Experiments in the EXFOR library for evaluation of thermal neutron constants

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Abstract. E.J. Axton's experimental database adopted in evaluation of thermal neutron constants by himself and also by a recent project to update the IAEA Neutron Standard was checked against the experimental literature and EXFOR library. We discovered that many data are found neither in the EXFOR library nor in the articles quoted by Axton due to various reasons. This paper summarizes the status of the experimental data cited by Axton in the experimental literature as well as in the EXFOR library.

Cross sections for thermal (2200 m/s) neutrons are fundamental neutron-induced reaction data, which have been evaluated at the IAEA since the pioneering works by Westcott [1], Hanna [2] and Lemmel [3,4]. In a typical evaluation of the thermal neutron constants (TNC) within the current IAEA Neutron Standards [5], 25 constants (elastic, fission and capture cross sections, absorption and fission g-factors, and total fission neutron multiplicities of ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu at the thermal energy as well as ^{252}Cf spontaneous total fission neutron multiplicity) measured both in differential (mono-energetic) and integral (broad spectrum) experiments are included in a simultaneous generalized least-squares analysis by the GMA code [5]. Recent TNC evaluations for update of the IAEA Neutron Standard are based on the comprehensive work by Axton [6–8]. However, Axton's experimental database (Table 1 of [8]) contains many data not available in the EXFOR library [9]. We have reviewed Axton's experimental database to identify the data missing in EXFOR and possible experimental corrections.

The results are summarized in Table 1, where

- "Quantity" gives the quantity given in the Axton's database, where (1) a, f, s, sm and γ stand for absorption, fission, scattering, scattering for rolled metal and capture; (2) 9, 0, 1, 2, 3, 4, 5, 52 for ^{239,240,241,242}Pu, ^{233,234,235}U and ^{252}Cf; (3) σ and η for 2200 m/s cross section and eta, $\bar{\nu}$ for total fission neutron multiplicity, $\bar{\sigma}$ and $\bar{\eta}$ for Maxwellian spectrum averaged σ and η at $T = 20^{\circ}$C), g' is the Westcott $(g + rs)$ factor at $T = 116^{\circ}$C and $r = 0.00075$, (4) F1HLF, F2HLF and F3HLF are special quantities defined in Appendix 3 of Ref. [7].
- "EXFOR #" gives the EXFOR data set (subentry) number, where (1) five-digit number means that the experimental work is in EXFOR but the quantity cited by Axton is not seen in the literature, (2) eight-digit number with ".000" means the same quantity is under compilation for EXFOR.

The table shows that the same quantity is often not reported by the experimentalist (*e.g.*, absolute cross section in the literature converted to the cross section ratio by Axton, 2200 m/s cross section in the literature converted to the Maxwellian spectrum averaged cross section by Axton, prompt fission neutron multiplicity in the literature converted to the total fission neutron multiplicity by Axton). There are also many cases where the original value is corrected with a newer reference value by Axton (*e.g.*, half-life adopted in sample mass determination, average fission neutron energy for fission neutron detector efficiency calibration). Such values corrected or derived from the literature values are often taken by Axton from Sjöstrand and Story [10], Lemmel [3] and Divadeenam [11] as noted by Axton in Appendix 4 of Ref. [7]. They are not for EXFOR compilation, but we plan to keep them in the "EXFOR Data Correction System" (a complement to the EXFOR database maintained by IAEA NDS) as they could be useful to trace corrections done by the experts.

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Table 1. Status of experimental thermal neutron constants adopted in Axton's database [8].

ID	Quantity	X4/Axton	EXFOR #	Reference reporting the original value
1	$\bar{\sigma}_{a,9}/\bar{\sigma}_{a,5}$			(quantity not reported in the literature)
2	$\bar{\sigma}_{\gamma,9}$		12367	(quantity not reported in the literature)
3	$\bar{\sigma}_{\gamma,3}$	1.044	12335.002	J.Halperin+,J,NSE,16,245,1963
4	$\bar{\sigma}_{\gamma,3}/(\bar{\sigma}_{a,3}\text{-}\bar{\sigma}_{\gamma,4})$		20459	(quantity not reported in the literature)
5	$\bar{\sigma}_{\gamma,4}$			(quantity not for EXFOR)
6	$\bar{\sigma}_{f,5}$			D.Popovic+,R,JENER-19,1953 (not available)
7	$\bar{\sigma}_{f,3}T_{1/2,3}$		20047	(quantity not for EXFOR)
8	$\bar{\sigma}_{f,3}T_{1/2,3}$		23309	(quantity not for EXFOR)
9	$\bar{\sigma}_{f,5}T_{1/2,3}$		23309	(quantity not for EXFOR)
10	$\bar{\sigma}_{f,9}T_{1/2,9}$		23309	(quantity not for EXFOR)
11	$\bar{\sigma}_{f,3}T_{1/2,3}$		12356	(quantity not for EXFOR)
12	$\bar{\sigma}_{f,1}/\bar{\sigma}_{f,9}$	1.005	12521.003	A.H.Jaffey+,R,ANL-5397,1955
13	$\bar{\sigma}_{f,9}/\bar{\sigma}_{f,5}$	1.020	21494.008	P.H.White+,C,66PARIS,2,29,1966
14	$\bar{\sigma}_{f,1}/\bar{\sigma}_{f,5}$	1.021	21494.009	P.H.White+,C,66PARIS,2,29,1966
15	$\bar{\sigma}_{f,3}/\bar{\sigma}_{f,5}$	0.999	20552.000	R.Vidal+,C,70HELSINKI,1,295,1970
16	$\bar{\sigma}_{f,3}/\bar{\sigma}_{f,5}$	1.001	12356.002	C.B.Bigham,J,NSE,59,50,1975
17	$\bar{\sigma}_{f,9}T_{1/2,9}/\bar{\sigma}_{f,5}T_{1/2,4}$			(quantity not for EXFOR)
18	$\bar{\sigma}_{f,9}T_{1/2,9}/\bar{\sigma}_{f,3}T_{1/2,3}$		12356	(quantity not for EXFOR)
19	$\bar{\sigma}_{f,9}T_{1/2,9}/\bar{\sigma}_{f,5}T_{1/2,3}$		12356	(quantity not for EXFOR)
20	$\bar{\sigma}_{f,1}/(\bar{\sigma}_{f,9}T_{1/2,9}$ F3HLF)		12356	(quantity not for EXFOR)
21	$\sigma_{\gamma,3}/\sigma_{f,3}$	1.044	10013.002	M.Lounsbury+,C,70HELSINKI,1,287,1970
22	$\sigma_{\gamma,5}/\sigma_{f,5}$	1.003	10013.003	M.Lounsbury+,C,70HELSINKI,1,287,1970
23	$\sigma_{\gamma,9}/\sigma_{f,9}$	1.012	10013.004	M.Lounsbury+,C,70HELSINKI,1,287,1970
24	$\bar{\sigma}_{\gamma,3}/\bar{\sigma}_{f,3}$		12351?	(quantity not reported in the literature)
25	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		23310	(quantity not reported in the literature)
26	$\bar{\sigma}_{\gamma,3}/\bar{\sigma}_{f,3}$		12350	(quantity not reported in the literature)
27	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		12420	(quantity not reported in the literature)
28	$\bar{\sigma}_{\gamma,3}/\bar{\sigma}_{f,3}$			(quantity not reported in the literature)
29	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		10000	(quantity not reported in the literature)
30	$\bar{\sigma}_{\gamma,3}/\bar{\sigma}_{f,3}$		12313	(quantity not reported in the literature)
31	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		12313	(quantity not reported in the literature)
32	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		12428	(quantity not reported in the literature)
33	$\bar{\sigma}_{\gamma,9}/\bar{\sigma}_{f,9}$		12428	(quantity not reported in the literature)
34	$\bar{\sigma}_{\gamma,3}/\bar{\sigma}_{f,3}$		20459	(quantity not reported in the literature)
35	$\bar{\sigma}_{\gamma,5}/\bar{\sigma}_{f,5}$		20459	(quantity not reported in the literature)
36	$\bar{\sigma}_{\gamma,9}/\bar{\sigma}_{f,9}$		20459	(quantity not reported in the literature)
37	$\bar{\eta}_3/\bar{\eta}_5$	1.000	?	(Its EXFOR entry number has not been assigned yet.)
38	$\bar{\eta}_9/\bar{\eta}_5$	1.001	12505.002	E.Fast+,R,IN-1060,1960
39	$\bar{\eta}_1/\bar{\eta}_5$	0.995	12505.003	E.Fast+,R,IN-1060,1960
40	$(\bar{\eta}_3-1)\bar{\sigma}_{a,3}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		23311	(quantity not reported in the literature)
41	$(\bar{\eta}_9-1)\bar{\sigma}_{a,9}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		23311	(quantity not reported in the literature)
42	$(\bar{\eta}_3-1)\bar{\sigma}_{a,3}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		23311	(quantity not reported in the literature)
43	$(\bar{\eta}_9-1)\bar{\sigma}_{a,9}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		23311	(quantity not reported in the literature)
44	$\bar{\eta}_3\bar{\sigma}_{a,3}/\bar{\eta}_5\bar{\sigma}_{a,5}$	1.000	10207.009	D.W.Magnuson,J,NSE,44,266,1971
45	$\bar{\eta}_9\bar{\sigma}_{a,9}/\bar{\eta}_5\bar{\sigma}_{a,5}$	1.000	10207.010	D.W.Magnuson,J,NSE,44,266,1971
46	$(\bar{\eta}_3-1)\bar{\sigma}_{a,3}$		10208	(quantity not reported in the literature)
47	$(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		10208	(quantity not reported in the literature)
48	$(\bar{\eta}_9-1)\bar{\sigma}_{a,9}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$			(quantity not reported in the literature)
49	$(\bar{\eta}_1-1)\bar{\sigma}_{a,1}/(\bar{\eta}_9-1)\bar{\sigma}_{a,9}$			(quantity not reported in the literature)
50	$(\bar{\eta}_3-1)\bar{\sigma}_{a,3}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		40804	(quantity not reported in the literature)
51	$(\bar{\eta}_9-1)\bar{\sigma}_{a,9}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		40804	(quantity not reported in the literature)
52	$(\bar{\eta}_3-1)\bar{\sigma}_{a,3}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		12361	(quantity not reported in the literature)
53	$(\bar{\eta}_9-1)\bar{\sigma}_{a,9}/(\bar{\eta}_5-1)\bar{\sigma}_{a,5}$		12361	(quantity not reported in the literature)
54	$g_{a,3}$			(quantity not for EXFOR)
55	$g_{a,5}$			(quantity not for EXFOR)
56	$g_{a,9}$			(quantity not for EXFOR)
57	$g_{a,1}$			(quantity not for EXFOR)
58	$g_{f,3}$			(quantity not for EXFOR)
59	$g_{f,5}$			(quantity not reported in the literature)
60	$g_{f,9}$			(quantity not for EXFOR)
61	$g_{f,1}$			(quantity not for EXFOR)
62	$\sigma_{a,5}+\sigma_{sm,5}$	1.000	21179.000	P.A.Egelstaff,R,AERE-NP/R-2104,1,1957
63	$\sigma_{a,5}+\sigma_{sm,5}$	0.995	12426.002	E.Melkonian+,R,CU-115,1953
64	$\sigma_{a,5}+\sigma_{sm,5}$	1.000	12410.003	H.Palevsky+,J,PR,94,1088,1954

Table 1. Continued.

ID	Quantity	X4/Axton	EXFOR #	Reference reporting the original value
65	$\sigma_{a,5}+\sigma_{s,5}$	1.000	41219.007	S.J.Nikitin+,C,55GENEVA,4,224,1956
66	$\sigma_{a,5}+\sigma_{sm,5}$	1.000	12329.003	O.D.Simpson+,J,NSE,7,187,1960
67	$\sigma_{a,5}+\sigma_{s,5}$	0.998	12404.002	G.J.Safford+,J,NSE,6,433,1959
68	$\sigma_{a,5}+\sigma_{sm,5}$	1.001	12404.003	G.J.Safford+,J,NSE,6,433,1959
69	$\sigma_{a,5}+\sigma_{sm,5}$	1.000	12024.013	R.C.Block+,J,NSE,8,112,1960
70	$\sigma_{a,5}+\sigma_{sm,5}$	0.997	12406.003	A.Saplakoglu,J,NSE,11,312,1961
71	$\sigma_{a,5}$	1.000	40651.002	V.F.Gerasimov+,J,SJA,13,977,1963
72	$\sigma_{a,9}+\sigma_{sm,9}$		52081	(This EXFOR entry is missing in the current EXFOR Master.)
73	$\sigma_{a,9}+\sigma_{s,9}$	1.000	41219.009	S.J.Nikitin+,C,55GENEVA,4,224,1956
74	$\sigma_{a,9}+\sigma_{sm,9}$	0.993	12502.002	L.M.Bollinger+,C,58GENEVA,15,127,1958
75	$\sigma_{a,9}+\sigma_{sm,9}$	1.002	21033.003	N.J.Pattenden,J,JNE,2,300,1956
76	$\sigma_{a,9}+\sigma_{sm,9}$	1.000	12507.002	G.J.Safford+,J,NSE,11,65,1961
77	$\sigma_{a,3}+\sigma_{sm,3}$		50645	(This EXFOR entry is missing in the current EXFOR Master.)
78	$\sigma_{a,3}+\sigma_{sm,3}$	1.005	41219.003	S.J.Nikitin+,C,55GENEVA,4,224,1956
79	$\sigma_{a,3}+\sigma_{sm,3}$	0.989	21065.003	N.J.Pattenden,J,JNE,3,28,1956
80	$\sigma_{a,3}$	1.007	21186.002.3	T.S.Green+,J,JNE,4,409,1957
81	$\sigma_{a,3}+\sigma_{sm,3}$	1.000	12341.005	O.D.Simpson+,J,NSE,7,187,1960
82	$\sigma_{a,3}+\sigma_{s,3}$	1.002	12362.003	G.J.Safford+,J,PR,118,799,1960
83	$\sigma_{a,3}+\sigma_{sm,3}$	1.001	12362.004	G.J.Safford+,J,PR,118,799,1960
84	$\sigma_{a,3}+\sigma_{sm,3}$	1.000	12024.012	R.C.Block+,J,NSE,8,112,1960
85	$\sigma_{a,1}+\sigma_{s,1}$		12537	(quantity not reported in the literature)
86	$\sigma_{a,1}+\sigma_{s,1}$	1.002	12528.017	D.S.Craig+,J,CJP,42,2384,1968
87	$\sigma_{a,1}+\sigma_{sm,1}$	1.000	13019.000	J.R.Smith,R,EPRI-NP-3436,(4),1984
88	$\sigma_{s,3}$			(value assumed in the least-squares fit in [3])
89	$\sigma_{s,3}$-$\sigma_{sm,3}$			(value assumed in the least-squares fit in [3])
90	$\sigma_{s,5}$			(value assumed in the least-squares fit in [3])
91	$\sigma_{s,5}$-$\sigma_{sm,5}$			(value assumed in the least-squares fit in [3])
92	$\sigma_{s,9}$			(value assumed in the least-squares fit in [3])
93	$\sigma_{s,9}$-$\sigma_{sm,9}$			(value assumed in the least-squares fit in [3])
94	$\sigma_{s,1}$			(value assumed in the least-squares fit in [3])
95	$\sigma_{s,1}$-$\sigma_{sm,1}$			(value assumed in the least-squares fit in [3])
96	$\sigma_{f,9}T_{1/2,9}$		20143	(quantity not for EXFOR)
97	$\sigma_{f,5}T_{1/2,4}$		20143	(quantity not for EXFOR)
98	$\sigma_{f,5}$	0.996	20189.003	A.J.Deruytter+,J,JNE/AB,15,165,1961
99	$\sigma_{f,9}/\sigma_{f,5}$	1.000	21494.002	P.H.White+,C,66PARIS,2,29,1967
100	$\sigma_{f,1}/\sigma_{f,5}$	1.005	21494.003	P.H.White+,C,66PARIS,2,29,1967
101	$\sigma_{f,5}T_{1/2,4}$		30399	(quantity not for EXFOR)
102	$\sigma_{f,3}T_{1/2,3}$		21471	(quantity not for EXFOR)
103	$\sigma_{f,5}$	1.000	21471.006	J.F.Raffle,R,AERE/R-2998,1959
104	$\sigma_{f,9}T_{1/2,9}$		21471	(quantity not for EXFOR)
105	$\sigma_{f,1}/\sigma_{f,9}$		21031	(quantity not reported in the literature)
106	$\sigma_{f,5}$	0.980	21387.002	E.E.Maslin+,J,PR,139,B852,1965
107	$\sigma_{f,5}$	1.020	12392.002	A.Saplakoglu,C,58GENEVA,16,103,1958
108	$\sigma_{f,1}$	0.976	12529.005	T.Watanabe+,R,IDO-16995,1964
109	$\sigma_{f,9}T_{1/2,9}/\sigma_{f,5}T_{1/2,4}$		21520	(quantity not for EXFOR)
110	$\sigma_{f,9}T_{1/2,9}/\sigma_{f,5}T_{1/2,4}$		30089	(quantity not reported in the literature)
111	$\bar{\nu}_{52}$		31761	(quantity not reported in the literature)
112	$\bar{\nu}_3/\bar{\nu}_{52}$		30772	(quantity not reported in the literature)
113	$\bar{\nu}_5/\bar{\nu}_{52}$		30772	(quantity not reported in the literature)
114	$\bar{\nu}_9/\bar{\nu}_{52}$		30772	(quantity not reported in the literature)
115	$\bar{\nu}_1/\bar{\nu}_{52}$		30772	(quantity not reported in the literature)
116	$\bar{\nu}_{52}$		10954	(quantity not reported in the literature)
117	$\bar{\nu}_3/\bar{\nu}_{52}$		12833	R.Gwin+,J,NSE,87,381,1984
118	$\bar{\nu}_5/\bar{\nu}_{52}$		12833	R.Gwin+,J,NSE,87,381,1984
119	$\bar{\nu}_9/\bar{\nu}_{52}$		12833	R.Gwin+,J,NSE,87,381,1984
120	$\bar{\nu}_1/\bar{\nu}_{52}$		12834	R.Gwin+,J,NSE,87,381,1984
121	$\bar{\nu}_{52}$	0.998	12326.007	J.C.Hopkins+,J,NP,48,433,1963
122	$\bar{\nu}_3/\bar{\nu}_{52}$		12326	(quantity not reported in the literature)
123	$\bar{\nu}_5/\bar{\nu}_{52}$		12326	(quantity not reported in the literature)
124	$\bar{\nu}_9/\bar{\nu}_{52}$		12326	(quantity not reported in the literature)
125	$\bar{\nu}_{52}$		20074	(quantity not reported in the literature)
126	$\bar{\nu}_5/\bar{\nu}_{52}$	0.997	20025.000	H.Conde,J,AF,29,293,1965
127	$\bar{\nu}_{52}$	0.994	21198.002	P.H.White+,J,JNE,22,73,1968
128	$\bar{\nu}_{52}$	0.999	22004.002	E.J.Axton,J,MET,21,59,1985

Table 1. Continued.

ID	Quantity	X4/Axton	EXFOR #	Reference reporting the original value
129	$\bar{\nu}_{52}$			(No reference information in Axton's report.)
130	$\bar{\nu}_{52}$			(No reference information in Axton's report.)
131	$\bar{\nu}_3/\bar{\nu}_5$	1.000	21454.002	D.W.Colvin+,C,65SALZBURG,2,25,1965
132	$\bar{\nu}_9/\bar{\nu}_5$	0.999	21454.003	D.W.Colvin+,C,65SALZBURG,2,25,1965
133	$\bar{\nu}_1/\bar{\nu}_5$	1.000	21454.006	D.W.Colvin+,C,65SALZBURG,2,25,1965
134	$\bar{\nu}_5/\bar{\nu}_{52}$		21454	(quantity not reported in the literature)
135	$\bar{\nu}_3/\bar{\nu}_{52}$		21135	(quantity not reported in the literature)
136	$\bar{\nu}_5/\bar{\nu}_{52}$		21252	(quantity not reported in the literature)
137	$\bar{\nu}_9/\bar{\nu}_{52}$		21135	(quantity not reported in the literature)
138	$\bar{\nu}_{52}$	0.999	41595.002	B.M.Aleksandrov+,C,80KIEV,4,119,1981
139	$\bar{\nu}_{52}$	1.000	10941.002	J.R.Smith,R,EPRI-NP-3436,1984
140	$\bar{\nu}_{52}$		21833	(quantity not reported in the literature)
141	$\bar{\nu}_{52}$	0.999	10717.002	H.Bozorgmanesh+,J,ANS,27,864,1977
142	$\bar{\nu}_{52}$	0.994	10166.003	A.De Volpi,J,JNE,26,75,1972
143	$\bar{\nu}_{52}$		30536	(quantity not reported in the literature)
144	$\bar{\nu}_{52}$			(no publication exists, *e.g.*, private communication)
145	η_3			(reanalysis of 12554 and 12318 experiments)
146	η_5			(reanalysis of 12554 and 12318 experiments)
147	η_9			(reanalysis of 12554 and 12318 experiments)
148	η_1			(reanalysis of 12554 and 12318 experiments)
149	η_3	0.993	12349.002	R.L.Macklin+,J,NSE,8,210,1960
150	η_5	1.001	12349.003	R.L.Macklin+,J,NSE,8,210,1960
151	η_9	1.013	12508.002	R.L.Macklin+,J,NSE,14,101,1962
152	$\sigma_{\gamma,0}\ g'_{\gamma,0}$-$\sigma_{\gamma,2}\ g'_{\gamma,2}$	1.009	21410.002	M.J.Cabell,R,AERE-R-5874,1968
153	$\sigma_{\mathrm{a},9}\ g'_{a,9}$-$\sigma_{\gamma,2}\ g'_{\gamma,2}$	1.009	21410.004	M.J.Cabell,R,AERE-R-5874,1968
154	$\sigma_{\mathrm{a},9}\ g'_{a,9}/\sigma_{\gamma,9}\ g'_{\gamma,9}$	1.000	21410.000	M.J.Cabell,R,AERE-R-5874,1968
155	$(\sigma_{\mathrm{a},1}\ g'_{a,1}$-$\sigma_{\mathrm{a},9}\ g'_{a,9})$/F1HLF		21410	(quantity not for EXFOR)
156	$\sigma_{\mathrm{a},1}\ g'_{a,1}/\sigma_{\gamma,1}\ g'_{\gamma,1}$ F2HLF		21410	(quantity not for EXFOR)
157	$\sigma_{\gamma,0}$			(quantity not for EXFOR)
158	$\sigma_{\gamma,2}$			(quantity not for EXFOR)
159	$g'_{\gamma,9}$			(quantity not for EXFOR)
160	$g'_{\gamma,0}$			(quantity not for EXFOR)
161	$g'_{\gamma,1}$			(quantity not for EXFOR)
162	$g'_{\gamma,2}$			(quantity not for EXFOR)
163	$g'_{a,9}$			(quantity not for EXFOR)
164	$g'_{a,1}$			(quantity not for EXFOR)
165	$\eta_9/\sigma_{\mathrm{f},9}$		12793	(quantity not reported in the literature)
166	$\sigma_{\mathrm{a},5}$+$\sigma_{\mathrm{sm},5}$	1.000	12941.004	R.R.Spencer,J,NSE,96,318,1987
167	$\sigma_{\mathrm{a},9}$+$\sigma_{\mathrm{sm},9}$	0.999	12941.005	R.R.Spencer,J,NSE,96,318,1987

ID: the data point identification number in Axton's database.

Quantity: the quantity in Axton's database. See text for details.

X4/Axton: the ratio of the EXFOR value to Axton's value.

EXFOR #: EXFOR data set number. See text for details.

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