NONUNIFORM HEAT GENERATION
EXPERIMENTAL PROGRAM

Quarterly Progress Report No. 6

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by
THE BABCOCK & WILCOX COMPANY
Atomic Energy Division
Lynchburg, Virginia

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PREFACE

The Babcock & Wilcox Company and the United States Atomic Energy Commission, acting for the Joint U.S.-Euratom Research and Development Board, signed an agreement for a nonuniform heat generation experimental program.

The program includes experimental and analytical investigations to determine how nonuniformly distributed heat flux along lengths of tubular and annular channels affects the onset of burnout (departure from nucleate boiling). The experimental program is being conducted in the 1.8-MW heat transfer facility at B&W's Research Center, Alliance, Ohio. The analytical program is being conducted by the Atomic Energy Division, Lynchburg, Virginia.

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ABSTRACT

The Babcock & Wilcox Company, as part of the Joint U.S.-Euratom Research and Development Program, is conducting experimental and analytical investigations to determine the effects of irregular heat flow through reactor channels on the operating conditions that cause burnout (departure from nucleate boiling). This program seeks to improve design correlations that will be suitable for direct use by reactor designers. Tubular specimens with four axial power shapes and annular specimens with five power shapes are being used, and an effort to correlate the experimental data with empirical and analytical models will be made.

During the sixth quarter, data were obtained from two test sections, one with the peak heat flux near the inlet and one with the peak heat flux near the outlet. A bridge circuit was added to the test section monitoring system in an effort to provide more information about the critical heat flux condition.

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1. INTRODUCTION

Nuclear reactors and modern boilers require more and more knowledge about the limitations on the transfer rates of heat from channel walls to flowing liquids. Burnout (departure from nucleate boiling) is a very serious design problem still facing the reactor designer. The result of this phenomenon is that the heat transfer conductance is reduced considerably, causing the metal and fuel temperatures to rise and initiate failure of the fuel element. Although considerable attention has been given to this problem in recent years, the predictability of the occurrence of burnout conditions is quite uncertain. In fact, there is still much disagreement on the effect of the channel geometry and operating conditions upon burnout.

In an effort to clarify some of the areas of disagreement, Babcock & Wilcox (B&W), as part of the Joint U.S.-Euratom Research and Development Program, is conducting an experimental and analytical program to determine the effects of nonuniform heat generation rates in tubular and annular flow channels on the operating conditions causing burnout under experimental conditions representative of water reactor systems. The objective of the program is to seek improved design correlations suitable for direct use by reactor designers. The technical approach to the work emphasizes the development of an improved understanding of the physical phenomena involved and their relation to design variables.

The experimental program, which was discussed in the first quarterly report*, is being conducted on a heat transfer facility at B&W's Research Center in Alliance, Ohio. The controlled variables for the tests are pressure, inlet subcooling, and mass velocity. The tests are

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*Judd, D. F., et al., Non-Uniform Heat Generation Experimental Program, Quarterly Technical Report No. 1, The Babcock & Wilcox Company, BAW-1287, Lynchburg, Virginia, September 1963.

being performed in 6-foot-long tubular and annular test sections having both uniform and nonuniform axial heat flux distributions. The analytical program will be conducted by the Atomic Energy Division in Lynchburg, Virginia.

Problems that developed in the power supply have been solved, improving operation near the extremes of the specified range. During this quarter data were obtained from flux shape 3 (inlet peak) and flux shape 4 (outlet peak) for the originally planned conditions: pressures of 2000, 1500, and 1000 psia; mass velocities of 0.5, 1.5, and 2.5 million lb/hr-ft²; and inlet subcoolings of 20, 50, 100, and 150 °F.

2. PROGRAM

2.1. Test Facility Modifications

A device that is potentially capable of determining the stability of burnout data was added to the loop instrumentation. This device, referred to as the bridge circuit, operates on the principle of the temperature dependence of the electrical resistance of the test section. The circuit consists essentially of a Wheatstone bridge, and because of the requirements of this circuitry, only two segments of the test section can be monitored at one time. Therefore, the test section is divided in half, and the resistance of the outlet half is compared to the resistance of the inlet half in the bridge circuit. In operation, the bridge circuit is balanced prior to a test run; when the critical condition occurs, the bridge circuit becomes unbalanced because of resistance changes in the test section, and the resulting signal is recorded. Actual test operation has shown that the bridge circuit records a signal at critical conditions. The significance of these recordings is currently under study.

All design work and material fabrication for the changes to the bus-bar system for the annular test sections are complete.

2.2. Test Sections

2.2.1. Tubular Test Sections

Flux shape 3 has been supplied with thermocouples and voltage taps as shown in Figure 1. The dimensions of test section 4 (outlet peak longitudinal flux shape) are shown in Table 1. This test section is instrumented with voltage taps and thermocouples as shown in Figure 2. Three additional voltage taps (A, B, C) are used to determine actual flux shape on the tube more accurately. Also, voltage tap A is used to divide the outlet six inches of the test section into two 3-inch stations so that the location of burnout can be defined more closely. Therefore, this test section has eleven 6-inch stations (Nos. 1 - 11) and

two 3-inch stations (Nos. 12 and 13), whereas the first three tubular test sections had twelve 6-inch stations. Curves showing the detailed flux shapes are given in BAW-1287*.

2.2.2. Annular Test Sections

All components for the first section have been fabricated, and the section is ready to be installed. Some spare parts are being fabricated to prevent delay in case of a failure. Final checkout must be made to determine the acceptability of the spacer-piece design and the present concepts of instrumentation of the inside tube.

The general arrangement of these test sections is shown in Figure 3, and more detail of the outside tube is shown in Figure 4. Figure 4 also shows that the inside tube is located concentrically within the outside tube by three spacer pins at each of eight locations. The pins are made of Zircaloy-2 which is then oxidized to form a layer of zirconium oxide that acts as electrical insulation between the inside and outside tubes on the contact surfaces. If the zirconium oxide does not withstand the expected operating conditions, these pins will be replaced with stainless steel pins coated with aluminum oxide.

The instrumentation on the inside tube consists of thirteen voltage taps and one thermocouple. The voltage taps provide twelve stations for determining the burnout location. These taps are not bonded to the tube, but are pressed against the tube surface by spring action of a contactor, as shown in Figure 5. Instrumentation wires are then led out through the top of the test section to the instrument panel board. The thermocouple attachment, using the same spring-action principle, is also shown in Figure 5. The sheath thermocouple is coated with aluminum oxide to prevent conduction of electric current through the stainless steel sheath.

Design work has been started on the last two annular test sections, which utilize a nonuniform longitudinal heat input rate on the outside tube. The objective here is to allow some interchangeability of all test sections in the test loop so that changes can be made without undue delay.

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* Op. cit.

Figure 1. Test Section No. 3 Instrumentation

Figure 2. Test Section No. 4 Instrumentation

Figure 3. Annular Test Section Arrangement

Figure 4. Annular Test Section Detail

Figure 5. Annular Test Section Instrumentation

DETAIL OF THERMOCOUPE INSTALLATION

DETAIL OF VOLTAGE TAP INSTALLATION

Table 1. Geometry of Test Section 4

Distance from outlet end of heated length, in.	Required wall thickness, in.	Required tolerance, in.	Actual measured variation, in.
72	0.1752	±0.003	+0.001
70	.1752	±0.003	+0.001
68	.1752	±0.003	±0.001
66	.1739	±0.003	-0.001
64	.1699	±0.003	±0.000
62	.1686	±0.003	-0.001
60	.1686	±0.003	-0.002
58	.1626	±0.003	+0.001
56	.1570	±0.003	+0.001
54	.1518	±0.003	+0.000
52	.1467	±0.002	-0.001
50	.1379	±0.002	-0.001
48	.1341	±0.002	+0.001
46	.1233	±0.002	±0.000
44	.1172	±0.002	±0.000
42	.1063	±0.002	+0.001
40	.0997	±0.002	±0.000
38	.0919	±0.001	+0.001
36	.0823	±0.001	+0.000
34	.0734	±0.001	+0.001
32	.0655	±0.001	-0.001
30	.0583	±0.001	+0.000
28	.0537	±0.001	±0.000
26	.0505	±0.001	±0.000
24	.0475	±0.001	±0.000
22	.0462	±0.001	+0.001
20	.0447	±0.001	-0.001
18	.0445	±0.001	+0.000
16	.0447	±0.001	+0.001
14	.0466	±0.001	-0.001
12	.0493	±0.001	+0.001
10	.0537	±0.001	±0.000
8	.0605	±0.001	-0.001
6	.0712	±0.001	+0.001
4	.0868	±0.002	±0.000
2	.1172	±0.002	±0.000
0	0.1752	±0.002	±0.001

3. TEST OPERATION

At the end of the fifth quarter, tests on the first two test sections had been completed, and test section 3 (inlet peak) was being installed and checked out. Testing was completed on flux shapes 3 and 4 during the sixth quarter. All testing on these last two test sections was conducted with the burnout detector being used to detect critical conditions, with thermocouples being used to determine metal temperature stability at critical conditions, and with a turbine flow meter and test section inlet pressure transducer being used to determine loop stability at critical conditions. Bridge circuit recordings were also obtained.

After completing tests on flux shape 3, it was found to be damaged slightly, having a slight bulge and bend at about 25 inches from the inlet of the heated length. This area of the tube showed discoloration indicative of excessive metal temperature, and it is believed that the overheating occurred during run 270, which was the first run with an indication of a burnout at that location. After this run, only two additional required runs (273 and 275) and five check runs (276 - 280) were made. Based on the results of the check runs, the damage to the tube apparently did not affect either the operating conditions or the location at which burnout occurred for any of the data obtained on the test section.

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4. TEST DATA

Tabulated results of tests on flux shapes 3 and 4 are presented in Tables 2 and 3. The same data are also presented graphically in Figures 6 through 8 for flux shape 3 and in Figures 9 through 11 for flux shape 4. In all cases, the plotted points represent conditions causing burnout. Also shown are the results from flux shape 1 (uniform flux).

Referring first to the data for flux shape 3, Figures 6 through 8 use coordinates of average test section heat input rate versus test section inlet subcooling and show that good agreement exists between the data for the inlet peak and the uniformly heated test sections at 2000 psi, while decreasing pressure shows less agreement.

Data from test section 4 are presented in Figures 9 through 11, which also use coordinates of average test section heat input rate versus test section inlet subcooling. The curves show that the best agreement exists between the data for the outlet peak and the uniformly heated test sections at 2000 psi, while decreasing pressure again shows less agreement.

A more comprehensive review of all of the tubular test section data will be completed during the next quarter. The objective of this review is to determine (1) how the nonuniform heat input rates covered in these tests affect the operating conditions causing burnout, and (2) whether the conclusions drawn are consistent with test results presented by other investigators.

During the course of current testing, other data concerning the stability of test section metal temperature, flow rate, and inlet pressure during periods of transition to film boiling were obtained. Metal temperature stability data were originally planned to be obtained from the burnout detector recording instrumentation, but since no way for obtaining detector output recordings has been developed yet, and since thermocouples are installed, the stability data were obtained with the thermocouple monitoring system. A preliminary survey indicates that

there were no indications of fluctuating temperatures that can be attributed to burnout. Flow and inlet pressure data indicate that no apparent instability of these variables is caused by critical conditions.

Figure 6. Critical Heat Flux Data for Inlet Peak Heat Flux Distribution at 2000 psia

Figure 7. Critical Heat Flux Data for Inlet Peak Heat Flux Distribution at 1500 psia

Figure 8. Critical Heat Flux Data for Inlet Peak Heat Flux Distribution at 1000 psia

Figure 9. Critical Heat Flux Data for Outlet Peak Heat Flux Distribution at 2000 psia

Figure 10. Critical Heat Flux Data for Outlet Peak Heat Flux Distribution at 1500 psia

Figure 11. Critical Heat Flux Data for Outlet Peak Heat Flux Distribution at 1000 psia

List of Symbols for Tables 2 and 3

DNB	0 indicates the station number at which DNB occurred. 0 on left side of column indicates DNB on tubular test section or outside tube of annular test section. 0 on right side of column indicates DNB on inside tube of annular test section.
P	Test section outlet pressure, psia
ΔP	Total test section pressure drop, psid
G	Test section mass velocity, lb/hr-ft ²
KW	Net electrical power input to the test section, kilowatts
Sta. No.	Location on test section for which local operating conditions are calculated
ΔT_s	Fluid subcooling at station number indicated, degrees F
h	Fluid enthalpy at station number indicated, Btu/lb
x	Steam quality, by weight, at station number indicated, %
$\phi_{1,o}$	Local average heat input rate at station number indicated, for <u>tubular test sections</u> and <u>outside tube</u> in annular test sections - Btu/hr-ft ²
ϕ_o	Integrated heat input rate from test section inlet to center of station number indicated, for <u>tubular test sections</u> and <u>outside tube</u> in annular test sections - Btu/hr-ft ²
$\phi_{1,i}$	Local average heat input rate at station number indicated, for <u>inside tube</u> in annular test section - Btu/hr-ft ²
ϕ_i	Integrated heat input rate from test section inlet to center of station number indicated for <u>inside tube</u> in annular test section - Btu/hr-ft ²

Table 2. Preliminary Report of Test Results From Flux Shape 3

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_i}{10^6}$	$\frac{\phi_{i,i}}{10^6}$	$\frac{\phi_i}{10^6}$
228		09-21-64	11:43	998	1.31	.493	79.3	INLET	22.3	514.3	-4.27	2.9				
								1	9.7	529.9	-1.88	2.9	.287	.287		
								2	.0	576.8	5.34	6.1	.562	.383		
								3	.0	645.1	15.86	12.2	.732	.482		
								4	.0	724.3	28.05	19.3	.738	.552		
								5	.0	798.3	39.43	25.9	.628	.581		
								6	.0	855.1	48.17	31.8	.456	.570		
								7	.0	901.4	55.30	35.2	.310	.548		
								8	.0	926.2	59.12	37.4	.231	.506		
								9	.0	947.8	62.44	39.3	.188	.470		
								10	.0	969.9	65.83	41.3	.159	.441		
								11	.0	987.2	68.50	42.9	.146	.415		
								12	.0	1008.0	71.70	44.7	.141	.395		
								EXIT	.0	1015.7	72.88	45.4		.385		
229		09-21-64	12:07	998	1.49	.509	84.6	INLET	24.4	511.8	-4.66	2.9				
0								12	.0	1022.5	73.93	47.5	.151	.422		
0								EXIT	.0	1030.4	75.15	48.2		.410		
230		09-21-64	13:39	1005	6.66	1.503	98.6	INLET	21.1	516.9	-4.05	8.7				
0								7	.0	675.7	28.45	45.0	.398	.685		
0								8	.0	687.8	22.31	48.3	.288	.639		
0								9	.0	697.7	23.83	51.0	.235	.596		
0								10	.0	705.3	25.01	53.0	.199	.556		
0								11	.0	711.2	25.91	54.6	.183	.519		
0								12	.0	718.4	27.02	56.6	.176	.491		
0								EXIT	.0	721.5	27.50	57.4		.478		
231		09-21-64	15:30	1010	5.89	1.494	104.0	INLET	48.4	484.6	-9.16	8.4				
0								8	.0	665.4	18.76	41.8	.303	.672		
0								9	.0	676.1	20.41	44.5	.246	.628		
0								10	.0	684.4	21.70	46.7	.210	.586		
0								11	.0	691.4	22.78	48.6	.195	.549		
0								12	.0	698.4	23.85	50.5	.186	.518		
0								EXIT	.0	701.7	24.37	51.4		.504		
232		09-22-64	10:28	1008	5.84	1.483	104.5	INLET	47.0	486.0	-8.89	8.4				
0								8	.0	669.4	19.42	42.9	.305	.677		
0								9	.0	679.7	21.01	45.3	.249	.631		
0								10	.0	687.3	22.17	47.3	.210	.586		
0								11	.0	695.4	23.42	49.5	.195	.552		
0								12	.0	702.3	24.50	51.3	.187	.521		
0								EXIT	.0	705.7	25.02	52.2		.507		
233		09-22-64	19:01	1005	4.87	1.512	118.6	INLET	98.6	426.7	-17.96	8.1				
0								8	.0	630.2	13.42	32.8	.347	.766		
0								9	.0	642.0	15.24	36.1	.282	.715		
0								10	.0	650.9	16.61	38.5	.239	.666		
0								11	.0	659.8	17.99	40.9	.221	.626		
0								12	.0	667.6	19.19	43.1	.212	.591		
0								EXIT	.0	671.4	19.77	44.1		.535		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{i0}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{i1}}{10^6}$	$\frac{\phi_i}{10^6}$
234		09-22-64	16127	1003	4.60	1.910	137.8	INLET	145.8	374.9	-25.89	7.8				
	0							7	.0	595.4	8.10	23.4	.546	.956		
	0							8	.0	611.5	10.59	27.8	.404	.889		
	0							9	.0	624.9	12.64	31.9	.329	.829		
	0							10	.0	635.6	14.30	34.4	.277	.773		
	0							11	.0	645.3	15.78	37.0	.257	.725		
	0							12	.0	655.2	17.32	39.8	.247	.687		
	0							EXIT	.0	659.6	18.00	41.0		.666		
235		09-23-64	12147	1000	1.27	.504	103.7	INLET	147.7	372.6	-26.15	2.6				
	0							12	.0	1004.8	71.21	45.3	.185	.517		
	0							EXIT	.0	1014.7	72.73	46.2		.503		
236		09-23-64	13152	1000	1.29	.499	97.0	INLET	101.4	422.9	-18.40	2.7				
	0							12	.0	1019.7	73.50	46.2	.173	.483		
	0							EXIT	.0	1029.0	74.93	47.1		.470		
237		09-23-64	15105	1000	1.34	.497	88.6	INLET	50.3	481.0	-9.45	2.8				
	0							12	.0	1028.4	74.85	46.8	.157	.441		
	0							EXIT	.0	1036.9	76.15	47.5		.429		
238		09-24-64	10150	990	10.55	2.478	96.3	INLET	17.0	519.7	-3.25	14.5				
	0							7	.0	614.0	11.24	46.0	.384	.671		
	0							8	.0	621.0	12.31	51.2	.283	.625		
	0							9	.0	626.6	13.17	53.8	.231	.582		
	0							10	.0	631.8	13.97	56.1	.193	.546		
	0							11	.0	635.9	14.59	57.9	.182	.512		
	0							12	.0	639.0	15.08	59.4	.174	.480		
	0							EXIT	.0	640.9	15.37	60.2		.467		
239		09-24-64	11141	1008	8.92	2.497	102.6	INLET	46.4	486.7	-8.78	14.1				
	0							8	.0	593.5	7.70	37.4	.299	.663		
	0							9	.0	599.5	8.62	40.1	.243	.618		
	0							10	.0	603.6	9.25	42.0	.207	.573		
	0							11	.0	608.9	10.07	44.4	.191	.542		
	0							12	.0	612.9	10.70	46.2	.183	.511		
	0							EXIT	.0	614.9	11.00	47.1		.498		
240		09-24-64	13138	1010	7.18	2.513	137.6	INLET	101.3	424.4	-18.47	13.4				
	0							7	.0	556.2	1.90	20.7	.549	.951		
	0							8	.0	566.6	3.50	25.3	.404	.889		
	0							9	.0	574.6	4.74	29.0	.329	.829		
	0							10	.0	581.1	5.74	31.9	.278	.773		
	0							11	.0	586.8	6.63	34.5	.258	.725		
	0							12	.0	592.5	7.51	37.1	.248	.686		
	0							EXIT	.0	595.2	7.92	38.3		.667		
241		09-24-64	16147	1010	6.02	2.520	165.5	INLET	151.8	369.4	-26.95	12.9				
	0							7	12.5	528.1	-2.44	14.9	.658	1.148		
	0							12	.0	571.1	4.20	27.5	.300	.825		
	0							EXIT	.0	574.3	4.70	28.9		.803		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_s}{10^6}$	$\frac{\phi_{in}}{10^6}$	$\frac{\phi_i}{10^6}$
242		09-24-64	16106	1005	6.84	2.462	171.6	INLET	148.6	372.2	-26.36	12.7				
	0							7	2.5	540.0	-1.49	14.7	.678	1.186		
								12	.0	586.2	6.64	33.9	.310	.855		
								EXIT	.0	589.6	7.16	35.4		.832		
243		09-25-64	10145	1495	2.23	1.516	127.4	INLET	150.2	425.8	-33.23	8.1				
	0							6	3.2	606.6	-1.79	9.8	.736	.930		
	0							7	.0	628.8	3.20	13.3	.505	.884		
	0							8	.0	645.1	6.13	16.5	.374	.827		
	0							9	.0	656.7	8.22	18.7	.302	.769		
								10	.0	666.3	9.93	20.5	.258	.716		
								11	.0	675.4	11.57	22.3	.240	.673		
								12	.0	683.9	13.09	23.9	.228	.635		
								EXIT	.0	687.9	13.81	24.7		.618		
244		09-25-64	12127	1498	2.22	1.509	104.3	INLET	102.6	479.9	-23.61	8.4				
	0							10	.0	677.6	11.91	22.5	.211	.586		
	0							11	.0	685.5	13.32	24.0	.195	.551		
	0							12	.0	692.2	14.53	25.3	.186	.520		
	0							EXIT	.0	695.5	15.12	25.9		.506		
245		09-25-64	14110	1495	2.17	1.499	74.0	INLET	45.1	550.0	-10.94	9.0				
	0							10	.0	693.4	14.79	25.4	.148	.422		
	0							11	.0	698.0	15.61	26.3	.137	.394		
	0							12	.0	701.7	16.28	27.0	.130	.369		
	0							EXIT	.0	704.0	16.70	27.4		.359		
246		09-25-64	15108	1500	2.40	1.489	64.1	INLET	19.9	583.8	-5.00	9.4				
	0							11	.0	711.8	18.01	28.6	.117	.339		
	0							12	.0	716.0	18.76	29.4	.112	.319		
	0							EXIT	.0	718.0	19.13	29.7		.311		
247		09-28-64	11100	1495		.483	53.8	INLET	17.5	586.4	-4.40	3.0				
	0							12	.0	928.7	57.02	22.6	.094	.268		
	0							EXIT	.0	933.9	57.96	22.9		.261		
248		09-28-64	11149	1500		.496	59.5	INLET	56.3	536.4	-13.52	2.9				
	0							12	.0	904.8	52.70	21.6	.104	.296		
	0							EXIT	.0	910.4	53.71	22.0		.288		
249		09-28-64	13106	1495		.508	67.2	INLET	100.7	481.8	-23.18	2.8				
	0							12	.0	888.1	49.74	21.2	.118	.335		
	0							EXIT	.0	894.4	50.86	21.6		.326		
250		09-28-64	14106	1495		.511	76.5	INLET	147.1	429.3	-32.61	2.7				
	0							12	.0	889.3	49.95	21.4	.137	.381		
	0							EXIT	.0	896.4	51.23	21.8		.371		
251		09-29-64	10107	1495	5.84	2.513	67.6	INLET	18.0	585.8	-4.52	15.8				
	0							9	.0	659.5	8.71	31.8	.159	.407		
	0							10	.0	662.5	9.25	32.8	.133	.379		
	0							11	.0	665.1	9.72	33.6	.124	.354		
	0							12	.0	668.4	10.31	34.7	.119	.337		
	0							EXIT	.0	669.7	10.54	35.1		.328		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	X	V_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{11}}{10^6}$	$\frac{\phi_i}{10^6}$
252		09-29-64	12103	1495	5.30	2.512	88.0	INLET	51.3	542.1	-12.35	15.0				
								9	.0	638.7	4.98	25.2	.209	.533		
								10	.0	642.5	5.65	26.4	.176	.495		
								11	.0	646.2	6.33	27.6	.163	.465		
								12	.0	649.7	6.95	28.7	.156	.438		
								EXIT	.0	651.3	7.25	29.2		.427		
253		09-29-64	12126	1500	5.21	2.487	94.7	INLET	51.3	542.7	-12.39	14.9				
	0							9	.0	647.2	6.40	27.4	.226	.571		
	0							10	.0	652.0	7.26	28.9	.189	.534		
	0							11	.0	655.4	7.88	30.0	.176	.498		
	0							12	.0	659.6	8.63	31.3	.168	.472		
	0							EXIT	.0	661.4	8.95	31.9		.459		
254		09-29-64	15107	1490	5.12	2.500	133.7	INLET	98.8	483.5	-22.72	14.0				
	0							7	.0	613.6	.58	17.3	.532	.933		
								8	.0	623.1	2.29	20.3	.393	.868		
								9	.0	630.6	3.63	22.7	.321	.807		
								10	.0	636.9	4.76	24.7	.272	.793		
								11	.0	642.2	5.72	26.4	.251	.705		
								12	.0	647.8	6.71	28.2	.242	.666		
								EXIT	.0	650.4	7.18	29.0		.649		
255		09-30-64	12125	1490	4.26	2.563	160.5	INLET	150.1	425.4	-33.12	13.7				
								1	144.6	431.5	-32.05	13.7	.575	.575		
								2	128.5	449.5	-28.82	13.9	1.140	.765		
								3	104.7	476.6	-23.95	14.3	1.491	.979		
								4	78.1	508.3	-18.28	14.7	1.507	1.132		
								5	54.5	537.4	-13.06	15.2	1.278	1.190		
								6	36.3	560.9	-8.86	15.7	.934	1.177		
								7	23.9	577.3	-5.92	16.0	.639	1.117		
								8	15.3	588.9	-3.83	16.2	.472	1.042		
								9	9.0	597.7	-2.26	16.4	.385	.969		
								10	3.6	605.1	-.93	16.6	.324	.904		
								11	.0	611.8	.27	17.2	.303	.849		
								12	.0	617.7	-1.33	19.1	.289	.800		
								EXIT	.0	620.8	1.87	20.1		.778		
256		09-30-64	13108	1490	4.85	2.518	171.5	INLET	146.7	429.1	-32.46	13.5				
	0							6	25.0	575.8	-6.19	15.6	.999	1.253		
								7	11.7	593.8	-2.96	16.0	.684	1.190		
								8	2.9	606.5	-.69	16.3	.506	1.111		
								9	.0	616.4	1.10	18.4	.411	1.035		
								10	.0	623.9	2.43	20.8	.350	.963		
								11	.0	631.3	3.77	23.1	.323	.905		
								12	.0	638.3	5.01	25.4	.309	.854		
								EXIT	.0	641.6	5.60	26.4		.832		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{11}}{10^6}$	$\frac{\phi_i}{10^6}$
297		10-01-64	09146	1995	1.36	1.491	51.2	INLET	20.8	636.7	-7.41	10.0				
								4	.0	682.3	2.41	12.3	.465	.362		
								5	.0	698.6	5.91	14.6	.410	.383		
								6	.0	711.5	8.69	16.5	.297	.378		
								7	.0	720.2	10.97	17.8	.202	.357		
								8	.0	726.2	11.86	18.6	.148	.332		
	0							9	.0	730.7	12.83	19.3	.119	.308		
	0							10	.0	735.0	13.76	19.9	.099	.288		
	0							11	.0	738.8	14.57	20.5	.091	.270		
	0							12	.0	742.1	15.29	20.9	.088	.255		
	0							EXIT	.0	743.7	15.63	21.2		.248		
298		10-01-64	11130	1995	1.40	1.508	66.4	INLET	46.6	599.0	+15.94	9.6				
								4	8.0	657.4	-2.96	10.5	.624	.470		
								5	.0	677.7	1.42	11.7	.927	.492		
								6	.0	693.9	4.91	14.1	.382	.486		
								7	.0	709.1	7.32	15.8	.261	.460		
	0							8	.0	713.9	9.21	17.0	.191	.431		
	0							9	.0	719.7	10.47	17.9	.156	.400		
	0							10	.0	724.3	11.44	18.6	.131	.371		
	0							11	.0	728.9	12.45	19.2	.120	.348		
	0							12	.0	734.2	13.59	20.0	.116	.331		
	0							EXIT	.0	736.3	14.03	20.3		.322		
299		10-01-64	13105	2000	1.54	1.504	92.8	INLET	96.2	534.8	+29.53	8.8				
								1	91.4	540.8	+28.24	8.9	.336	.336		
								2	77.5	558.5	+24.44	9.1	.662	.442		
								3	57.0	585.3	+18.65	9.4	.864	.566		
								4	34.5	616.5	+11.91	9.8	.873	.654		
								5	15.8	644.9	-5.79	10.2	.738	.686		
	0							6	2.3	667.7	-.87	10.6	.538	.678		
	0							7	.0	683.7	2.58	12.5	.368	.642		
								8	.0	695.6	5.16	14.2	.271	.601		
								9	.0	704.5	7.08	15.5	.220	.560		
								10	.0	711.3	8.54	16.5	.186	.521		
								11	.0	718.2	10.03	17.5	.171	.490		
								12	.0	724.5	11.40	18.5	.163	.463		
								EXIT	.0	727.4	12.02	18.9		.450		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{i,0}}{10^6}$	$\frac{\phi_0}{10^6}$	$\frac{\phi_{i,1}}{10^6}$	$\frac{\phi_1}{10^6}$
261		10-02-64	10:13	2000		.501	35.4	INLET	24.8	631.1	-8.77	3.3				
								4	.0	725.2	11.56	6.2	.339	.251		
								5	.0	757.7	18.55	7.8	.286	.263		
								6	.0	784.6	24.37	9.1	.206	.261		
								7	.0	802.3	28.18	9.9	.140	.246		
								8	.0	815.9	31.11	10.6	.101	.230		
								9	.0	825.9	33.28	11.1	.081	.214		
	0							10	.0	834.7	35.18	11.5	.067	.200		
	0							11	.0	842.2	36.80	11.9	.062	.188		
	0							12	.0	848.7	38.20	12.2	.059	.177		
	0							EXIT	.0	851.9	38.89	12.3		.172		
262		10-02-64	11:42	2000		.503	42.6	INLET	51.6	592.6	-17.07	3.2				
								4	.0	704.9	7.16	5.2	.403	.301		
								5	.0	744.9	15.80	7.2	.340	.318		
	0							6	.0	776.4	22.60	8.7	.246	.314		
								7	.0	798.7	27.40	9.8	.168	.298		
								8	.0	813.7	30.65	10.5	.121	.277		
								9	.0	829.6	33.22	11.1	.098	.258		
								10	.0	836.2	35.50	11.6	.082	.241		
								11	.0	843.5	37.07	12.0	.076	.224		
	0							12	.0	852.5	39.02	12.4	.072	.212		
	0							EXIT	.0	856.4	39.85	12.6		.206		
263		10-02-64	13:51	1995		.509	53.8	INLET	104.1	524.8	-31.51	3.0				
								1	95.8	534.9	+29.33	3.0	.192	.192		
								2	72.0	565.1	+22.83	3.1	.384	.255		
								3	36.9	612.4	-12.64	3.3	.502	.333		
								4	4.2	664.2	-1.50	3.6	.509	.378		
								5	.0	713.3	9.08	5.7	.429	.398		
								6	.0	755.1	18.08	7.8	.312	.397		
								7	.0	782.6	24.01	9.2	.211	.377		
								8	.0	803.7	28.54	10.2	.155	.353		
								9	.0	818.3	31.69	10.9	.124	.328		
								10	.0	830.1	34.25	11.5	.105	.305		
	0							11	.0	840.4	36.46	12.0	.098	.285		
	0							12	.0	849.5	38.42	12.5	.093	.268		
	0							EXIT	.0	854.4	39.47	12.7		.261		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{i,0}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{i,1}}{10^6}$	$\frac{\phi_i}{10^6}$
264		10-02-64	15:46	2000		.512	64.0	INLET	148.9	472.4	-43.01	2.8				
								4	19.0	639.9	-4.86	3.5	.603	.457		
								5	.0	696.6	5.36	4.9	.509	.476		
								6	.0	742.2	15.22	7.2	.370	.469		
								7	.0	773.5	21.98	8.7	.252	.443		
								8	.0	797.6	27.18	9.9	.186	.414		
								9	.0	815.7	31.08	10.8	.151	.386		
								10	.0	832.1	34.62	11.6	.127	.362		
	0							11	.0	843.3	37.03	12.2	.117	.338		
	0							12	.0	856.5	39.88	12.9	.112	.319		
	0							EXIT	.0	862.3	41.14	13.1		.311		
265		10-05-64	10:54	2000	5.50	2.517	71.1	INLET	19.5	639.2	-7.01	16.9				
								4	.0	676.7	1.08	19.2	.674	.503		
								5	.0	689.8	3.92	22.4	.567	.528		
	0							6	.0	700.6	6.25	25.0	.412	.524		
	0							7	.0	707.9	7.80	26.8	.282	.496		
	0							8	.0	713.1	8.93	28.1	.207	.462		
	0							9	.0	717.2	9.82	29.1	.166	.431		
	0							10	.0	720.5	10.53	29.9	.141	.402		
	0							11	.0	723.4	11.15	30.6	.131	.376		
	0							12	.0	725.9	11.71	31.2	.125	.354		
	0							EXIT	.0	727.3	11.99	31.6		.345		
266		10-05-64	11:57	1998	5.23	2.534	99.0	INLET	47.3	598.3	-15.77	16.1				
								4	12.3	650.5	-4.52	17.4	.931	.705		
								5	1.8	668.5	-6.64	18.0	.789	.737		
	0							6	.0	682.8	2.45	20.9	.574	.726		
	0							7	.0	693.2	4.69	23.4	.393	.690		
								8	.0	700.6	6.27	25.3	.290	.645		
								9	.0	706.0	7.45	26.6	.235	.599		
								10	.0	710.5	8.42	27.7	.197	.556		
								11	.0	714.7	9.32	28.7	.163	.524		
								12	.0	718.3	10.10	29.6	.177	.493		
								EXIT	.0	720.2	10.50	30.1		.480		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{i0}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{i1}}{10^6}$	$\frac{\phi_i}{10^6}$
267		10-05-64	14:48	1995	3.83	2.496	122.7	INLET	96.1	534.6	-29.40	14.7				
								1	92.3	539.4	-28.38	14.7	.442	.442		
								2	81.0	553.5	-25.33	15.0	.872	.587		
								3	64.5	574.8	-20.74	15.3	1.141	.749		
								4	46.3	599.4	-15.45	15.8	1.154	.862		
								5	29.9	622.9	-10.38	16.4	.975	.914		
								6	18.5	640.2	-6.65	16.8	.711	.894		
								7	10.5	653.1	-3.88	17.2	.485	.849		
								8	5.1	662.4	-1.87	17.5	.360	.794		
								9	1.2	669.6	-.33	17.8	.291	.740		
								10	.0	675.3	.89	18.8	.246	.690		
								11	.0	680.3	1.98	20.0	.229	.646		
								12	.0	685.6	3.12	21.3	.218	.612		
268		10-05-64	15:10	1995	3.80	2.501	127.5	EXIT	.0	688.0	3.63	21.9		.595		
								INLET	102.7	526.5	-31.15	14.6				
								4	50.4	593.8	-16.66	15.8	1.200	.897		
								5	33.4	617.7	-11.51	16.3	1.015	.945		
								6	20.8	636.6	-7.43	16.8	.738	.934		
								7	12.4	650.0	-4.54	17.2	.504	.887		
								8	6.9	659.2	-2.57	17.4	.373	.826		
								9	2.7	666.8	-.94	17.7	.304	.770		
								10	.0	672.5	.31	18.2	.297	.717		
								11	.0	678.0	1.48	19.5	.238	.673		
								12	.0	683.1	2.57	20.7	.228	.635		
								EXIT	.0	685.5	3.10	21.3		.618		
269		10-05-64	15:25	1995	4.30	2.491	132.6	INLET	98.3	531.8	-30.00	14.6				
								4	44.1	602.4	-14.80	15.9	1.250	.937		
								5	26.9	627.3	-9.45	16.4	1.055	.985		
								6	14.4	646.7	-5.27	17.0	.769	.970		
								7	6.0	660.8	-2.23	17.4	.526	.922		
								8	.5	670.9	-.85	17.8	.388	.861		
								9	.0	678.6	1.62	19.6	.316	.803		
								10	.0	684.6	2.90	21.0	.267	.747		
								11	.0	690.2	4.10	22.4	.247	.701		
								12	.0	695.3	5.22	23.6	.237	.661		
								EXIT	.0	697.9	5.77	24.3		.643		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_i}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_i}{10^6}$
270		10-05-64	15:39	2000	4.60	2.505	137.5	INLET	97.4	533.4	-29.84	14.7				
	0							4	41.6	606.3	-14.10	16.0	1.292	.974		
	0							5	24.5	631.5	-8.69	16.6	1.094	1.010		
								6	11.6	651.8	-4.29	17.2	.794	1.006		
								7	3.1	666.4	-1.14	17.7	.546	.956		
								8	.0	676.3	.99	19.0	.403	.890		
								9	.0	684.2	2.69	20.9	.327	.829		
								10	.0	690.5	4.05	22.5	.277	.773		
								11	.0	696.8	5.41	24.0	.257	.727		
								12	.0	702.0	6.54	25.3	.247	.685		
								EXIT	.0	704.6	7.11	25.9		.667		
271		10-06-64	10:00	1995	3.24	2.525	155.7	INLET	148.1	472.8	-42.70	13.9				
								4	80.5	554.2	-25.19	15.1	1.463	1.094		
								5	58.4	582.9	-19.00	15.7	1.228	1.152		
								6	41.9	605.5	-14.14	16.1	.900	1.136		
								7	31.3	620.7	-10.86	16.5	.617	1.072		
								8	23.0	633.3	-8.15	16.8	.457	1.008		
								9	17.1	642.3	-6.20	17.1	.370	.939		
								10	12.8	649.3	-4.69	17.3	.313	.875		
								11	8.8	656.0	-3.26	17.5	.292	.822		
								12	5.2	662.2	-1.93	17.7	.280	.776		
								EXIT	3.6	665.1	-1.29	17.8		.755		
272		10-06-64	10:17	1995	3.46	2.513	161.6	INLET	147.2	473.9	-42.47	13.9				
								4	76.8	558.8	-24.18	15.2	1.520	1.138		
								5	54.2	588.6	-17.77	15.7	1.279	1.195		
								6	37.2	612.1	-12.71	16.2	.938	1.178		
								7	25.9	628.9	-9.10	16.6	.641	1.118		
								8	18.2	640.7	-6.56	17.0	.475	1.043		
								9	12.4	649.9	-4.56	17.2	.386	.971		
								10	7.7	657.8	-2.86	17.5	.326	.908		
								11	4.1	664.3	-1.47	17.7	.303	.850		
								12	.0	671.3	.05	18.0	.290	.805		
								EXIT	.0	674.4	.71	18.7		.784		
273		10-06-64	10:40	1998	3.76	2.526	172.6	INLET	147.4	474.0	-42.59	14.0				
	0							4	72.9	564.2	-23.13	15.3	1.623	1.215		
								5	49.0	595.9	-16.29	16.0	1.364	1.278		
								6	31.6	620.6	-10.98	16.5	1.008	1.256		
								7	19.3	639.3	-6.94	17.0	.684	1.199		
								8	11.5	651.8	-4.23	17.4	.907	1.118		
								9	5.9	661.4	-2.18	17.7	.413	1.039		
								10	1.0	669.9	-.34	18.0	.348	.972		
								11	.0	676.9	1.17	19.4	.324	.911		
								12	.0	683.8	2.65	21.0	.311	.860		
								EXIT	.0	687.1	3.36	21.9		.837		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_s}{10^6}$	$\frac{\phi_{in}}{10^6}$	$\frac{\phi_i}{10^6}$
274		10-06-64	12:53	1995	1.11	1.504	106.9	INLET	148.2	472.7	-42.72	8.3				
								4	70.7	566.7	-22.49	9.2	1.009	.754		
								5	45.7	600.2	-15.27	9.6	.847	.796		
								6	28.0	625.7	-9.78	9.9	.621	.781		
								7	15.8	644.5	-5.74	10.2	.424	.742		
								8	7.7	657.8	-2.86	10.5	.314	.693		
								9	2.1	667.9	-.70	10.7	.254	.645		
								10	.0	676.1	1.08	11.5	.215	.602		
								11	.0	683.5	2.66	12.6	.199	.564		
								12	.0	690.7	4.22	13.6	.191	.533		
								EXIT	.0	694.1	4.95	14.1		.518		
275		10-06-64	14:12	1995	1.34	1.514	119.6	INLET	148.0	473.0	-42.67	8.4				
								4	62.3	577.8	-20.11	9.3	1.129	.845		
								5	36.0	613.7	-12.26	9.8	.945	.883		
								6	16.5	643.3	-5.99	10.3	.694	.874		
								7	4.1	664.2	-1.48	10.7	.474	.831		
								8	.0	678.9	1.68	11.9	.350	.776		
								9	.0	690.1	4.08	13.6	.285	.721		
								10	.0	699.3	6.07	15.0	.242	.673		
								11	.0	708.6	8.07	16.3	.223	.634		
								12	.0	715.7	9.61	17.4	.214	.596		
								EXIT	.0	719.5	10.42	17.9		.580		
276		10-07-64	10:45	1000	8.56	2.020	101.9	INLET	29.9	505.3	-5.71	11.6				
								4	.0	568.6	4.03	21.7	.959	.681		
								5	.0	591.2	7.51	30.0	.803	.719		
								6	.0	609.2	10.29	36.6	.590	.712		
								7	.0	626.9	13.01	43.1	.405	.705		
								8	.0	636.4	14.47	46.6	.298	.659		
								9	.0	644.2	15.68	49.4	.242	.616		
								10	.0	649.6	16.52	51.4	.205	.573		
								11	.0	654.8	17.31	53.3	.190	.536		
								12	.0	660.2	18.14	55.3	.182	.508		
								EXIT	.0	662.6	18.51	56.2		.494		
277		10-07-64	12:38	1000	11.87	2.454	97.2	INLET	9.7	530.1	-1.89	14.5				
								4	.0	582.5	6.17	32.6	.915	.685		
								5	.0	600.6	8.97	40.6	.765	.717		
								6	.0	615.1	11.20	47.1	.562	.707		
								7	.0	625.6	12.81	51.8	.383	.672		
								8	.0	632.7	13.90	54.9	.284	.626		
								9	.0	638.7	14.82	57.6	.220	.585		
								10	.0	643.3	15.54	59.6	.195	.545		
								11	.0	647.4	16.17	61.5	.181	.511		
								12	.0	651.8	16.84	63.4	.175	.484		
								EXIT	.0	653.7	17.14	64.3		.471		

Table 2. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{i,0}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{i,1}}{10^6}$	$\frac{\phi_i}{10^6}$	
278		10-07-64	15111	995	1.27	.516	116.4	INLET	217.5	298.5	-37.38	2.5					
								4	.0	595.6	8.29	8.2	1.095	.817			
								5	.0	702.0	24.65	18.2	.920	.863			
								6	.0	784.0	37.27	25.9	.674	.890			
								7	.0	845.1	46.67	31.6	.463	.810			
								8	.0	885.3	52.84	35.4	.342	.753			
								9	.0	918.1	57.89	38.5	.278	.702			
								10	.0	945.4	62.08	41.1	.236	.656			
								11	.0	968.4	65.62	43.2	.219	.614			
	0							12	.0	991.0	69.10	45.4	.209	.580			
	0							EXIT	.0	1001.9	70.77	46.4		.564			
279		10-08-64	10144	1997		.507	90.0	INLET	85.6	547.8	-26.62	3.0					
								4	.0	678.4	1.52	4.0	.477	.353			
								5	.0	726.1	11.80	6.3	.397	.375			
	0							6	.0	761.1	19.35	8.0	.291	.367			
								7	.0	787.6	25.06	9.4	.197	.349			
								8	.0	806.0	29.02	10.3	.143	.326			
								9	.0	820.0	32.03	10.9	.116	.303			
	0							10	.0	830.5	34.30	11.5	.097	.281			
	0							11	.0	840.4	36.44	12.0	.089	.264			
	0							12	.0	851.2	38.76	12.5	.085	.249			
	0							EXIT	.0	855.7	39.73	12.7		.243			
280		10-08-64	14106	1995		.509	91.8	INLET	310.3	298.8	-80.18	2.5					
								4	.0	93.7	537.6	-28.76	3.0	.867	.648		
								5	.0	31.7	620.1	-10.99	3.3	.725	.679		
								6	.0	686.8	3.38	4.4	.531	.670			
								7	.0	733.7	13.47	6.7	.363	.636			
								8	.0	766.1	20.45	8.3	.268	.592			
								9	.0	793.6	26.37	9.7	.217	.553			
								10	.0	814.8	30.94	10.8	.184	.516			
								11	.0	835.0	35.30	11.8	.170	.485			
	0							12	.0	852.3	39.01	12.6	.163	.457			
	0							EXIT	.0	860.8	40.86	13.0		.445			

Table 3. Preliminary Report of Test Results From Flux Shape 4

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_i}{10^6}$	$\frac{\phi_{o,i}}{10^6}$	$\frac{\phi_i}{10^6}$
281		10-26-64	15145	1012	3.78	2.517	133.8	INLET	150.4	371.2	-26.74	12.9				
								12	11.4	529.8	-2.22	14.9	.620	.662		
								13	7.2	535.1	-1.41	15.0	.365	.655		
								EXIT	5.7	537.0	-1.11	15.0		.649		
282	0	10-26-64	15158	1005	4.35	2.499	143.5	INLET	148.5	372.3	-26.35	12.8				
								12	.0	543.8	.10	15.3	.666	.711		
								13	.0	549.3	.95	17.8	.389	.702		
								EXIT	.0	551.4	1.27	18.7		.696		
283	0	10-27-64	10117	1015	5.07	2.528	117.6	INLET	104.8	421.1	-19.11	13.5				
								12	.0	560.0	2.37	22.2	.545	.583		
								13	.0	564.6	3.08	24.2	.317	.576		
								EXIT	.0	566.3	3.34	25.0		.571		
284	0	10-27-64	13130	1010	4.66	2.486	95.5	INLET	51.5	421.0	-9.71	14.0				
								12	.0	595.6	7.99	38.1	.438	.473		
								13	.0	599.4	8.57	39.7	.260	.467		
								EXIT	.0	600.8	8.78	40.4		.463		
285	0	10-27-64	15114	997	9.47	2.489	87.8	INLET	21.5	515.2	-4.11	14.5				
								1	20.0	517.0	-3.23	14.5	.168	.168		
								2	16.9	520.8	-3.26	14.6	.176	.172		
								3	13.7	524.7	-2.65	14.6	.190	.177		
								4	10.2	529.1	-1.97	14.7	.218	.184		
								5	5.9	534.5	-1.15	14.8	.267	.198		
								6	1.0	541.0	-.14	14.9	.353	.218		
								7	.0	550.2	1.27	18.7	.507	.250		
								8	.0	563.2	3.27	24.5	.691	.297		
								9	.0	579.3	5.75	31.8	.802	.350		
								10	.0	596.7	8.43	39.7	.790	.398		
								11	.0	611.4	10.69	46.4	.619	.425		
								12	.0	620.4	12.08	50.4	.406	.434		
								13	.0	624.0	12.63	52.1	.240	.430		
								EXIT	.0	625.3	12.83	52.7		.426		
286	0	10-27-64	15144	1000	9.92	2.494	93.3	INLET	20.7	516.6	-3.98	14.5				
								12	.0	628.2	13.21	53.8	.430	.462		
								13	.0	631.9	13.78	55.4	.254	.457		
								EXIT	.0	633.3	13.99	56.1		.452		
287	0	10-29-64	14114	1000	2.56	1.507	116.5	INLET	151.9	368.0	-24.25	7.7				
								12	.0	596.7	8.67	24.4	.540	.576		
								13	.0	606.3	9.23	26.5	.317	.570		
								EXIT	.0	609.1	10.27	27.3		.565		
288	0	10-29-64	15131	1000	3.35	1.512	99.0	INLET	99.1	425.5	-18.00	8.1				
								12	.0	620.9	12.09	30.6	.456	.490		
								13	.0	627.3	13.07	32.4	.267	.484		
								EXIT	.0	629.7	13.44	33.0		.480		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	X	V_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_0}{10^6}$	$\frac{\phi_{11}}{10^6}$	$\frac{\phi_1}{10^6}$
289		10-29-64	15:49	1000	3.53	1.504	103.4	INLET	98.3	426.4	-17.87	8.1				
	0							12	.0	631.8	13.76	33.4	.477	.512		
	0							13	.0	638.3	14.77	35.2	.278	.506		
	0							EXIT	.0	640.8	15.16	35.9		.502		
290		11-02-64	10:44	1007	4.73	1.583	96.1	INLET	46.8	486.0	-8.86	8.9				
	0							12	.0	667.2	19.10	44.8	.440	.476		
	0							13	.0	673.2	20.01	46.5	.261	.470		
	0							EXIT	.0	675.4	20.36	47.2		.466		
291		11-02-64	12:20	993	5.93	1.477	92.9	INLET	17.9	519.0	-3.43	8.6				
	0							11	.0	690.4	22.91	49.0	.650	.450		
	0							12	.0	706.6	25.39	53.4	.427	.460		
	0							13	.0	712.8	26.35	55.1	.251	.455		
	0							EXIT	.0	715.1	26.70	55.7		.450		
292		11-02-64	14:51	998	.84	.497	77.5	INLET	22.2	514.4	-4.26	2.9				
	0							12	.0	579.5	67.32	42.5	.355	.384		
	0							13	.0	594.8	69.67	43.9	.212	.379		
	0							EXIT	.0	1000.5	70.55	44.4		.376		
293		11-03-64	10:36	1010	.82	.504	81.3	INLET	50.0	482.8	-0.44	2.8				
	0							12	.0	964.5	64.96	41.1	.373	.403		
	0							13	.0	980.2	67.37	42.6	.219	.398		
	0							EXIT	.0	986.0	68.27	43.1		.394		
294		11-03-64	11:50	998	.82	.507	82.7	INLET	98.9	425.4	-17.96	2.7				
	0							12	.0	912.2	56.96	37.2	.380	.410		
	0							13	.0	927.8	59.37	38.6	.226	.405		
	0							EXIT	.0	933.8	60.28	39.1		.401		
295		11-03-64	12:06	998	.88	.507	88.2	INLET	99.5	424.8	-18.05	2.7				
	0							12	.0	943.1	61.71	40.0	.405	.436		
	0							13	.0	960.7	64.43	41.6	.238	.432		
	0							EXIT	.0	967.0	65.40	42.2		.428		
296		11-03-64	13:20	995	.84	.505	93.5	INLET	148.1	371.4	-26.17	2.6				
	0							12	.0	923.9	58.78	38.2	.432	.463		
	0							13	.0	942.2	61.60	39.9	.255	.458		
	0							EXIT	.0	949.0	62.64	40.5		.453		
297		11-03-64	14:55	1500		.501	68.3	INLET	150.1	426.4	-33.30	2.7				
	0							12	.0	833.9	39.95	17.3	.313	.339		
	0							13	.0	846.8	42.28	18.2	.186	.334		
	0							EXIT	.0	851.8	43.17	18.5		.331		
298		11-05-64	10:16	1505		.490	62.1	INLET	101.7	441.7	-23.51	2.7				
	0							12	.0	859.6	44.53	18.5	.284	.307		
	0							13	.0	871.9	46.76	19.3	.169	.304		
	0							EXIT	.0	876.6	47.60	19.5		.301		
299		11-05-64	12:19	1500		.494	57.1	INLET	52.6	541.0	-12.70	2.9				
	0							12	.0	885.7	40.28	20.3	.263	.282		
	0							13	.0	897.4	51.38	21.1	.157	.280		
	0							EXIT	.0	901.7	52.15	21.3		.277		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_s}{10^6}$	$\frac{\phi_{LI}}{10^6}$	$\frac{\phi_I}{10^6}$
300		11-05-64	13147	1498		.511	53.5	INLET	23.8	578.4	-5.93	3.2				
	0							12	.0	691.6	50.34	21.4	.246	.265		
	0							13	.0	901.5	52.13	22.1	.147	.262		
	0							EXIT	.0	905.4	52.82	22.3		.260		
301		11-05-64	15126	1498	2.27	1.474	63.3	INLET	21.2	581.9	-5.29	9.2				
	0							12	.0	710.0	17.71	28.0	.291	.313		
	0							13	.0	714.1	18.46	28.8	.173	.310		
	0							EXIT	.0	715.7	18.75	29.1		.307		
302		11-06-64	10137	1495	1.95	1.495	65.4	INLET	46.7	547.9	-11.31	9.0				
								1	45.0	550.2	-10.91	9.0	.125	.125		
								2	41.4	554.8	-10.08	9.1	.132	.128		
								3	37.5	559.8	-9.18	9.1	.143	.133		
								4	33.3	565.4	-8.18	9.2	.163	.139		
								5	28.4	571.9	-7.01	9.2	.201	.149		
								6	22.0	580.3	-5.49	9.3	.263	.164		
								7	13.8	591.5	-3.49	9.5	.377	.187		
								8	2.3	607.9	-.54	9.7	.514	.223		
								9	.0	627.6	2.98	12.9	.595	.261		
								10	.0	648.8	6.79	16.9	.588	.296		
								11	.0	667.7	10.19	20.5	.461	.318		
								12	.0	678.6	12.14	22.6	.303	.324		
								13	.0	682.8	12.90	23.4	.180	.320		
								EXIT	.0	684.4	13.19	23.7		.317		
303		11-06-64	10154	1495	1.95	1.500	68.5	INLET	46.7	548.0	-11.29	9.0				
	0							12	.0	684.1	13.13	23.7	.318	.339		
	0							13	.0	688.8	13.98	24.6	.188	.335		
	0							EXIT	.0	690.5	14.28	24.9		.332		
304		11-06-64	12159	1495	1.52	1.510	79.3	INLET	98.0	485.0	-22.61	8.5				
								12	.0	641.8	9.54	19.8	.367	.393		
								13	.0	647.0	6.46	16.7	.216	.388		
								EXIT	.0	648.9	6.81	17.1		.385		
305		11-06-64	13125	1493	1.63	1.507	85.0	INLET	97.1	485.8	-22.40	8.5				
	0							12	.0	654.3	7.81	18.2	.391	.421		
	0							13	.0	659.6	8.78	19.2	.231	.416		
	0							EXIT	.0	661.7	9.14	19.6		.412		
306		11-06-64	15116	1508	1.43	1.515	102.1	INLET	146.3	431.4	-32.66	8.1				
	n							12	.0	632.8	3.63	13.7	.471	.506		
	n							13	.0	639.2	4.79	15.0	.277	.500		
	n							EXIT	.0	641.6	5.23	15.4		.495		
307		11-09-64	17101	1500	4.80	2.489	64.2	INLET	21.9	581.2	-5.47	15.6				
	n							12	.0	658.1	8.37	30.9	.297	.318		
	n							13	.0	660.6	8.82	31.7	.176	.314		
	n							EXIT	.0	661.6	8.99	32.0		.311		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_o}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_o}{10^6}$
308		11-09-64	11:32	1500	4.36	2.562	78.8	INLET	49.3	545.2	-11.54	15.0				
	0							12	.0	638.9	4.51	25.0	.365	.390		
	0							13	.0	642.0	5.46	26.0	.217	.385		
	0							EXIT	.0	643.2	5.67	26.4		.382		
309		11-09-64	13:25	1493	3.65	2.497	111.9	INLET	99.5	483.0	-22.91	14.0				
	0							12	.0	616.7	1.08	18.2	.516	.554		
	0							13	.0	621.2	1.88	19.6	.300	.548		
	0							EXIT	.0	622.8	2.16	20.1		.543		
310		11-09-64	14:45	1500	3.26	2.522	139.4	INLET	151.2	425.2	-33.51	13.4				
	0							11	25.7	576.1	-6.39	15.7	.989	.676		
	0							12	15.2	590.3	-3.83	16.0	.644	.691		
	0							13	11.3	595.6	-2.87	16.1	.376	.683		
	0							EXIT	9.9	597.6	-2.51	16.1		.676		
311		11-10-64	09:40	2005	1.31	1.913	46.9	INLET	21.7	636.2	-7.79	10.1				
	0							11	.0	720.9	10.92	17.0	.329	.228		
	0							12	.0	728.6	12.19	19.1	.218	.232		
	0							13	.0	731.7	12.85	19.6	.130	.229		
	0							EXIT	.0	732.9	13.10	19.7		.227		
312		11-10-64	10:46	2000	1.18	1.924	57.0	INLET	47.6	598.1	-15.88	9.7				
	0							11	.0	700.1	6.13	15.1	.399	.276		
	0							12	.0	709.7	8.20	16.5	.262	.282		
	0							13	.0	713.4	9.01	17.1	.158	.279		
	0							EXIT	.0	714.8	9.31	17.3		.276		
313		11-10-64	13:40	2005	.86	1.923	70.9	INLET	99.9	530.7	-30.61	8.9				
								1	98.0	533.1	-30.10	8.9	.135	.139		
								2	94.1	537.9	-29.05	9.0	.141	.137		
								3	89.9	543.2	-27.92	9.0	.153	.141		
								4	85.3	548.9	-26.67	9.1	.175	.148		
								5	79.8	555.9	-25.17	9.2	.216	.159		
								6	73.0	564.7	-23.27	9.2	.286	.176		
								7	63.7	576.8	-20.64	9.4	.410	.202		
								8	51.1	593.7	-16.99	9.6	.559	.239		
								9	35.8	615.1	-12.37	9.9	.646	.282		
								10	20.7	637.8	-7.46	10.2	.637	.320		
								11	8.2	658.2	-3.04	10.6	.500	.345		
								12	1.6	669.5	-.59	10.8	.327	.351		
								13	.0	674.2	.42	11.2	.195	.347		
								EXIT	.0	676.0	.80	11.4		.344		
314		11-10-64	13:56	2000	1.02	1.913	77.8	INLET	97.6	533.2	-29.89	8.9				
	0							11	.0	674.0	.49	11.1	.548	.378		
	0							12	.0	686.6	3.21	13.0	.361	.385		
	0							13	.0	691.6	4.30	13.7	.215	.381		
	0							EXIT	.0	693.5	4.71	14.0		.377		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_{11}}{10^6}$	$\frac{\phi_{12}}{10^6}$
315	0	11-10-64	19:01	2005	.75	1.514	92.0	INLET	149.6	472.0	-43.31	8.4				
								11	21.4	636.8	-7.68	10.1	.647	.443		
								12	11.1	653.3	-4.11	10.4	.424	.455		
								13	7.5	659.3	-2.81	10.6	.250	.450		
								EXIT	6.2	661.5	-2.33	10.6		.446		
316	0	11-11-64	11:43	2005		.518	33.6	INLET	23.4	633.7	-8.34	3.9				
	0							11	.0	811.5	30.10	10.7	.233	.164		
	0							12	.0	826.8	33.41	11.9	.156	.166		
	0							13	.0	833.3	34.83	11.8	.095	.164		
	0							EXIT	.0	835.8	35.36	11.9		.163		
318	0	11-11-64	13:14	2005		.514	36.9	INLET	55.8	587.3	-18.38	3.2				
	0							11	.0	782.4	23.82	9.2	.258	.178		
	0							12	.0	801.5	27.94	10.1	.169	.183		
								13	.0	808.5	29.45	10.5	.102	.180		
								EXIT	.0	811.1	30.02	10.6		.179		
319	0	11-11-64	14:37	2007		.517	43.0	INLET	103.3	526.7	-31.55	3.0				
	0							11	.0	753.7	17.58	7.8	.300	.208		
	0							12	.0	774.9	22.16	8.8	.200	.213		
								13	.0	783.4	24.01	9.2	.120	.211		
								EXIT	.0	786.5	24.68	9.4		.209		
320		11-11-64	16:11	2000		.506	44.8	INLET	152.3	468.5	-43.86	2.8				
								11	.0	709.8	8.23	5.5	.314	.217		
								12	.0	732.2	13.06	6.6	.207	.221		
								13	.0	741.2	14.99	7.0	.124	.219		
								EXIT	.0	744.4	15.70	7.2		.217		
321	0	11-11-64	16:30	2000		.503	49.5	INLET	152.4	468.4	-43.88	2.8				
								11	.0	738.7	14.46	6.9	.349	.241		
								12	.0	762.1	19.50	8.0	.229	.245		
								13	.0	771.6	21.56	8.5	.137	.242		
								EXIT	.0	775.3	22.35	8.6		.240		
322		11-12-64	09:46	2010	4.19	2.491	56.3	INLET	22.4	635.7	-8.05	16.7				
								11	.0	697.3	5.30	23.7	.393	.273		
								12	.0	703.1	6.56	25.1	.258	.279		
								13	.0	705.4	7.06	25.7	.155	.276		
								EXIT	.0	706.3	7.24	25.9		.273		
323	0	11-12-64	10:03	2005	4.30	2.480	60.6	INLET	20.0	638.9	-7.23	16.7				
	0							11	.0	706.0	7.28	25.8	.426	.296		
	0							12	.0	711.7	8.53	27.2	.280	.300		
								13	.0	714.1	9.05	27.8	.167	.296		
								EXIT	.0	715.0	9.24	28.0		.294		
324	0	11-12-64	12:05	2005	3.74	2.534	79.3	INLET	47.2	599.0	-15.84	16.1				
	0							11	.0	684.8	2.72	21.2	.559	.386		
	0							12	.0	692.5	4.37	23.1	.365	.393		
								13	.0	695.5	5.83	23.8	.217	.388		
								EXIT	.0	696.7	5.28	24.1		.385		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	V_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_{20}}{10^6}$	$\frac{\phi_{30}}{10^6}$	$\frac{\phi_{40}}{10^6}$
325	0	11-12-64	13:50	2005	3.08	2.512	111.6	INLET	98.0	533.1	-30.10	14.7				
								11	10.4	654.4	-3.86	17.4	.789	.542		
								12	3.8	665.6	-1.44	17.7	.519	.552		
								13	1.3	670.0	-.49	17.8	.304	.546		
								EXIT	.4	671.6	-.14	17.9		.541		
326	0	11-12-64	15:05	2002	2.90	2.539	142.9	INLET	150.5	470.7	-43.45	14.0				
								11	29.2	624.6	-10.22	16.7	1.014	.694		
								12	19.8	638.9	-7.12	17.1	.663	.708		
								13	16.3	644.3	-5.96	17.2	.387	.700		
								EXIT	15.1	646.4	-5.52	17.3		.693		
327		11-13-64	12:58	1998	5.98	3.542	135.6	INLET	97.7	532.8	-29.29	20.8				
								11	20.3	637.7	-7.28	23.8	.962	.660		
								12	14.3	647.2	-5.24	24.2	.628	.671		
								13	12.1	650.9	-4.44	24.3	.365	.664		
								EXIT	11.2	652.3	-4.14	24.4		.658		
328	0	11-13-64	13:17	1998	6.07	3.544	142.4	INLET	98.0	532.5	-29.96	20.8				
								11	16.9	643.0	-6.14	24.0	1.012	.696		
								12	11.1	652.5	-4.08	24.4	.661	.705		
								13	8.8	656.4	-3.25	24.6	.385	.697		
								EXIT	7.9	657.8	-2.94	24.7		.691		
329	0	11-13-64	15:07	2000	8.42	3.536	80.3	INLET	24.4	631.6	-8.65	23.5				
								11	.0	693.5	4.69	32.7	.560	.388		
								12	.0	699.5	6.00	34.8	.369	.398		
								13	.0	701.7	6.47	35.5	.221	.393		
								EXIT	.0	702.5	6.65	35.8		.390		
330	0	11-16-64	10:00	1495	6.05	3.497	139.7	INLET	99.9	483.2	-22.92	19.6				
								11	13.3	592.3	-3.35	22.2	.988	.678		
								12	6.0	602.5	-1.52	22.5	.647	.692		
								13	3.3	606.4	-.82	22.6	.376	.684		
								EXIT	2.4	607.8	-.56	22.7		.677		
331	0	11-16-64	12:16	1500	8.65	3.507	70.9	INLET	19.9	583.8	-9.00	22.8				
								12	.0	644.1	9.84	37.3	.325	.351		
								13	.0	646.1	6.21	38.2	.194	.347		
								EXIT	.0	646.9	6.34	38.5		.344		
332	0	11-16-64	13:30	1500	5.64	2.481	60.7	INLET	8.1	600.1	-2.06	15.9				
								12	.0	673.1	11.06	35.5	.279	.300		
								13	.0	675.5	11.49	36.2	.167	.297		
								EXIT	.0	676.4	11.65	36.5		.294		
333		11-16-64	15:02	1500	1.97	1.515	57.8	INLET	10.3	597.1	-2.61	9.7				
								12	.0	710.9	17.84	28.9	.265	.286		
								13	.0	714.7	18.53	29.6	.160	.283		
								EXIT	.0	716.1	18.79	29.9		.280		

Table 3. (Cont'd)

RUN NO.	DNB	DATE	TIME	P	ΔP	$G \times 10^{-6}$	KW	STA NO.	ΔT_s	h	x	v_m	$\frac{\phi_{10}}{10^6}$	$\frac{\phi_o}{10^6}$	$\frac{\phi_H}{10^6}$	$\frac{\phi_L}{10^6}$
334		11-16-64	15:21	1903	1.99	1.516	61.4	INLET	9.6	598.5	-2.43	9.7				
	0							12	.0	719.3	19.32	30.4	.283	.304		
	0							13	.0	723.3	20.04	31.2	.168	.301		
	0							EXIT	.0	724.8	20.30	31.5		.298		
342		11-20-64	11:48	2000	.68	1.495	88.6	INLET	146.6	474.9	-42.46	8.3				
	0							11	21.0	636.8	-7.53	10.0	.627	.430		
								12	11.6	651.8	-4.29	10.3	.411	.438		
								13	8.1	657.8	-3.01	10.4	.246	.434		
								EXIT	6.8	660.0	-2.54	10.4		.430		
343		11-20-64	13:20	2000	2.85	2.515	141.9	INLET	146.2	475.5	-42.35	13.9				
	0							11	25.7	629.6	-9.08	16.6	1.006	.689		
								12	16.4	644.0	-5.97	17.1	.698	.703		
								13	13.1	649.4	-4.81	17.2	.382	.695		
								EXIT	11.8	651.5	-4.37	17.3		.688		
344		11-20-64	15:28	1998	3.10	2.503	112.5	INLET	98.9	531.3	-30.21	14.7				
	0							11	9.9	654.5	-3.65	17.3	.795	.548		
								12	3.5	665.6	-1.28	17.7	.521	.557		
								13	1.0	670.0	-.32	17.8	.305	.551		
								EXIT	.0	671.6	.03	17.9		.546		
345		11-23-64	11:12	2005	1.02	1.515	78.0	INLET	98.5	532.5	-30.24	8.9				
	0							11	.3	672.2	-.01	10.8	.548	.376		
	0							12	.0	686.1	2.98	12.9	.359	.386		
								13	.0	691.1	4.06	13.6	.213	.382		
								EXIT	.0	692.9	4.47	13.9		.378		

5. PROGRAM SCHEDULE

The schedule presented below indicates the work that is expected to be completed during the next two quarters.

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