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DOWNFLOW HEAT TRANSFER IN A HEATED RIBBED VERTICAL ANNULUS WITH A COSINE POWER PROFILE (RESULTS FROM TEST SERIES ECS-2C)

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ABSTRACT

Experiments designed to investigate downflow heat transfer in a heated, ribbed annulus test section simulating one of the annular coolant channels of a Savannah River Plant production reactor Mark 22 fuel assembly have been conducted at the Idaho National Engineering Laboratory. The inner surface of the annulus was constructed of aluminum and was electrically heated to provide an axial cosine power profile and a flat azimuthal power shape. Data presented in this report are from the ECS-2c series, which was a follow on series to the ECS-2b series, conducted specifically to provide additional data on the effect of different powers at the same test conditions, for use in evaluation of possible power effects on the aluminum temperature measurements. Electrical powers at 90%, 100%, and 110% of the power required to result in the maximum aluminum temperature at fluid saturation temperature were used at each set of test conditions previously used in the ECS-2b series. The ECS-2c series was conducted in the same test rig as the previous ECS-2b series. Data and experimental description for the ECS-2b series is provided in a previous report[1].

SUMMARY

Experiments have been conducted at the Idaho National Engineering Laboratory to examine the hydraulics and heat transfer associated with downflow in a heated, ribbed aluminum tube surrounded by a polycarbonate shroud. The annular test section designed and constructed to conduct these investigations represents a geometry and axial cosine power shape consistent with the inner-middle coolant channel of a Mark 22 fuel assembly in a Savannah River Production reactor. Experiments conducted represent hydraulic conditions expected during the ECS phase of a large break Loss-of-Coolant Accident. Data gathered during the experiments will be used to gain insight on downflow heat transfer phenomena and for assessment and verification of computer codes used in power limits setting.

Four different series of experiments have been conducted to date. The ECS-2 and ECS-2cE series provided information on the conditions leading to dryout in the test section[2]. The ECS-2b series provided information on the heat transfer coefficient in the test section when the heater wall temperature was limited to a value equal to the local fluid saturation temperature. The ECS-2c series was a follow on to the ECS-2b series and provided information on the effects of differing power levels under the same conditions and test apparatus as the ECS-2b series. Data and information in this report provide results from the ECS-2c experiments.

Experiments conducted have provided insight on the influence of air entrainment, inlet fluid temperature, liquid flowrate, and test section back pressure on the heat transfer coefficient inferred from the data. Heat transfer coefficient (HTC) values are consistent with data reported from test facilities using heaters with flat axial power profiles. Over the range of conditions investigated, the HTC is primarily a function of liquid superficial velocity. While air entrainment is a strong function of liquid superficial velocity, air entrainment had only a minor effect on the HTCs. Test section back pressure had a small effect on the heat transfer coefficients particularly at low liquid flow rates where pooling in the test section occurred. Due to significant uncertainty in calculated heat transfer coefficients (thermocouple installation effects, uncertainty in thermal contact resistances between heater components, and variations in local hydraulic conditions all contribute to the uncertainty), it is not possible to make conclusions regarding the axial trends in the HTC.

ACKNOWLEDGEMENTS

Many people contributed to the success of the experiments reported in the following pages. B. R. Merkley kept the facility hardware operating. P. R. Schwieder and J. R. Boyce solved the electronics mysteries. B. R. Merkley and J. R. Boyce helped conduct the experiments.

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1. INTRODUCTION

In mid 1987, the U.S. Department of Energy (DOE) initiated a vigorous program to review the safety and operation of the nuclear materials production and nuclear testing facilities under DOE management in the U.S. A major purpose of this ongoing review effort is to insure that the facilities in the existing research and weapons materials production complex are operated in a safe manner during normal operation and given a hypothetical, design basis accident, the risk to the public is within acceptable limits.

As part of this review effort, Westinghouse Savannah River Site (WSRS) has conducted or contracted research to examine heat transfer in the Savannah River Plant (SRP) reactor fuel assembly during the Emergency Cooling System (ECS) phase of a hypothesized Loss-of-Coolant Accident (LOCA). During this portion of the accident, the reactor fuel assemblies are expected to be filled with a two-component air-water mixture. Safety requirements dictate that the power levels be low enough during the ECS phase of the accident so that no melting occurs in the assemblies.

Two different criteria, wall saturation temperature and wall dryout, are under consideration for use in calculation of power limits. Simply stated, wall saturation criteria involves determination of the power for a given thermal-hydraulic condition (flowrate, inlet fluid temperature, etc) at which the assembly wall temperature just reaches the local saturation temperature. Dryout criteria involves determination of the power at which heat transfer from the surface of the heated assembly wall degrades to a point where the surface is basically dry and the wall temperature starts to increase in a nearly adiabatic fashion. Of the two criteria, wall saturation is the considerably more conservative.

Complex geometry and hydraulic interactions involving air entrainment, flooding, and heat transfer to two-phase mixtures necessitate experimental investigation of the processes involved to help determine key factors influencing assembly cooling and hence the power limit criteria. Research results from such investigations will be used in the verification and assessment of models used for establishing acceptable power limits for the reactors.

Experimental efforts conducted at the WSRS Heat Transfer Laboratory to examine ECS power limits are reviewed by Steimke [3]. Prior to 1988, experiments were conducted in an annulus consisting of a heated stainless steel surface (rather than aluminum as in actual fuel assemblies) and glass or aluminum as the other wall of the annulus [4; 5]. Stainless steel was used as the heated surface because of technical difficulties associated with resistively heating aluminum to the power levels required for the desired experiments. These facilities did not contain axial spacer ribs in the annulus, a unique feature of the reactor assembly design. Also, these test sections used a flat axial power profile and uniform azimuthal power. Facilities that included spacer ribs and an azimuthal power tilt were constructed in 1988 [6; 7; 8]. Other facilities were built in 1989 [9] for visualization studies and to incorporate flame spray technology for the construction of aluminum heated surfaces [10; 11]. All test sections mentioned above incorporated a flat axial power profile (the FB rig had an azimuthal power tilt) and with the exception of two test sections, used stainless steel for the heated surface. Although, both of the flame-sprayed test sections used aluminum for the heated surface, then current technology allowed only the outer annulus wall to be heated.

The ECS-1 facility [12] was constructed and operated at the Idaho National Engineering Laboratory (INEL) in 1989 to help address the influences of heater surface material properties and conditions on test results. The ECS-1 facility was sponsored by the Department of Energy, Office of Safety Appraisal, Environment Safety and Health and consisted of a ribbed aluminum tube heated from inside with a resistively heated stainless steel tube and surrounded by a Lexan™ shroud to permit visual observation. Nearly 50 experiments were conducted to examine the effects of air entrainment, flow regime transition, flow distribution, and flooding on the heat transfer processes in the annulus.

The success of the heater design used in the ECS-1 facility prompted the construction of the ECS-2 facility at the INEL. The ECS-2 program was sponsored by WSRS and incorporated several improvements relative to the ECS-1 fixture. Foremost was a new inner heater with an axial power profile consistent with the power shape to be used in setting assembly power limits and improvements in the inlet and outlet geometry of the test section to make the plenums more prototypic.

Two different categories of experiments were run during the course of the INEL ECS-2 program. Approximately 50 experiments (the ECS-2, WSR, and ECS-2cE series) were conducted to establish and examine the variables and conditions that lead to sustained dryout on the heated surface in the annulus. Results from these experiments are discussed by Larson, et. al.[2] More than 70 experiments (the ECS-2b, and ECS-2c series) were conducted to determine the hydraulic conditions that lead to heater wall temperatures that just exceed fluid saturation temperature. Results from the first series of these experiments (ECS-2b) are discussed by Anderson, et al.[1]

Tests conducted in these programs were designed to parametrically examine the influence of coolant temperature, coolant flowrate, and back pressure on the heat transfer processes in the ribbed annulus. A follow on series (ECS-2c) was conducted to investigate the effect of different power levels upon the aluminum thermocouple response. Previous experiments had raised questions as to possible installation effects upon the thermocouple readings. It was decided to perform the ECS-2c series under the same conditions as the ECS-2b series, with the exception that electrical power to the heater would be set at 90%, 100%, and 110% of the power required to raise the <u>maximum</u> measured aluminum temperature to the fluid saturation temperature. Data gathered will be used to improve understanding of the physical processes involved and in the assessment and validation of models used in the calculation of power limits criteria (in particular, the sensitivity of the wall temperature to power).

Subsequent to the ECS-2c series, two follow on series were performed in an attempt to resolve the question of the large (~ 60 K) azimuthal temperature variations observed at the various axial locations during the ECS-2b and ECS-2c experiments. These series were the LFb series, performed under conditions of all liquid downflow, and the Submergence series, performed in a large all liquid pool under conditions of constant power and no flow. Analysis of these experiments (documented in Reference[13]) indicated that the observed azimuthal variation was not simply an effect of the thermocouple installation. However, the exact physical mechanism causing the variation has not currently been determined. A correction methodology, based upon total test section power and the LFb data, had been previously proposed [14]. However, without knowing the physical mechanism, it was decided that application of this correction methodology to the ECS-2 data would not be performed at this time. For documentation of work performed, the ECS-2c thermocouple data corrected using this methodology is presented in an appendix.

A chronological overview of all of the ECS-2 experiments is provided in Appendix A.

The remainder of this report details results of the ECS-2c series conducted at the INEL, in the ECS-2b facility, during June 14-July 3, 1990. Section 2 describes facility design, support systems, measurement capabilities, and data acquisition system. Experiment conduct and test matrices are addressed in Section 3. Results of the experimental investigations are presented in Section 4. Conclusions and summary statements are given in Section 5. Appendices to this report provide a chronological overview of all of the ECS-2 experiments, lists of measurements recorded for the various experiments, tabulations of averages for data recorded, and other relevant information.

2. FACILITY DESCRIPTION

This section describes the ECS-2b facility (used to perform the ECS-2c experiments)[1], support systems, instrumentation, and data acquisition system. These descriptions have been previously provided[1], however, for easy reference the descriptions will be repeated herein, with the exception that the facility drawings will not be included in this report. The ECS-2b test section is actually made up from the upper and lower plenums and shroud from the ECS-2 test section and the heater which was intended for the dual heated annulus program, consequently titles on referenced drawings may refer to either ECS-2 or dual heated annulus programs. The dual heated inner heater is the same design as the ECS-2 heater with slight changes to simplify and improve the fabrication of the heater. The number and location of the test section fluid temperature, absolute pressure, and differential pressure measurements are significantly different than in the ECS-2 test section.

2.1 Loop Description

The ECS-2b loop schematic is shown in Figure 2.1. Water is pumped from the storage tank through the heated make up tank, where it is heated to the desired inlet temperature, and into the upper plenum. The flowrate is controlled remotely from the control room via an air operated flow control valve. For very low flowrates the test section bypass valve was opened to reduce pump outlet pressure. Air is allowed to aspirate into the upper plenum through a 6.7 cm (2.625 in) ID acrylic tube. The air-water mixture then flows down through the test section annulus into the lower plenum. The test section is described in more detail in Section 2.2. The test section is heated over 381 cm (150 in.) of its length by a directly heated Inconel tube inside an aluminum outer tube. Power to the heater is supplied by ten 4/0 copper leads from a Transrex DC power supply. Current to the heater is controlled manually from the control room.

The lower plenum serves as a separator allowing the air to exit from the top and the liquid from the bottom. A cooling coil placed in

1. Since the facility used for the ECS-2c series was the same facility previously referred to as the ECS-2b facility, this designation will be used in this report.

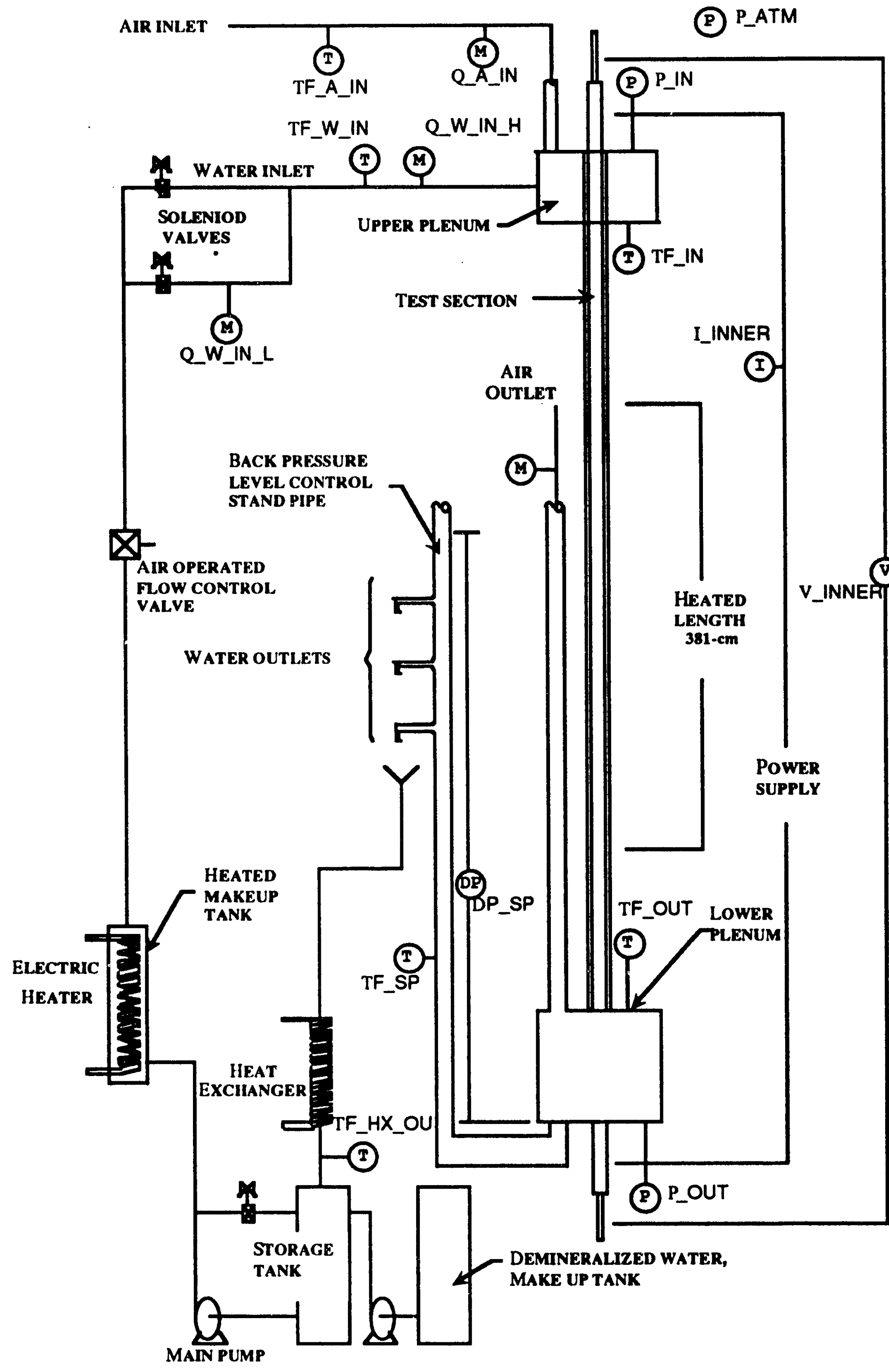


Figure 2.1. ECS-2b loop schematic.

the lower plenum can be used to condense any vapor generated in the test section preventing the vapor from exiting through the outlet air measurement station. This feature was not used during the ECS-2c experiments. The liquid level in the test section is controlled by the height of the water outlet taps located in the back pressure level control standpipe. For the ECS-2c test series these levels were 0, 48, and 140 cm (0.0, 19.0, and 55.0 in) above the bottom of the heated length. The water then flows from the outlet tap through a heat exchanger and back into the storage tank completing the loop. The loop inventory is supplied by water from the demineralized water tank.

2.1.1 Loop Instrumentation

Sufficient loop instrumentation is provided to control and monitor inlet conditions to satisfy program objectives and to calculate a test section energy balance. (A listing of all instrumentation is provided in Appendix C). The energy balance is monitored continuously on line to provide an overall integrity check and to determine when the system has reached steady state conditions following a change in power or flowrate. All fluid thermocouples are 1.5-mm (0.060 in) type K stainless steel sheathed with a grounded junction inserted directly into the fluid stream. They are connected to type K extension wire which runs to a 339 K (150°F) reference oven. Regular conductors are used to connect the ovens to the DAS.

The air inlet and outlet flowrates (Q_A_IN and Q_A_OUT) are measured using Teledyne/Hastings model LU-3M mass flow meters having a measurement range of 0-50 standard liters per minute (SLPM). These are very low pressure drop instruments having an internal diameter of about 6 cm (2.5 in). The inlet and outlet temperatures (TF_A_IN and TF_A_OUT) were measured using fluid thermocouples described above. Both a high flow (Q_W_IN_H) and a low flow (Q_W_IN_L) turbine meter were used to measure the inlet liquid flow. For flowrates below 0.30 l/s flow was routed through both turbine meters and for flowrates above 0.30 l/s only the high flow turbine was used. The liquid inlet temperature (TF_W_IN) was measured using a fluid thermocouple and was checked regularly against a calibrated glass thermometer inserted into the inlet liquid stream. The inlet liquid temperature was controlled by manually controlling the heat input to the heated make up tank. No outlet liquid flowrate measurements were made and the liquid outlet temperature was measured using a fluid thermocouple (TF_SP). The inlet (TF_IN) and outlet (TF_OUT) plenum temperatures were also measured using fluid thermocouples. The inlet (P_IN) and outlet (P_OUT) plenum absolute pressures were measured using Sensotec absolute pressure transducers. The liquid temperature at the outlet of the heat exchanger (TF_HX_OUT) was measured using a fluid thermocouple. The liquid level in the level control standpipe was measured using a differential pressure cell (DP_SP) connected between the bottom of the lower plenum and a point above the highest outlet tap. During testing the storage tank temperature was monitored to help determine the necessary secondary heat exchanger flowrate but was not recorded. The water flowrate (Q_W_CC) through the lower plenum cooling coil was measured using a turbine flowmeter and the inlet (TF_CC_IN) and the outlet (TF_CC_OU) temperatures were measured using fluid thermocouples[2].

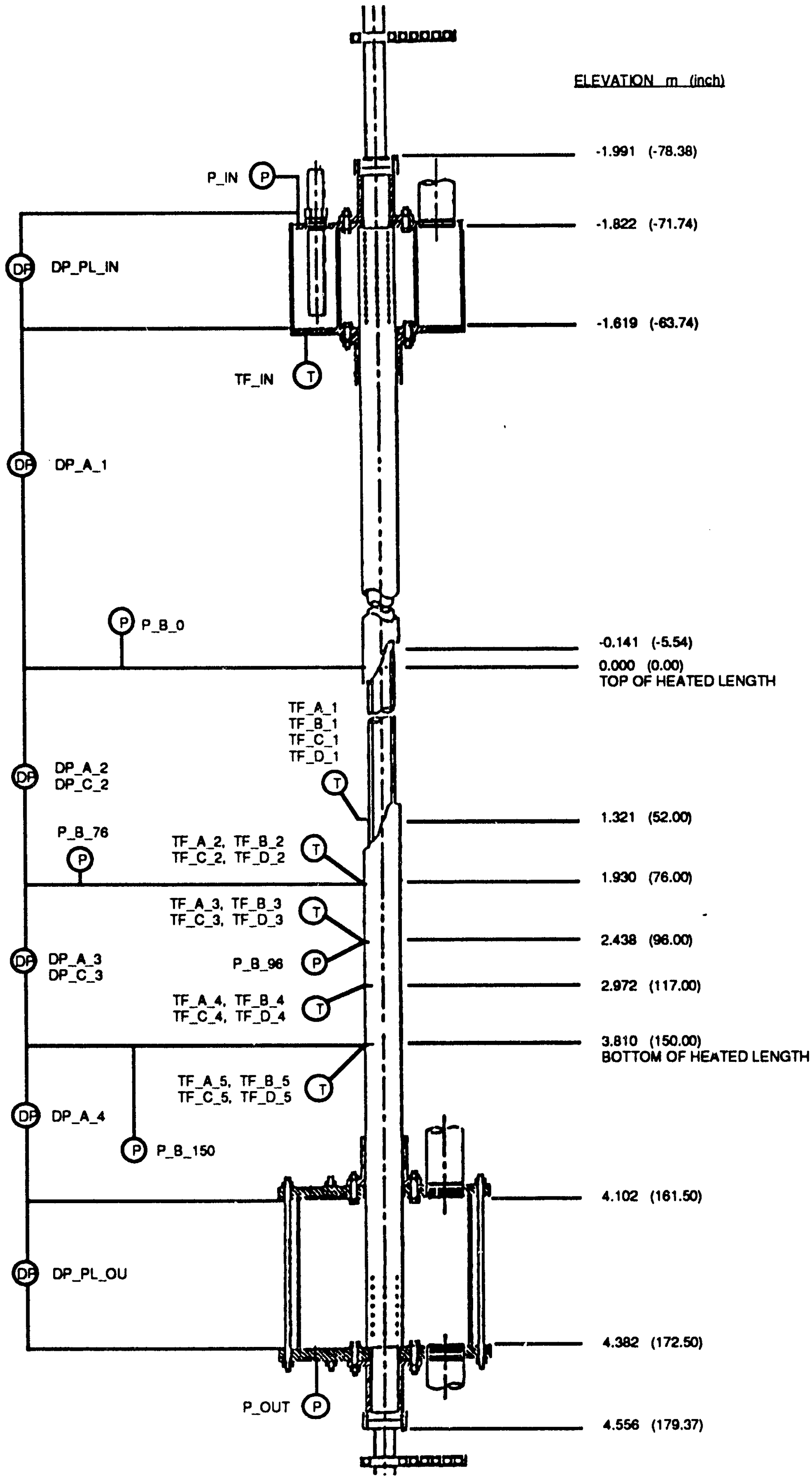
The test section voltage (V_INNER) was measured with a volt meter connected directly across the test section. The current through the test section (I_INNER) was determined by measuring the voltage across a current shunt of known resistance.

Local atmospheric pressure (P_ATM) was measured using a Sensotec electronic barometer and was checked daily against the atmospheric pressure recorded at the INEL Standards and Calibration Laboratory.

2.2 Test Section Description

For this discussion the test section is defined as the upper and lower plenums, the connecting transparent shroud, and the composite heater. Figure 2.2 shows the test section with pertinent elevations indicated on the right side and instrumentation designations on the left side. Instrumentation on the composite heater is not shown on this figure. A cross section view through the heated portion of the test section is shown in Figure 2.3.

2. The lower plenum cooling coil was not used during the ECS-2c series.


ELEVATION m (inch)
-1.991 (-78.38)
-1.822 (-71.74)
-1.619 (-63.74)
-0.141 (-5.54)
0.000 (0.00)
TOP OF HEATED LENGTH
1.321 (52.00)
1.930 (76.00)
2.438 (96.00)
2.972 (117.00)
3.810 (150.00)
BOTTOM OF HEATED LENGTH
4.102 (161.50)
4.382 (172.50)
4.556 (179.37)
P_IN
DP_PL_IN
TF_IN
DP_A_1
P_B_0
TF_A_1
TF_B_1
TF_C_1
TF_D_1
DP_A_2
DP_C_2
P_B_76
TF_A_2, TF_B_2
TF_C_2, TF_D_2
TF_A_3, TF_B_3
TF_C_3, TF_D_3
DP_A_3
DP_C_3
P_B_96
TF_A_4, TF_B_4
TF_C_4, TF_D_4
TF_A_5, TF_B_5
TF_C_5, TF_D_5
DP_A_4
P_B_150
DP_PL_OU
P_OUT

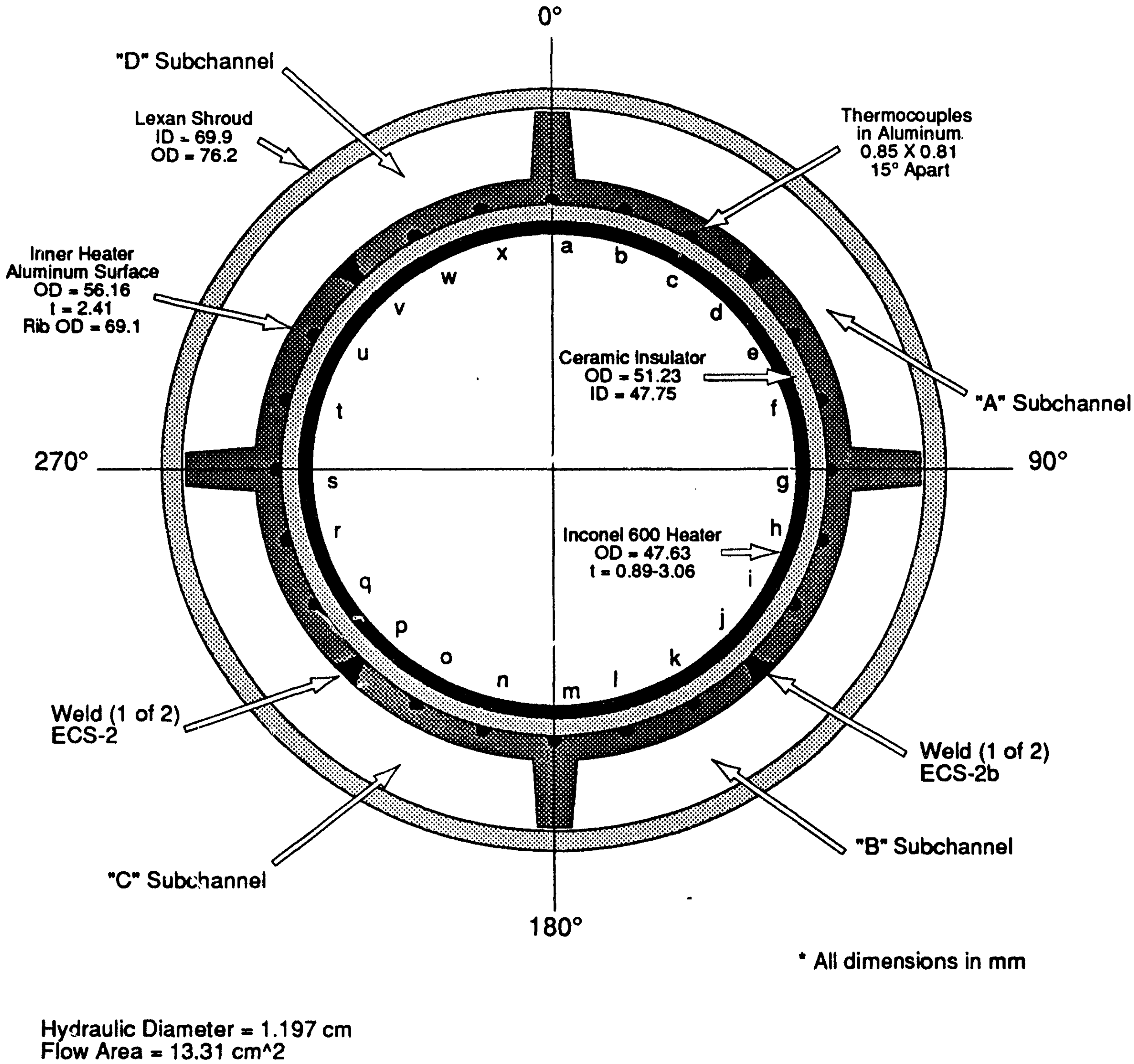


Figure 2.3. ECS-2b test section cross section through heater, viewed from the bottom.

2.2.1 Composite Heater

The composite heater, shown in Figure 2.3, consists of a 4.76 cm (1.875 in) OD Inconel 600 resistively heated tube fitted inside a 1.75 mm (0.069 in) thick ceramic insulator, with an aluminum outer tube in which the fins have been machined. The aluminum outer tube was made in two halves and welded onto the assembly in order to facilitate fabrication. Power leads through the unheated portion of the heater were made of copper tubing (wall thickness of 8.59 mm [0.338 in]) brazed to the ends of the Inconel heater tube. The composite heater was fabricated by sliding the ceramic insulator over the inconel tube, placing the two aluminum halves over the insulator, and then TIG welding the aluminum halves together longitudinally, with the welds in subchannels B & D. As the weld cooled the composite was drawn tightly together. The weld surface was then dressed to the basic tube diameter. The completed assembly is shown in Drawing 430679 in Appendix A of Reference[1].

The Inconel heater tube was fabricated by welding together eight sections of Inconel 600 tubing of various lengths having five different wall thicknesses in order to produce the axial power profile shown in Figure 2.4. Information for each section is presented in Table 2.1. The sections were welded together using an Astro Arc automatic tube welder. No welding filler material was required with this automatic welder. Several sample pieces for each of the weld joint thickness were made and destructively examined to determine the proper welder settings to assure a full penetration and uniform weld for each joint. The copper power leads were then brazed to each end of the Inconel tube. The completed assembly is shown in Drawing 430437 in Appendix A of Reference[1]. The completed assembly was then hung vertically in air and power leads attached to the copper leads and a thermocouple was attached in the center of each power zone. Power was applied to the heater until the hottest zone reached 800 K (1000°F) and then was held for approximately one-half hour. The temperature profile was similar to the desired power profile indicating the correct sequence of heater sections. Any weld voids would show as dark spots in the welded zone. None were found. The electrical resistance of the heater was calculated to be 0.0206 ohm from the voltage and current measurements. This was within 5% of the expected resistance calculated from the tube lengths and thicknesses and the published resistivity for Inconel.

The Macor machinable ceramic was purchased as cylinders slightly larger than 5 cm (2 in.) in diameter and approximately 15-cm (6-in) in length. Each cylinder was machined to an inside diameter of 4.78-cm (1.880-in.) and an outside diameter of 5.12-cm (2.017-in).

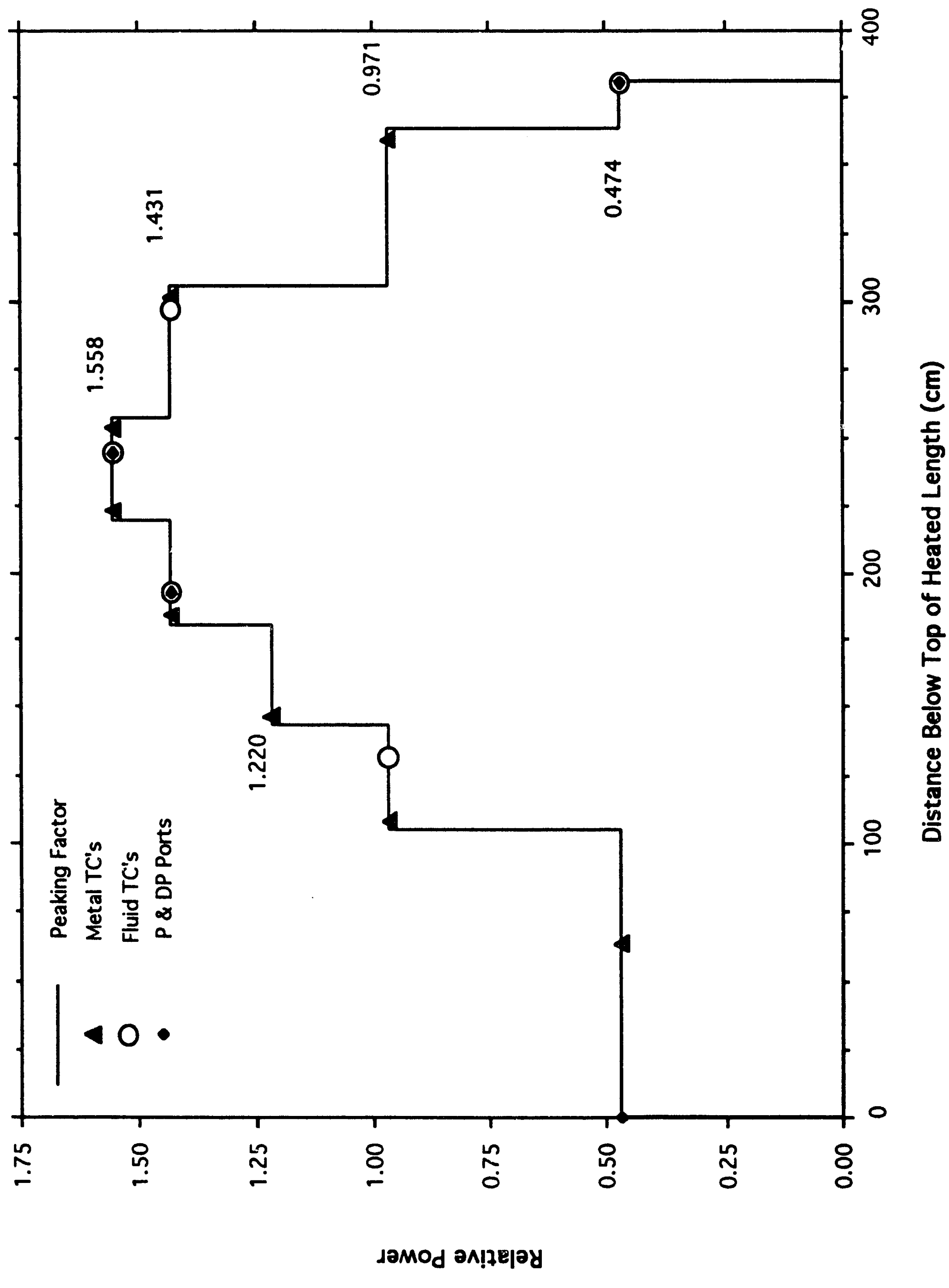


Figure 2.4. ECS-2b heater power peaking factors and instrument locations.

Table 2.1. Inconel 600 heater information

Section	Power factor	Distance from top of heater (cm)	Length (cm)	Wall thickness (mm)
1	0.474	000 - 105	104.8	3.07
2	0.971	105 - 143	38.1	1.45
3	1.220	143 - 181	38.1	1.14
4	1.431	181 - 219	38.1	0.97
5	1.558	219 - 257	38.1	0.89
6	1.431	257 - 306	48.6	0.97
7	0.971	306 - 363	57.7	1.45
8	0.474	363 - 381	17.5	3.07

A cross section of the aluminum tube in the region of the fins is shown in Figure 2.5. Complete details are given in Drawing 430678 in Appendix A of reference[1]. The tube was made from 6061 Aluminum, instead of 1100 Aluminum as used in a SRS Mark-22 fuel assembly, because of its good machinability. The fin profile is identical to that used in the SRS Mark-22 fuel assembly. The longitudinal groves placed at 15 ° intervals allow for the placement of thermocouples in the aluminum tube. Location and routing of thermocouples are detailed in Drawing 430677 in Appendix A of reference[1]. Those portions of groves not used for the actual thermocouples are filled with nonactive thermocouple wire. The thermocouples are 0.81-mm (0.032-in) OD type K stainless steel sheathed having a grounded junction.

After assembly, welding, and dressing of the heater assembly, a helium leak test was performed to assure there were no leaks in the weld joints. Helium gas at 350 kPa (50 psi) was applied inside the aluminum tube and leaks were detected by covering the surface, one side at a time, with alcohol and observing any bubbles formed. After any leaks were repaired, the heater assembly was placed inside the flow shroud, connected to the water and power supply and thermally cycled several times to temperatures expected during the test matrix.

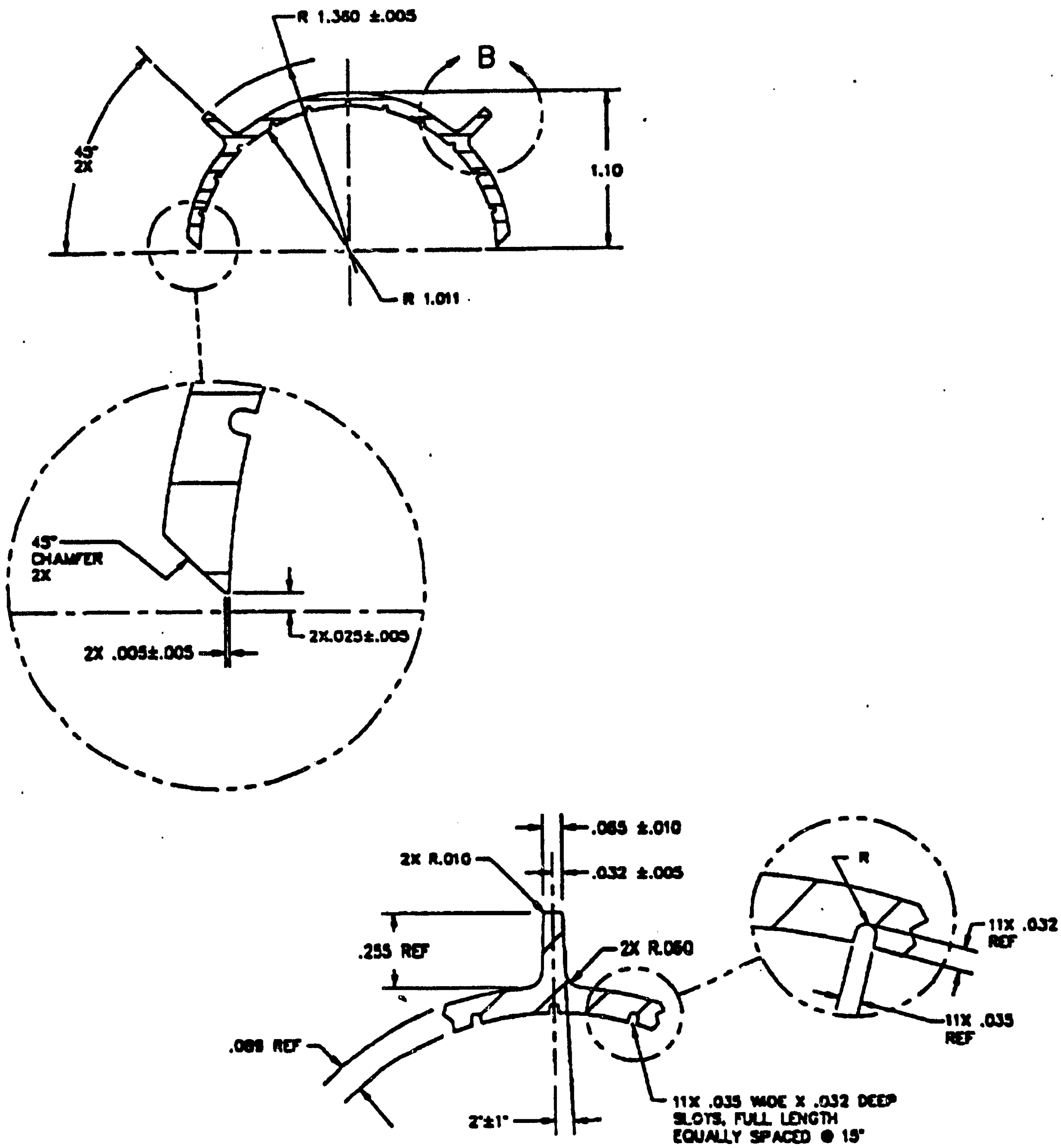


Figure 2.5 ECS-2b aluminum tube cross section

The heater assembly was removed from the flow shroud and again the welds were checked for leaks using the same helium leak test procedure. When convinced that no water could leak into the test section internals, the outer surface of the aluminum was treated to make it wettable by immersing the entire heater assembly in a bath of dilute sodium hydroxide for approximately three minutes. Verification of each thermocouple location was made by identifying each junction using a heat gun applied to the heater surface.

2.2.2 Plena and Shroud

The upper and lower plena were made from acrylic plastic to allow observation of the interior and were designed to provide prototypical elevations and flow resistances. The plenum assembly details are shown in Drawings 430049 and 431747 in Appendix A of Reference[1]. The outer flow shroud was made from an 8-cm (3.0-in) OD polycarbonate tube. Details of the outer shroud are shown in Drawing 430050 in Appendix A of Reference[1].

2.2.3 Test section Instrumentation

Fluid measurements in the test section are shown in Figure 2.2 and consist of fluid temperature measurements, absolute pressure and differential pressure measurements.

Test section fluid temperature measurements are summarized below:

TF_IN	Upper plenum temperature	
TF_OUT	Lower plenum temperature	
TF_A_1	Subchannel A	132-cm (52-in) below top of heated length
TF_B_1	Subchannel B	132-cm (52-in) below top of heated length
TF_C_1	Subchannel C	132-cm (52-in) below top of heated length

TF_D_1	Subchannel D	132-cm (52-in) below top of heated length
TF_A_2	Subchannel A	193-cm (76-in) below top of heated length
TF_B_2	Subchannel B	193-cm (76-in) below top of heated length
TF_C_2	Subchannel C	193-cm (76-in) below top of heated length
TF_D_2	Subchannel D	193-cm (76-in) below top of heated length
TF_A_3	Subchannel A	244-cm (96-in) below top of heated length
TF_B_3	Subchannel B	244-cm (96-in) below top of heated length
TF_C_3	Subchannel C	244-cm (96-in) below top of heated length
TF_D_3	Subchannel D	244-cm (96-in) below top of heated length
TF_A_4	Subchannel A	297-cm (117-in) below top of heated length
TF_B_4	Subchannel B	297-cm (117-in) below top of heated length
TF_C_4	Subchannel C	297-cm (117-in) below top of heated length
TF_D_4	Subchannel D	297-cm (117-in) below top of heated length
TF_A_5	Subchannel A	381-cm (150-in) below top of heated length
TF_B_5	Subchannel B	381-cm (150-in) below top of heated length
TF_C_5	Subchannel C	381-cm (150-in) below top of heated length
TF_D_5	Subchannel D	381-cm (150-in) below top of heated length

Six absolute pressure measurements are identified below:

P_IN	Upper plenum pressure	
P_OUT	Lower plenum pressure	
P_B_0	Subchannel B	at beginning of heated length
P_B_76	Subchannel B	193-cm (76-in) below top of heated length
P_B_96	Subchannel B	244-cm (96-in) below top of heated length
P_B_150	Subchannel B	bottom of heated length

There are the following eight differential pressure measurements;

DP_PL_IN	top to bottom of upper plenum
DP_PL_OU	top to bottom of lower plenum

DP_A_1	Subchannel A bottom of upper plenum to beginning of heated length
DP_A_2	Subchannel A top of heated length to 193-cm (76-in) below top of heated length
DP_C_2	Subchannel C top of heated length to 193-cm (76-in) below top of heated length
DP_A_3	Subchannel A 193-cm (76-in) below top of heated length to bottom of heated length
DP_C_3	Subchannel C 193-cm (76-in) below top of heated length to bottom of heated length
DP_A_4	Subchannel A from bottom of heated length to top of lower plenum

A master list of all instrumentation for ECS-2c is included as Appendix C. Uncertainty information for each type of measurement is included as Appendix D of Reference[1].

2.2.4 Data Acquisition System

A Megadac 2200C interfaced to an IBM System/2 PC made up the data acquisition system (DAS) used for the ECS-2 tests. The Megadac 2200C is a high-speed data acquisition, signal conditioning, and data recording system capable of a continuous sampling rate of up to 20,000 samples per second. Expandable modules allow the Megadac to provide amplification, multiplexing, and analog-to-digital conversion for up to 128 channels of differential input. Signal conditioning included low band pass 4-pole Butterworth filters set for a pass frequency of 2 Hz for thermocouples and 5 Hz for other measurements[3]. The IBM PC is used to perform engineering unit conversion and obtain calculated parameters from various measurements.

3. The proper analog filter frequency is less than the Nyquist frequency, which is 1/2 the sample frequency. Thus at a recording frequency of 2 samples per second the filters should be set at a frequency of less than 1 Hz. Unfortunately, the construction of the Megadac boards precluded installation of a filter circuit with this low of a cutoff frequency. Filters were installed at the lowest attainable frequencies of 5 Hz.

3. EXPERIMENT DESCRIPTION

Procedures used to conduct experiments in the ECS-2c series and to help insure the validity of the data base generated with the test facility are briefly described in this section. System operational checkout and other tests conducted to verify the design, measurement, and support systems are discussed first. Daily procedures used in test setup and measurement calibration are then described. Finally, the procedure used to conduct actual experiments and the test matrix conducted are addressed.

3.1 Checkout Tests

Once the ECS-2b facility hardware and measurements system had been completely installed, numerous checkout tests were conducted to insure that the component systems were working properly. These tests included measurements verification, system operational tests, and two different classes of tests run to help verify the inner heater design - a power pulse on the heater conducted in air and a single-phase liquid full heat transfer test.

3.1.1 Measurement Verification

After the entire measurement and data acquisition system had been installed, a number of checks were conducted to guarantee proper operation of the instrumentation and data recording system. After the DAS,had been set up with necessary calibration constants, transform functions, etc; end-to-end check on each individual measurement was performed. This involved using known voltage insertion at the sensor location to verify the proper response of the measurement signal at the DAS. Where possible, all measurements were checked by inserting known voltages that corresponded to the endpoints of the range for which it was calibrated. This procedure also allowed verification of instrument cabling, patch panel setup, and so forth.

Air flow measurement outputs were verified using a technique involving the use of a suction fan and soap bubbles. The system was configured with a large intake pipe on the upstream side of the measurement station being checked and an air-soap bubble mixture was drawn through it. With a known cross section area of the piping, the time required for a single bubble to travel a known distance allowed calculation of the volumetric flowrate, and was checked against the measurement signal output to the DAS (data was not recorded). Although crude, the methodology gave confidence in the measurement.

Turbine meters used to provide liquid flow rate measurement were verified after installation using timed measurements and calibrated collection devices.

Differential pressures, pressures, and fluid and metal thermocouples in the system were verified for location and response while slowly filling the test section with water. Response of the measurements was correlated with the liquid level in the test section using both hot and cold water bottom fills.

3.1.2 System Operational (SO) Test

The ECS-2b facility and all supporting equipment (electrical power, data acquisition, water supply, and so forth) were checked in an integral fashion prior to the conduct of any of the planned experiment by conducting a System Operational test. The objective of the SO test was to insure that the overall system could function as desired. Included in the SO test were component checks and a "dry run" for a bonifide experiment complete with data archiving and analysis.

3.1.3 Air Power Pulse (APP) and Liquid Full (LFb) Checkout Tests

Two different tests were run to examine the design details of the inner heater. Three air power pulse tests (APP) were conducted to help verify the axial and azimuthal power profile on the heater and four liquid full (LF) tests were conducted to examine heat transfer to single-phase liquid.

APP tests involved pulsing the test section with a low, constant value of power for approximately one minute with the test section in a dry air environment. Such a heatup in air was expected to result in a nearly adiabatic heatup rate of the test section. Rise rates for each wall thermocouple could then be related to the local power generation rate for comparison to expected values and to investigate evidence of azimuthal variation. Details of the first two APP tests and conclusions reached are contained in Appendix E of the ECS-2b data report[1].

Forty tests (designated LFb) were run to examine the axial variation in heat transfer to single-phase liquid. These tests were run by setting the standpipe at a level above the top of the inlet plenum to insure only liquid flow existed in the flow channel. Heat transfer coefficients were then computed from the data and compared with expected values to establish confidence in the data. Details of the LFb tests and results from the analysis of LFb test data are contained in Appendix C of Reference [13].

3.2 Routine Data Integrity Checks

To insure the integrity of the data produced in the ECS-2b facility, certain procedures were routinely performed (weekly, daily, or prior to every test if required).

DAS balance and calibration were electronically checked daily. Even though the DAS electronics were very stable, electronic balance and two point calibration on the cards in the acquisition system were performed weekly, or following instrument changeout or measurement channel patch changes.

Differential pressure transducers were checked daily. The cells were valved out of the system, the sense lines were backfilled, and the instruments were checked for any abnormal zero offsets, then were valved back into the system.

Pretest and posttest scans of all measurements were conducted for each test. Known, steady-state thermal conditions were established in the test section. Review of this information helped to identify any problems with measurement and electronics consistency. The fluid temperature reading from a calibrated glass thermometer, installed at the inlet to the test section, was compared with the inlet fluid thermocouples to insure measurement consistency.

Daily , barometric pressure readings, obtained from the INEL Standards and Calibration Laboratory, were recorded in the test operations log book

[References [15], [16], and [17]. Daily, water pH measurement results were also recorded in the test operations log book. These readings are summarized in Appendix B.

3.3 Experimental Procedure

All the experiments in the ECS-2c series were conducted using the same procedure. For any given experiment, the sequence of events was as follows:

Prior to initiation of power to the heater

- Set test section standpipe to desired value,
- Initiate inlet flow and set to desired value,
- Start the heated water makeup system and adjust the fluid temperature to the desired value,
- Start DAS (in monitor mode),
- Verify systems operating.

Test Initiation

- Set Inconel test section power to approximately 20 kW and maintain long enough to achieve thermal equilibrium,
- Increase test section power in small increments followed by 2 minute soak periods while monitoring wall temperatures for approach to the wall temperature criteria,
- When the test criteria are satisfied maintain conditions and soak for 10 minutes; initiate DAS record while maintaining conditions for a minimum of 5 minutes; terminate DAS record,
- Decrease power to 90% of wall temperature criteria power followed by a 10 minute soak period; initiate DAS record and maintain conditions for a minimum of 5 minutes; terminate DAS record,
- Increase power to 110% of wall temperature criteria power followed by a 10 minute soak period; initiate DAS record and maintain conditions for a minimum of 5 minutes; terminate DAS record,
- Terminate test section power.

Post Test Activities

- Archive recorded data,

- Conduct engineering units calculations and prepare Quick Look plots,
- Conduct posttest facility check.

The goal for tests in the ECS-2c series was to establish and measure the steady-state conditions in the test section when the wall temperature at any location on the axial length of the heater was just equal to local fluid saturation temperature. Corrections for the temperature drop from the thermocouple to the surface of the aluminum wall and for expected thermocouple uncertainty were factored into the measured temperature used for power control. Local fluid saturation temperature was computed using an Antoine equation curvefit of saturation temperature as a function of pressure in conjunction with local pressure measurements. Appendix G of Reference[1] describes the calculated parameters.

In addition to the wall saturation criteria of major interest, an ancillary test section power limit criteria was implemented for test section protection during the ECS-2c experiments. Equipment design considerations limited the maximum heater power to 150 kW although this limit was not a factor in the test matrix covered.

3.4 Test Matrix

Four different series of experiments were conducted in the ECS-2c program. The major goal of these experiments was to determine the effect of small test section power changes upon the azimuthal thermocouple response required to achieve saturation temperature at some axial location on the heater wall as a function of inlet flow, inlet subcooling, and test section back pressure. Tests conducted encompassed the range of test parameters shown in Table 3.1. A brief discussion of each series and associated objectives is given below. Table 3.2 provides the nominal conditions for the test matrix conducted.

Conditions in Table 3.2 were specified with input from WSRS personnel and reflect boundary conditions required to duplicate as closely as possible experiments previously conducted during the ECS-2b series and at the WSRS Heat Transfer Laboratory. Specifications for the ECS-2c1xx tests reflect the desire to examine the influence of liquid flow rate on the heat transfer processes for the expected plant fuel assembly inlet fluid

Table 3.1. Range of Parameters for ECS-2c Experiments

Parameter	Range
coolant flow rate	0 - 1.6 l/s (0 - 25 gpm)
inlet plenum pressure	86.2 kPa (local atmospheric)
outlet plenum pressure	0 - 139.7 cm of water (0 - 55 inches of water) referenced to the bottom of the heated length.
inlet liquid temperature	293 - 326.5 K (20 - 53.5 C)
heater power	0 - 150 kW

temperature of 311.5 K and tank liquid level (back pressure) of 48.3 cm. Specifications for the remaining three groups of experiments reflect expected bounding values of the inlet temperature and reactor tank levels.

Series 1 (ECS-2c1xx) - Eighteen tests were conducted in the first group of experiments. The major objective of these tests was to examine the heater power-wall temperature behavior as a function of inlet flow rate for a constant inlet subcooling of 57 K (311.5 K inlet water temperature) and a constant test section back pressure of 48.3 cm of water relative to the bottom of the heated length. This inlet temperature and back pressure setting represent the best estimate of what the boundary conditions on the reactor fuel assembly will be during the ECS phase of the accident.

Series 2 (ECS-2c2xx) - Twelve tests were conducted in the second group of experiments. All twelve experiments were conducted using a constant flow rate of 0.406 l/s (liquid superficial velocity of 0.305 m/s). The objective of these experiments was to determine the influence of bounding values of subcooling and backpressure on the heat transfer in the test section. Two values of inlet fluid subcooling of 42 K and 75 K (326.5 K and 295 K inlet fluid temperature) and two different values of back pressure (0 and 139.7 cm of water relative to the bottom of the heat-

Table 3.2. Test Matrix for the ECS-2c Series

Test Name	Inlet Subcooling (K)	Inlet Temp (K)	Volumetric Flow (l/s)	Liq. Superficial Velocity (m/s)	Standpipe (cm)
ECS-2c11(A,B,C)*	57	311.5	0.406	0.305	48.3
ECS-2c12(A,B,C)	57	311.5	0.609	0.457	48.3
ECS-2c13(A,B,C)	57	311.5	0.811	0.61	48.3
ECS-2c14(A,B,C)	57	311.5	1.014	0.762	48.3
ECS-2c15(A,B,C)	57	311.5	1.217	0.914	48.3
ECS-2c16(A,B,C)	57	311.5	1.420	1.067	48.3
ECS-2c21(A,B,C)	42	326.5	0.406	0.305	0
ECS-2c22(A,B,C)	42	326.5	0.406	0.305	139.7
ECS-2c23(A,B,C)	75	293.5	0.406	0.305	0
ECS-2c24(A,B,C)	75	293.5	0.406	0.305	139.7
ECS-2c31(A,B,C)	42	326.5	0.811	0.61	0
ECS-2c32(A,B,C)	42	326.5	0.811	0.61	139.7
ECS-2c33(A,B,C)	75	293.5	0.811	0.61	0
ECS-2c34(A,B,C)	75	293.5	0.811	0.61	139.7
ECS-2c41(A,B,C)	42	326.5	1.217	0.914	0
ECS-2c42(A,B,C)	42	326.5	1.217	0.914	139.7
ECS-2c43(A,B,C)	75	293.5	1.217	0.914	0
ECS-2c44(A,B,C)	75	293.5	1.217	0.914	139.7

* Test Point designation suffix A,B,C was an indication of the power level used for the test point (i.e. A for 90%, B for 100%, and C for 110% of the power required to obtain the maximum wall temperature at saturation temperature.

ed length) were examined.

Series 3 (ECS-2c3xx) - Experiments conducted in the third set were similar to the experiments in the ECS-2c2xx group in that the same two values of inlet subcooling and standpipe setting were used. The only difference was the inlet flow was increased to 0.61 l/s (0.611 m/s liquid superficial velocity).

Series 4 (ECS-2c4xx) - The fourth group of tests was identical to the second and third groups except for the flow rate. In the last group of tests, the flow rate was increased to 1.217 l/s corresponding to a liquid superficial velocity of 0.914 m/s.

4. RESULTS

Results from the ECS-2c series of experiments are presented in this section. First an overview of a typical experiment will be given to illustrate the test conduct and the format of the data obtained. Unique characteristics of the data including azimuthal and axial variations are discussed. Finally, all the data collected will be summarized. Appendix D contains tables of data averages for all the experiments.

4.1 Typical Test Results

Data from Test ECS-2c14b are presented to demonstrate the character of the data obtained for a typical experiment in the ECS-2c program. As shown in Table 3.2, ECS-2c14b was conducted with an inlet flow rate of 1.014 l/s, an inlet temperature of 311 K, and a standpipe level of 48.3 cm relative to the bottom of the heated length.

ECS-2c14b was conducted per the procedure discussed in Section 3.3. After the flow and inlet temperature were established, the power was slowly increased until the wall temperature criteria (based on review of the maximum temperature at the high power location) was achieved. For the specified boundary conditions, this power was approximately 55.12 kW. Figure 4.1 shows a comparison of the electrical power and the thermal power for the test. Thermal power is computed with a simple heat balance using the flow rate and the test section inlet and outlet fluid temperatures. While the thermal power oscillates considerably, it is evident that steady conditions were achieved as desired.

4.1.1 Wall Temperatures

Aluminum wall temperature traces for the high power zone (253.4 cm) for Test ECS-2c14b are shown in Figure 4.2. The maximum, minimum, and the average of all the functioning thermocouples are presented along with the fluid saturation temperature computed from the pressure measurement at the 244-cm elevation. The aluminum temperature fluctuations during this test were considerable, with the maximum temperature

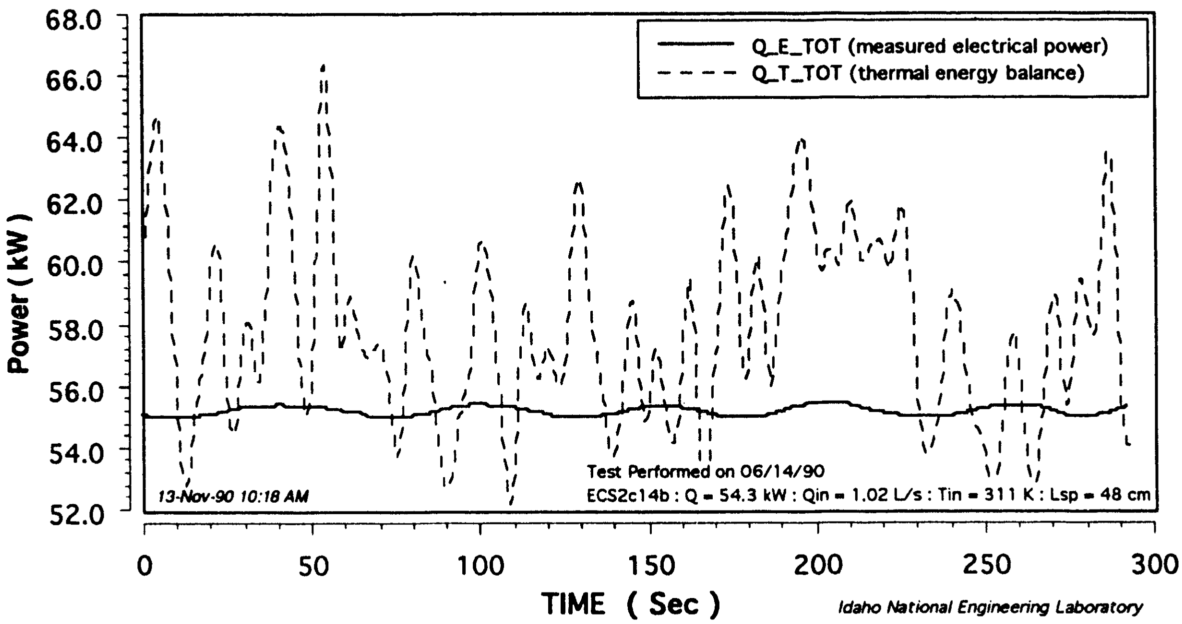


Figure 4.1. Comparison of electric and thermal power for Test ECS-2c14B

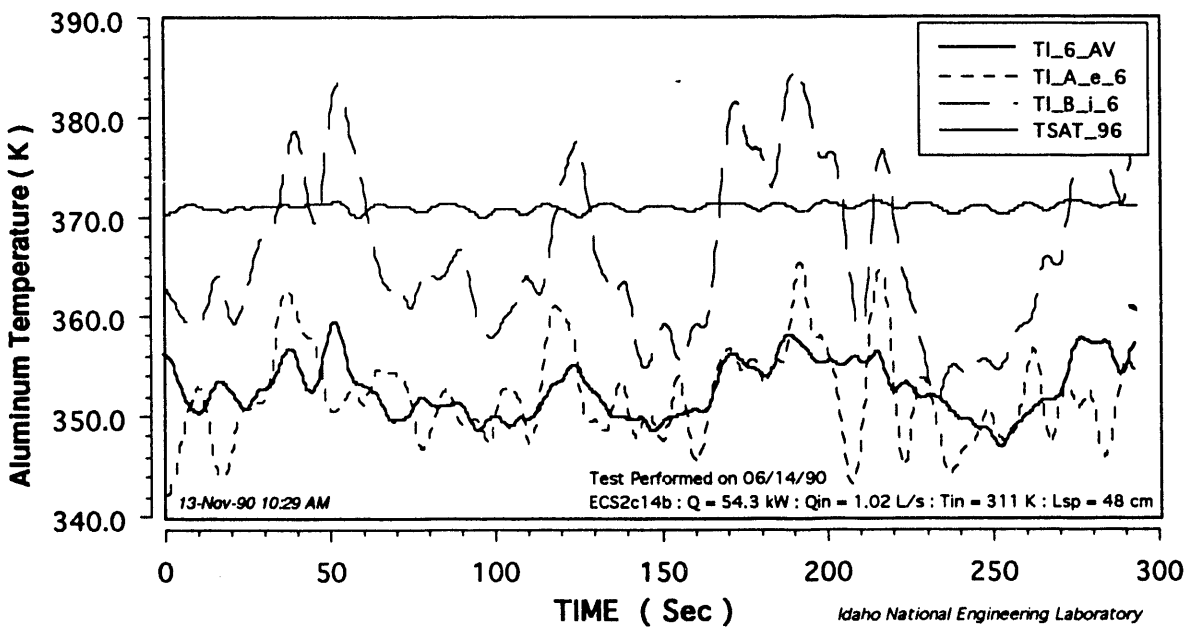


Figure 4.2. Max, min, and average wall temperatures at 253 cm compared to saturation temperature for Test ECS-2c14B

(TI_B_i_6) varying by approximately 30 K during the 5 minute data acquisition period. For the ECS-2c experiments, the desired average wall temperature was to be within ±3 K of the local saturation temperature. Under the conditions for Test ECS-2c14b, the temperature decrease from the thermocouple location to the heater surface is approximately 1.5 K (see Appendix C of Reference[1] for a discussion of the conduction calculation). Hydraulic fluctuations due to air entrainment, cross flow between subchannels, and some local flooding made it impossible to maintain facility conditions any closer to the desired tolerance on wall temperature[4].

4.1.2 Pressures and Differential Pressures

Measured pressures and differential pressures indicated the existence of significant hydraulic fluctuations that produced the character of the measured temperatures shown in Figure 4.2. Figure 4.3 shows a comparison of the pressure at the inlet, the outlet, and the 244 cm elevation in the test section. The inlet pressure (measured in the inlet plenum) is constant at a value near the local atmospheric pressure while the outlet pressure (measured in the outlet plenum) is about 12 kPa higher. As expected based on visual observations during the conduct of the tests, the outlet pressure shows a small oscillation as a result of the fluctuating liquid head in the test section. All pressures measured in the heated length showed ±6 kPa oscillations similar to that shown in Figure 4.3 for the P_B_96 measurement. As suggested above, these oscillations are largely the product of local flooding and churn type flow regimes.

Figure 4.4 shows a comparison of differential pressures measured in the A and C subchannels for Test ECS-2c14b. Both measurements represent the differential pressure between taps at 193 cm (just upstream of the high power zone) and 381 cm (bottom of the heated length) elevations. Like the pressures shown in Figure 4.3, the differential pressures show fluctuations due to churn flows, local flooding, and air entrainment. An interesting point to note from the data shown in Figure 4.4 is that while the measurements presented are from subchannels located 180° apart, the differential pressures are nearly identical. Similar comparisons of other differential pressure measurements between subchannels indicate the same agreement. Since under these test conditions, the differential

4. The data acquisition system did not permit a time averaged temperature to be displayed for power control.

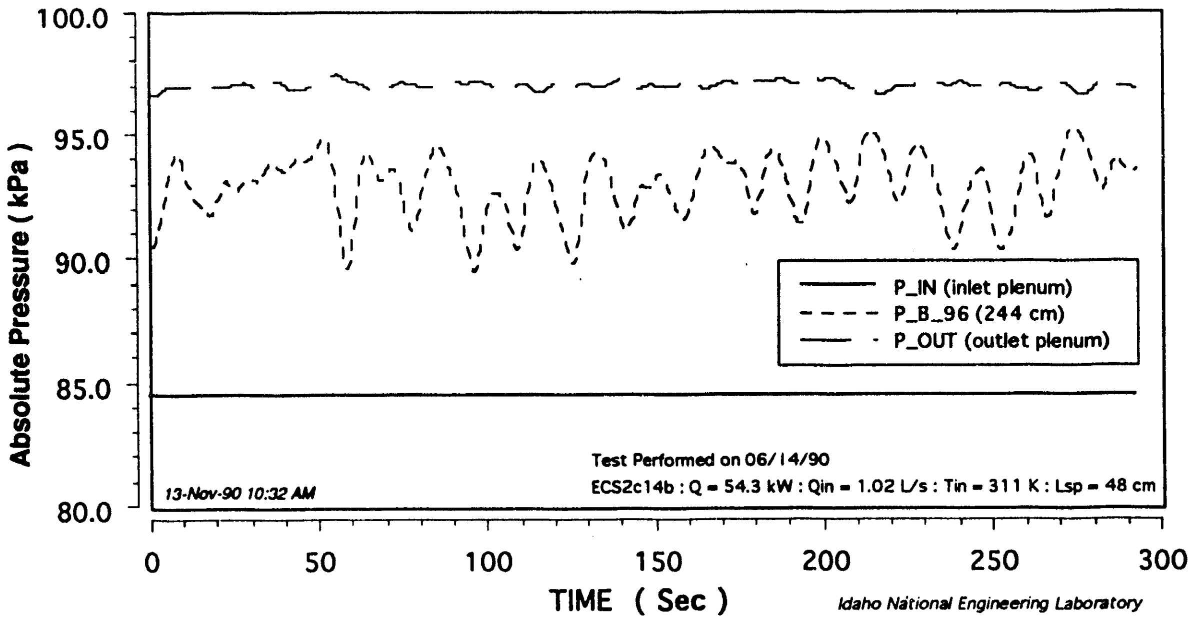


Figure 4.3. Measured pressures for Test ECS-2c14b

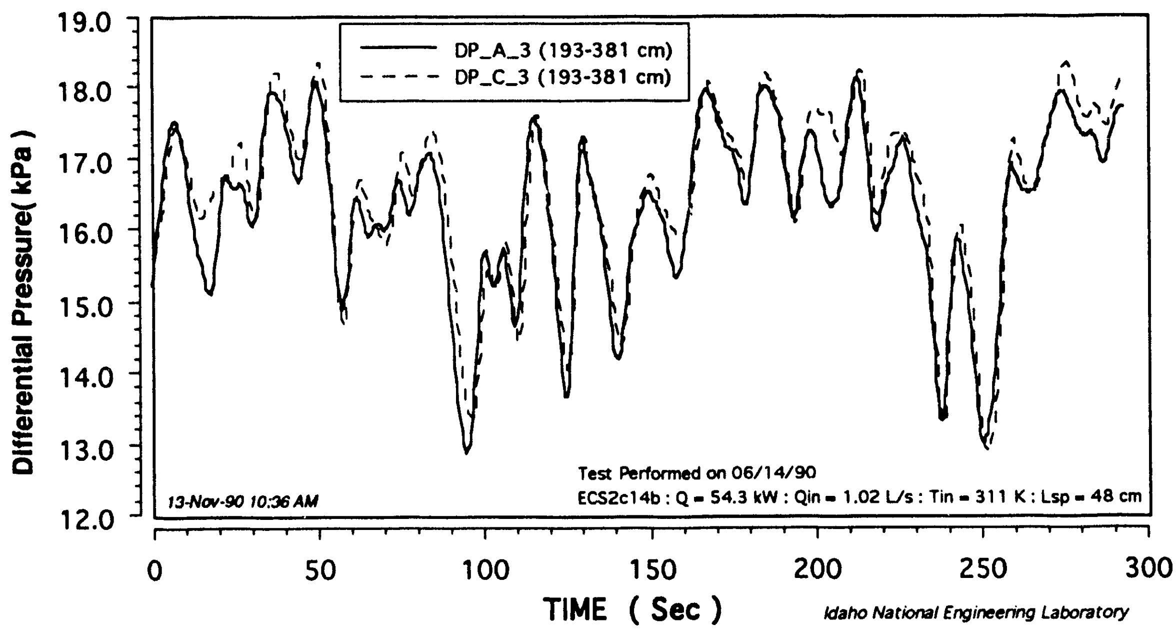


Figure 4.4. Differential pressures from 193 cm to 381 cm in A and C subchannels for Test ECS-2c14b

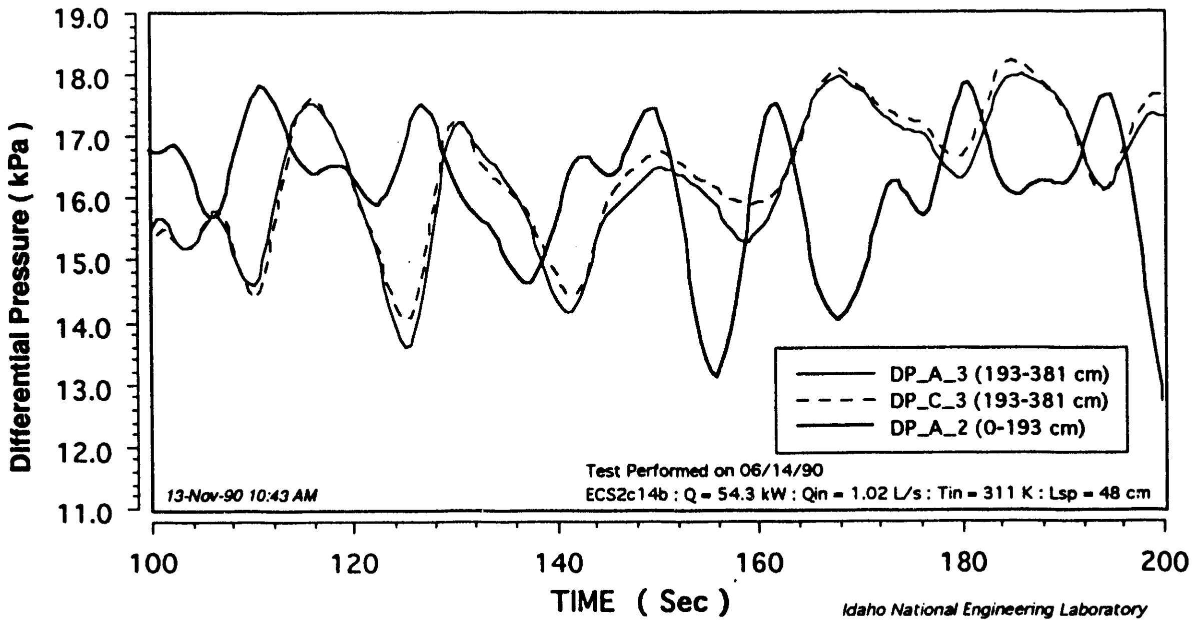


Figure 4.5. Comparison of A and C subchannel differential pressure measurements from Test ECS-2c14b

pressure is an indication of the average subchannel void fraction, the conclusion from these comparisons is that fairly uniform conditions exist between subchannels. Additional evidence of subchannel uniformity is presented in Figure 4.5. This figure shows the same data as Figure 4.4 on an expanded time scale plus the A subchannel differential pressure measurement from the beginning of the heated length to the 193 cm elevation. Data in Figure 4.5 show that while the details of the A and C subchannel differential pressures are same even when examined on a smaller time scale, the differential pressure in the top of the heated length (0- to 193-cm elevation) is different (at least for part of the experiment) than the differential pressure in the bottom half of the test section. Visual observations of void distributions during the test suggested that this should be the case even though the taps for the measurements shown in Figure 4.5 are approximately the same axial distance apart.

4.1.3 Fluid Temperature

Fluid temperature measurements were made at five different axial locations along the heated length for the ECS-2b series of tests. Each location

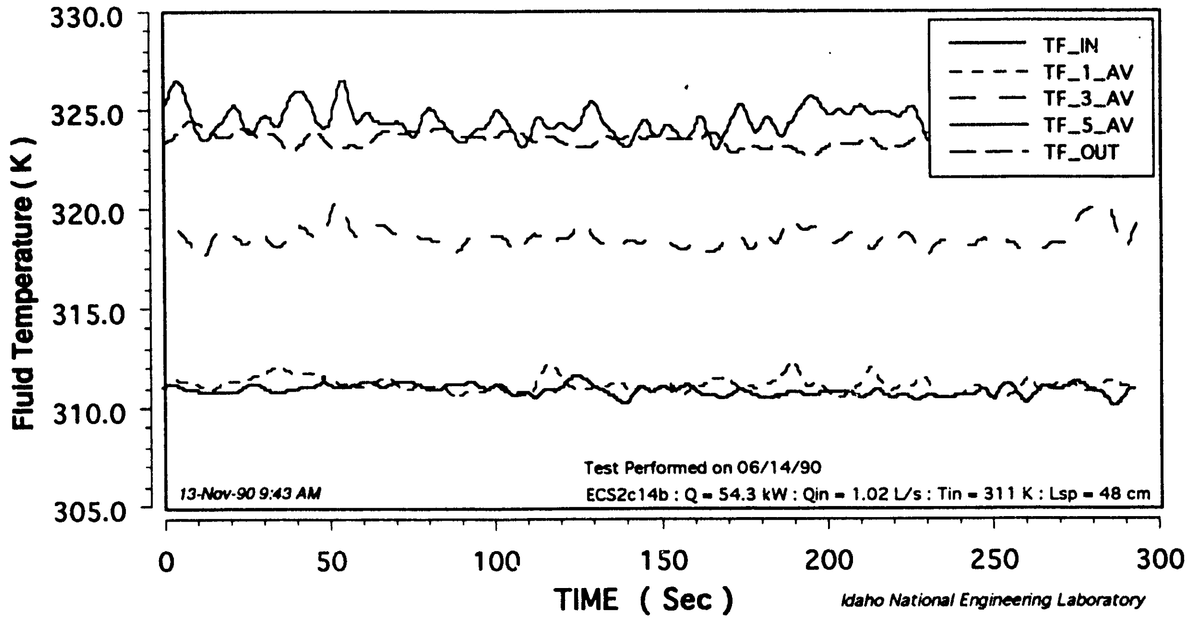


Figure 4.6. Fluid temperatures in the heated zone for Test ECS-2c14B

included one fluid thermocouple in each subchannel. Figure 4.6 shows a comparison of the average fluid temperature at the test section inlet, the 132-, 244-, and the 381-cm elevations along with the fluid temperature in the outlet plenum.

Although the data shown in Figure 4.6 have been azimuthally averaged, filtered and decimated[5], the fluctuations noted in the discussion of the pressures and wall temperatures above are also evident in the fluid temperature measurements. It is evident that for this experiment, the warmest fluid in the test section is still 45 K subcooled (45 K less than the saturation temperature of 370 K) indicating no bulk boiling was taking place.

Data shown in Figure 4.6 show the proper fluid temperature increase down the test section. In other words, the fluid temperature rise down the

5. Decimation is a process of reducing the total set of time series data to a manageable size. It basically involves only keeping every nth point of data. The correct method is to filter the data first, using a low band pass filter, and then decimate to the desired data set size. This process maintains information from those data points which have been removed from the data set.

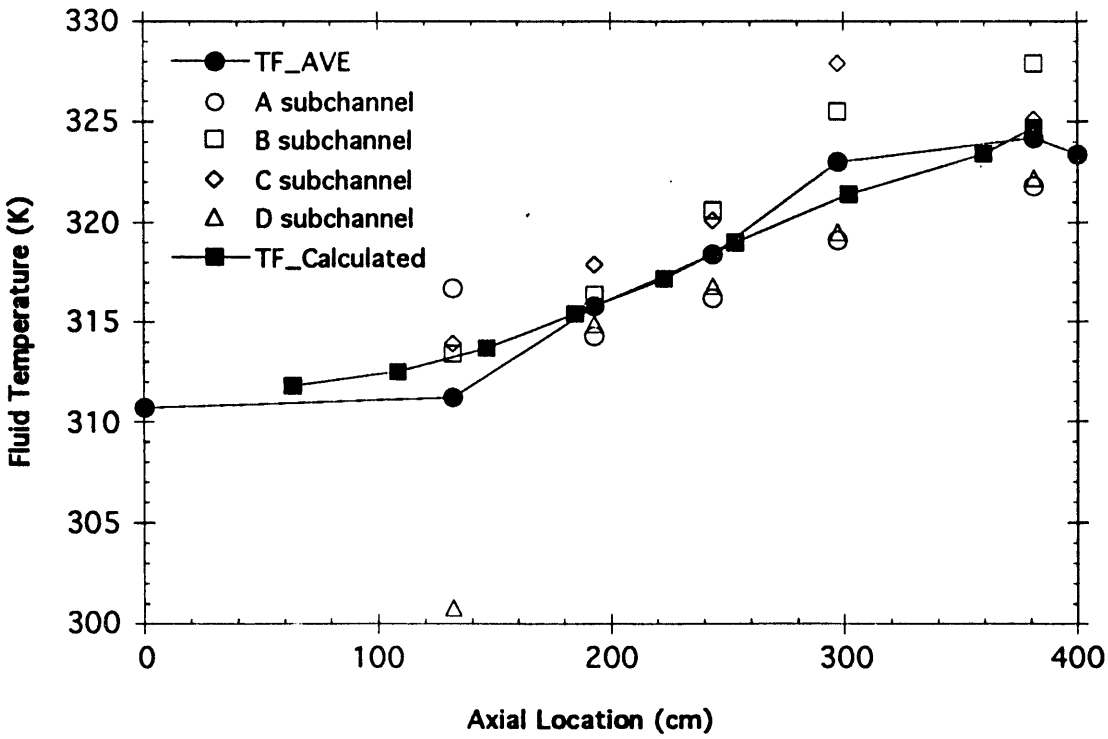


Figure 4.7. Comparison of calculated and measured axial fluid temperature distribution for Test ECS-2c14b

test section is consistent with a sensible heat balance based on the measured electrical power, the measured flow rate, and the inlet fluid temperature. Figure 4.7 shows a comparison of the calculated axial fluid temperature distribution and the measured fluid temperatures. In light of uncertainties in the fluid temperature measurements and the oscillatory nature of the hydraulic phenomena being measured, the agreement between the measured and calculated fluid temperature is considered quite good. Figure 4.7 typifies the agreement for other experiments in the ECS-2c series.

4.1.4 Air Entrainment

Test section inlet and outlet air flow rates were measured for all experiments in the ECS-2c test series. Figure 4.8 is a typical comparison of the inlet and outlet measurements. As shown, the average entrainment rate is about 12 SLPM for this experiment. Cyclic entrainment rate increases of about 25% above the average occur with a period of about 40 s. These cycles coincide with the oscillations in the wall temperatures, the

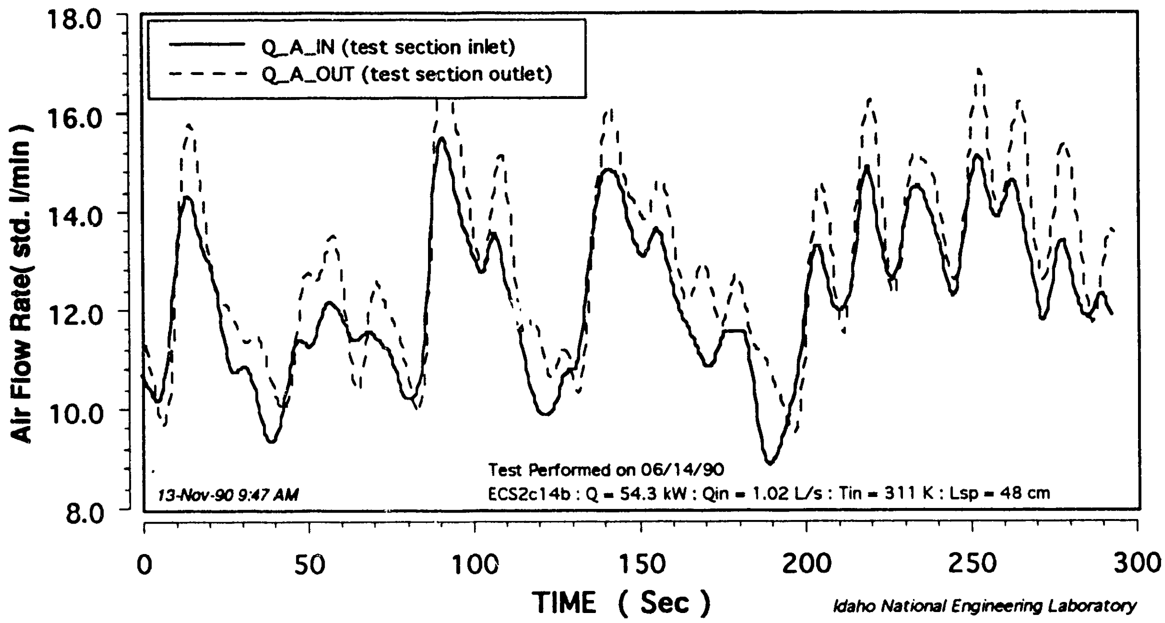


Figure 4.8. Comparison of test section inlet and outlet air flow rates for Test ECS-2c14b

differential pressures, and in the pressure measured at the 244 cm location as shown in Figure 4.2, Figure 4.3, and Figure 4.4, respectively.

As discussed in detail below, the air entrainment was noted to be a strong function of the test section flow rate and a lesser function of inlet liquid temperature. Air entrainment increased with increasing liquid flow rate and all other parameters being equal, generally decreased with increasing inlet fluid temperature. For a given inlet liquid flow rate and liquid temperature, the air entrainment was noted to increase with decreasing stand pipe level[6]. The effect of standpipe level on the air entrainment was more pronounced at higher inlet liquid flow rates (> 0.4 l/s) than at low flow rates.

6. The stand pipe level is referenced relative to the bottom of the heated length.

4.1.5 Heat Transfer Coefficient Calculation

Heat transfer coefficients at each axial power step were calculated using the standard definition. In these calculations, average subchannel wall temperatures[7] and fluid temperatures computed from an energy balance as discussed in Section 4.1.3 were used. Axial locations where the fluid temperature was calculated coincided with the location of the wall temperatures. As an example for Test ECS-2c14b, Figure 4.9 shows the wall and fluid axial temperature distributions used in the calculations.

Heat transfer coefficients computed using the data in Figure 4.9 in conjunction with the measured power and known peaking factors for the inner heater are shown in Figure 4.10. The "saw-toothed" shape of the heat transfer coefficient as a function of axial position is typical of the majority of the ECS-2c experiments with the lowest HTC at Level 6 (high power zone). The magnitude of the heat transfer coefficients shown in Figure 4.10 are consistent with data reported by Steimke [3]. Detailed discussion of the heat transfer coefficient behavior is given in section 4.3.

4.2 Azimuthal Wall Temperature Variation

As shown in Figure 4.2, the wall temperature data for a given power step indicate a considerable azimuthal variation from one thermocouple to another. As suggested in the facility uncertainty analysis (see Wilkins [18] and Appendix C of Reference[1] for additional discussion), a part of the variation can possibly be attributed to thermocouple installation effects and as suggested above, part is due to the hydraulic fluctuations. The possible installation effects and possible "correction" methodology was extensively discussed in Reference [13], with the conclusion that a significant portion of the azimuthal temperature variation is due to an unknown installation effect. It has been suggested that this azimuthal variation is a function of the test section power, and could be removed using a power correction factor derived from all liquid flow data. This methodology was evaluated in Reference[13], and it was concluded that, without knowing the actual physical mechanism causing the variation, application of the correction methodology was not justified. However, to provide complete docu-

7. The aluminum temperatures under the fins were excluded from the average temperature calculation, because of potential fin effects upon the heat transfer which would tend to decrease the measured temperature relative to the aluminum temperature between the fins.

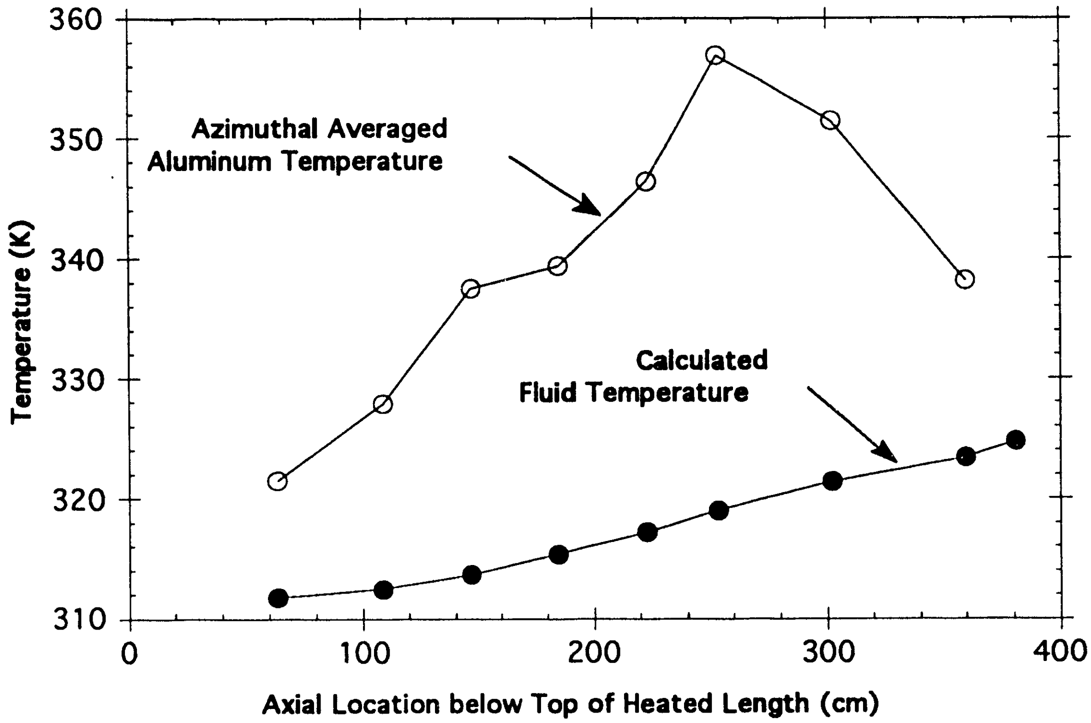


Figure 4.9. Calculated fluid temperature and average measured wall temperature for Test ECS-2c14b.

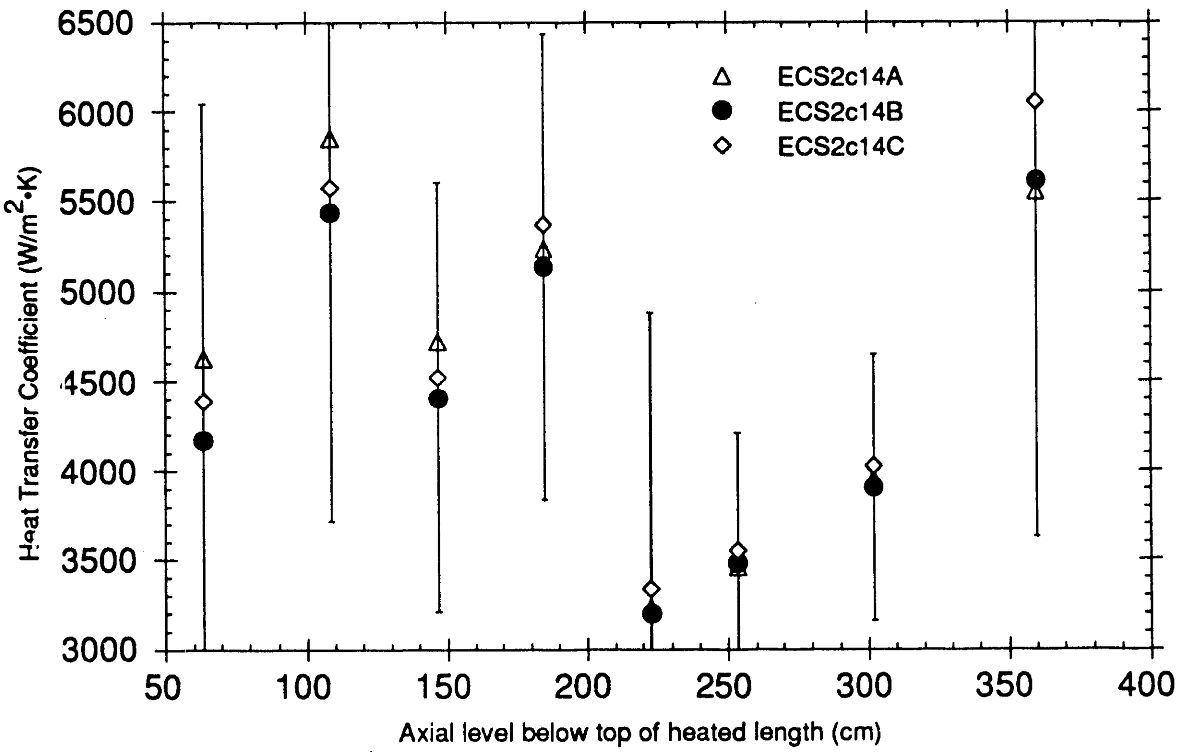


Figure 4.10. Average heat transfer coefficients calculated for Test ECS-2c14(a,b,c)

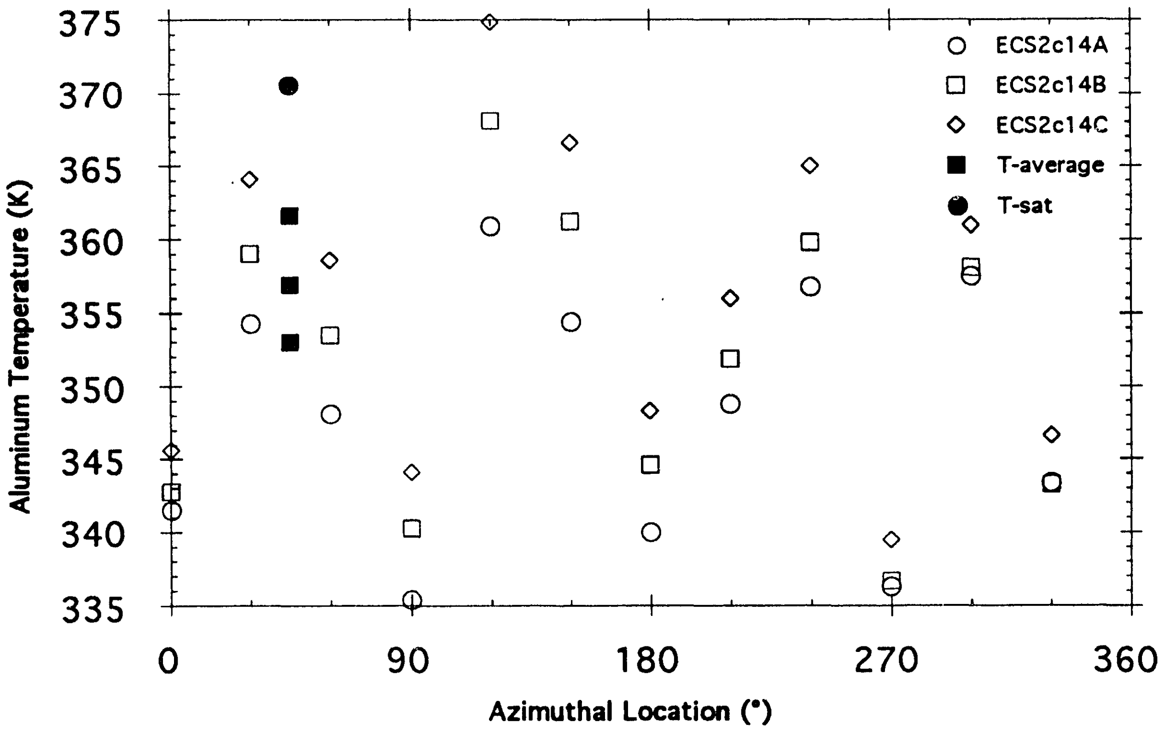


Figure 4.11. Wall thermocouple variation at 253 cm location for Test ECS-2c14(a,b,c)

mentation of the work performed, tabulations of the aluminum thermocouple measurements corrected using the power correction methodology are provided in Appendix E. The recommended use of the data for calculation of HTCs is to average the subchannel thermocouple readings at each axial location (the thermocouples under the fins are not used in this average).

Figure 4.11 shows data from the wall thermocouples at the 253 cm elevation for Test ECS-2c14(a,b,c). Shown is a comparison of the average value (averaged over a 100 second time period) from each wall thermocouple, the average of all the subchannel[7] thermocouples, and the local saturation temperature based on the pressure at 243.8 cm. Data shown in this figure are representative of that obtained for other experiments in the test series.

Thermocouple data in Figure 4.11 show that there is as much as 20 K variation from the average wall temperature at the high power location. It is interesting to note that in general, thermocouples under the ribs (0°, 90°, 180°, and 270°) indicate lower temperatures than the other thermocouples. As discussed in Appendix E of Reference[1], there is no evidence of azimuthal power gradients so the variation shown in Figure 4.11 has to be attributed to rib effects, thermocouple installation effects, and the hydraulics.

4.3 Local Heat Transfer Coefficients

In order to accurately calculate the maximum cladding temperatures of the fuel in a Mark-22 assembly during the ECS accident phase, a thorough understanding of the convective heat transfer at the cladding surface during anticipated conditions is required. The ECS-2c experiments were intended to provide data (additional to the ECS-2b experiments) for evaluating the heat transfer in the coolant channel between the two fuel elements of a Mark-22 assembly[8]. To help in this endeavor the local heat transfer coefficients (HTC) at each of the aluminum thermocouple elevations were calculated. These calculations were based upon the average of the measured temperatures (excluding the temperatures measured under the fins) at each elevation, and the calculated average fluid temperature (based upon an energy balance) at each elevation.

The calculated HTCs[9] for the tests ECS-2c14b and ECS-2b14, at a superficial velocity of 0.77 m/s, are shown in Figure 4.12, as a function of axial position. This permits comparison of the results from the two test series (ECS-2b & ECS-2c) under the same nominal boundary conditions and different test powers (ECS-2b14 was performed at a power of 88.5 kW and ECS-2c14b at 55.1 kW). The HTCs calculated from the ECS-2b tests are 10-30% higher than those calculated from the ECS-2c experiments, although still within the combined uncertainties for the calculations. All of the calculated HTCs in these experiments exhibit a sawtooth pattern in the axial direction. It is believed that this is a result of unknown installation effects of the aluminum thermocouples, coupled with hydraulic effects. It should be noted that the ECS-2b test assembly (used for the ECS-2c series) was originally designed and fabricated for investigating dryout and the resulting thermal excursion. As a result, the embedded thermocouples were installed for detection of large (~200 K) and rapid temperature increases, not to make accurate wall temperature measurements. The uncertainties

8. Predictions for the flow through the Mark-22 coolant channel #3 are on the order of 0.4-0.6 l/s (6-10 gpm), corresponding to superficial velocities of 0.3-0.5 m/s.
9. The heat transfer coefficients are calculated using the azimuthal average of the measured aluminum temperatures within the subchannels (excluding the temperatures under the fins), adjusted to give the surface temperature.

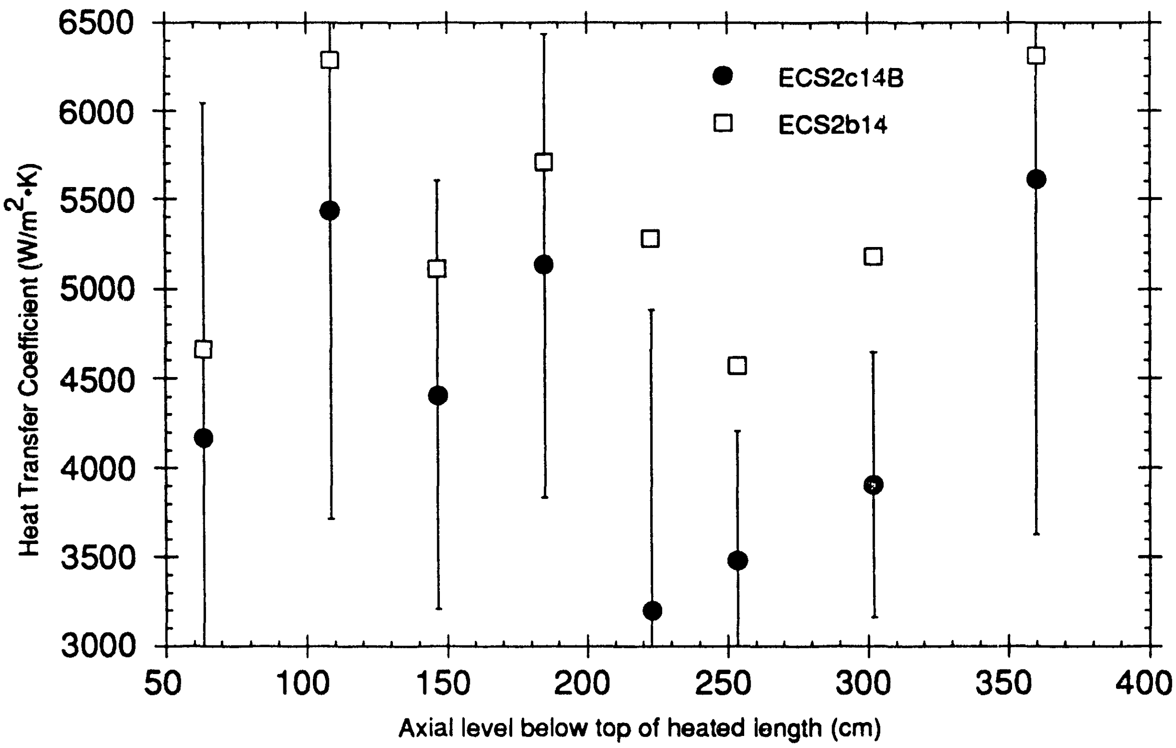


Figure 4.12. Axial variation in convective heater transfer coefficients for ECS-2b14 and ECS-2c14B experiments. Superficial liquid velocity of 0.77 m/s.

in each of the HTCs are sufficiently large that few conclusions on the axial trend in the HTCs can be drawn.

Heat transfer coefficient results for all of the ECS-2c tests, at each axial location, are shown in Figure 4.13 as a function of local Reynolds Number (based upon the liquid superficial velocity). The HTCs calculated for Level 6 were observed to be significantly lower under conditions of single phase all liquid flow. This finding tends to also be true of the data shown in Figure 4.12, although the magnitude of the difference is not as significant as was exhibited for the single phase cases. As a result of this observation, for the single phase cases, it was recommended [13] that the Level 6 data not be used for calculation of HTCs.

The calculated HTCs presented in Figure 4.13 include all of the ECS-2c data at each axial level (for three different injection temperatures and three different standpipe levels). There is a large variation in the HTCs at any value of the Reynolds Number. The HTC data at a single injection tem-

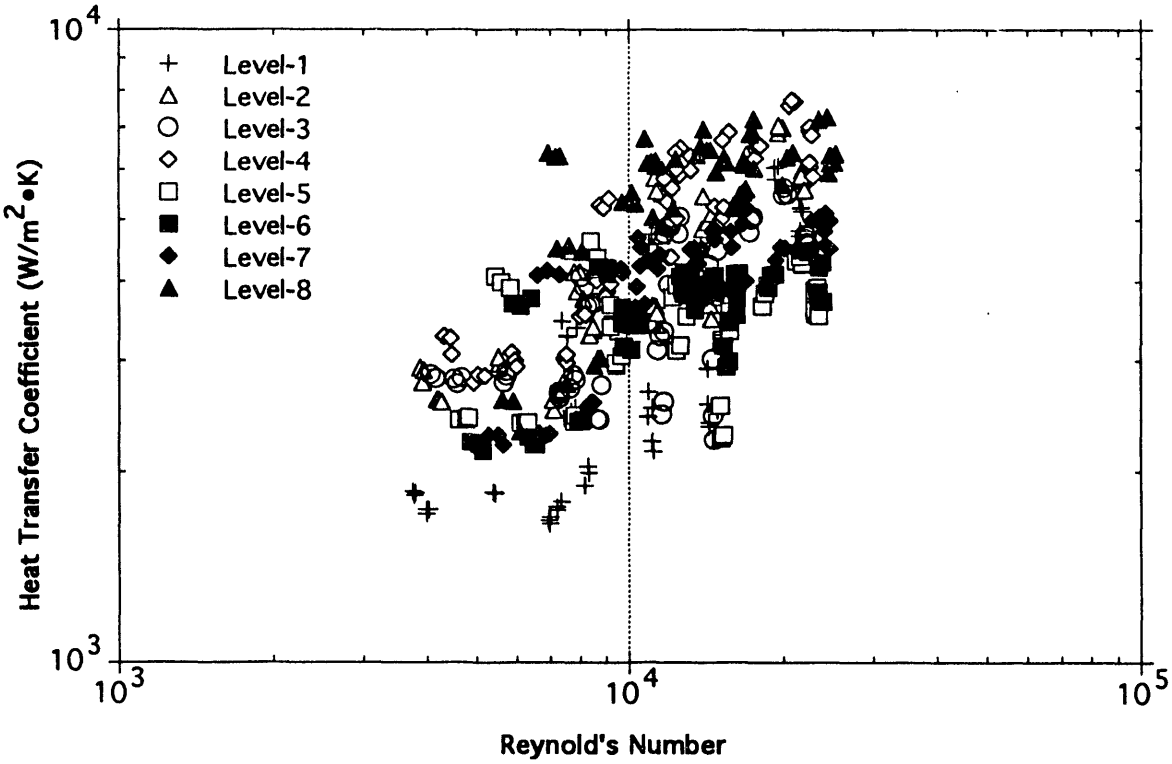


Figure 4.13 Convective heat transfer coefficients versus Reynolds number for the ECS-2c series. Results from each axial level shown.

perature and standpipe level (test points ECS2c1x(A,B,C)) is given in Figure 4.14. With the exception of Level 8 data, these data have a much smaller amount of scatter than the entire data set. The Level 8 data appear to be essentially constant. This may be due to the standpipe level being 21 cm above the Level 8 thermocouples, maintaining a pool at the bottom of the test section. The data for a standpipe level of 0 cm (at the bottom of the heated length) and injection temperatures of 293 and 326 K are presented in Figure 4.15. For these conditions the Level 8 data vary approximately as do the Level 5, 6, and 7 data. The larger amount of scatter in the data, compared to the data in Figure 4.14, may be a result of the two injection temperatures. The data for a standpipe level of 140 cm and injection temperatures of 293 and 326 K are presented in Figure 4.16. A standpipe level of 140 cm corresponds to a test section level between the Level 5 and Level 6 thermocouples. At the lowest flowrate (0.4 L/s) the pool level in the test section was near the Level 6 thermocouples (judging from the test section differential pressures). However, as the flowrate was increased, the pool level in the test section decreased, such that at a flowrate of 1.2 L/s the level was approximately 30 cm, which is below the Level 8 thermocouples. The changes in the test section pool level with both flowrate

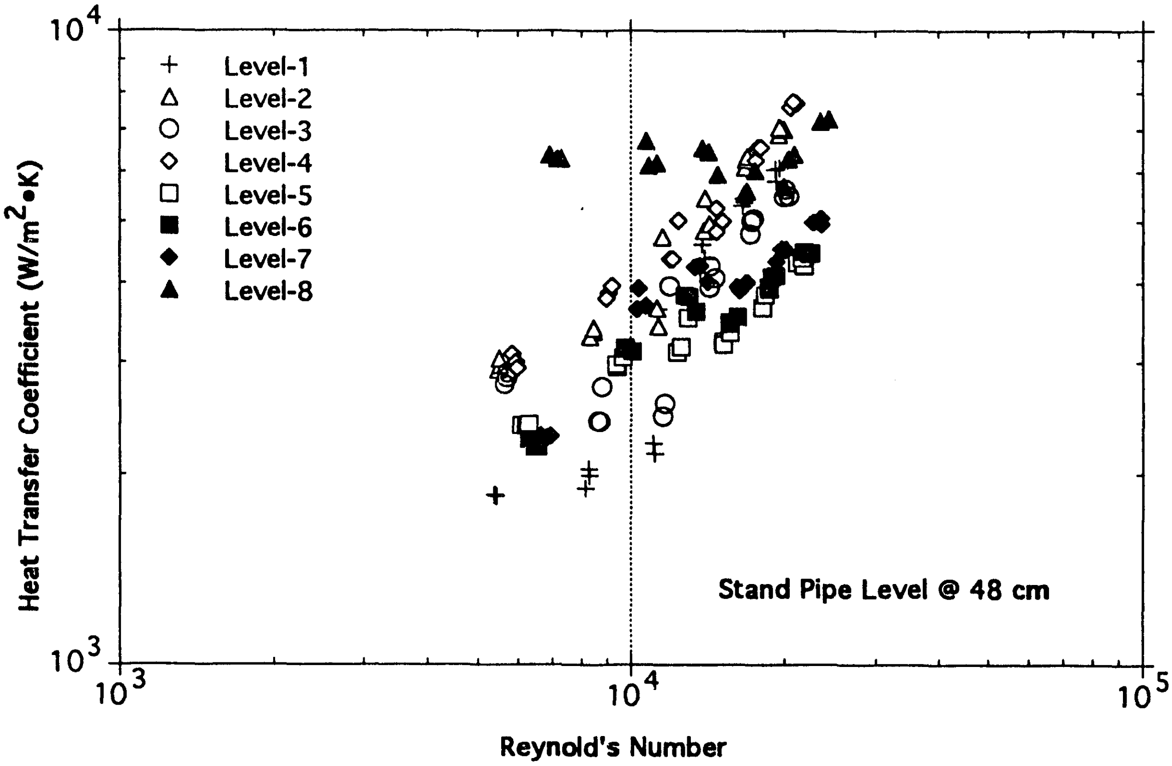


Figure 4.14 ECS-2c HTC data for an injection temperature of 311 K and standpipe level of 48 cm. Tests ECS2c1x(A,B,C).

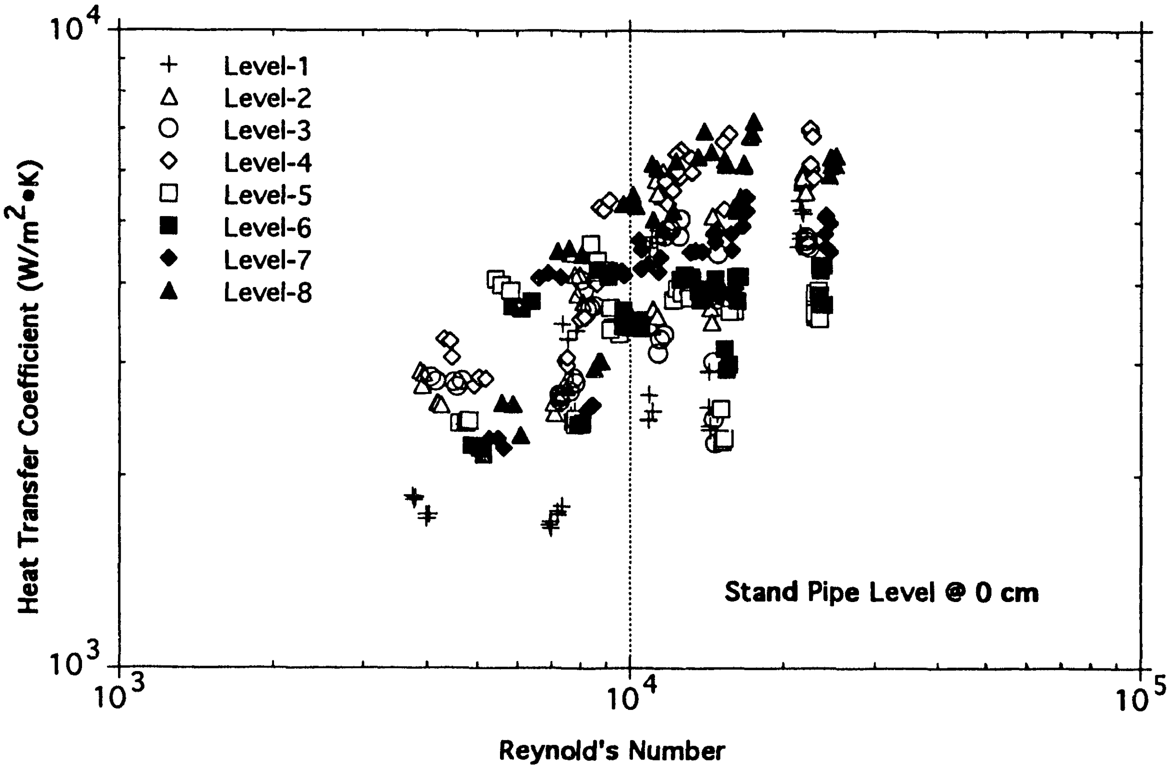


Figure 4.15 ECS-2c HTC data for a standpipe level of 0 cm, and injection temperatures of 293 and 326 K.

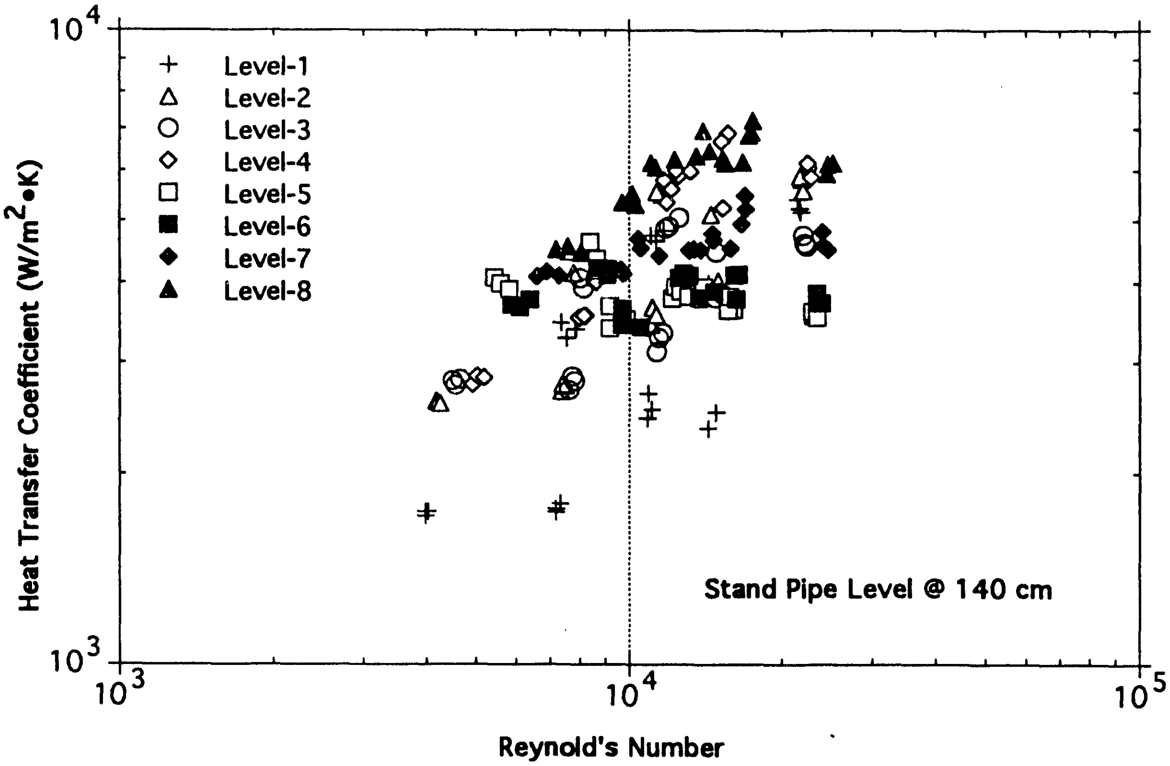


Figure 4.16 ECS-2c HTC data for a standpipe level of 140 cm, and injection temperatures of 293 and 326 K.

and injection temperature (which effected the liquid density and thus hydrostatic head) are probably the major contributor to the data scatter in Figure 4.16.

The calculated HTCs for all axial levels and all test points of the ECS-2c series were transformed into a dimensionless parameter ($Nu/Pr^{0.4}$) and presented versus the Reynolds Number in Figure 4.17. For comparison the Dittus-Boelter correlation is also shown. Although there is a great deal of scatter in the data, the Dittus-Boelter correlation gives results in the middle of the data. As a result of prior analysis of all liquid downflow heat transfer data (Reference[13]) it was recommended that the Level 6 thermocouple data not be used for calculation of HTCs. All of the HTC data, with the exception of Level 6 data, is presented as a function of the dimensionless parameter ($Nu/Pr^{0.4}$) versus the Reynolds Number in Figure 4.18. A least squares curve fit of this data was performed (using the 2σ uncertainties for each data point as weighting factors in the least squares fit). The resulting HTC correlation (designated the ECS-2c correlation) is given by,

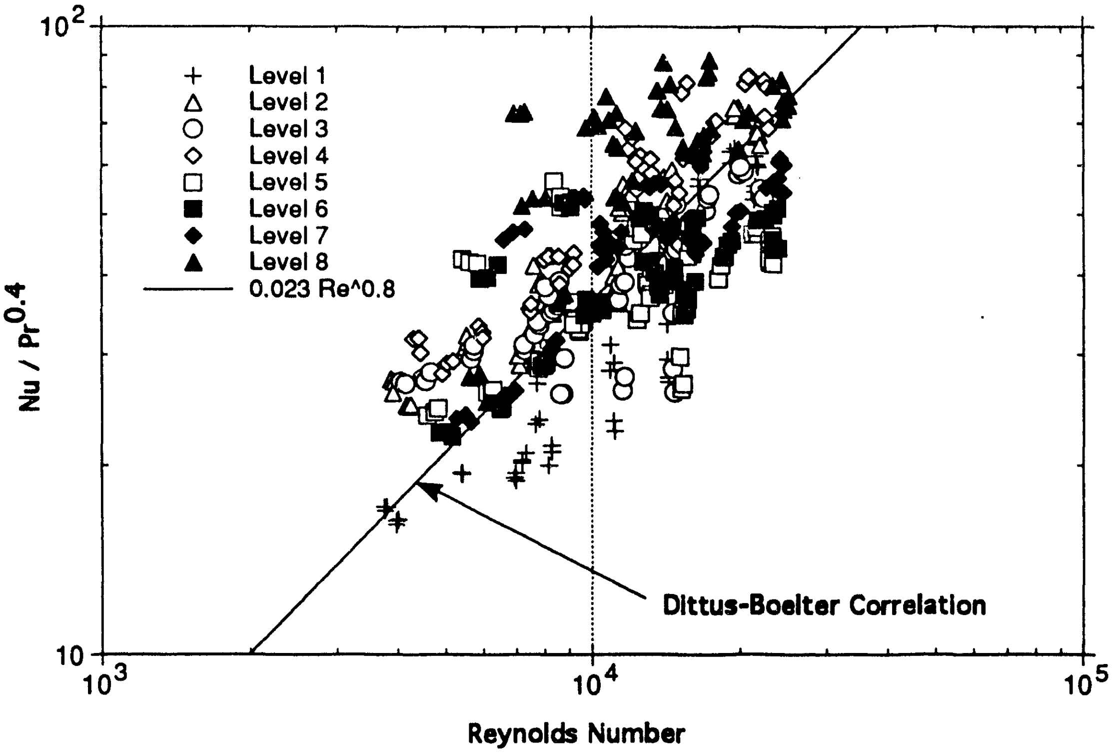
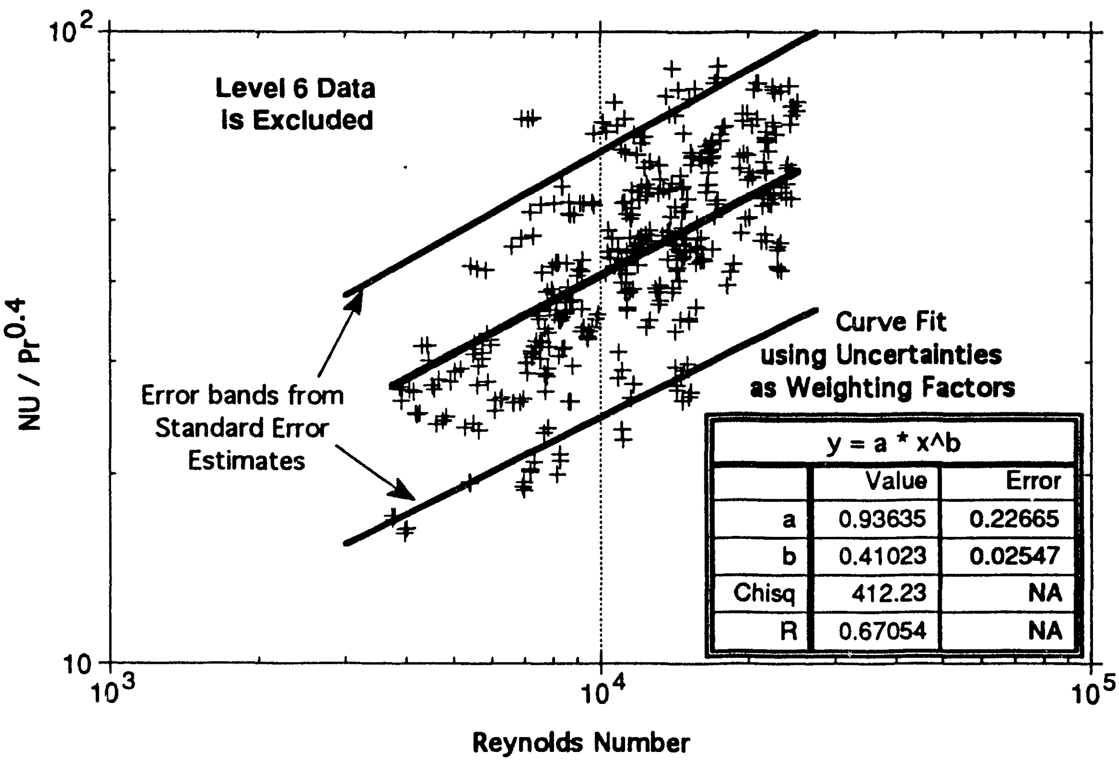


Figure 4.17. Nondimensional HTC parameter ($Nu/Pr^{0.4}$) versus Reynolds number for ECS-2c series. Results from each axial level shown.



y = a * x^b		
	Value	Error
a	0.93635	0.22665
b	0.41023	0.02547
Chisq	412.23	NA
R	0.67054	NA

Figure 4.18 ECs-2c HTC data (excluding Level 6) as a function of Reynolds number, with curve fit weighted by uncertainties.

$$Nu = 0.936\ (\pm 0.227)\ Re^{0.410\ (\pm 0.025)}\ Pr^{0.4} \qquad (1)$$

where the variances in each of the coefficients are the standard estimates of error obtained from the general curve fitting routine. This curve fit is included in Figure 4.18, along with the 2σ standard error limits of the fit.

4.4 Power Limits (Tsat Criteria)

One of the proposed criteria for setting the power limits of an SRP reactor is to limit the surface temperature of the fuel elements to less than the fluid saturation temperature during the ECS phase of the postulated LOCA (referred to as the Tsat criteria). The power required to meet this criteria can be calculated for the ECS-2c test rig using Eq(1) and a mass and energy balance of the system. This was performed for the three injection temperatures, using the lower limits of the coefficients in Eq(1), designated as the minimum correlation, to provide the most conservative results. The results from these calculations are presented in Figure 4.19, along with the ECS-2c test section electrical powers at which the nominal test points at the injection temperature of 311 K were performed. The ECS-2c data points generally follow the calculated power, except at the lowest and highest flowrates. The axial location at which the maximum surface temperature occurred in the calculations was at Level 6 and Level 7. The maximum temperature only occurred at Level 7 for the lowest flowrates (0.4 and 0.6 L/s), although the actual temperature difference between Level 6 and Level 7 for these cases was < 2 K.

The powers required to satisfy the Tsat criteria for the ECS-2c test rig were calculated for the nominal HTC correlation, given in Eq(1), the minimum correlation, and compared to the results from using the Dittus-Boelter correlation in Figure 4.20. As expected, the minimum correlation results in powers about 25-35% lower that the nominal ECS-2c correlation. Even though the coefficients for the nominal and Dittus-Boelter correlations are very different, the powers calculated from using these two correlations are very close.

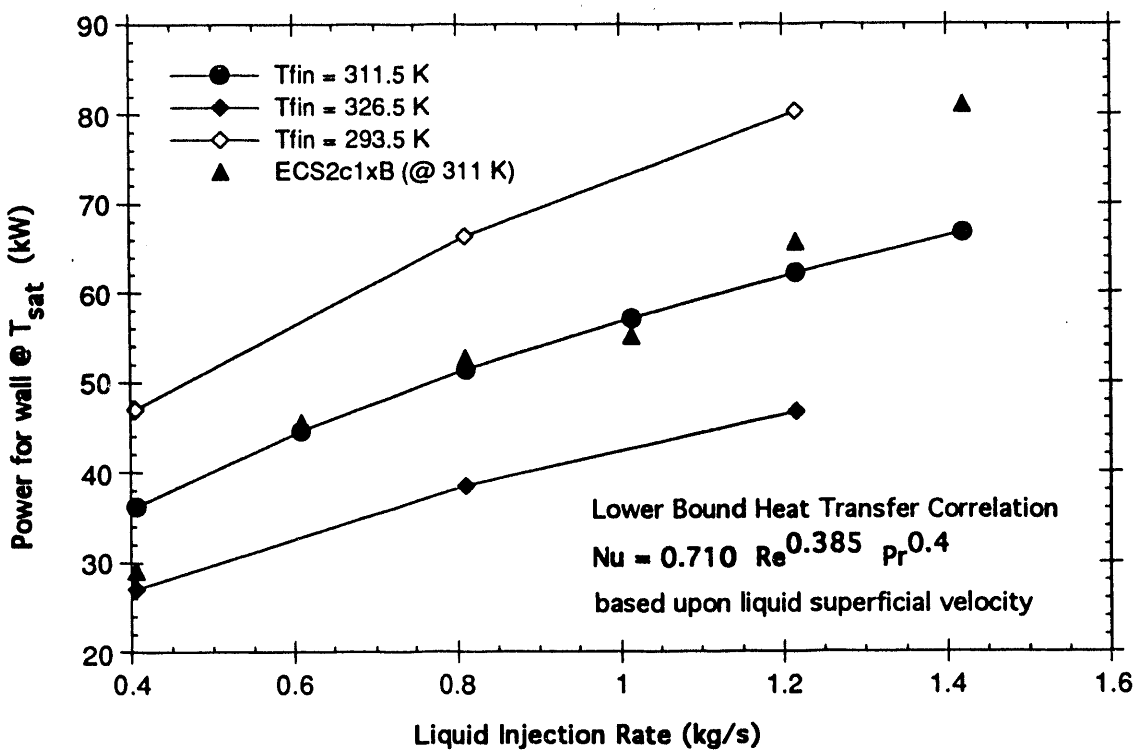


Figure 4.19 Comparison of power required to raise ECS-2c heater surface to saturation temperature for 3 inlet temperatures.

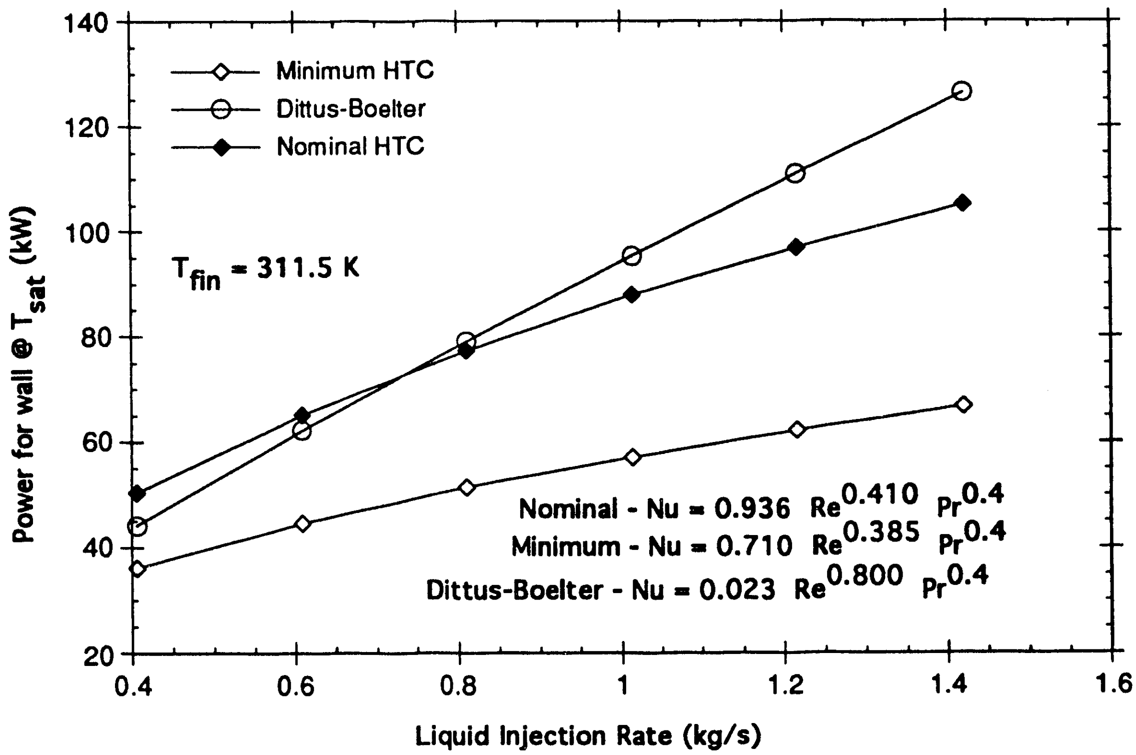


Figure 4.20 Comparison of powers required to raise ECS-2c heater to saturation temperature using nominal, minimum, and Dittus-Boelter HTC correlations.

5. SUMMARY AND CONCLUSIONS

The ECS-2c experiments were performed to provide a large data set for determining the maximum power for the wall at saturation temperature, and for determination of possible power effects upon the thermocouple readings. These tests were performed at the same conditions as the ECS-2b series, with the exception that the maximum measured aluminum temperature was used for determining when the test criteria had been satisfied (as opposed to the average at each axial location used during the ECS-2b series), and each test point was performed at the nominal power and ±10% variation from the nominal power. Because of the use of a single thermocouple for determining when the test criteria was satisfied, and the large temperature fluctuations occurring during the test, there is a large uncertainty in the power at which the wall temperature reached the liquid saturation temperature.

Subsequent tests and analysis have determined that use of a single thermocouple for determining the peak temperature is not justified for the ECS-2c test section. Use of the azimuthal averaged temperature at each axial location is recommended.

It has been proposed that a correction, based upon single phase liquid test data and the total test section power, be applied to the thermocouple data for removal of the azimuthal variations. However, a physical explanation for the observed azimuthal variation has not been proposed that explains the data. Without a plausible explanation for the observed variation it is not recommended that the power correction methodology be applied to the ECS-2 data.

A heat transfer correlation, based upon the liquid superficial velocity and the azimuthal averaged thermocouple readings at each axial level, has been developed using the ECS-2c data. This correlation is given by,

$$Nu = 0.936\ (\pm 0.227)\ Re^{0.410\ (\pm 0.025)}\ Pr^{0.4}. \qquad (1)$$

The effect of the ± 10% variation in power at a set of conditions had a minimal effect (<5%) upon the average heat transfer coefficients at an axial location. The influence of air entrainment upon the heat transfer coefficients appears to be small, and is included in the presented heat transfer correlation. The uncertainties in the calculated HTCs were too large to ascertain the effect of the axial power profile upon the HTCs. However, the major effect of the chopped cosine axial power profile was that, as expected, the maximum surface temperatures occurred at the bottom of the high power zone (Level 6) or, at low flowrates, at the bottom of the next lower power zone (Level 7). The location of the maximum surface temperature is a combination of high heat flux and high liquid enthalpy, and is primarily a function of the inlet flowrate and temperature. A secondary effect is the back pressure (standpipe level), which, in combination with the flowrate and temperature, determines the level of the pool in the test section. At lower flowrates, this pool is quasi-quiescent, with a level approximately that of the standpipe, and significantly effects the HTC for the submerged area of the heater. At higher flowrates, the pool may not exist due to nearly uniform mixing of air and water throughout the test section, or, if a higher density (lower void fraction) zone does exist, the level of the interface will be significantly below the level in the standpipe. Thus, the effect of the standpipe level upon the heat transfer rates is minimized at higher flowrates.

6. REFERENCES

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APPENDIX A

CHRONOLOGICAL SEQUENCE OF ECS-2 EXPERIMENTS

APPENDIX A

CHRONOLOGICAL SEQUENCE OF ECS-2 EXPERIMENTS

DATE	TEST ID	CONDITIONS / COMMENTS
10/12/89	TESTSO_1	Pre-SO checkout of thermocouples
10/13/89	SOTEST_A	Hot water bottom fill checkout of DP's & TC's
10/16/89	ISOTHERM	Isothermal checkout of thermocouples
	SOTEST_B	Flow control checkout
10/17/89	SOTEST_C	Final SO test to checkout power and controls Crack in heater assembly - repaired but lost some TC's
10/21/89		Modified POSTASC to remove zero data at end of file and add title and date/time to file
	*** First 2-ft sample piece for checkout of weld repair techniques to be used on ECS-2 heater ***	
10/21/89	SAMP_1	Flow @ 1 L/s, step power up to 28 kW - 4 pin holes in welds
	SAMP_2	Flow @ 1 L/s, step power up to 30 kW & soaked
	SAMP_3	Flow @ 1 L/s, step power up to 39 kW & soaked
	SAMP_4	Flow @ 0.2, 0.1, & 0.05 L/s; step power up to 42, 45, & 20 kW, respectively, until dryout occurred at each flowrate.
	*** Second sample piece ***	
11/2/89	SAMP_2_1	Flow @ 1.1 L/s, step power up to 27 kW
	SAMP_2_2	Flow @ .45 L/s, step power up to 50 kW
	SAMP_2_3	Flow @ .43 L/s, step power up to 47 kW
	SAMP_2_4	Flow @ .43 L/s, step power up to 16 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	SAMP_2_5	Flow @ .44 L/s, step power up to 53 kW - Inconel heater failed by melting
		*** Heater assembly repaired and ready for continuation of experiments - lost all TI_A_d_x and TI_C_p_x thermocouples ***
11/22/89	THERM_1	Thermal cycle of heater with 0.8 L/s flow, up to 160 kW - Pinhole leak @ 60" in Subchannel A observed
	THERM_2	Power ramp to 150 kW and manual trip - data apparently not stored
	THERM_3	Repeat

*** Third 2 foot sample piece tests (for DHA experiments) ***

DATE	TEST ID	CONDITIONS / COMMENTS
12/5/89	SAMP_3_1	Flow @ 0.400 L/s, power up to 17 kW
	SAMP_3_2	Flow @ 0.400 L/s, power up to 27 kW
	SAMP_3_3	Flow @ 0.086 L/s, power up to 28 kW, no dryout observed
12/13/89	ISO_B_1	Isothermal checkout of thermocouples
	SO_B_2	Flow control checkout
12/14/89	SO_B_1	Hot water bottom fill for checkout of TC's and DP's
	SO_B_1D	Drain following SO_B_1
	SO_B_3	Powered checkout of system
12/15/89	BL_12	Q_{in}=0.5 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}= kW
	BL_13	Q_{in}=0.7 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}=100 kW
	BL_14	Q_{in}=0.9 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}=110 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	BL_5	Q_{in}=0.1 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=54.0 kW
	BL_6	Q_{in}=0.5 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}=97.5 kW
		*** Melted Lexan tube, replaced 6-foot section over highest power zones with aluminum tube ***
12/18/89		New Semiscale rod inserted inside of heater, new TC ID's
12/19/89	ISO_C_1	Isothermal checkout of TC's
	SO_C_1	Hot water bottom fill and drain
	BL_5b	Q_{in}=0.1 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=50 kW
		*** Repeated BL_5 to determine effect (if any) of aluminum - insulated aluminum to improve energy balance
	BL_7	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=90 kW
	BL_26	Q_{in}=0.3 L/s; T_{in}=324 K; L_{sp}=80 cm; P_{dryout}=92.5 kW
	BL_27	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=80 cm; P_{dryout}=92.5 kW
	BL_22	Q_{in}=0.3 L/s; T_{in}=324 K; L_{sp}=112 cm; P_{dryout}=70 kW
12/20/89	BL_23	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=112 cm; P_{dryout}=102.5 kW
	BL_17	Q_{in}=0.3 L/s; T_{in}=324 K; L_{sp}=1715 cm; P_{dryout}=63.4 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	BL_18	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=1715 cm; P_{dryout}=97.5 kW *** Second Semiscale rod fails ***
	AIR INGRESS TESTS (Q_{in}=0 - 1.5 L/s)	
12/20/89	AI_5	T_{in}=324 K; L_{sp}=171 cm
	AI_6	T_{in}=324 K; L_{sp}=112 cm
12/21/89	BL_23b	Repeat of BL_23 for tour Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=112 cm; P_{dryout}=92.5 kW
	AI_7	T_{in}=324 K; L_{sp}=80 cm
	AI_8	T_{in}=324 K; L_{sp}=43 cm
	AI_12	T_{in}=346 K; L_{sp}=43 cm
	AI_11	T_{in}=346 K; L_{sp}=80 cm
12/22/89	AI_10	T_{in}=346 K; L_{sp}=112 cm
	AI_9	T_{in}=346 K; L_{sp}=171 cm
	AI_1	T_{in}=296 K; L_{sp}=171 cm
	AI_2	T_{in}=296 K; L_{sp}=112 cm
	AI_3	T_{in}=296 K; L_{sp}=80 cm
12/27/89	AI_4	T_{in}=296 K; L_{sp}=43 cm
	BL_1	Q_{in}=0.1 L/s; T_{in}=296 K; L_{sp}=43 cm; P_{dryout}=70.8 kW
12/29/89	BL_2	Q_{in}=0.3 L/s; T_{in}=296 K; L_{sp}=43 cm; P_{dryout}=101.6 kW
	BL_1b	Q_{in}=0.1 L/s; T_{in}=296 K; L_{sp}=43 cm; P_{dryout}=78.9 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	BL_7b	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=99.0 kW
	BL_5c	Q_{in}=0.1 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=48.0 kW
	BL_26b	Q_{in}=0.3 L/s; T_{in}=324 K; L_{sp}=80 cm; P_{dryout}=88.9 kW
	FC_1	Flow Coastdown - Q_{in}=0.126 L/s @ dryout; T_{in}=324 K; L_{sp}=80 cm; P_{dryout}=40 kW
	FC_2	Flow Coastdown - Q_{in}=0.274 L/s @ dryout; T_{in}=324 K; L_{sp}=80 cm; P_{dryout}=80 kW
	BL_11b	Q_{in}=0.3 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}=70.6 kW
	BL_12b	Q_{in}=0.5 L/s; T_{in}=346 K; L_{sp}=43 cm; P_{dryout}=96.2 kW
1/10/90	BL_5d	Q_{in}=0.1 L/s; T_{in}=324 K; L_{sp}=43 cm; P_{dryout}=50.3 kW
	BL_18b	Q_{in}=0.5 L/s; T_{in}=324 K; L_{sp}=171 cm; P_{dryout}=98.8 kW
1/15/90		*** Discovered a factor of 2 (high) problem with load cell on weigh tank - corrected
	WSR0380	Q_{in}=0.380L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=101 kW
1/16/90	WSR0580	Q_{in}=0.580L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=121.2 kW
	WSR0580b	Repeat at smaller power steps - Lost data off of DAS

DATE	TEST ID	CONDITIONS / COMMENTS
		Q_{in}=0.580L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=111.1 kW
	WSR0580c	Q_{in}=0.580L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=111.3 kW
	WSR0760	Q_{in}=0.760L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=126.6 kW
	WSR0960	Q_{in}=0.960L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=162.5 kW
1/17/90	WSR1040	Q_{in}=1.040 L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=161.7 kW *** TI_D_u_7 failed open and tripped power
	WSR1040b	Q_{in}=1.040 L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=161.8 kW
	WSR1340	Q_{in}=1.340 L/s; T_{in}=315 K; L_{sp}=109 cm; P_{dryout}=171.4 kW *** Heater failed prior to dryout ***

*** Continued ECS-2 experiments with the DHA heater assembly - Designated as ECS-2b ***

DATE	TEST ID	CONDITIONS / COMMENTS
3/5/90		Thermal cycles of new heater
	THERM_4	Q = 1 L/s; Step power up to 120 kW and manually trip power
	THERM_5	Repeat *** A few pinholes were discovered in welds - these were repaired
3/14/90	SO_3_A	Hot water bottom fill and drain

DATE	TEST ID	CONDITIONS / COMMENTS
		*** ALUMINUM WALL AT TSAT CRITERIA SERIES ***
3/16/90	ECS2b11	Q_{in}=0.406 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=47.2 kW
	ECS2b12	Q_{in}=0.609 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=66.9 kW
	ECS2b13	Q_{in}=0.811 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=80.9 kW
	ECS2b14	Q_{in}=1.015 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=88.8 kW
	ECS2b15	Q_{in}=1.217 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=99.4 kW
	ECS2b16	Q_{in}=1.420 L/s; T_{in}=315 K; L_{sp}=48.3 cm; P_{Tsat}=110.6 kW
	ECS2b23	Q_{in}=0.406 L/s; T_{in}=294 K; L_{sp}=0 cm; P_{Tsat}=62.7 kW
	ECS2b33	Q_{in}=0.811 L/s; T_{in}=294 K; L_{sp}=0 cm; P_{Tsat}=103.5 kW
	ECS2b43	Q_{in}=1.210 L/s; T_{in}=294 K; L_{sp}=0 cm; P_{Tsat}=6122.6 kW
	ECS2b24	Q_{in}=0.406 L/s; T_{in}=297 K; L_{sp}=139.7 cm; P_{Tsat}=81.0 kW
	ECS2b34	Q_{in}=0.811 L/s; T_{in}=297 K; L_{sp}=139.7 cm; P_{Tsat}=105.7 kW
	ECS2b44	Q_{in}=1.210 L/s; T_{in}=297 K; L_{sp}=139.7 cm; P_{Tsat}=121.4 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	ECS2b22	Q_{in}=0.406 L/s; T_{in}=326 K; L_{sp}=139.7 cm; P_{Tsat}=48.2 kW
	ECS2b32	Q_{in}=0.811 L/s; T_{in}=326 K; L_{sp}=139.7 cm; P_{Tsat}=65.9 kW
	ECS2b42	Q_{in}=1.217 L/s; T_{in}=326 K; L_{sp}=139.7 cm; P_{Tsat}=70.0 kW
	ECS2b21	Q_{in}=0.406 L/s; T_{in}=326 K; L_{sp}=0 cm; P_{Tsat}=37.4 kW
	ECS2b31	Q_{in}=0.811 L/s; T_{in}=326 K; L_{sp}=0 cm; P_{Tsat}=62.4 kW
	ECS2b41	Q_{in}=1.217 L/s; T_{in}=326 K; L_{sp}=0 cm; P_{Tsat}=77.9 kW
	*** LIQUID FULL TESTS **	
4/5/90	LF_1	Q_{in}=0.406 L/s; T_{in}=296 K; L_{sp}=483 cm; P_{Tsat}=47.1 kW
	LF_2	Q_{in}=0.609 L/s; T_{in}=296 K; L_{sp}=483 cm; P_{Tsat}=57.4 kW
	LF_3	Q_{in}=1.014 L/s; T_{in}=296 K; L_{sp}=483 cm; P_{Tsat}=63.7 kW
	LF_4	Q_{in}=1.420 L/s; T_{in}=296 K; L_{sp}=483 cm; P_{Tsat}=69.3 kW
	*** AIR POWER PULSE TESTS ***	
	APP_1	P = 20 kW
	APP_2	Repeat
	*** ECS-2C TEST SERIES ***	
6/13/90	SO_4_A	Hot water bottom fill DP and TC checkout

DATE	TEST ID	CONDITIONS / COMMENTS
6/14/90	ECS2c11b	Q_{in}=0.405 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=26.9 kW
	ECS2c11a	Q_{in}=0.405 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 24.2 kW
	ECS2c11c	Q_{in}=0.405 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 29.6 kW
	ECS2c12b	Q_{in}=0.605 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=44.9 kW
	ECS2c12a	Q_{in}=0.605 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 40.9 kW
	ECS2c12c	Q_{in}=0.605 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 49.4 kW
	ECS2c13b	Q_{in}=0.815 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=52.1 kW
	ECS2c13a	Q_{in}=0.815 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 46.7 kW
	ECS2c13c	Q_{in}=0.815 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 57.5 kW
	ECS2c14b	Q_{in}=1.02 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=54.3 kW
	ECS2c14a	Q_{in}=1.02 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 48.8 kW
	ECS2c14c	Q_{in}=1.02 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 59.5 kW
6/18/90	ECS2c15b	Q_{in}=1.22 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=64.4 kW
	ECS2c15a	Q_{in}=01.22 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 57.9 kW
	ECS2c15c	Q_{in}=1.22 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 70.9 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	PWRTRIP	Power trip from ECS2c15c final conditions, for thermocouple checkout
	ECS2c16b	Q_{in}=1.42 L/s; T_{in}=311 K; L_{sp}=48 cm; P_{Tsat}=79.5 kW
	ECS2c16a	Q_{in}=1.42 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 71.4 kW
	ECS2c16c	Q_{in}=1.42 L/s; T_{in}=311 K; L_{sp}=48 cm; P = 87.5 kW
	ECS2c22b	Q_{in}=0.402 L/s; T_{in}=327 K; L_{sp}=140 cm; P_{Tsat}=41.5 kW
	ECS2c22c	Q_{in}=0.402 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 45.6 kW
	ECS2c22a	Q_{in}=0.402 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 37.2 kW
	ECS2c32e	Q_{in}=0.610 L/s; T_{in}=327 K; L_{sp}=140 cm; P_{Tsat}=45.9 kW
	ECS2c32d	Q_{in}=0.610 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 41.3 kW
	ECS2c32f	Q_{in}=0.610 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 50.5 kW
6/20/90	ECS2c32b	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=140 cm; P_{Tsat}=44.4 kW
	ECS2c32a	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 40.0 kW
	ECS2c32c	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 48.8 kW
	ECS2c42b	Q_{in}=1.217 L/s; T_{in}=327 K; L_{sp}=140 cm; P_{Tsat}=48.0 kW
	ECS2c42a	Q_{in}=1.217 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 43.3 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	ECS2c42c	Q_{in}=1.271 L/s; T_{in}=327 K; L_{sp}=140 cm; P = 52.9 kW
	ECS2c21b	Q_{in}=0.403 L/s; T_{in}=327 K; L_{sp}=0 cm; P_{Tsat}=25.6 kW
	ECS2c21a	Q_{in}=0.406 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 22.9 kW
	ECS2c21c	Q_{in}=0.406 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 28.0 kW
	ECS2c31b	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=0 cm; P_{Tsat}=29.4 kW
	ECS2c31a	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 26.6 kW
	ECS2c31c	Q_{in}=0.811 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 32.6 kW
6/21/90	ECS2c41b	Q_{in}=1.217 L/s; T_{in}=327 K; L_{sp}=0 cm; P_{Tsat}=51.6 kW
	ECS2c41a	Q_{in}=1.217 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 46.5 kW
	ECS2c41c	Q_{in}=1.271 L/s; T_{in}=327 K; L_{sp}=0 cm; P = 57.0 kW
	ECS2c23b	Q_{in}=0.406 L/s; T_{in}=295 K; L_{sp}=0 cm; P_{Tsat}=38.6 kW
	ECS2c23a	Q_{in}=0.406 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 34.6 kW
	ECS2c23c	Q_{in}=0.406 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 42.5 kW
	ECS2c33b	Q_{in}=0.811 L/s; T_{in}=295 K; L_{sp}=0 cm; P_{Tsat}=72.4 kW
	ECS2c33a	Q_{in}=0.811 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 65.2 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	ECS2c33c	Q_{in}=0.811 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 79.6 kW
	ECS2c43b	Q_{in}=1.217 L/s; T_{in}=295 K; L_{sp}=0 cm; P_{Tsat}=88.7 kW
	ECS2c43a	Q_{in}=1.217 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 79.7 kW
	ECS2c43c	Q_{in}=1.217 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 97.7 kW
6/25/90	ECS2c24b	Q_{in}=0.406 L/s; T_{in}=293 K; L_{sp}=140 cm; P_{Tsat}=64.2 kW
	ECS2c24a	Q_{in}=0.406 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 57.8 kW
	ECS2c24c	Q_{in}=0.406 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 70.6 kW
	ECS2c34b	Q_{in}=0.811 L/s; T_{in}=293 K; L_{sp}=140 cm; P_{Tsat}=75.9 kW
	ECS2c34a	Q_{in}=0.811 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 68.0 kW
	ECS2c34c	Q_{in}=0.811 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 83.5 kW
	ECS2c44b	Q_{in}=1.217 L/s; T_{in}=293 K; L_{sp}=140 cm; P_{Tsat}=87.8 kW
	ECS2c44a	Q_{in}=1.217 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 78.7 kW
	ECS2c44c	Q_{in}=1.217 L/s; T_{in}=293 K; L_{sp}=140 cm; P = 96.6 kW
	ECS2c33P	Repeat of 33 to give info on air ingress - 10 kW power steps Q_{in}=0.811 L/s; T_{in}=295 K; L_{sp}=0 cm; P = 100 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	LF_FLOW	Liquid full, no power, step flow from 0 - 1.217 L/s - 0 for info on hydraulic resistances
	LFPP_1	Liquid full power pulse @ 20 kW until boiling occurred
6/26/90	APP_3	Air power pulse @ 20 kW
		*** Replaced Lexan shroud with aluminum tube over 3 highest power zones prior to performing excursion tests ***
	*** ECS-2cE EXCURSION TESTS ***	
6/27/90	SO_5_A	Hot water bottom fill
	ECS2cE21	Q_{in} = 0.406 L/s; T_{in} = 326 K; L_{sp} = 0 cm; P_{dryout} = 81.9 kW
	ECS2cE31	Q_{in} = 0.811 L/s; T_{in} = 326 K; L_{sp} = 0 cm; P_{dryout} = 132.2 kW
	ECS2cE22	Q_{in} = 0.406 L/s; T_{in} = 326 K; L_{sp} = 140 cm; P_{dryout} = 73.1 kW
	ECS2cE32	Q_{in} = 0.811 L/s; T_{in} = 326 K; L_{sp} = 140 cm; P_{dryout} = 96.2 kW
	ECS2cE42	Q_{in} = 1.217 L/s; T_{in} = 326 K; L_{sp} = 140 cm; P_{dryout} = 117.2 kW
	ECS2cE11	Q_{in} = 0.406 L/s; T_{in} = 311 K; L_{sp} = 48 cm; P_{dryout} = 93.3 kW
	ECS2cE12	Q_{in} = 0.609 L/s; T_{in} = 311 K; L_{sp} = 48 cm; P_{dryout} = 124.2 kW
	ECS2cE13	Q_{in} = 0.811 L/s; T_{in} = 311 K; L_{sp} = 48 cm; P_{dryout} = 143.5 kW
7/3/90	ECS2cE24	Q_{in} = 0.406 L/s; T_{in} = 293 K; L_{sp} = 140 cm; P_{dryout} = 113.8 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	ECS2cE34	Q_{in} = 0.811 L/s; T_{in} = 293 K; L_{sp} = 140 cm; P_{dryout} = 150.2 kW
	ECS2cE23	Q_{in} = 0.406 L/s; T_{in} = 293 K; L_{sp} = 0 cm; P_{dryout} = 115.7 kW
	ECS2cE33	Q_{in} = 0.811 L/s; T_{in} = 293 K; L_{sp} = 0 cm; P =150.2 kW *** No dryout - no data file recorded
	ECS2cE14	Q_{in} = 1.014 L/s; T_{in} = 311 K; L_{sp} = 48 cm; P_{dryout} = 149.8 kW

*** LIQUID FULL TESTS - LFb (L_{sp} = 580 cm; T_{in} = 311 K) ***

8/13/90	LFb_1a	Q_{in} = 0.4 L/s; P =0 kW
	LFb_1b	Q_{in} = 0.4 L/s; P =10.3 kW
	LFb_11	Q_{in} = 0.4 L/s; P =20.3 kW
	LFb_12	Q_{in} = 0.4 L/s; P =50.8 kW
	LFb_13	Q_{in} = 0.4 L/s; P =75.8 kW
	LFb_2a	Q_{in} = 0.6 L/s; P =0 kW
	LFb_21	Q_{in} = 0.6 L/s; P =20.3 kW
	LFb_22	Q_{in} = 0.6 L/s; P =50.5 kW
	LFb_23	Q_{in} = 0.6 L/s; P =75.9 kW
	LFb_24	Q_{in} = 0.6 L/s; P =100.6 kW
8/14/90	LFb_3a	Q_{in} = 0.8 L/s; P =0 kW
	LFb_31	Q_{in} = 0.8 L/s; P =20.3 kW
	LFb_32	Q_{in} = 0.8 L/s; P =50.5 kW
	LFb_33	Q_{in} = 0.8 L/s; P =76.2 kW
	LFb_34	Q_{in} = 0.8 L/s; P =100.4 kW

DATE	TEST ID	CONDITIONS / COMMENTS
	LFb_35	Q_{in} = 0.8 L/s; P =126.1 kW
	LFb_34d	Q_{in} = 0.8 L/s; P =100.5 kW
	LFb_33d	Q_{in} = 0.8 L/s; P =76.3 kW
	LFb_32d	Q_{in} = 0.8 L/s; P =50.5 kW
	LFb_31d	Q_{in} = 0.8 L/s; P =20.5 kW
	LFb_3ad	Q_{in} = 0.8 L/s; P =0 kW
	LFb_41	Q_{in} = 1.0 L/s; P =20.5 kW
	LFb_42	Q_{in} = 1.0 L/s; P =50.4 kW
	LFb_43	Q_{in} = 1.0 L/s; P =76.1 kW
	LFb_44	Q_{in} = 1.0 L/s; P =100.3 kW
	LFb_45	Q_{in} = 1.0 L/s; P =126.2 kW
	LFb_46	Q_{in} = 1.0 L/s; P =150.1 kW
	LFb_51	Q_{in} = 1.23 L/s; P =20.3 kW
	LFb_52	Q_{in} = 1.23 L/s; P =50.2 kW
	LFb_53	Q_{in} = 1.23 L/s; P =75.8 kW
	LFb_54	Q_{in} = 1.23 L/s; P =99.6 kW
	LFb_55	Q_{in} = 1.23 L/s; P =125.3 kW
	LFb_56	Q_{in} = 1.23 L/s; P =149.8 kW
	LFb_61	Q_{in} = 1.4 L/s; P =20.4 kW
	LFb_62	Q_{in} = 1.4 L/s; P =50.0 kW
	LFb_63	Q_{in} = 1.4 L/s; P =75.7 kW
	LFb_64	Q_{in} = 1.4 L/s; P =99.5 kW
	LFb_65	Q_{in} = 1.4 L/s; P =124.6 kW
	LFb_66	Q_{in} = 1.4 L/s; P =149.7 kW
	LFb_6a	Q_{in} = 1.4 L/s; P =0 kW
	*** SUBMERGENCE TESTS ***	
3/4/91	ISOTHERM	Isothermal checkout of thermocouples
	SO_S_1	Fill and drain checkout test

DATE	TEST ID	CONDITIONS / COMMENTS
	SO_S_2	Flowmeter SO checkout test
	SUB_P_1	Power pulse @ 20 kW, no flow
	SUB_P_2	No flow test - stepped power up to 50.3 kW
	SUB_P_3	No flow test - stepped power up to 75.7 kW
	SUB_P_4	No flow test - stepped power up to 100.8 kW
	SUB_F_1	Q_{in} = 0.406 L/s; T_{in} = 312 K; Stepped power up to 120 kW (in 20 kW increments) and back down
3/6/91	SUB_P_5	No flow test - stepped power up to 125.1 kW
	SUB_P_6	No flow test - stepped power up to 149.7 kW

APPENDIX B

MISCELLANEOUS MEASUREMENTS FROM THE LOG BOOKS

APPENDIX B

MISCELLANEOUS MEASUREMENTS FROM THE LOG BOOKS

The following are tabulations of miscellaneous measurements recorded in the three log books from the ECS-2 experiments (References [1], [2], and [3]). Included are measurements of the water Ph (measured using A Cole-Palmer model 5985-80 Ph meter) and daily barometric pressure (from the standards and calibration laboratory).

TABLE B-1 PH Readings

DATE	TIME	PH	DATE	TIME	PH
12/14/89	14:08	7.45	6/20/90	10:10	7.39
12/15/89		7.60		13:07	7.07
12/16/89		6.50	6/21/90	9:14	7.15
12/19/89	16:51	7.94	6/25/90	9:40	7.00
12/20/89	8:43	7.91		11:02	6.75
12/22/89	9:20	7.19		13:21	6.63
	14:30	6.25	6/27/90	15:52	7.26
12/29/89	9:07	8.12	6/28/90	7:40	6.30
	13:09	6.82		9:54	7.38
1/15/90	14:25	7.68		10:47	7.15
6/14/90	10:11	6.95	7/3/90	13:36	7.20
	14:25	7.04	3/4/91	11:22	6.48
6/18/90	9:08	7.90			
	10:50	7.52			
	14:50	7.45			

Table B-2 Barometric pressure measurements from the Standards and Calibration Laboratory, compared to measurements form the electronic barometer (P_ATM).

DATE	TIME	PRESSURE (kPa) STDS. LAB	P ATM
12/20/89	8:45	85.06	85.4
12/21/89	14:10	85.17	85.60
12/22/89	9:20	86.1	86.4
12/29/89	9:33	85.2	85.3
1/16/90	8:00	84.37	
1/17/90	8:00	84.83	
4/5/90	8:09	84.62	84.9
6/12/90	9:00	84.71	84.94
6/14/90	7:50	84.22	84.52
6/18/90	9:00	84.69	85.0
6/21/90	9:20	85.11	85.52
6/25/90	7:50	84.83	85.24
6/27/90	8:10	84.51	84.94
7/3/90	8:22	85.00	84.76
8/13/90	11:42	85.44	85.10
8/14/90	8:35	85.11	85.36

REFERENCES

[1] J. L. Anderson, K. G. Condie, and T. K. Larson, "Savannah River Site ECS-2 Downflow Heat Transfer Experiments - Experiment Log Book," Volume 1 of 3, INEL-NBU-2205, 10/10/89 - 12/29/89,

[2] J. L. Anderson, K. G. Condie, and T. K. Larson, "Savannah River Site ECS-2 Downflow Heat Transfer Experiments - Experiment Log Book," Volume 2 of 3, INEL-NBU-2206, 12/29/89 - 6/28/90.

[3] J. L. Anderson, K. G. Condie, and T. K. Larson, "Savannah River Site ECS-2 Downflow Heat Transfer Experiments - Experiment Log Book," Volume 3 of 3, INEL-NBU-2207, 6/28/90 - 3/6/91.

APPENDIX C

MEASUREMENTS LIST
FOR ECS-2C EXPERIMENTS

APPENDIX C

MEASUREMENTS LIST FOR ECS-2C EXPERIMENTS

Common practice established during the conduct of the ECS-2c test series was to use a shorthand notation called the "DAS tag ID" when referring to a particular measurement. Since this practice was also utilized throughout the main body of this report, it is prudent to provide reference information regarding the relationship between the DAS Tag ID, measurement location, and so forth. This appendix provides such documentation for historical preservation.

The measurements used on a typical ECS-2c heat transfer experiment are listed on the attached tables. Columns in this measurements list contain the tag name used in the data acquisition system that is associated with the measurement identification, the type of measurement being made, the physical location of the measurement in the test section (or on the facility), the test section fluid subchannel where the measurement is located (if applicable), and the range over which the measurement was specified to operate.

Table C-1. Measurements List for the ECS-2c experiments

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
P_ATM	Absolute Pressure	Building		0-200 kPa
P_IN	Absolute Pressure	Top of Inlet Plenum		0-200 kPa
P_B_0	Absolute Pressure	Top of Heated Length	A	0-200 kPa
P_B_76	Absolute Pressure	Middle of Heated Length	A	0-200 kPa
P_B_96	Absolute Pressure	Middle of Heated Length	A	0-200 kPa
P_B_150	Absolute Pressure	Bottom of Heated Length	A	0-200 kPa
P_OUT	Absolute Pressure	Bottom of Outlet Plenum @ 174"		0-200 kPa
DP_PL_IN	Differential Pressure	Across Inlet Plenum (-72" to -64")		0-32 kPa
DP_A_1	Differential Pressure	Inlet Plenum to Top of Heated Length	A	0-256 kPa
DP_A_2	Differential Pressure	Top of Heated Length	A	0-304 kPa
DP_A_3	Differential Pressure	Bottom of Heated Length	A	0-256 kPa
DP_A_4	Differential Pressure	Bottom of Heated Length to Top of Outlet Plenum	A	0-52 kPa
DP_C_2	Differential Pressure	Top of Heated Length	C	0-304 kPa
DP_C_3	Differential Pressure	Bottom of Heated Length	C	0-256 kPa
DP_PL_OU	Differential Pressure	Across Outlet Plenum (163" to 174")		0-44 kPa
DP_SP	Differential Pressure	Across StandPipe		0-480 kPa

Table C-1. Measurements List (cont.)

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
Q_W_IN_L	Liquid Flowmeter	Inlet to T/S		0-0.3 L/s
Q_W_IN_H	Liquid Flowmeter	Inlet to T/S		0.3-1.5 L/s
Q_W_CC	Liquid Flowmeter	Inlet to Lower Plenum Cooling Coil		0-0.3 L/s
Q_A_IN	Air Flowmeter	Inlet to T/S		0-50 SLPM
Q_A_OUT	Air Flowmeter	Inlet to T/S		0-50 SLPM
V_INNER	Voltage	Inner Heater		0-50 V
I_INNER	Current	Inner Heater		0-2700 amps
TF_W_IN	Fluid TC	Inlet Water		273-821 K
TF_IN	Fluid TC	Bottom of Inlet Plenum		273-821 K
TF_OUT	Fluid TC	Bottom of Outlet Plenum		273-821 K
TF_A_IN	Fluid TC	Inlet Air		273-821 K
TF_A_OUT	Fluid TC	Outlet Air		273-821 K
TF_CC_IN	Fluid TC	Inlet to Lower Plenum Cooling Coil		273-821 K
TF_CC_OU	Fluid TC	Outlet to Lower Plenum Cooling Coil		273-821 K
TF_HX_OU	Fluid TC	Outlet of the 10 coil Heat Exchanger		273-821 K
TF_SP	Fluid TC	StandPipe @ 174" from top of heated length		273-821 K

Table C-1. Measurements List (cont.)

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
TF_A_1	Fluid TC	Coolant Channel 3 @ 52"	A	273-821 K
TF_B_1	Fluid TC	Coolant Channel 3 @ 52"	B	273-821 K
TF_C_1	Fluid TC	Coolant Channel 3 @ 52"	C	273-821 K
TF_D_1	Fluid TC	Coolant Channel 3 @ 52"	D	273-821 K
TF_A_2	Fluid TC	Coolant Channel 3 @ 76"	A	273-821 K
TF_B_2	Fluid TC	Coolant Channel 3 @ 76"	B	273-821 K
TF_C_2	Fluid TC	Coolant Channel 3 @ 76"	C	273-821 K
TF_D_2	Fluid TC	Coolant Channel 3 @ 76"	D	273-821 K
TF_A_3	Fluid TC	Coolant Channel 3 @ 96"	A	273-821 K
TF_B_3	Fluid TC	Coolant Channel 3 @ 96"	B	273-821 K
TF_C_3	Fluid TC	Coolant Channel 3 @ 96"	C	273-821 K
TF_D_3	Fluid TC	Coolant Channel 3 @ 96"	D	273-821 K
TF_A_4	Fluid TC	Coolant Channel 3 @ 117"	A	273-821 K
TF_B_4	Fluid TC	Coolant Channel 3 @ 117"	B	273-821 K
TF_C_4	Fluid TC	Coolant Channel 3 @ 117"	C	273-821 K
TF_D_4	Fluid TC	Coolant Channel 3 @ 117"	D	273-821 K

Table C-1. Measurements List (cont.)

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
TF_A_5	Fluid TC	Coolant Channel 3 @ 150"	A	273-821 K
TF_B_5	Fluid TC	Coolant Channel 3 @ 150"	B	273-821 K
TF_C_5	Fluid TC	Coolant Channel 3 @ 150"	C	273-821 K
TF_D_5	Fluid TC	Coolant Channel 3 @ 150"	D	273-821 K
TI_A_d_1	Metal TC	Inner Coolant Wall @ 25"	A	273-821 K
TI_C_p_1	Metal TC	Inner Coolant Wall @ 25"	C	273-821 K
TI_A_d_2	Metal TC	Inner Coolant Wall @ 42.75"	A	273-821 K
TI_B_k_2	Metal TC	Inner Coolant Wall @ 42.75"	B	273-821 K
TI_C_p_2	Metal TC	Inner Coolant Wall @ 42.75"	C	273-821 K
TI_D_w_2	Metal TC	Inner Coolant Wall @ 42.75"	D	273-821 K
TI_A_d_3	Metal TC	Inner Coolant Wall @ 57.75"	A	273-821 K
TI_B_k_3	Metal TC	Inner Coolant Wall @ 57.75"	B	273-821 K
TI_C_p_3	Metal TC	Inner Coolant Wall @ 57.75"	C	273-821 K
TI_D_w_3	Metal TC	Inner Coolant Wall @ 57.75"	D	273-821 K
TI_A_d_4	Metal TC	Inner Coolant Wall @ 72.75"	A	273-821 K
TI_B_i_4	Metal TC	Inner Coolant Wall @ 72.75"	B	273-821 K

Table C-1. Measurements List (cont.)

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
TI_C_p_4	Metal TC	Inner Coolant Wall @ 72.75"	C	273-821 K
TI_D_u_4	Metal TC	Inner Coolant Wall @ 72.75"	D	273-821 K
TI_A_a_5	Metal TC	Inner Coolant Wall @ 87.75"	D/A	273-821 K
TI_A_d_5	Metal TC	Inner Coolant Wall @ 87.75"	A	273-821 K
TI_B_g_5	Metal TC	Inner Coolant Wall @ 87.75"	A/B	273-821 K
TI_B_i_5	Metal TC	Inner Coolant Wall @ 87.75"	B	273-821 K
TI_C_m_5	Metal TC	Inner Coolant Wall @ 87.75"	B/C	273-821 K
TI_C_p_5	Metal TC	Inner Coolant Wall @ 87.75"	C	273-821 K
TI_D_s_5	Metal TC	Inner Coolant Wall @ 87.75"	C/D	273-821 K
TI_D_u_5	Metal TC	Inner Coolant Wall @ 87.75"	D	273-821 K
TI_A_a_6	Metal TC	Inner Coolant Wall @ 99.75"	D/A	273-821 K
TI_A_c_6	Metal TC	Inner Coolant Wall @ 99.75"	A	273-821 K
TI_A_e_6	Metal TC	Inner Coolant Wall @ 99.75"	A	273-821 K
TI_B_g_6	Metal TC	Inner Coolant Wall @ 99.75"	A/B	273-821 K
TI_B_i_6	Metal TC	Inner Coolant Wall @ 99.75"	B	273-821 K
TI_B_k_6	Metal TC	Inner Coolant Wall @ 99.75"	B	273-821 K

Table C-1. Measurements List (cont.)

DAS Tag ID	Measurement Type	Measurement Location	Fluid Sub-Channel	Required Measurement Range
TI_C_m_6	Metal TC	Inner Coolant Wall @ 99.75"	B/C	273-821 K
TI_C_o_6	Metal TC	Inner Coolant Wall @ 99.75"	C	273-821 K
TI_C_q_6	Metal TC	Inner Coolant Wall @ 99.75"	C	273-821 K
TI_D_s_6	Metal TC	Inner Coolant Wall @ 99.75"	C/D	273-821 K
TI_D_u_6	Metal TC	Inner Coolant Wall @ 99.75"	D	273-821 K
TI_D_w_6	Metal TC	Inner Coolant Wall @ 99.75"	D	273-821 K
TI_A_a_7	Metal TC	Inner Coolant Wall @ 118.88"	D/A	273-821 K
TI_A_d_7	Metal TC	Inner Coolant Wall @ 118.88"	A	273-821 K
TI_B_g_7	Metal TC	Inner Coolant Wall @ 118.88"	A/B	273-821 K
TI_B_k_7	Metal TC	Inner Coolant Wall @ 118.88"	B	273-821 K
TI_C_m_7	Metal TC	Inner Coolant Wall @ 118.88"	B/C	273-821 K
TI_C_p_7	Metal TC	Inner Coolant Wall @ 118.88"	C	273-821 K
TI_D_s_7	Metal TC	Inner Coolant Wall @ 118.88"	C/D	273-821 K
TI_D_w_7	Metal TC	Inner Coolant Wall @ 118.88"	D	273-821 K
TI_A_d_8	Metal TC	Inner Coolant Wall @ 141.69"	A	273-821 K
TI_C_p_8	Metal TC	Inner Coolant Wall @ 141.69"	C	273-821 K

APPENDIX D

ECS-2c DATA TABULATIONS

APPENDIX D

ECS-2c DATA TABULATIONS

Experiments conducted in the ECS-2c series were steady-state tests with constant boundary conditions. However, due to the fluctuating nature of the phenomena that was occurring, data averages are needed to facilitate use and interpretation of the data. Tables in this appendix present data averages computed for each measurement for each experiment conducted in the ECS-2c series. These averages were computed over a 100-200 second portion of the five minute period during which data was recorded by the data acquisition period. A listing of the tables follows.

LIST OF TABLES

Table D - 1. General Test Parameters.

TEST ID	Water Inlet Flowrate (L/s)	Superficial Velocity (m/s)	Water Inlet Temperatur (K)	Air Inlet Flowrate (Std. L/min)	Air Inlet Temperatur (K)	Stand Pipe Elevation (cm)	Total Test Section Power (kW)
ECS2c11A	0.401	0.30	311.0	00.3	290.7	335	26.09
ECS2c11B	0.401	0.30	310.8	00.3	290.5	335	29.11
ECS2c11C	0.401	0.30	310.6	00.2	290.9	335	31.98
ECS2c12A	0.601	0.45	312.0	01.2	291.1	333	40.93
ECS2c12B	0.601	0.45	311.1	01.2	291.1	334	45.47
ECS2c12C	0.600	0.45	311.5	01.0	291.3	334	49.93
ECS2c13A	0.816	0.61	311.3	03.4	291.5	331	47.37
ECS2c13B	0.816	0.61	311.2	03.3	291.3	332	52.72
ECS2c13C	0.816	0.61	312.0	04.4	291.9	332	58.35
ECS2c14A	1.020	0.77	311.2	12.8	292.4	329	49.64
ECS2c14B	1.020	0.77	310.6	11.8	292.3	329	55.12
ECS2c14C	1.021	0.77	311.9	12.2	292.5	329	60.51
ECS2c15A	1.226	0.92	311.0	22.7	294.0	322	59.15
ECS2c15B	1.226	0.92	311.1	22.9	293.4	323	65.72
ECS2c15C	1.225	0.92	311.3	22.8	294.4	323	72.17
ECS2c16A	1.434	1.08	310.8	30.5	295.4	321	72.89
ECS2c16B	1.431	1.08	311.6	28.8	295.3	321	81.10
ECS2c16C	1.439	1.08	310.2	30.1	295.8	321	89.41
ECS2c21A	0.398	0.30	325.5	00.1	298.7	378	23.73
ECS2c21B	0.399	0.30	325.3	00.1	298.7	379	26.46
ECS2c21C	0.398	0.30	324.8	00.0	299.0	380	28.91
ECS2c22A	0.393	0.30	327.6	00.0	298.4	238	38.10
ECS2c22B	0.398	0.30	327.8	00.0	298.0	240	42.38
ECS2c22C	0.398	0.30	326.4	00.0	298.2	240	46.66
ECS2c23A	0.403	0.30	293.1	04.8	298.1	378	35.75
ECS2c23B	0.403	0.30	293.3	04.7	297.9	378	39.80
ECS2c23C	0.403	0.30	292.9	04.7	298.4	378	43.73
ECS2c24A	0.409	0.31	294.0	00.3	299.9	239	58.15
ECS2c24B	0.409	0.31	293.8	00.2	299.4	239	64.33

Table D - 1 (cont.) General Test Parameters.

TEST ID	Water Inlet Flowrate (L/s)	Superficial Velocity (m/s)	Water Inlet Temperatur (K)	Air Inlet Flowrate (Std. L/min)	Air Inlet Temperatur (K)	Stand Pipe Elevation (cm)	Total Test Section Power (kW)
ECS2c24C	0.404	0.30	294.3	00.2	300.3	240	70.89
ECS2c31A	0.810	0.61	326.2	02.9	299.3	376	27.58
ECS2c31B	0.810	0.61	326.1	02.8	299.2	376	30.31
ECS2c31C	0.810	0.61	326.3	02.6	299.4	377	33.62
ECS2c32A	0.810	0.61	328.5	01.6	296.7	237	39.82
ECS2c32B	0.812	0.61	326.2	01.7	296.3	236	44.32
ECS2c32C	0.811	0.61	326.1	02.4	297.0	236	49.06
ECS2c32D	0.607	0.46	326.5	00.5	298.5	238	42.42
ECS2c32E	0.601	0.45	327.2	00.5	298.3	237	47.26
ECS2c32F	0.627	0.47	325.6	00.4	298.7	238	51.78
ECS2c33A	0.810	0.61	293.9	05.8	298.9	375	66.84
ECS2c33B	0.810	0.61	294.1	05.7	298.6	375	74.09
ECS2c33C	0.810	0.61	294.4	05.1	299.2	375	81.80
ECS2c34A	0.811	0.61	293.2	05.1	301.0	235	68.19
ECS2c34B	0.811	0.61	291.9	04.6	300.9	235	76.17
ECS2c34C	0.812	0.61	294.3	04.7	301.3	236	83.77
ECS2c41A	1.209	0.91	326.7	18.9	296.9	373	47.92
ECS2c41B	1.210	0.91	326.3	17.4	296.3	373	53.00
ECS2c41C	1.208	0.91	326.8	18.1	297.9	374	58.51
ECS2c42A	1.216	0.91	327.0	09.6	298.2	233	44.49
ECS2c42B	1.217	0.91	326.4	08.9	297.9	233	49.20
ECS2c42C	1.216	0.91	327.2	08.5	298.5	233	54.32
ECS2c43A	1.219	0.92	293.3	36.5	299.1	371	79.65
ECS2c43B	1.220	0.92	291.9	34.5	299.1	372	88.88
ECS2c43C	1.219	0.92	294.4	32.8	299.1	371	97.50
ECS2c44A	1.223	0.92	293.4	17.1	301.6	231	78.98
ECS2c44B	1.223	0.92	292.1	16.1	301.2	232	88.33
ECS2c44C	1.222	0.92	294.6	16.1	301.8	233	96.95

Table D - 2 Average Fluid Temperatures, Normalized to TF_W_IN.

TEST ID	Axial Position relative to top of Heated Length (cm)						
	-162.6	132.1	193	243.8	297.2	381	438.2
ECS2c11A	310.6	310.1	314.1	316.1	320.2	325.7	325.5
ECS2c11B	310.9	310.7	314.9	317.2	321.8	327.9	327.9
ECS2c11C	310.5	310.7	315.0	317.7	322.6	329.2	329.3
ECS2c12A	312.0	311.7	317.0	318.6	323.1	246.0	328.2
ECS2c12B	311.0	311.2	316.8	318.3	324.2	246.6	329.4
ECS2c12C	311.6	311.9	317.5	319.7	325.9	248.4	331.4
ECS2c13A	311.3	311.1	316.7	318.5	323.3	324.8	324.9
ECS2c13B	311.4	311.9	317.5	319.8	325.3	326.8	326.8
ECS2c13C	312.2	312.5	317.5	320.5	325.4	328.3	328.3
ECS2c14A	311.4	311.0	315.7	317.7	321.9	322.9	322.5
ECS2c14B	310.9	311.0	315.5	317.9	322.4	323.7	323.0
ECS2c14C	311.9	312.3	317.0	319.7	324.2	325.9	324.9
ECS2c15A	311.1	310.8	315.1	317.1	321.7	322.5	321.9
ECS2c15B	311.2	310.9	315.4	317.7	322.4	323.5	323.1
ECS2c15C	311.4	311.5	316.2	318.7	323.9	325.1	324.9
ECS2c16A	310.8	313.6	315.1	317.2	321.2	322.6	322.7
ECS2c16B	311.8	314.6	316.3	318.7	323.2	324.9	324.9
ECS2c16C	310.3	313.5	315.4	318.0	322.9	324.7	324.8
ECS2c21A	325.6	328.4	329.0	330.9	334.9	339.8	329.3
ECS2c21B	325.3	328.4	329.1	331.2	335.7	340.7	341.4
ECS2c21C	324.9	328.0	328.8	331.2	336.3	341.7	342.3
ECS2c22A	327.7	332.5	333.5	341.1	346.0	349.6	338.8
ECS2c22B	327.8	333.5	334.2	342.6	348.0	351.8	351.2
ECS2c22C	326.5	333.2	333.9	342.7	348.8	353.1	352.9
ECS2c23A	293.1	296.1	297.9	300.4	304.8	313.7	309.5
ECS2c23B	293.4	296.6	298.7	301.6	306.5	316.3	311.7
ECS2c23C	293.0	296.8	299.0	302.5	308.1	318.6	312.9
ECS2c24A	294.1	300.2	302.6	314.9	322.2	328.2	321.2
ECS2c24B	293.8	300.6	303.5	316.9	325.1	331.4	324.0
ECS2c24C	294.3	302.0	305.8	320.0	329.1	336.5	327.6

Table D - 2 (cont). Average Fluid Temperatures, Normalized to TF_W_IN.

TEST ID	Axial Position relative to top of Heated Length (cm)						
	-162.6	132.1	193	243.8	297.2	381	438.2
ECS2c31.A	326.4	357.4	328.7	330.2	333.4	334.4	333.8
ECS2c31B	326.3	335.4	329.7	330.9	334.3	335.6	334.6
ECS2c31C	326.5	364.3	331.4	332.5	335.7	337.0	336.2
ECS2c32A	328.5	330.8	333.9	336.2	338.6	339.9	339.8
ECS2c32B	326.2	328.9	332.4	334.8	337.3	339.0	339.1
ECS2c32C	326.2	329.7	330.7	333.2	337.9	340.2	340.4
ECS2c32D	326.7	329.7	333.4	337.0	340.5	342.8	342.8
ECS2c32E	327.4	330.6	333.8	338.6	342.5	345.1	344.7
ECS2c32F	325.7	329.5	333.1	337.9	342.1	345.0	344.9
ECS2c33A	293.9	297.7	300.7	303.8	309.5	311.5	309.8
ECS2c33B	294.0	298.5	301.9	305.5	311.6	313.5	311.7
ECS2c33C	294.4	299.4	302.8	306.5	313.2	316.0	313.7
ECS2c34A	293.2	299.2	300.2	303.5	309.8	313.3	310.1
ECS2c34B	291.9	297.9	299.7	304.2	310.5	314.1	311.0
ECS2c34C	294.4	301.3	302.5	306.7	313.4	319.0	315.4
ECS2c41A	327.0	329.1	330.3	332.1	335.7	336.0	336.1
ECS2c41B	326.6	328.9	330.4	332.4	336.1	336.7	337.0
ECS2c41C	327.0	329.5	331.0	333.1	337.4	337.9	338.1
ECS2c42A	327.2	329.2	330.5	332.2	335.6	335.6	335.5
ECS2c42B	326.5	328.8	330.3	332.1	336.1	335.8	335.6
ECS2c42C	327.3	329.9	331.8	333.9	338.0	337.2	337.2
ECS2c43A	293.5	296.4	298.4	300.9	306.0	307.9	305.9
ECS2c43B	291.9	295.3	297.6	300.4	306.0	308.2	306.4
ECS2c43C	294.4	298.2	300.7	303.9	310.1	312.4	309.8
ECS2c44A	293.4	296.9	299.0	301.8	306.3	308.3	306.5
ECS2c44B	292.2	295.9	298.5	301.8	306.9	309.3	307.1
ECS2c44C	294.5	299.1	301.7	305.2	310.8	313.4	311.0

Table D - 3. Fluid Temperatures at 132 and 193 cm.

TEST ID	Subchannel Temperatures @ 132 cm				Subchannel Temperatures @193 cm			
	A	B	C	D	A	B	C	D
ECS2c11A	315.0	311.5	314.1	300.5	313.9	313.8	315.7	314.3
ECS2c11B	316.3	311.9	314.8	300.7	314.8	314.3	316.5	315.0
ECS2c11C	316.4	311.7	314.7	300.6	315.1	314.4	316.5	314.9
ECS2c12A	315.9	312.5	316.2	303.1	314.9	314.3	318.1	321.9
ECS2c12B	315.2	311.5	315.9	303.1	314.4	313.2	317.6	323.0
ECS2c12C	316.2	312.5	317.0	302.7	315.3	315.3	319.4	321.2
ECS2c13A	313.6	311.4	316.3	304.0	313.3	312.8	318.2	323.8
ECS2c13B	314.0	312.0	318.5	303.9	313.6	314.1	320.0	323.6
ECS2c13C	319.5	314.8	315.4	301.2	316.8	317.8	319.2	317.4
ECS2c14A	316.0	313.6	314.1	301.3	314.4	315.4	317.9	316.1
ECS2c14B	316.7	313.4	313.9	300.8	314.3	316.1	317.9	314.9
ECS2c14C	318.4	314.8	315.1	301.6	315.8	317.6	319.5	316.3
ECS2c15A	315.4	313.2	313.4	301.9	314.0	315.1	316.8	315.4
ECS2c15B	316.0	313.3	313.4	301.8	314.5	315.3	317.1	315.8
ECS2c15C	316.6	313.9	314.1	302.4	315.1	316.0	318.1	316.7
ECS2c16A	315.3	313.2	313.4	313.2	314.3	314.8	316.6	315.7
ECS2c16B	316.4	314.2	314.4	314.2	315.2	316.2	318.0	316.8
ECS2c16C	315.4	313.0	313.4	313.1	314.4	315.2	317.1	315.9
ECS2c21A	328.6	326.2	331.5	328.1	327.9	328.1	331.8	329.3
ECS2c21B	328.3	325.9	332.5	327.8	327.9	327.9	332.4	329.2
ECS2c21C	328.2	325.1	332.1	327.3	327.6	327.8	332.2	328.9
ECS2c22A	333.5	329.7	337.3	330.4	331.5	333.0	337.8	332.6
ECS2c22B	334.8	329.8	339.8	330.6	332.4	333.5	339.0	333.2
ECS2c22C	334.4	328.8	340.9	329.4	331.8	333.3	339.1	332.3
ECS2c23A	296.3	294.7	297.9	296.1	297.4	297.4	300.3	297.9
ECS2c23B	296.7	295.1	298.9	296.6	298.0	298.0	301.3	298.6
ECS2c23C	297.1	295.2	299.5	296.2	298.7	298.3	301.6	298.3
ECS2c24A	302.6	296.5	304.3	298.3	303.8	300.8	305.5	301.5
ECS2c24B	302.6	296.8	305.6	298.4	305.0	301.6	306.6	301.9

Table D - 3 (cont.) Fluid Temperatures at 132 and 193 cm.

TEST ID	Subchannel Temperatures @ 132 cm				Subchannel Temperatures @193 cm			
	A	B	C	D	A	B	C	D
ECS2c24C	304.0	297.3	308.6	299.1	309.1	303.2	309.0	302.9
ECS2c31A	327.8	446.7	328.5	327.5	326.9	328.6	331.0	329.6
ECS2c31B	327.9	354.9	329.5	330.3	326.9	327.5	331.7	333.6
ECS2c31C	328.0	463.7	331.3	334.8	327.2	327.6	333.1	339.0
ECS2c32A	331.2	328.8	332.0	332.1	331.3	332.0	336.1	337.4
ECS2c32B	329.3	326.6	330.3	330.1	329.5	330.2	334.8	336.0
ECS2c32C	334.8	328.5	328.2	328.2	331.4	330.6	331.3	330.7
ECS2c32D	329.0	328.6	332.8	329.3	330.2	334.9	336.9	332.8
ECS2c32E	330.1	329.2	334.0	330.1	330.8	334.7	337.6	333.4
ECS2c32F	328.7	327.5	333.9	328.6	330.0	333.7	336.9	333.0
ECS2c33A	296.4	296.6	301.4	297.3	297.5	300.9	304.8	300.6
ECS2c33B	297.3	296.9	302.3	298.1	298.3	301.5	307.1	302.0
ECS2c33C	297.8	298.1	304.7	298.0	299.1	303.6	308.1	301.7
ECS2c34A	308.3	296.8	296.2	296.3	302.3	300.2	300.2	299.1
ECS2c34B	305.8	295.5	295.3	295.9	301.7	299.2	299.9	299.2
ECS2c34C	311.5	298.0	297.8	298.8	305.0	300.9	302.5	302.8
ECS2c41A	329.9	328.7	329.5	328.9	328.8	330.2	332.4	331.0
ECS2c41B	329.4	328.5	329.7	328.7	328.5	330.2	332.8	331.1
ECS2c41C	330.6	328.9	330.0	329.2	329.3	330.9	333.3	331.6
ECS2c42A	330.5	328.9	329.3	328.9	329.3	330.8	332.3	330.6
ECS2c42B	329.9	328.5	329.0	328.5	329.1	330.8	332.1	330.3
ECS2c42C	331.9	329.7	329.9	329.1	330.5	332.8	333.9	331.0
ECS2c43A	297.9	295.8	296.6	295.9	297.5	298.4	300.2	298.4
ECS2c43B	296.8	294.8	295.8	294.8	296.6	297.8	299.5	297.5
ECS2c43C	299.9	297.6	298.6	297.6	299.4	301.1	303.0	300.5
ECS2c44A	299.6	296.1	296.4	296.4	299.4	298.8	299.8	299.1
ECS2c44B	297.6	295.0	295.9	295.8	298.1	298.2	299.8	298.9
ECS2c44C	302.7	297.8	298.1	298.6	302.7	301.0	302.1	302.1

Table D - 4. Fluid Temperatures at 244 and 297 cm.

TEST ID	Subchannel Temperatures @ 244 cm				Subchannel Temperatures @ 297 cm			
	A	B	C	D	A	B	C	D
ECS2c11A	315.9	317.0	317.2	316.7	318.5	319.6	324.8	320.3
ECS2c11B	317.5	318.1	318.0	317.7	320.7	320.9	326.1	321.8
ECS2c11C	318.4	318.4	318.4	317.9	321.9	321.5	326.7	322.6
ECS2c12A	317.0	317.6	319.8	322.4	320.4	321.1	327.0	326.2
ECS2c12B	316.8	316.7	319.3	322.8	320.9	321.3	330.2	326.7
ECS2c12C	317.9	319.3	321.5	322.5	322.2	323.8	332.8	327.0
ECS2c13A	315.5	316.4	320.6	323.7	320.4	321.3	328.1	325.8
ECS2c13B	316.3	318.4	322.8	324.0	321.6	323.6	331.0	327.2
ECS2c13C	319.6	322.3	322.1	320.2	323.2	326.8	330.1	323.9
ECS2c14A	316.1	319.2	319.7	318.0	318.4	323.1	328.2	320.3
ECS2c14B	316.2	320.6	320.1	316.8	319.1	325.5	327.9	319.5
ECS2c14C	318.1	322.7	321.8	318.5	320.9	328.0	328.9	321.4
ECS2c15A	315.8	319.0	318.9	317.0	318.0	323.1	329.0	319.2
ECS2c15B	316.3	319.3	319.5	317.8	318.7	323.5	329.4	320.2
ECS2c15C	317.2	320.2	320.7	319.1	319.9	324.6	331.4	322.0
ECS2c16A	316.1	318.2	318.8	318.0	318.4	321.4	326.5	320.9
ECS2c16B	317.3	320.0	320.5	319.2	320.0	323.9	329.4	322.0
ECS2c16C	316.6	319.0	319.9	318.7	319.5	322.8	329.4	322.2
ECS2c21A	329.7	331.5	333.0	331.6	332.6	334.6	340.0	334.8
ECS2c21B	330.0	331.7	333.6	331.8	333.1	335.3	341.4	335.3
ECS2c21C	330.0	331.7	333.4	331.8	333.6	335.8	342.1	335.9
ECS2c22A	339.9	342.4	343.1	341.2	344.6	347.2	348.7	345.8
ECS2c22B	341.7	344.0	344.4	342.5	346.7	349.5	350.8	347.5
ECS2c22C	341.9	344.1	344.5	342.7	347.5	350.1	351.8	348.0
ECS2c23A	299.8	300.7	302.3	301.3	304.0	304.3	307.7	305.6
ECS2c23B	301.1	301.8	303.6	302.3	306.0	305.9	309.3	307.2
ECS2c23C	303.7	302.5	303.8	302.1	311.6	307.7	308.3	307.1
ECS2c24A	315.7	316.4	314.8	314.9	321.6	323.7	324.5	321.4
ECS2c24B	317.7	318.6	317.0	316.8	324.5	326.5	327.2	324.3

Table D - 4 (cont.) Fluid Temperatures at 244 and 297 cm.

TEST ID	Subchannel Temperatures @ 244 cm				Subchannel Temperatures @ 297 cm			
	A	B	C	D	A	B	C	D
ECS2c24C	320.9	321.4	320.0	320.1	328.2	330.5	332.2	328.0
ECS2c31A	327.7	331.1	332.8	331.6	329.0	332.9	340.5	333.5
ECS2c31B	327.6	330.0	333.1	335.2	328.9	332.2	342.6	335.7
ECS2c31C	328.0	330.3	334.4	339.5	329.3	332.8	344.5	338.4
ECS2c32A	333.9	335.4	338.2	339.7	336.7	337.6	341.8	340.4
ECS2c32B	332.3	333.8	336.9	338.4	335.6	336.4	340.3	339.2
ECS2c32C	333.6	334.8	333.6	333.2	337.0	339.2	341.0	336.8
ECS2c32D	334.7	338.9	339.6	337.0	338.5	342.0	343.2	340.5
ECS2c32E	336.4	340.6	341.1	338.7	340.5	344.4	345.0	342.3
ECS2c32F	335.4	339.7	340.6	338.2	339.9	344.1	345.0	341.8
ECS2c33A	300.6	305.2	307.5	304.1	304.9	309.3	317.8	308.3
ECS2c33B	302.1	306.6	309.6	306.0	306.5	311.4	321.2	309.9
ECS2c33C	302.9	308.7	311.2	305.7	307.8	313.8	322.9	310.7
ECS2c34A	305.2	305.3	303.2	302.6	309.9	312.2	311.0	308.6
ECS2c34B	305.5	305.4	304.2	304.0	310.8	311.6	312.0	310.0
ECS2c34C	308.3	306.5	306.3	307.9	312.8	313.1	316.0	314.0
ECS2c41A	330.3	333.3	334.3	332.7	332.2	336.1	342.1	334.7
ECS2c41B	330.2	333.5	335.0	333.2	332.4	336.3	342.7	335.4
ECS2c41C	331.1	334.3	335.5	333.7	333.5	337.8	344.5	336.0
ECS2c42A	330.7	334.3	334.1	332.0	332.6	337.5	340.9	333.7
ECS2c42B	330.7	334.5	333.9	331.7	332.9	338.5	341.8	333.5
ECS2c42C	332.4	337.4	335.8	332.3	335.0	342.4	342.7	334.4
ECS2c43A	299.8	302.1	302.8	301.3	302.8	306.2	312.7	304.6
ECS2c43B	299.1	301.9	302.5	300.5	302.5	306.4	313.1	304.4
ECS2c43C	302.0	305.4	306.4	303.9	305.8	310.6	318.5	308.1
ECS2c44A	301.8	302.9	302.8	302.0	304.8	307.5	310.0	305.4
ECS2c44B	301.2	302.9	303.3	302.1	304.9	308.1	311.3	305.7
ECS2c44C	305.7	305.6	305.7	306.2	309.6	311.2	314.1	310.6

Table D - 5. Fluid Temperatures at 381 cm and outlet plenum.

TEST ID	Subchannel Temperatures @ 381 cm					
	A	B	C	D	Average	Outlet Plenum
ECS2c11A	325.5	326.5	326.1	327.0	326.3	325.9
ECS2c11B	327.6	328.7	328.1	329.3	328.4	328.3
ECS2c11C	329.0	329.9	329.3	330.7	329.7	329.6
ECS2c12A	327.5	329.3	328.4	330.4	246.6	328.5
ECS2c12B	328.4	394.5	329.8	330.6	247.2	329.7
ECS2c12C	330.8	336.0	332.3	332.6	248.9	331.7
ECS2c13A	323.8	325.0	326.5	326.1	325.4	325.3
ECS2c13B	325.6	327.1	328.9	327.6	327.3	327.1
ECS2c13C	327.6	330.3	329.5	327.9	328.8	328.7
ECS2c14A	321.2	325.3	325.0	322.2	323.4	322.9
ECS2c14B	321.8	327.9	325.1	322.2	324.2	323.4
ECS2c14C	323.7	330.5	327.3	324.3	326.4	325.2
ECS2c15A	321.1	325.1	325.0	321.1	323.1	322.3
ECS2c15B	321.9	325.7	325.9	322.6	324.0	323.5
ECS2c15C	323.6	327.0	327.6	324.3	325.6	325.2
ECS2c16A	321.8	323.6	324.8	322.6	323.2	323.0
ECS2c16B	323.7	326.4	327.3	324.2	325.4	325.2
ECS2c16C	323.6	325.4	327.3	324.5	325.2	325.2
ECS2c21A	339.7	585.8	340.3	341.0	340.3	329.7
ECS2c21B	341.3	290.6	341.1	341.4	341.3	341.7
ECS2c21C	342.4	469.3	341.9	342.5	342.3	342.7
ECS2c22A	348.6	350.3	352.3	349.3	350.1	339.1
ECS2c22B	350.9	352.9	354.5	351.3	352.4	351.5
ECS2c22C	352.2	354.0	356.0	352.3	353.6	353.2
ECS2c23A	314.8	314.1	313.2	314.8	314.2	309.8
ECS2c23B	318.0	316.8	315.5	316.9	316.8	312.0
ECS2c23C	320.2	319.6	317.8	319.1	319.2	313.2
ECS2c24A	327.6	329.3	330.9	327.3	328.8	321.5
ECS2c24B	331.9	331.9	333.8	330.0	331.9	324.4

Table D - 5 (cont.) Fluid Temperatures at 381 cm.

TEST ID	Subchannel Temperatures @ 381 cm					
	A	B	C	D	Average	Outlet Plenum
ECS2c24C	335.8	337.4	339.7	335.2	337.0	327.9
ECS2c31A	332.0	670.0	338.4	334.4	334.9	334.2
ECS2c31B	332.5	388.1	340.0	335.9	336.1	335.0
ECS2c31C	333.5	873.3	341.6	337.6	337.6	336.6
ECS2c32A	338.9	340.5	341.6	340.9	340.5	340.2
ECS2c32B	338.2	440.6	340.4	340.2	339.6	339.4
ECS2c32C	340.1	342.3	341.1	340.8	340.7	340.7
ECS2c32D	342.0	343.9	344.8	342.8	343.4	343.1
ECS2c32E	344.1	346.4	347.1	345.0	345.7	345.1
ECS2c32F	344.0	346.3	347.1	344.8	345.6	345.2
ECS2c33A	310.8	312.3	314.4	310.7	312.0	310.2
ECS2c33B	312.5	314.5	316.8	312.4	314.0	312.0
ECS2c33C	313.9	317.6	320.1	314.7	316.6	314.0
ECS2c34A	312.8	315.4	313.7	313.4	313.8	310.5
ECS2c34B	314.3	315.3	314.6	314.4	314.6	311.4
ECS2c34C	318.5	320.1	319.2	320.2	319.5	315.8
ECS2c41A	334.7	337.5	339.2	335.8	336.6	336.5
ECS2c41B	335.3	461.6	340.1	336.5	337.3	337.3
ECS2c41C	336.6	340.2	341.4	337.4	338.5	338.4
ECS2c42A	334.7	338.2	338.3	335.4	336.1	335.8
ECS2c42B	335.0	339.3	338.5	335.5	336.3	336.0
ECS2c42C	336.9	342.2	339.4	336.8	337.7	337.6
ECS2c43A	307.2	309.2	310.4	307.0	308.5	306.2
ECS2c43B	307.5	309.4	310.8	307.3	308.7	306.7
ECS2c43C	310.9	313.9	315.6	311.5	313.0	310.1
ECS2c44A	308.5	309.9	309.0	307.9	308.8	306.9
ECS2c44B	308.3	311.1	310.8	309.1	309.8	307.4
ECS2c44C	313.0	314.6	314.4	313.7	313.9	311.3

Table D - 6. Absolute Pressures (kPa).

TEST ID	Measurement Location						
	Atmo- spheric	Inlet Plenum	0 (cm)	193 (cm)	244 (cm)	381 (cm)	Outlet Plenum
ECS2c11A	84.20	84.18	84.39	84.70	84.79	90.22	95.29
ECS2c11B	84.21	84.20	84.40	84.71	84.80	90.16	95.27
ECS2c11C	84.20	84.18	84.39	84.70	84.79	90.20	95.35
ECS2c12A	84.15	84.13	84.49	84.85	84.85	90.91	95.54
ECS2c12B	84.15	84.13	84.51	84.88	84.89	90.88	95.54
ECS2c12C	84.17	84.14	84.57	84.95	84.91	90.85	95.57
ECS2c13A	84.20	84.17	84.56	84.74	85.28	91.80	95.67
ECS2c13B	84.17	84.15	84.57	84.76	85.41	91.76	95.72
ECS2c13C	84.20	84.18	88.51	89.59	90.15	92.70	95.71
ECS2c14A	84.27	84.25	88.00	92.23	92.75	94.49	95.88
ECS2c14B	84.25	84.22	89.04	91.95	92.32	94.33	96.02
ECS2c14C	84.31	84.28	89.17	91.94	92.42	94.57	95.97
ECS2c15A	84.72	84.68	88.52	93.39	94.06	96.08	96.55
ECS2c15B	84.73	84.69	88.23	93.28	93.93	96.09	96.67
ECS2c15C	84.72	84.69	88.28	93.16	93.84	96.30	96.66
ECS2c16A	84.68	84.63	88.13	93.04	93.98	96.92	96.75
ECS2c16B	84.71	84.64	88.46	93.52	94.73	95.35	96.81
ECS2c16C	84.68	84.62	88.46	93.48	94.33	96.94	96.78
ECS2c21A	84.86	84.86	85.13	85.27	85.20	86.58	91.26
ECS2c21B	84.87	84.88	85.13	85.27	85.21	86.58	91.34
ECS2c21C	84.83	84.84	85.10	85.24	85.17	86.52	91.32
ECS2c22A	84.61	84.56	84.79	85.27	87.11	99.41	104.73
ECS2c22B	84.62	84.58	84.82	85.28	87.05	99.25	104.72
ECS2c22C	84.61	84.56	84.80	85.28	87.03	99.26	104.69
ECS2c23A	85.15	85.17	85.38	85.62	85.64	86.88	91.36
ECS2c23B	85.16	85.17	85.39	85.59	85.61	86.83	91.39
ECS2c23C	85.15	85.15	85.40	85.62	85.60	86.81	91.39
ECS2c24A	84.88	84.88	84.96	85.32	87.49	99.52	104.77
ECS2c24B	84.87	84.88	84.98	85.32	87.42	99.47	104.78

Table D - 6 (cont.) Absolute Pressures (kPa).

TEST ID	Measurement Location						
	Atmo-spheric	Inlet Plenum	0 (cm)	193 (cm)	244 (cm)	381 (cm)	Outlet Plenum
ECS2c24C	84.88	84.89	84.98	85.29	87.34	99.52	104.81
ECS2c31A	84.76	84.77	85.45	85.78	85.85	87.96	91.58
ECS2c31B	84.76	84.77	85.35	85.60	85.55	87.81	91.62
ECS2c31C	84.74	84.75	85.23	85.40	85.39	87.75	91.61
ECS2c32A	85.17	85.17	85.52	88.95	91.82	101.27	105.60
ECS2c32B	85.16	85.17	85.51	88.90	91.76	101.19	105.62
ECS2c32C	85.15	85.15	94.30	95.52	95.83	101.55	105.64
ECS2c32D	84.51	84.47	84.91	86.12	89.29	99.98	104.78
ECS2c32E	84.53	84.49	84.98	86.11	89.17	99.93	104.80
ECS2c32F	84.50	84.46	85.01	86.17	89.35	99.96	104.78
ECS2c33A	85.07	85.08	85.72	87.02	87.49	89.09	91.59
ECS2c33B	85.08	85.09	85.80	87.40	87.98	89.14	91.62
ECS2c33C	85.07	85.08	86.03	87.31	87.63	88.80	91.60
ECS2c34A	84.86	84.87	93.71	94.72	95.09	101.29	105.02
ECS2c34B	84.86	84.88	91.57	93.28	94.24	101.31	105.00
ECS2c34C	84.86	84.87	94.78	95.95	96.44	101.40	105.00
ECS2c41A	85.16	85.15	86.51	89.28	89.81	92.05	92.60
ECS2c41B	85.15	85.15	86.08	88.63	89.26	92.03	92.61
ECS2c41C	85.17	85.15	86.80	89.60	90.13	92.21	92.58
ECS2c42A	85.00	84.99	90.22	97.77	98.41	104.09	105.79
ECS2c42B	85.02	85.02	90.45	98.34	99.37	103.75	105.84
ECS2c42C	84.97	84.97	92.54	99.51	100.32	103.69	105.75
ECS2c43A	85.01	85.02	86.47	89.91	90.52	92.20	91.90
ECS2c43B	85.02	85.03	86.31	89.88	90.41	92.19	91.96
ECS2c43C	85.00	85.01	86.41	89.96	90.46	92.05	91.87
ECS2c44A	84.82	84.83	89.08	97.57	99.32	104.06	105.16
ECS2c44B	84.83	84.84	88.48	97.82	99.46	103.95	105.25
ECS2c44C	84.81	84.81	89.76	98.33	99.90	104.20	105.21

Table D - 7 Differential Pressures (kPa).

TEST ID	PL_IN	A_1	A_2	C_2	A_3	C_3	A_4	PL_OUT
	(-183) -163 cm	(-163)- 0 cm	0-193 cm	0-193 cm	193-381 cm	193-381 cm	381-414 cm	414-442 cm
ECS2c11A	1.60	16.57	18.56	18.80	13.18	13.06	0.76	0.21
ECS2c11B	1.60	16.57	18.56	18.79	13.20	13.11	0.75	0.21
ECS2c11C	1.60	16.55	18.57	18.80	13.25	13.15	0.74	0.21
ECS2c12A	1.38	16.63	18.18	18.72	13.09	12.59	1.24	0.21
ECS2c12B	1.38	16.61	18.19	18.73	13.09	12.59	1.30	0.21
ECS2c12C	1.38	16.60	18.13	18.67	13.17	12.71	1.25	0.21
ECS2c13A	1.17	16.83	18.15	18.74	12.18	11.86	1.97	0.22
ECS2c13B	1.17	16.87	18.13	18.75	12.26	11.89	1.90	0.21
ECS2c13C	1.17	12.95	17.16	17.72	16.32	15.99	2.65	0.22
ECS2c14A	1.01	13.68	14.19	14.66	16.91	16.70	4.08	0.23
ECS2c14B	1.00	12.49	15.70	16.15	16.79	16.49	3.95	0.21
ECS2c14C	1.01	12.45	15.62	16.08	16.62	16.41	4.15	0.22
ECS2c15A	0.90	13.54	14.05	14.09	16.21	16.53	4.98	0.19
ECS2c15B	0.91	13.86	13.82	13.82	15.93	16.41	5.04	0.22
ECS2c15C	0.91	13.86	14.18	14.17	15.81	16.04	5.05	0.20
ECS2c16A	0.72	14.10	13.94	13.92	15.07	15.53	5.60	0.23
ECS2c16B	0.73	13.74	13.89	13.97	15.54	15.83	5.52	0.23
ECS2c16C	0.72	13.65	13.89	13.96	15.53	15.79	5.47	0.24
ECS2c21A	1.55	16.63	18.53	19.02	17.72	17.28	0.62	0.43
ECS2c21B	1.55	16.64	18.54	19.02	17.79	17.39	0.64	0.43
ECS2c21C	1.55	16.63	18.54	19.02	17.80	17.44	0.59	0.43
ECS2c22A	1.56	16.62	18.40	18.77	4.76	4.85	0.51	0.15
ECS2c22B	1.56	16.61	18.40	18.75	4.89	5.02	0.50	0.14
ECS2c22C	1.56	16.63	18.41	18.75	4.94	5.10	0.50	0.14
ECS2c23A	1.64	16.53	18.63	18.79	17.33	17.25	1.12	0.14
ECS2c23B	1.64	16.53	18.63	18.80	17.41	17.31	1.09	0.14
ECS2c23C	1.64	16.51	18.65	18.80	17.44	17.39	1.07	0.14
ECS2c24A	1.60	16.51	18.43	18.39	4.66	4.55	0.55	0.08
ECS2c24B	1.61	16.52	18.42	18.42	4.66	4.53	0.57	0.08
ECS2c24C	1.61	16.51	18.46	18.39	4.66	4.57	0.56	0.08

Table D - 7 (Cont.) Differential Pressures (kPa).

TEST ID	PL_IN	A_1	A_2	C_2	A_3	C_3	A_4	PL_OUT
	(-183) -163 cm	(-163)- 0 cm	0-193 cm	0-193 cm	193-381 cm	193-381 cm	381-414 cm	414-442 cm
ECS2c31A	1.15	16.76	18.30	18.78	16.69	16.41	1.77	0.43
ECS2c31B	1.16	16.73	18.54	18.95	16.68	16.44	1.62	0.44
ECS2c31C	1.15	16.83	18.63	19.00	16.54	16.26	1.69	0.44
ECS2c32A	1.17	16.78	15.77	16.15	6.33	6.03	1.36	0.44
ECS2c32B	1.17	16.77	15.60	15.95	6.31	6.07	1.36	0.45
ECS2c32C	1.16	7.85	17.76	17.90	12.93	12.64	1.55	0.45
ECS2c32D	1.34	16.68	17.71	17.89	4.96	5.26	1.03	0.04
ECS2c32E	1.34	16.57	17.88	18.18	4.87	5.07	1.03	0.04
ECS2c32F	1.34	16.56	17.75	17.92	5.20	5.46	1.00	0.04
ECS2c33A	1.25	16.53	17.55	17.79	16.50	16.44	2.96	0.15
ECS2c33B	1.24	16.47	17.34	17.54	16.73	16.67	3.00	0.14
ECS2c33C	1.25	16.28	17.64	17.86	17.04	16.88	2.65	0.15
ECS2c34A	1.22	8.12	17.75	17.76	12.23	12 36	1.92	0.08
ECS2c34B	1.23	10.19	17.21	17.20	10.69	10.90	1.91	0.09
ECS2c34C	1.23	6.95	17.61	17.57	13.39	13.59	2.00	0.08
ECS2c41A	0.90	16.24	16.42	16.50	15.75	15.86	5.13	0.20
ECS2c41B	0.90	16.71	16.57	16.74	15.04	15.19	5.07	0.19
ECS2c41C	0.90	15.99	16.23	16.32	15.91	15.97	5.19	0.20
ECS2c42A	0.83	12.22	11.71	11.91	12.46	12.41	3.66	0.45
ECS2c42B	0.83	12.10	11.25	11.50	13.42	13.32	3.36	0.46
ECS2c42C	0.83	9.94	11.96	12.28	14.73	14.51	3.39	0.48
ECS2c43A	0.94	15.98	15.53	15.51	16.25	16.40	5.37	0.21
ECS2c43B	0.94	16.18	15.78	15.78	16.22	16.31	5.31	0.23
ECS2c43C	0.94	16.03	15.60	15.54	16.47	16.58	5.34	0.23
ECS2c44A	0.89	13.03	10.37	10.33	12.08	12.47	4.33	0.13
ECS2c44B	0.89	13.60	9.37	9.42	12.84	13.19	4.16	0.12
ECS2c44C	0.90	12.34	10.20	10.20	12.88	13.22	4.36	0.13

Table D - 8 Hydrostatic Heads (cm)[1].

TEST ID	PL_IN	A_1	A_2	C_2	A_3	C_3	A_4	PL_OUT
	(-183) -163 cm	(-163)- 0 cm	0-193 cm	0-193 cm	193-381 cm	193-381 cm	381-414 cm	414-442 cm
ECS2c11A	6.6	-6.0	3.7	1.3	54.2	55.5	21.7	26.3
ECS2c11B	6.6	-6.0	3.7	1.3	54.0	55.1	21.9	26.3
ECS2c11C	6.6	-5.8	3.6	1.2	53.5	54.7	22.0	26.3
ECS2c12A	8.8	-6.6	7.6	2.1	55.1	60.5	16.8	26.2
ECS2c12B	8.8	-6.4	7.6	2.0	55.1	60.6	16.2	26.2
ECS2c12C	8.9	-6.3	8.2	2.5	54.4	59.4	16.8	26.3
ECS2c13A	11.0	-8.6	8.0	1.8	64.5	68.1	9.2	26.2
ECS2c13B	11.0	-9.0	8.1	1.7	63.8	67.9	10.0	26.2
ECS2c13C	11.1	31.3	18.2	12.3	21.7	25.3	2.2	26.1
ECS2c14A	12.7	23.8	48.8	43.9	15.6	17.8	-12.7	26.0
ECS2c14B	12.8	36.0	33.2	28.6	16.9	20.1	-11.3	26.2
ECS2c14C	12.6	36.5	34.1	29.2	18.7	20.9	-13.3	26.2
ECS2c15A	13.7	25.2	50.3	49.8	22.8	19.6	-22.0	26.4
ECS2c15B	13.7	22.0	52.6	52.5	25.7	20.9	-22.5	26.1
ECS2c15C	13.7	22.0	48.9	49.0	27.0	24.8	-22.7	26.3
ECS2c16A	15.6	19.4	51.3	51.6	34.7	30.0	-28.3	26.0
ECS2c16B	15.6	23.2	51.9	51.0	29.8	26.9	-27.5	26.0
ECS2c16C	15.6	24.1	51.9	51.2	29.9	27.3	-27.0	26.0
ECS2c21A	7.1	-6.6	4.0	-1.0	7.3	11.9	23.4	24.0
ECS2c21B	7.1	-6.7	4.0	-1.1	6.5	10.7	23.3	24.1
ECS2c21C	7.1	-6.6	3.9	-1.0	6.5	10.2	23.8	24.2
ECS2c22A	7.1	-6.5	5.4	1.6	143.3	142.7	24.7	27.1
ECS2c22B	7.1	-6.4	5.4	1.7	142.1	141.1	24.9	27.4
ECS2c22C	7.1	-6.6	5.3	1.7	141.6	140.4	24.9	27.4
ECS2c23A	6.2	-5.5	3.0	1.3	11.2	12.0	17.9	26.8
ECS2c23B	6.2	-5.5	3.0	1.2	10.3	11.4	18.3	26.8
ECS2c23C	6.2	-5.4	2.8	1.2	10.1	10.5	18.5	26.8
ECS2c24A	6.5	-5.3	5.0	5.5	142.4	143.7	23.9	27.5
ECS2c24B	6.5	-5.4	5.2	5.2	142.5	144.1	23.8	27.6
ECS2c24C	6.4	-5.4	4.7	5.4	142.8	144.1	24.0	27.6

1. Differential Pressure corrected for liquid head of reference legs and converted to level using liquid density calculated from nearest fluid temperature.

Table D - 8 (cont.) Hydrostatic Heads (cm).

TEST ID	PL_IN	A_1	A_2	C_2	A_3	C_3	A_4	PL_OUT
	(-183) -163 cm	(-163)- 0 cm	0-193 cm	0-193 cm	193-381 cm	193-381 cm	381-414 cm	414-442 cm
ECS2c31A	11.3	-8.0	6.5	1.5	18.0	21.0	11.3	24.0
ECS2c31B	11.2	-7.6	4.0	-0.3	18.0	20.7	12.9	24.0
ECS2c31C	11.3	-8.7	3.0	-0.9	19.5	22.6	12.2	24.0
ECS2c32A	11.1	-8.2	32.8	28.8	126.1	129.7	15.6	24.0
ECS2c32B	11.1	-8.1	34.5	30.8	126.3	129.2	15.6	24.0
ECS2c32C	11.2	84.4	12.1	10.6	57.3	60.4	13.7	23.9
ECS2c32D	9.3	-7.1	12.6	10.7	140.6	137.9	19.2	28.3
ECS2c32E	9.3	-6.0	10.8	7.7	141.7	140.0	19.2	28.3
ECS2c32F	9.3	-5.9	12.1	10.4	138.2	135.9	19.5	28.3
ECS2c33A	10.1	-5.5	14.0	11.6	19.8	20.5	-1.0	26.7
ECS2c33B	10.2	-4.9	16.2	14.1	17.4	18.1	-1.5	26.8
ECS2c33C	10.2	-3.0	13.1	10.8	14.1	15.9	2.2	26.7
ECS2c34A	10.4	80.6	12.0	11.9	63.7	62.3	9.7	27.4
ECS2c34B	10.4	59.4	17.5	17.6	79.5	77.5	9.8	27.3
ECS2c34C	10.4	92.6	13.5	13.9	51.8	49.9	8.8	27.4
ECS2c41A	13.9	-2.6	26.0	25.1	27.8	26.8	-23.6	26.5
ECS2c41B	13.9	-7.4	24.4	22.7	35.1	33.8	-23.0	26.6
ECS2c41C	13.9	0.0	28.0	27.1	26.2	25.7	-24.3	26.6
ECS2c42A	14.7	39.1	74.9	72.9	62.0	62.9	-8.3	23.8
ECS2c42B	14.6	40.3	79.7	77.0	52.1	53.3	-5.2	23.8
ECS2c42C	14.6	62.7	72.4	69.0	38.5	41.0	-5.6	23.6
ECS2c43A	13.3	0.1	34.8	34.9	22.2	20.8	-25.9	26.0
ECS2c43B	13.3	-1.9	32.1	32.1	22.6	21.8	-25.2	25.8
ECS2c43C	13.3	-0.4	34.0	34.7	20.0	19.0	-25.5	25.8
ECS2c44A	13.8	30.3	87.7	88.0	65.1	61.3	-15.2	26.8
ECS2c44B	13.8	24.5	97.8	97.3	57.4	53.8	-13.4	26.9
ECS2c44C	13.7	37.4	89.5	89.4	57.0	53.6	-15.4	26.9

Table D - 9 Average Heat Transfer Coefficients at each axial level.

TEST ID	Level 1 63.5 cm	Level 2 108.6 cm	Level 3 146.7 cm	Level 4 184.8 cm	Level 5 222.9 cm	Level 6 253.4 cm	Level 7 302.0 cm	Level 8 359.9 cm
ECS2c11A	1,853	2,925	2,775	3,087	2,390	2,272	2,305	6,377
ECS2c11B	1,845	2,972	2,841	2,998	2,380	2,209	2,284	6,288
ECS2c11C	1,856	3,039	2,894	2,939	2,394	2,211	2,298	6,298
ECS2c12A	1,990	3,357	2,418	3,852	2,952	3,168	3,639	6,711
ECS2c12B	1,902	3,290	2,428	3,783	2,976	3,150	3,924	6,134
ECS2c12C	2,036	3,387	2,743	3,962	3,054	3,122	3,684	6,199
ECS2c13A	2,238	3,648	2,468	4,361	3,114	3,816	4,242	6,533
ECS2c13B	2,154	3,412	2,584	4,366	3,173	3,796	4,256	6,446
ECS2c13C	3,640	4,729	3,958	5,027	3,528	3,600	4,017	5,954
ECS2c14A	4,608	5,447	4,250	5,255	3,237	3,449	3,941	5,531
ECS2c14B	4,156	4,830	3,934	4,827	3,199	3,473	3,894	5,591
ECS2c14C	4,374	4,965	4,072	5,013	3,337	3,540	4,013	6,029
ECS2c15A	5,303	6,097	4,788	6,260	3,652	3,945	4,327	5,691
ECS2c15B	5,453	6,270	5,003	6,551	3,825	4,090	4,528	6,292
ECS2c15C	5,432	6,351	5,058	6,561	3,915	4,112	4,514	6,401
ECS2c16A	5,797	6,863	5,479	7,572	4,301	4,485	4,988	7,205
ECS2c16B	6,071	6,991	5,492	7,685	4,255	4,466	4,951	7,251
ECS2c16C	6,045	7,050	5,623	7,734	4,379	4,456	5,063	7,261
ECS2c21A	1,696	2,601	2,652	3,024	2,431	2,407	2,532	2,953
ECS2c21B	1,653	2,506	2,624	2,979	2,399	2,405	2,578	3,021
ECS2c21C	1,676	2,597	2,678	3,071	2,460	2,422	2,580	3,024
ECS2c22A	1,737	2,697	2,713	3,521	4,628	4,216	4,206	5,347
ECS2c22B	1,792	2,752	2,799	3,555	4,176	4,107	4,191	5,515
ECS2c22C	1,756	2,769	2,848	3,551	4,349	4,198	4,127	5,301
ECS2c23A	1,858	2,925	2,853	3,275	2,418	2,229	2,283	2,602
ECS2c23B	1,850	2,890	2,812	3,252	2,422	2,211	2,284	2,589
ECS2c23C	1,830	2,773	2,815	3,071	2,443	2,157	2,209	2,314
ECS2c24A	1,717	2,609	2,806	2,768	4,069	3,686	4,091	4,501
ECS2c24B	1,741	2,597	2,762	2,849	3,990	3,658	4,155	4,545

Table D - 9 (cont). Average Heat Transfer Coefficients at each axial level.

TEST ID	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
	63.5 cm	108.6 cm	146.7 cm	184.8 cm	222.9 cm	253.4 cm	302.0 cm	359.9 cm
ECS2c24C	1,739	2,582	2,823	2,836	3,902	3,761	4,100	4,452
ECS2c31A	2,916	3,834	3,020	4,881	2,544	3,168	3,854	5,279
ECS2c31B	2,562	3,669	2,458	3,965	2,259	2,938	3,830	5,208
ECS2c31C	2,396	3,493	2,251	3,827	2,288	2,993	3,943	5,470
ECS2c32A	2,499	4,015	3,839	6,882	3,627	4,116	5,208	6,891
ECS2c32B	2,359	3,872	3,782	6,689	3,622	4,103	4,938	6,810
ECS2c32C	3,994	5,109	4,466	5,238	3,799	3,777	5,472	7,200
ECS2c32D	2,448	3,439	3,115	5,806	3,786	4,066	4,498	6,333
ECS2c32E	2,679	3,650	3,278	5,335	3,937	4,140	4,519	6,938
ECS2c32F	2,525	3,566	3,337	5,604	3,869	4,109	4,508	6,444
ECS2c33A	2,496	3,854	3,655	5,271	3,422	3,545	4,229	5,050
ECS2c33B	2,893	4,133	3,680	5,231	3,342	3,418	4,316	4,895
ECS2c33C	2,522	3,750	3,707	5,413	3,463	3,516	4,191	5,217
ECS2c34A	3,278	4,139	3,915	4,010	3,391	3,434	4,686	6,162
ECS2c34B	3,462	4,472	4,062	4,445	3,672	3,641	4,532	6,054
ECS2c34C	3,378	4,531	4,064	4,211	3,509	3,407	4,413	6,234
ECS2c41A	4,718	5,866	4,676	6,930	3,826	4,270	5,077	6,318
ECS2c41B	4,589	5,772	4,600	7,018	3,871	4,210	5,128	6,314
ECS2c41C	4,814	5,989	4,726	6,809	3,908	4,285	4,986	6,356
ECS2c42A	5,220	5,812	4,609	6,055	3,563	3,850	4,798	5,934
ECS2c42B	5,408	5,867	4,743	6,160	3,602	3,722	4,566	6,133
ECS2c42C	5,162	5,582	4,566	5,856	3,533	3,720	4,508	6,170
ECS2c43A	4,862	5,994	4,872	6,483	4,060	3,934	4,838	6,154
ECS2c43B	4,578	5,814	4,763	6,390	3,979	3,890	4,796	6,188
ECS2c43C	4,804	5,892	4,755	6,309	3,889	4,083	4,793	6,142
ECS2c44A	4,654	5,497	4,902	5,884	3,841	3,785	4,775	6,275
ECS2c44B	4,745	5,555	4,868	6,007	3,796	3,792	4,668	6,169
ECS2c44C	4,827	5,728	5,051	5,984	3,942	3,875	4,527	6,177

Table D - 10. Average aluminum temperatures at each axial level.

TEST ID	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
	63.5 cm	108.6 cm	146.7 cm	184.8 cm	222.9 cm	253.4 cm	302.0 cm	359.9 cm
ECS2c11A	321.9	325.9	331.8	334.7	344.3	347.6	347.9	331.9
ECS2c11B	323.5	327.7	334.0	338.3	348.6	352.9	352.7	334.7
ECS2c11C	324.3	328.7	335.6	341.2	351.8	356.8	356.3	336.7
ECS2c12A	327.9	332.3	347.2	341.2	353.2	353.0	350.0	337.0
ECS2c12B	329.5	333.9	350.0	343.9	356.5	356.7	351.2	339.7
ECS2c12C	330.7	336.2	350.1	346.5	360.6	362.2	357.6	343.1
ECS2c13A	327.5	332.5	350.1	340.2	354.5	349.7	347.2	335.7
ECS2c13B	330.2	336.5	353.0	343.7	358.8	354.4	351.3	338.8
ECS2c13C	325.1	333.0	343.8	344.1	360.3	361.7	358.1	343.6
ECS2c14A	320.1	326.7	336.0	336.5	353.8	353.0	348.5	336.2
ECS2c14B	321.5	329.7	340.2	340.8	358.4	356.9	352.5	338.2
ECS2c14C	323.0	332.1	343.1	343.7	362.3	361.6	356.6	340.8
ECS2c15A	320.1	327.4	337.1	336.4	355.7	354.3	350.7	338.0
ECS2c15B	321.0	328.8	339.0	338.3	358.8	357.8	353.7	339.4
ECS2c15C	322.2	330.6	341.7	341.2	362.7	362.4	358.3	342.2
ECS2c16A	321.0	328.6	338.9	336.9	357.7	357.6	353.1	338.0
ECS2c16B	322.6	331.3	343.0	340.5	364.4	364.0	359.1	342.0
ECS2c16C	322.4	331.7	344.0	341.9	367.0	368.0	361.7	343.6
ECS2c21A	336.7	341.0	345.6	347.9	356.0	358.0	357.7	351.4
ECS2c21B	337.9	343.1	347.8	350.4	359.5	361.4	360.6	353.7
ECS2c21C	338.6	343.7	349.1	351.8	361.6	364.2	363.6	356.0
ECS2c22A	345.2	351.8	359.3	359.9	359.3	364.1	366.7	361.1
ECS2c22B	346.8	354.2	362.1	363.3	365.2	368.8	371.1	364.3
ECS2c22C	347.7	355.3	363.7	365.6	366.6	371.0	374.5	367.1
ECS2c23A	308.5	314.1	321.4	324.6	338.8	344.3	344.4	333.9
ECS2c23B	310.6	317.1	325.3	328.7	344.3	350.8	350.5	338.9
ECS2c23C	312.1	319.9	328.0	333.5	348.5	357.2	357.1	345.9
ECS2c24A	321.0	331.7	340.7	352.2	345.6	353.2	353.1	346.3
ECS2c24B	323.2	335.6	346.1	356.7	351.5	359.6	358.6	351.4
ECS2c24C	326.8	340.7	351.1	364.1	359.1	365.9	366.6	358.8

Table D - 10 (cont). Average aluminum temperatures at each axial level.

TEST ID	Level 1 63.5 cm	Level 2 108.6 cm	Level 3 146.7 cm	Level 4 184.8 cm	Level 5 222.9 cm	Level 6 253.4 cm	Level 7 302.0 cm	Level 8 359.9 cm
ECS2c31A	333.8	338.2	345.3	341.8	356.2	352.2	348.7	342.1
ECS2c31B	335.4	339.7	351.2	346.3	362.5	356.4	351.0	343.7
ECS2c31C	337.3	342.1	356.5	349.4	366.3	359.5	353.3	345.4
ECS2c32A	340.8	344.9	350.7	345.7	360.7	359.1	355.1	348.7
ECS2c32B	340.7	345.1	351.3	345.8	362.1	360.4	356.8	348.8
ECS2c32C	336.2	342.6	350.3	352.2	364.4	366.4	358.0	350.7
ECS2c32D	340.5	347.4	356.1	349.1	362.0	362.3	361.3	353.2
ECS2c32E	341.5	349.3	358.8	353.9	365.7	366.7	365.9	356.1
ECS2c32F	342.0	350.0	359.4	353.5	367.8	368.5	367.3	357.2
ECS2c33A	314.7	322.5	332.8	329.2	350.5	351.4	344.8	332.9
ECS2c33B	314.2	323.8	336.9	333.4	358.0	359.5	349.7	337.9
ECS2c33C	319.6	330.2	341.4	336.7	363.0	365.1	357.1	341.3
ECS2c34A	309.7	320.5	330.6	337.8	351.3	353.2	341.7	329.3
ECS2c34B	309.6	320.5	332.4	337.9	352.9	356.0	347.3	332.7
ECS2c34C	314.3	325.5	339.0	347.2	363.9	368.6	356.4	338.6
ECS2c41A	335.1	340.7	348.6	346.0	361.8	360.0	355.7	347.7
ECS2c41B	335.8	341.9	350.8	347.4	364.7	363.4	358.1	349.5
ECS2c41C	336.7	343.3	353.0	350.4	368.7	367.1	362.5	352.2
ECS2c42A	334.0	339.9	347.4	346.7	361.4	360.4	354.9	347.0
ECS2c42B	333.9	340.5	348.3	347.8	364.0	364.2	358.2	348.0
ECS2c42C	335.8	343.4	352.2	351.8	369.4	369.0	362.6	351.0
ECS2c43A	306.7	315.8	328.1	326.7	348.5	351.8	342.7	328.2
ECS2c43B	307.4	317.4	331.2	329.3	354.2	357.6	347.1	330.5
ECS2c43C	310.7	322.0	337.6	335.9	364.1	363.7	355.0	336.9
ECS2c44A	306.9	317.2	327.4	328.9	350.4	353.0	342.5	327.4
ECS2c44B	307.1	318.5	330.5	331.2	356.6	358.8	348.1	330.5
ECS2c44C	310.7	322.7	335.3	337.6	363.1	366.4	357.3	336.7

Table D - 11 Level 1 & 8 Aluminum Temperatures (K).

TEST ID	Level 1 Azimuthal Location			Level 8 Azimuthal Location		
	45°	225°	Average	45°	225°	Average
ECS2c11A	314.9	328.9	321.9	332.1	331.6	331.9
ECS2c11B	315.6	331.3	323.5	335.1	334.2	334.7
ECS2c11C	315.8	332.8	324.3	337.4	336.0	336.7
ECS2c12A	318.4	337.5	327.9	336.8	337.3	337.0
ECS2c12B	318.3	340.6	329.5	338.7	340.7	339.7
ECS2c12C	318.8	342.6	330.7	342.2	344.0	343.1
ECS2c13A	317.3	337.7	327.5	334.1	337.3	335.7
ECS2c13B	317.6	342.8	330.2	337.1	340.6	338.8
ECS2c13C	320.9	329.2	325.1	342.8	344.3	343.6
ECS2c14A	317.9	322.2	320.1	332.9	339.4	336.2
ECS2c14B	318.8	324.1	321.5	334.8	341.7	338.2
ECS2c14C	320.6	325.4	323.0	337.0	344.6	340.8
ECS2c15A	317.9	322.4	320.1	334.1	341.9	338.0
ECS2c15B	318.8	323.1	321.0	336.4	342.5	339.4
ECS2c15C	319.6	324.9	322.2	338.8	345.6	342.2
ECS2c16A	318.4	323.5	321.0	335.6	340.4	338.0
ECS2c16B	319.8	325.4	322.6	339.0	344.9	342.0
ECS2c16C	319.3	325.5	322.4	340.7	346.4	343.6
ECS2c21A	329.7	343.7	336.7	354.6	348.2	351.4
ECS2c21B	329.7	346.2	337.9	356.9	350.6	353.7
ECS2c21C	329.6	347.6	338.6	359.9	352.1	356.0
ECS2c22A	333.3	357.0	345.2	359.6	362.6	361.1
ECS2c22B	334.2	359.3	346.8	362.4	366.2	364.3
ECS2c22C	333.2	362.2	347.7	365.4	368.9	367.1
ECS2c23A	299.6	317.4	308.5	339.0	328.7	333.9
ECS2c23B	300.5	320.8	310.6	345.0	332.9	338.9
ECS2c23C	300.8	323.3	312.1	353.7	338.1	345.9
ECS2c24A	304.0	337.9	321.0	344.2	348.4	346.3
ECS2c24B	305.1	341.3	323.2	349.6	353.2	351.4

Table D - 11 (cont.) Level 1 & 8 Aluminum Temperatures (K).

TEST ID	Level 1 Azimuthal Location			Level 8 Azimuthal Location		
	45°	225°	Average	45°	225°	Average
ECS2c24C	306.3	347.4	326.8	356.5	361.1	358.8
ECS2c31A	328.6	338.9	333.8	337.8	346.4	342.1
ECS2c31B	329.1	341.8	335.4	338.4	349.0	343.7
ECS2c31C	329.8	344.7	337.3	339.9	350.8	345.4
ECS2c32A	332.5	349.1	340.8	347.5	350.0	348.7
ECS2c32B	330.7	350.7	340.7	347.7	350.0	348.8
ECS2c32C	335.8	336.6	336.2	350.6	350.7	350.7
ECS2c32D	331.4	349.5	340.5	351.5	354.9	353.2
ECS2c32E	332.7	350.4	341.5	354.7	357.5	356.1
ECS2c32F	331.5	352.4	342.0	355.6	358.7	357.2
ECS2c33A	301.1	328.3	314.7	332.4	333.3	332.9
ECS2c33B	302.4	326.0	314.2	335.9	339.9	337.9
ECS2c33C	303.7	335.5	319.6	338.9	343.8	341.3
ECS2c34A	310.0	309.5	309.7	328.6	330.1	329.3
ECS2c34B	309.2	310.0	309.6	332.4	332.9	332.7
ECS2c34C	314.3	314.2	314.3	338.5	338.8	338.6
ECS2c41A	331.5	338.7	335.1	344.2	351.3	347.7
ECS2c41B	331.2	340.4	335.8	345.9	353.2	349.5
ECS2c41C	332.6	340.7	336.7	348.3	356.1	352.2
ECS2c42A	332.3	335.8	334.0	345.4	348.7	347.0
ECS2c42B	332.1	335.6	333.9	345.7	350.4	348.0
ECS2c42C	333.9	337.6	335.8	349.7	352.3	351.0
ECS2c43A	302.2	311.2	306.7	326.3	330.2	328.2
ECS2c43B	301.8	312.9	307.4	329.0	332.0	330.5
ECS2c43C	304.9	316.4	310.7	333.9	339.9	336.9
ECS2c44A	304.6	309.3	306.9	326.9	327.8	327.4
ECS2c44B	303.7	310.4	307.1	328.2	332.9	330.5
ECS2c44C	308.3	313.0	310.7	335.1	338.3	336.7

Table D - 12 Level 2 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	45°	150°	225°	Average
ECS2c11A	321.4	325.7	330.7	325.9
ECS2c11B	323.0	327.2	333.0	327.7
ECS2c11C	323.7	328.0	334.4	328.7
ECS2c12A	325.2	326.7	344.9	332.3
ECS2c12B	325.8	326.4	349.7	333.9
ECS2c12C	326.9	331.8	349.9	336.2
ECS2c13A	323.7	326.6	347.1	332.5
ECS2c13B	324.5	331.1	353.9	336.5
ECS2c13C	329.9	334.8	334.3	333.0
ECS2c14A	325.5	328.1	326.4	326.7
ECS2c14B	326.8	332.9	329.5	329.7
ECS2c14C	329.3	335.8	331.2	332.1
ECS2c15A	325.7	329.6	326.8	327.4
ECS2c15B	327.5	331.2	327.7	328.8
ECS2c15C	328.8	333.2	329.8	330.6
ECS2c16A	327.1	330.8	328.0	328.6
ECS2c16B	329.1	334.4	330.4	331.3
ECS2c16C	329.5	334.9	330.7	331.7
ECS2c21A	335.4	338.7	349.0	341.0
ECS2c21B	335.9	340.0	353.3	343.1
ECS2c21C	336.3	340.7	354.2	343.7
ECS2c22A	341.1	350.9	363.4	351.8
ECS2c22B	342.7	352.4	367.4	354.2
ECS2c22C	342.6	353.5	370.0	355.3
ECS2c23A	307.5	312.2	322.6	314.1
ECS2c23B	309.0	314.9	327.2	317.1
ECS2c23C	310.3	317.3	331.9	319.9
ECS2c24A	316.6	327.0	351.6	331.7
ECS2c24B	318.7	331.7	356.5	335.6
ECS2c24C	321.6	336.1	364.5	340.7

Table D - 12 (cont.) Level 2 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	45°	150°	225°	Average
ECS2c31A	332.3	339.4	342.7	338.2
ECS2c31B	333.1	337.6	348.5	339.7
ECS2c31C	334.3	338.9	353.2	342.1
ECS2c32A	338.0	341.9	354.8	344.9
ECS2c32B	336.6	341.3	357.3	345.1
ECS2c32C	343.9	343.6	340.2	342.6
ECS2c32D	337.4	349.0	355.6	347.4
ECS2c32E	339.5	350.5	357.8	349.3
ECS2c32F	339.0	350.2	360.9	350.0
ECS2c33A	310.0	323.0	334.4	322.5
ECS2c33B	312.2	324.2	335.0	323.8
ECS2c33C	314.3	331.2	345.2	330.2
ECS2c34A	322.5	323.7	315.4	320.5
ECS2c34B	322.3	323.1	316.1	320.5
ECS2c34C	328.7	326.2	321.6	325.5
ECS2c41A	337.2	342.4	342.4	340.7
ECS2c41B	337.2	344.0	344.5	341.9
ECS2c41C	339.3	345.4	345.1	343.3
ECS2c42A	338.7	341.6	339.3	339.9
ECS2c42B	339.2	342.6	339.6	340.5
ECS2c42C	341.8	346.6	341.8	343.4
ECS2c43A	312.5	318.4	316.4	315.8
ECS2c43B	313.3	320.6	318.3	317.4
ECS2c43C	317.1	325.5	323.5	322.0
ECS2c44A	317.3	319.9	314.3	317.2
ECS2c44B	317.3	321.7	316.6	318.5
ECS2c44C	323.8	325.4	319.0	322.7

Table D - 13 Level 3 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	150°	225°	330°	Average
ECS2c11A	333.0	333.8	328.5	331.8
ECS2c11B	334.7	336.3	331.1	334.0
ECS2c11C	335.9	338.2	332.7	335.6
ECS2c12A	332.8	349.9	358.9	347.2
ECS2c12B	332.7	353.8	363.5	350.0
ECS2c12C	339.3	354.4	356.7	350.1
ECS2c13A	331.7	355.7	363.0	350.1
ECS2c13B	336.9	360.6	361.4	353.0
ECS2c13C	343.9	344.6	343.0	343.8
ECS2c14A	335.9	335.8	336.5	336.0
ECS2c14B	343.0	341.0	336.5	340.2
ECS2c14C	346.5	343.4	339.5	343.1
ECS2c15A	337.0	336.8	337.5	337.1
ECS2c15B	338.4	337.8	340.8	339.0
ECS2c15C	340.3	341.1	343.8	341.7
ECS2c16A	336.6	337.8	342.3	338.9
ECS2c16B	341.4	341.9	345.6	343.0
ECS2c16C	341.9	343.3	347.0	344.0
ECS2c21A	343.4	351.3	342.1	345.6
ECS2c21B	345.2	354.5	343.7	347.8
ECS2c21C	346.7	355.7	345.0	349.1
ECS2c22A	359.0	365.8	353.2	359.3
ECS2c22B	361.3	368.9	356.1	362.1
ECS2c22C	362.9	371.0	357.3	363.7
ECS2c23A	317.3	326.4	320.6	321.4
ECS2c23B	320.8	331.7	323.5	325.3
ECS2c23C	323.7	336.3	324.1	328.0
ECS2c24A	335.5	353.2	333.4	340.7
ECS2c24B	340.9	359.8	337.6	346.1
ECS2c24C	347.1	364.5	341.5	351.1

Table D - 13 (cont.) Level 3 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	150°	225°	330°	Average
ECS2c31A	344.6	348.1	343.1	345.3
ECS2c31B	341.9	356.2	355.5	351.2
ECS2c31C	343.4	362.6	363.5	356.5
ECS2c32A	344.0	352.4	355.8	350.7
ECS2c32B	343.5	353.6	356.7	351.3
ECS2c32C	350.4	348.0	352.4	350.3
ECS2c32D	356.9	361.2	350.1	356.1
ECS2c32E	358.5	364.2	353.6	358.8
ECS2c32F	358.1	365.7	354.4	359.4
ECS2c33A	329.4	340.1	328.9	332.8
ECS2c33B	332.3	343.8	334.6	336.9
ECS2c33C	338.8	350.3	335.1	341.4
ECS2c34A	333.5	328.0	330.1	330.6
ECS2c34B	332.5	329.7	335.1	332.4
ECS2c34C	335.5	336.6	344.8	339.0
ECS2c41A	347.2	349.6	349.0	348.6
ECS2c41B	348.5	352.6	351.2	350.8
ECS2c41C	351.1	354.3	353.7	353.0
ECS2c42A	348.6	346.7	346.9	347.4
ECS2c42B	349.1	347.3	348.5	348.3
ECS2c42C	354.6	351.4	350.6	352.2
ECS2c43A	326.0	328.5	329.7	328.1
ECS2c43B	330.0	332.0	331.7	331.2
ECS2c43C	336.4	339.6	336.8	337.6
ECS2c44A	327.0	325.2	330.2	327.4
ECS2c44B	329.2	328.9	333.4	330.5
ECS2c44C	334.1	331.4	340.5	335.3

Table D - 14 Level 4 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	45°	225°	300°	Average
ECS2c11A	336.4	333.0		334.7
ECS2c11B	341.3	335.4		338.3
ECS2c11C	344.5	337.8		341.2
ECS2c12A	335.7	346.7		341.2
ECS2c12B	337.9	349.9		343.9
ECS2c12C	341.1	352.0		346.5
ECS2c13A	330.1	350.4		340.2
ECS2c13B	331.9	355.4		343.7
ECS2c13C	342.4	345.7		344.1
ECS2c14A	332.3	340.8		336.5
ECS2c14B	335.8	345.8		340.8
ECS2c14C	339.6	347.9		343.7
ECS2c15A	332.4	340.4		336.4
ECS2c15B	334.9	341.6		338.3
ECS2c15C	337.1	345.3		341.2
ECS2c16A	334.5	339.4		336.9
ECS2c16B	336.7	344.3		340.5
ECS2c16C	338.0	345.7		341.9
ECS2c21A	346.8	349.1		347.9
ECS2c21B	348.6	352.3		350.4
ECS2c21C	350.2	353.4		351.8
ECS2c22A	355.4	364.3		359.9
ECS2c22B	359.6	367.0		363.3
ECS2c22C	362.0	369.1		365.6
ECS2c23A	325.2	324.0		324.6
ECS2c23B	329.1	328.4		328.7
ECS2c23C	335.9	331.0		333.5
ECS2c24A	357.7	346.8		352.2
ECS2c24B	362.0	351.5		356.7
ECS2c24C	369.6	358.6		364.1

Table D - 14 (cont.) Level 4 Aluminum Temperatures (K).

TEST ID	Azimuthal Location			
	45°	225°	300°	Average
ECS2c31A	334.9	348.6		341.8
ECS2c31B	336.0	356.5		346.3
ECS2c31C	337.4	361.3		349.4
ECS2c32A	343.2	348.3		345.7
ECS2c32B	342.6	349.0		345.8
ECS2c32C	355.1	349.3		352.2
ECS2c32D	345.6	352.5		349.1
ECS2c32E	349.4	358.5		353.9
ECS2c32F	349.8	357.1		353.5
ECS2c33A	321.1	337.3		329.2
ECS2c33B	324.2	342.6		333.4
ECS2c33C	327.7	345.7		336.7
ECS2c34A	344.9	330.8		337.8
ECS2c34B	343.6	332.2		337.9
ECS2c34C	352.8	341.6		347.2
ECS2c41A	341.7	350.2		346.0
ECS2c41B	342.2	352.5		347.4
ECS2c41C	345.4	355.5		350.4
ECS2c42A	343.9	349.6		346.7
ECS2c42B	345.3	350.4		347.8
ECS2c42C	348.8	354.9		351.8
ECS2c43A	323.2	330.2		326.7
ECS2c43B	324.6	334.0		329.3
ECS2c43C	328.6	343.1		335.9
ECS2c44A	330.2	327.6		328.9
ECS2c44B	330.7	331.8		331.2
ECS2c44C	341.0	334.1		337.6

Table D - 15 Level 5 Aluminum Temperatures (K).

TEST ID	Azimuthal Location						
	0°	180°	270°	120°	225°	300°	Average
ECS2c11A	331.6	331.9	328.4	339.7	340.5	352.7	344.3
ECS2c11B	335.4	334.0	330.9	343.8	343.9	358.1	348.6
ECS2c11C	337.6	335.9	332.7	346.7	347.1	361.6	351.8
ECS2c12A	333.5	332.2	341.3	339.9	353.0	366.8	353.2
ECS2c12B	335.3	332.5	344.3	341.2	355.4	372.8	356.5
ECS2c12C	336.6	338.7	344.4	348.5	360.0	373.3	360.6
ECS2c13A	331.8	330.7	344.7	336.6	353.1	373.8	354.5
ECS2c13B	332.5	335.0	346.6	341.5	358.5	376.6	358.8
ECS2c13C	333.0	339.9	338.2	353.4	358.6	368.9	360.3
ECS2c14A	326.9	336.4	334.1	347.3	355.1	359.0	353.8
ECS2c14B	326.9	341.7	334.7	355.5	359.8	360.0	358.4
ECS2c14C	328.7	344.8	336.7	360.2	363.4	363.3	362.3
ECS2c15A	325.7	336.3	332.9	350.4	355.2	361.4	355.7
ECS2c15B	327.7	337.3	335.1	352.0	358.0	366.4	358.8
ECS2c15C	329.9	339.2	338.1	354.1	362.1	372.0	362.7
ECS2c16A	329.1	332.6	334.3	347.0	354.9	371.2	357.7
ECS2c16B	330.4	336.8	338.6	353.9	361.9	377.4	364.4
ECS2c16C	331.4	336.8	340.2	354.1	364.5	382.3	367.0
ECS2c21A	342.2	344.8	342.7	350.7	354.8	362.5	356.0
ECS2c21B	343.2	346.9	344.6	353.6	358.5	366.4	359.5
ECS2c21C	344.3	348.5	346.1	355.8	360.1	368.9	361.6
ECS2c22A	345.6	349.8	348.4	352.6	358.4	367.0	359.3
ECS2c22B	348.5	352.7	351.3	356.4	364.4	374.8	365.2
ECS2c22C	348.6	354.1	352.4	357.6	366.2	376.0	366.6
ECS2c23A	320.4	319.5	320.8	330.0	333.7	352.7	338.8
ECS2c23B	323.5	323.6	324.6	335.1	339.1	358.6	344.3
ECS2c23C	328.9	326.7	325.3	341.9	343.1	360.4	348.5
ECS2c24A	325.6	326.4	327.7	336.4	341.8	358.4	345.6
ECS2c24B	328.3	330.0	331.3	341.1	348.3	365.1	351.5
ECS2c24C	332.6	336.6	337.6	346.6	358.0	372.7	359.1

Table D - 15 (cont.) Level 5 Aluminum Temperatures (K).

TEST ID	Azimuthal Location						
	0°	180°	270°	120°	225°	300°	Average
ECS2c31A	335.9	344.2	343.2	349.2	355.2	364.1	356.2
ECS2c31B	340.1	343.2	353.6	346.7	361.6	379.3	362.5
ECS2c31C	342.7	344.5	359.0	347.9	365.7	385.2	366.3
ECS2c32A	345.6	344.7	349.5	349.1	358.7	374.4	360.7
ECS2c32B	344.9	344.4	349.7	349.1	360.2	377.0	362.1
ECS2c32C	344.8	346.7	344.6	360.4	360.9	372.1	364.4
ECS2c32D	344.0	348.0	347.9	354.5	360.5	371.2	362.0
ECS2c32E	346.3	350.2	350.6	356.4	364.4	376.4	365.7
ECS2c32F	346.4	350.4	351.5	358.8	366.1	378.6	367.8
ECS2c33A	317.1	328.5	326.8	339.3	351.8	360.4	350.5
ECS2c33B	319.8	332.5	332.2	346.0	359.7	368.2	358.0
ECS2c33C	321.7	337.7	333.6	353.5	364.0	371.5	363.0
ECS2c34A	323.4	327.5	323.1	348.8	347.0	358.1	351.3
ECS2c34B	326.2	325.9	327.4	342.1	349.0	367.5	352.9
ECS2c34C	333.3	330.4	335.6	352.2	359.7	379.8	363.9
ECS2c41A	338.7	346.0	344.3	354.4	361.7	369.3	361.8
ECS2c41B	339.8	347.0	346.5	355.4	365.2	373.6	364.7
ECS2c41C	340.9	349.5	348.1	360.4	368.6	377.1	368.7
ECS2c42A	338.1	347.2	342.7	358.9	361.3	364.1	361.4
ECS2c42B	338.7	348.6	343.3	361.9	364.4	365.8	364.0
ECS2c42C	339.8	353.1	345.6	369.1	370.2	369.0	369.4
ECS2c43A	315.4	322.3	323.9	334.7	347.7	363.0	348.5
ECS2c43B	316.1	325.2	326.7	339.6	353.1	370.0	354.2
ECS2c43C	319.6	331.2	333.3	350.7	362.5	379.2	364.1
ECS2c44A	319.7	323.5	324.2	341.7	347.0	362.5	350.4
ECS2c44B	320.3	326.2	327.7	346.6	353.0	370.2	356.6
ECS2c44C	327.9	327.0	333.1	350.4	357.1	381.7	363.1

Table D - 16 Level 6 Aluminum Temperatures (K).

TEST ID	Azimuthal Location				Subchannel Averages			
	0°	90°	180°	270°	A	B	C	D
ECS2c11A	340.6	335.3	320.7	330.5	360.5	344.4	339.0	346.4
ECS2c11B	345.7	339.3	320.8	333.3	368.2	349.4	342.7	351.5
ECS2c11C	348.9	342.2	324.9	335.3	373.1	353.1	345.8	354.9
ECS2c12A	346.2	334.4	333.5	339.6	358.4	348.3	348.4	357.0
ECS2c12B	350.1	336.4	332.3	342.0	363.5	350.9	350.7	361.9
ECS2c12C	352.8	340.9	341.2	343.8	368.9	358.9	356.0	365.1
ECS2c13A	345.3	328.9	332.6	340.5	349.3	345.4	346.8	357.3
ECS2c13B	348.7	332.0	337.6	343.3	353.4	351.4	352.4	360.3
ECS2c13C	350.1	342.4	343.9	340.6	365.8	364.3	356.1	360.4
ECS2c14A	341.5	335.4	340.0	336.3	351.2	357.7	352.8	350.4
ECS2c14B	342.8	340.3	344.6	336.7	356.3	364.7	355.9	350.7
ECS2c14C	345.6	344.1	348.3	339.5	361.4	370.8	360.5	353.8
ECS2c15A	339.8	337.3	341.1	335.4	353.1	361.6	352.3	350.2
ECS2c15B	343.6	339.3	342.8	337.6	358.5	363.5	355.0	354.1
ECS2c15C	347.8	341.4	345.1	341.0	362.8	366.6	358.8	361.5
ECS2c16A	348.0	336.7	338.3	337.5	360.1	358.7	351.3	360.2
ECS2c16B	350.9	341.7	344.0	341.6	365.9	367.1	358.2	364.8
ECS2c16C	353.9	342.1	344.9	343.6	370.0	368.4	361.2	372.3
ECS2c21A	347.7	346.7	345.7	344.5	364.7	357.1	352.8	357.2
ECS2c21B	351.0	348.8	348.3	346.3	368.8	360.8	356.0	359.9
ECS2c21C	351.8	350.6	350.2	348.1	371.4	363.8	358.3	363.2
ECS2c22A	358.7	353.9	353.5	353.8	365.3	365.1	360.7	365.3
ECS2c22B	361.9	356.3	355.6	356.3	371.0	369.7	364.1	370.3
ECS2c22C	364.3	358.6	357.8	358.0	373.2	372.0	366.2	372.5
ECS2c23A	331.6	327.1	322.6	323.6	357.9	340.6	332.4	346.5
ECS2c23B	336.0	332.1	327.0	327.5	366.7	346.7	337.9	352.0
ECS2c23C	340.6	336.9	330.7	330.1	376.7	353.6	342.6	356.0
ECS2c24A	342.4	338.5	317.6	336.3	357.2	354.6	344.7	356.4
ECS2c24B	353.8	342.6	319.4	340.7	363.8	361.0	349.8	363.6
ECS2c24C	353.6	348.6	322.9	346.1	370.9	366.4	356.0	370.1

Table D - 16 (cont.) Level 6 Aluminum Temperatures (K).

TEST ID	Azimuthal Location				Subchannel Averages			
	0°	90°	180°	270°	A	B	C	D
ECS2c31A	340.4	337.5	344.9	344.5	345.1	354.5	353.1	356.2
ECS2c31B	344.0	337.1	344.7	353.0	347.2	354.0	358.3	366.2
ECS2c31C	346.8	338.3	346.0	357.5	349.6	355.6	361.3	371.4
ECS2c32A	355.2	345.3	346.8	350.5	359.1	356.9	356.1	364.5
ECS2c32B	355.8	345.1	346.5	350.6	361.2	358.2	356.2	366.0
ECS2c32C	352.9	353.4	350.4	347.7	372.2	369.2	358.9	365.4
ECS2c32D	352.1	350.1	350.9	350.5	363.0	364.2	358.4	363.8
ECS2c32E	356.6	353.1	353.7	353.1	368.2	368.3	362.0	368.3
ECS2c32F	356.4	353.9	354.6	354.2	369.8	370.3	363.4	370.2
ECS2c33A	331.1	326.5	333.4	329.7	349.9	354.5	347.9	353.1
ECS2c33B	335.5	332.2	339.7	335.9	357.1	363.6	357.0	360.4
ECS2c33C	339.1	336.2	345.0	337.4	363.0	370.5	361.2	365.9
ECS2c34A	335.0	335.5	316.2	327.6	361.2	357.4	342.8	351.4
ECS2c34B	340.1	336.4	316.4	330.7	364.6	357.6	342.6	359.4
ECS2c34C	347.7	341.4	320.5	340.0	377.3	367.2	357.0	372.9
ECS2c41A	346.5	344.7	348.2	347.0	356.7	363.2	358.7	361.2
ECS2c41B	348.9	345.4	350.1	349.6	360.7	365.2	362.3	365.6
ECS2c41C	351.5	349.3	353.0	351.7	363.7	370.5	365.3	368.8
ECS2c42A	346.5	347.9	350.5	345.6	359.4	367.0	359.3	355.8
ECS2c42B	347.3	350.3	353.2	346.6	363.6	372.2	362.8	358.4
ECS2c42C	350.0	354.7	358.4	349.1	368.3	378.9	367.6	360.9
ECS2c43A	332.0	327.2	329.8	326.6	353.4	355.7	344.5	353.8
ECS2c43B	334.4	330.2	333.8	329.6	357.8	362.6	350.1	359.8
ECS2c43C	340.3	336.6	341.3	336.8	365.1	360.1	359.9	369.6
ECS2c44A	334.5	330.2	330.3	327.8	356.9	357.6	343.3	354.2
ECS2c44B	337.0	333.3	318.4	331.3	361.8	363.3	350.1	359.9
ECS2c44C	345.7	338.4	337.5	336.9	371.2	368.3	354.8	371.3

Table D - 17 Level 6 Aluminum Temperatures (K) - Within Subchannels.

TEST ID	Azimuthal Locations within Subchannels							
	30°	60°	120°	150°	210°	240°	300°	330°
ECS2c11A	362.5	358.5	345.7	343.2	336.3	341.7	349.5	343.2
ECS2c11B	370.7	365.7	350.7	348.1	339.8	345.6	354.9	348.1
ECS2c11C	375.6	370.6	354.8	351.4	342.5	349.1	358.7	351.1
ECS2c12A	362.4	354.4	350.5	346.1	342.9	354.0	362.2	351.7
ECS2c12B	368.1	358.9	353.6	348.1	34[illegible]8	356.6	367.7	356.0
ECS2c12C	373.2	364.7	361.3	356.4	350.1	361.9	371.4	358.8
ECS2c13A	354.2	344.4	348.9	342.0	341.5	352.1	363.8	350.8
ECS2c13B	358.6	348.2	354.4	348.5	346.9	358.0	367.5	353.1
ECS2c13C	369.8	361.8	368.6	360.1	351.2	361.1	367.8	353.0
ECS2c14A	354.3	348.1	360.9	354.4	348.8	356.8	357.5	343.4
ECS2c14B	359.0	353.5	368.1	361.2	351.9	359.8	358.1	343.3
ECS2c14C	364.1	358.6	374.9	366.6	356.0	365.0	361.0	346.6
ECS2c15A	356.5	349.7	365.1	358.0	347.8	356.7	357.8	342.6
ECS2c15B	362.5	354.5	367.0	360.0	350.1	359.9	362.2	346.1
ECS2c15C	367.1	358.6	370.7	362.4	353.1	364.5	370.0	353.0
ECS2c16A	365.1	355.0	364.0	353.3	345.0	357.7	368.3	352.0
ECS2c16B	370.9	360.9	372.5	361.6	351.6	364.7	373.7	355.8
ECS2c16C	375.9	364.2	374.5	362.3	353.9	368.5	383.6	360.9
ECS2c21A	366.5	363.0	358.3	355.9	350.8	354.8	360.5	354.0
ECS2c21B	370.9	366.8	362.0	359.7	353.7	358.3	363.6	356.1
ECS2c21C	373.2	369.6	365.1	362.6	356.0	360.6	366.9	359.5
ECS2c22A	367.8	362.8	367.5	362.7	357.4	364.0	368.8	361.8
ECS2c22B	374.6	367.5	372.6	366.8	359.9	368.2	374.9	365.8
ECS2c22C	376.5	370.0	374.9	369.1	362.3	370.1	376.9	368.1
ECS2c23A	360.8	355.0	342.8	338.5	329.6	335.1	351.3	341.7
ECS2c23B	369.8	363.6	349.2	344.3	334.8	341.0	357.3	346.7
ECS2c23C	380.3	373.2	356.3	350.9	339.2	345.9	361.4	350.6
ECS2c24A	362.1	352.2	361.3	348.0	341.4	347.9	362.0	350.9
ECS2c24B	370.7	356.9	368.5	353.5	346.0	353.6	370.4	356.8
ECS2c24C	376.3	365.4	375.5	357.4	351.8	360.2	376.7	363.6

Table D - 17 (cont.) **Level 6 Aluminum Temperatures (K) - Within Subchannels.**

TEST ID	Azimuthal Locations within Subchannels							
	30°	60°	120°	150°	210°	240°	300°	330°
ECS2c31A	347.8	342.3	355.0	354.1	350.7	355.5	360.5	351.8
ECS2c31B	351.0	343.4	354.5	353.5	353.7	362.9	372.0	360.5
ECS2c31C	353.7	345.4	356.2	354.9	356.0	366.7	377.6	365.2
ECS2c32A	363.0	355.2	359.5	354.4	352.1	360.0	369.1	359.9
ECS2c32B	365.6	356.8	361.2	355.2	352.1	360.3	371.5	360.4
ECS2c32C	375.1	369.3	372.9	365.4	355.3	362.5	370.8	360.0
ECS2c32D	366.1	359.9	366.5	361.8	354.7	362.1	368.5	359.0
ECS2c32E	371.9	364.5	371.1	365.6	358.0	366.0	373.6	363.1
ECS2c32F	373.5	366.2	373.7	367.0	359.1	367.8	375.5	364.8
ECS2c33A	354.4	345.3	359.4	349.5	342.9	353.0	361.9	344.4
ECS2c33B	362.2	352.1	368.8	358.4	351.4	362.6	370.5	350.3
ECS2c33C	367.7	358.2	376.3	364.7	355.9	366.5	376.4	355.4
ECS2c34A	364.9	357.5	364.9	349.9	337.9	347.6	359.0	343.8
ECS2c34B	369.3	360.0	368.1	347.0	338.0	347.2	368.1	350.6
ECS2c34C	382.3	372.3	375.8	358.6	350.0	364.0	382.9	363.0
ECS2c41A	361.4	352.0	365.9	360.5	354.4	363.0	367.8	354.7
ECS2c41B	365.8	355.6	367.8	362.6	357.4	367.2	373.0	358.3
ECS2c41C	369.3	358.0	373.7	367.3	360.0	370.7	376.5	361.0
ECS2c42A	361.4	357.4	369.9	364.2	356.1	362.4	361.8	349.7
ECS2c42B	365.8	361.3	375.2	369.2	359.6	366.0	365.0	351.7
ECS2c42C	370.0	366.6	382.1	375.8	364.1	371.2	367.9	353.9
ECS2c43A	358.5	348.4	363.4	347.9	338.4	350.6	364.5	343.1
ECS2c43B	363.3	352.3	370.8	354.4	343.5	356.7	371.5	348.1
ECS2c43C	371.2	359.1	355.8	364.5	352.3	367.5	382.9	356.3
ECS2c44A	361.6	352.2	366.0	349.2	337.3	349.4	364.2	344.2
ECS2c44B	366.5	357.1	372.1	354.5	343.7	356.4	371.4	348.5
ECS2c44C	376.6	365.8	378.2	358.3	346.9	362.7	383.8	358.8

Table D - 18 Level 7 Aluminum Temperatures (K).

TEST ID	Azimuthal Location under Fins				Azimuthal Location within Subchannel			
	0°	90°	180°	270°	45°	150°	225°	330°
ECS2c11A	342.5	339.6	332.8	333.3	357.5	344.7	339.5	349.9
ECS2c11B	347.5	343.8	336.1	336.2	363.9	349.5	343.0	354.4
ECS2c11C	350.6	347.3	338.3	338.0	368.4	353.3	345.9	357.8
ECS2c12A	347.6	337.8	336.1	339.3	351.2	347.7	346.6	354.3
ECS2c12B	350.3	339.0	337.5	340.2	352.2	349.6	347.5	355.6
ECS2c12C	354.6	344.4	342.7	343.2	358.9	356.8	352.8	361.8
ECS2c13A	345.0	335.2	335.1	339.1	346.8	344.3	345.1	352.6
ECS2c13B	348.3	338.4	339.2	342.5	349.8	349.7	349.4	356.5
ECS2c13C	352.1	346.8	345.0	342.1	360.5	360.1	353.0	358.7
ECS2c14A	340.4	338.5	341.1	336.9	346.0	353.4	349.1	345.7
ECS2c14B	342.7	343.3	345.3	337.7	350.8	360.1	351.8	347.3
ECS2c14C	346.2	346.1	348.6	340.7	353.9	364.8	355.5	352.3
ECS2c15A	340.1	339.3	342.7	336.9	346.8	358.8	350.5	346.6
ECS2c15B	345.0	341.5	343.6	338.9	350.7	361.4	351.7	351.0
ECS2c15C	348.0	343.5	346.8	342.5	354.2	365.3	355.7	357.8
ECS2c16A	347.8	337.3	339.5	338.9	350.8	356.4	348.5	356.9
ECS2c16B	352.1	342.7	345.1	342.9	355.8	365.9	353.7	361.1
ECS2c16C	357.4	342.8	346.4	344.9	358.1	366.3	356.0	366.2
ECS2c21A	349.4	351.1	347.1	346.0	365.9	359.0	351.4	354.6
ECS2c21B	351.2	352.8	349.5	348.1	368.9	362.6	354.2	356.8
ECS2c21C	353.3	355.3	351.7	350.1	371.5	366.1	356.1	360.6
ECS2c22A	361.8	357.5	359.3	358.7	365.9	368.3	365.0	367.7
ECS2c22B	365.2	360.6	362.2	361.8	370.2	373.0	368.8	372.3
ECS2c22C	368.5	363.1	364.9	364.1	373.7	376.8	371.8	375.6
ECS2c23A	333.7	330.9	325.8	325.7	359.0	344.2	333.5	340.7
ECS2c23B	339.0	336.0	330.4	330.2	366.2	350.9	338.5	346.5
ECS2c23C	345.7	340.2	333.9	334.0	377.0	356.0	344.6	350.7
ECS2c24A	346.6	344.0	345.7	344.6	355.1	353.8	352.5	351.0
ECS2c24B	351.3	348.3	350.4	349.1	361.0	359.7	357.8	355.9
ECS2c24C	358.6	355.4	357.9	356.1	368.8	367.1	366.0	364.6

Table D - 18 (cont). Level 7 Aluminum Temperatures (K).

TEST ID	Azimuthal Location under Fins				Azimuthal Location within Subchannel			
	0°	90°	180°	270°	45°	150°	225°	330°
ECS2c31A	340.2	338.2	344.3	345.5	343.0	352.3	351.1	348.5
ECS2c31B	341.4	338.8	345.3	350.5	344.4	354.3	355.5	349.7
ECS2c31C	344.1	340.2	346.8	353.7	346.2	356.3	358.1	352.8
ECS2c32A	350.9	346.9	348.0	350.9	355.8	354.7	355.2	354.7
ECS2c32B	351.9	347.1	347.8	350.8	357.0	355.9	355.7	358.7
ECS2c32C	352.7	353.1	351.2	349.1	362.4	357.9	356.7	354.9
ECS2c32D	355.9	351.5	353.3	352.7	360.3	363.6	359.2	362.1
ECS2c32E	360.1	355.1	356.9	355.8	364.8	368.9	363.1	366.9
ECS2c32F	361.1	356.0	358.0	356.8	366.3	370.6	364.2	368.1
ECS2c33A	331.4	327.7	333.1	330.0	345.1	352.6	341.9	339.6
ECS2c33B	335.6	334.1	340.1	336.0	351.7	353.5	350.5	343.0
ECS2c33C	341.1	337.6	344.7	339.1	357.1	368.7	354.2	348.2
ECS2c34A	333.7	333.1	332.3	329.1	347.4	341.2	338.3	339.8
ECS2c34B	339.6	336.1	334.7	332.7	353.6	351.4	341.7	342.6
ECS2c34C	344.1	342.8	339.8	340.6	361.7	364.5	350.7	348.8
ECS2c41A	347.7	345.3	349.1	347.2	353.5	362.7	356.6	350.1
ECS2c41B	351.2	346.4	350.6	349.5	355.4	365.2	359.1	352.8
ECS2c41C	349.9	349.3	354.3	352.4	360.0	371.0	363.4	355.5
ECS2c42A	347.0	348.4	350.4	345.5	355.1	362.2	356.0	346.2
ECS2c42B	348.6	351.3	353.5	347.0	358.2	367.7	359.4	347.5
ECS2c42C	350.0	356.4	359.0	349.2	363.6	374.7	363.3	349.0
ECS2c43A	330.9	326.9	331.4	327.3	343.9	353.7	339.7	333.4
ECS2c43B	333.4	330.0	334.2	330.2	347.1	360.8	343.3	337.1
ECS2c43C	339.4	336.0	341.8	337.7	352.6	370.6	352.9	343.9
ECS2c44A	332.2	332.4	332.9	328.1	346.5	351.2	339.4	333.1
ECS2c44B	334.0	336.1	337.5	331.5	350.9	360.2	344.7	336.5
ECS2c44C	342.3	341.0	341.9	338.4	358.5	366.5	351.2	353.1

APPENDIX E

ECS-2c TABULATIONS
OF
ALUMINUM TEMPERATURES
MODIFIED USING POWER CORRECTION

APPENDIX E

ECS-2c TABULATIONS
OF
ALUMINUM TEMPERATURES
MODIFIED USING POWER CORRECTION

The aluminum temperatures measured during the various ECS-2 experimental series have been observed to exhibit large (≈ 60 K) azimuthal variations (see References 1 and 2) that increase with increasing test section power. It has been postulated that these variations are a result of installation effects, perhaps a result of the thermocouples measuring a temperature closer to the Macor insulator temperature than to the aluminum temperature. It was proposed that this azimuthal variation could, and should, be removed through the use of a linear correction as a function of test section poser, based upon all liquid test data. This correction process was evaluated and documented in Reference 2, with the recommendation that the correction process not be applied to the ECS-2c data, since a viable physical mechanism to explain the azimuthal variation that was consistent with all of the observed data could not be identified. However, since the data corrections had been conditionally applied to the ECS-2c data and some preliminary analysis had been performed, it was decided to document this work. The tabulations in this appendix are based upon the time average data values and the correction methodology documented in Reference 2. A listing of these tables is provided.

REFERENCES

1. J. L. Anderson, K. G. Condie, and T. K. Larson, Downflow Heat Transfer in a Heated Ribbed Vertical Annulus with a Cosine Power Profile (Results from Test Series ECS-2b), EGG-EAST-9144.

2. J. L. Anderson, T. K. Larson, and K. G. Condie, Metal Thermocouple Correction Methodology and Evaluation (Ecs-2c and ECS-2b Test Series), EGG-EAST-9352, June 1991.

LIST OF TABLES

Table E - 1 **Correction Coefficients for Aluminum Thermocouples, based upon LFb Series.**

ID	Intercept (K)	Slope (K/kW)[1]	ID	Intercept (K)	Slope (K/kW)
TI_A_d_1	1.3	-0.01364	TI_A_a_6	1.2	0.15882
TI_C_p_1	1.4	0.01648	TI_A_c_6	0.6	0.36324
			TI_A_e_6	2.4	0.17101
TI_A_d_2	-1.2	0.00790	TI_B_g_6	-1.7	-0.00325
TI_B_k_2	-1.3	0.04526	TI_B_i_6	2.8	0.29222
TI_C_p_2	0.7	-0.03448	TI_B_k_6	4.7	0.11035
TI_D_w_2[2]			TI_C_m_6[3]		
			TI_C_o_6	1.8	0.17838
TI_A_d_3[4]			TI_C_q_6	0.6	0.23414
TI_B_k_3	2.9	-0.06755	TI_D_s_6	-1.0	0.00041
TI_C_p_3	0.5	0.00419	TI_D_u_6	4.2	0.42511
TI_D_w_3	7.3	0.04863	TI_D_w_6	2.2	0.20561
TI_A_d_4	1.7	-0.02781	TI_A_a_7	3.4	0.08640
TI_C_p_4	-0.1	-0.01372	TI_A_d_7	1.8	0.10203
TI_D_u_4	7.8	-0.51248	TI_B_g_7	-1.2	-0.03214
			TI_B_k_7	4.4	0.02700
TI_A_a_5	1.5	-0.15177	TI_C_m_7	-1.8	-0.04406
TI_A_d_5[5]			TI_C_p_7	-0.5	0.03821
TI_B_i_5	1.9	0.07070	TI_D_s_7	-0.9	-0.00808
TI_C_m_5	0.8	-0.16663	TI_D_w_7	4.8	0.13095
TI_C_p_5	1.9	0.08482			
TI_D_s_5	0.1	-0.03973	TI_A_d_8	1.3	-0.03510
			TI_C_p_8	0.1	-0.01271

1 **The correction coefficients were set to zero (0) during TC correction for all thermocouples in which the tabulated slope is negative.**

2 TI_D_w_2 failed prior to the ECS-2c test series.

3 TI_C_m_6 failed prior to the ECS-2c test series.

4 TI_A_d_3 appears to have failed prior to or during the LFb tests. Therefore no correction coefficients exist.

5 TI_A_d_5 failed between the LFb and ECS-2c tests. Therefore no correction coefficients exist.

Table E - 2 **Level 1 & 8 Aluminum Temperatures (K) - using Power Correction Methodology**

TEST ID	Level 1 Azimuthal Location			Level 8 Azimuthal Location		
	45°	225°	Maximum	45°	225°	Maximum
ECS2c11A	314.9	327.0	327.0	332.1	331.6	332.1
ECS2c11B	315.6	329.4	329.4	335.1	334.2	335.1
ECS2c11C	315.8	330.9	330.9	337.4	336.0	337.4
ECS2c12A	318.4	335.5	335.5	336.8	337.3	337.3
ECS2c12B	318.3	338.5	338.5	338.7	340.7	340.7
ECS2c12C	318.8	340.3	340.3	342.2	344.0	344.0
ECS2c13A	317.3	335.6	335.6	334.1	337.3	337.3
ECS2c13B	317.6	340.5	340.5	337.1	340.6	340.6
ECS2c13C	320.9	326.8	326.8	342.8	344.3	344.3
ECS2c14A	317.9	320.0	320.0	332.9	339.4	339.4
ECS2c14B	318.8	321.8	321.8	334.8	341.7	341.7
ECS2c14C	320.6	323.0	323.0	337.0	344.6	344.6
ECS2c15A	317.9	320.0	320.0	334.1	341.9	341.9
ECS2c15B	318.8	320.7	320.7	336.4	342.5	342.5
ECS2c15C	319.6	322.3	322.3	338.8	345.6	345.6
ECS2c16A	318.4	320.9	320.9	335.6	340.4	340.4
ECS2c16B	319.8	322.7	322.7	339.0	344.9	344.9
ECS2c16C	319.3	322.6	322.6	340.7	346.4	346.4
ECS2c21A	329.7	341.9	341.9	354.6	348.2	354.6
ECS2c21B	329.7	344.4	344.4	356.9	350.6	356.9
ECS2c21C	329.6	345.7	345.7	359.9	352.1	359.9
ECS2c22A	333.3	355.0	355.0	359.6	362.6	362.6
ECS2c22B	334.2	357.2	357.2	362.4	366.2	366.2
ECS2c22C	333.2	360.0	360.0	365.4	368.9	368.9
ECS2c23A	299.6	315.4	315.4	339.0	328.7	339.0
ECS2c23B	300.5	318.7	318.7	345.0	332.9	345.0
ECS2c23C	300.8	321.2	321.2	353.7	338.1	353.7
ECS2c24A	304.0	335.6	335.6	344.2	348.4	348.4
ECS2c24B	305.1	338.8	338.8	349.6	353.2	353.2
ECS2c24C	306.3	344.8	344.8	356.5	361.1	361.1

Table E - 2 (cont.) **Level 1 & 8 Aluminum Temperatures (K) - using Power Correction Methodology**

TEST ID	Level 1 Azimuthal Location			Level 8 Azimuthal Location		
	45°	225°	Maximum	45°	225°	Maximum
ECS2c31A	328.6	337.0	337.0	337.8	346.4	346.4
ECS2c31B	329.1	339.9	339.9	338.4	349.0	349.0
ECS2c31C	329.8	342.8	342.8	339.9	350.8	350.8
ECS2c32A	332.5	347.1	347.1	347.5	350.0	350.0
ECS2c32B	330.7	348.6	348.6	347.7	350.0	350.0
ECS2c32C	335.8	334.4	335.8	350.6	350.7	350.7
ECS2c32D	331.4	347.5	347.5	351.5	354.9	354.9
ECS2c32E	332.7	348.2	348.2	354.7	357.5	357.5
ECS2c32F	331.5	350.2	350.2	355.6	358.7	358.7
ECS2c33A	301.1	325.8	325.8	332.4	333.3	333.3
ECS2c33B	302.4	323.4	323.4	335.9	339.9	339.9
ECS2c33C	303.7	332.7	332.7	338.9	343.8	343.8
ECS2c34A	310.0	306.9	310.0	328.6	330.1	330.1
ECS2c34B	309.2	307.3	309.2	332.4	332.9	332.9
ECS2c34C	314.3	311.5	314.3	338.5	338.8	338.8
ECS2c41A	331.5	336.5	336.5	344.2	351.3	351.3
ECS2c41B	331.2	338.1	338.1	345.9	353.2	353.2
ECS2c41C	332.6	338.4	338.4	348.3	356.1	356.1
ECS2c42A	332.3	333.6	333.6	345.4	348.7	348.7
ECS2c42B	332.1	333.4	333.4	345.7	350.4	350.4
ECS2c42C	333.9	335.3	335.3	349.7	352.3	352.3
ECS2c43A	302.2	308.5	308.5	326.3	330.2	330.2
ECS2c43B	301.8	310.1	310.1	329.0	332.0	332.0
ECS2c43C	304.9	313.4	313.4	333.9	339.9	339.9
ECS2c44A	304.6	306.6	306.6	326.9	327.8	327.8
ECS2c44B	303.7	307.6	307.6	328.2	332.9	332.9
ECS2c44C	308.3	310.0	310.0	335.1	338.3	338.3

Table E - 3 Level 2 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location					
	45°	150°	225°	330°	Average	Maximum
ECS2c11A	322.3	325.9	330.7		326.3	330.7
ECS2c11B	323.9	327.2	333.0		328.1	333.0
ECS2c11C	324.6	327.9	334.4		329.0	334.4
ECS2c12A	326.1	326.2	344.9		332.4	344.9
ECS2c12B	326.6	325.7	349.7		334.0	349.7
ECS2c12C	327.7	330.9	349.9		336.2	349.9
ECS2c13A	324.5	325.8	347.1		332.5	347.1
ECS2c13B	325.2	330.1	353.9		336.4	353.9
ECS2c13C	330.6	333.5	334.3		332.8	334.3
ECS2c14A	326.3	327.2	326.4		326.6	327.2
ECS2c14B	327.6	331.7	329.5		329.6	331.7
ECS2c14C	330.0	334.4	331.2		331.9	334.4
ECS2c15A	326.4	328.2	326.8		327.1	328.2
ECS2c15B	328.2	329.6	327.7		328.5	329.6
ECS2c15C	329.4	331.3	329.8		330.2	331.3
ECS2c16A	327.7	328.8	328.0		328.2	328.8
ECS2c16B	329.6	332.0	330.4		330.7	332.0
ECS2c16C	330.0	332.2	330.7		331.0	332.2
ECS2c21A	336.4	338.9	349.0		341.5	349.0
ECS2c21B	336.8	340.2	353.3		343.4	353.3
ECS2c21C	337.2	340.7	354.2		344.1	354.2
ECS2c22A	341.9	350.5	363.4		351.9	363.4
ECS2c22B	343.5	351.8	367.4		354.2	367.4
ECS2c22C	343.4	352.7	370.0		355.3	370.0
ECS2c23A	308.3	311.9	322.6		314.3	322.6
ECS2c23B	309.9	314.5	327.2		317.2	327.2
ECS2c23C	311.1	316.7	331.9		319.9	331.9
ECS2c24A	317.3	325.7	351.6		331.5	351.6
ECS2c24B	319.3	330.1	356.5		335.3	356.5
ECS2c24C	322.2	334.2	364.5		340.3	364.5

Table E - 3 (cont.) **Level 2 Aluminum Temperatures (K) - using Power Correction Methodology**

TEST ID	Azimuthal Location					
	45°	150°	225°	330°	Average	Maximum
ECS2c31A	333.2	339.5	342.7		338.5	342.7
ECS2c31B	334.1	337.6	348.5		340.0	348.5
ECS2c31C	335.2	338.7	353.2		342.4	353.2
ECS2c32A	338.8	341.4	354.8		345.0	354.8
ECS2c32B	337.4	340.6	357.3		345.1	357.3
ECS2c32C	344.7	342.8	340.2		342.6	344.7
ECS2c32D	338.3	348.4	355.6		347.4	355.6
ECS2c32E	340.3	349.7	357.8		349.3	357.8
ECS2c32F	339.7	349.2	360.9		350.0	360.9
ECS2c33A	310.6	321.4	334.4		322.1	334.4
ECS2c33B	312.8	322.2	335.0		323.3	335.0
ECS2c33C	314.8	328.8	345.2		329.6	345.2
ECS2c34A	323.2	321.9	315.4		320.2	323.2
ECS2c34B	322.9	321.0	316.1		320.0	322.9
ECS2c34C	329.2	323.8	321.6		324.9	329.2
ECS2c41A	338.0	341.5	342.4		340.6	342.4
ECS2c41B	337.9	342.9	344.5		341.8	344.5
ECS2c41C	340.0	344.1	345.1		343.1	345.1
ECS2c42A	339.6	341.0	339.3		340.0	341.0
ECS2c42B	340.0	341.7	339.6		340.4	341.7
ECS2c42C	342.5	345.5	341.8		343.3	345.5
ECS2c43A	313.0	316.1	316.4		315.2	316.4
ECS2c43B	313.8	317.9	318.3		316.6	318.3
ECS2c43C	317.5	322.5	323.5		321.2	323.5
ECS2c44A	317.8	317.7	314.3		316.6	317.8
ECS2c44B	317.8	319.0	316.6		317.8	319.0
ECS2c44C	324.2	322.3	319.0		321.8	324.2

Table E - 4 Level 3 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location			Average	Maximum
	150°	225°	330°		
ECS2c11A	333.0	333.2	319.9	328.7	333.2
ECS2c11B	334.7	335.6	322.4	330.9	335.6
ECS2c11C	335.9	337.5	323.8	332.4	337.5
ECS2c12A	332.8	349.2	349.6	343.9	349.6
ECS2c12B	332.7	353.1	353.9	346.6	353.9
ECS2c12C	339.3	353.7	347.0	346.6	353.7
ECS2c13A	331.7	355.0	353.4	346.7	355.0
ECS2c13B	336.9	359.8	351.6	349.4	359.8
ECS2c13C	343.9	343.8	332.9	340.2	343.9
ECS2c14A	335.9	335.1	326.7	332.5	335.9
ECS2c14B	343.0	340.3	326.5	336.6	343.0
ECS2c14C	346.5	342.6	329.2	339.4	346.5
ECS2c15A	337.0	336.0	327.3	333.5	337.0
ECS2c15B	338.4	337.0	330.3	335.2	338.4
ECS2c15C	340.3	340.3	333.0	337.9	340.3
ECS2c16A	336.6	337.0	331.4	335.0	337.0
ECS2c16B	341.4	341.0	334.3	338.9	341.4
ECS2c16C	341.9	342.4	335.4	339.9	342.4
ECS2c21A	343.4	350.7	333.6	342.6	350.7
ECS2c21B	345.2	353.9	335.1	344.7	353.9
ECS2c21C	346.7	355.0	336.2	346.0	355.0
ECS2c22A	359.0	365.1	344.0	356.0	365.1
ECS2c22B	361.3	368.2	346.7	358.7	368.2
ECS2c22C	362.9	370.2	347.7	360.3	370.2
ECS2c23A	317.3	325.7	311.5	318.2	325.7
ECS2c23B	320.8	331.0	314.2	322.0	331.0
ECS2c23C	323.7	335.5	314.6	324.6	335.5
ECS2c24A	335.5	352.4	323.3	337.1	352.4
ECS2c24B	340.9	359.0	327.2	342.3	359.0
ECS2c24C	347.1	363.6	330.8	347.2	363.6

Table E - 4 (cont.) Level 3 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location				
	150°	225°	330°	Average	Maximum
ECS2c31A	344.6	347.5	334.4	342.2	347.5
ECS2c31B	341.9	355.6	346.7	348.1	355.6
ECS2c31C	343.4	361.9	354.5	353.3	361.9
ECS2c32A	344.0	351.7	346.5	347.4	351.7
ECS2c32B	343.5	352.9	347.3	347.9	352.9
ECS2c32C	350.4	347.3	342.7	346.8	350.4
ECS2c32D	356.9	360.5	340.7	352.7	360.5
ECS2c32E	358.5	363.5	344.0	355.3	363.5
ECS2c32F	358.1	365.0	344.5	355.9	365.0
ECS2c33A	329.4	339.3	318.3	329.0	339.3
ECS2c33B	332.3	343.0	323.7	333.0	343.0
ECS2c33C	338.8	349.5	323.8	337.4	349.5
ECS2c34A	333.5	327.2	319.5	326.7	333.5
ECS2c34B	332.5	328.8	324.0	328.5	332.5
ECS2c34C	335.5	335.7	333.4	334.9	335.7
ECS2c41A	347.2	348.9	339.3	345.1	348.9
ECS2c41B	348.5	351.8	341.3	347.2	351.8
ECS2c41C	351.1	353.5	343.5	349.4	353.5
ECS2c42A	348.6	346.0	337.5	344.0	348.6
ECS2c42B	349.1	346.6	338.8	344.8	349.1
ECS2c42C	354.6	350.7	340.6	348.6	354.6
ECS2c43A	326.0	327.7	318.5	324.1	327.7
ECS2c43B	330.0	331.1	320.0	327.0	331.1
ECS2c43C	336.4	338.6	324.7	333.3	338.6
ECS2c44A	327.0	324.3	319.0	323.4	327.0
ECS2c44B	329.2	328.0	321.8	326.3	329.2
ECS2c44C	334.1	330.4	328.5	331.0	334.1

Table E - 5 **Level 4 Aluminum Temperatures (K) - using Power Correction Methodology**

TEST ID	Azimuthal Location			
	45°	225°	Average	Maximum
ECS2c11A	336.4	333.0	334.7	336.4
ECS2c11B	341.3	335.4	338.3	341.3
ECS2c11C	344.5	337.8	341.2	344.5
ECS2c12A	335.7	346.7	341.2	346.7
ECS2c12B	337.9	349.9	343.9	349.9
ECS2c12C	341.1	352.0	346.5	352.0
ECS2c13A	330.1	350.4	340.2	350.4
ECS2c13B	331.9	355.4	343.7	355.4
ECS2c13C	342.4	345.7	344.1	345.7
ECS2c14A	332.3	340.8	336.5	340.8
ECS2c14B	335.8	345.8	340.8	345.8
ECS2c14C	339.6	347.9	343.7	347.9
ECS2c15A	332.4	340.4	336.4	340.4
ECS2c15B	334.9	341.6	338.3	341.6
ECS2c15C	337.1	345.3	341.2	345.3
ECS2c16A	334.5	339.4	336.9	339.4
ECS2c16B	336.7	344.3	340.5	344.3
ECS2c16C	338.0	345.7	341.9	345.7
ECS2c21A	346.8	349.1	347.9	349.1
ECS2c21B	348.6	352.3	350.4	352.3
ECS2c21C	350.2	353.4	351.8	353.4
ECS2c22A	355.4	364.3	359.9	364.3
ECS2c22B	359.6	367.0	363.3	367.0
ECS2c22C	362.0	369.1	365.6	369.1
ECS2c23A	325.2	324.0	324.6	325.2
ECS2c23B	329.1	328.4	328.7	329.1
ECS2c23C	335.9	331.0	333.5	335.9
ECS2c24A	357.7	346.8	352.2	357.7
ECS2c24B	362.0	351.5	356.7	362.0
ECS2c24C	369.6	358.6	364.1	369.6

Table E - 5 (cont.) Level 4 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location			
	45°	225°	Average	Maximum
ECS2c31A	334.9	348.6	341.8	348.6
ECS2c31B	336.0	356.5	346.3	356.5
ECS2c31C	337.4	361.3	349.4	361.3
ECS2c32A	343.2	348.3	345.7	348.3
ECS2c32B	342.6	349.0	345.8	349.0
ECS2c32C	355.1	349.3	352.2	355.1
ECS2c32D	345.6	352.5	349.1	352.5
ECS2c32E	349.4	358.5	353.9	358.5
ECS2c32F	349.8	357.1	353.5	357.1
ECS2c33A	321.1	337.3	329.2	337.3
ECS2c33B	324.2	342.6	333.4	342.6
ECS2c33C	327.7	345.7	336.7	345.7
ECS2c34A	344.9	330.8	337.8	344.9
ECS2c34B	343.6	332.2	337.9	343.6
ECS2c34C	352.8	341.6	347.2	352.8
ECS2c41A	341.7	350.2	346.0	350.2
ECS2c41B	342.2	352.5	347.4	352.5
ECS2c41C	345.4	355.5	350.4	355.5
ECS2c42A	343.9	349.6	346.7	349.6
ECS2c42B	345.3	350.4	347.8	350.4
ECS2c42C	348.8	354.9	351.8	354.9
ECS2c43A	323.2	330.2	326.7	330.2
ECS2c43B	324.6	334.0	329.3	334.0
ECS2c43C	328.6	343.1	335.9	343.1
ECS2c44A	330.2	327.6	328.9	330.2
ECS2c44B	330.7	331.8	331.2	331.8
ECS2c44C	341.0	334.1	337.6	341.0

Table E - 6 Level 5 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location					
	0°	180°	270°	120°	225°	Maximum
ECS2c11A	331.6	331.9	328.4	336.0	336.4	336.4
ECS2c11B	335.4	334.0	330.9	339.8	339.5	339.8
ECS2c11C	337.6	335.9	332.7	342.6	342.5	342.6
ECS2c12A	333.5	332.2	341.3	335.1	347.6	347.6
ECS2c12B	335.3	332.5	344.3	336.1	349.6	349.6
ECS2c12C	336.6	338.7	344.4	343.1	353.8	353.8
ECS2c13A	331.8	330.7	344.7	331.4	347.2	347.2
ECS2c13B	332.5	335.0	346.6	335.8	352.1	352.1
ECS2c13C	333.0	339.9	338.2	347.4	351.8	351.8
ECS2c14A	326.9	336.4	334.1	341.9	349.0	349.0
ECS2c14B	326.9	341.7	334.7	349.7	353.2	353.2
ECS2c14C	328.7	344.8	336.7	354.0	356.4	356.4
ECS2c15A	325.7	336.3	332.9	344.3	348.3	348.3
ECS2c15B	327.7	337.3	335.1	345.4	350.5	350.5
ECS2c15C	329.9	339.2	338.1	347.1	354.1	354.1
ECS2c16A	329.1	332.6	334.3	339.9	346.9	346.9
ECS2c16B	330.4	336.8	338.6	346.3	353.1	353.1
ECS2c16C	331.4	336.8	340.2	345.9	355.1	355.1
ECS2c21A	342.2	344.8	342.7	347.1	350.9	350.9
ECS2c21B	343.2	346.9	344.6	349.8	354.3	354.3
ECS2c21C	344.3	348.5	346.1	351.8	355.8	355.8
ECS2c22A	345.6	349.8	348.4	348.0	353.3	353.3
ECS2c22B	348.5	352.7	351.3	351.5	359.0	359.0
ECS2c22C	348.6	354.1	352.4	352.4	360.3	360.3
ECS2c23A	320.4	319.5	320.8	325.6	328.8	328.8
ECS2c23B	323.5	323.6	324.6	330.4	333.9	333.9
ECS2c23C	328.9	326.7	325.3	336.9	337.5	337.5
ECS2c24A	325.6	326.4	327.7	330.4	335.0	335.0
ECS2c24B	328.3	330.0	331.3	334.6	341.0	341.0
ECS2c24C	332.6	336.6	337.6	339.7	350.1	350.1

Table E - 6 (cont.) Level 5 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location					
	0°	180°	270°	120°	225°	Maximum
ECS2c31A	335.9	344.2	343.2	345.4	351.0	351.0
ECS2c31B	340.1	343.2	353.6	342.6	357.2	357.2
ECS2c31C	342.7	344.5	359.0	343.6	361.0	361.0
ECS2c32A	345.6	344.7	349.5	344.3	353.4	353.4
ECS2c32B	344.9	344.4	349.7	344.1	354.6	354.6
ECS2c32C	344.8	346.7	344.6	355.0	354.8	355.0
ECS2c32D	344.0	348.0	347.9	349.5	355.0	355.0
ECS2c32E	346.3	350.2	350.6	351.2	358.5	358.5
ECS2c32F	346.4	350.4	351.5	353.2	359.8	359.8
ECS2c33A	317.1	328.5	326.8	332.7	344.2	344.2
ECS2c33B	319.8	332.5	332.2	338.9	351.5	351.5
ECS2c33C	321.7	337.7	333.6	345.8	355.2	355.2
ECS2c34A	323.4	327.5	323.1	342.1	339.3	342.1
ECS2c34B	326.2	325.9	327.4	334.8	340.7	340.7
ECS2c34C	333.3	330.4	335.6	344.4	350.8	350.8
ECS2c41A	338.7	346.0	344.3	349.1	355.7	355.7
ECS2c41B	339.8	347.0	346.5	349.7	358.8	358.8
ECS2c41C	340.9	349.5	348.1	354.3	361.8	361.8
ECS2c42A	338.1	347.2	342.7	353.8	355.7	355.7
ECS2c42B	338.7	348.6	343.3	356.5	358.3	358.3
ECS2c42C	339.8	353.1	345.6	363.4	363.7	363.7
ECS2c43A	315.4	322.3	323.9	327.1	339.0	339.0
ECS2c43B	316.1	325.2	326.7	331.4	343.7	343.7
ECS2c43C	319.6	331.2	333.3	341.9	352.3	352.3
ECS2c44A	319.7	323.5	324.2	334.2	338.4	338.4
ECS2c44B	320.3	326.2	327.7	338.4	343.6	343.6
ECS2c44C	327.9	327.0	333.1	341.6	347.0	347.0

Table E - 7 Level 6 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location				Subchannel Averages			
	0°	90°	180°	270°	A	B	C	D
ECS2c11A	335.2	335.3	320.7	331.5	352.0	335.5	332.4	334.9
ECS2c11B	339.9	339.3	320.8	334.3	359.0	339.8	335.5	339.1
ECS2c11C	342.6	342.2	324.9	336.3	363.1	343.0	338.0	341.7
ECS2c12A	338.5	334.4	333.5	340.6	346.0	336.3	338.8	340.9
ECS2c12B	341.7	336.4	332.3	343.0	349.9	338.0	340.1	344.4
ECS2c12C	343.7	340.9	341.2	344.8	354.1	345.1	344.5	346.1
ECS2c13A	336.6	328.9	332.6	341.5	335.2	332.2	335.8	339.2
ECS2c13B	339.1	332.0	337.6	344.3	337.9	337.1	340.4	340.5
ECS2c13C	339.7	342.4	343.9	341.6	348.7	348.8	342.9	338.8
ECS2c14A	332.4	335.4	340.0	337.3	336.5	343.9	341.4	331.6
ECS2c14B	332.9	340.3	344.6	337.7	340.1	349.8	343.3	330.1
ECS2c14C	334.8	344.1	348.3	340.5	343.8	354.9	346.8	331.6
ECS2c15A	329.2	337.3	341.1	336.4	335.8	345.9	338.9	328.4
ECS2c15B	332.0	339.3	342.8	338.6	339.5	346.6	340.2	330.2
ECS2c15C	335.2	341.4	345.1	342.0	342.1	348.3	342.7	335.6
ECS2c16A	335.2	336.7	338.3	338.5	339.1	340.3	335.1	334.0
ECS2c16B	336.9	341.7	344.0	342.6	342.8	347.0	340.3	336.0
ECS2c16C	338.6	342.1	344.9	344.6	344.7	346.7	341.6	340.9
ECS2c21A	342.7	346.7	345.7	345.6	356.9	348.6	346.7	346.6
ECS2c21B	345.6	348.8	348.3	347.4	360.3	351.8	349.4	348.3
ECS2c21C	346.1	350.6	350.2	349.2	362.2	354.3	351.1	350.9
ECS2c22A	351.4	353.9	353.5	354.8	353.6	353.7	351.6	350.1
ECS2c22B	354.0	356.3	355.6	357.3	358.2	357.4	354.1	353.8
ECS2c22C	355.7	358.6	357.8	359.0	359.3	358.9	355.4	354.6
ECS2c23A	324.7	327.1	322.6	324.6	346.9	329.7	323.8	332.0
ECS2c23B	328.5	332.1	327.0	328.5	354.6	335.0	328.5	336.2
ECS2c23C	332.4	336.9	330.7	331.1	363.6	341.0	332.4	339.0
ECS2c24A	332.0	338.5	317.6	337.3	340.2	339.2	331.5	334.9
ECS2c24B	342.4	342.6	319.4	341.7	345.2	344.3	335.3	340.1
ECS2c24C	341.2	348.6	322.9	347.1	350.5	348.4	340.2	344.6

Table E - 7 (cont.) Level 6 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location				Subchannel Averages			
	0°	90°	180°	270°	A	B	C	D
ECS2c31A	334.8	337.5	344.9	345.5	336.2	345.2	346.2	344.3
ECS2c31B	338.0	337.1	344.7	354.1	337.6	344.1	350.8	353.5
ECS2c31C	340.3	338.3	346.0	358.5	339.1	345.1	353.2	357.6
ECS2c32A	347.7	345.3	346.8	351.5	347.0	345.2	346.6	348.7
ECS2c32B	347.5	345.1	346.5	351.7	347.9	345.5	345.9	348.8
ECS2c32C	344.0	353.4	350.4	348.7	357.6	355.6	347.6	346.7
ECS2c32D	344.2	350.1	350.9	351.5	350.2	351.9	348.4	347.2
ECS2c32E	347.9	353.1	353.7	354.1	354.1	355.1	351.0	350.3
ECS2c32F	347.0	353.9	354.6	355.2	354.5	356.2	351.6	350.7
ECS2c33A	319.3	326.5	333.4	330.7	330.6	337.3	332.9	328.9
ECS2c33B	322.5	332.2	339.7	336.9	335.9	345.0	340.5	333.8
ECS2c33C	324.9	336.2	345.0	338.4	339.6	350.3	343.1	336.9
ECS2c34A	323.0	335.5	316.2	328.6	341.5	339.9	327.5	326.7
ECS2c34B	326.8	336.4	316.4	331.7	342.8	338.5	325.7	332.2
ECS2c34C	333.3	341.4	320.5	341.0	353.4	346.6	338.6	343.3
ECS2c41A	337.7	344.7	348.2	348.1	342.4	349.9	347.6	342.9
ECS2c41B	339.3	345.4	350.1	350.7	345.0	350.8	350.2	345.7
ECS2c41C	341.0	349.3	353.0	352.7	346.6	355.0	352.1	347.1
ECS2c42A	338.2	347.9	350.5	346.6	346.0	354.3	348.9	338.6
ECS2c42B	338.3	350.3	353.2	347.7	348.9	358.5	351.4	339.7
ECS2c42C	340.2	354.7	358.4	350.1	352.3	364.3	355.2	340.6
ECS2c43A	318.1	327.2	329.8	327.6	330.7	335.9	326.9	325.5
ECS2c43B	319.1	330.2	333.8	330.6	332.6	341.0	330.6	328.6
ECS2c43C	323.6	336.6	341.3	337.8	337.6	336.8	338.6	335.7
ECS2c44A	320.8	330.2	330.3	328.8	334.4	338.0	325.9	326.1
ECS2c44B	321.7	333.3	318.4	332.3	336.7	341.8	330.6	328.9
ECS2c44C	329.1	338.4	337.5	337.9	343.8	345.0	333.6	337.5

Table E - 8 **Level 6 Aluminum Temperatures (K) - Within Subchannels** - using Power Correction Methodology

TEST ID	Azimuthal Location								
	30°	60°	120°	150°	210°	240°	300°	330°	Max.
ECS2c11A	352.4	351.7	335.3	335.6	329.9	335.0	334.2	335.7	352.4
ECS2c11B	359.5	358.4	339.4	340.2	332.8	338.2	338.3	339.9	359.5
ECS2c11C	363.4	362.8	342.7	343.2	335.1	341.0	340.9	342.4	363.4
ECS2c12A	347.0	345.0	335.7	336.9	333.8	343.8	340.6	341.1	347.0
ECS2c12B	351.0	348.8	337.5	338.5	334.9	345.4	344.2	344.5	351.0
ECS2c12C	354.5	353.8	344.0	346.2	339.4	349.6	345.9	346.4	354.5
ECS2c13A	336.4	333.9	332.2	332.1	331.2	340.4	339.4	338.9	340.4
ECS2c13B	338.9	336.9	336.2	338.0	335.7	345.0	340.9	340.1	345.0
ECS2c13C	348.0	349.5	348.7	349.0	339.0	346.8	338.8	338.9	349.5
ECS2c14A	335.7	337.2	343.6	344.3	338.2	344.6	332.2	331.0	344.6
ECS2c14B	338.4	341.7	349.2	350.5	340.3	346.3	330.5	329.8	350.5
ECS2c14C	341.6	345.9	354.4	355.3	343.4	350.3	331.1	332.0	355.3
ECS2c15A	334.4	337.3	345.0	346.8	335.5	342.3	328.4	328.3	346.8
ECS2c15B	338.0	340.9	345.0	348.1	336.6	343.9	330.0	330.4	348.1
ECS2c15C	340.3	343.9	346.9	349.8	338.5	347.0	335.1	336.0	349.8
ECS2c16A	338.1	340.2	339.9	340.6	330.2	340.0	333.1	334.9	340.6
ECS2c16B	340.9	344.7	346.0	348.0	335.4	345.1	335.0	337.0	348.0
ECS2c16C	342.8	346.6	345.6	347.8	336.2	347.0	341.4	340.4	347.8
ECS2c21A	357.3	356.6	348.6	348.7	344.8	348.7	346.2	346.9	357.3
ECS2c21B	360.7	360.0	351.4	352.1	347.2	351.5	348.2	348.5	360.7
ECS2c21C	362.1	362.3	353.8	354.7	349.0	353.2	350.4	351.4	362.3
ECS2c22A	353.3	353.9	353.6	353.9	348.9	354.4	348.4	351.8	354.4
ECS2c22B	358.6	357.8	357.4	357.5	350.6	357.7	352.6	354.9	358.6
ECS2c22C	359.0	359.6	358.4	359.3	352.1	358.6	352.9	356.3	359.6
ECS2c23A	347.3	346.5	329.6	329.8	321.5	326.1	331.9	332.2	347.3
ECS2c23B	354.8	354.4	334.8	335.2	326.0	331.1	336.2	336.3	354.8
ECS2c23C	363.8	363.3	340.7	341.4	329.7	335.1	338.6	339.4	363.8
ECS2c24A	340.4	339.9	341.5	336.9	329.3	333.7	333.0	336.8	341.5
ECS2c24B	346.8	343.6	346.9	341.7	332.8	337.9	338.8	341.4	346.9
ECS2c24C	350.0	350.9	352.0	344.9	337.3	343.0	342.4	346.8	352.0

Table E - 8 (cont.) Level 6 Aluminum Temperatures (K) - Within Subchannels

TEST ID	Azimuthal Location								
	30°	60°	120°	150°	210°	240°	300°	330°	Max.
ECS2c31A	337.2	335.2	344.1	346.4	344.0	348.4	344.6	344.0	348.4
ECS2c31B	339.4	335.9	342.8	345.5	346.5	355.2	354.9	352.1	355.2
ECS2c31C	340.9	337.3	343.6	346.5	348.2	358.2	359.1	356.1	359.1
ECS2c32A	347.9	346.1	345.0	345.3	343.2	350.1	347.9	349.5	350.1
ECS2c32B	348.9	346.9	345.4	345.6	342.4	349.3	348.5	349.1	349.3
ECS2c32C	356.7	358.6	355.8	355.3	344.8	350.4	345.7	347.7	358.6
ECS2c32D	350.1	350.3	351.4	352.5	345.4	351.5	346.3	348.1	352.5
ECS2c32E	354.1	354.0	354.5	355.7	347.8	354.3	349.3	351.2	355.7
ECS2c32F	354.1	355.0	355.7	356.6	348.1	355.1	349.3	352.0	356.6
ECS2c33A	329.6	331.5	337.1	337.5	329.2	336.7	329.3	328.5	337.5
ECS2c33B	334.7	337.0	344.3	345.6	336.4	344.6	334.8	332.9	345.6
ECS2c33C	337.4	341.9	349.6	351.0	339.5	346.7	337.4	336.4	351.0
ECS2c34A	339.5	343.5	342.2	337.7	323.9	331.1	325.8	327.6	343.5
ECS2c34B	341.0	344.6	343.1	333.9	322.6	328.7	331.5	332.8	344.6
ECS2c34C	351.3	355.6	348.5	344.7	333.3	343.8	343.1	343.6	355.6
ECS2c41A	343.4	341.4	349.1	350.6	344.0	351.2	343.2	342.6	351.2
ECS2c41B	345.9	344.2	349.6	352.0	346.1	354.2	346.2	345.2	354.2
ECS2c41C	347.5	345.7	353.8	356.1	347.8	356.4	347.4	346.8	356.4
ECS2c42A	344.6	347.5	354.1	354.6	346.4	351.4	338.7	338.4	354.6
ECS2c42B	347.3	350.6	358.0	359.1	349.0	353.9	339.9	339.4	359.1
ECS2c42C	349.7	354.9	363.4	365.1	352.6	357.9	340.6	340.6	365.1
ECS2c43A	328.9	332.4	337.4	334.4	322.4	331.4	326.4	324.6	337.4
ECS2c43B	330.4	334.7	342.1	339.9	325.8	335.3	329.5	327.7	342.1
ECS2c43C	335.2	340.0	324.5	349.0	333.1	344.1	337.2	334.1	349.0
ECS2c44A	332.3	336.4	340.1	335.8	321.4	330.3	326.4	325.8	340.1
ECS2c44B	333.9	339.6	343.5	340.1	326.1	335.1	329.6	328.1	343.5
ECS2c44C	340.8	346.8	347.1	343.0	327.8	339.4	338.4	336.7	347.1

Table E - 9 Level 7 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location under Fins				Azimuthal Location within Subchannel				
	0°	90°	180°	270°	45°	150°	225°	330°	Max.
ECS2c11A	336.8	339.6	332.8	333.3	353.0	339.6	339.1	341.7	353.0
ECS2c11B	341.5	343.8	336.1	336.2	359.1	344.3	342.4	345.8	359.1
ECS2c11C	344.4	347.3	338.3	338.0	363.3	348.1	345.2	348.8	363.3
ECS2c12A	340.7	337.8	336.1	339.3	345.2	342.2	345.5	344.1	345.5
ECS2c12B	342.9	339.0	337.5	340.2	345.8	343.9	346.3	344.8	346.3
ECS2c12C	346.9	344.4	342.7	343.2	352.0	351.1	351.5	350.5	352.0
ECS2c13A	337.4	335.2	335.1	339.1	340.2	338.6	343.8	341.6	343.8
ECS2c13B	340.3	338.4	339.2	342.5	342.6	343.9	347.9	344.8	347.9
ECS2c13C	343.6	346.8	345.0	342.1	352.8	354.1	351.3	346.3	354.1
ECS2c14A	332.7	338.5	341.1	336.9	339.1	347.6	347.8	334.4	347.8
ECS2c14B	334.5	343.3	345.3	337.7	343.4	354.2	350.2	335.3	354.2
ECS2c14C	337.5	346.1	348.6	340.7	345.9	358.8	353.8	339.5	358.8
ECS2c15A	331.5	339.3	342.7	336.9	338.9	352.8	348.8	334.0	352.8
ECS2c15B	335.9	341.5	343.6	338.9	342.2	355.2	349.7	337.6	355.2
ECS2c15C	338.3	343.5	346.8	342.5	345.0	359.0	353.5	343.5	359.0
ECS2c16A	338.0	337.3	339.5	338.9	341.6	350.0	346.2	342.5	350.0
ECS2c16B	341.6	342.7	345.1	342.9	345.7	359.3	351.2	345.7	359.3
ECS2c16C	346.2	342.8	346.4	344.9	347.2	359.4	353.2	349.7	359.4
ECS2c21A	343.9	351.1	347.1	346.0	361.6	353.9	351.0	346.7	361.6
ECS2c21B	345.5	352.8	349.5	348.1	364.4	357.5	353.8	348.5	364.4
ECS2c21C	347.3	355.3	351.7	350.1	366.7	360.9	355.5	352.0	366.7
ECS2c22A	355.1	357.5	359.3	358.7	360.1	362.9	364.1	357.9	364.1
ECS2c22B	358.1	360.6	362.2	361.8	364.0	367.4	367.8	361.9	367.8
ECS2c22C	361.0	363.1	364.9	364.1	367.1	371.1	370.6	364.6	371.1
ECS2c23A	327.2	330.9	325.8	325.7	353.5	338.8	332.7	331.2	353.5
ECS2c23B	332.2	336.0	330.4	330.2	360.3	345.4	337.5	336.5	360.3
ECS2c23C	338.5	340.2	333.9	334.0	370.8	350.4	343.5	340.2	370.8
ECS2c24A	338.1	344.0	345.7	344.6	347.3	347.8	350.9	338.6	350.9
ECS2c24B	342.3	348.3	350.4	349.1	352.6	353.6	355.9	342.7	355.9
ECS2c24C	349.0	355.4	357.9	356.1	359.7	360.8	363.9	350.5	363.9

Table E - 9 (cont.) Level 7 Aluminum Temperatures (K) - using Power Correction Methodology

TEST ID	Azimuthal Location under Fins				Azimuthal Location within Subchannel				
	0°	90°	180°	270°	45°	150°	225°	330°	Max.
ECS2c31A	334.4	338.2	344.3	345.5	338.3	347.2	350.6	340.1	350.6
ECS2c31B	335.3	338.8	345.3	350.5	339.5	349.1	354.8	340.9	354.8
ECS2c31C	337.7	340.2	346.8	353.7	340.9	351.0	357.3	343.6	357.3
ECS2c32A	344.1	346.9	348.0	350.9	349.9	349.2	354.2	344.7	354.2
ECS2c32B	344.6	347.1	347.8	350.8	350.7	350.3	354.5	348.1	354.5
ECS2c32C	345.0	353.1	351.2	349.1	355.6	352.2	355.4	343.6	355.6
ECS2c32D	348.8	351.5	353.3	352.7	354.1	358.0	358.1	351.7	358.1
ECS2c32E	352.6	355.1	356.9	355.8	358.2	363.2	361.8	355.9	363.2
ECS2c32F	353.2	356.0	358.0	356.8	359.2	364.8	362.8	356.5	364.8
ECS2c33A	322.2	327.7	333.1	330.0	336.4	346.4	339.9	326.1	346.4
ECS2c33B	325.7	334.1	340.1	336.0	342.3	347.1	348.2	328.5	348.2
ECS2c33C	330.6	337.6	344.7	339.1	346.9	362.1	351.6	332.7	362.1
ECS2c34A	324.3	333.1	332.3	329.1	338.6	335.0	336.2	326.1	338.6
ECS2c34B	329.5	336.1	334.7	332.7	344.0	344.9	339.3	327.8	344.9
ECS2c34C	333.5	342.8	339.8	340.6	351.3	357.8	348.0	333.1	357.8
ECS2c41A	340.1	345.3	349.1	347.2	346.8	357.0	355.3	339.0	357.0
ECS2c41B	343.1	346.4	350.6	349.5	348.1	359.3	357.6	341.1	359.3
ECS2c41C	341.4	349.3	354.3	352.4	352.2	365.0	361.7	343.0	365.0
ECS2c42A	339.7	348.4	350.4	345.5	348.7	356.6	354.8	335.6	356.6
ECS2c42B	340.9	351.3	353.5	347.0	351.4	362.0	358.1	336.3	362.0
ECS2c42C	341.9	356.4	359.0	349.2	356.2	368.8	361.8	337.0	368.8
ECS2c43A	320.5	326.9	331.4	327.3	333.9	347.2	337.2	318.2	347.2
ECS2c43B	322.3	330.0	334.2	330.2	336.2	354.0	340.5	320.7	354.0
ECS2c43C	327.6	336.0	341.8	337.7	340.8	363.6	349.7	326.3	363.6
ECS2c44A	321.9	332.4	332.9	328.1	336.6	344.7	336.9	317.9	344.7
ECS2c44B	322.9	336.1	337.5	331.5	340.1	353.4	341.9	320.1	353.4
ECS2c44C	330.5	341.0	341.9	338.4	346.8	359.5	348.0	335.6	359.5

Table E-10 ECS2c - Summary of Results - Powers Required for Surface at Saturation Temperature using Maximum Corrected Aluminum Temperatures

TEST ID	Superficial Velocities (m/s)		Inlet Fluid	Stand Pipe	Total Test Section Powers (kW)			Power Ratios	
	Liquid	Air	Temp. (K)	Level (cm)[1]	P at Maximum Corrected	P Uncertain.	Outlet Fluid at Tsat	R	R Uncertain.
ECS2c11A	0.30	0.00	311.0	48	37.4	9.4	101.7	0.368	0.092
ECS2c11B	0.30	0.00	310.8	48	36.5	8.1	102.0	0.358	0.079
ECS2c11C	0.30	0.00	310.6	48	37.0	7.7	102.2	0.362	0.075
ECS2c12A	0.45	0.00	312.0	48	65.0	21.2	149.7	0.434	0.142
ECS2c12B	0.45	0.00	311.1	48	64.2	18.6	152.0	0.422	0.123
ECS2c12C	0.45	0.00	311.5	48	70.2	22.1	150.9	0.465	0.146
ECS2c13A	0.61	0.05	311.3	48	65.6	16.9	206.0	0.318	0.082
ECS2c13B	0.61	0.05	311.2	48	66.1	16.0	206.3	0.320	0.077
ECS2c13C	0.61	0.07	312.0	48	83.2	26.3	203.5	0.409	0.129
ECS2c14A	0.77	0.20	311.2	48	80.0	23.9	258.1	0.310	0.092
ECS2c14B	0.77	0.18	310.6	48	77.9	20.7	260.8	0.299	0.079
ECS2c14C	0.77	0.19	311.9	48	77.4	19.9	255.4	0.303	0.078
ECS2c15A	0.92	0.35	311.0	48	86.7	24.1	312.1	0.278	0.077
ECS2c15B	0.92	0.35	311.1	48	91.1	25.4	312.3	0.292	0.081
ECS2c15C	0.92	0.35	311.3	48	92.3	25.1	310.5	0.297	0.081
ECS2c16A	1.08	0.47	310.8	48	114.2	38.0	367.2	0.311	0.104
ECS2c16B	1.08	0.44	311.6	48	103.4	29.4	361.7	0.286	0.081
ECS2c16C	1.08	0.46	310.2	48	112.8	33.4	371.7	0.304	0.090

TEST ID	Superficial Velocities (m/s)		Inlet Fluid	Stand Pipe	Total Test Section Powers (kW)			Power Ratios	
	Liquid	Air	Temp. (K)	Level (cm)[1]	P at Maximum Corrected	P Uncertain.	Outlet Fluid at Tsat	R	R Uncertain.
ECS2c21A	0.30	0.00	325.5	0	29.7	8.9	74.6	0.399	0.120
ECS2c21B	0.30	0.00	325.3	0	30.8	8.8	75.2	0.409	0.116
ECS2c21C	0.30	0.00	324.8	0	31.8	8.7	75.8	0.419	0.114
ECS2c22A	0.30	0.00	327.6	140	47.6	20.2	76.0	0.626	0.266
ECS2c22B	0.30	0.00	327.8	140	48.8	20.0	76.7	0.636	0.261
ECS2c22C	0.30	0.00	326.4	140	50.1	19.0	79.0	0.634	0.241
ECS2c23A	0.30	0.07	293.1	0	45.9	8.5	131.1	0.350	0.065
ECS2c23B	0.30	0.07	293.3	0	46.1	8.0	130.7	0.353	0.061
ECS2c23C	0.30	0.07	292.9	0	43.7	6.6	131.2	0.333	0.051
ECS2c24A	0.31	0.00	294.0	140	73.4	18.3	137.3	0.534	0.133
ECS2c24B	0.31	0.00	293.8	140	76.0	18.9	137.8	0.552	0.137
ECS2c24C	0.30	0.00	294.3	140	75.4	17.9	135.3	0.557	0.133
ECS2c31A	0.61	0.04	326.2	0	49.8	20.4	149.5	0.333	0.137
ECS2c31B	0.61	0.04	326.1	0	43.8	14.0	150.2	0.292	0.093
ECS2c31C	0.61	0.04	326.3	0	42.1	11.8	149.3	0.282	0.079
ECS2c32A	0.61	0.02	328.5	140	69.7	32.7	154.6	0.451	0.212
ECS2c32B	0.61	0.03	326.2	140	68.9	27.3	162.7	0.424	0.168
ECS2c32C	0.61	0.04	326.1	140	73.3	29.6	163.0	0.450	0.181
ECS2c32D	0.46	0.01	326.5	140	60.0	23.8	120.3	0.499	0.198
ECS2c32E	0.45	0.01	327.2	140	61.6	24.4	117.3	0.525	0.208
ECS2c32F	0.47	0.01	325.6	140	64.2	23.5	126.6	0.507	0.186

	Superficial Velocities (m/s)		Inlet Fluid	Stand Pipe	Total Test Section Powers (kW)			Power Ratios	
ECS2c32E	Liquid	Air	Temp. (K)	Level (cm)[1]	P at Maximum Corrected	P Uncertain.	Outlet Fluid at Tsat	R	R Uncertain.
ECS2c33A	0.61	0.09	293.9	0	97.8	25.4	260.7	0.375	0.097
ECS2c33B	0.61	0.09	294.1	0	98.8	24.8	260.0	0.380	0.095
ECS2c33C	0.61	0.08	294.4	0	92.2	20.3	258.7	0.356	0.078
ECS2c34A	0.61	0.08	293.2	140	106.9	28.8	275.7	0.388	0.105
ECS2c34B	0.61	0.07	291.9	140	118.4	34.2	280.2	0.423	0.122
ECS2c34C	0.61	0.07	294.3	140	105.8	26.0	272.1	0.389	0.096
ECS2c41A	0.91	0.29	326.7	0	71.0	26.4	222.4	0.319	0.119
ECS2c41B	0.91	0.27	326.3	0	72.5	25.6	224.5	0.323	0.114
ECS2c41C	0.91	0.28	326.8	0	68.0	21.2	221.5	0.307	0.096
ECS2c42A	0.91	0.15	327.0	140	72.0	26.2	239.9	0.300	0.109
ECS2c42B	0.91	0.14	326.4	140	66.9	20.3	243.5	0.275	0.083
ECS2c42C	0.91	0.13	327.2	140	61.9	16.4	238.9	0.259	0.069
ECS2c43A	0.92	0.56	293.3	0	115.0	29.0	395.7	0.291	0.073
ECS2c43B	0.92	0.53	291.9	0	113.0	26.1	403.2	0.280	0.065
ECS2c43C	0.92	0.51	294.4	0	107.8	23.6	390.1	0.276	0.061
ECS2c44A	0.92	0.27	293.4	140	124.7	33.0	415.1	0.300	0.080
ECS2c44B	0.92	0.25	292.1	140	118.8	27.7	421.6	0.282	0.066
ECS2c44C	0.92	0.25	294.6	140	119.3	28.1	408.6	0.292	0.069

1 Level above bottom of heated length.

2 Use of the Maximum Corrected data, results in majority of maximum temperatures occurring at Level 7.

END

DATE
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12/20/91