	7.30	4.33	2.73	1.72	1.47	1.83	1.07E1	2.79E4
40.0	1.55E1	1.10E1	7.96	4.57	2.83	1.76	1.49	1.84	1.56E1	1.49E5
R(MFP)	ENERGY (MEV)									
	0.075	0.07	0.065	0.06	0.058	0.056	0.054	0.052	0.051	0.05
0.5	1.68	1.72	1.77	1.81	1.81	1.80	1.80	1.78	1.78	1.02
1.0	2.24	2.37	2.51	2.65	2.66	2.68	2.68	2.67	2.67	1.03
2.0	3.29	3.76	4.29	4.87	5.00	5.14	5.25	5.32	5.38	1.04
3.0	4.44	5.54	6.92	8.58	9.08	9.62	1.01E1	1.05E1	1.08E1	1.05
4.0	5.91	8.16	1.13E1	1.54E1	1.69E1	1.85E1	2.01E1	2.16E1	2.24E1	1.06
5.0	7.89	1.22E1	1.87E1	2.84E1	3.23E1	3.66E1	4.11E1	4.54E1	4.80E1	1.06
6.0	1.06E1	1.82E1	3.13E1	5.25E1	6.20E1	7.29E1	8.45E1	9.62E1	1.03E2	1.07
7.0	1.44E1	2.75E1	5.22E1	9.49E1	1.16E2	1.37E2	1.65E2	1.95E2	2.09E2	1.08
8.0	1.94E1	4.12E1	8.46E1	1.66E2	2.10E2	2.57E2	3.18E2	3.87E2	4.21E2	1.08
10.0	3.61E1	9.09E1	2.25E2	5.30E2	7.13E2	9.27E2	1.22E3	1.57E3	1.75E3	1.09
15.0	2.07E2	8.38E2	3.16E3	1.10E4	1.70E4	2.53E4	3.79E4	5.54E4	6.62E4	1.11
20.0	1.53E3	9.76E3	5.40E4	2.66E5	4.66E5	7.84E5	1.32E6	2.16E6	2.73E6	1.13
25.0	1.27E4	1.27E5	1.03E6	7.14E6	1.41E7	2.65E7	4.97E7	9.03E7	1.20E8	1.14
30.0	1.09E5	1.73E6	2.09E7	2.04E8	4.51E8	9.51E8	1.98E9	3.98E9	5.58E9	1.15
35.0	9.58E5	2.39E7	4.35E8	6.01E9	1.50E10	3.55E10	8.21E10	1.82E11	2.69E11	1.16
40.0	8.49E6	3.35E8	9.15E9	1.81E11	5.11E11	1.36E12	3.50E12	8.60E12	1.33E13	1.17
R(MFP)	ENERGY (MEV)									
	0.04	0.03	0.02	0.015						
0.5	1.01	1.01	1.00	1.00						
1.0	1.02	1.01	1.00	1.00						
2.0	1.02	1.01	1.00	1.00						
3.0	1.03	1.01	1.01	1.00						
4.0	1.03	1.02	1.01	1.00						
5.0	1.04	1.02	1.01	1.00						
6.0	1.04	1.02	1.01	1.00						
7.0	1.04	1.02	1.01	1.00						
8.0	1.05	1.02	1.01	1.00						
10.0	1.05	1.02	1.01	1.00						
15.0	1.06	1.03	1.01	1.01						
20.0	1.07	1.04	1.01	1.01						
25.0	1.08	1.04	1.01	1.01						
30.0	1.09	1.04	1.01	1.01						
35.0	1.09	1.04	1.02	1.01						
40.0	1.10	1.05	1.02	1.01						

Table 3.4 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK GADOLINIUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.40	1.37	1.36	1.34	1.33	1.27	1.27	1.27	1.25	1.23
1.0	1.77	1.66	1.60	1.56	1.55	1.47	1.50	1.53	1.52	1.48
2.0	2.52	2.18	2.04	1.96	1.96	1.85	1.96	2.07	2.08	2.01
3.0	3.54	2.83	2.54	2.40	2.41	2.27	2.44	2.59	2.61	2.50
4.0	4.97	3.65	3.15	2.90	2.92	2.75	2.96	3.13	3.13	2.98
5.0	6.93	4.68	3.88	3.49	3.50	3.29	3.53	3.69	3.68	3.46
6.0	9.61	5.96	4.75	4.18	4.18	3.90	4.16	4.30	4.25	3.97
7.0	1.33E1	7.56	5.80	4.97	4.94	4.58	4.84	4.93	4.83	4.48
8.0	1.83E1	9.55	7.04	5.88	5.81	5.34	5.57	5.59	5.42	5.00
10.0	3.43E1	1.51E1	1.03E1	8.10	7.87	7.07	7.17	6.98	6.63	6.06
15.0	1.57E2	4.45E1	2.49E1	1.68E1	1.54E1	1.29E1	1.20E1	1.08E1	9.74	8.80
20.0	6.77E2	1.25E2	5.71E1	3.23E1	2.73E1	2.10E1	1.79E1	1.49E1	1.29E1	1.16E1
25.0	2.80E3	3.34E2	1.25E2	5.82E1	4.53E1	3.18E1	2.47E1	1.93E1	1.61E1	1.45E1
30.0	1.12E4	8.66E2	2.63E2	1.00E2	7.14E1	4.56E1	3.24E1	2.38E1	1.92E1	1.75E1
35.0	4.36E4	2.18E3	5.36E2	1.66E2	1.08E2	6.28E1	4.08E1	2.84E1	2.23E1	2.03E1
40.0	1.66E5	5.33E3	1.06E3	2.67E2	1.59E2	8.36E1	4.98E1	3.30E1	2.54E1	2.32E1
R(NFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.09	0.08
0.5	1.22	1.19	1.17	1.30	1.22	1.17	1.19	1.49	1.58	1.67
1.0	1.46	1.38	1.33	1.46	1.32	1.21	1.23	1.72	1.93	2.18
2.0	1.94	1.76	1.64	1.67	1.44	1.27	1.26	1.90	2.33	3.00
3.0	2.37	2.09	1.90	1.85	1.54	1.31	1.29	1.94	2.55	3.75
4.0	2.77	2.39	2.13	2.00	1.63	1.35	1.31	1.95	2.71	4.56
5.0	3.18	2.70	2.36	2.14	1.70	1.38	1.33	1.96	2.83	5.50
6.0	3.59	3.01	2.58	2.27	1.77	1.41	1.35	1.96	2.94	6.61
7.0	4.00	3.32	2.80	2.39	1.84	1.44	1.36	1.95	3.04	8.03
8.0	4.42	3.62	3.01	2.50	1.90	1.46	1.38	1.95	3.15	9.88
10.0	5.25	4.22	3.44	2.72	2.00	1.51	1.40	1.95	3.39	1.48E1
15.0	7.26	5.58	4.36	3.17	2.22	1.58	1.45	1.94	4.16	5.05E1
20.0	9.19	6.86	5.24	3.55	2.39	1.64	1.48	1.95	5.03	2.20E2
25.0	1.11E1	8.06	6.07	3.87	2.54	1.69	1.51	1.95	6.34	1.08E3
30.0	1.29E1	9.24	6.84	4.16	2.66	1.73	1.53	1.96	8.41	5.54E3
35.0	1.47E1	1.04E1	7.56	4.41	2.77	1.77	1.54	1.97	1.18E1	2.91E4
40.0	1.64E1	1.14E1	8.25	4.65	2.87	1.81	1.56	1.98	1.73E1	1.55E5
R(MFP)	ENERGY (MEV)									
	0.075	0.07	0.065	0.06	0.058	0.056	0.054	0.052	0.051	0.05
0.5	1.70	1.74	1.77	1.79	1.79	1.80	1.80	1.79	1.79	1.02
1.0	2.29	2.40	2.51	2.62	2.64	2.66	2.68	2.68	2.69	1.03
2.0	3.38	3.81	4.28	4.78	4.94	5.10	5.25	5.36	5.44	1.04
3.0	4.57	5.62	6.90	8.39	8.95	9.54	1.01E1	1.06E1	1.09E1	1.05
4.0	6.09	8.28	1.12E1	1.51E1	1.67E1	1.84E1	2.01E1	2.17E1	2.27E1	1.06
5.0	8.13	1.23E1	1.87E1	2.77E1	3.17E1	3.63E1	4.11E1	4.58E1	4.86E1	1.07
6.0	1.09E1	1.85E1	3.12E1	5.12E1	6.09E1	7.22E1	8.44E1	9.69E1	1.05E2	1.07
7.0	1.48E1	2.79E1	5.19E1	9.25E1	1.14E2	1.36E2	1.64E2	1.96E2	2.11E2	1.08
8.0	2.00E1	4.17E1	8.41E1	1.62E2	2.06E2	2.54E2	3.17E2	3.89E2	4.26E2	1.08
10.0	3.71E1	9.20E1	2.24E2	5.15E2	6.99E2	9.16E2	1.21E3	1.57E3	1.77E3	1.09
15.0	2.12E2	8.45E2	3.12E3	1.06E4	1.66E4	2.50E4	3.77E4	5.57E4	6.67E4	1.11
20.0	1.57E3	9.82E3	5.33E4	2.57E5	4.54E5	7.71E5	1.31E6	2.17E6	2.75E6	1.13
25.0	1.30E4	1.28E5	1.02E6	6.89E6	1.37E7	2.60E7	4.92E7	9.03E7	1.21E8	1.14
30.0	1.12E5	1.73E6	2.06E7	1.97E8	4.38E8	9.33E8	1.96E9	3.97E9	5.60E9	1.16
35.0	9.80E5	2.40E7	4.28E8	5.79E9	1.46E10	3.48E10	8.11E10	1.82E11	2.69E11	1.17
40.0	8.69E6	3.37E8	9.00E9	1.74E11	4.96E11	1.33E12	3.46E12	8.57E12	1.33E13	1.17
R(MFP)	ENERGY (MEV)									
	0.04	0.03	0.02	0.015						
0.5	1.01	1.01	1.00	1.00						
1.0	1.02	1.01	1.00	1.00						
2.0	1.02	1.01	1.00	1.00						
3.0	1.03	1.01	1.01	1.00						
4.0	1.03	1.02	1.01	1.00						
5.0	1.04	1.02	1.01	1.00						
6.0	1.04	1.02	1.01	1.00						
7.0	1.04	1.02	1.01	1.00						
8.0	1.05	1.02	1.01	1.00						
10.0	1.05	1.02	1.01	1.00						
15.0	1.06	1.03	1.01	1.01						
20.0	1.07	1.04	1.01	1.01						
25.0	1.08	1.04	1.01	1.01						
30.0	1.09	1.04	1.01	1.01						
35.0	1.09	1.04	1.02	1.01						
40.0	1.10	1.05	1.02	1.01						

Table 3.5 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick tungsten

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP-THICK TUNGSTEN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.28	1.31	1.35	1.40	1.42	1.38	1.43	1.45	1.42	1.40
1.0	1.51	1.51	1.53	1.58	1.60	1.54	1.64	1.77	1.77	1.73
2.0	1.91	1.84	1.82	1.87	1.91	1.84	2.07	2.39	2.45	2.39
3.0	2.45	2.24	2.16	2.20	2.25	2.18	2.52	2.96	3.05	2.93
4.0	3.21	2.76	2.58	2.58	2.64	2.57	3.01	3.53	3.62	3.42
5.0	4.25	3.41	3.07	3.03	3.08	3.02	3.54	4.13	4.19	3.90
6.0	5.70	4.23	3.66	3.55	3.60	3.53	4.13	4.77	4.79	4.39
7.0	7.71	5.26	4.38	4.15	4.18	4.09	4.76	5.43	5.39	4.88
8.0	1.05E1	6.56	5.23	4.83	4.84	4.71	5.43	6.11	6.00	5.36
10.0	1.96E1	1.02E1	7.47	6.54	6.42	6.15	6.91	7.52	7.20	6.31
15.0	9.40E1	3.11E1	1.80E1	1.34E1	1.23E1	1.10E1	1.14E1	1.13E1	1.02E1	8.57
20.0	4.42E2	9.31E1	4.25E1	2.60E1	2.18E1	1.79E1	1.67E1	1.53E1	1.30E1	1.08E1
25.0	2.01E3	2.71E2	9.74E1	4.85E1	3.67E1	2.72E1	2.29E1	1.94E1	1.58E1	1.29E1
30.0	8.87E3	7.69E2	2.17E2	8.69E1	5.91E1	3.94E1	2.99E1	2.35E1	1.85E1	1.49E1
35.0	3.82E4	2.13E3	4.73E2	1.51E2	9.21E1	5.50E1	3.76E1	2.77E1	2.12E1	1.70E1
40.0	1.61E5	5.74E3	1.01E3	2.56E2	1.39E2	7.44E1	4.59E1	3.18E1	2.38E1	1.88E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.14	0.13	0.12
0.5	1.78	1.66	1.71	1.60	1.47	1.40	1.45	1.47	1.47	1.48
1.0	2.21	1.99	1.99	1.79	1.56	1.47	1.62	1.67	1.72	1.78
2.0	2.73	2.36	2.30	1.99	1.67	1.44	1.61	1.70	1.84	2.02
3.0	3.20	2.69	2.56	2.17	1.76	1.38	1.47	1.57	1.74	2.03
4.0	3.61	2.97	2.78	2.30	1.84	1.41	1.45	1.54	1.72	2.09
5.0	4.03	3.24	2.99	2.42	1.90	1.44	1.45	1.54	1.72	2.17
6.0	4.44	3.51	3.19	2.54	1.96	1.46	1.46	1.54	1.72	2.24
7.0	4.83	3.75	3.37	2.64	2.01	1.48	1.47	1.54	1.73	2.33
8.0	5.20	3.99	3.53	2.74	2.06	1.50	1.47	1.54	1.74	2.45
10.0	5.93	4.44	3.84	2.91	2.15	1.53	1.49	1.54	1.75	2.74
15.0	7.59	5.43	4.50	3.28	2.33	1.59	1.51	1.56	1.76	3.71
20.0	9.11	6.25	5.09	3.57	2.46	1.63	1.54	1.57	1.77	5.09
25.0	1.05E1	6.96	5.58	3.82	2.57	1.67	1.55	1.58	1.76	7.47
30.0	1.18E1	7.61	6.00	4.03	2.67	1.69	1.57	1.59	1.76	1.17E1
35.0	1.30E1	8.21	6.36	4.22	2.76	1.72	1.58	1.61	1.76	1.95E1
40.0	1.42E1	8.78	6.69	4.39	2.84	1.74	1.59	1.62	1.76	3.41E1
R(MFP)	ENERGY (MEV)									
	0.11	0.1	0.09	0.08	0.075	0.07	0.069	0.06	0.05	0.04
0.5	1.47	1.47	1.47	1.47	1.48	1.49	1.03	1.02	1.01	1.01
1.0	1.82	1.86	1.91	1.95	1.99	2.04	1.04	1.03	1.02	1.01
2.0	2.22	2.46	2.76	3.07	3.28	3.51	1.06	1.04	1.03	1.02
3.0	2.44	3.02	3.86	4.90	5.57	6.33	1.07	1.05	1.03	1.02
4.0	2.75	3.87	5.75	8.47	1.03E1	1.25E1	1.08	1.06	1.04	1.02
5.0	3.11	5.00	8.74	1.50E1	1.95E1	2.53E1	1.09	1.06	1.04	1.02
6.0	3.52	6.51	1.34E1	2.65E1	3.68E1	5.07E1	1.10	1.07	1.04	1.02
7.0	4.08	8.82	2.10E1	4.74E1	7.00E1	1.01E2	1.11	1.08	1.05	1.03
8.0	4.84	1.19E1	3.31E1	8.42E1	1.32E2	2.02E2	1.12	1.08	1.05	1.03
10.0	6.85	2.28E1	8.38E1	2.75E2	4.82E2	8.20E2	1.13	1.09	1.06	1.03
15.0	1.99E1	1.48E2	1.06E3	6.04E3	1.35E4	2.91E4	1.16	1.11	1.07	1.04
20.0	7.20E1	1.18E3	1.59E4	1.52E5	4.20E5	1.13E6	1.18	1.13	1.08	1.05
25.0	2.87E2	1.02E4	2.63E5	4.16E6	1.42E7	4.65E7	1.20	1.14	1.09	1.05
30.0	1.19E3	9.10E4	4.50E6	1.20E8	5.07E8	2.02E9	1.22	1.15	1.10	1.05
35.0	5.07E3	8.23E5	7.83E7	3.57E9	1.88E10	9.11E10	1.23	1.16	1.10	1.06
40.0	2.20E4	7.53E6	1.38E9	1.08E11	7.10E11	4.21E12	1.24	1.17	1.11	1.06
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.00	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.01	1.00	1.00							
3.0	1.01	1.00	1.00							
4.0	1.01	1.00	1.00							
5.0	1.01	1.00	1.00							
6.0	1.01	1.00	1.00							
7.0	1.01	1.00	1.00							
8.0	1.01	1.01	1.00							
10.0	1.02	1.01	1.00							
15.0	1.02	1.01	1.00							
20.0	1.02	1.01	1.00							
25.0	1.02	1.01	1.00							
30.0	1.03	1.01	1.01							
35.0	1.03	1.01	1.01							
40.0	1.03	1.01	1.01							

Table 3.5 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK TUNGSTEN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.30	1.27	1.26	1.25	1.24	1.22	1.23	1.23	1.21	1.18
1.0	1.62	1.51	1.46	1.43	1.42	1.38	1.41	1.44	1.42	1.37
2.0	2.27	1.97	1.85	1.77	1.75	1.71	1.80	1.88	1.85	1.76
3.0	3.22	2.56	2.30	2.15	2.13	2.07	2.21	2.30	2.25	2.09
4.0	4.55	3.32	2.84	2.59	2.55	2.48	2.64	2.73	2.63	2.40
5.0	6.41	4.28	3.50	3.10	3.04	2.94	3.12	3.18	3.02	2.71
6.0	9.01	5.49	4.29	3.70	3.60	3.47	3.64	3.65	3.42	3.03
7.0	1.26E1	7.04	5.25	4.39	4.24	4.05	4.20	4.14	3.83	3.34
8.0	1.77E1	8.99	6.40	5.19	4.97	4.70	4.80	4.63	4.23	3.65
10.0	3.44E1	1.46E1	9.44	7.17	6.71	6.19	6.11	5.67	5.04	4.26
15.0	1.72E2	4.66E1	2.39E1	1.52E1	1.32E1	1.12E1	1.00E1	8.43	7.03	5.71
20.0	8.23E2	1.43E2	5.79E1	3.01E1	2.38E1	1.84E1	1.48E1	1.13E1	8.96	7.12
25.0	3.77E3	4.20E2	1.35E2	5.68E1	4.05E1	2.81E1	2.02E1	1.43E1	1.08E1	8.51
30.0	1.67E4	1.20E3	3.03E2	1.03E2	6.57E1	4.09E1	2.64E1	1.74E1	1.27E1	9.85
35.0	7.21E4	3.32E3	6.62E2	1.79E2	1.03E2	5.71E1	3.32E1	2.04E1	1.44E1	1.11E1
40.0	3.04E5	9.00E3	1.41E3	3.04E2	1.56E2	7.73E1	4.05E1	2.34E1	1.62E1	1.23E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.14	0.13	0.12
0.5	1.38	1.32	1.27	1.22	1.15	1.10	1.19	1.22	1.26	1.31
1.0	1.61	1.50	1.41	1.32	1.21	1.13	1.26	1.32	1.40	1.50
2.0	1.93	1.73	1.59	1.45	1.29	1.16	1.27	1.35	1.47	1.67
3.0	2.22	1.95	1.75	1.56	1.35	1.17	1.23	1.30	1.44	1.70
4.0	2.49	2.13	1.89	1.65	1.40	1.20	1.23	1.30	1.44	1.76
5.0	2.77	2.32	2.02	1.73	1.45	1.22	1.24	1.30	1.44	1.82
6.0	3.02	2.49	2.14	1.80	1.49	1.24	1.25	1.30	1.45	1.89
7.0	3.27	2.66	2.26	1.87	1.52	1.25	1.25	1.31	1.46	1.97
8.0	3.51	2.81	2.36	1.94	1.56	1.27	1.26	1.31	1.47	2.07
10.0	3.98	3.11	2.55	2.05	1.62	1.29	1.27	1.32	1.48	2.30
15.0	5.04	3.77	2.97	2.29	1.74	1.34	1.30	1.33	1.50	3.08
20.0	6.03	4.32	3.33	2.48	1.83	1.37	1.32	1.35	1.50	4.16
25.0	6.92	4.80	3.64	2.65	1.91	1.40	1.33	1.36	1.50	6.05
30.0	7.76	5.24	3.91	2.78	1.98	1.42	1.34	1.37	1.50	9.43
35.0	8.55	5.65	4.14	2.91	2.04	1.44	1.36	1.38	1.50	1.56E1
40.0	9.30	6.03	4.35	3.03	2.09	1.46	1.37	1.39	1.50	2.73E1
R(MFP)	ENERGY (MEV)									
	0.11	0.1	0.09	0.08	0.075	0.07	0.069	0.06	0.05	0.04
0.5	1.37	1.44	1.52	1.60	1.62	1.65	1.03	1.02	1.01	1.01
1.0	1.64	1.81	2.00	2.23	2.30	2.37	1.04	1.03	1.02	1.01
2.0	1.96	2.40	2.95	3.70	4.00	4.33	1.05	1.04	1.03	1.02
3.0	2.16	2.98	4.22	6.12	7.04	8.11	1.06	1.05	1.03	1.02
4.0	2.43	3.85	6.40	1.09E1	1.34E1	1.64E1	1.08	1.05	1.04	1.02
5.0	2.76	5.05	9.92	1.97E1	2.58E1	3.38E1	1.08	1.06	1.04	1.02
6.0	3.15	6.68	1.55E1	3.55E1	4.95E1	6.86E1	1.09	1.07	1.04	1.02
7.0	3.67	9.21	2.48E1	6.43E1	9.50E1	1.38E2	1.10	1.07	1.05	1.03
8.0	4.39	1.26E1	3.94E1	1.15E2	1.81E2	2.78E2	1.11	1.08	1.05	1.03
10.0	6.28	2.47E1	1.03E2	3.85E2	6.70E2	1.14E3	1.12	1.09	1.06	1.03
15.0	1.86E1	1.68E2	1.35E3	8.80E3	1.94E4	4.18E4	1.15	1.11	1.07	1.04
20.0	6.80E1	1.36E3	2.10E4	2.28E5	6.25E5	1.67E6	1.17	1.12	1.08	1.05
25.0	2.72E2	1.19E4	3.50E5	6.39E6	2.17E7	7.06E7	1.19	1.14	1.09	1.05
30.0	1.13E3	1.06E5	6.03E6	1.87E8	7.88E8	3.13E9	1.20	1.15	1.09	1.05
35.0	4.84E3	9.63E5	1.05E8	5.60E9	2.95E10	1.43E11	1.22	1.16	1.10	1.06
40.0	2.11E4	8.84E6	1.86E9	1.70E11	1.12E12	6.67E12	1.23	1.17	1.11	1.06
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.00	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.01	1.00	1.00							
3.0	1.01	1.00	1.00							
4.0	1.01	1.00	1.00							
5.0	1.01	1.00	1.00							
6.0	1.01	1.00	1.00							
7.0	1.01	1.00	1.00							
8.0	1.01	1.01	1.00							
10.0	1.02	1.01	1.00							
15.0	1.02	1.01	1.00							
20.0	1.02	1.01	1.00							
25.0	1.02	1.01	1.00							
30.0	1.03	1.01	1.01							
35.0	1.03	1.01	1.01							
40.0	1.03	1.01	1.01							

Table 3.5 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK TUNGSTEN

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.35	1.32	1.30	1.29	1.28	1.25	1.25	1.25	1.23	1.20
1.0	1.70	1.58	1.52	1.48	1.46	1.41	1.44	1.47	1.45	1.40
2.0	2.43	2.09	1.93	1.83	1.82	1.74	1.84	1.92	1.91	1.80
3.0	3.46	2.73	2.42	2.23	2.22	2.11	2.25	2.35	2.32	2.15
4.0	4.91	3.55	3.00	2.70	2.67	2.54	2.70	2.78	2.72	2.48
5.0	6.96	4.60	3.70	3.23	3.19	3.01	3.19	3.24	3.13	2.81
6.0	9.81	5.93	4.55	3.86	3.78	3.55	3.73	3.73	3.55	3.13
7.0	1.38E1	7.62	5.58	4.59	4.46	4.16	4.30	4.23	3.98	3.46
8.0	1.93E1	9.75	6.82	5.43	5.24	4.82	4.92	4.74	4.41	3.78
10.0	3.77E1	1.59E1	1.01E1	7.52	7.09	6.36	6.27	5.80	5.25	4.42
15.0	1.89E2	5.09E1	2.57E1	1.60E1	1.40E1	1.15E1	1.03E1	8.64	7.33	5.94
20.0	9.04E2	1.56E2	6.23E1	3.18E1	2.53E1	1.90E1	1.52E1	1.16E1	9.36	7.41
25.0	4.14E3	4.61E2	1.45E2	6.00E1	4.31E1	2.90E1	2.08E1	1.47E1	1.13E1	8.86
30.0	1.83E4	1.32E3	3.26E2	1.08E2	7.01E1	4.22E1	2.71E1	1.78E1	1.32E1	1.03E1
35.0	7.94E4	3.65E3	7.14E2	1.90E2	1.10E2	5.89E1	3.41E1	2.09E1	1.51E1	1.16E1
40.0	3.35E5	9.89E3	1.53E3	3.22E2	1.67E2	7.98E1	4.16E1	2.41E1	1.69E1	1.29E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.14	0.13	0.12
0.5	1.41	1.34	1.29	1.23	1.17	1.14	1.26	1.30	1.35	1.40
1.0	1.66	1.52	1.44	1.34	1.23	1.18	1.36	1.44	1.53	1.65
2.0	1.99	1.77	1.63	1.47	1.31	1.19	1.37	1.47	1.63	1.86
3.0	2.30	1.99	1.80	1.58	1.37	1.20	1.30	1.40	1.57	1.89
4.0	2.58	2.18	1.94	1.67	1.42	1.22	1.30	1.38	1.56	1.96
5.0	2.86	2.37	2.07	1.76	1.47	1.24	1.30	1.38	1.57	2.04
6.0	3.13	2.55	2.20	1.83	1.51	1.26	1.31	1.38	1.57	2.12
7.0	3.39	2.72	2.32	1.90	1.55	1.28	1.31	1.39	1.58	2.21
8.0	3.65	2.88	2.42	1.97	1.58	1.30	1.32	1.39	1.59	2.33
10.0	4.13	3.19	2.62	2.08	1.65	1.32	1.33	1.40	1.60	2.62
15.0	5.25	3.87	3.05	2.33	1.77	1.37	1.36	1.41	1.62	3.58
20.0	6.27	4.43	3.43	2.53	1.86	1.41	1.38	1.42	1.62	4.93
25.0	7.21	4.92	3.75	2.69	1.94	1.43	1.40	1.44	1.62	7.27
30.0	8.08	5.38	4.02	2.84	2.01	1.46	1.41	1.45	1.62	1.15E1
35.0	8.90	5.80	4.26	2.97	2.07	1.47	1.42	1.46	1.62	1.92E1
40.0	9.69	6.19	4.47	3.08	2.13	1.49	1.43	1.47	1.62	3.37E1
R(MFP)	ENERGY (MEV)									
	0.11	0.1	0.09	0.08	0.075	0.07	0.069	0.06	0.05	0.04
0.5	1.46	1.53	1.59	1.64	1.66	1.69	1.03	1.02	1.01	1.01
1.0	1.79	1.98	2.13	2.31	2.38	2.46	1.04	1.03	1.02	1.01
2.0	2.20	2.68	3.21	3.86	4.18	4.54	1.05	1.04	1.03	1.01
3.0	2.44	3.37	4.63	6.41	7.40	8.55	1.07	1.05	1.03	1.02
4.0	2.77	4.39	7.08	1.14E1	1.41E1	1.74E1	1.08	1.05	1.04	1.02
5.0	3.17	5.80	1.10E1	2.07E1	2.72E1	3.57E1	1.09	1.06	1.04	1.02
6.0	3.62	7.71	1.72E1	3.72E1	5.21E1	7.24E1	1.10	1.07	1.04	1.02
7.0	4.25	1.07E1	2.75E1	6.73E1	9.99E1	1.46E2	1.10	1.07	1.05	1.03
8.0	5.11	1.47E1	4.37E1	1.21E2	1.90E2	2.92E2	1.11	1.08	1.05	1.03
10.0	7.39	2.87E1	1.13E2	4.01E2	7.01E2	1.20E3	1.13	1.09	1.06	1.03
15.0	2.21E1	1.94E2	1.48E3	9.08E3	2.02E4	4.37E4	1.15	1.11	1.07	1.04
20.0	8.14E1	1.57E3	2.28E4	2.34E5	6.45E5	1.73E6	1.17	1.12	1.08	1.05
25.0	3.26E2	1.37E4	3.80E5	6.52E6	2.22E7	7.28E7	1.19	1.14	1.09	1.05
30.0	1.36E3	1.22E5	6.54E6	1.90E8	8.04E8	3.21E9	1.21	1.15	1.09	1.05
35.0	5.80E3	1.11E6	1.14E8	5.68E9	3.00E10	1.46E11	1.22	1.16	1.10	1.06
40.0	2.52E4	1.01E7	2.01E9	1.72E11	1.14E12	6.80E12	1.23	1.17	1.11	1.06
R(MFP)	ENERGY (MEV)									
	0.03	0.02	0.015							
0.5	1.00	1.00	1.00							
1.0	1.01	1.00	1.00							
2.0	1.01	1.00	1.00							
3.0	1.01	1.00	1.00							
4.0	1.01	1.00	1.00							
5.0	1.01	1.00	1.00							
6.0	1.01	1.00	1.00							
7.0	1.01	1.00	1.00							
8.0	1.01	1.01	1.00							
10.0	1.02	1.01	1.00							
15.0	1.02	1.01	1.00							
20.0	1.02	1.01	1.00							
25.0	1.02	1.01	1.00							
30.0	1.03	1.01	1.01							
35.0	1.03	1.01	1.01							
40.0	1.03	1.01	1.01							

Table 3.6 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick lead

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK LEAD										
R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.32	1.36	1.39	1.44	1.47	1.51	1.43	1.42	1.37	1.32
1.0	1.53	1.54	1.55	1.59	1.62	1.69	1.63	1.69	1.66	1.58
2.0	1.91	1.86	1.83	1.87	1.92	2.03	2.01	2.20	2.19	2.06
3.0	2.43	2.26	2.16	2.19	2.26	2.42	2.43	2.70	2.67	2.47
4.0	3.16	2.77	2.56	2.55	2.64	2.84	2.85	3.17	3.08	2.80
5.0	4.17	3.41	3.04	2.97	3.07	3.30	3.31	3.64	3.49	3.12
6.0	5.56	4.20	3.61	3.45	3.56	3.81	3.80	4.13	3.89	3.43
7.0	7.48	5.21	4.30	4.00	4.12	4.37	4.33	4.65	4.31	3.74
8.0	1.01E1	6.45	5.12	4.64	4.75	4.99	4.89	5.17	4.72	4.05
10.0	1.89E1	9.95	7.25	6.19	6.24	6.40	6.11	6.23	5.50	4.64
15.0	9.01E1	2.94E1	1.72E1	1.23E1	1.17E1	1.10E1	9.69	9.00	7.36	5.99
20.0	4.23E0	8.59E1	4.02E1	2.35E1	2.06E1	1.75E1	1.39E1	1.18E1	9.06	7.24
25.0	1.94E3	2.45E2	9.17E1	4.32E1	3.44E1	2.61E1	1.86E1	1.46E1	1.07E1	8.44
30.0	8.63E3	6.82E2	2.04E2	7.66E1	5.52E1	3.73E1	2.38E1	1.75E1	1.22E1	9.57
35.0	3.75E4	1.85E3	4.45E2	1.32E2	8.58E1	5.13E1	2.95E1	2.03E1	1.36E1	1.06E1
40.0	1.60E5	4.94E3	9.52E2	2.22E2	1.30E2	6.84E1	3.54E1	2.31E1	1.50E1	1.16E1
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.16	0.15	0.14	0.13
0.5	1.30	1.25	1.20	1.15	1.40	1.46	1.48	1.48	1.49	1.50
1.0	1.52	1.42	1.32	1.23	1.48	1.60	1.74	1.78	1.83	1.88
2.0	1.93	1.71	1.55	1.38	1.58	1.67	2.00	2.13	2.32	2.55
3.0	2.26	1.94	1.72	1.49	1.66	1.69	2.11	2.33	2.70	3.19
4.0	2.51	2.11	1.84	1.57	1.72	1.71	2.16	2.48	3.05	3.93
5.0	2.75	2.27	1.95	1.63	1.77	1.73	2.20	2.60	3.40	4.83
6.0	2.97	2.41	2.05	1.69	1.81	1.75	2.22	2.70	3.77	5.94
7.0	3.20	2.55	2.16	1.75	1.85	1.76	2.24	2.80	4.20	7.42
8.0	3.42	2.68	2.26	1.81	1.89	1.78	2.25	2.91	4.72	9.41
10.0	3.83	2.93	2.44	1.90	1.94	1.80	2.28	3.14	6.04	1.49E1
15.0	4.70	3.44	2.81	2.10	2.06	1.85	2.32	3.89	1.22E1	6.08E1
20.0	5.49	3.87	3.14	2.26	2.14	1.89	2.33	4.78	3.10E1	3.18E2
25.0	6.19	4.23	3.43	2.40	2.20	1.92	2.34	6.13	9.00E1	1.85E3
30.0	6.82	4.57	3.69	2.54	2.26	1.95	2.35	8.32	2.81E2	1.12E4
35.0	7.40	4.89	3.93	2.66	2.31	1.97	2.35	1.19E1	9.11E2	6.90E4
40.0	7.95	5.20	4.15	2.76	2.36	1.99	2.36	1.81E1	3.03E3	4.33E5
R(MFP)	ENERGY (MEV)									
	0.12	0.11	0.1	0.09	0.089	0.088	0.08	0.06	0.05	0.04
0.5	1.50	1.50	1.48	1.51	1.51	1.07	1.03	1.02	1.01	1.01
1.0	1.93	1.97	1.98	2.07	2.08	1.09	1.04	1.02	1.01	1.01
2.0	2.79	3.05	3.28	3.68	3.73	1.10	1.06	1.03	1.02	1.01
3.0	3.81	4.58	5.38	6.66	6.81	1.12	1.08	1.04	1.02	1.01
4.0	5.21	7.00	9.19	1.27E1	1.31E1	1.13	1.09	1.04	1.03	1.01
5.0	7.20	1.10E1	1.62E1	2.51E1	2.62E1	1.15	1.10	1.04	1.03	1.02
6.0	1.01E1	1.75E1	2.91E1	5.02E1	5.29E1	1.16	1.11	1.05	1.03	1.02
7.0	1.44E1	2.81E1	5.22E1	9.66E1	1.03E2	1.17	1.11	1.05	1.03	1.02
8.0	2.02E1	4.42E1	8.98E1	1.83E2	1.97E2	1.18	1.12	1.06	1.04	1.02
10.0	4.09E1	1.11E2	2.77E2	6.81E2	7.44E2	1.20	1.14	1.06	1.04	1.02
15.0	2.99E2	1.36E3	5.35E3	1.99E4	2.26E4	1.24	1.16	1.08	1.05	1.03
20.0	2.80E3	2.05E4	1.22E5	6.53E5	7.67E5	1.26	1.18	1.09	1.06	1.03
25.0	2.89E4	3.44E5	3.06E6	2.33E7	2.82E7	1.28	1.20	1.10	1.07	1.04
30.0	3.09E5	6.04E6	8.17E7	8.77E8	1.10E9	1.29	1.21	1.11	1.08	1.04
35.0	3.38E6	1.09E8	2.25E9	3.44E10	4.44E10	1.31	1.22	1.11	1.08	1.04
40.0	3.72E7	1.97E9	6.30E10	1.38E12	1.84E12	1.32	1.24	1.12	1.09	1.04
R(MFP)	ENERGY (MEV)									
	0.03									
0.5	1.00									
1.0	1.00									
2.0	1.01									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.02									
25.0	1.02									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.6 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK LEAD

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.32	1.29	1.27	1.26	1.25	1.25	1.24	1.21	1.19	1.16
1.0	1.62	1.51	1.46	1.42	1.40	1.41	1.41	1.39	1.37	1.31
2.0	2.26	1.97	1.82	1.74	1.71	1.74	1.77	1.76	1.73	1.61
3.0	3.16	2.54	2.26	2.10	2.06	2.11	2.13	2.12	2.05	1.87
4.0	4.43	3.26	2.78	2.51	2.45	2.49	2.51	2.47	2.34	2.10
5.0	6.21	4.17	3.40	2.98	2.89	2.92	2.91	2.83	2.63	2.32
6.0	8.69	5.32	4.15	3.52	3.39	3.40	3.34	3.20	2.92	2.54
7.0	1.21E1	6.78	5.05	4.14	3.96	3.92	3.81	3.58	3.21	2.75
8.0	1.69E1	8.60	6.13	4.86	4.61	4.50	4.30	3.97	3.50	2.96
10.0	3.28E1	1.38E1	8.97	6.64	6.14	5.80	5.37	4.76	4.05	3.37
15.0	1.64E2	4.28E1	2.24E1	1.37E1	1.18E1	1.01E1	8.43	6.80	5.35	4.30
20.0	7.83E2	1.28E2	5.36E1	2.66E1	2.10E1	1.61E1	1.20E1	8.89	6.56	5.17
25.0	3.61E3	3.69E2	1.24E2	4.94E1	3.53E1	2.42E1	1.61E1	1.10E1	7.70	6.00
30.0	1.61E4	1.03E3	2.78E2	8.83E1	5.70E1	3.46E1	2.06E1	1.31E1	8.78	6.80
35.0	7.03E4	2.82E3	6.10E2	1.53E2	8.89E1	4.77E1	2.56E1	1.52E1	9.81	7.53
40.0	3.00E5	7.51E3	1.31E3	2.59E2	1.35E2	6.37E1	3.10E1	1.73E1	1.08E1	8.21
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.16	0.15	0.14	0.13
0.5	1.14	1.12	1.09	1.07	1.08	1.14	1.22	1.25	1.29	1.33
1.0	1.28	1.22	1.18	1.13	1.12	1.19	1.34	1.41	1.49	1.59
2.0	1.53	1.41	1.32	1.23	1.19	1.23	1.47	1.60	1.79	2.05
3.0	1.74	1.57	1.44	1.31	1.24	1.25	1.53	1.72	2.03	2.50
4.0	1.91	1.69	1.53	1.37	1.28	1.26	1.57	1.82	2.26	3.03
5.0	2.08	1.80	1.61	1.42	1.31	1.28	1.59	1.90	2.50	3.70
6.0	2.24	1.90	1.69	1.47	1.34	1.29	1.61	1.96	2.76	4.55
7.0	2.39	2.00	1.77	1.52	1.37	1.31	1.62	2.03	3.06	5.70
8.0	2.54	2.10	1.85	1.56	1.39	1.32	1.64	2.11	3.44	7.27
10.0	2.83	2.28	1.98	1.64	1.43	1.34	1.66	2.27	4.41	1.17E1
15.0	3.44	2.65	2.27	1.79	1.51	1.37	1.69	2.77	8.96	4.96E1
20.0	4.00	2.97	2.52	1.92	1.57	1.40	1.70	3.36	2.29E1	2.66E2
25.0	4.49	3.24	2.74	2.04	1.62	1.42	1.71	4.26	6.68E1	1.56E3
30.0	4.94	3.50	2.94	2.15	1.65	1.44	1.72	5.71	2.09E2	9.48E3
35.0	5.35	3.74	3.13	2.25	1.69	1.45	1.72	8.13	6.83E2	5.89E4
40.0	5.74	3.97	3.31	2.33	1.72	1.47	1.73	1.22E1	2.28E3	3.71E5
R(MFP)	ENERGY (MEV)									
	0.12	0.11	0.1	0.09	0.089	0.088	0.08	0.06	0.05	0.04
0.5	1.38	1.45	1.52	1.58	1.59	1.05	1.02	1.01	1.01	1.01
1.0	1.71	1.87	2.05	2.23	2.25	1.07	1.03	1.02	1.01	1.01
2.0	2.39	2.85	3.44	4.09	4.17	1.08	1.05	1.03	1.02	1.01
3.0	3.21	4.26	5.72	7.55	7.77	1.10	1.06	1.03	1.02	1.01
4.0	4.34	6.53	9.90	1.46E1	1.52E1	1.11	1.08	1.04	1.02	1.01
5.0	6.01	1.03E1	1.77E1	2.93E1	3.08E1	1.13	1.09	1.04	1.03	1.02
6.0	8.44	1.66E1	3.22E1	5.92E1	6.28E1	1.14	1.09	1.05	1.03	1.02
7.0	1.22E1	2.70E1	5.83E1	1.15E2	1.23E2	1.15	1.10	1.05	1.03	1.02
8.0	1.73E1	4.30E1	1.02E2	2.20E2	2.38E2	1.16	1.11	1.06	1.04	1.02
10.0	3.58E1	1.11E2	3.20E2	8.32E2	9.14E2	1.18	1.12	1.06	1.04	1.02
15.0	2.78E2	1.45E3	6.55E3	2.54E4	2.90E4	1.21	1.15	1.08	1.05	1.03
20.0	2.68E3	2.26E4	1.55E5	8.67E5	1.02E6	1.23	1.17	1.09	1.06	1.03
25.0	2.80E4	3.86E5	4.01E6	3.19E7	3.88E7	1.25	1.18	1.10	1.07	1.04
30.0	3.02E5	6.85E6	1.09E8	1.23E9	1.55E9	1.27	1.20	1.10	1.08	1.04
35.0	3.31E6	1.24E8	3.02E9	4.89E10	6.35E10	1.28	1.21	1.11	1.08	1.04
40.0	3.66E7	2.26E9	8.51E10	1.98E12	2.66E12	1.29	1.22	1.12	1.09	1.04
R(MFP)	ENERGY (MEV)									
	0.03									
0.5	1.00									
1.0	1.00									
2.0	1.00									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.02									
25.0	1.02									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.6 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK LEAD

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.37	1.33	1.31	1.29	1.28	1.27	1.24	1.22	1.20	1.17
1.0	1.71	1.58	1.51	1.46	1.44	1.44	1.41	1.41	1.39	1.33
2.0	2.40	2.07	1.90	1.79	1.77	1.78	1.76	1.79	1.77	1.65
3.0	3.38	2.69	2.37	2.17	2.14	2.15	2.13	2.16	2.10	1.92
4.0	4.77	3.48	2.92	2.60	2.55	2.55	2.51	2.51	2.41	2.16
5.0	6.71	4.47	3.58	3.09	3.02	2.99	2.92	2.88	2.71	2.38
6.0	9.41	5.72	4.38	3.66	3.55	3.48	3.36	3.25	3.01	2.61
7.0	1.32E1	7.30	5.35	4.31	4.15	4.02	3.83	3.65	3.31	2.83
8.0	1.84E1	9.29	6.50	5.07	4.84	4.61	4.33	4.04	3.61	3.05
10.0	3.58E1	1.49E1	9.54	6.93	6.47	5.96	5.42	4.85	4.18	3.47
15.0	1.79E2	4.65E1	2.39E1	1.43E1	1.24E1	1.04E1	8.58	6.93	5.54	4.43
20.0	8.57E2	1.39E2	5.74E1	2.79E1	2.22E1	1.66E1	1.23E1	9.05	6.80	5.33
25.0	3.95E3	4.02E2	1.33E2	5.19E1	3.75E1	2.49E1	1.65E1	1.12E1	7.98	6.20
30.0	1.77E4	1.13E3	2.99E2	9.30E1	6.05E1	3.56E1	2.11E1	1.33E1	9.10	7.02
35.0	7.71E4	3.06E3	6.55E2	1.61E2	9.44E1	4.91E1	2.61E1	1.55E1	1.02E1	7.78
40.0	3.29E5	8.21E3	1.40E3	2.73E2	1.43E2	6.56E1	3.13E1	1.76E1	1.12E1	8.48
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.2	0.16	0.15	0.14	0.13
0.5	1.15	1.12	1.10	1.07	1.10	1.19	1.30	1.34	1.38	1.42
1.0	1.29	1.23	1.19	1.14	1.15	1.26	1.46	1.55	1.64	1.75
2.0	1.56	1.43	1.34	1.24	1.21	1.30	1.63	1.81	2.03	2.33
3.0	1.78	1.59	1.46	1.32	1.26	1.32	1.71	1.97	2.34	2.91
4.0	1.96	1.71	1.56	1.38	1.31	1.34	1.76	2.08	2.64	3.58
5.0	2.13	1.83	1.64	1.44	1.34	1.36	1.79	2.19	2.95	4.42
6.0	2.30	1.93	1.72	1.48	1.37	1.37	1.81	2.28	3.28	5.48
7.0	2.46	2.04	1.80	1.53	1.40	1.38	1.82	2.36	3.66	6.91
8.0	2.62	2.14	1.88	1.57	1.42	1.39	1.84	2.46	4.14	8.86
10.0	2.91	2.32	2.02	1.65	1.46	1.41	1.86	2.66	5.37	1.44E1
15.0	3.55	2.70	2.31	1.81	1.54	1.45	1.89	3.31	1.12E1	6.11E1
20.0	4.12	3.03	2.57	1.94	1.60	1.48	1.91	4.08	2.88E1	3.27E2
25.0	4.63	3.30	2.79	2.06	1.65	1.50	1.92	5.25	8.45E1	1.91E3
30.0	5.10	3.56	3.00	2.17	1.69	1.52	1.92	7.14	2.65E2	1.16E4
35.0	5.53	3.81	3.19	2.27	1.73	1.54	1.93	1.03E1	8.63E2	7.21E4
40.0	5.93	4.05	3.37	2.36	1.76	1.55	1.93	1.56E1	2.88E3	4.54E5
R(MFP)	ENERGY (MEV)									
	0.12	0.11	0.1	0.09	0.089	0.088	0.08	0.06	0.05	0.04
0.5	1.47	1.53	1.59	1.63	1.64	1.06	1.02	1.01	1.01	1.00
1.0	1.88	2.04	2.20	2.32	2.34	1.07	1.03	1.02	1.01	1.01
2.0	2.72	3.21	3.78	4.32	4.39	1.09	1.05	1.02	1.02	1.01
3.0	3.72	4.88	6.39	8.05	8.24	1.10	1.06	1.03	1.02	1.01
4.0	5.11	7.56	1.11E1	1.56E1	1.62E1	1.12	1.07	1.03	1.02	1.01
5.0	7.14	1.20E1	2.00E1	3.13E1	3.27E1	1.13	1.08	1.04	1.03	1.01
6.0	1.01E1	1.94E1	3.64E1	6.33E1	6.68E1	1.14	1.09	1.04	1.03	1.02
7.0	1.46E1	3.17E1	6.60E1	1.23E2	1.31E2	1.15	1.10	1.05	1.03	1.02
8.0	2.08E1	5.04E1	1.15E2	2.35E2	2.53E2	1.16	1.11	1.05	1.03	1.02
10.0	4.31E1	1.29E2	3.61E2	8.86E2	9.68E2	1.18	1.12	1.06	1.04	1.02
15.0	3.33E2	1.67E3	7.30E3	2.68E4	3.04E4	1.22	1.14	1.07	1.05	1.03
20.0	3.19E3	2.60E4	1.72E5	9.09E5	1.07E6	1.24	1.16	1.08	1.06	1.03
25.0	3.32E4	4.42E5	4.42E6	3.32E7	4.03E7	1.26	1.18	1.09	1.07	1.03
30.0	3.58E5	7.83E6	1.20E8	1.28E9	1.60E9	1.27	1.19	1.10	1.07	1.04
35.0	3.92E6	1.41E8	3.32E9	5.07E10	6.54E10	1.29	1.21	1.11	1.08	1.04
40.0	4.34E7	2.57E9	9.33E10	2.05E12	2.73E12	1.30	1.22	1.11	1.08	1.04
R(MFP)	ENERGY (MEV)									
	0.03									
0.5	1.00									
1.0	1.00									
2.0	1.00									
3.0	1.01									
4.0	1.01									
5.0	1.01									
6.0	1.01									
7.0	1.01									
8.0	1.01									
10.0	1.01									
15.0	1.01									
20.0	1.02									
25.0	1.02									
30.0	1.02									
35.0	1.02									
40.0	1.02									

Table 3.7 Gamma-ray buildup factors for point isotropic source
in 45-mfp-thick uranium

ABSORBED DOSE BUILDUP FACTORS IN 45-MFP THICK URANIUM										
R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.33	1.36	1.40	1.44	1.46	1.48	1.49	1.46	1.38	1.35
1.0	1.53	1.54	1.55	1.58	1.61	1.62	1.68	1.70	1.63	1.58
2.0	1.91	1.86	1.83	1.82	1.86	1.92	2.03	2.15	2.10	1.99
3.0	2.42	2.26	2.15	2.10	2.15	2.25	2.41	2.57	2.49	2.29
4.0	3.13	2.76	2.54	2.41	2.47	2.61	2.80	2.97	2.83	2.55
5.0	4.10	3.38	2.99	2.77	2.83	2.99	3.21	3.37	3.14	2.80
6.0	5.43	4.14	3.52	3.18	3.23	3.41	3.65	3.79	3.46	3.04
7.0	7.25	5.09	4.14	3.65	3.69	3.88	4.12	4.23	3.78	3.28
8.0	9.76	6.27	4.89	4.17	4.20	4.38	4.61	4.66	4.10	3.51
10.0	1.79E1	9.53	6.80	5.45	5.39	5.51	5.67	5.53	4.70	3.93
15.0	8.26E1	2.71E1	1.54E1	1.03E1	9.64	9.14	8.67	7.76	6.13	4.85
20.0	3.77E2	7.64E1	3.42E1	1.89E1	1.63E1	1.40E1	1.21E1	9.98	7.47	5.69
25.0	1.68E3	2.11E2	7.47E1	3.35E1	2.65E1	2.04E1	1.59E1	1.22E1	8.72	6.45
30.0	7.32E3	5.70E2	1.60E2	5.76E1	4.16E1	2.85E1	1.99E1	1.44E1	9.96	7.18
35.0	3.12E4	1.51E3	3.35E2	9.67E1	6.33E1	3.84E1	2.43E1	1.66E1	1.13E1	7.83
40.0	1.30E5	3.92E3	6.92E2	1.59E2	9.41E1	5.05E1	2.88E1	1.88E1	1.27E1	8.43
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.25	0.2	0.19	0.18	0.17
0.5	1.35	1.34	1.35	1.38	1.43	1.46	1.48	1.49	1.49	1.49
1.0	1.55	1.48	1.46	1.45	1.54	1.63	1.76	1.80	1.83	1.87
2.0	1.90	1.73	1.64	1.58	1.61	1.73	2.06	2.19	2.32	2.48
3.0	2.14	1.90	1.77	1.66	1.66	1.75	2.21	2.42	2.68	3.03
4.0	2.34	2.03	1.87	1.73	1.70	1.77	2.29	2.60	3.01	3.61
5.0	2.53	2.16	1.96	1.79	1.73	1.80	2.36	2.75	3.34	4.28
6.0	2.71	2.28	2.04	1.84	1.77	1.81	2.40	2.88	3.68	5.07
7.0	2.88	2.40	2.12	1.89	1.79	1.83	2.44	3.01	4.06	6.06
8.0	3.04	2.52	2.19	1.94	1.82	1.84	2.47	3.15	4.51	7.35
10.0	3.35	2.73	2.33	2.02	1.86	1.87	2.54	3.47	5.68	1.08E1
15.0	3.97	3.13	2.59	2.18	1.94	1.93	2.68	4.52	1.08E1	3.47E1
20.0	4.52	3.47	2.82	2.32	1.99	1.97	2.80	5.96	2.51E1	1.42E2
25.0	4.98	3.75	3.02	2.44	2.04	2.00	2.86	8.40	6.64E1	6.55E2
30.0	5.40	4.00	3.19	2.55	2.08	2.03	2.92	1.26E1	1.90E2	3.17E3
35.0	5.78	4.22	3.35	2.65	2.11	2.06	2.98	2.03E1	5.65E2	1.57E4
40.0	6.16	4.43	3.51	2.74	2.15	2.09	3.04	3.42E1	1.73E3	7.93E4
R(MFP)	ENERGY (MEV)									
	0.16	0.15	0.14	0.13	0.12	0.116	0.115	0.1	0.08	0.06
0.5	1.49	1.49	1.50	1.51	1.51	1.51	1.10	1.06	1.02	1.01
1.0	1.90	1.92	1.98	2.03	2.06	2.07	1.12	1.08	1.03	1.01
2.0	2.65	2.82	3.07	3.32	3.56	3.64	1.14	1.09	1.04	1.02
3.0	3.44	3.91	4.58	5.35	6.14	6.47	1.16	1.11	1.05	1.02
4.0	4.41	5.45	6.95	8.87	1.11E1	1.20E1	1.18	1.12	1.06	1.03
5.0	5.68	7.71	1.08E1	1.52E1	2.07E1	2.33E1	1.20	1.13	1.06	1.03
6.0	7.36	1.10E1	1.70E1	2.63E1	3.92E1	4.55E1	1.21	1.14	1.07	1.03
7.0	9.69	1.61E1	2.74E1	4.61E1	7.28E1	8.75E1	1.23	1.16	1.07	1.04
8.0	1.28E1	2.32E1	4.31E1	7.74E1	1.32E2	1.63E2	1.24	1.16	1.08	1.04
10.0	2.28E1	4.87E1	1.07E2	2.25E2	4.45E2	5.84E2	1.26	1.18	1.09	1.04
15.0	1.18E2	3.92E2	1.26E3	3.82E3	1.06E4	1.58E4	1.30	1.21	1.11	1.05
20.0	7.87E2	3.98E3	1.83E4	7.68E4	2.87E5	4.80E5	1.33	1.23	1.12	1.06
25.0	5.83E3	4.47E4	2.95E5	1.72E6	8.55E6	1.59E7	1.35	1.24	1.13	1.07
30.0	4.49E4	5.23E5	5.01E6	4.05E7	2.70E8	5.58E8	1.37	1.26	1.14	1.07
35.0	3.52E5	6.25E6	8.71E7	9.83E8	8.81E9	2.03E10	1.39	1.27	1.15	1.08
40.0	2.80E6	7.54E7	1.53E9	2.43E10	2.94E11	7.54E11	1.40	1.28	1.16	1.08
R(MFP)	ENERGY (MEV)									
	0.05	0.04	0.03							
0.5	1.01	1.00	1.00							
1.0	1.01	1.01	1.00							
2.0	1.01	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.01							
5.0	1.02	1.01	1.01							
6.0	1.02	1.01	1.01							
7.0	1.02	1.01	1.01							
8.0	1.03	1.01	1.01							
10.0	1.03	1.02	1.01							
15.0	1.03	1.02	1.01							
20.0	1.04	1.02	1.01							
25.0	1.04	1.03	1.01							
30.0	1.05	1.03	1.01							
35.0	1.05	1.03	1.01							
40.0	1.05	1.03	1.02							

Table 3.7 (continued)

EXPOSURE BUILDUP FACTORS IN 45-MFP THICK URANIUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.31	1.27	1.25	1.25	1.23	1.21	1.21	1.19	1.16	1.14
1.0	1.60	1.48	1.42	1.39	1.37	1.35	1.36	1.35	1.31	1.27
2.0	2.21	1.92	1.77	1.66	1.63	1.63	1.66	1.66	1.61	1.50
3.0	3.07	2.46	2.17	1.97	1.93	1.94	1.97	1.96	1.86	1.69
4.0	4.27	3.14	2.65	2.32	2.25	2.26	2.29	2.25	2.09	1.86
5.0	5.94	3.98	3.21	2.72	2.62	2.61	2.63	2.54	2.31	2.03
6.0	8.24	5.04	3.87	3.17	3.03	3.00	2.99	2.84	2.53	2.19
7.0	1.14E1	6.36	4.66	3.69	3.49	3.43	3.38	3.15	2.74	2.34
8.0	1.59E1	8.01	5.60	4.28	4.01	3.90	3.79	3.45	2.95	2.49
10.0	3.02E1	1.26E1	8.03	5.71	5.22	4.94	4.66	4.08	3.36	2.77
15.0	1.46E2	3.76E1	1.90E1	1.12E1	9.56	8.28	7.12	5.66	4.34	3.38
20.0	6.77E2	1.09E2	4.35E1	2.09E1	1.64E1	1.28E1	9.93	7.24	5.25	3.94
25.0	3.04E3	3.03E2	9.63E1	3.76E1	2.69E1	1.87E1	1.30E1	8.82	6.11	4.46
30.0	1.33E4	8.24E2	2.08E2	6.52E1	4.25E1	2.62E1	1.64E1	1.04E1	6.96	4.94
35.0	5.67E4	2.19E3	4.38E2	1.10E2	6.50E1	3.54E1	1.99E1	1.20E1	7.91	5.39
40.0	2.37E5	5.69E3	9.07E2	1.82E2	9.70E1	4.66E1	2.36E1	1.35E1	8.85	5.79
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.25	0.2	0.19	0.18	0.17
0.5	1.12	1.10	1.09	1.08	1.10	1.13	1.21	1.23	1.25	1.29
1.0	1.23	1.18	1.15	1.13	1.14	1.19	1.33	1.38	1.44	1.51
2.0	1.43	1.32	1.26	1.21	1.19	1.24	1.47	1.58	1.70	1.87
3.0	1.58	1.43	1.34	1.26	1.22	1.27	1.55	1.70	1.91	2.21
4.0	1.71	1.52	1.41	1.31	1.25	1.29	1.60	1.81	2.11	2.59
5.0	1.83	1.60	1.47	1.35	1.28	1.30	1.64	1.90	2.32	3.05
6.0	1.95	1.68	1.52	1.38	1.30	1.32	1.68	1.98	2.54	3.60
7.0	2.06	1.76	1.57	1.42	1.32	1.33	1.70	2.07	2.80	4.31
8.0	2.17	1.84	1.62	1.45	1.34	1.34	1.73	2.16	3.11	5.26
10.0	2.37	1.98	1.72	1.51	1.36	1.36	1.77	2.37	3.92	7.85
15.0	2.78	2.25	1.90	1.62	1.42	1.40	1.87	3.05	7.51	2.63E1
20.0	3.15	2.48	2.06	1.72	1.46	1.43	1.94	3.98	1.76E1	1.11E2
25.0	3.46	2.68	2.20	1.81	1.49	1.45	1.99	5.55	4.69E1	5.16E2
30.0	3.74	2.85	2.32	1.89	1.52	1.48	2.02	8.30	1.35E2	2.52E3
35.0	4.01	3.00	2.44	1.96	1.54	1.49	2.06	1.32E1	4.05E2	1.26E4
40.0	4.26	3.16	2.55	2.03	1.56	1.51	2.10	2.23E1	1.25E3	6.37E4
R(MFP)	ENERGY (MEV)									
	0.16	0.15	0.14	0.13	0.12	0.116	0.115	0.1	0.08	0.06
0.5	1.32	1.36	1.40	1.45	1.50	1.52	1.06	1.04	1.02	1.01
1.0	1.59	1.68	1.78	1.90	2.04	2.09	1.08	1.06	1.02	1.01
2.0	2.08	2.35	2.67	3.06	3.51	3.71	1.10	1.07	1.03	1.02
3.0	2.63	3.20	3.92	4.89	6.09	6.66	1.12	1.09	1.04	1.02
4.0	3.32	4.41	5.93	8.14	1.11E1	1.26E1	1.14	1.10	1.05	1.03
5.0	4.26	6.25	9.26	1.41E1	2.09E1	2.46E1	1.16	1.11	1.06	1.03
6.0	5.53	9.01	1.48E1	2.47E1	4.02E1	4.87E1	1.17	1.12	1.06	1.03
7.0	7.35	1.34E1	2.41E1	4.38E1	7.56E1	9.45E1	1.18	1.13	1.07	1.03
8.0	9.85	1.95E1	3.85E1	7.45E1	1.38E2	1.78E2	1.20	1.14	1.07	1.04
10.0	1.79E1	4.23E1	9.85E1	2.24E2	4.81E2	6.55E2	1.22	1.16	1.08	1.04
15.0	9.97E1	3.69E2	1.26E3	4.10E3	1.22E4	1.88E4	1.26	1.19	1.10	1.05
20.0	6.87E2	3.90E3	1.93E4	8.71E4	3.50E5	6.04E5	1.28	1.21	1.11	1.06
25.0	5.16E3	4.47E4	3.20E5	2.01E6	1.09E7	2.09E7	1.30	1.22	1.13	1.07
30.0	4.01E4	5.29E5	5.50E6	4.83E7	3.51E8	7.52E8	1.32	1.23	1.14	1.07
35.0	3.16E5	6.35E6	9.63E7	1.19E9	1.17E10	2.78E10	1.34	1.25	1.15	1.08
40.0	2.53E6	7.71E7	1.70E9	2.95E10	3.93E11	1.05E12	1.35	1.26	1.15	1.08
R(MFP)	ENERGY (MEV)									
	0.05	0.04	0.03							
0.5	1.01	1.00	1.00							
1.0	1.01	1.01	1.00							
2.0	1.01	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.01							
5.0	1.02	1.01	1.01							
6.0	1.02	1.01	1.01							
7.0	1.02	1.01	1.01							
8.0	1.02	1.01	1.01							
10.0	1.03	1.02	1.01							
15.0	1.03	1.02	1.01							
20.0	1.04	1.02	1.01							
25.0	1.04	1.03	1.01							
30.0	1.05	1.03	1.01							
35.0	1.05	1.03	1.01							
40.0	1.05	1.03	1.02							

Table 3.7 (continued)

DOSE EQUIVALENT BUILDUP FACTORS IN 45-MFP THICK URANIUM

R(MFP)	ENERGY (MEV)									
	15	10	8	6	5	4	3	2	1.5	1
0.5	1.35	1.31	1.29	1.28	1.26	1.23	1.23	1.20	1.17	1.15
1.0	1.67	1.54	1.47	1.43	1.41	1.37	1.38	1.36	1.33	1.28
2.0	2.34	2.03	1.84	1.71	1.69	1.66	1.69	1.68	1.64	1.53
3.0	3.27	2.60	2.27	2.03	2.00	1.97	2.00	1.98	1.91	1.72
4.0	4.58	3.33	2.77	2.40	2.34	2.31	2.33	2.27	2.14	1.90
5.0	6.39	4.25	3.37	2.81	2.72	2.67	2.68	2.57	2.37	2.07
6.0	8.90	5.39	4.07	3.28	3.16	3.07	3.05	2.87	2.59	2.23
7.0	1.24E1	6.83	4.92	3.83	3.64	3.51	3.44	3.19	2.82	2.39
8.0	1.72E1	8.61	5.92	4.44	4.19	3.98	3.86	3.51	3.04	2.55
10.0	3.29E1	1.36E1	8.51	5.94	5.47	5.05	4.75	4.14	3.46	2.83
15.0	1.59E2	4.08E1	2.03E1	1.17E1	1.01E1	8.48	7.26	5.75	4.47	3.46
20.0	7.39E2	1.18E2	4.64E1	2.19E1	1.74E1	1.31E1	1.01E1	7.36	5.41	4.03
25.0	3.32E3	3.30E2	1.03E2	3.94E1	2.85E1	1.92E1	1.33E1	8.96	6.30	4.57
30.0	1.45E4	8.96E2	2.22E2	6.84E1	4.50E1	2.68E1	1.67E1	1.06E1	7.18	5.07
35.0	6.19E4	2.38E3	4.69E2	1.16E2	6.89E1	3.63E1	2.03E1	1.22E1	8.15	5.52
40.0	2.59E5	6.20E3	9.71E2	1.91E2	1.03E2	4.78E1	2.41E1	1.37E1	9.13	5.94
R(MFP)	ENERGY (MEV)									
	0.8	0.6	0.5	0.4	0.3	0.25	0.2	0.19	0.18	0.17
0.5	1.13	1.11	1.10	1.10	1.12	1.17	1.26	1.29	1.32	1.35
1.0	1.25	1.19	1.16	1.14	1.17	1.24	1.42	1.48	1.54	1.62
2.0	1.45	1.34	1.28	1.22	1.30	1.60	1.72	1.87	2.07	
3.0	1.61	1.45	1.36	1.28	1.26	1.32	1.69	1.88	2.13	2.48
4.0	1.75	1.54	1.43	1.33	1.29	1.34	1.75	2.00	2.37	2.94
5.0	1.87	1.63	1.49	1.37	1.31	1.36	1.80	2.11	2.62	3.49
6.0	2.00	1.71	1.55	1.41	1.34	1.37	1.84	2.21	2.89	4.14
7.0	2.11	1.79	1.60	1.44	1.35	1.39	1.87	2.32	3.20	4.99
8.0	2.22	1.87	1.66	1.47	1.37	1.40	1.90	2.43	3.57	6.13
10.0	2.43	2.02	1.75	1.53	1.40	1.42	1.95	2.68	4.54	9.20
15.0	2.86	2.30	1.94	1.65	1.46	1.46	2.06	3.50	8.84	3.10E1
20.0	3.24	2.53	2.10	1.75	1.50	1.49	2.15	4.62	2.09E1	1.31E2
25.0	3.55	2.73	2.24	1.84	1.53	1.52	2.20	6.52	5.60E1	6.09E2
30.0	3.85	2.90	2.37	1.92	1.56	1.54	2.24	9.85	1.61E2	2.97E3
35.0	4.12	3.06	2.49	2.00	1.58	1.56	2.28	1.58E1	4.84E2	1.48E4
40.0	4.39	3.22	2.60	2.07	1.61	1.57	2.33	2.68E1	1.49E3	7.50E4
R(MFP)	ENERGY (MEV)									
	0.16	0.15	0.14	0.13	0.12	0.116	0.115	0.1	0.08	0.06
0.5	1.39	1.43	1.46	1.50	1.54	1.56	1.07	1.05	1.02	1.01
1.0	1.71	1.81	1.91	2.02	2.12	2.17	1.08	1.06	1.02	1.01
2.0	2.31	2.61	2.93	3.31	3.72	3.90	1.10	1.08	1.03	1.02
3.0	2.96	3.61	4.38	5.36	6.51	7.04	1.13	1.09	1.04	1.02
4.0	3.79	5.05	6.69	8.98	1.19E1	1.33E1	1.14	1.11	1.05	1.03
5.0	4.91	7.20	1.05E1	1.56E1	2.25E1	2.60E1	1.16	1.12	1.06	1.03
6.0	6.41	1.04E1	1.68E1	2.74E1	4.32E1	5.16E1	1.18	1.13	1.06	1.03
7.0	8.56	1.55E1	2.75E1	4.85E1	8.11E1	1.00E2	1.19	1.14	1.07	1.03
8.0	1.15E1	2.26E1	4.38E1	8.25E1	1.48E2	1.88E2	1.20	1.15	1.07	1.04
10.0	2.10E1	4.91E1	1.12E2	2.47E2	5.14E2	6.90E2	1.22	1.16	1.08	1.04
15.0	1.16E2	4.25E2	1.42E3	4.46E3	1.29E4	1.96E4	1.26	1.19	1.10	1.05
20.0	7.99E2	4.47E3	2.15E4	9.42E4	3.67E5	6.25E5	1.29	1.21	1.11	1.06
25.0	5.99E3	5.10E4	3.55E5	2.16E6	1.13E7	2.15E7	1.31	1.22	1.13	1.07
30.0	4.65E4	6.03E5	6.09E6	5.19E7	3.65E8	7.71E8	1.33	1.24	1.14	1.07
35.0	3.66E5	7.23E6	1.07E8	1.27E9	1.21E10	2.84E10	1.34	1.25	1.15	1.07
40.0	2.93E6	8.77E7	1.88E9	3.16E10	4.06E11	1.07E12	1.36	1.26	1.16	1.08
R(MFP)	ENERGY (MEV)									
	0.05	0.04	0.03							
0.5	1.01	1.00	1.00							
1.0	1.01	1.01	1.00							
2.0	1.01	1.01	1.00							
3.0	1.02	1.01	1.00							
4.0	1.02	1.01	1.01							
5.0	1.02	1.01	1.01							
6.0	1.02	1.01	1.01							
7.0	1.02	1.01	1.01							
8.0	1.02	1.01	1.01							
10.0	1.03	1.02	1.01							
15.0	1.03	1.02	1.01							
20.0	1.04	1.02	1.01							
25.0	1.04	1.03	1.01							
30.0	1.05	1.03	1.01							
35.0	1.05	1.03	1.01							
40.0	1.05	1.03	1.02							

Table 4.1 G-P parameters for gamma-ray buildup factors
in molybdenum medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK MOLYBDENUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MeV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.404	0.984	0.072	14.18	-0.0947	4.7	1	2.44
10	1.411	0.863	0.091	14.31	-0.1056	4.9	1	2.59
8	1.465	0.805	0.105	14.27	-0.1188	5.9	0.5	2.98
6	1.545	0.784	0.107	13.97	-0.1249	5.5	0.5	3.02
5	1.596	0.819	0.090	13.79	-0.1087	5.6	0.5	2.86
4	1.563	0.900	0.057	13.51	-0.0796	3.3	0.5	2.06
3	1.690	0.950	0.035	13.30	-0.0570	2.0	0.5	1.40
2	1.860	1.032	0.006	13.22	-0.0281	1.6	2	0.73
1.5	1.946	1.096	-0.015	12.83	-0.0080	1.8	3	0.84
1	2.104	1.125	-0.020	14.71	-0.0060	1.8	3	0.82
0.8	2.226	1.096	-0.012	12.80	-0.0130	1.6	1	0.69
0.6	2.302	1.058	0.0	13.28	-0.0230	1.2	1	0.61
0.5	2.348	0.964	0.024	13.64	-0.0357	2.1	0.5	0.84
0.4	3.132	0.627	0.148	13.47	-0.1297	5.7	0.5	2.79
0.3	2.666	0.501	0.201	13.48	-0.1541	4.6	0.5	2.47
0.2	1.874	0.344	0.290	12.99	-0.2102	4.8	0.5	2.18
0.15	1.422	0.291	0.330	12.85	-0.2300	3.5	0.5	1.69
0.1	1.156	0.252	0.363	13.03	-0.2549	1.8	0.5	0.85
0.08	1.085	0.240	0.379	13.14	-0.2715	0.9	0.5	0.50
0.06	1.028	0.505	0.150	13.57	-0.0706	0.1	0.5	0.07
0.05	1.380	0.053	-0.090	9.94	0.1063	0.4	4	0.23
0.04	1.486	0.349	0.064	29.63	-0.0674	0.4	15	0.18
0.035	1.545	0.529	0.259	17.17	-0.2122	1.5	0.5	0.74
0.03	1.511	1.111	0.103	28.91	-0.1158	4.3	8	2.41
0.028	1.553	1.275	0.087	36.00	-0.2236	7.3	40	4.05
0.026	1.595	1.413	0.083	10.64	-0.0623	9.5	3	5.48
0.024	1.594	1.632	0.057	9.15	-0.0313	10.8	3	4.61
0.022	1.596	1.785	0.049	10.68	-0.0390	11.7	3	4.84
0.021	1.531	1.997	0.022	20.26	-0.0122	7.6	3	4.31
0.02	1.011	0.365	0.261	14.32	-0.1599	0.1	0.5	0.05
0.015	1.005	0.347	0.282	13.56	-0.1759	0.1	10	0.04

Table 4.1 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK MOLYBDENUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.567	1.081	0.044	13.97	-0.0699	4.4	1	2.12
10	1.510	0.936	0.067	14.16	-0.0860	4.5	0.5	2.37
8	1.496	0.904	0.070	14.12	-0.0891	4.9	0.5	2.37
6	1.517	0.901	0.064	13.82	-0.0869	4.2	0.5	2.27
5	1.524	0.940	0.047	13.63	-0.0713	3.9	0.5	1.99
4	1.509	1.003	0.023	13.32	-0.0502	2.4	0.5	1.40
3	1.566	1.042	0.006	12.98	-0.0329	1.2	35	0.81
2	1.628	1.097	-0.013	12.41	-0.0128	1.3	2	0.61
1.5	1.639	1.150	-0.030	16.02	0.0042	1.8	0.5	0.85
1	1.665	1.184	-0.036	12.85	0.0068	2.2	0.5	1.00
0.8	1.673	1.179	-0.035	15.87	0.0062	1.9	3	0.93
0.6	1.648	1.163	-0.030	12.04	0.0016	1.4	0.5	0.73
0.5	1.620	1.093	-0.015	13.51	-0.0045	1.4	3	0.71
0.4	1.968	0.742	0.095	13.37	-0.0836	3.7	0.5	1.88
0.3	1.754	0.634	0.129	13.45	-0.0939	3.3	0.5	1.66
0.2	1.444	0.501	0.178	13.08	-0.1140	2.9	0.5	1.33
0.15	1.241	0.462	0.192	12.98	-0.1125	2.4	0.5	1.05
0.1	1.108	0.373	0.250	13.00	-0.1638	1.4	0.5	0.62
0.08	1.065	0.341	0.275	13.17	-0.1833	0.8	0.5	0.39
0.06	1.025	0.556	0.123	14.26	-0.0506	0.1	0.5	0.07
0.05	2.981	0.038	-0.226	16.53	0.0483	2.6	1	1.04
0.04	3.839	0.345	0.050	30.30	-0.0921	0.8	15	0.40
0.035	3.897	0.545	0.248	17.68	-0.1994	2.1	15	1.04
0.03	3.621	1.090	0.110	36.26	-0.3084	5.8	0.5	3.41
0.028	3.577	1.275	0.087	25.69	-0.1113	9.1	3	5.57
0.026	3.252	1.519	0.057	26.56	-0.0687	12.8	40	6.29
0.024	3.272	1.606	0.063	10.16	-0.0447	12.8	3	5.60
0.022	2.935	1.820	0.043	10.51	-0.0326	11.4	3	4.89
0.021	2.758	1.945	0.031	10.77	-0.0230	10.3	3	4.64
0.02	1.011	0.376	0.250	14.35	-0.1476	0.1	10	0.06
0.015	1.005	0.377	0.249	15.04	-0.1493	0.1	0.5	0.04

Table 4.1 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40 MFP IN 45-MFP THICK MOLYBDENUM AND COMPARISON TO VALUES CALCULATED BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.660	1.048	0.054	13.98	-0.0807	5.1	1	2.49
10	1.600	0.894	0.082	14.14	-0.1014	5.2	0.5	2.75
8	1.583	0.850	0.090	14.09	-0.1092	5.2	0.5	2.74
6	1.578	0.873	0.074	13.84	-0.0961	5.2	0.5	2.59
5	1.597	0.903	0.060	13.63	-0.0832	4.5	0.5	2.30
4	1.558	0.972	0.033	13.41	-0.0590	2.8	0.5	1.63
3	1.615	1.019	0.013	13.10	-0.0387	1.6	35	0.97
2	1.665	1.121	-0.025	5.00	0.0116	1.9	2	0.63
1.5	1.709	1.142	-0.028	16.30	0.0032	2.1	0.5	0.92
1	1.738	1.177	-0.034	13.20	0.0051	2.5	0.5	1.06
0.8	1.751	1.168	-0.032	22.93	0.0064	2.0	1	0.97
0.6	1.706	1.153	-0.027	10.79	-0.0013	1.5	0.5	0.74
0.5	1.676	1.085	-0.013	16.26	-0.0066	1.4	1	0.71
0.4	2.031	0.734	0.098	13.46	-0.0854	3.6	0.5	1.92
0.3	1.784	0.633	0.129	13.51	-0.0931	3.7	0.5	1.72
0.2	1.471	0.486	0.187	13.05	-0.1217	3.1	0.5	1.40
0.15	1.260	0.430	0.215	12.81	-0.1339	2.5	0.5	1.13
0.1	1.115	0.353	0.266	12.93	-0.1764	1.4	0.5	0.66
0.08	1.067	0.330	0.285	13.17	-0.1932	0.9	0.5	0.40
0.06	1.025	0.542	0.132	13.73	-0.0581	0.1	0.5	0.06
0.05	2.539	0.038	-0.310	15.80	0.0557	2.0	1	0.82
0.04	3.127	0.346	0.055	25.76	-0.0643	0.7	15	0.36
0.035	3.310	0.542	0.251	17.37	-0.2035	2.4	0.5	0.94
0.03	3.201	1.101	0.106	28.78	-0.1329	5.4	3	3.15
0.028	3.101	1.310	0.079	32.82	-0.1454	8.7	40	4.90
0.026	3.308	1.377	0.089	11.87	-0.0574	14.5	3	6.93
0.024	3.019	1.624	0.059	10.67	-0.0388	12.3	3	5.60
0.022	2.780	1.831	0.041	11.36	-0.0300	11.3	3	5.01
0.021	2.586	1.986	0.024	35.45	-0.0642	8.1	3	4.69
0.02	1.011	0.365	0.261	14.32	-0.1599	0.1	0.5	0.05
0.015	1.005	0.347	0.282	13.56	-0.1759	0.1	10	0.04

Table 4.2 G-P parameters for gamma-ray buildup factors
in tin medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK TIN AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.398	1.055	0.064	14.06	-0.0929	6.0	1	2.81
10	1.435	0.895	0.088	14.80	-0.1043	5.8	0.5	3.32
8	1.469	0.807	0.112	14.26	-0.1297	7.2	0.5	3.38
6	1.568	0.732	0.136	14.03	-0.1584	5.7	0.5	3.70
5	1.575	0.814	0.096	13.88	-0.1167	7.8	0.5	3.42
4	1.517	0.891	0.063	13.52	-0.0873	5.1	0.5	2.52
3	1.643	0.933	0.043	13.32	-0.0665	3.7	0.5	1.85
2	1.814	0.981	0.021	13.33	-0.0392	1.5	35	0.86
1.5	1.889	1.021	0.004	13.07	-0.0193	1.1	2	0.63
1	1.983	1.032	0.0	15.26	-0.0134	1.3	3	0.70
0.8	2.853	0.741	0.103	13.39	-0.0987	4.5	0.5	2.49
0.6	2.852	0.686	0.123	13.42	-0.1098	4.9	0.5	2.64
0.5	2.763	0.604	0.157	13.49	-0.1340	5.4	0.5	2.66
0.4	2.566	0.506	0.199	13.50	-0.1511	5.0	0.5	2.47
0.3	2.077	0.399	0.254	13.45	-0.1782	4.0	0.5	2.02
0.2	1.507	0.292	0.325	12.77	-0.2238	3.3	0.5	1.60
0.15	1.170	0.504	0.152	13.45	-0.0750	0.9	0.5	0.40
0.1	1.123	0.245	0.342	12.99	-0.2053	1.1	0.5	0.44
0.09	1.115	0.192	0.403	13.17	-0.2361	0.7	2	0.37
0.08	1.393	0.033	0.741	14.35	-0.2278	0.5	3	0.24
0.07	1.476	0.064	0.125	8.62	0.1096	0.6	1	0.33
0.06	1.566	0.258	-0.080	21.22	0.0579	0.5	0.5	0.27
0.055	1.610	0.315	0.243	15.34	0.1054	1.5	0.5	0.81
0.05	1.636	0.496	0.276	16.81	-0.2316	1.9	20	0.91
0.045	1.647	0.881	0.152	17.98	-0.1158	2.6	4	1.52
0.04	1.691	1.229	0.096	29.62	-0.1824	6.3	3	3.78
0.035	1.671	1.705	0.030	13.79	0.0447	5.5	3	2.92
0.03	1.787	1.859	0.042	11.10	-0.0316	11.3	3	4.82
0.029	1.017	0.366	0.260	14.11	-0.1578	0.1	3	0.08
0.02	1.006	0.381	0.252	13.99	-0.1592	0.1	15	0.03
0.015	1.003	0.405	0.215	26.26	-0.3092	0.1	4	0.04

Table 4.2 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK TIN AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.573	1.170	0.033	13.84 -0.0640	4.8	1	2.25	
10	1.509	0.987	0.061	14.01 -0.0850	4.8	0.5	2.49	
8	1.478	0.945	0.063	14.24 -0.0840	5.5	0.5	2.49	
6	1.486	0.924	0.062	13.89 -0.0870	5.1	0.5	2.44	
5	1.480	0.970	0.041	13.72 -0.0672	5.1	0.5	2.19	
4	1.459	1.018	0.021	13.31 -0.0504	3.4	0.5	1.58	
3	1.506	1.058	0.003	13.05 -0.0314	2.0	0.5	0.97	
2	1.567	1.073	-0.007	12.77 -0.0162	1.3	2	0.49	
1.5	1.572	1.101	-0.020	12.62 0.0008	1.4	2	0.66	
1	1.569	1.109	-0.022	10.63 0.0041	1.6	0.5	0.80	
0.8	1.976	0.827	0.068	13.28 -0.0675	4.0	0.5	1.92	
0.6	1.906	0.784	0.081	13.28 -0.0737	4.0	0.5	1.97	
0.5	1.823	0.724	0.100	13.47 -0.0846	3.6	0.5	1.79	
0.4	1.723	0.630	0.132	13.48 -0.0953	3.2	0.5	1.68	
0.3	1.518	0.537	0.166	13.55 -0.1074	2.8	0.5	1.38	
0.2	1.274	0.450	0.200	12.80 -0.1216	2.2	0.5	0.99	
0.15	1.104	0.640	0.091	13.89 -0.0357	0.3	3	0.15	
0.1	1.117	0.229	0.366	13.11 -0.2253	1.0	0.5	0.46	
0.09	1.139	0.134	0.498	13.46 -0.2889	0.8	2	0.39	
0.08	1.765	0.018	0.810	15.18 -0.1613	1.1	1	0.35	
0.07	2.215	0.050	-0.558	9.48 0.1018	0.8	2	0.40	
0.06	2.848	0.236	-0.030	5.00 -0.0542	0.6	40	0.38	
0.055	3.104	0.326	0.225	14.57 0.1272	2.1	2	1.31	
0.05	3.386	0.491	0.279	16.78 -0.2340	2.3	0.5	1.18	
0.045	3.407	0.867	0.157	17.52 -0.1194	3.4	4	2.02	
0.04	3.472	1.233	0.094	27.06 -0.1217	8.2	3	4.12	
0.035	3.122	1.612	0.052	27.11 -0.0716	12.6	25	6.73	
0.03	2.901	1.854	0.044	9.47 -0.0403	11.5	3	4.87	
0.029	1.016	0.401	0.234	14.00 -0.1396	0.2	0.5	0.08	
0.02	1.006	0.377	0.255	14.12 -0.1620	0.1	10	0.03	
0.015	1.003	0.382	0.234	28.06 -0.4056	0.1	4	0.04	

Table 4.2 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40 MFP IN 45-MFP THICK TIN AND COMPARISON TO VALUES CALCULATED BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.663	1.135	0.043	13.78	-0.0756	5.4	1	2.63
10	1.578	0.969	0.067	14.03	-0.0913	6.2	0.5	2.88
8	1.551	0.898	0.080	14.07	-0.1022	6.1	0.5	2.87
6	1.543	0.891	0.074	13.88	-0.0990	5.9	0.5	2.80
5	1.552	0.918	0.059	13.67	-0.0845	5.5	0.5	2.53
4	1.497	0.990	0.030	13.34	-0.0588	3.9	0.5	1.85
3	1.553	1.022	0.014	13.21	-0.0410	2.0	0.5	1.14
2	1.609	1.056	-0.002	12.97	-0.0205	1.1	2	0.52
1.5	1.629	1.082	-0.014	11.95	-0.0052	1.6	0.5	0.68
1	1.625	1.097	-0.019	7.31	0.0030	1.9	0.5	0.83
0.8	2.073	0.817	0.072	13.28	-0.0716	3.8	0.5	1.95
0.6	1.979	0.772	0.086	13.27	-0.0782	3.8	0.5	2.01
0.5	1.883	0.717	0.103	13.47	-0.0869	3.7	0.5	1.84
0.4	1.757	0.627	0.133	13.61	-0.0957	3.4	0.5	1.73
0.3	1.539	0.528	0.171	13.53	-0.1113	2.9	0.5	1.41
0.2	1.287	0.440	0.206	12.79	-0.1255	2.4	0.5	1.03
0.15	1.110	0.631	0.094	13.87	-0.0374	0.4	0.5	0.17
0.1	1.125	0.220	0.374	13.07	-0.2271	1.0	0.5	0.48
0.09	1.141	0.137	0.492	13.31	-0.2847	0.8	2	0.39
0.08	1.702	0.019	0.806	15.22	-0.1694	0.9	1	0.33
0.07	2.070	0.051	-0.550	9.12	0.1074	0.7	2	0.38
0.06	2.553	0.238	-0.022	5.00	-0.0544	0.6	8	0.34
0.055	2.811	0.323	0.232	14.60	0.1162	2.1	0.5	1.26
0.05	3.091	0.495	0.277	16.76	-0.2333	2.1	0.5	1.10
0.045	3.067	0.874	0.155	17.21	-0.1148	3.5	0.5	2.02
0.04	3.132	1.222	0.098	19.11	-0.0717	8.8	3	4.84
0.035	3.097	1.535	0.068	13.19	-0.0466	13.0	3	6.88
0.03	2.807	1.862	0.042	10.55	-0.0344	11.6	3	4.96
0.029	1.017	0.366	0.260	14.11	-0.1578	0.1	3	0.08
0.02	1.006	0.381	0.252	13.99	-0.1592	0.1	15	0.03
0.015	1.003	0.405	0.215	26.26	-0.3092	0.1	4	0.04

Table 4.3 G-P parameters for gamma-ray buildup factors
in lanthanum medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK LANTHANUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	I	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.400	1.096	0.061	13.99	-0.0938	6.9	1	3.10	
10	1.422	0.919	0.089	14.18	-0.1121	7.3	0.5	3.36	
8	1.404	0.924	0.073	14.62	-0.0883	10.9	0.5	4.13	
6	1.518	0.788	0.115	14.12	-0.1361	9.1	0.5	3.85	
5	1.574	0.797	0.107	13.96	-0.1293	8.8	0.5	3.80	
4	1.513	0.873	0.073	13.60	-0.0989	6.6	0.5	3.00	
3	1.647	0.899	0.056	13.34	-0.0789	5.1	0.5	2.30	
2	1.822	0.942	0.033	13.34	-0.0477	1.6	0.5	1.09	
1.5	1.876	0.985	0.013	13.12	-0.0237	1.4	2	0.61	
1	1.957	0.970	0.017	14.11	-0.0234	1.2	1	0.63	
0.8	2.002	0.910	0.033	13.55	-0.0324	1.2	1	0.72	
0.6	1.939	0.847	0.050	13.66	-0.0383	1.4	0.5	0.83	
0.5	2.404	0.515	0.195	13.58	-0.1507	4.5	0.5	2.36	
0.4	2.176	0.421	0.243	13.44	-0.1718	3.8	0.5	2.06	
0.3	1.745	0.345	0.286	13.27	-0.1912	3.3	0.5	1.70	
0.2	1.333	0.275	0.333	12.89	-0.2172	2.7	0.5	1.18	
0.15	1.170	0.338	0.259	12.95	-0.1506	1.4	0.5	0.60	
0.1	1.450	0.043	0.646	14.35	-0.1780	0.6	1	0.24	
0.08	1.604	0.214	-0.058	14.49	0.0680	0.4	1	0.16	
0.07	1.699	0.288	0.358	26.36	-0.3037	3.7	0.5	1.73	
0.06	1.694	0.794	0.175	16.64	-0.1387	2.4	1	1.27	
0.055	1.794	1.018	0.134	17.05	-0.1003	6.9	3	3.37	
0.05	1.768	1.347	0.080	33.49	-0.1719	6.4	20	3.96	
0.048	1.811	1.434	0.072	25.88	-0.0836	13.4	40	5.43	
0.046	1.809	1.558	0.059	26.72	-0.0842	15.0	40	5.75	
0.044	1.848	1.646	0.054	18.45	-0.0407	11.1	25	6.26	
0.042	1.856	1.753	0.046	13.62	-0.0330	10.1	20	6.07	
0.04	1.907	1.787	0.050	11.12	-0.0373	12.1	3	5.13	
0.039	1.912	1.854	0.043	11.56	-0.0330	11.7	3	5.07	
0.038	1.021	0.399	0.237	13.92	-0.1449	0.3	0.5	0.12	
0.03	1.012	0.371	0.256	14.48	-0.1601	0.1	4	0.08	
0.02	1.004	0.385	0.242	15.44	-0.1504	0.1	5	0.03	
0.015	1.002	0.351	0.272	14.37	-0.1700	0.1	6	0.02	

Table 4.3 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK LANTHANUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.581	1.220	0.029	13.69	-0.0637	4.9	1	2.35
10	1.493	1.055	0.047	13.98	-0.0734	5.7	0.5	2.54
8	1.468	0.974	0.060	14.13	-0.0838	5.9	0.5	2.56
6	1.467	0.938	0.061	13.94	-0.0871	5.5	0.5	2.49
5	1.466	0.966	0.047	13.73	-0.0749	5.2	0.5	2.33
4	1.431	1.026	0.022	13.38	-0.0535	3.7	0.5	1.72
3	1.481	1.051	0.006	13.03	-0.0342	2.3	0.5	1.09
2	1.536	1.053	-0.002	12.93	-0.0187	0.9	2	0.49
1.5	1.534	1.070	-0.013	13.11	-0.0029	1.3	2	0.55
1	1.517	1.067	-0.012	21.66	-0.0028	1.5	2	0.68
0.8	1.502	1.027	-0.004	12.99	-0.0039	1.5	2	0.67
0.6	1.441	0.984	0.005	13.70	-0.0053	1.3	2	0.53
0.5	1.660	0.645	0.126	13.59	-0.0931	3.4	0.5	1.63
0.4	1.553	0.561	0.157	13.50	-0.1026	3.1	0.5	1.44
0.3	1.378	0.483	0.189	13.38	-0.1159	2.4	0.5	1.17
0.2	1.189	0.422	0.213	12.93	-0.1247	1.6	0.5	0.71
0.15	1.089	0.537	0.135	13.64	-0.0636	0.8	0.5	0.29
0.1	1.455	0.040	0.661	14.48	-0.1748	0.7	1	0.25
0.08	2.014	0.216	-0.123	16.23	0.0673	0.7	1	0.32
0.07	2.381	0.305	0.340	24.83	-0.2257	4.1	0.5	2.25
0.06	2.786	0.778	0.182	16.42	-0.1492	2.7	4	1.57
0.055	2.849	1.084	0.114	20.72	-0.0981	5.6	0.5	3.00
0.05	3.178	1.269	0.100	18.88	-0.1095	12.8	40	6.98
0.048	3.042	1.426	0.075	26.95	-0.1311	12.5	40	5.63
0.046	3.095	1.510	0.070	16.32	-0.0550	12.4	3	7.17
0.044	2.970	1.647	0.054	19.11	-0.0472	11.3	25	6.63
0.042	3.029	1.684	0.059	10.66	-0.0434	12.9	3	5.68
0.04	2.900	1.811	0.046	11.12	-0.0333	11.8	3	5.15
0.039	2.812	1.867	0.041	10.66	-0.0308	11.4	3	5.07
0.038	1.022	0.380	0.251	13.91	-0.1574	0.2	0.5	0.11
0.03	1.012	0.367	0.263	13.73	-0.1674	0.1	0.5	0.06
0.02	1.004	0.385	0.242	15.44	-0.1504	0.1	5	0.03
0.015	1.002	0.351	0.272	14.37	-0.1700	0.1	6	0.02

Table 4.3 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40 MFP IN 45-MFP THICK LANTHANUM AND COMPARISON TO VALUES CALCULATED BY THE PALLAS CODE

E (MeV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.666	1.191	0.037	13.65	-0.0732	5.7	1	2.73
10	1.576	1.011	0.061	13.97	-0.0888	6.5	0.5	2.97
8	1.532	0.939	0.072	14.08	-0.0965	6.8	0.5	2.97
6	1.516	0.912	0.070	13.97	-0.0958	6.6	0.5	2.87
5	1.520	0.939	0.056	13.77	-0.0834	6.3	0.5	2.66
4	1.462	1.004	0.029	13.40	-0.0598	4.6	0.5	1.99
3	1.511	1.032	0.012	13.14	-0.0399	2.9	0.5	1.26
2	1.568	1.040	0.002	13.01	-0.0222	1.1	2	0.55
1.5	1.576	1.061	-0.010	11.98	-0.0058	1.5	2	0.56
1	1.564	1.053	-0.008	15.90	-0.0049	1.7	0.5	0.71
0.8	1.546	1.017	-0.001	13.24	-0.0062	1.4	0.5	0.70
0.6	1.470	0.979	0.006	14.68	-0.0052	1.3	2	0.56
0.5	1.702	0.640	0.128	13.62	-0.0945	3.5	0.5	1.66
0.4	1.584	0.545	0.166	13.47	-0.1098	2.8	0.5	1.47
0.3	1.391	0.478	0.191	13.47	-0.1159	2.5	0.5	1.20
0.2	1.198	0.410	0.221	12.93	-0.1308	1.7	0.5	0.75
0.15	1.102	0.486	0.163	13.30	-0.0843	1.0	0.5	0.36
0.1	1.518	0.037	0.657	14.68	-0.1509	0.7	1	0.27
0.08	2.019	0.218	-0.118	16.77	0.0677	0.7	1	0.33
0.07	2.339	0.306	0.342	27.94	-0.3397	4.1	0.5	2.06
0.06	2.635	0.792	0.177	16.33	-0.1431	2.8	1	1.65
0.055	2.760	1.087	0.113	19.94	-0.0848	5.1	0.5	2.80
0.05	3.048	1.295	0.093	20.58	-0.0948	9.5	3	5.27
0.048	2.765	1.508	0.059	29.90	-0.0961	11.0	40	5.97
0.046	2.946	1.538	0.064	10.18	-0.0246	10.9	3	4.82
0.044	2.970	1.599	0.064	13.03	-0.0451	13.0	3	6.37
0.042	2.911	1.690	0.058	10.98	-0.0418	12.8	3	5.65
0.04	2.813	1.787	0.051	10.34	-0.0409	12.3	3	5.28
0.039	2.738	1.853	0.044	10.83	-0.0343	11.9	3	5.12
0.038	1.021	0.401	0.235	14.15	-0.1456	0.3	0.5	0.12
0.03	1.012	0.371	0.256	14.48	-0.1601	0.1	4	0.08
0.02	1.004	0.385	0.242	15.44	-0.1504	0.1	5	0.03
0.015	1.002	0.351	0.272	14.37	-0.1700	0.1	6	0.02

Table 4.4 G-P parameters for gamma-ray buildup factors
in gadolinium medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK GADOLINIUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MeV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.415	1.120	0.060	13.92	-0.0949	7.0	0.5	3.26
10	1.433	0.938	0.087	14.14	-0.1117	8.2	0.5	3.54
8	1.466	0.820	0.116	14.21	-0.1362	9.0	0.5	3.85
6	1.482	0.828	0.100	14.26	-0.1177	11.6	0.5	4.23
5	1.616	0.713	0.145	14.15	-0.1708	7.7	0.5	4.29
4	1.490	0.854	0.081	13.71	-0.1057	8.0	0.5	3.34
3	1.625	0.866	0.068	13.44	-0.0887	6.3	0.5	2.67
2	1.795	0.889	0.049	13.34	-0.0585	2.5	0.5	1.35
1.5	1.836	0.925	0.029	13.26	-0.0318	1.1	5	0.67
1	1.866	0.905	0.033	14.38	-0.0287	1.2	2	0.63
0.8	1.869	0.848	0.046	15.57	-0.0357	1.3	2	0.84
0.6	1.767	0.779	0.068	13.62	-0.0426	1.5	0.5	0.87
0.5	1.677	0.696	0.096	14.14	-0.0552	1.5	0.5	0.81
0.4	1.879	0.358	0.279	13.49	-0.1861	3.0	0.5	1.69
0.3	1.737	0.241	0.380	13.26	-0.2513	3.2	0.5	1.66
0.2	1.488	0.119	0.555	13.16	-0.3477	2.7	2	1.34
0.15	1.433	0.076	0.629	13.32	-0.3336	1.5	2	0.75
0.1	1.648	0.242	-0.006	19.35	0.0590	0.4	0.5	0.17
0.09	1.710	0.330	0.268	10.53	0.0625	1.6	2	0.95
0.08	1.739	0.609	0.235	16.12	-0.2033	2.2	35	1.23
0.075	1.757	0.830	0.169	16.56	-0.1377	2.7	1	1.42
0.07	1.771	1.069	0.117	20.36	-0.0956	3.8	0.5	2.10
0.065	1.821	1.261	0.093	37.31	-0.3050	5.3	3	3.12
0.06	1.903	1.408	0.085	18.32	-0.0988	15.2	40	7.47
0.058	1.849	1.603	0.049	13.03	0.0133	7.7	3	3.51
0.056	2.022	1.508	0.080	12.29	-0.0541	14.0	3	6.30
0.054	2.026	1.603	0.070	11.81	-0.0505	13.9	3	6.18
0.052	1.990	1.736	0.053	12.46	-0.0402	12.4	3	5.86
0.051	1.997	1.769	0.051	10.56	-0.0359	11.8	3	5.13
0.05	1.030	0.408	0.228	13.76	-0.1346	0.4	0.5	0.17
0.04	1.017	0.393	0.238	14.15	-0.1412	0.2	0.5	0.10
0.03	1.008	0.370	0.262	14.04	-0.1718	0.1	3	0.06
0.02	1.003	0.304	0.321	14.04	-0.2144	0.0	4	0.02
0.015	1.001	0.623	0.099	11.85	-0.0272	0.1	4	0.03

Table 4.4 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK GADOLINIUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.590	1.269	0.022	13.68	-0.0562	4.8	1	2.25
10	1.503	1.074	0.046	13.91	-0.0738	5.2	0.5	2.42
8	1.457	0.995	0.056	14.08	-0.0790	5.9	0.5	2.48
6	1.443	0.949	0.059	14.02	-0.0835	5.6	0.5	2.43
5	1.438	0.967	0.048	13.80	-0.0749	5.4	0.5	2.27
4	1.392	1.036	0.020	13.47	-0.0510	4.2	0.5	1.73
3	1.444	1.038	0.010	13.33	-0.0365	2.5	0.5	1.13
2	1.496	1.016	0.007	13.01	-0.0237	1.0	35	0.54
1.5	1.486	1.026	-0.003	12.37	-0.0067	1.1	2	0.44
1	1.458	1.007	0.001	17.08	-0.0060	1.3	0.5	0.59
0.8	1.434	0.952	0.013	13.84	-0.0096	1.3	2	0.58
0.6	1.361	0.926	0.017	13.84	-0.0068	1.4	2	0.51
0.5	1.314	0.854	0.037	15.44	-0.0163	1.1	2	0.46
0.4	1.430	0.494	0.186	13.54	-0.1145	2.5	0.5	1.21
0.3	1.293	0.431	0.215	13.41	-0.1270	2.1	0.5	0.99
0.2	1.182	0.307	0.298	12.89	-0.1787	1.8	0.5	0.78
0.15	1.175	0.182	0.427	13.11	-0.2640	1.2	2	0.60
0.1	1.607	0.246	-0.005	19.62	0.0612	0.3	0.5	0.18
0.09	1.822	0.331	0.270	9.77	0.0566	1.9	0.5	1.02
0.08	2.066	0.621	0.230	16.01	-0.1998	2.4	1	1.40
0.075	2.171	0.836	0.168	16.31	-0.1389	3.0	1	1.69
0.07	2.336	1.043	0.126	17.83	-0.0956	5.5	3	2.62
0.065	2.476	1.255	0.095	26.75	-0.1659	9.4	40	4.18
0.06	2.651	1.449	0.076	19.01	-0.0762	10.5	40	6.14
0.058	2.835	1.445	0.086	12.65	-0.0598	14.2	3	6.59
0.056	2.758	1.580	0.066	13.26	-0.0444	12.5	3	6.28
0.054	2.760	1.659	0.060	12.87	-0.0430	12.9	3	6.47
0.052	2.749	1.729	0.055	11.49	-0.0404	12.8	3	5.66
0.051	2.752	1.762	0.053	11.10	-0.0399	12.6	3	5.45
0.05	1.029	0.419	0.220	13.78	-0.1281	0.4	0.5	0.17
0.04	1.017	0.393	0.238	14.15	-0.1412	0.2	0.5	0.10
0.03	1.008	0.380	0.252	14.05	-0.1597	0.1	0.5	0.05
0.02	1.003	0.304	0.321	14.04	-0.2144	0.0	4	0.02
0.015	1.001	0.673	0.069	23.28	0.0179	0.1	7	0.03

Table 4.4 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40 MFP IN 45-MFP THICK GADOLINIUM AND COMPARISON TO VALUES CALCULATED BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	I	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.670	1.243	0.029	13.57	-0.0652	5.6	0.5	2.63	
10	1.572	1.048	0.054	13.91	-0.0825	6.3	0.5	2.82	
8	1.519	0.959	0.068	14.09	-0.0916	6.8	0.5	2.88	
6	1.494	0.912	0.072	13.99	-0.0967	6.4	0.5	2.80	
5	1.487	0.940	0.057	13.82	-0.0832	6.3	0.5	2.63	
4	1.423	1.004	0.030	13.52	-0.0598	4.8	0.5	2.02	
3	1.467	1.026	0.014	13.21	-0.0406	3.3	0.5	1.32	
2	1.520	1.009	0.009	13.17	-0.0248	0.8	2	0.57	
1.5	1.526	1.010	0.002	12.79	-0.0111	1.0	2	0.48	
1	1.490	0.998	0.004	15.11	-0.0085	1.5	2	0.61	
0.8	1.465	0.951	0.013	12.90	-0.0083	1.4	2	0.62	
0.6	1.386	0.908	0.023	13.54	-0.0111	1.2	2	0.52	
0.5	1.335	0.842	0.041	15.11	-0.0186	1.1	2	0.48	
0.4	1.448	0.487	0.190	13.53	-0.1178	2.5	0.5	1.23	
0.3	1.309	0.418	0.224	13.34	-0.1344	2.3	0.5	1.03	
0.2	1.215	0.263	0.341	12.88	-0.2093	2.1	0.5	0.88	
0.15	1.232	0.137	0.495	13.19	-0.2937	1.3	2	0.66	
0.1	1.726	0.245	-0.021	20.47	0.0624	0.4	0.5	0.22	
0.09	1.925	0.331	0.269	9.98	0.0590	2.0	0.5	1.06	
0.08	2.150	0.606	0.238	15.93	-0.2101	2.3	35	1.37	
0.075	2.226	0.828	0.171	16.23	-0.1421	2.9	4	1.70	
0.07	2.346	1.043	0.126	17.57	-0.0938	4.7	3	2.47	
0.065	2.425	1.273	0.091	36.15	-0.3023	6.1	40	3.61	
0.06	2.539	1.487	0.067	35.25	-0.1837	8.7	40	4.62	
0.058	2.629	1.553	0.061	9.99	-0.0163	10.4	35	6.02	
0.056	2.661	1.624	0.058	14.55	-0.0400	12.5	20	6.64	
0.054	2.679	1.701	0.052	13.79	-0.0365	11.3	20	6.25	
0.052	2.763	1.728	0.055	11.19	-0.0402	12.7	3	5.67	
0.051	2.768	1.767	0.052	11.25	-0.0378	12.5	3	5.48	
0.05	1.029	0.416	0.224	13.82	-0.1355	0.4	0.5	0.16	
0.04	1.016	0.419	0.222	13.82	-0.1330	0.2	0.5	0.09	
0.03	1.008	0.370	0.262	14.04	-0.1718	0.1	3	0.06	
0.02	1.003	0.304	0.321	14.04	-0.2144	0.0	4	0.02	
0.015	1.001	0.623	0.099	11.85	-0.0272	0.1	4	0.03	

Table 4.5 G-P parameters for gamma-ray buildup factors
in tungsten medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK TUNGSTEN AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.396	1.164	0.054	13.90	-0.0885	7.3	1	3.17
10	1.481	0.844	0.128	14.12	-0.1624	7.0	3	4.40
8	1.431	0.839	0.112	14.28	-0.1304	8.9	0.5	3.71
6	1.480	0.768	0.127	14.27	-0.1441	9.7	0.5	3.95
5	1.509	0.756	0.126	14.11	-0.1441	9.9	0.5	4.02
4	1.460	0.828	0.091	13.78	-0.1126	9.5	0.5	3.67
3	1.582	0.840	0.076	13.53	-0.0922	8.2	0.5	3.01
2	1.748	0.827	0.068	13.39	-0.0694	4.0	0.5	1.72
1.5	1.768	0.843	0.052	13.33	-0.0422	1.4	0.5	0.86
1	1.742	0.803	0.060	14.41	-0.0369	1.0	10	0.64
0.8	2.163	0.485	0.208	13.60	-0.1495	4.3	0.5	2.27
0.6	1.959	0.415	0.247	13.35	-0.1741	3.6	0.5	2.02
0.5	1.977	0.330	0.302	13.74	-0.2036	4.0	0.5	1.91
0.4	1.797	0.252	0.367	13.43	-0.2382	3.1	0.5	1.60
0.3	1.578	0.178	0.450	13.32	-0.2795	2.9	0.5	1.39
0.2	1.402	0.028	0.956	15.12	-0.6428	4.5	1	1.88
0.15	1.479	0.023	-0.247	10.15	0.1778	8.5	1	3.14
0.14	1.520	0.133	-0.244	13.55	0.1120	8.9	1	3.54
0.13	1.685	0.179	-0.446	5.56	0.0571	3.3	2	1.40
0.12	1.719	0.170	0.552	17.29	-0.4575	6.0	2	2.60
0.11	1.703	0.462	0.321	15.31	-0.3350	6.8	15	4.03
0.1	1.728	0.774	0.202	15.09	-0.2055	6.9	1	3.41
0.09	1.752	1.145	0.116	16.58	-0.0995	8.1	1	3.15
0.08	1.946	1.335	0.104	14.16	-0.0888	11.8	3	4.67
0.075	1.984	1.492	0.085	12.90	-0.0690	11.9	3	4.75
0.07	1.991	1.683	0.062	11.93	-0.0465	10.5	3	4.20
0.069	1.042	0.417	0.220	13.25	-0.1249	0.6	0.5	0.23
0.06	1.029	0.415	0.224	13.44	-0.1325	0.5	0.5	0.18
0.05	1.018	0.407	0.230	13.80	-0.1384	0.3	0.5	0.11
0.04	1.011	0.346	0.279	14.35	-0.1832	0.1	8	0.06
0.03	1.004	0.554	0.136	15.36	-0.0677	0.2	0.5	0.06
0.02	1.002	0.246	0.414	13.11	-0.3510	0.1	2	0.03
0.015	1.001	0.277	0.342	19.18	-0.3351	0.1	3	0.03

Table 4.5 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK TUNGSTEN AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.544	1.332	0.013	13.57 -0.0464	4.4	1	1.87	
10	1.442	1.156	0.028	14.05 -0.0537	4.6	0.5	1.97	
8	1.416	1.024	0.050	14.34 -0.0707	4.3	0.5	2.12	
6	1.395	0.953	0.060	14.15 -0.0823	4.0	0.5	2.13	
5	1.365	1.010	0.035	13.97 -0.0597	4.8	0.5	1.92	
4	1.346	1.039	0.019	13.73 -0.0470	4.3	0.5	1.68	
3	1.392	1.028	0.012	13.29 -0.0362	2.8	0.5	1.11	
2	1.435	0.985	0.013	13.24 -0.0234	1.0	0.5	0.57	
1.5	1.421	0.970	0.009	13.45 -0.0092	1.1	2	0.39	
1	1.379	0.924	0.019	17.14 -0.0101	1.3	2	0.48	
0.8	1.581	0.600	0.144	13.61 -0.0983	3.6	0.5	1.69	
0.6	1.473	0.546	0.165	13.40 -0.1081	3.2	0.5	1.50	
0.5	1.395	0.502	0.181	13.89 -0.1117	2.5	0.5	1.17	
0.4	1.312	0.436	0.213	13.54 -0.1261	2.1	0.5	0.98	
0.3	1.208	0.384	0.241	13.28 -0.1388	1.8	0.5	0.79	
0.2	1.127	0.232	0.386	13.26 -0.2696	1.5	3	0.68	
0.15	1.234	0.035	0.346	7.53 0.2213	2.1	1	1.04	
0.14	1.293	0.110	-0.388	9.46 0.2107	2.4	2	1.00	
0.13	1.400	0.214	-0.545	5.00 0.1668	1.3	3	0.60	
0.12	1.465	0.221	0.473	16.83 -0.3682	4.2	15	2.10	
0.11	1.529	0.530	0.278	15.18 -0.2795	6.5	1	3.84	
0.1	1.677	0.833	0.181	14.98 -0.1835	7.6	1	3.56	
0.09	1.850	1.154	0.117	15.35 -0.1045	7.4	1	3.28	
0.08	2.223	1.347	0.105	13.74 -0.1039	12.1	3	4.92	
0.075	2.309	1.487	0.089	13.11 -0.0858	13.3	3	5.34	
0.07	2.271	1.733	0.054	13.15 -0.0363	9.9	3	4.05	
0.069	1.034	0.495	0.172	13.26 -0.0911	0.4	0.5	0.19	
0.06	1.026	0.448	0.203	13.55 -0.1178	0.3	0.5	0.15	
0.05	1.017	0.432	0.213	13.80 -0.1254	0.2	0.5	0.10	
0.04	1.011	0.346	0.279	14.35 -0.1832	0.1	8	0.06	
0.03	1.005	0.408	0.224	14.86 -0.1299	0.1	0.5	0.03	
0.02	1.002	0.258	0.394	13.12 -0.3192	0.0	4	0.02	
0.015	1.001	0.277	0.342	19.18 -0.3351	0.1	3	0.03	

Table 4.5 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40 MFP IN 45-MFP THICK TUNGSTEN AND COMPARISON TO VALUES CALCULATED BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.611	1.312	0.018	13.52 -0.0524	5.2	1	2.19	
10	1.501	1.128	0.036	14.00 -0.0627	5.4	0.5	2.32	
8	1.469	0.980	0.065	14.05 -0.0877	4.9	0.5	2.46	
6	1.415	0.959	0.058	14.11 -0.0799	5.7	0.5	2.36	
5	1.413	0.964	0.050	13.97 -0.0739	5.3	0.5	2.23	
4	1.363	1.024	0.024	13.55 -0.0521	5.3	0.5	1.94	
3	1.409	1.018	0.015	13.30 -0.0383	3.5	0.5	1.29	
2	1.464	0.955	0.023	13.22 -0.0322	1.1	4	0.70	
1.5	1.453	0.952	0.015	13.02 -0.0141	0.9	2	0.43	
1	1.406	0.909	0.024	15.90 -0.0137	1.2	2	0.49	
0.8	1.622	0.590	0.149	13.60 -0.1023	3.6	0.5	1.74	
0.6	1.498	0.538	0.169	13.43 -0.1106	3.3	0.5	1.53	
0.5	1.421	0.490	0.188	13.86 -0.1169	2.6	0.5	1.22	
0.4	1.331	0.421	0.223	13.53 -0.1332	2.1	0.5	1.02	
0.3	1.227	0.358	0.261	13.22 -0.1540	1.8	0.5	0.83	
0.2	1.169	0.133	0.551	13.61 -0.4097	1.9	3	0.80	
0.15	1.308	0.041	-0.185	8.64 0.2497	4.0	1	1.59	
0.14	1.375	0.080	-0.339	10.48 0.1697	4.8	2	1.69	
0.13	1.536	0.192	-0.769	5.00 0.1175	1.7	2	0.68	
0.12	1.596	0.210	0.489	16.89 -0.3873	5.0	2	2.40	
0.11	1.675	0.505	0.294	15.16 -0.3024	6.6	1	4.10	
0.1	1.833	0.807	0.191	14.94 -0.1972	7.4	1	3.72	
0.09	2.004	1.114	0.128	15.32 -0.1216	6.6	3	3.44	
0.08	2.326	1.326	0.109	13.92 -0.1070	13.3	3	5.36	
0.075	2.324	1.536	0.077	13.35 -0.0596	11.3	3	4.44	
0.07	2.458	1.644	0.072	12.69 -0.0716	13.0	3	5.22	
0.069	1.036	0.475	0.183	13.43 -0.0980	0.4	0.5	0.19	
0.06	1.025	0.465	0.193	13.56 -0.1123	0.4	0.5	0.15	
0.05	1.017	0.444	0.202	13.99 -0.1125	0.3	0.5	0.10	
0.04	1.010	0.401	0.237	13.66 -0.1458	0.2	0.5	0.07	
0.03	1.005	0.401	0.231	14.64 -0.1381	0.1	3	0.04	
0.02	1.002	0.258	0.394	13.12 -0.3192	0.0	4	0.02	
0.015	1.001	0.277	0.342	19.18 -0.3351	0.1	3	0.03	

Table 4.6 G-P parameters for gamma-ray buildup factors
in lead medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK LEAD AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.404	1.124	0.065	13.91	-0.0991	9.2	0.5	3.79
10	1.424	0.940	0.090	14.20	-0.1121	10.4	0.5	3.92
8	1.443	0.808	0.123	14.30	-0.1385	10.9	0.5	4.15
6	1.497	0.721	0.145	14.37	-0.1578	11.5	0.5	4.26
5	1.530	0.722	0.139	14.19	-0.1526	12.1	0.5	4.36
4	1.612	0.706	0.137	14.11	-0.1471	11.3	0.5	4.14
3	1.575	0.778	0.096	13.78	-0.1032	8.4	0.5	3.06
2	1.670	0.785	0.079	13.58	-0.0696	4.2	0.5	1.66
1.5	1.656	0.778	0.069	13.61	-0.0452	1.4	0.5	0.73
1	1.589	0.744	0.076	14.76	-0.0406	0.8	10	0.53
0.8	1.533	0.682	0.094	14.43	-0.0455	0.9	10	0.53
0.6	1.424	0.621	0.113	13.77	-0.0478	0.7	0.5	0.42
0.5	1.332	0.590	0.127	14.62	-0.0572	0.9	1	0.52
0.4	1.237	0.552	0.134	15.25	-0.0504	1.0	0.5	0.43
0.3	1.494	0.183	0.421	12.80	-0.2485	2.4	0.5	1.20
0.2	1.588	0.097	0.441	14.49	-0.1076	0.8	1	0.27
0.16	1.742	0.317	0.124	12.50	-0.0510	0.1	40	0.09
0.15	1.783	0.318	0.310	26.45	-0.1233	2.8	0.5	1.29
0.14	1.824	0.456	0.292	16.71	-0.2395	1.9	20	1.07
0.13	1.840	0.689	0.209	15.78	-0.1834	2.9	35	1.44
0.12	1.863	0.953	0.141	16.79	-0.1122	3.3	1	1.78
0.11	1.862	1.242	0.090	28.31	-0.1473	5.4	0.5	2.94
0.1	2.014	1.393	0.083	20.93	-0.0912	10.0	3	5.32
0.09	2.056	1.679	0.052	14.62	-0.0356	12.3	20	6.32
0.089	2.026	1.730	0.045	58.63	-0.4542	10.8	40	5.38
0.088	1.086	0.227	0.400	13.28	-0.2937	1.1	0.5	0.56
0.08	1.044	0.403	0.227	13.24	-0.1318	0.6	0.5	0.25
0.06	1.020	0.413	0.226	13.73	-0.1353	0.2	0.5	0.10
0.05	1.013	0.368	0.273	13.99	-0.1844	0.2	0.5	0.07
0.04	1.007	0.414	0.227	13.71	-0.1370	0.1	5	0.05
0.03	1.003	0.506	0.167	14.21	-0.0950	0.1	0.5	0.04

Table 4.6 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK LEAD AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.548	1.287	0.024	13.50 -0.0571	4.7	0.5	2.21	
10	1.448	1.121	0.036	13.98 -0.0599	5.5	0.5	2.20	
8	1.424	0.968	0.068	13.98 -0.0874	4.2	0.5	2.35	
6	1.377	0.941	0.062	14.14 -0.0795	5.3	0.5	2.15	
5	1.361	0.956	0.051	13.95 -0.0709	5.3	0.5	2.06	
4	1.378	0.954	0.042	14.04 -0.0603	4.6	0.5	1.72	
3	1.385	0.960	0.029	13.48 -0.0421	3.6	0.5	1.31	
2	1.388	0.939	0.024	13.33 -0.0266	1.0	0.5	0.51	
1.5	1.375	0.891	0.029	13.29 -0.0168	0.5	2	0.35	
1	1.318	0.860	0.035	16.49 -0.0154	0.7	3	0.38	
0.8	1.283	0.800	0.050	15.20 -0.0191	0.9	0.5	0.43	
0.6	1.228	0.744	0.064	14.47 -0.0184	0.9	3	0.40	
0.5	1.179	0.725	0.072	14.89 -0.0244	0.7	3	0.36	
0.4	1.135	0.670	0.085	19.56 -0.0325	0.5	0.5	0.26	
0.3	1.122	0.533	0.137	13.69 -0.0612	0.8	0.5	0.32	
0.2	1.184	0.190	0.381	13.27 -0.1868	0.5	3	0.26	
0.16	1.339	0.343	0.151	12.54 -0.0682	0.2	4	0.11	
0.15	1.408	0.362	0.281	21.46 -0.0964	1.2	0.5	0.66	
0.14	1.474	0.512	0.259	16.39 -0.2077	1.6	35	1.07	
0.13	1.549	0.746	0.187	15.62 -0.1639	2.6	1	1.64	
0.12	1.652	0.999	0.130	16.27 -0.1064	3.6	1	1.87	
0.11	1.850	1.204	0.103	16.88 -0.0848	6.5	3	3.22	
0.1	2.037	1.432	0.079	18.37 -0.0935	10.5	40	5.97	
0.09	2.168	1.728	0.045	16.92 -0.0346	10.9	40	5.81	
0.089	2.368	1.604	0.071	12.64 -0.0578	13.9	3	6.19	
0.088	1.062	0.350	0.272	13.10 -0.1845	1.0	0.5	0.44	
0.08	1.033	0.523	0.153	13.30 -0.0777	0.4	0.5	0.17	
0.06	1.017	0.487	0.180	13.37 -0.1037	0.3	0.5	0.11	
0.05	1.012	0.405	0.244	14.18 -0.1624	0.1	0.5	0.07	
0.04	1.007	0.438	0.204	14.26 -0.1093	0.1	3	0.05	
0.03	1.003	0.396	0.248	14.56 -0.1696	0.1	5	0.04	

Table 4.6 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40
MFP IN 45-MFP THICK LEAD AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.612	1.271	0.028	13.58	-0.0619	5.9	0.5	2.65
10	1.510	1.084	0.047	13.94	-0.0721	5.9	0.5	2.48
8	1.457	0.967	0.068	14.14	-0.0876	5.9	0.5	2.57
6	1.443	0.847	0.097	14.03	-0.1166	4.3	0.5	2.85
5	1.395	0.935	0.058	14.04	-0.0774	6.0	0.5	2.28
4	1.403	0.928	0.051	13.93	-0.0686	5.0	0.5	1.95
3	1.384	0.963	0.029	13.61	-0.0456	3.6	0.5	1.34
2	1.401	0.935	0.025	13.24	-0.0266	1.3	0.5	0.63
1.5	1.395	0.889	0.029	13.75	-0.0156	0.7	2	0.36
1	1.341	0.842	0.041	15.93	-0.0189	0.8	1	0.47
0.8	1.297	0.803	0.048	15.95	-0.0168	1.1	3	0.48
0.6	1.237	0.741	0.065	13.82	-0.0184	0.9	3	0.43
0.5	1.189	0.718	0.074	15.14	-0.0253	0.6	3	0.34
0.4	1.139	0.667	0.086	16.78	-0.0250	0.7	0.5	0.27
0.3	1.143	0.474	0.170	13.23	-0.0852	1.2	0.5	0.47
0.2	1.251	0.154	0.411	13.45	-0.1739	0.4	3	0.24
0.16	1.462	0.334	0.144	12.40	-0.0675	0.2	35	0.11
0.15	1.551	0.347	0.293	22.96	-0.1245	1.7	0.5	0.82
0.14	1.628	0.496	0.269	16.36	-0.2196	2.3	35	1.14
0.13	1.710	0.731	0.193	15.63	-0.1704	2.5	1	1.70
0.12	1.818	0.982	0.135	16.17	-0.1115	3.4	0.5	1.97
0.11	1.994	1.210	0.101	17.48	-0.0845	5.6	3	3.02
0.1	2.256	1.393	0.085	16.20	-0.0622	11.3	3	5.02
0.09	2.197	1.754	0.040	29.31	-0.0769	11.3	40	5.47
0.089	2.342	1.702	0.052	13.94	-0.0374	10.6	3	5.87
0.088	1.067	0.318	0.299	13.25	-0.2057	1.0	0.5	0.48
0.08	1.031	0.541	0.144	13.42	-0.0714	0.4	0.5	0.14
0.06	1.015	0.530	0.157	13.50	-0.0890	0.2	0.5	0.11
0.05	1.009	0.553	0.151	14.26	-0.0870	0.2	0.5	0.07
0.04	1.006	0.452	0.206	14.38	-0.1351	0.1	4	0.04
0.03	1.003	0.422	0.231	13.42	-0.1520	0.1	3	0.02

Table 4.7 G-P parameters for gamma-ray buildup factors
in uranium medium

PARAMETERS FOR POINT SOURCE ABSORBED DOSE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK URANIUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.411	1.096	0.071	13.88	-0.1035	9.6	0.5	3.87
10	1.435	0.915	0.096	14.23	-0.1155	10.0	0.5	3.79
8	1.449	0.783	0.129	14.39	-0.1393	11.2	0.5	4.10
6	1.479	0.677	0.161	14.46	-0.1666	11.7	0.5	4.38
5	1.506	0.669	0.159	14.38	-0.1641	11.8	0.5	4.34
4	1.554	0.677	0.147	14.11	-0.1506	11.1	0.5	4.01
3	1.624	0.681	0.135	13.81	-0.1336	9.5	0.5	3.49
2	1.674	0.698	0.113	13.58	-0.0938	5.6	0.5	2.13
1.5	1.639	0.680	0.107	13.23	-0.0624	1.7	0.5	0.90
1	1.578	0.641	0.114	14.32	-0.0605	1.8	0.5	0.86
0.8	1.558	0.547	0.155	13.52	-0.0864	1.8	0.5	0.88
0.6	1.487	0.450	0.209	13.34	-0.1284	2.9	0.5	1.20
0.5	1.469	0.346	0.274	13.50	-0.1558	3.2	0.5	1.19
0.4	1.474	0.217	0.392	13.47	-0.2187	2.9	0.5	1.27
0.3	1.539	0.121	0.494	13.05	-0.2398	1.4	2	0.70
0.25	1.617	0.129	0.356	14.93	-0.0606	0.6	1	0.25
0.2	1.759	0.336	0.183	15.97	-0.0460	0.8	20	0.35
0.19	1.804	0.339	0.311	27.44	-0.2754	2.6	0.5	1.29
0.18	1.839	0.436	0.300	16.83	-0.2422	2.4	0.5	1.12
0.17	1.839	0.611	0.232	15.95	-0.2006	2.2	35	1.36
0.16	1.839	0.810	0.172	16.12	-0.1429	3.2	1	1.54
0.15	1.858	1.007	0.129	17.25	-0.0990	3.4	0.5	1.93
0.14	1.890	1.219	0.093	23.66	-0.0969	4.7	0.5	2.64
0.13	2.006	1.362	0.082	19.14	-0.0699	7.3	3	4.54
0.12	2.081	1.518	0.070	17.94	-0.0719	11.2	40	6.58
0.116	2.112	1.584	0.065	13.81	-0.0481	11.7	3	5.98
0.115	1.119	0.207	0.420	13.13	-0.2998	1.4	0.5	0.72
0.1	1.076	0.248	0.367	13.01	-0.2542	0.9	2	0.51
0.08	1.028	0.417	0.220	13.29	-0.1242	0.4	0.5	0.18
0.06	1.013	0.446	0.202	13.86	-0.1161	0.3	0.5	0.10
0.05	1.009	0.379	0.255	13.55	-0.1651	0.1	0.5	0.07
0.04	1.005	0.448	0.191	19.76	-0.1466	0.1	0.5	0.05
0.03	1.003	0.270	0.357	14.60	-0.2551	0.1	3	0.04

Table 4.7 (continued)

PARAMETERS FOR POINT SOURCE EXPOSURE BUILDUP FACTORS UP TO 40 MFP
IN 45-MFP THICK URANIUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.526	1.285	0.022	13.61	-0.0515	4.8	0.5	2.17
10	1.429	1.111	0.036	14.05	-0.0565	4.7	0.5	1.91
8	1.376	1.009	0.050	14.37	-0.0633	4.9	0.5	1.90
6	1.335	0.930	0.062	14.27	-0.0740	6.2	0.5	2.26
5	1.338	0.889	0.071	14.10	-0.0838	4.4	0.5	2.33
4	1.317	0.963	0.036	14.07	-0.0506	4.1	0.5	1.52
3	1.335	0.948	0.031	13.63	-0.0436	3.3	0.5	1.27
2	1.341	0.911	0.030	13.96	-0.0258	1.2	0.5	0.61
1.5	1.317	0.849	0.041	12.50	-0.0154	1.0	2	0.42
1	1.271	0.796	0.053	15.45	-0.0219	0.7	0.5	0.37
0.8	1.235	0.746	0.067	13.79	-0.0264	0.6	2	0.32
0.6	1.177	0.724	0.073	13.34	-0.0304	0.8	10	0.40
0.5	1.149	0.660	0.094	14.55	-0.0343	0.5	2	0.25
0.4	1.129	0.556	0.136	14.89	-0.0530	0.5	0.5	0.29
0.3	1.138	0.358	0.242	13.01	-0.1319	0.9	0.5	0.44
0.25	1.189	0.228	0.323	13.26	-0.1347	0.3	10	0.21
0.2	1.329	0.369	0.197	14.10	-0.0755	0.4	20	0.18
0.19	1.377	0.401	0.269	20.45	-0.1382	1.1	15	0.58
0.18	1.421	0.514	0.253	16.30	-0.1962	1.9	35	1.06
0.17	1.457	0.704	0.191	15.76	-0.1599	3.2	1	1.66
0.16	1.533	0.874	0.153	15.65	-0.1309	3.3	1	1.78
0.15	1.606	1.080	0.112	16.63	-0.0875	4.4	1	2.02
0.14	1.719	1.250	0.090	16.51	-0.0597	4.8	4	2.59
0.13	1.957	1.313	0.100	13.21	-0.0889	10.6	3	5.22
0.12	2.027	1.566	0.064	17.89	-0.0695	9.3	25	5.74
0.116	2.128	1.602	0.064	13.21	-0.0410	11.1	3	4.84
0.115	1.074	0.374	0.248	12.98	-0.1601	1.2	0.5	0.50
0.1	1.053	0.362	0.270	12.21	-0.1943	0.7	1	0.38
0.08	1.021	0.550	0.139	13.56	-0.0621	0.4	0.5	0.12
0.06	1.012	0.457	0.198	13.92	-0.1168	0.2	0.5	0.08
0.05	1.008	0.451	0.199	14.63	-0.1175	0.1	0.5	0.05
0.04	1.005	0.448	0.191	19.76	-0.1466	0.1	0.5	0.05
0.03	1.003	0.275	0.355	14.80	-0.2744	0.1	3	0.04

Table 4.7 (continued)

PARAMETERS FOR POINT SOURCE DOSE EQUIVALENT BUILDUP FACTORS UP TO 40
MFP IN 45-MFP THICK URANIUM AND COMPARISON TO VALUES CALCULATED
BY THE PALLAS CODE

E (MEV)	B	C	A	XK	D	MAX. DEV(%)	XMAX (MFP)	RMS DEV(%)
15	1.588	1.262	0.028	13.54 -0.0587	5.4	0.5	2.43	
10	1.481	1.087	0.043	14.11 -0.0638	5.3	0.5	2.21	
8	1.473	0.876	0.097	13.99 -0.1156	5.0	35	3.11	
6	1.349	0.938	0.059	14.39 -0.0702	7.6	0.5	2.67	
5	1.360	0.888	0.071	14.15 -0.0840	6.0	0.5	2.33	
4	1.341	0.928	0.048	13.96 -0.0616	4.6	0.5	1.73	
3	1.350	0.933	0.036	13.58 -0.0474	3.9	0.5	1.39	
2	1.358	0.884	0.040	13.49 -0.0350	1.3	0.5	0.72	
1.5	1.337	0.838	0.044	13.49 -0.0159	0.7	2	0.44	
1	1.284	0.788	0.056	15.01 -0.0240	0.8	2	0.37	
0.8	1.247	0.747	0.066	13.98 -0.0253	1.0	2	0.34	
0.6	1.192	0.691	0.087	13.41 -0.0411	1.0	10	0.43	
0.5	1.165	0.624	0.110	14.24 -0.0451	0.5	10	0.26	
0.4	1.142	0.528	0.150	14.45 -0.0617	1.0	0.5	0.37	
0.3	1.169	0.301	0.286	13.03 -0.1573	1.0	0.5	0.53	
0.25	1.237	0.200	0.338	13.53 -0.1237	0.3	3	0.20	
0.2	1.419	0.357	0.199	14.32 -0.0722	0.5	20	0.22	
0.19	1.480	0.382	0.283	20.43 -0.1498	1.4	0.5	0.68	
0.18	1.529	0.500	0.261	16.40 -0.2043	2.2	35	1.11	
0.17	1.580	0.681	0.201	15.75 -0.1706	2.6	6	1.70	
0.16	1.648	0.864	0.156	15.69 -0.1330	3.5	1	1.84	
0.15	1.737	1.058	0.118	16.40 -0.0933	4.0	1	2.08	
0.14	1.871	1.207	0.101	16.84 -0.0858	5.9	4	3.24	
0.13	1.982	1.394	0.078	18.00 -0.0661	7.0	3	3.89	
0.12	2.063	1.601	0.056	22.83 -0.0804	11.5	40	5.09	
0.116	2.225	1.581	0.068	12.91 -0.0481	11.8	3	5.16	
0.115	1.079	0.350	0.267	12.94 -0.1744	1.3	0.5	0.53	
0.1	1.059	0.355	0.256	12.95 -0.1525	1.1	0.5	0.45	
0.08	1.022	0.522	0.155	13.45 -0.0750	0.3	0.5	0.13	
0.06	1.012	0.453	0.202	13.62 -0.1228	0.2	0.5	0.07	
0.05	1.009	0.372	0.259	14.15 -0.1693	0.1	25	0.07	
0.04	1.005	0.448	0.191	19.76 -0.1466	0.1	0.5	0.05	
0.03	1.003	0.270	0.357	14.60 -0.2551	0.1	3	0.04	

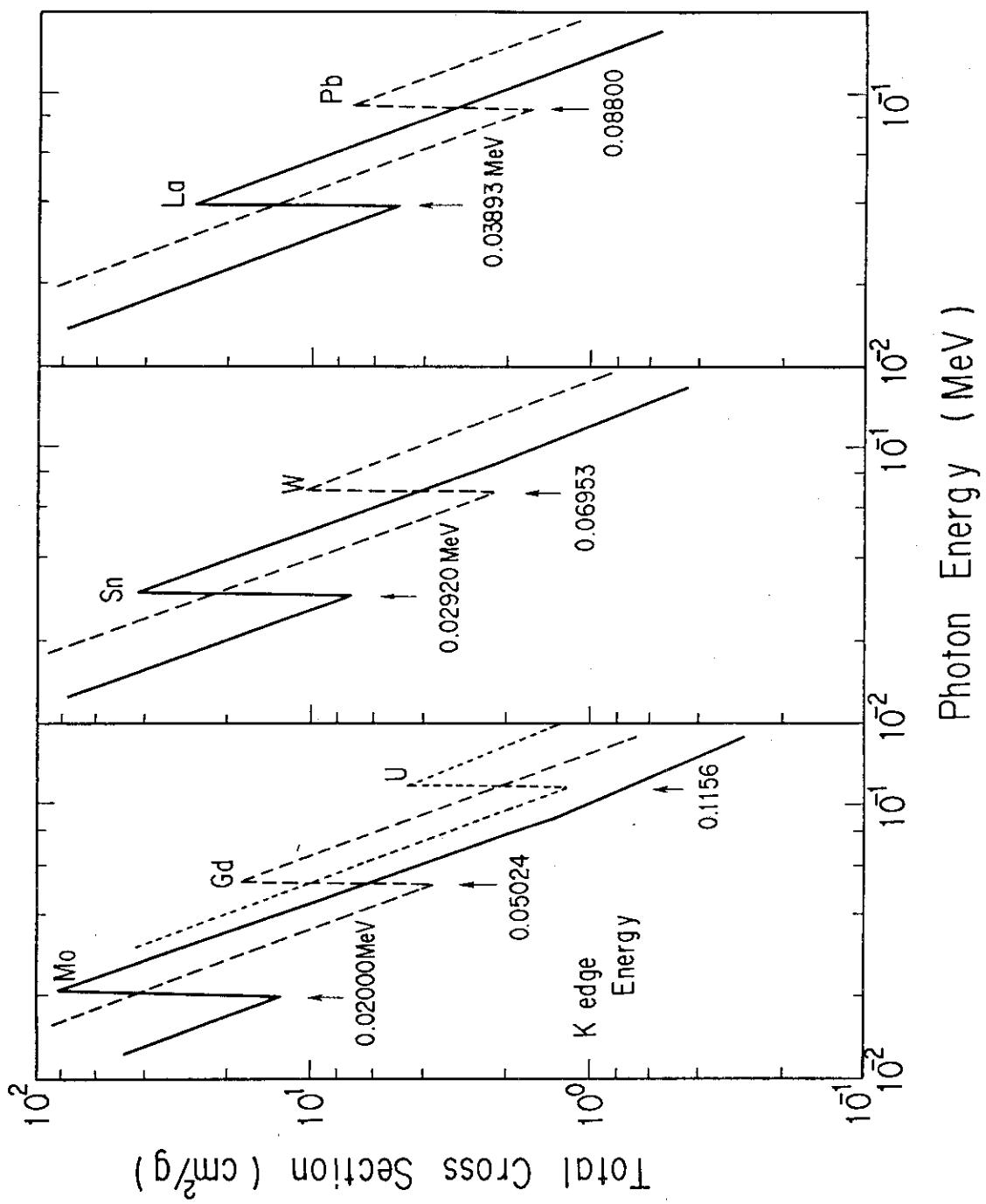


Fig. 1 Total cross section versus photon energy for several materials

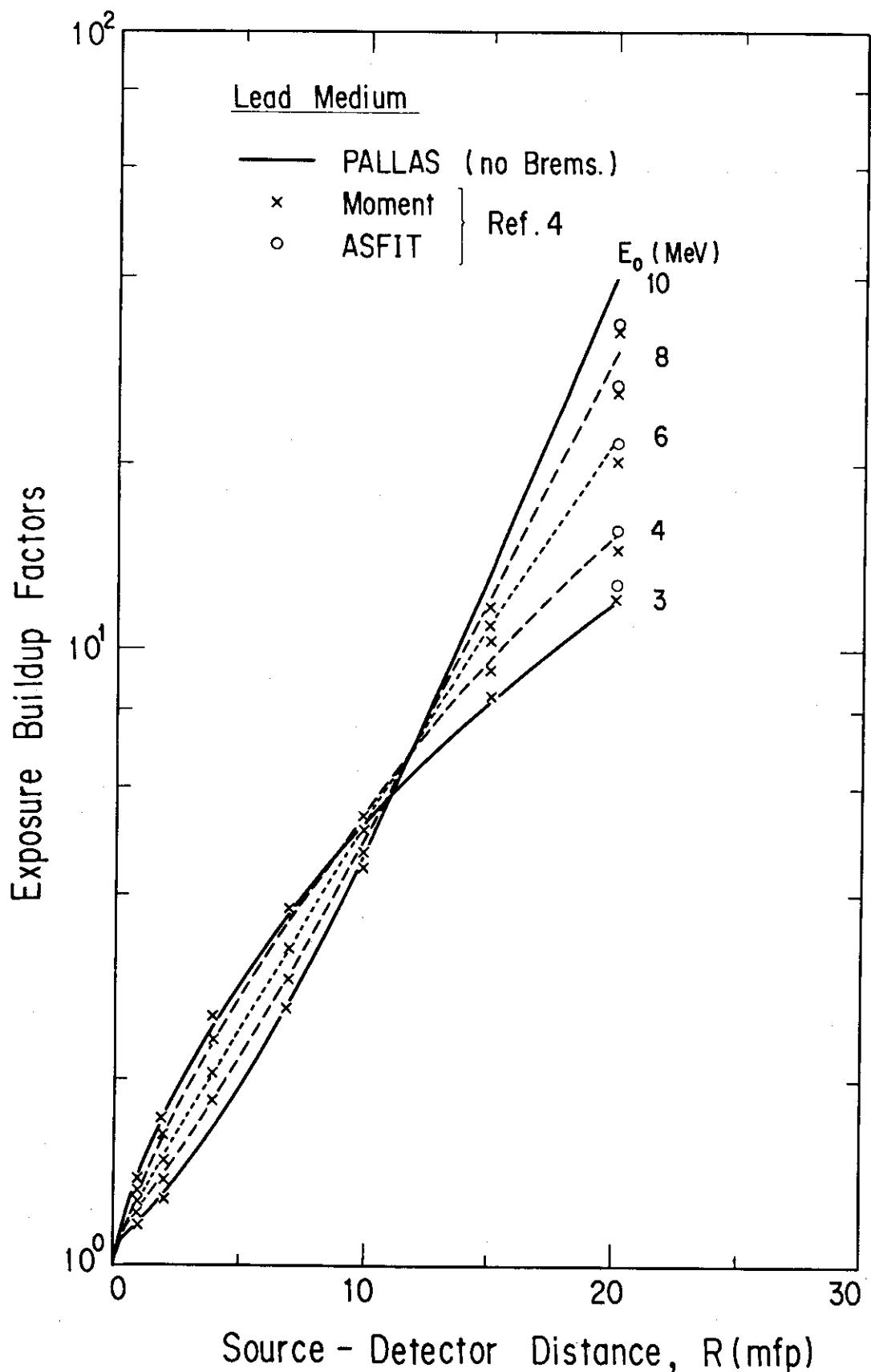


Fig. 2 Exposure buildup factors of lead medium via source-detector distance excluding the contribution of bremsstrahlung

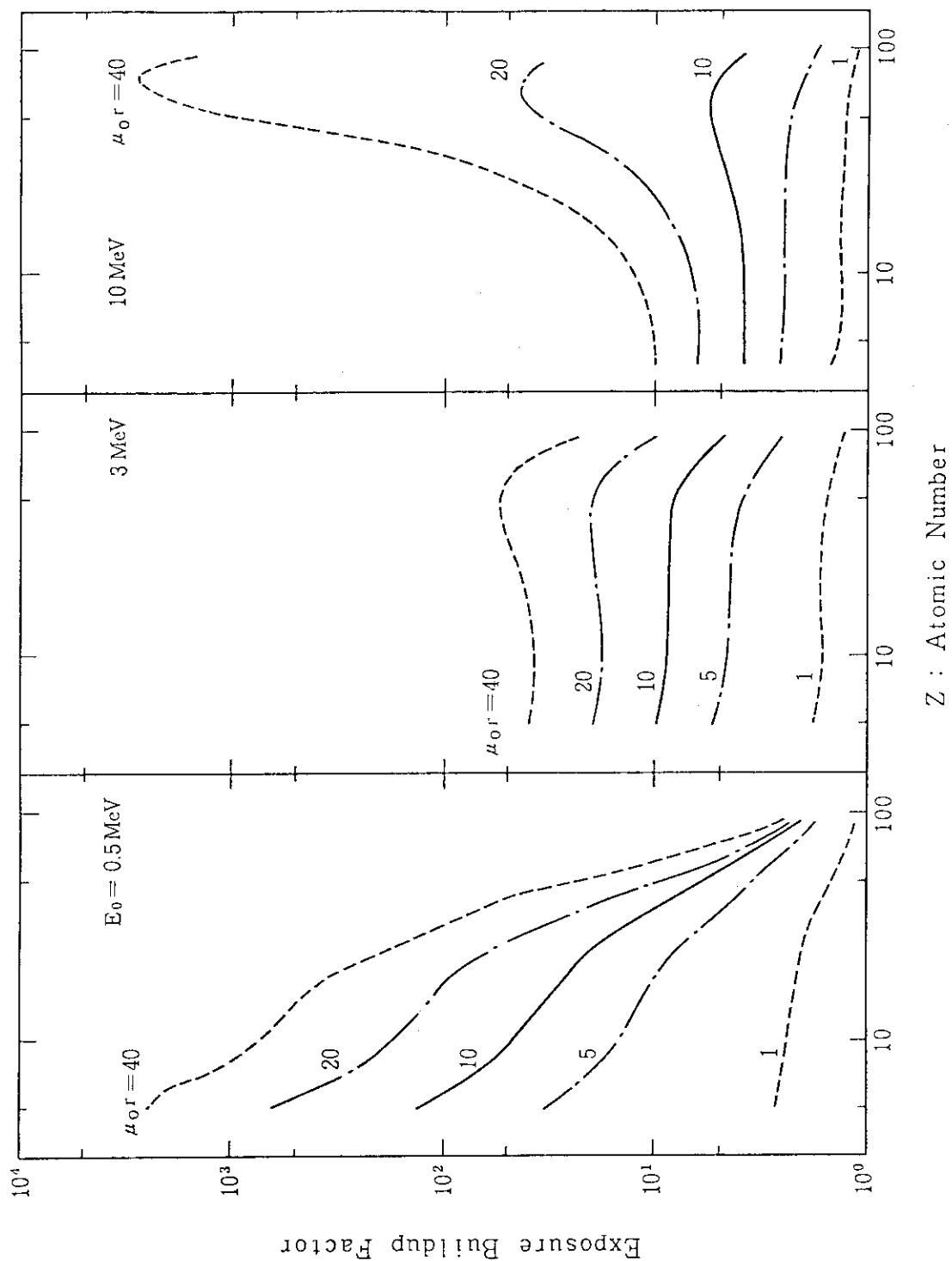


Fig. 3 Exposure buildup factor dependence on the atomic number