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Comparison of Stopping Power and Range Databases for Radiation Transport Study

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Abstract

The codes used to calculate stopping power and range for the space radiation shielding program at the Langley Research Center are based on the work of Ziegler but with modifications. As more experience is gained from experiments at heavy ion accelerators, prudence dictates a reevaluation of the current databases. Numerical values of stopping power and range calculated from four different codes currently in use are presented for selected ions and materials in the energy domain suitable for space radiation transport. This study of radiation transport has found that for most collision systems and for intermediate particle energies, agreement is less than 1 percent, in general, among all the codes. However, greater discrepancies are seen for heavy systems, especially at low particle energies.

1. Introduction

Both analytical and experimental approaches are needed when studying the transport of space radiation for the purpose of protecting astronauts and flight instruments. Experimental work is important because it serves as the ultimate verification, but it is expensive and time-consuming. Analytical (or computational) approaches, therefore, are needed as a tool to obtain the necessary information. One essentially tries to solve the Boltzmann transport equations (ref. 1) with proper boundary conditions and data input files, such as stopping power, ranges, nuclear fragmentation cross sections, nuclear absorption cross section. Accurate and reliable information about stopping powers and ranges is therefore important in the study of radiation transport. The purpose of this report is not to give an in-depth description of the physical mechanism nor the various computational models but rather to compare the numerical results generated by some of the codes currently in use and to establish how the results calculated with different codes differ from each other. The present code (referred to as the "LaRC code") is based on the work of Ziegler (refs. 2 to 7) with the heavy ion Thomas-Fermi scaling rule being used. However, modifications to Ziegler's basic method were made. Ziegler (Ziegler code) based his algorithm on a fit to experimental data, and for the present study we use it in the same domain. For extrapolations to other domains of interest, we made some exceptions to Ziegler's method. Bichsel (RSTAN and RSHEV codes) states that his parameters are based on more recent experimental data. The third and fourth sets of limited data are from the work of Hubert (Hubert code) (ref. 8) and Janni (Janni code) (ref. 9). The values of stopping power and range generated by these codes are presented for different pairs of particles and absorbers in different energy domains. In sections 2, 3, and 4, the basic definition and nomenclature of stopping power and range theory are discussed, and in section 5, the LaRC code is briefly described. In section 6, the numerical comparisons generated by different codes are briefly discussed.

2. General Theoretical Considerations

A fast charged particle traversing matter makes collisions and loses energy to atomic electrons and nuclei. An important difference in the loss mechanism is present if the medium is in a gas phase or in a condensed phase. In isolated atoms, the smallest energy losses are to discrete excited electronic states, and ionization occurs for energy transfer exceeding the binding energy of each atomic shell (ref. 10). When atoms are brought closer together to form a liquid or solid, their valence electrons are under the influence of the cores of surrounding atoms. A core consists of the nucleus and all the electrons inside the valence shell. For metals, the valence electrons form a conduction band where the electrons are nearly free. If a charged particle moves through the solid, the transfer of very small energies to the electrons by Rutherford scattering is not observed. Instead many thousands of valence electrons interact simultaneously with the particle, and this interaction leads to many bodies in excited states. For metals, this process is called a plasmon excitation; for insulators, a collective excitation.

For particles heavier than electrons, the collisions with absorber electrons and nuclei have different consequences. The electrons can receive large amounts of energy from the incident particle without causing significant deflections, whereas the nuclei absorb very little energy but cause scattering of the incident particle because of their greater mass. The deflection of the particle from its incident direction results mainly from elastic collisions with the nuclei. The scattering is confined to rather small angles; therefore, a heavy particle keeps a more or less straight path until it nears the end of its range.

The study of stopping power and range theory has attracted physicists for the nine decades since the days Madame Curie discovered radioactivity in materials. Hundreds of papers and dozens of review articles have been written on this vast subject. (See, e.g., refs. 10 to 22.) The stopping power is defined as the mean energy loss per unit path length $-dE/dx$. The range of a particle of given initial kinetic energy E_0 is defined as the mean path length traveled before coming to rest. In the continuous slowing-down approximation, the range $R(E_0)$ can be expressed as the integral over the reciprocal of stopping power from zero energy to E_0.

For speeds v greater than $c/137$, the basic loss mechanism is well understood, especially for light ions such as protons and alpha particles. The analytical predictions and experimental results agree within 3 percent. However, when the ion and/or the target are heavy or the incident energy is low, the calculations and experimental results begin to show larger discrepancies. At lower particle energies (i.e., at $v < c/137$), which are comparable with those of outer atomic electrons, capture and loss of electrons by the penetrating particle complicate its energy loss processes.

3. Basic Formula of Energy Loss

A particle of mass M_1 and charge Z_1e penetrates a material composed of atoms of atomic number Z_2 and atomic mass M_2. The projectile interacts via the electromagnetic force with the electrons and nuclei of the medium and via the strong nuclear force with the nuclei of the absorber. For thin absorbers, the nuclear force can be disregarded to first order because the ratio of the nuclear to atomic cross sections is very small ($\approx 10^{-8}$). The projectile slows down mainly by losing energy to the electrons of the absorbing medium. Different approaches to this energy loss lead to similar expressions. The commonly accepted model is the Bethe solution, and most recently developed approaches follow closely the Bethe approach by fine-tuning some of the parameters in the model.

Bethe's treatment (ref. 23) of the energy loss is based on the Born approximation applied to the collisions between the heavy particle and the atomic electrons. In this theory, the projectile heavy particle is assumed to be structureless, and the target nucleus is assumed infinitely massive. The differential cross section for a process in which the heavy particle transfers a given momentum to the atomic electrons is given by the square of the matrix element of the Coulomb interaction between appropriate initial and final states. Plane waves are used for the wave functions of the incident and scattered heavy particle. The initial state of the atom for the ground state is described by the unperturbed atomic wave function; for the final state, by the wave function for one of the excited states. Multiplying the cross section for a given energy loss by the energy loss and summing over all possibilities give the final expression for the average energy lost per atom. With relativistic and other correction terms (refs. 24, 25, and 26), the final equation can be written as

$$S = \frac{4\pi Z_1^2 Z_2 e^4}{mv^2} N \left\{ B_0 - \frac{C(\beta)}{Z_2} + Z_1 L_1(\beta) + Z_1^2 L_2(\beta) + \frac{1}{2}[G(M_1,\beta) - \delta(\beta)] \right\} \tag{1}$$

where

$$B_0 = \ln\left(\frac{2mc^2\beta^2\gamma^2}{I}\right) - \beta^2 \tag{2}$$

is the asymptotic stopping number, e is the electronic charge, N is the density of the atoms in the target, m is mass of electron, c is speed of light, $\beta = v/c$, and $\gamma^2 = 1/(1-\beta^2)$. Equation (1) serves as the common foundation of most theoretical treatments of stopping power.

The various parameters in equation (1) are considered next. The mean excitation energy I is treated as a property of each material defined by

$$\ln(I) = \sum_n f_n \ln(E_n) \tag{3}$$

where

$$f_n = \frac{2\pi E_n}{\hbar^2 Z_2} \left| \sum_j \langle n | x_j | 0 \rangle \right|^2 \tag{4}$$

is the dipole oscillator strength for the nth energy level and $\hbar = h/2\pi$ (where h is the Planck constant). Equation (4) satisfies the Thomas-Reiche-Kuhn sum rule

$$\sum_n f_n = 1 \tag{5}$$

However, Rustgi, Leung, and Long have shown that for the heavy systems, a sum-rule calculation in a semi-relativistic approach may lead to inaccurate results (refs. 27 and 28). The determination of I presents considerable difficulty because the most important excitation energies E_n lie in the range of 10 to 1000 eV where the oscillator strengths f_n are poorly known. Usually, the value of I is treated as an adjustable parameter determined empirically. For rough estimates of I, the approximation (ref. 29)

$$\left.\begin{aligned} I &\approx 11.7 + \frac{11.2}{Z_2} \text{ eV} \qquad (Z_2 \le 13) \\ I &\approx 9.5 \pm 1 \text{ eV} \qquad (Z_2 > 13) \end{aligned}\right\} \tag{6}$$

is useful, together with the Bragg rule for compounds and composite materials

$$n_e \ln(I) = \sum_i n_i \ln(I_i) \qquad (7)$$

where n_i is the electron density associated with element i and n_e is the average electron density.

In equation (1), the correction terms are as follows:

Shell correction: The asymptotic expression for the stopping power depends on the assumption that the speed of the incident heavy particle is much higher than that of the atomic electrons in their normal bound states. This approximation is inadequate, especially for the inner shell electrons of the heavy elements that move with much faster speeds. The correction $C(\beta)/Z_2$ is defined as an average over the contributions of the several shells, with $C = C_K + C_L + \cdots$. Each shell correction can be estimated by using hydrogenic wave functions (refs. 16, 26, 30, 31, and 32).

Barkas term: The term $L_1(\beta)$ arises from polarization of the target electrons by the incident particle. The Barkas effect is the difference in stopping power of heavy particles of opposite charge under otherwise equal conditions. Positively charged projectiles draw atomic electrons closer to them, whereas negatively charged projectiles repel electrons. The observation of the Barkas effect signaled the start of a general study of the departure of energy loss phenomena from the scaling law of the plane-wave Born approximation. These differences are alternatively called Z_1^3 effects because the theoretical accounts that have been developed to address this phenomenon treat terms to this order. Since the Z_1^3 term appears to arise from distortions of the target electron motion or wave function during the collision, it is also referred to as a “polarization effect.” So far, the status of experiment and theory does not provide a definite conclusion. The role of high-order terms in inner-shell ionization as the primary origin of the Barkas effect has been suggested. (See refs. 33 and 34.)

Bloch term: The term $L_2(\beta)$ arises from corrections to the approximation that for close collisions, the outgoing electrons can be represented by plane waves (refs. 33, 34, and 35). Bloch considered an intermediate impact parameter b_1, and assumed that the electrons confined to the interior of a cylinder of radius b_1 cannot be represented by plane waves. This assumption introduces transverse momentum components that interfere with one another under the influence of the scattering potential; this results in the Bloch correction term

$$Z_1^2 L_2(\beta) = -y^2 \sum_{j=1}^{\infty} \frac{1}{j(j^2 + y^2)} \qquad (8)$$

where $y = Z_1\alpha/\beta$ and the fine structure constant α equals 1/137.04.

Mott term: The term $G(M_1,\beta)$ is a kinematic recoil correction, which becomes important for relativistic projectiles. For a spinless nucleus, the correction is (ref. 21)

$$G(M_1,\beta) = \ln(1 + 2t) - \frac{t\beta^2}{\gamma^2} \qquad (9)$$

where $t = m\gamma/M_1$.

Density correction: The term $\delta(\beta)$ arises from the dielectric response of a solid absorber as a whole to the electric field generated by the projectile and the work done by the interaction. Sternheimer (ref. 36) and Sternheimer and Peierls (ref. 37) have given the expressions as well as the parameters to be used in an approximation for the density effect correction. Shinn et al. (ref. 38) have taken the asymptotic expression suggested by Sternheimer as a correction in the LaRC code.

Other corrections: The corrections in equation (2) may not be independent. For example, Basbas (ref. 33) has suggested that to separate B_0 from L_1 and L_2 may not be plausible. In addition to the corrections mentioned previously, other important corrections at ultrarelativistic velocities include (1) radiative correction, (2) projectile structure correction (represented by the nuclear form factor), and (3) bremsstrahlung and pair production.

At small projectile energies, the various correction terms in equation (2) become large compared with B_0. In particular, for $2mv^2 = I$, B_0 becomes zero. For example, as pointed out by Bichsel (ref. 26) for α particles impinging on uranium (I = 840 eV), B_0 equals 0 at E_0 = 1.5 MeV, and S consists only of correction terms. For smaller energies, an empirical approach is used to describe S. Heavy ions at small energies have electrons attached and thus have a reduced charge $Z_1^* < Z_1$. If Z_1^* is defined to give the correct observed stopping power, it is not equal to the mean charge per particle of a beam leaving an absorber. An equation commonly used for the effective charge has been published in references 39 and 40 and is

$$\frac{Z_1^*}{Z_1} = 1 - \exp(-1.316x + 0.1112x^2 - 0.0650x^3) \quad (10)$$

where $x = 100\beta/Z_1^{2/3}$.

In the LaRC code, the following formula proposed by Barkas (ref. 41) has been used:

$$\frac{Z_1^*}{Z_1} = 1 - \exp(-1.25x) \quad (11)$$

The difference in Z_1^* in equations (10) and (11) is no more than 2 percent for all speeds and Z_2. Hubert, Bimbot, and Gauvin published another effective charge parameterization formula (ref. 8), which depends on both Z_1 and target charge number Z_2.

4. Range-Energy Relations

The mean path length in the continuous slowing-down approximation (CSDA) is defined as

$$R(E_0) = \int_{E_{\min}}^{E_0} S^{-1}\, dE \quad (12)$$

where $E_{\min}$ is the thermal energy of the particle. For practical purpose, $E_{\min}$ can be set to zero.

5. Description of LaRC code

An outline of the procedures used in the LaRC code is given in this section with energy E in kiloelectron volts.

5.1. Electronic Stopping Power for Protons

In the LaRC code, which follows the approach of Ziegler, the section that evaluates the stopping power of protons is generated in subroutine ATOPP. The modified Ziegler results are used as follows:

$$S_p = \begin{cases} a_1\sqrt{E} & (0 \le E \le 10 \text{ keV}) \\ \dfrac{S_L S_H}{(S_L + S_H)} & (10 \text{ keV} \le E \le 999 \text{ keV}) \\ \dfrac{a_6}{\beta^2}\left[\ln\left(\dfrac{a_7\beta^2}{1-\beta^2}\right) - \beta^2 - C - \dfrac{\delta}{2}\right] & (1000 \text{ keV} \le E) \end{cases} \quad (13)$$

where

$$S_L = a_2 E^{0.45} \quad (14)$$

$$S_H = \frac{a_3}{E}\ln\left(1 + \frac{a_4}{E} + a_5 E\right) \quad (15)$$

$$C = \sum_{i=1}^{5} a_{7+i}[\ln(E)]^{i-1}\left\{1 - \exp\left[-2\left(\frac{10^5}{E}\right)^2\right]\right\} \quad (16)$$

where Ziegler's parameter a_i is used and δ equals the density effect obtained from the Sternheimer asymptotic form. In equations (13), in the high-energy expression, the density effect and the post factor in equation (16) (the term in braces, that is, $\{1 - \exp[-2(10^5/E)^2]\}$) have been added to the Ziegler expression. This post factor was chosen so that shell correction vanishes for large *E*. (See section 4 in ref. 17.) The coefficients $a_1, a_2, \ldots, a_{12}$ can be found in tables 1 and 2 in reference 13.

5.2. Electronic Stopping Power for α Particles

In the LaRC code, the section that evaluates the stopping power of α particles is generated in subroutine ATOPA with the following algorithms:

$$S_\alpha = \begin{cases} a_1 E^{a_2} & (E \le 1 \text{ keV}) \\ \dfrac{S_L S_H}{(S_L + S_H)} & (1 \text{ keV} \le E \le 10^4 \text{ keV}) \\ S_1 & (10^4 \text{ keV} \le E \le 2\times10^4 \text{ keV}) \\ \left[1 - \dfrac{E - (2\times10^4)}{2\times10^4}\right]S_1 + \left[\dfrac{E-(2\times10^4)}{2\times10^4}\right]4S_p & (2\times10^4 \text{ keV} \le E \le 4\times10^4 \text{ keV}) \\ 4S_p & (E \ge 4\times10^4 \text{ keV}) \end{cases} \quad (17)$$

where

$$S_L = a_1 E^{a_2} \quad (18)$$

$$S_H = \frac{10^3 a_3}{E}\ln\left(1 + \frac{10^3 a_4}{E} + a_5\frac{E}{10^3}\right) \quad (19)$$

$$S_1 = \exp\left\{a_6 + a_7\ln\left(\frac{1000}{E}\right) + a_8\left[\ln\left(\frac{1000}{E}\right)\right]^2 + a_9\left[\ln\left(\frac{1000}{E}\right)\right]^3\right\} \quad (20)$$

The coefficients $a_1, a_2, ..., a_9$ for the α particle are from reference 5. Ziegler's coefficients are for the phase of material where experiments were performed except for hydrogen where values for the condensed phase are used. The term S_p is simply the proton stopping power at the corresponding speed.

5.3. Electronic Stopping Power for Other Ions

The scaling scheme from the stopping power of the α particle was adopted to obtain the ion stopping power in subroutine SIONA by

$$S_{\text{ion}} = \frac{(Z^*_{\text{ion}})^2}{(Z^*_{\alpha})^2} S_{\alpha} \tag{21}$$

where S_α is the stopping power of α particles and Z^* is the effective charge defined in equation (11).

5.4. Nuclear Stopping Power

In the LaRC code, the section that evaluates the stopping power of incident ion due to the screened Coulombic potential of the target nucleus is generated as ATOPN. The treatment of Ziegler is followed in expressing the universal nuclear stopping power in terms of reduced energy and universal screen length. (See ref. 2.)

6. Numerical Results

Proton stopping power results generated by the LaRC code and the results published in reference 4 (from the multivolume work edited by Ziegler) are presented for nine targets at a low energy of 0.01 MeV to a medium energy of 100 MeV, where Ziegler's table ends. Although some modifications to Ziegler's parameters were made, such as density effect and cutoff factor, the numerical differences in these energy ranges are small; thus, a numerical comparison is not presented. However, the differences are expected to increase as ultrarelativistic energies are approached. Ziegler's results would have a logarithmic divergence behavior which is not physical, whereas the present results clearly have been properly corrected by the cutoff factor in equation (16). Next the contribution of the density effect correction to the total stopping power was explored. The formalism of Sternheimer (ref. 36) as implemented by Shinn et al. (ref. 38) was adopted; however, only the asymptotic expression, which is much easier to implement, was used. Armstrong and Alsmiller (ref. 42) have shown overestimation by using the asymptotic formula because the value of the density effect is no more than 6 percent. Slight inaccuracies in a small correction are assumed to have negligible influence and can be tolerated. The data in table 1 clearly show when the density effect contributes appreciably as a function of impinging energy. At extremely high energies, for example, beyond 500 GeV, the data in table 1 suggest that density effect could make more than a 20-percent contribution to the total stopping power.

In table 2, the present results and the stopping power values of Janni are given. He used a different scheme for the corrections. For the shell correction, he obtained a total correction by calculating the correction of each subshell and then summing the results. For the density effect, the correction was calculated from first principles for each material from the fundamental equations; the material independent term was not included. The adjusted ionization potentials were determined in a weighted least-squares analysis by fitting the Bethe equation to the experimental data. In the low-energy region, a different fit of experimental data was used including nuclear stopping. In table 2, when comparing the data from the LaRC and Janni codes, good agreement is found with the proton energy above 40 keV except when iron is the target. Then a consistent discrepancy of 5 to 10 percent throughout the whole energy range is seen. Also, the difference between the two results can go as high as 30 percent at the low-energy end (10 keV).

In tables 3, 4, and 5, the results from the LaRC and the Hubert codes are presented. The tables of Hubert, Bimbot, and Gauvin (ref. 8), whose scheme includes a more elaborate effective charge parameterization formula that includes a dependence on Z_2 (the target atomic number), are used. Hubert claims that the dependence is necessary in order to be able to reproduce the whole set of experimental stopping powers. From tables 3, 4, and 5, for the limited systems and the energy specified, which lacks low energies, however, the two results seem to agree very well.

The results of the LaRC and Bichsel codes are presented in tables 6 to 11. Because Bichsel states that his code is only reliable for $E/A > 2.5$ MeV/nucleon and for $Z_1 < 20$, the low-energy data are questionable; these data should be disregarded in tables 6 to 11. For the space radiation transport studies, p, α, C, Ca, Ar, and Fe were used as the projectile ions; C, Cu, Au, U, and H_2O, as the targets. The energy range is from ≈2 MeV to ≈50 GeV, depending upon the collision partners. In fact, two slightly different versions of the Bichsel code were used: RSTAN and RSHEV. In the RSTAN code, Bichsel uses the K- and L-shell corrections originally derived by Walske with the nonrelativistic hydrogen approximation (refs. 31 and 32), and he further uses the scaling procedure on the L-shell for the outer shells, whereas in RSHEV he uses the separate subshell corrections for three L-subshells, five M-subshells, and the scaling procedure for the outer shells (N, O, and P). The RSHEV code is supposedly more suitable for heavier targets because of more detailed shell correction treatment. Which code was used is clearly stated in tables 6 to 11. The RSHEV code was used for targets Au and U and all projectiles except Fe, and the RSTAN code was used for Fe projectiles and targets Au and U simply because it generated better agreement. The reason for this better agreement is not clear. Tables 6 to 11 are arranged according to weight of the projectile and the target; the last target, water, is a compound. Table 6 gives stopping powers which show good agreement, especially for lighter targets. The range values show greater difference because of the larger difference in stopping values in the low-energy domain, which contributes to the range values through integration. In tables 6 to 11, as the projectile gets heavier, in general, the agreement gets worse with the Fe-U system being the worst (table 11(e)). At a total energy of 145.60 MeV (2.6 MeV/nucleon), the difference can be as high as 35 percent in stopping power and 43 percent in range values. Of course, the discrepancy is expected as the colliding system gets heavier; this implies that the physics involved becomes more complicated. However, judging from tables 5, 11(d), and 11(e), for iron as the projectile, the results indicate that the LaRC code agrees better with the Hubert code than with the Bichsel RSTAN code. Sometimes, the range values calculated at low energy by Bichsel show negative results (e.g., in table 10(c)) which of course are the result of an interpolation error.

7. Concluding Remarks

With four different codes, a numerical comparison of stopping power for selected collision pairs of materials covering a wide range of energies was performed. The purpose of this study was to survey the currently available stopping power and range prediction codes and to reassess the present databases in the Langley transport code. For the lighter projectiles, such as protons and alpha particles, in a wide energy domain, the agreement is fairly good for light targets. The discrepancy is less than 3 percent for stopping power values but is a little worse for range values. As the target becomes heavier, in general the discrepancy gets worse, especially for low energies. Based on this numerical exercise, the stopping power and range databases used in the Langley transport code are still acceptable for most impact energies and in most of the collision systems. For the extremely low energies and extremely heavy systems, further experimental data are needed for the databases.

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Table 1. Stopping Power Calculated by LaRC Code for Protons on Various Targets

(a) Target, ^{4}He; atomic density, 189×10^{22} atoms/cm^2

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	2.11	2.11	0.0
2	1.95	1.95	0.0
3	1.95	1.95	0.0
4	1.98	1.98	0.0
5	2.01	2.01	0.0
8	2.11	2.11	0.0
9	2.14	2.12	0.7
20	2.36	2.22	5.6
50	2.62	2.36	10.2
90	2.80	2.45	12.7
100	2.83	2.46	13.1
200	3.04	2.57	15.7
500	3.32	2.71	18.6
600	3.38	2.73	19.1
700	3.43	2.76	19.5

(b) Target, ^{7}Li; atomic density, 4.60×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.80	1.80	0.0
2	1.66	1.66	0.0
4	1.69	1.69	0.0
6	1.76	1.72	2.0
8	1.81	1.74	3.8
90	1.84	1.75	4.5
20	2.02	1.84	9.0
40	2.20	1.93	12.3
60	2.30	1.98	14.1
80	2.38	2.02	15.2
90	2.41	2.03	15.6
100	2.43	2.04	16.0
200	2.62	2.14	18.4
400	2.80	2.23	20.5
500	2.86	2.26	21.1
800	2.98	2.32	22.3

Table 1. Continued

(c) Target, ^{9}Be; atomic density, 1.21×10^{23} atoms /cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.80	1.80	0.0
2	1.67	1.67	0.0
4	1.70	1.66	2.1
6	1.76	1.68	4.7
8	1.82	1.70	6.5
9	1.85	1.71	7.2
20	2.04	1.80	11.5
40	2.22	1.89	14.7
60	2.32	1.95	16.3
80	2.40	1.98	17.4
90	2.43	2.00	17.9
100	2.46	2.01	18.2
200	2.65	2.11	20.5
400	2.84	2.20	22.4
600	2.95	2.26	23.5
800	3.03	2.30	24.2
1000	3.09	2.32	24.7

(d) Target, ^{12}C; atomic density, 1.14×10^{23} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.98	1.98	0.0
2	1.84	1.84	0.0
5	1.92	1.85	3.3
8	2.02	1.89	6.3
20	2.26	2.00	11.4
40	2.46	2.10	14.7
50	2.53	2.13	15.6
80	2.67	2.20	17.4
90	2.71	2.22	17.9
100	2.74	2.24	18.2
200	2.95	2.34	20.5
500	3.23	2.48	23.1
800	3.37	2.55	24.2

Table 1. Continued

(e) Target, ^{20}Ne; atomic density, 3.59×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.85	1.85	0.0
2	1.73	1.73	0.0
4	1.77	1.77	0.0
5	1.81	1.81	0.0
8	1.91	1.91	0.0
9	1.94	1.94	0.2
20	2.15	2.03	5.5
50	2.42	2.17	10.5
80	2.56	2.24	12.6
100	2.63	2.27	13.6
200	2.84	2.37	16.3
500	3.11	2.51	19.3

(f) Target, ^{27}Al; atomic density, 6.02×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.77	1.77	0.0
2	1.65	1.65	0.0
5	1.74	1.74	0.0
6	1.77	1.77	0.0
9	1.86	1.82	2.1
20	2.07	1.92	7.2
50	2.33	2.05	12.1
80	2.47	2.12	14.2
90	2.50	2.13	14.7
500	3.00	2.39	20.6
600	3.06	2.41	21.1

Table 1. Continued

(g) Target, ^{56}Fe; atomic density, 8.99×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.53	1.53	0.0
2	1.43	1.43	0.0
4	1.48	1.48	0.0
8	1.60	1.58	1.3
9	1.63	1.59	2.2
20	1.82	1.68	7.5
50	2.06	1.80	12.5
80	2.18	1.86	14.7
100	2.24	1.89	15.6
200	2.43	1.99	18.2
500	2.68	2.11	21.2
800	2.81	2.18	22.5

(h) Target, ^{63}Cu; atomic density, 8.48×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.55	1.55	0.0
2	1.46	1.46	0.0
5	1.55	1.55	0.0
8	1.64	1.63	0.3
9	1.67	1.65	1.2
20	1.86	1.74	6.7
40	2.05	1.83	10.7
80	2.24	1.93	14.1
100	2.30	1.96	15.0
200	2.49	2.05	17.7
500	2.75	2.18	20.7

Table 1. Continued

(i) Target, ^{107}Ag; atomic density, 5.85 $\times 10^{22}$ atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.42	1.42	0.0
2	1.34	1.34	0.0
4	1.39	1.39	0.0
6	1.46	1.46	0.0
9	1.54	1.54	0.0
20	1.73	1.65	4.5
40	1.91	1.74	8.8
60	2.01	1.79	11.0
80	2.09	1.83	12.4
100	2.15	1.86	13.4
200	2.33	1.95	16.3
400	2.52	2.04	18.8
800	2.70	2.14	20.9

(j) Target, ^{132}Xe; atomic density, 1.40 $\times 10^{22}$ atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.33	1.33	0.0
2	1.25	1.25	0.0
4	1.30	1.30	0.0
6	1.37	1.37	0.0
8	1.42	1.42	0.0
20	1.63	1.63	0.0
40	1.79	1.72	3.9
60	1.89	1.77	6.3
80	1.96	1.81	7.9
100	2.02	1.84	9.1
200	2.19	1.92	12.3
400	2.37	2.01	15.1
500	2.42	2.04	15.9
800	2.54	2.10	17.5
1000	2.60	2.12	18.2

Table 1. Continued

(k) Target, ^{197}Au; atomic density, 5.90×10^{22} atoms/cm^3

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.23	1.23	0.0
2	1.16	1.16	0.0
5	1.25	1.25	0.0
9	1.36	1.36	0.0
20	1.53	1.49	2.9
50	1.75	1.60	8.8
80	1.86	1.65	11.3
90	1.89	1.67	11.9
100	1.92	1.68	12.4
200	2.09	1.76	15.5
500	2.31	1.88	18.9

(l) Target, ^{208}Pb; atomic density, 3.29×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.21	1.21	0.0
2	1.15	1.15	0.0
4	1.20	1.20	0.0
6	1.26	1.26	0.0
8	1.32	1.32	0.0
20	1.51	1.50	0.7
40	1.67	1.58	5.5
60	1.77	1.63	7.9
80	1.84	1.66	9.5
90	1.87	1.68	10.1
100	1.89	1.69	10.7
200	2.06	1.77	13.9
400	2.23	1.86	16.6
600	2.33	1.91	18.0
800	2.40	1.94	18.9
1000	2.45	1.97	19.6

Table 1. Concluded

(m) Target, ^{238}U; atomic density, 4.82×10^{22} atoms/cm^3

Energy, GeV	Stopping power, MeV-cm^2/g		Difference, percent
	Without density correction	With density correction	
1	1.17	1.17	0.0
2	1.11	1.11	0.0
4	1.16	1.16	0.0
6	1.22	1.22	0.0
8	1.27	1.27	0.0
20	1.46	1.44	1.8
40	1.62	1.51	6.5
50	1.67	1.54	7.9
60	1.71	1.56	8.9
80	1.78	1.60	10.5
100	1.83	1.62	11.6
200	2.00	1.70	14.8
400	2.16	1.78	17.4
600	2.26	1.83	18.8
800	2.33	1.87	19.7
1000	2.38	1.89	20.4

Table 2. Stopping Power Calculated by LaRC and Janni Codes for Protons on Various Targets

(a) Target, ^{4}He

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	212.59	198.88	−6.9
0.01	592.13	530.25	−11.7
0.04	988.43	983.77	−0.5
0.07	1091.48	1089.80	−0.2
0.10	1079.06	1059.90	−1.8
0.40	542.19	553.46	2.0
0.70	362.74	381.41	4.9
1.00	286.52	290.43	1.4
4.00	96.66	97.88	1.3
7.00	61.26	61.97	1.1
10.00	45.67	46.17	1.1
40.00	14.54	14.67	0.9
70.00	9.29	9.36	0.8
100.00	7.06	7.12	0.8
400.00	2.91	2.93	0.8
700.00	2.32	2.34	0.8
1000.00	2.11	2.12	0.3
4000.00	1.98	1.99	0.6
7000.00	2.08	2.09	0.6
10000.00	2.14	2.18	2.0

(b) Target, ^{7}Li

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	139.10	126.38	−10.1
0.01	392.06	374.78	−4.6
0.04	661.91	678.26	2.4
0.07	740.47	756.68	2.1
0.10	741.29	751.89	1.4
0.40	414.16	418.37	1.0
0.70	290.23	285.45	−1.7
1.00	229.24	223.97	−2.4
4.00	80.61	78.72	−2.4
7.00	51.51	50.20	−2.6
10.00	38.54	37.54	−2.7
40.00	12.36	12.06	−2.5
70.00	7.90	7.72	−2.3
100.00	6.01	5.88	−2.1
400.00	2.48	2.44	−1.9
700.00	1.98	1.95	−1.8
1000.00	1.80	1.77	−1.7
4000.00	1.69	1.64	−3.1
7000.00	1.73	1.71	−1.3
10000.00	1.76	1.76	−0.1

Table 2. Continued

(c) Target, ^{9}Be

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	164.86	128.53	−28.3
0.01	479.96	412.43	−16.4
0.04	697.98	673.18	−3.7
0.07	676.52	702.85	3.8
0.10	629.82	684.02	7.9
0.40	376.14	400.93	6.2
0.70	274.36	282.75	3.0
1.00	218.90	222.86	1.8
4.00	78.50	78.71	0.3
7.00	50.40	50.32	−0.1
10.00	37.80	37.68	−0.3
40.00	12.22	12.16	−0.5
70.00	7.83	7.80	−0.4
100.00	5.96	5.94	−0.4
400.00	2.47	2.47	−0.3
700.00	1.98	1.97	−0.5
1000.00	1.80	1.79	−0.9
4000.00	1.66	1.63	−2.0
7000.00	1.69	1.69	−0.3
10000.00	1.72	1.73	0.4

(d) Target, ^{12}C

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	145.69	123.66	−17.8
0.01	421.85	400.88	−5.2
0.04	697.19	683.14	−2.1
0.07	753.11	740.10	−1.8
0.10	729.71	734.25	0.6
0.40	399.32	423.04	5.6
0.70	288.25	288.05	−0.1
1.00	228.96	229.27	0.1
4.00	83.68	84.98	1.5
7.00	54.12	54.84	1.3
10.00	40.76	41.26	1.2
40.00	13.32	13.43	0.8
70.00	8.56	8.63	0.8
100.00	6.53	6.58	0.8
400.00	2.72	2.74	0.7
700.00	2.18	2.19	0.7
1000.00	1.98	2.00	0.6
4000.00	1.84	1.89	2.2
7000.00	1.88	1.97	4.8
10000.00	1.91	2.03	5.9

Table 2. Continued

(e) Target, ^{20}Ne

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	67.51	52.22	–29.3
0.01	187.71	160.43	–17.0
0.04	331.72	321.52	–3.2
0.07	398.46	395.97	–0.6
0.10	429.75	426.00	–0.9
0.40	317.88	311.63	–2.0
0.70	230.22	219.65	–4.8
1.00	188.60	183.64	–2.7
4.00	72.59	73.04	0.6
7.00	47.61	47.98	0.8
10.00	36.14	36.44	0.8
40.00	12.09	12.18	0.7
70.00	7.83	7.88	0.7
100.00	5.99	6.03	0.6
400.00	2.52	2.54	0.6
700.00	2.03	2.04	0.5
1000.00	1.85	1.86	0.5
4000.00	1.77	1.78	0.4
7000.00	1.88	1.89	0.4
10000.00	1.95	1.97	1.3

(f) Target, ^{27}Al

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	99.88	77.84	–28.3
0.01	296.03	253.92	–16.6
0.04	463.98	4316.18	–6.4
0.07	471.91	449.58	–5.0
0.10	446.91	431.00	–3.7
0.40	284.76	276.94	–2.8
0.70	215.58	213.16	–1.1
1.00	172.50	171.58	–0.5
4.00	67.46	67.67	0.3
7.00	44.51	44.68	0.4
10.00	33.90	34.04	0.4
40.00	11.46	11.50	0.3
70.00	7.44	7.46	0.3
100.00	5.70	5.72	0.2
400.00	2.41	2.41	0.2
700.00	1.94	1.94	–0.0
1000.00	1.77	1.77	–0.3
2000.00	1.65	1.63	–1.1
4000.00	1.70	1.66	–2.5
5000.00	1.74	1.68	–3.2
6000.00	1.77	1.71	–3.8
8000.00	1.81	1.75	–3.7
9000.00	1.82	1.76	–3.3
10000.00	1.83	1.78	–3.0

Table 2. Continued

(g) Target, ^{56}Fe

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	39.43	36.26	−8.7
0.01	115.24	122.24	5.7
0.04	205.74	210.21	2.1
0.07	248.69	252.80	1.6
0.10	269.58	276.65	2.6
0.40	203.03	226.03	10.2
0.70	150.39	159.23	5.6
1.00	124.62	130.60	4.6
4.00	52.41	55.08	4.8
7.00	35.34	37.22	5.0
10.00	27.24	28.73	5.2
40.00	9.53	10.06	5.3
70.00	6.25	6.60	5.3
100.00	4.82	5.08	5.2
400.00	2.06	2.18	5.3
700.00	1.66	1.76	5.2
1000.00	1.53	1.61	5.1
4000.00	1.48	1.52	2.6
7000.00	1.57	1.59	0.9
10000.00	1.61	1.64	2.1

(h) Target, ^{63}Cu

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	38.20	31.39	−21.7
0.01	112.20	103.24	−8.7
0.04	194.08	180.84	−7.3
0.07	223.22	205.36	−8.7
0.10	231.11	215.52	−7.2
0.40	181.62	179.95	−0.9
0.70	144.66	140.54	−2.9
1.00	119.52	118.18	−1.1
4.00	51.50	51.52	0.0
7.00	34.98	35.03	0.2
10.00	27.06	27.10	0.2
40.00	9.58	9.59	0.2
70.00	6.30	6.30	0.1
100.00	4.86	4.86	0.0
400.00	2.09	2.09	0.0
700.00	1.69	1.69	0.0
1000.00	1.55	1.55	−0.1
4000.00	1.51	1.48	−2.0
7000.00	1.61	1.55	−4.2
10000.00	1.66	1.60	−3.7

Table 2. Continued

(i) Target, ^{107}Ag

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	33.12	28.96	−14.4
0.01	100.21	96.71	−3.6
0.04	173.15	163.98	−5.6
0.07	197.32	181.06	−9.0
0.10	201.38	186.16	−8.2
0.40	145.24	146.52	0.9
0.70	114.87	113.17	−1.5
1.00	92.50	92.75	0.3
4.00	42.22	42.33	0.3
7.00	29.36	29.44	0.3
10.00	23.02	23.11	0.4
40.00	8.46	8.47	0.2
70.00	5.62	5.62	0.1
100.00	4.36	4.36	−0.0
400.00	1.90	1.90	−0.1
700.00	1.54	1.54	−0.1
1000.00	1.42	1.42	−0.2
4000.00	1.39	1.36	−2.5
7000.00	1.49	1.43	−4.1
10000.00	1.56	1.49	−5.3

(j) Target, ^{132}Xe

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	30.73	34.48	10.9
0.01	93.80	103.40	9.3
0.04	164.95	217.83	24.3
0.07	192.51	241.46	20.3
0.10	200.31	234.67	14.6
0.40	143.37	140.35	−2.2
0.70	113.90	102.47	−11.2
1.00	85.43	84.72	−0.8
4.00	38.90	38.72	−0.5
7.00	27.10	27.05	−0.2
10.00	21.27	21.21	−0.3
40.00	7.86	7.86	−0.0
70.00	5.23	5.22	−0.3
100.00	4.07	4.05	−0.4
400.00	1.78	1.77	−0.4
700.00	1.44	1.44	−0.3
1000.00	1.33	1.33	−0.2
4000.00	1.30	1.30	−0.1
7000.00	1.40	1.40	−0.1
10000.00	1.47	1.47	−0.1

Table 2. Continued

(k) Target, ^{197}Au

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	15.59	14.53	–7.3
0.01	47.44	47.16	–0.6
0.04	85.94	85.32	–0.7
0.07	105.77	99.85	–5.9
0.10	116.85	107.53	–8.7
0.40	96.92	94.84	–2.2
1.00	63.75	62.99	–1.2
4.00	31.70	31.87	0.5
7.00	22.64	22.75	0.5
10.00	18.01	16.07	–12.1
40.00	6.93	6.92	–0.2
70.00	4.67	4.65	–0.4
100.00	3.66	3.63	–1.0
400.00	1.63	1.61	–1.1
700.00	1.33	1.32	–0.9
1000.00	1.23	1.22	–0.9
4000.00	1.63	1.61	–1.9
7000.00	1.31	1.27	–3.4
8000.00	1.33	1.29	–3.8
10000.00	1.38	1.32	–4.6

(l) Target, ^{208}Pb

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	16.15	12.84	–25.7
0.01	49.36	40.05	–23.2
0.04	89.40	85.18	–5.0
0.07	109.96	111.70	1.6
0.10	121.49	122.89	1.1
0.40	99.75	98.30	–1.5
0.70	75.33	76.45	1.5
1.00	63.02	63.94	1.4
4.00	31.20	31.45	0.8
7.00	22.30	22.30	–0.0
10.00	17.76	17.75	–0.1
40.00	6.83	6.80	–0.6
70.00	4.60	4.57	–0.6
108.00	3.61	3.57	–1.0
400.00	1.61	1.59	–1.3
700.00	1.31	1.30	–1.1
1000.00	1.21	1.20	–1.0
4000.00	1.20	1.18	–1.8
7000.00	1.29	1.25	–2.9
10000.00	1.36	1.31	–3.9

Table 2. Concluded

(m) Target, ^{238}U

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Janni code	
0.001	19.00	16.71	−13.7
0.01	58.74	54.26	−8.3
0.04	105.97	99.94	−6.0
0.07	129.07	117.17	−10.2
0.10	140.73	123.34	−14.1
0.40	101.75	95.28	−6.8
0.70	73.09	73.57	0.7
1.00	60.71	61.53	1.3
4.00	29.57	29.56	−0.0
7.00	21.15	21.17	0.1
10.00	16.85	16.81	−0.2
40.00	6.52	6.52	0.1
70.00	4.40	4.39	−0.1
108.00	3.45	3.44	−0.4
400.00	1.55	1.53	−0.7
700.00	1.26	1.25	−0.6
1000.00	1.17	1.16	−0.5
4000.00	1.16	1.14	−1.4
7000.00	1.25	1.22	−2.4
10000.00	1.32	1.27	−3.3

Table 3. Stopping Power Calculated by LaRC and Hubert Codes for α Particles on Various Targets

(a) Target, ^{12}C

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
10	477.18	477.60	0.1
16	736.19	336.40	0.1
20	283.10	283.30	0.1
26	220.10	230.60	0.2
32	l94.90	195.50	0.3
44	150.93	151.30	0.2
60	117.59	117.60	0.0
120	67.11	67.00	−0.2
160	53.24	53.20	−0.2
220	41.31	41.36	0.1
260	36.24	36.32	0.2
360	28.22	28.34	0.4
600	19.48	19.53	0.2
1200	12.6	12.73	0.9
2000	9.83	9.86	0.3

(b) Target, ^{27}Al

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
10	377.81	377.90	0.0
16	271.23	271.30	0.0
20	230.23	230.30	0.0
26	188.77	189.10	0.2
32	160.96	161.30	0.2
44	125.86	126.00	0.1
60	98.90	98.80	−0.1
120	57.39	57.10	−0.5
160	45.80	45.61	−0.4
220	35.76	35.66	−0.3
260	31.45	31.40	−0.2
360	24.63	24.63	−0.0
600	17.11	17.11	−0.1
1200	1l.14	11.20	0.5
2000	8.72	8.73	0.0

Table 3. Concluded

(c) Target, ^{63}Cu

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
10	279.90	279.90	–0.0
16	207.02	207.00	–0.0
20	177.95	178.00	0.0
26	147.88	148.10	0.1
32	127.31	127.60	0.2
44	100.89	101.10	0.2
60	80.22	80.10	–0.2
120	47.60	47.40	–0.4
160	38.27	38.10	–0.5
220	30.11	30.00	–0.4
260	26.58	26.51	–0.3
360	20.95	20.92	–0.2
600	14.69	14.65	–0.3
1200	9.65	9.68	0.2
2000	7.60	7.59	–0.1

(d) Target, ^{197}Au

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
10	161.46	161.40	–0.0
16	125.94	125.90	–0.0
20	110.76	110.70	–0.1
26	94.60	94.50	–0.1
32	83.09	83.00	–0.1
44	67.64	67.40	–0.4
60	54.94	54.72	–0.4
120	33.96	33.79	–0.5
160	27.70	27.59	–0.4
220	22.11	22.06	–0.3
260	19.66	19.63	–0.2
360	15.71	15.69	–0.1
600	11.23	11.17	–0.5
1200	7.49	7.42	–1.1
2000	5.95	5.87	–1.3

Table 4. Stopping Power Calculated by LaRC and Hubert Codes for ^{20}Ne Ions on Various Targets

(a) Target, ^{12}C

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
50	8877.67	9245.00	4.0
80	7073.75	7138.00	0.9
100	6229.82	6213.00	–0.3
130	5280.01	5221.00	–1.1
160	4587.63	4518.00	–1.5
220	3652.21	3584.00	–1.9
300	2892.36	2836.00	–2.0
600	1674.23	1653.00	–1.3
800	1330.01	1319.00	–0.8
1100	1032.78	1029.00	–0.4
1300	905.99	904.70	–0.1
1800	705.72	707.10	0.2
3000	487.24	487.90	0.1
6000	315.27	318.30	0.9
10000	245.82	247.10	0.5

(b) Target, ^{27}Al

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
50	7028.87	7299.00	3.7
80	5706.98	5840.00	2.3
100	5066.59	5145.00	1.5
130	4331.75	4371.00	0.9
160	3788.61	3808.00	0.5
220	3045 48	3044.00	–0.0
300	2432.55	2421.00	–0.5
600	1431.65	1422.00	–0.7
800	1144.13	1138.00	–0.5
1100	893.83	891.00	–0.3
1300	786.42	784.60	–0.2
1800	615.81	615.80	–0.0
3000	427.97	427.80	–0.0
6000	278.68	280.00	0.5
10000	218.20	218.20	0.0

Table 4. Concluded

(c) Target, ^{63}Cu

Energy, MeV	Stopping power, MeV-cm²/g		Difference, percent
	LaRC code	Hubert code	
50	5207.40	5283.00	1.4
80	4355.95	4398.00	1.0
100	3916.05	3937.00	0.5
130	3393.41	3401.00	0.2
160	2996.72	2998.00	0.0
220	2441.40	2434.00	–0.3
300	1973.32	1962.00	–0.6
600	1187.38	1179.00	–0.7
800	956.19	950.00	–0.7
1100	752.65	749.00	–0.5
1300	664.60	662.40	–0.3
1800	523.89	523.00	–0.2
3000	367.44	366.30	–0.3
6000	241.42	241.90	0.2
10000	190.00	l89.70	–0.2

(d) Target, ^{197}Au

Energy, MeV	Stopping power, MeV-cm²/g		Difference, percent
	LaRC code	Hubert code	
50	3003.94	2964.0	–1.3
80	2649.85	2632.0	–0.7
100	2437.39	2421.0	–0.7
130	2170.93	2153.0	–0.8
160	1955.90	1937.0	–1.0
220	1636.70	1619.0	–1.1
300	1351.52	1337.0	–1.1
600	847.22	841.0	–0.7
800	692.20	68S.1	–0.6
1100	552.81	550.9	–0.3
1300	491.63	490.5	–0.2
1800	392.83	392.2	–0.1
3000	280.76	279.4	–0.5
6000	187.45	185.6	–1.0
10000	148.72	146.8	–1.3

Table 5. Stopping Power Calculated by LaRC and Hubert Codes for ^{56}Fe Ions on Various Targets

(a) Target, ^{197}Au

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
140	0.12×10^5	0.10×10^5	−10.4
168	0.12×10^5	0.11×10^5	−7.9
196	0.12×10^5	0.11×10^5	−6.6
224	0.11×10^5	0.11×10^5	−5.8
252	0.11×10^5	0.11×10^5	−5.2
280	0.11×10^5	0.11×10^5	−4.9
308	0.11×10^5	0.10×10^5	−4.8
336	0.11×10^5	0.10×10^5	−4.7
364	0.11×10^5	0.10×10^5	−4.7
392	0.10×10^5	0.99×10^4	−4.7
448	0.10×10^5	0.96×10^4	−4.9
504	0.97×10^4	0.92×10^4	−4.9
560	0.94×10^4	0.89×10^4	−5.2
616	0.91×10^4	0.86×10^4	−5.3
672	0.88×10^4	0.83×10^4	−5.4
840	0.80×10^4	0.76×10^4	−5.4
1120	0.69×10^4	0.66×10^4	−4.7
1400	0.61×10^4	0.58×10^4	−4.3
1680	0.55×10^4	0.52×10^4	−4.0
1960	0.50×10^4	0.48×10^4	−3.7
2240	0.46×10^4	0.44×10^4	−3.4
2520	0.42×10^4	0.41×10^4	−3.1
2800	0.39×10^4	0.38×10^4	−2.9
3080	0.37×10^4	0.36×10^4	−2.6
3360	0.35×10^4	0.34×10^4	−2.4
3640	0.33×10^4	0.32×10^4	−2.2
3920	0.32×10^4	0.31×10^4	−2.0
4480	0.29×10^4	0.28×10^4	−1.8
5040	0.27×10^4	0.26×10^4	−1.6
5600	0.25×10^4	0.24×10^4	−1.5
8400	0.19×10^4	0.19×10^4	−1.4
11200	0.16×10^4	0.16×10^4	−1.7
14000	0.14×10^4	0.14×10^4	−1.7
16800	0.13×10^4	0.13×10^4	−1.5
19600	0.12×10^4	0.12×10^4	−1.4
22400	0.11×10^4	0.11×10^4	−1.5

Table 5. Concluded

(b) Target, ^{238}U

Energy, MeV	Stopping power, MeV-cm^2/g		Difference, percent
	LaRC code	Hubert code	
140	0.11×10^5	0.97×10^4	−11.4
168	0.11×10^5	1.00×10^4	−8.7
196	0.11×10^5	0.10×10^5	−7.3
224	0.11×10^5	0.10×10^5	−6.5
252	0.11×10^5	0.10×10^5	−6.0
280	0.11×10^5	0.99×10^4	−5.4
308	0.10×10^5	0.98×10^4	−5.1
336	0.10×10^5	0.96×10^4	−4.8
364	0.99×10^4	0.95×10^4	−4.5
392	0.97×10^4	0.93×10^4	−4.4
448	0.94×10^4	0.90×10^4	−4.2
504	0.90×10^4	0.87×10^4	−3.9
560	0.87×10^4	0.84×10^4	−3.9
616	0.84×10^4	0.81×10^4	−3.8
672	0.81×10^4	0.78×10^4	−3.8
840	0.74×10^4	0.71×10^4	−3.8
1120	0.64×10^4	0.62×10^4	−3.8
1400	0.57×10^4	0.55×10^4	−3.5
1680	0.51×10^4	0.49×10^4	−3.3
1960	0.46×10^4	0.45×10^4	−3.0
2240	0.43×10^4	0.41×10^4	−2.8
2520	0.39×10^4	0.38×10^4	−2.5
2800	0.37×10^4	0.36×10^4	−2.3
3080	0.35×10^4	0.34×10^4	−2.0
3360	0.33×10^4	0.32×10^4	−1.9
3640	0.31×10^4	0.30×10^4	−1.7
3920	0.29×10^4	0.29×10^4	−1.6
4480	0.27×10^4	0.27×10^4	−1.3
5040	0.25×10^4	0.25×10^4	−1.2
5600	0.23×10^4	0.23×10^4	−1.1
8400	0.18×10^4	0.18×10^4	−1.1
11200	0.15×10^4	0.15×10^4	−1.3
14000	0.13×10^4	0.13×10^4	−0.8
16800	0.12×10^4	0.12×10^4	−0.6
19600	0.11×10^4	0.11×10^4	−0.6
22400	0.10×10^4	0.10×10^4	−0.6

Table 6. Stopping Power and Energy Range Calculated by LaRC and Bichsel Codes for Protons on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
0.5	0.35×10^{3}	0.37×10^{3}	5.3	0.10×10^{-2}	0.81×10^{-3}	–21.0
0.6	0.32×10^{3}	0.33×10^{3}	3.6	0.13×10^{-2}	0.11×10^{-2}	–17.2
0.7	0.29×10^{3}	0.30×10^{3}	2.6	0.17×10^{-2}	0.14×10^{-2}	–14.3
0.8	0.27×10^{3}	0.27×10^{3}	1.9	0.20×10^{-2}	0.18×10^{-2}	–12.1
0.9	0.25×10^{3}	0.25×10^{3}	1.3	0.24×10^{-2}	0.22×10^{-2}	–10.4
1.0	0.23×10^{3}	0.23×10^{3}	1.2	0.28×10^{-2}	0.26×10^{-2}	–9.0
1.2	0.20×10^{3}	0.20×10^{3}	1.2	0.38×10^{-2}	0.35×10^{-2}	–6.9
1.4	0.18×10^{3}	0.18×10^{3}	1.1	0.48×10^{-2}	0.45×10^{-2}	–5.5
1.6	0.17×10^{3}	0.17×10^{3}	0.9	0.59×10^{-2}	0.57×10^{-2}	–4.6
1.8	0.15×10^{3}	0.15×10^{3}	0.7	0.72×10^{-2}	0.69×10^{-2}	–4.1
2.0	0.14×10^{3}	0.14×10^{3}	0.6	0.86×10^{-2}	0.83×10^{-2}	–3.5
2.2	0.13×10^{3}	0.13×10^{3}	0.6	0.10×10^{-1}	0.98×10^{-2}	–3.1
2.4	0.12×10^{3}	0.12×10^{3}	0.6	0.12×10^{-1}	0.11×10^{-1}	–2.7
2.6	0.12×10^{3}	0.12×10^{3}	0.5	0.13×10^{-1}	0.13×10^{-1}	–2.5
2.8	0.11×10^{3}	0.11×10^{3}	0.5	0.15×10^{-1}	0.15×10^{-1}	–2.2
3.0	0.10×10^{3}	0.11×10^{3}	0.5	0.17×10^{-1}	0.17×10^{-1}	–2.0
3.5	0.93×10^{2}	0.93×10^{2}	0.5	0.22×10^{-1}	0.22×10^{-1}	–1.7
4.0	0.84×10^{2}	0.84×10^{2}	0.4	0.28×10^{-1}	0.27×10^{-1}	–1.4
4.5	0.77×10^{2}	0.77×10^{2}	0.4	0.34×10^{-1}	0.34×10^{-1}	–1.2
5.0	0.71×10^{2}	0.71×10^{2}	0.4	0.41×10^{-1}	0.40×10^{-1}	–1.1
5.5	0.66×10^{2}	0.66×10^{2}	0.3	0.48×10^{-1}	0.48×10^{-1}	–1.0
6.0	0.61×10^{2}	0.61×10^{2}	0.3	0.56×10^{-1}	0.56×10^{-1}	–0.9
6.5	0.58×10^{2}	0.58×10^{2}	0.3	0.65×10^{-1}	0.64×10^{-1}	–0.8
7.0	0.54×10^{2}	0.54×10^{2}	0.2	0.73×10^{-1}	0.73×10^{-1}	–0.7
7.5	0.51×10^{2}	0.51×10^{2}	0.2	0.83×10^{-1}	0.82×10^{-1}	–0.7
10.0	0.41×10^{2}	0.41×10^{2}	0.1	0.14×10^{0}	0.14×10^{0}	–0.5
15.0	0.30×10^{2}	0.30×10^{2}	–0.1	0.28×10^{0}	0.28×10^{0}	–0.2
20.0	0.23×10^{2}	0.23×10^{2}	–0.1	0.48×10^{0}	0.48×10^{0}	–0.1
25.0	0.20×10^{2}	0.20×10^{2}	–0.1	0.71×10^{0}	0.71×10^{0}	0.0
30.0	0.17×10^{2}	0.17×10^{2}	–0.2	0.99×10^{0}	0.99×10^{0}	0.0
50.0	0.11×10^{2}	0.11×10^{2}	–0.2	0.25×10^{1}	0.25×10^{1}	0.1
70.0	0.86×10^{1}	0.86×10^{1}	–0.2	0.46×10^{1}	0.46×10^{1}	0.1
90.0	0.71×10^{1}	0.71×10^{1}	–0.1	0.71×10^{1}	0.72×10^{1}	0.1
125.0	0.56×10^{1}	0.56×10^{1}	–0.1	0.13×10^{2}	0.13×10^{2}	0.1
175.0	0.44×10^{1}	0.44×10^{1}	–0.1	0.23×10^{2}	0.23×10^{2}	0.1
225.0	0.37×10^{1}	0.37×10^{1}	–0.1	0.35×10^{2}	0.35×10^{2}	0.1
275.0	0.33×10^{1}	0.33×10^{1}	–0.1	0.50×10^{2}	0.50×10^{2}	0.1
350.0	0.29×10^{1}	0.29×10^{1}	–0.1	0.74×10^{2}	0.74×10^{2}	0.1
450.0	0.26×10^{1}	0.26×10^{1}	–0.1	0.11×10^{3}	0.11×10^{3}	0.1
550.0	0.24×10^{1}	0.24×10^{1}	–0.1	0.15×10^{3}	0.15×10^{3}	0.1
650.0	0.22×10^{1}	0.22×10^{1}	–0.1	0.20×10^{3}	0.20×10^{3}	0.1
750.0	0.21×10^{1}	0.21×10^{1}	–0.1	0.24×10^{3}	0.24×10^{3}	0.1
850.0	0.21×10^{1}	0.21×10^{1}	–0.2	0.29×10^{3}	0.29×10^{3}	0.1
950.0	0.20×10^{1}	0.20×10^{1}	–0.3	0.34×10^{3}	0.34×10^{3}	0.1

Table 6. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
0.5	0.26×10^3	0.26×10^3	0.4	0.15×10^{-2}	0.13×10^{-2}	–16.6
0.6	0.23×10^3	0.23×10^3	–0.3	0.19×10^{-2}	0.17×10^{-2}	–13.0
0.7	0.22×10^3	0.21×10^3	–0.8	0.24×10^{-2}	0.21×10^{-2}	–10.5
0.8	0.20×10^3	0.20×10^3	–1.1	0.28×10^{-2}	0.26×10^{-2}	–8.5
0.9	0.19×10^3	0.18×10^3	–1.4	0.34×10^{-2}	0.31×10^{-2}	–7.0
1.0	0.17×10^3	0.17×10^3	0.2	0.39×10^{-2}	0.37×10^{-2}	–5.8
1.2	0.15×10^3	0.15×10^3	1.8	0.51×10^{-2}	0.49×10^{-2}	–4.2
1.4	0.14×10^3	0.14×10^3	2.3	0.65×10^{-2}	0.63×10^{-2}	–3.1
1.6	0.13×10^3	0.13×10^3	2.0	0.80×10^{-2}	0.78×10^{-2}	–2.5
1.8	0.12×10^3	0.12×10^3	0.0	0.97×10^{-2}	0.94×10^{-2}	–2.4
2.0	0.11×10^3	0.11×10^3	–0.1	0.11×10^{-1}	0.11×10^{-1}	–2.0
2.2	0.10×10^3	0.10×10^3	–0.1	0.13×10^{-1}	0.13×10^{-1}	–1.6
2.4	0.97×10^2	0.97×10^2	–0.2	0.15×10^{-1}	0.15×10^{-1}	–1.4
2.6	0.92×10^2	0.92×10^2	–0.2	0.17×10^{-1}	0.17×10^{-1}	–1.2
2.8	0.87×10^2	0.87×10^2	–0.2	0.20×10^{-1}	0.19×10^{-1}	–1.0
3.0	0.83×10^2	0.83×10^2	–0.3	0.22×10^{-1}	0.22×10^{-1}	–0.9
3.5	0.74×10^2	0.74×10^2	–0.3	0.28×10^{-1}	0.28×10^{-1}	–0.7
4.0	0.67×10^2	0.67×10^2	–0.3	0.36×10^{-1}	0.35×10^{-1}	–0.6
4.5	0.62×10^2	0.62×10^2	–0.3	0.43×10^{-1}	0.43×10^{-1}	–0.4
5.0	0.57×10^2	0.57×10^2	–0.3	0.52×10^{-1}	0.52×10^{-1}	–0.3
5.5	0.53×10^2	0.53×10^2	–0.3	0.61×10^{-1}	0.61×10^{-1}	–0.1
6.0	0.50×10^2	0.50×10^2	–0.3	0.70×10^{-1}	0.70×10^{-1}	0.0
6.5	0.47×10^2	0.47×10^2	–0.3	0.81×10^{-1}	0.81×10^{-1}	0.0
7.0	0.45×10^2	0.44×10^2	–0.3	0.92×10^{-1}	0.92×10^{-1}	0.0
7.5	0.42×10^2	0.42×10^2	–0.2	0.10×10^0	0.10×10^0	0.0
10.0	0.34×10^2	0.34×10^2	–0.2	0.17×10^0	0.17×10^0	0.2
15.0	0.25×10^2	0.25×10^2	–0.3	0.34×10^0	0.35×10^0	0.4
20.0	0.20×10^2	0.20×10^2	–0.2	0.57×10^0	0.57×10^0	0.2
25.0	0.17×10^2	0.17×10^2	–0.1	0.85×10^0	0.85×10^0	0.1
30.0	0.14×10^2	0.14×10^2	–0.2	0.12×10^1	0.12×10^1	0.2
50.0	0.96×10^1	0.96×10^1	–0.3	0.29×10^1	0.29×10^1	0.2
70.0	0.74×10^1	0.74×10^1	–0.3	0.53×10^1	0.53×10^1	0.1
90.0	0.62×10^1	0.61×10^1	–0.3	0.83×10^1	0.83×10^1	0.3
125.0	0.49×10^1	0.48×10^1	–0.2	0.15×10^2	0.15×10^2	0.2
175.0	0.39×10^1	0.39×10^1	–0.2	0.26×10^2	0.27×10^2	0.2
225.0	0.33×10^1	0.33×10^1	–0.2	0.41×10^2	0.41×10^2	0.2
275.0	0.29×10^1	0.29×10^1	–0.2	0.57×10^2	0.57×10^2	0.3
350.0	0.26×10^1	0.26×10^1	–0.2	0.84×10^2	0.84×10^2	0.2
450.0	0.23×10^1	0.23×10^1	–0.2	0.13×10^3	0.13×10^3	0.3
550.0	0.21×10^1	0.21×10^1	–0.1	0.17×10^3	0.17×10^3	0.2
650.0	0.20×10^1	0.20×10^1	–0.1	0.22×10^3	0.22×10^3	0.1
750.0	0.19×10^1	0.20×10^1	–0.1	0.27×10^3	0.27×10^3	0.2
850.0	0.18×10^1	0.18×10^1	–0.2	0.33×10^3	0.33×10^3	0.1
950.0	0.18×10^1	0.18×10^1	–0.3	0.38×10^3	0.38×10^3	0.1

Table 6. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
0.5	0.17×10^3	0.16×10^3	–6.3	0.26×10^{-2}	0.22×10^{-2}	–14.6
0.6	0.16×10^3	0.15×10^3	–6.2	0.32×10^{-2}	0.29×10^{-2}	–10.6
0.7	0.15×10^3	0.14×10^3	–5.9	0.39×10^{-2}	0.36×10^{-2}	–7.7
0.8	0.14×10^3	0.13×10^3	–5.4	0.46×10^{-2}	0.44×10^{-2}	–5.6
0.9	0.13×10^3	0.12×10^3	–4.8	0.54×10^{-2}	0.52×10^{-2}	–4.0
1.0	0.12×10^3	0.12×10^3	–3.6	0.62×10^{-2}	0.60×10^{-2}	–2.9
1.2	0.11×10^3	0.11×10^3	–1.8	0.79×10^{-2}	0.78×10^{-2}	–1.3
1.4	0.99×10^2	0.98×10^2	–1.0	0.98×10^{-2}	0.98×10^{-2}	–0.4
1.6	0.92×10^2	0.90×10^2	–1.4	0.12×10^{-1}	0.12×10^{-1}	0.2
1.8	0.86×10^2	0.85×10^2	–2.1	0.14×10^{-1}	0.14×10^{-1}	0.2
2.0	0.81×10^2	0.80×10^2	–2.0	0.17×10^{-1}	0.17×10^{-1}	0.5
2.2	0.76×10^2	0.75×10^2	–1.9	0.19×10^{-1}	0.19×10^{-1}	0.7
2.4	0.72×10^2	0.71×10^2	–1.8	0.22×10^{-1}	0.22×10^{-1}	0.9
2.6	0.69×10^2	0.68×10^2	–1.7	0.25×10^{-1}	0.25×10^{-1}	1.0
2.8	0.66×10^2	0.65×10^2	–1.6	0.28×10^{-1}	0.28×10^{-1}	1.1
3.0	0.63×10^2	0.62×10^2	–1.6	0.31×10^{-1}	0.31×10^{-1}	1.1
3.5	0.57×10^2	0.56×10^2	–1.4	0.39×10^{-1}	0.40×10^{-1}	1.2
4.0	0.52×10^2	0.51×10^2	–1.2	0.48×10^{-1}	0.49×10^{-1}	1.2
4.5	0.48×10^2	0.47×10^2	–1.1	0.58×10^{-1}	0.59×10^{-1}	1.2
5.0	0.45×10^2	0.44×10^2	–1.0	0.69×10^{-1}	0.70×10^{-1}	1.2
5.5	0.42×10^2	0.41×10^2	–1.0	0.81×10^{-1}	0.82×10^{-1}	1.2
6.0	0.39×10^2	0.39×10^2	–0.9	0.93×10^{-1}	0.94×10^{-1}	1.1
6.5	0.37×10^2	0.37×10^2	–0.9	0.11×10^0	0.11×10^0	1.1
7.0	0.35×10^2	0.35×10^2	–0.8	0.12×10^0	0.12×10^0	1.1
7.5	0.34×10^2	0.33×10^2	–0.8	0.13×10^0	0.14×10^0	1.1
10.0	0.27×10^2	0.27×10^2	–0.7	0.22×10^0	0.22×10^0	0.9
15.0	0.20×10^2	0.20×10^2	–0.7	0.43×10^0	0.44×10^0	0.9
20.0	0.16×10^2	0.16×10^2	–0.7	0.71×10^0	0.72×10^0	0.8
25.0	0.14×10^2	0.14×10^2	–0.7	0.10×10^1	0.11×10^1	0.7
30.0	0.12×10^2	0.12×10^2	–0.7	0.14×10^1	0.15×10^1	0.7
50.0	0.82×10^1	0.81×10^1	–0.8	0.35×10^1	0.35×10^1	0.8
70.0	0.64×10^1	0.63×10^1	–0.8	0.63×10^1	0.64×10^1	0.8
90.0	0.53×10^1	0.52×10^1	–0.9	0.98×10^1	0.99×10^1	0.8
125.0	0.42×10^1	0.42×10^1	–1.0	0.17×10^2	0.17×10^2	0.9
175.0	0.34×10^1	0.33×10^1	–1.0	0.31×10^2	0.31×10^2	0.9
225.0	0.29×10^1	0.28×10^1	–1.0	0.47×10^2	0.47×10^2	1.0
275.0	0.26×10^1	0.25×10^1	–1.0	0.66×10^2	0.66×10^2	1.0
350.0	0.23×10^1	0.22×10^1	–0.9	0.97×10^2	0.98×10^2	1.0
450.0	0.20×10^1	0.20×10^1	–0.9	0.14×10^3	0.15×10^3	1.0
550.0	0.19×10^1	0.18×10^1	–0.9	0.20×10^3	0.20×10^3	1.0
650.0	0.18×10^1	0.17×10^1	–0.9	0.25×10^3	0.26×10^3	0.9
750.0	0.17×10^1	0.17×10^1	–0.9	0.31×10^3	0.31×10^3	0.9
850.0	0.16×10^1	0.16×10^1	–0.9	0.37×10^3	0.38×10^3	0.9
950.0	0.16×10^1	0.16×10^1	–1.1	0.43×10^3	0.44×10^3	0.9

Table 6. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
0.4	0.10×10^{3}	0.92×10^{2}	–9.2	0.38×10^{-2}	0.31×10^{-2}	–19.4
0.5	0.91×10^{2}	0.84×10^{2}	–7.6	0.49×10^{-2}	0.42×10^{-2}	–13.3
0.6	0.83×10^{2}	0.78×10^{2}	–6.2	0.60×10^{-2}	0.55×10^{-2}	–9.3
0.7	0.77×10^{2}	0.73×10^{2}	–5.1	0.73×10^{-2}	0.68×10^{-2}	–6.7
0.8	0.72×10^{2}	0.69×10^{2}	–4.4	0.86×10^{-2}	0.82×10^{-2}	–4.9
0.9	0.69×10^{2}	0.66×10^{2}	–3.8	0.10×10^{-1}	0.97×10^{-2}	–3.6
1.0	0.65×10^{2}	0.63×10^{2}	–3.2	0.12×10^{-1}	0.11×10^{-1}	–2.6
1.2	0.60×10^{2}	0.58×10^{2}	–2.5	0.15×10^{-1}	0.15×10^{-1}	–1.3
1.4	0.53×10^{2}	0.54×10^{2}	–2.1	0.18×10^{-1}	0.18×10^{-1}	–0.4
1.6	0.52×10^{2}	0.51×10^{2}	–2.1	0.22×10^{-1}	0.22×10^{-1}	0.2
1.8	0.49×10^{2}	0.48×10^{2}	–2.7	0.26×10^{-1}	0.26×10^{-1}	0.4
2.0	0.47×10^{2}	0.46×10^{2}	–2.6	0.30×10^{-1}	0.30×10^{-1}	0.8
2.2	0.45×10^{2}	0.43×10^{2}	–2.5	0.34×10^{-1}	0.35×10^{-1}	1.0
2.4	0.43×10^{2}	0.42×10^{2}	–2.4	0.39×10^{-1}	0.40×10^{-1}	1.2
2.6	0.41×10^{2}	0.40×10^{2}	–2.4	0.44×10^{-1}	0.44×10^{-1}	1.3
2.8	0.39×10^{2}	0.38×10^{2}	–2.3	0.49×10^{-1}	0.50×10^{-1}	1.4
3.0	0.38×10^{2}	0.37×10^{2}	–2.3	0.54×10^{-1}	0.55×10^{-1}	1.5
3.5	0.35×10^{2}	0.34×10^{2}	–2.2	0.68×10^{-1}	0.69×10^{-1}	1.7
4.0	0.32×10^{2}	0.32×10^{2}	–2.1	0.83×10^{-1}	0.84×10^{-1}	1.8
4.5	0.30×10^{2}	0.29×10^{2}	–2.0	0.99×10^{-1}	0.10×10^{0}	1.8
5.0	0.28×10^{2}	0.28×10^{2}	–1.9	0.12×10^{0}	0.12×10^{0}	1.8
5.5	0.27×10^{2}	0.26×10^{2}	–1.8	0.13×10^{0}	0.14×10^{0}	1.9
6.0	0.25×10^{2}	0.25×10^{2}	–1.7	0.15×10^{0}	0.16×10^{0}	1.8
6.5	0.24×10^{2}	0.24×10^{2}	–1.7	0.17×10^{0}	0.18×10^{0}	1.8
7.0	0.23×10^{2}	0.23×10^{2}	–1.6	0.20×10^{0}	0.20×10^{0}	1.8
9.5	0.19×10^{2}	0.19×10^{2}	–1.4	0.32×10^{0}	0.32×10^{0}	1.7
14.0	0.15×10^{2}	0.14×10^{2}	–1.1	0.59×10^{0}	0.60×10^{0}	1.5
19.0	0.12×10^{2}	0.12×10^{2}	–1.0	0.98×10^{0}	0.99×10^{0}	1.3
24.0	0.10×10^{2}	0.99×10^{1}	–0.9	0.14×10^{1}	0.15×10^{1}	1.2
29.0	0.88×10^{1}	0.87×10^{1}	–0.9	0.20×10^{1}	0.20×10^{1}	1.1
48.0	0.61×10^{1}	0.61×10^{1}	–0.9	0.46×10^{1}	0.47×10^{1}	1.0
68.0	0.48×10^{1}	0.48×10^{1}	–1.1	0.83×10^{1}	0.84×10^{1}	1.0
88.0	0.40×10^{1}	0.40×10^{1}	–1.3	0.13×10^{2}	0.13×10^{2}	1.1
120.0	0.33×10^{1}	0.32×10^{1}	–1.7	0.22×10^{2}	0.22×10^{2}	1.3
170.0	0.26×10^{1}	0.26×10^{1}	–1.9	0.39×10^{2}	0.40×10^{2}	1.5
220.0	0.22×10^{1}	0.22×10^{1}	–2.0	0.60×10^{2}	0.61×10^{2}	1.7
270.0	0.20×10^{1}	0.20×10^{1}	–2.0	0.84×10^{2}	0.85×10^{2}	1.8
340.0	0.18×10^{1}	0.17×10^{1}	–2.0	0.12×10^{3}	0.12×10^{3}	1.8
440.0	0.16×10^{1}	0.15×10^{1}	–2.0	0.18×10^{3}	0.19×10^{3}	1.9
540.0	0.15×10^{1}	0.14×10^{1}	–2.0	0.25×10^{3}	0.25×10^{3}	2.0
640.0	0.14×10^{1}	0.13×10^{1}	–2.1	0.32×10^{3}	0.33×10^{3}	2.0
740.0	0.13×10^{1}	0.13×10^{1}	–2.2	0.39×10^{3}	0.40×10^{3}	2.0
840.0	0.13×10^{1}	0.13×10^{1}	–2.3	0.47×10^{3}	0.48×10^{3}	2.1

Table 6. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 841.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
0.4	0.10×10^{3}	0.82×10^{2}	−19.7	0.35×10^{-2}	0.37×10^{-2}	5.0
0.5	0.89×10^{2}	0.76×10^{2}	−14.5	0.46×10^{-2}	0.50×10^{-2}	8.5
0.6	0.80×10^{2}	0.71×10^{2}	−10.6	0.58×10^{-2}	0.63×10^{-2}	9.7
0.7	0.73×10^{2}	0.67×10^{2}	−7.8	0.71×10^{-2}	0.78×10^{-2}	9.8
0.8	0.68×10^{2}	0.64×10^{2}	−5.7	0.85×10^{-2}	0.93×10^{-2}	9.3
0.9	0.64×10^{2}	0.61×10^{2}	−4.2	0.10×10^{-1}	0.11×10^{-1}	8.7
1.0	0.61×10^{2}	0.58×10^{2}	−3.8	0.12×10^{-1}	0.13×10^{-1}	8.0
1.2	0.56×10^{2}	0.54×10^{2}	−3.1	0.15×10^{-1}	0.16×10^{-1}	6.9
1.4	0.52×10^{2}	0.50×10^{2}	−2.5	0.19×10^{-1}	0.20×10^{-1}	6.0
1.6	0.48×10^{2}	0.47×10^{2}	−2.0	0.23×10^{-1}	0.24×10^{-1}	5.3
1.8	0.46×10^{2}	0.45×10^{2}	−1.4	0.27×10^{-1}	0.28×10^{-1}	4.7
2.0	0.43×10^{2}	0.43×10^{2}	−1.2	0.32×10^{-1}	0.33×10^{-1}	4.2
2.2	0.41×10^{2}	0.41×10^{2}	−1.0	0.36×10^{-1}	0.38×10^{-1}	3.8
2.4	0.39×10^{2}	0.39×10^{2}	−0.9	0.41×10^{-1}	0.43×10^{-1}	3.5
2.6	0.38×10^{2}	0.37×10^{2}	−0.8	0.47×10^{-1}	0.48×10^{-1}	3.2
2.8	0.36×10^{2}	0.36×10^{2}	−0.7	0.52×10^{-1}	0.54×10^{-1}	2.9
3.0	0.35×10^{2}	0.35×10^{2}	−0.6	0.58×10^{-1}	0.59×10^{-1}	2.7
3.5	0.32×10^{2}	0.32×10^{2}	−0.5	0.73×10^{-1}	0.74×10^{-1}	2.3
4.0	0.30×10^{2}	0.29×10^{2}	−0.4	0.89×10^{-1}	0.91×10^{-1}	1.9
4.5	0.28×10^{2}	0.28×10^{2}	−0.4	0.11×10^{0}	0.11×10^{0}	1.7
5.0	0.26×10^{2}	0.26×10^{2}	−0.3	0.13×10^{0}	0.13×10^{0}	1.5
5.5	0.25×10^{2}	0.25×10^{2}	−0.3	0.15×10^{0}	0.15×10^{0}	1.3
6.0	0.23×10^{2}	0.23×10^{2}	−0.2	0.17×10^{0}	0.17×10^{0}	1.2
6.5	0.22×10^{2}	0.22×10^{2}	−0.2	0.19×10^{0}	0.19×10^{0}	1.1
7.0	0.21×10^{2}	0.21×10^{2}	−0.1	0.21×10^{0}	0.21×10^{0}	1.0
9.5	0.17×10^{2}	0.17×10^{2}	0.0	0.34×10^{0}	0.34×10^{0}	0.6
14.0	0.14×10^{2}	0.14×10^{2}	0.2	0.64×10^{0}	0.64×10^{0}	0.3
19.0	0.11×10^{2}	0.11×10^{2}	0.4	0.11×10^{1}	0.11×10^{1}	0.0
24.0	0.93×10^{1}	0.94×10^{1}	0.5	0.16×10^{1}	0.16×10^{1}	−0.1
29.0	0.82×10^{1}	0.82×10^{1}	0.5	0.21×10^{1}	0.21×10^{1}	−0.2
48.0	0.57×10^{1}	0.58×10^{1}	0.5	0.50×10^{1}	0.49×10^{1}	−0.4
68.0	0.45×10^{1}	0.45×10^{1}	0.4	0.89×10^{1}	0.89×10^{1}	−0.4
88.0	0.38×10^{1}	0.38×10^{1}	0.2	0.14×10^{2}	0.14×10^{2}	−0.4
120.0	0.31×10^{1}	0.31×10^{1}	−0.2	0.23×10^{2}	0.23×10^{2}	−0.2
170.0	0.25×10^{1}	0.24×10^{1}	−0.6	0.42×10^{2}	0.42×10^{2}	0.1
220.0	0.21×10^{1}	0.21×10^{1}	−0.7	0.64×10^{2}	0.64×10^{2}	0.3
270.0	0.19×10^{1}	0.19×10^{1}	−0.7	0.89×10^{2}	0.90×10^{2}	0.4
340.0	0.17×10^{1}	0.17×10^{1}	−0.7	0.13×10^{3}	0.13×10^{3}	0.5
440.0	0.15×10^{1}	0.15×10^{1}	−0.8	0.19×10^{3}	0.19×10^{3}	0.6
540.0	0.14×10^{1}	0.14×10^{1}	−0.9	0.26×10^{3}	0.27×10^{3}	0.7
640.0	0.13×10^{1}	0.13×10^{1}	−0.9	0.34×10^{3}	0.34×10^{3}	0.7
740.0	0.12×10^{1}	0.12×10^{1}	−1.0	0.42×10^{3}	0.42×10^{3}	0.8
840.0	0.12×10^{1}	0.12×10^{1}	−1.1	0.50×10^{3}	0.50×10^{3}	0.8

Table 6. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 69.04 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
0.5	0.43×10^3	0.44×10^3	2.8	0.81×10^{-3}	0.69×10^{-3}	–14.9
0.6	0.38×10^3	0.39×10^3	2.8	0.11×10^{-2}	0.93×10^{-3}	–12.0
0.7	0.34×10^3	0.35×10^3	2.6	0.13×10^{-2}	0.12×10^{-2}	–10.0
0.8	0.31×10^3	0.32×10^3	2.2	0.16×10^{-2}	0.15×10^{-2}	–8.6
0.9	0.29×10^3	0.29×10^3	2.0	0.20×10^{-2}	0.18×10^{-2}	–7.5
1.0	0.26×10^3	0.27×10^3	2.4	0.23×10^{-2}	0.22×10^{-2}	–6.6
1.2	0.23×10^3	0.24×10^3	2.7	0.32×10^{-2}	0.30×10^{-2}	–5.2
1.4	0.21×10^3	0.21×10^3	2.7	0.41×10^{-2}	0.39×10^{-2}	–4.4
1.6	0.19×10^3	0.19×10^3	2.3	0.51×10^{-2}	0.49×10^{-2}	–3.8
1.8	0.17×10^3	0.18×10^3	1.4	0.62×10^{-2}	0.60×10^{-2}	–3.6
2.0	0.16×10^3	0.16×10^3	1.3	0.74×10^{-2}	0.71×10^{-2}	–3.2
2.2	0.15×10^3	0.15×10^3	1.2	0.87×10^{-2}	0.84×10^{-2}	–2.9
2.4	0.14×10^3	0.14×10^3	1.1	0.10×10^{-1}	0.98×10^{-2}	–2.7
2.6	0.13×10^3	0.13×10^3	1.0	0.12×10^{-1}	0.11×10^{-1}	–2.4
2.8	0.13×10^3	0.13×10^3	1.0	0.13×10^{-1}	0.13×10^{-1}	–2.3
3.0	0.12×10^3	0.12×10^3	1.0	0.15×10^{-1}	0.14×10^{-1}	–2.1
3.5	0.11×10^3	0.11×10^3	1.0	0.19×10^{-1}	0.19×10^{-1}	–1.9
4.0	0.95×10^2	0.96×10^2	0.9	0.24×10^{-1}	0.24×10^{-1}	–1.7
4.5	0.87×10^2	0.88×10^2	0.9	0.30×10^{-1}	0.29×10^{-1}	–1.5
5.0	0.80×10^2	0.81×10^2	0.8	0.36×10^{-1}	0.35×10^{-1}	–1.4
5.5	0.74×10^2	0.75×10^2	0.7	0.42×10^{-1}	0.42×10^{-1}	–1.3
6.0	0.69×10^2	0.70×10^2	0.7	0.49×10^{-1}	0.49×10^{-1}	–1.2
6.5	0.65×10^2	0.66×10^2	0.7	0.57×10^{-1}	0.56×10^{-1}	–1.1
7.0	0.61×10^2	0.62×10^2	0.6	0.65×10^{-1}	0.64×10^{-1}	–1.0
7.5	0.58×10^2	0.58×10^2	0.6	0.73×10^{-1}	0.72×10^{-1}	–1.1
10.0	0.46×10^2	0.46×10^2	0.5	0.12×10^0	0.12×10^0	–0.7
15.0	0.33×10^2	0.33×10^2	0.3	0.25×10^0	0.25×10^0	–0.3
20.0	0.26×10^2	0.26×10^2	0.2	0.42×10^0	0.42×10^0	–0.4
25.0	0.22×10^2	0.22×10^2	0.2	0.63×10^0	0.63×10^0	–0.5
30.0	0.19×10^2	0.19×10^2	0.2	0.88×10^0	0.87×10^0	–0.4
50.0	0.13×10^2	0.13×10^2	0.2	0.22×10^1	0.22×10^1	–0.3
70.0	0.96×10^1	0.97×10^1	0.3	0.41×10^1	0.40×10^1	–0.4
90.0	0.80×10^1	0.80×10^1	0.3	0.63×10^1	0.63×10^1	–0.2
125.0	0.62×10^1	0.63×10^1	0.3	0.11×10^2	0.11×10^2	–0.4
175.0	0.49×10^1	0.50×10^1	0.4	0.21×10^2	0.20×10^2	–0.4
225.0	0.42×10^1	0.42×10^1	0.3	0.32×10^2	0.31×10^2	–0.4
275.0	0.37×10^1	0.37×10^1	0.4	0.44×10^2	0.44×10^2	–0.4
350.0	0.33×10^1	0.33×10^1	0.4	0.66×10^2	0.66×10^2	–0.4
450.0	0.29×10^1	0.29×10^1	0.4	0.99×10^2	0.98×10^2	–0.3
550.0	0.27×10^1	0.27×10^1	0.4	0.14×10^3	0.13×10^3	–0.3
650.0	0.25×10^1	0.25×10^1	0.3	0.17×10^3	0.17×10^3	–0.3
750.0	0.24×10^1	0.24×10^1	0.3	0.22×10^3	0.21×10^3	–0.3
850.0	0.23×10^1	0.23×10^1	0.2	0.26×10^3	0.26×10^3	–0.4

Table 7. Stopping Power and Energy Range Calculated by LaRC and Bichsel Codes for α Particles on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
2.0	0.15×10^{4}	0.14×10^{4}	–1.3	0.12×10^{-2}	0.85×10^{-3}	–25.6
2.4	0.13×10^{4}	0.13×10^{4}	–1.4	0.14×10^{-2}	0.12×10^{-2}	–20.1
2.8	0.12×10^{4}	0.12×10^{4}	–1.0	0.18×10^{-2}	0.15×10^{-2}	–16.2
3.2	0.11×10^{4}	0.11×10^{4}	–0.7	0.21×10^{-2}	0.18×10^{-2}	–13.3
3.6	0.99×10^{3}	0.98×10^{3}	–0.4	0.25×10^{-2}	0.22×10^{-2}	–11.2
4.0	0.92×10^{3}	0.91×10^{3}	–0.3	0.29×10^{-2}	0.27×10^{-2}	–9.5
4.8	0.81×10^{3}	0.81×10^{3}	–0.1	0.39×10^{-2}	0.36×10^{-2}	–7.1
5.6	0.73×10^{3}	0.73×10^{3}	0.0	0.49×10^{-2}	0.46×10^{-2}	–5.4
6.4	0.66×10^{3}	0.66×10^{3}	0.0	0.61×10^{-2}	0.58×10^{-2}	–4.3
7.2	0.61×10^{3}	0.61×10^{3}	0.1	0.74×10^{-2}	0.71×10^{-2}	–3.9
8.0	0.56×10^{3}	0.56×10^{3}	0.0	0.87×10^{-2}	0.84×10^{-2}	–3.2
8.8	0.53×10^{3}	0.52×10^{3}	–0.1	0.10×10^{-1}	0.99×10^{-2}	–2.7
9.6	0.49×10^{3}	0.49×10^{3}	–0.3	0.12×10^{-1}	0.12×10^{-1}	–2.4
10.4	0.47×10^{3}	0.46×10^{3}	–0.4	0.13×10^{-1}	0.13×10^{-1}	–2.0
11.2	0.44×10^{3}	0.44×10^{3}	–0.4	0.15×10^{-1}	0.15×10^{-1}	–1.8
12.0	0.42×10^{3}	0.42×10^{3}	–0.5	0.17×10^{-1}	0.17×10^{-1}	–1.5
14.0	0.37×10^{3}	0.37×10^{3}	–0.6	0.22×10^{-1}	0.22×10^{-1}	–1.0
16.0	0.34×10^{3}	0.34×10^{3}	–0.7	0.28×10^{-1}	0.28×10^{-1}	–0.7
18.0	0.31×10^{3}	0.31×10^{3}	–0.8	0.34×10^{-1}	0.34×10^{-1}	–0.4
20.0	0.28×10^{3}	0.28×10^{3}	–0.8	0.41×10^{-1}	0.41×10^{-1}	–0.2
22.0	0.26×10^{3}	0.26×10^{3}	–0.7	0.48×10^{-1}	0.48×10^{-1}	–0.1
24.0	0.25×10^{3}	0.24×10^{3}	–0.7	0.56×10^{-1}	0.56×10^{-1}	0.0
26.0	0.23×10^{3}	0.23×10^{3}	–0.6	0.64×10^{-1}	0.65×10^{-1}	0.1
28.0	0.22×10^{3}	0.22×10^{3}	–0.6	0.73×10^{-1}	0.74×10^{-1}	0.2
30.0	0.21×10^{3}	0.21×10^{3}	–0.6	0.83×10^{-1}	0.83×10^{-1}	0.2
40.0	0.16×10^{3}	0.16×10^{3}	–0.4	0.14×10^{0}	0.14×10^{0}	0.3
60.0	0.12×10^{3}	0.12×10^{3}	–0.5	0.28×10^{0}	0.29×10^{0}	0.5
80.0	0.93×10^{2}	0.93×10^{2}	–0.6	0.48×10^{0}	0.48×10^{0}	0.5
100.0	0.78×10^{2}	0.77×10^{2}	–0.7	0.71×10^{0}	0.72×10^{0}	0.5
120.0	0.67×10^{2}	0.67×10^{2}	–0.7	0.99×10^{0}	1.00×10^{0}	0.6
200.0	0.45×10^{2}	0.44×10^{2}	–0.7	0.25×10^{1}	0.25×10^{1}	0.7
280.0	0.34×10^{2}	0.34×10^{2}	–0.6	0.46×10^{1}	0.46×10^{1}	0.7
360.0	0.28×10^{2}	0.28×10^{2}	–0.6	0.71×10^{1}	0.72×10^{1}	0.6
500.0	0.22×10^{2}	0.22×10^{2}	–0.6	0.13×10^{2}	0.13×10^{2}	0.6
700.0	0.18×10^{2}	0.18×10^{2}	–0.5	0.23×10^{2}	0.23×10^{2}	0.5
900.0	0.15×10^{2}	0.15×10^{2}	–0.5	0.35×10^{2}	0.36×10^{2}	0.6
1100.0	0.13×10^{2}	0.13×10^{2}	–0.4	0.50×10^{2}	0.50×10^{2}	0.5
1400.0	0.12×10^{2}	0.12×10^{2}	–0.4	0.74×10^{2}	0.74×10^{2}	0.5
1800.0	0.10×10^{2}	0.10×10^{2}	–0.3	0.11×10^{3}	0.11×10^{3}	0.4
2200.0	0.95×10^{1}	0.95×10^{1}	–0.3	0.15×10^{3}	0.15×10^{3}	0.4
2600.0	0.89×10^{1}	0.89×10^{1}	–0.3	0.20×10^{3}	0.20×10^{3}	0.4
3000.0	0.85×10^{1}	0.85×10^{1}	–0.2	0.24×10^{3}	0.24×10^{3}	0.3
3400.0	0.83×10^{1}	0.82×10^{1}	–0.3	0.29×10^{3}	0.29×10^{3}	0.3

Table 7. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
2.0	0.99×10^3	0.10×10^4	1.8	0.19×10^{-2}	0.13×10^{-2}	−27.8
2.4	0.91×10^3	0.92×10^3	1.0	0.23×10^{-2}	0.18×10^{-2}	−22.9
2.8	0.84×10^3	0.85×10^3	0.4	0.27×10^{-2}	0.22×10^{-2}	−19.2
3.2	0.79×10^3	0.78×10^3	−0.1	0.32×10^{-2}	0.27×10^{-2}	−16.2
3.6	0.74×10^3	0.73×10^3	−0.4	0.38×10^{-2}	0.32×10^{-2}	−14.0
4.0	0.69×10^3	0.69×10^3	−0.6	0.43×10^{-2}	0.38×10^{-2}	−12.1
4.8	0.62×10^3	0.61×10^3	−1.0	0.55×10^{-2}	0.50×10^{-2}	−9.2
5.6	0.56×10^3	0.56×10^3	−1.1	0.69×10^{-2}	0.64×10^{-2}	−7.1
6.4	0.52×10^3	0.51×10^3	−1.1	0.84×10^{-2}	0.79×10^{-2}	−5.6
7.2	0.48×10^3	0.47×10^3	−0.9	0.10×10^{-1}	0.95×10^{-2}	−4.8
8.0	0.44×10^3	0.44×10^3	−0.9	0.12×10^{-1}	0.11×10^{-1}	−3.9
8.8	0.42×10^3	0.41×10^3	−0.8	0.14×10^{-1}	0.13×10^{-1}	−3.3
9.6	0.39×10^3	0.39×10^3	−0.7	0.16×10^{-1}	0.15×10^{-1}	−2.8
10.4	0.37×10^3	0.37×10^3	−0.7	0.18×10^{-1}	0.17×10^{-1}	−2.3
11.2	0.35×10^3	0.35×10^3	−0.7	0.20×10^{-1}	0.20×10^{-1}	−2.0
12.0	0.33×10^3	0.33×10^3	−0.8	0.22×10^{-1}	0.22×10^{-1}	−1.7
14.0	0.30×10^3	0.30×10^3	−0.9	0.29×10^{-1}	0.28×10^{-1}	−1.2
16.0	0.27×10^3	0.27×10^3	−1.0	0.36×10^{-1}	0.35×10^{-1}	−0.8
18.0	0.25×10^3	0.25×10^3	−1.1	0.43×10^{-1}	0.43×10^{-1}	−0.5
20.0	0.23×10^3	0.23×10^3	−1.1	0.52×10^{-1}	0.52×10^{-1}	−0.2
22.0	0.21×10^3	0.21×10^3	−1.1	0.61×10^{-1}	0.61×10^{-1}	0.0
24.0	0.20×10^3	0.20×10^3	−1.0	0.70×10^{-1}	0.71×10^{-1}	0.2
26.0	0.19×10^3	0.19×10^3	−0.9	0.81×10^{-1}	0.81×10^{-1}	0.3
28.0	0.18×10^3	0.18×10^3	−0.8	0.92×10^{-1}	0.92×10^{-1}	0.3
30.0	0.17×10^3	0.17×10^3	−0.8	0.10×10^0	0.10×10^0	0.4
40.0	0.14×10^3	0.14×10^3	−0.6	0.17×10^0	0.17×10^0	0.6
60.0	0.99×10^2	0.98×10^2	−0.6	0.34×10^0	0.35×10^0	0.8
80.0	0.79×10^2	0.78×10^2	−0.6	0.57×10^0	0.58×10^0	0.6
100.0	0.66×10^2	0.66×10^2	−0.6	0.85×10^0	0.86×10^0	0.6
120.0	0.57×10^2	0.57×10^2	−0.6	0.12×10^1	0.12×10^1	0.6
200.0	0.39×10^2	0.38×10^2	−0.7	0.29×10^1	0.29×10^1	0.6
280.0	0.30×10^2	0.30×10^2	−0.7	0.53×10^1	0.54×10^1	0.6
360.0	0.25×10^2	0.24×10^2	−0.8	0.83×10^1	0.83×10^1	0.8
500.0	0.19×10^2	0.19×10^2	−0.6	0.15×10^2	0.15×10^2	0.7
700.0	0.15×10^2	0.15×10^2	−0.6	0.26×10^2	0.27×10^2	0.7
900.0	0.13×10^2	0.13×10^2	−0.5	0.41×10^2	0.41×10^2	0.6
1100.0	0.12×10^2	0.12×10^2	−0.5	0.57×10^2	0.57×10^2	0.7
1400.0	0.10×10^2	0.10×10^2	−0.4	0.84×10^2	0.85×10^2	0.5
1800.0	0.91×10^1	0.91×10^1	−0.3	0.13×10^3	0.13×10^3	0.6
2200.0	0.84×10^1	0.84×10^1	−0.3	0.17×10^3	0.17×10^3	0.4
2600.0	0.79×10^1	0.79×10^1	−0.2	0.22×10^3	0.22×10^3	0.4
3000.0	0.76×10^1	0.76×10^1	−0.2	0.27×10^3	0.27×10^3	0.4
3400.0	0.73×10^1	0.73×10^1	−0.2	0.33×10^3	0.33×10^3	0.3

Table 7. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
2.0	0.63×10^3	0.60×10^3	–5.8	0.35×10^{-2}	0.26×10^{-2}	–26.2
2.4	0.60×10^3	0.57×10^3	–5.5	0.42×10^{-2}	0.33×10^{-2}	–21.1
2.8	0.57×10^3	0.54×10^3	–5.2	0.48×10^{-2}	0.40×10^{-2}	–17.3
3.2	0.54×10^3	0.51×10^3	–4.8	0.56×10^{-2}	0.48×10^{-2}	–14.4
3.6	0.51×10^3	0.49×10^3	–4.4	0.63×10^{-2}	0.56×10^{-2}	–12.0
4.0	0.48×10^3	0.46×10^3	–4.5	0.71×10^{-2}	0.64×10^{-2}	–10.1
4.8	0.44×10^3	0.43×10^3	–3.9	0.89×10^{-2}	0.82×10^{-2}	–7.3
5.6	0.41×10^3	0.39×10^3	–3.5	0.11×10^{-1}	0.10×10^{-1}	–5.3
6.4	0.38×10^3	0.36×10^3	–3.5	0.13×10^{-1}	0.12×10^{-1}	–3.9
7.2	0.35×10^3	0.34×10^3	–2.7	0.15×10^{-1}	0.15×10^{-1}	–2.9
8.0	0.33×10^3	0.32×10^3	–2.5	0.17×10^{-1}	0.17×10^{-1}	–2.1
8.8	0.31×10^3	0.30×10^3	–2.2	0.20×10^{-1}	0.20×10^{-1}	–1.6
9.6	0.29×10^3	0.29×10^3	–1.9	0.23×10^{-1}	0.22×10^{-1}	–1.2
10.4	0.28×10^3	0.27×10^3	–1.7	0.25×10^{-1}	0.25×10^{-1}	–0.9
11.2	0.26×10^3	0.26×10^3	–1.6	0.28×10^{-1}	0.28×10^{-1}	–0.6
12.0	0.25×10^3	0.25×10^3	–1.5	0.32×10^{-1}	0.31×10^{-1}	–0.4
14.0	0.23×10^3	0.23×10^3	–1.5	0.40×10^{-1}	0.40×10^{-1}	0.0
16.0	0.21×10^3	0.21×10^3	–1.5	0.49×10^{-1}	0.49×10^{-1}	0.3
18.0	0.19×10^3	0.19×10^3	–1.5	0.59×10^{-1}	0.59×10^{-1}	0.5
20.0	0.18×10^3	0.18×10^3	–1.4	0.70×10^{-1}	0.70×10^{-1}	0.7
22.0	0.17×10^3	0.17×10^3	–1.4	0.81×10^{-1}	0.82×10^{-1}	0.8
24.0	0.16×10^3	0.16×10^3	–1.3	0.94×10^{-1}	0.94×10^{-1}	0.9
26.0	0.15×10^3	0.15×10^3	–1.2	0.11×10^0	0.11×10^0	0.9
28.0	0.14×10^3	0.14×10^3	–1.1	0.12×10^0	0.12×10^0	0.9
30.0	0.14×10^3	0.13×10^3	–1.0	0.14×10^0	0.14×10^0	0.9
40.0	0.11×10^3	0.11×10^3	–0.9	0.22×10^0	0.22×10^0	0.9
60.0	0.81×10^2	0.80×10^2	–0.9	0.43×10^0	0.44×10^0	1.0
80.0	0.65×10^2	0.65×10^2	–1.0	0.71×10^0	0.72×10^0	1.0
100.0	0.55×10^2	0.55×10^2	–1.1	0.11×10^1	0.11×10^1	1.0
120.0	0.48×10^2	0.48×10^2	–1.1	0.14×10^1	0.15×10^1	1.0
200.0	0.33×10^2	0.32×10^2	–1.2	0.35×10^1	0.35×10^1	1.1
280.0	0.25×10^2	0.25×10^2	–1.3	0.63×10^1	0.64×10^1	1.2
360.0	0.21×10^2	0.21×10^2	–1.3	0.98×10^1	0.99×10^1	1.2
500.0	0.17×10^2	0.17×10^2	–1.4	0.17×10^2	0.18×10^2	1.3
700.0	0.13×10^2	0.13×10^2	–1.3	0.31×10^2	0.31×10^2	1.3
900.0	0.12×10^2	0.11×10^2	–1.3	0.47×10^2	0.48×10^2	1.4
1100.0	0.10×10^2	0.10×10^2	–1.2	0.66×10^2	0.66×10^2	1.3
1400.0	0.90×10^1	0.89×10^1	–1.2	0.97×10^2	0.98×10^2	1.3
1800.0	0.80×10^1	0.79×10^1	–1.1	0.14×10^3	0.15×10^3	1.2
2200.0	0.74×10^1	0.73×10^1	–1.0	0.20×10^3	0.20×10^3	1.2
2600.0	0.70×10^1	0.69×10^1	–1.0	0.25×10^3	0.26×10^3	1.2
3000.0	0.67×10^1	0.66×10^1	–1.0	0.31×10^3	0.31×10^3	1.1
3400.0	0.65×10^1	0.64×10^1	–1.0	0.37×10^3	0.38×10^3	1.1

Table 7. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
1.6	0.36×10^3	0.32×10^3	–11.3	0.60×10^{-2}	0.44×10^{-2}	–26.2
2.0	0.33×10^3	0.31×10^3	–8.2	0.71×10^{-2}	0.57×10^{-2}	–20.2
2.4	0.31×10^3	0.29×10^3	–5.8	0.84×10^{-2}	0.70×10^{-2}	–16.1
2.8	0.30×10^3	0.28×10^3	–3.9	0.97×10^{-2}	0.84×10^{-2}	–13.2
3.2	0.28×10^3	0.27×10^3	–2.6	0.11×10^{-1}	0.99×10^{-2}	–11.1
3.6	0.27×10^3	0.26×10^3	–1.7	0.13×10^{-1}	0.11×10^{-1}	–9.6
4.0	0.26×10^3	0.25×10^3	–1.0	0.14×10^{-1}	0.13×10^{-1}	–8.4
4.8	0.24×10^3	0.24×10^3	–0.2	0.17×10^{-1}	0.16×10^{-1}	–6.6
5.6	0.22×10^3	0.22×10^3	0.2	0.21×10^{-1}	0.20×10^{-1}	–5.4
6.4	0.21×10^3	0.21×10^3	0.5	0.25×10^{-1}	0.24×10^{-1}	–4.6
7.2	0.19×10^3	0.20×10^3	0.6	0.29×10^{-1}	0.27×10^{-1}	–4.2
8.0	0.18×10^3	0.19×10^3	0.8	0.33×10^{-1}	0.32×10^{-1}	–3.7
8.8	0.18×10^3	0.18×10^3	1.1	0.37×10^{-1}	0.36×10^{-1}	–3.5
9.6	0.17×10^3	0.17×10^3	1.3	0.42×10^{-1}	0.41×10^{-1}	–3.2
10.4	0.16×10^3	0.16×10^3	1.4	0.47×10^{-1}	0.46×10^{-1}	–3.0
11.2	0.15×10^3	0.16×10^3	1.4	0.52×10^{-1}	0.51×10^{-1}	–2.8
12.0	0.15×10^3	0.15×10^3	1.4	0.57×10^{-1}	0.56×10^{-1}	–2.7
14.0	0.14×10^3	0.14×10^3	1.0	0.72×10^{-1}	0.70×10^{-1}	–2.4
16.0	0.13×10^3	0.13×10^3	0.7	0.87×10^{-1}	0.85×10^{-1}	–2.1
18.0	0.12×10^3	0.12×10^3	0.6	0.10×10^0	0.10×10^0	–1.9
20.0	0.11×10^3	0.11×10^3	0.4	0.12×10^0	0.12×10^0	–1.7
22.0	0.11×10^3	0.11×10^3	0.2	0.14×10^0	0.14×10^0	–1.5
24.0	1.00×10^2	1.00×10^2	0.0	0.16×10^0	0.16×10^0	–1.3
26.0	0.95×10^2	0.95×10^2	–0.2	0.18×10^0	0.18×10^0	–1.1
28.0	0.91×10^2	0.91×10^2	–0.3	0.20×10^0	0.20×10^0	–1.0
38.0	0.75×10^2	0.75×10^2	–1.0	0.32×10^0	0.32×10^0	–0.4
56.0	0.59×10^2	0.58×10^2	–1.5	0.60×10^0	0.60×10^0	0.3
76.0	0.47×10^2	0.47×10^2	–1.0	0.98×10^0	0.99×10^0	0.6
96.0	0.40×10^2	0.40×10^2	–1.0	0.14×10^1	0.15×10^1	0.7
116.0	0.35×10^2	0.35×10^2	–1.0	0.20×10^1	0.20×10^1	0.8
192.0	0.25×10^2	0.24×10^2	–1.2	0.46×10^1	0.47×10^1	1.0
272.0	0.19×10^2	0.19×10^2	–1.3	0.83×10^1	0.84×10^1	1.1
352.0	0.16×10^2	0.16×10^2	–1.6	0.13×10^2	0.13×10^2	1.2
480.0	0.13×10^2	0.13×10^2	–1.9	0.22×10^2	0.22×10^2	1.5
680.0	0.10×10^2	0.10×10^2	–2.2	0.39×10^2	0.40×10^2	1.7
880.0	0.90×10^1	0.88×10^1	–2.2	0.60×10^2	0.61×10^2	1.9
1080.0	0.80×10^1	0.78×10^1	–2.2	0.84×10^2	0.85×10^2	2.0
1360.0	0.71×10^1	0.69×10^1	–2.1	0.12×10^3	0.12×10^3	2.1
1760.0	0.63×10^1	0.62×10^1	–2.1	0.18×10^3	0.19×10^3	2.1
2160.0	0.58×10^1	0.57×10^1	–2.1	0.25×10^3	0.25×10^3	2.1
2560.0	0.55×10^1	0.54×10^1	–2.1	0.32×10^3	0.33×10^3	2.1
2960.0	0.53×10^1	0.52×10^1	–2.2	0.39×10^3	0.40×10^3	2.1

Table 7. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 841.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
1.6	0.39×10^{3}	0.28×10^{3}	–28.0	0.49×10^{-2}	0.53×10^{-2}	8.4
2.0	0.36×10^{3}	0.28×10^{3}	–22.0	0.60×10^{-2}	0.68×10^{-2}	12.8
2.4	0.33×10^{3}	0.27×10^{3}	–17.4	0.72×10^{-2}	0.82×10^{-2}	14.8
2.8	0.30×10^{3}	0.26×10^{3}	–14.0	0.84×10^{-2}	0.97×10^{-2}	15.3
3.2	0.29×10^{3}	0.25×10^{3}	–11.4	0.98×10^{-2}	0.11×10^{-1}	15.2
3.6	0.27×10^{3}	0.24×10^{3}	–9.4	0.11×10^{-1}	0.13×10^{-1}	14.7
4.0	0.26×10^{3}	0.24×10^{3}	–7.9	0.13×10^{-1}	0.15×10^{-1}	14.1
4.8	0.23×10^{3}	0.22×10^{3}	–5.6	0.16×10^{-1}	0.18×10^{-1}	12.8
5.6	0.21×10^{3}	0.21×10^{3}	–4.1	0.20×10^{-1}	0.22×10^{-1}	11.5
6.4	0.20×10^{3}	0.19×10^{3}	–3.0	0.24×10^{-1}	0.26×10^{-1}	10.3
7.2	0.19×10^{3}	0.18×10^{3}	–2.1	0.28×10^{-1}	0.30×10^{-1}	8.9
8.0	0.18×10^{3}	0.17×10^{3}	–1.6	0.32×10^{-1}	0.35×10^{-1}	8.0
8.8	0.17×10^{3}	0.17×10^{3}	–0.9	0.37×10^{-1}	0.39×10^{-1}	7.0
9.6	0.16×10^{3}	0.16×10^{3}	–0.5	0.42×10^{-1}	0.44×10^{-1}	6.2
10.4	0.15×10^{3}	0.15×10^{3}	–0.2	0.47×10^{-1}	0.50×10^{-1}	5.6
11.2	0.15×10^{3}	0.15×10^{3}	–0.1	0.52×10^{-1}	0.55×10^{-1}	5.0
12.0	0.14×10^{3}	0.14×10^{3}	0.0	0.58×10^{-1}	0.61×10^{-1}	4.6
14.0	0.13×10^{3}	0.13×10^{3}	–0.2	0.73×10^{-1}	0.76×10^{-1}	3.7
16.0	0.12×10^{3}	0.12×10^{3}	–0.3	0.89×10^{-1}	0.92×10^{-1}	3.0
18.0	0.11×10^{3}	0.11×10^{3}	–0.4	0.11×10^{0}	0.11×10^{0}	2.6
20.0	0.11×10^{3}	0.10×10^{3}	–0.4	0.13×10^{0}	0.13×10^{0}	2.3
22.0	0.99×10^{2}	0.98×10^{2}	–0.3	0.15×10^{0}	0.15×10^{0}	2.0
24.0	0.94×10^{2}	0.93×10^{2}	–0.3	0.17×10^{0}	0.17×10^{0}	1.8
26.0	0.89×10^{2}	0.89×10^{2}	–0.2	0.19×10^{0}	0.19×10^{0}	1.6
28.0	0.85×10^{2}	0.85×10^{2}	–0.1	0.21×10^{0}	0.21×10^{0}	1.5
38.0	0.70×10^{2}	0.70×10^{2}	0.3	0.34×10^{0}	0.34×10^{0}	0.9
56.0	0.54×10^{2}	0.54×10^{2}	0.4	0.64×10^{0}	0.64×10^{0}	0.3
76.0	0.44×10^{2}	0.44×10^{2}	0.4	0.11×10^{1}	0.11×10^{1}	0.0
96.0	0.37×10^{2}	0.38×10^{2}	0.4	0.16×10^{1}	0.16×10^{1}	–0.1
116.0	0.33×10^{2}	0.33×10^{2}	0.4	0.21×10^{1}	0.21×10^{1}	–0.2
192.0	0.23×10^{2}	0.23×10^{2}	0.3	0.50×10^{1}	0.49×10^{1}	–0.3
272.0	0.18×10^{2}	0.18×10^{2}	0.2	0.89×10^{1}	0.89×10^{1}	–0.3
352.0	0.15×10^{2}	0.15×10^{2}	–0.1	0.14×10^{2}	0.14×10^{2}	–0.2
480.0	0.12×10^{2}	0.12×10^{2}	–0.5	0.23×10^{2}	0.23×10^{2}	0.0
680.0	0.98×10^{1}	0.97×10^{1}	–0.8	0.42×10^{2}	0.42×10^{2}	0.3
880.0	0.84×10^{1}	0.83×10^{1}	–0.9	0.64×10^{2}	0.64×10^{2}	0.5
1080.0	0.75×10^{1}	0.74×10^{1}	–0.9	0.89×10^{2}	0.90×10^{2}	0.6
1360.0	0.67×10^{1}	0.66×10^{1}	–0.9	0.13×10^{3}	0.13×10^{3}	0.7
1760.0	0.59×10^{1}	0.59×10^{1}	–0.9	0.19×10^{3}	0.19×10^{3}	0.8
2160.0	0.55×10^{1}	0.54×10^{1}	–0.9	0.26×10^{3}	0.27×10^{3}	0.8
2560.0	0.52×10^{1}	0.51×10^{1}	–1.0	0.34×10^{3}	0.34×10^{3}	0.8
2960.0	0.50×10^{1}	0.49×10^{1}	–1.0	0.42×10^{3}	0.42×10^{3}	0.9

Table 7. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 69.04 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
2.0	0.15×10^4	0.17×10^4	12.1	0.12×10^{-2}	0.73×10^{-3}	–39.8
2.4	0.14×10^4	0.15×10^4	10.8	0.15×10^{-2}	0.99×10^{-3}	–34.3
2.8	0.12×10^4	0.14×10^4	9.8	0.18×10^{-2}	0.13×10^{-2}	–30.0
3.2	0.11×10^4	0.12×10^4	8.8	0.22×10^{-2}	0.16×10^{-2}	–26.6
3.6	0.11×10^4	0.11×10^4	8.0	0.25×10^{-2}	0.19×10^{-2}	–23.8
4.0	0.99×10^3	0.11×10^4	7.2	0.29×10^{-2}	0.23×10^{-2}	–21.6
4.8	0.88×10^3	0.93×10^3	5.8	0.38×10^{-2}	0.31×10^{-2}	–18.0
5.6	0.80×10^3	0.84×10^3	4.5	0.47×10^{-2}	0.40×10^{-2}	–15.2
6.4	0.74×10^3	0.76×10^3	3.3	0.58×10^{-2}	0.50×10^{-2}	–13.1
7.2	0.68×10^3	0.70×10^3	2.0	0.69×10^{-2}	0.61×10^{-2}	–11.6
8.0	0.64×10^3	0.64×10^3	1.4	0.81×10^{-2}	0.73×10^{-2}	–10.1
8.8	0.60×10^3	0.60×10^3	0.9	0.94×10^{-2}	0.86×10^{-2}	–8.7
9.6	0.56×10^3	0.56×10^3	0.5	0.11×10^{-1}	1.00×10^{-2}	–7.6
10.4	0.53×10^3	0.53×10^3	0.2	0.12×10^{-1}	0.11×10^{-1}	–6.7
11.2	0.50×10^3	0.50×10^3	0.0	0.14×10^{-1}	0.13×10^{-1}	–5.9
12.0	0.48×10^3	0.48×10^3	–0.2	0.15×10^{-1}	0.15×10^{-1}	–5.3
14.0	0.42×10^3	0.42×10^3	–0.3	0.20×10^{-1}	0.19×10^{-1}	–4.1
16.0	0.38×10^3	0.38×10^3	–0.4	0.25×10^{-1}	0.24×10^{-1}	–3.3
18.0	0.35×10^3	0.35×10^3	–0.4	0.30×10^{-1}	0.30×10^{-1}	–2.7
20.0	0.32×10^3	0.32×10^3	–0.3	0.36×10^{-1}	0.36×10^{-1}	–2.2
22.0	0.30×10^3	0.30×10^3	–0.3	0.43×10^{-1}	0.42×10^{-1}	–1.7
24.0	0.28×10^3	0.28×10^3	–0.2	0.50×10^{-1}	0.49×10^{-1}	–1.4
26.0	0.26×10^3	0.26×10^3	–0.2	0.57×10^{-1}	0.57×10^{-1}	–1.2
28.0	0.25×10^3	0.25×10^3	–0.1	0.65×10^{-1}	0.64×10^{-1}	–1.0
30.0	0.23×10^3	0.23×10^3	–0.1	0.74×10^{-1}	0.73×10^{-1}	–1.0
40.0	0.18×10^3	0.18×10^3	–0.1	0.12×10^0	0.12×10^0	–0.4
60.0	0.13×10^3	0.13×10^3	–0.2	0.25×10^0	0.25×10^0	0.2
80.0	0.11×10^3	0.11×10^3	–0.3	0.42×10^0	0.42×10^0	0.0
100.0	0.88×10^2	0.88×10^2	–0.3	0.63×10^0	0.63×10^0	0.0
120.0	0.76×10^2	0.76×10^2	–0.3	0.88×10^0	0.88×10^0	0.1
200.0	0.50×10^2	0.50×10^2	–0.3	0.22×10^1	0.22×10^1	0.2
280.0	0.39×10^2	0.39×10^2	–0.2	0.41×10^1	0.41×10^1	0.1
360.0	0.32×10^2	0.32×10^2	–0.2	0.63×10^1	0.64×10^1	0.3
500.0	0.25×10^2	0.25×10^2	–0.1	0.11×10^2	0.11×10^2	0.1
700.0	0.20×10^2	0.20×10^2	0.0	0.21×10^2	0.21×10^2	0.1
900.0	0.17×10^2	0.17×10^2	0.0	0.32×10^2	0.32×10^2	0.1
1100.0	0.15×10^2	0.15×10^2	0.0	0.44×10^2	0.44×10^2	0.0
1400.0	0.13×10^2	0.13×10^2	0.2	0.66×10^2	0.66×10^2	–0.1
1800.0	0.12×10^2	0.12×10^2	0.2	0.99×10^2	0.99×10^2	0.0
2200.0	0.11×10^2	0.11×10^2	0.2	0.14×10^3	0.14×10^3	0.0
2600.0	0.10×10^2	0.10×10^2	0.2	0.17×10^3	0.17×10^3	–0.1
3000.0	0.96×10^1	0.96×10^1	0.2	0.22×10^3	0.21×10^3	–0.1
3400.0	0.92×10^1	0.93×10^1	0.1	0.26×10^3	0.26×10^3	–0.2

Table 8. Stopping Power and Energy Range Calculated by LaRC and Bichsel Codes for ^{12}C Ions on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
6.0	0.77×10^4	0.71×10^4	−7.3	0.86×10^{-3}	0.65×10^{-3}	−25.2
7.2	0.72×10^4	0.68×10^4	−6.7	0.10×10^{-2}	0.82×10^{-3}	−20.0
8.4	0.68×10^4	0.65×10^4	−5.2	0.12×10^{-2}	0.10×10^{-2}	−16.2
9.6	0.65×10^4	0.62×10^4	−4.0	0.14×10^{-2}	0.12×10^{-2}	−13.5
10.8	0.62×10^4	0.60×10^4	−3.1	0.16×10^{-2}	0.14×10^{-2}	−11.4
12.0	0.59×10^4	0.58×10^4	−2.4	0.18×10^{-2}	0.16×10^{-2}	−9.8
14.4	0.55×10^4	0.54×10^4	−1.3	0.22×10^{-2}	0.20×10^{-2}	−7.5
16.8	0.51×10^4	0.51×10^4	−0.4	0.26×10^{-2}	0.25×10^{-2}	−6.0
19.2	0.48×10^4	0.48×10^4	0.2	0.31×10^{-2}	0.30×10^{-2}	−5.0
21.6	0.45×10^4	0.46×10^4	0.6	0.36×10^{-2}	0.35×10^{-2}	−4.4
24.0	0.43×10^4	0.43×10^4	0.9	0.42×10^{-2}	0.40×10^{-2}	−3.9
26.4	0.41×10^4	0.41×10^4	1.0	0.48×10^{-2}	0.46×10^{-2}	−3.5
28.8	0.39×10^4	0.39×10^4	1.1	0.54×10^{-2}	0.52×10^{-2}	−3.3
31.2	0.37×10^4	0.38×10^4	1.1	0.60×10^{-2}	0.58×10^{-2}	−3.0
33.6	0.36×10^4	0.36×10^4	1.2	0.66×10^{-2}	0.65×10^{-2}	−2.9
36.0	0.34×10^4	0.35×10^4	1.2	0.73×10^{-2}	0.71×10^{-2}	−2.7
42.0	0.31×10^4	0.32×10^4	1.1	0.92×10^{-2}	0.90×10^{-2}	−2.4
48.0	0.29×10^4	0.29×10^4	1.0	0.11×10^{-1}	0.11×10^{-1}	−2.1
54.0	0.26×10^4	0.27×10^4	0.8	0.13×10^{-1}	0.13×10^{-1}	−1.9
60.0	0.25×10^4	0.25×10^4	0.7	0.16×10^{-1}	0.16×10^{-1}	−1.7
66.0	0.23×10^4	0.23×10^4	0.5	0.18×10^{-1}	0.18×10^{-1}	−1.6
72.0	0.22×10^4	0.22×10^4	0.4	0.21×10^{-1}	0.21×10^{-1}	−1.4
78.0	0.20×10^4	0.20×10^4	0.3	0.24×10^{-1}	0.24×10^{-1}	−1.3
84.0	0.19×10^4	0.19×10^4	0.1	0.27×10^{-1}	0.27×10^{-1}	−1.2
90.0	0.18×10^4	0.18×10^4	0.0	0.30×10^{-1}	0.30×10^{-1}	−1.1
120.0	0.15×10^4	0.15×10^4	−0.4	0.49×10^{-1}	0.48×10^{-1}	−0.6
180.0	0.11×10^4	0.11×10^4	−0.8	0.98×10^{-1}	0.98×10^{-1}	0.2
240.0	0.84×10^3	0.83×10^3	−0.9	0.16×10^0	0.16×10^0	0.4
300.0	0.70×10^3	0.70×10^3	−0.9	0.24×10^0	0.24×10^0	0.5
360.0	0.61×10^3	0.60×10^3	−0.9	0.33×10^0	0.34×10^0	0.6
600.0	0.40×10^3	0.40×10^3	−0.7	0.83×10^0	0.84×10^0	0.7
840.0	0.31×10^3	0.31×10^3	−0.6	0.15×10^1	0.15×10^1	0.7
1080.0	0.26×10^3	0.25×10^3	−0.5	0.24×10^1	0.24×10^1	0.7
1500.0	0.20×10^3	0.20×10^3	−0.4	0.43×10^1	0.43×10^1	0.6
2100.0	0.16×10^3	0.16×10^3	−0.3	0.77×10^1	0.77×10^1	0.4
2700.0	0.14×10^3	0.13×10^3	−0.3	0.12×10^2	0.12×10^2	0.4
3300.0	0.12×10^3	0.12×10^3	−0.1	0.17×10^2	0.17×10^2	0.3
4200.0	0.11×10^3	0.11×10^3	−0.1	0.25×10^2	0.25×10^2	0.3
5400.0	0.93×10^2	0.93×10^2	0.0	0.37×10^2	0.37×10^2	0.2
6600.0	0.85×10^2	0.85×10^2	0.1	0.50×10^2	0.50×10^2	0.1
7800.0	0.80×10^2	0.80×10^2	0.1	0.65×10^2	0.65×10^2	0.1
9000.0	0.77×10^2	0.77×10^2	0.2	0.80×10^2	0.80×10^2	0.0
10200.0	0.74×10^2	0.74×10^2	0.1	0.96×10^2	0.96×10^2	0.0
11400.0	0.72×10^2	0.72×10^2	0.0	0.11×10^3	0.11×10^3	0.0

Table 8. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
6.0	0.52×10^4	0.51×10^4	–3.3	0.14×10^{-2}	0.11×10^{-2}	–20.3
7.2	0.51×10^4	0.50×10^4	–1.8	0.16×10^{-2}	0.14×10^{-2}	–17.0
8.4	0.49×10^4	0.49×10^4	–1.0	0.19×10^{-2}	0.16×10^{-2}	–14.6
9.6	0.48×10^4	0.48×10^4	–0.5	0.21×10^{-2}	0.18×10^{-2}	–12.7
10.8	0.46×10^4	0.46×10^4	–0.1	0.24×10^{-2}	0.21×10^{-2}	–11.4
12.0	0.45×10^4	0.45×10^4	0.1	0.26×10^{-2}	0.24×10^{-2}	–10.2
14.4	0.42×10^4	0.42×10^4	0.5	0.32×10^{-2}	0.29×10^{-2}	–8.5
16.8	0.40×10^4	0.40×10^4	0.9	0.38×10^{-2}	0.35×10^{-2}	–7.2
19.2	0.38×10^4	0.38×10^4	1.5	0.44×10^{-2}	0.41×10^{-2}	–6.4
21.6	0.37×10^4	0.36×10^4	2.0	0.51×10^{-2}	0.48×10^{-2}	–5.8
24.0	0.34×10^4	0.35×10^4	2.3	0.57×10^{-2}	0.54×10^{-2}	–5.3
26.4	0.32×10^4	0.33×10^4	2.6	0.65×10^{-2}	0.61×10^{-2}	–4.9
28.8	0.31×10^4	0.32×10^4	2.7	0.72×10^{-2}	0.69×10^{-2}	–4.7
31.2	0.30×10^4	0.30×10^4	2.8	0.80×10^{-2}	0.77×10^{-2}	–4.5
33.6	0.28×10^4	0.29×10^4	2.8	0.89×10^{-2}	0.85×10^{-2}	–4.3
36.0	0.27×10^4	0.28×10^4	2.7	0.97×10^{-2}	0.93×10^{-2}	–4.1
42.0	0.25×10^4	0.26×10^4	2.4	0.12×10^{-1}	0.12×10^{-1}	–3.9
48.0	0.23×10^4	0.23×10^4	2.0	0.15×10^{-1}	0.14×10^{-1}	–3.6
54.0	0.21×10^4	0.22×10^4	1.7	0.17×10^{-1}	0.17×10^{-1}	–3.3
60.0	0.20×10^4	0.20×10^4	1.4	0.20×10^{-1}	0.20×10^{-1}	–3.1
66.0	0.19×10^4	0.19×10^4	1.1	0.23×10^{-1}	0.23×10^{-1}	–2.8
72.0	0.18×10^4	0.18×10^4	0.9	0.27×10^{-1}	0.26×10^{-1}	–2.5
78.0	0.17×10^4	0.17×10^4	0.7	0.30×10^{-1}	0.29×10^{-1}	–2.3
84.0	0.16×10^4	0.16×10^4	0.5	0.34×10^{-1}	0.33×10^{-1}	–2.1
90.0	0.15×10^4	0.15×10^4	0.4	0.38×10^{-1}	0.37×10^{-1}	–2.0
120.0	0.12×10^4	0.12×10^4	–0.1	0.60×10^{-1}	0.59×10^{-1}	–1.2
180.0	0.89×10^3	0.88×10^3	–0.7	0.12×10^0	0.12×10^0	–0.2
240.0	0.71×10^3	0.71×10^3	–0.7	0.20×10^0	0.20×10^0	0.0
300.0	0.60×10^3	0.59×10^3	–0.7	0.29×10^0	0.29×10^0	0.2
360.0	0.52×10^3	0.51×10^3	–0.7	0.40×10^0	0.40×10^0	0.3
600.0	0.35×10^3	0.34×10^3	–0.7	0.98×10^0	0.98×10^0	0.6
840.0	0.27×10^3	0.27×10^3	–0.6	0.18×10^1	0.18×10^1	0.5
1080.0	0.22×10^3	0.22×10^3	–0.7	0.28×10^1	0.28×10^1	0.7
1500.0	0.18×10^3	0.17×10^3	–0.5	0.49×10^1	0.50×10^1	0.5
2100.0	0.14×10^3	0.14×10^3	–0.3	0.88×10^1	0.89×10^1	0.5
2700.0	0.12×10^3	0.12×10^3	–0.3	0.14×10^2	0.14×10^2	0.4
3300.0	0.11×10^3	0.11×10^3	–0.2	0.19×10^2	0.19×10^2	0.4
4200.0	0.92×10^2	0.92×10^2	–0.1	0.28×10^2	0.28×10^2	0.2
5400.0	0.82×10^2	0.82×10^2	0.0	0.42×10^2	0.42×10^2	0.2
6600.0	0.76×10^2	0.76×10^2	0.1	0.57×10^2	0.57×10^2	0.1
7800.0	0.71×10^2	0.71×10^2	0.2	0.74×10^2	0.74×10^2	0.1
9000.0	0.68×10^2	0.68×10^2	0.2	0.91×10^2	0.91×10^2	0.1
10200.0	0.66×10^2	0.66×10^2	0.2	0.11×10^3	0.11×10^3	–0.1
11400.0	0.64×10^2	0.64×10^2	0.0	0.13×10^3	0.13×10^3	–0.1

Table 8. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV; RSTAN code

Energy, MeV	Stopping power: LaRC code	Stopping power: RSTAN code	Difference, percent	Energy range: LaRC code	Energy range: RSTAN code	Difference, percent
6.0	0.34×10^4	0.25×10^4	–25.1	0.27×10^{-2}	0.39×10^{-2}	41.6
7.2	0.34×10^4	0.27×10^4	–19.4	0.31×10^{-2}	0.43×10^{-2}	40.2
8.4	0.33×10^4	0.28×10^4	–15.0	0.34×10^{-2}	0.47×10^{-2}	38.2
9.6	0.33×10^4	0.29×10^4	–11.5	0.38×10^{-2}	0.52×10^{-2}	36.0
10.8	0.32×10^4	0.29×10^4	–8.6	0.42×10^{-2}	0.56×10^{-2}	33.8
12.0	0.31×10^4	0.29×10^4	–7.5	0.46×10^{-2}	0.60×10^{-2}	31.7
14.4	0.30×10^4	0.29×10^4	–4.2	0.53×10^{-2}	0.68×10^{-2}	27.9
16.8	0.29×10^4	0.28×10^4	–2.0	0.62×10^{-2}	0.77×10^{-2}	24.6
19.2	0.27×10^4	0.27×10^4	–1.1	0.70×10^{-2}	0.85×10^{-2}	21.8
21.6	0.26×10^4	0.26×10^4	0.3	0.79×10^{-2}	0.94×10^{-2}	19.5
24.0	0.25×10^4	0.25×10^4	1.0	0.88×10^{-2}	0.10×10^{-1}	17.4
26.4	0.24×10^4	0.24×10^4	1.7	0.98×10^{-2}	0.11×10^{-1}	15.4
28.8	0.23×10^4	0.24×10^4	2.1	0.11×10^{-1}	0.12×10^{-1}	13.8
31.2	0.22×10^4	0.23×10^4	2.5	0.12×10^{-1}	0.13×10^{-1}	12.3
33.6	0.21×10^4	0.22×10^4	2.5	0.13×10^{-1}	0.15×10^{-1}	11.1
36.0	0.21×10^4	0.21×10^4	2.6	0.14×10^{-1}	0.16×10^{-1}	10.0
42.0	0.19×10^4	0.20×10^4	2.7	0.17×10^{-1}	0.19×10^{-1}	7.8
48.0	0.18×10^4	0.18×10^4	2.5	0.20×10^{-1}	0.22×10^{-1}	6.2
54.0	0.17×10^4	0.17×10^4	2.2	0.24×10^{-1}	0.25×10^{-1}	4.9
60.0	0.16×10^4	0.16×10^4	2.0	0.28×10^{-1}	0.29×10^{-1}	4.0
66.0	0.15×10^4	0.15×10^4	1.7	0.32×10^{-1}	0.33×10^{-1}	3.3
72.0	0.14×10^4	0.14×10^4	1.5	0.36×10^{-1}	0.37×10^{-1}	2.7
78.0	0.13×10^4	0.13×10^4	1.3	0.40×10^{-1}	0.41×10^{-1}	2.2
84.0	0.13×10^4	0.13×10^4	1.1	0.45×10^{-1}	0.46×10^{-1}	1.9
90.0	0.12×10^4	0.12×10^4	0.9	0.50×10^{-1}	0.51×10^{-1}	1.6
120.0	0.98×10^3	0.98×10^3	0.2	0.78×10^{-1}	0.79×10^{-1}	0.8
180.0	0.73×10^3	0.72×10^3	–0.6	0.15×10^0	0.15×10^0	0.7
240.0	0.59×10^3	0.58×10^3	–0.8	0.24×10^0	0.24×10^0	0.6
300.0	0.50×10^3	0.49×10^3	–0.9	0.35×10^0	0.36×10^0	0.7
360.0	0.43×10^3	0.43×10^3	–1.0	0.48×10^0	0.49×10^0	0.8
600.0	0.29×10^3	0.29×10^3	–1.1	0.12×10^1	0.12×10^1	0.9
840.0	0.23×10^3	0.23×10^3	–1.1	0.21×10^1	0.21×10^1	1.0
1080.0	0.19×10^3	0.19×10^3	–1.1	0.33×10^1	0.33×10^1	1.0
1500.0	0.15×10^3	0.15×10^3	–1.1	0.58×10^1	0.58×10^1	1.1
2100.0	0.12×10^3	0.12×10^3	–1.0	0.10×10^2	0.10×10^2	1.1
2700.0	0.10×10^3	0.10×10^3	–1.0	0.16×10^2	0.16×10^2	1.1
3300.0	0.92×10^2	0.91×10^2	–0.9	0.22×10^2	0.22×10^2	1.0
4200.0	0.81×10^2	0.80×10^2	–0.8	0.32×10^2	0.33×10^2	1.0
5400.0	0.72×10^2	0.72×10^2	–0.7	0.48×10^2	0.49×10^2	0.9
6600.0	0.67×10^2	0.66×10^2	–0.6	0.66×10^2	0.66×10^2	0.8
7800.0	0.63×10^2	0.63×10^2	–0.6	0.84×10^2	0.85×10^2	0.8
9000.0	0.60×10^2	0.60×10^2	–0.5	0.10×10^3	0.10×10^3	0.7
10200.0	0.58×10^2	0.58×10^2	–0.5	0.12×10^3	0.13×10^3	0.7
11400.0	0.57×10^2	0.57×10^2	–0.7	0.15×10^3	0.15×10^3	0.7

Table 8. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
4.8	0.18×10^4	0.16×10^4	–12.3	0.50×10^{-2}	0.28×10^{-2}	–43.5
6.0	0.18×10^4	0.15×10^4	–14.1	0.56×10^{-2}	0.36×10^{-2}	–36.4
7.2	0.18×10^4	0.15×10^4	–13.5	0.63×10^{-2}	0.44×10^{-2}	–30.8
8.4	0.17×10^4	0.15×10^4	–12.2	0.70×10^{-2}	0.52×10^{-2}	–26.3
9.6	0.17×10^4	0.15×10^4	–10.7	0.77×10^{-2}	0.60×10^{-2}	–22.7
10.8	0.17×10^4	0.15×10^4	–9.2	0.84×10^{-2}	0.68×10^{-2}	–19.9
12.0	0.17×10^4	0.15×10^4	–7.9	0.91×10^{-2}	0.75×10^{-2}	–17.5
14.4	0.16×10^4	0.15×10^4	–5.4	0.11×10^{-1}	0.91×10^{-2}	–14.1
16.8	0.16×10^4	0.15×10^4	–3.4	0.12×10^{-1}	0.11×10^{-1}	–11.8
19.2	0.15×10^4	0.15×10^4	–1.7	0.14×10^{-1}	0.12×10^{-1}	–10.1
21.6	0.15×10^4	0.14×10^4	–0.5	0.15×10^{-1}	0.14×10^{-1}	–8.8
24.0	0.14×10^4	0.14×10^4	0.6	0.17×10^{-1}	0.16×10^{-1}	–8.0
26.4	0.14×10^4	0.14×10^4	1.7	0.19×10^{-1}	0.17×10^{-1}	–7.4
28.8	0.13×10^4	0.14×10^4	2.6	0.21×10^{-1}	0.19×10^{-1}	–6.9
31.2	0.13×10^4	0.13×10^4	3.2	0.22×10^{-1}	0.21×10^{-1}	–6.6
33.6	0.12×10^4	0.13×10^4	3.6	0.24×10^{-1}	0.23×10^{-1}	–6.3
36.0	0.12×10^4	0.13×10^4	3.9	0.26×10^{-1}	0.25×10^{-1}	–6.1
42.0	0.11×10^4	0.12×10^4	4.0	0.31×10^{-1}	0.30×10^{-1}	–5.7
48.0	0.11×10^4	0.11×10^4	3.9	0.37×10^{-1}	0.35×10^{-1}	–5.4
54.0	0.10×10^4	0.11×10^4	3.8	0.43×10^{-1}	0.40×10^{-1}	–5.2
60.0	0.96×10^3	0.99×10^3	3.6	0.49×10^{-1}	0.46×10^{-1}	–5.0
66.0	0.91×10^3	0.94×10^3	3.2	0.55×10^{-1}	0.53×10^{-1}	–4.8
72.0	0.87×10^3	0.90×10^3	2.9	0.62×10^{-1}	0.59×10^{-1}	–4.6
78.0	0.84×10^3	0.86×10^3	2.5	0.69×10^{-1}	0.66×10^{-1}	–4.4
84.0	0.80×10^3	0.82×10^3	2.2	0.76×10^{-1}	0.73×10^{-1}	–4.2
114.0	0.67×10^3	0.68×10^3	0.9	0.12×10^0	0.11×10^0	–3.2
168.0	0.53×10^3	0.52×10^3	–0.3	0.21×10^0	0.21×10^0	–1.9
228.0	0.43×10^3	0.43×10^3	0.1	0.34×10^0	0.33×10^0	–1.3
288.0	0.36×10^3	0.36×10^3	0.0	0.49×10^0	0.49×10^0	–0.9
348.0	0.32×10^3	0.32×10^3	–0.2	0.67×10^0	0.67×10^0	–0.6
576.0	0.22×10^3	0.22×10^3	–0.4	0.16×10^1	0.16×10^1	–0.1
816.0	0.17×10^3	0.17×10^3	–0.6	0.28×10^1	0.28×10^1	0.2
1056.0	0.15×10^3	0.14×10^3	–0.9	0.43×10^1	0.43×10^1	0.4
1440.0	0.12×10^3	0.12×10^3	–1.2	0.73×10^1	0.73×10^1	0.7
2040.0	0.94×10^2	0.93×10^2	–1.5	0.13×10^2	0.13×10^2	1.0
2640.0	0.81×10^2	0.79×10^2	–1.6	0.20×10^2	0.20×10^2	1.2
3240.0	0.72×10^2	0.71×10^2	–1.5	0.28×10^2	0.28×10^2	1.3
4080.0	0.64×10^2	0.63×10^2	–1.5	0.40×10^2	0.41×10^2	1.4
5280.0	0.57×10^2	0.56×10^2	–1.4	0.61×10^2	0.61×10^2	1.4
6480.0	0.52×10^2	0.52×10^2	–1.4	0.83×10^2	0.84×10^2	1.4
7680.0	0.49×10^2	0.49×10^2	–1.5	0.11×10^3	0.11×10^3	1.4
8880.0	0.47×10^2	0.47×10^2	–1.5	0.13×10^3	0.13×10^3	1.4

Table 8. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 841.00 eV; RSHEV code

Energy, MeV	Stopping power LaRC code	Stopping power RSHEV code	Difference, percent	Energy range LaRC code	Energy range RSHEV code	Difference, percent
4.8	0.20×10^4	0.14×10^4	–28.8	0.41×10^{-2}	0.34×10^{-2}	–18.6
6.0	0.19×10^4	0.14×10^4	–27.2	0.48×10^{-2}	0.42×10^{-2}	–11.0
7.2	0.18×10^4	0.14×10^4	–24.5	0.54×10^{-2}	0.51×10^{-2}	–5.6
8.4	0.18×10^4	0.14×10^4	–21.7	0.61×10^{-2}	0.60×10^{-2}	–1.7
9.6	0.17×10^4	0.14×10^4	–19.0	0.68×10^{-2}	0.68×10^{-2}	1.1
10.8	0.17×10^4	0.14×10^4	–16.6	0.75×10^{-2}	0.77×10^{-2}	3.1
12.0	0.17×10^4	0.14×10^4	–14.5	0.82×10^{-2}	0.85×10^{-2}	4.4
14.4	0.16×10^4	0.14×10^4	–10.7	0.97×10^{-2}	0.10×10^{-1}	6.0
16.8	0.15×10^4	0.14×10^4	–7.7	0.11×10^{-1}	0.12×10^{-1}	6.6
19.2	0.15×10^4	0.14×10^4	–5.3	0.13×10^{-1}	0.14×10^{-1}	6.7
21.6	0.14×10^4	0.14×10^4	–3.3	0.15×10^{-1}	0.16×10^{-1}	6.4
24.0	0.13×10^4	0.13×10^4	–1.8	0.16×10^{-1}	0.17×10^{-1}	6.1
26.4	0.13×10^4	0.13×10^4	–0.4	0.18×10^{-1}	0.19×10^{-1}	5.5
28.8	0.13×10^4	0.13×10^4	0.7	0.20×10^{-1}	0.21×10^{-1}	4.9
31.2	0.12×10^4	0.12×10^4	1.5	0.22×10^{-1}	0.23×10^{-1}	4.4
33.6	0.12×10^4	0.12×10^4	2.1	0.24×10^{-1}	0.25×10^{-1}	3.9
36.0	0.11×10^4	0.12×10^4	2.5	0.26×10^{-1}	0.27×10^{-1}	3.4
42.0	0.11×10^4	0.11×10^4	2.8	0.31×10^{-1}	0.32×10^{-1}	2.4
48.0	0.10×10^4	0.10×10^4	2.8	0.37×10^{-1}	0.38×10^{-1}	1.6
54.0	0.96×10^3	0.98×10^3	2.8	0.43×10^{-1}	0.44×10^{-1}	1.0
60.0	0.91×10^3	0.93×10^3	2.7	0.50×10^{-1}	0.50×10^{-1}	0.5
66.0	0.86×10^3	0.88×10^3	2.7	0.57×10^{-1}	0.57×10^{-1}	0.1
72.0	0.82×10^3	0.84×10^3	2.6	0.64×10^{-1}	0.64×10^{-1}	–0.2
78.0	0.78×10^3	0.80×10^3	2.6	0.71×10^{-1}	0.71×10^{-1}	–0.4
84.0	0.75×10^3	0.77×10^3	2.5	0.79×10^{-1}	0.79×10^{-1}	–0.6
114.0	0.62×10^3	0.64×10^3	2.2	0.12×10^0	0.12×10^0	–1.2
168.0	0.48×10^3	0.49×10^3	1.7	0.22×10^0	0.22×10^0	–1.4
228.0	0.39×10^3	0.40×10^3	1.5	0.36×10^0	0.36×10^0	–1.5
288.0	0.34×10^3	0.34×10^3	1.4	0.53×10^0	0.52×10^0	–1.5
348.0	0.29×10^3	0.30×10^3	1.3	0.72×10^0	0.71×10^0	–1.4
576.0	0.21×10^3	0.21×10^3	1.1	0.17×10^1	0.16×10^1	–1.3
816.0	0.16×10^3	0.16×10^3	0.9	0.30×10^1	0.30×10^1	–1.2
1056.0	0.14×10^3	0.14×10^3	0.6	0.46×10^1	0.46×10^1	–1.0
1440.0	0.11×10^3	0.11×10^3	0.2	0.78×10^1	0.77×10^1	–0.8
2040.0	0.88×10^2	0.88×10^2	–0.1	0.14×10^2	0.14×10^2	–0.4
2640.0	0.76×10^2	0.76×10^2	–0.3	0.21×10^2	0.21×10^2	–0.2
3240.0	0.68×10^2	0.67×10^2	–0.2	0.30×10^2	0.30×10^2	–0.1
4080.0	0.60×10^2	0.60×10^2	–0.2	0.43×10^2	0.43×10^2	0.0
5280.0	0.53×10^2	0.53×10^2	–0.2	0.64×10^2	0.64×10^2	0.1
6480.0	0.49×10^2	0.49×10^2	–0.2	0.88×10^2	0.88×10^2	0.1
7680.0	0.47×10^2	0.47×10^2	–0.3	0.11×10^3	0.11×10^3	0.1
8880.0	0.45×10^2	0.45×10^2	–0.3	0.14×10^3	0.14×10^3	0.2

Table 8. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 69.04 eV; RSTAN code

Energy, MeV	Stopping power, LaRC code	Stopping power, RSTAN code	Difference, percent	Energy range, LaRC code	Energy range, RSTAN code	Difference, percent
6.0	0.79×10^{4}	0.81×10^{4}	2.5	0.93×10^{-3}	0.59×10^{-3}	–36.3
7.2	0.75×10^{4}	0.78×10^{4}	2.9	0.11×10^{-2}	0.74×10^{-3}	–31.5
8.4	0.72×10^{4}	0.74×10^{4}	3.1	0.13×10^{-2}	0.90×10^{-3}	–27.7
9.6	0.69×10^{4}	0.71×10^{4}	3.2	0.14×10^{-2}	0.11×10^{-2}	–24.8
10.8	0.66×10^{4}	0.69×10^{4}	3.6	0.16×10^{-2}	0.12×10^{-2}	–22.4
12.0	0.64×10^{4}	0.66×10^{4}	3.6	0.18×10^{-2}	0.14×10^{-2}	–20.4
14.4	0.60×10^{4}	0.62×10^{4}	3.5	0.22×10^{-2}	0.18×10^{-2}	–17.3
16.8	0.57×10^{4}	0.58×10^{4}	3.3	0.26×10^{-2}	0.22×10^{-2}	–15.0
19.2	0.54×10^{4}	0.55×10^{4}	2.9	0.30×10^{-2}	0.26×10^{-2}	–13.3
21.6	0.51×10^{4}	0.52×10^{4}	2.1	0.35×10^{-2}	0.31×10^{-2}	–11.9
24.0	0.49×10^{4}	0.50×10^{4}	1.9	0.40×10^{-2}	0.35×10^{-2}	–10.7
26.4	0.46×10^{4}	0.47×10^{4}	1.7	0.45×10^{-2}	0.40×10^{-2}	–9.6
28.8	0.44×10^{4}	0.45×10^{4}	1.6	0.50×10^{-2}	0.46×10^{-2}	–8.7
31.2	0.42×10^{4}	0.43×10^{4}	1.5	0.55×10^{-2}	0.51×10^{-2}	–7.9
33.6	0.41×10^{4}	0.41×10^{4}	1.4	0.61×10^{-2}	0.57×10^{-2}	–7.3
36.0	0.39×10^{4}	0.40×10^{4}	1.3	0.67×10^{-2}	0.63×10^{-2}	–6.7
42.0	0.35×10^{4}	0.36×10^{4}	1.4	0.84×10^{-2}	0.79×10^{-2}	–5.8
48.0	0.32×10^{4}	0.33×10^{4}	1.3	0.10×10^{-1}	0.96×10^{-2}	–5.0
54.0	0.30×10^{4}	0.30×10^{4}	1.2	0.12×10^{-1}	0.12×10^{-1}	–4.4
60.0	0.28×10^{4}	0.28×10^{4}	1.0	0.14×10^{-1}	0.14×10^{-1}	–3.9
66.0	0.26×10^{4}	0.26×10^{4}	0.9	0.16×10^{-1}	0.16×10^{-1}	–3.4
72.0	0.24×10^{4}	0.25×10^{4}	0.8	0.19×10^{-1}	0.18×10^{-1}	–3.1
78.0	0.23×10^{4}	0.23×10^{4}	0.7	0.21×10^{-1}	0.21×10^{-1}	–2.8
84.0	0.22×10^{4}	0.22×10^{4}	0.6	0.24×10^{-1}	0.23×10^{-1}	–2.5
90.0	0.21×10^{4}	0.21×10^{4}	0.5	0.27×10^{-1}	0.26×10^{-1}	–2.4
120.0	0.17×10^{4}	0.17×10^{4}	0.0	0.43×10^{-1}	0.43×10^{-1}	–1.5
180.0	0.12×10^{4}	0.12×10^{4}	–0.6	0.87×10^{-1}	0.86×10^{-1}	–0.4
240.0	0.95×10^{3}	0.94×10^{3}	–0.5	0.14×10^{0}	0.14×10^{0}	–0.1
300.0	0.79×10^{3}	0.79×10^{3}	–0.5	0.21×10^{0}	0.21×10^{0}	0.0
360.0	0.68×10^{3}	0.68×10^{3}	–0.5	0.30×10^{0}	0.30×10^{0}	0.1
600.0	0.45×10^{3}	0.45×10^{3}	–0.4	0.74×10^{0}	0.74×10^{0}	0.3
840.0	0.35×10^{3}	0.35×10^{3}	–0.2	0.14×10^{1}	0.14×10^{1}	0.2
1080.0	0.29×10^{3}	0.29×10^{3}	–0.1	0.21×10^{1}	0.21×10^{1}	0.3
1500.0	0.23×10^{3}	0.23×10^{3}	0.0	0.38×10^{1}	0.38×10^{1}	0.0
2100.0	0.18×10^{3}	0.18×10^{3}	0.2	0.68×10^{1}	0.68×10^{1}	–0.1
2700.0	0.15×10^{3}	0.15×10^{3}	0.2	0.11×10^{2}	0.11×10^{2}	–0.2
3300.0	0.13×10^{3}	0.13×10^{3}	0.3	0.15×10^{2}	0.15×10^{2}	–0.1
4200.0	0.12×10^{3}	0.12×10^{3}	0.4	0.22×10^{2}	0.22×10^{2}	–0.3
5400.0	0.10×10^{3}	0.10×10^{3}	0.5	0.33×10^{2}	0.33×10^{2}	–0.2
6600.0	0.96×10^{2}	0.96×10^{2}	0.5	0.45×10^{2}	0.45×10^{2}	–0.3
7800.0	0.90×10^{2}	0.91×10^{2}	0.6	0.58×10^{2}	0.58×10^{2}	–0.4
9000.0	0.86×10^{2}	0.87×10^{2}	0.6	0.72×10^{2}	0.71×10^{2}	–0.4
10200.0	0.83×10^{2}	0.84×10^{2}	0.5	0.86×10^{2}	0.85×10^{2}	–0.5

Table 9. Stopping Power and Energy Range Calculated by LaRC and Bichsel Codes for ^{40}Ca Ions on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.31×10^5	0.28×10^5	–8.3	0.87×10^{-3}	0.67×10^{-3}	–22.8
24.0	0.30×10^5	0.28×10^5	–7.5	0.10×10^{-2}	0.82×10^{-3}	–18.8
28.0	0.30×10^5	0.28×10^5	–5.5	0.11×10^{-2}	0.96×10^{-3}	–15.8
32.0	0.29×10^5	0.28×10^5	–5.0	0.13×10^{-2}	0.11×10^{-2}	–13.5
36.0	0.29×10^5	0.28×10^5	–5.2	0.14×10^{-2}	0.13×10^{-2}	–11.7
40.0	0.29×10^5	0.27×10^5	–5.8	0.16×10^{-2}	0.14×10^{-2}	–10.1
48.0	0.28×10^5	0.26×10^5	–7.1	0.18×10^{-2}	0.17×10^{-2}	–7.4
56.0	0.27×10^5	0.25×10^5	–8.3	0.21×10^{-2}	0.20×10^{-2}	–5.2
64.0	0.27×10^5	0.24×10^5	–9.3	0.24×10^{-2}	0.23×10^{-2}	–3.4
72.0	0.26×10^5	0.23×10^5	–10.2	0.27×10^{-2}	0.27×10^{-2}	–1.8
80.0	0.26×10^5	0.23×10^5	–10.8	0.30×10^{-2}	0.30×10^{-2}	–0.4
88.0	0.25×10^5	0.22×10^5	–11.3	0.34×10^{-2}	0.34×10^{-2}	0.8
96.0	0.25×10^5	0.22×10^5	–11.7	0.37×10^{-2}	0.37×10^{-2}	1.9
104.0	0.24×10^5	0.21×10^5	–11.9	0.40×10^{-2}	0.41×10^{-2}	2.8
112.0	0.24×10^5	0.21×10^5	–12.0	0.43×10^{-2}	0.45×10^{-2}	3.6
120.0	0.23×10^5	0.20×10^5	–12.1	0.47×10^{-2}	0.49×10^{-2}	4.3
140.0	0.22×10^5	0.19×10^5	–11.9	0.56×10^{-2}	0.59×10^{-2}	5.8
160.0	0.21×10^5	0.19×10^5	–11.4	0.65×10^{-2}	0.70×10^{-2}	6.9
180.0	0.20×10^5	0.18×10^5	–10.9	0.75×10^{-2}	0.80×10^{-2}	7.6
200.0	0.19×10^5	0.17×10^5	–10.4	0.85×10^{-2}	0.92×10^{-2}	8.1
220.0	0.19×10^5	0.17×10^5	–9.8	0.95×10^{-2}	0.10×10^{-1}	8.5
240.0	0.18×10^5	0.16×10^5	–9.2	0.11×10^{-1}	0.12×10^{-1}	8.7
260.0	0.17×10^5	0.16×10^5	–8.7	0.12×10^{-1}	0.13×10^{-1}	8.8
280.0	0.17×10^5	0.15×10^5	–8.1	0.13×10^{-1}	0.14×10^{-1}	8.8
300.0	0.16×10^5	0.15×10^5	–7.6	0.14×10^{-1}	0.16×10^{-1}	8.8
400.0	0.14×10^5	0.13×10^5	–5.5	0.21×10^{-1}	0.23×10^{-1}	8.2
600.0	0.11×10^5	0.10×10^5	–3.2	0.38×10^{-1}	0.40×10^{-1}	6.5
800.0	0.88×10^4	0.86×10^4	–2.1	0.59×10^{-1}	0.62×10^{-1}	5.1
1000.0	0.75×10^4	0.73×10^4	–1.6	0.84×10^{-1}	0.87×10^{-1}	4.1
1200.0	0.65×10^4	0.64×10^4	–1.5	0.11×10^0	0.12×10^0	3.5
2000.0	0.44×10^4	0.44×10^4	–1.2	0.26×10^0	0.27×10^0	2.3
2800.0	0.34×10^4	0.34×10^4	–0.9	0.47×10^0	0.48×10^0	1.7
3600.0	0.28×10^4	0.28×10^4	–0.6	0.73×10^0	0.74×10^0	1.4
5000.0	0.22×10^4	0.22×10^4	–0.1	0.13×10^1	0.13×10^1	1.0
7000.0	0.18×10^4	0.18×10^4	0.3	0.23×10^1	0.23×10^1	0.4
9000.0	0.15×10^4	0.15×10^4	0.6	0.36×10^1	0.36×10^1	0.2
11000.0	0.13×10^4	0.13×10^4	0.8	0.50×10^1	0.50×10^1	–0.1
14000.0	0.12×10^4	0.12×10^4	1.0	0.74×10^1	0.74×10^1	–0.4
18000.0	0.10×10^4	0.10×10^4	1.2	0.11×10^2	0.11×10^2	–0.6
22000.0	0.95×10^3	0.96×10^3	1.4	0.15×10^2	0.15×10^2	–0.8
26000.0	0.89×10^3	0.91×10^3	1.5	0.20×10^2	0.19×10^2	–0.9
30000.0	0.85×10^3	0.87×10^3	1.5	0.24×10^2	0.24×10^2	–1.0
34000.0	0.83×10^3	0.84×10^3	1.5	0.29×10^2	0.29×10^2	–1.1

Table 9. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.21×10^5	0.20×10^5	–5.3	0.14×10^{-2}	0.29×10^{-2}	106.3
24.0	0.21×10^5	0.22×10^5	4.9	0.16×10^{-2}	0.31×10^{-2}	93.6
28.0	0.22×10^5	0.23×10^5	8.5	0.18×10^{-2}	0.32×10^{-2}	83.1
32.0	0.22×10^5	0.24×10^5	9.0	0.20×10^{-2}	0.34×10^{-2}	74.4
36.0	0.22×10^5	0.23×10^5	8.2	0.21×10^{-2}	0.36×10^{-2}	67.3
40.0	0.22×10^5	0.23×10^5	6.9	0.23×10^{-2}	0.38×10^{-2}	61.3
48.0	0.21×10^5	0.22×10^5	3.9	0.27×10^{-2}	0.41×10^{-2}	52.1
56.0	0.21×10^5	0.21×10^5	1.5	0.31×10^{-2}	0.45×10^{-2}	45.4
64.0	0.21×10^5	0.21×10^5	0.3	0.35×10^{-2}	0.49×10^{-2}	40.2
72.0	0.21×10^5	0.20×10^5	–1.0	0.38×10^{-2}	0.52×10^{-2}	36.3
80.0	0.20×10^5	0.20×10^5	–2.0	0.42×10^{-2}	0.56×10^{-2}	33.0
88.0	0.20×10^5	0.19×10^5	–2.9	0.46×10^{-2}	0.61×10^{-2}	30.4
96.0	0.19×10^5	0.19×10^5	–3.7	0.51×10^{-2}	0.65×10^{-2}	28.2
104.0	0.19×10^5	0.18×10^5	–4.4	0.55×10^{-2}	0.69×10^{-2}	26.4
112.0	0.19×10^5	0.18×10^5	–5.0	0.59×10^{-2}	0.74×10^{-2}	24.8
120.0	0.18×10^5	0.17×10^5	–5.5	0.63×10^{-2}	0.78×10^{-2}	23.5
140.0	0.18×10^5	0.17×10^5	–6.5	0.74×10^{-2}	0.90×10^{-2}	21.0
160.0	0.17×10^5	0.16×10^5	–7.1	0.86×10^{-2}	0.10×10^{-1}	19.1
180.0	0.16×10^5	0.15×10^5	–7.4	0.98×10^{-2}	0.12×10^{-1}	17.7
200.0	0.16×10^5	0.15×10^5	–7.4	0.11×10^{-1}	0.13×10^{-1}	16.6
220.0	0.15×10^5	0.14×10^5	–7.3	0.12×10^{-1}	0.14×10^{-1}	15.7
240.0	0.15×10^5	0.14×10^5	–7.1	0.14×10^{-1}	0.16×10^{-1}	14.9
260.0	0.14×10^5	0.13×10^5	–6.8	0.15×10^{-1}	0.17×10^{-1}	14.2
280.0	0.14×10^5	0.13×10^5	–6.5	0.17×10^{-1}	0.19×10^{-1}	13.6
300.0	0.13×10^5	0.12×10^5	–6.1	0.18×10^{-1}	0.20×10^{-1}	12.9
400.0	0.11×10^5	0.11×10^5	–4.5	0.26×10^{-1}	0.29×10^{-1}	10.7
600.0	0.89×10^4	0.87×10^4	–2.7	0.46×10^{-1}	0.50×10^{-1}	7.7
800.0	0.74×10^4	0.73×10^4	–1.8	0.71×10^{-1}	0.75×10^{-1}	5.7
1000.0	0.63×10^4	0.63×10^4	–1.3	0.10×10^0	0.11×10^0	4.4
1200.0	0.56×10^4	0.55×10^4	–1.2	0.13×10^0	0.14×10^0	3.6
2000.0	0.38×10^4	0.38×10^4	–1.1	0.31×10^0	0.32×10^0	2.3
2800.0	0.30×10^4	0.29×10^4	–0.8	0.55×10^0	0.56×10^0	1.6
3600.0	0.25×10^4	0.24×10^4	–0.6	0.85×10^0	0.86×10^0	1.4
5000.0	0.19×10^4	0.19×10^4	–0.1	0.15×10^1	0.15×10^1	0.9
7000.0	0.15×10^4	0.16×10^4	0.4	0.27×10^1	0.27×10^1	0.4
9000.0	0.13×10^4	0.13×10^4	0.6	0.41×10^1	0.41×10^1	0.1
11000.0	0.12×10^4	0.12×10^4	0.9	0.57×10^1	0.57×10^1	–0.1
14000.0	0.10×10^4	0.10×10^4	1.2	0.85×10^1	0.84×10^1	–0.4
18000.0	0.91×10^3	0.93×10^3	1.4	0.13×10^2	0.13×10^2	–0.6
22000.0	0.84×10^3	0.85×10^3	1.5	0.17×10^2	0.17×10^2	–0.8
26000.0	0.79×10^3	0.81×10^3	1.6	0.22×10^2	0.22×10^2	–1.0
30000.0	0.76×10^3	0.77×10^3	1.7	0.27×10^2	0.27×10^2	–1.1
34000.0	0.73×10^3	0.75×10^3	1.7	0.33×10^2	0.32×10^2	–1.2

Table 9. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.14×10^5	0.17×10^4	–87.7	0.27×10^{-2}	-0.20×10^{-2}	–172.4
24.0	0.14×10^5	0.62×10^4	–56.3	0.30×10^{-2}	-0.63×10^{-3}	–121.3
28.0	0.15×10^5	0.91×10^4	–37.2	0.33×10^{-2}	-0.98×10^{-4}	–103.0
32.0	0.15×10^5	0.11×10^5	–24.5	0.35×10^{-2}	0.30×10^{-3}	–91.5
36.0	0.15×10^5	0.13×10^5	–15.7	0.38×10^{-2}	0.64×10^{-3}	–83.3
40.0	0.15×10^5	0.13×10^5	–13.4	0.41×10^{-2}	0.95×10^{-3}	–76.7
48.0	0.15×10^5	0.14×10^5	–6.6	0.46×10^{-2}	0.15×10^{-2}	–66.7
56.0	0.15×10^5	0.15×10^5	–3.6	0.51×10^{-2}	0.21×10^{-2}	–59.3
64.0	0.15×10^5	0.15×10^5	–3.0	0.57×10^{-2}	0.26×10^{-2}	–53.5
72.0	0.15×10^5	0.15×10^5	–2.5	0.62×10^{-2}	0.32×10^{-2}	–48.6
80.0	0.15×10^5	0.15×10^5	–2.6	0.67×10^{-2}	0.37×10^{-2}	–44.5
88.0	0.15×10^5	0.14×10^5	–2.9	0.73×10^{-2}	0.43×10^{-2}	–41.0
96.0	0.15×10^5	0.14×10^5	–3.2	0.78×10^{-2}	0.49×10^{-2}	–37.9
104.0	0.14×10^5	0.14×10^5	–3.6	0.84×10^{-2}	0.54×10^{-2}	–35.1
112.0	0.14×10^5	0.14×10^5	–4.5	0.89×10^{-2}	0.60×10^{-2}	–32.7
120.0	0.14×10^5	0.13×10^5	–4.4	0.95×10^{-2}	0.66×10^{-2}	–30.4
140.0	0.14×10^5	0.13×10^5	–4.5	0.11×10^{-1}	0.81×10^{-2}	–25.7
160.0	0.13×10^5	0.13×10^5	–4.7	0.13×10^{-1}	0.97×10^{-2}	–22.0
180.0	0.13×10^5	0.12×10^5	–4.8	0.14×10^{-1}	0.11×10^{-1}	–19.0
200.0	0.12×10^5	0.12×10^5	–4.9	0.16×10^{-1}	0.13×10^{-1}	–16.6
220.0	0.12×10^5	0.11×10^5	–4.8	0.17×10^{-1}	0.15×10^{-1}	–14.5
240.0	0.12×10^5	0.11×10^5	–4.6	0.19×10^{-1}	0.17×10^{-1}	–12.7
260.0	0.11×10^5	0.11×10^5	–4.5	0.21×10^{-1}	0.18×10^{-1}	–11.2
280.0	0.11×10^5	0.10×10^5	–4.3	0.23×10^{-1}	0.20×10^{-1}	–10.0
300.0	0.11×10^5	0.10×10^5	–4.1	0.25×10^{-1}	0.22×10^{-1}	–8.9
400.0	0.91×10^4	0.88×10^4	–3.2	0.35×10^{-1}	0.33×10^{-1}	–5.1
600.0	0.73×10^4	0.72×10^4	–2.1	0.59×10^{-1}	0.58×10^{-1}	–1.9
800.0	0.61×10^4	0.60×10^4	–1.4	0.90×10^{-1}	0.89×10^{-1}	–0.7
1000.0	0.53×10^4	0.52×10^4	–1.2	0.13×10^0	0.13×10^0	–0.2
1200.0	0.47×10^4	0.46×10^4	–1.2	0.17×10^0	0.17×10^0	0.2
2000.0	0.32×10^4	0.32×10^4	–1.3	0.38×10^0	0.38×10^0	0.8
2800.0	0.25×10^4	0.25×10^4	–1.1	0.66×10^0	0.66×10^0	1.0
3600.0	0.21×10^4	0.21×10^4	–0.9	0.10×10^1	0.10×10^1	1.0
5000.0	0.17×10^4	0.17×10^4	–0.6	0.18×10^1	0.18×10^1	0.9
7000.0	0.13×10^4	0.13×10^4	–0.2	0.31×10^1	0.31×10^1	0.7
9000.0	0.12×10^4	0.12×10^4	0.0	0.48×10^1	0.48×10^1	0.5
11000.0	0.10×10^4	0.10×10^4	0.3	0.66×10^1	0.66×10^1	0.3
14000.0	0.90×10^3	0.91×10^3	0.6	0.97×10^1	0.97×10^1	0.0
18000.0	0.80×10^3	0.81×10^3	0.8	0.15×10^2	0.14×10^2	–0.2
22000.0	0.74×10^3	0.75×10^3	0.9	0.20×10^2	0.20×10^2	–0.4
26000.0	0.70×10^3	0.71×10^3	1.1	0.25×10^2	0.25×10^2	–0.5
30000.0	0.67×10^3	0.68×10^3	1.1	0.31×10^2	0.31×10^2	–0.6
34000.0	0.65×10^3	0.66×10^3	1.1	0.37×10^2	0.37×10^2	–0.7

Table 9. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV; RSHEV code

Energy, MeV	Stopping power, LaRC code	Stopping power, RSHEV code	Difference, percent	Energy range, LaRC code	Energy range, RSHEV code	Difference, percent
5.0	0.39×10^4	0.20×10^4	–49.2	0.30×10^{-2}	0.50×10^{-3}	–83.2
15.0	0.67×10^4	0.20×10^4	–70.5	0.48×10^{-2}	0.15×10^{-2}	–68.7
25.0	0.74×10^4	0.20×10^4	–73.3	0.62×10^{-2}	0.32×10^{-2}	–48.5
35.0	0.78×10^4	0.20×10^4	–74.6	0.75×10^{-2}	0.53×10^{-2}	–29.5
45.0	0.81×10^4	0.20×10^4	–75.3	0.88×10^{-2}	0.70×10^{-2}	–20.2
55.0	0.82×10^4	0.66×10^4	–19.7	0.10×10^{-1}	0.86×10^{-2}	–14.4
65.0	0.83×10^4	0.68×10^4	–17.7	0.11×10^{-1}	0.10×10^{-1}	–10.4
75.0	0.84×10^4	0.70×10^4	–16.3	0.12×10^{-1}	0.12×10^{-1}	–7.3
85.0	0.83×10^4	0.71×10^4	–14.8	0.14×10^{-1}	0.13×10^{-1}	–5.1
95.0	0.83×10^4	0.72×10^4	–13.5	0.15×10^{-1}	0.14×10^{-1}	–3.3
105.0	0.82×10^4	0.72×10^4	–12.5	0.16×10^{-1}	0.16×10^{-1}	–2.0
115.0	0.82×10^4	0.72×10^4	–11.6	0.17×10^{-1}	0.17×10^{-1}	–0.9
125.0	0.81×10^4	0.72×10^4	–10.9	0.19×10^{-1}	0.19×10^{-1}	0.0
135.0	0.81×10^4	0.72×10^4	–10.4	0.20×10^{-1}	0.20×10^{-1}	0.8
145.0	0.80×10^4	0.72×10^4	–9.9	0.21×10^{-1}	0.21×10^{-1}	1.4
155.0	0.79×10^4	0.72×10^4	–9.4	0.22×10^{-1}	0.23×10^{-1}	1.9
165.0	0.79×10^4	0.72×10^4	–8.9	0.24×10^{-1}	0.24×10^{-1}	2.4
175.0	0.78×10^4	0.71×10^4	–8.4	0.25×10^{-1}	0.25×10^{-1}	2.7
185.0	0.77×10^4	0.71×10^4	–7.9	0.26×10^{-1}	0.27×10^{-1}	3.0
195.0	0.76×10^4	0.70×10^4	–7.5	0.27×10^{-1}	0.28×10^{-1}	3.3
205.0	0.75×10^4	0.70×10^4	–7.1	0.29×10^{-1}	0.30×10^{-1}	3.5
215.0	0.74×10^4	0.69×10^4	–6.8	0.30×10^{-1}	0.31×10^{-1}	3.7
225.0	0.74×10^4	0.69×10^4	–6.5	0.31×10^{-1}	0.33×10^{-1}	3.8
235.0	0.73×10^4	0.68×10^4	–6.2	0.33×10^{-1}	0.34×10^{-1}	3.9
245.0	0.72×10^4	0.68×10^4	–5.9	0.34×10^{-1}	0.36×10^{-1}	4.0
295.0	0.68×10^4	0.65×10^4	–4.6	0.41×10^{-1}	0.43×10^{-1}	4.3
345.0	0.65×10^4	0.62×10^4	–3.5	0.49×10^{-1}	0.51×10^{-1}	4.3
395.0	0.61×10^4	0.60×10^4	–2.7	0.57×10^{-1}	0.59×10^{-1}	4.1
445.0	0.58×10^4	0.57×10^4	–2.1	0.65×10^{-1}	0.68×10^{-1}	3.9
495.0	0.56×10^4	0.55×10^4	–1.5	0.74×10^{-1}	0.77×10^{-1}	3.6
595.0	0.51×10^4	0.50×10^4	–0.6	0.93×10^{-1}	0.96×10^{-1}	3.0
695.0	0.46×10^4	0.47×10^4	0.6	0.11×10^{0}	0.12×10^{0}	2.3
795.0	0.43×10^4	0.43×10^4	1.0	0.14×10^{0}	0.14×10^{0}	1.9
895.0	0.40×10^4	0.40×10^4	1.2	0.16×10^{0}	0.16×10^{0}	1.4
995.0	0.37×10^4	0.38×10^4	1.3	0.19×10^{0}	0.19×10^{0}	1.0
1095.0	0.35×10^4	0.36×10^4	1.4	0.21×10^{0}	0.22×10^{0}	0.7
1195.0	0.33×10^4	0.34×10^4	1.3	0.24×10^{0}	0.24×10^{0}	0.5
1295.0	0.32×10^4	0.32×10^4	1.3	0.27×10^{0}	0.28×10^{0}	0.3
1395.0	0.30×10^4	0.31×10^4	1.3	0.31×10^{0}	0.31×10^{0}	0.1
1495.0	0.29×10^4	0.29×10^4	1.2	0.34×10^{0}	0.34×10^{0}	0.0
1595.0	0.28×10^4	0.28×10^4	1.1	0.38×10^{0}	0.38×10^{0}	–0.1
1695.0	0.27×10^4	0.27×10^4	1.0	0.41×10^{0}	0.41×10^{0}	–0.2
1795.0	0.25×10^4	0.26×10^4	1.0	0.45×10^{0}	0.45×10^{0}	–0.3

Table 9. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 841.00 eV; RSHEV code

Energy, MeV	Stopping power: LaRC code	Stopping power: RSHEV code	Difference, percent	Energy range: LaRC code	Energy range: RSHEV code	Difference, percent
5.0	0.48×10^4	0.20×10^4	–58.9	0.25×10^{-2}	0.50×10^{-3}	–80.1
15.0	0.74×10^4	0.20×10^4	–73.3	0.41×10^{-2}	0.15×10^{-2}	–63.1
25.0	0.77×10^4	0.20×10^4	–74.4	0.54×10^{-2}	0.33×10^{-2}	–38.3
35.0	0.79×10^4	0.20×10^4	–74.8	0.67×10^{-2}	0.57×10^{-2}	–15.0
45.0	0.80×10^4	0.20×10^4	–75.0	0.79×10^{-2}	0.75×10^{-2}	–5.1
55.0	0.80×10^4	0.61×10^4	–24.0	0.92×10^{-2}	0.92×10^{-2}	0.4
65.0	0.80×10^4	0.63×10^4	–21.1	0.10×10^{-1}	0.11×10^{-1}	3.8
75.0	0.80×10^4	0.65×10^4	–18.9	0.12×10^{-1}	0.12×10^{-1}	6.1
85.0	0.80×10^4	0.66×10^4	–17.1	0.13×10^{-1}	0.14×10^{-1}	7.6
95.0	0.79×10^4	0.67×10^4	–15.6	0.14×10^{-1}	0.15×10^{-1}	8.6
105.0	0.78×10^4	0.67×10^4	–14.3	0.16×10^{-1}	0.17×10^{-1}	9.4
115.0	0.78×10^4	0.67×10^4	–13.3	0.17×10^{-1}	0.18×10^{-1}	9.9
125.0	0.77×10^4	0.67×10^4	–12.4	0.18×10^{-1}	0.20×10^{-1}	10.2
135.0	0.76×10^4	0.67×10^4	–11.9	0.19×10^{-1}	0.21×10^{-1}	10.5
145.0	0.76×10^4	0.67×10^4	–11.3	0.21×10^{-1}	0.23×10^{-1}	10.6
155.0	0.75×10^4	0.67×10^4	–10.7	0.22×10^{-1}	0.24×10^{-1}	10.7
165.0	0.74×10^4	0.67×10^4	–10.2	0.23×10^{-1}	0.26×10^{-1}	10.8
175.0	0.73×10^4	0.66×10^4	–9.7	0.25×10^{-1}	0.27×10^{-1}	10.8
185.0	0.73×10^4	0.66×10^4	–9.1	0.26×10^{-1}	0.29×10^{-1}	10.8
195.0	0.72×10^4	0.66×10^4	–8.6	0.27×10^{-1}	0.30×10^{-1}	10.7
205.0	0.71×10^4	0.65×10^4	–8.1	0.29×10^{-1}	0.32×10^{-1}	10.6
215.0	0.70×10^4	0.65×10^4	–7.6	0.30×10^{-1}	0.34×10^{-1}	10.5
225.0	0.69×10^4	0.64×10^4	–7.2	0.32×10^{-1}	0.35×10^{-1}	10.4
235.0	0.68×10^4	0.64×10^4	–6.7	0.33×10^{-1}	0.37×10^{-1}	10.3
245.0	0.68×10^4	0.63×10^4	–6.3	0.35×10^{-1}	0.38×10^{-1}	10.1
295.0	0.64×10^4	0.61×10^4	–4.3	0.42×10^{-1}	0.46×10^{-1}	9.3
345.0	0.60×10^4	0.58×10^4	–2.8	0.50×10^{-1}	0.55×10^{-1}	8.4
395.0	0.57×10^4	0.56×10^4	–1.5	0.59×10^{-1}	0.63×10^{-1}	7.5
445.0	0.54×10^4	0.53×10^4	–0.6	0.68×10^{-1}	0.73×10^{-1}	6.6
495.0	0.51×10^4	0.51×10^4	0.2	0.78×10^{-1}	0.82×10^{-1}	5.8
595.0	0.47×10^4	0.47×10^4	1.2	0.98×10^{-1}	0.10×10^{0}	4.5
695.0	0.43×10^4	0.44×10^4	2.0	0.12×10^{0}	0.12×10^{0}	3.3
795.0	0.40×10^4	0.41×10^4	2.3	0.15×10^{0}	0.15×10^{0}	2.4
895.0	0.37×10^4	0.38×10^4	2.6	0.17×10^{0}	0.17×10^{0}	1.6
995.0	0.35×10^4	0.36×10^4	2.8	0.20×10^{0}	0.20×10^{0}	1.0
1095.0	0.33×10^4	0.34×10^4	2.8	0.21×10^{0}	0.23×10^{0}	0.6
1195.0	0.31×10^4	0.32×10^4	2.8	0.26×10^{0}	0.26×10^{0}	0.2
1295.0	0.30×10^4	0.30×10^4	2.8	0.29×10^{0}	0.29×10^{0}	–0.2
1395.0	0.28×10^4	0.29×10^4	2.8	0.33×10^{0}	0.33×10^{0}	–0.4
1495.0	0.27×10^4	0.28×10^4	2.7	0.36×10^{0}	0.36×10^{0}	–0.6
1595.0	0.26×10^4	0.26×10^4	2.6	0.40×10^{0}	0.40×10^{0}	–0.8
1695.0	0.25×10^4	0.25×10^4	2.6	0.44×10^{0}	0.44×10^{0}	–1.0
1795.0	0.24×10^4	0.24×10^4	2.6	0.48×10^{0}	0.48×10^{0}	–1.1

Table 9. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 70.00 eV; RSTAN code

Energy, MeV	Stopping power, LaRC code	Stopping power, RSTAN code	Difference, percent	Energy range, LaRC code	Energy range, RSTAN code	Difference, percent
20.0	0.32×10^5	0.29×10^5	−8.5	0.94×10^{-3}	0.83×10^{-3}	−11.9
24.0	0.32×10^5	0.30×10^5	−5.1	0.11×10^{-2}	0.96×10^{-3}	−9.6
28.0	0.31×10^5	0.30×10^5	−4.4	0.12×10^{-2}	0.11×10^{-2}	−8.1
32.0	0.31×10^5	0.30×10^5	−5.1	0.13×10^{-2}	0.12×10^{-2}	−6.8
36.0	0.31×10^5	0.30×10^5	−4.9	0.15×10^{-2}	0.14×10^{-2}	−5.8
40.0	0.31×10^5	0.29×10^5	−5.1	0.16×10^{-2}	0.15×10^{-2}	−4.8
48.0	0.30×10^5	0.29×10^5	−6.3	0.18×10^{-2}	0.18×10^{-2}	−3.2
56.0	0.30×10^5	0.28×10^5	−7.6	0.21×10^{-2}	0.21×10^{-2}	−1.8
64.0	0.30×10^5	0.27×10^5	−9.0	0.24×10^{-2}	0.24×10^{-2}	−0.6
72.0	0.29×10^5	0.26×10^5	−10.7	0.26×10^{-2}	0.27×10^{-2}	0.6
80.0	0.29×10^5	0.26×10^5	−11.3	0.29×10^{-2}	0.30×10^{-2}	1.7
88.0	0.28×10^5	0.25×10^5	−11.9	0.32×10^{-2}	0.33×10^{-2}	2.7
96.0	0.28×10^5	0.24×10^5	−12.3	0.35×10^{-2}	0.36×10^{-2}	3.7
104.0	0.27×10^5	0.24×10^5	−12.5	0.38×10^{-2}	0.39×10^{-2}	4.5
112.0	0.27×10^5	0.23×10^5	−12.5	0.41×10^{-2}	0.43×10^{-2}	5.2
120.0	0.26×10^5	0.23×10^5	−12.5	0.44×10^{-2}	0.46×10^{-2}	5.8
140.0	0.25×10^5	0.22×10^5	−12.2	0.52×10^{-2}	0.55×10^{-2}	7.1
160.0	0.24×10^5	0.21×10^5	−11.7	0.60×10^{-2}	0.64×10^{-2}	8.0
180.0	0.23×10^5	0.20×10^5	−11.1	0.68×10^{-2}	0.74×10^{-2}	8.5
200.0	0.22×10^5	0.20×10^5	−10.4	0.77×10^{-2}	0.84×10^{-2}	8.9
220.0	0.21×10^5	0.19×10^5	−9.8	0.87×10^{-2}	0.95×10^{-2}	9.2
240.0	0.20×10^5	0.18×10^5	−9.1	0.96×10^{-2}	0.11×10^{-1}	9.3
260.0	0.19×10^5	0.18×10^5	−8.5	0.11×10^{-1}	0.12×10^{-1}	9.4
280.0	0.19×10^5	0.17×10^5	−8.0	0.12×10^{-1}	0.13×10^{-1}	9.4
300.0	0.18×10^5	0.17×10^5	−7.4	0.13×10^{-1}	0.14×10^{-1}	9.2
400.0	0.15×10^5	0.15×10^5	−5.3	0.19×10^{-1}	0.20×10^{-1}	8.5
600.0	0.12×10^5	0.12×10^5	−3.0	0.34×10^{-1}	0.36×10^{-1}	6.8
800.0	0.99×10^4	0.97×10^4	−1.9	0.52×10^{-1}	0.55×10^{-1}	5.1
1000.0	0.84×10^4	0.83×10^4	−1.4	0.74×10^{-1}	0.77×10^{-1}	4.0
1200.0	0.74×10^4	0.73×10^4	−1.2	1.00×10^{-1}	0.10×10^0	3.3
2000.0	0.50×10^4	0.49×10^4	−1.0	0.24×10^0	0.24×10^0	2.1
2800.0	0.38×10^4	0.38×10^4	−0.6	0.42×10^0	0.43×10^0	1.4
3600.0	0.32×10^4	0.32×10^4	−0.3	0.65×10^0	0.66×10^0	1.2
5000.0	0.25×10^4	0.25×10^4	0.1	0.12×10^1	0.12×10^1	0.7
7000.0	0.20×10^4	0.20×10^4	0.7	0.21×10^1	0.21×10^1	0.1
9000.0	0.17×10^4	0.17×10^4	0.9	0.32×10^1	0.32×10^1	−0.2
11000.0	0.15×10^4	0.15×10^4	1.1	0.44×10^1	0.44×10^1	−0.4
14000.0	0.13×10^4	0.13×10^4	1.4	0.66×10^1	0.66×10^1	−0.7
18000.0	0.12×10^4	0.12×10^4	1.6	0.99×10^1	0.98×10^1	−0.9
22000.0	0.11×10^4	0.11×10^4	1.7	0.14×10^2	0.13×10^2	−1.1
26000.0	0.10×10^4	0.10×10^4	1.8	0.17×10^2	0.17×10^2	−1.2
30000.0	0.96×10^3	0.97×10^3	1.8	0.22×10^2	0.21×10^2	−1.3
34000.0	0.92×10^3	0.94×10^3	1.7	0.26×10^2	0.25×10^2	−1.4

Table 10. Stopping Power and Energy Range Calculated by LaRC and Bichsel Codes for ^{40}Ar Ions on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.28×10^5	0.29×10^5	5.0	0.97×10^{-3}	0.55×10^{-3}	−43.3
24.0	0.27×10^5	0.28×10^5	2.2	0.11×10^{-2}	0.69×10^{-3}	−38.0
28.0	0.27×10^5	0.27×10^5	1.9	0.13×10^{-2}	0.84×10^{-3}	−33.8
32.0	0.26×10^5	0.26×10^5	0.8	0.14×10^{-2}	0.99×10^{-3}	−30.3
36.0	0.26×10^5	0.26×10^5	−0.4	0.16×10^{-2}	0.12×10^{-2}	−27.3
40.0	0.25×10^5	0.25×10^5	−1.7	0.17×10^{-2}	0.13×10^{-2}	−24.8
48.0	0.25×10^5	0.24×10^5	−3.9	0.21×10^{-2}	0.16×10^{-2}	−20.4
56.0	0.24×10^5	0.23×10^5	−5.5	0.24×10^{-2}	0.20×10^{-2}	−16.8
64.0	0.23×10^5	0.22×10^5	−6.8	0.27×10^{-2}	0.24×10^{-2}	−13.9
72.0	0.23×10^5	0.21×10^5	−7.9	0.31×10^{-2}	0.27×10^{-2}	−11.4
80.0	0.22×10^5	0.20×10^5	−8.6	0.34×10^{-2}	0.31×10^{-2}	−9.3
88.0	0.22×10^5	0.20×10^5	−9.3	0.38×10^{-2}	0.35×10^{-2}	−7.4
96.0	0.21×10^5	0.19×10^5	−9.7	0.42×10^{-2}	0.39×10^{-2}	−5.8
104.0	0.21×10^5	0.19×10^5	−10.0	0.45×10^{-2}	0.43×10^{-2}	−4.4
112.0	0.20×10^5	0.18×10^5	−10.1	0.49×10^{-2}	0.48×10^{-2}	−3.2
120.0	0.20×10^5	0.18×10^5	−10.2	0.53×10^{-2}	0.52×10^{-2}	−2.1
140.0	0.19×10^5	0.17×10^5	−10.1	0.64×10^{-2}	0.64×10^{-2}	0.1
160.0	0.18×10^5	0.16×10^5	−9.7	0.74×10^{-2}	0.76×10^{-2}	1.7
180.0	0.17×10^5	0.16×10^5	−9.3	0.86×10^{-2}	0.88×10^{-2}	2.9
200.0	0.17×10^5	0.15×10^5	−8.8	0.98×10^{-2}	0.10×10^{-1}	3.7
220.0	0.16×10^5	0.15×10^5	−8.3	0.11×10^{-1}	0.12×10^{-1}	4.4
240.0	0.15×10^5	0.14×10^5	−7.7	0.12×10^{-1}	0.13×10^{-1}	4.9
260.0	0.15×10^5	0.14×10^5	−7.2	0.14×10^{-1}	0.14×10^{-1}	5.2
280.0	0.14×10^5	0.13×10^5	−6.7	0.15×10^{-1}	0.16×10^{-1}	5.4
300.0	0.14×10^5	0.13×10^5	−6.3	0.17×10^{-1}	0.17×10^{-1}	5.6
400.0	0.11×10^5	0.11×10^5	−4.4	0.25×10^{-1}	0.26×10^{-1}	5.6
600.0	0.88×10^4	0.86×10^4	−2.6	0.45×10^{-1}	0.47×10^{-1}	4.7
800.0	0.72×10^4	0.71×10^4	−1.8	0.70×10^{-1}	0.73×10^{-1}	3.8
1000.0	0.61×10^4	0.60×10^4	−1.5	0.10×10^0	0.10×10^0	3.1
1200.0	0.53×10^4	0.53×10^4	−1.5	0.14×10^0	0.14×10^0	2.7
2000.0	0.36×10^4	0.36×10^4	−1.3	0.32×10^0	0.33×10^0	2.0
2800.0	0.28×10^4	0.27×10^4	−1.0	0.58×10^0	0.59×10^0	1.6
3600.0	0.23×10^4	0.23×10^4	−0.6	0.90×10^0	0.91×10^0	1.3
5000.0	0.18×10^4	0.18×10^4	−0.3	0.16×10^1	0.16×10^1	1.0
7000.0	0.14×10^4	0.14×10^4	0.2	0.29×10^1	0.29×10^1	0.5
9000.0	0.12×10^4	0.12×10^4	0.4	0.44×10^1	0.44×10^1	0.3
11000.0	0.11×10^4	0.11×10^4	0.6	0.62×10^1	0.62×10^1	0.0
14000.0	0.94×10^3	0.95×10^3	0.8	0.91×10^1	0.91×10^1	−0.2
18000.0	0.84×10^3	0.84×10^3	1.0	0.14×10^2	0.14×10^2	−0.4
22000.0	0.77×10^3	0.78×10^3	1.1	0.19×10^2	0.19×10^2	−0.6
26000.0	0.72×10^3	0.73×10^3	1.2	0.24×10^2	0.24×10^2	−0.7
30000.0	0.69×10^3	0.70×10^3	1.3	0.30×10^2	0.30×10^2	−0.8
34000.0	0.67×10^3	0.68×10^3	1.3	0.36×10^2	0.35×10^2	−0.9
38000.0	0.65×10^3	0.66×10^3	1.2	0.42×10^2	0.41×10^2	−0.9

Table 10. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.19×10^5	0.21×10^5	13.5	0.16×10^{-2}	0.13×10^{-2}	–19.7
24.0	0.19×10^5	0.22×10^5	17.0	0.18×10^{-2}	0.14×10^{-2}	–19.0
28.0	0.19×10^5	0.22×10^5	16.8	0.20×10^{-2}	0.16×10^{-2}	–18.5
32.0	0.19×10^5	0.22×10^5	15.0	0.22×10^{-2}	0.18×10^{-2}	–18.0
36.0	0.19×10^5	0.22×10^5	12.8	0.24×10^{-2}	0.20×10^{-2}	–17.5
40.0	0.19×10^5	0.21×10^5	10.6	0.26×10^{-2}	0.22×10^{-2}	–16.9
48.0	0.19×10^5	0.20×10^5	6.6	0.30×10^{-2}	0.26×10^{-2}	–15.6
56.0	0.19×10^5	0.19×10^5	3.6	0.35×10^{-2}	0.30×10^{-2}	–14.3
64.0	0.18×10^5	0.19×10^5	2.0	0.39×10^{-2}	0.34×10^{-2}	–13.0
72.0	0.18×10^5	0.18×10^5	0.5	0.43×10^{-2}	0.38×10^{-2}	–11.7
80.0	0.18×10^5	0.17×10^5	–0.7	0.48×10^{-2}	0.43×10^{-2}	–10.6
88.0	0.17×10^5	0.17×10^5	–1.7	0.52×10^{-2}	0.48×10^{-2}	–9.5
96.0	0.17×10^5	0.16×10^5	–2.6	0.57×10^{-2}	0.52×10^{-2}	–8.5
104.0	0.17×10^5	0.16×10^5	–3.3	0.62×10^{-2}	0.57×10^{-2}	–7.6
112.0	0.16×10^5	0.16×10^5	–3.8	0.67×10^{-2}	0.62×10^{-2}	–6.8
120.0	0.16×10^5	0.15×10^5	–4.3	0.72×10^{-2}	0.68×10^{-2}	–6.0
140.0	0.15×10^5	0.14×10^5	–5.3	0.85×10^{-2}	0.81×10^{-2}	–4.3
160.0	0.15×10^5	0.14×10^5	–5.8	0.98×10^{-2}	0.95×10^{-2}	–2.9
180.0	0.14×10^5	0.13×10^5	–6.1	0.11×10^{-1}	0.11×10^{-1}	–1.8
200.0	0.13×10^5	0.13×10^5	–6.2	0.13×10^{-1}	0.13×10^{-1}	–0.8
220.0	0.13×10^5	0.12×10^5	–6.1	0.14×10^{-1}	0.14×10^{-1}	0.0
240.0	0.12×10^5	0.12×10^5	–5.9	0.16×10^{-1}	0.16×10^{-1}	0.7
260.0	0.12×10^5	0.11×10^5	–5.5	0.17×10^{-1}	0.18×10^{-1}	1.2
280.0	0.12×10^5	0.11×10^5	–5.2	0.19×10^{-1}	0.20×10^{-1}	1.6
300.0	0.11×10^5	0.11×10^5	–4.9	0.21×10^{-1}	0.21×10^{-1}	1.8
400.0	0.95×10^4	0.91×10^4	–3.6	0.31×10^{-1}	0.32×10^{-1}	2.8
600.0	0.74×10^4	0.72×10^4	–2.3	0.55×10^{-1}	0.56×10^{-1}	3.0
800.0	0.61×10^4	0.60×10^4	–1.5	0.85×10^{-1}	0.87×10^{-1}	2.4
1000.0	0.52×10^4	0.51×10^4	–1.3	0.12×10^0	0.12×10^0	2.0
1200.0	0.46×10^4	0.45×10^4	–1.3	0.16×10^0	0.17×10^0	1.8
2000.0	0.31×10^4	0.31×10^4	–1.2	0.38×10^0	0.39×10^0	1.5
2800.0	0.24×10^4	0.24×10^4	–0.9	0.68×10^0	0.69×10^0	1.3
3600.0	0.20×10^4	0.20×10^4	–0.7	0.10×10^1	0.11×10^1	1.1
5000.0	0.16×10^4	0.16×10^4	–0.3	0.18×10^1	0.19×10^1	0.8
7000.0	0.13×10^4	0.13×10^4	0.2	0.33×10^1	0.33×10^1	0.5
9000.0	0.11×10^4	0.11×10^4	0.5	0.50×10^1	0.50×10^1	0.2
11000.0	0.95×10^3	0.95×10^3	0.6	0.70×10^1	0.70×10^1	0.0
14000.0	0.83×10^3	0.84×10^3	0.9	0.10×10^2	0.10×10^2	–0.3
18000.0	0.74×10^3	0.75×10^3	1.1	0.16×10^2	0.16×10^2	–0.5
22000.0	0.68×10^3	0.69×10^3	1.3	0.21×10^2	0.21×10^2	–0.7
26000.0	0.64×10^3	0.65×10^3	1.4	0.27×10^2	0.27×10^2	–0.8
30000.0	0.61×10^3	0.62×10^3	1.5	0.34×10^2	0.33×10^2	–0.8
34000.0	0.59×10^3	0.60×10^3	1.5	0.40×10^2	0.40×10^2	–1.0
38000.0	0.58×10^3	0.59×10^3	1.3	0.47×10^2	0.47×10^2	–1.1

Table 10. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.12×10^5	0.58×10^4	–52.2	0.30×10^{-2}	-0.32×10^{-2}	–206.3
24.0	0.13×10^5	0.84×10^4	–32.7	0.33×10^{-2}	-0.26×10^{-2}	–178.7
28.0	0.13×10^5	0.10×10^5	–20.7	0.37×10^{-2}	-0.22×10^{-2}	–160.1
32.0	0.13×10^5	0.11×10^5	–12.6	0.40×10^{-2}	-0.18×10^{-2}	–146.0
36.0	0.13×10^5	0.12×10^5	–6.8	0.43×10^{-2}	-0.15×10^{-2}	–134.8
40.0	0.13×10^5	0.13×10^5	–6.4	0.46×10^{-2}	-0.12×10^{-2}	–125.5
48.0	0.13×10^5	0.13×10^5	–2.2	0.52×10^{-2}	-0.54×10^{-3}	–110.4
56.0	0.13×10^5	0.13×10^5	–0.7	0.58×10^{-2}	0.68×10^{-4}	–98.8
64.0	0.13×10^5	0.13×10^5	–0.8	0.64×10^{-2}	0.67×10^{-3}	–89.4
72.0	0.13×10^5	0.13×10^5	–0.8	0.70×10^{-2}	0.13×10^{-2}	–81.5
80.0	0.13×10^5	0.13×10^5	–1.2	0.76×10^{-2}	0.19×10^{-2}	–74.9
88.0	0.13×10^5	0.13×10^5	–1.6	0.82×10^{-2}	0.25×10^{-2}	–69.1
96.0	0.13×10^5	0.12×10^5	–2.1	0.88×10^{-2}	0.32×10^{-2}	–64.0
104.0	0.12×10^5	0.12×10^5	–2.5	0.95×10^{-2}	0.38×10^{-2}	–59.5
112.0	0.12×10^5	0.12×10^5	–3.4	0.10×10^{-1}	0.45×10^{-2}	–55.5
120.0	0.12×10^5	0.12×10^5	–3.3	0.11×10^{-1}	0.52×10^{-2}	–51.9
140.0	0.12×10^5	0.11×10^5	–3.5	0.13×10^{-1}	0.69×10^{-2}	–44.3
160.0	0.11×10^5	0.11×10^5	–3.7	0.14×10^{-1}	0.88×10^{-2}	–38.4
180.0	0.11×10^5	0.10×10^5	–3.8	0.16×10^{-1}	0.11×10^{-1}	–33.6
200.0	0.10×10^5	0.10×10^5	–3.8	0.18×10^{-1}	0.13×10^{-1}	–29.6
220.0	0.10×10^5	0.97×10^4	–3.8	0.20×10^{-1}	0.15×10^{-1}	–26.3
240.0	0.97×10^4	0.94×10^4	–3.6	0.22×10^{-1}	0.17×10^{-1}	–23.5
260.0	0.94×10^4	0.91×10^4	–3.5	0.24×10^{-1}	0.19×10^{-1}	–21.1
280.0	0.91×10^4	0.88×10^4	–3.3	0.26×10^{-1}	0.21×10^{-1}	–19.1
300.0	0.88×10^4	0.86×10^4	–3.1	0.28×10^{-1}	0.23×10^{-1}	–17.3
400.0	0.76×10^4	0.75×10^4	–2.3	0.41×10^{-1}	0.36×10^{-1}	–11.3
600.0	0.61×10^4	0.60×10^4	–1.6	0.70×10^{-1}	0.66×10^{-1}	–5.6
800.0	0.50×10^4	0.50×10^4	–1.2	0.11×10^0	0.10×10^0	–3.3
1000.0	0.43×10^4	0.43×10^4	–1.1	0.15×10^0	0.15×10^0	–2.1
1200.0	0.38×10^4	0.38×10^4	–1.2	0.20×10^0	0.20×10^0	–1.2
2000.0	0.26×10^4	0.26×10^4	–1.4	0.46×10^0	0.46×10^0	0.3
2800.0	0.21×10^4	0.20×10^4	–1.2	0.81×10^0	0.81×10^0	0.7
3600.0	0.17×10^4	0.17×10^4	–1.0	0.12×10^1	0.13×10^1	0.9
5000.0	0.14×10^4	0.14×10^4	–0.8	0.26×10^1	0.22×10^1	0.9
7000.0	0.11×10^4	0.11×10^4	–0.4	0.38×10^1	0.39×10^1	0.7
9000.0	0.93×10^3	0.93×10^3	–0.2	0.58×10^1	0.59×10^1	0.6
11000.0	0.83×10^3	0.83×10^3	0.1	0.81×10^1	0.82×10^1	0.4
14000.0	0.73×10^3	0.73×10^3	0.3	0.12×10^2	0.12×10^2	0.2
18000.0	0.65×10^3	0.65×10^3	0.5	0.18×10^2	0.18×10^2	0.0
22000.0	0.60×10^3	0.60×10^3	0.7	0.24×10^2	0.24×10^2	–0.1
26000.0	0.57×10^3	0.57×10^3	0.8	0.31×10^2	0.31×10^2	–0.3
30000.0	0.54×10^3	0.55×10^3	0.9	0.38×10^2	0.38×10^2	–0.4
34000.0	0.53×10^3	0.53×10^3	0.9	0.46×10^2	0.46×10^2	–0.5
38000.0	0.51×10^3	0.52×10^3	0.8	0.54×10^2	0.53×10^2	–0.5

Table 10. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
2.0	0.18×10^4	0.10×10^5	470.0	0.22×10^{-2}	0.12×10^{-3}	−94.6
12.0	0.56×10^4	0.28×10^4	−50.4	0.49×10^{-2}	0.25×10^{-2}	−47.9
22.0	0.64×10^4	0.55×10^4	−14.5	0.65×10^{-2}	0.51×10^{-2}	−22.2
32.0	0.68×10^4	0.60×10^4	−12.8	0.80×10^{-2}	0.68×10^{-2}	−15.0
42.0	0.71×10^4	0.61×10^4	−13.1	0.94×10^{-2}	0.85×10^{-2}	−10.4
52.0	0.72×10^4	0.63×10^4	−13.0	0.11×10^{-1}	0.10×10^{-1}	−7.1
62.0	0.73×10^4	0.63×10^4	−12.7	0.12×10^{-1}	0.12×10^{-1}	−4.6
72.0	0.73×10^4	0.64×10^4	−12.4	0.14×10^{-1}	0.13×10^{-1}	−2.6
82.0	0.73×10^4	0.64×10^4	−11.6	0.15×10^{-1}	0.15×10^{-1}	−1.1
92.0	0.72×10^4	0.64×10^4	−10.7	0.16×10^{-1}	0.16×10^{-1}	0.0
102.0	0.72×10^4	0.64×10^4	−10.0	0.18×10^{-1}	0.18×10^{-1}	0.9
112.0	0.71×10^4	0.64×10^4	−9.3	0.19×10^{-1}	0.20×10^{-1}	1.7
122.0	0.71×10^4	0.64×10^4	−8.7	0.21×10^{-1}	0.21×10^{-1}	2.2
132.0	0.70×10^4	0.64×10^4	−8.4	0.22×10^{-1}	0.23×10^{-1}	2.7
142.0	0.69×10^4	0.64×10^4	−8.0	0.23×10^{-1}	0.24×10^{-1}	3.1
152.0	0.68×10^4	0.63×10^4	−7.6	0.25×10^{-1}	0.26×10^{-1}	3.4
162.0	0.68×10^4	0.63×10^4	−7.1	0.26×10^{-1}	0.27×10^{-1}	3.7
172.0	0.67×10^4	0.62×10^4	−6.7	0.28×10^{-1}	0.29×10^{-1}	3.9
182.0	0.66×10^4	0.62×10^4	−6.3	0.29×10^{-1}	0.31×10^{-1}	4.1
192.0	0.65×10^4	0.61×10^4	−5.9	0.31×10^{-1}	0.32×10^{-1}	4.2
202.0	0.64×10^4	0.61×10^4	−5.6	0.32×10^{-1}	0.34×10^{-1}	4.3
212.0	0.64×10^4	0.60×10^4	−5.3	0.34×10^{-1}	0.36×10^{-1}	4.4
222.0	0.63×10^4	0.60×10^4	−5.0	0.36×10^{-1}	0.37×10^{-1}	4.4
232.0	0.62×10^4	0.59×10^4	−4.7	0.37×10^{-1}	0.39×10^{-1}	4.5
242.0	0.61×10^4	0.59×10^4	−4.5	0.39×10^{-1}	0.41×10^{-1}	4.5
292.0	0.58×10^4	0.56×10^4	−3.3	0.47×10^{-1}	0.49×10^{-1}	4.4
342.0	0.54×10^4	0.53×10^4	−2.4	0.56×10^{-1}	0.59×10^{-1}	4.2
392.0	0.51×10^4	0.51×10^4	−1.7	0.66×10^{-1}	0.68×10^{-1}	3.9
442.0	0.49×10^4	0.48×10^4	−1.2	0.76×10^{-1}	0.78×10^{-1}	3.6
492.0	0.46×10^4	0.46×10^4	−0.8	0.86×10^{-1}	0.89×10^{-1}	3.2
592.0	0.42×10^4	0.42×10^4	−0.1	0.11×10^0	0.11×10^0	2.6
692.0	0.38×10^4	0.39×10^4	1.0	0.13×10^0	0.14×10^0	1.9
792.0	0.35×10^4	0.36×10^4	1.1	0.16×10^0	0.16×10^0	1.5
892.0	0.33×10^4	0.33×10^4	1.3	0.19×10^0	0.19×10^0	1.0
992.0	0.31×10^4	0.31×10^4	1.3	0.22×10^0	0.22×10^0	0.7

Table 10. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 841.00 eV; RSHEV code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSHEV code		LaRC code	RSHEV code	
2.0	0.22×10^4	0.10×10^5	351.0	0.19×10^{-2}	0.16×10^{-3}	−91.7
22.0	0.68×10^4	0.50×10^4	−26.4	0.56×10^{-2}	0.34×10^{-2}	−39.0
42.0	0.70×10^4	0.57×10^4	−19.2	0.85×10^{-2}	0.71×10^{-2}	−15.7
62.0	0.70×10^4	0.59×10^4	−16.3	0.11×10^{-1}	0.11×10^{-1}	−6.3
82.0	0.69×10^4	0.60×10^4	−14.0	0.14×10^{-1}	0.14×10^{-1}	−1.3
102.0	0.68×10^4	0.60×10^4	−11.8	0.17×10^{-1}	0.17×10^{-1}	1.4
122.0	0.67×10^4	0.60×10^4	−10.3	0.20×10^{-1}	0.21×10^{-1}	3.0
142.0	0.65×10^4	0.59×10^4	−9.4	0.23×10^{-1}	0.24×10^{-1}	4.1
162.0	0.64×10^4	0.59×10^4	−8.4	0.26×10^{-1}	0.27×10^{-1}	4.8
182.0	0.62×10^4	0.58×10^4	−7.5	0.29×10^{-1}	0.31×10^{-1}	5.2
202.0	0.61×10^4	0.57×10^4	−6.6	0.33×10^{-1}	0.34×10^{-1}	5.5
222.0	0.59×10^4	0.56×10^4	−5.7	0.36×10^{-1}	0.38×10^{-1}	5.6
242.0	0.58×10^4	0.55×10^4	−4.9	0.39×10^{-1}	0.42×10^{-1}	5.6
262.0	0.56×10^4	0.54×10^4	−4.1	0.43×10^{-1}	0.45×10^{-1}	5.5
282.0	0.55×10^4	0.53×10^4	−3.4	0.47×10^{-1}	0.49×10^{-1}	5.4
302.0	0.53×10^4	0.52×10^4	−2.7	0.50×10^{-1}	0.53×10^{-1}	5.3
322.0	0.52×10^4	0.51×10^4	−2.2	0.54×10^{-1}	0.57×10^{-1}	5.1
342.0	0.51×10^4	0.50×10^4	−1.6	0.58×10^{-1}	0.61×10^{-1}	4.9
362.0	0.49×10^4	0.49×10^4	−1.2	0.62×10^{-1}	0.65×10^{-1}	4.7
382.0	0.48×10^4	0.48×10^4	−0.7	0.66×10^{-1}	0.69×10^{-1}	4.4
402.0	0.47×10^4	0.47×10^4	−0.3	0.70×10^{-1}	0.73×10^{-1}	4.2
422.0	0.46×10^4	0.46×10^4	0.0	0.75×10^{-1}	0.76×10^{-1}	4.0
442.0	0.45×10^4	0.45×10^4	0.3	0.79×10^{-1}	0.82×10^{-1}	3.8
462.0	0.44×10^4	0.44×10^4	0.6	0.83×10^{-1}	0.86×10^{-1}	3.5
482.0	0.43×10^4	0.44×10^4	0.8	0.88×10^{-1}	0.91×10^{-1}	3.3
582.0	0.39×10^4	0.40×10^4	1.7	0.11×10^{0}	0.12×10^{0}	2.3
682.0	0.36×10^4	0.37×10^4	2.4	0.14×10^{0}	0.14×10^{0}	1.5
782.0	0.33×10^4	0.34×10^4	2.5	0.17×10^{0}	0.17×10^{0}	0.8
882.0	0.31×10^4	0.32×10^4	2.7	0.20×10^{0}	0.20×10^{0}	0.3
982.0	0.29×10^4	0.30×10^4	2.8	0.23×10^{0}	0.23×10^{0}	−0.1

Table 10. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 69.04 eV; RSTAN code

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
20.0	0.28×10^5	0.31×10^5	7.8	0.11×10^{-2}	0.60×10^{-3}	−42.8
24.0	0.28×10^5	0.30×10^5	6.7	0.12×10^{-2}	0.73×10^{-3}	−38.5
28.0	0.28×10^5	0.29×10^5	4.9	0.13×10^{-2}	0.87×10^{-3}	−35.0
32.0	0.28×10^5	0.28×10^5	2.4	0.15×10^{-2}	0.10×10^{-2}	−31.9
36.0	0.27×10^5	0.28×10^5	1.4	0.16×10^{-2}	0.12×10^{-2}	−29.2
40.0	0.27×10^5	0.27×10^5	0.2	0.18×10^{-2}	0.13×10^{-2}	−26.8
48.0	0.27×10^5	0.26×10^5	−2.1	0.21×10^{-2}	0.16×10^{-2}	−22.8
56.0	0.26×10^5	0.25×10^5	−4.1	0.24×10^{-2}	0.19×10^{-2}	−19.4
64.0	0.26×10^5	0.24×10^5	−5.9	0.27×10^{-2}	0.22×10^{-2}	−16.6
72.0	0.26×10^5	0.24×10^5	−7.8	0.30×10^{-2}	0.26×10^{-2}	−14.0
80.0	0.25×10^5	0.23×10^5	−8.7	0.33×10^{-2}	0.29×10^{-2}	−11.8
88.0	0.25×10^5	0.22×10^5	−9.4	0.36×10^{-2}	0.33×10^{-2}	−9.8
96.0	0.24×10^5	0.22×10^5	−9.8	0.39×10^{-2}	0.36×10^{-2}	−8.1
104.0	0.24×10^5	0.21×10^5	−10.1	0.43×10^{-2}	0.40×10^{-2}	−6.6
112.0	0.23×10^5	0.21×10^5	−10.3	0.46×10^{-2}	0.44×10^{-2}	−5.2
120.0	0.23×10^5	0.20×10^5	−10.3	0.50×10^{-2}	0.48×10^{-2}	−4.1
140.0	0.22×10^5	0.19×10^5	−10.1	0.59×10^{-2}	0.58×10^{-2}	−1.7
160.0	0.21×10^5	0.19×10^5	−9.7	0.68×10^{-2}	0.68×10^{-2}	0.1
180.0	0.20×10^5	0.18×10^5	−9.2	0.78×10^{-2}	0.79×10^{-2}	1.4
200.0	0.19×10^5	0.17×10^5	−8.6	0.89×10^{-2}	0.91×10^{-2}	2.3
220.0	0.18×10^5	0.16×10^5	−8.0	1.00×10^{-2}	0.10×10^{-1}	3.1
240.0	0.17×10^5	0.16×10^5	−7.4	0.11×10^{-1}	0.12×10^{-1}	3.7
260.0	0.16×10^5	0.15×10^5	−6.8	0.12×10^{-1}	0.13×10^{-1}	4.2
280.0	0.16×10^5	0.15×10^5	−6.3	0.14×10^{-1}	0.14×10^{-1}	4.5
300.0	0.15×10^5	0.14×10^5	−5.8	0.15×10^{-1}	0.16×10^{-1}	4.6
400.0	0.13×10^5	0.12×10^5	−4.1	0.22×10^{-1}	0.23×10^{-1}	4.8
600.0	1.00×10^4	0.97×10^4	−2.3	0.40×10^{-1}	0.41×10^{-1}	4.2
800.0	0.81×10^4	0.80×10^4	−1.4	0.62×10^{-1}	0.64×10^{-1}	3.2
1000.0	0.69×10^4	0.68×10^4	−1.1	0.89×10^{-1}	0.91×10^{-1}	2.5
1200.0	0.60×10^4	0.59×10^4	−1.1	0.12×10^0	0.12×10^0	2.2
2000.0	0.40×10^4	0.40×10^4	−0.8	0.29×10^0	0.29×10^0	1.5
2800.0	0.31×10^4	0.31×10^4	−0.5	0.52×10^0	0.52×10^0	1.0
3600.0	0.26×10^4	0.26×10^4	−0.3	0.80×10^0	0.81×10^0	0.9
5000.0	0.20×10^4	0.20×10^4	0.2	0.14×10^1	0.14×10^1	0.5
7000.0	0.16×10^4	0.16×10^4	0.6	0.25×10^1	0.26×10^1	0.0
9000.0	0.14×10^4	0.14×10^4	0.8	0.39×10^1	0.39×10^1	−0.2
11000.0	0.12×10^4	0.12×10^4	1.0	0.55×10^1	0.55×10^1	−0.4
14000.0	0.11×10^4	0.11×10^4	1.3	0.82×10^1	0.81×10^1	−0.7
18000.0	0.94×10^3	0.95×10^3	1.5	0.12×10^2	0.12×10^2	−0.9
22000.0	0.86×10^3	0.87×10^3	1.6	0.17×10^2	0.17×10^2	−1.0
26000.0	0.81×10^3	0.82×10^3	1.7	0.22×10^2	0.21×10^2	−1.2
30000.0	0.77×10^3	0.79×10^3	1.7	0.27×10^2	0.26×10^2	−1.3
34000.0	0.75×10^3	0.76×10^3	1.6	0.32×10^2	0.31×10^2	−1.4

Table 11. Stopping Power and Energy Range Calculated by LaRc and Bichsel RSTAN Codes for ^{56}Fe Ions on Various Targets

(a) Target, ^{12}C; density, 1.80 g/cm^3; mean ionization potential, 78.00 eV

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
28.0	0.40×10^5	0.10×10^5	−74.8	0.98×10^{-3}	0.51×10^{-3}	−47.6
33.6	0.39×10^5	0.44×10^4	−88.7	0.11×10^{-2}	0.14×10^{-2}	23.7
39.2	0.39×10^5	0.13×10^5	−67.7	0.13×10^{-2}	0.22×10^{-2}	70.9
44.8	0.39×10^5	0.18×10^5	−54.6	0.14×10^{-2}	0.25×10^{-2}	80.2
50.4	0.38×10^5	0.21×10^5	−46.0	0.16×10^{-2}	0.28×10^{-2}	82.2
56.0	0.38×10^5	0.23×10^5	−40.1	0.17×10^{-2}	0.31×10^{-2}	81.6
67.2	0.37×10^5	0.25×10^5	−33.0	0.20×10^{-2}	0.36×10^{-2}	78.1
78.4	0.37×10^5	0.26×10^5	−28.9	0.23×10^{-2}	0.40×10^{-2}	73.8
89.6	0.36×10^5	0.27×10^5	−26.5	0.26×10^{-2}	0.44×10^{-2}	69.7
100.8	0.36×10^5	0.27×10^5	−25.0	0.29×10^{-2}	0.49×10^{-2}	65.9
112.0	0.35×10^5	0.27×10^5	−23.9	0.32×10^{-2}	0.53×10^{-2}	62.6
123.2	0.35×10^5	0.27×10^5	−23.1	0.36×10^{-2}	0.57×10^{-2}	59.8
134.4	0.34×10^5	0.27×10^5	−22.5	0.39×10^{-2}	0.61×10^{-2}	57.3
145.6	0.34×10^5	0.26×10^5	−22.0	0.42×10^{-2}	0.65×10^{-2}	55.0
156.8	0.33×10^5	0.26×10^5	−21.5	0.46×10^{-2}	0.70×10^{-2}	53.0
168.0	0.33×10^5	0.26×10^5	−21.0	0.49×10^{-2}	0.74×10^{-2}	51.2
196.0	0.32×10^5	0.25×10^5	−19.8	0.58×10^{-2}	0.85×10^{-2}	47.3
224.0	0.30×10^5	0.25×10^5	−18.8	0.67×10^{-2}	0.96×10^{-2}	44.2
252.0	0.29×10^5	0.24×10^5	−17.8	0.76×10^{-2}	0.11×10^{-1}	41.5
280.0	0.28×10^5	0.24×10^5	−16.9	0.86×10^{-2}	0.12×10^{-1}	39.2
308.0	0.27×10^5	0.23×10^5	−16.1	0.96×10^{-2}	0.13×10^{-1}	37.2
336.0	0.27×10^5	0.23×10^5	−15.3	0.11×10^{-1}	0.14×10^{-1}	35.3
364.0	0.26×10^5	0.22×10^5	−14.5	0.12×10^{-1}	0.16×10^{-1}	33.7
392.0	0.25×10^5	0.22×10^5	−13.8	0.13×10^{-1}	0.17×10^{-1}	32.2
420.0	0.24×10^5	0.21×10^5	−13.1	0.14×10^{-1}	0.18×10^{-1}	30.9
560.0	0.21×10^5	0.19×10^5	−10.4	0.20×10^{-1}	0.25×10^{-1}	25.4
840.0	0.17×10^5	0.16×10^5	−6.9	0.35×10^{-1}	0.42×10^{-1}	18.6
1120.0	0.14×10^5	0.13×10^5	−4.8	0.53×10^{-1}	0.61×10^{-1}	14.3
1400.0	0.12×10^5	0.12×10^5	−3.5	0.75×10^{-1}	0.83×10^{-1}	11.4
1680.0	0.11×10^5	0.10×10^5	−2.8	0.99×10^{-1}	0.11×10^0	9.4
2800.0	0.74×10^4	0.73×10^4	−1.6	0.23×10^0	0.24×10^0	5.3
3920.0	0.57×10^4	0.57×10^4	−1.2	0.40×10^0	0.42×10^0	3.6
5040.0	0.48×10^4	0.47×10^4	−0.8	0.62×10^0	0.63×10^0	2.7
7000.0	0.38×10^4	0.37×10^4	−0.3	0.11×10^1	0.11×10^1	1.8
9800.0	0.30×10^4	0.30×10^4	0.3	0.19×10^1	0.20×10^1	0.9
12600.0	0.25×10^4	0.25×10^4	0.6	0.30×10^1	0.30×10^1	0.5
15400.0	0.22×10^4	0.23×10^4	1.0	0.41×10^1	0.42×10^1	0.1
19600.0	0.20×10^4	0.20×10^4	1.3	0.62×10^1	0.61×10^1	−0.3
25200.0	0.17×10^4	0.18×10^4	1.6	0.92×10^1	0.91×10^1	−0.7
30800.0	0.16×10^4	0.16×10^4	1.8	0.13×10^2	0.12×10^2	−0.9
36400.0	0.15×10^4	0.15×10^4	1.9	0.16×10^2	0.16×10^2	−1.1
42000.0	0.14×10^4	0.15×10^4	2.0	0.20×10^2	0.20×10^2	−1.3
47600.0	0.14×10^4	0.14×10^4	2.0	0.24×10^2	0.24×10^2	−1.4
53200.0	0.14×10^4	0.14×10^4	1.9	0.28×10^2	0.28×10^2	−1.5

Table 11. Continued

(b) Target, ^{27}Al; density, 2.70 g/cm^3; mean ionization potential, 166.00 eV

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
28.0	0.27×10^5	0.10×10^5	−62.9	0.16×10^{-2}	0.28×10^{-2}	80.0
33.6	0.28×10^5	0.10×10^5	−63.8	0.18×10^{-2}	0.34×10^{-2}	90.9
39.2	0.28×10^5	0.83×10^4	−70.5	0.20×10^{-2}	0.40×10^{-2}	102.9
44.8	0.28×10^5	0.14×10^5	−51.4	0.22×10^{-2}	0.45×10^{-2}	108.6
50.4	0.29×10^5	0.17×10^5	−39.7	0.24×10^{-2}	0.49×10^{-2}	106.6
56.0	0.29×10^5	0.19×10^5	−32.2	0.26×10^{-2}	0.52×10^{-2}	102.7
67.2	0.29×10^5	0.22×10^5	−24.1	0.30×10^{-2}	0.57×10^{-2}	94.2
78.4	0.29×10^5	0.23×10^5	−19.8	0.33×10^{-2}	0.62×10^{-2}	86.4
89.6	0.28×10^5	0.24×10^5	−16.6	0.37×10^{-2}	0.67×10^{-2}	79.6
100.8	0.28×10^5	0.24×10^5	−14.8	0.41×10^{-2}	0.72×10^{-2}	74.0
112.0	0.28×10^5	0.24×10^5	−13.9	0.45×10^{-2}	0.77×10^{-2}	68.8
123.2	0.27×10^5	0.24×10^5	−13.4	0.49×10^{-2}	0.81×10^{-2}	64.5
134.4	0.27×10^5	0.24×10^5	−13.2	0.54×10^{-2}	0.86×10^{-2}	60.7
145.6	0.27×10^5	0.23×10^5	−13.1	0.58×10^{-2}	0.91×10^{-2}	57.4
156.8	0.26×10^5	0.23×10^5	−13.1	0.62×10^{-2}	0.96×10^{-2}	54.5
168.0	0.26×10^5	0.23×10^5	−13.1	0.66×10^{-2}	0.10×10^{-1}	52.0
196.0	0.25×10^5	0.22×10^5	−13.3	0.77×10^{-2}	0.11×10^{-1}	46.8
224.0	0.25×10^5	0.21×10^5	−13.4	0.88×10^{-2}	0.13×10^{-1}	42.8
252.0	0.24×10^5	0.21×10^5	−13.4	0.10×10^{-1}	0.14×10^{-1}	39.6
280.0	0.23×10^5	0.20×10^5	−13.2	0.11×10^{-1}	0.15×10^{-1}	37.0
308.0	0.22×10^5	0.19×10^5	−12.9	0.12×10^{-1}	0.17×10^{-1}	34.8
336.0	0.22×10^5	0.19×10^5	−12.6	0.14×10^{-1}	0.18×10^{-1}	33.0
364.0	0.21×10^5	0.18×10^5	−12.2	0.15×10^{-1}	0.20×10^{-1}	31.4
392.0	0.20×10^5	0.18×10^5	−11.8	0.16×10^{-1}	0.21×10^{-1}	29.9
420.0	0.20×10^5	0.18×10^5	−11.3	0.18×10^{-1}	0.23×10^{-1}	28.5
560.0	0.18×10^5	0.16×10^5	−9.2	0.25×10^{-1}	0.31×10^{-1}	23.5
840.0	0.14×10^5	0.13×10^5	−6.4	0.43×10^{-1}	0.51×10^{-1}	17.3
1120.0	0.12×10^5	0.11×10^5	−4.5	0.65×10^{-1}	0.74×10^{-1}	13.4
1400.0	0.10×10^5	1.00×10^4	−3.2	0.90×10^{-1}	1.00×10^{-1}	10.6
1680.0	0.91×10^4	0.89×10^4	−2.6	0.12×10^0	0.13×10^0	8.8
2800.0	0.64×10^4	0.63×10^4	−1.5	0.27×10^0	0.28×10^0	5.0
3920.0	0.50×10^4	0.49×10^4	−1.1	0.47×10^0	0.49×10^0	3.3
5040.0	0.41×10^4	0.41×10^4	−0.8	0.72×10^0	0.74×10^0	2.6
7000.0	0.33×10^4	0.33×10^4	−0.3	0.13×10^1	0.13×10^1	1.7
9800.0	0.26×10^4	0.26×10^4	0.4	0.22×10^1	0.22×10^1	0.9
12600.0	0.22×10^4	0.22×10^4	0.8	0.34×10^1	0.34×10^1	0.4
15400.0	0.20×10^4	0.20×10^4	1.1	0.47×10^1	0.47×10^1	0.1
19600.0	0.17×10^4	0.18×10^4	1.5	0.70×10^1	0.70×10^1	−0.4
25200.0	0.15×10^4	0.16×10^4	1.7	0.10×10^2	0.10×10^2	−0.8
30800.0	0.14×10^4	0.15×10^4	2.0	0.14×10^2	0.14×10^2	−1.0
36400.0	0.13×10^4	0.14×10^4	2.1	0.18×10^2	0.18×10^2	−1.3
42000.0	0.13×10^4	0.13×10^4	2.2	0.23×10^2	0.22×10^2	−1.4
47600.0	0.12×10^4	0.13×10^4	2.3	0.27×10^2	0.27×10^2	−1.6
53200.0	0.12×10^4	0.12×10^4	2.2	0.32×10^2	0.31×10^2	−1.6

Table 11. Continued

(c) Target, ^{63}Cu; density, 8.96 g/cm^3; mean ionization potential, 322.00 eV

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
28.0	0.17×10^5	0.10×10^5	–42.4	0.30×10^{-2}	0.28×10^{-2}	–6.2
33.6	0.18×10^5	0.10×10^5	–45.1	0.33×10^{-2}	0.34×10^{-2}	1.9
39.2	0.19×10^5	0.10×10^5	–47.0	0.36×10^{-2}	0.39×10^{-2}	8.9
44.8	0.19×10^5	0.10×10^5	–48.3	0.39×10^{-2}	0.45×10^{-2}	15.1
50.4	0.20×10^5	0.21×10^4	–89.6	0.42×10^{-2}	0.59×10^{-2}	40.5
56.0	0.20×10^5	0.54×10^4	–73.3	0.45×10^{-2}	0.76×10^{-2}	70.7
67.2	0.20×10^5	0.11×10^5	–47.0	0.50×10^{-2}	0.91×10^{-2}	81.4
78.4	0.21×10^5	0.14×10^5	–32.8	0.56×10^{-2}	0.10×10^{-1}	79.9
89.6	0.21×10^5	0.15×10^5	–25.3	0.61×10^{-2}	0.11×10^{-1}	76.5
100.8	0.21×10^5	0.16×10^5	–20.3	0.66×10^{-2}	0.12×10^{-1}	72.9
112.0	0.21×10^5	0.17×10^5	–17.3	0.72×10^{-2}	0.12×10^{-1}	69.1
123.2	0.20×10^5	0.17×10^5	–15.5	0.77×10^{-2}	0.13×10^{-1}	65.5
134.4	0.20×10^5	0.17×10^5	–14.2	0.83×10^{-2}	0.14×10^{-1}	62.3
145.6	0.20×10^5	0.17×10^5	–13.4	0.89×10^{-2}	0.14×10^{-1}	59.4
156.8	0.20×10^5	0.17×10^5	–13.6	0.94×10^{-2}	0.15×10^{-1}	56.8
168.0	0.20×10^5	0.17×10^5	–12.7	1.00×10^{-2}	0.15×10^{-1}	54.5
196.0	0.19×10^5	0.17×10^5	–11.5	0.11×10^{-1}	0.17×10^{-1}	49.4
224.0	0.19×10^5	0.17×10^5	–10.9	0.13×10^{-1}	0.19×10^{-1}	45.2
252.0	0.18×10^5	0.17×10^5	–10.5	0.14×10^{-1}	0.20×10^{-1}	41.7
280.0	0.18×10^5	0.16×10^5	–10.2	0.16×10^{-1}	0.22×10^{-1}	38.8
308.0	0.18×10^5	0.16×10^5	–10.0	0.18×10^{-1}	0.24×10^{-1}	36.3
336.0	0.17×10^5	0.15×10^5	–9.7	0.19×10^{-1}	0.26×10^{-1}	34.2
364.0	0.17×10^5	0.15×10^5	–9.4	0.21×10^{-1}	0.28×10^{-1}	32.3
392.0	0.16×10^5	0.15×10^5	–9.2	0.23×10^{-1}	0.29×10^{-1}	30.6
420.0	0.16×10^5	0.14×10^5	–8.9	0.24×10^{-1}	0.31×10^{-1}	29.2
560.0	0.14×10^5	0.13×10^5	–7.6	0.34×10^{-1}	0.42×10^{-1}	23.5
840.0	0.12×10^5	0.11×10^5	–5.7	0.56×10^{-1}	0.65×10^{-1}	17.1
1120.0	0.99×10^4	0.95×10^4	–4.1	0.82×10^{-1}	0.93×10^{-1}	13.2
1400.0	0.86×10^4	0.83×10^4	–3.1	0.11×10^0	0.12×10^0	10.6
1680.0	0.77×10^4	0.75×10^4	–2.5	0.15×10^0	0.16×10^0	8.8
2800.0	0.54×10^4	0.53×10^4	–1.7	0.33×10^0	0.34×10^0	5.1
3920.0	0.43×10^4	0.42×10^4	–1.4	0.56×10^0	0.58×10^0	3.6
5040.0	0.36×10^4	0.35×10^4	–1.1	0.85×10^0	0.87×10^0	2.8
7000.0	0.28×10^4	0.28×10^4	–0.7	0.15×10^1	0.15×10^1	2.0
9800.0	0.23×10^4	0.23×10^4	–0.2	0.26×10^1	0.26×10^1	1.3
12600.0	0.19×10^4	0.19×10^4	0.2	0.39×10^1	0.40×10^1	0.9
15400.0	0.17×10^4	0.17×10^4	0.6	0.55×10^1	0.55×10^1	0.5
19600.0	0.15×10^4	0.15×10^4	0.9	0.81×10^1	0.81×10^1	0.1
25200.0	0.14×10^4	0.14×10^4	1.2	0.12×10^2	0.12×10^2	–0.3
30800.0	0.13×10^4	0.13×10^4	1.4	0.16×10^2	0.16×10^2	–0.6
36400.0	0.12×10^4	0.12×10^4	1.6	0.21×10^2	0.21×10^2	–0.8
42000.0	0.11×10^4	0.12×10^4	1.7	0.26×10^2	0.26×10^2	–0.9
47600.0	0.11×10^4	0.11×10^4	1.8	0.31×10^2	0.31×10^2	–1.1
53200.0	0.11×10^4	0.11×10^4	1.7	0.36×10^2	0.36×10^2	–1.1

Table 11. Continued

(d) Target, ^{197}Au; density, 19.32 g/cm^3; mean ionization potential, 790.00 eV

Energy, MeV	Stopping power LaRC code	Stopping power RSTAN code	Difference, percent	Energy range LaRC code	Energy range RSTAN code	Difference, percent
28.0	0.91×10^4	0.10×10^5	9.5	0.61×10^{-2}	0.28×10^{-2}	–53.8
33.6	0.95×10^4	0.10×10^5	5.1	0.67×10^{-2}	0.34×10^{-2}	–49.6
39.2	0.98×10^4	0.10×10^5	1.7	0.72×10^{-2}	0.39×10^{-2}	–45.9
44.8	0.10×10^5	0.10×10^5	–1.0	0.78×10^{-2}	0.45×10^{-2}	–42.6
50.4	0.10×10^5	0.10×10^5	–3.3	0.84×10^{-2}	0.50×10^{-2}	–39.7
56.0	0.11×10^5	0.10×10^5	–5.2	0.89×10^{-2}	0.56×10^{-2}	–37.0
67.2	0.11×10^5	0.43×10^3	–96.1	0.99×10^{-2}	0.14×10^{-1}	39.6
78.4	0.11×10^5	0.28×10^4	–75.0	0.11×10^{-1}	0.25×10^{-1}	132.1
89.6	0.11×10^5	0.44×10^4	–61.0	0.12×10^{-1}	0.29×10^{-1}	139.6
100.8	0.11×10^5	0.56×10^4	–51.5	0.13×10^{-1}	0.31×10^{-1}	139.1
112.0	0.12×10^5	0.64×10^4	–44.3	0.14×10^{-1}	0.33×10^{-1}	135.7
123.2	0.12×10^5	0.71×10^4	–38.8	0.15×10^{-1}	0.35×10^{-1}	131.5
134.4	0.12×10^5	0.76×10^4	–34.5	0.16×10^{-1}	0.36×10^{-1}	127.0
145.6	0.12×10^5	0.80×10^4	–31.0	0.17×10^{-1}	0.37×10^{-1}	122.5
156.8	0.12×10^5	0.83×10^4	–28.2	0.18×10^{-1}	0.39×10^{-1}	118.1
168.0	0.12×10^5	0.85×10^4	–25.9	0.19×10^{-1}	0.40×10^{-1}	113.9
196.0	0.12×10^5	0.90×10^4	–22.0	0.21×10^{-1}	0.43×10^{-1}	104.5
224.0	0.11×10^5	0.92×10^4	–18.9	0.24×10^{-1}	0.46×10^{-1}	96.3
252.0	0.11×10^5	0.94×10^4	–16.6	0.26×10^{-1}	0.49×10^{-1}	89.3
280.0	0.11×10^5	0.94×10^4	–14.8	0.29×10^{-1}	0.52×10^{-1}	83.1
308.0	0.11×10^5	0.95×10^4	–13.5	0.31×10^{-1}	0.55×10^{-1}	77.7
336.0	0.11×10^5	0.94×10^4	–12.2	0.34×10^{-1}	0.58×10^{-1}	72.9
364.0	0.11×10^5	0.94×10^4	–11.2	0.36×10^{-1}	0.61×10^{-1}	68.6
392.0	0.10×10^5	0.93×10^4	–10.4	0.39×10^{-1}	0.64×10^{-1}	64.7
420.0	0.10×10^5	0.93×10^4	–9.5	0.42×10^{-1}	0.67×10^{-1}	61.3
560.0	0.94×10^4	0.88×10^4	–6.7	0.56×10^{-1}	0.83×10^{-1}	47.9
840.0	0.80×10^4	0.77×10^4	–3.2	0.89×10^{-1}	0.12×10^0	32.0
1120.0	0.69×10^4	0.68×10^4	–0.6	0.13×10^0	0.16×10^0	22.9
1400.0	0.61×10^4	0.61×10^4	0.6	0.17×10^0	0.20×10^0	17.0
1680.0	0.55×10^4	0.55×10^4	1.1	0.22×10^0	0.25×10^0	13.0
2800.0	0.39×10^4	0.40×10^4	1.6	0.47×10^0	0.49×10^0	5.4
3920.0	0.32×10^4	0.32×10^4	1.4	0.78×10^0	0.80×10^0	2.5
5040.0	0.27×10^4	0.27×10^4	1.3	0.12×10^1	0.12×10^1	1.3
7000.0	0.21×10^4	0.22×10^4	1.1	0.20×10^1	0.20×10^1	0.3
9800.0	0.17×10^4	0.18×10^4	1.3	0.35×10^1	0.35×10^1	–0.4
12600.0	0.15×10^4	0.15×10^4	1.4	0.52×10^1	0.52×10^1	–0.6
15400.0	0.13×10^4	0.14×10^4	1.7	0.72×10^1	0.72×10^1	–0.9
19600.0	0.12×10^4	0.12×10^4	2.0	0.11×10^2	0.10×10^2	–1.2
25200.0	0.11×10^4	0.11×10^4	2.2	0.16×10^2	0.15×10^2	–1.5
30800.0	0.98×10^3	1.00×10^3	2.4	0.21×10^2	0.21×10^2	–1.7
36400.0	0.92×10^3	0.95×10^3	2.6	0.27×10^2	0.27×10^2	–1.8
42000.0	0.89×10^3	0.91×10^3	2.7	0.33×10^2	0.33×10^2	–2.0
47600.0	0.86×10^3	0.88×10^3	2.8	0.40×10^2	0.39×10^2	–2.1
53200.0	0.84×10^3	0.87×10^3	2.8	0.46×10^2	0.45×10^2	–2.2

Table 11. Continued

(e) Target, ^{238}U; density, 19.07 g/cm^3; mean ionization potential, 900.00 eV

Energy, MeV	Stopping power		Difference, percent	Energy range		Difference, percent
	LaRC code	RSTAN code		LaRC code	RSTAN code	
28.0	0.98×10^4	0.10×10^5	2.5	0.52×10^{-2}	0.28×10^{-2}	−46.5
33.6	1.00×10^4	0.10×10^5	0.4	0.58×10^{-2}	0.34×10^{-2}	−42.0
39.2	0.10×10^5	0.10×10^5	−1.3	0.64×10^{-2}	0.39×10^{-2}	−38.3
44.8	0.10×10^5	0.10×10^5	−2.7	0.69×10^{-2}	0.45×10^{-2}	−35.1
50.4	0.10×10^5	0.10×10^5	−4.0	0.74×10^{-2}	0.50×10^{-2}	−32.3
56.0	0.11×10^5	0.10×10^5	−5.0	0.80×10^{-2}	0.56×10^{-2}	−29.8
67.2	0.11×10^5	0.10×10^5	−6.6	0.90×10^{-2}	0.67×10^{-2}	−25.6
78.4	0.11×10^5	0.22×10^4	−79.7	0.10×10^{-1}	0.94×10^{-2}	−6.8
89.6	0.11×10^5	0.38×10^4	−65.2	0.11×10^{-1}	0.13×10^{-1}	19.7
100.8	0.11×10^5	0.49×10^4	−55.4	0.12×10^{-1}	0.16×10^{-1}	31.1
112.0	0.11×10^5	0.57×10^4	−48.3	0.13×10^{-1}	0.18×10^{-1}	37.1
123.2	0.11×10^5	0.63×10^4	−42.5	0.14×10^{-1}	0.20×10^{-1}	40.4
134.4	0.11×10^5	0.68×10^4	−38.1	0.15×10^{-1}	0.22×10^{-1}	42.2
145.6	0.11×10^5	0.72×10^4	−34.6	0.16×10^{-1}	0.23×10^{-1}	43.1
156.8	0.11×10^5	0.75×10^4	−31.7	0.17×10^{-1}	0.25×10^{-1}	43.5
168.0	0.11×10^5	0.77×10^4	−29.3	0.18×10^{-1}	0.26×10^{-1}	43.5
196.0	0.11×10^5	0.82×10^4	−25.1	0.21×10^{-1}	0.30×10^{-1}	42.8
224.0	0.11×10^5	0.84×10^4	−21.9	0.23×10^{-1}	0.33×10^{-1}	41.5
252.0	0.11×10^5	0.86×10^4	−19.5	0.26×10^{-1}	0.36×10^{-1}	39.9
280.0	0.11×10^5	0.86×10^4	−17.5	0.29×10^{-1}	0.40×10^{-1}	38.3
308.0	0.10×10^5	0.87×10^4	−16.0	0.31×10^{-1}	0.43×10^{-1}	36.8
336.0	0.10×10^5	0.86×10^4	14.4	0.34×10^{-1}	0.46×10^{-1}	35.3
364.0	0.99×10^4	0.86×10^4	−13.1	0.37×10^{-1}	0.49×10^{-1}	33.8
392.0	0.97×10^4	0.86×10^4	−12.0	0.40×10^{-1}	0.53×10^{-1}	32.4
420.0	0.95×10^4	0.85×10^4	−11.0	0.43×10^{-1}	0.56×10^{-1}	31.1
560.0	0.87×10^4	0.81×10^4	−7.1	0.58×10^{-1}	0.73×10^{-1}	25.5
840.0	0.74×10^4	0.72×10^4	−2.9	0.93×10^{-1}	0.11×10^0	17.7
1120.0	0.64×10^4	0.64×10^4	−0.7	0.13×10^0	0.15×10^0	12.9
1400.0	0.57×10^4	0.57×10^4	0.6	0.18×10^0	0.20×10^0	9.5
1680.0	0.51×10^4	0.51×10^4	1.2	0.23×10^0	0.25×10^0	7.2
2800.0	0.37×10^4	0.38×10^4	1.9	0.50×10^0	0.51×10^0	2.5
3920.0	0.29×10^4	0.30×10^4	1.8	0.84×10^0	0.85×10^0	0.7
5040.0	0.25×10^4	0.25×10^4	1.7	0.13×10^1	0.13×10^1	−0.1
7000.0	0.20×10^4	0.20×10^4	1.5	0.21×10^1	0.21×10^1	−0.7
9800.0	0.16×10^4	0.17×10^4	1.6	0.37×10^1	0.37×10^1	−1.1
12600.0	0.14×10^4	0.14×10^4	1.7	0.56×10^1	0.55×10^1	−1.2
15400.0	0.13×10^4	0.13×10^4	2.0	0.77×10^1	0.76×10^1	−1.4
19600.0	0.11×10^4	0.11×10^4	2.2	0.11×10^2	0.11×10^2	−1.6
25200.0	0.99×10^3	0.10×10^4	2.5	0.17×10^2	0.16×10^2	−1.8
30800.0	0.92×10^3	0.95×10^3	2.7	0.23×10^2	0.22×10^2	−2.0
36400.0	0.87×10^3	0.90×10^3	2.8	0.29×10^2	0.28×10^2	−2.2
42000.0	0.84×10^3	0.86×10^3	2.9	0.35×10^2	0.35×10^2	−2.3
47600.0	0.81×10^3	0.84×10^3	3.0	0.42×10^2	0.41×10^2	−2.4

Table 11. Concluded

(f) Target, H_2O; density, 1.00 g/cm^3; mean ionization potential, 69.04 eV

Energy, MeV	Stopping power, LaRC code	Stopping power, RSTAN code	Difference, percent	Energy range, LaRC code	Energy range, RSTAN code	Difference, percent
28.0	4.08×10^4	1.00×10^4	−7.6	1.05×10^{-3}	3.18×10^{-4}	−7.0
33.6	4.10×10^4	2.40×10^3	−9.4	1.19×10^{-3}	1.59×10^{-3}	3.3
39.2	4.09×10^4	1.12×10^4	−7.3	1.33×10^{-3}	2.75×10^{-3}	10.7
44.8	4.09×10^4	1.65×10^4	−6.0	1.46×10^{-3}	3.16×10^{-3}	11.6
50.4	4.09×10^4	2.07×10^4	−4.9	1.60×10^{-3}	3.46×10^{-3}	11.6
56.0	4.08×10^4	2.36×10^4	−4.2	1.74×10^{-3}	3.72×10^{-3}	11.4
67.2	4.07×10^4	2.69×10^4	−3.4	2.01×10^{-3}	4.16×10^{-3}	10.7
78.4	4.05×10^4	2.86×10^4	−3.0	2.29×10^{-3}	4.56×10^{-3}	10.0
89.6	4.02×10^4	2.95×10^4	−2.7	2.56×10^{-3}	4.95×10^{-3}	9.3
100.8	4.02×10^4	2.99×10^4	−2.6	2.84×10^{-3}	5.33×10^{-3}	8.7
112.0	3.97×10^4	3.00×10^4	−2.5	3.13×10^{-3}	5.70×10^{-3}	8.2
123.2	3.93×10^4	3.00×10^4	−2.4	3.41×10^{-3}	6.08×10^{-3}	7.8
134.4	3.88×10^4	2.99×10^4	−2.3	3.69×10^{-3}	6.45×10^{-3}	7.5
145.6	3.83×10^4	2.98×10^4	−2.2	3.98×10^{-3}	6.82×10^{-3}	7.1
156.8	3.78×10^4	2.96×10^4	−2.2	4.28×10^{-3}	7.20×10^{-3}	6.8
168.0	3.72×10^4	2.93×10^4	−2.1	4.57×10^{-3}	7.58×10^{-3}	6.6
196.0	3.58×10^4	2.87×10^4	−2.0	5.34×10^{-3}	8.55×10^{-3}	6.0
224.0	3.45×10^4	2.80×10^4	−1.9	6.14×10^{-3}	9.54×10^{-3}	5.5
252.0	3.33×10^4	2.74×10^4	−1.8	6.96×10^{-3}	1.06×10^{-2}	5.1
280.0	3.21×10^4	2.68×10^4	−1.7	7.82×10^{-3}	1.16×10^{-2}	4.8
308.0	3.10×10^4	2.61×10^4	−1.6	8.71×10^{-3}	1.26×10^{-2}	4.5
336.0	3.00×10^4	2.55×10^4	−1.5	9.62×10^{-3}	1.37×10^{-2}	4.3
364.0	2.90×10^4	2.49×10^4	−1.4	1.06×10^{-2}	1.48×10^{-2}	4.0
392.0	2.81×10^4	2.44×10^4	−1.3	1.15×10^{-2}	1.60×10^{-2}	3.8
420.0	2.73×10^4	2.38×10^4	−1.3	1.26×10^{-2}	1.71×10^{-2}	3.6
560.0	2.38×10^4	2.14×10^4	−1.0	1.81×10^{-2}	2.33×10^{-2}	2.9
840.0	1.90×10^4	1.78×10^4	−0.6	3.12×10^{-2}	3.76×10^{-2}	2.1
1120.0	1.59×10^4	1.52×10^4	−0.4	4.75×10^{-2}	5.48×10^{-2}	1.6
1400.0	1.37×10^4	1.33×10^4	−0.3	6.66×10^{-2}	7.46×10^{-2}	1.2
1680.0	1.21×10^4	1.18×10^4	−0.2	8.84×10^{-2}	9.70×10^{-2}	1.0
2800.0	8.30×10^3	8.21×10^3	−0.1	2.03×10^{-1}	2.13×10^{-1}	0.5
3920.0	6.44×10^3	6.40×10^3	−0.1	3.58×10^{-1}	3.69×10^{-1}	0.3
5040.0	5.34×10^3	5.32×10^3	−0.0	5.49×10^{-1}	5.62×10^{-1}	0.2
7000.0	4.21×10^3	4.21×10^3	0.0	9.67×10^{-1}	9.80×10^{-1}	0.1
9800.0	3.33×10^3	3.36×10^3	0.9	1.72×10^0	1.73×10^0	0.1
12600.0	2.83×10^3	2.87×10^3	0.1	2.64×10^0	2.64×10^0	−0.0
15400.0	2.52×10^3	2.55×10^3	0.1	3.69×10^0	3.68×10^0	−0.0
19600.0	2.20×10^3	2.24×10^3	0.2	5.49×10^0	5.44×10^0	−0.1
25200.0	1.95×10^3	1.99×10^3	0.2	8.19×10^0	8.10×10^0	−0.1
30800.0	1.80×10^3	1.84×10^3	0.2	1.12×10^1	1.10×10^1	−0.1
36400.0	1.69×10^3	1.73×10^3	0.2	1.44×10^1	1.42×10^1	−0.2
42000.0	1.62×10^3	1.66×10^3	0.2	1.78×10^1	1.75×10^1	−0.2
47600.0	1.56×10^3	1.60×10^3	0.2	2.13×10^1	2.09×10^1	−0.2

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13. ABSTRACT *(Maximum 200 words)*

The codes used to calculate stopping power and range for the space radiation shielding program at the Langley Research Center are based on the work of Ziegler but with modifications. As more experience is gained from experiments at heavy ion accelerators, prudence dictates a reevaluation of the current databases. Numerical values of stopping power and range calculated from four different codes currently in use are presented for selected ions and materials in the energy domain suitable for space radiation transport. This study of radiation transport has found that for most collision systems and for intermediate particle energies, agreement is less than 1 percent, in general, among all the codes. However, greater discrepancies are seen for heavy systems, especially at low particle energies.

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