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**THERMAL-NEUTRON-CAPTURE
PROMPT-GAMMA EMISSION SPECTRA
OF REPRESENTATIVE COALS**

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by

C. L. Herzenberg and I. K. Olson

FOSSIL ENERGY PROGRAM

ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

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Applied Physics Division

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December 1981

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ABSTRACT

Prompt gamma ray emission spectra have been calculated from 1.5 to 11 MeV for a wide range of coal compositions exposed to a thermal neutron flux. These include contributions to the spectra from all of the major and minor elements present in the coals. Characteristics of the spectra are discussed and correlated with the coal compositions.

1. INTRODUCTION

During the last several years, the application of neutron-induced gamma spectrometry for analysis of the elemental composition of coals and related materials has received increasing attention as a promising method for continuous automated analysis of coals, coal feedstocks, and related process stream materials.^{1-17,35} This general method is based on the fact that the neutron-induced gamma spectrum of a complex substance is composed of the superposition of the characteristic spectra of the elements present. Intensities of those spectra correspond to the abundances of the elements composing the materials.^{5,8} While several useful studies have also been conducted using higher energy neutron sources,^{16,17} most studies in this application area have been conducted using ²⁵²Cf neutron sources.¹⁻¹⁵ These isotopic neutron sources emit fission spectrum neutrons which become thermalized relatively easily in hydrogenous materials such as coal and coal slurries.^{3-5,27,28} Thus, the thermal neutron capture prompt gamma rays emitted by coals play a very basic role in this important application area.

In this paper, we report calculations of the higher energy part (above 1.5 MeV) of the thermal neutron capture prompt gamma emission spectra of coals. A certain amount of previous experimental work has largely concentrated on the lower energy part of the capture gamma spectra, in part because of higher sensitivity of certain low energy lines and higher efficiency of detectors at lower energies.^{31,34} However, for practical applications involving composition analysis of large coal samples, including through-the-pipe applications, the higher energy gamma rays are far more useful not only because they absorbed less in traversing matter, but also because the spectral features in the 1.5-11 MeV range are dominated by the major and minor elements which are of primary interest for on-line analysis.

In a laboratory measurement or in the design of an analysis instrument based on neutron-induced gamma spectrometry, it is necessary to take into consideration a wide range of other effects beyond the basic thermal neutron-induced gamma emission spectra. For example, some fraction of the fission spectrum of neutrons will interact at higher energies (e.g., resonance capture in sulfur or iron), and produce a contribution in the spectra.^{8,16,18,27,28,39} Activation gammas are present in the experimental spectra, in addition to prompt gammas.^{5,8,9,16} The ^{252}Cf source itself emits a continuum of fission gamma radiation which will make some contribution to the detected gamma ray spectra even with appreciable shielding.^{27,28} Compton scattered gamma radiation produces a continuum of radiation entering the detector.^{8,29} Thus, in general, an experimental spectrum consists of a line spectrum superposed on a continuum; it is only the line spectrum which we are concerned with here, and only that portion of it originating directly from the coal. The relative intensity of gammas of different energy originating from different spatial regions of neutron flux is affected by the differential attenuation of

intervening material.²⁹ Since the neutron flux is generally not entirely confined to the localized region containing the coal or other material under interrogation, additional emission lines are generated from nearby materials.^{2,5,8} The efficiency of the detector varies with energy, and the detected spectrum is complicated by interactions that occur within the detector itself, including the presence of subsidiary single escape and double escape peaks at lower energies, 0.511 and 1.02 MeV below the full energy peaks, originating from pair production interactions.^{8,19} Line widths depend on detector characteristics and energy and are vastly different for low resolution detectors such as NaI (Tl) crystals in comparison with high resolution detectors such as HPGe or Ge(Li) detectors.^{5,7,12,13}

As a result, detailed interpretation of experimentally measured neutron-induced gamma spectra of coals requires extensive additional calculations. However, a great deal of basic and useful information is provided by the fundamental thermal neutron capture prompt gamma emission spectra of the coals. Availability of such spectra can provide insight for improvements in instrumentation design and methodology, as well as aiding in the interpretation and understanding of experimental spectra of coals.

2. METHODOLOGY

The general procedure followed is to determine the fate of thermal neutrons in an infinite sample of material of the composition in question, using tabulated nuclear properties of the isotopes of the elements present in this composition. For n_0 neutrons incident per unit area on a region containing nuclei of a given type which are present in the concentration N_T per unit volume, and which interact with the neutrons by a process described by the cross section σ , the total number of interactions produced in the unit volume

will be given by the product $n_0 N_T \sigma$. (Since all materials dealt with in the present report consist of the natural isotopic mixtures, all cross sections and other parameters used will be referred henceforth to the natural isotopic mixture of the element.)

If we have an element present in weight percent abundance w_e in the sample, the concentration per unit volume of nuclei of this element will be given by

$$N_T = \frac{w_e}{100} \cdot \frac{L}{A} \rho \quad (1)$$

where L = Avogadro's number, A is the atomic weight of the element, and ρ is the density of the sample.

Accordingly, we can evaluate the percent of all of the neutrons absorbed which are absorbed by a particular element in a sample of coal by the expression:

$$100 \frac{w_e \sigma_{abs}/A}{\sum (w_e \sigma_{abs}/A)} \quad (2)$$

where σ_{abs} is the total absorption cross section, and the summation in the denominator is performed over all elements composing the material.

Absorption of thermal neutrons in the light elements of which coal is largely composed occurs mainly by radiative capture processes so that, for most of these elements, $\sigma_{abs} \approx \sigma_c$ where σ_c will henceforth designate the radiative capture cross section for the element. (For a few elements, including, for example nitrogen, other processes such as the (n,p) or (n,α) reactions are of importance and, in these instances, the absorption cross section is noticeably larger than the radiative capture cross section.)^{24-26,39}

The fraction of thermal neutron absorption interactions in an element which leads to radiative capture is then given by the ratio of the two cross sections (σ_c/σ_{abs}). Following radiative capture, a complex spectrum of gamma radiation is, in general, emitted, corresponding to deexcitation cascade processes in the different isotopes.^{21-23,32} For present purposes, the intensities of these various gamma rays (as well as their energies) are quantities of significance, and these may be described conveniently by the parameter I_γ , defined as the number of gammas of energy E emitted per hundred neutrons undergoing radiative capture in that element.^{19-23,31-33}

Thus, we can evaluate the number of gammas of a particular energy E emitted per 10,000 neutrons absorbed in the coal as:

$$100 \frac{I_\gamma w_e \sigma_c / A}{\Sigma(w_e \sigma_{abs}) / A} \quad (3)$$

A computer program has been written to evaluate the absorption of neutrons by the elements present, and to calculate the intensity of each contributing gamma ray from these elements, for coals and coal-related materials of known or specified composition. The contributing nuclear data have been entered from values in the literature.^{19-26,31-34,36,37,39} Input data required for the program are the weight percent values for all contributing elements in the coal composition under study.

The nuclear data values adopted for input into the calculations are listed in the computer printout example in Table 1. The initial data set was based largely on values reported in references 19 and 20; more recently available cross sections and I_γ values have been adopted from the literature

previously cited, and additional gamma rays have been included. No special effort has been made to list more accurate gamma ray energy values, although the energies of a number of these gamma rays are at present known to much higher precision.^{31,36,37} There is some evidence that a few relatively low-intensity gamma rays tabulated in the literature have been incorrectly ascribed to certain of the elements (originating, instead, from contaminants present in the original experiments);³¹ however, until such cases have been verified to be of contaminant origin rather than intrinsic spectral features, we are retaining them in the computer code.

It should be noted that energies and intensities for a few prominent activation (decay) gamma lines^{19,20} have also been included, as these have been found to be useful in conjunction with experimental work.^{5,8,9,16}

The program calculates the percent neutrons absorbed in each element entered for the coal (Table 7). It calculates the number of gammas emitted per 10,000 neutrons absorbed in the coal for each gamma ray entered, including, at present, all gamma rays of energy 1.5 MeV or greater having both an intensity greater than one gamma ray per 100 neutrons undergoing radiative capture in the element, and a sensitivity factor ($I_{\gamma} \sigma_c / A$) greater than 0.01. (The rationale for these particular criteria is discussed in Refs. 19, 20, and 35.) The program prints out these data for each element in the coal. The printout also lists by energy all gammas emitted, together with their individual intensities (number emitted per 10,000 neutrons absorbed in the coal) and the element responsible for each emission line (Table 8). In addition, a semilogarithmic plot is produced which shows the intensity of each emission line at its characteristic energy (Figs. 1-25).

In performing the calculation of the thermal neutron-induced gamma emission spectrum of a coal, we have included the contributions of all of the major and minor elements. A few trace elements have also been included. (Table 1 gives a listing of the elements included in the calculation, together with their nuclear parameters.) Most listed trace elements in these coals have not been included because their contributions are, on the whole, of low intensity in the higher energy region (1.5 MeV to 11 MeV), although a few of the trace elements would contribute noticeably at lower energies.²⁰

For a sample containing a number of different elements, as a coal does, the contribution of a given element to the spectrum is proportional to the abundance of that element, as measured by the weight percent of that element present in the coal (Eq. 2); thus, the spectral contributions of different elements on a coal are weighted in favor of the more abundant elements.

However, the intrinsic sensitivity of response of a particular element relative to other elements in neutron capture prompt gamma spectrometry is also important, a measure of this is provided by the quantity (σ_c/A) for each element,²³ or, better yet, by the sensitivity factor ($I_\gamma \sigma_c/A$) corresponding to the strongest penetrating primary gamma ray for each element.³⁵

Most of the major and minor elements of which coal is composed have sensitivity factors in the range 0.1 to 1.0.³⁵ (The largest number of all elements are found within this sensitivity range also.) Of the major and minor elements composing coal, only carbon and oxygen are noticeably lower, while Fe, Ti, and Cl have higher sensitivity factors. Only four elements (B, Gd, Cd, and Sm) have sensitivity factors in ranges larger by an order of magnitude or more than that of chlorine, and they occur only as trace elements in coals; furthermore, their gamma emission following neutron absorption is

predominantly at low energies (below 1.5 MeV).^{18,19} (Since analyses were not available for them in these coals, Gd and Sm are not included in the present computer program.) Consequently, the thermal neutron capture prompt gamma emission spectra of coals are dominated at higher energies by spectral lines emitted by the major and minor elements composing the coal, and thus spectral analysis of these gammas can provide direct composition information on the major and minor elements of the coal.^{5,8}

We have generally included in the calculation only those elements that contribute one or more lines of intensity greater than one gamma per 10,000 neutrons absorbed in the coal. There are some exceptions: for example, upper limits are included for contributions from the major element oxygen, even though its gamma intensities are generally lower than this criterion. Some minor elements, which do not meet the criterion level in all samples (such as magnesium), are included. Most trace elements have been excluded, although in a few instances, lines from trace elements such as manganese or vanadium may be near the criterion level of one gamma per 10,000 neutrons absorbed in radiative capture. However, the trace elements boron (which contributes appreciably to the gamma spectrum only at energies below 1.5 MeV) and cadmium have been included because of their exceptionally high thermal neutron absorption cross sections, so as to obtain a more accurate evaluation of the percent neutrons absorbed in the different elements in the coals.

It should be noted that as a result of this analytical procedure, listings of spectral lines from a coal will include some very low intensity lines from elements that also contribute stronger lines, while excluding other lines of comparable low intensity from elements that do not produce any sufficiently strong line to have been included in the calculation.

Some particular items should be pointed out in regard to use of the composition data available to us. In the first place, current practice for determining the oxygen content of coal is by difference (in particular, by subtracting from 100% the sum of the percentages of carbon, hydrogen, sulfur, nitrogen, moisture, and ash)³⁸ and accordingly, "oxygen" reported from chemically analyzed coal is only indirectly connected to true total oxygen, which is what is directly determined by nuclear methods.^{16,38} However, because of its extraordinarily low thermal neutron radiative capture cross section, oxygen in the coal makes virtually no significant contribution to these spectra, so we have not attempted to adjust "oxygen" values from different types of analysis and input compositions to mutual consistency. As regards sulfur, the Illinois State Geological Survey analyzed samples^{30,40} have reported organic sulfur, pyritic sulfur, sulfate sulfur, total sulfur, and sulfur by x-ray fluorescence (Tables 4 and 5); it is total sulfur for these samples that has been used in the calculations, since neutron-induced gamma spectrometry is sensitive to total sulfur.

3. COMPOSITIONS STUDIED

In these computer calculations, we have generated the thermal neutron capture prompt gamma emission spectra to be expected for a variety of coals on the basis of their known compositions (or, more precisely, what is known to us of their compositions).

The coal compositions whose spectra are reported here range from zero ash to high ash and include lignite, subbituminous and bituminous coals, and a range of western coals as well as eastern coals, and an 82-sample average of Illinois basin coals. Coals high and low in pyrite, chlorine, nitrogen, and

other components are included to clarify the effects of these components on the spectra. Some washed coal compositions are included.

Included are compositions of a number of our simulated coal standards (materials of predetermined composition, mixed from laboratory chemicals, to provide standards of known elemental compositions simulating coals of different ash content for experimental measurements^{5,8,16}) (Table 2).

Included also are compositions of four of the actual coals which have been used in experiments in our laboratory and for which independent chemical analyses have been performed at Argonne National Laboratory analytical chemistry facilities and, in some cases, also by the Illinois State Geological Survey. These analyzed coals include a lignite, a coking (low sulfur) coal, a Pittsburgh seam bituminous coal from Marshall County, West Virginia, and a pyritic (high sulfur) coal from Iowa (Table 3).

Finally, we have generated spectra for a composition corresponding to mean analytical values for 82 further analyses (Table 4) and also for the compositions reported for 16 additional coals analyzed in detail by multiple methods by the Illinois State Geological Survey^{30,40} (Table 5).

The Illinois State Geological Survey analyzed samples have been identified by the ISGS alphanumeric sample identifiers.^{30,40} The following compositions represent production from individual mines: C-17095 and C-17243 (Belmont County, Ohio), C-17046 and C-17047 (Montana), C-17045 (Arizona), C-17092 (Coshocton County, Ohio), C-17096 (Utah), C-17244 (Harrison County, Ohio); C-17099 (Marion, Pennsylvania); C-17309 (Arizona); and C-17097 (Colorado).³⁰ The following compositions represent not raw coal samples but, instead, commercially-washed coal from the mines: C-17307 (Henry County, Missouri); C-17245 (Jefferson County, Ohio), C-17246 (Kanawha County, West

Virginia); and C-17303 (Washington County, Pennsylvania).³⁰ Table 6 gives an index of all of the Illinois State Geological Survey coals reported on in this study and lists the ISGS alphanumeric sample identifier, state of origin, bed name or other descriptive term, rank of the coal, and sample type for each coal.⁴⁰

4. DISCUSSION OF RESULTS

The characteristic features of the thermal neutron capture prompt gamma emission spectra of coals in the energy range discussed here are determined almost entirely by the abundances of the major and minor elements present in the coal. Most trace elements contribute to the spectra at levels below those calculated here (i.e., at less than one gamma per 10,000 neutrons) in most coals, with occasional exceptions of coals containing unusually high amounts of certain trace elements that have high thermal neutron cross sections. (Significant contributions to gamma ray spectra of actual coals may be made by a few exceptionally high cross section trace elements which were not included in the analyses of these coals, particularly at gamma ray energies lower than 1.5 MeV, however.)³¹ Trace elements do contribute significantly to the absorption of thermal neutrons in many coals.

Hydrogen in the coals accounts for more absorption of thermal neutrons than any other element, and hydrogen accounted for more than half of the total absorption of neutrons in almost all of the coal compositions studied (Table 7). Carbon absorbs from about 1/2% to 1% of the thermal neutrons in the coal (while carbon is, of course, the most abundant element in coals, its thermal neutron absorption cross section is quite low, only about 3.4 millibarns, a factor of approximately 100 smaller than the thermal neutron absorption cross

section of hydrogen). Oxygen, which is also a major element and ranges in concentration up to 16 weight percent in these coals, has an even smaller thermal neutron absorption cross section and typically absorbs somewhat less than one-hundredth of one percent of the thermal neutrons.

Some minor elements and trace elements account for absorption of large numbers of thermal neutrons in the coals. Nitrogen absorbed up to 19% of the neutrons in the compositions studied. Chlorine, a minor element, has such a high thermal neutron capture cross section that when even half a percent of chlorine is present in a coal, nearly 20% of the neutrons can be absorbed in the chlorine. Because of its exceptionally high thermal neutron absorption cross section, boron accounted for up to 34% of the neutron absorption, even though its abundance as a trace element did not exceed 140 μg per gram. Iron, sulfur, and the ash-forming metal elements account for most of the rest of the neutron absorption in these compositions. The calculations described in this paper have been conducted for coal compositions and composition data in which rare earth elements were not included; however, it should be noted that even trace amounts of some of those few elements that have exceptionally high thermal neutron absorption cross sections may be expected to contribute noticeably to the absorption of neutrons.

We emphasize these points because a well-understood neutron economy is of importance in the design of equipment and the quantitative interpretation of spectral data for analytic purposes.

The most prominent emission line in the spectra of all coals is the 2.223 MeV line, the only line emitted by hydrogen^{20,21} (Table 8). This

dominates the spectra and accounts for more than half of the gammas emitted from every coal. It is the major line present in experimental spectra.^{5,8}

To clarify the origin of the basic features of the coal spectra, we have included the spectrum of a "zero ash" coal composition, containing only the elements carbon and hydrogen, in a one-to-one atomic ratio (see Fig. 1, this and other figures are semilog plots of intensity versus energy). Only three lines are present in the spectrum; the most intense line, containing 99% of the gammas emitted, is in the 2.223 MeV hydrogen line. Two weak lines from carbon are also present, a line at 4.945 MeV (accounting for 0.68% of the gamma emission) and a lower energy line at 3.684 MeV (accounting for 0.32% of the gamma emission). A composition containing realistic amounts of oxygen as well as carbon and hydrogen would also produce only these three lines (at the level of sensitivity under consideration -- above one gamma per 10^4 neutrons absorbed) because of the extremely small thermal neutron radiative capture cross section of oxygen.

When even relatively small amounts of the ash-forming elements are introduced, as in a low-ash coal composition (Table 2), a proliferation of gamma lines appears (Fig. 2). Medium-ash (Fig. 3) and high-ash (Fig. 4) coal compositions show again a great abundance of lines, which can be seen to be much more intense (on the semilogarithmic plot) than those of the low-ash sample.

A further discussion of some of the characteristic features of these spectra will be of assistance in interpreting the spectra of various real coals to follow.

In the low-ash simulated coal spectrum (Fig. 2), a line from nitrogen, which is well separated from the rest of the spectrum, can be seen at

10.828 MeV.¹⁹ This is the highest energy major gamma ray line present in the (n, γ) spectra and is also an easily recognizable feature of experimental spectra.^{5,8} Below it is a well-separated line of iron at 9.298 MeV.^{5,8,19} A much stronger doublet from iron occurs at 7.632 and 7.646 MeV.^{5,8,19} Lines from sulfur, silicon, titanium, and even sodium and potassium are reasonably distinctive.

The medium-ash composition (Table 2) exhibits a spectrum (Fig. 3) with many lines from chlorine as very prominent features. Note that this occurs with only about 0.6 wt% chlorine present in the composition. Because of its high radiative capture cross section, chlorine, when present, contributes strongly to coal spectra.

The high-ash composition (Table 2) contained no nitrogen, and so the high-energy line at 10.828 MeV is absent from Fig. 4. In this spectrum, in addition to the elements previously noted as providing distinctive lines, aluminum and calcium also provide prominent contributions. A magnesium line of low intensity can also be distinguished.

The next group of samples corresponds to a selection of real coals which have been used in our laboratory which have had chemical analyses performed one or more times by the analytical chemistry group at Argonne National Laboratory and also in some instances independently by the Illinois State Geological Survey. These compositions are listed in Table 3, the emission spectrum intensities are given in Table 8, and the spectra are shown in Figs. 5-8.

Figure 5 shows a lignite, which is reasonably high in nitrogen. Figure 6 shows a coking coal, which is a low sulfur coal. This exhibits the prominent chlorine lines previously noted in Fig. 3; silicon lines, however, are less

intense in this spectrum, and the sulfur lines are of relatively low intensity as would be expected.

Figure 7 shows the spectrum of a pyritic Iowa coal. As would be anticipated for a pyritic coal high in sulfur and iron, iron and sulfur lines are by far the most prominent lines in the spectrum, apart from hydrogen. In Fig. 8, a Pittsburgh seam bituminous coal spectrum is shown, the iron and sulfur lines are somewhat less prominent, with other lines such as those of silicon becoming more distinctive. (This may be compared with the spectra of other Pittsburgh #8 seam coals in Figs. 10 and 14).

Figure 9 shows the spectrum corresponding to mean analytical values for 82 coals from the Illinois basin, as reported by the Illinois State Geological Survey.³⁰ Figures 10-18 show spectra for a variety of eastern and mid-continent coals also reported on by the Illinois State Geological Survey.^{30,40} Figures 19-25 correspond to western coals reported on by the Illinois State Geological Survey.^{30,40}

5. SUMMARY

The composition data and spectra reported here provide an overview of the characteristics of thermal neutron-induced prompt gamma emission spectra of coals, together with a detailed rendering of over 200 line intensities for each of 25 particular coal compositions. An important characteristic exhibited by these spectra is their complexity; thus, low resolution gamma spectrometry is likely to miss some important features and high resolution gamma detection is definitely desirable for automated analysis of coals. We have found the information provided by these calculations useful both in improving design of instrumentation and methodology and in the analysis of experimental spectra of coals, and anticipate that this will promote both improved design and insight into the applicability of these techniques in this and related areas.

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Table 1. Nuclear Data Adopted for Input into Calculations -- Example

STARR MINE(IOWA)HIGH PYRITE

INPUT- THERMAL NEUTRON RADIATIVE CAPTURE CROSS-SECTION, THERMAL NEUTRON ABSORPTION CROSS-SECTION, ATOMIC MASS, WEIGHT % ENERGY (MEV), AND NUMBER OF PHOTONS/100 NEUTRONS CAPTURED AT THAT MEV										
H--1	1	.332200	.332200	1.00790	4.94000					
	2,223	100.000								
C--6	2	.003390	.003390	12.01100	58.61000					
	3,684	31.800	4.945	67.000						
N--7	19	.075500	1.892000	14.00670	1.71000					
	1,679	6.040	1.888	27.450	2.062	3.740	2.157	3.650	2.175	2.650
	2,357	4.450	2.519	9.430	3.531	9.580	3.675	15.520	4.508	15.810
	5.267	25.410	5.297	16.580	5.532	17.790	5.560	9.050	6.321	16.650
	7.299	8.360	7.414	1.200	8.309	4.220	10.828	15.000		
O--8	2	.000178	.000266	15.99940	8.69000					
	2.180	100.000	3.271	100.000						
NA11	38	.535000	.535000	22.98977	.01900					
	1.634	8.630	1.749	2.430	1.890	2.630	1.932	1.380	1.949	2.320
	1.965	1.220	1.984	1.910	2.027	19.810	2.057	1.450	2.124	2.690
	2.138	1.500	2.198	2.540	2.251	1.150	2.361	2.420	2.396	2.180
	2.415	6.430	2.518	17.120	2.594	2.140	2.716	1.000	2.754	102.380
	2.809	4.460	2.863	11.750	2.903	2.930	2.982	3.680	3.026	4.010
	3.098	9.670	3.214	1.530	3.280	1.160	3.371	4.030	3.412	1.720
	3.505	2.280	3.588	17.310	3.644	2.020	3.879	6.230	3.982	21.580
	4.188	1.680	5.617	5.990	6.395	25.690				
MG12	11	.064900	.064900	24.30500	.03600					
	1.633	4.620	1.690	6.520	1.809	25.160	1.890	7.260	2.828	35.690
	3.054	10.830	3.301	7.460	3.414	5.480	3.831	5.640	3.916	40.820
	8.154	3.980								
AL13	23	.231400	.231400	23.98154	.57000					
	1.623	3.220	1.779	88.170	2.108	1.180	2.140	1.470	2.284	1.660
	2.822	2.580	2.960	6.160	3.034	5.820	3.466	4.300	3.592	2.630
	3.850	1.430	3.876	1.280	4.134	4.260	4.260	4.070	4.660	1.250
	4.691	2.520	4.734	3.490	4.903	1.840	5.134	1.630	6.102	1.790
	6.316	1.470	7.694	4.170	7.724	20.100				

Table 1. Nuclear Data Adopted for Input into Calculations -- Example (cont'd)

SI14	12	.170000	.170000	28.08550	1.16000					
2.093	26.780	2.426	3.930	2.780	1.930	3.539	79.580	3.661	4.610	
3.955	3.060	4.934	70.550	5.107	3.680	6.380	12.620	6.742	1.840	
7.199	7.160	8.472	2.310							
S+15	17	.518000	.521000	32.06400	8.19000					
1.598	11.840	1.891	7.090	2.380	31.970	2.491	1.950	2.753	4.100	
2.865	1.260	2.931	16.050	3.221	19.460	3.370	3.780	3.723	2.030	
4.431	3.160	4.639	1.490	4.870	8.240	5.047	2.260	5.420	42.440	
7.800	2.810	8.641	1.910							
CL17	20	32.900000	33.300000	35.45300	.03000					
1.601	4.330	1.951	21.370	1.958	15.130	2.676	3.270	2.864	6.770	
2.975	1.140	2.998	1.150	3.062	3.730	3.116	1.420	3.562	1.080	
3.824	1.780	4.980	3.820	5.517	1.500	5.715	4.620	6.111	15.780	
6.620	10.000	6.978	1.720	7.414	8.520	7.790	6.630	8.579	2.300	
K+19	45	2.080000	2.090000	39.09830	.06800					
1.524	2.210	1.564	1.950	1.618	7.910	1.703	1.890	1.795	1.430	
1.929	2.530	1.957	2.150	2.018	1.160	2.041	2.670	2.046	2.610	
2.073	10.240	2.153	1.160	2.291	3.440	2.390	1.960	2.422	1.490	
2.546	3.640	2.612	1.750	2.640	1.010	2.757	1.540	2.806	1.900	
2.840	1.400	3.056	2.030	3.263	2.240	3.452	1.660	3.547	4.260	
3.651	1.290	3.693	2.280	3.730	1.020	4.003	1.230	4.062	1.170	
4.136	2.610	4.201	1.690	4.361	3.410	4.367	1.260	4.992	1.730	
5.043	1.670	5.070	1.160	5.174	2.490	5.380	7.300	5.510	2.480	
5.696	4.640	5.730	1.620	5.752	4.390	6.999	2.050	7.769	4.540	
CA20	27	.429900	.431900	40.08000	1.90000					
1.649	1.410	1.672	1.930	1.691	1.420	1.704	1.380	1.724	2.100	
1.826	1.540	1.880	1.020	1.943	52.580	2.001	7.200	2.009	5.400	
2.078	1.400	2.094	1.690	2.118	1.670	2.122	1.010	2.130	2.530	
2.149	1.140	2.295	1.800	2.660	1.100	2.611	2.390	3.586	1.650	
3.610	4.580	3.760	1.900	4.419	10.790	4.750	1.980	5.515	1.740	
5.901	3.070	6.420	28.090							

Table 1. Nuclear Data Adopted for Input into Calculations -- Example (cont'd)

Ti22	21	6.150000	6.150000	47.90000	.02400					
1.586	8.560	1.762	7.910	1.792	3.570	1.842	1.420	1.893	1.670	
2.048	1.470	2.087	1.040	2.278	1.020	2.943	1.470	3.027	3.470	
3.476	2.350	3.554	1.410	3.734	1.610	3.920	1.740	4.673	1.020	
4.714	1.240	4.881	5.670	4.967	3.740	6.418	36.470	6.556	6.490	
6.760	54.070									
FE26	15	2.590000	2.590000	55.84700	4.25000					
1.613	5.850	1.725	8.030	2.722	1.430	3.268	1.190	3.414	1.500	
3.437	1.350	4.219	4.020	4.407	1.310	4.810	1.660	5.921	8.290	
6.018	8.080	7.279	4.600	7.632	27.190	7.646	22.140	9.298	3.650	
B--5	6	.107200	.760,341000	10.81000	.01130					
4.470	80.000	4.730	30.000	6.740	10.000	6.980	18.000	8.910	6.000	
11.430	.800									
CD48	11	2450.000000	2450.000000	112.41000	.00018					
1.661	1.630	2.398	1.090	2.456	4.520	2.550	1.600	2.660	3.110	
2.701	1.220	2.767	1.440	3.000	1.600	3.109	1.120	5.431	1.080	
5.824	2.310									

Table 2. Composition of Simulated Coals for Analytic Studies
(Second Series - 1977)

Element	Weight Percent in Simulated Coal		
	Low Ash Simulated Coal	Medium Ash Simulated Coal	High Ash Simulated Coal
C	80.6	72.4	60.4
H	6.69	6.01	4.97
O	5.46	7.38	13.0
N	0.56	0.09	0.00
Si	1.52	3.04	6.04
Al	1.15	2.07	3.42
Ca	0.58	1.04	2.14
Fe	1.45	2.61	4.04
S	0.725	3.26	5.36
Na	0.59	0.38	0.35
Mg	0.00	0.78	0.19
K	0.56	0.25	0.08
Ti	0.131	0.00	0.00
Cl	0.00	0.59	0.00

Table 3. Compositions of Analyzed Argonne Coals^a

Element	Element Weight Percent in Coal			
	Lignite (ANL #3)	Coking Coal	Pittsburgh Seam Bituminous	Pyritic Coal (IA)
C	54.1	74.47	60.72	58.61
H	4.57	4.87	4.37	4.94
O	15.4	6.99	4.22	8.69
N	2.74	2.22	1.77	1.71
Al	0.67	0.975	2.43	0.57
Ca	1.45	0.515	0.45	1.90
S	0.72	0.870	4.65	8.19
Fe	0.32	0.405	2.59	4.25
Si	1.92	1.95	5.67	1.16
Na	0.034	0.0915	0.111	0.019
Mg	0.51	0.0325	0.089	0.036
K	0.092	0.145	0.379	0.068
Ti	0.04	0.0585	0.143	0.024
Cl	<0.01	0.445	0.060	0.030
B	64 ppm	117 ppm	69 ppm	113 ppm
Cd	0.13	0.046	0.115	1.75
P	--	--	336	--
Co	--	--	5.4	--
Cu	--	--	16	--
Pb	--	--	13	--
Li	--	--	23	--
Ni	--	--	11	--
Zn	--	--	27	--

^aResults reported on an "as received" basis.

Table 4. Mean Analytical Values for 82 Coals from the Illinois Basins^a

Constituent	Mean	Std.	Min.	Max.
As	14.91 ppm	18.94	1.70	93.00
B	113.79 ppm	51.72	12.00	224.00
Be	1.72 ppm	0.83	0.50	4.00
Br	15.27 ppm	5.60	6.00	52.00
Cd	2.89 ppm	8.32	0.10	65.00
Co	9.15 ppm	5.76	2.00	34.00
Cr	14.10 ppm	7.48	4.00	54.00
Cu	14.09 ppm	6.78	5.00	44.00
F	59.30 ppm	19.79	30.00	143.00
Ga	3.04 ppm	1.03	1.60	7.50
Ge	7.51 ppm	7.08	1.00	43.00
Hg	0.21 ppm	0.22	0.03	1.60
Mn	53.16 ppm	40.98	6.00	181.00
Mo	7.96 ppm	5.68	1.00	29.00
Ni	22.35 ppm	10.81	8.00	68.00
P	62.77 ppm	65.66	5.00	339.00
Pb	39.83 ppm	45.94	4.00	218.00
Sb	1.35 ppm	1.42	0.20	8.90
Se	1.99 ppm	0.93	0.45	7.70
Sn	4.56 ppm	6.64	1.00	51.00
V	33.13 ppm	11.63	16.00	78.00
Zn	313.04 ppm	749.92	10.00	5350.00
Zr	72.10 ppm	58.01	12.00	133.00
Al	1.22 %	0.37	0.43	3.04
Ca	0.74 %	0.49	0.05	2.67
Cl	0.15 %	0.15	0.01	0.54
Fe	2.06 %	0.71	0.48	4.32
K	0.16 %	0.04	0.04	0.30
Mg	0.05 %	0.02	0.01	0.17
Na	0.05 %	0.04	0.00	0.19
Si	2.39 %	0.62	0.58	4.63
Ti	0.06 %	0.02	0.02	0.15
ORS	1.54 %	0.62	0.37	3.09
PYS	1.88 %	0.74	0.29	3.78
SUS	0.09 %	0.18	0.01	1.06

cont'd . . . /

Table 4. Mean Analytical Values for 82 Coals from the Illinois Basin^a (cont'd)

Constituent	Mean	Std.	Min.	Max.
TOS	3.51 %	1.12	0.85	5.59
SXRF	3.19 %	1.08	0.79	5.40
ADL	7.70 %	3.47	1.40	16.70
MOIS	10.02 %	4.23	1.60	18.20
VOL	39.80 %	3.17	31.90	46.40
FIXC	48.98 %	3.92	41.30	61.00
Ash	11.28 %	1.98	4.60	16.00
Btu/lb	12748.91	464.50	11562.00	14362.00
C	70.69 %	3.11	62.49	79.94
H	4.98 %	0.26	4.19	5.76
N	1.35 %	0.20	0.93	1.84
O	8.19 %	1.84	4.15	14.36
HTA	11.18 %	2.17	3.28	16.04
LTA	15.22 %	3.22	3.82	23.53

^aAdapted from Ref. 30.

Note: Abbreviations other than standard chemical symbols: organic sulfur (ORS), pyritic sulfur (PYS), sulfate (SUS), total sulfur (TOS), sulfur by x-ray fluorescence (SXRF), air-dry loss (ADL), moisture (MOIS), volatile matter (VOL), fixed carbon (FIXC), high-temperature ash (HTA), and low-temperature ash (LTA).

Table 5(a). Proximate and Ultimate Analyses of Illinois State Geological Survey Analyzed Coals^a
(Percent of Whole Coal, Except for Btu Values)

Sample No.	Coal Seam	ADL	MOIS	VOL	FIXC	ASH	BTU	C	H	N	O	HTA	LTA
C-17045	AZ	--	7.1	44.9	41.5	13.6	--	65.83	4.73	0.96	14.36	13.65	22.65
C-17046	MT	--	20.1	49.6	34.6	15.8	--	63.32	4.08	0.90	14.79	15.83	14.86
C-17047	MT	--	20.7	52.7	35.4	11.9	--	66.26	4.26	0.91	15.37	11.92	16.54
C-17054	CO	--	2.2	32.8	54.9	12.3	--	72.57	4.58	1.06	8.77	12.27	14.01
C-17096	UT	--	2.2	45.2	47.1	7.7	--	73.84	5.79	1.23	10.79	7.72	7.79
C-17097	CO	—	8.9	45.6	43.5	10.8	--	67.75	4.76	1.46	14.64	10.83	15.19
C-17307	MO	—	2.2	36.3	37.9	25.8	--	55.23	4.03	0.78	7.64	25.85	31.70
C-17309	AZ	—	6.2	44.7	48.8	6.6	--	70.99	5.05	1.01	15.98	6.56	7.90
C-17092	OH	—	3.4	38.2	47.0	14.8	--	64.65	4.55	1.05	10.34	14.76	21.18
C-17095	OH	—	2.0	36.7	45.0	18.3	--	62.86	4.45	0.94	9.44	18.27	22.26
C-17099	PA	—	1.0	39.9	49.0	11.1	--	64.16	4.79	0.95	16.03	11.10	14.61
C-17243	OH	—	2.4	37.8	46.2	16.0	--	65.27	4.70	1.00	8.75	16.02	21.32
C-17244	OH	—	1.5	35.5	51.7	12.7	--	70.47	4.81	1.18	8.12	12.72	15.92
C-17245	OH	—	1.7	37.7	51.7	10.5	--	70.62	4.91	1.07	9.22	10.53	14.56
C-17246	WV	—	0.9	34.1	59.7	6.1	--	80.14	5.29	1.29	6.22	6.15	7.57
C-17303	PA	—	1.6	36.1	57.3	6.7	--	78.01	5.26	1.29	7.49	6.66	8.53

^aAdapted from Ref. 30.

Table 5(b). Sulfur Analyses for Illinois State Geological Survey Analyzed Coals (Percent, Moisture-Free Coal)^a

Sample No.	Coal Seam	ORS	PYS	SUS	TOS	SXRF
C-17045	AZ	0.31	0.10	0.02	0.44	0.54
C-17046	MT	0.56	0.53	0.02	1.11	0.80
C-17047	MT	0.70	1.16	0.02	1.88	0.98
C-17054	CO	0.49	0.31	0.02	0.83	0.87
C-17096	UT	0.40	0.24	0.04	0.69	0.68
C-17097	CO	0.46	0.07	0.02	0.55	0.57
C-17307	MO	1.84	3.65	0.98	6.47	4.02
C-17309	AZ	0.34	0.06	0.01	0.42	0.54
C-17092	OH	1.41	2.37	0.16	3.94	3.96
C-17095	OH	1.42	2.59	0.19	4.20	2.94
C-17099	PA	1.01	1.82	0.21	3.04	2.33
C-17243	OH	1.32	2.41	0.42	4.15	3.21
C-17244	OH	0.69	1.85	0.12	2.66	1.82
C-17245	OH	1.05	2.39	0.24	3.68	2.85
C-17246	WV	0.74	0.19	0.02	0.96	1.23
C-17303	PA	0.75	0.48	0.06	1.29	1.46

^a Adapted from Ref. 30.

Note: Abbreviations: organic sulfur (ORS), pyritic sulfur (PYS), sulfate sulfur (SUS), total sulfur (TOS), sulfur by x-ray fluorescence (SXRF).

Table 5(c). Major and Minor Elements in Illinois State Geological Survey Analyzed Coals^a (Percent, Moisture-Free Whole Coal)

Sample No.	Coal Seam	Al	Ca	Cl	Fe	K	Mg	Na	Si	Ti
C-17045	AZ	1.76	1.44	0.01	0.49	0.06	0.09	0.027	3.11	0.08
C-17046	MT	1.71	1.65	0.02	0.60	0.11	0.23	0.020	3.09	0.06
C-17047	MT	1.63	1.49	0.01	1.23	0.12	0.25	0.019	3.10	0.06
C-17054	CO	2.23	0.60	0.03	0.51	0.08	0.03	0.013	3.40	0.13
C-17096	UT	0.72	0.93	0.03	0.48	0.02	0.03	0.200	1.99	0.06
C-17097	CO	1.82	0.62	0.02	0.34	0.12	0.09	0.028	3.32	0.06
C-17307	MO	2.37	1.16	0.06	3.07	0.43	0.10	0.072	6.09	0.08
C-17309	AZ	0.73	2.47	0.02	0.55	0.02	0.07	0.089	1.25	0.05
C-17092	OH	1.18	0.87	0.37	2.32	0.12	0.02	0.061	1.80	0.06
C-17095	OH	2.46	0.30	0.04	2.45	0.27	0.07	0.023	4.50	0.11
C-17099	PA	1.53	0.25	0.08	2.01	0.15	0.04	0.028	2.52	0.08
C-17243	OH	1.75	0.76	0.05	2.53	0.27	0.09	0.035	3.83	0.08
C-17244	OH	1.81	0.30	0.22	1.79	0.29	0.05	0.036	3.20	0.10
C-17245	OH	1.24	0.11	0.10	2.60	0.15	0.04	0.023	2.51	0.06
C-17246	WV	1.14	0.11	0.19	0.54	0.15	0.02	0.022	1.81	0.08
C-17303	PA	1.14	2.57	0.12	0.93	0.13	0.04	0.022	2.01	0.07

^a Adapted from Ref. 30.

Table 5(d). Trace Elements in Illinois State Geological Survey
Analyzed Coals^a (Parts per Million, Moisture-free Whole Coal)

Sample Number	Coal Seam	As	B	Be	Br	Co	Co	Cr	Cu	F	Ga	Ge	Mg
C-17045	AZ	1.2	30	0.6	7	<0.6	2	8	12	78	4.4	2	0.02
C-17046	MT	1.2	92	1.0	20	<0.4	2	5	18	42	3.5	3	0.09
C-17047	MT	2.5	84	1.1	25	<0.4	2	7	15	52	3.4	2	0.07
C-17054	CO	0.7	39	1.4	10	<0.4	2	6	16	63	2.4	2	0.02
C-17096	UT	0.5	--	0.4	23	<0.2	1	7	11	50	1.6	1	0.04
C-17097	CO	0.5	138	0.8	19	<0.4	2	5	10	105	3.7	3	0.02
C-17307	MO	9.3	66	1.2	7	11.0	43	22	61	91	4.0	9	0.18
C-17309	AZ	1.3	17	0.2	4	<0.2	7	5	22	39	1.6	2	0.06
C-17092	OH	14.0	83	1.5	8	<0.6	5	14	22	125	4.4	6	0.15
C-17095	OH	6.7	45	0.9	12	<0.5	8	16	12	90	3.2	<1	0.13
C-17099	PA	19.0	38	0.6	17	<0.4	10	11	15	67	2.9	1	0.16
C-17243	OH	13.0	78	1.4	11	<0.6	20	16	20	71	3.6	4	0.16
C-17244	OH	25.0	59	1.6	17	<0.4	33	23	28	88	3.9	<1	0.46
C-17245	OH	35.0	68	1.4	14	<0.4	28	10	12	51	3.0	5	0.26
C-17246	WV	5.1	9	2.6	26	<0.2	16	12	26	50	4.6	2	0.08
C-17303	PA	6.7	5	1.3	23	<0.2	12	18	11	52	4.2	2	0.14

Sample Number	Coal Seam	Mn	Mo	Ni	P	Pb	Sb	Se	Sn	V	Zn	Zr
C-17045	AZ	22	<1	7	109	6	0.4	1.6	5	26	7	--
C-17046	MT	101	30	4	48	7	0.9	0.8	<5	14	12	169
C-17047	MT	88	8	6	39	7	0.9	0.8	15	18	10	0
C-17054	CO	16	2	8	10	6	0.6	2.3	8	20	12	41
C-17096	UT	<8	1	4	80	4	0.2	1.2	<2	11	13	74
C-17097	CO	12	2	3	400	5	0.2	1.0	5	14	7	25
C-17307	MO	108	14	80	248	102	1.2	2.9	<10	40	1444	40
C-17309	AZ	6	2	5	125	4	0.3	1.2	<2	17	15	--
C-17092	OH	55	11	11	86	11	0.6	3.2	<3	42	40	42
C-17095	OH	27	<4	16	94	4	0.6	3.8	<4	46	26	30
C-17099	PA	18	8	16	133	8	0.3	2.2	2	38	27	--
C-17243	OH	48	6	16	179	8	1.2	2.0	<6	28	31	--
C-17244	OH	29	4	22	70	10	1.5	6.3	<5	49	32	--
C-17245	OH	12	5	12	64	6	1.0	1.8	3	24	30	48
C-17246	WV	9	1	19	16	7	1.3	3.1	6	28	22	8
C-17303	PA	12	1	20	104	7	0.9	1.3	5	46	21	--

^aAdapted from Ref. 30.

Table 6. Illinois State Geological Survey Analyzed Coals^a

Sample No.	State	Origin	Rank (ASTM)	Sample Type
C-17045	AZ	Black Mesa Field	high volatile C bituminous	run of mine sample
C-17046	MT	Rosebud Seam	subbituminous C	run of mine sample
C-17047	MT	McKay Seam	subbituminous C	run of mine sample
C-17054	CO	Nucla Seam	high volatile C bituminous	run of mine sample
C-17096	UT	Wasatch Plateau	high volatile C bituminous	run of mine sample
C-17097	CO	Wadge	high volatile C bituminous	run of mine sample
C-17307	MO	USBM mixed coal	--	washed sample
C-17309	AZ	Black Mesa Field	high volatile C bituminous	run of mine sample
C-17092	OH	Middle Kittanning	high volatile C bituminous	run of mine sample
C-17095	OH	Pittsburgh 8	high volatile C bituminous	run of mine sample
C-17099	PA	Pittsburgh 8	high volatile B bituminous	run of mine sample
C-17243	OH	Meigs Creek	high volatile C bituminous	run of mine sample
C-17244	OH	Lower Freeport	high volatile B bituminous	run of mine sample
C-17245	OH	Pittsburgh 8	high volatile C bituminous	washed sample
C-17246	WV	Hernshaw	high volatile B bituminous	washed sample
C-17303	PA	Pittsburgh 8	high volatile C bituminous	washed sample

^aAdapted from Ref. 40.

Table 7: Absorption of Neutrons in Coals Studied

ZERO ASH SIMULATED COAL

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	7.74	98.990
C	92.26	1.010

LOW ASH SIMULATED COAL

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	6.6900	89.332
C	80.6000	.922
S	.7250	.477
SI	1.5200	.373
AL	1.1500	.400
K	.5600	1.213
N	.5600	3.065
CA	.5800	.253
TI	.1310	.681
FE	1.4500	2.724
O	5.4600	.004
NA	.5900	.556

MEDIUM ASH SIMULATED COAL

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	6.0100	70.408
C	72.4000	.726
O	7.3800	.004
N	.0900	.432
SI	3.0400	.654
AL	2.0700	.631
CA	1.0400	.398
FE	2.6100	4.302
S	3.2600	1.883
NA	.3800	.314
MG	.7800	.074
K	.2500	.475
CL	.5900	19.697

Table 7 (cont'd)

HIGH ASH SIMULATED COAL

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.9700	80.627
C	60.4000	.839
O	13.0000	.011
SI	6.0400	1.799
AL	3.4200	1.444
CA	2.1400	1.135
FE	4.0400	9.222
S	5.3600	4.287
NA	.3500	.401
MG	.1900	.025
K	.0800	.210

LIGNITE (ANL NO. 3 SAMPLE)

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.5700	62.299
C	54.1000	.632
N	2.7400	15.308
O	15.4000	.011
NA	.0340	.033
MG	.5100	.056
AL	.6700	.238
SI	1.9200	.481
S	.7200	.484
CL	.0040	.155
K	.0920	.203
CA	1.4500	.646
TI	.0400	.212
FE	.3200	.614
CD	.0000	.009
B	.0064	18.619

Table 7 (cont'd)

COKING COAL

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.87000	49.493
C	74.47000	.648
N	2.22000	9.246
O	6.99000	.004
NA	.09150	.066
MG	.03250	.003
AL	.97500	.258
SI	1.95000	.364
S	.87000	.436
CL	.44500	12.888
K	.14500	.239
CA	.51500	.171
TI	.05850	.232
FE	.40500	.579
B	.01170	25.375

PITTSBURG SEAM, W. V.

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.37000	56.801
C	60.72000	.676
N	1.77000	9.429
O	4.22000	.003
NA	.11100	.102
MG	.08900	.009
AL	2.43000	.822
SI	5.67000	1.353
S	4.65000	2.980
CL	.06000	2.222
K	.37900	.799
CA	.45000	.191
TI	.14300	.724
FE	2.59000	4.737
B	.00690	19.139
CO	.00054	.013

Table 7 (cont'd)

HIGH PYRITE COAL, IOWA

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.94000	52.991
C	58.61000	.538
N	1.71000	7.518
O	8.69000	.005
NA	.01900	.014
MG	.03600	.003
AL	.57000	.159
SI	1.16000	.229
S	8.19000	4.331
CL	.03000	.917
K	.06800	.118
CA	1.90000	.666
TI	.02400	.100
FE	4.25000	6.415
B	.01130	25.868
CD	.00018	.128

82 COALS, ILLINOIS BASIN

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.9800	54.816
C	70.6900	.666
N	1.3500	6.090
O	8.1900	.005
NA	.0500	.039
MG	.0500	.004
AL	1.2200	.349
SI	2.3900	.483
S	3.5100	1.905
CL	.1500	4.705
K	.1600	.286
CA	.7400	.266
TI	.0600	.257
FE	2.0600	3.191
B	.0114	26.708
CO	.0009	.019
CD	.0003	.211

Table 7 (cont'd)

SAMPLE 17045, ARIZONA

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.7300	77.114
C	65.8300	.919
N	.9600	6.414
O	14.3600	.012
NA	.0270	.031
MG	.0900	.012
AL	1.7600	.747
SI	3.1100	.931
S	.4400	.354
CL	.0100	.465
K	.0600	.159
CA	1.4400	.768
TI	.0800	.508
FE	.4900	1.124
B	.0030	10.437
CO	.0002	.006

SAMPLE 17046, MONTANA

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.0800	59.337
C	63.3200	.789
N	.9000	5.364
O	14.7900	.011
NA	.2000	.205
MG	.2300	.027
AL	1.7100	.647
SI	3.0900	.825
S	1.1100	.796
CL	.0200	.829
K	.1100	.259
CA	1.6500	.785
TI	.0600	.340
FE	.6000	1.228
B	.0092	28.553
CO	.0002	.006

Table 7 (cont'd)

SAMPLE 17047, MONTANA

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.2600	61.102
C	66.2600	.814
N	.9100	5.349
O	15.3700	.011
NA	.0190	.019
MG	.2500	.029
AL	1.6300	.608
SI	3.1000	.817
S	1.8800	1.329
CL	.0100	.409
K	.1200	.279
CA	1.4900	.699
TI	.0600	.335
FE	1.2300	2.482
B	.0084	25.711
CO	.0002	.005

SAMPLE 17054, COLORADO

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.5800	72.552
C	72.5700	.984
N	1.0600	6.882
O	8.7700	.007
NA	.0130	.015
MG	.0300	.004
AL	2.2300	.919
SI	3.4000	.989
S	.8300	.648
CL	.0300	1.354
K	.0800	.206
CA	.6000	.311
TI	.1300	.802
FE	.5100	1.137
B	.0039	13.184
CO	.0002	.006

Table 7 (cont'd)

SAMPLE 17096, UTAH

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	5.7900	86.784
C	73.8400	.948
N	1.2300	7.556
O	10.7900	.008
NA	.2000	.212
MG	.0300	.004
AL	.7200	.281
SI	1.9900	.548
S	.6900	.510
CL	.0300	1.281
K	.0200	.049
CA	.9300	.456
TI	.0600	.350
FE	.4800	1.012
CO	.0001	.003

SAMPLE 17097, COLORADO

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.7600	54.642
C	67.7500	.666
N	1.4600	6.869
O	14.6400	.008
NA	.0280	.023
MG	.0900	.008
AL	1.8200	.544
SI	3.3200	.700
S	.5500	.311
CL	.0200	.654
K	.1200	.223
CA	.6200	.233
TI	.0600	.268
FE	.3400	.549
B	.0140	34.296
CO	.0002	.004

Table 7 (cont'd)

HENRY COUNTY, MO., NO. 17307

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.0300	56.546
C	55.2300	.664
N	.7800	4.485
O	7.6400	.005
NA	.0720	.071
MG	.1000	.011
AL	2.3700	.865
SI	6.0900	1.569
S	6.4700	4.475
CL	.0600	2.399
K	.4300	.979
CA	1.1600	.532
TI	.0800	.437
FE	3.0700	6.061
B	.0066	19.762
CO	.0043	.116
CD	.0011	1.021

SAMPLE 17309, ARIZONA

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	5.0500	81.491
C	70.9900	.981
N	1.0100	6.679
O	15.9800	.013
NA	.0890	.101
MG	.0700	.009
AL	.7300	.307
SI	1.2500	.370
S	.4200	.334
CL	.0200	.920
K	.0200	.052
CA	2.4700	1.303
TI	.0500	.314
FE	.5500	1.249
B	.0017	5.854
CO	.0007	.022

Table 7 (cont'd)

COSHINGTON COUNTY, OH., 17092

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.5500	53.385
C	64.6500	.650
N	1.0500	5.049
O	10.3400	.006
NA	.0610	.051
MG	.0200	.002
AL	1.1800	.360
SI	1.8000	.388
S	3.9400	2.279
CL	.3700	12.371
K	.1200	.228
CA	.8700	.334
TI	.0600	.274
FE	2.3200	3.830
B	.0083	20.782
CO	.0005	.011

BELMONT COUNTY, OH., 17095

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.4500	65.804
C	62.8600	.796
N	.9400	5.697
O	9.4400	.007
NA	.0230	.024
MG	.0700	.008
AL	2.4600	.947
SI	4.5000	1.222
S	4.2000	3.062
CL	.0400	1.686
K	.2700	.648
CA	.3000	.145
TI	.1100	.634
FE	2.4500	5.098
B	.0045	14.201
CO	.0008	.023

Table 7 (cont'd)

MARION, PA., SAMPLE 17099

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.7900	69.818
C	64.1600	.801
N	.9500	5.675
O	16.0300	.012
NA	.0280	.029
MG	.0400	.005
AL	1.5300	.580
SI	2.5200	.675
S	3.0400	2.184
CL	.0800	3.323
K	.1500	.355
CA	.2500	.119
TI	.0800	.454
FE	2.0100	4.122
B	.0038	11.820
CO	.0010	.028

BELMONT COUNTY, OH., 17243

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.7000	60.594
C	65.2700	.721
N	1.0000	5.284
O	8.7500	.006
NA	.0350	.032
MG	.0900	.009
AL	1.7500	.587
SI	3.8300	.907
S	4.1500	2.638
CL	.0500	1.837
K	.2700	.565
CA	.7600	.320
TI	.0800	.402
FE	2.5300	4.590
B	.0078	21.460
CO	.0020	.049

Table 7 (cont'd)

HARRISON COUNTY, OH., 17244

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.8100	61.397
C	70.4700	.770
N	1.1800	6.173
O	8.1200	.005
NA	.0360	.032
MG	.0500	.005
AL	1.8100	.601
SI	3.2000	.750
S	2.6600	1.674
CL	.2200	8.003
K	.2900	.600
CA	.3000	.125
TI	.1000	.497
FE	1.7900	3.215
B	.0059	16.071
CO	.0033	.081

JEFFERSON COUNTY, OH., 17245

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	4.9100	62.709
C	70.6200	.772
N	1.0700	5.601
O	9.2200	.006
NA	.0230	.021
MG	.0400	.004
AL	1.2400	.412
SI	2.5100	.589
S	3.6800	2.317
CL	.1000	3.640
K	.1500	.311
CA	.1100	.046
TI	.0600	.299
FE	2.6000	4.672
B	.0068	18.534
CO	.0028	.068

Table 7 (cont'd)

KANAWHA COUNTY, W. V., 17246

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	5.2900	76.988
C	80.1400	.999
N	1.2900	7.694
O	6.2200	.005
NA	.0220	.023
MG	.0200	.002
AL	1.1400	.432
SI	1.8100	.484
S	.9600	.689
CL	.1900	7.880
K	.1500	.354
CA	.1100	.052
TI	.0800	.454
FE	.5400	1.106
B	.0009	2.795
CO	.0016	.045

WASHINGTON COUNTY, PA, 17303

ELEMENT	WEIGHT %	% NEUTRONS ABSORBED
H	5.2600	78.483
C	78.0100	.997
N	1.2900	7.888
O	7.4900	.006
NA	.0220	.023
MG	.0400	.005
AL	1.1400	.443
SI	2.0100	.551
S	1.2900	.949
CL	.1200	5.102
K	.1300	.315
CA	2.5700	1.254
TI	.0700	.407
FE	.9300	1.952
B	.0005	1.592
CO	.0012	.034

Table 8. Thermal Neutron Capture Prompt Gamma Emission Line
Energies and Intensities from Elements in Coals

ZERO ASH SIMULATED COAL
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED
2.223 9898.904 H 3.664 32.148 C 4.946 67.734 C

L24 ASH SIMULATED COAL ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED										
1.524	2.667 K-19	2.078	.353 CA20	2.806	2.293 K-19	3.693	2.752 K-19	5.174	3.005 K-19	
1.564	2.354 K-19	2.087	.709 TI22	2.809	2.461 NA11	3.723	.963 S-16	5.267	3.107 N--7	
1.586	5.633 TI22	2.093	9.982 SI14	2.811	.602 CA20	3.730	1.231 K-19	5.297	2.272 N--7	
1.598	5.618 S-16	2.094	.403 CA20	2.822	1.031 AL13	3.734	1.097 TI22	5.360	8.811 K-19	
1.613	15.938 FE	2.108	.471 AL13	2.840	1.798 K-19	3.760	.479 CA20	5.420	20.138 S	
1.618	9.547 K-19	2.118	.421 CA20	2.863	6.536 NA11	3.850	.571 AL13	5.510	2.993 K-19	
1.623	1.287 AL13	2.122	.255 CA20	2.865	.607 S-16	3.876	.511 AL13	5.515	.439 CA20	
1.634	4.800 NA11	2.124	1.496 NA11	2.903	1.630 NA11	3.879	3.465 NA11	5.532	2.176 N--7	
1.649	.355 CA20	2.130	.638 CA20	2.931	7.616 S-16	3.920	1.186 TI22	5.560	1.107 N--7	
1.672	.486 CA20	2.138	.834 NA11	2.943	1.002 TI22	3.955	1.141 SI14	5.617	3.332 NA11	
1.679	.739 N--7	2.140	.587 AL13	2.960	2.461 AL13	3.982	12.004 NA	5.696	5.600 K-19	
1.691	.358 CA20	2.149	.287 CA20	2.982	2.047 NA11	4.003	1.485 K-19	5.730	1.955 K-19	
1.703	2.261 K-19	2.153	1.400 K-19	3.026	2.231 NA11	4.062	1.412 K-19	5.752	5.299 K-19	
1.704	.348 CA20	2.157	.446 N--7	3.027	2.365 TI22	4.134	1.702 AL13	5.901	.774 CA20	
1.724	.529 CA20	2.175	.324 N--7	3.034	2.326 AL13	4.136	3.150 K-19	5.921	22.585 FE	
1.725	21.877 FE	2.180	.246 N--8	3.056	2.450 K-19	4.168	.935 NA11	6.018	22.013 FE	
1.749	1.352 NA11	2.198	1.413 NA11	3.098	5.379 NA11	4.201	2.040 K-19	6.102	.715 AL13	
1.762	5.390 TI22	2.223	8933.247 H	3.214	.851 NA11	4.219	10.952 FE	6.316	.587 AL13	
1.779	35.230 AL	2.251	.640 NA11	3.221	9.234 S-16	4.260	1.626 AL13	6.321	2.036 N--7	
1.792	2.433 TI22	2.278	.695 TI22	3.263	2.704 K-19	4.361	4.116 K-19	6.380	4.704 SI14	
1.795	1.726 K-19	2.284	.663 AL13	3.268	3.242 FE26	4.387	1.521 K-19	6.395	14.290 NA	
1.826	.388 CA20	2.291	4.152 K-19	3.271	.246 N--8	4.407	3.569 FE26	6.418	24.651 TI	
1.842	.968 TI22	2.295	.454 CA20	3.280	.645 NA11	4.419	2.720 CA20	6.420	7.080 CA20	
1.880	.257 CA20	2.357	.544 N--7	3.370	1.794 S-16	4.431	1.499 S-16	6.556	4.422 TI22	
1.883	1.135 TI22	2.361	1.346 NA11	3.371	2.242 NA11	4.508	1.933 N--7	6.742	.686 SI14	
1.888	3.357 N--7	2.380	15.170 S	3.412	.957 NA11	4.639	.707 S-16	6.760	36.344 TI	
1.890	1.463 NA11	2.390	2.366 K-19	3.414	4.087 FE26	4.660	.511 AL13	6.999	2.474 K-19	
1.891	3.364 S-16	2.398	1.213 NA11	3.437	3.678 FE26	4.673	.695 TI22	7.199	2.569 SI14	
1.929	3.054 K-19	2.415	3.577 NA11	3.452	2.004 K-19	4.691	1.007 AL13	7.279	12.532 FE	
1.932	.768 NA11	2.422	1.796 K-19	3.466	1.718 AL13	4.714	.845 TI22	7.279	1.022 N--7	
1.943	13.232 CA	2.426	1.465 SI14	3.476	1.601 TI22	4.734	1.395 AL13	7.414	.147 N--7	
1.949	1.291 NA11	2.491	.925 S-16	3.505	1.268 NA11	4.750	.499 CA20	7.632	74.076 FE	
1.957	2.595 K-19	2.518	9.523 NA11	3.531	1.172 N--7	4.810	4.522 FE26	7.646	60.318 FE	
1.965	.679 NA11	2.519	1.153 N--7	3.539	29.663 SI	4.870	3.910 S-16	7.694	1.666 AL13	
1.984	1.062 NA11	2.546	4.393 K-19	3.547	5.142 K-19	4.881	3.864 TI22	7.724	8.031 AL13	
2.001	1.815 CA20	2.594	1.190 NA11	3.554	.961 TI22	4.903	.735 AL13	7.769	5.480 K-19	
2.009	1.361 CA20	2.612	2.052 K-19	3.586	.416 CA20	4.934	26.297 SI	7.800	1.333 S-16	
2.018	1.400 K-19	2.640	1.219 K-19	3.588	9.629 NA11	4.945	61.749 C	8.309	.516 N	

Table 8 (cont'd)

2.027	11.019 NA	2.660	.277 CA20	3.592	1.131 AL13	4.967	2.548 TI22	8.472	.861 SI
2.041	3.223 K-19	2.716	.556 NA11	3.610	1.154 CA20	4.992	2.052 K-19	8.641	.906 S
2.046	3.150 K-19	2.722	3.896 FE26	3.644	1.124 NA11	5.043	2.016 K-19	9.298	10.489 FE
2.048	1.002 TI22	2.753	1.988 S-16	3.651	1.557 K-19	5.047	1.072 S-16	10.828	1.834 N
2.057	.807 NA11	2.754	56.949 NA	3.661	1.718 SI14	5.070	1.400 K-19		
2.062	.457 N--7	2.757	1.859 K-19	3.675	1.898 N--7	5.107	1.372 SI14		
2.073	12.383 K	2.760	.719 SI14	3.684	29.308 C	5.134	.651 AL13		

MEDIUM ASH SIMULATED COAL
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.524	1.045 K-19	2.093	17.515 SI	2.828	2.642 MG12	3.693	1.078 K-19	5.420	79.446 S
1.564	.922 K-19	2.094	.634 CA20	2.840	.704 K-19	3.723	3.800 S-16	5.510	1.172 K-19
1.598	22.164 S	2.108	.745 AL13	2.863	3.693 NA11	3.730	.482 K-19	5.515	.690 CA20
1.601	64.265 CL	2.118	.662 CA20	2.864	131.749 CL	3.760	.753 CA20	5.517	29.191 CL
1.613	25.169 FE	2.122	.400 CA20	2.865	2.396 S-16	3.824	34.640 CL	5.532	.307 N--7
1.618	3.739 K-19	2.124	.846 NA11	2.903	.921 NA11	3.831	.418 MG12	5.560	.156 N--7
1.623	2.032 AL13	2.130	1.003 CA20	2.931	30.045 S	3.850	.902 AL13	5.617	1.883 NA11
1.633	.342 MG12	2.138	.471 NA11	2.960	3.887 AL13	3.876	.808 AL13	5.696	2.193 K-19
1.634	2.713 NA11	2.140	.928 AL13	2.975	22.185 CL	3.879	1.958 NA11	5.715	89.909 CL
1.649	.559 CA20	2.149	.452 CA20	2.982	1.157 NA11	3.916	3.022 MG12	5.730	.766 K-19
1.672	.765 CA20	2.153	.548 K-19	2.998	22.380 CL	3.955	2.001 SI14	5.752	2.075 K-19
1.679	.104 N--7	2.157	.063 N--7	3.026	1.260 NA11	3.982	6.783 NA11	5.901	1.217 CA20
1.690	.483 MG12	2.175	.046 N--7	3.034	3.672 AL13	4.003	.581 K-19	5.921	35.666 FE
1.691	.563 CA20	2.180	.292 N--8	3.054	.802 MG12	4.062	.553 K-19	6.018	34.763 FE
1.703	.893 K-19	2.198	.798 NA11	3.056	.960 K-19	4.134	2.688 AL13	6.102	1.129 AL13
1.704	.547 CA20	2.223	7040.796 H	3.062	72.589 CL	4.136	1.234 K-19	6.111	307.091 CL
1.724	.833 CA20	2.251	.361 NA11	3.098	3.039 NA11	4.188	.528 NA11	6.316	.923 AL13
1.725	34.548 FE	2.284	1.047 AL13	3.116	27.634 CL	4.201	.799 K-19	6.321	.287 N--7
1.749	.764 NA11	2.291	1.626 K-19	3.214	.481 NA11	4.219	17.295 FE	6.380	8.254 SI14
1.779	55.636 AL	2.295	.714 CA20	3.221	36.428 S	4.260	2.568 AL13	6.395	8.075 NA11
1.795	.676 K-19	2.357	.077 N--7	3.263	1.059 K-19	4.361	1.612 K-19	6.420	11.135 CA
1.809	1.863 MG12	2.361	.761 NA11	3.268	5.120 FE26	4.387	.596 K-19	6.620	194.608 CL
1.826	.611 CA20	2.380	59.846 S	3.271	.292 N--8	4.407	5.636 FE26	6.742	1.203 SI14
1.880	.404 CA20	2.390	.927 K-19	3.280	.365 NA11	4.419	4.278 CA20	6.978	33.473 CL
1.888	.473 N--7	2.398	.685 NA11	3.301	.552 MG12	4.431	5.915 S-16	6.999	.969 K-19
1.890	.827 NA11	2.415	2.021 NA11	3.370	7.076 S-16	4.508	.273 N--7	7.199	4.683 SI14
1.890	.537 MG12	2.422	.704 K-19	3.371	1.267 NA11	4.639	2.789 S-16	7.279	19.791 FE
1.891	13.272 S	2.426	2.570 SI14	3.412	.541 NA11	4.660	.808 AL13	7.299	.144 N--7
1.929	1.196 K-19	2.491	3.650 S-16	3.414	.402 MG12	4.691	1.590 AL13	7.414	165.806 CL
1.932	.434 NA11	2.518	5.381 NA11	3.414	6.454 FE26	4.734	2.202 AL13	7.414	.021 N--7
1.943	20.816 CA	2.519	.163 N--7	3.437	5.808 FE26	4.750	.785 CA20	7.632	116.961 FE
1.949	.729 NA11	2.546	1.721 K-19	3.452	.785 K-19	4.810	7.142 FE26	7.646	95.254 FE
1.951	415.877 CL	2.594	.673 NA11	3.466	2.713 AL13	4.870	15.425 S	7.694	2.631 AL13
1.957	1.016 K-19	2.612	.804 K-19	3.505	.717 NA11	4.903	1.161 AL13	7.724	12.683 AL
1.958	294.441 CL	2.640	.477 K-19	3.531	.165 N--7	4.934	46.143 SI	7.769	2.146 K-19
1.965	.383 NA11	2.660	.436 CA20	3.539	52.049 SI	4.945	48.663 C	7.790	129.025 CL
1.984	.600 NA11	2.676	63.637 CL	3.547	2.014 K-19	4.980	74.340 CL	7.800	5.260 S-16
2.001	2.855 CA20	2.716	.314 NA11	3.562	21.018 CL	4.992	.804 K-19	8.154	.295 MG

Table 8 (cont'd)

2.009	2.141	CA20	2.722	6.152	FE26	3.586	.654	CA20	5.043	.789	K-19	8.309	.073	N
2.018	.548	K-19	2.753	7.843	S-16	3.588	5.441	NA11	5.047	4.231	S-16	8.472	1.511	SI
2.027	6.227	NA11	2.754	32.180	NA	3.592	1.786	AL13	5.070	.548	K-19	8.579	44.760	CL
2.041	1.262	K-19	2.757	.728	K-19	3.610	1.816	CA20	5.107	2.407	SI14	8.641	3.575	S
2.046	1.234	K-19	2.780	1.262	SI14	3.644	.635	NA11	5.134	1.029	AL13	9.298	16.564	FE
2.057	.456	NA11	2.806	.898	K-19	3.651	.610	K-19	5.174	1.177	K-19	10.828	.259	N
2.062	.064	N--7	2.809	1.402	NA11	3.661	3.015	SI14	5.267	.438	N--7			
2.073	4.850	K-19	2.811	.948	CA20	3.675	.268	N--7	5.297	.320	N--7			
2.078	.555	CA20	2.822	1.628	AL13	3.684	23.097	C	5.380	3.451	K-19			

HIGH ASH SIMULATED COAL														
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.524	.463	K-19	2.073	2.149	K-19	2.780	3.473	SI14	3.610	5.174	CA20	4.992	.356	K-19
1.564	.408	K-19	2.076	1.582	CA20	2.806	.398	K-19	3.644	.810	NA11	5.043	.350	K-19
1.598	50.463	S	2.093	46.190	SI	2.809	1.786	NA11	3.651	.270	K-19	5.047	9.632	S-16
1.613	53.948	FE	2.094	1.868	CA20	2.811	2.700	CA20	3.661	8.296	SI14	5.070	.243	K-19
1.618	1.657	K-19	2.108	1.764	AL13	2.822	3.725	AL13	3.684	26.683	C	5.107	6.622	SI14
1.623	4.649	AL13	2.118	1.887	CA20	2.828	.691	MG12	3.693	.478	K-19	5.134	2.353	AL13
1.633	.115	MG12	2.122	1.141	CA20	2.840	.312	K-19	3.723	8.652	S-16	5.174	.522	K-19
1.634	3.460	NA11	2.124	1.076	NA11	2.863	4.711	NA11	3.730	.214	K-19	5.360	1.529	K-19
1.649	1.593	CA20	2.130	2.858	CA20	2.865	5.455	S-16	3.760	2.147	CA20	5.420	180.882	S
1.672	2.180	CA20	2.138	.601	NA11	2.903	1.175	NA11	3.631	.141	MG12	5.510	.520	K-19
1.690	.163	MG12	2.140	2.122	AL13	2.931	68.406	S	3.650	2.064	AL13	5.515	1.966	CA20
1.691	1.604	CA20	2.149	1.288	CA20	2.960	8.893	AL13	3.876	1.848	AL13	5.617	2.401	NA11
1.703	.396	K-19	2.153	.243	K-19	2.982	1.475	NA11	3.879	2.498	NA11	5.696	.972	K-19
1.704	1.559	CA20	2.180	.712	N--8	3.026	1.608	NA11	3.916	1.019	MG12	5.730	.339	K-19
1.724	2.373	CA20	2.198	1.018	NA11	3.034	8.402	AL13	3.955	5.506	SI14	5.752	.920	K-19
1.725	74.052	FE	2.223	8062.704	H	3.054	.270	MG12	3.982	8.651	NA11	5.901	3.468	CA20
1.749	.974	NA11	2.251	.461	NA11	3.056	.425	K-19	4.003	.258	K-19	5.921	76.450	FE
1.779	127.287	AL	2.284	2.396	AL13	3.098	3.877	NA11	4.062	.245	K-19	6.018	74.513	FE
1.795	.300	K-19	2.291	.721	K-19	3.214	.613	NA11	4.134	6.150	AL13	6.102	2.584	AL13
1.809	.628	MG12	2.295	2.034	CA20	3.221	82.940	S	4.136	.547	K-19	6.316	2.122	AL13
1.826	1.740	CA20	2.361	.970	NA11	3.263	.469	K-19	4.188	.674	NA11	6.380	22.709	SI
1.880	1.152	CA20	2.380	136.258	S	3.268	10.974	FE	4.201	.354	K-19	6.395	10.209	NA
1.890	1.054	NA11	2.390	.411	K-19	3.271	.712	J--8	4.219	37.072	FE	6.420	31.736	CA
1.890	.181	MG12	2.398	.874	NA11	3.280	.465	NA11	4.260	5.876	AL13	6.742	3.311	SI14
1.891	30.218	S	2.415	2.578	NA11	3.301	.186	MG12	4.361	.714	K-19	6.999	.429	K-19
1.929	.530	K-19	2.422	.312	K-19	3.370	16.111	S	4.387	.264	K-19	7.199	12.884	SI
1.932	.553	NA11	2.426	7.072	SI14	3.371	1.616	NA11	4.407	12.081	FE	7.279	42.421	FE
1.943	59.314	CA	2.491	8.311	S-16	3.412	.690	NA11	4.419	12.190	CA	7.632	250.745	FE
1.949	.930	NA11	2.518	6.863	NA11	3.414	13.833	FE	4.431	13.468	S	7.646	204.174	FE
1.957	.450	K-19	2.546	.762	K-19	3.414	.136	MG12	4.639	6.350	S-16	7.694	6.020	AL13
1.965	.489	NA11	2.594	.858	NA11	3.437	12.450	FE	4.660	1.848	AL13	7.724	20.019	AL
1.984	.766	NA11	2.612	.356	K-19	3.452	.348	K-19	4.691	3.633	AL13	7.769	.951	K-19
2.001	8.134	CA20	2.640	.212	K-19	3.466	6.208	AL13	4.734	5.038	AL13	7.800	11.976	S
2.009	6.101	CA20	2.660	1.243	CA20	3.505	.914	NA11	4.750	2.237	CA20	8.154	.099	MG
2.018	.243	K-19	2.716	.401	NA11	3.539	143.202	SI	4.810	15.306	FE	8.472	4.157	SI
2.027	7.942	NA11	2.722	13.187	FE	3.547	.892	K-19	4.870	35.119	S	8.641	8.141	S
2.041	.559	K-19	2.753	17.858	S	3.586	1.564	CA20	4.903	2.656	AL13	9.298	35.505	FE
2.046	.547	K-19	2.754	41.044	NA	3.588	6.939	NA11	4.934	126.953	SI			
.057	.581	NA11	2.757	.323	K-19	3.592	4.086	AL13	4.945	56.218	C			

Table 8 (cont'd)

LIGNITE (ANL NO. 3 SAMPLE)									
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.524	.447 K-19	2.087	.221 TI22	2.822	.613 AL13	3.693	.462 K-19	5.380	1.478 K-19
1.564	.395 K-19	2.093	12.873 SI	2.828	2.010 MG12	3.723	.977 S-16	5.420	20.416 S
1.586	1.816 TI22	2.094	1.029 CA20	2.840	.302 K-19	3.730	.206 K-19	5.431	.010 CD48
1.598	5.696 S-16	2.108	.280 AL13	2.863	.385 NA11	3.734	.342 TI22	5.510	.502 K-19
1.601	.665 CL17	2.118	1.074 CA20	2.864	1.039 CL17	3.760	1.222 CA20	5.515	1.119 CA20
1.613	3.591 FE26	2.122	.650 CA20	2.865	.616 S-16	3.824	.273 CL17	5.517	.230 CL17
1.618	1.601 K-19	2.124	.088 NA11	2.903	.096 NA11	3.831	.318 MG12	5.532	10.867 N
1.623	.765 AL13	2.130	1.627 CA20	2.931	7.722 S-16	3.850	.340 AL13	5.560	5.528 N--7
1.633	.260 MG12	2.138	.049 NA11	2.943	.312 TI22	3.876	.304 AL13	5.617	.196 NA11
1.634	.282 NA11	2.140	.349 AL13	2.960	1.464 AL13	3.879	.204 NA11	5.696	.939 K-19
1.649	.907 CA20	2.149	.733 CA20	2.975	.175 CL17	3.916	2.299 MG12	5.715	.709 CL17
1.661	.015 CD48	2.153	.235 K-19	2.982	.120 NA11	3.920	.370 TI22	5.730	.328 K-19
1.672	1.242 CA20	2.157	2.230 N--7	2.996	.177 CL17	3.955	1.471 SI14	5.752	.889 K-19
1.679	3.690 N--7	2.175	1.619 N--7	3.000	.014 CD48	3.982	.706 NA11	5.824	.021 CD48
1.690	.367 MG12	2.180	.709 N--8	3.026	.131 NA11	4.003	.249 K-19	5.901	1.975 CA20
1.691	.913 CA20	2.198	.083 NA11	3.027	.737 TI22	4.062	.237 K-19	5.921	5.089 FE26
1.703	.383 K-19	2.223	6229.948 H	3.034	1.383 AL13	4.134	1.012 AL13	6.018	4.960 FE26
1.704	.888 CA20	2.251	.038 NA11	3.054	.610 MG12	4.136	.528 K-19	6.102	.425 AL13
1.724	1.351 CA20	2.276	.217 TI22	3.056	.411 K-19	4.188	.055 NA11	6.111	2.423 CL17
1.725	4.929 FE26	2.284	.395 AL13	3.062	.573 CL17	4.201	.342 K-19	6.316	.349 AL13
1.749	.080 NA11	2.291	.696 K-19	3.098	.316 NA11	4.219	2.468 FE26	6.321	10.171 N
1.762	1.680 TI22	2.295	1.158 CA20	3.109	.010 CD48	4.260	.967 AL13	6.380	6.066 SI14
1.779	20.955 AL	2.357	2.718 N--7	3.116	.218 CL17	4.361	.690 K-19	6.395	.841 NA11
1.792	.758 TI22	2.361	.079 NA11	3.214	.050 NA11	4.387	.255 K-19	6.418	7.747 TI22
1.795	.289 K-19	2.380	15.381 S	3.221	9.362 S-16	4.407	.804 FE26	6.420	18.069 CA
1.809	1.417 MG12	2.390	.397 K-19	3.263	.453 K-19	4.419	6.941 CA20	6.556	1.379 TI22
1.826	.991 CA20	2.398	.071 NA11	3.268	.730 FE26	4.431	1.520 S-16	6.620	1.535 CL17
1.842	.302 TI22	2.398	.010 CD48	3.271	.709 N--8	4.470	.210 B--5	6.740	.026 B--5
1.880	.656 CA20	2.415	.210 NA11	3.280	.038 NA11	4.508	9.658 N--7	6.742	.884 SI14
1.863	.355 TI22	2.422	.302 K-19	3.361	.420 MG12	4.639	.717 S-16	6.760	11.485 TI
1.888	16.768 N	2.426	1.889 SI14	3.370	1.819 S-16	4.660	.304 AL13	6.978	.264 CL17
1.890	.086 NA11	2.456	.041 CD48	3.371	.132 NA11	4.673	.217 TI22	6.980	.047 B--5
1.890	.409 MG12	2.491	.938 S-16	3.412	.056 NA11	4.691	.599 AL13	6.999	.415 K-19
1.891	3.411 S-16	2.518	.560 NA11	3.414	.306 MG12	4.714	.263 TI22	7.199	3.442 SI14
1.929	.512 K-19	2.519	5.760 N--7	3.414	.921 FE26	4.730	.079 B--5	7.279	2.824 FE26
1.932	.045 NA11	2.546	.737 K-19	3.437	.829 FE26	4.734	.829 AL13	7.299	5.107 N--7
1.943	33.772 CA	2.550	.014 CD48	3.452	.336 K-19	4.750	1.274 CA20	7.414	1.308 CL17
1.949	.076 NA11	2.594	.070 NA11	3.466	1.022 AL13	4.810	1.019 FE26	7.414	.733 N--7
1.951	3.281 CL17	2.612	.344 K-19	3.476	.499 TI22	4.870	3.964 S-16	7.632	16.690 FE
1.957	.435 K-19	2.640	.204 K-19	3.505	.075 NA11	4.861	1.204 TI22	7.646	13.590 FE
1.958	2.323 CL17	2.660	.028 CD48	3.531	5.852 N--7	4.903	.437 AL13	7.694	.991 AL13
1.965	.040 NA11	2.660	.708 CA20	3.539	38.252 SI	4.934	33.912 SI	7.724	4.777 AL13
1.984	.063 NA11	2.676	.502 CL17	3.547	.862 K-19	4.945	42.313 C	7.769	.919 K-19
2.001	4.632 CA20	2.701	.011 CD48	3.554	.300 TI22	4.967	.794 TI22	7.790	1.018 CL17
2.009	3.474 CA20	2.716	.033 NA11	3.562	.166 CL17	4.980	.586 CL17	7.800	1.352 S-16

Table 8 (cont'd)

2.018	.235 K-19	2.722	.878 FE26	3.585	1.061 CA20	4.992	.344 K-19	8.154	.224 MG
2.027	.648 NA11	2.753	2.016 S-16	3.583	.566 NA11	5.043	.336 K-19	8.309	2.578 N
2.041	.540 K-19	2.754	3.350 NA11	3.592	.673 AL13	5.047	1.087 S-16	8.472	1.110 SI
2.046	.528 K-19	2.757	.312 K-19	3.610	2.946 CA20	5.070	.235 K-19	8.579	.353 CL
2.048	.312 TI22	2.767	.013 CD48	3.644	.066 NA11	5.107	1.769 SI14	8.641	.919 S
2.057	.047 NA11	2.780	.928 SI14	3.651	.261 K-19	5.134	.387 AL13	8.910	.016 B
2.062	2.285 N--7	2.806	.385 K-19	3.661	2.216 SI14	5.174	.504 K-19	9.298	2.363 FE
2.073	2.077 K-19	2.809	.146 NA11	3.675	9.481 N--7	5.267	15.522 N	10.828	9.163 N
2.078	.901 CA20	2.811	1.537 CA20	3.684	20.083 C	5.297	11.350 N	11.430	.002 S

COOKING COAL ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.524	.526 K-19	2.078	.238 CA20	2.863	.771 NA11	3.734	.373 TI22	5.420	18.392 S
1.564	.464 K-19	2.087	.241 TI22	2.864	86.203 CL	3.760	.324 CA20	5.510	.590 K-19
1.586	1.982 TI22	2.093	9.746 SI14	2.865	.555 S-16	3.824	22.665 CL	5.515	.296 CA20
1.598	5.131 S-16	2.094	.273 CA20	2.903	.192 NA11	3.831	.015 MG12	5.517	19.100 CL
1.601	55.134 CL	2.108	.304 AL13	2.931	6.956 S-16	3.850	.369 AL13	5.532	6.564 N--7
1.613	3.388 FE26	2.118	.284 CA20	2.943	.340 TI22	3.876	.330 AL13	5.560	3.339 N--7
1.618	1.881 K-19	2.122	.172 CA20	2.960	1.588 AL13	3.879	.409 NA11	5.617	.393 NA11
1.623	.830 AL13	2.124	.177 NA11	2.975	14.516 CL	3.916	.109 MG12	5.696	1.104 K-19
1.633	.012 MG12	2.130	.431 CA20	2.982	.242 NA11	3.920	.403 TI22	5.715	58.827 CL
1.634	.567 NA11	2.138	.098 NA11	2.998	14.643 CL	3.955	1.114 SI14	5.730	.385 K-19
1.649	.240 CA20	2.140	.379 AL13	3.026	.263 NA11	3.982	1.417 NA11	5.752	1.044 K-19
1.672	.329 CA20	2.149	.194 CA20	3.027	.804 TI22	4.003	.293 K-19	5.901	.523 CA20
1.679	2.229 N--7	2.153	.276 K-19	3.034	1.501 AL13	4.062	.278 K-19	5.921	4.801 FE26
1.690	.017 MG12	2.157	1.347 N--7	3.054	.029 MG12	4.134	1.098 AL13	6.018	4.679 FE26
1.691	.242 CA20	2.175	.978 N--7	3.056	.483 K-19	4.136	.621 K-19	6.102	.462 AL13
1.703	.450 K-19	2.180	.240 S--8	3.062	47.494 CL	4.188	.110 NA11	6.111	200.928 CL
1.704	.235 CA20	2.198	.167 NA11	3.098	.635 NA11	4.201	.402 K-19	6.316	.379 AL13
1.724	.358 CA20	2.223	4949.273 H	3.116	18.081 CL	4.219	2.328 FE26	6.321	6.143 N--7
1.725	4.651 FE26	2.251	.076 NA11	3.214	.100 NA11	4.260	1.049 AL13	6.380	4.593 SI14
1.749	.160 NA11	2.278	.236 TI22	3.221	8.433 S-16	4.361	.811 K-19	6.395	1.687 NA11
1.762	1.832 TI22	2.284	.428 AL13	3.263	.533 K-19	4.387	.300 K-19	6.418	8.446 TI22
1.779	22.733 AL	2.291	.818 K-19	3.268	.689 FE26	4.407	.759 FE26	6.420	4.784 CA20
1.792	.827 TI22	2.295	.307 CA20	3.271	.240 S--8	4.419	1.838 CA20	6.556	1.503 TI22
1.795	.340 K-19	2.357	1.642 N--7	3.280	.076 NA11	4.431	1.369 S-16	6.620	127.331 CL
1.809	.067 MG12	2.361	.159 NA11	3.301	.020 MG12	4.470	.286 B--5	6.740	.036 B--5
1.826	.262 CA20	2.380	13.855 S	3.370	1.638 S-16	4.508	5.833 N--7	6.742	.670 SI14
1.842	.329 TI22	2.390	.466 K-19	3.371	.265 NA11	4.639	.646 S-16	6.760	12.522 TI
1.880	.174 CA20	2.398	.143 NA11	3.412	.113 NA11	4.660	.330 AL13	6.978	21.901 CL
1.883	.387 TI22	2.415	.422 NA11	3.414	.869 FE26	4.673	.236 TI22	6.980	.064 B--5
1.888	10.128 N	2.422	.354 K-19	3.414	.015 MG12	4.691	.650 AL13	6.999	.488 K-19
1.890	.019 MG12	2.426	1.430 SI14	3.437	.782 FE26	4.714	.287 TI22	7.199	2.606 SI14
1.890	.173 NA11	2.491	.845 S-16	3.452	.395 K-19	4.730	.107 B--5	7.279	2.664 FE26
1.891	3.073 S-16	2.518	1.124 NA11	3.466	1.109 AL13	4.734	.900 AL13	7.299	3.085 N--7
1.929	.602 K-19	2.519	3.479 N--7	3.476	.544 TI22	4.750	.337 CA20	7.414	.443 N--7
1.932	.091 NA11	2.546	.866 K-19	3.505	.150 NA11	4.810	.961 FE26	7.414	108.486 CL

Table 8 (cont'd)

1.943	8.942	CA20	2.594	.141	NA11	3.531	3.535	N--7	4.870	3.571	S-16	7.632	15.747	FE
1.949	.152	NA11	2.612	.404	K-19	3.539	28.962	SI	4.861	1.313	TI22	7.646	12.822	FE
1.951	272.106	CL	2.640	.240	K-19	3.547	1.013	K-19	4.903	.474	AL13	7.694	1.075	AL13
1.957	.511	K-19	2.660	.187	CA20	3.554	.327	TI22	4.934	25.676	SI	7.724	5.182	AL13
1.958	192.651	CL	2.676	41.637	CL	3.562	13.752	CL	4.945	43.422	C	7.769	1.080	K-19
1.965	.080	NA11	2.716	.066	NA11	3.586	.281	CA20	4.967	.866	TI22	7.790	84.420	CL
1.984	.125	NA11	2.722	.828	FE26	3.588	1.136	NA11	4.980	48.640	CL	7.800	1.218	S-16
2.001	1.226	CA20	2.753	1.816	S-16	3.592	.730	AL13	4.992	.404	K-19	8.154	.011	MG
2.009	.920	CA20	2.754	6.722	NA11	3.610	.780	CA20	5.043	.397	K-19	8.309	1.557	N
2.018	.276	K-19	2.757	.366	K-19	3.644	.133	NA11	5.047	.979	S-16	8.472	.841	SI
2.027	1.301	NA11	2.780	.702	SI14	3.651	.307	K-19	5.070	.276	K-19	8.579	29.286	CL
2.041	.635	K-19	2.806	.452	K-19	3.661	1.678	SI14	5.107	1.339	SI14	8.641	.828	S
2.046	.621	K-19	2.809	.293	NA11	3.675	5.726	N--7	5.134	.420	AL13	8.910	.021	B
2.048	.340	TI22	2.811	.407	CA20	3.684	20.609	C	5.174	.592	K-19	9.298	2.230	FE
2.057	.095	NA11	2.822	.665	AL13	3.693	.542	K-19	5.267	9.376	N--7	10.828	5.535	N
2.062	1.380	N--7	2.828	.096	MG12	3.723	.880	S-16	5.297	6.856	N--7	11.430	.003	B
2.073	2.440	K-19	2.840	.354	K-19	3.730	.243	K-19	5.380	1.736	K-19			

PITTSBURG SEAM, W. V. ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.516	.038	C027	2.078	.266	CA20	2.943	1.064	TI22	3.955	4.142	SI14	5.715	10.144	CL
1.524	1.757	K-19	2.087	.753	TI22	2.960	5.063	AL13	3.982	2.198	NA11	5.730	1.288	K-19
1.564	1.550	K-19	2.093	36.245	SI	2.975	2.503	CL17	4.003	.978	K-19	5.743	.027	C027
1.586	6.198	TI22	2.094	.305	CA20	2.982	.375	NA11	4.029	.022	C027	5.752	3.491	K-19
1.598	35.076	S	2.108	.970	AL13	2.998	2.525	CL17	4.062	.930	K-19	5.901	.584	CA20
1.601	9.508	CL17	2.118	.318	CA20	3.026	.408	NA11	4.134	3.501	AL13	5.921	39.268	FE
1.613	27.711	FE	2.122	.192	CA20	3.027	2.512	TI22	4.136	2.075	K-19	5.926	.023	C027
1.618	6.289	K-19	2.124	.274	NA11	3.034	4.783	AL13	4.188	.171	NA11	5.976	.087	C027
1.623	2.646	AL13	2.130	.482	CA20	3.054	.101	MG12	4.201	1.344	K-19	6.018	38.274	FE
1.633	.043	MG12	2.138	.153	NA11	3.056	1.614	K-19	4.209	.015	C027	6.102	1.471	AL13
1.634	.879	NA11	2.140	1.208	AL13	3.062	8.190	CL17	4.219	19.042	FE	6.111	34.649	CL
1.649	.268	CA20	2.149	.217	CA20	3.098	.985	NA11	4.260	3.345	AL13	6.316	1.208	AL13
1.672	.367	CA20	2.153	.922	K-19	3.116	3.118	CL17	4.361	2.711	K-19	6.321	6.265	N--7
1.679	2.273	N--7	2.157	1.373	N--7	3.214	.156	NA11	4.387	1.062	K-19	6.380	17.080	SI
1.690	.061	MG12	2.175	.997	N--7	3.221	57.650	S	4.407	6.205	FE26	6.395	2.617	NA11
1.691	.270	CA20	2.180	.185	0--8	3.263	1.781	K-19	4.419	2.054	CA20	6.418	26.406	TI
1.703	1.503	K-19	2.198	.259	NA11	3.268	5.637	FE26	4.431	9.361	S-16	6.420	5.347	CA20
1.704	.263	CA20	2.223	5680.059	H	3.271	.185	0--8	4.470	.216	B--5	6.486	.085	C027
1.724	.400	CA20	2.251	.117	NA11	3.280	.118	NA11	4.508	5.948	N--7	6.556	4.699	TI22
1.725	38.037	FE	2.278	.739	TI22	3.301	.070	MG12	4.639	4.414	S-16	6.620	21.958	CL
1.749	.248	NA11	2.284	1.364	AL13	3.370	11.198	S	4.660	1.052	AL13	6.706	.097	C027
1.762	5.727	TI22	2.291	2.735	K-19	3.371	.411	NA11	4.673	.739	TI22	6.740	.027	B--5
1.779	72.462	AL	2.295	.343	CA20	3.412	.175	NA11	4.691	2.071	AL13	6.742	2.490	SI14
1.792	2.585	TI22	2.357	1.674	N--7	3.414	7.105	FE26	4.714	.898	TI22	6.760	39.149	TI
1.795	1.137	K-19	2.361	.247	NA11	3.414	.051	MG12	4.730	.081	B--5	6.877	.104	C027
1.801	.015	C027	2.380	94.710	S	3.437	6.395	FE26	4.734	2.868	AL13	6.978	3.777	CL17
1.809	.236	MG12	2.390	1.558	K-19	3.452	1.320	K-19	4.750	.377	CA20	6.980	.049	B--5

Table 8 (cont'd)

1.826	.293	CA20	2,398	.222	NA11	3.466	3,534	AL13	4.810	7,863	FE26	6.985	.038	C027
1.830	.066	C027	2,415	.655	NA11	3.476	1,702	TI22	4.870	24,411	S	6.999	1.630	K-19
1.842	1.028	TI22	2,422	1,185	K-19	3.505	.232	NA11	4.881	4,105	TI22	7.056	.022	C027
1.853	.016	C027	2,426	5,319	SI14	3.531	3,604	N--7	4.903	1,512	AL13	7.199	9,691	SI14
1.880	.194	CA20	2,491	5,777	S-16	3.539	107,707	SI	4,934	95,485	SI	7.214	.061	C027
1.883	1,209	TI22	2,518	1,744	NA11	3.547	3,387	K-19	4,945	45,281	C	7.279	21,789	FE
1.888	10,328	N	2,519	3,548	N--7	3.554	1,021	TI22	4,967	2,708	TI22	7.299	3,145	N--7
1.890	.068	MG12	2,546	2,894	K-19	3.562	2,371	CL17	4,980	8,388	CL17	7.414	.451	N--7
1.890	.268	NA11	2,594	.218	NA11	3.586	.314	CA20	4,992	1,352	K-19	7.414	18,708	CL
1.891	21,004	S	2,612	1,352	K-19	3.588	1,763	NA11	5,043	1,328	K-19	7.491	.039	C027
1.929	2,012	K-19	2,640	.803	K-19	3.592	2,326	AL13	5,047	6,695	S-16	7.632	128,795	FE
1.932	.141	NA11	2,660	.209	CA20	3.610	.872	CA20	5,070	.922	K-19	7.646	104,874	FE
1.943	9,993	CA20	2,676	7,180	CL17	3.644	.206	NA11	5,107	4,981	SI14	7.694	3,427	AL13
1.949	.236	NA11	2,716	.102	NA11	3.651	1,026	K-19	5,134	1,340	AL13	7.724	16,519	AL
1.951	46,923	CL	2,722	6,774	FE26	3.661	6,239	SI14	5,174	1,980	K-19	7.769	3,610	K-19
1.957	1,710	K-19	2,753	12,413	S	3.675	5,839	N--7	5,182	.029	C027	7.790	14,558	CL
1.958	33,222	CL	2,754	10,429	NA	3.684	21,492	C	5,267	9,560	N--7	7.800	8,325	S-16
1.965	.124	NA11	2,757	1,224	K-19	3.693	1,813	K-19	5,270	.015	C027	8.154	.037	MG
1.984	.195	NA11	2,780	2,612	SI14	3.723	6,014	S-16	5,297	6,991	N--7	8,309	1,588	N
2.001	1,370	CA20	2,806	1,511	K-19	3.730	.811	K-19	5,380	5,804	K-19	8,472	3,126	SI
2.009	1,028	CA20	2,809	.454	NA11	3.734	1,166	TI22	5,420	125,727	S	8,579	5,050	CL
2.018	.922	K-19	2,811	.455	CA20	3.749	.018	C027	5,510	1,972	K-19	8,641	5,658	S
2.027	2,018	NA11	2,822	2,120	AL13	3.760	.362	CA20	5,515	.331	CA20	8,910	.016	B
2.033	.018	C027	2,828	.334	MG12	3.824	3,908	CL17	5,517	3,294	CL17	9,298	18,237	FE
2.041	2,123	K-19	2,840	1,185	K-19	3.831	.053	MG12	5,532	6,693	N--7	10,828	5,644	N
2.046	2,075	K-19	2,863	1,197	NA11	3.850	1,175	AL13	5,560	3,405	N--7	11,430	.002	B
2.048	1,064	TI22	2,864	14,865	CL	3.876	1,052	AL13	5,603	.014	C027			
2.057	.148	NA11	2,865	3,792	S-16	3.879	.635	NA11	5,617	.610	NA11			
2.062	1,407	N--7	2,903	.298	NA11	3.916	.383	MG12	5,660	.083	C027			
2.073	8,158	K-19	2,931	47,548	S	3.920	1,260	TI22	5,696	3,689	K-19			

HIGH PYRITE COAL, IOWA ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.524	.260	K-19	2,087	.104	TI22	2.822	.410	AL13	3,693	.268	K-19	5,380	.859	K-19
1.564	.230	K-19	2,093	6,120	SI14	2.828	.112	MG12	3,723	8,741	S-16	5,420	182,753	S
1.586	.858	TI22	2,094	1,061	CA20	2.840	.175	K-19	3,730	.120	K-19	5,431	.138	CD48
1.598	50,985	S	2,108	.188	AL13	2.863	.169	NA11	3,734	.161	TI22	5,510	.292	K-19
1.601	3,923	CL17	2,118	1,108	CA20	2.864	6,134	CL17	3,760	1,260	CA20	5,515	1,154	CA20
1.613	37,527	FE	2,122	.670	CA20	2.865	5,512	S-16	3,824	1,613	CL17	5,517	1,359	CL17
1.618	.931	K-19	2,124	.039	NA11	2.903	.042	NA11	3,831	.018	MG12	5,532	5,337	N--7
1.623	.512	AL13	2,130	1,678	CA20	2.931	69,114	S	3,850	.228	AL13	5,560	2,715	N--7
1.633	.014	MG12	2,138	.022	NA11	2.943	.147	TI22	3,876	.204	AL13	5,617	.086	NA11
1.634	.124	NA11	2,140	.234	AL13	2.960	.980	AL13	3,879	.090	NA11	5,696	.546	K-19
1.649	.935	CA20	2,149	.756	CA20	2.975	1,033	CL17	3,916	.128	MG12	5,715	4,166	CL17
1.661	.208	CD48	2,153	.137	K-19	2.982	.053	NA11	3,920	.174	TI22	5,730	.191	K-19
1.672	1,280	CA20	2,157	1,095	N--7	2.998	1,042	CL17	3,955	.699	SI14	5,752	.517	K-19
1.679	1,812	N--7	2,175	.795	N--7	3.000	.204	CD48	3,982	.311	NA11	5,824	.295	CD48

Table 8 (cont'd)

1.690	.020	MG12	2,180	.315	0--8	3.026	.058	NA11	4.003	.145	K-19	5.901	2,036	CA20
1.691	.942	CA20	2,198	.037	NA11	3.027	.348	TI22	4.052	.138	K-19	5.921	53,179	FE
1.703	.223	K-19	2,223	5299,112	H	3.034	.926	AL13	4,134	.678	AL13	6.018	51,832	FE
1.704	.915	CA20	2,251	.017	NA11	3.054	.034	MG12	4,136	.307	K-19	6.102	.285	AL13
1.724	1,393	CA20	2,278	.102	TI22	3.056	.239	K-19	4,188	.024	NA11	6.111	14,298	CL
1.725	51,511	FE	2,284	.264	AL13	3.062	3,380	CL17	4,201	.199	K-19	6.316	.234	AL13
1.749	.035	NA11	2,291	.405	K-19	3.098	.139	NA11	4,219	25,767	FE	6.321	4,995	N--7
1.762	.793	TI22	2,295	1,194	CA20	3.109	.143	CD48	4,260	.648	AL13	6.380	2,884	SI14
1.779	14,028	AL	2,357	1,335	N--7	3.116	1,287	CL17	4,361	.401	K-19	6.395	.370	NA11
1.792	.358	TI22	2,361	.035	NA11	3.214	.022	NA11	4,387	.148	K-19	6.418	3,657	TI22
1.795	.168	K-19	2,380	137,668	S	3.221	83,798	S	4,407	8,403	FE26	6.420	18,631	CA
1.809	.079	MG12	2,390	.231	K-19	3.263	.264	K-19	4,419	7,157	CA20	6.556	.651	TI22
1.826	1,021	CA20	2,398	.031	NA11	3.268	7,634	FE26	4,431	13,607	S	6.620	9,061	CL17
1.842	.142	TI22	2,398	.139	CD48	3.271	.315	0--8	4,470	.292	B--5	6.740	.036	B--5
1.880	.677	CA20	2,415	.093	NA11	3.280	.017	NA11	4,508	4,743	N--7	6.742	.420	SI14
1.883	.167	TI22	2,422	.175	K-19	3.301	.023	MG12	4,639	6,416	S-16	6.760	5,423	TI22
1.888	8,235	N--7	2,426	.898	SI14	3.370	16,277	S	4,660	.204	AL13	6.978	1,558	CL17
1.890	.038	NA11	2,456	.577	CD48	3.371	.058	NA11	4,673	.102	TI22	6.980	.066	B--5
1.890	.023	MG12	2,491	8,397	S-16	3.412	.025	NA11	4,691	.401	AL13	6.999	.241	K-19
1.891	30,531	S	2,518	.246	NA11	3.414	.017	MG12	4,714	.124	TI22	7.199	1,636	SI14
1.929	.298	K-19	2,519	2,829	N--7	3.414	9,622	FE26	4,730	.109	B--5	7.279	29,508	FE
1.932	.020	NA11	2,546	.429	K-19	3.437	8,660	FE26	4,734	.555	AL13	7.299	2,508	N--7
1.943	34,821	CA	2,550	.204	CD48	3.452	.195	K-19	4,750	1,313	CA20	7.414	7,720	CL17
1.949	.033	NA11	2,594	.031	NA11	3.466	.684	AL13	4,810	10,649	FE	7.414	.360	N--7
1.951	19,363	CL	2,612	.200	K-19	3.476	.236	TI22	4,870	35,483	S	7.632	174,418	FE
1.957	.253	K-19	2,640	.119	K-19	3.505	.033	NA11	4,881	.569	TI22	7.646	142,024	FE
1.958	13,709	CL	2,660	.397	CD48	3.531	2,874	N--7	4,903	.293	AL13	7.694	.663	AL13
1.965	.018	NA11	2,660	.730	CA20	3.539	18,185	SI	4,934	16,122	SI	7.724	3,198	AL13
1.984	.027	NA11	2,676	2,963	CL17	3.547	.502	K-19	4,945	36,071	C	7.769	.535	K-19
2.001	4,776	CA20	2,701	.156	CD48	3.554	.141	TI22	4,967	.375	TI22	7.790	6,007	CL17
2.009	3,582	CA20	2,716	.014	NA11	3.562	.979	CL17	4,980	3,461	CL17	7.800	12,100	S
2.018	.137	K-19	2,722	9,173	FE26	3.586	1,094	CA20	4,992	.200	K-19	8.154	.012	MG
2.027	.285	NA11	2,753	18,043	S	3.588	.249	NA11	5,043	.197	K-19	8.309	1,266	N
2.041	.314	K-19	2,754	1,473	NA11	3.592	.450	AL13	5,047	9,732	S-16	8.472	.528	SI
2.046	.307	K-19	2,757	.181	K-19	3.610	3,038	CA20	5,070	.137	K-19	8.579	2,084	CL
2.048	.147	TI22	2,767	.184	CD48	3.644	.029	NA11	5,107	.841	SI14	8.641	8,225	S
2.057	.021	NA11	2,780	.441	SI14	3.651	.152	K-19	5,134	.259	AL13	8.910	.022	B
2.062	1,122	N--7	2,806	.224	K-19	3.661	1,053	SI14	5,174	.293	K-19	9.298	24,697	FE
2.073	1,208	K-19	2,809	.064	NA11	3.675	4,656	N--7	5,267	7,623	N--7	10,828	4,500	N
2.078	.929	CA20	2,811	1,585	CA20	3.684	17,120	C	5,297	5,574	N--7	11,430	.003	B

Table 8 (cont'd)

82 COALS, ILLINOIS BASIN														
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.516	.055	CO27	2.087	.208	TI22	2.865	2.424	S-16	3.879	.242	NA11	5.660	.120	CO27
1.524	.628	K-19	2.093	12.938	SI	2.903	.114	NA11	3.916	.182	MG12	5.696	1.319	K-19
1.564	.554	K-19	2.094	.424	CA20	2.931	30.394	S	3.920	.448	TI22	5.715	21.477	CL
1.586	2.202	TI22	2.108	.412	AL13	2.943	.378	TI22	3.955	1.478	SI14	5.730	.461	K-19
1.598	22.421	S	2.118	.443	CA20	2.960	2.152	AL13	3.982	.839	NA11	5.743	.038	CO27
1.601	20.129	CL	2.122	.268	CA20	2.975	5.299	CL17	4.003	.350	K-19	5.752	1.248	K-19
1.613	18.664	FE	2.124	.105	NA11	2.982	.143	NA11	4.029	.031	CO27	5.824	.483	CD48
1.618	2.249	K-19	2.130	.671	CA20	2.998	5.346	CL17	4.062	.333	K-19	5.901	.814	CA20
1.623	1.125	AL13	2.138	.058	NA11	3.000	.338	CD48	4.134	1.489	AL13	5.921	26.449	FE
1.633	.021	MG12	2.140	.514	AL13	3.026	.156	NA11	4.136	.742	K-19	5.926	.034	CO27
1.634	.335	NA11	2.149	.302	CA20	3.027	.893	TI22	4.188	.065	NA11	5.976	.126	CO27
1.649	.374	CA20	2.153	.330	K-19	3.034	2.034	AL13	4.201	.480	K-19	6.018	25.779	FE
1.661	.344	CD48	2.157	.687	N--7	3.054	.048	MG12	4.209	.022	CO27	6.102	.625	AL13
1.672	.512	CA20	2.175	.644	N--7	3.056	.577	K-19	4.219	12.826	FE	6.111	73.356	CL
1.679	1.468	N--7	2.180	.305	W--H	3.062	17.339	CL	4.260	1.422	AL13	6.316	.514	AL13
1.690	.029	MG12	2.198	.099	NA11	3.098	.376	NA11	4.361	.969	K-19	6.321	4.046	N--7
1.691	.376	CA20	2.223	5481.564	H	3.109	.236	CD48	4.387	.358	K-19	6.380	6.097	SI14
1.703	.537	K-19	2.251	.045	NA11	3.116	6.601	CL17	4.407	4.180	FE26	6.395	.998	NA11
1.704	.366	CA20	2.278	.262	TI22	3.214	.059	NA11	4.419	2.860	CA20	6.418	9.383	TI22
1.724	.557	CA20	2.284	.580	AL13	3.221	36.851	S	4.431	5.984	S-16	6.420	7.446	CA20
1.725	25.620	FE	2.291	.978	K-19	3.263	.637	K-19	4.470	.301	B--5	6.486	.122	CO27
1.749	.094	NA11	2.295	.477	CA20	3.268	3.797	FE26	4.508	3.842	N--7	6.556	1.670	TI22
1.762	2.035	TI22	2.357	1.081	N--7	3.271	.305	W--8	4.639	2.822	S-16	6.620	46.487	CL
1.779	30.808	AL	2.361	.094	NA11	3.280	.045	NA11	4.660	.447	AL13	6.706	.140	CO27
1.792	.918	TI22	2.380	60.542	S	3.301	.033	MG12	4.673	.262	TI22	6.740	.038	B--5
1.795	.406	K-19	2.390	.557	K-19	3.370	7.158	S-16	4.691	.881	AL13	6.742	.889	SI14
1.801	.022	CO27	2.398	.230	CD48	3.371	.157	NA11	4.714	.319	TI22	6.760	13.910	TI
1.809	.112	MG12	2.398	.085	NA11	3.412	.067	NA11	4.730	.113	B--5	6.877	.151	CO27
1.826	.408	CA20	2.415	.250	NA11	3.414	.024	MG12	4.734	1.219	AL13	6.978	7.996	CL17
1.830	.096	CO27	2.422	.424	K-19	3.414	4.786	FE26	4.750	.525	CA20	6.980	.068	B--5
1.842	.365	TI22	2.426	1.899	SI14	3.437	4.307	FE26	4.810	5.296	FE26	6.985	.055	CO27
1.853	.023	CO27	2.456	.954	CD48	3.452	.472	K-19	4.870	15.604	S	6.999	.583	K-19
1.880	.270	CA20	2.491	3.693	S-16	3.466	1.503	AL13	4.881	1.459	TI22	7.056	.032	CO27
1.883	.430	TI22	2.518	.665	NA11	3.476	.605	TI22	4.903	.643	AL13	7.199	3.459	SI14
1.888	6.671	N--7	2.519	2.292	N--7	3.505	.089	NA11	4.934	34.084	SI	7.214	.088	CO27
1.890	.102	NA11	2.546	1.035	K-19	3.531	2.328	N--7	4.945	44.642	C	7.279	14.676	FE
1.890	.032	MG12	2.550	.338	CD48	3.539	38.447	SI	4.967	.962	TI22	7.299	2.032	N--7
1.891	13.426	S	2.594	.083	NA11	3.547	1.211	K-19	4.980	17.758	CL	7.414	39.607	CL
1.929	.719	K-19	2.612	.483	K-19	3.554	.363	TI22	4.992	.483	K-19	7.414	.292	N--7
1.932	.054	NA11	2.640	.287	K-19	3.562	5.021	CL17	5.043	.475	K-19	7.491	.056	CO27
1.943	13.916	CA	2.660	.292	CA20	3.586	.437	CA20	5.047	4.280	S-16	7.632	86.750	FE
1.949	.090	NA11	2.660	.656	CD48	3.588	.673	NA11	5.070	.330	K-19	7.646	70.638	FE
1.951	99.342	CL	2.676	15.201	CL	3.592	.989	AL13	5.107	1.776	SI14	7.694	1.457	AL13
1.957	.611	K-19	2.701	.258	CD48	3.610	1.214	CA20	5.134	.570	AL13	7.724	7.023	AL13

Table 8 (cont'd)

1.958	70.334	CL	2.716	.039	NA11	3.644	.078	NA11	5.174	.708	K-19	7.769	1.291	K-19
1.965	.047	NA11	2.722	4.562	FE26	3.651	.367	K-19	5.182	.042	C027	7.790	30.821	CL
1.984	.074	NA11	2.753	7.935	S-16	3.661	2.227	SI14	5.267	6.175	N--7	7.800	5.321	S-16
2.001	1.909	CA20	2.754	3.978	NA11	3.675	3.772	N--7	5.270	.022	C027	8.154	.018	MG
2.009	1.431	CA20	2.757	.438	K-19	3.684	21.188	C	5.297	4.515	N--7	8.309	1.026	N
2.018	.330	K-19	2.767	.304	CD48	3.693	.648	K-19	5.380	2.075	K-19	8.472	1.116	SI
2.027	.770	NA11	2.760	.932	SI14	3.723	3.844	S-16	5.420	80.369	S	8.579	10.692	CL
2.033	.026	C027	2.806	.540	K-19	3.730	.290	K-19	5.431	.228	CD48	8.641	3.617	S
2.041	.759	K-19	2.809	.173	NA11	3.734	.414	TI22	5.510	.705	K-19	8.910	.023	B
2.046	.742	K-19	2.811	.634	CA20	3.749	.026	C027	5.515	.461	CA20	9.298	12.283	FE
2.048	.378	TI22	2.822	.902	AL13	3.760	.504	CA20	5.517	6.973	CL17	10.828	3.545	N
2.057	.056	NA11	2.828	.159	MG12	3.824	8.275	CL17	5.532	4.323	N--7	11.430	.003	B
2.062	.909	N--7	2.840	.424	K-19	3.831	.025	MG12	5.560	2.199	N--7			
2.073	2.917	K-19	2.863	.457	NA11	3.850	.500	AL13	5.603	.021	C027			
2.078	.371	CA20	2.864	31.471	CL	3.876	.447	AL13	5.617	.233	NA11			

SAMPLE 17045, ARIZONA
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.516	.018	C027	2.078	1.070	CA20	2.943	.747	TI22	3.955	2.849	SI14	5.715	2.121	CL17
1.524	.349	K-19	2.087	.528	TI22	2.960	4.599	AL13	3.982	.671	NA11	5.730	.256	K-19
1.564	.308	K-19	2.093	24.936	SI	2.975	.523	CL17	4.003	.194	K-19	5.743	.012	C027
1.586	4.349	TI22	2.094	1.222	CA20	2.982	.114	NA11	4.029	.010	C027	5.752	.693	K-19
1.598	4.163	S-16	2.108	.881	AL13	2.998	.528	CL17	4.062	.125	K-19	5.901	2.345	CA20
1.601	1.988	CL17	2.118	1.276	CA20	3.026	.125	NA11	4.134	3.161	AL13	5.921	9.318	FE26
1.613	6.576	FE26	2.122	.772	CA20	3.027	1.763	TI22	4.136	.412	K-19	5.926	.011	C027
1.618	1.249	K-19	2.124	.084	NA11	3.034	4.345	AL13	4.188	.052	NA11	5.976	.041	C027
1.623	2.404	AL13	2.130	1.933	CA20	3.054	.129	MG12	4.201	.267	K-19	6.018	9.082	FE26
1.633	.055	MG12	2.138	.047	NA11	3.056	.321	K-19	4.209	.007	C027	6.102	1.336	AL13
1.634	.268	NA11	2.140	1.098	AL13	3.062	1.712	CL17	4.219	4.519	FE26	6.111	7.243	CL17
1.649	1.077	CA20	2.149	.871	CA20	3.098	.301	NA11	4.260	3.039	AL13	6.316	1.098	AL13
1.672	1.475	CA20	2.153	.183	K-19	3.116	.652	CL17	4.361	.538	K-19	6.321	4.262	N--7
1.679	1.546	N--7	2.157	.934	N--7	3.214	.048	NA11	4.387	.199	K-19	6.380	11.751	SI
1.690	.078	MG12	2.175	.678	N--7	3.221	6.842	S-16	4.407	1.473	FE26	6.395	.798	NA11
1.691	1.085	CA20	2.180	.791	N--8	3.263	.354	K-19	4.419	8.244	CA20	6.418	18.529	TI
1.703	.298	K-19	2.198	.079	NA11	3.268	1.338	FE26	4.431	1.111	S-16	6.420	21.461	CA
1.704	1.054	CA20	2.223	7711.393	H	3.271	.791	N--8	4.470	.118	B--5	6.486	.039	C027
1.724	1.604	CA20	2.251	.036	NA11	3.280	.036	NA11	4.508	4.047	N--7	6.556	3.297	TI22
1.725	9.026	FE26	2.278	.518	TI22	3.301	.089	MG12	4.639	.524	S-16	6.620	4.590	CL17
1.749	.076	NA11	2.284	1.239	AL13	3.370	1.329	S-16	4.660	.956	AL13	6.706	.045	C027
1.762	4.019	TI22	2.291	.543	K-19	3.371	.125	NA11	4.673	.518	TI22	6.740	.015	B--5
1.779	65.829	AL	2.295	1.375	CA20	3.412	.053	NA11	4.691	1.881	AL13	6.742	1.713	SI14
1.792	1.814	TI22	2.357	1.139	N--7	3.414	1.686	FE26	4.714	.630	TI22	6.760	27.471	TI
1.795	.226	K-19	2.361	.075	NA11	3.414	.065	MG12	4.730	.644	B--5	6.877	.049	C027
1.801	.007	C027	2.380	11.241	S	3.437	1.517	FE26	4.734	2.606	AL13	6.978	.790	CL17
1.809	.299	MG12	2.390	.309	K-19	3.452	.262	K-19	4.750	1.513	CA20	6.980	.026	B--5
1.826	1.177	CA20	2.398	.068	NA11	3.466	3.210	AL13	4.810	1.866	FE26	6.985	.018	C027

Table 8 (cont'd)

1.830	.031	C027	2,415	.200	NA11	3.476	1,194	TI22	4.870	2.897	S-16	6.999	.324	K-19
1.842	.721	TI22	2,422	.235	K-19	3,505	.071	NA11	4.881	2.881	TI22	7.056	.010	C027
1.853	.008	C027	2,426	3.659	SI14	3,531	2,452	N--7	4.903	1,374	AL13	7.199	6.667	SI14
1.880	.779	CA20	2,491	.686	S-16	3,539	74,100	SI	4,934	65,692	SI	7,214	.028	C027
1.883	.848	TI22	2,518	.532	NA11	3,547	.673	K-19	4,945	61,576	C	7,279	5.171	FE26
1.888	7.026	N--7	2,519	2,414	N--7	3,554	.716	TI22	4,967	1,900	TI22	7,299	2.140	N--7
1.890	.086	MG12	2,546	.575	K-19	3,562	.496	CL17	4,980	1,753	CL17	7,414	.307	N--7
1.890	.082	NA11	2,594	.067	NA11	3,586	1,261	CA20	4,992	.268	K-19	7,414	3.911	CL17
1.891	2,493	S-16	2,612	.268	K-19	3,588	.538	NA11	5,043	.264	K-19	7,491	.018	C027
1.929	.399	K-19	2,640	.159	K-19	3,592	2,113	AL13	5,047	.795	S-16	7,632	30.563	FE
1.932	.043	NA11	2,660	.840	CA20	3,610	3,499	CA20	5,070	.183	K-19	7,646	24.686	FE
1.943	40,110	CA	2,676	1,201	CL17	3,644	.063	NA11	5,107	3,427	SI14	7,694	3.113	AL13
1.949	.072	NA11	2,716	.031	NA11	3,651	.204	K-19	5,134	1,217	AL13	7,724	15.007	AL
1.951	9,809	CL17	2,722	1,607	FE26	3,661	4,293	SI14	5,174	.393	K-19	7,769	.717	K-19
1.957	.339	K-19	2,753	1,473	S-16	3,675	3,972	N--7	5,182	.013	C027	7,790	3.043	CL17
1.958	6,945	CL17	2,754	3,182	NA11	3,684	29,225	C	5,267	6,504	N--7	7,800	.988	S-16
1.965	.038	NA11	2,757	.243	K-19	3,693	.360	K-19	5,270	.007	C027	8,154	.047	MG
1.984	.059	NA11	2,780	1,797	SI14	3,723	.714	S-16	5,297	4,756	N--7	8,309	1.080	N
2.001	5,501	CA20	2,806	.300	K-19	3,730	.161	K-19	5,380	1,153	K-19	8,472	2.151	SI
2.009	4,126	CA20	2,809	.139	NA11	3,734	.818	TI22	5,420	14,922	S	8,579	1.056	CL
2.018	.183	K-19	2,811	1,826	CA20	3,749	.008	C027	5,510	.392	K-19	8,641	.672	S
2.027	.616	NA11	2,822	1,926	AL13	3,760	1,452	CA20	5,515	1,329	CA20	8,910	.009	B
2.033	.008	C027	2,826	.424	MG12	3,824	.817	CL17	5,517	.689	CL17	9,298	4.328	FE
2.041	.422	K-19	2,840	.235	K-19	3,831	.067	MG12	5,532	4,554	N--7	10,828	3.839	N
2.046	.412	K-19	2,863	.365	NA11	3,850	1,068	AL13	5,560	2,316	N--7	11,430	.001	B
2.048	.747	TI22	2,864	3,108	CL17	3,876	.956	AL13	5,603	.007	C027			
2.057	.045	NA11	2,865	.450	S-16	3,879	.194	NA11	5,617	.186	NA11			
2.062	.957	N--7	2,903	.091	NA11	3,916	.485	MG12	5,660	.039	C027			
2.073	1,620	K-19	2,931	5,643	S-16	3,920	.884	TI22	5,696	.733	K-19			

SAMPLE 17046, MONTANA
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.516	.016	C027	2,076	1,093	CA20	2,943	.500	TI22	3,955	2,525	SI14	5,715	3,784	CL17
1.524	.571	K-19	2,087	.354	TI22	2,960	3,986	AL13	3,982	4,432	NA11	5,730	.418	K-19
1.564	.504	K-19	2,093	22,101	SI	2,975	.934	CL17	4,003	.318	K-19	5,743	.011	C027
1.586	2,910	TI22	2,094	1,249	CA20	2,982	.756	NA11	4,029	.009	C027	5,752	1.134	K-19
1.598	9,368	S-16	2,108	.764	AL13	2,998	.942	CL17	4,062	.302	K-19	5,901	2,397	CA20
1.601	3,546	CL17	2,118	1,304	CA20	3,026	.624	NA11	4,134	2,757	AL13	5,921	10,179	FE
1.613	7,183	FE26	2,122	.789	CA20	3,027	1,180	TI22	4,136	.674	K-19	5,926	.010	C027
1.618	2,042	K-19	2,124	.552	NA11	3,034	3,766	AL13	4,188	.345	NA11	5,976	.036	C027
1.623	2,084	AL13	2,130	1,976	CA20	3,054	.293	MG12	4,201	.436	K-19	6,018	9,921	FE26
1.633	.125	MG12	2,138	.308	NA11	3,056	.524	K-19	4,209	.006	C027	6,102	1,158	AL13
1.634	1,772	NA11	2,140	.951	AL13	3,062	3,055	CL17	4,219	4,936	FE26	6,111	12,923	CL
1.649	1,101	CA20	2,149	.890	CA20	3,098	1,986	NA11	4,260	2,634	AL13	6,316	.951	AL13
1.672	1,507	CA20	2,153	.300	K-19	3,116	1,163	CL17	4,361	.861	K-19	6,321	3,564	N--7
1.679	1,293	N--7	2,157	.731	N--7	3,214	.314	NA11	4,387	.325	K-19	6,380	10,415	SI
1.690	.177	MG12	2,175	.567	N--7	3,221	15,398	S	4,407	1,608	FE26	6,395	5,276	NA11

Table 8 (cont'd)

1.691	1.109	CA20	2.180	.727	W--8	3.263	.578	K-19	4.419	8.426	CA20	6.418	12.397	TI
1.703	.488	K-19	2.198	.522	NA11	3.268	1.461	FE26	4.431	2.500	S-16	6.420	21.936	CA
1.704	1.078	CA20	2.223	5933.653	H	3.271	.727	W--8	4.470	.322	B--5	6.486	.035	C027
1.724	1.640	CA20	2.251	.236	NA11	3.260	.238	NA11	4.508	3.384	N--7	6.556	2.206	TI22
1.725	9.859	FE26	2.278	.347	TI22	3.301	.202	MG12	4.639	1.179	S-16	6.620	8.189	CL17
1.749	.499	NA11	2.284	1.074	AL13	3.370	2.991	S-16	4.660	.828	AL13	6.706	.040	C027
1.762	2.689	TI22	2.291	.888	K-19	3.371	.828	NA11	4.673	.347	TI22	6.740	.040	B--5
1.779	57.055	AL	2.295	1.406	CA20	3.412	.353	NA11	4.691	1.631	AL13	6.742	1.519	SI14
1.792	1.213	TI22	2.357	.953	N--7	3.414	1.842	FE26	4.714	.421	TI22	6.760	18.379	TI
1.795	.369	K-19	2.361	.497	NA11	3.414	.147	MG12	4.730	.121	B--5	6.877	.043	C027
1.801	.006	C027	2.380	25.296	S	3.437	1.658	FE26	4.734	2.258	AL13	6.978	1.409	CL17
1.809	.682	MG12	2.390	.506	K-19	3.452	.429	K-19	4.750	1.546	CA20	6.980	.072	B--5
1.826	1.203	CA20	2.398	.448	NA11	3.466	2.783	AL13	4.810	2.038	FE26	6.985	.016	C027
1.830	.027	C027	2.415	1.321	NA11	3.476	.799	TI22	4.870	6.520	S-16	6.999	.529	K-19
1.842	.483	TI22	2.422	.385	K-19	3.505	.468	NA11	4.881	1.927	TI22	7.056	.009	C027
1.853	.007	C027	2.426	3.243	SI14	3.531	2.051	N--7	4.903	1.191	AL13	7.199	5.909	SI14
1.880	.797	CA20	2.491	1.543	S-16	3.539	65.676	SI	4.934	58.224	SI	7.214	.025	C027
1.883	.568	TI22	2.518	3.516	NA11	3.547	1.100	K-19	4.945	52.834	C	7.279	5.648	FE26
1.888	5.876	N--7	2.519	2.019	N--7	3.554	.479	TI22	4.967	1.271	TI22	7.299	1.790	N--7
1.890	.197	MG12	2.546	.940	K-19	3.562	.884	CL17	4.980	3.128	CL17	7.414	.257	N--7
1.890	.540	NA11	2.594	.439	NA11	3.586	1.289	CA20	4.992	.439	K-19	7.414	6.977	CL17
1.891	5.610	S-16	2.612	.439	K-19	3.588	3.555	NA11	5.043	.431	K-19	7.491	.016	C027
1.929	.653	K-19	2.640	.261	K-19	3.592	1.831	AL13	5.047	1.788	S-16	7.632	33.384	FE
1.932	.283	NA11	2.660	.859	CA20	3.610	3.577	CA20	5.070	.300	K-19	7.646	27.184	FE
1.943	40.998	CA	2.676	2.678	CL17	3.644	.415	NA11	5.107	3.037	SI14	7.694	2.698	AL13
1.949	.476	NA11	2.716	.205	NA11	3.651	.333	K-19	5.134	1.055	AL13	7.724	13.007	AL
1.951	17.501	CL	2.722	1.756	FE26	3.661	3.805	SI14	5.174	.643	K-19	7.769	1.172	K-19
1.957	.555	K-19	2.753	3.315	S-16	3.675	3.322	N--7	5.182	.012	C027	7.790	5.430	CL17
1.958	12.391	CL	2.754	21.025	NA	3.684	25.077	C	5.267	5.439	N--7	7.800	2.223	S-16
1.965	.251	NA11	2.757	.398	K-19	3.693	.589	K-19	5.270	.006	C027	8.154	.108	MG
1.984	.392	NA11	2.780	1.593	SI14	3.723	1.606	S-16	5.297	3.977	N--7	8.309	.903	N
2.001	5.623	CA20	2.806	.491	K-19	3.730	.263	K-19	5.380	1.885	K-19	8.472	1.906	SI
2.009	4.217	CA20	2.809	.916	NA11	3.734	.547	TI22	5.420	33.581	S	8.579	1.884	CL
2.018	.300	K-19	2.811	1.866	CA20	3.749	.007	C027	5.510	.640	K-19	8.641	1.511	S
2.027	4.066	NA11	2.822	1.670	AL13	3.760	1.484	CA20	5.515	1.359	CA20	8.910	.024	B
2.033	.008	C027	2.828	.967	MG12	3.824	1.458	CL17	5.517	1.228	CL17	9.298	4.727	FE
2.041	.689	K-19	2.840	.385	K-19	3.831	.153	MG12	5.532	3.808	N--7	10.828	3.211	N
2.046	.674	K-19	2.863	2.413	NA11	3.850	.925	AL13	5.560	1.937	N--7	11.430	.003	B
2.048	.500	TI22	2.864	5.544	CL17	3.876	.828	AL13	5.603	.006	C027			
2.057	.298	NA11	2.865	1.013	S-16	3.879	1.279	NA11	5.617	1.230	NA11			
2.062	.801	N--7	2.903	.602	NA11	3.916	1.106	MG12	5.660	.035	C027			
2.073	2.649	K-19	2.931	12.700	S	3.920	.591	TI22	5.696	1.198	K-19			

Table 8 (cont'd)

SAMPLE 17047, MONTANA											
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED											
1.516	.015 C027	2.078	.974 CA20	2.943	.493 TI22	3.955	2.499 SI14	5.715	1.866 CL17		
1.524	.614 K-19	2.087	.349 TI22	2.960	3.747 AL13	3.982	.415 NA11	5.730	.450 K-19		
1.564	.542 K-19	2.093	21.868 SI	2.975	.460 CL17	4.003	.342 K-19	5.743	.011 C027		
1.586	2.870 TI22	2.094	1.113 CA20	2.982	.071 NA11	4.029	.009 C027	5.752	1.220 K-19		
1.598	15.649 S	2.108	.718 AL13	2.998	.464 CL17	4.062	.325 K-19	5.901	2.135 CA20		
1.601	1.749 CL17	2.118	1.161 CA20	3.026	.077 NA11	4.134	2.592 AL13	5.921	20.579 FE		
1.613	14.522 FE	2.122	.702 CA20	3.027	1.163 TI22	4.136	.725 K-19	5.926	.010 C027		
1.618	2.197 K-19	2.124	.052 NA11	3.034	3.541 AL13	4.188	.032 NA11	5.976	.036 C027		
1.623	1.959 AL13	2.130	1.760 CA20	3.054	.315 MG12	4.201	.470 K-19	6.018	20.058 FE		
1.633	.134 MG12	2.138	.029 NA11	3.056	.564 K-19	4.209	.006 C027	6.102	1.089 AL13		
1.634	.166 NA11	2.140	.894 AL13	3.062	1.506 CL17	4.219	9.979 FE26	6.111	6.373 CL17		
1.649	.981 CA20	2.149	.793 CA20	3.098	.186 NA11	4.260	2.476 AL13	6.316	.894 AL13		
1.672	1.342 CA20	2.153	.322 K-19	3.116	.573 CL17	4.361	.947 K-19	6.321	3.554 N--7		
1.679	1.289 N--7	2.157	.779 N--7	3.214	.029 NA11	4.387	.350 K-19	6.380	10.305 SI		
1.690	.189 MG12	2.175	.566 N--7	3.221	25.720 S	4.407	3.252 FE26	6.395	.494 NA11		
1.691	.988 CA20	2.180	.745 N--8	3.263	.622 K-19	4.419	7.504 CA20	6.418	12.226 TI		
1.703	.525 K-19	2.198	.049 NA11	3.268	2.954 FE26	4.431	4.177 S-16	6.420	19.536 CA		
1.704	.960 CA20	2.223	6110.207 H	3.271	.745 N--8	4.470	.290 B--5	6.486	.035 C027		
1.724	1.461 CA20	2.251	.022 NA11	3.280	.022 NA11	4.508	3.375 N--7	6.556	2.176 TI22		
1.725	19.934 FE	2.278	.342 TI22	3.301	.217 MG12	4.639	1.969 S-16	6.620	4.038 CL17		
1.749	.047 NA11	2.284	1.010 AL13	3.370	4.996 S-16	4.660	.779 AL13	6.706	.040 C027		
1.762	2.652 TI22	2.291	.956 K-19	3.371	.078 NA11	4.673	.342 TI22	6.740	.036 B--5		
1.779	53.638 AL	2.295	1.252 CA20	3.412	.033 NA11	4.691	1.533 AL13	6.742	1.502 SI14		
1.792	1.197 TI22	2.357	.950 N--7	3.414	3.724 FE26	4.714	.416 TI22	6.760	18.126 TI		
1.795	.397 K-19	2.361	.047 NA11	3.414	.158 MG12	4.730	.109 B--5	6.877	.043 C027		
1.801	.006 C027	2.380	42.255 S	3.437	3.351 FE26	4.734	2.123 AL13	6.978	.693 CL17		
1.809	.731 MG12	2.390	.545 K-19	3.452	.461 K-19	4.750	1.377 CA20	6.980	.065 B--5		
1.826	1.071 CA20	2.398	.042 NA11	3.466	2.616 AL13	4.810	4.121 FE26	6.985	.015 C027		
1.830	.027 C027	2.415	.124 NA11	3.476	.788 TI22	4.870	10.891 S	6.999	.570 K-19		
1.842	.476 TI22	2.422	.414 K-19	3.505	.044 NA11	4.881	1.701 TI22	7.056	.009 C027		
1.853	.007 C027	2.426	3.209 SI14	3.531	2.045 N--7	4.903	1.119 AL13	7.199	5.847 SI14		
1.880	.709 CA20	2.491	2.577 S-16	3.539	64.983 SI	4.934	57.609 SI	7.214	.025 C027		
1.883	.560 TI22	2.518	.329 NA11	3.547	1.183 K-19	4.945	54.527 C	7.279	11.419 FE		
1.888	5.859 N--7	2.519	2.013 N--7	3.554	.473 TI22	4.967	1.254 TI22	7.299	1.765 N--7		
1.890	.211 MG12	2.546	1.011 K-19	3.562	.436 CL17	4.980	1.543 CL17	7.414	.256 N--7		
1.890	.051 NA11	2.594	.041 NA11	3.586	1.148 CA20	4.992	.472 K-19	7.414	3.441 CL17		
1.891	9.371 S-16	2.612	.472 K-19	3.588	.333 NA11	5.043	.464 K-19	7.491	.016 C027		
1.929	.703 K-19	2.640	.281 K-19	3.592	1.722 AL13	5.047	2.987 S-16	7.632	67.496 FE		
1.932	.027 NA11	2.660	.765 CA20	3.610	3.185 CA20	5.070	.322 K-19	7.646	54.960 FE		
1.943	36.513 CA	2.676	1.321 CL17	3.644	.039 NA11	5.107	3.005 SI14	7.694	2.537 AL13		
1.949	.045 NA11	2.716	.019 NA11	3.651	.358 K-19	5.134	.992 AL13	7.724	12.228 AL		
1.951	8.630 CL17	2.722	3.550 FE26	3.661	3.764 SI14	5.174	.692 K-19	7.769	1.261 K-19		
1.957	.597 K-19	2.753	5.538 S-16	3.675	3.313 N--7	5.182	.012 C027	7.790	2.677 CL17		
1.958	6.110 CL17	2.754	1.970 NA11	3.684	25.880 C	5.267	5.424 N--7	7.800	3.714 S-16		
1.965	.023 NA11	2.757	.428 K-19	3.693	.633 K-19	5.270	.006 C027	8.154	.116 MG		
1.984	.037 NA11	2.780	1.576 SI14	3.723	2.683 S-16	5.297	3.966 N--7	8.309	.901 N		

Table 8 (cont'd)

2.001	5.008 CA20	2.806	.528 K-19	3.730	.283 K-19	5.380	2.028 K-19	8.472	1.886 SI
2.009	3.756 CA20	2.809	.086 NA11	3.734	.540 TI22	5.420	56.093 S	8.579	.929 CL
2.018	.322 K-19	2.811	1.662 CA20	3.749	.007 C027	5.510	.689 K-19	8.641	2.524 S
2.027	.381 NA11	2.822	1.570 AL13	3.760	1.321 CA20	5.515	1.210 CA20	8.910	.022 B
2.033	.007 C027	2.828	1.037 MG12	3.824	.719 CL17	5.517	.606 CL17	9.298	9.557 FE
2.041	.742 K-19	2.840	.414 K-19	3.831	.164 MG12	5.532	3.797 N--7	10.828	3.202 N
2.046	.725 K-19	2.863	.226 NA11	3.850	.870 AL13	5.560	1.932 N--7	11.430	.003 B
2.048	.493 TI22	2.864	2.734 CL17	3.876	.779 AL13	5.603	.006 C027		
2.057	.028 NA11	2.865	1.692 S-16	3.879	.120 NA11	5.617	.115 NA11		
2.062	.798 N--7	2.903	.056 NA11	3.916	1.186 MG12	5.660	.034 C027		
2.073	2.850 K-19	2.931	21.213 S	3.920	.583 TI22	5.696	1.269 K-19		

SAMPLE 17054, COLORADO
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.516	.017 C027	2.078	.433 CA20	2.943	1.179 TI22	3.955	3.027 SI14	5.715	6.182 CL17
1.524	.452 K-19	2.087	.834 TI22	2.960	5.662 AL13	3.982	.314 NA11	5.730	.331 K-19
1.564	.399 K-19	2.093	26.489 SI	2.975	1.525 CL17	4.003	.252 K-19	5.743	.012 C027
1.586	6.867 TI22	2.094	.495 CA20	2.982	.054 NA11	4.029	.010 C027	5.752	.898 K-19
1.598	7.630 S-16	2.108	1.085 AL13	2.998	1.539 CL17	4.062	.239 K-19	5.901	.950 CA20
1.601	5.794 CL17	2.118	.517 CA20	3.026	.058 NA11	4.134	3.916 AL13	5.921	9.424 FE26
1.613	6.650 FE26	2.122	.312 CA20	3.027	2.784 TI22	4.136	.534 K-19	5.926	.010 C027
1.618	1.618 K-19	2.124	.039 NA11	3.034	5.350 AL13	4.188	.024 NA11	5.976	.039 C027
1.623	2.960 AL13	2.130	.763 CA20	3.054	.042 MG12	4.201	.346 K-19	6.018	9.185 FE26
1.633	.018 MG12	2.138	.022 NA11	3.056	.415 K-19	4.209	.007 C027	6.102	1.645 AL13
1.634	.125 NA11	2.140	1.351 AL13	3.062	4.991 CL17	4.219	4.570 FE26	6.111	21.114 CL
1.649	.436 CA20	2.149	.353 CA20	3.098	.141 NA11	4.260	3.741 AL13	6.316	1.351 AL13
1.672	.597 CA20	2.153	.237 K-19	3.116	1.900 CL17	4.361	.698 K-19	6.321	4.572 N--7
1.679	1.659 N--7	2.157	1.002 N--7	3.214	.022 NA11	4.387	.258 K-19	6.380	12.483 SI
1.690	.025 MG12	2.175	.728 N--7	3.221	12.541 S	4.407	1.489 FE26	6.395	.374 NA11
1.691	.439 CA20	2.180	.469 0--8	3.263	.458 K-19	4.419	3.337 CA20	6.418	29.256 TI
1.703	.387 K-19	2.198	.037 NA11	3.268	1.353 FE26	4.431	2.036 S-16	6.420	8.689 CA20
1.704	.427 CA20	2.223	7255.226 H	3.271	.469 0--8	4.470	.149 B--5	6.486	.038 C027
1.724	.650 CA20	2.251	.017 NA11	3.280	.017 NA11	4.508	4.342 N--7	6.556	5.206 TI22
1.725	9.128 FE26	2.278	.818 TI22	3.301	.029 MG12	4.639	.960 S-16	6.620	13.380 CL
1.749	.035 NA11	2.284	1.526 AL13	3.370	2.436 S-16	4.660	1.177 AL13	6.706	.044 C027
1.762	6.345 TI22	2.291	.704 K-19	3.371	.059 NA11	4.673	.818 TI22	6.740	.019 B--5
1.779	81.045 AL	2.295	.557 CA20	3.412	.025 NA11	4.691	2.316 AL13	6.742	1.820 SI14
1.792	2.864 TI22	2.357	1.222 N--7	3.414	1.705 FE26	4.714	.995 TI22	6.760	43.375 TI
1.795	.293 K-19	2.361	.035 NA11	3.414	.021 MG12	4.730	.056 B--5	6.877	.047 C027
1.801	.007 C027	2.380	20.603 S	3.437	1.535 FE26	4.734	3.208 AL13	6.978	2.301 CL17
1.809	.097 MG12	2.390	.401 K-19	3.452	.340 K-19	4.750	.612 CA20	6.980	.033 B--5
1.826	.476 CA20	2.398	.032 NA11	3.466	3.953 AL13	4.810	1.887 FE26	6.985	.017 C027
1.830	.030 C027	2.415	.093 NA11	3.476	1.885 TI22	4.870	5.310 S-16	6.999	.419 K-19
1.842	1.139 TI22	2.422	.305 K-19	3.505	.033 NA11	4.881	4.549 TI22	7.056	.010 C027
1.853	.007 C027	2.426	3.887 SI14	3.531	2.631 N--7	4.903	1.691 AL13	7.199	7.082 SI14
1.880	.315 CA20	2.491	1.257 S-16	3.539	78.714 SI	4.934	69.782 SI	7.214	.028 C027
1.883	1.340 TI22	2.518	.249 NA11	3.547	.871 K-19	4.945	65.956 C	7.279	5.229 FE26

Table 8 (cont'd)

1.888	7.538 N--7	2.519	2.590 N--7	3.554	1.131 TI22	4.967	3.000 TI22	7.299	2.296 N--7
1.890	.028 MG12	2.546	.745 K-19	3.562	1.445 CL17	4.980	5.111 CL17	7.414	.330 N--7
1.890	.038 NA11	2.594	.031 NA11	3.586	.510 CA20	4.992	.348 K-19	7.414	11.400 CL
1.891	4.569 S-16	2.612	.348 K-19	3.588	.252 NA11	5.043	.342 K-19	7.491	.018 C027
1.929	.518 K-19	2.640	.207 K-19	3.592	2.601 AL13	5.047	1.456 S-16	7.632	30.909 FE
1.932	.020 NA11	2.660	.340 CA20	3.610	1.417 CA20	5.070	.237 K-19	7.646	25.168 FE
1.943	16.239 CA	2.676	4.375 CL17	3.644	.029 NA11	5.107	3.640 SI14	7.694	3.833 AL13
1.949	.034 NA11	2.716	.015 NA11	3.651	.264 K-19	5.134	1.498 AL13	7.724	18.476 AL
1.951	28.594 CL	2.722	1.626 FE26	3.661	4.560 SI14	5.174	.509 K-19	7.769	.929 K-19
1.957	.440 K-19	2.753	2.700 S-16	3.675	4.262 N--7	5.182	.013 C027	7.790	8.871 CL17
1.958	20.244 CL	2.754	1.469 NA11	3.684	31.305 C	5.267	6.978 N--7	7.800	1.811 S-16
1.965	.018 NA11	2.757	.315 K-19	3.693	.466 K-19	5.270	.007 C027	8.154	.015 MG
1.984	.028 NA11	2.780	1.909 SI14	3.723	1.308 S-16	5.297	5.102 N--7	8.309	1.159 N
2.001	2.227 CA20	2.806	.389 K-19	3.730	.209 K-19	5.380	1.493 K-19	8.472	2.285 SI
2.009	1.670 CA20	2.809	.065 NA11	3.734	1.292 TI22	5.420	27.351 S	8.579	3.077 CL
2.018	.237 K-19	2.811	.739 CA20	3.749	.008 C027	5.510	.507 K-19	8.641	1.231 S
2.027	.288 NA11	2.822	2.372 AL13	3.760	.568 CA20	5.515	.538 CA20	8.910	.011 B
2.033	.008 C027	2.828	.137 MG12	3.624	2.382 CL17	5.517	2.007 CL17	9.298	4.377 FE
2.041	.546 K-19	2.840	.305 K-19	3.631	.022 MG12	5.532	4.885 N--7	10.828	4.119 N
2.046	.534 K-19	2.863	.171 NA11	3.850	1.314 AL13	5.560	2.485 N--7	11.430	.001 B
2.048	1.179 TI22	2.864	9.058 CL17	3.876	1.177 AL13	5.603	.006 C027		
2.057	.021 NA11	2.865	.825 S-16	3.679	.091 NA11	5.617	.087 NA11		
2.062	1.027 N--7	2.903	.043 NA11	3.916	.157 MG12	5.660	.038 C027		
2.073	2.099 K-19	2.931	10.344 S	3.920	1.396 TI22	5.696	.949 K-19		

SAMPLE 17096, UTAH									
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.516	.008 C027	2.062	1.128 N--7	2.864	8.571 CL17	3.831	.021 MG12	5.532	5.364 N--7
1.524	.107 K-19	2.073	.496 K-19	2.865	.649 S-16	3.850	.402 AL13	5.560	2.729 N--7
1.564	.094 K-19	2.078	.635 CA20	2.903	.620 NA11	3.876	.359 AL13	5.603	.003 C027
1.586	2.999 TI22	2.087	.364 TI22	2.931	8.136 S-16	3.879	1.319 NA11	5.617	1.268 NA11
1.598	6.002 S-16	2.093	14.669 SI	2.943	.515 TI22	3.916	.149 MG12	5.660	.018 C027
1.601	5.482 CL17	2.094	.726 CA20	2.960	1.730 AL13	3.920	.610 TI22	5.696	.225 K-19
1.613	5.922 FE26	2.108	.331 AL13	2.975	1.443 CL17	3.955	1.676 SI14	5.715	5.849 CL17
1.618	.383 K-19	2.118	.758 CA20	2.982	.779 NA11	3.982	4.567 NA11	5.730	.078 K-19
1.623	.904 AL13	2.122	.456 CA20	2.998	1.456 CL17	4.003	.060 K-19	5.743	.006 C027
1.633	.017 MG12	2.124	.569 NA11	3.026	.849 NA11	4.029	.005 C027	5.752	.212 K-19
1.634	1.827 NA11	2.130	1.148 CA20	3.027	1.216 TI22	4.062	.057 K-19	5.901	1.393 CA20
1.649	.640 CA20	2.138	.317 NA11	3.034	1.634 AL13	4.134	1.196 AL13	5.921	8.392 FE26
1.672	.876 CA20	2.140	.413 AL13	3.054	.039 MG12	4.136	.126 K-19	5.926	.005 C027
1.679	1.821 N--7	2.149	.517 CA20	3.056	.098 K-19	4.168	.356 NA11	5.976	.019 C027
1.690	.024 MG12	2.153	.056 K-19	3.062	4.722 CL17	4.201	.082 K-19	6.018	8.180 FE26
1.691	.644 CA20	2.157	1.100 N--7	3.098	2.047 NA11	4.209	.003 C027	6.102	.503 AL13
1.703	.091 K-19	2.175	.799 N--7	3.116	1.798 CL17	4.219	4.070 FE26	6.111	19.978 CL
1.704	.626 CA20	2.180	.546 N--8	3.214	.324 NA11	4.260	1.143 AL13	6.316	.413 AL13
1.724	.953 CA20	2.198	.538 NA11	3.221	9.865 S-16	4.361	.165 K-19	6.321	5.020 N--7
1.725	8.129 FE26	2.223	8678.352 H	3.263	.108 K-19	4.367	.061 K-19	6.380	6.913 SI14
1.749	.514 NA11	2.251	.243 NA11	3.268	1.205 FE26	4.407	1.326 FE26	6.395	5.437 NA11

Table 8 (cont'd)

1.762	2.771	TI22	2.278	.357	TI22	3.271	.546	Z--8	4.419	4.895	CA20	6.418	12.776	TI
1.779	24.759	AL	2.284	.466	AL13	3.280	.246	NA11	4.431	1.602	S-16	6.420	12.742	CA
1.792	1.251	TI22	2.291	.166	K-19	3.301	.027	MG12	4.508	4.767	N--7	6.486	.018	C027
1.795	.069	K-19	2.295	.817	CA20	3.370	1.916	S-16	4.639	.755	S-16	6.556	2.274	TI22
1.801	.003	C027	2.357	1.342	N--7	3.371	.853	NA11	4.660	.359	AL13	6.620	12.660	CL
1.809	.092	MG12	2.361	.512	NA11	3.412	.364	NA11	4.673	.357	TI22	6.706	.021	C027
1.826	.699	CA20	2.360	16.206	S	3.414	1.518	FE26	4.691	.708	AL13	6.742	1.009	SI14
1.830	.014	C027	2.390	.095	K-19	3.414	.020	MG12	4.714	.434	TI22	6.760	18.942	TI
1.842	.497	TI22	2.398	.461	NA11	3.437	1.367	FE26	4.734	.980	AL13	6.877	.022	C027
1.853	.003	C027	2.415	1.361	NA11	3.452	.080	K-19	4.750	.698	CA20	6.978	2.176	CL17
1.880	.463	CA20	2.422	.072	K-19	3.466	1.207	AL13	4.810	1.680	FE26	6.985	.008	C027
1.883	.585	TI22	2.426	2.153	SI14	3.476	.823	TI22	4.870	4.177	S-16	6.999	.099	K-19
1.888	8.276	N--7	2.491	.988	S-16	3.505	.483	NA11	4.881	1.988	TI22	7.056	.005	C027
1.890	.026	MG12	2.518	3.624	NA11	3.531	2.888	N--7	4.903	.517	AL13	7.199	3.922	SI14
1.890	.557	NA11	2.519	2.843	N--7	3.539	43.591	SI	4.934	38.645	SI	7.214	.013	C027
1.891	3.594	S-16	2.546	.176	K-19	3.547	.206	K-19	4.945	63.499	C	7.279	4.657	FE26
1.929	.122	K-19	2.594	.453	NA11	3.554	.494	TI22	4.967	1.310	TI22	7.299	2.521	N--7
1.932	.292	NA11	2.612	.082	K-19	3.562	1.367	CL17	4.980	4.836	CL17	7.414	.362	N--7
1.943	23.815	CA	2.640	.049	K-19	3.586	.748	CA20	4.992	.082	K-19	7.414	10.786	CL
1.949	.491	NA11	2.660	.499	CA20	3.588	3.664	NA11	5.043	.081	K-19	7.491	.008	C027
1.951	27.055	CL	2.676	4.140	CL17	3.592	.795	AL13	5.047	1.146	S-16	7.632	27.525	FE
1.957	.104	K-19	2.716	.212	NA11	3.610	2.078	CA20	5.070	.056	K-19	7.646	22.413	FE
1.958	19.155	CL	2.722	1.448	FE26	3.644	.428	NA11	5.107	2.016	SI14	7.694	1.171	AL13
1.965	.258	NA11	2.753	2.124	S-16	3.651	.062	K-19	5.134	.458	AL13	7.724	5.644	AL13
1.984	.404	NA11	2.754	21.669	NA	3.661	2.525	SI14	5.174	.120	K-19	7.769	.220	K-19
2.001	3.266	CA20	2.757	.075	K-19	3.675	4.679	N--7	5.182	.006	C027	7.790	8.394	CL17
2.009	2.450	CA20	2.760	1.057	SI14	3.684	30.138	C	5.267	7.661	N--7	7.800	1.424	S-16
2.018	.056	K-19	2.806	.092	K-19	3.693	.110	K-19	5.270	.003	C027	8.154	.014	MG
2.027	4.193	NA11	2.809	.944	NA11	3.723	1.029	S-16	5.297	5.602	N--7	8.309	1.272	N
2.033	.004	C027	2.811	1.084	CA20	3.730	.049	K-19	5.380	.353	K-19	8.472	1.265	SI
2.041	.129	K-19	2.822	.724	AL13	3.734	.564	TI22	5.420	21.514	S	8.579	2.912	CL
2.046	.126	K-19	2.826	.130	MG12	3.749	.004	C027	5.510	.120	K-19	8.641	.968	S
2.048	.515	TI22	2.840	.072	K-19	3.760	.862	CA20	5.515	.789	CA20	9.298	3.897	FE
2.057	.307	NA11	2.863	2.487	NA11	3.824	2.254	CL17	5.517	1.899	CL17	10.828	4.523	N

SAMPLE 17097, COLORADO
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.516	.012	C027	2.078	.324	CA20	2.943	.394	TI22	3.955	2.142	SI14	5.715	2.986	CL17
1.524	.491	K-19	2.087	.279	TI22	2.960	3.349	AL13	3.982	.490	NA11	5.730	.360	K-19
1.564	.434	K-19	2.093	18.744	SI	2.975	.737	CL17	4.003	.273	K-19	5.743	.009	C027
1.586	2.297	TI22	2.094	.371	CA20	2.982	.084	NA11	4.029	.007	C027	5.752	.976	K-19
1.598	3.664	S-16	2.108	.641	AL13	2.998	.743	CL17	4.062	.260	K-19	5.901	.711	CA20
1.601	2.799	CL17	2.118	.387	CA20	3.026	.091	NA11	4.134	2.316	AL13	5.921	4.553	FE26
1.613	3.213	FE26	2.122	.234	CA20	3.027	.931	TI22	4.136	.580	K-19	5.926	.008	C027
1.618	1.759	K-19	2.124	.061	NA11	3.034	3.164	AL13	4.188	.038	NA11	5.976	.029	C027
1.623	1.751	AL13	2.130	.586	CA20	3.054	.091	MG12	4.201	.376	K-19	6.018	4.437	FE26
1.633	.039	MG12	2.138	.034	NA11	3.056	.451	K-19	4.206	.005	C027	6.102	.973	AL13
1.634	.196	NA11	2.140	.799	AL13	3.062	2.411	CL17	4.219	2.208	FE26	6.111	10.200	CL

Table 8 (cont'd)

1.649	.327 CA20	2.149	.264 CA20	3.098	.219 NA11	4.260	2.213 AL13	6.316	.799 AL13
1.672	.447 CA20	2.153	.258 K-19	3.116	.918 CL17	4.361	.758 K-19	6.321	4.564 N--7
1.679	1.656 N--7	2.157	1.000 N--7	3.214	.035 NA11	4.387	.280 K-19	6.380	8.833 SI14
1.690	.055 MG12	2.175	.726 N--7	3.221	6.022 S-16	4.407	.719 FE26	6.395	.583 NA11
1.691	.329 CA20	2.180	.568 0--E	3.263	.498 K-19	4.419	2.499 CA20	6.418	9.785 TI22
1.703	.420 K-19	2.198	.058 NA11	3.268	.654 FE26	4.431	.978 S-16	6.420	6.506 CA20
1.704	.320 CA20	2.223	5464.216 H	3.271	.568 0--8	4.470	.387 B--5	6.486	.028 C027
1.724	.486 CA20	2.251	.026 NA11	3.280	.026 NA11	4.508	4.333 N--7	6.556	1.741 TI22
1.725	4.410 FE26	2.278	.274 TI22	3.301	.062 MG12	4.639	.461 S-16	6.620	6.464 CL17
1.749	.055 NA11	2.284	.902 AL13	3.370	1.170 S-16	4.660	.696 AL13	6.706	.032 C027
1.762	2.122 TI22	2.291	.765 K-19	3.371	.091 NA11	4.673	.274 TI22	6.740	.048 B--5
1.779	47.932 AL	2.295	.417 CA20	3.412	.039 NA11	4.691	1.370 AL13	6.742	1.288 SI14
1.792	.958 TI22	2.357	1.220 N--7	3.414	.824 FE26	4.714	.333 TI22	6.760	14.507 TI
1.795	.318 K-19	2.361	.055 NA11	3.414	.045 MG12	4.730	.145 B--5	6.877	.034 C027
1.801	.005 C027	2.380	9.894 S-16	3.437	.741 FE26	4.734	1.897 AL13	6.978	1.112 CL17
1.809	.211 MG12	2.390	.436 K-19	3.452	.369 K-19	4.750	.459 CA20	6.980	.087 B--5
1.826	.357 CA20	2.398	.049 NA11	3.466	2.338 AL13	4.810	.912 FE26	6.985	.012 C027
1.830	.022 C027	2.415	.146 NA11	3.476	.631 TI22	4.870	2.550 S-16	6.999	.456 K-19
1.842	.381 TI22	2.422	.331 K-19	3.505	.052 NA11	4.881	1.521 TI22	7.056	.007 C027
1.853	.005 C027	2.426	2.751 SI14	3.531	2.626 N--7	4.903	1.000 AL13	7.199	5.011 SI14
1.880	.236 CA20	2.491	.603 S-16	3.539	55.699 SI	4.934	49.379 SI	7.214	.020 C027
1.883	.448 TI22	2.518	.389 NA11	3.547	.947 K-19	4.945	44.621 C	7.279	2.526 FE26
1.888	7.524 N--7	2.519	2.585 N--7	3.554	.378 TI22	4.967	1.003 TI22	7.299	2.291 N--7
1.890	.061 MG12	2.546	.809 K-19	3.562	.698 CL17	4.980	2.469 CL17	7.414	.329 N--7
1.890	.060 NA11	2.594	.049 NA11	3.586	.382 CA20	4.992	.378 K-19	7.414	5.507 CL17
1.891	2.194 S-16	2.612	.378 K-19	3.588	.393 NA11	5.043	.371 K-19	7.491	.013 C027
1.929	.563 K-19	2.640	.225 K-19	3.592	1.538 AL13	5.047	.699 S-16	7.632	14.932 FE
1.932	.031 NA11	2.660	.255 CA20	3.610	1.061 CA20	5.070	.258 K-19	7.646	12.159 FE
1.943	12.160 CA	2.676	2.114 CL17	3.644	.046 NA11	5.107	2.576 SI14	7.694	2.267 AL13
1.949	.053 NA11	2.716	.023 NA11	3.651	.287 K-19	5.134	.886 AL13	7.724	10.927 AL
1.951	13.814 CL	2.722	.785 FE26	3.661	3.227 SI14	5.174	.554 K-19	7.769	1.009 K-19
1.957	.478 K-19	2.753	1.297 S-16	3.675	4.254 N--7	5.182	.009 C027	7.790	4.286 CL17
1.958	9.780 CL17	2.754	2.323 NA11	3.684	21.179 C	5.267	6.965 N--7	7.800	.870 S-16
1.965	.028 NA11	2.757	.342 K-19	3.693	.507 K-19	5.270	.005 C027	8.154	.033 MG
1.984	.043 NA11	2.780	1.351 SI14	3.723	.628 S-16	5.297	5.093 N--7	8.309	1.157 N
2.001	1.668 CA20	2.806	.422 K-19	3.730	.227 K-19	5.380	1.623 K-19	8.472	1.617 SI
2.009	1.251 CA20	2.809	.101 NA11	3.734	.432 TI22	5.420	13.134 S	8.579	1.487 CL
2.018	.258 K-19	2.811	.554 CA20	3.749	.006 C027	5.510	.551 K-19	8.641	.591 S
2.027	.450 NA11	2.822	1.403 AL13	3.760	.440 CA20	5.515	.403 CA20	8.910	.029 B
2.033	.006 C027	2.828	.299 MG12	3.824	1.151 CL17	5.517	.970 CL17	9.298	2.114 FE
2.041	.594 K-19	2.840	.331 K-19	3.831	.047 MG12	5.532	4.876 N--7	10.828	4.111 N
2.046	.580 K-19	2.863	.267 NA11	3.850	.777 AL13	5.560	2.481 N--7	11.430	.004 B
2.048	.394 TI22	2.864	4.376 CL17	3.876	.696 AL13	5.603	.005 C027		
2.057	.033 NA11	2.865	.396 S-16	3.879	.141 NA11	5.617	.136 NA11		
2.062	1.025 N--7	2.903	.066 NA11	3.916	.342 MG12	5.660	.027 C027		
2.073	2.281 K-19	2.931	4.967 S-16	3.920	.467 TI22	5.696	1.032 K-19		

Table 8 (cont'd)

HENRY COUNTY, MA., N2.17307														
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.515	.324	C27	2.087	.455	TI22	2.865	5.696	S-16	3.879	.444	NA11	5.660	.718	C27
1.524	2.152	K-19	2.093	42.025	SI	2.903	.209	NA11	3.916	.464	MG12	5.696	4.519	K-19
1.544	1.899	K-19	2.094	.847	CA20	2.931	71.418	S	3.920	.761	TI22	5.715	10.951	CL
1.554	3.743	TI22	2.108	1.021	AL13	2.943	.643	TI22	3.955	4.802	SI14	5.730	1.578	K-19
1.598	52.655	S	2.118	.885	CA20	2.960	5.330	AL13	3.982	1.539	NA11	5.743	.229	C27
1.601	10.254	CL	2.122	.535	CA20	2.975	2.702	CL17	4.003	1.198	K-19	5.752	4.275	K-19
1.613	35.458	FE	2.124	.192	NA11	2.982	.262	NA11	4.029	.185	C27	5.824	2.358	CD48
1.618	7.703	K-19	2.130	1.340	CA20	2.998	2.726	CL17	4.062	1.139	K-19	5.901	1.626	CA20
1.623	2.786	AL13	2.136	.107	NA11	3.000	1.633	CD48	4.134	3.686	AL13	5.921	50.247	FE
1.633	.053	MG12	2.140	1.272	AL13	3.026	.286	NA11	4.136	2.542	K-19	5.926	.200	C27
1.634	.616	NA11	2.149	.604	CA20	3.027	1.517	TI22	4.188	.120	NA11	5.976	.750	C27
1.649	.747	CA20	2.153	1.130	K-19	3.034	5.036	AL13	4.201	1.646	K-19	6.018	48.974	FE
1.661	1.664	CD48	2.157	.653	N--7	3.054	.123	MG12	4.209	.128	C27	6.102	1.549	AL13
1.672	1.022	CA20	2.175	.474	N--7	3.056	1.977	K-19	4.219	24.366	FE	6.111	37.404	CL
1.679	1.081	N--7	2.180	.362	Z--8	3.062	8.841	CL17	4.260	3.522	AL13	6.316	1.272	AL13
1.690	.074	MG12	2.198	.181	NA11	3.098	.690	NA11	4.361	3.321	K-19	6.321	2.980	N--7
1.691	.752	CA20	2.223	5654.604	H	3.109	1.143	CD48	4.387	1.227	K-19	6.330	10.804	SI
1.703	1.841	K-19	2.251	.082	NA11	3.116	3.366	CL17	4.407	7.940	FE26	6.395	1.832	NA11
1.704	.731	CA20	2.278	.446	TI22	3.214	.109	NA11	4.419	5.715	CA20	6.418	15.947	TI
1.724	1.112	CA20	2.284	1.436	AL13	3.221	86.591	S	4.431	14.061	S	6.420	14.879	CA
1.725	48.671	FE	2.291	3.350	K-19	3.263	2.181	K-19	4.470	.223	B--5	6.486	.727	C27
1.749	.173	NA11	2.295	.953	CA20	3.268	7.213	FE26	4.508	2.630	N--7	6.556	2.836	TI22
1.762	3.459	TI22	2.357	.796	N--7	3.271	.362	Z--8	4.639	6.630	S-16	6.620	23.703	CL
1.779	76.292	AL	2.361	.173	NA11	3.280	.083	NA11	4.660	1.108	AL13	6.706	.834	C27
1.792	1.561	TI22	2.380	142.257	S	3.301	.085	MG12	4.673	.446	TI22	6.740	.028	B--5
1.795	1.393	K-19	2.390	1.909	K-19	3.370	16.820	S	4.691	2.131	AL13	6.742	2.857	SI14
1.801	.132	C27	2.398	1.112	CD48	3.371	.287	NA11	4.714	.542	TI22	6.760	23.643	TI
1.809	.286	MG12	2.398	.155	NA11	3.412	.123	NA11	4.730	.084	B--5	6.877	.896	C27
1.826	.816	CA20	2.415	.459	NA11	3.414	.062	MG12	4.734	3.020	AL13	6.976	4.077	CL17
1.830	.570	C27	2.422	1.451	K-19	3.414	9.092	FE26	4.750	1.049	CA20	6.980	.050	B--5
1.842	.621	TI22	2.426	6.167	SI14	3.437	8.183	FE26	4.810	10.061	FE	6.985	.326	C27
1.853	.140	C27	2.456	4.613	CD48	3.452	1.617	K-19	4.870	36.666	S	6.999	1.996	K-19
1.880	.540	CA20	2.491	8.677	S-16	3.466	3.721	AL13	4.881	2.479	TI22	7.056	.191	C27
1.883	.730	TI22	2.518	1.221	NA11	3.476	1.028	TI22	4.903	1.592	AL13	7.196	11.236	SI
1.888	4.913	N--7	2.519	1.688	N--7	3.505	.163	NA11	4.934	110.712	SI	7.214	.527	C27
1.890	.198	NA11	2.546	3.545	K-19	3.531	1.715	N--7	4.945	44.462	C	7.279	27.881	FE
1.890	.063	MG12	2.550	1.633	CD48	3.539	124.883	SI	4.967	1.635	TI22	7.299	1.496	N--7
1.891	31.548	S	2.594	.153	NA11	3.547	4.149	K-19	4.980	9.055	CL17	7.414	20.195	CL
1.929	2.464	K-19	2.612	1.656	K-19	3.554	.617	TI22	4.992	1.656	K-19	7.414	.215	N--7
1.937	.096	NA11	2.640	.984	K-19	3.562	2.560	CL17	5.043	1.626	K-19	7.491	.336	C27
1.943	27.808	CA	2.660	.583	CA20	3.586	.074	CA20	5.047	10.055	S	7.632	164.802	FE
1.949	.165	NA11	2.660	3.174	CD48	3.588	1.235	NA11	5.070	1.130	K-19	7.646	134.193	FE
1.951	50.654	CL	2.676	7.751	CL17	3.592	2.449	AL13	5.187	5.775	SI14	7.694	3.608	AL13
1.957	2.094	K-19	2.701	1.245	CD48	3.610	2.426	CA20	5.134	1.410	AL13	7.724	17.392	AL
1.958	35.863	CL	2.716	.071	NA11	3.644	.144	NA11	5.174	2.425	K-19	7.769	4.421	K-19

Table 8 (cont'd)

1.965	.087	NA11	2.722	6.667	FE26	3.651	1.256	K-19	5.182	.250	C027	7.790	15.715	CL
1.984	.136	NA11	2.753	18.644	S	3.661	7.234	SI14	5.267	4.548	N--7	7.600	12.504	S
2.001	3.814	CA20	2.754	7.303	NA11	3.675	2.778	N--7	5.270	.122	C027	6.154	.045	MG
2.009	2.860	CA20	2.757	1.500	K-19	3.684	21.103	C	5.297	3.326	N--7	8.309	.755	V
2.018	1.170	K-19	2.767	1.470	CD48	3.693	2.220	K-19	5.360	7.109	K-19	6.472	3.625	SI
2.027	1.413	NA11	2.750	3.029	SI14	3.723	9.033	S-16	5.420	188.846	S	8.579	5.452	CL
2.033	.156	C027	2.806	1.850	K-19	3.730	.993	K-19	5.431	1.102	CD46	8.641	8.499	S
2.041	2.600	K-19	2.809	.318	NA11	3.734	.704	TI22	5.510	2.415	K-19	8.910	.017	B
2.046	2.542	K-19	2.811	1.266	CA20	3.749	.154	C027	5.515	.922	CA20	9.298	23.335	FE
2.048	.643	TI22	2.822	2.232	AL13	3.760	1.006	CA20	5.517	3.555	CL17	10.828	2.685	V
2.057	.103	NA11	2.828	.406	MG12	3.824	4.219	CL17	5.532	3.184	N--7	11.430	.002	B
2.062	.669	N--7	2.840	1.451	K-19	3.831	.064	MG12	5.560	1.620	N--7			
2.073	9.992	K-19	2.863	.638	NA11	3.850	1.237	AL13	5.603	.124	C027			
2.078	.742	CA20	2.864	16.047	CL	3.876	1.108	AL13	5.617	.427	NA11			

COSHOCTON COUNTY, OH., 17092
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED

1.516	.032	C027	2.078	.465	CA20	2.943	.403	TI22	3.955	1.187	SI14	5.715	56.469	CL
1.524	.502	K-19	2.087	.285	TI22	2.960	2.219	AL13	3.982	1.090	NA11	5.730	.368	K-19
1.564	.443	K-19	2.093	10.387	SI	2.975	13.934	CL	4.003	.280	K-19	5.743	.022	C027
1.586	2.347	TI22	2.094	.532	CA20	2.982	.186	NA11	4.029	.018	C027	5.752	.998	K-19
1.598	26.828	S	2.108	.425	AL13	2.998	14.056	CL	4.062	.266	K-19	5.901	1.020	CA20
1.601	52.925	CL	2.118	.555	CA20	3.026	.203	NA11	4.134	1.535	AL13	5.921	31.752	FE
1.613	22.406	FE	2.122	.336	CA20	3.027	.952	TI22	4.136	.593	K-19	5.926	.019	C027
1.618	1.798	K-19	2.124	.136	NA11	3.034	2.097	AL13	4.188	.085	NA11	5.976	.073	C027
1.623	1.160	AL13	2.130	.840	CA20	3.054	.021	MG12	4.201	.384	K-19	6.018	30.947	FE
1.633	.009	MG12	2.138	.076	NA11	3.056	.461	K-19	4.209	.012	C027	6.102	.645	AL13
1.634	.436	NA11	2.140	.530	AL13	3.062	45.591	CL	4.219	15.397	FE	6.111	192.875	CL
1.649	.468	CA20	2.149	.379	CA20	3.098	.489	NA11	4.260	1.466	AL13	6.316	.530	AL13
1.672	.641	CA20	2.153	.264	K-19	3.116	17.356	CL	4.361	.775	K-19	6.321	3.355	N--7
1.679	1.217	N--7	2.157	.735	N--7	3.214	.077	NA11	4.387	.286	K-19	6.380	4.895	SI14
1.690	.012	MG12	2.175	.534	N--7	3.221	44.094	S	4.407	5.017	FE26	6.395	1.298	NA11
1.691	.472	CA20	2.180	.410	N--8	3.263	.509	K-19	4.419	3.584	CA20	6.418	10.001	TI
1.703	.430	K-19	2.198	.128	NA11	3.268	4.558	FE26	4.431	7.160	S-16	6.420	9.331	CA20
1.704	.458	CA20	2.223	5338.491	H	3.271	.410	N--8	4.470	.234	B--5	6.486	.071	C027
1.724	.698	CA20	2.251	.058	NA11	3.280	.059	NA11	4.508	3.185	N--7	6.556	1.780	TI22
1.725	30.756	FE	2.278	.280	TI22	3.301	.014	MG12	4.639	3.376	S-16	6.620	122.228	CL
1.749	.123	NA11	2.284	.598	AL13	3.370	8.565	S-16	4.660	.461	AL13	6.706	.081	C027
1.762	2.169	TI22	2.291	.782	K-19	3.371	.204	NA11	4.673	.280	TI22	6.740	.029	B--5
1.779	31.763	AL	2.295	.598	CA20	3.412	.087	NA11	4.691	.908	AL13	6.742	.714	SI14
1.792	.979	TI22	2.357	.897	N--7	3.414	5.745	FE26	4.714	.340	TI22	6.760	14.828	TI
1.795	.325	K-19	2.361	.122	NA11	3.414	.010	MG12	4.730	.088	B--5	6.877	.087	C027
1.801	.013	C027	2.380	72.440	S	3.437	5.171	FE26	4.734	1.257	AL13	6.978	21.023	CL
1.809	.048	MG12	2.390	.445	K-19	3.452	.377	K-19	4.750	.658	CA20	6.980	.053	B--5
1.826	.512	CA20	2.398	.110	NA11	3.466	1.549	AL13	4.810	6.356	FE26	6.985	.032	C027
1.830	.055	C027	2.415	.325	NA11	3.476	.644	TI22	4.870	18.671	S	6.999	.466	K-19
1.842	.389	TI22	2.422	.339	K-19	3.505	.115	NA11	4.881	1.555	TI22	7.056	.019	C027
1.853	.014	C027	2.426	1.524	SI14	3.531	1.930	N--7	4.903	.663	AL13	7.199	2.777	SI14

Table 8 (cont'd)

1.880	.339	CA20	2.491	4.418	S-16	3.539	30.665	SI	4.934	27.363	SI	7.214	.051	C027
1.883	.458	TI22	2.518	.865	NA11	3.547	.968	K-19	4.945	43.520	C	7.279	17.619	FE
1.888	5.531	N--7	2.519	1.900	N--7	3.554	.387	TI22	4.967	1.026	TI22	7.299	1.684	N--7
1.890	.014	MG12	2.546	.827	K-19	3.562	13.201	CL	4.980	46.691	CL	7.414	.242	N--7
1.890	.133	NA11	2.594	.108	NA11	3.586	.548	CA20	4.992	.386	K-19	7.414	104.138	CL
1.891	16.065	S	2.612	.386	K-19	3.588	.875	NA11	5.043	.380	K-19	7.491	.033	C027
1.929	.575	K-19	2.640	.230	K-19	3.592	1.020	AL13	5.047	5.121	S-16	7.632	104.141	FE
1.932	.070	NA11	2.660	.365	CA20	3.610	1.521	CA20	5.070	.264	K-19	7.646	84.799	FE
1.943	17.440	CA	2.676	39.968	CL	3.644	.102	NA11	5.107	1.427	SI14	7.694	1.502	AL13
1.949	.117	NA11	2.716	.051	NA11	3.651	.293	K-19	5.134	.587	AL13	7.724	7.241	AL13
1.951	261.201	CL	2.722	5.477	FE26	3.661	1.788	SI14	5.174	.566	K-19	7.769	1.032	K-19
1.957	.489	K-19	2.753	9.494	S-16	3.675	3.127	N--7	5.182	.024	C027	7.790	81.037	CL
1.958	184.930	CL	2.754	5.374	NA11	3.684	20.656	C	5.267	5.120	N--7	7.800	6.367	S-16
1.965	.062	NA11	2.757	.350	K-19	3.693	.518	K-19	5.270	.012	C027	8.154	.008	MG
1.984	.097	NA11	2.780	.749	SI14	3.723	4.600	S-16	5.297	3.743	N--7	8.309	.850	N
2.001	2.392	CA20	2.806	.432	K-19	3.730	.232	K-19	5.380	1.659	K-19	8.472	.896	SI
2.009	1.794	CA20	2.809	.225	NA11	3.734	.442	TI22	5.420	96.163	S	8.579	28.112	CL
2.018	.264	K-19	2.811	.794	CA20	3.749	.015	C027	5.510	.564	K-19	8.641	4.328	S
2.027	1.001	NA11	2.822	.929	AL13	3.760	.631	CA20	5.515	.578	CA20	8.910	.018	B
2.033	.015	C027	2.828	.368	MG12	3.824	21.757	CL	5.517	18.334	CL	9.298	14.746	FE
2.041	.607	K-19	2.840	.339	K-19	3.831	.011	MG12	5.532	3.584	N--7	10.828	3.022	N
2.046	.593	K-19	2.863	.594	NA11	3.850	.515	AL13	5.560	1.823	N--7	11.430	.002	B
2.048	.403	TI22	2.864	82.748	CL	3.876	.461	AL13	5.603	.012	C027			
2.057	.073	NA11	2.865	2.900	S-16	3.879	.315	NA11	5.617	.303	NA11			
2.062	.754	N--7	2.903	.148	NA11	3.916	.078	MG12	5.660	.070	C027			
2.073	2.332	K-19	2.931	36.367	S	3.920	.477	TI22	5.696	1.054	K-19			

SAMPLE 173J9, ARIZONA														
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.516	.061	C027	2.078	1.816	CA20	2.943	.462	TI22	3.955	1.134	SI14	5.715	4.198	CL17
1.524	.115	K-19	2.087	.327	TI22	2.960	1.888	AL13	3.982	2.188	NA11	5.730	.084	K-19
1.564	.102	K-19	2.093	9.920	SI14	2.975	1.036	CL17	4.003	.064	K-19	5.743	.043	C027
1.586	2.690	TI22	2.094	2.075	CA20	2.982	.373	NA11	4.029	.035	C027	5.752	.229	K-19
1.598	3.933	S-16	2.108	.362	AL13	2.998	1.045	CL17	4.062	.061	K-19	5.901	3.982	CA20
1.601	3.935	CL17	2.118	2.166	CA20	3.026	.407	NA11	4.134	1.306	AL13	5.921	10.353	FE
1.613	7.306	FE26	2.122	1.310	CA20	3.027	1.091	TI22	4.136	.136	K-19	5.926	.037	C027
1.618	.412	K-19	2.124	.273	NA11	3.034	1.784	AL13	4.188	.170	NA11	5.976	.140	C027
1.623	.987	AL13	2.130	3.262	CA20	3.054	.099	MG12	4.201	.088	K-19	6.018	10.090	FE
1.633	.042	MG12	2.138	.152	NA11	3.056	.106	K-19	4.209	.024	C027	6.102	.549	AL13
1.634	.875	NA11	2.140	.451	AL13	3.062	3.389	CL17	4.219	5.020	FE26	6.111	14.339	CL
1.649	1.829	CA20	2.149	1.479	CA20	3.098	.981	NA11	4.260	1.248	AL13	6.316	.451	AL13
1.672	2.503	CA20	2.153	.060	K-19	3.116	1.290	CL17	4.361	.178	K-19	6.321	4.438	N--7
1.679	1.610	N--7	2.157	.973	N--7	3.214	.155	NA11	4.387	.066	K-19	6.380	4.675	SI14
1.690	.060	MG12	2.175	.706	N--7	3.221	6.465	S-16	4.407	1.636	FE26	6.395	2.605	NA11
1.691	1.842	CA20	2.180	.871	0--8	3.263	.117	K-19	4.419	13.996	CA	6.418	11.463	TI
1.703	.098	K-19	2.198	.258	NA11	3.268	1.486	FE26	4.431	1.050	S-16	6.420	36.435	CA
1.704	1.790	CA20	2.223	8149.079	H	3.271	.871	0--8	4.470	.066	B--5	6.486	.136	C027

Table 8 (cont'd)

1.724	2.724	CA20	2.251	.117	NA11	3.280	.118	NA11	4.508	4.214	N--7	6.556	2.040	TI22
1.725	10.028	FE	2.278	.321	TI22	3.301	.068	MG12	4.639	.495	S-16	6.620	9.087	CL17
1.749	.246	NA11	2.284	.509	AL13	3.370	1.256	S-16	4.660	.392	AL13	6.706	.156	C027
1.762	2.486	TI22	2.291	.179	K-19	3.371	.409	NA11	4.673	.321	TI22	6.740	.008	B--5
1.779	27.026	AL	2.295	2.335	CA20	3.412	.174	NA11	4.691	.772	AL13	6.742	.682	SI14
1.792	1.122	TI22	2.357	1.186	N--7	3.414	1.673	FE26	4.714	.390	TI22	6.760	16.994	TI
1.795	.074	K-19	2.361	.245	NA11	3.414	.050	MG12	4.730	.025	B--5	6.877	.168	C027
1.801	.025	C027	2.380	10.620	S	3.437	1.686	FE26	4.734	1.070	AL13	6.978	1.563	CL17
1.809	.230	MG12	2.390	.102	K-19	3.452	.066	K-19	4.750	2.568	CA20	6.980	.015	B--5
1.826	1.998	CA20	2.398	.221	NA11	3.466	1.318	AL13	4.810	2.073	FE26	6.985	.061	C027
1.830	.107	C027	2.415	.652	NA11	3.476	.739	TI22	4.870	2.737	S-16	6.999	.107	K-19
1.842	.446	TI22	2.422	.078	K-19	3.505	.231	NA11	4.881	1.782	TI22	7.056	.036	C027
1.853	.026	C027	2.426	1.456	SI14	3.531	2.553	N--7	4.903	.564	AL13	7.199	2.652	SI14
1.880	1.323	CA20	2.491	.648	S-16	3.539	29.479	SI	4.934	26.134	SI	7.214	.099	C027
1.883	.525	TI22	2.516	1.736	NA11	3.547	.222	K-19	4.945	65.725	C	7.279	5.745	FE26
1.888	7.317	N--7	2.519	2.514	N--7	3.554	.443	TI22	4.967	1.175	TI22	7.299	2.228	N--7
1.890	.066	MG12	2.546	.190	K-19	3.562	.981	CL17	4.980	3.471	CL17	7.414	.320	N--7
1.890	.267	NA11	2.594	.217	NA11	3.586	2.140	CA20	4.992	.089	K-19	7.414	7.742	CL17
1.891	2.355	S-16	2.612	.089	K-19	3.588	1.755	NA11	5.043	.087	K-19	7.491	.063	C027
1.929	.132	K-19	2.640	.053	K-19	3.592	.867	AL13	5.047	.751	S-16	7.632	33.955	FE
1.932	.140	NA11	2.660	1.427	CA20	3.610	5.941	CA20	5.070	.060	K-19	7.646	27.649	FE
1.943	68.097	CA	2.676	2.971	CL17	3.644	.205	NA11	5.107	1.363	SI14	7.694	1.278	AL13
1.949	.235	NA11	2.716	.101	NA11	3.651	.067	K-19	5.134	.500	AL13	7.724	6.161	AL13
1.951	19.418	CL	2.722	1.786	FE26	3.661	1.708	SI14	5.174	.130	K-19	7.769	.236	K-19
1.957	.112	K-19	2.753	1.392	S-16	3.675	4.137	N--7	5.182	.047	C027	7.790	6.025	CL17
1.958	13.748	CL	2.754	10.381	NA	3.684	31.195	C	5.267	6.773	N--7	7.800	.933	S-16
1.965	.124	NA11	2.757	.080	K-19	3.693	.119	K-19	5.270	.024	C027	8.154	.036	MG
1.984	.194	NA11	2.780	.715	SI14	3.723	.674	S-16	5.297	4.952	N--7	8.309	1.125	N
2.001	9.339	CA20	2.806	.099	K-19	3.730	.053	K-19	5.380	.380	K-19	8.472	.856	SI
2.009	7.004	CA20	2.809	.452	NA11	3.734	.506	TI22	5.420	14.098	S	8.579	2.090	CL
2.018	.060	K-19	2.811	3.100	CA20	3.749	.029	C027	5.510	.129	K-19	8.641	.634	S
2.027	2.009	NA11	2.822	.791	AL13	3.760	2.464	CA20	5.515	2.257	CA20	8.910	.005	B
2.033	.029	C027	2.828	.327	MG12	3.824	1.617	CL17	5.517	1.363	CL17	9.298	4.808	FE
2.041	.139	K-19	2.840	.078	K-19	3.831	.052	MG12	5.532	4.742	N--7	10.828	3.998	N
2.046	.136	K-19	2.863	1.191	NA11	3.850	.438	AL13	5.560	2.412	N--7	11.430	.001	B
2.048	.462	TI22	2.864	6.152	CL17	3.876	.392	AL13	5.603	.023	C027			
2.057	.147	NA11	2.865	.425	S-16	3.879	.632	NA11	5.617	.607	NA11			
2.062	.997	N--7	2.903	.297	NA11	3.916	.374	MG12	5.660	.134	C027			
2.073	.534	K-19	2.931	5.332	S-16	3.920	.547	TI22	5.696	.242	K-19			

Table 8 (cont'd)

BELMONT COUNTY, OH., 17095														
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.516	.064	CE27	2.076	.202	CA20	2.943	.931	TI22	3.955	3.740	SI14	5.715	7.694	CL17
1.524	1.424	K-19	2.087	.659	TI22	2.960	5.831	AL13	3.982	.518	NA11	5.730	1.044	K-19
1.564	1.257	K-19	2.093	32.727	SI	2.975	1.899	CL17	4.003	.793	K-19	5.743	.045	CE27
1.586	5.424	TI22	2.094	.231	CA20	2.982	.088	NA11	4.029	.036	CE27	5.752	2.829	K-19
1.598	36.043	S	2.108	1.117	AL13	2.998	1.915	CL17	4.062	.754	K-19	5.901	.443	CA20
1.601	7.211	CL17	2.118	.241	CA20	3.026	.096	NA11	4.134	4.032	AL13	5.921	42.260	FE
1.613	29.822	FE	2.122	.146	CA20	3.027	2.199	TI22	4.136	1.682	K-19	5.926	.039	CE27
1.618	5.098	K-19	2.124	.065	NA11	3.034	5.509	AL13	4.188	.040	NA11	5.976	.147	CE27
1.623	3.048	AL13	2.130	.365	CA20	3.054	.091	MG12	4.201	1.089	K-19	6.018	41.190	FE
1.633	.039	MG12	2.138	.036	NA11	3.056	1.308	K-19	4.209	.025	CE27	6.102	1.694	AL13
1.634	.207	NA11	2.140	1.391	AL13	3.062	6.212	CL17	4.219	20.493	FE	6.111	26.280	CL
1.649	.204	CA20	2.149	.165	CA20	3.098	.232	NA11	4.260	3.852	AL13	6.316	1.391	AL13
1.672	.279	CA20	2.153	.748	K-19	3.116	2.365	CL17	4.361	2.198	K-19	6.321	3.795	N--7
1.679	1.373	N--7	2.157	.830	N--7	3.214	.037	NA11	4.387	.812	K-19	6.380	15.422	SI
1.690	.055	MG12	2.175	.802	N--7	3.221	59.240	S	4.407	6.678	FE26	6.395	.617	NA11
1.691	.205	CA20	2.180	.472	W--8	3.263	1.444	K-19	4.419	1.558	CA20	6.418	23.109	TI
1.703	1.218	K-19	2.198	.061	NA11	3.268	6.066	FE26	4.431	9.620	S-16	6.420	4.055	CA20
1.704	.199	CA20	2.223	6580.444	H	3.271	.472	W--8	4.470	.160	B--5	6.486	.143	CE27
1.724	.303	CA20	2.251	.028	NA11	3.280	.028	NA11	4.508	3.594	N--7	6.556	4.112	TI22
1.725	40.935	FE	2.278	.646	TI22	3.301	.063	MG12	4.639	4.536	S-16	6.620	16.654	CL
1.749	.058	NA11	2.284	1.571	AL13	3.370	11.507	S	4.660	1.212	AL13	6.706	.164	CE27
1.762	5.012	TI22	2.291	2.217	K-19	3.371	.097	NA11	4.673	.646	TI22	6.740	.020	B--5
1.779	83.456	AL	2.295	.260	CA20	3.412	.041	NA11	4.691	2.365	AL13	6.742	2.249	SI14
1.792	2.262	TI22	2.357	1.012	N--7	3.414	7.647	FE26	4.714	.786	TI22	6.760	34.261	TI
1.795	.922	K-19	2.361	.058	NA11	3.414	.046	MG12	4.730	.060	B--5	6.877	.176	CE27
1.801	.026	CE27	2.380	97.323	S	3.437	6.882	FE26	4.734	3.303	AL13	6.978	2.864	CL17
1.809	.211	MG12	2.390	1.263	K-19	3.452	1.070	K-19	4.750	.286	CA20	6.980	.036	B--5
1.826	.222	CA20	2.398	.052	NA11	3.466	4.070	AL13	4.810	8.462	FE26	6.985	.064	CE27
1.830	.112	CE27	2.415	.154	NA11	3.476	1.489	TI22	4.870	25.084	S	6.999	1.321	K-19
1.842	.900	TI22	2.422	.960	K-19	3.505	.055	NA11	4.881	3.593	TI22	7.056	.037	CE27
1.853	.027	CE27	2.426	4.803	SI14	3.531	2.178	N--7	4.903	1.742	AL13	7.199	8.750	SI14
1.880	.147	CA20	2.491	5.936	S-16	3.539	97.251	SI	4.934	86.216	SI	7.214	.103	CE27
1.883	1.058	TI22	2.518	.411	NA11	3.547	2.745	K-19	4.945	53.331	C	7.279	23.450	FE
1.888	6.240	N--7	2.519	2.144	N--7	3.554	.893	TI22	4.967	2.370	TI22	7.299	1.900	N--7
1.890	.061	MG12	2.546	2.346	K-19	3.562	1.799	CL17	4.980	6.362	CL17	7.414	.273	N--7
1.890	.063	NA11	2.594	.051	NA11	3.586	.238	CA20	4.992	1.096	K-19	7.414	14.189	CL
1.891	21.583	S	2.612	1.096	K-19	3.588	.416	NA11	5.043	1.076	K-19	7.491	.066	CE27
1.929	1.630	K-19	2.640	.651	K-19	3.592	2.679	AL13	5.047	6.880	S-16	7.632	138.608	FE
1.932	.033	NA11	2.660	.159	CA20	3.610	.661	CA20	5.070	.748	K-19	7.646	112.864	FE
1.943	7.579	CA20	2.676	5.446	CL17	3.644	.049	NA11	5.107	4.497	SI14	7.694	3.947	AL13
1.949	.056	NA11	2.716	.024	NA11	3.651	.831	K-19	5.134	1.543	AL13	7.724	19.026	AL
1.951	35.589	CL	2.722	7.290	FE26	3.661	5.634	SI14	5.174	1.605	K-19	7.769	2.926	K-19
1.957	1.386	K-19	2.753	12.755	S	3.675	3.528	N--7	5.182	.049	CE27	7.790	11.042	CL
1.958	25.197	CL	2.754	2.459	NA11	3.684	25.313	C	5.267	5.776	N--7	7.800	8.554	S-16
1.965	.029	NA11	2.757	.992	K-19	3.693	1.469	K-19	5.270	.025	CE27	8.154	.033	MG
1.984	.046	NA11	2.780	2.359	SI14	3.723	6.180	S-16	5.297	4.224	N--7	8.309	.959	N

Table 8 (cont'd)

2.001	1.039 CA20	2.806	1.224 K-19	3.730	.657 K-19	5.380	4.704 K-19	8.472	2.823 SI
2.009	.780 CA20	2.809	.107 NA11	3.734	1.020 TI22	5.420	129.196 S	8.579	3.830 CL
2.018	.748 K-19	2.811	.345 CA20	3.749	.030 C027	5.510	1.598 K-19	8.641	5.814 S
2.027	.476 NA11	2.822	2.442 AL13	3.760	.274 CA20	5.515	.251 CA20	8.910	.012 B
2.033	.031 C027	2.828	.299 MG12	3.824	2.964 CL17	5.517	2.498 CL17	9.298	19.626 FE
2.041	1.721 K-19	2.840	.960 K-19	3.831	.047 MG12	5.532	4.044 N--7	10.828	3.410 N
2.046	1.682 K-19	2.863	.262 NA11	3.850	1.354 AL13	5.560	2.057 N--7	11.430	.002 B
2.048	.931 TI22	2.864	11.275 CL	3.876	1.212 AL13	5.603	.024 C027		
2.057	.035 NA11	2.865	3.897 S-16	3.879	.150 NA11	5.617	.144 NA11		
2.062	.850 N--7	2.903	.070 NA11	3.916	.342 MG12	5.660	.141 C027		
2.073	6.612 K-19	2.931	48.860 S	3.920	1.103 TI22	5.696	2.990 K-19		

MARION, PA., SAMPLE 17099

ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.516	.079 C027	2.076	.166 CA20	2.943	.668 TI22	3.955	2.064 SI14	5.715	15.168 CL
1.524	.780 K-19	2.087	.472 TI22	2.960	3.575 AL13	3.982	.622 NA11	5.730	.572 K-19
1.564	.688 K-19	2.093	18.065 SI	2.975	3.743 CL17	4.003	.434 K-19	5.743	.055 C027
1.586	3.888 TI22	2.094	.190 CA20	2.982	.106 NA11	4.029	.045 C027	5.752	1.549 K-19
1.598	25.715 S	2.108	.685 AL13	2.998	3.776 CL17	4.062	.413 K-19	5.901	.364 CA20
1.601	14.216 CL	2.116	.198 CA20	3.026	.116 NA11	4.134	2.472 AL13	5.921	34.174 FE
1.613	24.116 FE	2.122	.120 CA20	3.027	1.576 TI22	4.136	.921 K-19	5.926	.048 C027
1.618	2.791 K-19	2.124	.078 NA11	3.034	3.377 AL13	4.188	.048 NA11	5.976	.181 C027
1.623	1.869 AL13	2.130	.300 CA20	3.054	.051 MG12	4.201	.596 K-19	6.018	33.309 FE
1.633	.022 MG12	2.138	.043 NA11	3.056	.716 K-19	4.209	.031 C027	6.102	1.039 AL13
1.634	.249 NA11	2.140	.853 AL13	3.062	12.246 CL	4.219	16.572 FE	6.111	51.607 CL
1.649	.167 CA20	2.149	.135 CA20	3.098	.279 NA11	4.260	2.362 AL13	6.316	.853 AL13
1.672	.229 CA20	2.153	.409 K-19	3.116	4.662 CL17	4.361	1.203 K-19	6.321	3.771 N--7
1.679	1.366 N--7	2.157	.827 N--7	3.214	.044 NA11	4.387	.445 K-19	6.380	8.513 SI14
1.690	.031 MG12	2.175	.600 N--7	3.221	42.265 S	4.407	5.400 FE26	6.395	.740 NA11
1.691	.168 CA20	2.180	.789 N--8	3.263	.790 K-19	4.419	1.280 CA20	6.418	16.566 TI
1.703	.667 K-19	2.198	.073 NA11	3.266	4.906 FE26	4.431	6.663 S-16	6.420	3.331 CA20
1.704	.164 CA20	2.223	6981.831 H	3.271	.789 N--8	4.470	.133 N--5	6.486	.176 C027
1.724	.249 CA20	2.251	.033 NA11	3.280	.033 NA11	4.508	3.580 N--7	6.556	2.948 TI22
1.725	33.103 FE	2.278	.463 TI22	3.301	.035 MG12	4.639	3.236 S-16	6.620	32.831 CL
1.749	.070 NA11	2.284	.963 AL13	3.370	8.210 S-16	4.660	.743 AL13	6.706	.202 C027
1.762	3.593 TI22	2.291	1.214 K-19	3.371	.116 NA11	4.673	.463 TI22	6.740	.017 N--5
1.779	51.164 AL	2.295	.213 CA20	3.412	.050 NA11	4.691	1.462 AL13	6.742	1.241 SI14
1.792	1.622 TI22	2.357	1.006 N--7	3.414	6.184 FE26	4.714	.563 TI22	6.760	24.561 TI
1.795	.505 K-19	2.361	.070 NA11	3.414	.026 MG12	4.730	.050 N--5	6.877	.217 C027
1.801	.032 C027	2.380	69.435 S	3.437	5.565 FE26	4.734	2.025 AL13	6.978	5.647 CL17
1.809	.119 MG12	2.390	.692 K-19	3.452	.586 K-19	4.750	.235 CA20	6.980	.030 N--5
1.826	.183 CA20	2.398	.063 NA11	3.466	2.495 AL13	4.810	6.843 FE26	6.985	.079 C027
1.830	.138 C027	2.415	.185 NA11	3.476	1.067 TI22	4.870	17.896 S	6.999	.723 K-19
1.842	.645 TI22	2.422	.526 K-19	3.505	.066 NA11	4.881	2.576 TI22	7.056	.046 C027
1.853	.034 C027	2.426	2.651 SI14	3.531	2.169 N--7	4.903	1.068 AL13	7.199	4.830 SI14
1.880	.121 CA20	2.491	4.235 S-16	3.539	53.681 SI	4.934	47.590 SI	7.214	.127 C027
1.883	.759 TI22	2.518	.493 NA11	3.547	1.503 K-19	4.945	53.655 C	7.279	18.963 FE

Table 8 (cont'd)

1.388	6.216 N--7	2.519	2.135 N--7	3.554	.640 TI22	4.967	1.699 TI22	7.299	1.893 N--7
1.390	.034 MG12	2.546	1.285 K-19	3.562	3.546 CL17	4.980	12.541 CL	7.414	.272 N--7
1.390	.076 NA11	2.594	.062 NA11	3.586	.196 CA20	4.992	.600 K-19	7.414	27.972 CL
1.891	15.399 S	2.612	.600 K-19	3.588	.499 NA11	5.043	.589 K-19	7.491	.081 C027
1.929	.893 K-19	2.640	.356 K-19	3.592	1.642 AL13	5.047	4.908 S-16	7.632	112.087 FE
1.932	.040 NA11	2.660	.130 CA20	3.610	.543 CA20	5.070	.409 K-19	7.646	91.269 FE
1.943	6.226 CA20	2.676	10.736 CL	3.644	.058 NA11	5.107	2.482 SI14	7.694	2.420 AL13
1.949	.067 NA11	2.716	.029 NA11	3.651	.455 K-19	5.134	.946 AL13	7.724	11.664 AL
1.951	70.160 CL	2.722	5.895 FE26	3.661	3.110 SI14	5.174	.879 K-19	7.769	1.602 K-19
1.957	.759 K-19	2.753	9.100 S-16	3.675	3.515 N--7	5.182	.060 C027	7.790	21.767 CL
1.958	49.673 CL	2.754	2.950 NA11	3.684	25.466 C	5.267	5.754 N--7	7.800	6.103 S-16
1.965	.035 NA11	2.757	.543 K-19	3.693	.805 K-19	5.270	.031 C027	8.154	.019 MG
1.984	.055 NA11	2.780	1.302 SI14	3.723	4.419 S-16	5.297	4.206 N--7	8.309	.956 N
2.001	.854 CA20	2.806	.671 K-19	3.730	.360 K-19	5.380	2.576 K-19	8.472	1.558 SI
2.309	.640 CA20	2.809	.129 NA11	3.734	.731 TI22	5.420	92.175 S	8.579	7.551 CL
2.018	.409 K-19	2.811	.283 CA20	3.749	.037 C027	5.510	.875 K-19	8.641	4.148 S
2.027	.571 NA11	2.822	1.497 AL13	3.760	.225 CA20	5.515	.206 CA20	8.910	.010 B
2.033	.038 C027	2.828	.169 MG12	3.824	5.844 CL17	5.517	4.925 CL17	9.298	15.871 FE
2.041	.942 K-19	2.840	.526 K-19	3.831	.027 MG12	5.532	4.029 N--7	10.828	3.397 N
2.046	.921 K-19	2.863	.339 NA11	3.850	.830 AL13	5.560	2.049 N--7	11.430	.001 B
2.048	.668 TI22	2.864	22.227 CL	3.876	.743 AL13	5.603	.030 C027		
2.057	.042 NA11	2.865	2.780 S-16	3.879	.180 NA11	5.617	.173 NA11		
2.062	.847 N--7	2.903	.084 NA11	3.916	.193 MG12	5.660	.173 C027		
2.073	3.621 K-19	2.931	34.859 S	3.920	.790 TI22	5.696	1.637 K-19		

BELMONT COUNTY, OH., 17243									
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.516	.139 C027	2.078	.446 CA20	2.943	.591 TI22	3.955	2.775 SI14	5.715	8.385 CL17
1.524	1.242 K-19	2.087	.418 TI22	2.960	3.616 AL13	3.982	.689 NA11	5.730	.910 K-19
1.564	1.096 K-19	2.093	24.285 SI	2.975	2.069 CL17	4.003	.691 K-19	5.743	.098 C027
1.586	3.439 TI22	2.094	.510 CA20	2.982	.117 NA11	4.029	.079 C027	5.752	2.467 K-19
1.598	31.050 S	2.108	.693 AL13	2.998	2.087 CL17	4.062	.657 K-19	5.901	.979 CA20
1.601	7.859 CL17	2.118	.533 CA20	3.026	.128 NA11	4.134	2.501 AL13	5.921	38.048 FE
1.613	26.849 FE	2.122	.322 CA20	3.027	1.394 TI22	4.136	1.466 K-19	5.926	.085 C027
1.618	4.444 K-19	2.124	.086 NA11	3.034	3.417 AL13	4.188	.054 NA11	5.976	.320 C027
1.623	1.890 AL13	2.130	.807 CA20	3.054	.102 MG12	4.201	.950 K-19	6.018	37.084 FE
1.633	.043 MG12	2.138	.048 NA11	3.056	1.141 K-19	4.209	.055 C027	6.102	1.051 AL13
1.634	.275 NA11	2.140	.863 AL13	3.062	6.770 CL17	4.219	18.450 FE	6.111	28.640 CL
1.649	.450 CA20	2.149	.364 CA20	3.098	.308 NA11	4.260	2.389 AL13	6.316	.863 AL13
1.672	.615 CA20	2.153	.652 K-19	3.116	2.577 CL17	4.361	1.916 K-19	6.321	3.511 N--7
1.679	1.274 N--7	2.157	.770 N--7	3.214	.049 NA11	4.387	.708 K-19	6.380	11.444 SI
1.690	.061 MG12	2.175	.559 N--7	3.221	51.034 S	4.407	6.012 FE26	6.395	.818 NA11
1.691	.453 CA20	2.180	.381 N--8	3.263	1.259 K-19	4.419	3.441 CA20	6.418	14.653 TI
1.703	1.062 K-19	2.198	.081 NA11	3.268	5.462 FE26	4.431	8.287 S-16	6.420	8.957 CA20
1.704	.440 CA20	2.223	6059.449 H	3.271	.381 N--8	4.470	.242 B--5	6.486	.311 C027
1.724	.670 CA20	2.251	.037 NA11	3.280	.037 NA11	4.508	3.333 N--7	6.556	2.608 TI22
1.725	36.854 FE	2.278	.410 TI22	3.301	.070 MG12	4.639	3.908 S-16	6.620	18.150 CL

Table 8 (cont'd)

1.749	.077 NA11	2.284	.975 AL13	3.370	9.913 S-16	4.660	.751 AL13	6.706	.357 C027
1.762	3.178 TI22	2.291	1.933 K-19	3.371	.128 NA11	4.673	.410 TI22	6.740	.030 B--5
1.779	51.762 AL	2.295	.574 CA20	3.412	.055 NA11	4.691	1.479 AL13	6.742	1.669 SI14
1.792	1.434 TI22	2.357	.938 N--7	3.414	6.884 FE26	4.714	.498 TI22	6.760	21.724 TI
1.795	.803 K-19	2.361	.077 NA11	3.414	.051 MG12	4.730	.091 B--5	6.877	.384 C027
1.801	.056 C027	2.380	83.841 S	3.437	6.196 FE26	4.734	2.049 AL13	6.978	3.122 CL17
1.809	.237 MG12	2.390	1.101 K-19	3.452	.933 K-19	4.750	.631 CA20	6.980	.054 B--5
1.826	.491 CA20	2.398	.069 NA11	3.466	2.524 AL13	4.810	7.619 FE26	6.985	.139 C027
1.830	.243 C027	2.415	.205 NA11	3.476	.944 TI22	4.870	21.609 S	6.999	1.152 K-19
1.842	.571 TI22	2.422	.837 K-19	3.505	.073 NA11	4.881	2.278 TI22	7.056	.081 C027
1.853	.060 C027	2.426	3.564 SI14	3.531	2.020 N--7	4.903	1.080 AL13	7.199	6.493 SI14
1.880	.325 CA20	2.491	5.114 S-16	3.539	72.164 SI	4.934	63.976 SI	7.214	.225 C027
1.883	.671 TI22	2.518	.545 NA11	3.547	2.393 K-19	4.945	48.279 C	7.279	21.112 FE
1.888	5.788 N--7	2.519	1.988 N--7	3.554	.567 TI22	4.967	1.503 TI22	7.299	1.763 N--7
1.890	.068 MG12	2.546	2.045 K-19	3.562	1.960 CL17	4.980	6.933 CL17	7.414	.253 N--7
1.890	.084 NA11	2.594	.068 NA11	3.566	.526 CA20	4.992	.955 K-19	7.414	15.463 CL
1.891	18.593 S	2.612	.955 K-19	3.588	.551 NA11	5.043	.938 K-19	7.491	.144 C027
1.929	1.421 K-19	2.640	.567 K-19	3.592	1.661 AL13	5.047	5.927 S-16	7.632	124.791 FE
1.932	.044 NA11	2.660	.351 CA20	3.610	1.460 CA20	5.070	.652 K-19	7.646	101.613 FE
1.943	16.740 CA	2.676	5.935 CL17	3.644	.064 NA11	5.107	3.337 SI14	7.694	2.448 AL13
1.949	.074 NA11	2.716	.032 NA11	3.651	.725 K-19	5.134	.957 AL13	7.724	11.800 AL
1.951	38.786 CL	2.722	6.563 FE26	3.661	4.180 SI14	5.174	1.399 K-19	7.769	2.551 K-19
1.957	1.208 K-19	2.753	10.988 S	3.675	3.272 N--7	5.182	.107 C027	7.790	12.033 CL
1.958	27.460 CL	2.754	3.262 NA11	3.684	22.915 C	5.267	5.358 N--7	7.800	7.369 S-16
1.965	.039 NA11	2.757	.865 K-19	3.693	1.281 K-19	5.270	.055 C027	8.154	.037 MG
1.984	.061 NA11	2.780	1.750 SI14	3.723	5.324 S-16	5.297	3.918 N--7	8.309	.890 N
2.001	2.296 CA20	2.806	1.068 K-19	3.730	.573 K-19	5.380	4.102 K-19	8.472	2.095 SI
2.009	1.722 CA20	2.809	.142 NA11	3.734	.647 TI22	5.420	11.298 S	8.579	4.174 CL
2.018	.652 K-19	2.811	.762 CA20	3.749	.066 C027	5.510	1.393 K-19	8.641	5.009 S
2.027	.631 NA11	2.822	1.515 AL13	3.760	.606 CA20	5.515	.555 CA20	8.910	.018 B
2.033	.067 C027	2.828	.335 MG12	3.824	3.231 CL17	5.517	2.722 CL17	9.298	17.670 FE
2.041	1.500 K-19	2.840	.837 K-19	3.831	.053 MG12	5.532	3.751 N--7	10.828	3.163 N
2.046	1.466 K-19	2.863	.374 NA11	3.850	.840 AL13	5.560	1.908 N--7	11.430	.002 B
2.048	.591 TI22	2.864	12.287 CL	3.876	.751 AL13	5.603	.053 C027		
2.057	.046 NA11	2.865	3.357 S-16	3.879	.198 NA11	5.617	.191 NA11		
2.062	.789 N--7	2.903	.093 NA11	3.916	.384 MG12	5.660	.307 C027		
2.073	5.765 K-19	2.931	42.091 S	3.920	.699 TI22	5.696	2.607 K-19		

Table 8 (cont'd)

HARRISON COUNTY, OH., 17244											
ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED											
1.516	.227 C027	2.078	.174 CA20	2.943	.731 TI22	3.955	2.295 SI14	5.715	36.528 CL		
1.524	1.320 K-19	2.087	.517 TI22	2.960	3.703 AL13	3.982	.700 NA11	5.730	.968 K-19		
1.564	1.165 K-19	2.093	20.086 SI	2.975	9.013 CL17	4.003	.735 K-19	5.743	.160 C027		
1.586	4.256 TI22	2.094	.199 CA20	2.982	.119 NA11	4.029	.129 C027	5.752	2.623 K-19		
1.598	19.704 S	2.108	.709 AL13	2.998	9.092 CL17	4.062	.699 K-19	5.901	.383 CA20		
1.601	34.235 CL	2.118	.208 CA20	3.026	.130 NA11	4.134	2.561 AL13	5.921	26.652 FE		
1.613	18.807 FE	2.122	.126 CA20	3.027	1.725 TI22	4.136	1.559 K-19	5.926	.140 C027		
1.618	4.726 K-19	2.124	.087 NA11	3.034	3.499 AL13	4.188	.055 NA11	5.976	.524 C027		
1.623	1.936 AL13	2.130	.315 CA20	3.054	.056 MG12	4.201	1.010 K-19	6.018	25.977 FE		
1.633	.024 MG12	2.138	.049 NA11	3.056	1.213 K-19	4.209	.090 C027	6.102	1.076 AL13		
1.634	.280 NA11	2.140	.884 AL13	3.062	29.491 CL	4.219	12.924 FE	6.111	124.764 CL		
1.649	.176 CA20	2.149	.142 CA20	3.098	.314 NA11	4.260	2.447 AL13	6.316	.884 AL13		
1.672	.241 CA20	2.153	.693 K-19	3.116	11.227 CL	4.361	2.037 K-19	6.321	4.101 N--7		
1.679	1.488 N--7	2.157	.899 N--7	3.214	.050 NA11	4.387	.753 K-19	6.380	9.467 SI14		
1.690	.034 MG12	2.175	.653 N--7	3.221	32.386 S	4.407	4.212 FE26	6.395	.833 NA11		
1.691	.177 CA20	2.180	.350 N--8	3.263	1.338 K-19	4.419	1.345 CA20	6.418	18.134 TI		
1.703	1.129 K-19	2.198	.082 NA11	3.268	3.826 FE26	4.431	5.259 S-16	6.420	3.500 CA20		
1.704	.172 CA20	2.223	6139.661 H	3.271	.350 N--8	4.470	.181 B--5	6.486	.507 C027		
1.724	.262 CA20	2.251	.037 NA11	3.280	.038 NA11	4.508	3.894 N--7	6.556	3.227 TI22		
1.725	25.816 FE	2.278	.507 TI22	3.301	.039 MG12	4.639	2.480 S-16	6.620	79.065 CL		
1.749	.079 NA11	2.284	.998 AL13	3.370	6.291 S-16	4.660	.769 AL13	6.706	.582 C027		
1.762	3.933 TI22	2.291	2.055 K-19	3.371	.151 NA11	4.673	.507 TI22	6.740	.023 B--5		
1.779	53.005 AL	2.295	.224 CA20	3.412	.056 NA11	4.691	1.515 AL13	6.742	1.380 SI14		
1.792	1.775 TI22	2.357	1.096 N--7	3.414	4.822 FE26	4.714	.617 TI22	6.760	26.885 TI		
1.795	.854 K-19	2.361	.079 NA11	3.414	.028 MG12	4.730	.068 B--5	6.877	.627 C027		
1.801	.092 C027	2.380	53.205 S	3.437	4.340 FE26	4.734	2.098 AL13	6.978	13.599 CL		
1.809	.130 MG12	2.390	1.171 K-19	3.452	.992 K-19	4.750	.247 CA20	6.980	.041 B--5		
1.826	.192 CA20	2.398	.071 NA11	3.466	2.585 AL13	4.810	5.337 FE26	6.985	.227 C027		
1.830	.398 C027	2.415	.209 NA11	3.476	1.168 TI22	4.870	13.713 S	6.999	1.225 K-19		
1.842	.706 TI22	2.422	.890 K-19	3.505	.074 NA11	4.881	2.819 TI22	7.056	.133 C027		
1.853	.098 C027	2.426	2.948 SI14	3.531	2.360 N--7	4.903	1.106 AL13	7.199	5.371 SI14		
1.880	.127 CA20	2.491	3.245 S-16	3.539	59.695 SI	4.934	52.921 SI	7.214	.368 C027		
1.883	.830 TI22	2.518	.555 NA11	3.547	2.545 K-19	4.945	51.608 C	7.279	14.789 FE		
1.888	6.762 N--7	2.519	2.325 N--7	3.554	.701 TI22	4.967	1.860 TI22	7.299	2.059 N--7		
1.890	.038 MG12	2.546	2.175 K-19	3.562	8.539 CL17	4.980	30.203 CL	7.414	.296 N--7		
1.890	.085 NA11	2.594	.069 NA11	3.586	.206 CA20	4.992	1.016 K-19	7.414	67.363 CL		
1.891	11.799 S	2.612	1.016 K-19	3.588	.562 NA11	5.043	.998 K-19	7.491	.235 C027		
1.929	1.512 K-19	2.640	.603 K-19	3.592	1.701 AL13	5.047	3.761 S-16	7.632	87.414 FE		
1.932	.045 NA11	2.660	.137 CA20	3.610	.571 CA20	5.070	.693 K-19	7.646	71.178 FE		
1.943	6.542 CA20	2.676	25.854 CL	3.644	.066 NA11	5.107	2.760 SI14	7.694	2.507 AL13		
1.949	.075 NA11	2.716	.032 NA11	3.651	.771 K-19	5.134	.980 AL13	7.724	12.083 AL		
1.951	168.961 CL	2.722	4.597 FE26	3.661	3.458 SI14	5.174	1.488 K-19	7.769	2.713 K-19		
1.957	1.285 K-19	2.753	6.973 S-16	3.675	3.823 N--7	5.182	.174 C027	7.790	52.420 CL		
1.958	119.625 CL	2.754	3.322 NA11	3.684	24.495 C	5.267	6.259 N--7	7.800	4.676 S-16		
1.965	.040 NA11	2.757	.920 K-19	3.693	1.362 K-19	5.270	.090 C027	8.154	.021 MG		
1.984	.062 NA11	2.780	1.448 SI14	3.723	3.378 S-16	5.297	4.577 N--7	8.309	1.039 N		

Table 8 (cont'd)

2.001	.897 CA20	2,806	1,135 K-19	3,730	.609 K-19	5,380	4,362 K-19	8,472	1,733 SI
2.009	.673 CA20	2,809	.145 NA11	3,734	.801 TI22	5,420	70,630 S	8,579	18,185 CL
2.018	.693 K-19	2,811	.298 CA20	3,749	.107 C027	5,510	1,482 K-19	8,641	3,179 S
2.027	.643 NA11	2,822	1,551 AL13	3,760	.237 CA20	5,515	.217 CA20	8,910	.014 B
2.033	.109 C027	2,828	.185 MG12	3,824	14,074 CL	5,517	11,860 CL	9,298	12,377 FE
2.041	1,595 K-19	2,840	.890 K-19	3,831	.029 MG12	5,532	4,382 N--7	10,828	3,695 N
2.046	1,559 K-19	2,863	.381 NA11	3,850	.860 AL13	5,560	2,229 N--7	11,430	.002 B
2.048	.731 TI22	2,864	53,527 CL	3,876	.769 AL13	5,603	.086 C027		
2.057	.047 NA11	2,865	2,130 S-16	3,879	.202 NA11	5,617	.194 NA11		
2.062	.921 N--7	2,903	.095 NA11	3,916	.211 MG12	5,660	.501 C027		
2.073	6,130 K-19	2,931	26,711 S	3,920	.865 TI22	5,696	2,772 K-19		

JEFFERSON COUNTY, OH., 17245

ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED									
1.516	.193 C027	2,078	.064 CA20	2,943	.439 TI22	3,955	1,801 SI14	5,715	16,613 CL
1.524	.683 K-19	2,097	.310 TI22	2,960	2,538 AL13	3,982	.448 NA11	5,730	.501 K-19
1.564	.603 K-19	2,093	15,766 SI	2,975	4,099 CL17	4,003	.380 K-19	5,743	.136 C027
1.566	2,555 TI22	2,094	.073 CA20	2,982	.076 NA11	4,029	.110 C027	5,752	1,357 K-19
1.598	27,276 S	2,108	.486 AL13	2,996	4,135 CL17	4,062	.362 K-19	5,901	.140 CA20
1.601	15,570 CL	2,118	.076 CA20	3,026	.083 NA11	4,134	1,755 AL13	5,921	38,734 FE
1.613	27,334 FE	2,122	.046 CA20	3,027	1,036 TI22	4,136	.807 K-19	5,926	.118 C027
1.618	2,446 K-19	2,124	.956 NA11	3,034	2,398 AL13	4,188	.035 NA11	5,976	.444 C027
1.623	1,327 AL13	2,130	.116 CA20	3,054	.045 MG12	4,201	.523 K-19	6,018	37,753 FE
1.633	.019 MG12	2,138	.031 NA11	3,056	.628 K-19	4,209	.076 C027	6,102	.738 AL13
1.634	.179 NA11	2,140	.606 AL13	3,062	13,413 CL	4,219	18,783 FE	6,111	56,744 CL
1.649	.064 CA20	2,149	.052 CA20	3,098	.201 NA11	4,260	1,677 AL13	6,316	.606 AL13
1.672	.088 CA20	2,153	.359 K-19	3,116	5,106 CL17	4,361	1,054 K-19	6,321	3,721 N--7
1.679	1,350 N--7	2,157	.816 N--7	3,214	.032 NA11	4,387	.390 K-19	6,380	7,430 SI14
1.690	.027 MG12	2,175	.592 N--7	3,221	44,830 S	4,407	6,121 FE26	6,395	.533 NA11
1.691	.065 CA20	2,180	.398 N--8	3,263	.693 K-19	4,419	.493 CA20	6,418	10,887 TI
1.703	.584 K-19	2,198	.053 NA11	3,268	5,560 FE26	4,431	7,280 S-16	6,420	1,284 CA20
1.704	.063 CA20	2,223	6270,912 H	3,271	.398 N--8	4,470	.209 B--5	6,486	.431 C027
1.724	.096 CA20	2,251	.024 NA11	3,280	.024 NA11	4,508	3,533 N--7	6,556	1,937 TI22
1.725	37,519 FE	2,278	.304 TI22	3,301	.031 MG12	4,639	3,433 S-16	6,620	35,959 CL
1.749	.050 NA11	2,284	.684 AL13	3,370	8,708 S-16	4,660	.527 AL13	6,706	.494 C027
1.762	2,361 TI22	2,291	1,064 K-19	3,371	.084 NA11	4,673	.304 TI22	6,740	.026 B--5
1.779	36,333 AL	2,295	.082 CA20	3,412	.036 NA11	4,691	1,038 AL13	6,742	1,083 SI14
1.792	1,066 TI22	2,357	.995 N--7	3,414	7,009 FE26	4,714	.370 TI22	6,760	16,140 TI
1.795	.442 K-19	2,361	.050 NA11	3,414	.022 MG12	4,730	.078 B--5	6,877	.532 C027
1.801	.078 C027	2,380	73,649 S	3,437	6,308 FE26	4,734	1,438 AL13	6,978	6,185 CL17
1.809	.104 MG12	2,390	.606 K-19	3,452	.513 K-19	4,750	.091 CA20	6,980	.047 B--5
1.826	.070 CA20	2,398	.045 NA11	3,466	1,772 AL13	4,810	7,756 FE26	6,985	.193 C027
1.830	.338 C027	2,415	.133 NA11	3,476	.701 TI22	4,870	18,983 S	6,999	.634 K-19
1.842	.424 TI22	2,422	.461 K-19	3,505	.047 NA11	4,881	1,693 TI22	7,056	.113 C027
1.853	.083 C027	2,426	2,314 SI14	3,531	2,141 N--7	4,903	.758 AL13	7,199	4,215 SI14
1.880	.047 CA20	2,491	4,492 S-16	3,539	46,850 SI	4,934	41,534 SI	7,214	.312 C027

Table 8 (cont'd)

1.883	.499	TI22	2.518	.355	NA11	3.547	1.317	K-19	4.945	51.748	C	7.279	21.493	FE
1.888	6.135	N--7	2.519	2.108	N--7	3.554	.421	TI22	4.967	1.116	TI22	7.299	1.868	N--7
1.890	.030	MG12	2.546	1.126	K-19	3.562	3.884	CL17	4.980	13.736	CL	7.414	.266	N--7
1.890	.055	NA11	2.594	.044	NA11	3.586	.075	CA20	4.992	.526	K-19	7.414	30.637	CL
1.891	16.333	S	2.612	.526	K-19	3.588	.359	NA11	5.043	.516	K-19	7.491	.199	C027
1.929	.782	K-19	2.610	.312	K-19	3.592	1.166	AL13	5.047	5.206	S-16	7.632	127.043	FE
1.932	.029	NA11	2.660	.050	CA20	3.610	.209	CA20	5.070	.359	K-19	7.646	103.447	FE
1.943	2.400	CA20	2.676	11.759	CL	3.644	.042	NA11	5.107	2.166	SI14	7.694	1.718	AL13
1.949	.040	NA11	2.716	.021	NA11	3.651	.399	K-19	5.134	.672	AL13	7.724	8.283	AL13
1.951	76.845	CL	2.722	6.682	FE26	3.661	2.714	SI14	5.174	.770	K-19	7.769	1.404	K-19
1.957	.665	K-19	2.753	9.653	S-16	3.675	3.469	N--7	5.182	.148	C027	7.790	23.841	CL
1.958	54.406	CL	2.754	2.123	NA11	3.684	24.561	C	5.267	5.679	N--7	7.800	6.473	S-16
1.965	.025	NA11	2.757	.476	K-19	3.693	.705	K-19	5.270	.076	C027	8.154	.016	MG
1.984	.040	NA11	2.780	1.136	SI14	3.723	4.677	S-16	5.297	4.152	N--7	8.309	.943	N
2.001	.329	CA20	2.806	.588	K-19	3.730	.315	K-19	5.380	2.257	K-19	8.472	1.360	SI
2.009	.247	CA20	2.809	.093	NA11	3.734	.481	TI22	5.420	97.769	S	8.579	8.271	CL
2.018	.359	K-19	2.811	.109	CA20	3.749	.091	C027	5.510	.767	K-19	8.641	4.400	S
2.027	.411	NA11	2.822	1.063	AL13	3.760	.087	CA20	5.515	.080	CA20	8.910	.016	B
2.033	.092	C027	2.828	.148	MG12	3.824	6.401	CL17	5.517	5.394	CL17	9.298	17.989	FE
2.041	.826	K-19	2.840	.461	K-19	3.831	.023	MG12	5.532	3.976	N--7	10.828	3.352	N
2.046	.807	K-19	2.863	.244	NA11	3.850	.589	AL13	5.560	2.023	N--7	11.430	.002	B
2.048	.439	TI22	2.864	24.344	CL	3.876	.527	AL13	5.603	.073	C027			
2.057	.030	NA11	2.865	2.949	S-16	3.879	.129	NA11	5.617	.124	NA11			
2.062	.836	N--7	2.903	.661	NA11	3.916	.169	MG12	5.660	.425	C027			
2.073	3.173	K-19	2.931	36.974	S	3.920	.519	TI22	5.696	1.435	K-19			

KANAWHA COUNTY, W. V., 17246

ENERGY, GAMMAS EMITTED PER 10000 NEUTRONS ABSORBED, AND ELEMENT INVOLVED														
1.516	.126	C027	2.078	.073	CA20	2.943	.667	TI22	3.955	1.480	SI14	5.715	35.969	CL
1.524	.779	K-19	2.067	.472	TI22	2.960	2.659	AL13	3.982	.468	NA11	5.730	.571	K-19
1.564	.687	K-19	2.093	12.955	SI	2.975	8.875	CL17	4.003	.433	K-19	5.743	.088	C027
1.586	3.882	TI22	2.094	.083	CA20	2.982	.083	NA11	4.029	.071	C027	5.752	1.547	K-19
1.598	8.108	S-16	2.108	.509	AL13	2.998	8.953	CL17	4.062	.412	K-19	5.901	.160	CA20
1.601	33.711	CL	2.118	.087	CA20	3.026	.091	NA11	4.134	1.839	AL13	5.921	9.167	FE26
1.613	6.469	FE26	2.122	.053	CA20	3.027	1.574	TI22	4.136	.920	K-19	5.926	.077	C027
1.618	2.787	K-19	2.124	.061	NA11	3.034	2.513	AL13	4.188	.036	NA11	5.976	.289	C027
1.623	1.390	AL13	2.130	.132	CA20	3.054	.026	MG12	4.201	.595	K-19	6.018	8.935	FE26
1.633	.011	MG12	2.138	.034	NA11	3.056	.715	K-19	4.209	.050	C027	6.102	.773	AL13
1.634	.195	NA11	2.140	.635	AL13	3.062	29.040	CL	4.219	4.445	FE26	6.111	122.854	CL
1.649	.073	CA20	2.149	.059	CA20	3.099	.219	NA11	4.260	1.757	AL13	6.316	.635	AL13
1.672	.101	CA20	2.153	.409	K-19	3.116	11.055	CL	4.361	1.202	K-19	6.321	5.112	N--7
1.679	1.854	N--7	2.157	1.121	N--7	3.214	.035	NA11	4.387	.444	K-19	6.380	6.105	SI14
1.690	.015	MG12	2.175	.814	N--7	3.221	13.326	S	4.407	1.449	FE26	6.395	.581	NA11
1.691	.074	CA20	2.180	.306	S--8	3.263	.789	K-19	4.419	.562	CA20	6.418	16.541	TI
1.703	.666	K-19	2.198	.057	NA11	3.268	1.316	FE26	4.431	2.164	S-16	6.420	1.463	CA20
1.704	.072	CA20	2.223	7698.781	H	3.271	.306	S--8	4.470	.032	B--5	6.486	.281	C027
1.724	.109	CA20	2.251	.026	NA11	3.280	.026	NA11	4.508	4.854	N--7	6.556	2.943	TI22
1.725	8.880	FE26	2.278	.463	TI22	3.301	.018	MG12	4.639	1.020	S-16	6.620	77.854	CL

Table 8 (cont'd)

1.749	.055 NA11	2.284	.717 AL13	3.370	2.569 S-16	4.660	.553 AL13	6.706	.322 C227
1.762	3.587 TI22	2.291	1.212 K-19	3.371	.091 NA11	4.673	.463 TI22	6.740	.004 S--5
1.779	38.063 AL	2.295	.094 CA20	3.412	.039 NA11	4.691	1.088 AL13	6.742	.890 SI14
1.792	1.619 TI22	2.357	1.366 N--7	3.414	1.659 FE26	4.714	.562 TI22	6.760	24.523 TI
1.795	.504 K-19	2.361	.055 NA11	3.414	.013 MG12	4.730	.012 B--5	6.877	.347 C227
1.801	.051 C227	2.380	21.693 S	3.437	1.493 FE26	4.734	1.507 AL13	6.978	13.391 CL
1.809	.059 MG12	2.390	.691 K-19	3.452	.585 K-19	4.750	.103 CA20	6.980	.007 B--5
1.826	.080 CA20	2.398	.049 NA11	3.466	1.856 AL13	4.810	1.836 FE26	6.955	.126 C227
1.830	.220 C227	2.415	.145 NA11	3.476	1.066 TI22	4.870	5.643 S-16	6.999	.722 K-19
1.842	.644 TI22	2.422	.525 K-19	3.505	.052 NA11	4.881	2.572 TI22	7.056	.074 C227
1.853	.054 C227	2.426	1.901 SI14	3.531	2.941 N--7	4.903	.794 AL13	7.199	3.464 SI14
1.880	.053 CA20	2.491	1.335 S-16	3.539	38.498 SI	4.934	34.129 SI	7.214	.203 C227
1.883	.757 TI22	2.518	.387 NA11	3.547	1.501 K-19	4.945	66.916 C	7.279	5.087 FE26
1.888	8.428 N--7	2.519	2.895 N--7	3.554	.639 TI22	4.967	1.696 TI22	7.299	2.567 N--7
1.890	.017 MG12	2.546	1.283 K-19	3.562	8.408 CL17	4.980	29.740 CL	7.414	.366 N--7
1.890	.059 NA11	2.594	.048 NA11	3.586	.086 CA20	4.992	.599 K-19	7.414	66.332 CL
1.891	4.855 S-16	2.612	.599 K-19	3.588	.391 NA11	5.043	.588 K-19	7.491	.130 C227
1.929	.891 K-19	2.640	.356 K-19	3.592	1.222 AL13	5.047	1.548 S-16	7.632	30.067 FE
1.932	.031 NA11	2.660	.057 CA20	3.610	.239 CA20	5.070	.409 K-19	7.646	24.482 FE
1.943	2.735 CA20	2.676	25.458 CL	3.644	.046 NA11	5.107	1.780 SI14	7.694	1.800 AL13
1.949	.052 NA11	2.716	.023 NA11	3.651	.455 K-19	5.134	.704 AL13	7.724	8.677 AL13
1.951	166.374 CL	2.722	1.581 FE26	3.661	2.230 SI14	5.174	.877 K-19	7.769	1.600 K-19
1.957	.758 K-19	2.753	2.869 S-16	3.675	4.765 N--7	5.182	.096 C227	7.790	51.617 CL
1.958	117.793 CL	2.754	2.314 NA11	3.684	31.760 C	5.267	7.802 N--7	7.800	1.924 S-16
1.965	.028 NA11	2.757	.543 K-19	3.693	.803 K-19	5.270	.050 C227	8.154	.009 MG
1.984	.043 NA11	2.780	.934 SI14	3.723	1.390 S-16	5.297	5.705 N--7	8.309	1.296 N
2.001	.375 CA20	2.806	.669 K-19	3.730	.359 K-19	5.380	2.572 K-19	8.472	1.117 SI
2.009	.281 CA20	2.809	.101 NA11	3.734	.730 TI22	5.420	29.063 S	8.579	17.906 CL
2.018	.409 K-19	2.811	.125 CA20	3.749	.059 C227	5.510	.874 K-19	8.641	1.308 S
2.027	.448 NA11	2.822	1.114 AL13	3.760	.099 CA20	5.515	.091 CA20	8.910	.002 S
2.033	.060 C227	2.828	.084 MG12	3.824	13.858 CL	5.517	11.678 CL	9.298	4.257 FE
2.041	.941 K-19	2.840	.525 K-19	3.831	.013 MG12	5.532	5.462 N--7	10.828	4.605 N
2.046	.920 K-19	2.863	.266 NA11	3.850	.617 AL13	5.560	2.779 N--7	11.430	.900 S
2.048	.667 TI22	2.864	52.707 CL	3.876	.553 AL13	5.603	.048 C227		
2.057	.033 NA11	2.865	.877 S-16	3.879	.141 NA11	5.617	.135 NA11		
2.062	1.148 N--7	2.903	.066 NA11	3.916	.096 MG12	5.660	.277 C227		
2.073	3.615 K-19	2.931	10.991 S	3.920	.789 TI22	5.696	1.635 K-19		

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1.516	.097 C227	2.078	1.747 CA20	2.943	.598 TI22	3.955	1.685 SI14	5.715	23.290 CL
1.524	.692 K-19	2.087	.423 TI22	2.960	2.726 AL13	3.982	.500 NA11	5.730	.507 K-19
1.564	.611 K-19	2.093	14.750 SI	2.975	5.747 CL17	4.003	.385 K-19	5.743	.068 C227
1.566	3.483 TI22	2.094	1.997 CA20	2.982	.085 NA11	4.029	.055 C227	5.752	1.374 K-19
1.598	11.170 S	2.108	.522 AL13	2.998	5.797 CL17	4.062	.366 K-19	5.901	3.831 CA20
1.601	21.828 CL	2.118	2.084 CA20	3.026	.093 NA11	4.134	1.885 AL13	5.921	16.186 FE
1.613	11.422 FE	2.122	1.260 CA20	3.027	1.412 TI22	4.136	.817 K-19	5.926	.059 C227
1.618	2.476 K-19	2.124	.062 NA11	3.034	2.576 AL13	4.188	.039 NA11	5.976	.223 C227

Table 8 (cont'd)

1.623	1.425	AL13	2,130	3.157	CA20	3.054	.052	MG12	4.201	.529	K-19	6.018	15.776	FE
1.633	.022	MG12	2,138	.035	NA11	3.056	.636	K-19	4.209	.038	C027	6.102	.792	AL13
1.634	.200	NA11	2,140	.651	AL13	3.062	18.804	CL	4.219	7.849	FE26	6.111	79.549	CL
1.649	1.760	CA20	2,149	1.423	CA20	3.098	.224	NA11	4.260	1.801	AL13	6.316	.651	AL13
1.672	2.408	CA20	2,153	.363	K-19	3.116	7.158	CL17	4.361	1.068	K-19	6.321	5.241	N--7
1.679	1.901	N--7	2,157	1.149	N--7	3.214	.035	NA11	4.387	.394	K-19	6.380	6.951	SI14
1.690	.032	MG12	2,175	.834	N--7	3.221	18.359	S	4.407	2.558	FE26	6.395	.595	NA11
1.691	1.772	CA20	2,180	.378	N--8	3.263	.701	K-19	4.419	13.465	CA	6.418	14.838	TI
1.703	.592	K-19	2,198	.059	NA11	3.268	2.323	FE26	4.431	2.981	S-16	6.420	35.053	CA
1.704	1.722	CA20	2,223	7848.268	H	3.271	.378	N--8	4.470	.018	H--5	6.486	.216	C027
1.724	2.621	CA20	2,251	.027	NA11	3.280	.027	NA11	4.508	4.977	N--7	6.556	2.641	TI22
1.725	15.678	FE	2,278	.415	TI22	3.301	.036	MG12	4.639	1.406	S-16	6.620	50.412	CL
1.749	.056	NA11	2,284	.735	AL13	3.370	3.566	S-16	4.660	.567	AL13	6.706	.248	C027
1.762	3.218	TI22	2,291	1.077	K-19	3.371	.093	NA11	4.673	.415	TI22	6.740	.002	B--5
1.779	39.024	AL	2,295	2.246	CA20	3.412	.040	NA11	4.691	1.115	AL13	6.742	1.013	SI14
1.792	1.452	TI22	2,357	1.401	N--7	3.414	2.929	FE26	4.714	.505	TI22	6.760	21.999	TI
1.795	.448	K-19	2,361	.056	NA11	3.414	.026	MG12	4.730	.007	B--5	6.877	.266	C027
1.801	.039	C027	2,380	30.161	S	3.437	2.636	FE26	4.734	1.545	AL13	6.978	8.671	CL17
1.809	.122	MG12	2,390	.614	K-19	3.452	.520	K-19	4.750	2.471	CA20	6.980	.004	B--5
1.826	1.922	CA20	2,398	.051	NA11	3.466	1.903	AL13	4.810	3.241	FE26	6.985	.097	C027
1.830	.169	C027	2,415	.149	NA11	3.476	.956	TI22	4.870	7.774	S-16	6.999	.642	K-19
1.842	.578	TI22	2,422	.466	K-19	3.505	.053	NA11	4.881	2.307	TI22	7.056	.057	C027
1.853	.041	C027	2,426	2.165	SI14	3.531	3.016	N--7	4.903	.814	AL13	7.199	3.943	SI14
1.880	1.273	CA20	2,491	1.840	S-16	3.539	43.830	SI	4.934	38.857	SI	7.214	.156	C027
1.883	.679	TI22	2,518	.397	NA11	3.547	1.334	K-19	4.945	66.781	C	7.279	8.981	FE26
1.888	8.641	N--7	2,519	2.968	N--7	3.554	.574	TI22	4.967	1.522	TI22	7.299	2.632	N--7
1.890	.035	MG12	2,546	1.140	K-19	3.562	5.444	CL17	4.980	19.257	CL	7.414	.378	N--7
1.890	.061	NA11	2,594	.050	NA11	3.586	2.059	CA20	4.992	.532	K-19	7.414	42.951	CL
1.891	6.689	S-16	2,612	.532	K-19	3.588	.401	NA11	5.043	.523	K-19	7.491	.100	C027
1.929	.792	K-19	2,640	.316	K-19	3.592	1.253	AL13	5.047	2.132	S-16	7.632	53.088	FE
1.932	.032	NA11	2,660	1.373	CA20	3.610	5.715	CA20	5.070	.363	K-19	7.646	43.228	FE
1.943	65.515	CA	2,676	16.485	CL	3.644	.047	NA11	5.107	2.027	SI14	7.694	1.846	AL13
1.949	.054	NA11	2,716	.023	NA11	3.651	.404	K-19	5.134	.721	AL13	7.724	8.896	AL13
1.951	107.729	CL	2,722	2.792	FE26	3.661	2.539	SI14	5.174	.780	K-19	7.769	1.421	K-19
1.957	.673	K-19	2,753	3.953	S-16	3.675	4.885	N--7	5.182	.074	C027	7.790	33.423	CL
1.958	76.273	CL	2,754	2.373	NA11	3.684	31.696	C	5.267	7.999	N--7	7.800	2.651	S-16
1.965	.028	NA11	2,757	.482	K-19	3.693	.714	K-19	5.270	.038	C027	8.154	.019	MG
1.984	.044	NA11	2,780	1.063	SI14	3.723	1.915	S-16	5.297	5.849	N--7	8.309	1.328	N
2.001	8.985	CA20	2,806	.595	K-19	3.730	.319	K-19	5.380	2.285	K-19	8.472	1.272	SI
2.009	6.739	CA20	2,809	.103	NA11	3.734	.655	TI22	5.420	40.039	S	8.579	11.595	CL
2.018	.363	K-19	2,811	2.982	CA20	3.749	.046	C027	5.510	.776	K-19	8.641	1.802	S
2.027	.459	NA11	2,822	1.142	AL13	3.760	2.371	CA20	5.515	2.171	CA20	8.910	.001	B
2.033	.046	C027	2,828	.173	MG12	3.824	8.973	CL17	5.517	7.562	CL17	9.298	7.517	FE
2.041	.836	K-19	2,840	.466	K-19	3.831	.027	MG12	5.532	5.600	N--7	10.828	4.722	N
2.046	.817	K-19	2,863	.272	NA11	3.850	.633	AL13	5.560	2.849	N--7	11.430	.000	B
2.048	.598	TI22	2,864	34.129	CL	3.876	.567	AL13	5.603	.037	C027			
2.057	.034	NA11	2,865	1.208	S-16	3.879	.144	NA11	5.617	.139	NA11			
2.062	1.177	N--7	2,903	.068	NA11	3.916	.197	MG12	5.660	.213	C027			
2.073	3.212	K-19	2,931	15.142	S	3.920	.708	TI22	5.696	1.453	K-19

Fig. 1. Zero Ash Simulated Coal

Fig. 3. Medium Ash Simulated Coal

Fig. 5. Lignite (ANL No. 3 Sample)

Fig. 6. Coking Coal

Fig. 7. Pyritic Coal

Fig. 8. Pittsburgh Seam Coal

Fig. 9. Average Composition of 82 Illinois Basin Coals

Fig. 10. Marion PA Coal, C-17099

Fig. 11. Washington County PA Coal, C-17303

Fig. 12. Kanawha County WV Coal, C-17246

Fig. 13. Coshocton County OH Coal, C-17092

Fig. 14. Belmont County OH Coal, C-17095

Fig. 15. Belmont County OH Coal, C-17243

Fig. 16. Harrison County OH Coal, C-17244

Fig. 17. Jefferson County OH Coal, C-17245

Fig. 18. Henry County MO Coal, C-17307

Fig. 19. Utah Coal, C-17096

Fig. 20. Colorado Coal, C-17097

Fig. 21. Colorado Coal, C-17054

Fig. 22. Montana Coal, C-17046

Fig. 23. Montana Coal, C-17047

Fig. 24. Arizona Coal, C-17045

Fig. 25. Arizona Coal, C-17309

APPENDIX A

This Appendix is included in order to clarify the origin of the equations on which these calculations are based, and also in order to identify more clearly and explicitly all quantities involved and provide brief and relevant examples.

The basic equations used in these calculations may be derived as follows. The many possible interactions of neutrons with matter are expressed quantitatively in terms of the cross sections for these interactions, which give the probabilities of these interactions in a given neutron flux.^{A-1, A-14} For an incident beam containing a neutron density of n neutrons per cubic centimeter, moving with a velocity v toward N nuclei, the rate of nuclear interactions of all types can be expressed as:^{A-1}

$$\text{Interactions/sec} = nv\sigma_T N \quad (1)$$

Equation (1) can be rewritten to give a simple definition of total cross section:^{A-1}

$$\sigma_T = \frac{\text{total interactions/sec}}{nvN} \quad (2)$$

The quantity, nv , which is an important item in most neutron experiments, is referred to as the flux,^{A-1, A-14} and usually designated ϕ . It has the units neutrons per square centimeter per second. Thus, the total cross section is just the number of interactions of all types per second for a single nucleus and unit incident flux (i.e., one neutron per cm^2 per second).^{A-1} The neutron flux is obtained by multiplying the neutron density by the velocity.^{A-15} For a unidirectional beam of neutrons of density n and velocity v , the flux is usually described geometrically as the number of neutrons crossing one cm^2 of area in one second.^{A-15} For the case of an isotropic neutron flux, with

neutrons moving in all directions, the geometric interpretation just referred to is not correct; however, a simple geometrical interpretation can be retained, as in this case the flux is equal to the number of neutrons passing through a sphere of 1 cm^2 cross sectional area in one second.^{A-1, A-15} This definition will give the correct flux for any angular distribution.^{A-1}

The preceding discussion involves only the collision cross section, without reference to the course of events ensuing after the collision.^{A-1} There are many possible nuclear interactions, but the cross-section expression used above applies to the sum of all of these interactions.^{A-1} In addition, the cross section for any particular process (e.g., neutron scattering, capture, or fission)^{A-1} is in itself also proportional to the number of such processes occurring per second per unit incident flux. The total cross section σ_T is equal to the sum of the absorption cross section σ_{abs} and the scattering cross section σ_s :^{A-2}

$$\sigma_T = \sigma_{\text{abs}} + \sigma_s \quad (3)$$

Each of these partial cross sections can, in turn, be subdivided into components corresponding to the various absorption and scattering processes,^{A-2} as indicated in the preceding paragraph.

All cross sections have dimensions of area and are usually measured in barns ($1 \text{ barn} = 10^{-24} \text{ cm}^2$).^{A-2, A-14} To phrase it slightly more accurately, cross sections are measured in barns per nucleus, or barns per atom.

Thus, for any particular nuclear reaction process, the number of reactions per unit time is given by:^{A-3, A-14}

$$\text{Reactions of type } r \text{ per second} = \phi \sigma_r N \quad (4)$$

As before, ϕ is the neutron flux, N is the total number of target atoms, and the quantity σ_r is the cross section for the particular reaction process.

Since the number of reactions is independent of the area presented to the neutron beam by the target, the number of reactions is the same whether the target is exposed to a broad incident beam, or to the isotropic flux inside a moderating material.^{A-3} As mentioned earlier, in a unidirectional beam, the neutron flux can be expressed as the product of the number of neutrons per unit volume and their velocity. When the neutrons are moving in all directions, the same concept of neutron flux is retained.^{A-3} It should be mentioned that thermal neutrons are neutrons in thermal equilibrium with their environment. Thus, they are not monoenergetic but, instead, have a Maxwellian velocity distribution. A corresponding neutron flux distribution is present.^{A-15} Corrections to monoenergetic cross section values must be applied on this account.^{A-5,A-9,A-15}

As an example of a particular process, the cross section for the process:

for thermal neutrons is about 21,000 barns.^{A-3} This is an example of a radiative capture process; cross sections for this type of process will henceforward be designated σ_c .

The total neutron cross section can be written in the form:^{A-4}

$$\sigma_T = \sigma_c + \sigma_\alpha + \sigma_p + \sigma_f + \sigma_s \quad (6)$$

where, as before, σ_s is the scattering cross section and σ_c is the radiative capture cross section. In addition, σ_α is the cross section for alpha emission, σ_p is the cross section for proton emission, and σ_f is the fission cross section.

Accordingly, from equations (3) and (6), we can write down the absorption cross section:

$$\sigma_{\text{abs}} = \sigma_c + \sigma_\alpha + \sigma_p + \sigma_f \quad (7)$$

For most nuclei, the cross sections for α emission, proton emission, and fission at thermal neutron energies are small compared to the cross section for radiative capture.^{A-11} Thus, in most instances, for the case of thermal neutrons:

$$\sigma_{\text{abs}} \approx \sigma_c \quad (8)$$

For example, for hydrogen, $\sigma_{\text{abs}} = 0.333$ barns/nucleus, and also $\sigma_c = 0.333$ barns/nucleus.^{A-5} However, for some nuclei, the other processes can be important. For example, for nitrogen, the cross section for proton emission is much larger than the radiative capture cross section. (For ^{14}N , $\sigma_p = 1.82$ barns and $\sigma_c = 0.075$ barns).^{A-6} Unless otherwise specified, all cross sections referred to henceforth will be the thermal neutron cross sections of the natural mixture of isotopes for each element.^{A-7, A-13}

Let us now examine the absorption of neutrons in a more complex material, such as coal, which contains nuclei of many different elements.

The amount of these various elements in a multielement material can be described by the fraction of atoms corresponding to each element. Thus:

$$f_e = \frac{N_e}{\sum N_e} \quad (9)$$

Here, N_e is the number of atoms of a particular element present in the sample, and the summation in the denominator is over all elements. Thus:

$$\sum N_e = N_T \quad (10)$$

where N_T is the total number of nuclei or atoms in the sample. It follows that:

$$\sum f_e = 1 \quad (11)$$

for a summation over all elements. (As an example, for moisture, H_2O , $f_H = 0.67$, and $f_O = 0.33$.)

For most purposes, the concentration of an element in a complex material is usually expressed in terms related to the fraction of the total mass that it represents. For the major and minor elements, this is usually expressed as a weight percent:

$$w_e = 100 \frac{m_e}{m} \quad (12)$$

where m_e is the mass corresponding to the particular element and m is the total mass of the sample. The relationship:

$$m = \sum m_e \quad (13)$$

is correct when the summation is carried out over all elements in the sample.

On the other hand, for trace elements, the form more frequently used is parts per million or the micrograms per gram ratio, that being $10^6(m_e/m)$. From the definition, it follows that:

$$\sum w_e = 100 \quad (14)$$

The different parameters describing the concentration of elements in a sample can be related in a rather straightforward fashion. The number of atoms of an element of atomic weight A_e in the mass m_e will be given by:

$$N_e = \frac{m_e}{A_e} L \quad (15)$$

where L = Avogadro's number, 6.023×10^{23} atoms per gram-molecular weight.

Inserting m_e from equation (12) into equation (15), we find:

$$N_e = \frac{mL}{A_e} \cdot \frac{w_e}{100} \quad (16)$$

or, combining equations (12), (13), and (15), one finds:

$$w_e = 100 \frac{N_e A_e}{\sum (N_e A_e)} \quad (17)$$

Thus, for example, in water, 11 weight percent hydrogen is present and 89 weight percent oxygen is present.

Using equation (4), we find that, if a target consisting of N_e atoms of a particular element having absorption cross section $\sigma_{abs,e}$ is present in a neutron flux ϕ , then the number of neutrons absorbed per second will be:

$$a_e = \phi \sigma_{abs,e} N_e \quad (18)$$

If, in addition, atoms of other elements are present, they will also absorb neutrons; and the neutrons absorbed per unit time by each element will be described by an equation of the form (18).

The total number of neutrons absorbed per unit time by all of the atoms present will then be given by the summation over all elements present of the number of neutrons absorbed per second by each:

$$A_T = \sum a_e = \sum (\phi \sigma_{abs,e} N_e) = \phi \sum (\sigma_{abs,e} N_e) \quad (19)$$

Next, we can take the ratio of the number of neutrons absorbed per unit time by a particular element to the number of neutrons absorbed per unit time by all elements. From equations (18) and (19), this is:

$$\frac{a_e}{A_T} = \frac{\phi \sigma_{abs,e} N_e}{\phi \sum (\sigma_{abs,e} N_e)} = \frac{\sigma_{abs,e} N_e}{\sum (\sigma_{abs,e} N_e)} \quad (20)$$

This is independent of the time and, consequently, also gives the ratio of the number of neutrons absorbed over any arbitrary time interval by a particular element to the number of neutrons absorbed over the corresponding time interval by all elements in the sample. Thus, we can obtain from Eq. (20) the percentage of neutrons absorbed by the particular element in the sample:

percentage of neutrons
absorbed by element
e in the sample

$$= 100 \frac{a_e}{a_T}$$

$$= 100 \frac{\sigma_{\text{abs},e} N_e}{\sum (\sigma_{\text{abs},e} N_e)} \quad (21)$$

This equation can be re-expressed in terms of weight percent element concentrations with the help of equation (16); one obtains:

percent of all neutrons
absorbed by element e
in the sample

$$= 100 \frac{\sigma_{\text{abs},e} \frac{mL}{A_e} \frac{w_e}{100}}{\sum \sigma_{\text{abs},e} \frac{mL}{A_e} \frac{w_e}{100}}$$

$$= 100 \frac{w_e \sigma_{\text{abs},e} / A_e}{\sum (w_e \sigma_{\text{abs},e} / A_e)} \quad (22)$$

This completes the derivation of the first equation used in the calculations, equation (2) of the main text of the report. (In that equation, the notation is slightly simplified.) (As an example, consider the absorption of thermal neutrons in water, H_2O . The thermal neutron absorption cross sections for hydrogen and oxygen are 0.33 barns and 0.0003 barns, respectively. Thus, the percentage of thermal neutrons absorbed by the hydrogen in water will be 99.95%.)

Next, let us examine the radiative capture process. Using equation (4), the number of radiative captures occurring per second in a sample of N_T target atoms exhibiting a radiative capture cross section σ_c would be:

$$\text{Radiative captures per sec} = \phi \sigma_c N_T \quad (23)$$

where, as before, ϕ is the thermal neutron flux. (As an example, if one gram of hydrogen is placed in a flux of 3×10^4 neutrons per square centimeter per second, then 6000 radiative captures of thermal neutrons will occur every second in the hydrogen.)

Suppose next that we are dealing with a complex sample containing more than one element. Then, the number of radiative captures in a particular element e will, as before, be proportional to the number of target atoms of type e :

$$\left. \begin{array}{l} \text{Radiative captures} \\ \text{per second in} \\ \text{element } e \end{array} \right\} = \phi \sigma_c N_e \quad (24)$$

where σ_c here designates the radiative capture cross section of the particular element e .

Using equations (9) and (10), this can be re-expressed as:

$$\left. \begin{array}{l} \text{Radiative captures} \\ \text{per second in} \\ \text{element } e \end{array} \right\} = \phi \sigma_c f_e N_T \quad (25)$$

or, using equation (15), it can alternatively be expressed as:

$$\left. \begin{array}{l} \text{Radiative captures} \\ \text{per second in} \\ \text{element } e \end{array} \right\} = \phi \sigma_c \frac{m_e L}{A_e} \quad (26)$$

However, we are interested not only in the capture of the neutrons but also, and primarily, in the subsequent emission of prompt gamma radiation. This process is quantified by a parameter I_γ , which is defined as equal to the number of gamma rays of a particular energy E_γ emitted following capture of 100 neutrons by atoms of a particular element.^{A-7, A-8} (As an example, the parameter I_γ is equal to 100 for the 2.223 MeV gamma emitted in the radiative capture of thermal neutrons by hydrogen; this is a consequence of the fact that essentially every absorption of a thermal neutron by hydrogen leads to the emission of a 2.223 MeV gamma ray.)

Using the definition of I_γ just introduced, it follows that:

$$\left. \begin{array}{l} \text{Number of gamma} \\ \text{rays of energy} \\ E_\gamma \text{ emitted} \\ \text{per sec} \end{array} \right\} = \left(\begin{array}{l} \text{radiative captures} \\ \text{per second in} \\ \text{element } e \end{array} \right) \times \left(\begin{array}{l} \text{number of gammas} \\ \text{of energy } E_\gamma \\ \text{emitted per} \\ \text{radiative capture} \\ \text{in element } e \end{array} \right) \quad (27)$$

Thus, we can write, combining equation (27) with equation (24):^{A-9}

$$\begin{array}{l} \text{Number of gamma} \\ \text{rays of energy} \\ E_{\gamma} \text{ emitted per sec} \end{array} = \phi \sigma_c N_e \cdot \frac{I_{\gamma}}{100} \quad (28)$$

We can now take the ratio of the number of gammas of energy E_{γ} emitted per second by the sample to the total number of neutrons absorbed per second in the sample, by combining equations (28) and (19):

$$\frac{\left(\begin{array}{l} \text{Number of gammas of} \\ \text{energy } E_{\gamma} \text{ emitted} \\ \text{per sec by sample} \end{array} \right)}{\left(\begin{array}{l} \text{Total number of neutrons} \\ \text{absorbed per sec by sample} \end{array} \right)} = \frac{\phi \sigma_c N_e \frac{I_{\gamma}}{100}}{\phi \Sigma \sigma_{\text{abs},e} N_e} \quad (29)$$

Since the thermal neutron flux appearing in the numerator and denominator is the same, it can be cancelled, and the equation thus simplified to obtain:

$$\frac{\left(\begin{array}{l} \text{Number of gammas of} \\ \text{energy } E_{\gamma} \text{ emitted} \\ \text{per sec by sample} \end{array} \right)}{\left(\begin{array}{l} \text{Total number of neutrons} \\ \text{absorbed per sec by sample} \end{array} \right)} = \frac{\sigma_c N_e \frac{I_{\gamma}}{100}}{\Sigma \sigma_{\text{abs},e} N_e} \quad (30)$$

For practical purposes, we need to re-express this equation in terms of the concentrations in weight percent of the various elements present in the sample using equation (16):

$$\frac{\left(\begin{array}{l} \text{Number of gammas of} \\ \text{energy } E_{\gamma} \text{ emitted} \\ \text{per sec by sample} \end{array} \right)}{\left(\begin{array}{l} \text{Total number of neutrons} \\ \text{absorbed per sec by sample} \end{array} \right)} = \frac{\sigma_c N_e \frac{I_{\gamma}}{100} \cdot \frac{mL}{A_e} \frac{w_e}{100}}{\Sigma \sigma_{\text{abs},e} \frac{mL}{A_e} \frac{w_e}{100}} \quad (31)$$

$$= \frac{1}{100} \cdot \frac{\frac{mL}{100} \frac{I_{\gamma} w_e \sigma_c}{A_e}}{\frac{mL}{100} \Sigma (w_e \sigma_{\text{abs},e} / A_e)} \quad (32)$$

This can be simplified to:

$$\frac{\left(\begin{array}{c} \text{Number of gammas of} \\ \text{energy } E_{\gamma} \text{ emitted} \\ \text{per sec by sample} \end{array} \right)}{\left(\begin{array}{c} \text{Total number of neutrons} \\ \text{absorbed per sec by sample} \end{array} \right)} = \frac{1}{100} \frac{I_{\gamma} w_e \sigma_c / A_e}{\Sigma(w_e \sigma_{\text{abs},e} / A_e)} \quad (33)$$

The above equation gives the ratio of the number of gammas of a particular energy emitted per second to the numbers of neutrons absorbed in the sample per second. This is independent of the time, and is thus also equal to the ratio of the number of gammas of a particular energy emitted from the sample over any arbitrary time period to the number of neutrons absorbed in the sample during the corresponding time period. Thus, this quantity is equal to the number of gammas of a particular energy emitted per neutron absorbed in the sample.

The number of gammas of a particular energy emitted per neutron absorbed in the sample will in all cases be a number less than (or at most equal to) one. Rather than using this particular ratio and consequently working with fractions of decimals, we find it somewhat more convenient to use the ratio of gammas emitted for a certain appropriate number of neutrons absorbed. As a convenience in performing comparisons with experimental data, we use the ratio 10^4 , and calculate the number of gammas of a particular energy emitted per 10,000 neutrons absorbed. From equation (33), this quantity is given by:

$$\left. \begin{array}{l} \text{Number of gammas of a} \\ \text{particular energy emitted} \\ \text{per 10,000 neutrons absorbed} \end{array} \right\} = 100 \frac{I_{\gamma} w_e \sigma_c / A_e}{\Sigma(w_e \sigma_{\text{abs},e} / A_e)} \quad (34)$$

This completes the derivation of the final equation in the main text, equation (3). (Note that the notation used in the main text is slightly simplified with respect to the notation used in the derivations.)

(As a final example, the number of 2.223 MeV gamma rays emitted per 10,000 neutrons absorbed in water can be calculated to be 9995. The corresponding number for neutron absorption in coals ranges between 8678 and 4949 for the real coals calculated here, and is always smaller than the value in water because of absorption by the many other coal-forming elements present in addition to hydrogen and oxygen.)

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