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STANDARD THERMAL ENERGY GROUP STRUCTURE FOR GENERATION OF THERMAL GROUP CONSTANTS FROM ENDF/B DATA

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PREPARED FOR THE U. S. ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(07-2)-1

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by

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ABSTRACT

This report contains the final specifications of a standard energy group structure for the generation of thermal group constants from ENDF/B data. The report represents the work of a committee appointed by the Codes and Formats Subcommittee of the Cross Section Evaluation Working Group and is a parallel effort to work being done in the epithermal energy range.

The thermal energy group structure specified in this report was accepted November 10, 1972, by the Cross Section Evaluation Working Group as the standard for generation of thermal group constants from ENDF/B data.

The standard thermal group structure specified in this report is consistent with past design experience and thermal spectrum codes, and incorporates specific features for effects known to be important in nuclear design applications in the thermal energy range.

Specific recommendations are made as to methods to be used for generation of thermal group constants.

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INTRODUCTION

In May 1972, the Chairman of the Codes and Formats Subcommittee of the Cross Section Evaluation Working Group (CSEWG) appointed a committee to:

- Prepare a standard energy group structure spanning the thermal energy region for generating standard ENDF/B thermal group constants
- Recommend procedures for generating thermal group constants from ENDF/B data on this standard group structure
- Recommend an output format for thermal group constants on this standard group structure

The efforts of this special committee were a parallel effort to a similar committee appointed to make recommendations for the fast (epithermal) energy region.

A preliminary report of the thermal region committee was submitted and accepted by the CSEWG Codes and Formats Subcommittee on November 9, 1972. This same report was forwarded to and accepted by the Cross Section Evaluation Working Group on November 10, 1972.

After the epithermal standard group structure was accepted by CSEWG, very small modifications were necessary to resolve discrepancies in the interface region between the epithermal and thermal group structures.

This report represents a final set of specifications of the standard thermal energy group structure accepted by the Cross Section Evaluation Working Group for generation of thermal group constants from ENDF/B data.

SPECIFICATION OF THE THERMAL ENERGY GROUP STRUCTURE

ENERGY GROUP STRUCTURE FOR SMOOTH CROSS SECTIONS

In setting out the specifications of a thermal energy group structure for smooth thermal cross sections, three questions were asked.

1. *How high in energy should the group structure extend?*

   Different thermal spectra reactors require a different high energy cutoff. What is desired is to select a high enough cutoff energy so that all thermal spectra reactor needs are satisfied.

2. *What energy group breaks are necessary to enable interface to standard thermal spectrum codes?*

   A vast amount of money and time has been spent on developing the existing thermal spectrum codes. Any standard group structure should make every effort to interface as many of these as possible.

3. *Are the energy groups sufficiently narrow to enable a unit weighting spectrum to be used in averaging the group constants?*

   Because the group structure is to be valid for all thermal spectra, it is necessary to produce group constants from ENDF/B using a unit spectrum to preserve the integrity of the ENDF/B data.

The first question was resolved by discussing it with several persons involved in design and/or analysis of thermal reactor lattices. The upper energy was chosen as 3.15 eV to provide energy groups significantly higher in energy than the effects of the 1.056 eV resonance in ^{240}Pu, and simultaneously to span the 3.059 eV group break of the MUFT[9] and GAM[10] slowing-down codes.

The second question was resolved by compiling a compendium of group breaks for the commonly used thermal spectrum codes. The specific codes included in this compendium were the following:

THERMOS[2]	30 groups
LASER[3]	35 groups
KATE[4]	246 groups
GATHER II[5]	101 groups
GATHER (Rev.)[5]	101 groups
TEMPEST[6]	246 and 309 groups
SOFOCATE[7]	246 and 309 groups
LEOPARD[8]	172 and 309 groups
MUFT III, IV, V[9]	Group breaks <3.15 eV
GAM I and II[10]	Group breaks <3.15 eV

The result of this compendium was a group structure comprising 482 groups and a high energy cutoff of 3.15 eV. Many of the group breaks in this structure were very close together (<1/4%); hence, slight shifts of group boundaries were made to eliminate those breaks that yielded physically insignificant energy groups.

No shifts were introduced that could conceivably alter group constants, and care was taken to preserve the MUFT and GAM group breaks where they overlap the thermal energy group structure.

An examination of the resulting energy group structure containing 460 energy groups showed that Question 3 was easily satisfied by this structure.

The 460 energy group structure shown in Table I is the standard group structure for generation of thermal group constants from ENDF/B data.

Table I contains all energy breaks for the 460 group set expressed to five significant digits. Also shown is the group structure(s) from which the particular energy break arose. The spectrum codes are designated by a code number in the table, and the key is given below.

Code Number	Group Structure Name
1	MUFT III, IV, V
2	GAM I and II
3	THERMOS - 30 groups
4	LASER - 35 groups
5	H_2O KERNEL - 50 groups
6	GATHER II
7	GATHER (REV)
8	TEMPEST - 246 groups
9	TEMPEST - 309 groups

TABLE I

460 Energy Group Structure for Smooth Cross Sections

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
1	0.0								X	X
2	0.50000D-04									X
3	0.63200D-04			X		X				
4	0.15000D-03									X
5	0.25000D-03									X
6	0.25300D-03				X					
7	0.35000D-03									X
8	0.45000D-03									X
9	0.50000D-03						X	X	X	
10	0.55000D-03									X
11	0.56920D-03			X		X				
12	0.65000D-03									X
13	0.75000D-03									X
14	0.85000D-03									X
15	0.95000D-03									X
16	0.10500D-02									X
17	0.11500D-02									X
18	0.12500D-02									X
19	0.13500D-02									X
20	0.14500D-02									X
21	0.15000D-02						X	X	X	
22	0.15500D-02									X
23	0.15812D-02			X		X				
24	0.16500D-02									X
25	0.17500D-02									X
26	0.18500D-02									X
27	0.19500D-02									X
28	0.20500D-02									X
29	0.21500D-02									X
30	0.22500D-02									X
31	0.22770D-02				X					
32	0.23500D-02									X
33	0.24500D-02									X
34	0.25000D-02								X	
35	0.25500D-02									X
36	0.26500D-02									X
37	0.27500D-02									X
38	0.28500D-02									X
39	0.29500D-02									X
40	0.30000D-02						X	X		
41	0.30500D-02									X
42	0.30992D-02			X		X				
43	0.31500D-02									X
44	0.32500D-02									X
45	0.33500D-02									X
46	0.34500D-02									X
47	0.35000D-02								X	
48	0.35500D-02									X
49	0.36500D-02									X
50	0.37500D-02									X

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
51	0.38500D-02									X
52	0.39500D-02									X
53	0.40500D-02									X
54	0.41500D-02									X
55	0.42500D-02									X
56	0.43500D-02									X
57	0.44500D-02									X
58	0.45000D-02						X		X	
59	0.45500D-02									X
60	0.46500D-02									X
61	0.47500D-02									X
62	0.48500D-02									X
63	0.49500D-02									X
64	0.50000D-02							X		
65	0.50500D-02									X
66	0.51232D-02			X		X				
67	0.51500D-02									X
68	0.52500D-02									X
69	0.53500D-02									X
70	0.54500D-02									X
71	0.55000D-02								X	
72	0.55500D-02									X
73	0.56500D-02									X
74	0.57500D-02									X
75	0.58500D-02									X
76	0.59500D-02									X
77	0.60000D-02						X			
78	0.60500D-02									X
79	0.63250D-02				X					
80	0.65000D-02								X	
81	0.75000D-02						X		X	X
82	0.76532D-02			X		X				
83	0.80000D-02							X		
84	0.85000D-02								X	X
85	0.90000D-02						X			
86	0.95000D-02								X	X
87	0.10500D-01								X	X
88	0.10689D-01			X		X				
89	0.11500D-01								X	X
90	0.12397D-01				X					
91	0.12500D-01						X	X	X	X
92	0.13500D-01								X	X
93	0.14231D-01			X		X				
94	0.14500D-01								X	X
95	0.15500D-01								X	X
96	0.16500D-01								X	X
97	0.17500D-01						X	X	X	X
98	0.18279D-01			X		X				
99	0.18500D-01								X	X
100	0.19500D-01								X	X

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
101	0.20500D-01				X				X	X
102	0.21500D-01								X	X
103	0.22500D-01						X	X	X	X
104	0.22833D-01			X		X				
105	0.23500D-01								X	X
106	0.24500D-01								X	X
107	0.25500D-01								X	X
108	0.26500D-01								X	X
109	0.27500D-01						X		X	X
110	0.27893D-01			X		X				
111	0.28000D-01							X		
112	0.28500D-01								X	X
113	0.29500D-01								X	X
114	0.30500D-01								X	X
115	0.30613D-01				X					
116	0.31500D-01								X	X
117	0.32500D-01								X	X
118	0.33500D-01			X		X			X	X
119	0.34500D-01								X	X
120	0.35000D-01						X			
121	0.35500D-01								X	X
122	0.36500D-01								X	X
123	0.37000D-01							X		
124	0.37500D-01								X	X
125	0.38500D-01								X	X
126	0.39500D-01			X		X			X	X
127	0.40500D-01								X	X
128	0.41500D-01								X	X
129	0.42500D-01								X	X
130	0.42757D-01				X					
131	0.43500D-01								X	X
132	0.44500D-01								X	X
133	0.45000D-01						X	X		
134	0.45500D-01								X	X
135	0.46100D-01			X		X				
136	0.46500D-01								X	X
137	0.47500D-01								X	X
138	0.48500D-01								X	X
139	0.49500D-01								X	X
140	0.50500D-01								X	X
141	0.51500D-01									X
142	0.52500D-01									X
143	0.53000D-01							X		
144	0.53200D-01			X		X				
145	0.53500D-01									X
146	0.54500D-01									X
147	0.55000D-01						X			
148	0.55500D-01									X
149	0.56500D-01									X
150	0.56925D-01				X					

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
151	0.575C0D-01									X
152	0.585C0D-01									X
153	C.595C0D-01									X
154	0.605C0D-01									X
155	C.608C0D-01			X		X				
156	0.61000D-01							X		
157	C.625C0D-01						X			
158	0.650C0D-01								X	
159	C.67CC0D-01							X		
160	0.675C0D-01						X			
161	C.697C0D-01			X		X				
162	C.725C0D-01						X	X		
163	0.750C0D-01								X	X
164	0.775C0D-01						X	X		
165	0.801C0D-01			X		X				
166	C.819720-01				X					
167	0.825C0D-01						X	X		
168	C.85CC0D-01								X	X
169	0.875C0D-01						X	X		
170	0.925C0D-01			X		X	X	X		
171	0.950C0D-01								X	X
172	0.975C0D-01						X	X		
173	0.10300D 00							X		
174	0.1050CD 0C								X	X
175	0.10632D 00			X		X				
176	C.11CC0D 00						X	X		
177	0.11157D 00				X					
178	0.115C0D 0C							X	X	X
179	0.12190D 00			X		X				
180	0.125C0D 0C							X	X	X
181	0.13000D 00						X			
182	0.135C0D 0C							X	X	X
183	0.14C91D 00			X		X				
184	0.145C0D 00								X	X
185	C.14573D 00				X					
186	0.150C0D 00						X	X		
187	C.155C0D 00								X	X
188	0.160C0D 00							X		
189	0.164510 00			X		X				
190	0.165C0D 0C								X	X
191	0.17CC0D 00						X			
192	0.175C0D 00								X	X
193	0.18CCCD 0C							X		
194	0.184440 00				X					
195	C.185CCD 00								X	X
196	0.190C0D 00						X	X		
197	0.194120 0C			X		X				
198	0.195C0D 00								X	X
199	0.205C0D 00								X	X
200	0.210C0D 00						X	X		

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
201	0.21500D 00								X	X
202	0.22000D 00							X		
203	0.22500D 00						X		X	X
204	0.22770D 00				X					
205	0.23150D 00			X		X				
206	0.23500D 00						X	X	X	X
207	0.24500D 00						X	X	X	X
208	0.25104D 00				X					
209	0.25500D 00						X	X	X	X
210	0.26500D 00						X	X	X	X
211	0.27053D 00				X					
212	0.27500D 00						X	X	X	X
213	0.27887D 00			X		X				
214	0.28500D 00						X	X	X	X
215	0.29075D 00				X					
216	0.29500D 00						X	X	X	X
217	0.30113D 00				X					
218	0.30500D 00						X	X	X	X
219	0.31500D 00						X	X	X	X
220	0.32064D 00				X					
221	0.32500D 00						X	X	X	X
222	0.33500D 00						X	X	X	X
223	0.33891D 00			X		X				
224	0.34500D 00						X	X	X	X
225	0.35500D 00						X	X	X	X
226	0.35768D 00				X					
227	0.36500D 00							X	X	X
228	0.37000D 00						X			
229	0.37500D 00								X	X
230	0.38500D 00							X	X	X
231	0.39000D 00						X			
232	0.39500D 00								X	X
233	0.40500D 00							X	X	X
234	0.41399D 00		X	X		X				
235	0.41500D 00						X		X	X
236	0.41704D 00				X					
237	0.42500D 00						X	X	X	X
238	0.43500D 00							X	X	X
239	0.44000D 00						X			
240	0.44500D 00								X	X
241	0.45000D 00							X		
242	0.45500D 00						X		X	X
243	0.46000D 00							X		
244	0.46500D 00						X		X	X
245	0.47250D 00						X			
246	0.47500D 00								X	X
247	0.47750D 00						X	X		
248	0.48500D 00						X		X	X
249	0.49000D 00							X		
250	0.49500D 00						X		X	X

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
251	0.50326D 00				X					
252	0.50500D 00							X	X	X
253	0.51118D 00			X		X				
254	0.51500D 00						X		X	X
255	0.52000D 00							X		
256	0.52500D 00								X	X
257	0.53158D 00		X							
258	0.53500D 00								X	X
259	0.54000D 00						X			
260	0.54500D 00							X	X	X
261	0.55500D 00								X	X
262	0.56000D 00						X			
263	0.56500D 00							X	X	X
264	0.57500D 00								X	X
265	0.58000D 00						X			
266	0.58500D 00							X	X	X
267	0.59500D 00						X		X	X
268	0.60500D 00								X	X
269	0.61500D 00						X	X	X	X
270	0.62506D 00	X			X				X	X
271	0.63250D 00			X		X				
272	0.63500D 00						X	X	X	X
273	0.64500D 00								X	X
274	0.65500D 00								X	X
275	0.66500D 00							X	X	X
276	0.67000D 00						X			
277	0.67500D 00								X	X
278	0.68256D 00		X							
279	0.68500D 00							X	X	X
280	0.69000D 00						X			
281	0.69500D 00								X	X
282	0.70500D 00								X	X
283	0.71500D 00							X	X	X
284	0.72500D 00						X		X	X
285	0.73500D 00								X	X
286	0.74500D 00								X	X
287	0.75500D 00							X	X	X
288	0.76500D 00								X	X
289	0.77500D 00						X		X	X
290	0.78211D 00				X					
291	0.78500D 00			X		X			X	X
292	0.79500D 00								X	X
293	0.80500D 00							X	X	X
294	0.81500D 00								X	X
295	0.82500D 00						X		X	X
296	0.83368D 00	X				X			X	X
297	0.84000D 00							X		
298	0.84500D 00								X	X
299	0.85500D 00								X	X
300	0.86000D 00						X			

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
301	0.865000 00								X	X
302	0.870000 00							X		
303	0.87642D 00		X			X			X	X
304	0.880000 00						X			
305	0.885000 00								X	X
306	0.895000 00								X	X
307	0.900000 00						X			
308	0.905000 00								X	X
309	0.910000 00					X		X		
310	0.915000 00								X	X
311	0.920000 00						X			
312	0.925000 00								X	X
313	0.935000 00								X	X
314	0.940000 00						X	X		
315	0.945000 00					X			X	X
316	0.95070D 00				X					
317	0.955000 00								X	X
318	0.960000 00						X			
319	0.965000 00								X	X
320	0.970000 00							X		
321	0.975000 00					X	X		X	X
322	0.985000 00						X		X	X
323	0.995000 00						X	X	X	X
324	0.100500 01							X	X	X
325	0.101000 01						X			
326	0.101500 01				X	X			X	X
327	0.102500 01							X	X	X
328	0.103500 01						X	X	X	X
329	0.104500 01				X	X		X	X	X
330	0.105500 01				X		X	X	X	X
331	0.106500 01				X	X	X	X	X	X
332	0.10722D 01				X					
333	0.107500 01						X		X	X
334	0.108500 01					X	X	X	X	X
335	0.109500 01							X	X	X
336	0.110000 01				X		X			
337	0.110500 01					X			X	X
338	0.111500 01							X	X	X
339	0.112000 01						X	X		
340	0.11254D 01	X	X			X			X	X
341	0.11275D 01						X			
342	0.113000 01							X		
343	0.113500 01								X	X
344	0.114000 01						X			
345	0.114500 01							X	X	X
346	0.115500 01								X	X
347	0.116500 01				X				X	X
348	0.117500 01						X	X	X	X
349	0.118500 01								X	X
350	0.119500 01								X	X

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
351	0.12050D 01								X	X
352	0.12150D 01							X	X	X
353	0.12250D 01					X	X		X	X
354	0.12350D 01								X	X
355	0.12450D 01								X	X
356	0.12550D 01								X	X
357	0.12650D 01								X	X
358	0.12750D 01						X	X	X	X
359	0.12850D 01								X	X
360	0.12950D 01								X	X
361	0.13050D 01								X	X
362	0.13079D 01				X					
363	0.13150D 01								X	X
364	0.13250D 01					X	X	X	X	X
365	0.13350D 01								X	X
366	0.13450D 01								X	X
367	0.13550D 01								X	X
368	0.13650D 01								X	X
369	0.13750D 01								X	X
370	0.13850D 01								X	X
371	0.13950D 01								X	X
372	0.14000D 01						X	X		
373	0.14050D 01								X	X
374	0.14150D 01								X	X
375	0.14250D 01								X	X
376	0.14350D 01								X	X
377	0.14350D 01	X				X				
378	0.14450D 01		X						X	X
379	0.14550D 01								X	X
380	0.14600D 01				X			X		
381	0.14650D 01								X	X
382	0.14700D 01						X			
383	0.14750D 01								X	X
384	0.14850D 01								X	X
385	0.14950D 01								X	X
386	0.15050D 01								X	X
387	0.15150D 01								X	X
388	0.15250D 01								X	X
389	0.15350D 01								X	X
390	0.15450D 01								X	X
391	0.15500D 01						X	X		
392	0.15550D 01								X	X
393	0.15650D 01								X	X
394	0.15750D 01								X	X
395	0.15850D 01								X	X
396	0.15950D 01				X				X	X
397	0.16050D 01								X	X
398	0.16150D 01								X	X
399	0.16250D 01								X	X
400	0.16350D 01					X			X	X

BREAK POINT	ENERGY EV	CODE 1	CODE 2	CODE 3	CODE 4	CODE 5	CODE 6	CODE 7	CODE 8	CODE 9
401	0.16450D 01								X	X
402	0.16500D 01						X	X		
403	0.16550D 01								X	X
404	0.16650D 01								X	X
405	0.16750D 01								X	X
406	0.16850D 01								X	X
407	0.16950D 01								X	X
408	0.17050D 01								X	X
409	0.17150D 01								X	X
410	0.17250D 01				X				X	X
411	0.17350D 01								X	X
412	0.17400D 01						X			
413	0.17450D 01								X	X
414	0.17550D 01								X	X
415	0.17650D 01								X	X
416	0.17750D 01								X	X
417	0.17850D 01								X	X
418	0.17950D 01								X	X
419	0.18000D 01							X		
420	0.18050D 01								X	X
421	0.18150D 01								X	X
422	0.18200D 01						X			
423	0.18250D 01								X	X
424	0.18350D 01								X	X
425	0.18450D 01								X	X
426	0.18554D 01	X	X		X	X			X	X
427	0.18650D 01								X	X
428	0.18750D 01								X	X
429	0.18800D 01						X			
430	0.18854D 01								X	X
431	0.18950D 01								X	X
432	0.19000D 01							X		
433	0.19050D 01								X	X
434	0.19150D 01								X	X
435	0.19250D 01								X	X
436	0.19350D 01								X	X
437	0.19450D 01								X	X
438	0.19500D 01						X			
439	0.19550D 01								X	X
440	0.19650D 01								X	X
441	0.19750D 01								X	X
442	0.19850D 01								X	X
443	0.19950D 01								X	X
444	0.20050D 01					X			X	X
445	0.20500D 01						X			
446	0.20600D 01							X		
447	0.21500D 01						X			
448	0.21600D 01							X		
449	0.22500D 01						X			
450	0.23100D 01						X			
451	0.23200D 01							X		
452	0.23500D 01						X			
453	0.23824D 01	X	X			X				
454	0.24100D 01						X			
455	0.24500D 01							X		
456	0.25700D 01							X		
457	0.27100D 01					X		X		
458	0.28300D 01							X		
459	0.29700D 01							X		
460	0.30590D 01	X	X			X				
461	0.31500D 01							X		

ENERGY GROUP STRUCTURE FOR THERMAL SCATTERING MATRICES

A necessary part of any set of thermal region group constants are thermal scattering matrices. These matrices contain molecular structure, lattice binding, and upscattering in addition to normal scattering effects, and require considerable computer time to generate from ENDF/B $S(\alpha,\beta)$ data.

It is not within the reasonable limits of existing computers to generate thermal scattering matrices on the 460 energy group structure. Further, matrices generated on such a group structure would be of only limited use. A typical user requires matrices on his specific group structure; hence, matrices must be reduced to his structure by appropriate weighting and averaging. This is possible only if the high and low energies of his group structure are identical to a standard group structure; otherwise, the detailed balance condition of all thermal scattering matrices generated from ENDF/B data will be destroyed. By making arbitrary assumptions, it is possible to restore the detailed balance, but not the physical meaning of the matrices.

Thermal scattering matrices should, therefore, be prepared specifically for a user's energy group structure. Any standardization of thermal scattering matrices can have meaning only for a restricted set of problems and conditions such as thermal data testing.

It is desirable for the purpose of thermal data testing within the CSEWG community to specify a common energy group structure for thermal scattering matrices. The selection of this group structure is, however, based on choosing a group structure of wide usage, familiarity, and general applicability to reactor lattices.

Table II shows a standard 50 energy group structure specified for the purpose of thermal data testing within CSEWG. This energy group structure was obtained from the widely used 30 energy group structure of the THERMOS thermal spectrum code by adding 20 additional energy groups to a high energy cutoff of 3.15 eV.

The 50 energy group structure of Table II extends to energies much higher than is typically required in most reactor lattices. In most cases the 30 group THERMOS group structure is adequate (Groups 1-30 of Table II) for most moderator materials. For H_2O-moderated lattices, however, upscattering effects can occur significantly higher in energy than 1.0 eV. For lattices with large amounts of ^{240}Pu, ignoring the upscattering effects leads to a serious underprediction of the ^{240}Pu reaction rates. The 50 energy group structure of Table II is designed to allow this

effect and other similar effects to be accounted for in data testing. Where no such effects are present, the more widely known 30 group THERMOS energy group structure is recommended for data testing.

TABLE II

50 Energy Group Structure for Thermal Scattering Matrices

Group	Avg Energy, eV	Energy Range, eV	Group	Avg Energy, eV	Energy Range, eV
1	0.000253	0.0000632 - 0.0005692	26	0.30815	0.27886 - 0.33891
2	0.001012	0.0005692 - 0.001581	27	0.37551	0.33891 - 0.41399
3	0.002277	0.001581 - 0.003099	28	0.46131	0.41399 - 0.51118
4	0.004048	0.003099 - 0.005123	29	0.57002	0.51118 - 0.63250
5	0.006325	0.005123 - 0.007653	30	0.70668	0.63250 - 0.78500
6	0.009108	0.007653 - 0.010689	31	0.80980	0.78500 - 0.83500
7	0.012397	0.010689 - 0.014231	32	0.85487	0.83500 - 0.87500
8	0.016192	0.014231 - 0.018279	33	0.89240	0.87500 - 0.91000
9	0.020493	0.018279 - 0.022833	34	0.92741	0.91000 - 0.94500
10	0.025300	0.022833 - 0.027893	35	0.95993	0.94500 - 0.97500
11	0.030632	0.027843 - 0.033500	36	0.99489	0.97500 - 1.01500
12	0.036438	0.033500 - 0.039500	37	1.02990	1.01500 - 1.04500
13	0.042736	0.039500 - 0.046100	38	1.05500	1.04500 - 1.06500
14	0.049586	0.046100 - 0.053200	39	1.07500	1.06500 - 1.08500
15	0.056936	0.053200 - 0.060800	40	1.09500	1.08500 - 1.10500
16	0.065174	0.060800 - 0.069700	41	1.11500	1.10500 - 1.12540
17	0.074838	0.069700 - 0.080160	42	1.17450	1.12540 - 1.22500
18	0.086219	0.080160 - 0.092500	43	1.27450	1.22500 - 1.32500
19	0.099291	0.092500 - 0.106320	44	1.38160	1.32500 - 1.43950
20	0.113976	0.106320 - 0.121890	45	1.53570	1.43950 - 1.63500
21	0.131230	0.121890 - 0.140910	46	1.74330	1.63500 - 1.85540
22	0.152483	0.140910 - 0.164510	47	1.92930	1.85540 - 2.00500
23	0.179012	0.164510 - 0.194120	48	2.18960	2.00500 - 2.38240
24	0.212405	0.194128 - 0.231510	49	2.54350	2.38240 - 2.71000
25	0.254637	0.231510 - 0.278860	50	2.88180	2.71000 - 3.05900

RECOMMENDATIONS FOR GENERATION OF THERMAL GROUP CONSTANTS

SPECTRUM

Thermal group constants should be generated with a unit spectrum (weight 1.0 at all energies) so that they are applicable to all thermal spectrum reactors.

RESONANCE CROSS SECTIONS

A number of fissile and fertile isotopes have resonances below the 3.15 eV maximum energy of the 460 group standard thermal energy group structure. Doppler broadening and self-shielding effects are important for many of these isotopes, although the self-shielding effects are highly dependent on geometry and spectrum.

Resonances lying below 3.15 eV and any tails of resonances that extend below this energy should be included in thermal group constants at infinite dilution with Doppler broadening. A sufficient number of temperatures must be included in the group constants to assure accurate interpolation at intermediate temperatures.

SCATTERING MATRICES

A basic set of 30 group thermal scattering matrices prepared from ENDF/B $S(\alpha,\beta)$ data is recommended for thermal data testing. These scattering matrices are available from the Argonne Code Center[11] (ACC Abstract 543) and consist of thermal scattering matrices up to P_5 Legendre order for the materials shown in Table III. These thermal scattering matrices are documented in Reference 12.

Included in the same package from the Argonne Code Center (ACC Abstract 543) are 50 group scattering matrices for the materials shown in Table IV.

TABLE III

30 Group THERMOS Scattering Matrices Included in ACC Abstract 543

Material (ENDF/B MAT Number)	Temperatures, °K
H_2O (1002)	296, 350, 400, 450, 500, 600, 700, 800
D_2O (1004)	296, 350, 400, 450, 500, 600, 700, 800
Graphite (1065)	296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000
Zr bound in ZrH_x (1096)	296, 400, 500, 600, 700, 800, 1000, 1200
H bound in ZrH_x (1097)	296, 400, 500, 600, 700, 800, 1000, 1200
$(C_2H_4)_x$ Polyethylene (1011)	296, 350
Be (1064)	296, 400, 500, 600, 700, 800, 1000, 1200
BeO (1099)	296, 400, 500, 600, 700, 800, 1000, 1200
C_6H_6 Benzene (1095)	296, 350, 400, 450, 500, 600, 700, 800, 1000
UO_2 (1098)	296, 400, 500, 600, 700, 800, 1000, 1200

TABLE IV

50 Group Thermal Scattering Matrices Included in ACC Abstract 543

Material (ENDF/B MAT)	Temperatures, °K
H_2O (1002)	296, 350, 400, 450, 500, 600, 700, 800
H bound in H_2O (1002)	296, 350, 400, 450, 500, 600, 700, 800
Free Gas Oxygen (1134)	296, 350, 400, 450, 500, 600, 700, 800

OUTPUT FORMAT

The Codes and Formats Subcommittee of CSEWG has adopted the formats[13] specified by the Committee on Computer Code Coordination for all standard group constants generated from ENDF/B data.

COMPUTER CODES FOR GENERATION OF THERMAL GROUP CONSTANTS

Several computer codes exist that are capable of producing the required standard thermal group constants. Some of these codes may require modification to handle 460 energy groups. Table V shows some of the available codes and the differences in their methods of generation of group constants from the above recommendations.

TABLE V

Thermal Region Cross Section Codes Interfaced to ENDF/B Data

Code Name	Comments
FLANGE II (Version 71-1)[14]	Can handle only 200 energy groups
ETOT[15]	Does not allow Doppler broadening of resonance cross sections
	Cannot process $S(\alpha,\beta)$ data
The following two codes may be used together to generate group constants:	
RESEND[16]	Treats only room temperature data
INTEND[17]	Does not handle thermal scattering matrices

Table VI shows the group equivalences between the standard thermal energy group structure and energy group structures for the thermal spectrum codes used to generate the compendium structures.

TABLE VI

Equivalences Between Group Structures

GROUP NO	MUFT III,IV,V	GAM I AND II	THERMOS - 30 GRP	LASER 35 GRP	H2O KERNEL 50 GP	GATHER II
1	270 - 295	234 - 256	3 - 10	6 - 30	3 - 10	9 - 20
2	296 - 339	257 - 277	11 - 22	31 - 78	11 - 22	21 - 39
3	340 - 376	278 - 302	23 - 41	79 - 89	23 - 41	40 - 57
4	377 - 425	303 - 339	42 - 65	90 - 100	42 - 65	58 - 76
5	426 - 452	340 - 377	66 - 81	101 - 114	66 - 81	77 - 80
6	453 - 459	378 - 425	82 - 87	115 - 129	82 - 87	81 - 84
7	0 - 0	426 - 452	88 - 92	130 - 149	88 - 92	85 - 90
8	0 - 0	453 - 459	93 - 97	150 - 165	93 - 97	91 - 96
9	0 - 0	0 - 0	98 - 103	166 - 176	98 - 103	97 - 102
10	0 - 0	0 - 0	104 - 109	177 - 184	104 - 109	103 - 108
11	0 - 0	0 - 0	110 - 117	185 - 193	110 - 117	109 - 119
12	0 - 0	0 - 0	118 - 125	194 - 203	118 - 125	120 - 132
13	0 - 0	0 - 0	126 - 134	204 - 207	126 - 134	133 - 146
14	0 - 0	0 - 0	135 - 143	208 - 210	135 - 143	147 - 156
15	0 - 0	0 - 0	144 - 154	211 - 214	144 - 154	157 - 159
16	0 - 0	0 - 0	155 - 160	215 - 216	155 - 160	160 - 161
17	0 - 0	0 - 0	161 - 164	217 - 219	161 - 164	162 - 163
18	0 - 0	0 - 0	165 - 169	220 - 225	165 - 169	164 - 166
19	0 - 0	0 - 0	170 - 174	226 - 235	170 - 174	167 - 168
20	0 - 0	0 - 0	175 - 178	236 - 250	175 - 178	169 - 169
21	0 - 0	0 - 0	179 - 182	251 - 269	179 - 182	170 - 171
22	0 - 0	0 - 0	183 - 188	270 - 289	183 - 188	172 - 175
23	0 - 0	0 - 0	189 - 196	290 - 315	189 - 196	176 - 180
24	0 - 0	0 - 0	197 - 204	316 - 325	197 - 204	181 - 185
25	0 - 0	0 - 0	205 - 212	326 - 328	205 - 212	186 - 190
26	0 - 0	0 - 0	213 - 222	329 - 329	213 - 222	191 - 195
27	0 - 0	0 - 0	223 - 233	330 - 330	223 - 233	196 - 199
28	0 - 0	0 - 0	234 - 252	331 - 331	234 - 252	200 - 202
29	0 - 0	0 - 0	253 - 270	332 - 335	253 - 270	203 - 205
30	0 - 0	0 - 0	271 - 290	336 - 346	271 - 290	206 - 206
31	0 - 0	0 - 0	0 - 0	347 - 361	291 - 295	207 - 208
32	0 - 0	0 - 0	0 - 0	362 - 379	296 - 302	209 - 209
33	0 - 0	0 - 0	0 - 0	380 - 395	303 - 308	210 - 211
34	0 - 0	0 - 0	0 - 0	396 - 409	309 - 314	212 - 213
35	0 - 0	0 - 0	0 - 0	410 - 425	315 - 320	214 - 215
36	0 - 0	0 - 0	0 - 0	0 - 0	321 - 325	216 - 217
37	0 - 0	0 - 0	0 - 0	0 - 0	326 - 328	218 - 218
38	0 - 0	0 - 0	0 - 0	0 - 0	329 - 330	219 - 220
39	0 - 0	0 - 0	0 - 0	0 - 0	331 - 333	221 - 221
40	0 - 0	0 - 0	0 - 0	0 - 0	334 - 336	222 - 223
41	0 - 0	0 - 0	0 - 0	0 - 0	337 - 339	224 - 224
42	0 - 0	0 - 0	0 - 0	0 - 0	340 - 352	225 - 227
43	0 - 0	0 - 0	0 - 0	0 - 0	353 - 363	228 - 230
44	0 - 0	0 - 0	0 - 0	0 - 0	364 - 376	231 - 234
45	0 - 0	0 - 0	0 - 0	0 - 0	377 - 399	235 - 236
46	0 - 0	0 - 0	0 - 0	0 - 0	400 - 425	237 - 238
47	0 - 0	0 - 0	0 - 0	0 - 0	426 - 443	239 - 241
48	0 - 0	0 - 0	0 - 0	0 - 0	444 - 452	242 - 243
49	0 - 0	0 - 0	0 - 0	0 - 0	453 - 456	244 - 244
50	0 - 0	0 - 0	0 - 0	0 - 0	457 - 459	245 - 246

GROUP NO	MUFT III,IV,V	GAM I AND II	THERMOS - 30 GRP	LASER 35 GRP	H2O KERNEL 50 GP	GATHER II
51	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	247 - 247
52	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	248 - 249
53	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	250 - 253
54	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	254 - 258
55	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	259 - 261
56	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	262 - 264
57	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	265 - 266
58	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	267 - 268
59	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	269 - 271
60	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	272 - 275
61	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	276 - 279
62	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	280 - 283
63	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	284 - 288
64	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	289 - 294
65	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	295 - 299
66	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	300 - 303
67	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	304 - 306
68	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	307 - 310
69	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	311 - 313
70	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	314 - 317
71	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	318 - 320
72	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	321 - 321
73	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	322 - 322
74	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	323 - 324
75	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	325 - 327
76	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	328 - 329
77	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	330 - 330
78	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	331 - 332
79	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	333 - 333
80	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	334 - 335
81	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	336 - 338
82	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	339 - 340
83	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	341 - 343
84	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	344 - 347
85	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	348 - 352
86	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	353 - 357
87	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	358 - 363
88	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	364 - 371
89	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	372 - 381
90	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	382 - 390
91	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	391 - 401
92	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	402 - 411
93	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	412 - 421
94	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	422 - 428
95	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	429 - 437
96	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	438 - 444
97	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	445 - 446
98	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	447 - 448
99	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	449 - 449
100	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	450 - 451
101	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	452 - 453

GROUP NC	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
1	9 - 20	1 - 8	1 - 1
2	21 - 39	9 - 20	2 - 3
3	40 - 63	21 - 33	4 - 4
4	64 - 82	34 - 46	5 - 6
5	83 - 90	47 - 57	7 - 7
6	91 - 96	58 - 70	8 - 9
7	97 - 102	71 - 79	10 - 11
8	103 - 110	80 - 80	12 - 12
9	111 - 122	81 - 83	13 - 13
10	123 - 132	84 - 85	14 - 14
11	133 - 142	86 - 86	15 - 15
12	143 - 155	87 - 88	16 - 16
13	156 - 158	89 - 90	17 - 17
14	159 - 161	91 - 91	18 - 18
15	162 - 163	92 - 93	19 - 19
16	164 - 166	94 - 94	20 - 21
17	167 - 168	95 - 95	22 - 23
18	169 - 169	96 - 96	24 - 24
19	170 - 171	97 - 98	25 - 25
20	172 - 172	99 - 99	26 - 26
21	173 - 175	100 - 100	27 - 27
22	176 - 177	101 - 101	28 - 28
23	178 - 179	102 - 102	29 - 29
24	180 - 181	103 - 104	30 - 31
25	182 - 185	105 - 105	32 - 32
26	186 - 187	106 - 106	33 - 34
27	188 - 192	107 - 107	35 - 35
28	193 - 195	108 - 108	36 - 36
29	196 - 199	109 - 111	37 - 37
30	200 - 201	112 - 112	38 - 38
31	202 - 205	113 - 113	39 - 40
32	206 - 206	114 - 115	41 - 42
33	207 - 208	116 - 116	43 - 43
34	209 - 209	117 - 117	44 - 44
35	210 - 211	118 - 118	45 - 45
36	212 - 213	119 - 120	46 - 47
37	214 - 215	121 - 121	48 - 48
38	216 - 217	122 - 123	49 - 49
39	218 - 218	124 - 124	50 - 50
40	219 - 220	125 - 125	51 - 51
41	221 - 221	126 - 126	52 - 52
42	222 - 223	127 - 127	53 - 53
43	224 - 224	128 - 128	54 - 54
44	225 - 226	129 - 130	55 - 55
45	227 - 229	131 - 131	56 - 56
46	230 - 232	132 - 133	57 - 58
47	233 - 236	134 - 135	59 - 59
48	237 - 237	136 - 136	60 - 60
49	238 - 240	137 - 137	61 - 61
50	241 - 242	138 - 138	62 - 62

GROUP NC	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
51	243 - 246	139 - 139	63 - 64
52	247 - 248	140 - 157	65 - 66
53	249 - 251	158 - 162	67 - 67
54	252 - 254	163 - 167	68 - 68
55	255 - 259	168 - 170	69 - 69
56	260 - 262	171 - 173	70 - 71
57	263 - 265	174 - 177	72 - 72
58	266 - 268	178 - 179	73 - 73
59	269 - 271	180 - 181	74 - 74
60	272 - 274	182 - 183	75 - 75
61	275 - 278	184 - 186	76 - 77
62	279 - 282	187 - 189	78 - 80
63	283 - 286	190 - 191	81 - 83
64	287 - 292	192 - 194	84 - 85
65	293 - 296	195 - 197	86 - 86
66	297 - 301	198 - 198	87 - 88
67	302 - 308	199 - 200	89 - 90
68	309 - 313	201 - 202	91 - 91
69	314 - 319	203 - 205	92 - 93
70	320 - 322	206 - 206	94 - 94
71	323 - 323	207 - 208	95 - 95
72	324 - 326	209 - 209	96 - 96
73	327 - 327	210 - 211	97 - 98
74	328 - 328	212 - 213	99 - 99
75	329 - 329	214 - 215	100 - 100
76	330 - 330	216 - 217	101 - 101
77	331 - 333	218 - 218	102 - 102
78	334 - 334	219 - 220	103 - 104
79	335 - 337	221 - 221	105 - 105
80	338 - 338	222 - 223	106 - 106
81	339 - 341	224 - 224	107 - 107
82	342 - 344	225 - 226	108 - 108
83	345 - 347	227 - 228	109 - 111
84	348 - 351	229 - 229	112 - 112
85	352 - 357	230 - 231	113 - 113
86	358 - 363	232 - 232	114 - 115
87	364 - 371	233 - 234	116 - 116
88	372 - 379	235 - 236	117 - 117
89	380 - 390	237 - 237	118 - 118
90	391 - 401	238 - 239	119 - 120
91	402 - 418	240 - 241	121 - 121
92	419 - 431	242 - 243	122 - 123
93	432 - 445	244 - 245	124 - 124
94	446 - 447	246 - 247	125 - 125
95	448 - 450	248 - 249	126 - 126
96	451 - 454	250 - 251	127 - 127
97	455 - 455	252 - 253	128 - 128
98	456 - 456	254 - 255	129 - 130
99	457 - 457	256 - 257	131 - 131
100	458 - 458	258 - 259	132 - 133

GROUP NC	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
101	459 - 460	260 - 260	134 - 135
102	0 - 0	261 - 262	136 - 136
103	0 - 0	263 - 263	137 - 137
104	0 - 0	264 - 265	138 - 138
105	0 - 0	266 - 266	139 - 139
106	0 - 0	267 - 267	140 - 140
107	0 - 0	268 - 268	141 - 141
108	0 - 0	269 - 269	142 - 144
109	0 - 0	270 - 271	145 - 145
110	0 - 0	272 - 272	146 - 147
111	0 - 0	273 - 273	148 - 148
112	0 - 0	274 - 274	149 - 150
113	0 - 0	275 - 276	151 - 151
114	0 - 0	277 - 278	152 - 152
115	0 - 0	279 - 280	153 - 153
116	0 - 0	281 - 281	154 - 162
117	0 - 0	282 - 282	163 - 167
118	0 - 0	283 - 283	168 - 170
119	0 - 0	284 - 284	171 - 173
120	0 - 0	285 - 285	174 - 177
121	0 - 0	286 - 286	178 - 179
122	0 - 0	287 - 287	180 - 181
123	0 - 0	288 - 288	182 - 183
124	0 - 0	289 - 290	184 - 186
125	0 - 0	291 - 291	187 - 189
126	0 - 0	292 - 292	190 - 191
127	0 - 0	293 - 293	192 - 194
128	0 - 0	294 - 294	195 - 197
129	0 - 0	295 - 295	198 - 198
130	0 - 0	296 - 297	199 - 200
131	0 - 0	298 - 298	201 - 202
132	0 - 0	299 - 300	203 - 205
133	0 - 0	301 - 302	206 - 206
134	0 - 0	303 - 304	207 - 208
135	0 - 0	305 - 305	209 - 209
136	0 - 0	306 - 307	210 - 211
137	0 - 0	308 - 309	212 - 213
138	0 - 0	310 - 311	214 - 215
139	0 - 0	312 - 312	216 - 217
140	0 - 0	313 - 314	218 - 218
141	0 - 0	315 - 316	219 - 220
142	0 - 0	317 - 318	221 - 221
143	0 - 0	319 - 320	222 - 223
144	0 - 0	321 - 321	224 - 224
145	0 - 0	322 - 322	225 - 226
146	0 - 0	323 - 323	227 - 228
147	0 - 0	324 - 325	229 - 229
148	0 - 0	326 - 326	230 - 231
149	0 - 0	327 - 327	232 - 232
150	0 - 0	328 - 328	233 - 234

GROUP NO	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
151	0 - 0	329 - 329	235 - 236
152	0 - 0	330 - 330	237 - 237
153	0 - 0	331 - 332	238 - 239
154	0 - 0	333 - 333	240 - 241
155	0 - 0	334 - 334	242 - 243
156	0 - 0	335 - 336	244 - 245
157	0 - 0	337 - 337	246 - 247
158	0 - 0	338 - 339	248 - 249
159	0 - 0	340 - 342	250 - 251
160	0 - 0	343 - 344	252 - 253
161	0 - 0	345 - 345	254 - 255
162	0 - 0	346 - 346	256 - 257
163	0 - 0	347 - 347	258 - 259
164	0 - 0	348 - 348	260 - 260
165	0 - 0	349 - 349	261 - 262
166	0 - 0	350 - 350	263 - 263
167	0 - 0	351 - 351	264 - 265
168	0 - 0	352 - 352	266 - 266
169	0 - 0	353 - 353	267 - 267
170	0 - 0	354 - 354	268 - 268
171	0 - 0	355 - 355	269 - 269
172	0 - 0	356 - 356	270 - 271
173	0 - 0	357 - 357	272 - 272
174	0 - 0	358 - 358	273 - 273
175	0 - 0	359 - 359	274 - 274
176	0 - 0	360 - 360	275 - 276
177	0 - 0	361 - 362	277 - 278
178	0 - 0	363 - 363	279 - 280
179	0 - 0	364 - 364	281 - 281
180	0 - 0	365 - 365	282 - 282
181	0 - 0	366 - 366	283 - 283
182	0 - 0	367 - 367	284 - 284
183	0 - 0	368 - 368	285 - 285
184	0 - 0	369 - 369	286 - 286
185	0 - 0	370 - 370	287 - 287
186	0 - 0	371 - 372	288 - 288
187	0 - 0	373 - 373	289 - 290
188	0 - 0	374 - 374	291 - 291
189	0 - 0	375 - 375	292 - 292
190	0 - 0	376 - 377	293 - 293
191	0 - 0	378 - 378	294 - 294
192	0 - 0	379 - 380	295 - 295
193	0 - 0	381 - 382	296 - 297
194	0 - 0	383 - 383	298 - 298
195	0 - 0	384 - 384	299 - 300
196	0 - 0	385 - 385	301 - 302
197	0 - 0	386 - 386	303 - 304
198	0 - 0	387 - 387	305 - 305
199	0 - 0	388 - 388	306 - 307
200	0 - 0	389 - 389	308 - 309

GROUP NO	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
201	0 - 0	390 - 391	310 - 311
202	0 - 0	392 - 392	312 - 312
203	0 - 0	393 - 393	313 - 314
204	0 - 0	394 - 394	315 - 316
205	0 - 0	395 - 395	317 - 318
206	0 - 0	396 - 396	319 - 320
207	0 - 0	397 - 397	321 - 321
208	0 - 0	398 - 398	322 - 322
209	0 - 0	399 - 399	323 - 323
210	0 - 0	400 - 400	324 - 325
211	0 - 0	401 - 402	326 - 326
212	0 - 0	403 - 403	327 - 327
213	0 - 0	404 - 404	328 - 328
214	0 - 0	405 - 405	329 - 329
215	0 - 0	406 - 406	330 - 330
216	0 - 0	407 - 407	331 - 332
217	0 - 0	408 - 408	333 - 333
218	0 - 0	409 - 409	334 - 334
219	0 - 0	410 - 410	335 - 336
220	0 - 0	411 - 412	337 - 337
221	0 - 0	413 - 413	338 - 339
222	0 - 0	414 - 414	340 - 342
223	0 - 0	415 - 415	343 - 344
224	0 - 0	416 - 416	345 - 345
225	0 - 0	417 - 417	346 - 346
226	0 - 0	418 - 419	347 - 347
227	0 - 0	420 - 420	348 - 348
228	0 - 0	421 - 422	349 - 349
229	0 - 0	423 - 423	350 - 350
230	0 - 0	424 - 424	351 - 351
231	0 - 0	425 - 425	352 - 352
232	0 - 0	426 - 426	353 - 353
233	0 - 0	427 - 427	354 - 354
234	0 - 0	428 - 429	355 - 355
235	0 - 0	430 - 430	356 - 356
236	0 - 0	431 - 432	357 - 357
237	0 - 0	433 - 433	358 - 358
238	0 - 0	434 - 434	359 - 359
239	0 - 0	435 - 435	360 - 360
240	0 - 0	436 - 436	361 - 362
241	0 - 0	437 - 438	363 - 363
242	0 - 0	439 - 439	364 - 364
243	0 - 0	440 - 440	365 - 365
244	0 - 0	441 - 441	366 - 366
245	0 - 0	442 - 442	367 - 367
246	0 - 0	443 - 443	368 - 368
247	0 - 0	0 - 0	369 - 369
248	0 - 0	0 - 0	370 - 370
249	0 - 0	0 - 0	371 - 372
250	0 - 0	0 - 0	373 - 373

GROUP NU	GATHER (REV)	TEMPEST - 246 GP	TEMPEST - 309 GP
251	0 - 0	0 - 0	374 - 374
252	0 - 0	0 - 0	375 - 375
253	0 - 0	0 - 0	376 - 377
254	0 - 0	0 - 0	378 - 378
255	0 - 0	0 - 0	379 - 380
256	0 - 0	0 - 0	381 - 382
257	0 - 0	0 - 0	383 - 383
258	0 - 0	0 - 0	384 - 384
259	0 - 0	0 - 0	385 - 385
260	0 - 0	0 - 0	386 - 386
261	0 - 0	0 - 0	387 - 387
262	0 - 0	0 - 0	388 - 388
263	0 - 0	0 - 0	389 - 389
264	0 - 0	0 - 0	390 - 391
265	0 - 0	0 - 0	392 - 392
266	0 - 0	0 - 0	393 - 393
267	0 - 0	0 - 0	394 - 394
268	0 - 0	0 - 0	395 - 395
269	0 - 0	0 - 0	396 - 396
270	0 - 0	0 - 0	397 - 397
271	0 - 0	0 - 0	398 - 398
272	0 - 0	0 - 0	399 - 399
273	0 - 0	0 - 0	400 - 400
274	0 - 0	0 - 0	401 - 402
275	0 - 0	0 - 0	403 - 403
276	0 - 0	0 - 0	404 - 404
277	0 - 0	0 - 0	405 - 405
278	0 - 0	0 - 0	406 - 406
279	0 - 0	0 - 0	407 - 407
280	0 - 0	0 - 0	408 - 408
281	0 - 0	0 - 0	409 - 409
282	0 - 0	0 - 0	410 - 410
283	0 - 0	0 - 0	411 - 412
284	0 - 0	0 - 0	413 - 413
285	0 - 0	0 - 0	414 - 414
286	0 - 0	0 - 0	415 - 415
287	0 - 0	0 - 0	416 - 416
288	0 - 0	0 - 0	417 - 417
289	0 - 0	0 - 0	418 - 419
290	0 - 0	0 - 0	420 - 420
291	0 - 0	0 - 0	421 - 422
292	0 - 0	0 - 0	423 - 423
293	0 - 0	0 - 0	424 - 424
294	0 - 0	0 - 0	425 - 425
295	0 - 0	0 - 0	426 - 426
296	0 - 0	0 - 0	427 - 427
297	0 - 0	0 - 0	428 - 429
298	0 - 0	0 - 0	430 - 430
299	0 - 0	0 - 0	431 - 432
300	0 - 0	0 - 0	433 - 433
301	0 - 0	0 - 0	434 - 434
302	0 - 0	0 - 0	435 - 435
303	0 - 0	0 - 0	436 - 436
304	0 - 0	0 - 0	437 - 438
305	0 - 0	0 - 0	439 - 439
306	0 - 0	0 - 0	440 - 440
307	0 - 0	0 - 0	441 - 441
308	0 - 0	0 - 0	442 - 442
309	0 - 0	0 - 0	443 - 443

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