January 1976

PHYSICS VERIFICATION PROGRAM
PART IV, TASK 1
QUARTERLY TECHNICAL REPORT
JULY-SEPTEMBER 1975

by
M. N. Baldwin

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

ERDA Contract No. AT(11-1)-3109
B&W Contract No. 41-2007
(WO 6636-01 & RDE-2331-01)

Prepared for
THE ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
by
BABCOCK & WILCOX
Research and Development Division
Lynchburg Research Center
P.O. Box 1260
Lynchburg, Virginia 24505

Babcock & Wilcox *ab*

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

ACKNOWLEDGMENT

The author wishes to thank W. T. Hamilton and J. O. Towles for their assistance on this project.

The Babcock & Wilcox Company
Research and Development Division
Lynchburg Research Center
Lynchburg, Virginia

Report BAW-3647-36

January 1976

Physics Verification Program, Part IV, Task 1
Quarterly Technical Report, July-September 1975

M. N. Baldwin

Key Words: Critical Assembly, Neutron Absorption
Reactivity Worth, Power Perturbations

ABSTRACT

The reactivity and power perturbation effects of poison and neutral pins in mockups of 15 by 15 fuel assemblies are being measured. The experimental facility - a water-moderated, 4% enriched UO_2 lattice - is arranged to simulate the fuel assemblies of the consolidated nuclear steam generator (CNSG) core.

CONTENTS

	Page
1. INTRODUCTION	1
2. DESCRIPTION OF FACILITY	2
2.1. Facility	2
2.2. Fuel Rods	2
2.3. Perturbing Pins	2
3. MEASUREMENTS	3
3.1. Task Description	3
3.2. Critical Parameters	3
3.3. Numerical Adjustment of Boron Concentration	4
3.4. Power Profile Measurements	4
REFERENCES	15

List of Tables

Table

1. Core Loadings Studied During Third Quarter	5
2. Core Loadings Adjusted to 160.0 cm Critical Moderator Height	6
3. Midplane Power Profile for Core XVI-B1	7
4. Midplane Power Profile for Core XVI-B2	8
5. Midplane Power Profile for Core XVI-D1	9
6. Midplane Power Profile for Core XVI-D2	10

List of Figures

Figure

1. Core XVI-A Loading Diagram	11
2. Core XVI-B Loading Diagram	12
3. Core XVI-C Loading Diagram	13
4. Core XVI-D Loading Diagram	14

1. INTRODUCTION

Babcock & Wilcox (B&W) initiated Part IV of the Physics Verification Program in December 1974. The objective of Part IV is to generate accurate experimental data for use in verifying the calculational techniques that will be used to design the consolidated nuclear steam generator (CNSG) core.

This report describes the experimental results obtained during the third calendar quarter of 1975. Work performed during the first and second quarters is reported in references 1 and 2, and completed phases of the program are summarized in references 3 through 9. The program is jointly supported by Babcock & Wilcox and the U. S. Energy Research and Development Administration (ERDA).

2. DESCRIPTION OF FACILITY

2.1. Facility

The CX-10 facility is located at B&W's Lynchburg Research Center. The critical assembly is erected in a core tank 5 feet in diameter by 6 feet high with aluminum walls 0.5 inch thick. The facility is described further in reference 1.

2.2. Fuel Rods

The fuel rods are 0.475 inch in outside diameter by approximately 71.5 inches long. The cladding is 0.016-inch-thick, type 304 stainless steel, and the UO_2 fuel is enriched to 4.02 wt % uranium-235. The fuel is described further in reference 1.

2.3. Perturbing Pins

Poison pins, neutral pins, and vacant water-filled positions within the core lattice are being used to produce lattice heterogeneities for study. The physical and chemical properties of these pins are reported in references 1 and 2.

3. MEASUREMENTS

3.1. Task Description

Accurate experimental data suitable for verifying and/or improving the calculational techniques that will be used to design the CNSG core are generated under this task. Unclad Pyrex glass rods, aluminum-clad Vicor glass rods, aluminum-clad B_4C powder, aluminum-clad zone-loaded rods, aluminum-clad Al_2O_3 powder (neutral rods), and water holes are spaced on selected patterns in an otherwise uniform clean lattice to study their effects on reactivity and power shape.

Two kinds of data are being obtained:

1. The moderator boron concentration required to give a critical condition at a known moderator height of 160 cm.
2. Power maps in selected regions of a portion of the core loadings.

3.2. Critical Parameters

The change in the moderator boron concentration is being used as a measure of reactivity change since this quantity can be readily compared with computer calculations. Excess reactivity is controlled by dissolving boric acid (H_2BO_3) in the moderator (demineralized water). The boron concentration in parts per million (ppm) is defined as the grams of natural boron per million cubic centimeters of moderator at 25C; it is determined by titration against a standard KOH solution. The measurements have an absolute standard deviation of ± 3 ppm.

During the quarter, the exact moderator boron concentration for the just-critical condition was established for the four core loadings diagrammed in Figures 1 through 4. Data from these loadings are presented in Table 1. All measurements reported were taken with all safety blades fully withdrawn. Moderator height measurements are referenced to the top of the base plate.

3.3. Numerical Adjustment of Boron Concentration

The moderator boron concentration of each core was adjusted (as described in reference 1) to produce a just-critical condition at a moderator height of 160.0 cm. Adjusted values are presented in Table 2 for each loading studied during the quarter.

3.4. Power Profile Measurements

The midplane relative power densities over each of two one-eighth sections of the central 15 by 15 array of Cores XVI-B1, XVI-B2, XVI-D1, and XVI-D2 were obtained and compared. Relative power density is determined by using a sodium iodide (thallium-activated) scintillation counter to count collimated fission product gammas from activated fuel rods. The Lynchburg Research Center has used this method extensively; results are presented in Tables 3 through 6.

Table 1. Core Loadings Studied During Third Quarter

Core	Run	Moderator boron conc, ppm	Moderator ht, cm		Doubling time, s	$\Delta\rho$, %	ΔH , cm	$\bar{H}$, cm	$\Delta\rho/\Delta H$	$(\Delta\rho/\Delta H)^{-1/3}$
			Critical	Super- critical						
XVI-A2	2127	1952.5	160.16	166.85	68	9.4	6.69	163.5	1.41	0.892
XVI-A1	2134	1824.9	159.52	167.78	50.5	11.8	8.26	163.6	1.43	0.888
XVI-B2	2139	1645.5	159.61	165.15	78	8.4	5.54	162.4	1.52	0.870
XVI-B1	2155	1551.4	159.70	167.48	51.5	11.7	7.78	163.6	1.50	0.874
XVI-C2	2166	1513.5	159.29	167.00	53	11.3	7.71	163.1	1.47	0.879
XVI-C1	2164	1439.3	159.77	167.59	49.5	11.9	7.82	163.7	1.52	0.870
XVI-D2	2169	1385.2	159.90	166.55	62	10.1	6.65	163.2	1.52	0.870
XVI-D1	2180	1334.4	159.38	167.26	50	11.9	7.88	163.3	1.51	0.872
XVI-D1	2189	1317.9	150.16	154.93	65.5	9.7	4.77	152.5	2.03	0.790
XVI-D1	2190	1304.9	140.74	145.33	52.5	11.4	4.59	143.0	2.48	0.739
XVI-D1	2192	1266.3	121.85	124.29	69	9.3	2.44	123.1	3.81	0.640
XVI-D1	2193	1288.7	131.96	134.51	87	7.7	2.55	133.2	3.02	0.692

Table 2. Core Loadings Adjusted to 160.0 cm
Critical Moderator Height

Core	No. of fuel rods	No. of positions			Moderator boron conc, ppm
		Water- filled	Pyrex- filled	B ₄ C- filled	
XVI-A2	4204	225	72	0	1952
XVI-A1	4204	201	72	24	1826
XVI-B2	4132	225	144	0	1646
XVI-B1	4132	201	144	24	1552
XVI-C2	4096	225	180	0	1515
XVI-C1	4096	201	180	24	1440
XVI-D2	4060	225	216	0	1385
XVI-D1	4060	201	216	24	1335

Table 3. Midplane Power Profile for Core XVI-B1

Northwest segment				Southeast segment				Avg of symmetric locations	Standard deviation, %
Location	Run 2157	Run 2158	Average	Location	Run 2159	Run 2160	Average		
N1	0.497	0.482	0.490	S1	0.497	0.505	0.501	0.496	1.1
N1W1	0.457	0.439	0.448	S1E1	0.436	0.450	0.443	0.446	0.6
N2W1	0.413	0.400	0.406	S2E1	0.395	0.401	0.398	0.402	1.0
N3	0.411	0.412	0.412	S3	0.397	0.412	0.404	0.408	1.0
N3W1	0.390	0.383	0.386	S3E1	0.392	0.396	0.394	0.390	1.0
N3W2	0.390	0.393	0.392	S3E2	0.394	0.396	0.395	0.394	0.4
N4	0.387	0.395	0.391	S4	0.394	0.394	0.394	0.392	0.4
N4W2	0.407	0.404	0.406	S4E2	0.404	0.409	0.406	0.406	0.0
N4W3	0.415	0.423	0.419	S4E3	0.415	0.413	0.414	0.416	0.6
N4W4	0.432	0.449	0.440	S4E4	0.417	0.428	0.422	0.431	2.1
N5	0.451	0.485	0.468	S5	0.477	0.473	0.475	0.472	0.7
N5W1	0.450	0.471	0.460	S5E1	0.455	0.454	0.454	0.457	0.7
N5W2	0.448	0.469	0.458	S5E2	0.439	0.454	0.446	0.452	1.3
N5W4	0.426	0.448	0.437	S5E4	0.437	0.425	0.431	0.434	0.7
N6W1	0.534	0.567	0.550	S6E1	0.547	0.552	0.550	0.550	0.0
N6W2	0.526	0.547	0.536	S6E2	0.537	0.533	0.535	0.536	0.1
N6W3	0.518	0.537	0.528	S6E3	0.511	0.514	0.512	0.520	1.6
N6W4	0.527	0.549	0.538	S6E4	0.532	0.531	0.532	0.535	0.6
N6W5	0.548	0.559	0.554	S6E5	0.553	0.562	0.558	0.556	0.4
N7	0.592	0.601	0.596	S7	0.602	0.606	0.604	0.600	0.7
N7W1	0.592	0.618	0.605	S7E1	0.609	0.606	0.608	0.606	0.2
N7W2	0.603	0.615	0.609	S7E2	0.613	0.620	0.616	0.612	0.6
N7W3	0.622	0.634	0.628	S7E3	0.618	0.604	0.611	0.620	1.4
N7W4	0.629	0.645	0.637	S7E4	0.625	0.625	0.625	0.631	1.0
N7W5	0.657	0.668	0.662	S7E5	0.618	0.654	0.636	0.649	2.0
N7W6	0.754	0.694	0.724	S7E6	0.664	0.680	0.672	0.698	3.9
N7W7	0.620	0.735	0.678	S7E7	0.689	0.713	0.701	0.690	1.7

Table 4. Midplane Power Profile for Core XVI-B2

<u>Northwest segment</u>		<u>Southeast segment</u>		<u>Avg of symmetric locations</u>	<u>Standard deviation, %</u>
<u>Location</u>	<u>Run 2150</u>	<u>Location</u>	<u>Run 2151</u>		
N1	1.055	S1	1.096	1.076	1.9
N1W1	1.029	S1E1	1.043	1.036	0.7
N2W1	1.114	S2E1	1.120	1.117	0.3
N3	1.102	S3	1.108	1.105	0.3
N3W1	1.157	S3E1	1.149	1.153	0.4
N3W2	1.146	S3E2	1.175	1.160	1.3
N4	1.235	S4	1.221	1.228	0.6
N4W2	1.169	S4E2	1.144	1.156	1.1
N4W3	1.154	S4E3	1.127	1.140	1.2
N4W4	1.159	S4E4	1.125	1.142	1.5
N5	1.095	S5	1.081	1.088	0.6
N5W1	1.134	S5E1	1.129	1.132	0.2
N5W2	1.153	S5E2	1.151	1.152	0.1
N5W4	1.245	S5E4	1.241	1.243	0.2
N6W1	1.032	S6E1	1.029	1.030	0.1
N6W2	1.047	S6E2	1.031	1.039	0.8
N6W3	1.140	S6E3	1.118	1.129	1.0
N6W4	1.109	S6E4	1.082	1.096	1.2
N6W5	1.147	S6E5	1.120	1.134	1.2
N7	0.940	S7	0.945	0.942	0.3
N7W1	0.989	S7E1	0.983	0.986	0.3
N7W2	1.004	S7E2	1.002	1.003	0.1
N7W3	0.994	S7E3	1.000	0.997	0.3
N7W4	1.027	S7E4	0.970	0.998	2.9
N7W5	1.039	S7E5	1.016	1.028	1.1
N7W6	1.013	S7E6	0.989	1.001	1.2
N7W7	0.987	S7E7	0.963	0.975	1.2

Table 5. Midplane Power Profile for Core XVI-D1

Northwest segment					Southeast segment					Avg of symmetric locations	Standard deviation, %
Location	Run 2182	Run 2183	Run 2188	Average	Location	Run 2184	Run 2185	Run 2186	Run 2187	Average	
N1	371	381	0.363	0.372	S1	0.348	0.362	0.402	0.385	0.374	0.3
N1W1	340	343	.333	.339	S1E1	.329	.339	.358	.346	.343	0.6
N2W1	304	308	.295	.302	S2E1	.297	.319	.316	.307	.310	1.3
N3	318	322	.307	.316	S3	.312	.329	.325	.317	.321	0.8
N3W1	301	304	.293	.299	S3E1	.302	.314	.312	.303	.308	1.5
N3W2	301	311	.300	.304	S3E2	.297	.312	.315	.309	.308	0.7
N4	306	319	.302	.309	S4	.299	.314	.306	.301	.305	0.7
N4W2	308	316	.302	.309	S4E2	.320	.329	.319	.314	.320	1.8
N4W3	322	334	.323	.326	S4E3	.316	.344	.324	.318	.326	0.0
N4W4	353	354	.335	.347	S4E4	.335	.352	.340	.330	.339	1.2
N5	364	371	.356	.364	S5	.373	.378	.371	.362	.371	1.0
N5W1	353	371	.347	.357	S5E1	.352	.360	.364	.349	.356	0.1
N5W2	346	347	.328	.340	S5E2	.363	.367	.357	.340	.357	2.5
N5W4	362	365	.348	.358	S5E4	.336	.355	.351	.347	.347	1.6
N6W1	424	440	.406	.423	S6E1	.431	.435	.417	.405	.422	0.1
N6W3	409	405	.406	.407	S6E3	.402	.423	.419	.412	.414	0.9
N6W4	433	440	.425	.433	S6E4	.426	.440	.440	.424	.432	0.1
N6W5	443	455	.425	.441	S6E5	.431	.457	.448	.440	.444	0.3
N7	485	490	.474	.483	S7	.460	.483	.461	.459	.466	1.8
N7W1	485	485	.469	.480	S7E1	.470	.486	.482	.476	.478	0.2
N7W2	485	499	.481	.488	S7E2	.462	.491	.495	.481	.482	0.6
N7W3	495	506	.482	.494	S7E3	.481	.499	.502	.491	.493	0.1
N7W4	517	524	.492	.511	S7E4	.492	.511	.511	.500	.504	0.7
N7W5	538	545	.522	.535	S7E5	.512	.540	.527	.515	.524	1.0
N7W6	540	552	.543	.545	S7E6	.532	.556	.542	.539	.542	0.3
N7W7	589	596	0.564	0.583	S7E7	0.577	0.587	0.580	0.568	0.578	0.4

Table 6. Midplane Power Profile for Core XVI-D2

Northwest segment				Southeast segment				Avg of symmetric locations	Standard deviation, %
Location	Run 2172	Run 2173	Average	Location	Run 2174	Run 2175	Average		
N1	0.795	0.829	0.812	S1	0.855	0.849	0.852	0.832	2.5
N1W1	.790	.812	.801	S1E1	.797	.815	.806	.804	0.3
N2W1	.844	.860	.852	S2E1	.839	.853	.846	.849	0.4
N3	.839	.831	.835	S3	.911	.839	.875	.855	2.4
N3W1	.877	.884	.880	S3E1	.847	.888	.868	.874	0.7
N3W2	.875	.905	.890	S3E2	.859	.896	.878	.884	0.7
N4	.943	.927	.935	S4	.883	.937	.910	.922	1.4
N4W2	.891	.903	.897	S4E2	.828	.892	.860	.878	2.2
N4W3	.891	.901	.896	S4E3	.876	.868	.872	.884	1.4
N4W4	.870	.887	.878	S4E4	.857	.858	.858	.868	1.2
N5	.799	.806	.802	S5	.884	.822	.853	.828	3.2
N5W1	.860	.858	.859	S5E1	.825	.857	.841	.850	1.1
N5W2	.888	.858	.873	S5E2	.901	.862	.882	.878	0.5
N5W4	.966	.964	.965	S5E4	.974	.959	.966	.966	0.1
N6W1	.726	.738	.732	S6E1	.760	.778	.769	.750	2.5
N6W3	.848	.855	.852	S6E3	.854	.855	.854	.853	0.0
N6W4	.820	.844	.832	S6E4	.832	.831	.832	.832	0.0
N6W5	.871	.874	.872	S6E5	.883	.893	.888	.880	0.9
N7	.737	.754	.746	S7	.752	.740	.746	.746	0.0
N7W1	.723	.745	.734	S7E1	.747	.754	.750	.742	1.1
N7W2	.744	.759	.752	S7E2	.736	.768	.752	.752	0.0
N7W3	.784	.778	.781	S7E3	.760	.790	.775	.778	0.4
N7W4	.781	.799	.790	S7E4	.784	.780	.782	.786	0.5
N7W5	.784	.796	.790	S7E5	.769	.799	.784	.787	0.4
N7W6	.781	.773	.777	S7E6	.758	.759	.758	.768	1.3
N7W7	0.784	0.785	0.784	S7E7	0.754	0.759	0.756	0.770	1.9

Figure 1. Core XVI-A Loading Diagram

- Pyrex-filled positions (72 total)
- o Water-filled positions (201 total)
- x Positions where content is varied (24 total)

<u>Core</u>	<u>Contents of x positions</u>
XVI-A1	B ₄ C
XVI-A2	Water

Figure 2. Core XVI-B Loading Diagram

- Pyrex-filled positions (144 total)
- Water-filled positions (201 total)
- x Positions where content is varied (24 total)

<u>Core</u>	<u>Contents of x positions</u>
XVI-B1	B ₄ C
XVI-B2	Water

Figure 3. Core XVI-C Loading Diagram

- Pyrex-filled positions (180 total)
- o Water-filled positions (201 total)
- x Positions where content is varied (24 total)

<u>Core</u>	<u>Contents of x positions</u>
XVI-C1	B ₄ C
XVI-C2	Water

Figure 4. Core XVI-D Loading Diagram

- Pyrex-filled positions (216 total)
- o Water-filled positions (201 total)
- x Positions where content is varied (24 total)

<u>Core</u>	<u>Contents of x positions</u>
XVI-D1	B ₄ C
XVI-D2	Water

REFERENCES

- ¹ M. N. Baldwin, Physics Verification Program - Part IV, Task 1, Quarterly Technical Report, December 1975-March 1975, BAW-3647-34, Babcock & Wilcox, Lynchburg, Virginia, May 1975.
- ² M. N. Baldwin, Physics Verification Program - Part IV, Task 1, Quarterly Technical Report, April-June 1975, BAW-3647-35, Babcock & Wilcox, Lynchburg, Virginia, August 1975.
- ³ R. H. Clark, et al., Physics Verification Program - Part I, Final Report, BAW-3647-3, Babcock & Wilcox, Lynchburg, Virginia, March 1967.
- ⁴ M. N. Baldwin, R. H. Clark, and J. E. Rogers, Physics Verification Program - Part II, Final Report, BAW-3647-7, Babcock & Wilcox, Lynchburg, Virginia, April 1968.

M. N. Baldwin and M. E. Stern, Physics Verification Program - Part III, Task 1, Final Report, BAW-3647-13, Babcock & Wilcox, Lynchburg, Virginia, July 1969.
- ⁵ M. N. Baldwin, et al., Physics Verification Program - Part III, Task 2 and 3, Final Report, BAW-3647-16, Babcock & Wilcox, Lynchburg, Virginia, April 1970.
- ⁶ M. N. Baldwin and M. E. Stern, Physics Verification Program - Part III, Task 4, Summary Report, BAW-3647-20, Babcock & Wilcox, Lynchburg, Virginia, March 1971.
- ⁷ M. N. Baldwin and G. T. Fairburn, Physics Verification Program - Part III, Tasks 5, 6, and 7, Summary Report, BAW-3647-24, Babcock & Wilcox, Lynchburg, Virginia, March 1972.
- ⁸ M. N. Baldwin, et al., Physics Verification Program - Part III, Task 8, 9, 10, and 11, Summary Report, BAW-3647-33, Babcock & Wilcox, Lynchburg, Virginia, October 1975.

DISTRIBUTION

	<u>No. of Copies</u>
1. U. S. Energy Research & Development Administration Director, Contracts Division Chicago Operations Office 9800 South Cass Ave. Argonne, Illinois 60439	1
2. U. S. Nuclear Regulatory Commission Directorate of Licensing Washington, D. C. 20545	1
ATTN: Dr. H. Richings	
3. U. S. Energy Research & Development Administration Water Projects Branch - DRD&T Washington, D. C. 20545	1
4. U. S. Energy Research & Development Administration Reactor Physics Branch - DRD&T Washington, D. C. 20545	1
5. U. S. Energy Research & Development Administration Technical Information Center P. O. Box 62 Oak Ridge, Tennessee 37830	3
6. U. S. Energy Research & Development Administration Division of Naval Reactors P. O. Box 109 West Mifflin, Pennsylvania 15122	1
Attn: Dr. Harry Raab	
7. Dr. Neal E. Carter, Manager Nuclear Engineering Department PACIFIC NORTHWEST LABORATORIES Richland, Washington 99352	1
8. Mr. Jess Greenborg DONALD DOUGLAS LABORATORIES P. O. Box 310 Richland, Washington 99352	1

	<u>No. of Copies</u>
9. Dr. Gerhard Dessauer, Director Physics Section E. I. duPont deNemours & Co., Inc. Aiken, South Carolina 29802	1
10. Dr. Sidney Visner COMBUSTION ENGINEERING, INC. Nuclear Division P. O. Box 500 Windsor, Connecticut 06095	1
11. Dr. George Minton WESTINGHOUSE ELECTRIC CORP. Atomic Power Dept. P. O. Box 355 Pittsburgh, Pennsylvania 15230	1
12. Dr. Peter Aline GE ATOMIC PRODUCTS DIVISION 175 Curtner Ave. San Jose, California 95112	1
13. Dr. Michael Driscoll Department of Nuclear Engineering MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, Massachusetts 02139	1
14. Dr. Mel Levine BROOKHAVEN NATIONAL LABORATORY Upton, Long Island, New York 11973	1
15. Dr. Robert Avery, Director Reactor Physics Division ARGONNE NATIONAL LABORATORY 9700 South Cass Ave. Argonne, Illinois 60439	1
16. Dr. E. R. Gaerttner, Director Linac Project RENSSELAER POLYTECHNIC INSTITUTE Troy, New York 12180	1
17. Dr. Mark Nelkin, Professor Nuclear Reactor Laboratory CORNELL UNIVERSITY Ithaca, New York 14850	1

	<u>No. of Copies</u>
18. <u>Babcock & Wilcox (58)</u>	
<u>Patent Department</u>	
<u>New York, New York</u>	
Maguire, JM	1
<u>Power Generation Division</u>	
<u>Barberton, Ohio 44203</u>	
Probert, PB	1
<u>Power Generation Division</u>	
<u>Lynchburg, Virginia 24505</u>	
Andrews, JB	1
Bailey, DA	1
Brunson, WT	1
Connell, CW	2
Green, ID	1
Harwell, JW	1
Hassan, HA	1
Howard, JO	1
Jones, HM	2
Kane, ER	1
Kochendarfer, RA	1
Kulynych, GE	1
Lesniak, LM	1
Library	1
Liu, YS	1
Livolsi, AZ	1
Mays, CW	1
McDaniel, GT	1
Norman, F	1
Patterson, ES	1
Paulson, ES	1
Roy, DH	1
Sapota, JJ	1
Schuler, TM	1
Travis, CC/TRG	1
Tulenko, JS	1
Turner, RA	1
Wittkopf, WA	1
<u>Research and Development Division</u>	
<u>Alliance, Ohio 44601</u>	
Library	2
Markert, W	1
Poor, HH	1

No. of
Copies

Research and Development Division
Lynchburg, Virginia 24505

ACEPL File	5
Baldwin, MN	3
Baroch, CJ	1
Currie, RL	1
Dixon, RR	1
Engelder, TC	1
Hamilton, WT	1
Kubik, RN	1
Lewis, RH	1
Lynch, ED	1
Library	1
McAdams, VD	1
Pettus, WG	1
Pitts, TG	1
Snidow, NL	1
Towles, JO	1
Warren, HD	1
Webb, HW	1
Welfare, FG	1