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SUBJECT: Recommended Photon Production Data from Thermal Neutron Capture Reactions in Iron Isotopes

I. Introduction

This research note assesses the photon production data at incident thermal neutron energies for the four stable isotopes of iron. This work is motivated primarily by the Multispectral Logging Project[1-3] and the ACTI CRADA[4], each of which requires high-quality photon production data at thermal energies. For a more complete background on these projects and the motivation behind this work, see the research note XTM-RN(U)97-008.

The purpose of this research note is to present the best possible thermal-neutron capture spectrum for each stable isotope of iron. These will be the recommended ACTI spectra. To accomplish this task, several sources of data were analyzed; standard ENDF/B-VI[5], ENSDF[6], the preliminary ACTI data produced by T-2, and experimental papers.

The Evaluated Nuclear Data File (ENDF/B-VI) photon production data for the iron isotopes contain very few discrete gamma-rays and do not provide isotopic data (the same secondary photon spectra are used for each isotope of iron in the evaluations). Therefore it will not be discussed in detail in this research note. Compilations such as Lone[7] and Orphan[8] will also not be considered since they contain only elemental information and were shown to be inferior to experimental papers in a similar analysis of chlorine (see XTM-RN(U)97-008). Because the preliminary ACTI data for the iron isotopes was based on Orphan[8], and is therefore not isotopic, it will also not be presented here. This research note will compare the ENSDF data and experimental papers in detail to derive the best possible spectra.

The ENSDF spectra were obtained from the National Nuclear Data Center (NNDC) online data retrieval service (accessed by following the NNDC Online Data Service link at the URL "http://www.nndc.bnl.gov/"). The experimental papers compared in this research note were obtained through an exhaustive search process. First, searches employing many different sets of keywords were performed using LANL's SciSearch. All available years (1974-1997) were repeatedly searched. Second, the "Recent References" sections of all volumes of Nuclear Data Sheets from the present back to 1966 were combed. Third, the Nuclear Science References (NSR) section of the National Nuclear Data Center's online data service was extensively searched. Finally, all papers found were in turn searched for additional references. Papers published prior to 1966 were not sought since the best and most detailed spectral data for each isotope were contained in more recent papers.

The natural abundances, thermal-neutron radiative capture cross-sections (σ^{th}), contributions to the gamma-ray spectrum of natural iron, and Q-values for thermal neutron capture are listed in Table 1 for the stable iron isotopes. Each isotope will now be discussed in turn.

Table 1: The stable isotopes of iron

Isotope	Natural Abundance (Atom Fraction)	σ^{th} (barns)	Contribution to Natural Spectrum (%)	Q-Value for Neutron Capture (keV)[a]
^{54}Fe	0.058	2.3	5.18	9297.90
^{56}Fe	0.9172	2.6	92.55	7646.03
^{57}Fe	0.022	2.5	2.14	10044.46
^{58}Fe	0.0028	1.28	0.14	6580.90

[a]Values taken from Audi[9].

II. ^{54}Fe

A. Comparison of Data

The search for experimental data resulted in only four recent papers containing appreciable amounts of thermal-neutron capture data for ^{54}Fe. Brief information for each data set is listed in Table 2. Included are the total gamma-ray yields per neutron capture, and the designations that will be used to refer to each data source.

Table 2: Summary of experimental papers for ^{54}Fe

Author(s)	Designation	Year	Number of gamma-rays	Total Yield (keV)
J. Kopecky et al.[10]	Kop72	1972	10	8292.44
S. Arnell et al.[11]	Arn67	1967	39	9451.01
E. Earle and G. Bartholomew[12]	Ear66	1966	28	---[a]
E. I. Firsov et al.[13]	Fir65	1965	27	8723.37

[a]Only gamma-ray energies were listed.

Of these papers, the measurements of Kop72 are the most recent and precise. Unfortunately, Kop72 only lists 10 gamma-rays. Ear66 only lists gamma-ray energies and not intensities, while Fir65 and Arn67 provide the most complete spectra. The spectrum from each data set as well as the ENSDF spectrum for ^{54}Fe are compared in Table 3.

Table 3: Comparison of thermal-neutron capture spectra for ^{54}Fe

Arn67		Ear66	Fir65		Kop72		ENSDF	
Eγ (keV)	Iγ [a]	Eγ (keV)	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
412	19.0	412	410	29.0	--------	----	412	19.0
931	2.1	931	930	10.0	----	----	931	2.1
----	----	----	1240	1.0	----	----	1240	1.0
1315	0.8	----	1320	1.0	----	----	1315	0.8
1503	0.7	1506	1500	1.5	----	----	1506	0.7
1640	1.7	1638	1630	1.5	----	----	1638	1.7
1878	0.8	1872	----	----	----	----	1872	0.8
1920	2.1	1918	1920	2.5	----	----	1918	2.1
2050	2.0	2052	2050	2.5	----	----	2052	2.0
2468	3.9	2470	2470	2.4	----	----	2470	3.9
2618	2.4	2618	2630	1.0	----	----	2618	2.4
----	----	----	2670	1.5	----	----	2670	1.5
2791	0.7	----	----	----	----	----	2791	0.7
2873	1.1	----	2900	1.0	----	----	2873	1.1
3005	1.0	----	----	----	----	----	3005	1.0
3028	2.6	3028	----	----	----	----	3028	2.6
3040	0.5	----	3070	4.0	----	----	3040	0.5
----	----	----	3380	1.5	----	----	3380	1.5
3508	1.0	----	----	----	----	----	3508	1.0
3555	1.4	3548	----	----	----	----	3552	1.4
3790	1.8	3792	3790	1.7	----	----	3792	1.8
3906	0.8	3902	----	----	----	----	3906	0.8
3960	0.5	----	----	----	----	----	3960	0.5
4012	0.3	----	----	----	----	----	4012	0.3
4180	0.8	----	4170	1.5	----	----	4180	0.8
4456	1.6	4455	4460	1.5	----	----	4455	1.6
4495	3.4	4495	----	----	----	----	4495	3.4
4535	0.5	4532	----	----	----	----	4535	0.5
4589	2.7	4587	4550	1.4	4589.6	2.6	4589.6	2.6

Table 3: Comparison of thermal-neutron capture spectra for ^{54}Fe

Arn67		Ear66	Fir65		Kop72		ENSDF	
Eγ (keV)	Iγ[a]	Eγ (keV)	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]
4715	1.2	4707	4730	3.0	----	----	4707	<1.8
4800	3.3	4802	----	----	4802.8	2.9	4802.8	2.9
5388	1.1	5391	5370	1.3	5391.1	1.2	5391.1	1.2
5504	2.9	5509	5500	2.0	5507.5	2.4	5507.5	2.4
5747	2.6	5746	5750	2.5	5745.4	2.3	5745.4	2.3
6265	3.5	6266	6270	3.0	6268.9	3.2	6268.9	3.2
6617	0.7	----	----	----	----	----	6617	0.7
6820	2.2	6828	6820	2.0	6826.8	1.9	6826.8	1.9
7250	1.8	7248	7270	3.0	7246.3	2.0	7246.3	2.0
7363	0.1	----	----	----	----	----	7363	0.1
7385	0.1	7377	----	----	----	----	7385	0.1
8885	12.0	8886	8890	12.0	8886.4	12.3	8886.4	12.3
9297	65.0	9296	9310	61.0	9297.8	66	9297.8	66.0

[a]Number of photons per 100 neutron captures.

A careful examination of Table 3 reveals good agreement between the four experimental data sets. Except for a few gamma-rays (for example the 412 keV line) the energies and intensities of the matching lines agree within the experimental uncertainties. Additionally, the ENSDF spectrum agrees extremely well with the experimental data. The ENSDF spectrum adopts the more precise energy and intensity values of Kop72, and includes the three gamma-rays observed only by Fir65 (the 1240, 2670, and 3380 keV lines). Except for the energies taken from Kop72, most of the ENSDF energies are taken from the slightly more precise measurements of Ear66 (when possible). Except for the intensity values taken from Kop72, and the three gamma-rays from Fir65, all other ENSDF intensities were taken from the next-most recent measurements of Arn67.

B. Recommended ACTI spectrum for ^{54}Fe

The only problem with the ENSDF spectrum is the intensity of the 4707 keV line, which is listed as < 1.8. The ENSDF documentation indicates that this gamma-ray was “multiply placed” and that therefore the “undivided intensity” is given. It is unclear what this means. However, since Arn67 lists the intensity of this line as 1.2 (less than 1.8) whereas Fir65 gives an intensity of 3.0 (greater than 1.8) it seems reasonable to adopt the more recent measurement of Arn67. Except for this change, and a normalization of the yield to the Q-value of Audi, the recommended ACTI spectrum for ^{54}Fe is equivalent to the ENSDF spectrum. The recommended ACTI spectrum is listed in Table 4.

Table 4: Recommended ACTI spectrum for ^{54}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
412	18.43	3906	0.78
931	2.04	3960	0.48
1240	0.97	4012	0.29
1315	0.78	4180	0.78
1506	0.68	4455	1.55
1638	1.65	4495	3.30
1872	0.78	4535	0.48
1918	2.04	4589.6	2.52
2052	1.94	4707	1.16[c]
2470	3.78	4802.8	2.81
2618	2.33	5391.1	1.16
2670	1.45	5507.5	2.33
2791	0.68	5745.4	2.23
2873	1.07	6268.9	3.10
3005	0.97	6617	0.68
3028	2.52	6826.8	1.84
3040	0.48	7246.3	1.94
3380	1.45	7363	0.10
3508	0.97	7385	0.10
3552	1.36	8886.4	11.93
3792	1.75	9297.8	64.01

[a]All values are from ENSDF[6] unless otherwise noted.
[b]Number of photons per 100 neutron captures, normalized to give a yield of 9297.9 keV.
[c]Unnormalized value taken from Arn67[11].

III. ^{56}Fe

A. Comparison of Data

The search for thermal-neutron capture data for ^{56}Fe resulted in four recent experimental papers with appreciable amounts of data. Because ^{56}Fe produces over 92% of the photon production spectrum of natural iron, all of the experiments employed natural targets. A brief summary of each paper is given in Table 5, along with the designation that will be used to refer to it.

Table 5: Summary of experimental papers for ^{56}Fe

Author(s)	Designation	Year	Number of gamma-rays	Total Yield (keV)
R. Vennink et al.[14]	Ven80	1980	253	7629.385
S. Sakamoto[15]	Sak79	1979	49	---[a]
M. L. Stelts and R. E. Chrien[16]	Ste78	1978	31	6706.112
E. A. Eissa and J. Honzatko[17]	Eis71	1971	28	854.403

[a]The observed yield is unclear since intensities for only six of the forty-nine gamma-rays were listed.

Of these four papers the most recent, Ven80, is by far the best source of data. It represents the most complete and detailed investigation of the ^{56}Fe(n,γ)^{57}Fe reaction. Vennink et al. took the time to measure many more weak gamma-rays than the other authors, and constructed a detailed decay scheme for ^{57}Fe. They were also the only experimenters to measure and subtract spectral contributions from the other stable iron isotopes. In fact, their stated purpose was to improve the thermal-neutron capture data for ^{56}Fe and ^{58}Fe. The ^{56}Fe thermal-neutron capture spectrum from each paper is listed in Table 6.

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]
122.08	----[b]	121.9	3.8	128.7	----	----	----
136.52	----[b]	136.6	0.5	----	----	----	----
211.87	0.08	----	----	----	----	----	----
230.29	0.87	230.3	0.9	230.3	----	----	----
251.1	0.04	----	----	----	----	----	----
335.9	0.04	----	----	----	----	----	----
339.54	0.08	----	----	----	----	----	----
352.36	9.5	352.3	11.9	352	7.5	----	----
366.75	1.68	366.2	2.1	366.3	----	----	----
460.1	0.03	----	----	----	----	----	----
564.19	0.22	----	----	----	----	----	
569.92	0.52	570.2	0.6	569.9	----	----	----
575.09	0.19	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
598.63	0.22	----	----	----	----	----	----
601.3	0.14	----	----	----	----	----	----
603.54	0.16	----	----	----	----	----	----
657.56	0.25	----	----	----	----	----	----
692.03	4.75	692.2	9	692.1	----	----	----
703.4	0.05	----	----	----	----	----	----
706.4	0.27	705	2.4	----	----	----	----
723	0.01	----	----	----	----	----	----
735.1	0.04	----	----	----	----	----	----
747.31	0.12	----	----	----	----	----	----
749.4	0.04	----	----	----	----	----	----
803.09	0.21	----	----	----	----	----	----
818.6	0.04	----	----	----	----	----	----
834.91	0.21	----	----	----	----	----	----
837.9	0.07	----	----	----	----	----	----
849.5	0.04	----	----	----	----	----	----
870.75	0.17	----	----	----	----	----	----
884.78	0.28	----	----	----	----	----	----
898.28	1.9	898.3	3	898.2	----	----	----
920.85	0.76	921	1.3	920.2	----	----	----
942	0.02	----	----	----	----	----	----
977.1	0.05	----	----	----	----	----	----
988.2	0.03	----	----	----	----	----	----
991.8	0.04	----	----	----	----	----	----
1006.9	0.03	----	----	----	----	----	----
1019.02	1.74	1018.6	3.1	1019.1	----	----	----
1022	0.05	----	----	----	----	----	----
1026.4	0.05	----	----	----	----	----	----
1041.1	0.03	----	----	----	----	----	----
1043.9	0.07	----	----	----	----	----	----
1077.3	0.04	----	----	----	----	----	----
1110.9	0.05	----	----	----	----	----	----
1115.64	0.09	----	----	----	----	----	----
1119.8	0.02	----	----	----	----	----	----
1159.5	0.02	----	----	----	----	----	----
1186	0.04	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
1197.27	0.36	----	----	----	----	----	----
1215.38	0.1	----	----	----	----	----	----
1218.55	0.07	----	----	----	----	----	----
1250.99	0.12	1250.9	0.2	----	----	----	----
1255.5	0.02	----	----	----	----	----	----
1260.6	2.5	1261.4	5.1	1260.7	----	----	----
1263.3	0.1	----	----	----	----	----	----
1282.3	0.09	----	----	----	----	----	----
1284	0.1	----	----	----	----	----	----
1300.9	0.09	----	----	----	----	----	----
1305.5	0.07	----	----	----	----	----	----
1345.2	0.06	----	----	----	----	----	----
1351.8	0.05	----	----	----	----	----	----
1355.6	0.13	----	----	----	----	----	----
1358.71	0.9	1359.3	1.9	1358.9	----	----	----
1369.1	0.13	----	----	----	----	----	----
1371.6	0.06	----	----	----	----	----	----
1381.7	0.13	----	----	----	----	----	----
1412.01	0.17	----	----	----	----	----	----
1430.2	0.04	----	----	----	----	----	----
1435.58	0.22	----	----	----	----	----	----
1447	0.08	----	----	----	----	----	----
1457.4	0.04	----	----	----	----	----	----
1460.9	0.08	----	----	----	----	----	----
1487.2	0.03	----	----	----	----	----	----
1492.4	0.06	----	----	----	----	----	----
1506	0.08	----	----	----	----	----	----
1584.6	0.07	----	----	----	----	----	----
1612.78	5.38	1612.4	9.2	1612.9	----	1612.7	5.7
1627.05	0.21	1627.3	1	----	----	----	----
1646	0.07	----	----	----	----	----	----
1655.51	0.15	----	----	----	----	----	----
1672.1	0.04	----	----	----	----	----	----
1674.62	0.08	----	----	----	----	----	----
1691	0.07	----	----	----	----	----	----
1697.34	0.27	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
1700.8	0.11	----	----	----	----	----	----
1705	0.03	----	----	----	----	----	----
1710.2	0.25	----	----	----	----	----	----
1717.2	0.07	----	----	----	----	----	----
1722.4	0.33	----	----	----	----	----	----
1725.29	6.3	1725.7	12.5	1725.4	----	1725.05	7.4
1760.1	0.12	----	----	----	----	----	----
1802.3	0.04	----	----	----	----	----	----
1810.51	0.25	----	----	----	----	----	----
1812.9	0.07	----	----	----	----	----	----
1825.9	0.09	----	----	----	----	----	----
1828.9	0.03	----	----	----	----	----	----
1836.4	0.06	----	----	----	----	----	----
1841.9	0.09	----	----	----	----	----	----
1851.3	0.06	----	----	----	----	----	----
1855.9	0.06	----	----	----	----	----	----
1899.5	0.06	----	----	----	----	----	----
1927.6	0.04	----	----	----	----	----	----
1931.8	0.06	----	----	----	----	----	----
1943.1	0.29	----	----	----	----	----	----
1965.3	0.29	----	----	----	----	----	----
1973.4	0.15	----	----	----	----	----	----
1976.4	0.04	----	----	----	----	----	----
1982.1	0.08	----	----	----	----	----	----
1987	0.04	----	----	----	----	----	----
1991	0.03	----	----	----	----	----	----
2033.2	0.05	----	----	----	----	----	----
2039.7	0.05	----	----	----	----	----	----
2045.7	0.07	----	----	----	----	----	----
2066.17	0.49	----	----	----	----	2066.06	0.7
2068.9	0.11	----	----	----	----	----	----
2081.2	0.1	----	----	----	----	----	----
2091.85	0.38	----	----	----	----	----	----
2097	0.05	----	----	----	----	----	----
2101.3	0.08	----	----	----	----	----	----
2104.5	0.14	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
2113.4	0.15	----	----	----	----	----	----
2129.48	0.67	----	----	2129.4	1	2129.16	0.9
2138.63	0.17	2137.6	0.9	----	----	----	----
2151.5	0.17	----	----	----	----	----	----
2164.69	0.2	----	----	----	----	----	----
2186.6	0.04	----	----	----	----	----	----
2192.8	0.25	----	----	----	----	----	----
2198.2	0.17	----	----	----	----	----	----
2202.7	0.13	----	----	----	----	----	----
2206.8	0.21	----	----	----	----	----	----
2216.2	0.12	----	----	----	----	----	----
2246	0.11	----	----	----	----	----	----
2348.9	0.06	----	----	----	----	----	----
2351.7	0.11	----	----	----	----	----	----
2385.3	0.09	----	----	----	----	----	----
2391.8	0.22	----	----	----	----	----	----
2407.4	0.1	----	----	----	----	----	----
2415.1	0.16	----	----	----	----	----	----
2424.3	0.06	----	----	----	----	----	----
2462.1	0.07	----	----	----	----	----	----
2466	0.08	2468.5	0.8	----	----	2469.17	0.6
2480.2	0.06	----	----	----	----	----	----
2486	0.08	----	----	----	----	----	----
2490.8	0.03	----	----	----	----	----	----
2507.2	0.04	----	----	----	----	----	----
2517	0.1	----	----	----	----	----	----
2526.2	0.29	----	----	2527.9	----	2526.42	0.5
2534	0.06	----	----	----	----	----	----
2537.1	0.08	----	----	----	----	----	----
2562.4	0.04	----	----	----	----	----	----
2574.3	0.11	----	----	----	----	----	----
2582	0.09	----	----	----	----	----	----
2598.1	0.03	----	----	----	----	----	----
2603.1	0.07	----	----	----	----	----	----
2618.9	0.05	----	----	----	----	----	----
2654.3	0.05	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
2682.5	0.43	2683.2	0.6	2683.2	----	2682.54	0.6
2691.6	0.07	----	----	----	----	----	----
2696.6	0.3	2696.4	0.5	2696.4	----	----	----
2704.6	0.05	----	----	----	----	----	----
2721.17	1.37	2721.9	2.1	2721.6	2.3	2721.32	1.8
2734.2	0.15	----	----	----	----	----	----
2753	0.42	----	----	----	----	----	----
2755.9	0.57	----	----	----	----	----	----
2815	0.09	----	----	----	----	----	----
2821.5	0.1	2820.8	0.3	----	----	----	----
2832.46	0.53	----	----	----	----	----	----
2835.43	0.25	2835	0.7	2835.1	1.4	2835.6	0.6
2873.7	0.37	2873.7	0.6	2873.3	----	2873.7	0.5
2935.8	0.05	----	----	----	----	----	----
2943.4	0.08	----	----	----	----	----	----
2950.2	0.07	----	----	----	----	----	----
2954.04	0.36	----	----	2953.6	----	2953.86	0.5
2970.3	0.18	----	----	----	----	----	----
3014.7	0.12	----	----	----	----	----	----
3027.55	0.11	----	----	----	----	----	----
3047.9	0.04	----	----	----	----	----	----
3060.9	0.15	----	----	3060.8	----	----	----
3075.1	0.11	----	----	----	----	----	----
3103.1	0.67	----	----	3103.6	----	3103.23	0.9
3166.9	0.16	----	----	3171.2	----	----	----
3186.0	0.68	----	----	3186.5	----	3185.78	0.8
3225.3	0.3	----	----	3225.7	----	----	----
3239.3	0.35	----	----	3239.8	----	----	----
3267.05	1.29	----	----	3267.7	----	3267.37	1.7
3291.1	0.3	----	----	----	----	----	----
3356.3	0.34	----	----	3358.2	----	----	----
3412.9	1.61	----	----	3413.5	----	3413.16	2.2
3436.4	1.63	----	----	3437.1	----	3436.61	2.1
----	----	----	----	----	----	3486.72[c]	0.5
3504.5	0.18	----	----	3507.7	----	----	----
3508.6	0.05	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
3610.2	0.05	----	----	----	----	----	----
3641.33	0.2	----	----	----	----	----	----
3649	0.03	----	----	----	----	----	----
3663.0	0.13	----	----	----	----	----	----
3689.4	0.06	----	----	----	----	----	----
3710.9	0.07	----	----	----	----	----	----
3723.6	0.18	----	----	----	----	----	----
3776.6	0.08	----	----	3778.5	----	----	----
----	----	----	----	3792.5[d]	----	----	----
3842.4	0.29	----	----	----	----	----	----
3854	0.19	----	----	3854.3	----	3854.27	1.6
3921.5	1.34	----	----	----	----	----	----
3955.3	0.11	----	----	----	----	----	----
3981.7	0.1	----	----	----	----	----	----
3991	0.05	----	----	----	----	----	----
----	----	----	----	4012.1[e]	----	----	----
4073.3	0.21	----	----	----	----	----	----
4194.8	0.13	----	----	----	----	----	----
4210.2	0.07	----	----	----	----	----	----
4217.98	3.77	----	----	4218.6	3.5	4218.28	4.2
4274.5	0.25	----	----	4275.1	----	4274.72	0.5
4323.8	0.12	----	----	----	----	----	----
4378.3	0.16	----	----	----	----	----	----
4405.74	1.64	----	----	4406.2	----	4406.11	1.9
4418.2	0.13	----	----	----	----	----	----
4462.5	0.52	----	----	4460.7	0.4	4462.66	0.6
4555.5	0.09	----	----	----	----	----	----
----	----	----	----	4575.1	----	----	----
4597.4	0.15	----	----	----	----	----	----
4659.3	0.09	----	----	----	----	----	----
4675.1	0.4	----	----	----	----	----	----
4687	0.11	----	----	----	----	----	----
4724	0.28	----	----	----	----	----	----
4809.83	1.85	----	----	4810.4	----	4809.94	1.8
4825.6	0.07	----	----	----	----	----	----
4840	0.07	----	----	----	----	----	----

Table 6: Comparison of thermal-neutron capture spectra for ^{56}Fe

Vennink 1980		Eissa 1971		Sakamoto 1979		Stelts 1978	
Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]
4845.5	0.1	----	----	----	----	----	----
4856.6	0.1	----	----	----	----	----	----
4914	0.15	----	----	----	----	----	----
4948.3	0.85	----	----	4948.9	----	4948.85	0.8
5042.1	0.18	----	----	----	----	----	----
5047.4	0.17	----	----	----	----	----	----
5179.7	0.05	----	----	----	----	----	----
5318	0.09	----	----	----	----	----	----
5325.8	0.18	----	----	----	----	----	----
5730.64	0.46	----	----	----	----	----	----
5784.9	0.19	----	----	----	----	----	----
5901.4	0.19	----	----	----	----	----	----
5920.35	9.6	----	----	5920.3	----	5920.31	9.1
5992	0.22	----	----	----	----	----	----
6018.42	9.9	----	----	6018.6	----	6018.47	9.3
6102.1	0.05	----	----	----	----	----	----
6129.3	0.12	----	----	----	----	----	----
6219.4	0.08	----	----	----	----	----	----
6276.4	0.12	----	----	----	----	----	----
6380.47	1.11	----	----	6380.9	----	6380.74	0.8
6548.5	0.16	----	----	----	----	----	----
6717.4	0.45	----	----	----	----	----	----
6742	0.12	----	----	----	----	----	----
7199	0.1	----	----	----	----	----	----
7278.82	6	----	----	7278.9	----	7278.76	5.7
7631.18	29	----	----	7631.6	----	7631.09	27.7
7645.58	25	----	----	7644.9	----	7645.47	24.4
----	----	----	----	----	----	8885.76[d]	0.8

[a]Number of photons per 100 neutron captures.
[b]Intensity not listed since the detector efficiency was poorly known below $E_\gamma \approx 200 keV$.
[c]Most likely from capture in ^{57}Fe.
[d]Most likely from capture in ^{54}Fe.
[e]Most likely from capture in ^{58}Fe.

Although Ven80 is the best data source, a line-by-line analysis of Table 6 was performed to try and spot problems with it. Two indications of problems were sought. First, gamma-rays observed by multiple authors but *not* Ven80 might indicate a missed line. No such gamma-rays were found. Second, two or more authors in strong disagreement (energy or intensity) with Ven80 might indicate incorrect values. All gamma-rays observed by Ven80 and *two or more* authors were analyzed to look for such disagreements.

An examination of the gamma-ray energies revealed excellent agreement between all the authors. An analysis of all gamma-ray intensities resulted in only six cases where two or more authors were in strong disagreement with Ven80; the 2129, 2466, 2682, 2721, 2835, and 2873 keV lines. However, if the other authors' intensities are averaged and substituted for only these six cases, the resulting spectral yield becomes 7691.58 keV, which is greater than the total available energy of 7646.03 keV (from Audi[9]). This is because the other authors' intensities are much larger. In fact, in *all cases* where there is significant disagreement between Ven80 and at least one other author, the other authors' intensities are always higher than Ven80, often by factors of two or more. This strongly suggests that all the other authors' intensities are consistently inflated and the values from Ven80 should be used since the total energy available would be exceeded otherwise.

B. Comparison with ENSDF and Recommended ACTI spectrum for

Table 7: Recommended ACTI spectrum for ^{56}Fe[a]

Eγ (keV)	Iγ [b]	Eγ (keV)	Iγ [b]
122.08	3.81[c]	991.80	0.04
136.52	0.50[c]	1006.90	0.03
211.87	0.08	1019.02	1.74
230.29	0.87	1022.00	0.05
251.10	0.04	1026.40	0.05
335.90	0.04	1041.10	0.03
339.54	0.08	1043.90	0.07
352.36	9.51	1077.30	0.04
366.75	1.68	1110.90	0.05
460.10	0.03	1115.64	0.09
564.19	0.22	1119.80	0.02
569.92	0.52	1159.50	0.02
575.09	0.19	1186.00	0.04
598.63	0.22	1197.27	0.36
601.30	0.14	1215.38	0.10
603.54	0.16	1218.55	0.07
657.56	0.25	1250.99	0.12
692.03	4.76	1255.50	0.02
703.40	0.05	1260.60	2.50
706.40	0.27	1263.30	0.10
723.00	0.01	1282.30	0.09
735.10	0.04	1284.00	0.10
747.31	0.12	1300.90	0.09
749.40	0.04	1305.50	0.07
803.09	0.21	1345.20	0.06
818.60	0.04	1351.80	0.05
834.91	0.21	1355.60	0.13
837.90	0.07	1358.71	0.90
849.50	0.04	1369.10	0.13
870.75	0.17	1371.60	0.06
884.78	0.28	1381.70	0.13
898.28	1.90	1412.01	0.17
920.85	0.76	1430.20	0.04
942.00	0.02	1435.58	0.22
977.10	0.05	1447.00	0.08
988.20	0.03	1457.40	0.04

Table 7: Recommended ACTI spectrum for ^{56}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
1460.90	0.08	1987.00	0.04
1487.20	0.03	1991.00	0.03
1492.40	0.06	2033.20	0.05
1506.00	0.08	2039.70	0.05
1584.60	0.07	2045.70	0.07
1612.78	5.39	2066.17	0.49
1627.05	0.21	2068.90	0.11
1646.00	0.07	2081.20	0.10
1655.51	0.15	2091.85	0.38
1672.10	0.04	2097.00	0.05
1674.62	0.08	2101.30	0.08
1691.00	0.07	2104.50	0.14
1697.34	0.27	2113.40	0.15
1700.80	0.11	2129.48	0.67
1705.00	0.03	2138.63	0.17
1710.20	0.25	2151.50	0.17
1717.20	0.07	2164.69	0.20
1722.40	0.33	2186.60	0.04
1725.29	6.31	2192.80	0.25
1760.10	0.12	2198.20	0.17
1802.30	0.04	2202.70	0.13
1810.51	0.25	2206.80	0.21
1812.90	0.07	2216.20	0.12
1825.90	0.09	2246.00	0.11
1828.90	0.03	2348.90	0.06
1836.40	0.06	2351.70	0.11
1841.90	0.09	2385.30	0.09
1851.30	0.06	2391.80	0.22
1855.90	0.06	2407.40	0.10
1899.50	0.06	2415.10	0.16
1927.60	0.04	2424.30	0.06
1931.80	0.06	2462.10	0.07
1943.10	0.29	2466.00	0.08
1965.30	0.29	2480.20	0.06
1973.40	0.15	2486.00	0.08
1976.40	0.04	2490.80	0.03
1982.10	0.08	2507.20	0.04

Table 7: Recommended ACTI spectrum for ^{56}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
2517.00	0.10	3225.30	0.30
2526.20	0.29	3239.30	0.35
2534.00	0.06	3267.05	1.29
2537.10	0.08	3291.10	0.30
2562.40	0.04	3356.30	0.34
2574.30	0.11	3412.90	1.61
2582.00	0.09	3436.40	1.63
2598.10	0.03	3504.50	0.18
2603.10	0.07	3508.60	0.05
2618.90	0.05	3610.20	0.05
2654.30	0.05	3641.33	0.20
2682.50	0.43	3649.00	0.03
2691.60	0.07	3663.00	0.13
2696.60	0.30	3689.40	0.06
2704.60	0.05	3710.90	0.07
2721.17	1.37	3723.60	0.18
2734.20	0.15	3776.60	0.08
2753.00	0.42	3842.40	0.29
2755.90	0.57	3854.00	0.19
2815.00	0.09	3921.50	1.34
2821.50	0.10	3955.30	0.11
2832.46	0.53	3981.70	0.10
2835.43	0.25	3991.00	0.05
2873.70	0.37	4073.30	0.21
2935.80	0.05	4194.80	0.13
2943.40	0.08	4210.20	0.07
2950.20	0.07	4217.98	3.78
2954.04	0.36	4274.50	0.25
2970.30	0.18	4323.80	0.12
3014.70	0.12	4378.30	0.16
3027.55	0.11	4405.74	1.64
3047.90	0.04	4418.20	0.13
3060.90	0.15	4462.50	0.52
3075.10	0.11	4555.50	0.09
3103.10	0.67	4597.40	0.15
3166.90	0.16	4659.30	0.09
3186.00	0.68	4675.10	0.40

Table 7: Recommended ACTI spectrum for ^{56}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
4687.00	0.11	5901.40	0.19
4724.00	0.28	5920.35	9.61
4809.83	1.85	5992.00	0.22
4825.60	0.07	6018.42	9.91
4840.00	0.07	6102.10	0.05
4845.50	0.10	6129.30	0.12
4856.60	0.10	6219.40	0.08
4914.00	0.15	6276.40	0.12
4948.30	0.85	6380.47	1.11
5042.10	0.18	6548.50	0.16
5047.40	0.17	6717.40	0.45
5179.70	0.05	6742.00	0.12
5318.00	0.09	7199.00	0.10
5325.80	0.18	7278.82	6.01
5730.64	0.46	7631.18	29.04
5784.90	0.19	7645.58	25.04

[a]All values are from Ven80[14] unless otherwise noted.
[b]Number of photons per 100 captures, normalized to Q-value of Audi[9].
[c]From Eis71[17].

IV. ^{57}Fe

A. Comparison of Data

The search for experimental data for ^{57}Fe resulted in only two papers with appreciable amounts of spectral information. Brief summaries of each experimental source as well as the ENSDF data for ^{57}Fe are listed in Table 8. The three spectra are listed in full in Table 9.

Table 8: Sources of thermal-neutron capture data for ^{57}Fe

Author(s)	Designation	Year	Number of gamma-rays	Total Yield (keV)
ENSDF[6]	ENSDF	1973[a]	99	9788.555
U. Fanger et al.[18]	Fan69	1969	99	9810.651
J. Kopecky et al.[19]	Kop73	1973	24	6387.440

[a]The latest paper referenced in the evaluation is from 1973.

Table 9: Comparison of data sources for ^{57}Fe

Fanger 1969		Kopecky 1973		ENSDF 1973	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
233.6	0.03	----	----	233.6	0.03
238.7	0.07	----	----	238.7	0.07
243.1	0.04	----	----	243.1	0.04
252.6	0.05	----	----	252.6	0.05
278.1	0.14	----	----	278.1	0.14
410.9	0.08	----	----	410.9	0.08
459.3	0.39	----	----	459.3	0.39
524.7	1.20	----	----	524.7	1.20
810.48	66.0	----	----	810.48	66.0
854.4	0.10	----	----	854.4	0.10
863.6	18.1	----	----	867.5[b]	18.1
898.2	0.4	----	----	898.2	0.4
1097.4	0.4	----	----	1097.4	0.4
1107.3	3.4	----	----	1107.3	3.4
1164.6	0.3	----	----	1164.6	0.3
1238.7	0.2	----	----	1238.7	0.2
1250.7	0.2	----	----	1250.7	0.2
1260.2	0.6	----	----	1260.2	0.6
1266.8	0.3	----	----	1266.8	0.3
1269.0	0.1	----	----	1269.0	0.1
1292.7	0.35	----	----	1292.7	0.35
1306.0	0.8	----	----	1306.0	0.8
1322.5	1.1	----	----	1322.5	1.1
1446.3	3.5	----	----	1446.3	3.5
1467.7	0.4	----	----	1467.7	0.4
1657.2	0.4	----	----	1657.2	0.4
1662.5	0.9	----	----	1662.5	0.9
1674.2	17.6	----	----	1674.2	17.6
1862.5	1.6	----	----	1862.5	1.6
1971.0	7.3	----	----	1971.0	7.3
2065.5	6.3	----	----	2065.5	6.3
2137.6	0.7	----	----	2137.6	0.7
2273.3	13.0	----	----	2273.3	13.0
2433.5	2.0	----	----	2433.5	2.0
2466.9	0.6	----	----	2466.9	0.6

Table 9: Comparison of data sources for ^{57}Fe

Fanger 1969		Kopecky 1973		ENSDF 1973	
Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]	Eγ (keV)	Iγ [a]
2490.6	0.7	----	----	2490.6	0.7
2513.5	1.6	----	----	2513.5	1.6
2726.0	7.2	----	----	2726.0	7.2
2781.0	3.4	----	----	2781.0	3.4
2820	1.9	----	----	2820	1.9
2876	5.7	----	----	2876	5.7
3071	1.6	----	----	3071	1.6
3162	1.4	----	----	3162	1.4
3183	0.5	----	----	3183	0.5
3205	0.8	----	----	3205	0.8
3280	0.3	----	----	3280	0.3
3326	5.7	----	----	3326	5.7
3486	1.0	----	----	3486	1.0
3540	1.8	----	----	3540	1.8
3740	1.1	----	----	3740	1.1
3881	1.4	3881.8	1.2	3881.8	1.4
3952	0.4	----	----	3952	0.4
3987	0.3	----	----	3987	0.3
4006	0.4	----	----	4006	0.4
4062	0.1	----	----	4062	0.1
4080	0.6	----	----	4080	0.6
4139	2.4	4139.9	2.1	4139.9	2.4
4185	0.2	----	----	4185	0.2
4189	0.3	----	----	4189	0.3
4296	1.0	4298.1	0.8	4298.1	1.0
4322	2.1	4322.1	2.8	4322.1	2.1
4342	0.4	----	----	4342	0.4
4380	0.2	----	----	4380	0.2
4411	0.5	----	----	4411	0.5
4443	0.7	----	----	4443	0.7
4483	0.5	----	----	4483	0.5
4506	0.4	----	----	4506	0.4
4521	0.8	----	----	4521	0.8
4592	0.3	----	----	4592	0.3
4629	3.0	4626.5	3.3	4626.5	3.3
4712	0.6	----	----	4712	0.6

Table 9: Comparison of data sources for ^{57}Fe

Fanger 1969		Kopecky 1973		ENSDF 1973	
Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]	Eγ (keV)	Iγ[a]
4749	2.8	4749.8	3.0	4749.8	3.0
4789	0.4	----	----	4789	0.4
4822	2.8	4823.9	2.4	4823.9	2.4
4889	0.6	----	----	4889	0.6
5001	1.4	5001.0	1.5	5001.0	1.5
5042	10.0	5044.0	10.7	5044.0	10.7
5092	0.2	----	----	5092	0.2
5212	0.55	----	----	5212	0.6
5223	0.6	----	----	5223	0.6
5241	0.4	----	----	5241	0.4
5493	11.5	5493.9	10.9	5493.9	10.9
5600	1.1	5600.2	1.1	5600.2	1.1
5690	2.6	5691.6	2.5	5691.6	2.5
5721	3.0	5721.8	2.5	5721.8	2.5
5745	2.9	5747.0	2.4	5747.0	2.4
5890	0.4	----	----	5890	0.4
5904	2.25	5905.6	2.5	5905.6	2.5
6033	1.0	6028.7	1.2	6028.7	1.2
6162	3.0	6163.1	3.3	6163.1	3.3
6413	1.5	6414.3	1.6	6414.3	1.6
6505	7.0	6506.4	6.8	6506.4	6.8
6840	0.2	----	----	6840	0.2
6957	11.5	6960.7	10.5	6960.7	10.5
7163	0.6	----	----	7163	0.6
7262	11.6	7262.2	11.4	7262.2	11.4
8368	11.2	8369.7	11.8	8369.7	11.8
9233	2.2	9233.7	2.2	9233.7	2.2
10043	2.5	10044.1	2.7	10044.1	2.7

[a]Number of photons per 100 neutron captures.
[b]Value calculated from initial and final state energies.

Table 9 reveals excellent agreement between Fan69 and Kop73. In fact, a careful comparison of the spectra shows that all matching energies and intensities agree within experimental uncertainty.

The ENSDF spectrum is a combination of Kop73 and Fan69. Most ENSDF values are from the more complete Fan69 spectrum. However, because the Kop73 energies were measured more precisely, ENSDF adopts them when possible. The ENSDF intensities are also mostly from Fan69, but many Kop73 values were adopted. It is not clear why some Kop73 intensities were adopted while others were not, but this is hardly a concern given the excellent agreement between Fan69 and Kop73.

Finally, ENSDF adopts 867.5 keV as the energy of the 863.6 keV gamma-ray measured by Fan69. The ENSDF documentation states this was done because the initial and final energy levels of this transition were known more precisely than the actual gamma-ray energy.

B. Recommended ACTI spectrum for ^{57}Fe

The recommended ACTI spectrum for ^{57}Fe is listed in Table 10. All values are from ENSDF, and the yield has been normalized to 10044.46 keV, the Q-value from Audi[9].

Table 10: Recommended ACTI spectrum for ^{57}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
233.60	0.031	1292.70	0.359
238.70	0.072	1306.00	0.821
243.10	0.041	1322.50	1.129
252.60	0.051	1446.30	3.592
278.10	0.144	1467.70	0.410
410.90	0.082	1657.20	0.410
459.30	0.400	1662.50	0.924
524.70	1.231	1674.20	18.060
810.48	67.725	1862.50	1.642
854.40	0.103	1971.00	7.491
867.50	18.573	2065.50	6.465
898.20	0.410	2137.60	0.718
1097.40	0.410	2273.30	13.340
1107.30	3.489	2433.50	2.052
1164.60	0.308	2466.90	0.616
1238.70	0.205	2490.60	0.718
1250.70	0.205	2513.50	1.642
1260.20	0.616	2726.00	7.388
1266.80	0.308	2781.00	3.489
1269.00	0.103	2820.00	1.950

Table 10: Recommended ACTI spectrum for ^{57}Fe[a]

Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
2876.00	5.849	4712.00	0.616
3071.00	1.642	4749.80	3.078
3162.00	1.437	4789.00	0.410
3183.00	0.513	4823.90	2.463
3205.00	0.821	4889.00	0.616
3280.00	0.308	5001.00	1.539
3326.00	5.849	5044.00	10.980
3486.00	1.026	5092.00	0.205
3540.00	1.847	5212.00	0.616
3740.00	1.129	5223.00	0.616
3881.80	1.437	5241.00	0.410
3952.00	0.410	5493.90	11.185
3987.00	0.308	5600.20	1.129
4006.00	0.410	5691.60	2.565
4062.00	0.103	5721.80	2.565
4080.00	0.616	5747.00	2.463
4139.90	2.463	5890.00	0.410
4185.00	0.205	5905.60	2.565
4189.00	0.308	6028.70	1.231
4298.10	1.026	6163.10	3.386
4322.10	2.155	6414.30	1.642
4342.00	0.410	6506.40	6.978
4380.00	0.205	6840.00	0.205
4411.00	0.513	6960.70	10.775
4443.00	0.718	7163.00	0.616
4483.00	0.513	7262.20	11.698
4506.00	0.410	8369.70	12.108
4521.00	0.821	9233.70	2.258
4592.00	0.308	10044.10	2.771
4626.50	3.386		

[a]All values are from ENSDF[6], and the yield was normalized to the Q-value of Audi[9].
[b]Number of photons per 100 neutron captures.

V. ^{58}Fe

Of all the stable isotopes of iron, ^{58}Fe contributes the least (0.14%) to the total photon production spectrum of natural iron at thermal energies. The search for experimental data resulted in only two papers. Brief summaries of each experimental source as well as the ENSDF data for ^{58}Fe are listed in Table 11.

Table 11: Sources of thermal-neutron capture data for ^{58}Fe

Author(s)	Designation	Year	Number of gamma-rays	Total Yield (keV)
ENSDF[6]	ENSDF	1983[a]	139	6572.142
R. Vennink et al.[14]	Ven80	1980	139	6572.142
A. P. Bogdanov et al.[20]	Bog72	1972	13	5907.774

[a]The latest reference in the evaluation is from 1983.

Of the two experimental papers, Ven80 is clearly superior. Bog72 only measured 13 gamma-rays, and the experimental uncertainties were large (on the order of 3-6 keV for energies). Also, the detectors used by Bogdanov et al. had roughly a factor of five worse resolution than those used by Vennink et al. For these reasons, Bog72 will not be considered in detail. The spectra from Ven80 and ENSDF are compared in Table 12.

Table 12 shows that the ENSDF spectrum is almost identical to Ven80. The only difference is the 570.87 keV ENSDF gamma-ray, which is listed as 570.81 keV in Ven80. Because Ven80 is the only decent source of experimental data, the recommended ACTI spectrum for ^{58}Fe is simply the spectrum from Ven80 normalized to the Q-value of Audi[9]. The recommended ACTI spectrum for ^{58}Fe is also listed in Table 12.

Table 12: Comparison of thermal-neutron capture data for ^{58}Fe

Vennink 1980		ENSDF 1983		Recommended ACTI Spectrum[a]	
Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
280.4	0.38	280.4	0.38	280.40	0.381
287.03	59	287.03	59	287.03	59.079
374.7	0.08	374.7	0.08	374.70	0.080
379.1	0.05	379.1	0.05	379.10	0.050
439.43	0.75	439.43	0.75	439.43	0.751
465.0	0.23	465.0	0.23	465.00	0.230
537.4	0.04	537.4	0.04	537.40	0.040
552.5	0.08	552.5	0.08	552.50	0.080
570.81	4.9	570.87	4.9	570.81	4.907
591.20	3.26	591.20	3.26	591.20	3.264
605.38	0.42	605.38	0.42	605.38	0.421
610.7	0.35	610.7	0.35	610.70	0.350
613.1	0.20	613.1	0.20	613.10	0.200
627.3	0.10	627.3	0.10	627.30	0.100
642.9	0.09	642.9	0.09	642.90	0.090
670.6	0.07	670.6	0.07	670.60	0.070
688.6	0.10	688.6	0.10	688.60	0.100
697.19	0.42	697.19	0.42	697.19	0.421
699.7	0.36	699.7	0.36	699.70	0.360
710.9	0.14	710.9	0.14	710.90	0.140
727.4	20.2	727.4	20.2	727.40	20.227
756.92	0.25	756.92	0.25	756.92	0.250
767.0	0.06	767.0	0.06	767.00	0.060
776.9	0.05	776.9	0.05	776.90	0.050
826.9	0.07	826.9	0.07	826.90	0.070
841.24	0.77	841.24	0.77	841.24	0.771
875.12	0.95	875.12	0.95	875.12	0.951
968.9	0.04	968.9	0.04	968.90	0.040
1048.8	0.10	1048.8	0.10	1048.80	0.100
1059.1	0.05	1059.1	0.05	1059.10	0.050
1062.1	0.10	1062.1	0.10	1062.10	0.100
1136.9	0.16	1136.9	0.16	1136.90	0.160
1162.17	0.48	1162.17	0.48	1162.17	0.481
1192.50	0.73	1192.50	0.73	1192.50	0.731

Table 12: Comparison of thermal-neutron capture data for ^{58}Fe

Vennink 1980		ENSDF 1983		Recommended ACTI Spectrum[a]	
Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
1211.24	1.95	1211.24	1.95	1211.24	1.953
1235.54	2.36	1235.54	2.36	1235.54	2.363
1273.6	0.21	1273.6	0.21	1273.60	0.210
1323.3	0.08	1323.3	0.08	1323.30	0.080
1348.4	0.23	1348.4	0.23	1348.40	0.230
1376.2	0.06	1376.2	0.06	1376.20	0.060
1468.3	0.11	1468.3	0.11	1468.30	0.110
1477.3	0.11	1477.3	0.11	1477.30	0.110
1544.8	0.08	1544.8	0.08	1544.80	0.080
1548.8	0.07	1548.8	0.07	1548.80	0.070
1551.7	0.06	1551.7	0.06	1551.70	0.060
1569.88	0.70	1569.88	0.70	1569.88	0.701
1598.79	0.59	1598.79	0.59	1598.79	0.591
1647.6	0.36	1647.6	0.36	1647.60	0.360
1719.9	0.72	1719.9	0.72	1719.90	0.721
1722.1	0.73	1722.1	0.73	1722.10	0.731
1730.3	0.11	1730.3	0.11	1730.30	0.110
1749.5	0.08	1749.5	0.08	1749.50	0.080
1904.3	0.07	1904.3	0.07	1904.30	0.070
1918.71	5.69	1918.71	5.69	1918.71	5.698
1956.8	0.15	1956.8	0.15	1956.80	0.150
1961.92	0.84	1961.92	0.84	1961.92	0.841
2084.0	0.19	2084.0	0.19	2084.00	0.190
2091.0	0.40	2091.0	0.40	2091.00	0.401
2103.0	0.23	2103.0	0.23	2103.00	0.230
2138.20	0.37	2138.20	0.37	2138.20	0.370
2160.20	2.31	2160.20	2.31	2160.20	2.313
2240.9	0.14	2240.9	0.14	2240.90	0.140
2279.3	0.05	2279.3	0.05	2279.30	0.050
2322.4	0.28	2322.4	0.28	2322.40	0.280
2339.7	0.13	2339.7	0.13	2339.70	0.130
2361.62	0.32	2361.62	0.32	2361.62	0.320
2428.6	0.06	2428.6	0.06	2428.60	0.060
2447.8	0.25	2447.8	0.25	2447.80	0.250
2494.3	0.05	2494.3	0.05	2494.30	0.050
2505.1	0.08	2505.1	0.08	2505.10	0.080

Table 12: Comparison of thermal-neutron capture data for ^{58}Fe

Vennink 1980		ENSDF 1983		Recommended ACTI Spectrum[a]	
Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
2533.2	0.24	2533.2	0.24	2533.20	0.240
2578.4	0.10	2578.4	0.10	2578.40	0.100
2635.4	0.22	2635.4	0.22	2635.40	0.220
2751.6	0.33	2751.6	0.33	2751.60	0.330
2872.57	0.30	2872.57	0.30	2872.57	0.300
2896.4	0.08	2896.4	0.08	2896.40	0.080
2908.6	0.62	2908.6	0.62	2908.60	0.621
2916.2	0.06	2916.2	0.06	2916.20	0.060
2948.2	0.30	2948.2	0.30	2948.20	0.300
2966.6	0.18	2966.6	0.18	2966.60	0.180
3057.1	0.05	3057.1	0.05	3057.10	0.050
3070.4	0.1	3070.4	0.1	3070.40	0.100
3081.4	0.16	3081.4	0.16	3081.40	0.160
3097.9	0.07	3097.9	0.07	3097.90	0.070
3108.4	0.57	3108.4	0.57	3108.40	0.571
3114.0	1.0	3114.0	1.0	3114.00	1.001
3129.2	0.06	3129.2	0.06	3129.20	0.060
3196.41	0.10	3196.41	0.10	3196.41	0.100
3200.3	0.08	3200.3	0.08	3200.30	0.080
3239.5	1.00	3239.5	1.00	3239.50	1.001
3337.1	0.04	3337.1	0.04	3337.10	0.040
3340.8	1.06	3340.8	1.06	3340.80	1.061
3422.6	0.06	3422.6	0.06	3422.60	0.060
3477.8	0.06	3477.8	0.06	3477.80	0.060
3502.2	0.43	3502.2	0.43	3502.20	0.431
3513	0.04	3513	0.04	3513.00	0.040
3523.4	0.12	3523.4	0.12	3523.40	0.120
3532.1	0.22	3532.1	0.22	3532.10	0.220
3590.0	0.33	3590.0	0.33	3590.00	0.330
3664.4	0.19	3664.4	0.19	3664.40	0.190
3757.3	0.08	3757.3	0.08	3757.30	0.080
3770.5	0.33	3770.5	0.33	3770.50	0.330
3824.0	0.13	3824.0	0.13	3824.00	0.130
3862	0.06	3862	0.06	3862.00	0.060
4011.5	0.71	4011.5	0.71	4011.50	0.711
4035.7	0.07	4035.7	0.07	4035.70	0.070

Table 12: Comparison of thermal-neutron capture data for ^{58}Fe

Vennink 1980		ENSDF 1983		Recommended ACTI Spectrum[a]	
Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]	Eγ (keV)	Iγ[b]
4072.5	0.18	4072.5	0.18	4072.50	0.180
4114.2	0.12	4114.2	0.12	4114.20	0.120
4126.0	0.13	4126.0	0.13	4126.00	0.130
4133.4	3.58	4133.4	3.58	4133.40	3.585
4164.3	0.31	4164.3	0.31	4164.30	0.310
4260.0	0.39	4260.0	0.39	4260.00	0.391
4418.7	0.49	4418.7	0.49	4418.70	0.491
4508.0	0.45	4508.0	0.45	4508.00	0.451
4618.86	3.4	4618.86	3.4	4618.86	3.405
4628.7	0.33	4628.7	0.33	4628.70	0.330
4661.81	8.2	4661.81	8.2	4661.81	8.211
4729.5	0.07	4729.5	0.07	4729.50	0.070
4757.8	0.42	4757.8	0.42	4757.80	0.421
4763.8	0.17	4763.8	0.17	4763.80	0.170
4923.2	0.21	4923.2	0.21	4923.20	0.210
5009.2	0.37	5009.2	0.37	5009.20	0.370
5136	0.07	5136	0.07	5136.00	0.070
5204.3	0.11	5204.3	0.11	5204.30	0.110
5369.1	0.33	5369.1	0.33	5369.10	0.330
5375.4	0.26	5375.4	0.26	5375.40	0.260
5383.3	0.19	5383.3	0.19	5383.30	0.190
5419.5	7.1	5419.5	7.1	5419.50	7.109
5565.3	0.4	5565.3	0.4	5565.30	0.401
5573.9	0.36	5573.9	0.36	5573.90	0.360
5611.7	0.28	5611.7	0.28	5611.70	0.280
5672.2	0.17	5672.2	0.17	5672.20	0.170
5854.25	14.9	5854.25	14.9	5854.25	14.920
6012.7	0.54	6012.7	0.54	6012.70	0.541
6097.0	0.19	6097.0	0.19	6097.00	0.190
6104.4	0.23	6104.4	0.23	6104.40	0.230
6228.4	0.2	6228.4	0.2	6228.40	0.200
6293.63	47	6293.63	47	6293.63	47.063
6580.89	3.4	6580.89	3.4	6580.89	3.405

[a]All values are from Ven80[14]. Yield was normalized to Q-value of Audi[9].
[b]Number of photons per 100 neutron captures.

VI. Summary

Several sources of thermal-neutron capture data for the stable iron isotopes have been analyzed, and the best possible photon production spectrum for each isotope has been produced and presented. These spectra are recommended for use by ACTI and any other applications requiring high-quality photon production data for thermal-neutron capture in iron. A similar analysis of photon production data for the stable copper isotopes is currently underway.

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