BNWL-1044

UC-80

2-

11-69

GROUP CONSTANTS FOR ANALYSIS
OF FFTF CRITICAL EXPERIMENTS

November 1969

AEC RESEARCH &
DEVELOPMENT REPORT

DATE TO	P.R. NO.	LOCATION	FILED FOR REVIEW

BNWL-1044

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

PACIFIC NORTHWEST LABORATORY

RICHLAND, WASHINGTON

operated by

BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

3 3679 00061 6153

BNWL-1044
UC-80, Reactor
Technology

GROUP CONSTANTS FOR ANALYSIS
OF FFTF CRITICAL EXPERIMENTS

J. V. Nelson
S. L. DeMyer

Reactor and Plant Technology Department
FFTF Project

November 1969

REST UNRESTRICTED
CLASSIFIED

DEC 21 '69

BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

BNWL-1044

Printed in the United States of America
Available from
Clearinghouse for Federal Scientific and Technical Information
National Bureau of Standards, U.S. Department of Commerce
Springfield, Virginia 22151
Price: Printed Copy \$3.00; Microfiche \$0.65

GROUP CONSTANTS FOR ANALYSIS
OF FFTF CRITICAL EXPERIMENTS
J. V. Nelson and S. L. DeMyer

This report completes the formal, referencable documentation of nuclear data and multigroup constants which have been available to date (April 1969) for the analysis of FFTF critical experiments.^(1,2,3) In general, the cross section data is identical to the 26 group Russian set⁽⁴⁾ with the exception that some group constants, for several isotopes, have been modified. This report presents only the data which differ from those compiled in Reference 4.

Modified data listed below are identified by isotope with a prefix letter and a modification number, e.g., M3 Pu239 is the third modification of the original Russian ²³⁹Pu cross section set. Modified isotopes include:

²³⁹ Pu	²³⁶ U
²⁴¹ Pu	²³⁸ U
²³³ U	O
²³⁴ U	Fe
²³⁵ U	¹⁰ B

Tabulation of new values of group constants for these isotopes follow the definition of symbols given below. Also, Mn cross section data from the ENDF/B library are available in the 26 group Russian format and a complete listing of the values for this isotope is presented following the data for the modified isotopes.

IDENTIFICATION OF ABBREVIATED TABLE HEADINGS

<u>Report Abbreviation</u>	<u>Bondarenko Designation</u>	
SIGT	σ_t	Group averaged value of the total cross section
SIGF	σ_f	Group averaged value of the fission cross section
NU	ν	Group averaged value of the number of secondary neutrons per fission
SIGC	σ_c	Group averaged value of the capture cross section
SIGIN	σ_{in}	Group averaged value of the inelastic scattering cross section
SIGEL	$\sigma_{e(i,i+k)}$	Group averaged value of the elastic scattering cross section
MUEL	$\mu_{e(i,i+k)}$	Group averaged value of the average cosine of the elastic scattering angle
XI	ξ	Group averaged value of the average lethargy change per elastic scattering event
SIGDEL	$\sigma_{d(e)}$	Group averaged elastic slowing down cross section
GXG	$\sigma_{in(i,i)}$	Group averaged in-group inelastic scattering cross section
GXG+i	$\sigma_{in(i,i+k)}$	Group averaged inelastic scattering cross section from group G to group G+i
SIGO	$\sigma_{o,\ell}$	The sum of the total macroscopic cross sections of all the other elements included in the medium referred to a single atom of isotope ℓ

$$\sigma_{o,\ell} = \frac{1}{N\ell} \sum_{m \neq \ell} \sigma_{t,m} N_m$$

where N is the atom density for a particular isotope in the medium.

REFERENCES

1. Q. L. Baird and S. L. Engstrom. Evaluation of NPTR/FTR Neutronics Differences, BNWL-762. Battelle-Northwest, Richland, Washington, April 1968.
2. S. L. Engstrom and H. C. F. Ripfel. NPTR Tertiary Reactivity Control System, BNWL-767. Battelle-Northwest, Richland, Washington, April 1968.
3. R. A. Bennett and S. L. DeMyer. Analysis of FTR Phase A Control Rod Experiments in ZPR III, Assembly 48 and 48a, BNWL-967. Battelle-Northwest, Richland, Washington, March 1969.
4. I. I. Bondarenko et al. Group Constants for Nuclear Calculations. Consultants Bureau, New York, 1964.

CROSS SECTION DATA FOR M3PU49

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
2	7.751	1.900		.021					
4	7.351	2.000		.041					
5	7.248	1.750		.058					
6	8.257	1.640		.107					
7	9.867	1.630		.167					
9	12.239	1.700		.289					
10	13.451	1.750		.561					
11	14.130	1.800		.810					

CROSS SECTION DATA FOR M2PU49

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1			3.820						
2	7.751	1.900	3.470	.021					
3			3.240						
4	7.351	2.000	3.090	.041					
5	7.248	1.750	2.980	.058					
6	8.257	1.640	2.920	.107					
7	9.867	1.630	2.880	.167					
8			2.860						
9	12.239	1.700	2.850	.289					
10	13.451	1.750	2.840	.561					
11	14.130	1.800	2.840	.810					
12			2.840						
13			2.840						
14			2.840						
15			2.840						
16			2.840						
17			2.840						
18			2.840						
19			2.840						
20			2.840						
21			2.840						
22			2.840						
23			2.840						
24			2.840						
25			2.840						
26			2.840						

CROSS SECTION DATA FOR M2PU41

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	7.000	2.000							
2	7.851	1.500		.011					
3	8.052	1.550		.022					
4	7.555	1.700		.035					
5	7.562	1.550		.072					
6	8.514	1.500		.104					
7	10.110	1.700		.170					
8	11.466	2.070		.256					
9	12.210	2.370		.330					
10	13.298	2.850		.458					
11	14.541	3.400		.611					
12	15.884	4.070		.814					
13	19.517	6.150		1.367					
14	23.430	8.400		2.030					
15	28.500	12.400		3.100					
16	45.567	26.600		6.967					
17	47.720	28.200		7.520					

CROSS SECTION DATA FOR M2U233

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
2	7.320	1.520							
3	7.447	1.600		.027					
4	6.910	1.840							
5	6.510	1.840							
6	7.184	1.850		.104					
7	9.080	2.190		.190					
8	10.380	2.200		.240					
9	11.536	2.300		.276					
10	12.614	3.000		.514					
11	14.408	4.100		.758					
12	14.876	4.600		.976					
13	20.130	7.400		1.730					
14	27.625	12.500		3.125					
15	40.254	21.100		6.154					
16	53.740	29.100		11.640					
17	70.400	41.000		16.400					

CROSS SECTION DATA FOR M2U234

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	6.180	1.880							
2	7.247	1.300		.017					
3	7.577	1.400		.037					
4									
5	6.952	1.180		.242					
6				.214					

CROSS SECTION DATA FOR M2U235

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
4	7.032	1.310		.062					
6	7.366	1.200		.166					
7	9.130	1.350		.240					
8	10.984	1.525		.359					
9	12.178	1.850		.528					
10	13.529	2.300		.869					
11	15.206	2.850		1.256					
12	18.410	4.000		1.910					

CROSS SECTION DATA FOR M2U236

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1									
2	7.459	.880		.019					
3	7.637	.840		.047					
4									
5	6.864	.400		.314					
6	7.635	.015		.150					

CROSS SECTION DATA FOR M1U238

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	6.508				2.008				
2	7.523				2.533				
3	7.715				2.615				
4	7.750				2.900				
5	7.216				2.466				
6	7.928				1.778				
7	9.770			.140	1.230				
8	11.741			.170	.841				
9	12.761			.260	.241				
10	13.540			.500					
11	14.150			.750					

INELASTIC SCATTERING MATRIX FOR M1U238

GROUP	GXG	GXG+1	GXG+2	. . .							
1		.005	.060	.285	.528	.748	.614	.352	.157	.046	.015
2	.004	.080	.436	.748	.741	.350	.123			.003	.001
3	.020	.249	.664	.891	.510	.196	.064	.015	.004	.001	
4	.086	.570	1.319	.674	.186	.050	.012	.003			
5	.976	.625	.528	.254	.065	.013	.002	.001			
6	1.368	.363	.021	.017	.006	.002					
7	.825	.374	.029	.001							
8	.448	.382	.008	.002							
9	.062	.131	.036	.009	.002						

BNWL-1044

CROSS SECTION DATA FOR E3 0

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	1.110			.089	.193	.827	.153	.106	.098
2	1.405			.058		1.347	.257	.093	.279
3	1.930					1.928	.185	.102	.707
4	1.659					1.659	.097	.113	.324
5	4.102					4.102	.088		.837
6	5.448					5.448	.269	.092	.720
7	3.570					3.570	-.124	.141	.724
8	3.404					3.404	-.015	.127	.624
9	3.523					3.523	.018	.123	.565
10	3.590					3.590	.031	.121	.564
11	3.621					3.621	.037		.570
12	3.633					3.633			.570
13	3.645					3.645			.567
14	3.656					3.656	.041		.573
15	3.667					3.667	.042		.575
16	3.679					3.679	.042		.572
17	3.690					3.690	.042		.578
18	3.701					3.701	.042		.580
19	3.713					3.713	.042		.577
20	3.725					3.725	.042		
21	3.736					3.736	.042		.585
22	3.748					3.748	.042		.583
23	3.759					3.759	.042		.589
24	3.765					3.765	.042		.590
25	3.765					3.765	.042		.585
26	3.765					3.765	.042	.120	.590

BNWL-1044

INELASTIC SCATTERING MATRIX FOR E3 O

GROUP	GXG	GXG+1	GXG+2	. . .
1	.006	.055	.080	.039 .012 .000

CAPTURE SELF-SHIELDING FACTORS FOR E3 O (TEMPERATURE INDEPENDENT)

SIGO GROUP	1.0+02	2.0+01	1.5+01	1.0+01	1.0+00	1.0-03
1	1.000	.998	.998	.998	.992	.987
2	.999	.996	.995	.993	.973	.959
3	.996	.976	.969	.957	.804	.675
4	.000	.000	.000			
5	.000	.000	.000			
6	.000	.000	.000			
7	.000	.000	.000			

TOTAL SELF-SHIELDING FACTORS FOR E3 O (TEMPERATURE INDEPENDENT)

SIGO GROUP	1.0+02	2.0+01	1.5+01	1.0+01	1.0+00	1.0-03
1	.999	.997	.996	.994	.968	.935
2	.997	.984	.980	.972	.887	.821
3	.992	.964	.954	.936	.772	.686
4	.995	.978	.971	.959	.749	.175
5	.988	.953	.942	.924	.836	.810
6	.953	.842	.814	.776	.641	.615
7	.999	.995	.993	.991	.978	.974
8	1.000	1.000	1.000	1.000	1.000	1.000

ELASTIC SELF-SHIELDING FACTORS FOR E3 O (TEMPERATURE INDEPENDENT)

SIGO GROUP	1.0+02	2.0+01	1.5+01	1.0+01	1.0+00	1.0-03
1	1.000	.998	.998	.997	.987	.975
2	.998	.991	.989	.984	.937	.896
3	.996	.979	.973	.964	.870	.809
4	.998	.989	.986	.980	.889	.632
5	.994	.975	.970	.960	.904	.885
6	.976	.912	.895	.869	.755	.726
7	.999	.997	.996	.995	.988	.985
8	1.000	1.000	1.000	1.000	1.000	1.000

CROSS SECTION DATA FOR M2 FE

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	3.409			.045					
2	3.824			.029					
3	3.507			.009					
4	3.299			.002					
5	2.899			.003					
7	3.003			.009					
8	3.697			.007					
9	5.302			.009					
10	14.503			.020					
11	4.020			.025					
12	8.458			.062					
13	5.912			.023					
14	7.525			.131					
15	10.012			.027					
16	11.001			.029					
17	11.394			.031					

CROSS SECTION DATA FOR M1 FE									
ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET									
GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
8	3.702			.012					
9	5.313			.020					
10	14.525			.042					
11	4.015			.020					
12	8.456			.060					

CROSS SECTION DATA FOR M1B10

ALL DATA WHICH IS OMITTED IS UNCHANGED FROM THE RUSSIAN SET

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
5	2.522			.242					
6	4.170			.570					
7	5.010			1.010					
8	4.869			1.669					
9	4.753			2.353					
10	5.456			3.456					
11	7.375			5.075					
12	10.042			7.442					
13	13.830			10.930					
14	19.148			16.048					
15	26.733			23.533					
16	37.863			34.563					
17	54.049			50.749					
18	77.718			74.418					
19	112.297			109.297					
20	163.483			160.483					
21	238.330			235.330					
22	348.627			345.627					
23	510.493			507.493					
24	747.180			744.180					
25	1095.970			1092.970					
26	3383.600			3371.600					

BNWL-1044

CROSS SECTION DATA FOR E4 MN

GROUP	SIGT	SIGF	NU	SIGC	SIGIN	SIGEL	MUEL	XI	SIGDEL
1	3.388	.000	.000	.058	1.370	1.959	.718	.010	.022
2	3.734	.000	.000	.014	1.366	2.353	.655	.013	.067
3	3.642	.000	.000	.002	1.274	2.365	.552	.016	.140
4	3.495	.000	.000	.003	1.086	2.407	.372	.023	.096
5	3.217	.000	.000	.003	.742	2.472	.103	.033	.144
6	3.398	.000	.000	.004	.458	2.935	.061	.034	.145
7	4.701	.000	.000	.008	.377	4.315	.055	.034	.214
8	7.346	.000	.000	.015	.194	7.137	.040	.035	.360
9	7.690	.000	.000	.025		7.665	.032	.035	.353
10	14.838	.000	.000	.051		14.787	.027	.035	.678
11	9.617	.000	.000	.096		9.520	.023	.035	.441
12	35.611	.000	.000	.046		35.566	.019	.036	1.653
13	172.853	.000	.000	.206		172.647	.016	.036	8.001
14	113.259	.000	.000	1.406		111.853	.013	.036	5.248
15	18.343	.000	.000	.176		18.167	.012	.036	.855
16	435.266	.000	.000	9.922		425.343	.012	.036	19.942
17	11.184	.000	.000	.510		10.675	.012	.036	.506
18	5.727	.000	.000	.375		5.352	.012	.036	.254
19	4.947	.000	.000	.443		4.504	.012	.037	.213
20	4.799	.000	.000	.596		4.204	.012	.037	.201
21	4.937	.000	.000	.841		4.096	.012	.037	.196
22	5.264	.000	.000	1.214		4.051	.012	.037	.193
23	5.795	.000	.000	1.768		4.027	.012	.037	.194
24	6.601	.000	.000	2.584		4.017	.012	.037	.194
25	7.801	.000	.000	3.788		4.013	.012	.037	.193
26	9.569	.000	.000	5.558		4.011	.012	.037	.195

BNWL-1044

INELASTIC SCATTERING MATRIX FOR E4 MN

GROUP	GXG	GXG+1	GXG+2	.	.	.	.	.	.
1	.008	.111	.270	.419	.299	.179	.061	.018	.005 .001
2	.061	.281	.438	.312	.186	.063	.018	.005	.001
3	.155	.478	.341	.204	.069	.020	.006	.001	
4	.420	.299	.242	.076	.031	.013	.002		
5	.450	.152	.071	.038	.023	.008			
6	.293	.165							
7	.116	.198	.063						
8	.000	.075	.073	.032	.011	.003			

CAPTURE SELF-SHIELDING FACTORS FOR E4 MN (TEMPERATURE INDEPENDENT)

SIG0	1.0+05	1.0+04	5.0+03	1.0+03	1.0+03	1.0+02
GROUP						
10	1.000	1.000	.999	.996	.970	
11	1.000	1.000	.999	.997	.977	
12	.999	.995	.989	.950	.729	
13	.997	.972	.946	.794	.402	
14	.994	.947	.903	.705	.401	
15	1.000	1.000	.999	.996	.968	
16	.987	.895	.821	.572	.298	
17	1.000	1.000	1.000	.999	.991	
18	1.000	1.000	1.000	1.000	1.000	
19	1.000	1.000	1.000	1.000	1.000	
20	1.000	1.000	1.000	1.000	1.000	
21	1.000	1.000	1.000	1.000	1.000	
22	1.000	1.000	1.000	1.000	1.000	

TOTAL SELF-SHIELDING FACTORS FOR E4 MN (TEMPERATURE INDEPENDENT)

SIGO GROUP	1.0+05	1.0+04	5.0+03	1.0+03	1.0+02
10	.857	.854	.851	.826	.647
11	.916	.912	.908	.879	.693
12	.998	.988	.977	.902	.539
13	.995	.950	.906	.669	.255
14	1.000	.963	.931	.798	.586
15	1.000	1.000	.999	.994	.935
16	.975	.804	.684	.378	.164
17	1.021	1.020	1.020	1.018	.994
18	1.038	1.038	1.038	1.038	1.037
19	1.021	1.022	1.022	1.022	1.022
20	1.000	1.000	1.000	1.000	1.000
21	1.002	1.002	1.002	1.002	1.002
22	1.002	1.003	1.003	1.003	1.002

ELASTIC SELF-SHIELDING FACTORS FOR E4 MN (TEMPERATURE INDEPENDENT)

SIGO GROUP	1.0+05	1.0+04	5.0+03	1.0+03	1.0+02
10	1.000	.998	.997	.985	.888
11	1.000	.998	.996	.981	.868
12	.999	.994	.989	.950	.719
13	.997	.975	.951	.815	.453
14	.998	.979	.961	.876	.697
15	1.000	1.000	.999	.997	.976
16	.987	.894	.820	.568	.289
17	1.000	1.000	1.000	.998	.986
18	1.000	1.000	1.000	1.000	1.000
19	1.000	1.000	1.000	1.000	1.000
20	1.000	1.000	1.000	1.000	1.000
21	1.000	1.000	1.000	1.000	1.000
22	1.000	1.000	1.000	1.000	1.000

DISTRIBUTION

No. of
Copies
OFFSITE

1	<u>AEC Chicago Patent Group</u> G. H. Lee
31	<u>AEC Division of Reactor Development and Technology</u> M. Shaw, Director, RDT Asst Dir for Nuclear Safety Analysis & Evaluation Br, RDT:NS Environmental & Sanitary Engrg Br, RDT:NS Research & Development Br, RDT:NS Asst Dir for Plant Engrg, RDT Facilities Br, RDT:PE Components Br, RDT:PE Instrumentation & Control Br, RDT:PE Liquid Metal Systems Br, RDT:PE Asst Dir for Program Analysis, RDT Asst Dir for Project Mgmt, RDT Liquid Metals Projects Br, RDT:PM FFTF Project Manager, RDT:PM (3) Asst Dir for Reactor Engrg, RDT Control Mechanisms Br, RDT:RE Core Design Br, RDT:RE (2) Fuel Engineering Br, RDT:RE Fuel Handling Br, RDT:RE Reactor Vessels Br, RDT:RE Asst Dir for Reactor Tech, RDT Coolant Chemistry Br, RDT:RT Fuel Recycle Br, RDT:RT Fuels & Materials Br, RDT:RT Reactor Physics Br, RDT:RE Special Technology Br, RDT:RT Asst Dir for Engrg Standards, RDT EBR-II Project Manager, RDT:PM
197	<u>AEC Division of Technical Information Extension</u>
1	<u>AEC Idaho Operations Office</u> <u>Nuclear Technology Division</u> C. W. Bills, Director
1	<u>AEC San Francisco Operations Office</u> <u>Director, Reactor Division</u>
4	<u>AEC Site Representatives</u> Argonne National Laboratory Atomics International Atomic Power Development Assoc. General Electric Co.

No. of
Copies

3 Argonne National Laboratory
 R. A. Jaross
 LMFBR Program Office
 N. J. Swanson

1 Atomic Power Development Assoc.
 Document Librarian

7 Atomics International
 FFTF Program Office (5)
 Liquid Metal Information Center
 J. J. Droher (2)

2 Babcock & Wilcox Co.
 Atomic Energy Division
 S. H. Esleeck
 G. B. Garton

1 BNW Representative
 R. M. Fleischman (ZPPR)

1 Combustion Engineering
 1000 MWe Follow-On Study
 W. P. Staker, Project Manager

5 General Electric Company
 Advanced Products Operation
 Karl Cohen (4)
 Nuclear Systems Programs
 D. H. Ahmann

2 Gulf General Atomic Inc.
 General Atomic Div
 D. Coburn

1 Idaho Nuclear Corporation
 D. R. deBoisblanc

3 Oak Ridge National Laboratory
 W. O. Harms

No. of
Copies

1 Stanford University
 Nuclear Division
 Division of Mechanical Engrg
 R. Sher

1 United Nuclear Corporation
 Research and Engineering Center
 R. F. DeAngelis

10 Bechtel Corporation
 J. J. Teachnor, Project Administrator, FFTF (10)

15 Westinghouse Electric Corporation
 Atomic Power Division
 Advanced Reactor Systems
 J. C. R. Kelly

ONSITE-HANFORD

1 Bechtel Corporation
 M. O. Rothwell (Richland)

1 Westinghouse Electric Corporation
 R. Strzelecki (Richland)

4 AEC RDT Site Representative
 P. G. Holsted
 T. A. Nemzek

2 AEC Richland Operations Office
 J. M. Shivley

1 AEC Chicago Patent Group
 R. K. Sharp (Richland)

3 Battelle Memorial Institute

97 Battelle-Northwest
 S. O. Arneson D. C. Boyd
 E. R. Astley W. L. Bunch
 Q. L. Baird E. D. Clayton
 R. A. Bennett J. C. Cochran
 E. T. Boulette P. D. Cohn

Battelle-Northwest (contd)

D. L. Condotta	V. O. Uotinen
R. R. Cone	R. C. Walker
J. M. Davidson	A. E. Waltar
F. G. Dawson	J. F. Wett
V. A. De Liso	N. G. Wittenbrock
S. L. DeMyer (5)	M. R. Wood
J. F. Erben	W. R. Wykoff
E. A. Evans	W. R. Young
L. M. Finch	FFTF Files, 703 Bldg (10)
F. C. Gronemeyer	FFTF TPO (List "T") (3)
V. W. Gustafson	Legal - 703 Bldg
J. P. Hale	Legal - ROB, 221-A
R. W. Hardie	Technical Information (5)
K. M. Harmon	Technical Publications (2)
R. A. Harvey	
R. E. Heineman	
J. W. Helm	
R. J. Hennig	
P. L. Hofmann	
E. M. Johnston	
H. D. Lenkersdorfer	
R. C. Liikala	
C. W. Lindenmeier	
H. E. Little	
W. W. Little, Jr.	
B. Mann	
C. A. Mansius	
D. Marinos	
D. R. Marr	
W. B. McDonald	
J. S. McMahon	
J. W. Mitchell	
R. A. Moen	
C. A. Munro	
C. R. Nash	
J. V. Nelson (5)	
L. D. O'Dell	
D. P. O'Keefe	
R. Omberg	
J. A. Perry	
R. E. Peterson	
H. C. Ripfel	
W. E. Roake	
R. L. Roske	
J. M. Seehuus	
J. R. Sheff	
R. J. Squires	
D. D. Stepnewski	
C. D. Swanson	