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Volume 2

Rod Bundle Heat Transfer Facility Two-Phase Mixture Level Swell and Uncovery Test Experiments Data Report

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Rod Bundle Heat Transfer Facility Two-Phase Mixture Level Swell and Uncovery Test Experiments Data Report

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ABSTRACT

A series of two-phase level swell and uncovery experiments have been performed in the US Nuclear Regulatory Commission/ Penn State Rod Bundle Heat Transfer Test (RBHT) Facility. A total of 75 experiments were performed in a quasi-steady state manner in which the inlet flooding rated into the RBHT rod bundle was slowly decreased in steps and the two-phase mixture level in the bundle was allowed to decrease. In several of the experiments the top region of the rod bundle became uncovered and the heater rod temperatures were significantly above the saturation temperature.

The range of conditions investigated in the experiments were: pressure, 0.138 to 0.414 Mpa (20 to 60 psia); Inlet subcooling 11.1 to 69.4 degrees K (20 to 125 degrees F); Inlet injection temperature 334 to 393 degrees K (142 to 247 degrees F); Peak linear power 0.492 to 1.31 kw/m (0.15 to 0.4 kw/ft); and Inlet flooding rate 2.54 to 40.64 mm/s (0.1 to 1.6 in/s).

A one-dimensional energy balance was used to calculate the saturation location in the bundle as well as the local fluid quality. The resulting calculations were used to estimate the single and two-phase friction and acceleration pressure drop components such that the differential pressure measurements could be corrected and used to estimate the local void fraction distribution along the heated bundle. The two-phase mixture level or dryout locations were also determined from the heater rod thermocouple response as the local heat transfer changed from boiling to steam cooling. The resulting data can be used to assess the void fraction models and heat transfer models in the Nuclear Regulatory Commission advanced safety analysis computer codes.

FOREWORD

A loss-of-coolant accident (LOCA) is one of the primary postulated accidents that must be considered in the design of nuclear power plants. The plant response to such an accident, including the performance of safety systems that are designed to mitigate the accident, is mainly analyzed using computer codes. For effective analyses of accidents and operational transients, the U.S. Nuclear Regulatory Commission (NRC) consolidated earlier thermal-hydraulics analysis codes into one called TRACE.

The NRC is now assessing and improving the TRACE code as weaknesses are identified. One such weakness is inaccurate prediction of peak clad temperatures of fuel rods, particularly in the later stage of a large-break loss of coolant accident (LBLOCA), called the reflood phase. Specifically, the reflood models currently employed in the TRACE code are not sufficiently accurate and, consequently, improved models must be developed to provide necessary support for risk-informed regulations. Accurate prediction of the consequences of an LBLOCA is important because this is one of the limiting postulated accidents used to determine whether plant design parameters (such as power densities, equipment sizes, etc.) have been appropriately selected to ensure safety. As the NRC places increasing emphasis on risk-informed regulations, the agency needs a more accurate and reliable computer code to obtain realistic (rather than conservative) predictions.

To develop better computer code models for an LBLOCA, we need detailed, fundamental data that show heat, mass, and momentum exchanges. Some of these detailed data have only recently become possible because of recent advances in instrumentation technology for two-phase flow measurements. Consequently, to acquire detailed, fundamental data for use in developing models for an LBLOCA, the NRC sponsored the construction of a rod bundle heat transfer (RBHT) test facility and completion of four test series; reflood tests, liquid-gas interfacial drag tests, steam cooling tests without liquid droplet injection, and steam cooling tests with liquid droplet injection.

This report presents the results of liquid-gas interfacial drag tests. The data from these tests will be used to develop and assess an interfacial drag model which is a component of a LOCA model for the TRACE code. The results of other test series will be reported in separate reports.

With improved data and code models for an LBLOCA, we can more accurately predict the consequences of LBLOCA accidents and provide better technical bases for regulations associated with such accidents. As a result, this study will help to achieve the NRC's strategic performance goals of making the agency's regulations more effective, efficient, and realistic.

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EXECUTIVE SUMMARY

As part of the Nuclear Regulatory Commission safety analysis computer code development efforts, the Rod Bundle Heat Transfer test facility has been designed and constructed at The Pennsylvania State University. The Rod Bundle Heat Transfer (RBHT) Facility is a full length simulation of a portion of a Pressurized Water Reactor (PWR) fuel assembly. The bundle is a 7 by 7 rod array with four unheated corner rods and 45 heated electrical rod which simulate a 17 by 17 PWR fuel assembly. The rod Bundle Heat Transfer Facility is full length, 3.66 m (12 ft), with typical PWR rod diameters of 9.49 mm (0.374 in) and a rod pitch of 12.6 m (0.496 in). The heater rods have a top skewed power shape with a peak to average power of 1.5 at the 2.77 m (9.08 ft) elevation. Typical PWR mixing vane spacer grids were simulated in the RBHT bundle.

A series of 75 quasi-steady state, two-phase level swell and uncovery experiments were performed in the (RBHT) Facility. The inlet flooding rated into the RBHT rod bundle was slowly decreased in steps and the two-phase mixture level in the bundle was allowed to decrease. In several of the experiments the top region of the rod bundle became uncovered and the heater rod temperatures were significantly above the saturation temperature. The range of conditions investigated in the experiments were: pressure, 0.138 to 0.414 Mpa (20 to 60 psia); Inlet subcooling 11.1 to 69.4 degrees K (20 to 125 degrees F); Inlet injection temperature 334 to 393 degrees K (142 to 247 degrees F); Peak linear power 0.492 to 1.31 kw/m (0.15 to 0.4 kw/ft); and Inlet flooding rate 2.54 to 40.64 mm/s (0.1 to 1.6 in/s). The data from these experiments were qualified and submitted to the Nuclear Regulatory Commission data bank for analysis and code validation purposes.

There are several unique features of the RBHT facility. There were traversing miniature steam probes in the bundle which measured the superheated steam temperature in the presence of entrained droplets. Steam probes were located in the bottom subcooled region, in the saturated boiling region, as well as in the upper region of the bundle where steam superheat occurred. There were a large number of sensitive differential pressure cells along the bundle which could be used, with analysis, to determine the local average void fraction over the differential pressure cell span. Some of the differential pressure cell spans were as short as 10.16 cm (4-inches). The mixing vane grids were also instrumented with miniature thermocouples such that spacer grid temperature behavior could also be characterized in addition to the heater rod and vapor temperature measurements. The detailed axial distribution of the heater rod thermocouples allowed for accurate determination of the two-phase mixture height in the RBHT facility. As the mixture height would decrease, the local thermocouple location would transition from a boiling situation to steam cooling with a corresponding sharp increase in the thermocouple response as the heater rod temperature increased.

A one-dimensional energy balance method was used to calculate the saturation location in the bundle as well as the local fluid quality distribution along the bundle in the boiling region. The resulting calculations were then used to estimate the single and two-phase friction and acceleration pressure drop components such that the differential pressure measurements could be corrected and used to estimate the local void fraction distribution along the heated bundle. The two-phase mixture level or dryout locations were also determined from the heater rod thermocouple response as the local heat transfer changed from boiling to steam cooling. The resulting data are used to assess the void fraction and heat transfer models in the Nuclear Regulatory Commission advanced safety analysis computer codes.

ABBREVIATIONS

Acronyms:

ASME – American Society of Mechanical Engineering

CHF – Critical Heat Flux

LHS – Left-Hand-Side

LOCA – Loss-of-Coolant Accident

NRC – Nuclear Regulatory Commission

OSV – Onset of Significant Void

PWR – Pressurized-Water Reactor

RBHT – Rod Bundle Heat Transfer

RHS – Right-Hand-Side

Greek Symbols:

α – void fraction

Δ – difference

ϕ^2 – two-phase multiplier

μ – viscosity

ν – specific volume

ρ – density

σ – surface tension

Symbols:

A – area

c – specific heat

D_h – hydraulic diameter

D_e – hydraulic equivalent diameter

f – friction factor

Fr – Froude number

G – mass flux

g – acceleration due to gravity

g_c – gravitational constant

h – enthalpy

j – superficial velocity

$\dot{m}$ – mass flow rate

P – pressure

PF – power factor

q' – linear power

q''' – volumetric heat rate

Re – Reynolds number

R – radius

V – velocity

We – Weber number

X – Martinelli parameter

x – quality

Subscripts:

1ϕ – two-phase

2ϕ – two-phase

@ 9 ft. – at elevation of 9 feet

accel – acceleration

c – cross-sectional

calc – calculated

elev – elevation

exp – experimental

f – liquid

fg– latent heat of vaporization

fo – liquid only

fric – friction

g – vapor

go – vapor only

grid – spacer grid

i – generic incremental identifier

in – inlet

mix – mixture

p – constant pressure

rel – relative

sat – saturation

span – differential pressure cell height

STP – standard temperature and pressure

T – total

TP – two-phase

wf – wall to liquid

wg – wall to vapor

APPENDIX A. TEST RESULTS FOR ALL VALID EXPERIMENTS

(Continuing From Test 1655A)

- **Summary and Comment Sheet** – listing of the as-run conditions for the experiment steady-state window.

- **Critical Instrument Plots** – verify that steady-state conditions were achieved and maintained for boundary conditions during the respective time windows of the experiment. The following experimental data is plotted over the steady-state window:

    1. Upper Plenum Pressure
    2. Bundle Power
    3. Inlet Flow Rate
    4. Inlet Flow Temperature

- **Data Tables** – tabulated representation of the following test parameters versus elevation:

    1. Superficial Phase Velocities
    2. Quality
    3. Local Pressure
    4. Local Heat Flux
    5. $\Delta P_{measured}$
    6. $\Delta P_{friction}$
    7. $\Delta P_{acceleration}$
    8. ΔP_{grid}
    9. $\alpha_{corrected}$
    10. $\alpha_{\mu\nu\iota\mu\upsilon\mu}$
    11. $\alpha_{maximum}$

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-A

Test Conditions

Date: 7/7/2003
Steady-state time window: 1440 – 1485 seconds
Inlet flow rate: 3.988 cm/sec (1.570 in./sec)
Inlet mass flow rate: 0.188 kg/sec (0.415 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

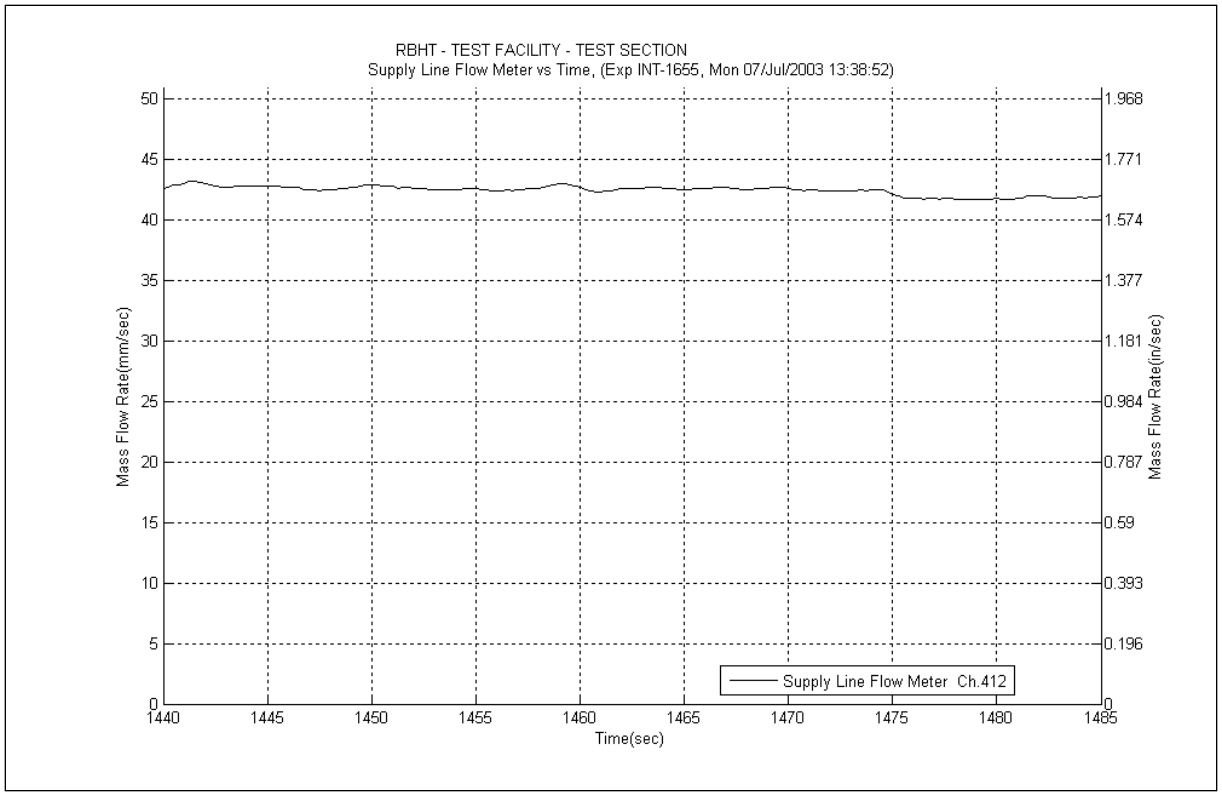

Figure A-491 Inlet Flow Plot for Experiment 1655A

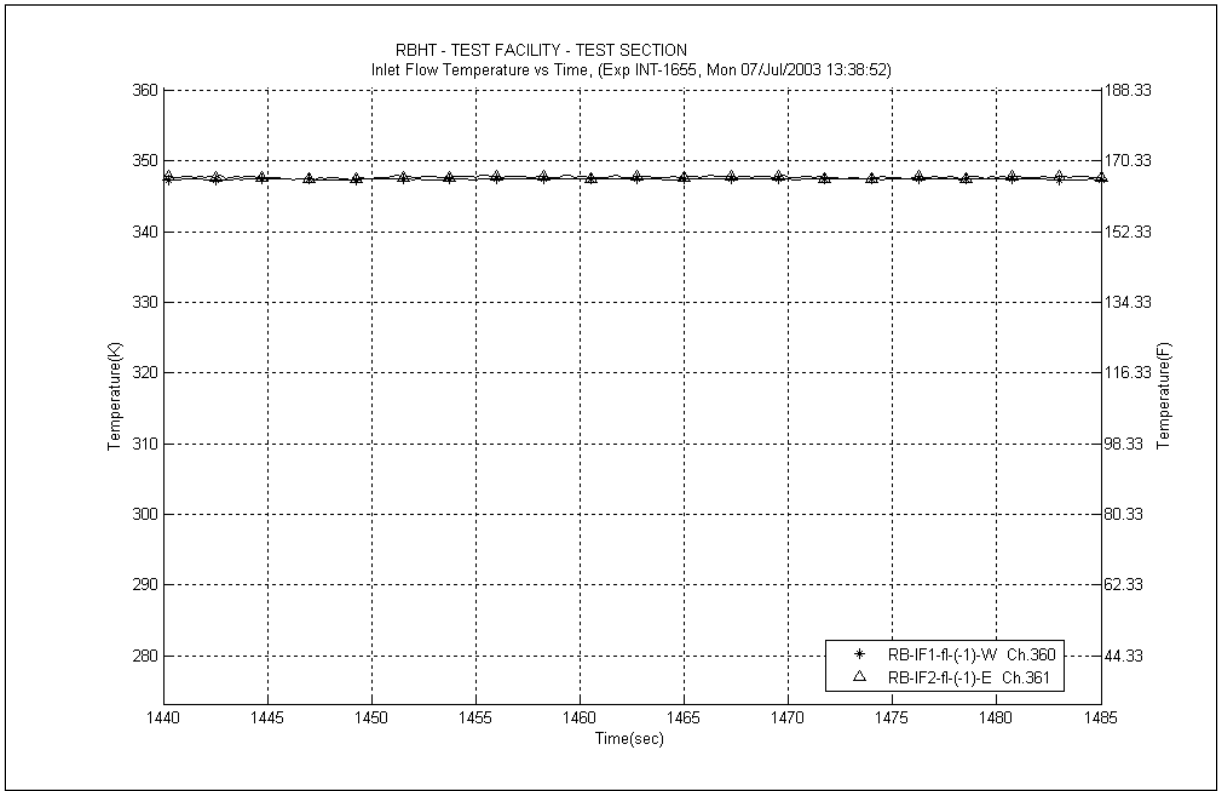

Figure A-492 Inlet Temperature Plot for Experiment 1655A

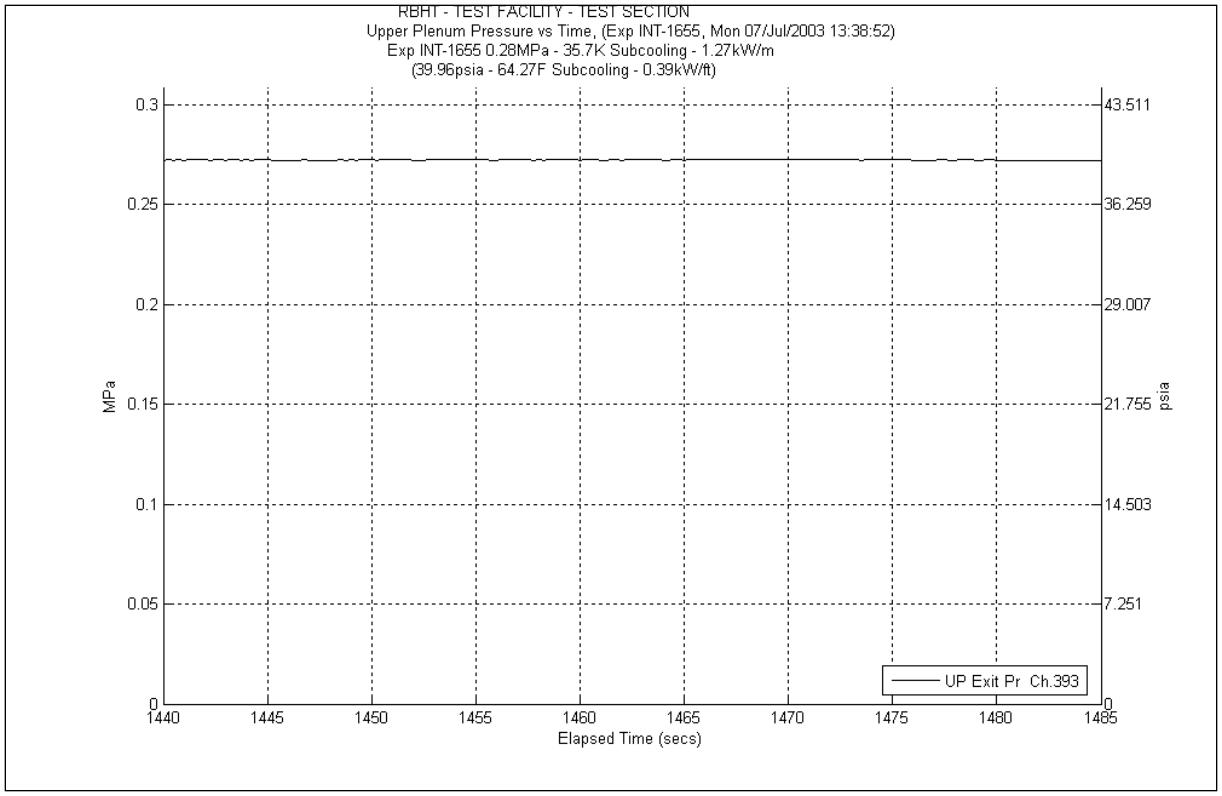

Figure A-493 System Pressure Plot for Experiment 1655A

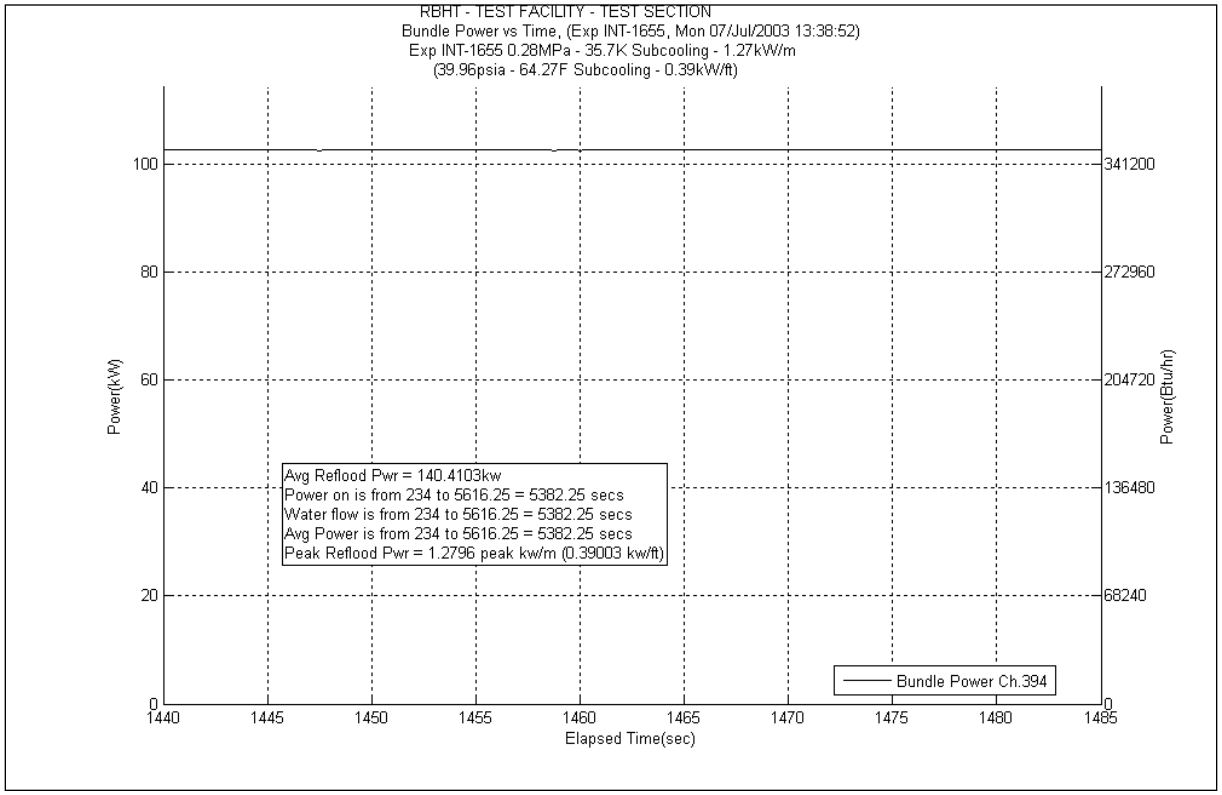

Figure A-494 Bundle Power Plot for Experiment 1655A

Table A-197 Data Results for RBHT Test 1655 for Time Period 1440 to 1485

Results for RBHT Test 1655
Valid Time Period 1440 to 1485 seconds
Collapsed Liquid Level = 92.941 inches = 2360.71 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.739	14.910	713.897	1.294	61.957	0.360	17.237	0.000	0.000	13.25	634.413	5773.25	276424.6937	0.768	0.764	0.772
*	120-133	3048-3378	383	0.712	19.433	930.478	1.409	67.463	0.643	30.787	1.591	76.199	15.79	756.029	5789.04	277180.723	0.766	0.762	0.770
*	108-120	2743-3048	382	0.662	21.059	1008.308	1.139	54.536	0.802	38.400	4.318	206.745	14.8	708.628	5803.84	277889.3508	0.762	0.758	0.766
	100-108	2540-2743	381	0.731	11.192	535.858	0.653	31.266	0.587	28.106	0.000	0.000	9.947	476.265	5813.787	278365.6157	0.761	0.757	0.765
	97-100	2464-2540	380	0.647	5.495	263.080	0.221	10.582	0.213	10.198	0.000	0.000	5.06	242.274	5818.847	278607.8898	0.675	0.672	0.678
	93-97	2362-2464	379	0.640	7.489	358.565	0.274	13.119	0.277	13.263	0.000	0.000	6.935	332.050	5825.782	278939.9394	0.666	0.663	0.669
*	85-93	2159-2362	378	0.460	22.440	1074.451	0.480	22.983	0.531	25.424	7.319	350.454	14.11	675.590	5839.892	279615.5298	0.66	0.657	0.663
	81-85	2057-2159	377	0.633	7.634	365.527	0.204	9.768	0.255	12.209	0.000	0.000	7.175	343.541	5847.067	279959.0707	0.655	0.652	0.658
	78-81	1981-2057	376	0.487	7.998	382.933	0.137	6.560	0.186	8.906	0.000	0.000	7.669	367.194	5854.736	280326.2643	0.508	0.505	0.511
	75-78	1905-1981	375	0.442	8.699	416.502	0.123	5.889	0.182	8.714	0.000	0.000	8.388	401.620	5863.124	280727.8839	0.461	0.459	0.463
	72-75	1829-1905	374	0.375	9.732	465.985	0.109	5.219	0.178	8.523	0.000	0.000	9.441	452.038	5872.565	281179.9214	0.394	0.392	0.396
*	67-72	1702-1829	373	0.313	17.829	853.643	0.148	7.086	0.287	13.742	0.024	1.135	17.37	831.680	5889.935	282011.6015	0.331	0.329	0.333
	63-67	1600-1702	372	0.253	15.518	742.990	0.085	4.070	0.221	10.582	0.000	0.000	15.21	728.259	5905.145	282739.8602	0.268	0.267	0.269
	60-63	1524-1600	371	0.052	14.765	706.935	0.040	1.915	0.161	7.709	0.000	0.000	14.56	697.137	5919.705	283436.9968	0.065	0.062	0.068
	57-60	1448-1524	370	0.071	14.469	692.761	0.018	0.862	0.103	4.932	0.000	0.000	14.34	686.603	5934.045	284123.5996	0.079	0.075	0.083
	53-57	1346-1448	369	0.056	19.610	938.933	0.003	0.144	0.000	0.000	0.000	0.000	19.6	938.453	5953.645	285062.0527	0.056	0.053	0.059
*	46-53	1168-1346	368	0.053	34.427	1648.354	0.006	0.287	0.000	0.000	-0.189	-9.069	34.61	1657.136	5988.255	286719.1884	0.048	0.046	0.050
	43-46	1092-1168	367	0.039	14.978	717.130	0.002	0.096	0.000	0.000	0.000	0.000	14.97	716.767	6003.225	287435.9558	0.039	0.037	0.041
	37-43	940-1092	366	0.040	29.919	1432.519	0.005	0.239	0.000	0.000	0.000	0.000	29.9	1431.620	6033.125	288867.5755	0.04	0.038	0.042
*	25-37	635-940	365	0.032	60.331	2888.660	0.010	0.479	0.000	0.000	0.221	10.577	60.1	2877.603	6093.225	291745.179	0.035	0.033	0.037
	13-25	330-635	364	0.030	60.430	2893.384	0.010	0.479	0.000	0.000	0.000	0.000	60.4	2891.968	6153.625	294637.1465	0.03	0.029	0.032
*	0-13	0-330	363	0.020	66.153	3167.405	0.010	0.479	0.000	0.000	-0.317	-15.195	66.46	3182.122	6220.085	297819.2684	0.015	0.014	0.016

Table A-198 Energy Balance Results for RBHT Test 1655A for Time Period 1440 to 1485 seconds

Results for RBHT Test 1655
Valid Time Period 1440 to 1485 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4656.7842	14.69	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
0.25	6.35	4915.4944	15.506	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
0.50	12.70	5174.2047	16.322	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
0.75	19.05	5432.9149	17.139	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
1.00	25.40	5691.6251	17.955	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
1.25	31.75	5950.3353	18.771	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
1.50	38.10	6209.0456	19.587	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
1.75	44.45	6467.7558	20.403	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
2.00	50.80	6726.466	21.219	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
2.25	57.15	6985.1763	22.035	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
2.50	63.50	7243.8865	22.851	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
2.75	69.85	7502.5967	23.667	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
3.00	76.20	7761.307	24.484	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
3.25	82.55	8020.0172	25.3	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
3.50	88.90	8278.7274	26.116	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
3.75	95.25	8537.4377	26.932	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
4.00	101.60	8796.1479	27.748	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
4.25	107.95	9054.8581	28.564	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
4.50	114.30	9313.5684	29.38	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
4.75	120.65	9572.2786	30.196	0.00E+00	0.00E+00	0.00E+00	1.36E-01	6.16E-02
5.00	127.00	9830.9888	31.013	5.03E-03	4.18E-01	1.90E-01	1.35E-01	6.13E-02
5.25	133.35	10089.699	31.829	1.29E-02	1.07E+00	4.86E-01	1.34E-01	6.08E-02
5.50	139.70	10348.409	32.645	2.10E-02	1.74E+00	7.91E-01	1.33E-01	6.03E-02
5.75	146.05	10607.12	33.461	2.93E-02	2.43E+00	1.10E+00	1.32E-01	5.98E-02
6.00	152.40	10865.83	34.277	3.77E-02	3.14E+00	1.42E+00	1.31E-01	5.93E-02
6.25	158.75	11124.54	35.093	4.64E-02	3.86E+00	1.75E+00	1.29E-01	5.87E-02
6.50	165.10	11383.25	35.909	5.53E-02	4.60E+00	2.08E+00	1.28E-01	5.82E-02
6.75	171.45	11641.96	36.725	6.44E-02	5.35E+00	2.43E+00	1.27E-01	5.76E-02
7.00	177.80	11900.671	37.542	7.37E-02	6.12E+00	2.78E+00	1.26E-01	5.70E-02
7.25	184.15	12159.381	38.358	8.32E-02	6.91E+00	3.14E+00	1.24E-01	5.65E-02
7.50	190.50	12418.091	39.174	9.29E-02	7.72E+00	3.50E+00	1.23E-01	5.59E-02
7.75	196.85	12676.801	39.99	1.03E-01	8.54E+00	3.87E+00	1.22E-01	5.53E-02
8.00	203.20	12935.512	40.806	1.13E-01	9.39E+00	4.26E+00	1.20E-01	5.46E-02
8.25	209.55	13194.222	41.622	1.23E-01	1.02E+01	4.65E+00	1.19E-01	5.40E-02
8.50	215.90	13452.932	42.438	1.34E-01	1.11E+01	5.04E+00	1.18E-01	5.33E-02
8.75	222.25	13711.642	43.254	1.45E-01	1.20E+01	5.45E+00	1.16E-01	5.27E-02
9.00	228.60	13970.353	44.07	1.56E-01	1.29E+01	5.86E+00	1.15E-01	5.20E-02
9.25	234.95	13194.222	41.622	1.66E-01	1.38E+01	6.26E+00	1.13E-01	5.13E-02
9.50	241.30	12418.091	39.174	1.76E-01	1.46E+01	6.64E+00	1.12E-01	5.07E-02
9.75	247.65	11641.96	36.725	1.86E-01	1.54E+01	7.00E+00	1.11E-01	5.01E-02
10.00	254.00	10865.83	34.277	1.95E-01	1.62E+01	7.34E+00	1.09E-01	4.96E-02
10.25	260.35	10089.699	31.829	2.03E-01	1.69E+01	7.65E+00	1.08E-01	4.91E-02
10.50	266.70	9313.5684	29.38	2.11E-01	1.75E+01	7.94E+00	1.07E-01	4.86E-02
10.75	273.05	8537.4377	26.932	2.18E-01	1.81E+01	8.20E+00	1.06E-01	4.82E-02
11.00	279.40	7761.307	24.484	2.24E-01	1.86E+01	8.45E+00	1.05E-01	4.78E-02
11.25	285.75	6985.1763	22.035	2.30E-01	1.91E+01	8.67E+00	1.05E-01	4.74E-02
11.50	292.10	6209.0456	19.587	2.35E-01	1.95E+01	8.86E+00	1.04E-01	4.71E-02
11.75	298.45	5432.9149	17.139	2.40E-01	1.99E+01	9.04E+00	1.03E-01	4.68E-02
12.00	304.80	4656.7842	14.69	2.44E-01	2.03E+01	9.19E+00	1.03E-01	4.66E-02

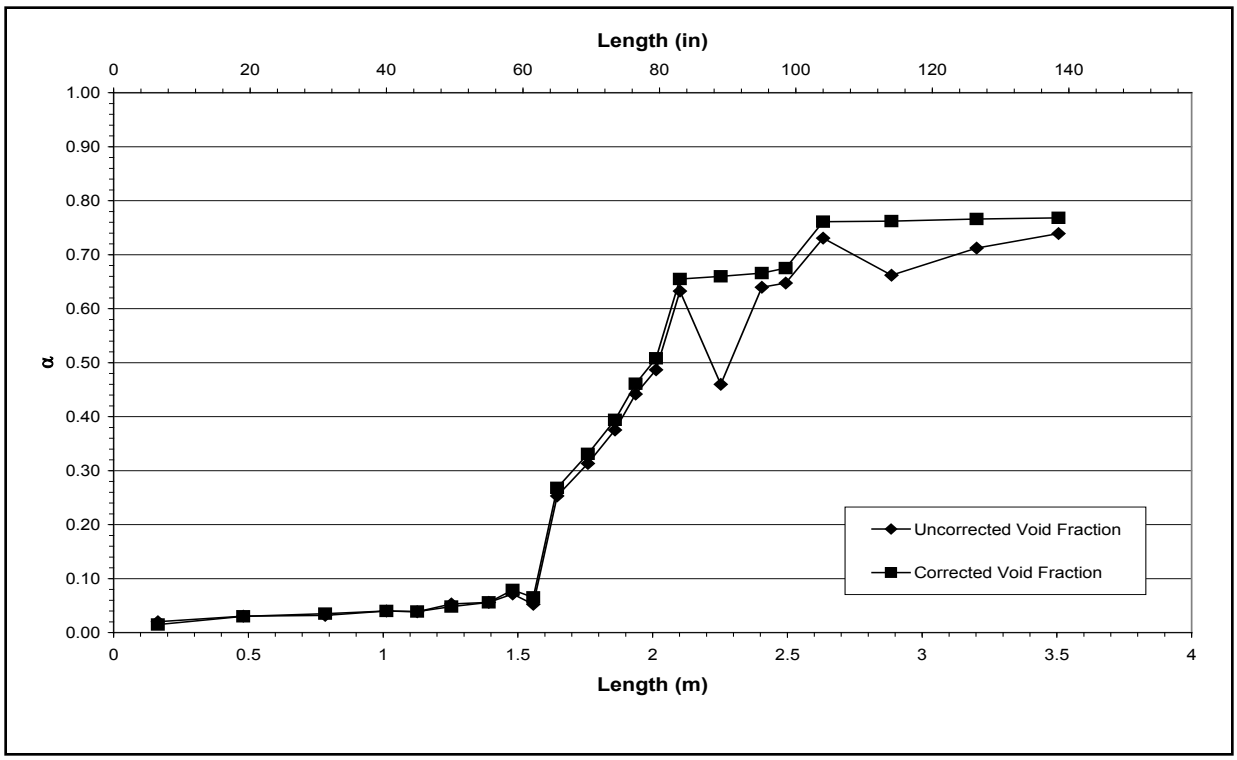

Figure A-495 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655A for Time Period 1440 to 1485 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-B

Test Conditions

Date: 7/7/2003
Steady-state time window: 1790 – 1860 seconds
Inlet flow rate: 3.551 cm/sec (1.398 in./sec)
Inlet mass flow rate: 0.167 kg/sec (0.369 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

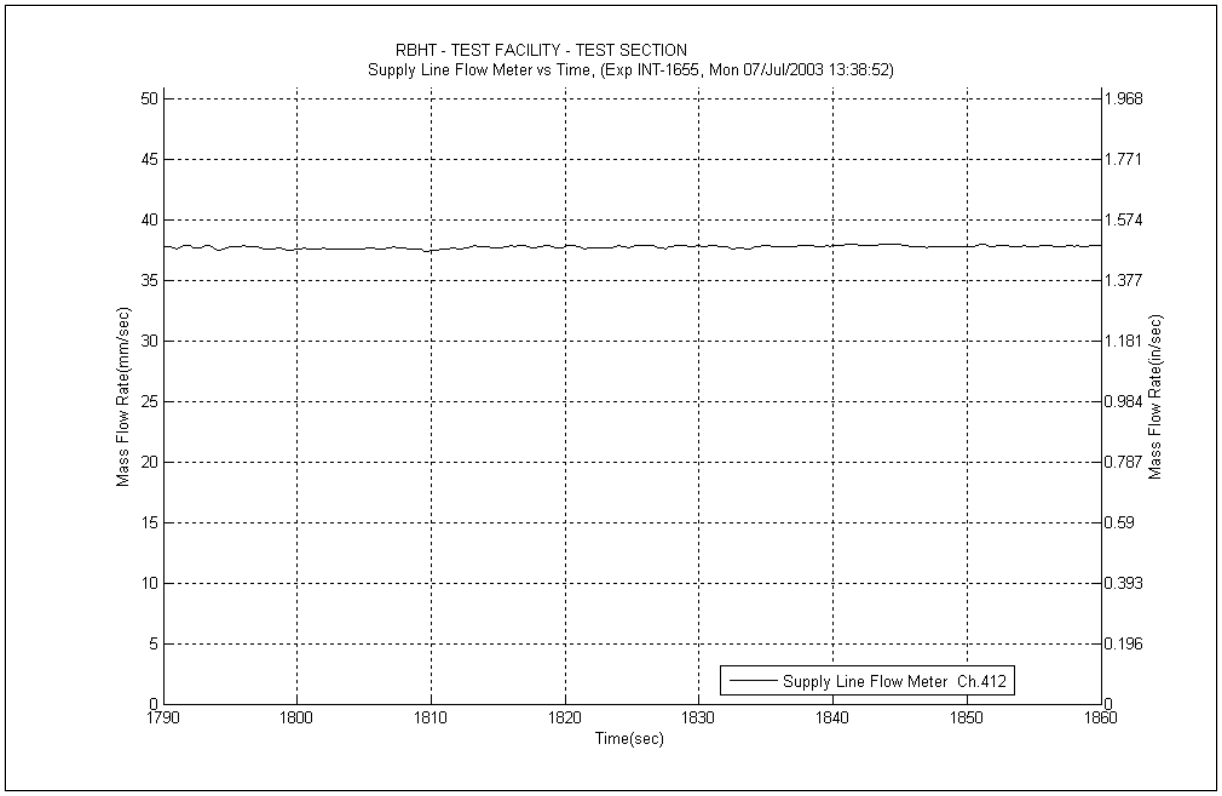

Figure A-496 Inlet Flow Plot for Experiment 1655B

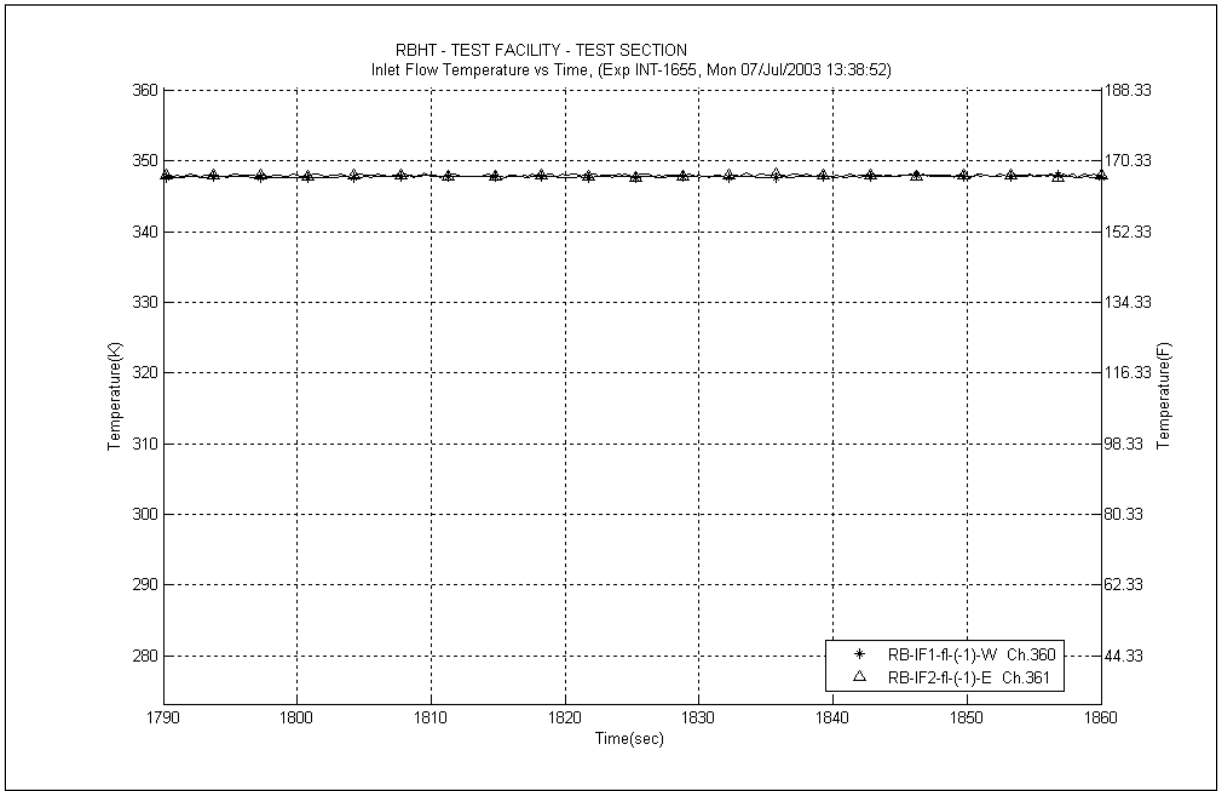

Figure A-497 Inlet Temperature Plot for Experiment 1655B

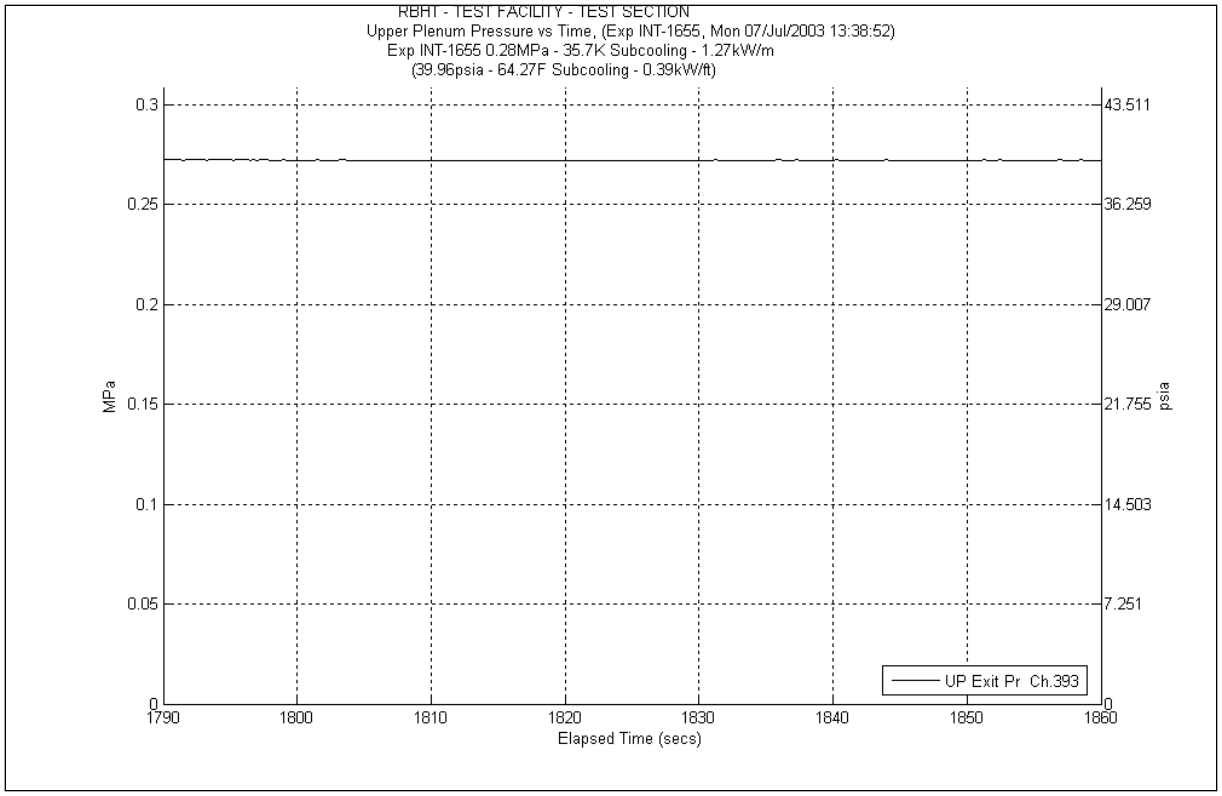

Figure A-498 System Pressure Plot for Experiment 1655B

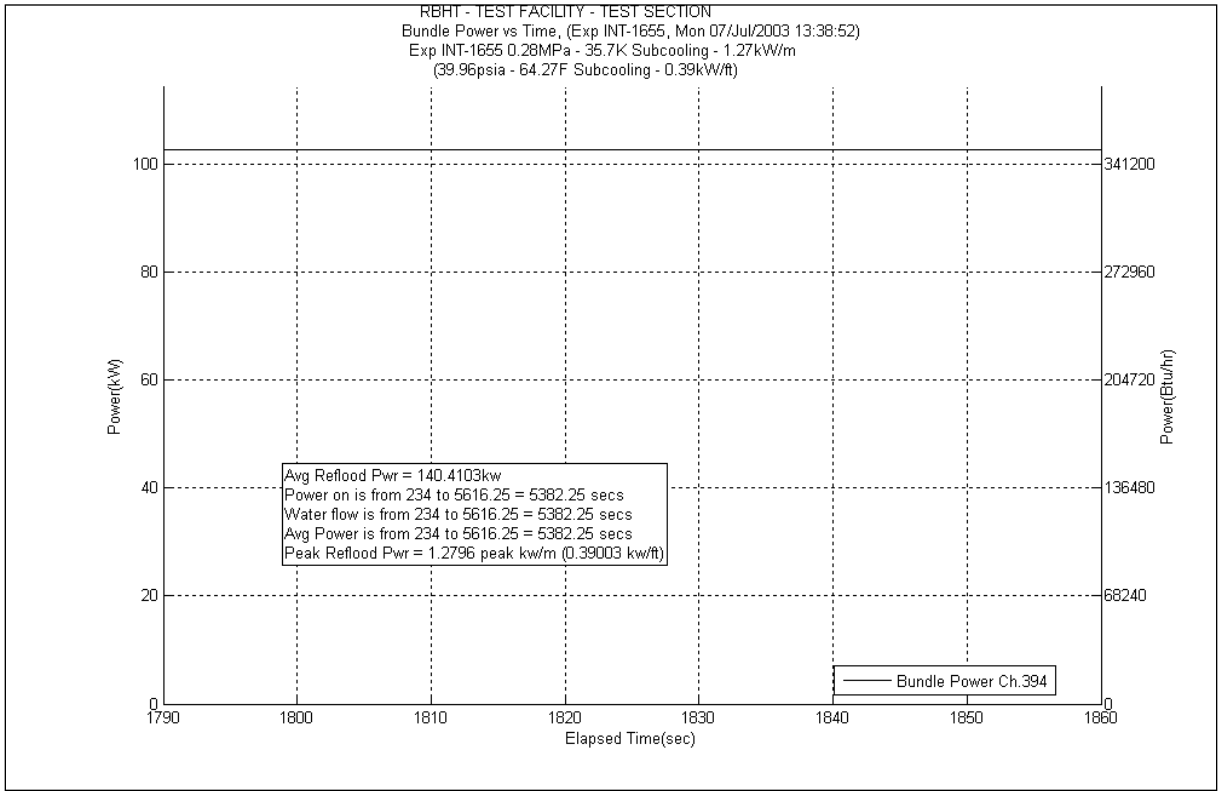

Figure A-499 Bundle Power Plot for Experiment 1655B

Table A-199 Data Results for RBHT Test 1655 for Time Period 1790 to 1860

Results for RBHT Test 1655
Valid Time Period 1790 to 1860 seconds
Collapsed Liquid Level = 88.672 inches = 2252.27 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.765	13.440	643.527	1.182	56.594	0.320	15.322	0.000	0.000	11.93	571.211	5771.93	276361.4918	0.791	0.787	0.795
*	120-133	3048-3378	383	0.732	18.099	866.573	1.291	61.813	0.572	27.388	1.906	91.248	14.33	686.124	5786.26	277047.6159	0.788	0.784	0.792
*	108-120	2743-3048	382	0.686	19.563	936.695	1.049	50.226	0.714	34.187	4.130	197.759	13.67	654.523	5799.93	277702.139	0.781	0.777	0.785
	100-108	2540-2743	381	0.750	10.387	497.316	0.605	28.968	0.522	24.993	0.000	0.000	9.254	443.084	5809.184	278145.2229	0.777	0.773	0.781
	97-100	2464-2540	380	0.683	4.939	236.474	0.206	9.863	0.189	9.049	0.000	0.000	4.539	217.328	5813.723	278362.5514	0.709	0.705	0.713
	93-97	2362-2464	379	0.681	6.627	317.288	0.258	12.353	0.246	11.779	0.000	0.000	6.118	292.931	5819.841	278655.4828	0.705	0.701	0.709
*	85-93	2159-2362	378	0.492	21.095	1010.049	0.457	21.881	0.472	22.599	7.806	373.768	12.36	591.800	5832.201	279247.2828	0.702	0.698	0.706
	81-85	2057-2159	377	0.679	6.668	319.277	0.198	9.480	0.226	10.821	0.000	0.000	6.242	298.869	5838.443	279546.1513	0.699	0.696	0.702
	78-81	1981-2057	376	0.539	7.188	344.143	0.136	6.512	0.165	7.900	0.000	0.000	6.883	329.560	5845.326	279875.7111	0.558	0.555	0.561
	75-78	1905-1981	375	0.508	7.671	367.268	0.124	5.937	0.162	7.757	0.000	0.000	7.384	353.548	5852.71	280229.2589	0.526	0.523	0.529
	72-75	1829-1905	374	0.414	9.125	436.892	0.113	5.410	0.158	7.565	0.000	0.000	8.852	423.836	5861.562	280653.095	0.432	0.430	0.434
*	67-72	1702-1829	373	0.365	16.489	789.489	0.161	7.709	0.255	12.209	1.423	68.125	14.65	701.446	5876.212	281354.5407	0.436	0.434	0.438
	63-67	1600-1702	372	0.425	11.945	571.913	0.103	4.932	0.197	9.432	0.000	0.000	11.64	557.326	5887.852	281911.8669	0.439	0.437	0.441
	60-63	1524-1600	371	0.302	10.880	520.938	0.061	2.921	0.143	6.847	0.000	0.000	10.67	510.882	5898.522	282422.7493	0.315	0.313	0.317
	57-60	1448-1524	370	0.204	12.396	593.547	0.046	2.202	0.139	6.655	0.000	0.000	12.21	584.618	5910.732	283007.3672	0.216	0.215	0.217
	53-57	1346-1448	369	0.068	19.371	927.494	0.032	1.532	0.180	8.618	0.000	0.000	19.15	916.907	5929.882	283924.2741	0.078	0.074	0.082
*	46-53	1168-1346	368	0.058	34.234	1639.153	0.004	0.192	0.000	0.000	0.100	4.809	34.13	1634.153	5964.012	285558.4273	0.061	0.058	0.064
	43-46	1092-1168	367	0.044	14.900	713.400	0.002	0.096	0.000	0.000	0.000	0.000	14.89	712.937	5978.902	286271.3643	0.044	0.042	0.046
	37-43	940-1092	366	0.042	29.841	1428.789	0.004	0.192	0.000	0.000	0.000	0.000	29.83	1428.268	6008.732	287699.6324	0.042	0.040	0.044
*	25-37	635-940	365	0.034	60.180	2881.449	0.008	0.383	0.000	0.000	0.182	8.729	59.99	2872.337	6068.722	290571.969	0.037	0.035	0.039
	13-25	330-635	364	0.032	60.352	2889.654	0.008	0.383	0.000	0.000	0.000	0.000	60.33	2888.616	6129.052	293460.5849	0.032	0.030	0.034
*	0-13	0-330	363	0.021	66.111	3165.416	0.008	0.383	0.000	0.000	-0.317	-15.174	66.42	3180.207	6195.472	296640.7916	0.016	0.015	0.017

Table A-200 Energy Balance Results for RBHT Test 1655B for Time Period 1790 to 1860 seconds

Results for RBHT Test 1655
Valid Time Period 1790 to 1860 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.8045	14.693	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
0.25	6.35	4916.5714	15.51	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
0.50	12.70	5175.3383	16.326	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
0.75	19.05	5434.1052	17.142	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
1.00	25.40	5692.8721	17.959	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
1.25	31.75	5951.6391	18.775	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
1.50	38.10	6210.406	19.591	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
1.75	44.45	6469.1729	20.407	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
2.00	50.80	6727.9398	21.224	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
2.25	57.15	6986.7067	22.04	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
2.50	63.50	7245.4736	22.856	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
2.75	69.85	7504.2406	23.673	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
3.00	76.20	7763.0075	24.489	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
3.25	82.55	8021.7744	25.305	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
3.50	88.90	8280.5413	26.122	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
3.75	95.25	8539.3082	26.938	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
4.00	101.60	8798.0751	27.754	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
4.25	107.95	9056.842	28.57	0.00E+00	0.00E+00	0.00E+00	1.21E-01	5.48E-02
4.50	114.30	9315.609	29.387	2.72E-03	2.01E-01	9.11E-02	1.21E-01	5.47E-02
4.75	120.65	9574.3759	30.203	1.11E-02	8.20E-01	3.72E-01	1.20E-01	5.42E-02
5.00	127.00	9833.1428	31.019	1.97E-02	1.46E+00	6.61E-01	1.18E-01	5.37E-02
5.25	133.35	10091.91	31.836	2.86E-02	2.11E+00	9.57E-01	1.17E-01	5.32E-02
5.50	139.70	10350.677	32.652	3.76E-02	2.78E+00	1.26E+00	1.16E-01	5.28E-02
5.75	146.05	10609.444	33.468	4.69E-02	3.47E+00	1.57E+00	1.15E-01	5.22E-02
6.00	152.40	10868.21	34.285	5.65E-02	4.17E+00	1.89E+00	1.14E-01	5.17E-02
6.25	158.75	11126.977	35.101	6.62E-02	4.89E+00	2.22E+00	1.13E-01	5.12E-02
6.50	165.10	11385.744	35.917	7.62E-02	5.63E+00	2.55E+00	1.12E-01	5.06E-02
6.75	171.45	11644.511	36.733	8.65E-02	6.39E+00	2.90E+00	1.10E-01	5.01E-02
7.00	177.80	11903.278	37.55	9.69E-02	7.16E+00	3.25E+00	1.09E-01	4.95E-02
7.25	184.15	12162.045	38.366	1.08E-01	7.95E+00	3.61E+00	1.08E-01	4.89E-02
7.50	190.50	12420.812	39.182	1.19E-01	8.75E+00	3.97E+00	1.07E-01	4.83E-02
7.75	196.85	12679.579	39.999	1.30E-01	9.57E+00	4.34E+00	1.05E-01	4.77E-02
8.00	203.20	12938.346	40.815	1.41E-01	1.04E+01	4.72E+00	1.04E-01	4.71E-02
8.25	209.55	13197.113	41.631	1.53E-01	1.13E+01	5.11E+00	1.02E-01	4.65E-02
8.50	215.90	13455.88	42.448	1.64E-01	1.21E+01	5.51E+00	1.01E-01	4.58E-02
8.75	222.25	13714.647	43.264	1.77E-01	1.30E+01	5.91E+00	9.95E-02	4.51E-02
9.00	228.60	13973.413	44.08	1.89E-01	1.39E+01	6.33E+00	9.80E-02	4.45E-02
9.25	234.95	13197.113	41.631	2.01E-01	1.48E+01	6.73E+00	9.66E-02	4.38E-02
9.50	241.30	12420.812	39.182	2.12E-01	1.57E+01	7.11E+00	9.52E-02	4.32E-02
9.75	247.65	11644.511	36.733	2.23E-01	1.65E+01	7.47E+00	9.39E-02	4.26E-02
10.00	254.00	10868.21	34.285	2.33E-01	1.72E+01	7.80E+00	9.27E-02	4.20E-02
10.25	260.35	10091.91	31.836	2.42E-01	1.79E+01	8.11E+00	9.16E-02	4.15E-02
10.50	266.70	9315.609	29.387	2.51E-01	1.85E+01	8.40E+00	9.05E-02	4.11E-02
10.75	273.05	8539.3082	26.938	2.59E-01	1.91E+01	8.67E+00	8.96E-02	4.06E-02
11.00	279.40	7763.0075	24.489	2.66E-01	1.96E+01	8.91E+00	8.87E-02	4.02E-02
11.25	285.75	6986.7067	22.04	2.73E-01	2.01E+01	9.13E+00	8.79E-02	3.99E-02
11.50	292.10	6210.406	19.591	2.78E-01	2.06E+01	9.33E+00	8.72E-02	3.96E-02
11.75	298.45	5434.1052	17.142	2.84E-01	2.09E+01	9.50E+00	8.66E-02	3.93E-02
12.00	304.80	4657.8045	14.693	2.88E-01	2.13E+01	9.65E+00	8.60E-02	3.90E-02

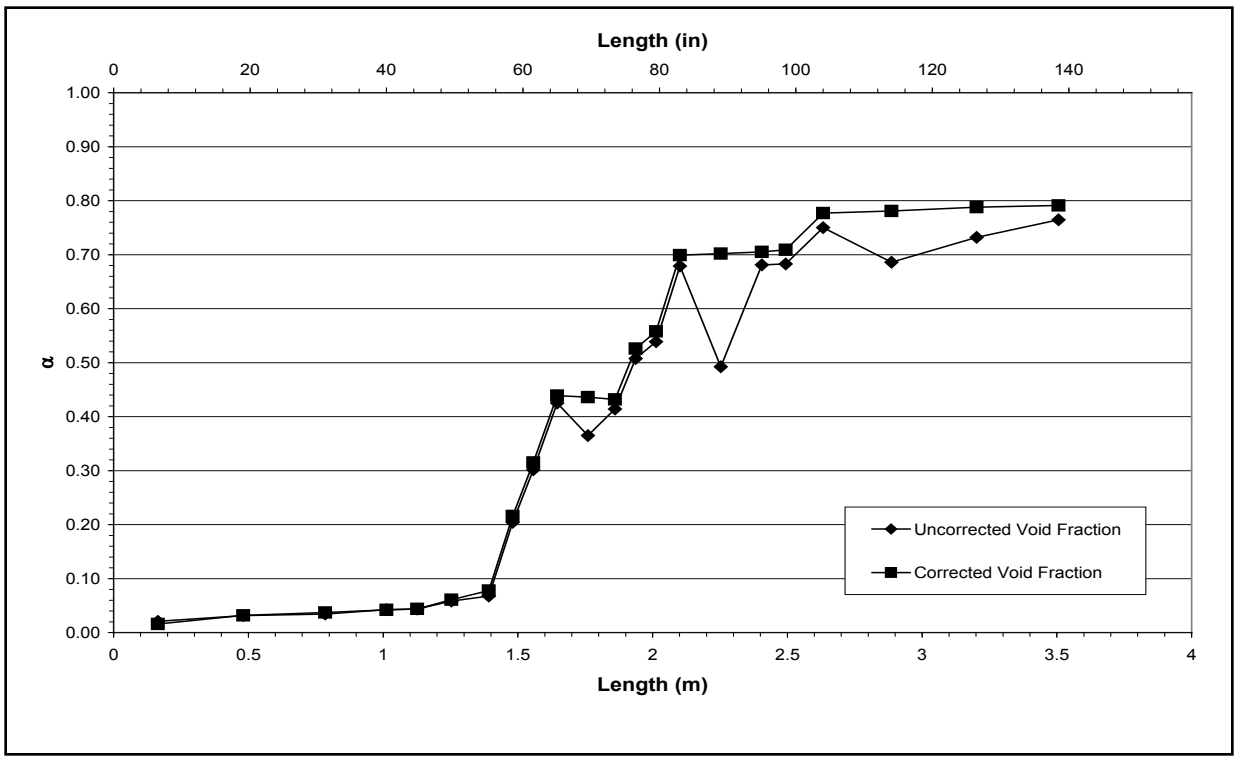

Figure A-500 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655B for Time Period 1790 to 1860 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-C

Test Conditions

Date: 7/7/2003
Steady-state time window: 1980 – 2040 seconds
Inlet flow rate: 3.538 cm/sec (1.393 in./sec)
Inlet mass flow rate: 0.167 kg/sec (0.368 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

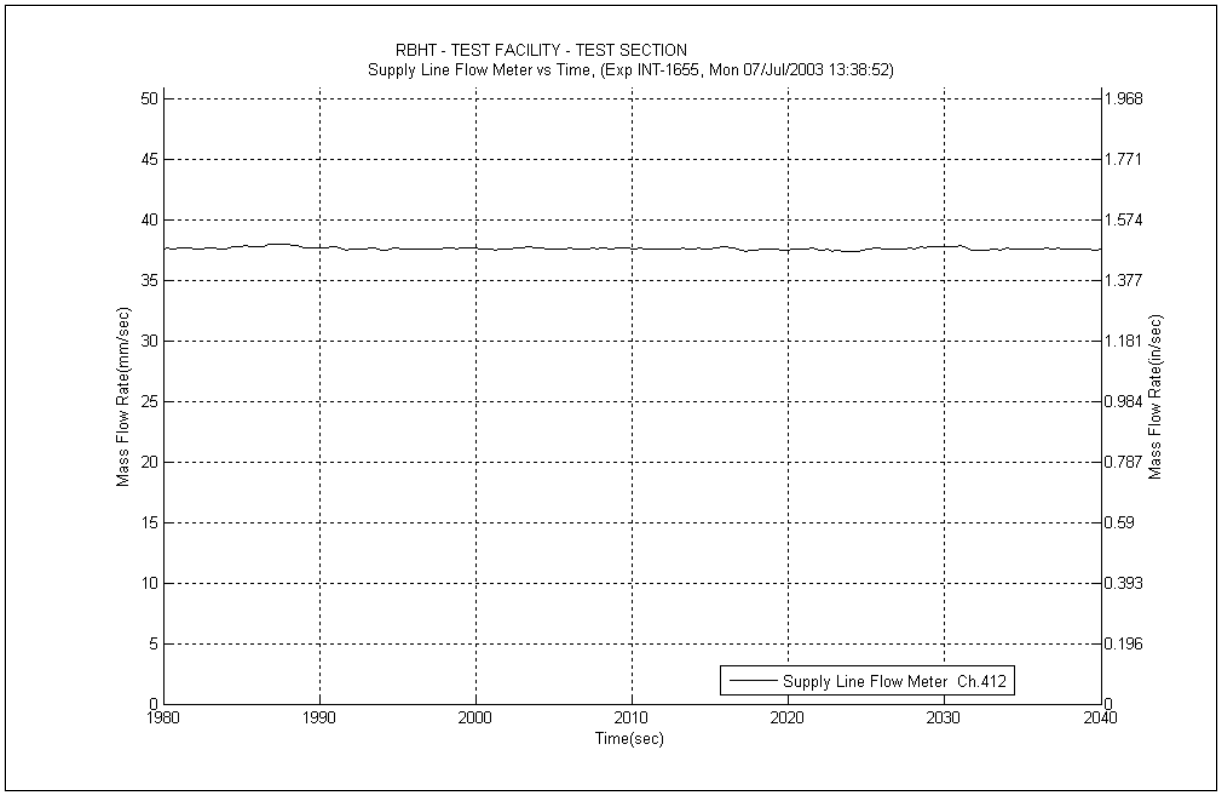

Figure A-501 Inlet Flow Plot for Experiment 1655C

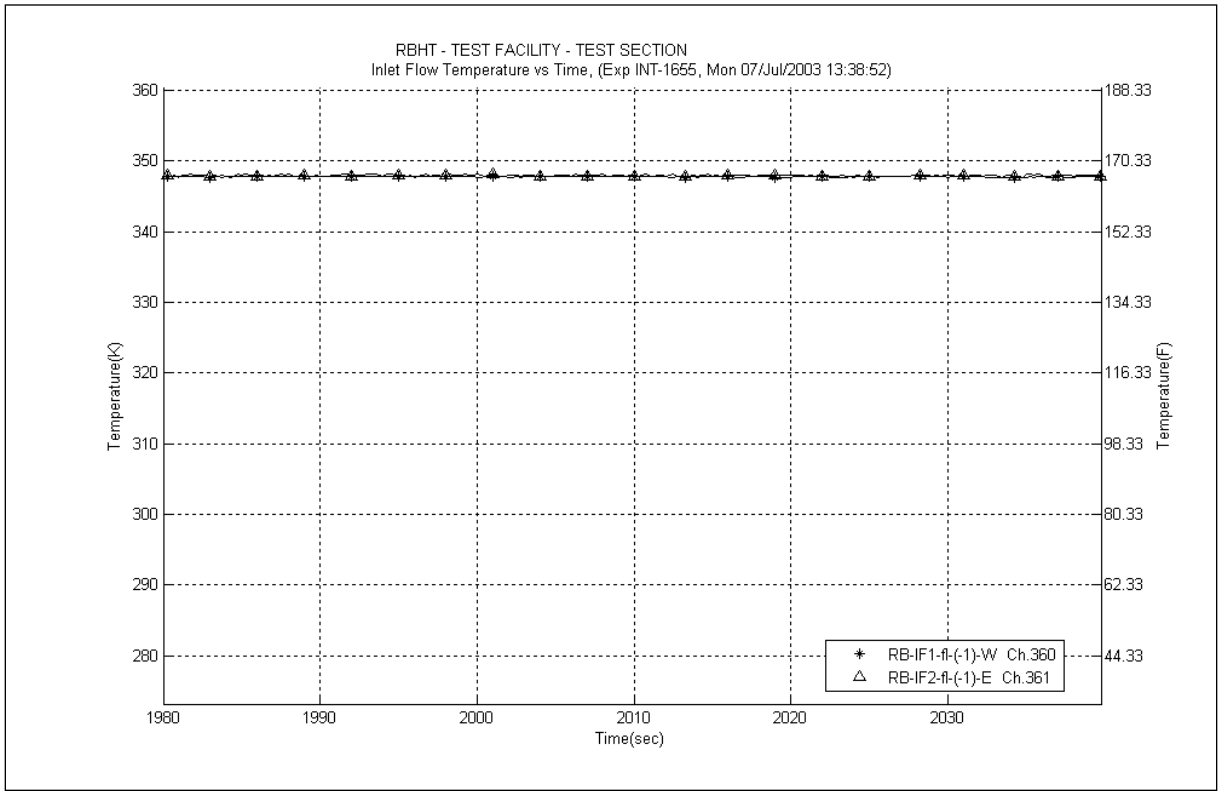

Figure A-502 Inlet Temperature Plot for Experiment 1655C

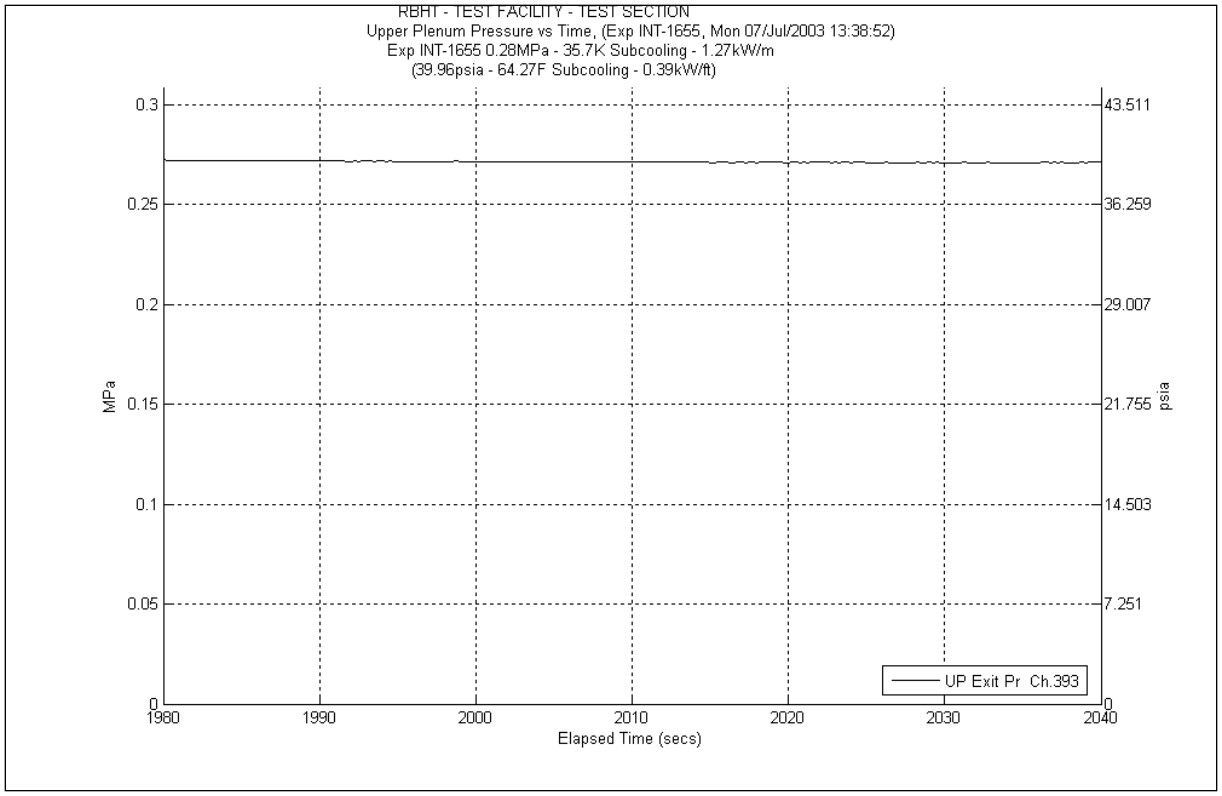

Figure A-503 System Pressure Plot for Experiment 1655C

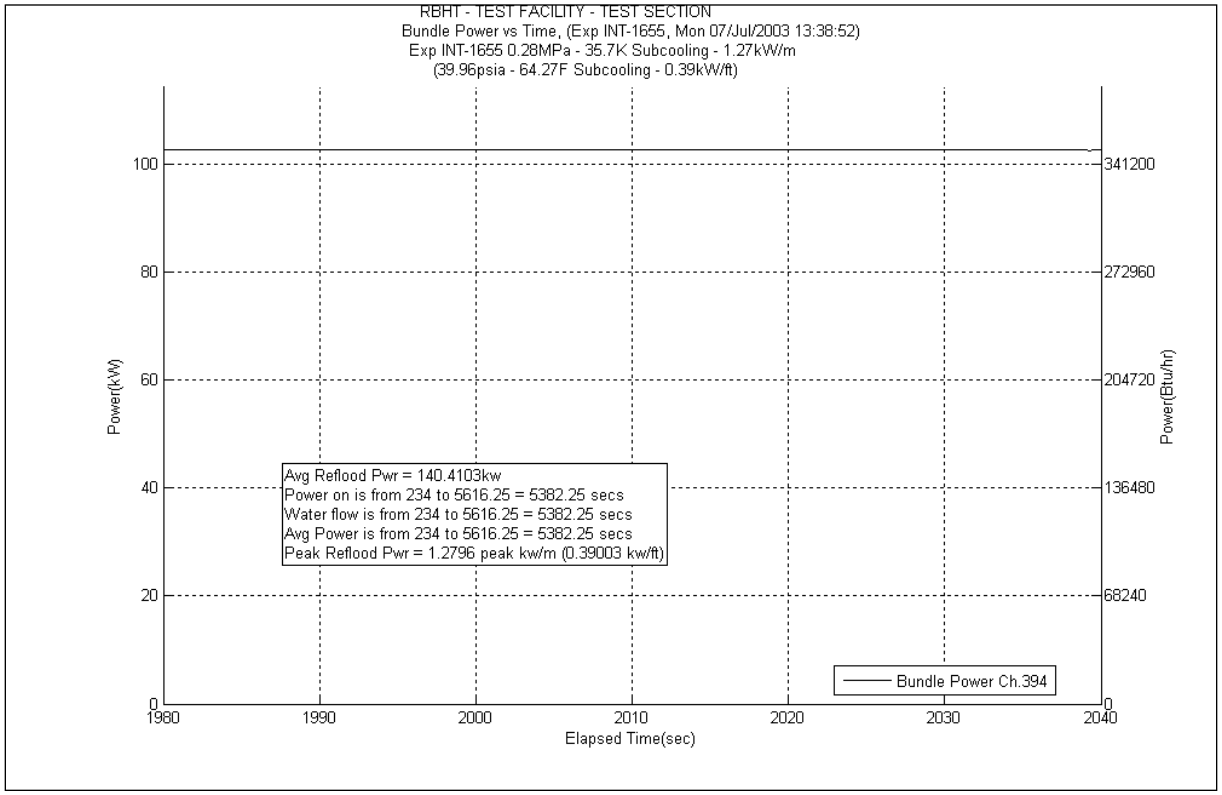

Figure A-504 Bundle Power Plot for Experiment 1655C

Table A-201 Data Results for RBHT Test 1655 for Time Period 1980 to 2040

Results for RBHT Test 1655
Valid Time Period 1980 to 2040 seconds
Collapsed Liquid Level = 88.254 inches = 2241.65 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.769	13.207	632.337	1.178	56.403	0.319	15.274	0.000	0.000	11.7	560.199	5771.7	276350.4793	0.795	0.791	0.799
*	120-133	3048-3378	383	0.737	17.782	851.405	1.286	61.574	0.570	27.292	1.806	86.470	14.12	676.069	5785.82	277026.5486	0.791	0.787	0.795
*	108-120	2743-3048	382	0.689	19.387	928.240	1.045	50.035	0.711	34.043	4.081	195.385	13.55	648.777	5799.37	277675.326	0.782	0.778	0.786
	100-108	2540-2743	381	0.751	10.340	495.078	0.604	28.920	0.520	24.898	0.000	0.000	9.212	441.073	5808.582	278116.399	0.778	0.774	0.782
	97-100	2464-2540	380	0.688	4.856	232.495	0.206	9.863	0.188	9.001	0.000	0.000	4.459	213.498	5813.041	278329.897	0.714	0.710	0.718
	93-97	2362-2464	379	0.685	6.554	313.806	0.257	12.305	0.245	11.731	0.000	0.000	6.05	289.676	5819.091	278619.5726	0.709	0.705	0.713
*	85-93	2159-2362	378	0.497	20.882	999.854	0.455	21.786	0.471	22.552	7.736	370.420	12.22	585.097	5831.311	279204.6693	0.706	0.702	0.710
	81-85	2057-2159	377	0.683	6.596	315.796	0.198	9.480	0.225	10.773	0.000	0.000	6.169	295.373	5837.48	279500.0426	0.703	0.699	0.707
	78-81	1981-2057	376	0.540	7.167	343.148	0.135	6.464	0.165	7.900	0.000	0.000	6.865	328.698	5844.345	279828.7406	0.559	0.556	0.562
	75-78	1905-1981	375	0.506	7.691	368.262	0.124	5.937	0.161	7.709	0.000	0.000	7.402	354.410	5851.747	280183.1503	0.525	0.522	0.528
	72-75	1829-1905	374	0.421	9.016	431.670	0.112	5.363	0.157	7.517	0.000	0.000	8.742	418.569	5860.489	280601.7195	0.439	0.437	0.441
*	67-72	1702-1829	373	0.369	16.390	784.765	0.161	7.709	0.254	12.162	1.525	73.025	14.45	691.870	5874.939	281293.5892	0.443	0.441	0.445
	63-67	1600-1702	372	0.434	11.763	563.210	0.103	4.932	0.196	9.385	0.000	0.000	11.46	548.708	5886.399	281842.2969	0.448	0.446	0.450
	60-63	1524-1600	371	0.312	10.724	513.479	0.062	2.969	0.143	6.847	0.000	0.000	10.52	503.700	5896.919	282345.9972	0.325	0.323	0.327
	57-60	1448-1524	370	0.221	12.137	581.114	0.046	2.202	0.139	6.655	0.000	0.000	11.95	572.169	5908.869	282918.1663	0.233	0.232	0.234
	53-57	1346-1448	369	0.076	19.205	919.537	0.033	1.580	0.179	8.571	0.000	0.000	18.98	908.767	5927.849	283826.9336	0.086	0.082	0.090
*	46-53	1168-1346	368	0.059	34.214	1638.159	0.008	0.383	0.004	0.192	0.222	10.613	33.98	1626.971	5961.829	285453.9047	0.065	0.062	0.068
	43-46	1092-1168	367	0.044	14.900	713.400	0.002	0.096	0.000	0.000	0.000	0.000	14.89	712.937	5976.719	286166.8417	0.044	0.042	0.046
	37-43	940-1092	366	0.042	29.841	1428.789	0.004	0.192	0.000	0.000	0.000	0.000	29.83	1428.268	6006.549	287595.1098	0.042	0.040	0.044
*	25-37	635-940	365	0.034	60.180	2881.449	0.008	0.383	0.000	0.000	0.182	8.729	59.99	2872.337	6066.539	290467.4464	0.037	0.035	0.039
	13-25	330-635	364	0.032	60.352	2889.654	0.008	0.383	0.000	0.000	0.000	0.000	60.33	2888.616	6126.869	293356.0623	0.032	0.030	0.034
*	0-13	0-330	363	0.021	66.111	3165.416	0.008	0.383	0.000	0.000	-0.317	-15.174	66.42	3180.207	6193.289	296536.269	0.016	0.015	0.017

Table A-202 Energy Balance Results for RBHT Test 1655C for Time Period 1980 to 2040 seconds

Results for RBHT Test 1655
Valid Time Period 1980 to 2040 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4653.5216	14.68	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
0.25	6.35	4912.0506	15.495	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
0.50	12.70	5170.5796	16.311	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
0.75	19.05	5429.1086	17.127	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
1.00	25.40	5687.6376	17.942	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
1.25	31.75	5946.1665	18.758	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
1.50	38.10	6204.6955	19.573	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
1.75	44.45	6463.2245	20.389	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
2.00	50.80	6721.7535	21.204	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
2.25	57.15	6980.2825	22.02	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
2.50	63.50	7238.8114	22.835	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
2.75	69.85	7497.3404	23.651	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
3.00	76.20	7755.8694	24.466	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
3.25	82.55	8014.3984	25.282	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
3.50	88.90	8272.9274	26.098	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
3.75	95.25	8531.4563	26.913	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
4.00	101.60	8789.9853	27.729	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
4.25	107.95	9048.5143	28.544	0.00E+00	0.00E+00	0.00E+00	1.20E-01	5.46E-02
4.50	114.30	9307.0433	29.36	3.02E-03	2.22E-01	1.01E-01	1.20E-01	5.45E-02
4.75	120.65	9565.5723	30.175	1.14E-02	8.42E-01	3.82E-01	1.19E-01	5.40E-02
5.00	127.00	9824.1012	30.991	2.01E-02	1.48E+00	6.70E-01	1.18E-01	5.35E-02
5.25	133.35	10082.63	31.806	2.89E-02	2.13E+00	9.66E-01	1.17E-01	5.30E-02
5.50	139.70	10341.159	32.622	3.80E-02	2.80E+00	1.27E+00	1.16E-01	5.25E-02
5.75	146.05	10599.688	33.437	4.74E-02	3.49E+00	1.58E+00	1.15E-01	5.20E-02
6.00	152.40	10858.217	34.253	5.69E-02	4.19E+00	1.90E+00	1.14E-01	5.15E-02
6.25	158.75	11116.746	35.069	6.67E-02	4.91E+00	2.23E+00	1.12E-01	5.10E-02
6.50	165.10	11375.275	35.884	7.67E-02	5.65E+00	2.56E+00	1.11E-01	5.04E-02
6.75	171.45	11633.804	36.7	8.70E-02	6.40E+00	2.91E+00	1.10E-01	4.99E-02
7.00	177.80	11892.333	37.515	9.75E-02	7.18E+00	3.26E+00	1.09E-01	4.93E-02
7.25	184.15	12150.862	38.331	1.08E-01	7.97E+00	3.61E+00	1.07E-01	4.87E-02
7.50	190.50	12409.391	39.146	1.19E-01	8.77E+00	3.98E+00	1.06E-01	4.81E-02
7.75	196.85	12667.92	39.962	1.30E-01	9.60E+00	4.35E+00	1.05E-01	4.75E-02
8.00	203.20	12926.449	40.777	1.42E-01	1.04E+01	4.73E+00	1.03E-01	4.69E-02
8.25	209.55	13184.978	41.593	1.53E-01	1.13E+01	5.12E+00	1.02E-01	4.62E-02
8.50	215.90	13443.507	42.409	1.65E-01	1.22E+01	5.52E+00	1.01E-01	4.56E-02
8.75	222.25	13702.036	43.224	1.77E-01	1.31E+01	5.92E+00	9.91E-02	4.49E-02
9.00	228.60	13960.565	44.04	1.90E-01	1.40E+01	6.33E+00	9.76E-02	4.43E-02
9.25	234.95	13184.978	41.593	2.02E-01	1.49E+01	6.74E+00	9.61E-02	4.36E-02
9.50	241.30	12409.391	39.146	2.13E-01	1.57E+01	7.12E+00	9.48E-02	4.30E-02
9.75	247.65	11633.804	36.7	2.24E-01	1.65E+01	7.48E+00	9.35E-02	4.24E-02
10.00	254.00	10858.217	34.253	2.34E-01	1.72E+01	7.81E+00	9.23E-02	4.19E-02
10.25	260.35	10082.63	31.806	2.43E-01	1.79E+01	8.12E+00	9.11E-02	4.13E-02
10.50	266.70	9307.0433	29.36	2.52E-01	1.85E+01	8.41E+00	9.01E-02	4.09E-02
10.75	273.05	8531.4563	26.913	2.60E-01	1.91E+01	8.67E+00	8.91E-02	4.04E-02
11.00	279.40	7755.8694	24.466	2.67E-01	1.97E+01	8.92E+00	8.83E-02	4.00E-02
11.25	285.75	6980.2825	22.02	2.74E-01	2.01E+01	9.14E+00	8.75E-02	3.97E-02
11.50	292.10	6204.6955	19.573	2.79E-01	2.06E+01	9.33E+00	8.68E-02	3.94E-02
11.75	298.45	5429.1086	17.127	2.85E-01	2.10E+01	9.51E+00	8.61E-02	3.91E-02
12.00	304.80	4653.5216	14.68	2.89E-01	2.13E+01	9.66E+00	8.56E-02	3.88E-02

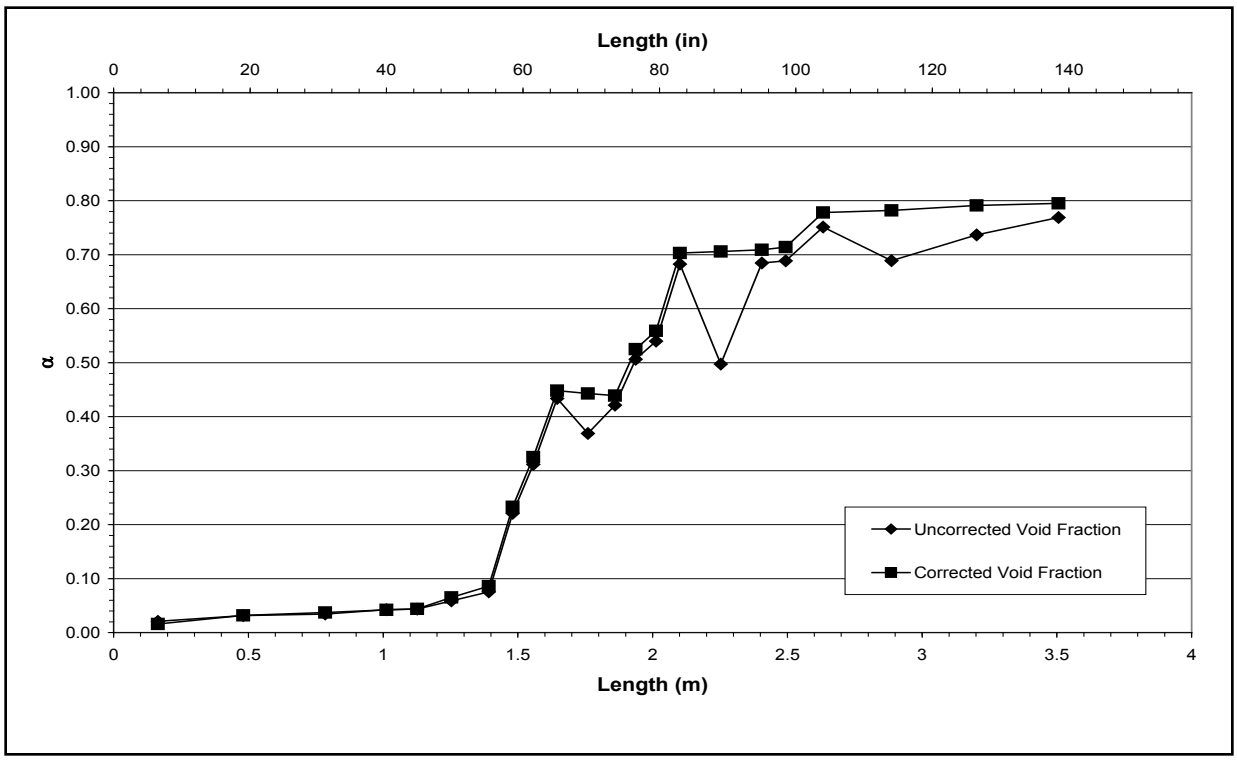

Figure A-505 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655C for Time Period 1980 to 2040 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-D

Test Conditions

Date: 7/7/2003
Steady-state time window: 2266 – 2315 seconds
Inlet flow rate: 3.010 cm/sec (1.185 in./sec)
Inlet mass flow rate: 0.142 kg/sec (0.313 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

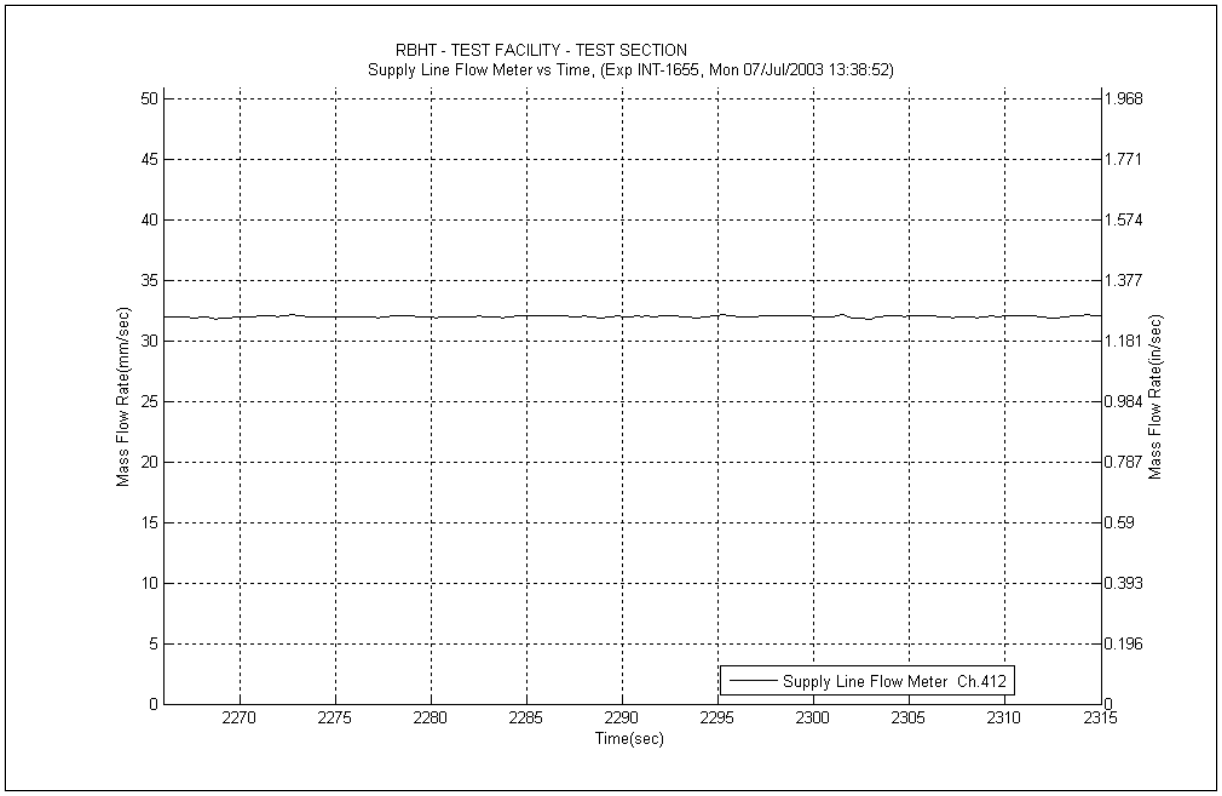

Figure A-506 Inlet Flow Plot for Experiment 1655D

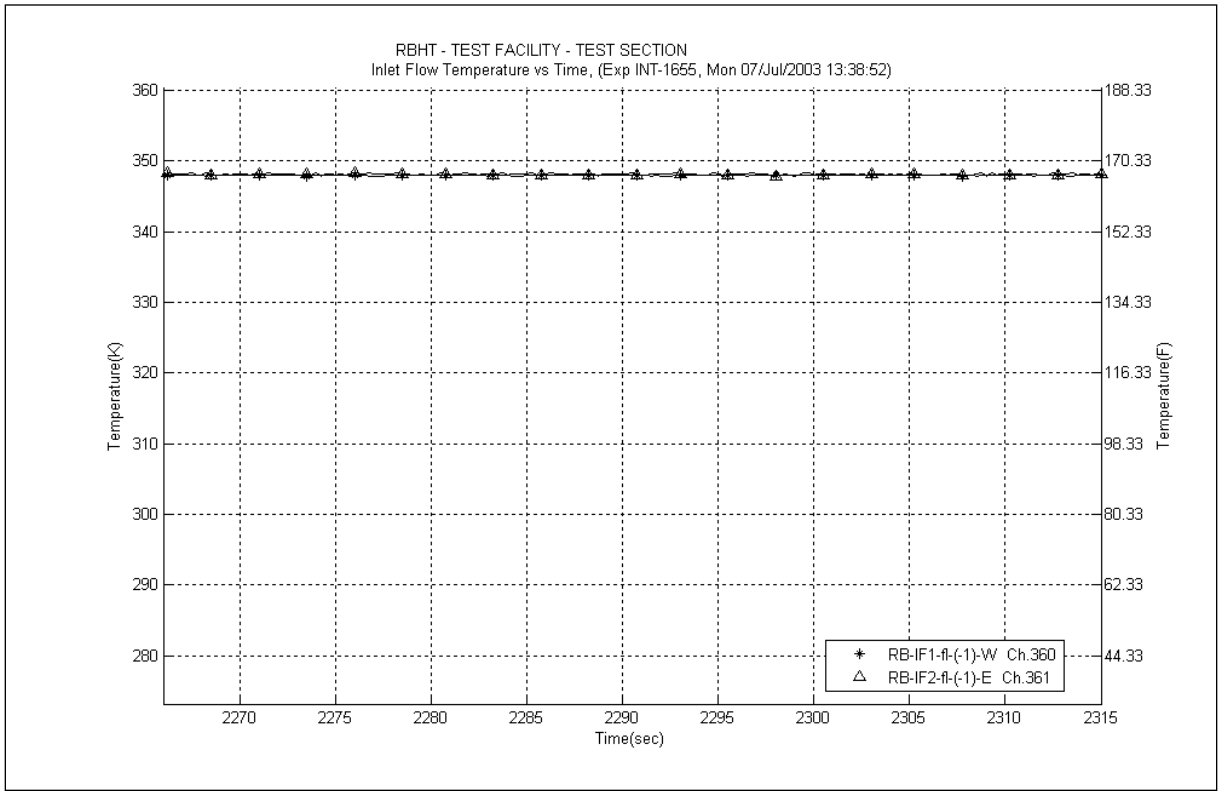

Figure A-507 Inlet Temperature Plot for Experiment 1655D

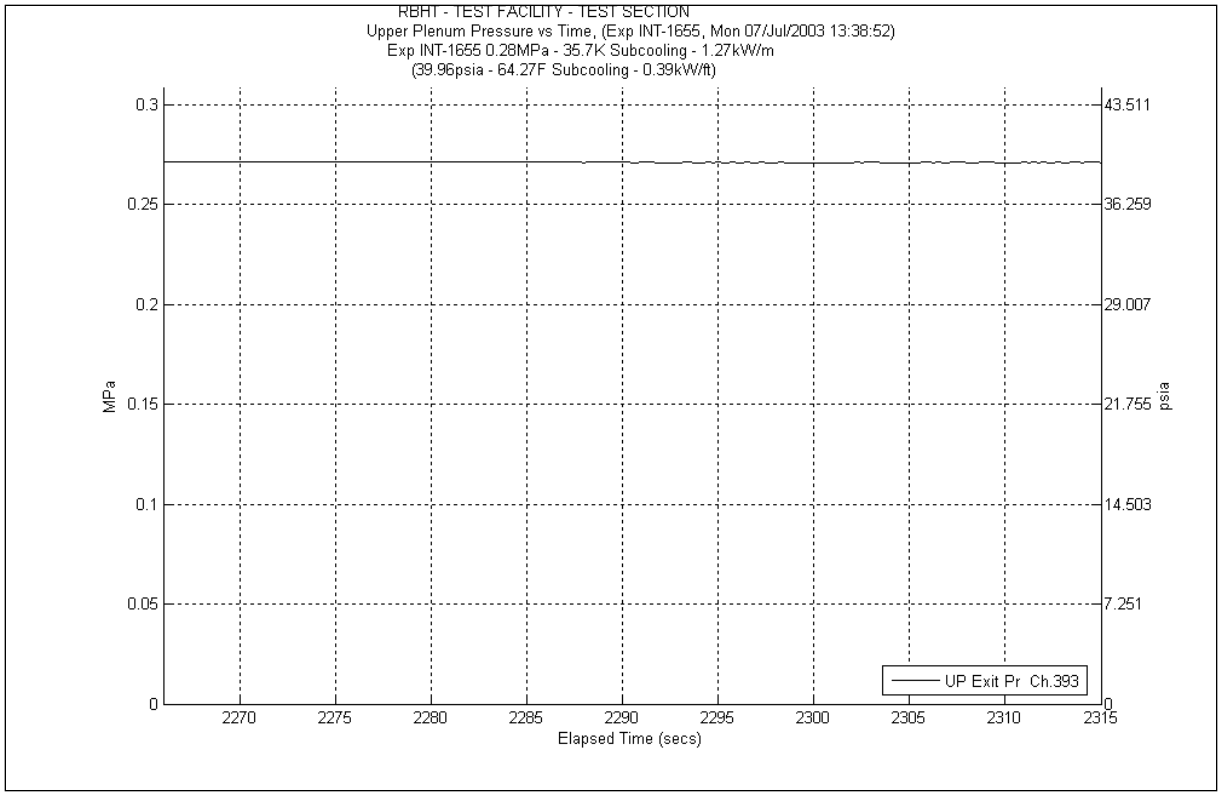

Figure A-508 System Pressure Plot for Experiment 1655D

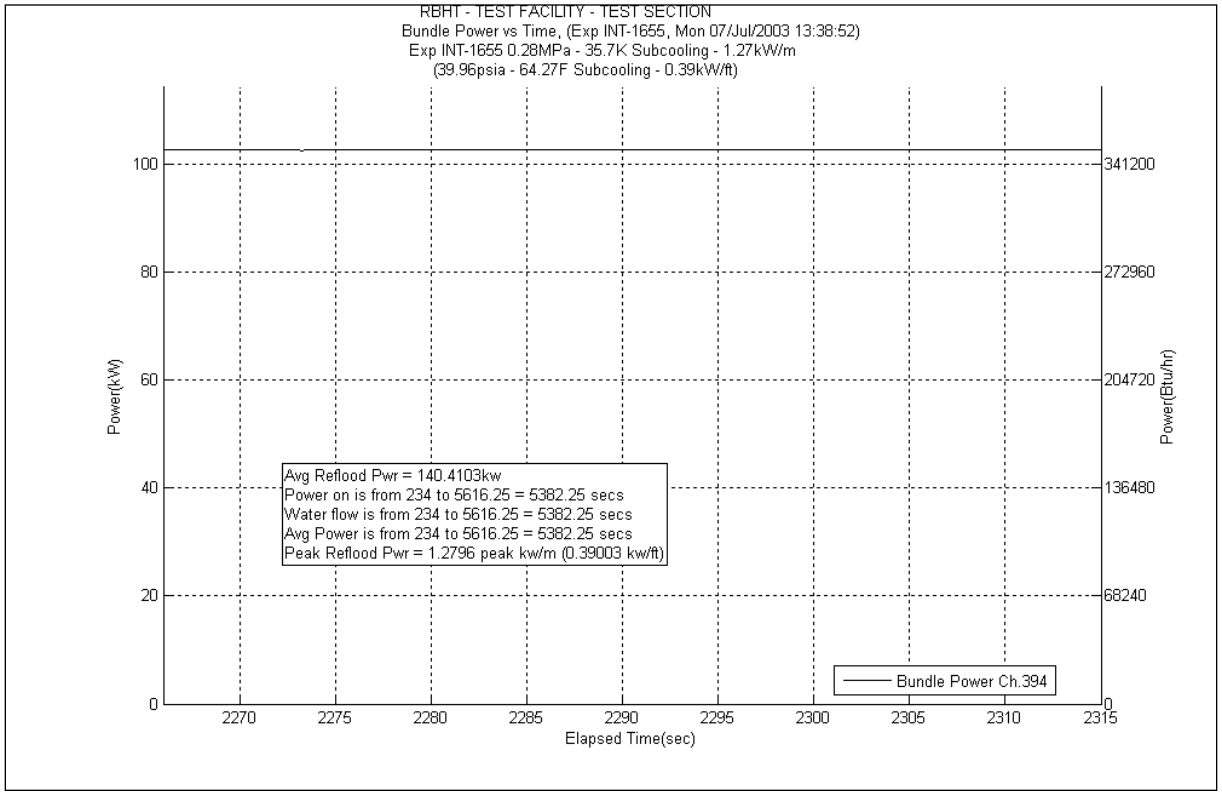

Figure A-509 Bundle Power Plot for Experiment 1655D

Table A-203 Data Results for RBHT Test 1655 for Time Period 2266 to 2315

Results for RBHT Test 1655
Valid Time Period 2266 to 2315 seconds
Collapsed Liquid Level = 83.205 inches = 2113.40 mm
(Z_{osv}) Onset of Significant Void = 44.5 inches = 1130 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.798	11.550	553.015	1.038	49.700	0.273	13.071	0.000	0.000	10.24	490.294	5770.24	276280.5742	0.821	0.817	0.825
*	120-133	3048-3378	383	0.758	16.369	783.770	1.135	54.344	0.487	23.318	2.227	106.647	12.52	599.461	5782.76	276880.035	0.815	0.811	0.819
*	108-120	2743-3048	382	0.712	17.948	859.362	0.927	44.385	0.607	29.063	4.084	195.550	12.33	590.364	5795.09	277470.3985	0.802	0.798	0.806
	100-108	2540-2743	381	0.772	9.467	453.303	0.539	25.807	0.444	21.259	0.000	0.000	8.479	405.977	5803.569	277876.3752	0.796	0.792	0.800
	97-100	2464-2540	380	0.716	4.430	212.105	0.185	8.858	0.161	7.709	0.000	0.000	4.083	195.495	5807.652	278071.8703	0.738	0.734	0.742
	93-97	2362-2464	379	0.719	5.842	279.740	0.232	11.108	0.209	10.007	0.000	0.000	5.398	258.458	5813.05	278330.328	0.74	0.736	0.744
*	85-93	2159-2362	378	0.530	19.537	935.451	0.416	19.918	0.402	19.248	7.759	371.518	10.96	524.768	5824.01	278855.0956	0.736	0.732	0.740
	81-85	2057-2159	377	0.714	5.941	284.465	0.184	8.810	0.193	9.241	0.000	0.000	5.564	266.406	5829.574	279121.5013	0.732	0.728	0.736
	78-81	1981-2057	376	0.593	6.341	303.611	0.127	6.081	0.141	6.751	0.000	0.000	6.069	290.585	5835.643	279412.0866	0.61	0.607	0.613
	75-78	1905-1981	375	0.570	6.694	320.520	0.118	5.650	0.138	6.607	0.000	0.000	6.435	308.109	5842.078	279720.1961	0.587	0.584	0.590
	72-75	1829-1905	374	0.489	7.961	381.193	0.109	5.219	0.134	6.416	0.000	0.000	7.717	369.492	5849.795	280089.688	0.504	0.501	0.507
*	67-72	1702-1829	373	0.406	15.429	738.763	0.162	7.757	0.217	10.390	2.880	137.913	12.17	582.703	5861.965	280672.3907	0.531	0.528	0.534
	63-67	1600-1702	372	0.545	9.457	452.806	0.111	5.315	0.167	7.996	0.000	0.000	9.177	439.397	5871.142	281111.7878	0.558	0.555	0.561
	60-63	1524-1600	371	0.419	9.052	433.411	0.071	3.399	0.122	5.841	0.000	0.000	8.855	423.980	5879.997	281535.7675	0.431	0.429	0.433
	57-60	1448-1524	370	0.362	9.935	475.683	0.061	2.921	0.119	5.698	0.000	0.000	9.753	466.976	5889.75	282002.7437	0.374	0.372	0.376
	53-57	1346-1448	369	0.283	14.889	712.902	0.065	3.112	0.153	7.326	0.000	0.000	14.67	702.403	5904.42	282705.147	0.294	0.293	0.295
*	46-53	1168-1346	368	0.109	32.396	1551.128	0.060	2.873	0.235	11.252	2.021	96.766	30.08	1440.238	5934.5	284145.3852	0.172	0.171	0.173
	43-46	1092-1168	367	0.051	14.791	708.178	0.001	0.048	0.000	0.000	0.000	0.000	14.78	707.670	5949.28	284853.0554	0.051	0.048	0.054
	37-43	940-1092	366	0.048	29.669	1420.583	0.003	0.144	0.000	0.000	0.000	0.000	29.66	1420.128	5978.94	286273.1838	0.048	0.046	0.050
*	25-37	635-940	365	0.038	59.962	2871.005	0.005	0.239	0.000	0.000	0.187	8.963	59.77	2861.803	6038.71	289134.9867	0.041	0.039	0.043
	13-25	330-635	364	0.033	60.248	2884.681	0.005	0.239	0.000	0.000	0.000	0.000	60.22	2883.349	6098.93	292018.3358	0.033	0.031	0.035
*	0-13	0-330	363	0.022	66.059	3162.929	0.006	0.287	0.000	0.000	-0.317	-15.170	66.37	3177.813	6165.3	295196.1485	0.017	0.016	0.018

Table A-204 Energy Balance Results for RBHT Test 1655D for Time Period 2266 to 2315 seconds

Results for RBHT Test 1655
Valid Time Period 2266 to 2315 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4656.5477	14.689	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.25	6.35	4915.2448	15.505	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.50	12.70	5173.9419	16.322	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.75	19.05	5432.6389	17.138	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.00	25.40	5691.336	17.954	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.25	31.75	5950.0331	18.77	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.50	38.10	6208.7302	19.586	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.75	44.45	6467.4273	20.402	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.00	50.80	6726.1244	21.218	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.25	57.15	6984.8215	22.034	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.50	63.50	7243.5186	22.85	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.75	69.85	7502.2157	23.666	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.00	76.20	7760.9128	24.482	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.25	82.55	8019.6099	25.298	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.50	88.90	8278.307	26.115	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.75	95.25	8537.0041	26.931	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
4.00	101.60	8795.7011	27.747	4.43E-03	2.79E-01	1.26E-01	1.02E-01	4.62E-02
4.25	107.95	9054.3982	28.563	1.38E-02	8.66E-01	3.93E-01	1.01E-01	4.58E-02
4.50	114.30	9313.0953	29.379	2.34E-02	1.47E+00	6.67E-01	1.00E-01	4.54E-02
4.75	120.65	9571.7924	30.195	3.33E-02	2.09E+00	9.49E-01	9.90E-02	4.49E-02
5.00	127.00	9830.4895	31.011	4.35E-02	2.73E+00	1.24E+00	9.80E-02	4.44E-02
5.25	133.35	10089.187	31.827	5.39E-02	3.39E+00	1.54E+00	9.69E-02	4.39E-02
5.50	139.70	10347.884	32.643	6.46E-02	4.06E+00	1.84E+00	9.58E-02	4.34E-02
5.75	146.05	10606.581	33.459	7.56E-02	4.75E+00	2.15E+00	9.47E-02	4.29E-02
6.00	152.40	10865.278	34.275	8.68E-02	5.46E+00	2.48E+00	9.35E-02	4.24E-02
6.25	158.75	11123.975	35.091	9.83E-02	6.18E+00	2.80E+00	9.23E-02	4.19E-02
6.50	165.10	11382.672	35.907	1.10E-01	6.92E+00	3.14E+00	9.11E-02	4.13E-02
6.75	171.45	11641.369	36.724	1.22E-01	7.68E+00	3.49E+00	8.99E-02	4.08E-02
7.00	177.80	11900.066	37.54	1.35E-01	8.46E+00	3.84E+00	8.86E-02	4.02E-02
7.25	184.15	12158.763	38.356	1.47E-01	9.25E+00	4.20E+00	8.73E-02	3.96E-02
7.50	190.50	12417.46	39.172	1.60E-01	1.01E+01	4.56E+00	8.60E-02	3.90E-02
7.75	196.85	12676.158	39.988	1.73E-01	1.09E+01	4.94E+00	8.47E-02	3.84E-02
8.00	203.20	12934.855	40.804	1.87E-01	1.17E+01	5.32E+00	8.33E-02	3.78E-02
8.25	209.55	13193.552	41.62	2.00E-01	1.26E+01	5.71E+00	8.19E-02	3.72E-02
8.50	215.90	13452.249	42.436	2.14E-01	1.35E+01	6.11E+00	8.05E-02	3.65E-02
8.75	222.25	13710.946	43.252	2.28E-01	1.44E+01	6.51E+00	7.90E-02	3.58E-02
9.00	228.60	13969.643	44.068	2.43E-01	1.53E+01	6.93E+00	7.75E-02	3.52E-02
9.25	234.95	13193.552	41.62	2.57E-01	1.62E+01	7.33E+00	7.61E-02	3.45E-02
9.50	241.30	12417.46	39.172	2.71E-01	1.70E+01	7.71E+00	7.47E-02	3.39E-02
9.75	247.65	11641.369	36.724	2.83E-01	1.78E+01	8.07E+00	7.34E-02	3.33E-02
10.00	254.00	10865.278	34.275	2.95E-01	1.85E+01	8.41E+00	7.22E-02	3.28E-02
10.25	260.35	10089.187	31.827	3.06E-01	1.92E+01	8.72E+00	7.11E-02	3.22E-02
10.50	266.70	9313.0953	29.379	3.16E-01	1.99E+01	9.01E+00	7.00E-02	3.18E-02
10.75	273.05	8537.0041	26.931	3.25E-01	2.05E+01	9.28E+00	6.91E-02	3.13E-02
11.00	279.40	7760.9128	24.482	3.34E-01	2.10E+01	9.52E+00	6.82E-02	3.09E-02
11.25	285.75	6984.8215	22.034	3.42E-01	2.15E+01	9.74E+00	6.74E-02	3.06E-02
11.50	292.10	6208.7302	19.586	3.49E-01	2.19E+01	9.94E+00	6.67E-02	3.03E-02
11.75	298.45	5432.6389	17.138	3.55E-01	2.23E+01	1.01E+01	6.61E-02	3.00E-02
12.00	304.80	4656.5477	14.689	3.60E-01	2.26E+01	1.03E+01	6.55E-02	2.97E-02

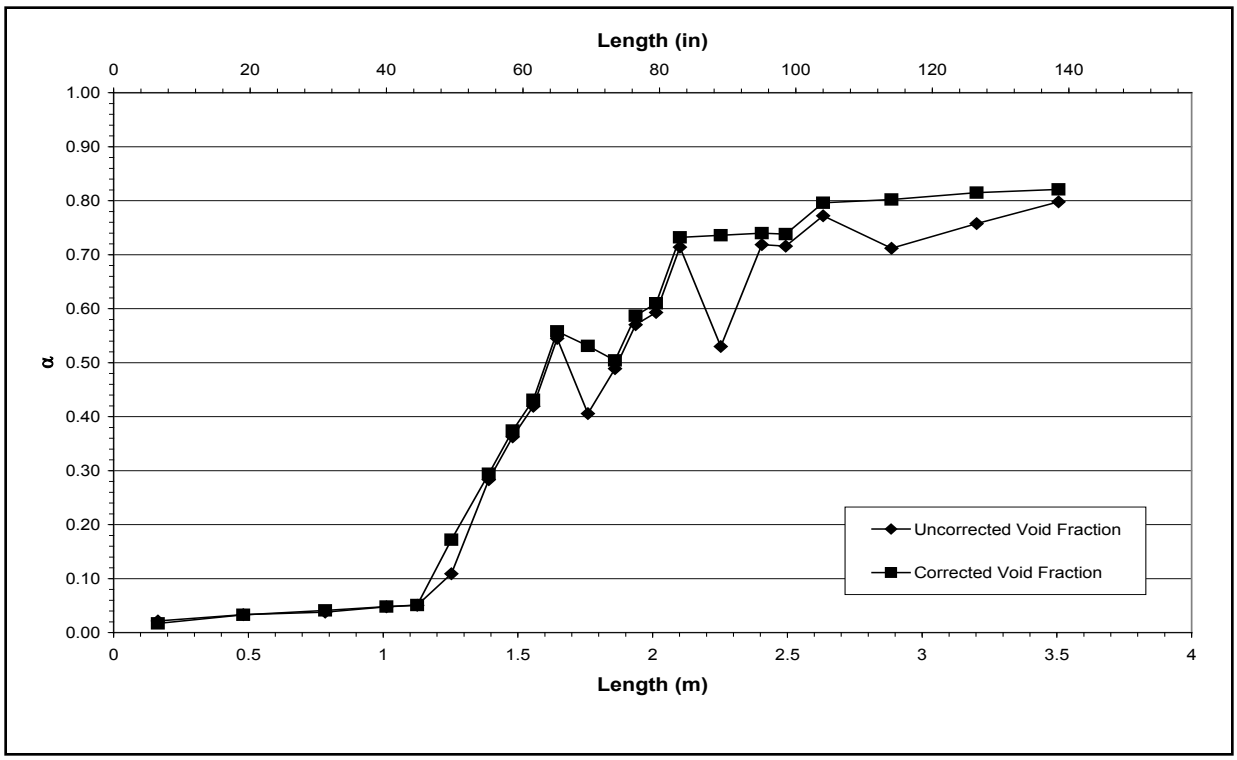

Figure A-510 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655D for Time Period 2266 to 2315 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-E

Test Conditions

Date: 7/7/2003
Steady-state time window: 2505 – 2565 seconds
Inlet flow rate: 3.066 cm/sec (1.207 in./sec)
Inlet mass flow rate: 0.145 kg/sec (0.319 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

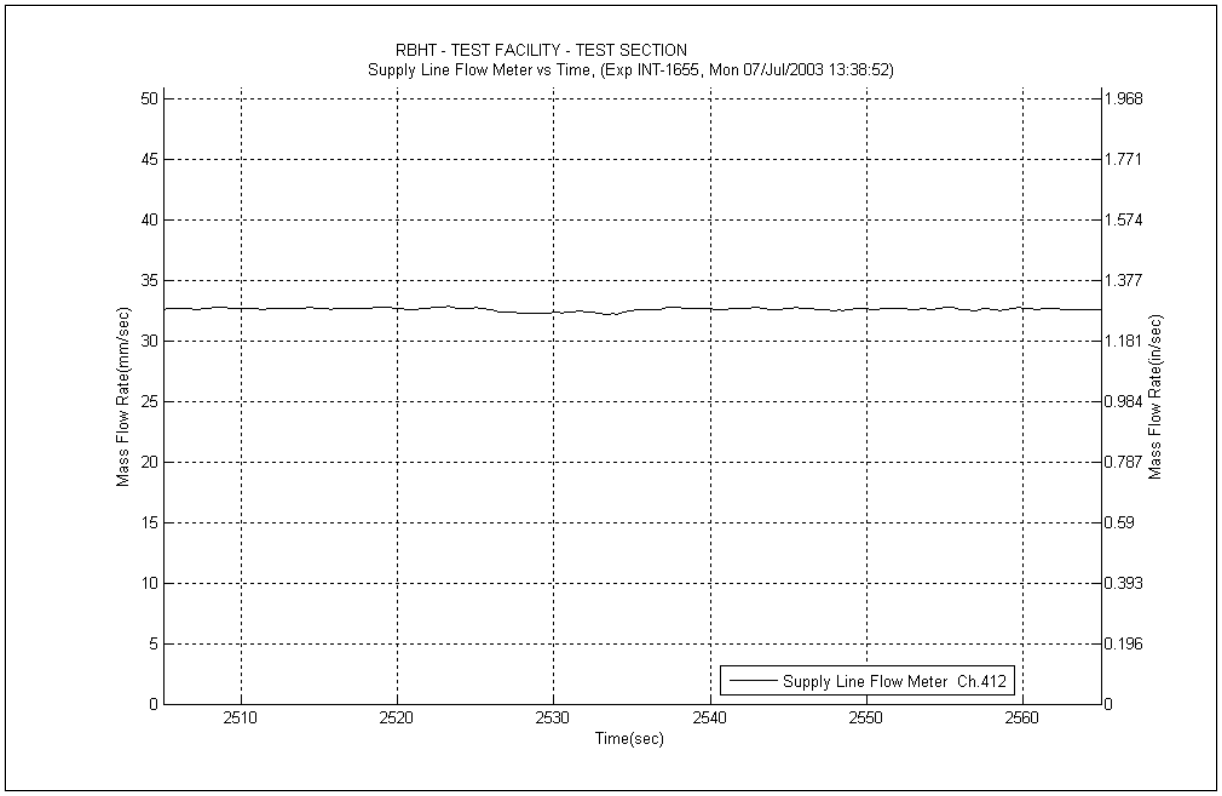

Figure A-511 Inlet Flow Plot for Experiment 1655E

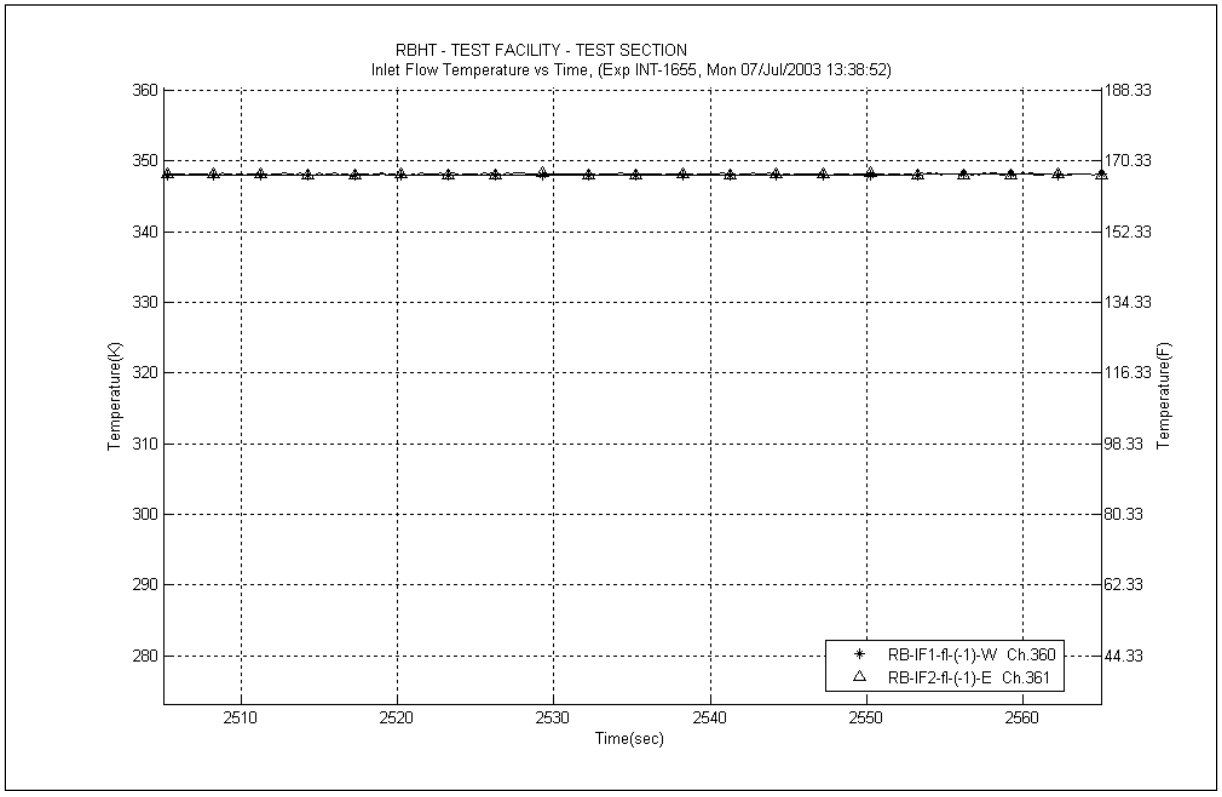

Figure A-512 Inlet Temperature Plot for Experiment 1655E

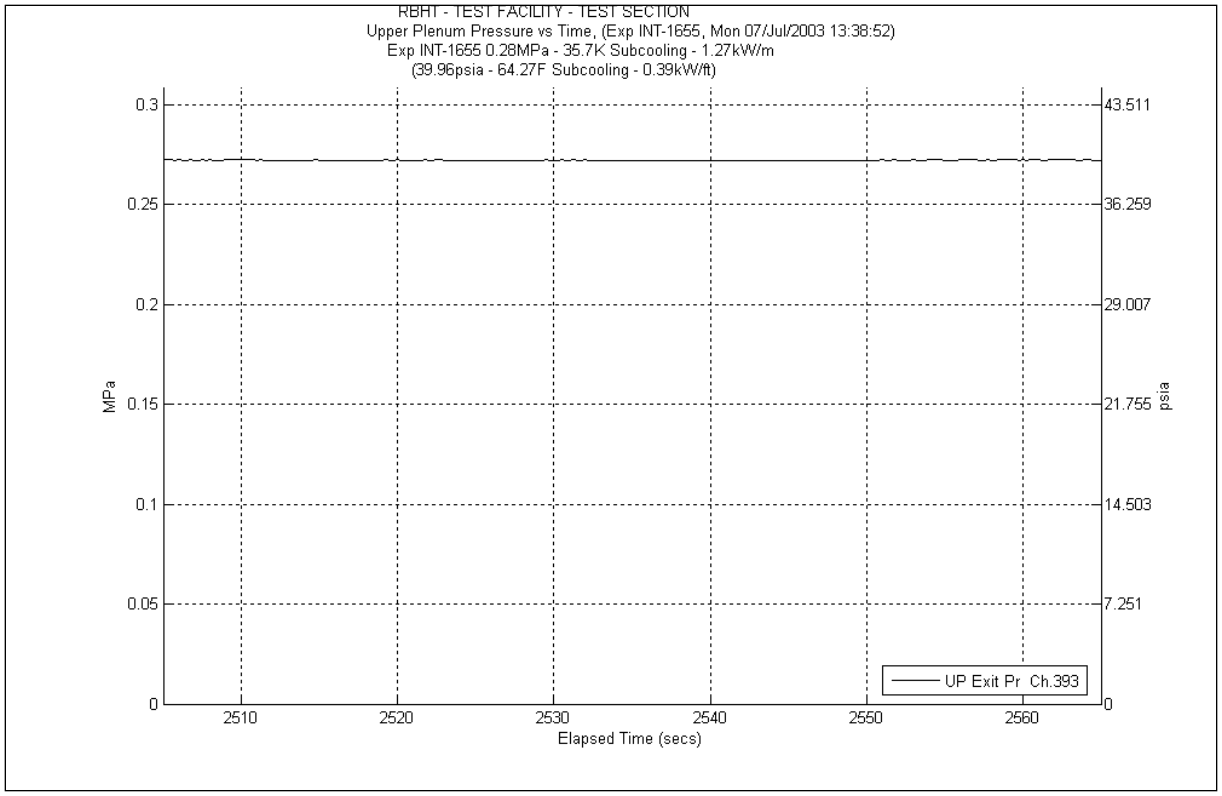

Figure A-513 System Pressure Plot for Experiment 1655E

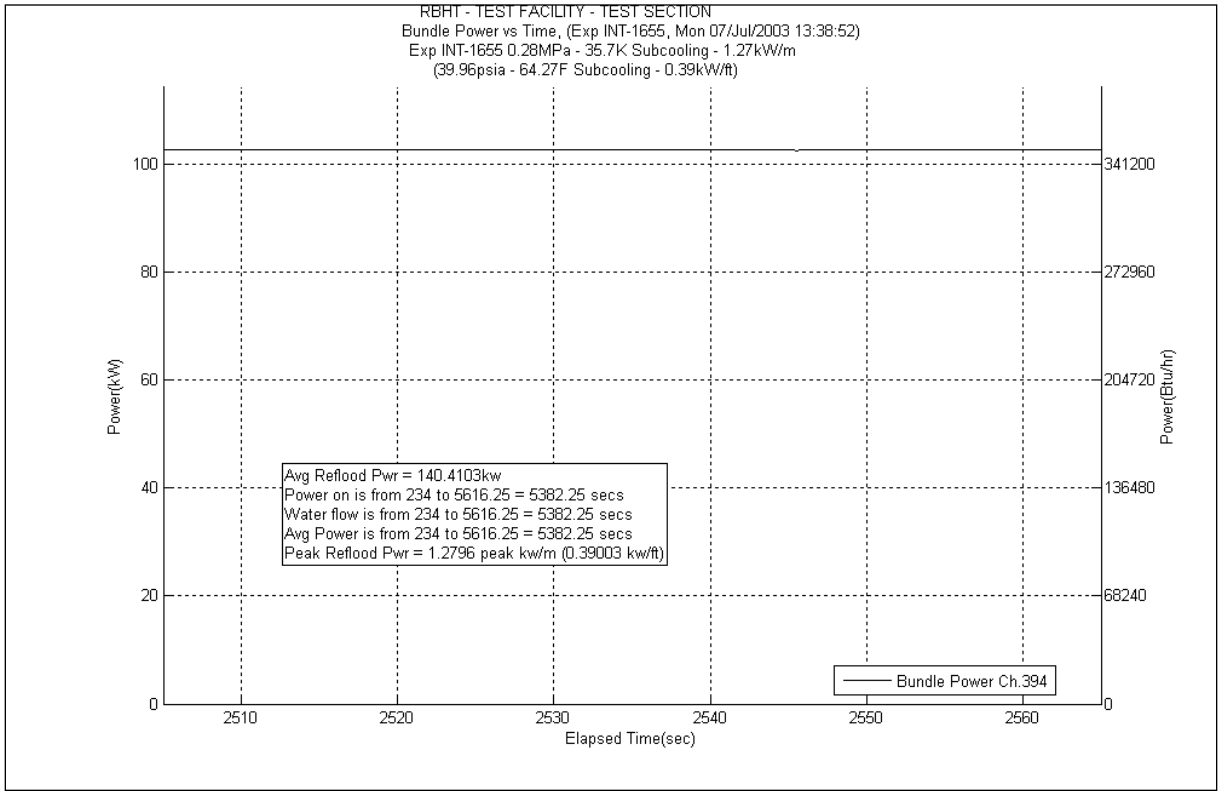

Figure A-514 Bundle Power Plot for Experiment 1655E

Table A-205 Data Results for RBHT Test 1655 for Time Period 2505 to 2565

Results for RBHT Test 1655
Valid Time Period 2505 to 2565 seconds
Collapsed Liquid Level = 83.724 inches = 2126.59 mm
(Z_{osv}) Onset of Significant Void = 44.5 inches = 1130 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.796	11.638	557.243	1.050	50.274	0.276	13.215	0.000	0.000	10.31	493.645	5770.31	276283.9258	0.82	0.816	0.824
*	120-133	3048-3378	383	0.756	16.468	788.494	1.148	54.967	0.493	23.605	2.217	106.153	12.61	603.770	5782.92	276887.6958	0.813	0.809	0.817
*	108-120	2743-3048	382	0.710	18.104	866.822	0.936	44.816	0.616	29.494	4.112	196.881	12.44	595.630	5795.36	277483.3262	0.8	0.796	0.804
	100-108	2540-2743	381	0.770	9.556	457.531	0.544	26.047	0.450	21.546	0.000	0.000	8.557	409.711	5803.917	277893.0376	0.794	0.790	0.798
	97-100	2464-2540	380	0.713	4.466	213.846	0.187	8.954	0.163	7.804	0.000	0.000	4.113	196.931	5808.03	278089.9691	0.736	0.732	0.740
	93-97	2362-2464	379	0.717	5.889	281.978	0.234	11.204	0.212	10.151	0.000	0.000	5.443	260.612	5813.473	278350.5813	0.738	0.734	0.742
*	85-93	2159-2362	378	0.526	19.693	942.911	0.419	20.062	0.408	19.535	7.796	373.280	11.07	530.034	5824.543	278880.6157	0.734	0.730	0.738
	81-85	2057-2159	377	0.711	6.009	287.697	0.185	8.858	0.195	9.337	0.000	0.000	5.625	269.326	5830.168	279149.9422	0.729	0.725	0.733
	78-81	1981-2057	376	0.589	6.403	306.595	0.128	6.129	0.143	6.847	0.000	0.000	6.132	293.602	5836.3	279443.5439	0.606	0.603	0.609
	75-78	1905-1981	375	0.566	6.757	323.504	0.119	5.698	0.140	6.703	0.000	0.000	6.497	311.078	5842.797	279754.622	0.583	0.580	0.586
	72-75	1829-1905	374	0.483	8.050	385.420	0.109	5.219	0.136	6.512	0.000	0.000	7.801	373.514	5850.598	280128.1358	0.499	0.497	0.501
*	67-72	1702-1829	373	0.402	15.523	743.239	0.162	7.757	0.220	10.534	2.841	136.021	12.3	588.927	5862.898	280717.063	0.526	0.523	0.529
	63-67	1600-1702	372	0.540	9.566	458.028	0.110	5.267	0.170	8.140	0.000	0.000	9.286	444.616	5872.184	281161.6791	0.553	0.550	0.556
	60-63	1524-1600	371	0.406	9.255	443.109	0.070	3.352	0.124	5.937	0.000	0.000	9.057	433.651	5881.241	281595.3306	0.419	0.417	0.421
	57-60	1448-1524	370	0.359	9.987	478.169	0.060	2.873	0.120	5.746	0.000	0.000	9.805	469.466	5891.046	282064.7965	0.371	0.369	0.373
	53-57	1346-1448	369	0.275	15.055	720.859	0.062	2.969	0.155	7.421	0.000	0.000	14.83	710.064	5905.876	282774.8607	0.286	0.285	0.287
*	46-53	1168-1346	368	0.101	32.682	1564.805	0.057	2.729	0.211	10.103	2.174	104.074	30.24	1447.899	5936.116	284222.7597	0.168	0.167	0.169
	43-46	1092-1168	367	0.050	14.801	708.675	0.001	0.048	0.000	0.000	0.000	0.000	14.79	708.149	5950.906	284930.9087	0.05	0.048	0.053
	37-43	940-1092	366	0.048	29.664	1420.334	0.003	0.144	0.000	0.000	0.000	0.000	29.65	1419.650	5980.556	286350.5583	0.048	0.046	0.050
*	25-37	635-940	365	0.037	59.988	2872.248	0.006	0.287	0.000	0.000	0.212	10.158	59.77	2861.803	6040.326	289212.3612	0.041	0.039	0.043
	13-25	330-635	364	0.033	60.258	2885.178	0.006	0.287	0.000	0.000	0.000	0.000	60.23	2883.828	6100.556	292096.1891	0.033	0.031	0.035
*	0-13	0-330	363	0.021	66.070	3163.427	0.006	0.287	0.000	0.000	-0.306	-14.673	66.37	3177.813	6166.926	295274.0018	0.017	0.016	0.018

Table A-206 Energy Balance Results for RBHT Test 1655E for Time Period 2505 to 2565 seconds

Results for RBHT Test 1655
Valid Time Period 2505 to 2565 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4655.8601	14.687	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
0.25	6.35	4914.5189	15.503	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
0.50	12.70	5173.1778	16.319	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
0.75	19.05	5431.8367	17.135	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
1.00	25.40	5690.4956	17.951	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
1.25	31.75	5949.1545	18.767	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
1.50	38.10	6207.8134	19.583	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
1.75	44.45	6466.4723	20.399	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
2.00	50.80	6725.1312	21.215	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
2.25	57.15	6983.7901	22.031	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
2.50	63.50	7242.449	22.847	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
2.75	69.85	7501.1079	23.663	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
3.00	76.20	7759.7668	24.479	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
3.25	82.55	8018.4256	25.295	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
3.50	88.90	8277.0845	26.111	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
3.75	95.25	8535.7434	26.927	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.73E-02
4.00	101.60	8794.4023	27.743	2.07E-03	1.32E-01	5.99E-02	1.04E-01	4.72E-02
4.25	107.95	9053.0612	28.559	1.13E-02	7.17E-01	3.25E-01	1.03E-01	4.68E-02
4.50	114.30	9311.7201	29.374	2.07E-02	1.32E+00	5.98E-01	1.02E-01	4.64E-02
4.75	120.65	9570.379	30.19	3.04E-02	1.94E+00	8.79E-01	1.01E-01	4.59E-02
5.00	127.00	9829.0379	31.006	4.04E-02	2.57E+00	1.17E+00	1.00E-01	4.54E-02
5.25	133.35	10087.697	31.822	5.06E-02	3.23E+00	1.46E+00	9.91E-02	4.49E-02
5.50	139.70	10346.356	32.638	6.11E-02	3.90E+00	1.77E+00	9.80E-02	4.44E-02
5.75	146.05	10605.015	33.454	7.19E-02	4.58E+00	2.08E+00	9.69E-02	4.39E-02
6.00	152.40	10863.673	34.27	8.29E-02	5.29E+00	2.40E+00	9.57E-02	4.34E-02
6.25	158.75	11122.332	35.086	9.42E-02	6.01E+00	2.72E+00	9.45E-02	4.29E-02
6.50	165.10	11380.991	35.902	1.06E-01	6.74E+00	3.06E+00	9.33E-02	4.23E-02
6.75	171.45	11639.65	36.718	1.18E-01	7.50E+00	3.40E+00	9.21E-02	4.18E-02
7.00	177.80	11898.309	37.534	1.30E-01	8.27E+00	3.75E+00	9.08E-02	4.12E-02
7.25	184.15	12156.968	38.35	1.42E-01	9.06E+00	4.11E+00	8.95E-02	4.06E-02
7.50	190.50	12415.627	39.166	1.55E-01	9.86E+00	4.47E+00	8.82E-02	4.00E-02
7.75	196.85	12674.286	39.982	1.68E-01	1.07E+01	4.85E+00	8.69E-02	3.94E-02
8.00	203.20	12932.945	40.798	1.81E-01	1.15E+01	5.23E+00	8.55E-02	3.88E-02
8.25	209.55	13191.603	41.614	1.94E-01	1.24E+01	5.62E+00	8.41E-02	3.81E-02
8.50	215.90	13450.262	42.43	2.08E-01	1.33E+01	6.01E+00	8.27E-02	3.75E-02
8.75	222.25	13708.921	43.246	2.22E-01	1.41E+01	6.42E+00	8.12E-02	3.68E-02
9.00	228.60	13967.58	44.062	2.36E-01	1.51E+01	6.83E+00	7.97E-02	3.62E-02
9.25	234.95	13191.603	41.614	2.50E-01	1.59E+01	7.23E+00	7.83E-02	3.55E-02
9.50	241.30	12415.627	39.166	2.63E-01	1.68E+01	7.61E+00	7.69E-02	3.49E-02
9.75	247.65	11639.65	36.718	2.76E-01	1.76E+01	7.97E+00	7.56E-02	3.43E-02
10.00	254.00	10863.673	34.27	2.87E-01	1.83E+01	8.30E+00	7.44E-02	3.37E-02
10.25	260.35	10087.697	31.822	2.98E-01	1.90E+01	8.61E+00	7.33E-02	3.32E-02
10.50	266.70	9311.7201	29.374	3.08E-01	1.96E+01	8.90E+00	7.22E-02	3.28E-02
10.75	273.05	8535.7434	26.927	3.17E-01	2.02E+01	9.17E+00	7.13E-02	3.23E-02
11.00	279.40	7759.7668	24.479	3.26E-01	2.08E+01	9.41E+00	7.04E-02	3.19E-02
11.25	285.75	6983.7901	22.031	3.33E-01	2.12E+01	9.63E+00	6.96E-02	3.16E-02
11.50	292.10	6207.8134	19.583	3.40E-01	2.17E+01	9.83E+00	6.89E-02	3.12E-02
11.75	298.45	5431.8367	17.135	3.46E-01	2.20E+01	1.00E+01	6.83E-02	3.10E-02
12.00	304.80	4655.8601	14.687	3.51E-01	2.24E+01	1.01E+01	6.77E-02	3.07E-02

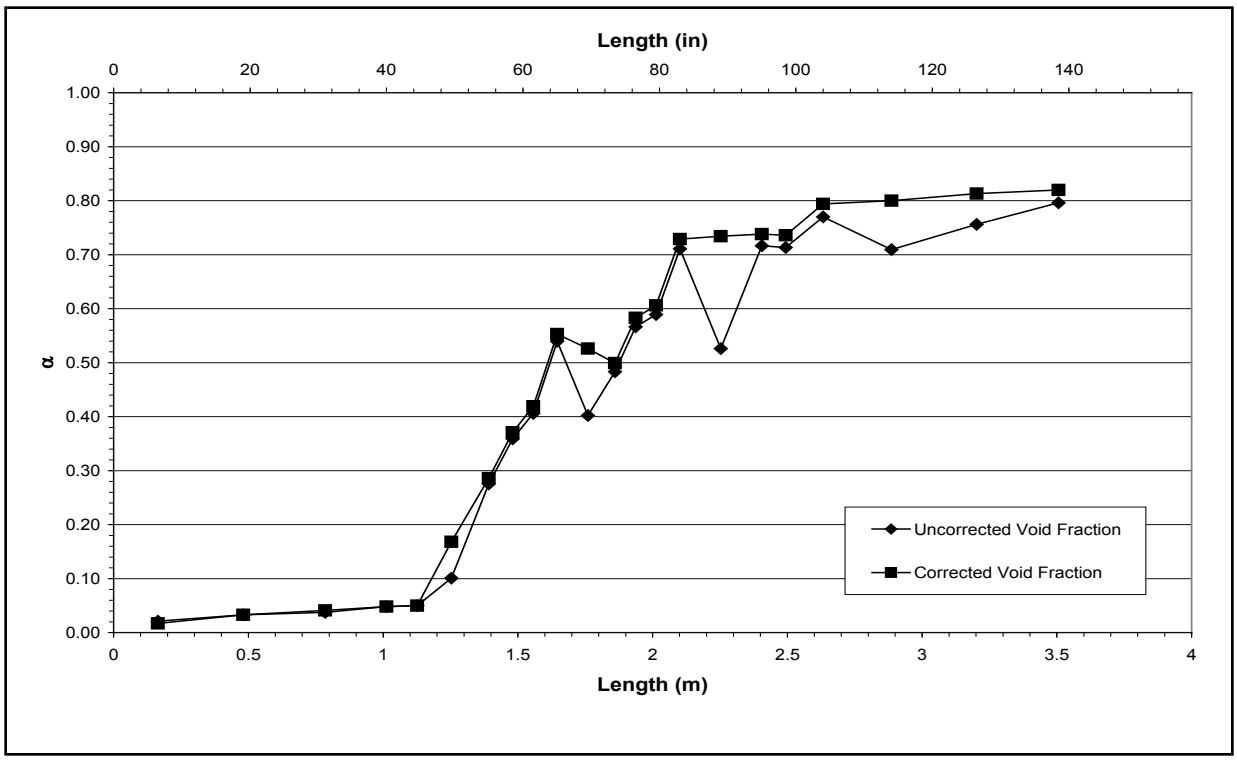

Figure A-515 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655E for Time Period 2505 to 2565 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-F

Test Conditions

Date: 7/7/2003
Steady-state time window: 2790 – 2815 seconds
Inlet flow rate: 2.522 cm/sec (0.993 in./sec)
Inlet mass flow rate: 0.119 kg/sec (0.262 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

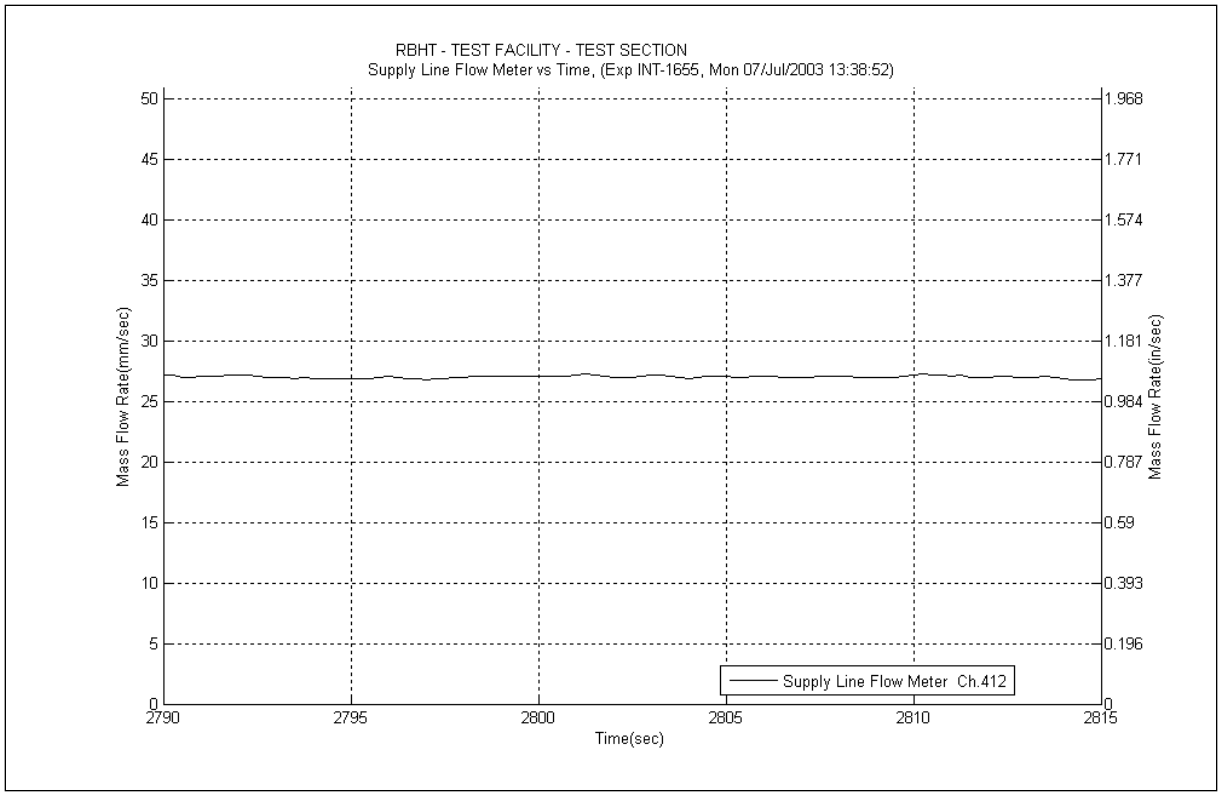

Figure A-516 Inlet Flow Plot for Experiment 1655F

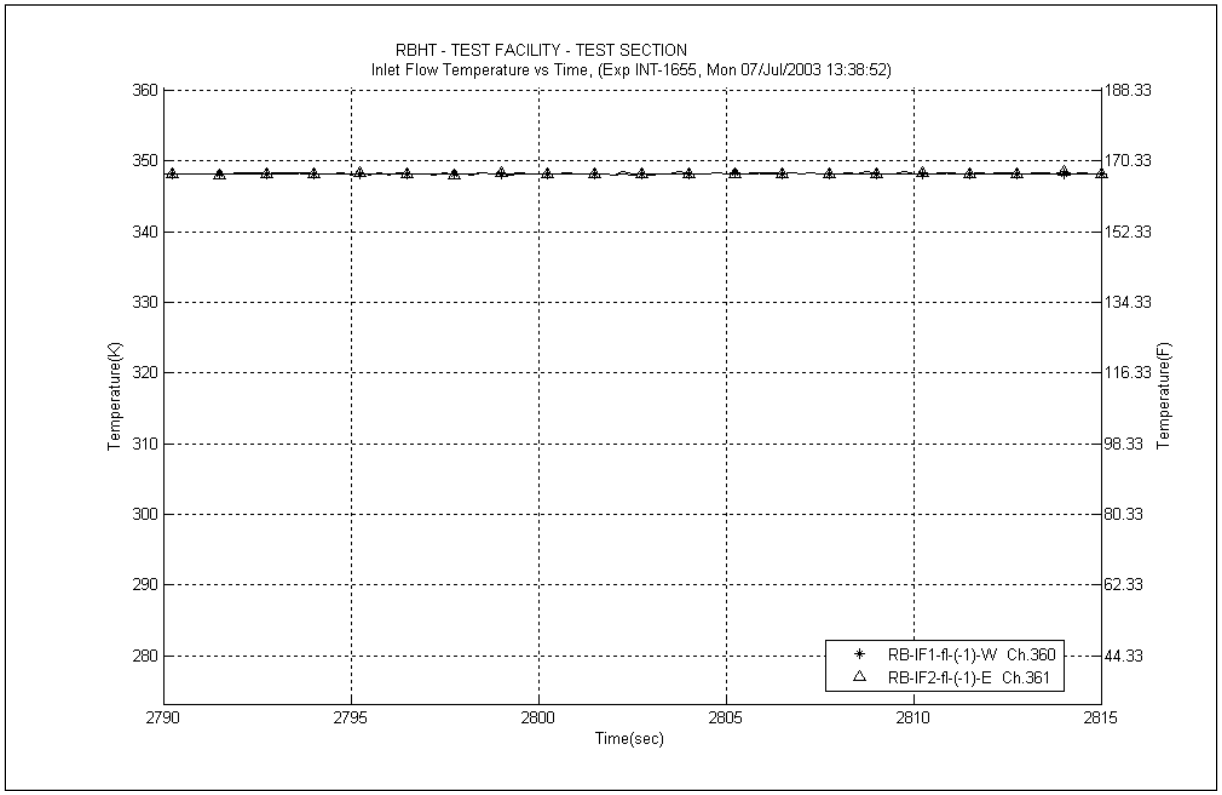

Figure A-517 Inlet Temperature Plot for Experiment 1655F

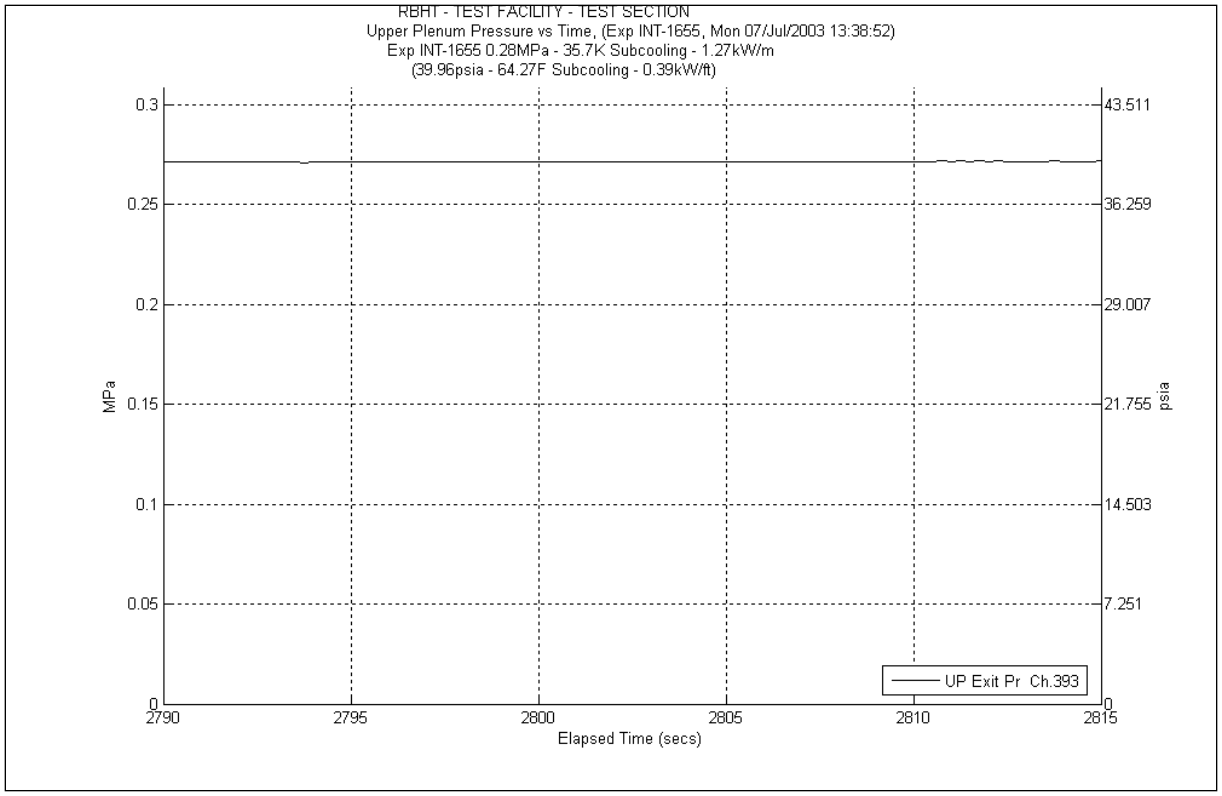

Figure A-518 System Pressure Plot for Experiment 1655F

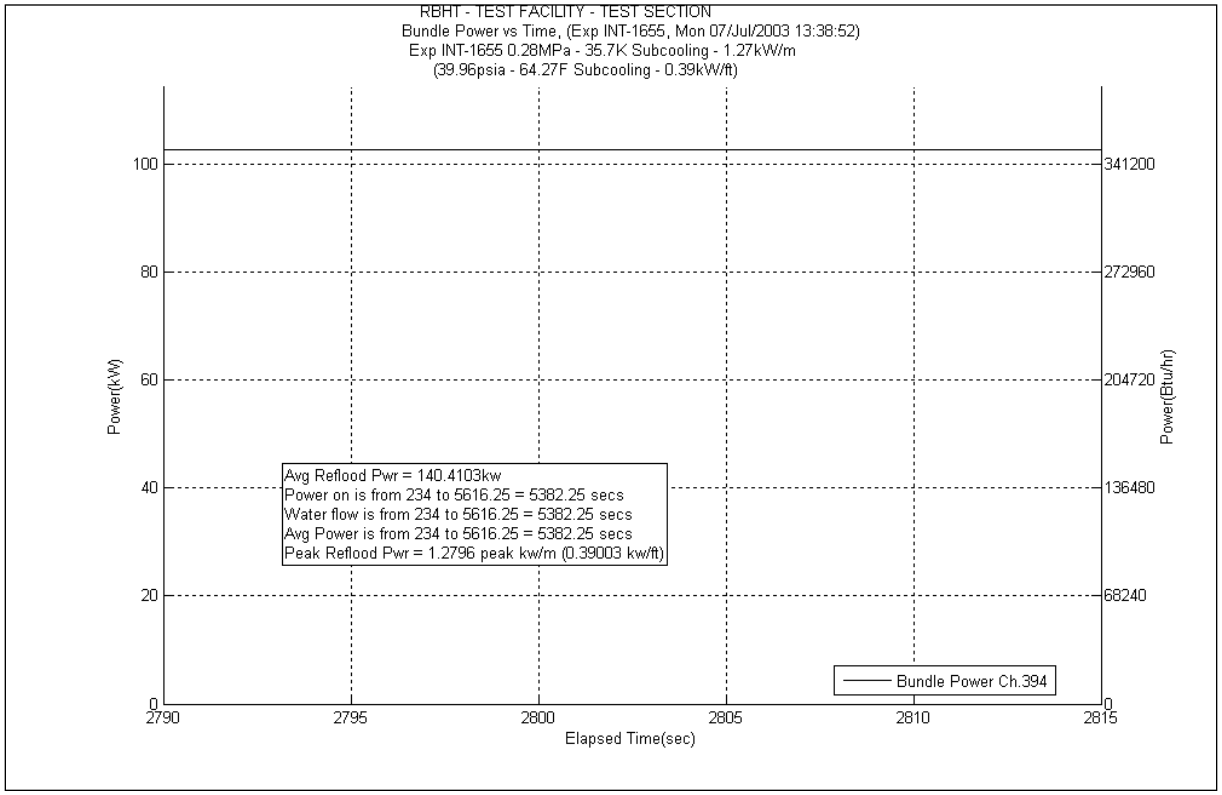

Figure A-519 Bundle Power Plot for Experiment 1655F

Table A-207 Data Results for RBHT Test 1655 for Time Period 2785 to 2850

Results for RBHT Test 1655
Valid Time Period 2785 to 2850 seconds
Collapsed Liquid Level = 78.373 inches = 1990.68 mm
(Z_{osv}) Onset of Significant Void = 40 inches = 1016 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.829	9.758	467.228	0.893	42.757	0.228	10.917	0.000	0.000	8.637	413.542	5768.637	276203.8221	0.849	0.845	0.853
*	120-133	3048-3378	383	0.785	14.547	696.491	0.978	46.827	0.406	19.439	2.313	110.724	10.85	519.501	5779.487	276723.3229	0.839	0.835	0.843
*	108-120	2743-3048	382	0.739	16.281	779.543	0.800	38.304	0.507	24.275	3.764	180.226	11.21	536.738	5790.697	277260.0606	0.82	0.816	0.824
	100-108	2540-2743	381	0.790	8.709	416.999	0.467	22.360	0.371	17.764	0.000	0.000	7.868	376.722	5798.565	277636.7824	0.811	0.807	0.815
	97-100	2464-2540	380	0.743	3.999	191.467	0.161	7.709	0.134	6.416	0.000	0.000	3.704	177.348	5802.269	277814.1309	0.762	0.758	0.766
	93-97	2362-2464	379	0.748	5.230	250.399	0.203	9.720	0.175	8.379	0.000	0.000	4.848	232.123	5807.117	278046.2544	0.767	0.763	0.771
*	85-93	2159-2362	378	0.565	18.073	865.330	0.366	17.524	0.336	16.088	7.377	353.203	9.994	478.515	5817.111	278524.7697	0.759	0.755	0.763
	81-85	2057-2159	377	0.737	5.474	262.086	0.163	7.804	0.161	7.709	0.000	0.000	5.146	246.392	5822.257	278771.1615	0.752	0.748	0.756
	78-81	1981-2057	376	0.633	5.713	273.524	0.114	5.458	0.118	5.650	0.000	0.000	5.481	262.432	5827.738	279033.5932	0.648	0.645	0.651
	75-78	1905-1981	375	0.619	5.931	283.967	0.107	5.123	0.115	5.506	0.000	0.000	5.706	273.205	5833.444	279306.7979	0.634	0.631	0.637
	72-75	1829-1905	374	0.555	6.938	332.207	0.100	4.788	0.112	5.363	0.000	0.000	6.724	321.947	5840.168	279628.7448	0.568	0.565	0.571
*	67-72	1702-1829	373	0.437	14.624	700.221	0.150	7.182	0.181	8.666	3.913	187.375	10.38	496.997	5850.548	280125.7418	0.6	0.597	0.603
	63-67	1600-1702	372	0.621	7.883	377.463	0.106	5.075	0.140	6.703	0.000	0.000	7.636	365.614	5858.184	280491.3555	0.632	0.629	0.635
	60-63	1524-1600	371	0.468	8.289	396.858	0.071	3.399	0.102	4.884	0.000	0.000	8.115	388.548	5866.299	280879.9038	0.479	0.477	0.481
	57-60	1448-1524	370	0.416	9.104	435.897	0.063	3.016	0.099	4.740	0.000	0.000	8.938	427.954	5875.237	281307.8575	0.426	0.424	0.428
	53-57	1346-1448	369	0.377	12.947	619.904	0.072	3.447	0.128	6.129	0.000	0.000	12.74	609.994	5887.977	281917.852	0.387	0.385	0.389
*	46-53	1168-1346	368	0.276	26.320	1260.199	0.091	4.357	0.213	10.198	-0.244	-11.693	26.26	1257.336	5914.237	283175.1875	0.278	0.277	0.279
	43-46	1092-1168	367	0.161	13.066	625.623	0.023	1.101	0.087	4.166	0.000	0.000	12.95	620.049	5927.187	283795.2368	0.169	0.168	0.170
	37-43	940-1092	366	0.056	29.410	1408.150	0.021	1.005	0.069	3.304	0.000	0.000	29.31	1403.370	5956.497	285198.6072	0.059	0.056	0.062
*	25-37	635-940	365	0.042	59.713	2859.069	0.004	0.192	0.000	0.000	0.359	17.185	59.35	2841.693	6015.847	288040.3004	0.047	0.045	0.049
	13-25	330-635	364	0.035	60.113	2878.216	0.004	0.192	0.000	0.000	0.000	0.000	60.09	2877.125	6075.937	290917.4251	0.035	0.033	0.037
*	0-13	0-330	363	0.022	66.012	3160.692	0.004	0.192	0.000	0.000	-0.282	-13.482	66.29	3173.982	6142.227	294091.4073	0.018	0.017	0.019

Table A-208 Energy Balance Results for RBHT Test 1655F for Time Period 2785 to 2850 seconds

Results for RBHT Test 1655
Valid Time Period 2785 to 2850 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4653.9366	14.681	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
0.25	6.35	4912.4886	15.497	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
0.50	12.70	5171.0407	16.312	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
0.75	19.05	5429.5927	17.128	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
1.00	25.40	5688.1447	17.944	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
1.25	31.75	5946.6968	18.759	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
1.50	38.10	6205.2488	19.575	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
1.75	44.45	6463.8008	20.391	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
2.00	50.80	6722.3529	21.206	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
2.25	57.15	6980.9049	22.022	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
2.50	63.50	7239.4569	22.837	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
2.75	69.85	7498.009	23.653	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
3.00	76.20	7756.561	24.469	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
3.25	82.55	8015.113	25.284	0.00E+00	0.00E+00	0.00E+00	8.58E-02	3.89E-02
3.50	88.90	8273.6651	26.1	4.93E-03	2.59E-01	1.18E-01	8.54E-02	3.87E-02
3.75	95.25	8532.2171	26.915	1.54E-02	8.11E-01	3.68E-01	8.45E-02	3.83E-02
4.00	101.60	8790.7691	27.731	2.63E-02	1.38E+00	6.26E-01	8.36E-02	3.79E-02
4.25	107.95	9049.3212	28.547	3.74E-02	1.96E+00	8.91E-01	8.26E-02	3.75E-02
4.50	114.30	9307.8732	29.362	4.89E-02	2.57E+00	1.16E+00	8.16E-02	3.70E-02
4.75	120.65	9566.4252	30.178	6.07E-02	3.19E+00	1.45E+00	8.06E-02	3.66E-02
5.00	127.00	9824.9773	30.994	7.28E-02	3.82E+00	1.73E+00	7.96E-02	3.61E-02
5.25	133.35	10083.529	31.809	8.53E-02	4.48E+00	2.03E+00	7.85E-02	3.56E-02
5.50	139.70	10342.081	32.625	9.80E-02	5.15E+00	2.33E+00	7.74E-02	3.51E-02
5.75	146.05	10600.633	33.44	1.11E-01	5.84E+00	2.65E+00	7.63E-02	3.46E-02
6.00	152.40	10859.185	34.256	1.25E-01	6.54E+00	2.97E+00	7.51E-02	3.41E-02
6.25	158.75	11117.737	35.072	1.38E-01	7.26E+00	3.29E+00	7.40E-02	3.35E-02
6.50	165.10	11376.289	35.887	1.52E-01	8.00E+00	3.63E+00	7.27E-02	3.30E-02
6.75	171.45	11634.841	36.703	1.67E-01	8.76E+00	3.97E+00	7.15E-02	3.24E-02
7.00	177.80	11893.394	37.519	1.81E-01	9.53E+00	4.32E+00	7.03E-02	3.19E-02
7.25	184.15	12151.946	38.334	1.96E-01	1.03E+01	4.68E+00	6.90E-02	3.13E-02
7.50	190.50	12410.498	39.15	2.12E-01	1.11E+01	5.05E+00	6.76E-02	3.07E-02
7.75	196.85	12669.05	39.965	2.28E-01	1.19E+01	5.42E+00	6.63E-02	3.01E-02
8.00	203.20	12927.602	40.781	2.43E-01	1.28E+01	5.80E+00	6.49E-02	2.95E-02
8.25	209.55	13186.154	41.597	2.60E-01	1.36E+01	6.19E+00	6.35E-02	2.88E-02
8.50	215.90	13444.706	42.412	2.76E-01	1.45E+01	6.58E+00	6.21E-02	2.82E-02
8.75	222.25	13703.258	43.228	2.93E-01	1.54E+01	6.99E+00	6.06E-02	2.75E-02
9.00	228.60	13961.81	44.044	3.11E-01	1.63E+01	7.40E+00	5.92E-02	2.68E-02
9.25	234.95	13186.154	41.597	3.28E-01	1.72E+01	7.80E+00	5.77E-02	2.62E-02
9.50	241.30	12410.498	39.15	3.44E-01	1.80E+01	8.19E+00	5.63E-02	2.56E-02
9.75	247.65	11634.841	36.703	3.59E-01	1.88E+01	8.55E+00	5.50E-02	2.50E-02
10.00	254.00	10859.185	34.256	3.73E-01	1.96E+01	8.88E+00	5.38E-02	2.44E-02
10.25	260.35	10083.529	31.809	3.86E-01	2.03E+01	9.19E+00	5.27E-02	2.39E-02
10.50	266.70	9307.8732	29.362	3.98E-01	2.09E+01	9.48E+00	5.17E-02	2.34E-02
10.75	273.05	8532.2171	26.915	4.09E-01	2.15E+01	9.75E+00	5.07E-02	2.30E-02
11.00	279.40	7756.561	24.469	4.19E-01	2.20E+01	9.99E+00	4.98E-02	2.26E-02
11.25	285.75	6980.9049	22.022	4.29E-01	2.25E+01	1.02E+01	4.90E-02	2.22E-02
11.50	292.10	6205.2488	19.575	4.37E-01	2.29E+01	1.04E+01	4.83E-02	2.19E-02
11.75	298.45	5429.5927	17.128	4.44E-01	2.33E+01	1.06E+01	4.77E-02	2.16E-02
12.00	304.80	4653.9366	14.681	4.50E-01	2.37E+01	1.07E+01	4.72E-02	2.14E-02

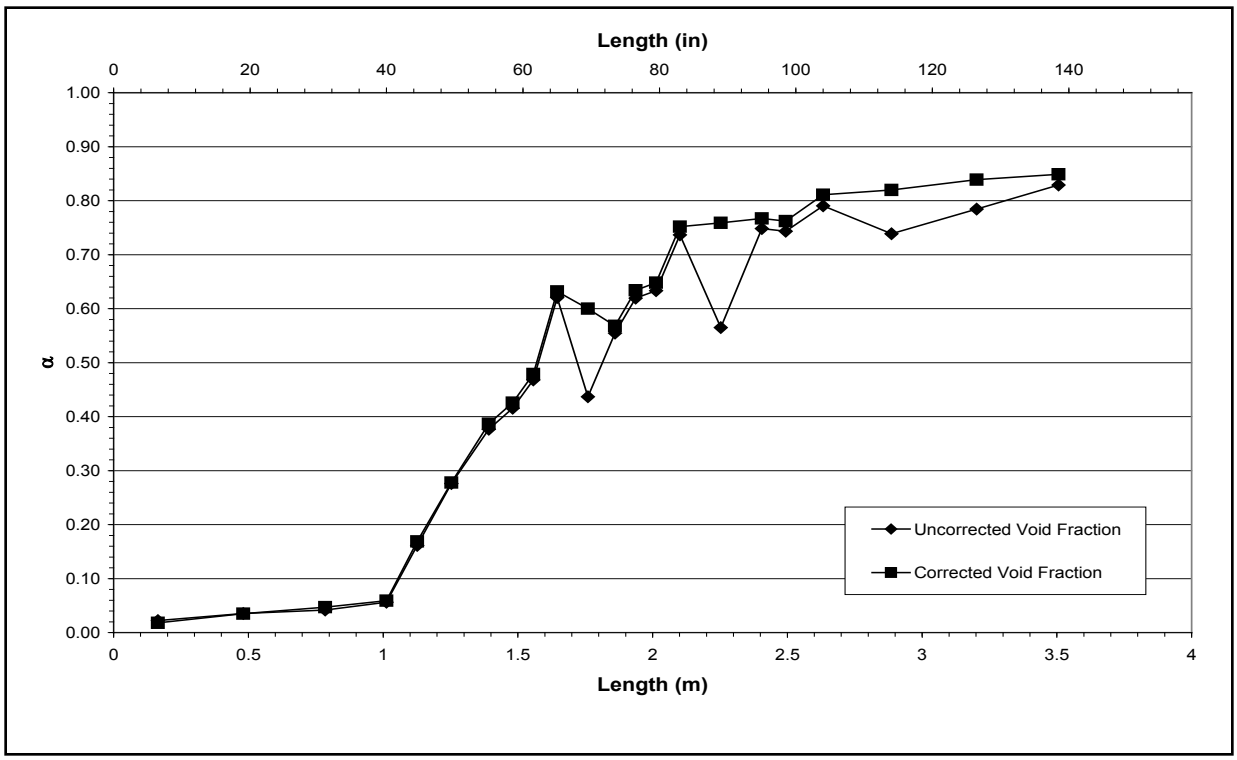

Figure A-520 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655F for Time Period 2785 to 2850 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-G

Test Conditions

Date: 7/7/2003
Steady-state time window: 2980 – 3131 seconds
Inlet flow rate: 2.540 cm/sec (1.000 in./sec)
Inlet mass flow rate: 0.120 kg/sec (0.264 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

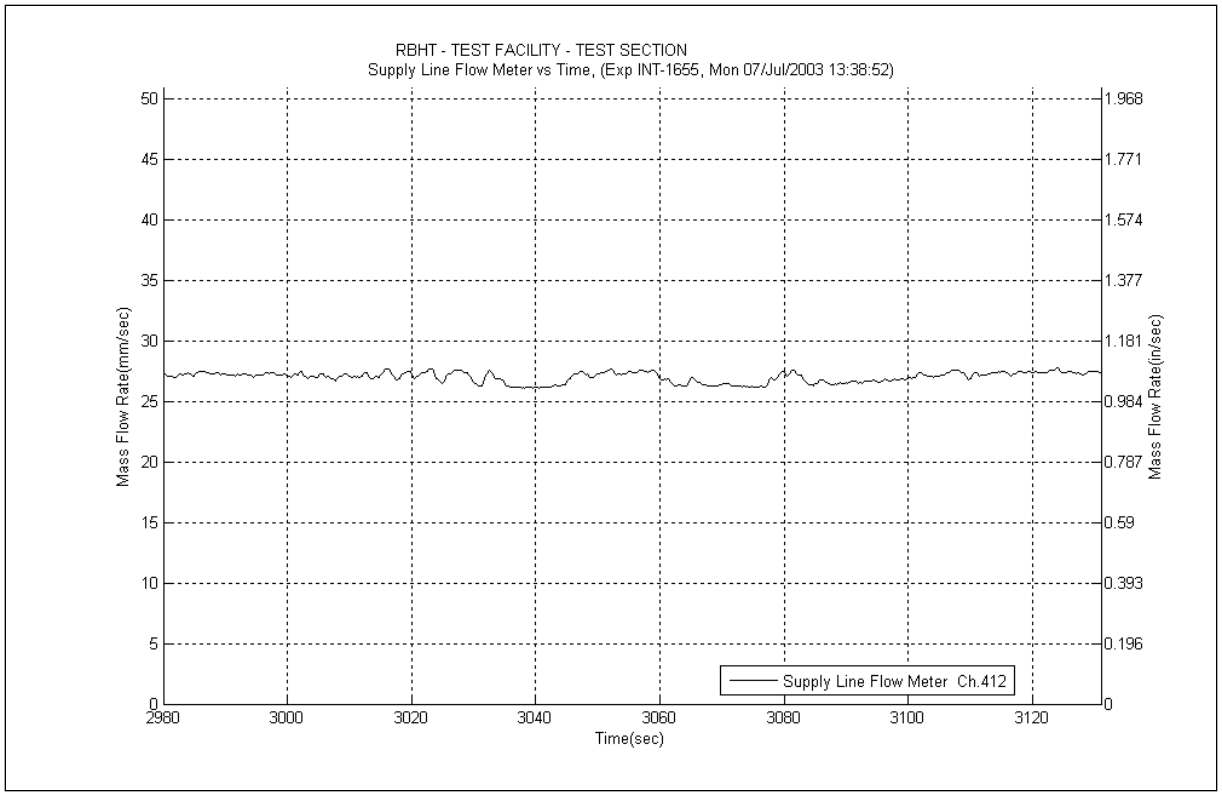

Figure A-521 Inlet Flow Plot for Experiment 1655G

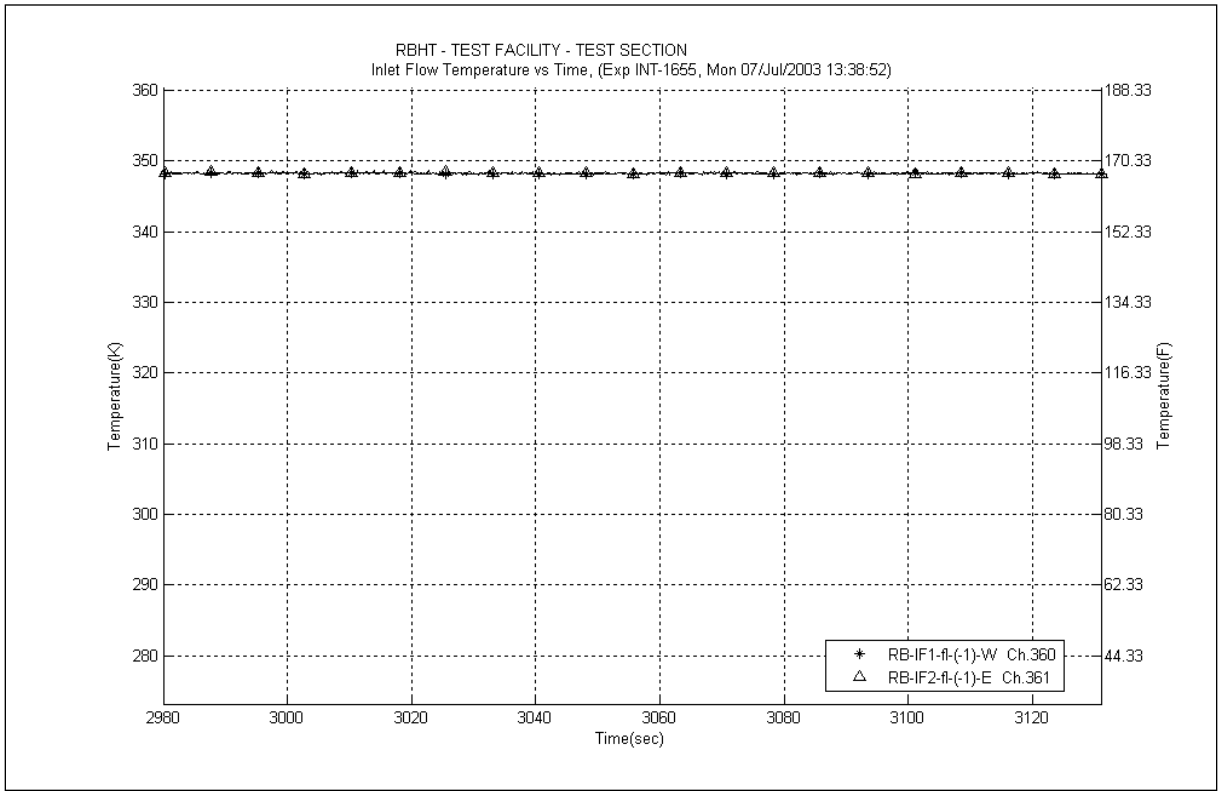

Figure A-522 Inlet Temperature Plot for Experiment 1655G

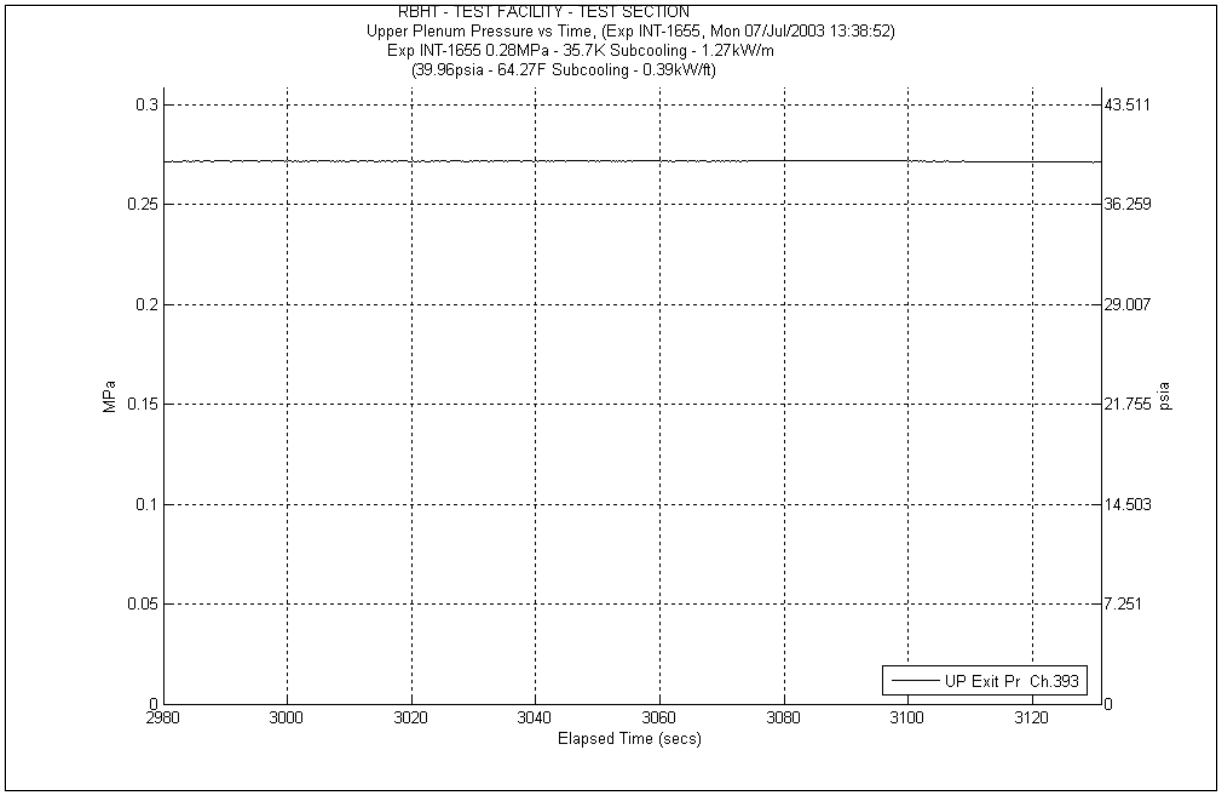

Figure A-523 System Pressure Plot for Experiment 1655G

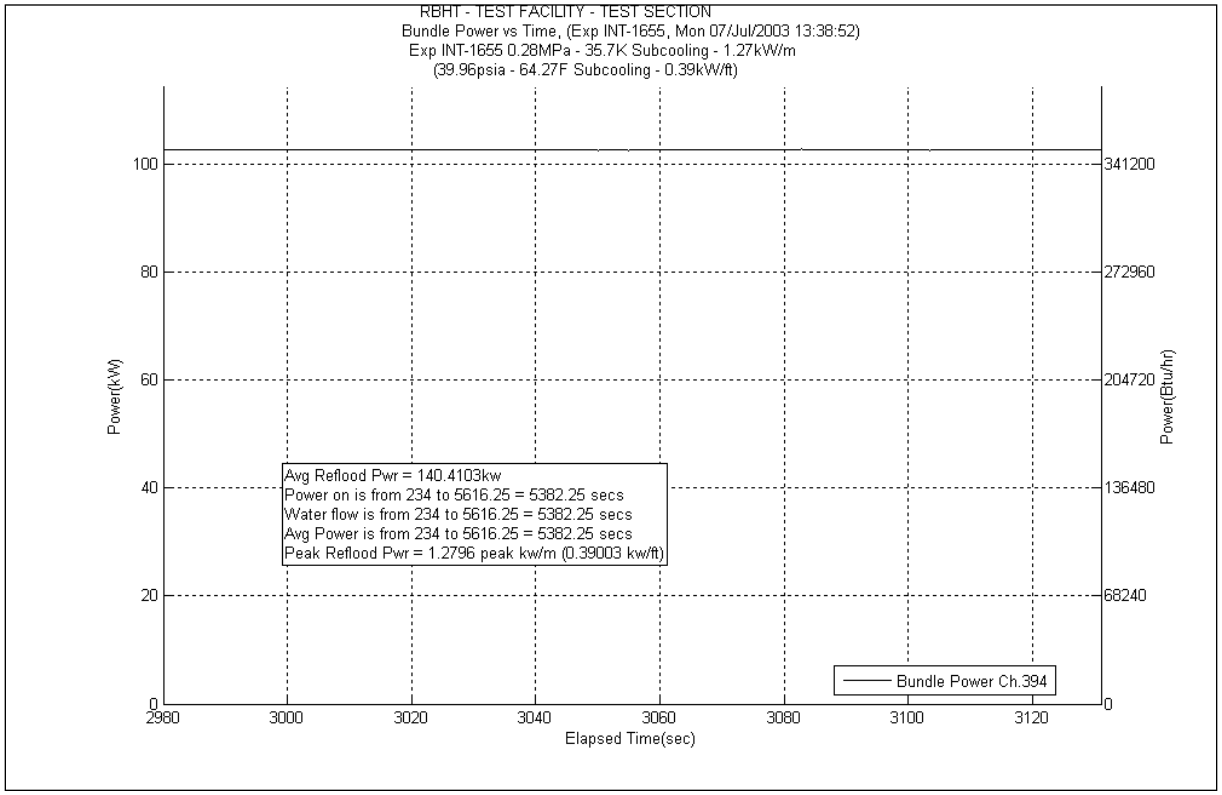

Figure A-524 Bundle Power Plot for Experiment 1655G

Table A-209 Data Results for RBHT Test 1655 for Time Period 2980 to 3131

Results for RBHT Test 1655
Valid Time Period 2980 to 3131 seconds
Collapsed Liquid Level = 78.123 inches = 1984.32 mm
(Z_{osv}) Onset of Significant Void = 40 inches = 1016 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.829	9.795	468.969	0.900	43.092	0.229	10.965	0.000	0.000	8.66	414.643	5768.66	276204.9233	0.848	0.844	0.852
*	120-133	3048-3378	383	0.785	14.547	696.491	0.985	47.162	0.410	19.631	2.312	110.676	10.84	519.022	5779.5	276723.9453	0.839	0.835	0.843
*	108-120	2743-3048	382	0.739	16.281	779.543	0.806	38.591	0.511	24.467	3.854	184.535	11.11	531.950	5790.61	277255.895	0.822	0.818	0.826
	100-108	2540-2743	381	0.792	8.626	413.021	0.470	22.504	0.374	17.907	0.000	0.000	7.78	372.508	5798.39	277628.4034	0.813	0.809	0.817
	97-100	2464-2540	380	0.742	4.014	192.213	0.162	7.757	0.135	6.464	0.000	0.000	3.716	177.923	5802.106	277806.3264	0.761	0.757	0.765
	93-97	2362-2464	379	0.748	5.230	250.399	0.204	9.768	0.176	8.427	0.000	0.000	4.846	232.028	5806.952	278038.3541	0.767	0.763	0.771
*	85-93	2159-2362	378	0.566	18.031	863.340	0.368	17.620	0.338	16.184	7.336	351.261	9.989	478.276	5816.941	278516.63	0.76	0.756	0.764
	81-85	2057-2159	377	0.737	5.474	262.086	0.164	7.852	0.162	7.757	0.000	0.000	5.143	246.248	5822.084	278762.8782	0.752	0.748	0.756
	78-81	1981-2057	376	0.637	5.661	271.037	0.115	5.506	0.119	5.698	0.000	0.000	5.426	259.798	5827.51	279022.6765	0.652	0.649	0.655
	75-78	1905-1981	375	0.624	5.853	280.238	0.108	5.171	0.116	5.554	0.000	0.000	5.629	269.518	5833.139	279292.1944	0.639	0.636	0.642
	72-75	1829-1905	374	0.549	7.027	336.434	0.100	4.788	0.113	5.410	0.000	0.000	6.811	326.112	5839.95	279618.3069	0.563	0.560	0.566
*	67-72	1702-1829	373	0.444	14.448	691.766	0.151	7.230	0.183	8.762	3.674	175.905	10.44	499.870	5850.39	280118.1768	0.598	0.595	0.601
	63-67	1600-1702	372	0.621	7.873	376.965	0.106	5.075	0.141	6.751	0.000	0.000	7.622	364.943	5858.012	280483.1201	0.633	0.630	0.636
	60-63	1524-1600	371	0.473	8.205	392.880	0.071	3.399	0.103	4.932	0.000	0.000	8.029	384.431	5866.041	280867.5507	0.485	0.483	0.487
	57-60	1448-1524	370	0.417	9.078	434.654	0.064	3.064	0.100	4.788	0.000	0.000	8.909	426.565	5874.95	281294.1159	0.428	0.426	0.430
	53-57	1346-1448	369	0.385	12.786	612.196	0.073	3.495	0.129	6.177	0.000	0.000	12.58	602.334	5887.53	281896.4495	0.394	0.392	0.396
*	46-53	1168-1346	368	0.278	26.232	1255.971	0.091	4.357	0.214	10.246	0.217	10.367	25.71	1231.001	5913.24	283127.4509	0.292	0.291	0.293
	43-46	1092-1168	367	0.184	12.718	608.963	0.022	1.053	0.087	4.166	0.000	0.000	12.6	603.291	5925.84	283730.7421	0.191	0.190	0.192
	37-43	940-1092	366	0.056	29.405	1407.901	0.021	1.005	0.065	3.112	0.000	0.000	29.31	1403.370	5955.15	285134.1125	0.059	0.056	0.062
*	25-37	635-940	365	0.042	59.687	2857.826	0.004	0.192	0.000	0.000	0.333	15.941	59.35	2841.693	6014.5	287975.8057	0.047	0.045	0.049
	13-25	330-635	364	0.036	60.108	2877.967	0.004	0.192	0.000	0.000	0.000	0.000	60.09	2877.125	6074.59	290852.9304	0.036	0.034	0.038
*	0-13	0-330	363	0.022	66.018	3160.940	0.004	0.192	0.000	0.000	-0.276	-13.234	66.29	3173.982	6140.88	294026.9126	0.018	0.017	0.019

Table A-210 Energy Balance Results for RBHT Test 1655G for Time Period 2980 to 3131 seconds

Results for RBHT Test 1655
Valid Time Period 2980 to 3131 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4655.7942	14.687	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
0.25	6.35	4914.4495	15.503	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
0.50	12.70	5173.1047	16.319	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
0.75	19.05	5431.7599	17.135	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
1.00	25.40	5690.4152	17.951	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
1.25	31.75	5949.0704	18.767	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
1.50	38.10	6207.7256	19.583	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
1.75	44.45	6466.3809	20.399	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
2.00	50.80	6725.0361	21.215	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
2.25	57.15	6983.6913	22.031	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
2.50	63.50	7242.3466	22.846	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
2.75	69.85	7501.0018	23.662	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
3.00	76.20	7759.657	24.478	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
3.25	82.55	8018.3123	25.294	0.00E+00	0.00E+00	0.00E+00	8.64E-02	3.92E-02
3.50	88.90	8276.9675	26.11	4.37E-03	2.31E-01	1.05E-01	8.60E-02	3.90E-02
3.75	95.25	8535.6227	26.926	1.48E-02	7.84E-01	3.55E-01	8.51E-02	3.86E-02
4.00	101.60	8794.278	27.742	2.56E-02	1.35E+00	6.14E-01	8.42E-02	3.82E-02
4.25	107.95	9052.9332	28.558	3.66E-02	1.94E+00	8.80E-01	8.32E-02	3.78E-02
4.50	114.30	9311.5885	29.374	4.80E-02	2.54E+00	1.15E+00	8.23E-02	3.73E-02
4.75	120.65	9570.2437	30.19	5.98E-02	3.16E+00	1.44E+00	8.12E-02	3.69E-02
5.00	127.00	9828.8989	31.006	7.18E-02	3.80E+00	1.72E+00	8.02E-02	3.64E-02
5.25	133.35	10087.554	31.822	8.42E-02	4.46E+00	2.02E+00	7.91E-02	3.59E-02
5.50	139.70	10346.209	32.638	9.68E-02	5.13E+00	2.33E+00	7.80E-02	3.54E-02
5.75	146.05	10604.865	33.454	1.10E-01	5.81E+00	2.64E+00	7.69E-02	3.49E-02
6.00	152.40	10863.52	34.27	1.23E-01	6.52E+00	2.96E+00	7.58E-02	3.44E-02
6.25	158.75	11122.175	35.086	1.37E-01	7.24E+00	3.29E+00	7.46E-02	3.38E-02
6.50	165.10	11380.83	35.902	1.51E-01	7.98E+00	3.62E+00	7.34E-02	3.33E-02
6.75	171.45	11639.486	36.718	1.65E-01	8.74E+00	3.96E+00	7.21E-02	3.27E-02
7.00	177.80	11898.141	37.534	1.80E-01	9.51E+00	4.32E+00	7.09E-02	3.21E-02
7.25	184.15	12156.796	38.349	1.95E-01	1.03E+01	4.67E+00	6.96E-02	3.16E-02
7.50	190.50	12415.451	39.165	2.10E-01	1.11E+01	5.04E+00	6.83E-02	3.10E-02
7.75	196.85	12674.107	39.981	2.25E-01	1.19E+01	5.41E+00	6.69E-02	3.04E-02
8.00	203.20	12932.762	40.797	2.41E-01	1.28E+01	5.79E+00	6.56E-02	2.97E-02
8.25	209.55	13191.417	41.613	2.58E-01	1.36E+01	6.19E+00	6.41E-02	2.91E-02
8.50	215.90	13450.072	42.429	2.74E-01	1.45E+01	6.58E+00	6.27E-02	2.85E-02
8.75	222.25	13708.727	43.245	2.91E-01	1.54E+01	6.99E+00	6.13E-02	2.78E-02
9.00	228.60	13967.383	44.061	3.08E-01	1.63E+01	7.40E+00	5.98E-02	2.71E-02
9.25	234.95	13191.417	41.613	3.25E-01	1.72E+01	7.80E+00	5.83E-02	2.65E-02
9.50	241.30	12415.451	39.165	3.41E-01	1.80E+01	8.19E+00	5.70E-02	2.58E-02
9.75	247.65	11639.486	36.718	3.56E-01	1.88E+01	8.54E+00	5.57E-02	2.52E-02
10.00	254.00	10863.52	34.27	3.70E-01	1.96E+01	8.88E+00	5.45E-02	2.47E-02
10.25	260.35	10087.554	31.822	3.83E-01	2.03E+01	9.19E+00	5.33E-02	2.42E-02
10.50	266.70	9311.5885	29.374	3.95E-01	2.09E+01	9.48E+00	5.23E-02	2.37E-02
10.75	273.05	8535.6227	26.926	4.06E-01	2.15E+01	9.75E+00	5.13E-02	2.33E-02
11.00	279.40	7759.657	24.478	4.16E-01	2.20E+01	9.99E+00	5.05E-02	2.29E-02
11.25	285.75	6983.6913	22.031	4.25E-01	2.25E+01	1.02E+01	4.97E-02	2.25E-02
11.50	292.10	6207.7256	19.583	4.33E-01	2.29E+01	1.04E+01	4.90E-02	2.22E-02
11.75	298.45	5431.7599	17.135	4.41E-01	2.33E+01	1.06E+01	4.83E-02	2.19E-02
12.00	304.80	4655.7942	14.687	4.47E-01	2.37E+01	1.07E+01	4.78E-02	2.17E-02

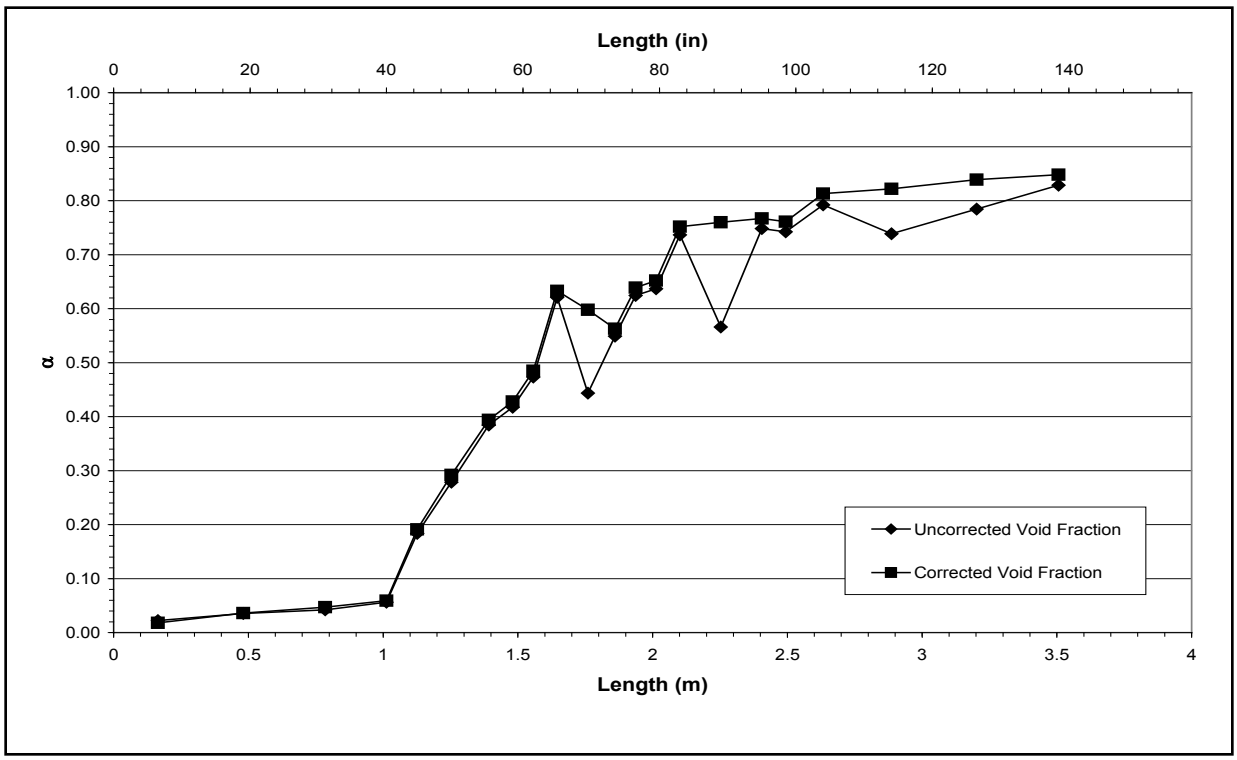

Figure A-525 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655G for Time Period 2980 to 3131 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-H

Test Conditions

Date: 7/7/2003
Steady-state time window: 950 – 1050 seconds
Inlet flow rate: 2.037 cm/sec (0.802 in./sec)
Inlet mass flow rate: 0.096 kg/sec (0.212 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

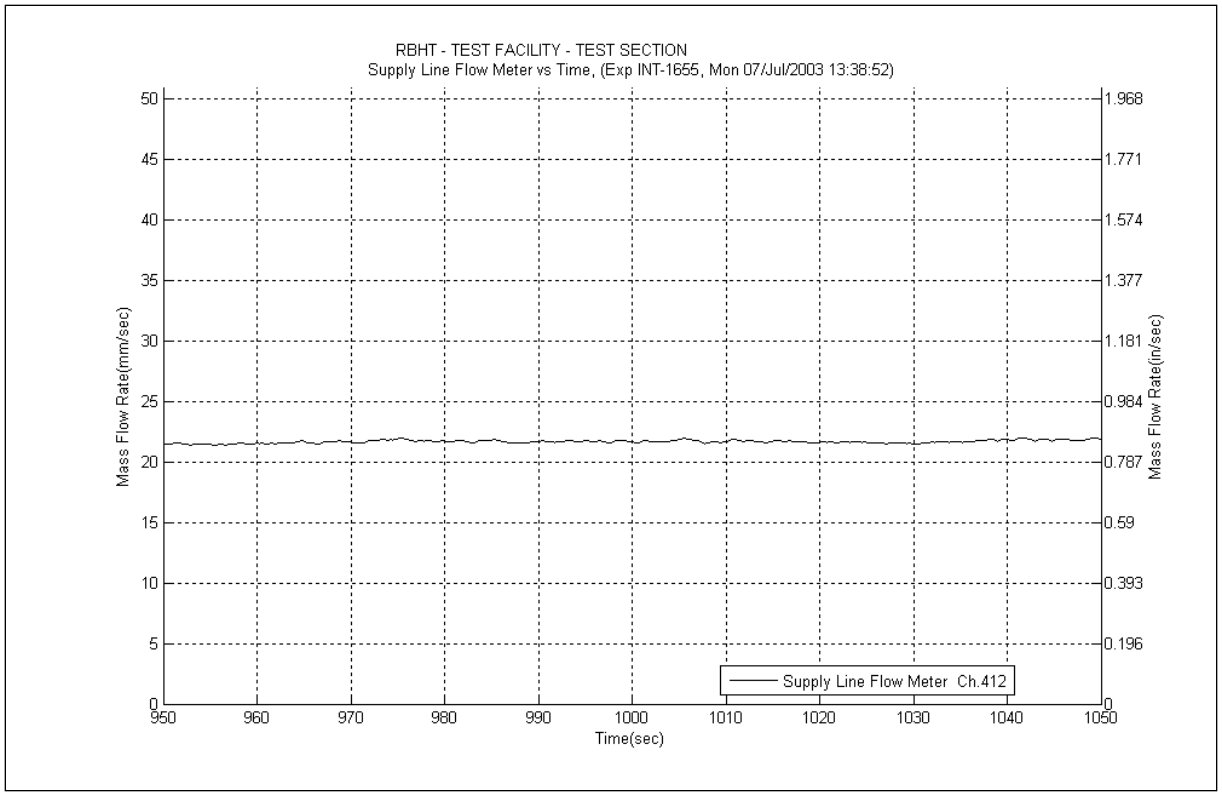

Figure A-526 Inlet Flow Plot for Experiment 1655H

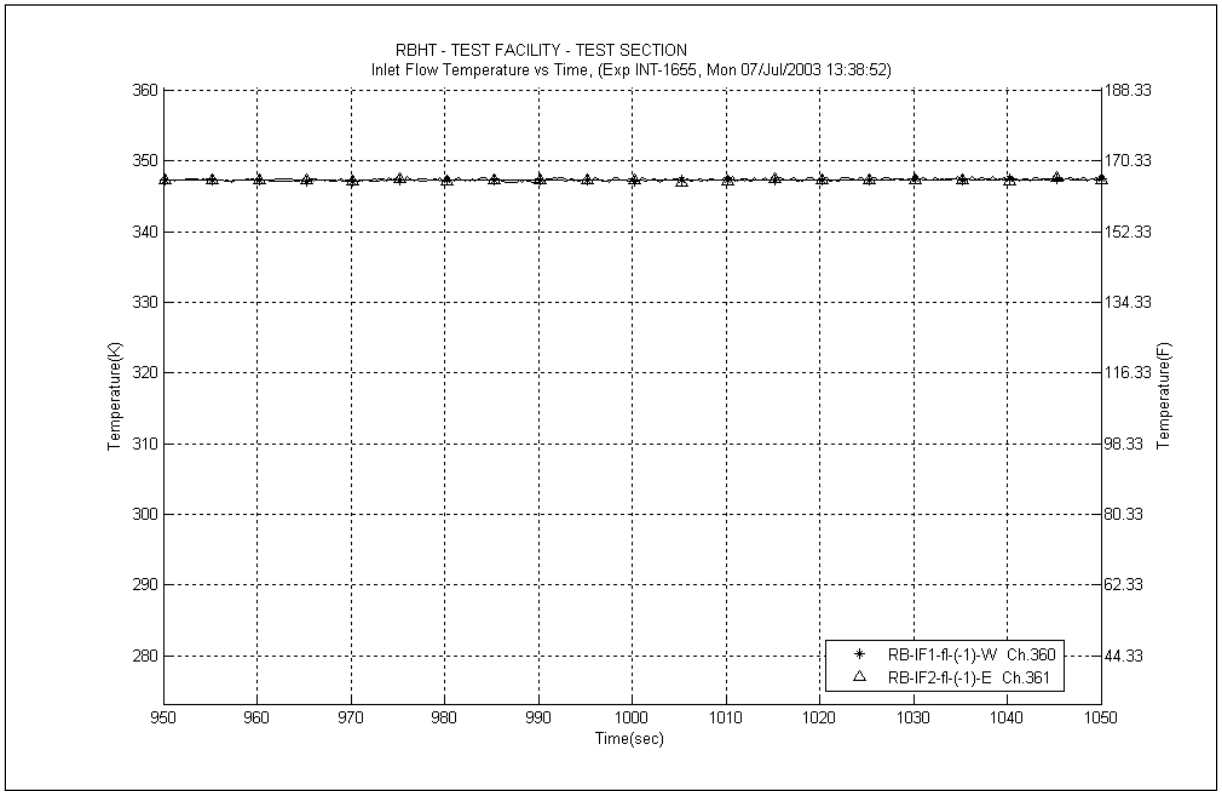

Figure A-527 Inlet Temperature Plot for Experiment 1655H

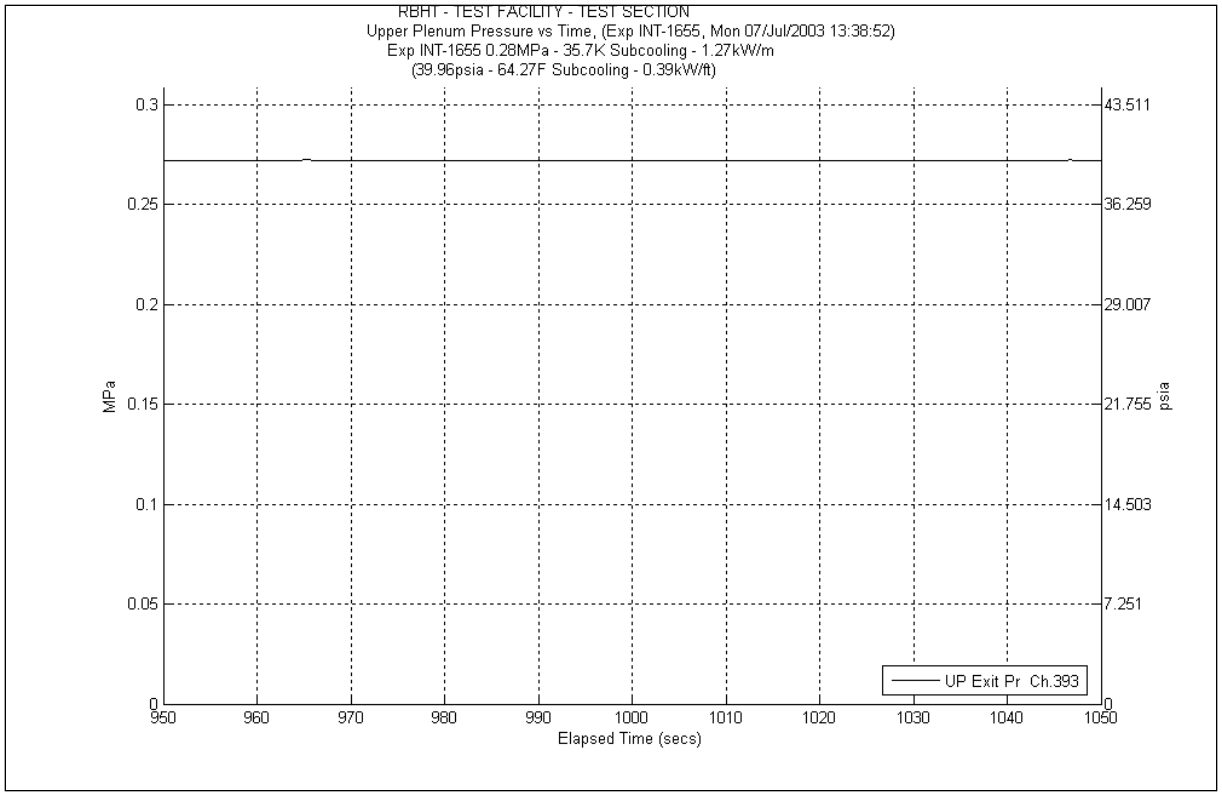

Figure A-528 System Pressure Plot for Experiment 1655H

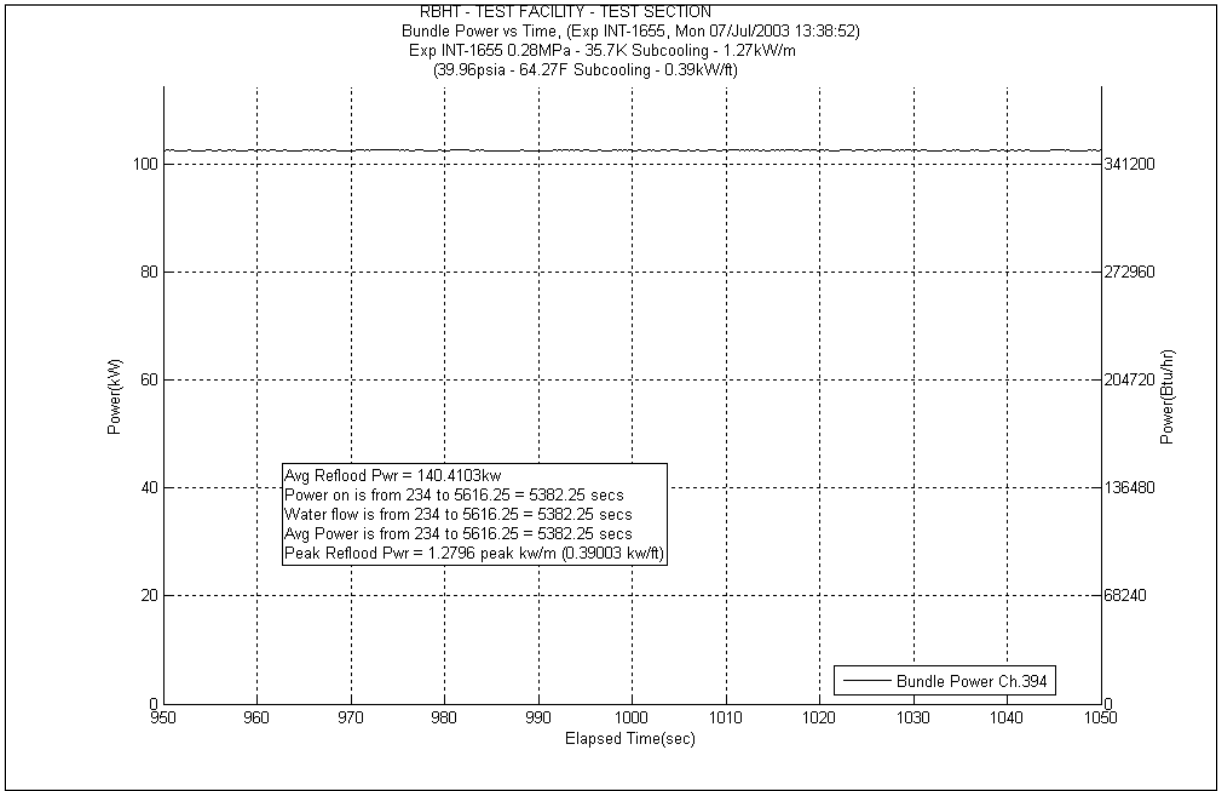

Figure A-529 Bundle Power Plot for Experiment 1655H

Table A-211 Data Results for RBHT Test 1655 for Time Period 950 to 1050

Results for RBHT Test 1655
Valid Time Period 950 to 1050 seconds
Collapsed Liquid Level = 72.840 inches = 1850.13 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.856	8.247	394.869	0.743	35.575	0.184	8.810	0.000	0.000	7.32	350.483	5767.32	276140.7638	0.872	0.868	0.876
*	120-133	3048-3378	383	0.813	12.599	603.244	0.814	38.975	0.328	15.705	2.085	99.831	9.372	448.734	5776.692	276589.4976	0.861	0.857	0.865
*	108-120	2743-3048	382	0.765	14.645	701.215	0.666	31.888	0.410	19.631	3.586	171.708	9.983	477.989	5786.675	277067.4862	0.84	0.836	0.844
	100-108	2540-2743	381	0.813	7.790	372.987	0.390	18.673	0.300	14.364	0.000	0.000	7.1	339.950	5793.775	277407.436	0.829	0.825	0.833
	97-100	2464-2540	380	0.765	3.666	175.553	0.134	6.416	0.108	5.171	0.000	0.000	3.425	163.990	5797.2	277571.4259	0.78	0.776	0.784
	93-97	2362-2464	379	0.771	4.757	227.771	0.170	8.140	0.141	6.751	0.000	0.000	4.446	212.876	5801.646	277784.3015	0.786	0.782	0.790
*	85-93	2159-2362	378	0.600	16.613	795.457	0.308	14.747	0.271	12.976	6.747	323.070	9.287	444.664	5810.933	278228.9654	0.776	0.772	0.780
	81-85	2057-2159	377	0.754	5.110	244.679	0.138	6.607	0.130	6.224	0.000	0.000	4.841	231.788	5815.774	278460.7538	0.767	0.763	0.771
	78-81	1981-2057	376	0.669	5.152	246.669	0.097	4.644	0.095	4.549	0.000	0.000	4.957	237.342	5820.731	278698.0962	0.682	0.679	0.685
	75-78	1905-1981	375	0.652	5.427	259.848	0.091	4.357	0.093	4.453	0.000	0.000	5.241	250.940	5825.972	278949.0366	0.664	0.661	0.667
	72-75	1829-1905	374	0.602	6.196	296.649	0.086	4.118	0.091	4.357	0.000	0.000	6.015	288.000	5831.987	279237.0364	0.614	0.611	0.617
*	67-72	1702-1829	373	0.462	13.965	668.641	0.131	6.272	0.146	6.991	4.518	216.317	9.17	439.062	5841.157	279676.0983	0.647	0.644	0.650
	63-67	1600-1702	372	0.670	6.860	328.477	0.094	4.501	0.113	5.410	0.000	0.000	6.652	318.499	5847.809	279994.5978	0.68	0.677	0.683
	60-63	1524-1600	371	0.523	7.426	355.581	0.064	3.064	0.082	3.926	0.000	0.000	7.276	348.377	5855.085	280342.9746	0.533	0.530	0.536
	57-60	1448-1524	370	0.461	8.392	401.831	0.058	2.777	0.080	3.830	0.000	0.000	8.253	395.156	5863.338	280738.1303	0.47	0.468	0.472
	53-57	1346-1448	369	0.425	11.950	572.162	0.069	3.304	0.103	4.932	0.000	0.000	11.77	563.551	5875.108	281301.6809	0.433	0.431	0.435
*	46-53	1168-1346	368	0.304	25.292	1210.964	0.097	4.644	0.172	8.235	3.633	173.926	21.39	1024.159	5896.498	282325.8396	0.411	0.409	0.413
	43-46	1092-1168	367	0.383	9.613	460.266	0.031	1.484	0.070	3.352	0.000	0.000	9.51	455.341	5906.008	282781.1809	0.389	0.387	0.391
	37-43	940-1092	366	0.210	24.606	1178.141	0.041	1.963	0.134	6.416	0.000	0.000	24.43	1169.715	5930.438	283950.8956	0.216	0.215	0.217
*	25-37	635-940	365	0.050	59.230	2835.944	0.031	1.484	0.050	2.394	4.789	229.295	54.36	2602.771	5984.798	286553.6663	0.127	0.126	0.128
	13-25	330-635	364	0.039	59.895	2867.772	0.002	0.096	0.000	0.000	0.000	0.000	59.87	2866.591	6044.668	289420.2573	0.039	0.037	0.041
*	0-13	0-330	363	0.023	65.935	3156.962	0.003	0.144	0.000	0.000	-0.248	-11.897	66.18	3168.715	6110.848	292588.9727	0.02	0.019	0.021

Table A-212 Energy Balance Results for RBHT Test 1655H for Time Period 950 to 1050 seconds

Results for RBHT Test 1655
Valid Time Period 950 to 1050 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4658.7267	14.696	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
0.25	6.35	4917.5448	15.513	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
0.50	12.70	5176.363	16.329	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
0.75	19.05	5435.1811	17.146	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
1.00	25.40	5693.9993	17.962	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
1.25	31.75	5952.8174	18.779	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
1.50	38.10	6211.6356	19.595	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
1.75	44.45	6470.4537	20.412	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
2.00	50.80	6729.2719	21.228	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
2.25	57.15	6988.09	22.044	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
2.50	63.50	7246.9082	22.861	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
2.75	69.85	7505.7263	23.677	0.00E+00	0.00E+00	0.00E+00	6.93E-02	3.14E-02
3.00	76.20	7764.5445	24.494	5.40E-03	2.29E-01	1.04E-01	6.90E-02	3.13E-02
3.25	82.55	8023.3626	25.31	1.76E-02	7.47E-01	3.39E-01	6.81E-02	3.09E-02
3.50	88.90	8282.1808	26.127	3.02E-02	1.28E+00	5.81E-01	6.72E-02	3.05E-02
3.75	95.25	8540.9989	26.943	4.33E-02	1.83E+00	8.32E-01	6.63E-02	3.01E-02
4.00	101.60	8799.8171	27.76	5.67E-02	2.40E+00	1.09E+00	6.54E-02	2.97E-02
4.25	107.95	9058.6352	28.576	7.05E-02	2.99E+00	1.36E+00	6.44E-02	2.92E-02
4.50	114.30	9317.4534	29.393	8.47E-02	3.59E+00	1.63E+00	6.35E-02	2.88E-02
4.75	120.65	9576.2715	30.209	9.93E-02	4.21E+00	1.91E+00	6.24E-02	2.83E-02
5.00	127.00	9835.0897	31.025	1.14E-01	4.85E+00	2.20E+00	6.14E-02	2.79E-02
5.25	133.35	10093.908	31.842	1.30E-01	5.50E+00	2.50E+00	6.03E-02	2.74E-02
5.50	139.70	10352.726	32.658	1.46E-01	6.17E+00	2.80E+00	5.92E-02	2.69E-02
5.75	146.05	10611.544	33.475	1.62E-01	6.86E+00	3.11E+00	5.81E-02	2.64E-02
6.00	152.40	10870.362	34.291	1.78E-01	7.56E+00	3.43E+00	5.70E-02	2.58E-02
6.25	158.75	11129.18	35.108	1.95E-01	8.28E+00	3.76E+00	5.58E-02	2.53E-02
6.50	165.10	11387.999	35.924	2.13E-01	9.03E+00	4.09E+00	5.46E-02	2.48E-02
6.75	171.45	11646.817	36.741	2.31E-01	9.78E+00	4.44E+00	5.33E-02	2.42E-02
7.00	177.80	11905.635	37.557	2.49E-01	1.06E+01	4.79E+00	5.21E-02	2.36E-02
7.25	184.15	12164.453	38.374	2.68E-01	1.13E+01	5.14E+00	5.08E-02	2.30E-02
7.50	190.50	12423.271	39.19	2.87E-01	1.21E+01	5.51E+00	4.95E-02	2.24E-02
7.75	196.85	12682.089	40.007	3.06E-01	1.30E+01	5.88E+00	4.81E-02	2.18E-02
8.00	203.20	12940.907	40.823	3.26E-01	1.38E+01	6.26E+00	4.67E-02	2.12E-02
8.25	209.55	13199.726	41.639	3.46E-01	1.47E+01	6.65E+00	4.53E-02	2.06E-02
8.50	215.90	13458.544	42.456	3.67E-01	1.55E+01	7.05E+00	4.39E-02	1.99E-02
8.75	222.25	13717.362	43.272	3.88E-01	1.64E+01	7.45E+00	4.24E-02	1.93E-02
9.00	228.60	13976.18	44.089	4.09E-01	1.73E+01	7.87E+00	4.10E-02	1.86E-02
9.25	234.95	13199.726	41.639	4.30E-01	1.82E+01	8.27E+00	3.95E-02	1.79E-02
9.50	241.30	12423.271	39.19	4.50E-01	1.91E+01	8.65E+00	3.81E-02	1.73E-02
9.75	247.65	11646.817	36.741	4.69E-01	1.99E+01	9.01E+00	3.68E-02	1.67E-02
10.00	254.00	10870.362	34.291	4.86E-01	2.06E+01	9.35E+00	3.56E-02	1.62E-02
10.25	260.35	10093.908	31.842	5.02E-01	2.13E+01	9.66E+00	3.45E-02	1.57E-02
10.50	266.70	9317.4534	29.393	5.17E-01	2.19E+01	9.95E+00	3.35E-02	1.52E-02
10.75	273.05	8540.9989	26.943	5.31E-01	2.25E+01	1.02E+01	3.25E-02	1.47E-02
11.00	279.40	7764.5445	24.494	5.44E-01	2.30E+01	1.05E+01	3.16E-02	1.43E-02
11.25	285.75	6988.09	22.044	5.55E-01	2.35E+01	1.07E+01	3.08E-02	1.40E-02
11.50	292.10	6211.6356	19.595	5.65E-01	2.40E+01	1.09E+01	3.01E-02	1.37E-02
11.75	298.45	5435.1811	17.146	5.74E-01	2.43E+01	1.10E+01	2.95E-02	1.34E-02
12.00	304.80	4658.7267	14.696	5.82E-01	2.47E+01	1.12E+01	2.90E-02	1.31E-02

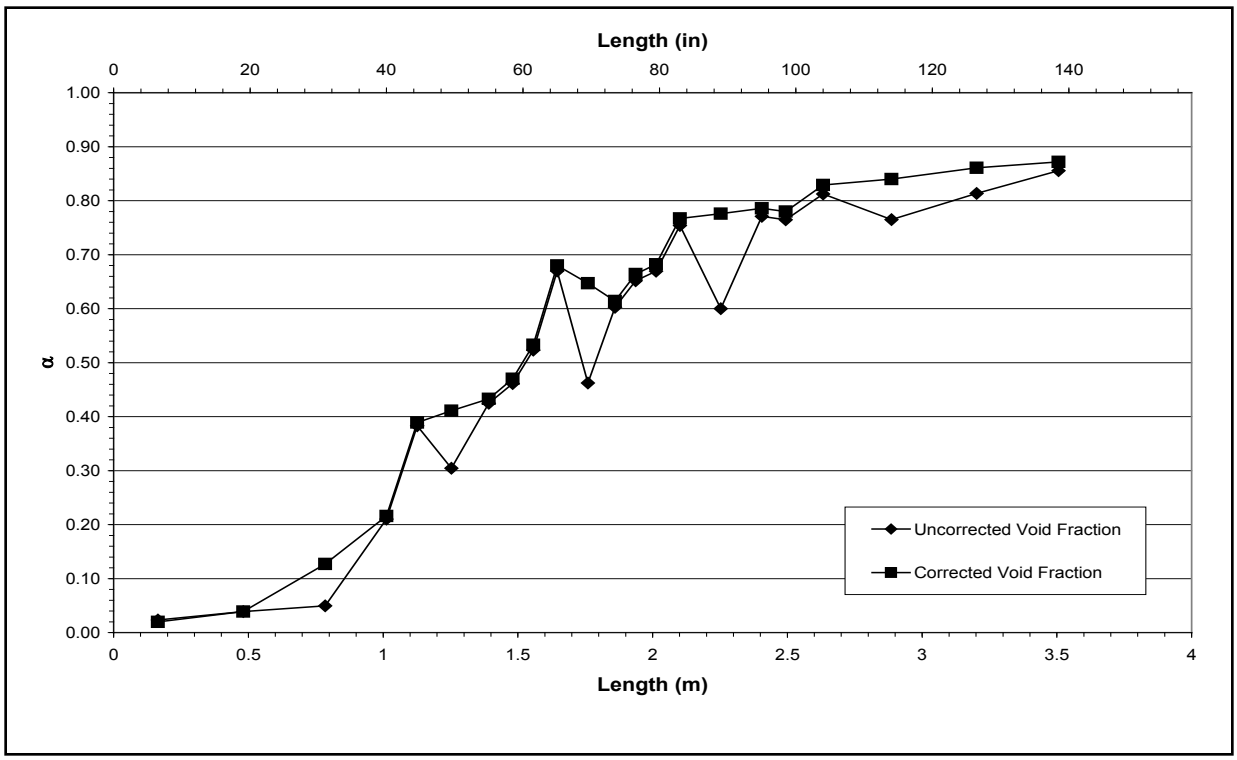

Figure A-530 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655H for Time Period 950 to 1050 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-I

Test Conditions

Date: 7/7/2003
Steady-state time window: 3402 – 3510 seconds
Inlet flow rate: 2.037 cm/sec (0.802 in./sec)
Inlet mass flow rate: 0.096 kg/sec (0.212 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

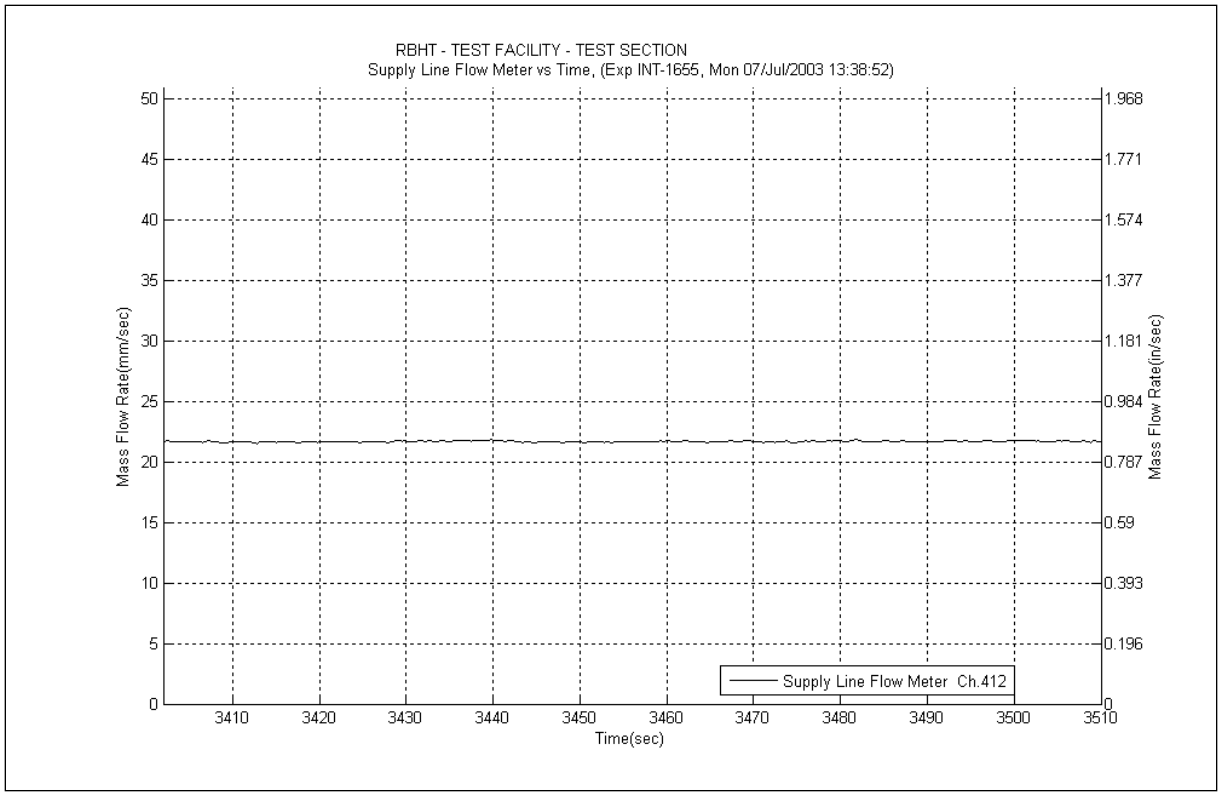

Figure A-531 Inlet Flow Plot for Experiment 1655l

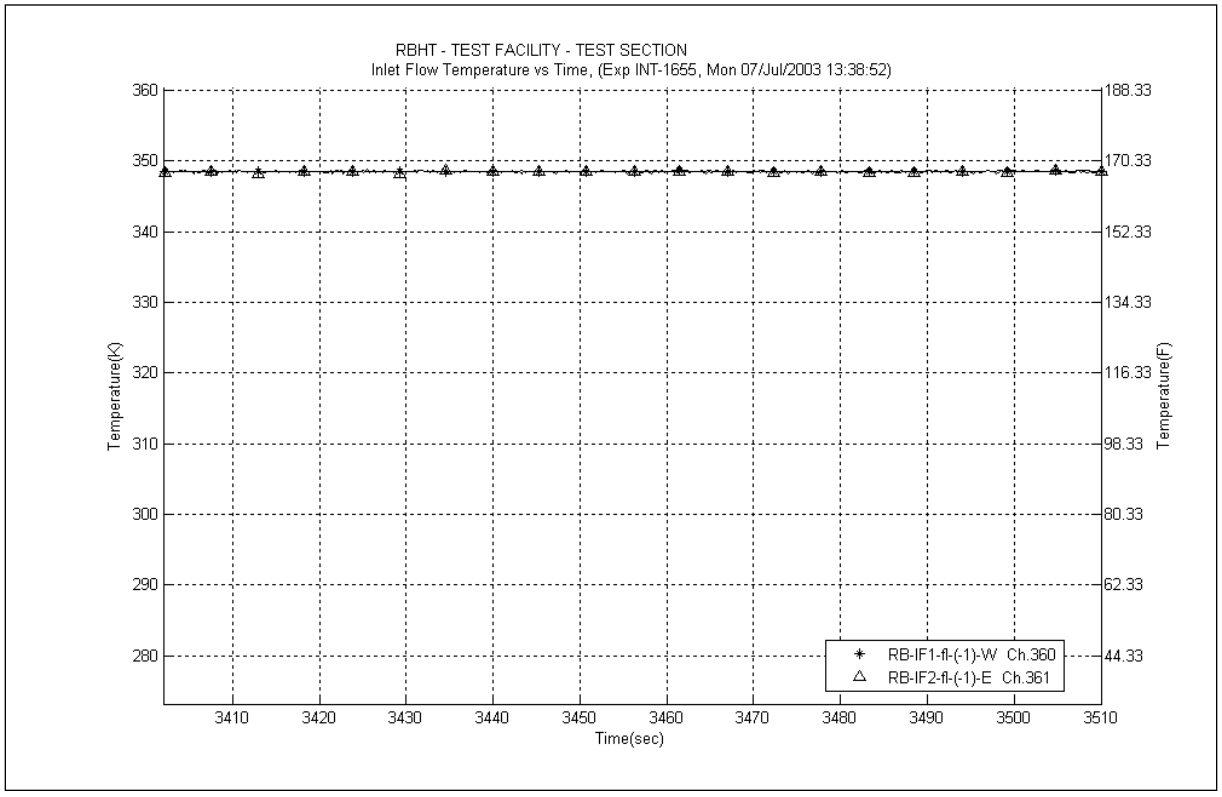

Figure A-532 Inlet Temperature Plot for Experiment 1655l

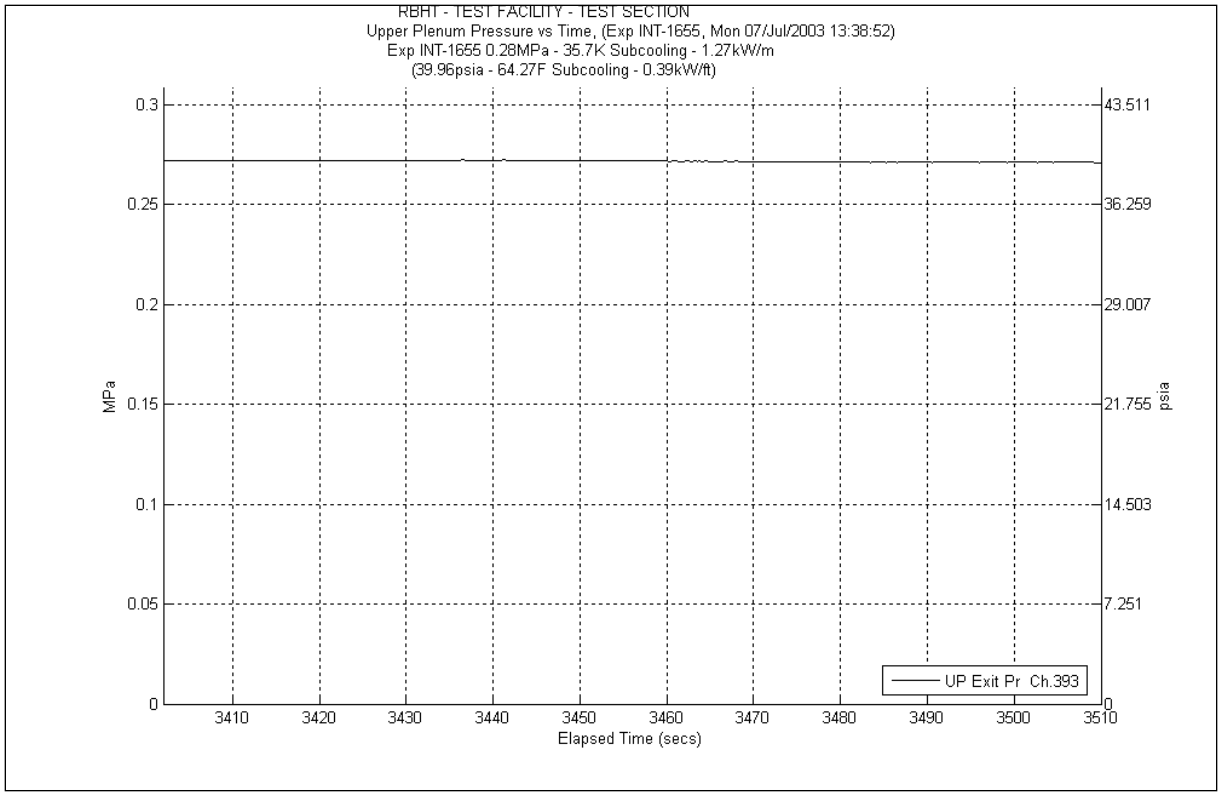

Figure A-533 System Pressure Plot for Experiment 1655I

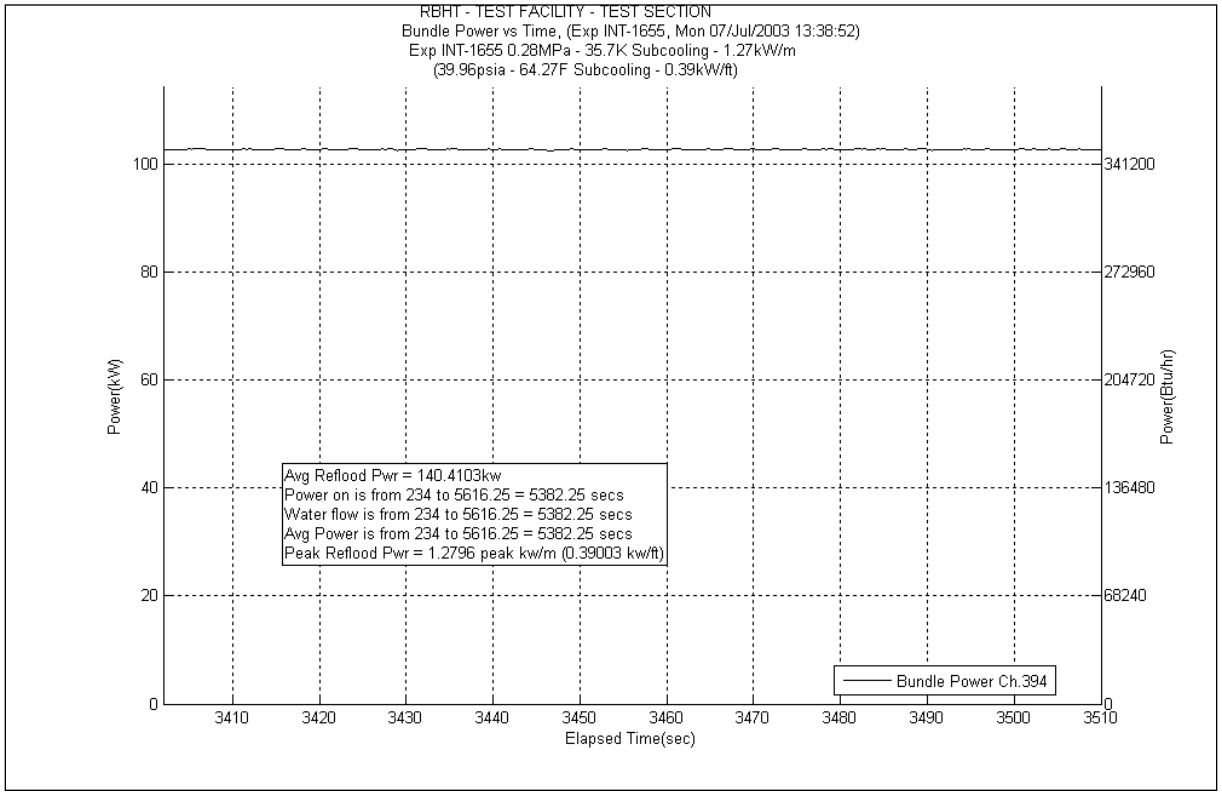

Figure A-534 Bundle Power Plot for Experiment 1655I

Table A-213 Data Results for RBHT Test 1655 for Time Period 3402 to 3510

Results for RBHT Test 1655
Valid Time Period 3402 to 3510 seconds
Collapsed Liquid Level = 72.500 inches = 1841.49 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.860	7.993	382.685	0.745	35.671	0.184	8.810	0.000	0.000	7.06	338.035	5767.06	276128.3149	0.876	0.872	0.880
*	120-133	3048-3378	383	0.816	12.407	594.044	0.817	39.118	0.328	15.705	2.189	104.803	9.073	434.418	5776.133	276562.7325	0.866	0.862	0.870
*	108-120	2743-3048	382	0.768	14.443	691.518	0.669	32.032	0.410	19.631	3.642	174.363	9.722	465.492	5785.855	277028.2244	0.844	0.840	0.848
	100-108	2540-2743	381	0.817	7.624	365.030	0.392	18.769	0.300	14.364	0.000	0.000	6.93	331.810	5792.785	277360.0345	0.833	0.829	0.837
	97-100	2464-2540	380	0.772	3.557	170.331	0.135	6.464	0.109	5.219	0.000	0.000	3.314	158.675	5796.099	277518.7097	0.787	0.783	0.791
	93-97	2362-2464	379	0.774	4.695	224.787	0.171	8.188	0.141	6.751	0.000	0.000	4.38	209.716	5800.479	277728.4252	0.789	0.785	0.793
*	85-93	2159-2362	378	0.609	16.240	777.553	0.309	14.795	0.271	12.976	6.512	311.774	9.148	438.009	5809.627	278166.4338	0.78	0.776	0.784
	81-85	2057-2159	377	0.758	5.038	241.198	0.139	6.655	0.130	6.224	0.000	0.000	4.767	228.245	5814.394	278394.679	0.77	0.766	0.774
	78-81	1981-2057	376	0.679	5.006	239.706	0.098	4.692	0.095	4.549	0.000	0.000	4.812	230.400	5819.206	278625.0788	0.691	0.688	0.694
	75-78	1905-1981	375	0.658	5.328	255.123	0.092	4.405	0.093	4.453	0.000	0.000	5.14	246.105	5824.346	278871.1833	0.67	0.667	0.673
	72-75	1829-1905	374	0.608	6.107	292.422	0.087	4.166	0.091	4.357	0.000	0.000	5.927	283.786	5830.273	279154.9696	0.62	0.617	0.623
*	67-72	1702-1829	373	0.467	13.830	662.176	0.132	6.320	0.146	6.991	4.565	218.566	8.987	430.300	5839.26	279585.2695	0.654	0.651	0.657
	63-67	1600-1702	372	0.678	6.689	320.271	0.095	4.549	0.113	5.410	0.000	0.000	6.478	310.168	5845.738	279895.4378	0.688	0.685	0.691
	60-63	1524-1600	371	0.534	7.265	347.873	0.065	3.112	0.082	3.926	0.000	0.000	7.115	340.668	5852.853	280236.1058	0.543	0.540	0.546
	57-60	1448-1524	370	0.468	8.283	396.609	0.059	2.825	0.080	3.830	0.000	0.000	8.143	389.889	5860.996	280625.9948	0.477	0.475	0.479
	53-57	1346-1448	369	0.438	11.680	559.232	0.070	3.352	0.103	4.932	0.000	0.000	11.5	550.623	5872.496	281176.6177	0.446	0.444	0.448
*	46-53	1168-1346	368	0.317	24.845	1189.580	0.099	4.740	0.172	8.235	4.044	193.623	20.53	982.982	5893.026	282159.5994	0.435	0.433	0.437
	43-46	1092-1168	367	0.418	9.073	434.405	0.032	1.532	0.070	3.352	0.000	0.000	8.966	429.294	5901.992	282588.8938	0.424	0.422	0.426
	37-43	940-1092	366	0.252	23.308	1115.977	0.044	2.107	0.134	6.416	0.000	0.000	23.12	1106.992	5925.112	283695.8853	0.258	0.257	0.259
*	25-37	635-940	365	0.050	59.194	2834.204	0.035	1.676	0.062	2.969	6.037	289.033	53.06	2540.526	5978.172	286236.4118	0.148	0.147	0.149
	13-25	330-635	364	0.039	59.884	2867.275	0.003	0.144	0.000	0.000	0.000	0.000	59.86	2866.112	6038.032	289102.5239	0.039	0.037	0.041
*	0-13	0-330	363	0.023	65.945	3157.459	0.003	0.144	0.000	0.000	-0.228	-10.921	66.17	3168.237	6104.202	292270.7605	0.02	0.019	0.021

Table A-214 Energy Balance Results for RBHT Test 1655I for Time Period 3402 to 3510 seconds

Results for RBHT Test 1655
Valid Time Period 3402 to 3510 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.6596	14.693	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.25	6.35	4916.4185	15.509	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.50	12.70	5175.1773	16.325	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.75	19.05	5433.9362	17.142	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.00	25.40	5692.6951	17.958	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.25	31.75	5951.4539	18.774	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.50	38.10	6210.2128	19.591	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.75	44.45	6468.9717	20.407	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.00	50.80	6727.7305	21.223	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.25	57.15	6986.4894	22.039	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.50	63.50	7245.2483	22.856	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.75	69.85	7504.0071	23.672	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
3.00	76.20	7762.766	24.488	7.58E-03	3.21E-01	1.46E-01	6.88E-02	3.12E-02
3.25	82.55	8021.5249	25.304	1.98E-02	8.39E-01	3.81E-01	6.80E-02	3.08E-02
3.50	88.90	8280.2837	26.121	3.24E-02	1.37E+00	6.23E-01	6.71E-02	3.04E-02
3.75	95.25	8539.0426	26.937	4.54E-02	1.93E+00	8.73E-01	6.62E-02	3.00E-02
4.00	101.60	8797.8015	27.753	5.88E-02	2.49E+00	1.13E+00	6.53E-02	2.96E-02
4.25	107.95	9056.5603	28.57	7.26E-02	3.08E+00	1.40E+00	6.43E-02	2.92E-02
4.50	114.30	9315.3192	29.386	8.68E-02	3.68E+00	1.67E+00	6.33E-02	2.87E-02
4.75	120.65	9574.0781	30.202	1.01E-01	4.30E+00	1.95E+00	6.23E-02	2.83E-02
5.00	127.00	9832.8369	31.018	1.16E-01	4.94E+00	2.24E+00	6.13E-02	2.78E-02
5.25	133.35	10091.596	31.835	1.32E-01	5.59E+00	2.54E+00	6.02E-02	2.73E-02
5.50	139.70	10350.355	32.651	1.48E-01	6.26E+00	2.84E+00	5.91E-02	2.68E-02
5.75	146.05	10609.114	33.467	1.64E-01	6.95E+00	3.15E+00	5.80E-02	2.63E-02
6.00	152.40	10867.872	34.283	1.81E-01	7.65E+00	3.47E+00	5.68E-02	2.58E-02
6.25	158.75	11126.631	35.1	1.98E-01	8.38E+00	3.80E+00	5.57E-02	2.52E-02
6.50	165.10	11385.39	35.916	2.15E-01	9.11E+00	4.13E+00	5.45E-02	2.47E-02
6.75	171.45	11644.149	36.732	2.33E-01	9.87E+00	4.48E+00	5.32E-02	2.41E-02
7.00	177.80	11902.908	37.549	2.51E-01	1.06E+01	4.83E+00	5.20E-02	2.36E-02
7.25	184.15	12161.667	38.365	2.70E-01	1.14E+01	5.18E+00	5.07E-02	2.30E-02
7.50	190.50	12420.426	39.181	2.89E-01	1.22E+01	5.55E+00	4.93E-02	2.24E-02
7.75	196.85	12679.184	39.997	3.08E-01	1.31E+01	5.92E+00	4.80E-02	2.18E-02
8.00	203.20	12937.943	40.814	3.28E-01	1.39E+01	6.31E+00	4.66E-02	2.11E-02
8.25	209.55	13196.702	41.63	3.48E-01	1.48E+01	6.69E+00	4.52E-02	2.05E-02
8.50	215.90	13455.461	42.446	3.69E-01	1.56E+01	7.09E+00	4.38E-02	1.99E-02
8.75	222.25	13714.22	43.262	3.90E-01	1.65E+01	7.49E+00	4.23E-02	1.92E-02
9.00	228.60	13972.979	44.079	4.11E-01	1.74E+01	7.91E+00	4.09E-02	1.85E-02
9.25	234.95	13196.702	41.63	4.32E-01	1.83E+01	8.31E+00	3.94E-02	1.79E-02
9.50	241.30	12420.426	39.181	4.52E-01	1.92E+01	8.69E+00	3.80E-02	1.72E-02
9.75	247.65	11644.149	36.732	4.71E-01	2.00E+01	9.05E+00	3.67E-02	1.67E-02
10.00	254.00	10867.872	34.283	4.88E-01	2.07E+01	9.38E+00	3.55E-02	1.61E-02
10.25	260.35	10091.596	31.835	5.04E-01	2.14E+01	9.70E+00	3.44E-02	1.56E-02
10.50	266.70	9315.3192	29.386	5.19E-01	2.20E+01	9.98E+00	3.34E-02	1.51E-02
10.75	273.05	8539.0426	26.937	5.33E-01	2.26E+01	1.03E+01	3.24E-02	1.47E-02
11.00	279.40	7762.766	24.488	5.46E-01	2.31E+01	1.05E+01	3.15E-02	1.43E-02
11.25	285.75	6986.4894	22.039	5.57E-01	2.36E+01	1.07E+01	3.07E-02	1.39E-02
11.50	292.10	6210.2128	19.591	5.67E-01	2.40E+01	1.09E+01	3.00E-02	1.36E-02
11.75	298.45	5433.9362	17.142	5.76E-01	2.44E+01	1.11E+01	2.94E-02	1.33E-02
12.00	304.80	4657.6596	14.693	5.84E-01	2.48E+01	1.12E+01	2.89E-02	1.31E-02

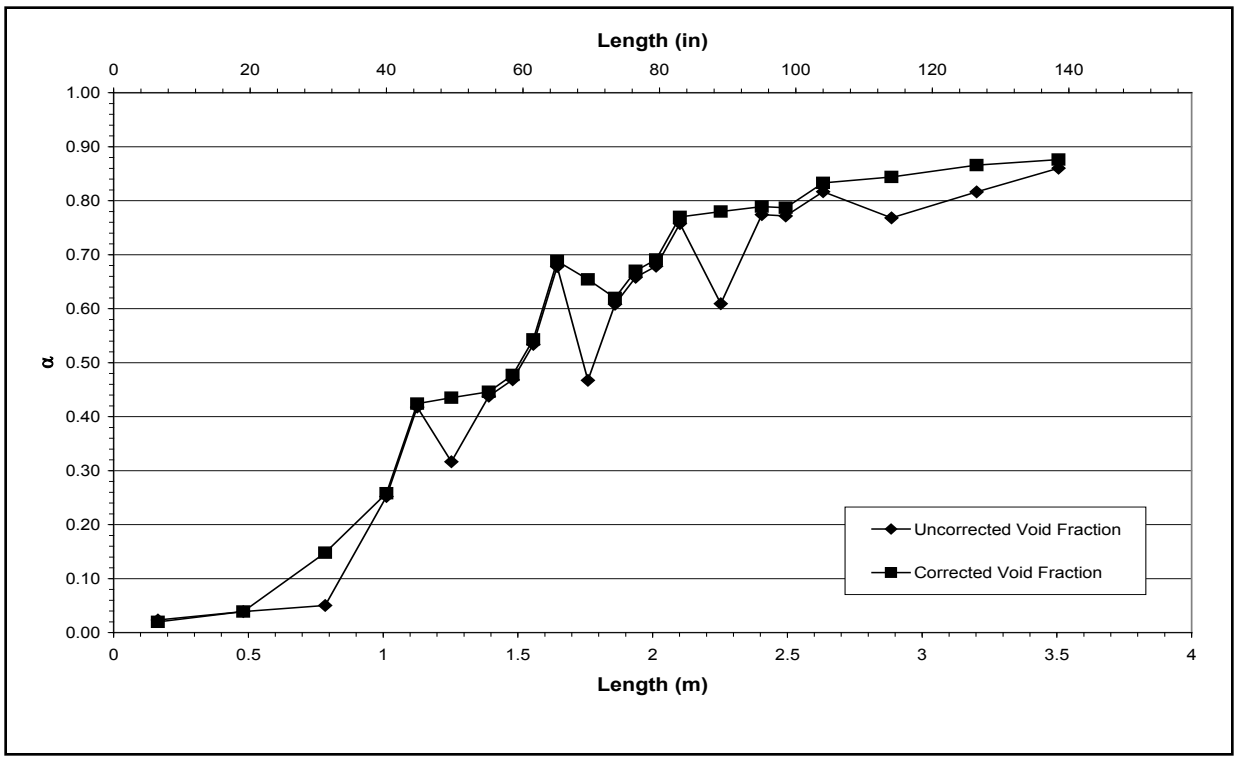

Figure A-535 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655l for Time Period 3402 to 3510 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-J

Test Conditions

Date: 7/7/2003
Steady-state time window: 3670 – 3810 seconds
Inlet flow rate: 2.027 cm/sec (0.798 in./sec)
Inlet mass flow rate: 0.096 kg/sec (0.211 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

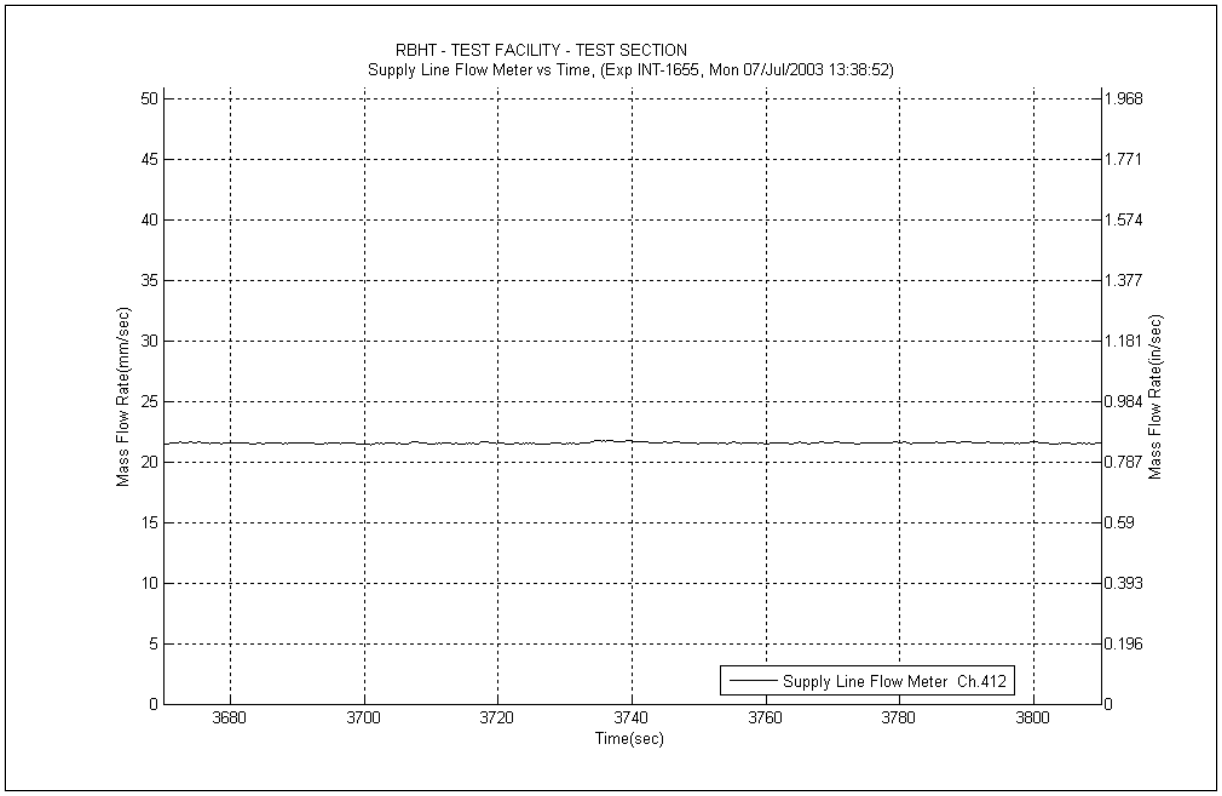

Figure A-536 Inlet Flow Plot for Experiment 1655J

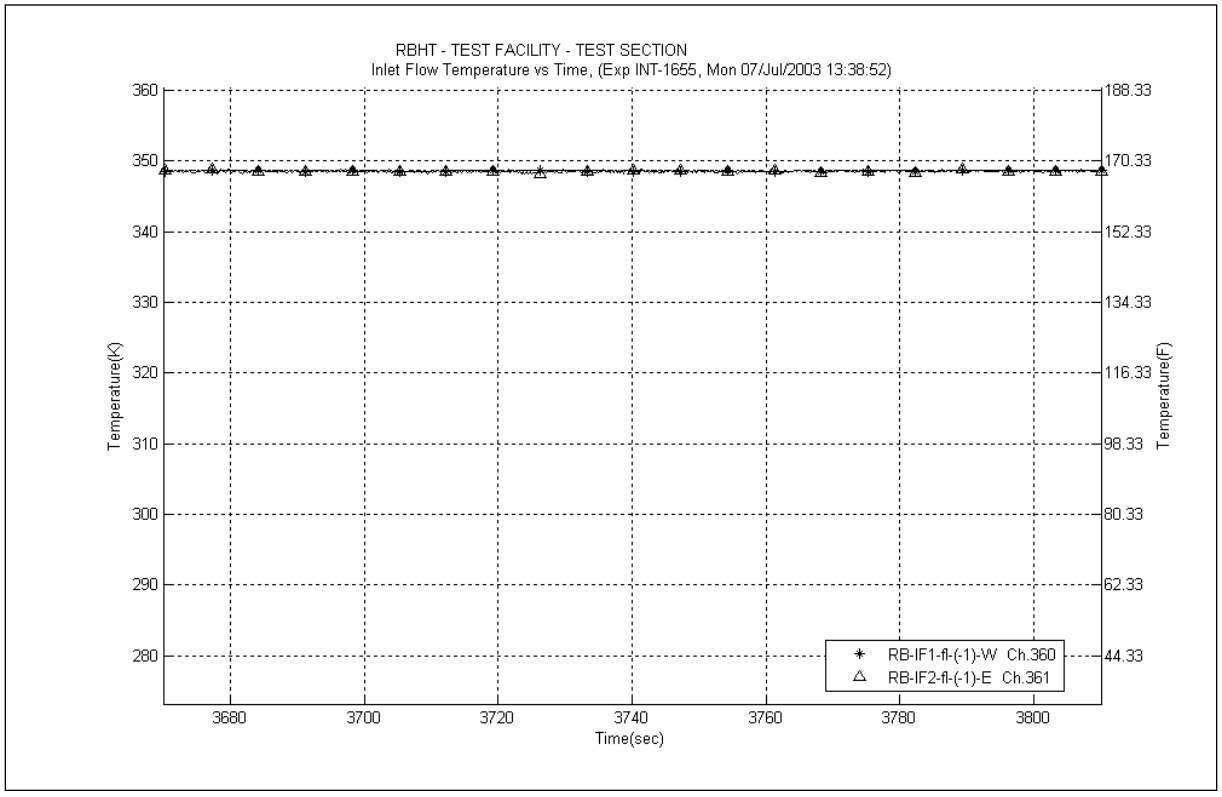

Figure A-537 Inlet Temperature Plot for Experiment 1655J

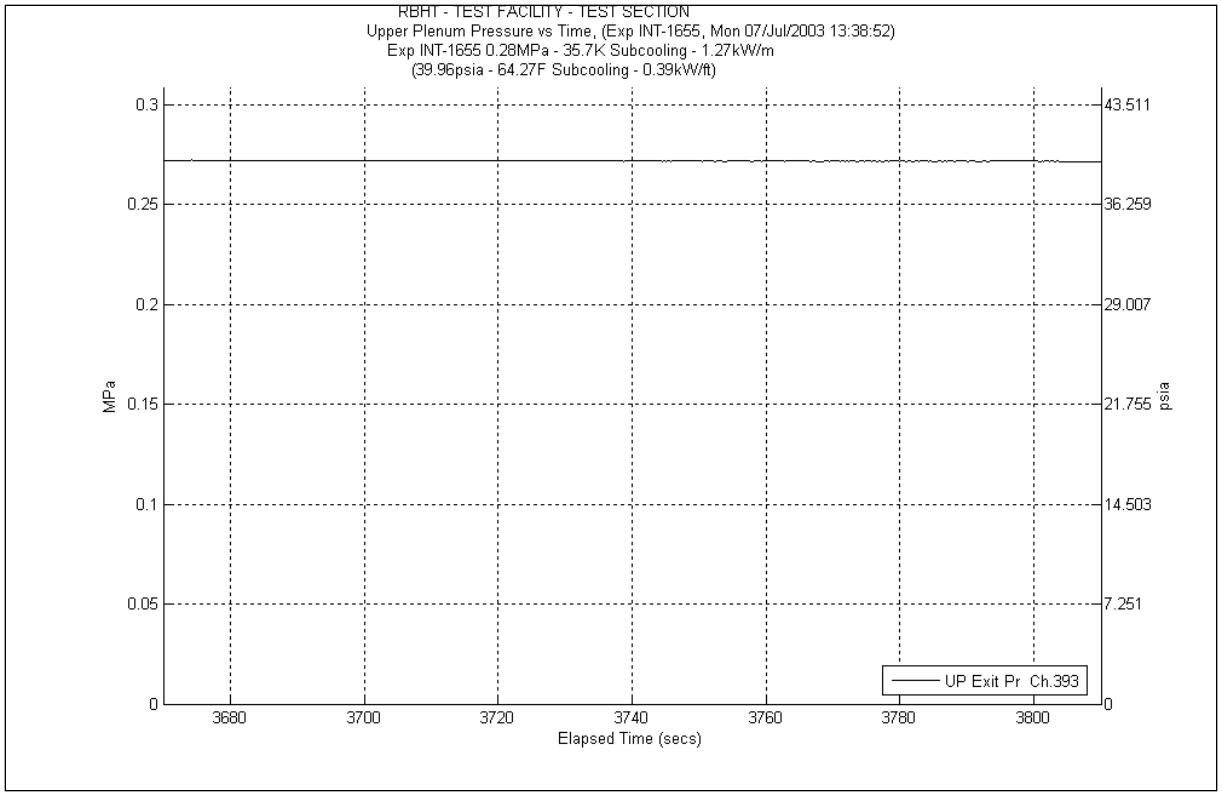

Figure A-538 System Pressure Plot for Experiment 1655J

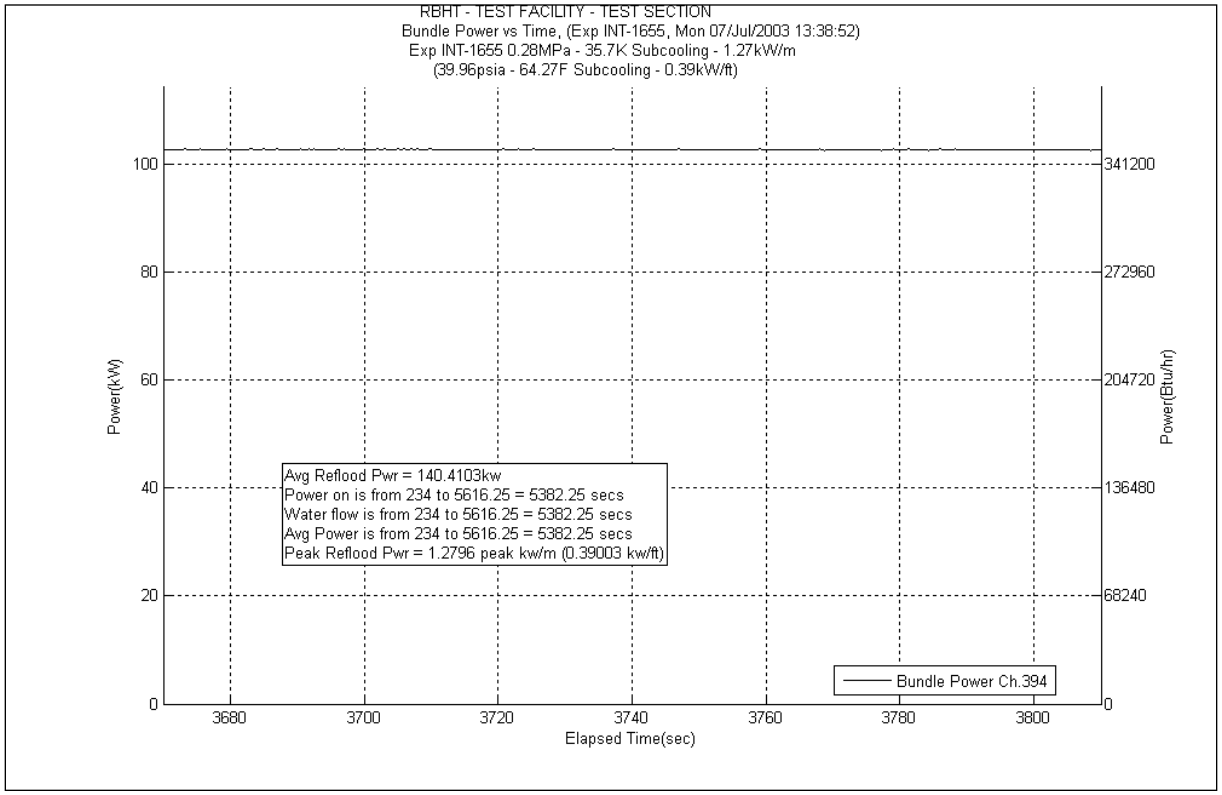

Figure A-539 Bundle Power Plot for Experiment 1655J

Table A-215 Data Results for RBHT Test 1655 for Time Period 3670 to 3810

Results for RBHT Test 1655
Valid Time Period 3670 to 3810 seconds
Collapsed Liquid Level = 72.362 inches = 1838.00 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.861	7.946	380.447	0.743	35.575	0.183	8.762	0.000	0.000	7.019	336.072	5767.019	276126.3518	0.877	0.873	0.881
*	120-133	3048-3378	383	0.818	12.272	587.579	0.814	38.975	0.327	15.657	2.104	100.732	9.027	432.215	5776.046	276558.5669	0.866	0.862	0.870
*	108-120	2743-3048	382	0.769	14.396	689.280	0.667	31.936	0.408	19.535	3.636	174.088	9.685	463.720	5785.731	277022.2872	0.845	0.841	0.849
	100-108	2540-2743	381	0.817	7.598	363.787	0.390	18.673	0.298	14.268	0.000	0.000	6.907	330.709	5792.638	277352.9961	0.834	0.830	0.838
	97-100	2464-2540	380	0.771	3.563	170.579	0.135	6.464	0.108	5.171	0.000	0.000	3.319	158.915	5795.957	277511.9107	0.787	0.783	0.791
	93-97	2362-2464	379	0.774	4.695	224.787	0.170	8.140	0.141	6.751	0.000	0.000	4.381	209.763	5800.338	277721.6741	0.789	0.785	0.793
*	85-93	2159-2362	378	0.608	16.297	780.289	0.308	14.747	0.270	12.928	6.617	316.808	9.102	435.806	5809.44	278157.4802	0.781	0.777	0.785
	81-85	2057-2159	377	0.760	4.991	238.960	0.139	6.655	0.129	6.177	0.000	0.000	4.721	226.043	5814.161	278383.5229	0.773	0.769	0.777
	78-81	1981-2057	376	0.679	5.006	239.706	0.097	4.644	0.095	4.549	0.000	0.000	4.814	230.496	5818.975	278614.0185	0.691	0.688	0.694
	75-78	1905-1981	375	0.659	5.308	254.128	0.092	4.405	0.092	4.405	0.000	0.000	5.121	245.195	5824.096	278859.2133	0.671	0.668	0.674
	72-75	1829-1905	374	0.608	6.102	292.173	0.086	4.118	0.090	4.309	0.000	0.000	5.922	283.547	5830.018	279142.7602	0.62	0.617	0.623
*	67-72	1702-1829	373	0.470	13.752	658.446	0.132	6.320	0.146	6.991	4.500	215.458	8.974	429.677	5838.992	279572.4376	0.654	0.651	0.657
	63-67	1600-1702	372	0.679	6.673	319.525	0.094	4.501	0.112	5.363	0.000	0.000	6.463	309.450	5845.455	279881.8877	0.689	0.686	0.692
	60-63	1524-1600	371	0.536	7.229	346.132	0.065	3.112	0.082	3.926	0.000	0.000	7.082	339.088	5852.537	280220.9757	0.545	0.542	0.548
	57-60	1448-1524	370	0.470	8.263	395.615	0.059	2.825	0.080	3.830	0.000	0.000	8.12	388.788	5860.657	280609.7633	0.479	0.477	0.481
	53-57	1346-1448	369	0.438	11.675	558.983	0.070	3.352	0.103	4.932	0.000	0.000	11.5	550.623	5872.157	281160.3863	0.446	0.444	0.448
*	46-53	1168-1346	368	0.318	24.798	1187.342	0.099	4.740	0.171	8.188	4.038	193.348	20.49	981.066	5892.647	282141.4528	0.436	0.434	0.438
	43-46	1092-1168	367	0.420	9.042	432.914	0.032	1.532	0.070	3.352	0.000	0.000	8.937	427.906	5901.584	282569.3586	0.426	0.424	0.428
	37-43	940-1092	366	0.261	23.038	1103.047	0.045	2.155	0.133	6.368	0.000	0.000	22.85	1094.064	5924.434	283663.4225	0.266	0.265	0.267
*	25-37	635-940	365	0.051	59.147	2831.966	0.036	1.724	0.065	3.112	6.266	300.010	52.78	2527.120	5977.214	286190.5425	0.153	0.152	0.154
	13-25	330-635	364	0.039	59.884	2867.275	0.002	0.096	0.000	0.000	0.000	0.000	59.86	2866.112	6037.074	289056.6546	0.039	0.037	0.041
*	0-13	0-330	363	0.023	65.950	3157.708	0.003	0.144	0.000	0.000	-0.223	-10.673	66.17	3168.237	6103.244	292224.8913	0.02	0.019	0.021

Table A-216 Energy Balance Results for RBHT Test 1655J for Time Period 3670 to 3810 seconds

Results for RBHT Test 1655 Valid Time Period 3670 to 3810 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4655.1418	14.685	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
0.25	6.35	4913.7608	15.501	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
0.50	12.70	5172.3798	16.317	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
0.75	19.05	5430.9987	17.132	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
1.00	25.40	5689.6177	17.948	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
1.25	31.75	5948.2367	18.764	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
1.50	38.10	6206.8557	19.58	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
1.75	44.45	6465.4747	20.396	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
2.00	50.80	6724.0937	21.212	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
2.25	57.15	6982.7127	22.027	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
2.50	63.50	7241.3317	22.843	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
2.75	69.85	7499.9506	23.659	0.00E+00	0.00E+00	0.00E+00	6.90E-02	3.13E-02
3.00	76.20	7758.5696	24.475	8.25E-03	3.49E-01	1.58E-01	6.85E-02	3.11E-02
3.25	82.55	8017.1886	25.291	2.05E-02	8.66E-01	3.93E-01	6.76E-02	3.07E-02
3.50	88.90	8275.8076	26.107	3.32E-02	1.40E+00	6.36E-01	6.67E-02	3.03E-02
3.75	95.25	8534.4266	26.922	4.62E-02	1.95E+00	8.86E-01	6.58E-02	2.99E-02
4.00	101.60	8793.0456	27.738	5.97E-02	2.52E+00	1.14E+00	6.49E-02	2.94E-02
4.25	107.95	9051.6646	28.554	7.36E-02	3.11E+00	1.41E+00	6.40E-02	2.90E-02
4.50	114.30	9310.2836	29.37	8.78E-02	3.71E+00	1.68E+00	6.30E-02	2.86E-02
4.75	120.65	9568.9025	30.186	1.03E-01	4.33E+00	1.96E+00	6.20E-02	2.81E-02
5.00	127.00	9827.5215	31.002	1.18E-01	4.97E+00	2.25E+00	6.09E-02	2.76E-02
5.25	133.35	10086.141	31.817	1.33E-01	5.62E+00	2.55E+00	5.98E-02	2.71E-02
5.50	139.70	10344.76	32.633	1.49E-01	6.29E+00	2.85E+00	5.88E-02	2.66E-02
5.75	146.05	10603.378	33.449	1.65E-01	6.98E+00	3.17E+00	5.76E-02	2.61E-02
6.00	152.40	10861.997	34.265	1.82E-01	7.68E+00	3.49E+00	5.65E-02	2.56E-02
6.25	158.75	11120.616	35.081	1.99E-01	8.41E+00	3.81E+00	5.53E-02	2.51E-02
6.50	165.10	11379.235	35.897	2.16E-01	9.14E+00	4.15E+00	5.41E-02	2.45E-02
6.75	171.45	11637.854	36.712	2.34E-01	9.90E+00	4.49E+00	5.29E-02	2.40E-02
7.00	177.80	11896.473	37.528	2.53E-01	1.07E+01	4.84E+00	5.16E-02	2.34E-02
7.25	184.15	12155.092	38.344	2.71E-01	1.15E+01	5.20E+00	5.03E-02	2.28E-02
7.50	190.50	12413.711	39.16	2.90E-01	1.23E+01	5.56E+00	4.90E-02	2.22E-02
7.75	196.85	12672.33	39.976	3.10E-01	1.31E+01	5.94E+00	4.76E-02	2.16E-02
8.00	203.20	12930.949	40.792	3.30E-01	1.39E+01	6.32E+00	4.63E-02	2.10E-02
8.25	209.55	13189.568	41.607	3.50E-01	1.48E+01	6.71E+00	4.49E-02	2.03E-02
8.50	215.90	13448.187	42.423	3.71E-01	1.57E+01	7.10E+00	4.34E-02	1.97E-02
8.75	222.25	13706.806	43.239	3.92E-01	1.66E+01	7.51E+00	4.20E-02	1.90E-02
9.00	228.60	13965.425	44.055	4.13E-01	1.75E+01	7.92E+00	4.05E-02	1.84E-02
9.25	234.95	13189.568	41.607	4.35E-01	1.84E+01	8.33E+00	3.90E-02	1.77E-02
9.50	241.30	12413.711	39.16	4.54E-01	1.92E+01	8.71E+00	3.77E-02	1.71E-02
9.75	247.65	11637.854	36.712	4.73E-01	2.00E+01	9.06E+00	3.64E-02	1.65E-02
10.00	254.00	10861.997	34.265	4.91E-01	2.07E+01	9.40E+00	3.52E-02	1.60E-02
10.25	260.35	10086.141	31.817	5.07E-01	2.14E+01	9.71E+00	3.40E-02	1.54E-02
10.50	266.70	9310.2836	29.37	5.22E-01	2.20E+01	1.00E+01	3.30E-02	1.50E-02
10.75	273.05	8534.4266	26.922	5.36E-01	2.26E+01	1.03E+01	3.20E-02	1.45E-02
11.00	279.40	7758.5696	24.475	5.48E-01	2.32E+01	1.05E+01	3.12E-02	1.41E-02
11.25	285.75	6982.7127	22.027	5.60E-01	2.37E+01	1.07E+01	3.04E-02	1.38E-02
11.50	292.10	6206.8557	19.58	5.70E-01	2.41E+01	1.09E+01	2.97E-02	1.35E-02
11.75	298.45	5430.9987	17.132	5.79E-01	2.45E+01	1.11E+01	2.90E-02	1.32E-02
12.00	304.80	4655.1418	14.685	5.87E-01	2.48E+01	1.12E+01	2.85E-02	1.29E-02

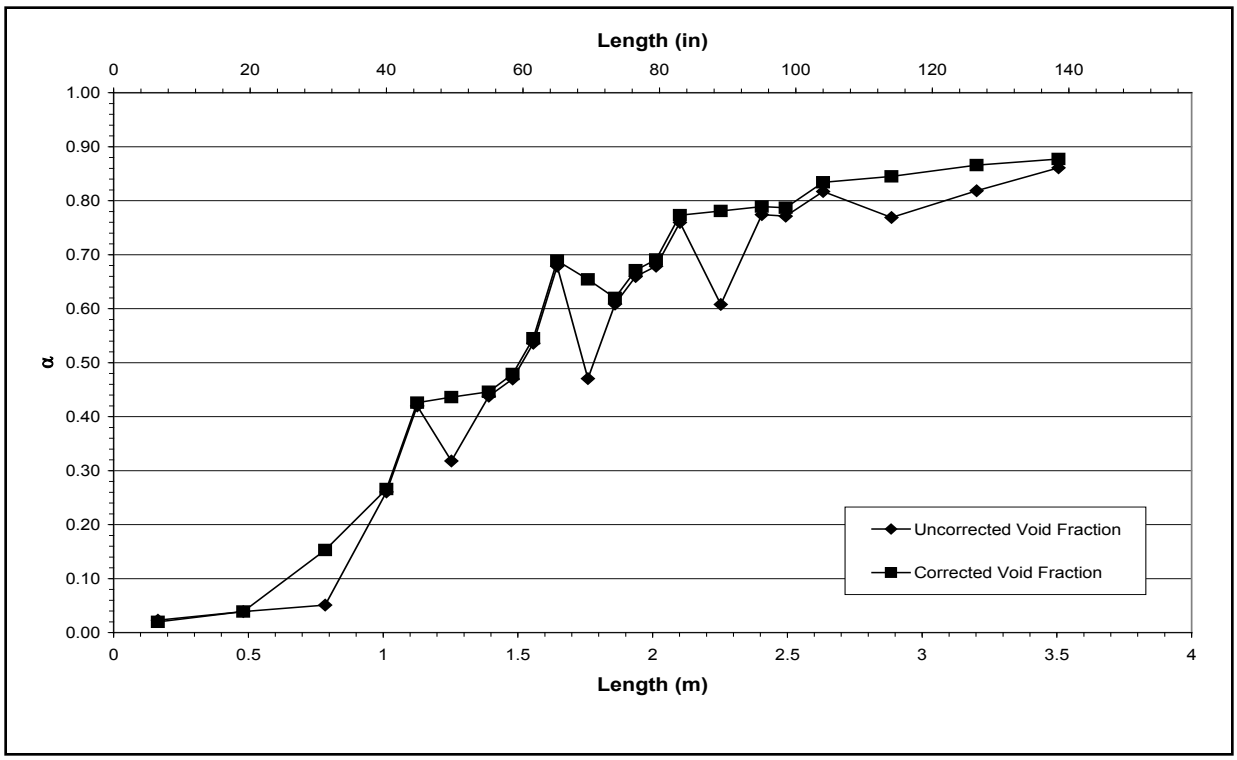

Figure A-540 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655J for Time Period 3670 to 3810 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-K

Test Conditions

Date: 7/7/2003
Steady-state time window: 4490 – 4530 seconds
Inlet flow rate: 1.524 cm/sec (0.600 in./sec)
Inlet mass flow rate: 0.072 kg/sec (0.159 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

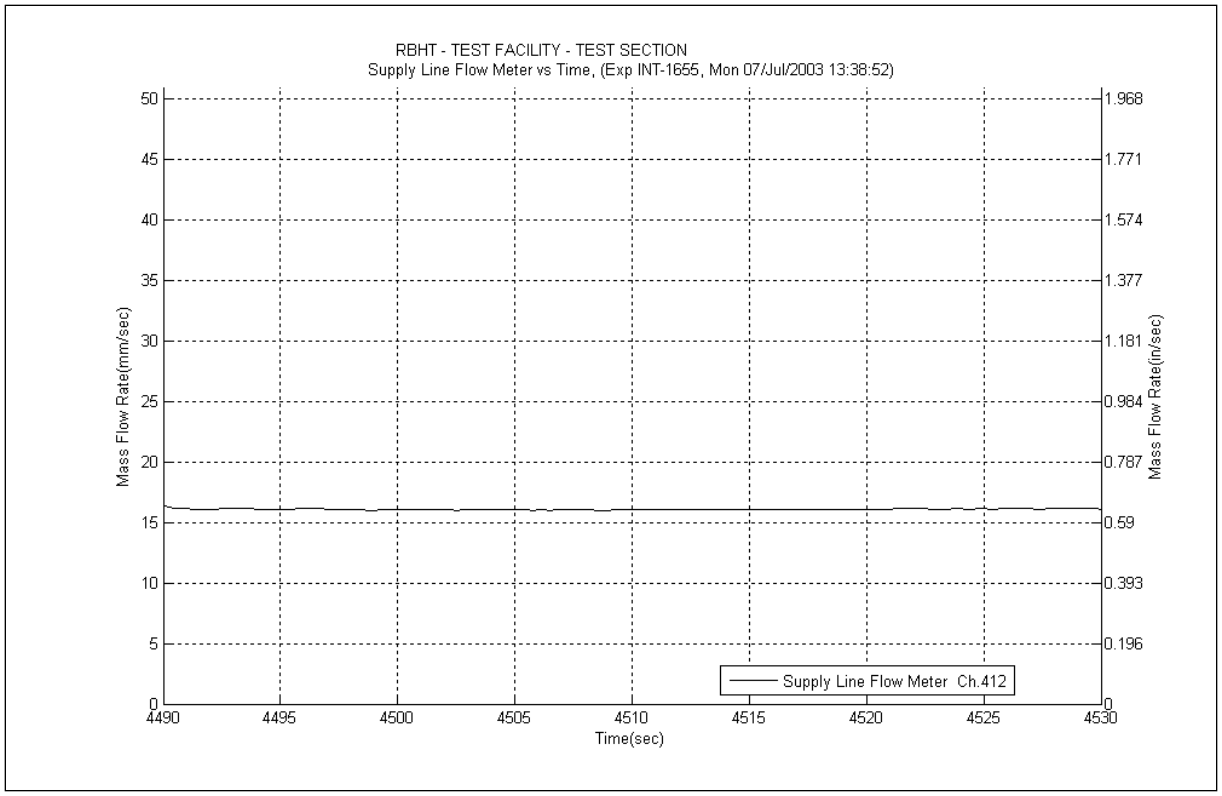

Figure A-541 Inlet Flow Plot for Experiment 1655K

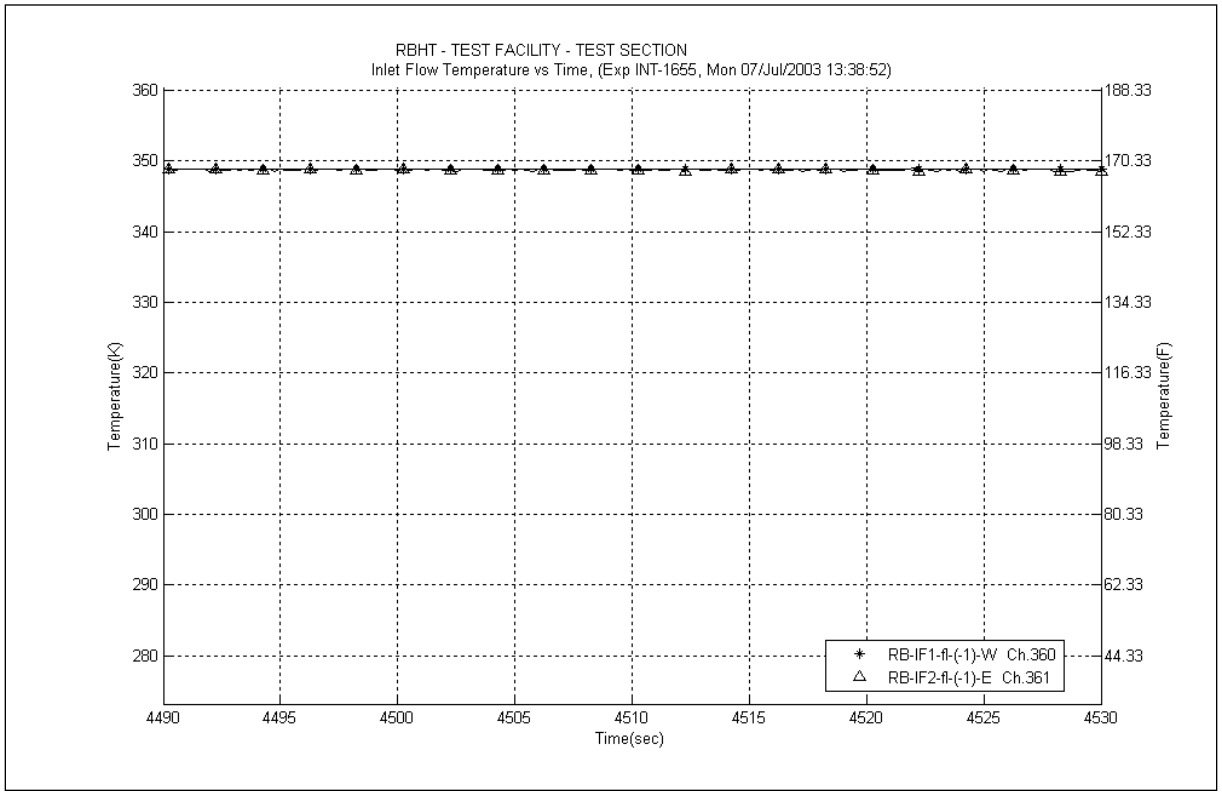

Figure A-542 Inlet Temperature Plot for Experiment 1655K

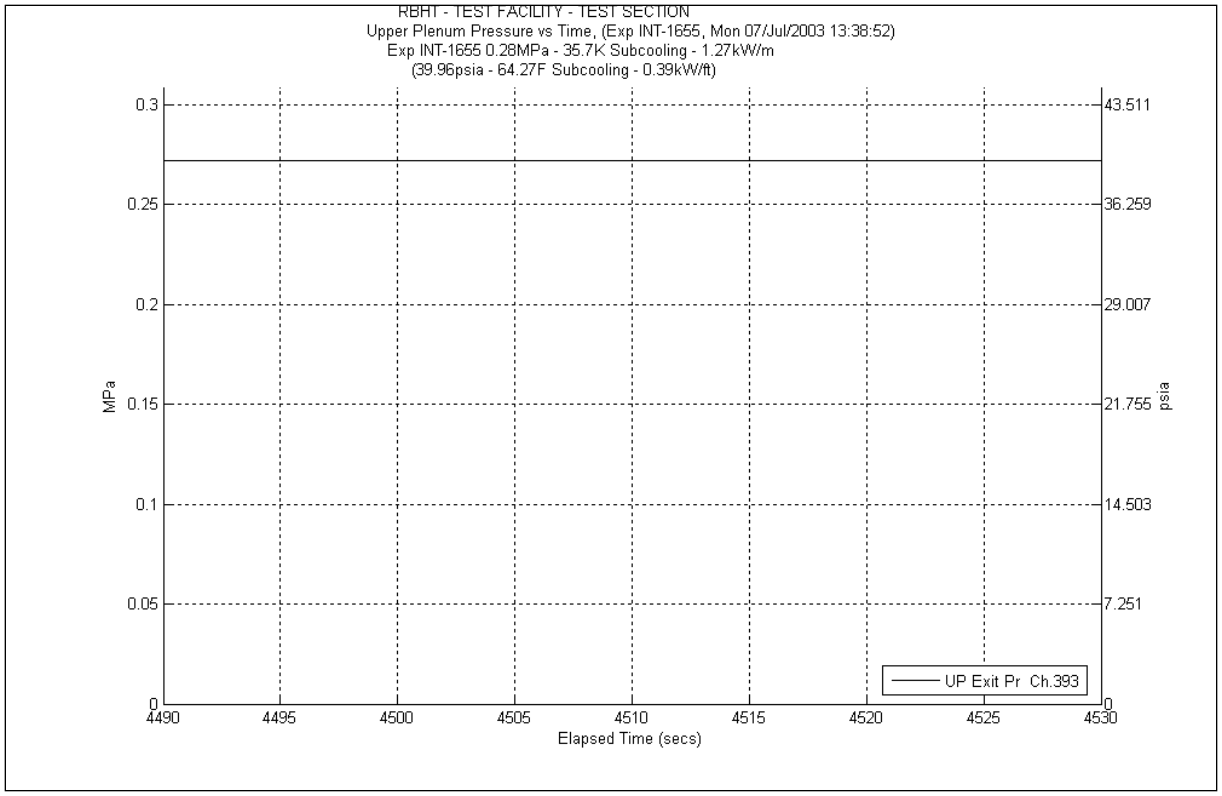

Figure A-543 System Pressure Plot for Experiment 1655K

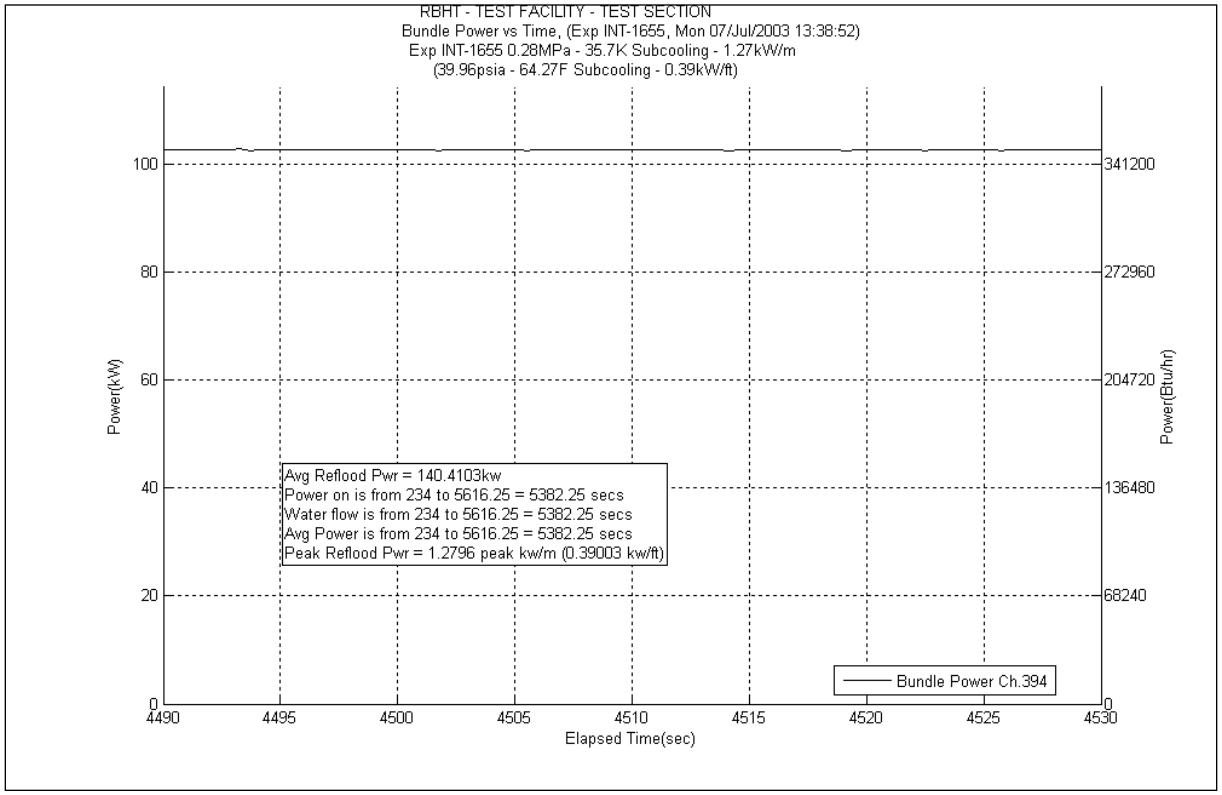

Figure A-544 Bundle Power Plot for Experiment 1655K

Table A-217 Data Results for RBHT Test 1655 for Time Period 4370 to 4700

Results for RBHT Test 1655
Valid Time Period 4370 to 4700 seconds
Collapsed Liquid Level = 65.766 inches = 1670.46 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.896	5.957	285.211	0.569	27.244	0.137	6.560	0.000	0.000	5.246	251.180	5765.246	276041.4601	0.908	0.903	0.913
*	120-133	3048-3378	383	0.858	9.592	459.271	0.629	30.117	0.245	11.731	1.762	84.369	6.956	333.055	5772.202	276374.5152	0.897	0.893	0.901
*	108-120	2743-3048	382	0.805	12.184	583.352	0.519	24.850	0.306	14.651	3.543	169.618	7.816	374.232	5780.018	276748.7473	0.875	0.871	0.879
	100-108	2540-2743	381	0.851	6.206	297.146	0.305	14.603	0.224	10.725	0.000	0.000	5.676	271.768	5785.694	277020.5156	0.863	0.859	0.867
	97-100	2464-2540	380	0.805	3.043	145.714	0.105	5.027	0.081	3.878	0.000	0.000	2.858	136.842	5788.552	277157.3574	0.817	0.813	0.821
	93-97	2362-2464	379	0.804	4.077	195.197	0.133	6.368	0.106	5.075	0.000	0.000	3.839	183.812	5792.391	277341.1697	0.815	0.811	0.819
*	85-93	2159-2362	378	0.656	14.287	684.058	0.242	11.587	0.203	9.720	5.776	276.549	8.066	386.202	5800.457	277727.3719	0.806	0.802	0.810
	81-85	2057-2159	377	0.787	4.435	212.354	0.109	5.219	0.097	4.644	0.000	0.000	4.227	202.390	5804.684	277929.7617	0.797	0.793	0.801
	78-81	1981-2057	376	0.720	4.362	208.873	0.077	3.687	0.071	3.399	0.000	0.000	4.213	201.720	5808.897	278131.4812	0.73	0.726	0.734
	75-78	1905-1981	375	0.698	4.705	225.284	0.073	3.495	0.069	3.304	0.000	0.000	4.564	218.525	5813.461	278350.0067	0.707	0.703	0.711
	72-75	1829-1905	374	0.653	5.411	259.102	0.069	3.304	0.068	3.256	0.000	0.000	5.273	252.473	5818.734	278602.4793	0.661	0.658	0.664
*	67-72	1702-1829	373	0.498	13.040	624.380	0.106	5.075	0.109	5.219	4.792	229.464	8.033	384.622	5826.767	278987.1014	0.691	0.688	0.694
	63-67	1600-1702	372	0.712	5.988	286.703	0.077	3.687	0.084	4.022	0.000	0.000	5.822	278.759	5832.589	279265.8603	0.72	0.716	0.724
	60-63	1524-1600	371	0.607	6.128	293.416	0.053	2.538	0.061	2.921	0.000	0.000	6.012	287.856	5838.601	279553.7164	0.614	0.611	0.617
	57-60	1448-1524	370	0.537	7.219	345.635	0.049	2.346	0.060	2.873	0.000	0.000	7.108	340.333	5845.709	279894.0493	0.544	0.541	0.547
	53-57	1346-1448	369	0.493	10.542	504.776	0.060	2.873	0.077	3.687	0.000	0.000	10.4	497.955	5856.109	280392.0039	0.499	0.497	0.501
*	46-53	1168-1346	368	0.358	23.354	1118.215	0.088	4.213	0.128	6.129	5.058	242.198	18.08	865.675	5874.189	281257.679	0.502	0.499	0.505
	43-46	1092-1168	367	0.500	7.785	372.738	0.031	1.484	0.052	2.490	0.000	0.000	7.696	368.486	5881.885	281626.1654	0.506	0.503	0.509
	37-43	940-1092	366	0.440	17.465	836.237	0.051	2.442	0.100	4.788	0.000	0.000	17.31	828.807	5899.195	282454.9727	0.444	0.442	0.446
*	25-37	635-940	365	0.169	51.809	2480.612	0.054	2.586	0.156	7.469	4.549	217.791	47.05	2252.766	5946.245	284707.7388	0.245	0.244	0.246
	13-25	330-635	364	0.045	59.516	2849.620	0.001	0.048	0.000	0.000	0.000	0.000	59.49	2848.396	6005.735	287556.1353	0.045	0.043	0.047
*	0-13	0-330	363	0.025	65.846	3152.734	0.002	0.096	0.000	0.000	-0.126	-6.022	65.97	3158.661	6071.705	290714.7958	0.023	0.022	0.024

Table A-218 Energy Balance Results for RBHT Test 1655K for Time Period 4370 to 4700 seconds

Results for RBHT Test 1655
Valid Time Period 4370 to 4700 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4655.4693	14.686	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
0.25	6.35	4914.1065	15.502	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
0.50	12.70	5172.7437	16.318	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
0.75	19.05	5431.3808	17.134	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
1.00	25.40	5690.018	17.95	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
1.25	31.75	5948.6552	18.765	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
1.50	38.10	6207.2924	19.581	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
1.75	44.45	6465.9296	20.397	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
2.00	50.80	6724.5668	21.213	0.00E+00	0.00E+00	0.00E+00	5.19E-02	2.35E-02
2.25	57.15	6983.2039	22.029	1.10E-03	3.49E-02	1.58E-02	5.18E-02	2.35E-02
2.50	63.50	7241.8411	22.845	1.58E-02	5.01E-01	2.27E-01	5.11E-02	2.32E-02
2.75	69.85	7500.4783	23.661	3.11E-02	9.84E-01	4.46E-01	5.03E-02	2.28E-02
3.00	76.20	7759.1155	24.477	4.68E-02	1.48E+00	6.73E-01	4.95E-02	2.24E-02
3.25	82.55	8017.7527	25.293	6.32E-02	2.00E+00	9.08E-01	4.86E-02	2.20E-02
3.50	88.90	8276.3899	26.108	8.00E-02	2.53E+00	1.15E+00	4.77E-02	2.17E-02
3.75	95.25	8535.027	26.924	9.74E-02	3.09E+00	1.40E+00	4.68E-02	2.12E-02
4.00	101.60	8793.6642	27.74	1.15E-01	3.65E+00	1.66E+00	4.59E-02	2.08E-02
4.25	107.95	9052.3014	28.556	1.34E-01	4.24E+00	1.92E+00	4.49E-02	2.04E-02
4.50	114.30	9310.9386	29.372	1.53E-01	4.84E+00	2.19E+00	4.40E-02	1.99E-02
4.75	120.65	9569.5758	30.188	1.72E-01	5.46E+00	2.48E+00	4.29E-02	1.95E-02
5.00	127.00	9828.213	31.004	1.92E-01	6.09E+00	2.76E+00	4.19E-02	1.90E-02
5.25	133.35	10086.85	31.82	2.13E-01	6.75E+00	3.06E+00	4.08E-02	1.85E-02
5.50	139.70	10345.487	32.636	2.34E-01	7.42E+00	3.36E+00	3.97E-02	1.80E-02
5.75	146.05	10604.125	33.451	2.56E-01	8.10E+00	3.68E+00	3.86E-02	1.75E-02
6.00	152.40	10862.762	34.267	2.78E-01	8.81E+00	3.99E+00	3.75E-02	1.70E-02
6.25	158.75	11121.399	35.083	3.01E-01	9.53E+00	4.32E+00	3.63E-02	1.65E-02
6.50	165.10	11380.036	35.899	3.24E-01	1.03E+01	4.66E+00	3.51E-02	1.59E-02
6.75	171.45	11638.673	36.715	3.48E-01	1.10E+01	5.00E+00	3.38E-02	1.54E-02
7.00	177.80	11897.31	37.531	3.72E-01	1.18E+01	5.35E+00	3.26E-02	1.48E-02
7.25	184.15	12155.948	38.347	3.97E-01	1.26E+01	5.71E+00	3.13E-02	1.42E-02
7.50	190.50	12414.585	39.163	4.22E-01	1.34E+01	6.07E+00	3.00E-02	1.36E-02
7.75	196.85	12673.222	39.979	4.48E-01	1.42E+01	6.44E+00	2.86E-02	1.30E-02
8.00	203.20	12931.859	40.794	4.75E-01	1.50E+01	6.82E+00	2.73E-02	1.24E-02
8.25	209.55	13190.496	41.61	5.02E-01	1.59E+01	7.21E+00	2.59E-02	1.17E-02
8.50	215.90	13449.134	42.426	5.29E-01	1.68E+01	7.61E+00	2.44E-02	1.11E-02
8.75	222.25	13707.771	43.242	5.57E-01	1.77E+01	8.01E+00	2.30E-02	1.04E-02
9.00	228.60	13966.408	44.058	5.86E-01	1.86E+01	8.42E+00	2.15E-02	9.74E-03
9.25	234.95	13190.496	41.61	6.14E-01	1.95E+01	8.83E+00	2.00E-02	9.08E-03
9.50	241.30	12414.585	39.163	6.41E-01	2.03E+01	9.21E+00	1.87E-02	8.46E-03
9.75	247.65	11638.673	36.715	6.65E-01	2.11E+01	9.56E+00	1.74E-02	7.87E-03
10.00	254.00	10862.762	34.267	6.89E-01	2.18E+01	9.90E+00	1.62E-02	7.33E-03
10.25	260.35	10086.85	31.82	7.10E-01	2.25E+01	1.02E+01	1.50E-02	6.82E-03
10.50	266.70	9310.9386	29.372	7.30E-01	2.31E+01	1.05E+01	1.40E-02	6.34E-03
10.75	273.05	8535.027	26.924	7.49E-01	2.37E+01	1.08E+01	1.30E-02	5.91E-03
11.00	279.40	7759.1155	24.477	7.66E-01	2.43E+01	1.10E+01	1.22E-02	5.51E-03
11.25	285.75	6983.2039	22.029	7.81E-01	2.47E+01	1.12E+01	1.14E-02	5.16E-03
11.50	292.10	6207.2924	19.581	7.95E-01	2.52E+01	1.14E+01	1.07E-02	4.83E-03
11.75	298.45	5431.3808	17.134	8.07E-01	2.56E+01	1.16E+01	1.00E-02	4.55E-03
12.00	304.80	4655.4693	14.686	8.17E-01	2.59E+01	1.17E+01	9.49E-03	4.31E-03

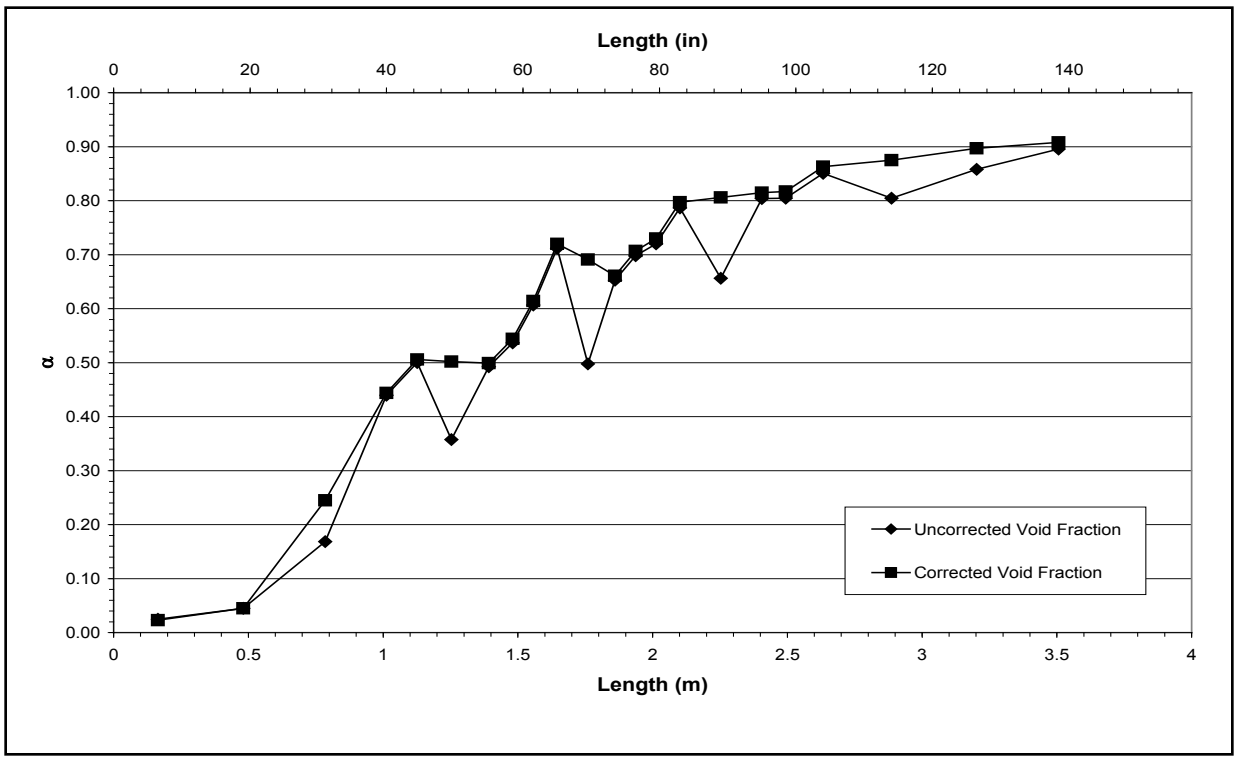

Figure A-545 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655K for Time Period 4370 to 4700 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1655-L

Test Conditions

Date: 7/7/2003
Steady-state time window: 5205 – 5539 seconds
Inlet flow rate: 1.016 cm/sec (0.400 in./sec)
Inlet mass flow rate: 0.048 kg/sec (0.106 lbm/sec)
Inlet flow temperature: 348.3 K (167.3 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.29 kW

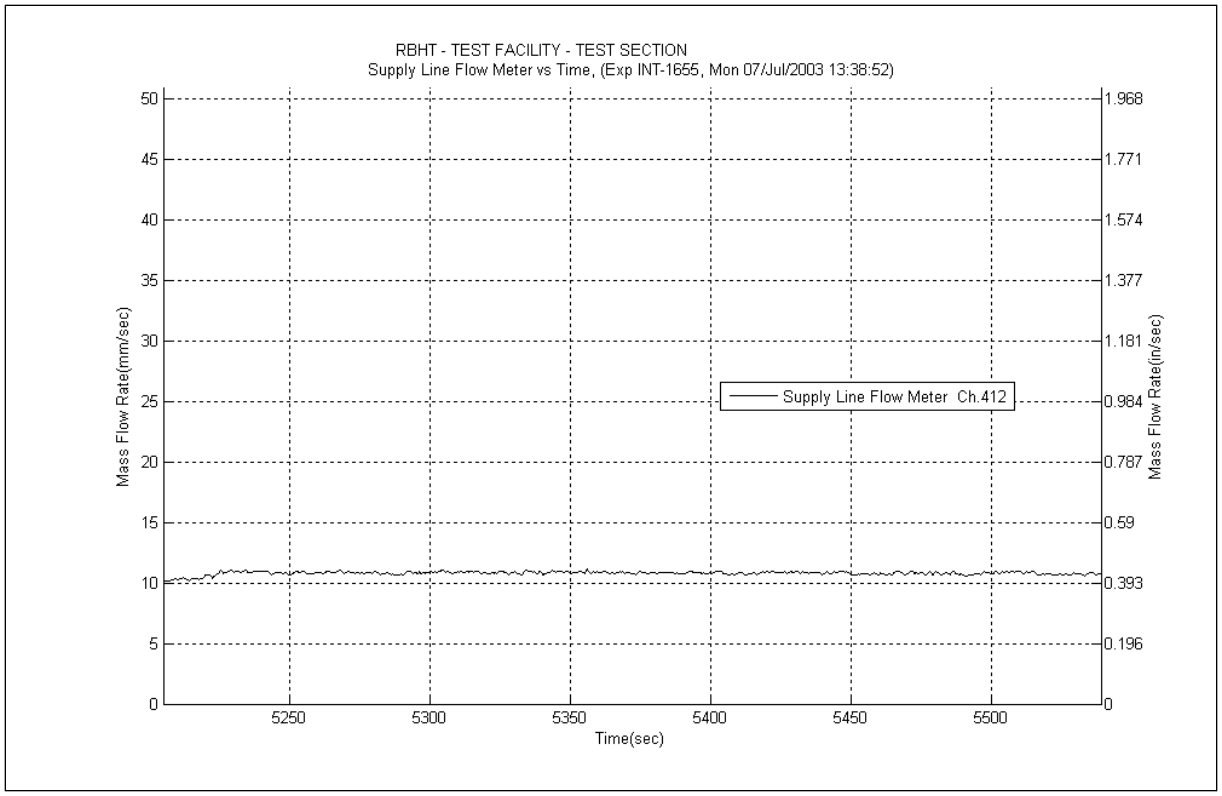

Figure A-546 Inlet Flow Plot for Experiment 1655L

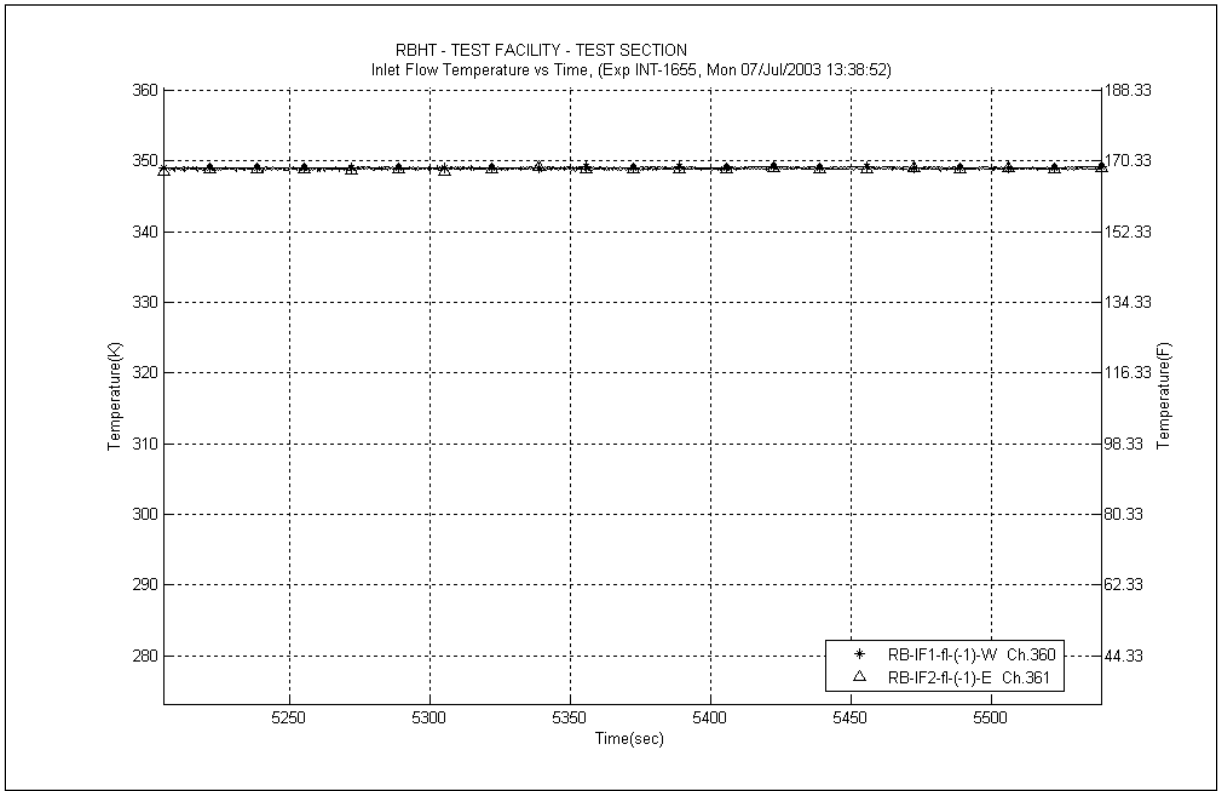

Figure A-547 Inlet Temperature Plot for Experiment 1655L

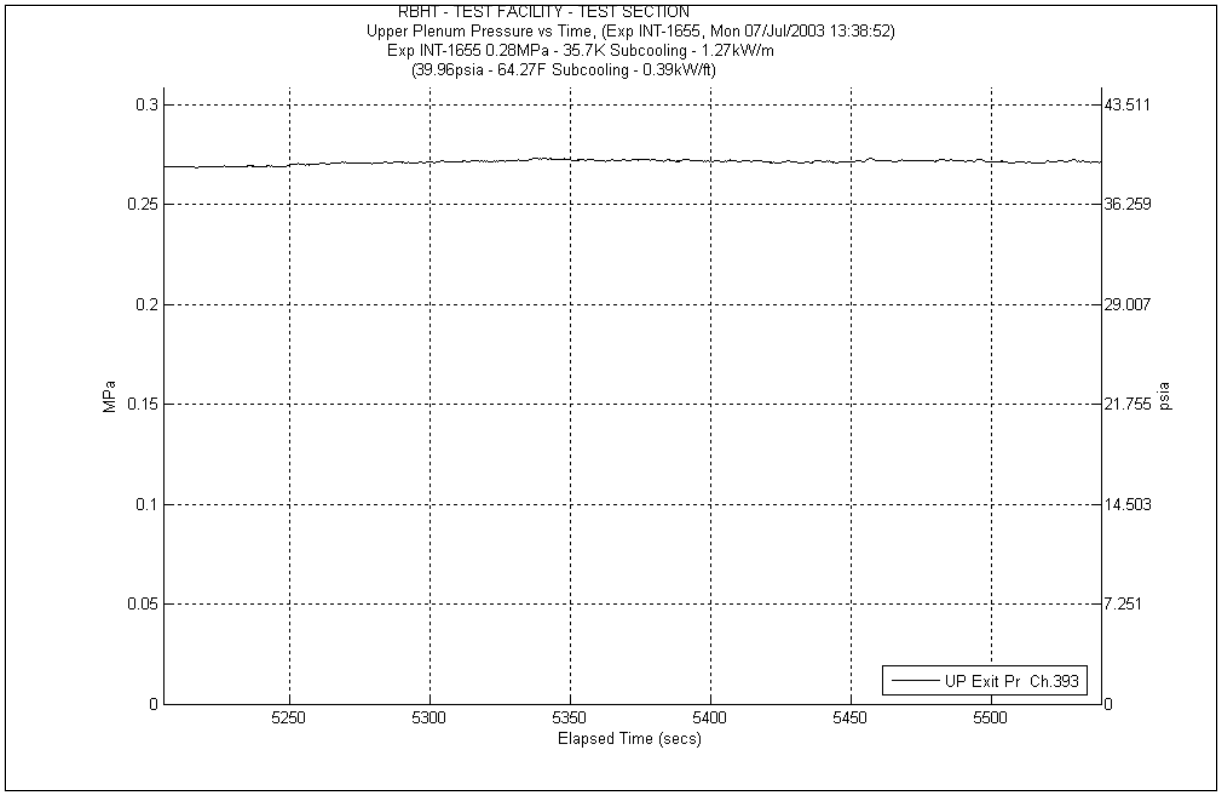

Figure A-548 System Pressure Plot for Experiment 1655L

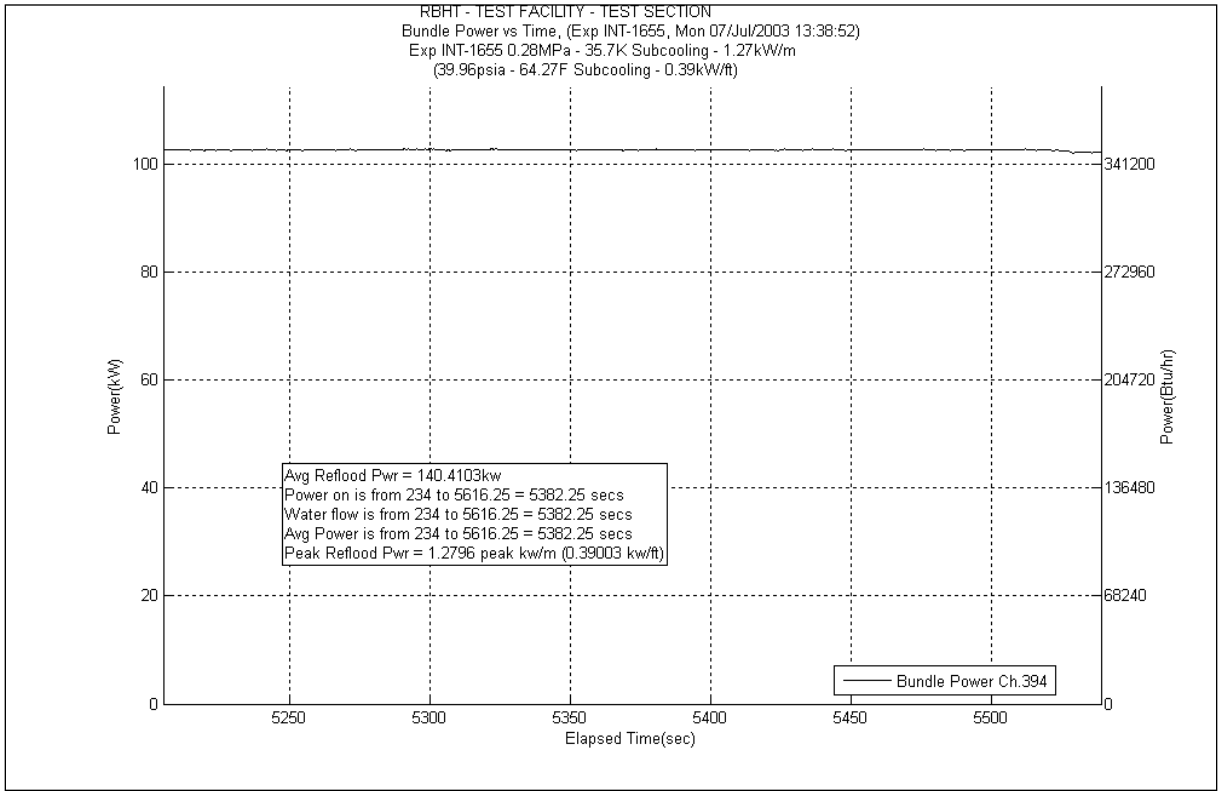

Figure A-549 Bundle Power Plot for Experiment 1655L

Table A-219 Data Results for RBHT Test 1655 for Time Period 5205 to 5539

Results for RBHT Test 1655
Valid Time Period 5205 to 5539 seconds
Collapsed Liquid Level = 55.112 inches = 1399.84 mm
(Z_{osv}) Onset of Significant Void = 6.5 inches = 165 mm
($Z_{2\phi}$) Two-Phase Level (Dryout) = 114.90 inches = 2918.46 mm
(S) Level Swell = 2.646

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.967	1.890	90.512	0.177	8.475	0.000	0.000	0.000	0.000	1.713	82.019	5761.713	275872.2992	0.97	0.965	0.975
*	120-133	3048-3378	383	0.943	3.879	185.748	0.209	10.007	0.000	0.000	0.791	37.893	2.879	137.847	5764.592	276010.1465	0.957	0.952	0.962
*	108-120	2743-3048	382	0.896	6.512	311.817	0.307	14.699	0.090	4.309	1.880	90.036	4.235	202.773	5768.827	276212.9193	0.932	0.927	0.937
	100-108	2540-2743	381	0.911	3.708	177.542	0.205	9.815	0.151	7.230	0.000	0.000	3.349	160.351	5772.176	276373.2703	0.919	0.914	0.924
	97-100	2464-2540	380	0.851	2.321	111.150	0.073	3.495	0.055	2.633	0.000	0.000	2.193	105.001	5774.369	276478.2717	0.859	0.855	0.863
	93-97	2362-2464	379	0.839	3.339	159.887	0.092	4.405	0.071	3.399	0.000	0.000	3.176	152.068	5777.545	276630.3394	0.847	0.843	0.851
*	85-93	2159-2362	378	0.718	11.701	560.226	0.170	8.140	0.136	6.512	4.579	219.223	6.816	326.352	5784.361	276956.6913	0.836	0.832	0.840
	81-85	2057-2159	377	0.818	3.786	181.272	0.077	3.687	0.065	3.112	0.000	0.000	3.64	174.284	5788.001	277130.9754	0.825	0.821	0.829
	78-81	1981-2057	376	0.762	3.713	177.790	0.054	2.586	0.048	2.298	0.000	0.000	3.609	172.800	5791.61	277303.7752	0.768	0.764	0.772
	75-78	1905-1981	375	0.733	4.165	199.424	0.052	2.490	0.047	2.250	0.000	0.000	4.063	194.537	5795.673	277498.3127	0.739	0.735	0.743
	72-75	1829-1905	374	0.696	4.731	226.527	0.049	2.346	0.046	2.202	0.000	0.000	4.633	221.829	5800.306	277720.142	0.703	0.699	0.707
*	67-72	1702-1829	373	0.543	11.872	568.432	0.075	3.591	0.074	3.543	4.041	193.482	7.682	367.816	5807.988	278087.9581	0.704	0.700	0.708
	63-67	1600-1702	372	0.700	6.227	298.141	0.055	2.633	0.057	2.729	0.000	0.000	6.114	292.740	5814.102	278380.698	0.706	0.702	0.710
	60-63	1524-1600	371	0.629	5.780	276.756	0.038	1.819	0.041	1.963	0.000	0.000	5.7	272.917	5819.802	278653.6154	0.634	0.631	0.637
	57-60	1448-1524	370	0.593	6.336	303.363	0.036	1.724	0.040	1.915	0.000	0.000	6.258	299.635	5826.06	278953.2501	0.598	0.595	0.601
	53-57	1346-1448	369	0.518	10.018	479.661	0.044	2.107	0.052	2.490	0.000	0.000	9.92	474.972	5835.98	279428.2222	0.522	0.519	0.525
*	46-53	1168-1346	368	0.385	22.347	1069.975	0.067	3.208	0.086	4.118	5.004	239.588	17.19	823.062	5853.17	280251.2839	0.527	0.524	0.530
	43-46	1092-1168	367	0.528	7.354	352.100	0.025	1.197	0.035	1.676	0.000	0.000	7.292	349.143	5860.462	280600.4267	0.532	0.529	0.535
	37-43	940-1092	366	0.502	15.518	742.990	0.042	2.011	0.067	3.208	0.000	0.000	15.41	737.835	5875.872	281338.2615	0.505	0.502	0.508
*	25-37	635-940	365	0.305	43.292	2072.813	0.057	2.729	0.122	5.841	0.513	24.543	42.6	2039.699	5918.472	283377.9604	0.316	0.314	0.318
	13-25	330-635	364	0.126	54.488	2608.919	0.022	1.053	0.056	2.681	0.000	0.000	54.39	2604.207	5972.862	285982.1676	0.127	0.126	0.128
*	0-13	0-330	363	0.028	65.618	3141.794	0.001	0.048	0.000	0.000	2.407	115.235	63.21	3026.511	6036.072	289008.6786	0.063	0.060	0.066

Table A-220 Energy Balance Results for RBHT Test 1655L for Time Period 5205 to 5539 seconds

Results for RBHT Test 1655
Valid Time Period 5205 to 5539 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4656.074	14.688	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
0.25	6.35	4914.7448	15.504	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
0.50	12.70	5173.4155	16.32	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
0.75	19.05	5432.0863	17.136	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
1.00	25.40	5690.7571	17.952	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
1.25	31.75	5949.4279	18.768	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
1.50	38.10	6208.0986	19.584	0.00E+00	0.00E+00	0.00E+00	3.46E-02	1.57E-02
1.75	44.45	6466.7694	20.4	1.45E-02	3.09E-01	1.40E-01	3.41E-02	1.55E-02
2.00	50.80	6725.4402	21.216	3.50E-02	7.45E-01	3.38E-01	3.34E-02	1.51E-02
2.25	57.15	6984.111	22.032	5.62E-02	1.20E+00	5.44E-01	3.26E-02	1.48E-02
2.50	63.50	7242.7818	22.848	7.83E-02	1.67E+00	7.57E-01	3.19E-02	1.45E-02
2.75	69.85	7501.4525	23.664	1.01E-01	2.16E+00	9.78E-01	3.11E-02	1.41E-02
3.00	76.20	7760.1233	24.48	1.25E-01	2.66E+00	1.21E+00	3.03E-02	1.37E-02
3.25	82.55	8018.7941	25.296	1.49E-01	3.18E+00	1.44E+00	2.94E-02	1.33E-02
3.50	88.90	8277.4649	26.112	1.75E-01	3.72E+00	1.69E+00	2.86E-02	1.30E-02
3.75	95.25	8536.1356	26.928	2.01E-01	4.28E+00	1.94E+00	2.77E-02	1.25E-02
4.00	101.60	8794.8064	27.744	2.27E-01	4.85E+00	2.20E+00	2.67E-02	1.21E-02
4.25	107.95	9053.4772	28.56	2.55E-01	5.44E+00	2.47E+00	2.58E-02	1.17E-02
4.50	114.30	9312.148	29.376	2.84E-01	6.05E+00	2.74E+00	2.48E-02	1.12E-02
4.75	120.65	9570.8187	30.192	3.13E-01	6.67E+00	3.03E+00	2.38E-02	1.08E-02
5.00	127.00	9829.4895	31.008	3.43E-01	7.31E+00	3.32E+00	2.27E-02	1.03E-02
5.25	133.35	10088.16	31.824	3.74E-01	7.97E+00	3.61E+00	2.17E-02	9.83E-03
5.50	139.70	10346.831	32.64	4.05E-01	8.65E+00	3.92E+00	2.06E-02	9.33E-03
5.75	146.05	10605.502	33.456	4.38E-01	9.34E+00	4.24E+00	1.94E-02	8.82E-03
6.00	152.40	10864.173	34.272	4.71E-01	1.00E+01	4.56E+00	1.83E-02	8.30E-03
6.25	158.75	11122.843	35.088	5.05E-01	1.08E+01	4.89E+00	1.71E-02	7.76E-03
6.50	165.10	11381.514	35.904	5.40E-01	1.15E+01	5.22E+00	1.59E-02	7.22E-03
6.75	171.45	11640.185	36.72	5.76E-01	1.23E+01	5.57E+00	1.47E-02	6.66E-03
7.00	177.80	11898.856	37.536	6.12E-01	1.31E+01	5.92E+00	1.34E-02	6.08E-03
7.25	184.15	12157.527	38.352	6.50E-01	1.39E+01	6.28E+00	1.21E-02	5.50E-03
7.50	190.50	12416.197	39.168	6.88E-01	1.47E+01	6.65E+00	1.08E-02	4.90E-03
7.75	196.85	12674.868	39.984	7.27E-01	1.55E+01	7.03E+00	9.46E-03	4.29E-03
8.00	203.20	12933.539	40.8	7.66E-01	1.63E+01	7.41E+00	8.09E-03	3.67E-03
8.25	209.55	13192.21	41.616	8.07E-01	1.72E+01	7.80E+00	6.69E-03	3.03E-03
8.50	215.90	13450.88	42.432	8.48E-01	1.81E+01	8.20E+00	5.26E-03	2.38E-03
8.75	222.25	13709.551	43.248	8.90E-01	1.90E+01	8.61E+00	3.80E-03	1.72E-03
9.00	228.60	13968.222	44.064	9.33E-01	1.99E+01	9.03E+00	2.32E-03	1.05E-03
9.25	234.95	13192.21	41.616	9.75E-01	2.08E+01	9.43E+00	8.61E-04	3.91E-04
9.50	241.30	12416.197	39.168	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
9.75	247.65	11640.185	36.72	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
10.00	254.00	10864.173	34.272	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
10.25	260.35	10088.16	31.824	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
10.50	266.70	9312.148	29.376	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
10.75	273.05	8536.1356	26.928	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
11.00	279.40	7760.1233	24.48	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
11.25	285.75	6984.111	22.032	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
11.50	292.10	6208.0986	19.584	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
11.75	298.45	5432.0863	17.136	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00
12.00	304.80	4656.074	14.688	1.00E+00	2.13E+01	9.67E+00	0.00E+00	0.00E+00

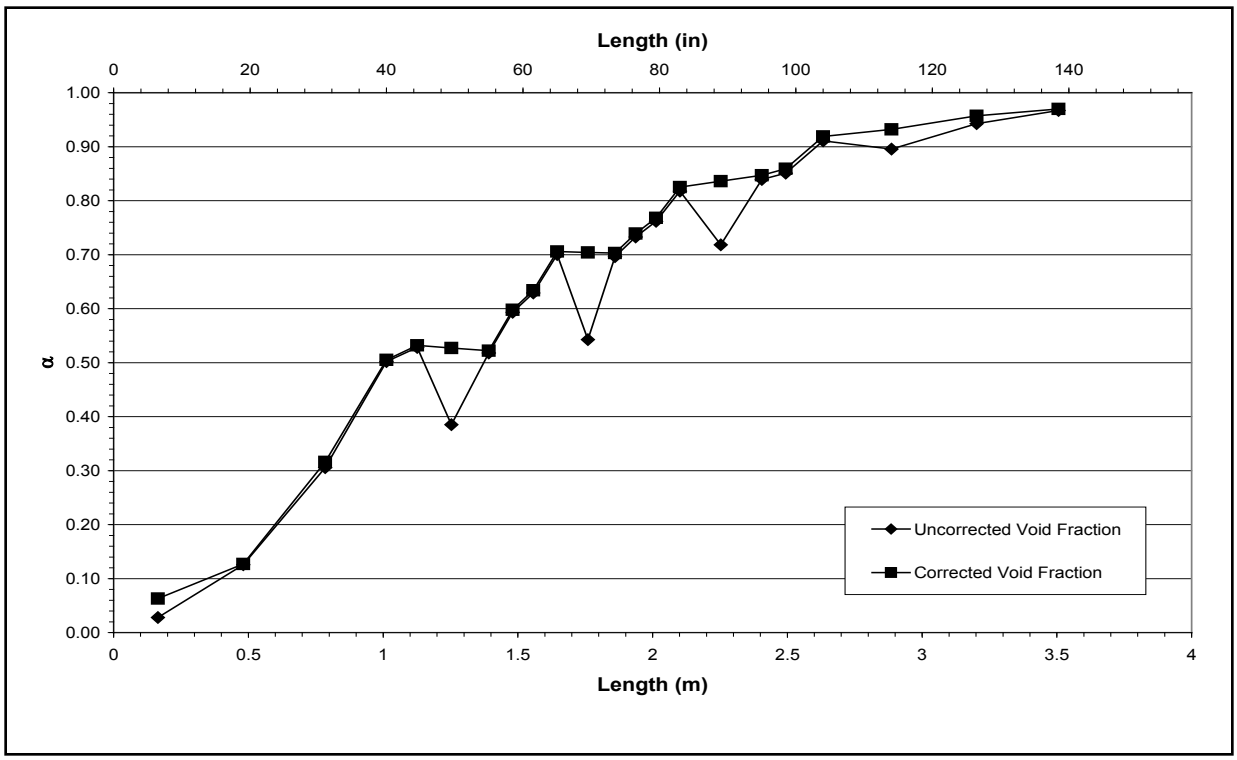

Figure A-550 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1655L for Time Period 5205 to 5539 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-A

Test Conditions

Date: 7/9/2003
Steady-state time window: 1950 – 2040 seconds
Inlet flow rate: 3.045 cm/sec (1.199 in./sec)
Inlet mass flow rate: 0.142 kg/sec (0.314 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

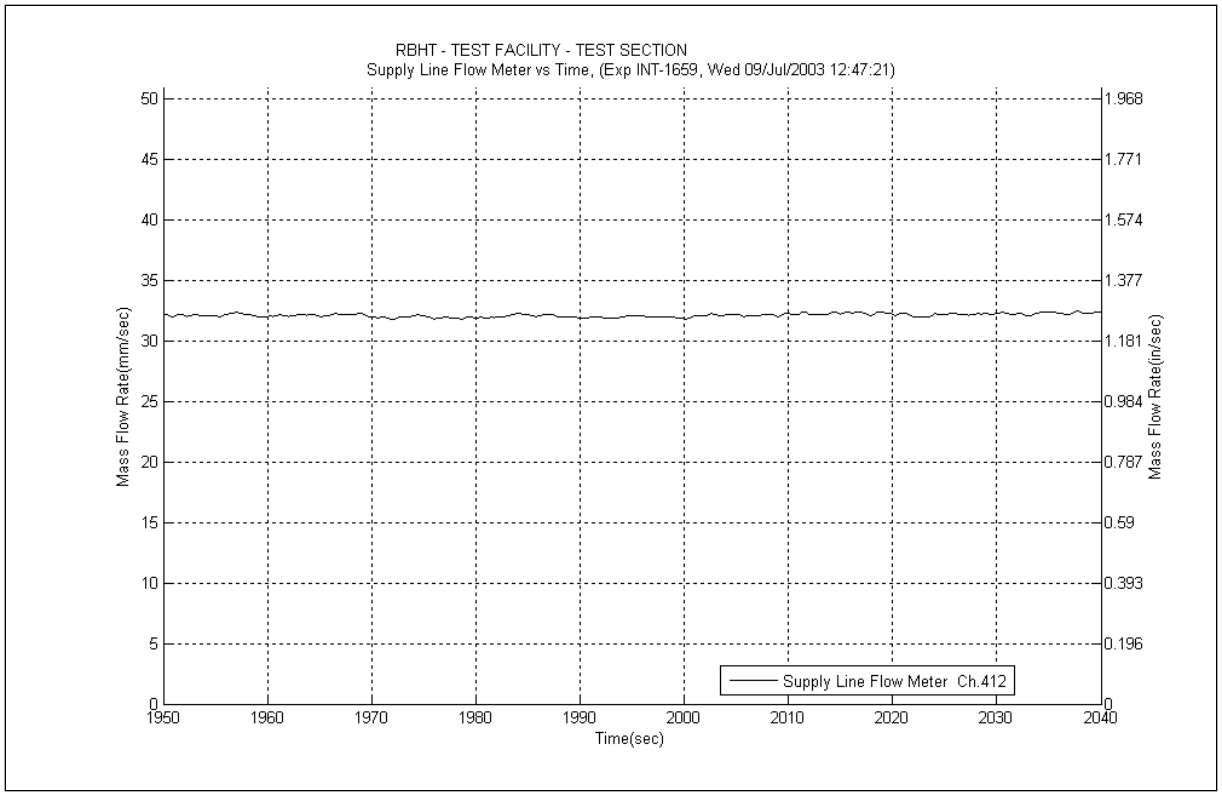

Figure A-551 Inlet Flow Plot for Experiment 1659A

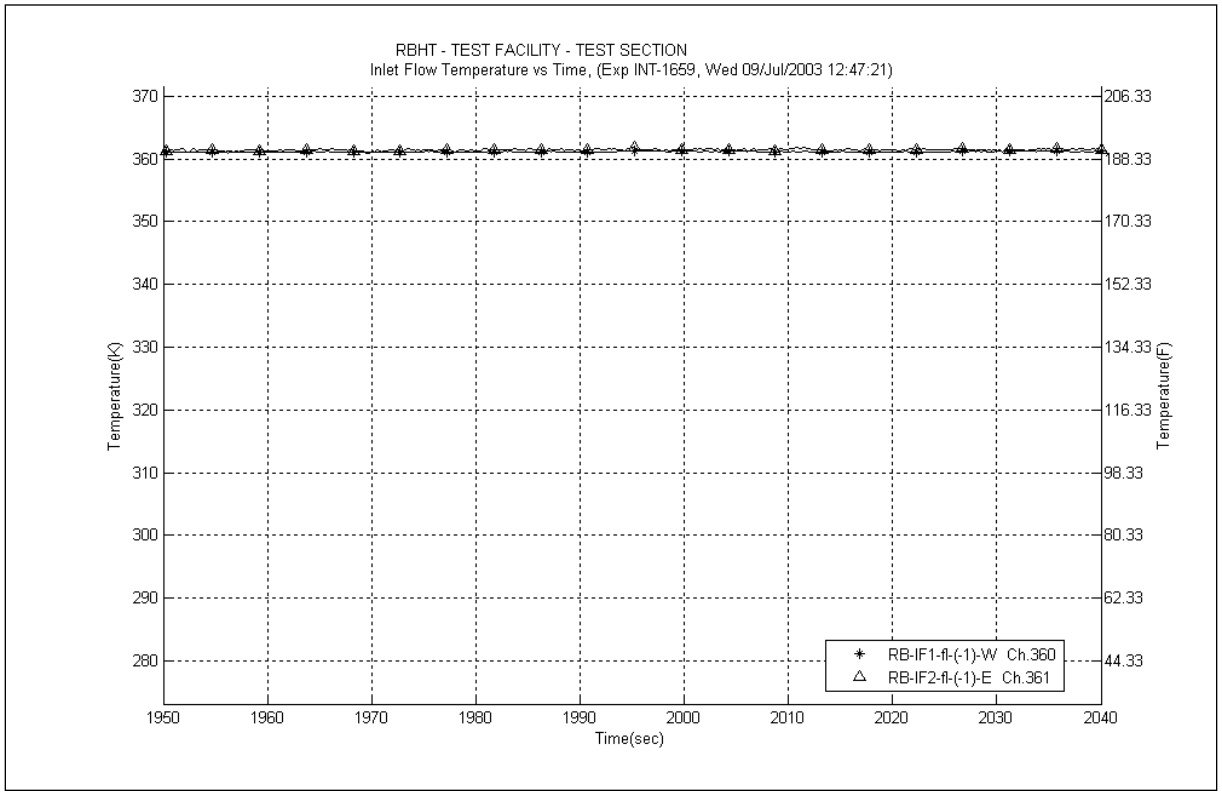

Figure A-552 Inlet Temperature Plot for Experiment 1659A

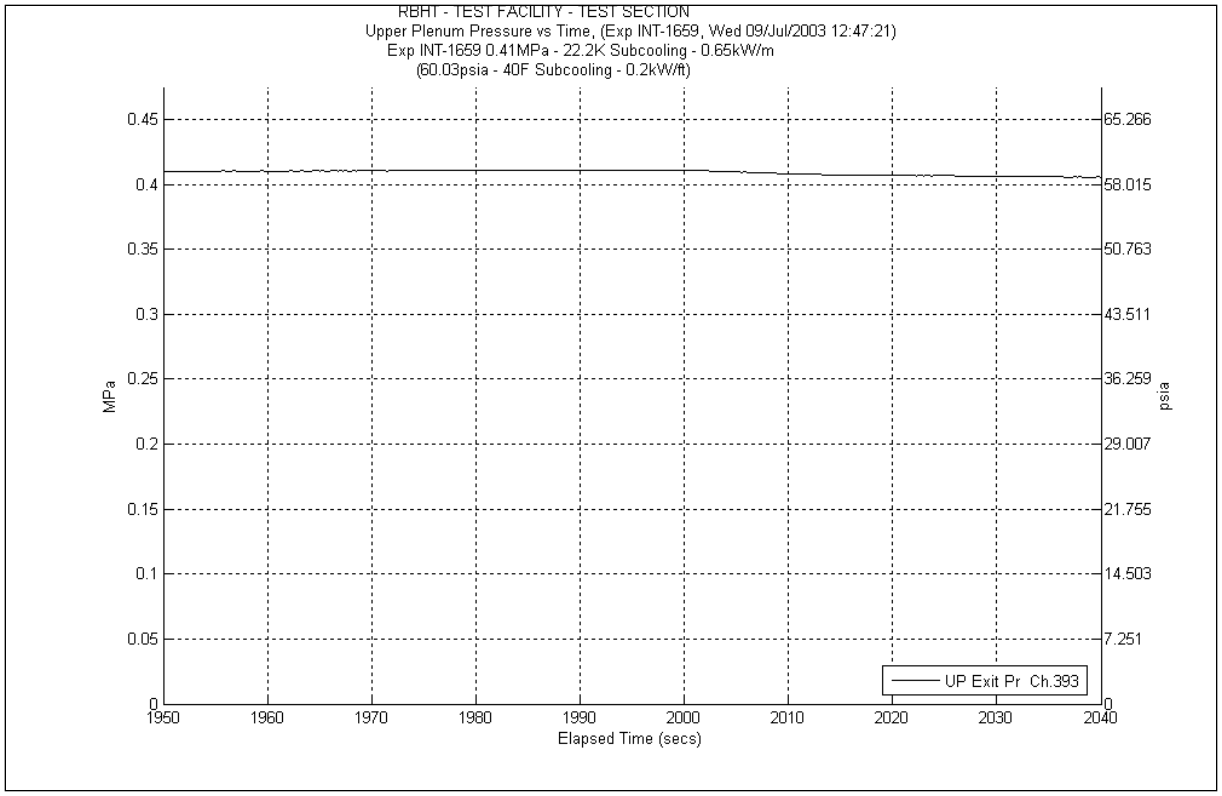

Figure A-553 System Pressure Plot for Experiment 1659A

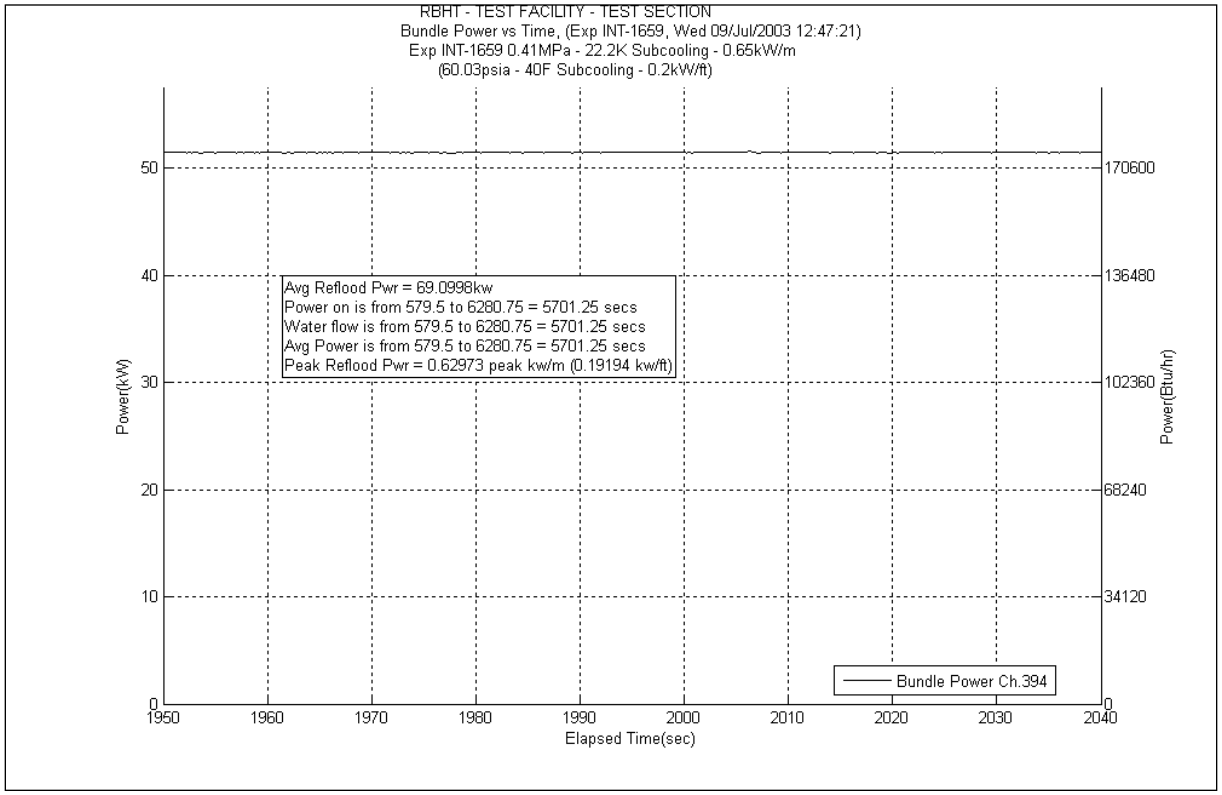

Figure A-554 Bundle Power Plot for Experiment 1659A

Table A-221 Data Results for RBHT Test 1659 for Time Period 1950 to 2040

Results for RBHT Test 1659
Valid Time Period 1950 to 2040 seconds
Collapsed Liquid Level = 117.234 inches = 2977.74 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.434	32.318	1547.399	0.362	17.333	0.095	4.549	0.000	0.000	31.85	1524.986	8671.85	415210.4067	0.442	0.440	0.444
*	120-133	3048-3378	383	0.499	33.855	1621.001	0.387	18.530	0.170	8.140	-5.132	-245.706	38.43	1840.038	8710.28	417050.4449	0.431	0.429	0.433
*	108-120	2743-3048	382	0.405	37.065	1774.672	0.300	14.364	0.212	10.151	-0.377	-18.061	36.93	1768.218	8747.21	418818.6628	0.407	0.405	0.409
	100-108	2540-2743	381	0.388	25.427	1217.429	0.160	7.661	0.155	7.421	0.000	0.000	25.1	1201.794	8772.31	420020.4573	0.396	0.394	0.398
	97-100	2464-2540	380	0.301	10.885	521.187	0.050	2.394	0.056	2.681	0.000	0.000	10.78	516.149	8783.09	420536.6065	0.308	0.306	0.310
	93-97	2362-2464	379	0.299	14.572	697.734	0.059	2.825	0.073	3.495	0.000	0.000	14.44	691.391	8797.53	421227.9974	0.305	0.303	0.307
*	85-93	2159-2362	378	0.174	34.333	1643.878	0.087	4.166	0.141	6.751	0.855	40.943	33.25	1592.019	8830.78	422820.0159	0.199	0.198	0.200
	81-85	2057-2159	377	0.090	18.909	905.364	0.024	1.149	0.067	3.208	0.000	0.000	18.81	900.628	8849.59	423720.6435	0.094	0.089	0.099
	78-81	1981-2057	376	0.177	12.822	613.937	0.008	0.383	0.037	1.772	0.000	0.000	12.77	611.431	8862.36	424332.0744	0.18	0.179	0.181
	75-78	1905-1981	375	0.076	14.396	689.280	0.001	0.048	0.000	0.000	0.000	0.000	14.39	688.997	8876.75	425021.0713	0.076	0.072	0.080
	72-75	1829-1905	374	0.073	14.437	691.269	0.001	0.048	0.000	0.000	0.000	0.000	14.43	690.912	8891.18	425711.9834	0.073	0.069	0.077
*	67-72	1702-1829	373	0.055	24.544	1175.158	0.002	0.096	0.000	0.000	0.222	10.614	24.32	1164.448	8915.5	426876.4313	0.063	0.060	0.066
	63-67	1600-1702	372	0.053	19.678	942.165	0.002	0.096	0.000	0.000	0.000	0.000	19.67	941.805	8935.17	427818.2359	0.053	0.050	0.056
	60-63	1524-1600	371	0.029	15.128	724.341	0.001	0.048	0.000	0.000	0.000	0.000	15.12	723.949	8950.29	428542.1854	0.029	0.028	0.030
	57-60	1448-1524	370	0.066	14.557	696.988	0.001	0.048	0.000	0.000	0.000	0.000	14.55	696.658	8964.84	429238.8432	0.066	0.063	0.069
	53-57	1346-1448	369	0.053	19.667	941.668	0.002	0.096	0.000	0.000	0.000	0.000	19.66	941.326	8984.5	430180.169	0.053	0.050	0.056
*	46-53	1168-1346	368	0.053	34.432	1648.602	0.003	0.144	0.000	0.000	-0.181	-8.677	34.61	1657.136	9019.11	431837.3047	0.048	0.046	0.050
	43-46	1092-1168	367	0.042	14.931	714.892	0.001	0.048	0.000	0.000	0.000	0.000	14.92	714.373	9034.03	432551.6781	0.042	0.040	0.044
	37-43	940-1092	366	0.042	29.851	1429.286	0.003	0.144	0.000	0.000	0.000	0.000	29.84	1428.747	9063.87	433980.425	0.042	0.040	0.044
*	25-37	635-940	365	0.036	60.076	2876.475	0.006	0.287	0.000	0.000	0.230	11.034	59.84	2865.155	9123.71	436845.5796	0.039	0.037	0.041
	13-25	330-635	364	0.037	60.030	2874.238	0.006	0.287	0.000	0.000	0.000	0.000	60.01	2873.294	9183.72	439718.8738	0.037	0.035	0.039
*	0-13	0-330	363	0.029	65.566	3139.307	0.006	0.287	0.000	0.000	-0.690	-33.047	66.25	3172.067	9249.97	442890.9408	0.018	0.017	0.019

Table A-222 Energy Balance Results for RBHT Test 1659A for Time Period 1950 to 2040 seconds

Results for RBHT Test 1659
Valid Time Period 1950 to 2040 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2332.9392	7.3594	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
0.25	6.35	2462.547	7.7683	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
0.50	12.70	2592.1547	8.1771	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
0.75	19.05	2721.7624	8.586	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
1.00	25.40	2851.3702	8.9949	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
1.25	31.75	2980.9779	9.4037	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
1.50	38.10	3110.5857	9.8126	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
1.75	44.45	3240.1934	10.221	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
2.00	50.80	3369.8011	10.63	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
2.25	57.15	3499.4089	11.039	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
2.50	63.50	3629.0166	11.448	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
2.75	69.85	3758.6243	11.857	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
3.00	76.20	3888.2321	12.266	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
3.25	82.55	4017.8398	12.675	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
3.50	88.90	4147.4475	13.083	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
3.75	95.25	4277.0553	13.492	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
4.00	101.60	4406.663	13.901	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
4.25	107.95	4536.2707	14.31	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
4.50	114.30	4665.8785	14.719	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
4.75	120.65	4795.4862	15.128	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
5.00	127.00	4925.0939	15.537	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
5.25	133.35	5054.7017	15.945	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
5.50	139.70	5184.3094	16.354	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
5.75	146.05	5313.9172	16.763	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
6.00	152.40	5443.5249	17.172	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
6.25	158.75	5573.1326	17.581	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
6.50	165.10	5702.7404	17.99	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.72E-02
6.75	171.45	5832.3481	18.399	4.59E-03	1.98E-01	8.96E-02	1.04E-01	4.70E-02
7.00	177.80	5961.9558	18.807	1.09E-02	4.68E-01	2.12E-01	1.03E-01	4.67E-02
7.25	184.15	6091.5636	19.216	1.73E-02	7.44E-01	3.38E-01	1.02E-01	4.64E-02
7.50	190.50	6221.1713	19.625	2.38E-02	1.03E+00	4.65E-01	1.02E-01	4.61E-02
7.75	196.85	6350.779	20.034	3.05E-02	1.31E+00	5.96E-01	1.01E-01	4.58E-02
8.00	203.20	6480.3868	20.443	3.74E-02	1.61E+00	7.29E-01	1.00E-01	4.55E-02
8.25	209.55	6609.9945	20.852	4.43E-02	1.91E+00	8.66E-01	9.95E-02	4.51E-02
8.50	215.90	6739.6022	21.261	5.14E-02	2.21E+00	1.00E+00	9.88E-02	4.48E-02
8.75	222.25	6869.21	21.669	5.87E-02	2.53E+00	1.15E+00	9.80E-02	4.45E-02
9.00	228.60	6998.8177	22.078	6.61E-02	2.84E+00	1.29E+00	9.72E-02	4.41E-02
9.25	234.95	6609.9945	20.852	7.33E-02	3.16E+00	1.43E+00	9.65E-02	4.38E-02
9.50	241.30	6221.1713	19.625	8.02E-02	3.45E+00	1.56E+00	9.58E-02	4.34E-02
9.75	247.65	5832.3481	18.399	8.66E-02	3.73E+00	1.69E+00	9.51E-02	4.31E-02
10.00	254.00	5443.5249	17.172	9.26E-02	3.98E+00	1.81E+00	9.45E-02	4.29E-02
10.25	260.35	5054.7017	15.945	9.82E-02	4.22E+00	1.92E+00	9.39E-02	4.26E-02
10.50	266.70	4665.8785	14.719	1.03E-01	4.45E+00	2.02E+00	9.34E-02	4.24E-02
10.75	273.05	4277.0553	13.492	1.08E-01	4.65E+00	2.11E+00	9.29E-02	4.21E-02
11.00	279.40	3888.2321	12.266	1.12E-01	4.84E+00	2.19E+00	9.24E-02	4.19E-02
11.25	285.75	3499.4089	11.039	1.16E-01	5.01E+00	2.27E+00	9.20E-02	4.17E-02
11.50	292.10	3110.5857	9.8126	1.20E-01	5.16E+00	2.34E+00	9.16E-02	4.16E-02
11.75	298.45	2721.7624	8.586	1.23E-01	5.29E+00	2.40E+00	9.13E-02	4.14E-02
12.00	304.80	2332.9392	7.3594	1.26E-01	5.41E+00	2.45E+00	9.10E-02	4.13E-02

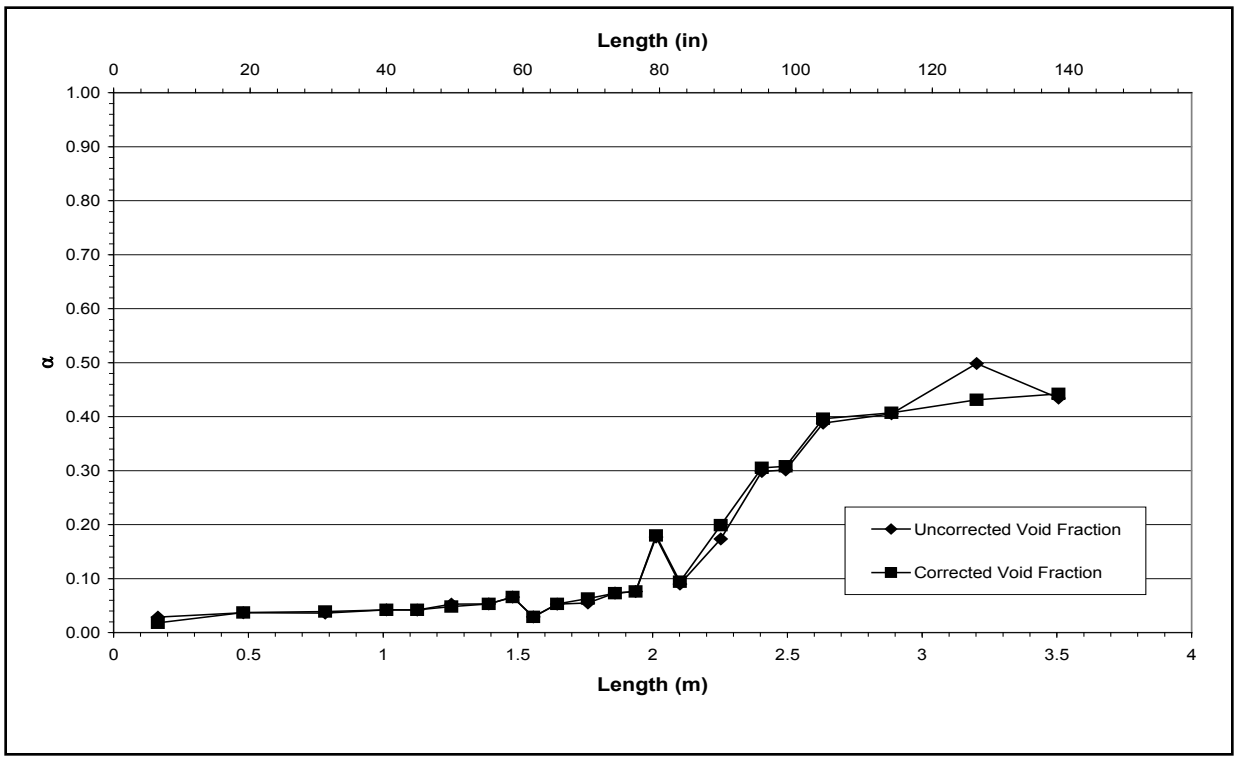

Figure A-555 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659A for Time Period 1950 to 2040 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-B

Test Conditions

Date: 7/9/2003
Steady-state time window: 2210 – 2300 seconds
Inlet flow rate: 3.061 cm/sec (1.205 in./sec)
Inlet mass flow rate: 0.143 kg/sec (0.315 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

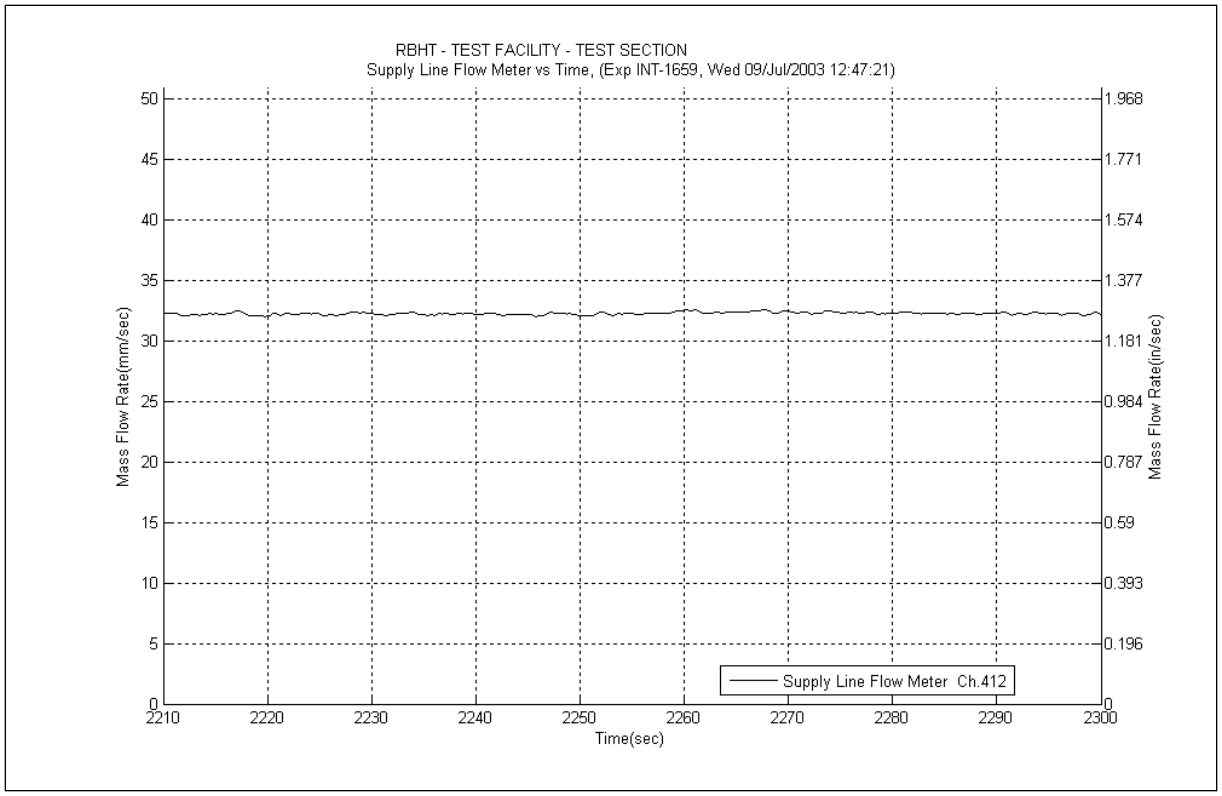

Figure A-556 Inlet Flow Plot for Experiment 1659B

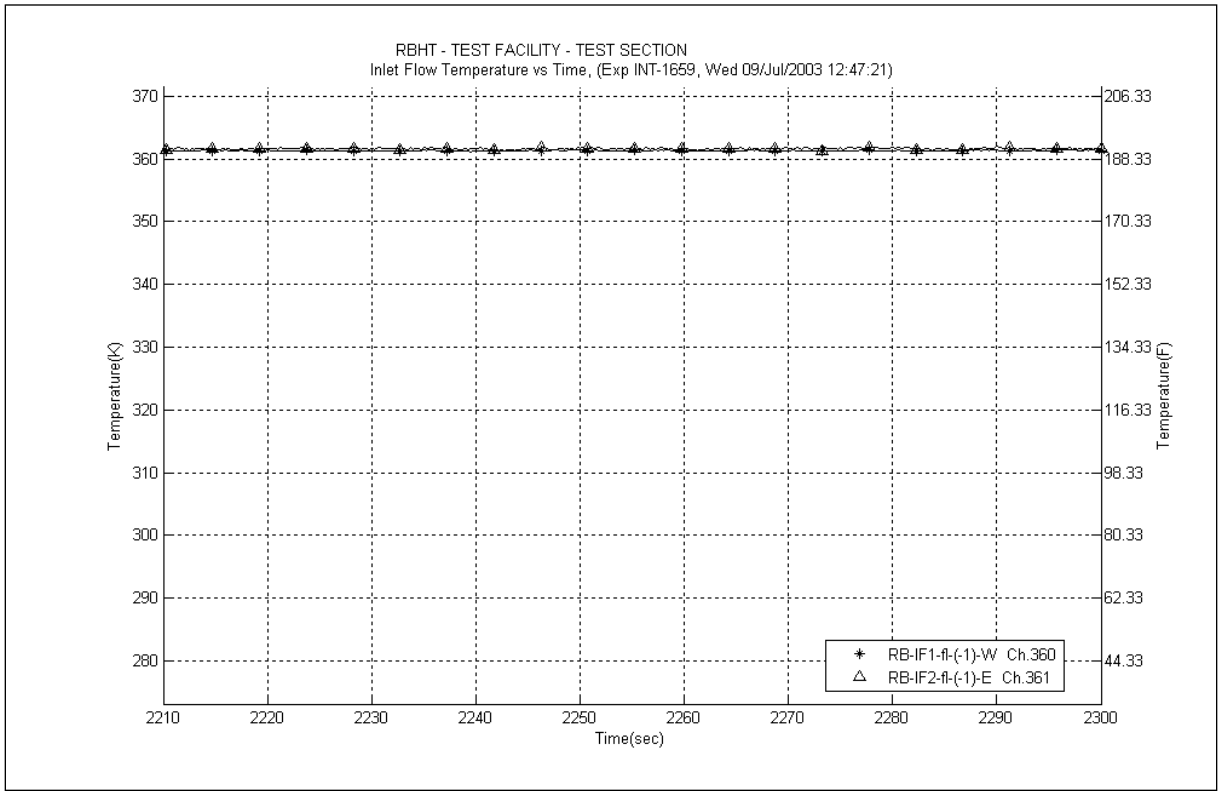

Figure A-557 Inlet Temperature Plot for Experiment 1659B

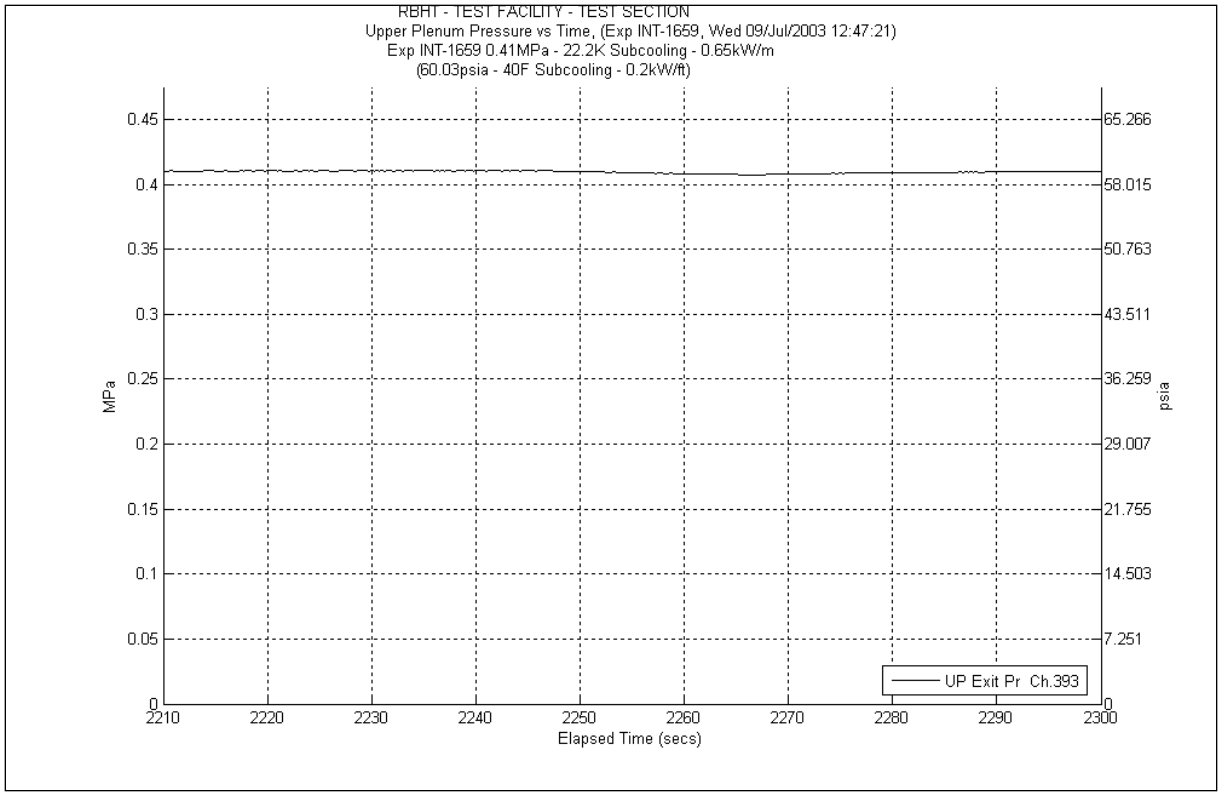

Figure A-558 System Pressure Plot for Experiment 1659B

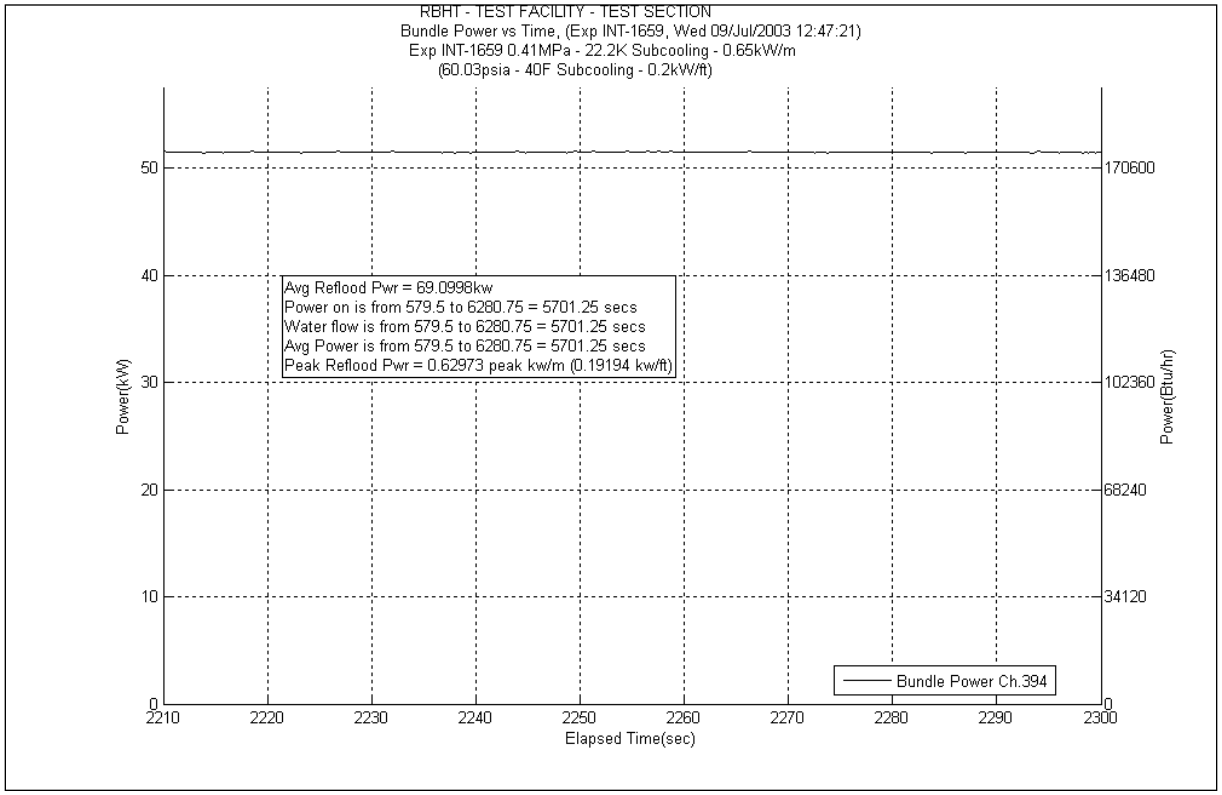

Figure A-559 Bundle Power Plot for Experiment 1659B

Table A-223 Data Results for RBHT Test 1659 for Time Period 2210 to 2300

Results for RBHT Test 1659
Valid Time Period 2210 to 2300 seconds
Collapsed Liquid Level = 117.372 inches = 2981.26 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.437	32.136	1538.696	0.364	17.428	0.096	4.597	0.000	0.000	31.66	1515.889	8671.66	415201.3094	0.446	0.444	0.448
*	120-133	3048-3378	383	0.498	33.907	1623.488	0.389	18.625	0.171	8.188	-4.943	-236.660	38.29	1833.335	8709.95	417034.6445	0.433	0.431	0.435
*	108-120	2743-3048	382	0.406	36.997	1771.439	0.301	14.412	0.213	10.198	-0.467	-22.347	36.95	1769.175	8746.9	418803.82	0.407	0.405	0.409
	100-108	2540-2743	381	0.386	25.494	1220.662	0.161	7.709	0.156	7.469	0.000	0.000	25.17	1205.146	8772.07	420008.966	0.394	0.392	0.396
	97-100	2464-2540	380	0.302	10.875	520.690	0.051	2.442	0.056	2.681	0.000	0.000	10.76	515.192	8782.83	420524.1576	0.309	0.307	0.311
	93-97	2362-2464	379	0.296	14.635	700.718	0.059	2.825	0.074	3.543	0.000	0.000	14.5	694.264	8797.33	421218.4213	0.302	0.300	0.304
*	85-93	2159-2362	378	0.171	34.427	1648.354	0.087	4.166	0.141	6.751	0.879	42.067	33.32	1595.370	8830.65	422813.7915	0.198	0.197	0.199
	81-85	2057-2159	377	0.089	18.919	905.861	0.024	1.149	0.068	3.256	0.000	0.000	18.82	901.106	8849.47	423714.8979	0.094	0.089	0.099
	78-81	1981-2057	376	0.177	12.828	614.185	0.008	0.383	0.035	1.676	0.000	0.000	12.78	611.910	8862.25	424326.8076	0.18	0.179	0.181
	75-78	1905-1981	375	0.076	14.401	689.529	0.001	0.048	0.000	0.000	0.000	0.000	14.39	688.997	8876.64	425015.8045	0.076	0.072	0.080
	72-75	1829-1905	374	0.073	14.443	691.518	0.001	0.048	0.000	0.000	0.000	0.000	14.44	691.391	8891.08	425707.1954	0.073	0.069	0.077
*	67-72	1702-1829	373	0.055	24.549	1175.406	0.002	0.096	0.000	0.000	0.217	10.384	24.33	1164.927	8915.41	426872.1221	0.063	0.060	0.066
	63-67	1600-1702	372	0.053	19.678	942.165	0.002	0.096	0.000	0.000	0.000	0.000	19.67	941.805	8935.08	427813.9267	0.053	0.050	0.056
	60-63	1524-1600	371	0.029	15.133	724.589	0.001	0.048	0.000	0.000	0.000	0.000	15.13	724.428	8950.21	428538.355	0.029	0.028	0.030
	57-60	1448-1524	370	0.066	14.557	696.988	0.001	0.048	0.000	0.000	0.000	0.000	14.55	696.658	8964.76	429235.0127	0.066	0.063	0.069
	53-57	1346-1448	369	0.053	19.667	941.668	0.002	0.096	0.000	0.000	0.000	0.000	19.66	941.326	8984.42	430176.3386	0.053	0.050	0.056
*	46-53	1168-1346	368	0.053	34.427	1648.354	0.003	0.144	0.000	0.000	-0.196	-9.404	34.62	1657.614	9019.04	431833.9531	0.047	0.045	0.049
	43-46	1092-1168	367	0.042	14.931	714.892	0.001	0.048	0.000	0.000	0.000	0.000	14.93	714.852	9033.97	432548.8053	0.042	0.040	0.044
	37-43	940-1092	366	0.042	29.851	1429.286	0.003	0.144	0.000	0.000	0.000	0.000	29.84	1428.747	9063.81	433977.5522	0.042	0.040	0.044
*	25-37	635-940	365	0.036	60.076	2876.475	0.006	0.287	0.000	0.000	0.230	11.034	59.84	2865.155	9123.65	436842.7068	0.039	0.037	0.041
	13-25	330-635	364	0.037	60.030	2874.238	0.006	0.287	0.000	0.000	0.000	0.000	60.01	2873.294	9183.66	439716.001	0.037	0.035	0.039
*	0-13	0-330	363	0.029	65.561	3139.058	0.006	0.287	0.000	0.000	-0.695	-33.296	66.25	3172.067	9249.91	442888.068	0.018	0.017	0.019

Table A-224 Energy Balance Results for RBHT Test 1659B for Time Period 2210 to 2300 seconds

Results for RBHT Test 1659
Valid Time Period 2210 to 2300 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2334.4158	7.3641	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.25	6.35	2464.1055	7.7732	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.50	12.70	2593.7953	8.1823	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.75	19.05	2723.4851	8.5914	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.00	25.40	2853.1748	9.0005	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.25	31.75	2982.8646	9.4097	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.50	38.10	3112.5543	9.8188	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.75	44.45	3242.2441	10.228	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.00	50.80	3371.9339	10.637	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.25	57.15	3501.6236	11.046	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.50	63.50	3631.3134	11.455	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.75	69.85	3761.0032	11.864	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.00	76.20	3890.6929	12.273	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.25	82.55	4020.3827	12.683	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.50	88.90	4150.0725	13.092	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.75	95.25	4279.7622	13.501	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.00	101.60	4409.452	13.91	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.25	107.95	4539.1418	14.319	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.50	114.30	4668.8315	14.728	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.75	120.65	4798.5213	15.137	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.00	127.00	4928.211	15.546	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.25	133.35	5057.9008	15.956	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.50	139.70	5187.5906	16.365	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.75	146.05	5317.2803	16.774	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.00	152.40	5446.9701	17.183	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.25	158.75	5576.6599	17.592	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.50	165.10	5706.3496	18.001	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.75	171.45	5836.0394	18.41	4.38E-03	1.89E-01	8.57E-02	1.04E-01	4.72E-02
7.00	177.80	5965.7292	18.819	1.06E-02	4.59E-01	2.08E-01	1.04E-01	4.70E-02
7.25	184.15	6095.4189	19.228	1.70E-02	7.35E-01	3.33E-01	1.03E-01	4.66E-02
7.50	190.50	6225.1087	19.638	2.36E-02	1.02E+00	4.61E-01	1.02E-01	4.63E-02
7.75	196.85	6354.7985	20.047	3.02E-02	1.31E+00	5.92E-01	1.01E-01	4.60E-02
8.00	203.20	6484.4882	20.456	3.70E-02	1.60E+00	7.25E-01	1.01E-01	4.57E-02
8.25	209.55	6614.178	20.865	4.40E-02	1.90E+00	8.61E-01	1.00E-01	4.54E-02
8.50	215.90	6743.8678	21.274	5.10E-02	2.20E+00	1.00E+00	9.93E-02	4.50E-02
8.75	222.25	6873.5575	21.683	5.83E-02	2.52E+00	1.14E+00	9.85E-02	4.47E-02
9.00	228.60	7003.2473	22.092	6.56E-02	2.83E+00	1.29E+00	9.78E-02	4.43E-02
9.25	234.95	6614.178	20.865	7.28E-02	3.15E+00	1.43E+00	9.70E-02	4.40E-02
9.50	241.30	6225.1087	19.638	7.96E-02	3.44E+00	1.56E+00	9.63E-02	4.37E-02
9.75	247.65	5836.0394	18.41	8.60E-02	3.72E+00	1.69E+00	9.56E-02	4.34E-02
10.00	254.00	5446.9701	17.183	9.20E-02	3.97E+00	1.80E+00	9.50E-02	4.31E-02
10.25	260.35	5057.9008	15.956	9.76E-02	4.21E+00	1.91E+00	9.44E-02	4.28E-02
10.50	266.70	4668.8315	14.728	1.03E-01	4.44E+00	2.01E+00	9.39E-02	4.26E-02
10.75	273.05	4279.7622	13.501	1.08E-01	4.64E+00	2.11E+00	9.34E-02	4.24E-02
11.00	279.40	3890.6929	12.273	1.12E-01	4.83E+00	2.19E+00	9.29E-02	4.22E-02
11.25	285.75	3501.6236	11.046	1.16E-01	5.00E+00	2.27E+00	9.25E-02	4.20E-02
11.50	292.10	3112.5543	9.8188	1.19E-01	5.15E+00	2.34E+00	9.22E-02	4.18E-02
11.75	298.45	2723.4851	8.5914	1.22E-01	5.28E+00	2.40E+00	9.18E-02	4.17E-02
12.00	304.80	2334.4158	7.3641	1.25E-01	5.40E+00	2.45E+00	9.15E-02	4.15E-02

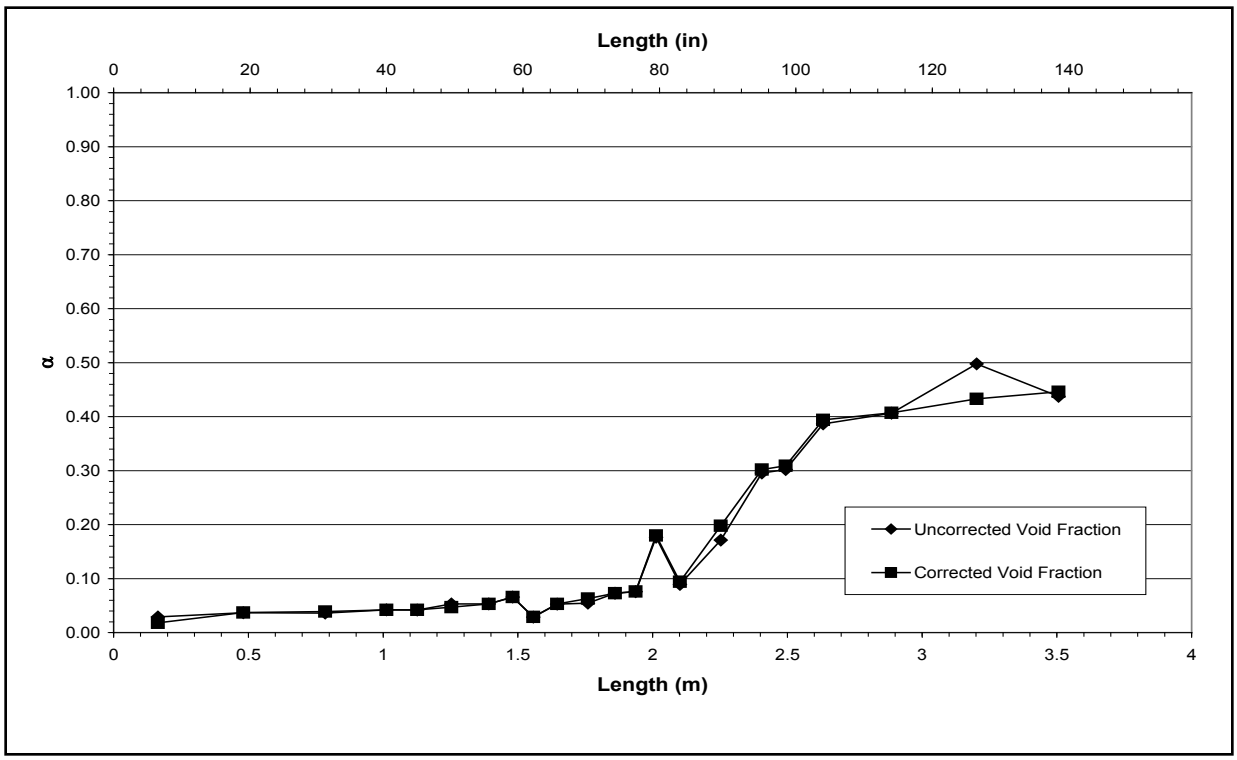

Figure A-560 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659B for Time Period 2210 to 2300 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-C

Test Conditions

Date: 7/9/2003
Steady-state time window: 2490 – 2557 seconds
Inlet flow rate: 3.030 cm/sec (1.193 in./sec)
Inlet mass flow rate: 0.142 kg/sec (0.312 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

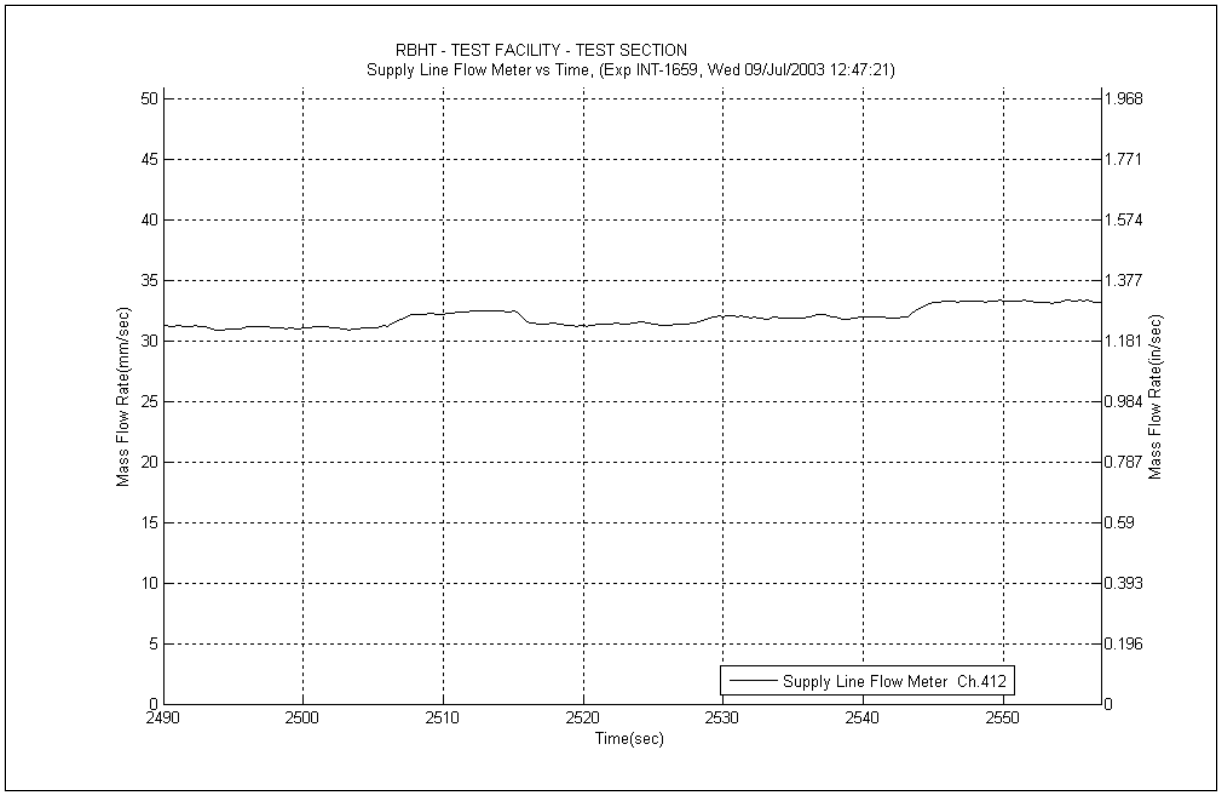

Figure A-561 Inlet Flow Plot for Experiment 1659C

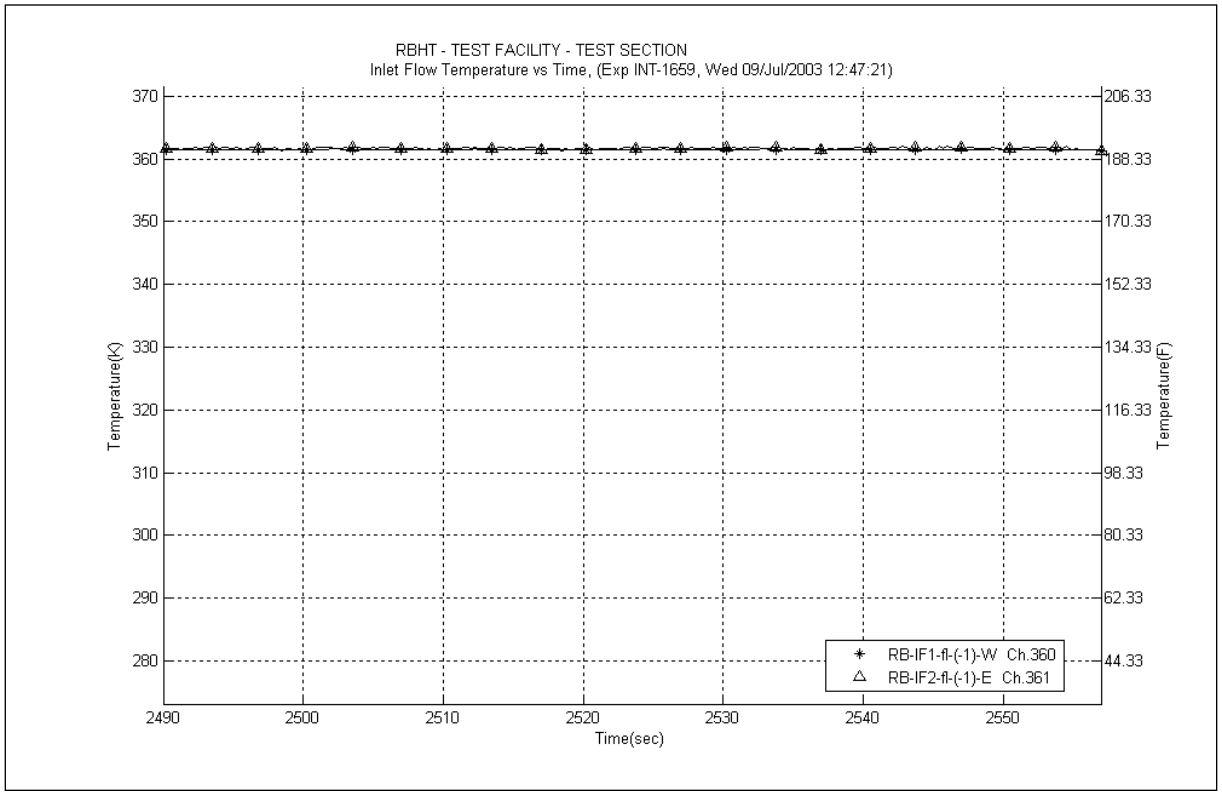

Figure A-562 Inlet Temperature Plot for Experiment 1659C

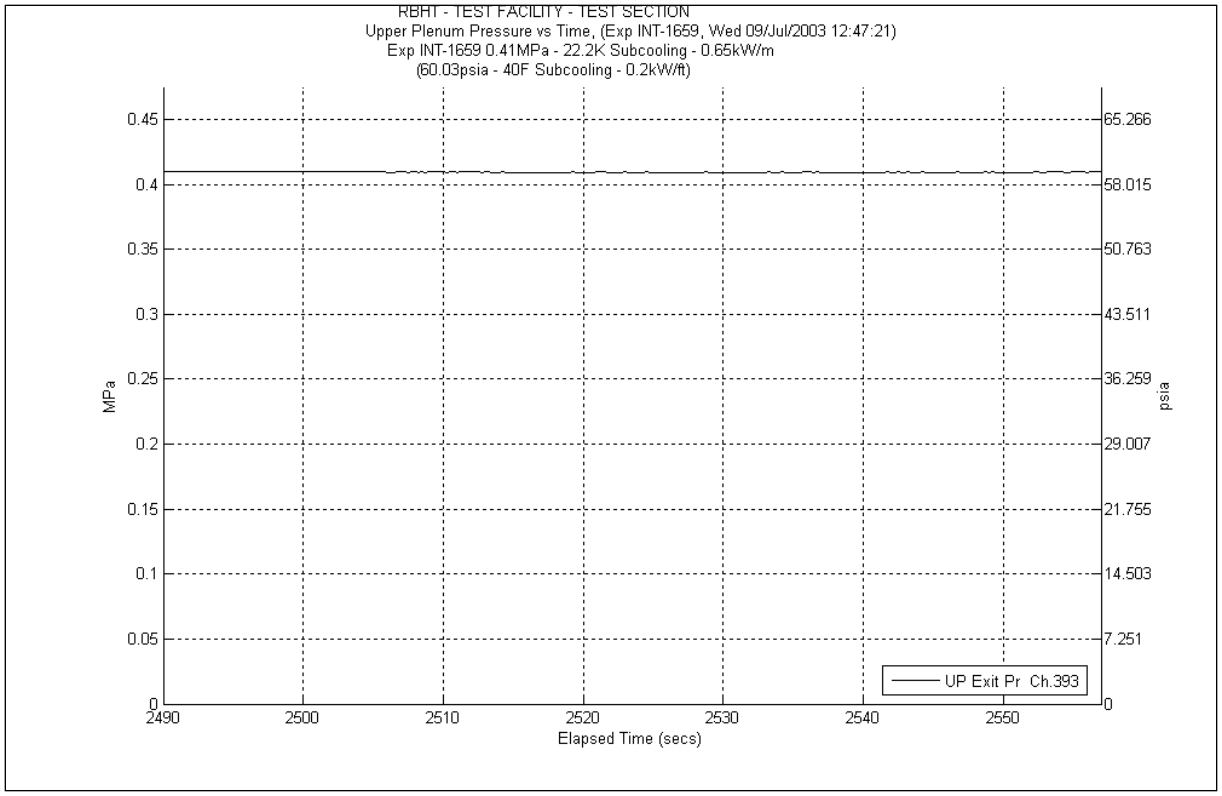

Figure A-563 System Pressure Plot for Experiment 1659C

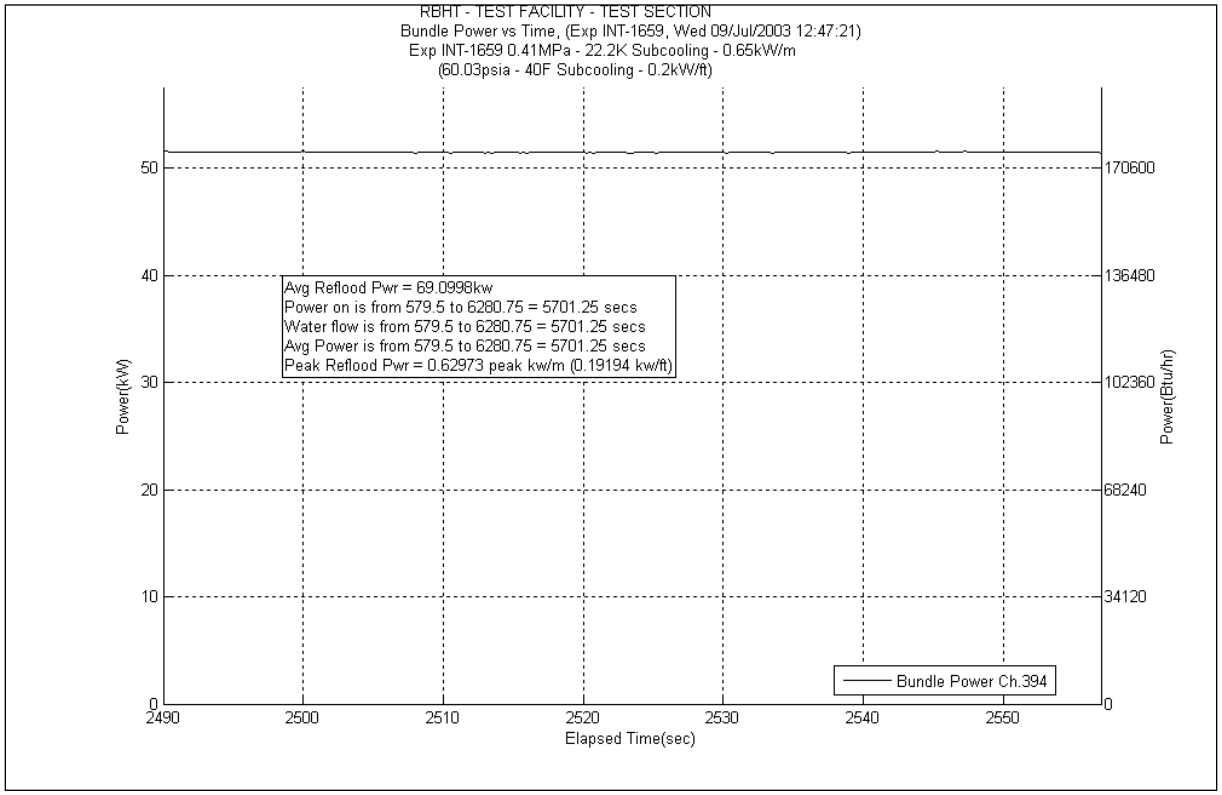

Figure A-564 Bundle Power Plot for Experiment 1659C

Table A-225 Data Results for RBHT Test 1659 for Time Period 2490 to 2557

Results for RBHT Test 1659
Valid Time Period 2490 to 2557 seconds
Collapsed Liquid Level = 117.091 inches = 2974.12 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.435	32.297	1546.404	0.362	17.333	0.095	4.549	0.000	0.000	31.83	1524.029	8671.83	415209.4491	0.443	0.441	0.445
*	120-133	3048-3378	383	0.496	34.047	1630.202	0.388	18.578	0.169	8.092	-4.920	-235.548	38.41	1839.081	8710.24	417048.5297	0.431	0.429	0.433
*	108-120	2743-3048	382	0.406	37.044	1773.677	0.301	14.412	0.211	10.103	-0.398	-19.055	36.93	1768.218	8747.17	418816.7476	0.407	0.405	0.409
	100-108	2540-2743	381	0.388	25.437	1217.927	0.161	7.709	0.154	7.374	0.000	0.000	25.11	1202.273	8772.28	420019.0209	0.395	0.393	0.397
	97-100	2464-2540	380	0.300	10.901	521.933	0.051	2.442	0.056	2.681	0.000	0.000	10.79	516.628	8783.07	420535.6488	0.307	0.305	0.309
	93-97	2362-2464	379	0.300	14.536	695.994	0.060	2.873	0.073	3.495	0.000	0.000	14.4	689.476	8797.47	421225.1245	0.307	0.305	0.309
*	85-93	2159-2362	378	0.174	34.302	1642.386	0.089	4.261	0.140	6.703	0.873	41.797	33.2	1589.625	8830.67	422814.7491	0.201	0.200	0.202
	81-85	2057-2159	377	0.090	18.909	905.364	0.026	1.245	0.067	3.208	0.000	0.000	18.81	900.628	8849.48	423715.3767	0.094	0.089	0.099
	78-81	1981-2057	376	0.177	12.822	613.937	0.009	0.431	0.046	2.202	0.000	0.000	12.77	611.431	8862.25	424326.8076	0.18	0.179	0.181
	75-78	1905-1981	375	0.076	14.401	689.529	0.001	0.048	0.000	0.000	0.000	0.000	14.39	688.997	8876.64	425015.8045	0.076	0.072	0.080
	72-75	1829-1905	374	0.073	14.448	691.766	0.001	0.048	0.000	0.000	0.000	0.000	14.44	691.391	8891.08	425707.1954	0.073	0.069	0.077
*	67-72	1702-1829	373	0.055	24.549	1175.406	0.002	0.096	0.000	0.000	0.217	10.384	24.33	1164.927	8915.41	426872.1221	0.063	0.060	0.066
	63-67	1600-1702	372	0.053	19.678	942.165	0.002	0.096	0.000	0.000	0.000	0.000	19.67	941.805	8935.08	427813.9267	0.053	0.050	0.056
	60-63	1524-1600	371	0.029	15.128	724.341	0.001	0.048	0.000	0.000	0.000	0.000	15.12	723.949	8950.2	428537.8762	0.029	0.028	0.030
	57-60	1448-1524	370	0.065	14.562	697.237	0.001	0.048	0.000	0.000	0.000	0.000	14.55	696.658	8964.75	429234.5339	0.066	0.063	0.069
	53-57	1346-1448	369	0.053	19.667	941.668	0.002	0.096	0.000	0.000	0.000	0.000	19.66	941.326	8984.41	430175.8598	0.053	0.050	0.056
*	46-53	1168-1346	368	0.053	34.427	1648.354	0.003	0.144	0.000	0.000	-0.186	-8.926	34.61	1657.136	9019.02	431832.9955	0.048	0.046	0.050
	43-46	1092-1168	367	0.042	14.931	714.892	0.001	0.048	0.000	0.000	0.000	0.000	14.92	714.373	9033.94	432547.3689	0.042	0.040	0.044
	37-43	940-1092	366	0.043	29.825	1428.043	0.003	0.144	0.000	0.000	0.000	0.000	29.82	1427.789	9063.76	433975.1582	0.043	0.041	0.045
*	25-37	635-940	365	0.036	60.066	2875.978	0.006	0.287	0.000	0.000	0.250	11.973	59.81	2863.718	9123.57	436838.8764	0.04	0.038	0.042
	13-25	330-635	364	0.037	60.025	2873.989	0.006	0.287	0.000	0.000	0.000	0.000	60	2872.815	9183.57	439711.6918	0.037	0.035	0.039
*	0-13	0-330	363	0.029	65.566	3139.307	0.006	0.287	0.000	0.000	-0.690	-33.047	66.25	3172.067	9249.82	442883.7588	0.018	0.017	0.019

Table A-226 Energy Balance Results for RBHT Test 1659C for Time Period 2490 to 2557 seconds

Results for RBHT Test 1659
Valid Time Period 2490 to 2557 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2333.6266	7.3616	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
0.25	6.35	2463.2725	7.7706	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
0.50	12.70	2592.9184	8.1795	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
0.75	19.05	2722.5643	8.5885	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
1.00	25.40	2852.2102	8.9975	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
1.25	31.75	2981.8562	9.4065	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
1.50	38.10	3111.5021	9.8155	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
1.75	44.45	3241.148	10.224	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
2.00	50.80	3370.7939	10.633	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
2.25	57.15	3500.4398	11.042	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
2.50	63.50	3630.0858	11.451	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
2.75	69.85	3759.7317	11.86	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
3.00	76.20	3889.3776	12.269	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
3.25	82.55	4019.0235	12.678	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
3.50	88.90	4148.6694	13.087	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
3.75	95.25	4278.3154	13.496	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
4.00	101.60	4407.9613	13.905	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
4.25	107.95	4537.6072	14.314	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
4.50	114.30	4667.2531	14.723	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
4.75	120.65	4796.8991	15.132	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
5.00	127.00	4926.545	15.541	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
5.25	133.35	5056.1909	15.95	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
5.50	139.70	5185.8368	16.359	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
5.75	146.05	5315.4827	16.768	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
6.00	152.40	5445.1287	17.177	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
6.25	158.75	5574.7746	17.586	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
6.50	165.10	5704.4205	17.995	0.00E+00	0.00E+00	0.00E+00	1.04E-01	4.70E-02
6.75	171.45	5834.0664	18.404	5.78E-03	2.47E-01	1.12E-01	1.03E-01	4.67E-02
7.00	177.80	5963.7123	18.813	1.21E-02	5.17E-01	2.35E-01	1.02E-01	4.64E-02
7.25	184.15	6093.3583	19.222	1.86E-02	7.93E-01	3.60E-01	1.02E-01	4.61E-02
7.50	190.50	6223.0042	19.631	2.52E-02	1.08E+00	4.88E-01	1.01E-01	4.58E-02
7.75	196.85	6352.6501	20.04	3.19E-02	1.36E+00	6.18E-01	1.00E-01	4.55E-02
8.00	203.20	6482.296	20.449	3.88E-02	1.66E+00	7.52E-01	9.95E-02	4.52E-02
8.25	209.55	6611.9419	20.858	4.58E-02	1.96E+00	8.88E-01	9.88E-02	4.48E-02
8.50	215.90	6741.5879	21.267	5.29E-02	2.26E+00	1.03E+00	9.81E-02	4.45E-02
8.75	222.25	6871.2338	21.676	6.02E-02	2.57E+00	1.17E+00	9.73E-02	4.41E-02
9.00	228.60	7000.8797	22.085	6.76E-02	2.89E+00	1.31E+00	9.66E-02	4.38E-02
9.25	234.95	6611.9419	20.858	7.49E-02	3.20E+00	1.45E+00	9.58E-02	4.35E-02
9.50	241.30	6223.0042	19.631	8.18E-02	3.50E+00	1.59E+00	9.51E-02	4.31E-02
9.75	247.65	5834.0664	18.404	8.82E-02	3.77E+00	1.71E+00	9.44E-02	4.28E-02
10.00	254.00	5445.1287	17.177	9.43E-02	4.03E+00	1.83E+00	9.38E-02	4.25E-02
10.25	260.35	5056.1909	15.95	9.99E-02	4.27E+00	1.94E+00	9.32E-02	4.23E-02
10.50	266.70	4667.2531	14.723	1.05E-01	4.49E+00	2.04E+00	9.27E-02	4.20E-02
10.75	273.05	4278.3154	13.496	1.10E-01	4.70E+00	2.13E+00	9.22E-02	4.18E-02
11.00	279.40	3889.3776	12.269	1.14E-01	4.89E+00	2.22E+00	9.17E-02	4.16E-02
11.25	285.75	3500.4398	11.042	1.18E-01	5.06E+00	2.29E+00	9.13E-02	4.14E-02
11.50	292.10	3111.5021	9.8155	1.22E-01	5.21E+00	2.36E+00	9.09E-02	4.13E-02
11.75	298.45	2722.5643	8.5885	1.25E-01	5.34E+00	2.42E+00	9.06E-02	4.11E-02
12.00	304.80	2333.6266	7.3616	1.28E-01	5.46E+00	2.48E+00	9.03E-02	4.10E-02

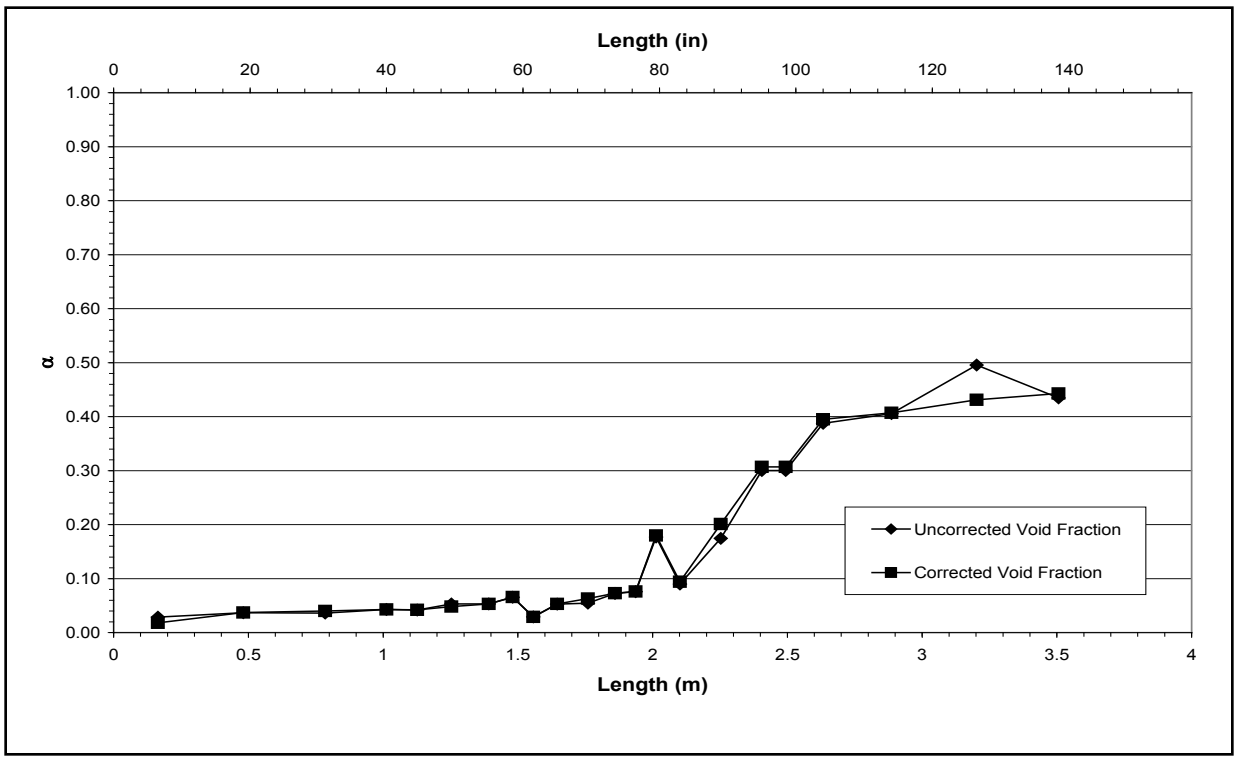

Figure A-565 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659C for Time Period 2490 to 2557 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-D

Test Conditions

Date: 7/9/2003
Steady-state time window: 2730 – 2820 seconds
Inlet flow rate: 2.540 cm/sec (1.000 in./sec)
Inlet mass flow rate: 0.119 kg/sec (0.263 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

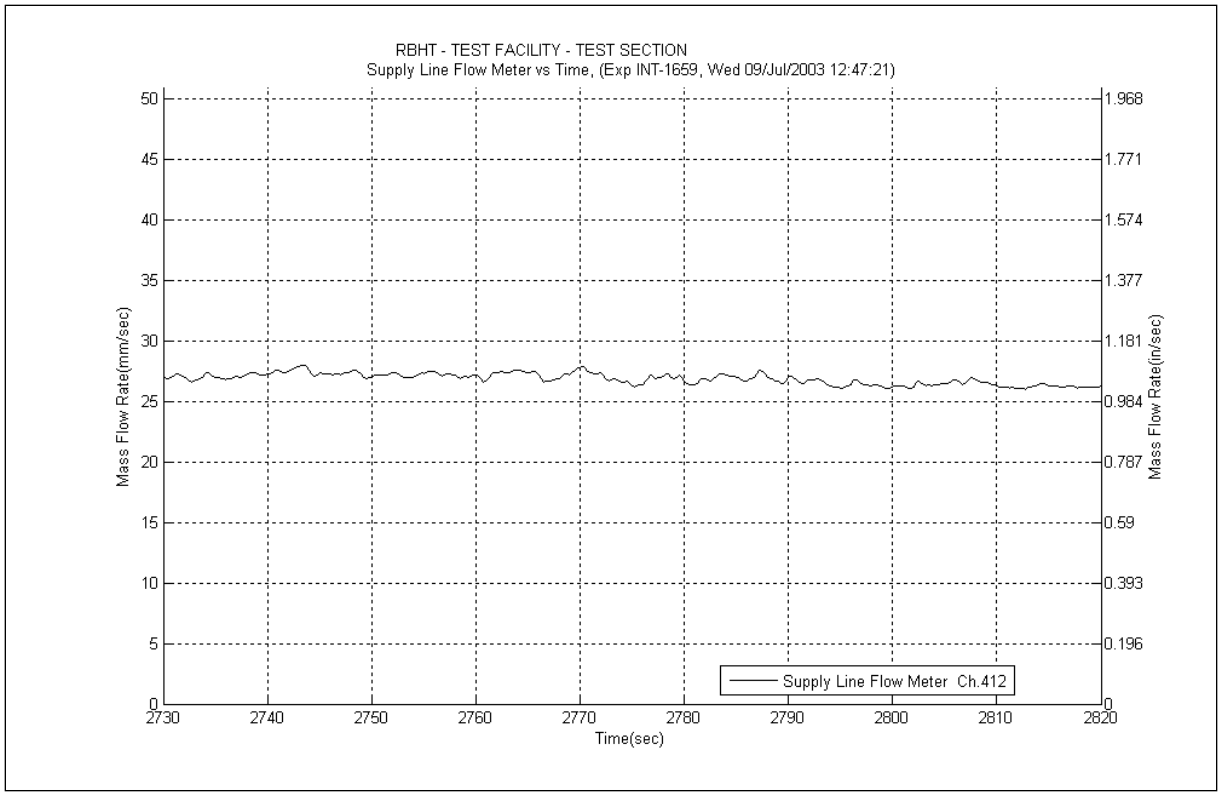

Figure A-566 Inlet Flow Plot for Experiment 1659D

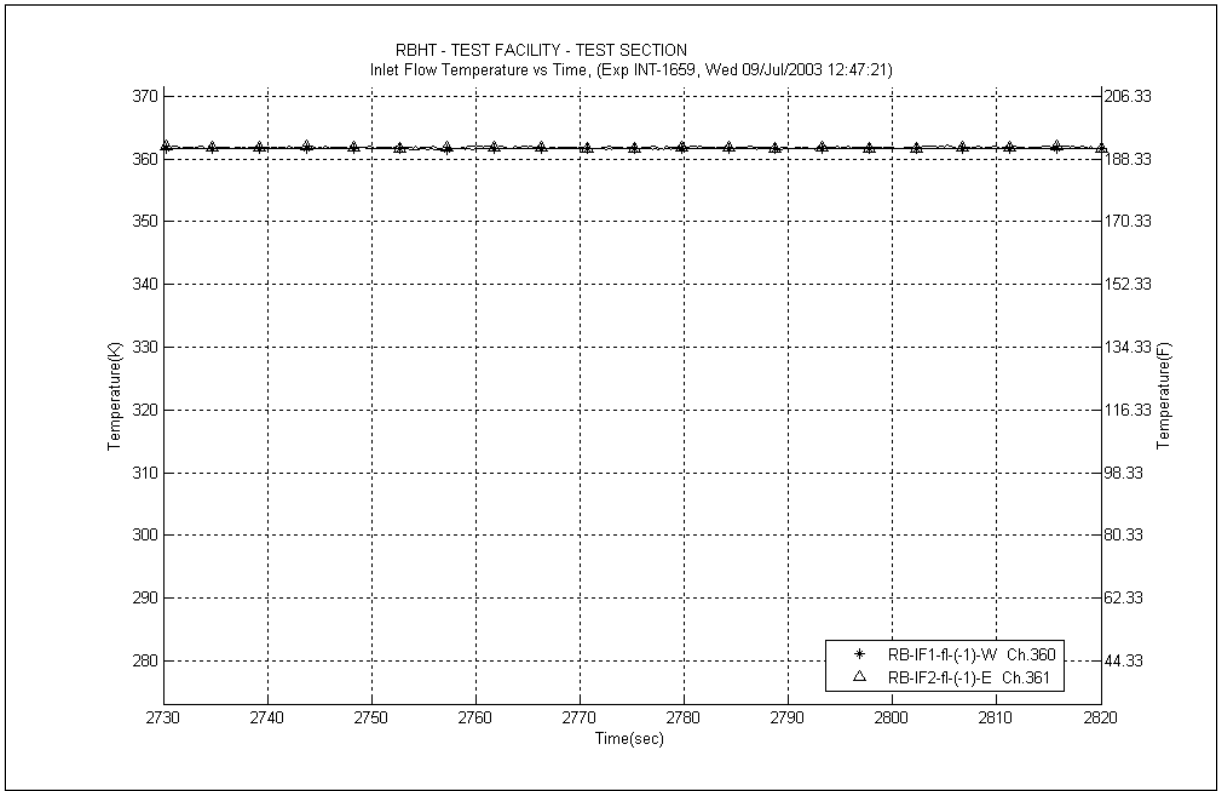

Figure A-567 Inlet Temperature Plot for Experiment 1659D

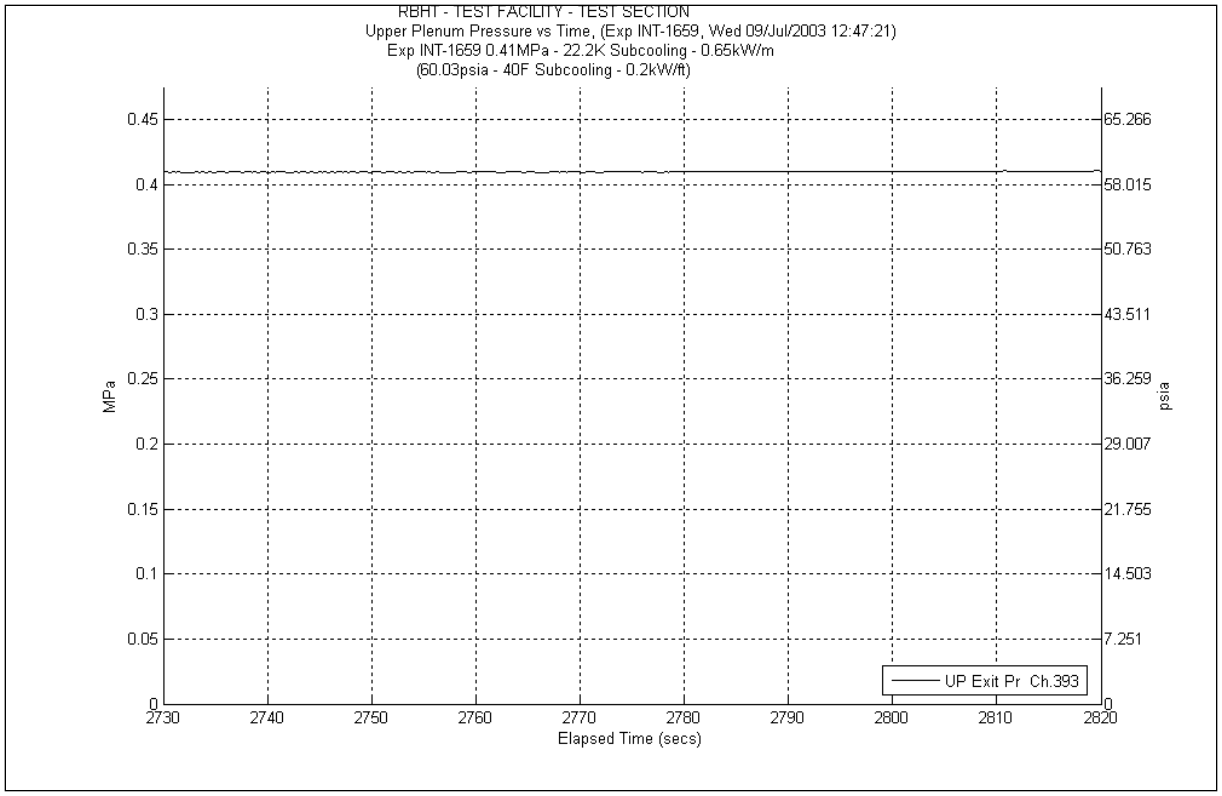

Figure A-568 System Pressure Plot for Experiment 1659D

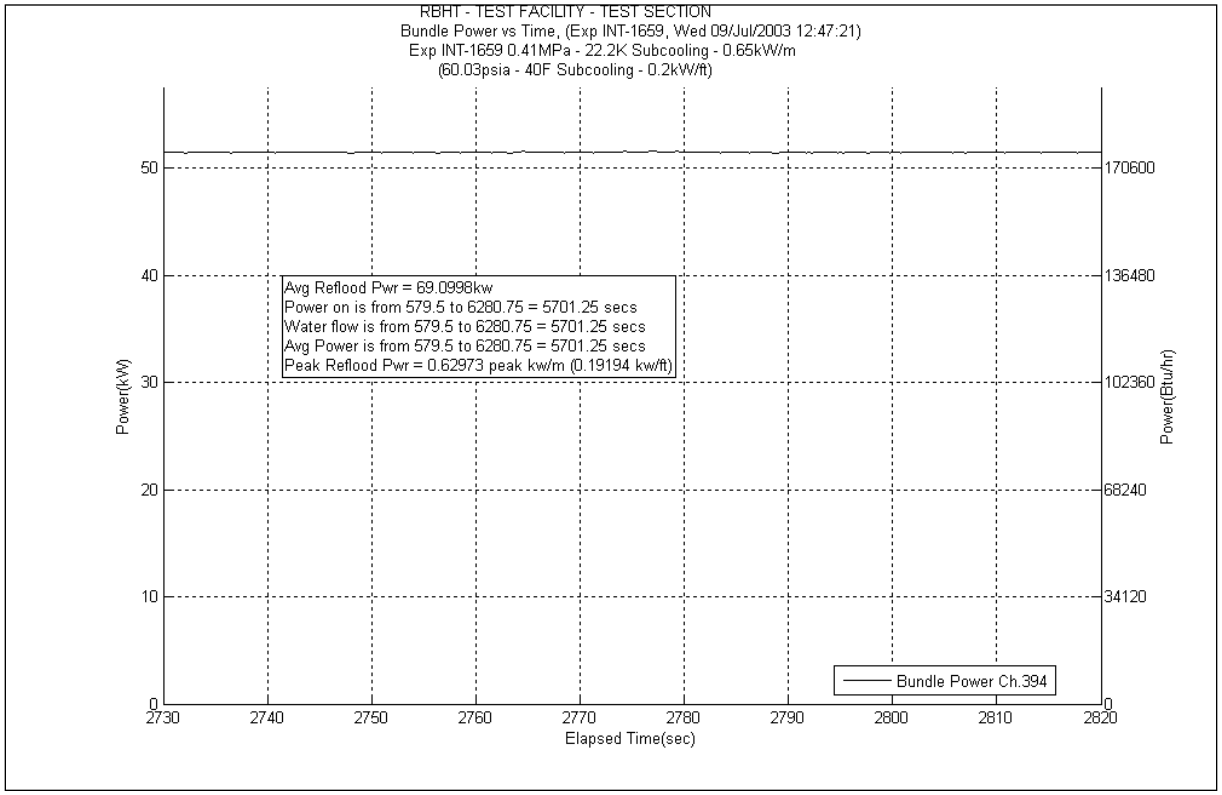

Figure A-569 Bundle Power Plot for Experiment 1659D

Table A-227 Data Results for RBHT Test 1659 for Time Period 2730 to 2820

Results for RBHT Test 1659
Valid Time Period 2730 to 2820 seconds
Collapsed Liquid Level = 112.697 inches = 2862.51 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.466	30.490	1459.871	0.326	15.609	0.080	3.830	0.000	0.000	30.07	1439.759	8670.07	415125.1798	0.473	0.471	0.475
*	120-133	3048-3378	383	0.531	31.664	1516.068	0.352	16.854	0.142	6.799	-4.820	-230.796	35.99	1723.210	8706.06	416848.3903	0.467	0.465	0.469
*	108-120	2743-3048	382	0.434	35.247	1687.642	0.281	13.454	0.177	8.475	0.739	35.390	34.05	1630.323	8740.11	418478.713	0.453	0.451	0.455
	100-108	2540-2743	381	0.440	23.271	1114.236	0.157	7.517	0.130	6.224	0.000	0.000	22.98	1100.288	8763.09	419579.0013	0.447	0.445	0.449
	97-100	2464-2540	380	0.342	10.246	490.602	0.052	2.490	0.047	2.250	0.000	0.000	10.15	485.985	8773.24	420064.9859	0.349	0.347	0.351
	93-97	2362-2464	379	0.353	13.440	643.527	0.063	3.016	0.061	2.921	0.000	0.000	13.31	637.286	8786.55	420702.2721	0.359	0.357	0.361
*	85-93	2159-2362	378	0.260	30.760	1472.801	0.105	5.027	0.117	5.602	2.128	101.894	28.41	1360.278	8814.96	422062.5502	0.316	0.314	0.318
	81-85	2057-2159	377	0.268	15.201	727.822	0.041	1.963	0.056	2.681	0.000	0.000	15.1	722.992	8830.06	422785.5421	0.273	0.272	0.274
	78-81	1981-2057	376	0.263	11.477	549.534	0.025	1.197	0.041	1.963	0.000	0.000	11.41	546.314	8841.47	423331.8559	0.268	0.267	0.269
	75-78	1905-1981	375	0.108	13.897	665.409	0.020	0.958	0.040	1.915	0.000	0.000	13.83	662.184	8855.3	423994.0398	0.112	0.111	0.113
	72-75	1829-1905	374	0.081	14.323	685.799	0.014	0.670	0.039	1.867	0.000	0.000	14.26	682.772	8869.56	424676.8123	0.084	0.080	0.088
*	67-72	1702-1829	373	0.061	24.377	1167.201	0.012	0.575	0.038	1.819	0.217	10.414	24.11	1154.393	8893.67	425831.2053	0.071	0.067	0.075
	63-67	1600-1702	372	0.058	19.568	936.943	0.001	0.048	0.000	0.000	0.000	0.000	19.56	936.538	8913.23	426767.7431	0.058	0.055	0.061
	60-63	1524-1600	371	0.034	15.055	720.859	0.001	0.048	0.000	0.000	0.000	0.000	15.05	720.598	8928.28	427488.341	0.034	0.032	0.036
	57-60	1448-1524	370	0.070	14.489	693.756	0.001	0.048	0.000	0.000	0.000	0.000	14.48	693.306	8942.76	428181.6471	0.07	0.067	0.074
	53-57	1346-1448	369	0.057	19.584	937.689	0.001	0.048	0.000	0.000	0.000	0.000	19.58	937.495	8962.34	429119.1425	0.057	0.054	0.060
*	46-53	1168-1346	368	0.057	34.292	1641.889	0.002	0.096	0.000	0.000	-0.180	-8.640	34.47	1650.432	8996.81	430769.575	0.052	0.049	0.055
	43-46	1092-1168	367	0.046	14.869	711.908	0.001	0.048	0.000	0.000	0.000	0.000	14.86	711.501	9011.67	431481.0756	0.046	0.044	0.048
	37-43	940-1092	366	0.046	29.742	1424.064	0.002	0.096	0.000	0.000	0.000	0.000	29.73	1423.480	9041.4	432904.5556	0.046	0.044	0.048
*	25-37	635-940	365	0.038	59.931	2869.513	0.004	0.192	0.000	0.000	0.237	11.349	59.69	2857.973	9101.09	435762.5282	0.042	0.040	0.044
	13-25	330-635	364	0.038	59.952	2870.508	0.004	0.192	0.000	0.000	0.000	0.000	59.93	2869.464	9161.02	438631.992	0.038	0.036	0.040
*	0-13	0-330	363	0.029	65.524	3137.318	0.004	0.192	0.000	0.000	-0.690	-33.026	66.21	3170.152	9227.23	441802.1438	0.019	0.018	0.020

Table A-228 Energy Balance Results for RBHT Test 1659D for Time Period 2730 to 2820 seconds

Results for RBHT Test 1659
Valid Time Period 2730 to 2820 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2333.5883	7.3615	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
0.25	6.35	2463.2321	7.7704	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
0.50	12.70	2592.8759	8.1794	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
0.75	19.05	2722.5197	8.5884	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
1.00	25.40	2852.1635	8.9974	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
1.25	31.75	2981.8073	9.4063	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
1.50	38.10	3111.4511	9.8153	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
1.75	44.45	3241.0949	10.224	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
2.00	50.80	3370.7387	10.633	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
2.25	57.15	3500.3825	11.042	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
2.50	63.50	3630.0263	11.451	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
2.75	69.85	3759.6701	11.86	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
3.00	76.20	3889.3139	12.269	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
3.25	82.55	4018.9577	12.678	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
3.50	88.90	4148.6015	13.087	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
3.75	95.25	4278.2453	13.496	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
4.00	101.60	4407.8891	13.905	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
4.25	107.95	4537.5329	14.314	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
4.50	114.30	4667.1767	14.723	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
4.75	120.65	4796.8205	15.132	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
5.00	127.00	4926.4642	15.541	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
5.25	133.35	5056.108	15.95	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
5.50	139.70	5185.7518	16.359	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
5.75	146.05	5315.3956	16.768	0.00E+00	0.00E+00	0.00E+00	8.71E-02	3.95E-02
6.00	152.40	5445.0394	17.177	6.72E-03	2.41E-01	1.10E-01	8.66E-02	3.93E-02
6.25	158.75	5574.6832	17.586	1.37E-02	4.94E-01	2.24E-01	8.59E-02	3.90E-02
6.50	165.10	5704.327	17.995	2.09E-02	7.51E-01	3.41E-01	8.53E-02	3.87E-02
6.75	171.45	5833.9708	18.404	2.82E-02	1.02E+00	4.60E-01	8.47E-02	3.84E-02
7.00	177.80	5963.6146	18.813	3.58E-02	1.29E+00	5.83E-01	8.40E-02	3.81E-02
7.25	184.15	6093.2584	19.222	4.34E-02	1.56E+00	7.08E-01	8.34E-02	3.78E-02
7.50	190.50	6222.9022	19.631	5.13E-02	1.84E+00	8.36E-01	8.27E-02	3.75E-02
7.75	196.85	6352.546	20.04	5.93E-02	2.13E+00	9.66E-01	8.20E-02	3.72E-02
8.00	203.20	6482.1898	20.449	6.74E-02	2.42E+00	1.10E+00	8.13E-02	3.69E-02
8.25	209.55	6611.8336	20.858	7.58E-02	2.72E+00	1.24E+00	8.05E-02	3.65E-02
8.50	215.90	6741.4774	21.266	8.43E-02	3.03E+00	1.37E+00	7.98E-02	3.62E-02
8.75	222.25	6871.1212	21.675	9.29E-02	3.34E+00	1.52E+00	7.90E-02	3.59E-02
9.00	228.60	7000.765	22.084	1.02E-01	3.66E+00	1.66E+00	7.83E-02	3.55E-02
9.25	234.95	6611.8336	20.858	1.10E-01	3.97E+00	1.80E+00	7.75E-02	3.52E-02
9.50	241.30	6222.9022	19.631	1.19E-01	4.26E+00	1.93E+00	7.68E-02	3.48E-02
9.75	247.65	5833.9708	18.404	1.26E-01	4.54E+00	2.06E+00	7.61E-02	3.45E-02
10.00	254.00	5445.0394	17.177	1.33E-01	4.80E+00	2.18E+00	7.55E-02	3.43E-02
10.25	260.35	5056.108	15.95	1.40E-01	5.04E+00	2.28E+00	7.49E-02	3.40E-02
10.50	266.70	4667.1767	14.723	1.46E-01	5.26E+00	2.39E+00	7.44E-02	3.37E-02
10.75	273.05	4278.2453	13.496	1.52E-01	5.46E+00	2.48E+00	7.39E-02	3.35E-02
11.00	279.40	3889.3139	12.269	1.57E-01	5.65E+00	2.56E+00	7.34E-02	3.33E-02
11.25	285.75	3500.3825	11.042	1.62E-01	5.82E+00	2.64E+00	7.30E-02	3.31E-02
11.50	292.10	3111.4511	9.8153	1.66E-01	5.97E+00	2.71E+00	7.27E-02	3.30E-02
11.75	298.45	2722.5197	8.5884	1.70E-01	6.10E+00	2.77E+00	7.23E-02	3.28E-02
12.00	304.80	2333.5883	7.3615	1.73E-01	6.22E+00	2.82E+00	7.21E-02	3.27E-02

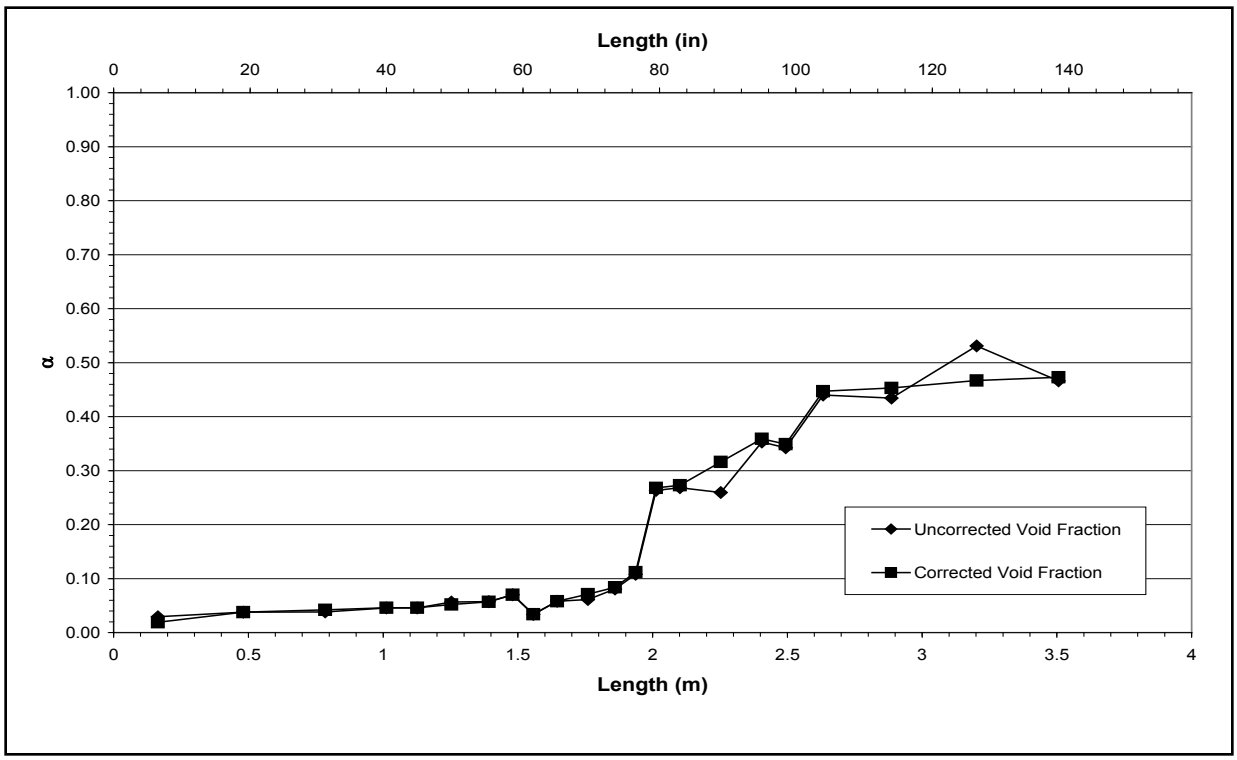

Figure A-570 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659D for Time Period 2730 to 2820 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-E

Test Conditions

Date: 7/9/2003
Steady-state time window: 3680 – 3730 seconds
Inlet flow rate: 2.525 cm/sec (0.994 in./sec)
Inlet mass flow rate: 0.118 kg/sec (0.260 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

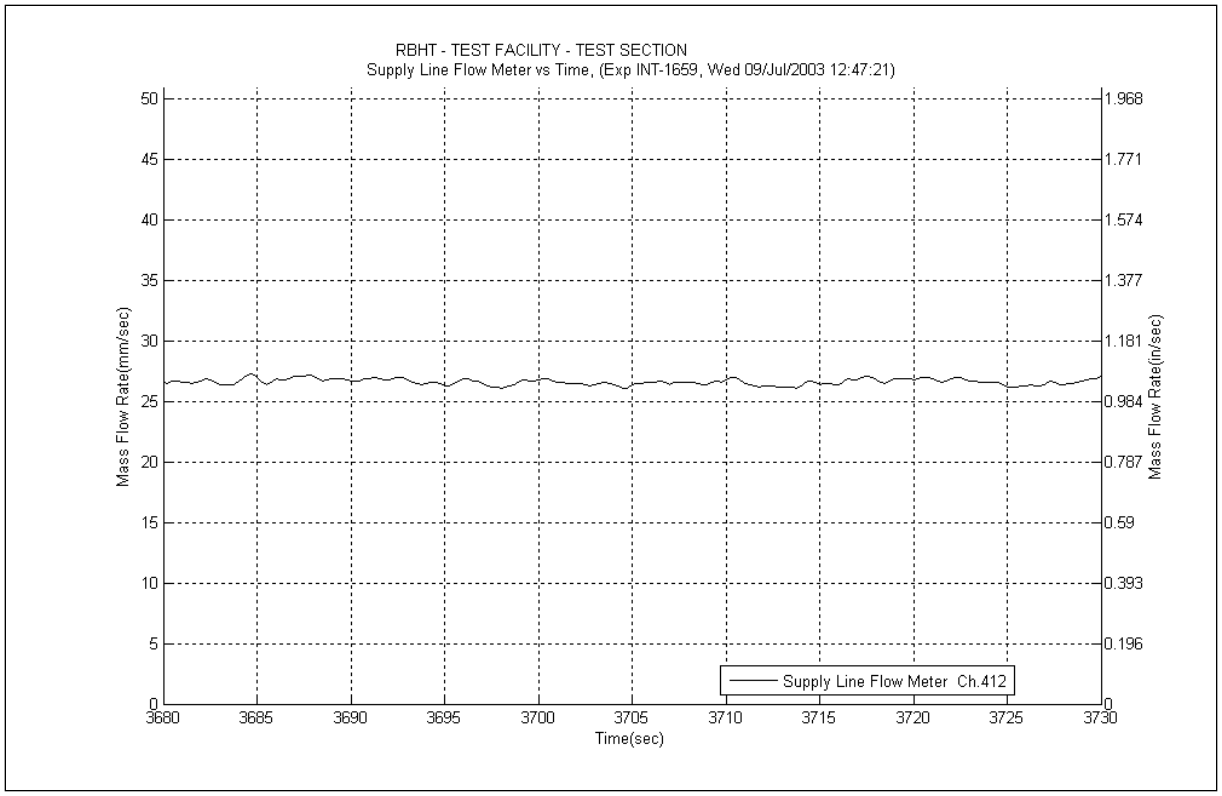

Figure A-571 Inlet Flow Plot for Experiment 1659E

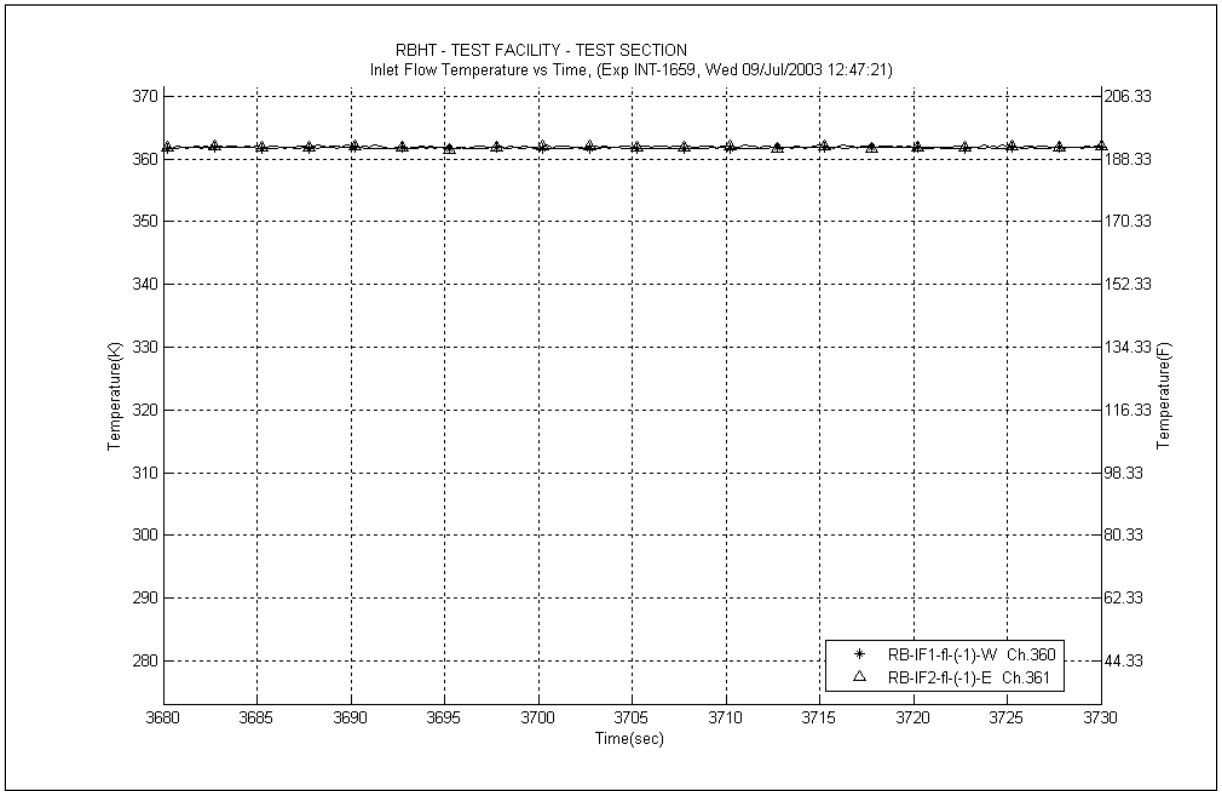

Figure A-572 Inlet Temperature Plot for Experiment 1659E

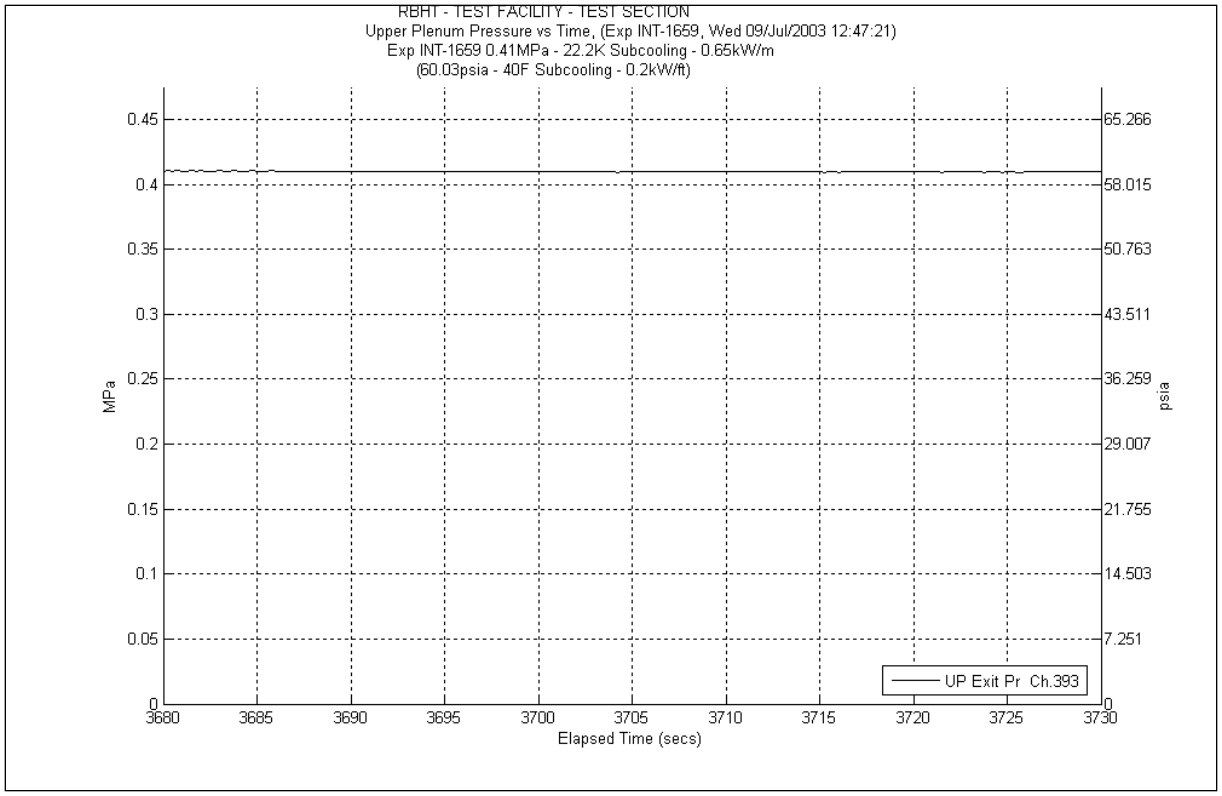

Figure A-573 System Pressure Plot for Experiment 1659E

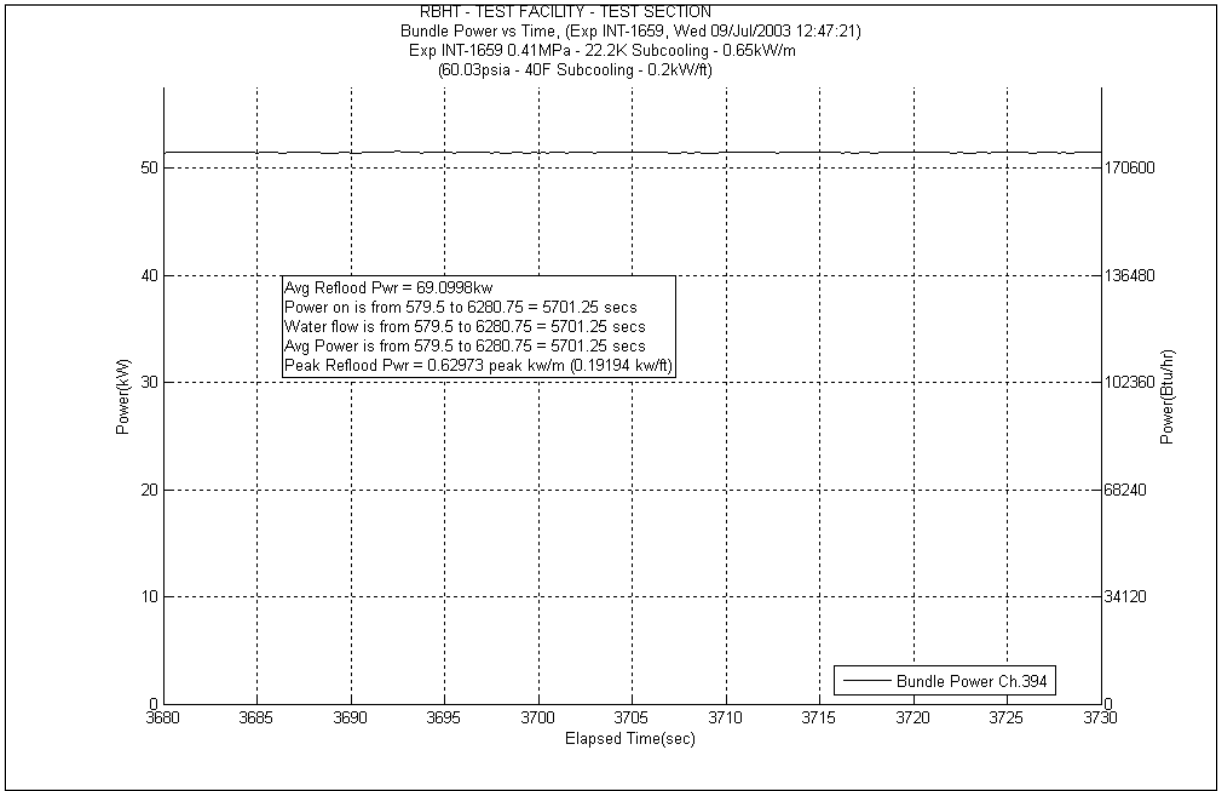

Figure A-574 Bundle Power Plot for Experiment 1659E

Table A-229 Data Results for RBHT Test 1659 for Time Period 3680 to 3730

Results for RBHT Test 1659
Valid Time Period 3680 to 3730 seconds
Collapsed Liquid Level = 112.212 inches = 2850.18 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.476	29.929	1433.016	0.323	15.465	0.079	3.783	0.000	0.000	29.52	1413.425	8669.52	415098.8457	0.483	0.481	0.485
*	120-133	3048-3378	383	0.539	31.098	1488.964	0.350	16.758	0.141	6.751	-4.623	-221.367	35.23	1686.821	8704.75	416785.6671	0.478	0.476	0.480
*	108-120	2743-3048	382	0.444	34.676	1660.289	0.279	13.359	0.176	8.427	1.071	51.273	33.15	1587.231	8737.9	418372.8976	0.468	0.466	0.470
	100-108	2540-2743	381	0.456	22.601	1082.160	0.156	7.469	0.128	6.129	0.000	0.000	22.31	1068.209	8760.21	419441.1062	0.463	0.461	0.465
	97-100	2464-2540	380	0.352	10.091	483.142	0.052	2.490	0.046	2.202	0.000	0.000	9.991	478.372	8770.201	419919.4778	0.359	0.357	0.361
	93-97	2362-2464	379	0.370	13.098	627.115	0.063	3.016	0.061	2.921	0.000	0.000	12.97	621.007	8783.171	420540.4848	0.375	0.373	0.377
*	85-93	2159-2362	378	0.281	29.882	1430.778	0.105	5.027	0.116	5.554	2.811	134.612	26.85	1285.585	8810.021	421826.0697	0.354	0.352	0.356
	81-85	2057-2159	377	0.327	13.980	669.387	0.041	1.963	0.056	2.681	0.000	0.000	13.88	664.578	8823.901	422490.6476	0.332	0.330	0.334
	78-81	1981-2057	376	0.319	10.605	507.760	0.026	1.245	0.041	1.963	0.000	0.000	10.54	504.658	8834.441	422995.3055	0.324	0.322	0.326
	75-78	1905-1981	375	0.158	13.113	627.861	0.021	1.005	0.040	1.915	0.000	0.000	13.05	624.837	8847.491	423620.1429	0.162	0.161	0.163
	72-75	1829-1905	374	0.091	14.162	678.090	0.015	0.718	0.039	1.867	0.000	0.000	14.1	675.112	8861.591	424295.2545	0.094	0.089	0.099
*	67-72	1702-1829	373	0.064	24.315	1164.217	0.013	0.622	0.044	2.107	0.298	14.277	23.96	1147.211	8885.551	425442.4655	0.077	0.073	0.081
	63-67	1600-1702	372	0.060	19.537	935.451	0.001	0.048	0.000	0.000	0.000	0.000	19.53	935.101	8905.081	426377.5669	0.06	0.057	0.063
	60-63	1524-1600	371	0.036	15.024	719.368	0.001	0.048	0.000	0.000	0.000	0.000	15.02	719.161	8920.101	427096.7283	0.036	0.034	0.038
	57-60	1448-1524	370	0.071	14.469	692.761	0.001	0.048	0.000	0.000	0.000	0.000	14.46	692.349	8934.561	427789.0769	0.071	0.067	0.075
	53-57	1346-1448	369	0.058	19.563	936.695	0.001	0.048	0.000	0.000	0.000	0.000	19.55	936.059	8954.111	428725.1359	0.058	0.055	0.061
*	46-53	1168-1346	368	0.057	34.266	1640.645	0.002	0.096	0.000	0.000	-0.176	-8.446	34.44	1648.996	8988.551	430374.1319	0.052	0.049	0.055
	43-46	1092-1168	367	0.046	14.858	711.410	0.001	0.048	0.000	0.000	0.000	0.000	14.85	711.022	9003.401	431085.1538	0.046	0.044	0.048
	37-43	940-1092	366	0.046	29.737	1423.816	0.002	0.096	0.000	0.000	0.000	0.000	29.73	1423.480	9033.131	432508.6338	0.046	0.044	0.048
*	25-37	635-940	365	0.038	59.926	2869.264	0.004	0.192	0.000	0.000	0.232	11.100	59.69	2857.973	9092.821	435366.6063	0.042	0.040	0.044
	13-25	330-635	364	0.038	59.957	2870.756	0.004	0.192	0.000	0.000	0.000	0.000	59.93	2869.464	9152.751	438236.0701	0.038	0.036	0.040
*	0-13	0-330	363	0.030	65.514	3136.820	0.004	0.192	0.000	0.000	-0.700	-33.523	66.21	3170.152	9218.961	441406.222	0.019	0.018	0.020

Table A-230 Energy Balance Results for RBHT Test 1659E for Time Period 3680 to 3730 seconds

Results for RBHT Test 1659
Valid Time Period 3680 to 3730 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2332.5832	7.3583	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
0.25	6.35	2462.1711	7.7671	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
0.50	12.70	2591.7591	8.1759	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
0.75	19.05	2721.347	8.5847	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
1.00	25.40	2850.935	8.9935	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
1.25	31.75	2980.5229	9.4023	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
1.50	38.10	3110.1109	9.8111	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
1.75	44.45	3239.6988	10.22	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
2.00	50.80	3369.2868	10.629	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
2.25	57.15	3498.8748	11.037	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
2.50	63.50	3628.4627	11.446	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
2.75	69.85	3758.0507	11.855	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
3.00	76.20	3887.6386	12.264	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
3.25	82.55	4017.2266	12.673	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
3.50	88.90	4146.8145	13.081	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
3.75	95.25	4276.4025	13.49	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
4.00	101.60	4405.9904	13.899	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
4.25	107.95	4535.5784	14.308	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
4.50	114.30	4665.1663	14.717	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
4.75	120.65	4794.7543	15.125	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
5.00	127.00	4924.3422	15.534	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
5.25	133.35	5053.9302	15.943	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
5.50	139.70	5183.5182	16.352	0.00E+00	0.00E+00	0.00E+00	8.63E-02	3.91E-02
5.75	146.05	5313.1061	16.761	1.13E-03	4.03E-02	1.83E-02	8.62E-02	3.91E-02
6.00	152.40	5442.6941	17.169	8.05E-03	2.86E-01	1.30E-01	8.56E-02	3.88E-02
6.25	158.75	5572.282	17.578	1.51E-02	5.38E-01	2.44E-01	8.50E-02	3.85E-02
6.50	165.10	5701.87	17.987	2.24E-02	7.96E-01	3.61E-01	8.44E-02	3.83E-02
6.75	171.45	5831.4579	18.396	2.98E-02	1.06E+00	4.81E-01	8.37E-02	3.80E-02
7.00	177.80	5961.0459	18.805	3.74E-02	1.33E+00	6.03E-01	8.31E-02	3.77E-02
7.25	184.15	6090.6338	19.213	4.51E-02	1.61E+00	7.28E-01	8.24E-02	3.74E-02
7.50	190.50	6220.2218	19.622	5.30E-02	1.89E+00	8.56E-01	8.17E-02	3.71E-02
7.75	196.85	6349.8097	20.031	6.11E-02	2.17E+00	9.86E-01	8.10E-02	3.67E-02
8.00	203.20	6479.3977	20.44	6.93E-02	2.47E+00	1.12E+00	8.03E-02	3.64E-02
8.25	209.55	6608.9856	20.849	7.77E-02	2.77E+00	1.26E+00	7.96E-02	3.61E-02
8.50	215.90	6738.5736	21.257	8.63E-02	3.07E+00	1.39E+00	7.88E-02	3.58E-02
8.75	222.25	6868.1616	21.666	9.51E-02	3.38E+00	1.53E+00	7.81E-02	3.54E-02
9.00	228.60	6997.7495	22.075	1.04E-01	3.70E+00	1.68E+00	7.73E-02	3.51E-02
9.25	234.95	6608.9856	20.849	1.13E-01	4.01E+00	1.82E+00	7.66E-02	3.47E-02
9.50	241.30	6220.2218	19.622	1.21E-01	4.31E+00	1.95E+00	7.58E-02	3.44E-02
9.75	247.65	5831.4579	18.396	1.29E-01	4.58E+00	2.08E+00	7.52E-02	3.41E-02
10.00	254.00	5442.6941	17.169	1.36E-01	4.84E+00	2.20E+00	7.45E-02	3.38E-02
10.25	260.35	5053.9302	15.943	1.43E-01	5.08E+00	2.30E+00	7.40E-02	3.36E-02
10.50	266.70	4665.1663	14.717	1.49E-01	5.30E+00	2.40E+00	7.34E-02	3.33E-02
10.75	273.05	4276.4025	13.49	1.55E-01	5.51E+00	2.50E+00	7.29E-02	3.31E-02
11.00	279.40	3887.6386	12.264	1.60E-01	5.69E+00	2.58E+00	7.25E-02	3.29E-02
11.25	285.75	3498.8748	11.037	1.65E-01	5.86E+00	2.66E+00	7.21E-02	3.27E-02
11.50	292.10	3110.1109	9.8111	1.69E-01	6.01E+00	2.73E+00	7.17E-02	3.25E-02
11.75	298.45	2721.347	8.5847	1.73E-01	6.15E+00	2.79E+00	7.14E-02	3.24E-02
12.00	304.80	2332.5832	7.3583	1.76E-01	6.26E+00	2.84E+00	7.11E-02	3.23E-02

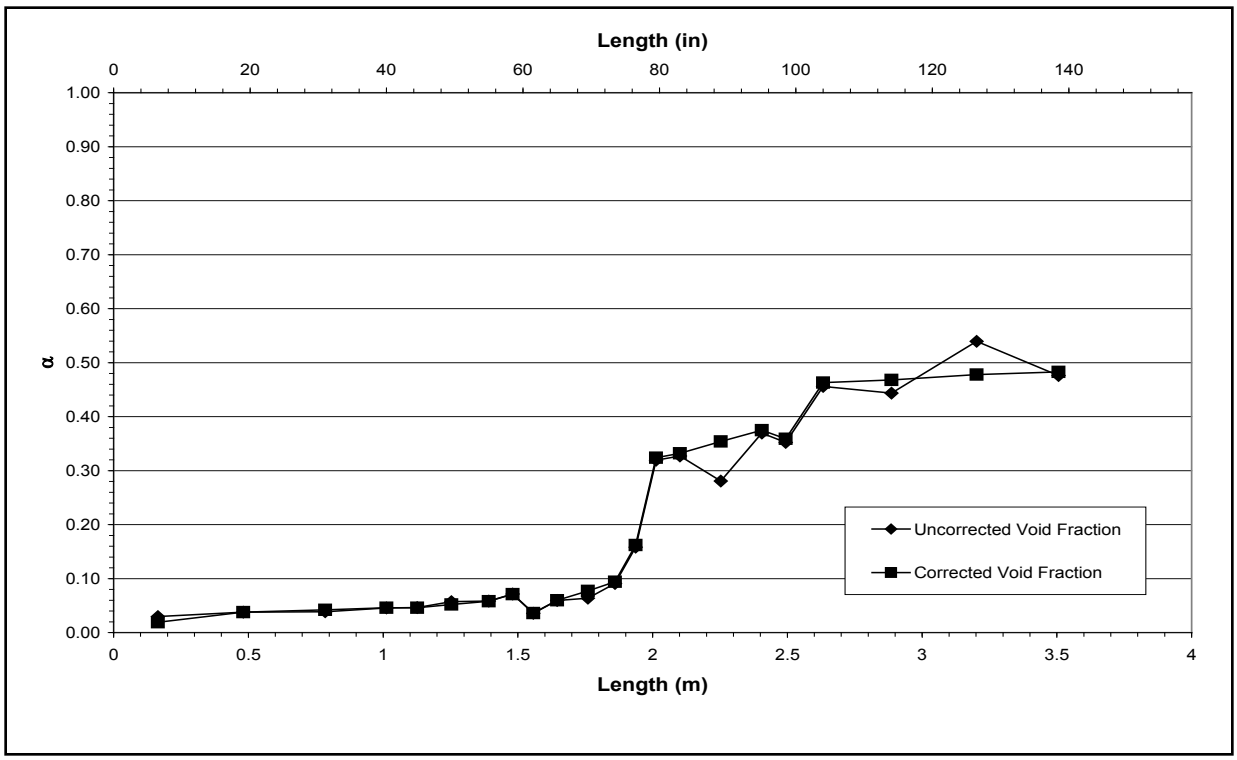

Figure A-575 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659E for Time Period 3680 to 3730 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-F

Test Conditions

Date: 7/9/2003
Steady-state time window: 996 – 1146 seconds
Inlet flow rate: 2.032 cm/sec (0.800 in./sec)
Inlet mass flow rate: 0.095 kg/sec (0.209 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

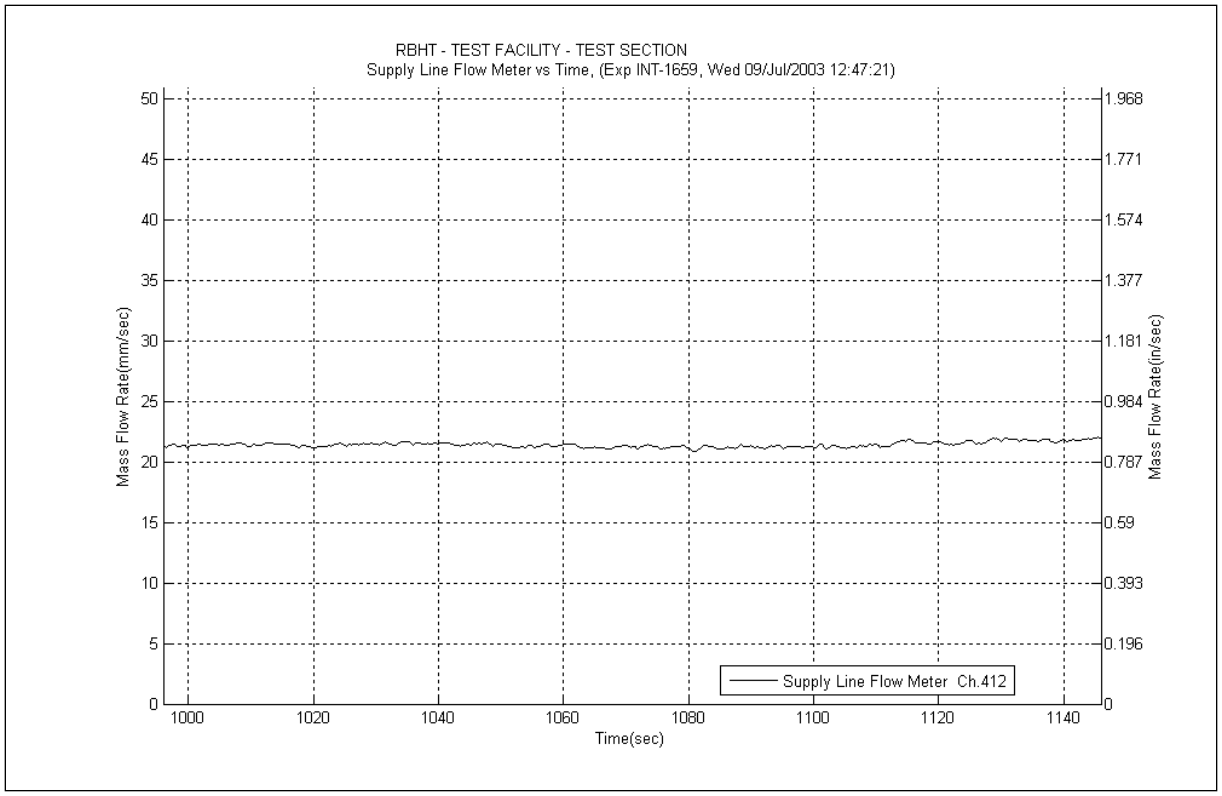

Figure A-576 Inlet Flow Plot for Experiment 1659F

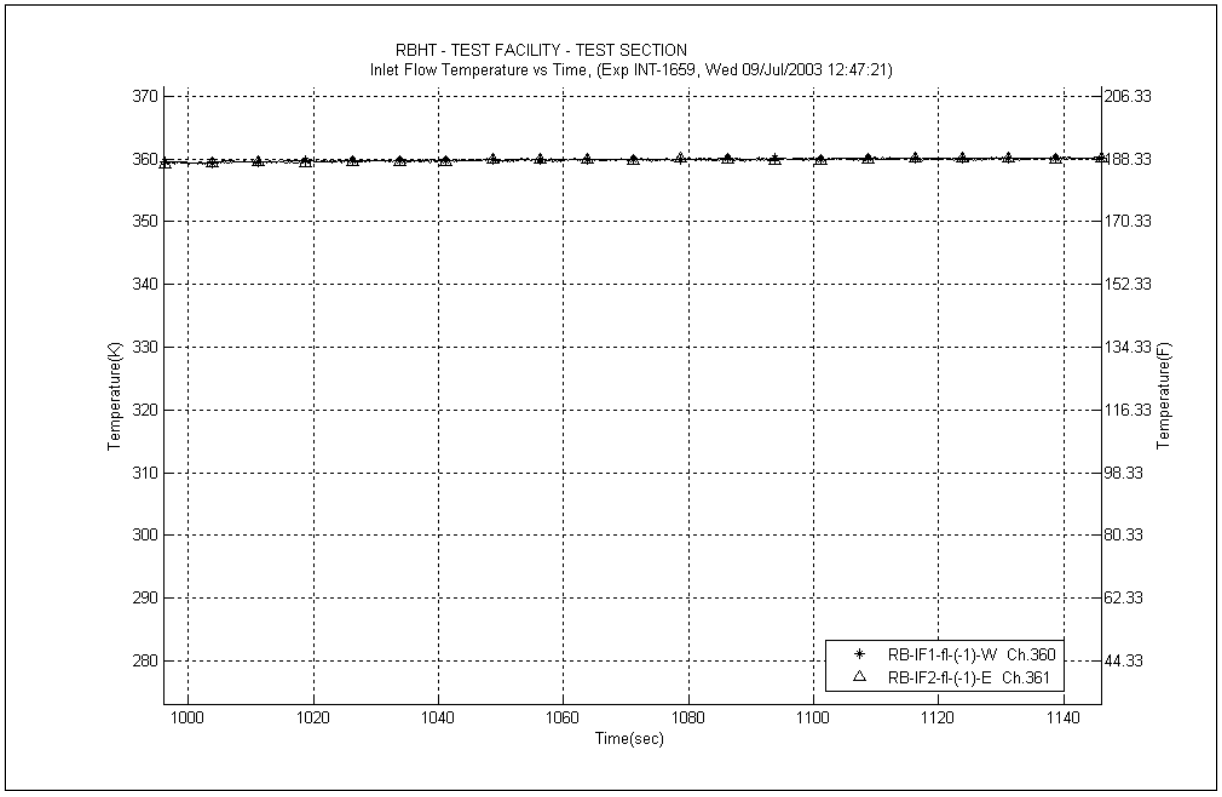

Figure A-577 Inlet Temperature Plot for Experiment 1659F

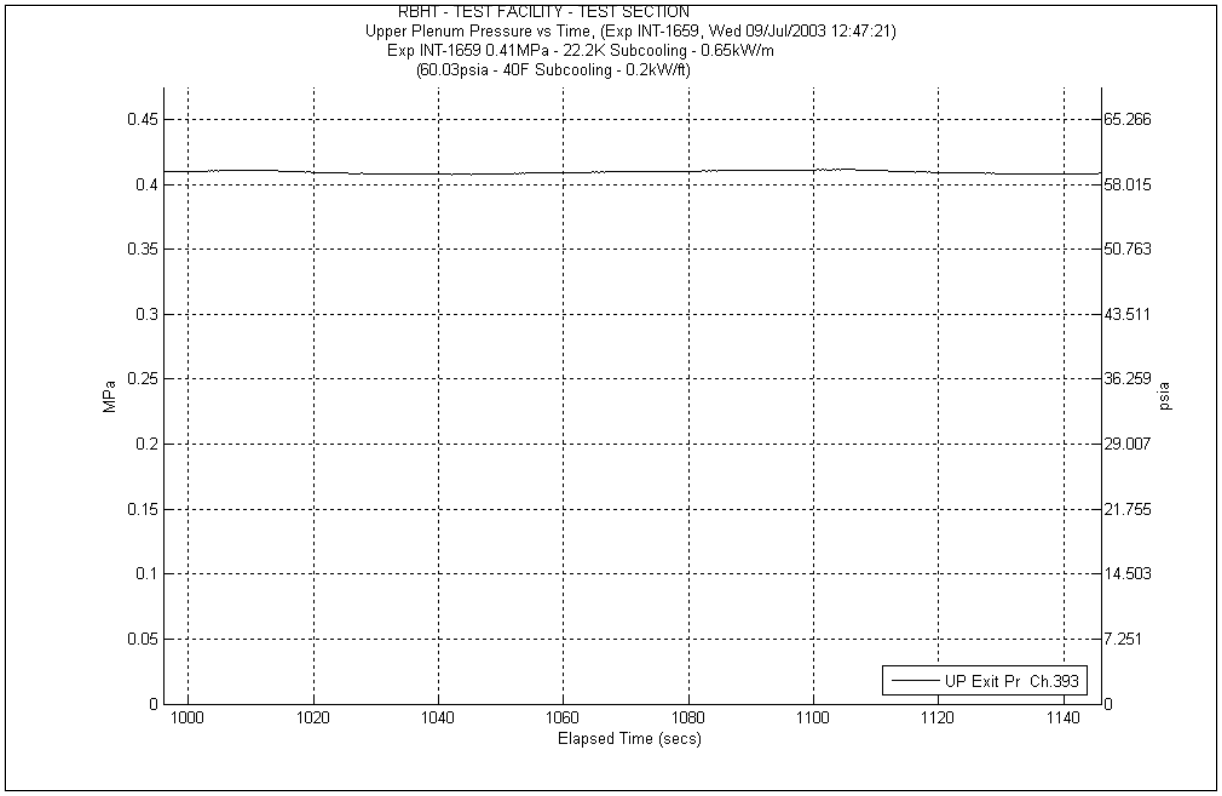

Figure A-578 System Pressure Plot for Experiment 1659F

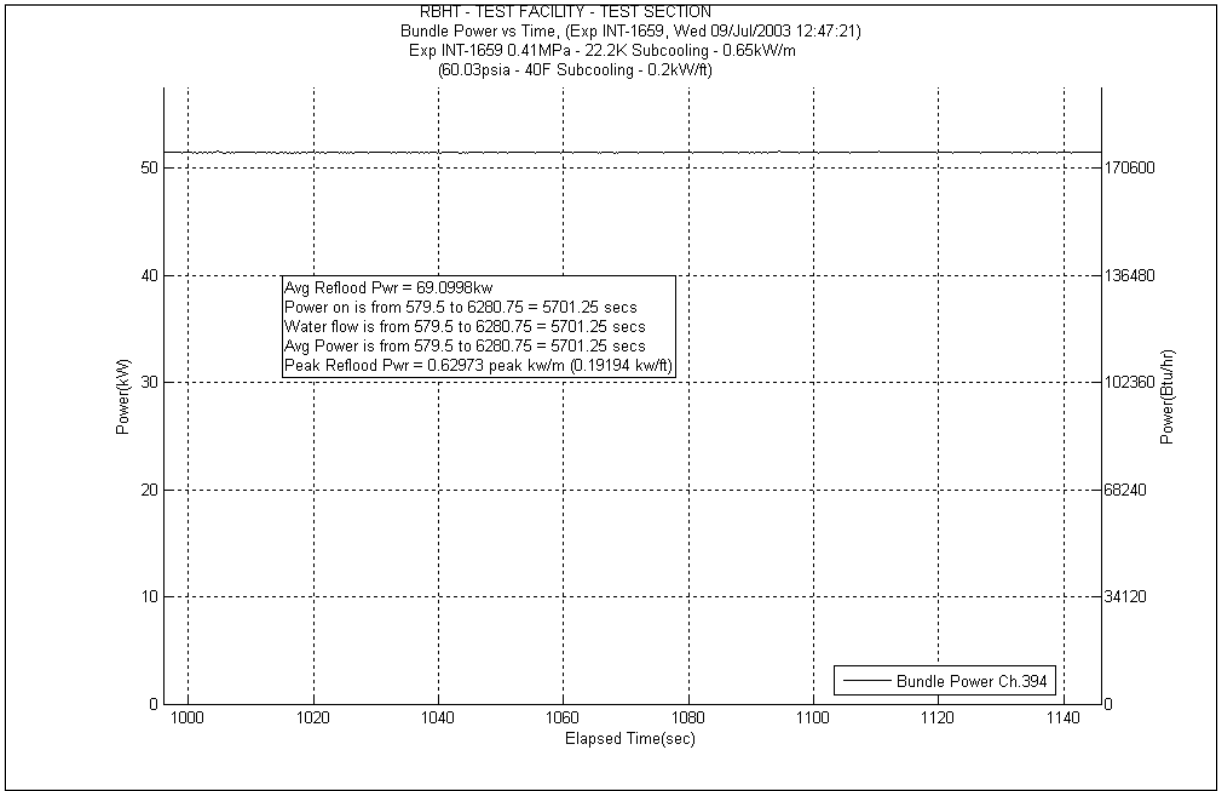

Figure A-579 Bundle Power Plot for Experiment 1659F

Table A-231 Data Results for RBHT Test 1659 for Time Period 996 to 1146

Results for RBHT Test 1659
Valid Time Period 996 to 1146 seconds
Collapsed Liquid Level = 109.254 inches = 2775.06 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.484	29.457	1410.388	0.272	13.023	0.064	3.064	0.000	0.000	29.11	1393.794	8669.11	415079.2148	0.49	0.488	0.492
*	120-133	3048-3378	383	0.553	30.158	1443.957	0.297	14.220	0.113	5.410	-4.982	-238.555	34.73	1662.881	8703.84	416742.0961	0.485	0.483	0.487
*	108-120	2743-3048	382	0.449	34.323	1643.381	0.240	11.491	0.142	6.799	1.291	61.800	32.65	1563.290	8736.49	418305.3865	0.476	0.474	0.478
	100-108	2540-2743	381	0.465	22.217	1063.759	0.137	6.560	0.104	4.980	0.000	0.000	21.97	1051.929	8758.46	419357.3157	0.471	0.469	0.473
	97-100	2464-2540	380	0.361	9.956	476.677	0.046	2.202	0.037	1.772	0.000	0.000	9.867	472.434	8768.327	419829.7502	0.367	0.365	0.369
	93-97	2362-2464	379	0.384	12.791	612.445	0.057	2.729	0.049	2.346	0.000	0.000	12.68	607.122	8781.007	420436.8719	0.39	0.388	0.392
*	85-93	2159-2362	378	0.294	29.342	1404.918	0.100	4.788	0.094	4.501	2.728	130.632	26.42	1264.996	8807.427	421701.8683	0.364	0.362	0.366
	81-85	2057-2159	377	0.334	13.830	662.176	0.042	2.011	0.045	2.155	0.000	0.000	13.74	657.875	8821.167	422359.743	0.339	0.337	0.341
	78-81	1981-2057	376	0.345	10.210	488.862	0.028	1.341	0.033	1.580	0.000	0.000	10.14	485.506	8831.307	422845.2488	0.349	0.347	0.351
	75-78	1905-1981	375	0.217	12.204	584.346	0.025	1.197	0.032	1.532	0.000	0.000	12.14	581.266	8843.447	423426.5151	0.22	0.219	0.221
	72-75	1829-1905	374	0.171	12.921	618.661	0.022	1.053	0.031	1.484	0.000	0.000	12.87	616.219	8856.317	424042.734	0.174	0.173	0.175
*	67-72	1702-1829	373	0.103	23.297	1115.480	0.029	1.389	0.051	2.442	0.377	18.064	22.84	1093.585	8879.157	425136.3191	0.12	0.119	0.121
	63-67	1600-1702	372	0.064	19.449	931.224	0.015	0.718	0.039	1.867	0.000	0.000	19.39	928.398	8898.547	426064.7173	0.066	0.063	0.069
	60-63	1524-1600	371	0.041	14.946	715.638	0.005	0.239	0.028	1.341	0.000	0.000	14.91	713.895	8913.457	426778.6119	0.043	0.041	0.045
	57-60	1448-1524	370	0.075	14.406	689.777	0.001	0.048	0.001	0.048	0.000	0.000	14.4	689.476	8927.857	427468.0876	0.075	0.071	0.079
	53-57	1346-1448	369	0.062	19.496	933.462	0.001	0.048	0.000	0.000	0.000	0.000	19.49	933.186	8947.347	428401.2738	0.061	0.058	0.064
*	46-53	1168-1346	368	0.060	34.177	1636.418	0.001	0.048	0.000	0.000	-0.164	-7.838	34.34	1644.208	8981.687	430045.4819	0.055	0.052	0.058
	43-46	1092-1168	367	0.049	14.817	709.421	0.001	0.048	0.000	0.000	0.000	0.000	14.81	709.107	8996.497	430754.5885	0.049	0.047	0.051
	37-43	940-1092	366	0.048	29.675	1420.832	0.001	0.048	0.000	0.000	0.000	0.000	29.66	1420.128	9026.157	432174.7169	0.048	0.046	0.050
*	25-37	635-940	365	0.040	59.806	2863.545	0.002	0.096	0.000	0.000	0.194	9.307	59.61	2854.142	9085.767	435028.859	0.043	0.041	0.045
	13-25	330-635	364	0.039	59.910	2868.518	0.002	0.096	0.000	0.000	0.000	0.000	59.89	2867.549	9145.657	437896.4076	0.039	0.037	0.041
*	0-13	0-330	363	0.029	65.529	3137.566	0.003	0.144	0.000	0.000	-0.664	-31.772	66.19	3169.194	9211.847	441065.6018	0.019	0.018	0.020

Table A-232 Energy Balance Results for RBHT Test 1659F for Time Period 996 to 1146 seconds

Results for RBHT Test 1659 Valid Time Period 996 to 1146 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2332.7696	7.3589	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
0.25	6.35	2462.3679	7.7677	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
0.50	12.70	2591.9662	8.1765	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
0.75	19.05	2721.5645	8.5854	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
1.00	25.40	2851.1629	8.9942	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
1.25	31.75	2980.7612	9.403	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
1.50	38.10	3110.3595	9.8119	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
1.75	44.45	3239.9578	10.221	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
2.00	50.80	3369.5561	10.63	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
2.25	57.15	3499.1544	11.038	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
2.50	63.50	3628.7527	11.447	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
2.75	69.85	3758.351	11.856	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
3.00	76.20	3887.9493	12.265	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
3.25	82.55	4017.5477	12.674	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
3.50	88.90	4147.146	13.082	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
3.75	95.25	4276.7443	13.491	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
4.00	101.60	4406.3426	13.9	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
4.25	107.95	4535.9409	14.309	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
4.50	114.30	4665.5392	14.718	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
4.75	120.65	4795.1375	15.127	0.00E+00	0.00E+00	0.00E+00	6.95E-02	3.15E-02
5.00	127.00	4924.7358	15.535	1.67E-04	4.79E-03	2.17E-03	6.94E-02	3.15E-02
5.25	133.35	5054.3342	15.944	8.13E-03	2.33E-01	1.06E-01	6.89E-02	3.13E-02
5.50	139.70	5183.9325	16.353	1.63E-02	4.68E-01	2.12E-01	6.83E-02	3.10E-02
5.75	146.05	5313.5308	16.762	2.47E-02	7.08E-01	3.21E-01	6.77E-02	3.07E-02
6.00	152.40	5443.1291	17.171	3.33E-02	9.55E-01	4.33E-01	6.71E-02	3.05E-02
6.25	158.75	5572.7274	17.58	4.21E-02	1.21E+00	5.48E-01	6.65E-02	3.02E-02
6.50	165.10	5702.3257	17.988	5.11E-02	1.47E+00	6.65E-01	6.59E-02	2.99E-02
6.75	171.45	5831.924	18.397	6.03E-02	1.73E+00	7.84E-01	6.53E-02	2.96E-02
7.00	177.80	5961.5223	18.806	6.97E-02	2.00E+00	9.07E-01	6.46E-02	2.93E-02
7.25	184.15	6091.1206	19.215	7.93E-02	2.28E+00	1.03E+00	6.40E-02	2.90E-02
7.50	190.50	6220.719	19.624	8.91E-02	2.56E+00	1.16E+00	6.33E-02	2.87E-02
7.75	196.85	6350.3173	20.033	9.92E-02	2.85E+00	1.29E+00	6.26E-02	2.84E-02
8.00	203.20	6479.9156	20.441	1.09E-01	3.14E+00	1.42E+00	6.19E-02	2.81E-02
8.25	209.55	6609.5139	20.85	1.20E-01	3.44E+00	1.56E+00	6.11E-02	2.77E-02
8.50	215.90	6739.1122	21.259	1.31E-01	3.75E+00	1.70E+00	6.04E-02	2.74E-02
8.75	222.25	6868.7105	21.668	1.41E-01	4.06E+00	1.84E+00	5.96E-02	2.71E-02
9.00	228.60	6998.3088	22.077	1.52E-01	4.37E+00	1.98E+00	5.89E-02	2.67E-02
9.25	234.95	6609.5139	20.85	1.63E-01	4.69E+00	2.13E+00	5.81E-02	2.64E-02
9.50	241.30	6220.719	19.624	1.74E-01	4.98E+00	2.26E+00	5.74E-02	2.60E-02
9.75	247.65	5831.924	18.397	1.83E-01	5.25E+00	2.38E+00	5.67E-02	2.57E-02
10.00	254.00	5443.1291	17.171	1.92E-01	5.51E+00	2.50E+00	5.61E-02	2.55E-02
10.25	260.35	5054.3342	15.944	2.01E-01	5.75E+00	2.61E+00	5.55E-02	2.52E-02
10.50	266.70	4665.5392	14.718	2.08E-01	5.98E+00	2.71E+00	5.50E-02	2.49E-02
10.75	273.05	4276.7443	13.491	2.15E-01	6.18E+00	2.80E+00	5.45E-02	2.47E-02
11.00	279.40	3887.9493	12.265	2.22E-01	6.37E+00	2.89E+00	5.40E-02	2.45E-02
11.25	285.75	3499.1544	11.038	2.28E-01	6.54E+00	2.97E+00	5.36E-02	2.43E-02
11.50	292.10	3110.3595	9.8119	2.33E-01	6.69E+00	3.03E+00	5.33E-02	2.42E-02
11.75	298.45	2721.5645	8.5854	2.38E-01	6.82E+00	3.10E+00	5.29E-02	2.40E-02
12.00	304.80	2332.7696	7.3589	2.42E-01	6.94E+00	3.15E+00	5.27E-02	2.39E-02

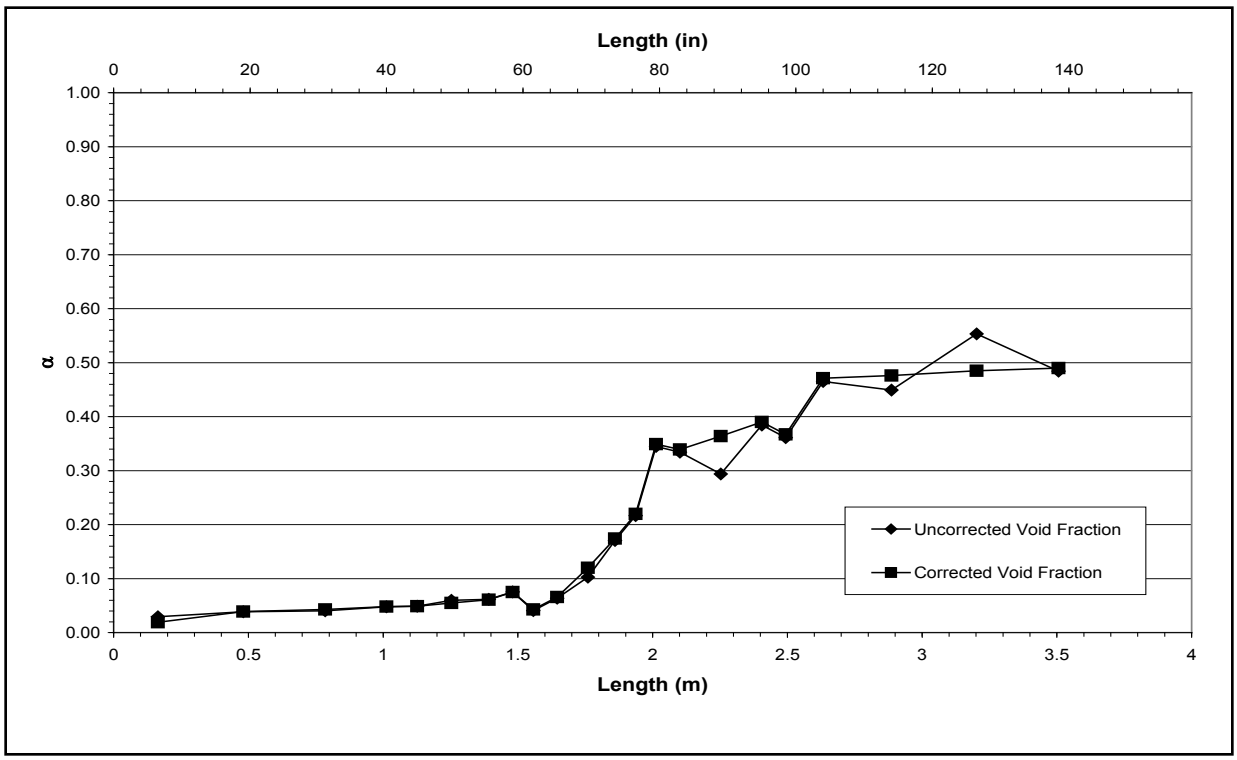

Figure A-580 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659F for Time Period 996 to 1146 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-G

Test Conditions

Date: 7/9/2003
Steady-state time window: 1443 – 1620 seconds
Inlet flow rate: 2.090 cm/sec (0.823 in./sec)
Inlet mass flow rate: 0.098 kg/sec (0.216 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

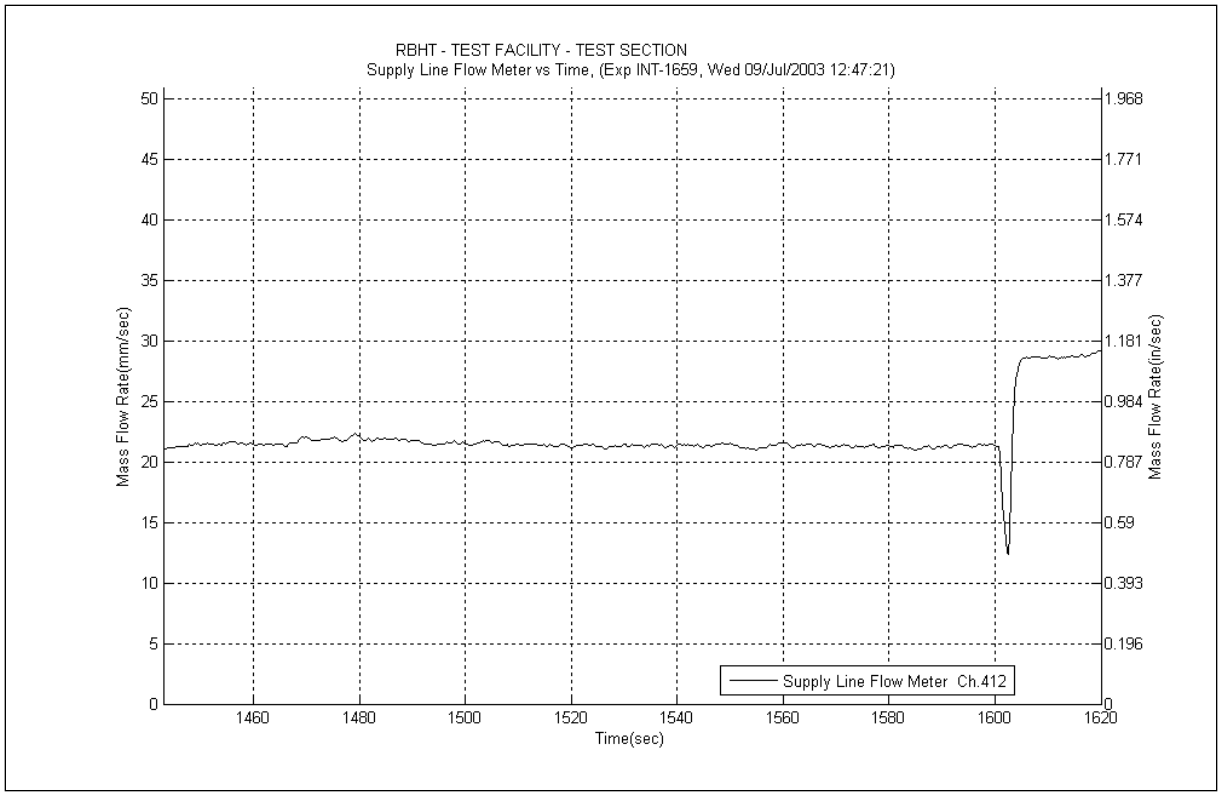

Figure A-581 Inlet Flow Plot for Experiment 1659G

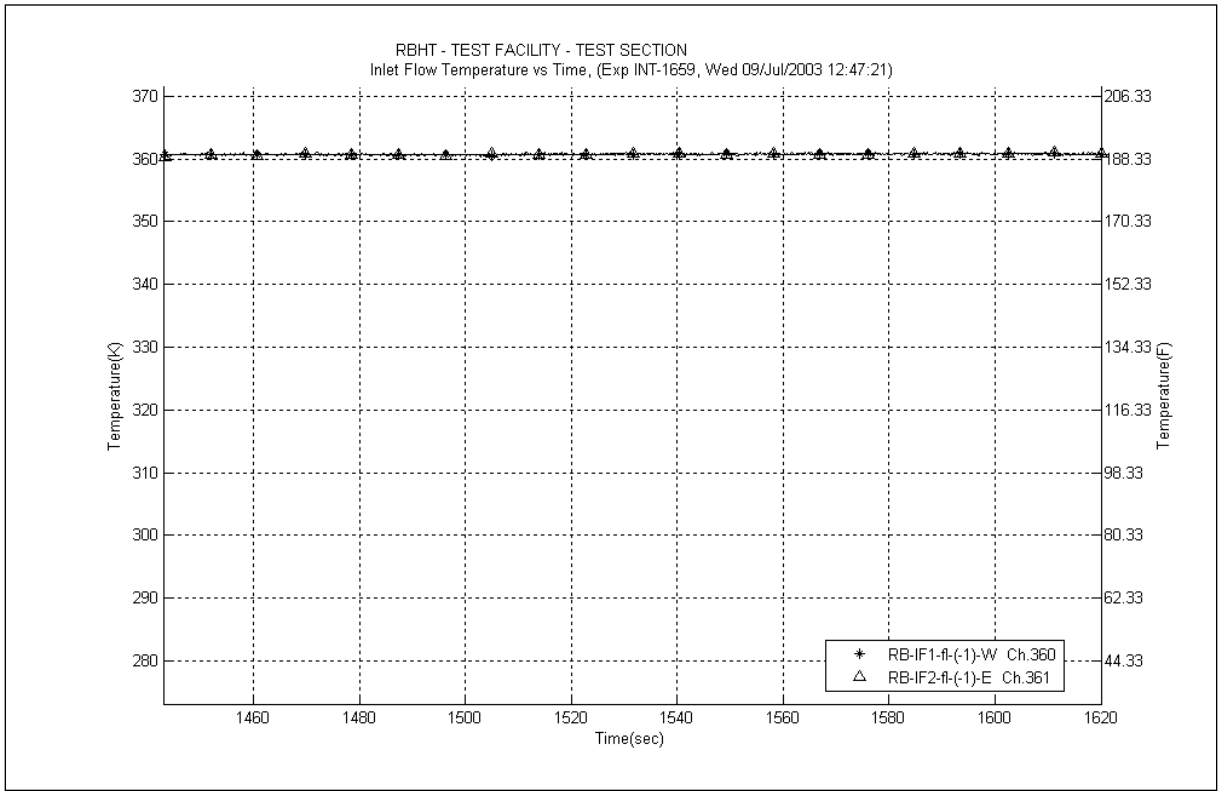

Figure A-582 Inlet Temperature Plot for Experiment 1659G

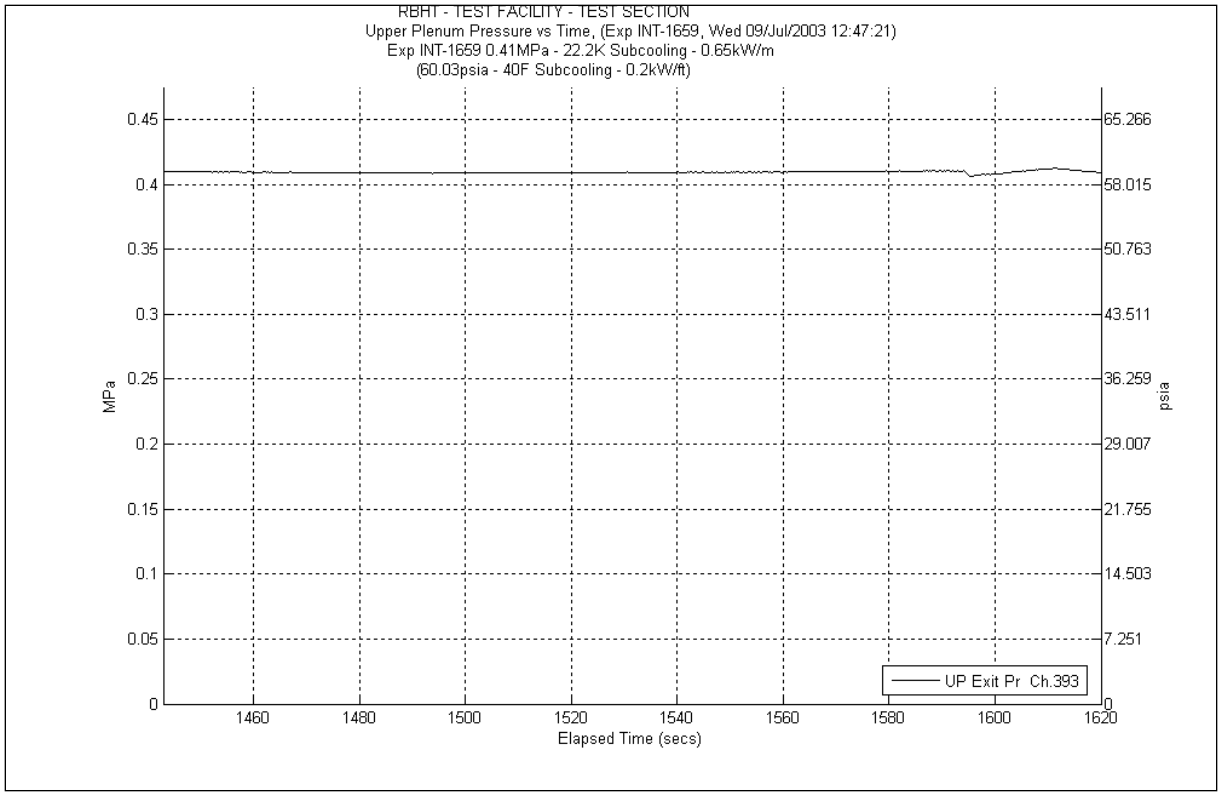

Figure A-583 System Pressure Plot for Experiment 1659G

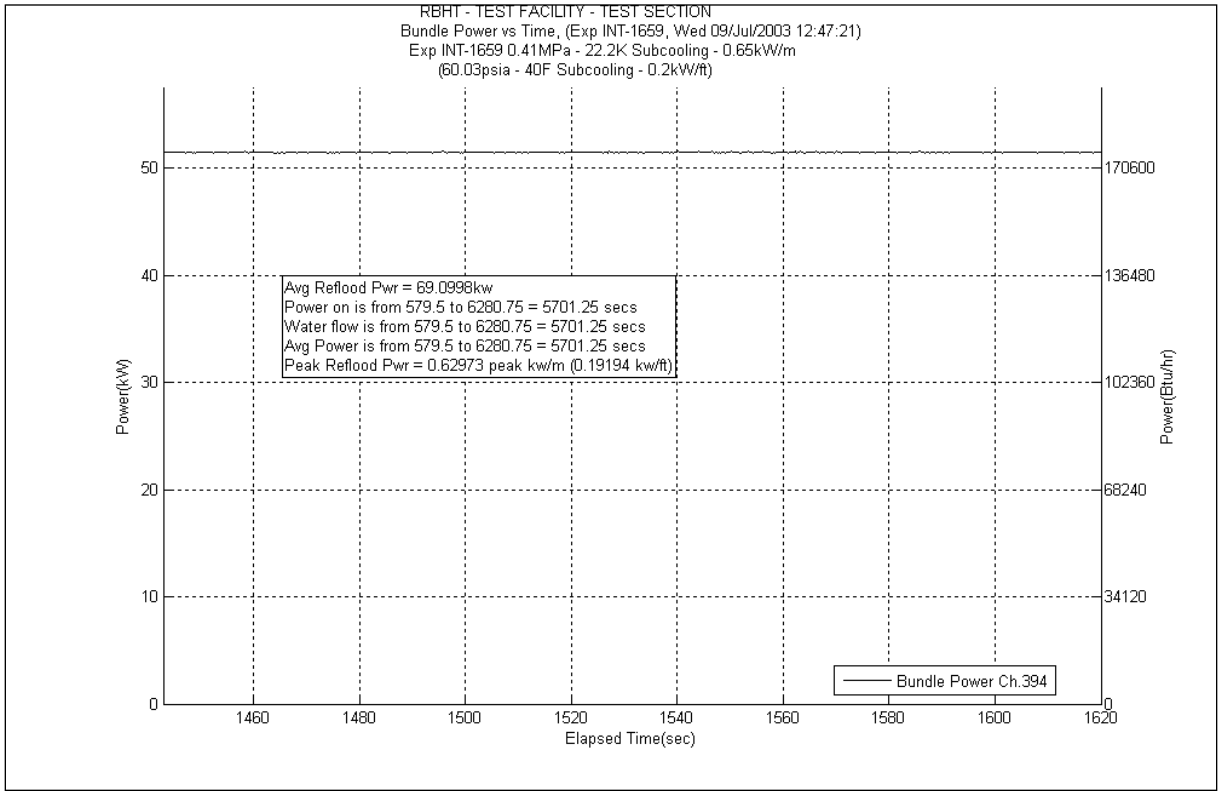

Figure A-584 Bundle Power Plot for Experiment 1659G

Table A-233 Data Results for RBHT Test 1659 for Time Period 1443 to 1620

Results for RBHT Test 1659
Valid Time Period 1443 to 1620 seconds
Collapsed Liquid Level = 107.382 inches = 2727.50 mm
(Z_{osv}) Onset of Significant Void = 44.5 inches = 1130 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.500	28.553	1367.122	0.279	13.359	0.065	3.112	0.000	0.000	28.2	1350.223	8668.2	415035.6437	0.506	0.503	0.509
*	120-133	3048-3378	383	0.568	29.150	1395.717	0.305	14.603	0.117	5.602	-4.692	-224.646	33.42	1600.158	8701.62	416635.8019	0.505	0.502	0.508
*	108-120	2743-3048	382	0.463	33.440	1601.109	0.246	11.779	0.146	6.991	2.028	97.094	31.02	1485.246	8732.64	418121.0475	0.502	0.499	0.505
	100-108	2540-2743	381	0.495	20.986	1004.827	0.141	6.751	0.106	5.075	0.000	0.000	20.73	992.558	8753.37	419113.6052	0.501	0.498	0.504
	97-100	2464-2540	380	0.382	9.628	461.012	0.047	2.250	0.039	1.867	0.000	0.000	9.539	456.730	8762.909	419570.335	0.388	0.386	0.390
	93-97	2362-2464	379	0.406	12.350	591.309	0.059	2.825	0.050	2.394	0.000	0.000	12.24	586.054	8775.149	420156.3893	0.411	0.409	0.413
*	85-93	2159-2362	378	0.330	27.857	1333.801	0.102	4.884	0.096	4.597	3.079	147.424	24.58	1176.897	8799.729	421333.2861	0.408	0.406	0.410
	81-85	2057-2159	377	0.401	12.443	595.785	0.043	2.059	0.046	2.202	0.000	0.000	12.35	591.321	8812.079	421924.6072	0.405	0.403	0.407
	78-81	1981-2057	376	0.403	9.296	445.098	0.029	1.389	0.034	1.628	0.000	0.000	9.229	441.887	8821.308	422366.4941	0.408	0.406	0.410
	75-78	1905-1981	375	0.276	11.280	540.085	0.025	1.197	0.033	1.580	0.000	0.000	11.22	537.216	8832.528	422903.7106	0.28	0.279	0.281
	72-75	1829-1905	374	0.220	12.147	581.611	0.022	1.053	0.032	1.532	0.000	0.000	12.09	578.872	8844.618	423482.5829	0.224	0.223	0.225
*	67-72	1702-1829	373	0.174	21.454	1027.206	0.029	1.389	0.052	2.490	-0.617	-29.559	21.99	1052.887	8866.608	424535.4698	0.153	0.152	0.154
	63-67	1600-1702	372	0.079	19.137	916.305	0.015	0.718	0.040	1.915	0.000	0.000	19.08	913.555	8885.688	425449.0251	0.081	0.077	0.085
	60-63	1524-1600	371	0.045	14.884	712.654	0.005	0.239	0.024	1.149	0.000	0.000	14.85	711.022	8900.538	426160.0469	0.047	0.045	0.049
	57-60	1448-1524	370	0.078	14.365	687.788	0.001	0.048	0.000	0.000	0.000	0.000	14.36	687.560	8914.898	426847.6074	0.078	0.074	0.082
	53-57	1346-1448	369	0.064	19.449	931.224	0.001	0.048	0.000	0.000	0.000	0.000	19.44	930.792	8934.338	427778.3996	0.064	0.061	0.067
*	46-53	1168-1346	368	0.062	34.099	1632.688	0.002	0.096	0.000	0.000	-0.163	-7.785	34.26	1640.378	8968.598	429418.7772	0.057	0.054	0.060
	43-46	1092-1168	367	0.050	14.796	708.427	0.001	0.048	0.000	0.000	0.000	0.000	14.79	708.149	8983.388	430126.9262	0.05	0.048	0.053
	37-43	940-1092	366	0.049	29.644	1419.340	0.001	0.048	0.000	0.000	0.000	0.000	29.63	1418.692	9013.018	431545.6182	0.049	0.047	0.051
*	25-37	635-940	365	0.041	59.739	2860.313	0.003	0.144	0.000	0.000	0.176	8.421	59.56	2851.748	9072.578	434397.3663	0.044	0.042	0.046
	13-25	330-635	364	0.039	59.864	2866.280	0.003	0.144	0.000	0.000	0.000	0.000	59.84	2865.155	9132.418	437262.5209	0.039	0.037	0.041
*	0-13	0-330	363	0.030	65.493	3135.826	0.003	0.144	0.000	0.000	-0.670	-32.076	66.16	3167.758	9198.578	440430.2787	0.02	0.019	0.021

Table A-234 Energy Balance Results for RBHT Test 1659G for Time Period 1443 to 1620 seconds

Results for RBHT Test 1659
Valid Time Period 1443 to 1620 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2333.0687	7.3598	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
0.25	6.35	2462.6836	7.7687	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
0.50	12.70	2592.2986	8.1776	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
0.75	19.05	2721.9135	8.5865	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
1.00	25.40	2851.5284	8.9953	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
1.25	31.75	2981.1433	9.4042	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
1.50	38.10	3110.7583	9.8131	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
1.75	44.45	3240.3732	10.222	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
2.00	50.80	3369.9881	10.631	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
2.25	57.15	3499.603	11.04	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
2.50	63.50	3629.218	11.449	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
2.75	69.85	3758.8329	11.858	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
3.00	76.20	3888.4478	12.266	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
3.25	82.55	4018.0628	12.675	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
3.50	88.90	4147.6777	13.084	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
3.75	95.25	4277.2926	13.493	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
4.00	101.60	4406.9075	13.902	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
4.25	107.95	4536.5225	14.311	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
4.50	114.30	4666.1374	14.72	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
4.75	120.65	4795.7523	15.129	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
5.00	127.00	4925.3672	15.537	0.00E+00	0.00E+00	0.00E+00	7.15E-02	3.24E-02
5.25	133.35	5054.9822	15.946	6.35E-03	1.87E-01	8.50E-02	7.10E-02	3.22E-02
5.50	139.70	5184.5971	16.355	1.43E-02	4.22E-01	1.91E-01	7.05E-02	3.20E-02
5.75	146.05	5314.212	16.764	2.24E-02	6.62E-01	3.00E-01	6.99E-02	3.17E-02
6.00	152.40	5443.827	17.173	3.08E-02	9.08E-01	4.12E-01	6.93E-02	3.14E-02
6.25	158.75	5573.4419	17.582	3.93E-02	1.16E+00	5.26E-01	6.87E-02	3.12E-02
6.50	165.10	5703.0568	17.991	4.81E-02	1.42E+00	6.43E-01	6.81E-02	3.09E-02
6.75	171.45	5832.6717	18.4	5.70E-02	1.68E+00	7.63E-01	6.74E-02	3.06E-02
7.00	177.80	5962.2867	18.808	6.62E-02	1.95E+00	8.85E-01	6.68E-02	3.03E-02
7.25	184.15	6091.9016	19.217	7.55E-02	2.23E+00	1.01E+00	6.61E-02	3.00E-02
7.50	190.50	6221.5165	19.626	8.51E-02	2.51E+00	1.14E+00	6.54E-02	2.97E-02
7.75	196.85	6351.1314	20.035	9.48E-02	2.80E+00	1.27E+00	6.47E-02	2.94E-02
8.00	203.20	6480.7464	20.444	1.05E-01	3.09E+00	1.40E+00	6.40E-02	2.90E-02
8.25	209.55	6610.3613	20.853	1.15E-01	3.39E+00	1.54E+00	6.33E-02	2.87E-02
8.50	215.90	6739.9762	21.262	1.25E-01	3.70E+00	1.68E+00	6.25E-02	2.84E-02
8.75	222.25	6869.5912	21.671	1.36E-01	4.01E+00	1.82E+00	6.18E-02	2.80E-02
9.00	228.60	6999.2061	22.079	1.47E-01	4.32E+00	1.96E+00	6.10E-02	2.77E-02
9.25	234.95	6610.3613	20.853	1.57E-01	4.63E+00	2.10E+00	6.03E-02	2.73E-02
9.50	241.30	6221.5165	19.626	1.67E-01	4.93E+00	2.24E+00	5.95E-02	2.70E-02
9.75	247.65	5832.6717	18.4	1.76E-01	5.20E+00	2.36E+00	5.89E-02	2.67E-02
10.00	254.00	5443.827	17.173	1.85E-01	5.46E+00	2.48E+00	5.82E-02	2.64E-02
10.25	260.35	5054.9822	15.946	1.93E-01	5.70E+00	2.59E+00	5.77E-02	2.62E-02
10.50	266.70	4666.1374	14.72	2.01E-01	5.93E+00	2.69E+00	5.71E-02	2.59E-02
10.75	273.05	4277.2926	13.493	2.08E-01	6.13E+00	2.78E+00	5.66E-02	2.57E-02
11.00	279.40	3888.4478	12.266	2.14E-01	6.32E+00	2.86E+00	5.62E-02	2.55E-02
11.25	285.75	3499.603	11.04	2.20E-01	6.49E+00	2.94E+00	5.58E-02	2.53E-02
11.50	292.10	3110.7583	9.8131	2.25E-01	6.64E+00	3.01E+00	5.54E-02	2.51E-02
11.75	298.45	2721.9135	8.5865	2.30E-01	6.77E+00	3.07E+00	5.51E-02	2.50E-02
12.00	304.80	2333.0687	7.3598	2.33E-01	6.89E+00	3.12E+00	5.48E-02	2.49E-02

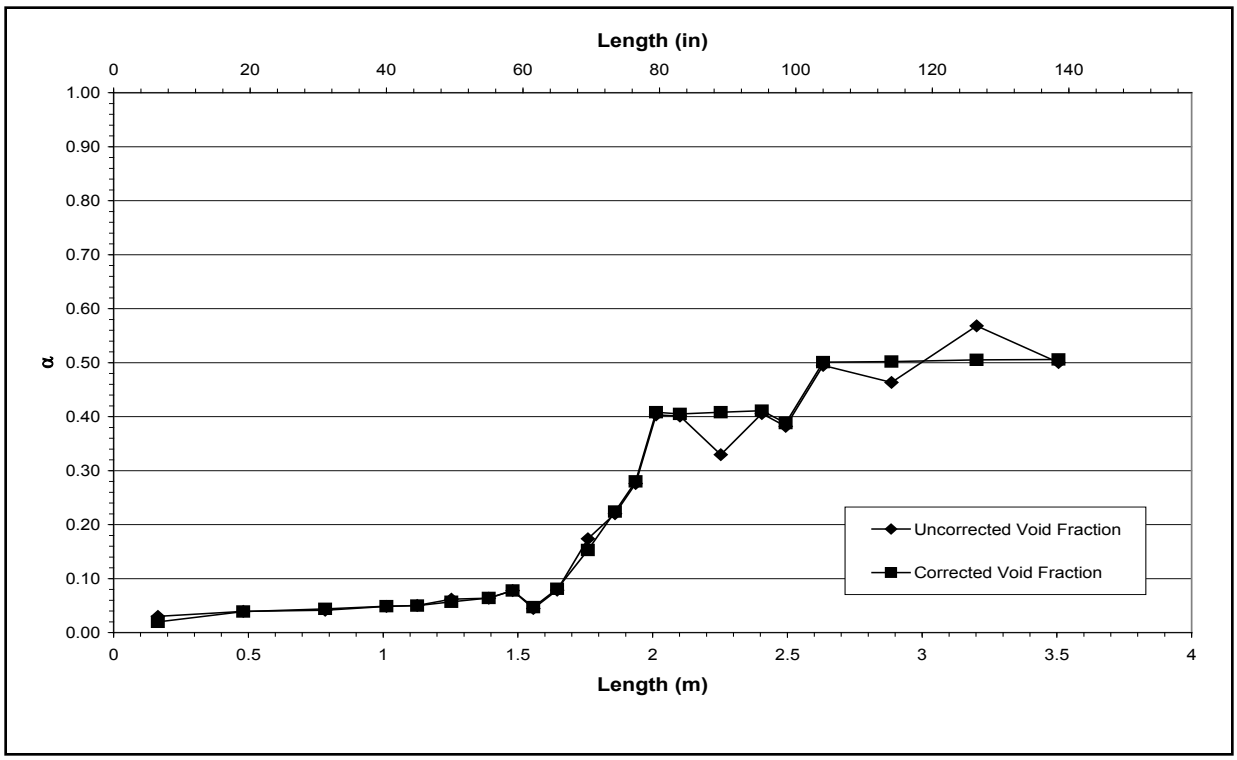

Figure A-585 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659G for Time Period 1443 to 1620 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-H

Test Conditions

Date: 7/9/2003
Steady-state time window: 4127 – 4270 seconds
Inlet flow rate: 2.029 cm/sec (0.799 in./sec)
Inlet mass flow rate: 0.095 kg/sec (0.209 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

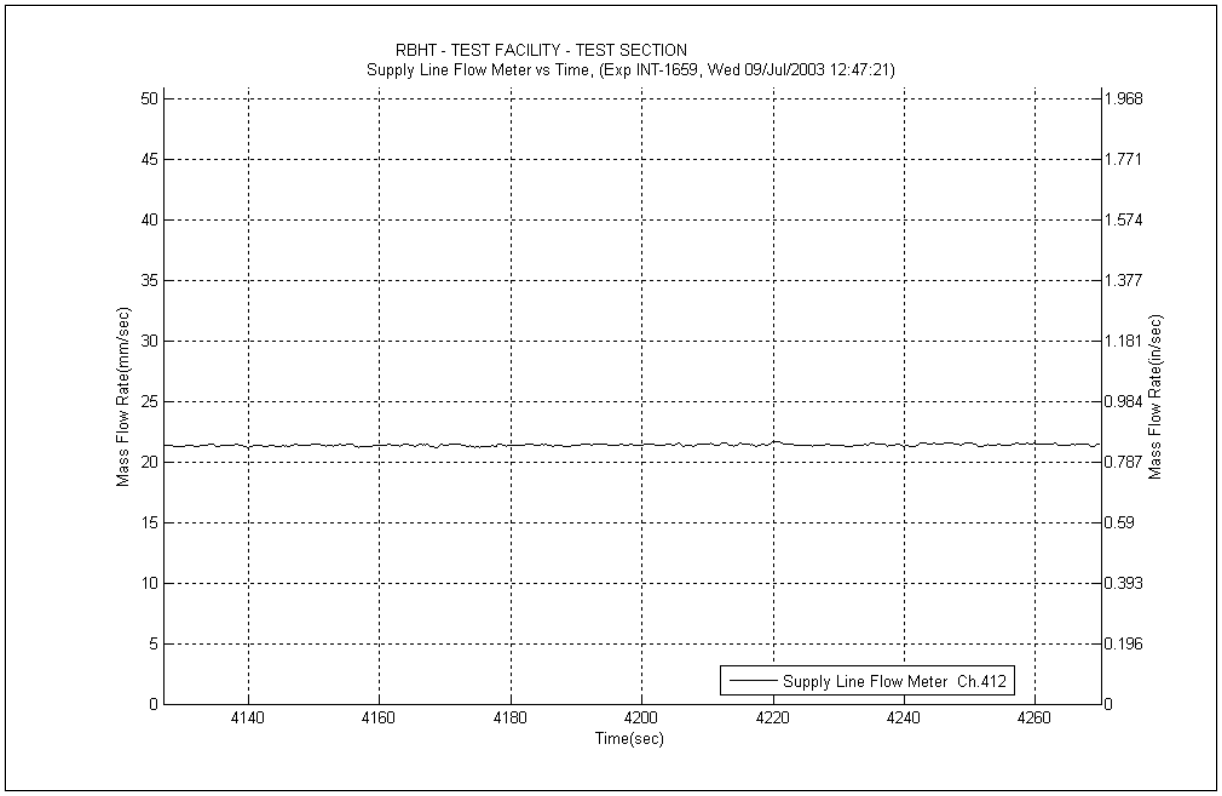

Figure A-586 Inlet Flow Plot for Experiment 1659H

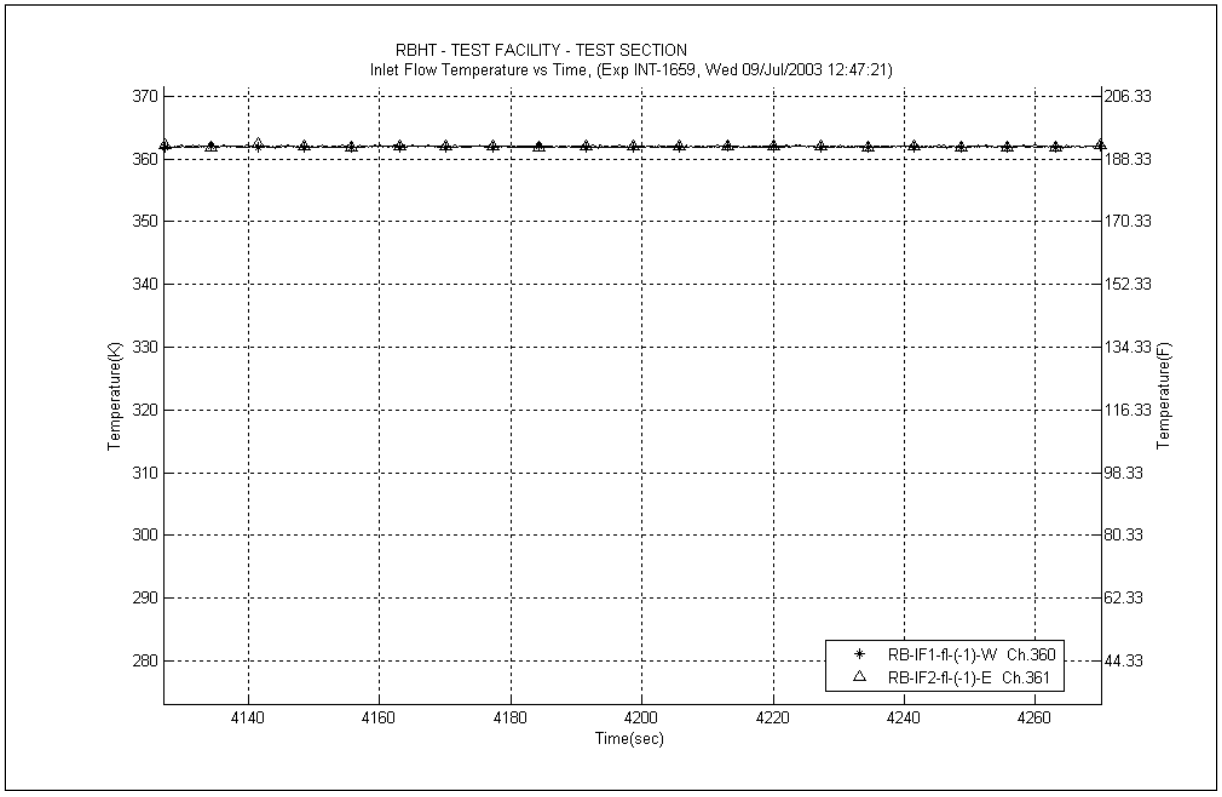

Figure A-587 Inlet Temperature Plot for Experiment 1659H

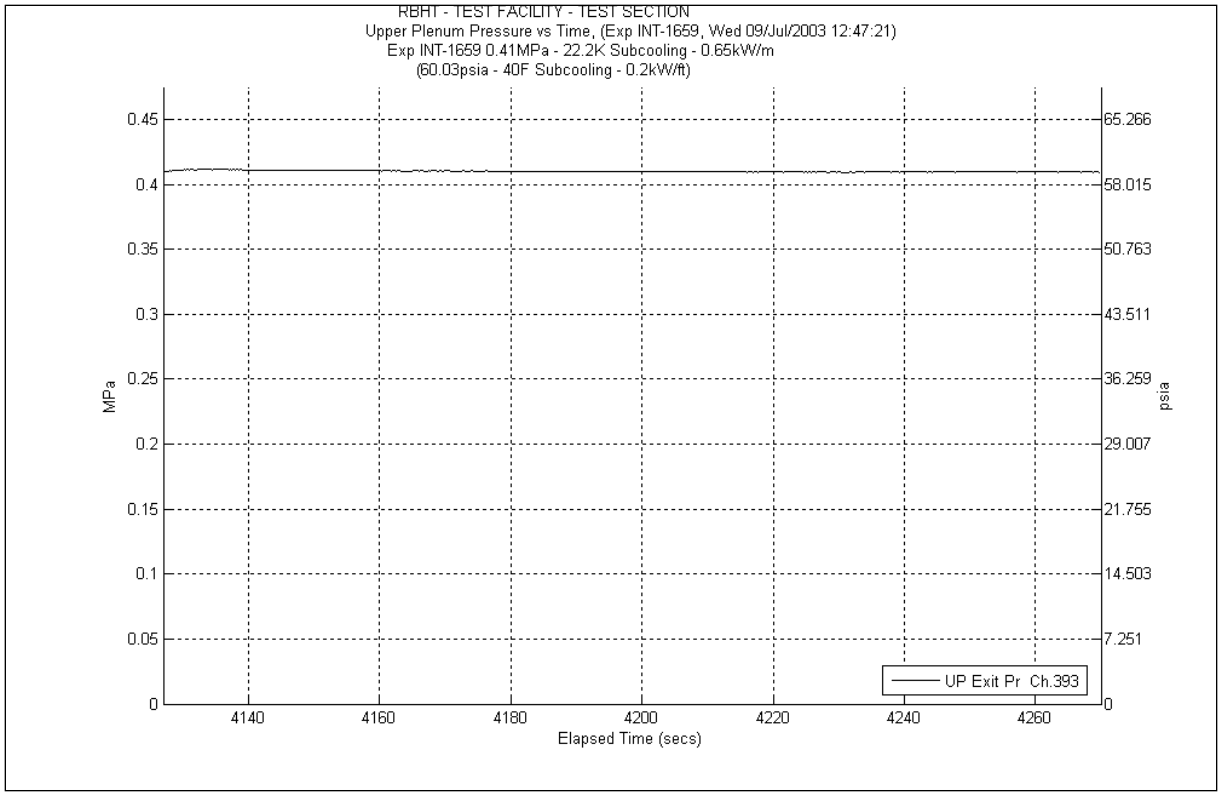

Figure A-588 System Pressure Plot for Experiment 1659H

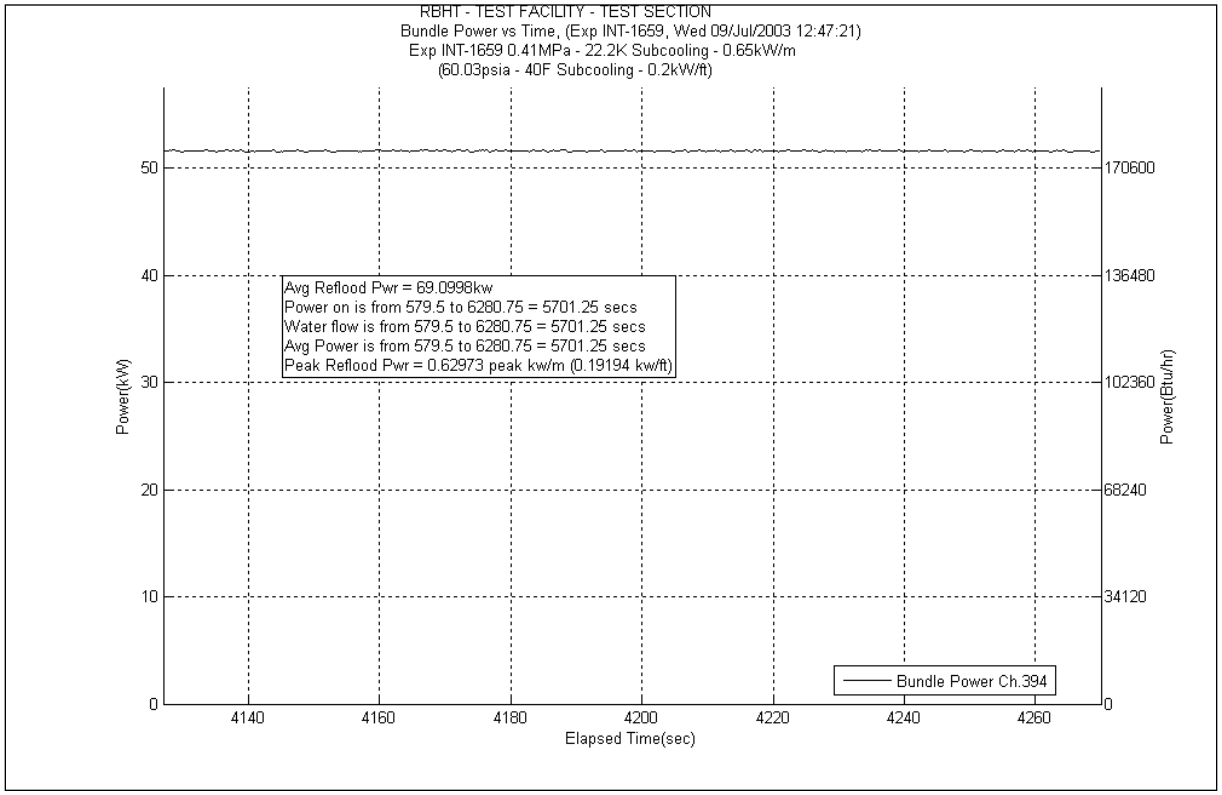

Figure A-589 Bundle Power Plot for Experiment 1659H

Table A-235 Data Results for RBHT Test 1659 for Time Period 4127 to 4270

Results for RBHT Test 1659
Valid Time Period 4127 to 4270 seconds
Collapsed Liquid Level = 106.565 inches = 2706.74 mm
(Z_{osv}) Onset of Significant Void = 40 inches = 1016 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.510	27.992	1340.266	0.275	13.167	0.063	3.016	0.000	0.000	27.64	1323.410	8667.64	415008.8308	0.516	0.513	0.519
*	120-133	3048-3378	383	0.576	28.626	1370.603	0.300	14.364	0.113	5.410	-4.467	-213.899	32.68	1564.727	8700.32	416573.5576	0.516	0.513	0.519
*	108-120	2743-3048	382	0.471	32.983	1579.227	0.243	11.635	0.141	6.751	2.409	115.336	30.19	1445.505	8730.51	418019.0625	0.515	0.512	0.518
	100-108	2540-2743	381	0.509	20.384	975.983	0.140	6.703	0.103	4.932	0.000	0.000	20.14	964.308	8750.65	418983.3709	0.515	0.512	0.518
	97-100	2464-2540	380	0.390	9.499	454.795	0.047	2.250	0.037	1.772	0.000	0.000	9.411	450.601	8760.061	419433.972	0.396	0.394	0.398
	93-97	2362-2464	379	0.419	12.069	577.881	0.059	2.825	0.049	2.346	0.000	0.000	11.96	572.648	8772.021	420006.6199	0.424	0.422	0.426
*	85-93	2159-2362	378	0.342	27.358	1309.930	0.103	4.932	0.093	4.453	3.442	164.826	23.72	1135.720	8795.741	421142.3396	0.429	0.427	0.431
	81-85	2057-2159	377	0.429	11.856	567.686	0.044	2.107	0.045	2.155	0.000	0.000	11.76	563.072	8807.501	421705.4114	0.434	0.432	0.436
	78-81	1981-2057	376	0.430	8.881	425.205	0.029	1.389	0.033	1.580	0.000	0.000	8.818	422.208	8816.319	422127.6195	0.434	0.432	0.436
	75-78	1905-1981	375	0.308	10.776	515.965	0.026	1.245	0.032	1.532	0.000	0.000	10.71	512.798	8827.029	422640.4171	0.312	0.310	0.314
	72-75	1829-1905	374	0.249	11.695	559.978	0.023	1.101	0.031	1.484	0.000	0.000	11.64	557.326	8838.669	423197.7433	0.253	0.252	0.254
*	67-72	1702-1829	373	0.219	20.270	970.512	0.032	1.532	0.050	2.394	-0.832	-39.857	21.02	1006.443	8859.689	424204.1863	0.19	0.189	0.191
	63-67	1600-1702	372	0.125	18.177	870.303	0.018	0.862	0.039	1.867	0.000	0.000	18.11	867.111	8877.799	425071.2977	0.128	0.127	0.129
	60-63	1524-1600	371	0.048	14.837	710.416	0.008	0.383	0.028	1.341	0.000	0.000	14.8	708.628	8892.599	425779.9255	0.05	0.048	0.053
	57-60	1448-1524	370	0.079	14.344	686.793	0.004	0.192	0.015	0.718	0.000	0.000	14.32	685.645	8906.919	426465.5708	0.081	0.077	0.085
	53-57	1346-1448	369	0.066	19.407	929.235	0.001	0.048	0.000	0.000	0.000	0.000	19.4	928.877	8926.319	427394.4478	0.066	0.063	0.069
*	46-53	1168-1346	368	0.064	34.032	1629.456	0.001	0.048	0.000	0.000	-0.169	-8.097	34.2	1637.505	8960.519	429031.9526	0.059	0.056	0.062
	43-46	1092-1168	367	0.052	14.770	707.183	0.001	0.048	0.000	0.000	0.000	0.000	14.76	706.713	8975.279	429738.6652	0.052	0.049	0.055
	37-43	940-1092	366	0.050	29.597	1417.102	0.001	0.048	0.000	0.000	0.000	0.000	29.59	1416.777	9004.869	431155.442	0.05	0.048	0.053
*	25-37	635-940	365	0.042	59.708	2858.821	0.002	0.096	0.000	0.000	0.206	9.850	59.5	2848.875	9064.369	434004.3173	0.045	0.043	0.047
	13-25	330-635	364	0.040	59.838	2865.037	0.002	0.096	0.000	0.000	0.000	0.000	59.82	2864.197	9124.189	436868.5142	0.04	0.038	0.042
*	0-13	0-330	363	0.030	65.467	3134.582	0.003	0.144	0.000	0.000	-0.686	-32.840	66.15	3167.279	9190.339	440035.7932	0.02	0.019	0.021

Table A-236 Energy Balance Results for RBHT Test 1659H for Time Period 4127 to 4270 seconds

Results for RBHT Test 1659
Valid Time Period 4127 to 4270 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2331.1588	7.3538	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.25	6.35	2460.6676	7.7624	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.50	12.70	2590.1765	8.1709	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
0.75	19.05	2719.6853	8.5794	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.00	25.40	2849.1941	8.988	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.25	31.75	2978.7029	9.3965	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.50	38.10	3108.2118	9.8051	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
1.75	44.45	3237.7206	10.214	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.00	50.80	3367.2294	10.622	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.25	57.15	3496.7382	11.031	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.50	63.50	3626.2471	11.439	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
2.75	69.85	3755.7559	11.848	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
3.00	76.20	3885.2647	12.256	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
3.25	82.55	4014.7735	12.665	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
3.50	88.90	4144.2824	13.073	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
3.75	95.25	4273.7912	13.482	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
4.00	101.60	4403.3	13.891	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
4.25	107.95	4532.8088	14.299	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
4.50	114.30	4662.3176	14.708	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
4.75	120.65	4791.8265	15.116	0.00E+00	0.00E+00	0.00E+00	6.94E-02	3.15E-02
5.00	127.00	4921.3353	15.525	4.29E-03	1.23E-01	5.57E-02	6.91E-02	3.13E-02
5.25	133.35	5050.8441	15.933	1.23E-02	3.51E-01	1.59E-01	6.85E-02	3.11E-02
5.50	139.70	5180.3529	16.342	2.04E-02	5.85E-01	2.65E-01	6.80E-02	3.08E-02
5.75	146.05	5309.8618	16.75	2.88E-02	8.25E-01	3.74E-01	6.74E-02	3.06E-02
6.00	152.40	5439.3706	17.159	3.74E-02	1.07E+00	4.86E-01	6.68E-02	3.03E-02
6.25	158.75	5568.8794	17.567	4.62E-02	1.32E+00	6.00E-01	6.62E-02	3.00E-02
6.50	165.10	5698.3882	17.976	5.52E-02	1.58E+00	7.17E-01	6.56E-02	2.97E-02
6.75	171.45	5827.8971	18.385	6.44E-02	1.84E+00	8.36E-01	6.49E-02	2.95E-02
7.00	177.80	5957.4059	18.793	7.38E-02	2.11E+00	9.59E-01	6.43E-02	2.92E-02
7.25	184.15	6086.9147	19.202	8.34E-02	2.39E+00	1.08E+00	6.36E-02	2.89E-02
7.50	190.50	6216.4235	19.61	9.33E-02	2.67E+00	1.21E+00	6.29E-02	2.85E-02
7.75	196.85	6345.9324	20.019	1.03E-01	2.96E+00	1.34E+00	6.22E-02	2.82E-02
8.00	203.20	6475.4412	20.427	1.14E-01	3.25E+00	1.48E+00	6.15E-02	2.79E-02
8.25	209.55	6604.95	20.836	1.24E-01	3.55E+00	1.61E+00	6.08E-02	2.76E-02
8.50	215.90	6734.4588	21.244	1.35E-01	3.86E+00	1.75E+00	6.01E-02	2.72E-02
8.75	222.25	6863.9676	21.653	1.46E-01	4.17E+00	1.89E+00	5.93E-02	2.69E-02
9.00	228.60	6993.4765	22.061	1.57E-01	4.48E+00	2.03E+00	5.85E-02	2.65E-02
9.25	234.95	6604.95	20.836	1.68E-01	4.80E+00	2.18E+00	5.78E-02	2.62E-02
9.50	241.30	6216.4235	19.61	1.78E-01	5.09E+00	2.31E+00	5.71E-02	2.59E-02
9.75	247.65	5827.8971	18.385	1.87E-01	5.36E+00	2.43E+00	5.64E-02	2.56E-02
10.00	254.00	5439.3706	17.159	1.96E-01	5.62E+00	2.55E+00	5.58E-02	2.53E-02
10.25	260.35	5050.8441	15.933	2.05E-01	5.86E+00	2.66E+00	5.52E-02	2.50E-02
10.50	266.70	4662.3176	14.708	2.13E-01	6.08E+00	2.76E+00	5.47E-02	2.48E-02
10.75	273.05	4273.7912	13.482	2.20E-01	6.29E+00	2.85E+00	5.42E-02	2.46E-02
11.00	279.40	3885.2647	12.256	2.26E-01	6.47E+00	2.94E+00	5.37E-02	2.44E-02
11.25	285.75	3496.7382	11.031	2.32E-01	6.64E+00	3.01E+00	5.33E-02	2.42E-02
11.50	292.10	3108.2118	9.8051	2.37E-01	6.79E+00	3.08E+00	5.29E-02	2.40E-02
11.75	298.45	2719.6853	8.5794	2.42E-01	6.93E+00	3.14E+00	5.26E-02	2.39E-02
12.00	304.80	2331.1588	7.3538	2.46E-01	7.04E+00	3.20E+00	5.23E-02	2.37E-02

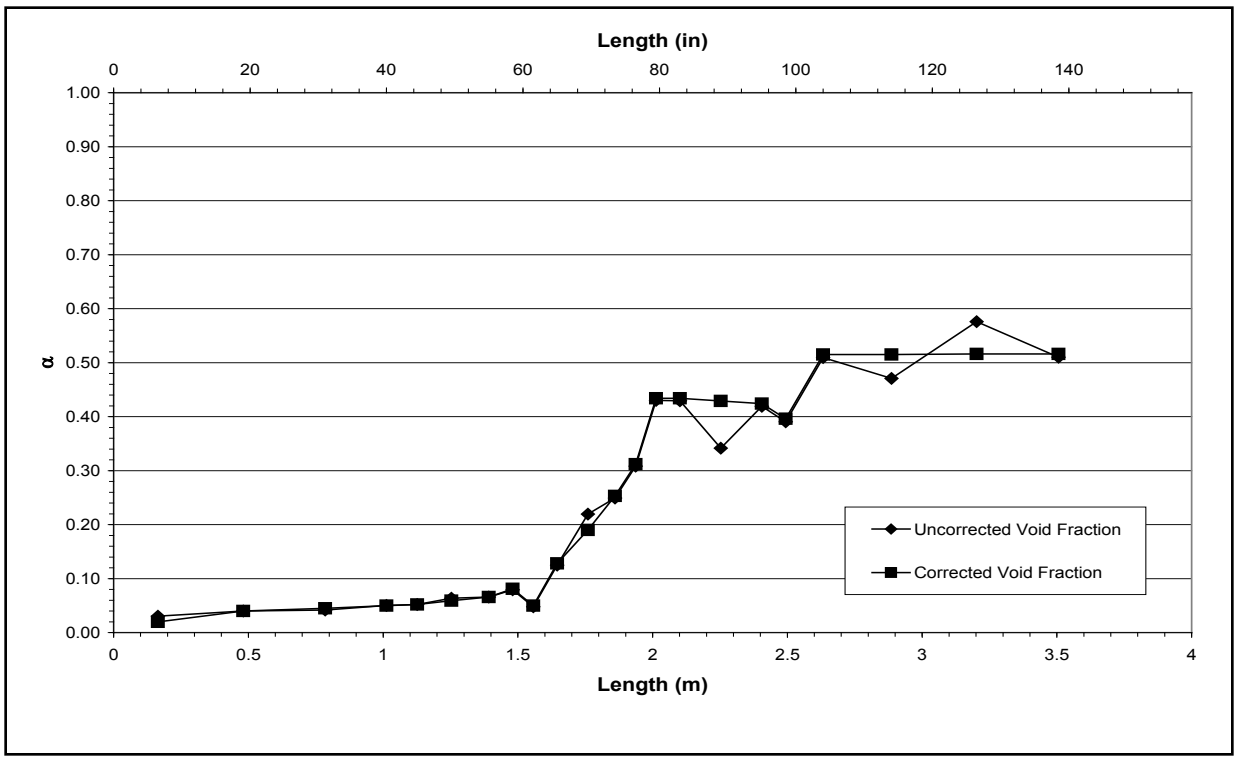

Figure A-590 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659H for Time Period 4127 to 4270 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-I

Test Conditions

Date: 7/9/2003
Steady-state time window: 4550 – 4660 seconds
Inlet flow rate: 1.527 cm/sec (0.601 in./sec)
Inlet mass flow rate: 0.071 kg/sec (0.157 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

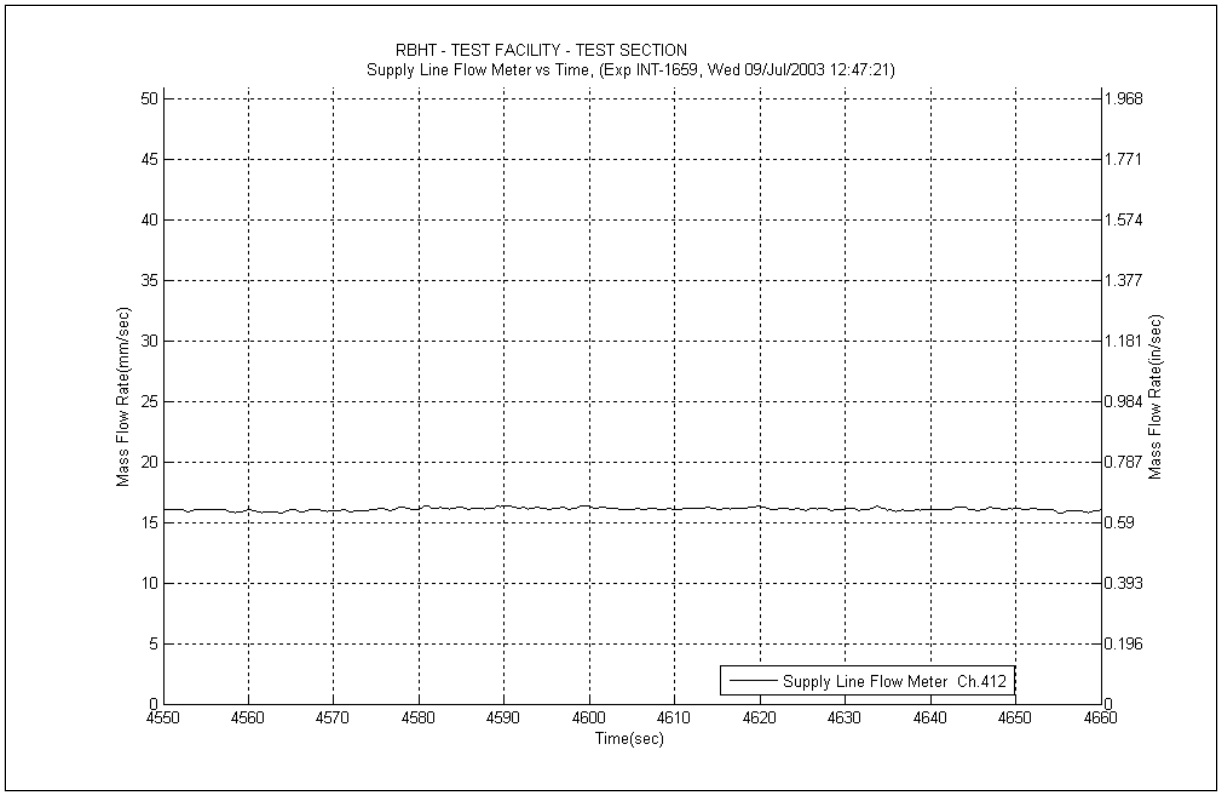

Figure A-591 Inlet Flow Plot for Experiment 1659l

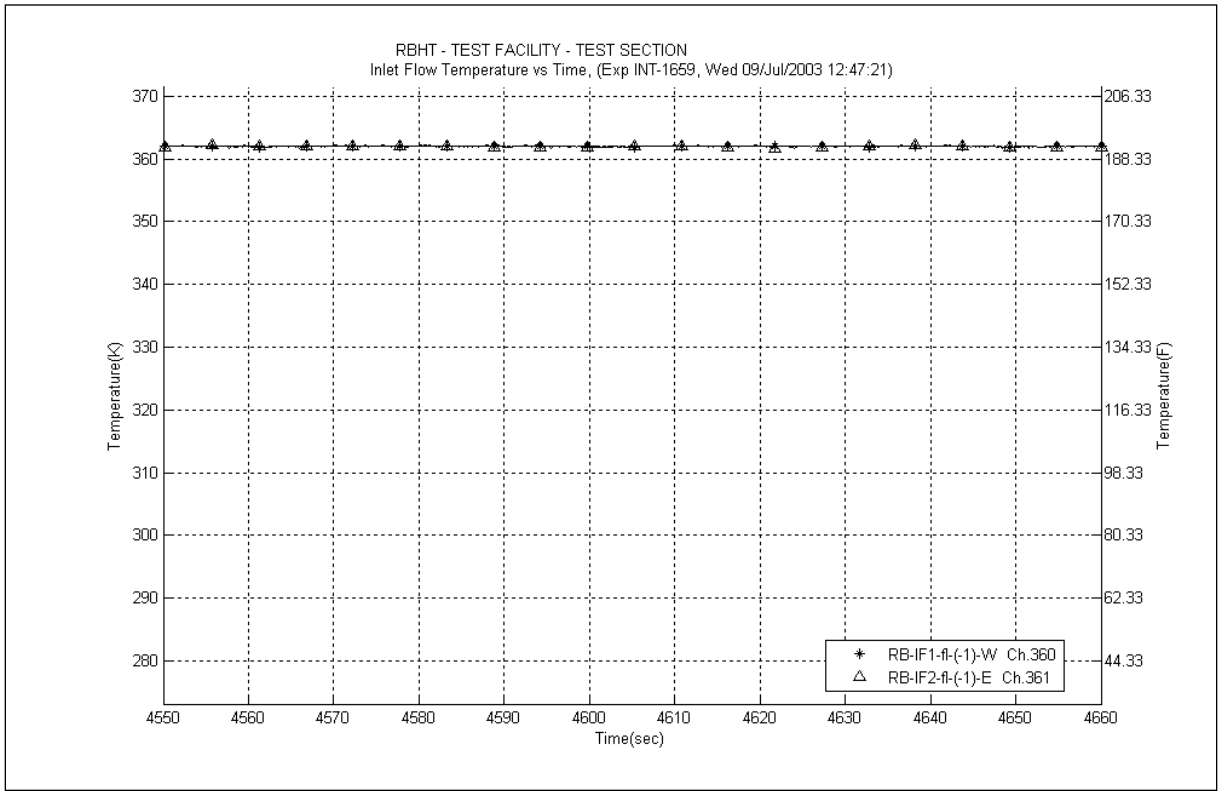

Figure A-592 Inlet Temperature Plot for Experiment 1659l

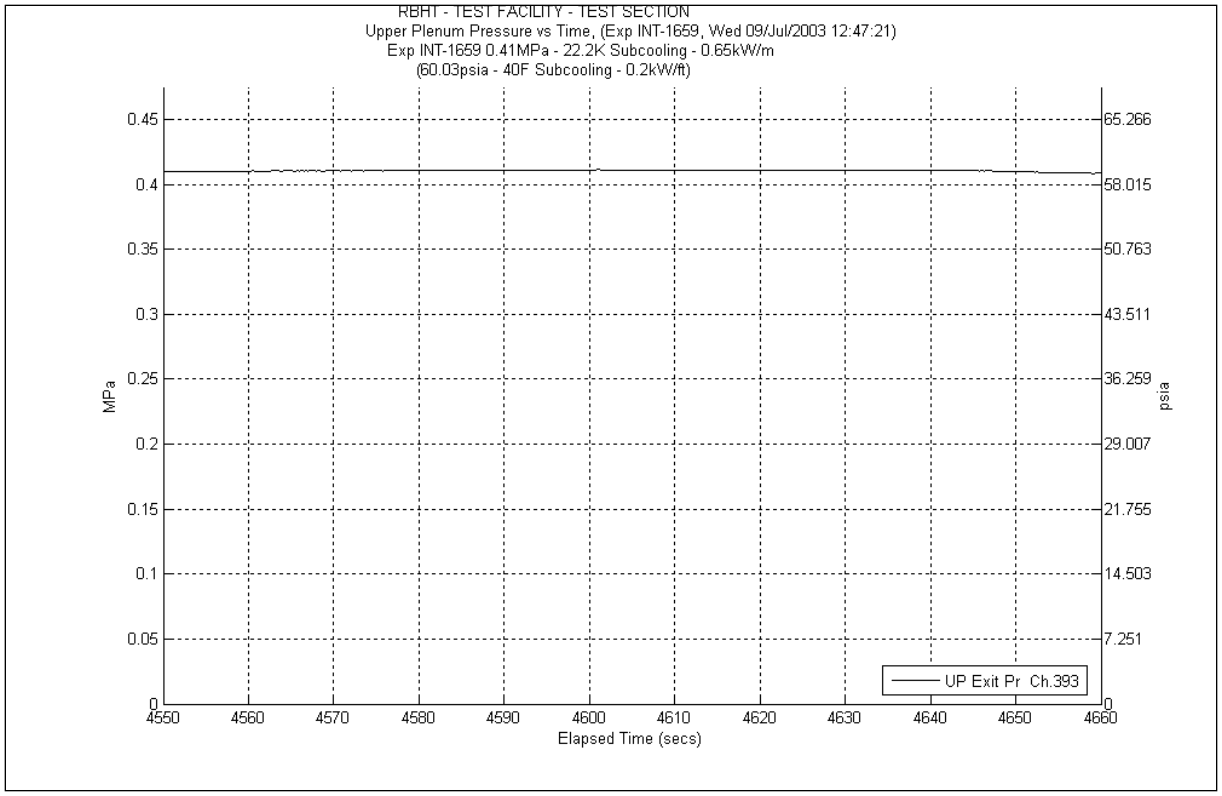

Figure A-593 System Pressure Plot for Experiment 1659l

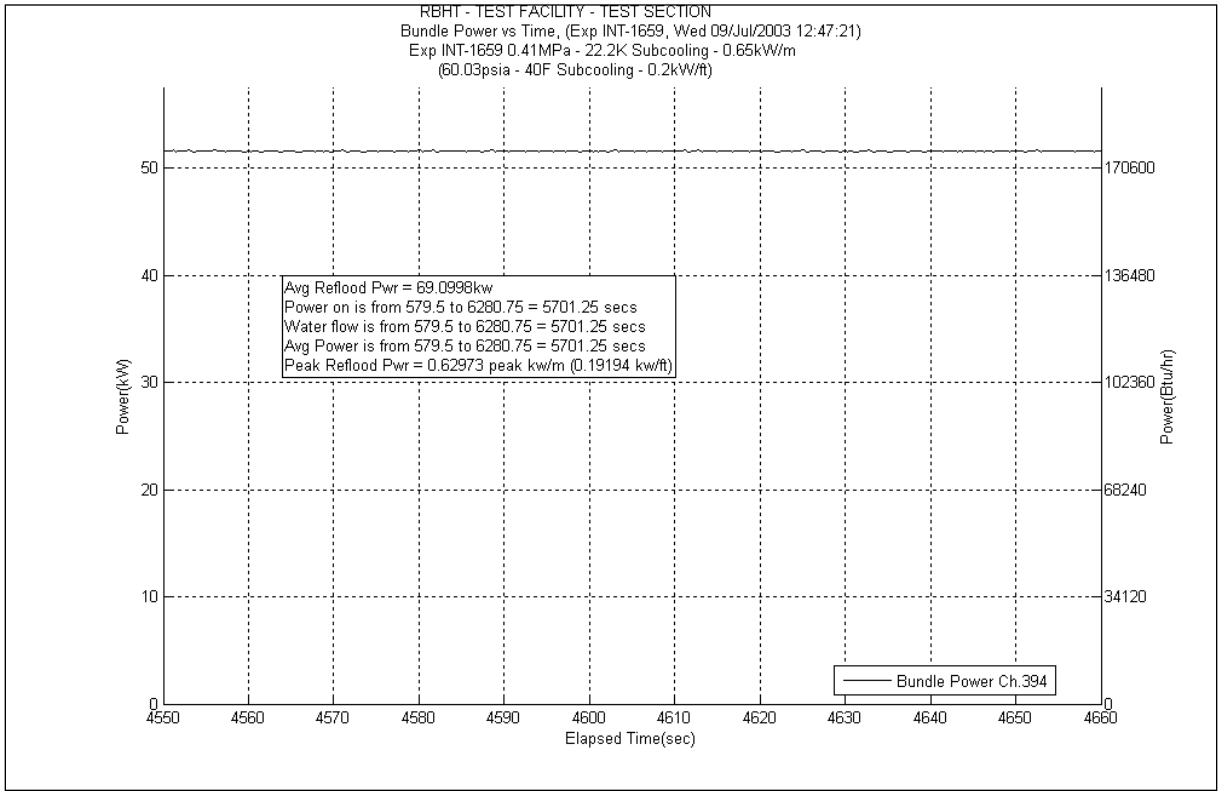

Figure A-594 Bundle Power Plot for Experiment 1659l

Table A-237 Data Results for RBHT Test 1659 for Time Period 4550 to 4660

Results for RBHT Test 1659
Valid Time Period 4550 to 4660 seconds
Collapsed Liquid Level = 100.262 inches = 2546.65 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.566	24.803	1187.590	0.217	10.390	0.048	2.298	0.000	0.000	24.53	1174.503	8664.53	414859.9232	0.57	0.567	0.573
*	120-133	3048-3378	383	0.610	26.351	1261.691	0.238	11.396	0.085	4.070	-3.062	-146.611	29.09	1392.837	8693.62	416252.7599	0.569	0.566	0.572
*	108-120	2743-3048	382	0.499	31.196	1493.688	0.195	9.337	0.106	5.075	3.855	184.594	27.04	1294.682	8720.66	417547.442	0.566	0.563	0.569
	100-108	2540-2743	381	0.560	18.286	875.525	0.114	5.458	0.078	3.735	0.000	0.000	18.09	866.154	8738.75	418413.5959	0.565	0.562	0.568
	97-100	2464-2540	380	0.425	8.953	428.686	0.039	1.867	0.028	1.341	0.000	0.000	8.882	425.272	8747.632	418838.8683	0.43	0.428	0.432
	93-97	2362-2464	379	0.462	11.186	535.609	0.049	2.346	0.037	1.772	0.000	0.000	11.1	531.471	8758.732	419370.3392	0.466	0.464	0.468
*	85-93	2159-2362	378	0.376	25.920	1241.052	0.088	4.213	0.070	3.352	4.522	216.510	21.24	1016.977	8779.972	420387.3158	0.489	0.487	0.491
	81-85	2057-2159	377	0.508	10.220	489.359	0.039	1.867	0.034	1.628	0.000	0.000	10.14	485.506	8790.112	420872.8216	0.512	0.509	0.515
	78-81	1981-2057	376	0.485	8.019	383.928	0.027	1.293	0.025	1.197	0.000	0.000	7.965	381.366	8798.077	421254.1879	0.489	0.487	0.491
	75-78	1905-1981	375	0.393	9.462	453.055	0.025	1.197	0.024	1.149	0.000	0.000	9.409	450.505	8807.486	421704.6932	0.396	0.394	0.398
	72-75	1829-1905	374	0.299	10.922	522.928	0.023	1.101	0.023	1.101	0.000	0.000	10.87	520.458	8818.356	422225.1516	0.302	0.300	0.304
*	67-72	1702-1829	373	0.311	17.886	856.378	0.034	1.628	0.038	1.819	0.414	19.814	17.4	833.116	8835.756	423058.2681	0.33	0.328	0.332
	63-67	1600-1702	372	0.355	13.409	642.035	0.023	1.101	0.029	1.389	0.000	0.000	13.35	639.201	8849.106	423697.4695	0.357	0.355	0.359
	60-63	1524-1600	371	0.260	11.534	552.269	0.015	0.718	0.021	1.005	0.000	0.000	11.49	550.144	8860.596	424247.6137	0.262	0.261	0.263
	57-60	1448-1524	370	0.227	12.038	576.389	0.013	0.622	0.021	1.005	0.000	0.000	12	574.563	8872.596	424822.1767	0.229	0.228	0.230
	53-57	1346-1448	369	0.166	17.335	830.020	0.013	0.622	0.027	1.293	0.000	0.000	17.29	827.850	8889.886	425650.0264	0.167	0.166	0.168
*	46-53	1168-1346	368	0.079	33.487	1603.347	0.012	0.575	0.038	1.819	1.267	60.645	32.17	1540.308	8922.056	427190.3342	0.115	0.114	0.116
	43-46	1092-1168	367	0.062	14.614	699.724	0.000	0.000	0.000	0.000	0.000	0.000	14.61	699.531	8936.666	427889.8648	0.062	0.059	0.065
	37-43	940-1092	366	0.059	29.337	1404.669	0.001	0.048	0.000	0.000	0.000	0.000	29.32	1403.849	8965.986	429293.7139	0.059	0.056	0.062
*	25-37	635-940	365	0.048	59.344	2841.415	0.001	0.048	0.000	0.000	0.203	9.728	59.14	2831.638	9025.126	432125.3523	0.051	0.048	0.054
	13-25	330-635	364	0.043	59.651	2856.086	0.001	0.048	0.000	0.000	0.000	0.000	59.63	2855.100	9084.756	434980.4521	0.043	0.041	0.045
*	0-13	0-330	363	0.031	65.400	3131.350	0.002	0.096	0.000	0.000	-0.652	-31.237	66.05	3162.491	9150.806	438142.943	0.021	0.020	0.022

Table A-238 Energy Balance Results for RBHT Test 1659I for Time Period 4550 to 4660 seconds

Results for RBHT Test 1659
Valid Time Period 4550 to 4660 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2331.6433	7.3553	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
0.25	6.35	2461.1791	7.764	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
0.50	12.70	2590.7148	8.1726	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
0.75	19.05	2720.2505	8.5812	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
1.00	25.40	2849.7863	8.9899	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
1.25	31.75	2979.322	9.3985	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
1.50	38.10	3108.8578	9.8071	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
1.75	44.45	3238.3935	10.216	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
2.00	50.80	3367.9292	10.624	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
2.25	57.15	3497.465	11.033	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
2.50	63.50	3627.0007	11.442	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
2.75	69.85	3756.5365	11.85	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
3.00	76.20	3886.0722	12.259	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
3.25	82.55	4015.6079	12.668	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
3.50	88.90	4145.1437	13.076	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
3.75	95.25	4274.6794	13.485	0.00E+00	0.00E+00	0.00E+00	5.22E-02	2.37E-02
4.00	101.60	4404.2152	13.893	3.00E-03	6.45E-02	2.93E-02	5.20E-02	2.36E-02
4.25	107.95	4533.7509	14.302	1.25E-02	2.69E-01	1.22E-01	5.15E-02	2.34E-02
4.50	114.30	4663.2866	14.711	2.23E-02	4.79E-01	2.17E-01	5.10E-02	2.31E-02
4.75	120.65	4792.8224	15.119	3.23E-02	6.96E-01	3.16E-01	5.05E-02	2.29E-02
5.00	127.00	4922.3581	15.528	4.26E-02	9.18E-01	4.16E-01	5.00E-02	2.27E-02
5.25	133.35	5051.8939	15.937	5.32E-02	1.15E+00	5.20E-01	4.94E-02	2.24E-02
5.50	139.70	5181.4296	16.345	6.41E-02	1.38E+00	6.26E-01	4.88E-02	2.22E-02
5.75	146.05	5310.9653	16.754	7.53E-02	1.62E+00	7.35E-01	4.83E-02	2.19E-02
6.00	152.40	5440.5011	17.162	8.67E-02	1.87E+00	8.47E-01	4.77E-02	2.16E-02
6.25	158.75	5570.0368	17.571	9.84E-02	2.12E+00	9.61E-01	4.70E-02	2.13E-02
6.50	165.10	5699.5726	17.98	1.10E-01	2.38E+00	1.08E+00	4.64E-02	2.11E-02
6.75	171.45	5829.1083	18.388	1.23E-01	2.64E+00	1.20E+00	4.58E-02	2.08E-02
7.00	177.80	5958.644	18.797	1.35E-01	2.91E+00	1.32E+00	4.51E-02	2.05E-02
7.25	184.15	6088.1798	19.206	1.48E-01	3.18E+00	1.44E+00	4.45E-02	2.02E-02
7.50	190.50	6217.7155	19.614	1.61E-01	3.47E+00	1.57E+00	4.38E-02	1.99E-02
7.75	196.85	6347.2513	20.023	1.74E-01	3.76E+00	1.70E+00	4.31E-02	1.95E-02
8.00	203.20	6476.787	20.431	1.88E-01	4.05E+00	1.84E+00	4.24E-02	1.92E-02
8.25	209.55	6606.3227	20.84	2.02E-01	4.35E+00	1.97E+00	4.16E-02	1.89E-02
8.50	215.90	6735.8585	21.249	2.16E-01	4.65E+00	2.11E+00	4.09E-02	1.86E-02
8.75	222.25	6865.3942	21.657	2.31E-01	4.96E+00	2.25E+00	4.02E-02	1.82E-02
9.00	228.60	6994.93	22.066	2.45E-01	5.28E+00	2.40E+00	3.94E-02	1.79E-02
9.25	234.95	6606.3227	20.84	2.60E-01	5.59E+00	2.54E+00	3.86E-02	1.75E-02
9.50	241.30	6217.7155	19.614	2.73E-01	5.89E+00	2.67E+00	3.79E-02	1.72E-02
9.75	247.65	5829.1083	18.388	2.86E-01	6.16E+00	2.79E+00	3.73E-02	1.69E-02
10.00	254.00	5440.5011	17.162	2.98E-01	6.42E+00	2.91E+00	3.66E-02	1.66E-02
10.25	260.35	5051.8939	15.937	3.09E-01	6.66E+00	3.02E+00	3.60E-02	1.64E-02
10.50	266.70	4663.2866	14.711	3.20E-01	6.88E+00	3.12E+00	3.55E-02	1.61E-02
10.75	273.05	4274.6794	13.485	3.29E-01	7.09E+00	3.21E+00	3.50E-02	1.59E-02
11.00	279.40	3886.0722	12.259	3.38E-01	7.27E+00	3.30E+00	3.46E-02	1.57E-02
11.25	285.75	3497.465	11.033	3.46E-01	7.44E+00	3.38E+00	3.41E-02	1.55E-02
11.50	292.10	3108.8578	9.8071	3.53E-01	7.59E+00	3.44E+00	3.38E-02	1.53E-02
11.75	298.45	2720.2505	8.5812	3.59E-01	7.73E+00	3.50E+00	3.35E-02	1.52E-02
12.00	304.80	2331.6433	7.3553	3.64E-01	7.84E+00	3.56E+00	3.32E-02	1.51E-02

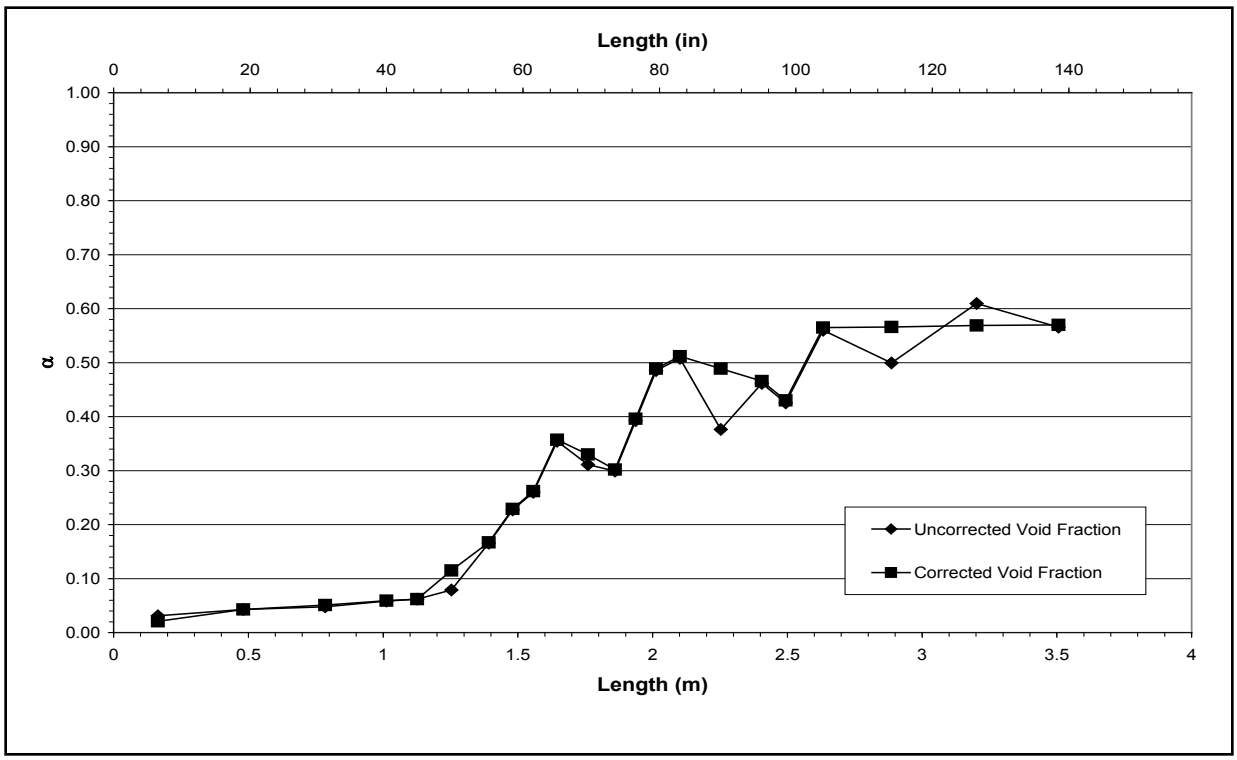

Figure A-595 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659I for Time Period 4550 to 4660 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-J

Test Conditions

Date: 7/9/2003
Steady-state time window: 4980 – 5100 seconds
Inlet flow rate: 1.016 cm/sec (0.400 in./sec)
Inlet mass flow rate: 0.048 kg/sec (0.105 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

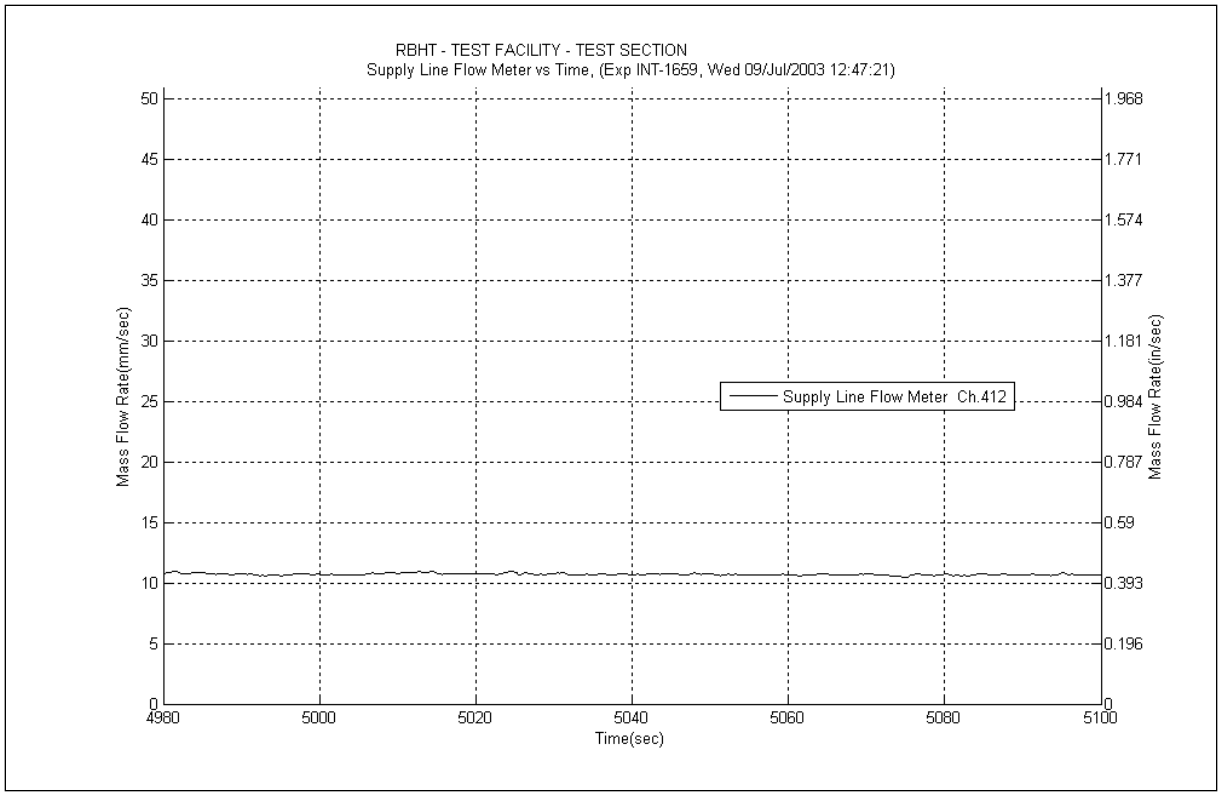

Figure A-596 Inlet Flow Plot for Experiment 1659J

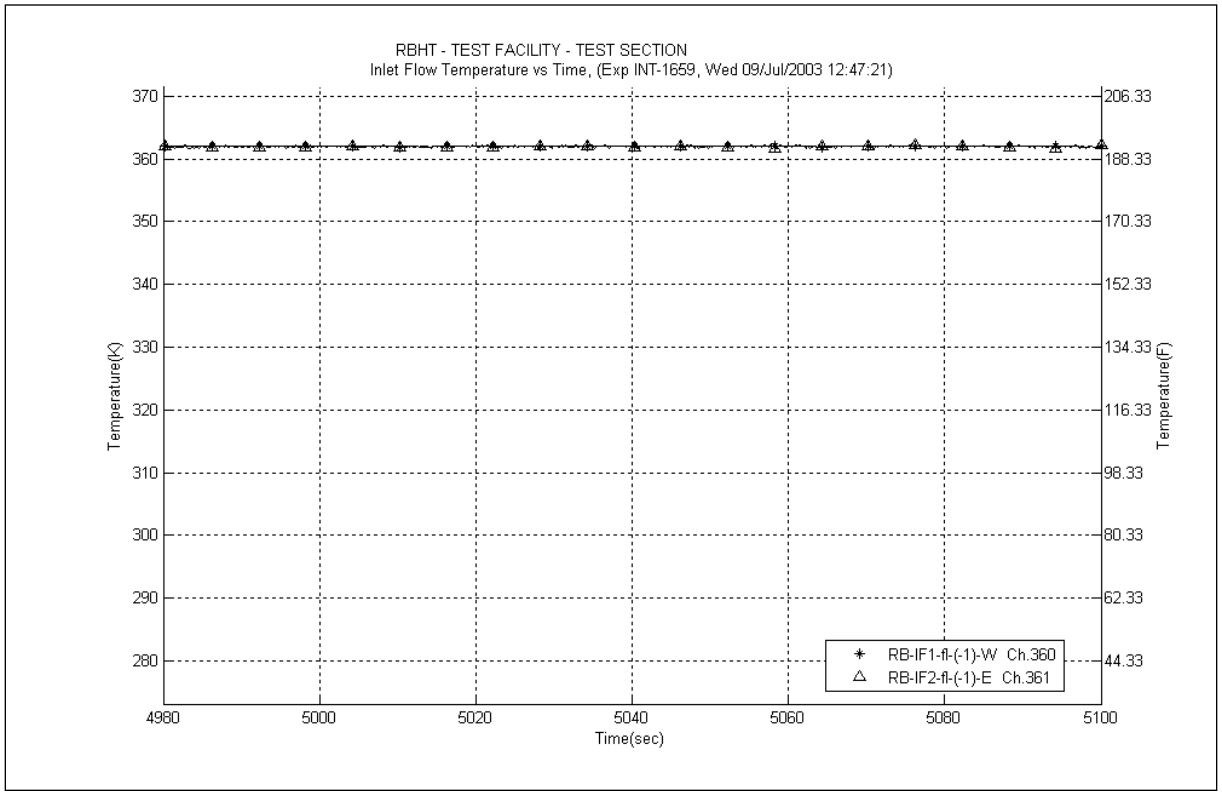

Figure A-597 Inlet Temperature Plot for Experiment 1659J

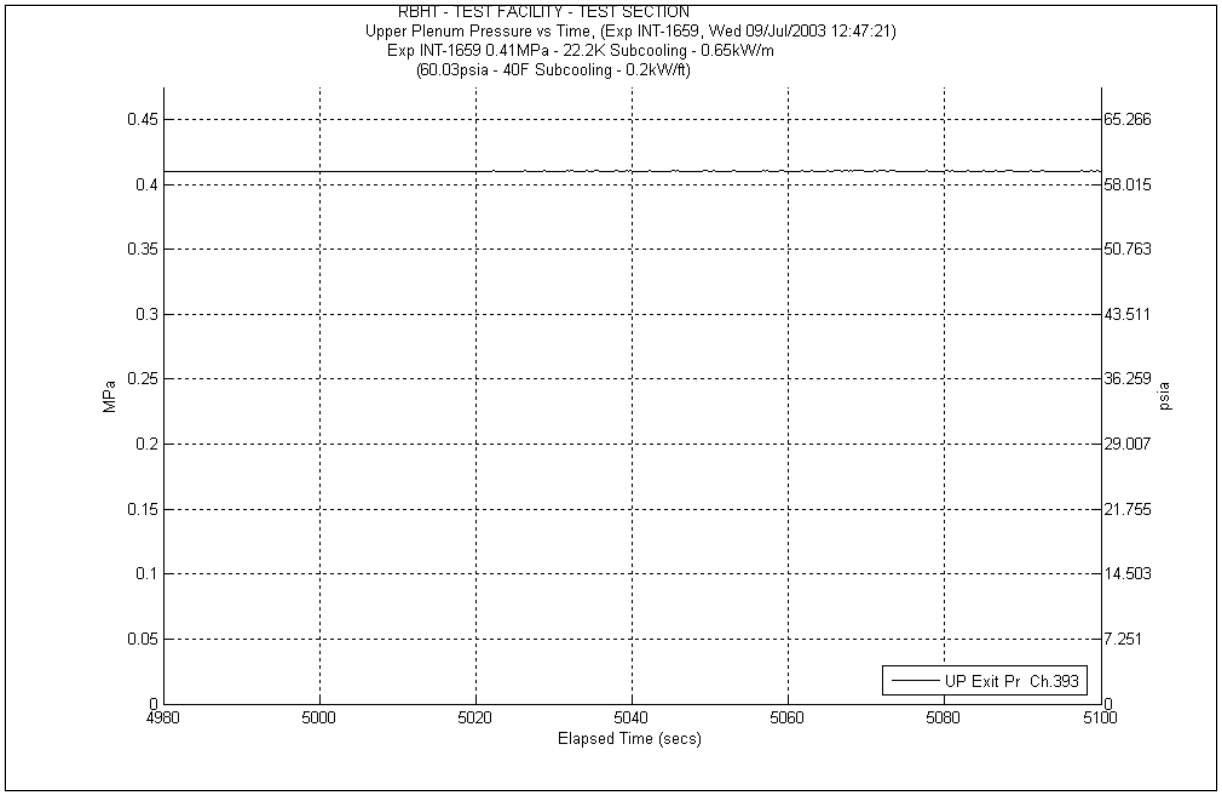

Figure A-598 System Pressure Plot for Experiment 1659J

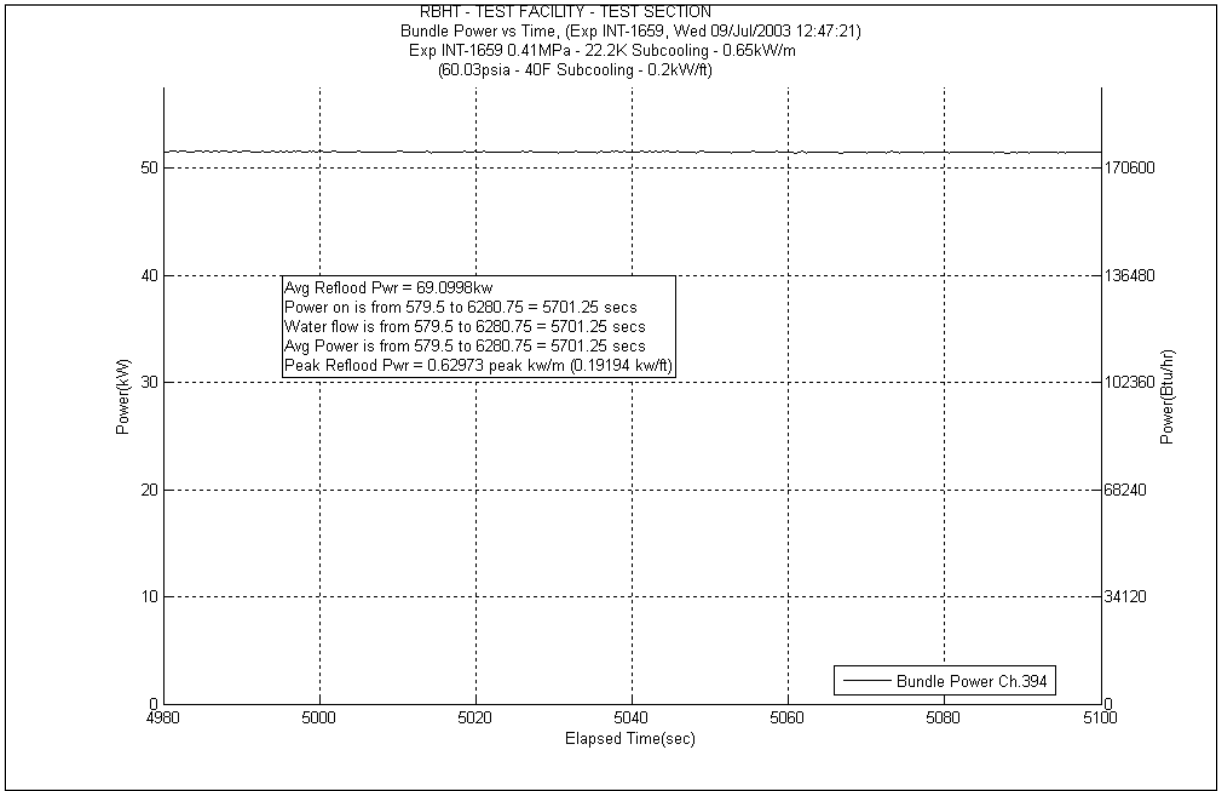

Figure A-599 Bundle Power Plot for Experiment 1659J

Table A-239 Data Results for RBHT Test 1659 for Time Period 4980 to 5100

Results for RBHT Test 1659
Valid Time Period 4980 to 5100 seconds
Collapsed Liquid Level = 92.734 inches = 2355.43 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.627	21.324	1020.990	0.151	7.230	0.032	1.532	0.000	0.000	21.13	1011.710	8661.13	414697.1303	0.63	0.627	0.633
*	120-133	3048-3378	383	0.634	24.720	1183.612	0.166	7.948	0.057	2.729	-0.863	-41.309	25.36	1214.243	8686.49	415911.3736	0.624	0.621	0.627
*	108-120	2743-3048	382	0.527	29.457	1410.388	0.137	6.560	0.071	3.399	5.129	245.557	24.12	1154.872	8710.61	417066.2454	0.613	0.610	0.616
	100-108	2540-2743	381	0.604	16.452	787.748	0.080	3.830	0.052	2.490	0.000	0.000	16.32	781.406	8726.93	417847.6512	0.607	0.604	0.610
	97-100	2464-2540	380	0.469	8.273	396.112	0.028	1.341	0.019	0.910	0.000	0.000	8.223	393.719	8735.153	418241.3706	0.472	0.470	0.474
	93-97	2362-2464	379	0.502	10.356	495.824	0.035	1.676	0.024	1.149	0.000	0.000	10.29	492.688	8745.443	418734.0584	0.504	0.501	0.507
*	85-93	2159-2362	378	0.396	25.105	1202.013	0.064	3.064	0.047	2.250	5.934	284.100	19.06	912.598	8764.503	419646.6561	0.541	0.538	0.544
	81-85	2057-2159	377	0.575	8.823	422.470	0.029	1.389	0.022	1.053	0.000	0.000	8.77	419.910	8773.273	420066.566	0.578	0.575	0.581
	78-81	1981-2057	376	0.523	7.426	355.581	0.020	0.958	0.016	0.766	0.000	0.000	7.385	353.596	8780.658	420420.1617	0.526	0.523	0.529
	75-78	1905-1981	375	0.456	8.470	405.561	0.019	0.910	0.016	0.766	0.000	0.000	8.432	403.726	8789.09	420823.888	0.459	0.457	0.461
	72-75	1829-1905	374	0.371	9.800	469.218	0.018	0.862	0.016	0.766	0.000	0.000	9.762	467.407	8798.852	421291.2951	0.373	0.371	0.375
*	67-72	1702-1829	373	0.361	16.582	793.965	0.028	1.341	0.025	1.197	1.339	64.126	15.19	727.301	8814.042	422018.5962	0.415	0.413	0.417
	63-67	1600-1702	372	0.454	11.337	542.820	0.020	0.958	0.019	0.910	0.000	0.000	11.29	540.568	8825.332	422559.1643	0.456	0.454	0.458
	60-63	1524-1600	371	0.323	10.542	504.776	0.014	0.670	0.014	0.670	0.000	0.000	10.51	503.222	8835.842	423062.3858	0.325	0.323	0.327
	57-60	1448-1524	370	0.309	10.771	515.717	0.012	0.575	0.014	0.670	0.000	0.000	10.74	514.234	8846.582	423576.6197	0.31	0.308	0.312
	53-57	1346-1448	369	0.299	14.562	697.237	0.015	0.718	0.018	0.862	0.000	0.000	14.53	695.700	8861.112	424272.3199	0.301	0.299	0.303
*	46-53	1168-1346	368	0.215	28.537	1366.376	0.021	1.005	0.030	1.436	2.726	130.538	25.76	1233.395	8886.872	425505.7153	0.291	0.290	0.292
	43-46	1092-1168	367	0.281	11.207	536.604	0.007	0.335	0.012	0.575	0.000	0.000	11.18	535.301	8898.052	426041.0166	0.282	0.281	0.283
	37-43	940-1092	366	0.137	26.891	1287.551	0.009	0.431	0.023	1.101	0.000	0.000	26.85	1285.585	8924.902	427326.6015	0.138	0.137	0.139
*	25-37	635-940	365	0.060	58.591	2805.359	0.007	0.335	0.010	0.479	2.094	100.268	56.48	2704.277	8981.382	430030.8784	0.093	0.088	0.098
	13-25	330-635	364	0.049	59.271	2837.933	0.001	0.048	0.000	0.000	0.000	0.000	59.25	2836.905	9040.632	432867.7836	0.049	0.047	0.051
*	0-13	0-330	363	0.033	65.285	3125.879	0.001	0.048	0.000	0.000	-0.556	-26.605	65.84	3152.436	9106.472	436020.2197	0.024	0.023	0.025

Table A-240 Energy Balance Results for RBHT Test 1659J for Time Period 4980 to 5100 seconds

Results for RBHT Test 1659
Valid Time Period 4980 to 5100 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2331.2985	7.3542	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
0.25	6.35	2460.8151	7.7628	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
0.50	12.70	2590.3317	8.1714	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
0.75	19.05	2719.8483	8.58	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
1.00	25.40	2849.3649	8.9885	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
1.25	31.75	2978.8815	9.3971	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
1.50	38.10	3108.3981	9.8057	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
1.75	44.45	3237.9146	10.214	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
2.00	50.80	3367.4312	10.623	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
2.25	57.15	3496.9478	11.031	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
2.50	63.50	3626.4644	11.44	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
2.75	69.85	3755.981	11.849	0.00E+00	0.00E+00	0.00E+00	3.47E-02	1.58E-02
3.00	76.20	3885.4976	12.257	7.52E-03	1.08E-01	4.89E-02	3.45E-02	1.56E-02
3.25	82.55	4015.0142	12.666	2.01E-02	2.88E-01	1.31E-01	3.40E-02	1.54E-02
3.50	88.90	4144.5307	13.074	3.32E-02	4.75E-01	2.15E-01	3.36E-02	1.52E-02
3.75	95.25	4274.0473	13.483	4.66E-02	6.68E-01	3.03E-01	3.31E-02	1.50E-02
4.00	101.60	4403.5639	13.891	6.05E-02	8.66E-01	3.93E-01	3.26E-02	1.48E-02
4.25	107.95	4533.0805	14.3	7.47E-02	1.07E+00	4.86E-01	3.21E-02	1.46E-02
4.50	114.30	4662.5971	14.708	8.94E-02	1.28E+00	5.81E-01	3.16E-02	1.43E-02
4.75	120.65	4792.1137	15.117	1.05E-01	1.50E+00	6.79E-01	3.11E-02	1.41E-02
5.00	127.00	4921.6303	15.526	1.20E-01	1.72E+00	7.80E-01	3.06E-02	1.39E-02
5.25	133.35	5051.1468	15.934	1.36E-01	1.95E+00	8.83E-01	3.00E-02	1.36E-02
5.50	139.70	5180.6634	16.343	1.52E-01	2.18E+00	9.89E-01	2.94E-02	1.34E-02
5.75	146.05	5310.18	16.751	1.69E-01	2.42E+00	1.10E+00	2.89E-02	1.31E-02
6.00	152.40	5439.6966	17.16	1.86E-01	2.67E+00	1.21E+00	2.83E-02	1.28E-02
6.25	158.75	5569.2132	17.568	2.04E-01	2.92E+00	1.32E+00	2.77E-02	1.25E-02
6.50	165.10	5698.7298	17.977	2.22E-01	3.18E+00	1.44E+00	2.70E-02	1.23E-02
6.75	171.45	5828.2464	18.386	2.40E-01	3.44E+00	1.56E+00	2.64E-02	1.20E-02
7.00	177.80	5957.7629	18.794	2.59E-01	3.71E+00	1.68E+00	2.57E-02	1.17E-02
7.25	184.15	6087.2795	19.203	2.78E-01	3.99E+00	1.81E+00	2.51E-02	1.14E-02
7.50	190.50	6216.7961	19.611	2.98E-01	4.27E+00	1.94E+00	2.44E-02	1.11E-02
7.75	196.85	6346.3127	20.02	3.18E-01	4.55E+00	2.07E+00	2.37E-02	1.07E-02
8.00	203.20	6475.8293	20.428	3.38E-01	4.85E+00	2.20E+00	2.30E-02	1.04E-02
8.25	209.55	6605.3459	20.837	3.59E-01	5.15E+00	2.33E+00	2.23E-02	1.01E-02
8.50	215.90	6734.8625	21.246	3.81E-01	5.45E+00	2.47E+00	2.15E-02	9.76E-03
8.75	222.25	6864.379	21.654	4.02E-01	5.76E+00	2.61E+00	2.08E-02	9.42E-03
9.00	228.60	6993.8956	22.063	4.24E-01	6.08E+00	2.76E+00	2.00E-02	9.07E-03
9.25	234.95	6605.3459	20.837	4.46E-01	6.39E+00	2.90E+00	1.92E-02	8.73E-03
9.50	241.30	6216.7961	19.611	4.67E-01	6.68E+00	3.03E+00	1.85E-02	8.40E-03
9.75	247.65	5828.2464	18.386	4.86E-01	6.96E+00	3.16E+00	1.79E-02	8.10E-03
10.00	254.00	5439.6966	17.16	5.04E-01	7.22E+00	3.27E+00	1.72E-02	7.82E-03
10.25	260.35	5051.1468	15.934	5.21E-01	7.46E+00	3.38E+00	1.67E-02	7.55E-03
10.50	266.70	4662.5971	14.708	5.36E-01	7.68E+00	3.48E+00	1.61E-02	7.31E-03
10.75	273.05	4274.0473	13.483	5.50E-01	7.88E+00	3.58E+00	1.56E-02	7.08E-03
11.00	279.40	3885.4976	12.257	5.63E-01	8.07E+00	3.66E+00	1.52E-02	6.88E-03
11.25	285.75	3496.9478	11.031	5.75E-01	8.24E+00	3.74E+00	1.48E-02	6.69E-03
11.50	292.10	3108.3981	9.8057	5.86E-01	8.39E+00	3.81E+00	1.44E-02	6.53E-03
11.75	298.45	2719.8483	8.58	5.95E-01	8.52E+00	3.87E+00	1.41E-02	6.38E-03
12.00	304.80	2331.2985	7.3542	6.03E-01	8.64E+00	3.92E+00	1.38E-02	6.25E-03

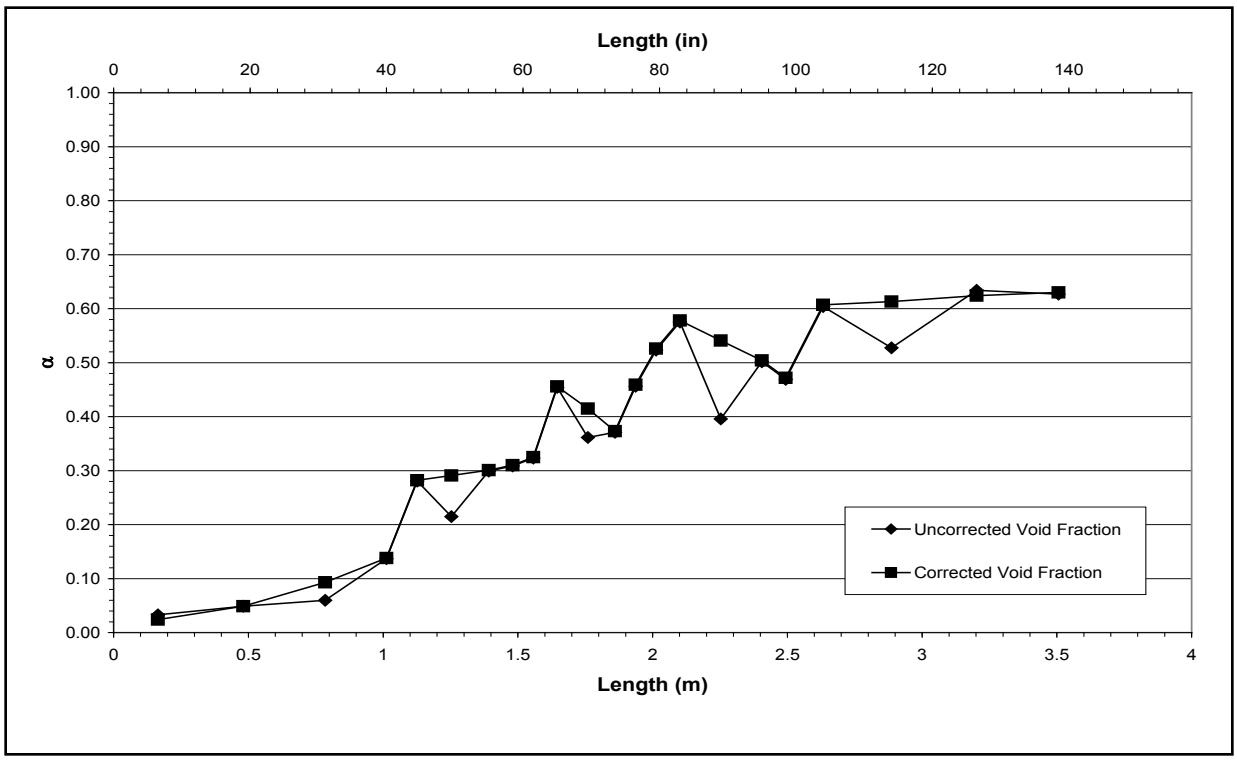

Figure A-600 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659J for Time Period 4980 to 5100 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1659-K

Test Conditions

Date: 7/9/2003
Steady-state time window: 5310 – 6120 seconds
Inlet flow rate: 0.508 cm/sec (0.200 in./sec)
Inlet mass flow rate: 0.024 kg/sec (0.052 lbm/sec)
Inlet flow temperature: 361.7 K (191.3 ºF)
Upper plenum pressure: 409.5 kPa (59.4 psia)
Bundle power: 72.28 kW

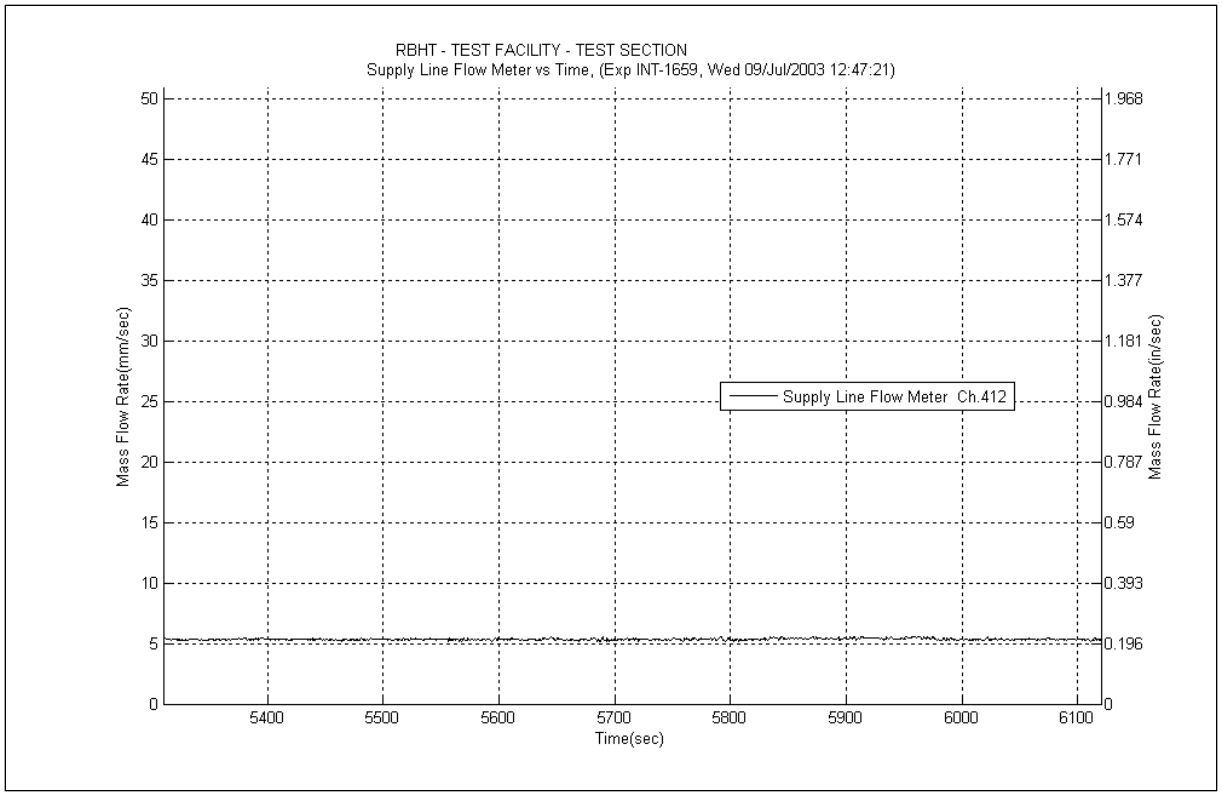

Figure A-601 Inlet Flow Plot for Experiment 1659K

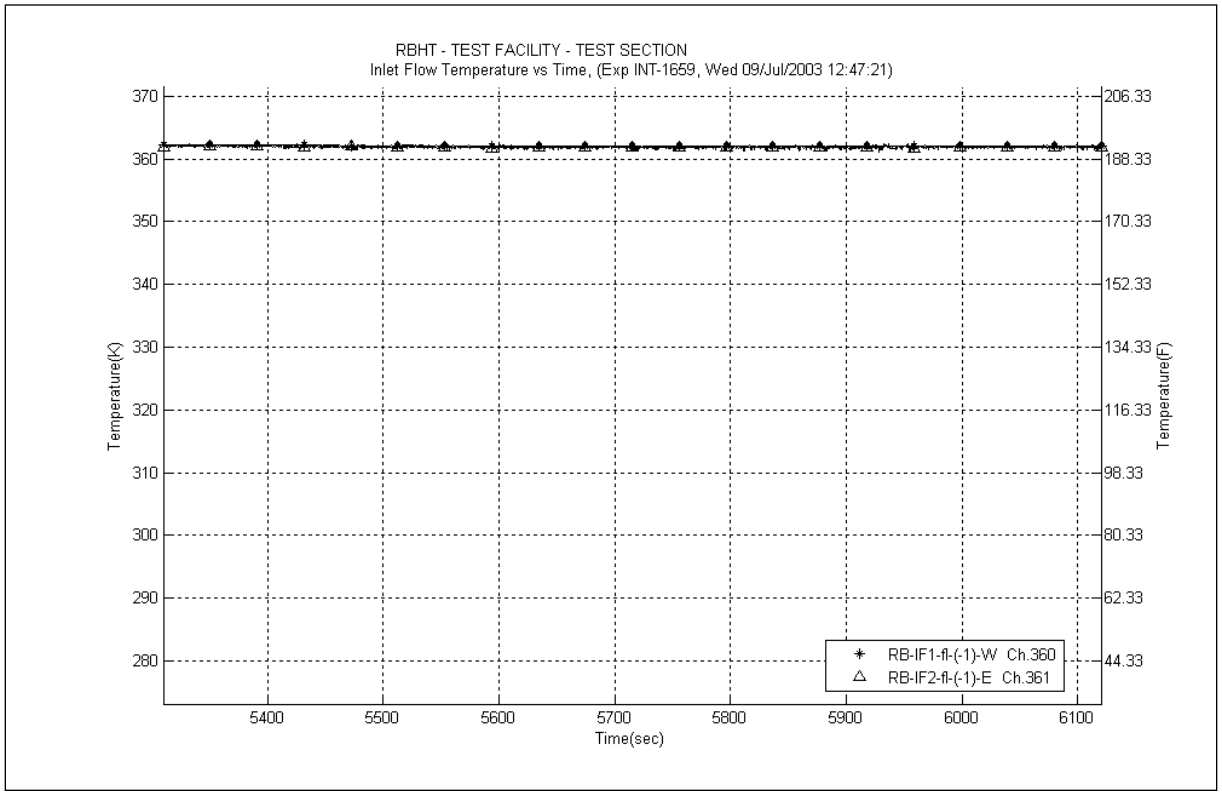

Figure A-602 Inlet Temperature Plot for Experiment 1659K

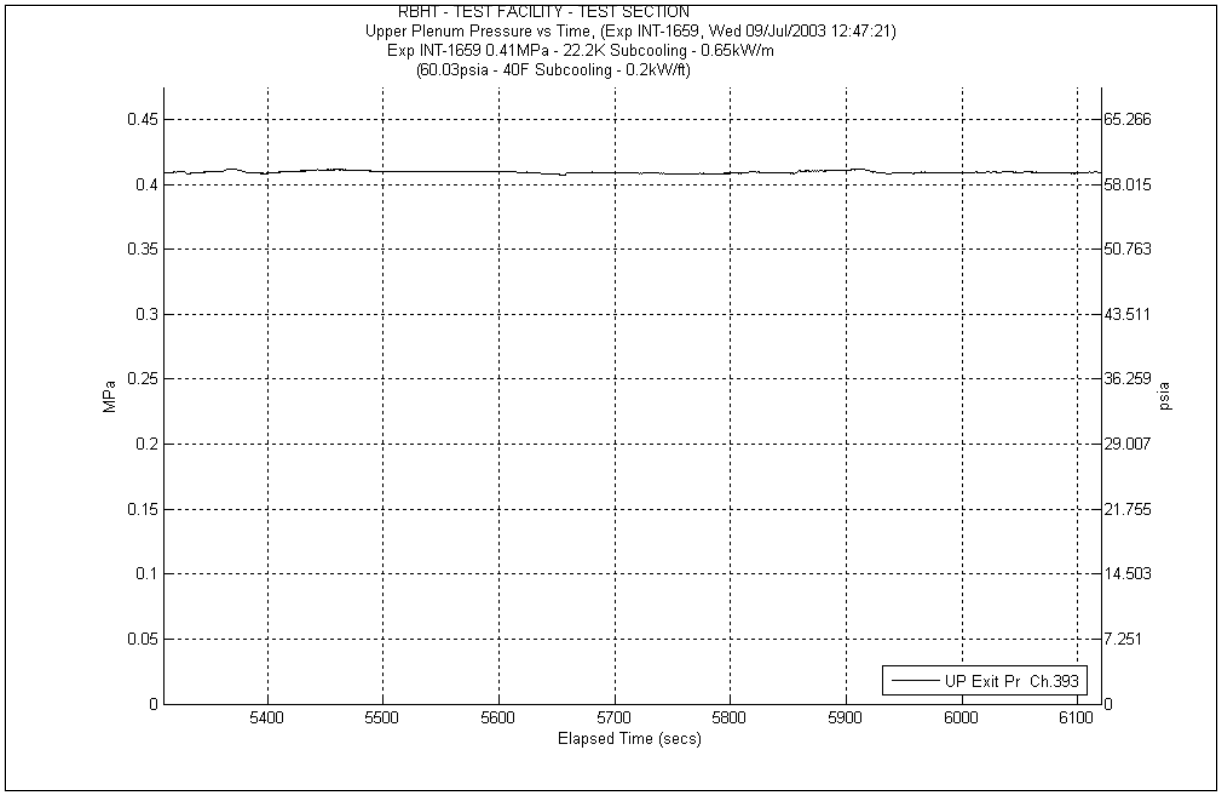

Figure A-603 System Pressure Plot for Experiment 1659K

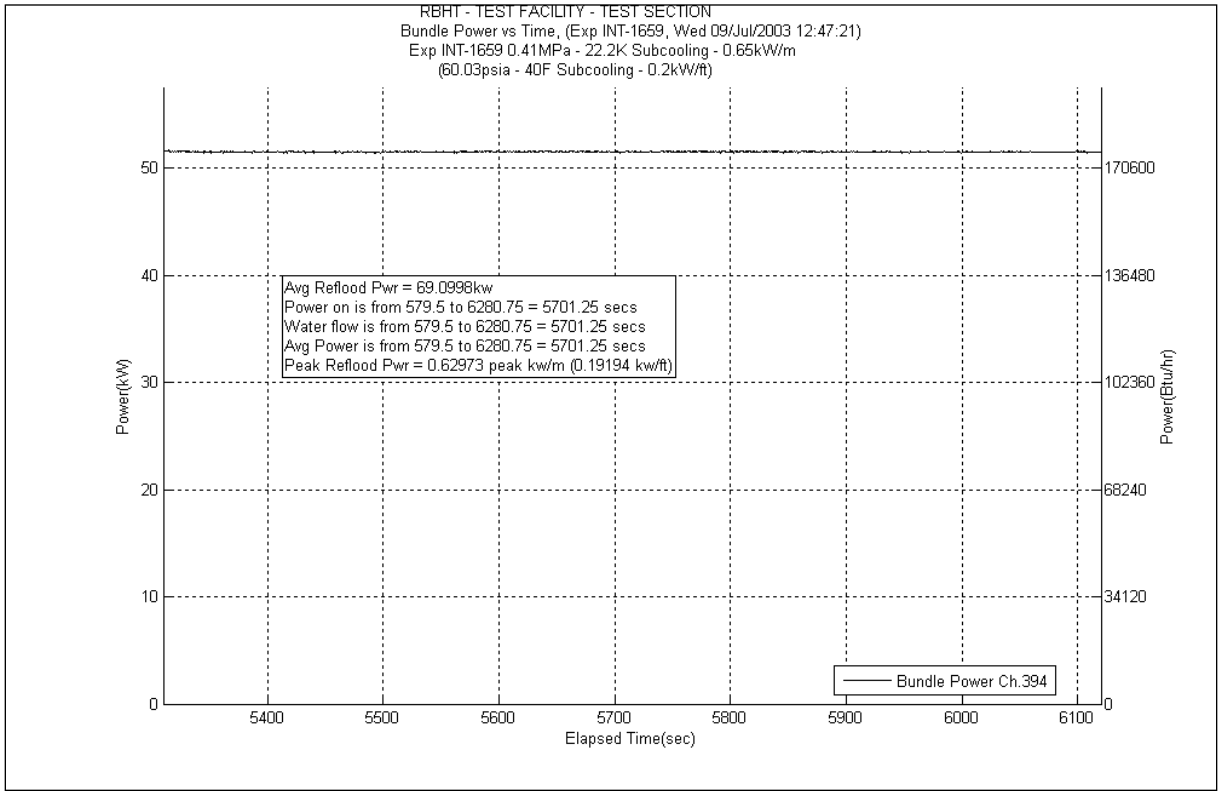

Figure A-604 Bundle Power Plot for Experiment 1659K

Table A-241 Data Results for RBHT Test 1659 for Time Period 5310 to 6120

Results for RBHT Test 1659
Valid Time Period 5310 to 6120 seconds
Collapsed Liquid Level = 76.188 inches = 1935.16 mm
(Z_{osv}) Onset of Significant Void = 19 inches = 482.5 mm
($Z_{2\phi}$) Two-Phase Level (Dryout) = 117.40 inches = 2981.96 mm
(S) Level Swell = 1.722

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.872	7.302	349.613	0.030	1.436	0.000	0.000	0.000	0.000	7.269	348.042	8647.269	414033.4621	0.873	0.869	0.877
*	120-133	3048-3378	383	0.837	11.010	527.155	0.036	1.724	0.000	0.000	-0.876	-41.950	11.85	567.381	8659.119	414600.8431	0.824	0.820	0.828
*	108-120	2743-3048	382	0.698	18.831	901.634	0.055	2.633	0.009	0.431	1.797	86.042	16.97	812.528	8676.089	415413.3711	0.728	0.724	0.732
	100-108	2540-2743	381	0.678	13.388	641.040	0.039	1.867	0.026	1.245	0.000	0.000	13.32	637.765	8689.409	416051.1361	0.679	0.676	0.682
	97-100	2464-2540	380	0.565	6.777	324.499	0.014	0.670	0.009	0.431	0.000	0.000	6.75	323.192	8696.159	416374.3278	0.567	0.564	0.570
	93-97	2362-2464	379	0.576	8.808	421.724	0.018	0.862	0.012	0.575	0.000	0.000	8.776	420.197	8704.935	416794.525	0.577	0.574	0.580
*	85-93	2159-2362	378	0.432	23.619	1130.896	0.034	1.628	0.023	1.101	6.642	318.033	16.92	810.134	8721.855	417604.6589	0.593	0.590	0.596
	81-85	2057-2159	377	0.607	8.174	391.388	0.015	0.718	0.011	0.527	0.000	0.000	8.142	389.841	8729.997	417994.5	0.608	0.605	0.611
	78-81	1981-2057	376	0.544	7.099	339.915	0.011	0.527	0.008	0.383	0.000	0.000	7.076	338.801	8737.073	418333.3007	0.546	0.543	0.549
	75-78	1905-1981	375	0.482	8.065	386.166	0.010	0.479	0.008	0.383	0.000	0.000	8.042	385.053	8745.115	418718.3537	0.484	0.482	0.486
	72-75	1829-1905	374	0.423	8.995	430.676	0.010	0.479	0.008	0.383	0.000	0.000	8.973	429.630	8754.088	419147.9832	0.424	0.422	0.426
*	67-72	1702-1829	373	0.363	16.551	792.473	0.015	0.718	0.013	0.622	2.673	127.991	13.85	663.142	8767.938	419811.1248	0.467	0.465	0.469
	63-67	1600-1702	372	0.508	10.215	489.110	0.011	0.527	0.010	0.479	0.000	0.000	10.19	487.900	8778.128	420299.0246	0.509	0.506	0.512
	60-63	1524-1600	371	0.348	10.158	486.375	0.008	0.383	0.007	0.335	0.000	0.000	10.14	485.506	8788.268	420784.5304	0.349	0.347	0.351
	57-60	1448-1524	370	0.336	10.340	495.078	0.007	0.335	0.007	0.335	0.000	0.000	10.32	494.124	8798.588	421278.6547	0.337	0.335	0.339
	53-57	1346-1448	369	0.335	13.814	661.430	0.009	0.431	0.009	0.431	0.000	0.000	13.79	660.269	8812.378	421938.9234	0.336	0.334	0.338
*	46-53	1168-1346	368	0.252	27.203	1302.470	0.014	0.670	0.015	0.718	4.754	227.607	22.42	1073.475	8834.798	423012.3988	0.383	0.381	0.385
	43-46	1092-1168	367	0.429	8.891	425.702	0.005	0.239	0.006	0.287	0.000	0.000	8.875	424.937	8843.673	423437.3361	0.43	0.428	0.432
	37-43	940-1092	366	0.285	22.279	1066.743	0.009	0.431	0.012	0.575	0.000	0.000	22.25	1065.336	8865.923	424502.6718	0.286	0.285	0.287
*	25-37	635-940	365	0.209	49.316	2361.256	0.012	0.575	0.021	1.005	-1.237	-59.235	50.52	2418.911	8916.443	426921.5824	0.189	0.188	0.190
	13-25	330-635	364	0.092	56.571	2708.631	0.005	0.239	0.009	0.431	0.000	0.000	56.54	2707.150	8972.983	429628.7321	0.092	0.087	0.097
*	0-13	0-330	363	0.038	64.932	3108.971	0.000	0.000	0.000	0.000	0.562	26.919	64.37	3082.052	9037.353	432710.7842	0.046	0.044	0.048

Table A-242 Energy Balance Results for RBHT Test 1659K for Time Period 5310 to 6120 seconds

Results for RBHT Test 1659 Valid Time Period 5310 to 6120 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2331.5891	7.3552	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
0.25	6.35	2461.1218	7.7638	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
0.50	12.70	2590.6546	8.1724	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
0.75	19.05	2720.1873	8.581	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
1.00	25.40	2849.72	8.9896	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
1.25	31.75	2979.2528	9.3983	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
1.50	38.10	3108.7855	9.8069	0.00E+00	0.00E+00	0.00E+00	1.73E-02	7.87E-03
1.75	44.45	3238.3182	10.216	1.31E-02	9.38E-02	4.26E-02	1.71E-02	7.77E-03
2.00	50.80	3367.8509	10.624	3.42E-02	2.45E-01	1.11E-01	1.68E-02	7.60E-03
2.25	57.15	3497.3837	11.033	5.62E-02	4.02E-01	1.82E-01	1.64E-02	7.43E-03
2.50	63.50	3626.9164	11.441	7.89E-02	5.65E-01	2.56E-01	1.60E-02	7.25E-03
2.75	69.85	3756.4491	11.85	1.03E-01	7.34E-01	3.33E-01	1.56E-02	7.06E-03
3.00	76.20	3885.9818	12.259	1.27E-01	9.09E-01	4.12E-01	1.51E-02	6.87E-03
3.25	82.55	4015.5146	12.667	1.52E-01	1.09E+00	4.95E-01	1.47E-02	6.67E-03
3.50	88.90	4145.0473	13.076	1.78E-01	1.28E+00	5.79E-01	1.43E-02	6.47E-03
3.75	95.25	4274.58	13.484	2.05E-01	1.47E+00	6.67E-01	1.38E-02	6.25E-03
4.00	101.60	4404.1128	13.893	2.33E-01	1.67E+00	7.57E-01	1.33E-02	6.04E-03
4.25	107.95	4533.6455	14.302	2.62E-01	1.87E+00	8.50E-01	1.28E-02	5.81E-03
4.50	114.30	4663.1782	14.71	2.91E-01	2.08E+00	9.45E-01	1.23E-02	5.58E-03
4.75	120.65	4792.7109	15.119	3.21E-01	2.30E+00	1.04E+00	1.18E-02	5.34E-03
5.00	127.00	4922.2437	15.528	3.52E-01	2.52E+00	1.14E+00	1.12E-02	5.10E-03
5.25	133.35	5051.7764	15.936	3.84E-01	2.75E+00	1.25E+00	1.07E-02	4.85E-03
5.50	139.70	5181.3091	16.345	4.17E-01	2.99E+00	1.35E+00	1.01E-02	4.59E-03
5.75	146.05	5310.8419	16.753	4.50E-01	3.23E+00	1.46E+00	9.54E-03	4.33E-03
6.00	152.40	5440.3746	17.162	4.85E-01	3.47E+00	1.57E+00	8.94E-03	4.06E-03
6.25	158.75	5569.9073	17.571	5.20E-01	3.72E+00	1.69E+00	8.33E-03	3.78E-03
6.50	165.10	5699.44	17.979	5.56E-01	3.98E+00	1.81E+00	7.71E-03	3.50E-03
6.75	171.45	5828.9728	18.388	5.93E-01	4.25E+00	1.93E+00	7.07E-03	3.21E-03
7.00	177.80	5958.5055	18.797	6.30E-01	4.52E+00	2.05E+00	6.41E-03	2.91E-03
7.25	184.15	6088.0382	19.205	6.69E-01	4.79E+00	2.17E+00	5.75E-03	2.61E-03
7.50	190.50	6217.571	19.614	7.08E-01	5.07E+00	2.30E+00	5.06E-03	2.30E-03
7.75	196.85	6347.1037	20.022	7.48E-01	5.36E+00	2.43E+00	4.37E-03	1.98E-03
8.00	203.20	6476.6364	20.431	7.89E-01	5.65E+00	2.56E+00	3.66E-03	1.66E-03
8.25	209.55	6606.1691	20.84	8.31E-01	5.95E+00	2.70E+00	2.93E-03	1.33E-03
8.50	215.90	6735.7019	21.248	8.74E-01	6.26E+00	2.84E+00	2.19E-03	9.94E-04
8.75	222.25	6865.2346	21.657	9.17E-01	6.57E+00	2.98E+00	1.44E-03	6.52E-04
9.00	228.60	6994.7673	22.065	9.61E-01	6.89E+00	3.12E+00	6.70E-04	3.04E-04
9.25	234.95	6606.1691	20.84	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
9.50	241.30	6217.571	19.614	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
9.75	247.65	5828.9728	18.388	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
10.00	254.00	5440.3746	17.162	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
10.25	260.35	5051.7764	15.936	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
10.50	266.70	4663.1782	14.71	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
10.75	273.05	4274.58	13.484	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
11.00	279.40	3885.9818	12.259	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
11.25	285.75	3497.3837	11.033	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
11.50	292.10	3108.7855	9.8069	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
11.75	298.45	2720.1873	8.581	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00
12.00	304.80	2331.5891	7.3552	1.00E+00	7.16E+00	3.25E+00	0.00E+00	0.00E+00

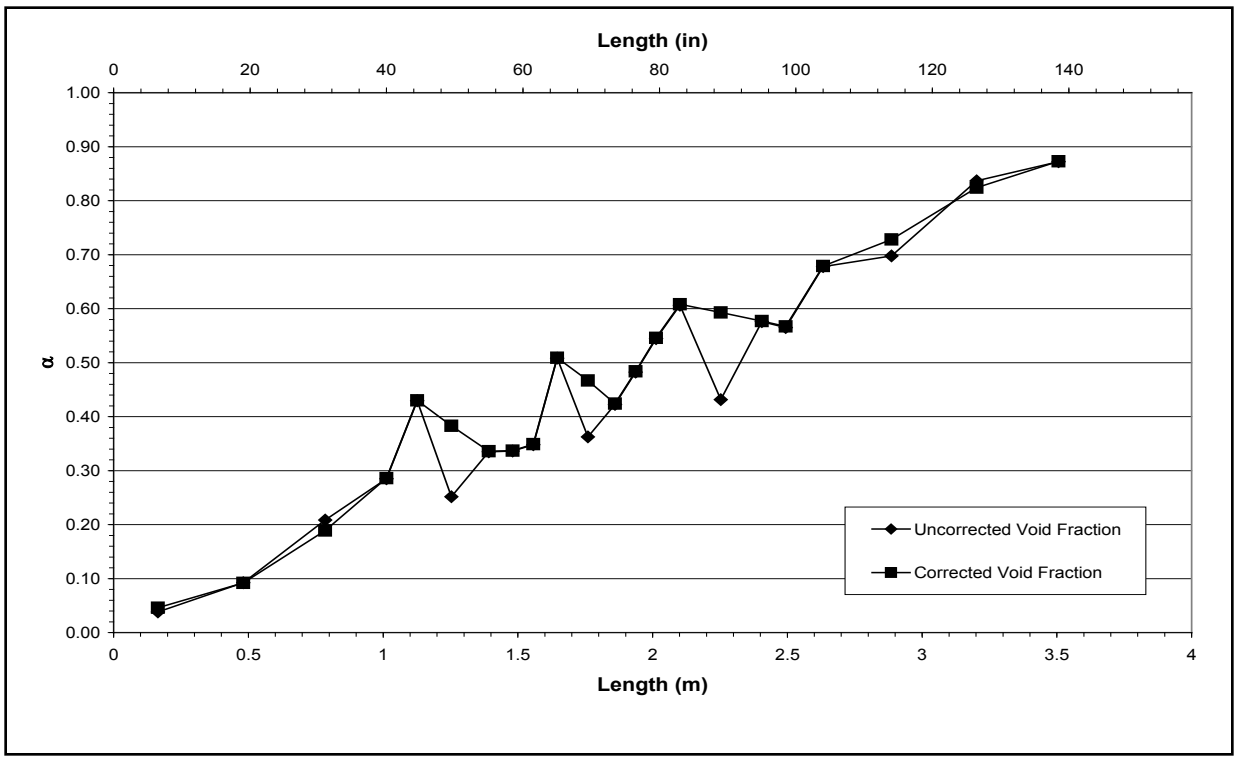

Figure A-605 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1659K for Time Period 5310 to 6120 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-A

Test Conditions

Date: 7/21/2003
Steady-state time window: 2930 – 3000 seconds
Inlet flow rate: 3.094 cm/sec (1.218 in./sec)
Inlet mass flow rate: 0.148 kg/sec (0.326 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

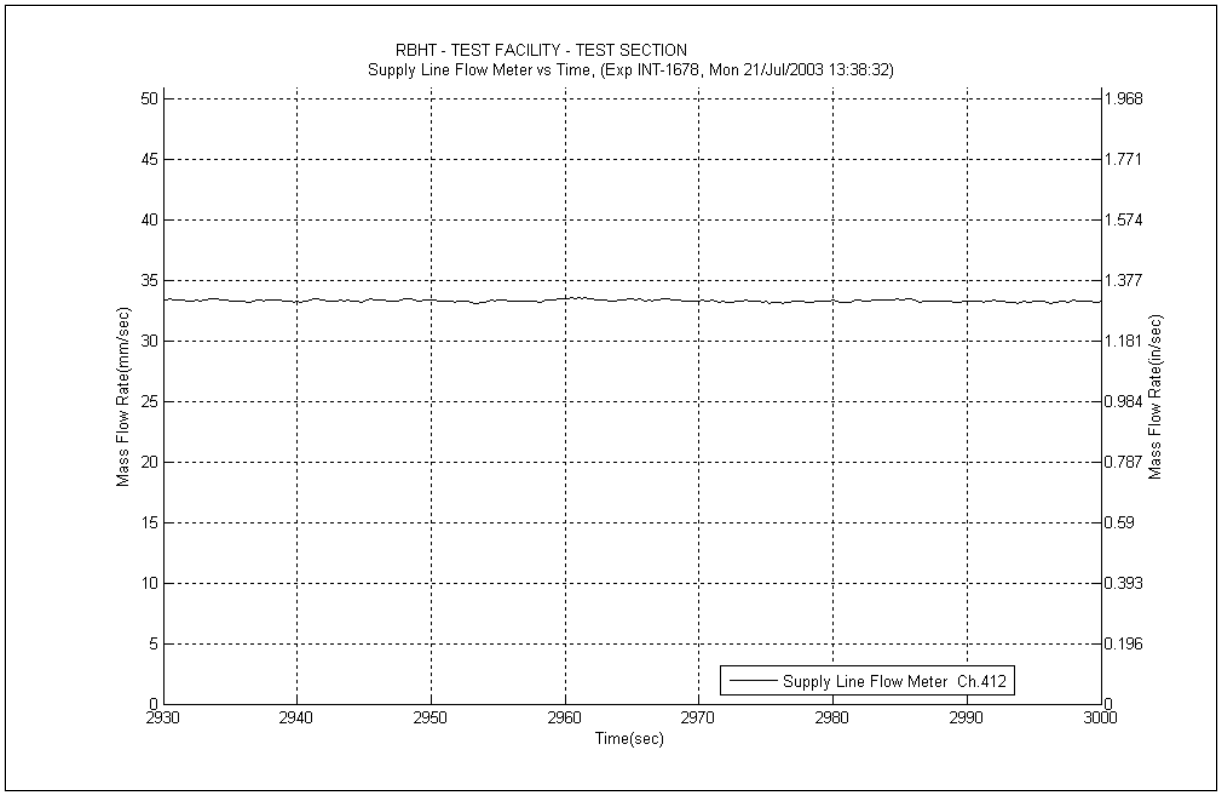

Figure A-606 Inlet Flow Plot for Experiment 1678A

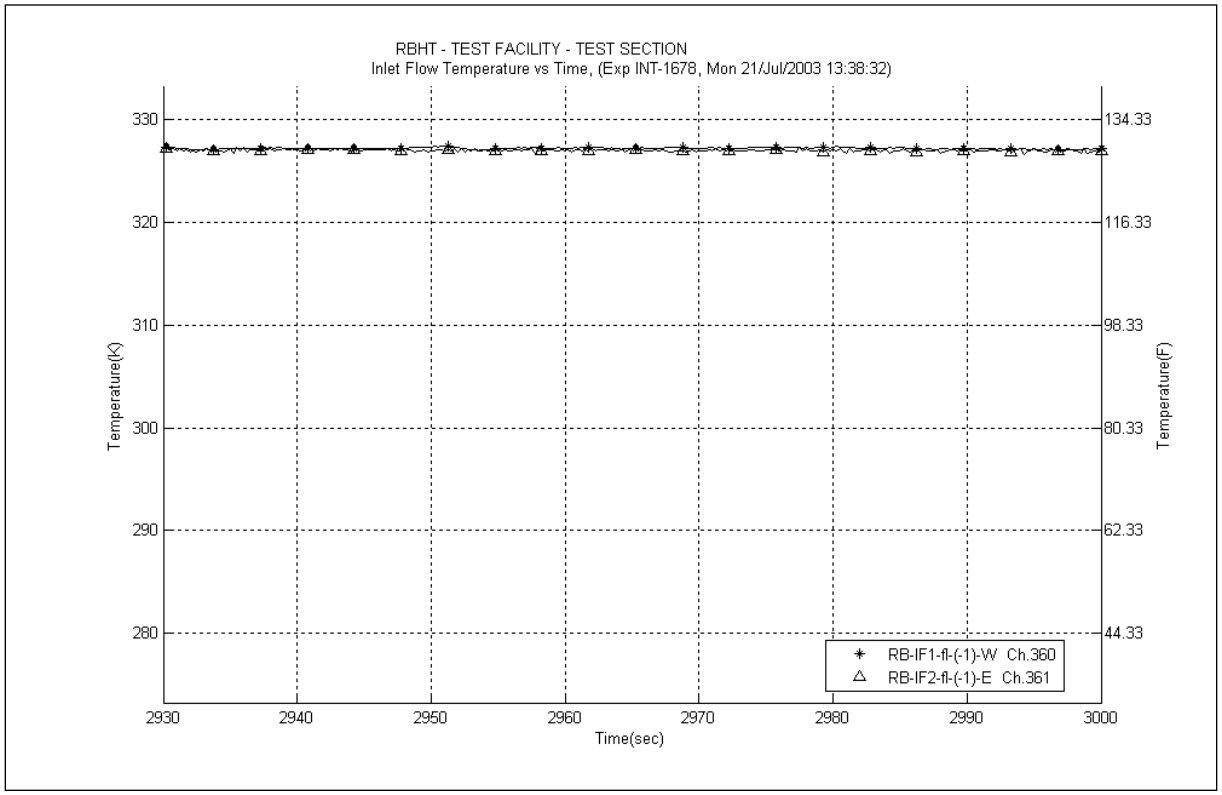

Figure A-607 Inlet Temperature Plot for Experiment 1678A

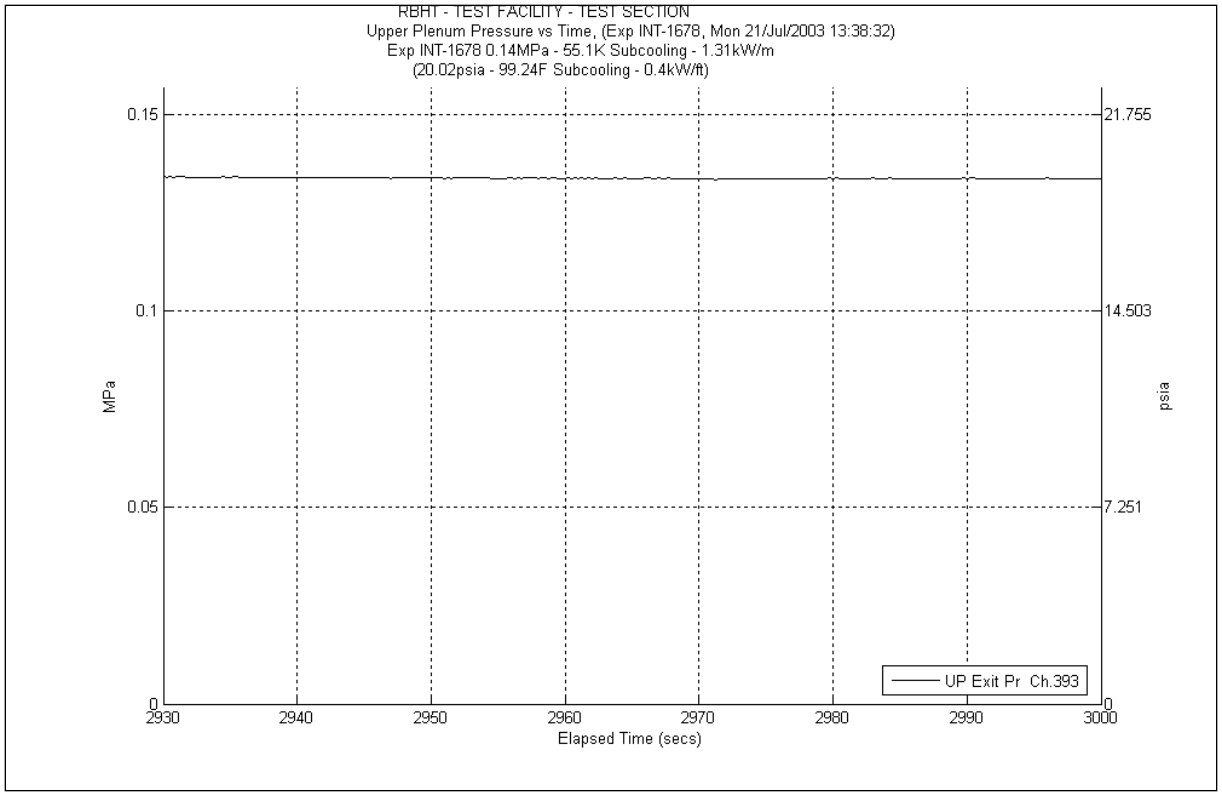

Figure A-608 System Pressure Plot for Experiment 1678A

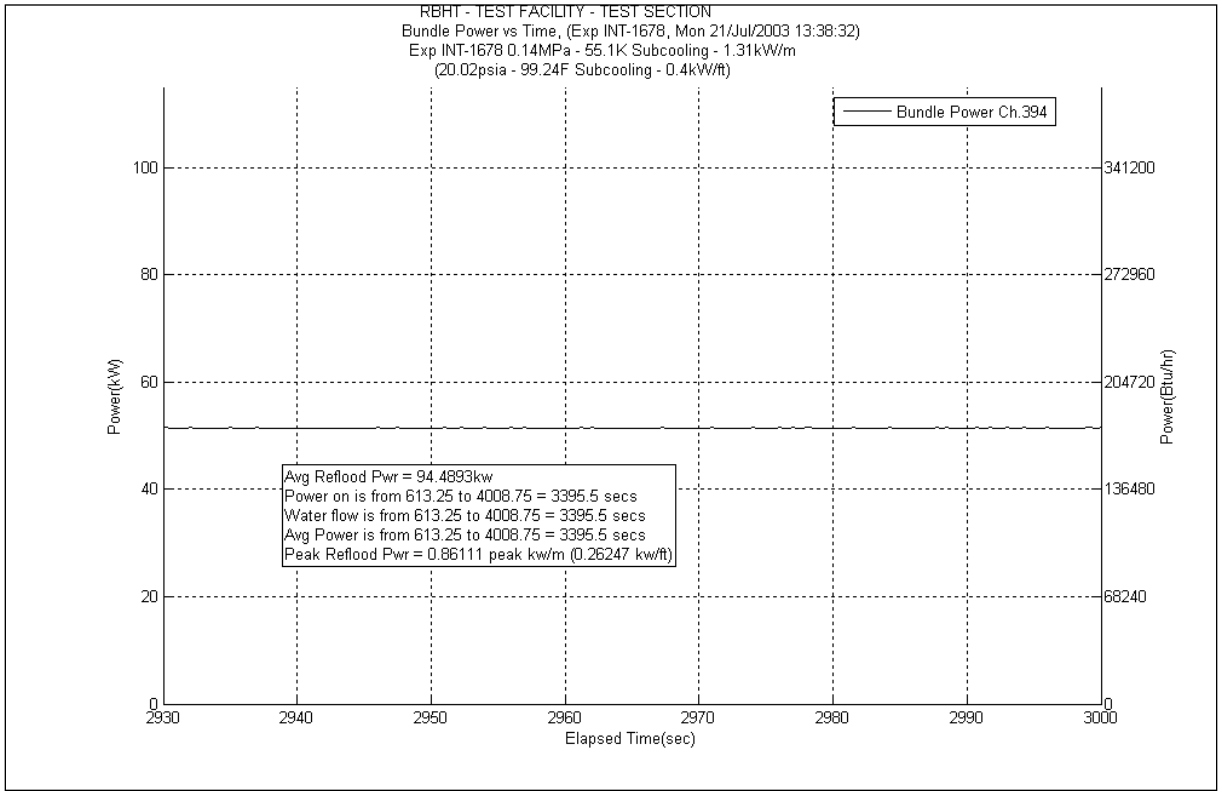

Figure A-609 Bundle Power Plot for Experiment 1678A

Table A-243 Data Results for RBHT Test 1678 for Time Period 2930 to 3000

Results for RBHT Test 1678
Valid Time Period 2930 to 3000 seconds
Collapsed Liquid Level = 115.163 inches = 2925.15 mm
(Z_{osv}) Onset of Significant Void = 83 inches = 2108 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.542	26.164	1252.739	0.773	37.011	0.263	12.593	0.000	0.000	25.12	1202.752	2905.12	139097.8922	0.56	0.557	0.563
*	120-133	3048-3378	383	0.575	28.678	1373.089	0.826	39.549	0.469	22.456	-3.057	-146.391	30.44	1457.475	2935.56	140555.3672	0.549	0.546	0.552
*	108-120	2743-3048	382	0.463	33.450	1601.606	0.638	30.548	0.585	28.010	2.737	131.060	29.49	1411.989	2965.05	141967.356	0.527	0.524	0.530
	100-108	2540-2743	381	0.497	20.898	1000.600	0.339	16.231	0.428	20.493	0.000	0.000	20.12	963.351	2985.17	142930.7068	0.516	0.513	0.519
	97-100	2464-2540	380	0.365	9.893	473.693	0.107	5.123	0.155	7.421	0.000	0.000	9.628	460.991	2994.798	143391.6979	0.382	0.380	0.384
	93-97	2362-2464	379	0.366	13.165	630.348	0.124	5.937	0.202	9.672	0.000	0.000	12.84	614.782	3007.638	144006.4804	0.382	0.380	0.384
*	85-93	2159-2362	378	0.196	33.393	1598.871	0.182	8.714	0.387	18.530	0.734	35.149	32.09	1536.477	3039.728	145542.9579	0.227	0.226	0.228
	81-85	2057-2159	377	0.062	19.496	933.462	0.050	2.394	0.186	8.906	0.000	0.000	19.26	922.174	3058.988	146465.1316	0.073	0.069	0.077
	78-81	1981-2057	376	-0.006	15.679	750.698	0.016	0.766	0.098	4.692	0.000	0.000	15.56	745.017	3074.548	147210.1484	0.001	0.001	0.001
	75-78	1905-1981	375	0.044	14.900	713.400	0.001	0.048	0.000	0.000	0.000	0.000	14.89	712.937	3089.438	147923.0854	0.044	0.042	0.046
	72-75	1829-1905	374	0.044	14.894	713.151	0.001	0.048	0.000	0.000	0.000	0.000	14.89	712.937	3104.328	148636.0225	0.044	0.042	0.046
*	67-72	1702-1829	373	0.026	25.286	1210.716	0.002	0.096	0.000	0.000	0.214	10.262	25.07	1200.358	3129.398	149836.3805	0.034	0.032	0.036
	63-67	1600-1702	372	0.025	20.264	970.263	0.002	0.096	0.000	0.000	0.000	0.000	20.26	970.054	3149.658	150806.4345	0.025	0.024	0.026
	60-63	1524-1600	371	0.005	15.507	742.493	0.001	0.048	0.000	0.000	0.000	0.000	15.5	742.144	3165.158	151548.5785	0.005	0.005	0.005
	57-60	1448-1524	370	0.038	14.988	717.627	0.001	0.048	0.000	0.000	0.000	0.000	14.98	717.246	3180.138	152265.8247	0.038	0.036	0.040
	53-57	1346-1448	369	0.027	20.207	967.528	0.002	0.096	0.000	0.000	0.000	0.000	20.2	967.181	3200.338	153233.0059	0.027	0.026	0.028
*	46-53	1168-1346	368	0.026	35.393	1694.604	0.003	0.144	0.000	0.000	-0.190	-9.119	35.58	1703.580	3235.918	154936.5855	0.021	0.020	0.022
	43-46	1092-1168	367	0.015	15.351	735.033	0.001	0.048	0.000	0.000	0.000	0.000	15.35	734.962	3251.268	155671.5474	0.015	0.014	0.016
	37-43	940-1092	366	0.018	30.599	1465.093	0.003	0.144	0.000	0.000	0.000	0.000	30.59	1464.657	3281.858	157136.2045	0.018	0.017	0.019
*	25-37	635-940	365	0.012	61.551	2947.094	0.006	0.287	0.000	0.000	0.255	12.226	61.29	2934.581	3343.148	160070.7854	0.016	0.015	0.017
	13-25	330-635	364	0.014	61.437	2941.624	0.006	0.287	0.000	0.000	0.000	0.000	61.41	2940.327	3404.558	163011.112	0.014	0.013	0.015
*	0-13	0-330	363	0.007	67.056	3210.672	0.006	0.287	0.000	0.000	0.040	1.928	67.01	3208.456	3471.568	166219.568	0.007	0.007	0.007

Table A-244 Energy Balance Results for RBHT Test 1678A for Time Period 2930 to 3000 seconds

Results for RBHT Test 1678
Valid Time Period 2930 to 3000 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2322.0053	7.3249	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.25	6.35	2451.0056	7.7319	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.50	12.70	2580.0058	8.1388	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
0.75	19.05	2709.0061	8.5458	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.00	25.40	2838.0064	8.9527	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.25	31.75	2967.0067	9.3596	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.50	38.10	3096.007	9.7666	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
1.75	44.45	3225.0073	10.174	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.00	50.80	3354.0076	10.58	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.25	57.15	3483.0079	10.987	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.50	63.50	3612.0082	11.394	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
2.75	69.85	3741.0085	11.801	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.00	76.20	3870.0088	12.208	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.25	82.55	3999.0091	12.615	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.50	88.90	4128.0093	13.022	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
3.75	95.25	4257.0096	13.429	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.00	101.60	4386.0099	13.836	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.25	107.95	4515.0102	14.243	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.50	114.30	4644.0105	14.65	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
4.75	120.65	4773.0108	15.057	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.00	127.00	4902.0111	15.464	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.25	133.35	5031.0114	15.871	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.50	139.70	5160.0117	16.278	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
5.75	146.05	5289.012	16.685	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.00	152.40	5418.0123	17.092	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.25	158.75	5547.0126	17.498	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.50	165.10	5676.0129	17.905	0.00E+00	0.00E+00	0.00E+00	1.05E-01	4.75E-02
6.75	171.45	5805.0131	18.312	4.05E-03	5.05E-01	2.29E-01	1.04E-01	4.73E-02
7.00	177.80	5934.0134	18.719	9.79E-03	1.22E+00	5.54E-01	1.04E-01	4.70E-02
7.25	184.15	6063.0137	19.126	1.57E-02	1.96E+00	8.87E-01	1.03E-01	4.67E-02
7.50	190.50	6192.014	19.533	2.17E-02	2.70E+00	1.23E+00	1.02E-01	4.64E-02
7.75	196.85	6321.0143	19.94	2.78E-02	3.47E+00	1.57E+00	1.02E-01	4.61E-02
8.00	203.20	6450.0146	20.347	3.40E-02	4.25E+00	1.93E+00	1.01E-01	4.58E-02
8.25	209.55	6579.0149	20.754	4.04E-02	5.04E+00	2.29E+00	1.00E-01	4.55E-02
8.50	215.90	6708.0152	21.161	4.69E-02	5.86E+00	2.66E+00	9.97E-02	4.52E-02
8.75	222.25	6837.0155	21.568	5.35E-02	6.68E+00	3.03E+00	9.90E-02	4.49E-02
9.00	228.60	6966.0158	21.975	6.03E-02	7.53E+00	3.41E+00	9.83E-02	4.46E-02
9.25	234.95	6579.0149	20.754	6.69E-02	8.35E+00	3.79E+00	9.76E-02	4.43E-02
9.50	241.30	6192.014	19.533	7.32E-02	9.13E+00	4.14E+00	9.70E-02	4.40E-02
9.75	247.65	5805.0131	18.312	7.90E-02	9.87E+00	4.48E+00	9.64E-02	4.37E-02
10.00	254.00	5418.0123	17.092	8.45E-02	1.06E+01	4.79E+00	9.58E-02	4.34E-02
10.25	260.35	5031.0114	15.871	8.96E-02	1.12E+01	5.08E+00	9.53E-02	4.32E-02
10.50	266.70	4644.0105	14.65	9.44E-02	1.18E+01	5.34E+00	9.48E-02	4.30E-02
10.75	273.05	4257.0096	13.429	9.87E-02	1.23E+01	5.59E+00	9.43E-02	4.28E-02
11.00	279.40	3870.0088	12.208	1.03E-01	1.28E+01	5.82E+00	9.39E-02	4.26E-02
11.25	285.75	3483.0079	10.987	1.06E-01	1.33E+01	6.02E+00	9.35E-02	4.24E-02
11.50	292.10	3096.007	9.7666	1.10E-01	1.37E+01	6.20E+00	9.32E-02	4.23E-02
11.75	298.45	2709.0061	8.5458	1.12E-01	1.40E+01	6.36E+00	9.29E-02	4.21E-02
12.00	304.80	2322.0053	7.3249	1.15E-01	1.43E+01	6.50E+00	9.26E-02	4.20E-02

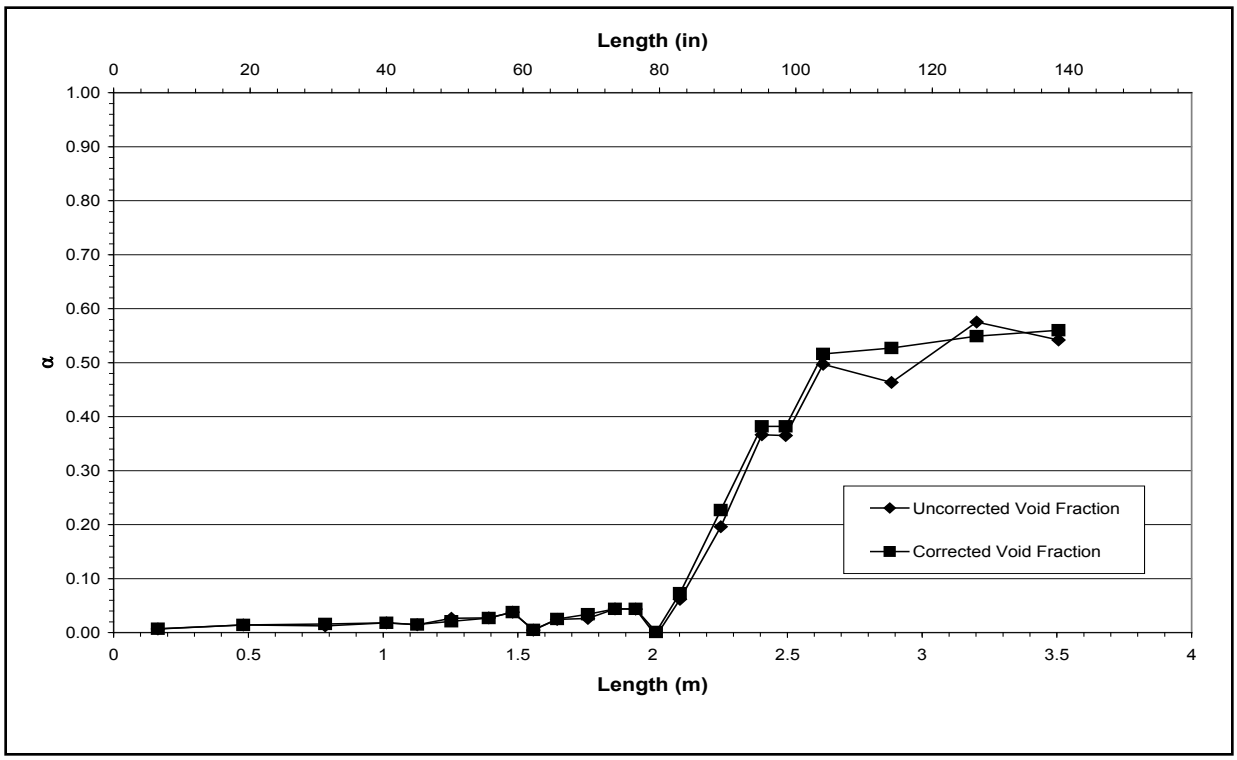

Figure A-610 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678A for Time Period 2930 to 3000 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-B

Test Conditions

Date: 7/21/2003
Steady-state time window: 3150 – 3200 seconds
Inlet flow rate: 3.038 cm/sec (1.196 in./sec)
Inlet mass flow rate: 0.145 kg/sec (0.320 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

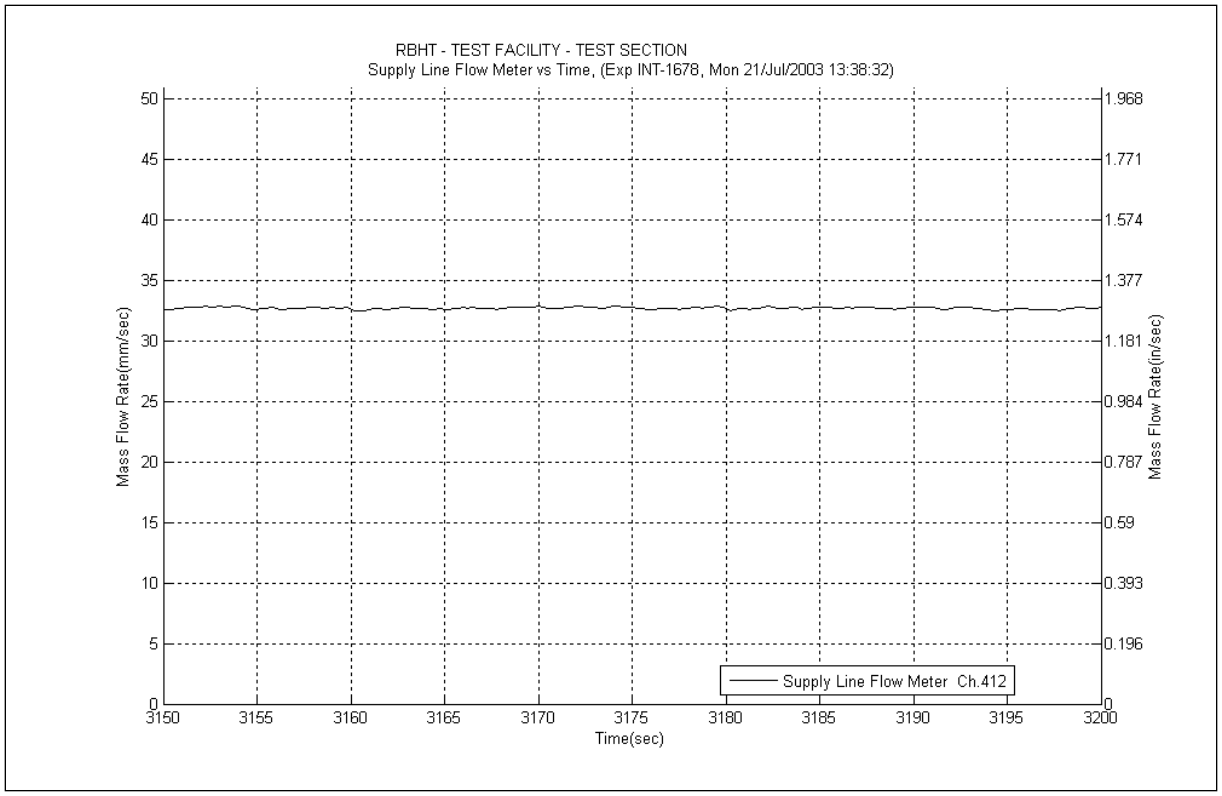

Figure A-611 Inlet Flow Plot for Experiment 1678B

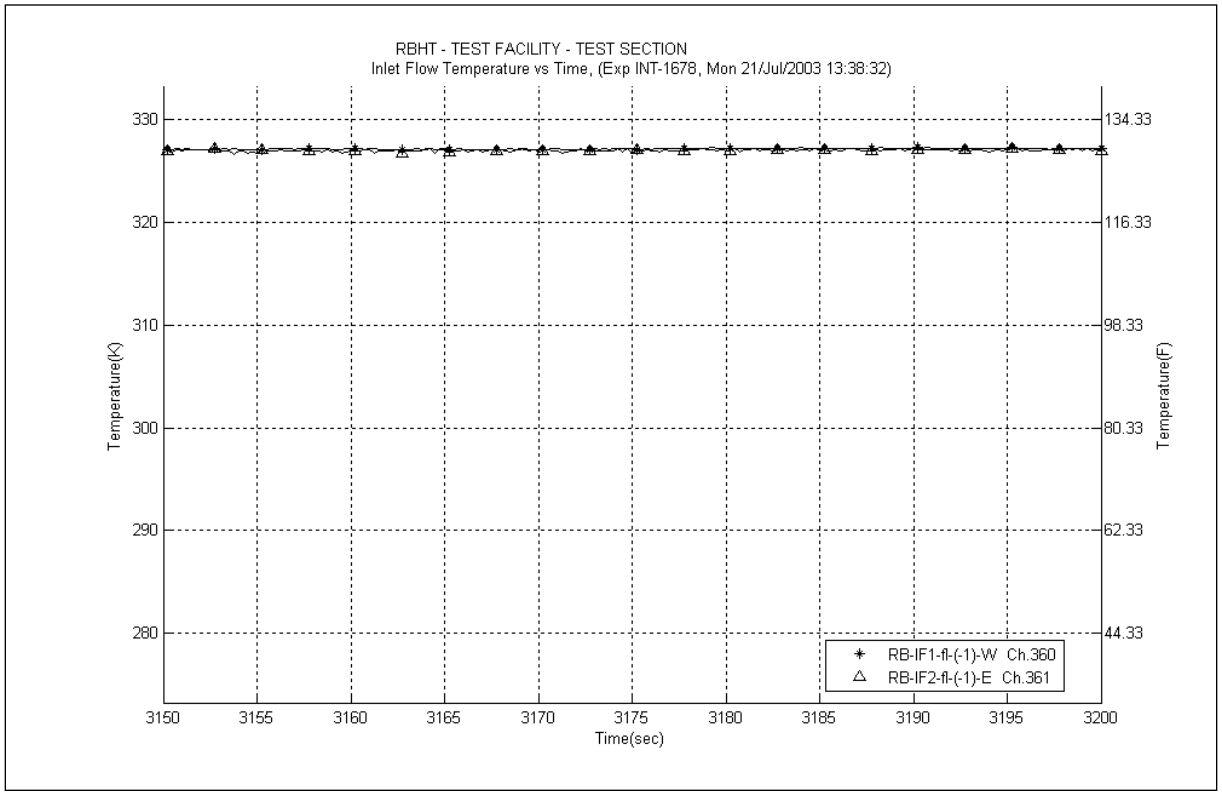

Figure A-612 Inlet Temperature Plot for Experiment 1678B

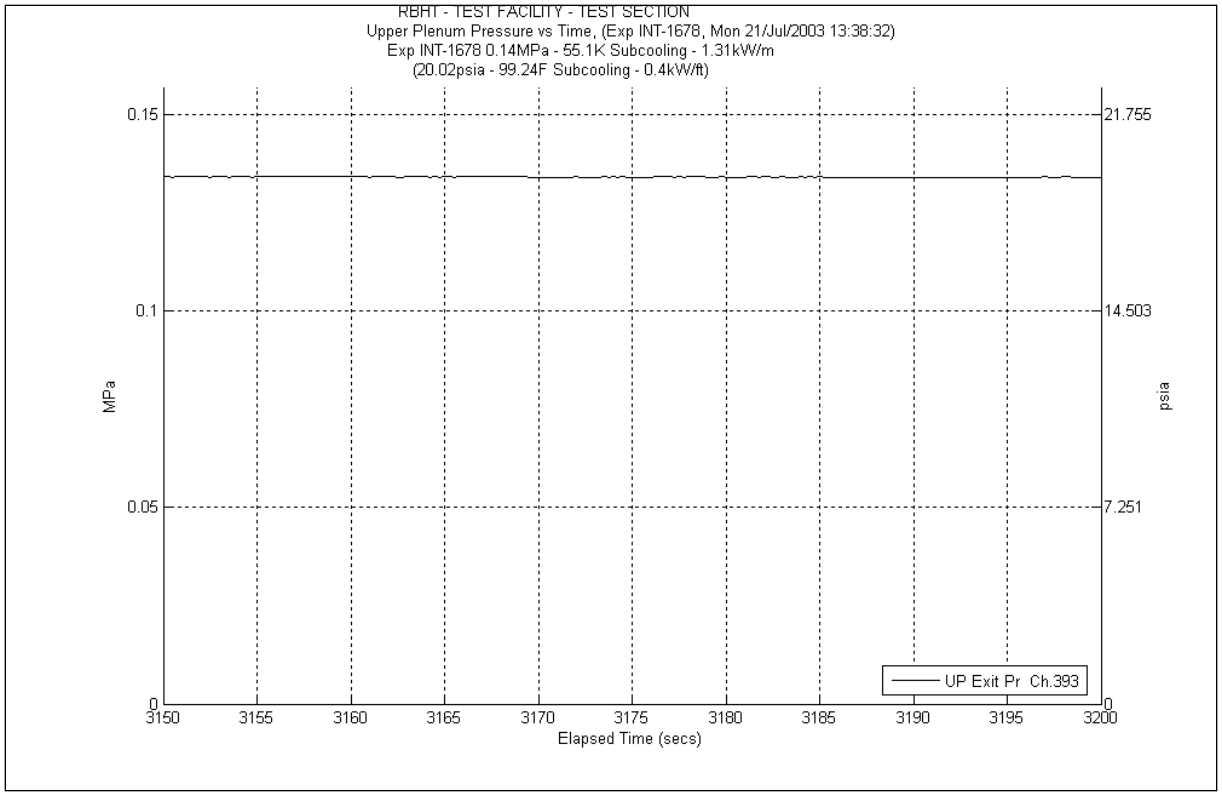

Figure A-613 System Pressure Plot for Experiment 1678B

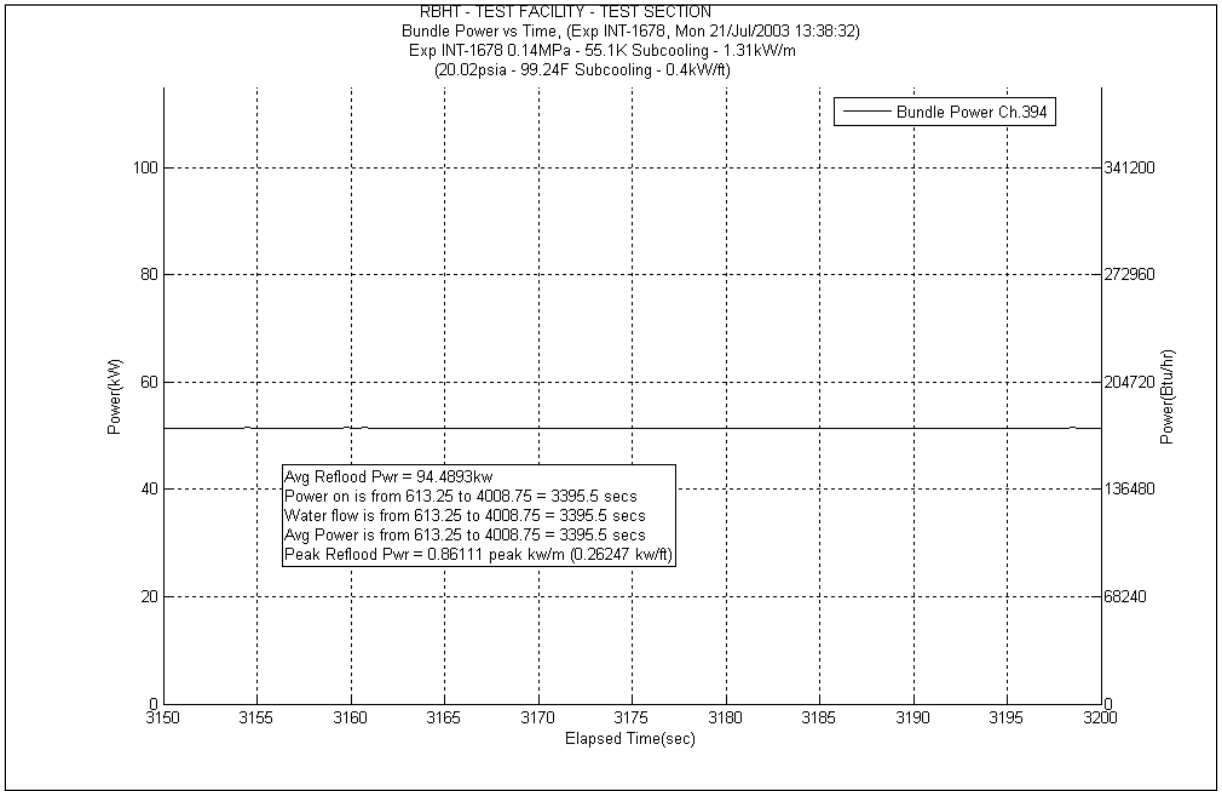

Figure A-614 Bundle Power Plot for Experiment 1678B

Table A-245 Data Results for RBHT Test 1678 for Time Period 3150 to 3200

Results for RBHT Test 1678
Valid Time Period 3150 to 3200 seconds
Collapsed Liquid Level = 114.885 inches = 2918.08 mm
(Z_{osv}) Onset of Significant Void = 83 inches = 2108 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.543	26.086	1249.009	0.763	36.533	0.257	12.305	0.000	0.000	25.06	1199.879	2905.06	139095.0194	0.561	0.558	0.564
*	120-133	3048-3378	383	0.577	28.527	1365.878	0.816	39.070	0.459	21.977	-3.158	-151.208	30.41	1456.039	2935.47	140551.058	0.549	0.546	0.552
*	108-120	2743-3048	382	0.463	33.492	1603.595	0.633	30.308	0.573	27.435	2.736	130.990	29.55	1414.862	2965.02	141965.9196	0.526	0.523	0.529
	100-108	2540-2743	381	0.496	20.960	1003.584	0.338	16.184	0.419	20.062	0.000	0.000	20.2	967.181	2985.22	142933.1008	0.514	0.511	0.517
	97-100	2464-2540	380	0.365	9.898	473.942	0.107	5.123	0.152	7.278	0.000	0.000	9.635	461.326	2994.855	143394.4271	0.381	0.379	0.383
	93-97	2362-2464	379	0.366	13.175	630.845	0.125	5.985	0.198	9.480	0.000	0.000	12.85	615.261	3007.705	144009.6884	0.381	0.379	0.383
*	85-93	2159-2362	378	0.197	33.378	1598.125	0.187	8.954	0.379	18.147	0.702	33.590	32.11	1537.435	3039.815	145547.1234	0.227	0.226	0.228
	81-85	2057-2159	377	0.061	19.511	934.208	0.056	2.681	0.182	8.714	0.000	0.000	19.27	922.653	3059.085	146469.776	0.072	0.068	0.076
	78-81	1981-2057	376	-0.006	15.679	750.698	0.020	0.958	0.133	6.368	0.000	0.000	15.52	743.102	3074.605	147212.8776	0.003	0.003	0.003
	75-78	1905-1981	375	0.044	14.894	713.151	0.003	0.144	0.004	0.192	0.000	0.000	14.88	712.458	3089.485	147925.3358	0.045	0.043	0.047
	72-75	1829-1905	374	0.044	14.894	713.151	0.001	0.048	0.000	0.000	0.000	0.000	14.89	712.937	3104.375	148638.2728	0.044	0.042	0.046
*	67-72	1702-1829	373	0.026	25.286	1210.716	0.002	0.096	0.000	0.000	0.214	10.262	25.07	1200.358	3129.445	149838.6309	0.034	0.032	0.036
	63-67	1600-1702	372	0.025	20.264	970.263	0.002	0.096	0.000	0.000	0.000	0.000	20.26	970.054	3149.705	150808.6849	0.025	0.024	0.026
	60-63	1524-1600	371	0.005	15.502	742.244	0.001	0.048	0.000	0.000	0.000	0.000	15.5	742.144	3165.205	151550.8289	0.005	0.005	0.005
	57-60	1448-1524	370	0.038	14.988	717.627	0.001	0.048	0.000	0.000	0.000	0.000	14.98	717.246	3180.185	152268.0751	0.038	0.036	0.040
	53-57	1346-1448	369	0.027	20.207	967.528	0.002	0.096	0.000	0.000	0.000	0.000	20.2	967.181	3200.385	153235.2563	0.027	0.026	0.028
*	46-53	1168-1346	368	0.026	35.393	1694.604	0.003	0.144	0.000	0.000	-0.190	-9.119	35.58	1703.580	3235.965	154938.8358	0.021	0.020	0.022
	43-46	1092-1168	367	0.015	15.351	735.033	0.001	0.048	0.000	0.000	0.000	0.000	15.34	734.483	3251.305	155673.319	0.015	0.014	0.016
	37-43	940-1092	366	0.018	30.609	1465.590	0.003	0.144	0.000	0.000	0.000	0.000	30.6	1465.136	3281.905	157138.4548	0.018	0.017	0.019
*	25-37	635-940	365	0.013	61.536	2946.348	0.006	0.287	0.000	0.000	0.230	11.001	61.3	2935.060	3343.205	160073.5146	0.016	0.015	0.017
	13-25	330-635	364	0.014	61.437	2941.624	0.006	0.287	0.000	0.000	0.000	0.000	61.41	2940.327	3404.615	163013.8412	0.014	0.013	0.015
*	0-13	0-330	363	0.007	67.051	3210.423	0.006	0.287	0.000	0.000	0.035	1.680	67.01	3208.456	3471.625	166222.2972	0.007	0.007	0.007

Table A-246 Energy Balance Results for RBHT Test 1678B for Time Period 3150 to 3200 seconds

Results for RBHT Test 1678
Valid Time Period 3150 to 3200 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2321.8417	7.3244	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
0.25	6.35	2450.8329	7.7313	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
0.50	12.70	2579.8241	8.1382	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
0.75	19.05	2708.8153	8.5452	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
1.00	25.40	2837.8065	8.9521	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
1.25	31.75	2966.7977	9.359	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
1.50	38.10	3095.7889	9.7659	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
1.75	44.45	3224.7801	10.173	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
2.00	50.80	3353.7713	10.58	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
2.25	57.15	3482.7625	10.987	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
2.50	63.50	3611.7537	11.394	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
2.75	69.85	3740.745	11.8	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
3.00	76.20	3869.7362	12.207	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
3.25	82.55	3998.7274	12.614	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
3.50	88.90	4127.7186	13.021	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
3.75	95.25	4256.7098	13.428	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
4.00	101.60	4385.701	13.835	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
4.25	107.95	4514.6922	14.242	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
4.50	114.30	4643.6834	14.649	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
4.75	120.65	4772.6746	15.056	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
5.00	127.00	4901.6658	15.463	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
5.25	133.35	5030.657	15.87	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
5.50	139.70	5159.6482	16.276	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
5.75	146.05	5288.6394	16.683	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
6.00	152.40	5417.6306	17.09	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
6.25	158.75	5546.6218	17.497	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.66E-02
6.50	165.10	5675.613	17.904	1.60E-04	1.95E-02	8.85E-03	1.03E-01	4.66E-02
6.75	171.45	5804.6042	18.311	5.89E-03	7.19E-01	3.26E-01	1.02E-01	4.63E-02
7.00	177.80	5933.5954	18.718	1.17E-02	1.43E+00	6.51E-01	1.01E-01	4.60E-02
7.25	184.15	6062.5866	19.125	1.77E-02	2.17E+00	9.82E-01	1.01E-01	4.57E-02
7.50	190.50	6191.5779	19.532	2.38E-02	2.91E+00	1.32E+00	1.00E-01	4.55E-02
7.75	196.85	6320.5691	19.939	3.01E-02	3.67E+00	1.67E+00	9.96E-02	4.52E-02
8.00	203.20	6449.5603	20.346	3.64E-02	4.45E+00	2.02E+00	9.89E-02	4.49E-02
8.25	209.55	6578.5515	20.753	4.29E-02	5.25E+00	2.38E+00	9.83E-02	4.46E-02
8.50	215.90	6707.5427	21.159	4.96E-02	6.06E+00	2.75E+00	9.76E-02	4.43E-02
8.75	222.25	6836.5339	21.566	5.63E-02	6.88E+00	3.12E+00	9.69E-02	4.40E-02
9.00	228.60	6965.5251	21.973	6.32E-02	7.72E+00	3.50E+00	9.62E-02	4.36E-02
9.25	234.95	6578.5515	20.753	7.00E-02	8.55E+00	3.88E+00	9.55E-02	4.33E-02
9.50	241.30	6191.5779	19.532	7.63E-02	9.33E+00	4.23E+00	9.48E-02	4.30E-02
9.75	247.65	5804.6042	18.311	8.23E-02	1.01E+01	4.56E+00	9.42E-02	4.27E-02
10.00	254.00	5417.6306	17.09	8.79E-02	1.07E+01	4.87E+00	9.37E-02	4.25E-02
10.25	260.35	5030.657	15.87	9.31E-02	1.14E+01	5.16E+00	9.31E-02	4.22E-02
10.50	266.70	4643.6834	14.649	9.79E-02	1.20E+01	5.43E+00	9.26E-02	4.20E-02
10.75	273.05	4256.7098	13.428	1.02E-01	1.25E+01	5.68E+00	9.22E-02	4.18E-02
11.00	279.40	3869.7362	12.207	1.06E-01	1.30E+01	5.90E+00	9.18E-02	4.16E-02
11.25	285.75	3482.7625	10.987	1.10E-01	1.35E+01	6.10E+00	9.14E-02	4.14E-02
11.50	292.10	3095.7889	9.7659	1.13E-01	1.39E+01	6.29E+00	9.10E-02	4.13E-02
11.75	298.45	2708.8153	8.5452	1.16E-01	1.42E+01	6.45E+00	9.07E-02	4.12E-02
12.00	304.80	2321.8417	7.3244	1.19E-01	1.45E+01	6.58E+00	9.05E-02	4.10E-02

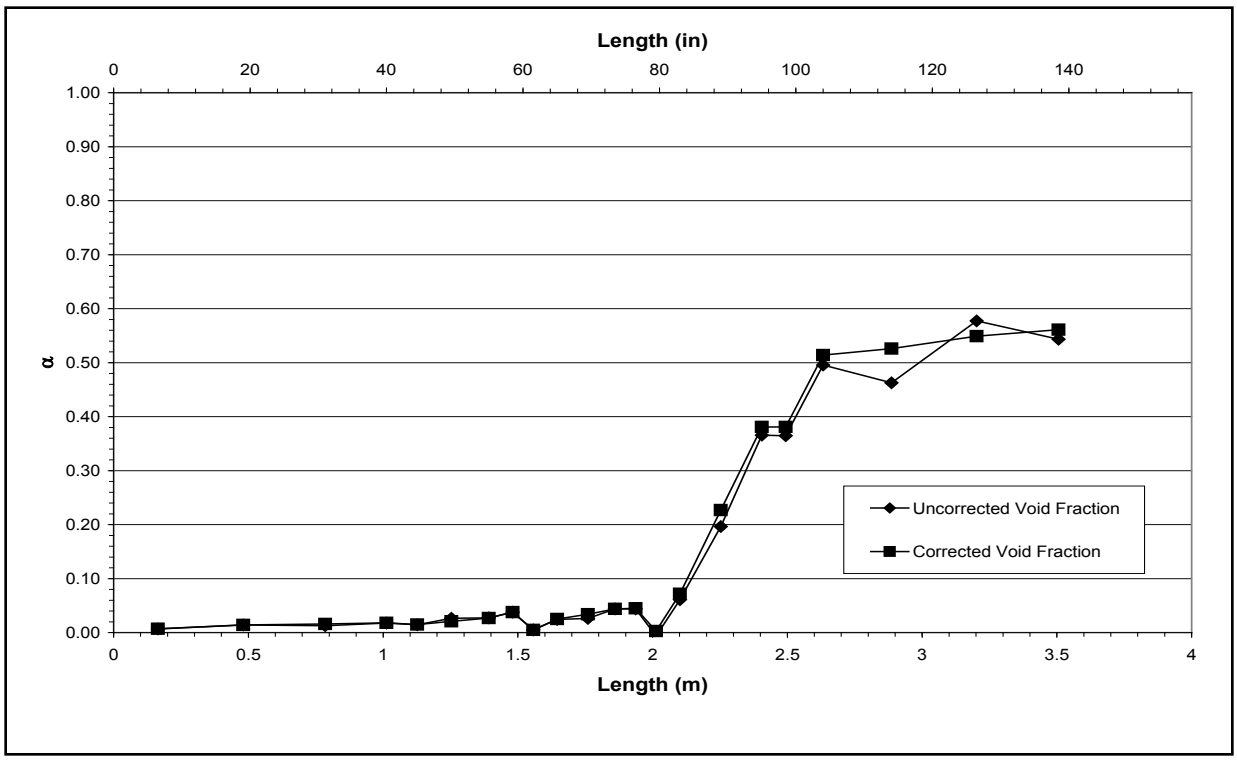

Figure A-615 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678B for Time Period 3150 to 3200 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-C

Test Conditions

Date: 7/21/2003
Steady-state time window: 3480 – 3550 seconds
Inlet flow rate: 3.043 cm/sec (1.198 in./sec)
Inlet mass flow rate: 0.145 kg/sec (0.320 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

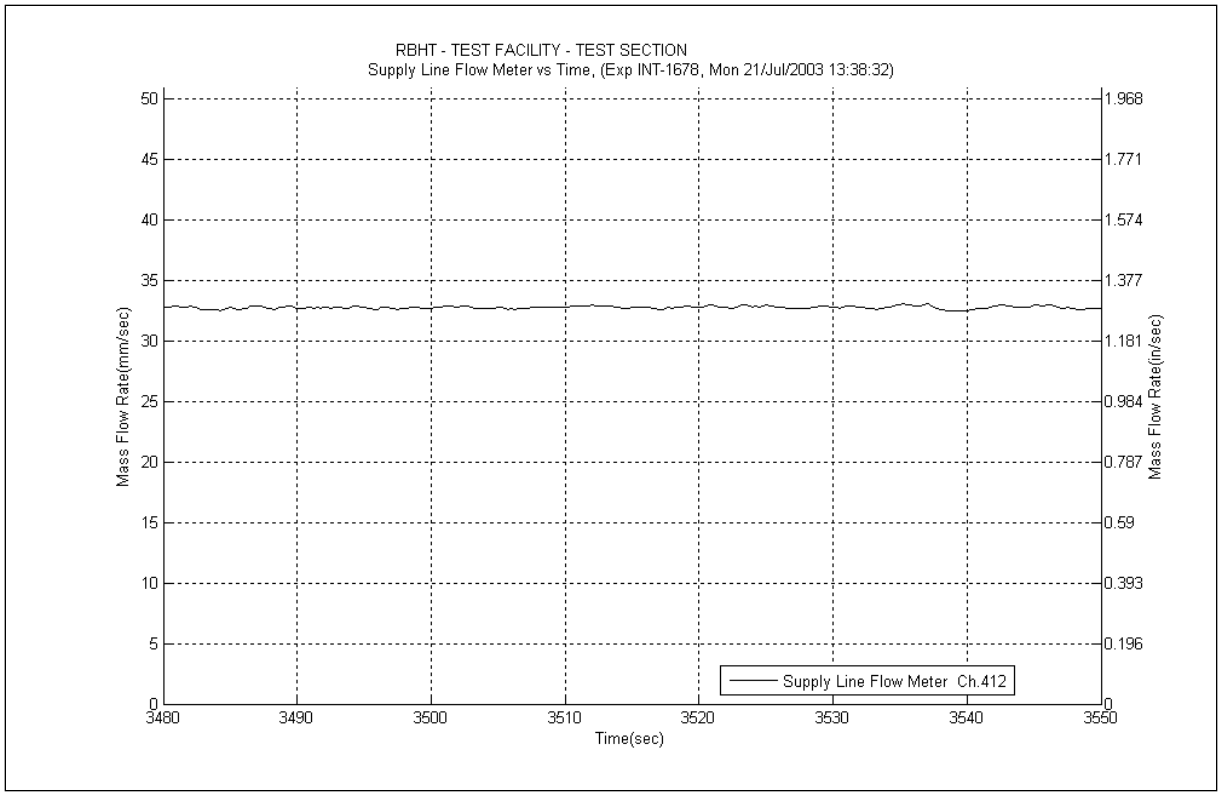

Figure A-616 Inlet Flow Plot for Experiment 1678C

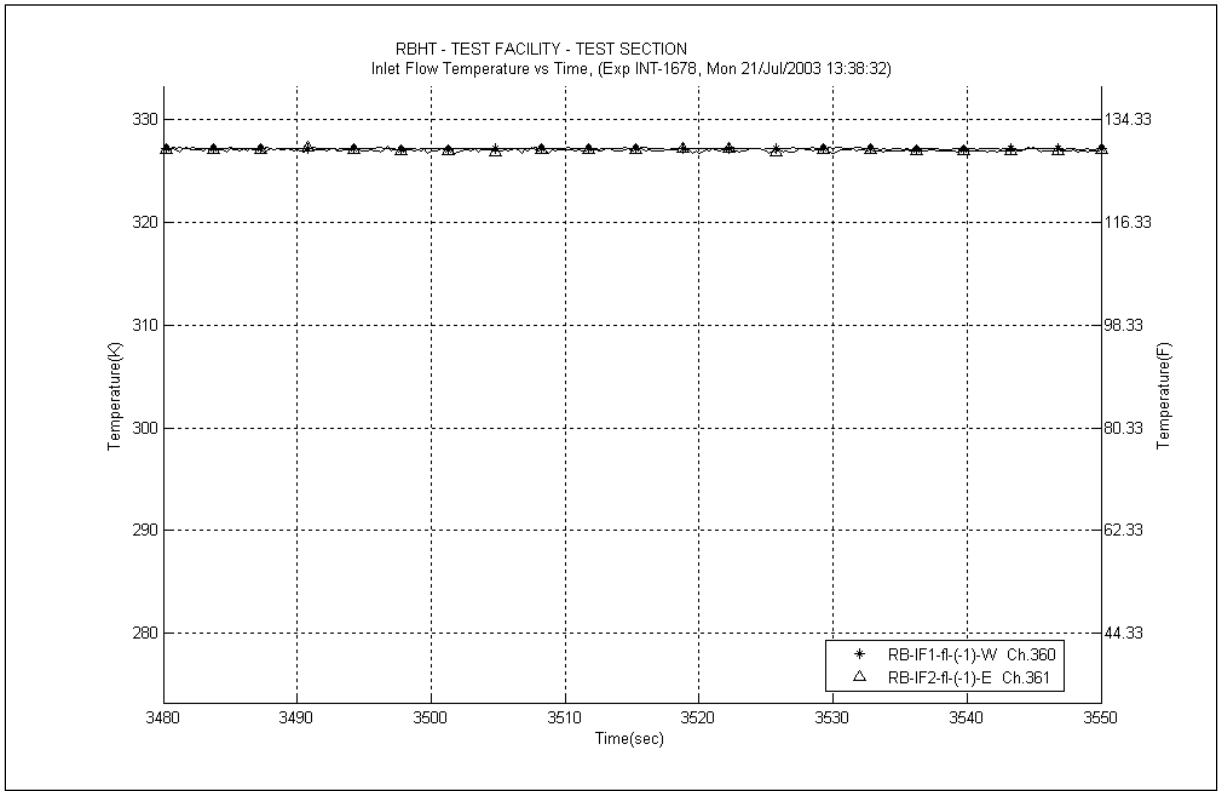

Figure A-617 Inlet Temperature Plot for Experiment 1678C

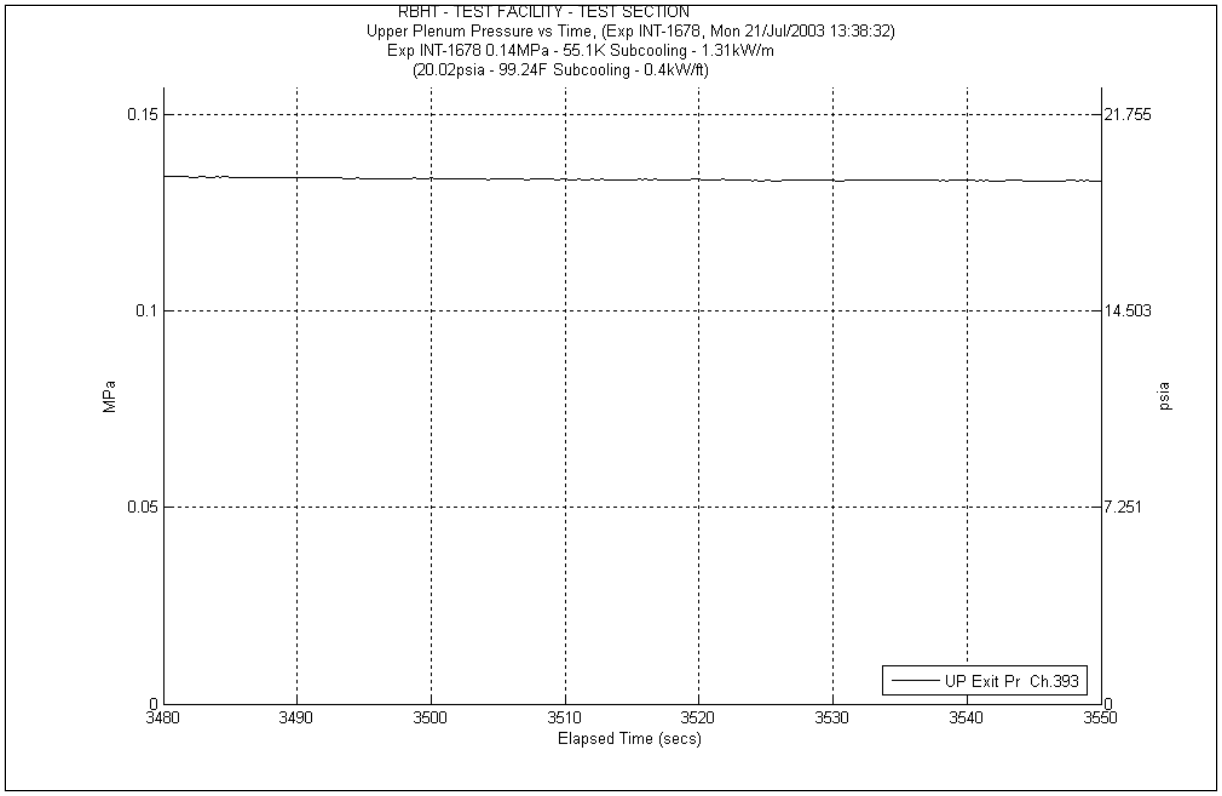

Figure A-618 System Pressure Plot for Experiment 1678C

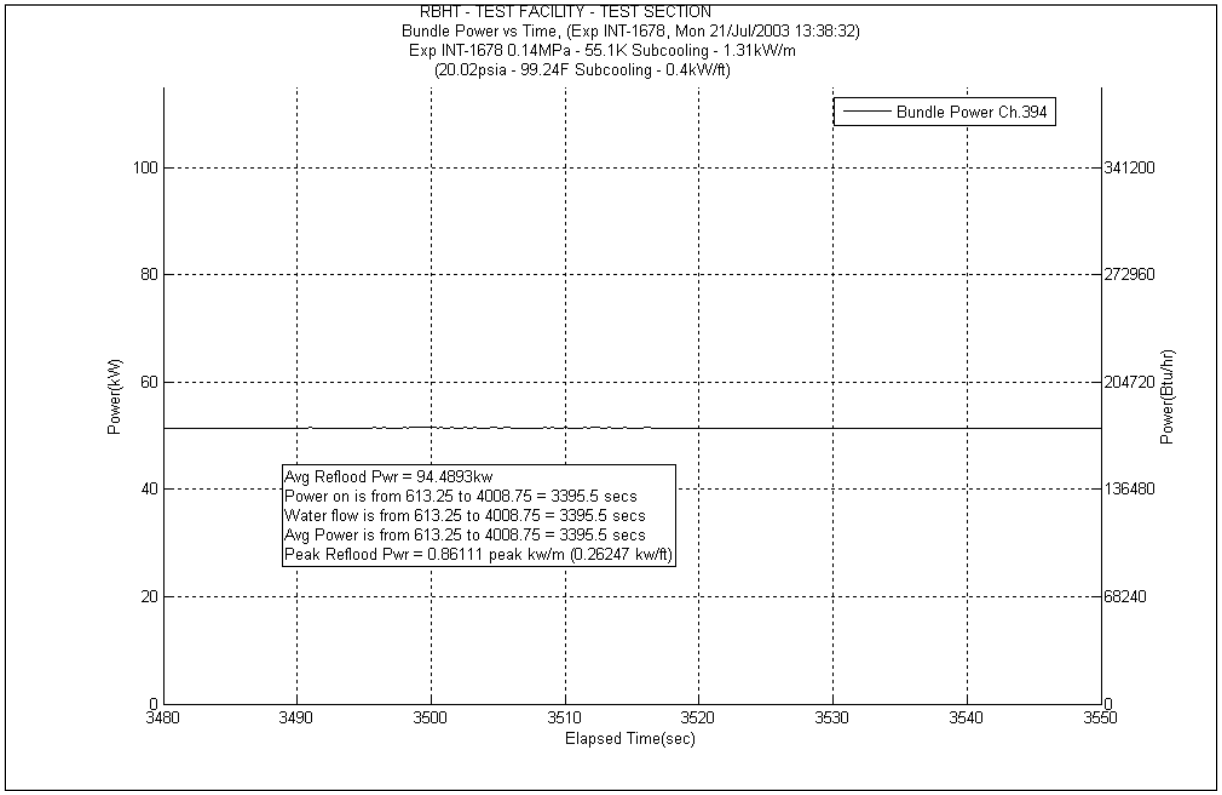

Figure A-619 Bundle Power Plot for Experiment 1678C

Table A-247 Data Results for RBHT Test 1678 for Time Period 3480 to 3550

Results for RBHT Test 1678
Valid Time Period 3480 to 3550 seconds
Collapsed Liquid Level = 114.749 inches = 2914.62 mm
(Z_{osv}) Onset of Significant Void = 83 inches = 2108 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.540	26.263	1257.463	0.767	36.724	0.258	12.353	0.000	0.000	25.23	1208.019	2905.23	139103.159	0.558	0.555	0.561
*	120-133	3048-3378	383	0.579	28.433	1361.402	0.819	39.214	0.461	22.073	-3.357	-160.711	30.51	1460.827	2935.74	140563.9857	0.548	0.545	0.551
*	108-120	2743-3048	382	0.462	33.502	1604.093	0.635	30.404	0.575	27.531	2.852	136.563	29.44	1409.595	2965.18	141973.5805	0.527	0.524	0.530
	100-108	2540-2743	381	0.499	20.820	996.870	0.339	16.231	0.421	20.158	0.000	0.000	20.05	959.999	2985.23	142933.5796	0.517	0.514	0.520
	97-100	2464-2540	380	0.365	9.893	473.693	0.107	5.123	0.152	7.278	0.000	0.000	9.63	461.087	2994.86	143394.6665	0.382	0.380	0.384
	93-97	2362-2464	379	0.367	13.150	629.602	0.126	6.033	0.198	9.480	0.000	0.000	12.82	613.825	3007.68	144008.4914	0.383	0.381	0.385
*	85-93	2159-2362	378	0.200	33.248	1591.908	0.188	9.001	0.381	18.242	0.609	29.145	32.07	1535.520	3039.75	145544.0112	0.228	0.227	0.229
	81-85	2057-2159	377	0.062	19.491	933.213	0.056	2.681	0.182	8.714	0.000	0.000	19.25	921.695	3059	146465.7062	0.073	0.069	0.077
	78-81	1981-2057	376	-0.006	15.679	750.698	0.020	0.958	0.133	6.368	0.000	0.000	15.52	743.102	3074.52	147208.8078	0.004	0.004	0.004
	75-78	1905-1981	375	0.043	14.905	713.648	0.002	0.096	0.003	0.144	0.000	0.000	14.89	712.937	3089.41	147921.7448	0.044	0.042	0.046
	72-75	1829-1905	374	0.044	14.894	713.151	0.001	0.048	0.000	0.000	0.000	0.000	14.89	712.937	3104.3	148634.6818	0.044	0.042	0.046
*	67-72	1702-1829	373	0.026	25.286	1210.716	0.002	0.096	0.000	0.000	0.214	10.262	25.07	1200.358	3129.37	149835.0398	0.034	0.032	0.036
	63-67	1600-1702	372	0.025	20.264	970.263	0.002	0.096	0.000	0.000	0.000	0.000	20.25	969.575	3149.62	150804.6151	0.025	0.024	0.026
	60-63	1524-1600	371	0.003	15.528	743.487	0.001	0.048	0.000	0.000	0.000	0.000	15.52	743.102	3165.14	151547.7166	0.003	0.003	0.003
	57-60	1448-1524	370	0.038	14.993	717.876	0.001	0.048	0.000	0.000	0.000	0.000	14.98	717.246	3180.12	152264.9629	0.038	0.036	0.040
	53-57	1346-1448	369	0.027	20.212	967.777	0.002	0.096	0.000	0.000	0.000	0.000	20.2	967.181	3200.32	153232.1441	0.027	0.026	0.028
*	46-53	1168-1346	368	0.026	35.398	1694.853	0.003	0.144	0.000	0.000	-0.185	-8.870	35.58	1703.580	3235.9	154935.7236	0.021	0.020	0.022
	43-46	1092-1168	367	0.015	15.351	735.033	0.001	0.048	0.000	0.000	0.000	0.000	15.34	734.483	3251.24	155670.2068	0.015	0.014	0.016
	37-43	940-1092	366	0.019	30.573	1463.849	0.003	0.144	0.000	0.000	0.000	0.000	30.56	1463.221	3281.8	157133.4274	0.019	0.018	0.020
*	25-37	635-940	365	0.013	61.541	2946.597	0.006	0.287	0.000	0.000	0.265	12.686	61.27	2933.623	3343.07	160067.0508	0.017	0.016	0.018
	13-25	330-635	364	0.014	61.442	2941.873	0.006	0.287	0.000	0.000	0.000	0.000	61.42	2940.805	3404.49	163007.8562	0.014	0.013	0.015
*	0-13	0-330	363	0.007	67.056	3210.672	0.006	0.287	0.000	0.000	0.040	1.928	67.01	3208.456	3471.5	166216.3122	0.007	0.007	0.007

Table A-248 Energy Balance Results for RBHT Test 1678C for Time Period 3480 to 3550 seconds

Results for RBHT Test 1678
Valid Time Period 3480 to 3550 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2322.6919	7.3271	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
0.25	6.35	2451.7303	7.7342	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
0.50	12.70	2580.7688	8.1412	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
0.75	19.05	2709.8072	8.5483	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
1.00	25.40	2838.8457	8.9553	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
1.25	31.75	2967.8841	9.3624	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
1.50	38.10	3096.9225	9.7695	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
1.75	44.45	3225.961	10.177	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
2.00	50.80	3354.9994	10.584	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
2.25	57.15	3484.0379	10.991	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
2.50	63.50	3613.0763	11.398	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
2.75	69.85	3742.1147	11.805	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
3.00	76.20	3871.1532	12.212	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
3.25	82.55	4000.1916	12.619	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
3.50	88.90	4129.2301	13.026	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
3.75	95.25	4258.2685	13.433	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
4.00	101.60	4387.3069	13.84	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
4.25	107.95	4516.3454	14.247	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
4.50	114.30	4645.3838	14.654	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
4.75	120.65	4774.4223	15.061	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
5.00	127.00	4903.4607	15.468	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
5.25	133.35	5032.4991	15.875	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
5.50	139.70	5161.5376	16.282	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
5.75	146.05	5290.576	16.689	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
6.00	152.40	5419.6145	17.097	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
6.25	158.75	5548.6529	17.504	0.00E+00	0.00E+00	0.00E+00	1.03E-01	4.67E-02
6.50	165.10	5677.6913	17.911	1.27E-04	1.56E-02	7.09E-03	1.03E-01	4.67E-02
6.75	171.45	5806.7298	18.318	5.84E-03	7.17E-01	3.25E-01	1.02E-01	4.64E-02
7.00	177.80	5935.7682	18.725	1.17E-02	1.43E+00	6.50E-01	1.02E-01	4.61E-02
7.25	184.15	6064.8066	19.132	1.77E-02	2.17E+00	9.82E-01	1.01E-01	4.59E-02
7.50	190.50	6193.8451	19.539	2.38E-02	2.91E+00	1.32E+00	1.00E-01	4.56E-02
7.75	196.85	6322.8835	19.946	3.00E-02	3.68E+00	1.67E+00	9.98E-02	4.53E-02
8.00	203.20	6451.922	20.353	3.63E-02	4.46E+00	2.02E+00	9.92E-02	4.50E-02
8.25	209.55	6580.9604	20.76	4.28E-02	5.25E+00	2.38E+00	9.85E-02	4.47E-02
8.50	215.90	6709.9988	21.167	4.94E-02	6.07E+00	2.75E+00	9.78E-02	4.44E-02
8.75	222.25	6839.0373	21.574	5.62E-02	6.89E+00	3.13E+00	9.71E-02	4.41E-02
9.00	228.60	6968.0757	21.981	6.31E-02	7.74E+00	3.51E+00	9.64E-02	4.37E-02
9.25	234.95	6580.9604	20.76	6.98E-02	8.56E+00	3.88E+00	9.57E-02	4.34E-02
9.50	241.30	6193.8451	19.539	7.61E-02	9.34E+00	4.24E+00	9.51E-02	4.31E-02
9.75	247.65	5806.7298	18.318	8.21E-02	1.01E+01	4.57E+00	9.45E-02	4.28E-02
10.00	254.00	5419.6145	17.097	8.77E-02	1.08E+01	4.88E+00	9.39E-02	4.26E-02
10.25	260.35	5032.4991	15.875	9.29E-02	1.14E+01	5.17E+00	9.33E-02	4.23E-02
10.50	266.70	4645.3838	14.654	9.77E-02	1.20E+01	5.44E+00	9.28E-02	4.21E-02
10.75	273.05	4258.2685	13.433	1.02E-01	1.25E+01	5.68E+00	9.24E-02	4.19E-02
11.00	279.40	3871.1532	12.212	1.06E-01	1.30E+01	5.91E+00	9.20E-02	4.17E-02
11.25	285.75	3484.0379	10.991	1.10E-01	1.35E+01	6.12E+00	9.16E-02	4.15E-02
11.50	292.10	3096.9225	9.7695	1.13E-01	1.39E+01	6.29E+00	9.13E-02	4.14E-02
11.75	298.45	2709.8072	8.5483	1.16E-01	1.42E+01	6.46E+00	9.10E-02	4.13E-02
12.00	304.80	2322.6919	7.3271	1.19E-01	1.45E+01	6.60E+00	9.07E-02	4.11E-02

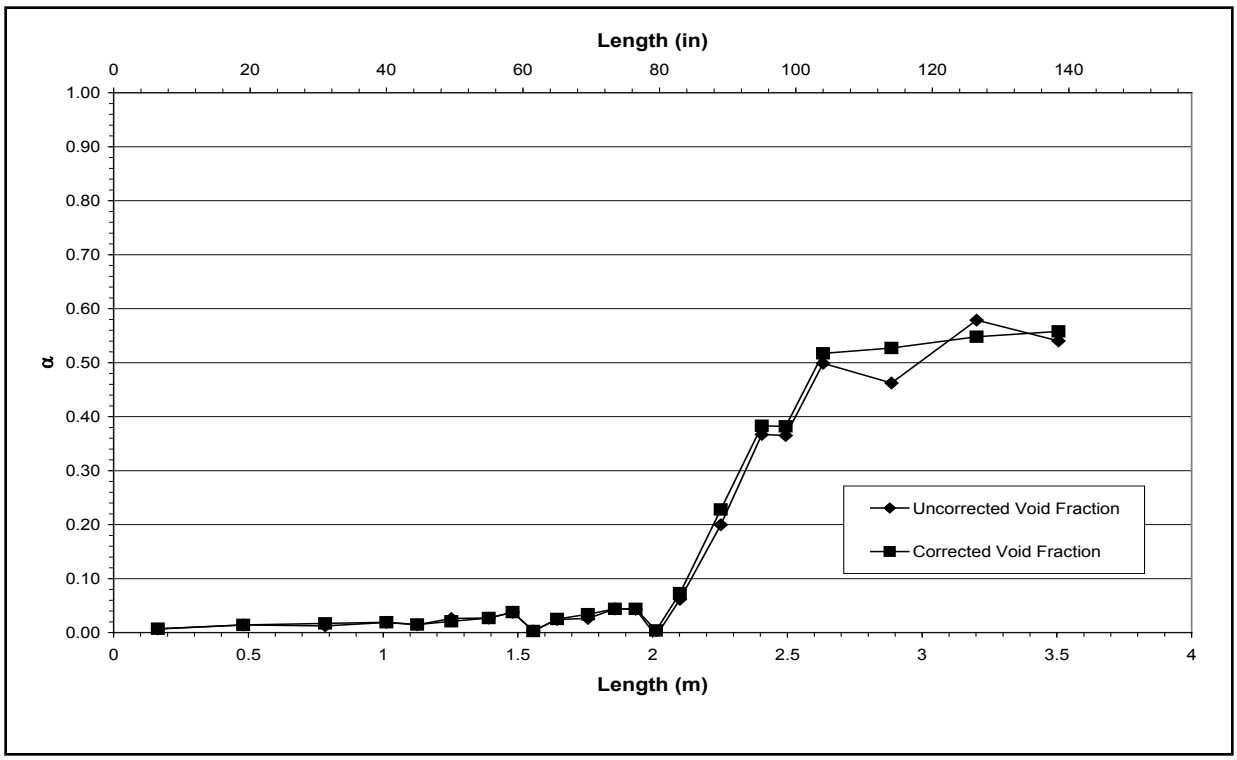

Figure A-620 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678C for Time Period 3480 to 3550 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-D

Test Conditions

Date: 7/21/2003
Steady-state time window: 2340 – 2410 seconds
Inlet flow rate: 2.540 cm/sec (1.000 in./sec)
Inlet mass flow rate: 0.121 kg/sec (0.267 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

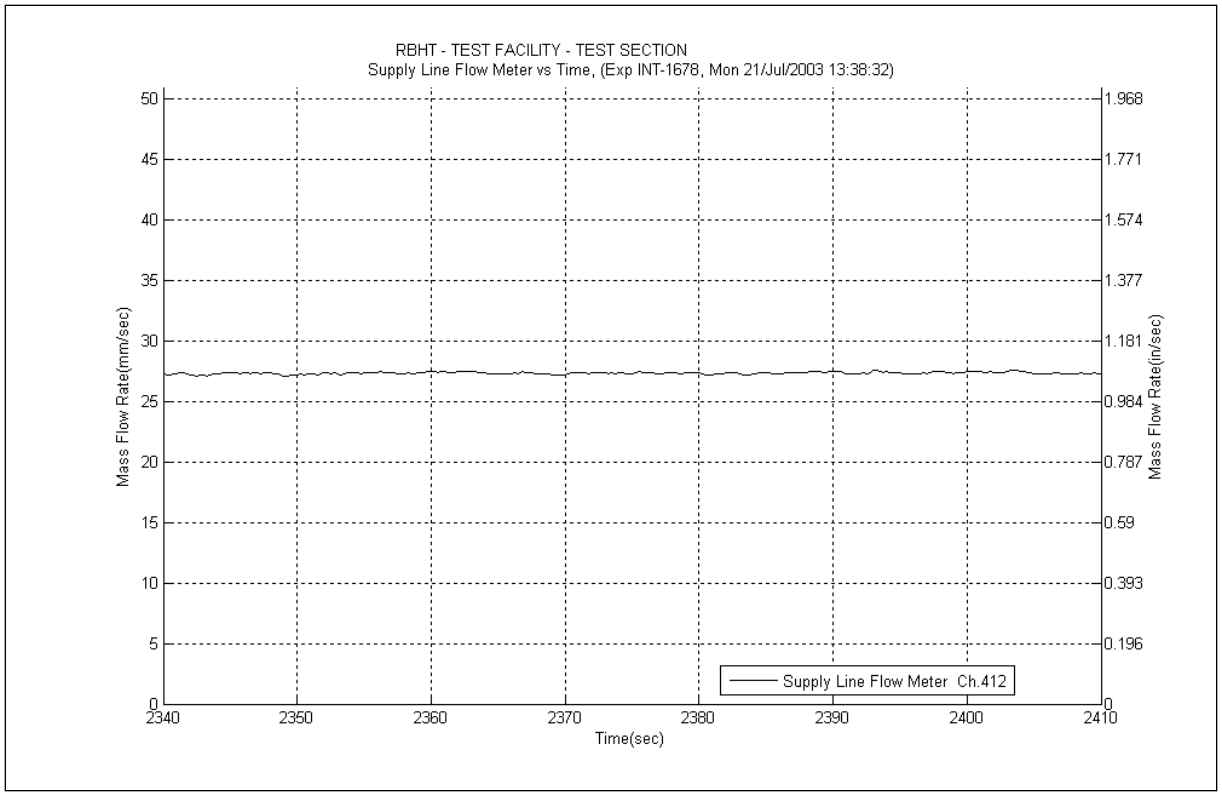

Figure A-621 Inlet Flow Plot for Experiment 1678D

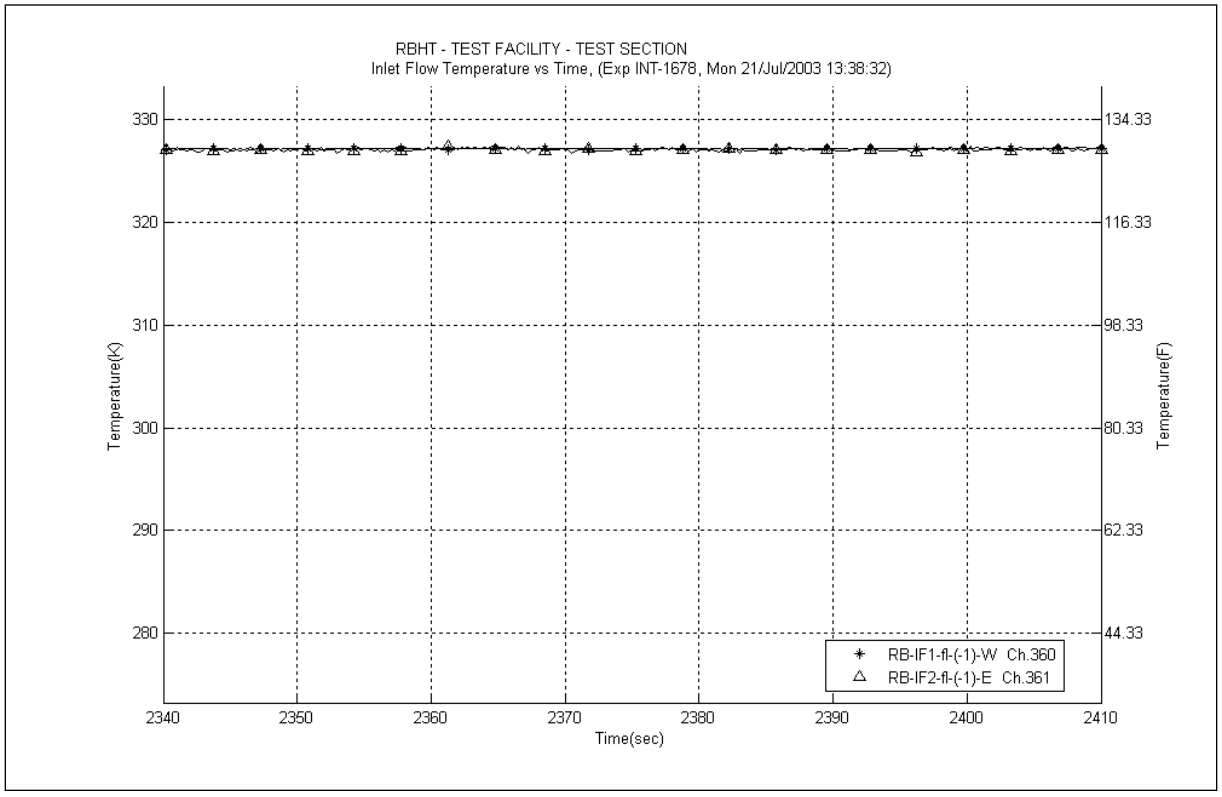

Figure A-622 Inlet Temperature Plot for Experiment 1678D

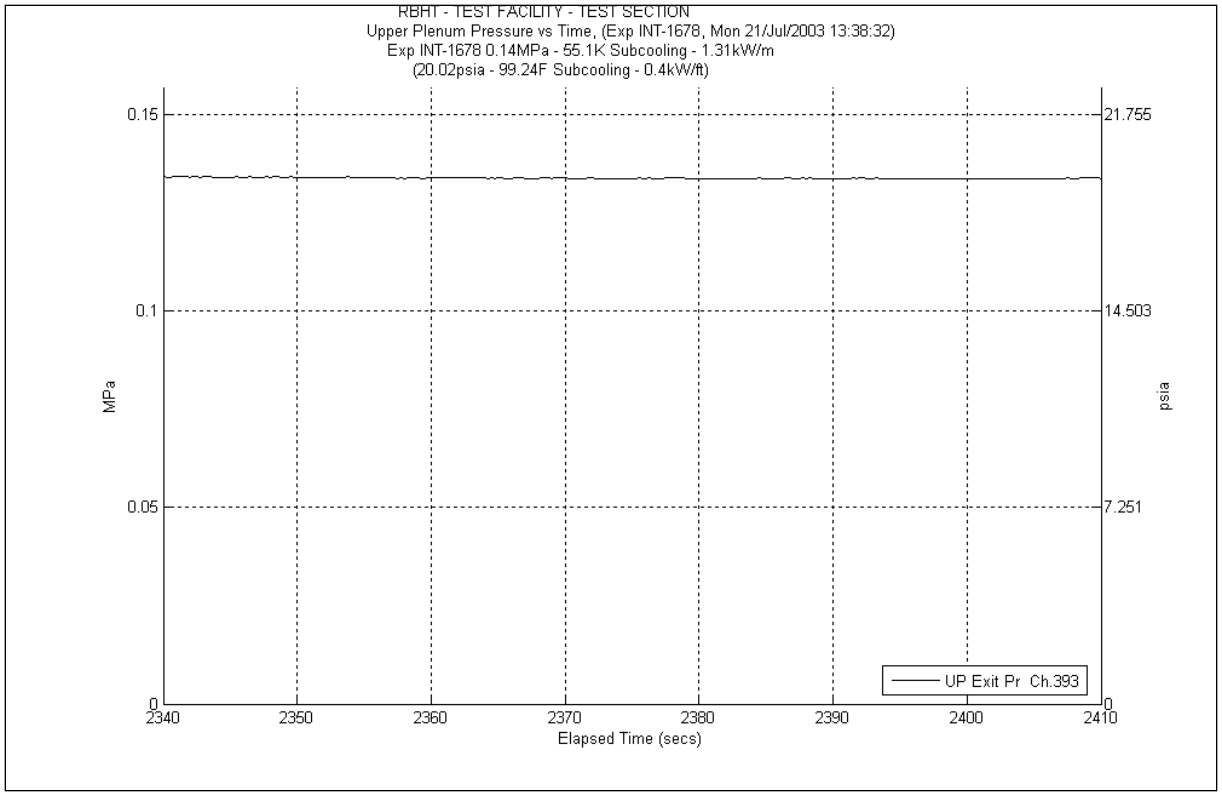

Figure A-623 System Pressure Plot for Experiment 1678D

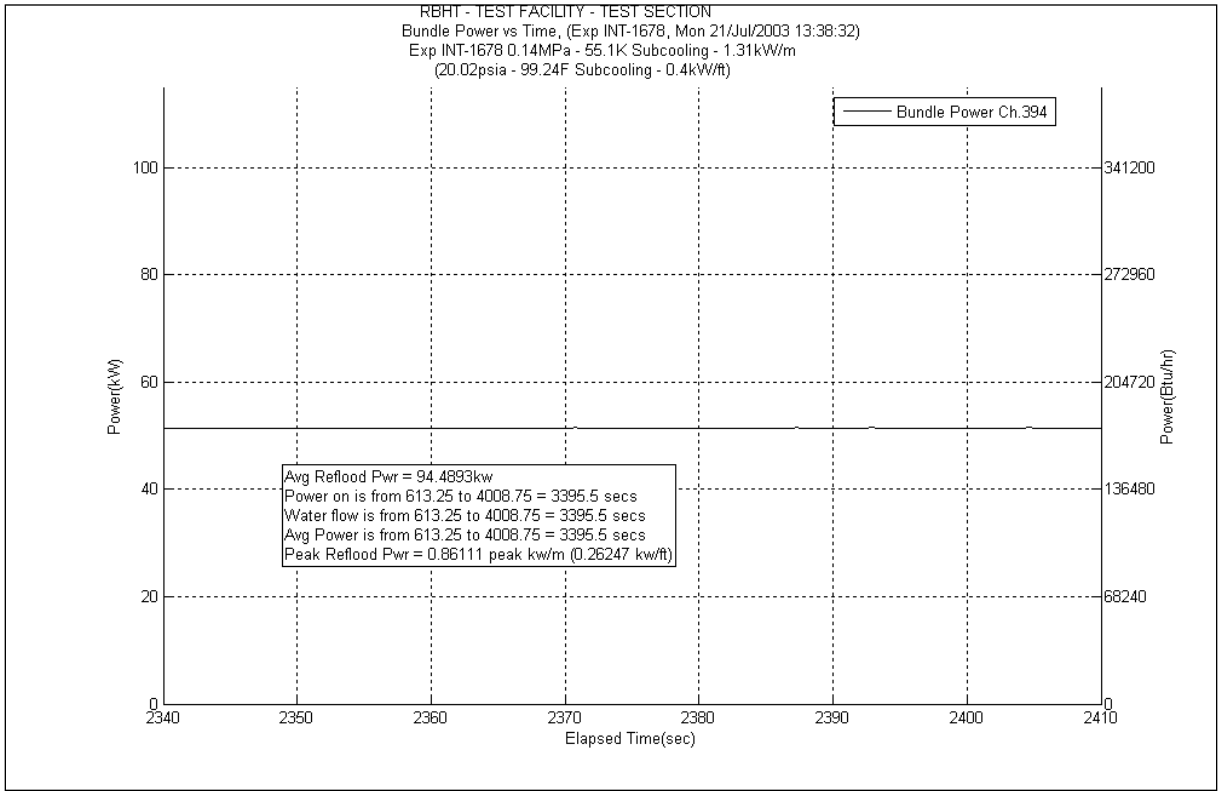

Figure A-624 Bundle Power Plot for Experiment 1678D

Table A-249 Data Results for RBHT Test 1678 for Time Period 2340 to 2410

Results for RBHT Test 1678
Valid Time Period 2340 to 2410 seconds
Collapsed Liquid Level = 108.606 inches = 2758.58 mm
(Z_{osv}) Onset of Significant Void = 73.5 inches = 1867 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.607	22.456	1075.197	0.686	32.846	0.215	10.294	0.000	0.000	21.55	1031.820	2901.55	138926.9597	0.623	0.620	0.626
*	120-133	3048-3378	383	0.616	25.899	1240.057	0.742	35.527	0.384	18.386	-1.207	-57.785	25.98	1243.929	2927.53	140170.8888	0.615	0.612	0.618
*	108-120	2743-3048	382	0.509	30.620	1466.087	0.590	28.249	0.480	22.983	4.610	220.722	24.94	1194.134	2952.47	141365.0224	0.6	0.597	0.603
	100-108	2540-2743	381	0.576	17.626	843.945	0.329	15.753	0.351	16.806	0.000	0.000	16.94	811.092	2969.41	142176.1139	0.592	0.589	0.595
	97-100	2464-2540	380	0.434	8.813	421.973	0.109	5.219	0.127	6.081	0.000	0.000	8.573	410.477	2977.983	142586.5914	0.45	0.448	0.452
	93-97	2362-2464	379	0.438	11.669	558.734	0.132	6.320	0.166	7.948	0.000	0.000	11.37	544.399	2989.353	143130.9899	0.453	0.451	0.455
*	85-93	2159-2362	378	0.318	28.330	1356.429	0.221	10.582	0.318	15.226	4.201	201.127	23.59	1129.495	3012.943	144260.4852	0.432	0.430	0.434
	81-85	2057-2159	377	0.400	12.469	597.028	0.086	4.118	0.152	7.278	0.000	0.000	12.23	585.576	3025.173	144846.0607	0.411	0.409	0.413
	78-81	1981-2057	376	0.187	12.667	606.477	0.054	2.586	0.111	5.315	0.000	0.000	12.49	598.024	3037.663	145444.0851	0.198	0.197	0.199
	75-78	1905-1981	375	0.132	13.523	647.505	0.043	2.059	0.109	5.219	0.000	0.000	13.37	640.159	3051.033	146084.2442	0.142	0.141	0.143
	72-75	1829-1905	374	0.057	14.692	703.453	0.032	1.532	0.106	5.075	0.000	0.000	14.55	696.658	3065.583	146780.9019	0.066	0.063	0.069
*	67-72	1702-1829	373	0.034	25.089	1201.267	0.027	1.293	0.120	5.746	0.242	11.586	24.7	1182.642	3090.283	147963.5442	0.048	0.046	0.050
	63-67	1600-1702	372	0.031	20.135	964.047	0.001	0.048	0.000	0.000	0.000	0.000	20.12	963.351	3110.403	148926.895	0.031	0.029	0.033
	60-63	1524-1600	371	0.010	15.429	738.763	0.001	0.048	0.000	0.000	0.000	0.000	15.42	738.314	3125.823	149665.2086	0.01	0.010	0.011
	57-60	1448-1524	370	0.043	14.905	713.648	0.001	0.048	0.000	0.000	0.000	0.000	14.9	713.416	3140.723	150378.6244	0.044	0.042	0.046
	53-57	1346-1448	369	0.032	20.114	963.052	0.001	0.048	0.000	0.000	0.000	0.000	20.11	962.872	3160.833	151341.4964	0.032	0.030	0.034
*	46-53	1168-1346	368	0.031	35.242	1687.393	0.002	0.096	0.000	0.000	-0.180	-8.621	35.42	1695.919	3196.253	153037.4151	0.025	0.024	0.026
	43-46	1092-1168	367	0.019	15.284	731.800	0.001	0.048	0.000	0.000	0.000	0.000	15.28	731.610	3211.533	153769.0254	0.019	0.018	0.020
	37-43	940-1092	366	0.021	30.506	1460.617	0.002	0.096	0.000	0.000	0.000	0.000	30.5	1460.348	3242.033	155229.3732	0.021	0.020	0.022
*	25-37	635-940	365	0.015	61.380	2938.889	0.004	0.192	0.000	0.000	0.216	10.341	61.16	2928.357	3303.193	158157.7298	0.018	0.017	0.019
	13-25	330-635	364	0.016	61.349	2937.397	0.004	0.192	0.000	0.000	0.000	0.000	61.32	2936.017	3364.513	161093.7471	0.016	0.015	0.017
*	0-13	0-330	363	0.008	66.984	3207.191	0.004	0.192	0.000	0.000	0.020	0.937	66.96	3206.062	3431.473	164299.8091	0.008	0.008	0.008

Table A-250 Energy Balance Results for RBHT Test 1678D for Time Period 2340 to 2410 seconds

Results for RBHT Test 1678
Valid Time Period 2340 to 2410 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2321.4746	7.3233	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
0.25	6.35	2450.4454	7.7301	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
0.50	12.70	2579.4162	8.137	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
0.75	19.05	2708.3871	8.5438	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
1.00	25.40	2837.3579	8.9506	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
1.25	31.75	2966.3287	9.3575	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
1.50	38.10	3095.2995	9.7643	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
1.75	44.45	3224.2703	10.171	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
2.00	50.80	3353.2411	10.578	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
2.25	57.15	3482.2119	10.985	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
2.50	63.50	3611.1827	11.392	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
2.75	69.85	3740.1536	11.799	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
3.00	76.20	3869.1244	12.205	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
3.25	82.55	3998.0952	12.612	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
3.50	88.90	4127.066	13.019	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
3.75	95.25	4256.0368	13.426	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
4.00	101.60	4385.0076	13.833	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
4.25	107.95	4513.9784	14.24	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
4.50	114.30	4642.9492	14.647	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
4.75	120.65	4771.9201	15.053	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
5.00	127.00	4900.8909	15.46	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
5.25	133.35	5029.8617	15.867	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
5.50	139.70	5158.8325	16.274	0.00E+00	0.00E+00	0.00E+00	8.59E-02	3.90E-02
5.75	146.05	5287.8033	16.681	1.02E-03	1.04E-01	4.72E-02	8.58E-02	3.89E-02
6.00	152.40	5416.7741	17.088	7.40E-03	7.58E-01	3.44E-01	8.52E-02	3.87E-02
6.25	158.75	5545.7449	17.494	1.39E-02	1.43E+00	6.47E-01	8.47E-02	3.84E-02
6.50	165.10	5674.7157	17.901	2.06E-02	2.11E+00	9.58E-01	8.41E-02	3.81E-02
6.75	171.45	5803.6866	18.308	2.75E-02	2.81E+00	1.28E+00	8.35E-02	3.79E-02
7.00	177.80	5932.6574	18.715	3.45E-02	3.53E+00	1.60E+00	8.29E-02	3.76E-02
7.25	184.15	6061.6282	19.122	4.16E-02	4.26E+00	1.93E+00	8.23E-02	3.73E-02
7.50	190.50	6190.599	19.529	4.89E-02	5.01E+00	2.27E+00	8.17E-02	3.70E-02
7.75	196.85	6319.5698	19.936	5.64E-02	5.77E+00	2.62E+00	8.10E-02	3.68E-02
8.00	203.20	6448.5406	20.342	6.40E-02	6.55E+00	2.97E+00	8.04E-02	3.65E-02
8.25	209.55	6577.5114	20.749	7.18E-02	7.35E+00	3.33E+00	7.97E-02	3.62E-02
8.50	215.90	6706.4822	21.156	7.97E-02	8.16E+00	3.70E+00	7.90E-02	3.58E-02
8.75	222.25	6835.4531	21.563	8.78E-02	8.99E+00	4.08E+00	7.83E-02	3.55E-02
9.00	228.60	6964.4239	21.97	9.60E-02	9.83E+00	4.46E+00	7.76E-02	3.52E-02
9.25	234.95	6577.5114	20.749	1.04E-01	1.07E+01	4.84E+00	7.69E-02	3.49E-02
9.50	241.30	6190.599	19.529	1.12E-01	1.14E+01	5.19E+00	7.63E-02	3.46E-02
9.75	247.65	5803.6866	18.308	1.19E-01	1.22E+01	5.52E+00	7.57E-02	3.43E-02
10.00	254.00	5416.7741	17.088	1.26E-01	1.29E+01	5.83E+00	7.51E-02	3.41E-02
10.25	260.35	5029.8617	15.867	1.32E-01	1.35E+01	6.12E+00	7.46E-02	3.38E-02
10.50	266.70	4642.9492	14.647	1.38E-01	1.41E+01	6.39E+00	7.41E-02	3.36E-02
10.75	273.05	4256.0368	13.426	1.43E-01	1.46E+01	6.63E+00	7.36E-02	3.34E-02
11.00	279.40	3869.1244	12.205	1.48E-01	1.51E+01	6.86E+00	7.32E-02	3.32E-02
11.25	285.75	3482.2119	10.985	1.52E-01	1.56E+01	7.06E+00	7.28E-02	3.30E-02
11.50	292.10	3095.2995	9.7643	1.56E-01	1.60E+01	7.25E+00	7.25E-02	3.29E-02
11.75	298.45	2708.3871	8.5438	1.59E-01	1.63E+01	7.40E+00	7.22E-02	3.27E-02
12.00	304.80	2321.4746	7.3233	1.62E-01	1.66E+01	7.54E+00	7.19E-02	3.26E-02

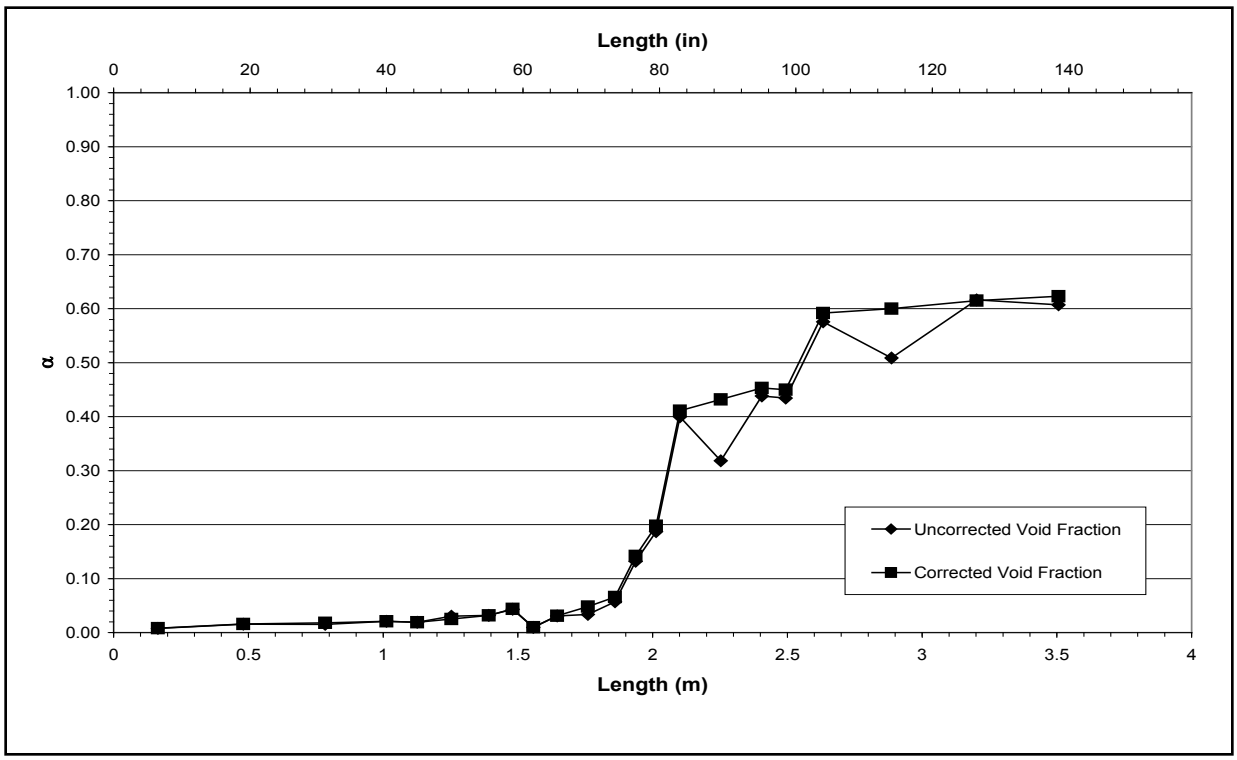

Figure A-625 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678D for Time Period 2340 to 2410 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-E

Test Conditions

Date: 7/21/2003
Steady-state time window: 2550 – 2610 seconds
Inlet flow rate: 2.540 cm/sec (1.000 in./sec)
Inlet mass flow rate: 0.122 kg/sec (0.268 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

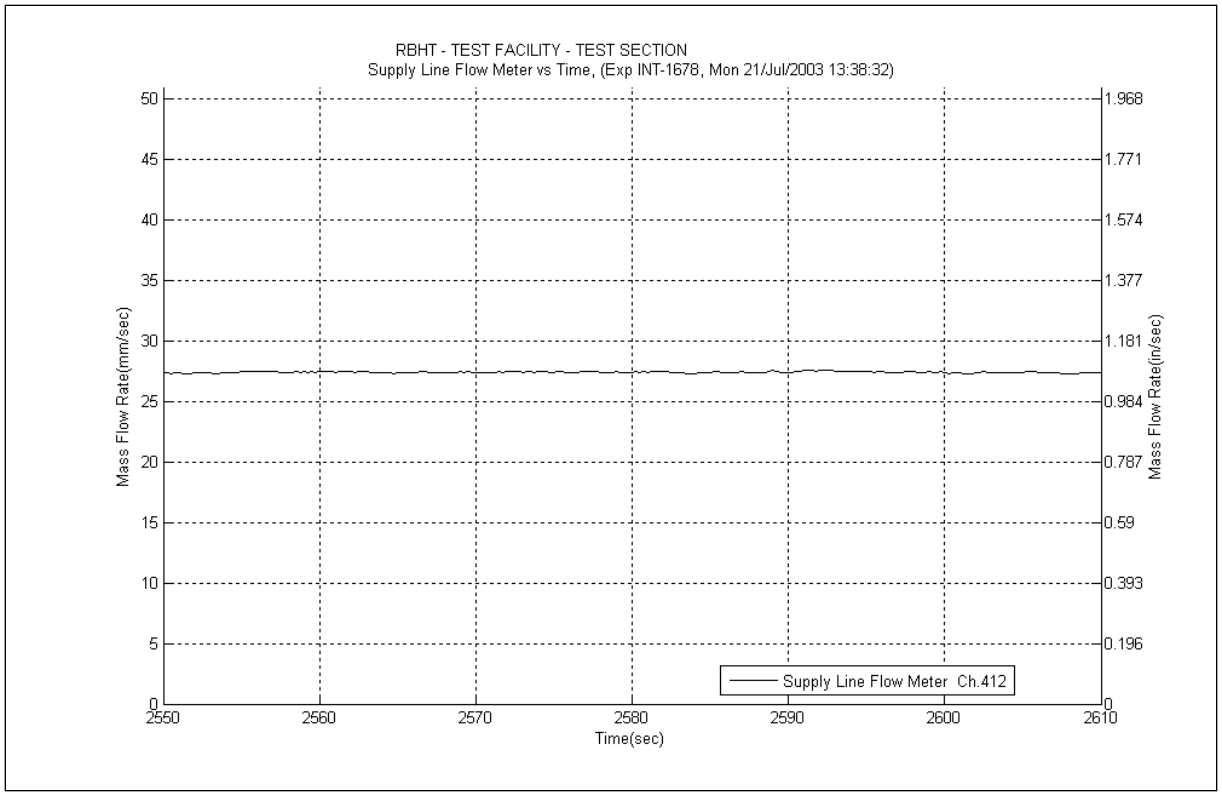

Figure A-626 Inlet Flow Plot for Experiment 1678E

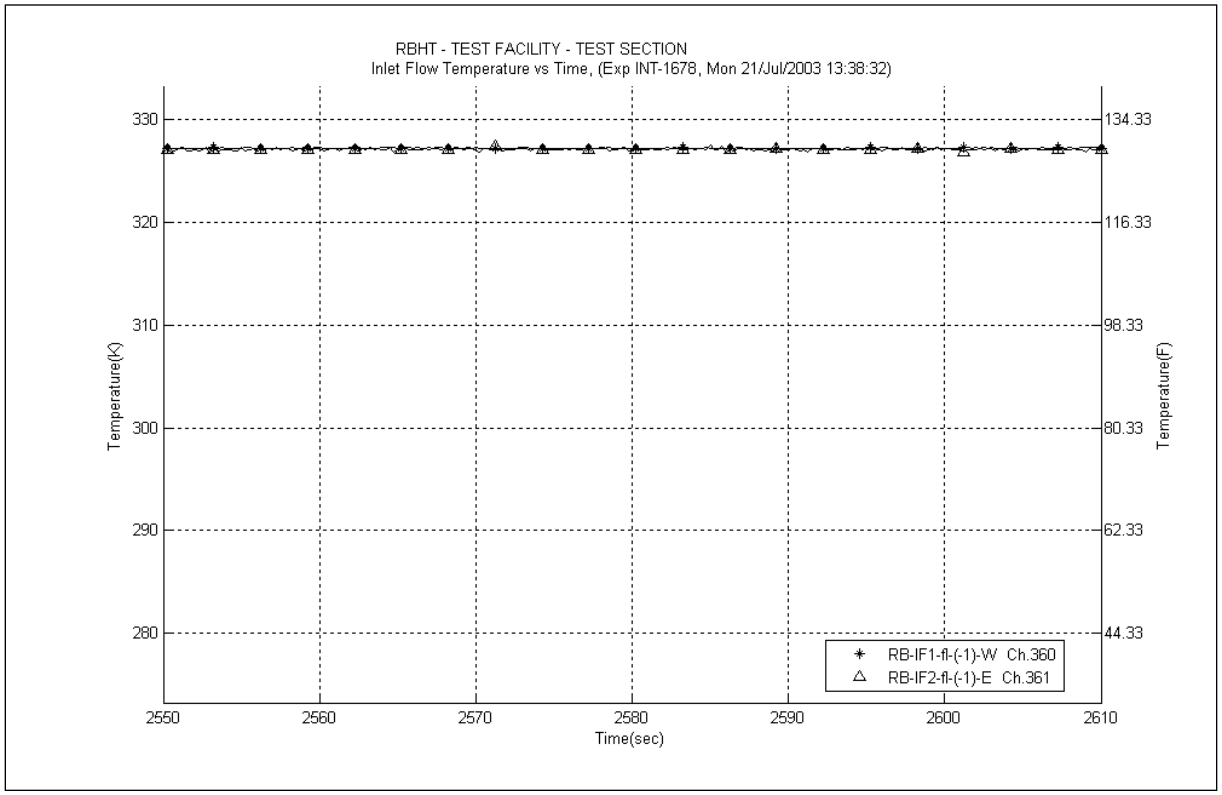

Figure A-627 Inlet Temperature Plot for Experiment 1678E

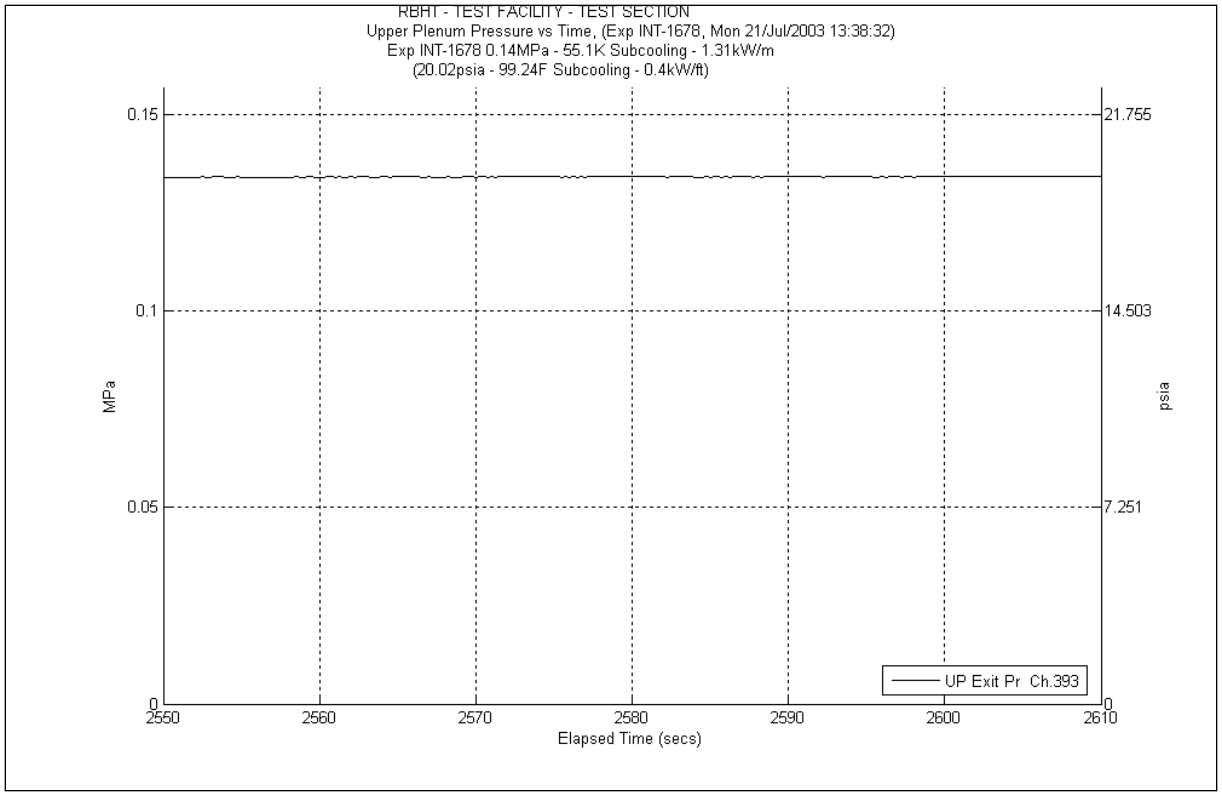

Figure A-628 System Pressure Plot for Experiment 1678E

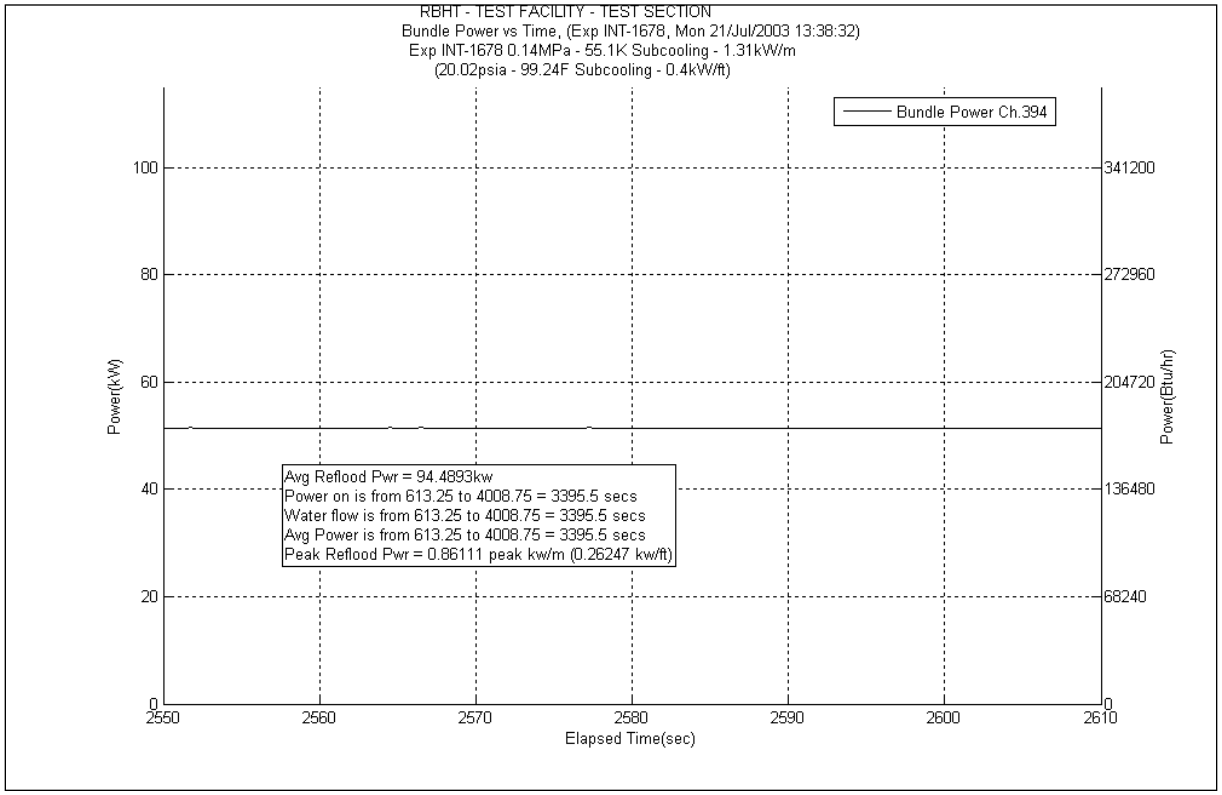

Figure A-629 Bundle Power Plot for Experiment 1678E

Table A-251 Data Results for RBHT Test 1678 for Time Period 2550 to 2610

Results for RBHT Test 1678
Valid Time Period 2550 to 2610 seconds
Collapsed Liquid Level = 108.822 inches = 2764.07 mm
(Z_{osv}) Onset of Significant Void = 73.5 inches = 1867 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.607	22.430	1073.954	0.688	32.942	0.216	10.342	0.000	0.000	21.52	1030.383	2901.52	138925.5233	0.623	0.620	0.626
*	120-133	3048-3378	383	0.615	25.961	1243.041	0.744	35.623	0.386	18.482	-1.159	-55.471	25.99	1244.408	2927.51	140169.9312	0.615	0.612	0.618
*	108-120	2743-3048	382	0.507	30.724	1471.061	0.591	28.297	0.481	23.030	4.622	221.290	25.03	1198.443	2952.54	141368.374	0.598	0.595	0.601
	100-108	2540-2743	381	0.574	17.720	848.421	0.330	15.800	0.352	16.854	0.000	0.000	17.03	815.401	2969.57	142183.7748	0.59	0.587	0.593
	97-100	2464-2540	380	0.430	8.886	425.454	0.109	5.219	0.127	6.081	0.000	0.000	8.648	414.068	2978.218	142597.8432	0.445	0.443	0.447
	93-97	2362-2464	379	0.440	11.633	556.994	0.133	6.368	0.166	7.948	0.000	0.000	11.33	542.483	2989.548	143140.3266	0.454	0.452	0.456
*	85-93	2159-2362	378	0.316	28.428	1361.154	0.221	10.582	0.319	15.274	4.308	206.282	23.58	1129.016	3013.128	144269.343	0.432	0.430	0.434
	81-85	2057-2159	377	0.399	12.490	598.022	0.086	4.118	0.153	7.326	0.000	0.000	12.24	586.054	3025.368	144855.3974	0.41	0.408	0.412
	78-81	1981-2057	376	0.185	12.698	607.969	0.054	2.586	0.112	5.363	0.000	0.000	12.53	599.940	3037.898	145455.337	0.196	0.195	0.197
	75-78	1905-1981	375	0.130	13.549	648.749	0.043	2.059	0.109	5.219	0.000	0.000	13.39	641.117	3051.288	146096.4536	0.14	0.139	0.141
	72-75	1829-1905	374	0.056	14.702	703.951	0.031	1.484	0.107	5.123	0.000	0.000	14.56	697.137	3065.848	146793.5902	0.065	0.062	0.068
*	67-72	1702-1829	373	0.033	25.099	1201.764	0.026	1.245	0.117	5.602	0.246	11.796	24.71	1183.121	3090.558	147976.7113	0.048	0.046	0.050
	63-67	1600-1702	372	0.031	20.140	964.296	0.001	0.048	0.000	0.000	0.000	0.000	20.13	963.830	3110.688	148940.5409	0.031	0.029	0.033
	60-63	1524-1600	371	0.010	15.429	738.763	0.001	0.048	0.000	0.000	0.000	0.000	15.43	738.792	3126.118	149679.3333	0.01	0.010	0.011
	57-60	1448-1524	370	0.043	14.910	713.897	0.001	0.048	0.000	0.000	0.000	0.000	14.9	713.416	3141.018	150392.7491	0.043	0.041	0.045
	53-57	1346-1448	369	0.031	20.124	963.550	0.001	0.048	0.000	0.000	0.000	0.000	20.11	962.872	3161.128	151355.621	0.031	0.029	0.033
*	46-53	1168-1346	368	0.030	35.252	1687.890	0.002	0.096	0.000	0.000	-0.180	-8.603	35.43	1696.398	3196.558	153052.0186	0.025	0.024	0.026
	43-46	1092-1168	367	0.019	15.284	731.800	0.001	0.048	0.000	0.000	0.000	0.000	15.28	731.610	3211.838	153783.6289	0.019	0.018	0.020
	37-43	940-1092	366	0.021	30.516	1461.114	0.002	0.096	0.000	0.000	0.000	0.000	30.5	1460.348	3242.338	155243.9767	0.021	0.020	0.022
*	25-37	635-940	365	0.015	61.390	2939.386	0.004	0.192	0.000	0.000	0.216	10.359	61.17	2928.835	3303.508	158172.812	0.018	0.017	0.019
	13-25	330-635	364	0.015	61.359	2937.894	0.004	0.192	0.000	0.000	0.000	0.000	61.33	2936.496	3364.838	161109.3082	0.016	0.015	0.017
*	0-13	0-330	363	0.008	66.989	3207.439	0.004	0.192	0.000	0.000	0.015	0.707	66.97	3206.541	3431.808	164315.849	0.008	0.008	0.008

Table A-252 Energy Balance Results for RBHT Test 1678E for Time Period 2550 to 2610 seconds

Results for RBHT Test 1678
Valid Time Period 2550 to 2610 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2320.9583	7.3216	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
0.25	6.35	2449.9005	7.7284	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
0.50	12.70	2578.8426	8.1351	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
0.75	19.05	2707.7847	8.5419	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
1.00	25.40	2836.7269	8.9487	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
1.25	31.75	2965.669	9.3554	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
1.50	38.10	3094.6111	9.7622	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
1.75	44.45	3223.5533	10.169	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
2.00	50.80	3352.4954	10.576	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
2.25	57.15	3481.4375	10.982	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
2.50	63.50	3610.3796	11.389	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
2.75	69.85	3739.3218	11.796	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
3.00	76.20	3868.2639	12.203	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
3.25	82.55	3997.206	12.609	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
3.50	88.90	4126.1482	13.016	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
3.75	95.25	4255.0903	13.423	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
4.00	101.60	4384.0324	13.83	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
4.25	107.95	4512.9746	14.237	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
4.50	114.30	4641.9167	14.643	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
4.75	120.65	4770.8588	15.05	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
5.00	127.00	4899.8009	15.457	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
5.25	133.35	5028.7431	15.864	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
5.50	139.70	5157.6852	16.27	0.00E+00	0.00E+00	0.00E+00	8.61E-02	3.91E-02
5.75	146.05	5286.6273	16.677	8.12E-04	8.34E-02	3.78E-02	8.60E-02	3.90E-02
6.00	152.40	5415.5695	17.084	7.18E-03	7.37E-01	3.34E-01	8.55E-02	3.88E-02
6.25	158.75	5544.5116	17.491	1.37E-02	1.41E+00	6.38E-01	8.49E-02	3.85E-02
6.50	165.10	5673.4537	17.897	2.04E-02	2.09E+00	9.48E-01	8.43E-02	3.83E-02
6.75	171.45	5802.3959	18.304	2.72E-02	2.79E+00	1.27E+00	8.38E-02	3.80E-02
7.00	177.80	5931.338	18.711	3.42E-02	3.51E+00	1.59E+00	8.32E-02	3.77E-02
7.25	184.15	6060.2801	19.118	4.13E-02	4.24E+00	1.92E+00	8.25E-02	3.74E-02
7.50	190.50	6189.2223	19.524	4.86E-02	4.99E+00	2.26E+00	8.19E-02	3.72E-02
7.75	196.85	6318.1644	19.931	5.60E-02	5.75E+00	2.61E+00	8.13E-02	3.69E-02
8.00	203.20	6447.1065	20.338	6.36E-02	6.53E+00	2.96E+00	8.06E-02	3.66E-02
8.25	209.55	6576.0486	20.745	7.14E-02	7.33E+00	3.32E+00	8.00E-02	3.63E-02
8.50	215.90	6704.9908	21.151	7.93E-02	8.14E+00	3.69E+00	7.93E-02	3.60E-02
8.75	222.25	6833.9329	21.558	8.73E-02	8.96E+00	4.07E+00	7.86E-02	3.56E-02
9.00	228.60	6962.875	21.965	9.55E-02	9.81E+00	4.45E+00	7.79E-02	3.53E-02
9.25	234.95	6576.0486	20.745	1.04E-01	1.06E+01	4.83E+00	7.72E-02	3.50E-02
9.50	241.30	6189.2223	19.524	1.11E-01	1.14E+01	5.18E+00	7.65E-02	3.47E-02
9.75	247.65	5802.3959	18.304	1.18E-01	1.21E+01	5.51E+00	7.59E-02	3.44E-02
10.00	254.00	5415.5695	17.084	1.25E-01	1.28E+01	5.82E+00	7.53E-02	3.42E-02
10.25	260.35	5028.7431	15.864	1.31E-01	1.35E+01	6.11E+00	7.48E-02	3.39E-02
10.50	266.70	4641.9167	14.643	1.37E-01	1.41E+01	6.38E+00	7.43E-02	3.37E-02
10.75	273.05	4255.0903	13.423	1.42E-01	1.46E+01	6.62E+00	7.39E-02	3.35E-02
11.00	279.40	3868.2639	12.203	1.47E-01	1.51E+01	6.85E+00	7.34E-02	3.33E-02
11.25	285.75	3481.4375	10.982	1.51E-01	1.55E+01	7.05E+00	7.31E-02	3.31E-02
11.50	292.10	3094.6111	9.7622	1.55E-01	1.59E+01	7.23E+00	7.27E-02	3.30E-02
11.75	298.45	2707.7847	8.5419	1.59E-01	1.63E+01	7.40E+00	7.24E-02	3.29E-02
12.00	304.80	2320.9583	7.3216	1.62E-01	1.66E+01	7.54E+00	7.22E-02	3.27E-02

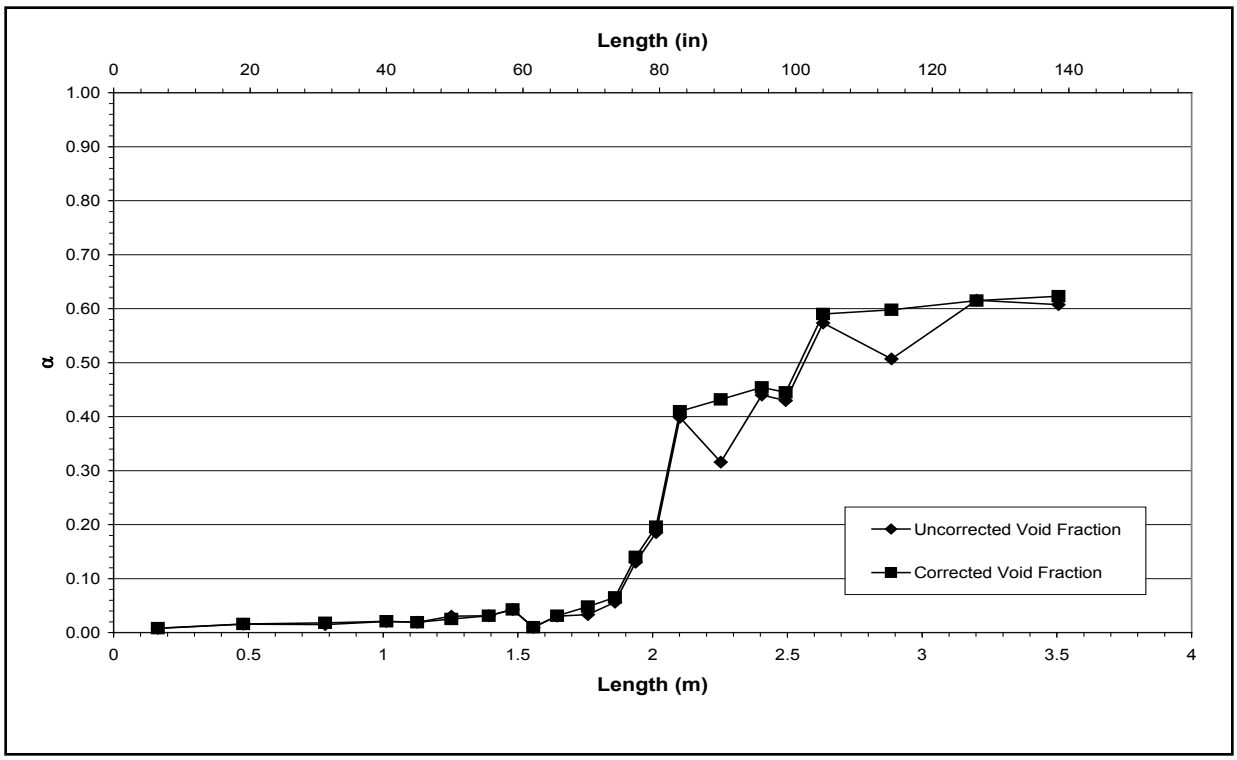

Figure A-630 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678E for Time Period 2550 to 2610 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1678-F

Test Conditions

Date: 7/21/2003
Steady-state time window: 3960 – 3990 seconds
Inlet flow rate: 2.022 cm/sec (0.796 in./sec)
Inlet mass flow rate: 0.097 kg/sec (0.213 lbm/sec)
Inlet flow temperature: 327.2 K (129.2 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 71.96 kW

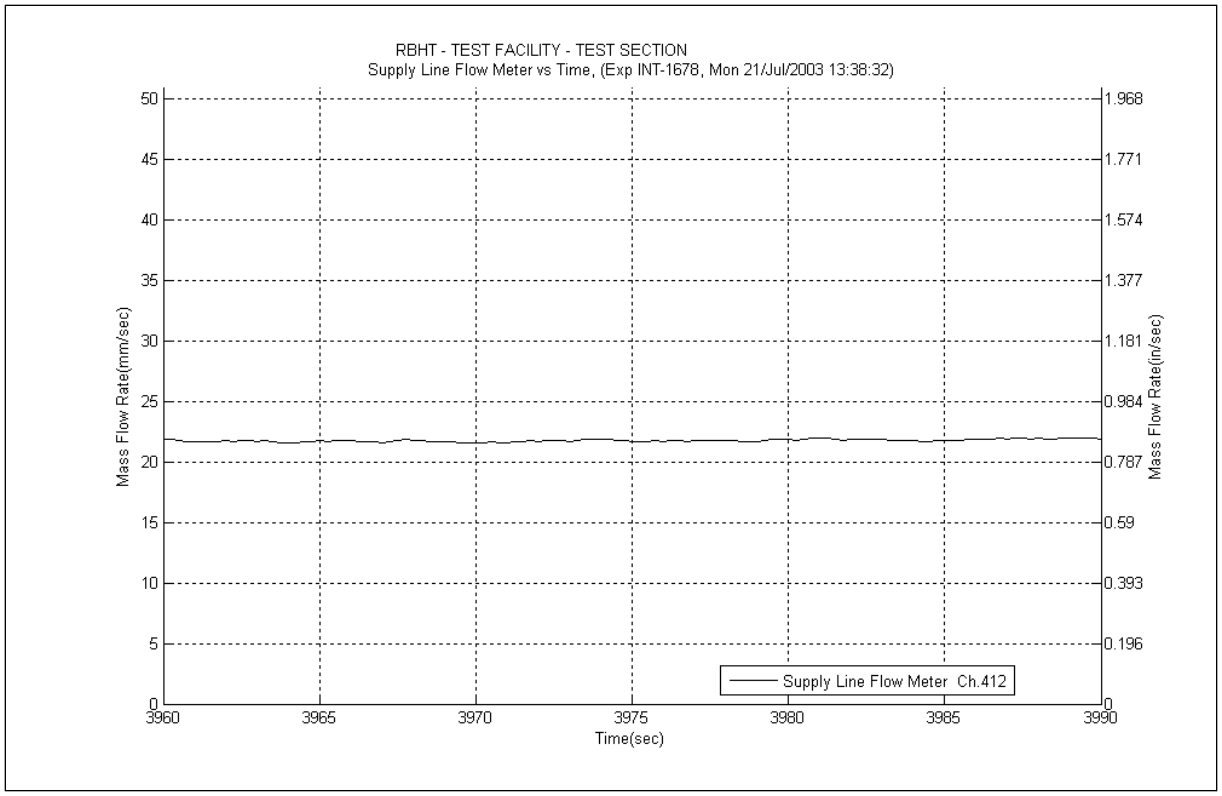

Figure A-631 Inlet Flow Plot for Experiment 1678F

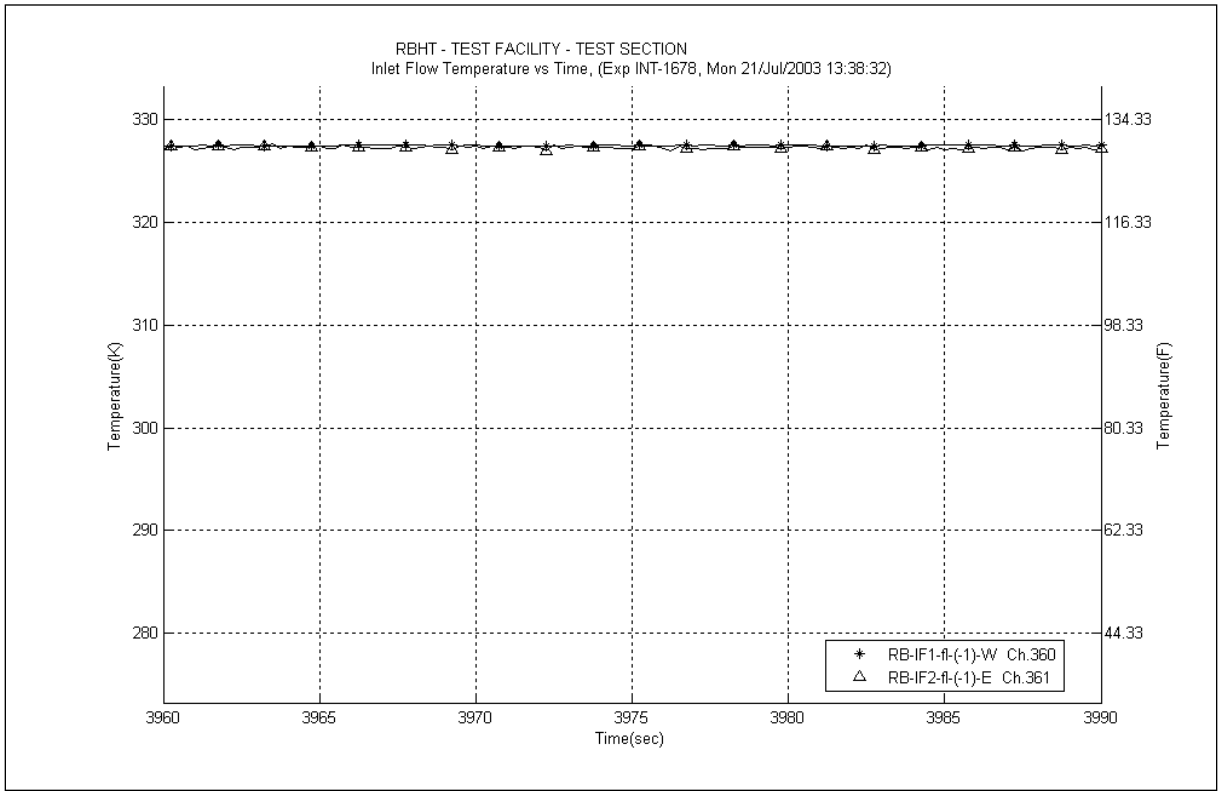

Figure A-632 Inlet Temperature Plot for Experiment 1678F

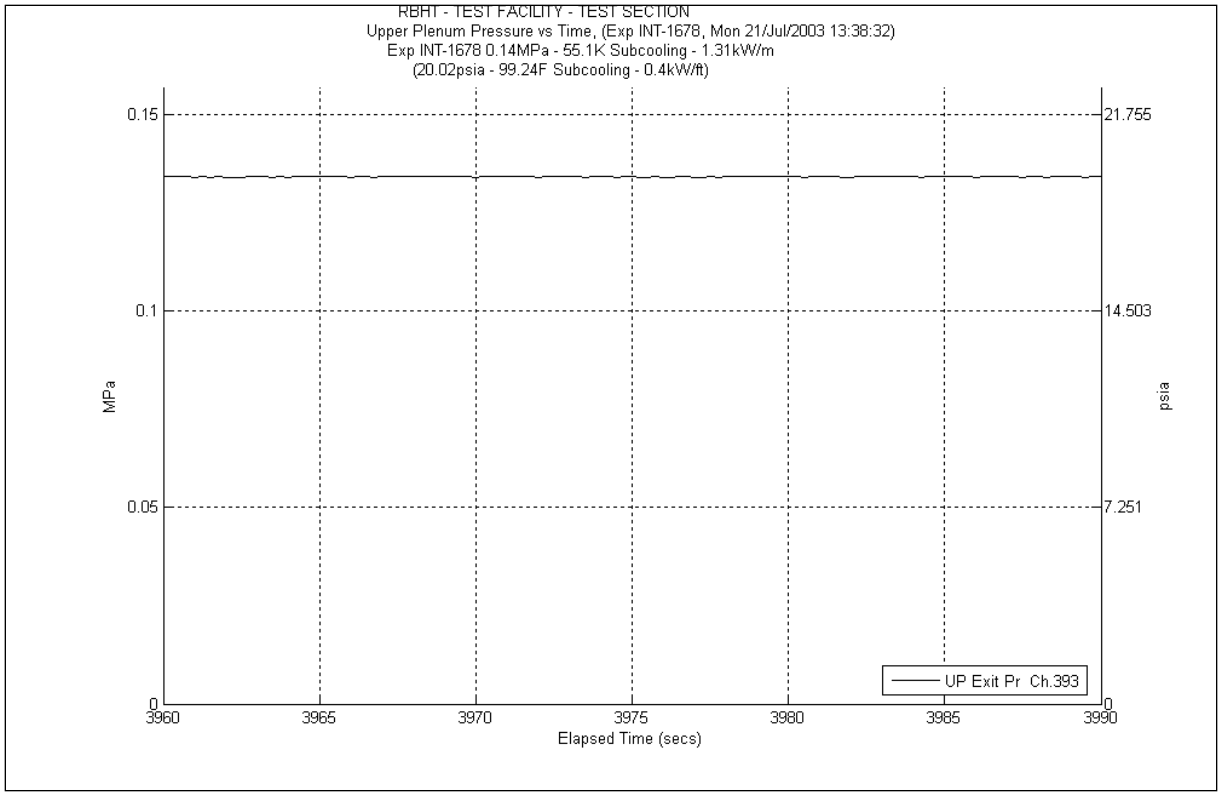

Figure A-633 System Pressure Plot for Experiment 1678F

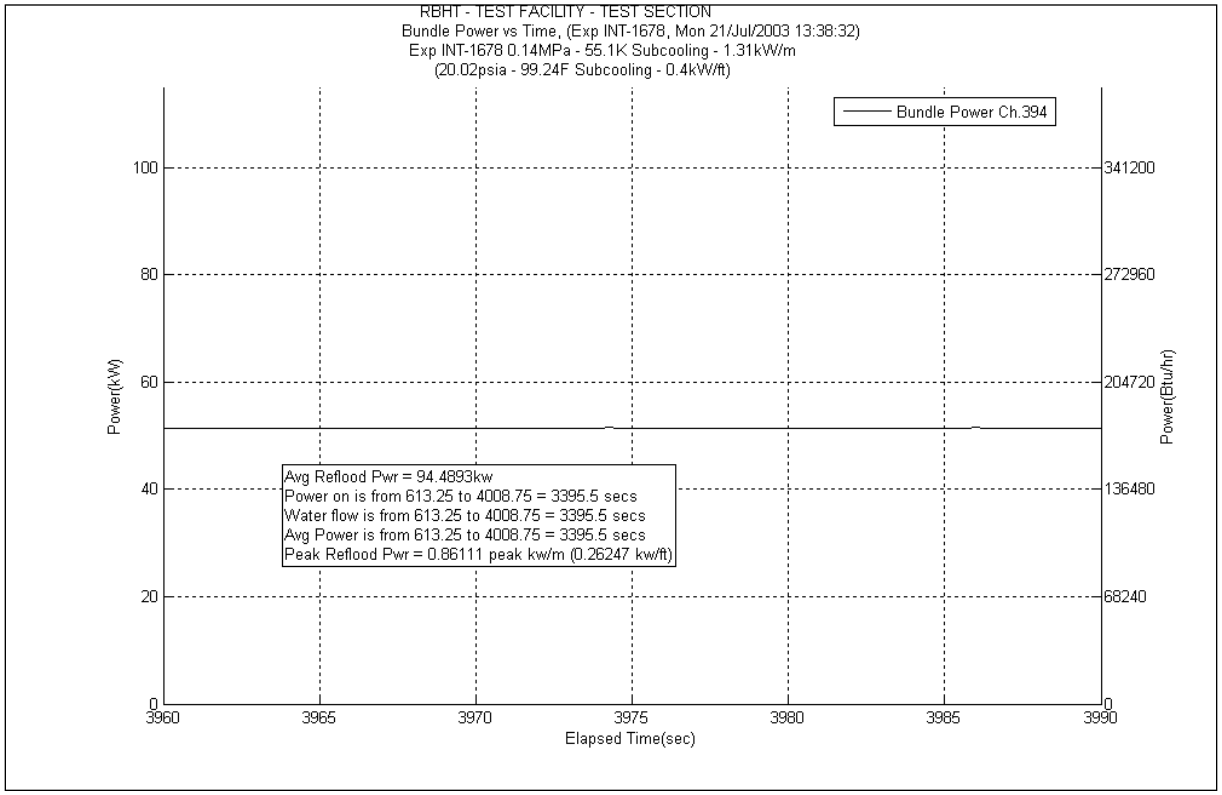

Figure A-634 Bundle Power Plot for Experiment 1678F

Table A-253 Data Results for RBHT Test 1678 for Time Period 3960 to 3990

Results for RBHT Test 1678
Valid Time Period 3960 to 3990 seconds
Collapsed Liquid Level = 101.669 inches = 2582.39 mm
(Z_{osv}) Onset of Significant Void = 58.5 inches = 1486 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.671	18.821	901.137	0.580	27.771	0.171	8.188	0.000	0.000	18.06	864.717	2898.06	138759.8576	0.684	0.681	0.687
*	120-133	3048-3378	383	0.649	23.697	1134.626	0.632	30.260	0.305	14.603	0.830	39.749	21.93	1050.014	2919.99	139809.8716	0.675	0.672	0.678
*	108-120	2743-3048	382	0.551	28.002	1340.764	0.511	24.467	0.380	18.194	5.781	276.817	21.33	1021.286	2941.32	140831.1575	0.658	0.655	0.661
	100-108	2540-2743	381	0.635	15.159	725.833	0.293	14.029	0.278	13.311	0.000	0.000	14.58	698.094	2955.9	141529.2517	0.649	0.646	0.652
	97-100	2464-2540	380	0.489	7.967	381.441	0.099	4.740	0.101	4.836	0.000	0.000	7.764	371.742	2963.664	141900.994	0.501	0.498	0.504
	93-97	2362-2464	379	0.508	10.215	489.110	0.123	5.889	0.131	6.272	0.000	0.000	9.957	476.744	2973.621	142377.7377	0.521	0.518	0.524
*	85-93	2159-2362	378	0.381	25.707	1230.857	0.216	10.342	0.252	12.066	6.029	288.669	19.21	919.780	2992.831	143297.5174	0.538	0.535	0.541
	81-85	2057-2159	377	0.544	9.467	453.303	0.092	4.405	0.121	5.794	0.000	0.000	9.251	442.940	3002.082	143740.4577	0.555	0.552	0.558
	78-81	1981-2057	376	0.290	11.062	529.641	0.062	2.969	0.088	4.213	0.000	0.000	10.91	522.374	3012.992	144262.8313	0.3	0.299	0.302
	75-78	1905-1981	375	0.375	9.732	465.985	0.055	2.633	0.086	4.118	0.000	0.000	9.585	458.932	3022.577	144721.7636	0.385	0.383	0.387
	72-75	1829-1905	374	0.296	10.974	525.414	0.049	2.346	0.084	4.022	0.000	0.000	10.84	519.022	3033.417	145240.7855	0.304	0.302	0.306
*	67-72	1702-1829	373	0.229	20.015	958.328	0.067	3.208	0.136	6.512	-0.738	-35.331	20.55	983.939	3053.967	146224.7248	0.208	0.207	0.209
	63-67	1600-1702	372	0.106	18.582	889.698	0.038	1.819	0.105	5.027	0.000	0.000	18.43	882.433	3072.397	147107.158	0.113	0.112	0.114
	60-63	1524-1600	371	0.019	15.289	732.049	0.018	0.862	0.076	3.639	0.000	0.000	15.19	727.301	3087.587	147834.4591	0.025	0.024	0.026
	57-60	1448-1524	370	0.049	14.817	709.421	0.008	0.383	0.052	2.490	0.000	0.000	14.75	706.234	3102.337	148540.6929	0.053	0.050	0.056
	53-57	1346-1448	369	0.037	20.000	957.582	0.001	0.048	0.000	0.000	0.000	0.000	19.99	957.126	3122.327	149497.8192	0.037	0.035	0.039
*	46-53	1168-1346	368	0.036	35.050	1678.193	0.001	0.048	0.000	0.000	-0.171	-8.198	35.22	1686.343	3157.547	151184.1618	0.031	0.029	0.033
	43-46	1092-1168	367	0.025	15.196	727.573	0.001	0.048	0.000	0.000	0.000	0.000	15.19	727.301	3172.737	151911.463	0.025	0.024	0.026
	37-43	940-1092	366	0.025	30.397	1455.395	0.001	0.048	0.000	0.000	0.000	0.000	30.38	1454.602	3203.117	153366.0652	0.025	0.024	0.026
*	25-37	635-940	365	0.018	61.224	2931.429	0.002	0.096	0.000	0.000	0.202	9.680	61.02	2921.653	3264.137	156287.7184	0.021	0.020	0.022
	13-25	330-635	364	0.017	61.292	2934.661	0.002	0.096	0.000	0.000	0.000	0.000	61.27	2933.623	3325.407	159221.3418	0.017	0.016	0.018
*	0-13	0-330	363	0.008	66.942	3205.201	0.003	0.144	0.000	0.000	0.009	0.432	66.93	3204.626	3392.337	162425.9674	0.008	0.008	0.008

Table A-254 Energy Balance Results for RBHT Test 1678F for Time Period 3960 to 3990 seconds

Results for RBHT Test 1678
Valid Time Period 3960 to 3990 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2320.9385	7.3216	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
0.25	6.35	2449.8795	7.7283	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
0.50	12.70	2578.8206	8.1351	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
0.75	19.05	2707.7616	8.5418	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
1.00	25.40	2836.7026	8.9486	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
1.25	31.75	2965.6436	9.3553	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
1.50	38.10	3094.5847	9.7621	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
1.75	44.45	3223.5257	10.169	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
2.00	50.80	3352.4667	10.576	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
2.25	57.15	3481.4078	10.982	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
2.50	63.50	3610.3488	11.389	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
2.75	69.85	3739.2898	11.796	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
3.00	76.20	3868.2308	12.203	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
3.25	82.55	3997.1719	12.609	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
3.50	88.90	4126.1129	13.016	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
3.75	95.25	4255.0539	13.423	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
4.00	101.60	4383.9949	13.83	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
4.25	107.95	4512.936	14.236	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
4.50	114.30	4641.877	14.643	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
4.75	120.65	4770.818	15.05	0.00E+00	0.00E+00	0.00E+00	6.84E-02	3.10E-02
5.00	127.00	4899.7591	15.457	5.04E-03	4.09E-01	1.86E-01	6.80E-02	3.09E-02
5.25	133.35	5028.7001	15.863	1.25E-02	1.01E+00	4.60E-01	6.75E-02	3.06E-02
5.50	139.70	5157.6411	16.27	2.01E-02	1.63E+00	7.40E-01	6.70E-02	3.04E-02
5.75	146.05	5286.5821	16.677	2.79E-02	2.27E+00	1.03E+00	6.65E-02	3.01E-02
6.00	152.40	5415.5232	17.084	3.60E-02	2.92E+00	1.32E+00	6.59E-02	2.99E-02
6.25	158.75	5544.4642	17.49	4.42E-02	3.58E+00	1.63E+00	6.54E-02	2.96E-02
6.50	165.10	5673.4052	17.897	5.26E-02	4.27E+00	1.94E+00	6.48E-02	2.94E-02
6.75	171.45	5802.3463	18.304	6.12E-02	4.96E+00	2.25E+00	6.42E-02	2.91E-02
7.00	177.80	5931.2873	18.711	7.00E-02	5.68E+00	2.58E+00	6.36E-02	2.88E-02
7.25	184.15	6060.2283	19.117	7.89E-02	6.41E+00	2.91E+00	6.30E-02	2.86E-02
7.50	190.50	6189.1693	19.524	8.81E-02	7.15E+00	3.24E+00	6.23E-02	2.83E-02
7.75	196.85	6318.1104	19.931	9.75E-02	7.91E+00	3.59E+00	6.17E-02	2.80E-02
8.00	203.20	6447.0514	20.338	1.07E-01	8.69E+00	3.94E+00	6.11E-02	2.77E-02
8.25	209.55	6575.9924	20.744	1.17E-01	9.48E+00	4.30E+00	6.04E-02	2.74E-02
8.50	215.90	6704.9334	21.151	1.27E-01	1.03E+01	4.67E+00	5.97E-02	2.71E-02
8.75	222.25	6833.8745	21.558	1.37E-01	1.11E+01	5.04E+00	5.90E-02	2.68E-02
9.00	228.60	6962.8155	21.965	1.47E-01	1.19E+01	5.42E+00	5.83E-02	2.64E-02
9.25	234.95	6575.9924	20.744	1.57E-01	1.28E+01	5.80E+00	5.76E-02	2.61E-02
9.50	241.30	6189.1693	19.524	1.67E-01	1.35E+01	6.15E+00	5.70E-02	2.58E-02
9.75	247.65	5802.3463	18.304	1.76E-01	1.43E+01	6.48E+00	5.63E-02	2.56E-02
10.00	254.00	5415.5232	17.084	1.84E-01	1.50E+01	6.79E+00	5.58E-02	2.53E-02
10.25	260.35	5028.7001	15.863	1.92E-01	1.56E+01	7.07E+00	5.52E-02	2.51E-02
10.50	266.70	4641.877	14.643	1.99E-01	1.62E+01	7.34E+00	5.47E-02	2.48E-02
10.75	273.05	4255.0539	13.423	2.06E-01	1.67E+01	7.59E+00	5.43E-02	2.46E-02
11.00	279.40	3868.2308	12.203	2.12E-01	1.72E+01	7.81E+00	5.39E-02	2.44E-02
11.25	285.75	3481.4078	10.982	2.18E-01	1.77E+01	8.01E+00	5.35E-02	2.43E-02
11.50	292.10	3094.5847	9.7621	2.23E-01	1.81E+01	8.19E+00	5.32E-02	2.41E-02
11.75	298.45	2707.7616	8.5418	2.27E-01	1.84E+01	8.35E+00	5.29E-02	2.40E-02
12.00	304.80	2320.9385	7.3216	2.31E-01	1.87E+01	8.49E+00	5.26E-02	2.39E-02

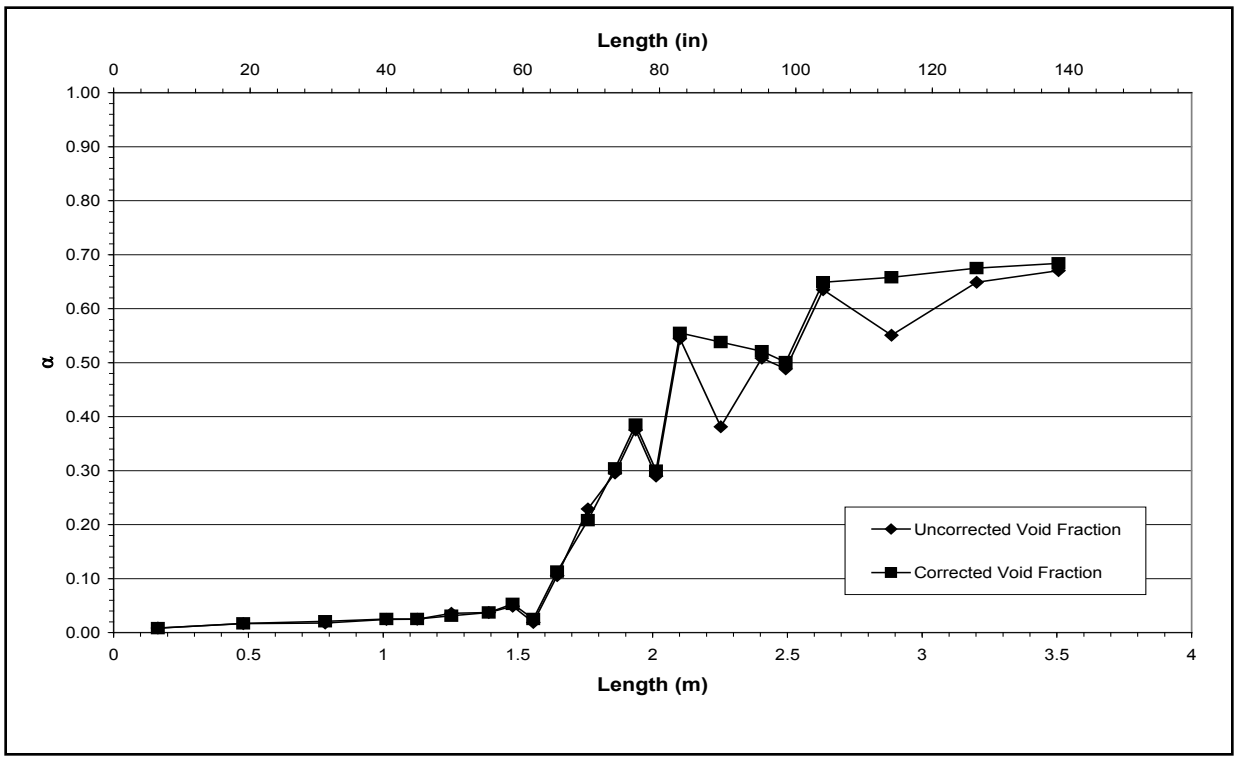

Figure A-635 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1678F for Time Period 3960 to 3990 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-A

Test Conditions

Date: 7/21/2003
Steady-state time window: 1620 – 1730 seconds
Inlet flow rate: 2.032 cm/sec (0.800 in./sec)
Inlet mass flow rate: 0.097 kg/sec (0.214 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

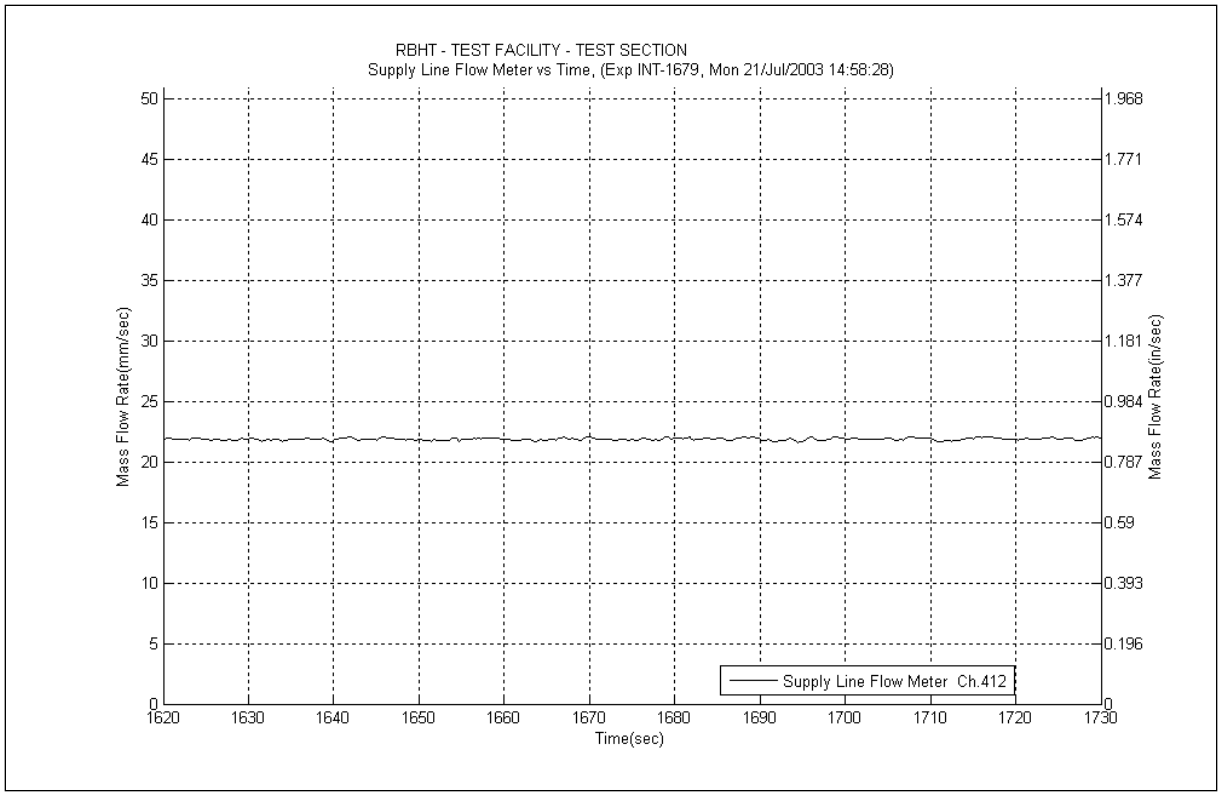

Figure A-636 Inlet Flow Plot for Experiment 1679A

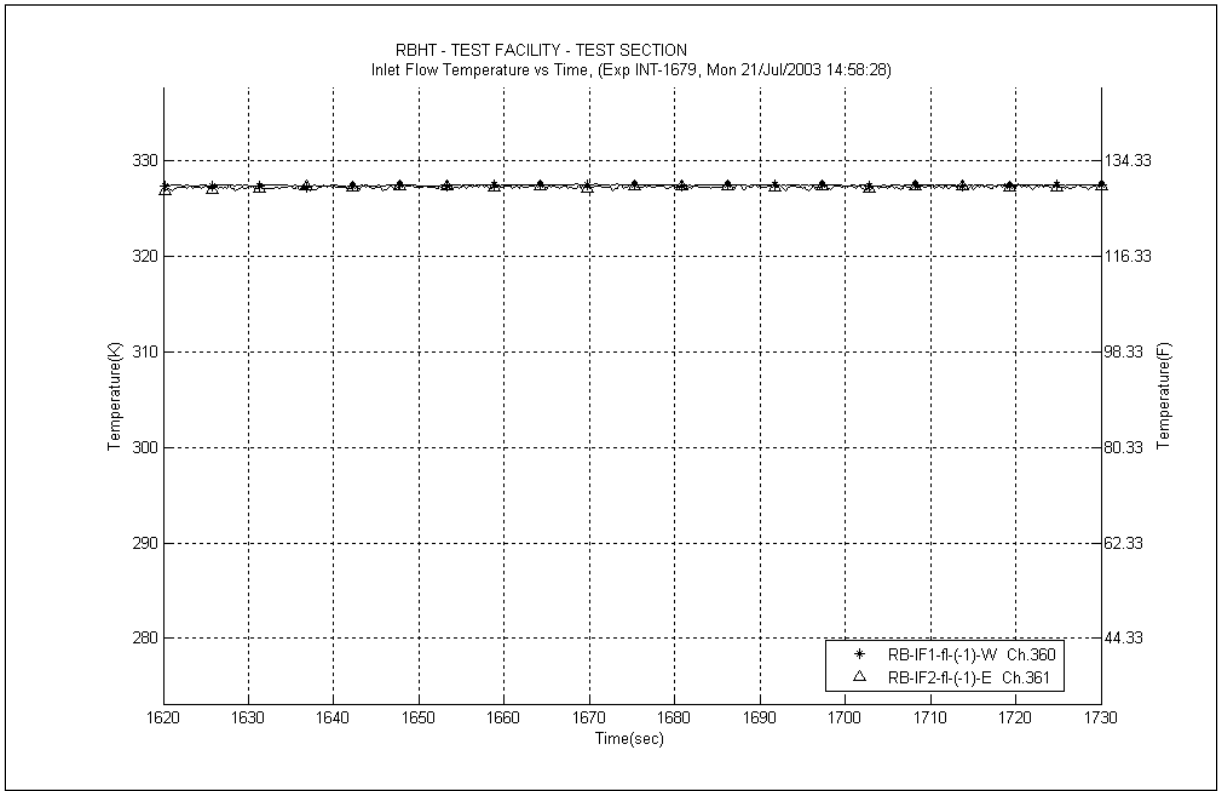

Figure A-637 Inlet Temperature Plot for Experiment 1679A

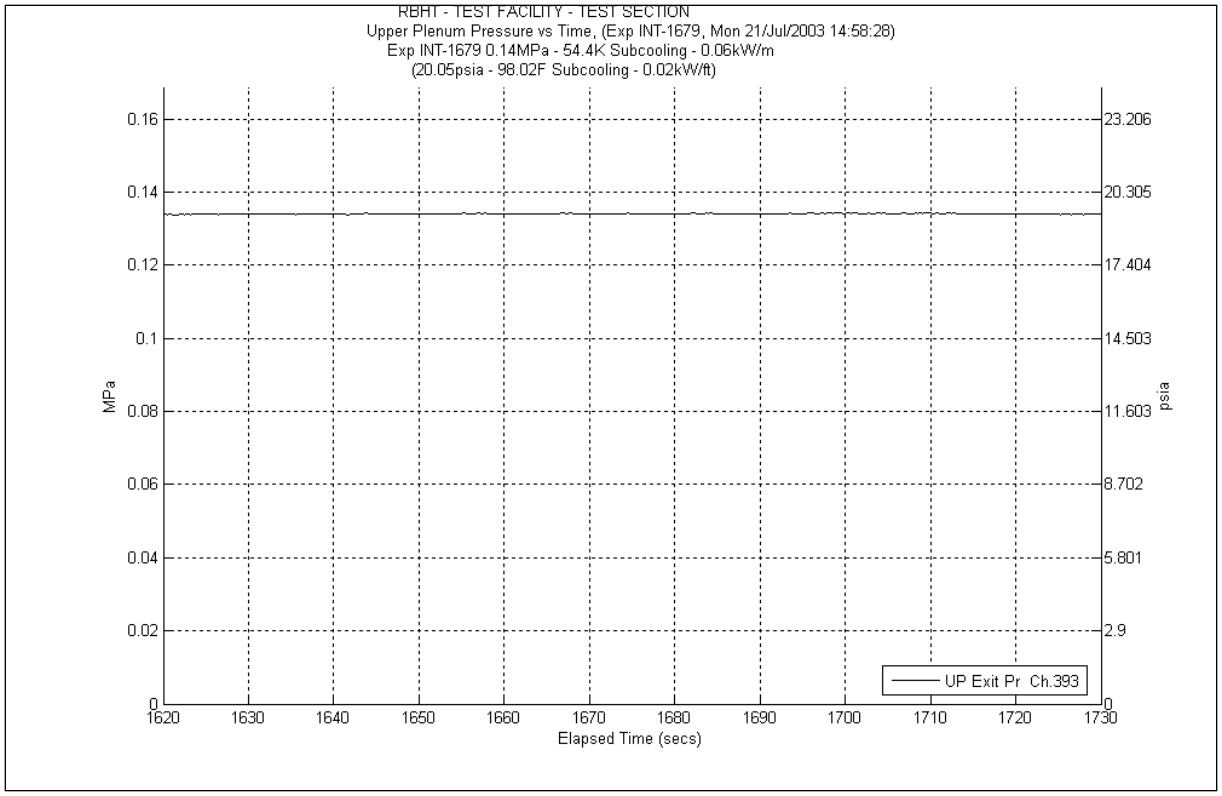

Figure A-638 System Pressure Plot for Experiment 1679A

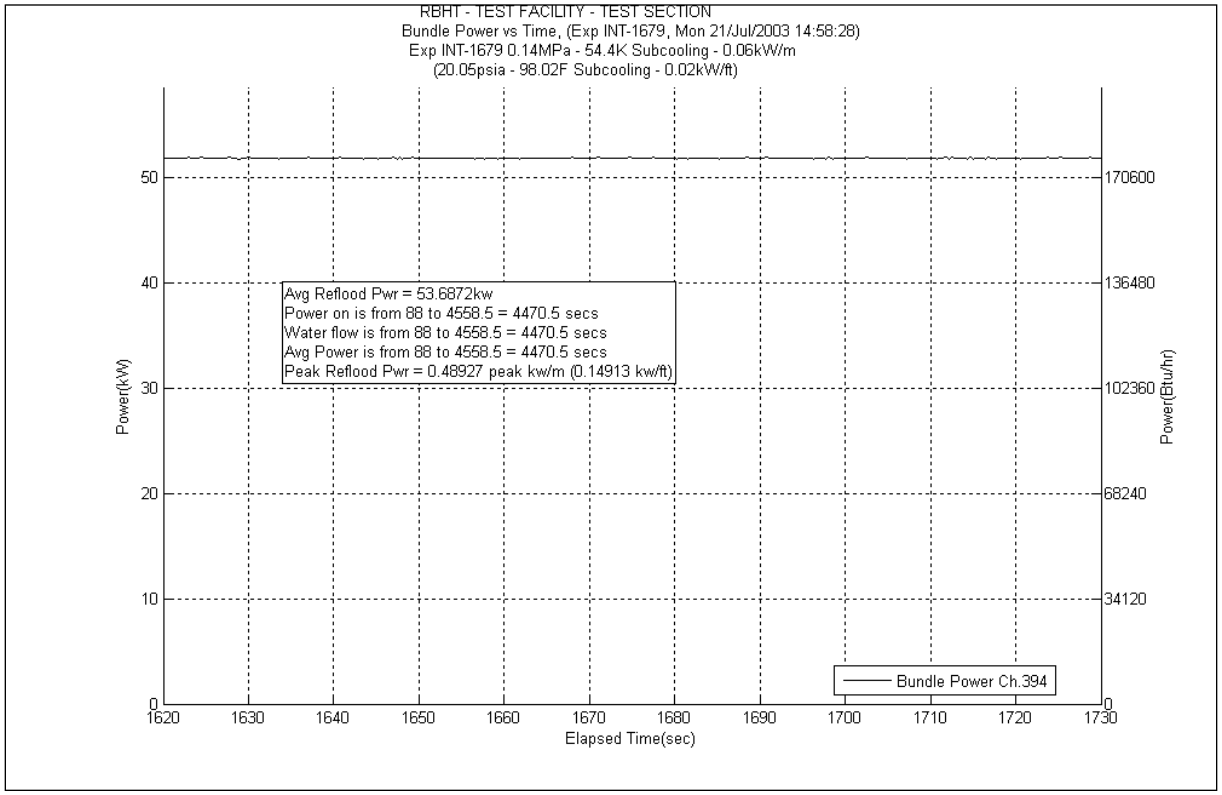

Figure A-639 Bundle Power Plot for Experiment 1679A

Table A-255 Data Results for RBHT Test 1679 for Time Period 1620 to 1730

Results for RBHT Test 1679
Valid Time Period 1620 to 1730 seconds
Collapsed Liquid Level = 101.491 inches = 2577.86 mm
(Z_{osv}) Onset of Significant Void = 58.5 inches = 1486 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.671	18.769	898.650	0.588	28.154	0.173	8.283	0.000	0.000	18	861.845	2898	138756.9848	0.685	0.682	0.688
*	120-133	3048-3378	383	0.650	23.640	1131.891	0.641	30.691	0.309	14.795	0.850	40.700	21.84	1045.705	2919.84	139802.6896	0.676	0.673	0.679
*	108-120	2743-3048	382	0.549	28.117	1346.234	0.519	24.850	0.386	18.482	6.012	287.841	21.2	1015.061	2941.04	140817.751	0.66	0.657	0.663
	100-108	2540-2743	381	0.637	15.066	721.357	0.297	14.220	0.283	13.550	0.000	0.000	14.48	693.306	2955.52	141511.0572	0.651	0.648	0.654
	97-100	2464-2540	380	0.493	7.904	378.457	0.101	4.836	0.102	4.884	0.000	0.000	7.701	368.726	2963.221	141879.783	0.506	0.503	0.509
	93-97	2362-2464	379	0.502	10.350	495.575	0.125	5.985	0.133	6.368	0.000	0.000	10.09	483.112	2973.311	142362.8948	0.514	0.511	0.517
*	85-93	2159-2362	378	0.383	25.650	1228.122	0.219	10.486	0.256	12.257	5.875	281.290	19.3	924.089	2992.611	143286.9838	0.535	0.532	0.538
	81-85	2057-2159	377	0.546	9.431	451.563	0.093	4.453	0.123	5.889	0.000	0.000	9.212	441.073	3001.823	143728.0567	0.556	0.553	0.559
	78-81	1981-2057	376	0.312	10.714	512.981	0.063	3.016	0.090	4.309	0.000	0.000	10.56	505.616	3012.383	144233.6722	0.322	0.320	0.324
	75-78	1905-1981	375	0.363	9.924	475.185	0.056	2.681	0.087	4.166	0.000	0.000	9.775	468.030	3022.158	144701.7017	0.372	0.370	0.374
	72-75	1829-1905	374	0.296	10.968	525.166	0.050	2.394	0.085	4.070	0.000	0.000	10.83	518.543	3032.988	145220.2449	0.305	0.303	0.307
*	67-72	1702-1829	373	0.234	19.901	952.857	0.068	3.256	0.138	6.607	-0.795	-38.072	20.49	981.066	3053.478	146201.3114	0.211	0.210	0.212
	63-67	1600-1702	372	0.110	18.499	885.720	0.039	1.867	0.106	5.075	0.000	0.000	18.35	878.603	3071.828	147079.9141	0.117	0.116	0.118
	60-63	1524-1600	371	0.021	15.258	730.557	0.019	0.910	0.077	3.687	0.000	0.000	15.16	725.865	3086.988	147805.7788	0.027	0.026	0.028
	57-60	1448-1524	370	0.049	14.811	709.173	0.009	0.431	0.055	2.633	0.000	0.000	14.74	705.755	3101.728	148511.5338	0.053	0.050	0.056
	53-57	1346-1448	369	0.038	19.984	956.836	0.001	0.048	0.000	0.000	0.000	0.000	19.98	956.648	3121.708	149468.1813	0.038	0.036	0.040
*	46-53	1168-1346	368	0.036	35.060	1678.690	0.001	0.048	0.000	0.000	-0.151	-7.222	35.21	1685.864	3156.918	151154.0452	0.031	0.029	0.033
	43-46	1092-1168	367	0.024	15.201	727.822	0.001	0.048	0.000	0.000	0.000	0.000	15.19	727.301	3172.108	151881.3463	0.025	0.024	0.026
	37-43	940-1092	366	0.025	30.386	1454.898	0.001	0.048	0.000	0.000	0.000	0.000	30.37	1454.123	3202.478	153335.4697	0.025	0.024	0.026
*	25-37	635-940	365	0.018	61.214	2930.932	0.003	0.144	0.000	0.000	0.201	9.613	61.01	2921.174	3263.488	156256.6442	0.021	0.020	0.022
	13-25	330-635	364	0.016	61.297	2934.910	0.003	0.144	0.000	0.000	0.000	0.000	61.27	2933.623	3324.758	159190.2675	0.016	0.015	0.017
*	0-13	0-330	363	0.009	66.932	3204.704	0.003	0.144	0.000	0.000	-0.011	-0.544	66.94	3205.104	3391.698	162395.3719	0.008	0.008	0.008

Table A-256 Energy Balance Results for RBHT Test 1679A for Time Period 1620 to 1730 seconds

Results for RBHT Test 1679
Valid Time Period 1620 to 1730 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2333.5395	7.3613	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
0.25	6.35	2463.1806	7.7703	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
0.50	12.70	2592.8217	8.1792	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
0.75	19.05	2722.4628	8.5882	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
1.00	25.40	2852.1039	8.9972	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
1.25	31.75	2981.745	9.4061	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
1.50	38.10	3111.3861	9.8151	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
1.75	44.45	3241.0271	10.224	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
2.00	50.80	3370.6682	10.633	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
2.25	57.15	3500.3093	11.042	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
2.50	63.50	3629.9504	11.451	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
2.75	69.85	3759.5915	11.86	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
3.00	76.20	3889.2326	12.269	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
3.25	82.55	4018.8737	12.678	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
3.50	88.90	4148.5147	13.087	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
3.75	95.25	4278.1558	13.496	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
4.00	101.60	4407.7969	13.905	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
4.25	107.95	4537.438	14.314	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
4.50	114.30	4667.0791	14.723	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
4.75	120.65	4796.7202	15.132	0.00E+00	0.00E+00	0.00E+00	6.87E-02	3.12E-02
5.00	127.00	4926.3613	15.541	5.32E-03	4.36E-01	1.98E-01	6.84E-02	3.10E-02
5.25	133.35	5056.0023	15.95	1.28E-02	1.05E+00	4.75E-01	6.78E-02	3.08E-02
5.50	139.70	5185.6434	16.358	2.04E-02	1.67E+00	7.58E-01	6.73E-02	3.05E-02
5.75	146.05	5315.2845	16.767	2.82E-02	2.31E+00	1.05E+00	6.68E-02	3.03E-02
6.00	152.40	5444.9256	17.176	3.62E-02	2.97E+00	1.35E+00	6.62E-02	3.00E-02
6.25	158.75	5574.5667	17.585	4.44E-02	3.64E+00	1.65E+00	6.57E-02	2.98E-02
6.50	165.10	5704.2078	17.994	5.29E-02	4.33E+00	1.97E+00	6.51E-02	2.95E-02
6.75	171.45	5833.8489	18.403	6.14E-02	5.04E+00	2.28E+00	6.45E-02	2.93E-02
7.00	177.80	5963.4899	18.812	7.02E-02	5.76E+00	2.61E+00	6.39E-02	2.90E-02
7.25	184.15	6093.131	19.221	7.92E-02	6.49E+00	2.95E+00	6.33E-02	2.87E-02
7.50	190.50	6222.7721	19.63	8.84E-02	7.25E+00	3.29E+00	6.26E-02	2.84E-02
7.75	196.85	6352.4132	20.039	9.78E-02	8.01E+00	3.64E+00	6.20E-02	2.81E-02
8.00	203.20	6482.0543	20.448	1.07E-01	8.80E+00	3.99E+00	6.13E-02	2.78E-02
8.25	209.55	6611.6954	20.857	1.17E-01	9.60E+00	4.35E+00	6.07E-02	2.75E-02
8.50	215.90	6741.3364	21.266	1.27E-01	1.04E+01	4.72E+00	6.00E-02	2.72E-02
8.75	222.25	6870.9775	21.675	1.37E-01	1.12E+01	5.10E+00	5.93E-02	2.69E-02
9.00	228.60	7000.6186	22.084	1.48E-01	1.21E+01	5.49E+00	5.86E-02	2.66E-02
9.25	234.95	6611.6954	20.857	1.58E-01	1.29E+01	5.86E+00	5.79E-02	2.63E-02
9.50	241.30	6222.7721	19.63	1.67E-01	1.37E+01	6.22E+00	5.72E-02	2.60E-02
9.75	247.65	5833.8489	18.403	1.76E-01	1.44E+01	6.55E+00	5.66E-02	2.57E-02
10.00	254.00	5444.9256	17.176	1.85E-01	1.51E+01	6.86E+00	5.60E-02	2.54E-02
10.25	260.35	5056.0023	15.95	1.92E-01	1.58E+01	7.15E+00	5.55E-02	2.52E-02
10.50	266.70	4667.0791	14.723	2.00E-01	1.64E+01	7.43E+00	5.50E-02	2.49E-02
10.75	273.05	4278.1558	13.496	2.06E-01	1.69E+01	7.67E+00	5.45E-02	2.47E-02
11.00	279.40	3889.2326	12.269	2.12E-01	1.74E+01	7.90E+00	5.41E-02	2.45E-02
11.25	285.75	3500.3093	11.042	2.18E-01	1.79E+01	8.10E+00	5.37E-02	2.44E-02
11.50	292.10	3111.3861	9.8151	2.23E-01	1.83E+01	8.29E+00	5.34E-02	2.42E-02
11.75	298.45	2722.4628	8.5882	2.27E-01	1.86E+01	8.45E+00	5.31E-02	2.41E-02
12.00	304.80	2333.5395	7.3613	2.31E-01	1.89E+01	8.59E+00	5.28E-02	2.40E-02

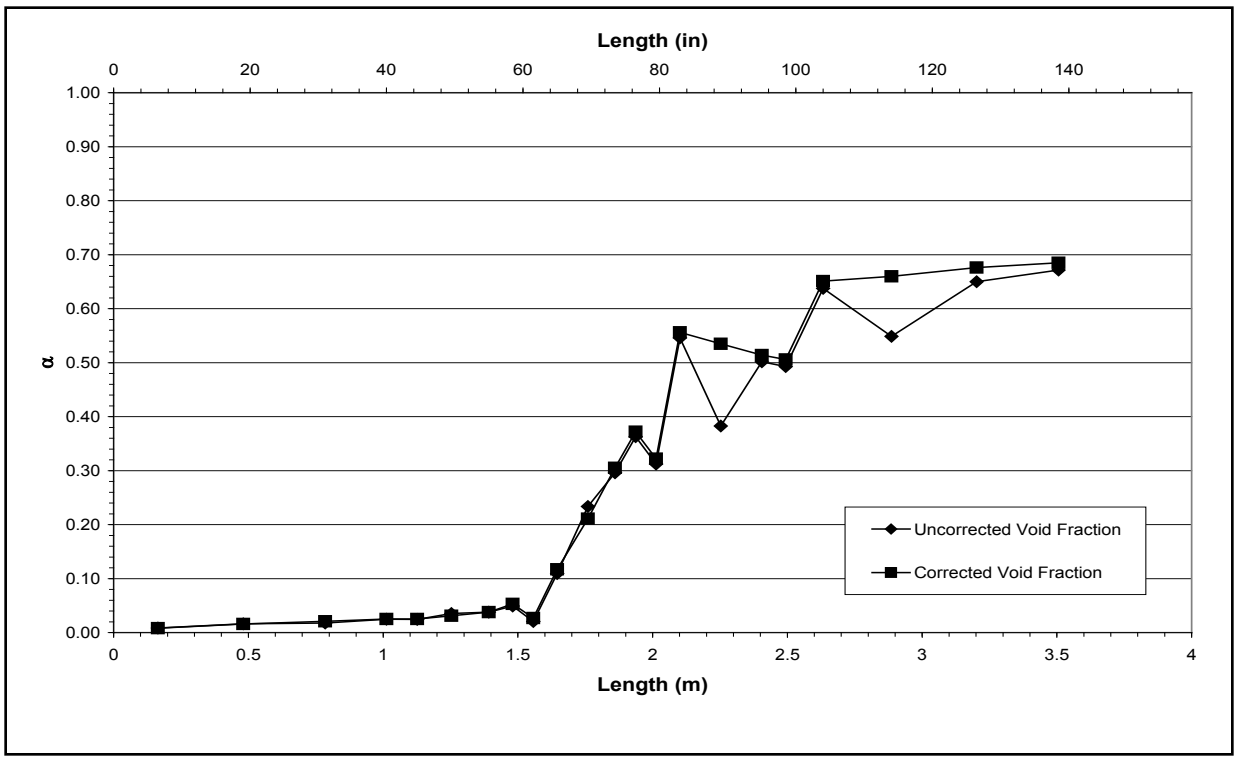

Figure A-640 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679A for Time Period 1620 to 1730 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-B

Test Conditions

Date: 7/21/2003
Steady-state time window: 2174 – 2234 seconds
Inlet flow rate: 1.524 cm/sec (0.600 in./sec)
Inlet mass flow rate: 0.073 kg/sec (0.160 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

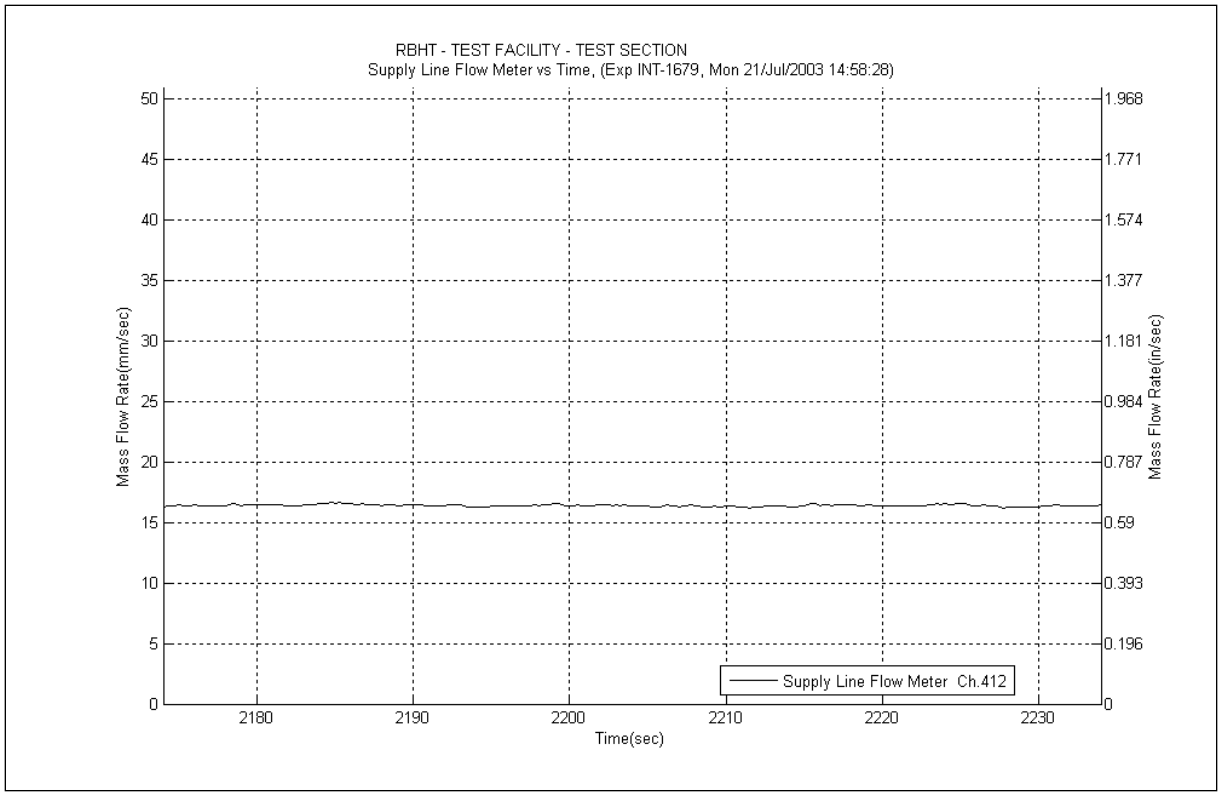

Figure A-641 Inlet Flow Plot for Experiment 1679B

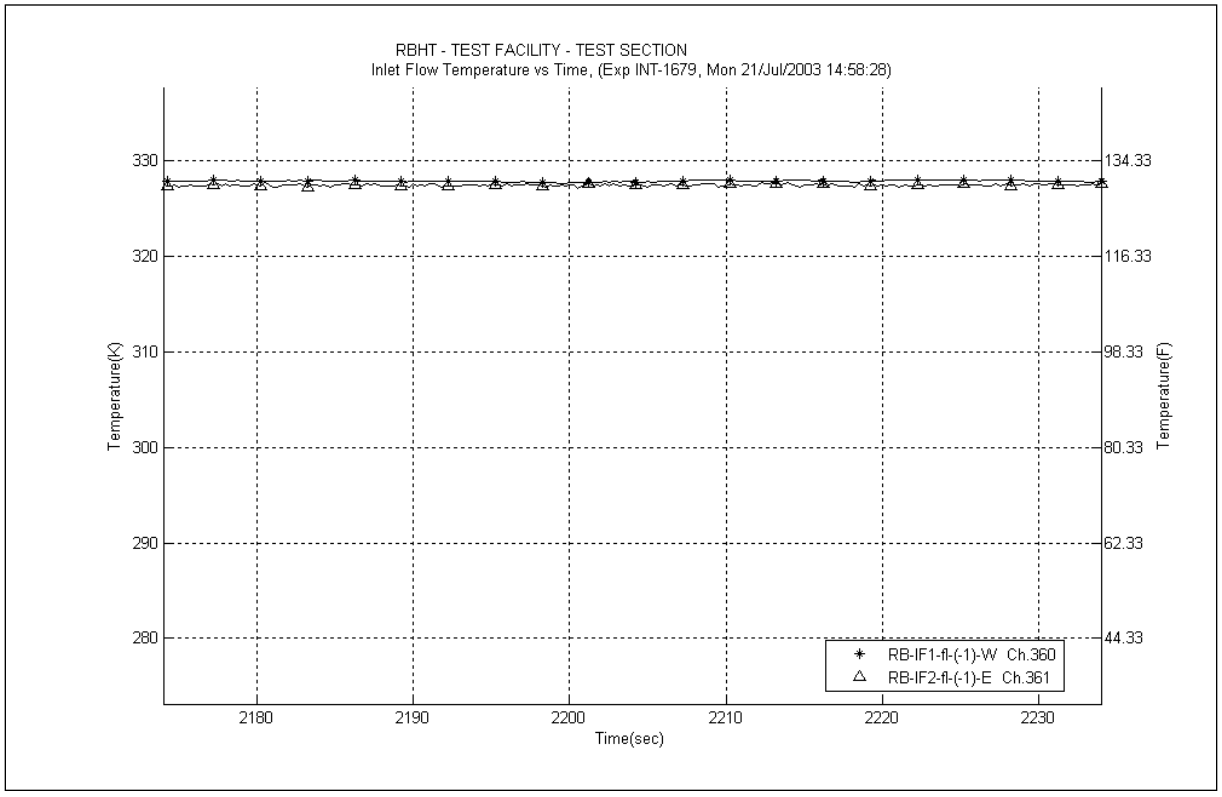

Figure A-642 Inlet Temperature Plot for Experiment 1679B

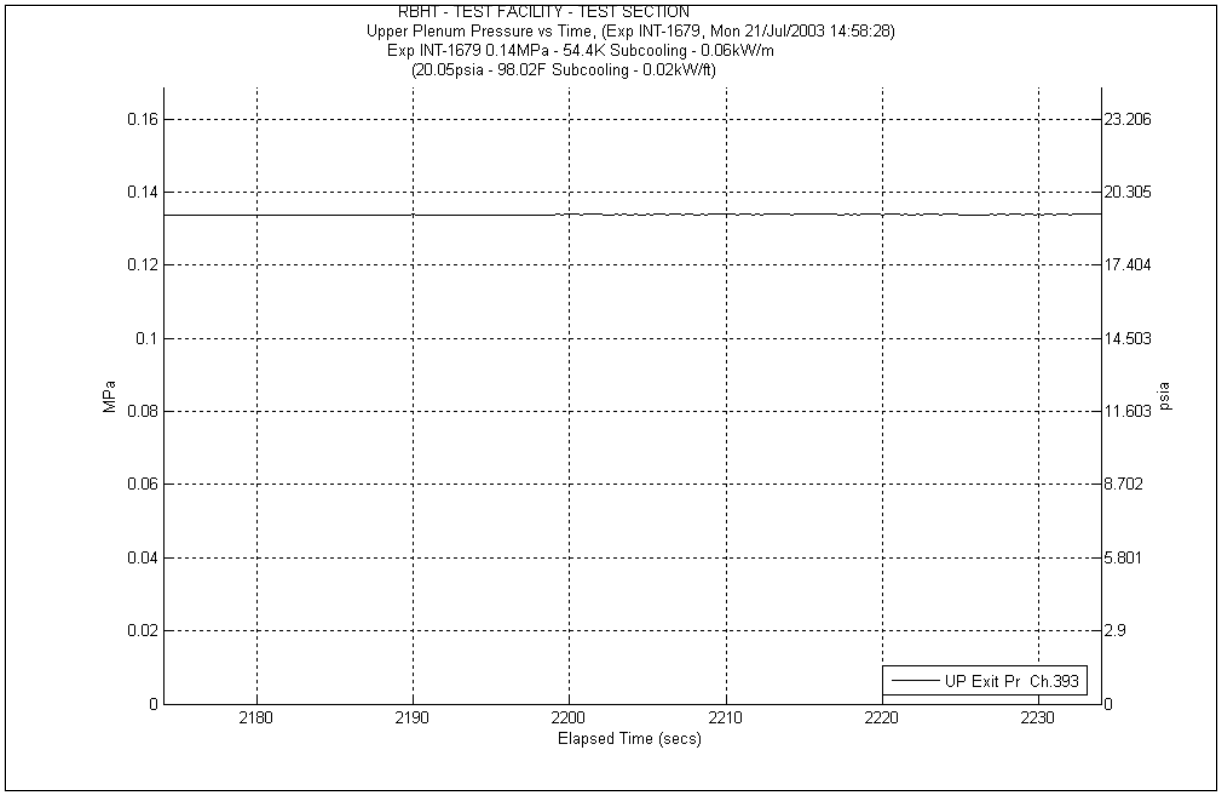

Figure A-643 System Pressure Plot for Experiment 1679B

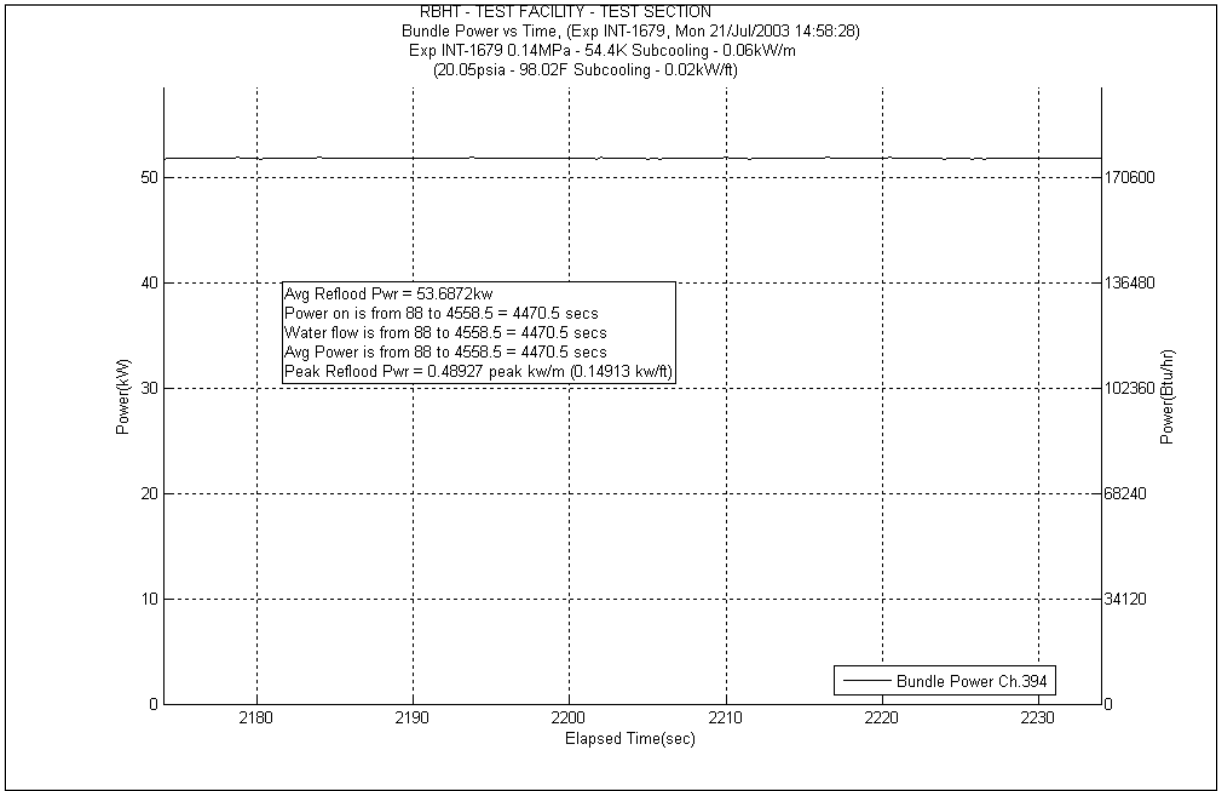

Figure A-644 Bundle Power Plot for Experiment 1679B

Table A-257 Data Results for RBHT Test 1679 for Time Period 2174 to 2234

Results for RBHT Test 1679
Valid Time Period 2174 to 2234 seconds
Collapsed Liquid Level = 93.151 inches = 2366.04 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.728	15.512	742.741	0.467	22.360	0.130	6.224	0.000	0.000	14.91	713.895	2894.91	138609.0348	0.739	0.735	0.743
*	120-133	3048-3378	383	0.691	20.851	998.362	0.511	24.467	0.232	11.108	1.878	89.930	18.23	872.857	2913.14	139481.8919	0.73	0.726	0.734
*	108-120	2743-3048	382	0.597	25.115	1202.510	0.418	20.014	0.290	13.885	6.457	309.160	17.95	859.451	2931.09	140341.3425	0.712	0.708	0.716
	100-108	2540-2743	381	0.692	12.802	612.942	0.243	11.635	0.212	10.151	0.000	0.000	12.34	590.842	2943.43	140932.1849	0.703	0.699	0.707
	97-100	2464-2540	380	0.555	6.928	331.710	0.083	3.974	0.077	3.687	0.000	0.000	6.765	323.910	2950.195	141256.0948	0.566	0.563	0.569
	93-97	2362-2464	379	0.568	8.974	429.681	0.105	5.027	0.100	4.788	0.000	0.000	8.765	419.670	2958.96	141675.7653	0.578	0.575	0.581
*	85-93	2159-2362	378	0.422	24.030	1150.540	0.188	9.001	0.192	9.193	7.800	373.444	15.85	758.902	2974.81	142434.6673	0.618	0.615	0.621
	81-85	2057-2159	377	0.650	7.265	347.873	0.083	3.974	0.092	4.405	0.000	0.000	7.088	339.375	2981.898	142774.0426	0.659	0.656	0.662
	78-81	1981-2057	376	0.390	9.499	454.795	0.058	2.777	0.067	3.208	0.000	0.000	9.373	448.782	2991.271	143222.8242	0.398	0.396	0.400
	75-78	1905-1981	375	0.458	8.444	404.318	0.054	2.586	0.066	3.160	0.000	0.000	8.321	398.412	2999.592	143621.2359	0.466	0.464	0.468
	72-75	1829-1905	374	0.386	9.566	458.028	0.049	2.346	0.064	3.064	0.000	0.000	9.45	452.468	3009.042	144073.7043	0.393	0.391	0.395
*	67-72	1702-1829	373	0.346	16.982	813.112	0.073	3.495	0.104	4.980	1.825	87.391	14.98	717.246	3024.022	144790.9505	0.423	0.421	0.425
	63-67	1600-1702	372	0.446	11.508	551.026	0.050	2.394	0.080	3.830	0.000	0.000	11.37	544.399	3035.392	145335.3491	0.452	0.450	0.454
	60-63	1524-1600	371	0.326	10.506	503.035	0.032	1.532	0.058	2.777	0.000	0.000	10.41	498.433	3045.802	145833.7825	0.332	0.330	0.334
	57-60	1448-1524	370	0.276	11.280	540.085	0.028	1.341	0.057	2.729	0.000	0.000	11.19	535.780	3056.992	146369.5626	0.282	0.281	0.283
	53-57	1346-1448	369	0.170	17.237	825.296	0.030	1.436	0.073	3.495	0.000	0.000	17.13	820.189	3074.122	147189.7514	0.175	0.174	0.176
*	46-53	1168-1346	368	0.055	34.359	1645.121	0.028	1.341	0.117	5.602	1.674	80.155	32.54	1558.024	3106.662	148747.775	0.105	0.104	0.106
	43-46	1092-1168	367	0.034	15.050	720.611	0.000	0.000	0.000	0.000	0.000	0.000	15.05	720.598	3121.712	149468.3728	0.034	0.032	0.036
	37-43	940-1092	366	0.031	30.189	1445.449	0.001	0.048	0.000	0.000	0.000	0.000	30.18	1445.026	3151.892	150913.399	0.031	0.029	0.033
*	25-37	635-940	365	0.023	60.887	2915.266	0.001	0.048	0.000	0.000	0.156	7.450	60.73	2907.768	3212.622	153821.167	0.025	0.024	0.026
	13-25	330-635	364	0.019	61.131	2926.953	0.001	0.048	0.000	0.000	0.000	0.000	61.11	2925.963	3273.732	156747.1295	0.019	0.018	0.020
*	0-13	0-330	363	0.010	66.864	3201.471	0.002	0.096	0.000	0.000	0.012	0.580	66.85	3200.795	3340.582	159947.9247	0.01	0.010	0.011

Table A-258 Energy Balance Results for RBHT Test 1679B for Time Period 2174 to 2234 seconds

Results for RBHT Test 1679 Valid Time Period 2174 to 2234 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2332.6162	7.3584	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
0.25	6.35	2462.206	7.7672	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
0.50	12.70	2591.7958	8.176	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
0.75	19.05	2721.3856	8.5848	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
1.00	25.40	2850.9754	8.9936	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
1.25	31.75	2980.5652	9.4024	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
1.50	38.10	3110.155	9.8112	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
1.75	44.45	3239.7448	10.22	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
2.00	50.80	3369.3346	10.629	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
2.25	57.15	3498.9244	11.038	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
2.50	63.50	3628.5142	11.446	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
2.75	69.85	3758.1039	11.855	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
3.00	76.20	3887.6937	12.264	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
3.25	82.55	4017.2835	12.673	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
3.50	88.90	4146.8733	13.082	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
3.75	95.25	4276.4631	13.49	0.00E+00	0.00E+00	0.00E+00	5.15E-02	2.34E-02
4.00	101.60	4406.0529	13.899	5.02E-03	3.09E-01	1.40E-01	5.12E-02	2.32E-02
4.25	107.95	4535.6427	14.308	1.39E-02	8.56E-01	3.88E-01	5.08E-02	2.30E-02
4.50	114.30	4665.2325	14.717	2.31E-02	1.42E+00	6.43E-01	5.03E-02	2.28E-02
4.75	120.65	4794.8223	15.126	3.25E-02	2.00E+00	9.06E-01	4.98E-02	2.26E-02
5.00	127.00	4924.4121	15.534	4.21E-02	2.59E+00	1.18E+00	4.93E-02	2.24E-02
5.25	133.35	5054.0019	15.943	5.20E-02	3.20E+00	1.45E+00	4.88E-02	2.21E-02
5.50	139.70	5183.5917	16.352	6.22E-02	3.83E+00	1.74E+00	4.83E-02	2.19E-02
5.75	146.05	5313.1814	16.761	7.27E-02	4.47E+00	2.03E+00	4.78E-02	2.17E-02
6.00	152.40	5442.7712	17.17	8.34E-02	5.13E+00	2.33E+00	4.72E-02	2.14E-02
6.25	158.75	5572.361	17.578	9.43E-02	5.80E+00	2.63E+00	4.66E-02	2.12E-02
6.50	165.10	5701.9508	17.987	1.06E-01	6.49E+00	2.94E+00	4.61E-02	2.09E-02
6.75	171.45	5831.5406	18.396	1.17E-01	7.20E+00	3.26E+00	4.55E-02	2.06E-02
7.00	177.80	5961.1304	18.805	1.29E-01	7.92E+00	3.59E+00	4.49E-02	2.04E-02
7.25	184.15	6090.7202	19.214	1.41E-01	8.66E+00	3.93E+00	4.43E-02	2.01E-02
7.50	190.50	6220.31	19.622	1.53E-01	9.41E+00	4.27E+00	4.36E-02	1.98E-02
7.75	196.85	6349.8998	20.031	1.65E-01	1.02E+01	4.62E+00	4.30E-02	1.95E-02
8.00	203.20	6479.4896	20.44	1.78E-01	1.10E+01	4.97E+00	4.23E-02	1.92E-02
8.25	209.55	6609.0794	20.849	1.91E-01	1.18E+01	5.34E+00	4.17E-02	1.89E-02
8.50	215.90	6738.6691	21.258	2.04E-01	1.26E+01	5.70E+00	4.10E-02	1.86E-02
8.75	222.25	6868.2589	21.666	2.18E-01	1.34E+01	6.08E+00	4.03E-02	1.83E-02
9.00	228.60	6997.8487	22.075	2.32E-01	1.43E+01	6.47E+00	3.96E-02	1.79E-02
9.25	234.95	6609.0794	20.849	2.45E-01	1.51E+01	6.84E+00	3.89E-02	1.76E-02
9.50	241.30	6220.31	19.622	2.58E-01	1.59E+01	7.20E+00	3.82E-02	1.73E-02
9.75	247.65	5831.5406	18.396	2.70E-01	1.66E+01	7.53E+00	3.76E-02	1.71E-02
10.00	254.00	5442.7712	17.17	2.81E-01	1.73E+01	7.85E+00	3.70E-02	1.68E-02
10.25	260.35	5054.0019	15.943	2.92E-01	1.79E+01	8.14E+00	3.65E-02	1.65E-02
10.50	266.70	4665.2325	14.717	3.01E-01	1.85E+01	8.41E+00	3.60E-02	1.63E-02
10.75	273.05	4276.4631	13.49	3.10E-01	1.91E+01	8.66E+00	3.55E-02	1.61E-02
11.00	279.40	3887.6937	12.264	3.18E-01	1.96E+01	8.88E+00	3.51E-02	1.59E-02
11.25	285.75	3498.9244	11.038	3.26E-01	2.00E+01	9.09E+00	3.47E-02	1.58E-02
11.50	292.10	3110.155	9.8112	3.32E-01	2.04E+01	9.27E+00	3.44E-02	1.56E-02
11.75	298.45	2721.3856	8.5848	3.38E-01	2.08E+01	9.43E+00	3.41E-02	1.55E-02
12.00	304.80	2332.6162	7.3584	3.43E-01	2.11E+01	9.57E+00	3.38E-02	1.53E-02

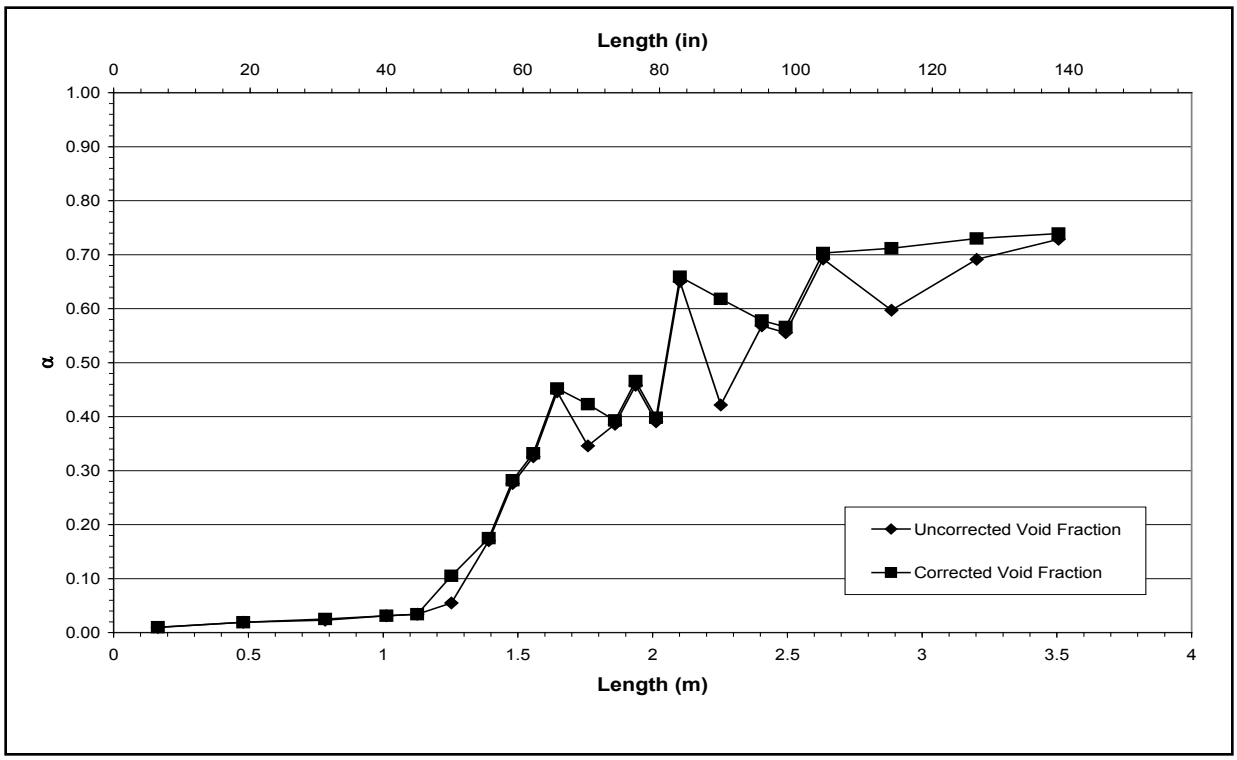

Figure A-645 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679B for Time Period 2174 to 2234 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-C

Test Conditions

Date: 7/21/2003
Steady-state time window: 1980 – 2070 seconds
Inlet flow rate: 1.532 cm/sec (0.603 in./sec)
Inlet mass flow rate: 0.073 kg/sec (0.161 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

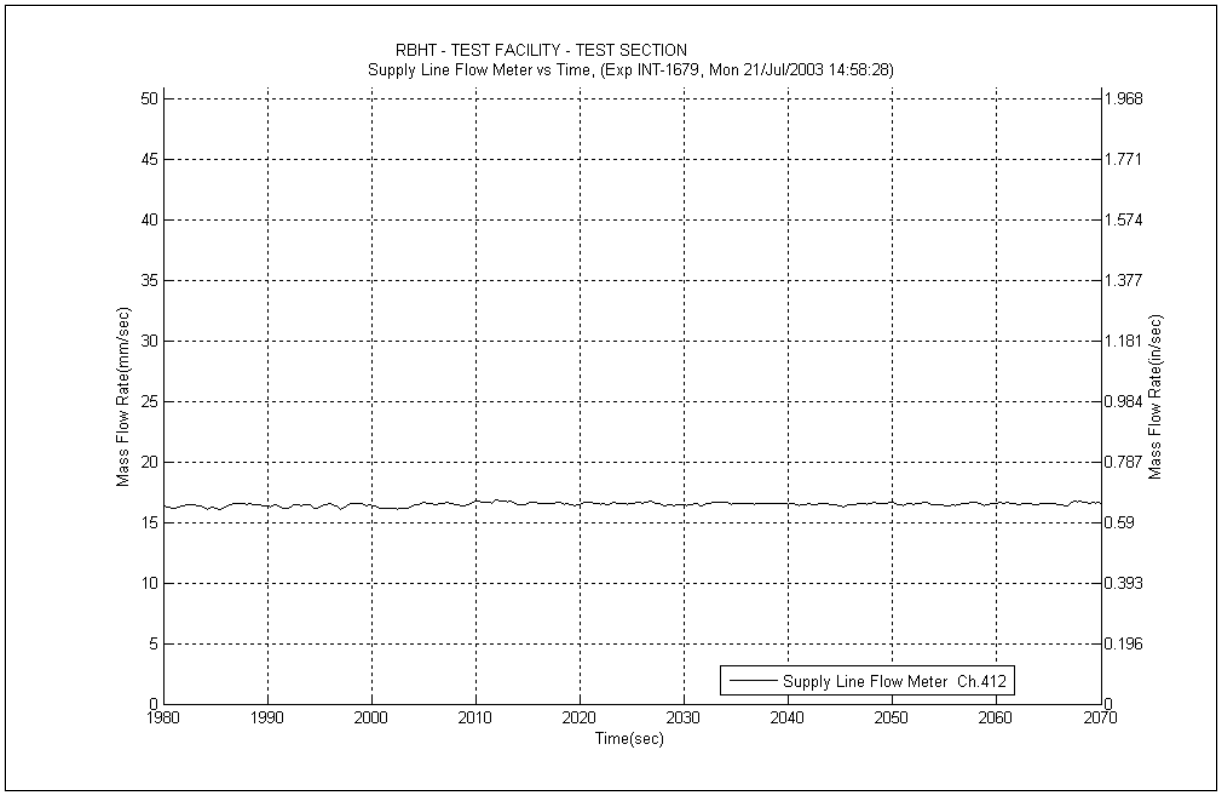

Figure A-646 Inlet Flow Plot for Experiment 1679C

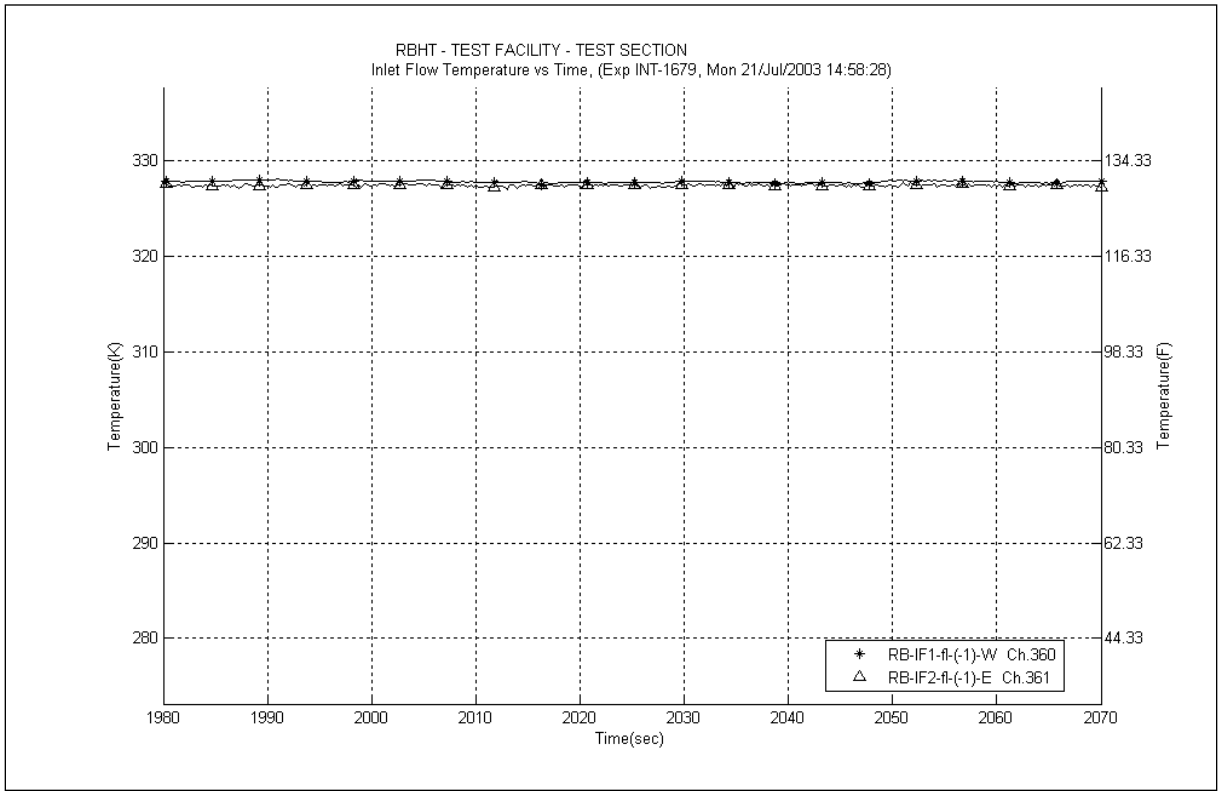

Figure A-647 Inlet Temperature Plot for Experiment 1679C

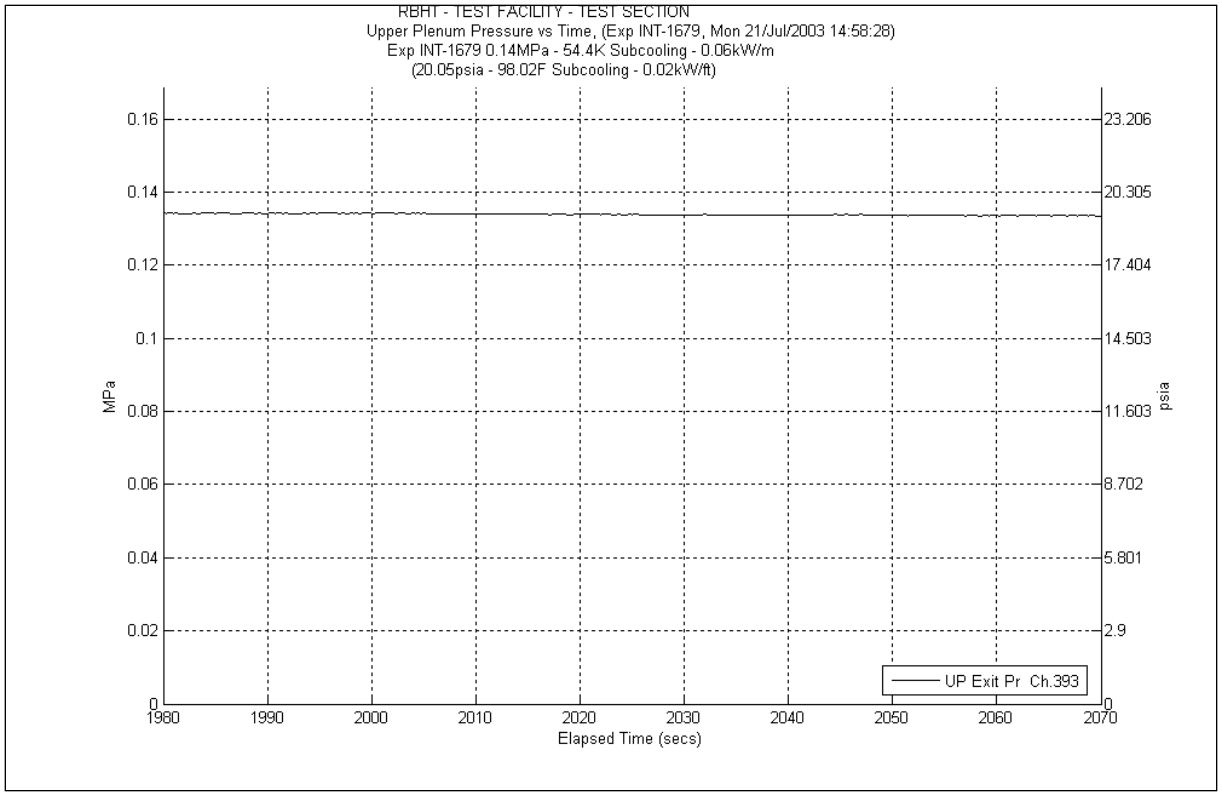

Figure A-648 System Pressure Plot for Experiment 1679C

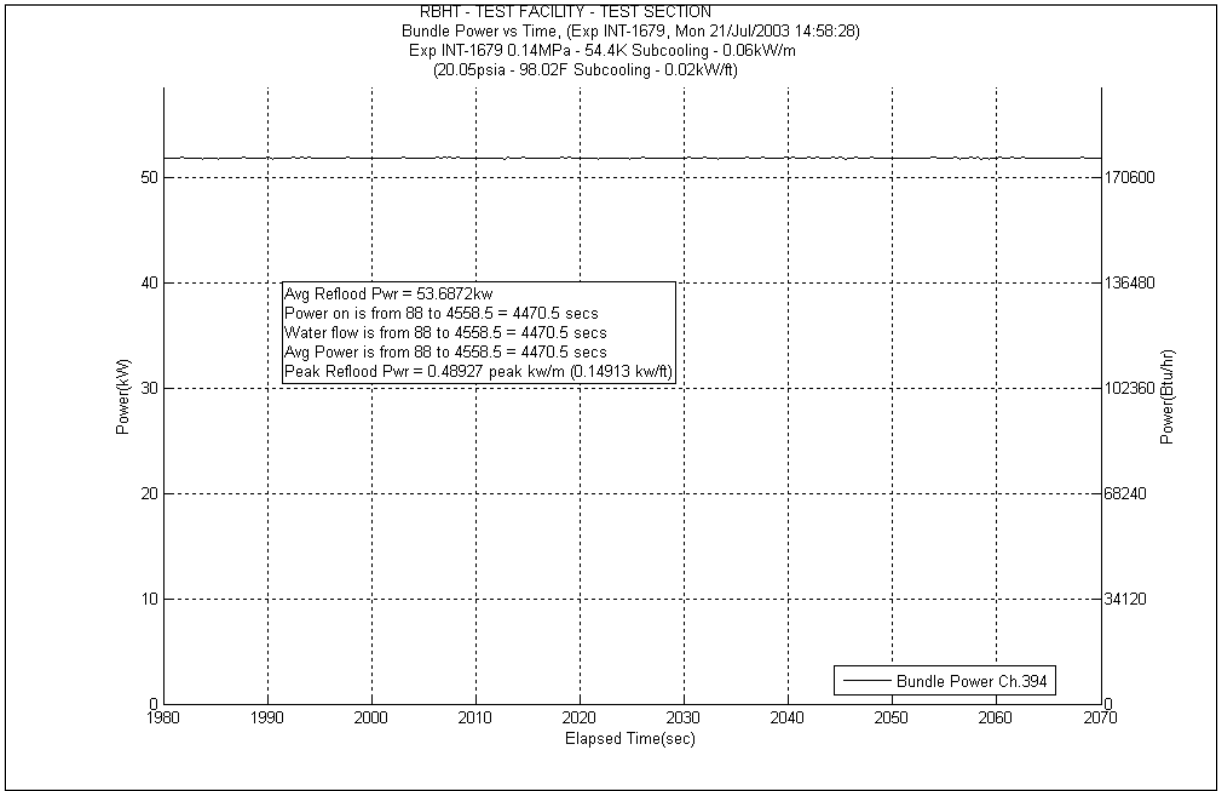

Figure A-649 Bundle Power Plot for Experiment 1679C

Table A-259: Data Results for RBHT Test 1679 for Time Period 1980 to 2070

Results for RBHT Test 1679
Valid Time Period 1980 to 2070 seconds
Collapsed Liquid Level = 93.116 inches = 2365.13 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.726	15.668	750.201	0.468	22.408	0.131	6.272	0.000	0.000	15.06	721.077	2895.06	138616.2168	0.736	0.732	0.740
*	120-133	3048-3378	383	0.689	21.028	1006.816	0.513	24.563	0.233	11.156	1.892	90.580	18.39	880.518	2913.45	139496.7348	0.728	0.724	0.732
*	108-120	2743-3048	382	0.594	25.312	1211.959	0.419	20.062	0.291	13.933	6.552	313.725	18.05	864.239	2931.5	140360.9734	0.71	0.706	0.714
	100-108	2540-2743	381	0.691	12.853	615.428	0.244	11.683	0.213	10.198	0.000	0.000	12.39	593.236	2943.89	140954.2098	0.702	0.698	0.706
	97-100	2464-2540	380	0.553	6.964	333.450	0.084	4.022	0.077	3.687	0.000	0.000	6.802	325.682	2950.692	141279.8913	0.563	0.560	0.566
	93-97	2362-2464	379	0.568	8.984	430.178	0.105	5.027	0.100	4.788	0.000	0.000	8.777	420.245	2959.469	141700.1363	0.577	0.574	0.580
*	85-93	2159-2362	378	0.419	24.133	1155.514	0.188	9.001	0.193	9.241	7.792	373.102	15.96	764.169	2975.429	142464.3052	0.616	0.613	0.619
	81-85	2057-2159	377	0.646	7.364	352.597	0.083	3.974	0.092	4.405	0.000	0.000	7.185	344.020	2982.614	142808.3249	0.654	0.651	0.657
	78-81	1981-2057	376	0.382	9.623	460.763	0.058	2.777	0.067	3.208	0.000	0.000	9.493	454.527	2992.107	143262.8521	0.391	0.389	0.393
	75-78	1905-1981	375	0.452	8.533	408.545	0.054	2.586	0.066	3.160	0.000	0.000	8.409	402.625	3000.516	143665.4772	0.46	0.458	0.462
	72-75	1829-1905	374	0.372	9.779	468.223	0.049	2.346	0.064	3.064	0.000	0.000	9.66	462.523	3010.176	144128.0005	0.38	0.378	0.382
*	67-72	1702-1829	373	0.341	17.122	819.825	0.073	3.495	0.104	4.980	1.495	71.601	15.45	739.750	3025.626	144867.7505	0.405	0.403	0.407
	63-67	1600-1702	372	0.424	11.976	573.405	0.050	2.394	0.080	3.830	0.000	0.000	11.84	566.902	3037.466	145434.6527	0.43	0.428	0.432
	60-63	1524-1600	371	0.326	10.501	502.786	0.032	1.532	0.058	2.777	0.000	0.000	10.41	498.433	3047.876	145933.0862	0.332	0.330	0.334
	57-60	1448-1524	370	0.253	11.638	557.243	0.028	1.341	0.057	2.729	0.000	0.000	11.55	553.017	3059.426	146486.1032	0.258	0.257	0.259
	53-57	1346-1448	369	0.140	17.865	855.383	0.029	1.389	0.073	3.495	0.000	0.000	17.76	850.353	3077.186	147336.4565	0.145	0.144	0.146
*	46-53	1168-1346	368	0.048	34.598	1656.559	0.027	1.293	0.113	5.410	1.358	65.020	33.1	1584.837	3110.286	148921.293	0.089	0.085	0.093
	43-46	1092-1168	367	0.033	15.061	721.108	0.000	0.000	0.000	0.000	0.000	0.000	15.06	721.077	3125.346	149642.3697	0.033	0.031	0.035
	37-43	940-1092	366	0.031	30.199	1445.946	0.001	0.048	0.000	0.000	0.000	0.000	30.19	1445.505	3155.536	151087.8747	0.031	0.029	0.033
*	25-37	635-940	365	0.023	60.892	2915.515	0.001	0.048	0.000	0.000	0.141	6.741	60.75	2908.726	3216.286	153996.6003	0.025	0.024	0.026
	13-25	330-635	364	0.019	61.136	2927.202	0.001	0.048	0.000	0.000	0.000	0.000	61.11	2925.963	3277.396	156922.5628	0.019	0.018	0.020
*	0-13	0-330	363	0.010	66.869	3201.720	0.002	0.096	0.000	0.000	0.017	0.829	66.85	3200.795	3344.246	160123.358	0.01	0.010	0.011

Table A-260 Energy Balance Results for RBHT Test 1679C for Time Period 1980 to 2070 seconds

Results for RBHT Test 1679
Valid Time Period 1980 to 2070 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2331.9295	7.3562	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.25	6.35	2461.4812	7.7649	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.50	12.70	2591.0328	8.1736	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.75	19.05	2720.5845	8.5823	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.00	25.40	2850.1361	8.991	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.25	31.75	2979.6877	9.3996	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.50	38.10	3109.2394	9.8083	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.75	44.45	3238.791	10.217	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.00	50.80	3368.3427	10.626	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.25	57.15	3497.8943	11.034	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.50	63.50	3627.4459	11.443	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.75	69.85	3756.9976	11.852	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
3.00	76.20	3886.5492	12.26	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
3.25	82.55	4016.1009	12.669	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
3.50	88.90	4145.6525	13.078	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
3.75	95.25	4275.2041	13.486	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
4.00	101.60	4404.7558	13.895	4.18E-03	2.58E-01	1.17E-01	5.16E-02	2.34E-02
4.25	107.95	4534.3074	14.304	1.30E-02	8.04E-01	3.65E-01	5.11E-02	2.32E-02
4.50	114.30	4663.8591	14.712	2.21E-02	1.37E+00	6.19E-01	5.06E-02	2.30E-02
4.75	120.65	4793.4107	15.121	3.15E-02	1.94E+00	8.81E-01	5.02E-02	2.28E-02
5.00	127.00	4922.9623	15.53	4.11E-02	2.54E+00	1.15E+00	4.97E-02	2.25E-02
5.25	133.35	5052.514	15.939	5.09E-02	3.15E+00	1.43E+00	4.92E-02	2.23E-02
5.50	139.70	5182.0656	16.347	6.11E-02	3.77E+00	1.71E+00	4.86E-02	2.21E-02
5.75	146.05	5311.6173	16.756	7.14E-02	4.41E+00	2.00E+00	4.81E-02	2.18E-02
6.00	152.40	5441.1689	17.165	8.21E-02	5.07E+00	2.30E+00	4.75E-02	2.16E-02
6.25	158.75	5570.7205	17.573	9.29E-02	5.74E+00	2.60E+00	4.70E-02	2.13E-02
6.50	165.10	5700.2722	17.982	1.04E-01	6.43E+00	2.92E+00	4.64E-02	2.10E-02
6.75	171.45	5829.8238	18.391	1.16E-01	7.13E+00	3.24E+00	4.58E-02	2.08E-02
7.00	177.80	5959.3755	18.799	1.27E-01	7.85E+00	3.56E+00	4.52E-02	2.05E-02
7.25	184.15	6088.9271	19.208	1.39E-01	8.58E+00	3.89E+00	4.46E-02	2.02E-02
7.50	190.50	6218.4787	19.617	1.51E-01	9.34E+00	4.24E+00	4.40E-02	1.99E-02
7.75	196.85	6348.0304	20.025	1.64E-01	1.01E+01	4.58E+00	4.33E-02	1.96E-02
8.00	203.20	6477.582	20.434	1.76E-01	1.09E+01	4.94E+00	4.27E-02	1.93E-02
8.25	209.55	6607.1337	20.843	1.89E-01	1.17E+01	5.30E+00	4.20E-02	1.90E-02
8.50	215.90	6736.6853	21.251	2.02E-01	1.25E+01	5.67E+00	4.13E-02	1.87E-02
8.75	222.25	6866.2369	21.66	2.16E-01	1.33E+01	6.05E+00	4.06E-02	1.84E-02
9.00	228.60	6995.7886	22.069	2.30E-01	1.42E+01	6.43E+00	3.99E-02	1.81E-02
9.25	234.95	6607.1337	20.843	2.43E-01	1.50E+01	6.81E+00	3.92E-02	1.78E-02
9.50	241.30	6218.4787	19.617	2.56E-01	1.58E+01	7.16E+00	3.85E-02	1.75E-02
9.75	247.65	5829.8238	18.391	2.68E-01	1.65E+01	7.50E+00	3.79E-02	1.72E-02
10.00	254.00	5441.1689	17.165	2.79E-01	1.72E+01	7.81E+00	3.73E-02	1.69E-02
10.25	260.35	5052.514	15.939	2.89E-01	1.79E+01	8.10E+00	3.68E-02	1.67E-02
10.50	266.70	4663.8591	14.712	2.99E-01	1.85E+01	8.37E+00	3.63E-02	1.65E-02
10.75	273.05	4275.2041	13.486	3.08E-01	1.90E+01	8.62E+00	3.59E-02	1.63E-02
11.00	279.40	3886.5492	12.26	3.16E-01	1.95E+01	8.84E+00	3.54E-02	1.61E-02
11.25	285.75	3497.8943	11.034	3.23E-01	1.99E+01	9.05E+00	3.51E-02	1.59E-02
11.50	292.10	3109.2394	9.8083	3.30E-01	2.04E+01	9.23E+00	3.47E-02	1.58E-02
11.75	298.45	2720.5845	8.5823	3.35E-01	2.07E+01	9.39E+00	3.44E-02	1.56E-02
12.00	304.80	2331.9295	7.3562	3.40E-01	2.10E+01	9.53E+00	3.42E-02	1.55E-02

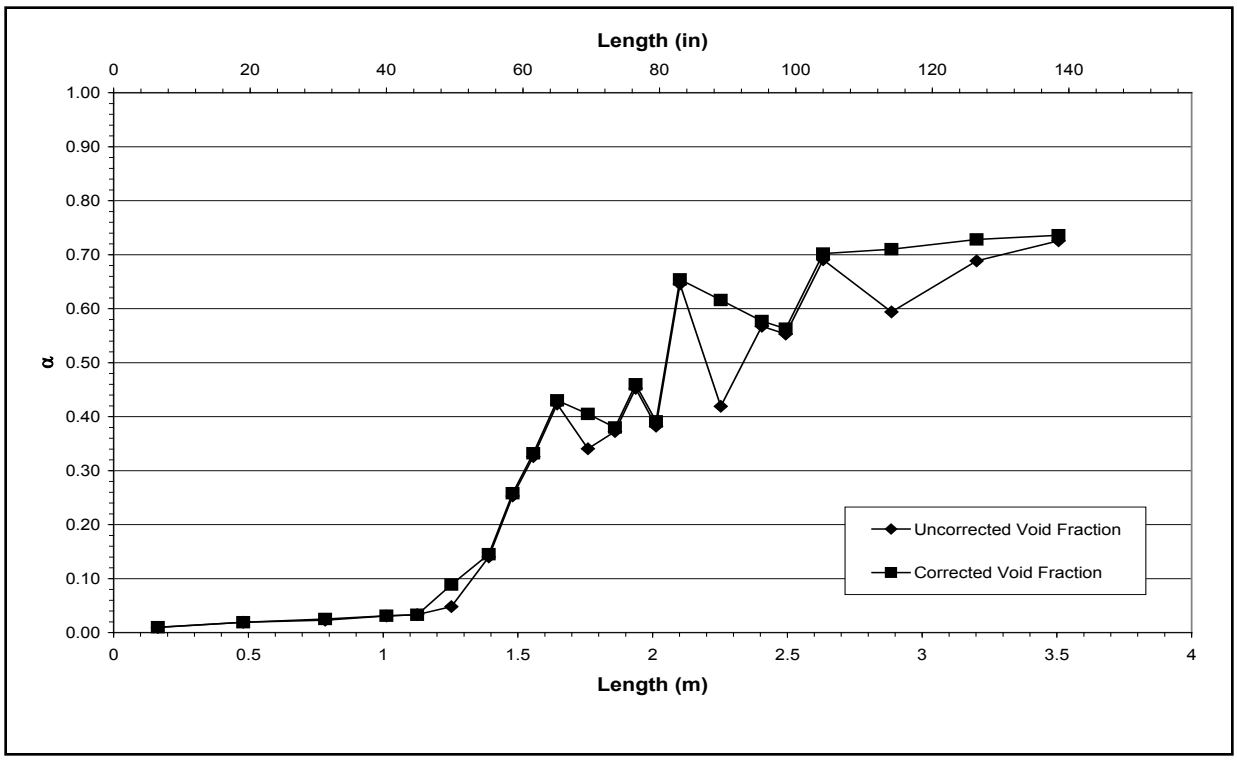

Figure A-650 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679C for Time Period 1980 to 2070 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-D

Test Conditions

Date: 7/21/2003
Steady-state time window: 2540 – 2720 seconds
Inlet flow rate: 1.011 cm/sec (0.398 in./sec)
Inlet mass flow rate: 0.048 kg/sec (0.106 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

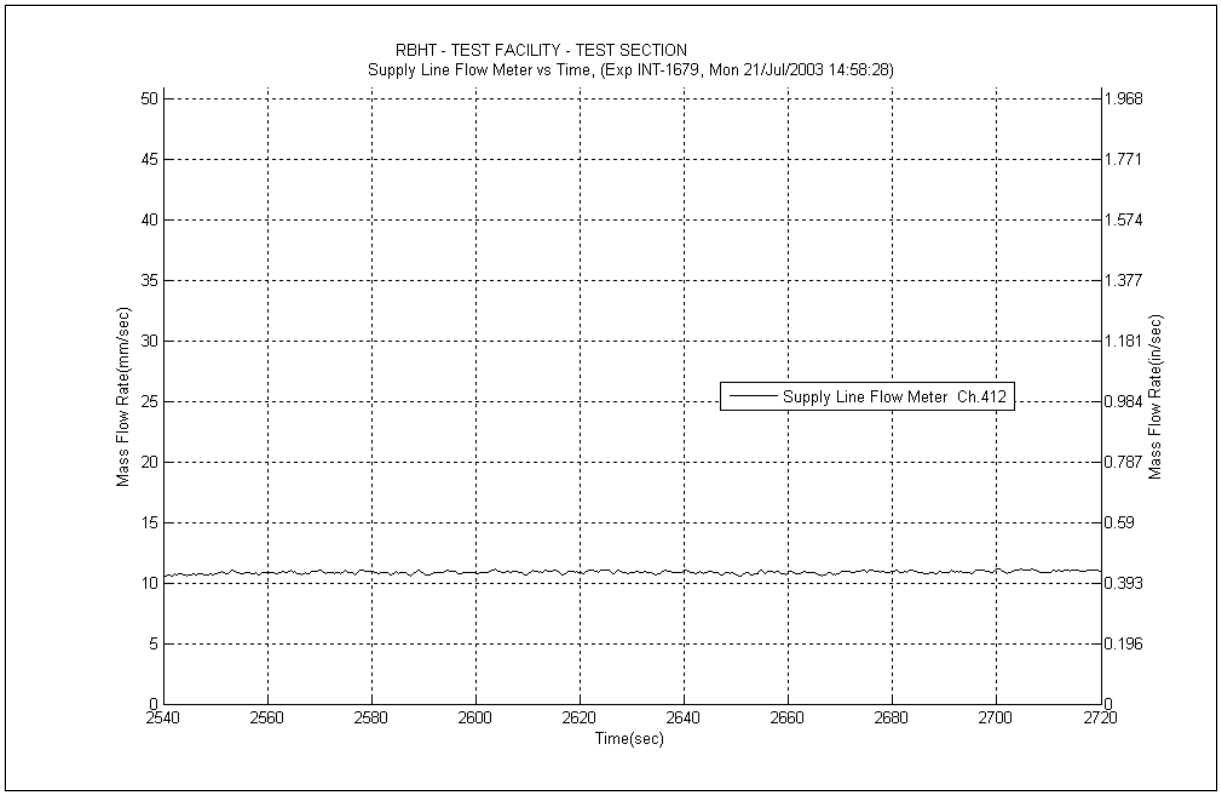

Figure A-651 Inlet Flow Plot for Experiment 1679D

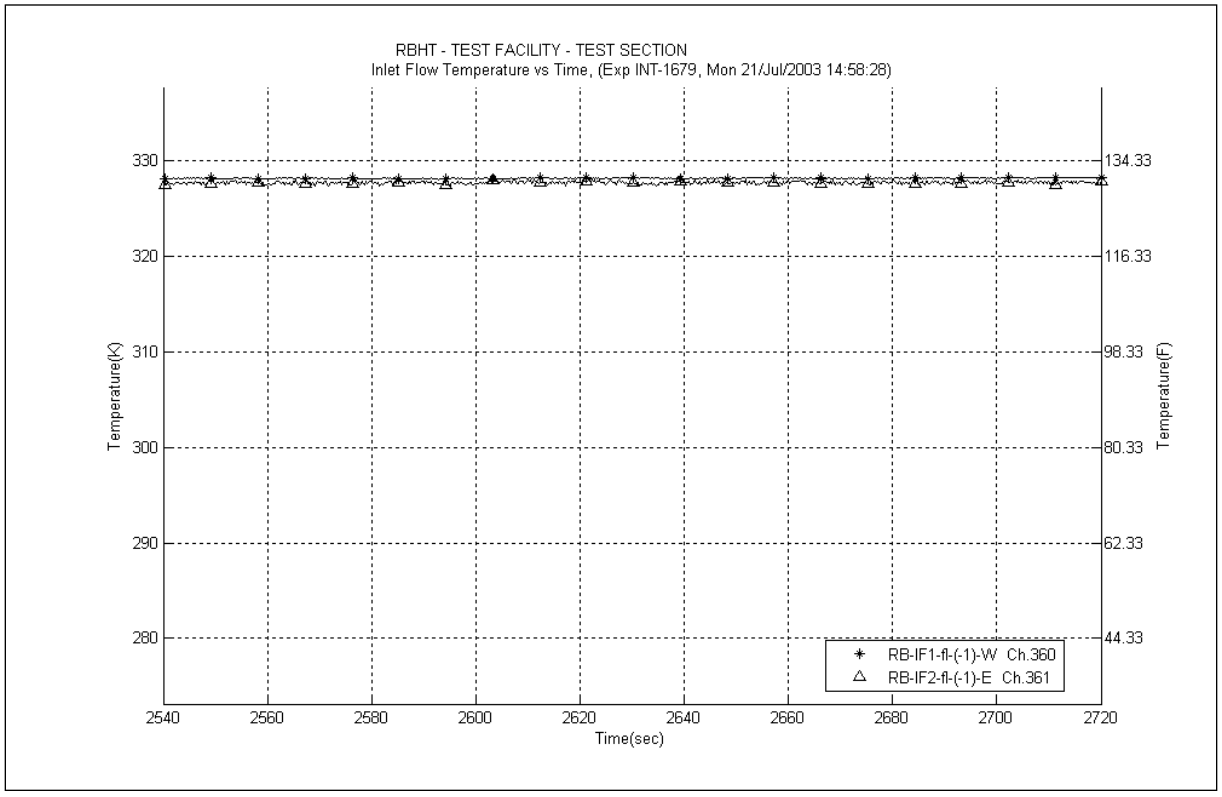

Figure A-652 Inlet Temperature Plot for Experiment 1679D

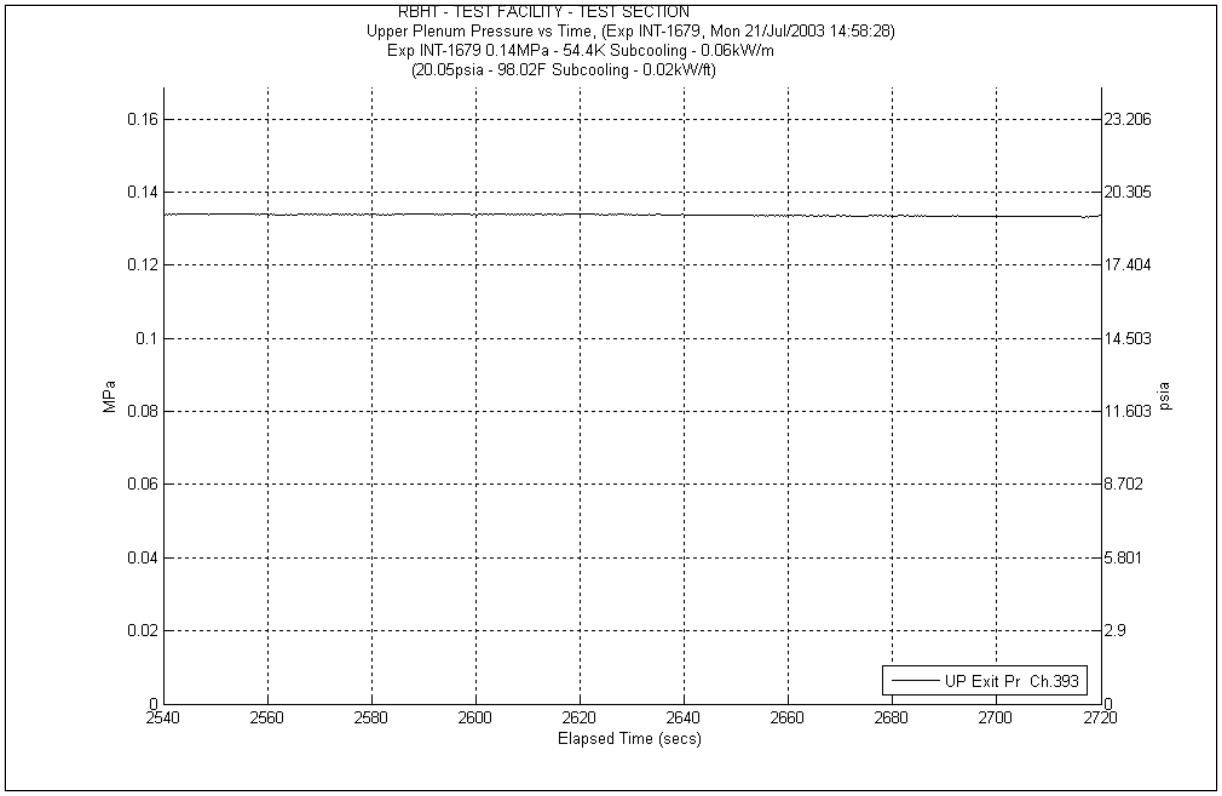

Figure A-653 System Pressure Plot for Experiment 1679D

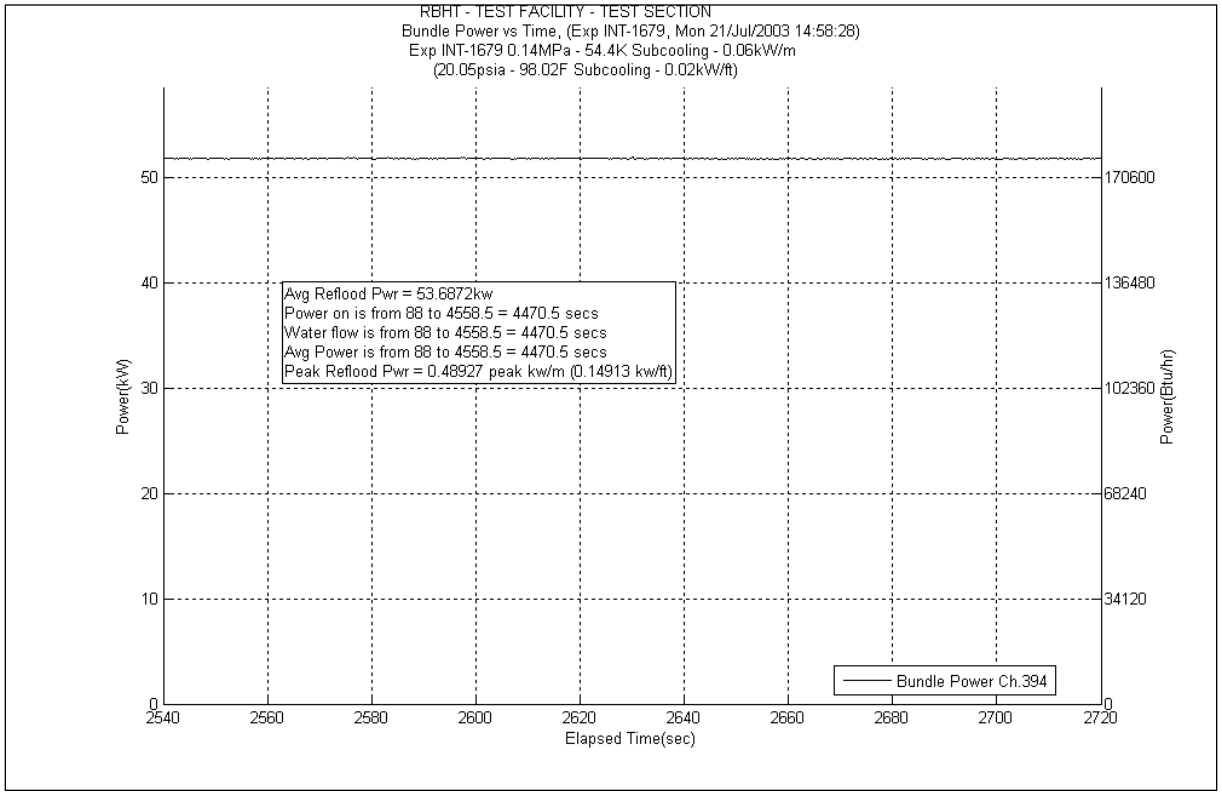

Figure A-654 Bundle Power Plot for Experiment 1679D

Table A-261 Data Results for RBHT Test 1679 for Time Period 2540 to 2720

Results for RBHT Test 1679
Valid Time Period 2540 to 2720 seconds
Collapsed Liquid Level = 83.861 inches = 2130.07 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.788	12.116	580.119	0.330	15.800	0.086	4.118	0.000	0.000	11.69	559.720	2891.69	138454.8604	0.795	0.791	0.799
*	120-133	3048-3378	383	0.743	17.366	831.512	0.361	17.285	0.154	7.374	2.161	103.493	14.69	703.361	2906.38	139158.2213	0.782	0.778	0.786
*	108-120	2743-3048	382	0.648	21.921	1049.585	0.296	14.173	0.192	9.193	6.283	300.834	15.15	725.386	2921.53	139883.6072	0.757	0.753	0.761
	100-108	2540-2743	381	0.736	10.953	524.420	0.174	8.331	0.141	6.751	0.000	0.000	10.63	508.967	2932.16	140392.5744	0.744	0.740	0.748
	97-100	2464-2540	380	0.635	5.692	272.529	0.060	2.873	0.051	2.442	0.000	0.000	5.581	267.220	2937.741	140659.7941	0.642	0.639	0.645
	93-97	2362-2464	379	0.635	7.593	363.538	0.076	3.639	0.066	3.160	0.000	0.000	7.448	356.612	2945.189	141016.4062	0.641	0.638	0.644
*	85-93	2159-2362	378	0.459	22.487	1076.689	0.138	6.607	0.127	6.081	8.852	423.842	13.37	640.159	2958.559	141656.5653	0.678	0.675	0.681
	81-85	2057-2159	377	0.709	6.050	289.687	0.062	2.969	0.061	2.921	0.000	0.000	5.925	283.691	2964.484	141940.2558	0.715	0.711	0.719
	78-81	1981-2057	376	0.471	8.247	394.869	0.043	2.059	0.045	2.155	0.000	0.000	8.157	390.559	2972.641	142330.815	0.476	0.474	0.478
	75-78	1905-1981	375	0.519	7.489	358.565	0.041	1.963	0.044	2.107	0.000	0.000	7.4	354.314	2980.041	142685.129	0.525	0.522	0.528
	72-75	1829-1905	374	0.479	8.122	388.901	0.039	1.867	0.043	2.059	0.000	0.000	8.04	384.957	2988.081	143070.0862	0.484	0.482	0.486
*	67-72	1702-1829	373	0.393	15.751	754.180	0.059	2.825	0.069	3.304	3.653	174.924	11.97	573.127	3000.051	143643.2129	0.539	0.536	0.542
	63-67	1600-1702	372	0.589	8.538	408.794	0.042	2.011	0.053	2.538	0.000	0.000	8.437	403.966	3008.488	144047.1786	0.594	0.591	0.597
	60-63	1524-1600	371	0.408	9.218	441.368	0.029	1.389	0.039	1.867	0.000	0.000	9.147	437.961	3017.635	144485.1393	0.413	0.411	0.415
	57-60	1448-1524	370	0.374	9.748	466.731	0.027	1.293	0.038	1.819	0.000	0.000	9.681	463.529	3027.316	144948.6681	0.378	0.376	0.380
	53-57	1346-1448	369	0.356	13.388	641.040	0.032	1.532	0.048	2.298	0.000	0.000	13.31	637.286	3040.626	145585.9543	0.359	0.357	0.361
*	46-53	1168-1346	368	0.251	27.218	1303.216	0.045	2.155	0.081	3.878	3.032	145.185	24.06	1151.999	3064.686	146737.9533	0.338	0.336	0.340
	43-46	1092-1168	367	0.314	10.693	511.987	0.015	0.718	0.033	1.580	0.000	0.000	10.64	509.446	3075.326	147247.3992	0.317	0.315	0.319
	37-43	940-1092	366	0.128	27.166	1300.730	0.021	1.005	0.063	3.016	0.000	0.000	27.07	1296.119	3102.396	148543.5178	0.131	0.130	0.132
*	25-37	635-940	365	0.033	60.237	2884.184	0.018	0.862	0.037	1.772	2.712	129.872	57.47	2751.678	3159.866	151295.1962	0.078	0.074	0.082
	13-25	330-635	364	0.024	60.814	2911.785	0.001	0.048	0.000	0.000	0.000	0.000	60.79	2910.641	3220.656	154205.837	0.024	0.023	0.025
*	0-13	0-330	363	0.011	66.750	3196.001	0.001	0.048	0.000	0.000	0.079	3.776	66.67	3192.177	3287.326	157398.0137	0.012	0.011	0.013

Table A-262 Energy Balance Results for RBHT Test 1679D for Time Period 2540 to 2720 seconds

Results for RBHT Test 1679
Valid Time Period 2540 to 2720 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2333.9311	7.3626	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
0.25	6.35	2463.5939	7.7716	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
0.50	12.70	2593.2567	8.1806	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
0.75	19.05	2722.9196	8.5896	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
1.00	25.40	2852.5824	8.9987	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
1.25	31.75	2982.2453	9.4077	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
1.50	38.10	3111.9081	9.8167	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
1.75	44.45	3241.5709	10.226	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
2.00	50.80	3371.2338	10.635	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
2.25	57.15	3500.8966	11.044	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
2.50	63.50	3630.5594	11.453	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
2.75	69.85	3760.2223	11.862	0.00E+00	0.00E+00	0.00E+00	3.41E-02	1.55E-02
3.00	76.20	3889.8851	12.271	1.03E-02	4.20E-01	1.91E-01	3.38E-02	1.53E-02
3.25	82.55	4019.548	12.68	2.22E-02	9.04E-01	4.10E-01	3.34E-02	1.51E-02
3.50	88.90	4149.2108	13.089	3.44E-02	1.40E+00	6.36E-01	3.30E-02	1.50E-02
3.75	95.25	4278.8736	13.498	4.70E-02	1.92E+00	8.70E-01	3.25E-02	1.48E-02
4.00	101.60	4408.5365	13.907	6.01E-02	2.45E+00	1.11E+00	3.21E-02	1.46E-02
4.25	107.95	4538.1993	14.316	7.35E-02	3.00E+00	1.36E+00	3.16E-02	1.44E-02
4.50	114.30	4667.8621	14.725	8.73E-02	3.56E+00	1.61E+00	3.12E-02	1.41E-02
4.75	120.65	4797.525	15.134	1.02E-01	4.14E+00	1.88E+00	3.07E-02	1.39E-02
5.00	127.00	4927.1878	15.543	1.16E-01	4.73E+00	2.15E+00	3.02E-02	1.37E-02
5.25	133.35	5056.8507	15.952	1.31E-01	5.34E+00	2.42E+00	2.97E-02	1.35E-02
5.50	139.70	5186.5135	16.361	1.46E-01	5.97E+00	2.71E+00	2.91E-02	1.32E-02
5.75	146.05	5316.1763	16.77	1.62E-01	6.61E+00	3.00E+00	2.86E-02	1.30E-02
6.00	152.40	5445.8392	17.179	1.78E-01	7.27E+00	3.30E+00	2.81E-02	1.27E-02
6.25	158.75	5575.502	17.588	1.95E-01	7.94E+00	3.60E+00	2.75E-02	1.25E-02
6.50	165.10	5705.1648	17.997	2.12E-01	8.63E+00	3.92E+00	2.69E-02	1.22E-02
6.75	171.45	5834.8277	18.406	2.29E-01	9.34E+00	4.24E+00	2.63E-02	1.19E-02
7.00	177.80	5964.4905	18.815	2.47E-01	1.01E+01	4.56E+00	2.57E-02	1.17E-02
7.25	184.15	6094.1534	19.224	2.65E-01	1.08E+01	4.90E+00	2.51E-02	1.14E-02
7.50	190.50	6223.8162	19.633	2.83E-01	1.15E+01	5.24E+00	2.45E-02	1.11E-02
7.75	196.85	6353.479	20.043	3.02E-01	1.23E+01	5.59E+00	2.38E-02	1.08E-02
8.00	203.20	6483.1419	20.452	3.21E-01	1.31E+01	5.94E+00	2.32E-02	1.05E-02
8.25	209.55	6612.8047	20.861	3.41E-01	1.39E+01	6.31E+00	2.25E-02	1.02E-02
8.50	215.90	6742.4675	21.27	3.61E-01	1.47E+01	6.68E+00	2.18E-02	9.90E-03
8.75	222.25	6872.1304	21.679	3.81E-01	1.56E+01	7.05E+00	2.11E-02	9.58E-03
9.00	228.60	7001.7932	22.088	4.02E-01	1.64E+01	7.44E+00	2.04E-02	9.26E-03
9.25	234.95	6612.8047	20.861	4.23E-01	1.72E+01	7.82E+00	1.97E-02	8.94E-03
9.50	241.30	6223.8162	19.633	4.42E-01	1.80E+01	8.17E+00	1.91E-02	8.65E-03
9.75	247.65	5834.8277	18.406	4.60E-01	1.88E+01	8.51E+00	1.84E-02	8.37E-03
10.00	254.00	5445.8392	17.179	4.77E-01	1.94E+01	8.82E+00	1.79E-02	8.10E-03
10.25	260.35	5056.8507	15.952	4.93E-01	2.01E+01	9.11E+00	1.73E-02	7.86E-03
10.50	266.70	4667.8621	14.725	5.07E-01	2.07E+01	9.38E+00	1.68E-02	7.63E-03
10.75	273.05	4278.8736	13.498	5.21E-01	2.12E+01	9.63E+00	1.64E-02	7.43E-03
11.00	279.40	3889.8851	12.271	5.33E-01	2.17E+01	9.86E+00	1.60E-02	7.24E-03
11.25	285.75	3500.8966	11.044	5.44E-01	2.22E+01	1.01E+01	1.56E-02	7.06E-03
11.50	292.10	3111.9081	9.8167	5.54E-01	2.26E+01	1.02E+01	1.52E-02	6.91E-03
11.75	298.45	2722.9196	8.5896	5.63E-01	2.29E+01	1.04E+01	1.49E-02	6.78E-03
12.00	304.80	2333.9311	7.3626	5.70E-01	2.32E+01	1.05E+01	1.47E-02	6.66E-03

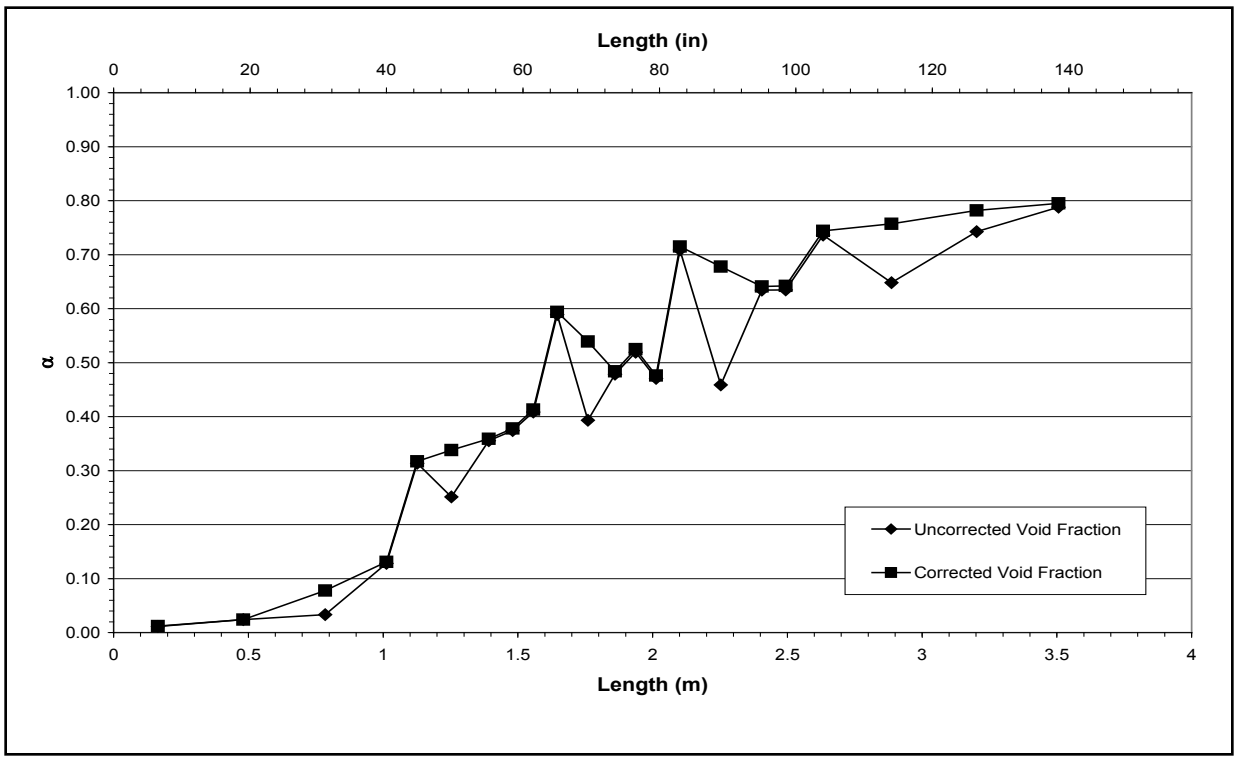

Figure A-655 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679D for Time Period 2540 to 2720 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-E

Test Conditions

Date: 7/21/2003
Steady-state time window: 3540 – 3960 seconds
Inlet flow rate: 0.508 cm/sec (0.200 in./sec)
Inlet mass flow rate: 0.024 kg/sec (0.053 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

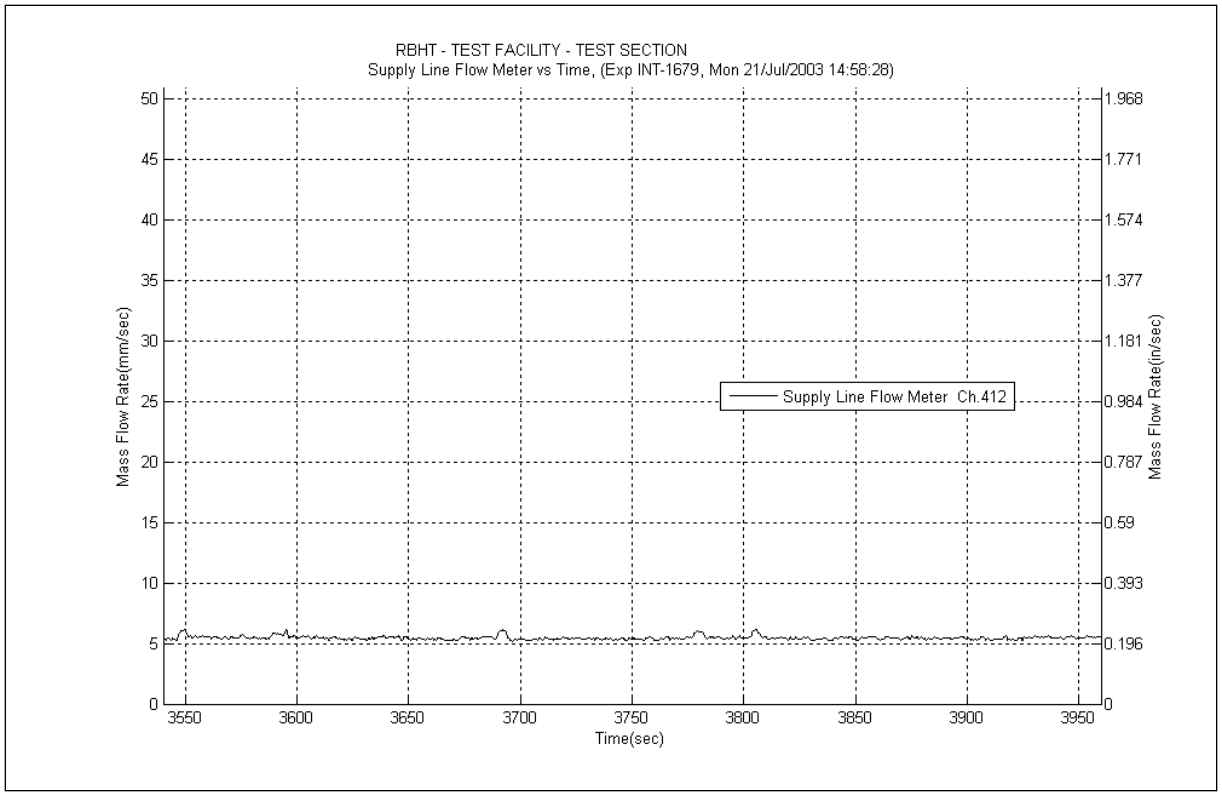

Figure A-656 Inlet Flow Plot for Experiment 1679E

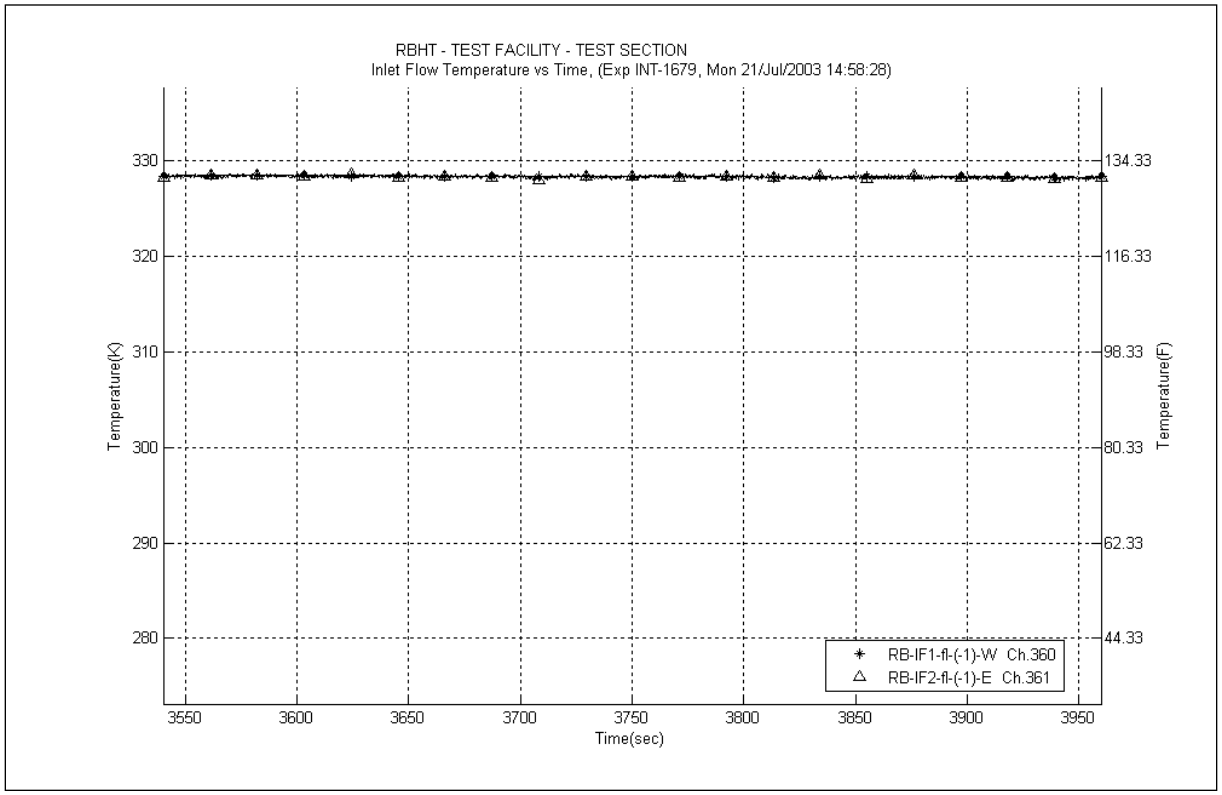

Figure A-657 Inlet Temperature Plot for Experiment 1679E

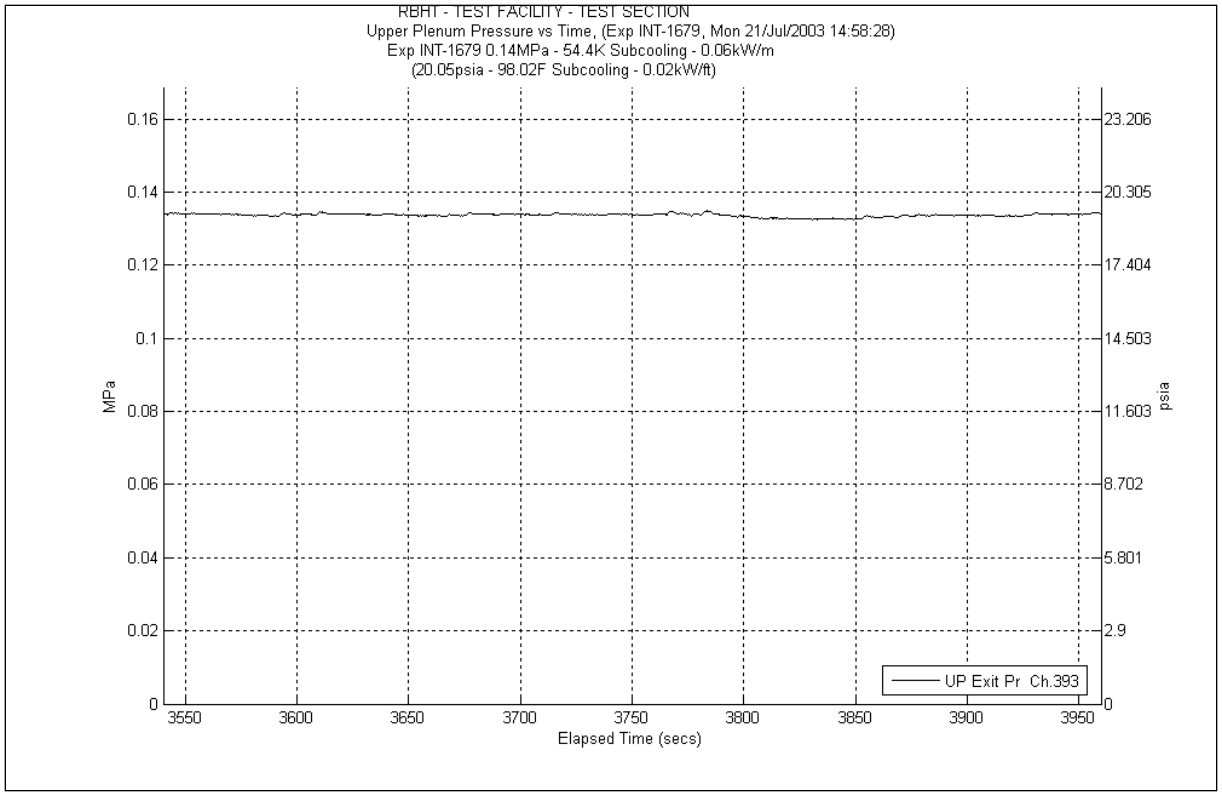

Figure A-658 System Pressure Plot for Experiment 1679E

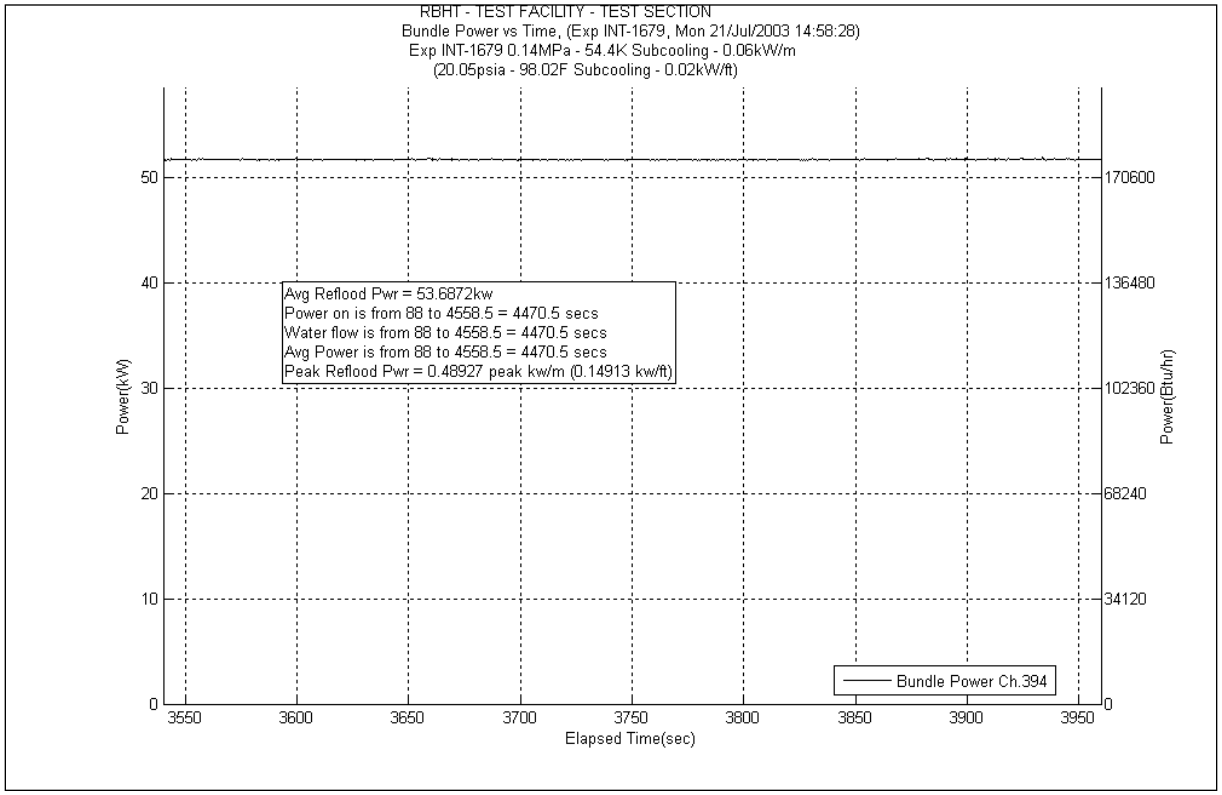

Figure A-659 Bundle Power Plot for Experiment 1679E

Table A-263 Data Results for RBHT Test 1679 for Time Period 3540 to 3960

Results for RBHT Test 1679
Valid Time Period 3540 to 3960 seconds
Collapsed Liquid Level = 66.429 inches = 1687.29 mm
(Z_{osv}) Onset of Significant Void = 19 inches = 482.5 mm
($Z_{2\phi}$) Two-Phase Level (Dryout) = 127.40 inches = 3235.96 mm
(S) Level Swell = 2.273

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.968	1.833	87.776	0.080	3.830	0.000	0.000	0.000	0.000	1.751	83.838	2881.751	137978.9785	0.969	0.964	0.974
*	120-133	3048-3378	383	0.928	4.840	231.749	0.095	4.549	0.000	0.000	0.549	26.295	4.196	200.906	2885.947	138179.884	0.938	0.933	0.943
*	108-120	2743-3048	382	0.826	10.854	519.695	0.141	6.751	0.063	3.016	2.849	136.414	7.801	373.514	2893.748	138553.3979	0.875	0.871	0.879
	100-108	2540-2743	381	0.839	6.673	319.525	0.091	4.357	0.071	3.399	0.000	0.000	6.509	311.653	2900.257	138865.0505	0.843	0.839	0.847
	97-100	2464-2540	380	0.767	3.625	173.563	0.032	1.532	0.026	1.245	0.000	0.000	3.565	170.693	2903.822	139035.7436	0.771	0.767	0.775
	93-97	2362-2464	379	0.759	5.001	239.458	0.041	1.963	0.033	1.580	0.000	0.000	4.923	235.715	2908.745	139271.4581	0.763	0.759	0.767
*	85-93	2159-2362	378	0.598	16.702	799.684	0.075	3.591	0.064	3.064	6.746	322.988	9.817	470.040	2918.562	139741.4986	0.764	0.760	0.768
	81-85	2057-2159	377	0.761	4.960	237.468	0.034	1.628	0.031	1.484	0.000	0.000	4.894	234.326	2923.456	139975.8246	0.764	0.760	0.768
	78-81	1981-2057	376	0.566	6.757	323.504	0.024	1.149	0.022	1.053	0.000	0.000	6.706	321.085	2930.162	140296.9096	0.569	0.566	0.572
	75-78	1905-1981	375	0.585	6.466	309.579	0.023	1.101	0.022	1.053	0.000	0.000	6.419	307.343	2936.581	140604.253	0.588	0.585	0.591
	72-75	1829-1905	374	0.547	7.053	337.678	0.022	1.053	0.021	1.005	0.000	0.000	7.009	335.593	2943.59	140939.8457	0.55	0.547	0.553
*	67-72	1702-1829	373	0.436	14.640	700.967	0.033	1.580	0.034	1.628	4.652	222.739	9.921	475.020	2953.511	141414.8657	0.618	0.615	0.621
	63-67	1600-1702	372	0.683	6.580	315.050	0.024	1.149	0.027	1.293	0.000	0.000	6.528	312.562	2960.039	141727.4281	0.686	0.683	0.689
	60-63	1524-1600	371	0.497	7.837	375.225	0.017	0.814	0.019	0.910	0.000	0.000	7.799	373.418	2967.838	142100.8462	0.499	0.497	0.501
	57-60	1448-1524	370	0.443	8.683	415.756	0.016	0.766	0.019	0.910	0.000	0.000	8.644	413.877	2976.482	142514.7231	0.445	0.443	0.447
	53-57	1346-1448	369	0.435	11.747	562.464	0.019	0.910	0.024	1.149	0.000	0.000	11.7	560.199	2988.182	143074.9221	0.437	0.435	0.439
*	46-53	1168-1346	368	0.334	24.196	1158.498	0.030	1.436	0.040	1.915	4.766	228.184	19.36	926.962	3007.542	144001.8839	0.467	0.465	0.469
	43-46	1092-1168	367	0.496	7.852	375.971	0.011	0.527	0.017	0.814	0.000	0.000	7.821	374.471	3015.363	144376.3554	0.498	0.496	0.500
	37-43	940-1092	366	0.427	17.849	854.637	0.019	0.910	0.032	1.532	0.000	0.000	17.79	851.790	3033.153	145228.1452	0.429	0.427	0.431
*	25-37	635-940	365	0.212	49.103	2351.061	0.025	1.197	0.057	2.729	2.231	106.818	46.79	2240.317	3079.943	147468.4624	0.249	0.248	0.250
	13-25	330-635	364	0.068	58.056	2779.748	0.010	0.479	0.027	1.293	0.000	0.000	58	2777.055	3137.943	150245.5173	0.069	0.066	0.072
*	0-13	0-330	363	0.016	66.423	3180.336	0.000	0.000	0.000	0.000	1.263	60.458	65.16	3119.878	3203.103	153365.3948	0.035	0.033	0.037

Table A-264 Energy Balance Results for RBHT Test 1679E for Time Period 3540 to 3960 seconds

Results for RBHT Test 1679
Valid Time Period 3540 to 3960 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2336.4757	7.3706	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
0.25	6.35	2466.2799	7.7801	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
0.50	12.70	2596.0841	8.1895	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
0.75	19.05	2725.8883	8.599	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
1.00	25.40	2855.6925	9.0085	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
1.25	31.75	2985.4967	9.418	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
1.50	38.10	3115.3009	9.8274	0.00E+00	0.00E+00	0.00E+00	1.72E-02	7.78E-03
1.75	44.45	3245.1051	10.237	1.56E-02	3.19E-01	1.45E-01	1.69E-02	7.66E-03
2.00	50.80	3374.9094	10.646	3.54E-02	7.24E-01	3.28E-01	1.65E-02	7.51E-03
2.25	57.15	3504.7136	11.056	5.59E-02	1.14E+00	5.19E-01	1.62E-02	7.35E-03
2.50	63.50	3634.5178	11.465	7.72E-02	1.58E+00	7.17E-01	1.58E-02	7.18E-03
2.75	69.85	3764.322	11.875	9.93E-02	2.03E+00	9.22E-01	1.55E-02	7.01E-03
3.00	76.20	3894.1262	12.284	1.22E-01	2.50E+00	1.13E+00	1.51E-02	6.83E-03
3.25	82.55	4023.9304	12.694	1.46E-01	2.98E+00	1.35E+00	1.47E-02	6.65E-03
3.50	88.90	4153.7346	13.103	1.70E-01	3.48E+00	1.58E+00	1.42E-02	6.46E-03
3.75	95.25	4283.5388	13.513	1.95E-01	4.00E+00	1.81E+00	1.38E-02	6.26E-03
4.00	101.60	4413.343	13.922	2.21E-01	4.53E+00	2.05E+00	1.34E-02	6.06E-03
4.25	107.95	4543.1472	14.332	2.48E-01	5.07E+00	2.30E+00	1.29E-02	5.85E-03
4.50	114.30	4672.9514	14.741	2.76E-01	5.64E+00	2.56E+00	1.24E-02	5.64E-03
4.75	120.65	4802.7556	15.151	3.04E-01	6.22E+00	2.82E+00	1.19E-02	5.42E-03
5.00	127.00	4932.5598	15.56	3.33E-01	6.81E+00	3.09E+00	1.14E-02	5.19E-03
5.25	133.35	5062.364	15.97	3.63E-01	7.42E+00	3.37E+00	1.09E-02	4.96E-03
5.50	139.70	5192.1682	16.379	3.93E-01	8.05E+00	3.65E+00	1.04E-02	4.72E-03
5.75	146.05	5321.9724	16.789	4.25E-01	8.69E+00	3.94E+00	9.87E-03	4.48E-03
6.00	152.40	5451.7766	17.198	4.57E-01	9.35E+00	4.24E+00	9.32E-03	4.23E-03
6.25	158.75	5581.5809	17.607	4.90E-01	1.00E+01	4.55E+00	8.75E-03	3.97E-03
6.50	165.10	5711.3851	18.017	5.24E-01	1.07E+01	4.86E+00	8.17E-03	3.71E-03
6.75	171.45	5841.1893	18.426	5.58E-01	1.14E+01	5.18E+00	7.58E-03	3.44E-03
7.00	177.80	5970.9935	18.836	5.93E-01	1.21E+01	5.51E+00	6.98E-03	3.17E-03
7.25	184.15	6100.7977	19.245	6.29E-01	1.29E+01	5.84E+00	6.36E-03	2.89E-03
7.50	190.50	6230.6019	19.655	6.66E-01	1.36E+01	6.18E+00	5.73E-03	2.60E-03
7.75	196.85	6360.4061	20.064	7.04E-01	1.44E+01	6.53E+00	5.08E-03	2.31E-03
8.00	203.20	6490.2103	20.474	7.42E-01	1.52E+01	6.89E+00	4.43E-03	2.01E-03
8.25	209.55	6620.0145	20.883	7.81E-01	1.60E+01	7.25E+00	3.76E-03	1.70E-03
8.50	215.90	6749.8187	21.293	8.21E-01	1.68E+01	7.62E+00	3.07E-03	1.39E-03
8.75	222.25	6879.6229	21.702	8.62E-01	1.76E+01	8.00E+00	2.37E-03	1.08E-03
9.00	228.60	7009.4271	22.112	9.03E-01	1.85E+01	8.38E+00	1.66E-03	7.54E-04
9.25	234.95	6620.0145	20.883	9.44E-01	1.93E+01	8.76E+00	9.64E-04	4.37E-04
9.50	241.30	6230.6019	19.655	9.82E-01	2.01E+01	9.12E+00	3.07E-04	1.39E-04
9.75	247.65	5841.1893	18.426	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
10.00	254.00	5451.7766	17.198	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
10.25	260.35	5062.364	15.97	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
10.50	266.70	4672.9514	14.741	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
10.75	273.05	4283.5388	13.513	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
11.00	279.40	3894.1262	12.284	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
11.25	285.75	3504.7136	11.056	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
11.50	292.10	3115.3009	9.8274	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
11.75	298.45	2725.8883	8.599	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00
12.00	304.80	2336.4757	7.3706	1.00E+00	2.05E+01	9.28E+00	0.00E+00	0.00E+00

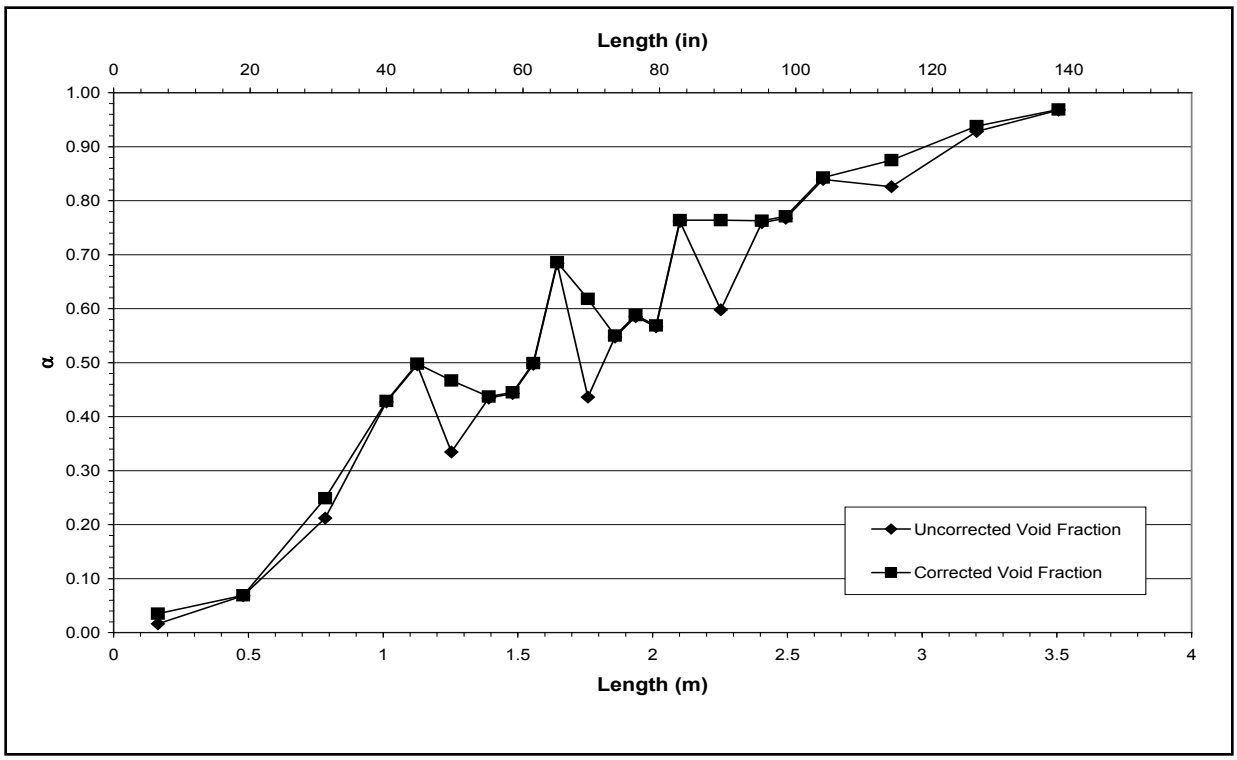

Figure A-660 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679E for Time Period 3540 to 3960 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1679-F

Test Conditions

Date: 7/21/2003
Steady-state time window: 4200 – 4410 seconds
Inlet flow rate: 0.373 cm/sec (0.147 in./sec)
Inlet mass flow rate: 0.018 kg/sec (0.039 lbm/sec)
Inlet flow temperature: 328.1 K (130.9 ºF)
Upper plenum pressure: 133.8 kPa (19.4 psia)
Bundle power: 72.35 kW

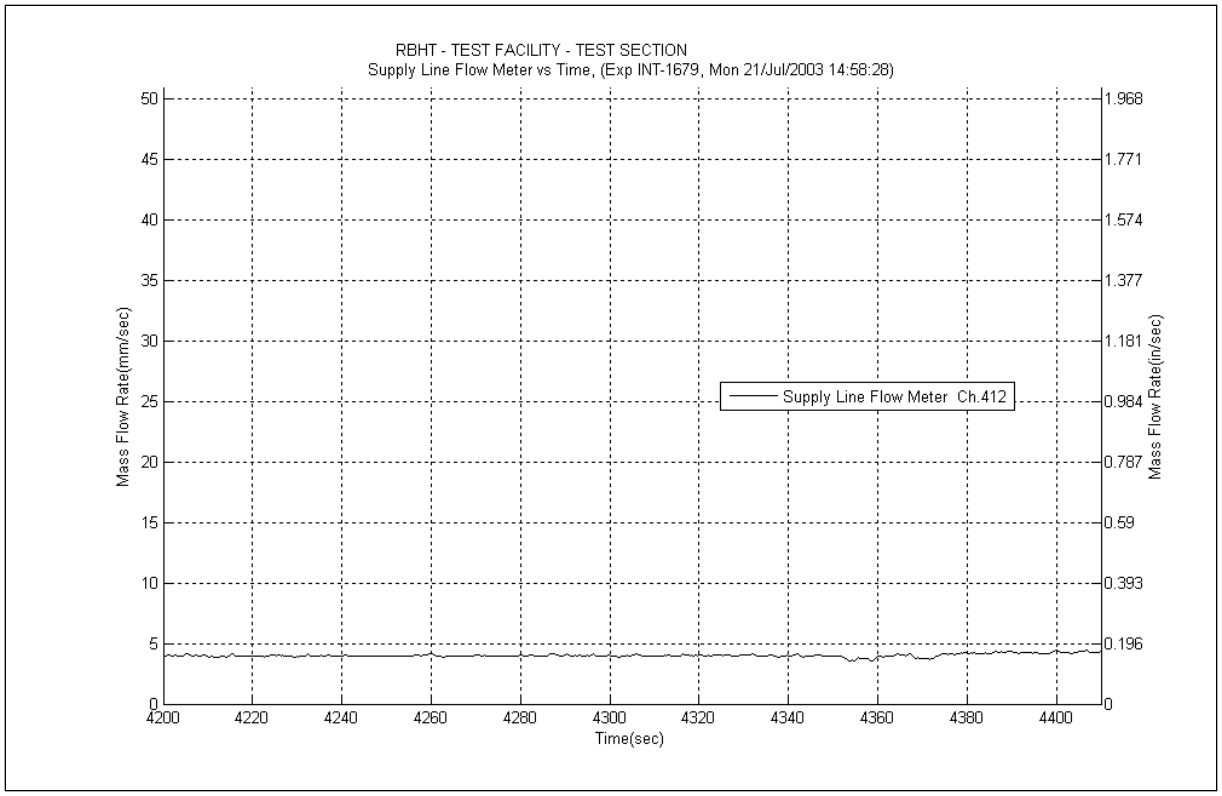

Figure A-661 Inlet Flow Plot for Experiment 1679F

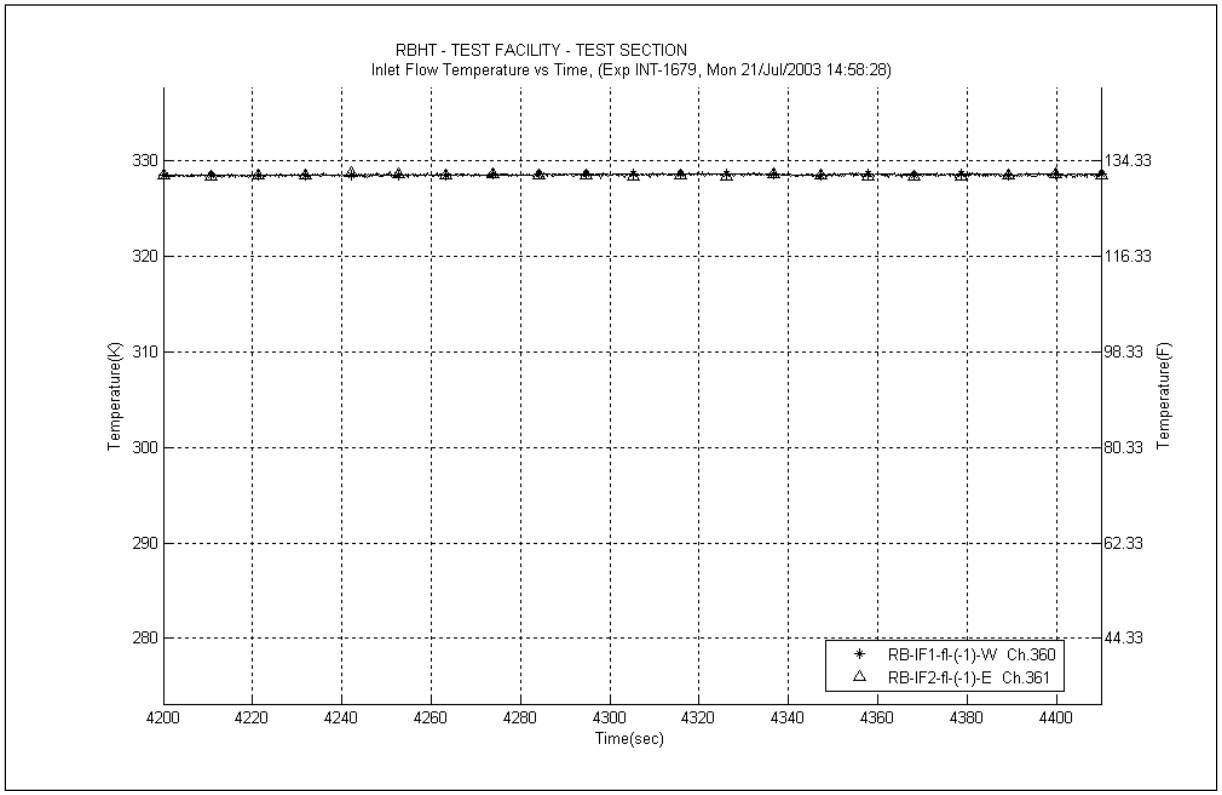

Figure A-662 Inlet Temperature Plot for Experiment 1679F

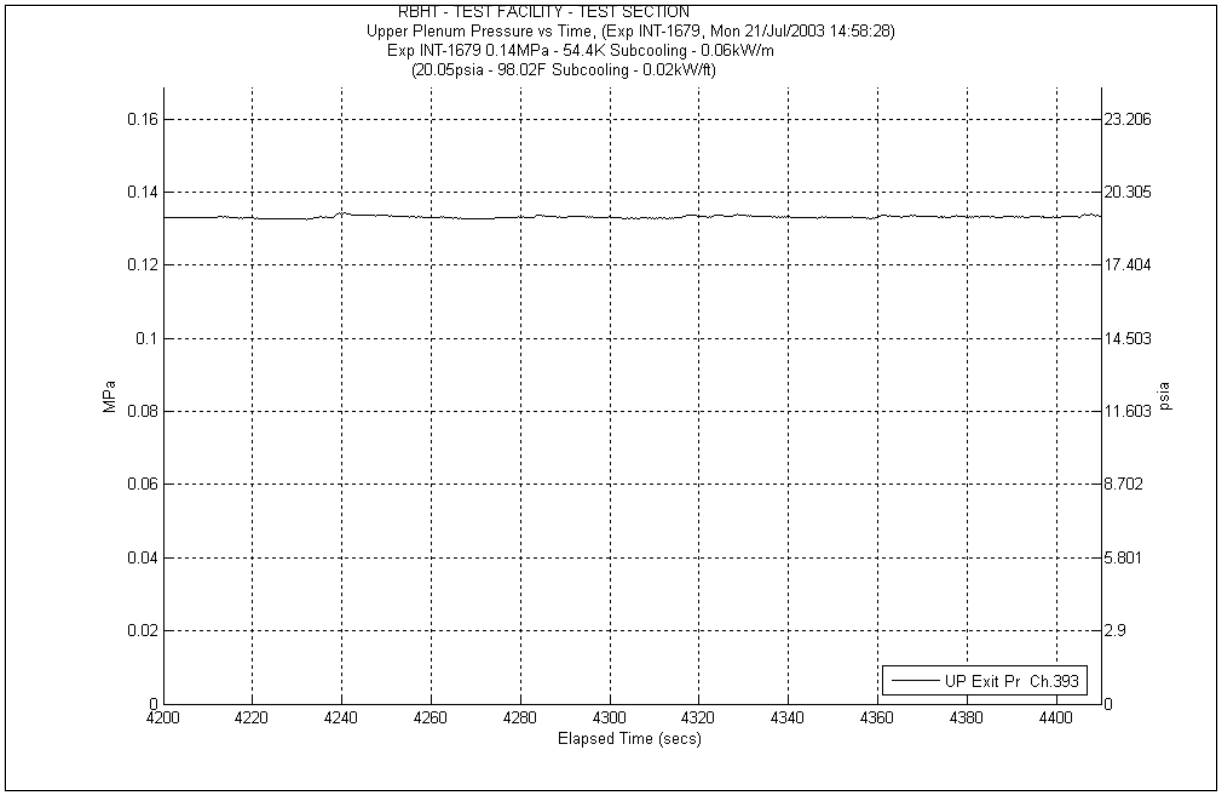

Figure A-663 System Pressure Plot for Experiment 1679F

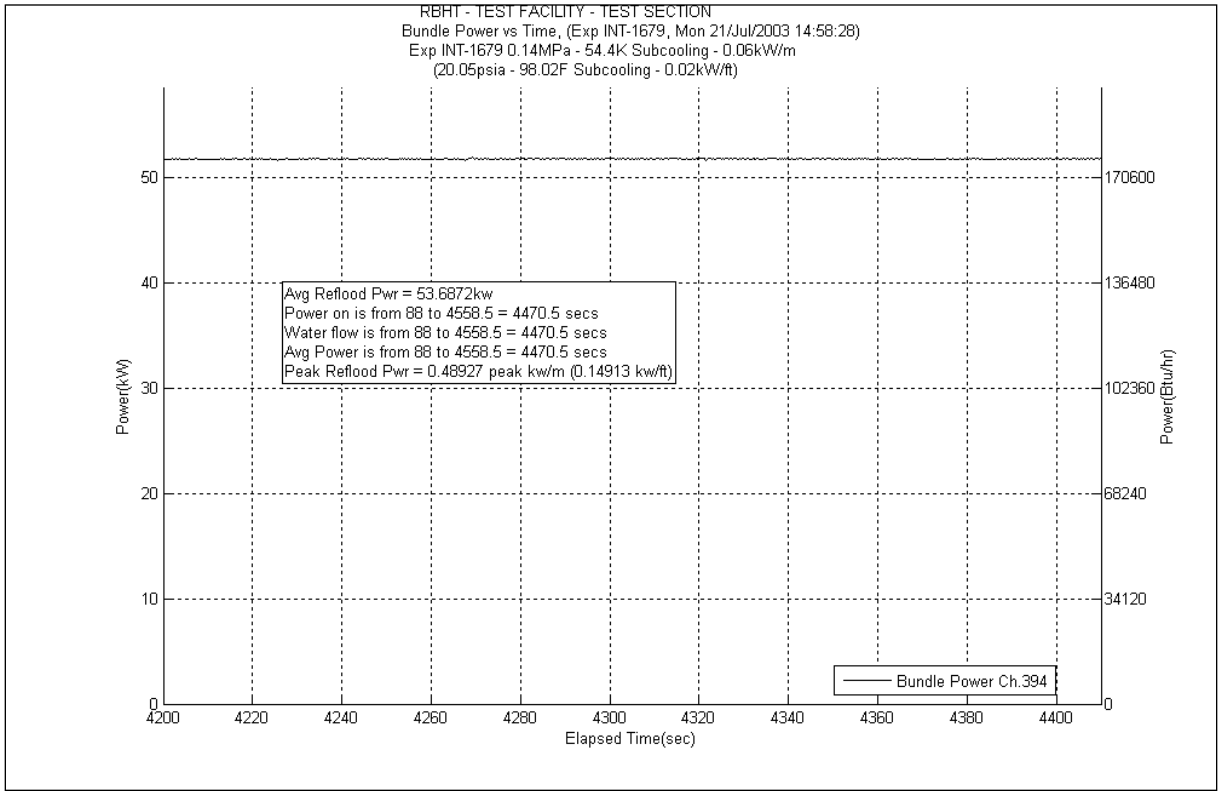

Figure A-664 Bundle Power Plot for Experiment 1679F

Table A-265 Data Results for RBHT Test 1679 for Time Period 4200 to 4410

Results for RBHT Test 1679
Valid Time Period 4200 to 4410 seconds
Collapsed Liquid Level = 58.549 inches = 1487.14 mm
(Z_{osv}) Onset of Significant Void = 6.5 inches = 165 mm
($Z_{2\phi}$) Two-Phase Level (Dryout) = 103.20 inches = 2621.28 mm
(S) Level Swell = 2.002

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.990	0.587	28.098	0.044	2.107	0.000	0.000	0.000	0.000	0.54	25.855	2880.54	137920.9955	0.991	0.986	0.996
*	120-133	3048-3378	383	0.975	1.709	81.808	0.052	2.490	0.000	0.000	0.152	7.259	1.505	72.060	2882.045	137993.0553	0.978	0.973	0.983
*	108-120	2743-3048	382	0.944	3.516	168.341	0.048	2.298	0.000	0.000	0.479	22.929	2.989	143.114	2885.034	138136.1694	0.952	0.947	0.957
	100-108	2540-2743	381	0.938	2.560	122.588	0.032	1.532	0.000	0.000	0.000	0.000	2.526	120.946	2887.56	138257.1149	0.939	0.934	0.944
	97-100	2464-2540	380	0.851	2.316	110.901	0.012	0.575	0.000	0.000	0.000	0.000	2.301	110.172	2889.861	138367.2874	0.852	0.848	0.856
	93-97	2362-2464	379	0.817	3.812	182.515	0.022	1.053	0.001	0.048	0.000	0.000	3.786	181.275	2893.647	138548.562	0.818	0.814	0.822
*	85-93	2159-2362	378	0.672	13.612	651.733	0.053	2.538	0.047	2.250	5.238	250.783	8.274	396.161	2901.921	138944.7233	0.801	0.797	0.805
	81-85	2057-2159	377	0.782	4.539	217.327	0.025	1.197	0.023	1.101	0.000	0.000	4.489	214.934	2906.41	139159.6577	0.784	0.780	0.788
	78-81	1981-2057	376	0.632	5.733	274.518	0.018	0.862	0.017	0.814	0.000	0.000	5.696	272.726	2912.106	139432.3837	0.634	0.631	0.637
	75-78	1905-1981	375	0.624	5.853	280.238	0.017	0.814	0.016	0.766	0.000	0.000	5.817	278.519	2917.923	139710.9031	0.627	0.624	0.630
	72-75	1829-1905	374	0.585	6.461	309.331	0.016	0.766	0.016	0.766	0.000	0.000	6.427	307.726	2924.35	140018.6296	0.587	0.584	0.590
*	67-72	1702-1829	373	0.446	14.386	688.783	0.025	1.197	0.026	1.245	4.551	217.880	9.784	468.460	2934.134	140487.09	0.623	0.620	0.626
	63-67	1600-1702	372	0.657	7.125	341.159	0.019	0.910	0.020	0.958	0.000	0.000	7.085	339.232	2941.219	140826.3216	0.659	0.656	0.662
	60-63	1524-1600	371	0.485	8.029	384.425	0.013	0.622	0.014	0.670	0.000	0.000	7.998	382.946	2949.217	141209.2679	0.487	0.485	0.489
	57-60	1448-1524	370	0.427	8.922	427.194	0.012	0.575	0.014	0.670	0.000	0.000	8.895	425.895	2958.112	141635.1628	0.429	0.427	0.431
	53-57	1346-1448	369	0.417	12.111	579.870	0.015	0.718	0.018	0.862	0.000	0.000	12.07	577.915	2970.182	142213.0775	0.419	0.417	0.421
*	46-53	1168-1346	368	0.307	25.182	1205.743	0.023	1.101	0.030	1.436	5.359	256.612	19.77	946.593	2989.952	143159.6702	0.456	0.454	0.458
	43-46	1092-1168	367	0.492	7.920	379.203	0.009	0.431	0.012	0.575	0.000	0.000	7.896	378.063	2997.848	143537.7327	0.493	0.491	0.495
	37-43	940-1092	366	0.427	17.855	854.886	0.015	0.718	0.023	1.101	0.000	0.000	17.81	852.747	3015.658	144390.4801	0.428	0.426	0.430
*	25-37	635-940	365	0.251	46.678	2234.938	0.022	1.053	0.042	2.011	2.094	100.245	44.52	2131.629	3060.178	146522.1091	0.285	0.284	0.286
	13-25	330-635	364	0.142	53.476	2560.431	0.010	0.479	0.034	1.628	0.000	0.000	53.42	2557.763	3113.598	149079.8724	0.143	0.142	0.144
*	0-13	0-330	363	0.020	66.179	3168.649	0.000	0.000	0.000	0.000	3.499	167.514	62.68	3001.135	3176.278	152081.0069	0.071	0.067	0.075

Table A-266 Energy Balance Results for RBHT Test 1679F for Time Period 4200 to 4410 seconds

Results for RBHT Test 1679
Valid Time Period 4200 to 4410 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	2338.3191	7.3764	0.00E+00	0.00E+00	0.00E+00	1.26E-02	5.71E-03
0.25	6.35	2468.2257	7.7862	0.00E+00	0.00E+00	0.00E+00	1.26E-02	5.71E-03
0.50	12.70	2598.1323	8.196	0.00E+00	0.00E+00	0.00E+00	1.26E-02	5.71E-03
0.75	19.05	2728.039	8.6058	0.00E+00	0.00E+00	0.00E+00	1.26E-02	5.71E-03
1.00	25.40	2857.9456	9.0156	0.00E+00	0.00E+00	0.00E+00	1.26E-02	5.71E-03
1.25	31.75	2987.8522	9.4254	8.26E-03	1.25E-01	5.69E-02	1.25E-02	5.66E-03
1.50	38.10	3117.7588	9.8352	3.31E-02	5.02E-01	2.28E-01	1.22E-02	5.52E-03
1.75	44.45	3247.6654	10.245	5.89E-02	8.95E-01	4.06E-01	1.18E-02	5.37E-03
2.00	50.80	3377.572	10.655	8.59E-02	1.30E+00	5.91E-01	1.15E-02	5.22E-03
2.25	57.15	3507.4787	11.065	1.14E-01	1.73E+00	7.84E-01	1.12E-02	5.06E-03
2.50	63.50	3637.3853	11.474	1.43E-01	2.17E+00	9.84E-01	1.08E-02	4.89E-03
2.75	69.85	3767.2919	11.884	1.73E-01	2.63E+00	1.19E+00	1.04E-02	4.72E-03
3.00	76.20	3897.1985	12.294	2.04E-01	3.10E+00	1.41E+00	1.00E-02	4.55E-03
3.25	82.55	4027.1051	12.704	2.36E-01	3.59E+00	1.63E+00	9.62E-03	4.36E-03
3.50	88.90	4157.0117	13.114	2.70E-01	4.09E+00	1.86E+00	9.20E-03	4.17E-03
3.75	95.25	4286.9184	13.523	3.04E-01	4.61E+00	2.09E+00	8.76E-03	3.98E-03
4.00	101.60	4416.825	13.933	3.39E-01	5.15E+00	2.34E+00	8.32E-03	3.77E-03
4.25	107.95	4546.7316	14.343	3.76E-01	5.70E+00	2.59E+00	7.86E-03	3.57E-03
4.50	114.30	4676.6382	14.753	4.13E-01	6.27E+00	2.85E+00	7.39E-03	3.35E-03
4.75	120.65	4806.5448	15.163	4.52E-01	6.86E+00	3.11E+00	6.90E-03	3.13E-03
5.00	127.00	4936.4514	15.572	4.91E-01	7.46E+00	3.38E+00	6.40E-03	2.91E-03
5.25	133.35	5066.3581	15.982	5.32E-01	8.08E+00	3.66E+00	5.89E-03	2.67E-03
5.50	139.70	5196.2647	16.392	5.74E-01	8.71E+00	3.95E+00	5.37E-03	2.43E-03
5.75	146.05	5326.1713	16.802	6.16E-01	9.36E+00	4.25E+00	4.83E-03	2.19E-03
6.00	152.40	5456.0779	17.212	6.60E-01	1.00E+01	4.55E+00	4.28E-03	1.94E-03
6.25	158.75	5585.9845	17.621	7.05E-01	1.07E+01	4.86E+00	3.71E-03	1.68E-03
6.50	165.10	5715.8912	18.031	7.51E-01	1.14E+01	5.17E+00	3.13E-03	1.42E-03
6.75	171.45	5845.7978	18.441	7.98E-01	1.21E+01	5.50E+00	2.54E-03	1.15E-03
7.00	177.80	5975.7044	18.851	8.46E-01	1.28E+01	5.83E+00	1.94E-03	8.79E-04
7.25	184.15	6105.611	19.261	8.95E-01	1.36E+01	6.16E+00	1.32E-03	5.99E-04
7.50	190.50	6235.5176	19.67	9.45E-01	1.44E+01	6.51E+00	6.89E-04	3.12E-04
7.75	196.85	6365.4242	20.08	9.97E-01	1.51E+01	6.86E+00	4.41E-05	2.00E-05
8.00	203.20	6495.3309	20.49	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
8.25	209.55	6625.2375	20.9	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
8.50	215.90	6755.1441	21.31	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
8.75	222.25	6885.0507	21.719	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
9.00	228.60	7014.9573	22.129	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
9.25	234.95	6625.2375	20.9	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
9.50	241.30	6235.5176	19.67	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
9.75	247.65	5845.7978	18.441	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
10.00	254.00	5456.0779	17.212	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
10.25	260.35	5066.3581	15.982	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
10.50	266.70	4676.6382	14.753	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
10.75	273.05	4286.9184	13.523	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
11.00	279.40	3897.1985	12.294	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
11.25	285.75	3507.4787	11.065	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
11.50	292.10	3117.7588	9.8352	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
11.75	298.45	2728.039	8.6058	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00
12.00	304.80	2338.3191	7.3764	1.00E+00	1.52E+01	6.89E+00	0.00E+00	0.00E+00

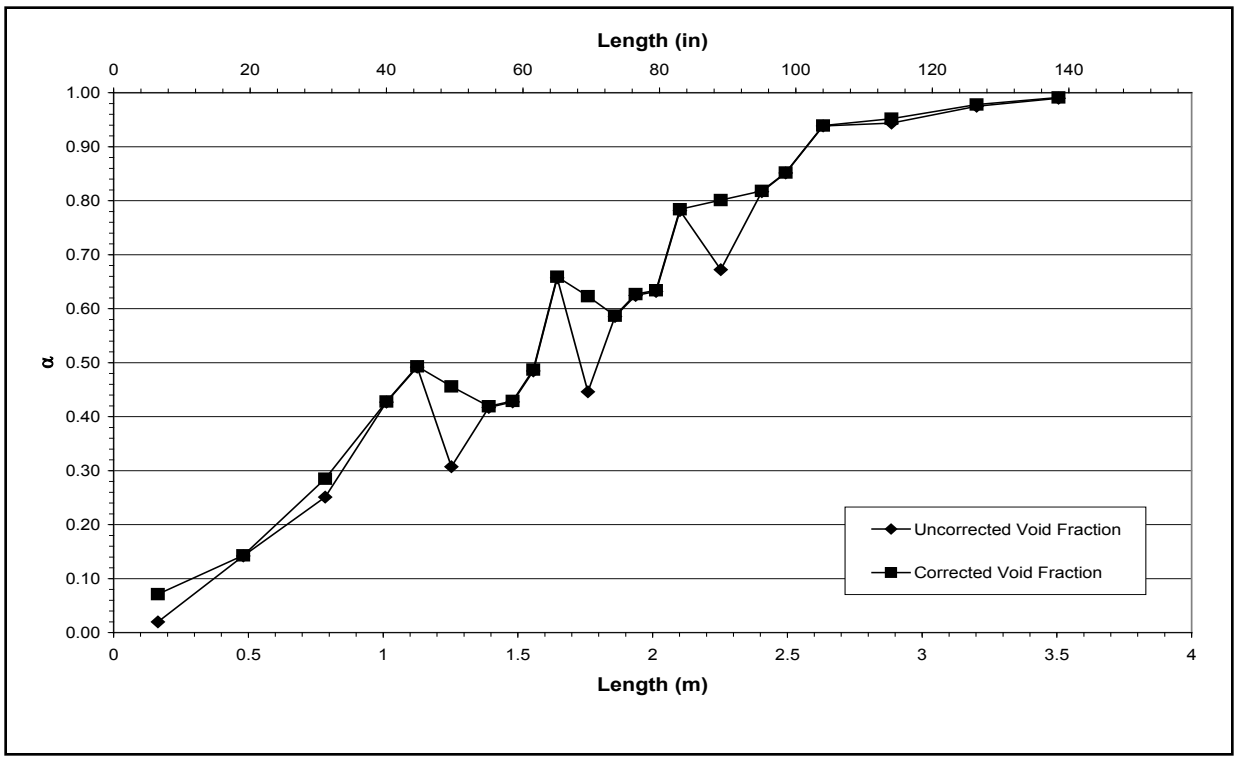

Figure A-665 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1679F for Time Period 4200 to 4410 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-A

Test Conditions

Date: 7/23/2003
Steady-state time window: 1550 – 1607 seconds
Inlet flow rate: 4.054 cm/sec (1.596 in./sec)
Inlet mass flow rate: 0.191 kg/sec (0.422 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

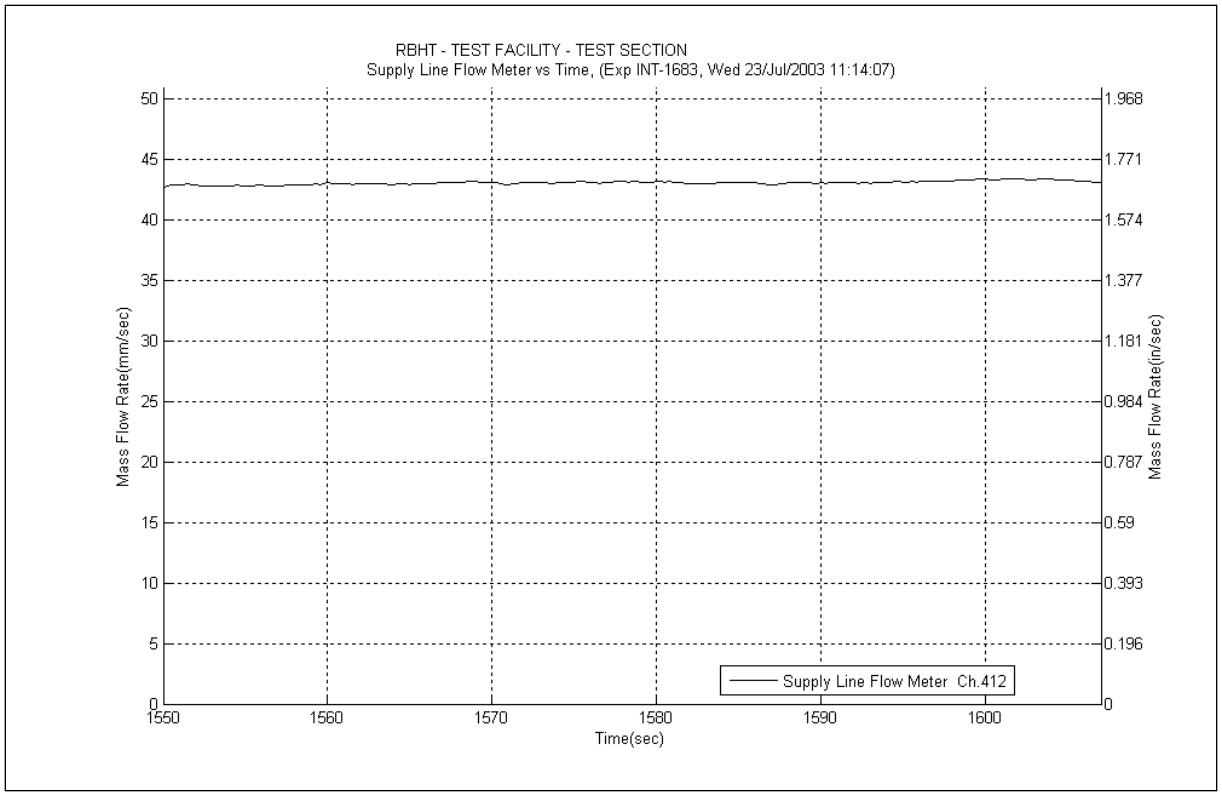

Figure A-666 Inlet Flow Plot for Experiment 1683A

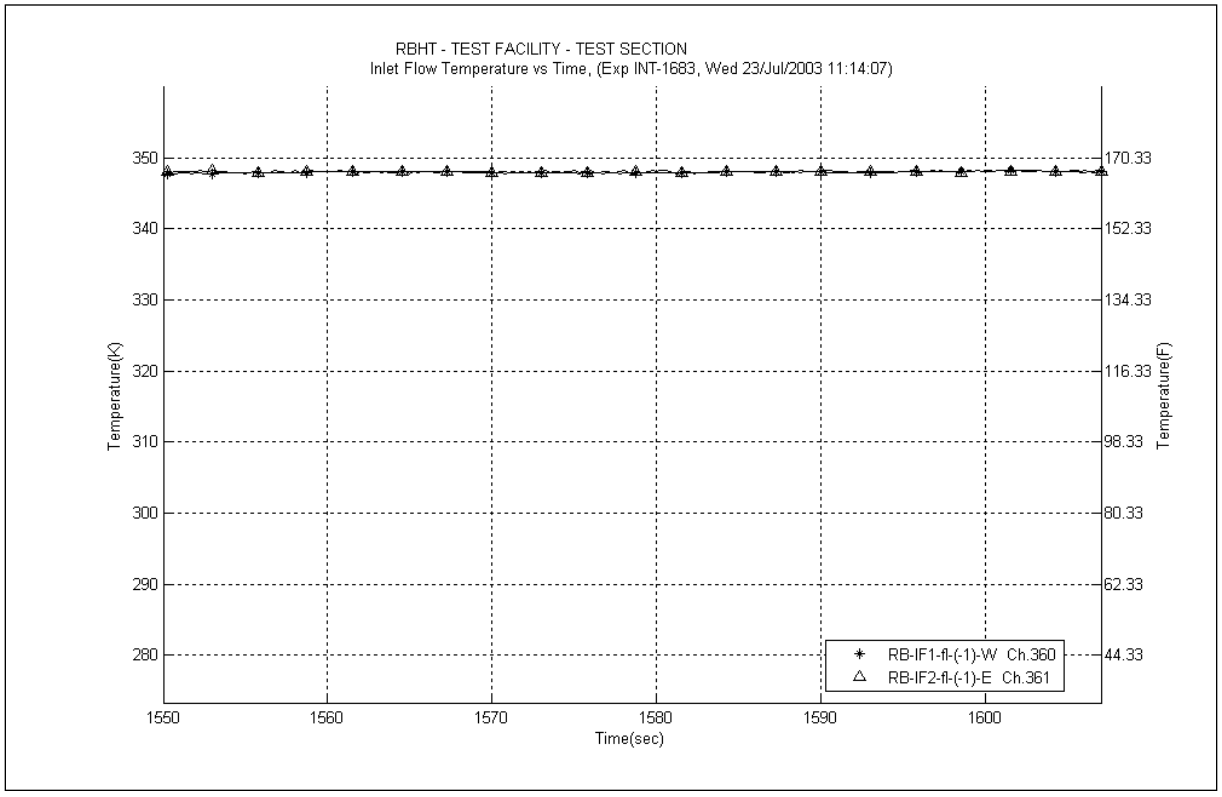

Figure A-667 Inlet Temperature Plot for Experiment 1683A

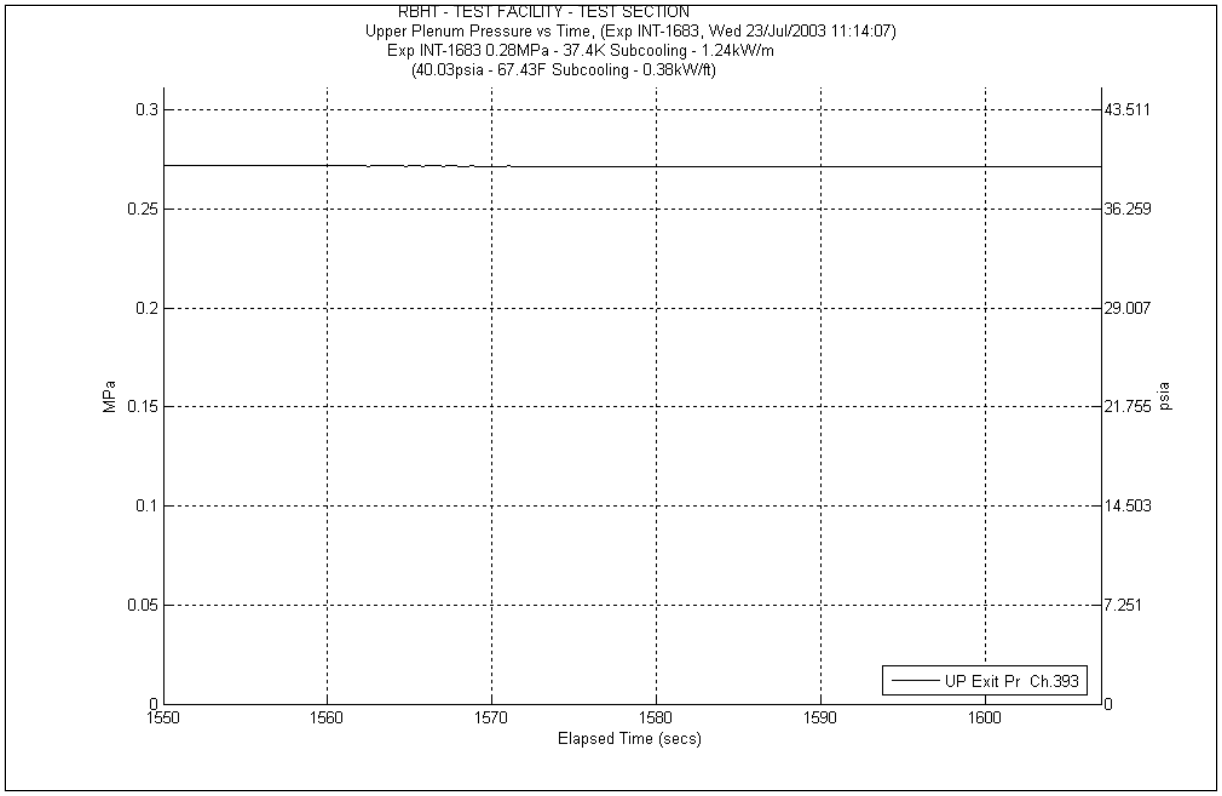

Figure A-668 System Pressure Plot for Experiment 1683A

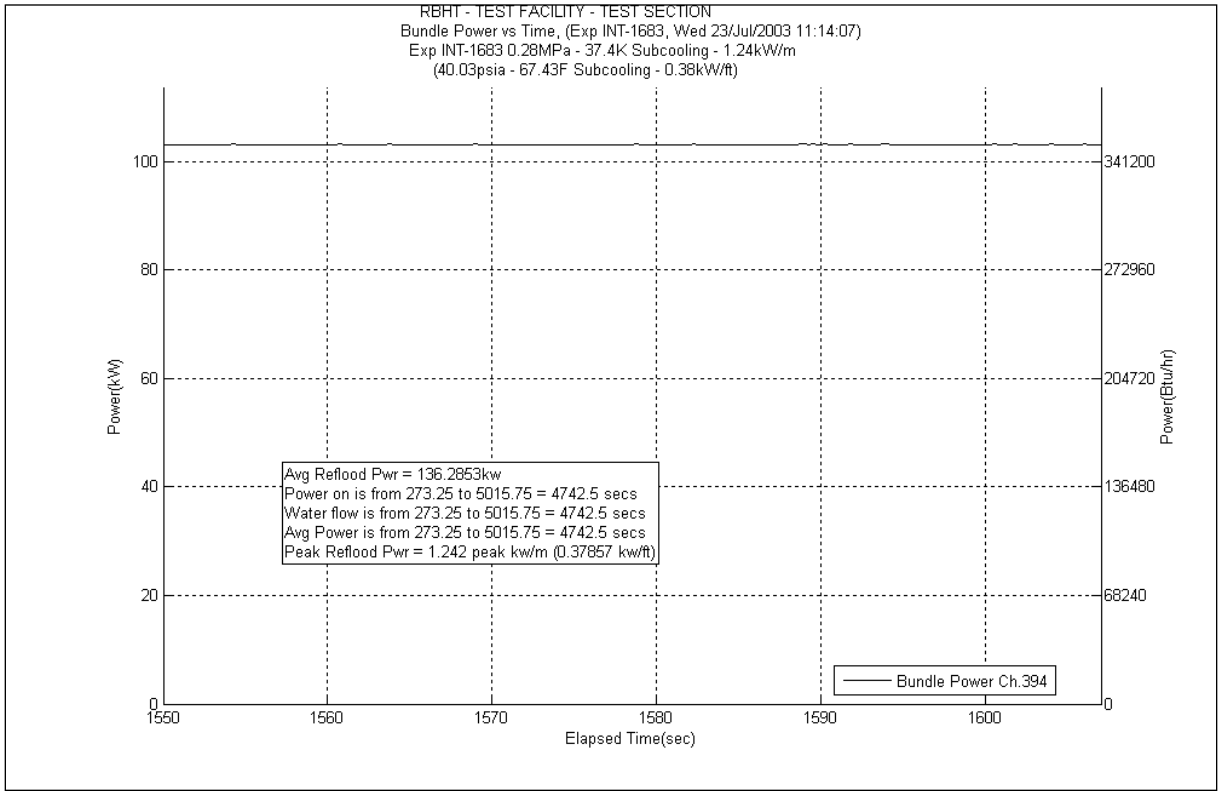

Figure A-669 Bundle Power Plot for Experiment 1683A

Table A-267 Data Results for RBHT Test 1683 for Time Period 1550 to 1607

Results for RBHT Test 1683
Valid Time Period 1550 to 1607 seconds
Collapsed Liquid Level = 93.461 inches = 2373.91 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.740	14.858	711.410	1.314	62.915	0.366	17.524	0.000	0.000	13.17	630.583	5773.17	276420.8633	0.769	0.765	0.773
*	120-133	3048-3378	383	0.703	20.062	960.566	1.431	68.517	0.653	31.266	2.198	105.233	15.78	755.550	5788.95	277176.4138	0.766	0.762	0.770
*	108-120	2743-3048	382	0.647	21.983	1052.569	1.157	55.397	0.816	39.070	5.050	241.813	14.96	716.289	5803.91	277892.7024	0.76	0.756	0.764
	100-108	2540-2743	381	0.727	11.363	544.064	0.662	31.697	0.597	28.585	0.000	0.000	10.1	483.591	5814.01	278376.293	0.757	0.753	0.761
	97-100	2464-2540	380	0.636	5.666	271.286	0.224	10.725	0.216	10.342	0.000	0.000	5.225	250.174	5819.235	278626.4673	0.665	0.662	0.668
	93-97	2362-2464	379	0.631	7.671	367.268	0.278	13.311	0.281	13.454	0.000	0.000	7.107	340.285	5826.342	278966.7523	0.658	0.655	0.661
*	85-93	2159-2362	378	0.457	22.544	1079.424	0.486	23.270	0.540	25.855	7.298	349.442	14.22	680.857	5840.562	279647.6096	0.658	0.655	0.661
	81-85	2057-2159	377	0.635	7.582	363.041	0.207	9.911	0.259	12.401	0.000	0.000	7.116	340.716	5847.678	279988.3255	0.657	0.654	0.660
	78-81	1981-2057	376	0.536	7.229	346.132	0.139	6.655	0.189	9.049	0.000	0.000	6.901	330.422	5854.579	280318.7471	0.557	0.554	0.560
	75-78	1905-1981	375	0.444	8.657	414.513	0.125	5.985	0.185	8.858	0.000	0.000	8.346	399.609	5862.925	280718.3558	0.464	0.462	0.466
	72-75	1829-1905	374	0.369	9.831	470.710	0.110	5.267	0.181	8.666	0.000	0.000	9.537	456.634	5872.462	281174.9898	0.388	0.386	0.390
*	67-72	1702-1829	373	0.310	17.912	857.621	0.149	7.134	0.291	13.933	-0.058	-2.787	17.53	839.341	5889.992	282014.3307	0.325	0.323	0.327
	63-67	1600-1702	372	0.247	15.648	749.206	0.085	4.070	0.225	10.773	0.000	0.000	15.33	734.004	5905.322	282748.335	0.262	0.261	0.263
	60-63	1524-1600	371	0.049	14.822	709.670	0.039	1.867	0.164	7.852	0.000	0.000	14.61	699.531	5919.932	283447.8656	0.062	0.059	0.065
	57-60	1448-1524	370	0.071	14.479	693.258	0.017	0.814	0.091	4.357	0.000	0.000	14.37	688.039	5934.302	284135.9049	0.077	0.073	0.081
	53-57	1346-1448	369	0.056	19.610	938.933	0.003	0.144	0.000	0.000	0.000	0.000	19.6	938.453	5953.902	285074.3579	0.056	0.053	0.059
*	46-53	1168-1346	368	0.053	34.432	1648.602	0.006	0.287	0.000	0.000	-0.184	-8.821	34.61	1657.136	5988.512	286731.4936	0.048	0.046	0.050
	43-46	1092-1168	367	0.039	14.978	717.130	0.002	0.096	0.000	0.000	0.000	0.000	14.97	716.767	6003.482	287448.2611	0.039	0.037	0.041
	37-43	940-1092	366	0.039	29.950	1434.011	0.005	0.239	0.000	0.000	0.000	0.000	29.93	1433.056	6033.412	288881.3171	0.039	0.037	0.041
*	25-37	635-940	365	0.032	60.336	2888.908	0.010	0.479	0.000	0.000	0.186	8.911	60.14	2879.519	6093.552	291760.8358	0.035	0.033	0.037
	13-25	330-635	364	0.030	60.450	2894.379	0.010	0.479	0.000	0.000	0.000	0.000	60.42	2892.925	6153.972	294653.7609	0.03	0.029	0.032
*	0-13	0-330	363	0.020	66.189	3169.146	0.011	0.527	0.000	0.000	-0.292	-13.981	66.47	3182.601	6220.442	297836.3616	0.015	0.014	0.016

Table A-268 Energy Balance Results for RBHT Test 1683A for Time Period 1550 to 1607 seconds

Results for RBHT Test 1683
Valid Time Period 1550 to 1607 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4658.2943	14.695	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
0.25	6.35	4917.0884	15.511	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
0.50	12.70	5175.8826	16.328	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
0.75	19.05	5434.6767	17.144	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
1.00	25.40	5693.4708	17.96	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
1.25	31.75	5952.2649	18.777	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
1.50	38.10	6211.0591	19.593	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
1.75	44.45	6469.8532	20.41	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
2.00	50.80	6728.6473	21.226	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
2.25	57.15	6987.4414	22.042	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
2.50	63.50	7246.2356	22.859	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
2.75	69.85	7505.0297	23.675	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
3.00	76.20	7763.8238	24.492	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
3.25	82.55	8022.618	25.308	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
3.50	88.90	8281.4121	26.124	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
3.75	95.25	8540.2062	26.941	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
4.00	101.60	8799.0003	27.757	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
4.25	107.95	9057.7945	28.573	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
4.50	114.30	9316.5886	29.39	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
4.75	120.65	9575.3827	30.206	0.00E+00	0.00E+00	0.00E+00	1.38E-01	6.25E-02
5.00	127.00	9834.1769	31.023	4.31E-03	3.64E-01	1.65E-01	1.37E-01	6.22E-02
5.25	133.35	10092.971	31.839	1.21E-02	1.02E+00	4.62E-01	1.36E-01	6.17E-02
5.50	139.70	10351.765	32.655	2.00E-02	1.69E+00	7.67E-01	1.35E-01	6.12E-02
5.75	146.05	10610.559	33.472	2.82E-02	2.38E+00	1.08E+00	1.34E-01	6.07E-02
6.00	152.40	10869.353	34.288	3.66E-02	3.09E+00	1.40E+00	1.33E-01	6.02E-02
6.25	158.75	11128.147	35.105	4.51E-02	3.81E+00	1.73E+00	1.32E-01	5.97E-02
6.50	165.10	11386.942	35.921	5.39E-02	4.55E+00	2.06E+00	1.30E-01	5.91E-02
6.75	171.45	11645.736	36.737	6.28E-02	5.30E+00	2.41E+00	1.29E-01	5.86E-02
7.00	177.80	11904.53	37.554	7.20E-02	6.08E+00	2.76E+00	1.28E-01	5.80E-02
7.25	184.15	12163.324	38.37	8.14E-02	6.87E+00	3.12E+00	1.27E-01	5.74E-02
7.50	190.50	12422.118	39.186	9.09E-02	7.68E+00	3.48E+00	1.25E-01	5.68E-02
7.75	196.85	12680.912	40.003	1.01E-01	8.50E+00	3.86E+00	1.24E-01	5.62E-02
8.00	203.20	12939.706	40.819	1.11E-01	9.34E+00	4.24E+00	1.23E-01	5.56E-02
8.25	209.55	13198.501	41.636	1.21E-01	1.02E+01	4.63E+00	1.21E-01	5.49E-02
8.50	215.90	13457.295	42.452	1.31E-01	1.11E+01	5.02E+00	1.20E-01	5.43E-02
8.75	222.25	13716.089	43.268	1.42E-01	1.20E+01	5.43E+00	1.18E-01	5.36E-02
9.00	228.60	13974.883	44.085	1.53E-01	1.29E+01	5.84E+00	1.17E-01	5.30E-02
9.25	234.95	13198.501	41.636	1.63E-01	1.38E+01	6.25E+00	1.15E-01	5.23E-02
9.50	241.30	12422.118	39.186	1.73E-01	1.46E+01	6.63E+00	1.14E-01	5.17E-02
9.75	247.65	11645.736	36.737	1.83E-01	1.54E+01	6.99E+00	1.13E-01	5.11E-02
10.00	254.00	10869.353	34.288	1.91E-01	1.61E+01	7.32E+00	1.11E-01	5.05E-02
10.25	260.35	10092.971	31.839	1.99E-01	1.68E+01	7.64E+00	1.10E-01	5.00E-02
10.50	266.70	9316.5886	29.39	2.07E-01	1.75E+01	7.93E+00	1.09E-01	4.96E-02
10.75	273.05	8540.2062	26.941	2.14E-01	1.81E+01	8.19E+00	1.08E-01	4.91E-02
11.00	279.40	7763.8238	24.492	2.20E-01	1.86E+01	8.44E+00	1.07E-01	4.87E-02
11.25	285.75	6987.4414	22.042	2.26E-01	1.91E+01	8.65E+00	1.07E-01	4.84E-02
11.50	292.10	6211.0591	19.593	2.31E-01	1.95E+01	8.85E+00	1.06E-01	4.81E-02
11.75	298.45	5434.6767	17.144	2.36E-01	1.99E+01	9.02E+00	1.05E-01	4.78E-02
12.00	304.80	4658.2943	14.695	2.40E-01	2.02E+01	9.17E+00	1.05E-01	4.75E-02

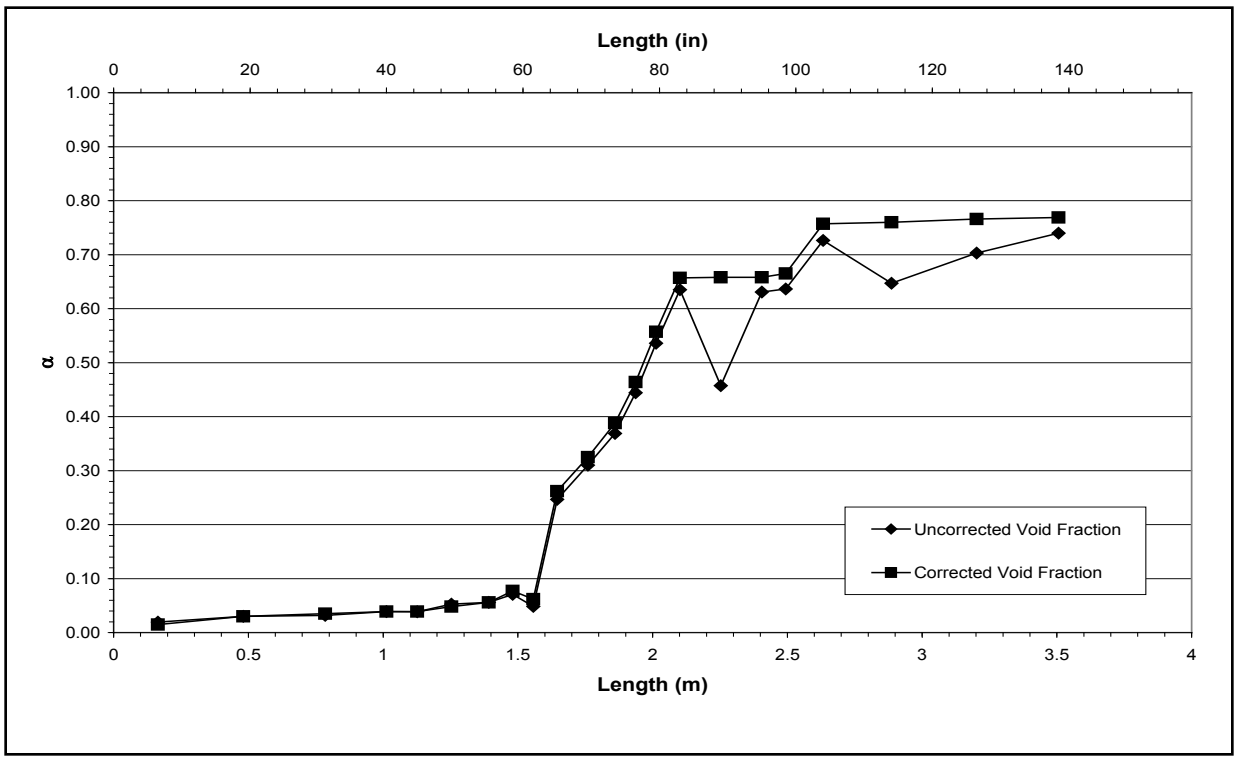

Figure A-670 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683A for Time Period 1550 to 1607 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-B

Test Conditions

Date: 7/23/2003
Steady-state time window: 2185 – 2220 seconds
Inlet flow rate: 4.105 cm/sec (1.616 in./sec)
Inlet mass flow rate: 0.194 kg/sec (0.427 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

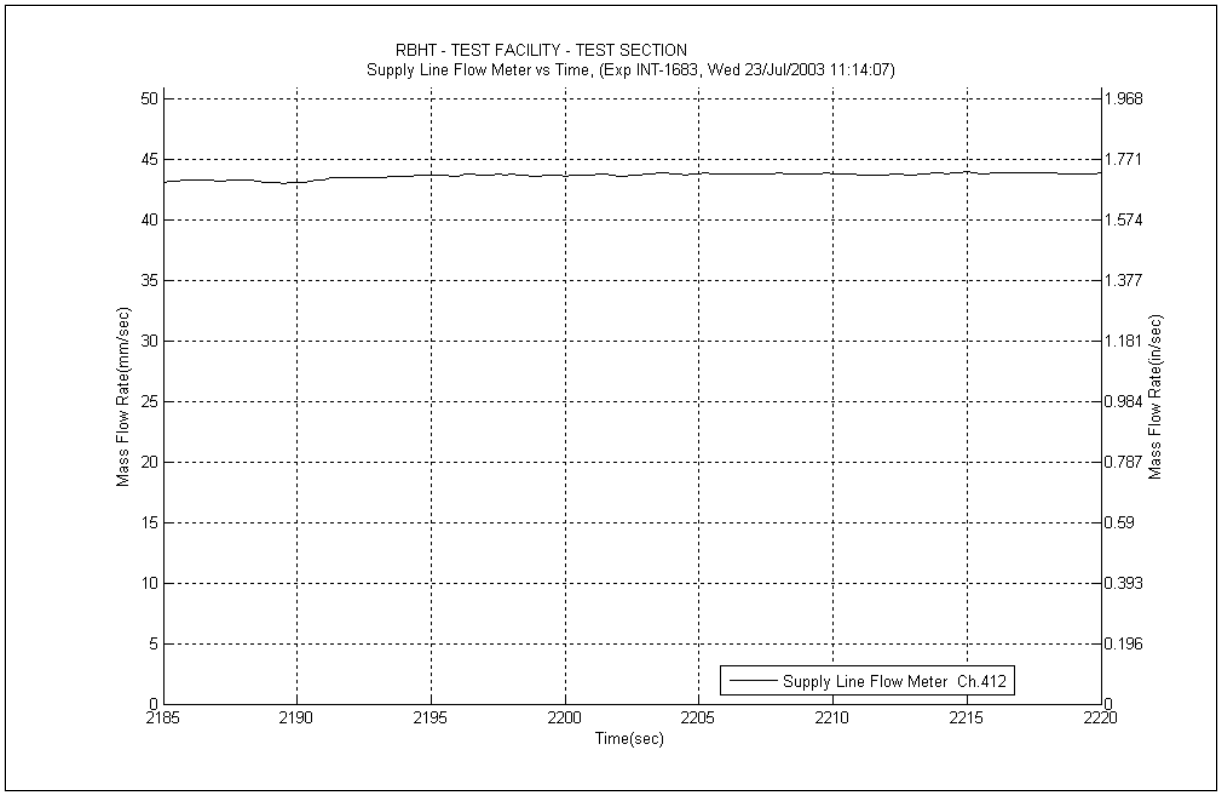

Figure A-671 Inlet Flow Plot for Experiment 1683B

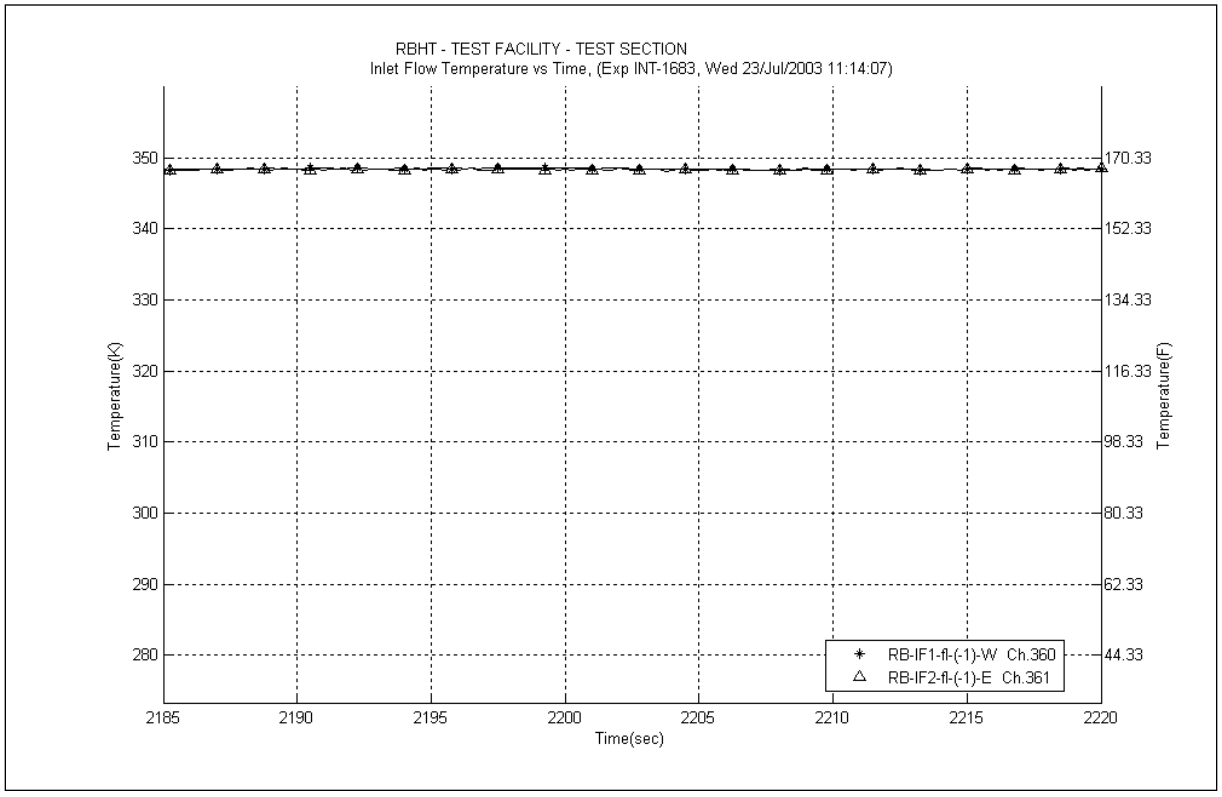

Figure A-672 Inlet Temperature Plot for Experiment 1683B

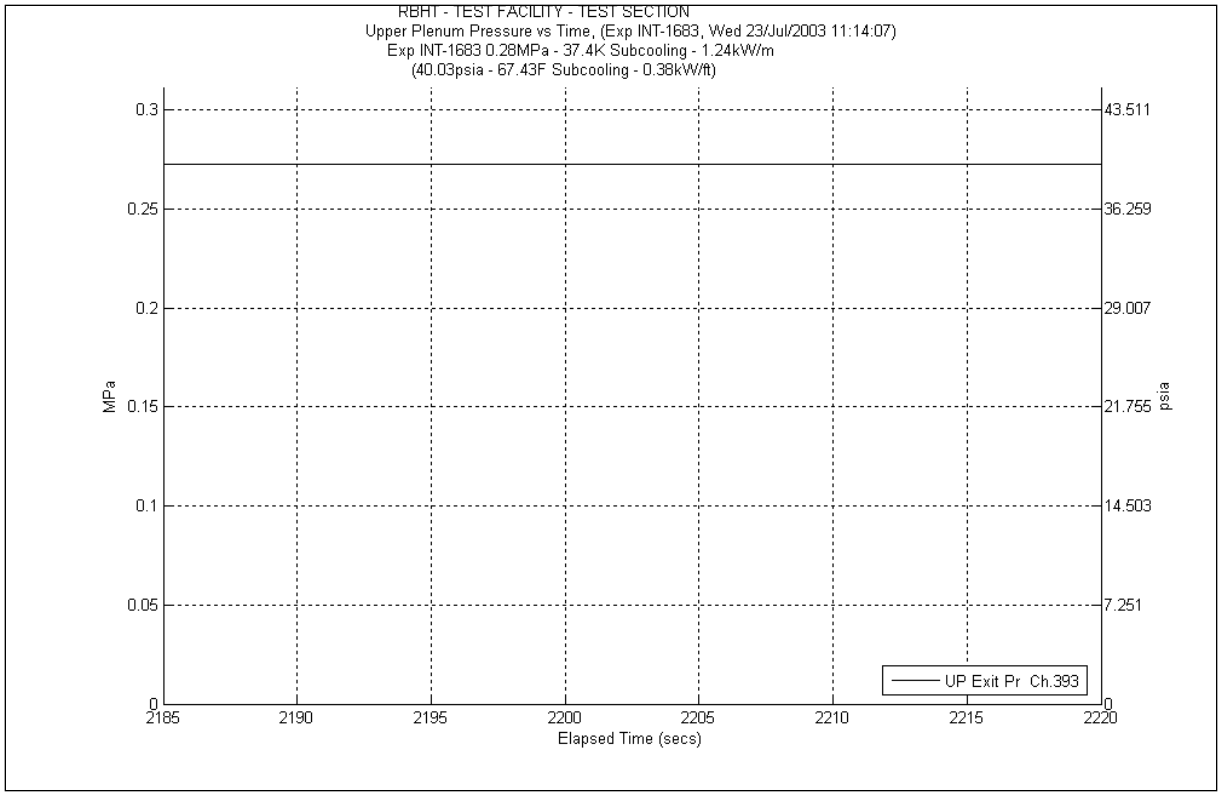

Figure A-673 System Pressure Plot for Experiment 1683B

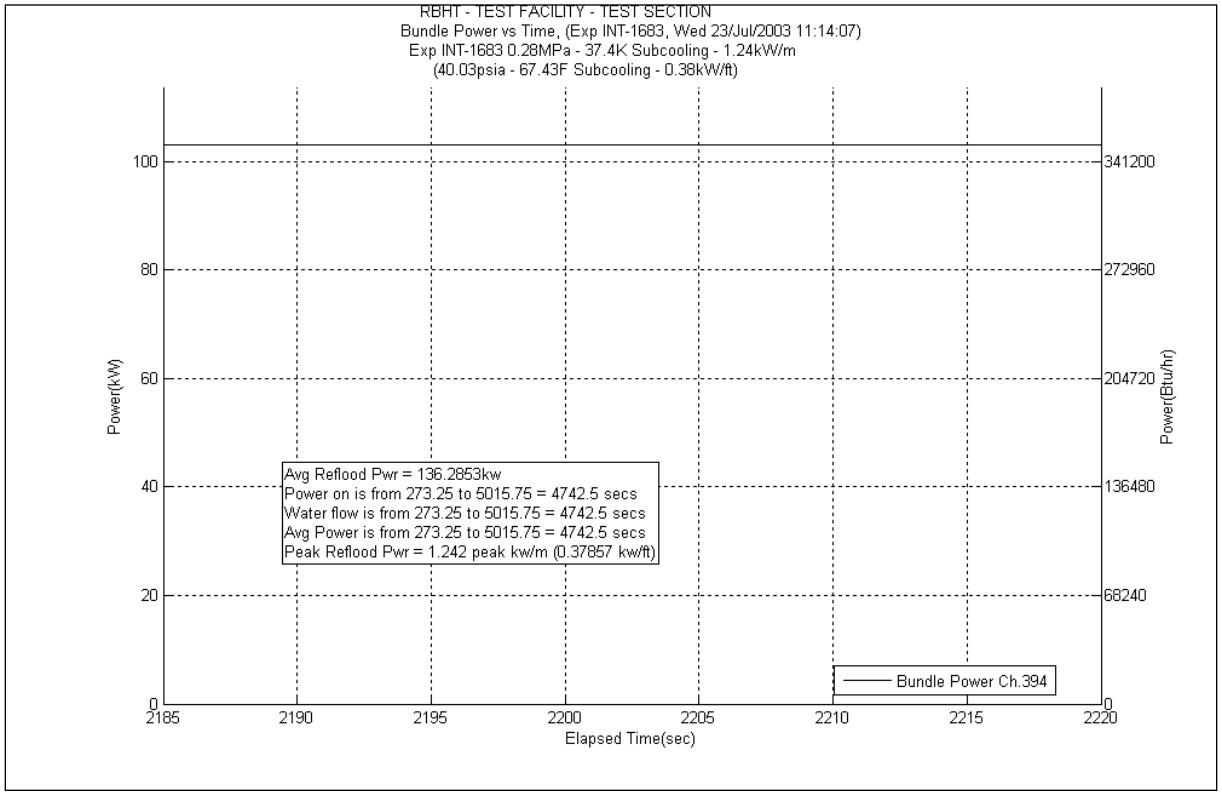

Figure A-674 Bundle Power Plot for Experiment 1683B

Table A-269 Data Results for RBHT Test 1683 for Time Period 2185 to 2220

Results for RBHT Test 1683
Valid Time Period 2185 to 2220 seconds
Collapsed Liquid Level = 93.743 inches = 2381.06 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.743	14.708	704.199	1.329	63.633	0.370	17.716	0.000	0.000	13	622.443	5773	276412.7237	0.772	0.768	0.776
*	120-133	3048-3378	383	0.702	20.124	963.550	1.447	69.283	0.661	31.649	2.406	115.207	15.61	747.411	5788.61	277160.1345	0.769	0.765	0.773
*	108-120	2743-3048	382	0.647	21.973	1052.072	1.169	55.972	0.825	39.501	5.109	244.619	14.87	711.979	5803.48	277872.1139	0.761	0.757	0.765
	100-108	2540-2743	381	0.727	11.337	542.820	0.669	32.032	0.604	28.920	0.000	0.000	10.06	481.675	5813.54	278353.7893	0.758	0.754	0.762
	97-100	2464-2540	380	0.639	5.630	269.545	0.226	10.821	0.219	10.486	0.000	0.000	5.185	248.259	5818.725	278602.0484	0.667	0.664	0.670
	93-97	2362-2464	379	0.627	7.754	371.246	0.281	13.454	0.285	13.646	0.000	0.000	7.186	344.068	5825.911	278946.1159	0.654	0.651	0.657
*	85-93	2159-2362	378	0.458	22.508	1077.684	0.490	23.461	0.546	26.143	7.212	345.307	14.26	682.772	5840.171	279628.8884	0.657	0.654	0.660
	81-85	2057-2159	377	0.637	7.546	361.300	0.208	9.959	0.262	12.545	0.000	0.000	7.075	338.753	5847.246	279967.6412	0.659	0.656	0.662
	78-81	1981-2057	376	0.536	7.224	345.883	0.140	6.703	0.191	9.145	0.000	0.000	6.889	329.847	5854.135	280297.4883	0.558	0.555	0.561
	75-78	1905-1981	375	0.441	8.704	416.751	0.125	5.985	0.187	8.954	0.000	0.000	8.388	401.620	5862.523	280699.1079	0.462	0.460	0.464
	72-75	1829-1905	374	0.370	9.815	469.964	0.110	5.267	0.183	8.762	0.000	0.000	9.518	455.724	5872.041	281154.8322	0.389	0.387	0.391
*	67-72	1702-1829	373	0.312	17.865	855.383	0.148	7.086	0.295	14.125	-0.018	-0.859	17.44	835.032	5889.481	281989.8639	0.328	0.326	0.330
	63-67	1600-1702	372	0.252	15.533	743.736	0.083	3.974	0.227	10.869	0.000	0.000	15.22	728.738	5904.701	282718.6014	0.267	0.266	0.268
	60-63	1524-1600	371	0.053	14.754	706.437	0.037	1.772	0.166	7.948	0.000	0.000	14.55	696.658	5919.251	283415.2591	0.066	0.063	0.069
	57-60	1448-1524	370	0.070	14.489	693.756	0.015	0.718	0.074	3.543	0.000	0.000	14.4	689.476	5933.651	284104.7348	0.076	0.072	0.080
	53-57	1346-1448	369	0.056	19.610	938.933	0.003	0.144	0.000	0.000	0.000	0.000	19.6	938.453	5953.251	285043.1879	0.056	0.053	0.059
*	46-53	1168-1346	368	0.053	34.437	1648.851	0.006	0.287	0.000	0.000	-0.189	-9.051	34.62	1657.614	5987.871	286700.8024	0.047	0.045	0.049
	43-46	1092-1168	367	0.039	14.978	717.130	0.003	0.144	0.000	0.000	0.000	0.000	14.97	716.767	6002.841	287417.5698	0.039	0.037	0.041
	37-43	940-1092	366	0.040	29.908	1432.021	0.005	0.239	0.000	0.000	0.000	0.000	29.89	1431.141	6032.731	288848.7107	0.04	0.038	0.042
*	25-37	635-940	365	0.032	60.341	2889.157	0.010	0.479	0.000	0.000	0.231	11.075	60.1	2877.603	6092.831	291726.3141	0.035	0.033	0.037
	13-25	330-635	364	0.030	60.445	2894.130	0.010	0.479	0.000	0.000	0.000	0.000	60.42	2892.925	6153.251	294619.2393	0.03	0.029	0.032
*	0-13	0-330	363	0.020	66.189	3169.146	0.011	0.527	0.000	0.000	-0.292	-13.981	66.47	3182.601	6219.721	297801.8399	0.015	0.014	0.016

Table A-270 Energy Balance Results for RBHT Test 1683B for Time Period 2185 to 2220 seconds

Results for RBHT Test 1683
Valid Time Period 2185 to 2220 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4656.9813	14.691	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
0.25	6.35	4915.7025	15.507	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
0.50	12.70	5174.4237	16.323	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
0.75	19.05	5433.1449	17.139	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
1.00	25.40	5691.8661	17.955	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
1.25	31.75	5950.5873	18.772	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
1.50	38.10	6209.3085	19.588	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
1.75	44.45	6468.0296	20.404	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
2.00	50.80	6726.7508	21.22	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
2.25	57.15	6985.472	22.036	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
2.50	63.50	7244.1932	22.852	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
2.75	69.85	7502.9144	23.668	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
3.00	76.20	7761.6356	24.485	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
3.25	82.55	8020.3568	25.301	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
3.50	88.90	8279.0779	26.117	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
3.75	95.25	8537.7991	26.933	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
4.00	101.60	8796.5203	27.749	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
4.25	107.95	9055.2415	28.565	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
4.50	114.30	9313.9627	29.382	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
4.75	120.65	9572.6839	30.198	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.33E-02
5.00	127.00	9831.4051	31.014	3.43E-03	2.93E-01	1.33E-01	1.39E-01	6.31E-02
5.25	133.35	10090.126	31.83	1.11E-02	9.47E-01	4.29E-01	1.38E-01	6.26E-02
5.50	139.70	10348.847	32.646	1.89E-02	1.62E+00	7.34E-01	1.37E-01	6.22E-02
5.75	146.05	10607.569	33.462	2.70E-02	2.31E+00	1.05E+00	1.36E-01	6.16E-02
6.00	152.40	10866.29	34.278	3.52E-02	3.01E+00	1.37E+00	1.35E-01	6.11E-02
6.25	158.75	11125.011	35.095	4.37E-02	3.73E+00	1.69E+00	1.34E-01	6.06E-02
6.50	165.10	11383.732	35.911	5.23E-02	4.47E+00	2.03E+00	1.32E-01	6.00E-02
6.75	171.45	11642.453	36.727	6.12E-02	5.23E+00	2.37E+00	1.31E-01	5.95E-02
7.00	177.80	11901.175	37.543	7.02E-02	6.00E+00	2.72E+00	1.30E-01	5.89E-02
7.25	184.15	12159.896	38.359	7.94E-02	6.79E+00	3.08E+00	1.29E-01	5.83E-02
7.50	190.50	12418.617	39.175	8.89E-02	7.60E+00	3.45E+00	1.27E-01	5.77E-02
7.75	196.85	12677.338	39.992	9.85E-02	8.42E+00	3.82E+00	1.26E-01	5.71E-02
8.00	203.20	12936.059	40.808	1.08E-01	9.26E+00	4.20E+00	1.25E-01	5.65E-02
8.25	209.55	13194.78	41.624	1.18E-01	1.01E+01	4.59E+00	1.23E-01	5.58E-02
8.50	215.90	13453.502	42.44	1.29E-01	1.10E+01	4.98E+00	1.22E-01	5.52E-02
8.75	222.25	13712.223	43.256	1.39E-01	1.19E+01	5.39E+00	1.20E-01	5.45E-02
9.00	228.60	13970.944	44.072	1.50E-01	1.28E+01	5.80E+00	1.19E-01	5.39E-02
9.25	234.95	13194.78	41.624	1.60E-01	1.37E+01	6.21E+00	1.17E-01	5.32E-02
9.50	241.30	12418.617	39.175	1.70E-01	1.45E+01	6.59E+00	1.16E-01	5.26E-02
9.75	247.65	11642.453	36.727	1.79E-01	1.53E+01	6.95E+00	1.15E-01	5.20E-02
10.00	254.00	10866.29	34.278	1.88E-01	1.60E+01	7.28E+00	1.13E-01	5.15E-02
10.25	260.35	10090.126	31.83	1.96E-01	1.67E+01	7.59E+00	1.12E-01	5.09E-02
10.50	266.70	9313.9627	29.382	2.03E-01	1.74E+01	7.88E+00	1.11E-01	5.05E-02
10.75	273.05	8537.7991	26.933	2.10E-01	1.80E+01	8.15E+00	1.10E-01	5.00E-02
11.00	279.40	7761.6356	24.485	2.17E-01	1.85E+01	8.39E+00	1.09E-01	4.96E-02
11.25	285.75	6985.472	22.036	2.22E-01	1.90E+01	8.61E+00	1.09E-01	4.93E-02
11.50	292.10	6209.3085	19.588	2.27E-01	1.94E+01	8.81E+00	1.08E-01	4.90E-02
11.75	298.45	5433.1449	17.139	2.32E-01	1.98E+01	8.98E+00	1.07E-01	4.87E-02
12.00	304.80	4656.9813	14.691	2.36E-01	2.01E+01	9.13E+00	1.07E-01	4.84E-02

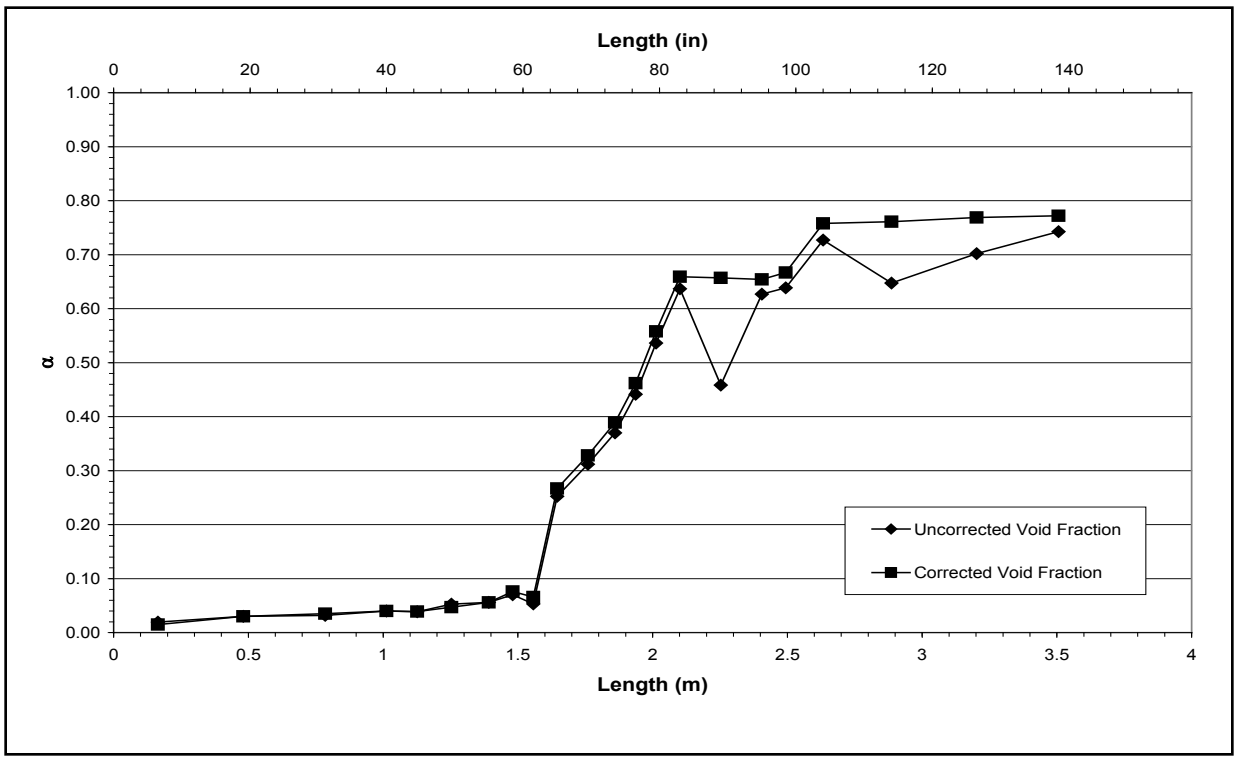

Figure A-675 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683B for Time Period 2185 to 2220 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-C

Test Conditions

Date: 7/23/2003
Steady-state time window: 2530 – 2600 seconds
Inlet flow rate: 4.122 cm/sec (1.623 in./sec)
Inlet mass flow rate: 0.195 kg/sec (0.429 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

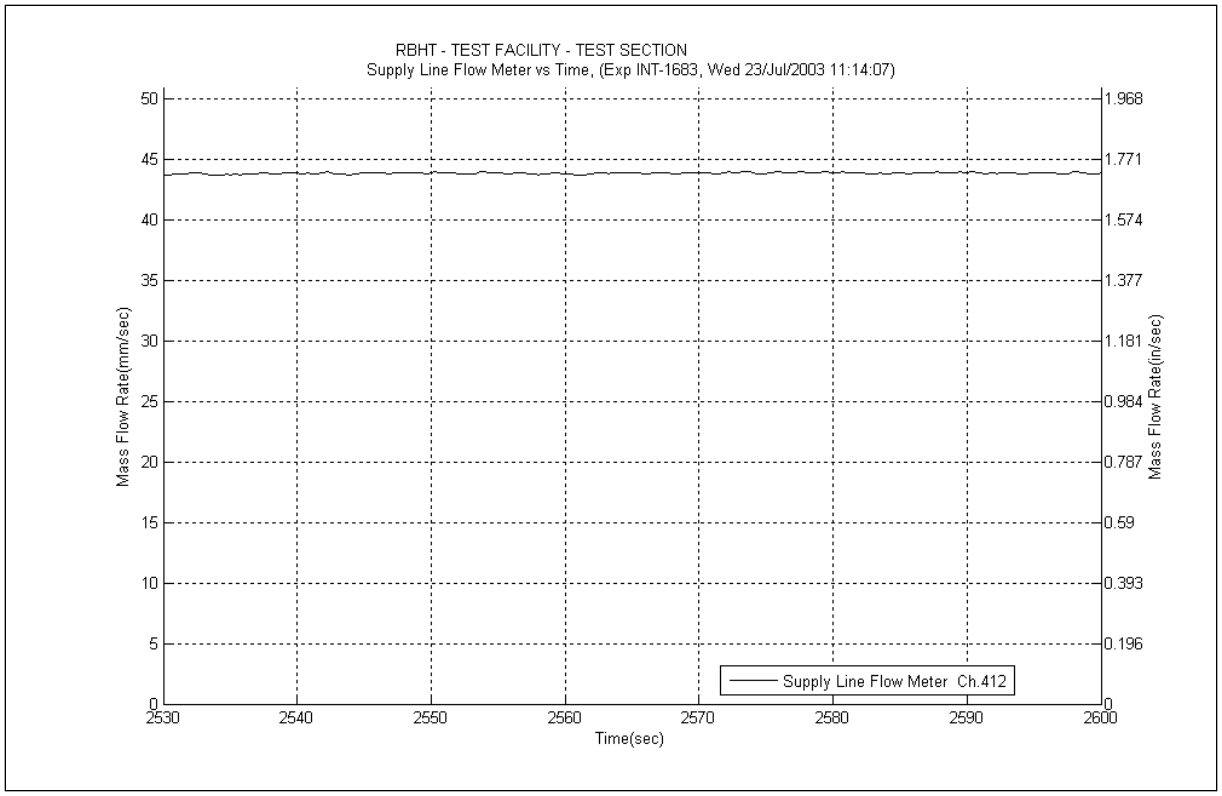

Figure A-676 Inlet Flow Plot for Experiment 1683C

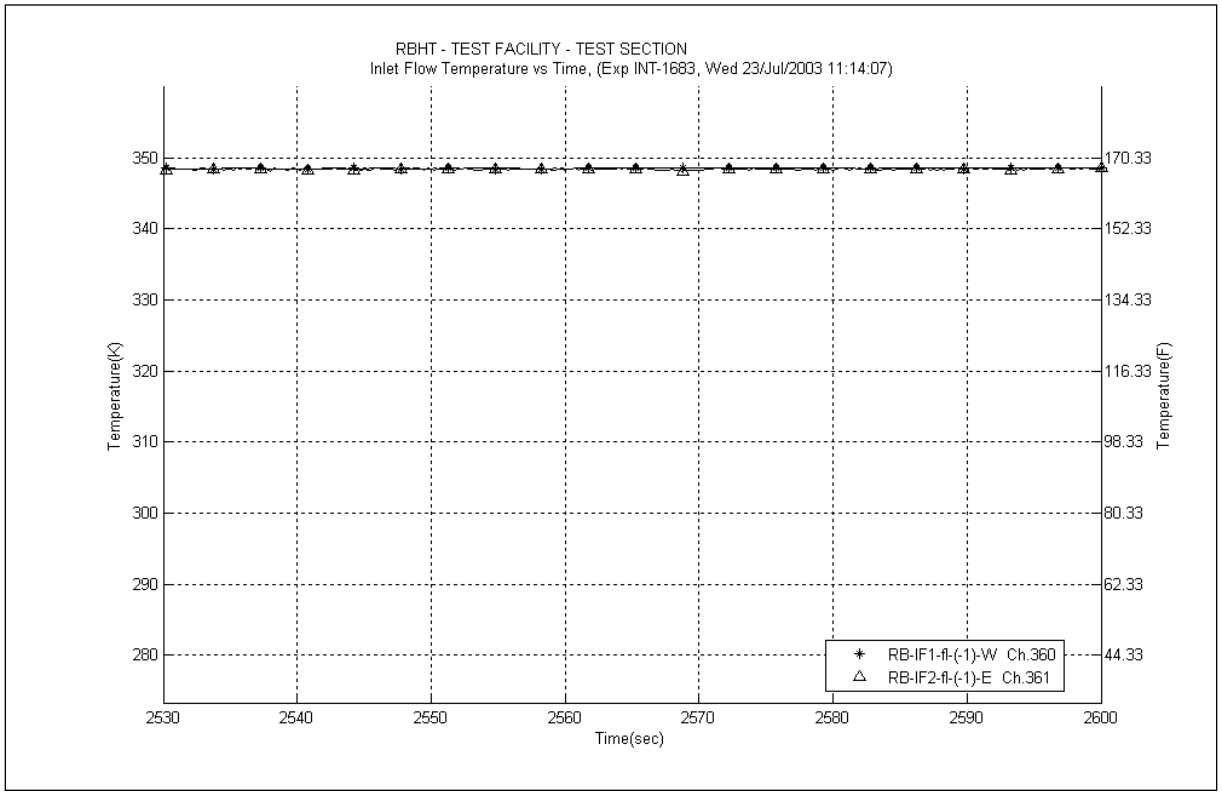

Figure A-677 Inlet Temperature Plot for Experiment 1683C

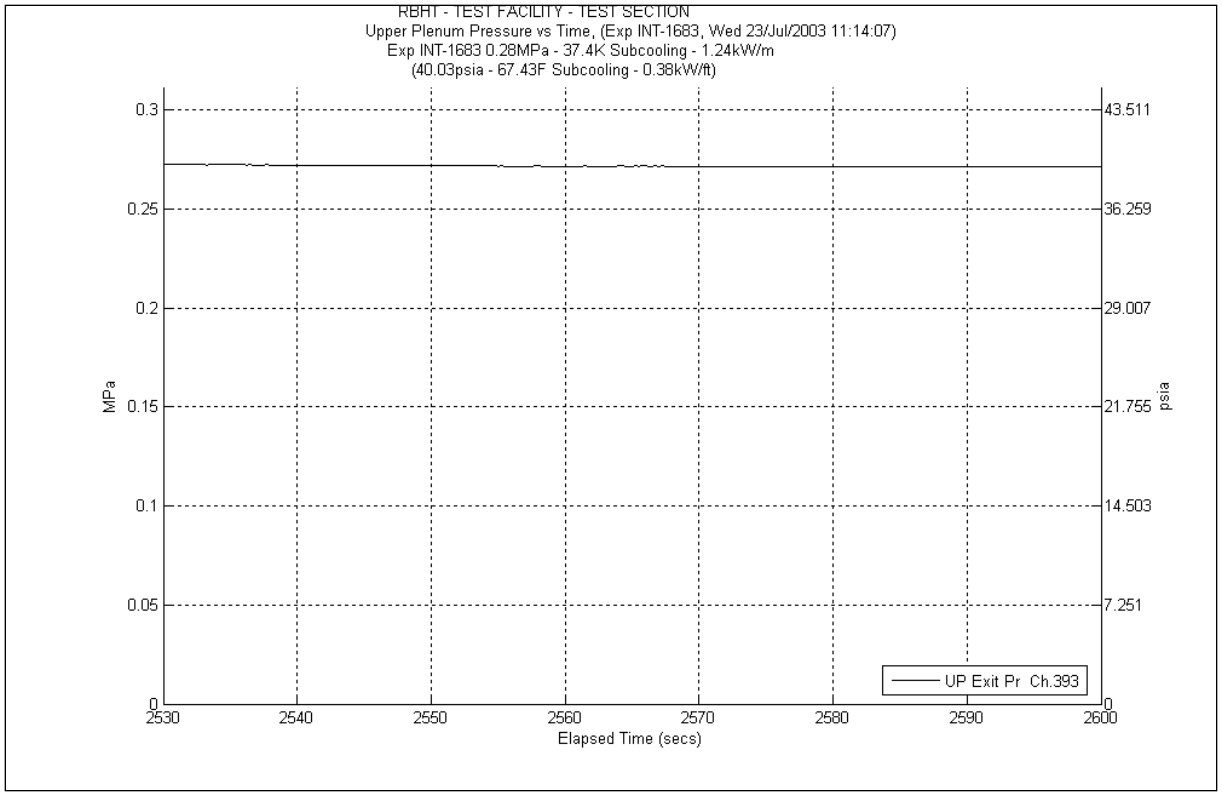

Figure A-678 System Pressure Plot for Experiment 1683C

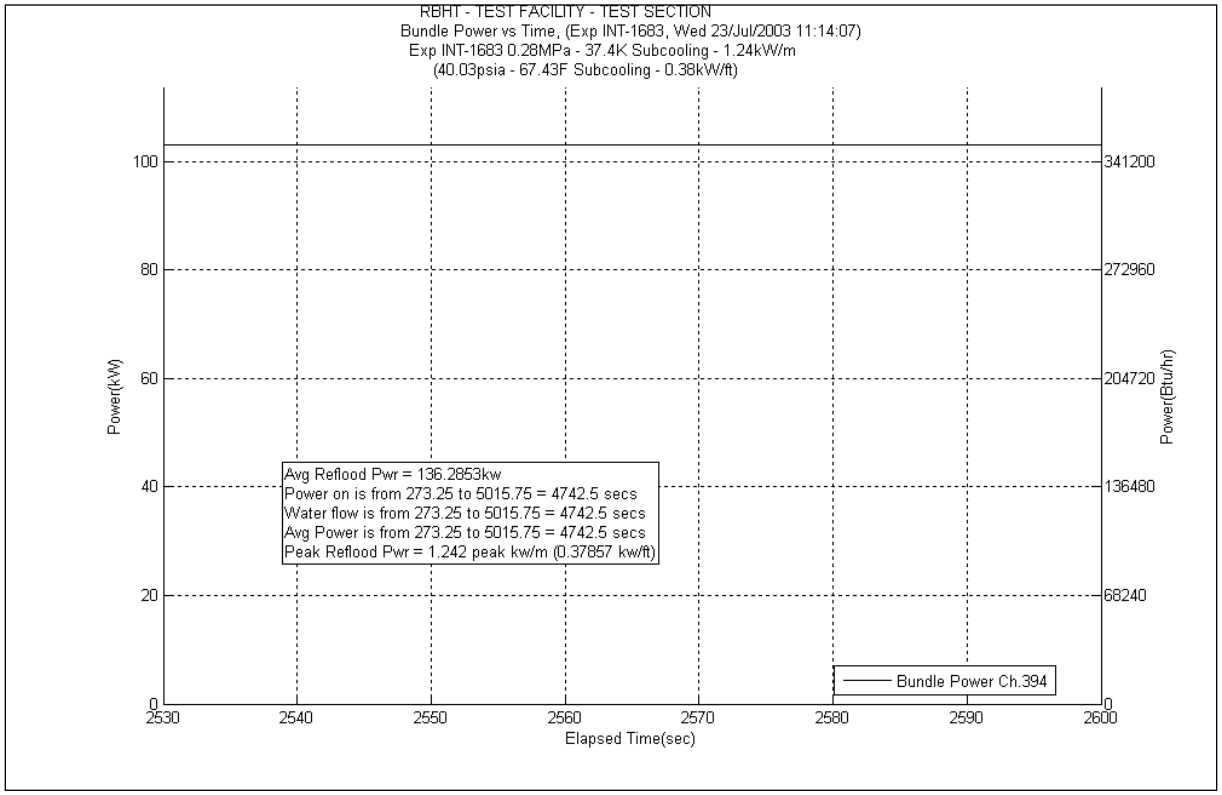

Figure A-679 Bundle Power Plot for Experiment 1683C

Table A-271 Data Results for RBHT Test 1683 for Time Period 2530 to 2600

Results for RBHT Test 1683
Valid Time Period 2530 to 2600 seconds
Collapsed Liquid Level = 94.084 inches = 2389.73 mm
(Z_{osv}) Onset of Significant Void = 55 inches = 1397 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.740	14.853	711.162	1.335	63.920	0.372	17.811	0.000	0.000	13.14	629.147	5773.14	276419.4269	0.77	0.766	0.774
*	120-133	3048-3378	383	0.702	20.093	962.058	1.454	69.618	0.665	31.840	2.214	106.007	15.76	754.593	5788.9	277174.0197	0.767	0.763	0.771
*	108-120	2743-3048	382	0.645	22.098	1058.040	1.174	56.211	0.830	39.741	5.124	245.320	14.97	716.767	5803.87	277890.7872	0.76	0.756	0.764
	100-108	2540-2743	381	0.726	11.405	546.053	0.672	32.176	0.607	29.063	0.000	0.000	10.12	484.548	5813.99	278375.3354	0.756	0.752	0.760
	97-100	2464-2540	380	0.636	5.676	271.783	0.227	10.869	0.220	10.534	0.000	0.000	5.228	250.318	5819.218	278625.6534	0.664	0.661	0.667
	93-97	2362-2464	379	0.631	7.676	367.516	0.282	13.502	0.286	13.694	0.000	0.000	7.104	340.141	5826.322	278965.7947	0.658	0.655	0.661
*	85-93	2159-2362	378	0.457	22.575	1080.916	0.492	23.557	0.549	26.286	7.304	349.737	14.23	681.336	5840.552	279647.1308	0.657	0.654	0.660
	81-85	2057-2159	377	0.634	7.603	364.035	0.209	10.007	0.263	12.593	0.000	0.000	7.128	341.290	5847.68	279988.4213	0.657	0.654	0.660
	78-81	1981-2057	376	0.531	7.312	350.110	0.140	6.703	0.192	9.193	0.000	0.000	6.976	334.013	5854.656	280322.4339	0.552	0.549	0.555
	75-78	1905-1981	375	0.443	8.678	415.507	0.125	5.985	0.188	9.001	0.000	0.000	8.364	400.470	5863.02	280722.9044	0.463	0.461	0.465
	72-75	1829-1905	374	0.374	9.758	467.228	0.110	5.267	0.184	8.810	0.000	0.000	9.46	452.947	5872.48	281175.8516	0.393	0.391	0.395
*	67-72	1702-1829	373	0.309	17.953	859.611	0.148	7.086	0.297	14.220	-0.002	-0.079	17.51	838.383	5889.99	282014.2349	0.326	0.324	0.328
	63-67	1600-1702	372	0.243	15.720	752.688	0.083	3.974	0.229	10.965	0.000	0.000	15.4	737.356	5905.39	282751.5909	0.258	0.257	0.259
	60-63	1524-1600	371	0.050	14.801	708.675	0.036	1.724	0.166	7.948	0.000	0.000	14.59	698.573	5919.98	283450.1638	0.063	0.060	0.066
	57-60	1448-1524	370	0.070	14.495	694.004	0.015	0.718	0.068	3.256	0.000	0.000	14.41	689.955	5934.39	284140.1183	0.075	0.071	0.079
	53-57	1346-1448	369	0.056	19.615	939.181	0.003	0.144	0.000	0.000	0.000	0.000	19.61	938.932	5954	285079.0502	0.056	0.053	0.059
*	46-53	1168-1346	368	0.053	34.437	1648.851	0.006	0.287	0.000	0.000	-0.199	-9.530	34.63	1658.093	5988.63	286737.1435	0.047	0.045	0.049
	43-46	1092-1168	367	0.038	14.983	717.378	0.003	0.144	0.000	0.000	0.000	0.000	14.97	716.767	6003.6	287453.9109	0.039	0.037	0.041
	37-43	940-1092	366	0.040	29.914	1432.270	0.005	0.239	0.000	0.000	0.000	0.000	29.9	1431.620	6033.5	288885.5306	0.04	0.038	0.042
*	25-37	635-940	365	0.032	60.352	2889.654	0.010	0.479	0.000	0.000	0.232	11.093	60.11	2878.082	6093.61	291763.6129	0.035	0.033	0.037
	13-25	330-635	364	0.030	60.450	2894.379	0.010	0.479	0.000	0.000	0.000	0.000	60.42	2892.925	6154.03	294656.538	0.03	0.029	0.032
*	0-13	0-330	363	0.020	66.189	3169.146	0.011	0.527	0.000	0.000	-0.292	-13.981	66.47	3182.601	6220.5	297839.1387	0.015	0.014	0.016

Table A-272 Energy Balance Results for RBHT Test 1683C for Time Period 2530 to 2600 seconds

Results for RBHT Test 1683
Valid Time Period 2530 to 2600 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.607	14.693	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
0.25	6.35	4916.3629	15.509	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
0.50	12.70	5175.1189	16.325	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
0.75	19.05	5433.8748	17.142	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
1.00	25.40	5692.6308	17.958	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
1.25	31.75	5951.3867	18.774	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
1.50	38.10	6210.1427	19.59	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
1.75	44.45	6468.8986	20.407	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
2.00	50.80	6727.6546	21.223	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
2.25	57.15	6986.4105	22.039	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
2.50	63.50	7245.1665	22.855	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
2.75	69.85	7503.9224	23.672	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
3.00	76.20	7762.6783	24.488	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
3.25	82.55	8021.4343	25.304	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
3.50	88.90	8280.1902	26.12	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
3.75	95.25	8538.9462	26.937	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
4.00	101.60	8797.7021	27.753	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
4.25	107.95	9056.4581	28.569	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
4.50	114.30	9315.214	29.386	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
4.75	120.65	9573.97	30.202	0.00E+00	0.00E+00	0.00E+00	1.40E-01	6.36E-02
5.00	127.00	9832.7259	31.018	3.11E-03	2.67E-01	1.21E-01	1.40E-01	6.34E-02
5.25	133.35	10091.482	31.834	1.07E-02	9.22E-01	4.18E-01	1.39E-01	6.30E-02
5.50	139.70	10350.238	32.651	1.85E-02	1.59E+00	7.22E-01	1.38E-01	6.25E-02
5.75	146.05	10608.994	33.467	2.66E-02	2.28E+00	1.03E+00	1.37E-01	6.20E-02
6.00	152.40	10867.75	34.283	3.48E-02	2.99E+00	1.35E+00	1.35E-01	6.14E-02
6.25	158.75	11126.506	35.099	4.32E-02	3.71E+00	1.68E+00	1.34E-01	6.09E-02
6.50	165.10	11385.262	35.916	5.18E-02	4.45E+00	2.02E+00	1.33E-01	6.04E-02
6.75	171.45	11644.018	36.732	6.06E-02	5.20E+00	2.36E+00	1.32E-01	5.98E-02
7.00	177.80	11902.773	37.548	6.96E-02	5.98E+00	2.71E+00	1.31E-01	5.92E-02
7.25	184.15	12161.529	38.364	7.88E-02	6.77E+00	3.07E+00	1.29E-01	5.86E-02
7.50	190.50	12420.285	39.181	8.82E-02	7.57E+00	3.44E+00	1.28E-01	5.80E-02
7.75	196.85	12679.041	39.997	9.78E-02	8.40E+00	3.81E+00	1.27E-01	5.74E-02
8.00	203.20	12937.797	40.813	1.08E-01	9.24E+00	4.19E+00	1.25E-01	5.68E-02
8.25	209.55	13196.553	41.629	1.18E-01	1.01E+01	4.58E+00	1.24E-01	5.62E-02
8.50	215.90	13455.309	42.446	1.28E-01	1.10E+01	4.98E+00	1.22E-01	5.55E-02
8.75	222.25	13714.065	43.262	1.38E-01	1.19E+01	5.38E+00	1.21E-01	5.49E-02
9.00	228.60	13972.821	44.078	1.49E-01	1.28E+01	5.79E+00	1.19E-01	5.42E-02
9.25	234.95	13196.553	41.629	1.59E-01	1.37E+01	6.20E+00	1.18E-01	5.35E-02
9.50	241.30	12420.285	39.181	1.69E-01	1.45E+01	6.58E+00	1.17E-01	5.29E-02
9.75	247.65	11644.018	36.732	1.78E-01	1.53E+01	6.94E+00	1.15E-01	5.23E-02
10.00	254.00	10867.75	34.283	1.87E-01	1.60E+01	7.27E+00	1.14E-01	5.18E-02
10.25	260.35	10091.482	31.834	1.95E-01	1.67E+01	7.59E+00	1.13E-01	5.13E-02
10.50	266.70	9315.214	29.386	2.02E-01	1.74E+01	7.87E+00	1.12E-01	5.08E-02
10.75	273.05	8538.9462	26.937	2.09E-01	1.79E+01	8.14E+00	1.11E-01	5.04E-02
11.00	279.40	7762.6783	24.488	2.15E-01	1.85E+01	8.38E+00	1.10E-01	4.99E-02
11.25	285.75	6986.4105	22.039	2.21E-01	1.90E+01	8.60E+00	1.09E-01	4.96E-02
11.50	292.10	6210.1427	19.59	2.26E-01	1.94E+01	8.80E+00	1.09E-01	4.93E-02
11.75	298.45	5433.8748	17.142	2.30E-01	1.98E+01	8.97E+00	1.08E-01	4.90E-02
12.00	304.80	4657.607	14.693	2.34E-01	2.01E+01	9.12E+00	1.07E-01	4.87E-02

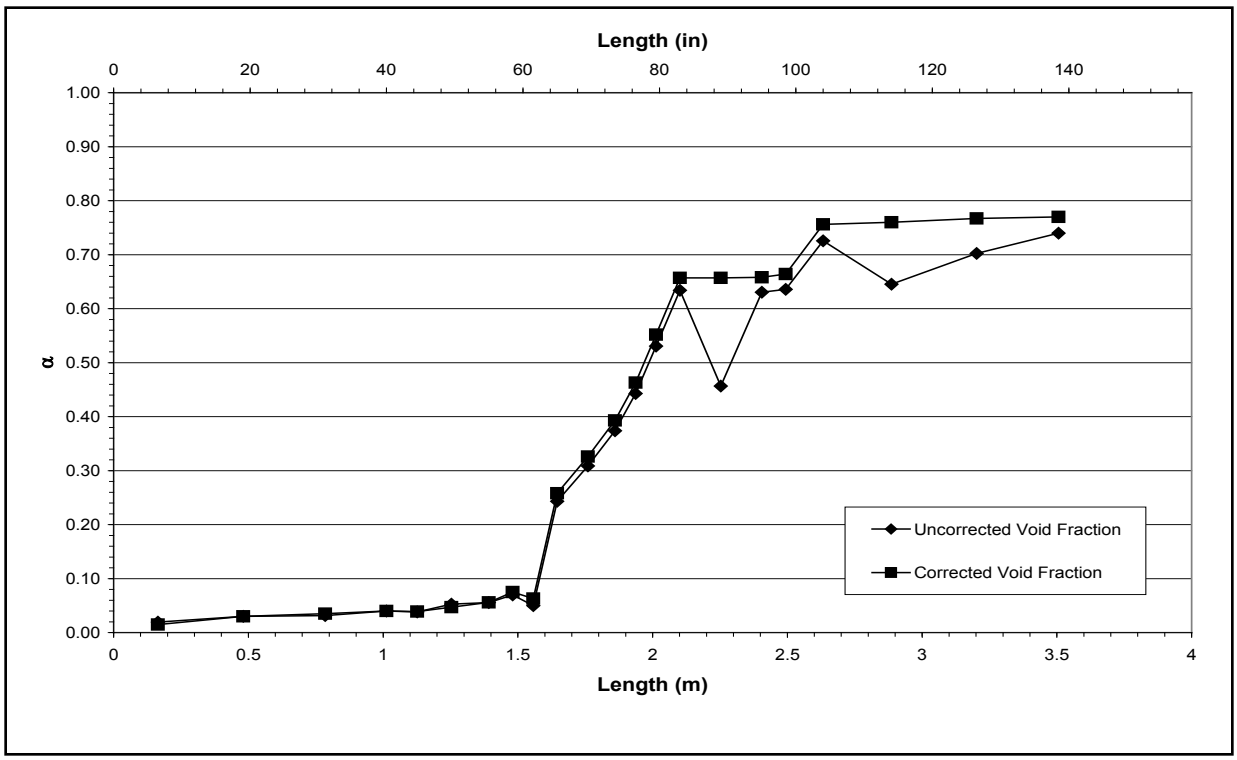

Figure A-680 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683C for Time Period 2530 to 2600 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-D

Test Conditions

Date: 7/23/2003
Steady-state time window: 2760 – 2800 seconds
Inlet flow rate: 3.452 cm/sec (1.359 in./sec)
Inlet mass flow rate: 0.163 kg/sec (0.359 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

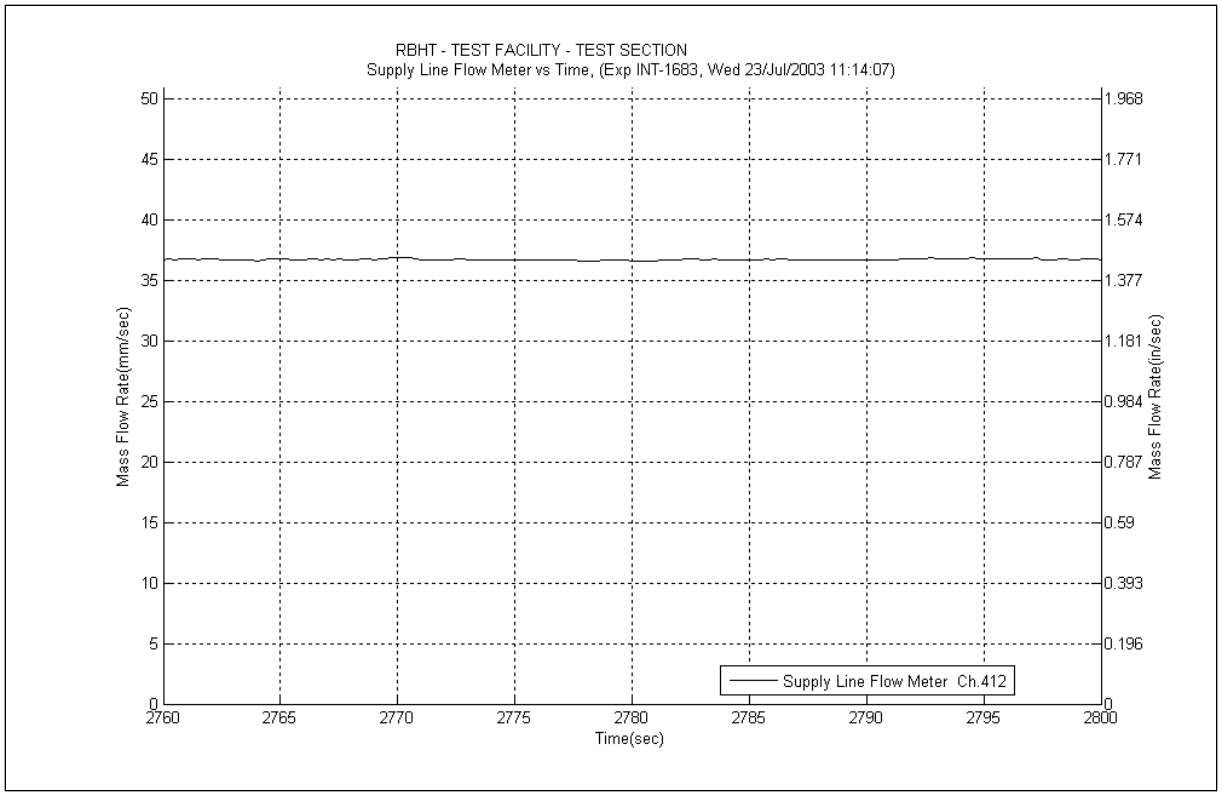

Figure A-681 Inlet Flow Plot for Experiment 1683D

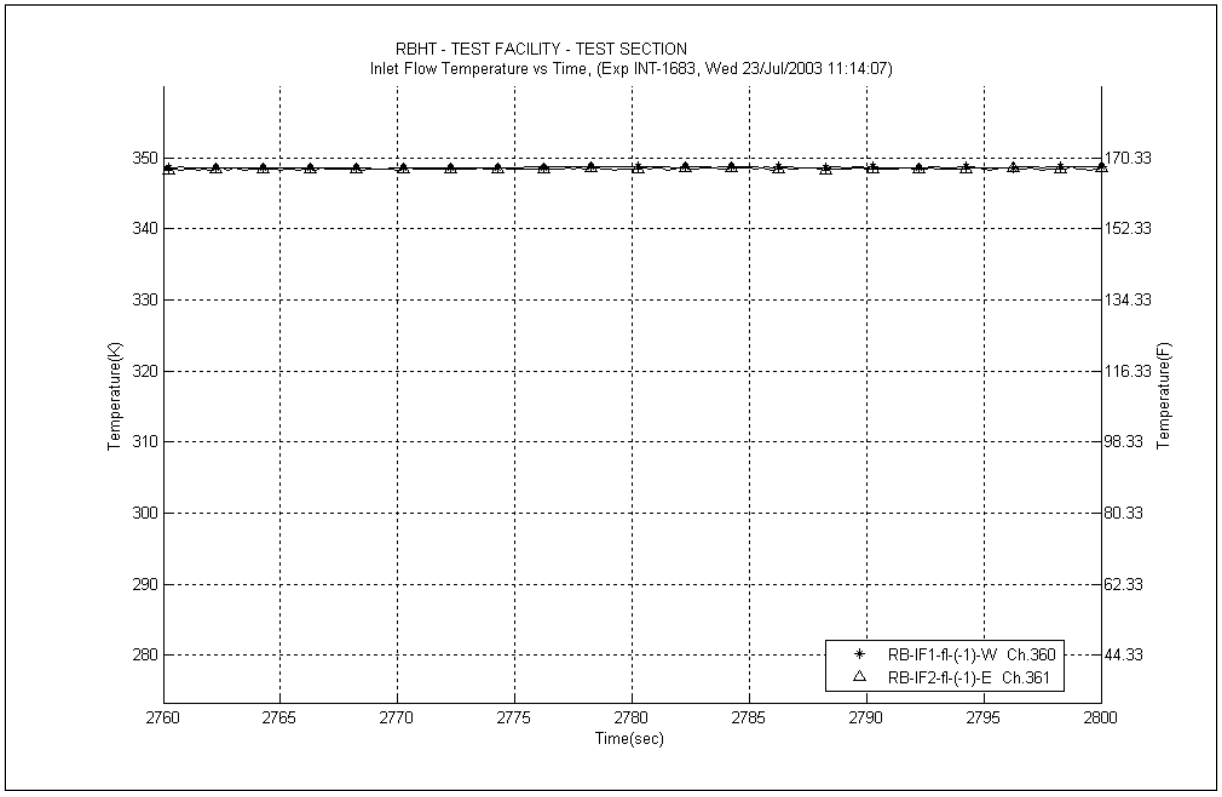

Figure A-682 Inlet Temperature Plot for Experiment 1683D

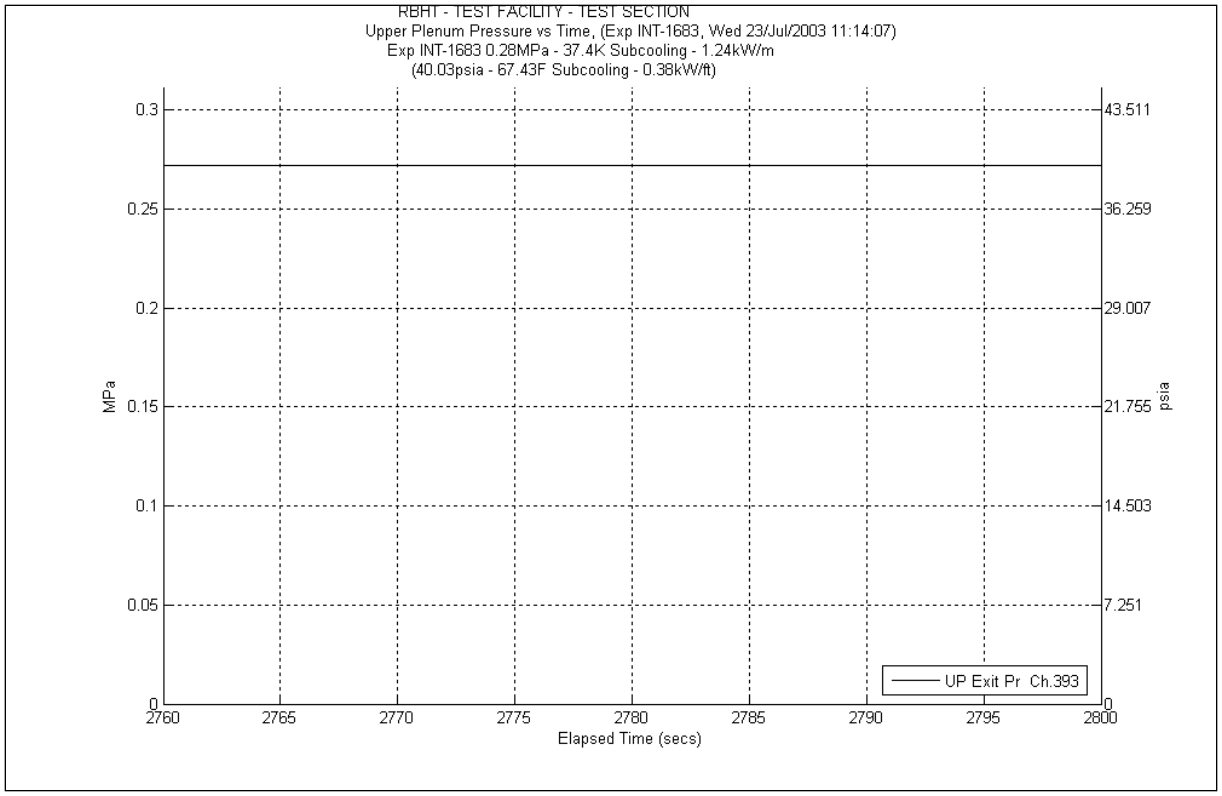

Figure A-683 System Pressure Plot for Experiment 1683D

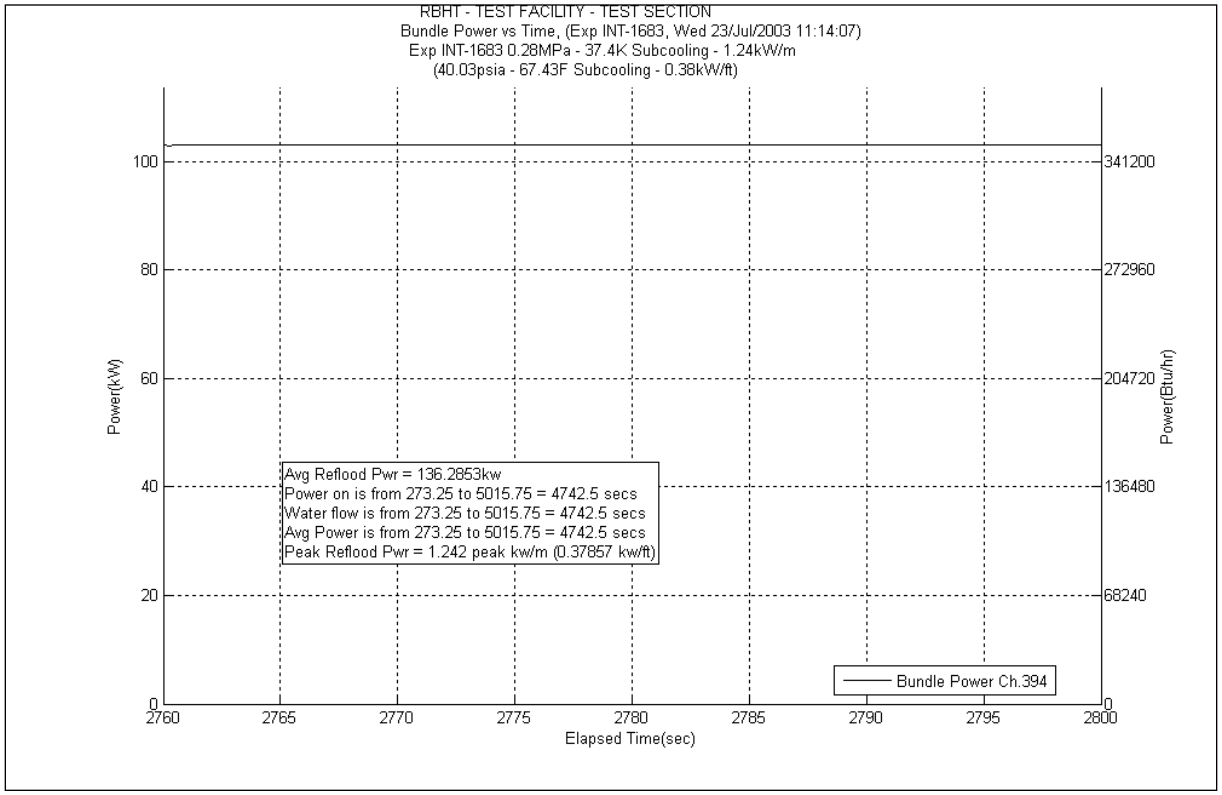

Figure A-684 Bundle Power Plot for Experiment 1683D

Table A-273 Data Results for RBHT Test 1683 for Time Period 2760 to 2800

Results for RBHT Test 1683
Valid Time Period 2760 to 2800 seconds
Collapsed Liquid Level = 88.424 inches = 2245.96 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.767	13.316	637.559	1.160	55.541	0.312	14.939	0.000	0.000	11.84	566.902	5771.84	276357.1826	0.793	0.789	0.797
*	120-133	3048-3378	383	0.721	18.826	901.385	1.268	60.712	0.556	26.621	2.672	127.927	14.33	686.124	5786.17	277043.3066	0.788	0.784	0.792
*	108-120	2743-3048	382	0.667	20.727	992.394	1.031	49.365	0.694	33.229	5.162	247.138	13.84	662.663	5800.01	277705.9694	0.778	0.774	0.782
	100-108	2540-2743	381	0.746	10.542	504.776	0.597	28.585	0.508	24.323	0.000	0.000	9.433	451.654	5809.443	278157.6239	0.773	0.769	0.777
	97-100	2464-2540	380	0.669	5.152	246.669	0.204	9.768	0.184	8.810	0.000	0.000	4.761	227.958	5814.204	278385.5818	0.694	0.691	0.697
	93-97	2362-2464	379	0.668	6.897	330.218	0.255	12.209	0.239	11.443	0.000	0.000	6.401	306.482	5820.605	278692.0633	0.692	0.689	0.695
*	85-93	2159-2362	378	0.485	21.402	1024.720	0.453	21.690	0.460	22.025	7.729	370.053	12.76	610.952	5833.365	279303.0154	0.693	0.690	0.696
	81-85	2057-2159	377	0.674	6.782	324.747	0.198	9.480	0.220	10.534	0.000	0.000	6.361	304.566	5839.726	279607.5817	0.694	0.691	0.697
	78-81	1981-2057	376	0.574	6.642	318.034	0.136	6.512	0.161	7.709	0.000	0.000	6.342	303.657	5846.068	279911.2383	0.593	0.590	0.596
	75-78	1905-1981	375	0.491	7.935	379.949	0.125	5.985	0.157	7.517	0.000	0.000	7.652	366.380	5853.72	280277.618	0.509	0.506	0.512
	72-75	1829-1905	374	0.407	9.234	442.114	0.114	5.458	0.154	7.374	0.000	0.000	8.962	429.103	5862.682	280706.7209	0.425	0.423	0.427
*	67-72	1702-1829	373	0.361	16.598	794.711	0.165	7.900	0.248	11.874	1.115	53.381	15.07	721.555	5877.752	281428.2763	0.419	0.417	0.421
	63-67	1600-1702	372	0.400	12.474	597.276	0.108	5.171	0.191	9.145	0.000	0.000	12.17	582.703	5889.922	282010.9791	0.414	0.412	0.416
	60-63	1524-1600	371	0.256	11.592	555.005	0.066	3.160	0.139	6.655	0.000	0.000	11.38	544.877	5901.302	282555.8564	0.269	0.268	0.270
	57-60	1448-1524	370	0.184	12.713	608.715	0.052	2.490	0.136	6.512	0.000	0.000	12.52	599.461	5913.822	283155.3172	0.196	0.195	0.197
	53-57	1346-1448	369	0.077	19.184	918.543	0.044	2.107	0.175	8.379	0.000	0.000	18.96	907.810	5932.782	284063.1269	0.087	0.083	0.091
*	46-53	1168-1346	368	0.057	34.266	1640.645	0.030	1.436	0.067	3.208	0.199	9.509	33.97	1626.492	5966.752	285689.6192	0.065	0.062	0.068
	43-46	1092-1168	367	0.043	14.910	713.897	0.002	0.096	0.000	0.000	0.000	0.000	14.9	713.416	5981.652	286403.035	0.043	0.041	0.045
	37-43	940-1092	366	0.043	29.820	1427.794	0.004	0.192	0.000	0.000	0.000	0.000	29.81	1427.310	6011.462	287830.3455	0.043	0.041	0.045
*	25-37	635-940	365	0.035	60.149	2879.957	0.007	0.335	0.000	0.000	0.172	8.242	59.97	2871.379	6071.432	290701.7245	0.037	0.035	0.039
	13-25	330-635	364	0.032	60.346	2889.406	0.007	0.335	0.000	0.000	0.000	0.000	60.32	2888.137	6131.752	293589.8616	0.032	0.030	0.034
*	0-13	0-330	363	0.020	66.132	3166.411	0.008	0.383	0.000	0.000	-0.296	-14.179	66.42	3180.207	6198.172	296770.0683	0.016	0.015	0.017

Table A-274 Energy Balance Results for RBHT Test 1683D for Time Period 2760 to 2800 seconds

Results for RBHT Test 1683 Valid Time Period 2760 to 2800 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4656.3805	14.689	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
0.25	6.35	4915.0683	15.505	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
0.50	12.70	5173.7561	16.321	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
0.75	19.05	5432.4439	17.137	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
1.00	25.40	5691.1317	17.953	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
1.25	31.75	5949.8196	18.769	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
1.50	38.10	6208.5074	19.585	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
1.75	44.45	6467.1952	20.401	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
2.00	50.80	6725.883	21.217	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
2.25	57.15	6984.5708	22.033	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
2.50	63.50	7243.2586	22.849	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
2.75	69.85	7501.9464	23.665	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
3.00	76.20	7760.6342	24.481	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
3.25	82.55	8019.322	25.298	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
3.50	88.90	8278.0098	26.114	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
3.75	95.25	8536.6976	26.93	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
4.00	101.60	8795.3854	27.746	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
4.25	107.95	9054.0732	28.562	0.00E+00	0.00E+00	0.00E+00	1.18E-01	5.33E-02
4.50	114.30	9312.761	29.378	7.20E-03	5.17E-01	2.35E-01	1.17E-01	5.29E-02
4.75	120.65	9571.4489	30.194	1.58E-02	1.14E+00	5.16E-01	1.16E-01	5.25E-02
5.00	127.00	9830.1367	31.01	2.47E-02	1.77E+00	8.04E-01	1.15E-01	5.20E-02
5.25	133.35	10088.824	31.826	3.38E-02	2.43E+00	1.10E+00	1.14E-01	5.15E-02
5.50	139.70	10347.512	32.642	4.31E-02	3.10E+00	1.41E+00	1.12E-01	5.10E-02
5.75	146.05	10606.2	33.458	5.27E-02	3.79E+00	1.72E+00	1.11E-01	5.05E-02
6.00	152.40	10864.888	34.274	6.25E-02	4.49E+00	2.04E+00	1.10E-01	5.00E-02
6.25	158.75	11123.576	35.09	7.25E-02	5.21E+00	2.36E+00	1.09E-01	4.94E-02
6.50	165.10	11382.263	35.906	8.28E-02	5.95E+00	2.70E+00	1.08E-01	4.89E-02
6.75	171.45	11640.951	36.722	9.33E-02	6.70E+00	3.04E+00	1.07E-01	4.83E-02
7.00	177.80	11899.639	37.538	1.04E-01	7.48E+00	3.39E+00	1.05E-01	4.78E-02
7.25	184.15	12158.327	38.354	1.15E-01	8.27E+00	3.75E+00	1.04E-01	4.72E-02
7.50	190.50	12417.015	39.17	1.26E-01	9.07E+00	4.11E+00	1.03E-01	4.66E-02
7.75	196.85	12675.703	39.986	1.38E-01	9.90E+00	4.49E+00	1.01E-01	4.60E-02
8.00	203.20	12934.39	40.802	1.49E-01	1.07E+01	4.87E+00	9.99E-02	4.53E-02
8.25	209.55	13193.078	41.619	1.61E-01	1.16E+01	5.26E+00	9.86E-02	4.47E-02
8.50	215.90	13451.766	42.435	1.74E-01	1.25E+01	5.66E+00	9.71E-02	4.41E-02
8.75	222.25	13710.454	43.251	1.86E-01	1.34E+01	6.06E+00	9.57E-02	4.34E-02
9.00	228.60	13969.142	44.067	1.99E-01	1.43E+01	6.47E+00	9.42E-02	4.27E-02
9.25	234.95	13193.078	41.619	2.11E-01	1.52E+01	6.88E+00	9.27E-02	4.21E-02
9.50	241.30	12417.015	39.17	2.23E-01	1.60E+01	7.26E+00	9.13E-02	4.14E-02
9.75	247.65	11640.951	36.722	2.34E-01	1.68E+01	7.62E+00	9.01E-02	4.08E-02
10.00	254.00	10864.888	34.274	2.44E-01	1.75E+01	7.95E+00	8.89E-02	4.03E-02
10.25	260.35	10088.824	31.826	2.53E-01	1.82E+01	8.26E+00	8.77E-02	3.98E-02
10.50	266.70	9312.761	29.378	2.62E-01	1.89E+01	8.55E+00	8.67E-02	3.93E-02
10.75	273.05	8536.6976	26.93	2.70E-01	1.94E+01	8.82E+00	8.57E-02	3.89E-02
11.00	279.40	7760.6342	24.481	2.78E-01	2.00E+01	9.06E+00	8.49E-02	3.85E-02
11.25	285.75	6984.5708	22.033	2.85E-01	2.05E+01	9.28E+00	8.41E-02	3.81E-02
11.50	292.10	6208.5074	19.585	2.91E-01	2.09E+01	9.47E+00	8.34E-02	3.78E-02
11.75	298.45	5432.4439	17.137	2.96E-01	2.13E+01	9.65E+00	8.27E-02	3.75E-02
12.00	304.80	4656.3805	14.689	3.01E-01	2.16E+01	9.80E+00	8.22E-02	3.73E-02

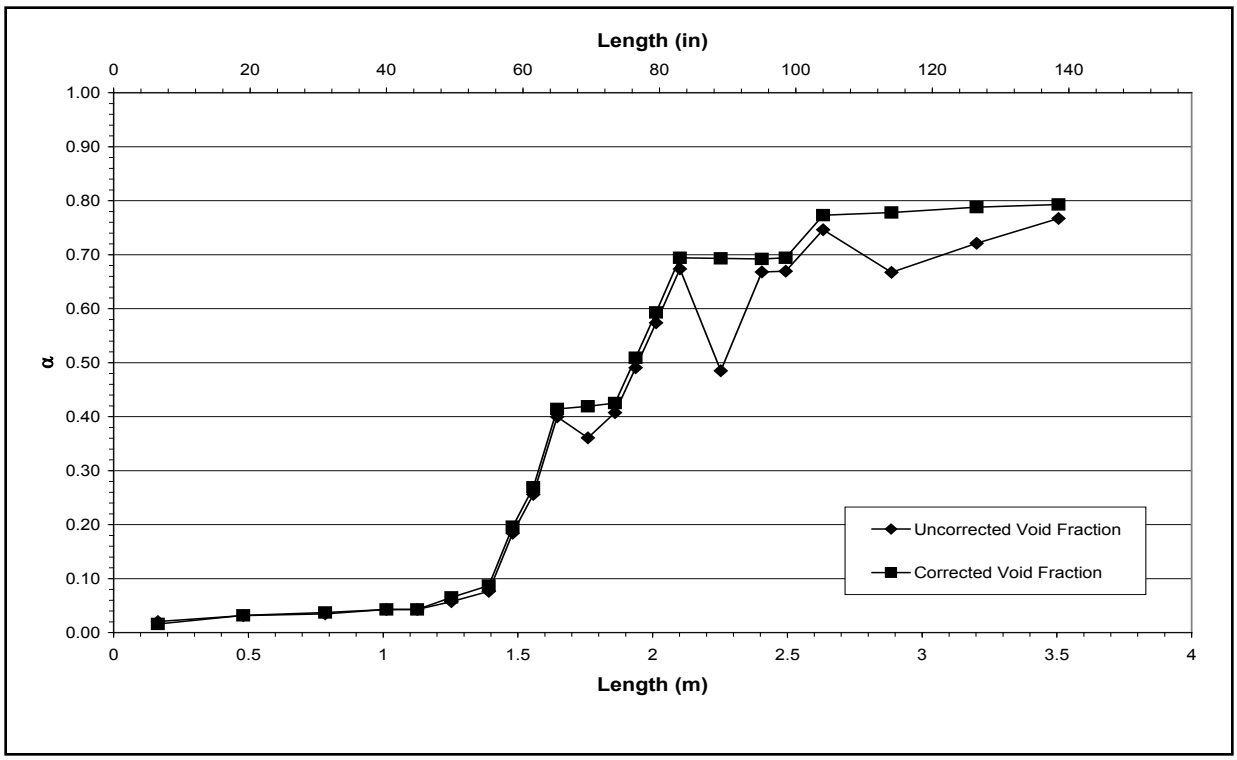

Figure A-685 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683D for Time Period 2760 to 2800 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-E

Test Conditions

Date: 7/23/2003
Steady-state time window: 2900 – 2970 seconds
Inlet flow rate: 3.647 cm/sec (1.436 in./sec)
Inlet mass flow rate: 0.172 kg/sec (0.379 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

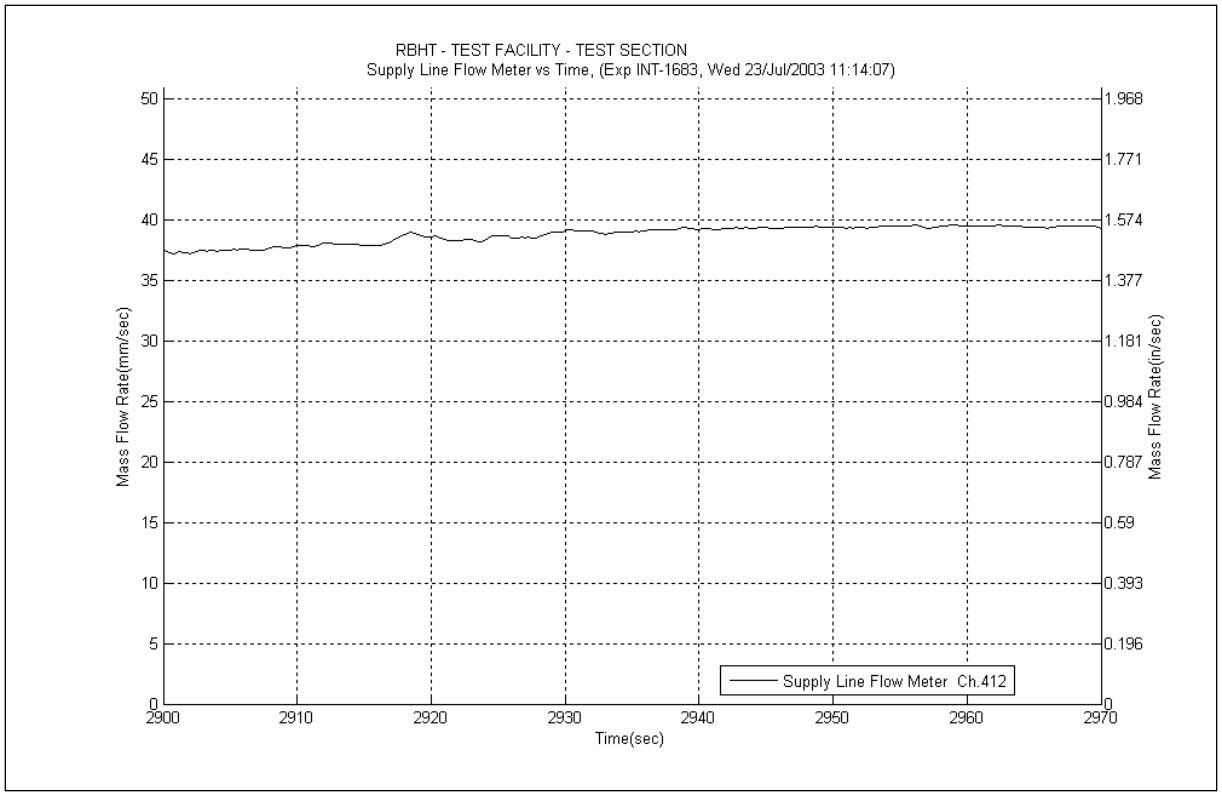

Figure A-686 Inlet Flow Plot for Experiment 1683E

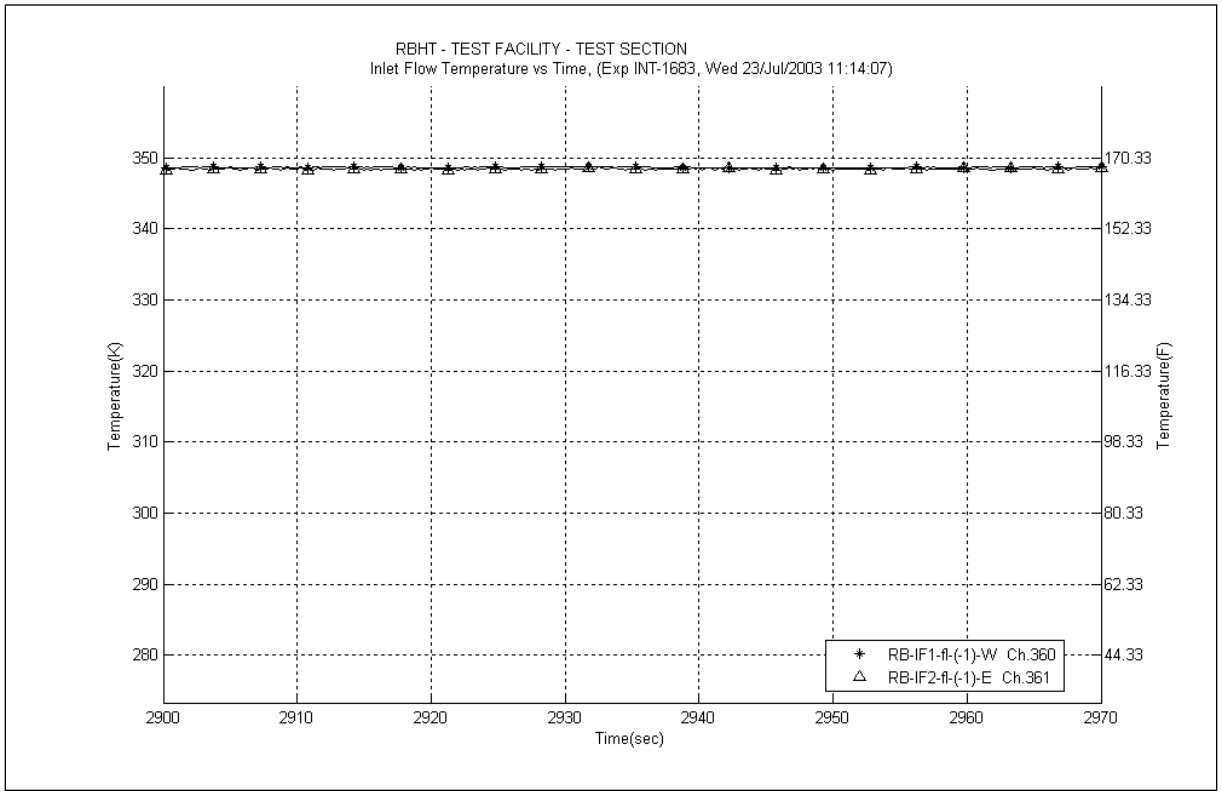

Figure A-687 Inlet Temperature Plot for Experiment 1683E

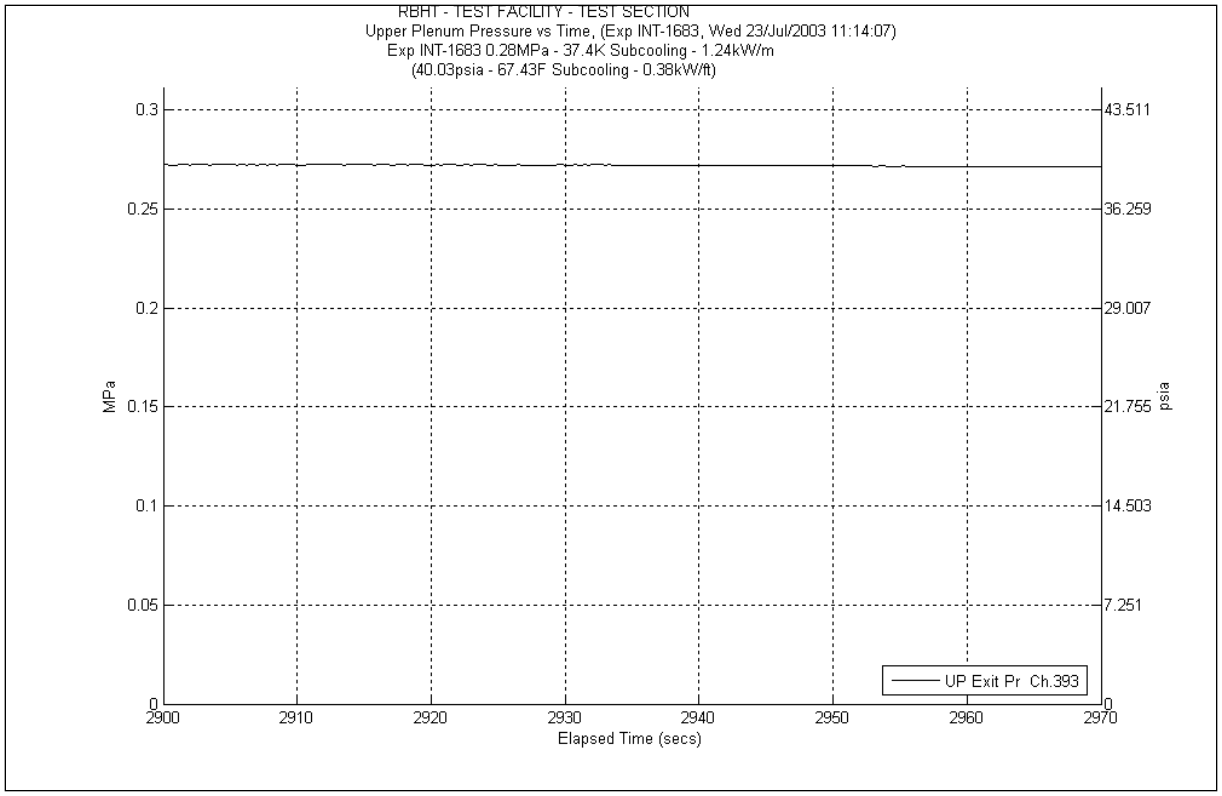

Figure A-688 System Pressure Plot for Experiment 1683E

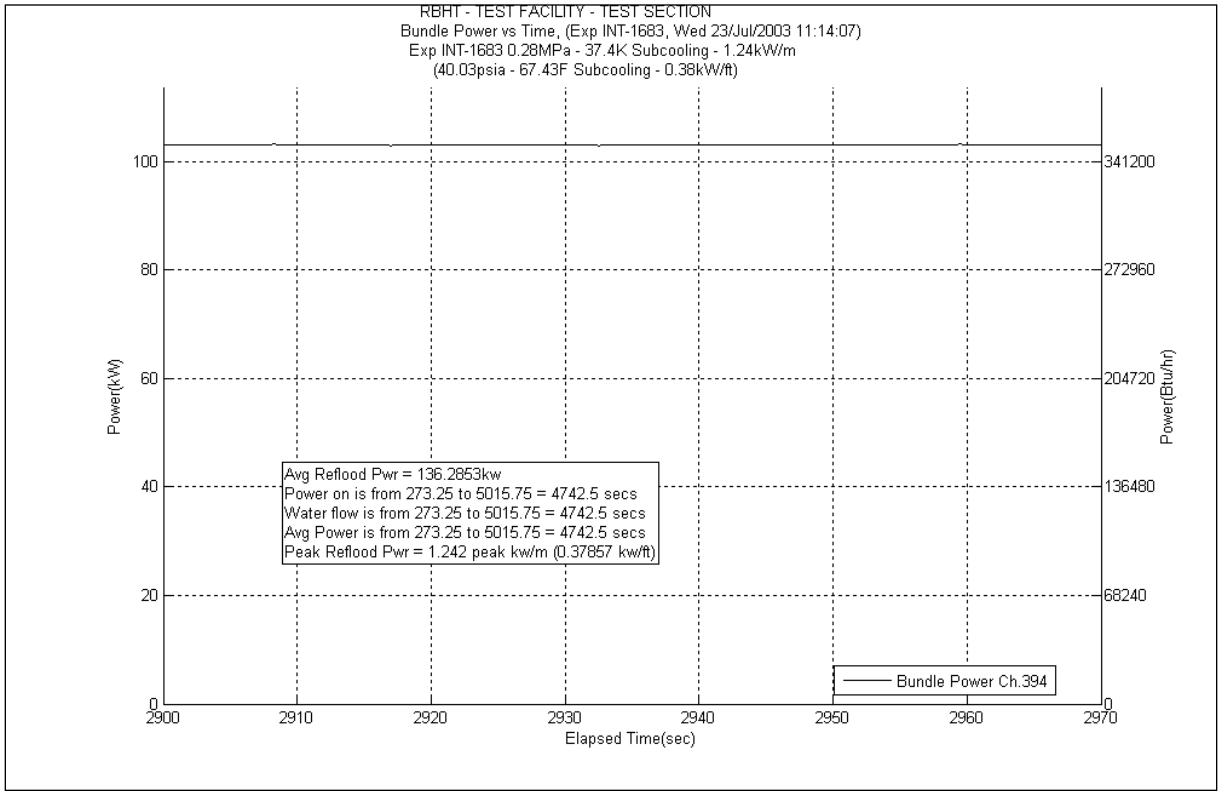

Figure A-689 Bundle Power Plot for Experiment 1683E

Table A-275: Data Results for RBHT Test 1683 for Time Period 2900 to 2970

Results for RBHT Test 1683
Valid Time Period 2900 to 2970 seconds
Collapsed Liquid Level = 89.336 inches = 2269.12 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.771	13.061	625.375	1.214	58.127	0.330	15.800	0.000	0.000	11.51	551.102	5771.51	276341.3821	0.798	0.794	0.802
*	120-133	3048-3378	383	0.724	18.654	893.179	1.325	63.441	0.588	28.154	2.741	131.261	14	670.324	5785.51	277011.7057	0.793	0.789	0.797
*	108-120	2743-3048	382	0.671	20.519	982.448	1.076	51.519	0.734	35.144	5.069	242.698	13.64	653.087	5799.15	277664.7924	0.781	0.777	0.785
	100-108	2540-2743	381	0.748	10.491	502.289	0.621	29.734	0.537	25.712	0.000	0.000	9.331	446.771	5808.481	278111.5631	0.775	0.771	0.779
	97-100	2464-2540	380	0.676	5.048	241.696	0.212	10.151	0.194	9.289	0.000	0.000	4.639	222.117	5813.12	278333.6796	0.702	0.698	0.706
	93-97	2362-2464	379	0.671	6.834	327.234	0.264	12.640	0.253	12.114	0.000	0.000	6.312	302.220	5819.432	278635.8998	0.696	0.693	0.699
*	85-93	2159-2362	378	0.489	21.230	1016.514	0.467	22.360	0.486	23.270	7.877	377.169	12.4	593.715	5831.832	279229.6149	0.701	0.697	0.705
	81-85	2057-2159	377	0.686	6.528	312.563	0.203	9.720	0.233	11.156	0.000	0.000	6.091	291.639	5837.923	279521.2536	0.707	0.703	0.711
	78-81	1981-2057	376	0.576	6.601	316.044	0.138	6.607	0.170	8.140	0.000	0.000	6.29	301.167	5844.213	279822.4204	0.596	0.593	0.599
	75-78	1905-1981	375	0.498	7.821	374.479	0.126	6.033	0.166	7.948	0.000	0.000	7.527	360.395	5851.74	280182.8151	0.517	0.514	0.520
	72-75	1829-1905	374	0.414	9.130	437.141	0.114	5.458	0.163	7.804	0.000	0.000	8.85	423.740	5860.59	280606.5554	0.432	0.430	0.434
*	67-72	1702-1829	373	0.370	16.359	783.273	0.163	7.804	0.262	12.545	1.334	63.872	14.6	699.052	5875.19	281305.6071	0.438	0.436	0.440
	63-67	1600-1702	372	0.429	11.862	567.935	0.104	4.980	0.202	9.672	0.000	0.000	11.55	553.017	5886.74	281858.6241	0.444	0.442	0.446
	60-63	1524-1600	371	0.303	10.864	520.192	0.061	2.921	0.147	7.038	0.000	0.000	10.65	509.925	5897.39	282368.5488	0.316	0.314	0.318
	57-60	1448-1524	370	0.212	12.282	588.076	0.044	2.107	0.143	6.847	0.000	0.000	12.09	578.872	5909.48	282947.4211	0.224	0.223	0.225
	53-57	1346-1448	369	0.080	19.111	915.061	0.030	1.436	0.159	7.613	0.000	0.000	18.92	905.894	5928.4	283853.3156	0.089	0.085	0.093
*	46-53	1168-1346	368	0.058	34.234	1639.153	0.005	0.239	0.000	0.000	0.299	14.337	33.93	1624.577	5962.33	285477.8927	0.066	0.063	0.069
	43-46	1092-1168	367	0.043	14.905	713.648	0.002	0.096	0.000	0.000	0.000	0.000	14.9	713.416	5977.23	286191.3085	0.044	0.042	0.046
	37-43	940-1092	366	0.043	29.815	1427.545	0.004	0.192	0.000	0.000	0.000	0.000	29.8	1426.832	6007.03	287618.1402	0.043	0.041	0.045
*	25-37	635-940	365	0.034	60.191	2881.946	0.008	0.383	0.000	0.000	0.203	9.705	59.98	2871.858	6067.01	290489.998	0.037	0.035	0.039
	13-25	330-635	364	0.031	60.378	2890.898	0.008	0.383	0.000	0.000	0.000	0.000	60.35	2889.574	6127.36	293379.5715	0.031	0.029	0.033
*	0-13	0-330	363	0.020	66.147	3167.157	0.009	0.431	0.000	0.000	-0.302	-14.439	66.44	3181.164	6193.8	296560.7358	0.016	0.015	0.017

Table A-276 Energy Balance Results for RBHT Test 1683E for Time Period 2900 to 2970 seconds

Results for RBHT Test 1683
Valid Time Period 2900 to 2970 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.395	14.692	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
0.25	6.35	4916.1392	15.508	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
0.50	12.70	5174.8833	16.325	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
0.75	19.05	5433.6275	17.141	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
1.00	25.40	5692.3717	17.957	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
1.25	31.75	5951.1158	18.773	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
1.50	38.10	6209.86	19.589	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
1.75	44.45	6468.6042	20.406	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
2.00	50.80	6727.3483	21.222	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
2.25	57.15	6986.0925	22.038	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
2.50	63.50	7244.8367	22.854	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
2.75	69.85	7503.5808	23.671	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
3.00	76.20	7762.325	24.487	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
3.25	82.55	8021.0692	25.303	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
3.50	88.90	8279.8133	26.119	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
3.75	95.25	8538.5575	26.935	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
4.00	101.60	8797.3017	27.752	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
4.25	107.95	9056.0458	28.568	0.00E+00	0.00E+00	0.00E+00	1.24E-01	5.63E-02
4.50	114.30	9314.79	29.384	1.13E-03	8.61E-02	3.91E-02	1.24E-01	5.62E-02
4.75	120.65	9573.5342	30.2	9.29E-03	7.07E-01	3.20E-01	1.23E-01	5.58E-02
5.00	127.00	9832.2783	31.017	1.77E-02	1.34E+00	6.10E-01	1.22E-01	5.53E-02
5.25	133.35	10091.023	31.833	2.63E-02	2.00E+00	9.06E-01	1.21E-01	5.48E-02
5.50	139.70	10349.767	32.649	3.51E-02	2.67E+00	1.21E+00	1.20E-01	5.43E-02
5.75	146.05	10608.511	33.465	4.42E-02	3.36E+00	1.52E+00	1.19E-01	5.38E-02
6.00	152.40	10867.255	34.282	5.35E-02	4.06E+00	1.84E+00	1.18E-01	5.33E-02
6.25	158.75	11125.999	35.098	6.30E-02	4.79E+00	2.17E+00	1.16E-01	5.28E-02
6.50	165.10	11384.743	35.914	7.27E-02	5.53E+00	2.51E+00	1.15E-01	5.22E-02
6.75	171.45	11643.488	36.73	8.26E-02	6.28E+00	2.85E+00	1.14E-01	5.17E-02
7.00	177.80	11902.232	37.546	9.28E-02	7.06E+00	3.20E+00	1.13E-01	5.11E-02
7.25	184.15	12160.976	38.363	1.03E-01	7.85E+00	3.56E+00	1.11E-01	5.05E-02
7.50	190.50	12419.72	39.179	1.14E-01	8.65E+00	3.92E+00	1.10E-01	4.99E-02
7.75	196.85	12678.464	39.995	1.25E-01	9.48E+00	4.30E+00	1.09E-01	4.93E-02
8.00	203.20	12937.208	40.811	1.36E-01	1.03E+01	4.68E+00	1.07E-01	4.87E-02
8.25	209.55	13195.953	41.628	1.47E-01	1.12E+01	5.07E+00	1.06E-01	4.80E-02
8.50	215.90	13454.697	42.444	1.59E-01	1.21E+01	5.47E+00	1.04E-01	4.74E-02
8.75	222.25	13713.441	43.26	1.70E-01	1.29E+01	5.87E+00	1.03E-01	4.67E-02
9.00	228.60	13972.185	44.076	1.82E-01	1.39E+01	6.28E+00	1.02E-01	4.61E-02
9.25	234.95	13195.953	41.628	1.94E-01	1.47E+01	6.69E+00	1.00E-01	4.54E-02
9.50	241.30	12419.72	39.179	2.05E-01	1.56E+01	7.07E+00	9.87E-02	4.48E-02
9.75	247.65	11643.488	36.73	2.15E-01	1.64E+01	7.43E+00	9.74E-02	4.42E-02
10.00	254.00	10867.255	34.282	2.25E-01	1.71E+01	7.77E+00	9.62E-02	4.36E-02
10.25	260.35	10091.023	31.833	2.34E-01	1.78E+01	8.08E+00	9.51E-02	4.31E-02
10.50	266.70	9314.79	29.384	2.43E-01	1.84E+01	8.37E+00	9.40E-02	4.26E-02
10.75	273.05	8538.5575	26.935	2.50E-01	1.90E+01	8.63E+00	9.31E-02	4.22E-02
11.00	279.40	7762.325	24.487	2.57E-01	1.96E+01	8.87E+00	9.22E-02	4.18E-02
11.25	285.75	6986.0925	22.038	2.64E-01	2.00E+01	9.09E+00	9.14E-02	4.15E-02
11.50	292.10	6209.86	19.589	2.69E-01	2.05E+01	9.29E+00	9.07E-02	4.11E-02
11.75	298.45	5433.6275	17.141	2.74E-01	2.09E+01	9.46E+00	9.01E-02	4.09E-02
12.00	304.80	4657.395	14.692	2.79E-01	2.12E+01	9.61E+00	8.95E-02	4.06E-02

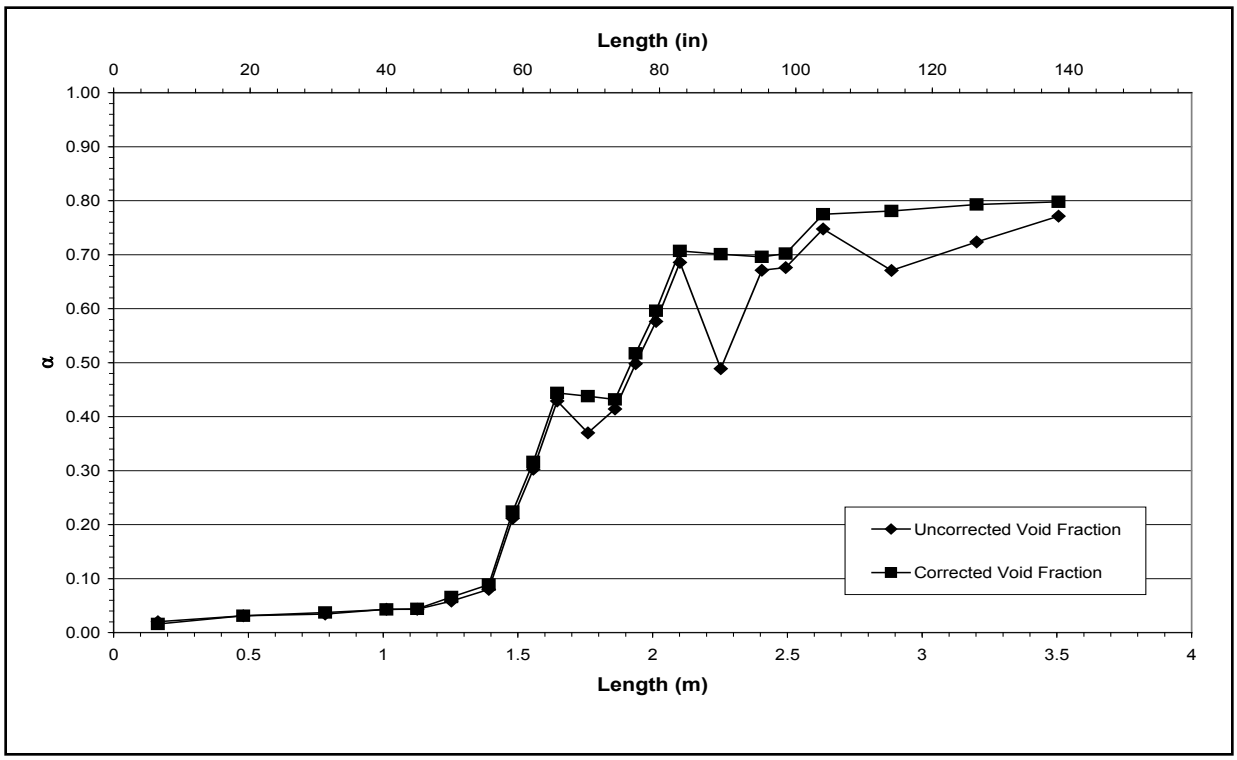

Figure A-690 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683E for Time Period 2900 to 2970 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-F

Test Conditions

Date: 7/23/2003
Steady-state time window: 3060 – 3160 seconds
Inlet flow rate: 3.592 cm/sec (1.414 in./sec)
Inlet mass flow rate: 0.170 kg/sec (0.374 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

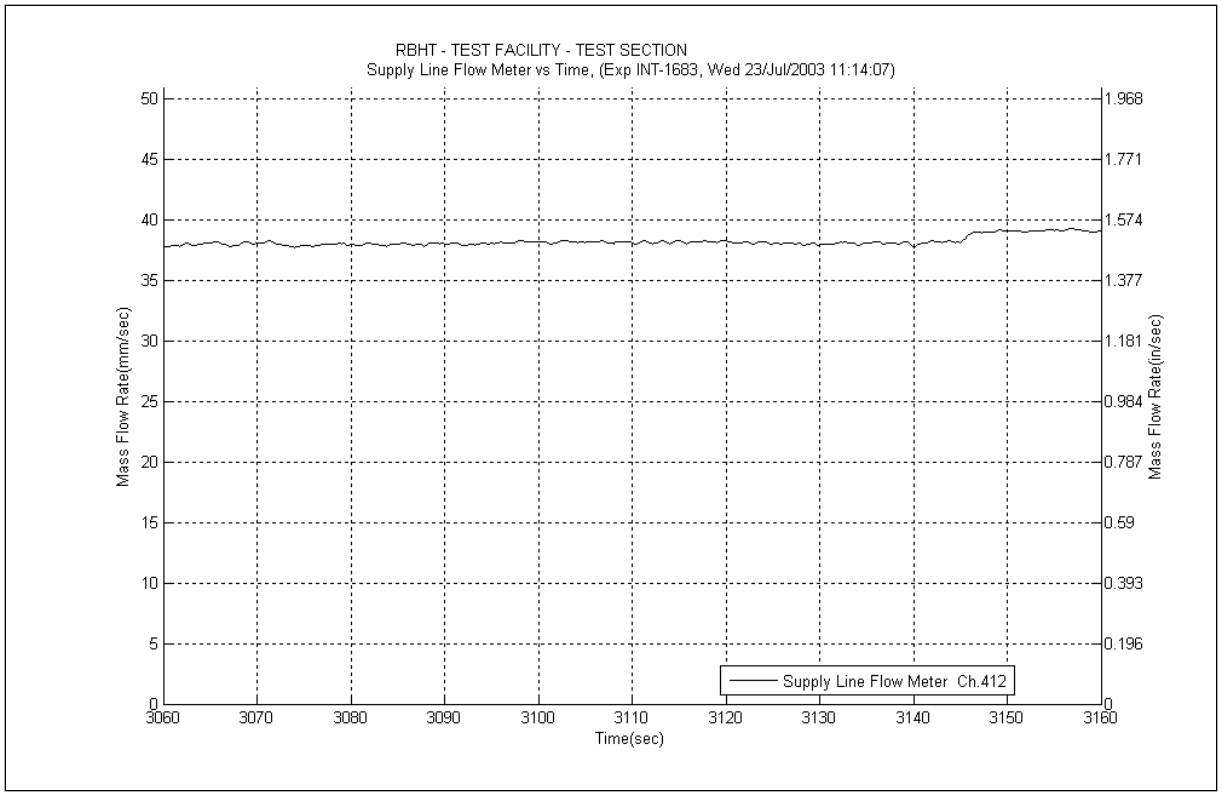

Figure A-691 Inlet Flow Plot for Experiment 1683F

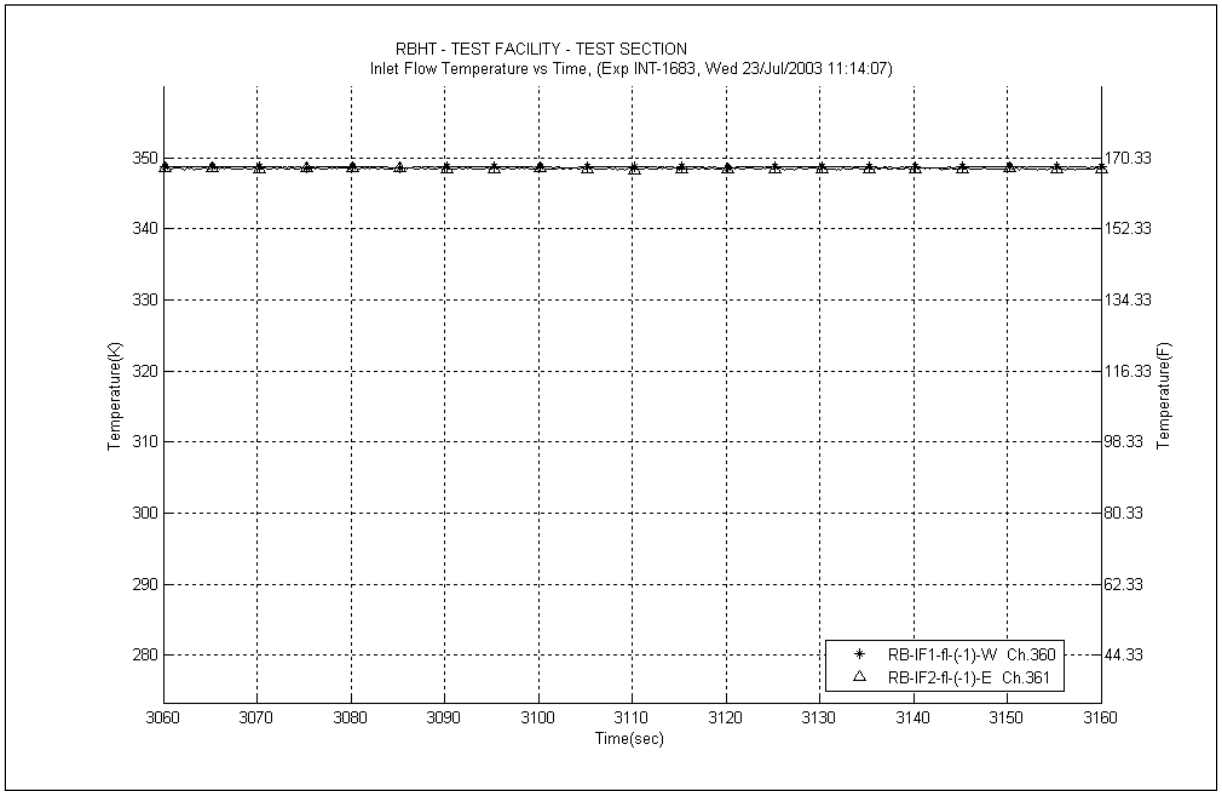

Figure A-692 Inlet Temperature Plot for Experiment 1683F

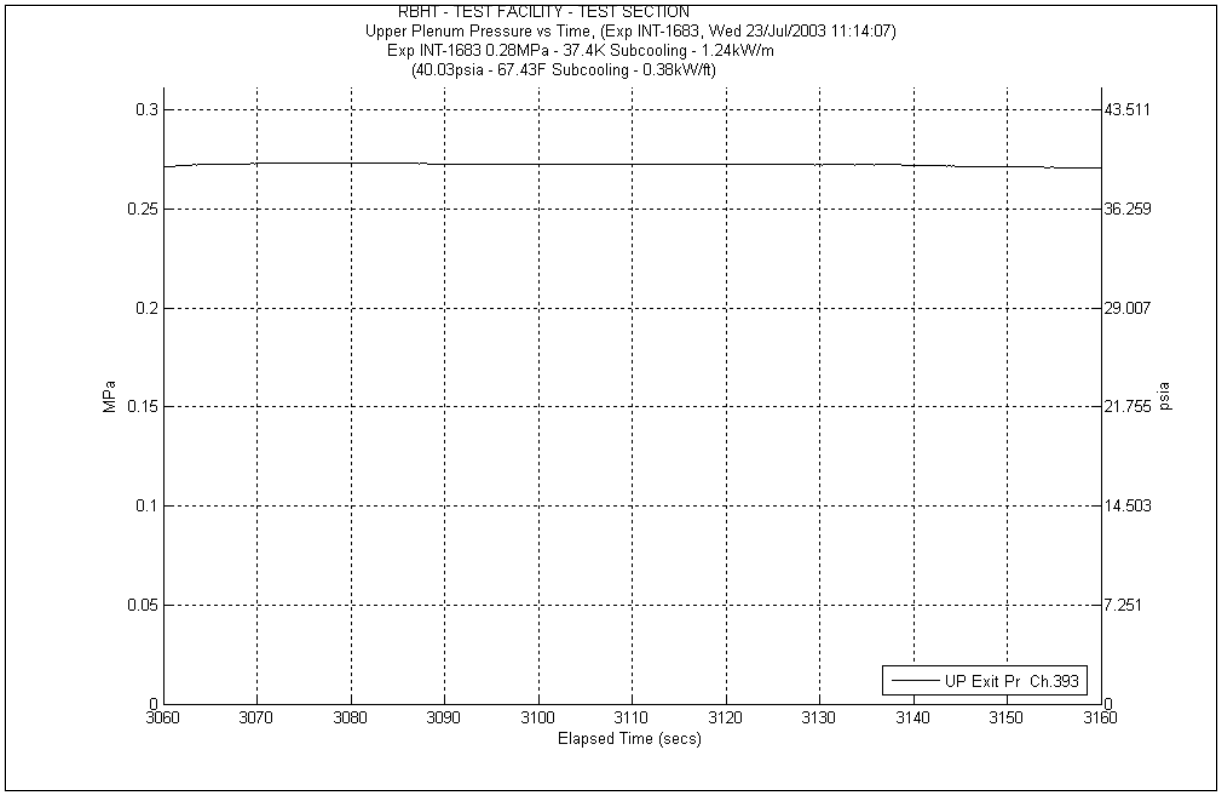

Figure A-693 System Pressure Plot for Experiment 1683F

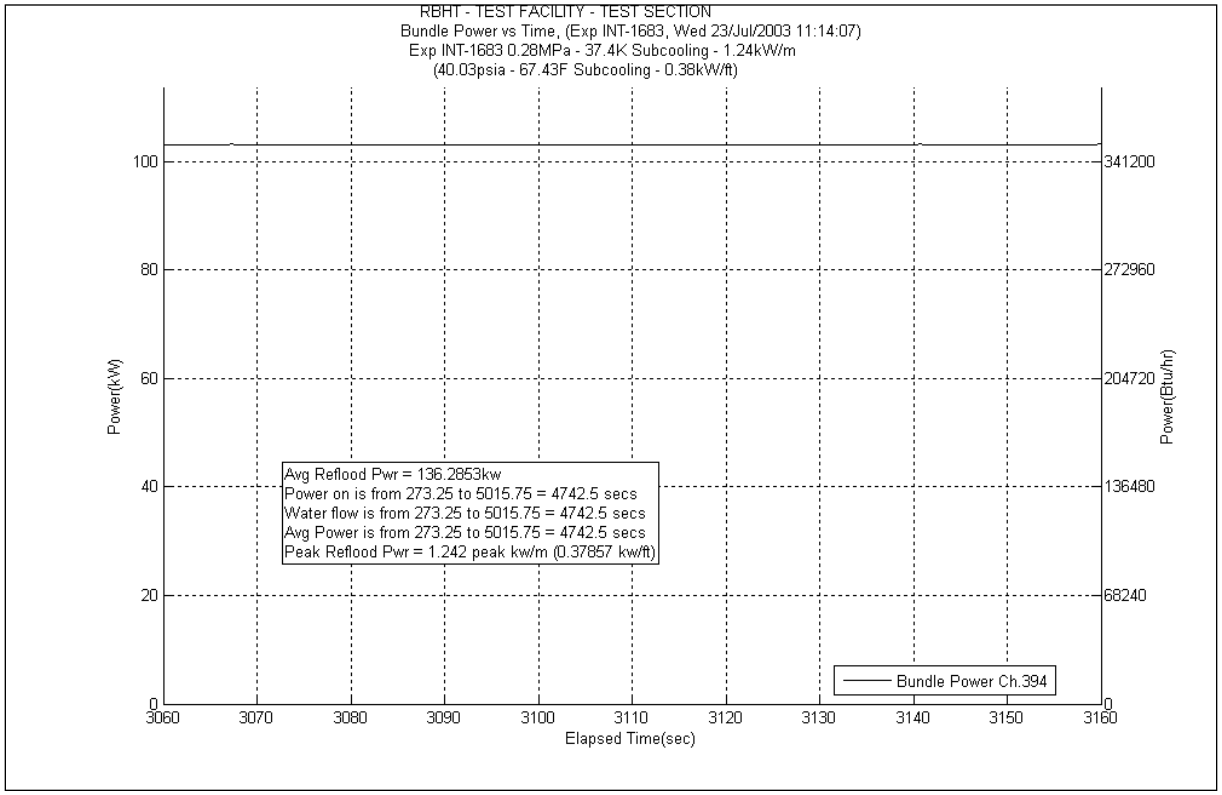

Figure A-694 Bundle Power Plot for Experiment 1683F

Table A-277 Data Results for RBHT Test 1683 for Time Period 3060 to 3160

Results for RBHT Test 1683
Valid Time Period 3060 to 3160 seconds
Collapsed Liquid Level = 89.430 inches = 2271.53 mm
(Z_{osv}) Onset of Significant Void = 49.5 inches = 1257 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.769	13.222	633.083	1.199	57.408	0.324	15.513	0.000	0.000	11.69	559.720	5771.69	276350.0005	0.795	0.791	0.799
*	120-133	3048-3378	383	0.722	18.784	899.396	1.309	62.675	0.579	27.723	2.666	127.662	14.23	681.336	5785.92	277031.3366	0.789	0.785	0.793
*	108-120	2743-3048	382	0.669	20.659	989.161	1.064	50.945	0.723	34.617	4.992	239.021	13.88	664.578	5799.8	277695.9145	0.777	0.773	0.781
	100-108	2540-2743	381	0.744	10.652	509.998	0.614	29.398	0.529	25.329	0.000	0.000	9.504	455.054	5809.304	278150.9685	0.771	0.767	0.775
	97-100	2464-2540	380	0.674	5.079	243.187	0.209	10.007	0.191	9.145	0.000	0.000	4.676	223.888	5813.98	278374.8566	0.7	0.697	0.704
	93-97	2362-2464	379	0.669	6.881	329.472	0.262	12.545	0.249	11.922	0.000	0.000	6.37	304.997	5820.35	278679.8538	0.693	0.690	0.696
*	85-93	2159-2362	378	0.484	21.438	1026.460	0.464	22.216	0.478	22.887	7.986	382.375	12.51	598.982	5832.86	279278.8358	0.699	0.696	0.702
	81-85	2057-2159	377	0.684	6.570	314.552	0.202	9.672	0.229	10.965	0.000	0.000	6.137	293.841	5838.997	279572.677	0.705	0.701	0.709
	78-81	1981-2057	376	0.569	6.720	321.763	0.138	6.607	0.168	8.044	0.000	0.000	6.414	307.104	5845.411	279879.781	0.588	0.585	0.591
	75-78	1905-1981	375	0.494	7.883	377.463	0.126	6.033	0.164	7.852	0.000	0.000	7.591	363.459	5853.002	280243.24	0.513	0.510	0.516
	72-75	1829-1905	374	0.413	9.145	437.887	0.114	5.458	0.160	7.661	0.000	0.000	8.867	424.554	5861.869	280667.7942	0.431	0.429	0.433
*	67-72	1702-1829	373	0.362	16.577	793.716	0.164	7.852	0.258	12.353	1.395	66.798	14.76	706.713	5876.629	281374.5068	0.431	0.429	0.433
	63-67	1600-1702	372	0.418	12.100	579.373	0.105	5.027	0.199	9.528	0.000	0.000	11.79	564.508	5888.419	281939.015	0.432	0.430	0.434
	60-63	1524-1600	371	0.286	11.119	532.377	0.063	3.016	0.145	6.943	0.000	0.000	10.91	522.374	5899.329	282461.3886	0.3	0.299	0.302
	57-60	1448-1524	370	0.187	12.661	606.228	0.047	2.250	0.141	6.751	0.000	0.000	12.47	597.067	5911.799	283058.4555	0.2	0.199	0.201
	53-57	1346-1448	369	0.070	19.330	925.505	0.033	1.580	0.182	8.714	0.000	0.000	19.11	914.992	5930.909	283973.4472	0.08	0.076	0.084
*	46-53	1168-1346	368	0.058	34.255	1640.148	0.007	0.335	0.003	0.144	0.145	6.952	34.1	1632.717	5965.009	285606.1639	0.062	0.059	0.065
	43-46	1092-1168	367	0.043	14.910	713.897	0.002	0.096	0.000	0.000	0.000	0.000	14.9	713.416	5979.909	286319.5798	0.043	0.041	0.045
	37-43	940-1092	366	0.043	29.825	1428.043	0.004	0.192	0.000	0.000	0.000	0.000	29.81	1427.310	6009.719	287746.8902	0.043	0.041	0.045
*	25-37	635-940	365	0.034	60.191	2881.946	0.008	0.383	0.000	0.000	0.203	9.705	59.98	2871.858	6069.699	290618.748	0.037	0.035	0.039
	13-25	330-635	364	0.031	60.372	2890.649	0.008	0.383	0.000	0.000	0.000	0.000	60.35	2889.574	6130.049	293508.3215	0.031	0.029	0.033
*	0-13	0-330	363	0.020	66.142	3166.908	0.008	0.383	0.000	0.000	-0.296	-14.161	66.43	3180.685	6196.479	296689.007	0.016	0.015	0.017

Table A-278 Energy Balance Results for RBHT Test 1683F for Time Period 3060 to 3160 seconds

Results for RBHT Test 1683 Valid Time Period 3060 to 3160 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4659.1271	14.698	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
0.25	6.35	4917.9675	15.514	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
0.50	12.70	5176.8079	16.331	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
0.75	19.05	5435.6483	17.147	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
1.00	25.40	5694.4887	17.964	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
1.25	31.75	5953.3291	18.78	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
1.50	38.10	6212.1695	19.597	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
1.75	44.45	6471.0099	20.413	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
2.00	50.80	6729.8503	21.23	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
2.25	57.15	6988.6907	22.046	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
2.50	63.50	7247.5311	22.863	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
2.75	69.85	7506.3715	23.679	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
3.00	76.20	7765.2119	24.496	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
3.25	82.55	8024.0523	25.312	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
3.50	88.90	8282.8927	26.129	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
3.75	95.25	8541.733	26.946	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
4.00	101.60	8800.5734	27.762	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
4.25	107.95	9059.4138	28.579	0.00E+00	0.00E+00	0.00E+00	1.22E-01	5.55E-02
4.50	114.30	9318.2542	29.395	2.87E-03	2.14E-01	9.72E-02	1.22E-01	5.53E-02
4.75	120.65	9577.0946	30.212	1.12E-02	8.35E-01	3.79E-01	1.21E-01	5.48E-02
5.00	127.00	9835.935	31.028	1.97E-02	1.47E+00	6.67E-01	1.20E-01	5.44E-02
5.25	133.35	10094.775	31.845	2.84E-02	2.13E+00	9.64E-01	1.19E-01	5.39E-02
5.50	139.70	10353.616	32.661	3.74E-02	2.80E+00	1.27E+00	1.18E-01	5.34E-02
5.75	146.05	10612.456	33.478	4.66E-02	3.48E+00	1.58E+00	1.17E-01	5.29E-02
6.00	152.40	10871.297	34.294	5.60E-02	4.19E+00	1.90E+00	1.15E-01	5.23E-02
6.25	158.75	11130.137	35.111	6.57E-02	4.91E+00	2.23E+00	1.14E-01	5.18E-02
6.50	165.10	11388.977	35.927	7.56E-02	5.65E+00	2.56E+00	1.13E-01	5.13E-02
6.75	171.45	11647.818	36.744	8.57E-02	6.41E+00	2.91E+00	1.12E-01	5.07E-02
7.00	177.80	11906.658	37.56	9.60E-02	7.18E+00	3.26E+00	1.11E-01	5.01E-02
7.25	184.15	12165.499	38.377	1.07E-01	7.97E+00	3.62E+00	1.09E-01	4.95E-02
7.50	190.50	12424.339	39.193	1.17E-01	8.77E+00	3.98E+00	1.08E-01	4.89E-02
7.75	196.85	12683.179	40.01	1.28E-01	9.60E+00	4.36E+00	1.07E-01	4.83E-02
8.00	203.20	12942.02	40.827	1.40E-01	1.04E+01	4.74E+00	1.05E-01	4.77E-02
8.25	209.55	13200.86	41.643	1.51E-01	1.13E+01	5.13E+00	1.04E-01	4.71E-02
8.50	215.90	13459.701	42.46	1.63E-01	1.22E+01	5.52E+00	1.02E-01	4.64E-02
8.75	222.25	13718.541	43.276	1.75E-01	1.31E+01	5.93E+00	1.01E-01	4.58E-02
9.00	228.60	13977.381	44.093	1.87E-01	1.40E+01	6.34E+00	9.94E-02	4.51E-02
9.25	234.95	13200.86	41.643	1.99E-01	1.49E+01	6.74E+00	9.79E-02	4.44E-02
9.50	241.30	12424.339	39.193	2.10E-01	1.57E+01	7.12E+00	9.66E-02	4.38E-02
9.75	247.65	11647.818	36.744	2.21E-01	1.65E+01	7.48E+00	9.53E-02	4.32E-02
10.00	254.00	10871.297	34.294	2.31E-01	1.72E+01	7.82E+00	9.41E-02	4.27E-02
10.25	260.35	10094.775	31.845	2.40E-01	1.79E+01	8.13E+00	9.29E-02	4.22E-02
10.50	266.70	9318.2542	29.395	2.48E-01	1.86E+01	8.42E+00	9.19E-02	4.17E-02
10.75	273.05	8541.733	26.946	2.56E-01	1.91E+01	8.68E+00	9.10E-02	4.13E-02
11.00	279.40	7765.2119	24.496	2.63E-01	1.97E+01	8.93E+00	9.01E-02	4.09E-02
11.25	285.75	6988.6907	22.046	2.70E-01	2.02E+01	9.14E+00	8.93E-02	4.05E-02
11.50	292.10	6212.1695	19.597	2.75E-01	2.06E+01	9.34E+00	8.86E-02	4.02E-02
11.75	298.45	5435.6483	17.147	2.81E-01	2.10E+01	9.51E+00	8.80E-02	3.99E-02
12.00	304.80	4659.1271	14.698	2.85E-01	2.13E+01	9.67E+00	8.74E-02	3.96E-02

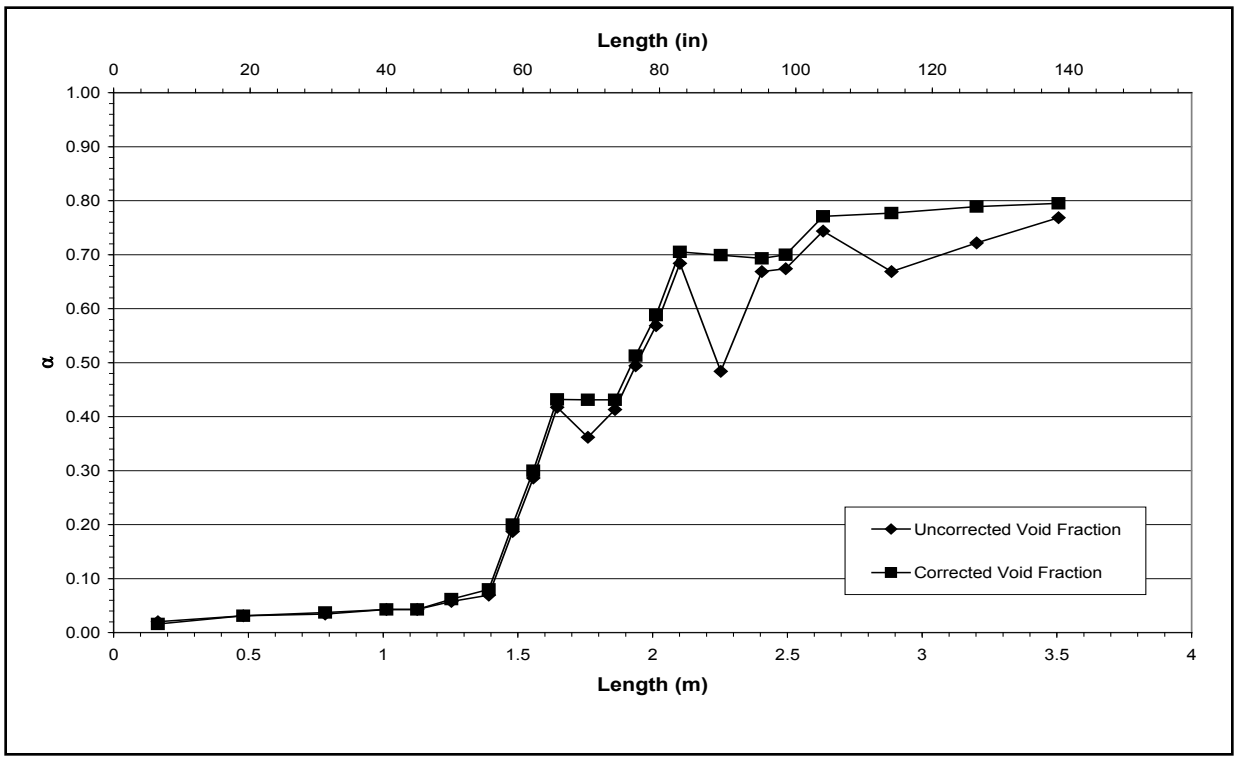

Figure A-695 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683F for Time Period 3060 to 3160 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-G

Test Conditions

Date: 7/23/2003
Steady-state time window: 3390 – 3505 seconds
Inlet flow rate: 3.007 cm/sec (1.184 in./sec)
Inlet mass flow rate: 0.142 kg/sec (0.313 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

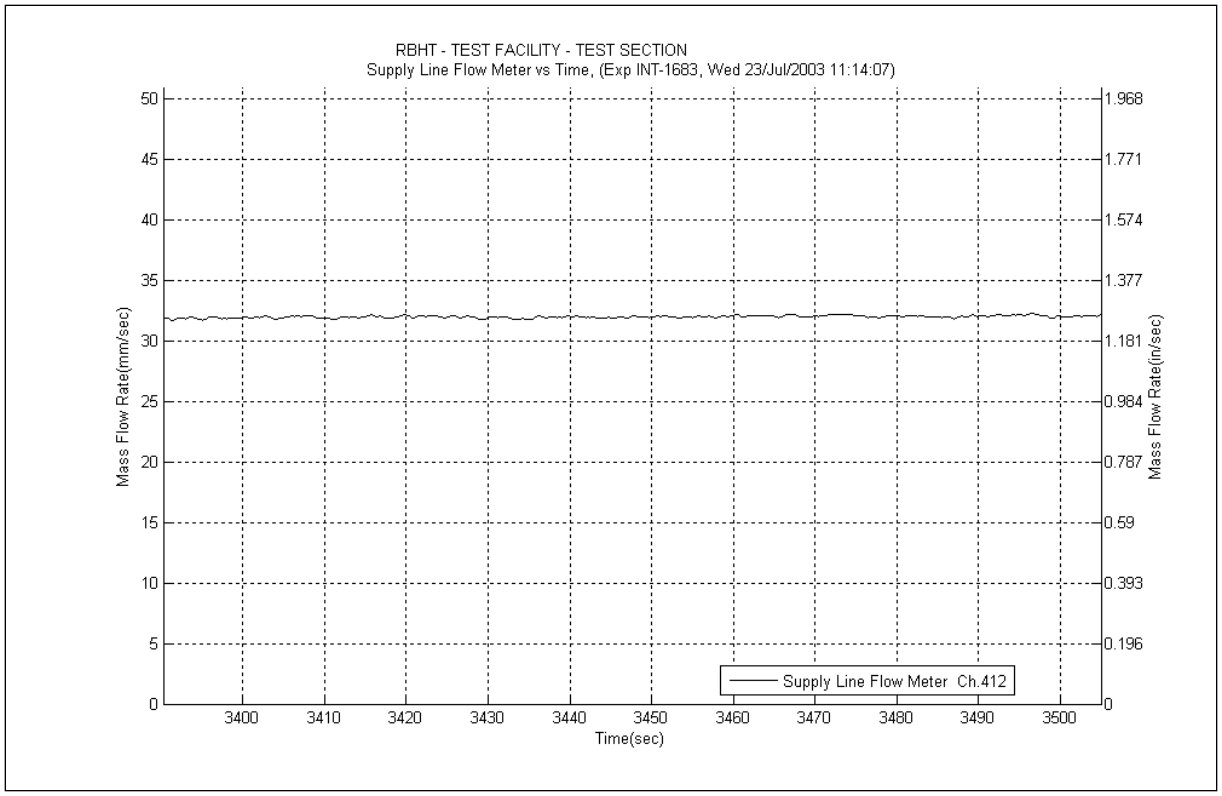

Figure A-696 Inlet Flow Plot for Experiment 1683G

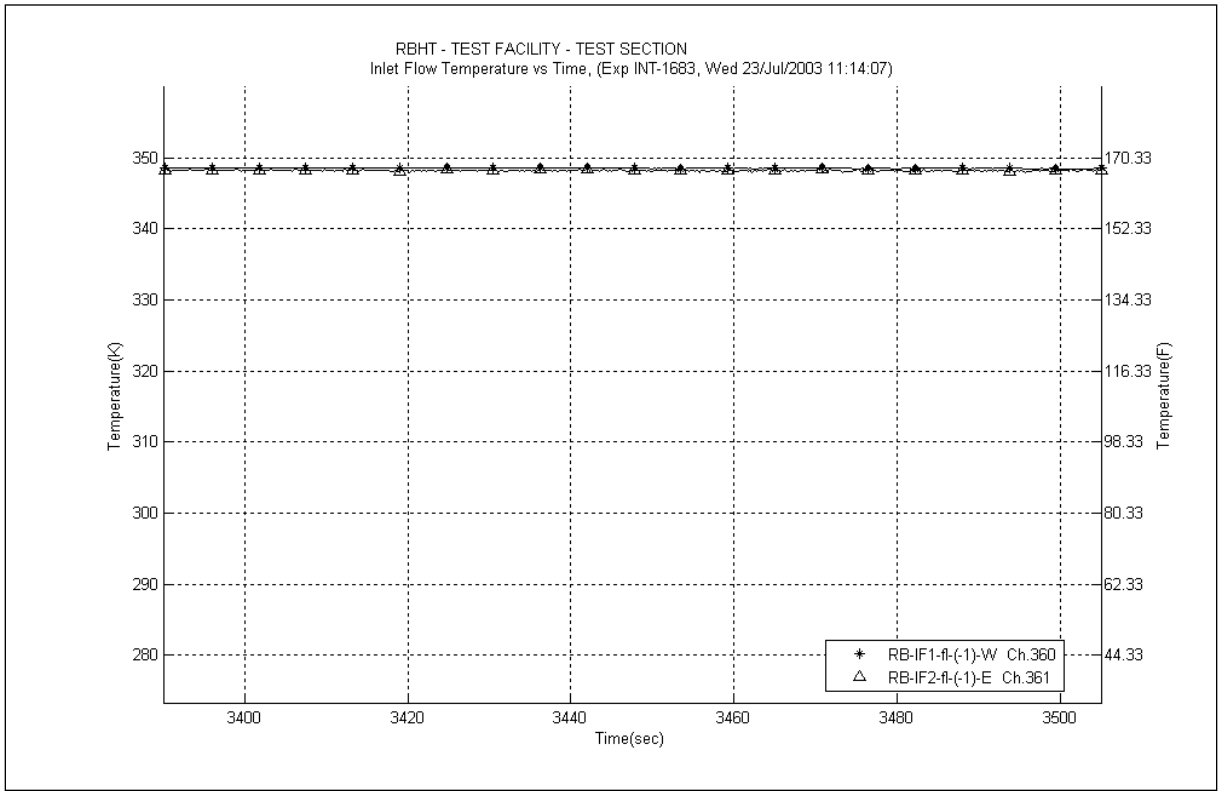

Figure A-697 Inlet Temperature Plot for Experiment 1683G

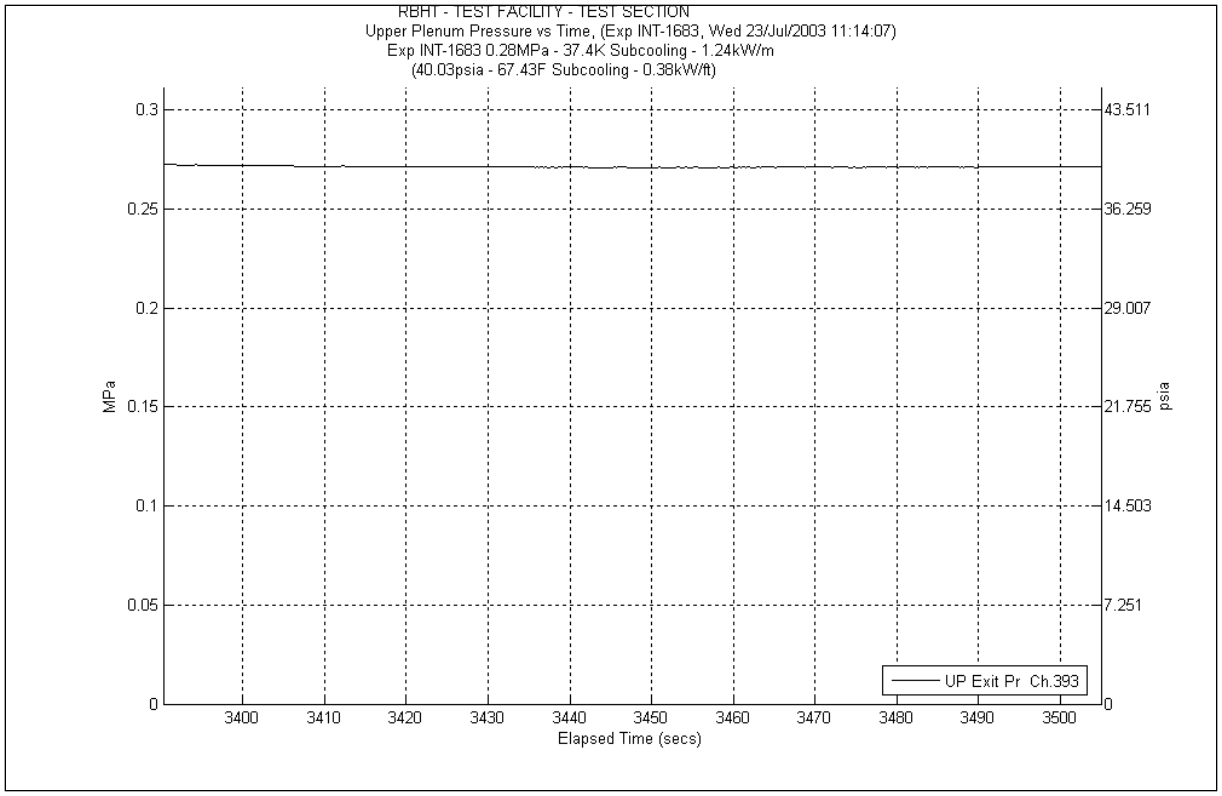

Figure A-698 System Pressure Plot for Experiment 1683G

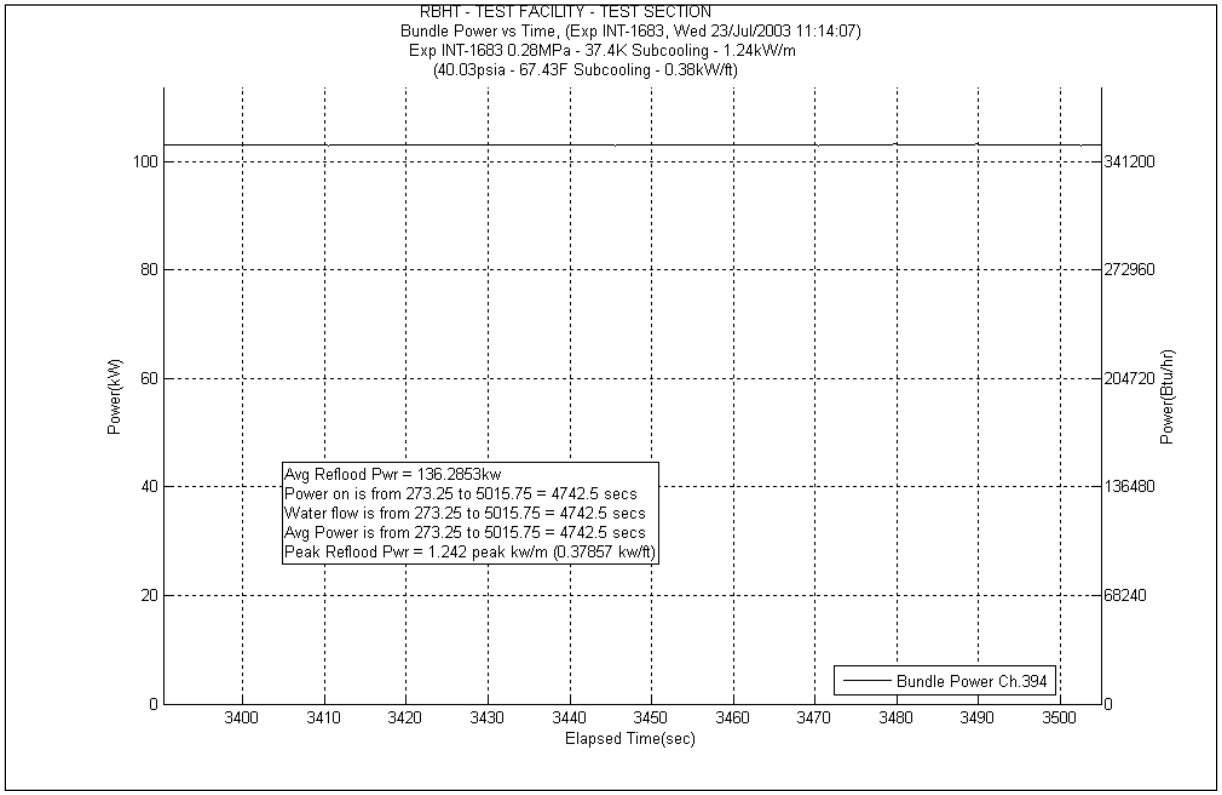

Figure A-699 Bundle Power Plot for Experiment 1683G

Table A-279 Data Results for RBHT Test 1683 for Time Period 3390 to 3505

Results for RBHT Test 1683
Valid Time Period 3390 to 3505 seconds
Collapsed Liquid Level = 83.784 inches = 2128.12 mm
(Z_{osv}) Onset of Significant Void = 44.5 inches = 1130 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.803	11.249	538.593	1.036	49.604	0.272	13.023	0.000	0.000	9.939	475.882	5769.939	276266.1622	0.826	0.822	0.830
*	120-133	3048-3378	383	0.749	16.956	811.868	1.134	54.296	0.485	23.222	2.987	143.029	12.35	591.321	5782.289	276857.4834	0.817	0.813	0.821
*	108-120	2743-3048	382	0.697	18.862	903.126	0.925	44.289	0.605	28.968	4.812	230.408	12.52	599.461	5794.809	277456.9442	0.799	0.795	0.803
	100-108	2540-2743	381	0.766	9.706	464.742	0.538	25.760	0.443	21.211	0.000	0.000	8.724	417.707	5803.533	277874.6515	0.79	0.786	0.794
	97-100	2464-2540	380	0.708	4.555	218.073	0.185	8.858	0.160	7.661	0.000	0.000	4.207	201.432	5807.74	278076.0838	0.73	0.726	0.734
	93-97	2362-2464	379	0.711	6.014	287.946	0.232	11.108	0.209	10.007	0.000	0.000	5.569	266.645	5813.309	278342.7289	0.732	0.728	0.736
*	85-93	2159-2362	378	0.520	19.937	954.598	0.416	19.918	0.401	19.200	8.010	383.530	11.11	531.950	5824.419	278874.6786	0.733	0.729	0.737
	81-85	2057-2159	377	0.715	5.915	283.221	0.184	8.810	0.192	9.193	0.000	0.000	5.539	265.209	5829.958	279139.8873	0.733	0.729	0.737
	78-81	1981-2057	376	0.629	5.775	276.508	0.127	6.081	0.140	6.703	0.000	0.000	5.507	263.677	5835.465	279403.5639	0.647	0.644	0.650
	75-78	1905-1981	375	0.557	6.897	330.218	0.118	5.650	0.137	6.560	0.000	0.000	6.641	317.973	5842.106	279721.5367	0.574	0.571	0.577
	72-75	1829-1905	374	0.475	8.185	391.885	0.109	5.219	0.134	6.416	0.000	0.000	7.937	380.026	5850.043	280101.5623	0.49	0.488	0.492
*	67-72	1702-1829	373	0.407	15.388	736.774	0.162	7.757	0.216	10.342	2.620	125.438	12.39	593.236	5862.433	280694.7987	0.523	0.520	0.526
	63-67	1600-1702	372	0.542	9.514	455.541	0.111	5.315	0.167	7.996	0.000	0.000	9.234	442.126	5871.667	281136.925	0.555	0.552	0.558
	60-63	1524-1600	371	0.400	9.353	447.833	0.072	3.447	0.121	5.794	0.000	0.000	9.156	438.392	5880.823	281575.3166	0.412	0.410	0.414
	57-60	1448-1524	370	0.351	10.111	484.137	0.062	2.969	0.118	5.650	0.000	0.000	9.929	475.403	5890.752	282050.7197	0.363	0.361	0.365
	53-57	1346-1448	369	0.280	14.952	715.886	0.065	3.112	0.153	7.326	0.000	0.000	14.73	705.276	5905.482	282755.9959	0.291	0.290	0.292
*	46-53	1168-1346	368	0.106	32.484	1555.356	0.061	2.921	0.241	11.539	2.042	97.785	30.14	1443.111	5935.622	284199.1068	0.171	0.170	0.172
	43-46	1092-1168	367	0.050	14.796	708.427	0.001	0.048	0.000	0.000	0.000	0.000	14.79	708.149	5950.412	284907.2558	0.05	0.048	0.053
	37-43	940-1092	366	0.047	29.690	1421.578	0.003	0.144	0.000	0.000	0.000	0.000	29.68	1421.086	5980.092	286328.3418	0.047	0.045	0.049
*	25-37	635-940	365	0.038	59.967	2871.254	0.005	0.239	0.000	0.000	0.162	7.775	59.8	2863.239	6039.892	289191.5812	0.04	0.038	0.042
	13-25	330-635	364	0.033	60.269	2885.676	0.005	0.239	0.000	0.000	0.000	0.000	60.24	2884.307	6100.132	292075.8879	0.033	0.031	0.035
*	0-13	0-330	363	0.021	66.101	3164.919	0.006	0.287	0.000	0.000	-0.285	-13.660	66.38	3178.291	6166.512	295254.1794	0.017	0.016	0.018

Table A-280 Energy Balance Results for RBHT Test 1683G for Time Period 3390 to 3505 seconds

Results for RBHT Test 1683 Valid Time Period 3390 to 3505 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.6306	14.693	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.25	6.35	4916.3878	15.509	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.50	12.70	5175.1451	16.325	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
0.75	19.05	5433.9023	17.142	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.00	25.40	5692.6596	17.958	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.25	31.75	5951.4168	18.774	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.50	38.10	6210.1741	19.59	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
1.75	44.45	6468.9313	20.407	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.00	50.80	6727.6886	21.223	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.25	57.15	6986.4458	22.039	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.50	63.50	7245.2031	22.856	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
2.75	69.85	7503.9603	23.672	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.00	76.20	7762.7176	24.488	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.25	82.55	8021.4749	25.304	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.50	88.90	8280.2321	26.121	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
3.75	95.25	8538.9894	26.937	0.00E+00	0.00E+00	0.00E+00	1.02E-01	4.64E-02
4.00	101.60	8797.7466	27.753	4.95E-03	3.10E-01	1.41E-01	1.02E-01	4.62E-02
4.25	107.95	9056.5039	28.569	1.43E-02	8.97E-01	4.07E-01	1.01E-01	4.58E-02
4.50	114.30	9315.2611	29.386	2.39E-02	1.50E+00	6.80E-01	9.99E-02	4.53E-02
4.75	120.65	9574.0184	30.202	3.38E-02	2.12E+00	9.62E-01	9.89E-02	4.49E-02
5.00	127.00	9832.7756	31.018	4.40E-02	2.76E+00	1.25E+00	9.78E-02	4.44E-02
5.25	133.35	10091.533	31.834	5.45E-02	3.41E+00	1.55E+00	9.68E-02	4.39E-02
5.50	139.70	10350.29	32.651	6.52E-02	4.08E+00	1.85E+00	9.57E-02	4.34E-02
5.75	146.05	10609.047	33.467	7.62E-02	4.77E+00	2.16E+00	9.46E-02	4.29E-02
6.00	152.40	10867.805	34.283	8.74E-02	5.48E+00	2.48E+00	9.34E-02	4.24E-02
6.25	158.75	11126.562	35.1	9.89E-02	6.20E+00	2.81E+00	9.22E-02	4.18E-02
6.50	165.10	11385.319	35.916	1.11E-01	6.94E+00	3.15E+00	9.10E-02	4.13E-02
6.75	171.45	11644.076	36.732	1.23E-01	7.69E+00	3.49E+00	8.98E-02	4.07E-02
7.00	177.80	11902.834	37.548	1.35E-01	8.46E+00	3.84E+00	8.85E-02	4.02E-02
7.25	184.15	12161.591	38.365	1.48E-01	9.25E+00	4.20E+00	8.72E-02	3.96E-02
7.50	190.50	12420.348	39.181	1.61E-01	1.01E+01	4.56E+00	8.59E-02	3.90E-02
7.75	196.85	12679.105	39.997	1.74E-01	1.09E+01	4.94E+00	8.46E-02	3.84E-02
8.00	203.20	12937.863	40.813	1.87E-01	1.17E+01	5.32E+00	8.32E-02	3.77E-02
8.25	209.55	13196.62	41.63	2.01E-01	1.26E+01	5.71E+00	8.18E-02	3.71E-02
8.50	215.90	13455.377	42.446	2.15E-01	1.35E+01	6.11E+00	8.04E-02	3.64E-02
8.75	222.25	13714.134	43.262	2.29E-01	1.44E+01	6.51E+00	7.89E-02	3.58E-02
9.00	228.60	13972.892	44.078	2.44E-01	1.53E+01	6.92E+00	7.74E-02	3.51E-02
9.25	234.95	13196.62	41.63	2.58E-01	1.62E+01	7.33E+00	7.60E-02	3.45E-02
9.50	241.30	12420.348	39.181	2.71E-01	1.70E+01	7.71E+00	7.46E-02	3.38E-02
9.75	247.65	11644.076	36.732	2.84E-01	1.78E+01	8.07E+00	7.33E-02	3.32E-02
10.00	254.00	10867.805	34.283	2.96E-01	1.85E+01	8.40E+00	7.21E-02	3.27E-02
10.25	260.35	10091.533	31.834	3.07E-01	1.92E+01	8.72E+00	7.10E-02	3.22E-02
10.50	266.70	9315.2611	29.386	3.17E-01	1.98E+01	9.00E+00	6.99E-02	3.17E-02
10.75	273.05	8538.9894	26.937	3.26E-01	2.04E+01	9.27E+00	6.90E-02	3.13E-02
11.00	279.40	7762.7176	24.488	3.35E-01	2.10E+01	9.51E+00	6.81E-02	3.09E-02
11.25	285.75	6986.4458	22.039	3.43E-01	2.15E+01	9.73E+00	6.73E-02	3.05E-02
11.50	292.10	6210.1741	19.59	3.49E-01	2.19E+01	9.93E+00	6.66E-02	3.02E-02
11.75	298.45	5433.9023	17.142	3.56E-01	2.23E+01	1.01E+01	6.60E-02	2.99E-02
12.00	304.80	4657.6306	14.693	3.61E-01	2.26E+01	1.03E+01	6.54E-02	2.97E-02

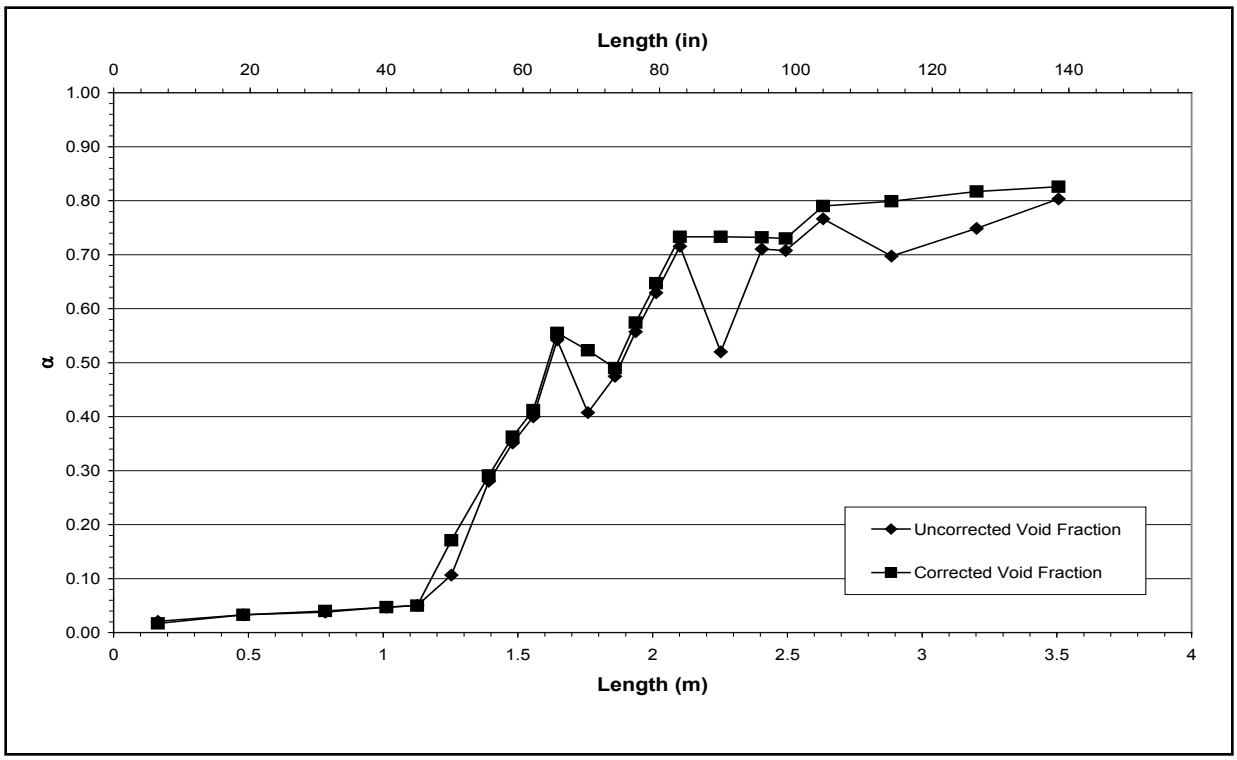

Figure A-700 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683G for Time Period 3390 to 3505 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-H

Test Conditions

Date: 7/23/2003
Steady-state time window: 3679 – 3750 seconds
Inlet flow rate: 2.532 cm/sec (0.997 in./sec)
Inlet mass flow rate: 0.119 kg/sec (0.263 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

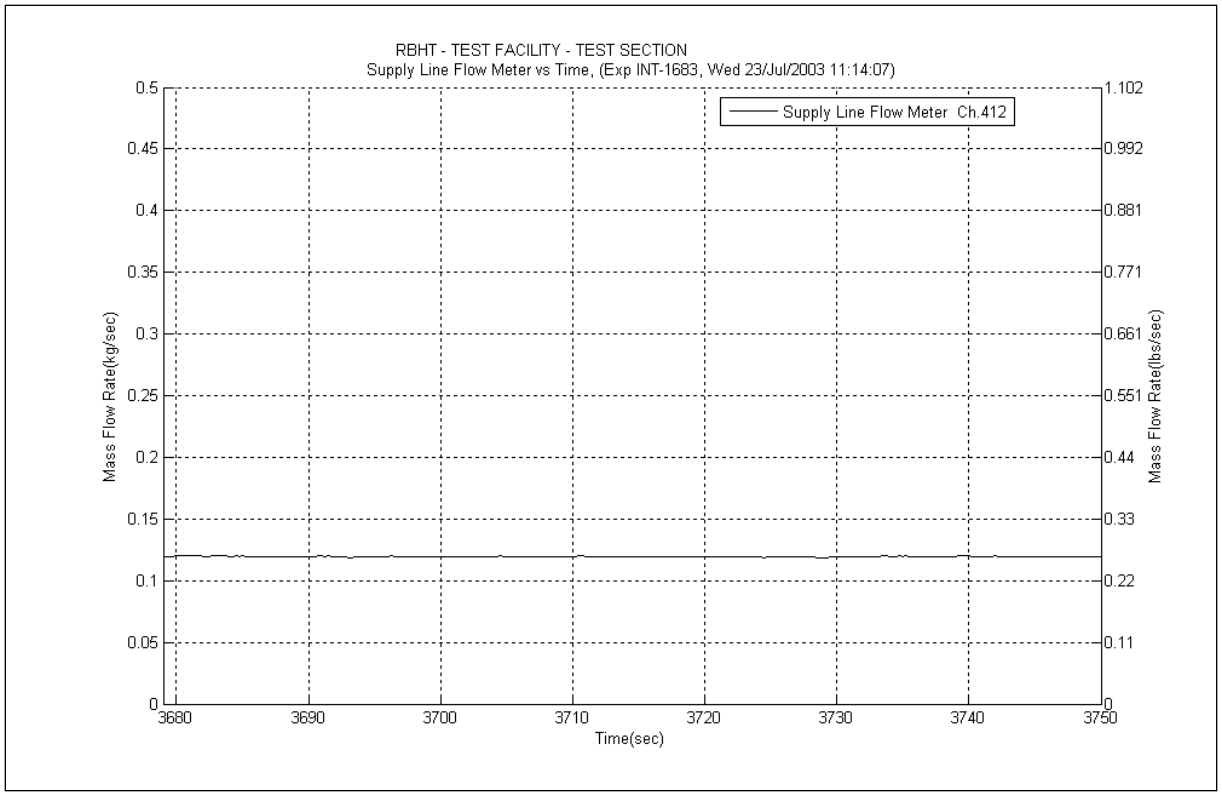

Figure A-701 Inlet Flow Plot for Experiment 1683H

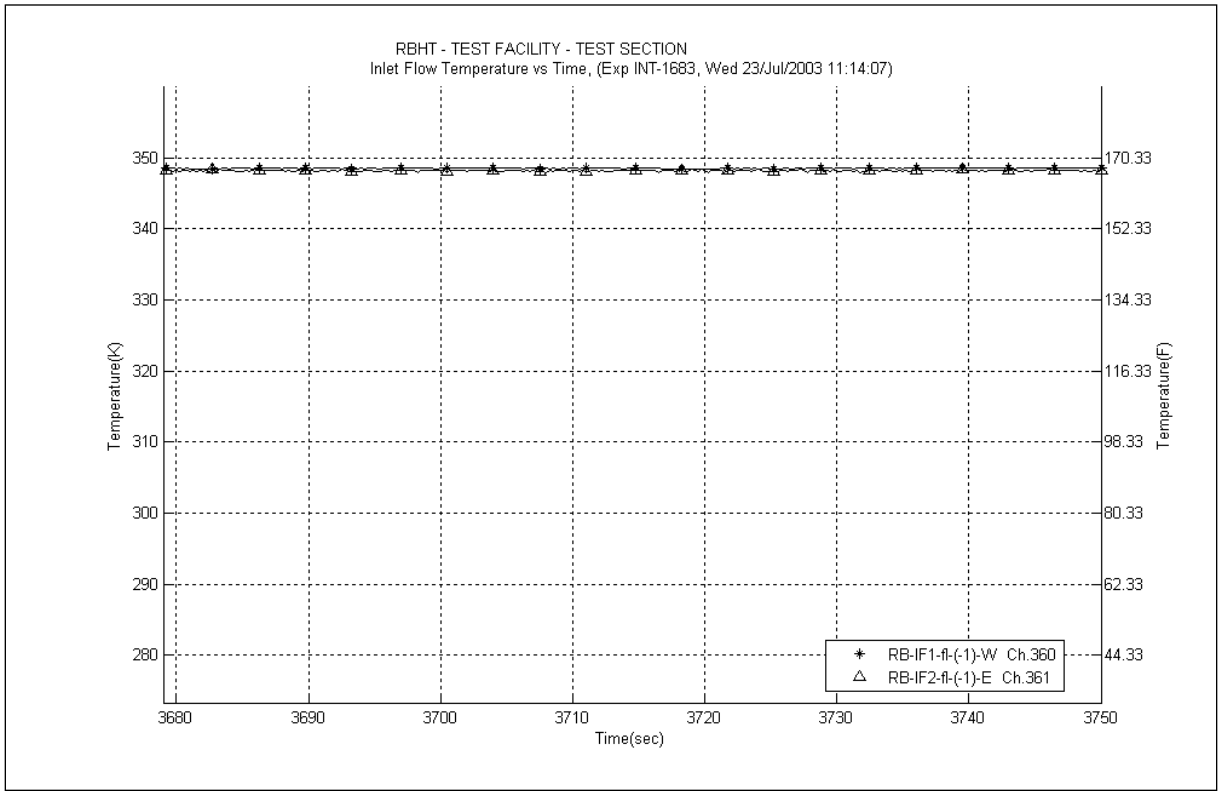

Figure A-702 Inlet Temperature Plot for Experiment 1683H

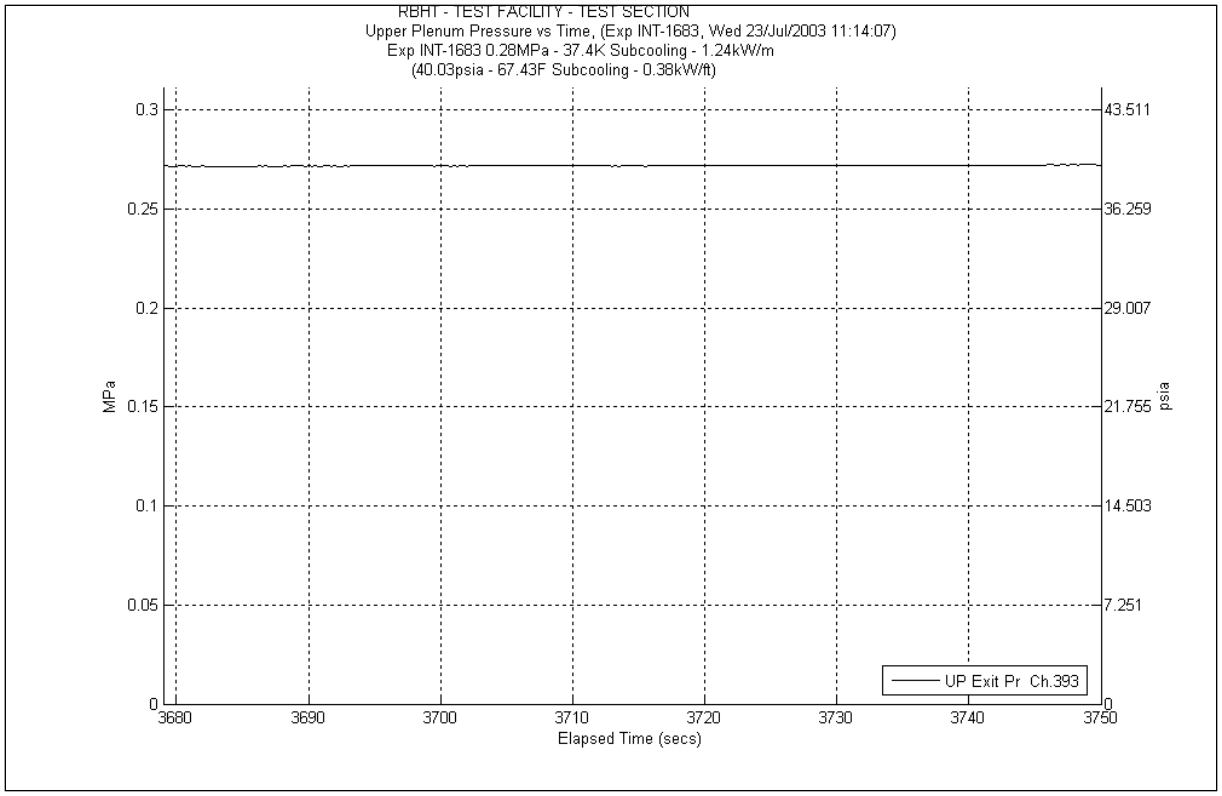

Figure A-703 System Pressure Plot for Experiment 1683H

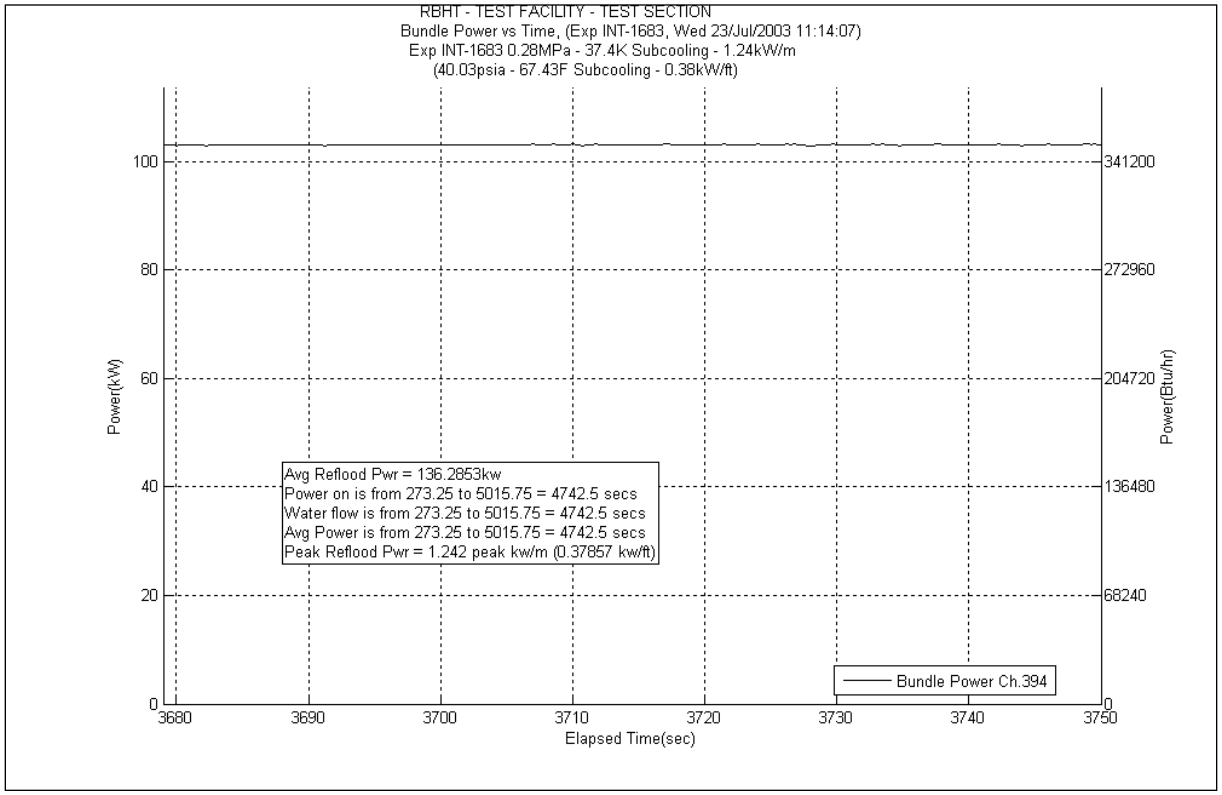

Figure A-704 Bundle Power Plot for Experiment 1683H

Table A-281 Data Results for RBHT Test 1683 for Time Period 3679 to 3750

Results for RBHT Test 1683
Valid Time Period 3679 to 3750 seconds
Collapsed Liquid Level = 79.198 inches = 2011.63 mm
(Z_{osv}) Onset of Significant Void = 40 inches = 1016 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.830	9.727	465.736	0.898	42.996	0.229	10.965	0.000	0.000	8.599	411.722	5768.599	276202.0026	0.849	0.845	0.853
*	120-133	3048-3378	383	0.771	15.450	739.757	0.983	47.066	0.409	19.583	3.168	151.692	10.89	521.416	5779.489	276723.4186	0.839	0.835	0.843
*	108-120	2743-3048	382	0.720	17.439	834.993	0.804	38.496	0.510	24.419	4.725	226.244	11.4	545.835	5790.889	277269.2536	0.817	0.813	0.821
	100-108	2540-2743	381	0.786	8.896	425.951	0.470	22.504	0.373	17.859	0.000	0.000	8.053	385.580	5798.942	277654.8333	0.806	0.802	0.810
	97-100	2464-2540	380	0.732	4.181	200.170	0.162	7.757	0.135	6.464	0.000	0.000	3.881	185.823	5802.823	277840.6566	0.751	0.747	0.755
	93-97	2362-2464	379	0.735	5.505	263.577	0.204	9.768	0.176	8.427	0.000	0.000	5.123	245.291	5807.946	278085.9471	0.753	0.749	0.757
*	85-93	2159-2362	378	0.551	18.660	893.428	0.368	17.620	0.338	16.184	7.634	365.500	10.32	494.124	5818.266	278580.0714	0.751	0.747	0.755
	81-85	2057-2159	377	0.734	5.531	264.821	0.164	7.852	0.162	7.757	0.000	0.000	5.202	249.073	5823.468	278829.1445	0.75	0.746	0.754
	78-81	1981-2057	376	0.667	5.183	248.161	0.115	5.506	0.118	5.650	0.000	0.000	4.946	236.816	5828.414	279065.9602	0.682	0.679	0.685
	75-78	1905-1981	375	0.595	6.305	301.871	0.107	5.123	0.116	5.554	0.000	0.000	6.082	291.208	5834.496	279357.1679	0.61	0.607	0.613
	72-75	1829-1905	374	0.526	7.380	353.343	0.100	4.788	0.113	5.410	0.000	0.000	7.162	342.918	5841.658	279700.0863	0.54	0.537	0.543
*	67-72	1702-1829	373	0.436	14.635	700.718	0.151	7.230	0.182	8.714	3.382	161.922	10.92	522.852	5852.578	280222.9388	0.579	0.576	0.582
	63-67	1600-1702	372	0.606	8.179	391.636	0.106	5.075	0.140	6.703	0.000	0.000	7.928	379.595	5860.506	280602.5334	0.618	0.615	0.621
	60-63	1524-1600	371	0.445	8.652	414.264	0.071	3.399	0.102	4.884	0.000	0.000	8.477	405.881	5868.983	281008.4144	0.456	0.454	0.458
	57-60	1448-1524	370	0.393	9.452	452.558	0.064	3.064	0.100	4.788	0.000	0.000	9.283	444.472	5878.266	281452.8868	0.404	0.402	0.406
	53-57	1346-1448	369	0.364	13.217	632.835	0.073	3.495	0.129	6.177	0.000	0.000	13.01	622.922	5891.276	282075.8089	0.373	0.371	0.375
*	46-53	1168-1346	368	0.247	27.379	1310.925	0.092	4.405	0.214	10.246	-0.237	-11.336	27.31	1307.610	5918.586	283383.4188	0.249	0.248	0.250
	43-46	1092-1168	367	0.117	13.762	658.944	0.023	1.101	0.087	4.166	0.000	0.000	13.65	653.566	5932.236	284036.9843	0.124	0.123	0.125
	37-43	940-1092	366	0.053	29.503	1412.626	0.021	1.005	0.068	3.256	0.000	0.000	29.4	1407.680	5961.636	285444.6638	0.056	0.053	0.059
*	25-37	635-940	365	0.042	59.708	2858.821	0.004	0.192	0.000	0.000	0.244	11.669	59.46	2846.960	6021.096	288291.6239	0.046	0.044	0.048
	13-25	330-635	364	0.035	60.134	2879.211	0.004	0.192	0.000	0.000	0.000	0.000	60.11	2878.082	6081.206	291169.7061	0.035	0.033	0.037
*	0-13	0-330	363	0.022	66.044	3162.183	0.004	0.192	0.000	0.000	-0.270	-12.948	66.31	3174.940	6147.516	294344.646	0.018	0.017	0.019

Table A-282 Energy Balance Results for RBHT Test 1683H for Time Period 3679 to 3750 seconds

Results for RBHT Test 1683
Valid Time Period 3679 to 3750 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4657.6799	14.693	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
0.25	6.35	4916.4399	15.509	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
0.50	12.70	5175.1999	16.326	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
0.75	19.05	5433.9599	17.142	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
1.00	25.40	5692.7199	17.958	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
1.25	31.75	5951.4799	18.774	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
1.50	38.10	6210.2399	19.591	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
1.75	44.45	6468.9999	20.407	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
2.00	50.80	6727.7599	21.223	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
2.25	57.15	6986.5199	22.039	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
2.50	63.50	7245.2799	22.856	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
2.75	69.85	7504.0399	23.672	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
3.00	76.20	7762.7999	24.488	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
3.25	82.55	8021.5599	25.305	0.00E+00	0.00E+00	0.00E+00	8.62E-02	3.91E-02
3.50	88.90	8280.3199	26.121	4.78E-03	2.52E-01	1.14E-01	8.58E-02	3.89E-02
3.75	95.25	8539.0799	26.937	1.52E-02	8.04E-01	3.65E-01	8.49E-02	3.85E-02
4.00	101.60	8797.8399	27.753	2.60E-02	1.37E+00	6.23E-01	8.40E-02	3.81E-02
4.25	107.95	9056.5999	28.57	3.71E-02	1.96E+00	8.89E-01	8.30E-02	3.77E-02
4.50	114.30	9315.3599	29.386	4.86E-02	2.56E+00	1.16E+00	8.20E-02	3.72E-02
4.75	120.65	9574.1199	30.202	6.03E-02	3.18E+00	1.44E+00	8.10E-02	3.67E-02
5.00	127.00	9832.8798	31.019	7.24E-02	3.82E+00	1.73E+00	8.00E-02	3.63E-02
5.25	133.35	10091.64	31.835	8.48E-02	4.47E+00	2.03E+00	7.89E-02	3.58E-02
5.50	139.70	10350.4	32.651	9.75E-02	5.15E+00	2.33E+00	7.78E-02	3.53E-02
5.75	146.05	10609.16	33.467	1.11E-01	5.83E+00	2.65E+00	7.67E-02	3.48E-02
6.00	152.40	10867.92	34.284	1.24E-01	6.54E+00	2.97E+00	7.55E-02	3.43E-02
6.25	158.75	11126.68	35.1	1.38E-01	7.26E+00	3.29E+00	7.43E-02	3.37E-02
6.50	165.10	11385.44	35.916	1.52E-01	8.00E+00	3.63E+00	7.31E-02	3.32E-02
6.75	171.45	11644.2	36.732	1.66E-01	8.76E+00	3.97E+00	7.19E-02	3.26E-02
7.00	177.80	11902.96	37.549	1.81E-01	9.53E+00	4.32E+00	7.06E-02	3.20E-02
7.25	184.15	12161.72	38.365	1.96E-01	1.03E+01	4.68E+00	6.94E-02	3.15E-02
7.50	190.50	12420.48	39.181	2.11E-01	1.11E+01	5.05E+00	6.80E-02	3.09E-02
7.75	196.85	12679.24	39.998	2.27E-01	1.20E+01	5.42E+00	6.67E-02	3.02E-02
8.00	203.20	12938	40.814	2.42E-01	1.28E+01	5.80E+00	6.53E-02	2.96E-02
8.25	209.55	13196.76	41.63	2.59E-01	1.37E+01	6.19E+00	6.39E-02	2.90E-02
8.50	215.90	13455.52	42.446	2.75E-01	1.45E+01	6.59E+00	6.25E-02	2.83E-02
8.75	222.25	13714.28	43.263	2.92E-01	1.54E+01	6.99E+00	6.10E-02	2.77E-02
9.00	228.60	13973.04	44.079	3.09E-01	1.63E+01	7.41E+00	5.95E-02	2.70E-02
9.25	234.95	13196.76	41.63	3.26E-01	1.72E+01	7.81E+00	5.81E-02	2.63E-02
9.50	241.30	12420.48	39.181	3.42E-01	1.81E+01	8.19E+00	5.67E-02	2.57E-02
9.75	247.65	11644.2	36.732	3.57E-01	1.89E+01	8.55E+00	5.54E-02	2.51E-02
10.00	254.00	10867.92	34.284	3.71E-01	1.96E+01	8.89E+00	5.42E-02	2.46E-02
10.25	260.35	10091.64	31.835	3.84E-01	2.03E+01	9.20E+00	5.31E-02	2.41E-02
10.50	266.70	9315.3599	29.386	3.96E-01	2.09E+01	9.49E+00	5.20E-02	2.36E-02
10.75	273.05	8539.0799	26.937	4.07E-01	2.15E+01	9.75E+00	5.11E-02	2.32E-02
11.00	279.40	7762.7999	24.488	4.18E-01	2.20E+01	9.99E+00	5.02E-02	2.28E-02
11.25	285.75	6986.5199	22.039	4.27E-01	2.25E+01	1.02E+01	4.94E-02	2.24E-02
11.50	292.10	6210.2399	19.591	4.35E-01	2.30E+01	1.04E+01	4.87E-02	2.21E-02
11.75	298.45	5433.9599	17.142	4.42E-01	2.33E+01	1.06E+01	4.81E-02	2.18E-02
12.00	304.80	4657.6799	14.693	4.49E-01	2.37E+01	1.07E+01	4.75E-02	2.16E-02

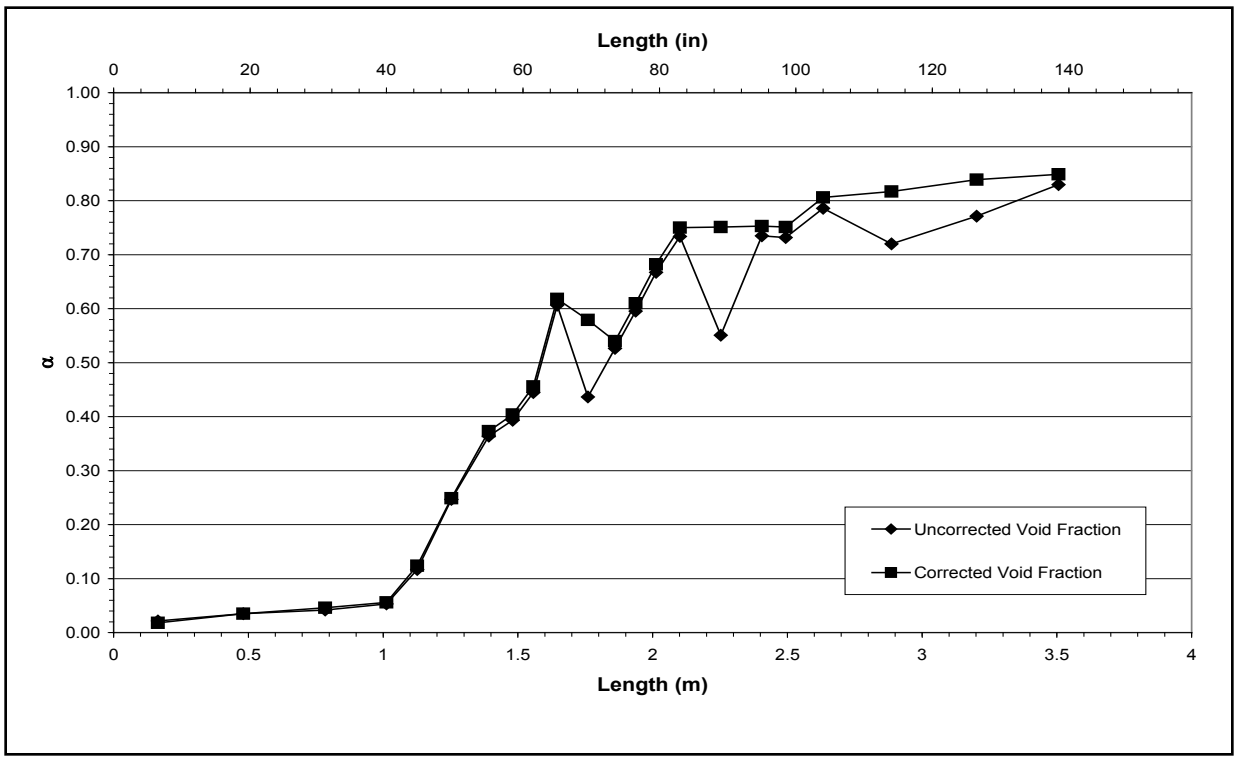

Figure A-705 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683H for Time Period 3679 to 3750 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-I

Test Conditions

Date: 7/23/2003
Steady-state time window: 1100 – 1200 seconds
Inlet flow rate: 1.984 cm/sec (0.781 in./sec)
Inlet mass flow rate: 0.093 kg/sec (0.206 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

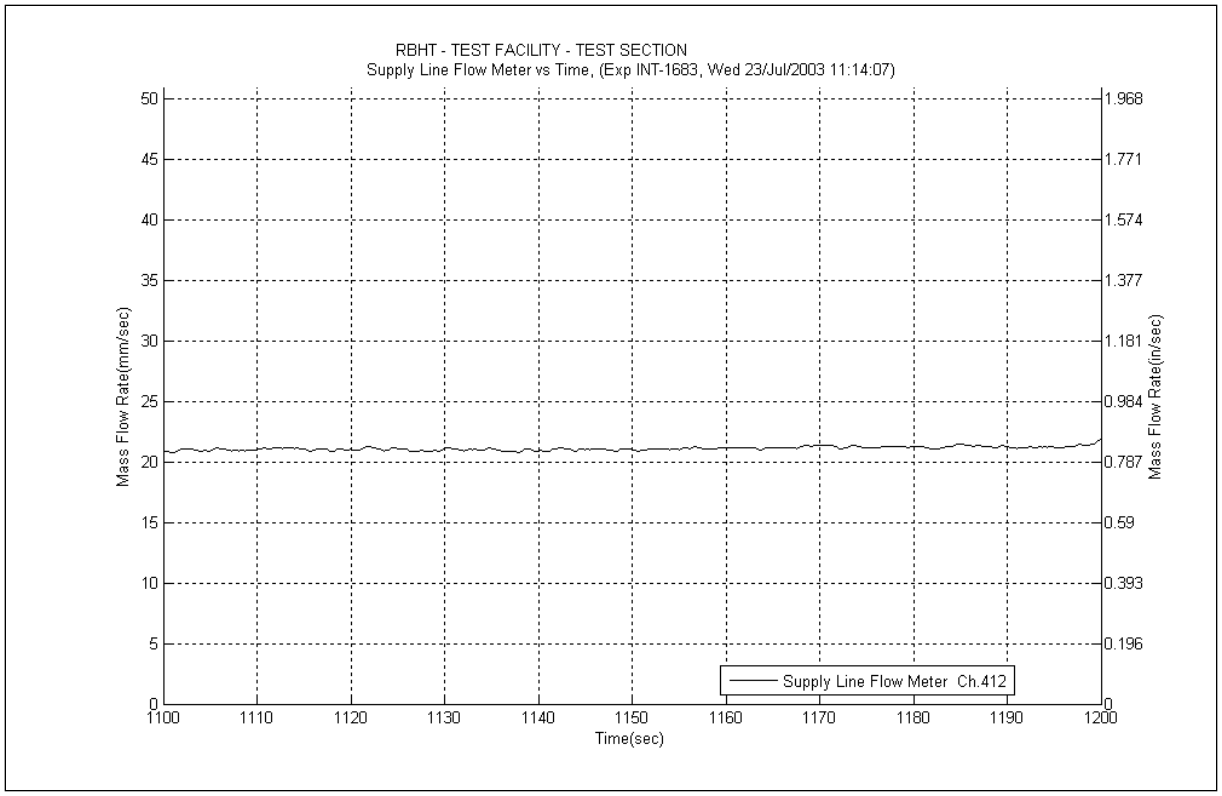

Figure A-706 Inlet Flow Plot for Experiment 1683l

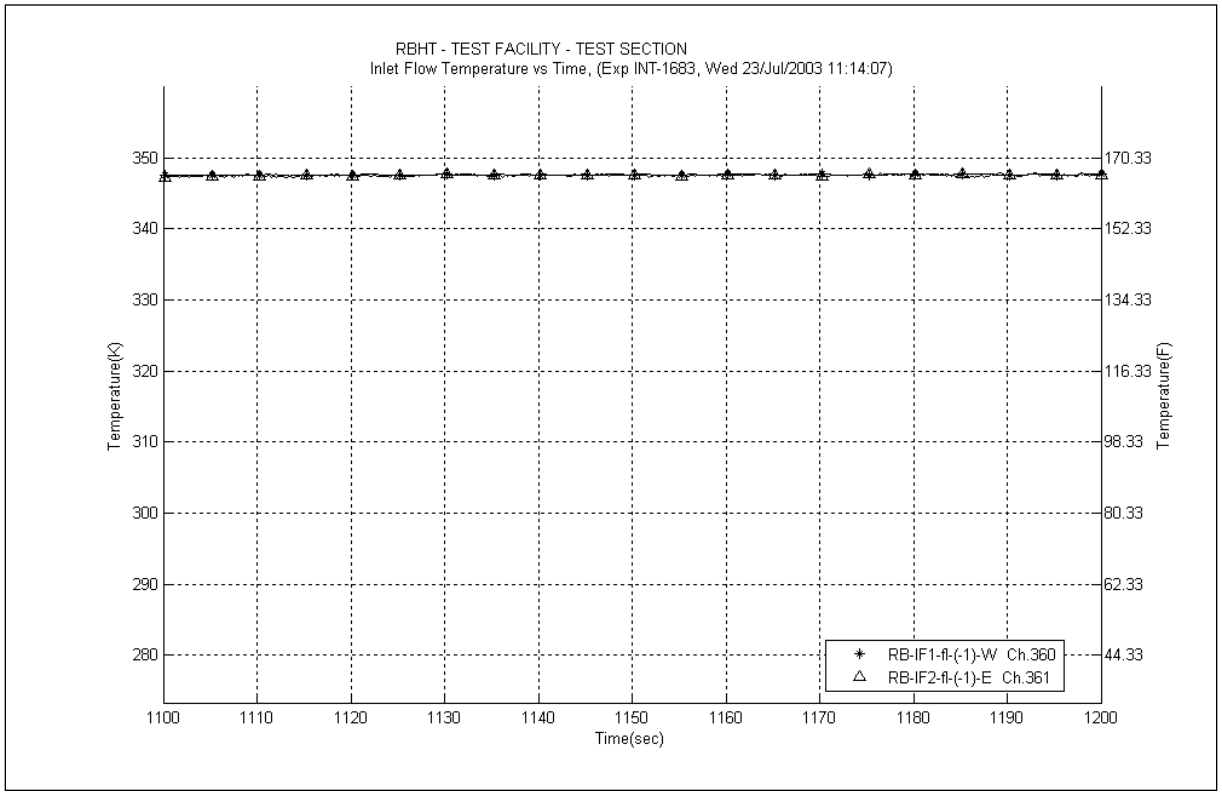

Figure A-707 Inlet Temperature Plot for Experiment 1683l

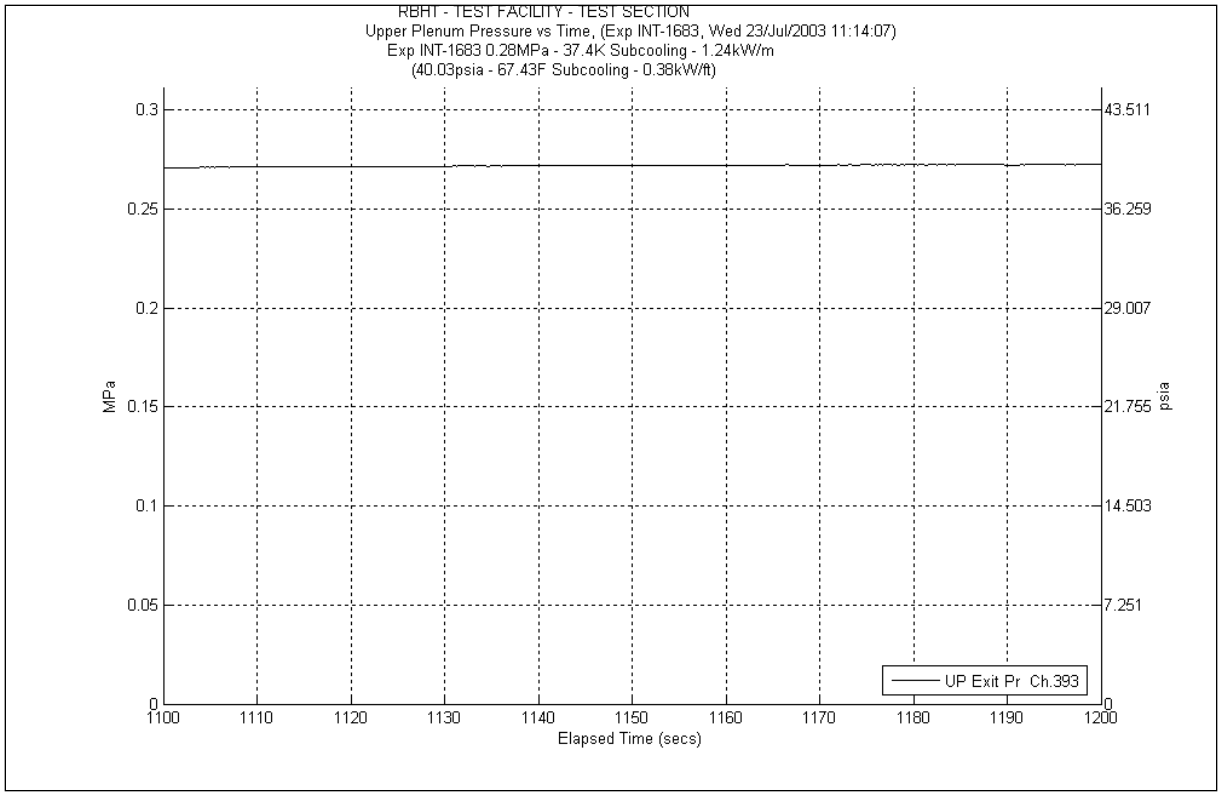

Figure A-708 System Pressure Plot for Experiment 1683I

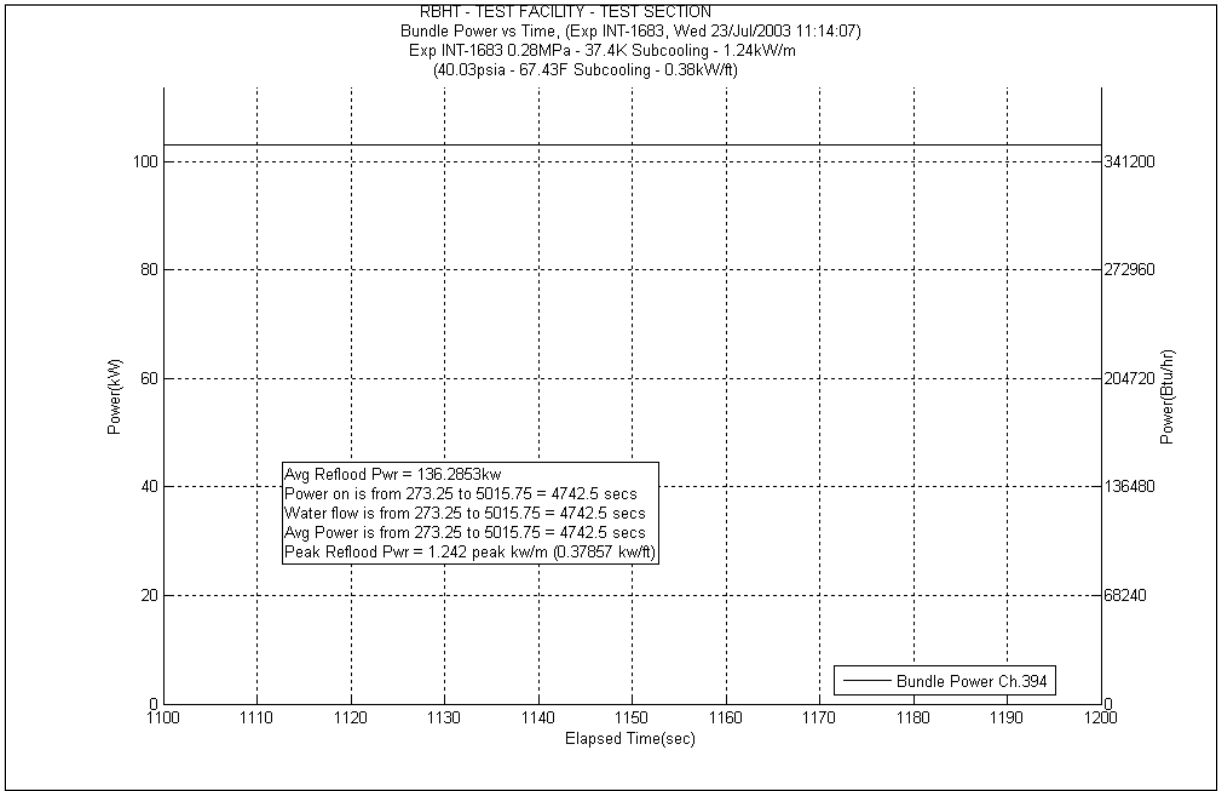

Figure A-709 Bundle Power Plot for Experiment 1683I

Table A-283 Data Results for RBHT Test 1683 for Time Period 1100 to 1200

Results for RBHT Test 1683
Valid Time Period 1100 to 1200 seconds
Collapsed Liquid Level = 73.552 inches = 1868.22 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.865	7.691	368.262	0.726	34.761	0.179	8.571	0.000	0.000	6.784	324.820	5766.784	276115.1	0.881	0.877	0.885
*	120-133	3048-3378	383	0.809	12.874	616.423	0.796	38.113	0.320	15.322	2.832	135.610	8.926	427.379	5775.71	276542.4792	0.868	0.864	0.872
*	108-120	2743-3048	382	0.756	15.196	727.573	0.652	31.218	0.399	19.104	4.229	202.470	9.916	474.781	5785.626	277017.2598	0.841	0.837	0.845
	100-108	2540-2743	381	0.811	7.847	375.722	0.381	18.242	0.292	13.981	0.000	0.000	7.169	343.254	5792.795	277360.5133	0.827	0.823	0.831
	97-100	2464-2540	380	0.760	3.744	179.282	0.132	6.320	0.106	5.075	0.000	0.000	3.506	167.868	5796.301	277528.3815	0.775	0.771	0.779
	93-97	2362-2464	379	0.764	4.903	234.733	0.166	7.948	0.138	6.607	0.000	0.000	4.598	220.153	5800.899	277748.535	0.779	0.775	0.783
*	85-93	2159-2362	378	0.595	16.847	806.646	0.301	14.412	0.264	12.640	6.922	331.435	9.36	448.159	5810.259	278196.6942	0.775	0.771	0.779
	81-85	2057-2159	377	0.758	5.027	240.701	0.135	6.464	0.127	6.081	0.000	0.000	4.762	228.006	5815.021	278424.6999	0.771	0.767	0.775
	78-81	1981-2057	376	0.721	4.347	208.127	0.095	4.549	0.092	4.405	0.000	0.000	4.158	199.086	5819.179	278623.786	0.733	0.729	0.737
	75-78	1905-1981	375	0.636	5.676	271.783	0.090	4.309	0.090	4.309	0.000	0.000	5.494	263.054	5824.673	278886.8402	0.647	0.644	0.650
	72-75	1829-1905	374	0.573	6.653	318.531	0.084	4.022	0.088	4.213	0.000	0.000	6.48	310.264	5831.153	279197.1042	0.584	0.581	0.587
*	67-72	1702-1829	373	0.472	13.721	656.954	0.129	6.177	0.143	6.847	3.916	187.488	9.533	456.442	5840.686	279653.5467	0.633	0.630	0.636
	63-67	1600-1702	372	0.672	6.819	326.488	0.092	4.405	0.110	5.267	0.000	0.000	6.614	316.680	5847.3	279970.2268	0.682	0.679	0.685
	60-63	1524-1600	371	0.508	7.665	367.019	0.063	3.016	0.080	3.830	0.000	0.000	7.518	359.964	5854.818	280330.1905	0.517	0.514	0.520
	57-60	1448-1524	370	0.451	8.559	409.788	0.058	2.777	0.078	3.735	0.000	0.000	8.418	403.056	5863.236	280733.2465	0.46	0.458	0.462
	53-57	1346-1448	369	0.429	11.867	568.183	0.069	3.304	0.101	4.836	0.000	0.000	11.69	559.720	5874.926	281292.9667	0.437	0.435	0.439
*	46-53	1168-1346	368	0.312	25.001	1197.039	0.097	4.644	0.167	7.996	3.667	175.562	21.07	1008.837	5895.996	282301.8038	0.42	0.418	0.422
	43-46	1092-1168	367	0.397	9.390	449.574	0.032	1.532	0.068	3.256	0.000	0.000	9.286	444.616	5905.282	282746.4198	0.404	0.402	0.406
	37-43	940-1092	366	0.212	24.544	1175.158	0.044	2.107	0.130	6.224	0.000	0.000	24.36	1166.363	5929.642	283912.7829	0.218	0.217	0.219
*	25-37	635-940	365	0.050	59.220	2835.447	0.036	1.724	0.066	3.160	4.818	230.665	54.3	2599.898	5983.942	286512.6808	0.128	0.127	0.129
	13-25	330-635	364	0.039	59.900	2868.021	0.002	0.096	0.000	0.000	0.000	0.000	59.88	2867.070	6043.822	289379.7506	0.039	0.037	0.041
*	0-13	0-330	363	0.023	65.966	3158.454	0.003	0.144	0.000	0.000	-0.217	-10.405	66.18	3168.715	6110.002	292548.466	0.019	0.018	0.020

Table A-284 Energy Balance Results for RBHT Test 1683I for Time Period 1100 to 1200 seconds

Results for RBHT Test 1683
Valid Time Period 1100 to 1200 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4652.5449	14.677	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
0.25	6.35	4911.0196	15.492	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
0.50	12.70	5169.4943	16.308	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
0.75	19.05	5427.9691	17.123	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
1.00	25.40	5686.4438	17.938	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
1.25	31.75	5944.9185	18.754	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
1.50	38.10	6203.3932	19.569	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
1.75	44.45	6461.8679	20.384	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
2.00	50.80	6720.3426	21.2	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
2.25	57.15	6978.8174	22.015	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
2.50	63.50	7237.2921	22.831	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
2.75	69.85	7495.7668	23.646	0.00E+00	0.00E+00	0.00E+00	6.75E-02	3.06E-02
3.00	76.20	7754.2415	24.461	8.83E-03	3.65E-01	1.66E-01	6.69E-02	3.04E-02
3.25	82.55	8012.7162	25.277	2.14E-02	8.83E-01	4.00E-01	6.61E-02	3.00E-02
3.50	88.90	8271.1909	26.092	3.43E-02	1.42E+00	6.43E-01	6.52E-02	2.96E-02
3.75	95.25	8529.6657	26.907	4.76E-02	1.97E+00	8.93E-01	6.43E-02	2.92E-02
4.00	101.60	8788.1404	27.723	6.14E-02	2.54E+00	1.15E+00	6.34E-02	2.87E-02
4.25	107.95	9046.6151	28.538	7.56E-02	3.12E+00	1.42E+00	6.24E-02	2.83E-02
4.50	114.30	9305.0898	29.354	9.01E-02	3.73E+00	1.69E+00	6.14E-02	2.79E-02
4.75	120.65	9563.5645	30.169	1.05E-01	4.34E+00	1.97E+00	6.04E-02	2.74E-02
5.00	127.00	9822.0392	30.984	1.21E-01	4.98E+00	2.26E+00	5.94E-02	2.69E-02
5.25	133.35	10080.514	31.8	1.36E-01	5.63E+00	2.56E+00	5.83E-02	2.65E-02
5.50	139.70	10338.989	32.615	1.53E-01	6.31E+00	2.86E+00	5.72E-02	2.60E-02
5.75	146.05	10597.463	33.43	1.69E-01	6.99E+00	3.17E+00	5.61E-02	2.54E-02
6.00	152.40	10855.938	34.246	1.86E-01	7.70E+00	3.49E+00	5.50E-02	2.49E-02
6.25	158.75	11114.413	35.061	2.04E-01	8.42E+00	3.82E+00	5.38E-02	2.44E-02
6.50	165.10	11372.888	35.877	2.22E-01	9.16E+00	4.15E+00	5.26E-02	2.38E-02
6.75	171.45	11631.362	36.692	2.40E-01	9.91E+00	4.50E+00	5.13E-02	2.33E-02
7.00	177.80	11889.837	37.507	2.59E-01	1.07E+01	4.85E+00	5.01E-02	2.27E-02
7.25	184.15	12148.312	38.323	2.78E-01	1.15E+01	5.20E+00	4.88E-02	2.21E-02
7.50	190.50	12406.786	39.138	2.97E-01	1.23E+01	5.57E+00	4.75E-02	2.15E-02
7.75	196.85	12665.261	39.953	3.17E-01	1.31E+01	5.94E+00	4.61E-02	2.09E-02
8.00	203.20	12923.736	40.769	3.37E-01	1.39E+01	6.32E+00	4.47E-02	2.03E-02
8.25	209.55	13182.211	41.584	3.58E-01	1.48E+01	6.71E+00	4.33E-02	1.97E-02
8.50	215.90	13440.685	42.4	3.79E-01	1.57E+01	7.11E+00	4.19E-02	1.90E-02
8.75	222.25	13699.16	43.215	4.01E-01	1.66E+01	7.51E+00	4.05E-02	1.84E-02
9.00	228.60	13957.635	44.03	4.23E-01	1.75E+01	7.93E+00	3.90E-02	1.77E-02
9.25	234.95	13182.211	41.584	4.44E-01	1.84E+01	8.33E+00	3.75E-02	1.70E-02
9.50	241.30	12406.786	39.138	4.65E-01	1.92E+01	8.71E+00	3.62E-02	1.64E-02
9.75	247.65	11631.362	36.692	4.84E-01	2.00E+01	9.07E+00	3.49E-02	1.58E-02
10.00	254.00	10855.938	34.246	5.02E-01	2.07E+01	9.40E+00	3.37E-02	1.53E-02
10.25	260.35	10080.514	31.8	5.18E-01	2.14E+01	9.72E+00	3.25E-02	1.48E-02
10.50	266.70	9305.0898	29.354	5.34E-01	2.21E+01	1.00E+01	3.15E-02	1.43E-02
10.75	273.05	8529.6657	26.907	5.48E-01	2.26E+01	1.03E+01	3.05E-02	1.38E-02
11.00	279.40	7754.2415	24.461	5.61E-01	2.32E+01	1.05E+01	2.97E-02	1.35E-02
11.25	285.75	6978.8174	22.015	5.72E-01	2.37E+01	1.07E+01	2.89E-02	1.31E-02
11.50	292.10	6203.3932	19.569	5.83E-01	2.41E+01	1.09E+01	2.82E-02	1.28E-02
11.75	298.45	5427.9691	17.123	5.92E-01	2.45E+01	1.11E+01	2.75E-02	1.25E-02
12.00	304.80	4652.5449	14.677	6.00E-01	2.48E+01	1.13E+01	2.70E-02	1.22E-02

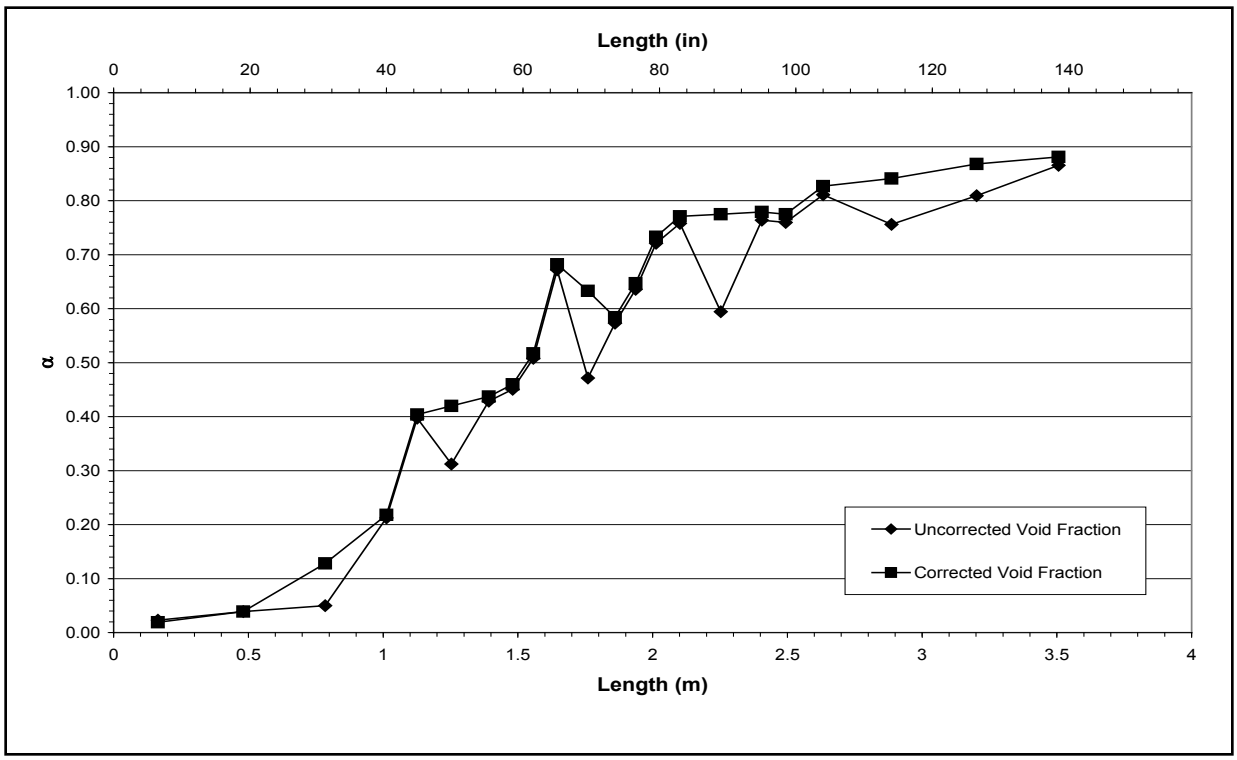

Figure A-710 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683I for Time Period 1100 to 1200 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-J

Test Conditions

Date: 7/23/2003
Steady-state time window: 4110 – 4260 seconds
Inlet flow rate: 1.521 cm/sec (0.599 in./sec)
Inlet mass flow rate: 0.072 kg/sec (0.158 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

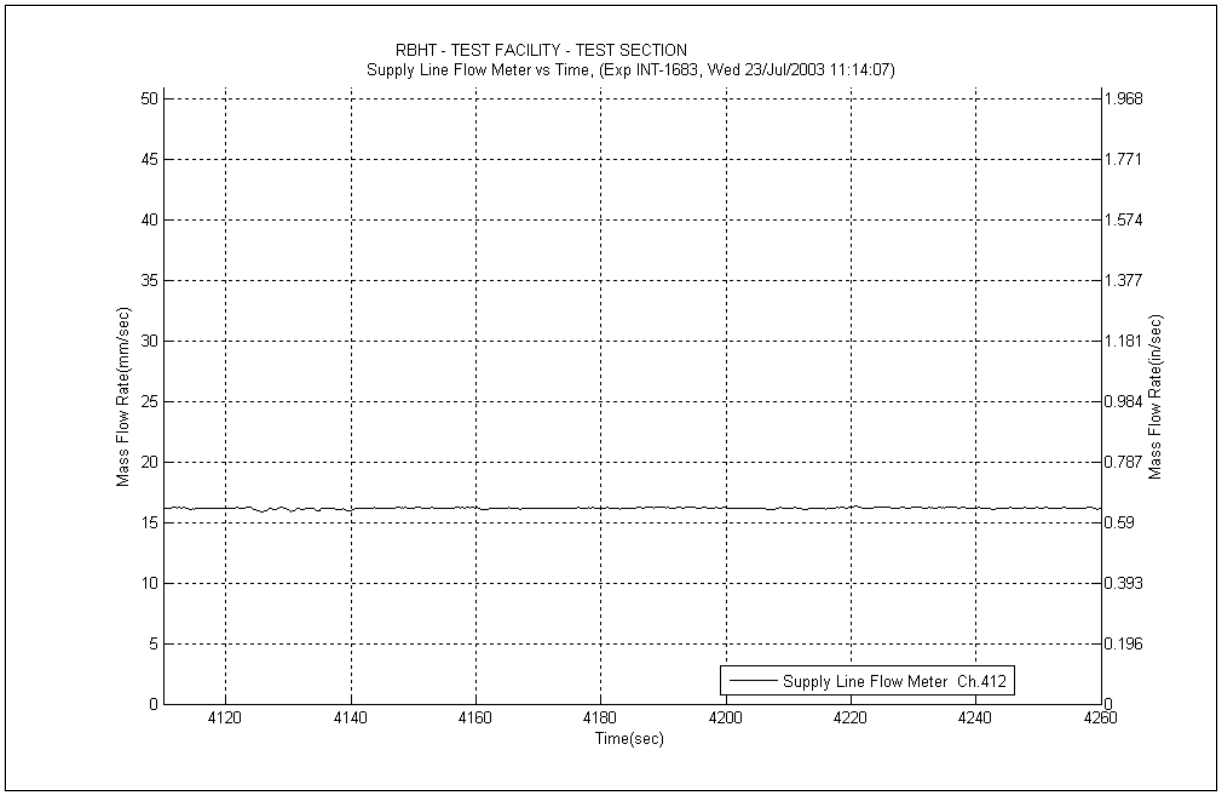

Figure A-711 Inlet Flow Plot for Experiment 1683J

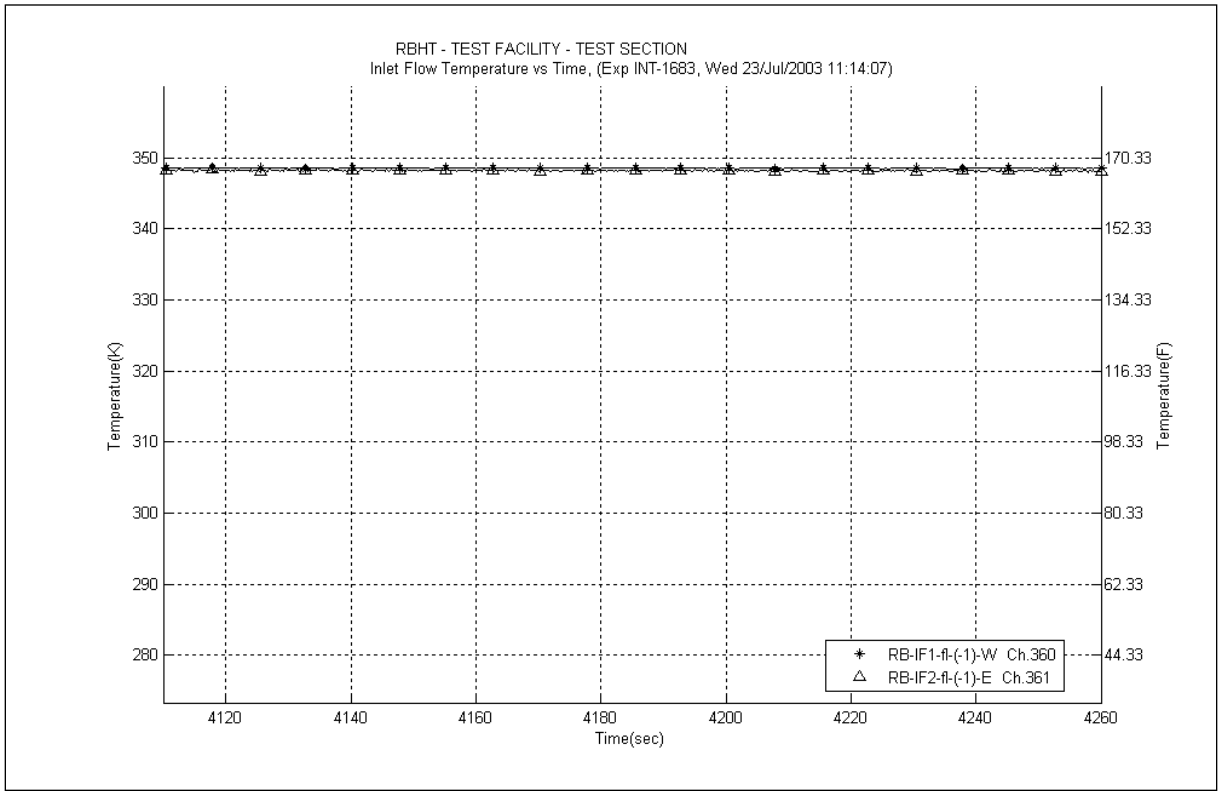

Figure A-712 Inlet Temperature Plot for Experiment 1683J

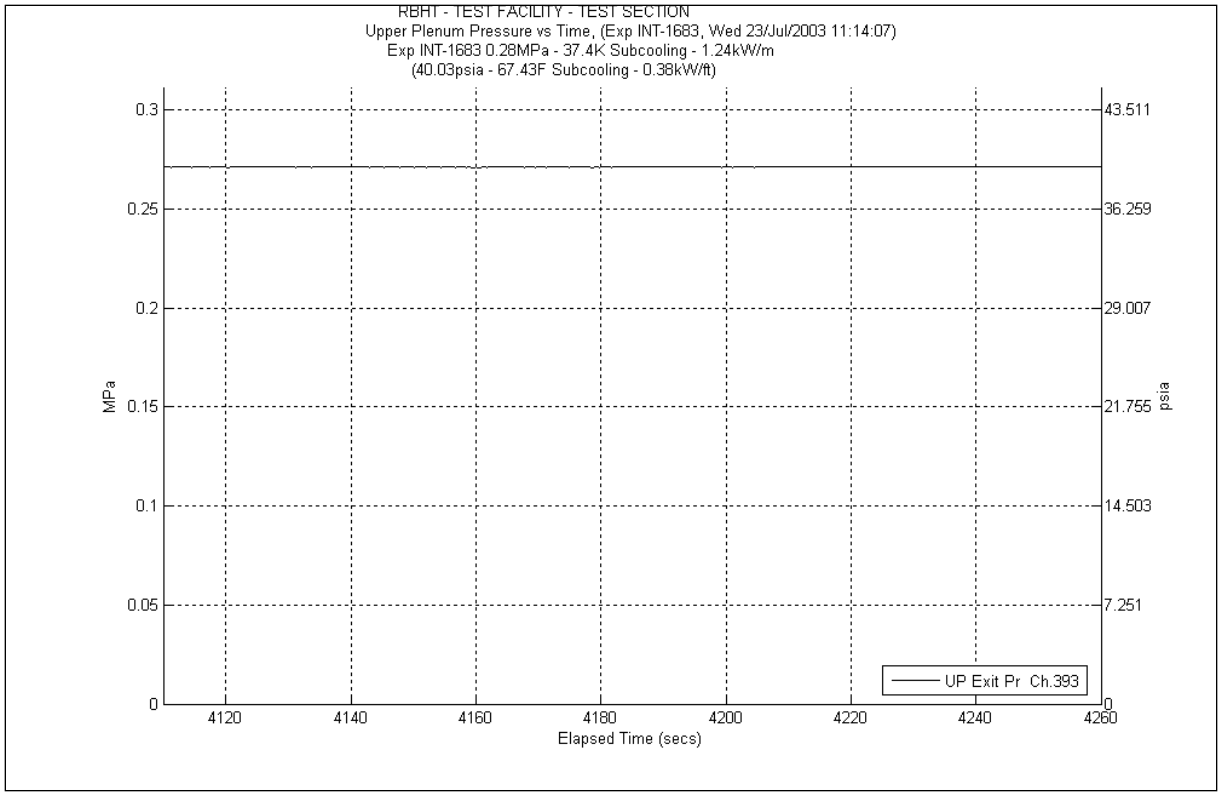

Figure A-713 System Pressure Plot for Experiment 1683J

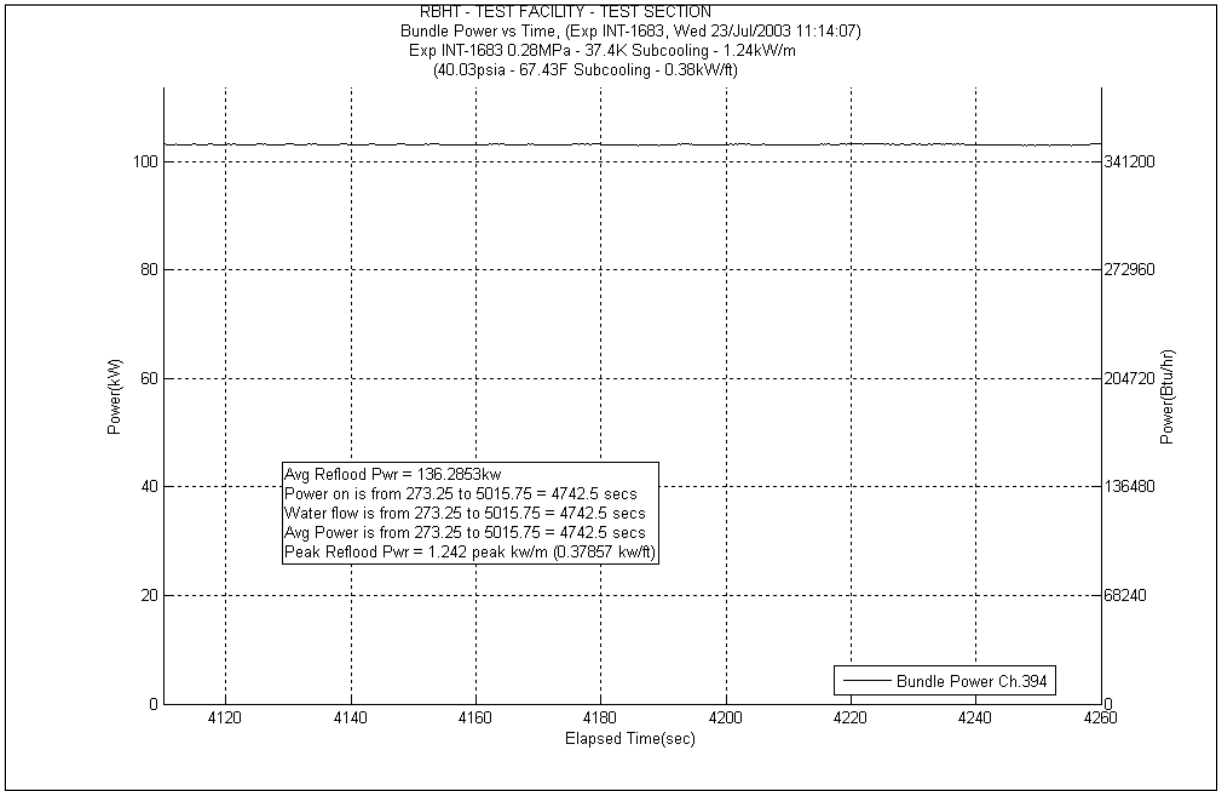

Figure A-714 Bundle Power Plot for Experiment 1683J

Table A-285 Data Results for RBHT Test 1683 for Time Period 4110 to 4260

Results for RBHT Test 1683
Valid Time Period 4110 to 4260 seconds
Collapsed Liquid Level = 66.383 inches = 1686.12 mm
(Z_{osv}) Onset of Significant Void = 31 inches = 787.5 mm

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.903	5.557	266.064	0.569	27.244	0.138	6.607	0.000	0.000	4.85	232.219	5764.85	276022.4996	0.915	0.910	0.920
*	120-133	3048-3378	383	0.857	9.644	461.758	0.630	30.165	0.246	11.779	2.141	102.512	6.627	317.302	5771.477	276339.802	0.902	0.897	0.907
*	108-120	2743-3048	382	0.805	12.178	583.103	0.519	24.850	0.307	14.699	3.583	171.572	7.769	371.982	5779.246	276711.7837	0.875	0.871	0.879
	100-108	2540-2743	381	0.849	6.263	299.882	0.305	14.603	0.224	10.725	0.000	0.000	5.73	274.354	5784.976	276986.1376	0.862	0.858	0.866
	97-100	2464-2540	380	0.800	3.121	149.443	0.105	5.027	0.081	3.878	0.000	0.000	2.933	140.433	5787.909	277126.5704	0.812	0.808	0.816
	93-97	2362-2464	379	0.799	4.181	200.170	0.133	6.368	0.106	5.075	0.000	0.000	3.943	188.792	5791.852	277315.3623	0.81	0.806	0.814
*	85-93	2159-2362	378	0.652	14.474	693.010	0.242	11.587	0.203	9.720	5.932	284.017	8.097	387.686	5799.949	277703.0487	0.805	0.801	0.809
	81-85	2057-2159	377	0.790	4.362	208.873	0.109	5.219	0.097	4.644	0.000	0.000	4.154	198.895	5804.103	277901.9433	0.8	0.796	0.804
	78-81	1981-2057	376	0.769	3.594	172.071	0.077	3.687	0.071	3.399	0.000	0.000	3.447	165.043	5807.55	278066.9865	0.779	0.775	0.783
	75-78	1905-1981	375	0.688	4.861	232.744	0.073	3.495	0.069	3.304	0.000	0.000	4.716	225.803	5812.266	278292.7898	0.697	0.694	0.700
	72-75	1829-1905	374	0.634	5.707	273.275	0.069	3.304	0.068	3.256	0.000	0.000	5.571	266.741	5817.837	278559.5307	0.642	0.639	0.645
*	67-72	1702-1829	373	0.494	13.139	629.105	0.106	5.075	0.110	5.267	4.645	222.410	8.278	396.353	5826.115	278955.8835	0.681	0.678	0.684
	63-67	1600-1702	372	0.712	5.978	286.205	0.077	3.687	0.084	4.022	0.000	0.000	5.817	278.519	5831.932	279234.403	0.72	0.716	0.724
	60-63	1524-1600	371	0.594	6.331	303.114	0.053	2.538	0.061	2.921	0.000	0.000	6.213	297.480	5838.145	279531.883	0.601	0.598	0.604
	57-60	1448-1524	370	0.510	7.629	365.279	0.049	2.346	0.060	2.873	0.000	0.000	7.518	359.964	5845.663	279891.8468	0.517	0.514	0.520
	53-57	1346-1448	369	0.486	10.688	511.738	0.060	2.873	0.077	3.687	0.000	0.000	10.55	505.137	5856.213	280396.9835	0.492	0.490	0.494
*	46-53	1168-1346	368	0.358	23.334	1117.220	0.088	4.213	0.129	6.177	4.767	228.228	18.35	878.603	5874.563	281275.5862	0.495	0.493	0.497
	43-46	1092-1168	367	0.493	7.899	378.209	0.031	1.484	0.052	2.490	0.000	0.000	7.814	374.136	5882.377	281649.7225	0.498	0.496	0.500
	37-43	940-1092	366	0.435	17.605	842.951	0.051	2.442	0.100	4.788	0.000	0.000	17.45	835.510	5899.827	282485.233	0.44	0.438	0.442
*	25-37	635-940	365	0.158	52.479	2512.689	0.054	2.586	0.155	7.421	5.060	242.255	47.21	2260.427	5947.037	284745.6599	0.242	0.241	0.243
	13-25	330-635	364	0.045	59.531	2850.366	0.001	0.048	0.000	0.000	0.000	0.000	59.51	2849.354	6006.547	287595.014	0.045	0.043	0.047
*	0-13	0-330	363	0.024	65.862	3153.480	0.002	0.096	0.000	0.000	-0.120	-5.755	65.98	3159.139	6072.527	290754.1534	0.022	0.021	0.023

Table A-286 Energy Balance Results for RBHT Test 1683J for Time Period 4110 to 4260 seconds

Results for RBHT Test 1683
Valid Time Period 4110 to 4260 seconds

Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4662.9085	14.709	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.25	6.35	4921.959	15.527	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.50	12.70	5181.0095	16.344	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
0.75	19.05	5440.0599	17.161	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.00	25.40	5699.1104	17.978	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.25	31.75	5958.1609	18.795	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.50	38.10	6217.2114	19.613	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
1.75	44.45	6476.2618	20.43	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.00	50.80	6735.3123	21.247	0.00E+00	0.00E+00	0.00E+00	5.18E-02	2.35E-02
2.25	57.15	6994.3628	22.064	7.90E-04	2.50E-02	1.14E-02	5.17E-02	2.35E-02
2.50	63.50	7253.4133	22.881	1.56E-02	4.93E-01	2.24E-01	5.10E-02	2.31E-02
2.75	69.85	7512.4637	23.699	3.08E-02	9.78E-01	4.43E-01	5.02E-02	2.28E-02
3.00	76.20	7771.5142	24.516	4.67E-02	1.48E+00	6.71E-01	4.94E-02	2.24E-02
3.25	82.55	8030.5647	25.333	6.31E-02	2.00E+00	9.07E-01	4.85E-02	2.20E-02
3.50	88.90	8289.6152	26.15	8.00E-02	2.53E+00	1.15E+00	4.76E-02	2.16E-02
3.75	95.25	8548.6656	26.967	9.74E-02	3.09E+00	1.40E+00	4.67E-02	2.12E-02
4.00	101.60	8807.7161	27.785	1.15E-01	3.66E+00	1.66E+00	4.58E-02	2.08E-02
4.25	107.95	9066.7666	28.602	1.34E-01	4.24E+00	1.93E+00	4.48E-02	2.03E-02
4.50	114.30	9325.8171	29.419	1.53E-01	4.85E+00	2.20E+00	4.39E-02	1.99E-02
4.75	120.65	9584.8675	30.236	1.73E-01	5.47E+00	2.48E+00	4.28E-02	1.94E-02
5.00	127.00	9843.918	31.053	1.93E-01	6.11E+00	2.77E+00	4.18E-02	1.90E-02
5.25	133.35	10102.968	31.871	2.13E-01	6.76E+00	3.07E+00	4.07E-02	1.85E-02
5.50	139.70	10362.019	32.688	2.35E-01	7.43E+00	3.37E+00	3.96E-02	1.80E-02
5.75	146.05	10621.069	33.505	2.56E-01	8.12E+00	3.69E+00	3.85E-02	1.75E-02
6.00	152.40	10880.12	34.322	2.79E-01	8.83E+00	4.00E+00	3.74E-02	1.69E-02
6.25	158.75	11139.17	35.139	3.01E-01	9.55E+00	4.33E+00	3.62E-02	1.64E-02
6.50	165.10	11398.221	35.957	3.25E-01	1.03E+01	4.67E+00	3.50E-02	1.59E-02
6.75	171.45	11657.271	36.774	3.49E-01	1.11E+01	5.01E+00	3.37E-02	1.53E-02
7.00	177.80	11916.322	37.591	3.73E-01	1.18E+01	5.36E+00	3.25E-02	1.47E-02
7.25	184.15	12175.372	38.408	3.98E-01	1.26E+01	5.72E+00	3.12E-02	1.41E-02
7.50	190.50	12434.423	39.225	4.23E-01	1.34E+01	6.09E+00	2.99E-02	1.35E-02
7.75	196.85	12693.473	40.042	4.50E-01	1.42E+01	6.46E+00	2.85E-02	1.29E-02
8.00	203.20	12952.524	40.86	4.76E-01	1.51E+01	6.84E+00	2.71E-02	1.23E-02
8.25	209.55	13211.574	41.677	5.03E-01	1.59E+01	7.23E+00	2.57E-02	1.17E-02
8.50	215.90	13470.625	42.494	5.31E-01	1.68E+01	7.63E+00	2.43E-02	1.10E-02
8.75	222.25	13729.675	43.311	5.59E-01	1.77E+01	8.04E+00	2.28E-02	1.04E-02
9.00	228.60	13988.726	44.128	5.88E-01	1.86E+01	8.45E+00	2.13E-02	9.68E-03
9.25	234.95	13211.574	41.677	6.16E-01	1.95E+01	8.85E+00	1.99E-02	9.02E-03
9.50	241.30	12434.423	39.225	6.42E-01	2.04E+01	9.24E+00	1.85E-02	8.40E-03
9.75	247.65	11657.271	36.774	6.67E-01	2.12E+01	9.59E+00	1.72E-02	7.81E-03
10.00	254.00	10880.12	34.322	6.91E-01	2.19E+01	9.93E+00	1.60E-02	7.26E-03
10.25	260.35	10102.968	31.871	7.12E-01	2.26E+01	1.02E+01	1.49E-02	6.75E-03
10.50	266.70	9325.8171	29.419	7.33E-01	2.32E+01	1.05E+01	1.38E-02	6.28E-03
10.75	273.05	8548.6656	26.967	7.51E-01	2.38E+01	1.08E+01	1.29E-02	5.85E-03
11.00	279.40	7771.5142	24.516	7.68E-01	2.43E+01	1.10E+01	1.20E-02	5.45E-03
11.25	285.75	6994.3628	22.064	7.83E-01	2.48E+01	1.13E+01	1.12E-02	5.09E-03
11.50	292.10	6217.2114	19.613	7.97E-01	2.53E+01	1.15E+01	1.05E-02	4.77E-03
11.75	298.45	5440.0599	17.161	8.09E-01	2.56E+01	1.16E+01	9.89E-03	4.49E-03
12.00	304.80	4662.9085	14.709	8.20E-01	2.60E+01	1.18E+01	9.35E-03	4.24E-03

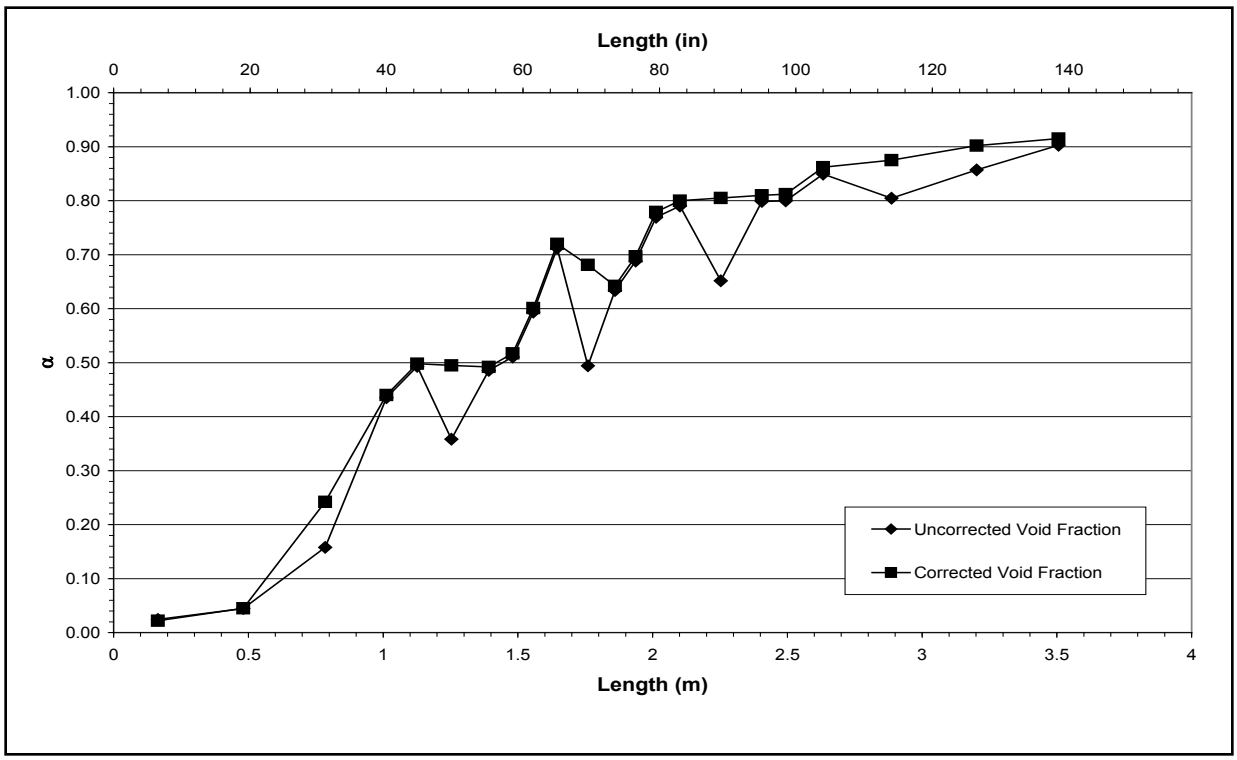

Figure A-715 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683J for Time Period 4110 to 4260 seconds

RBHT Two-Phase Mixture Level and Uncovery Test INT-1683-K

Test Conditions

Date: 7/23/2003
Steady-state time window: 4545 – 4845 seconds
Inlet flow rate: 1.013 cm/sec (0.399 in./sec)
Inlet mass flow rate: 0.048 kg/sec (0.105 lbm/sec)
Inlet flow temperature: 348.4 K (167.4 ºF)
Upper plenum pressure: 271.7 kPa (39.4 psia)
Bundle power: 144.41 kW

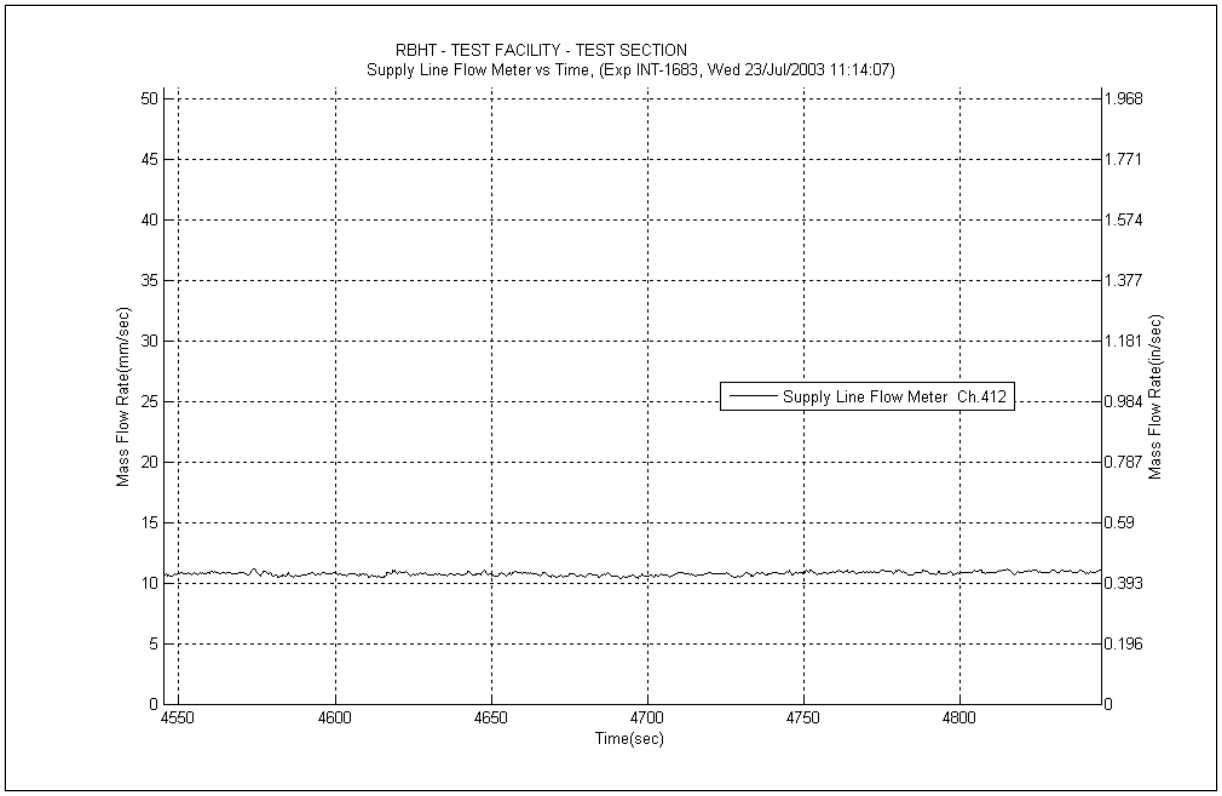

Figure A-716 Inlet Flow Plot for Experiment 1683K

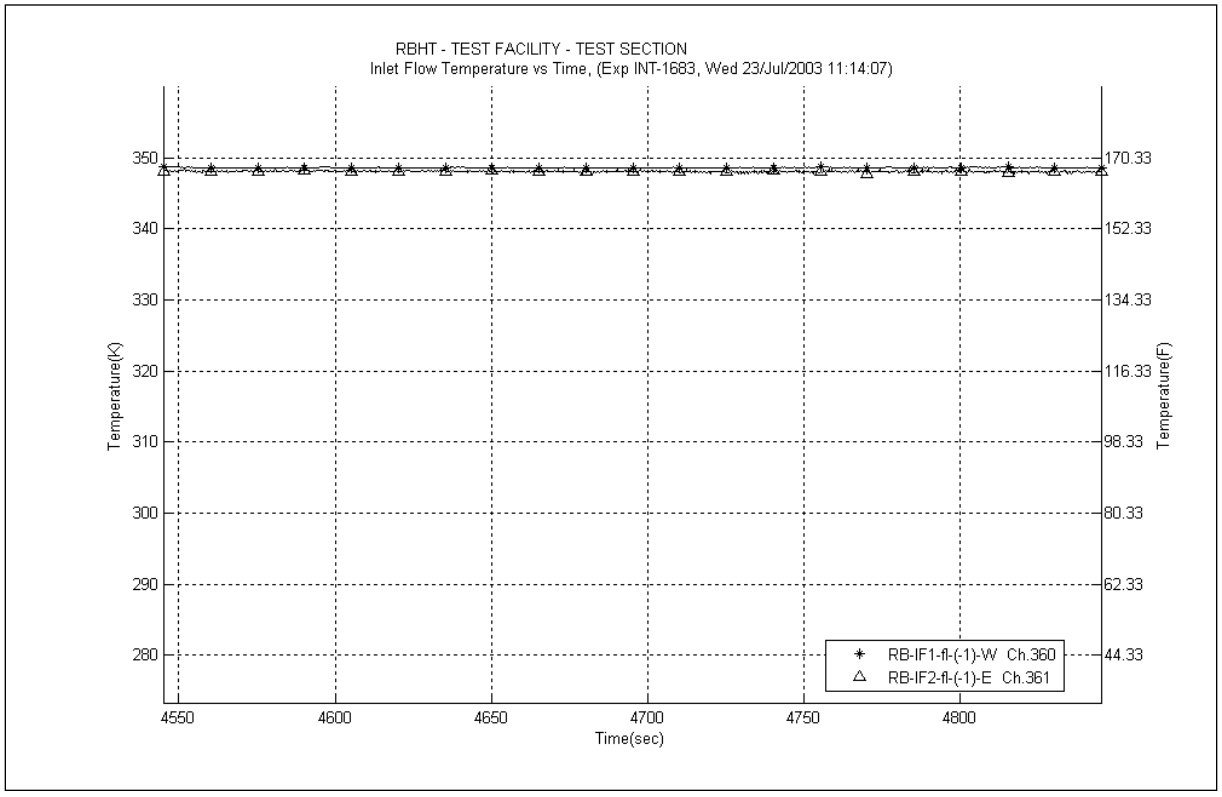

Figure A-717 Inlet Temperature Plot for Experiment 1683K

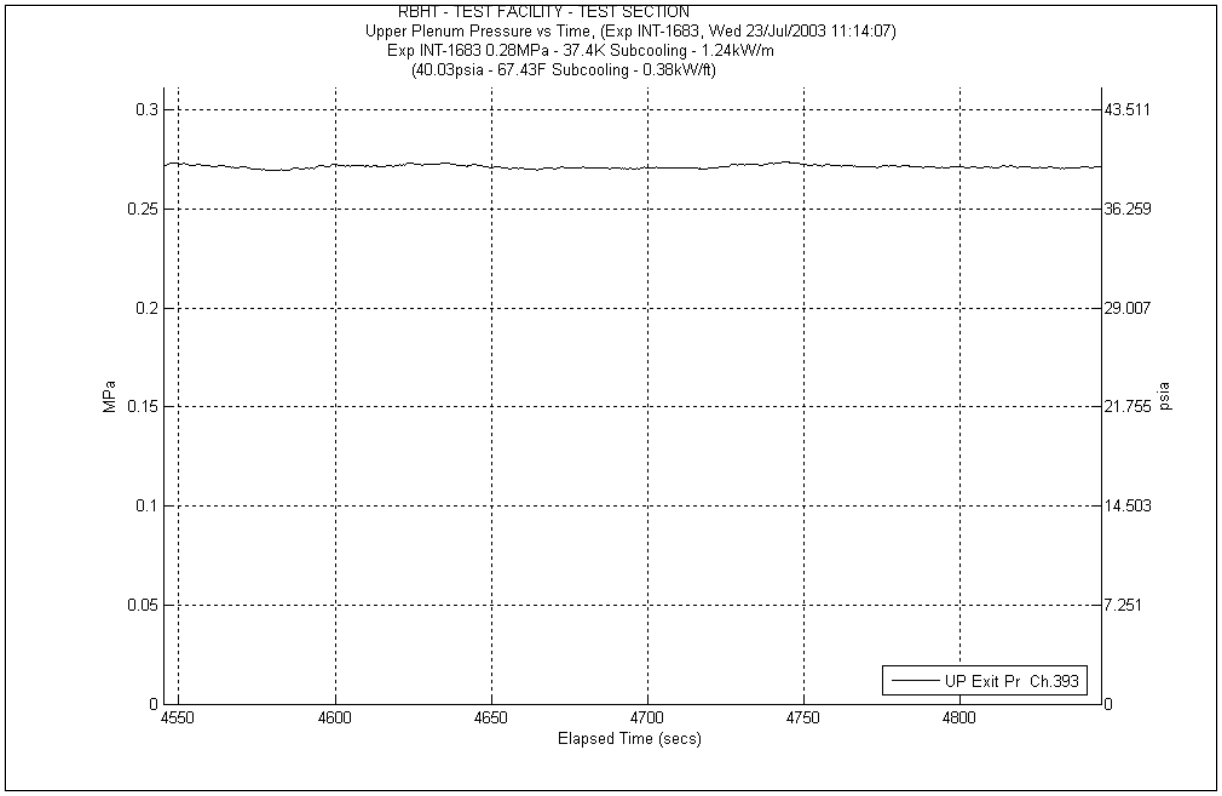

Figure A-718 System Pressure Plot for Experiment 1683K

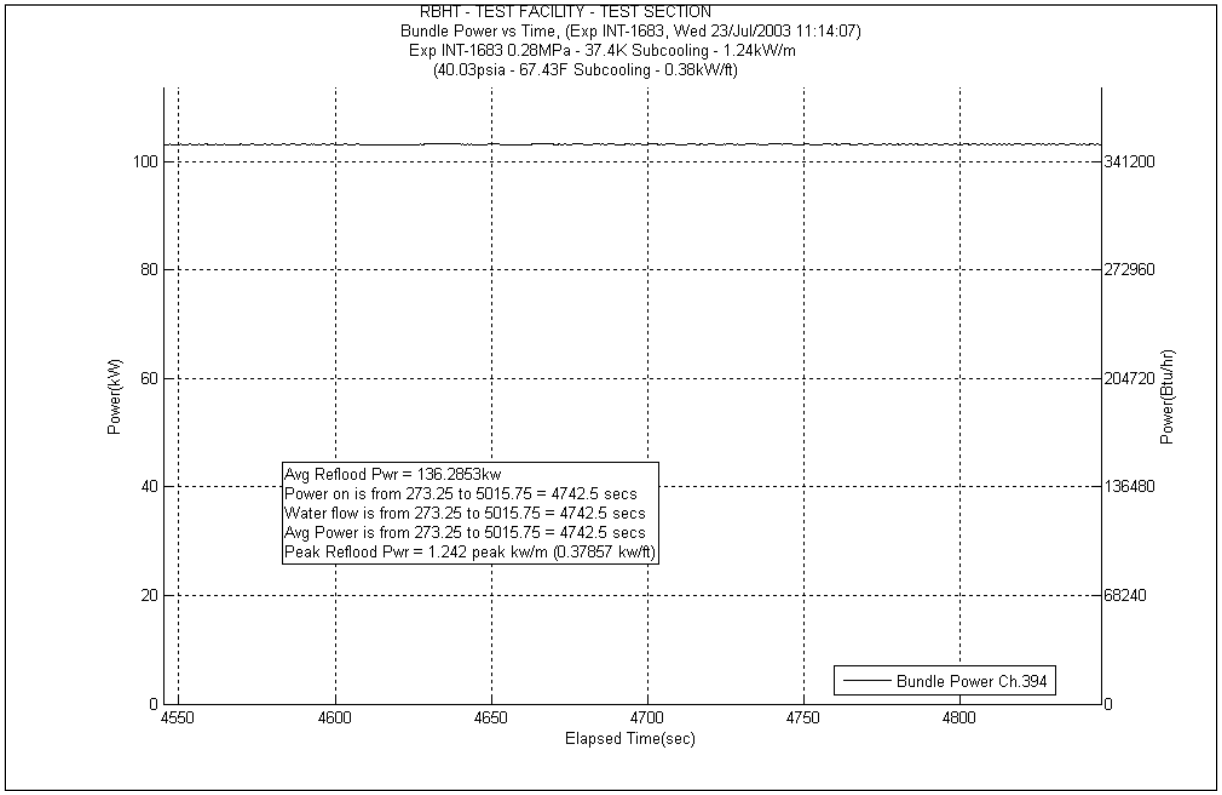

Figure A-719 Bundle Power Plot for Experiment 1683K

Table A-287 Data Results for RBHT Test 1683 for Time Period 4545 to 4845

Results for RBHT Test 1683
Valid Time Period 4545 to 4845 seconds
Collapsed Liquid Level = 55.636 inches = 1413.16 mm
(Z_{osv}) Onset of Significant Void = 6.5 inches = 165 mm
($Z_{2\phi}$) Two-Phase Level (Dryout) = 115.60 inches = 2936.24 mm
(S) Level Swell = 2.634

Grids	Elevation	Elevation	Chan.	$\alpha_{uncorrected}$	$\Delta P_{uncorrected}$	$\Delta P_{uncorrected}$	ΔP_{fric}	ΔP_{fric}	ΔP_{accel}	ΔP_{accel}	ΔP_{grid}	ΔP_{grid}	$\Delta P_{corrected}$	$\Delta P_{corrected}$	P_{local}	P_{local}	$\alpha_{corrected}$	α_{min}	α_{max}
	(in)	(mm)			(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)	(lbf/ft^2)	(Pa)			
	133-144	3378-3658	384	0.964	2.067	98.966	0.175	8.379	0.000	0.000	0.000	0.000	1.89	90.494	5761.89	275880.774	0.967	0.962	0.972
*	120-133	3048-3378	383	0.935	4.378	209.619	0.206	9.863	0.000	0.000	0.639	30.594	3.533	169.161	5765.423	276049.935	0.948	0.943	0.953
*	108-120	2743-3048	382	0.875	7.800	373.484	0.302	14.460	0.082	3.926	1.756	84.096	5.66	271.002	5771.083	276320.9372	0.909	0.904	0.914
	100-108	2540-2743	381	0.881	4.928	235.976	0.203	9.720	0.150	7.182	0.000	0.000	4.573	218.956	5775.656	276539.8936	0.89	0.886	0.894
	97-100	2464-2540	380	0.821	2.784	133.281	0.072	3.447	0.054	2.586	0.000	0.000	2.654	127.074	5778.31	276666.9678	0.83	0.826	0.834
	93-97	2362-2464	379	0.813	3.879	185.748	0.092	4.405	0.071	3.399	0.000	0.000	3.715	177.875	5782.025	276844.843	0.821	0.817	0.825
*	85-93	2159-2362	378	0.692	12.817	613.688	0.169	8.092	0.136	6.512	4.785	229.114	7.727	369.971	5789.752	277214.8137	0.814	0.810	0.818
	81-85	2057-2159	377	0.800	4.155	198.926	0.076	3.639	0.065	3.112	0.000	0.000	4.012	192.096	5793.764	277406.9093	0.807	0.803	0.811
	78-81	1981-2057	376	0.794	3.209	153.671	0.054	2.586	0.047	2.250	0.000	0.000	3.106	148.716	5796.87	277555.6254	0.801	0.797	0.805
	75-78	1905-1981	375	0.719	4.378	209.619	0.051	2.442	0.046	2.202	0.000	0.000	4.278	204.832	5801.148	277760.4571	0.725	0.721	0.729
	72-75	1829-1905	374	0.681	4.970	237.966	0.048	2.298	0.045	2.155	0.000	0.000	4.874	233.368	5806.022	277993.8255	0.687	0.684	0.690
*	67-72	1702-1829	373	0.530	12.215	584.844	0.075	3.591	0.073	3.495	4.122	197.349	7.945	380.409	5813.967	278374.2341	0.694	0.691	0.697
	63-67	1600-1702	372	0.696	6.325	302.865	0.055	2.633	0.056	2.681	0.000	0.000	6.213	297.480	5820.18	278671.7142	0.701	0.697	0.705
	60-63	1524-1600	371	0.621	5.905	282.724	0.038	1.819	0.041	1.963	0.000	0.000	5.822	278.759	5826.002	278950.473	0.626	0.623	0.629
	57-60	1448-1524	370	0.570	6.694	320.520	0.035	1.676	0.040	1.915	0.000	0.000	6.615	316.728	5832.617	279267.2009	0.575	0.572	0.578
	53-57	1346-1448	369	0.506	10.272	491.845	0.044	2.107	0.052	2.490	0.000	0.000	10.18	487.421	5842.797	279754.622	0.51	0.507	0.513
*	46-53	1168-1346	368	0.383	22.430	1073.954	0.066	3.160	0.086	4.118	4.598	220.153	17.68	846.523	5860.477	280601.1449	0.514	0.511	0.517
	43-46	1092-1168	367	0.513	7.582	363.041	0.024	1.149	0.035	1.676	0.000	0.000	7.52	360.060	5867.997	280961.2044	0.517	0.514	0.520
	37-43	940-1092	366	0.490	15.886	760.645	0.042	2.011	0.067	3.208	0.000	0.000	15.77	755.072	5883.767	281716.2761	0.494	0.492	0.496
*	25-37	635-940	365	0.306	43.281	2072.316	0.056	2.681	0.121	5.794	-0.216	-10.332	43.32	2074.173	5927.087	283790.4488	0.305	0.303	0.307
	13-25	330-635	364	0.114	55.190	2642.488	0.022	1.053	0.055	2.633	0.000	0.000	55.09	2637.723	5982.177	286428.1722	0.116	0.115	0.117
*	0-13	0-330	363	0.028	65.638	3142.788	0.001	0.048	0.000	0.000	2.047	98.035	63.59	3044.706	6045.767	289472.8777	0.058	0.055	0.061

Table A-288 Energy Balance Results for RBHT Test 1683K for Time Period 4545 to 4845 seconds

Results for RBHT Test 1683 Valid Time Period 4545 to 4845 seconds								
Elevation	Elevation	q''_w	q''_w	x	J_g	J_g	J_f	J_f
(in)	(mm)	BTU/hr-ft^2	KW/m^2		(ft/sec)	(m/sec)	(ft/sec)	(m/sec)
0.00	0.00	4667.1372	14.723	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
0.25	6.35	4926.4226	15.541	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
0.50	12.70	5185.708	16.359	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
0.75	19.05	5444.9934	17.177	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
1.00	25.40	5704.2788	17.995	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
1.25	31.75	5963.5642	18.812	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
1.50	38.10	6222.8495	19.63	0.00E+00	0.00E+00	0.00E+00	3.45E-02	1.56E-02
1.75	44.45	6482.1349	20.448	1.37E-02	2.90E-01	1.32E-01	3.40E-02	1.54E-02
2.00	50.80	6741.4203	21.266	3.43E-02	7.25E-01	3.29E-01	3.33E-02	1.51E-02
2.25	57.15	7000.7057	22.084	5.57E-02	1.18E+00	5.34E-01	3.25E-02	1.48E-02
2.50	63.50	7259.9911	22.902	7.79E-02	1.65E+00	7.47E-01	3.18E-02	1.44E-02
2.75	69.85	7519.2765	23.72	1.01E-01	2.13E+00	9.68E-01	3.10E-02	1.41E-02
3.00	76.20	7778.5619	24.538	1.25E-01	2.64E+00	1.20E+00	3.02E-02	1.37E-02
3.25	82.55	8037.8473	25.356	1.49E-01	3.16E+00	1.43E+00	2.93E-02	1.33E-02
3.50	88.90	8297.1327	26.174	1.75E-01	3.69E+00	1.68E+00	2.84E-02	1.29E-02
3.75	95.25	8556.4181	26.992	2.01E-01	4.25E+00	1.93E+00	2.75E-02	1.25E-02
4.00	101.60	8815.7035	27.81	2.28E-01	4.82E+00	2.19E+00	2.66E-02	1.21E-02
4.25	107.95	9074.9889	28.628	2.56E-01	5.41E+00	2.45E+00	2.56E-02	1.16E-02
4.50	114.30	9334.2743	29.446	2.84E-01	6.01E+00	2.73E+00	2.47E-02	1.12E-02
4.75	120.65	9593.5597	30.264	3.14E-01	6.64E+00	3.01E+00	2.36E-02	1.07E-02
5.00	127.00	9852.8451	31.082	3.44E-01	7.28E+00	3.30E+00	2.26E-02	1.03E-02
5.25	133.35	10112.131	31.899	3.75E-01	7.93E+00	3.60E+00	2.15E-02	9.77E-03
5.50	139.70	10371.416	32.717	4.07E-01	8.61E+00	3.90E+00	2.04E-02	9.27E-03
5.75	146.05	10630.701	33.535	4.40E-01	9.30E+00	4.22E+00	1.93E-02	8.76E-03
6.00	152.40	10889.987	34.353	4.73E-01	1.00E+01	4.54E+00	1.82E-02	8.23E-03
6.25	158.75	11149.272	35.171	5.08E-01	1.07E+01	4.87E+00	1.70E-02	7.70E-03
6.50	165.10	11408.558	35.989	5.43E-01	1.15E+01	5.21E+00	1.58E-02	7.15E-03
6.75	171.45	11667.843	36.807	5.79E-01	1.22E+01	5.55E+00	1.45E-02	6.59E-03
7.00	177.80	11927.128	37.625	6.15E-01	1.30E+01	5.90E+00	1.33E-02	6.01E-03
7.25	184.15	12186.414	38.443	6.53E-01	1.38E+01	6.26E+00	1.20E-02	5.43E-03
7.50	190.50	12445.699	39.261	6.91E-01	1.46E+01	6.63E+00	1.06E-02	4.83E-03
7.75	196.85	12704.984	40.079	7.30E-01	1.54E+01	7.01E+00	9.29E-03	4.22E-03
8.00	203.20	12964.27	40.897	7.70E-01	1.63E+01	7.39E+00	7.92E-03	3.59E-03
8.25	209.55	13223.555	41.715	8.11E-01	1.72E+01	7.78E+00	6.51E-03	2.95E-03
8.50	215.90	13482.841	42.533	8.53E-01	1.80E+01	8.18E+00	5.08E-03	2.31E-03
8.75	222.25	13742.126	43.351	8.95E-01	1.89E+01	8.58E+00	3.62E-03	1.64E-03
9.00	228.60	14001.411	44.168	9.38E-01	1.98E+01	9.00E+00	2.13E-03	9.68E-04
9.25	234.95	13223.555	41.715	9.80E-01	2.07E+01	9.40E+00	6.75E-04	3.06E-04
9.50	241.30	12445.699	39.261	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
9.75	247.65	11667.843	36.807	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
10.00	254.00	10889.987	34.353	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
10.25	260.35	10112.131	31.899	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
10.50	266.70	9334.2743	29.446	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
10.75	273.05	8556.4181	26.992	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
11.00	279.40	7778.5619	24.538	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
11.25	285.75	7000.7057	22.084	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
11.50	292.10	6222.8495	19.63	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
11.75	298.45	5444.9934	17.177	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00
12.00	304.80	4667.1372	14.723	1.00E+00	2.11E+01	9.59E+00	0.00E+00	0.00E+00

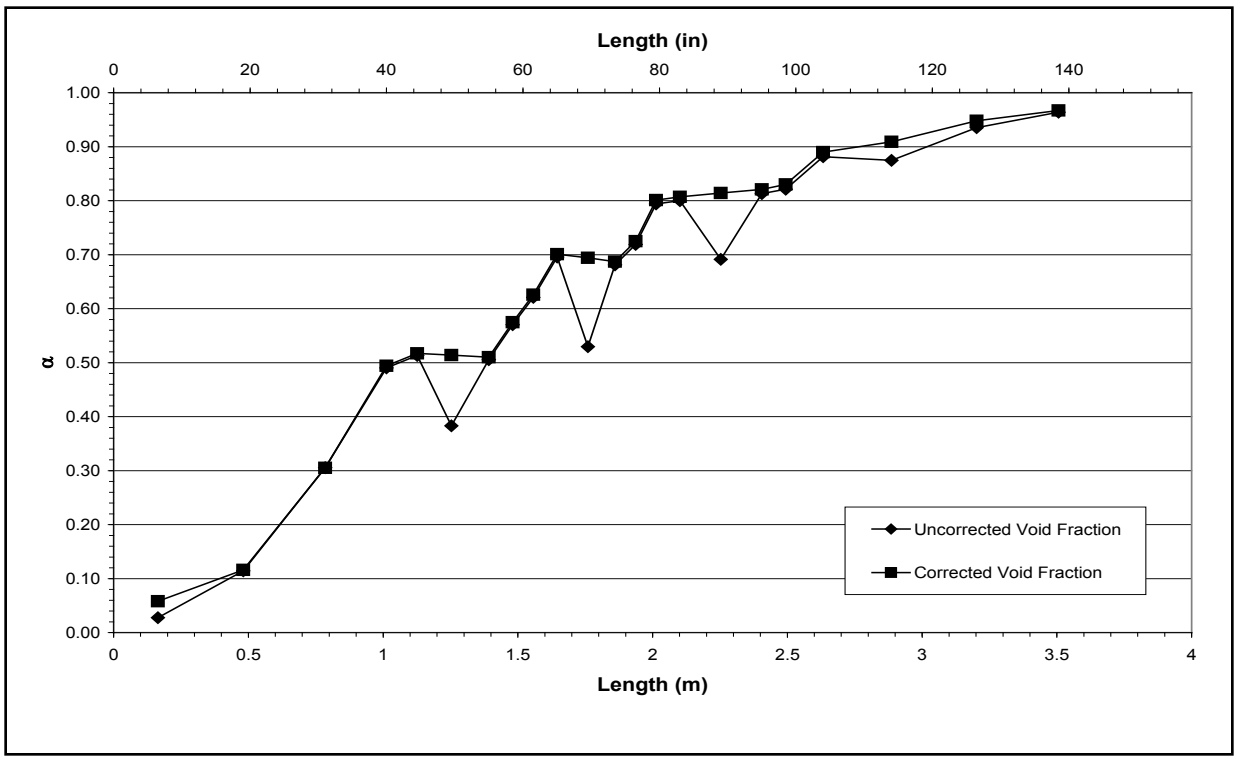

Figure A-720 Void Fraction Comparison Plot Before and After Applying Corrections for Experiment 1683K for Time Period 4545 to 4845 seconds

APPENDIX B. UNCERTAINTIES

The measurement errors in the calculations performed for the analysis are described herein. The first section contains the error analysis for temperature, pressure and flow measurements. The preceding section includes the description of the error analysis performed for the heat transfer calculations. The final section provides uncertainties for the droplet data measurements.

B.1 Measurement Uncertainty

The instrumentation error associated with the data from RBHT test series can be derived either from equipment manufacturers' specifications or system calibration data. Component calibrations are performed to verify that the manufacturers' specifications are met, and these manufacturers' specifications are used to compute the error estimate for the data path. System calibrations are performed when component calibrations are not expedient or when an accuracy improvement could be accomplished with a system calibration. The system calibration data are used to compute an estimate of error for the system response, and calibration data points. The total system error from a system calibration is a function of both system response error and calibration data error.

In all cases of error estimate, the standard deviation has been computed and presented as the most probable error. The manufacturer-specified error is the maximum possible error. The standard deviation error is calculated from the maximum error by the following:

$$\rho^2 = \sum_{i=1}^{n}\left(\frac{E_i^2}{n}\right) \qquad \text{(B-1)}$$

where,

Δ = data path standard deviation

E_i^2 = component i maximum error

n = number of sources of error

When a system calibration is performed, the standard deviation from the calibration data and that from the calibration equipment can be combined by the following equation to produce the best estimate of error:

$$\rho = \sqrt{E_d^2 + E_c^2} \qquad \text{(B-2)}$$

where,

E_d = calibration data standard deviation
E_c = calibration equipment standard deviation

The calibration data standard deviation is a measure of the error involved in fitting the calibration data. That is,

$$E_d \left[\frac{\sum_{i=1}^{n} (Y_i - Y_f)^2}{n} \right]^{1/2} \qquad \text{(B-3)}$$

where,

Y_i = calibration point
Y_f = predicted output from the calibrations curve
n = number of calibration points

The calibration equipment standard deviation is a measure of the absolute error of the calibration point. If the calibration point in the above equation is calculated from and equation of the form

$$Y = x_1 . x_2 . x_3 \qquad \text{(B-4)}$$

then

$$\left(\frac{\sigma_y}{y} \right)^2 = \sum_{i=1}^{n} \left(\frac{\sigma_{x_i}}{x} \right)^2 \qquad \text{(B-5)}$$

and

$$E_c \sqrt{\sigma_y^2} \qquad \text{(B-6)}$$

The data path has been broken down into three parts called sensor, conditioner, and readout. The sensor is the device whose electrical output is proportional to a physical quantity (temperature, pressure, flow, power). The conditioner is a device which matches the electrical output of the sensor to the input requirements of the readout device. The readout device measures and records the electrical value of the signal from the conditioner. This recorded electrical value is subsequently used to compute the physical quantity it represents. The errors due to the transmission wire errors are very small (±0.001 percent) in comparison to the element errors and are considered negligible.

The error values for sensor, conditioning, and readout are the manufacturers' specifications in engineering units. These numbers are used to compute the most probable error, as previously described. Where systems calibrations are performed, the equipment calibration data provide the standard deviation and maximum error as computed from the calibration data points in fitting the points to a first-order polynomial. The calibration point standard deviation is computed using the method described above. The calibration point maximum error occurs simultaneously in each component of the calibration equation. The overall system standard deviation may then be calculated using Equation (B-2).

The calculated Total Probable errors using Equation (B-2) for each instrumentation channel are shown in the following tables:

Table B-1 - Temperature measurements including the heater rods, grid fluid, grid walls, support rods, steam probe rakes, flow housing walls, flow housing insulation, vessel and piping walls, and quartz windows thermocouples.

Table B-2 - Differential pressure cells (D/P's), static pressure transducers (P's), and vessels liquid label transducers.

Table B-3 - Inlet Mass and exhaust steam flows transmitters (FM)

Table B-4 - Steam probe rakes linear position transmitter.

Table B-5 - Heater Rod Bundle input voltage (V), amperage (Amps), and Power measurements (W).

Table B-1: Error in Temperature Measurement

		INSTRUMENT			DATA ACQUISITION SYSTEM				
	INPUT SENSOR	RANGE	ERROR ± 1.11°C		SCP	AUTO-RANGING ± 0.02% TEMPERATURE RANGE	REF JCTN MEAS	ISO REF GRADIENT	TEMP RANGE FOR ERROR NUMBERS
CHANNEL NO.	TYPE K TC	°C	± °C		± °C	± °C	± °C	± °C	°C
1-96, 98-183, 185-248, 311-313	HEATER ROD'S	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
					0.25	0.16	0.01	0.20	375 TO 800
					0.40	0.27	0.01	0.20	800 TO 1371
249-276, 278-279	GRID WALL & FLUID	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
					0.25	0.16	0.01	0.20	375 TO 800
					0.40	0.27	0.01	0.20	800 TO 1371
280 THRU 295	SUPPORT RODS	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
					0.25	0.16	0.01	0.20	375 TO 800
					0.40	0.27	0.01	0.20	800 TO 1371
296-310, 314-334, 493-495	ST. PROBE RAKES	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
					0.25	0.16	0.01	0.20	375 TO 800
					0.40	0.27	0.01	0.20	800 TO 1371
335 THRU 359, & 496	FLOW HOUSING WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
					0.25	0.16	0.01	0.20	375 TO 800
					0.40	0.27	0.01	0.20	800 TO 1371
97, 184, 277, 400	INSULATION	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
386 THRU 388	L. PLEN. FL & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
389, 391, 392	U. PLEN. FL & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
399, 401	SUPPLY TANK FLUID	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
407 THRU 410	SUP LINE FL. & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
418 THRU 424	(SM, LG) CARRYOVER TANKS FL. & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
385, 404, 435, 436, 437	PRESS. OSC. DAMP TANK FL, & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
440 THRU 443	EXHAUST LINE	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
360, 361	ROD BUNDLE INLET	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
414-415	STM SUP FL & WALL	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
403, 428-432	STEAM SEP	10 - 1371 °C	1.11		0.20	0.08	0.01	0.20	0 TO 375
446-457	QUARTZ WINDOWS	10 - 1371 °C	1.11		0.20	0.08	0.01	0.200	0 TO 375
		10 - 1371 °C			0.25	0.160	0.01	0.200	375 TO 800
CHANNEL NO.	THERMISTOR TYPE 5000	°C	± °C		± °C	± °C	± °C	± °C	°C
497-512	TERM PNL REF THERMISTORS	-10 - 85 °C	0.01						-10 TO 65

Table B-2: Error in Differential Pressure Cells (D/P's), Static Pressure Transducers (P's), and Vessels Liquid Label Transducers

SPAN (CALIBRATION)	ACCURACY ± 0.075% SPAN	PERFORMANCE ± 0.15% SPAN	SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS	TOTAL PROBABLE ERROR
mm H_20	± mm H_20	± mm H_20	± mm H_20	± mm H_20	± mm H_20	± mm H_20	± Volts	± mm H_20
0 TO 76.2 mm H20	0.06	0.11	0.003	0.005	0.001	0.002	0.25	0.13
			0.010	0.021	0.003	0.007	1.00	0.13
0 TO 101.6 mm H20	0.08	0.15	0.003	0.007	0.001	0.003	0.25	0.17
			0.014	0.027	0.004	0.009	1.00	0.17
0 TO 127 mm H20	0.10	0.19	0.004	0.009	0.001	0.004	0.25	0.21
			0.017	0.034	0.005	0.011	1.00	0.22
0 TO 152.4 mm H20	0.11	0.23	0.005	0.010	0.002	0.005	0.25	0.26
			0.021	0.041	0.006	0.013	1.00	0.26
0 TO 177.8 mm H20	0.13	0.27	0.006	0.012	0.002	0.006	0.25	0.30
			0.024	0.048	0.007	0.015	1.00	0.30
0 TO 203.2 mm H20	0.15	0.30	0.007	0.014	0.002	0.006	0.25	0.34
			0.027	0.055	0.009	0.018	1.00	0.35
0 TO 279.4 mm H20	0.21	0.42	0.009	0.019	0.003	0.009	0.25	0.47
			0.038	0.075	0.012	0.024	1.00	0.48
0 TO 304.8 mm H20	0.23	0.46	0.010	0.021	0.003	0.009	0.25	0.51
			0.041	0.082	0.013	0.026	1.00	0.52
0 TO 330.2 mm H20	0.25	0.50	0.011	0.022	0.004	0.010	0.25	0.55
			0.045	0.089	0.014	0.029	1.00	0.56
0 TO 3657.6 mm H20	2.74	5.49	0.123	0.247	0.039	0.114	0.25	6.14
			0.494	0.987	0.153	0.316	1.00	6.24
0 TO 311.15 mm H20	0.23	0.47	0.011	0.021	0.003	0.010	0.25	0.52
			0.042	0.084	0.013	0.027	1.00	0.53
0 TO 127 mm H20	0.10	0.19	0.004	0.009	0.001	0.004	0.25	0.21
			0.017	0.034	0.005	0.011	1.00	0.22
0 TO 155.575 mm H20	0.12	0.23	0.005	0.011	0.002	0.005	0.25	0.26
			0.021	0.042	0.007	0.013	1.00	0.27
0 TO 6350 mm H20	4.76	9.53	0.214	0.429	0.069	0.197	0.25	10.66
			0.857	1.714	0.266	0.549	1.00	10.84
0 TO 3022.6 mm H20	2.27	4.53	0.102	0.204	0.033	0.094	0.25	5.08
			0.408	0.816	0.126	0.261	1.00	5.16
0 TO 1574.8 mm H20	1.18	2.36	0.053	0.106	0.017	0.049	0.25	2.64
			0.213	0.425	0.066	0.136	1.00	2.69
0 TO 895.35 mm H20	0.67	1.34	0.030	0.060	0.010	0.028	0.25	1.50
			0.121	0.242	0.037	0.077	1.00	1.53
0 TO 1663.7 mm H20	1.25	2.50	0.056	0.112	0.018	0.052	0.25	2.79
			0.225	0.449	0.070	0.144	1.00	2.84
kPa	± kPa	± kPa	± kPa	± kPa	± kPa	± kPa	± Volts	± kPa
0 TO 413.7 kPa	0.31	0.62	0.014	0.028	0.004	0.013	0.25	0.69
			0.056	0.112	0.017	0.036	1.00	0.71
0 TO 689.5 kPa	0.52	1.03	0.023	0.047	0.007	0.021	0.25	1.16
			0.093	0.186	0.029	0.060	1.00	1.18
0 TO 344.7 kPa	0.26	0.52	0.012	0.023	0.004	0.011	0.25	0.58
			0.047	0.093	0.014	0.030	1.00	0.59
0 TO 34.5 kPa	0.03	0.05	0.001	0.002	0.000	0.001	0.25	0.06
			0.005	0.009	0.001	0.003	1.00	0.06

Table B-3: Error in Inlet Mass and Exhaust Steam Flows Transmitters (FM)

	INSTRUMENT			DATA ACQUISITION SYSTEM					TOTAL
INPUT SENSOR	SPAN (CALIBRATION)	ACCURACY[1] ± 0.11% SPAN		SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS	TOTAL PROBABLE ERROR
MASS FLOW TRANSDUCER	g/sec	± g/sec		± g/sec	± g/sec	± g/sec	± g/sec	± Volts	± g/sec
SUPPLY LINE FM	0 TO 1247 g/sec	0.00137		0.042	0.084	0.013	0.039	0.25	0.103
				0.168	0.337	0.052	0.108	1.00	0.395
DROP INJ FM	0 TO 45 g/sec	0.00005		0.002	0.003	0.000	0.001	0.25	0.004
				0.006	0.012	0.002	0.004	1.00	0.014

	INSTRUMENT			DATA ACQUISITION SYSTEM					TOTAL
INPUT SENSOR	SPAN (CALIBRATION)	ACCURACY[1] ± 1.35% SPAN	PERFORMANCE ± 0.173% SPAN	SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS	TOTAL PROBABLE ERROR
VOLUME FLOW TRANSDUCER	m^3/min	± m^3/min	± m^3/min	± m^3/min	± m^3/min	± m^3/min	± m^3/min	± Volts	± m^3/min
STM SUPPLY FM	0 TO 7.1 m^3/min	0.096	0.012	0.000	0.000	0.000	0.000	0.25	0.096
				0.001	0.002	0.000	0.001	1.00	0.096
EXH PIPE FM	0 TO 12.7 m^3/min	0.172	0.022	0.000	0.001	0.000	0.000	0.25	0.172
				0.002	0.003	0.001	0.001	1.00	0.172

Table B-4: Error in Steam Probe Rakes Linear Position Transmitter

		INSTRUMENT			DATA ACQUISITION SYSTEM				
	INPUT SENSOR	SPAN (CALIBRATION)	ACCURACY ± 1.0% SPAN		SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS
CHANNEL NO.	POSITION TRANSDUCER	mm	± mm		± mm	± mm	± mm	± mm	± Volts
482-489	RAKE POSITION	0 TO 88.9 mm	0.889		0.003	0.006	0.001	0.003	0.25
					0.012	0.024	0.004	0.008	1.00

Table B-5: Error in Heater Rod Bundle Input Voltage (V), Amperage (Amps), and Power Measurements (W)

		INSTRUMENT			DATA ACQUISITION SYSTEM				
	INPUT SENSOR	SPAN (CALIBRATION)	ISOLATOR ACCURACY ± 0.1% SPAN		SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS
CHANNEL NO.	VOLTAGE TRANSDUCER	Volts	± V		± mV	± mV	± uV	± uV	± Volts
397	ELECTRICAL SYSTEM	0 TO 10 Volts	0.01		0.27	0.67	107.99	310.48	0.25
					1.08	2.70	418.47	863.93	1.00

		INSTRUMENT			DATA ACQUISITION SYSTEM				
	INPUT SENSOR	SPAN (CALIBRATION)	SHUNT ACCURACY ± 0.1% SPAN	ISOLATOR ACCURACY ± 0.1% SPAN	SCP LINEARITY ± 0.01% VOLTAGE RANGE	AUTO-RANGING ± 0.02% VOLTAGE RANGE	SCP OFFSET ERROR	NOISE	VOLTAGE RANGE FOR ERROR NUMBERS
CHANNEL NO.	CURRENT TRANSDUCER	Amps	± A	± A	± A	± A	± A	± A	± Volts
398	ELECTRICAL SYSTEM	0 TO 15000 Amps	15	15	0.40	1.01	0.16	0.47	0.25
					1.62	4.05	0.63	1.30	1.00

		INSTRUMENT			DATA ACQUISITION SYSTEM				
	INPUT SENSOR	SPAN (CALIBRATION)	DAS VOLTS ACCURACY ± 0.1% SPAN	DAS AMPS ACCURACY ± 0.14% SPAN					
CHANNEL NO.	DERIVED POWER (V*A)	kWatts	± W	± W					
397 * 398	ELECTRICAL SYSTEM	0 TO 750 kWatts	750	1050					

B.2 Void Fraction Uncertainty Estimate

An estimate has been made of the uncertainty in the calculated void fraction from the RBHT level swell experiments using the measured pressure drop data. There are two primary areas of uncertainty: the uncertainty in the differential pressure cell used for the measurements, and the uncertainty in the frictional and acceleration pressure drop calculations used to correct the experimental data.

The uncertainty in the differential pressure cells has been given in the Facility Description report for the Rod Bundle Test Facility [11]. This uncertainty contains the uncertainties of the instrument, the data stream, and the data acquisition system such that a total probable error or uncertainty for the instrument system has been obtained. This component of the uncertainty is directly applied to the reading of the instrument such that its effect on the calculated void fraction can be directly determined.

The uncertainties in the two-phase frictional and acceleration pressure drop are independent of the instrument uncertainties and refer to calculated corrections which are then applied to the experimental data to best estimate the elevation head which is then converted to void fraction.

The Friedel two-phase frictional pressure drop correlation is used to calculate the frictional pressure drop in the rod bundle in the two-phase region. The uncertainties in this correlation were estimated from the original paper, Figure 3a [9] and used as a multiplier in the data analysis program. Based on this figure, roughly a one-sigma estimate of the uncertainty was selected as plus or minus 30 percent. Therefore, in the data analysis program, the frictional pressure drop was increased by a factor of 1.3 when correcting for the frictional pressure drop to cover the uncertainties in the Friedel correlation. The revised frictional correlation was then used to calculate the frictional pressure drop in the rod bundle for experiment 1678/79. Increasing the frictional pressure drop would result in a larger correction to the data giving a higher void fraction in the bundle.

The homogeneous acceleration pressure drop model was used to account for the flow acceleration due to boiling in the bundle. If the uncertainties in the bundle hydraulic diameter and the fluid properties can be regarded to have negligible uncertainty, the primary parameters which affect the uncertainty in the acceleration pressure drop calculation are the uncertainties in the flow measurement and the bundle power. Using the propagation or errors technique given by Young [12], and considering that these two components of the uncertainty are independent since these are two independent measurements, the uncertainties can be combined using the square-root-sum of squares. The resulting calculation for Experiment 1678/79 indicates that the uncertainty in the acceleration pressure drop is 1.19 percent. It should be noted that this calculated uncertainty is only based on the power and flow measurement uncertainties. The calculation assumes that the application of the homogeneous acceleration model is perfectly correct for this application, which could also be questioned. Therefore, in the data analysis program, the acceleration pressure drop was increased by the acceleration pressure drop uncertainty amount to recalculate the void fraction from the experimental data. Increasing the acceleration pressure value will also increase the calculated void fraction from the experimental data.

The effects of considering the uncertainties in the differential pressure cell measurements, the two-phase frictional corrections, and the two-phase acceleration corrections were applied to the experimental data for experiment 1678/79. The comparisons of the calculated void fraction

using the corrections and the void fraction using the best-estimate corrections are shown in Figure B-1. As the figure indicates, the effects of the uncertainties on the calculated void fraction are very small. It is expected that the other experiments would yield similar results.

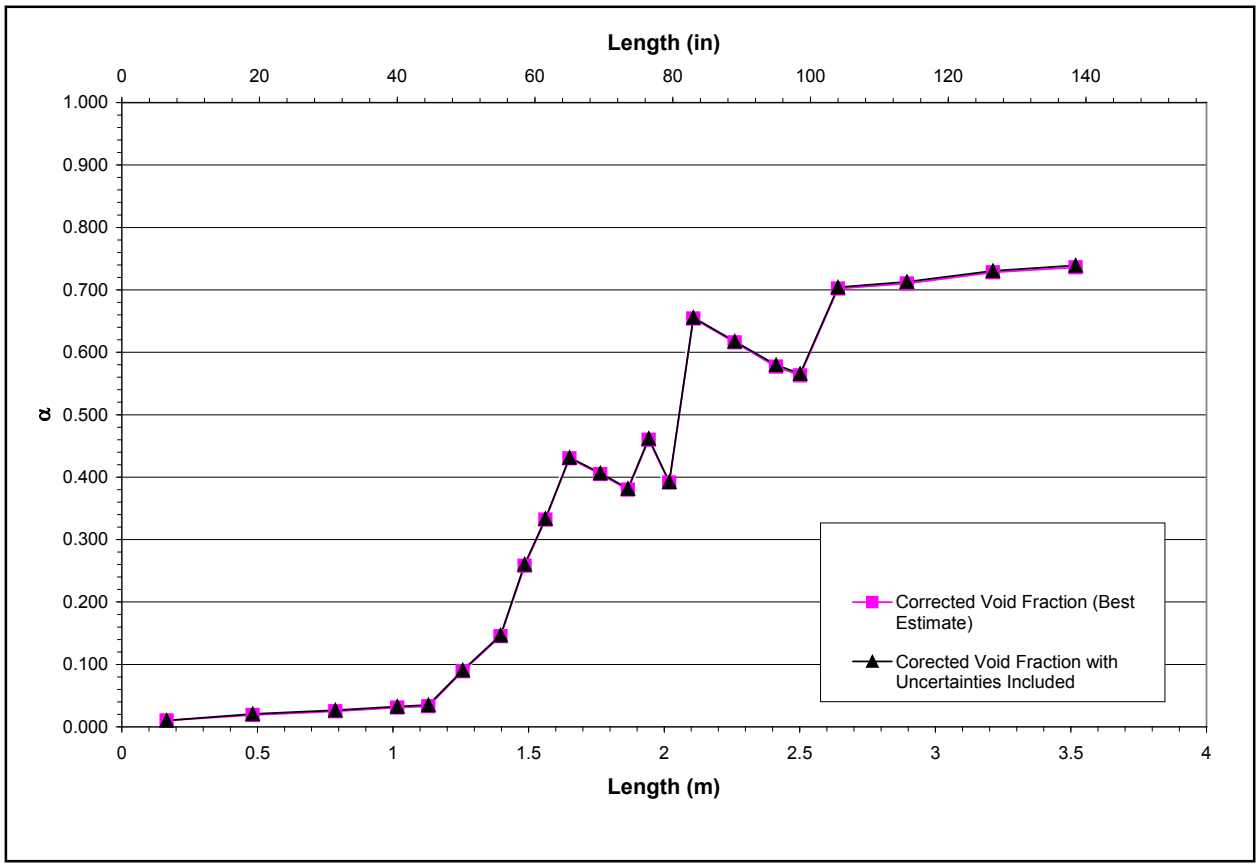

Figure B-1: Comparison of Corrected Void Fraction with and without Uncertainties Considered

B.3 Flashing Effects Estimate

The level swell experiments generate a vertical two-phase mixture level above the saturation location within the rod bundle. The local static pressure decreases along the bundle due to the change in the static head of the mixture. As the local static pressure decreases, some of the liquid phase energy can be converted to additional vapor generation due to the liquid slowly flashing as the static pressure decreases. The energy balance which has been used to calculate the flow quality in the bundle does not account for the additional steam flow due to this slowly flashing process as the mixture progresses upward along the bundle. An estimate of the additional steam flow due to the flashing process has been made for experiment 1678/79 which is at 0.1389 MPa (20 psia) , 15.24 mm/s (0.6 in/s) flow rate test. The saturation location for this experiment is at the 1.18 m (46.56 in) elevation. The pressure drop in the two-phase region is 1.31 m (51.67 in) of water at STP conditions.

The energy which is available to flash to steam is the difference between the saturated liquid enthalpy at the saturation line and the saturated liquid enthalpy at the bundle exit times the flow rate into the bundle. This is given as

$$Q_F = \dot{m}\left(h_{f_{sat}} - h_{f_{exit}}\right) \tag{B-7}$$

The mass flow of the steam generated due to flashing is given as

$$\dot{m}_{\substack{Flashing \\ Steam}} = \frac{Q_F}{h_{fg}} \tag{B-8}$$

Using the conditions for experiment 1678/79, the steam mass flow due to flashing can be calculated as 0.000322 kg/s (0.000710 lb_m/s). If the mass flow of the steam calculated due to flashing is compared to the steam flow, at the exit of the bundle due to the electrical heating, the additional contribution to the steam flow due to flashing as a result of the pressure gradient bundle is 1.29 percent.

Therefore, the additional amount of steam generated due to flashing is very small and can be neglected in the energy balance. It should be noted that the only place that the flow quality is used in the analysis of the data is in the calculation of the two-phase frictional and acceleration pressure drops which are used to correct the differential pressure cell readings to calculate the void fraction.

APPENDIX C. ENERGY BALANCE PROGRAM

The ENERGY BALANCE program completes an energy balance of the RBHT facility and calculates several values, such as two-phase mixture properties, quality, void fraction, and interfacial drag force per unit volume. The calculations are completed at axial incremental lengths of 76.2 mm (3 in) for the length of the 3.66 m (12 ft) rod bundle. The program also corrects the experimental pressure drop data for the effects of friction, acceleration, and spacer grids.

```
      program ENERGY BALANCE
!
!     ENERGY BALANCE models the interfacial drag experiments completed at
!     the RBHT test facility at the Pennsylvania State University
!     Written by Douglas J. Miller, 12/17/2003
!     Calculations and outputs are provided in both British and metric units
!
      Use MainVar
!
      implicit none
!
      integer count
!
      open (5, file = 'input.txt')
      open (6, file = 'output.txt')
      call steam_interact
!
      write(*,*) "Properties Calculated Successfully"
!     write(*,*) "Enter the Rod Bundle Power (kW)"
      read(5,*) Power
!     write(*,*) "Enter the Mass Flow Rate (lbm/sec)"
      read(5,*) Mdote
!
!  Convert power to BTU/hr and mass flow rate to lbm/hr
!
      Powere = Power*3412.3
      Mdothr = Mdote*3600
      Mdotm = Mdote*453.59237
!
      write(6,36) Powere,Power
      write(6,38) Mdote,Mdotm
!
36    format('Pwr =    ',g16.8,' BTU/hr       ',g16.8,' kW
     +           (power)')
38    format('Mdot =   ',g16.8,' lbm/sec      ',g16.8,' g/sec
     +      (mass flow rate)')
!
     PI = 3.14159
      WPerim = 5.997454
      HPerim = 4.406084
      Diam = 0.03491667
      Area = 0.052352778
      Height = 12.0
      NRods = 45
      Rod_Diam = 0.374
      FFactor = 0.005
```

```
      Rod_Diam = 0.374
      FFactor = 0.005
      Linear_Pwr = Powere/(3600*12)
      Avg_Heat_Flux = Linear_Pwr/(NRods*PI*Rod_Diam/12)
      RHOSTP = 62.3
      RHOSTPM = RHOSTP*0.01602
      Mass_Flux = Mdote/Area

      count = 1
      do while (count.NE.23)
      read(5,*) PDrop(count)
      count = count + 1
      end do

      count = 1
      Z(count) = 0

      Zsat1 = 2.0
      error = 2.0

      do while ((error.NE.1.0000) .AND. (count<=10000))
      Zsat2 = Mdothr*Height*(HF-HIN)/(Powere*(Zsat1/18+0.5))
      error = Zsat2/Zsat1
      Zsat1 = Zsat2
      count = count + 1
      end do

      Zsat = Zsat2

      count = 1
!  Do loop to calculate parameters with respect to axial position
      do while (Z(count)<=12)

      if (Z(count)<=9) then
      Quality(count)=0.0 + Powere/(Mdothr*HFG*Height)
     +*((Z(count)**2/18.+0.5*Z(count))-(Zsat**2/18.+0.5*Zsat))
      else
      Quality(count)=Quality(37) + Powere/(Mdothr*HFG*Height)
     +*((-(Z(count)**2)/6.+4.5*Z(count))-(-(9.**2)/6.+4.5*9.))
      end if

      if (Quality(count) < 0.0) then
      Quality(count) = 0.0
      else if (Quality(count) > 1.0) then
      Quality(count) = 1.0
      end if

      Mdotg(count) = Quality(count)*Mdote
      Mdotf(count) = (1.0 - Quality(count))*Mdote

      MixVel(count) = (1/Area)*(Mdotf(count)/RHOF + Mdotg(count)/RHOG)
      MixDens(count) = RHOF*(1-Quality(count)) + RHOG*Quality(count)
      InvrsVisc(count) = Quality(count)/VISCG + (1-Quality(count))/VISCF
      MixReynolds(count) = MixVel(count)*Diam*MixDens(count)*3600*
     +InvrsVisc(count)
!  While loop return
```

```
          count = count + 1
          Z(count) = Z(count-1) + 0.25
          end do
!
! Presentation of output
!
          count = 1
!
          write(6,125) Zsat
125   format('Zsat =   ', g16.8)
!
     write(6,150)
150   format(/1X,'Elevation',4X,'Quality',5X,'Vapor Flow',4X,'Liquid
    +Flow',3X,'Mixed Velocity',2X,'Mixed Reynolds',3X,'Mixed Density')
!
     write(6,155)
155   format('  (FT.)  ',4X,'       ',5X,' (lbm/sec) ',4X,
    +'(lbm/sec) ',3X,'   (FT/sec)   ',2X,'              ',
    +3X,'  (lbm/FT3)')
          do while (Z(count)<=12)
!
          write(6,160) Z(count), Quality(count), Mdotg(count),
    +Mdotf(count),MixVel(count),MixReynolds(count),MixDens(count)
160   format(1X,F7.2,4X,E10.4,4X,E10.4,4X,E10.4,6X,E10.4,6X,E10.4,
    +6X,E10.4)

          count=count+1
          end do

          Call Void_Frac_Correlations
          Call DP_Cell_Orientation
          Call Homogeneous
          Call Homogeneous_Two_Phase
          Call Friedel
          Call Acceleration_Press_Drop
          Call Corrected_Press_Drop
          Call Interfacial_Drag
          Call Flow_Regime_Identifier
          Call Results
          end
*******************************************************************************************
          MODULE MainVar

          double precision HGM,HG,HFM,HF,HINM,HIN,HFGM,HFG,RHOFM,RHOF,RHOGM,
    +RHOG,TSATM,TSAT,AFM,AF,ACM,AC,AFFM,AFF,APM,AP,RODR,PELR,VOLP,
    +QVOLAM,QVOLA,QCM,QC,FMDOTM,FMDOT,C1,C2,C3,F,VISCFM,VISCF,VISCGM,
    +VISCG, Z(50), Quality(50), Mdote, Mdothr, Powere, Mdotm, Diam, PI,
    +Area, Height, Gravity, Gravitym, Mdotg(50), Mdotf(50), PDrop(25),
    +WPerim, HPerim, Linear_Pwr, Avg_Heat_Flux, Rod_Diam, PFactor(25),
    +VISCIN, VIN, RHOIN, VISCINM, VINM, RHOINM, NUIN, NUG, NUF, NUINM,
    +NUGM, NUFM, VISCFG, VISCFGM, NUFG, NUFGM, FFactor, RHOSTP,RHOSTPM,
    +PDropConv(25), DPQuality(25), DPZ(25),SpanAvgQuality(25),DPAvg(25)

          double precision Zsat1, Zsat2, Zsat, Power, XIN, Mass_Flux,
    +MixReynolds(50), MixDens(50), InvrsVisc(50), MixVel(50), error,
    +Hom_Two_Phase_Mult(25), A1(25), A2(25), A3(25), Fr(25), We(25),
```

```
     +Frdl_Two_Phase_Mult(25), Hom_Fric_PDrop(25), Span_Avg_Power(25),
     +Hom_TP_Fric_PDrop(25), Frdl_Fric_PDrop(25), Accel_PDrop(25),
     +Corrected_PDrop_Hom(25), Corrected_PDrop_Hom_TP(25),
     +Corrected_PDrop_Frdl(25), ZCalc_Hom(25), ZCalc_Hom_TP(25),
     +ZCalc_Frdl(25), Alpha_Hom(25), Alpha_Hom_TP(25), Alpha_Frdl(25),
     +Rho_Hom(25), Rho_Hom_TP(25), Rho_Frdl(25), ElevDP_Hom(25),
     +ElevDP_Hom_TP(25), ElevDP_Frdl(25),      Intrfcl_Drag(25), Intrfcl(25)

           double precision a, ae
           double precision c, ce
           double precision cjth, cjthe
           double precision cjtt, cjtte
           double precision cp, cpe
           double precision cv, cve
           double precision dpdr, dpdre
           double precision dpdt, dpdte
           double precision dvdr, dvdre
           double precision dvdt, dvdte
           double precision eps
           double precision eta, etae
           double precision g, ge
           double precision h, he
           character ( len = 72 ) label
           double precision lambda, lambdae
           double precision p, pe
           double precision pr
           double precision rho, rhoe
           double precision s, se
           double precision sigma, sigmae
           double precision t, te
           double precision u, ue
           double precision v, ve
           double precision vir, vire
           double precision supfclvap(50), supfclliq(50)

           integer propchoice, NRods
           character Flow_Char(25)*25

           end module MainVar
*******************************************************************************
           subroutine steam_interact
!
!djm*****************************************************************
!
!djm      A portion of the Steam table program Steam_Interact was utilized
!djm  the portion used obtains properties for a given pressure and temp.
!
!djm      Additional steam table calculations were obtained from the program
!djm  PWRDNB. PWRDNB is called as a subroutine of Steam_Interact
!
!djm*****************************************************************
!
! STEAM_INTERACT interactively queries the NBS/NRC Steam Table routines.
!
!  The units used for internal calculations are:
!
```

```
!   Density      G/cm**3   grams per cubic centimeter
!   Enthalpy     J/G       joules per gram
!   Entropy      J/(GK)    joules per gram degree Kelvin
!   Length       M         meters
!   Pressure     MPa       megapascals
!   Temperature  K         degrees Kelvin
!
        Use MainVar
!
     implicit none
!       double precision a, ae
!       double precision c, ce
!       double precision cjth, cjthe
!       double precision cjtt, cjtte
!       double precision cp, cpe
!       double precision cv, cve
!       double precision dpdr, dpdre
!       double precision dpdt, dpdte
!       double precision dvdr, dvdre
!       double precision dvdt, dvdte
!       double precision eps
!       double precision eta, etae
!       double precision g, ge
!       double precision h, he
!       character ( len = 72 ) label
!       double precision lambda, lambdae
!       double precision p, pe
!       double precision pr
!       double precision rho, rhoe
!       double precision s, se
!       double precision sigma, sigmae
!       double precision t, te
!       double precision u, ue
!       double precision v, ve
!       double precision vir, vire
        character ans
        logical ok
        double precision gascon
        double precision gl
        double precision gv
        integer iopt
        integer ios
        integer itmax
        double precision, parameter :: p_crit = 3198.86D+00
        double precision, parameter :: p_max = 3190.88D+00
        double precision, parameter :: p_min = 0.0D+00
        double precision pl
        double precision ps
        double precision pv
        double precision rhol
        double precision, parameter :: rho_max = 118.613D+00
        double precision, parameter :: rho_min = 0.0D+00
        double precision rho_start
        double precision rhov
        double precision, parameter :: t_crit = 705.157D+00
        double precision, parameter :: t_max = 704.93D+00
```

```
          double precision, parameter :: t_min = 0.0D+00
!
          call timestamp ( )
!
          write ( *, '(a)' ) ' '
!djm  Interactive queries removed for input of pressure and temperature only
!         write ( *, '(a)' ) 'STEAM_INTERACT:'
!         write ( *, '(a)' ) 'Interactive queries of the NBS/NRC Steam Table
!    + Program.'
!
!  Read the next choice.
!
          open (5, file = 'input.txt')
          iopt = 2
!
!*********************************************************************
!  Option 2, properties for given pressure and temperature.
!*********************************************************************
!
!     write ( *, '(a)' ) ' '
!    write ( *, '(a)' ) ' Compute table for given pressure and temp.'
!     write ( *, '(a)' ) ' '
!
     do
!
!       write ( *, '(a)' ) ' '
!       write ( *, '(a)' ) 'Enter the pressure in psi'
!       write ( *, '(a,g14.6)' ) 'greater than ', p_min
!       write ( *, '(a,g14.6)' ) 'and less than or equal to ', p_max
!
       read ( 5, *, iostat = ios ) p
!
       if ( ios /= 0 ) then
         write ( *, '(a)' ) ' '
         write ( *, '(a)' ) 'Input error!'
         exit
       end if
!
       call d_gtle_range ( p, p_min, p_max, ok )
!
       if ( ok ) then
         exit
       end if
!
     end do
!
     if ( ios /= 0 ) then
     end if
!
     write ( *, '(a)' ) ' '
     write ( *, '(a,g14.6)' ) '  Specified pressure is ', p
          p=p*0.0068948
!
     do
!
!       write ( *, '(a)' ) ' '
```

```
!       write ( *, '(a)' ) 'Enter the temperature in degrees Fahrenheit'
!       write ( *, '(a,g14.6)' ) 'greater than ', t_min
!       write ( *, '(a,g14.6)' ) 'and less than or equal to ', t_max
!
        read ( 5, *, iostat = ios ) t
!
        if ( ios /= 0 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'Input error!'
          exit
        end if
!
        call d_gtle_range ( t, t_min, t_max, ok )
!
        if ( ok ) then
          exit
        end if
!
      end do
!
      if ( ios /= 0 ) then
      end if
!
      write ( *, '(a)' ) ' '
      write ( *, '(a,g14.6)' ) '  Specified temperature is ', t
            t=(t+459.67)/1.8
!
!  Get the density as function of P and T.
!
      ps = 20000.0D+00
      rhol = 0.0D+00
      rhov = 0.0D+00
!
      if ( t < t_crit ) then
        call psat ( t, ps, rhol, rhov )
      end if
!
      if ( p > ps ) then
        rho_start = rhol
      else
        rho_start = p / ( gascon() * t )
      end if
!
      call dense ( p, t, rho_start, rho, dpdr )
!
!  Compute properties as function of T and D.
!
      call therm (t,rho,a,cjth,cjtt, cp, cv, dpdr, dpdt, g, h, p, s, u )
!
      call dielectric ( t, rho, eps )
      call secvir ( t, vir )
!djm  Error in call to sound()
!djm  call sound ( t, p, c )
            c = sqrt ( 1000.0D+00 * cp * dpdr / cv )
      call surten ( t, sigma )
      call thercon ( t, rho, lambda )
```

```
      call viscosity ( t, rho, eta )
      call volume ( t, rho, v, dvdt, dvdr )
!djm  Error in call to prandtl()
!djm  call prandtl ( t, p, pr )
            pr = (eta * cp) / lambda
!
      label = 'Pressure and temperature were input.'
!
      call output
!
!djm  call to PWRDNBPROPS for additional property values
!
      call PWRDNBPROPS
            return
            end
*******************************************************************************************
                        subroutine base (t,rho, ab, cvb, dpdrb, dpdtb, gb,hb, pb, sb, ub)
!
!*****************************************************************************
!
!! BASE calculates quantities associated with the base Helmholtz function.
!
!
!  Discussion:
!
!    The equation for the base Helmholtz function AB(T,RHO) is:
!
!      AB(T,RHO) = R * T * (
!        - ln ( 1 - y )
!        - ( beta - 1 ) / ( 1 - y )
!        + ( alpha + beta + 1 ) / ( 2 * ( 1 - y )**2 )
!        + 4 * y * ( ( Bbar / b ) - gamma )
!        - 0.5 * ( alpha - beta + 3 )
!        + ln ( RHO * R * T / P0 ) )
!                                          (Equation 2)
!   where
!
!     y = b * rho / 4,
!     alpha = 11,
!     beta = 133/3,
!     gamma = 7/2,
!     P0 = 0.101325 MegaPascals = 1 atm
!
!   and
!
!     b(T) = b1 * ln(T/T0) + sum(j=0,1,3,5) b(j)*(T0/T)**j  (Equation 3)
!
!     Bbar(T) = sum(j=0,1,2,4) B(j)*(T0/T)**j              (Equation 4).
!
!   where
!
!     T0=647.073 K and the coefficients b(j) and B(j) are
!
!     j    b(j)                    B(j)
!    --    -----------              ----------
!     0    0.7478629                1.1278334
```

```
!    1   -0.3540782                -0.5944001
!    2    0                       -5.010996
!    3    0.007159876              0
!    4    0                        0.63684256
!    5   -0.003528426              0
!
! For the derived quantities, the following relations are used:
!
!   Pressure:                PB      = RHO**2 * dAB/dRHO
!   Density derivative:      DPDRB   = 2*PB/RHO + RHO**2 * d2AB/dRHO2
!   Temperature derivative:  DPDTB   = RHO**2 * d2AB/(dRHO dT)
!   Specific entropy:        SB      = ( UB - AB ) / T
!   Specific internal energy: UB     = AB + T * SB
!   Specific enthalpy:       HB      = UB + PB / RHO
!   Specific heat capacity
!     at constant volume:    CVB     = - T * d2AB/dT2
!   Specific Gibbs function: GB      = AB + PB / RHO
!
! Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
! Modified:
!
!   03 February 2002
!
! Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Input, double precision RHO, the density, in G/CM3.
!
!   Output, double precision AB, the base value of the Helmholtz function,
!   in KJ/kg.
!
!   Output, double precision CVB, the base value of the isochoric (constant
!   volume) heat capacity, in KJ/(kg degrees Kelvin).
!
!   Output, double precision DPDRB, the base value of the partial
!   derivative dP(T,RHO)/dRHO, with T held fixed, in (MegaPascals CM3)/G.
!
!   Output, double precision DPDTB, the base value of the partial
!   derivative dP(T,RHO)/dT, with RHO held fixed, in
!   MegaPascals/degrees Kelvin.
!
!   Output, double precision GB, the base value of the Gibbs free energy,
!   in KJ/kg.
```

```
!
!   Output, double precision HB, the base value of enthalpy, in KJ/kg.
!
!   Output, double precision PB, the base pressure, in MegaPascals.
!
!   Output, double precision SB, the base value of entropy,
!   in KJ/(kg degrees Kelvin).
!
!   Output, double precision UB, the base value of internal energy,
!   in KJ/kg.
!
        implicit none
!
        double precision ab
        double precision, parameter :: alpha = 11.0D+00
        double precision b1
        double precision b1t
        double precision b1tt
        double precision b2
        double precision b2t
        double precision b2tt
        double precision, parameter :: beta = 44.333333333333D+00
        double precision cvb
        double precision dpdrb
        double precision dpdtb
        double precision dz
        double precision dz0
        double precision, parameter :: gamma = 3.5D+00
        double precision gascon
        double precision gb
        double precision hb
        double precision, parameter :: p_zero = 0.101325D+00
        double precision pb
        double precision rho
        double precision sb
        double precision t
        double precision ub
        double precision x
        double precision y
        double precision z
        double precision z0
!
!  Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0 ) then
    write ( *, '(a)' ) ' '
    write ( *, '(a)' ) 'BASE - Fatal error!'
    write ( *, '(a)' ) '  The input temperature T must be positive.'
    write ( *, '(a,g14.6)' ) '  Input value was T = ', t
    stop
        end if
!
!  Refuse to handle zero or negative density.
!
        if ( rho <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
```

```
          write ( *, '(a)' ) 'BASE - Fatal error!'
          write ( *, '(a)' ) '  The input density RHO must be positive.'
          write ( *, '(a,g14.6)' ) '  Input value was RHO = ', rho
          stop
          end if
!
!  Compute auxilliary quantities for Equation 2.
!
          call bb ( t, b1, b2, b1t, b2t, b1tt, b2tt )

          y = 0.25D+00 * b1 * rho

          x = 1.0D+00 - y
!
!  Evaluate Equation 2.
!
          ab =   - log ( 1.0D+00 - y )
     + - ( beta - 1.0D+00 ) / ( 1.0D+00 - y )
     ++ ( alpha + beta + 1.0D+00 ) / ( 2.0D+00 * ( 1.0D+00 - y )**2 )
     ++ 4.0D+00 * y * ( ( b2 / b1 ) - gamma )
     +- 0.5D+00 * ( alpha - beta + 3.0D+00 )
     ++ log ( rho * gascon() * t / p_zero )
!
!  Determine quantities defined in terms of AB.
!
          pb = ( 1.0D+00 + alpha * y + beta * y**2 ) / ( 1.0D+00 - y )**3
     ++ 4.0D+00 * y * ( b2 / b1 - gamma )

          z0 = ( 1.0D+00 + alpha * y + beta * y**2 ) / ( 1.0D+00 - y )**3

          z = z0 + 4.0D+00 * y * ( b2 / b1 - gamma )

          dz0 = ( alpha + 2.0D+00 * beta * y ) / ( 1.0D+00 - y )**3
     ++3.0D+00 *(1.0D+00 + alpha * y + beta * y**2) /(1.0D+00 - y)**4

          dz = dz0 + 4.0D+00 * ( b2 / b1 - gamma )

          gb = ab + pb

          ub = - t * b1t * ( pb - 1.0D+00 - rho * b2 ) / b1 - rho * t * b2t

          hb = pb + ub
!
!  An incorrect version of this equation began:
!
!    cvb = 2.0D+00 * ub + ( pb - 1.0D+00 ) &
!
!  and caused me no end of trouble.  My fault, JVB, 03 February 2002
!
          cvb = 2.0D+00 * ub + ( z0 - 1.0D+00 )
     +* ( ( t * b1t / b1 )**2 - t**2 * b1tt / b1 )
     +- rho * t**2 * (b2tt - gamma * b1tt) - (t * b1t / b1)**2 * y * dz0

          dpdtb = pb /t + rho *(0.25D+00 *(dz0 + 4.0D+00 *(b2 / b1 - gamma))
     +* b1t + b2t - b2 / b1 * b1t )
```

```
        sb = ub - ab

        dpdrb = pb + y * ( dz0 + 4.0D+00 * ( b2 / b1 - gamma ) )
!
!  Assign dimensions.
!
        ab =    gascon() * t       * ab
        cvb =   gascon()           * cvb
        dpdrb = gascon() * t       * dpdrb
        dpdtb = gascon() * t * rho * dpdtb
        gb =    gascon() * t       * gb
        hb =    gascon() * t       * hb
        pb =    gascon() * t * rho * pb
        sb =    gascon()           * sb
        ub =    gascon() * t       * ub
        end
*******************************************************************************
        subroutine bb ( t, b1, b2, b1t, b2t, b1tt, b2tt )
!
!*******************************************************************************
!
!! BB calculates the B's of equations 3 and 4.
!
!
!  Discussion:
!
!    Here
!
!      b(T) = b1 * ln(T/T0) + sum(j=0,1,3,5) b(j)*(T0/T)**j  (Equation 3)
!
!      Bbar(T) = sum(j=0,1,2,4) B(j)*(T0/T)**j              (Equation 4).
!
!    where
!
!      T0 = 647.073 K
!
!    and the coefficients b(j) and B(j) are
!
!      j    b(j)                   B(j)
!     --    -----------             ----------
!      0    0.7478629                1.1278334
!      1   -0.3540782               -0.5944001
!      2    0                      -5.010996
!      3    0.007159876             0
!      4    0                       0.63684256
!      5   -0.003528426             0
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
```

```
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
! Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Output, double precision B1, the coefficient b from equation 3,
!   in CM3/G.
!
!   Output, double precision B2, the coefficient Bbar from equation 4,
!   in CM3/G.
!
!   Output, double precision B1T, the derivative dB1/dT,
!   in (CM3)/(G Degrees Kelvin).
!
!   Output, double precision B2T, the derivative dB2/dT,
!   in (CM3)/(G Degrees Kelvin).
!
!   Output, double precision B1TT, the second derivative of B1 with
!   respect to T, in (CM3)/(G (Degrees Kelvin)**2 ).
!
!   Output, double precision B2TT, the second derivative of B2 with
!   respect to T, in (CM3)/(G (Degrees Kelvin)**2 ).
!
        implicit none
!
        double precision b1
        double precision b1t
        double precision b1tt
        double precision b2
        double precision b2t
        double precision b2tt
        double precision, parameter, dimension ( 10 ) :: bp = (/
   + 0.7478629D+00,   -0.3540782D+00,    0.0D+00,          0.0D+00,
   + 0.007159876D+00,  0.0D+00,        -0.003528426D+00,   0.0D+00,
   + 0.0D+00,         0.0D+00 /)
        double precision, parameter, dimension ( 10 ) :: bq = (/
   + 1.1278334D+00,    0.0D+00,       -0.5944001D+00,  -5.010996D+00,
   + 0.0D+00,         0.63684256D+00,  0.0D+00,         0.0D+00,
   + 0.0D+00,         0.0D+00 /)
        integer i
        double precision t
        double precision, parameter :: t_ref = 647.073D+00
        double precision v(10)
!
! Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'BB - Fatal error!'
        write ( *, '(a)' ) '  The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  Input value was T = ', t
        stop
```

```
        end if
!
!  Set V(I) = ( T_REF / T )**(I-1).
!
        v(1) = 1.0D+00
        do i = 2, 10
        v(i) = v(i-1) * t_ref / t
        end do
!
!  Set B1, B1T, B1TT.
!
        b1 = bp(1) + bp(2) * log ( 1.0D+00 / v(2) )
        b1t = bp(2) * v(2) / t_ref
        b1tt = 0.0D+00
        do i = 3, 10
        b1 = b1 + bp(i) * v(i-1)
        b1t = b1t - dble ( i - 2 ) * bp(i) * v(i-1) / t
        b1tt = b1tt + bp(i) * dble ( i - 2 )**2 * v(i-1) / t**2
        end do

        b1tt = b1tt -  ( b1t / t )
!
!  Set B2, B2T, B2TT.
!
        b2 = bq(1)
        b2t = 0.0D+00
        b2tt = 0.0D+00
        do i = 3, 10
        b2 = b2 + bq(i) * v(i-1)
        b2t = b2t - dble ( i - 2 ) * bq(i) * v(i-1) / t
        b2tt = b2tt + bq(i) * dble ( i - 2 )**2 * v(i-1) / t**2
        end do

        b2tt = b2tt - ( b2t / t )

        return
        end
********************************************************************************************
        subroutine corr ( t, p, p_consistent, rhol, rhov, delg )
!
!*******************************************************************************
!
!! CORR evaluates an adjustment to the Gibbs function.
!
!
!  Discussion:
!
!    CORR is given T and P at or near the vapor pressure and evaluates
!    the corresponding liquid and vapor densities, and the residual
!    function DELG = (GL-GV)/(R*T) where GL and GV are the Gibbs functions
!    for the liquid and vapor phases, respectively.
!
!    These quantities are used to calculate a correction to the vapor
!    pressure or the vapor temperature.
!
!    The states corresponding to the coexisting phases of liquid
```

```
!   and vapor for the temperature range from the triple point
!   to within 0.5 C of the critical point 0.01 <= t <= tk-0.5 C
!   have been determined in exact accord with the Gibbs condition
!   of phase equilibrium: DELG = G(g)-G(l) = 0, P, t constant,
!   where G(g) and G(l) are the values of the Gibbs function
!   for saturated gas and liquid respectively.
!
!   For the region (tk-t)<=0.5 C, an exact solution for the
!   Helmholtz function yields values of density for the saturated
!   liquid that are shifted to lower values.  Also, the isotherms
!   in the pressure-density plane and the Gibbs function-density
!   plane are nearly flat, so that it is difficult to obtain
!   solutions.  As an alternative to exact solution, the power
!   law equation is used to define states:
!
!     rho(gas) = 0.322 - 0.657 * (1 - T/647.126)**0.325   (g/cm3).
!     rho(liq) = 0.322 + 0.657 * (1 - T/647.126)**0.325   (g/cm3).
!
!   In a poor instance of programming, the input pressure was
!   originally overwritten on output by a value consistent with
!   the computed densities.  This causes no end of misunderstandings,
!   since other routines expect the value of pressure to be input
!   only.  The code is now revised so that there is an input P
!   and an output P.  In a huff, JVB 05 February 2002.
!
!  Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Modified:
!
!   05 February 2002
!
!  Parameters:
!
!   Input, double precision T, the vapor temperature, in degrees Kelvin.
!
!   Input, double precision P, the vapor pressure, in MegaPascals.
!
!   Output, double precision P_CONSISTENT, the vapor pressure, in MegaPascals,
!   consistent with RHOL and RHOV.  This is equal to the input value of
!   P unless 646.3 <= T.
!
!   Input/output, double precision RHOL, the liquid density, in G/CM3.
!   On input, if RHOL is positive, it is used as an initial
!   estimate for the iteration.
!
```

```
!  Input/output, double precision RHOV, the vapor density, in G/CM3.
!  On input, if RHOV is positive, it is used as an initial
!  estimate for the iteration.
!
!  Output, double precision DELG, the residual function (GL-GV)/(R*T),
!  where GL is the liquid Gibbs function, GV the vapor Gibbs function,
!  dimensionless.  If T > 646.3, DELG is 0.
!
      implicit none
!
      double precision a
      double precision ab
      double precision ar
      double precision cd
      double precision cjth
      double precision cjtt
      double precision cp
      double precision cv
      double precision cvb
      double precision cvr
      logical, parameter :: debug = .false.
      double precision delg
      double precision dpdr
      double precision dpdrb
      double precision dpdrr
      double precision dpdt
      double precision dpdtb
      double precision dpdtr
      double precision g
      double precision gascon
      double precision gb
      double precision gl
      double precision gr
      double precision gv
      double precision h
      double precision hb
      double precision hr
      double precision p
      double precision p_consistent
      double precision, parameter :: p_crit = 22.055D+00
      double precision pb
      double precision pr
      double precision rho
      double precision rhol
      double precision, parameter :: rho_min = 1.0D-08
      double precision rhov
      double precision rho_start
      double precision s
      double precision sb
      double precision sr
      double precision t
      double precision tau
      double precision, parameter :: t_crit = 647.1260000001D+00
      double precision u
      double precision ub
      double precision ur
```

```
!
        p_consistent = p
!
!  Initialize output quantities.
!
        delg = 0.0D+00
!
!  Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'CORR - Fatal error!'
        write ( *, '(a)' ) '  The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was T = ', t
        stop
        end if
!
!  Refuse to handle zero or negative pressures.
!
        if ( p <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'CORR - Fatal error!'
        write ( *, '(a)' ) '  The input pressure P must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was P = ', p
        stop
        end if

        if ( t <= 646.3D+00 ) then

        if ( rhol <= 0.0D+00 ) then
     rho_start = 1.11D+00 - 0.0004D+00 * t
        else
     rho_start = rhol
        end if

        call dense ( p_consistent, t, rho_start, rho, dpdr )

        call therm ( t, rho, a, cjth, cjtt, cd, cv, dpdr, dpdt, g, h,
    +p_consistent, s, u )

        rhol = rho
        gl = g

        if ( rhov <= 0.0D+00 ) then
     rho_start = p_consistent / ( gascon() * t )
        else
     rho_start = rhov
        end if

        call dense ( p_consistent, t, rho_start, rho, dpdr )

        rho = max ( rho, rho_min )

        call therm ( t, rho, a, cjth, cjtt, cp, cv, dpdr, dpdt, g, h,
    +p_consistent, s, u )
```

```
          rhov = rho
          gv = g
          delg = ( gl - gv ) / ( gascon() * t )

          p_consistent = p

          if ( debug ) then
     write ( *, '(a,g14.6)' ) '  CORR - RHOL = ', rhol
     write ( *, '(a,g14.6)' ) '  RHOV = ', rhov
          end if

          else if ( t <= t_crit ) then

          if ( debug ) then
     write ( *, '(a)' ) 'CORR - Twilight zone'
          end if

          delg = 0.0D+00
          tau = 0.657128D+00 * ( 1.0D+00 - t / t_crit )**0.325D+00
          rhol = 0.322D+00 + tau
          rhov = 0.322D+00 - tau
          rho = rhov
          call base ( t, rho, ab, cvb, dpdrb, dpdtb, gb, hb, pb, sb, ub )
          call resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur )
          p_consistent = pb + pr

          else

          if ( debug ) then
     write ( *, '(a)' ) ' '
     write ( *, '(a)' ) 'CORR - Weirdo zone'
           end if

          rhol = 0.322D+00
          rhov = 0.322D+00
          p_consistent = p_crit
          delg = 0.0D+00

          end if

          return
          end
********************************************************************************
          subroutine cp_values ( n, tc, p, cp )
!
!*******************************************************************************
!
!! CP_VALUES returns some values of the specific heat at constant pressure.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
```

```
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3, pages 229-237.
!
!  Modified:
!
!   04 February 2002
!
!  Author:
!
!   John Burkardt
!
!  Parameters:
!
!   Input/output, integer N.
!   On input, if N is 0, the first test data is returned, and N is set
!   to the index of the test data.  On each subsequent call, N is
!   incremented and that test data is returned.  When there is no more
!   test data, N is set to 0.
!
!   Output, double precision TC, the temperature, in degrees Celsius.
!
!   Output, double precision P, the pressure, in bar.
!
!   Output, double precision CP, the specific heat at constant pressure,
!   in KJ/(kg K).
!
        implicit none
!
        integer, parameter :: nmax = 24
!
        double precision cp
        double precision, save, dimension ( nmax ) :: cpvec = (/
    + 4.228D+00, 2.042D+00, 1.975D+00, 2.013D+00, 2.040D+00,
    + 2.070D+00, 2.135D+00, 2.203D+00, 2.378D+00, 2.541D+00,
    + 2.792D+00, 2.931D+00, 4.226D+00, 4.223D+00, 4.202D+00,
    + 4.177D+00, 4.130D+00, 4.089D+00, 4.053D+00, 4.021D+00,
    + 3.909D+00, 3.844D+00, 3.786D+00, 2.89D+00 /)
        integer n
        double precision p
        double precision, save, dimension ( nmax ) :: pvec = (/
    + 1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,   1.0D+00,
    + 1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,   1.0D+00,
    + 1.0D+00,    1.0D+00,    5.0D+00,   10.0D+00,  50.0D+00,
    + 100.0D+00,  200.0D+00,  300.0D+00,  400.0D+00, 500.0D+00,
    + 1000.0D+00, 1500.0D+00, 2000.0D+00, 5000.0D+00  /)
        integer nn
        double precision tc
        double precision, save, dimension ( nmax ) :: tcvec = (/
    +  0.0D+00,  100.0D+00,  200.0D+00,  300.0D+00,  350.0D+00,
    + 400.0D+00,  500.0D+00,  600.0D+00,  850.0D+00, 1100.0D+00,
    + 1600.0D+00, 2000.0D+00,    0.0D+00,    0.0D+00,    0.0D+00,
    + 0.0D+00,    0.0D+00,    0.0D+00,    0.0D+00,    0.0D+00,
    + 0.0D+00,    0.0D+00,    0.0D+00,    0.0D+00 /)
!
        if ( nn < 0 ) then
          nn = 0
```

```
        end if

        if ( nn >= nmax ) then
        nn = 0
        tc = 0.0D+00
        p = 0.0D+00
        cp = 0.0D+00
        else
        nn = nn + 1
        tc = tcvec(nn)
        p = pvec(nn)
        cp = cpvec(nn)
        end if

        return
        end
******************************************************************************
        subroutine d_gtle_range ( x, a, b, ok )
!
!*****************************************************************
!
!! D_GTLE_RANGE checks that A < X <= B.
!
!
!  Modified:
!
!    31 January 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input, double precision X, the value to be checked.
!
!    Input, double precision A, B, the left and right endpoints.
!
!    Output, logical OK, is TRUE if A < X <= B.
!
        double precision a
        double precision b
        logical ok
        double precision x
!
        if ( x <= a ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) '  The input quantity is too small.'
        write ( *, '(a,g14.6)' ) '  The minimum legal value is ', a
        write ( *, '(a,g14.6)' ) '  The input value is         ', x
        ok = .false.
        else if ( b < x ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) '  The input quantity is too large.'
        write ( *, '(a,g14.6)' ) '  The maximum legal value is ', a
        write ( *, '(a,g14.6)' ) '  The input value is         ', x
```

```
          ok = .false.
          else
          ok = .true.
          end if
!
          return
          end
********************************************************************************
          subroutine dense ( p, t, rho_start, rho, dpdr )
!
!*******************************************************************************
!
!! DENSE computes the density for a given pressure and temperature.
!
!
!  Discussion:
!
!    The use of the variable RHO_START for two opposing purposes is
!    poor practice and will be corrected one of these days.  Meanwhile,
!    the algorithm's behavior, particularly in the two-phase region,
!    is very suspect.
!
!  Modified:
!
!    19 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision P, the pressure, in MegaPascals.
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Input, double precision RHO_START, an initial guess for the density,
!    in G/CM3.  The value of RHO_START also signals whether a vapor or liquid
!    calculation is to be done.  If DPDR is computed negative, then for
!    0.2967 <= RHO_START, liquid is assumed, otherwise gas.
!
!    Output, double precision RHO, the density for the given
!    pressure and temperature, in G/CM3.
!
!    Output, double precision DPDR, the partial derivative
!    dP(T,RHO)/dRHO, with T held fixed, in (MegaPascals CM3)/G.
!
```

```
      implicit none
!
      double precision ab
      double precision ar
      double precision cvb
      double precision cvr
      double precision dp
      double precision dpdr
      double precision dpdrb
      double precision dpdrr
      double precision dpdtb
      double precision dpdtr
      double precision dpdx
      double precision errtol
      double precision gb
      double precision gr
      double precision hb
      double precision hr
      integer it
      integer, parameter :: it_max = 50
      double precision p
      double precision pb
      double precision pp
      double precision pr
      double precision rho
      double precision, parameter :: rho_max = 1.9D+00
      double precision, parameter :: rho_min = 1.0D-08
      double precision rho_start
      double precision sb
      double precision sr
      double precision t
      double precision ub
      double precision ur
      double precision x
!
      errtol = sqrt ( epsilon ( errtol ) )
!
!  Refuse to handle zero or negative temperatures.
!
      if ( t <= 0.0D+00 ) then
      write ( *, '(a)' ) ' '
      write ( *, '(a)' ) 'DENSE - Fatal error!'
      write ( *, '(a)' ) 'The input temperature T must be positive.'
      write ( *, '(a,g14.6)' ) '  Input value was T = ', t
      stop
      end if
!
!  Refuse to handle zero or negative pressures.
!
      if ( p <= 0.0D+00 ) then
      write ( *, '(a)' ) ' '
      write ( *, '(a)' ) 'DENSE - Fatal error!'
      write ( *, '(a)' ) '  The input pressure P must be positive.'
      write ( *, '(a,g14.6)' ) '  Input value was P = ', p
      stop
      end if
```

```
          rho = rho_start
          rho = max ( rho, rho_min )
          rho = min ( rho, rho_max )

          do it = 1, it_max

          call resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur )

          call base ( t, rho, ab, cvb, dpdrb, dpdtb, gb, hb, pb, sb, ub )

          pp = pb + pr
          dpdr = dpdrb + dpdrr
!
!  Check for negative DP/DRho, which characterizes the two-phase region.
!
          if ( dpdr <= 0.0D+00 ) then

      if ( rho_start >= 0.2967D+00 ) then
        rho = rho * 1.02D+00
      else
        rho = rho * 0.98D+00
      end if

      if ( it <= 10 ) then
        cycle
      end if

          end if

          dpdx = 1.1D+00 * dpdr
          dpdx = max ( dpdx, 0.01D+00 )

          dp = abs ( 1.0D+00 - pp / p )

          if ( dp <= errtol .or.
     + ( rho > 0.3D+00 .and. dp <= errtol ) .or.
     + ( rho > 0.7D+00 .and. dp <= 10.0D+00 * errtol ) ) then
      return
          end if

          x = ( p - pp ) / dpdx
          if ( abs ( x ) > 0.1D+00 ) then
      x = x * 0.1D+00 / abs ( x )
          end if

          rho = rho + x

          rho = max ( rho, rho_min )
          rho = min ( rho, rho_max )

          end do

          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'DENSE - Warning!'
          write ( *, '(a)' ) '  The iteration did not converge.'
```

```
          write ( *, '(a,i6)' ) '  Number of iterations was ', it_max
          write ( *, '(a,g14.6)' ) '  Last iterate was ', rho

          return
          end
!*****************************************************************************80
          subroutine dielectric ( t, rho, eps )
!
!*****************************************************************************
!
!! DIELECTRIC returns the static dielectric constant.
!
!
!  Discussion:
!
!    According to the IAPS, the equation used is valid in the range
!
!      273.15 degrees Kelvin <= T <= 823.15 degrees K
!      0 MegaPascals         <= P <= 500 MegaPascals.
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, page 266.
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Modified:
!
!    02 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Input, double precision RHO, the density, in G/CM3.
!
!    Output, double precision EPS, the dielectric constant, dimensionless.
!
          implicit none
!
          integer, parameter :: npol_c = 4
!
          double precision, parameter, dimension ( 10 ) :: a = (/
     +7.62571D+00, 244.003D+00, -140.569D+00, 27.7841D+00, -96.2805D+00,
     +41.7909D+00, -10.2099D+00, -45.2059D+00, 84.6395D+00, -35.8644D+00
```

```
    +/)
          double precision c(0:npol_c)
          double precision eps
          double precision rho
          double precision t
          double precision t_copy
          double precision, parameter :: t_max = 823.15D+00
          double precision, parameter :: t_min = 273.15D+00
          double precision, parameter :: t_ref = 298.15D+00
          double precision t_star
!
!  Refuse to handle zero or negative temperatures.
!
          if ( t <= 0.0D+00 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'DIELECTRIC - Fatal error!'
          write ( *, '(a)' ) '  The input temperature T must be positive.'
          write ( *, '(a,g14.6)' ) '  Input value was T = ', t
          stop
          end if
!
!  Refuse to handle zero or negative density.
!
          if ( rho <= 0.0D+00 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'DIELECTRIC - Fatal error!'
          write ( *, '(a)' ) '  The input density RHO must be positive.'
          write ( *, '(a,g14.6)' ) '  Input value was RHO = ', rho
          stop
          end if

          t_copy = t
          t_copy = min ( t_copy, t_max )
          t_copy = max ( t_copy, t_min )

          t_star = t_copy / t_ref

          c(0) = 1.0D+00
          c(1) = a(1) / t_star
          c(2) = ( a(2) / t_star ) + a(3) + a(4) * t_star
          c(3) = ( a(5) / t_star ) + a(6) * t_star + a(7) * t_star**2
          c(4) = ( a(8) / t_star**2 ) + ( a(9) / t_star ) + a(10)

          call dpoly_val_horner ( npol_c, c, rho, eps )

          return
          end
!*******************************************************************************
          subroutine dielectric_values ( n, tc, p, eps )
!
!*******************************************************************************
!
!! DIELECTRIC_VALUES returns some values of the static dielectric constant.
!
!
!  Reference:
```

```
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3, page 266.
!
!  Modified:
!
!   03 February 2002
!
!  Author:
!
!   John Burkardt
!
!  Parameters:
!
!   Input/output, integer N.
!   On input, if N is 0, the first test data is returned, and N is set
!   to the index of the test data.  On each subsequent call, N is
!   incremented and that test data is returned.  When there is no more
!   test data, N is set to 0.
!
!   Output, double precision TC, the temperature, in degrees Celsius.
!
!   Output, double precision P, the pressure, in bar.
!
!   Output, double precision EPS, the dielectric constant, dimensionless.
!
        implicit none
!
        integer, parameter :: nmax = 15
!
        double precision eps
        double precision, save, dimension ( nmax ) :: epsvec = (/
    +88.29D+00, 90.07D+00, 92.02D+00, 95.14D+00, 100.77D+00,
    +78.85D+00, 70.27D+00, 62.60D+00, 55.78D+00,  44.31D+00,
    +35.11D+00, 20.40D+00,  1.17D+00,  1.11D+00,   1.08D+00 /)
        integer n
        double precision p
        double precision, save, dimension ( nmax ) :: pvec = (/
    +100.0D+00, 500.0D+00, 1000.0D+00, 2000.0D+00, 5000.0D+00,
    +100.0D+00, 100.0D+00, 100.0D+00, 100.0D+00, 100.0D+00,
    +100.0D+00, 100.0D+00, 100.0D+00, 100.0D+00, 100.0D+00 /)
        integer nn
        double precision tc
        double precision, save, dimension ( nmax ) :: tcvec = (/
    + 0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
    + 25.0D+00,  50.0D+00,  75.0D+00, 100.0D+00, 150.0D+00,
    + 200.0D+00, 300.0D+00, 400.0D+00, 500.0D+00, 600.0D+00 /)
!
        if ( nn < 0 ) then
        nn = 0
        end if
```

```
        if ( nn >= nmax ) then
        nn = 0
        tc = 0.0D+00
        p = 0.0D+00
        eps = 0.0D+00
        else
        nn = nn + 1
        tc = tcvec(nn)
        p = pvec(nn)
        eps = epsvec(nn)
        end if

        return
        end
********************************************************************************
        subroutine dpoly_val_horner ( n, c, x, cx )
!
!*******************************************************************************
!
!! DPOLY_VAL_HORNER evaluates a polynomial using Horner's method.
!
!
!  Modified:
!
!    08 August 1999
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input, integer N, the dimension of C.
!
!    Input, double precision C(0:N), the polynomial coefficients.
!    C(I) is the coefficient of X**I.
!
!    Input, double precision X, the point at which the polynomial
!    is to be evaluated.
!
!    Output, double precision CX, the value of the polynomial at X.
!
        implicit none
!
        integer n
!
        double precision c(0:n)
        double precision cx
        integer i
        double precision x
!
        cx = c(n)
        do i = n - 1, 0, -1
        cx = cx * x + c(i)
        end do
```

```
      return
      end
********************************************************************************
      function gascon ( )
!
!*******************************************************************************
!
!! GASCON returns the value of the specific gas constant.
!
!
!  Note:
!
!    The specific gas constant R is related to the universal gas
!    constant R-bar = 8.31441 J/(mol degrees Kelvin) by the molar mass
!    M = 18.0152 g/mol:
!
!      R = R-bar / M.
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Output, double precision GASCON, the value of the specific gas
!    constant, in J/(g degrees Kelvin).
!
      implicit none
!
      double precision gascon
!
      gascon = 0.461522D+00

      return
      end
********************************************************************************
      subroutine ideal ( t, ai, cpi, cvi, gi, hi, si, ui )
!
!*******************************************************************************
!
!! IDEAL computes ideal gas thermodynamic properties of water.
!
!
!  Discussion:
!
!    Values for thermodynamic properties of water in the ideal
!    gas state were reported by Woolley.  The formula for the ideal gas
```

```
!   term of the Helmholtz function approximates a term by term summation of
!   contributions from each of the rotation and vibration states.
!   The formula, equation #6 in the reference, is:
!
!   A(ideal)(T) = -R * T * ( 1 + ( C(1)/Tr + C(2) ) * ln(Tr)
!     + Sum ( 3 <= I <= 18) C(I) * Tr**(I-6)
!
!   where Tr=T/100 K.  The C(i) are tabulated coefficients.  Equation
!   6 can be used for temperatures below 3000 K, and is accurate to
!   within the tolerance of the gas constant for 50<=T<=2000 K.
!
! Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
! Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Output, double precision AI, the Helmholtz function, in KJ/kg.
!
!   Output, double precision CPI, the heat capacity at constant pressure,
!   in KJ/(kg degrees Kelvin).
!
!   Output, double precision CVI, the heat capacity at constant volume,
!   in KJ/(kg degrees Kelvin).
!
!   Output, double precision GI, the Gibbs free energy, in KJ/kg.
!
!   Output, double precision HI, the enthalpy, in KJ/kg.
!
!   Output, double precision SI, the entropy, in KJ/(kg degrees Kelvin).
!
!   Output, double precision UI, the internal energy, in KJ/kg.
!
        implicit none
!
        double precision ai
        double precision, parameter, dimension ( 18 ) :: c = (/
   +19.730271018D+00,      20.9662681977D+00,    -0.483429455355D+00,
   +6.05743189245D+00,     22.56023885D+00,      -9.87532442D+00,
   +-4.3135538513D+00,      0.458155781D+00,     -0.047754901883D+00,
   +0.0041238460633D+00,  -0.00027929052852D+00, 0.14481695261D-04,
   +-0.56473658748D-06,     0.16200446D-07,      -0.3303822796D-09,
   +0.451916067368D-11,   -0.370734122708D-13,   0.137546068238D-15 /)
        double precision cpi
        double precision cvi
        double precision gascon
        double precision gi
        double precision hi
        integer i
```

```
        double precision si
        double precision t
        double precision temp
        double precision tt
        double precision ui
!
!  Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'IDEAL - Fatal error!'
        write ( *, '(a)' ) '  The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  Input value was T = ', t
        stop
        end if

        tt = t / 100.0D+00

        gi = - ( c(1) / tt + c(2) ) * log ( tt )
        do i = 3, 18
        gi = gi - c(i) * tt**(i-6)
        end do

        hi = c(2) + c(1) * ( 1.0D+00 - log ( tt ) ) / tt
        do i = 3, 18
        hi = hi + dble ( i - 6 ) * c(i) * tt**(i-6)
        end do

        cpi = c(2) - c(1) / tt
        do i = 3, 18
        cpi = cpi + dble ( ( i - 6 ) * ( i - 5 ) ) * c(i) * tt**(i-6)
        end do

        ai = gi - 1.0D+00
        ui = hi - 1.0D+00
        cvi = cpi - 1.0D+00
        si = hi - gi
!
!  Assign dimensions.
!
        ai =  gascon() * t * ai
        cpi = gascon()     * cpi
        cvi = gascon()     * cvi
        gi =  gascon() * t * gi
        hi =  gascon() * t * hi
        si =  gascon()     * si
        ui =  gascon() * t * ui

        return
        end
********************************************************************************
        subroutine output
!
!**********************************************************************
!
!! OUTPUT prints the values of the thermodynamic quantities.
```

```
!
!
!  Modified:
!
!    02 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
          Use MainVar
!         implicit none
!
!cdjm Output changed to display both British and Metric values.
!         double precision a, ae
!         double precision c, ce
!         double precision cjth, cjthe
!         double precision cjtt, cjtte
!         double precision cp, cpe
!         double precision cv, cve
!         double precision dpdr, dpdre
!         double precision dpdt, dpdte
!         double precision dvdr, dvdre
!         double precision dvdt, dvdte
!         double precision eps
!         double precision eta, etae
!         double precision g, ge
!         double precision h, he
!         character ( len = 72 ) label
!         double precision lambda, lambdae
!         double precision p, pe
!         double precision pr
!         double precision rho, rhoe
!         double precision s, se
!         double precision sigma, sigmae
!         double precision t, te
!         double precision u, ue
!         double precision v, ve
!         double precision vir, vire
!
!cdjm British value conversion for each variable
!
          ae = a*.430
          ce = c*3.281
          cjthe = cjth*(1.8/145.04)
          cjtte = cjtt/62.43
          cpe = cp/4.187
          cve = cv/4.187
          dpdre = dpdr*(145.04/62.43)
          dpdte = dpdt*(145.04/1.8)
          dvdre = dvdr*(1/62.43)*(1/62.43)
          dvdte = dvdt*(1/62.43)*(1/1.8)
          etae = eta*2.4191E9
          ge = g*.430
```

```
          he = h*.430
          lambdae = lambda*1.4379E5
          pe = p*145.04
          rhoe = rho*62.43
          se = s/4.187
          sigmae = sigma*6.852E-2
          te = t*1.8-459.67
          ue = u*.430
          ve = v/62.43
          vire = vir/62.43
!
          open (6, file = 'output.txt')
!
! Option for user to view calculated properties in output
!
          open (5, file = 'input.txt')
!         write (*,*) "Enter (1) to view the calculated properties."
          read (5,*) propchoice
!
          if(propchoice == 1) then
          write ( 6, * ) ' '
          write ( 6, '(a)' ) trim ( label )
          write ( 6, '(a)' )' '
          write ( 6, 1096)ae,a
          write ( 6, 1097)ce,c
          write ( 6, 1095)cjthe,cjth
          write ( 6, 1099)cjtte,cjtt
          write ( 6, 1100)cpe,cp
          write ( 6, 1098)cve,cv
          write ( 6, 1102)rhoe,rho
          write ( 6, 1103)dpdre,dpdr
          write ( 6, 1104)dpdte,dpdt
          write ( 6, '(a,g16.8,a,g16.8,a)' )
    +'DVDR =   ', dvdre,   ' FT6/LB2      ', dvdr,' CM6/g2
    +         (d Specific Volume/d Density)'
          write ( 6, '(a,g16.8,a,g16.8,a)' )
    +'DVDT =   ', dvdte,   ' FT3/(LB F)   ', dvdt,' CM3/(g K)
    +      (d Specific Volume/ d T)'
          write ( 6, '(a,g16.8,a)' )
    +'EPS =    ', eps,    ' 1
    +                    (static dielectric constant)'
!
          write ( 6, 1094)etae,eta
          write ( 6, 1106)ge,g
          write ( 6, 1107)he,h
          write ( 6, '(a,g16.8,a,g16.8,a)' )
    +'LAMBDA = ', lambdae, ' BTU/(HR FT F)', lambda,' MW/(m K)
    +       (thermal conductivity)'
          write ( 6, 1108)pe,p
          write ( 6, '(a,g16.8,a)' )
    +'PR =     ', pr,     ' 1
    +                     (Prandtl number)'
          write ( 6, 1101)se,s
          write ( 6, 1092)sigmae,sigma
          write ( 6, 1109)te,t
          write ( 6, '(a,g16.8,a,g16.8,a)' )
```

```
     +'U =      ', ue,      ' BTU/LB       ', u,' KJ/kg
     +          (internal energy)'
           write ( 6, '(a,g16.8,a,g16.8,a)' )
     +'V =      ', ve,      ' FT3/LB       ', v,' CM3/g
     +          (specific volume)'
           write ( 6, '(a,g16.8,a,g16.8,a)' )
     +'VIR =    ', vire,    ' FT3/LB       ', vir,' CM3/g
     +          (second virial coefficient)'
           return
!
           else
           write ( 6, 1108)pe,p
           write ( 6, 1109)te,t
           end if
!
1092  format('SIGMA =  ',g16.8,' LB/FT        ',g16.8,' Pa M
     +          (surface tension)')
1094  format('ETA =    ',g16.8,' LB/(FT HR)   ',g16.8,' MPa s
     +          (viscosity)')
1095  format('CJTH =   ',g16.8,' F/PSIA       ',g16.8,' K/MPa
     +          (Joule-Thomson coefficient)')
1096  format('A =      ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (Helmholtz function)')
1097  format('C =      ',g16.8,' FT/s         ',g16.8,' M/s
     +           (speed of sound)')
1098  format('CV =     ',g16.8,' BTU/(LB F)   ',g16.8,' KJ/(kg K)
     +     (Specific heat at constant volume)')
1099  format('CJTT =   ',g16.8,' FT3/LB       ',g16.8,' CM3/g
     +          (Isothermal Joule-Thomson coefficient)')
1100  format('CP =     ',g16.8,' BTU/(LB F)   ',g16.8,' KJ/(kg K)
     +     (Specific heat at constant pressure)')
1101  format('S =      ',g16.8,' BTU/(LB F)   ',g16.8,' KJ/(kg K)
     +     (entropy)')
1102  format('RHO =    ',g16.8,' LB/FT3       ',g16.8,' g/CM3
     +          (density)')
1103  format('DPDR =   ',g16.8,' PSIA FT3/LB  ',g16.8,' MPa CM3/g
     +     (D Pressure/D Density)')
1104  format('DPDT =   ',g16.8,' PSIA/F       ',g16.8,' MPa/K
     +          (D Pressure/D Temperature)')
1106  format('G =      ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (Gibbs specific energy)')
1107  format('H =      ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (enthalpy)')
1108  format('P =      ',g16.8,' PSIA         ',g16.8,' MPa
     +           (pressure)')
1109  format('T =      ',g16.8,' Degrees F    ',g16.8,' K
     +           (temperature)')
!
           return
           end
*******************************************************************************************
           subroutine prandtl ( t, p, pr )
!
!*****************************************************************************
!
!! PRANDTL computes the Prandtl number.
```

```
!
!
!  Discussion:
!
!    This routine was NOT working properly for large pressures,
!    because the routine CORR was changing the input value of P.
!
!  Modified:
!
!    17 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Input, double precision P, the pressure, in MegaPascals.
!
!    Output, double precision PR, the Prandtl number, dimensionless.
!
          implicit none
!
          double precision a
          double precision cjth
          double precision cjtt
          double precision cp
          double precision cv
          logical, parameter :: debug = .false.
          double precision dpdr
          double precision dpdt
          double precision eta
          double precision g
          double precision h
          double precision lambda
          double precision p
          double precision pr
          double precision rho
          double precision rhol
          double precision rho_start
          double precision rhov
          double precision s
          double precision t
          double precision t2
          double precision u
```

```
!
!  Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'PRANDTL - Fatal error!'
        write ( *, '(a)' ) '  The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was T = ', t
        stop
        end if
!
!  Refuse to handle zero or negative pressures.
!
        if ( p <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'PRANDTL - Fatal error!'
        write ( *, '(a)' ) '  The input pressure P must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was P = ', p
        stop
        end if
!
!  Compute the density.
!
        if ( debug ) then
        write ( *, * ) 'PRANDTL - Call TSAT, with P = ', p
        end if

        rhol = 0.0D+00
        rhov = 0.0D+00

        call tsat ( t2, p, rhol, rhov )

        if ( debug ) then
        write ( *, * ) 'PRANDTL - T2 = ', t2
        end if

        if ( t < t2 ) then
         rho_start = 1.9D+00
        else
         rho_start = 0.01D+00
        end if

        call dense ( p, t, rho_start, rho, dpdr )

        if ( debug ) then
        write ( *, * ) 'PRANDTL - RHO = ', rho
        end if
!
!  Now from T and RHO, compute CP, ETA and LAMBDA.
!
        call therm ( t, rho, a, cjth, cjtt, cp, cv, dpdr, dpdt, g, h, p,
    + s, u )

        call viscosity ( t, rho, eta )

        call thercon ( t, rho, lambda )
```

```
          if ( debug ) then
           write ( *, '(7f10.4)' ) t, p, rho, eta, cp, lambda, pr
          end if

          pr = eta * cp / lambda

          return
          end
********************************************************************************
          subroutine prandtl_values ( n, tc, p, pr )
!
!*******************************************************************************
!
!! PRANDTL_VALUES returns some values of the Prandtl number for testing.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, page 265.
!
!  Modified:
!
!    04 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision TC, the temperature, in degrees Celsius.
!
!    Output, double precision P, the pressure, in bar.
!
!    Output, double precision PR, the Prandtl number, dimensionless.
!
          implicit none
!
          integer, parameter :: nmax = 35
!
          integer n
          double precision p
          double precision pr
          double precision, save, dimension ( nmax ) :: prvec = (/
```

```
     +13.50D+00, 13.48D+00, 13.46D+00, 13.39D+00, 13.27D+00,
     +13.15D+00, 13.04D+00, 12.93D+00, 12.83D+00, 12.73D+00,
     +12.63D+00, 12.53D+00, 12.43D+00, 12.34D+00, 12.25D+00,
     +12.08D+00, 11.92D+00, 11.77D+00, 11.62D+00, 11.48D+00,
     +11.36D+00, 11.23D+00, 11.12D+00, 10.91D+00, 10.72D+00,
     +10.55D+00,  6.137D+00, 3.555D+00, 2.378D+00, 1.000D+00,
     +0.974D+00, 0.960D+00, 0.924D+00, 0.899D+00, 0.882D+00 /)
           double precision, save, dimension ( nmax ) :: pvec = (/
     + 1.0D+00,    5.0D+00,   10.0D+00,   25.0D+00,   50.0D+00,
     +75.0D+00,  100.0D+00,  125.0D+00,  150.0D+00,  175.0D+00,
     +200.0D+00,  225.0D+00,  250.0D+00,  275.0D+00,  300.0D+00,
     +350.0D+00,  400.0D+00,  450.0D+00,  500.0D+00,  550.0D+00,
     +600.0D+00,  650.0D+00,  700.0D+00,  800.0D+00,  900.0D+00,
     +1000.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,
     + 1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00 /)
           integer nn
           double precision tc
           double precision, save, dimension ( nmax ) :: tcvec = (/
     +0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +0.0D+00,    25.0D+00,  50.0D+00,  75.0D+00, 100.0D+00,
     +150.0D+00, 200.0D+00, 400.0D+00, 600.0D+00, 800.0D+00 /)
!
           if ( nn < 0 ) then
             nn = 0
           end if

           if ( nn >= nmax ) then
             nn = 0
             tc = 0.0D+00
             p = 0.0D+00
             pr = 0.0D+00
           else
             nn = nn + 1
             tc = tcvec(nn)
            p = pvec(nn)
            pr = prvec(nn)
           end if

           return
           end
*****************************************************************************************
           subroutine psat ( t, p, rhol, rhov )
!
!*****************************************************************************
!
!! PSAT calculates the vapor pressure, and the liquid and vapor densities.
!
!
!  Discussion:
!
!    These quantities correspond to the input temperature T, corrected
!    so that the Gibbs functions for liquid and vapor phase are
```

```
!   equal to within a tolerance.
!
!  Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Modified:
!
!   04 February 2002
!
!  Parameters:
!
!   Input, double precision T, the vapor temperature, in degrees Kelvin.
!
!   Output, double precision P, the vapor pressure, in MegaPascals.
!
!   Output, double precision RHOL, the liquid density, in G/CM3.
!
!   Output, double precision RHOV, the vapor density, in G/CM3.
!
            implicit none
!
            double precision bot
            double precision delg
            double precision dp
            double precision errtol
            double precision gascon
            integer it
           integer, parameter :: it_max = 100
           double precision p
           double precision p_consistent
           double precision p_old
            double precision rhol
            double precision rhov
            double precision t
!
!  Ensure that output quantities are initialized,, obliterating any
!  input values.
!
            p = 0.0D+00
            rhol = 0.0D+00
            rhov = 0.0D+00
!
!  Set the error tolerance.
!
            errtol = 100.0D+00 * sqrt ( epsilon ( errtol ) )
!
```

```
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'PSAT - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if
!
!  Get an estimate for the saturation pressure.
!
            call psat_est ( t, p )

            dp = 0.0D+00

            do it = 1, it_max

              call corr ( t, p, p_consistent, rhol, rhov, delg )

              bot = ( rhol - rhov ) / ( rhol * rhov )

              if ( abs ( bot ) < errtol ) then
               write ( *, * ) 'PSAT - Warning, what is this?'
      bot = sign ( errtol, bot )
              end if

              dp = delg * gascon() * t / bot

              p_old = p
              p = p + dp

              if ( abs ( dp ) <= errtol * ( abs ( p ) + 1.0D+00 ) ) then
      return
            end if

              if ( p <= 0.0D+00 ) then
                write ( *, '(a)' ) ' '
                write ( *, '(a)' ) 'PSAT - Warning!'
                write ( *, '(a)' ) '  The iterates have become nonpositive.'
                write ( *, '(a,i6)' ) '  Iteration number = ', it
                write ( *, '(a,g14.6)' ) '  Last iterate was ', p
                write ( *, '(a,g14.6)' ) '  Previous iterate was ', p_old
                write ( *, '(a,g14.6)' ) '  Last correction was ', dp
                write ( *, '(a)' ) '  Trying to recover...'
                p = 0.5D+00 * p_old
              end if

              if ( p <= 0.0D+00 ) then
                write ( *, '(a)' ) ' '
                write ( *, '(a)' ) 'PSAT - Fatal error!'
                write ( *, '(a)' ) '  The iterates have become nonpositive.'
                write ( *, '(a,i6)' ) '  Iteration number = ', it
                write ( *, '(a,g14.6)' ) '  Last iterate was ', p
                write ( *, '(a,g14.6)' ) '  Previous iterate was ', p_old
                write ( *, '(a,g14.6)' ) '  Last correction was ', dp
```

```
            stop
          end if

          end do

          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'PSAT - Warning!'
          write ( *, '(a)' ) '  The iteration did not converge.'
          write ( *, '(a,i6)' ) '  The number of iterations was ', it_max
          write ( *, '(a,g14.6)' ) '  Convergence tolerance was ', errtol
          write ( *, '(a,g14.6)' ) '  Last iterate was ', p
          write ( *, '(a,g14.6)' ) '  Last correction was ', dp

          return
        end
*******************************************************************************
        subroutine psat_est ( t, p )
!
!*******************************************************************************
!
!! PSAT_EST makes a rough estimate of the vapor pressure.
!
!
!  Discussion:
!
!    The calculation agrees with tabulated data to within
!    0.02% for temperature to within a degree or so of the critical
!    temperature.  The approximate vapor pressure can be refined
!    by imposing the condition that the Gibbs functions of the vapor
!    and liquid phases be equal.
!
!  Modified:
!
!    21 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Output, double precision P, the vapor pressure, in MegaPascals.
!
          implicit none
!
```

```
          double precision, parameter, dimension ( 8 ) :: a = (/
     +-7.8889166D+00,   2.5514255D+00,   -6.716169D+00, 33.239495D+00,
     +-105.38479D+00,   174.35319D+00,  -148.39348D+00, 48.631602D+00 /)
          double precision b
          integer i
          double precision p
          double precision q
          double precision t
          double precision, parameter :: t_ref = 647.25D+00
          double precision v
          double precision w
          double precision z
!
!  Refuse to handle zero or negative temperatures.
!
          if ( t <= 0.0D+00 ) then
            write ( *, '(a)' ) ' '
            write ( *, '(a)' ) 'PSAT_EST - Fatal error!'
            write ( *, '(a)' ) 'The input temperature T must be positive.'
            write ( *, '(a,g14.6)' ) '  Input value was T = ', t
            stop
          end if

          if ( t <= 314.0D+00 ) then

            p = 0.1D+00 * exp ( 6.3573118D+00 - 8858.843D+00 / t
     +      + 607.56335D+00 * t**( -0.6D+00 ) )

          else

            v = t / t_ref
            w = abs ( 1.0D+00 - v )
            b = 0.0D+00
            do i = 1, 8
              z = i
              b = b + a(i) * w**( ( z + 1.0D+00 ) / 2.0D+00 )
            end do

            q = b / v
            p = 22.093D+00 * exp ( q )

          end if

          return
        end
*****************************************************************************************
        subroutine psat_values ( n, tc, p )
!
!*****************************************************************************
!
!! PSAT_VALUES returns some values of the saturation pressure.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
```

```
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3, pages 9-15.
!
!  Modified:
!
!   04 February 2002
!
!  Author:
!
!   John Burkardt
!
!  Parameters:
!
!   Input/output, integer N.
!   On input, if N is 0, the first test data is returned, and N is set
!   to the index of the test data.  On each subsequent call, N is
!   incremented and that test data is returned.  When there is no more
!   test data, N is set to 0.
!
!   Output, double precision TC, the temperature, in degrees Celsius.
!
!   Output, double precision P, the saturation pressure, in bar.
!
          implicit none
!
          integer, parameter :: nmax = 12
!
          integer n
          double precision p
          double precision, save, dimension ( nmax ) :: pvec = (/
     +0.0061173D+00,0.0065716D+00,0.0087260D+00,0.12344D+00, 1.0132D+00,
     +2.3201D+00,    4.7572D+00, 15.537D+00,    39.737D+00,  85.838D+00,
     +165.21D+00,  220.55D+00 /)
          double precision tc
          double precision, save, dimension ( nmax ) :: tcvec = (/
     +  0.01D+00,   1.0D+00,    5.0D+00,   50.0D+00,   100.0D+00,
     +125.0D+00,  150.0D+00,  200.0D+00,  250.0D+00,  300.0D+00,
     +350.0D+00,  373.976D+00 /)
!
          if ( n < 0 ) then
            n = 0
          end if

          if ( n >= nmax ) then
            n = 0
            tc = 0.0D+00
            p = 0.0D+00
          else
            n = n + 1
            tc = tcvec(n)
            p = pvec(n)
          end if
```

```
            return
          end

*******************************************************************************
          subroutine resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur )
!
!*******************************************************************************
!
!! RESID calculates residual contributions to thermodynamic quantities.
!
!
!  Discussion:
!
!    The residual function consists of 40 terms.  The first 36 are
!    used in a global least squares fit to experimental data.
!
!    Three terms were added that contribute only in the immediate
!    neighborhood of the critical point
!      (tk-5) <= T <= (tk+5) C
!      0.20   <= rho <= 0.44 g/cm3,
!
!    A single term was added for the region of high pressure and
!    low temperature: T < 75 C, P > 300 MPa.
!
!    Except in these limited regions, the residual function is
!    given by the first 36 terms.  The equation is
!
!      A(residual)(rho,T)=
!        sum(i=1 to 36) (g(i)/k(i)) * (T0/T)**(l(i)) (1-exp(-rho))**(k(i))
!      + sum(i=37 to 40) g(i)*delta(i)**(k(i))
!        * exp(-alpha(i)*delta(i)**(k(i)) - beta(i)*tau(i)**2)
!                                          (Equation 5)
!
!    where
!
!      g(i) are coefficients determined by fits to data,
!      delta(i) are reduced densities (delta(i)=((rho-rho(i))/rho(i))
!      tau(i) are reduced temperatures (tau(i)=((T-tau(i))/tau(i))
!      rho(i) are specified densities.
!      tau(i) are specified temperatures.
!      The k(i) and l(i) are specified integers.
!
!  Modified:
!
!    22 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
```

```
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Input, double precision RHO, the density, in G/CM3.
!
!   Output, double precision AR, the residual contribution to the
!   Helmholtz function, in KJ/kg.
!
!   Output, double precision CVR, the residual contribution to the
!   isochoric (constant volume) heat capacity, in KJ/(kg degrees Kelvin).
!
!   Output, double precision DPDRR, the residual contribution to
!   the partial derivative dP(T,RHO)/dRHO, with T held fixed, in
!   (MegaPascals CM3)/G.
!
!   Output, double precision DPDTR, the residual contribution to
!   the partial derivative dP(T,RHO)/dT, with RHO held fixed,
!   in MegaPascals/degrees Kelvin.
!
!   Output, double precision GR, the residual contribution to the Gibbs
!   function, in KJ/kg.
!
!   Output, double precision HR, the residual contribution to the
!   enthalpy, in KJ/kg.
!
!   Output, double precision PR, the residual contribution to the pressure,
!   in MegaPascals.
!
!   Output, double precision SR, the residual contribution to the entropy,
!   in KJ/(kg degrees Kelvin).
!
!   Output, double precision UR, the residual contribution to the
!   internal energy, in KJ/kg.
!
            implicit none
!
            double precision, parameter, dimension ( 4 ) :: aad = (/
     +   34.0D+00, 40.0D+00, 30.0D+00, 1050.0D+00 /)
            double precision, parameter, dimension ( 4 ) :: aat = (/
     +   20000.0D+00, 20000.0D+00, 40000.0D+00, 25.0D+00 /)
            double precision, parameter, dimension ( 4 ) :: adz = (/
     +   0.319D+00, 0.319D+00, 0.319D+00, 1.55D+00 /)
            double precision ar
            double precision att
            double precision, parameter, dimension ( 4 ) ::  atz = (/
     +   640.0D+00, 640.0D+00, 641.6D+00, 270.0D+00 /)
            double precision cvr
            double precision dadt
            double precision ddz
            double precision del
            double precision dex
```

```
      double precision dfdt
      double precision dpdrr
      double precision dpdtr
      double precision e
      double precision errtol
      double precision ex0
      double precision ex1
      double precision ex2
      double precision fct
      double precision, parameter, dimension (40) :: g = (/
+  -530.62968529023D+00,0.22744901424408D+04, 0.78779333020687D+03,
+  -69.830527374994D+00,0.17863832875422D+05,-0.39514731563338D+05,
+ 0.33803884280753D+05,-0.13855050202703D+05,-0.25637436613260D+06,
+0.48212575981415D+06, -0.34183016969660D+06, 0.12223156417448D+06,
+0.11797433655832D+07, -0.21734810110373D+07, 0.10829952168620D+07,
+-0.25441998064049D+06,-0.31377774947767D+07, 0.52911910757704D+07,
+-0.13802577177877D+07,-0.25109914369001D+06, 0.46561826115608D+07,
+-0.72752773275387D+07, 0.41774246148294D+06, 0.14016358244614D+07,
+-0.31555231392127D+07, 0.47929666384584D+07, 0.40912664781209D+06,
+-0.13626369388386D+07, 0.69625220862664D+06,-0.10834900096447D+07,
+-0.22722827401688D+06, 0.38365486000660D+06, 0.68833257944332D+04,
+ 0.21757245522644D+05,-0.26627944829770D+04,-0.70730418082074D+05,
+-0.225D+00, -1.68D+00, 0.055D+00, -93.0D+00 /)
      double precision gascon
      double precision gr
      double precision hr
      integer i
      integer, parameter, dimension ( 40 ) :: ii = (/
+    0,0,0,0,1,1,1,1,2,2,2,2,3,3,3,3,4,4,4,4,5,5,5,5,6,6,6,6,
+    8,8,8,8,2,2,0,4,2,2,2,4 /)
      integer j
      integer, parameter, dimension ( 40 ) :: jj = (/
+    2,3,5,7,2,3,5,7,2,3,5,7,2,3,5,7,2,3,5,7,2,3,5,7,2,3,5,7,
+    2,3,5,7,1,4,4,4,0,2,0,0 /)
      integer k
      integer l
      integer nc
      double precision pr
      double precision q10
      double precision q20
      double precision q2a
      double precision q5t
      double precision qm
      double precision qp
      double precision qr(11)
      double precision qt(10)
      double precision rho
      double precision sr
      double precision, parameter :: s_ref = 7.6180720166752D+00
      double precision t
      double precision, parameter :: t_ref = 647.073D+00
      double precision tau
      double precision tx
      double precision, parameter :: u_ref = - 4328.4549774261D+00
      double precision ur
      double precision v
```

```
!
        errtol = sqrt ( epsilon ( errtol ) )
!
!  Refuse to handle zero or negative temperatures.
!
        if ( t <= 0.0D+00 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'RESID - Fatal error!'
          write ( *, '(a)' ) '  The input temperature T must be positive.'
          write ( *, '(a,g14.6)' ) '  Input value was T = ', t
          stop
        end if
!
!  Refuse to handle zero or negative density.
!
        if ( rho <= 0.0D+00 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'RESID - Fatal error!'
          write ( *, '(a)' ) '  The input density RHO must be positive.'
          write ( *, '(a,g14.6)' ) '  Input value was RHO = ', rho
          stop
        end if

        nc = 36
        dpdrr = 0.0D+00
        pr = 0.0D+00
        ar = 0.0D+00
        dadt = 0.0D+00
        cvr = 0.0D+00
        dpdtr = 0.0D+00

        ex0 = - rho
! ex0 = max ( ex0, - 225.0D+00 )
! ex0 = min ( ex0, 225.0D+00 )
        e = exp ( ex0 )

        q10 = rho * rho * e
        q20 = 1.0D+00 - e

        qr(1) = 0.0D+00
        qr(2) = q10
        do i = 2, 10
          qr(i+1) = qr(i) * q20
        end do

        v = t_ref / t
        qt(1) = t / t_ref
        do i = 2, 10
          qt(i) = qt(i-1) * v
        end do

        do i = 1, nc

          k = ii(i) + 1
          l = jj(i)
          qp = g(i) * qr(k+1) * qt(l+1)
```

```
            pr = pr + qp

            dpdrr = dpdrr + (2.0D+00 / rho - (1.0D+00 - e * dble (k - 1)/
     +    ( 1.0D+00 - e ) ) ) * qp

            ar = ar + g(i) * qr(k+2) * qt(l+1) / ( rho**2 * e * dble ( k )
     +      * gascon ( ) * t )

           dfdt =(1.0D+00 - e)**k * dble (1 - l) * qt(l+2) / t_ref / dble (k)

            dadt = dadt + g(i) * dfdt

           dpdtr = dpdtr + g(i) * dfdt * rho**2 * e * dble (k) / (1.0D+00 -e)

            cvr = cvr + g(i) * dble ( l ) * dfdt / gascon()

           end do

           qp = 0.0D+00
           q2a = 0.0D+00

           do j = 37, 40

            k = ii(j)
            ddz = adz(j-36)
            del = rho / ddz - 1.0D+00

            if ( abs ( del ) < errtol ) then
              del = errtol
            end if

            ex1 = - aad(j-36) * del**k
!   ex1 = max ( ex1, - 225.0D+00 )
!   ex1 = min ( ex1, 225.0D+00 )
            dex = exp ( ex1 ) * del**jj(j)

            att = aat(j-36)
            tx = atz(j-36)
            tau = ( t / tx ) - 1.0D+00

            ex2 = - att * tau**2
!   ex2 = max ( ex2, - 225.0D+00 )
!   ex2 = min ( ex2, 225.0D+00 )
            q10 = dex * exp ( ex2 )

            qm = dble ( jj(j) ) / del - dble (k) * aad(j-36) * del**(k-1)
            fct = qm * rho**2 * q10 / ddz

          q5t = fct * (2.0D+00 / rho + qm / ddz) - (rho / ddz)**2 * q10 *
     +( dble ( jj(j) ) / del**2 + dble ( k * ( k - 1 ) ) * aad(j-36) *
     +del**(k-2) )

            dpdrr = dpdrr + q5t * g(j)
            qp = qp + g(j) * fct
            dadt = dadt - 2.0D+00 * g(j) * att * tau * q10 / tx
            dpdtr = dpdtr - 2.0D+00 * g(j) * att * tau * fct / tx
```

```
          q2a = q2a + t * g(j) * att *(4.0D+00 * ex2 + 2.0D+00)* q10 / tx**2

            ar = ar + q10 * g(j) / ( gascon() * t )

          end do

          cvr = cvr + q2a / gascon()
          pr = pr + qp
          sr = - dadt / gascon()
          ur = ar + sr
!
!  Assign dimensions.
!
          ar =  gascon() * t *  ar
          cvr = gascon() *     cvr
          sr =  gascon() *      sr
          ur =  gascon() * t *  ur
!
!  Adjust energies.
!
          ar = ar + gascon ( ) * t * s_ref - gascon ( ) * u_ref
          sr = sr - gascon ( ) * s_ref
          ur = ur - gascon ( ) * u_ref

          gr = ar + pr / rho
          hr = ur + pr / rho

          return
        end
!*******************************************************************************************
          subroutine secvir ( t, vir )
!
!*******************************************************************************
!
!! SECVIR calculates the second virial coefficient at a given temperature.
!
!
!  Discussion:
!
!    The second virial coefficient VIR appears in the first correction term
!    to the ideal gas equation of state:
!
!      P = R * T / volume + VIR / volume**2 + ...
!
!  Modified:
!
!    28 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
```

```
!   TJ270.H3
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Output, double precision VIR, the second virial coefficient, in CM3/G.
!
            implicit none
!
            double precision b1
            double precision b1t
            double precision b1tt
            double precision b2
            double precision b2t
            double precision b2tt
            double precision, parameter, dimension ( 5 ) :: g = (/
     +-0.53062968529023D+03,0.22744901424408D+04, -0.26627944829770D+04,
     +    0.78779333020687D+03, -0.69830527374994D+02 /)
            double precision gascon
            double precision t
            double precision, parameter :: t_ref = 647.073D+00
            double precision v
            double precision vir
!
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'SECVIR - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if

            call bb ( t, b1, b2, b1t, b2t, b1tt, b2tt )

            v = t_ref / t

            vir = b2 + (
     +      v    * ( g(1)
     +    + v    * ( g(2)
     +    + v    * ( g(3)
     +    + v    * ( g(4)
     +    + v**2 *   g(5) )))))
     +    / ( gascon ( ) * t )

            return
          end
*******************************************************************************
          subroutine secvir_values ( n, tc, vir )
!
```

```
!*****************************************************************************
!
!! SECVIR_VALUES returns some values of the second virial coefficient.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, pages 24-25.
!
!  Modified:
!
!    03 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision TC, the temperature, in degrees Celsius.
!
!    Output, double precision VIR, the second virial coefficient, in
!    m^3/kg.
!
            implicit none
!
            integer, parameter :: nmax = 19
!
            integer n
            double precision tc
            double precision, save, dimension ( nmax ) :: tcvec = (/
     +  0.0D+00,    5.0D+00,   10.0D+00,   20.0D+00,   30.0D+00,
     + 40.0D+00,   60.0D+00,   90.0D+00,  120.0D+00,  150.0D+00,
     +180.0D+00,  210.0D+00,  240.0D+00,  300.0D+00,  400.0D+00,
     +500.0D+00,  700.0D+00, 1000.0D+00, 2000.0D+00 /)
            double precision vir
            double precision, save, dimension ( nmax ) :: virvec = (/
     +    -98.96D+00, -90.08D+00, -82.29D+00, -69.36D+00, -59.19D+00,
     +    -51.07D+00, -39.13D+00, -27.81D+00, -20.83D+00, -16.21D+00,
     +    -12.98D+00, -10.63D+00,  -8.85D+00,  -6.39D+00,  -4.03D+00,
     +     -2.71D+00,  -1.32D+00,  -0.39D+00,   0.53D+00 /)
!
            if ( n < 0 ) then
              n = 0
            end if
```

```
            if ( n >= nmax ) then
              n = 0
              tc = 0.0D+00
              vir = 0.0D+00
            else
              n = n + 1
              tc = tcvec(n)
              vir = virvec(n)
            end if

            return
          end
**************************************************************************************
          subroutine sound ( t, p, c )
!
!*******************************************************************************
!
!! SOUND computes the speed of sound given temperature and pressure.
!
!
!  Modified:
!
!    22 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Input, double precision P, the pressure, in MegaPascals.
!
!    Output, double precision C, the speed of sound, in m/s.
!
            implicit none
!
            double precision ab
            double precision ai
            double precision ar
            double precision c
            double precision cp
            double precision cpi
            double precision cv
            double precision cvb
```

```
            double precision cvi
            double precision cvr
            double precision dpdr
            double precision dpdrb
            double precision dpdrr
            double precision dpdt
            double precision dpdtb
            double precision dpdtr
            double precision gb
            double precision gi
            double precision gr
            double precision hb
            double precision hi
            double precision hr
            double precision p
            double precision pb
            double precision pr
            double precision rho
            double precision rhol
            double precision rho_start
            double precision rhov
            double precision sb
            double precision si
            double precision sr
            double precision t
            double precision t2
            double precision ub
            double precision ui
            double precision ur
          !
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'SOUND - Fatal error!'
              write ( *, '(a)' ) '  The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if
!
!  Refuse to handle zero or negative pressures.
!
            if ( p <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'SOUND - Fatal error!'
              write ( *, '(a)' ) '  The input pressure P must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was P = ', p
              stop
            end if
!
!  For the given pressure, compute the saturation temperature.
!
            rhol = 0.0D+00
            rhov = 0.0D+00

            call tsat ( t2, p, rhol, rhov )
```

```
!
!  Depending on whether the temperature is above or below the
!  saturation temperature, we expect to compute the density of
!  a liquid or vapor.
!
            if ( t < t2 ) then
              rho_start = 1.9D+00
            else
              rho_start = 0.01D+00
            end if

            call dense ( p, t, rho_start, rho, dpdr )
!
!  From T and RHO, compute the thermodynamic properties.
!
            call ideal ( t, ai, cpi, cvi, gi, hi, si, ui )

            call resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur )

            call base ( t, rho, ab, cvb, dpdrb, dpdtb, gb, hb, pb, sb, ub )

            cv =     cvb +   cvr + cvi
            dpdr = dpdrb + dpdrr
            dpdt = dpdtb + dpdtr

            cp = cv + t * dpdt**2 / ( dpdr * rho**2 )

            c = sqrt ( 1000.0D+00 * cp * dpdr / cv )

            return
          end
!*******************************************************************************
          subroutine sound_values ( n, tc, p, c )
!
!*******************************************************************************
!
!! SOUND_VALUES returns some values of the speed of sound.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, page 238-246.
!
!  Modified:
!
!    04 February 2002
!
!  Author:
!
!    John Burkardt
!
```

```
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision TC, the temperature, in degrees Celsius.
!
!    Output, double precision P, the pressure, in bar.
!
!    Output, double precision C, the speed of sound, in m/s.
!
          implicit none
!
          integer, parameter :: nmax = 20
!
          double precision c
          double precision, save, dimension ( nmax ) :: cvec = (/
     +    1401.0D+00,  472.8D+00, 533.7D+00, 585.7D+00, 609.5D+00,
     +     632.2D+00,  674.6D+00, 713.9D+00, 802.0D+00, 880.1D+00,
     +    1017.8D+00, 1115.9D+00, 1401.7D+00,1402.6D+00, 1409.6D+00,
     +    1418.1D+00, 1443.1D+00, 1484.6D+00, 1577.1D+00, 1913.4D+00 /)
          integer n
          double precision p
          double precision, save, dimension ( nmax ) :: pvec = (/
     +     1.0D+00,   1.0D+00,   1.0D+00,    1.0D+00,    1.0D+00,
     +     1.0D+00,   1.0D+00,   1.0D+00,    1.0D+00,    1.0D+00,
     +     1.0D+00,   1.0D+00,   5.0D+00,  10.0D+00,    50.0D+00,
     +    100.0D+00, 250.0D+00, 500.0D+00, 1000.0D+00, 2500.0D+00 /)
          integer nn
          double precision tc
          double precision, save, dimension ( nmax ) :: tcvec = (/
     +      0.0D+00,  100.0D+00,  200.0D+00,  300.0D+00,  350.0D+00,
     +     400.0D+00,  500.0D+00,  600.0D+00,  850.0D+00, 1100.0D+00,
     +    1600.0D+00, 2000.0D+00,    0.0D+00,    0.0D+00,    0.0D+00,
     +      0.0D+00,    0.0D+00,    0.0D+00,    0.0D+00,    0.0D+00 /)
!
          if ( nn < 0 ) then
            nn = 0
          end if

          if ( nn >= nmax ) then
            nn = 0
            tc = 0.0D+00
            p = 0.0D+00
            c = 0.0D+00
          else
            nn = nn + 1
            tc = tcvec(nn)
            p = pvec(nn)
            c = cvec(nn)
          end if

          return
```

```
      end
********************************************************************************
      subroutine surten ( t, sigma )
!
!*******************************************************************************
!
!! SURTEN returns the surface tension as a function of temperature.
!
!
!  Discussion:
!
!    SURTEN uses an equation that yields values of the surface tension to
!    within the accuracy of measurements from the triple point to the
!    critical point.
!
!      Sigma = B * ( (TSTAR-T)/TSTAR)**Mu * (1+b*(TSTAR-T)/TSTAR)
!
!    where:
!
!      TSTAR = 647.15 Degrees Kelvin,
!      B = 0.2358 Pascals * Meters
!      b = -0.625,
!      Mu = 1.256.
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Output, double precision SIGMA, the surface tension,
!    in Pascal * m = Newton / m.
!
      implicit none
!
      double precision, parameter :: b_cap = 0.2358D+00
      double precision, parameter :: b_small = -0.625D+00
      double precision, parameter :: mu = 1.256D+00
      double precision sigma
      double precision t
      double precision, parameter :: t_star = 647.15D+00
      double precision term
!
!  Refuse to handle zero or negative temperatures.
!
```

```
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'SURTEN - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if

            term = ( t_star - t ) / t_star
            sigma = b_cap * term**mu * ( 1.0D+00 + b_small * term )
!
!djm The following comment is incorrect for units given in output table
!djm Removed conversion to obtain sigma in listed output units of (Pa M).
!
!  Need this conversion to match the table, but justification is there none.
!
!djm         sigma = 1000.0D+00 * sigma

            return
          end
********************************************************************************
          subroutine surten_values ( n, tc, sigma )
!
!*******************************************************************************
!
!! SURTEN_VALUES returns some values of the surface tension.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, pages 267.
!
!  Modified:
!
!    04 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision TC, the temperature, in degrees Celsius.
!
!    Output, double precision SIGMA, the surface tension,
```

```
!    in Pascal * m = Newton / m.
!
            implicit none
!
            integer, parameter :: nmax = 14
!
            integer n
            double precision sigma
            double precision, save, dimension ( nmax ) :: sigmavec = (/
     +    74.22D+00, 72.74D+00, 71.20D+00, 69.60D+00, 67.95D+00,
     +    58.92D+00, 48.75D+00, 37.68D+00, 26.05D+00, 14.37D+00,
     +     8.78D+00,  3.67D+00,  0.40D+00,  0.0D+00 /)
            double precision tc
            double precision, save, dimension ( nmax ) :: tcvec = (/
     +     10.0D+00,  20.0D+00,  30.0D+00,  40.0D+00,   50.0D+00,
     +    100.0D+00, 150.0D+00, 200.0D+00, 250.0D+00,  300.0D+00,
     +    325.0D+00, 350.0D+00, 370.0D+00, 373.976D+00 /)
!
            if ( n < 0 ) then
              n = 0
            end if

            if ( n >= nmax ) then
              n = 0
              tc = 0.0D+00
              sigma = 0.0D+00
            else
              n = n + 1
              tc = tcvec(n)
              sigma = sigmavec(n)
            end if

            return
          end
******************************************************************************************
          subroutine tdpsdt ( t, dp )
!
!*****************************************************************************
!
!! TDPSDT computes the quantity T * dP(Sat)/dT.
!
!
!  Discussion:
!
!    Here T is the temperature and P(Sat) is the vapor pressure.
!    It is used by TSAT_EST and TSAT.
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
```

```
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Output, double precision DP, the value T*(dP(Sat)/dT),
!   in MegaPascals.
!
            implicit none
!
            double precision, parameter, dimension ( 8 ) :: a = (/
     + -7.8889166D+00,  2.5514255D+00,  -6.716169D+00, 33.239495D+00,
     + -105.38479D+00,  174.35319D+00,  -148.39348D+00, 48.631602D+00 /)
            double precision b
            double precision c
            double precision dp
            integer i
            double precision q
            double precision t
            double precision, parameter :: t_ref = 647.25D+00
            double precision v
            double precision w
            double precision y
            double precision z
!
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'TDPSDT - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if

            v = t / t_ref
            w = 1.0D+00 - v
            b = 0.0D+00
            c = 0.0D+00
            do i = 1, 8
              z = dble ( i + 1 ) / 2.0D+00
              y = a(i) * w**z
              c = c + (y / w) * (0.5D+00 - 0.5D+00 * dble (i) - 1.0D+00 / v)
              b = b + y
            end do

            q = b / v
            dp = 22.093D+00 * exp ( q ) * c

            return
          end
*******************************************************************************
          subroutine thercon ( t, rho, lambda )
```

```
!
!*****************************************************************************
!
!! THERCON calculates the thermal conductivity for given temperature and density.
!
!
!  Modified:
!
!    20 November 1998
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision T, the temperature, in degrees Kelvin.
!
!    Input, double precision RHO, the density, in G/CM3.
!
!    Output, double precision LAMBDA, the thermal conductivity,
!    in mW/(m degrees Kelvin).
!
            implicit none
!
            double precision a
            double precision, parameter, dimension ( 0:3 ) :: acof = (/
     +    2.02223D+00, 14.11166D+00, 5.25597D+00, -2.01870D+00 /)
            double precision, parameter :: a_con = 18.66D+00
            double precision b(0:4,0:5)
            double precision, parameter :: b_con = 1.00D+00
            double precision, parameter :: c_con = 3.7711D-08
            double precision chi
            double precision cjth
            double precision cjtt
            double precision cp
            double precision cv
            double precision dpdr
            double precision dpdr2
            double precision dpdt
            double precision eta
            double precision g
            double precision h
            integer i
            integer j
            double precision lambda
            double precision lambda0
```

```
            double precision lambda_del
            double precision, parameter :: omega = 0.4678D+00
            double precision p
            double precision, parameter :: p_ref = 22.115D+00
            double precision power
            double precision rho
            double precision, parameter :: rho_ref = 317.763D+00
            double precision rho2
            double precision s
            double precision t
            double precision, parameter :: t_ref = 647.27D+00
            double precision total
            double precision u
!
            data b /
     +    1.3293046D+00,    1.7018363D+00,   5.2246158D+00,
     +    8.7127675D+00, -1.8525999D+00,
     +   -0.40452437D+00,  -2.2156845D+00, -10.124111D+00,
     +   -9.5000611D+00,  0.93404690D+00,
     +    0.24409490D+00,   1.6511057D+00,   4.9874687D+00,
     +    4.3786606D+00,  0.0D+00,
     +    0.018660751D+00, -0.76736002D+00, -0.27297694D+00,
     +    -0.91783782D+00, 0.0D+00,
     +    -0.12961068D+00,  0.37283344D+00, -0.43083393D+00,
     +     0.0D+00,        0.0D+00,
     +    0.044809953D+00, -0.11203160D+00,  0.13333849D+00,
     +    0.0D+00,        0.0D+00 /
!
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'THERCON - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was T = ', t
              stop
            end if
!
!  Refuse to handle zero or negative density.
!
            if ( rho <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'THERCON - Fatal error!'
              write ( *, '(a)' ) ' The input density RHO must be positive.'
              write ( *, '(a,g14.6)' ) '  Input value was RHO = ', rho
              stop
            end if
!
!  Compute DPDR, DPDT, ETA.
!
            call therm ( t, rho, a, cjth, cjtt, cp, cv, dpdr, dpdt, g, h, p,
     +  s, u )

            call viscosity ( t, rho, eta )
!
!  Convert RHO from G/CM3 to kg/M3,
```

```
!  Convert DPDR from ? to ?.
!
            rho2 = 1000.0D+00 * rho
            dpdr2 = dpdr / 1000.0D+00
!
!  Compute LAMBDA0.
!
            total = 0.0D+00
            do i = 0, 3
              total = total + acof(i) * ( t_ref / t )**i
            end do

            lambda0 = sqrt ( t / t_ref ) / total
!
!  Compute CHI.
!
            chi = rho2 * p_ref / ( rho_ref**2 * dpdr2 )
!
!  Compute delta_Lambda
!
            power = - a_con *((t_ref - t) / t)**2 - b_con *((rho2 - rho_ref)
     +    / rho_ref )**4

           lambda_del = (c_con / eta) * ((t * rho_ref) / (t_ref * rho))**2
     + *(t_ref / p_ref)**2 * dpdt**2 * chi**omega * sqrt(rho2 / rho_ref)
     + *exp ( power )
!
!  Compute LAMBDA.
!
            total = 0.0D+00
            do i = 0, 4
              do j = 0, 5
      total = total + b(i,j) * ( ( t_ref - t ) / t )**i *
     +(( rho2 - rho_ref ) / rho_ref )**j
              end do
            end do

            lambda = lambda0 * exp ((rho2 / rho_ref) * total) + lambda_del
!
!  Temporary fix.
!
            lambda = 1000.0D+00 * lambda

            return
          end
******************************************************************************************
          subroutine thercon_values ( n, tc, p, lambda )
!
!*****************************************************************************
!
!! THERCON_VALUES returns some values of the thermal conductivity.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
```

```
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3, page 264.
!
! Modified:
!
!   04 February 2002
!
! Author:
!
!   John Burkardt
!
! Parameters:
!
!   Input/output, integer N.
!   On input, if N is 0, the first test data is returned, and N is set
!   to the index of the test data.  On each subsequent call, N is
!   incremented and that test data is returned.  When there is no more
!   test data, N is set to 0.
!
!   Output, double precision TC, the temperature, in degrees Celsius.
!
!   Output, double precision P, the pressure, in bar.
!
!   Output, double precision LAMBDA, the thermal conductivity, in
!   mW/(m degrees Kelvin).
!
      implicit none
!
      integer, parameter :: nmax = 35
!
      integer n
      double precision p
      double precision lambda
      double precision, save, dimension ( nmax ) :: lambdavec = (/
     +  561.0D+00, 561.3D+00, 561.5D+00, 562.4D+00,  563.7D+00,
     +  565.1D+00, 566.5D+00, 567.9D+00, 569.3D+00,  570.6D+00,
     +  572.0D+00, 573.4D+00, 574.8D+00, 576.1D+00,  577.5D+00,
     +  580.2D+00, 582.9D+00, 585.5D+00, 588.1D+00,  590.7D+00,
     +  593.3D+00, 595.8D+00, 598.3D+00, 603.1D+00,  607.8D+00,
     +  612.2D+00, 607.2D+00, 643.6D+00, 666.8D+00,   25.08D+00,
     +  28.85D+00,  33.28D+00, 54.76D+00, 79.89D+00, 107.3D+00 /)
      double precision, save, dimension ( nmax ) :: pvec = (/
     +    1.0D+00,    5.0D+00,   10.0D+00,   25.0D+00,   50.0D+00,
     +   75.0D+00,  100.0D+00,  125.0D+00,  150.0D+00,  175.0D+00,
     +  200.0D+00,  225.0D+00,  250.0D+00,  275.0D+00,  300.0D+00,
     +  350.0D+00,  400.0D+00,  450.0D+00,  500.0D+00,  550.0D+00,
     +  600.0D+00,  650.0D+00,  700.0D+00,  800.0D+00,  900.0D+00,
     + 1000.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,
     +    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00 /)
      integer nn
      double precision tc
      double precision, save, dimension ( nmax ) :: tcvec = (/
     +  0.0D+00,    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
```

```
     +   0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +   0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +   0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +   0.0D+00,     0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +   0.0D+00,    25.0D+00,  50.0D+00,  75.0D+00, 100.0D+00,
     +   150.0D+00, 200.0D+00, 400.0D+00, 600.0D+00, 800.0D+00 /)
!
           if ( nn < 0 ) then
              nn = 0
            end if

            if ( nn >= nmax ) then
              nn = 0
              tc = 0.0D+00
              p = 0.0D+00
              lambda = 0.0D+00
            else
              nn = nn + 1
              tc = tcvec(nn)
              p = pvec(nn)
              lambda = lambdavec(nn)
            end if

            return
           end
*******************************************************************************
           subroutine therm (t, rho, a, cjth, cjtt, cp, cv, dpdr, dpdt, g, h,
     + p, s, u)
!
!******************************************************************************
!
!! THERM calculates thermodynamic functions given temperature and density.
!
!
!  Discussion:
!
!    Thermodynamic values were calculated from an analytic equation
!    that approximates the Helmholtz function (specific Helmholtz
!    energy) for ordinary water and steam, of the form A=A(rho,T)
!    where A is the Helmholtz function, rho the density, and T
!    the absolute (thermodynamic) temperature.  Any thermodynamic
!    value for any state, liquid, vapor or metastable, may be
!    calculated by differentiation of this equation in accord with
!    the first and second laws of thermodynamics.
!
!    The International Association for the Properties of Steam
!    has provisionally accepted this formulation for the range
!    273.15 <= T <= 1273.15 degrees Kelvin, where, for 423.15 <= T,
!    the maximum pressure is Pmax = 1500 MPa = 15000 bar, and for
!    273.15 <= T < 423.15, the maximum pressure is
!    Pmax = 100 * (5 + (T-273.15)/15) MPa.
!
!    Close to the critical point, a small region is excluded:
!    Abs(T-Tk) < 1, abs((rho-rhok)/rhok) < 0.3.
!
!    The equation has a wider useful range, namely, fluid states
```

```
!   of pure, undissociated water and steam defined by
!   260 <= T <= 2500 K and 0 <= P <= 3000 MPa.
!
!   Thermodynamic property values for specific volume, density,
!   specific internal energy, specific enthalpy, and specific
!   entropy of water and steam were tabulated over the range
!   0 <= t <= 2000 C, 0 <= P <= 3000 MPa.  The reference
!   state is the liquid at the triple point, for which the
!   internal energy and entropy have been assigned the value zero.
!
!   Thermodynamic quantities are determined from the Helmholtz function
!   A(rho,T), which is computed as the sum of three terms:
!
!     A(rho,T) = A(base)(rho,T) + A(residual)(rho,T) + A(ideal)(T)
!                                        (Equation 1)
!
!   Because A(rho,T) is everywhere single valued and analytic,
!   we can derive closed form relations for all other properties.
!   In the following, unless otherwise indicated, the independent
!   variables are temperature T and density RHO, and differentiation
!   with respect to one variable is to imply that the other is fixed.
!
!   Pressure:                P       = RHO**2 * dA/dRHO
!   Density derivative:      dP/dRHO = 2*P/RHO + RHO**2 * d2A/dRHO2
!   Temperature derivative:  dP/dT   = RHO**2 * d2A/(dRHO dT)
!   Specific entropy:        S       = - dA/dT
!   Specific internal energy: U      = A + T*S
!   Specific enthalpy:       H       = U + P/RHO
!   Specific heat capacity
!     at constant volume:    Cv      = - T * d2A/dT2
!   Specific Gibbs function: G       = A + P/RHO
!   Specific heat capacity
!     at constant pressure:  Cp      = Cv + (T*(dP/dT)**2)/(RHO**2*dP/dRHO)
!   Speed of sound:          Omega   = Sqrt ((Cp/Cv) * dP/dRHO)
!   Second virial coefficient: B     = 1/(2*R*T) * (d2P/dRHO2) (at RHO=0)
!   Isothermal Joule-Thomson
!     coefficient:           DeltaT  = (dH/dP) (fixed T) =
!                                (1/RHO)-(T*dP/dT)/(RHO**2*dP/dRHO)
!   Joule-Thomson coefficient: Mu    = (dT/dP) (fixed H) = DeltaT/Cp
!   Isentropic temperature-
!     pressure coefficient:  BetaS   = (dT/dP) (fixed S) =
!                                (DeltaT - 1/RHO)/Cp
!
!  Modified:
!
!   19 November 1998
!
!  Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
```

```
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Input, double precision RHO, the fluid density, in G/CM3.
!
!   Output, double precision A, the Helmholtz function, in KJ/kg.
!
!   Output, double precision CJTH, the Joule-Thomson coefficient,
!   in K/MegaPascals.
!
!   Output, double precision CJTT, the isothermal Joule-Thomson coefficient,
!   in CM3/G.
!
!   Output, double precision CP, the isobaric (constant pressure) heat
!   capacity, in KJ/(kg degrees Kelvin).
!
!   Output, double precision CV, the isochoric (constant volume) heat capacity,
!   in KJ/(kg degrees Kelvin).
!
!   Output, double precision DPDR, the partial derivative
!   dP(T,RHO)/dRHO, with T held fixed, in MegaPascals*CM3/G.
!
!   Output, double precision DPDT, the partial derivative
!   dP(T,RHO)/dT, with RHO held fixed, in MegaPascals/degrees Kelvin.
!
!   Output, double precision G, the Gibbs free energy, in KJ/kg.
!
!   Output, double precision H, the enthalpy, in KJ/kg.
!
!   Output, double precision P, the pressure, in MegaPascals.
!
!   Output, double precision S, the entropy, in KJ/(kg degrees Kelvin).
!
!   Output, double precision U, the internal energy, in KJ/kg.
!
        implicit none
!
        double precision a
        double precision ab
        double precision ai
        double precision ar
        double precision cjth
        double precision cjtt
        double precision cp
        double precision cpi
        double precision cv
        double precision cvb
        double precision cvi
        double precision cvr
        logical, parameter :: debug = .false.
        double precision dpdr
```

```
      double precision dpdrb
      double precision dpdrr
      double precision dpdt
      double precision dpdtb
      double precision dpdtr
      double precision g
      double precision gb
      double precision gi
      double precision gr
      double precision h
      double precision hb
      double precision hi
      double precision hr
      double precision p
      double precision pb
      double precision pr
      double precision rho
      double precision s
      double precision sb
      double precision si
      double precision sr
      double precision t
      double precision u
      double precision ub
      double precision ui
      double precision ur
!
!  Refuse to handle zero or negative temperatures.
!
      if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'THERM - Fatal error!'
        write ( *, '(a)' ) 'The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  Input value was T = ', t
        stop
      end if
!
!  Refuse to handle zero or negative density.
!
      if ( rho <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'THERM - Fatal error!'
        write ( *, '(a)' ) ' The input density RHO must be positive.'
        write ( *, '(a,g14.6)' ) '  Input value was RHO = ', rho
        stop
      end if

      call ideal ( t, ai, cpi, cvi, gi, hi, si, ui )

      call resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur)

      call base ( t, rho, ab, cvb, dpdrb, dpdtb, gb, hb, pb, sb, ub)

      a =      ab +    ar +  ai
      cv =     cvb +   cvr + cvi
```

```
            if ( debug ) then
              write ( *, * ) ' '
              write ( *, * ) 'THERM:'
              write ( *, * ) '  CVB = ', cvb
              write ( *, * ) '  CVR = ', cvr
              write ( *, * ) '  CVI = ', cvi
              write ( *, * ) '  CV  = ', cv
            end if

            dpdr = dpdrb + dpdrr
            dpdt = dpdtb + dpdtr
            p =       pb +    pr
            s =       sb +    sr +  si
            u =       ub +    ur +  ui

            if ( debug ) then
              write ( *, * ) ' '
              write ( *, * ) 'THERM:'
              write ( *, * ) '  UB = ', ub
              write ( *, * ) '  UR = ', ur
              write ( *, * ) '  UI = ', ui
            end if

            g = a + p / rho
            h = u + p / rho
            cp = cv + t * dpdt**2 / ( dpdr * rho**2 )
            cjtt = 1.0D+00 / rho - t * dpdt / ( dpdr * rho**2 )
            cjth = - cjtt / cp

            return
          end
!*****************************************************************************************
          subroutine timestamp ( )
!
!*****************************************************************************
!
!! TIMESTAMP prints the current YMDHMS date as a time stamp.
!
!
!  Example:
!
!    May 31 2001   9:45:54.872 AM
!
!  Modified:
!
!    31 May 2001
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    None
!
            implicit none
```

```
!
            character ( len = 8 ) ampm
            integer d
            character ( len = 8 ) date
            integer h
            integer m
            integer mm
            character ( len = 9 ), parameter, dimension(12) :: month = (/
     +   'January  ', 'February ', 'March    ', 'April    ',
     +   'May      ', 'June     ', 'July     ', 'August   ',
     +   'September', 'October  ', 'November ', 'December ' /)
            integer n
            integer s
            character ( len = 10 )  time
            integer values(8)
            integer y
            character ( len = 5 ) zone
!
            call date_and_time ( date, time, zone, values )

            y = values(1)
            m = values(2)
            d = values(3)
            h = values(5)
            n = values(6)
            s = values(7)
            mm = values(8)

            if ( h < 12 ) then
              ampm = 'AM'
            else if ( h == 12 ) then
              if ( n == 0 .and. s == 0 ) then
                ampm = 'Noon'
              else
      ampm = 'PM'
              end if
            else
              h = h - 12
              if ( h < 12 ) then
                ampm = 'PM'
              else if ( h == 12 ) then
                if ( n == 0 .and. s == 0 ) then
                  ampm = 'Midnight'
                else
                  ampm = 'AM'
                end if
              end if
            end if

            write ( *, '(a,1x,i2,1x,i4,2x,i2,a1,i2.2,a1,i2.2,a1,i3.3,1x,a)')
     +    trim (month(m)), d, y, h, ':', n, ':', s, '.', mm, trim(ampm)

            return
          end
*******************************************************************************************
          subroutine tsat ( t, p, rhol, rhov )
```

```
!
!*****************************************************************************
!
!! TSAT calculates the saturation temperature for a given pressure.
!
!
!  Discussion:
!
!    The corresponding liquid and vapor densities are also computed.
!    The saturation temperature is also known as the "vapor temperature".
!
!  Modified:
!
!    04 February 2002
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision P, the vapor pressure, in MegaPascals.
!
!    Output, double precision T, the vapor temperature, in degrees Kelvin.
!
!    Output, double precision RHOL, the liquid density, in G/CM3.
!
!    Output, double precision RHOV, the vapor density, in G/CM3.
!
      implicit none
!
      logical, parameter :: debug = .false.
      double precision delg
      double precision dp
      double precision dp2
      double precision errtol
      double precision gascon
      integer it
      integer, parameter :: it_max = 50
      double precision p
      double precision p_consistent
      double precision rhol
      double precision rhov
      double precision t
!
!  Initialize output quantities, obliterating any input value.
!
```

```
        t = 0.0D+00
        rhol = 0.0D+00
        rhov = 0.0D+00
!
!  Set the error tolerance.
!
        errtol = sqrt ( epsilon ( errtol ) )
!
!  Refuse to handle zero or negative pressure.
!
        if ( p <= 0.00000000D+00 ) then
          write ( *, '(a)' ) ' '
          write ( *, '(a)' ) 'TSAT - Fatal error!'
          write ( *, '(a)' ) '  The input pressure must be positive!'
          write ( *, '(a,g14.6)' ) '  Your value was P = ', p
          stop
        end if
!
!  Estimate the saturation temperature.
!
        call tsat_est ( p, t )

        if ( debug ) then
          write ( *, * ) ' '
          write ( *, * ) 'TSAT:'
          write ( *, '(2g14.6)' ) p, t, rhol, rhov
        end if

        do it = 1, it_max

          call corr ( t, p, p_consistent, rhol, rhov, delg )

          dp = delg * gascon ( ) * t  * rhol * rhov / ( rhol - rhov )

          call tdpsdt ( t, dp2 )

          t = t * ( 1.0D+00 - dp / dp2 )

          if ( debug ) then
            write ( *, '(2g14.6)' ) p, t, rhol, rhov
          end if

          if ( abs ( delg ) < errtol ) then
            return
          end if

        end do

        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'TSAT - Warning!'
        write ( *, '(a)' ) '  The iteration did not converge.'
        write ( *, '(a,i6)' ) '  Number of iterations was ', it_max
        write ( *, '(a,g14.6)' ) '  Last iterate was ', t
        write ( *, '(a,g14.6)' ) '  Last DELG was ', delg

        return
```

```
      end
********************************************************************************
      subroutine tsat_est ( p, t )
!
!*******************************************************************************
!
!! TSAT_EST makes a rough estimate of the saturation temperature.
!
!
!  Discussion:
!
!    The saturation temperature is also called the vapor temperature.
!
!  Modified:
!
!    02 February 2002
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3
!
!    C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!    ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!    American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!    Input, double precision P, the pressure, in MegaPascals.  The tabulated
!    range for P is
!      0.00061173 MegaPascals <= P <= P_CRIT = 22.055 MegaPascals.
!    The input value of P must be positive.
!
!    Output, double precision T, the saturation temperature,
!    in degrees Kelvin.  This value will always be in the range
!    [ 273.15, 647.126 ].
!
      implicit none
!
      integer, parameter :: npol = 4
!
      double precision, parameter, dimension ( 0:npol ) :: c = (/
     + 372.83D+00, 27.7589D+00, 2.3819D+00, 0.24834D+00, 0.0193855D+00/)
      double precision dp
      double precision dt
      double precision errtol
      integer it
      integer, parameter :: it_max = 8
      double precision p
      double precision pl
      double precision, parameter :: p_crit = 22.055D+00
      double precision pp
```

```
      double precision t
      double precision, parameter :: t_crit = 647.126D+00
      double precision, parameter :: t_min = 273.15D+00
      double precision t_old
!
      errtol = sqrt ( epsilon ( errtol ) )
!
!  Refuse to handle zero or negative pressure.
!
      if ( p <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'TSAT_EST - Fatal error!'
        write ( *, '(a)' ) '  The input pressure must be positive!'
        write ( *, '(a,g14.6)' ) '  Your value was P = ', p
        stop
      end if

      if ( p > p_crit ) then
        t = t_crit
        return
      end if
!
!  The initial estimate for T uses a polyonmial in the logarithm of P.
!
      pl = 2.302585D+00 + log ( p )

      call dpoly_val_horner ( npol, c, pl, t )

      t = min ( t, t_crit )
      t = max ( t, t_min )

      dt = 0.0D+00

      do it = 1, it_max

        call psat_est ( t, pp )

        call tdpsdt ( t, dp )

        if ( abs ( p - pp ) < errtol * p ) then
          return
        end if

        dt = t * ( p - pp ) / dp

        t_old = t
        t = t * ( 1.0D+00 + ( p - pp ) / dp )
        t = min ( t, t_crit )
        t = max ( t, t_min )

        if ( abs ( dt ) < errtol * ( abs ( t ) + 1.0D+00 ) ) then
          return
        else if ( abs ( t - t_old ) < errtol ) then
          return
        end if
```

```
            end do

            write ( *, '(a)' ) ' '
            write ( *, '(a)' ) 'TSAT_EST - Warning!'
            write ( *, '(a)' ) '  The iteration did not converge.'
            write ( *, '(a,i6)' ) '  Number of iterations was ', it_max
            write ( *, '(a,g14.6)' ) '  Convergence tolerance was ', errtol
            write ( *, '(a,g14.6)' ) '  Last iterate was ', t
            write ( *, '(a,g14.6)' ) '  Last correction was ', dt

            return
          end
********************************************************************************
          subroutine tsat_values ( n, p, tc )
!
!*******************************************************************************
!
!! TSAT_VALUES returns some values of the saturation temperature.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, pages 16-22.
!
!  Modified:
!
!    05 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision P, the pressure, in bar.
!
!    Output, double precision TC, the saturation temperature, in
!    degrees Celsius.
!
          implicit none
!
          integer, parameter :: nmax = 20
!
          integer n
          double precision p
```

```
            double precision, save, dimension ( nmax ) :: pvec = (/
     +  0.0061173D+00,  0.012D+00,   0.025D+00,  0.055D+00,  0.080D+00,
     +  0.11D+00,       0.16D+00,    0.25D+00,   0.50D+00,   0.75D+00,
     +  1.0D+00,        1.5D+00,   2.0D+00,      5.0D+00,   10.0D+00,
     +  20.0D+00,      50.0D+00, 100.0D+00,    200.0D+00,  220.55D+00 /)
            double precision tc
            double precision, save, dimension ( nmax ) :: tcvec = (/
     +  0.010D+00,  9.655D+00,   21.080D+00,  34.589D+00,  41.518D+00,
     + 47.695D+00, 55.327D+00,   64.980D+00,  81.339D+00,  91.783D+00,
     + 99.632D+00, 111.378D+00, 120.443D+00, 151.866D+00, 179.916D+00,
     +212.417D+00, 263.977D+00, 311.031D+00, 365.800D+00, 373.976D+00 /)
!
            if ( n < 0 ) then
              n = 0
            end if

            if ( n >= nmax ) then
              n = 0
              p = 0.0D+00
              tc = 0.0D+00

            else
              n = n + 1
              p = pvec(n)
              tc = tcvec(n)
            end if

            return
          end
******************************************************************************************
          subroutine viscosity ( t, rho, eta )
!
!*****************************************************************************
!
!! VISCOSITY calculates the viscosity for given temperature and density.
!
!
!  Discussion:
!
!    On 02 February 2002, I discovered that the Haar/Gallagher/Kell
!    reference apparently reversed the sign on the A3 coefficient.
!    That made the results better, but still off.
!
!    Apparently Haar/Gallagher/Kell had a transcription error in
!    the value of B(4,1), which they list as -0.273093, but which
!    should be -0.253093.
!
!    These two corrections courtesy of Meyer/McClintock/Silvestri/Spencer.
!
!    Now the results look proper!  And just 12 years late...
!
!  Modified:
!
!    02 February 2002
!
!  Reference:
```

```
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
!   International Association for the Properties of Steam,
!   Release on Dynamic Viscosity of Water Substance,
!   National Bureau of Standards, Washington DC, 1975, revised 1983.
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers,
!   Fifth Edition, 1983,
!   TJ270.A75.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Input, double precision RHO, the density, in G/CM3.
!
!   Output, double precision ETA, the viscosity, in MegaPascal seconds.
!
            implicit none
!
            integer, parameter :: npol_t = 3
!
            double precision, parameter, dimension ( 0:npol_t ) :: a = (/
     +    0.0181583D+00, 0.0177624D+00, 0.0105287D+00, -0.0036744D+00 /)
            double precision arg
            double precision, dimension(0:5,0:4) :: b = reshape ( (/
     +    0.501938D+00,   0.162888D+00,  -0.130356D+00,
     +    0.907919D+00,  -0.551119D+00,   0.146543D+00,
     +    0.235622D+00,   0.789393D+00,   0.673665D+00,
     +    1.207552D+00,   0.0670665D+00, -0.0843370D+00,
     +   -0.274637D+00,  -0.743539D+00,  -0.959456D+00,
     +   -0.687343D+00,  -0.497089D+00,   0.195286D+00,
     +    0.145831D+00,   0.263129D+00,   0.347247D+00,
     +    0.213486D+00,   0.100754D+00,  -0.032932D+00,
     +   -0.0270448D+00, -0.0253093D+00, -0.0267758D+00,
     +   -0.0822904D+00,  0.0602253D+00, -0.0202595D+00 /),
     +    (/ 6,5 /) )
            logical, parameter :: debug = .false.
            double precision eta
            double precision eta0
            integer i
            integer j
            integer k
            double precision rho
            double precision, parameter :: rho_max = 1.050D+00
            double precision, parameter :: rho_ref = 0.317763D+00
            double precision t
            double precision total
```

```
      double precision, parameter :: t_max = 800.00D+00
      double precision, parameter :: t_ref = 647.27D+00
      logical, save :: warning1 = .false.
      logical, save :: warning2 = .false.
!
!  Refuse to handle zero or negative temperatures.
!
      if ( t <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'VISCOSITY - Fatal error!'
        write ( *, '(a)' ) 'The input temperature T must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was T = ', t
        stop
      end if

      if ( t > t_max .and. .not. warning1 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'VISCOSITY - Warning (once only)!'
        write ( *, '(a,g14.6)' )
     +    '  The input temperature T should be no more than ', t_max
        write ( *, '(a,g14.6)' ) '  The input value was T = ', t
        write ( *, '(a)' ) ' '
        warning1 = .true.
      end if
!
!  Refuse to handle zero or negative density.
!
      if ( rho <= 0.0D+00 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'VISCOSITY - Fatal error!'
        write ( *, '(a)' ) '  The input density RHO must be positive.'
        write ( *, '(a,g14.6)' ) '  The input value was RHO = ', rho
        stop
      end if

      if ( rho > rho_max .and. .not. warning2 ) then
        write ( *, '(a)' ) ' '
        write ( *, '(a)' ) 'VISCOSITY - Warning (once only)!'
        write ( *, '(a,g14.6)' )
     +    '  The input density RHO should be no more than ', rho_max
        write ( *, '(a,g14.6)' ) '  The input value was RHO = ', rho
        write ( *, '(a)' ) ' '
        warning2 = .true.
      end if
!
!  Compute ETA0.
!
      arg = t_ref / t

      call dpoly_val_horner ( npol_t, a, arg, total )

      eta0 = sqrt ( t / t_ref ) / total
!
!  Compute ETA.
!
      total = 0.0D+00
```

```
            do i = 0, 5
              do j = 0, 4
                total = total + b(i,j) * ( ( t_ref - t ) / t )**i *
     +        ( ( rho - rho_ref ) / rho_ref )**j
              end do
            end do

            eta = eta0 * exp ( ( rho / rho_ref ) * total )

            return
          end
!*****************************************************************************************
          subroutine viscosity_values ( n, tc, p, eta )
!
!*****************************************************************************
!
!! VISCOSITY_VALUES returns some values of the viscosity function for testing.
!
!
!  Reference:
!
!    Lester Haar, John Gallagher and George Kell,
!    NBS/NRC Steam Tables:
!    Thermodynamic and Transport Properties and Computer Programs
!      for Vapor and Liquid States of Water in SI Units,
!    Hemisphere Publishing Corporation, Washington, 1984,
!    TJ270.H3, page 263.
!
!  Modified:
!
!    04 February 2002
!
!  Author:
!
!    John Burkardt
!
!  Parameters:
!
!    Input/output, integer N.
!    On input, if N is 0, the first test data is returned, and N is set
!    to the index of the test data.  On each subsequent call, N is
!    incremented and that test data is returned.  When there is no more
!    test data, N is set to 0.
!
!    Output, double precision TC, the temperature, in degrees Celsius.
!
!    Output, double precision P, the pressure, in bar.
!
!    Output, double precision ETA, the viscosity, in MegaPascal seconds.
!
            implicit none
!
            integer, parameter :: nmax = 34
!
            double precision eta
            double precision, save, dimension ( nmax ) :: etavec = (/
```

```
     +    1792.0D+00, 1791.0D+00, 1790.0D+00, 1786.0D+00, 1780.0D+00,
     +    1775.0D+00, 1769.0D+00, 1764.0D+00, 1759.0D+00, 1754.0D+00,
     +    1749.0D+00, 1744.0D+00, 1739.0D+00, 1735.0D+00, 1731.0D+00,
     +    1722.0D+00, 1714.0D+00, 1707.0D+00, 1700.0D+00, 1694.0D+00,
     +    1687.0D+00, 1682.0D+00, 1676.0D+00, 1667.0D+00, 1659.0D+00,
     +    1653.0D+00,  890.8D+00,  547.1D+00,  378.4D+00,   12.28D+00,
     +     16.18D+00,  24.45D+00,  32.61D+00,  40.38D+00 /)
           integer n
           double precision p
           double precision, save, dimension ( nmax ) :: pvec = (/
     +     1.0D+00,    5.0D+00,   10.0D+00,   25.0D+00,   50.0D+00,
     +    75.0D+00,  100.0D+00,  125.0D+00,  150.0D+00,  175.0D+00,
     +   200.0D+00,  225.0D+00,  250.0D+00,  275.0D+00,  300.0D+00,
     +   350.0D+00,  400.0D+00,  450.0D+00,  500.0D+00,  550.0D+00,
     +   600.0D+00,  650.0D+00,  700.0D+00,  800.0D+00,  900.0D+00,
     +  1000.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00,
     +     1.0D+00,    1.0D+00,    1.0D+00,    1.0D+00  /)
           integer nn
           double precision tc
           double precision, save, dimension ( nmax ) :: tcvec = (/
     +    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +    0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,   0.0D+00,
     +    0.0D+00,  25.0D+00,  50.0D+00,  75.0D+00, 100.0D+00,
     +  200.0D+00, 400.0D+00, 600.0D+00, 800.0D+00 /)
!
           if ( nn < 0 ) then
             nn = 0
           end if

           if ( nn >= nmax ) then
             nn = 0
             tc = 0.0D+00
             p = 0.0D+00
             eta = 0.0D+00
           else
             nn = nn + 1
             tc = tcvec(nn)
             p = pvec(nn)
             eta = etavec(nn)
           end if

           return
         end
*******************************************************************************************
         subroutine volume ( t, rho, v, dvdt, dvdr )
!
!*****************************************************************************
!
!! VOLUME computes specific volume derivatives given temperature and density.
!
!
!  Discussion:
!
```

```
!   Because A(rho,T) is everywhere single valued and analytic,
!   we can derive closed form relations for all other properties.
!
!   The independent variables are temperature T and density RHO,
!   and differentiation with respect to one variable is to imply that
!   the other is held at a fixed value.
!
!  Modified:
!
!   28 November 1998
!
!  Reference:
!
!   Lester Haar, John Gallagher and George Kell,
!   NBS/NRC Steam Tables:
!   Thermodynamic and Transport Properties and Computer Programs
!     for Vapor and Liquid States of Water in SI Units,
!   Hemisphere Publishing Corporation, Washington, 1984,
!   TJ270.H3
!
!   C A Meyer, R B McClintock, G J Silvestri, R C Spencer,
!   ASME Steam Tables: Thermodynamic and Transport Properties of Steam,
!   American Society of Mechanical Engineers, 1967.
!
!  Parameters:
!
!   Input, double precision T, the temperature, in degrees Kelvin.
!
!   Input, double precision RHO, the fluid density, in G/CM3.
!
!   Output, double precision V, the specific volume, in CM3/G.
!
!   Output, double precision DVDT, the partial derivative dV(T,RHO)/dT,
!   where V is the specific volume, in CM3 / (G * degrees Kelvin).
!
!   Output, double precision DVDR, the partial derivative dV(T,RHO)/dRHO,
!   where V is the specific volume, in CM3**2 / ( G**2 ).
!
        implicit none
!
        double precision ab
        double precision ar
        double precision cvb
        double precision cvr
        double precision dpdr
        double precision dpdrb
        double precision dpdrr
        double precision dpdt
        double precision dpdtb
        double precision dpdtr
        double precision dvdr
        double precision dvdt
        double precision gb
        double precision gr
        double precision hb
        double precision hr
```

```
            double precision pb
            double precision pr
            double precision rho
            double precision sb
            double precision sr
            double precision t
            double precision ub
            double precision ur
            double precision v
!
!  Refuse to handle zero or negative temperatures.
!
            if ( t <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
              write ( *, '(a)' ) 'VOLUME - Fatal error!'
              write ( *, '(a)' ) 'The input temperature T must be positive.'
              write ( *, '(a,g14.6)' ) '  The input value was T = ', t
              stop
            end if
!
!  Refuse to handle zero or negative density.
!
            if ( rho <= 0.0D+00 ) then
              write ( *, '(a)' ) ' '
             write ( *, '(a)' ) 'VOLUME - Fatal error!'
              write ( *, '(a)' ) '  The input density RHO must be positive.'
              write ( *, '(a,g14.6)' ) '  The input value was RHO = ', rho
              stop
            end if

            call resid ( t, rho, ar, cvr, dpdrr, dpdtr, gr, hr, pr, sr, ur )

            call base ( t, rho, ab, cvb, dpdrb, dpdtb, gb, hb, pb, sb, ub )

            dpdr = dpdrb + dpdrr
            dpdt = dpdtb + dpdtr

            dvdt = dpdt / ( dpdr * rho**2 )
!
!  Because V = 1/Rho, dV/dRho = -1/Rho**2
!
            dvdr = - 1.0D+00 / rho**2

            v = 1.0D+00 / rho

            return
           end
*******************************************************************************
          subroutine PWRDNBPROPS
!
!
!djm Subroutine PWRDNBPROPS uses the property formulas from the program
!     PWRDNB to calculate additional properties.
!
!
!C**********************************************************************
```

```
!C              DEFINITIONS & UNITS
!C
!C  HTC IS CONVECTIVE HEAT TRANSFER COEFFICIENT  (BTU/HR-FT**2-DEG F)
!C  RODD IS THE FUEL ROD OD  (INCHES)
!C  RODP IS THE FUEL ROD PITCH  (INCHES)
!C  PELD IS THE PELLET DIA.  (INCHES)
!C  CT IS THE CLAD THICKNESS  (INCHES)
!C  TKF IS THE FUEL THERMAL CONDUCTIVITY  (BTU/HR-FT-DEG F)
!C  TKC IS THE CLAD THERMAL CONDUCTIVITY  (BTU/HR-FT-DEG F)
!C  HGAP IS THE GAP HEAT TRANSFER COEFFICIENT  (BTU/HR-FT**2 DEG F)
!C  GIN IS THE CHANNEL MASS FLUID  (LBM/HR-FT**2)
!C  QC IS THE MAXIMUM VOLUMETRIC HEAT GENERATION
!C  QVOLA IS THE CORE AVG VOLUMETRIC HEAT GEN  (BTU/HR-FT**3)
!C  FQ IS THE TOTAL HOT CHANNEL FACTOR
!C  RODN IS THE NUMBER OF RODS PER ASSEMBLY
!C  ASSN IS THE NUMBER OF ASSEMBLIES
!C  RODL IS THE ACTIVE FUEL LENGTH  (FEET)
!C  QTHERM IS THE CORE THERMAL OUTPUT  (MEG. WATTS)
!C  HEX IS THE EXTRAPOLATION HEIGTH  (FEET)
!C  FMDOT IS CHANNEL MASS FLOW RATE  (LBM/HR)
!C  AFF IS CHANNEL FLOW AREA  (FT**2)
!C  AC IS CLAD DIAMETER  (FEET)
!C  AP IS PELLET DIAMETER  (FEET)
!C  F IS THE FLUX DEPRESSION FACTOR
!C  CP = SPECIFIC HEAT AT INLET TEMPERATURE
!C  CPP = SPECIFIC HEAT AVG. BETWEEN INLET & SATURATED TEMPERATURE
!C  HG = SPECIFIC ENTHALPY OF GAS (BTU/LB)
!C  HF = SPECIFIC ENTHALPY OF FLUID (BTU/LB)
!C  HIN = SPECIFIC ENTHALPY AT INLET CONDITIONS (BTU/LB)
!C  RHOF = FLUID DENSITY (LB/FT**3)
!C  RHOG = GAS DENSITY (LB/FT**3)
!C  VISCF = FLUID VISCOSITY (LB/FT*HR)
!C  VISCG = GAS VISCOSITY (LB/FT*HR)
!C
!C*********************************************************************
!
!djm Pressure and Temperature from steam_interact subroutine.
!
!
      Use MainVar
!
      TI=te
      PSYS=pe
!
    PI = 3.14159
!C
!C   STEAM TABLE CALLS FOR PROPERTIES
!C
      TSAT=TSL(PSYS)
    HG = HSV(PSYS,TSAT,S,VG)
    HF = HSL(TSAT)
    HIN = HCL(PSYS,TI,S)
    HFG = HG - HF
    VF=VSL(TSAT)
    RHOF=1./VF
    RHOG=1./VG
```

```
      VISCF=VISL(PSYS,TSAT)
      VISCF=VISCF*3600.
      VISCG=VISV(PSYS,TSAT)
      VISCG=VISCG*3600.
            VISCIN=VISL(PSYS,TI)
            VISCIN=VISCIN*3600
            VISCFG=VISCF - VISCG
            VIN=VSL(TI)
            RHOIN=1./VIN
            NUIN=1./RHOIN
            NUF=1./RHOF
            NUG=1./RHOG
            NUFG=NUG - NUF
!djm Conversion calculation for metric units
      HGM = HG*2.326
            HFM = HF*2.326
            HINM = HIN*2.326
            HFGM = HFG*2.326
            RHOFM = RHOF*0.01602
            RHOGM = RHOG*0.01602
            RHOINM=         RHOIN*0.01602
            TSATM = (TSAT+459.67)/1.8
            VISCFM = VISCF*4.1338E-10
            VISCGM = VISCG*4.1338E-10
            VISCINM=VISCIN*4.1338E-10
            VISCFGM=VISCFM - VISCGM
            NUINM=1./RHOINM
            NUFM=1./RHOFM
            NUGM=1./RHOGM
            NUFGM=NUGM - NUFM
!
            if (propchoice == 1) then
!djm
            open (6, file = 'output.txt')
!
      WRITE(6,100) HG,HGM,HF,HFM,HIN,HINM,HFG,HFGM,RHOF,RHOFM,RHOG,
     +RHOGM,RHOIN,RHOINM,TSAT,TSATM,VISCF,VISCFM,VISCG,VISCGM,VISCIN,
     +VISCINM, VISCFG, VISCFGM, NUF, NUFM, NUG, NUGM, NUIN, NUINM,
     +NUFG, NUFGM
            else
            write(6,110)TSAT,TSATM
            end if
!
!djm Output altered to display both British and Metric Values
!
  100 FORMAT(1X,/,
     1 1X'ADDITIONAL CALCULATED PROPERTIES'//
     1 1X,'HG =    ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (Specific Enthalpy of Gas)'/
     2 1X,'HF =    ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +       (Specific Enthalpy of Liquid)'/
     3 1X,'HIN =   ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (Specific Enthalpy at Inlet)'/
     4 1X,'HFG =   ',g16.8,' BTU/LB       ',g16.8,' KJ/kg
     +          (Specific Enthalpy of Two-Phase Flow)'/
     * 1X,'RHOF =  ',g16.8,' LB/FT3       ',g16.8,' g/CM3
```

```
     +         (Fluid Density)'/
     * 1X,'RHOG =  ',g16.8,' LB/FT3       ',g16.8,' g/CM3
     +         (Gas Density)'/
     * 1X,'RHOIN = ',g16.8,' LB/FT3       ',g16.8,' g/CM3
     +         (Inlet Density)'/
     5 1X,'TSAT =  ',g16.8,' Degrees F    ',g16.8,' K
     +            (Saturation Temperature)'/
     2 1X,'VISCF = ',g16.8,' LB/(FT HR)   ',g16.8,' MPa s
     +         (Fluid Viscosity)'/
     3 1X,'VISCG = ',g16.8,' LB/(FT HR)   ',g16.8,' MPa s
     +         (Gas Viscosity)'/
           3 1X,'VISCIN =',g16.8,' LB/(FT HR)   ',g16.8,' MPa s
     +         (Inlet Viscosity)'/
           3 1X,'VISCFG =',g16.8,' LB/(FT HR)   ',g16.8,' MPa s
     +         (Viscosity of Two-Phase Flow)'/
     * 1X,'NUF =   ',g16.8,' FT3/LB       ',g16.8,' CM3/g
     +         (Fluid Specific Volume)'/
     * 1X,'NUG =   ',g16.8,' FT3/LB       ',g16.8,' CM3/g
     +         (Gas Specific Volume)'/
     * 1X,'NUIN =  ',g16.8,' FT3/LB       ',g16.8,' CM3/g
     +         (Inlet Specific Volume)'/
     * 1X,'NUFG =  ',g16.8,' FT3/LB       ',g16.8,' CM3/g
     +         (Specific Volume of Two-Phase Flow)'/)

110   format('TSAT =   ',g16.8,' Degrees F    ',g16.8,' K
     +           (Saturation Temperature)')
           end
!c*****************************************************************************
!C     STEAM TABLE ROUTINES FOR PWRDNB
!C
      FUNCTION GRS (X,NDX,Y,NDY,XV,N,NRANGE)
!C
      DIMENSION X(NDX,3), Y(NDY,3), DX(3), DY(3), YP(2)
      NRANGE=0
      IF (XV.LT.X(1,1)) NRANGE=-1
      IF (XV.GT.X(1,N)) NRANGE=+1
      DO 1 I=1,N
      IF (XV-X(1,I)) 2,8,1
1     CONTINUE
      I=N
2     IF (I.GT.2) GO TO 3
      N1=3
      N2=2
      N3=1
      NP=3
      GO TO 6
3     IF (I.LT.N) GO TO 4
      NP=3
      GO TO 5
4     NP=4
      N4=I+1
5     N1=I-2
      N2=I-1
      N3=I
6     DX(1)=X(1,N2)-X(1,N1)
      DY(1)=Y(1,N2)-Y(1,N1)
```

```
      DX(2)=X(1,N3)-X(1,N2)
      DY(2)=Y(1,N3)-Y(1,N2)
      R=(XV-X(1,N2))/DX(2)
      YP(1)=(DY(1)*DX(2)**2+DY(2)*DX(1)**2)/(DX(1)*(DX(1)+DX(2)))
      IF (NP.EQ.4) GO TO 7
      GRS=Y(1,N2)+R*(YP(1)+R*(DY(2)-YP(1)))
      GO TO 9
7     DX(3)=X(1,N4)-X(1,N3)
      DY(3)=Y(1,N4)-Y(1,N3)
      YP(2)=(DY(2)*DX(3)**2+DY(3)*DX(2)**2)/(DX(3)*(DX(2)+DX(3)))
      GRS=Y(1,N2)+R*(YP(1)+R*(3.*DY(2)-2.*YP(1)-YP(2)+R*(YP(1)+YP(2)-2.*
     1DY(2))))
      GO TO 9
8     GRS=Y(1,I)
9     RETURN
      END
!C
      FUNCTION HCL (P,T,S)
!C
      IF (P.GT.16000.) GO TO 1
      HCL=HCSL(P,T,DUM,S,4)
      RETURN
1     CALL STER ('HCL',12,P,T)
      RETURN
      END
!C
      FUNCTION HCSL (P,T,V,S,IGO)
!C
!C     9.1 SUB-REGION 1
!C     ENTERED FROM HSL,SSL,VSL,HCL,VCL WHEN IGO =1,2,3,4,5 REPECTIVELY
!C     CALLED DIRECTLY WHEN IGO=6
      DOUBLE PRECISION A,SA,THETA,BETA,X,R,B2,B3,
     1     Q1,Q2,Y,Z,Z1,R1,R2,R3,YPRI,SUM
      DIMENSION THETA(16), A(23), SA(12)
      DATA (A(I),I=1,23) / 6.824687741D3,-5.422063673D2,
     1 -2.096666205D4,3.941286787D4,-6.733277739D4,
     2 9.902381028D4,-1.093911774D5,8.590841667D4,
     3 -4.511168742D4,1.418138926D4,-2.017271113D3,7.982692717D0,
     4 -2.616571843D-2,1.522411790D-3,2.284279054D-2,2.421647003D2,
     = 1.269716088D-10,2.074838328D-7,2.174020350D-8,
     5 1.105710498D-9,1.293441934D1,1.308119072D-5,
     6 6.047626338D-14 /
      DATA (SA(I),I=1,12) / .8438375405D0,5.362162162D-4,
     1 1.72D0,.07342278489D0,.0497585887D0,.65371543D0,
     2 1.15D-6,1.5108D-5,.14188D0,
     3 7.002753165D0,2.995284926D-4,.204D00 /
      IF (T.GT.705.47) GO TO 13
      IF (T.GT.662.0) GO TO 10
!C    THETA   =((T-32.0)/1.8+273.15)/647.3
      THETA(1)=8.582659595D-4*T+0.3945191136D0
      BETA=P/3208.234759D0
!C    X AND R ARE BOTH USED
      X=SA(6)-THETA(1)
      R = 0.0D0
      IF (DABS(X) .GT. 4.82D-5) R = X**9
!C    THIS DO LOOP GIVES THETA**2 THRU THETA**11
```

```
      DO 1 I=2,11
1     THETA(I)=THETA(I-1)*THETA(1)
!C    THETA(12)=THETA**17
      THETA(12)=THETA(8)*THETA(9)
!C    THIS DO LOOP GIVES THETA**18 THRU THETA**21
      DO 2 I=13,16
2     THETA(I)=THETA(I-1)*THETA(1)
      B2=BETA**2
      B3=B2*BETA
      Q2=(SA(10)+BETA)**4
      Q1=(SA(10)+BETA)/Q2
      Y=1.-SA(1)*THETA(2)-SA(2)/THETA(6)
      Z=Y+DSQRT(SA(3)*Y**2-2.D0*(SA(4)*THETA(1)-SA(5)*BETA))
!C    Z1=Z**(5./17.)
      Z1=Z**.2941176471
      R1=SA(7)+THETA(14)
      R2=SA(8)+THETA(11)
      R3=(((A(20)*BETA+A(19))*BETA+A(18))*BETA)/R2**2
      YPRI=-2.D0*SA(1)*THETA(1)+6.D0*SA(2)/THETA(7)
      GO TO (8,5,3,5,3,3), IGO
!C    SUBREGION 1 REDUCED VOLUME SUBSCRIPT OF A IS ONE MORE
!C    THAN REPORT SUBSCRIPT NUMBER
3     V=(A(12)*SA(5)/Z1+A(13)+A(14)*THETA(1)+A(15)*THETA(2)
     1 +A(16)*R*X+A(17)/R1-(A(18)+2.D0*A(19)*BETA+3.D0*
     2 A(20)*B2)/R2)*5.077852889D-2
      IF (T.LE.382.) GO TO 4
      V=V+(-A(21)*THETA(13)*(SA(9)+THETA(2))*(-3.D0/Q2+
     1 SA(11))+3.D0*A(22)*(SA(12)-THETA(1))*B2+4.D0*A(23)/
     2 THETA(15)*B3)*5.077852889D-2
!C    SUBREGION 1 REDUCED ENTROPY
4     GO TO (11,11,12,11,12,5), IGO
5     SUM=A(3)
      DO 6 I=1,8
6     SUM=SUM+FLOAT(I+1)*A(I+3)*THETA(I)
      S=(1.583237108D-6+A(1)*DLOG(THETA(1))-SUM+A(12)
     1 /Z1*((0.4166666667D0*Z-0.72D0*Y)*YPRI+SA(4))+BETA*(
     2 -A(14)-2.D0*A(15)*THETA(1)+10.D0*A(16)*R+19.D0*A(17)
     3 /R1**2*THETA(13))-11.D0*THETA(10)*R3)*2.587358228D-2
      IF (T.LE.382.) GO TO 7
      S=S+(A(21)*THETA(12)*(18.D0*SA(9)+20.D0*THETA(2))
     1 *(Q1+SA(11)*BETA)+B3*(A(22)+20.D0*A(23)/THETA(16)*BETA))
     2 *2.587358228D-2
!C    SUBREGION 1 REDUCED ENTHALPY
7     GO TO (11,12,11,8,11,8), IGO
8     SUM=-A(2)
!C    SECOND TERM OMITTED SINCE IT =0
      DO 9 I=2,9
9     SUM=SUM+DBLE(I-1)*A(I+2)*THETA(I)
      HCSL=(2.156561703D-7+A(1)*THETA(1)-SUM+A(12)/Z1
     1 *(Z*(0.5862068965D0*Z-1.416666667D0*Y+0.4166666667D0
     2 *THETA(1)*YPRI)+SA(4)*THETA(1)-0.72D0*THETA(1)*Y*YPRI)
     3 +BETA*(A(13)-A(15)*THETA(2)+A(16)*(9.D0*
     4 THETA(1)+SA(6))*R+A(17)*(20.D0*THETA(14)+SA(7))
     5 /R1**2)-(12.D0*THETA(11)+SA(8))*R3)*30.14634566D0
      IF (T.LE.382.) RETURN
      HCSL=HCSL+(A(21)*THETA(13)*(17.D0*SA(9)+19.D0
```

```
     1 *THETA(2))*(Q1+SA(11)*BETA)+(A(22)*SA(12)+21.D0*A(23)
     2 /THETA(15)*BETA)*B2)*30.14634566D0
       RETURN
10     HCSL=HCSLV1(P,T,V,S,IGO)
       RETURN
11     PRINT 14, IGO
       STOP
12     RETURN
13     CALL STER ('HCSL',2,T,0.)
!C
14     FORMAT (10X,28HWRONG STATEMENT IN HCSL,IGO=,I3)
!C
       RETURN
       END
!C
       SUBROUTINE STER (NAME,I,A,B)
!C
!C     STER IS A ROUTINE FOR PRINTING ERROR MESSAGES ASSOCIATED
!C     WITH THE STEAM TABLES.
!C     NAME IS THE BCD NAME OF THE CALLING ROUTINE.
!C     I POSITIVE PRINTS -OUT OF RANGE-
!C     I NEGATIVE PRINTS -NON CONVERGENT-
!C     IF I IS ONE DIGIT ITS CORRESPONDING ARGUMENT A IS PRINTED.
!C     IF I IS TWO DIGITS ITS TWO CORR. ARGUMENTS A AND B ARE PRINTED.
       CHARACTER*(*) NAME
       CHARACTER*5 M(8), MA(5) ,MP
       DATA (M(I),I=1,8)/
      1      ' OUT ','OF RA','NGE I','N    ',
      2      ' NON ','CONVE','RGENT',' IN  ' /
       DATA (MA(I),I=1,5)/'PRES=','TEMP=','ENTH=','VOL =','ENTR=' /
       IM=1
       IF (I.LT.0) IM=5
       I2=IABS(I)
       I1=I2/10
       I2=I2-I1*10
       MP=MA(I2)
       IF (I1.NE.0) MP=MA(I1)
       L = 1
       DO 9900 III=1,5
       IF (ICHAR(NAME(III:III)) .EQ. 0) GO TO 9901
       L = III
9900   CONTINUE
9901   CONTINUE
       PRINT 2,M(IM),M(IM+1),M(IM+2),M(IM+3),NAME(1:L),MP,A
       IF (I1.EQ.0) GO TO 1
       PRINT 3,MA(I2),B
1      STOP
2      FORMAT (1X,4A5,A,2X,A5,E13.6)
3      FORMAT (27X,A5,E13.6)
       END
!C
       FUNCTION HSL (T)
!C
       DIMENSION XG(3)
       COMMON /COHSL/ XG
       XG(1)=HCSL(PSL(T),T,XG(3),XG(2),1)
```

```
      HSL=XG(1)
      RETURN
      END
!C
      FUNCTION HSS (P,T,S,V)
!C
      ICNT=4
      JKL=0
      HSS=HSSFCT(P,T,S,V,ICNT,JKL)
      RETURN
      END
!C
      FUNCTION HSV (P,T,S,V)
!C
      IF (P.GT.3208.234765) GO TO 1
      T=TSL(P)
      HSV=HSS(P,T,S,V)
      RETURN
1     CALL STER ('HSV',1,P,0.)
      RETURN
      END
!C
      FUNCTION PSL (T)
!C
      COMMON /NUST/ TCORE,SCORE,VCORE,DPDT
      J=1
      PSL=PSLFCT(T,J)
      RETURN
      END
!C
      FUNCTION TSL (PIN)
!C
      COMMON /NUST/ TCORE,SCORE,VCORE,DPDT
      K=1
      TSL=TSLFCT(PIN,K)
      RETURN
      END
!C
      FUNCTION VCL (P,T)
!C
!C      IF (T .GT. TSL(P)) CALL STER('VCL',12,P,T)
      DUM=HCSL(P,T,VVV,DUM,5)
      VCL = VVV
      RETURN
      END
!C
      FUNCTION VISL (P,T)
!C
      DENS=VCL(P,T)
      VISL=VISLFC(P,T,DENS)
      RETURN
      END
!C
      FUNCTION VISLFC(P,T,DENS)
!C
      DIMENSION B(3),C0(5),C1(8),C2(10)
```

```
      DATA (B(I),I=1,3) / 1.021E2,6.765E2,3.53E2 /
      DATA (C0(I),I=1,5) / 7.5213978E1,-1.1879721E3,6.6840006E3,
     = -1.5488609E4,1.1802979E4 /
      DATA (C1(I),I=1,8) / -4.1416918E1,9.1177974E2,-8.2709230E3,
     = 3.9905545E4,-1.0974987E5,1.6919860E5,-1.3050794E5,3.6396424E4 /
      DATA (C2(I),I=1,10) / -1.1651331E-1,1.1075709E1,-1.7932076E2,
     = 1.1112731E3,-2.0826382E3,-8.1306942E3,5.0618906E4,-1.0609301E5,
     = 9.8673349E4,-3.1905419E4 /
1     TAU=(T-32.)/180.
      DENS=0.0160184634/DENS
      U1=0.
      DO 2 I=1,3
2     U1=(U1+B(I))*DENS
!C      TAU10=TAU**10
!C      C3T=1.0+5.739225024E-32*TAU10*TAU10*TAU10*TAU10*TAU10*TAU**5
      C3T=1.0
      IF(TAU .GT. 0.73) C3T=C3T+(TAU/3.698459353)**55
      C1T=C1(1)
      DO 3 I=2,8
3     C1T=C1T*TAU+C1(I)
      C0T=C0(1)
      DO 4 I=2,5
4     C0T=C0T*TAU+C0(I)
      C2T=C2(01)
      DO 5 I=2,10
5     C2T=C2T*TAU+C2(I)
      U1=U1+80.4+40.7*TAU+(-0.8+DENS*((C2T*DENS+C1T)*DENS+C0T))/C3T
      VISLFC=0.671968975E-7*U1
      RETURN
      END
!C
      FUNCTION VISV(P,T)
!C
      C1T=HSS(P,T,C2T,DENS)
      VISV=VISLFC(P,T,DENS)
      RETURN
      END
!C
      FUNCTION VSL(T)
!C
      COMMON /COHSL/ XG(3)
      XG(1)=HCSL(PSL(T),T,XG(3),XG(2),3)
      VSL=XG(3)
      RETURN
      END
!C
      FUNCTION HCSLV1 (P,T,V,S,IGO)
!C
!C     ENTERED FROM HSL,SSL,VSL,HCL,VCL WHEN IGO =1,2,3,4,5 REPECTIVELY
!C     CALLED DIRECTLY WHEN IGO=6
      DIMENSION VTRY(3)
!C     SUB-REGION 3 AND 4
      INT=1
!C     REMOVE CALC. FOR PB AND TC WHEN VLIQ IS MADE PART OF PROG.
      PB=P/14.503773773
      TC=(T-32.0)/1.8
```

```
!C     V FROM VLIQ IS IN CC/GM
      VTRY(1)=VLIQ(PB,TC,VMIN,VMAX)
      VMAX=3.17
      TOL=1.0E-7
      IF (P .GE. 2300.) TOL = 1.5E-7
      HCSLV1=HCSFCT(P,T,V,S,IGO,INT,PB,TC,VTRY,VMIN,VMAX,TOL)
      RETURN
      END
!C
      FUNCTION HSSFCT(P,T,S,V,ICNT,JKL)
!C
      DIMENSION IZ1(5,3),IZ6(3,2),Q(6),
     1     Z(4),IX6(3,2),B0(6),B1(3,5),B6(2,3),B9(7),
     2     SB6(2,3),AA(10)
      REAL*8 BETA,THETA,BL,Q,Z,B0,B1,B6,
     1     B9,SB6,AA,SB,XYZ,X,BT,BETAI,V1,S1,H1,V2,S2,H2,
     2     V3,S3,H3
      DATA (AA(I),I=1,10) / 290.69767D0,-1160.2D0,1214.5749D0,
     1     -8311.8D0,179.6814D0,-666.2D0,249.4970D0,
     2     -1220.4D0,676.7607D0,-5142.6D0 /
      DATA (B0(I),I=1,6) / .08565182058D0,-.6547711697D0,
     1     .4330662834D0,-54.38923329D0,28.56067796D0,16.83599274D0 /
      DATA B1 / .06670375918D0,1.388983801D0,0.D0,.08390104328D0,
     1     .02614670893D0,-.03373439453D0,.4520918904D0,
     2     .1069036614D0,0.D0,-.5975336707D0,
     3     -.08847535804D0,0.D0,.5958051609D0,
     4     -.5159303373D0,.2075021122D0 /
      DATA B6 / .1190610271D0,-.09867174132D0,.1683998803D0,
     1     -.05809438001D0,6.552390126D-3,5.710218649D-4 /
      DATA (B9(I),I=1,7) / 523.5718623D0,-2693.088365D0,
     1     5745.984054D0,-6508.211677D0,4126.607219D0,
     2     -1388.522425D0,193.6587558D0 /
      DATA SB / .7633333333D0 /
      DATA SB6 /.4006073948D0,0.D0,.08636081627D0,
     1     0.D0,-.8532322921D0,.3460208861D0/
      DATA IZ1 / 13,18,18,25,32,3,2,10,14,28,0,1,0,0,24 /
      DATA IZ6 /12,24,24,11,18,14/
      DATA IX6 /14,19,54,0,0,27/
1     BETA=P/3208.234759D0
      THETA=8.582659595D-4*T+0.3945191136D0
      BL=P23T(T)/3208.234759D0
      IF (BETA.GT.BL) GO TO 13
      XYZ=ALOG(P)
      X=DEXP(SB*(1.D0-THETA))
      BT=SB*THETA
      V1=0.D0
      S1=0.D0
      H1=0.D0
      DO 3 I=1,5
      DO 2 J=1,3
      Q(J)=B1(J,I)*X**IZ1(I,J)
2     Z(J)=DBLE(IZ1(I,J))
      BETAI=BETA**I
      V1=V1+DBLE(I)*(BETAI/BETA)*(Q(1)+Q(2)+Q(3))
      IF (JKL.EQ.1) GO TO 3
      S1=S1+BETAI*(Z(1)*Q(1)+Z(2)*Q(2)+Z(3)*Q(3))
```

```
      H1=H1+BETAI*((1.D0+Z(1)*BT)*Q(1)+(1.D0+Z(2)*BT)*Q(2)+(1.D0+Z(3)*
     1 BT)*Q(3))
3     CONTINUE
      V2=0.D0
      S2=0.D0
      H2=0.D0
      V3=0.D0
      S3=0.D0
      H3=0.D0
      IF (P.LE.200.) GO TO 10
      K=1
      IF (P.LE.2300.) GO TO 4
      K=3
      IF (P.GE.3500.) GO TO 5
4     TMIN=AA(K)*XYZ+AA(K+1)
      IF (T.GE.TMIN) GO TO 10
5     DO 7 I=1,3
      DO 6 J=1,2
      Q(J)=B6(J,I)*X**IZ6(I,J)
      Z(J)=DBLE(IZ6(I,J))
      Q(J+2)=SB6(J,I)*X**IX6(I,J)
6     Z(J+2)=DBLE(IX6(I,J))
      BETAI=BETA**(-3-I)
      Q(5)=BETAI+Q(3)+Q(4)
      V2=V2+(DBLE(I+3)*BETAI/BETA*(Q(1)+Q(2)))/Q(5)**2
      IF (JKL.EQ.1) GO TO 7
      Q(6)=(Z(3)*Q(3)+Z(4)*Q(4))/Q(5)
      S2=S2+(Q(1)*(Z(1)-Q(6))+Q(2)*(Z(2)-Q(6)))/Q(5)
      H2=H2+(Q(1)*((1.D0+Z(1)*BT)-BT*Q(6))+Q(2)*((1.D0+Z(2)*BT)-BT*
     1Q(6)))/Q(5)
7     CONTINUE
      IF (P.LE.1000.) GO TO 10
      K=5
      IF (P.LE.2800.) GO TO 8
      K=7
      IF (P.GT.9700.) K=9
8     TMIN=AA(K)*XYZ+AA(K+1)
      IF (T.GE.TMIN) GO TO 10
      Q(1)=(386.2761414D0*THETA-341.7061978D0)/BL
      DO 9 I=1,7
      V3=V3*X+B9(I)
      IF (JKL.EQ.1) GO TO 9
      Q(2)=Q(1)+DBLE(7-I)*SB
      S3=S3*X+Q(2)*B9(I)
      H3=H3*X+(1.D0+THETA*Q(2))*B9(I)
9     CONTINUE
      Q(1)=(BETA/BL)**10
10    V=(4.260321148D0*THETA/BETA-V1-V2+11.D0*Q(1)*V3)*.05077852889D0
      Q(2)=0.D0
      Q(3)=3.D0*B0(1)
      DO 11 I=1,4
      Q(2)=Q(2)*THETA+DBLE(5-I)*B0(I)
11    Q(3)=Q(3)*THETA+DBLE(3-I)*B0(I+1)
      S=(1.583237108D-6-4.260321148D0*DLOG(BETA)+B0(6)*
     1     DLOG(THETA)-Q(2)-SB*S1-SB*S2+BETA*Q(1)*S3)*.02587358228D0
      HSSFCT=(2.156561703D-7+B0(6)*THETA-Q(3)-H1-H2+BETA*Q(1)*H3)
```

```
     1      *30.14634566D0
12    RETURN
13         CONTINUE
      HSSFCT=HCSLV2(P,T,V,S,ICNT)
      RETURN
      END
!C
      FUNCTION PSLFCT(T,J)
!C
      DIMENSION AK(9)
      COMMON /NUST/ TCORE,SCORE,VCORE,DPDT
      DATA AK/-7.691234564,-26.08023696,-168.1706546,64.23285504,
     1-118.9646225,4.167117320,20.97506760,1.0E9,6./
      DATA AK2T2,AK3T3/-5.21604739E1,-5.04511964E2/
      DATA AK4T4,AK5T5/+2.56931420E2,-5.94823113E2/
      DATA AK7T2,AK8T2/+4.19501352E+1,+2.0E+9/
1     IF (T.GT.705.47) GO TO 3
!C    THETA   =((T-32.0)/1.8+273.15)/647.3
      THETA=(T+459.67)/1165.14
      X=1.-THETA
      Y=0.
      DO 2 I=1,5
      M6I=6-I
2     Y=(Y+AK(M6I))*X
!C    THE  K FUNCTION (SATURATION LINE) PAGE 12 PAR. 5
      DEN1=1.+X*(AK(6)+AK(7)*X)
      DEN2=AK(8)*X*X+AK(9)
      PSLFCT=EXP(Y/THETA/DEN1-X/DEN2)*3208.234759
      IF (J.NE.2) RETURN
      DSDT=-(AK(1)+X*(AK2T2+X*(AK3T3+X*(AK4T4+AK5T5*X))))
      B=THETA*DEN1
      DBDT=DEN1-THETA*(AK(6)+AK7T2*X)
      DBBDT=-AK8T2*X
      DPDT=(PSLFCT/1165.14)*(((B*DSDT-Y*DBDT)/(B*B))
     1+((DEN2+X*DBBDT)/(DEN2*DEN2)))
      RETURN
3     CALL STER ('PSL',2,T,0.)
      RETURN
      END
!C
      FUNCTION TSLFCT(PIN,K)
!C
      COMMON /NUST/ TCORE,SCORE,VCORE,DPDT
      REAL*8 B(12),DPIN,F,TX,TY,TZ,W,Y,DP,PR,PA,TOL
      DATA (B(I),I=1,12) /
     1 1.52264682686D0,-.682309517937D0,.164114951728D0,
     + -2.02321648831D-3,
     1 -1.92391110748D-3,-5.74549418696D-4,6.84115542402D-5,
     + 3.36500068426D-5,
     2 -1.23422483951D-5,1.48265501702D-6,-1.02116445578D-6,
     + -4.09080904092D-6 /
      DPIN = PIN
      I=1
      TOL=1.D-4
      IF (K.EQ.2) TOL=1.D-6
      F=1.D0
```

```
      IF (DPIN.GT.3208.234765D0) GO TO 7
      TSLFCT=705.47
      IF (DPIN.GE.3208.2347D0) GO TO 3
      I=-1
      TX=1.D0
      TY=(DLOG(3529.058235D0/DPIN)**0.4-1.48047125D0)/(-1.089944005D0)
      Y=2.*TY
      W=B(1)+TY*B(2)
      DO 2 N=3,12
      TZ=Y*TY-TX
      W=W+TZ*B(N)
      TX=TY
      TY=TZ
2     CONTINUE
      TSLFCT=1165.14/W-459.67
3     TY=.01
      I=1
      IF (TSLFCT.GT.705.47) TSLFCT=705.47
4     PA=PSL1(TSLFCT)
      DP=DPIN-PA
      PR=DP/DPIN
      TSLFCT=TSLFCT+F*DP/DPDT
      IF (ABS(PR) .LT. TOL) RETURN
5     IF (I.GT.29) RETURN
      I=I+1
      F=F*0.99D0
      IF (TSLFCT .LT. 705.47) GO TO 4
6     TY=0.9*TY
      TSLFCT=TSLFCT-TY
      GO TO 4
7     CALL STER ('TSL',I,PIN,0.)
8     RETURN
      END
!C
      FUNCTION P23T (TIN)
!C
!C    ARGUMENT IS TEMPERATURE
!C    RETURNS WITH PRESSURE
!C    BOUNDARY BETWEEN REGIONS 2 AND 3
      T=TIN
      P23T=0.
      IF (T.LT.32.) RETURN
      IF (T.GT.1600.) CALL STER ('P23T',2,T,0.)
      THETA=(T+459.67)/1165.14
      P23T=(1.574373327E1+THETA*(-3.417061978E1+THETA*1.931380707E1))*
     1 3208.234759
      RETURN
      END
!C
      FUNCTION HCSFCT(P,T,V,S,IGO,INT,PB,TC,VTRY,VMIN,VMAX,TOL)
!C
      DIMENSION VTRY(*)
      DIMENSION SUM(16),THETA(10),Q(9),X(9),C0(12),
     1     C1(10),C2(10),C3(10),C6(9),C7(9),PCT(3),Y(5),
     2     D3(5),D4(5)
      REAL*8 BR,P1,V1,C0,C1,C2,C3,C6,C7,D3,D4,C41,C50,D50,D51,D52,
```

```
     +        G,R,DP,B,SUM,SUM1,SUM2,SUM3,THETA,Q,X,Y,PCT,PCTP,DF,VTRY2(3),
     +        VPREV,PPREV
      DATA C40 / 2.759717760D-6 /
      DATA (C0(I),I=1,12) / -.017226042D0,-7.77175039D0,4.20460752D0,
     = -2.76807038D0,2.10419707D0,-1.14649588D0,.223138085D0,
     + .116250363D0,
     = -.0820900544D0,.0194129239D0,-1.694705760D-3,-4.311577033D0 /
      DATA (C1(I),I=1,10) / .708636085D0,12.3679455D0,-12.0389004D0,
     = 5.40437422D0,-.993865043D0,.0627523182D0,0.D0,0.D0,0.D0,
     + -7.74743016D0 /
      DATA (C2(I),I=1,10) / -4.29885092D0,43.1430538D0,-14.1619313D0,
     = 4.04172459D0,1.55546326D0,-1.66568935D0,.324881158D0,0.D0,0.D0,
     + 29.3655325D0 /
      DATA (C3(I),I=1,10) / 7.948418420D-6,80.8859747D0,-83.615338D0,
     = 35.8636517D0,7.51895954D0,-12.616064D0,1.09717462D0,2.12145492D0,
     = -.546529566D0,8.32875413D0 /
      DATA (C6(I),I=1,9) / .05528935335D0,-.2336365955D0,.369707142D0,
     = -.259641547D0,.06828087013D0,0.D0,0.D0,0.D0,0.D0 /
      DATA (C7(I),I=1,9) / -257.1600553D0,-151.8783715D0,22.20723208D0,
     = -180.203957D0,2357.09622D0,-1.462335698D4,4.542916630D4,
     + -7.053556432D4, 4.381571428D4 /
      DATA C41/ -5.090739850D-4 /
      DATA C50/ 2.106363320D2 /
      DATA (D3(I),I=1,5) / -1.717616747D0,3.526389875D0,-2.690899373D0,
     = .9070982605D0,-.1138791156D0 /
      DATA (D4(I),I=1,5) / 1.301023613D0,-2.642777743D0,1.996765362D0,
     = -.6661557013D0,.08270860589D0 /
      DATA D50 / 3.426663535D-4 /
      DATA D51/ -1.236521258D-3 /
      DATA D52/ 1.155018309D-3 /
      DATA G/ 80.409939D0 /
      DATA R/ 107.2132505D0 /
      VMAX2 = VMAX
      VMIN2 = VMIN
      DP = P
      DO 9000 I=1,3
9000  VTRY2(I) = VTRY(I)
1     K=1
      NT=1
      BETA=P/3208.234759D0
!C    THETA   =((T-32.0)/1.8+273.15)/647.3
      THETA(1)=8.582659595D-4*T+0.3945191136D0
      DF=0.25D0
      PCTP=0.D0
2     CONTINUE
      IF (VTRY2(1).LE.VMAX2) GO TO 3
      VTRY2(1)=VMAX2
      DF=1.D0
      GO TO 4
3     IF (VTRY2(1).GE.VMIN2) GO TO 4
      VTRY2(1)=VMIN2
      DF=1.D0
!C    SET-UP FOR SUB-REGION 3 PARAGRAPH 9.3 FOR PRESSURE CALCULATION
4     X(1)=VTRY2(K)/3.17D0
      DO 5 I=1,16
5     SUM(I)=0.D0
```

```
      Q(1)=THETA(1)-1.D0
      DO 6 I=2,9
      Q(I)=Q(I-1)*Q(1)
      X(I)=X(I-1)*X(1)
      THETA(I)=THETA(I-1)*THETA(1)
      B=DBLE(1-I)/X(I)
      SUM(1)=SUM(1)+B*C0(I)
      SUM(2)=SUM(2)+B*C1(I)
      SUM(3)=SUM(3)+B*C2(I)
      SUM(4)=SUM(4)+B*C3(I)
6     SUM(5)=SUM(5)+C6(I-1)/THETA(I)
!C    THE FOLLOWING ARE THE LAST TWO TERMS OF SUM(1)
      SUM(1)=SUM(1)-(9.D0*C0(10)/X(1)+10.D0*C0(11)/X(2))/X(9)
!C    THE FOLLOWING ARE THETA**22 AND THETA**23
      THETA(8)=THETA(7)*THETA(7)*THETA(7)*THETA(1)
      THETA(9)=THETA(8)*THETA(1)
      THETA(10)=1.D0
!C    SET-UP FOR SUB-REGION 4 PARAGRAPH 9.4
      IF (INT .EQ. 0) GO TO 9
7     Y(1)=(1.0D0-THETA(1))/3.730882125D-2
      SUM1=0.D0
      SUM2=3.0D0*D3(1)+4.0D0*D4(1)*Y(1)
      SUM3=D3(1)*(-2.0D0*Y(1)+G)+D4(1)*(-3.0D0*Y(1)+R)*Y(1)
      DO 8 I=2,5
      Y(I)=Y(I-1)*Y(1)
      SUM1=SUM1+(DBLE(I)-1.0D0)*(D3(I)+Y(1)*D4(I))/X(I)
      SUM2=SUM2+(3.0D0*D3(I)+4.0D0*D4(I)*Y(1))/X(I-1)
8     SUM3=SUM3+(D3(I)*(DBLE(I-3)*Y(1)+G)+D4(I)*(DBLE(I-4)*Y(1)+R)*
     1Y(1))/X(I-1)
      SUM1=SUM1*Y(3)
      SUM2=SUM2*Y(2)
      SUM3=SUM3*Y(2)
!C
!C     *********  PATCH FOR IBM PC MACHINE RANGE **********
!C
!C    Y(5) = DMAX1(Y(5),5.3D-52)**6
      Y(5) = Y(5)**6
      BR = SUM1
      HCSFCT = SUM3
      S = SUM2/3.73088212D-2
!C    IF (Y(5) .LT. 1.0D-37) GO TO 10
!C
!C     *********  END OF PATCH *********
!C
!C    P FROM SUB-REGION 4 PARAGRAPH 9.4
      BR=SUM1-Y(5)*Y(2)*(D51+2.0D0*D52*X(1))
!C    H FROM SUB-REGION 4 PARAGRAPH 9.4
      HCSFCT=SUM3-Y(5)*Y(1)*((31.D0*D50+32.D0*D51*X(1)+33.D0*D52*
     + X(2))*Y(1)-(D50+D51*X(1)+D52*X(2))*857.7060043D0)
!C    S FROM SUB-REGION 4 PARAGRAPH 9.4
      S=(SUM2+32.D0*Y(5)*Y(1)*(D50+D51*X(1)+D52*X(2)))/3.730882125D-2
      GO TO 10
9     BR=0.D0
      S=0.
      HCSFCT=0.
!C    P FROM SUB-REGION 3 PARAGRAPH 9.3
```

```
10    BR=(-C0(1)-SUM(1)-C0(12)/X(1)-(C1(1)+SUM(2)+C1(10)/X(1))*Q(1)-(
     1C2(1)+SUM(3)+C2(10)/X(1))*Q(2)-(C3(1)+SUM(4)+C3(10)/X(1))*Q(3)+
     + 5.D0*C41/X(6)*Q(1)/THETA(9)-6.D0*X(5)*SUM(5)+BR)*3208.234759D0
      PCT(K)=(BR-DP)/DP
      IF (DABS(PCT(K)).GT.TOL) GO TO 12
!C    REPLACE THIS CONVERSION IF VLIQ IS CHANGED TO USE ENGRG. UNITS
      V=VTRY2(K)/62.4279605761D0
      SUM(10)=C7(1)
      SUM(16)=C7(1)
      DO 11 I=2,9
      SUM(6)=SUM(6)+C1(I)/X(I-1)
      SUM(7)=SUM(7)+C2(I)/X(I-1)
      SUM(8)=SUM(8)+C3(I)/X(I-1)
      SUM(9)=SUM(9)+DBLE(I)*C6(I-1)/THETA(I+1)
      SUM(10)=SUM(10)+DBLE(I)*C7(I)*Q(I-1)
      B=DBLE(I)
      SUM(11)=SUM(11)+B*C0(I)/X(I-1)
      SUM(12)=SUM(12)+(B-1.D0)*C1(I)/X(I-1)
      SUM(13)=SUM(13)+(B-2.D0)*C2(I)/X(I-1)
      SUM(14)=SUM(14)+(B-3.D0)*C3(I)/X(I-1)
      SUM(15)=SUM(15)+(B-5.D0)*C6(I-1)/THETA(I)
11    SUM(16)=SUM(16)+C7(I)*(1.D0+(B-1.D0)*THETA(1))*Q(I-1)
      SUM(11)=SUM(11)+(10.D0*C0(10)+11.D0*C0(11)/X(1))/X(9)
      GO TO (18,19,21,18,21,18), IGO
12    IF (NT.GT.1000) GO TO 20
      IF (NT.LT.2) GO TO 16
      IF (PCTP*PCT(1)) 14,14,13
13    IF (DABS(PCT(1)).GT.DABS(0.3D0*PCTP)) GO TO 15
14    DF=0.67D0*DF
      DV=(VTRY2(1)-VPREV)*(P-BR)/(BR-PPREV)
      GO TO 17
15    DF=1.5D0*DF
16    DV=VTRY2(1)*PCT(1)*DF
17    VPREV=VTRY2(1)
      PPREV=BR
      PCTP=PCT(1)
      VTRY2(1)=VTRY2(1)+DV
      NT=NT+1
      GO TO 2
!C    H FROM SUB-REGION 3 PARAGRAPH 9.3
18    HCSFCT=(-213.164655D0-C1(1)*X(1)+SUM(11)-SUM(6)+(C0(12)-C1(10))*
     + DLOG(X(1))+Q(1)*(-C1(10)-C50-(C1(1)+2.D0*C2(1))*X(1)+SUM(12)-
     + 2.D0*(SUM(7)+C2(10)*DLOG(X(1))))+Q(2)*(-C2(10)-(2.D0*C2(1)+
     + 3.D0*C3(1))*X(1)+SUM(13)-3.D0*SUM(8)-(C2(10)+3.D0*C3(10))*
     + DLOG(X(1)))+Q(3)*(-3.D0*C3(1)*X(1)+SUM(14)-C3(10)*(1.D0+
     + 2.D0*DLOG(X(1))))+(C40*(23.D0-24.D0/THETA(1))-
     + C41*(-28.D0+29.D0/THETA(1))/X(5))/THETA(8)+X(6)*SUM(15)-SUM(16)+
     + HCSFCT)*30.14634566D0
      GO TO (21,21,21,19,21,19), IGO
!C    S FROM SUB-REGION 3 PARAGRAPH 9.3
19    S=(1.583237108D-6-C1(1)*X(1)-SUM(6)-C1(10)*DLOG(X(1))-C50-
     + 2.D0*Q(1)*(C2(1)*X(1)+SUM(7)+C2(10)*DLOG(X(1)))-3.D0*Q(2)*
     + (C3(1)*X(1)+SUM(8)+C3(10)*DLOG(X(1)))+(C40+C41/X(5))*(22.D0-
     + 23.D0/THETA(1))/THETA(9)-C50
     + *DLOG(THETA(1))+X(6)*SUM(9)-SUM(10)+S)*2.587358228D-2
      GO TO 21
```

```
20    CALL STER ('HCSL1',-12,P,T)
21    DO 9001 I=1,3
9001  VTRY(I) = VTRY2(I)
      RETURN
      END
!C
      FUNCTION PSL1(T)
!C
      J=2
      PSL1=PSLFCT(T,J)
      RETURN
      END
!C
      FUNCTION VLIQ (PIN,TIN,VMIN,VMAX)
!C
      DIMENSION T(8), V(8), VT(30), PT(6), TT(6), VX(6)
      DATA (VT(I),I=1,30) / 1.568,1.612,1.661,1.717,1.803,1.864,1.480,
     = 1.504,1.535,1.567,1.598,1.628,1.424,1.443,1.462,1.487,1.512,
     = 1.529,1.349,1.362,1.374,1.393,1.416,1.420,1.30,1.312,1.324,1.336,
     = 1.354,1.376 /
      DATA (PT(I),I=1,6) / 0.,276.,414.,552.,828.,1000. /
      DATA (TT(I),I=1,6) / 348.89,354.45,360.,365.55,371.11,375. /
      DATA (T(I),I=1,8) / 350.,360.,370.,371.,372.,373.,374.,374.15 /
      DATA (V(I),I=1,8) / 1.741,1.894,2.22,2.29,2.38,2.51,2.80,3.17 /
!C  0  PIN MUST BE IN BARS AND TC IN DEGREES C
!C     V WILL BE IN CC/GM
      PT(1)=(PSL(TIN*1.8+32.))/14.503773773
      VX(1)=GRS(T(1),1,V(1),1,TIN,8,I)
      DO 1 I=2,6
1     VX(I)=GRS(TT(1),1,VT(6*I-11),1,TIN,6,J)
      VLIQ=GRS(PT(1),1,VX(1),1,PIN,6,I)
      VMIN=.98*VX(6)
      VMAX=VX(1)*1.01
      RETURN
      END
!C
      FUNCTION HCSLV2(P,T,V,S,IGO)
!C
      DIMENSION VTRY(3)
      INT=0
!C V FROM VEST IS IN CC/GM
      PB = P/14.504
      TC = (T-32.0)/1.8
      CALL VEST (PB,TC,VTRY)
      VMAX=8.9
      VMIN=1.28
      TOL=5.0E-7
      IF (P .GE. 2300.) TOL = 1.5E-6
      HCSLV2=HCSFCT(P,T,V,S,IGO,INT,PB,TC,VTRY,VMIN,VMAX,TOL)
      RETURN
      END
!C
      SUBROUTINE VEST (PBARS,TC,VOUT)
!C
      REAL*8 A(10), B(11), P, T, S1, S2, S3
      DATA (A(I),I=1,10) / -1.1081080D1,3.2788736D-2,5.317674D-4,
```

```
     = -3.0184685D-8,7.8976204D1,-2.4914446D-1,1.9435772D-4,
     + -3.8913564D4,
     = 1.1542136D2,-8.4902827D-2 /
      DATA (B(I),I=1,11) / 2.7449451D1,-1.2338849D5,5.7668847D2,
     = -8.7256055D-1,3.4473356D-4,2.1473469D4,-1.5646970D2,2.0968062D-1,
     = -3.2079651D7,1.1201540D5,-9.7660051D1 /
      P=PBARS
      T=TC+273.15
      IF (TC .GT. 0.32*P+294.) GO TO 1
      S1=((A(10)*T+A(9))*T+A(8))*T
      S2=((A(7)*T+A(6))*T+A(5))*T
      S3=((A(4)*T-(A(3)*T)**18)*T+A(2))*T
      VOUT=(S1/P+S2)/P+S3+A(1)
      RETURN
1     S1=((B(11)*T+B(10))*T+B(9))*T
      S2=((B(8)*T+B(7))*T+B(6))*T
      S3=((B(5)*T+B(4))*T+B(3))*T+B(2)
      VOUT=((S1/P+S2)/P+S3)/P+B(1)
      RETURN
      END

      FUNCTION CPL(PF,TF)
!C
!C
!C      SPECIFIC HEAT OF COMPRESSED LIQUID
!C        AS A FUNCTION OF PRESSURE AND TEMPERATURE
!C                  C = F(P,T)
!C
!C          CALLING SEQUENCE - C = CPL(P,T)
!C
!C          C     SPECIFIC HEAT IN BTU/LB.-DEGREES F.          OUTPUT
!C          P     PRESSURE IN PSIA                        INPUT
!C          T     TEMPERATURE IN DEGREES F.                    INPUT
!C
!C
!C
      DIMENSION C(2)
      IND = 0
      T = TF
      P = PF
      IF (P .LT. 3208.234) THEN
        TSAT = TSL(P)
      ELSE
        TSAT = 705.47
      ENDIF
      H = 2.0
      IF (P .LT. 3000. .OR. P .GT. 4350.) GO TO 3
      IF (T .LT. 657. .OR. T .GT. 677.) GO TO 3
      T = 657.0
      DO 4 I=1,2
      C(I) = (HCL(P,T-2.*H,S)-HCL(P,T+2.*H,S)+
     1  8.*(HCL(P,T+H,S)-HCL(P,T-H,S)))/(12.*H)
      T = T+20.
4     CONTINUE
      CPL = C(1)+(TF-657.)*((C(2)-C(1))*0.05)
      RETURN
```

```
3     IF (P .GT. 4350. .AND. T .GT. 657.) GO TO 2
      H1=(TSAT-T)*0.5
      IF (H1 .LT. H) H=H1
      IF (H .GE. 0.125) GO TO 1
      H = 0.075
      T = TSAT-0.25
1     CONTINUE
      CPL = (HCL(P,T-2.*H,S)-HCL(P,T+2.*H,S)+
     1 8.*(HCL(P,T+H,S)-HCL(P,T-H,S)))/(12.*H)
      IF (IND .EQ. 0) RETURN
!can
!can Since CPV function makes trubles, it was ommited!
!can      C1 = CPL
!can      C2 = CPV(P,707.,S,V)
!can      CPL = C1+(TF-657.)*((C2-C1)/50.)
      RETURN
2     IND = 1
      T = 657.
      GO TO 1
      END
      FUNCTION CPV(PF,TF,VF)
!CCC
!C
!C      SPECIFIC HEAT AND SPECIFIC VOLUME OF SUPERHEATED STEAM
!C        AS A FUNCTION OF PRESSURE AND TEMPERATURE
!C                  C,V(= F(P,T)
!C
!C          CALLING SEQUENCE - C = CPV(P,T,V)
!C
!C          C     SPECIFIC HEAT IN BTU/LB.-DEGRESS F.          OUTPUT
!C          P     PRESSURE IN PSIA                        INPUT
!C          T     TEMPERATURE IN DEGREES F.                INPUT
!C          V     SPECIFIC VOLUME IN CUBIC FEET/LB.            OUTPUT
!C
!C
      T=TF
      P = PF
      IF (P .LT. 3208.234) THEN
        TSAT = TSL(P)
      ELSE
        TSAT = 705.47
      ENDIF
      H = 2.
      H1 = (T-TSAT)*0.5
      IF (H1 .LT. H) H = H1
      IF (H .GE. 0.125) GO TO 1
      H = 0.075
      T = TSAT+0.25
1     CONTINUE
      CPV = (HSS(P,T-2.*H,S,V)-HSS(P,T+2.*H,S,V)+
     &  8.*(HSS(P,T+H,S,V1)-HSS(P,T-H,S,V2)))/(12.*H)
      VF = 0.5*(V1+V2)
      IF (H .LE. 2.) V1 = HSS(P,TF,S,VF)
      RETURN
      END
*******************************************************************************
```

```
      Subroutine Void_Frac_Correlations

      Use MainVar
      implicit none
      integer count

      double precision Viscratio, Xratio, Rhoratio, BB, n1, n2, n3,
     +Homogen(50), Zivi(50), Wallis(50), LockMart(50), Cun_Yeh(50),
     +Thom(50), Baroczy(50), Vg, Vf, Rbcr, Vbcr

      open (6, file = 'output.txt')

      Gravity = 32.174
      Gravitym = 9.807

      count = 1
      do while (Z(count) <= 12)
      supfclvap(count) = (Mdotg(count)/(RHOG*Area))
      supfclliq(count) = (Mdotf(count)/(RHOF*Area))
!     vappt(count)= RHOG*(supfclvap(count)**2)
!     liqpt(count)= RHOF*(supfclliq(count)**2)
      count = count + 1
      enddo

! Void Fraction Correlations Comparisons
      Rhoratio = RHOG/RHOF
      Viscratio = VISCF/VISCG
!     write(6,*) 'Rbcr     Vbcr     Vg     Vf'
      count = 1
      do while (Z(count) <= 12)
      if (Quality(count) <= 0) then
      Homogen(count) = 0.
      Zivi(count) = 0.
      Wallis(count) = 0.
      LockMart(count) = 0.
      Thom(count) = 0.
      Baroczy(count) = 0.
      Cun_Yeh(count) = 0.
      Cun_Yeh_Mod(count) = 0.
      else if (Quality(count) >= 1) then
      Homogen(count) = 1.
      Zivi(count) = 1.
      Wallis(count) = 1.
      LockMart(count) = 1.
      Thom(count) = 1.
      Baroczy(count) = 1.
      Cun_Yeh(count) = 1.
      Cun_Yeh_Mod(count) = 1.
      else
      Xratio = (1-Quality(count))/Quality(count)
      BB = 1.
      n1 = 1.
      n2 = 1.
      n3 = 0.
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      Homogen(count)=0.
```

```
      else
      Homogen(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 1.
      n1 = 1.
      n2 = 0.67
      n3 = 0.
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      Zivi(count)=0.
      else
      Zivi(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 1.
      n1 = 0.72
      n2 = 0.40
      n3 = 0.08
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      Wallis(count)=0.
      else
      Wallis(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 0.28
      n1 = 0.64
      n2 = 0.36
      n3 = 0.07
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      LockMart(count)=0.
      else
      LockMart(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 1.
      n1 = 1.
      n2 = 0.89
      n3 = 0.18
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      Thom(count)=0.
      else
      Thom(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 1.
      n1 = 0.74
      n2 = 0.65
      n3 = 0.13
      if (1+BB*(Xratio**n1)*(Rhoratio**n2)*(Viscratio**n3).eq.0.00) then
      Baroczy(count)=0.
      else
      Baroczy(count) = (1+BB*(Xratio**n1)*(Rhoratio**n2)*
+(Viscratio**n3))**(-1)
      end if
      BB = 0.925
      Rbcr = ((1.53/(2./3.))**2)*((sigma/(Gravitym*RHOFM*1000))**0.5)
```

```
          Vbcr = (2./3.)*((Gravitym*Rbcr)**0.5)
          Vg = supfclvap(count)*0.3048
          Vf = supfclliq(count)*0.3048
!         write(6,10) Rbcr, Vbcr, Vg, Vf
          if ((Vg/Vbcr).LE.1.0) then
          Cun_Yeh(count)=0.925*(Rhoratio**0.239)*((Vg/Vbcr)**0.67)*
     +((Vg/(Vg+Vf))**0.6)
!         else if ((Vg/Vbcr).GE.4.31) then
!         Cun_Yeh(count)=1.035*(Rhoratio**0.239)*((Vg/Vbcr)**0.393)*
!     +((Vg/(Vg+Vf))**0.6)
          else
          Cun_Yeh(count)=0.925*(Rhoratio**0.239)*((Vg/Vbcr)**0.47)*
     +((Vg/(Vg+Vf))**0.6)
          end if
          if (Cun_Yeh(count) > 1.0) then
          Cun_Yeh(count) = 1.0
          end if
          if ((Vg/Vbcr).LE.1.0) then
          Cun_Yeh_Mod(count)=0.925*(Rhoratio**0.239)*((Vg/Vbcr)**0.67)*
     +((Vg/(Vg+Vf))**0.6)
          else if ((Vg/Vbcr).GE.4.31) then
          Cun_Yeh_Mod(count)=1.035*(Rhoratio**0.239)*((Vg/Vbcr)**0.393)*
     +((Vg/(Vg+Vf))**0.6)
          else
          Cun_Yeh_Mod(count)=0.925*(Rhoratio**0.239)*((Vg/Vbcr)**0.47)*
     +((Vg/(Vg+Vf))**0.6)
          end if
          if (Cun_Yeh_Mod(count) > 1.0) then
          Cun_Yeh_Mod(count) = 1.0
          end if
          end if
          count = count + 1
          end do
!
          write(6,*) '   '
          write(6,165)
165   format(/1X,'*************************
     + CALCULATED VOID FRACTION FOR VARIOUS VOID FRACTION CORRELATIONS
     + *************************')
          count = 1
      write(6,170)
170   format(/1X,'Elev.',2X,'Homogenous_Void',2X,'Zivi_Void',2X,
     +'Wallis_Void',2X,'LockMart_Void',2X,'Thom_Void',2X,'Baroczy_Void',
     +2X,'CunYeh_Void',2X,'CunYehMod_Void')
      write(6,175)
175   format(' (FT.)')
          do while (Z(count)<=12)
!
      write(6,180) Z(count),Homogen(count),Zivi(count),Wallis(count),
     +LockMart(count),Thom(count),Baroczy(count),Cun_Yeh(count),
     +Cun_Yeh_Mod(count)
180   format(1X,F5.2,4X,E10.4,4X,E10.4,3X,E10.4,3X,E10.4,3X,E10.4,3X,
     +E10.4,3X,E10.4,5X,E10.4)
          count=count+1
          end do
```

```
10      format(3X,E10.4,5X,E10.4,6X,E10.4,7X,E10.4)
        end
*******************************************************************************
        Subroutine DP_Cell_Orientation

        Use MainVar
        implicit none
        integer count

        count = 1
        do while (count.NE.23)
        PDropConv(count)=PDrop(count)*RHOSTP*Gravity/(12.*Gravity)
        count = count + 1
        end do

        DPZ(1)=0./12.
        DPZ(2)=13./12.
        DPZ(3)=25./12.
        DPZ(4)=37./12.
        DPZ(5)=43./12.
        DPZ(6)=46./12.
        DPZ(7)=53./12.
        DPZ(8)=57./12.
        DPZ(9)=60./12.
        DPZ(10)=63./12.
        DPZ(11)=67./12.
        DPZ(12)=72./12.
        DPZ(13)=75./12.
        DPZ(14)=78./12.
        DPZ(15)=81./12.
        DPZ(16)=85./12.
        DPZ(17)=93./12.
        DPZ(18)=97./12.
        DPZ(19)=100./12.
        DPZ(20)=108./12.
        DPZ(21)=120./12.
        DPZ(22)=133./12.
        DPZ(23)=144./12.

        DPAvg(1) = (DPZ(2)-DPZ(1))/2.
        count = 2
        do while (count.NE.23)
        DPAvg(count) = DPZ(count) + (DPZ(count+1)-DPZ(count))/2
        count = count + 1
        end do
        DPAvg(23) = DPZ(23)

        count = 1
        do while (count.NE.24)
        if (DPZ(count)<=9) then
        DPQuality(count)=0.0 + Powere/(Mdothr*HFG*Height)
   +*((DPZ(count)**2/18.+0.5*DPZ(count))-(Zsat**2/18.+0.5*Zsat))
        else
        DPQuality(count)=Quality(37) + Powere/(Mdothr*HFG*Height)
   +*((-(DPZ(count)**2)/6.+4.5*DPZ(count))-(-(9.**2)/6.+4.5*9.))
        end if
```

```
        if (DPQuality(count) < 0.0) then
        DPQuality(count) = 0.0
        else if (DPQuality(count) > 1.0) then
        DPQuality(count) = 1.0
        end if

        if (count.GE.2) then
        SpanAvgQuality(count-1)=(DPQuality(count-1)+DPQuality(count))/2.
        end if
        count = count + 1
        end do

        count = 1
        do while (count.NE.23)
        if (DPZ(count)<9.) then
        PFactor(count)=((DPZ(count)+DPZ(count+1))*6)/108 + 0.5
        else
        PFactor(count)=(-(DPZ(count)+DPZ(count+1))*6)/36 + 4.5
        end if
        Span_Avg_Power(count) = PFactor(count)*Avg_Heat_Flux
        count = count + 1
        end do
        end
*******************************************************************************************
        Subroutine Homogeneous

        Use MainVar
        implicit none
        integer count
        double precision nuavg

        count = 1
        do while (count.NE.23)
        nuavg = (NUF + SpanAvgQuality(count)*NUFG)

        if (SpanAvgQuality(count)==0.0) then
        Hom_Fric_PDrop(count)=2*FFactor*Mass_Flux**2/(Diam*gravity)*
   +(DPZ(count+1)-DPZ(count))*nuavg
        else
        Hom_Fric_PDrop(count)=2*FFactor*Mass_Flux**2/(Diam*gravity)*
   +((DPZ(count+1)-DPZ(count))*nuavg + 2*Span_Avg_Power(count)*NUFG/
   +(Diam*Mass_Flux*HFG)*(DPZ(count+1)**2-DPZ(count)**2))
        end if
        count = count + 1
        end do
        end
*******************************************************************************************
        Subroutine Homogeneous_Two_Phase

        Use MainVar
        implicit none
        integer count
        double precision fo

        fo = 16./(Mass_Flux*Diam*3600/VISCF)
```

```
          count = 1
          do while (count.NE.23)
          Hom_Two_Phase_Mult(count) = (1. +
     +(SpanAvgQuality(count)*NUFG/NUF))*
     +((1. + (SpanAvgQuality(count)*VISCFG/VISCG))**0.25)
          count = count + 1
          end do

          count = 1
          do while (count.NE.23)
          Hom_TP_Fric_PDrop(count) = 2*fo*Mass_Flux**2*NUF/(Diam*gravity)*
     +(DPZ(count+1)-DPZ(count))*Hom_Two_Phase_Mult(count)
!         write(*,*) Hom_TP_Fric_PDrop(count)
          count = count + 1
          end do
          end
*******************************************************************************************
          Subroutine Friedel

          Use MainVar
          implicit none
          integer count
          double precision invrhobar,fgo,ffo

      fgo=0.079/((Mass_Flux*3600*Diam/VISCG)**0.25)
      ffo=0.079/((Mass_Flux*3600*Diam/VISCF)**0.25)

          count = 1
          do while (count.NE.23)
          A1(count) = (1. - SpanAvgQuality(count))**2. +
     +(SpanAvgQuality(count)**2.)*(RHOF/RHOG)*(fgo/ffo)

          A2(count) = SpanAvgQuality(count)**0.78 *
     +(1.-SpanAvgQuality(count))**0.224

          A3(count) = (RHOF/RHOG)**0.91 * (VISCG/VISCF)**0.19 *
     +(1. - VISCG/VISCF)**0.7

          invrhobar = (NUF + SpanAvgQuality(count)*NUFG)

          Fr(count) = Mass_Flux**2.*(invrhobar**2.)/(gravity*Diam)

          We(count) = Mass_Flux**2.*Diam*invrhobar/(gravity*sigmae)

          Frdl_Two_Phase_Mult(count)=A1(count)+3.24*A2(count)*A3(count)/
     +((Fr(count)**0.045)*(We(count)**0.035))

          count = count + 1
          end do

          count = 1
          do while (count.NE.23)
          Frdl_Fric_PDrop(count)= 2*FFactor*NUF*(DPZ(count+1)-DPZ(count))*
     +Frdl_Two_Phase_Mult(count)*Mass_Flux**2/(Diam*gravity)
```

```
          count = count + 1
          end do

!         open (6, file = 'output.txt')
!         count = 1
!         do while (count.NE.23)
!         write(6,160) A1(count),A2(count),A3(count),
 !   +Fr(count),We(count)
!160   format(1X,E10.4,4X,E10.4,4X,E10.4,4X,E10.4,6X,E10.4)
!         write(6,*)
!         count = count + 1
!         enddo
          end
*******************************************************************************
          Subroutine Acceleration_Press_Drop

          Use MainVar
          implicit none
          integer count

          count = 1
          do while (count.NE.23)
          Accel_PDrop(count)=Mass_Flux**2*NUFG/gravity*
    +(DPQuality(count+1)-DPQuality(count))
!         write (*,*) Accel_PDrop(count)
          count = count + 1
          end do
          end
*******************************************************************************
          Subroutine Corrected_Press_Drop

          Use MainVar
          implicit none
          integer count

          count = 1
          do while (count.NE.23)
          Corrected_PDrop_Hom(count)=PDropConv(count)-Hom_Fric_PDrop(count)-
    +Accel_PDrop(count)
          ZCalc_Hom(count) = Corrected_PDrop_Hom(count)/RHOF
          Alpha_Hom(count) = 1.-(ZCalc_Hom(count)/(DPZ(count+1)-DPZ(count)))

          Corrected_PDrop_Hom_TP(count)=PDropConv(count)-Accel_PDrop(count)-
    +Hom_TP_Fric_PDrop(count)
          ZCalc_Hom_TP(count) = Corrected_PDrop_Hom_TP(count)/RHOF
          Alpha_Hom_TP(count) = 1. - ZCalc_Hom_TP(count)/(DPZ(count+1)-
    +DPZ(count))

          Corrected_PDrop_Frdl(count)=PDropConv(count)-
    +Accel_PDrop(count)-Frdl_Fric_PDrop(count)
          ZCalc_Frdl(count) = Corrected_PDrop_Frdl(count)/RHOF
          Alpha_Frdl(count) = 1. - (ZCalc_Frdl(count)/(DPZ(count+1)-
    +DPZ(count)))
!         write (*,*) Corrected_PDrop_Hom_Frdl(count)
          count = count + 1
          end do
```

```
          Call Grid_Effects

          count = 1
          do while (count.NE.23)
          Corrected_PDrop_Hom(count)= Corrected_PDrop_Hom(count) -
     +ElevDP_Hom(count)

          Corrected_PDrop_Hom_TP(count)=Corrected_PDrop_Hom_TP(count) -
     +ElevDP_Hom_TP(count)

          Corrected_PDrop_Frdl(count)=Corrected_PDrop_Frdl(count) -
     +ElevDP_Frdl(count)
!         write (*,*) Corrected_PDrop_Hom(count)
!         write (*,*) Corrected_PDrop_Hom_TP(count)
!         write (*,*) Corrected_PDrop_Frdl(count)
          count = count + 1
          end do
          end
*******************************************************************************
          Subroutine Interfacial_Drag

          Use MainVar
          implicit none
          integer count
          double precision ffo,Term1(25), Term2(25), Term3(25), Term4(25),
     +Term5(25), Term6(25)

      ffo=0.079/((Mass_Flux*3600*Diam/VISCF)**0.25)

!djm The various terms defined here are as follows:
!                   Term1 - The first term in equation 4.1 of Kelly's paper
!                   Term2 - The first term within the bracketed portion of eqn 4.1
!                   Term3 - The second term within the bracketed portion of eqn 4.1
!                   Term4 - Interfacial Drag Force per Unit Volume
!                   Term5 - Relative Velocity
!                   Term6 - Wall-Liquid Shear Force per Unit Volume times the void fraction

          count = 1
          do while (count.NE.23)
          Term1(count)=(1-Alpha_Frdl(count))*Alpha_Frdl(count)*gravity*
     +(RHOF-RHOG)

          Term2(count)=(1-Alpha_Frdl(count))*SpanAvgQuality(count)**2/
     +(Alpha_Frdl(count)*RHOG)

          Term3(count)=Alpha_Frdl(count)*(1-SpanAvgQuality(count))**2/
     +((1-Alpha_Frdl(count))*RHOF)

          Intrfcl_Drag(count)=(Term1(count)-Mass_Flux**2*
     +(1/(DPZ(count+1)-DPZ(count)))*(Term2(count)-Term3(count)))/gravity

          Term5(count)=Mass_Flux*(SpanAvgQuality(count)/RHOG-
     +(1-SpanAvgQuality(count))/RHOF)

          Term6(count)=(Frdl_Two_Phase_Mult(count)*2.*ffo*Mass_Flux**2/
```

```
     +(Diam*RHOF)*Alpha_Frdl(count))/gravity

           if (Alpha_Frdl(count).GE.0.80) then
           Intrfcl_Drag(count)=Intrfcl_Drag(count)+Term6(count)
           end if

           if (SpanAvgQuality(count)==0) then
           Intrfcl_Drag(count) = 0.0
           Intrfcl(count)=0.0
           else
           Intrfcl(count)=gravity*Intrfcl_Drag(count)/
     +(Term5(count)**2*RHOF)
           end if

           count = count + 1
           end do

           count = 1
           do while (count.NE.23)
!          write (*,*) Drag(count)
           count = count + 1
           end do
           end
*******************************************************************************
           Subroutine Results

           Use MainVar
           implicit none
           integer count

           open (6, file = 'output.txt')

           count=1
           write(6,*) '   '
           write(6,*) '   '
           write(6,*) '          ******* Friction Term Pressure Drop
     + Corrections ******* '
      write(6,50)
50    format(/1X,'DP_Cell',4X,'Hom_Fric_DP',4X, 'Hom_Two-Phase_Fric_DP',
     +4X,'Freidel_Fric_DP',7X,'Accel_DP_Correction')
!
      write(6,55)
55    format('  (in.)  ',4X,'(lbf/FT2)  ',5X,'   (lbf/FT2)   ',
     +9X,'  (lbf/FT2)',11X,'    (lbf/FT2)  ')
           do while (count.NE.23)
!
           write(6,60) DPAvg(count)*12., Hom_Fric_PDrop(count),
     +Hom_TP_Fric_PDrop(count),Frdl_Fric_PDrop(count),
     +Accel_PDrop(count)
60    format(1X,F7.2,4X,E10.4,10X,E10.4,12X,E10.4,15X,E10.4)

           count=count+1
           end do

           count = 1
           write(6,*) '   '
```

```
          write(6,*) '   '
          write(6,*) '          ******* Resulting Corrected Pressure Drop
     + Terms ******* '
      write(6,65)
65    format(/1X,'DP_Cell',6X,'Hom_DP',5X,'Hom_Two-Phase_DP',
     +5X,'Freidel_DP')
!
      write(6,70)
70    format('  (in.)  ',4X,
     +'(lbf/FT2) ',3X,'   (lbf/FT2)   ',3X,'  (lbf/FT2)')
          do while (count.NE.23)
!
          write(6,75) DPAvg(count)*12.,Corrected_PDrop_Hom(count),
     +Corrected_PDrop_Hom_TP(count),Corrected_PDrop_Frdl(count)
75    format(1X,F7.2,4X,E10.4,6X,E10.4,8X,E10.4)
          count=count+1
          end do
          count = 1
          write(6,*) '   '
          write(6,*) '   '
          write(6,*) '          ******* Calculated Void Fraction
     + ******* '
      write(6,80)
80    format(/1X,'DP_Cell',5X,'Homogeneous',4X,'Hom_Two-Phase',6X,
     +'Freidel',8X,'Flow_Regime')
!
      write(6,85)
85    format('  (in.)  ')
          do while (count.NE.23)
!
          write(6,90) DPAvg(count)*12., Alpha_Hom(count),
     +Alpha_Hom_TP(count),Alpha_Frdl(count),Flow_Char(count)
90    format(1X,F7.2,5X,E10.4,7X,E10.4,6X,E10.4,7X, A25)

          count=count+1
          end do
          count=1
          write(6,*) '   '
          write(6,*) '   '
          write(6,*) '          ******* Interfacial Drag Calculated
     + Results ******* '
      write(6,95)
95    format(/1X,'DP_Cell', 5X,' Int._Drag', 5X,
     +'fi*Ai/Volume')
!
      write(6,100)
100   format('  (in.)  ',4X,'(lbf/(FT3))  ',5X,'(1/FT)  ')
          do while (count.NE.23)
!
          write(6,105) DPAvg(count)*12.,Intrfcl_Drag(count), Intrfcl(count)
105   format(1X,F7.2,5X,E10.4,6X,E10.4)

          count=count+1
          end do
          end
```

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10. SUPPLEMENTARY NOTES
K. Tien, NRC Project Manager

11. ABSTRACT (200 words or less)

A series of two-phase level swell and uncovery experiments have been performed in the US Nuclear Regulatory Commission/ Penn State Rod Bundle Heat Transfer Test (RBHT) Facility. A total of 75 experiments were performed in a quasi-steady state manner in which the inlet flooding rated into the RBHT rod bundle was slowly decreased in steps and the two-phase mixture level in the bundle was allowed to decrease. In several of the experiments the top region of the rod bundle became uncovered and the heater rod temperatures were significantly above the saturation temperature. The range of conditions investigated in the experiments were: pressure, 0.138 to 0.414 Mpa (20 to 60 psia); Inlet subcooling 11.1 to 69.4 degrees K (20 to 125 degrees F); Inlet injection temperature 334 to 393 degrees K (142 to 247 degrees F); Peak linear power 0.492 to 1.31 kw/m (0.15 to 0.4 kw/ft); and Inlet flooding rate 2.54 to 40.64 mm/s (0.1 to 1.6 in/s). A one-dimensional energy balance was used to calculate the saturation location in the bundle as well as the local fluid quality. The resulting calculations were used to estimate the single and two-phase friction and acceleration pressure drop components such that the differential pressure measurements could be corrected and used to estimate the local void fraction distribution along the heated bundle. The two-phase mixture level or dryout locations were also determined from the heater rod thermocouple response as the local heat transfer changed from boiling to steam cooling. The resulting data can be used to assess the void fraction and heat transfer models in NRC safety analysis computer codes.

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