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Volume 2

Rod Bundle Heat Transfer Facility Steam Cooling with Droplet Injection Experiments Data Report

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Rod Bundle Heat Transfer Facility Steam Cooling with Droplet Injection Experiments Data Report

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ABSTRACT

As part of the Nuclear Regulatory Commission safety analysis computer code development efforts, the Rod Bundle Heat Transfer (RBHT) test facility has been designed and constructed at The Pennsylvania State University. The test series described in this report is the steam cooling tests with droplet injection. A total of 85 steady-state steam cooling experiments with prescribed droplet injection was performed in the RBHT. The purpose of the experiments was to examine steady-state dispersed flow film boiling in prototypical rod bundle geometry for computer code model development and validation.

The Rod Bundle Heat Transfer facility is a full length, 3.66 m (12 ft.), 7 by 7 rod array with typical Pressurized Water Reactor rod diameters of 9.49 mm (0.374 in.) and a rod pitch of 12.59 mm (0.496 in.). The heater rods have a top skewed power shape with a peak to average power of 1.5 at the 2.74 m (9 ft.) elevation. The RBHT facility has been designed using prototypical mixing vane spacer grids.

The bundle inlet steam Reynolds number ranged from 2000 to 15,000 with most of the experiments at the lower Reynolds number range. The droplets were injected upward in the center of the sub-channels at the 1.295 m (51 in.) elevation using two or four injection tubes. The injection tubes used a single row, linear hole pattern of four holes per sub-channel and four sub-channels per tube in the center of the bundle. One additional hole was located at the center of the rod gap location to minimize the chance of local boiling in the injection tube. The hole sizes used were 0.381 mm (0.015 in.) and 0.254 mm (0.01 in.). The injection tubes were bench tested before the bundle tests to optimize the performance of the liquid jets such that the injected droplets would flow upwards in the center of the sub-channel. The droplet sizes issuing from the holes were also measured. The selected hole sizes would produce drops that were typical of the drop sizes observed in the RBHT and FLECHT-SEASET reflood experiments.

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 (LB) LOCA, 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 steam cooling with droplet injection tests. The data from these tests will be used to develop and assess the droplet 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 (RBHT) test facility has been designed and constructed at The Pennsylvania State University to provide data and associated analysis to help support the code development efforts. This report describes one of the test series in the RBHT which included 85 steady-state steam cooling experiments with prescribed droplet injection. The purpose of the experiments was to examine steady-state dispersed flow film boiling in a prototypical rod bundle geometry for computer code model development and validation.

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 x 7 rod array with four unheated corner rods and 45 heated electrical rod which simulate a 17 x 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 12.59 mm (0.496 in.). The heater rods have a top skewed power shape with a peak to average power of 1.5 at the 2.74 m (9 ft.) elevation.

The droplet flow rates were estimated from examination of the RBHT and FLECHT-SEASET reflood experiments so as to obtain approximately the same two-phase quality behavior in the bundle with droplet injection. A droplet injector was designed and tested to provide the prescribed liquid flow rates at or very near the saturation temperature at the pressure of the experiments. It was found that the jet injection behavior was very sensitive to the temperature of the injection temperature or subcooling since high subcoolings would cause condensation and would collapse the droplet jet into a single stream.

The bundle inlet steam Reynolds number ranged from 2000 to 15,000 with most of the experiments at the lower Reynolds number range. The droplets were injected upward in the center of the sub-channels at the 1.295 m (51 in.) elevation using two or four injection tubes. The injection tubes used a single row, linear hole pattern of four holes per sub-channel and four sub-channels per tube such that the injection was in the center sub-channels of the bundle. One additional hole was located at the center of the rod gap location to minimize the chance of local boiling in the injection tube. The hole sizes used were 3.81 mm (0.015 in.) and 0.254 mm (0.01 in.). The injection tubes were bench tested before the bundle tests to optimize the performance of the liquid jets such that the injected droplets would flow upwards in the center of the sub-channel rather than impact the heater rods, causing early rod quench. The droplet sizes issuing from the holes were also measured. The selected hole sizes would produce drops that were typical of the drop sizes observed in the RBHT and FLECHT-SEASET reflood experiments.

The experiments were performed using a constant power rather than simulating the reactor decay power. The use of a constant bundle power enabled the bundle to reach a steady-state condition which then resulted in quasi-steady film boiling over the majority of the bundle length with droplet injection. There were approximately 500 channels of transient data recorded for each test including the bundle power, heater rod temperatures, upper plenum pressure, inlet flow rate, inlet water temperature, superheated vapor temperatures in the bundle, spacer grid temperatures, liquid carryout of the bundle, and the detailed axial bundle pressure drop. The experiments indicated the non-equilibrium behavior of the superheated steam with entrained saturated droplets. The experimental data has been qualified and submitted to the Nuclear Regulatory Data bank for analysis and computer code validation.

APPENDIX A. DATA PLOTS FOR INDIVIDUAL EXPERIMENTS

(CONTINUING FROM TEST 4042G)

RBHT Steam Cooling with Droplet Injection Test SCD-4042-G

Matrix Test # 2c

Test Conditions

Test Date – 11/1/2005
Steady State Time Window: 19620 – 20280
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55.0 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.7 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.011 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.381 mm (.015 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

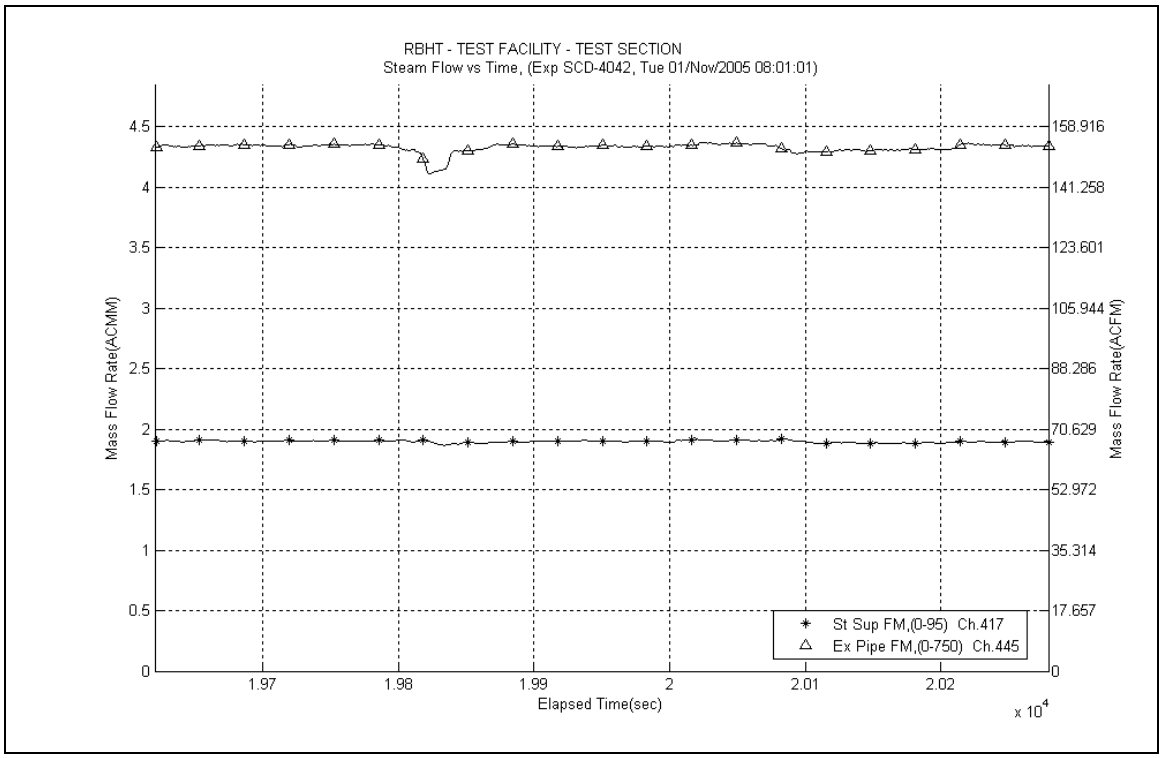

Figure A-1: Inlet and Exhaust Steam Flow Rates for Experiment 4042G

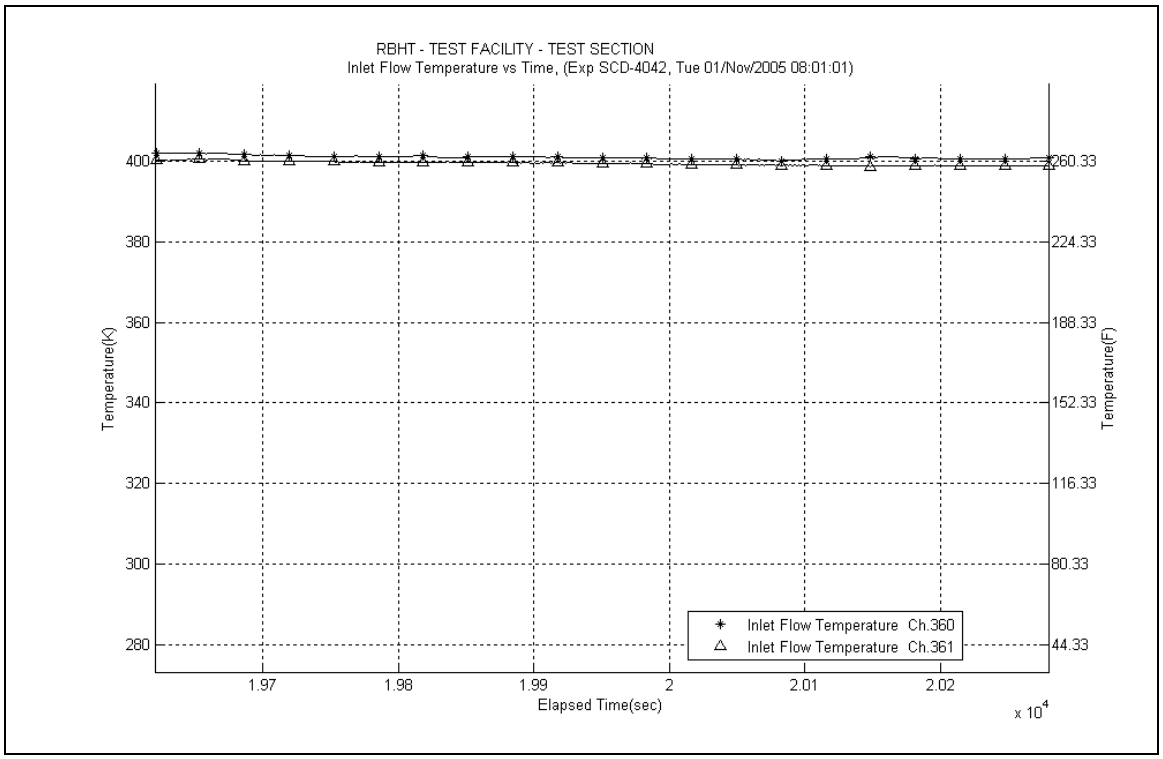

Figure A-2: Inlet Steam Temperature for Experiment 4042G

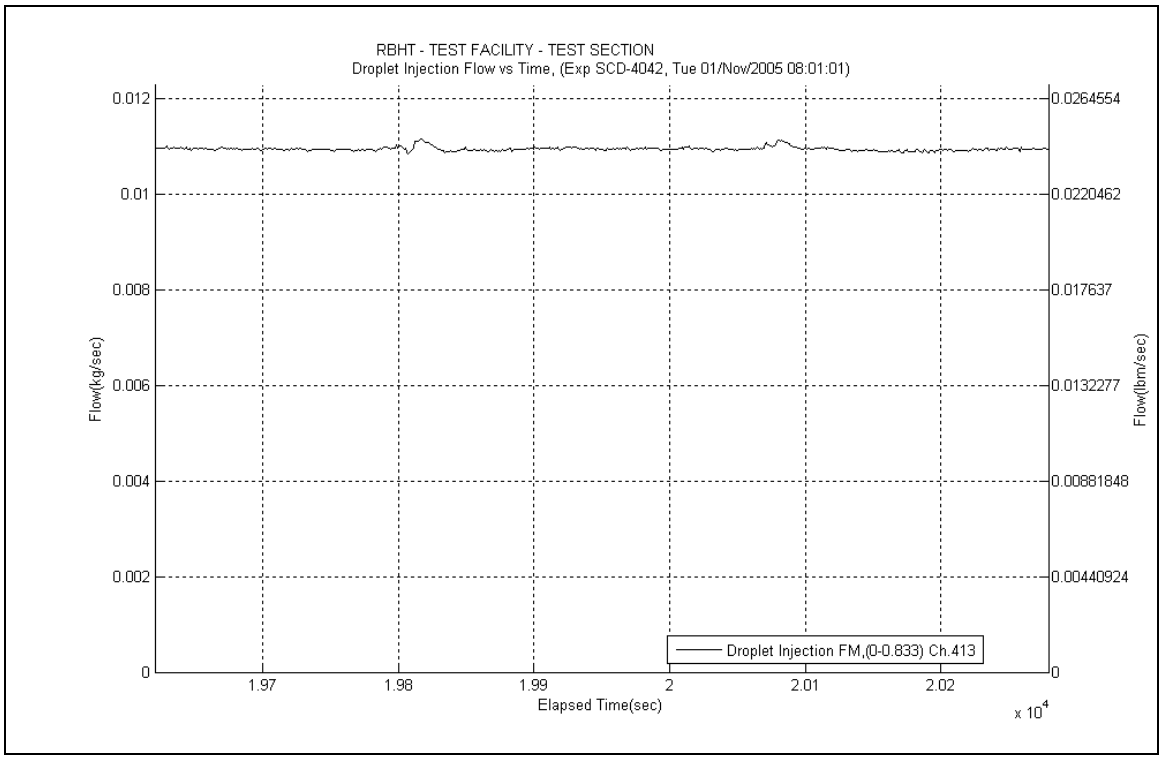

Figure A-3: Droplet Injection Flow Rate for Experiment 4042G

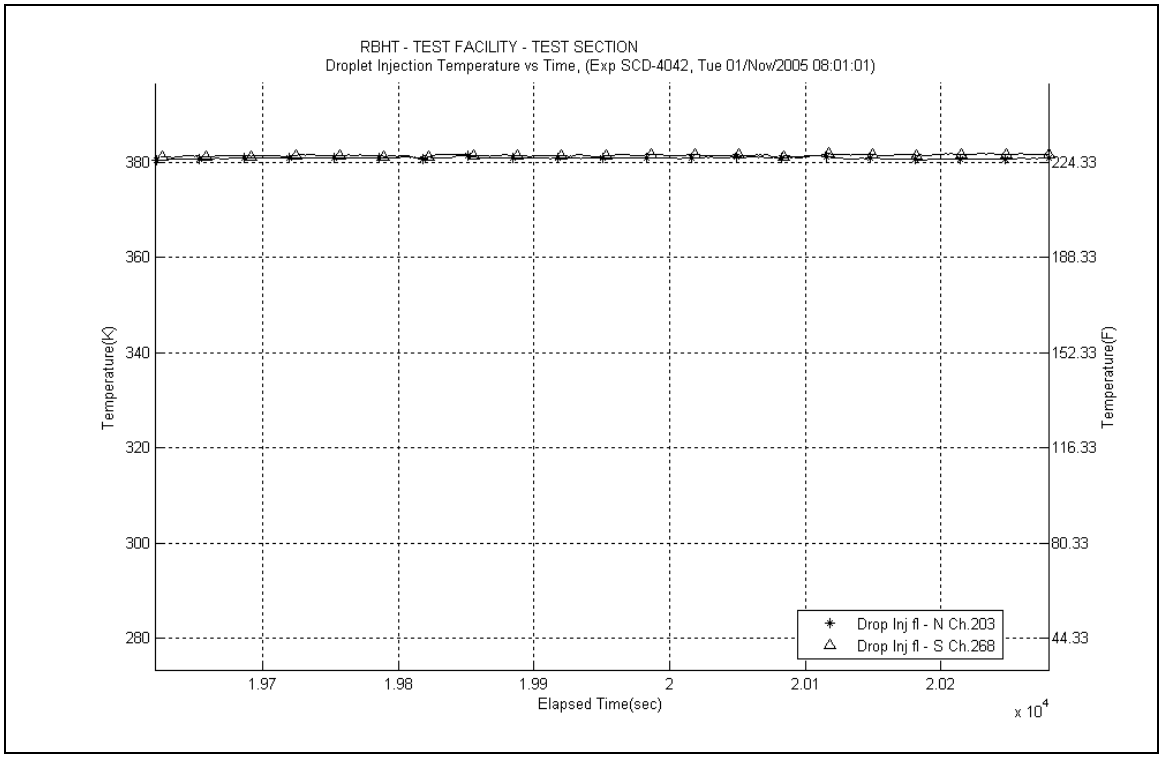

Figure A-4: Droplet Injection Temperature for Experiment 4042G

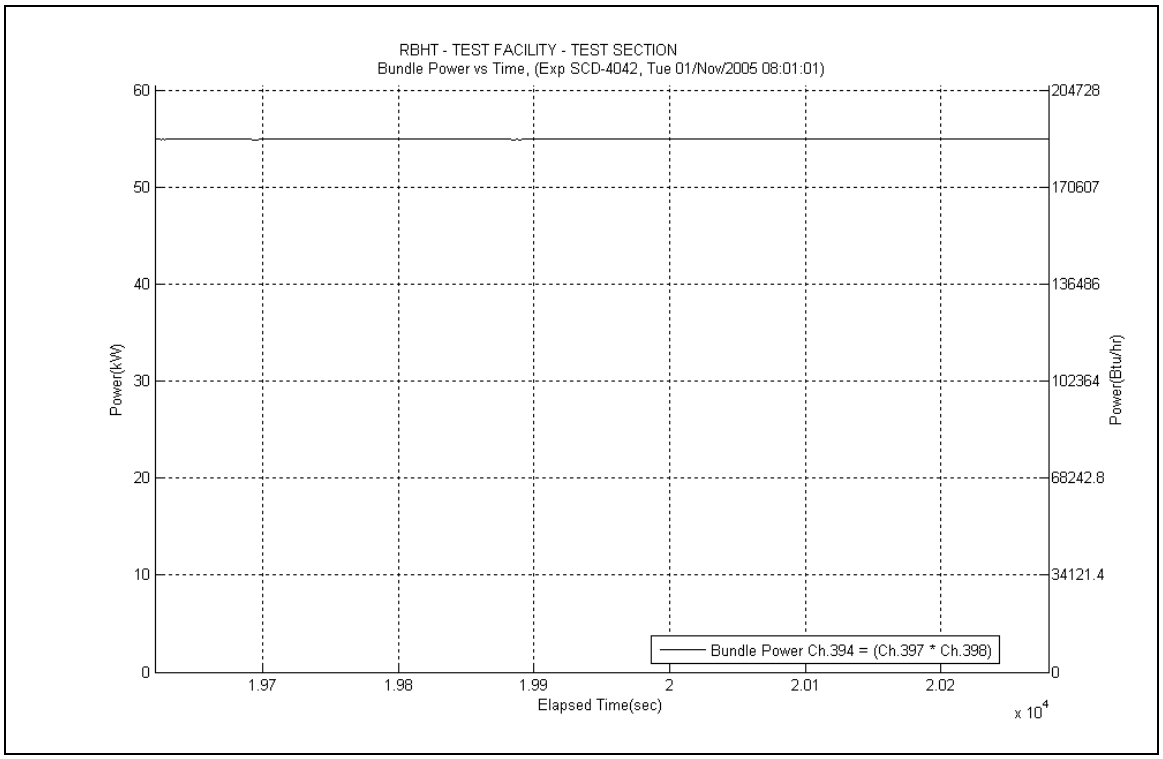

Figure A-5: Bundle Power for Experiment 4042G

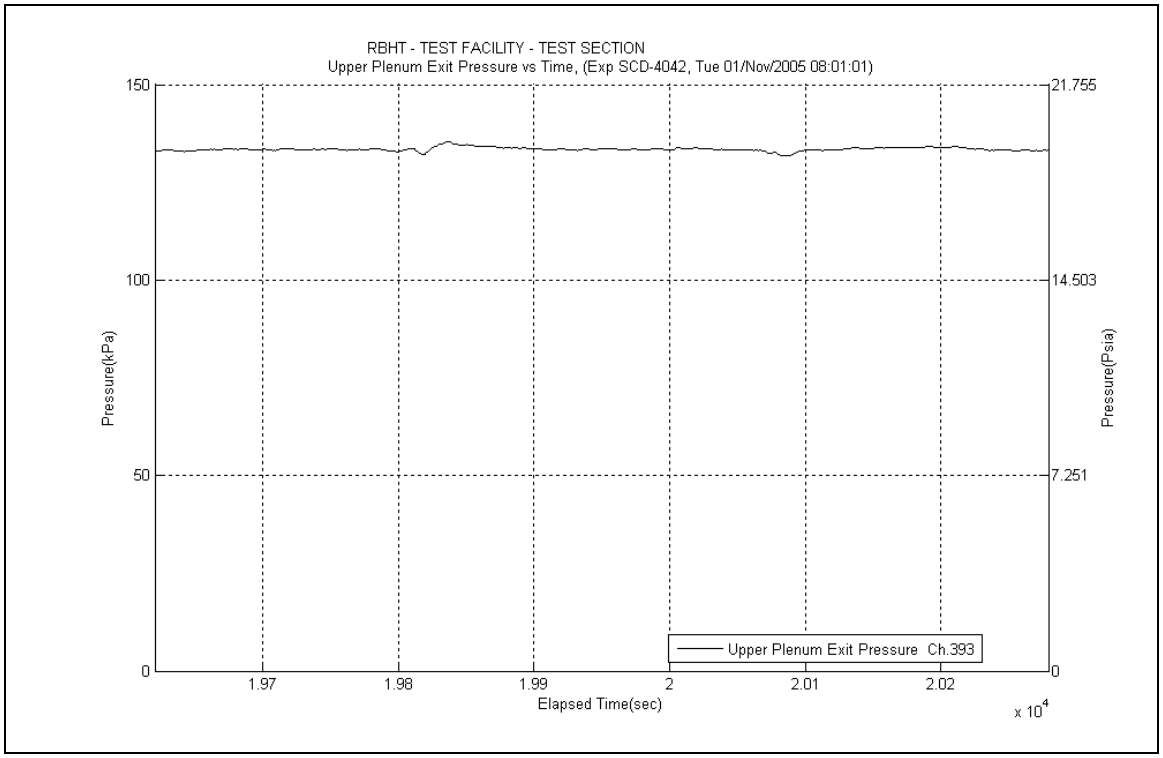

Figure A-6: Upper Plenum Pressure for Experiment 4042G

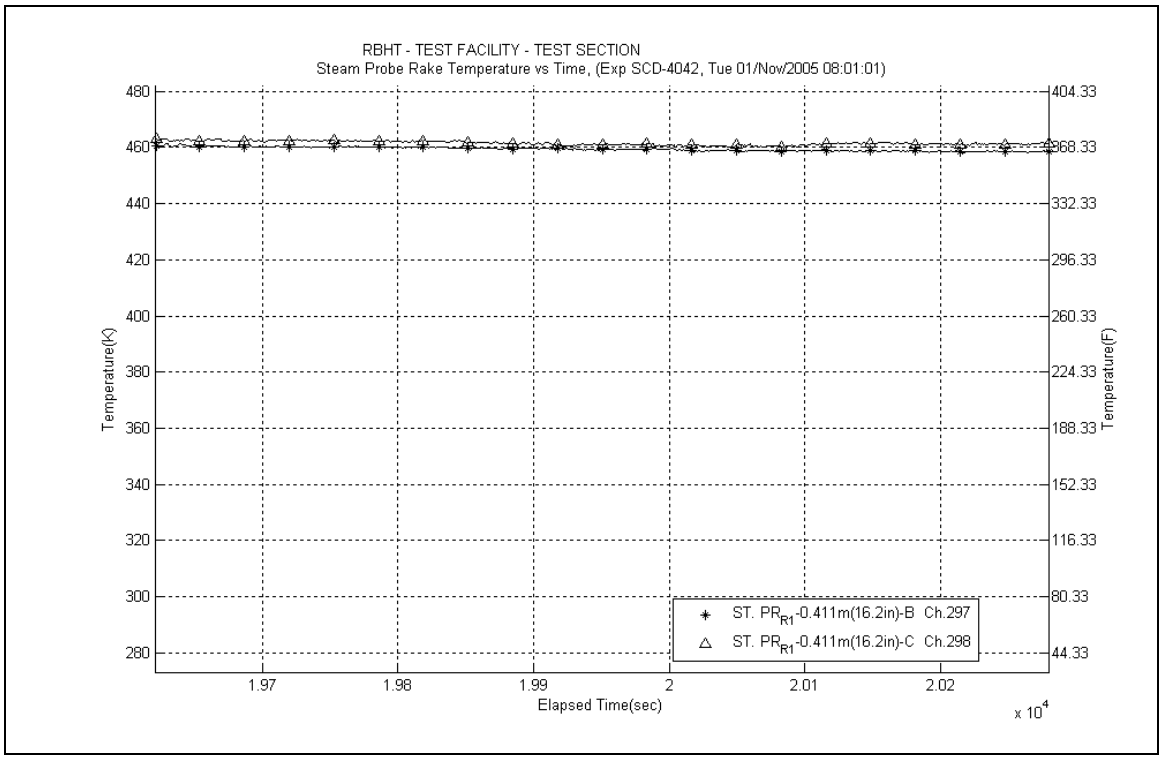

Figure A-7: Steam Probe Rake #1 Temperatures for Experiment 4042G

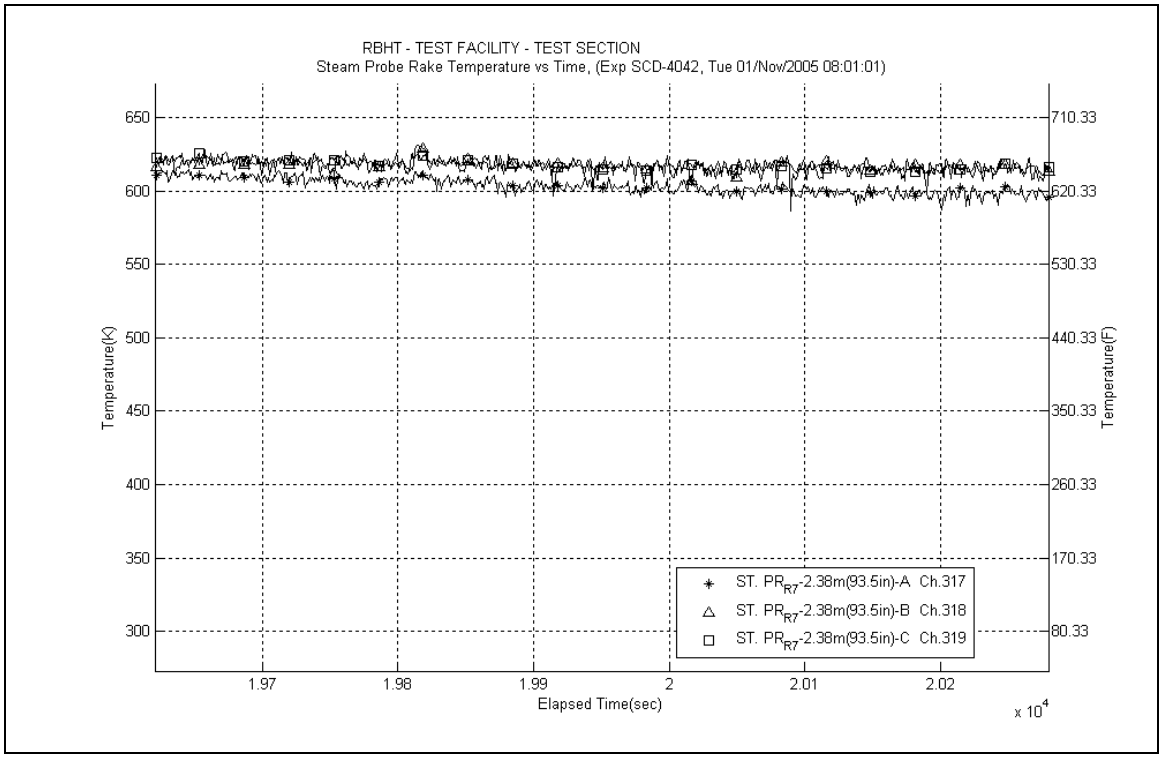

Figure A-8: Steam Probe Rake #7 Temperatures for Experiment 4042G

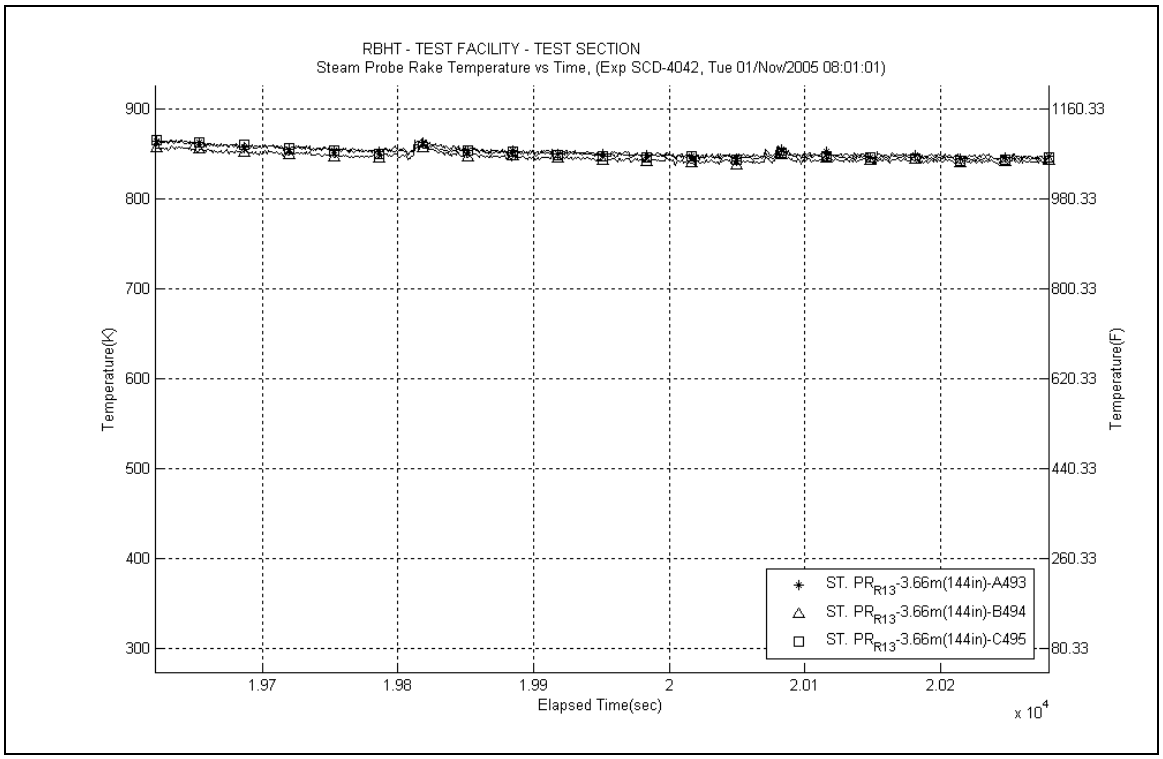

Figure A-9: Steam Probe Rake #13 Temperatures for Experiment 4042G

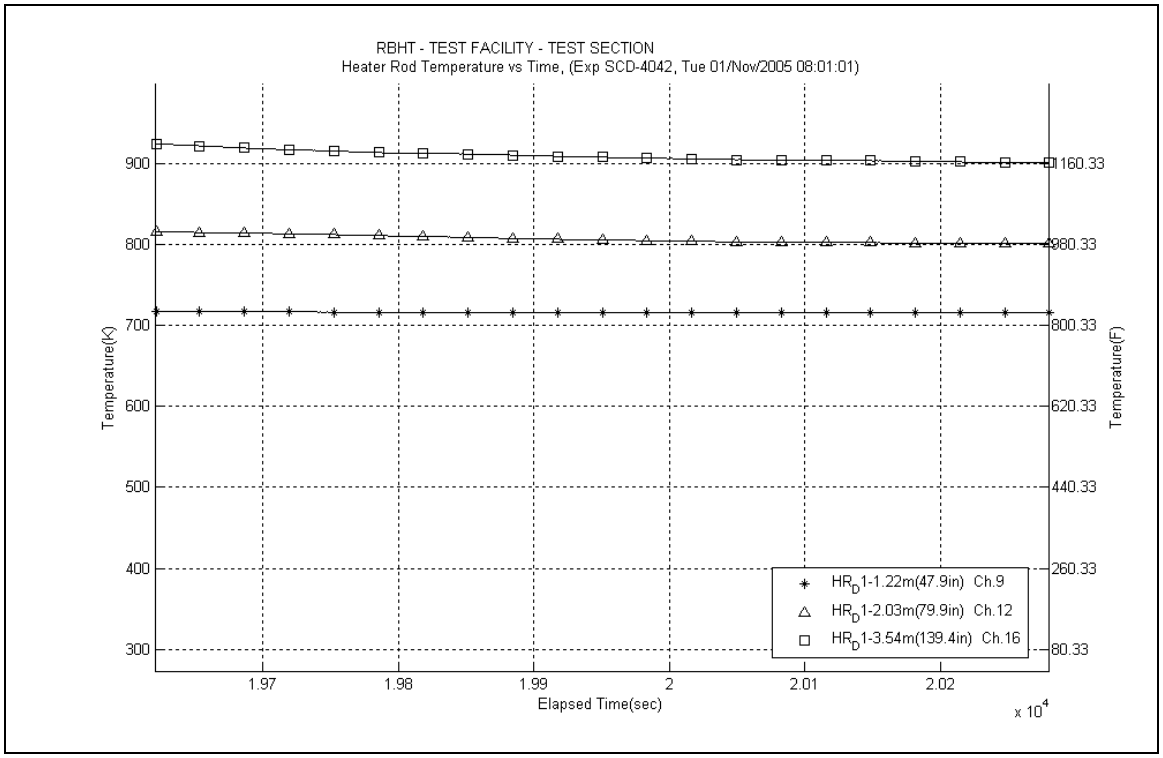

Figure A-10: Heater Rod D1 Temperatures for Experiment 4042G

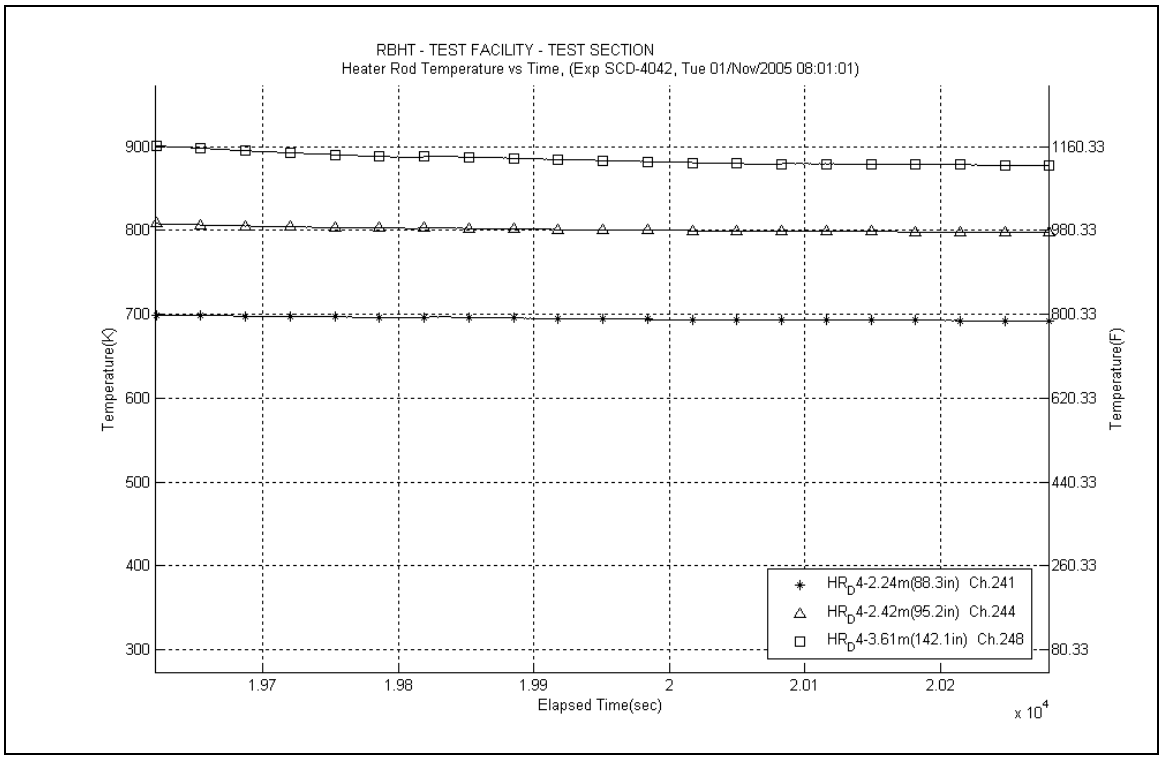

Figure A-11: Heater Rod D4 Temperatures for Experiment 4042G

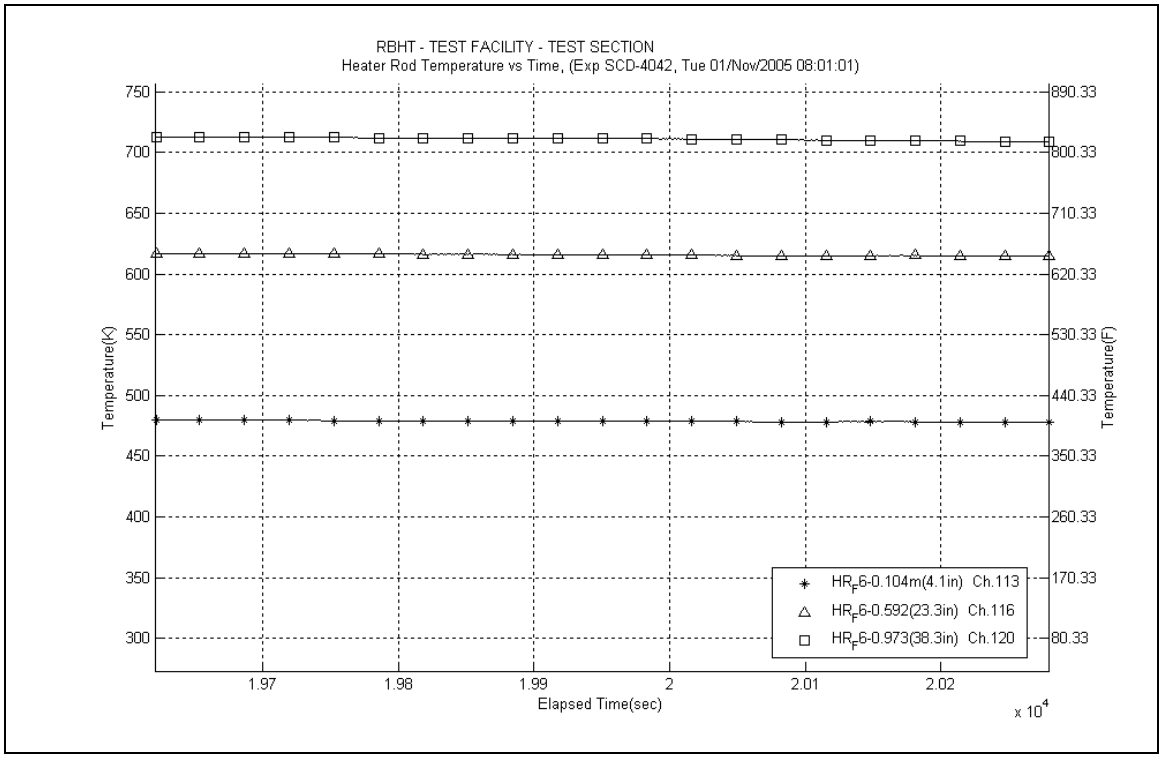

Figure A-12: Heater Rod F6 Temperatures for Experiment 4042G

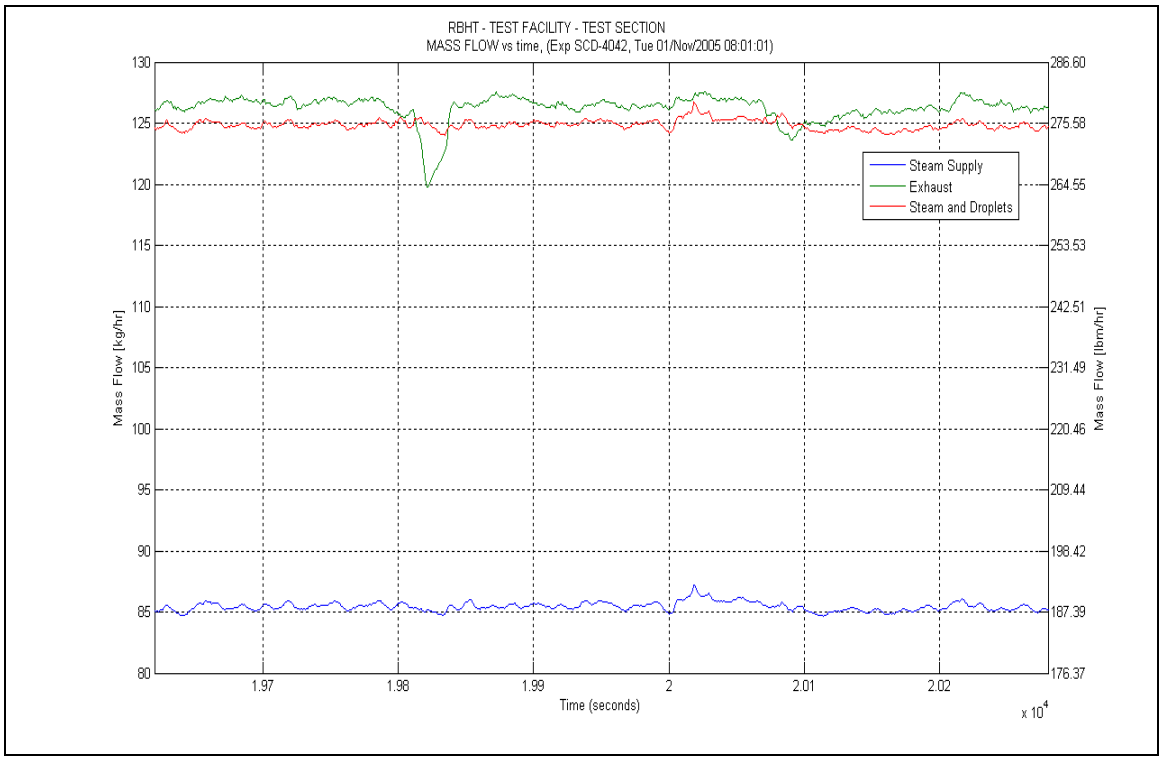

Figure A-13: Mass Flow for Experiment 4042G

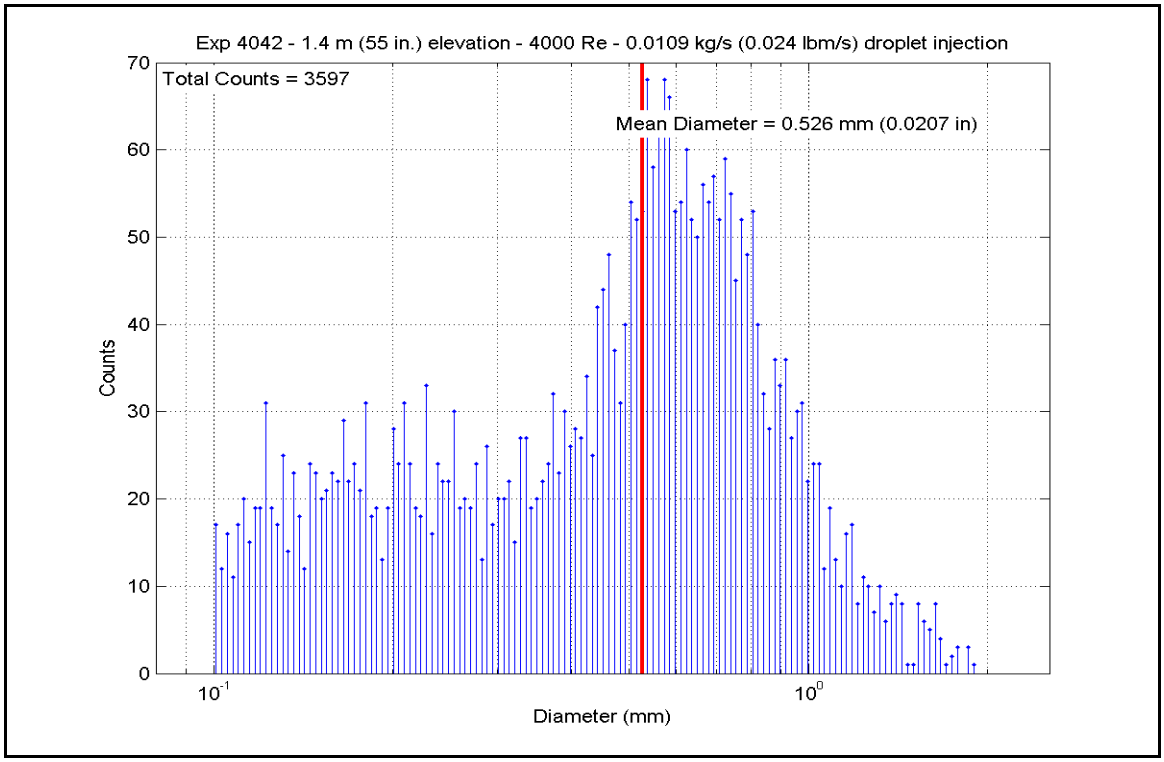

Figure A-14: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4042G

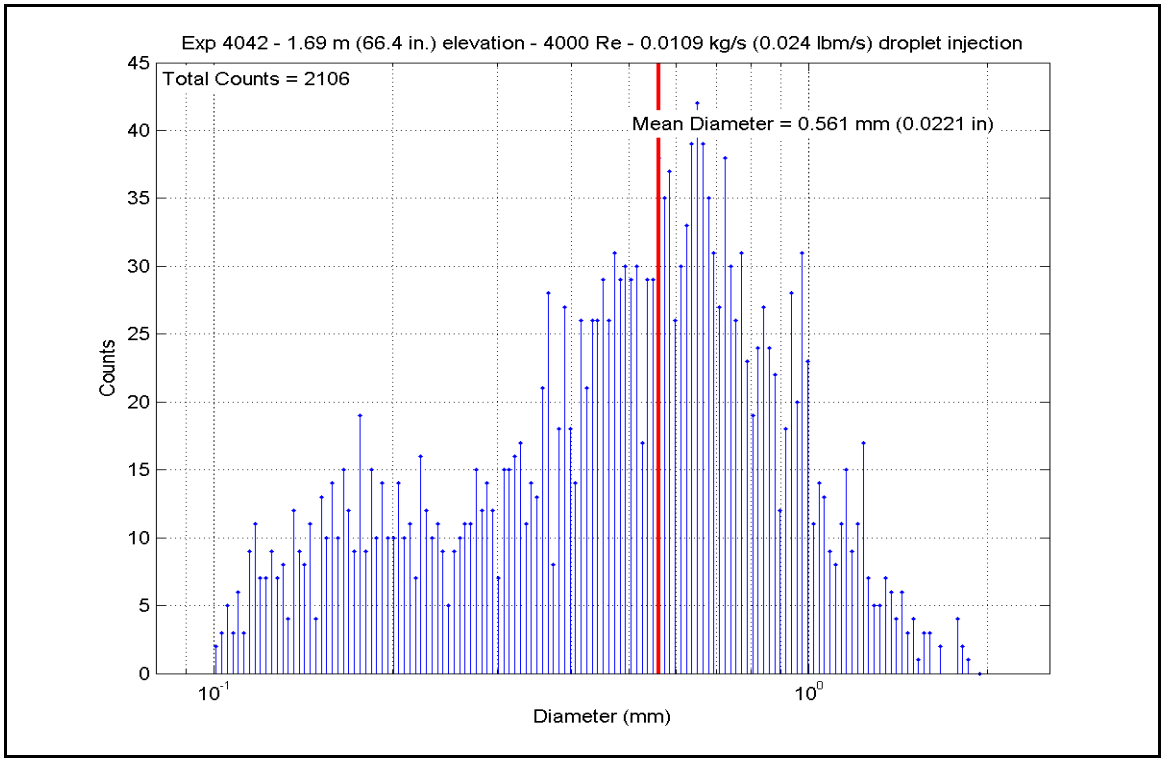

Figure A-15: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4042G

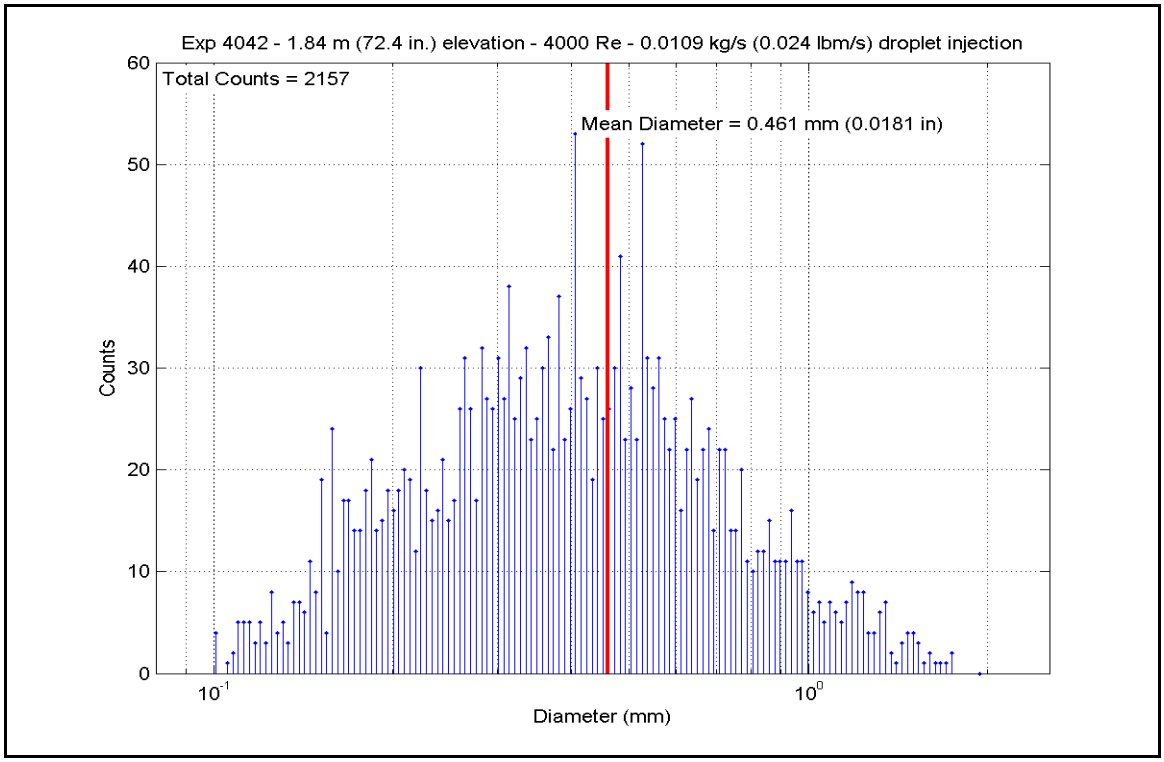

Figure A-16: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4042G

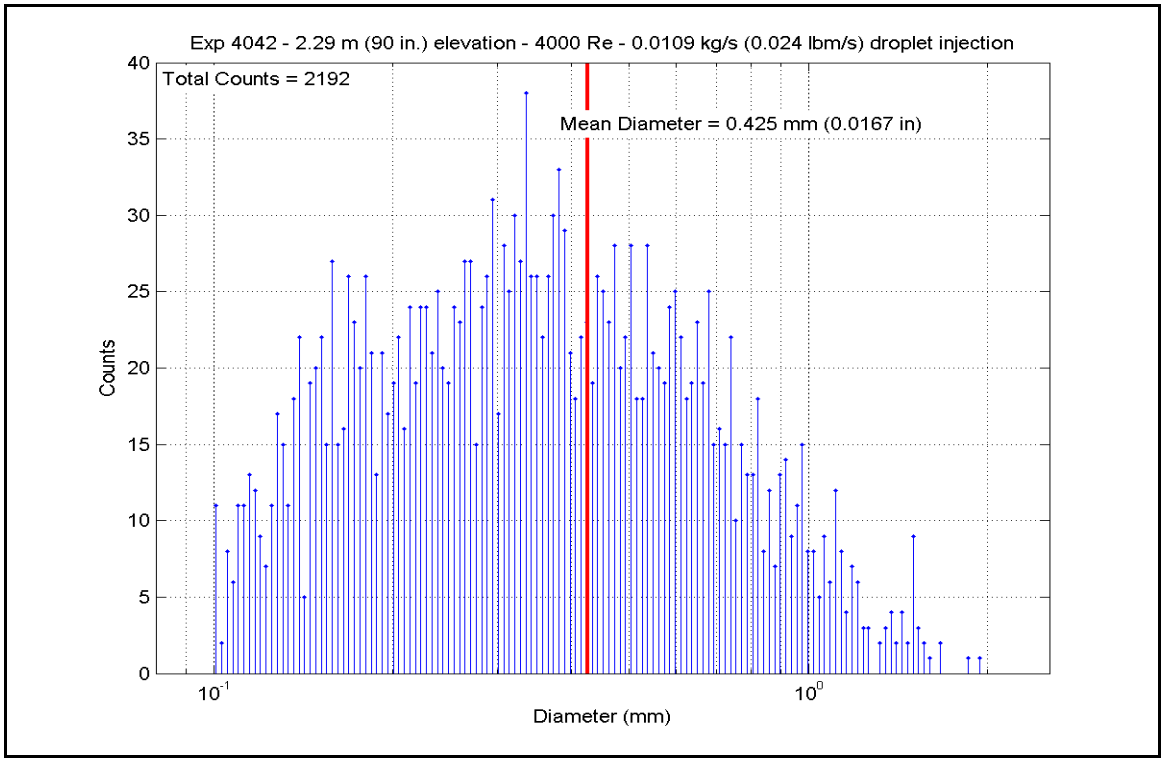

Figure A-17: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4042G

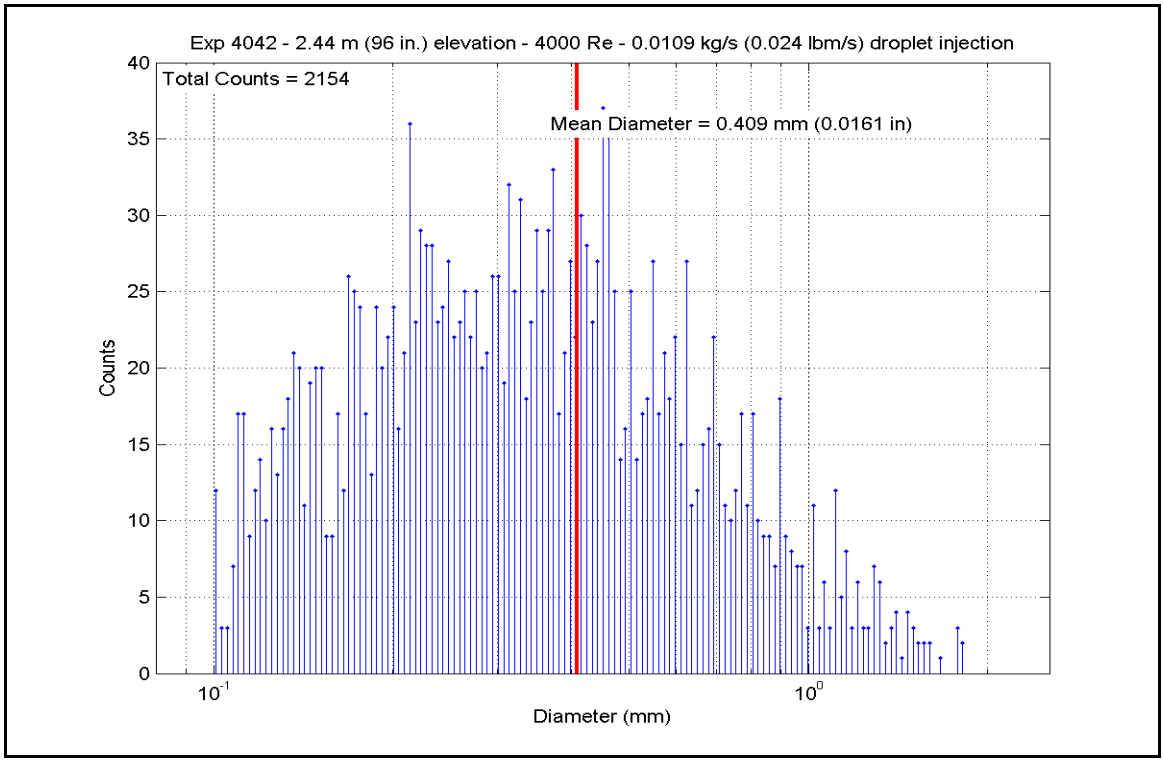

Figure A-18: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4042G

Table A-41: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042G

Test 4042-G	Inlet Reynolds:	4000		
Matrix test # 2c	UP Pressure:	137.9 kPa	20	psia
Time Window: 19620-20280	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	937.28	776.1	4815.32	15189.9	6.789	38.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	961.67	789.6	4889.30	15423.3	6.664	37.8
	RodD3_93.1	187	93.1	2.365	4.6	0.117	815.35	708.3	4711.63	14862.8	8.022	45.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	915.15	763.8	4816.82	15194.6	7.010	39.8
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1032.55	829.0	4989.10	15738.1	6.201	35.2
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1167.60	904.0	5279.94	16655.6	5.619	31.9
	RodD3_110	191	110	2.794	21.5	0.546	1098.72	865.8	5128.90	16179.1	5.890	33.5
	RodD3_142.1	192	142.1	3.609	8.6	0.218	827.45	715.1	4674.63	14746.1	7.798	44.3
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1067.79	848.6	4686.94	14784.9	5.581	31.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1114.22	874.4	4406.27	13899.6	4.972	28.2
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1147.53	892.9	4064.18	12820.5	4.420	25.1
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1163.07	901.5	3706.98	11693.7	3.964	22.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1075.83	853.1	5092.42	16064.0	6.006	34.1
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1081.25	856.1	5250.97	16564.2	6.154	34.9
	RodC4_110	239	110	2.794	21.5	0.546	1109.34	871.7	5350.38	16877.8	6.071	34.5
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1002.10	812.1	3867.50	12200.0	4.996	28.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	822.00	712.0	4174.27	13167.7	7.027	39.9
	RodD4_91.3	242	91.3	2.319	2.8	0.071	868.69	738.0	4240.96	13378.1	6.619	37.6
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1052.88	840.3	3780.70	11926.2	4.583	26.0
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1124.41	880.0	4506.63	14216.2	5.027	28.6
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1170.94	905.9	5338.03	16838.8	5.661	32.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1120.57	877.9	5259.50	16591.1	5.893	33.5
	RodD4_142.1	248	142.1	3.609	8.6	0.218	728.12	659.9	4071.16	12842.5	8.140	46.2
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	898.65	754.6	4767.30	15038.5	7.108	40.4
	RodE4_91.2	202	91.2	2.316	2.7	0.069	989.27	805.0	4912.28	15495.8	6.453	36.6
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1140.33	888.9	2052.75	6475.4	2.250	12.8
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1058.43	843.4	5192.48	16379.7	6.253	35.5
	RodE4_142.3	208	142.3	3.614	8.8	0.224	802.72	701.3	4669.23	14729.1	8.124	46.1

Table A-41: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1175.05	908.2	2815.08	8880.2	2.972	16.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1082.45	856.7	4675.62	14749.3	5.472	31.1
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1095.74	864.1	3847.33	12136.4	4.434	25.2
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1186.49	914.5	4660.40	14701.2	4.862	27.6
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1218.32	932.2	4391.49	13853.0	4.434	25.2
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1239.37	943.9	4012.18	12656.4	3.967	22.5
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1245.79	947.5	3668.27	11571.6	3.604	20.5
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1166.90	903.6	3164.45	9982.2	3.370	19.1
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1020.96	822.6	3747.83	11822.5	4.726	26.8
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1054.33	841.1	4888.18	15419.8	5.916	33.6
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1186.84	914.7	3236.24	10208.7	3.375	19.2
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1124.52	880.1	2864.60	9036.4	3.195	18.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	958.28	787.7	3421.94	10794.5	4.686	26.6
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	930.78	772.5	3551.39	11202.9	5.053	28.7
	RodC5_135.7	232	135.7	3.447	2.2	0.056	986.87	803.6	3650.09	11514.2	4.810	27.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1133.44	885.1	2024.00	6384.7	2.235	12.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1152.03	895.4	5388.39	16997.7	5.831	33.1
	RodE5_115.4	211	115.4	2.931	2.65	0.067	988.46	804.5	5001.11	15776.0	6.576	37.3
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1136.93	887.0	2091.37	6597.2	2.301	13.1
	RodE5_122.6	213	122.6	3.114	9.85	0.250	789.62	694.0	4735.78	14939.0	8.432	47.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	894.97	752.6	4840.94	15270.8	7.258	41.2
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	927.06	770.4	4916.00	15507.5	7.032	39.9
	RodE5_135.6	216	135.6	3.444	2.1	0.053	981.02	800.4	4987.31	15732.5	6.623	37.6
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	932.26	773.3	4825.78	15222.9	6.852	38.9
	RodC3_85.6	178	85.6	2.174	14.72	0.374	969.78	794.1	4887.21	15416.7	6.588	37.4
	RodC3_88.5	179	88.5	2.248	0	0.000	1131.72	884.1	2085.43	6578.5	2.308	13.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	899.67	755.2	3403.17	10735.3	5.067	28.8
	RodC3_94.4	181	94.4	2.398	5.9	0.150	975.04	797.1	3532.51	11143.3	4.729	26.9
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1131.12	883.8	5310.68	16752.6	5.880	33.4
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1022.45	823.4	5014.64	15818.7	6.312	35.8
Gr-8	RodD5_50	217	50	1.270	3	0.076	1109.97	872.0	3445.63	10869.2	3.907	22.2
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1179.91	910.9	3917.13	12356.6	4.115	23.4
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1184.01	913.2	3573.78	11273.5	3.738	21.2
	RodD5_60	220	60	1.524	13	0.330	1078.28	854.4	3122.28	9849.2	3.672	20.9
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1093.60	862.9	2780.52	8771.1	3.212	18.2
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	806.18	703.3	4743.83	14964.4	8.205	46.6
	RodD5_72.9	223	72.9	1.852	2.02	0.051	900.70	755.8	4839.56	15266.4	7.194	40.9
	RodD5_74.9	224	74.9	1.902	4.02	0.102	931.99	773.1	4933.63	15563.1	7.008	39.8

Table A-41: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)		H.R.Tw (K)		H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	579.42	577.3	2289.13	7221.1	6.514	37.0
	RodB5_52.9	154	52.9	1.344	5.9	0.150	646.24	614.4	2524.82	7964.5	6.037	34.3
	RodB5_55	155	55	1.397	8	0.203	669.62	627.4	2711.72	8554.1	6.140	34.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	751.36	672.8	2841.87	8964.7	5.430	30.8
	RodB5_64	157	64	1.626	17	0.432	784.12	691.0	2905.95	9166.8	5.225	29.7
	RodB5_73.9	158	73.9	1.877	3.02	0.077	830.26	716.6	3004.99	9479.2	4.990	28.3
	RodB5_75.9	159	75.9	1.928	5.02	0.128	874.53	741.2	3109.11	9807.7	4.809	27.3
	RodB5_76.9	160	76.9	1.953	6.02	0.153	969.51	794.0	3507.97	11065.9	4.731	26.9
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	585.78	580.8	2278.98	7189.0	6.370	36.2
	RodF5_53.1	106	53.1	1.349	6.1	0.155	647.95	615.3	2503.96	7898.7	5.963	33.9
	RodF5_55	107	55	1.397	8	0.203	654.50	619.0	2704.42	8531.1	6.341	36.0
	RodF5_57.8	108	57.8	1.468	10.8	0.274	742.47	667.9	2832.06	8933.7	5.505	31.3
	RodF5_64	109	64	1.626	17	0.432	775.17	686.0	2897.74	9140.9	5.296	30.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	819.55	710.7	2996.12	9451.3	5.065	28.8
	RodF5_75.8	111	75.8	1.925	4.92	0.125	922.43	767.8	3406.27	10745.1	4.905	27.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	984.06	802.1	3534.43	11149.3	4.675	26.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1054.29	841.1	2254.60	7112.1	2.729	15.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	765.82	680.8	3491.33	11013.4	6.492	36.9
	RodC2_55	59	55	1.397	8	0.203	903.90	757.5	4420.76	13945.3	6.541	37.1
	RodC2_57.8	60	57.8	1.468	10.8	0.274	901.10	756.0	5023.62	15847.0	7.463	42.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1031.35	828.3	4713.52	14868.8	5.867	33.3
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1106.18	869.9	3660.47	11547.0	4.168	23.7
	RodC2_75.8	63	75.8	1.925	4.92	0.125	946.35	781.1	4267.06	13460.4	5.940	33.7
	RodC2_76.8	64	76.8	1.951	5.92	0.150	963.08	790.4	4302.29	13571.6	5.853	33.2
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	1019.44	821.7	3624.95	11434.9	4.580	26.0
	RodC6_52.8	138	52.8	1.341	5.8	0.147	1002.25	812.2	3728.91	11762.8	4.816	27.4
	RodC6_54.8	139	54.8	1.392	7.8	0.198	1021.86	823.1	3927.04	12387.9	4.947	28.1
	RodC6_57.8	140	57.8	1.468	10.8	0.274	778.09	687.6	4044.17	12757.3	7.352	41.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	850.78	728.0	4155.40	13108.2	6.672	37.9
	RodC6_73.7	142	73.7	1.872	2.82	0.072	891.28	750.5	4226.26	13331.7	6.372	36.2
	RodC6_75.8	143	75.8	1.925	4.92	0.125	975.46	797.3	4386.30	13836.6	5.868	33.3
	RodC6_76.8	144	76.8	1.951	5.92	0.150	871.24	739.4	4588.48	14474.4	7.133	40.5

Table A-41: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	927.09	770.4	4296.78	13554.2	6.146	34.9
	RodB4_91.3	162	91.3	2.319	2.8	0.071	945.59	780.7	4330.88	13661.8	6.035	34.3
	RodB4_93.3	163	93.3	2.370	4.8	0.122	402.16	478.8	1880.54	5932.2	10.798	61.3
	RodB4_95.1	164	95.1	2.416	6.6	0.168	497.99	532.0	2118.06	6681.4	7.845	44.6
	RodB4_100	165	100	2.540	11.5	0.292	1128.35	882.2	5265.91	16611.3	5.849	33.2
	RodB4_106	166	106	2.692	17.5	0.445	1164.27	902.2	5365.09	16924.2	5.730	32.5
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1123.87	879.7	4917.60	15512.6	5.489	31.2
	RodB4_142.3	168	142.3	3.614	8.8	0.224	894.21	752.2	4225.65	13329.8	6.343	36.0
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	898.39	754.5	4253.35	13417.2	6.345	36.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	915.60	764.0	4287.12	13523.7	6.235	35.4
	RodF4_92.4	100	92.4	2.347	3.9	0.099	401.55	478.5	1882.91	5939.6	10.849	61.6
	RodF4_94.3	101	94.3	2.395	5.8	0.147	501.94	534.2	2114.90	6671.5	7.720	43.8
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1146.13	892.1	5368.98	16936.4	5.848	33.2
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1101.04	867.1	5203.46	16414.3	5.960	33.8
	RodF4_111	104	111	2.819	-1.75	-0.044	1089.72	860.8	5159.39	16275.3	5.987	34.0
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1011.11	817.1	5061.85	15967.6	6.464	36.7
	RodD2_106	66	106	2.692	17.5	0.445	1121.10	878.2	5269.37	16622.2	5.900	33.5
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1070.77	850.2	5092.29	16063.6	6.042	34.3
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1171.81	906.4	4701.52	14830.9	4.981	28.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1198.62	921.3	4463.95	14081.5	4.599	26.1
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1232.12	939.9	4143.62	13071.1	4.127	23.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1251.17	950.5	3763.12	11870.7	3.678	20.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1248.04	948.7	3394.16	10706.9	3.327	18.9
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1150.69	894.6	4826.36	15224.8	5.231	29.7
	RodD6_106	130	106	2.692	17.5	0.445	1081.20	856.0	5104.37	16101.7	5.983	34.0
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1020.82	822.5	4833.75	15248.1	6.097	34.6
	RodD6_114.9	132	114.9	2.918	2.15	0.055	956.44	786.7	3421.08	10791.8	4.696	26.7
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1022.83	823.6	3550.58	11200.3	4.467	25.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	930.42	772.3	4880.17	15394.5	6.948	39.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	989.68	805.2	4959.64	15645.2	6.511	37.0
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1171.83	906.4	1938.75	6115.8	2.054	11.7

Table A-41: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	1060.02	844.3	3646.58	11503.2	4.383	24.9
	RodE2_54	74	54	1.372	7	0.178	1094.57	863.5	3748.45	11824.5	4.326	24.6
	RodE2_56.9	75	56.9	1.445	9.9	0.251	1046.90	837.0	4075.28	12855.5	4.977	28.3
	RodE2_59.9	76	59.9	1.521	12.9	0.328	311.84	428.6	5209.13	16432.2	62.132	352.8
	RodE2_66	77	66	1.676	19	0.483	537.56	554.0	5641.03	17794.6	18.223	103.5
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	819.38	710.6	4891.02	15428.7	8.270	47.0
	RodE2_72.9	79	72.9	1.852	2.02	0.051	407.69	481.9	1853.40	5846.5	10.314	58.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	505.61	536.3	2094.71	6607.8	7.545	42.8
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1144.85	891.4	4135.75	13046.2	4.511	25.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1153.53	896.2	3761.55	11865.8	4.064	23.1
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1152.76	895.8	3382.61	10670.5	3.658	20.8
	RodB3_60.1	172	60.1	1.527	13.1	0.333	875.29	741.6	3084.42	9729.8	4.765	27.1
	RodB3_66.1	173	66.1	1.679	19.1	0.485	997.86	809.7	3509.82	11071.7	4.559	25.9
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	1017.43	820.6	3583.56	11304.4	4.539	25.8
	RodB3_73	175	73	1.854	2.12	0.054	1044.15	835.5	3686.69	11629.7	4.517	25.7
	RodB3_75	176	75	1.905	4.12	0.105	1085.54	858.5	3894.04	12283.7	4.541	25.8
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	925.35	769.5	4842.54	15275.8	6.944	39.4
	RodF3_54	90	54	1.372	7	0.178	966.73	792.4	4911.15	15492.2	6.648	37.8
	RodF3_57	91	57	1.448	10	0.254	868.63	737.9	3088.47	9742.6	4.821	27.4
	RodF3_60	92	60	1.524	13	0.330	952.95	784.8	3490.12	11009.6	4.814	27.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	981.45	800.6	3552.34	11205.9	4.715	26.8
	RodF3_70	94	70	1.778	-0.88	-0.022	1021.87	823.1	3634.89	11466.3	4.579	26.0
	RodF3_73	95	73	1.854	2.12	0.054	1057.66	843.0	3835.63	12099.5	4.623	26.3
	RodF3_75	96	75	1.905	4.12	0.105	858.71	732.4	4185.89	13204.4	6.637	37.7
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	584.75	580.2	2263.69	7140.8	6.345	36.0
	RodE6_54.1	122	54.1	1.374	7.1	0.180	647.33	615.0	2504.93	7901.8	5.974	33.9
	RodE6_57	123	57	1.448	10	0.254	664.46	624.5	2701.93	8523.2	6.191	35.2
	RodE6_60.2	124	60.2	1.529	13.2	0.335	749.14	671.6	2841.05	8962.1	5.452	31.0
	RodE6_66.1	125	66.1	1.679	19.1	0.485	780.67	689.1	2909.32	9177.4	5.264	29.9
	RodE6_70	126	70	1.778	-0.88	-0.022	824.13	713.2	3011.16	9498.7	5.051	28.7
	RodE6_73.1	127	73.1	1.857	2.22	0.056	947.88	782.0	3415.05	10772.8	4.744	26.9
	RodE6_75	128	75	1.905	4.12	0.105	1011.01	817.0	3544.74	11181.9	4.527	25.7

RBHT Steam Cooling with Droplet Injection Test SCD-4042-H

Matrix Test # 2d

Test Conditions

Test Date – 11/1/2005
Steady State Time Window: 21180 – 21900
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55.0 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.7 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0145 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.381 mm (.015 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

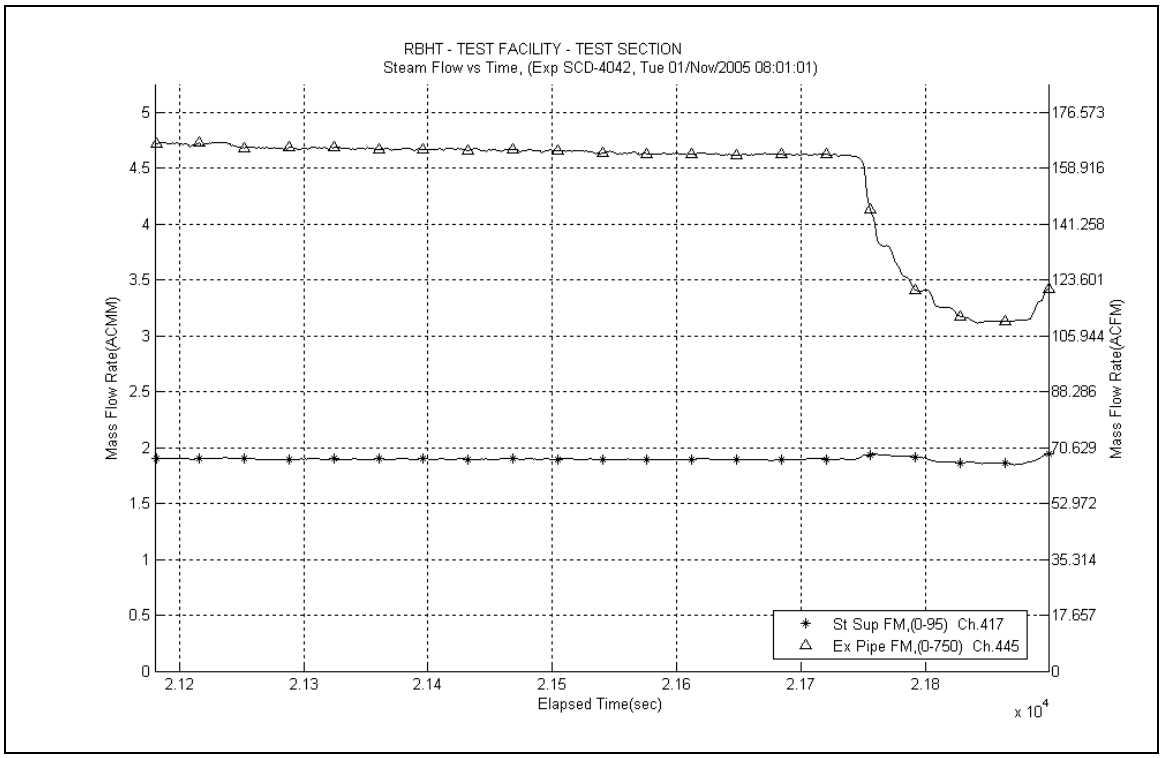

Figure A-19: Inlet and Exhaust Steam Flow Rates for Experiment 4042H

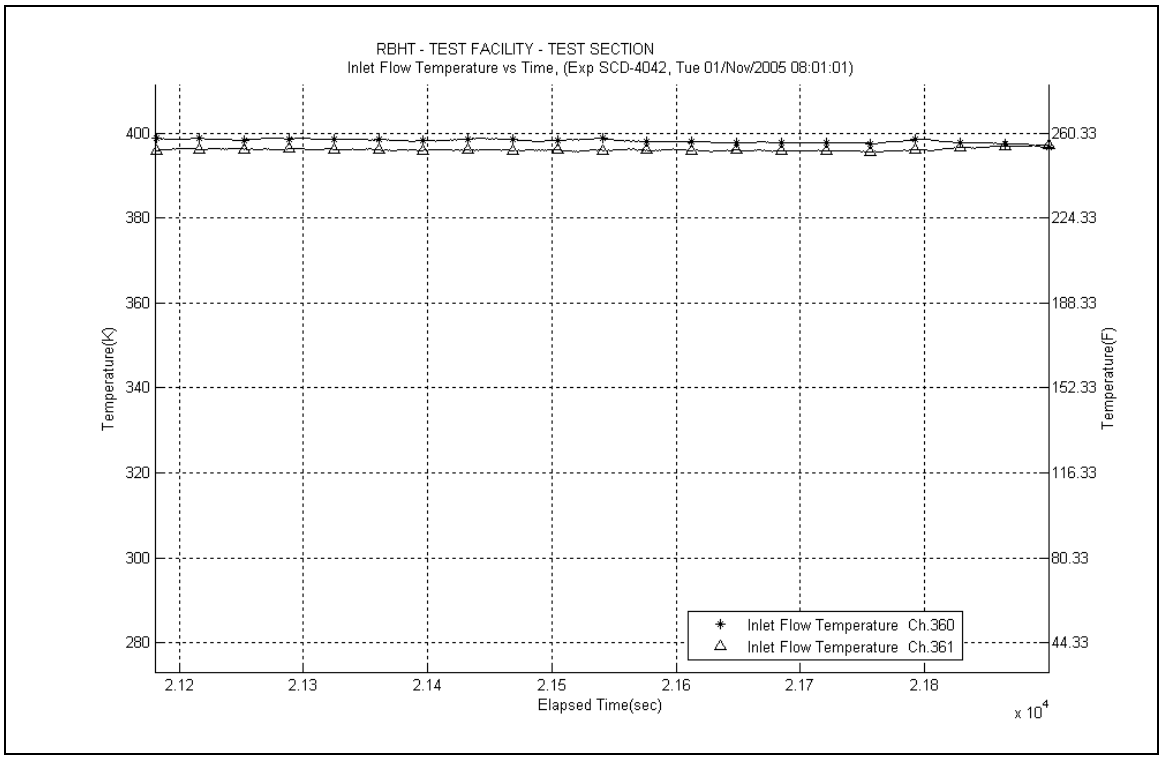

Figure A-20: Inlet Steam Temperature for Experiment 4042H

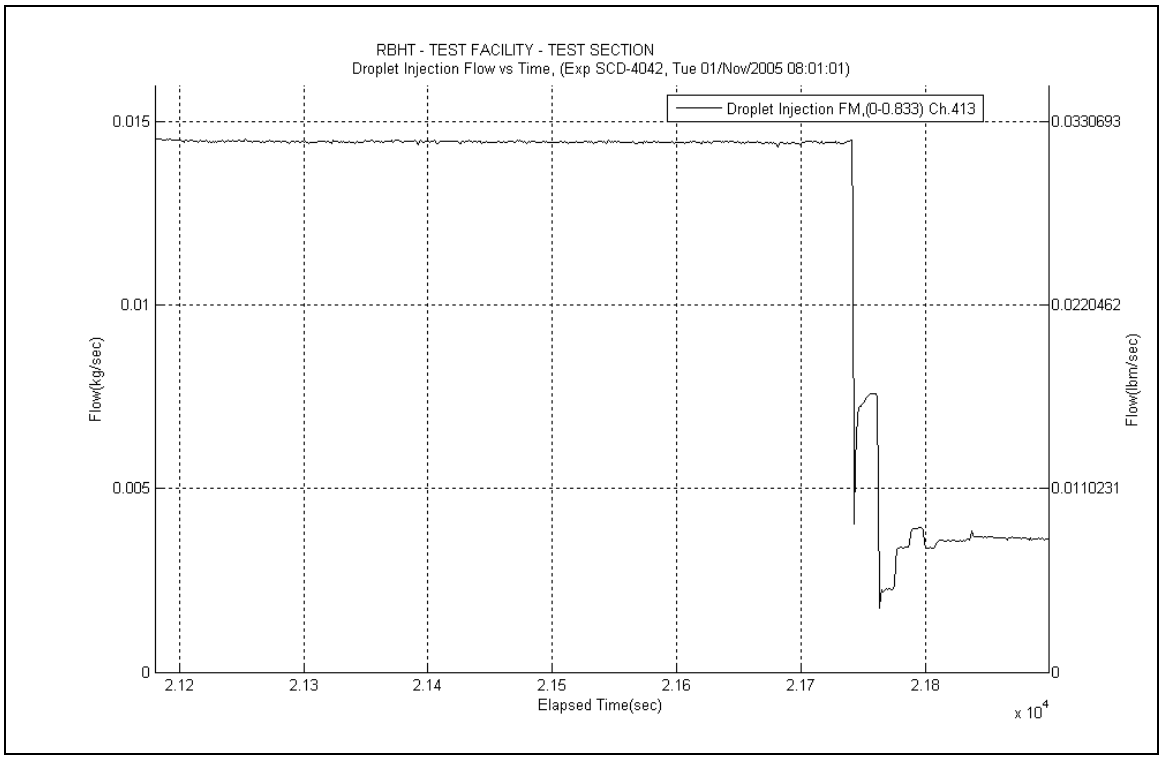

Figure A-21: Droplet Injection Flow Rate for Experiment 4042H

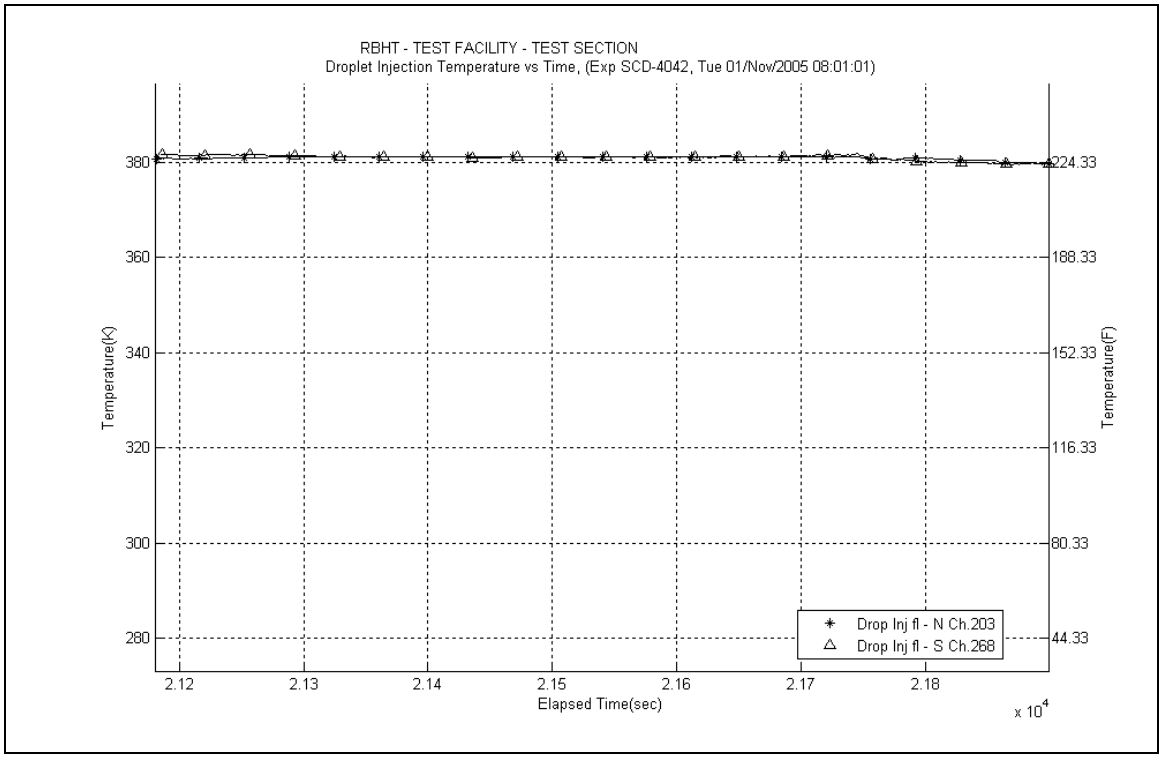

Figure A-22: Droplet Injection Temperature for Experiment 4042H

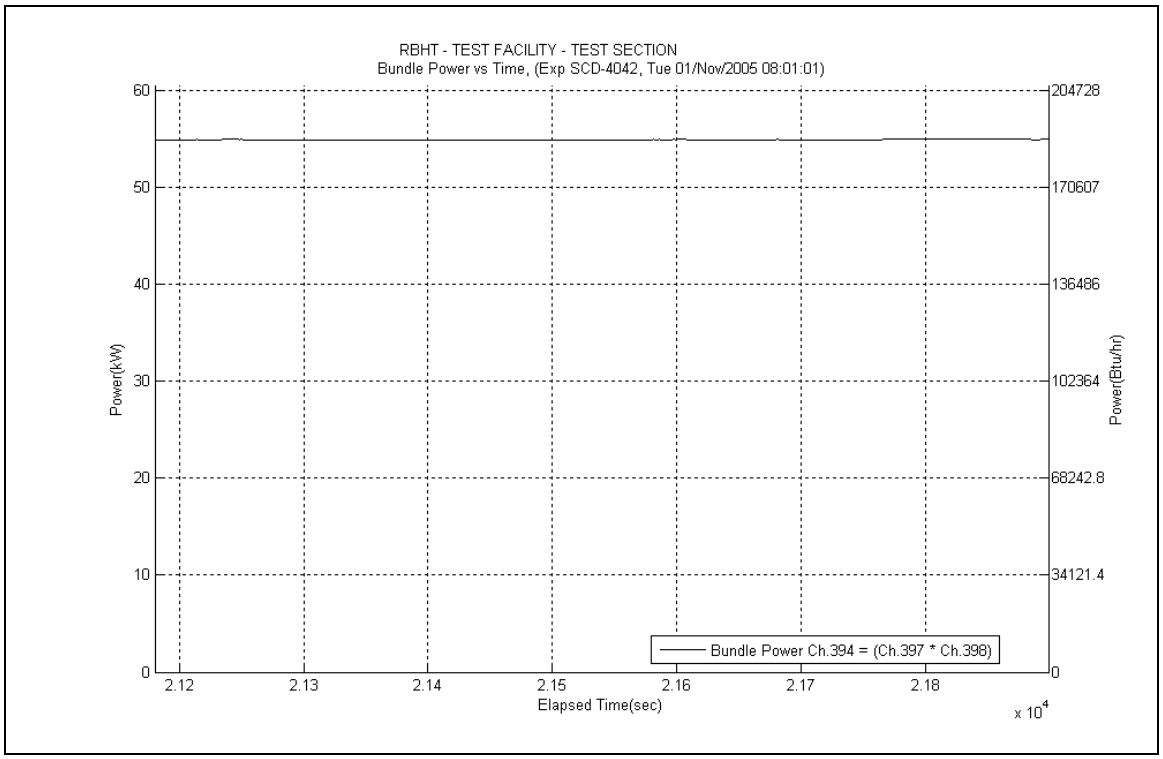

Figure A-23: Bundle Power for Experiment 4042H

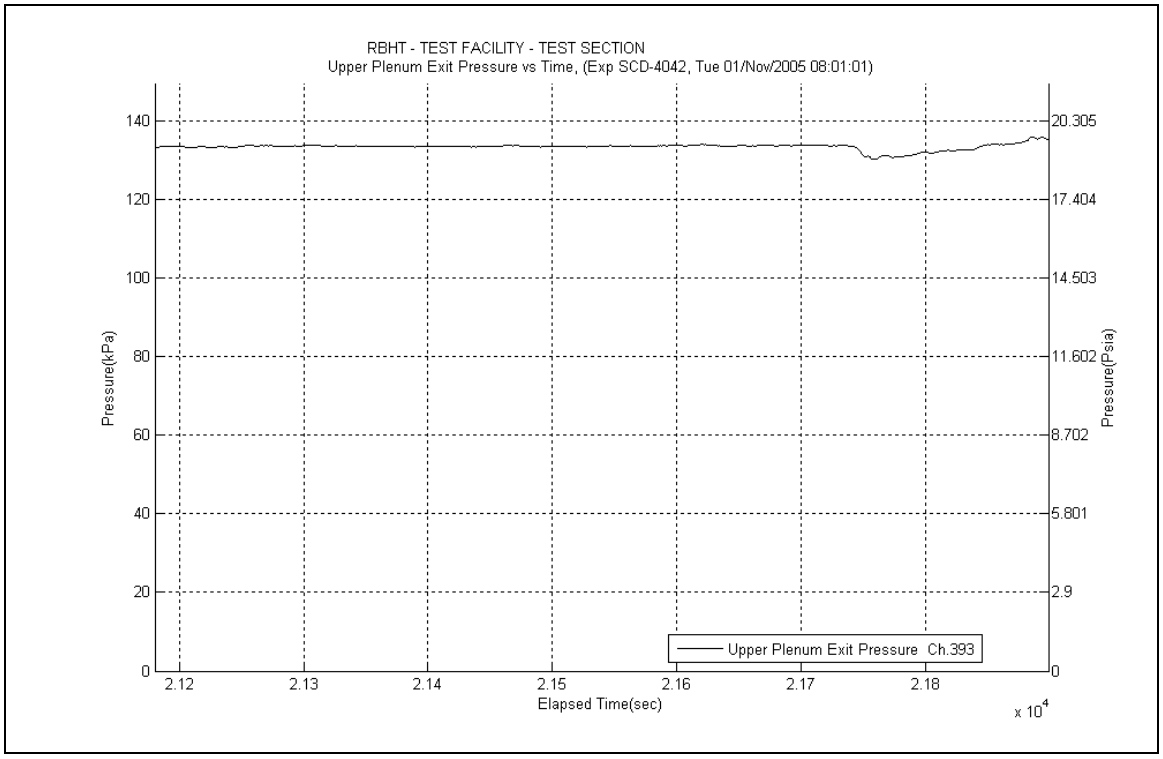

Figure A-24: Upper Plenum Pressure for Experiment 4042H

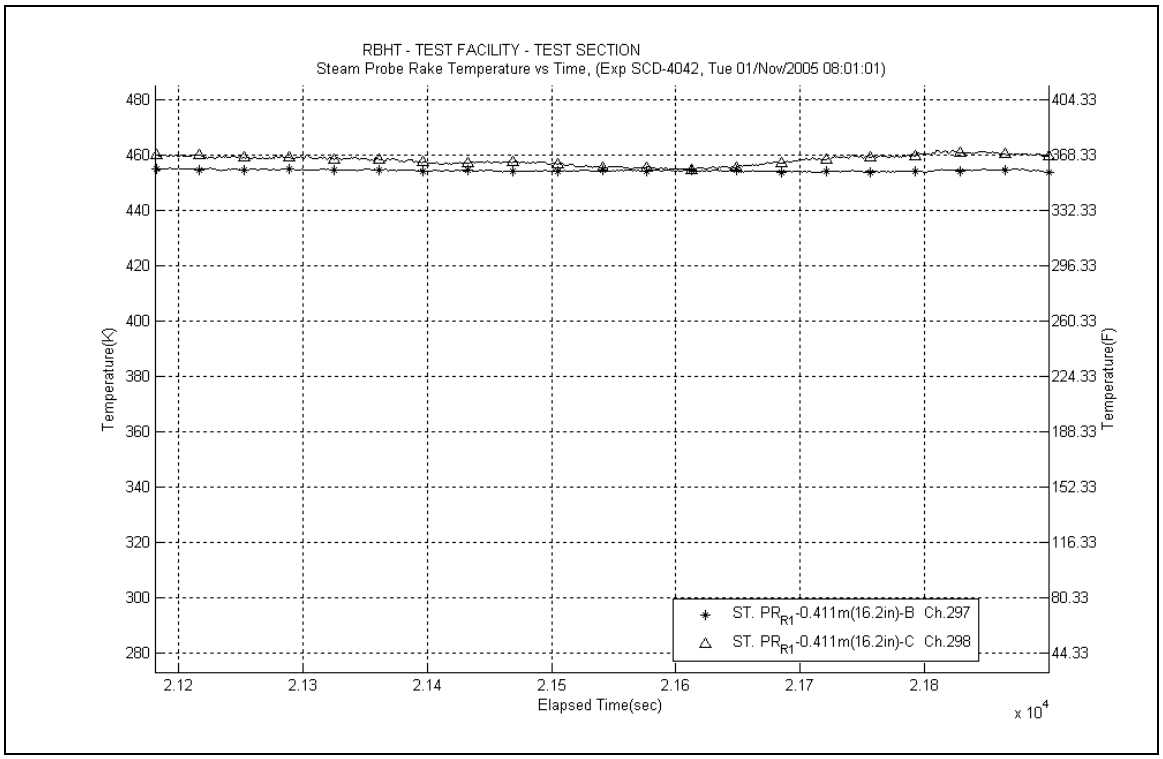

Figure A-25: Steam Probe Rake #1 Temperatures for Experiment 4042H

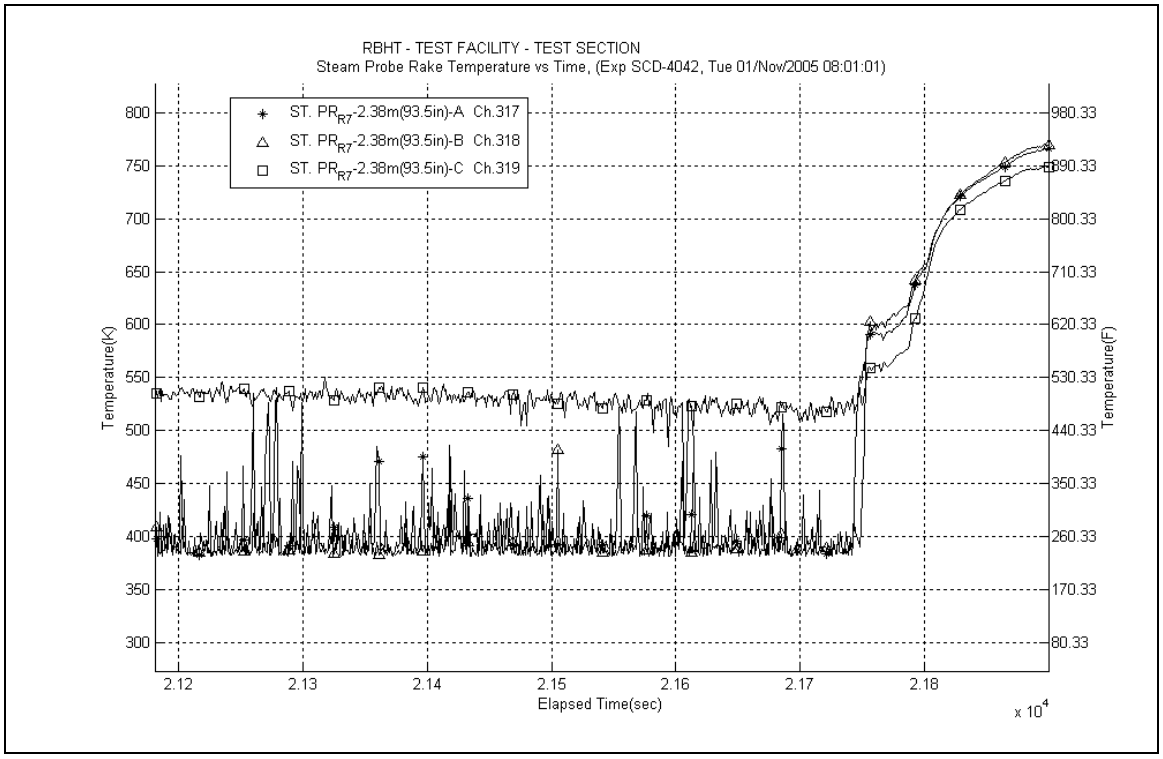

Figure A-26: Steam Probe Rake #7 Temperatures for Experiment 4042H

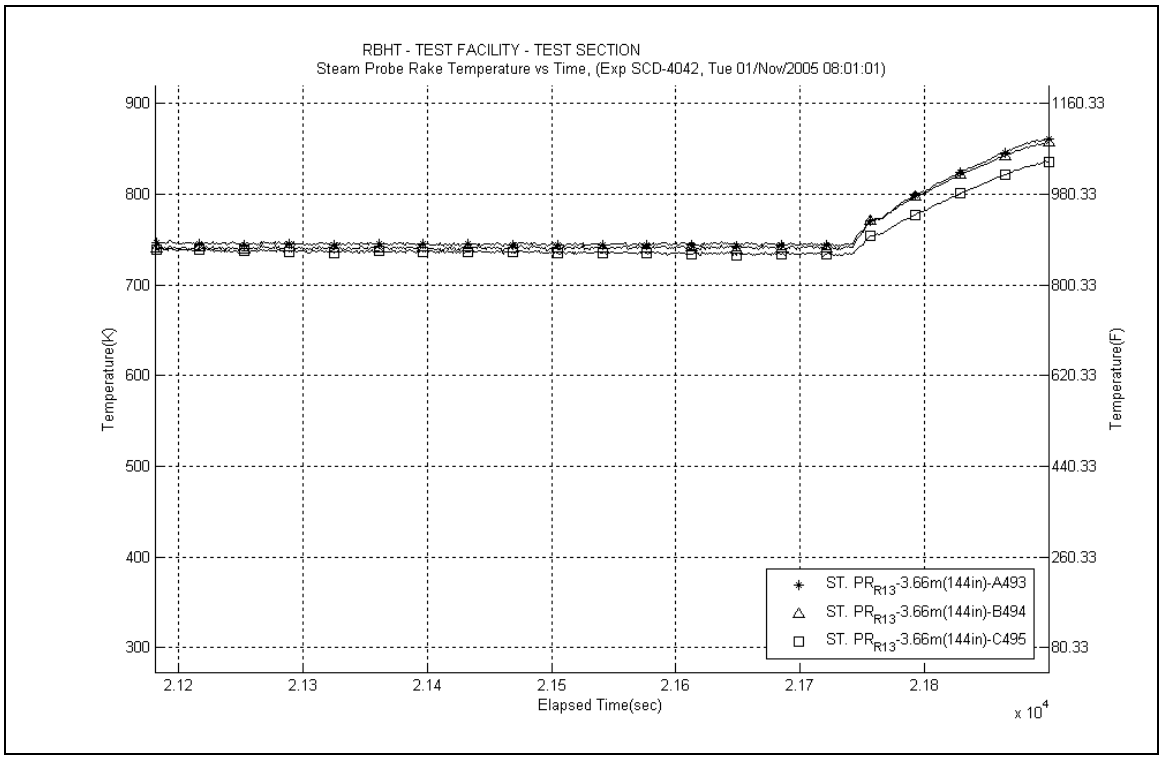

Figure A-27: Steam Probe Rake #13 Temperatures for Experiment 4042H

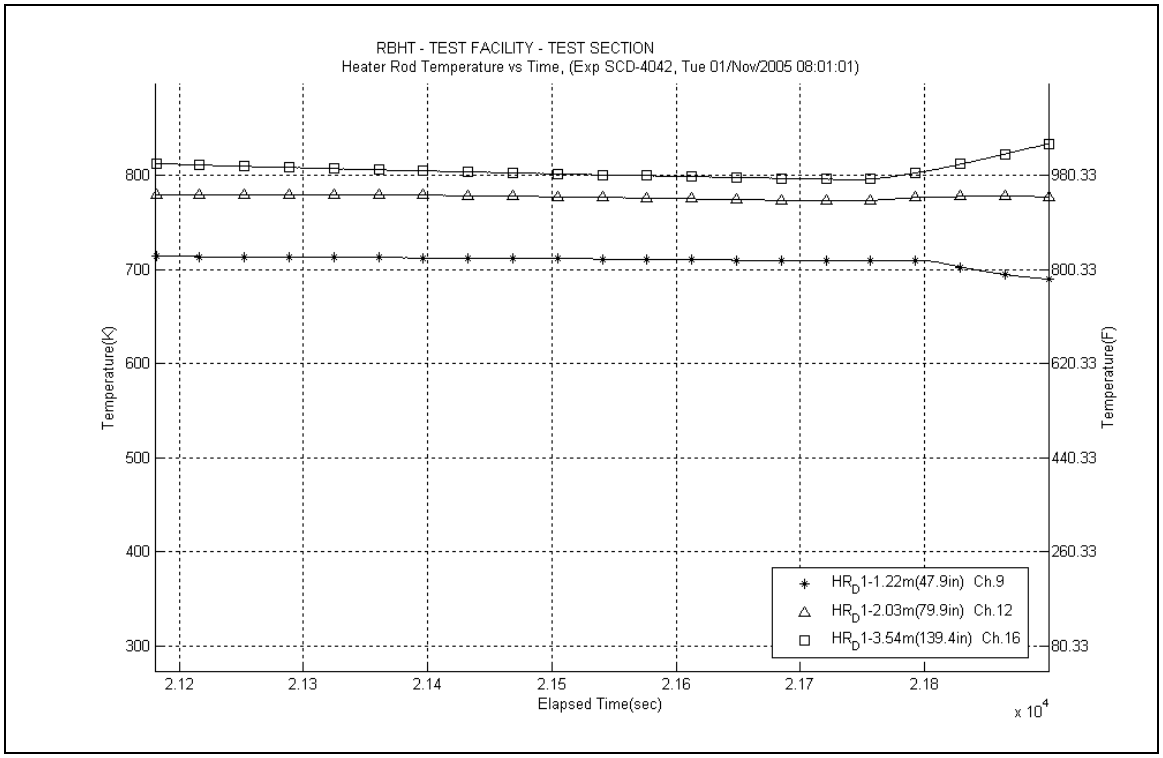

Figure A-28: Heater Rod D1 Temperatures for Experiment 4042H

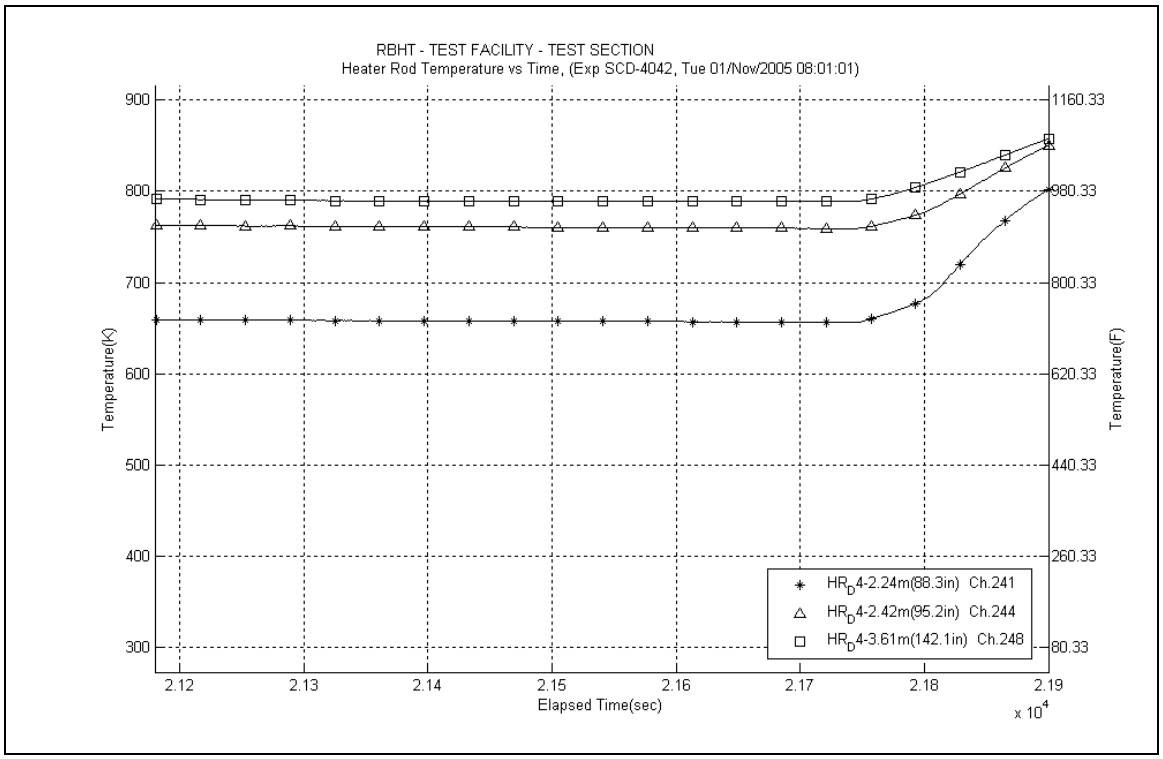

Figure A-29: Heater Rod D4 Temperatures for Experiment 4042H

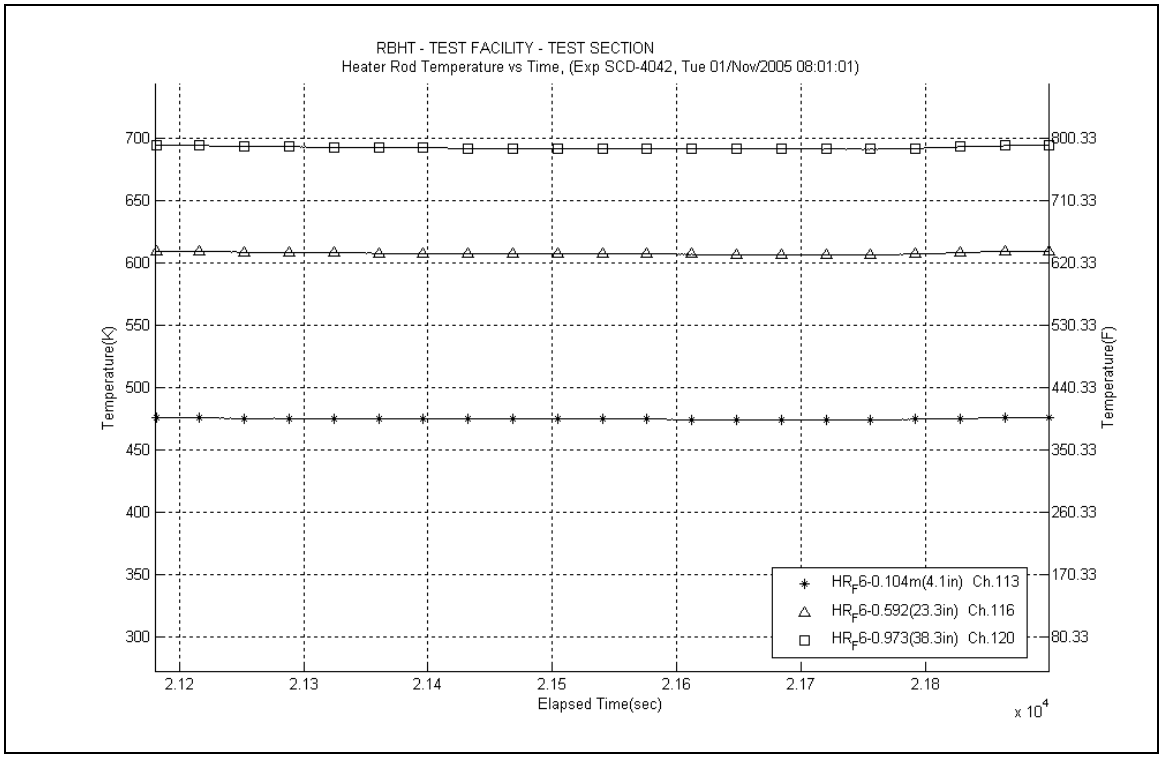

Figure A-30: Heater Rod F6 Temperatures for Experiment 4042H

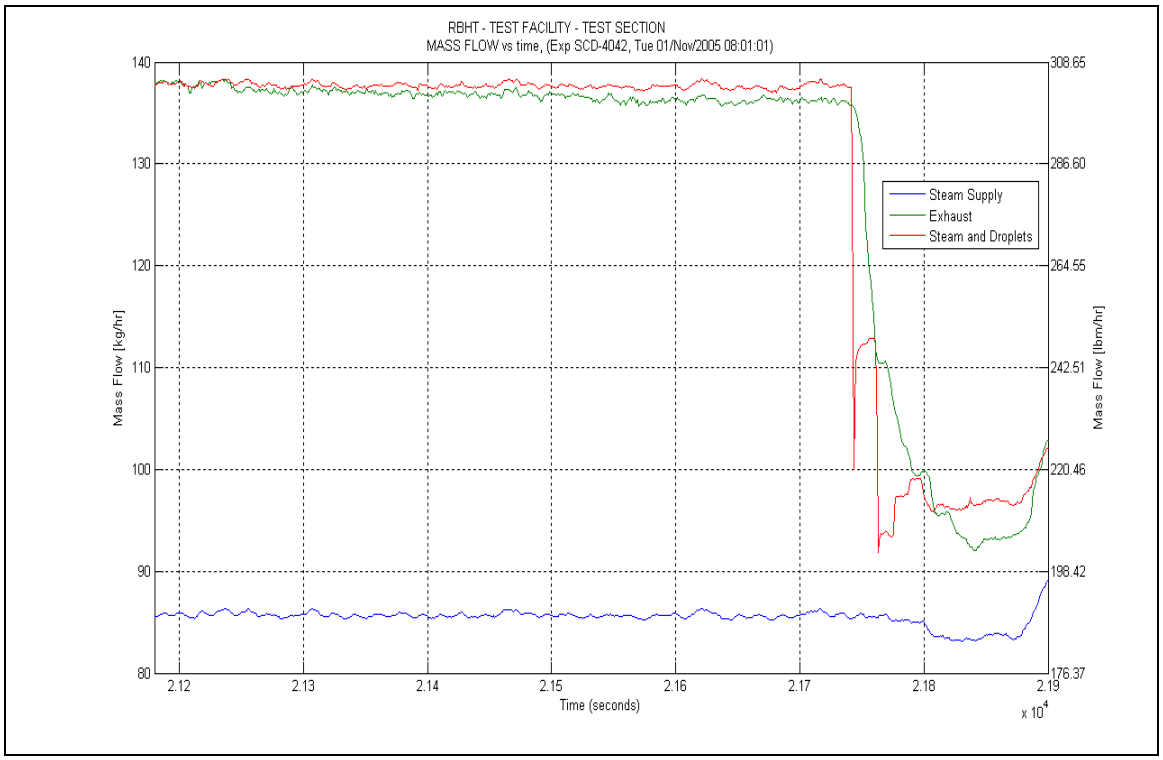

Figure A-31: Mass Flow for Experiment 4042H

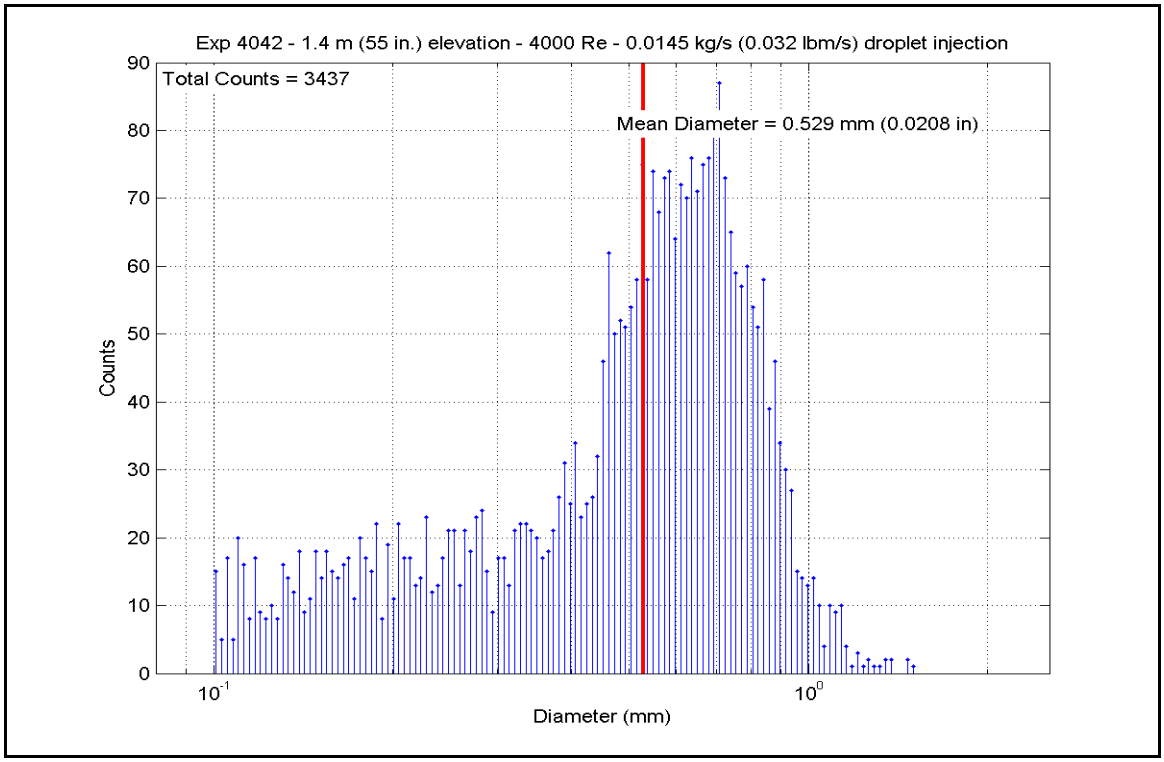

Figure A-32: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4042H

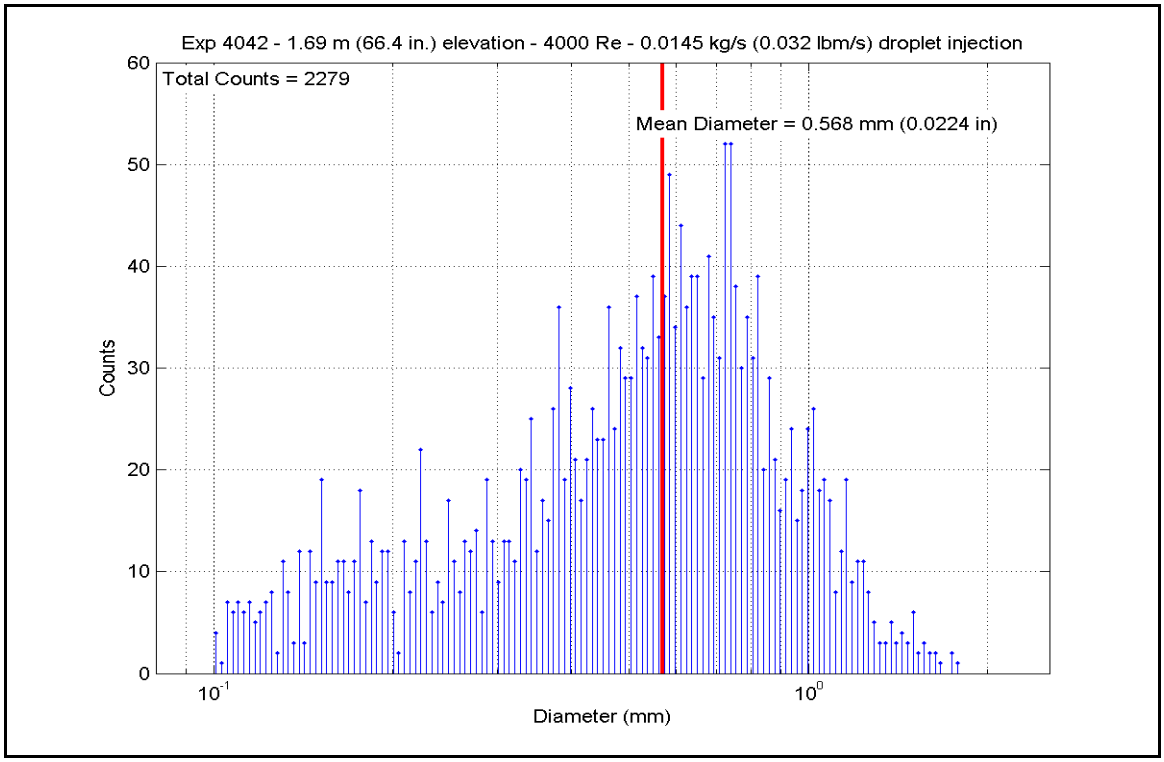

Figure A-33: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4042H

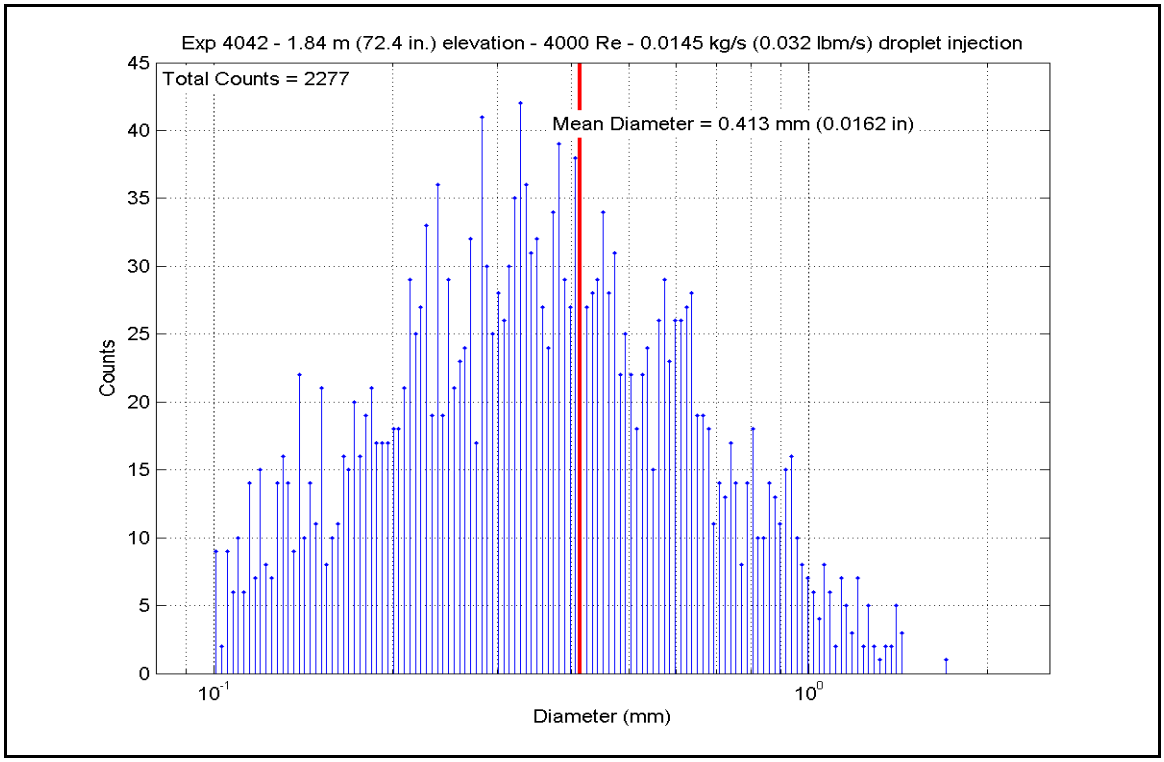

Figure A-34: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4042H

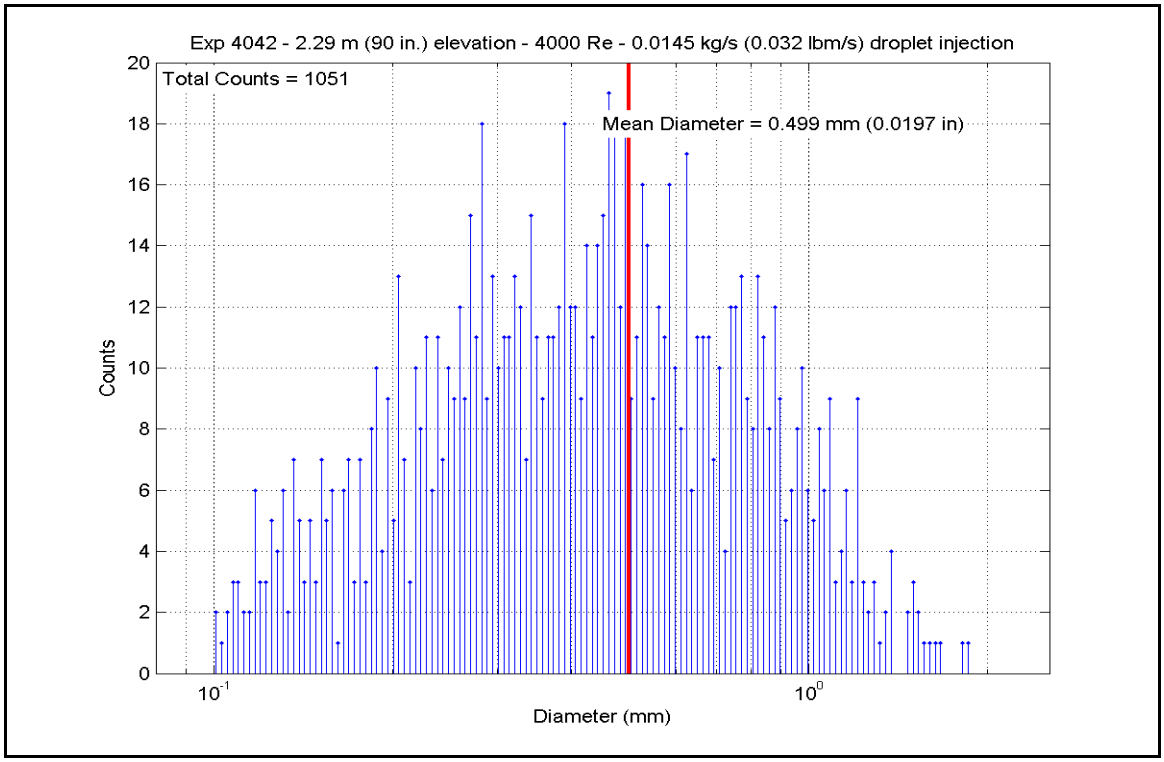

Figure A-35: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4042H

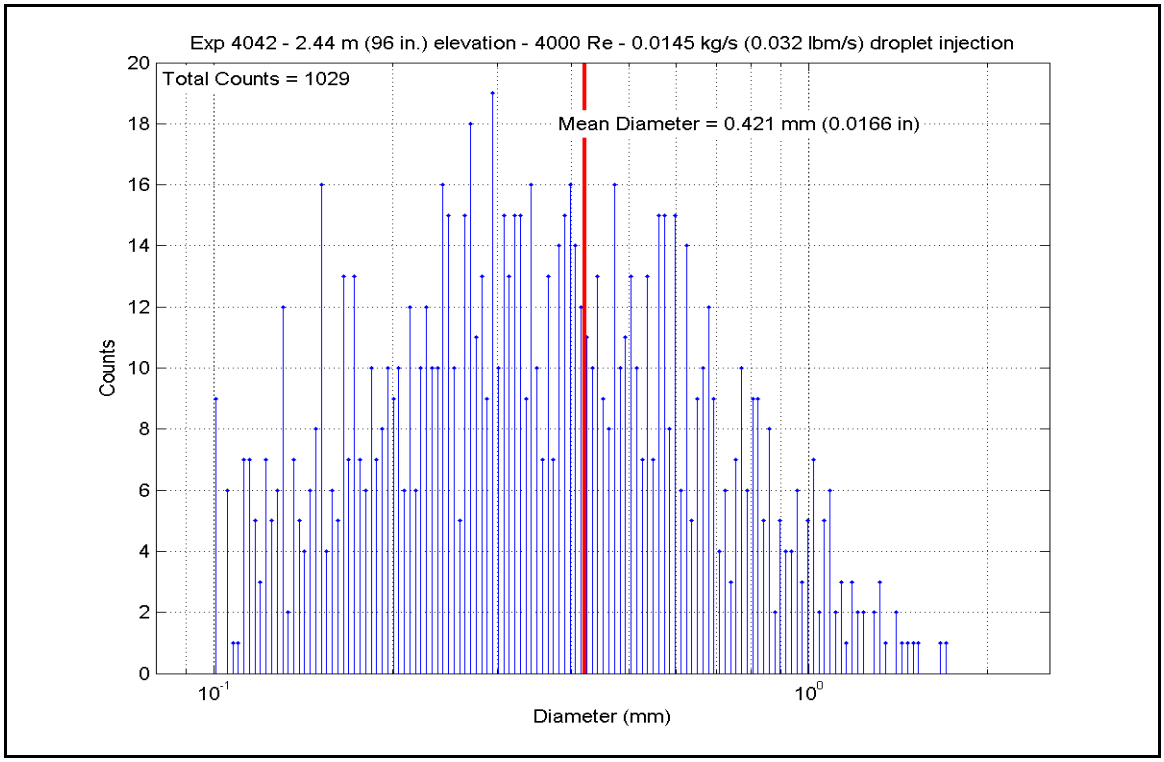

Figure A-36: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4042H

Table A-42: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042H

Test 4042-H	Inlet Reynolds:	4000		
Matrix test # 2d	UP Pressure:	137.9 kPa	20	psia
Time Window: 21180-21900	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	846.90	725.9	4442.56	14014.1	7.178	40.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	867.29	737.2	4510.67	14228.9	7.056	40.1
	RodD3_93.1	187	93.1	2.365	4.6	0.117	762.79	679.1	4205.67	13266.8	7.864	44.7
	RodD3_95.3	188	95.3	2.421	6.8	0.173	854.95	730.3	4431.93	13980.5	7.069	40.1
	RodD3_100.1	189	100.1	2.543	11.6	0.295	929.66	771.8	4606.29	14530.5	6.565	37.3
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1028.00	826.5	4875.17	15378.7	6.094	34.6
	RodD3_110	191	110	2.794	21.5	0.546	1025.91	825.3	4775.80	15065.3	5.985	34.0
	RodD3_142.1	192	142.1	3.609	8.6	0.218	758.00	676.5	4192.50	13225.3	7.910	44.9
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	842.46	723.4	4039.80	12743.6	6.575	37.3
	RodC4_91.1	234	91.1	2.314	2.6	0.066	896.94	753.7	3859.37	12174.4	5.769	32.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	935.77	775.2	3575.46	11278.8	5.052	28.7
	RodC4_95.3	236	95.3	2.421	6.8	0.173	958.87	788.1	3257.54	10275.9	4.457	25.3
	RodC4_100.1	237	100.1	2.543	11.6	0.295	828.70	715.8	4287.24	13524.1	7.137	40.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1037.92	832.0	4904.13	15470.1	6.055	34.4
	RodC4_110	239	110	2.794	21.5	0.546	1061.85	845.3	5008.30	15798.7	6.006	34.1
	RodC4_142.2	240	142.2	3.612	8.7	0.221	966.18	792.1	3676.56	11597.7	4.981	28.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	803.18	701.6	3853.71	12156.5	6.700	38.0
	RodD4_91.3	242	91.3	2.319	2.8	0.071	845.21	724.9	3935.76	12415.4	6.377	36.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1073.45	851.7	3682.79	11617.3	4.356	24.7
	RodD4_95.2	244	95.2	2.418	6.7	0.170	925.70	769.7	3939.31	12426.6	5.646	32.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1094.72	863.6	5004.83	15787.7	5.774	32.8
	RodD4_106.1	246	106.1	2.695	17.6	0.447	924.52	769.0	4545.37	14338.4	6.526	37.1
	RodD4_142.1	248	142.1	3.609	8.6	0.218	736.76	664.7	3670.63	11579.0	7.215	41.0
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	837.26	720.5	4370.87	13787.9	7.174	40.7
	RodE4_91.2	202	91.2	2.316	2.7	0.069	923.38	768.4	4555.59	14370.6	6.551	37.2
	RodE4_95.3	204	95.3	2.421	6.8	0.173	978.40	798.9	1686.76	5320.9	2.248	12.8
	RodE4_100.9	205	100.9	2.563	12.4	0.315	980.66	800.2	4751.18	14987.6	6.313	35.8
	RodE4_142.3	208	142.3	3.614	8.8	0.224	747.45	670.6	4154.46	13105.2	7.998	45.4

Table A-42: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	986.86	803.6	2432.44	7673.1	3.205	18.2
	RodE3_113.6	194	113.6	2.885	0.85	0.022	884.87	747.0	3977.01	12545.5	6.054	34.4
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1067.39	848.4	3694.64	11654.7	4.402	25.0
	RodE3_118.5	196	118.5	3.010	5.75	0.146	953.79	785.3	4123.69	13008.2	5.682	32.3
	RodE3_122.7	197	122.7	3.117	9.95	0.253	991.00	805.9	3912.64	12342.4	5.128	29.1
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1017.66	820.7	3574.99	11277.3	4.527	25.7
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1029.09	827.1	3262.90	10292.8	4.073	23.1
	RodE3_135.6	200	135.6	3.444	2.1	0.053	965.58	791.8	2687.73	8478.4	3.644	20.7
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1012.90	818.1	3619.99	11419.2	4.612	26.2
	RodC5_113.6	226	113.6	2.885	0.85	0.022	866.47	736.7	4153.29	13101.6	6.505	36.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1030.31	827.8	2753.80	8686.8	3.432	19.5
	RodC5_122.7	229	122.7	3.117	9.95	0.253	977.33	798.3	2365.60	7462.3	3.157	17.9
	RodC5_126.7	230	126.7	3.218	13.95	0.354	944.08	779.9	3429.94	10819.7	4.790	27.2
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	867.44	737.3	3279.28	10344.5	5.128	29.1
	RodC5_135.7	232	135.7	3.447	2.2	0.056	954.15	785.5	3478.11	10971.7	4.790	27.2
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	970.68	794.6	1634.77	5156.9	2.201	12.5
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1067.82	848.6	5034.50	15881.3	5.995	34.0
	RodE5_115.4	211	115.4	2.931	2.65	0.067	910.87	761.4	4597.24	14502.0	6.732	38.2
	RodE5_118.7	212	118.7	3.015	5.95	0.151	969.12	793.8	1725.77	5443.9	2.329	13.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	741.80	667.5	4149.07	13088.2	8.075	45.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	839.23	721.6	4399.28	13877.5	7.197	40.9
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	873.90	740.9	4478.99	14129.0	6.935	39.4
	RodE5_135.6	216	135.6	3.444	2.1	0.053	919.59	766.3	4580.42	14448.9	6.623	37.6
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	816.84	709.2	4456.86	14059.2	7.569	43.0
	RodC3_85.6	178	85.6	2.174	14.72	0.374	844.84	724.7	4539.77	14320.7	7.360	41.8
	RodC3_88.5	179	88.5	2.248	0	0.000	960.63	789.1	1776.22	5603.1	2.424	13.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	894.39	752.3	3437.31	10843.0	5.158	29.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	971.02	794.8	3574.02	11274.3	4.810	27.3
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1007.43	815.1	4896.78	15446.9	6.283	35.7
	RodC3_108.8	183	108.8	2.764	20.3	0.516	941.77	778.6	4687.56	14786.9	6.567	37.3
Gr-8	RodD5_50	217	50	1.270	3	0.076	957.54	787.3	3102.13	9785.7	4.252	24.1
	RodD5_54.1	218	54.1	1.374	7.1	0.180	991.01	805.9	3452.10	10889.6	4.524	25.7
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1002.02	812.0	3144.56	9919.5	4.063	23.1
	RodD5_60	220	60	1.524	13	0.330	926.26	770.0	2587.94	8163.7	3.706	21.0
	RodD5_66.1	221	66.1	1.679	19.1	0.485	942.31	778.9	2324.01	7331.1	3.254	18.5
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	752.38	673.4	4195.69	13235.3	8.001	45.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	831.80	717.5	4402.34	13887.2	7.291	41.4
	RodD5_74.9	224	74.9	1.902	4.02	0.102	862.20	734.4	4490.08	14164.0	7.080	40.2

Table A-42: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	562.93	568.1	2259.73	7128.3	6.747	38.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	627.67	604.1	2476.34	7811.6	6.196	35.2
	RodB5_55	155	55	1.397	8	0.203	651.85	617.5	2681.72	8459.5	6.327	35.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	731.98	662.0	2815.30	8880.9	5.586	31.7
	RodB5_64	157	64	1.626	17	0.432	765.09	680.4	2879.43	9083.2	5.361	30.4
	RodB5_73.9	158	73.9	1.877	3.02	0.077	812.31	706.7	2980.11	9400.8	5.100	29.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	866.56	736.8	3089.95	9747.3	4.839	27.5
	RodB5_76.9	160	76.9	1.953	6.02	0.153	956.76	786.9	3529.77	11134.7	4.844	27.5
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	567.34	570.6	2264.08	7142.0	6.672	37.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	633.48	607.3	2495.01	7870.5	6.153	34.9
	RodF5_55	107	55	1.397	8	0.203	639.56	610.7	2677.76	8447.0	6.506	36.9
	RodF5_57.8	108	57.8	1.468	10.8	0.274	720.42	655.6	2812.39	8871.7	5.711	32.4
	RodF5_64	109	64	1.626	17	0.432	747.15	670.5	2880.64	9087.0	5.549	31.5
	RodF5_73.8	110	73.8	1.875	2.92	0.074	785.69	691.9	2982.04	9406.8	5.347	30.4
	RodF5_75.8	111	75.8	1.925	4.92	0.125	901.37	756.1	3402.07	10731.8	5.052	28.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	962.30	790.0	3553.36	11209.1	4.839	27.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	912.12	762.1	1960.05	6183.0	2.865	16.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	720.20	655.5	3258.15	10277.8	6.620	37.6
	RodC2_55	59	55	1.397	8	0.203	865.39	736.1	4229.86	13343.1	6.636	37.7
	RodC2_57.8	60	57.8	1.468	10.8	0.274	831.83	717.5	4716.85	14879.3	7.812	44.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	831.14	717.1	4239.29	13372.8	7.029	39.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	905.12	758.2	3334.68	10519.3	4.925	28.0
	RodC2_75.8	63	75.8	1.925	4.92	0.125	918.33	765.6	4191.96	13223.5	6.072	34.5
	RodC2_76.8	64	76.8	1.951	5.92	0.150	931.54	772.9	4225.23	13328.5	6.006	34.1
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	1012.20	817.7	3636.63	11471.8	4.637	26.3
	RodC6_52.8	138	52.8	1.341	5.8	0.147	976.39	797.8	3668.95	11573.7	4.902	27.8
	RodC6_54.8	139	54.8	1.392	7.8	0.198	1002.20	812.2	3812.18	12025.5	4.924	28.0
	RodC6_57.8	140	57.8	1.468	10.8	0.274	758.31	676.7	3891.46	12275.6	7.338	41.7
	RodC6_63.8	141	63.8	1.621	16.8	0.427	811.90	706.4	3992.95	12595.7	6.838	38.8
	RodC6_73.7	142	73.7	1.872	2.82	0.072	847.05	726.0	4080.86	12873.1	6.592	37.4
	RodC6_75.8	143	75.8	1.925	4.92	0.125	923.09	768.2	4195.04	13233.2	6.035	34.3
	RodC6_76.8	144	76.8	1.951	5.92	0.150	819.21	710.5	4167.56	13146.6	7.049	40.0

Table A-42: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	929.58	771.8	4155.21	13107.6	5.923	33.6
	RodB4_91.3	162	91.3	2.319	2.8	0.071	945.88	780.9	4194.02	13230.0	5.842	33.2
	RodB4_93.3	163	93.3	2.370	4.8	0.122	385.38	469.5	1863.15	5877.3	11.838	67.2
	RodB4_95.1	164	95.1	2.416	6.6	0.168	487.78	526.4	2102.85	6633.4	8.095	46.0
	RodB4_100	165	100	2.540	11.5	0.292	1046.05	836.5	4979.36	15707.4	6.087	34.6
	RodB4_106	166	106	2.692	17.5	0.445	1077.06	853.7	5088.59	16052.0	5.993	34.0
	RodB4_109.9	167	109.9	2.791	21.4	0.544	893.49	751.8	4263.71	13449.9	6.407	36.4
	RodB4_142.3	168	142.3	3.614	8.8	0.224	901.81	756.4	4073.07	12848.5	6.045	34.3
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	851.88	728.6	3993.67	12598.0	6.401	36.4
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	866.16	736.6	4033.26	12722.9	6.320	35.9
	RodF4_92.4	100	92.4	2.347	3.9	0.099	395.04	474.8	1873.75	5910.7	11.217	63.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	486.96	525.9	2097.61	6616.9	8.100	46.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1076.96	853.7	4998.14	15766.6	5.887	33.4
	RodF4_108.8	103	108.8	2.764	20.3	0.516	901.18	756.0	4490.68	14165.9	6.671	37.9
	RodF4_111	104	111	2.819	-1.75	-0.044	1021.87	823.1	4779.86	15078.1	6.021	34.2
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	893.43	751.7	4630.66	14607.4	6.959	39.5
	RodD2_106	66	106	2.692	17.5	0.445	1008.79	815.8	4933.06	15561.3	6.318	35.9
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	843.51	724.0	4415.96	13930.1	7.174	40.7
	RodD2_114.9	68	114.9	2.918	2.15	0.055	941.64	778.5	4177.98	13179.4	5.854	33.2
	RodD2_117.4	69	117.4	2.982	4.65	0.118	967.94	793.1	3985.89	12573.5	5.387	30.6
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1005.92	814.2	3729.91	11766.0	4.795	27.2
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1026.86	825.8	3383.67	10673.8	4.236	24.1
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1027.08	826.0	3030.23	9558.8	3.792	21.5
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	919.65	766.3	4160.51	13124.3	6.015	34.2
	RodD6_106	130	106	2.692	17.5	0.445	1010.76	816.9	4731.97	14927.0	6.045	34.3
	RodD6_112.9	131	112.9	2.868	0.15	0.004	797.76	698.6	4022.40	12688.7	7.060	40.1
	RodD6_114.9	132	114.9	2.918	2.15	0.055	946.21	781.0	3478.25	10972.1	4.843	27.5
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1014.21	818.8	3660.06	11545.6	4.655	26.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	872.11	739.9	4468.98	14097.4	6.938	39.4
	RodD6_124.8	135	124.8	3.170	12.05	0.306	923.26	768.3	4587.56	14471.5	6.598	37.5
	RodD6_128.7	136	128.7	3.269	15.95	0.405	992.37	806.7	1616.13	5098.1	2.114	12.0

Table A-42: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	1053.38	840.6	3736.15	11785.7	4.527	25.7
	RodE2_54	74	54	1.372	7	0.178	1087.21	859.4	3810.03	12018.7	4.434	25.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	1018.82	821.4	4024.02	12693.8	5.088	28.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	229.18	382.7	4064.88	12822.7	3449.094	19587.0
	RodE2_66	77	66	1.676	19	0.483	263.56	401.8	3418.90	10784.9	96.143	546.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	273.01	407.0	3357.84	10592.3	74.599	423.6
	RodE2_72.9	79	72.9	1.852	2.02	0.051	398.70	476.9	1840.42	5805.6	10.782	61.2
	RodE2_74.9	80	74.9	1.902	4.02	0.102	493.28	529.4	2082.59	6569.5	7.851	44.6
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	964.69	791.3	3685.66	11626.4	5.003	28.4
	RodB3_54.1	170	54.1	1.374	7.1	0.180	983.72	801.9	3351.34	10571.8	4.435	25.2
	RodB3_56.9	171	56.9	1.445	9.9	0.251	986.24	803.3	2986.31	9420.3	3.938	22.4
	RodB3_60.1	172	60.1	1.527	13.1	0.333	867.93	737.6	3068.26	9678.8	4.795	27.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	978.85	799.2	3520.06	11104.0	4.688	26.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	1002.03	812.1	3573.99	11274.2	4.617	26.2
	RodB3_73	175	73	1.854	2.12	0.054	1031.87	828.6	3661.64	11550.6	4.555	25.9
	RodB3_75	176	75	1.905	4.12	0.105	1081.18	856.0	3848.83	12141.1	4.511	25.6
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	845.16	724.9	4493.82	14175.7	7.282	41.4
	RodF3_54	90	54	1.372	7	0.178	885.41	747.3	4585.21	14464.1	6.975	39.6
	RodF3_57	91	57	1.448	10	0.254	849.06	727.1	3084.94	9731.5	4.967	28.2
	RodF3_60	92	60	1.524	13	0.330	920.14	766.6	3491.92	11015.3	5.045	28.7
	RodF3_66.1	93	66.1	1.679	19.1	0.485	946.02	780.9	3512.07	11078.8	4.891	27.8
	RodF3_70	94	70	1.778	-0.88	-0.022	994.04	807.6	3609.16	11385.1	4.711	26.8
	RodF3_73	95	73	1.854	2.12	0.054	1029.69	827.4	3754.11	11842.3	4.683	26.6
	RodF3_75	96	75	1.905	4.12	0.105	820.26	711.1	3905.75	12320.7	6.595	37.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	570.92	572.5	2252.66	7106.0	6.569	37.3
	RodE6_54.1	122	54.1	1.374	7.1	0.180	634.31	607.8	2494.68	7869.5	6.140	34.9
	RodE6_57	123	57	1.448	10	0.254	650.09	616.5	2693.67	8497.2	6.382	36.2
	RodE6_60.2	124	60.2	1.529	13.2	0.335	737.09	664.9	2833.36	8937.8	5.566	31.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	769.44	682.8	2903.02	9157.6	5.362	30.4
	RodE6_70	126	70	1.778	-0.88	-0.022	814.36	707.8	3004.79	9478.6	5.124	29.1
	RodE6_73.1	127	73.1	1.857	2.22	0.056	925.81	769.7	3484.89	10993.1	4.994	28.4
	RodE6_75	128	75	1.905	4.12	0.105	1000.19	811.0	3610.86	11390.5	4.676	26.6

RBHT Steam Cooling with Droplet Injection Test SCD-4042-K

Matrix Test # 1c

Test Conditions

Test Date – 11/1/2005
Steady State Time Window: 22860 – 23760
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 28.9 kW
Bundle Inlet Reynolds Number: 2000
Bundle Inlet Steam Flow: 40.86 kg/hr (90 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.381 mm (.015 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

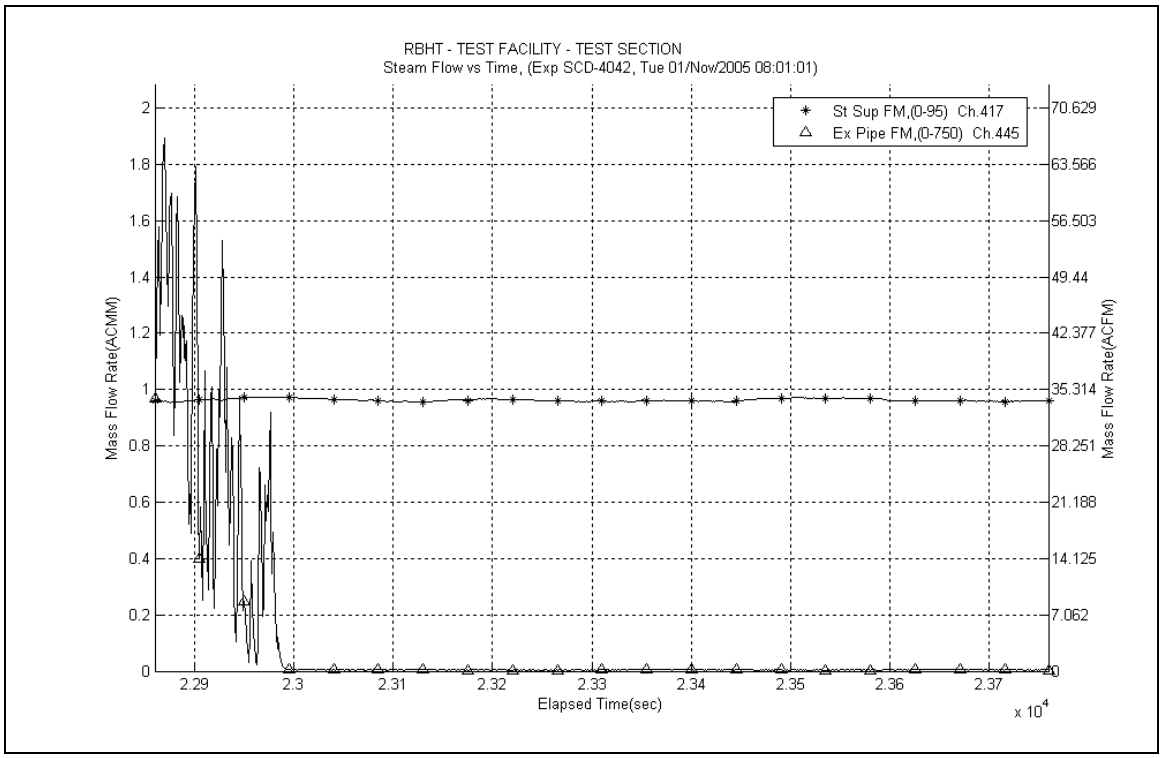

Figure A-37: Inlet and Exhaust Steam Flow Rates for Experiment 4042K

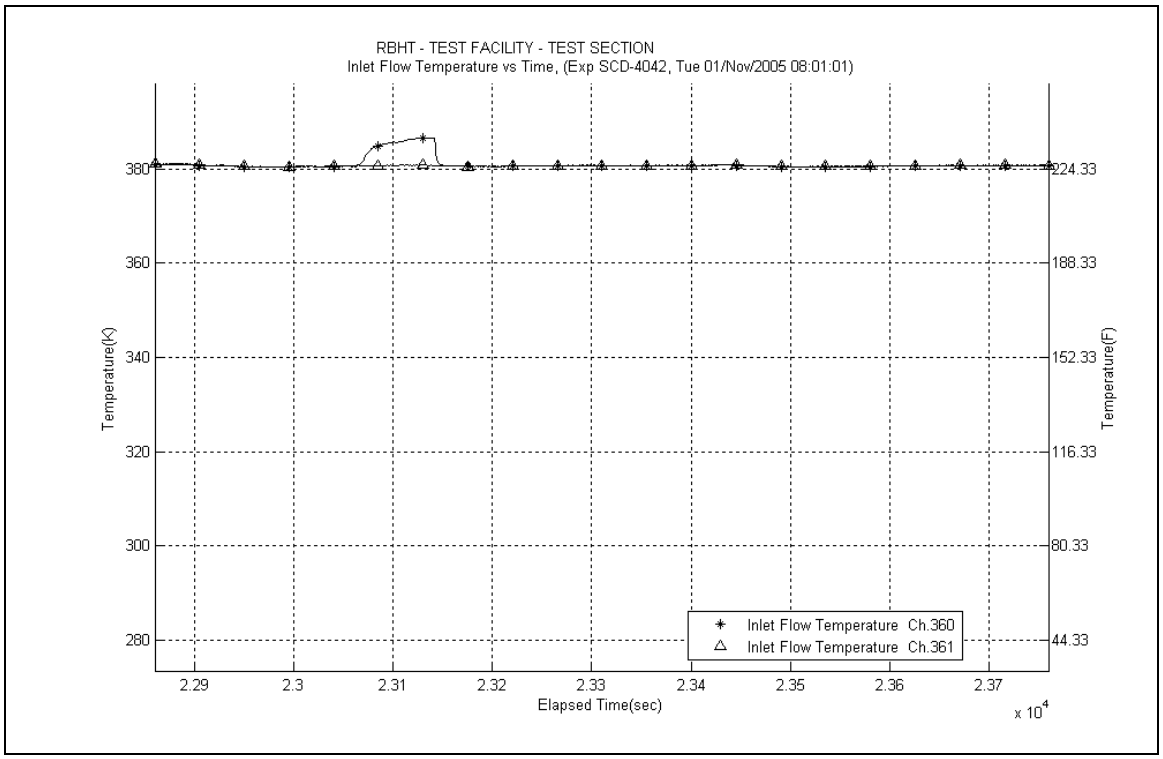

Figure A-38: Inlet Steam Temperature for Experiment 4042K

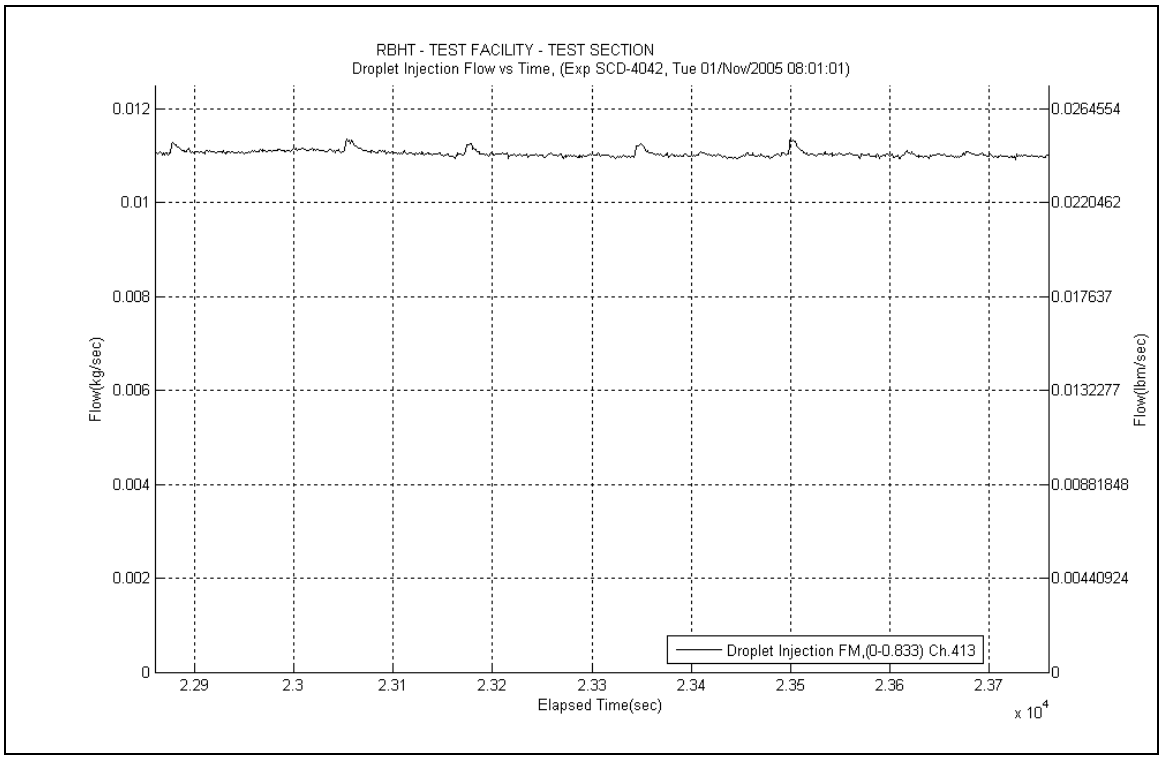

Figure A-39: Droplet Injection Flow Rate for Experiment 4042K

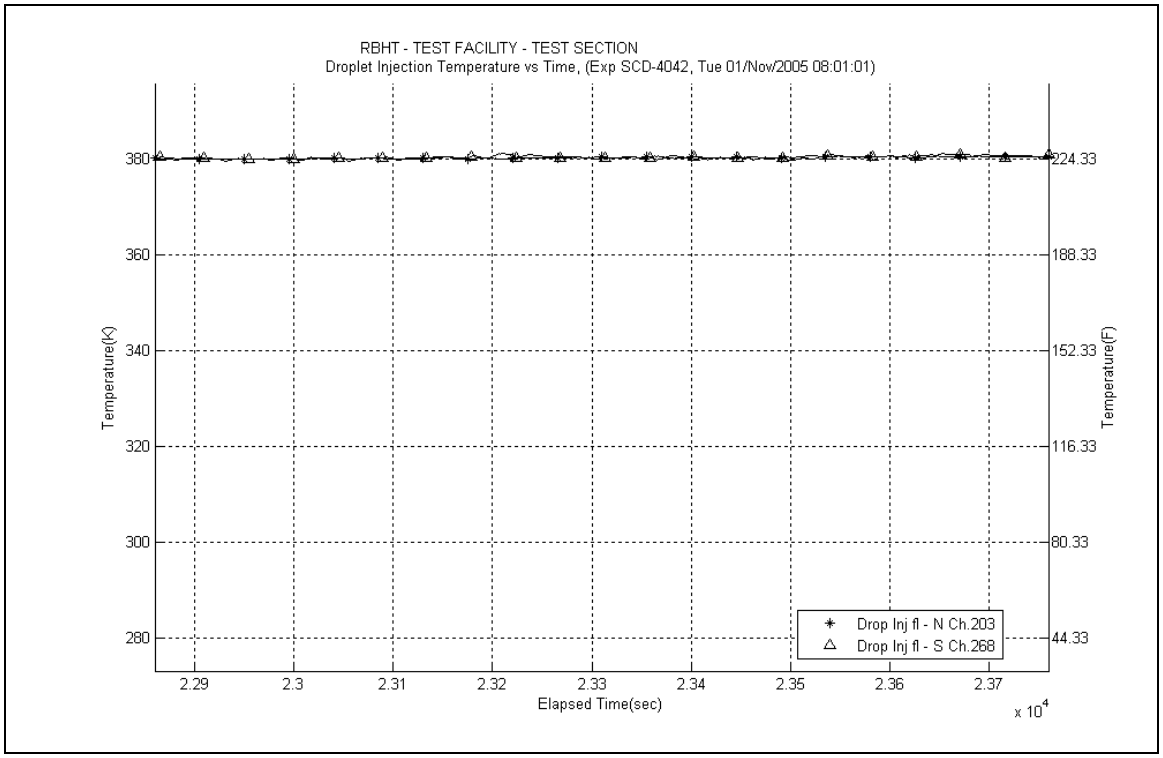

Figure A-40: Droplet Injection Temperature for Experiment 4042K

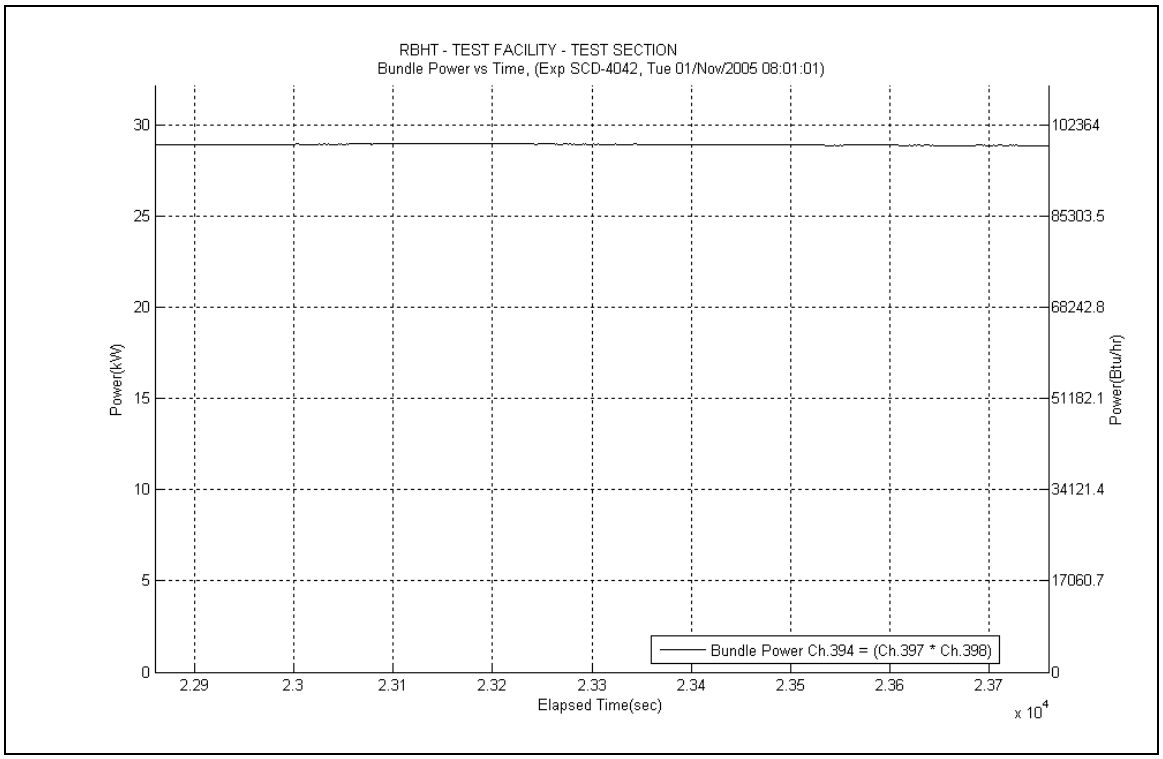

Figure A-41: Bundle Power for Experiment 4042K

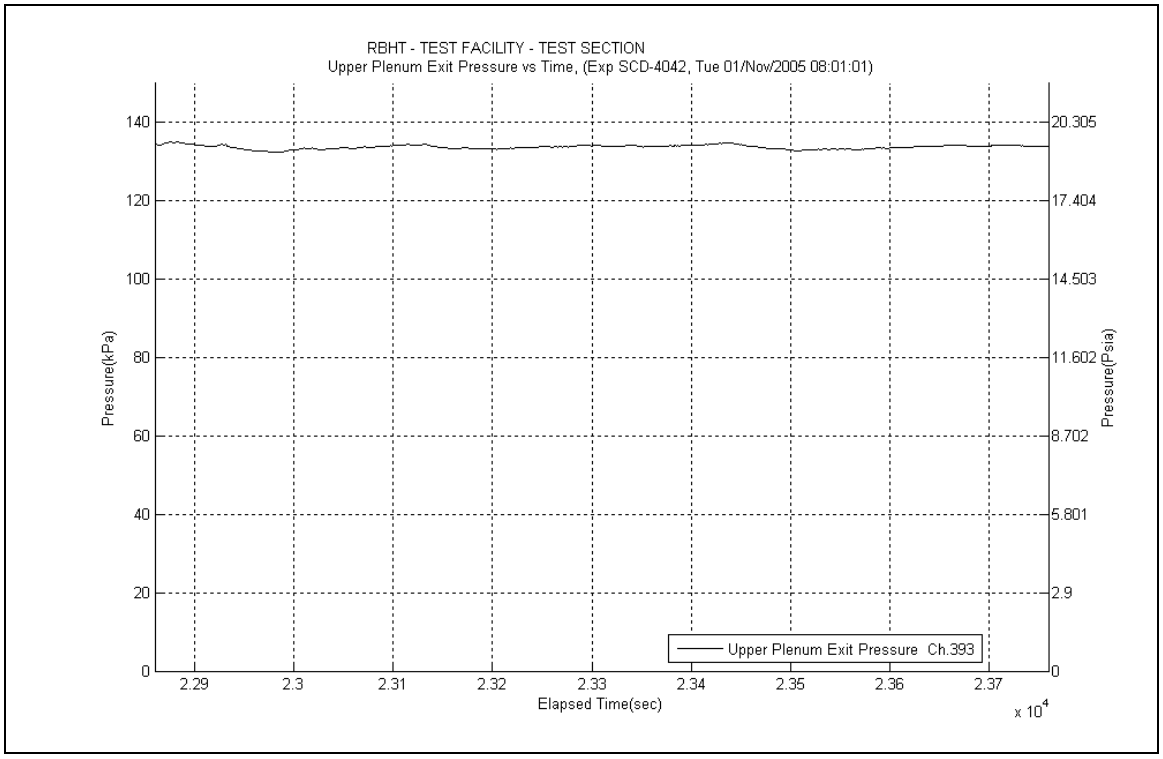

Figure A-42: Upper Plenum Pressure for Experiment 4042K

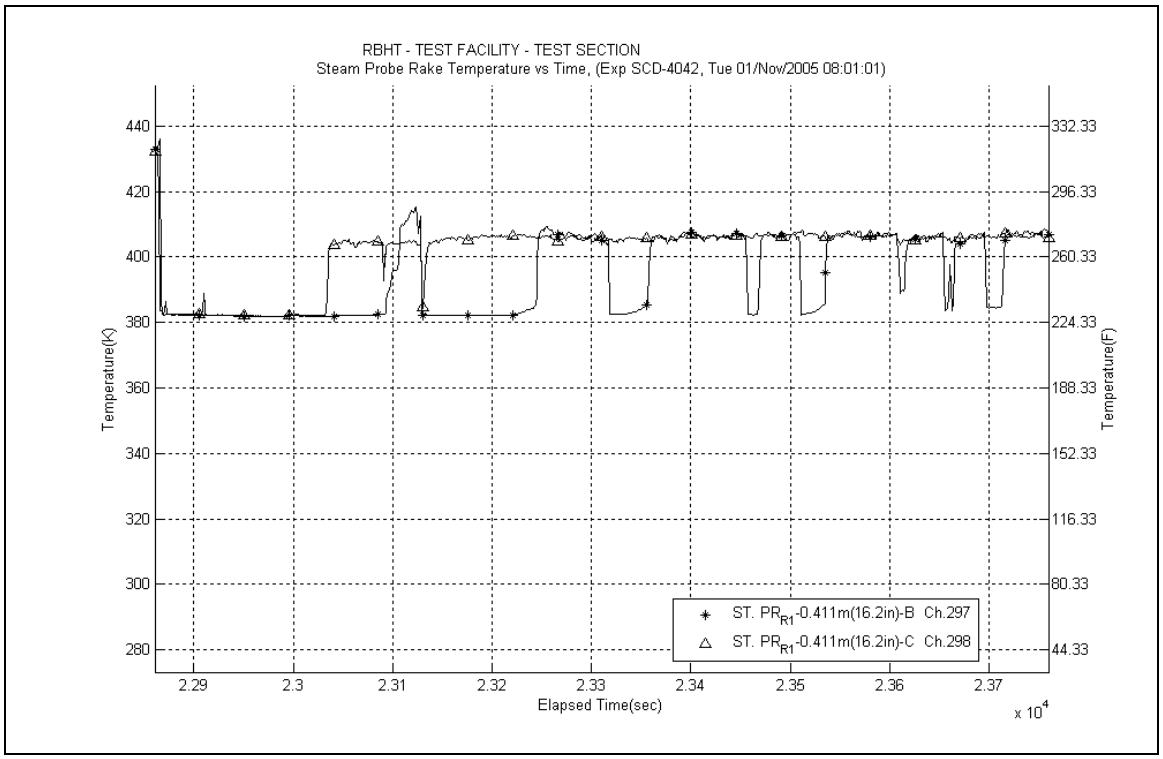

Figure A-43: Steam Probe Rake #1 Temperatures for Experiment 4042K

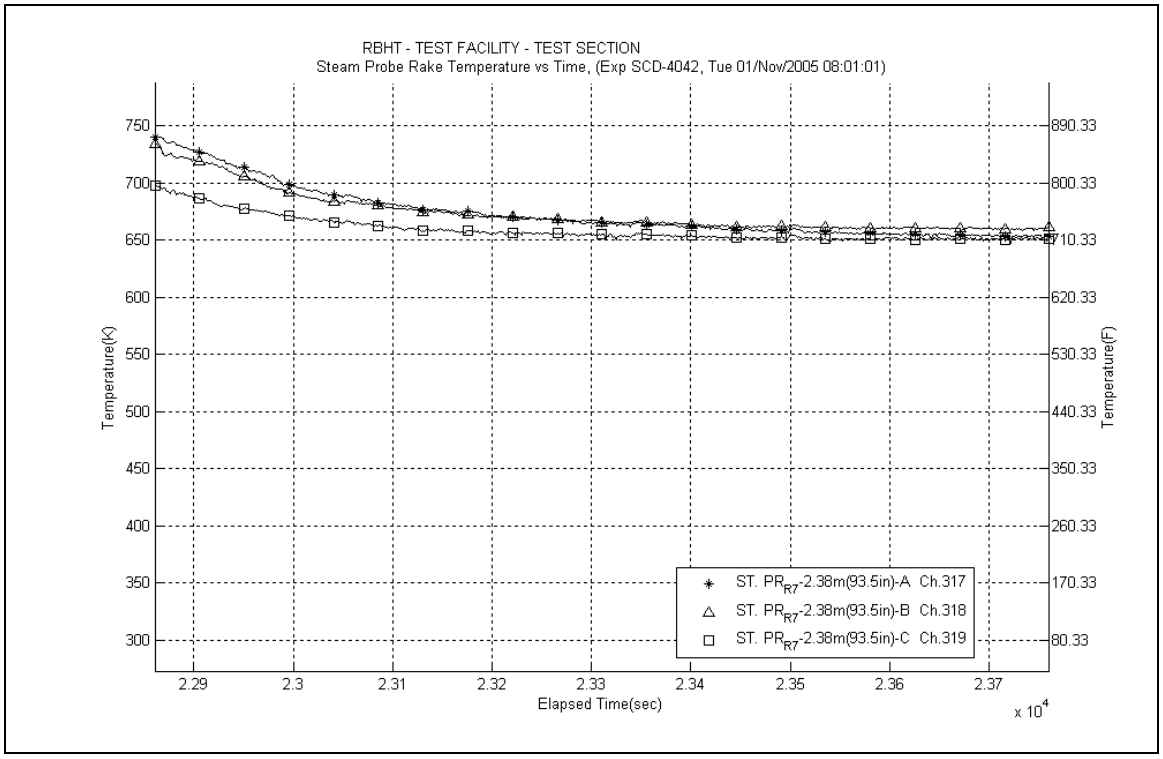

Figure A-44: Steam Probe Rake #7 Temperatures for Experiment 4042K

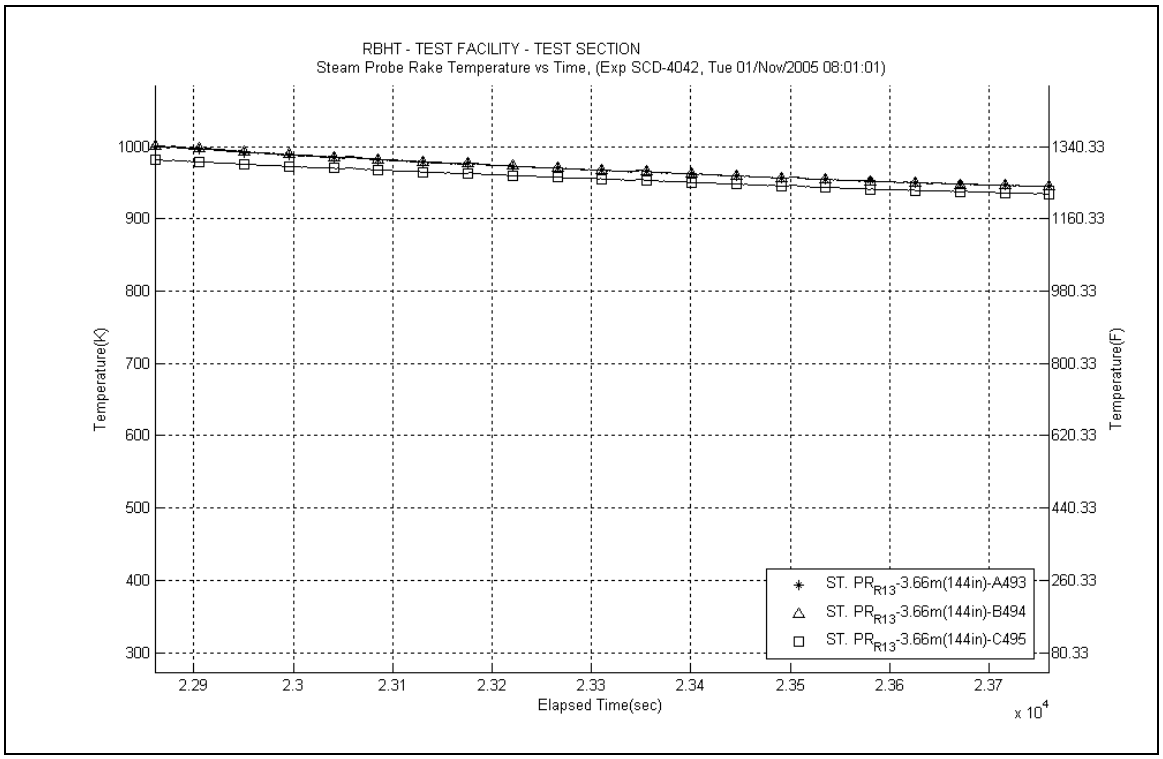

Figure A-45: Steam Probe Rake #13 Temperatures for Experiment 4042K

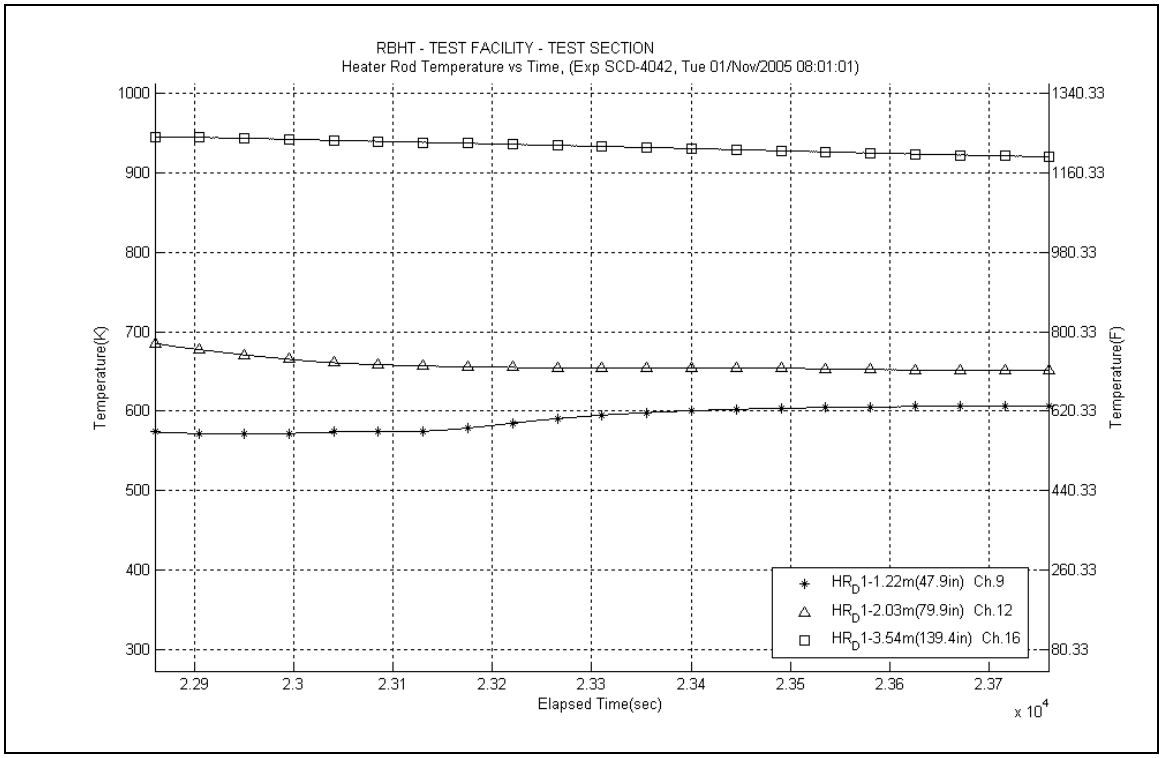

Figure A-46: Heater Rod D1 Temperatures for Experiment 4042K

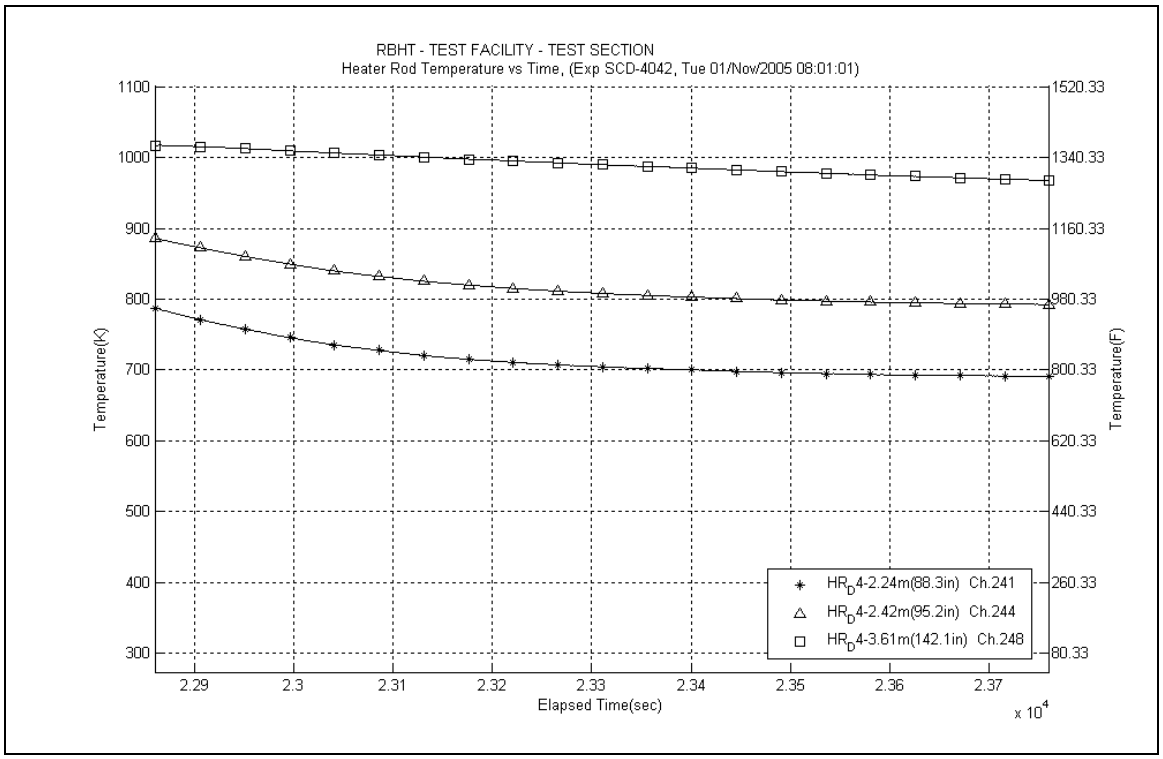

Figure A-47: Heater Rod D4 Temperatures for Experiment 4042K

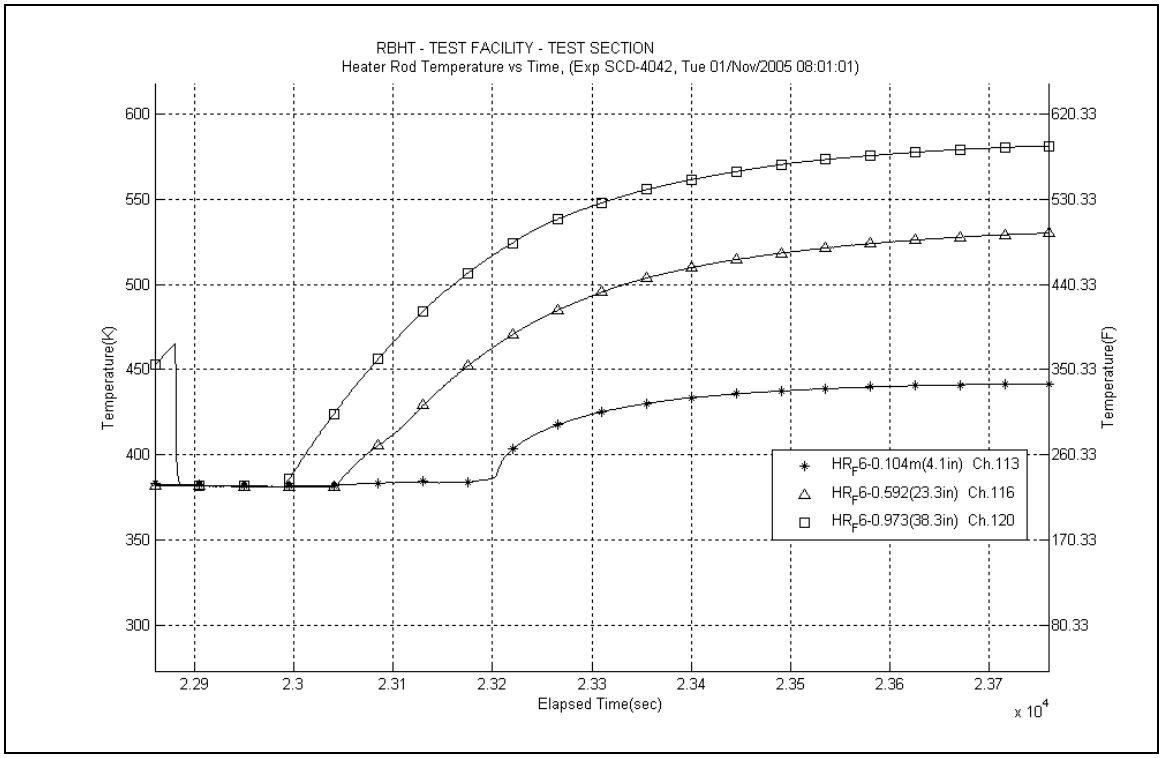

Figure A-48: Heater Rod F6 Temperatures for Experiment 4042K

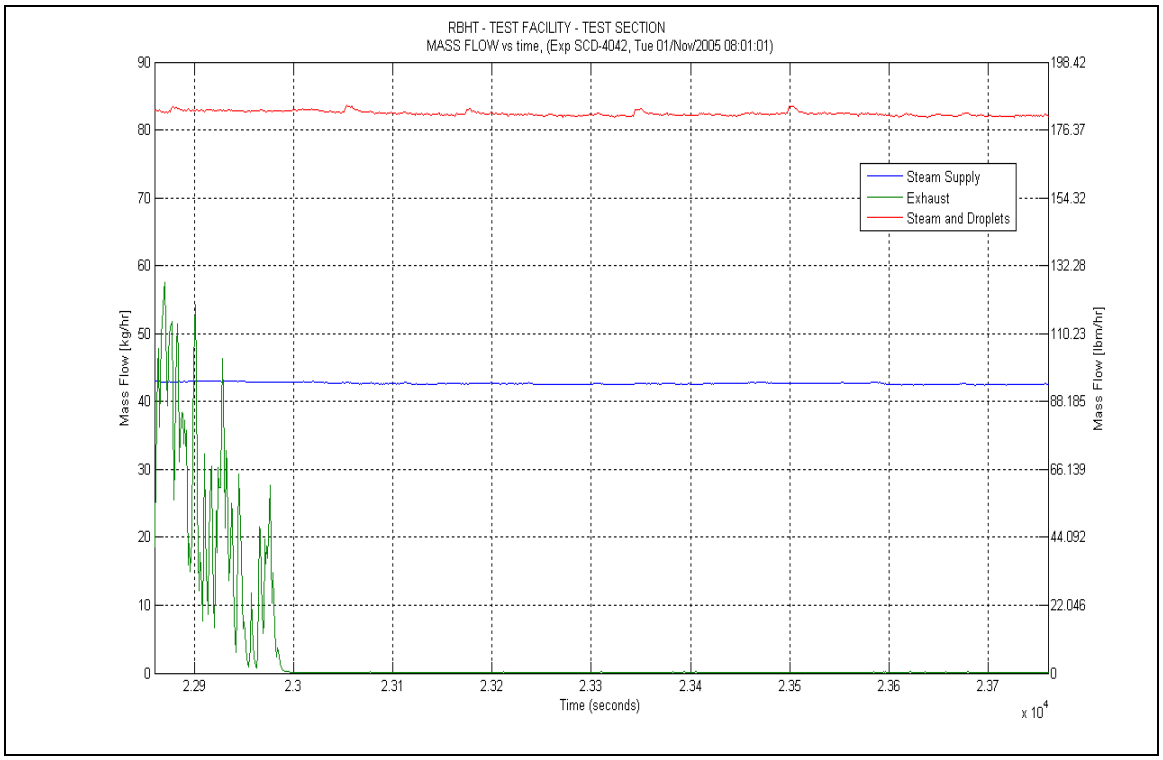

Figure A-49: Mass Flow for Experiment 4042K

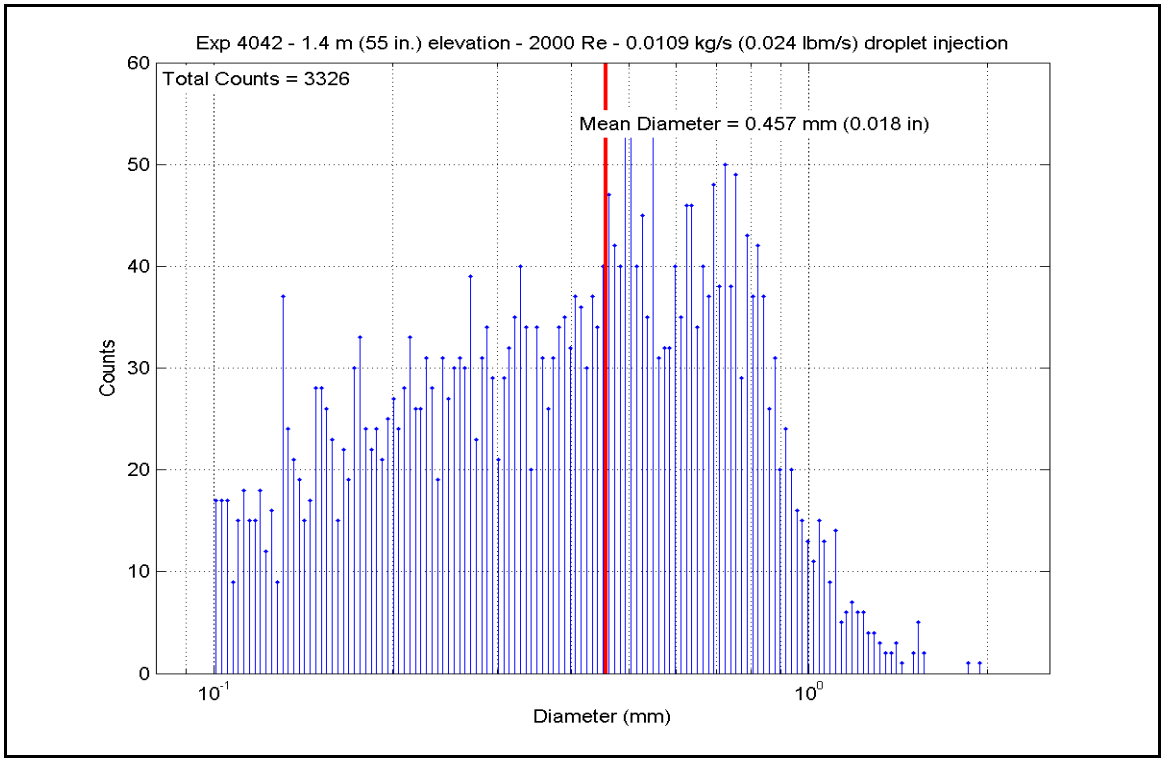

Figure A-50: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4042K

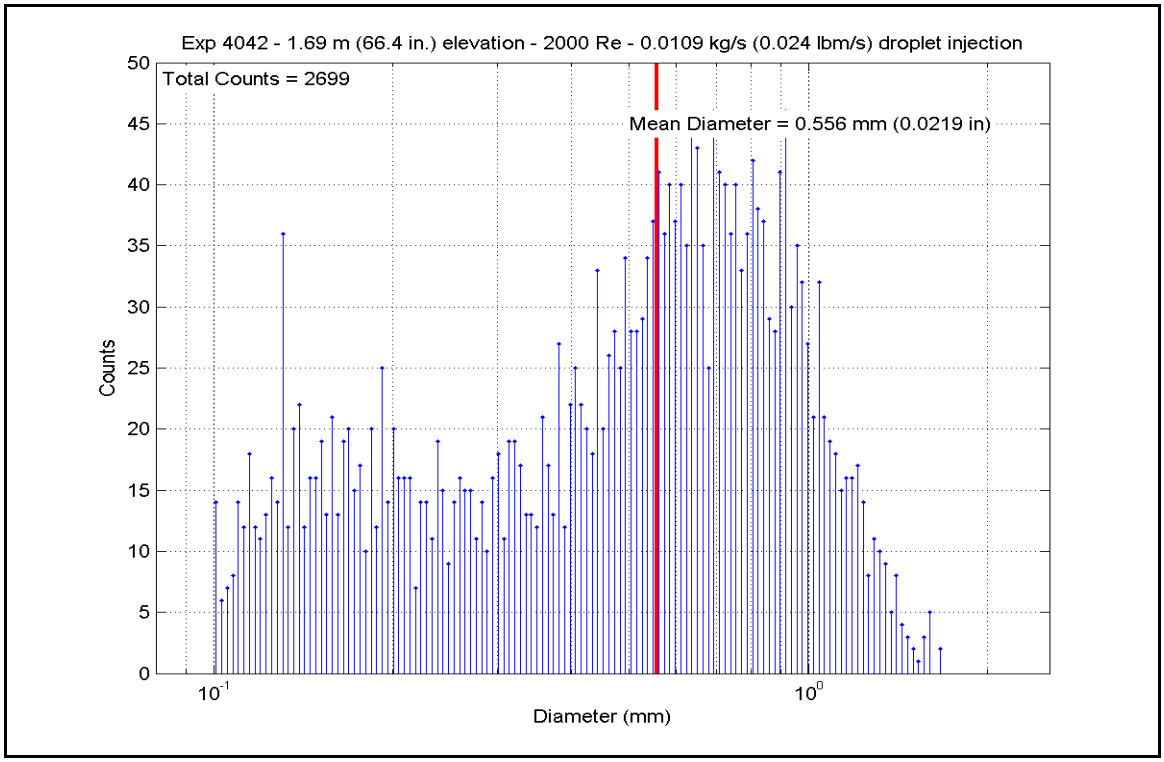

Figure A-51: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4042K

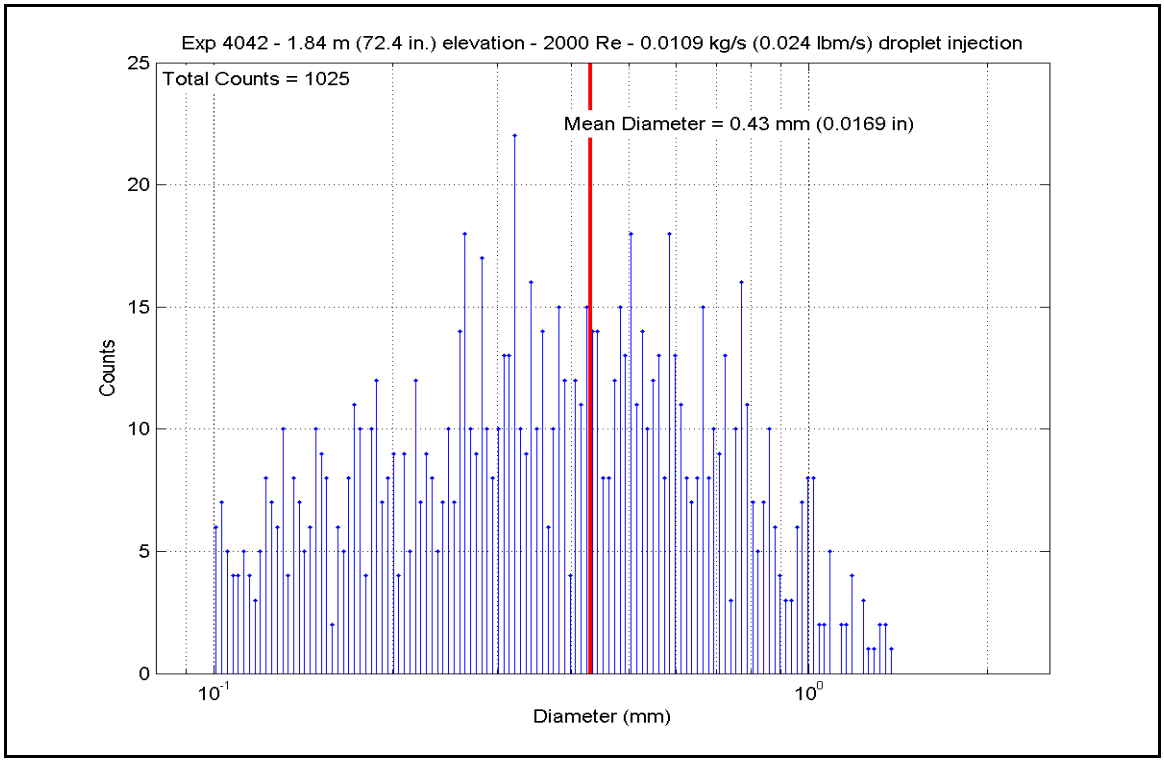

Figure A-52: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4042K

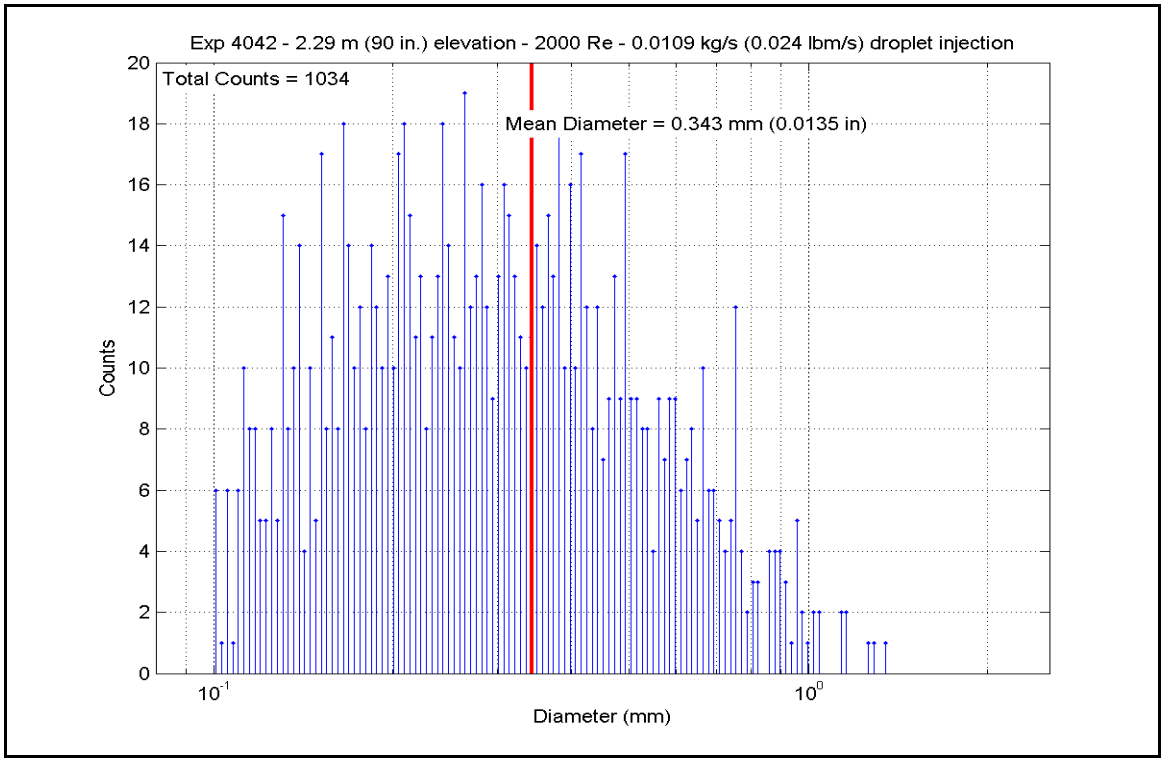

Figure A-53: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4042K

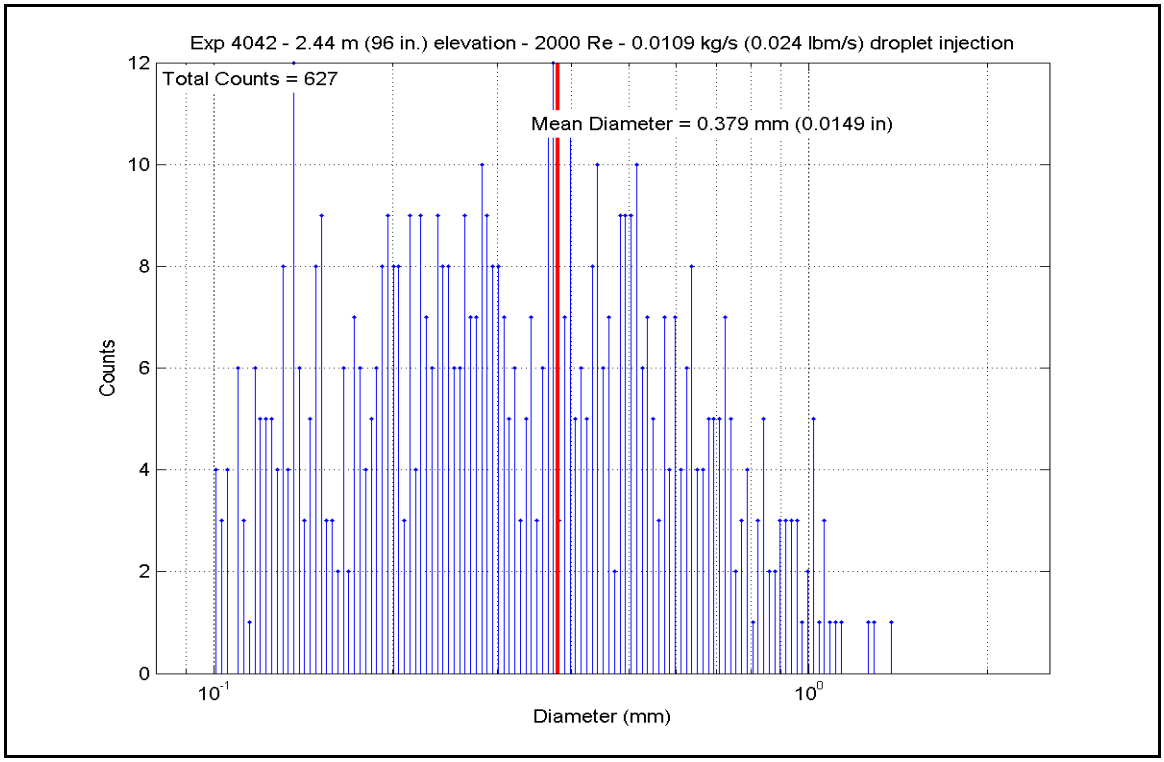

Figure A-54: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4042K

Table A-43: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042K

Test 4042-K	Inlet Reynolds:	2000	
Matrix test # 1c	UP Pressure:	137.9 kPa	20 psia
Time Window: 22860-23760	Bundle Power:	28.90 kW	98611 Btu/hr
	Steam flow:	0.0118 kg/s	94.0 lbm/hr
	Droplet flow:	0.0109 kg/s	0.024 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	901.31	756.1	2792.50	8809.0	4.147	23.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	944.63	780.2	2836.45	8947.6	3.958	22.5
	RodD3_93.1	187	93.1	2.365	4.6	0.117	821.95	712.0	2759.34	8704.3	4.646	26.4
	RodD3_95.3	188	95.3	2.421	6.8	0.173	893.22	751.6	2817.94	8889.2	4.236	24.1
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1001.19	811.6	2875.80	9071.7	3.719	21.1
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1134.88	885.9	3014.95	9510.6	3.325	18.9
	RodD3_110	191	110	2.794	21.5	0.546	1077.29	853.9	2983.49	9411.4	3.513	19.9
	RodD3_142.1	192	142.1	3.609	8.6	0.218	815.37	708.4	2695.34	8502.5	4.589	26.1
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1156.69	898.0	2734.83	8627.0	2.945	16.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1202.85	923.6	2571.90	8113.0	2.638	15.0
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1236.36	942.2	2378.55	7503.1	2.359	13.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1252.19	951.0	2175.65	6863.1	2.124	12.1
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1140.07	888.7	2911.83	9185.4	3.193	18.1
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1055.66	841.9	3018.77	9522.7	3.647	20.7
	RodC4_110	239	110	2.794	21.5	0.546	1084.77	858.0	3069.95	9684.2	3.583	20.3
	RodC4_142.2	240	142.2	3.612	8.7	0.221	658.52	621.2	2065.98	6517.1	4.799	27.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	631.92	606.4	2320.68	7320.6	5.745	32.6
	RodD4_91.3	242	91.3	2.319	2.8	0.071	683.11	634.9	2404.74	7585.7	5.284	30.0
	RodD4_93.2	243	93.2	2.367	4.7	0.119	705.26	647.2	2074.96	6545.5	4.348	24.7
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1203.56	924.0	2656.86	8381.1	2.723	15.5
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1141.18	889.4	3070.24	9685.1	3.362	19.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1146.32	892.2	3042.89	9598.8	3.314	18.8
	RodD4_142.1	248	142.1	3.609	8.6	0.218	544.60	557.9	2178.36	6871.6	6.880	39.1
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	901.66	756.3	2808.46	8859.3	4.169	23.7
	RodE4_91.2	202	91.2	2.316	2.7	0.069	994.08	807.6	2892.15	9123.3	3.775	21.4
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1316.25	986.6	1206.49	3805.9	1.109	6.3
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1076.52	853.4	2998.64	9459.2	3.534	20.1
	RodE4_142.3	208	142.3	3.614	8.8	0.224	833.47	718.4	2752.19	8681.8	4.546	25.8

Table A-43: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1306.44	981.2	1640.70	5175.6	1.521	8.6
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1169.12	904.9	2750.09	8675.2	2.922	16.6
	RodE3_115.5	195	115.5	2.934	2.75	0.070	703.31	646.1	2152.06	6788.7	4.528	25.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1221.92	934.2	2701.28	8521.2	2.718	15.4
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1251.42	950.6	2547.89	8037.3	2.490	14.1
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1279.29	966.1	2325.16	7334.7	2.212	12.6
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1291.81	973.0	2128.36	6713.9	2.001	11.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1294.95	974.8	1870.83	5901.5	1.753	10.0
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	668.87	627.0	2011.86	6346.4	4.563	25.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1129.95	883.1	2839.52	8957.3	3.148	17.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1337.59	998.5	1934.91	6103.7	1.744	9.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1313.80	985.3	1716.53	5414.8	1.581	9.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	619.38	599.5	1841.66	5809.5	4.706	26.7
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	584.33	580.0	1915.81	6043.4	5.376	30.5
	RodC5_135.7	232	135.7	3.447	2.2	0.056	639.56	610.7	1951.89	6157.2	4.743	26.9
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1325.45	991.7	1207.18	3808.1	1.100	6.2
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1138.53	887.9	3103.39	9789.6	3.408	19.4
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1004.61	813.5	2928.39	9237.6	3.771	21.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1314.90	985.9	1216.11	3836.2	1.119	6.4
	RodE5_122.6	213	122.6	3.114	9.85	0.250	828.76	715.8	2819.67	8894.6	4.694	26.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	907.77	759.7	2871.57	9058.4	4.224	24.0
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	960.78	789.1	2911.97	9185.8	3.974	22.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1014.23	818.8	2949.06	9302.8	3.751	21.3
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	913.33	762.8	2775.96	8756.8	4.051	23.0
	RodC3_85.6	178	85.6	2.174	14.72	0.374	946.87	781.4	2813.55	8875.3	3.914	22.2
	RodC3_88.5	179	88.5	2.248	0	0.000	1278.74	965.8	1175.40	3707.8	1.119	6.4
	RodC3_92.4	180	92.4	2.347	3.9	0.099	236.46	386.7	1743.89	5501.1	206.054	1170.2
	RodC3_94.4	181	94.4	2.398	5.9	0.150	383.72	468.6	1348.40	4253.5	8.659	49.2
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1134.29	885.5	3022.33	9533.9	3.335	18.9
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1014.57	819.0	2877.32	9076.5	3.658	20.8
Gr-8	RodD5_50	217	50	1.270	3	0.076	1176.73	909.1	1947.78	6144.3	2.053	11.7
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1260.17	955.5	2310.00	7286.9	2.238	12.7
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1278.28	965.5	2112.73	6664.6	2.012	11.4
	RodD5_60	220	60	1.524	13	0.330	1282.03	967.6	1889.30	5959.8	1.792	10.2
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1303.06	979.3	1656.99	5227.0	1.541	8.8
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	822.80	712.5	2768.94	8734.6	4.655	26.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	899.16	754.9	2830.36	8928.4	4.217	23.9
	RodD5_74.9	224	74.9	1.902	4.02	0.102	953.18	784.9	2882.54	9093.0	3.975	22.6

Table A-43: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	483.97	524.2	1208.43	3812.0	4.721	26.8
	RodB5_52.9	154	52.9	1.344	5.9	0.150	528.00	548.7	1316.61	4153.2	4.389	24.9
	RodB5_55	155	55	1.397	8	0.203	545.91	558.7	1395.06	4400.7	4.388	24.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	608.04	593.2	1477.42	4660.5	3.888	22.1
	RodB5_64	157	64	1.626	17	0.432	632.51	606.8	1518.10	4788.8	3.753	21.3
	RodB5_73.9	158	73.9	1.877	3.02	0.077	662.66	623.5	1584.75	4999.1	3.646	20.7
	RodB5_75.9	159	75.9	1.928	5.02	0.128	666.61	625.7	1710.19	5394.8	3.899	22.1
	RodB5_76.9	160	76.9	1.953	6.02	0.153	662.19	623.3	1907.93	6018.6	4.394	25.0
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	360.43	455.6	874.76	2759.4	6.606	37.5
	RodF5_53.1	106	53.1	1.349	6.1	0.155	382.33	467.8	930.46	2935.1	6.029	34.2
	RodF5_55	107	55	1.397	8	0.203	414.06	485.4	1151.31	3631.8	6.188	35.1
	RodF5_57.8	108	57.8	1.468	10.8	0.274	440.33	500.0	1148.97	3624.4	5.411	30.7
	RodF5_64	109	64	1.626	17	0.432	448.91	504.8	1164.05	3672.0	5.269	29.9
	RodF5_73.8	110	73.8	1.875	2.92	0.074	463.22	512.7	1191.65	3759.1	5.066	28.8
	RodF5_75.8	111	75.8	1.925	4.92	0.125	621.40	600.6	1779.63	5613.9	4.524	25.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	659.15	621.6	1871.02	5902.1	4.340	24.6
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1189.62	916.3	1257.16	3965.7	1.307	7.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	561.32	567.2	1678.09	5293.5	5.035	28.6
	RodC2_55	59	55	1.397	8	0.203	708.81	649.2	2420.94	7636.9	5.035	28.6
	RodC2_57.8	60	57.8	1.468	10.8	0.274	887.71	748.5	2793.23	8811.2	4.234	24.0
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1081.82	856.4	2628.47	8291.5	3.078	17.5
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1165.03	902.6	2006.34	6329.0	2.141	12.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	696.37	642.2	2321.54	7323.3	4.957	28.1
	RodC2_76.8	64	76.8	1.951	5.92	0.150	712.73	651.3	2349.27	7410.8	4.847	27.5
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	413.99	485.4	1283.82	4049.8	6.902	39.2
	RodC6_52.8	138	52.8	1.341	5.8	0.147	463.62	512.9	1295.50	4086.7	5.498	31.2
	RodC6_54.8	139	54.8	1.392	7.8	0.198	345.65	447.4	1566.51	4941.5	13.315	75.6
	RodC6_57.8	140	57.8	1.468	10.8	0.274	355.45	452.8	2024.79	6387.2	15.887	90.2
	RodC6_63.8	141	63.8	1.621	16.8	0.427	575.75	575.2	2188.38	6903.2	6.293	35.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	643.07	612.6	2298.83	7251.7	5.538	31.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	748.54	671.2	2511.12	7921.3	4.824	27.4
	RodC6_76.8	144	76.8	1.951	5.92	0.150	788.07	693.2	2634.92	8311.8	4.705	26.7

Table A-43: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	711.10	650.4	2399.02	7567.7	4.966	28.2
	RodB4_91.3	162	91.3	2.319	2.8	0.071	731.38	661.7	2431.45	7670.0	4.830	27.4
	RodB4_93.3	163	93.3	2.370	4.8	0.122	336.84	442.5	998.18	3148.8	9.171	52.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	417.88	487.5	1117.23	3524.3	5.884	33.4
	RodB4_100	165	100	2.540	11.5	0.292	1053.69	840.8	2959.38	9335.4	3.584	20.4
	RodB4_106	166	106	2.692	17.5	0.445	1084.99	858.1	3006.37	9483.6	3.508	19.9
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1131.51	884.0	2787.26	8792.4	3.085	17.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	671.83	628.6	2332.65	7358.3	5.256	29.8
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	708.52	649.0	2345.55	7399.1	4.881	27.7
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	727.19	659.4	2374.77	7491.2	4.757	27.0
	RodF4_92.4	100	92.4	2.347	3.9	0.099	283.86	413.1	996.75	3144.2	17.844	101.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	331.69	439.6	876.59	2765.2	8.454	48.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1141.09	889.3	3116.75	9831.8	3.413	19.4
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1132.63	884.6	3016.94	9516.9	3.335	18.9
	RodF4_111	104	111	2.819	-1.75	-0.044	1087.94	859.8	3020.92	9529.5	3.513	19.9
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1015.53	819.6	2886.06	9104.1	3.665	20.8
	RodD2_106	66	106	2.692	17.5	0.445	1097.81	865.3	2990.11	9432.3	3.438	19.5
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1099.57	866.2	2907.11	9170.5	3.335	18.9
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1170.35	905.6	2676.79	8443.9	2.841	16.1
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1196.05	919.8	2546.42	8032.7	2.630	14.9
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1232.85	940.3	2363.62	7456.0	2.352	13.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1257.50	954.0	2148.78	6778.3	2.087	11.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1269.96	960.9	1949.50	6149.7	1.871	10.6
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1193.08	918.2	2782.45	8777.2	2.883	16.4
	RodD6_106	130	106	2.692	17.5	0.445	1072.82	851.4	2971.91	9374.9	3.518	20.0
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1118.05	876.5	2814.97	8879.8	3.163	18.0
	RodD6_114.9	132	114.9	2.918	2.15	0.055	650.33	616.7	1791.02	5649.8	4.241	24.1
	RodD6_116.8	133	116.8	2.967	4.05	0.103	696.92	642.5	1887.89	5955.3	4.026	22.9
	RodD6_120.9	134	120.9	3.071	8.15	0.207	939.48	777.3	2863.42	9032.7	4.025	22.9
	RodD6_124.8	135	124.8	3.170	12.05	0.306	998.40	810.0	2914.85	9194.9	3.784	21.5
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1315.61	986.3	1136.41	3584.8	1.045	5.9

Table A-43: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4042, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	723.79	657.5	1951.43	6155.8	3.936	22.4
	RodE2_54	74	54	1.372	7	0.178	747.86	670.9	2027.06	6394.4	3.899	22.1
	RodE2_56.9	75	56.9	1.445	9.9	0.251	738.41	665.6	2183.03	6886.4	4.277	24.3
	RodE2_59.9	76	59.9	1.521	12.9	0.328	564.35	568.9	2189.89	6908.0	6.511	37.0
	RodE2_66	77	66	1.676	19	0.483	637.81	609.7	2290.10	7224.1	5.588	31.7
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	681.60	634.0	2351.97	7419.3	5.185	29.4
	RodE2_72.9	79	72.9	1.852	2.02	0.051	335.44	441.7	981.39	3095.8	9.134	51.9
	RodE2_74.9	80	74.9	1.902	4.02	0.102	410.57	483.5	1117.50	3525.2	6.121	34.8
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1210.86	928.1	2411.65	7607.6	2.454	13.9
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1230.11	938.8	2191.95	6914.5	2.187	12.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1248.60	949.0	1985.54	6263.4	1.945	11.0
	RodB3_60.1	172	60.1	1.527	13.1	0.333	684.12	635.4	1674.64	5282.7	3.671	20.8
	RodB3_66.1	173	66.1	1.679	19.1	0.485	701.86	645.3	1884.02	5943.1	3.976	22.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	717.48	654.0	1924.78	6071.7	3.932	22.3
	RodB3_73	175	73	1.854	2.12	0.054	731.05	661.5	1997.80	6302.1	3.971	22.6
	RodB3_75	176	75	1.905	4.12	0.105	751.93	673.1	2168.66	6841.0	4.139	23.5
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	924.03	768.7	2778.60	8765.1	3.992	22.7
	RodF3_54	90	54	1.372	7	0.178	963.33	790.6	2822.89	8904.8	3.839	21.8
	RodF3_57	91	57	1.448	10	0.254	637.68	609.6	1638.68	5169.2	4.000	22.7
	RodF3_60	92	60	1.524	13	0.330	656.54	620.1	1791.32	5650.7	4.180	23.7
	RodF3_66.1	93	66.1	1.679	19.1	0.485	677.62	631.8	1832.68	5781.2	4.076	23.1
	RodF3_70	94	70	1.778	-0.88	-0.022	696.44	642.3	1898.09	5987.5	4.052	23.0
	RodF3_73	95	73	1.854	2.12	0.054	727.54	659.6	2021.23	6376.0	4.046	23.0
	RodF3_75	96	75	1.905	4.12	0.105	664.58	624.6	2279.87	7191.8	5.222	29.7
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	472.75	518.0	1221.83	3854.3	4.992	28.3
	RodE6_54.1	122	54.1	1.374	7.1	0.180	510.89	539.2	1344.11	4240.0	4.751	27.0
	RodE6_57	123	57	1.448	10	0.254	522.07	545.4	1433.25	4521.2	4.874	27.7
	RodE6_60.2	124	60.2	1.529	13.2	0.335	586.86	581.4	1523.16	4804.8	4.244	24.1
	RodE6_66.1	125	66.1	1.679	19.1	0.485	612.66	595.7	1565.77	4939.2	4.071	23.1
	RodE6_70	126	70	1.778	-0.88	-0.022	646.77	614.7	1627.81	5134.9	3.887	22.1
	RodE6_73.1	127	73.1	1.857	2.22	0.056	653.17	618.2	1735.63	5475.0	4.082	23.2
	RodE6_75	128	75	1.905	4.12	0.105	699.63	644.1	1825.99	5760.1	3.872	22.0

RBHT Steam Cooling with Droplet Injection Test SCD-4049-A

Matrix test # 6A

Test Conditions

Date – 11/09/2005
Steady state time window: 13320 - 14280 sec
Inlet steam flow: 5.92 m^3/min (209 ft^3/min)
Inlet steam temperature: 417 K (291 °F)
Droplet injection flow: 0.0036 kg/sec (0.0079 lbm/sec)
Droplet injection temperature: 380 K (225 ^oF)
Upper plenum pressure: 138.6 kPa (20.1 psia)
Bundle power: 110.0 kW
Outlet steam temperature: 656 K (721 °F)
Bundle inlet Reynolds number: 15000

Test Notes

- No steam probes were traversed in this steady state window.

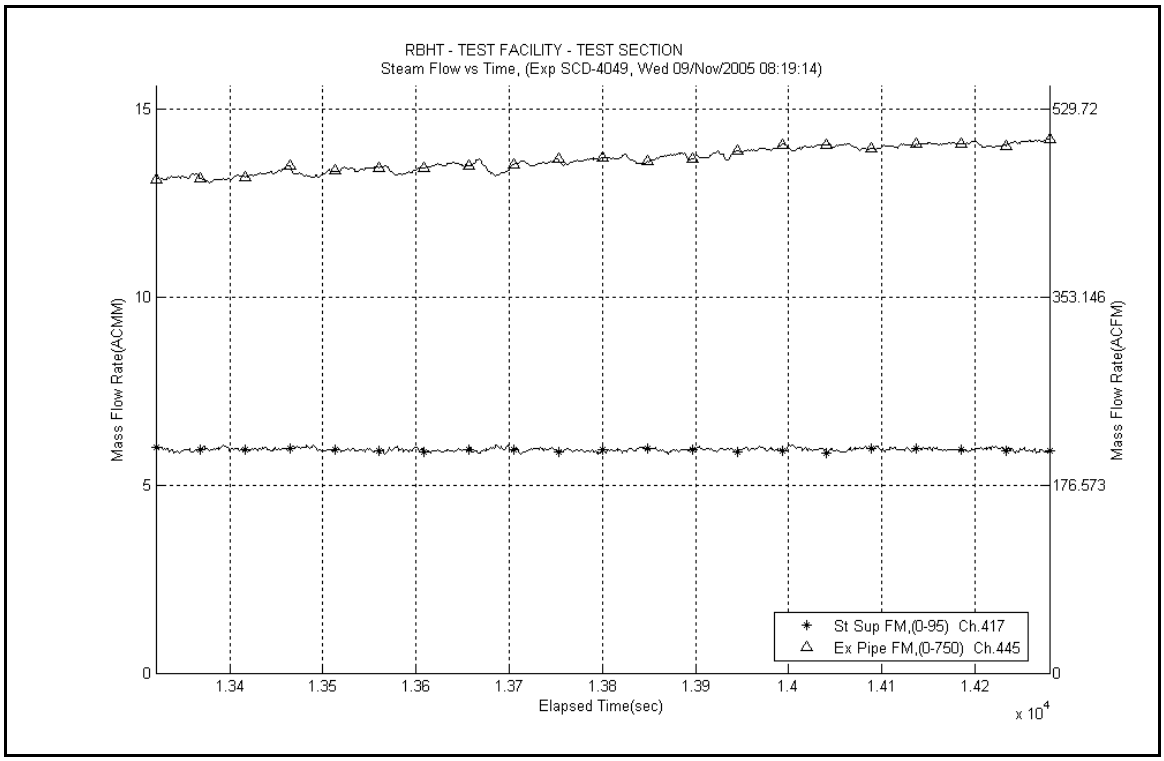

Figure A-55: Inlet and Exhaust Steam Flow Rates for Experiment 4049A

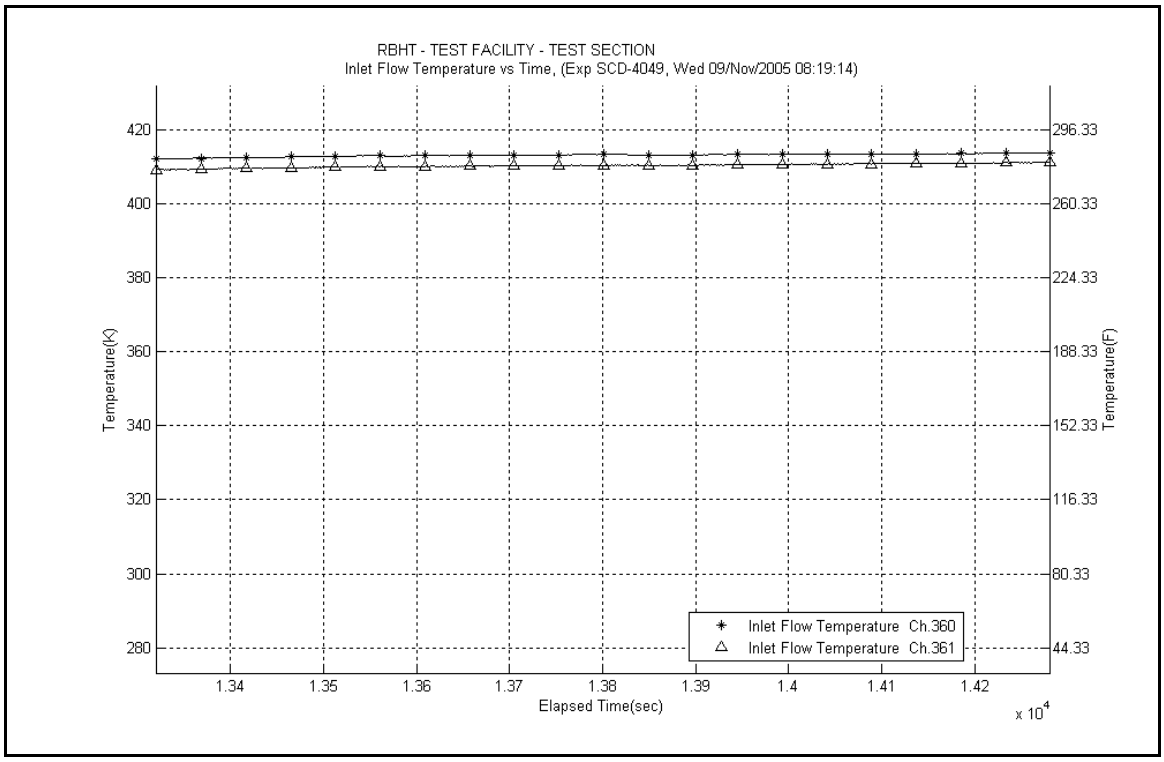

Figure A-56: Inlet Steam Temperature for Experiment 4049A

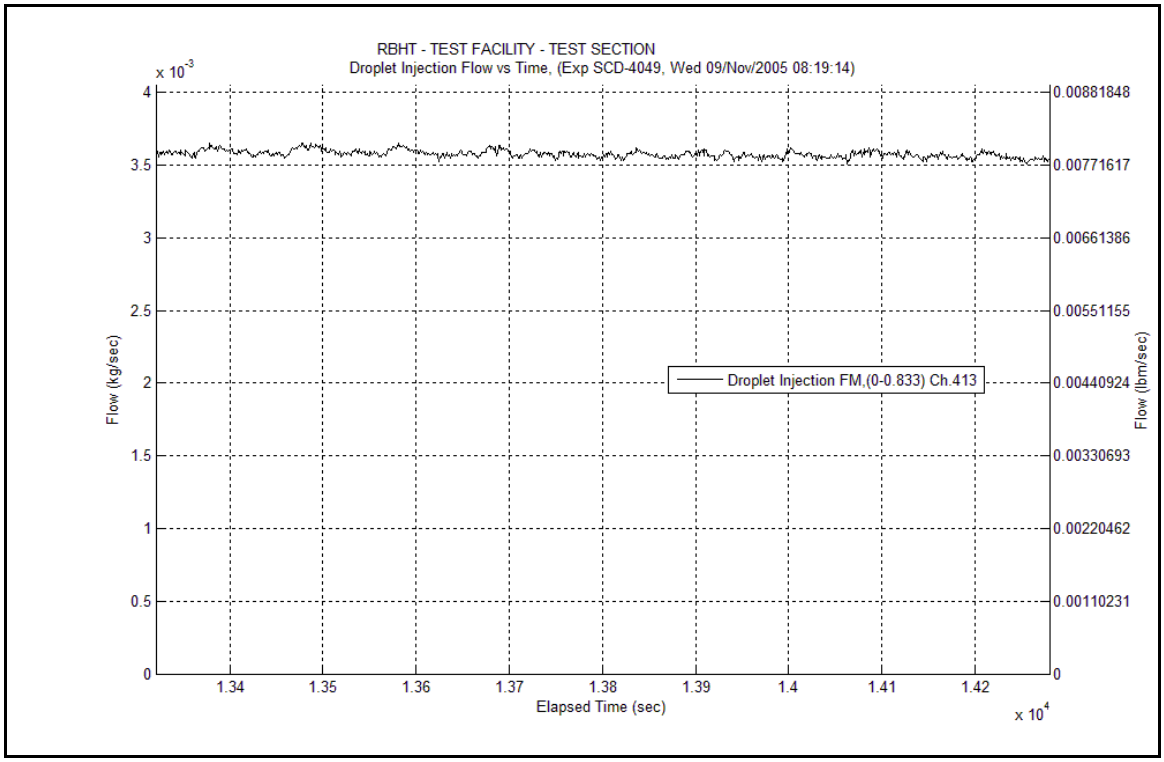

Figure A-57: Droplet Injection Flow Rate for Experiment 4049A

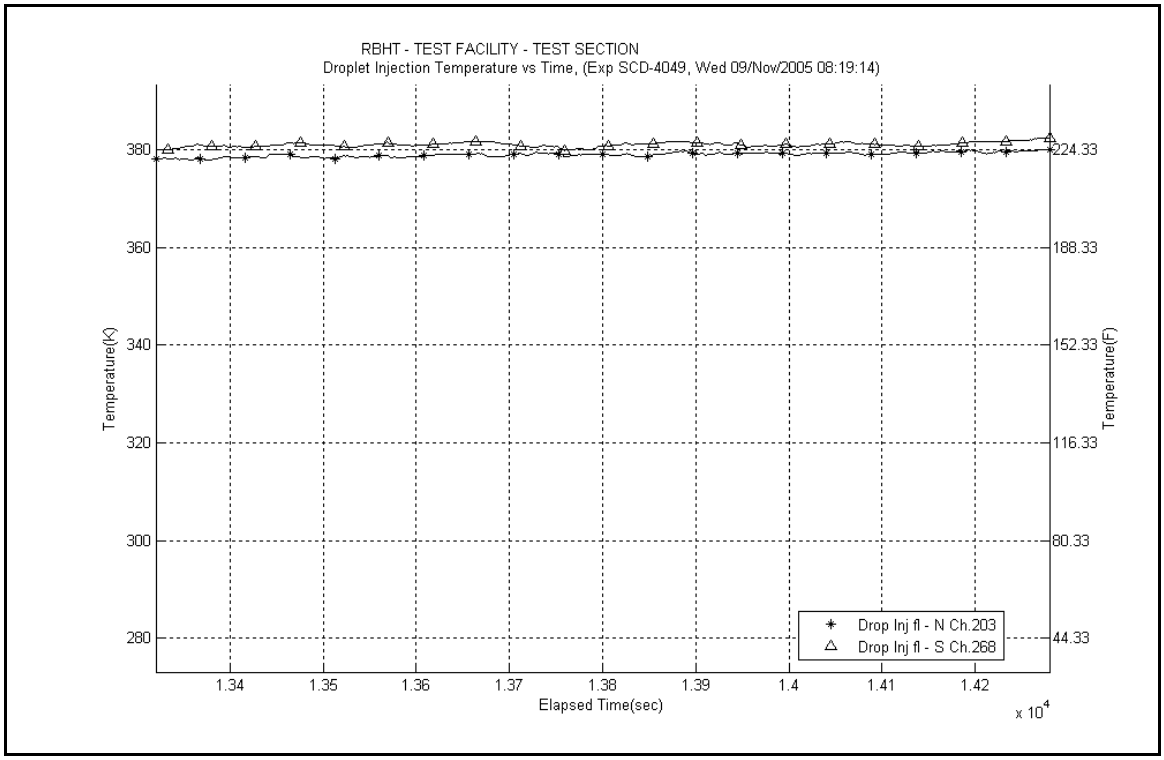

Figure A-58: Droplet Injection Temperature for Experiment 4049A

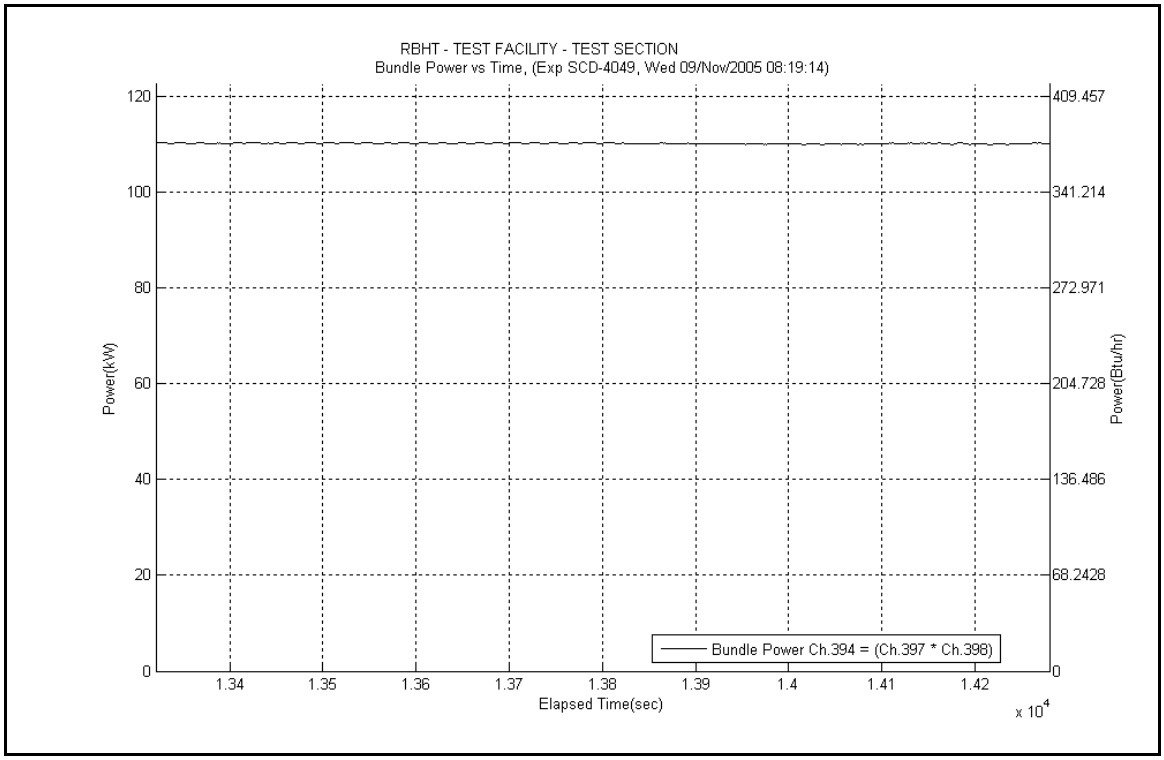

Figure A-59: Bundle Power for Experiment 4049A

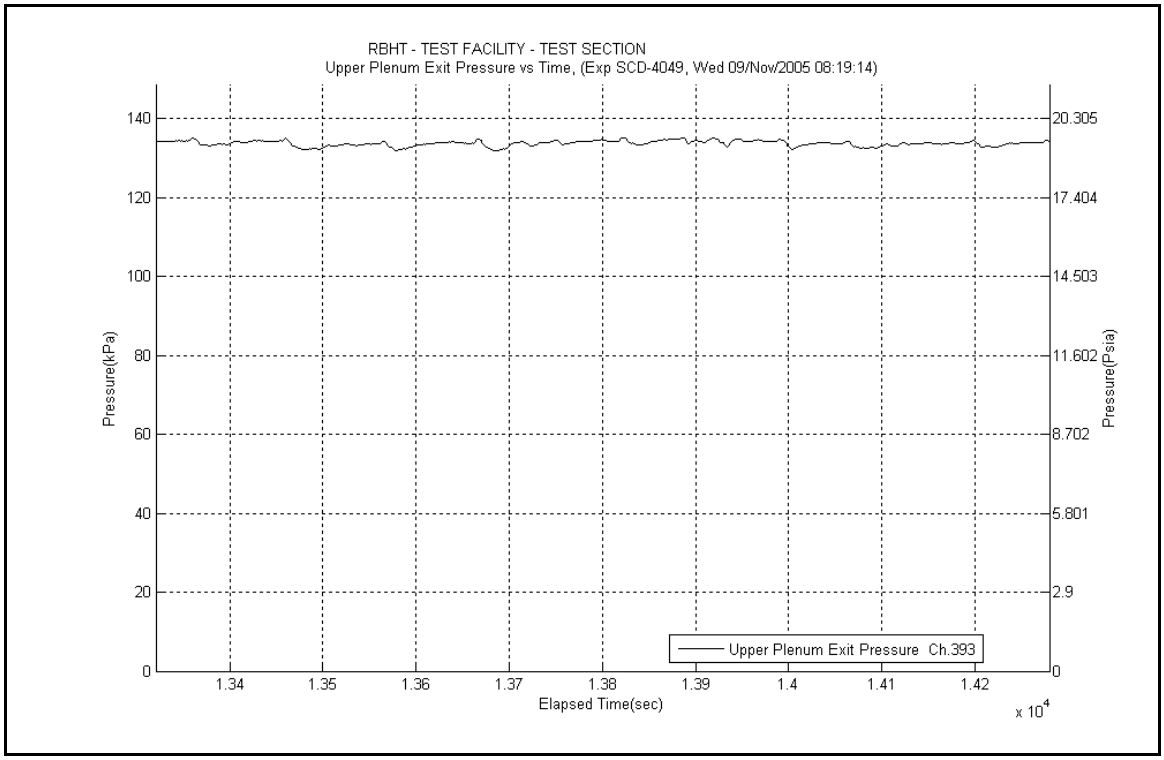

Figure A-60: Upper Plenum Pressure for Experiment 4049A

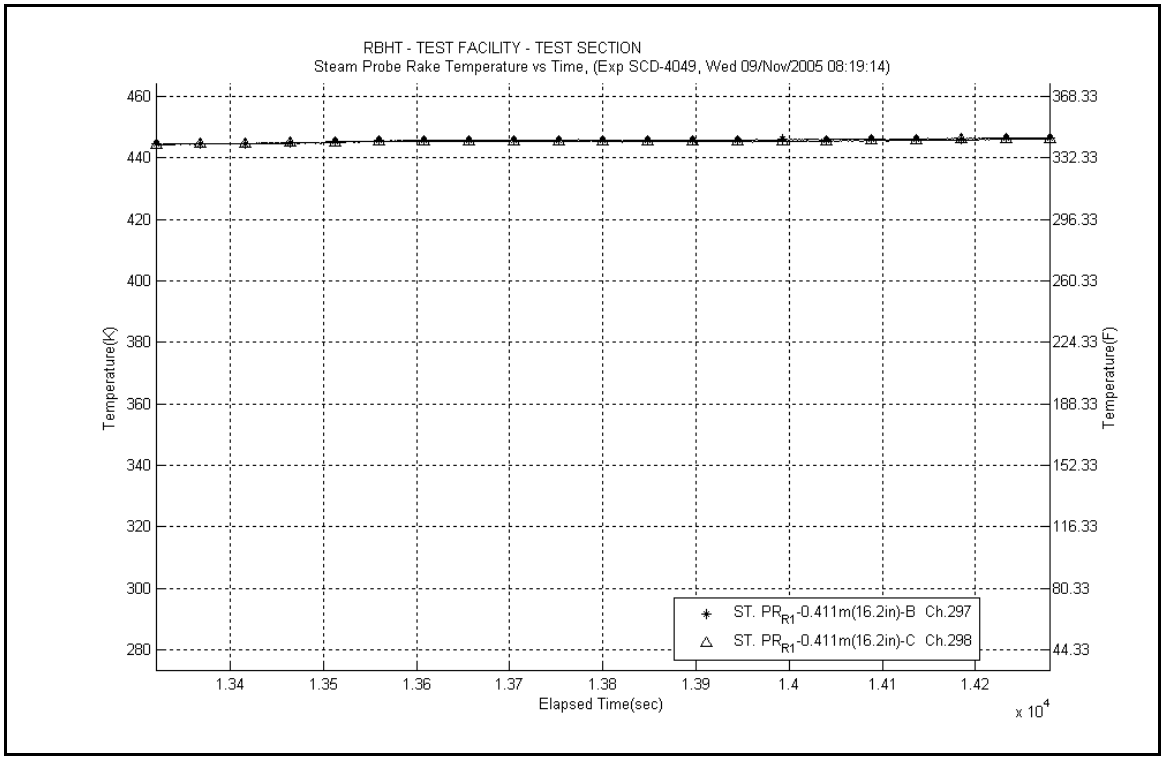

Figure A-61: Steam Probe Rake #1 Temperatures for Experiment 4049A

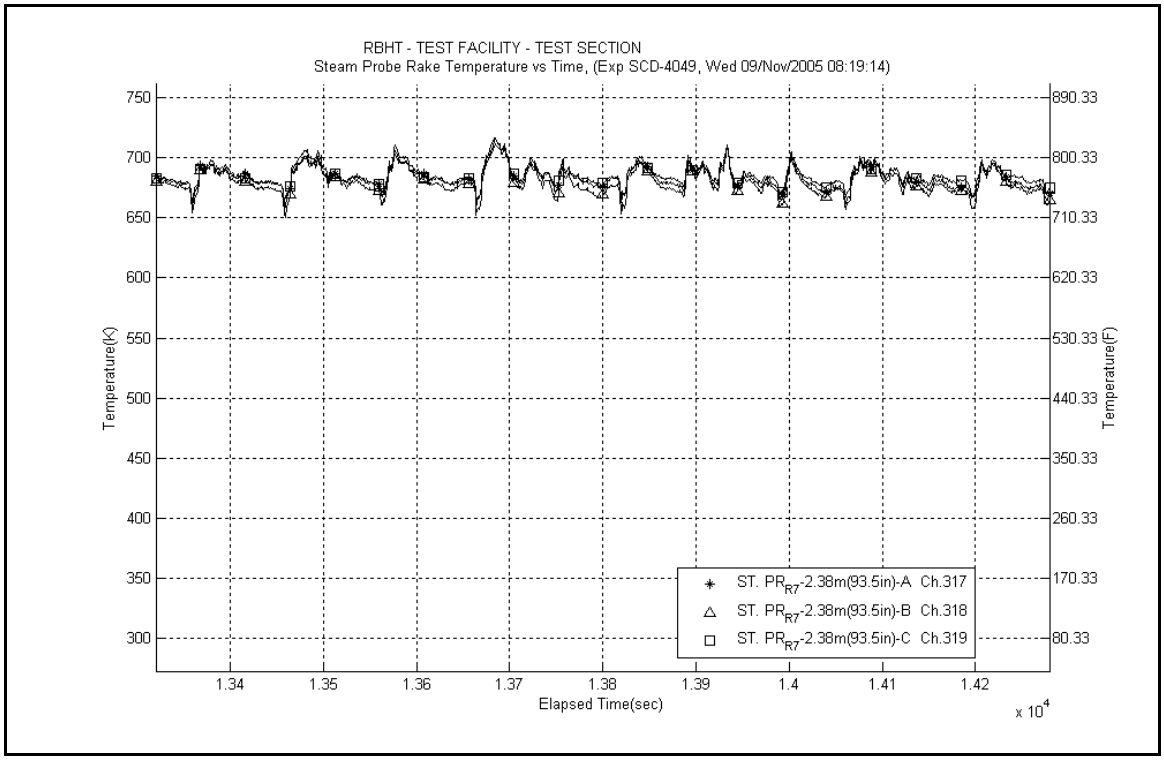

Figure A-62: Steam Probe Rake #7 Temperatures for Experiment 4049A

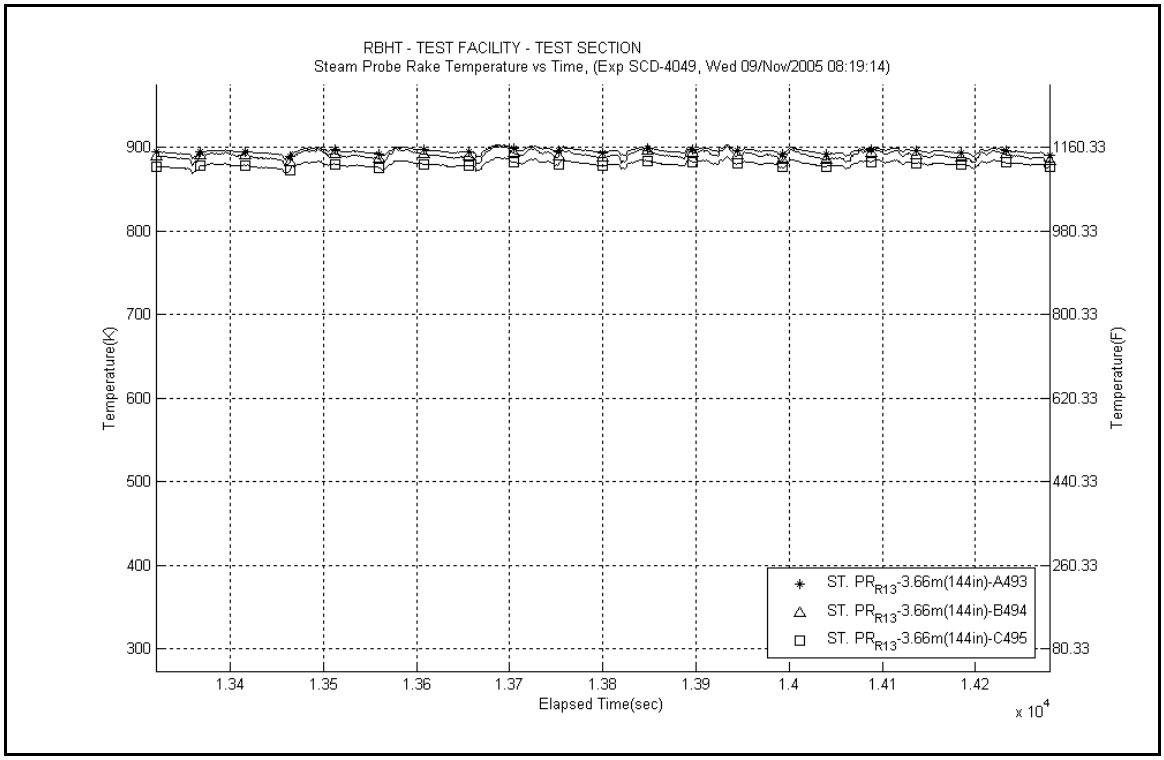

Figure A-63: Steam Probe Rake #13 Temperatures for Experiment 4049A

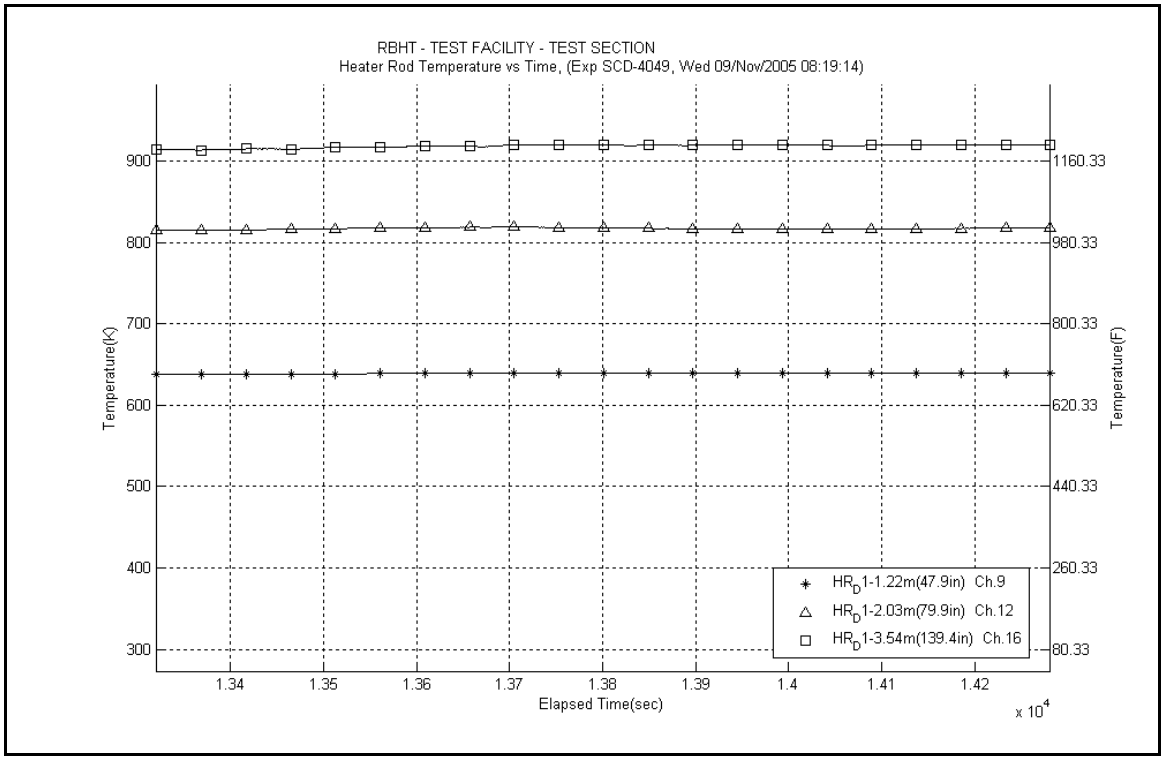

Figure A-64: Heater Rod D1 Temperatures for Experiment 4049A

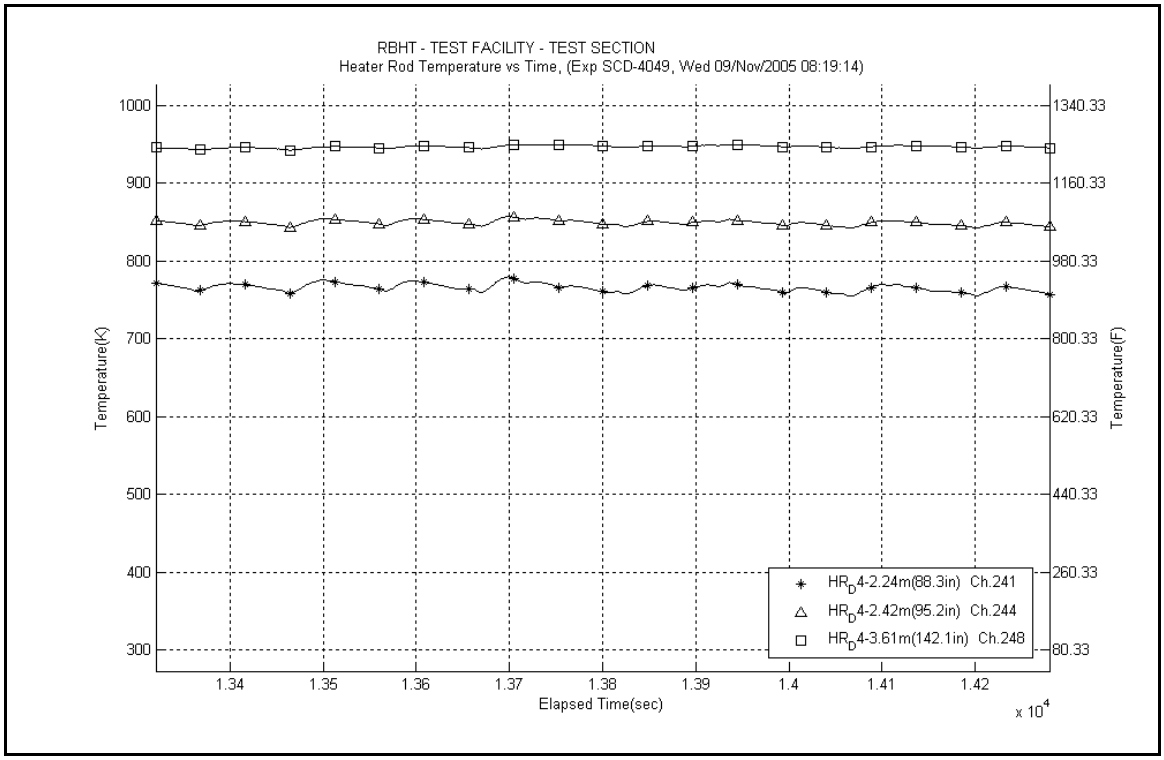

Figure A-65: Heater Rod D4 Temperatures for Experiment 4049A

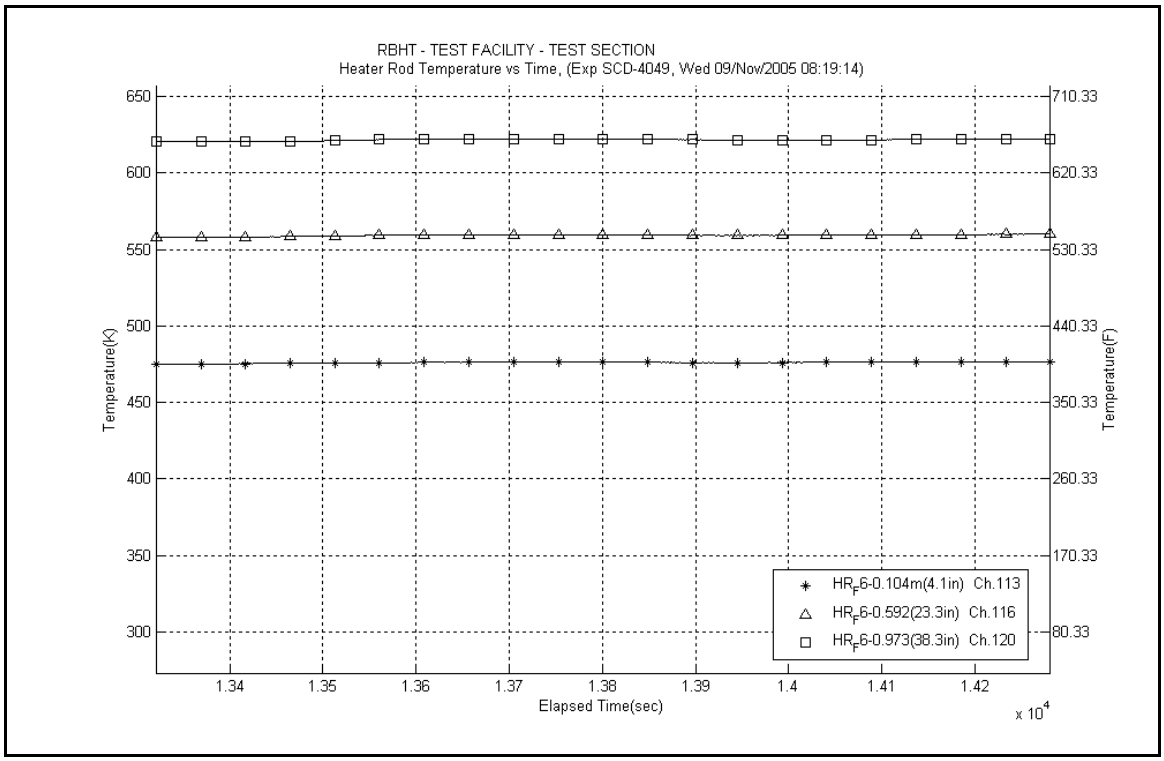

Figure A-66: Heater Rod F6 Temperatures for Experiment 4049A

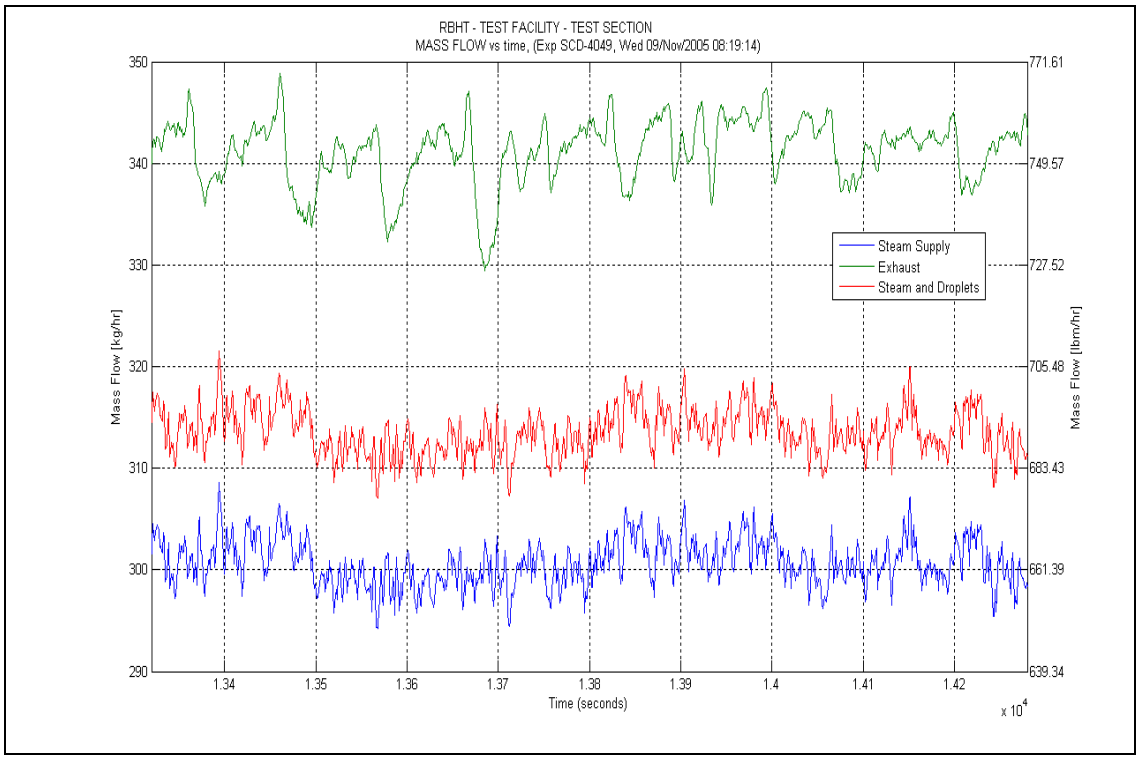

Figure A-67: Mass Flow for Experiment 4049A

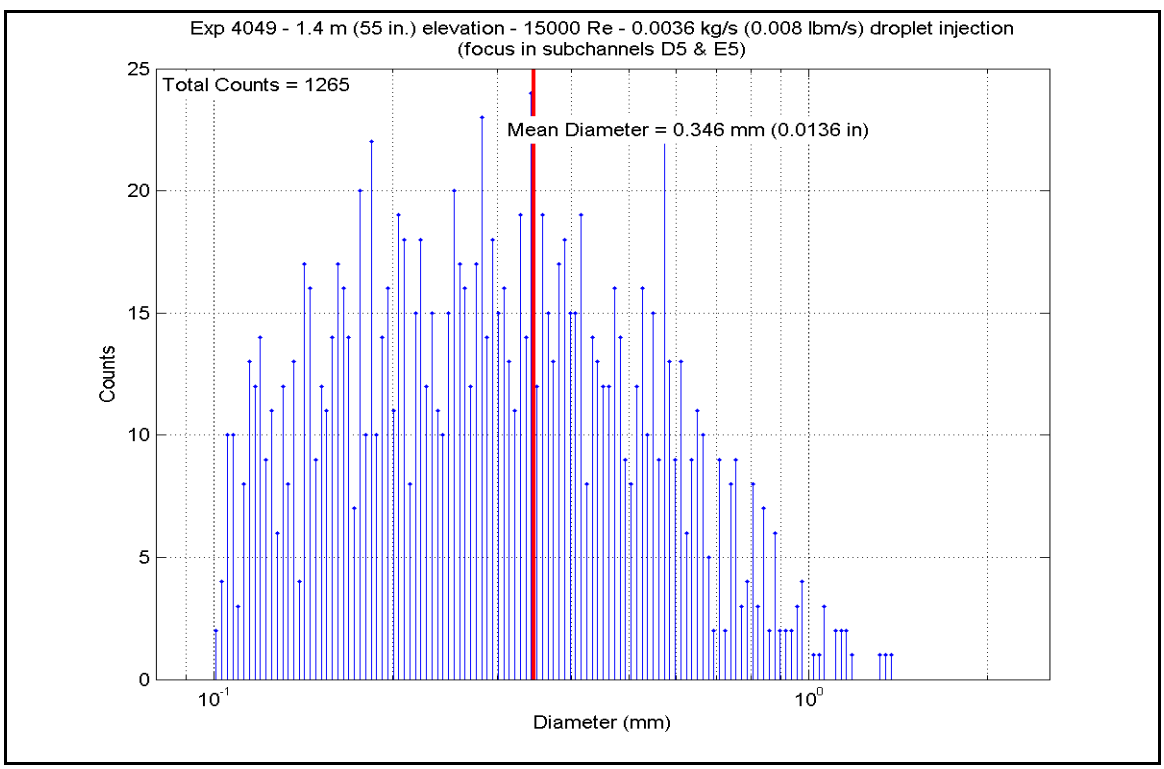

Figure A-68: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049A

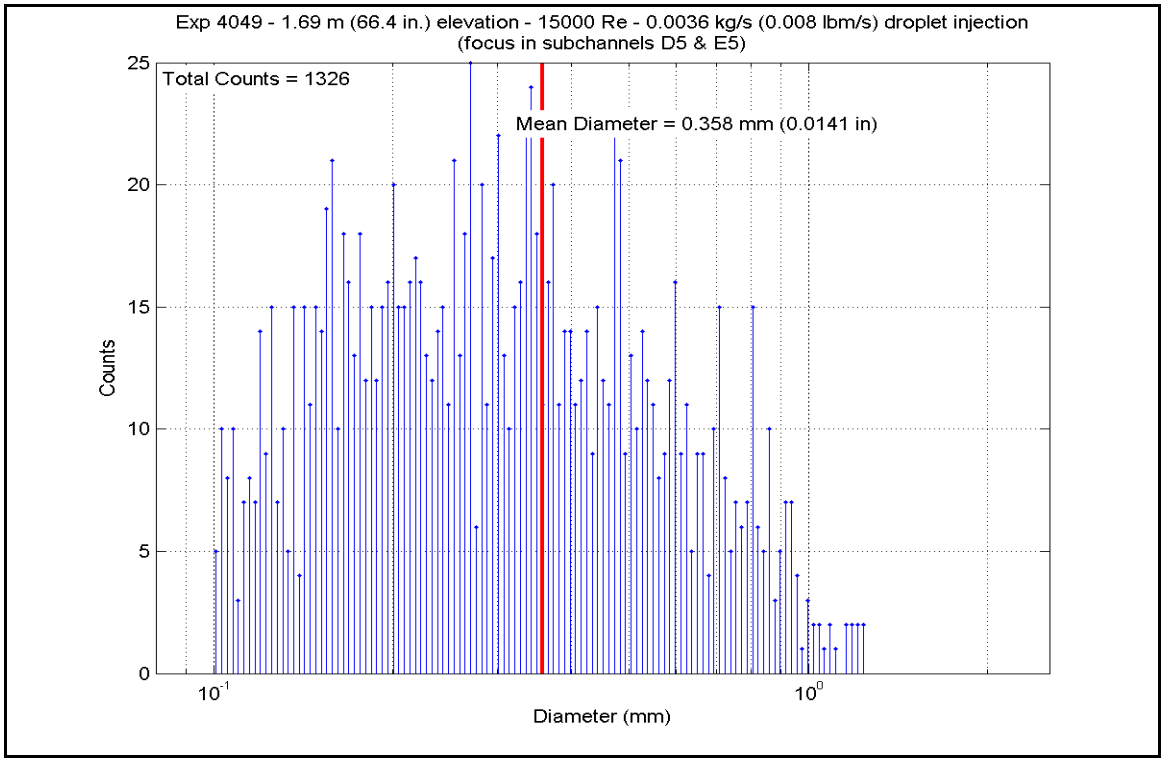

Figure A-69: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049A

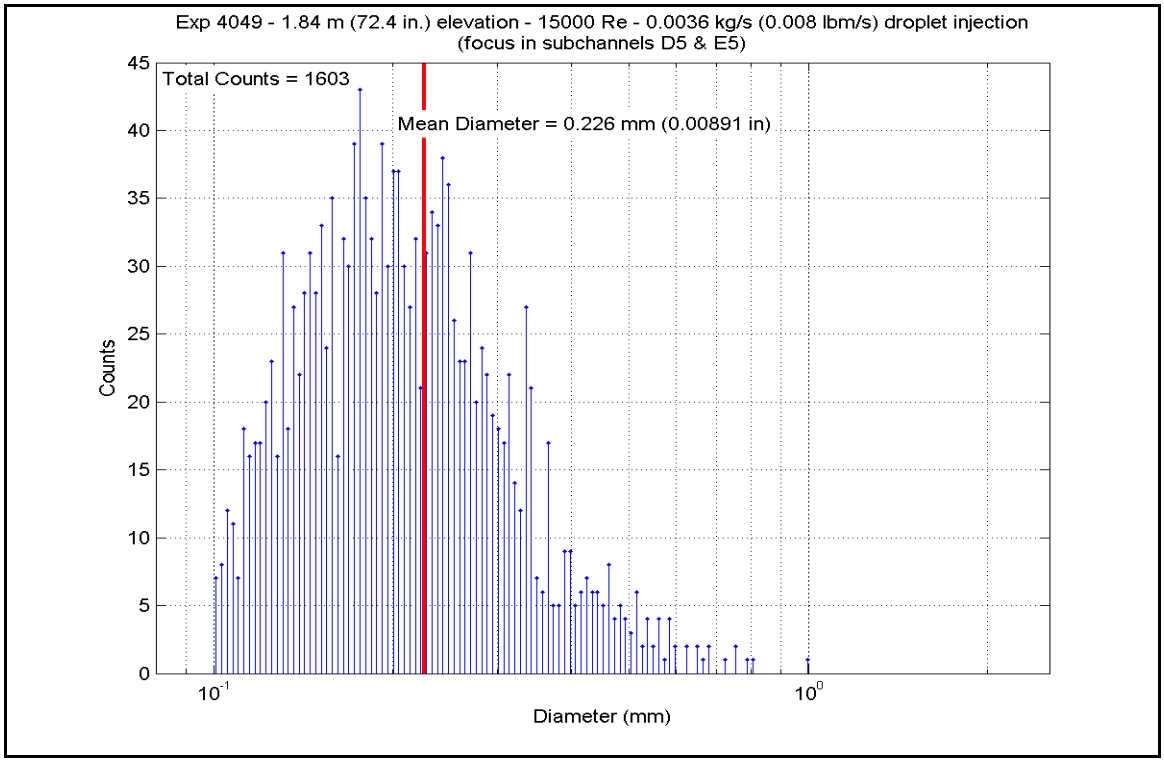

Figure A-70: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049A

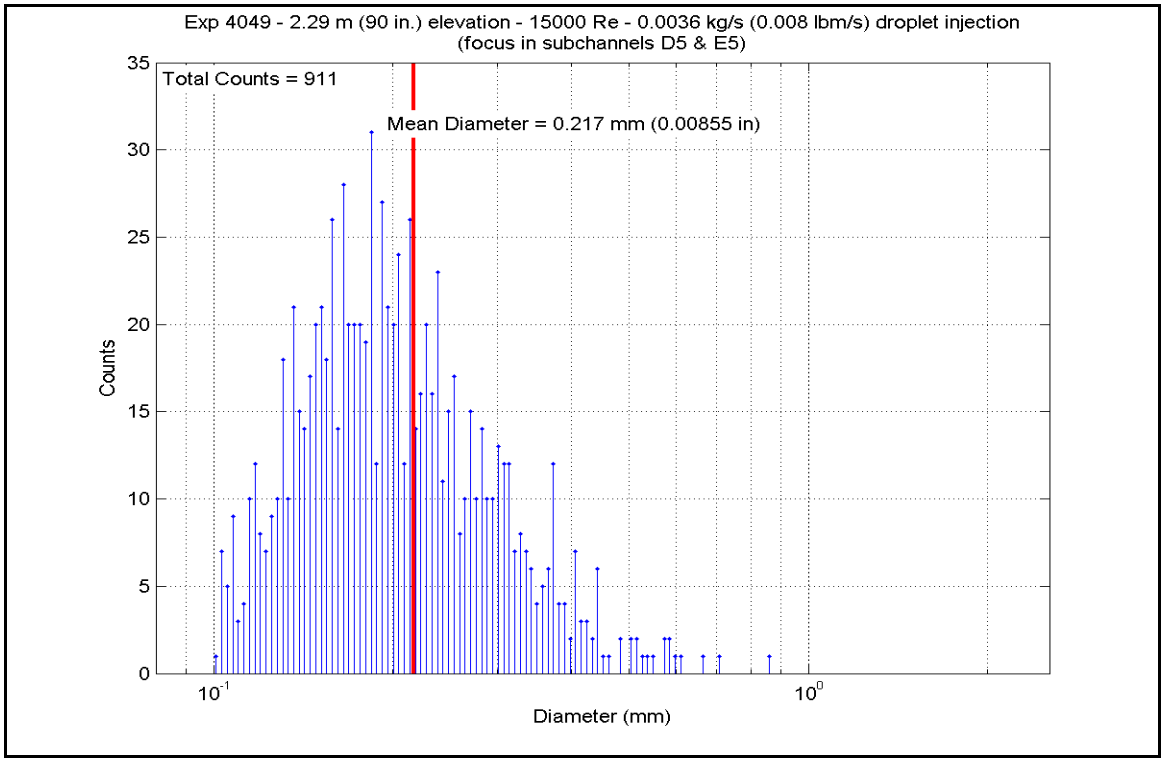

Figure A-71: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049A

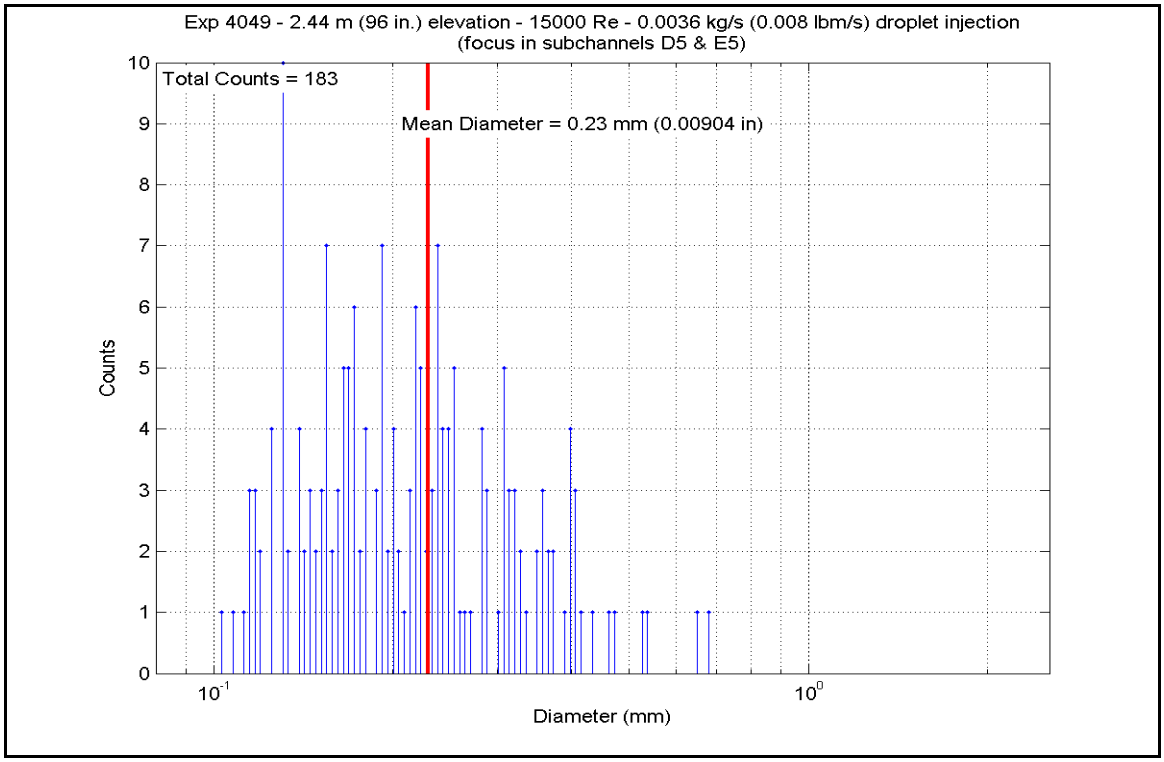

Figure A-72: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049A

Table A-44: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049A

SCD-4049-A	Inlet Reynolds:	6000	
Matrix Test # 6a	UP Pressure:	137.9 kPa	20 psia
Time Window: 13320-14280	Bundle Power:	119.00 kW	406045 Btu/hr
	Steam flow:	0.0265 kg/s	210.0 lbm/hr
	Droplet flow:	0.0036 kg/s	0.008 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	924.16	768.8	9367.65	29550.2	13.456	76.4
	RodD3_91.3	186	91.3	2.319	2.8	0.071	1018.93	821.4	9561.35	30161.3	12.089	68.7
	RodD3_93.1	187	93.1	2.365	4.6	0.117	1024.38	824.5	9684.64	30550.2	12.161	69.1
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1071.31	850.5	9827.24	31000.0	11.653	66.2
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1123.27	879.4	10155.63	32035.9	11.344	64.4
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1207.37	926.1	10542.95	33257.7	10.765	61.1
	RodD3_110	191	110	2.794	21.5	0.546	1137.04	887.1	10427.51	32893.6	11.471	65.1
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1240.24	944.4	3621.30	11423.4	3.578	20.3
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	931.45	772.8	9476.45	29893.5	13.471	76.5
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1023.59	824.0	9653.47	30451.9	12.134	68.9
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1045.21	836.0	9807.18	30936.8	12.001	68.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1087.89	859.8	9932.81	31333.1	11.551	65.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1131.95	884.2	10262.04	32371.6	11.352	64.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1194.57	919.0	10664.81	33642.1	11.034	62.7
	RodC4_110	239	110	2.794	21.5	0.546	1120.92	878.1	10335.25	32602.5	11.575	65.7
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1248.31	948.9	3931.19	12401.0	3.853	21.9
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	915.05	763.7	9458.09	29835.6	13.766	78.2
	RodD4_91.3	242	91.3	2.319	2.8	0.071	1006.56	814.6	9648.41	30435.9	12.393	70.4
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1031.23	828.3	9770.84	30822.1	12.164	69.1
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1064.93	847.0	9903.80	31241.5	11.833	67.2
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1120.56	877.9	10233.53	32281.7	11.465	65.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1181.95	912.0	10631.50	33537.1	11.145	63.3
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1242.75	945.8	3801.41	11991.6	3.746	21.3
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	925.32	769.4	9302.25	29343.9	13.340	75.8
	RodE4_91.2	202	91.2	2.316	2.7	0.069	1021.78	823.0	9472.35	29880.5	11.933	67.8
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1088.09	859.9	9731.48	30697.9	11.314	64.3
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1139.35	888.3	10095.49	31846.2	11.077	62.9
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1242.70	945.8	3837.13	12104.2	3.782	21.5

Table A-44: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	927.37	770.6	7676.66	24216.0	10.977	62.3
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1187.99	915.4	9487.83	29929.4	9.883	56.1
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1230.59	939.0	9126.97	28791.0	9.103	51.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1260.84	955.8	8569.01	27030.9	8.297	47.1
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1263.22	957.2	7789.80	24572.9	7.525	42.7
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1261.93	956.4	7083.45	22344.8	6.851	38.9
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1190.10	916.5	6129.11	19334.3	6.371	36.2
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1232.58	940.1	5395.29	17019.4	5.371	30.5
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	918.90	765.9	7527.92	23746.8	10.896	61.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1164.85	902.5	9253.37	29189.8	9.877	56.1
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1215.89	930.9	8877.10	28002.8	8.986	51.0
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1252.19	951.0	7642.63	24108.7	7.462	42.4
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1249.68	949.6	6936.52	21881.2	6.789	38.6
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1176.76	909.1	6082.03	19185.8	6.411	36.4
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1222.91	934.8	5352.43	16884.2	5.380	30.6
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	852.09	728.8	7715.19	24337.6	12.362	70.2
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1052.72	840.2	9563.17	30167.0	11.596	65.9
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1127.13	881.6	9216.37	29073.0	10.250	58.2
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1174.19	907.7	8608.42	27155.3	9.098	51.7
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1202.92	923.7	7894.96	24904.6	8.098	46.0
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1200.18	922.1	7165.70	22604.2	7.371	41.9
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1269.74	960.8	6233.92	19664.9	5.984	34.0
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1228.01	937.6	5524.45	17426.9	5.524	31.4
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	968.31	793.3	8741.52	27575.1	11.808	67.1
	RodC3_85.6	178	85.6	2.174	14.72	0.374	910.30	761.1	9134.72	28815.5	13.388	76.0
	RodC3_88.5	179	88.5	2.248	0	0.000	924.24	768.8	9324.78	29415.0	13.393	76.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	1036.44	831.2	9572.77	30197.3	11.841	67.2
	RodC3_94.4	181	94.4	2.398	5.9	0.150	1052.80	840.3	9704.05	30611.4	11.765	66.8
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1105.09	869.3	9891.56	31202.9	11.278	64.0
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1200.76	922.5	10426.39	32890.1	10.718	60.9
Gr-8	RodD5_50	217	50	1.270	3	0.076	790.45	694.5	6815.38	21499.1	12.117	68.8
	RodD5_54.1	218	54.1	1.374	7.1	0.180	816.46	709.0	7084.98	22349.6	12.040	68.4
	RodD5_56.9	219	56.9	1.445	9.9	0.251	859.64	733.0	7272.19	22940.1	11.513	65.4
	RodD5_60	220	60	1.524	13	0.330	884.83	746.9	7476.12	23583.4	11.382	64.6
	RodD5_66.1	221	66.1	1.679	19.1	0.485	934.15	774.3	7871.81	24831.6	11.147	63.3
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	819.39	710.6	8125.99	25633.4	13.740	78.0
	RodD5_72.9	223	72.9	1.852	2.02	0.051	903.01	757.0	8323.04	26255.0	12.330	70.0
	RodD5_74.9	224	74.9	1.902	4.02	0.102	943.70	779.6	8454.14	26668.6	11.812	67.1

Table A-44: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	713.70	651.9	6193.82	19538.4	12.752	72.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	783.22	690.5	6979.56	22017.0	12.571	71.4
	RodB5_55	155	55	1.397	8	0.203	823.30	712.8	7119.42	22458.2	11.959	67.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	862.31	734.4	7303.68	23039.5	11.514	65.4
	RodB5_64	157	64	1.626	17	0.432	913.09	762.6	7715.79	24339.5	11.262	64.0
	RodB5_73.9	158	73.9	1.877	3.02	0.077	920.51	766.8	8377.51	26426.8	12.097	68.7
	RodB5_75.9	159	75.9	1.928	5.02	0.128	947.97	782.0	8508.65	26840.5	11.818	67.1
	RodB5_76.9	160	76.9	1.953	6.02	0.153	958.90	788.1	8574.03	27046.8	11.731	66.6
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	696.29	642.2	6156.84	19421.8	13.147	74.7
	RodF5_53.1	106	53.1	1.349	6.1	0.155	769.83	683.1	6957.06	21946.1	12.840	72.9
	RodF5_55	107	55	1.397	8	0.203	805.39	702.8	7085.06	22349.8	12.271	69.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	840.42	722.3	7272.38	22940.7	11.875	67.4
	RodF5_64	109	64	1.626	17	0.432	884.40	746.7	7680.21	24227.2	11.701	66.4
	RodF5_73.8	110	73.8	1.875	2.92	0.074	894.95	752.6	8334.78	26292.1	12.497	71.0
	RodF5_75.8	111	75.8	1.925	4.92	0.125	926.00	769.8	8466.08	26706.3	12.129	68.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	937.01	775.9	8531.94	26914.0	12.034	68.3
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	713.22	651.6	6184.58	19509.2	12.746	72.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	827.47	715.1	6983.40	22029.1	11.649	66.2
	RodC2_55	59	55	1.397	8	0.203	836.30	720.0	7109.00	22425.3	11.687	66.4
	RodC2_57.8	60	57.8	1.468	10.8	0.274	856.49	731.2	7294.97	23012.0	11.607	65.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	885.85	747.5	7701.09	24293.1	11.706	66.5
	RodC2_73.8	62	73.8	1.875	2.92	0.074	923.68	768.5	8355.52	26357.5	12.011	68.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	948.99	782.6	8488.34	26776.5	11.773	66.9
	RodC2_76.8	64	76.8	1.951	5.92	0.150	958.22	787.7	8554.23	26984.3	11.715	66.5
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	701.32	645.0	6154.25	19413.6	13.002	73.8
	RodC6_52.8	138	52.8	1.341	5.8	0.147	827.51	715.1	6975.48	22004.2	11.635	66.1
	RodC6_54.8	139	54.8	1.392	7.8	0.198	836.47	720.1	7112.37	22436.0	11.689	66.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	867.02	737.0	7319.34	23088.9	11.454	65.0
	RodC6_63.8	141	63.8	1.621	16.8	0.427	900.13	755.4	7734.91	24399.8	11.508	65.4
	RodC6_73.7	142	73.7	1.872	2.82	0.072	955.86	786.4	8413.87	26541.5	11.560	65.6
	RodC6_75.8	143	75.8	1.925	4.92	0.125	977.78	798.6	8558.58	26998.0	11.415	64.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	993.82	807.5	8627.70	27216.1	11.266	64.0

Table A-44: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	929.41	771.7	9272.82	29251.1	13.220	75.1
	RodB4_91.3	162	91.3	2.319	2.8	0.071	1025.68	825.2	9458.00	29835.3	11.857	67.3
	RodB4_93.3	163	93.3	2.370	4.8	0.122	1040.17	833.2	9587.44	30243.6	11.805	67.0
	RodB4_95.1	164	95.1	2.416	6.6	0.168	1071.21	850.5	9700.60	30600.6	11.504	65.3
	RodB4_100	165	100	2.540	11.5	0.292	1115.40	875.0	10018.41	31603.1	11.290	64.1
	RodB4_106	166	106	2.692	17.5	0.445	1185.41	913.9	10397.80	32799.9	10.860	61.7
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1115.48	875.1	10076.47	31786.2	11.354	64.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1236.42	942.3	3894.62	12285.6	3.862	21.9
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	938.67	776.9	9163.45	28906.1	12.894	73.2
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	936.42	775.6	9351.29	29498.7	13.200	75.0
	RodF4_92.4	100	92.4	2.347	3.9	0.099	1046.13	836.6	9604.84	30298.5	11.740	66.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1076.73	853.6	9727.47	30685.3	11.461	65.1
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1114.06	874.3	9915.66	31278.9	11.191	63.6
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1187.61	915.2	10469.77	33026.9	10.910	62.0
	RodF4_111	104	111	2.819	-1.75	-0.044	1097.41	865.0	10056.26	31722.5	11.567	65.7
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1206.29	925.5	9226.28	29104.3	9.431	53.6
	RodD2_106	66	106	2.692	17.5	0.445	1231.62	939.6	8737.35	27562.0	8.706	49.4
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1254.78	952.5	8071.81	25462.5	7.861	44.6
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1257.25	953.8	7288.87	22992.8	7.082	40.2
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1248.00	948.7	6547.44	20653.9	6.419	36.5
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1175.86	908.6	10356.85	32670.7	10.927	62.1
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1201.54	922.9	10541.57	33253.4	10.828	61.5
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1152.59	895.7	9679.53	30534.1	10.469	59.5
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1166.72	903.6	10372.57	32720.3	11.050	62.7
	RodD6_106	130	106	2.692	17.5	0.445	1187.06	914.9	10562.26	33318.6	11.013	62.5
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1144.85	891.4	9647.26	30432.3	10.522	59.8
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1196.19	919.9	9246.86	29169.2	9.551	54.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1220.79	933.6	8868.64	27976.1	8.933	50.7
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1232.85	940.3	8054.92	25409.2	8.016	45.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1229.26	938.3	7284.15	22977.9	7.275	41.3
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1226.56	936.8	6514.10	20548.7	6.523	37.0

Table A-44: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	773.58	685.1	6841.99	21583.0	12.541	71.2
	RodE2_54	74	54	1.372	7	0.178	825.41	713.9	7102.21	22403.9	11.888	67.5
	RodE2_56.9	75	56.9	1.445	9.9	0.251	855.78	730.8	7296.93	23018.2	11.623	66.0
	RodE2_59.9	76	59.9	1.521	12.9	0.328	874.37	741.1	7497.61	23651.2	11.600	65.9
	RodE2_66	77	66	1.676	19	0.483	911.75	761.9	7906.10	24939.8	11.563	65.7
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	832.60	717.9	8163.42	25751.5	13.502	76.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	908.56	760.1	8368.95	26399.9	12.297	69.8
	RodE2_74.9	80	74.9	1.902	4.02	0.102	941.95	778.7	8503.04	26822.8	11.910	67.6
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	735.52	664.0	6799.58	21449.3	13.398	76.1
	RodB3_54.1	170	54.1	1.374	7.1	0.180	794.22	696.6	7054.35	22252.9	12.459	70.8
	RodB3_56.9	171	56.9	1.445	9.9	0.251	834.02	718.7	7239.28	22836.3	11.946	67.8
	RodB3_60.1	172	60.1	1.527	13.1	0.333	837.90	720.9	7454.83	23516.3	12.223	69.4
	RodB3_66.1	173	66.1	1.679	19.1	0.485	894.58	752.4	7848.59	24758.4	11.775	66.9
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	796.14	697.7	8101.74	25556.9	14.260	81.0
	RodB3_73	175	73	1.854	2.12	0.054	882.87	745.9	8305.06	26198.3	12.682	72.0
	RodB3_75	176	75	1.905	4.12	0.105	918.38	765.6	8436.37	26612.5	12.220	69.4
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	755.60	675.1	6796.88	21440.8	12.883	73.2
	RodF3_54	90	54	1.372	7	0.178	808.04	704.3	7066.01	22289.7	12.182	69.2
	RodF3_57	91	57	1.448	10	0.254	848.38	726.7	7271.49	22937.9	11.721	66.6
	RodF3_60	92	60	1.524	13	0.330	876.66	742.4	7473.58	23575.4	11.521	65.4
	RodF3_66.1	93	66.1	1.679	19.1	0.485	905.29	758.3	7882.21	24864.4	11.638	66.1
	RodF3_70	94	70	1.778	-0.88	-0.022	813.53	707.3	8148.09	25703.1	13.916	79.0
	RodF3_73	95	73	1.854	2.12	0.054	916.26	764.4	8349.20	26337.5	12.131	68.9
	RodF3_75	96	75	1.905	4.12	0.105	959.53	788.4	8484.78	26765.3	11.599	65.9
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	762.59	679.0	6794.94	21434.6	12.711	72.2
	RodE6_54.1	122	54.1	1.374	7.1	0.180	808.33	704.4	7049.64	22238.1	12.148	69.0
	RodE6_57	123	57	1.448	10	0.254	833.94	718.7	7239.05	22835.6	11.947	67.8
	RodE6_60.2	124	60.2	1.529	13.2	0.335	843.08	723.7	7448.69	23496.9	12.110	68.8
	RodE6_66.1	125	66.1	1.679	19.1	0.485	887.53	748.4	7835.18	24716.1	11.880	67.5
	RodE6_70	126	70	1.778	-0.88	-0.022	821.69	711.9	8092.46	25527.7	13.631	77.4
	RodE6_73.1	127	73.1	1.857	2.22	0.056	903.22	757.2	8298.01	26176.1	12.289	69.8
	RodE6_75	128	75	1.905	4.12	0.105	934.30	774.4	8423.18	26570.9	11.926	67.7

RBHT Steam Cooling with Droplet Injection Test SCD-4049-B

Matrix Test # 6b

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 15000 - 18240
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 110 kW
Bundle Inlet Reynolds Number: 15000
Bundle Inlet Steam Flow: 301.6 kg/hr (665 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

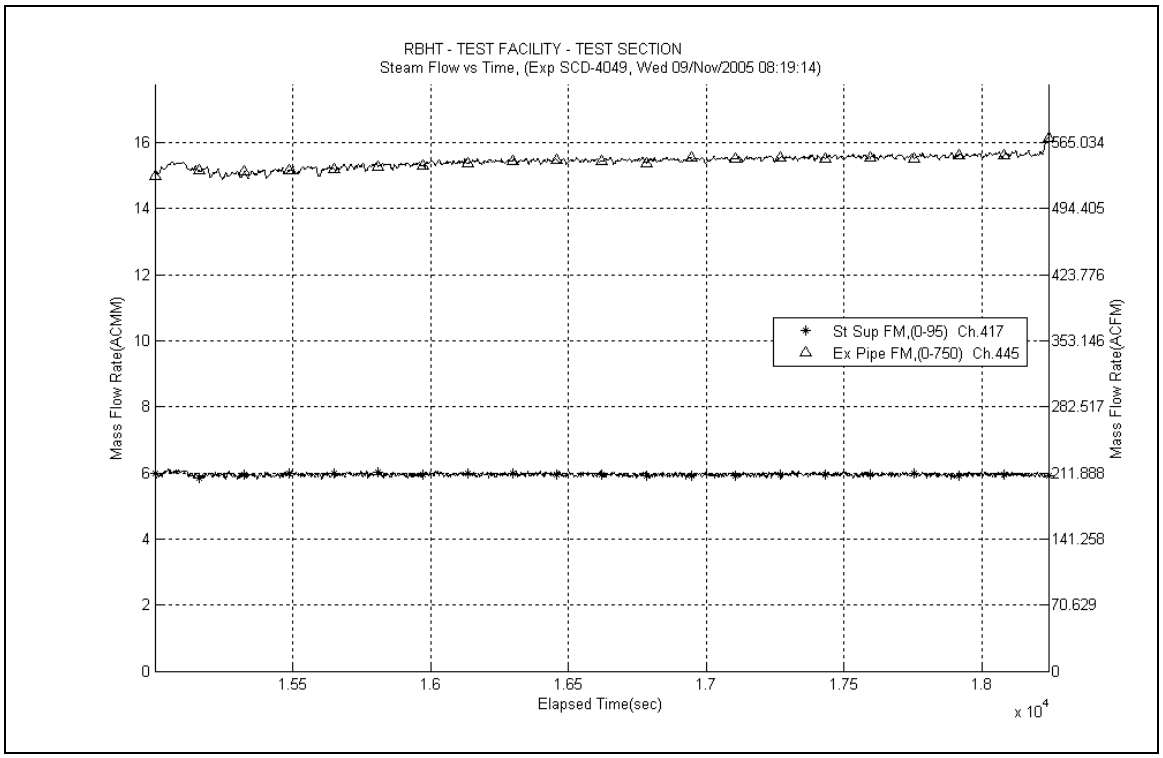

Figure A-73: Inlet and Exhaust Steam Flow Rates for Experiment 4049B

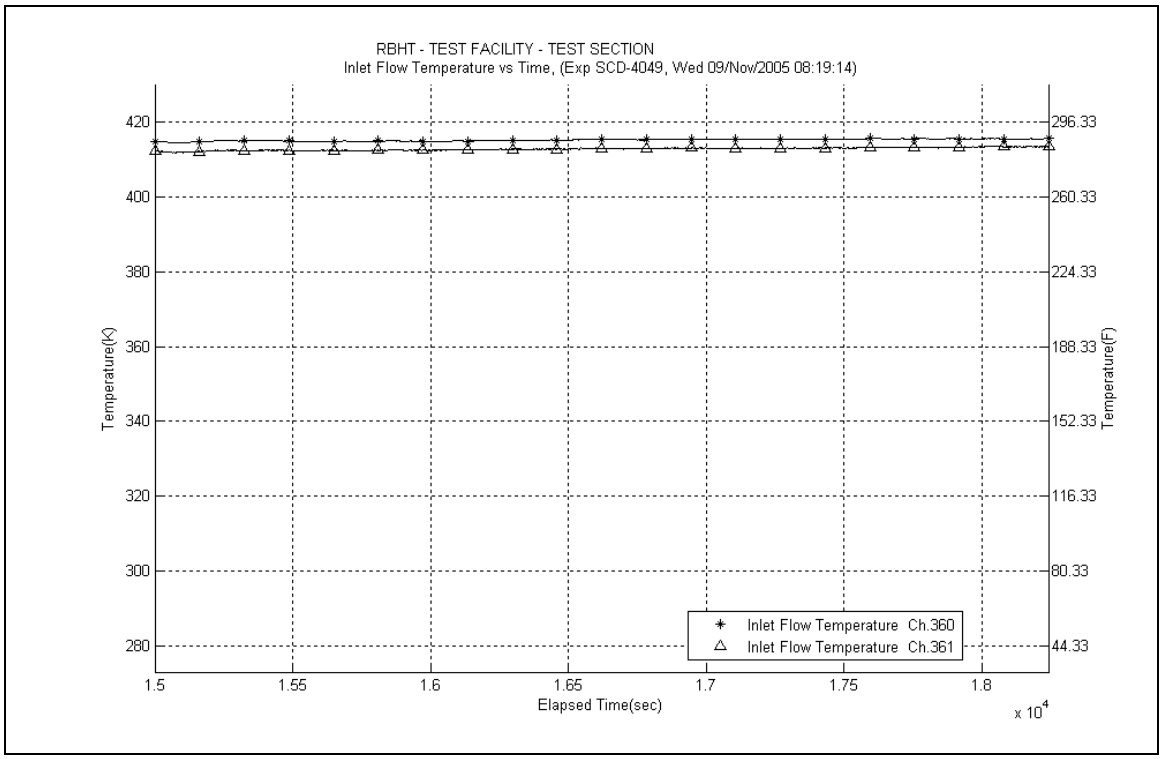

Figure A-74: Inlet Steam Temperature for Experiment 4049B

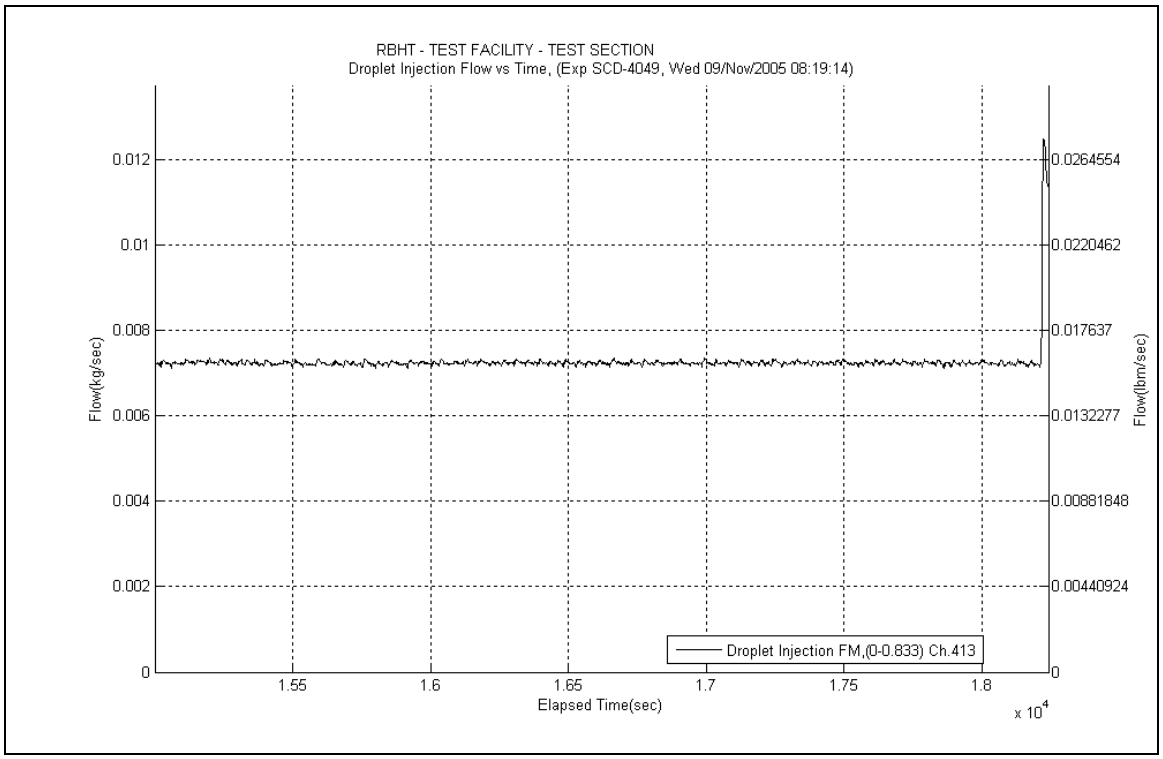

Figure A-75: Droplet Injection Flow Rate for Experiment 4049B

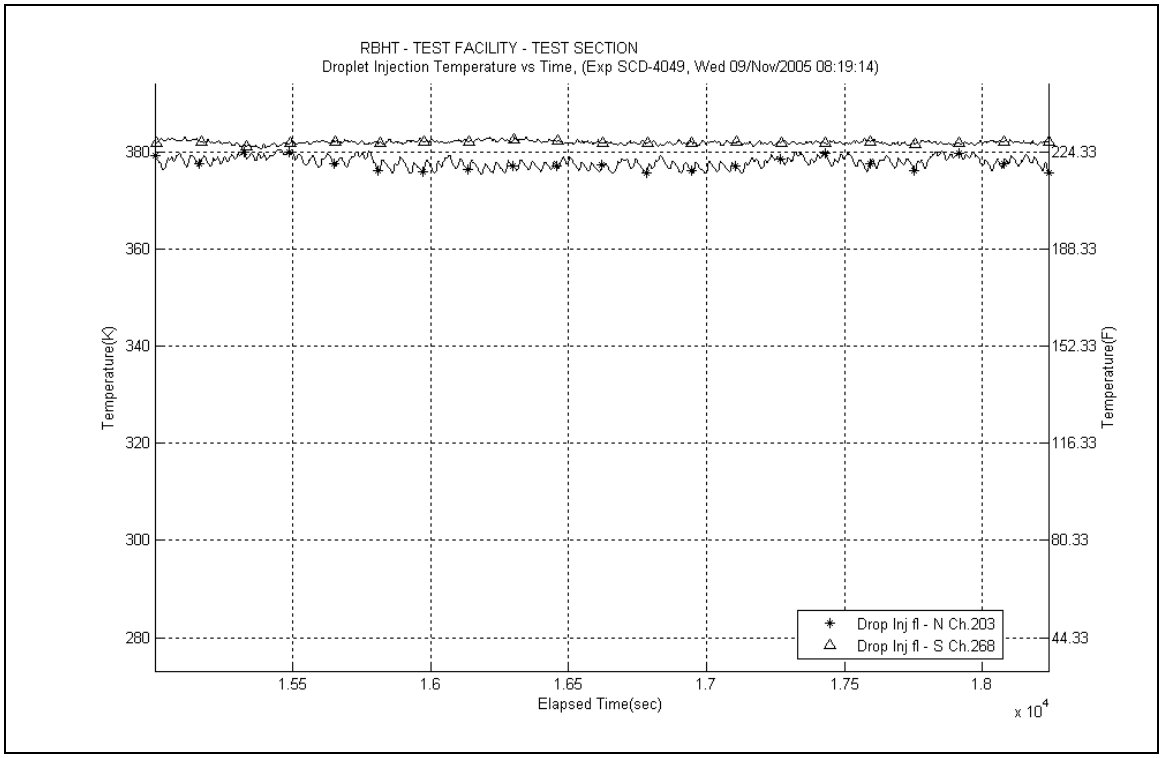

Figure A-76: Droplet Injection Temperature for Experiment 4049B

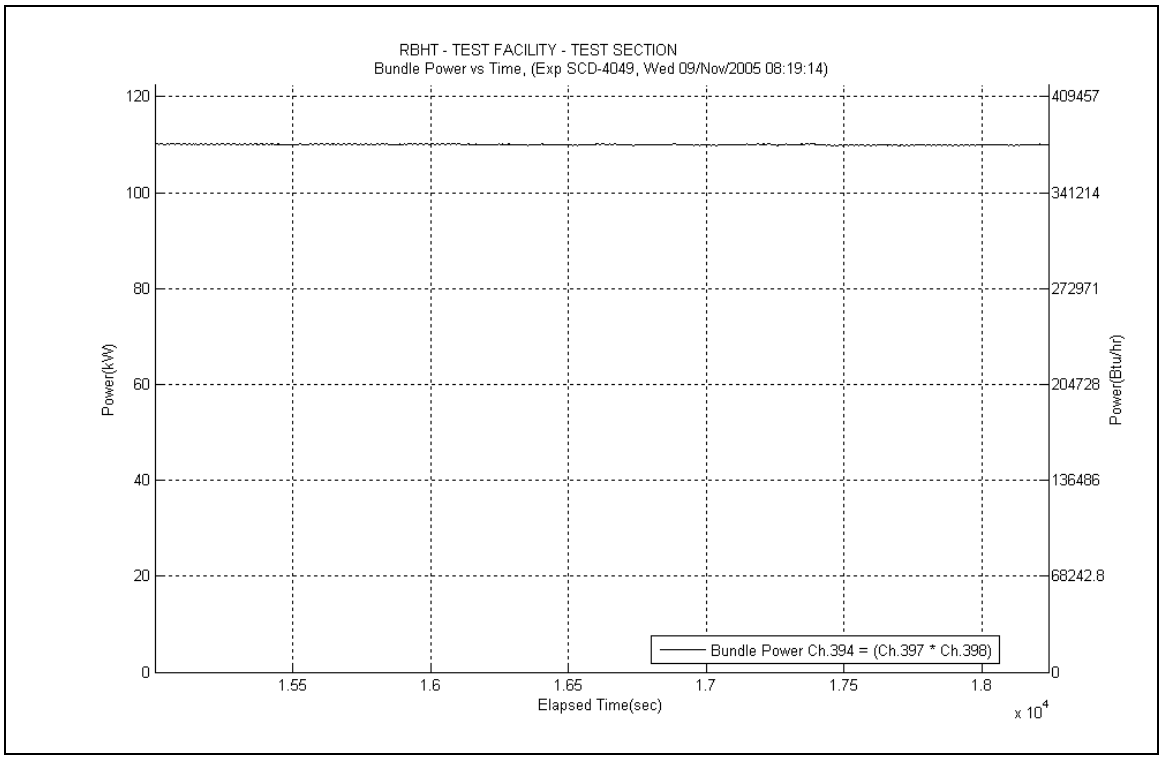

Figure A-77: Bundle Power for Experiment 4049B

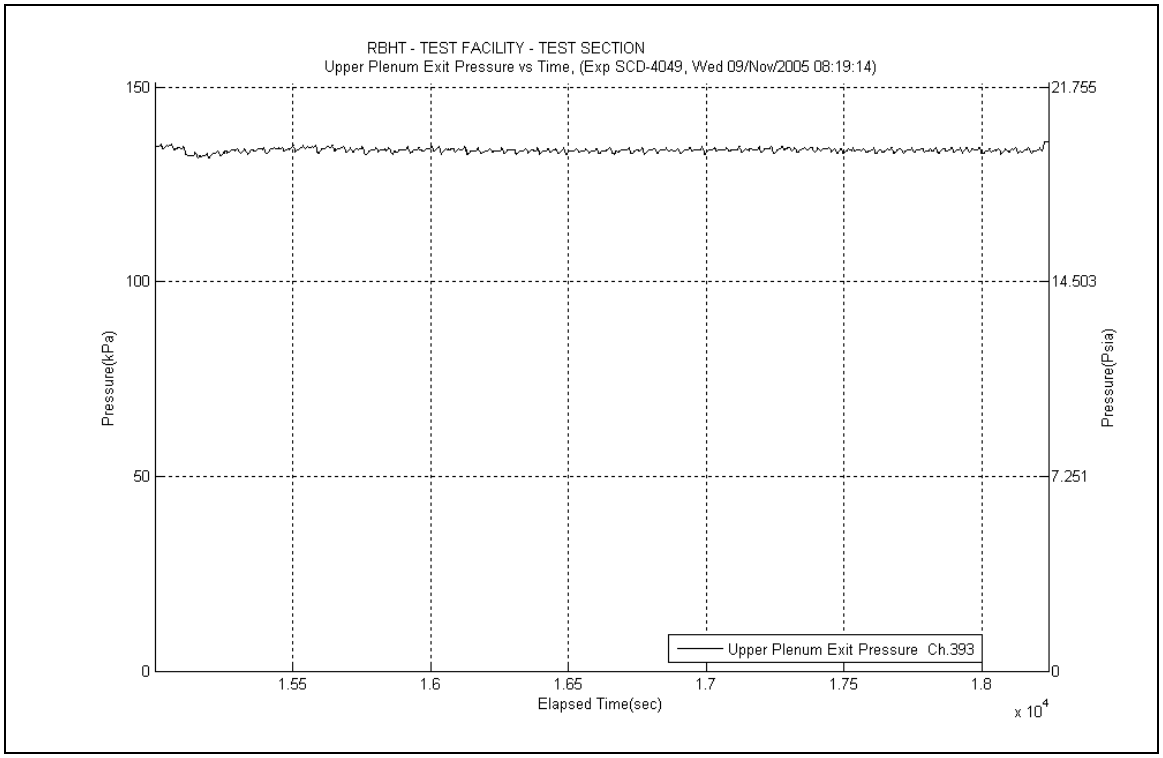

Figure A-78: Upper Plenum Pressure for Experiment 4049B

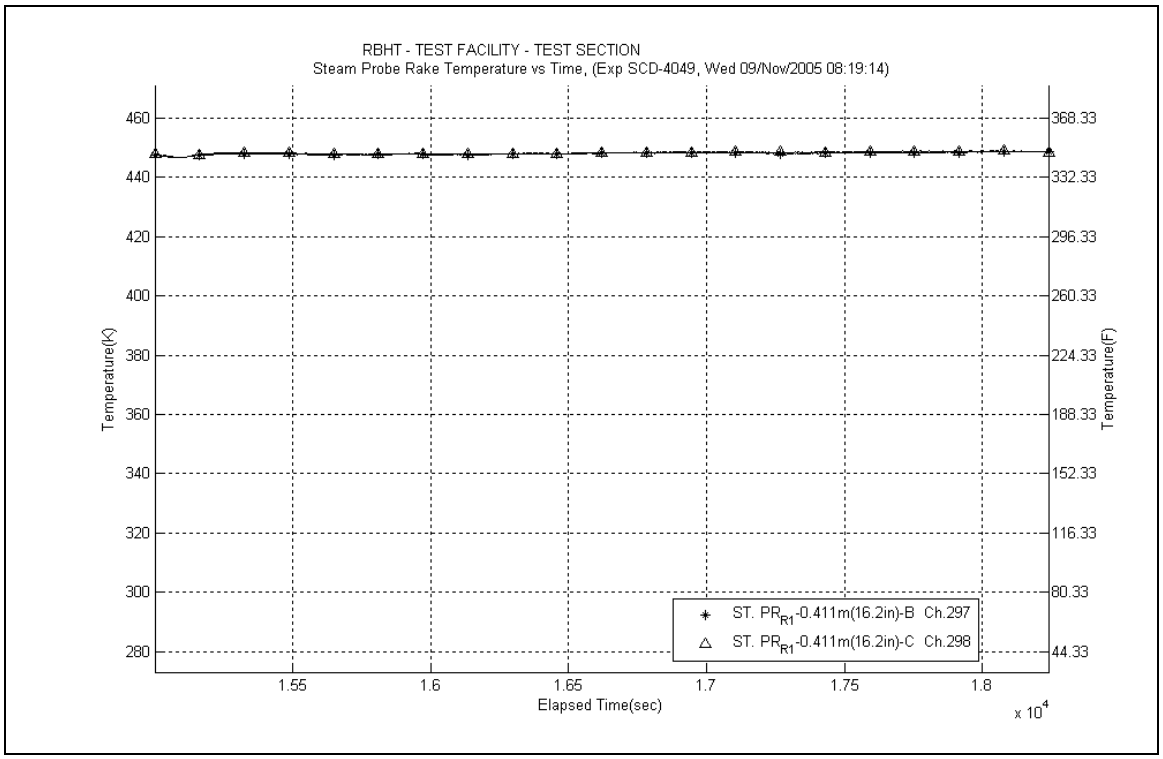

Figure A-79: Steam Probe Rake #1 Temperatures for Experiment 4049B

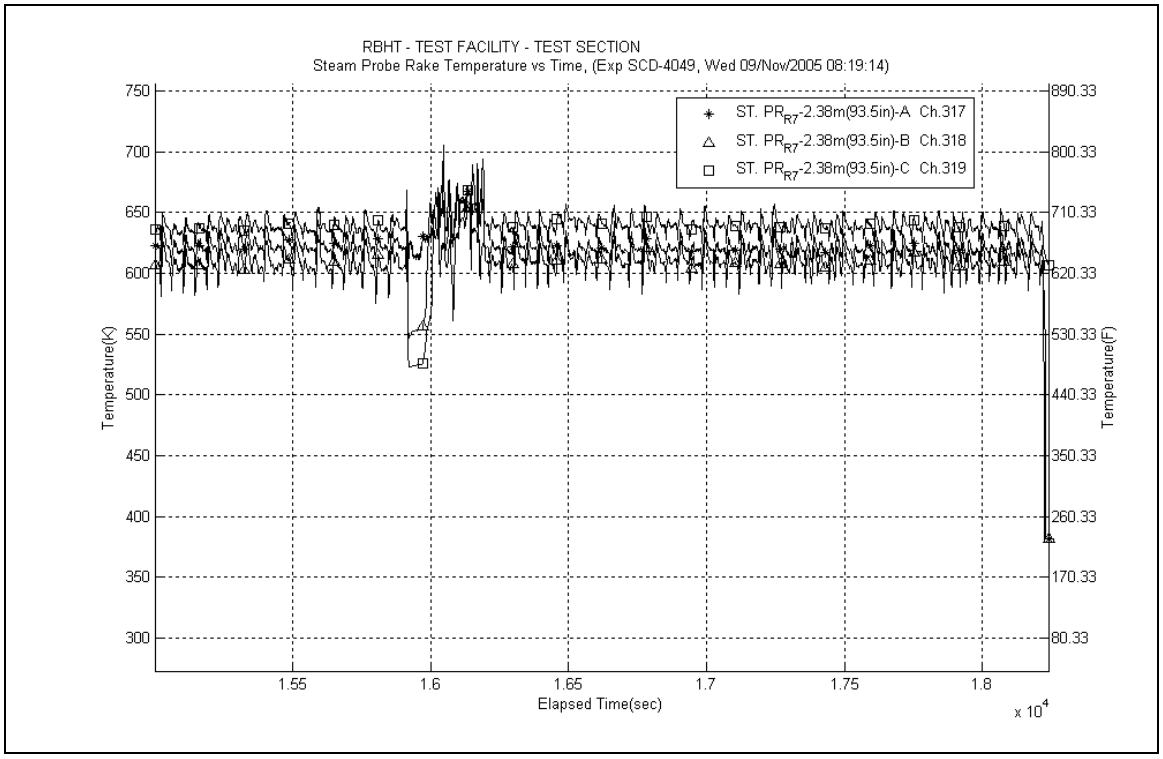

Figure A-80: Steam Probe Rake #7 Temperatures for Experiment 4049B

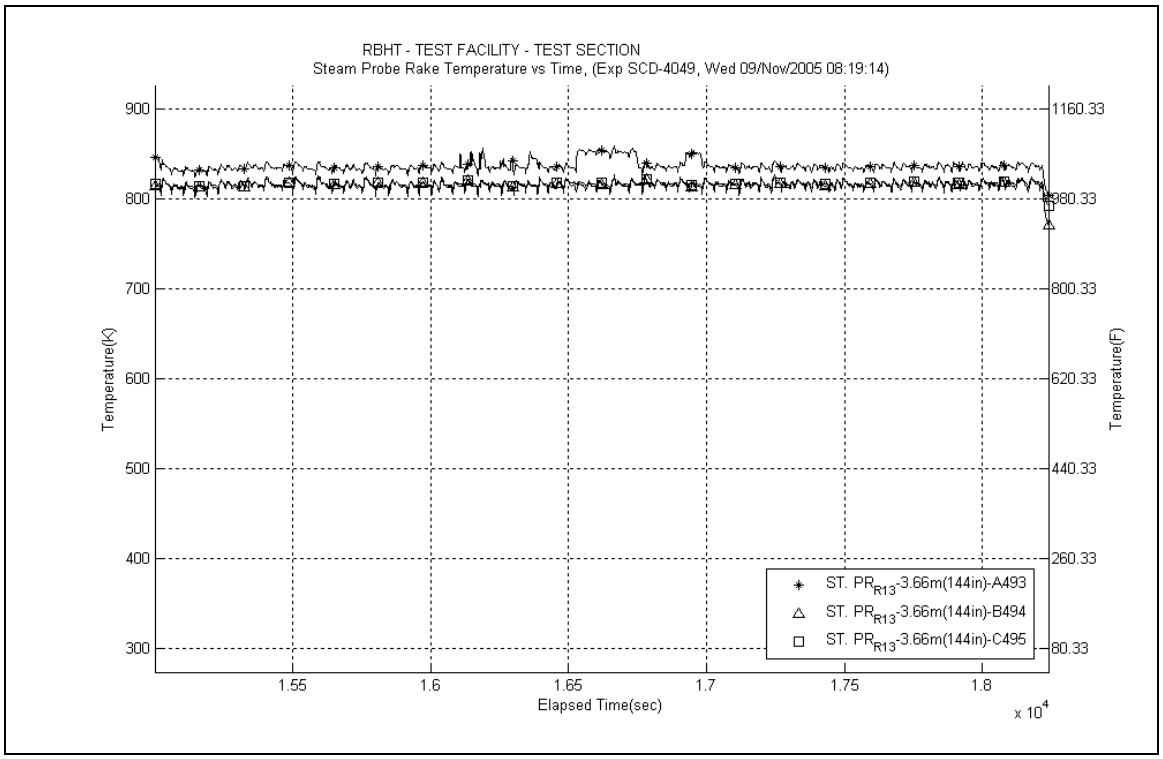

Figure A-81: Steam Probe Rake #13 Temperatures for Experiment 4049B

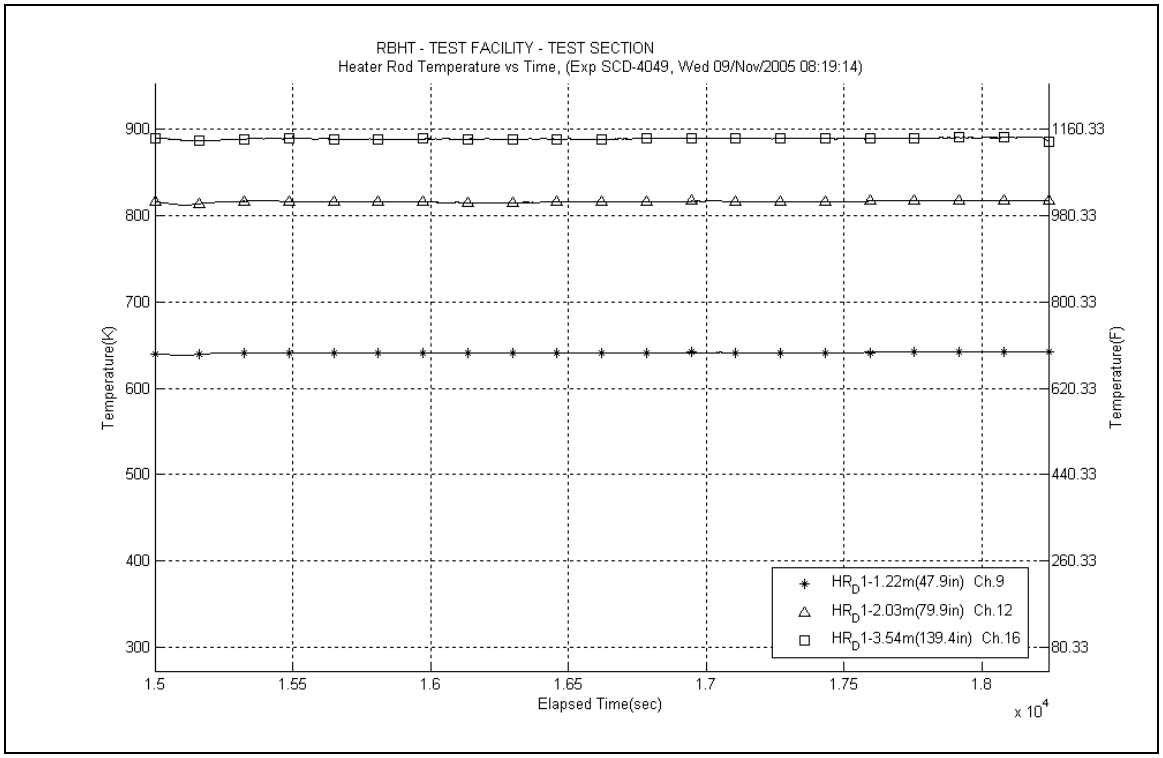

Figure A-82: Heater Rod D1 Temperatures for Experiment 4049B

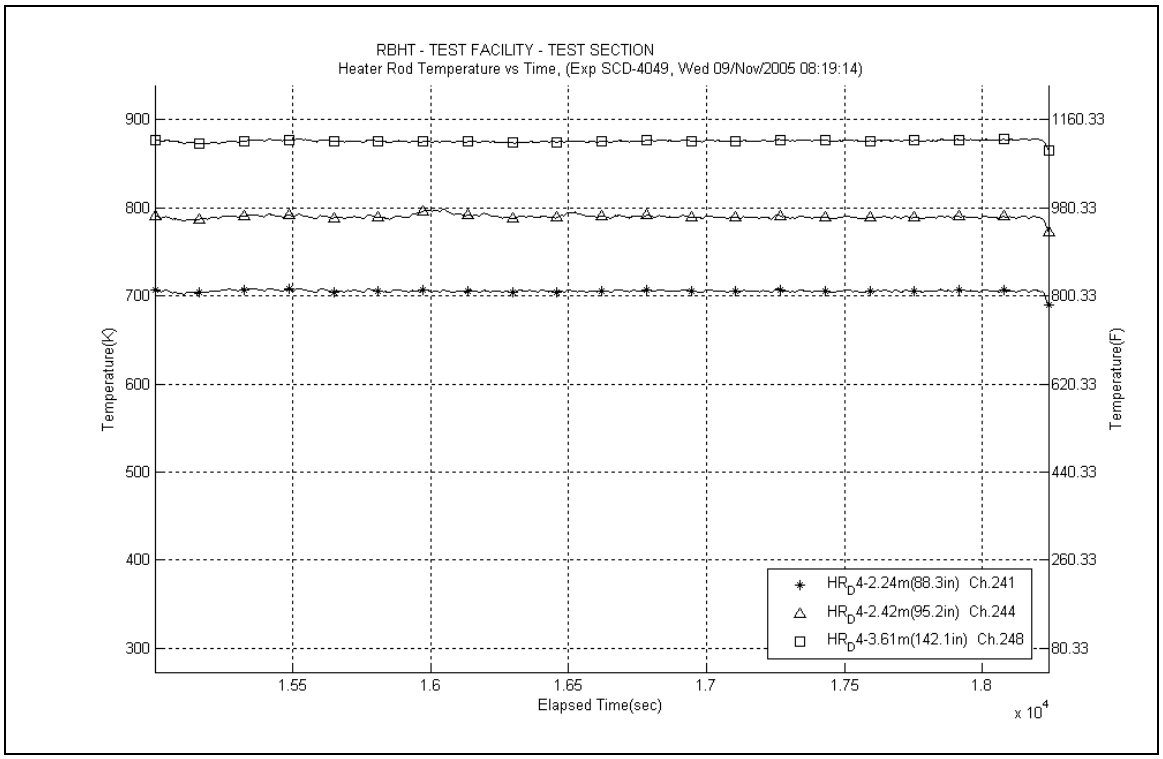

Figure A-83: Heater Rod D4 Temperatures for Experiment 4049B

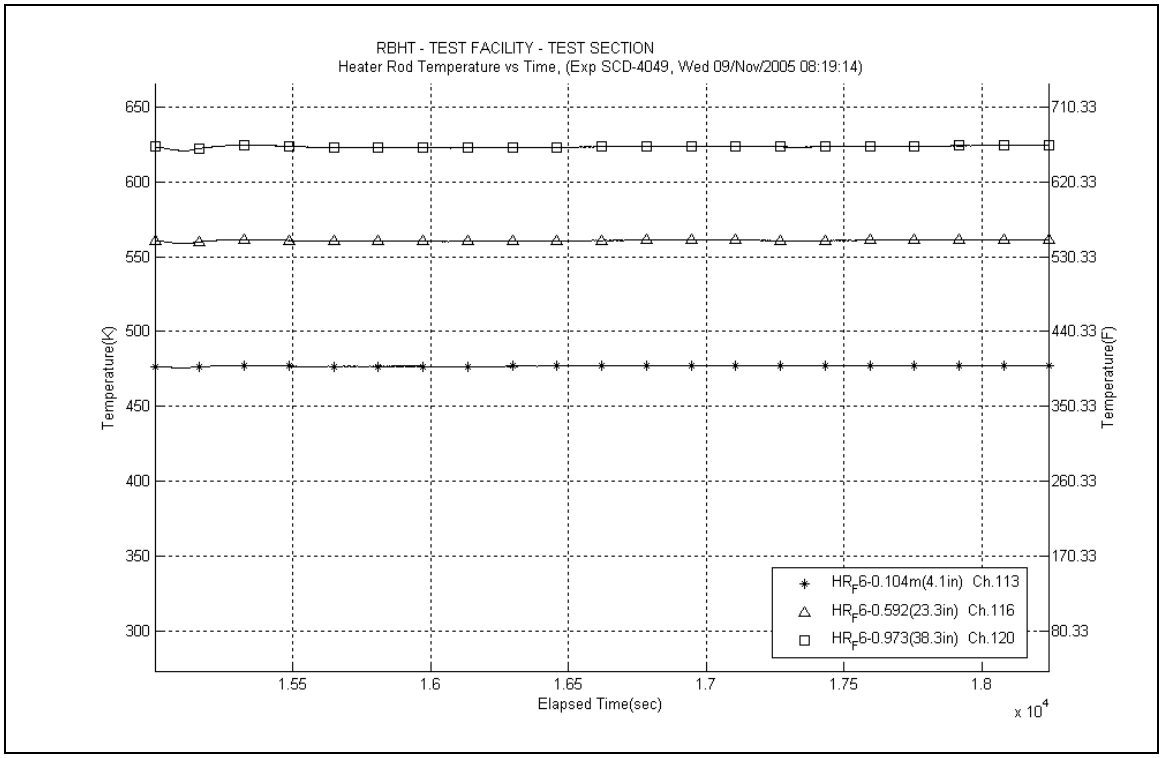

Figure A-84: Heater Rod F6 Temperatures for Experiment 4049B

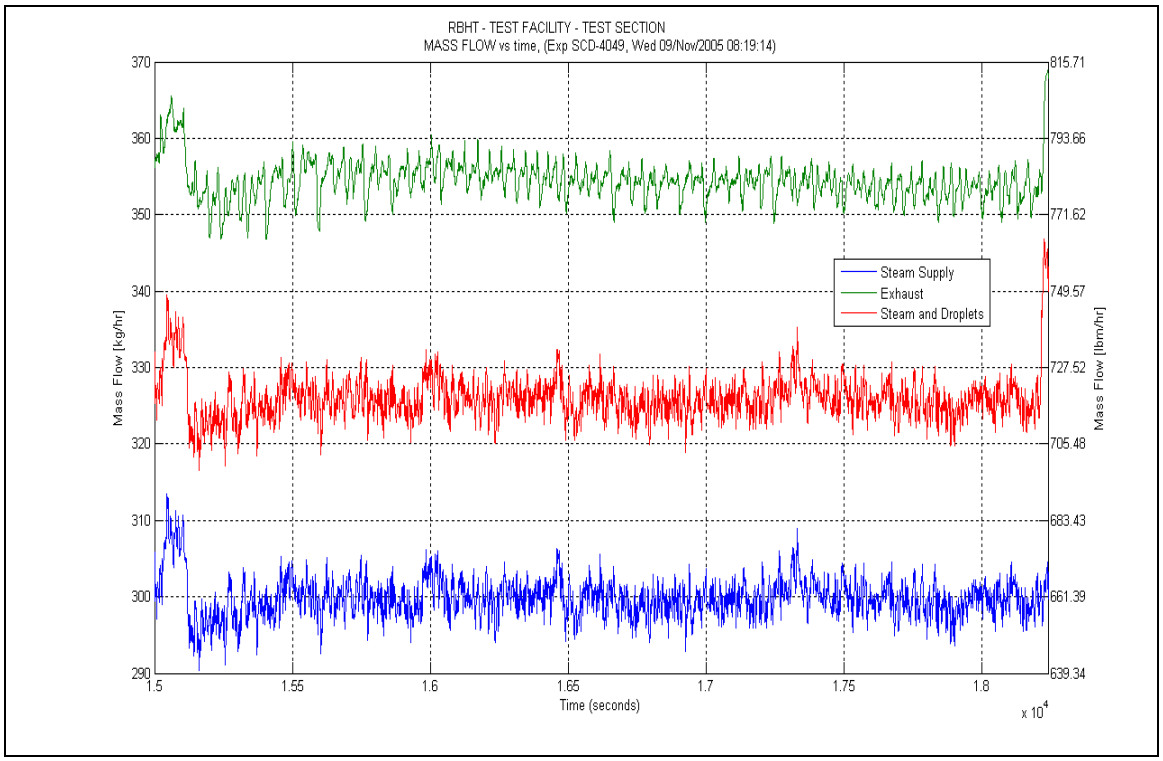

Figure A-85: Mass Flow for Experiment 4049B

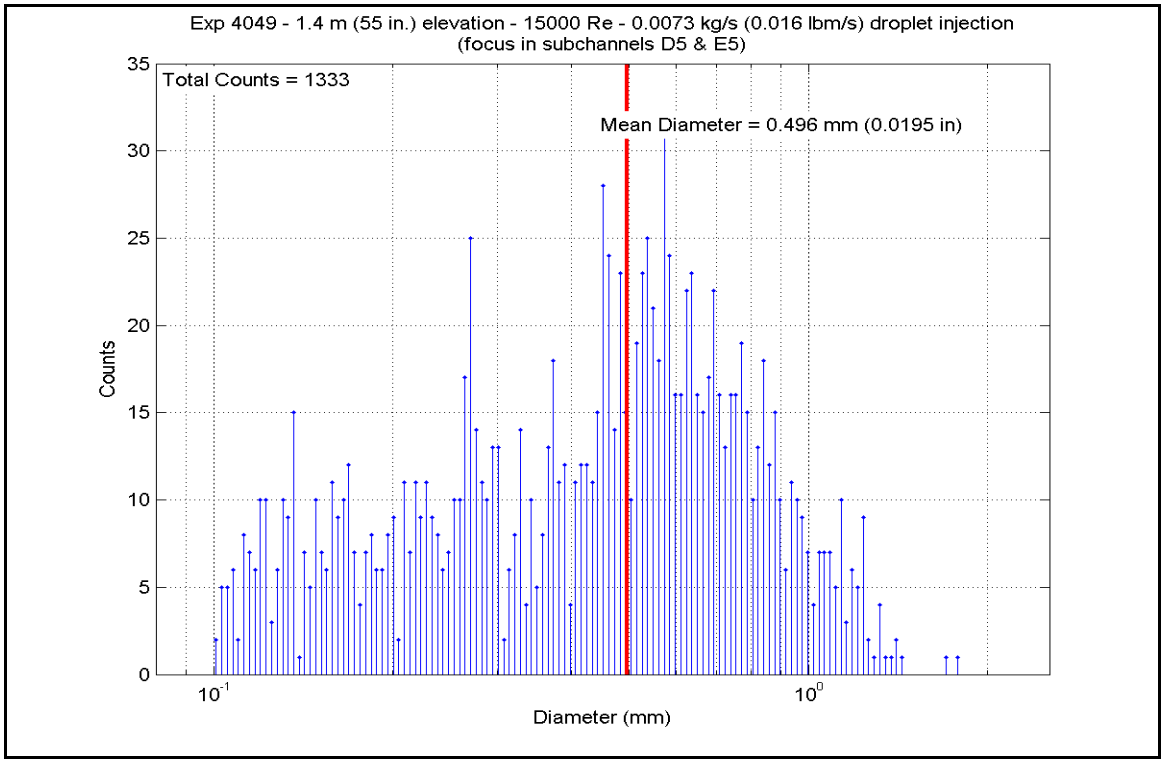

Figure A-86: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049B

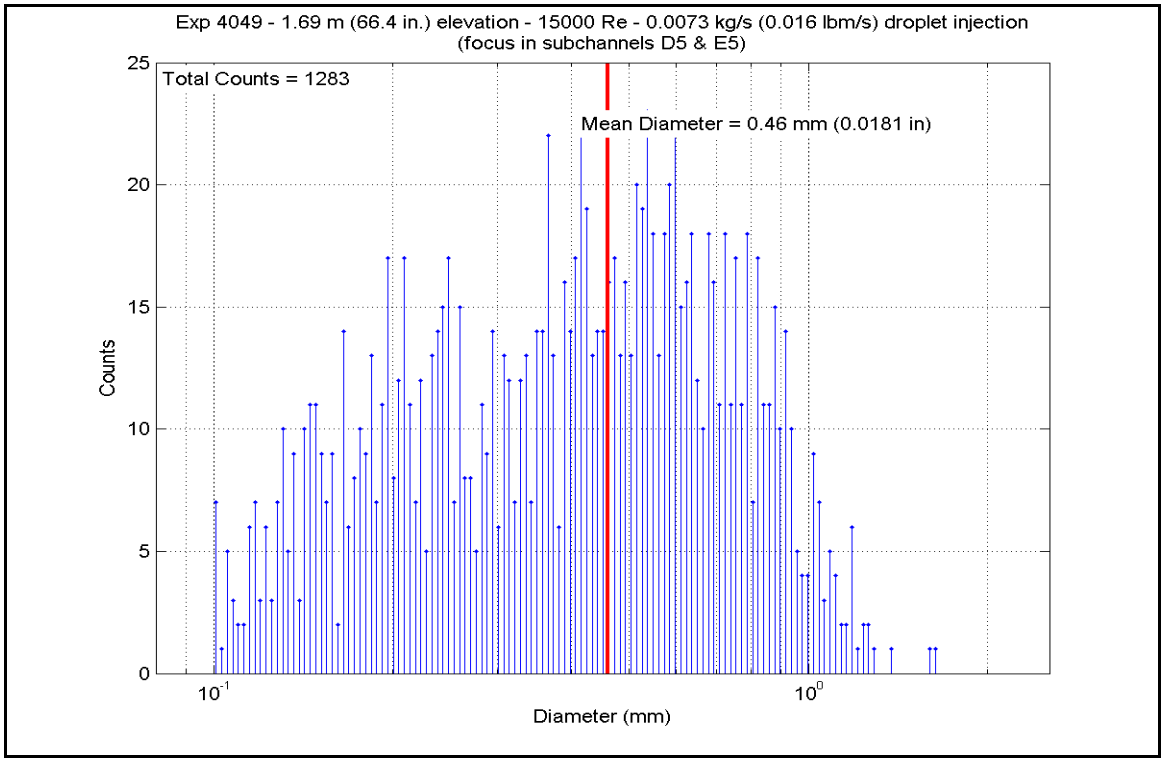

Figure A-87: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049B

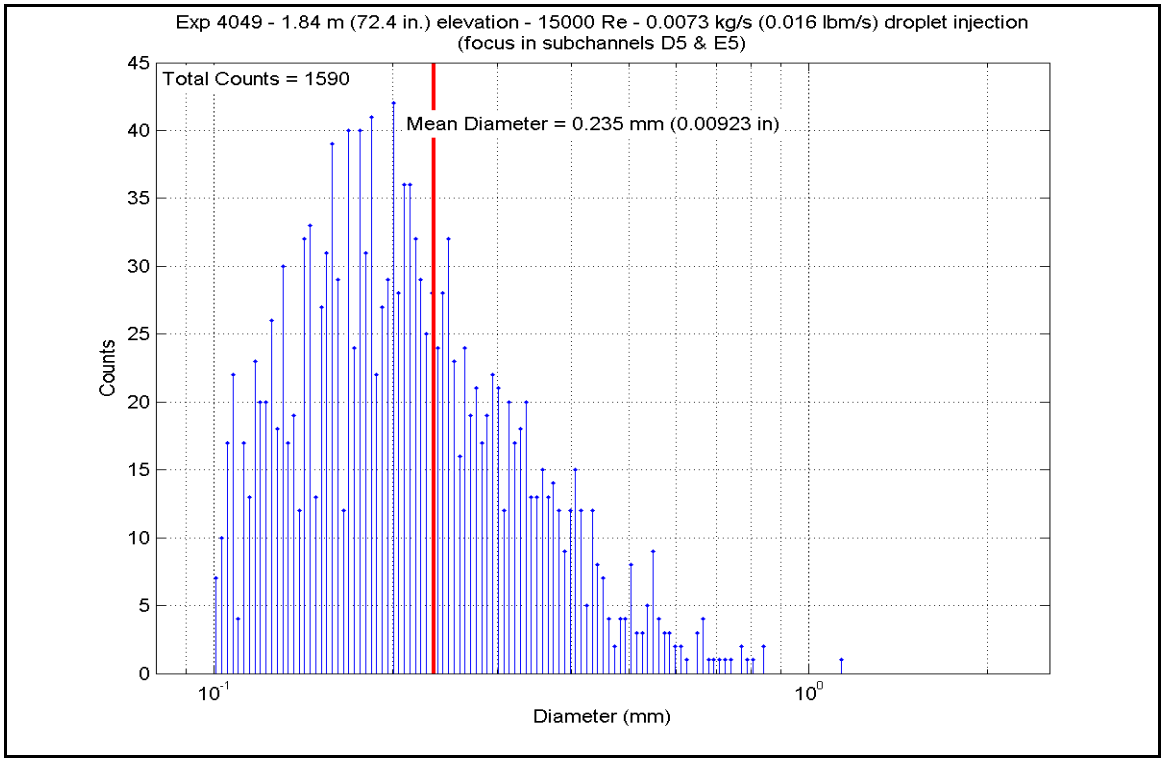

Figure A-88: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049B

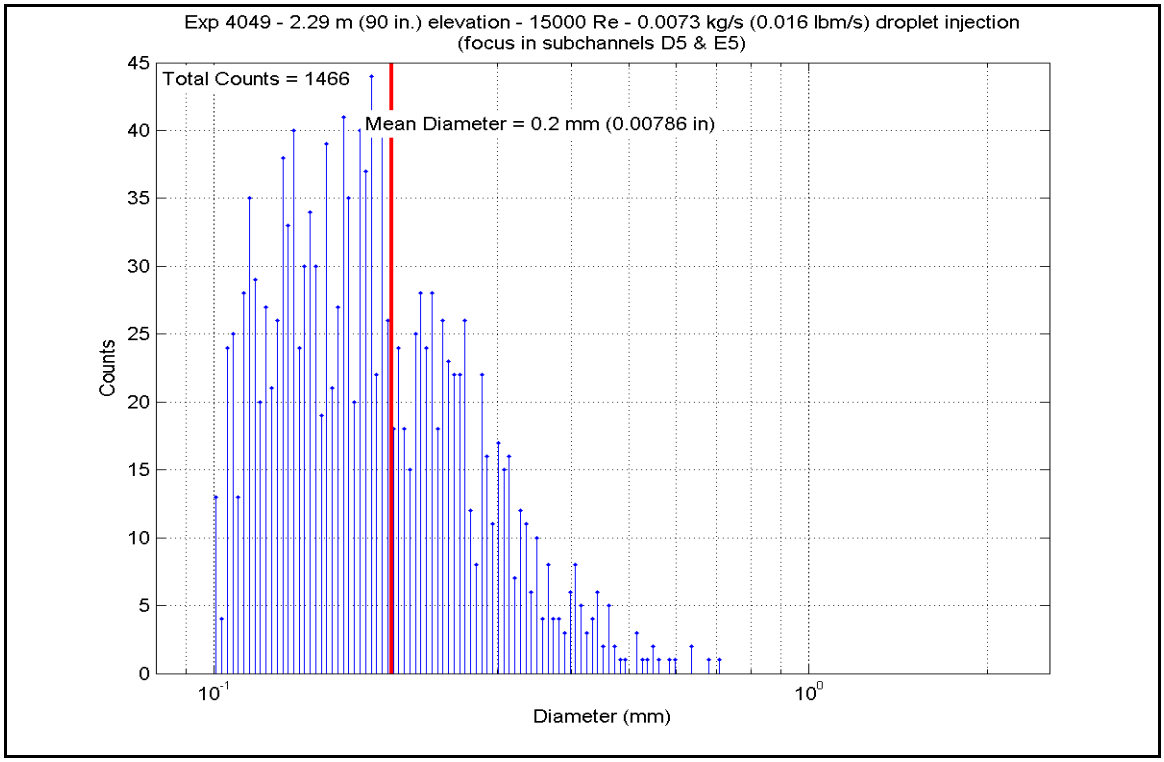

Figure A-89: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049B

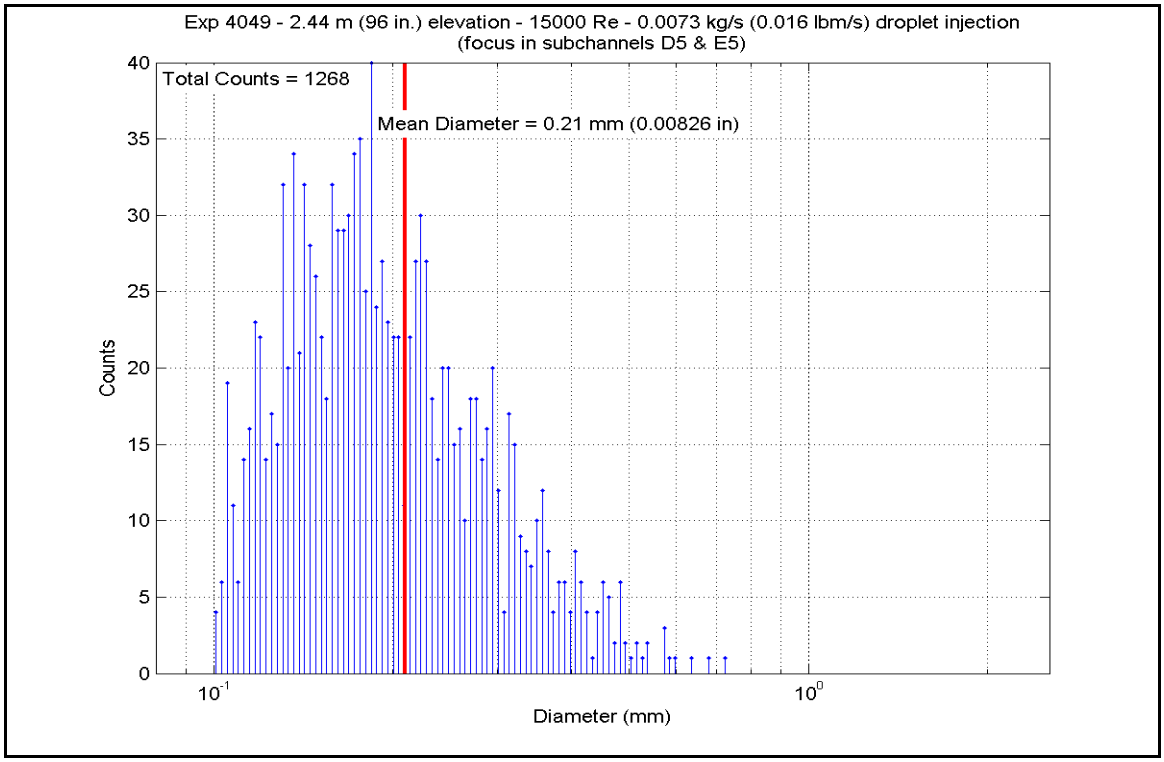

Figure A-90: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049B

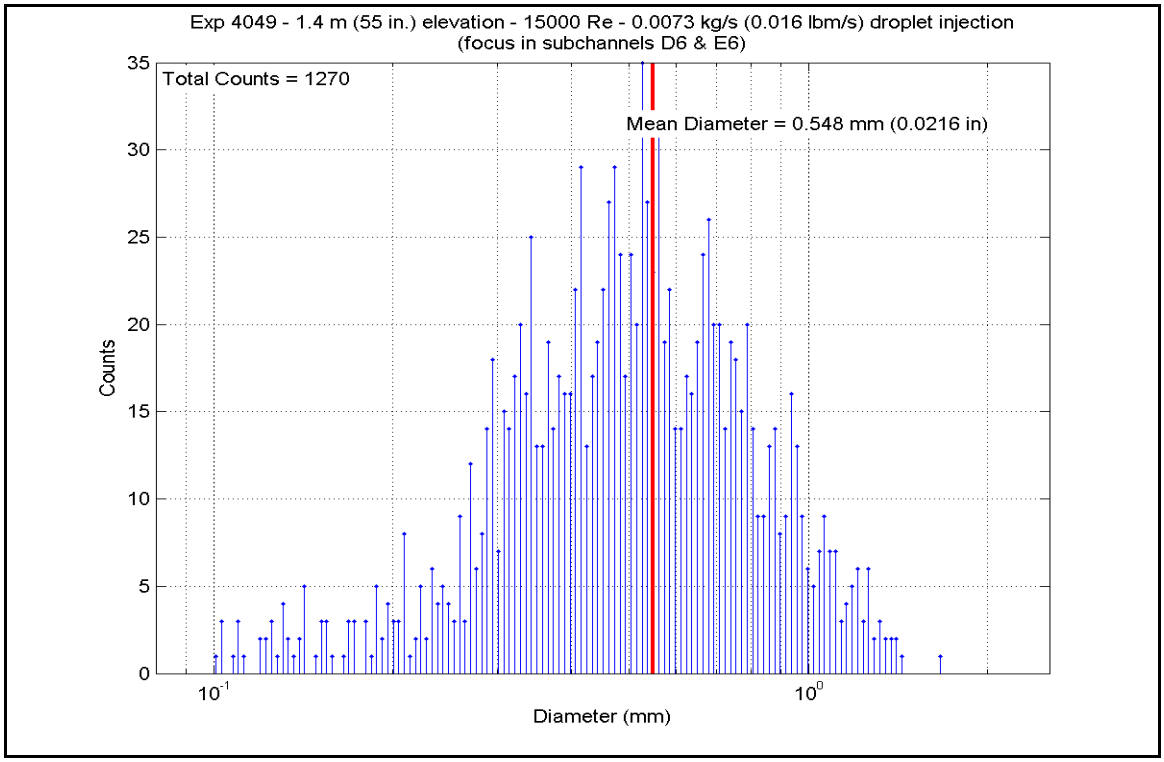

Figure A-91: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049B

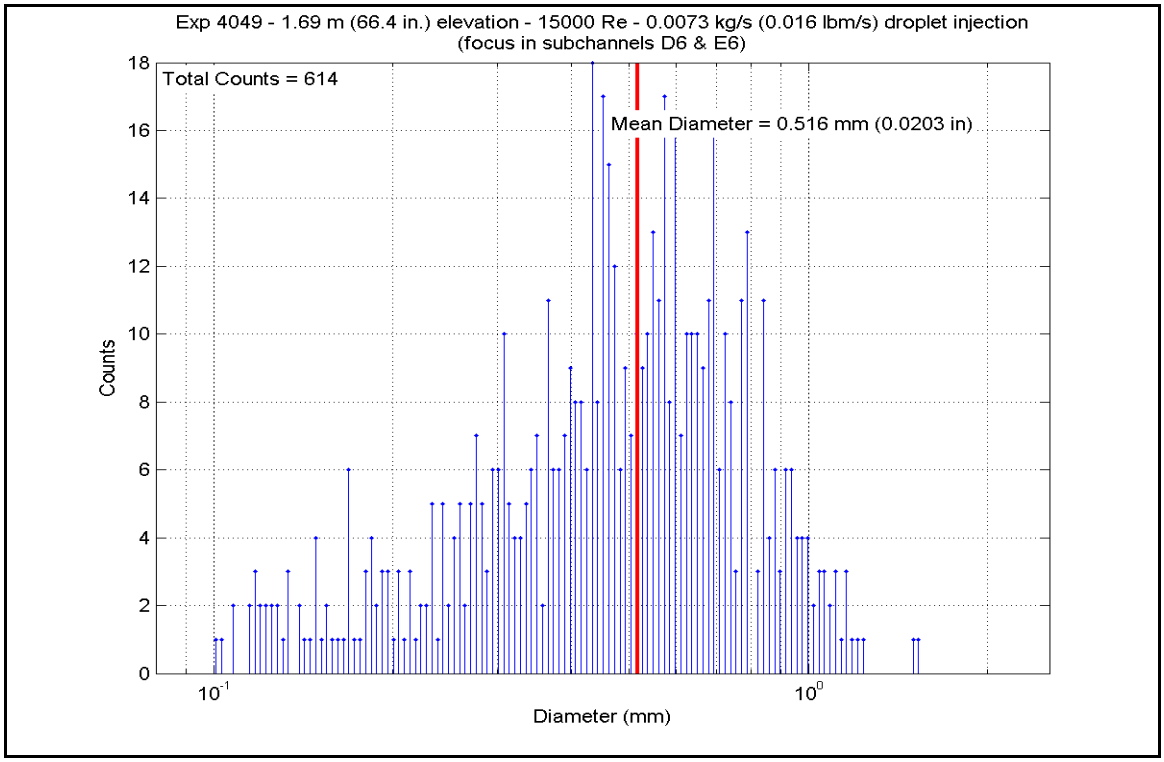

Figure A-92: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049B

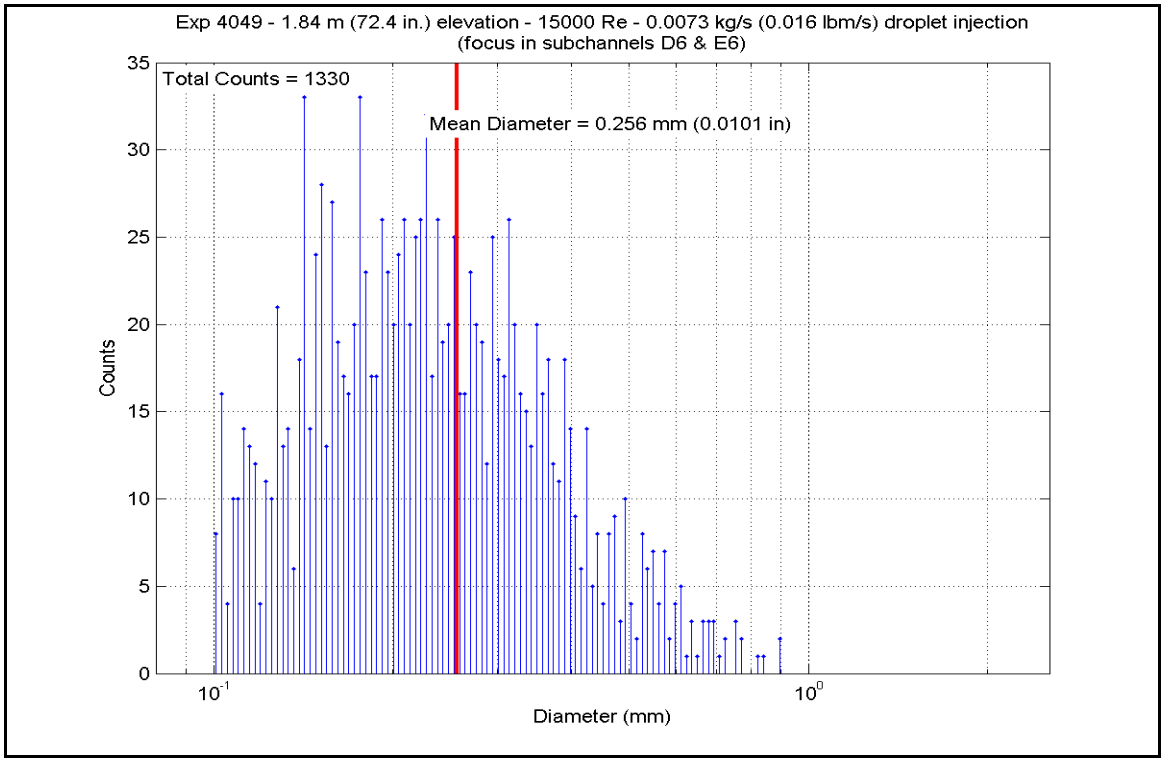

Figure A-93: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049B

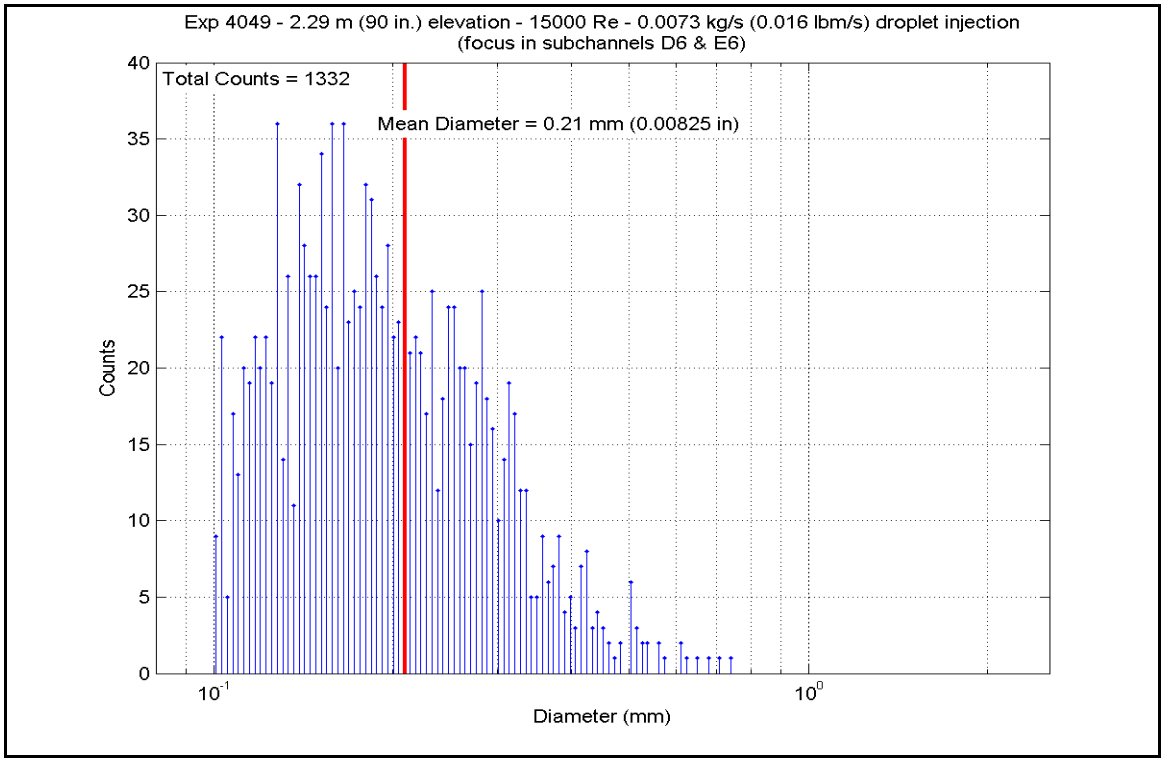

Figure A-94: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049B

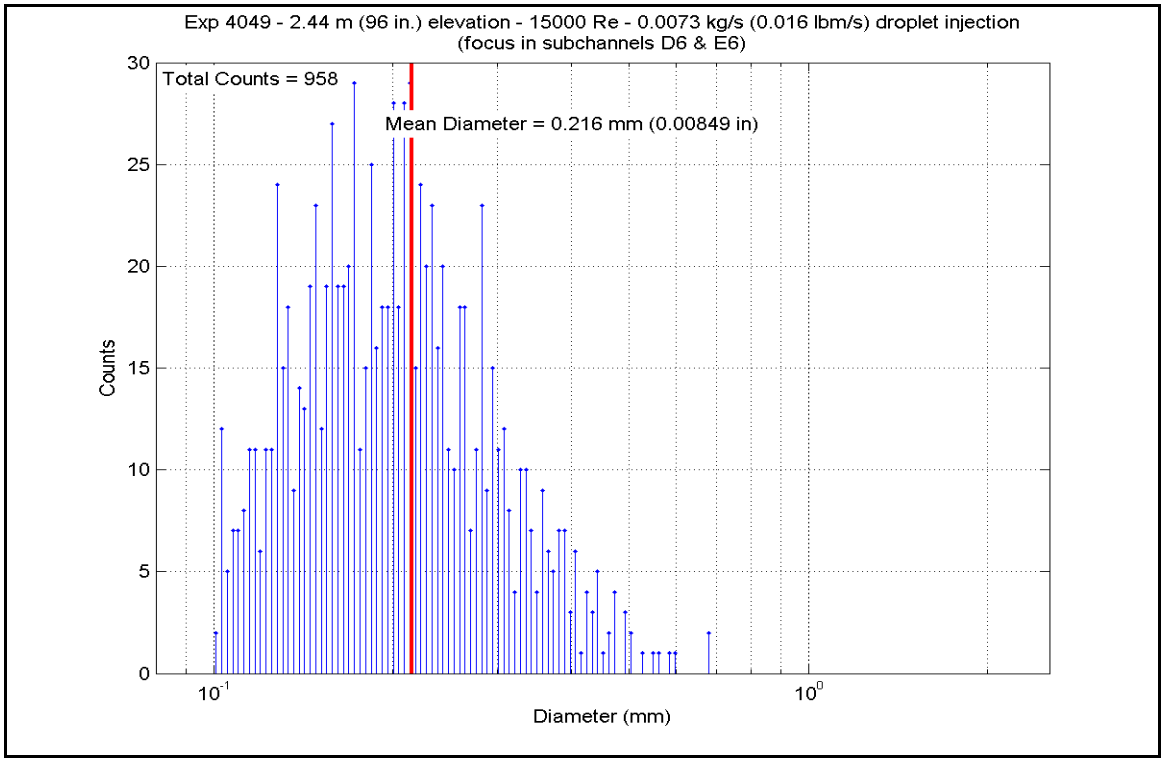

Figure A-95: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049B

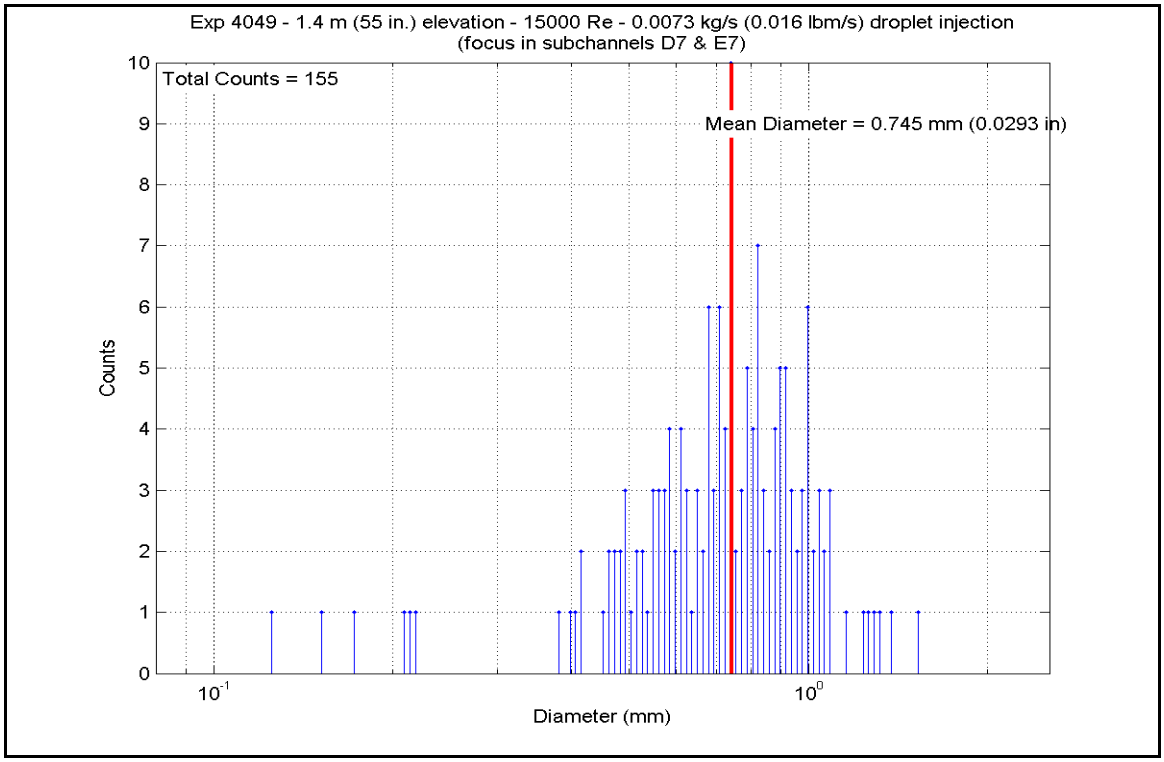

Figure A-96: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049B

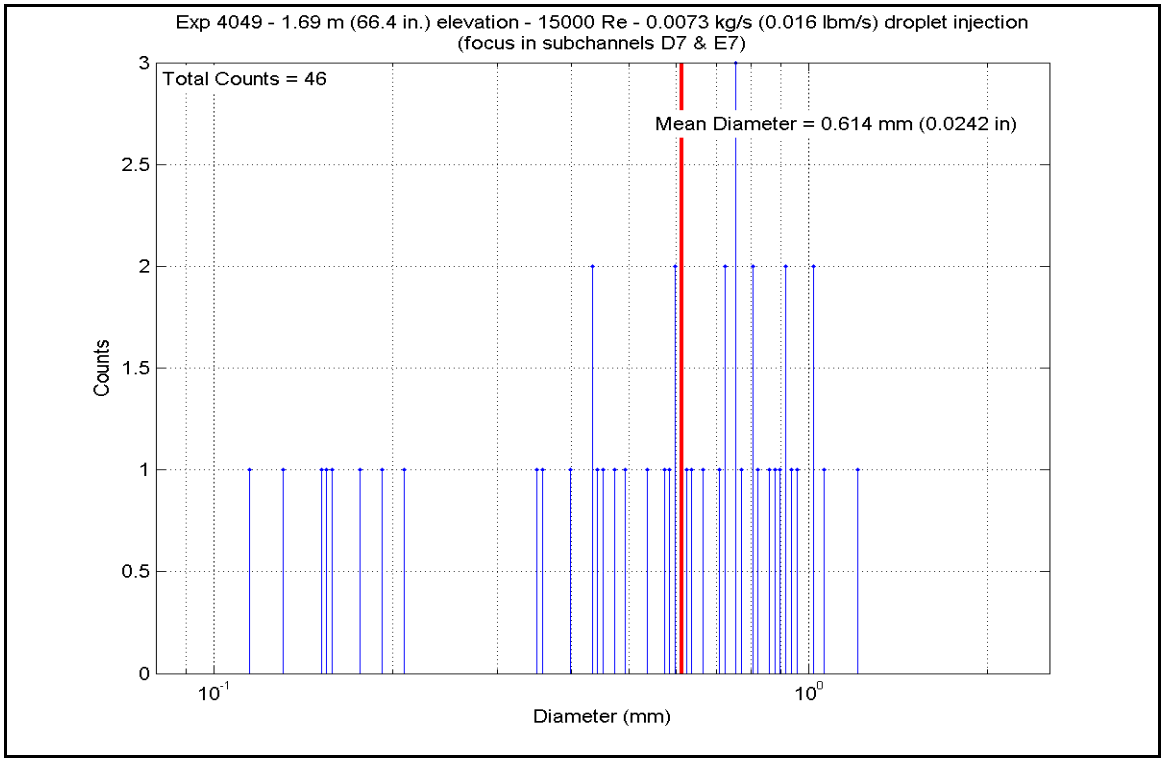

Figure A-97: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049B

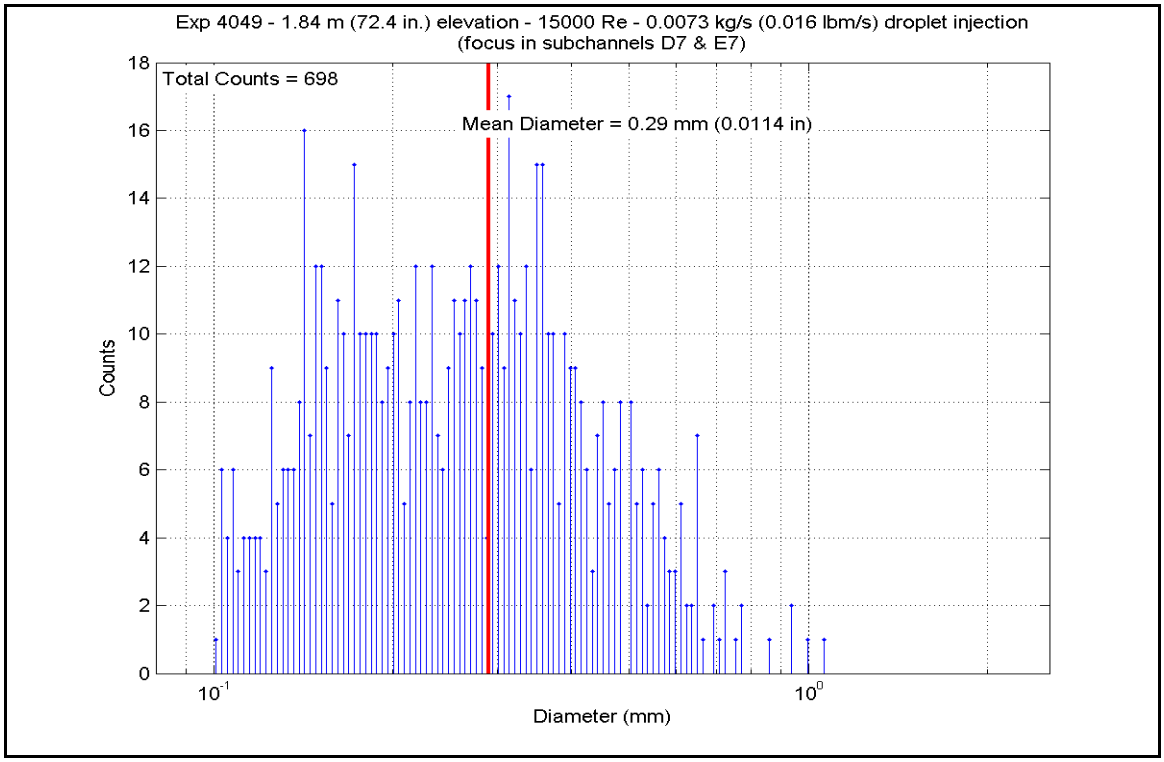

Figure A-98: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049B

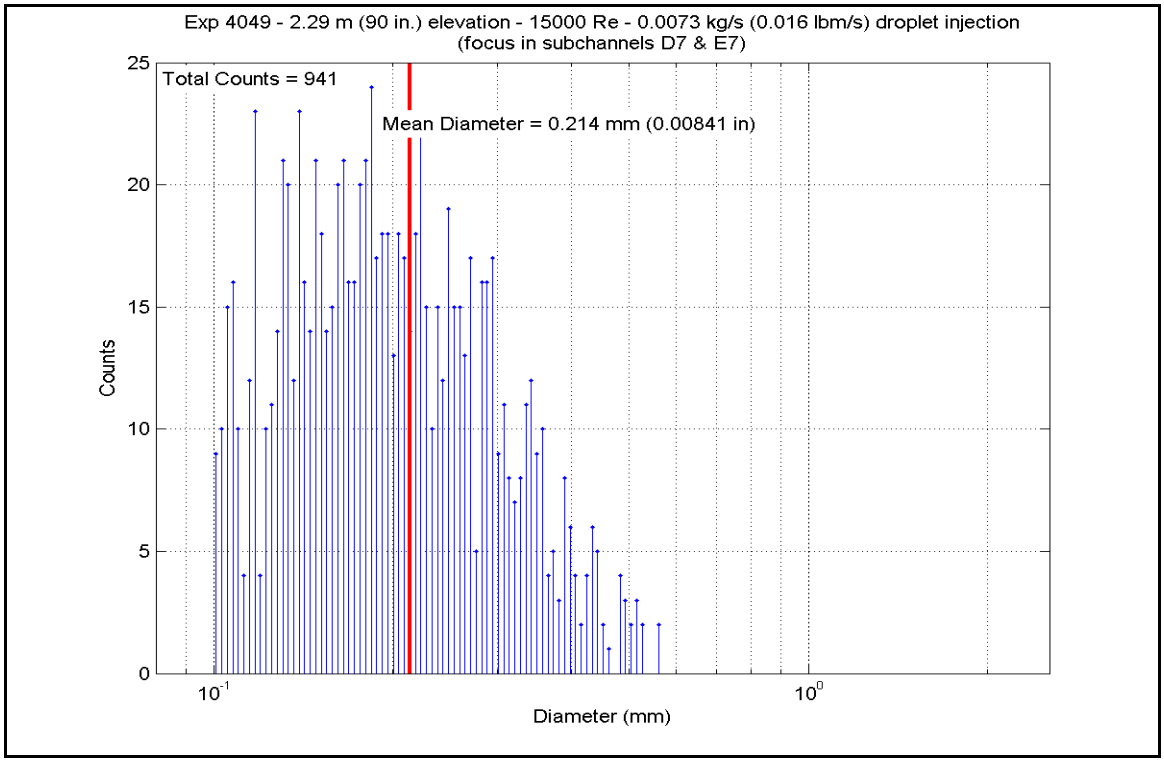

Figure A-99: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049B

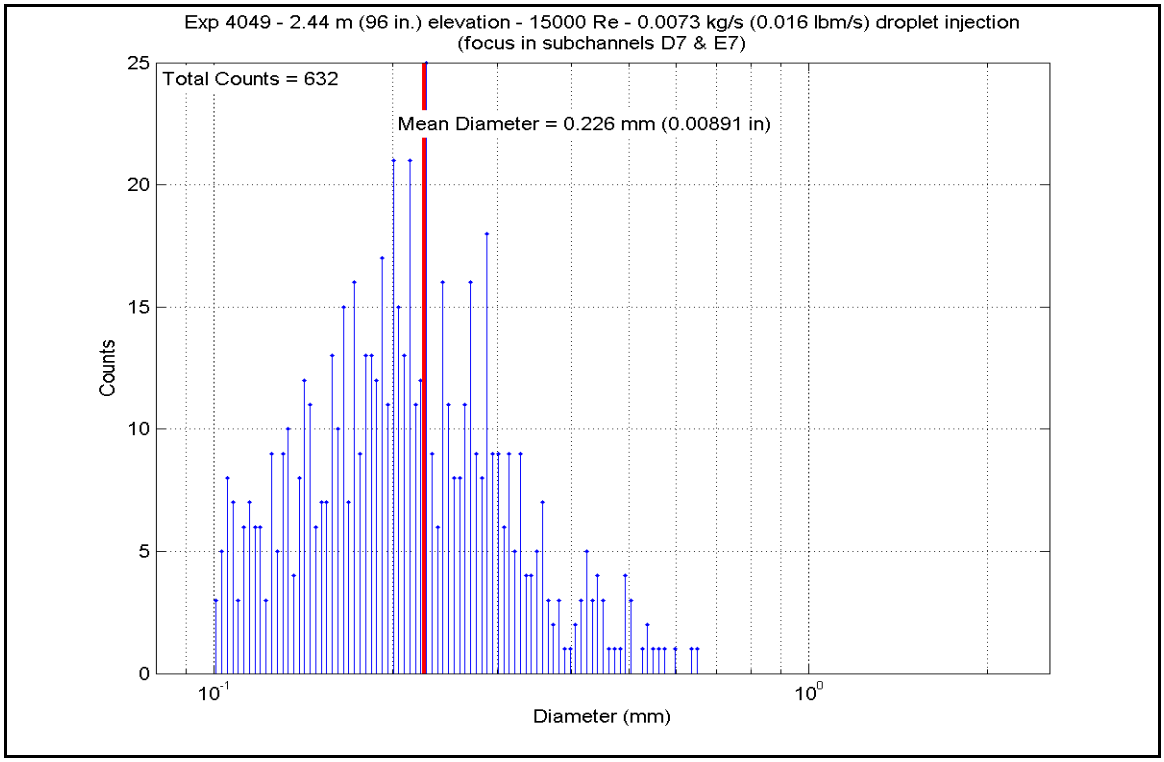

Figure A-100: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049B

Table A-45: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049B

SCD-4049-B	Inlet Reynolds:	15000		
Matrix Test # 6b	UP Pressure:	137.9 kPa	20	psia
Time Window: 15000-18240	Bundle Power:	110.00 kW	375335	Btu/hr
	Steam flow:	0.0838 kg/s	665.0	lbm/hr
	Droplet flow:	0.0073 kg/s	0.016	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	839.27	721.6	9350.59	29496.4	15.297	86.9
	RodD3_91.3	186	91.3	2.319	2.8	0.071	932.51	773.4	9545.64	30111.7	13.549	76.9
	RodD3_93.1	187	93.1	2.365	4.6	0.117	943.12	779.3	9666.73	30493.7	13.518	76.8
	RodD3_95.3	188	95.3	2.421	6.8	0.173	980.01	799.8	9810.62	30947.6	13.046	74.1
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1016.64	820.2	10136.19	31974.6	12.853	73.0
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1108.85	871.4	10530.42	33218.2	11.955	67.9
	RodD3_110	191	110	2.794	21.5	0.546	1015.29	819.4	10420.16	32870.4	13.236	75.2
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1133.89	885.3	3629.61	11449.6	4.007	22.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	828.47	715.6	9460.83	29844.2	15.756	89.5
	RodC4_91.1	234	91.1	2.314	2.6	0.066	926.81	770.3	9642.44	30417.1	13.798	78.4
	RodC4_93.4	235	93.4	2.372	4.9	0.124	951.06	783.7	9798.62	30909.8	13.552	77.0
	RodC4_95.3	236	95.3	2.421	6.8	0.173	993.74	807.5	9926.69	31313.7	12.964	73.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1026.36	825.6	10254.51	32347.8	12.844	72.9
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1090.99	861.5	10655.37	33612.4	12.347	70.1
	RodC4_110	239	110	2.794	21.5	0.546	991.54	806.2	10335.46	32603.2	13.536	76.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1117.99	876.5	3941.67	12434.0	4.429	25.2
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	806.57	703.5	9427.86	29740.2	16.295	92.5
	RodD4_91.3	242	91.3	2.319	2.8	0.071	901.31	756.1	9628.80	30374.0	14.301	81.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	925.36	769.5	9757.37	30779.6	13.992	79.5
	RodD4_95.2	244	95.2	2.418	6.7	0.170	958.18	787.7	9889.96	31197.9	13.545	76.9
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1010.60	816.8	10218.15	32233.2	13.057	74.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1072.22	851.0	10618.25	33495.3	12.578	71.4
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1115.05	874.8	3810.02	12018.7	4.295	24.4
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	824.76	713.6	9282.49	29281.6	15.555	88.3
	RodE4_91.2	202	91.2	2.316	2.7	0.069	930.93	772.6	9459.64	29840.4	13.457	76.4
	RodE4_95.3	204	95.3	2.421	6.8	0.173	998.38	810.0	9720.04	30661.9	12.617	71.7
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1048.16	837.7	10081.30	31801.4	12.292	69.8
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1123.91	879.8	3843.65	12124.8	4.290	24.4

Table A-45: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	923.36	768.4	7677.09	24217.4	11.040	62.7
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1079.82	855.3	9482.25	29911.8	11.132	63.2
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1123.06	879.3	9121.27	28773.0	10.191	57.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1152.55	895.7	8564.60	27017.0	9.264	52.6
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1150.21	894.4	7787.33	24565.1	8.444	48.0
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1150.98	894.8	7083.11	22343.7	7.674	43.6
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1068.62	849.0	6129.19	19334.5	7.291	41.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1126.07	881.0	5398.52	17029.6	6.011	34.1
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	918.05	765.4	7529.89	23753.1	10.912	62.0
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1042.22	834.4	9255.28	29195.8	11.367	64.6
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1094.89	863.6	8880.25	28012.7	10.244	58.2
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1126.42	881.2	7646.73	24121.6	8.511	48.3
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1128.67	882.4	6942.04	21898.7	7.708	43.8
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1040.30	833.3	6097.64	19235.0	7.507	42.6
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1092.22	862.2	5362.03	16914.5	6.204	35.2
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	850.71	728.0	7715.21	24337.6	12.390	70.4
	RodE5_113.6	210	113.6	2.885	0.85	0.022	929.90	772.0	9558.12	30151.1	13.618	77.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1008.11	815.4	9215.63	29070.7	11.813	67.1
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1066.60	847.9	8607.43	27152.1	10.264	58.3
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1096.00	864.3	7895.81	24907.3	9.097	51.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1092.90	862.5	7166.28	22606.0	8.286	47.1
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1163.77	901.9	6257.02	19737.8	6.686	38.0
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1108.12	871.0	5531.93	17450.5	6.285	35.7
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	935.65	775.2	8735.17	27555.1	12.344	70.1
	RodC3_85.6	178	85.6	2.174	14.72	0.374	821.45	711.7	9131.04	28803.9	15.386	87.4
	RodC3_88.5	179	88.5	2.248	0	0.000	844.98	724.8	9311.10	29371.9	15.091	85.7
	RodC3_92.4	180	92.4	2.347	3.9	0.099	957.08	787.1	9562.85	30166.0	13.116	74.5
	RodC3_94.4	181	94.4	2.398	5.9	0.150	971.80	795.3	9693.34	30577.6	13.032	74.0
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1021.96	823.1	9880.84	31169.1	12.445	70.7
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1107.10	870.4	10417.63	32862.4	11.850	67.3
Gr-8	RodD5_50	217	50	1.270	3	0.076	792.71	695.8	6815.45	21499.4	12.069	68.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	819.55	710.7	7087.69	22358.1	11.981	68.0
	RodD5_56.9	219	56.9	1.445	9.9	0.251	857.67	731.9	7270.50	22934.8	11.546	65.6
	RodD5_60	220	60	1.524	13	0.330	876.29	742.2	7472.85	23573.1	11.527	65.5
	RodD5_66.1	221	66.1	1.679	19.1	0.485	924.11	768.8	7872.14	24832.7	11.309	64.2
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	802.03	700.9	8127.30	25637.6	14.158	80.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	878.52	743.4	8322.41	26253.0	12.793	72.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	916.22	764.4	8453.12	26665.4	12.283	69.8

Table A-45: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	717.50	654.0	6196.73	19547.6	12.659	71.9
	RodB5_52.9	154	52.9	1.344	5.9	0.150	788.25	693.3	6983.86	22030.6	12.466	70.8
	RodB5_55	155	55	1.397	8	0.203	824.51	713.4	7123.10	22469.8	11.941	67.8
	RodB5_57.8	156	57.8	1.468	10.8	0.274	858.54	732.3	7310.06	23059.6	11.593	65.8
	RodB5_64	157	64	1.626	17	0.432	906.15	758.8	7719.84	24352.2	11.384	64.6
	RodB5_73.9	158	73.9	1.877	3.02	0.077	895.84	753.1	8374.74	26418.1	12.540	71.2
	RodB5_75.9	159	75.9	1.928	5.02	0.128	922.18	767.7	8506.91	26835.0	12.255	69.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	932.74	773.6	8573.26	27044.4	12.165	69.1
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	698.57	643.5	6157.29	19423.2	13.085	74.3
	RodF5_53.1	106	53.1	1.349	6.1	0.155	775.52	686.2	6957.42	21947.2	12.707	72.2
	RodF5_55	107	55	1.397	8	0.203	810.99	705.9	7082.85	22342.9	12.149	69.0
	RodF5_57.8	108	57.8	1.468	10.8	0.274	838.97	721.5	7266.39	22921.8	11.893	67.5
	RodF5_64	109	64	1.626	17	0.432	878.54	743.5	7677.47	24218.6	11.802	67.0
	RodF5_73.8	110	73.8	1.875	2.92	0.074	873.84	740.8	8328.42	26272.0	12.896	73.2
	RodF5_75.8	111	75.8	1.925	4.92	0.125	904.51	757.9	8460.54	26688.8	12.506	71.0
	RodF5_76.8	112	76.8	1.951	5.92	0.150	915.82	764.2	8526.40	26896.5	12.396	70.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	715.62	652.9	6185.35	19511.7	12.685	72.0
	RodC2_53.1	58	53.1	1.349	6.1	0.155	831.11	717.1	6985.76	22036.6	11.583	65.8
	RodC2_55	59	55	1.397	8	0.203	840.68	722.4	7111.54	22433.4	11.607	65.9
	RodC2_57.8	60	57.8	1.468	10.8	0.274	861.01	733.7	7296.50	23016.8	11.527	65.5
	RodC2_63.9	61	63.9	1.623	16.9	0.429	889.34	749.4	7699.91	24289.4	11.643	66.1
	RodC2_73.8	62	73.8	1.875	2.92	0.074	917.50	765.1	8356.13	26359.4	12.119	68.8
	RodC2_75.8	63	75.8	1.925	4.92	0.125	941.14	778.2	8488.65	26777.4	11.903	67.6
	RodC2_76.8	64	76.8	1.951	5.92	0.150	949.77	783.0	8554.71	26985.8	11.852	67.3
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	705.79	647.5	6156.52	19420.8	12.885	73.2
	RodC6_52.8	138	52.8	1.341	5.8	0.147	831.09	717.1	6977.51	22010.5	11.570	65.7
	RodC6_54.8	139	54.8	1.392	7.8	0.198	842.03	723.2	7115.48	22445.8	11.588	65.8
	RodC6_57.8	140	57.8	1.468	10.8	0.274	872.31	740.0	7322.41	23098.5	11.365	64.5
	RodC6_63.8	141	63.8	1.621	16.8	0.427	904.40	757.8	7736.29	24404.1	11.437	65.0
	RodC6_73.7	142	73.7	1.872	2.82	0.072	953.73	785.2	8421.55	26565.8	11.604	65.9
	RodC6_75.8	143	75.8	1.925	4.92	0.125	975.58	797.4	8566.39	27022.7	11.459	65.1
	RodC6_76.8	144	76.8	1.951	5.92	0.150	990.66	805.7	8635.62	27241.1	11.323	64.3

Table A-45: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	834.88	719.2	9271.60	29247.3	15.278	86.8
	RodB4_91.3	162	91.3	2.319	2.8	0.071	936.72	775.8	9456.14	29829.4	13.343	75.8
	RodB4_93.3	163	93.3	2.370	4.8	0.122	955.39	786.1	9583.96	30232.6	13.176	74.8
	RodB4_95.1	164	95.1	2.416	6.6	0.168	986.35	803.3	9698.91	30595.2	12.789	72.6
	RodB4_100	165	100	2.540	11.5	0.292	1025.13	824.9	10016.04	31595.6	12.565	71.4
	RodB4_106	166	106	2.692	17.5	0.445	1096.68	864.6	10396.34	32795.3	11.968	68.0
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1003.94	813.1	10075.72	31783.9	12.985	73.7
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1118.09	876.5	3908.11	12328.1	4.391	24.9
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	870.11	738.8	9148.80	28859.9	14.248	80.9
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	846.81	725.8	9333.76	29443.3	15.083	85.7
	RodF4_92.4	100	92.4	2.347	3.9	0.099	962.45	790.1	9595.25	30268.2	13.065	74.2
	RodF4_94.3	101	94.3	2.395	5.8	0.147	994.63	807.9	9718.22	30656.1	12.677	72.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1032.93	829.2	9907.38	31252.8	12.308	69.9
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1102.26	867.7	10462.38	33003.6	11.967	68.0
	RodF4_111	104	111	2.819	-1.75	-0.044	993.13	807.1	10049.37	31700.7	13.134	74.6
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1126.94	881.4	9223.43	29095.3	10.260	58.3
	RodD2_106	66	106	2.692	17.5	0.445	1150.87	894.7	8735.31	27555.5	9.465	53.8
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1169.36	905.0	8072.54	25464.8	8.575	48.7
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1169.74	905.2	7292.72	23004.9	7.744	44.0
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1157.16	898.2	6551.55	20666.9	7.051	40.0
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1123.92	879.8	10349.91	32648.8	11.552	65.6
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1148.67	893.5	10534.95	33232.5	11.443	65.0
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1076.60	853.5	9676.41	30524.2	11.403	64.8
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1114.68	874.6	10367.38	32703.9	11.692	66.4
	RodD6_106	130	106	2.692	17.5	0.445	1134.54	885.7	10558.23	33305.9	11.647	66.1
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1064.82	846.9	9654.40	30454.8	11.537	65.5
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1115.18	874.9	9252.30	29186.4	10.429	59.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1141.65	889.6	8874.44	27994.4	9.713	55.2
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1148.44	893.4	8059.83	25424.7	8.757	49.7
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1146.71	892.4	7289.78	22995.6	7.935	45.1
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1142.73	890.2	6520.61	20569.3	7.128	40.5

Table A-45: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	782.56	690.1	6837.31	21568.3	12.329	70.0
	RodE2_54	74	54	1.372	7	0.178	836.23	719.9	7097.88	22390.3	11.670	66.3
	RodE2_56.9	75	56.9	1.445	9.9	0.251	866.81	736.9	7291.81	23002.0	11.415	64.8
	RodE2_59.9	76	59.9	1.521	12.9	0.328	884.07	746.5	7492.38	23634.7	11.420	64.9
	RodE2_66	77	66	1.676	19	0.483	919.51	766.2	7900.14	24921.0	11.425	64.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	828.86	715.9	8155.79	25727.4	13.574	77.1
	RodE2_72.9	79	72.9	1.852	2.02	0.051	903.52	757.3	8362.95	26380.9	12.380	70.3
	RodE2_74.9	80	74.9	1.902	4.02	0.102	936.92	775.9	8496.14	26801.1	11.985	68.1
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	736.78	664.7	6797.95	21444.1	13.361	75.9
	RodB3_54.1	170	54.1	1.374	7.1	0.180	797.20	698.3	7055.35	22256.1	12.395	70.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	836.27	720.0	7240.61	22840.5	11.904	67.6
	RodB3_60.1	172	60.1	1.527	13.1	0.333	837.83	720.8	7452.61	23509.3	12.221	69.4
	RodB3_66.1	173	66.1	1.679	19.1	0.485	893.37	751.7	7849.65	24761.7	11.797	67.0
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	778.53	687.9	8101.75	25557.0	14.716	83.6
	RodB3_73	175	73	1.854	2.12	0.054	862.20	734.4	8306.94	26204.2	13.098	74.4
	RodB3_75	176	75	1.905	4.12	0.105	896.97	753.7	8439.31	26621.8	12.615	71.6
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	757.74	676.3	6799.88	21450.2	12.836	72.9
	RodF3_54	90	54	1.372	7	0.178	811.09	706.0	7061.66	22276.0	12.111	68.8
	RodF3_57	91	57	1.448	10	0.254	847.54	726.2	7264.60	22916.2	11.726	66.6
	RodF3_60	92	60	1.524	13	0.330	873.13	740.4	7467.86	23557.4	11.576	65.7
	RodF3_66.1	93	66.1	1.679	19.1	0.485	902.43	756.7	7881.14	24861.1	11.686	66.4
	RodF3_70	94	70	1.778	-0.88	-0.022	798.02	698.7	8143.55	25688.8	14.286	81.1
	RodF3_73	95	73	1.854	2.12	0.054	901.96	756.5	8346.60	26329.3	12.384	70.3
	RodF3_75	96	75	1.905	4.12	0.105	944.75	780.2	8482.13	26756.9	11.834	67.2
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	763.37	679.5	6796.00	21438.0	12.694	72.1
	RodE6_54.1	122	54.1	1.374	7.1	0.180	809.42	705.1	7051.21	22243.0	12.128	68.9
	RodE6_57	123	57	1.448	10	0.254	835.39	719.5	7240.89	22841.4	11.921	67.7
	RodE6_60.2	124	60.2	1.529	13.2	0.335	843.63	724.1	7450.33	23502.1	12.102	68.7
	RodE6_66.1	125	66.1	1.679	19.1	0.485	886.77	748.0	7836.38	24719.9	11.895	67.6
	RodE6_70	126	70	1.778	-0.88	-0.022	821.35	711.7	8093.60	25531.2	13.641	77.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	896.77	753.6	8296.90	26172.6	12.406	70.5
	RodE6_75	128	75	1.905	4.12	0.105	924.93	769.2	8421.41	26565.3	12.084	68.6

RBHT Steam Cooling with Droplet Injection Test SCD-4049-C

Matrix Test # 6c

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 18720 - 19140
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 110 kW
Bundle Inlet Reynolds Number: 15000
Bundle Inlet Steam Flow: 301.6 kg/hr (665 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

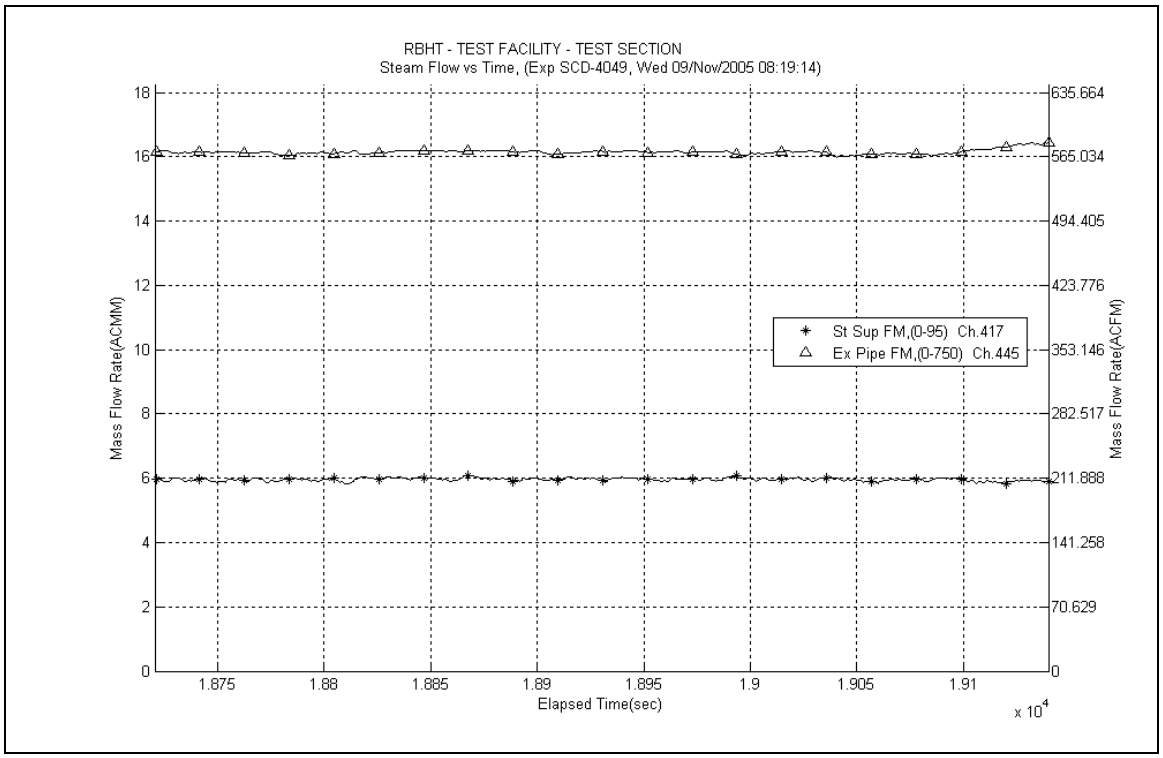

Figure A-101: Inlet and Exhaust Steam Flow Rates for Experiment 4049C

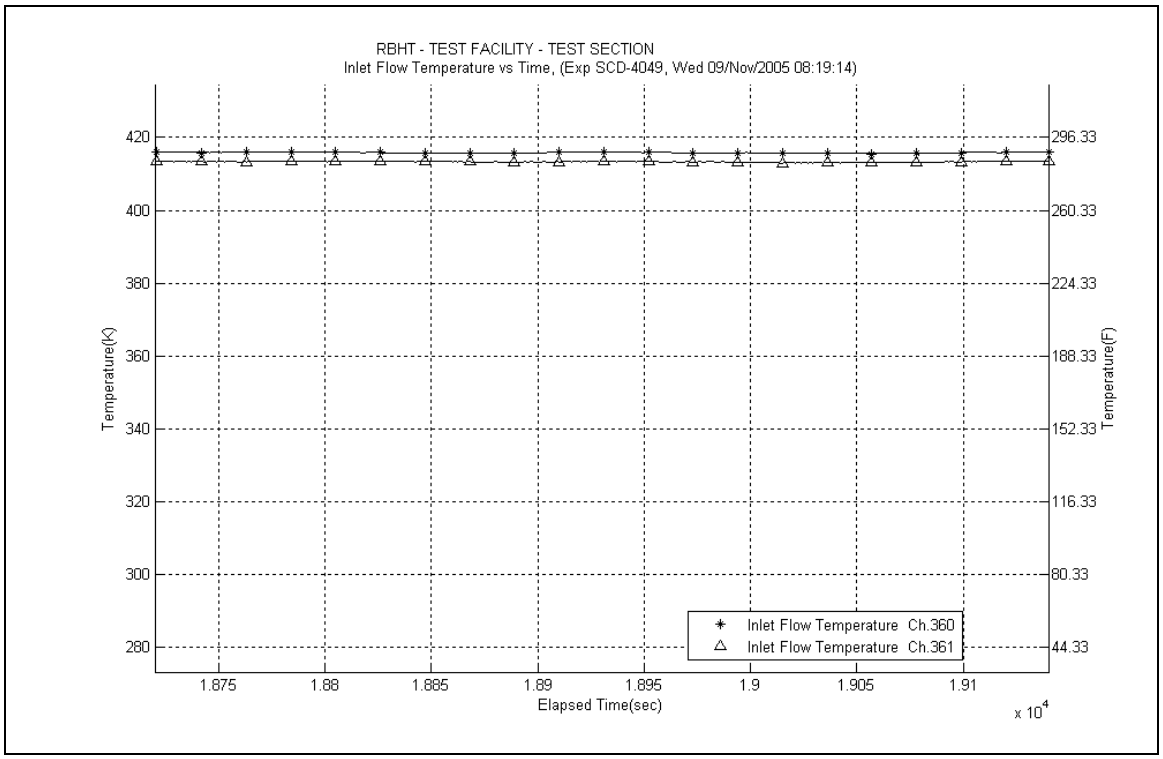

Figure A-102: Inlet Steam Temperature for Experiment 4049C

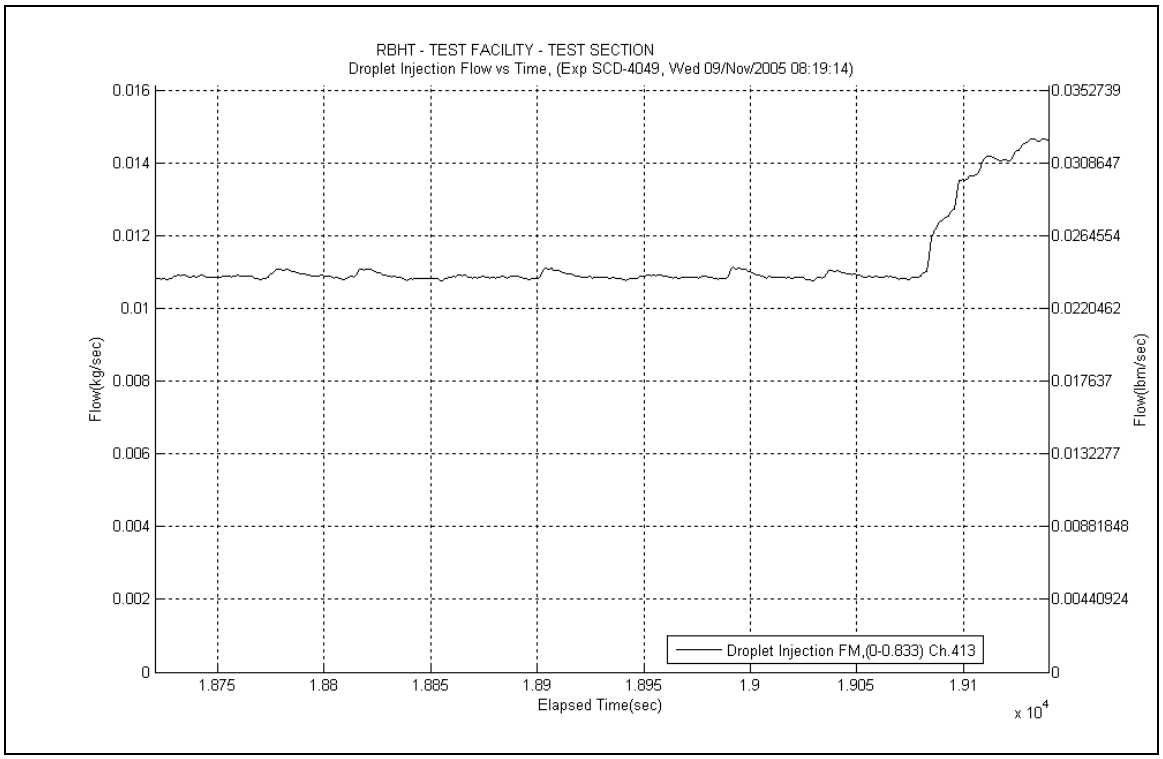

Figure A-103: Droplet Injecton Flow Rate for Experiment 4049C

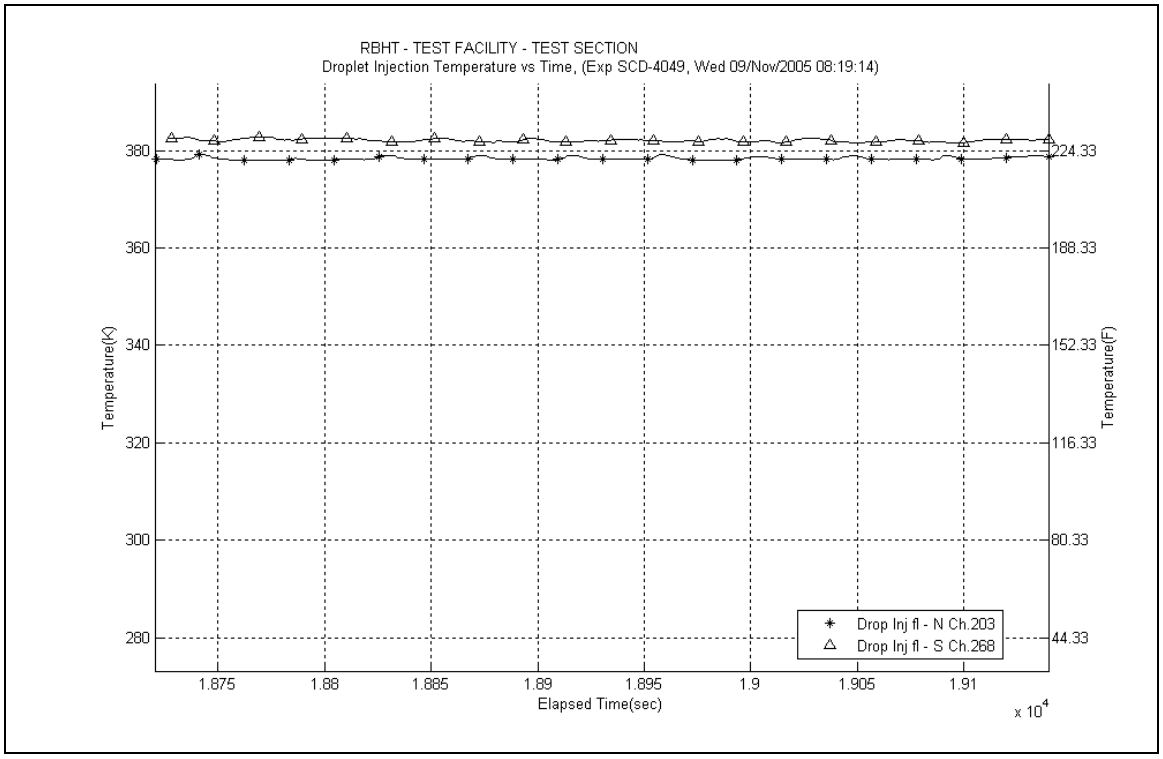

Figure A-104: Droplet Injection Temperature for Experiment 4049C

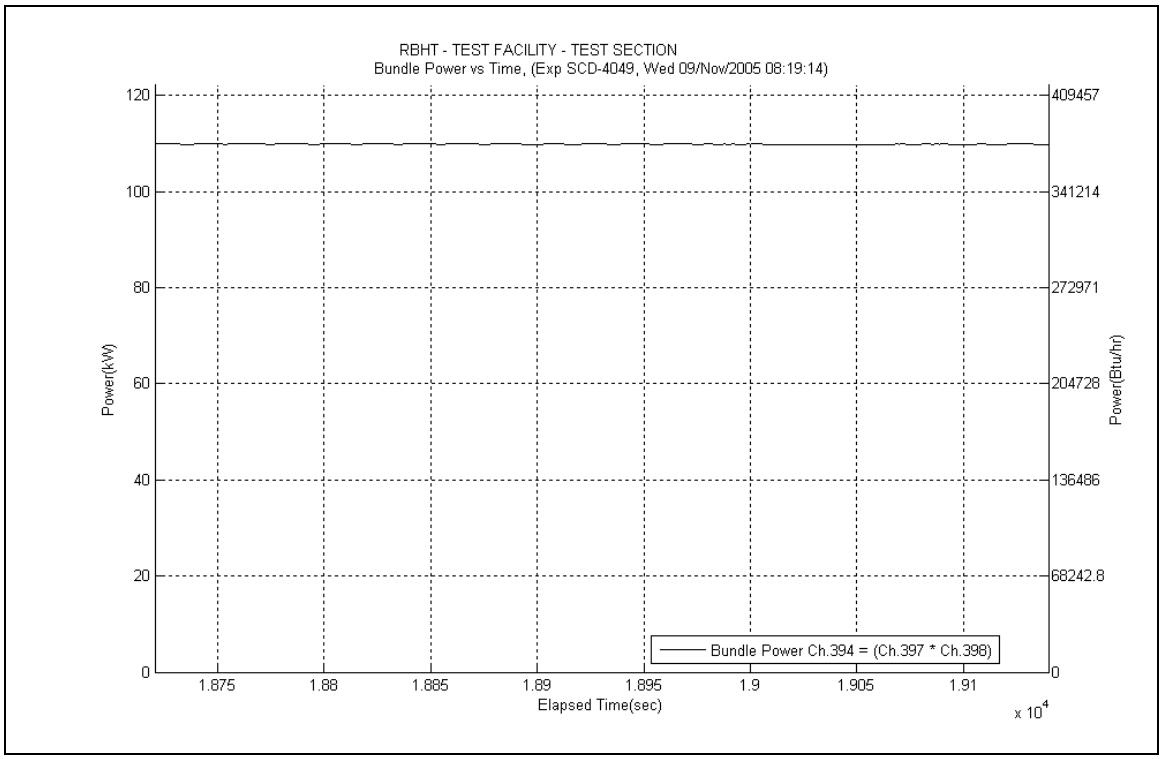

Figure A-105: Bundle Power for Experiment 4049C

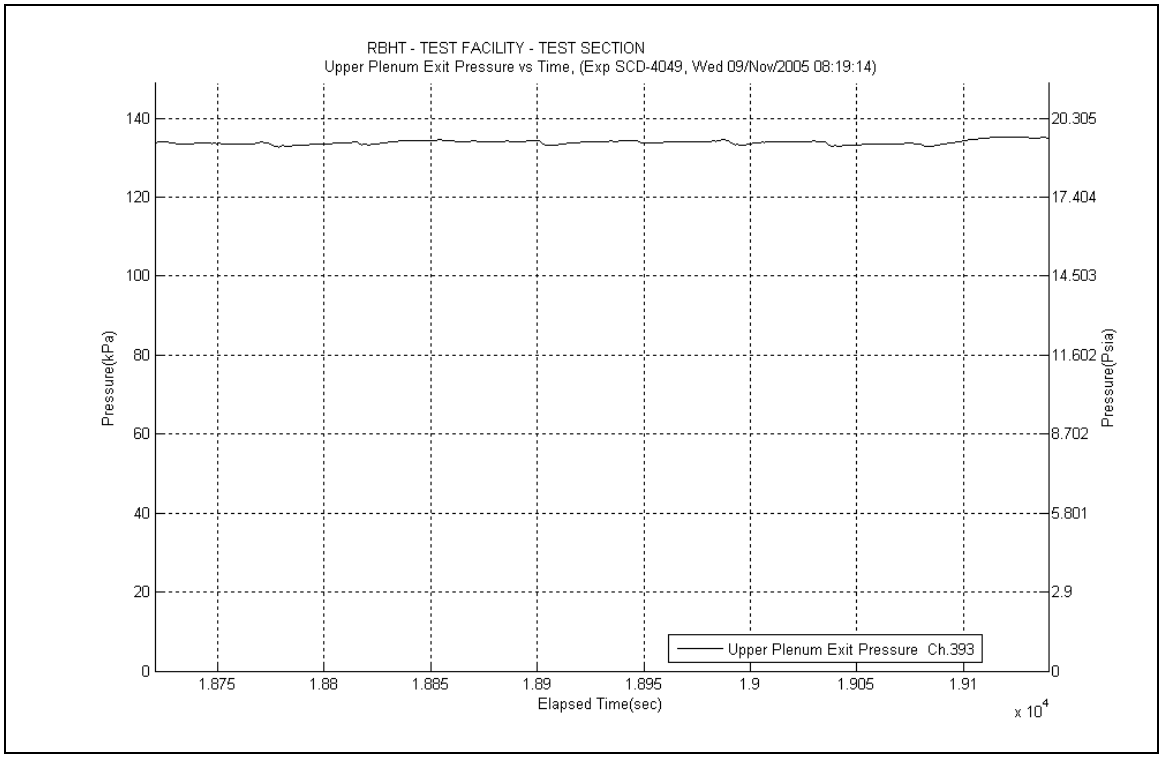

Figure A-106: Upper Plenum Pressure for Experiment 4049C

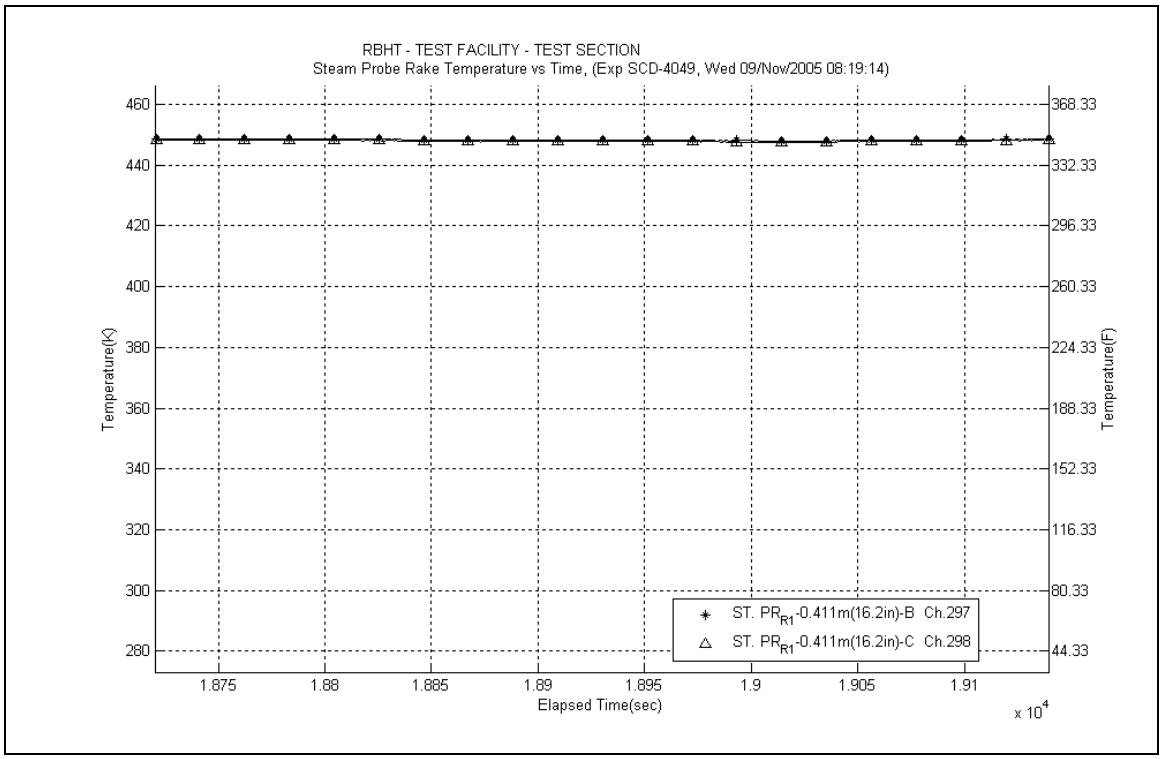

Figure A-107: Steam Probe Rake #1 Temperatures for Experiment 4049C

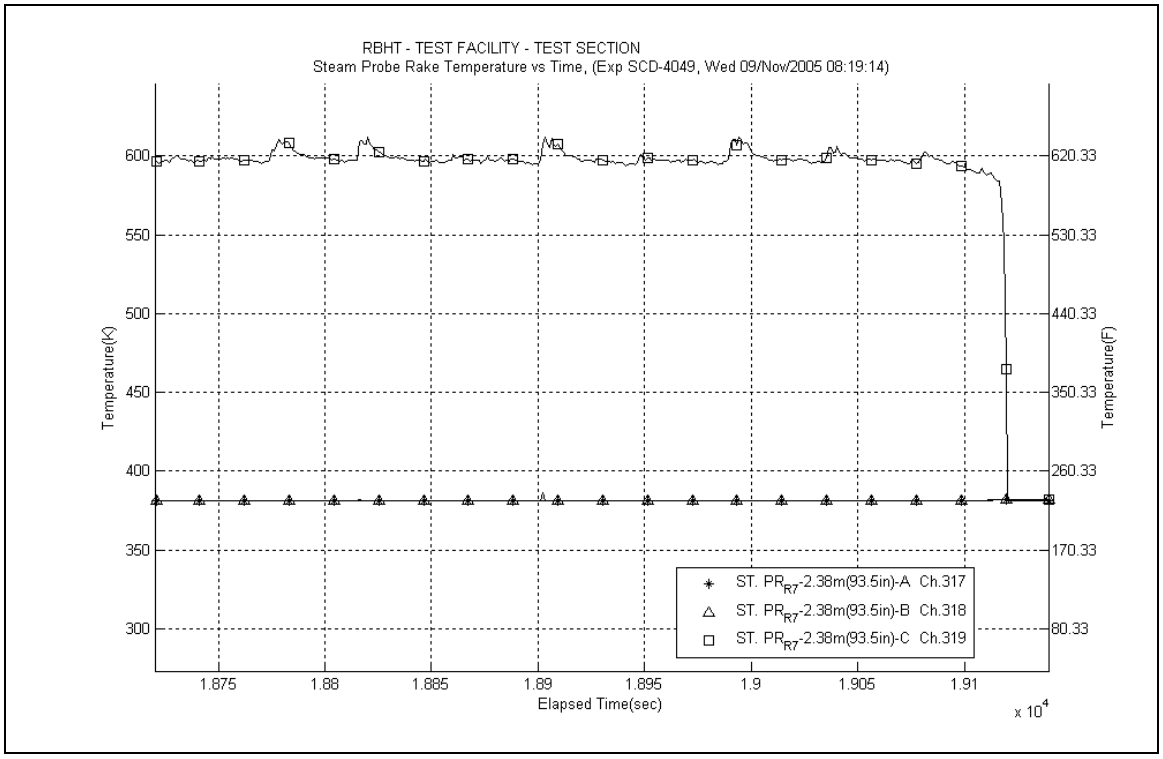

Figure A-108: Steam Probe Rake #7 Temperatures for Experiment 4049C

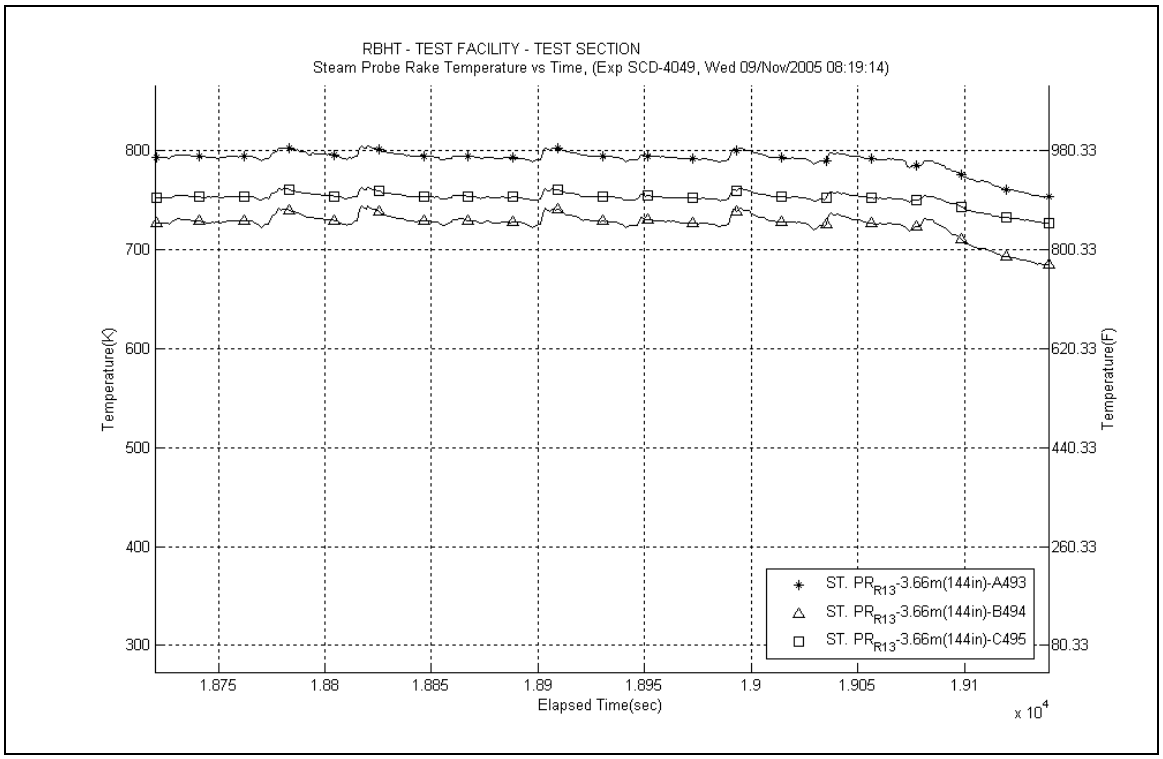

Figure A-109: Steam Probe Rake #13 Temperatures for Experiment 4049C

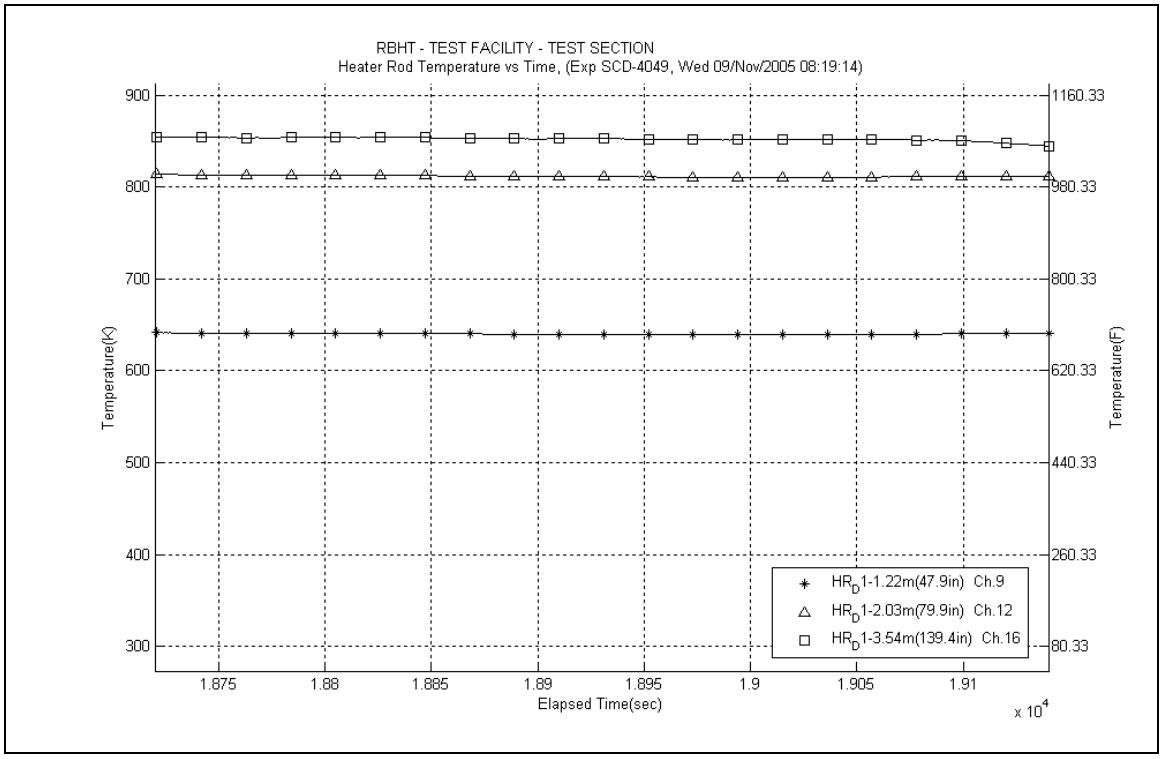

Figure A-110: Heater Rod D1 Temperatures for Experiment 4049C

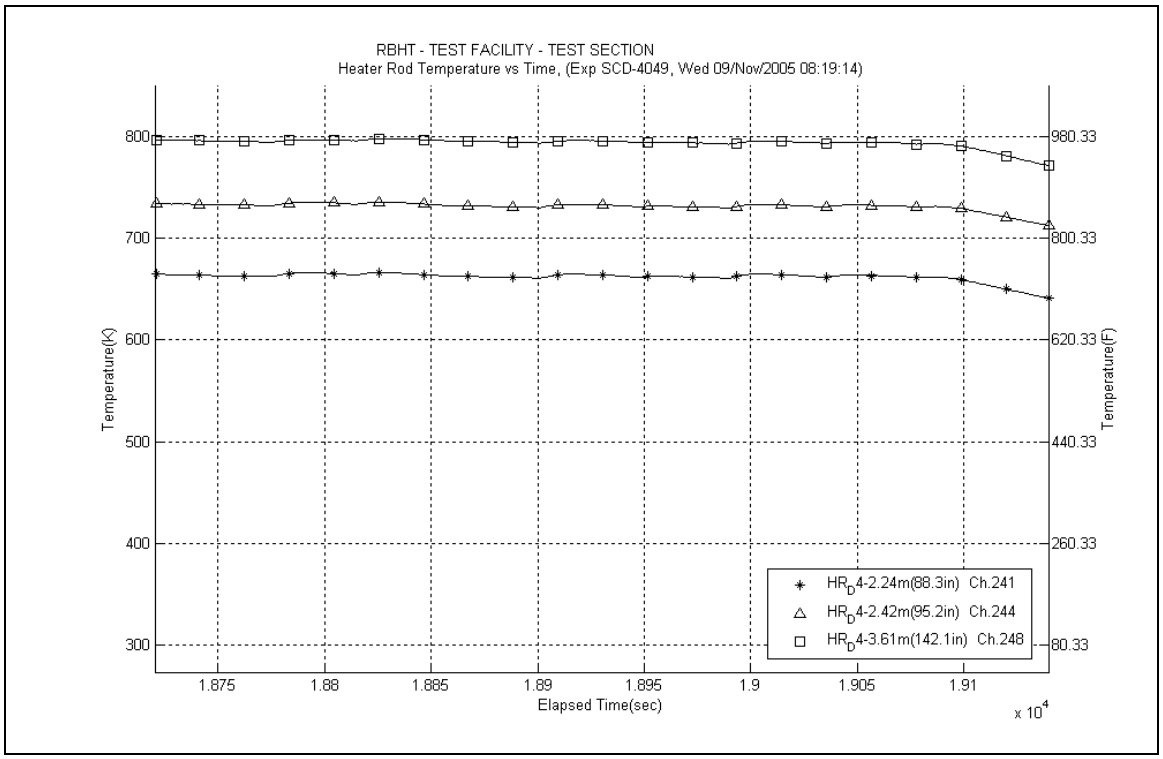

Figure A-111: Heater Rod D4 Temperatures for Experiment 4049C

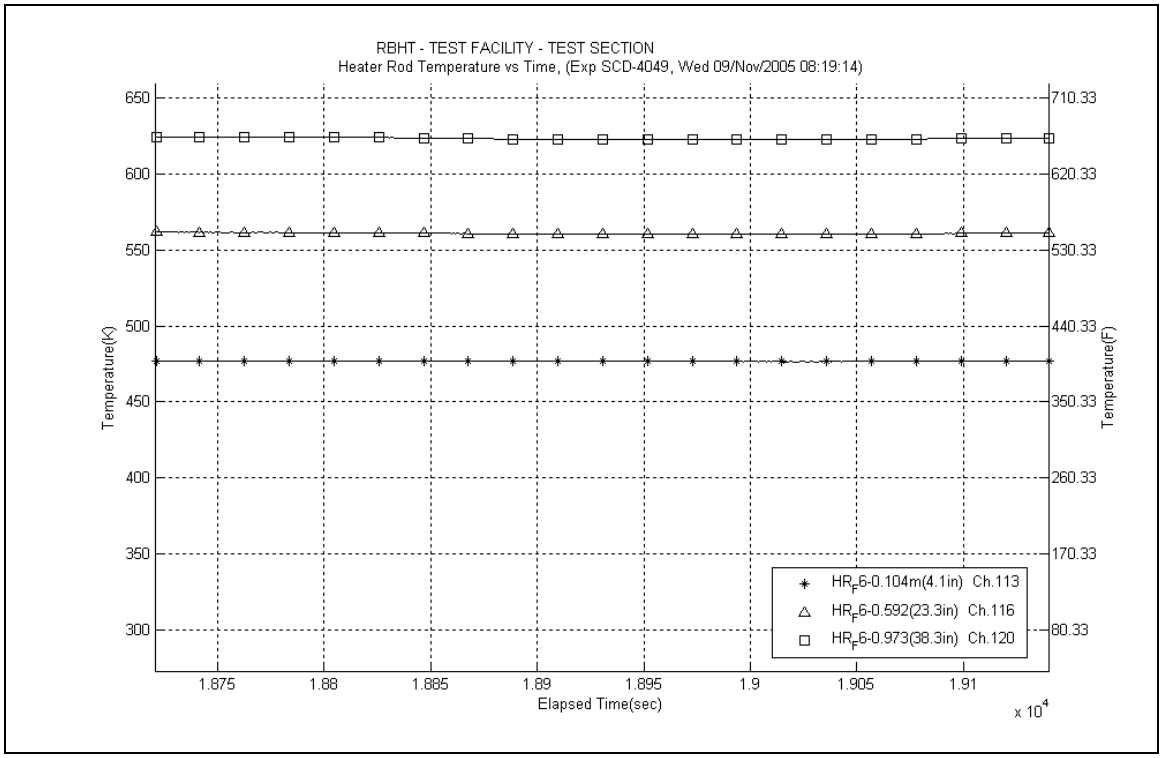

Figure A-112: Heater Rod F6 Temperatures for Experiment 4049C

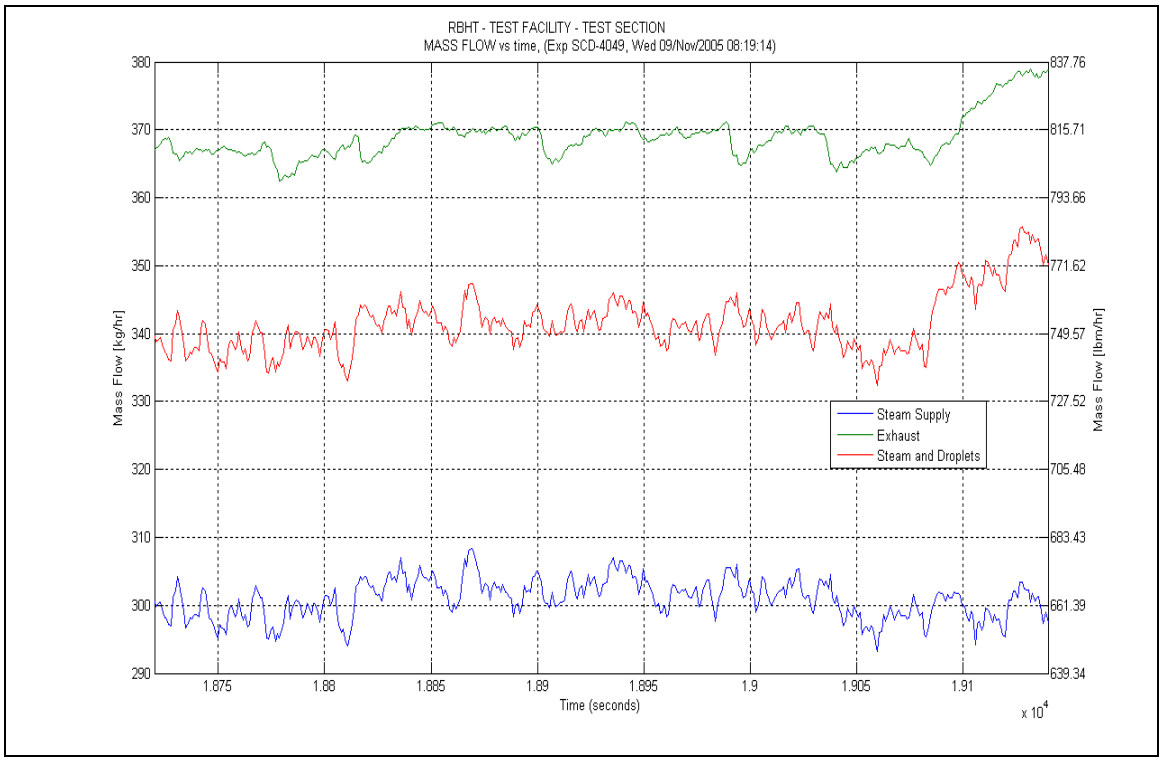

Figure A-113: Mass Flow for Experiment 4049C

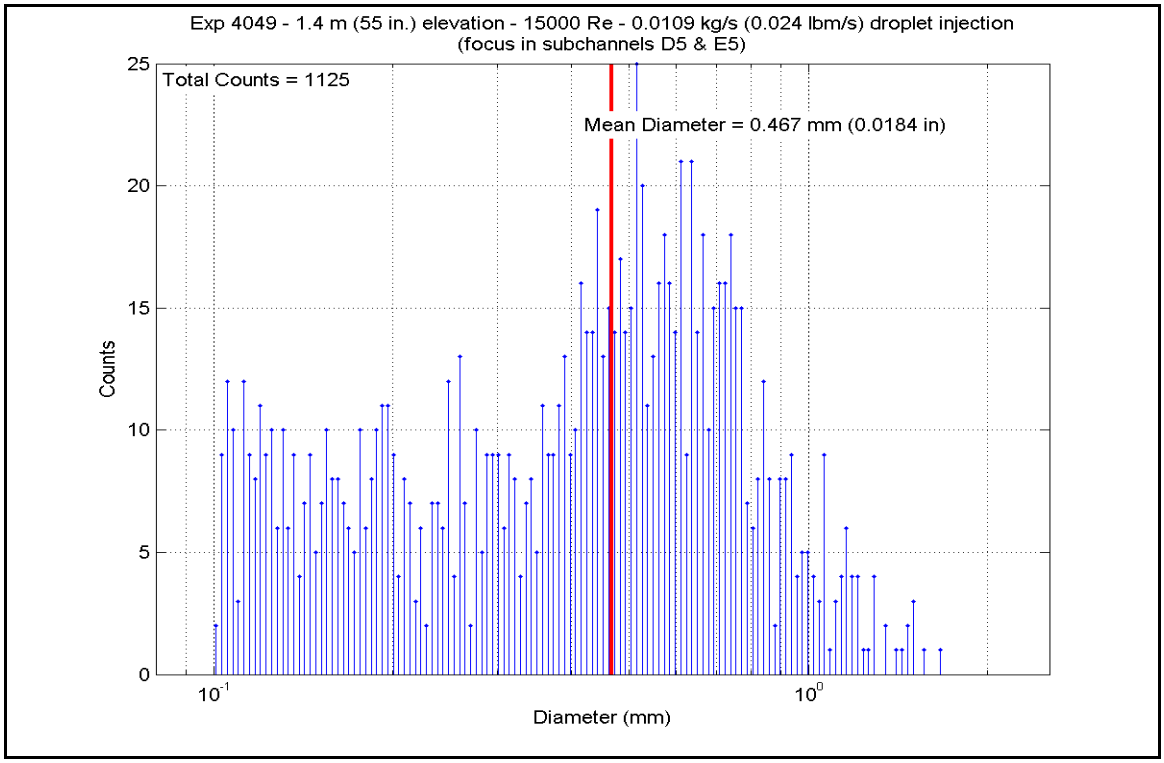

Figure A-114: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049C

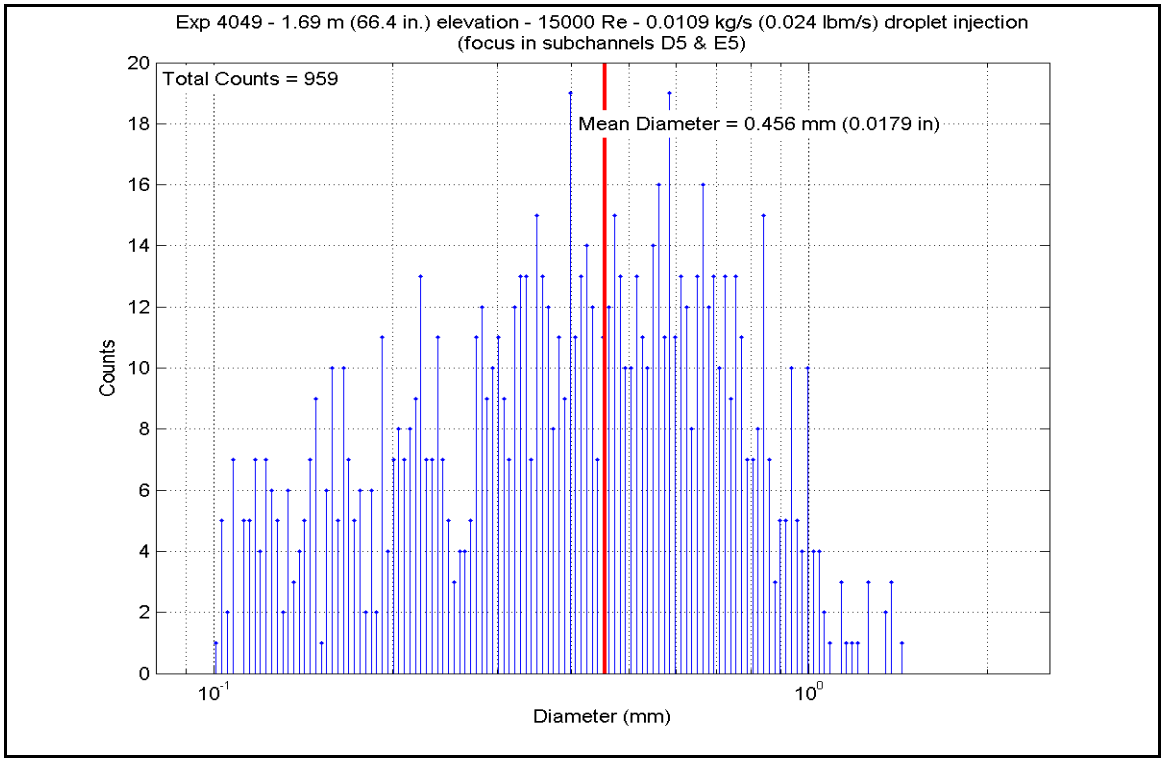

Figure A-115: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049C

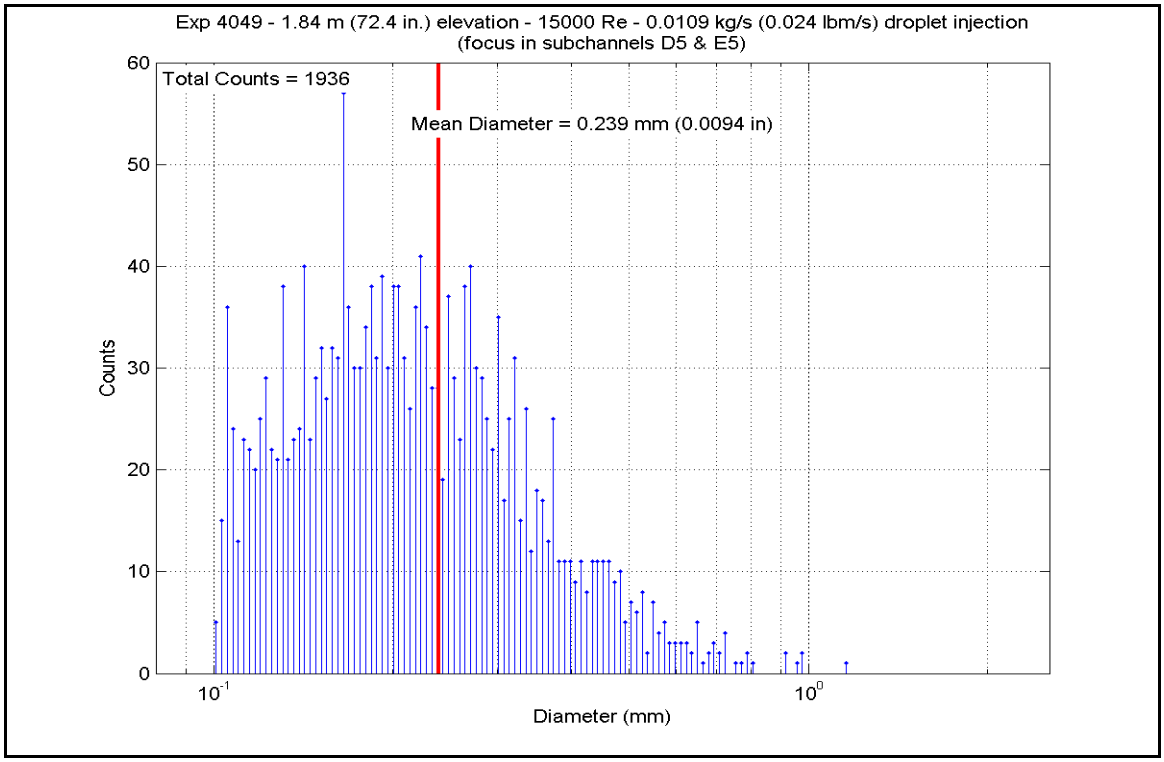

Figure A-116: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049C

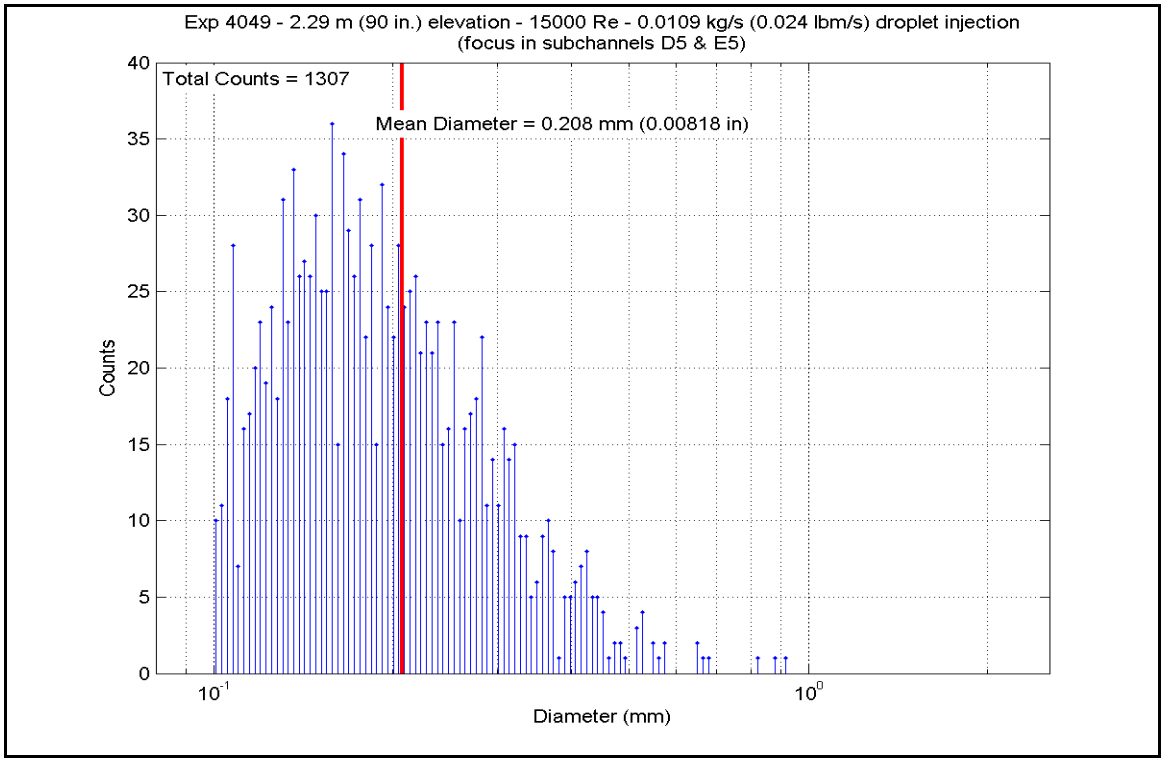

Figure A-117: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049C

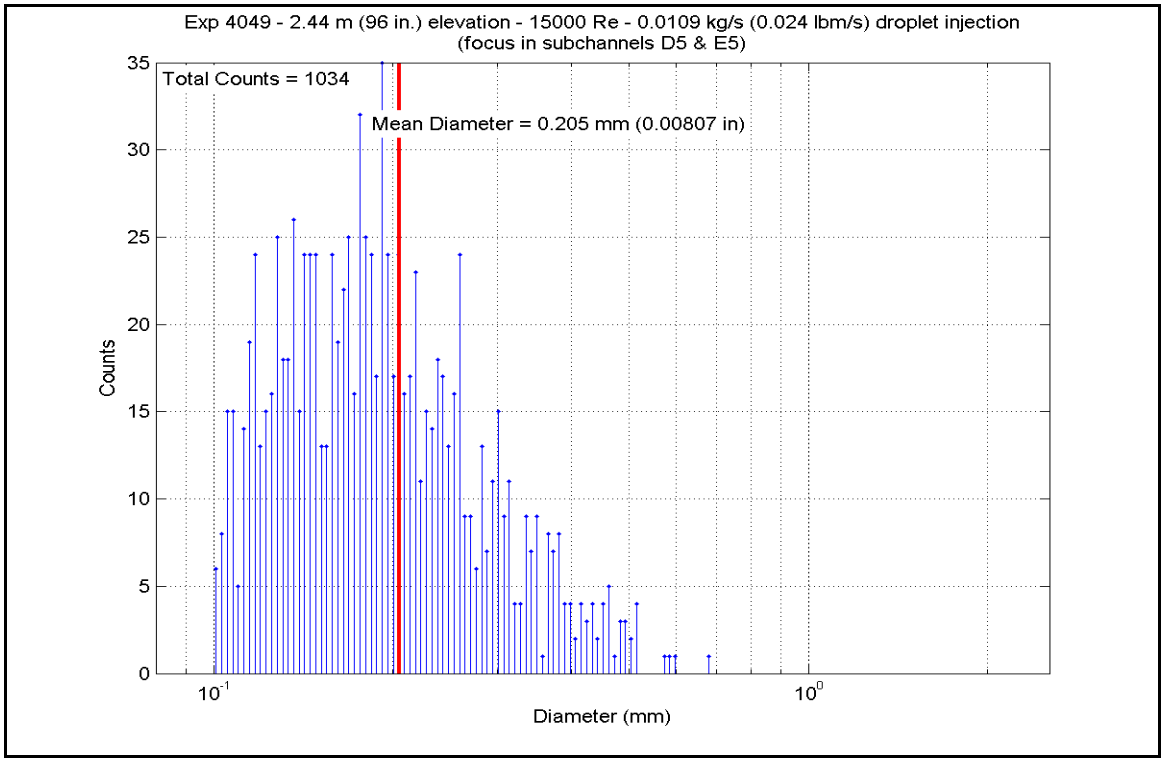

Figure A-118: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049C

Table A-46: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049C

SCD-4049-C	Inlet Reynolds:	15000		
Matrix Test # 6c	UP Pressure:	137.9 kPa	20	psia
Time Window: 18720-19140	Bundle Power:	110.00 kW	375335	Btu/hr
	Steam flow:	0.0838 kg/s	665.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	765.68	680.8	9426.60	29736.2	17.532	99.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	855.75	730.8	9630.90	30380.7	15.342	87.1
	RodD3_93.1	187	93.1	2.365	4.6	0.117	854.53	730.1	9773.67	30831.0	15.600	88.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	887.55	748.5	9916.81	31282.6	15.036	85.4
	RodD3_100.1	189	100.1	2.543	11.6	0.295	912.70	762.4	10286.94	32450.2	15.024	85.3
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1008.83	815.8	10671.42	33663.0	13.667	77.6
	RodD3_110	191	110	2.794	21.5	0.546	864.68	735.8	10633.07	33542.0	16.701	94.8
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1011.87	817.5	3759.03	11857.9	4.796	27.2
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	753.64	674.1	9518.71	30026.8	18.109	102.8
	RodC4_91.1	234	91.1	2.314	2.6	0.066	843.06	723.7	9706.89	30620.4	15.782	89.6
	RodC4_93.4	235	93.4	2.372	4.9	0.124	861.51	734.0	9868.90	31131.4	15.578	88.5
	RodC4_95.3	236	95.3	2.421	6.8	0.173	898.20	754.4	10008.34	31571.3	14.933	84.8
	RodC4_100.1	237	100.1	2.543	11.6	0.295	920.68	766.9	10331.08	32589.4	14.915	84.7
	RodC4_106.1	238	106.1	2.695	17.6	0.447	989.58	805.1	10736.07	33866.9	14.097	80.1
	RodC4_110	239	110	2.794	21.5	0.546	845.39	725.0	10462.93	33005.3	16.947	96.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	962.89	790.3	4101.42	12937.9	5.581	31.7
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	728.59	660.1	9566.84	30178.6	19.111	108.5
	RodD4_91.3	242	91.3	2.319	2.8	0.071	807.59	704.0	9758.53	30783.3	16.837	95.6
	RodD4_93.2	243	93.2	2.367	4.7	0.119	823.92	713.1	9888.97	31194.8	16.594	94.2
	RodD4_95.2	244	95.2	2.418	6.7	0.170	853.58	729.6	10021.16	31611.7	16.019	91.0
	RodD4_100.1	245	100.1	2.543	11.6	0.295	904.62	757.9	10354.57	32663.5	15.303	86.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	969.95	794.2	10757.91	33935.8	14.500	82.3
	RodD4_142.1	248	142.1	3.609	8.6	0.218	968.20	793.3	3986.27	12574.7	5.385	30.6
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	768.20	682.2	9408.13	29678.0	17.416	98.9
	RodE4_91.2	202	91.2	2.316	2.7	0.069	865.49	736.2	9564.06	30169.8	15.003	85.2
	RodE4_95.3	204	95.3	2.421	6.8	0.173	928.68	771.3	9823.18	30987.2	14.020	79.6
	RodE4_100.9	205	100.9	2.563	12.4	0.315	975.05	797.1	10200.21	32176.6	13.654	77.5
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1000.91	811.4	3984.12	12567.9	5.155	29.3

Table A-46: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	911.45	761.7	7693.19	24268.2	11.256	63.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	970.78	794.7	9655.53	30458.4	12.999	73.8
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1012.28	817.8	9267.39	29234.0	11.816	67.1
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1039.88	833.1	8707.36	27467.4	10.725	60.9
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1036.68	831.3	7929.31	25013.0	9.805	55.7
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1040.01	833.2	7219.03	22772.4	8.890	50.5
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	943.66	779.6	6339.44	19997.8	8.858	50.3
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1018.24	821.1	5533.63	17455.8	7.002	39.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	904.65	758.0	7554.19	23829.7	11.164	63.4
	RodC5_113.6	226	113.6	2.885	0.85	0.022	901.40	756.1	9404.42	29666.2	13.966	79.3
	RodC5_115.7	227	115.7	2.939	2.95	0.075	949.20	782.7	9025.39	28470.6	12.514	71.1
	RodC5_122.7	229	122.7	3.117	9.95	0.253	975.90	797.5	7786.58	24562.8	10.411	59.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	981.38	800.6	7077.73	22326.7	9.395	53.4
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	861.96	734.2	6347.48	20023.1	10.012	56.9
	RodC5_135.7	232	135.7	3.447	2.2	0.056	927.81	770.8	5562.61	17547.3	7.949	45.1
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	840.52	722.3	7732.68	24392.7	12.624	71.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	810.89	705.9	9760.72	30790.2	16.745	95.1
	RodE5_115.4	211	115.4	2.931	2.65	0.067	899.04	754.8	9389.41	29618.9	13.992	79.5
	RodE5_118.7	212	118.7	3.015	5.95	0.151	969.63	794.1	8760.08	27633.7	11.812	67.1
	RodE5_122.6	213	122.6	3.114	9.85	0.250	992.64	806.8	8040.87	25364.9	10.516	59.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	987.19	803.8	7300.46	23029.3	9.616	54.6
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1045.49	836.2	6449.22	20344.1	7.889	44.8
	RodE5_135.6	216	135.6	3.444	2.1	0.053	978.57	799.0	5744.98	18122.5	7.654	43.5
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	897.31	753.9	8781.33	27700.7	13.120	74.5
	RodC3_85.6	178	85.6	2.174	14.72	0.374	748.94	671.4	9223.80	29096.5	17.706	100.6
	RodC3_88.5	179	88.5	2.248	0	0.000	774.68	685.8	9377.32	29580.8	17.153	97.4
	RodC3_92.4	180	92.4	2.347	3.9	0.099	888.19	748.8	9627.12	30368.8	14.582	82.8
	RodC3_94.4	181	94.4	2.398	5.9	0.150	899.27	755.0	9767.79	30812.5	14.551	82.6
	RodC3_97.2	182	97.2	2.469	8.7	0.221	943.28	779.4	9965.65	31436.7	13.933	79.1
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1010.66	816.9	10528.93	33213.5	13.453	76.4
Gr-8	RodD5_50	217	50	1.270	3	0.076	793.15	696.0	6813.79	21494.1	12.057	68.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	807.15	703.8	7163.37	22596.8	12.369	70.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	841.94	723.1	7313.75	23071.2	11.913	67.7
	RodD5_60	220	60	1.524	13	0.330	860.64	733.5	7486.32	23615.6	11.833	67.2
	RodD5_66.1	221	66.1	1.679	19.1	0.485	905.11	758.2	7887.96	24882.6	11.649	66.2
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	764.12	679.9	8163.58	25752.0	15.227	86.5
	RodD5_72.9	223	72.9	1.852	2.02	0.051	837.04	720.4	8369.07	26400.2	13.741	78.0
	RodD5_74.9	224	74.9	1.902	4.02	0.102	870.86	739.2	8503.37	26823.9	13.227	75.1

Table A-46: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	716.88	653.6	6195.44	19543.5	12.673	72.0
	RodB5_52.9	154	52.9	1.344	5.9	0.150	788.79	693.6	6981.98	22024.7	12.450	70.7
	RodB5_55	155	55	1.397	8	0.203	825.80	714.1	7117.02	22450.6	11.905	67.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	853.11	729.3	7294.06	23009.1	11.668	66.3
	RodB5_64	157	64	1.626	17	0.432	896.71	753.5	7711.27	24325.2	11.531	65.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	886.36	747.8	8339.22	26306.1	12.667	71.9
	RodB5_75.9	159	75.9	1.928	5.02	0.128	911.17	761.6	8480.27	26751.0	12.413	70.5
	RodB5_76.9	160	76.9	1.953	6.02	0.153	919.92	766.4	8551.29	26975.1	12.359	70.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	699.41	643.9	6153.26	19410.4	13.053	74.1
	RodF5_53.1	106	53.1	1.349	6.1	0.155	775.50	686.2	6952.65	21932.1	12.699	72.1
	RodF5_55	107	55	1.397	8	0.203	813.19	707.1	7077.84	22327.1	12.095	68.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	848.02	726.5	7261.51	22906.4	11.712	66.5
	RodF5_64	109	64	1.626	17	0.432	884.73	746.9	7669.94	24194.8	11.679	66.3
	RodF5_73.8	110	73.8	1.875	2.92	0.074	873.50	740.7	8364.03	26384.3	12.957	73.6
	RodF5_75.8	111	75.8	1.925	4.92	0.125	902.33	756.7	8496.41	26801.9	12.600	71.6
	RodF5_76.8	112	76.8	1.951	5.92	0.150	913.33	762.8	8560.21	27003.2	12.491	70.9
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	715.18	652.7	6185.68	19512.7	12.697	72.1
	RodC2_53.1	58	53.1	1.349	6.1	0.155	830.67	716.9	6987.83	22043.1	11.595	65.8
	RodC2_55	59	55	1.397	8	0.203	840.78	722.5	7113.10	22438.3	11.608	65.9
	RodC2_57.8	60	57.8	1.468	10.8	0.274	861.33	733.9	7298.00	23021.5	11.523	65.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	888.81	749.2	7699.56	24288.3	11.652	66.2
	RodC2_73.8	62	73.8	1.875	2.92	0.074	904.15	757.7	8354.37	26353.8	12.356	70.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	927.52	770.7	8488.14	26775.8	12.134	68.9
	RodC2_76.8	64	76.8	1.951	5.92	0.150	936.40	775.6	8555.93	26989.7	12.078	68.6
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	705.07	647.1	6154.42	19414.1	12.900	73.3
	RodC6_52.8	138	52.8	1.341	5.8	0.147	831.57	717.4	6976.27	22006.7	11.558	65.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	842.42	723.4	7115.38	22445.5	11.581	65.8
	RodC6_57.8	140	57.8	1.468	10.8	0.274	871.80	739.7	7320.89	23093.8	11.371	64.6
	RodC6_63.8	141	63.8	1.621	16.8	0.427	903.74	757.4	7735.41	24401.3	11.447	65.0
	RodC6_73.7	142	73.7	1.872	2.82	0.072	934.66	774.6	8434.00	26605.0	11.935	67.8
	RodC6_75.8	143	75.8	1.925	4.92	0.125	956.01	786.5	8579.32	27063.5	11.785	66.9
	RodC6_76.8	144	76.8	1.951	5.92	0.150	969.96	794.2	8649.82	27285.9	11.658	66.2

Table A-46: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	788.34	693.3	9301.93	29342.9	16.601	94.3
	RodB4_91.3	162	91.3	2.319	2.8	0.071	880.74	744.7	9487.40	29928.0	14.535	82.5
	RodB4_93.3	163	93.3	2.370	4.8	0.122	895.52	752.9	9620.67	30348.4	14.412	81.8
	RodB4_95.1	164	95.1	2.416	6.6	0.168	924.66	769.1	9735.77	30711.5	13.975	79.4
	RodB4_100	165	100	2.540	11.5	0.292	962.59	790.1	10055.54	31720.2	13.689	77.7
	RodB4_106	166	106	2.692	17.5	0.445	1040.23	833.3	10432.33	32908.8	12.844	72.9
	RodB4_109.9	167	109.9	2.791	21.4	0.544	923.52	768.4	10146.00	32005.6	14.588	82.8
	RodB4_142.3	168	142.3	3.614	8.8	0.224	987.30	803.9	4014.10	12662.5	5.287	30.0
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	864.37	735.6	9295.67	29323.2	14.607	83.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	831.59	717.4	9459.12	29838.8	15.672	89.0
	RodF4_92.4	100	92.4	2.347	3.9	0.099	931.71	773.0	9702.25	30605.8	13.787	78.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	961.91	789.8	9822.78	30985.9	13.384	76.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	996.71	809.1	10014.27	31590.0	13.027	74.0
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1056.45	842.3	10585.89	33393.2	12.778	72.6
	RodF4_111	104	111	2.819	-1.75	-0.044	927.84	770.8	10299.50	32489.8	14.717	83.6
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1031.03	828.2	9337.88	29456.3	11.628	66.0
	RodD2_106	66	106	2.692	17.5	0.445	1053.72	840.8	8849.51	27915.8	10.717	60.9
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1067.17	848.2	8199.04	25863.9	9.770	55.5
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1066.47	847.9	7419.91	23406.1	8.849	50.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1050.84	839.2	6680.97	21075.1	8.119	46.1
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1070.40	850.0	10402.60	32815.0	12.349	70.1
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1094.69	863.5	10588.86	33402.5	12.218	69.4
	RodD2_128.6	72	128.6	3.266	15.85	0.403	985.82	803.1	9811.62	30950.8	12.947	73.5
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1060.25	844.4	10436.87	32923.1	12.541	71.2
	RodD6_106	130	106	2.692	17.5	0.445	1076.18	853.2	10634.37	33546.1	12.538	71.2
	RodD6_112.9	131	112.9	2.868	0.15	0.004	949.95	783.1	9841.86	31046.2	13.632	77.4
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1004.60	813.5	9400.33	29653.3	12.104	68.7
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1033.80	829.7	9006.49	28411.0	11.177	63.5
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1036.18	831.0	8182.93	25813.1	10.125	57.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1039.25	832.7	7405.01	23359.1	9.128	51.8
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1035.32	830.5	6638.52	20941.2	8.223	46.7

Table A-46: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	782.29	690.0	6836.32	21565.2	12.334	70.0
	RodE2_54	74	54	1.372	7	0.178	835.79	719.7	7097.66	22389.6	11.678	66.3
	RodE2_56.9	75	56.9	1.445	9.9	0.251	866.59	736.8	7290.90	22999.1	11.417	64.8
	RodE2_59.9	76	59.9	1.521	12.9	0.328	883.36	746.1	7491.22	23631.0	11.431	64.9
	RodE2_66	77	66	1.676	19	0.483	918.13	765.4	7898.62	24916.2	11.445	65.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	825.09	713.8	8132.25	25653.2	13.620	77.3
	RodE2_72.9	79	72.9	1.852	2.02	0.051	899.51	755.1	8341.85	26314.4	12.423	70.5
	RodE2_74.9	80	74.9	1.902	4.02	0.102	933.63	774.1	8483.98	26762.7	12.023	68.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	733.61	662.9	6792.51	21427.0	13.434	76.3
	RodB3_54.1	170	54.1	1.374	7.1	0.180	804.93	702.6	7047.42	22231.1	12.215	69.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	839.54	721.8	7226.28	22795.3	11.817	67.1
	RodB3_60.1	172	60.1	1.527	13.1	0.333	836.56	720.1	7433.61	23449.3	12.215	69.4
	RodB3_66.1	173	66.1	1.679	19.1	0.485	888.02	748.7	7840.43	24732.6	11.879	67.5
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	773.61	685.2	8066.04	25444.3	14.784	84.0
	RodB3_73	175	73	1.854	2.12	0.054	853.05	729.3	8284.33	26132.9	13.254	75.3
	RodB3_75	176	75	1.905	4.12	0.105	887.31	748.3	8424.95	26576.5	12.778	72.6
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	754.98	674.8	6799.33	21448.5	12.903	73.3
	RodF3_54	90	54	1.372	7	0.178	819.42	710.6	7058.64	22266.5	11.935	67.8
	RodF3_57	91	57	1.448	10	0.254	857.06	731.5	7249.33	22868.0	11.524	65.4
	RodF3_60	92	60	1.524	13	0.330	879.24	743.8	7447.60	23493.5	11.436	64.9
	RodF3_66.1	93	66.1	1.679	19.1	0.485	902.07	756.5	7864.89	24809.8	11.668	66.3
	RodF3_70	94	70	1.778	-0.88	-0.022	812.86	707.0	8086.18	25507.8	13.826	78.5
	RodF3_73	95	73	1.854	2.12	0.054	914.70	763.5	8330.33	26278.0	12.131	68.9
	RodF3_75	96	75	1.905	4.12	0.105	953.07	784.9	8481.80	26755.8	11.698	66.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	763.08	679.3	6791.35	21423.3	12.692	72.1
	RodE6_54.1	122	54.1	1.374	7.1	0.180	807.93	704.2	7048.97	22236.0	12.155	69.0
	RodE6_57	123	57	1.448	10	0.254	834.12	718.8	7238.08	22832.5	11.942	67.8
	RodE6_60.2	124	60.2	1.529	13.2	0.335	842.89	723.6	7446.89	23491.2	12.111	68.8
	RodE6_66.1	125	66.1	1.679	19.1	0.485	885.91	747.5	7832.99	24709.2	11.906	67.6
	RodE6_70	126	70	1.778	-0.88	-0.022	811.98	706.5	8103.41	25562.2	13.876	78.8
	RodE6_73.1	127	73.1	1.857	2.22	0.056	879.41	743.9	8322.24	26252.5	12.776	72.6
	RodE6_75	128	75	1.905	4.12	0.105	906.09	758.8	8448.15	26649.7	12.459	70.8

RBHT Steam Cooling with Droplet Injection Test SCD-4049-D

Matrix Test # 6d

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 19440 - 20040
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 110 kW
Bundle Inlet Reynolds Number: 15000
Bundle Inlet Steam Flow: 301.6 kg/hr (665 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

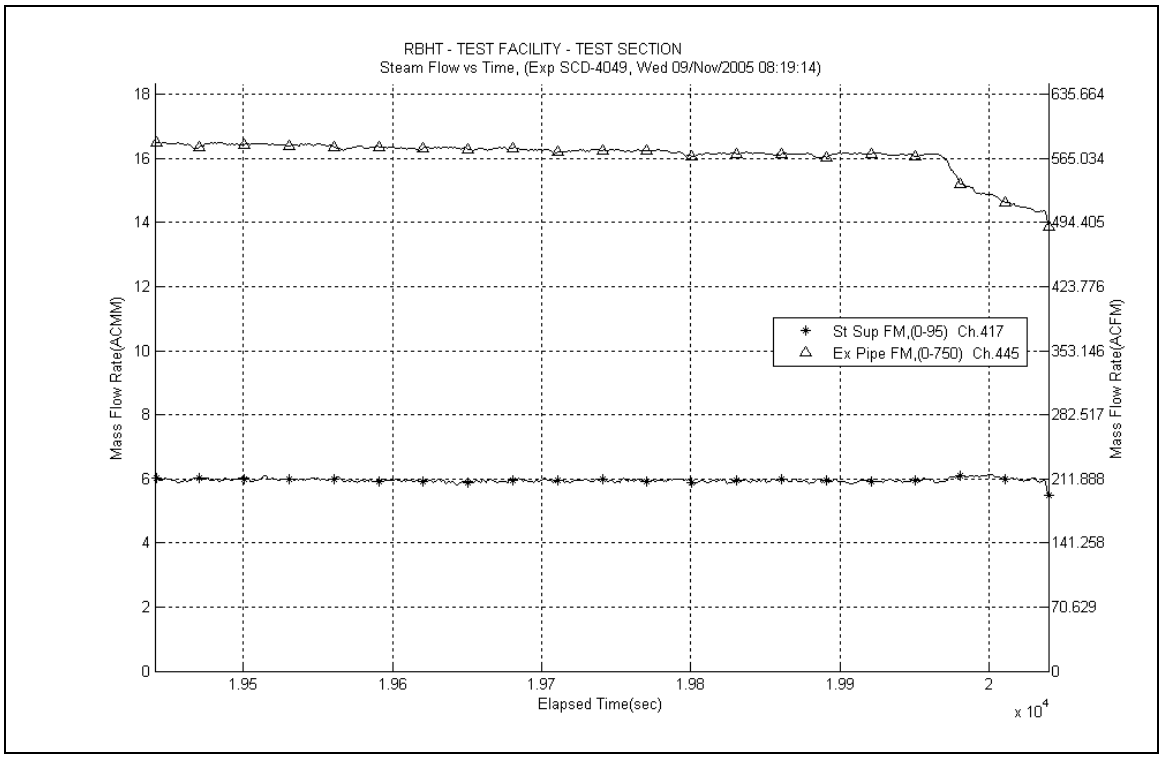

Figure A-119: Inlet and Exhaust Steam Flow Rates for Experiment 4049D

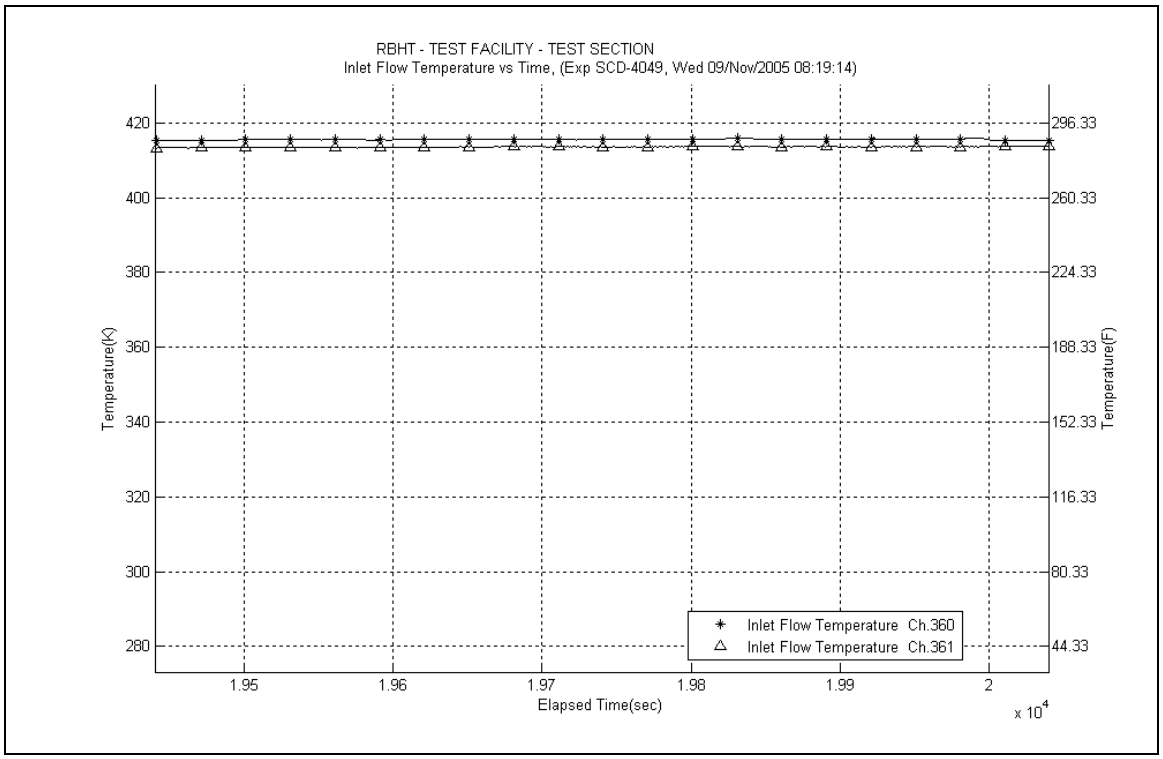

Figure A-120: Inlet Steam Temperature for Experiment 4049D

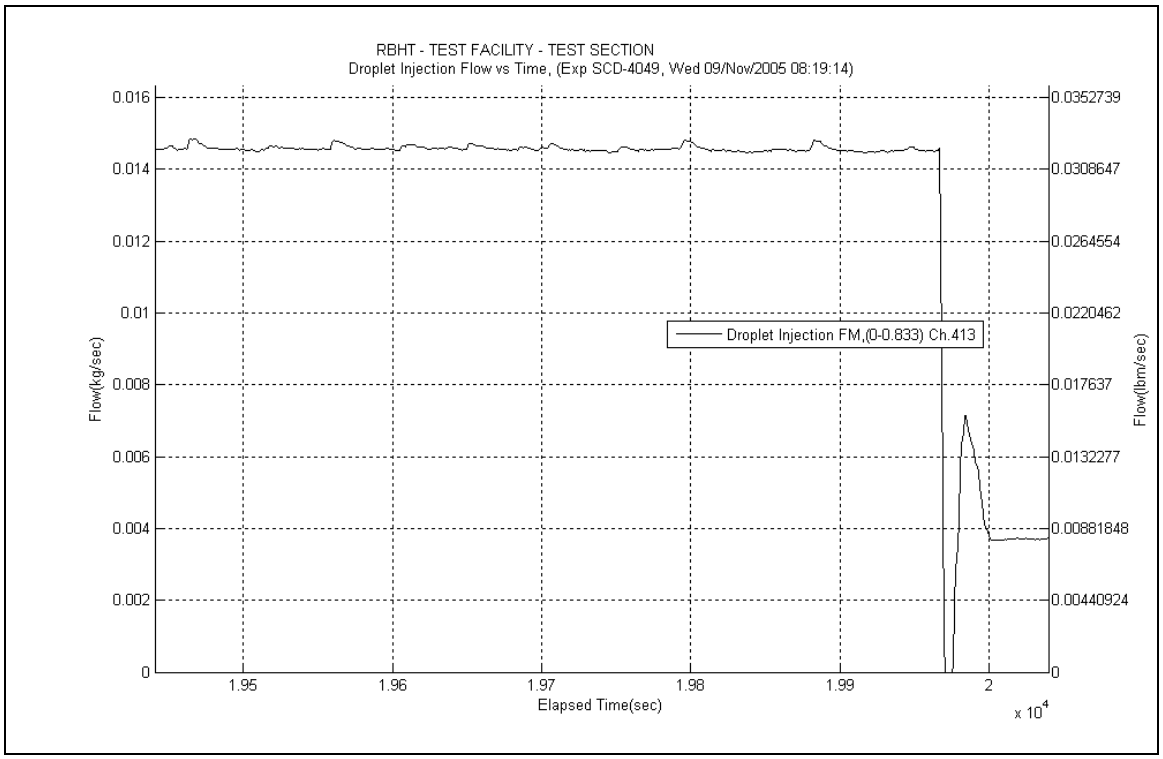

Figure A-121: Droplet Injection Flow Rate for Experiment 4049D

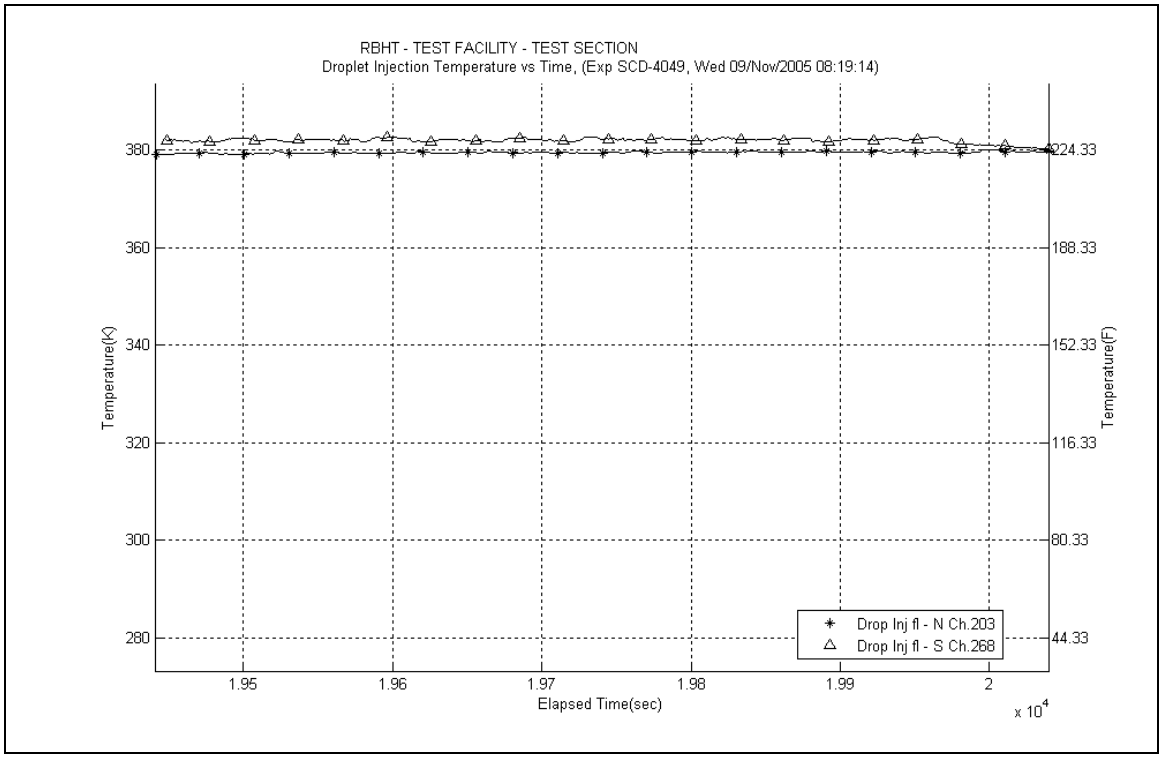

Figure A-122: Droplet Injection Temperature for Experiment 4049D

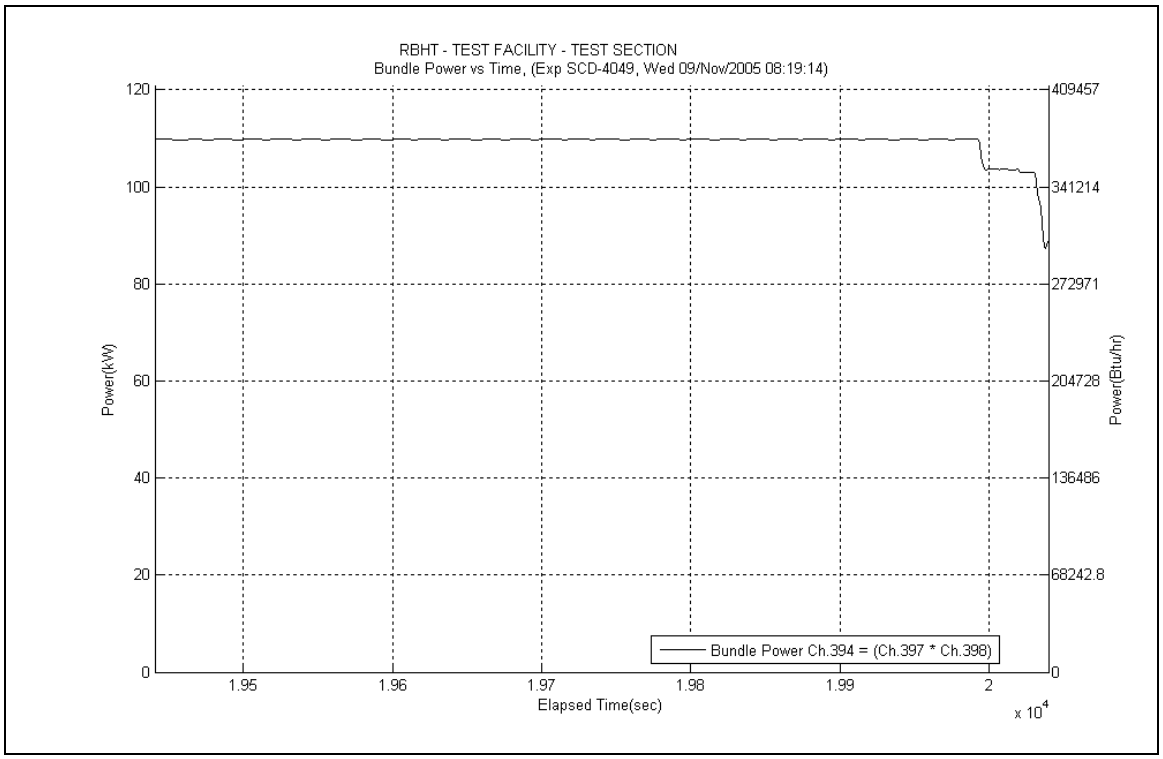

Figure A-123: Bundle Power for Experiment 4049D

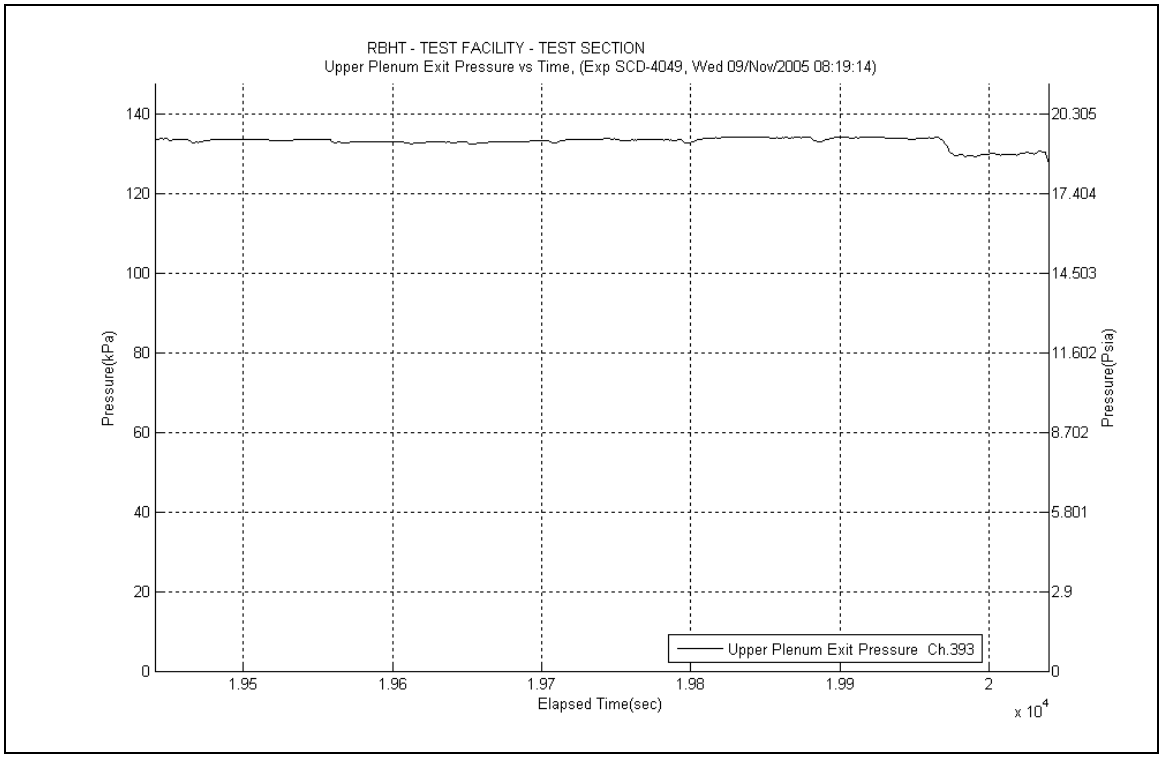

Figure A-124: Upper Plenum Pressure for Experiment 4049D

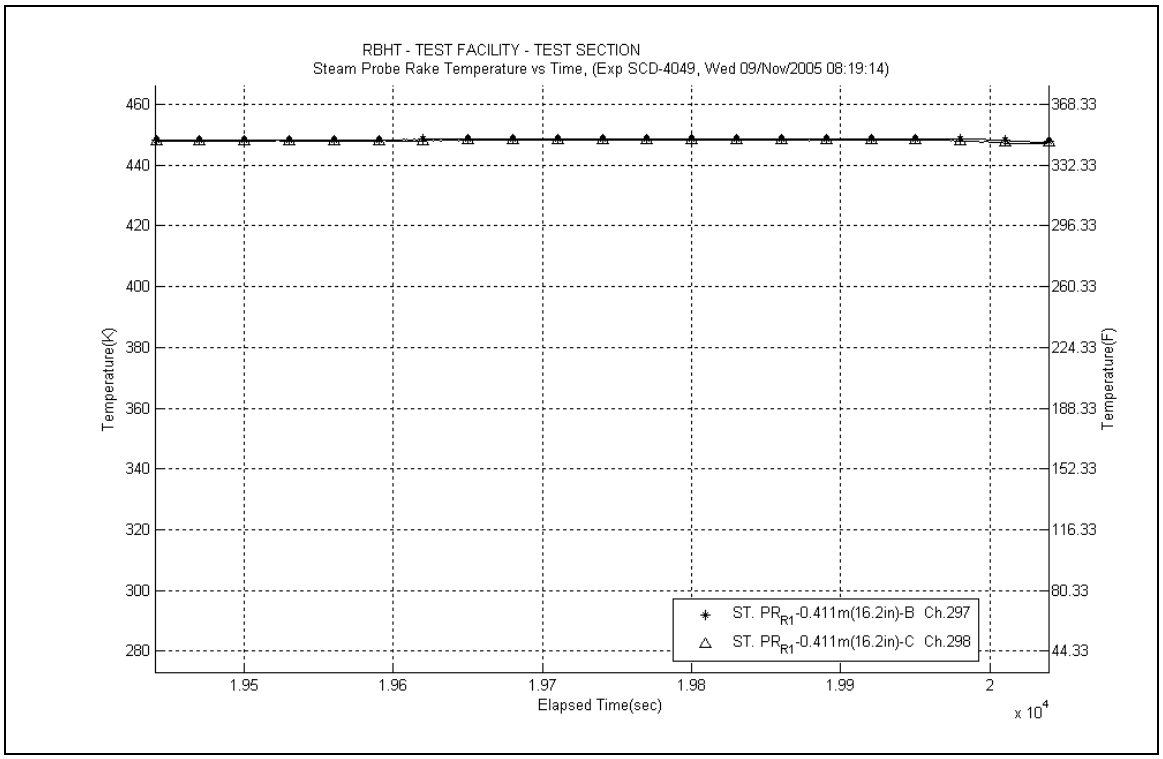

Figure A-125: Steam Probe Rake #1 Temperatures for Experiment 4049D

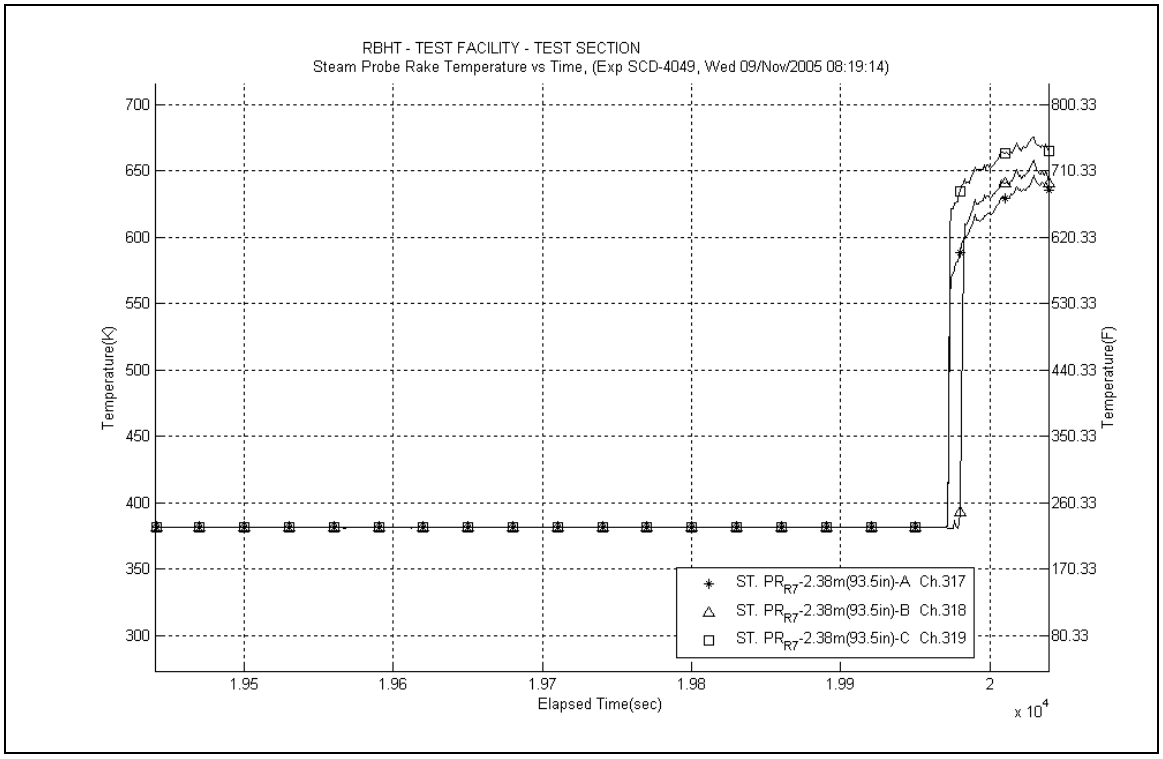

Figure A-126: Steam Probe Rake #7 Temperatures for Experiment 4049D

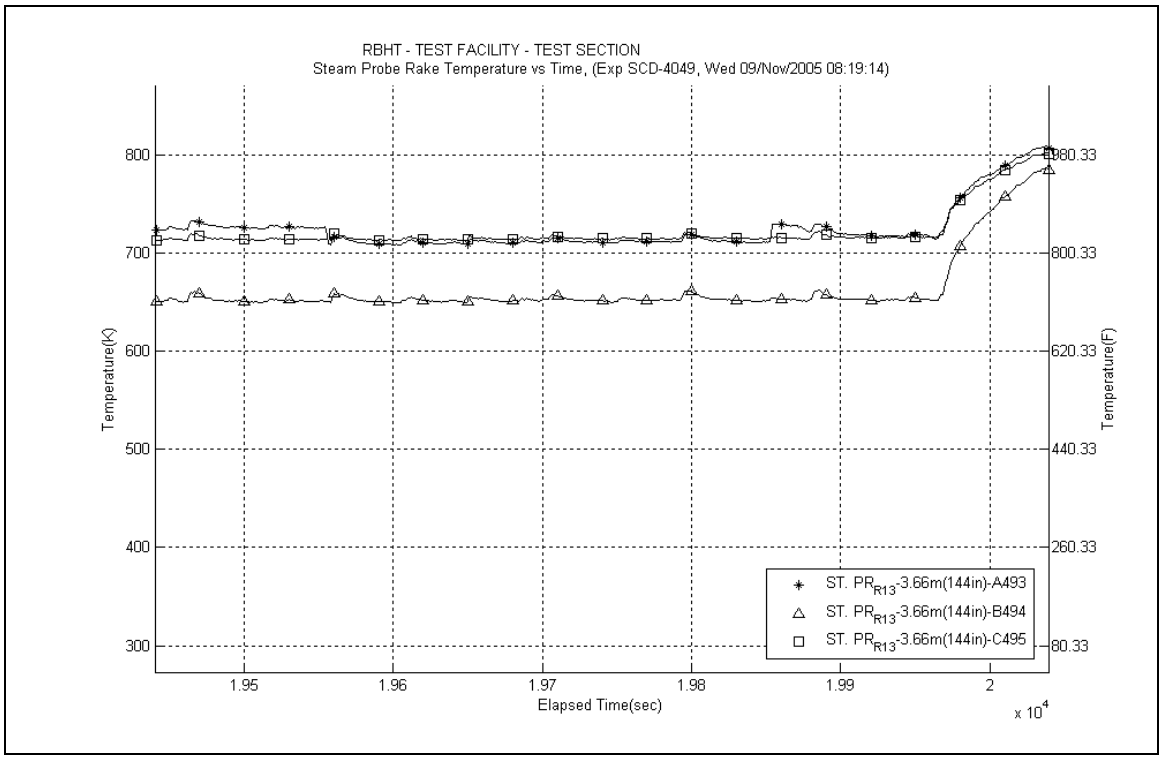

Figure A-127: Steam Probe Rake #13 Temperatures for Experiment 4049D

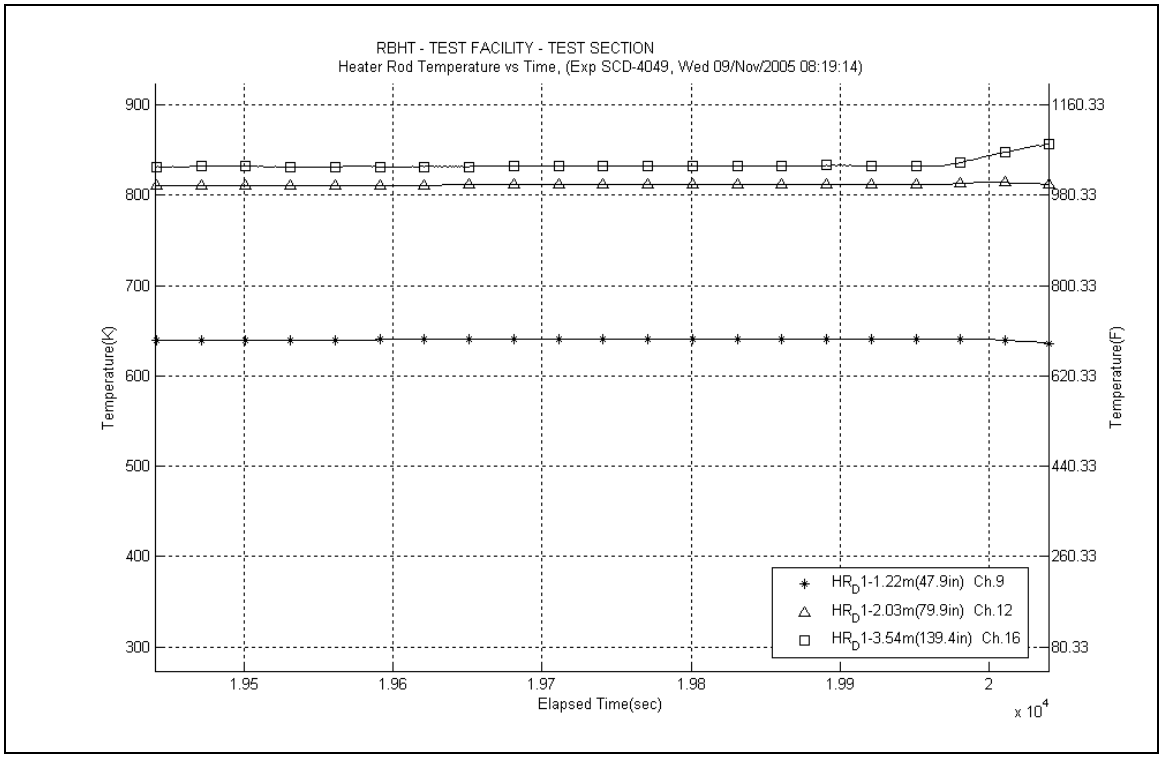

Figure A-128: Heater Rod D1 Temperatures for Experiment 4049D

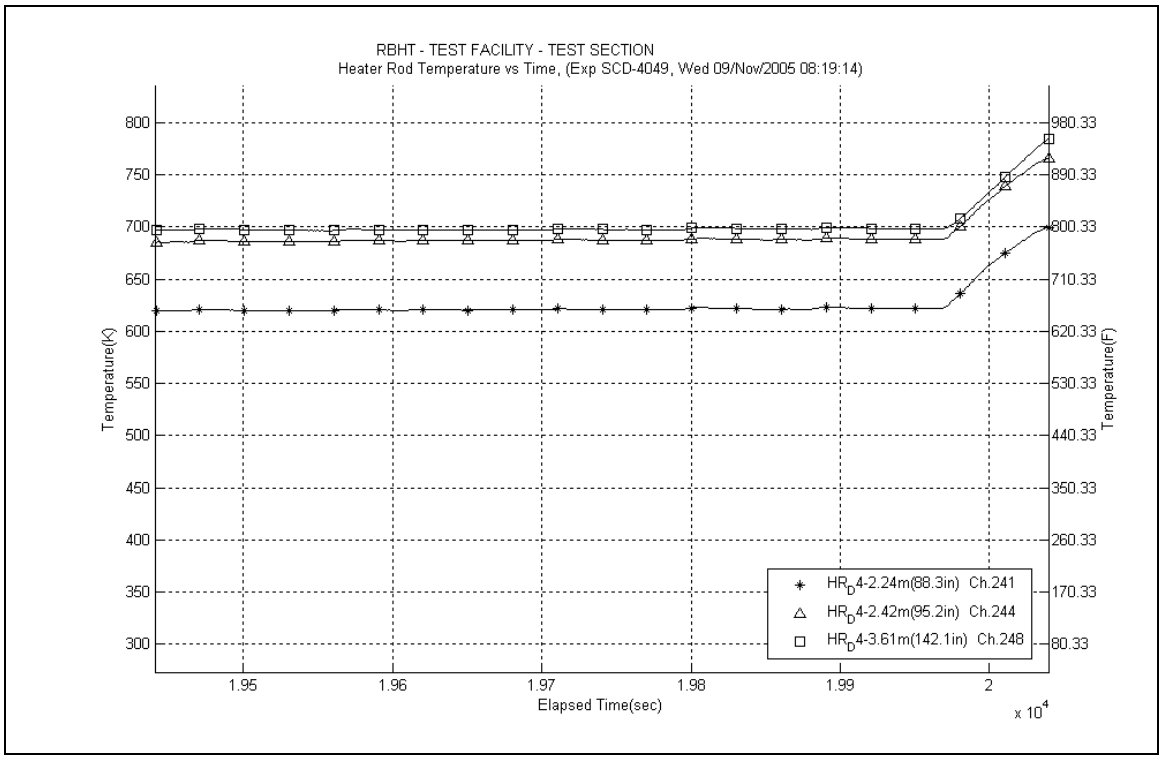

Figure A-129: Heater Rod D4 Temperatures for Experiment 4049D

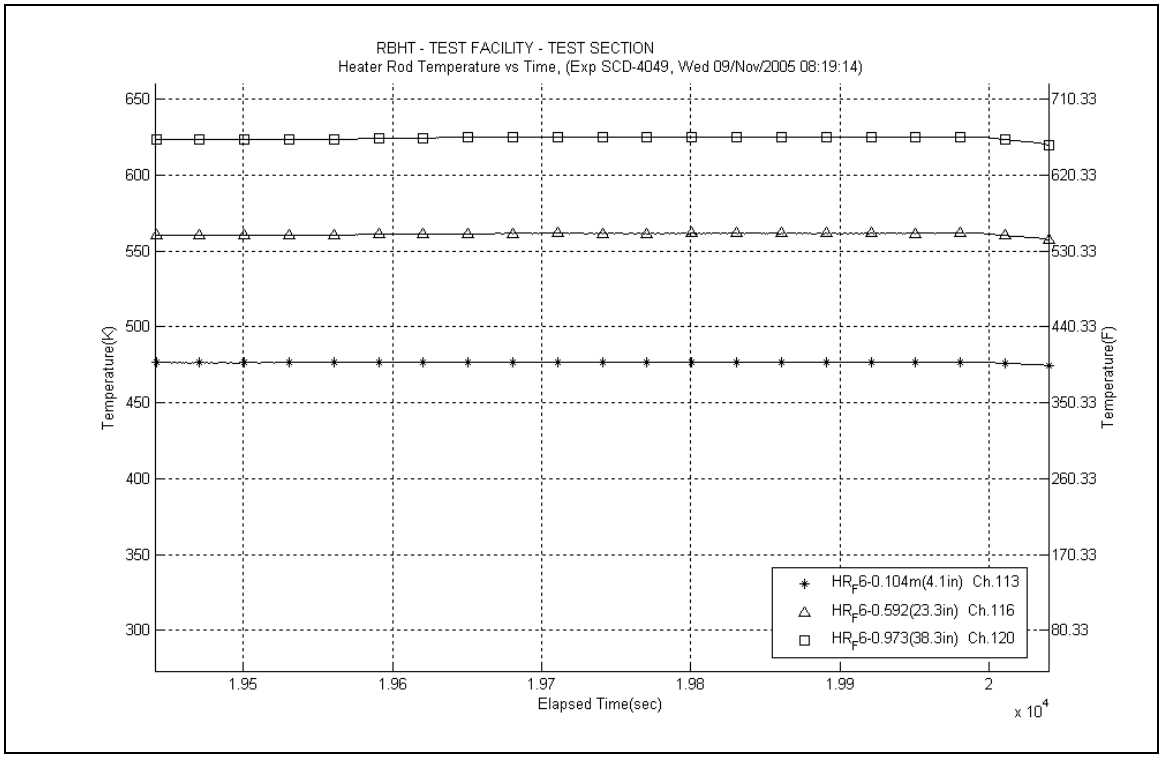

Figure A-130: Heater Rod F6 Temperatures for Experiment 4049D

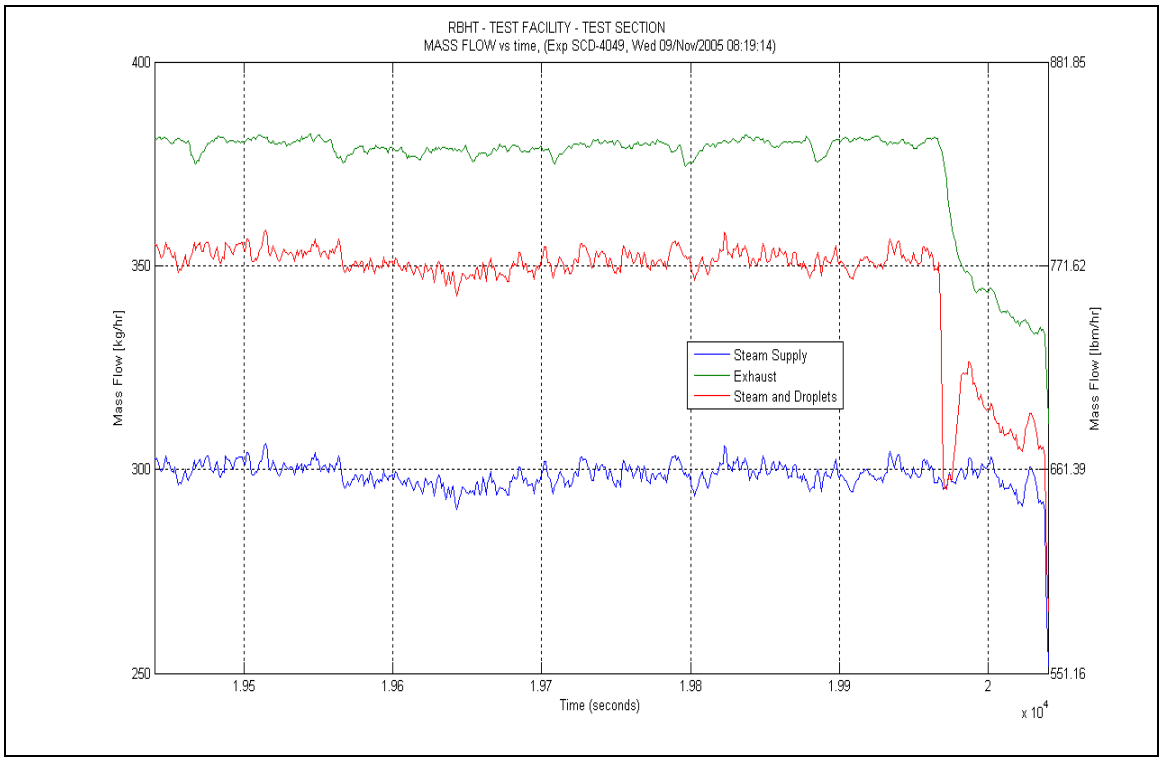

Figure A-131: Mass Flow for Experiment 4049D

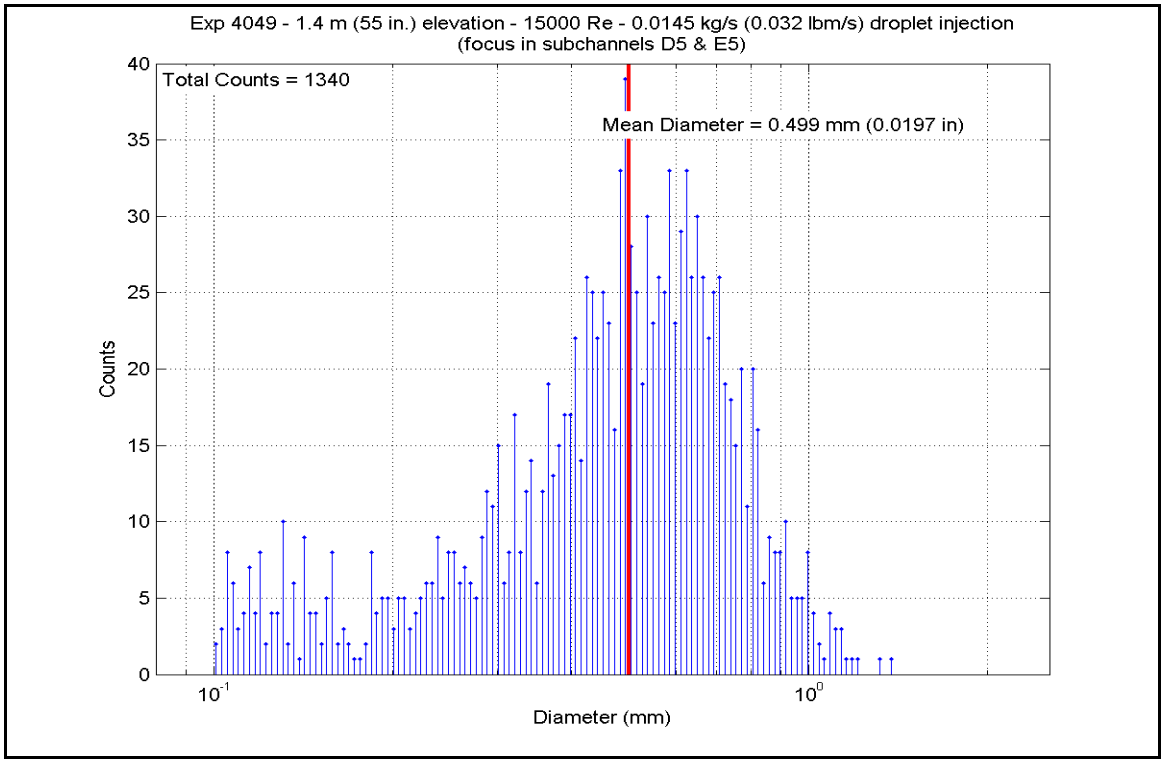

Figure A-132: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049D

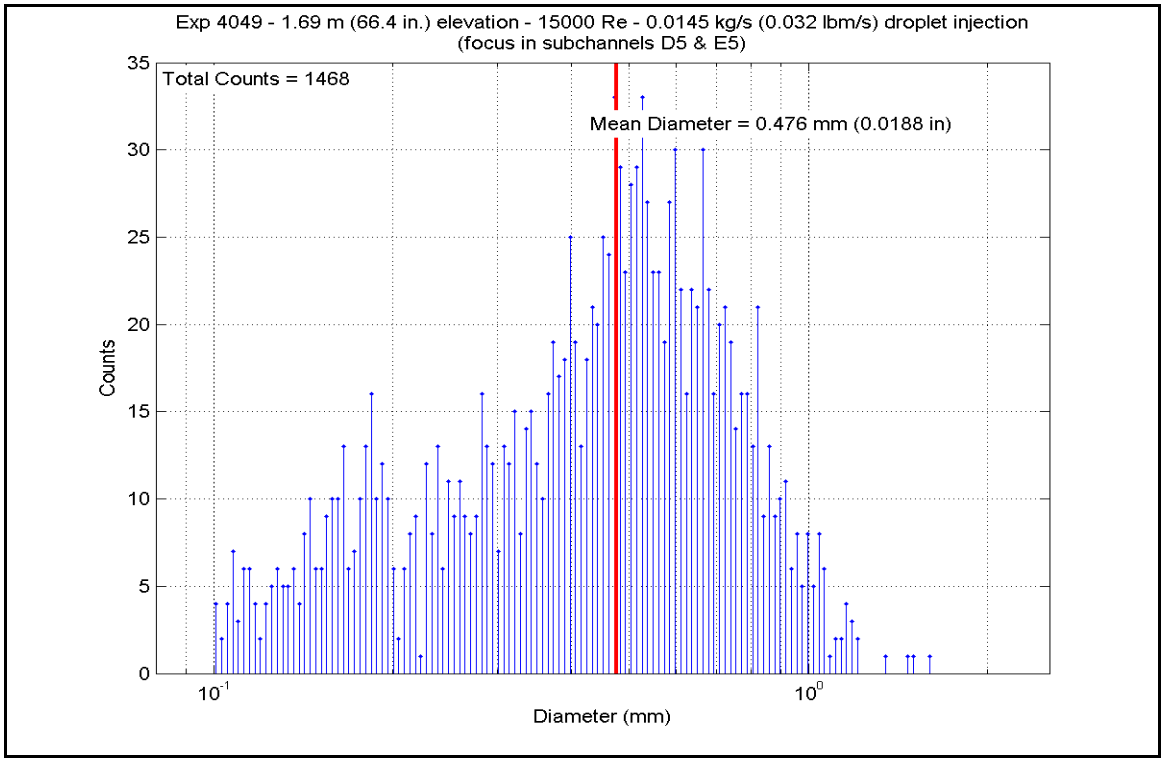

Figure A-133: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049D

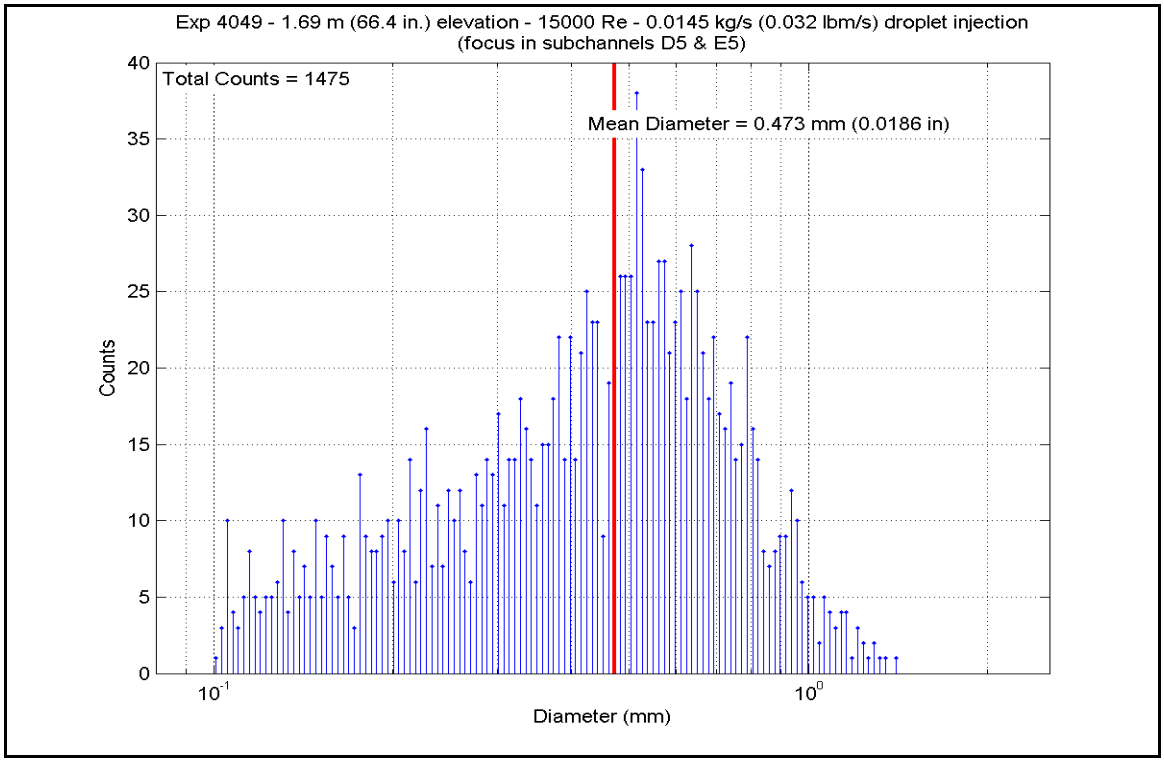

Figure A-134: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049D

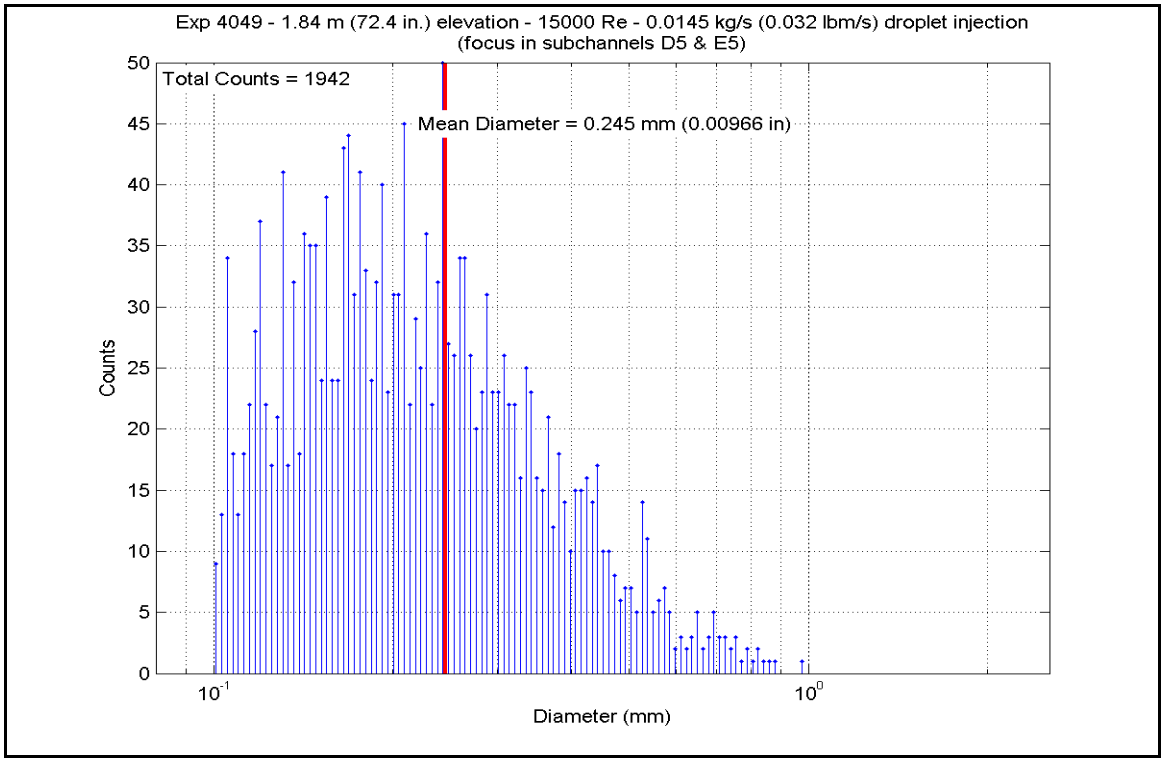

Figure A-135: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049D

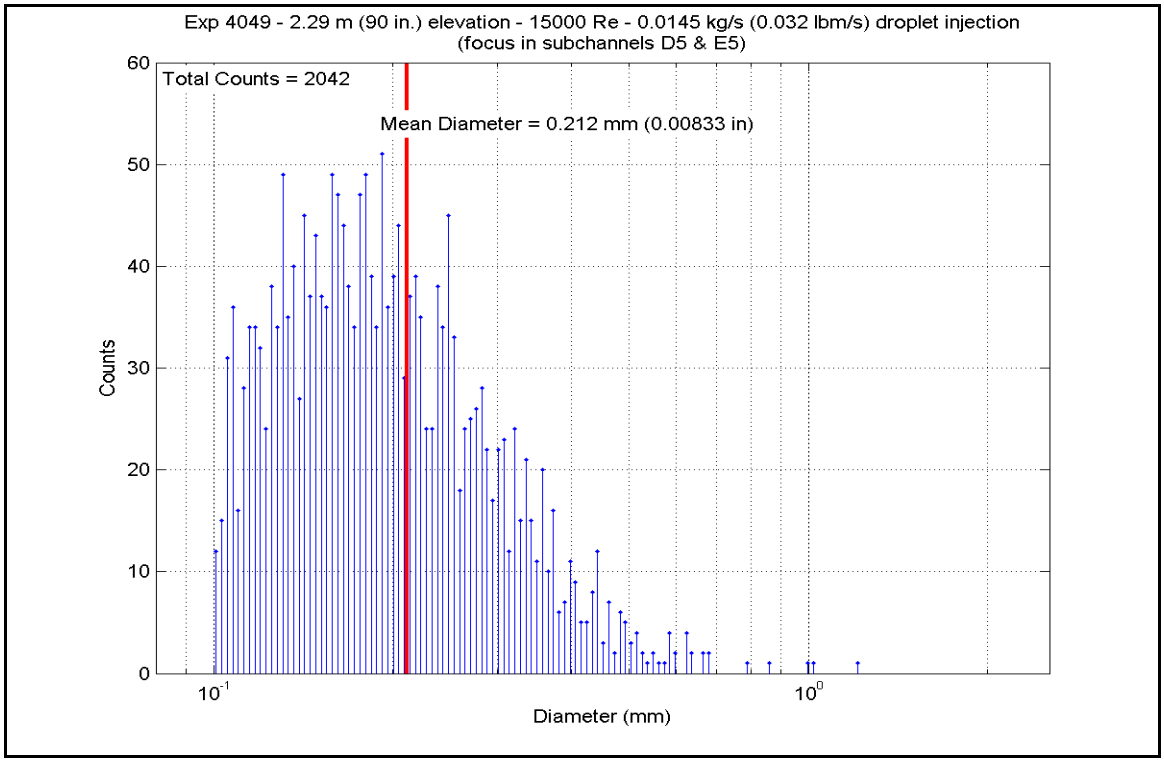

Figure A-136: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049D

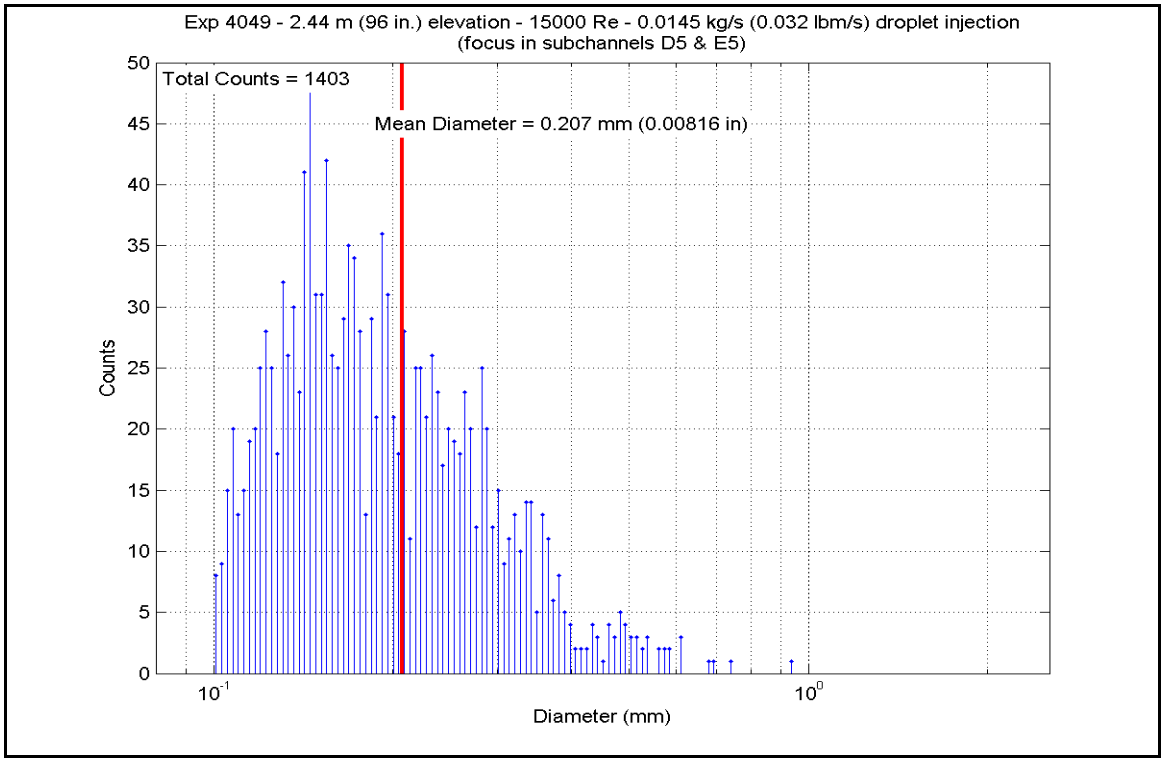

Figure A-137: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049D

Table A-47: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049D

SCD-4049-D	Inlet Reynolds:	15000		
Matrix Test # 6d	UP Pressure:	137.9 kPa	20	psia
Time Window: 19440-20040	Bundle Power:	110.00 kW	375335	Btu/hr
	Steam flow:	0.0838 kg/s	665.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	735.94	664.2	8948.29	28227.4	17.617	100.0
	RodD3_91.3	186	91.3	2.319	2.8	0.071	813.61	707.4	9166.00	28914.1	15.652	88.9
	RodD3_93.1	187	93.1	2.365	4.6	0.117	806.34	703.3	9257.69	29203.4	16.007	90.9
	RodD3_95.3	188	95.3	2.421	6.8	0.173	833.87	718.6	9383.95	29601.7	15.488	88.0
	RodD3_100.1	189	100.1	2.543	11.6	0.295	848.87	727.0	9625.42	30363.4	15.503	88.0
	RodD3_106.1	190	106.1	2.695	17.6	0.447	927.78	770.8	10044.33	31684.8	14.354	81.5
	RodD3_110	191	110	2.794	21.5	0.546	786.49	692.3	9714.23	30643.5	17.394	98.8
	RodD3_142.1	192	142.1	3.609	8.6	0.218	904.65	758.0	3302.90	10419.0	4.881	27.7
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	732.13	662.1	9015.96	28440.9	17.884	101.6
	RodC4_91.1	234	91.1	2.314	2.6	0.066	814.49	707.9	9213.40	29063.7	15.709	89.2
	RodC4_93.4	235	93.4	2.372	4.9	0.124	830.49	716.8	9355.40	29511.6	15.528	88.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	862.90	734.8	9477.45	29896.6	14.927	84.8
	RodC4_100.1	237	100.1	2.543	11.6	0.295	884.18	746.6	9773.62	30830.9	14.895	84.6
	RodC4_106.1	238	106.1	2.695	17.6	0.447	949.23	782.7	10213.98	32220.0	14.162	80.4
	RodC4_110	239	110	2.794	21.5	0.546	792.46	695.6	9630.54	30379.5	17.061	96.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	870.40	738.9	3532.22	11142.4	5.499	31.2
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	663.65	624.1	8955.07	28248.8	20.556	116.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	742.00	667.6	9153.60	28875.0	17.809	101.1
	RodD4_93.2	243	93.2	2.367	4.7	0.119	757.99	676.5	9258.17	29204.9	17.469	99.2
	RodD4_95.2	244	95.2	2.418	6.7	0.170	782.66	690.2	9391.21	29624.6	16.931	96.2
	RodD4_100.1	245	100.1	2.543	11.6	0.295	825.82	714.2	9716.33	30650.2	16.253	92.3
	RodD4_106.1	246	106.1	2.695	17.6	0.447	857.25	731.6	10102.54	31868.5	16.055	91.2
	RodD4_142.1	248	142.1	3.609	8.6	0.218	803.61	701.8	3328.37	10499.3	5.782	32.8
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	240.99	389.3	8376.24	26422.8	645.036	3663.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	248.54	393.4	8353.41	26350.8	406.738	2309.8
	RodE4_95.3	204	95.3	2.421	6.8	0.173	255.58	397.4	8446.77	26645.3	306.287	1739.4
	RodE4_100.9	205	100.9	2.563	12.4	0.315	269.64	405.2	8534.78	26923.0	204.968	1164.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	260.50	400.1	2479.22	7820.7	76.293	433.3

Table A-47: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	907.10	759.3	7572.24	23886.6	11.150	63.3
	RodE3_113.6	194	113.6	2.885	0.85	0.022	907.46	759.5	8966.43	28284.6	13.196	74.9
	RodE3_115.5	195	115.5	2.934	2.75	0.070	934.87	774.7	8663.99	27330.5	12.257	69.6
	RodE3_118.5	196	118.5	3.010	5.75	0.146	948.29	782.2	8116.79	25604.4	11.269	64.0
	RodE3_122.7	197	122.7	3.117	9.95	0.253	935.23	774.9	7339.71	23153.1	10.378	58.9
	RodE3_126.5	198	126.5	3.213	13.75	0.349	933.63	774.1	6657.26	21000.3	9.434	53.6
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	856.27	731.1	5613.93	17709.1	8.935	50.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	927.75	770.8	5041.54	15903.5	7.205	40.9
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	896.22	753.3	7431.03	23441.2	11.121	63.2
	RodC5_113.6	226	113.6	2.885	0.85	0.022	849.99	727.6	8618.27	27186.3	13.856	78.7
	RodC5_115.7	227	115.7	2.939	2.95	0.075	892.65	751.3	8295.68	26168.7	12.481	70.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	912.47	762.3	7115.41	22445.6	10.396	59.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	914.70	763.5	6450.04	20346.7	9.393	53.3
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	785.78	691.9	5396.08	17021.9	9.674	54.9
	RodC5_135.7	232	135.7	3.447	2.2	0.056	836.01	719.8	4823.23	15214.9	7.933	45.0
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	867.89	737.5	7666.59	24184.3	11.981	68.0
	RodE5_113.6	210	113.6	2.885	0.85	0.022	751.00	672.6	8904.34	28088.7	17.025	96.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	818.81	710.3	8658.95	27314.6	14.656	83.2
	RodE5_118.7	212	118.7	3.015	5.95	0.151	880.23	744.4	8140.24	25678.4	12.481	70.9
	RodE5_122.6	213	122.6	3.114	9.85	0.250	892.86	751.4	7433.92	23450.3	11.181	63.5
	RodE5_126.6	214	126.6	3.216	13.85	0.352	881.20	744.9	6716.88	21188.4	10.283	58.4
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	847.72	726.3	5522.72	17421.4	8.912	50.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	785.96	692.0	4828.09	15230.2	8.653	49.1
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	883.17	746.0	8514.41	26858.7	12.996	73.8
	RodC3_85.6	178	85.6	2.174	14.72	0.374	731.32	661.7	8699.24	27441.8	17.284	98.2
	RodC3_88.5	179	88.5	2.248	0	0.000	752.80	673.6	8927.08	28160.5	17.010	96.6
	RodC3_92.4	180	92.4	2.347	3.9	0.099	860.33	733.3	9215.85	29071.4	14.574	82.8
	RodC3_94.4	181	94.4	2.398	5.9	0.150	868.04	737.6	9330.44	29432.9	14.578	82.8
	RodC3_97.2	182	97.2	2.469	8.7	0.221	909.48	760.6	9492.88	29945.3	13.930	79.1
	RodC3_108.8	183	108.8	2.764	20.3	0.516	963.46	790.6	9974.83	31465.6	13.563	77.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	799.54	699.6	6775.64	21373.7	11.855	67.3
	RodD5_54.1	218	54.1	1.374	7.1	0.180	791.05	694.8	6949.64	21922.7	12.343	70.1
	RodD5_56.9	219	56.9	1.445	9.9	0.251	833.30	718.3	7140.66	22525.2	11.797	67.0
	RodD5_60	220	60	1.524	13	0.330	860.56	733.5	7356.46	23206.0	11.630	66.0
	RodD5_66.1	221	66.1	1.679	19.1	0.485	903.71	757.4	7752.57	24455.5	11.473	65.2
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	755.11	674.9	7934.99	25030.9	15.054	85.5
	RodD5_72.9	223	72.9	1.852	2.02	0.051	822.86	712.5	8104.15	25564.5	13.624	77.4
	RodD5_74.9	224	74.9	1.902	4.02	0.102	855.06	730.4	8228.63	25957.2	13.123	74.5

Table A-47: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	716.81	653.6	6157.17	19422.8	12.596	71.5
	RodB5_52.9	154	52.9	1.344	5.9	0.150	787.81	693.0	6939.08	21889.3	12.395	70.4
	RodB5_55	155	55	1.397	8	0.203	827.09	714.9	7079.64	22332.7	11.817	67.1
	RodB5_57.8	156	57.8	1.468	10.8	0.274	858.00	732.0	7247.86	22863.4	11.505	65.3
	RodB5_64	157	64	1.626	17	0.432	898.22	754.4	7638.77	24096.5	11.397	64.7
	RodB5_73.9	158	73.9	1.877	3.02	0.077	900.38	755.6	8298.08	26176.3	12.341	70.1
	RodB5_75.9	159	75.9	1.928	5.02	0.128	923.24	768.3	8421.29	26565.0	12.113	68.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	930.64	772.4	8480.36	26751.3	12.069	68.5
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	703.97	646.5	6126.48	19326.0	12.872	73.1
	RodF5_53.1	106	53.1	1.349	6.1	0.155	780.62	689.1	6924.52	21843.4	12.530	71.2
	RodF5_55	107	55	1.397	8	0.203	818.72	710.2	7056.61	22260.1	11.946	67.8
	RodF5_57.8	108	57.8	1.468	10.8	0.274	854.26	730.0	7244.20	22851.8	11.567	65.7
	RodF5_64	109	64	1.626	17	0.432	892.26	751.1	7637.09	24091.2	11.497	65.3
	RodF5_73.8	110	73.8	1.875	2.92	0.074	860.59	733.5	8219.03	25926.9	12.993	73.8
	RodF5_75.8	111	75.8	1.925	4.92	0.125	886.85	748.1	8347.93	26333.5	12.670	72.0
	RodF5_76.8	112	76.8	1.951	5.92	0.150	897.59	754.0	8414.55	26543.7	12.567	71.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	714.76	652.5	6146.23	19388.3	12.627	71.7
	RodC2_53.1	58	53.1	1.349	6.1	0.155	829.76	716.4	6942.21	21899.2	11.536	65.5
	RodC2_55	59	55	1.397	8	0.203	839.88	722.0	7068.05	22296.2	11.551	65.6
	RodC2_57.8	60	57.8	1.468	10.8	0.274	861.05	733.7	7253.42	22880.9	11.458	65.1
	RodC2_63.9	61	63.9	1.623	16.9	0.429	888.83	749.2	7654.77	24147.0	11.584	65.8
	RodC2_73.8	62	73.8	1.875	2.92	0.074	904.98	758.1	8260.59	26058.0	12.202	69.3
	RodC2_75.8	63	75.8	1.925	4.92	0.125	927.92	770.9	8395.91	26484.9	11.996	68.1
	RodC2_76.8	64	76.8	1.951	5.92	0.150	936.48	775.6	8461.34	26691.3	11.943	67.8
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	706.53	647.9	6116.10	19293.2	12.781	72.6
	RodC6_52.8	138	52.8	1.341	5.8	0.147	832.47	717.9	6930.82	21863.3	11.466	65.1
	RodC6_54.8	139	54.8	1.392	7.8	0.198	843.14	723.8	7066.53	22291.4	11.488	65.2
	RodC6_57.8	140	57.8	1.468	10.8	0.274	873.04	740.4	7273.84	22945.3	11.276	64.0
	RodC6_63.8	141	63.8	1.621	16.8	0.427	904.50	757.9	7681.24	24230.5	11.354	64.5
	RodC6_73.7	142	73.7	1.872	2.82	0.072	927.10	770.4	8304.90	26197.8	11.879	67.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	947.44	781.7	8448.41	26650.5	11.743	66.7
	RodC6_76.8	144	76.8	1.951	5.92	0.150	960.70	789.1	8511.93	26850.9	11.617	66.0

Table A-47: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	781.96	689.8	8929.48	28168.0	16.119	91.5
	RodB4_91.3	162	91.3	2.319	2.8	0.071	869.93	738.7	9140.79	28834.6	14.239	80.9
	RodB4_93.3	163	93.3	2.370	4.8	0.122	881.87	745.3	9259.04	29207.6	14.160	80.4
	RodB4_95.1	164	95.1	2.416	6.6	0.168	909.23	760.5	9375.71	29575.7	13.763	78.2
	RodB4_100	165	100	2.540	11.5	0.292	947.68	781.9	9673.20	30514.1	13.441	76.3
	RodB4_106	166	106	2.692	17.5	0.445	1024.71	824.7	10092.36	31836.4	12.667	71.9
	RodB4_109.9	167	109.9	2.791	21.4	0.544	904.63	757.9	9605.19	30299.6	14.196	80.6
	RodB4_142.3	168	142.3	3.614	8.8	0.224	921.96	767.6	3601.33	11360.4	5.190	29.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	816.14	708.8	8906.36	28095.1	15.143	86.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	788.19	693.3	9028.61	28480.7	16.117	91.5
	RodF4_92.4	100	92.4	2.347	3.9	0.099	882.33	745.6	9283.66	29285.3	14.188	80.6
	RodF4_94.3	101	94.3	2.395	5.8	0.147	907.97	759.8	9405.08	29668.3	13.832	78.5
	RodF4_97.2	102	97.2	2.469	8.7	0.221	935.45	775.1	9580.24	30220.9	13.542	76.9
	RodF4_108.8	103	108.8	2.764	20.3	0.516	975.06	797.1	10093.67	31840.5	13.511	76.7
	RodF4_111	104	111	2.819	-1.75	-0.044	860.79	733.6	9545.33	30110.8	15.084	85.7
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	987.93	804.2	8814.76	27806.2	11.599	65.9
	RodD2_106	66	106	2.692	17.5	0.445	1007.84	815.3	8344.52	26322.8	10.700	60.8
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1012.11	817.7	7675.05	24210.9	9.788	55.6
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1007.58	815.1	6903.73	21777.8	8.856	50.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	988.16	804.3	6168.90	19459.8	8.115	46.1
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1048.67	838.0	10086.87	31819.0	12.291	69.8
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1071.05	850.4	10271.90	32402.7	12.184	69.2
	RodD2_128.6	72	128.6	3.266	15.85	0.403	942.94	779.2	9215.70	29070.9	12.890	73.2
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1029.26	827.2	10092.50	31836.8	12.596	71.5
	RodD6_106	130	106	2.692	17.5	0.445	1043.11	834.9	10268.74	32392.7	12.598	71.5
	RodD6_112.9	131	112.9	2.868	0.15	0.004	895.47	752.9	9079.76	28642.1	13.603	77.3
	RodD6_114.9	132	114.9	2.918	2.15	0.055	949.32	782.8	8761.25	27637.4	12.146	69.0
	RodD6_116.8	133	116.8	2.967	4.05	0.103	977.51	798.4	8430.59	26594.3	11.248	63.9
	RodD6_120.9	134	120.9	3.071	8.15	0.207	975.55	797.3	7656.58	24152.7	10.242	58.2
	RodD6_124.8	135	124.8	3.170	12.05	0.306	977.91	798.7	6923.88	21841.4	9.233	52.4
	RodD6_128.7	136	128.7	3.269	15.95	0.405	969.88	794.2	6174.37	19477.0	8.323	47.3

Table A-47: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	782.88	690.3	6806.04	21469.7	12.266	69.7
	RodE2_54	74	54	1.372	7	0.178	836.25	720.0	7065.72	22288.8	11.616	66.0
	RodE2_56.9	75	56.9	1.445	9.9	0.251	867.31	737.2	7256.95	22892.0	11.351	64.5
	RodE2_59.9	76	59.9	1.521	12.9	0.328	884.09	746.5	7454.96	23516.7	11.363	64.5
	RodE2_66	77	66	1.676	19	0.483	918.63	765.7	7858.70	24790.3	11.379	64.6
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	832.77	718.0	8087.05	25510.6	13.372	75.9
	RodE2_72.9	79	72.9	1.852	2.02	0.051	906.93	759.2	8302.93	26191.6	12.229	69.4
	RodE2_74.9	80	74.9	1.902	4.02	0.102	938.32	776.7	8438.54	26619.4	11.880	67.5
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	732.81	662.5	6754.67	21307.6	13.381	76.0
	RodB3_54.1	170	54.1	1.374	7.1	0.180	803.88	702.0	7028.43	22171.2	12.205	69.3
	RodB3_56.9	171	56.9	1.445	9.9	0.251	842.67	723.5	7209.72	22743.1	11.729	66.6
	RodB3_60.1	172	60.1	1.527	13.1	0.333	843.42	723.9	7418.10	23400.4	12.054	68.5
	RodB3_66.1	173	66.1	1.679	19.1	0.485	893.48	751.7	7798.87	24601.5	11.719	66.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	785.94	692.0	8036.07	25349.8	14.403	81.8
	RodB3_73	175	73	1.854	2.12	0.054	861.34	733.9	8221.48	25934.7	12.981	73.7
	RodB3_75	176	75	1.905	4.12	0.105	893.35	751.7	8347.51	26332.2	12.546	71.2
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	754.52	674.5	6771.21	21359.8	12.860	73.0
	RodF3_54	90	54	1.372	7	0.178	821.46	711.7	7045.90	22226.3	11.873	67.4
	RodF3_57	91	57	1.448	10	0.254	863.00	734.8	7250.73	22872.4	11.418	64.8
	RodF3_60	92	60	1.524	13	0.330	887.61	748.5	7445.48	23486.8	11.288	64.1
	RodF3_66.1	93	66.1	1.679	19.1	0.485	908.91	760.3	7845.60	24749.0	11.522	65.4
	RodF3_70	94	70	1.778	-0.88	-0.022	830.98	717.0	8150.24	25709.9	13.517	76.8
	RodF3_73	95	73	1.854	2.12	0.054	919.42	766.2	8327.54	26269.2	12.044	68.4
	RodF3_75	96	75	1.905	4.12	0.105	953.07	784.9	8442.90	26633.1	11.644	66.1
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	768.02	682.1	6756.35	21312.9	12.511	71.1
	RodE6_54.1	122	54.1	1.374	7.1	0.180	812.37	706.7	7006.91	22103.3	11.991	68.1
	RodE6_57	123	57	1.448	10	0.254	838.32	721.1	7196.87	22702.5	11.792	67.0
	RodE6_60.2	124	60.2	1.529	13.2	0.335	846.93	725.9	7406.56	23364.0	11.967	68.0
	RodE6_66.1	125	66.1	1.679	19.1	0.485	889.84	749.7	7791.12	24577.1	11.772	66.9
	RodE6_70	126	70	1.778	-0.88	-0.022	811.47	706.2	8015.21	25284.0	13.737	78.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	871.40	739.5	8175.91	25790.9	12.707	72.2
	RodE6_75	128	75	1.905	4.12	0.105	897.45	754.0	8294.43	26164.8	12.390	70.4

RBHT Steam Cooling with Droplet Injection Test SCD-4049-E

Matrix Test # 5a

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 20820 - 21300
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 75 kW
Bundle Inlet Reynolds Number: 10000
Bundle Inlet Steam Flow: 181.4 kg/hr (400 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

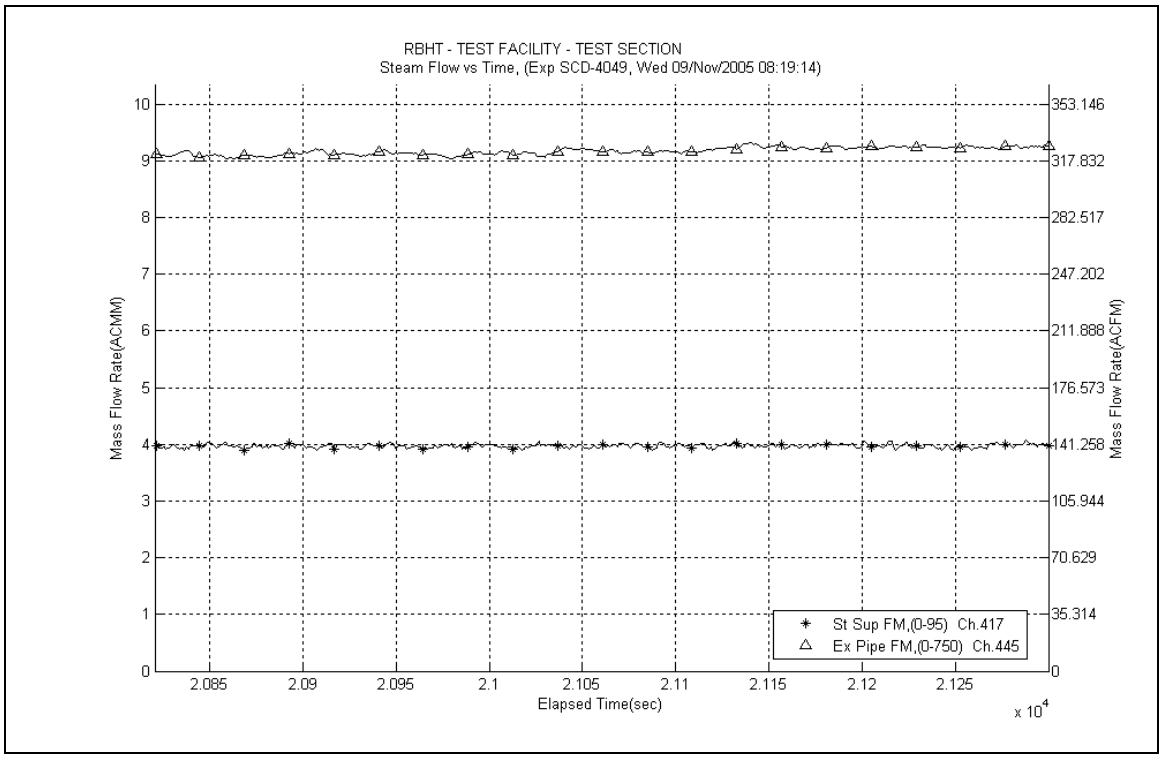

Figure A-138: Inlet and Exhaust Steam Flow Rates for Experiment 4049E

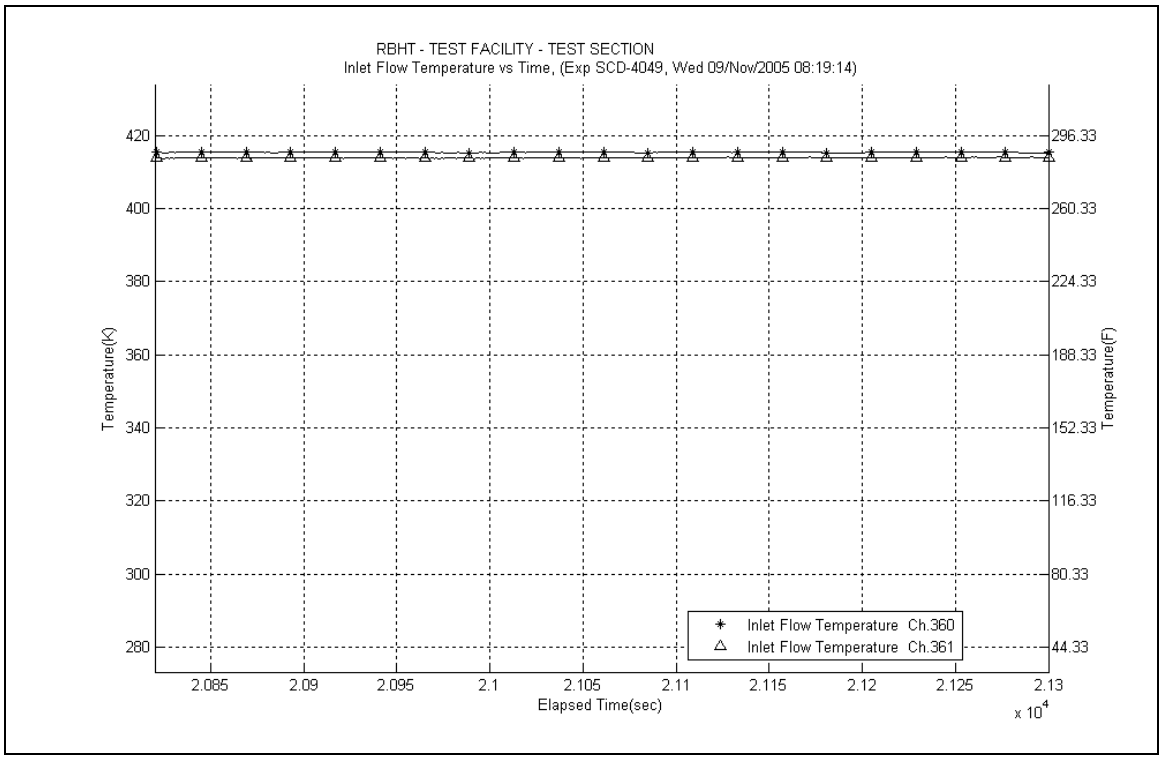

Figure A-139: Inlet Steam Temperature for Experiment 4049E

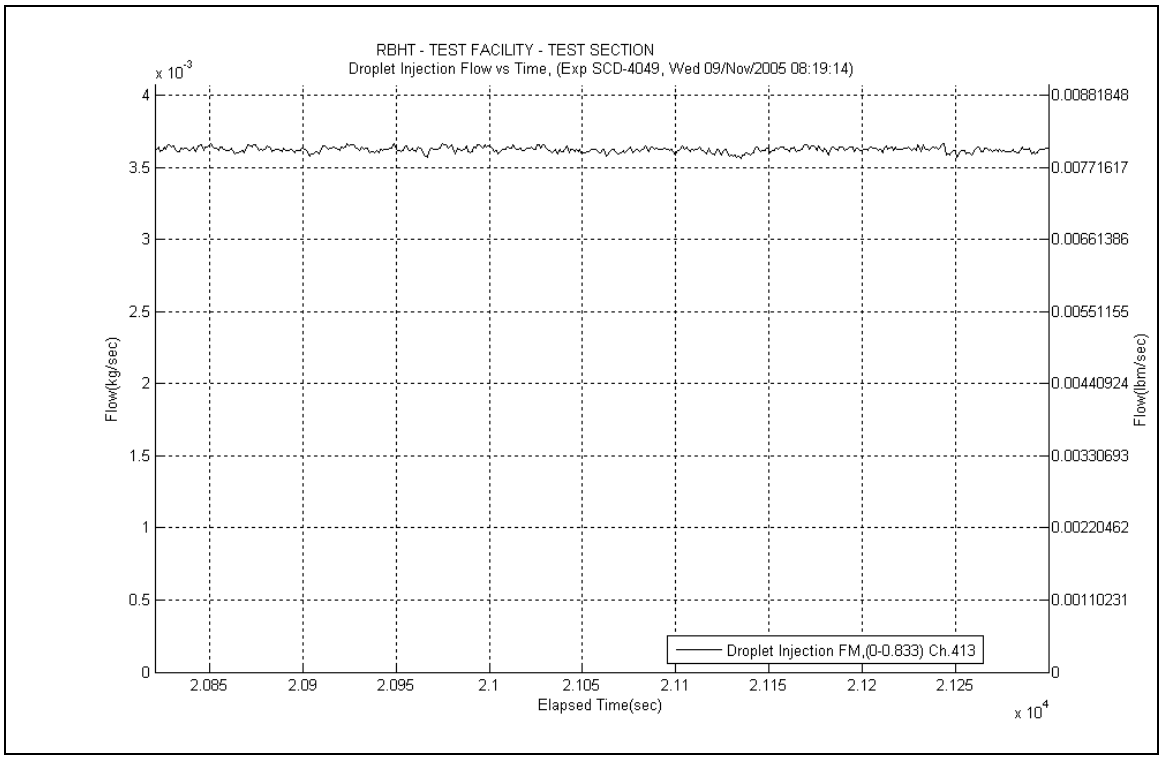

Figure A-140: Droplet Injection Flow Rate for Experiment 4049E

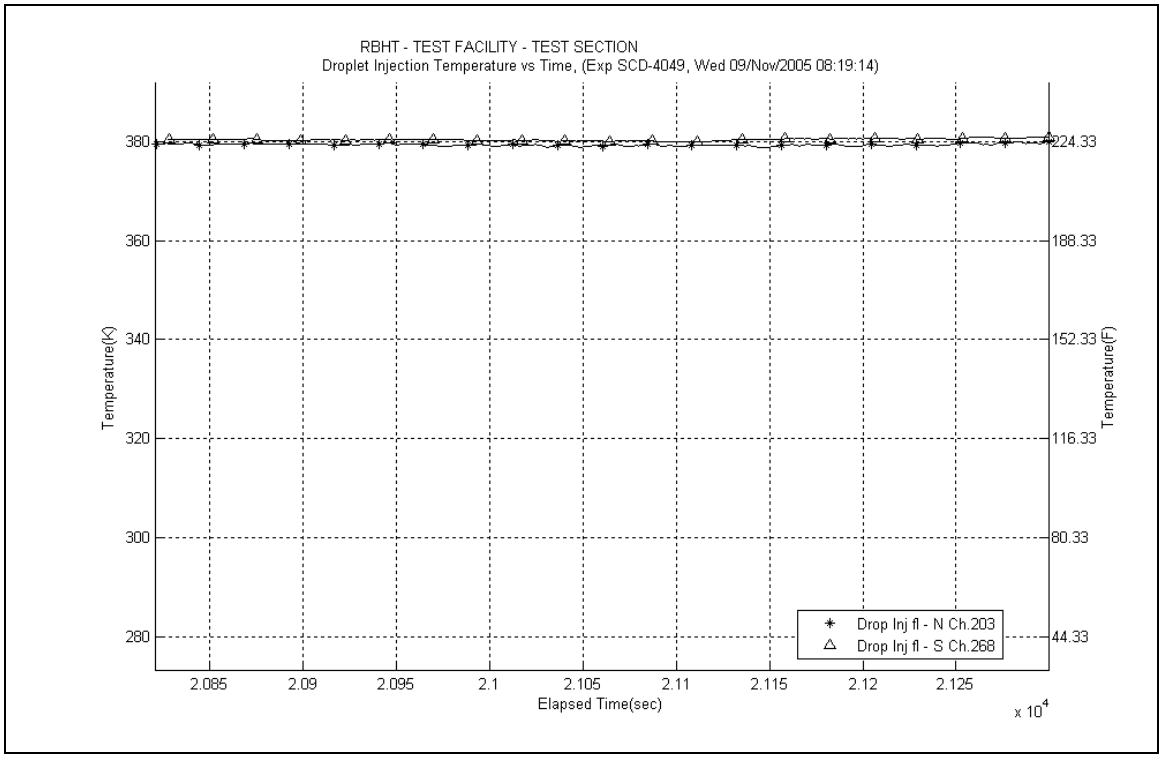

Figure A-141: Droplet Injection Temperature for Experiment 4049E

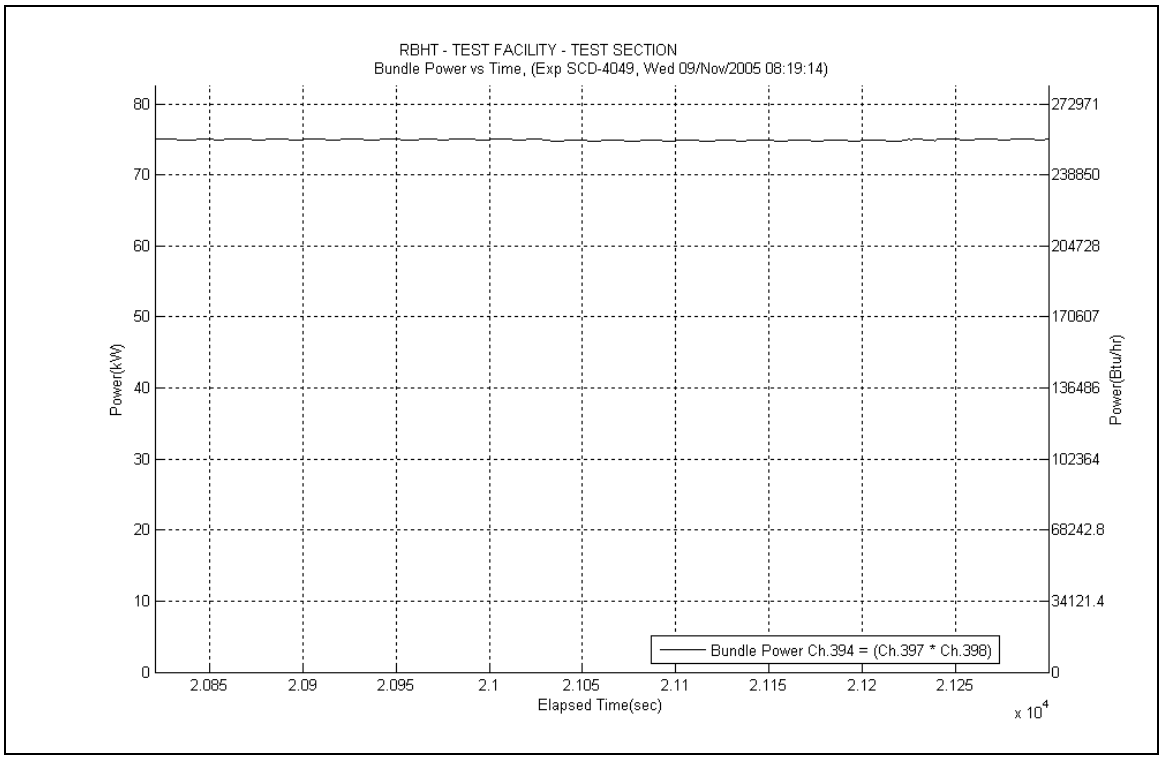

Figure A-142: Bundle Power for Experiment 4049E

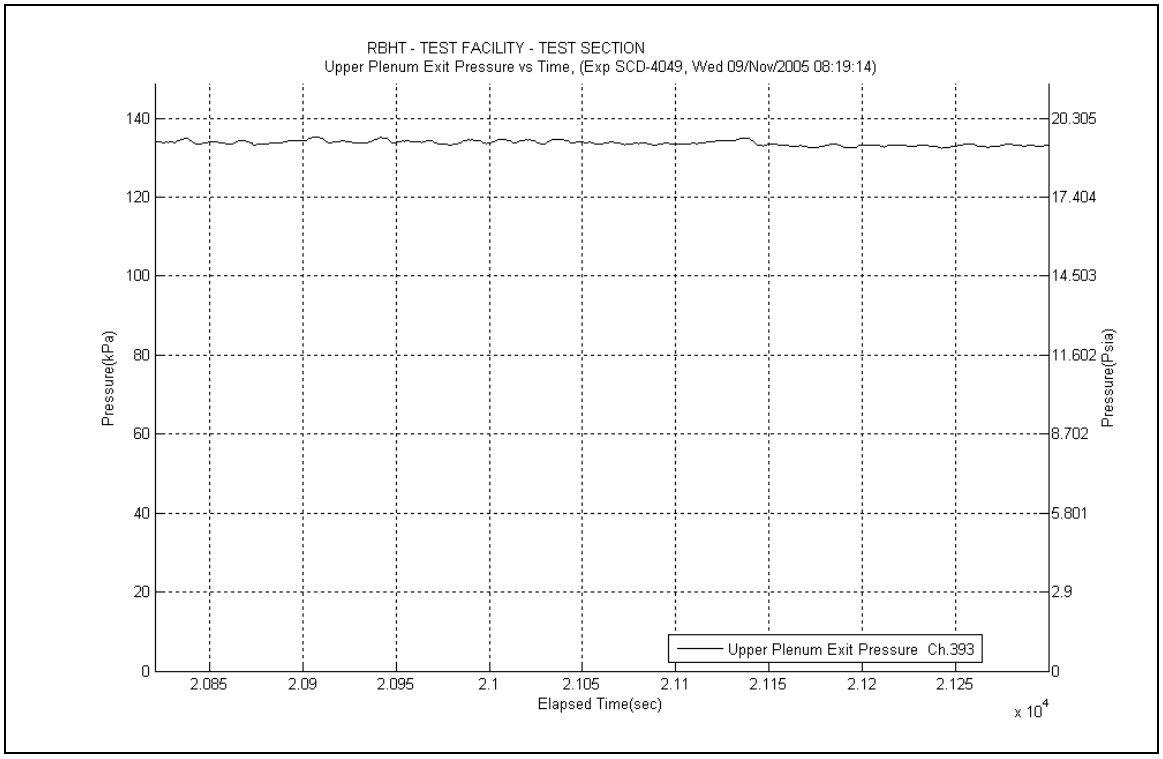

Figure A-143: Upper Plenum Pressure for Experiment 4049E

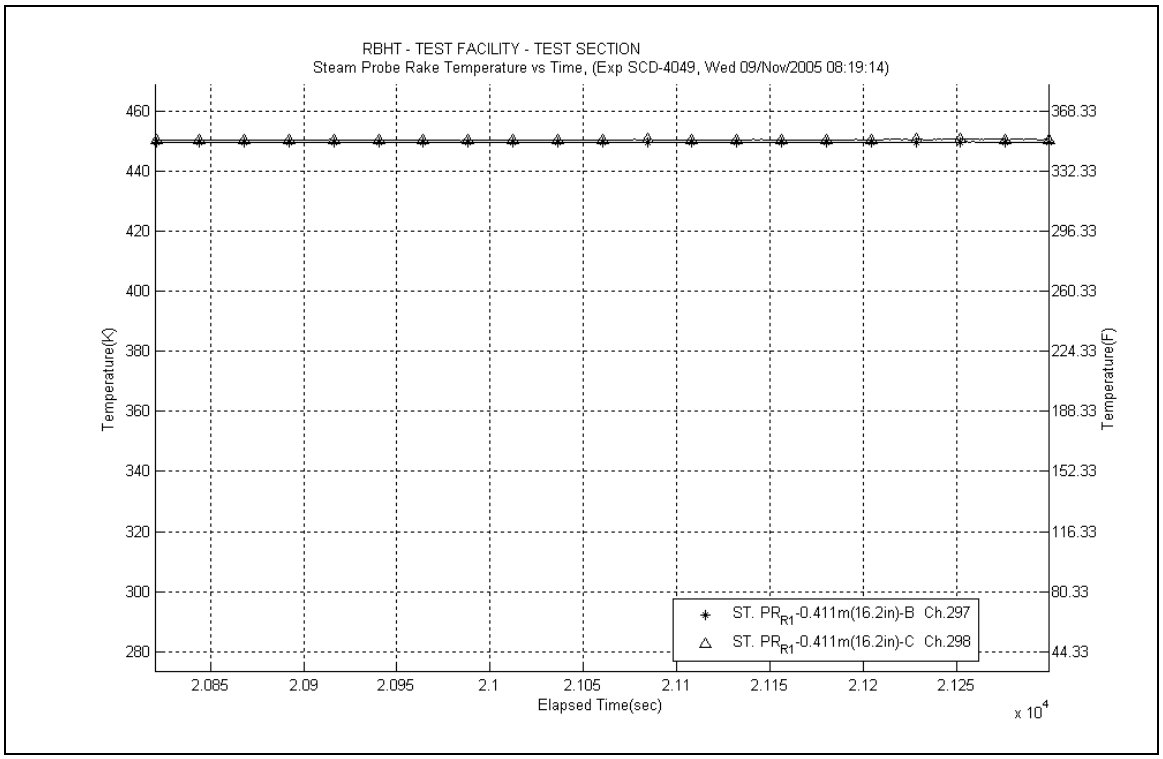

Figure A-144: Steam Probe Rake #1 Temperatures for Experiment 4049E

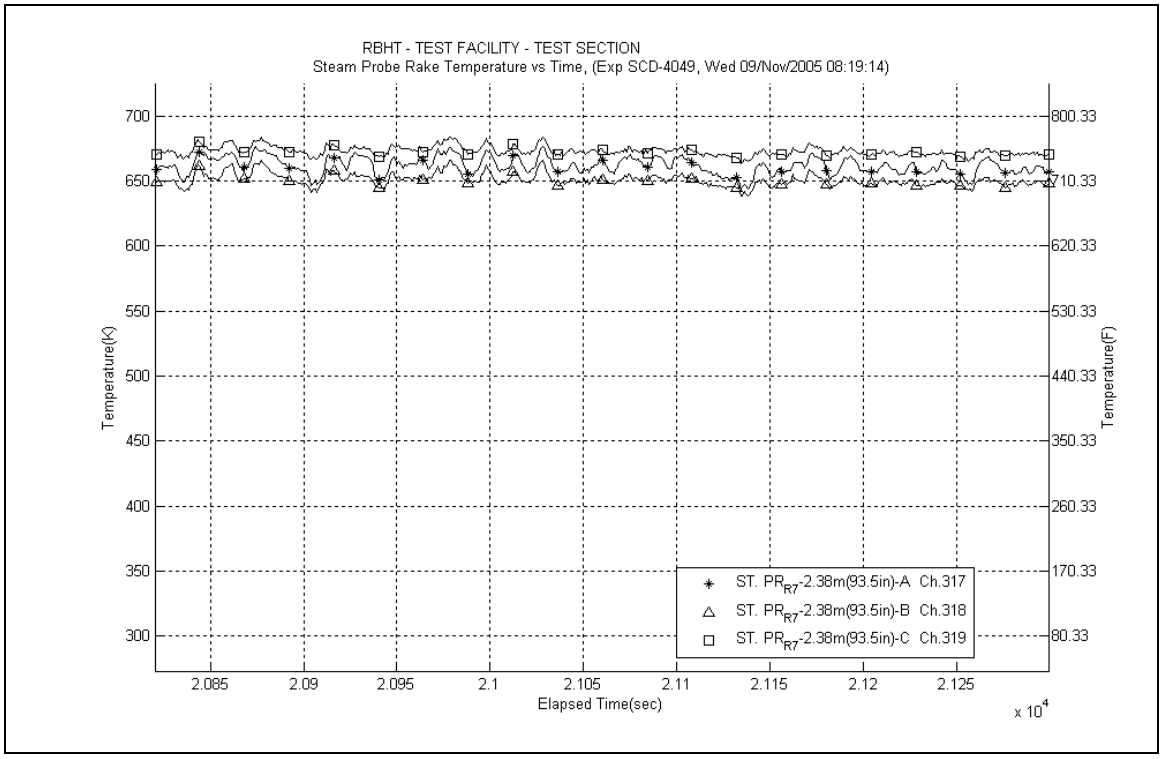

Figure A-145: Steam Probe Rake #7 Temperatures for Experiment 4049E

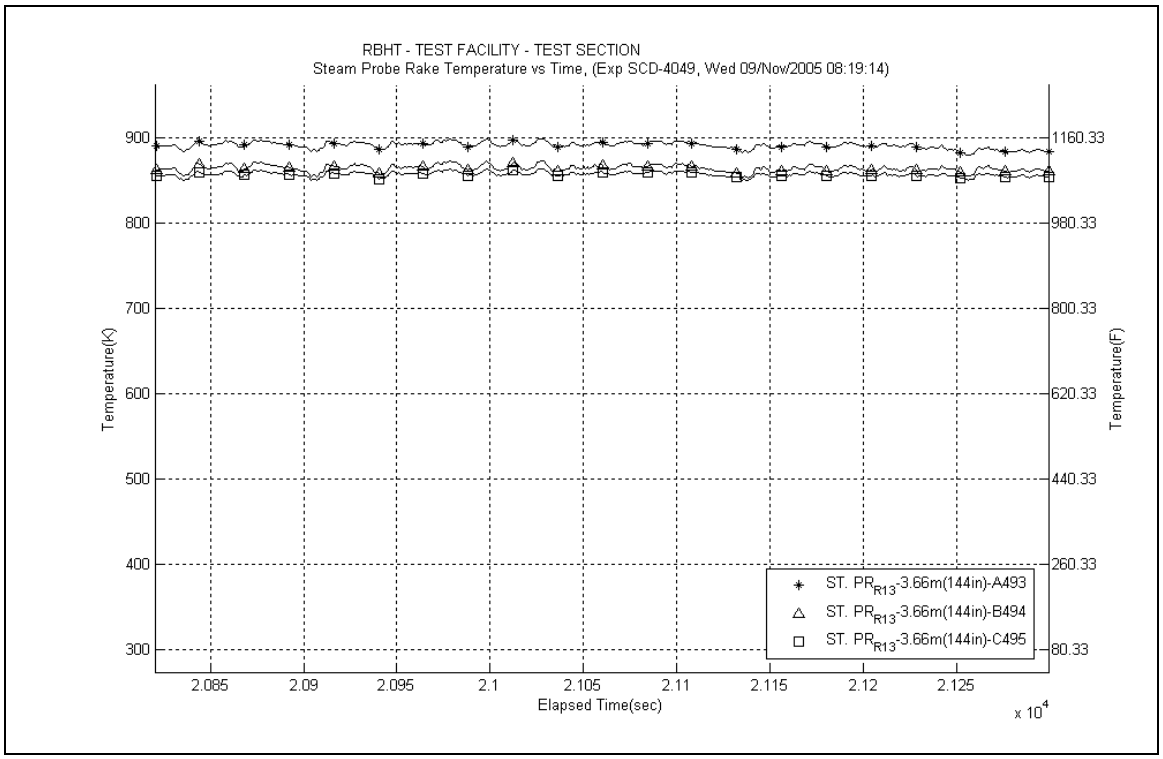

Figure A-146: Steam Probe Rake #13 Temperatures for Experiment 4049E

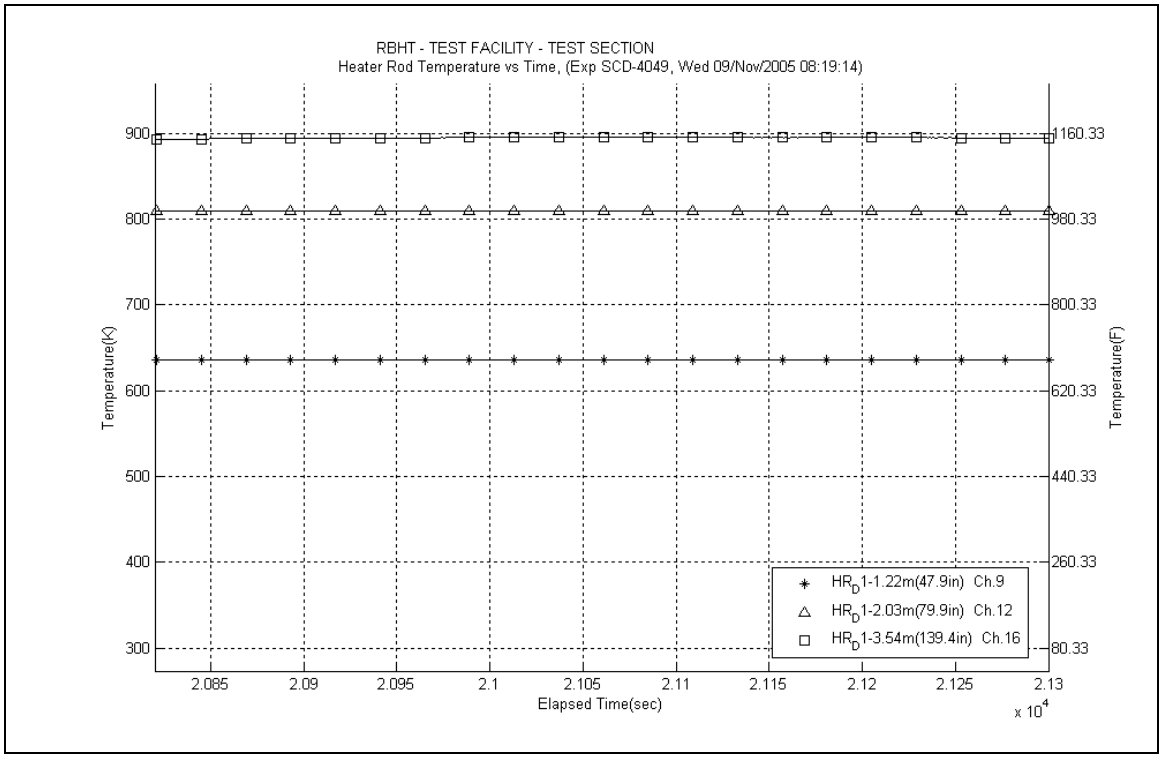

Figure A-147: Heater Rod D1 Temperatures for Experiment 4049E

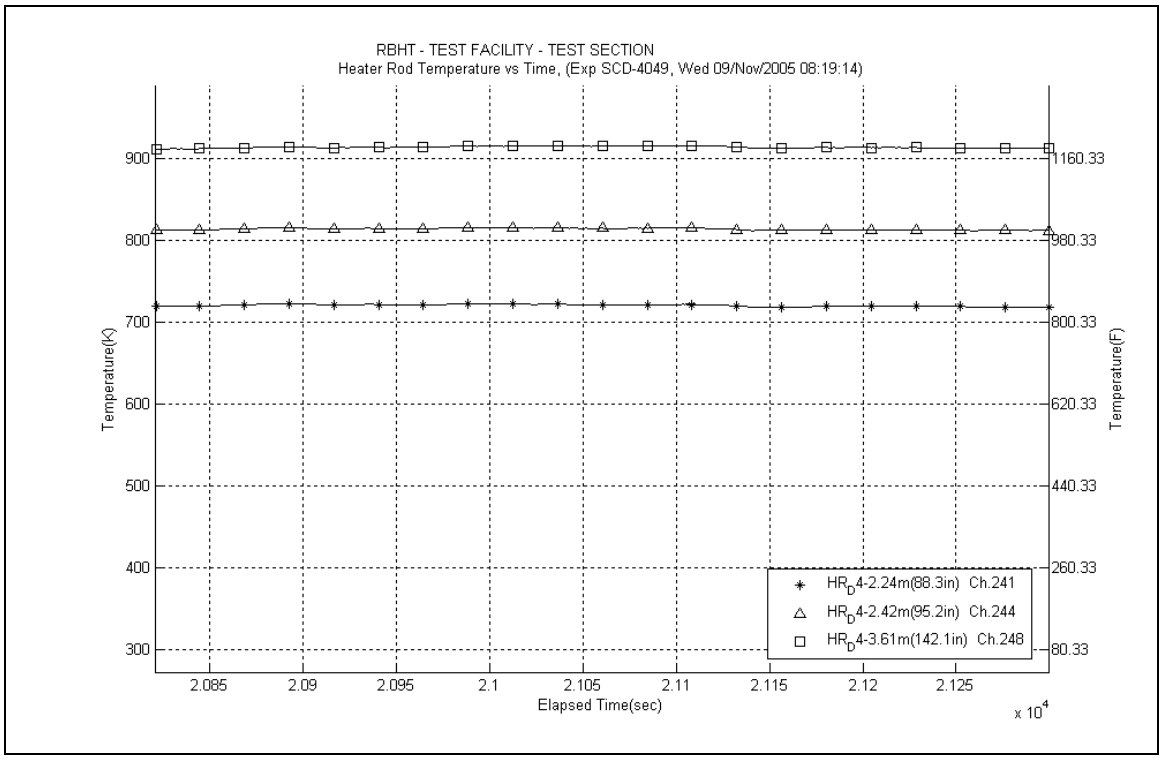

Figure A-148: Heater Rod D4 Temperatures for Experiment 4049E

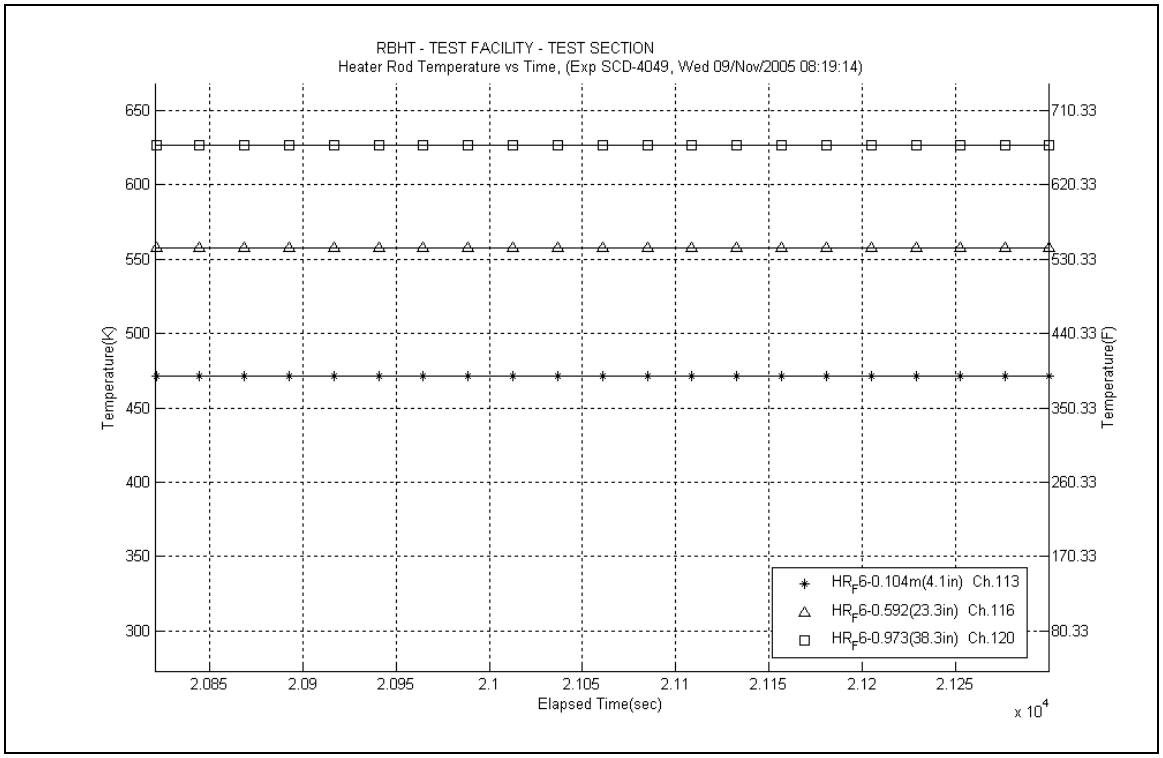

Figure A-149: Heater Rod F6 Temperatures for Experiment 4049E

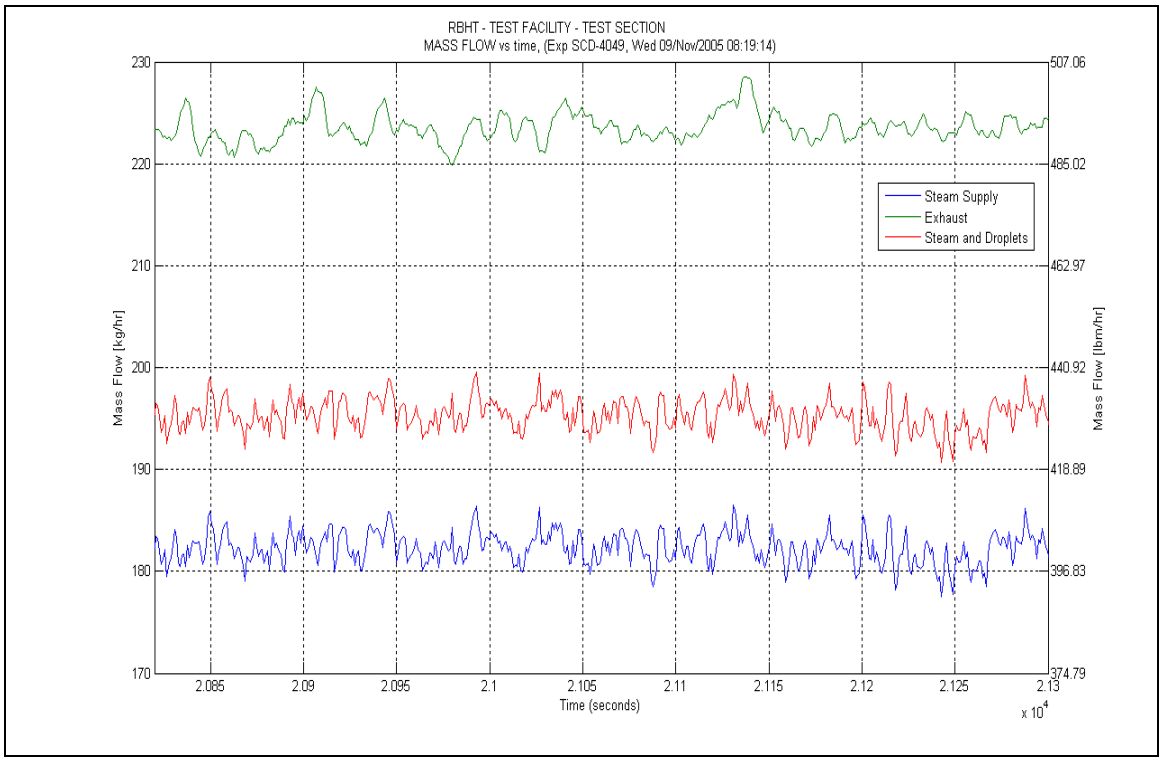

Figure A-150: Mass Flow for Experiment 4049E

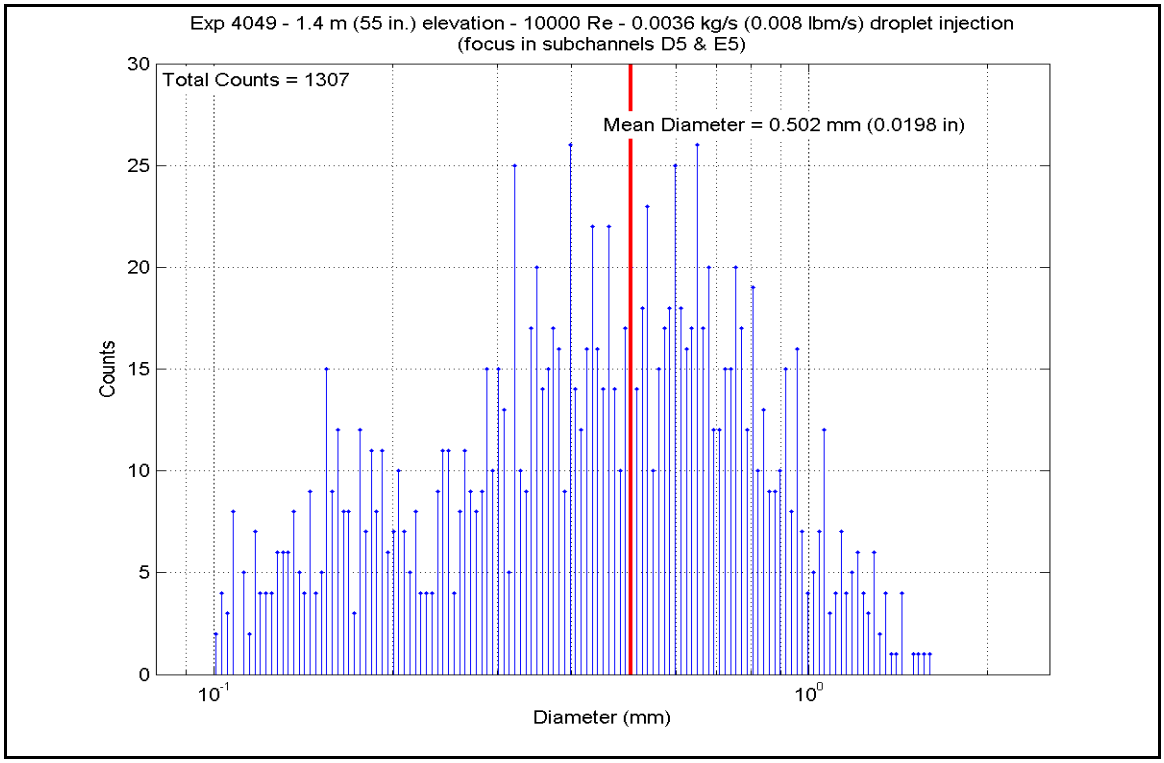

Figure A-151: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049E

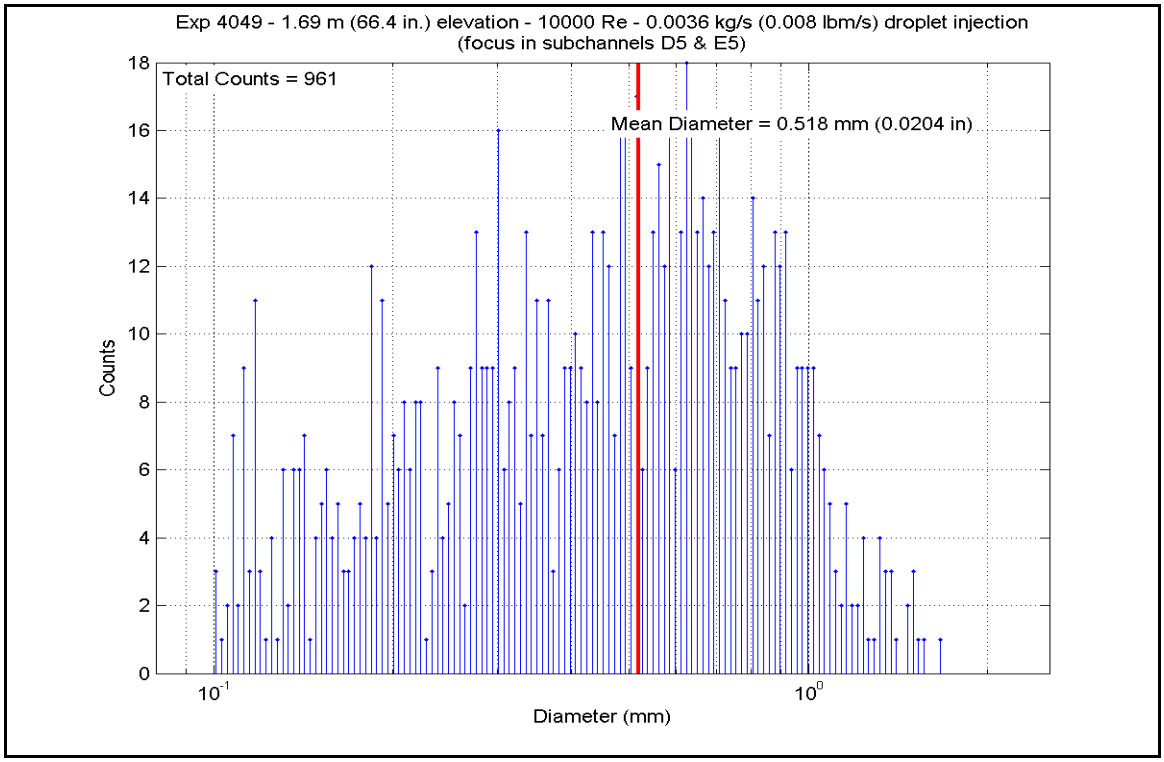

Figure A-152: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049E

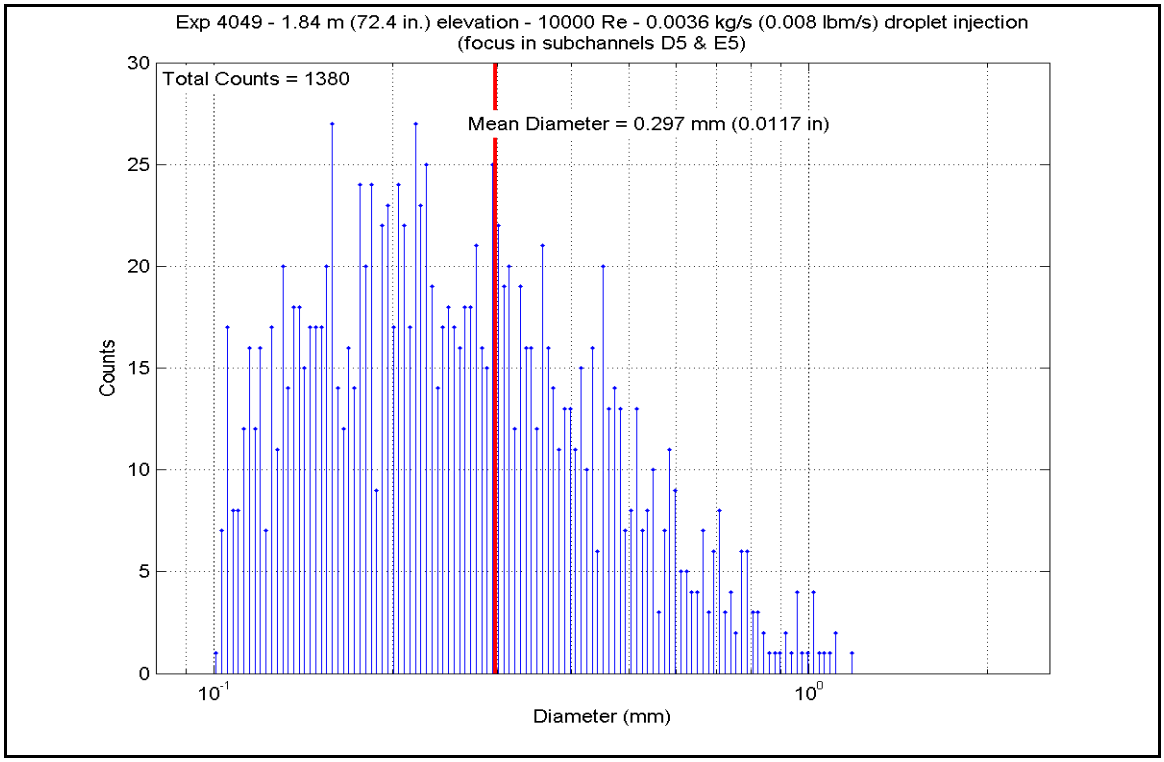

Figure A-153: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049E

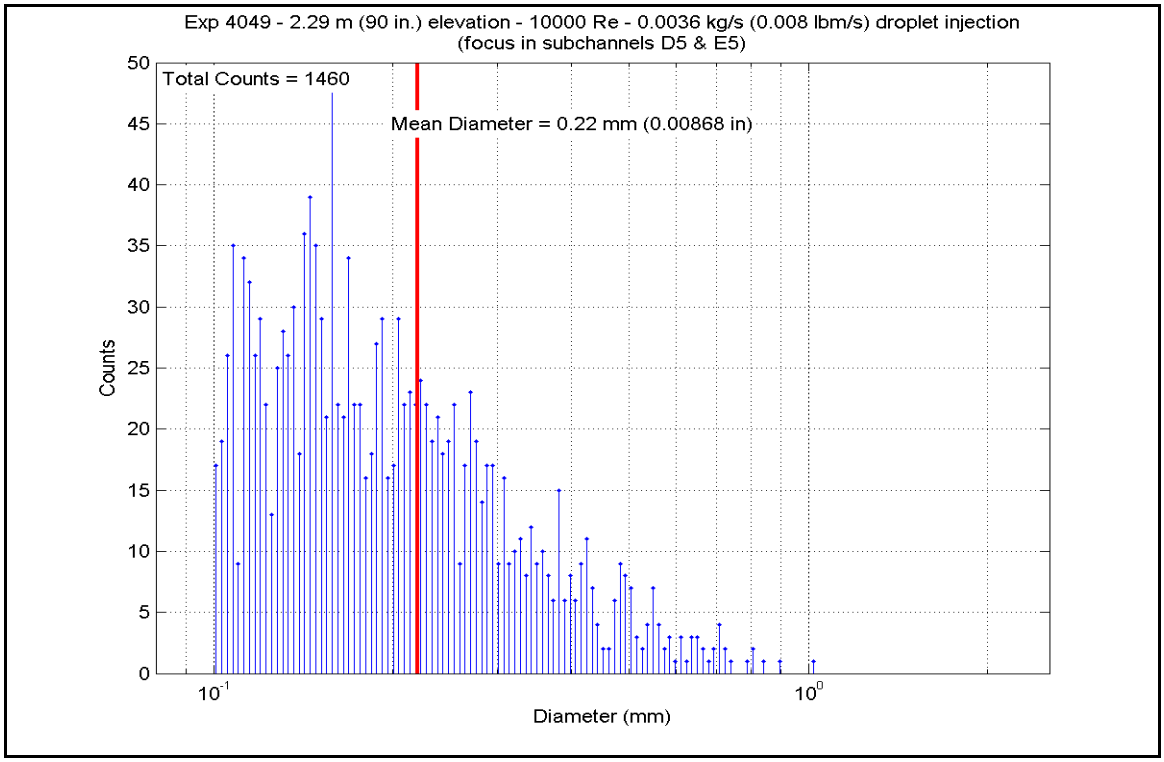

Figure A-154: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049E

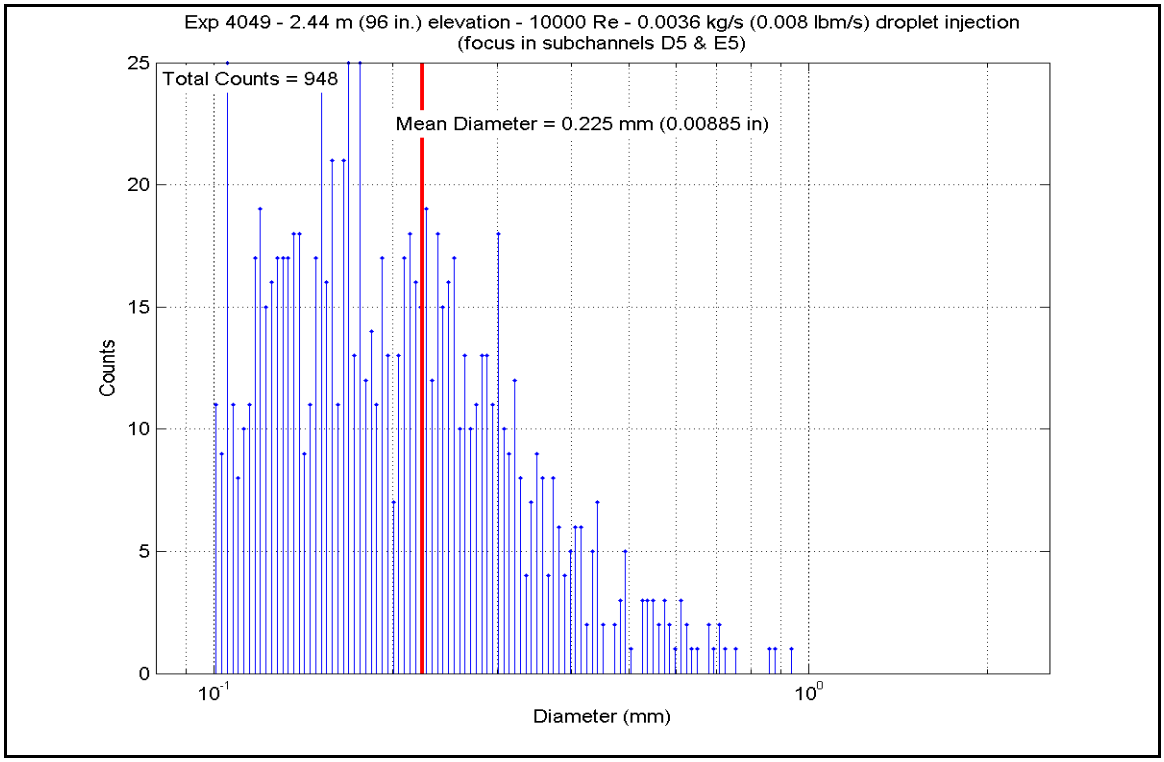

Figure A-155: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049E

Table A-48: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049E

SCD-4049-E				Inlet Reynolds:	10000							
Matrix Test # 5a				UP Pressure:	137.9 kPa		20 psia					
Time Window: 20820-21300				Bundle Power:	75.00 kW		255911 Btu/hr					
				Steam flow:	0.0504 kg/s		400.0 lbm/hr					
				Droplet flow:	0.0036 kg/s		0.008 lbm/s					
Inner 3x3												
H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	873.69	740.8	6363.61	20074.0	9.855	56.0
	RodD3_91.3	186	91.3	2.319	2.8	0.071	957.67	787.4	6498.83	20500.6	8.907	50.6
	RodD3_93.1	187	93.1	2.365	4.6	0.117	972.39	795.6	6579.51	20755.1	8.839	50.2
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1016.27	820.0	6679.49	21070.4	8.474	48.1
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1070.47	850.1	6894.97	21750.2	8.184	46.5
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1153.69	896.3	7165.30	22602.9	7.740	44.0
	RodD3_110	191	110	2.794	21.5	0.546	1083.74	857.5	7076.07	22321.5	8.269	47.0
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1185.96	914.2	2466.13	7779.4	2.574	14.6
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	857.86	732.0	6436.51	20304.0	10.219	58.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	952.28	784.4	6562.95	20702.8	9.061	51.5
	RodC4_93.4	235	93.4	2.372	4.9	0.124	979.00	799.3	6668.74	21036.5	8.880	50.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1019.57	821.8	6756.27	21312.6	8.535	48.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1070.64	850.2	6978.29	22013.0	8.281	47.0
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1136.16	886.6	7256.61	22891.0	7.990	45.4
	RodC4_110	239	110	2.794	21.5	0.546	1062.32	845.5	7022.83	22153.5	8.417	47.8
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1184.01	913.2	2675.42	8439.6	2.799	15.9
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	835.53	719.6	6412.80	20229.2	10.555	59.9
	RodD4_91.3	242	91.3	2.319	2.8	0.071	936.68	775.7	6548.67	20657.8	9.241	52.5
	RodD4_93.2	243	93.2	2.367	4.7	0.119	966.92	792.6	6635.64	20932.1	8.980	51.0
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1003.15	812.7	6726.56	21218.9	8.678	49.3
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1066.49	847.9	6949.43	21922.0	8.288	47.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1134.13	885.4	7222.98	22784.9	7.971	45.3
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1184.52	913.4	2584.71	8153.5	2.702	15.3
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	869.22	738.3	6320.93	19939.4	9.858	56.0
	RodE4_91.2	202	91.2	2.316	2.7	0.069	968.08	793.2	6435.72	20301.5	8.696	49.4
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1038.39	832.3	6614.11	20864.2	8.162	46.3
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1093.79	863.0	6859.20	21637.3	7.922	45.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1188.56	915.7	2607.75	8226.1	2.715	15.4

Table A-48: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	922.81	768.0	5226.47	16486.9	7.522	42.7
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1128.04	882.1	6442.31	20322.3	7.158	40.6
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1163.76	901.9	6202.30	19565.1	6.628	37.6
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1192.50	917.9	5824.04	18371.9	6.038	34.3
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1205.11	924.9	5294.65	16702.0	5.419	30.8
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1208.01	926.5	4815.49	15190.5	4.914	27.9
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1139.11	888.2	4156.74	13112.4	4.562	25.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1176.46	909.0	3667.21	11568.2	3.866	22.0
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	913.20	762.7	5126.32	16171.0	7.481	42.5
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1101.18	867.1	6287.68	19834.5	7.201	40.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1146.82	892.5	6035.30	19038.4	6.569	37.3
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1200.94	922.6	5196.47	16392.3	5.341	30.3
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1200.62	922.4	4717.32	14880.8	4.850	27.5
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1120.47	877.9	4130.32	13029.1	4.628	26.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1158.64	899.1	3638.31	11477.0	3.909	22.2
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	852.07	728.7	5250.15	16561.6	8.413	47.8
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1019.68	821.9	6486.94	20463.1	8.194	46.5
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1082.87	857.0	6259.81	19746.6	7.323	41.6
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1126.55	881.2	5851.17	18457.5	6.512	37.0
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1155.19	897.1	5367.58	16932.0	5.789	32.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1165.91	903.1	4871.03	15365.7	5.193	29.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1225.00	935.9	4256.70	13427.7	4.270	24.2
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1174.55	907.9	3746.49	11818.3	3.958	22.5
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	943.50	779.5	5949.63	18768.1	8.315	47.2
	RodC3_85.6	178	85.6	2.174	14.72	0.374	845.61	725.2	6226.06	19640.1	10.081	57.2
	RodC3_88.5	179	88.5	2.248	0	0.000	873.36	740.6	6336.98	19990.0	9.819	55.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	980.05	799.8	6510.62	20537.8	8.657	49.2
	RodC3_94.4	181	94.4	2.398	5.9	0.150	996.66	809.1	6600.45	20821.1	8.587	48.8
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1047.02	837.1	6727.14	21220.7	8.214	46.6
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1141.95	889.8	7094.75	22380.4	7.763	44.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	780.27	688.9	4642.18	14643.8	8.406	47.7
	RodD5_54.1	218	54.1	1.374	7.1	0.180	806.89	703.6	4826.18	15224.2	8.337	47.3
	RodD5_56.9	219	56.9	1.445	9.9	0.251	851.26	728.3	4949.25	15612.4	7.941	45.1
	RodD5_60	220	60	1.524	13	0.330	880.59	744.6	5085.82	16043.2	7.793	44.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	922.88	768.1	5356.26	16896.3	7.708	43.8
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	805.56	702.9	5527.85	17437.6	9.571	54.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	881.44	745.1	5662.35	17861.9	8.665	49.2
	RodD5_74.9	224	74.9	1.902	4.02	0.102	922.55	767.9	5751.88	18144.3	8.281	47.0

Table A-48: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	710.49	650.1	4221.56	13316.9	8.750	49.7
	RodB5_52.9	154	52.9	1.344	5.9	0.150	775.26	686.1	4760.17	15016.0	8.698	49.4
	RodB5_55	155	55	1.397	8	0.203	813.87	707.5	4852.61	15307.6	8.283	47.0
	RodB5_57.8	156	57.8	1.468	10.8	0.274	856.63	731.3	4977.61	15701.9	7.918	45.0
	RodB5_64	157	64	1.626	17	0.432	907.69	759.6	5257.11	16583.6	7.735	43.9
	RodB5_73.9	158	73.9	1.877	3.02	0.077	891.02	750.4	5707.91	18005.6	8.609	48.9
	RodB5_75.9	159	75.9	1.928	5.02	0.128	922.50	767.9	5798.37	18291.0	8.349	47.4
	RodB5_76.9	160	76.9	1.953	6.02	0.153	934.50	774.5	5842.95	18431.6	8.270	47.0
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	699.30	643.9	4191.89	13223.3	8.894	50.5
	RodF5_53.1	106	53.1	1.349	6.1	0.155	763.07	679.3	4738.63	14948.0	8.856	50.3
	RodF5_55	107	55	1.397	8	0.203	796.43	697.8	4822.14	15211.4	8.483	48.2
	RodF5_57.8	108	57.8	1.468	10.8	0.274	832.62	717.9	4946.45	15603.6	8.181	46.5
	RodF5_64	109	64	1.626	17	0.432	875.64	741.8	5225.91	16485.1	8.069	45.8
	RodF5_73.8	110	73.8	1.875	2.92	0.074	873.45	740.6	5668.84	17882.4	8.783	49.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	908.23	759.9	5759.20	18167.4	8.467	48.1
	RodF5_76.8	112	76.8	1.951	5.92	0.150	922.33	767.8	5804.11	18309.1	8.359	47.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	711.72	650.8	4214.12	13293.5	8.712	49.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	828.22	715.5	4759.46	15013.7	7.930	45.0
	RodC2_55	59	55	1.397	8	0.203	842.74	723.6	4844.96	15283.4	7.881	44.8
	RodC2_57.8	60	57.8	1.468	10.8	0.274	867.06	737.1	4971.08	15681.3	7.779	44.2
	RodC2_63.9	61	63.9	1.623	16.9	0.429	888.54	749.0	5245.36	16546.5	7.941	45.1
	RodC2_73.8	62	73.8	1.875	2.92	0.074	903.06	757.1	5695.77	17967.3	8.437	47.9
	RodC2_75.8	63	75.8	1.925	4.92	0.125	930.14	772.1	5784.81	18248.2	8.239	46.8
	RodC2_76.8	64	76.8	1.951	5.92	0.150	940.50	777.9	5829.66	18389.7	8.182	46.5
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	710.30	650.0	4194.76	13232.4	8.697	49.4
	RodC6_52.8	138	52.8	1.341	5.8	0.147	823.14	712.7	4754.41	14997.8	7.989	45.4
	RodC6_54.8	139	54.8	1.392	7.8	0.198	839.87	722.0	4847.84	15292.5	7.923	45.0
	RodC6_57.8	140	57.8	1.468	10.8	0.274	869.37	738.4	4988.46	15736.1	7.778	44.2
	RodC6_63.8	141	63.8	1.621	16.8	0.427	901.08	756.0	5270.14	16624.6	7.830	44.5
	RodC6_73.7	142	73.7	1.872	2.82	0.072	940.06	777.6	5735.54	18092.8	8.055	45.7
	RodC6_75.8	143	75.8	1.925	4.92	0.125	963.21	790.5	5834.33	18404.4	7.936	45.1
	RodC6_76.8	144	76.8	1.951	5.92	0.150	979.27	799.4	5881.38	18552.8	7.829	44.5

Table A-48: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	876.46	742.3	6320.22	19937.1	9.747	55.3
	RodB4_91.3	162	91.3	2.319	2.8	0.071	965.13	791.6	6443.42	20325.8	8.741	49.6
	RodB4_93.3	163	93.3	2.370	4.8	0.122	983.22	801.6	6530.34	20600.0	8.647	49.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	1011.81	817.5	6607.03	20841.9	8.429	47.9
	RodB4_100	165	100	2.540	11.5	0.292	1062.02	845.4	6822.62	21521.9	8.180	46.5
	RodB4_106	166	106	2.692	17.5	0.445	1130.60	883.5	7084.49	22348.0	7.849	44.6
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1057.68	843.0	6858.57	21635.4	8.267	46.9
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1169.84	905.3	2654.87	8374.8	2.819	16.0
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	922.70	768.0	6230.73	19654.8	8.969	50.9
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	906.97	759.2	6361.34	20066.9	9.369	53.2
	RodF4_92.4	100	92.4	2.347	3.9	0.099	1005.45	814.0	6529.78	20598.2	8.399	47.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1037.77	831.9	6613.24	20861.5	8.167	46.4
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1077.09	853.8	6742.33	21268.7	7.941	45.1
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1144.01	890.9	7116.57	22449.2	7.769	44.1
	RodF4_111	104	111	2.819	-1.75	-0.044	1062.41	845.6	6823.72	21525.4	8.178	46.4
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1148.88	893.6	6277.74	19803.1	6.817	38.7
	RodD2_106	66	106	2.692	17.5	0.445	1171.73	906.3	5945.15	18754.0	6.300	35.8
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1197.10	920.4	5493.28	17328.6	5.668	32.2
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1207.92	926.4	4961.31	15650.5	5.063	28.8
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1200.95	922.6	4457.09	14059.9	4.581	26.0
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1142.99	890.4	7048.25	22233.7	7.703	43.7
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1164.95	902.6	7174.45	22631.8	7.657	43.5
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1101.18	867.1	6583.94	20769.0	7.540	42.8
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1146.76	892.5	7059.96	22270.6	7.684	43.6
	RodD6_106	130	106	2.692	17.5	0.445	1160.97	900.4	7189.78	22680.2	7.706	43.8
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1104.05	868.7	6558.54	20688.9	7.486	42.5
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1146.48	892.3	6286.51	19830.8	6.844	38.9
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1170.86	905.8	6031.12	19025.2	6.397	36.3
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1189.96	916.5	5479.64	17285.5	5.696	32.3
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1195.31	919.4	4955.65	15632.6	5.123	29.1
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1187.84	915.3	4432.29	13981.7	4.618	26.2

Table A-48: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	766.37	681.1	4655.34	14685.3	8.647	49.1
	RodE2_54	74	54	1.372	7	0.178	827.33	715.0	4832.17	15243.1	8.063	45.8
	RodE2_56.9	75	56.9	1.445	9.9	0.251	856.94	731.5	4963.39	15657.0	7.892	44.8
	RodE2_59.9	76	59.9	1.521	12.9	0.328	884.63	746.8	5100.69	16090.1	7.768	44.1
	RodE2_66	77	66	1.676	19	0.483	912.45	762.3	5379.37	16969.2	7.859	44.6
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	830.37	716.7	5556.29	17527.3	9.224	52.4
	RodE2_72.9	79	72.9	1.852	2.02	0.051	894.23	752.2	5695.74	17967.2	8.549	48.5
	RodE2_74.9	80	74.9	1.902	4.02	0.102	922.63	767.9	5786.51	18253.5	8.330	47.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	726.96	659.2	4631.43	14609.8	9.282	52.7
	RodB3_54.1	170	54.1	1.374	7.1	0.180	785.75	691.9	4807.33	15164.7	8.619	48.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	825.71	714.1	4933.14	15561.6	8.253	46.9
	RodB3_60.1	172	60.1	1.527	13.1	0.333	826.27	714.4	5074.76	16008.3	8.482	48.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	879.61	744.0	5346.27	16864.8	8.205	46.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	774.07	685.4	5518.99	17409.6	10.107	57.4
	RodB3_73	175	73	1.854	2.12	0.054	853.92	729.8	5661.66	17859.7	9.045	51.4
	RodB3_75	176	75	1.905	4.12	0.105	890.94	750.3	5753.09	18148.1	8.678	49.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	743.26	668.3	4630.48	14606.8	8.987	51.0
	RodF3_54	90	54	1.372	7	0.178	798.63	699.1	4809.01	15170.0	8.428	47.9
	RodF3_57	91	57	1.448	10	0.254	838.63	721.3	4949.57	15613.4	8.106	46.0
	RodF3_60	92	60	1.524	13	0.330	869.47	738.4	5087.65	16049.0	7.931	45.0
	RodF3_66.1	93	66.1	1.679	19.1	0.485	898.14	754.3	5368.01	16933.4	8.010	45.5
	RodF3_70	94	70	1.778	-0.88	-0.022	791.94	695.3	5542.25	17483.0	9.828	55.8
	RodF3_73	95	73	1.854	2.12	0.054	886.29	747.8	5683.88	17929.8	8.634	49.0
	RodF3_75	96	75	1.905	4.12	0.105	928.62	771.3	5777.19	18224.1	8.246	46.8
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	750.36	672.2	4628.66	14601.1	8.861	50.3
	RodE6_54.1	122	54.1	1.374	7.1	0.180	805.98	703.1	4802.01	15148.0	8.308	47.2
	RodE6_57	123	57	1.448	10	0.254	833.05	718.2	4931.37	15556.0	8.150	46.3
	RodE6_60.2	124	60.2	1.529	13.2	0.335	853.49	729.5	5073.41	16004.1	8.111	46.1
	RodE6_66.1	125	66.1	1.679	19.1	0.485	883.53	746.2	5337.02	16835.6	8.142	46.2
	RodE6_70	126	70	1.778	-0.88	-0.022	821.30	711.6	5511.07	17384.7	9.289	52.8
	RodE6_73.1	127	73.1	1.857	2.22	0.056	888.41	748.9	5648.04	17816.7	8.552	48.6
	RodE6_75	128	75	1.905	4.12	0.105	919.74	766.3	5733.48	18086.3	8.288	47.1

RBHT Steam Cooling with Droplet Injection Test SCD-4049-F

Matrix Test # 5b

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 21900 - 24000
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 75 kW
Bundle Inlet Reynolds Number: 10000
Bundle Inlet Steam Flow: 181.4 kg/hr (400 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

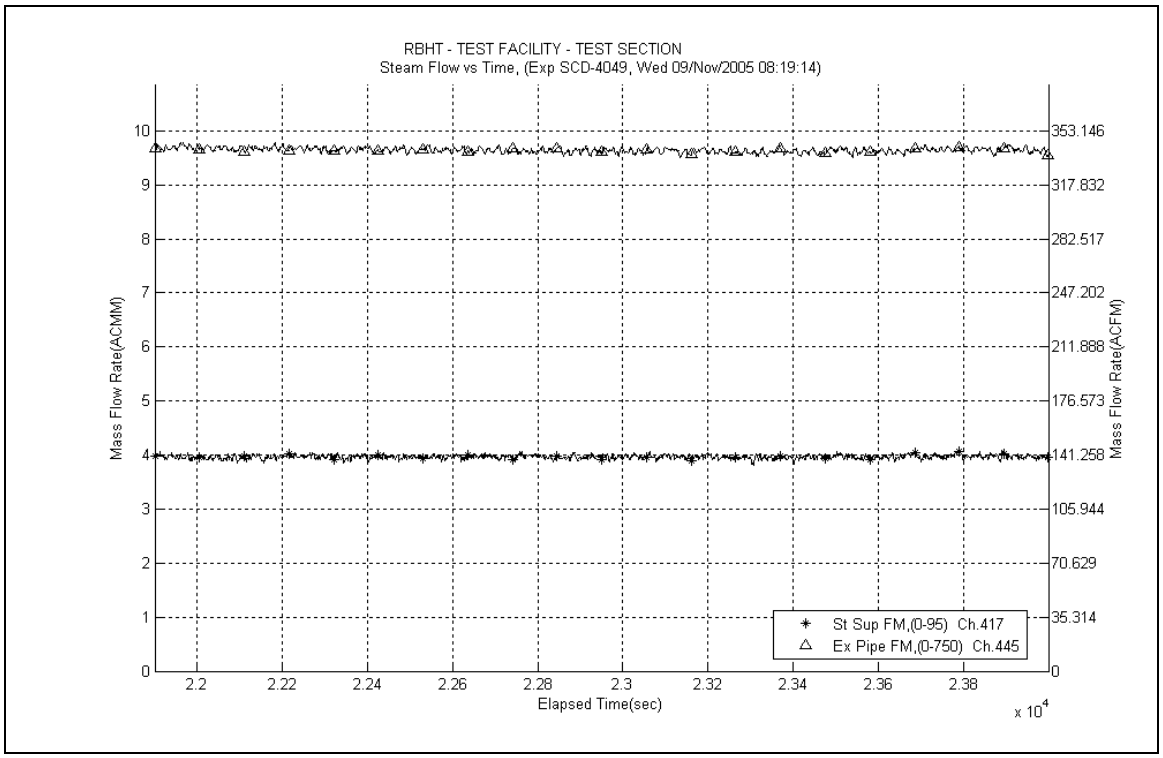

Figure A-156: Inlet and Exhaust Steam Flow Rates for Experiment 4049F

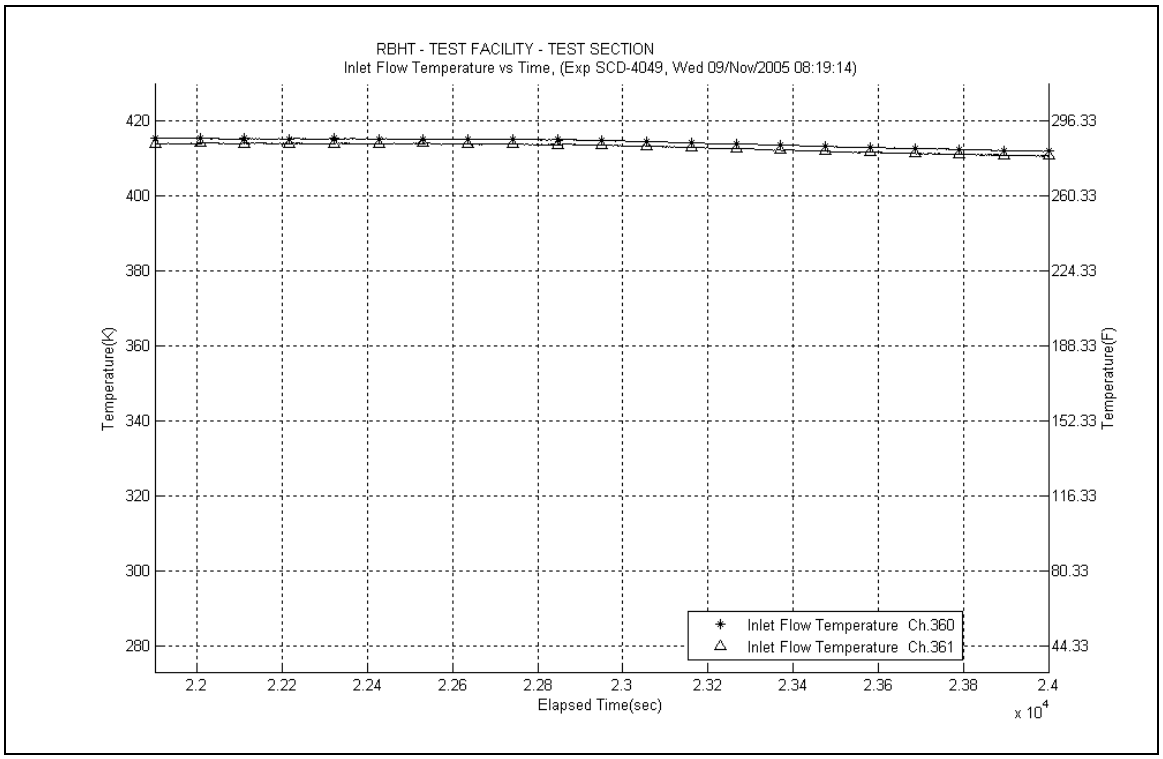

Figure A-157: Inlet Steam Temperature for Experiment 4049F

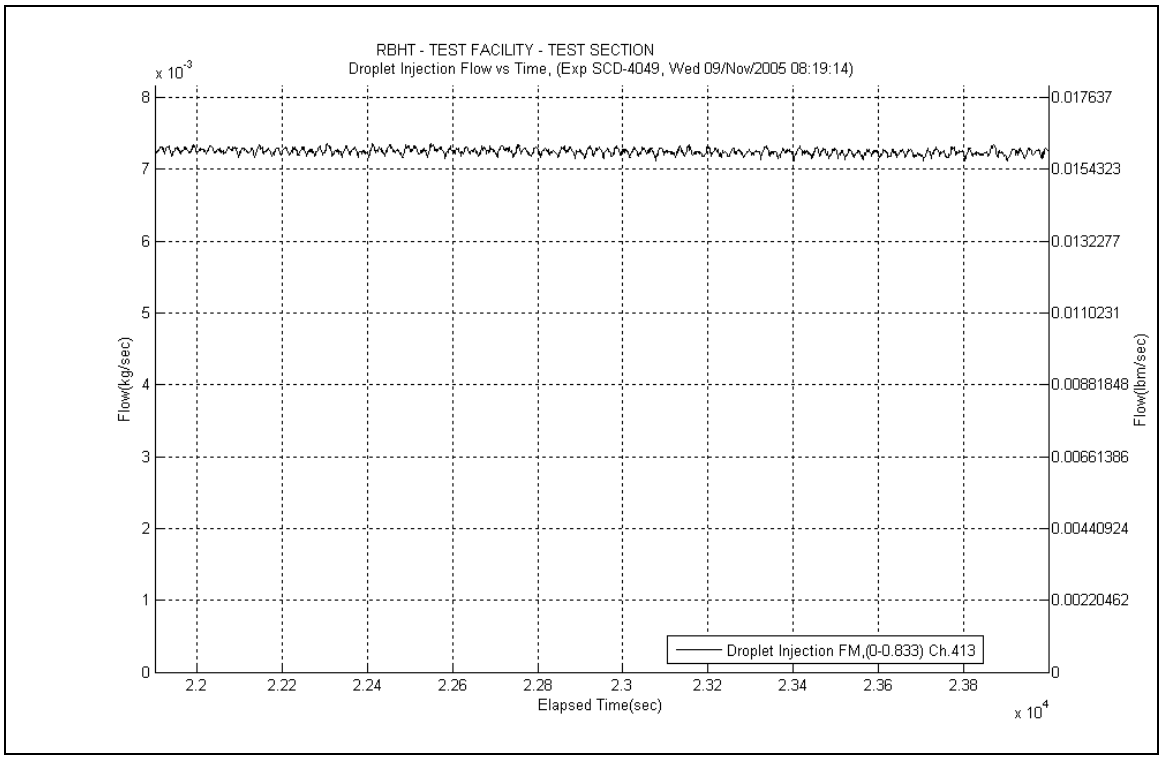

Figure A-158: Droplet Injection Flow Rate for Experiment 4049F

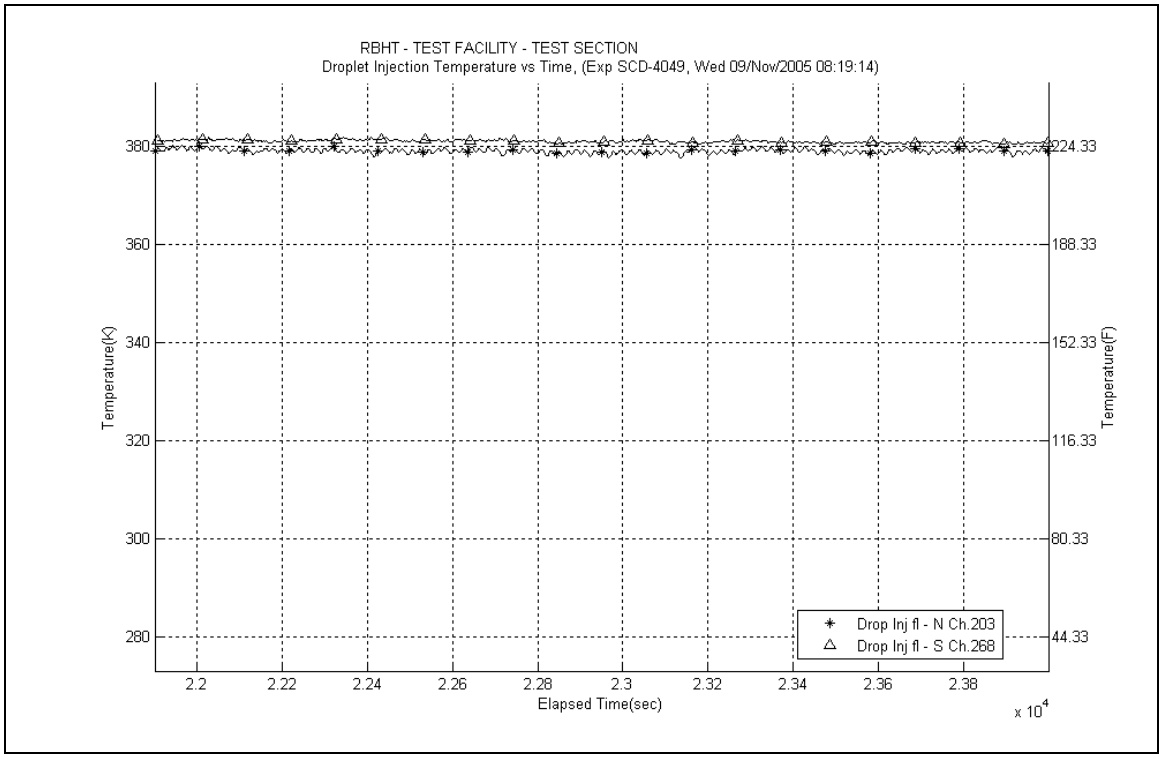

Figure A-159: Droplet Injection Temperature for Experiment 4049F

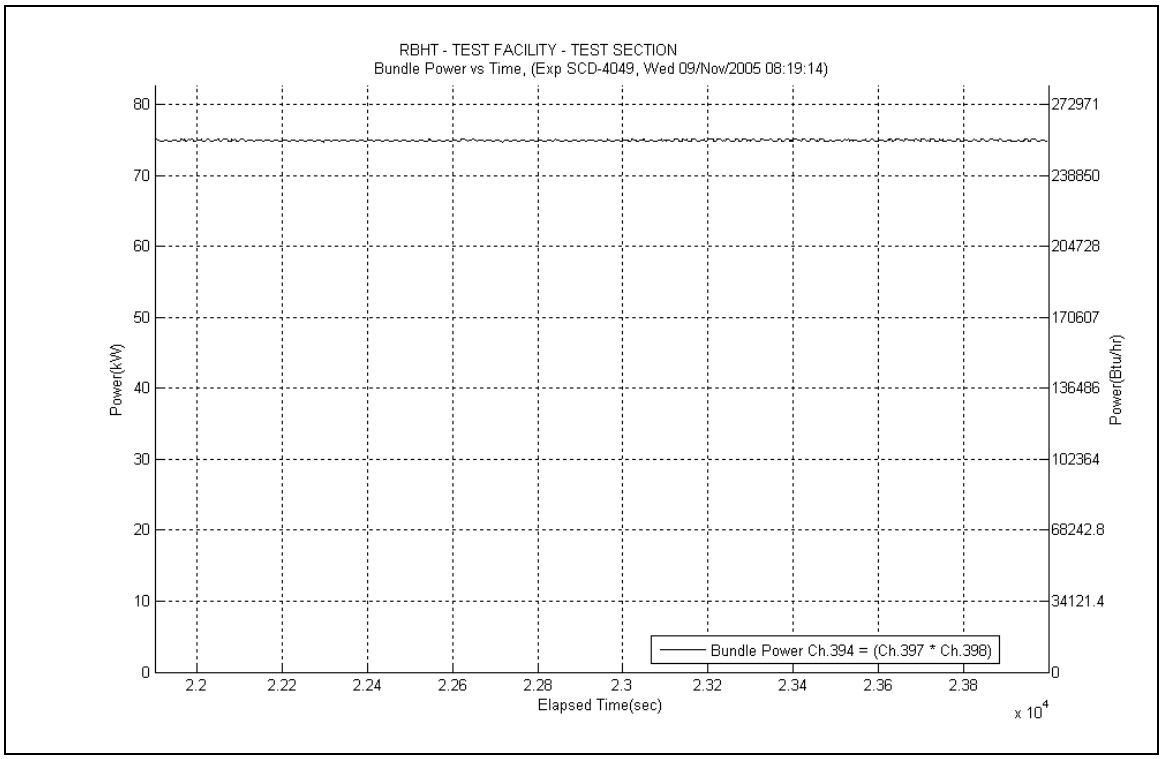

Figure A-160: Bundle Power for Experiment 4049F

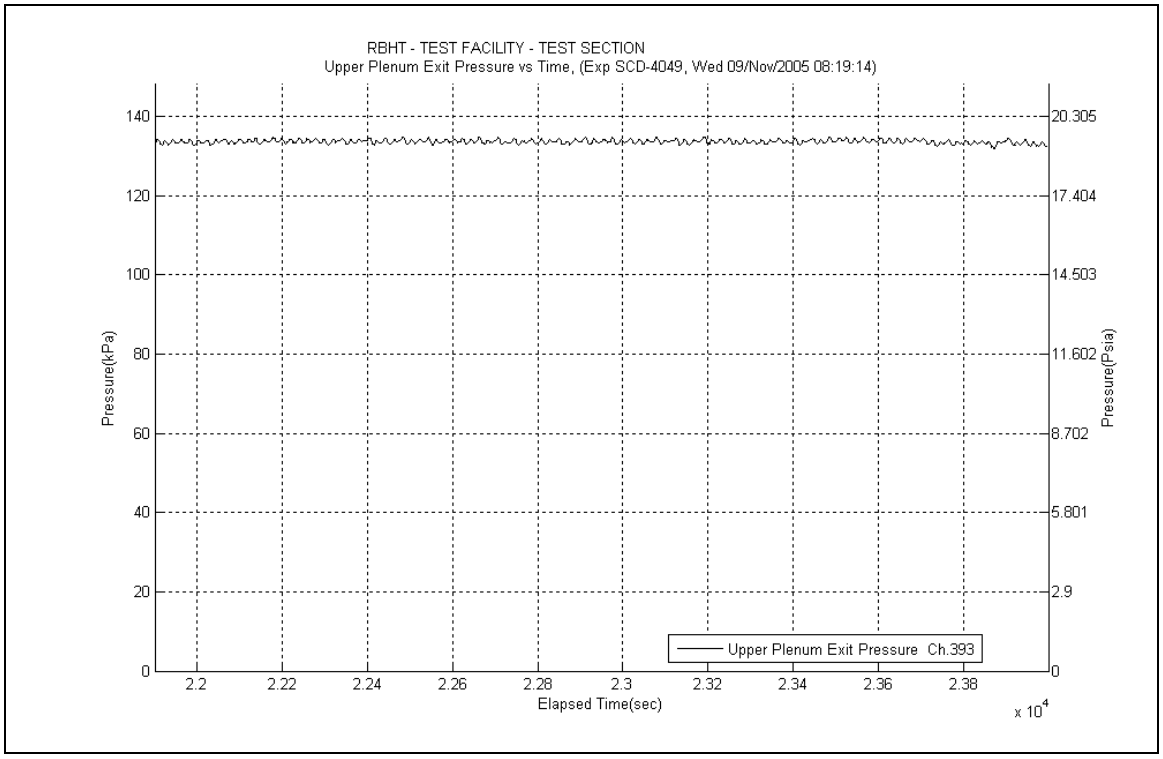

Figure A-161: Upper Plenum Pressure for Experiment 4049F

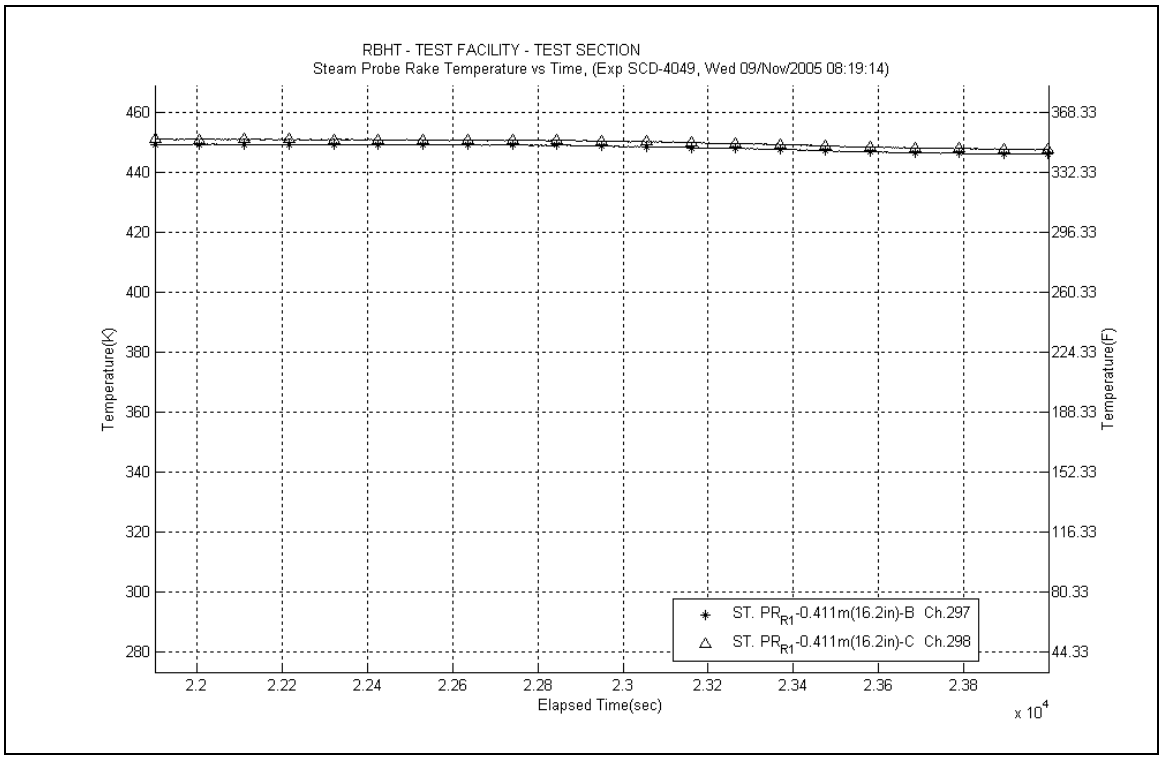

Figure A-162: Steam Probe Rake #1 Temperatures for Experiment 4049F

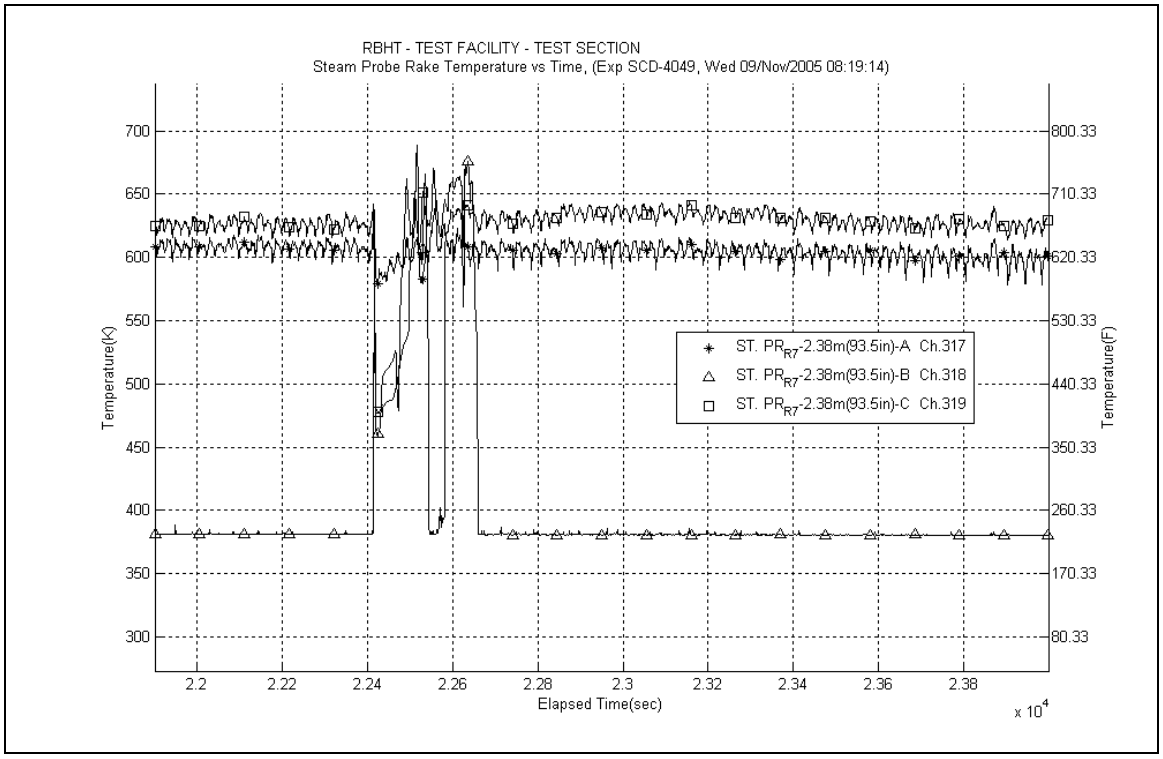

Figure A-163: Steam Probe Rake #7 Temperatures for Experiment 4049F

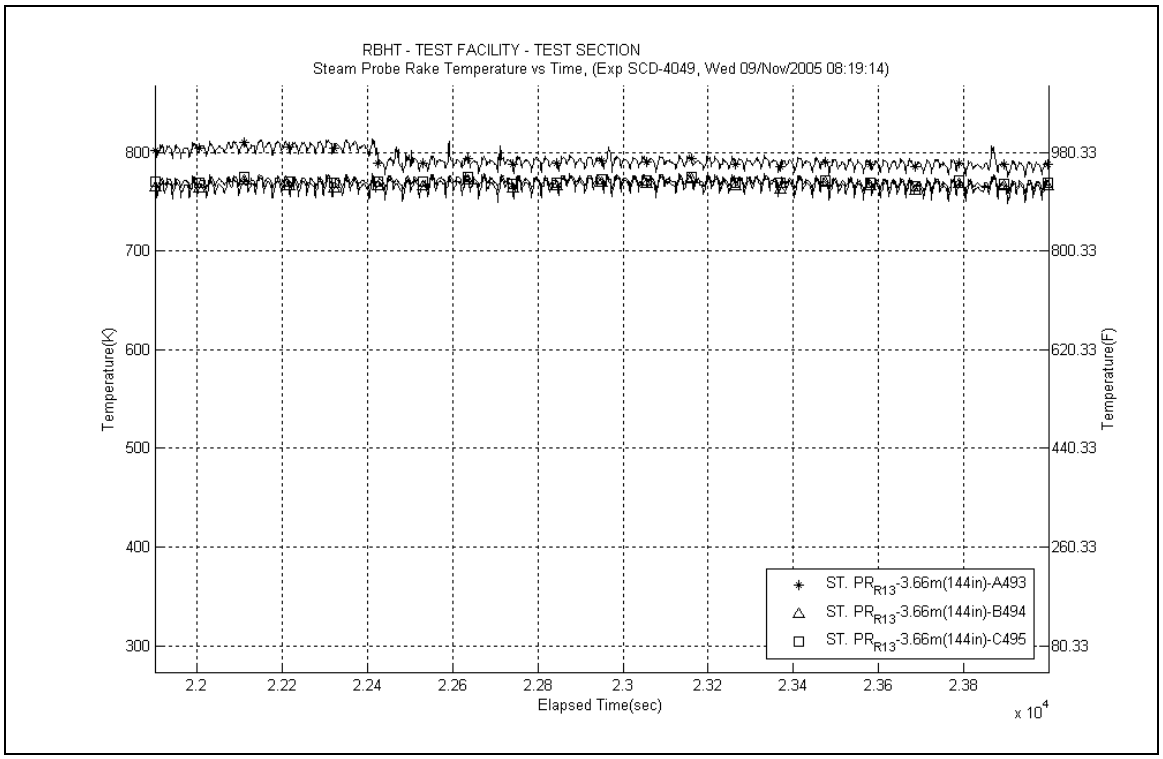

Figure A-164: Steam Probe Rake #13 Temperatures for Experiment 4049F

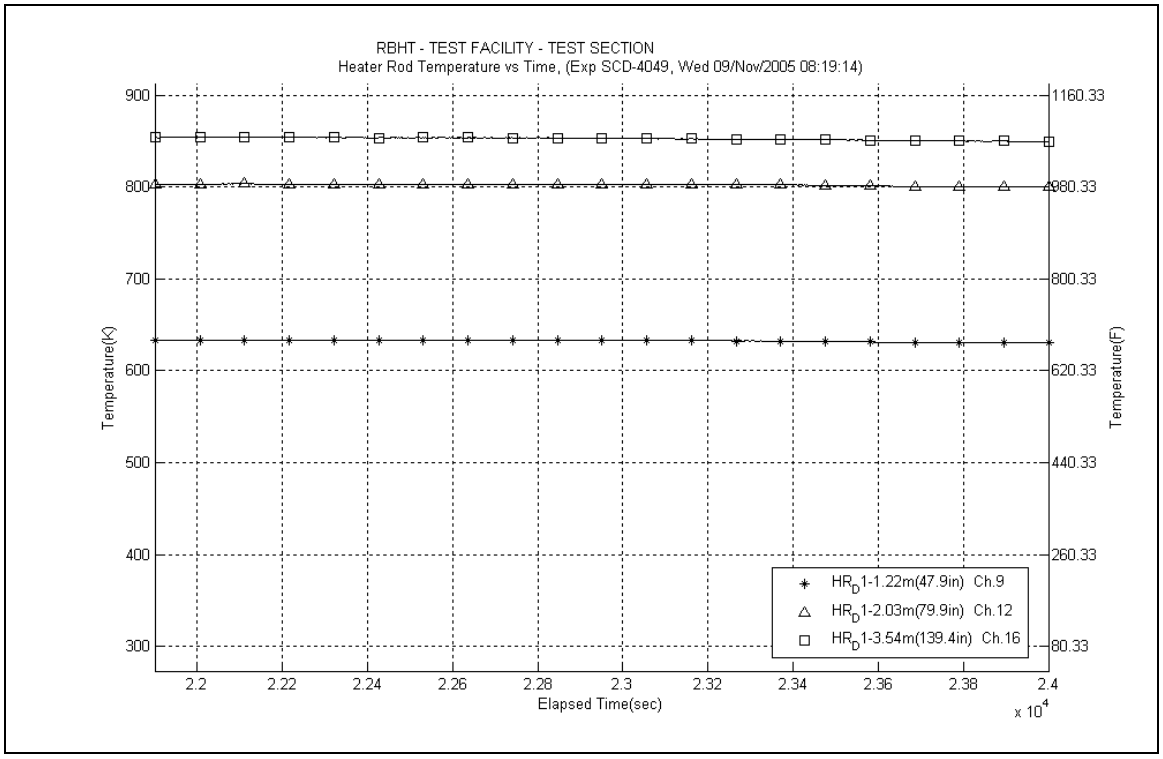

Figure A-165: Heater Rod D1 Temperatures for Experiment 4049F

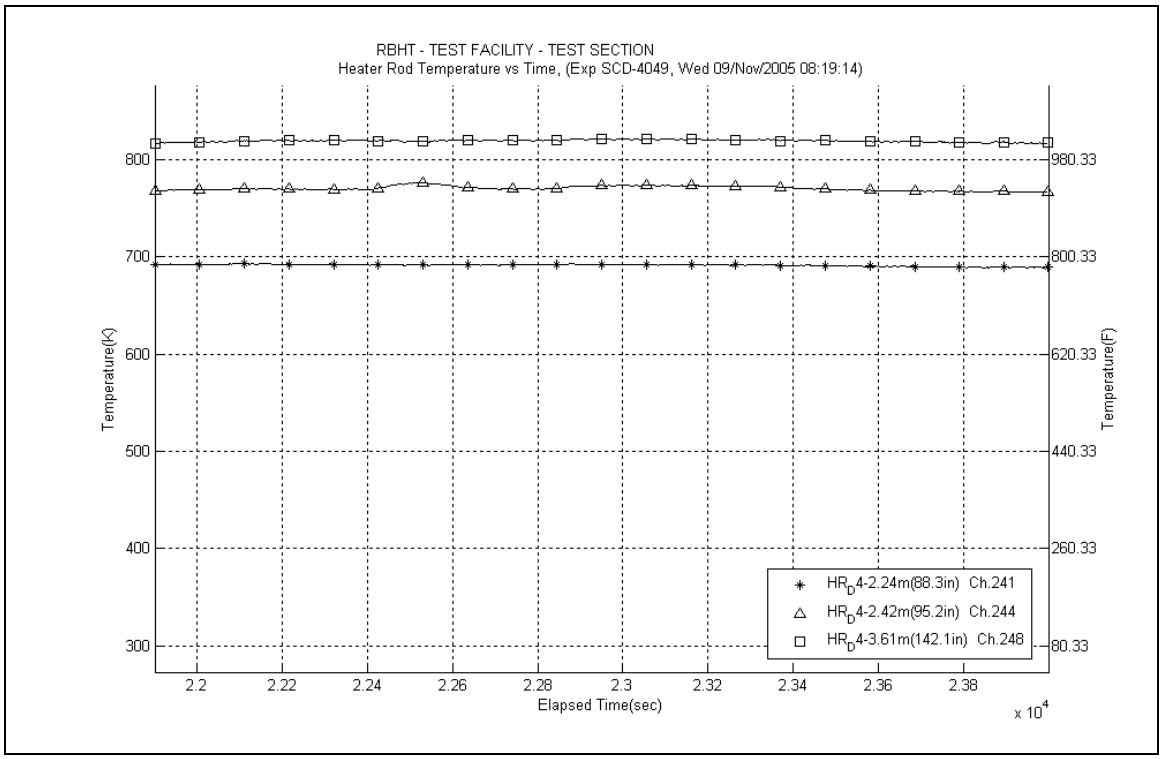

Figure A-166: Heater Rod D4 Temperatures for Experiment 4049F

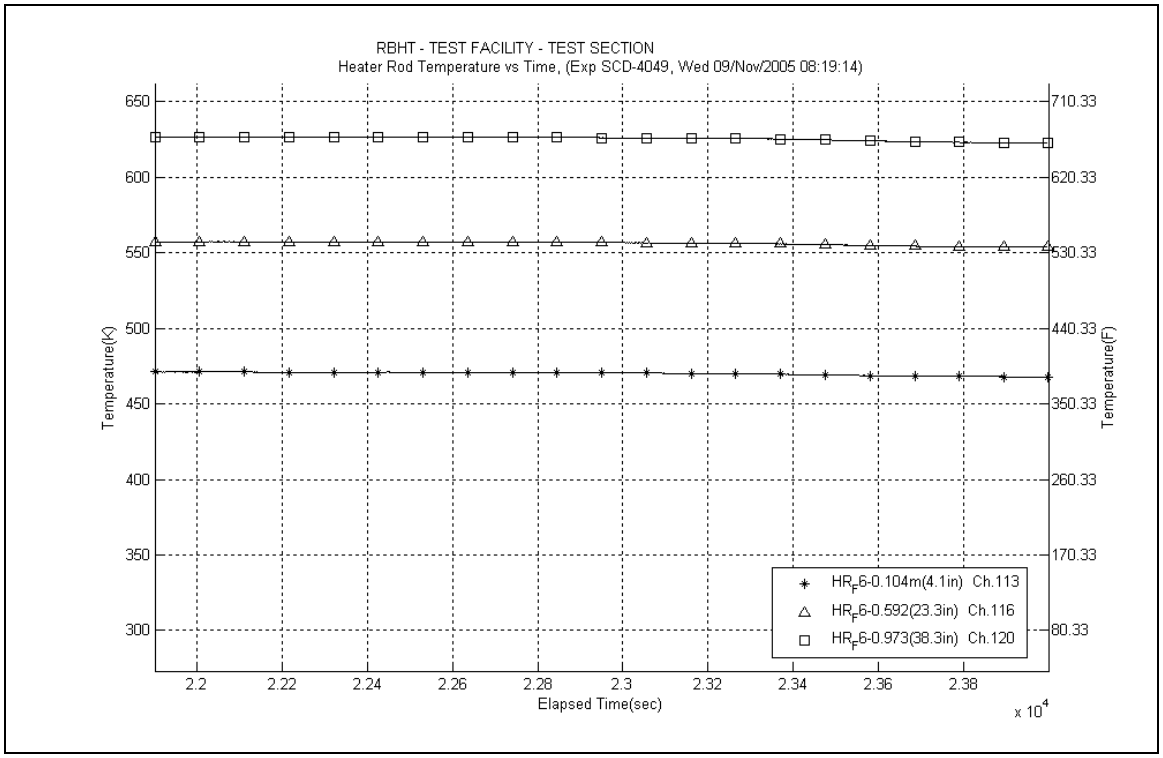

Figure A-167: Heater Rod F6 Temperatures for Experiment 4049F

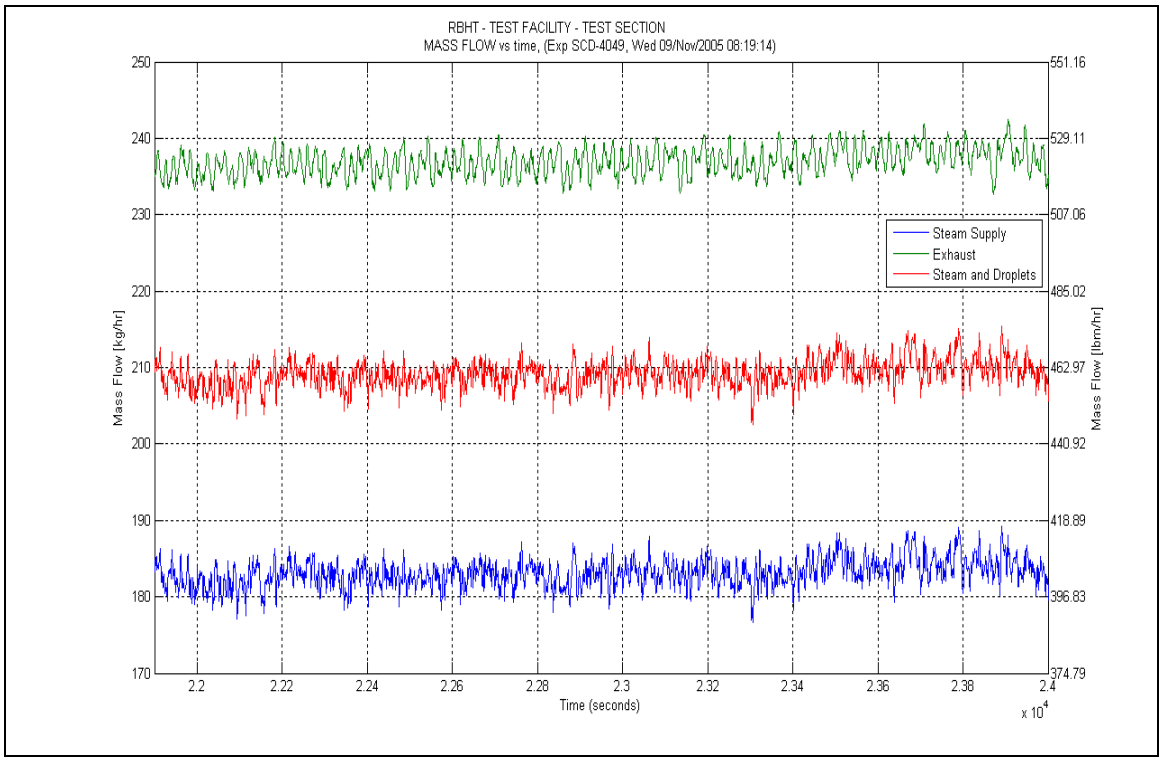

Figure A-168: Mass Flow for Experiment 4049F

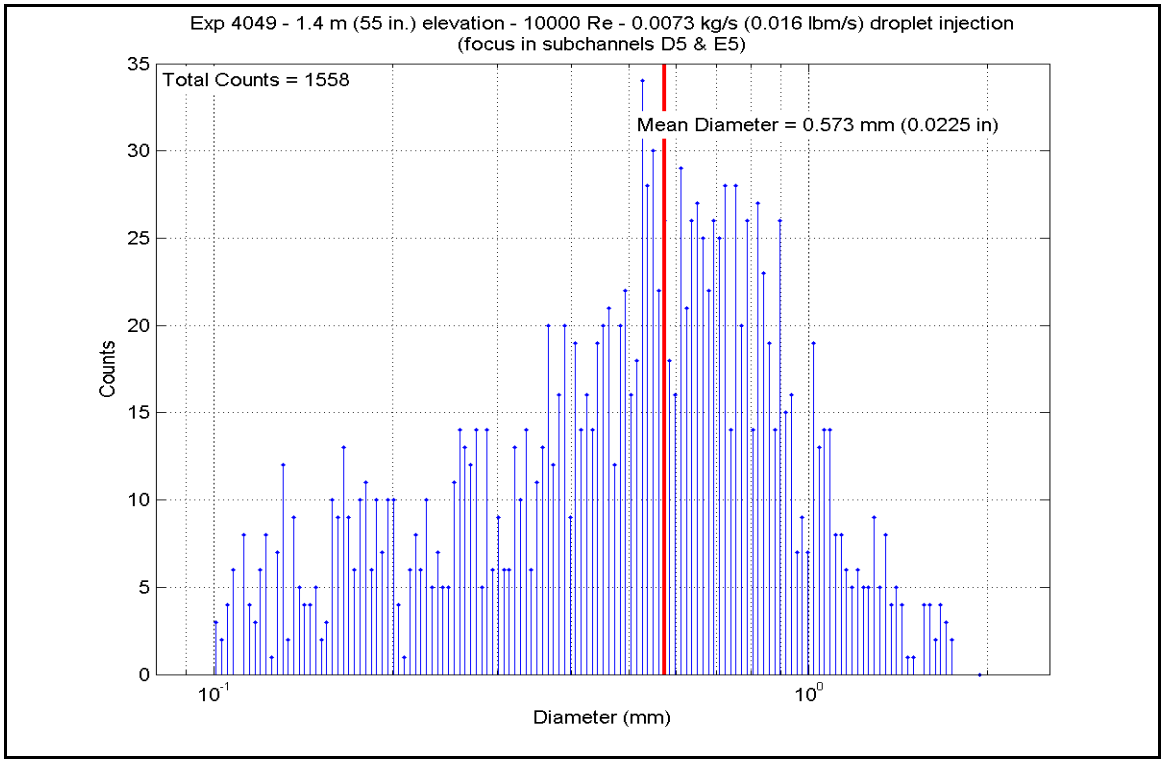

Figure A-169: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049F

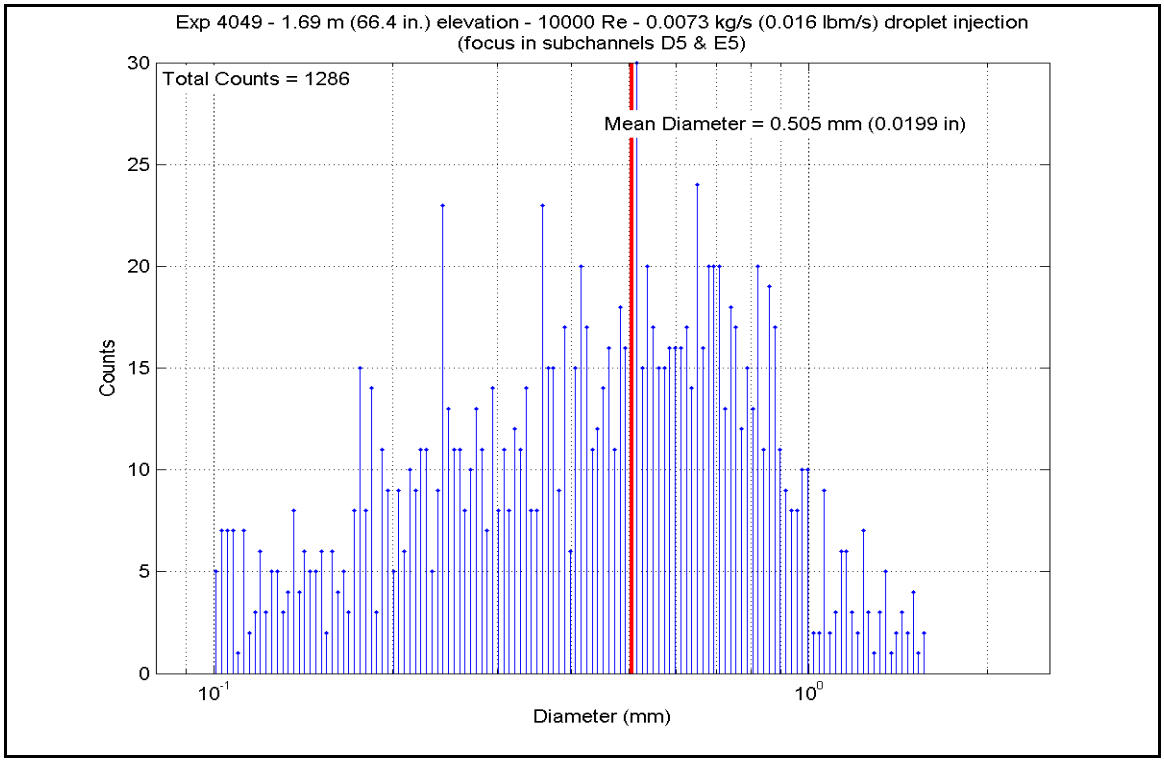

Figure A-170: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049F

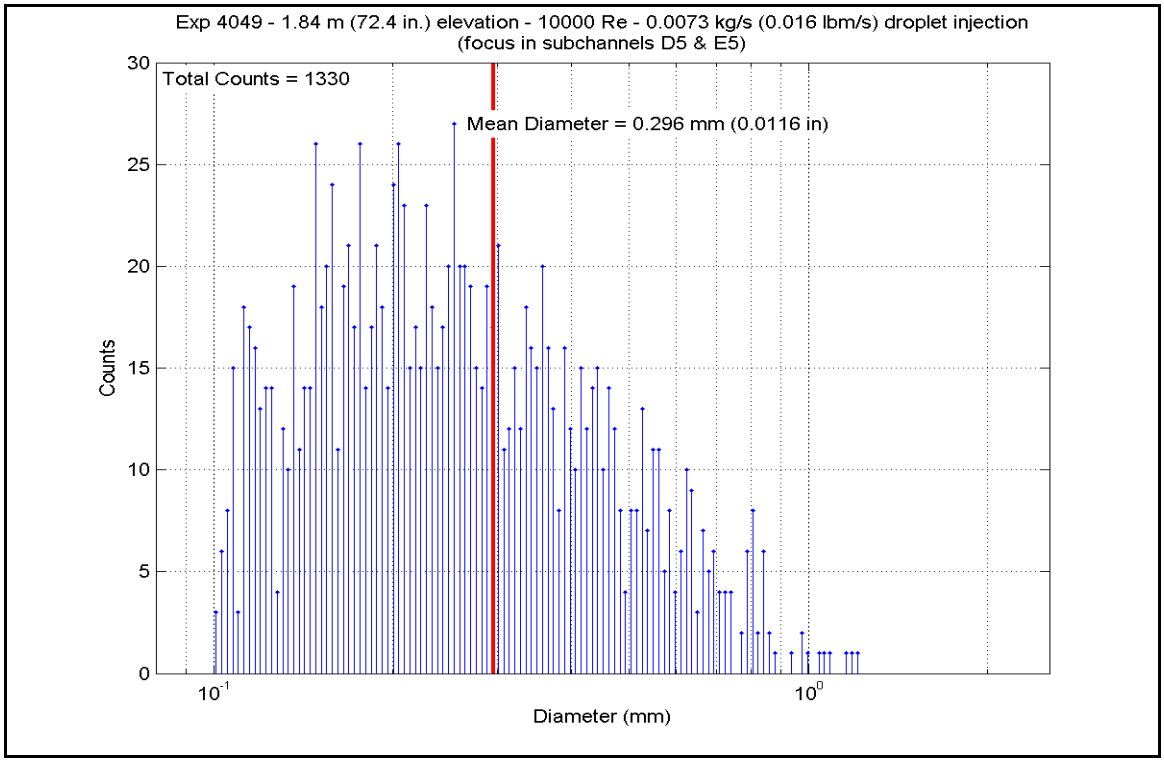

Figure A-171: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049F

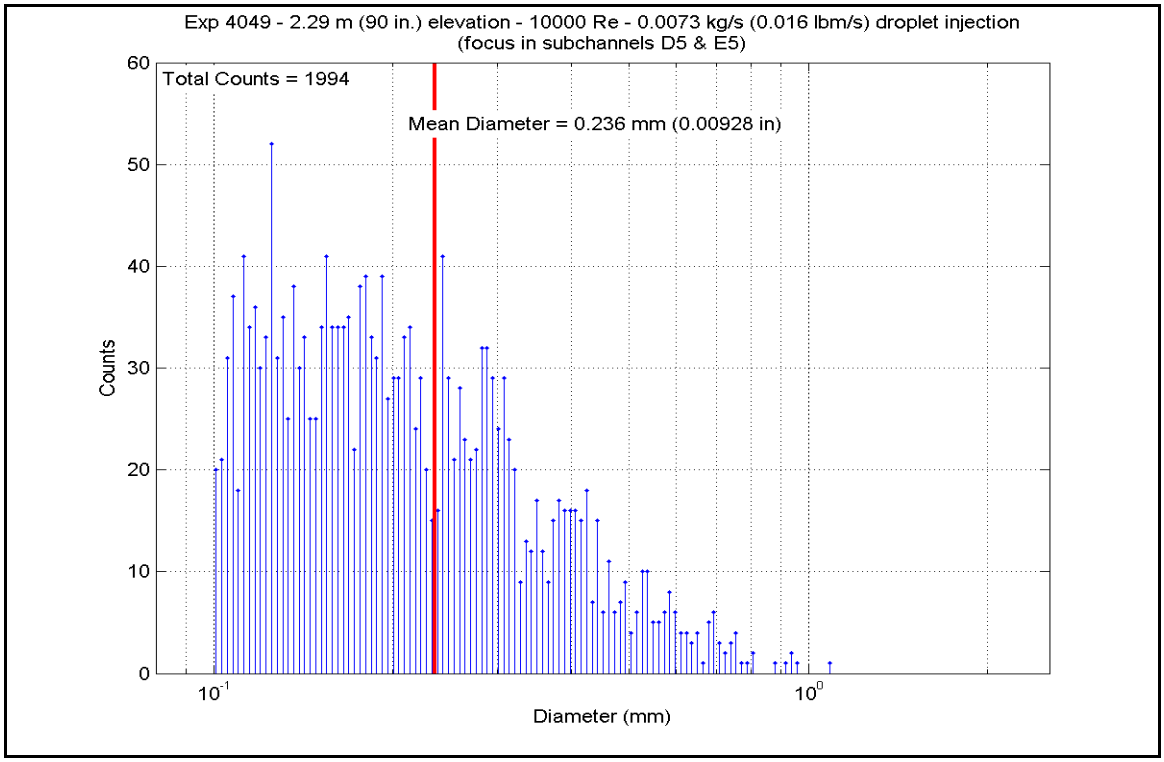

Figure A-172: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049F

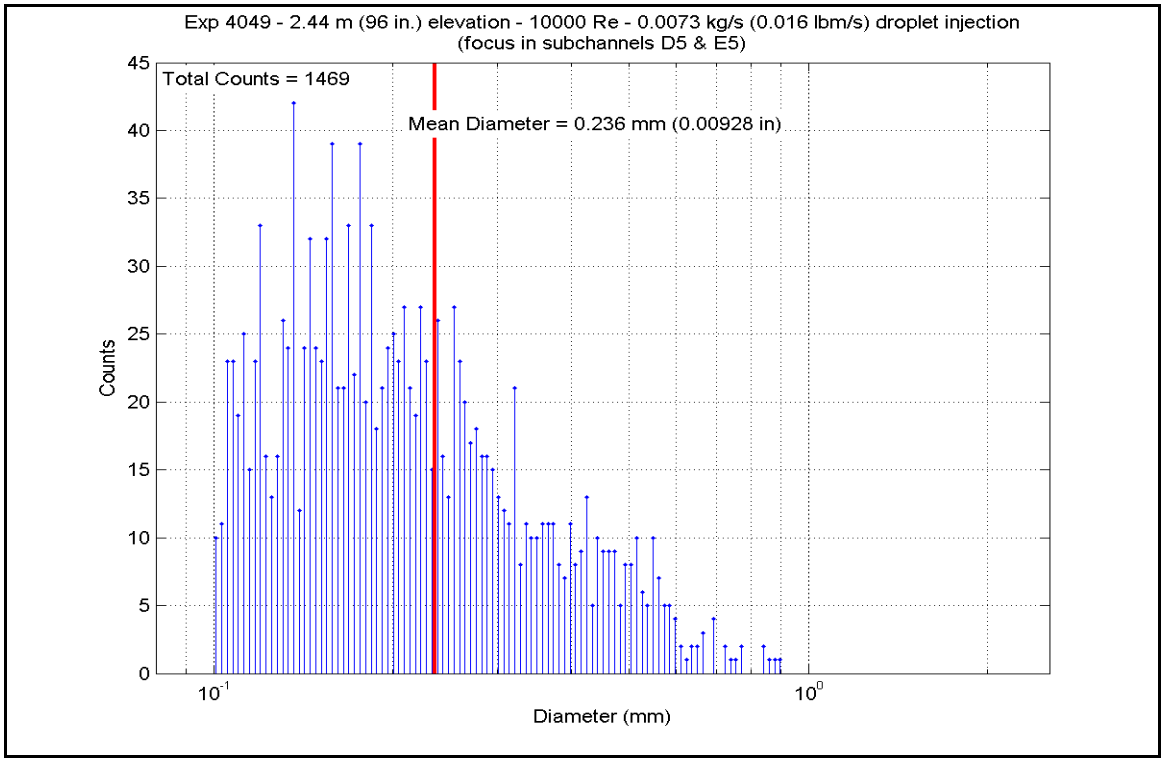

Figure A-173: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049F

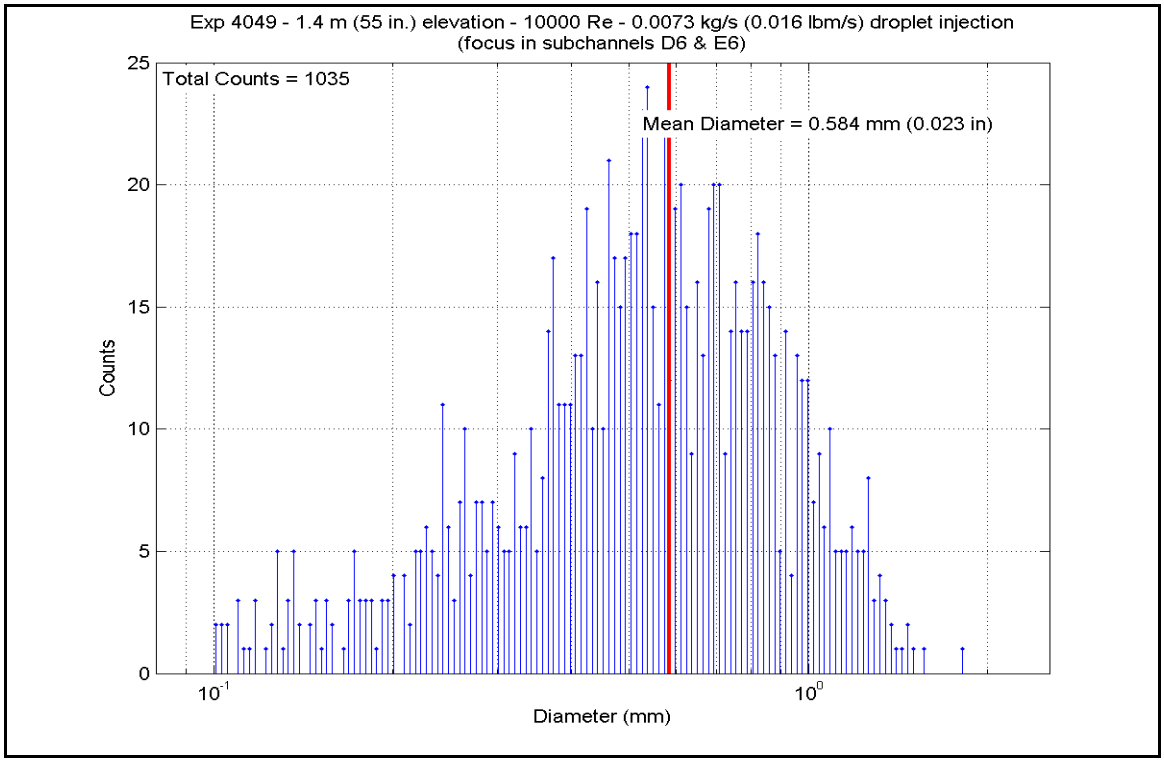

Figure A-174: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049F

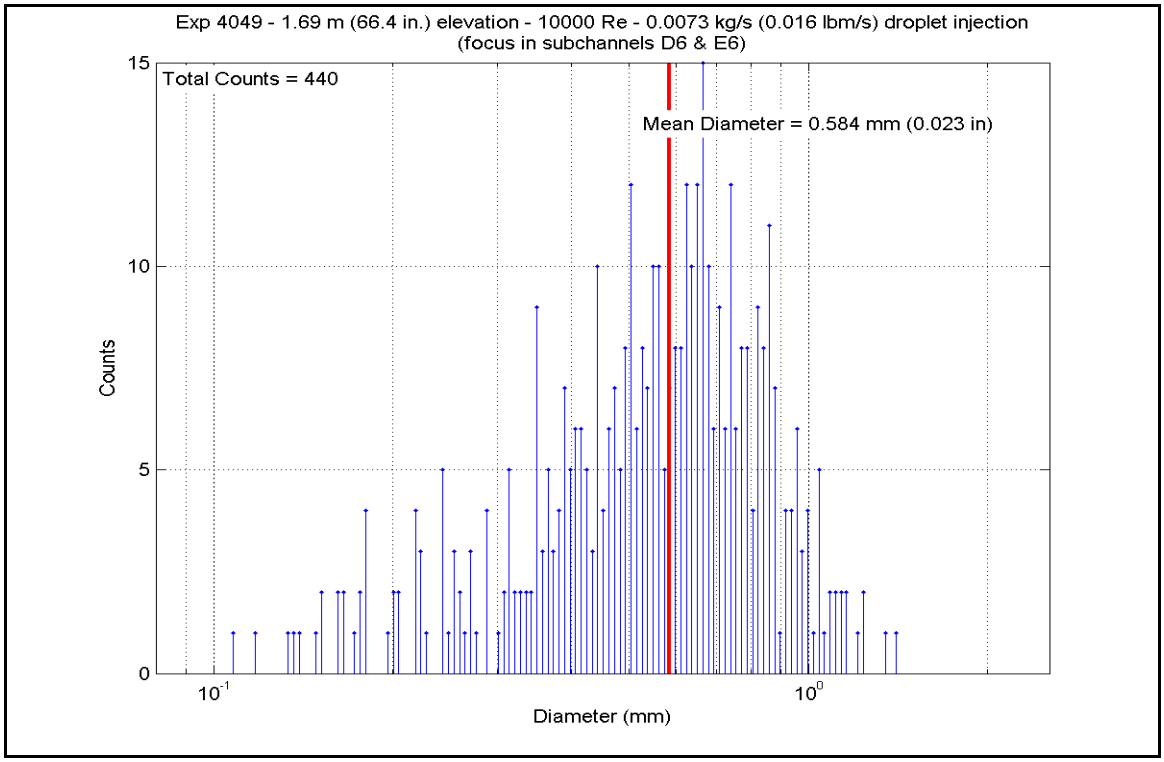

Figure A-175: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049F

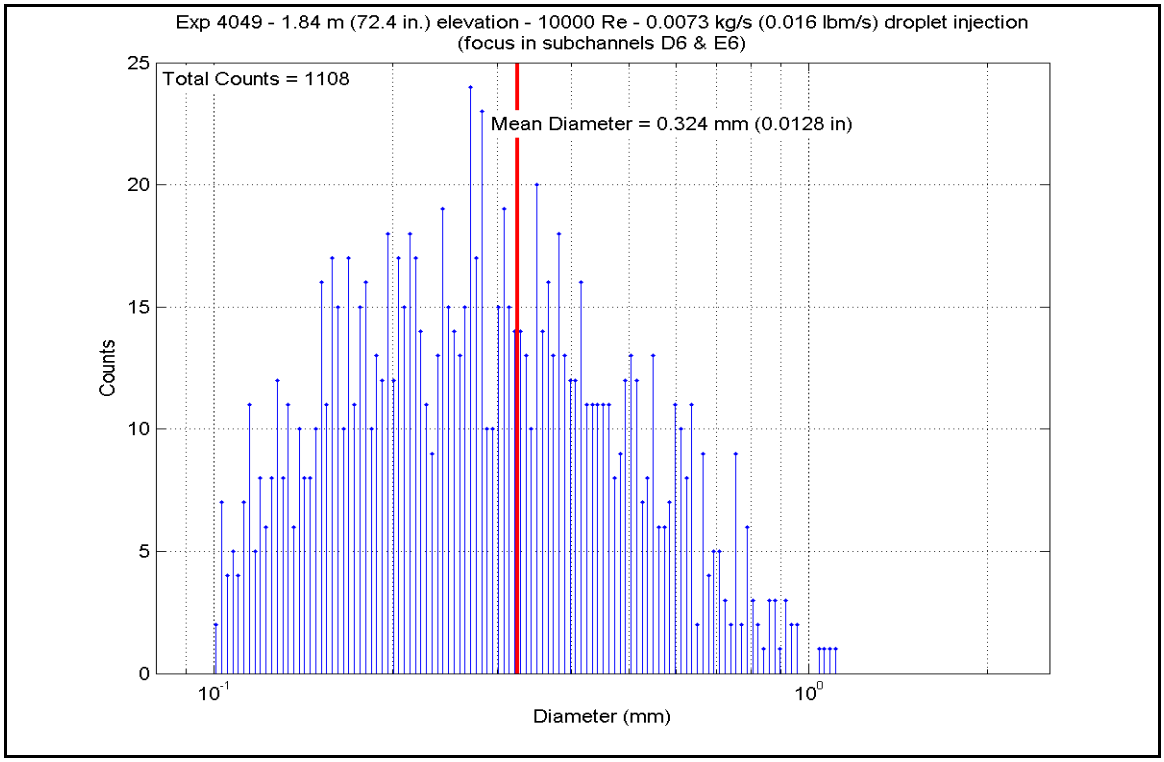

Figure A-176: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049F

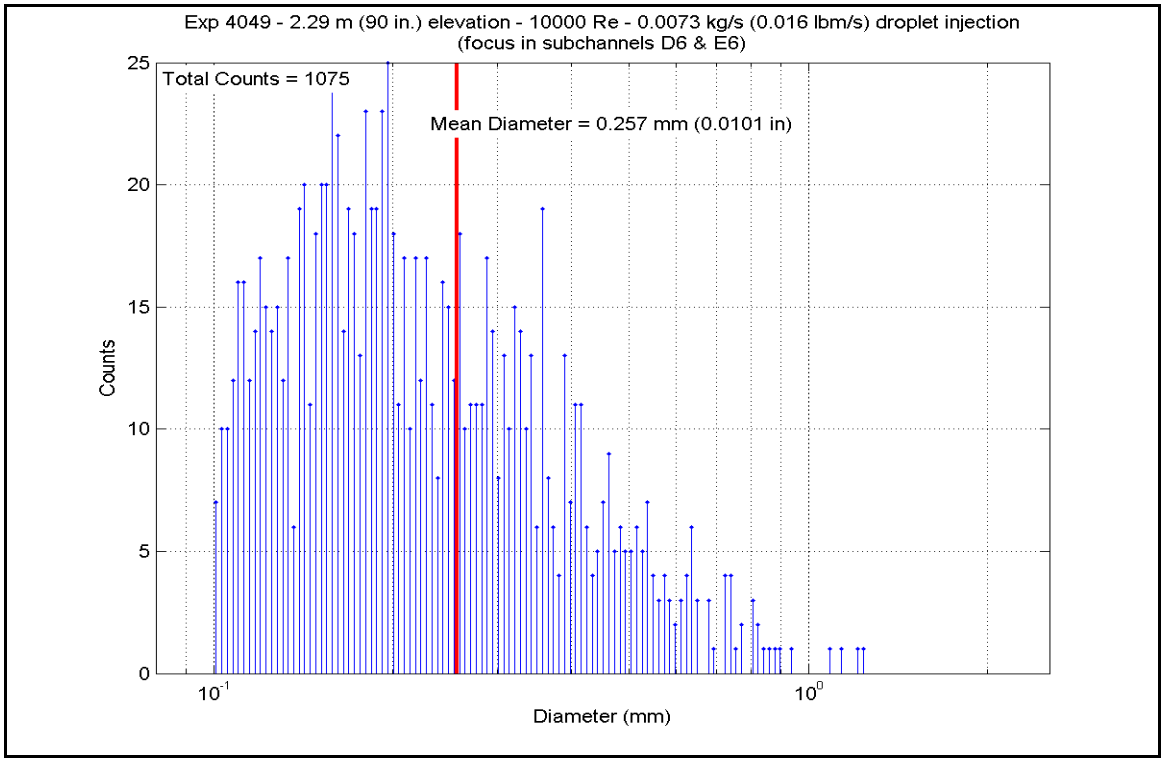

Figure A-177: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049F

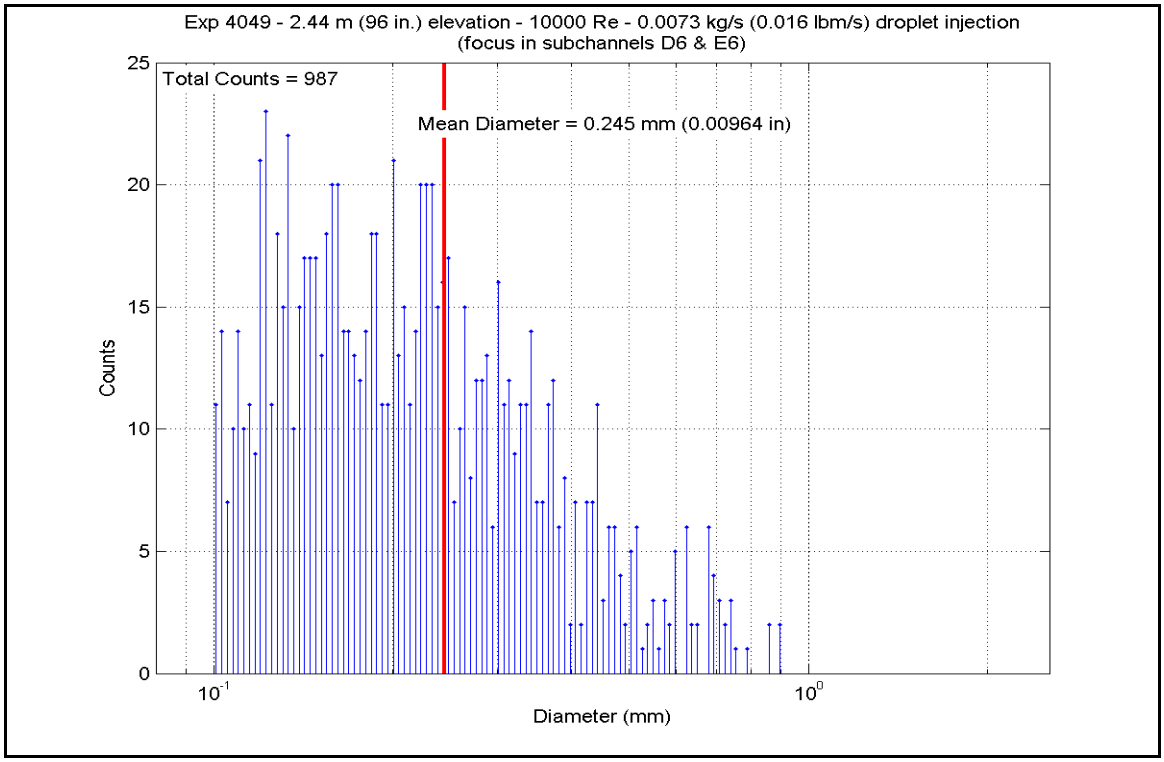

Figure A-178: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049F

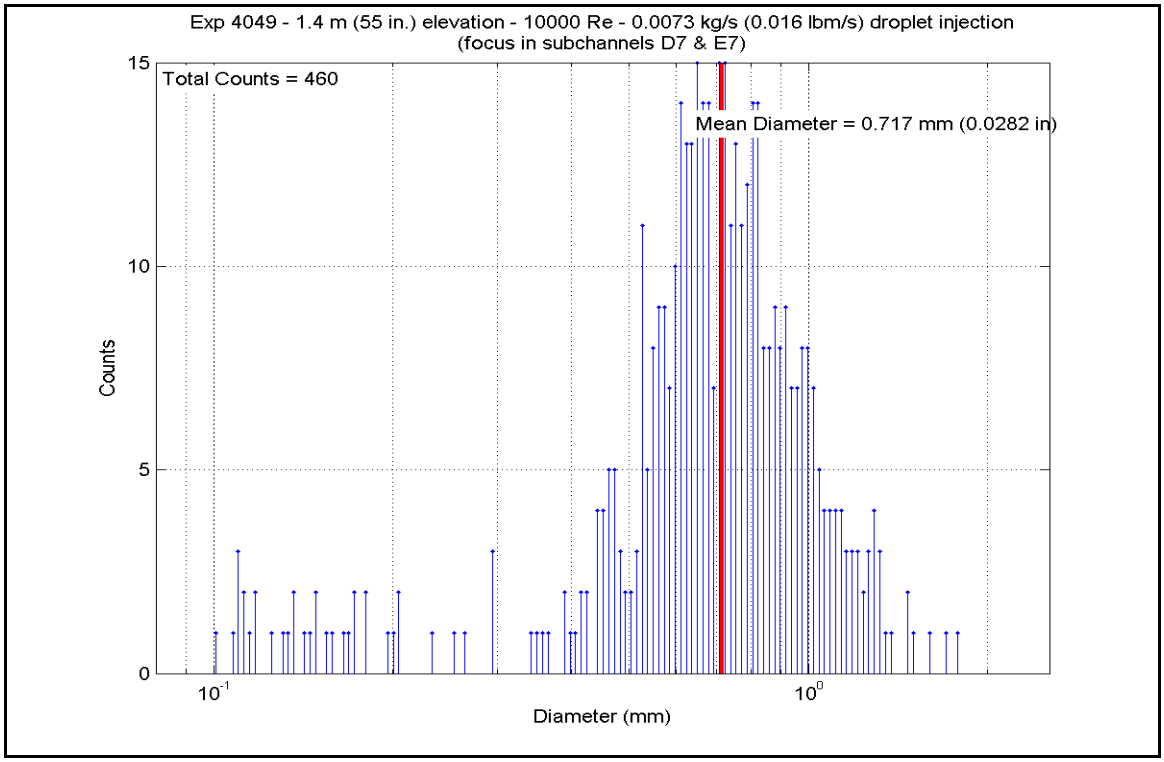

Figure A-179: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049F

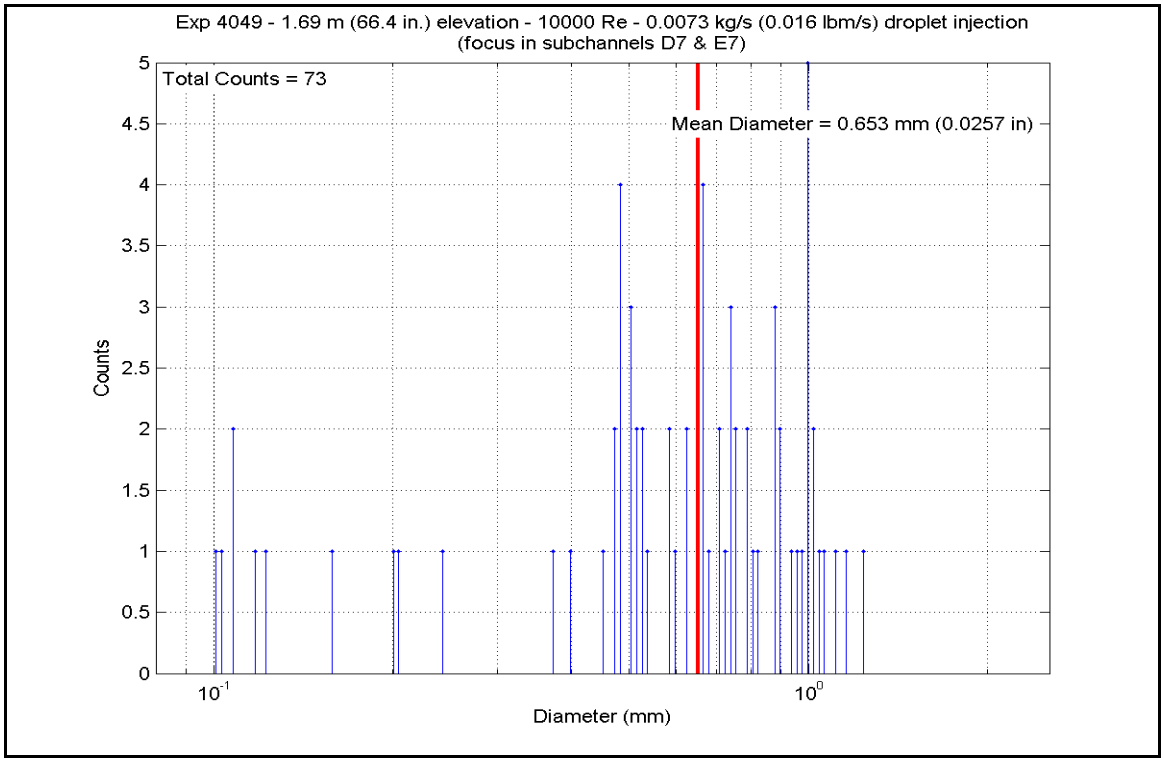

Figure A-180: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049F

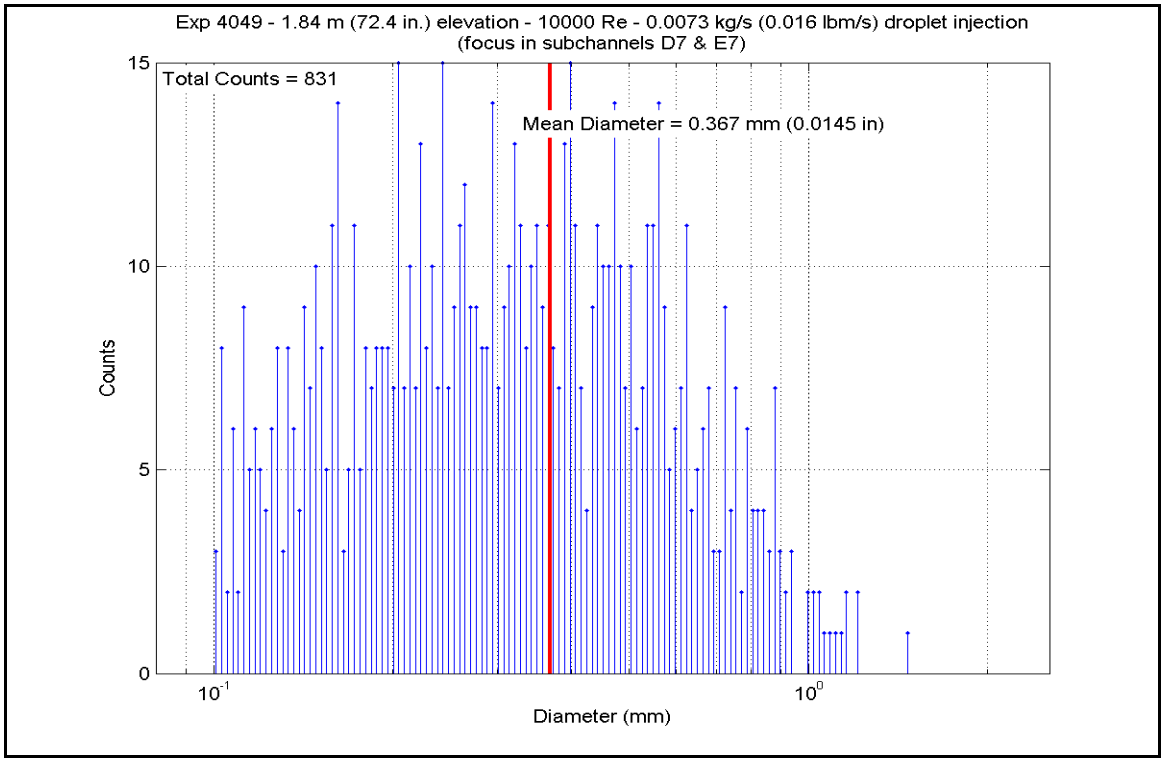

Figure A-181: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049F

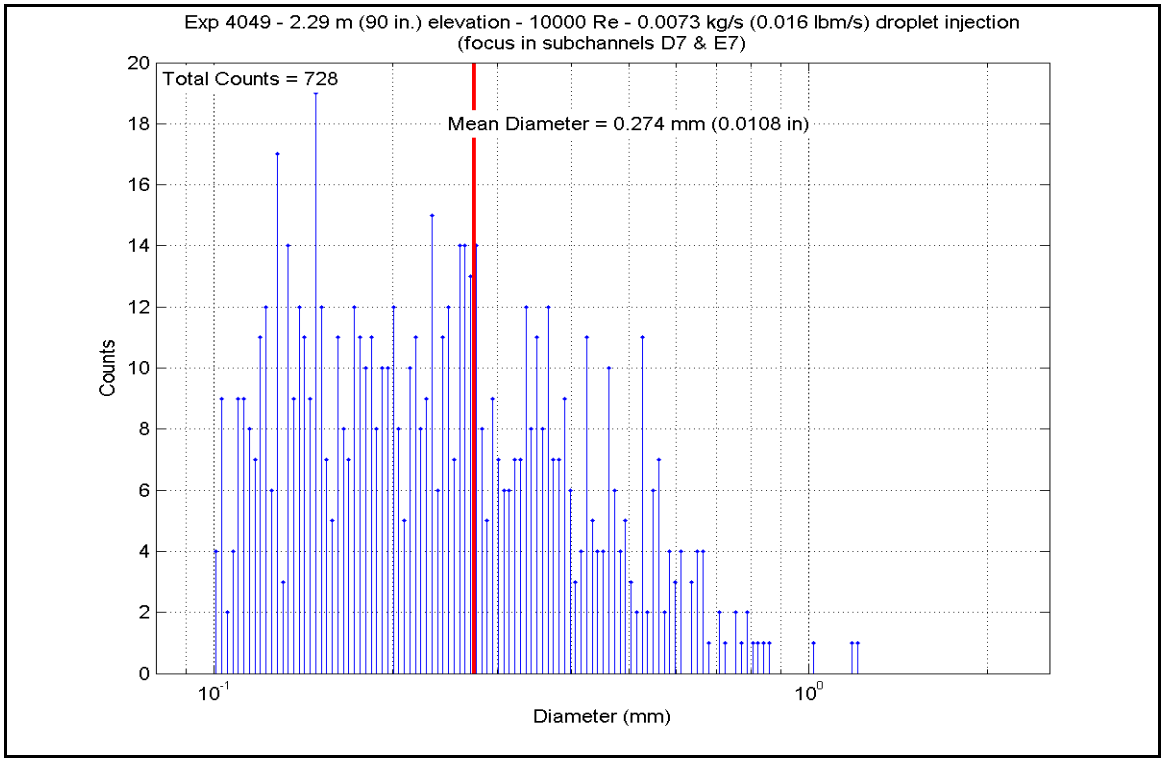

Figure A-182: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049F

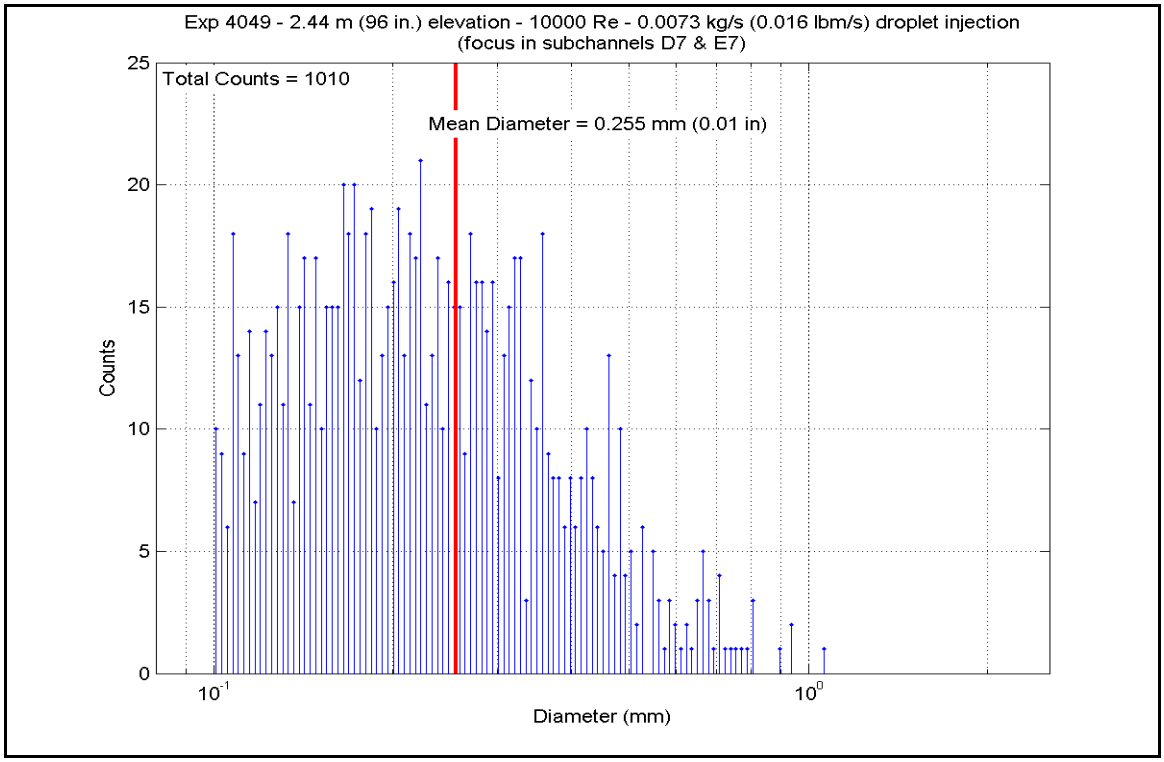

Figure A-183: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049F

Table A-49: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049F

SCD-4049-F		Inlet Reynolds:	10000		
Matrix Test # 5b		UP Pressure:	137.9 kPa	20	psia
Time Window: 21900-24000		Bundle Power:	75.00 kW	255911	Btu/hr
		Steam flow:	0.0504 kg/s	400.0	lbm/hr
		Droplet flow:	0.0073 kg/s	0.016	lbm/s
Inner 3x3					

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	815.71	708.5	6365.07	20078.6	10.830	61.5
	RodD3_91.3	186	91.3	2.319	2.8	0.071	895.98	753.1	6499.53	20502.8	9.730	55.3
	RodD3_93.1	187	93.1	2.365	4.6	0.117	902.54	756.8	6580.53	20758.3	9.756	55.4
	RodD3_95.3	188	95.3	2.421	6.8	0.173	945.03	780.4	6679.90	21071.8	9.316	52.9
	RodD3_100.1	189	100.1	2.543	11.6	0.295	977.53	798.4	6897.07	21756.8	9.202	52.3
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1069.57	849.6	7167.63	22610.3	8.517	48.4
	RodD3_110	191	110	2.794	21.5	0.546	971.41	795.0	7080.05	22334.0	9.524	54.1
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1045.88	836.4	2470.84	7794.2	3.021	17.2
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	789.51	694.0	6438.68	20310.8	11.467	65.1
	RodC4_91.1	234	91.1	2.314	2.6	0.066	876.55	742.3	6562.07	20700.1	10.118	57.5
	RodC4_93.4	235	93.4	2.372	4.9	0.124	898.96	754.8	6667.75	21033.4	9.938	56.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	937.44	776.2	6754.85	21308.2	9.521	54.1
	RodC4_100.1	237	100.1	2.543	11.6	0.295	968.30	793.3	6974.79	22002.0	9.422	53.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1037.21	831.6	7250.68	22872.3	8.960	50.9
	RodC4_110	239	110	2.794	21.5	0.546	919.39	766.1	7022.98	22154.0	10.158	57.7
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1007.25	815.0	2678.05	8447.9	3.437	19.5
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	782.74	690.2	6416.74	20241.6	11.567	65.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	869.36	738.3	6551.19	20665.7	10.215	58.0
	RodD4_93.2	243	93.2	2.367	4.7	0.119	891.03	750.4	6637.11	20936.7	10.010	56.8
	RodD4_95.2	244	95.2	2.418	6.7	0.170	924.73	769.1	6728.20	21224.1	9.657	54.8
	RodD4_100.1	245	100.1	2.543	11.6	0.295	973.98	796.5	6952.15	21930.6	9.319	52.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1038.58	832.4	7225.28	22792.2	8.914	50.6
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1014.22	818.8	2588.22	8164.5	3.292	18.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	792.30	695.5	6320.21	19937.1	11.200	63.6
	RodE4_91.2	202	91.2	2.316	2.7	0.069	889.46	749.5	6441.24	20318.9	9.738	55.3
	RodE4_95.3	204	95.3	2.421	6.8	0.173	957.93	787.6	6619.82	20882.2	9.069	51.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1006.66	814.6	6863.94	21652.3	8.815	50.1
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1036.78	831.4	2617.24	8256.1	3.236	18.4

Table A-49: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	905.98	758.7	5236.19	16517.5	7.723	43.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1019.41	821.7	6450.35	20347.6	8.150	46.3
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1053.80	840.8	6210.09	19589.7	7.520	42.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1080.07	855.4	5831.38	18395.1	6.844	38.9
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1084.28	857.8	5301.86	16724.7	6.192	35.2
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1084.94	858.1	4822.85	15213.7	5.628	32.0
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1000.00	810.9	4167.03	13144.9	5.398	30.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1044.74	835.8	3676.16	11596.4	4.501	25.6
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	896.43	753.4	5134.07	16195.4	7.681	43.6
	RodC5_113.6	226	113.6	2.885	0.85	0.022	936.45	775.6	6291.77	19847.4	8.881	50.4
	RodC5_115.7	227	115.7	2.939	2.95	0.075	985.30	802.8	6039.62	19052.0	7.975	45.3
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1028.85	827.0	5200.70	16405.6	6.494	36.9
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1028.05	826.5	4722.11	14895.9	5.902	33.5
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	927.71	770.8	4134.25	13041.5	5.908	33.6
	RodC5_135.7	232	135.7	3.447	2.2	0.056	973.78	796.4	3642.79	11491.2	4.885	27.7
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	835.96	719.8	5260.43	16594.0	8.653	49.1
	RodE5_113.6	210	113.6	2.885	0.85	0.022	874.64	741.3	6494.20	20486.0	10.043	57.0
	RodE5_115.4	211	115.4	2.931	2.65	0.067	941.89	778.6	6267.74	19771.6	8.780	49.9
	RodE5_118.7	212	118.7	3.015	5.95	0.151	998.19	809.9	5857.23	18476.6	7.605	43.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1030.99	828.1	5372.64	16948.0	6.691	38.0
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1035.36	830.6	4875.58	15380.0	6.039	34.3
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1087.10	859.3	4261.41	13442.6	4.960	28.2
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1018.67	821.3	3758.43	11856.0	4.753	27.0
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	911.57	761.8	5953.53	18780.4	8.709	49.5
	RodC3_85.6	178	85.6	2.174	14.72	0.374	767.87	682.0	6205.43	19575.0	11.494	65.3
	RodC3_88.5	179	88.5	2.248	0	0.000	803.14	701.6	6339.73	19998.7	11.023	62.6
	RodC3_92.4	180	92.4	2.347	3.9	0.099	913.71	763.0	6513.07	20545.5	9.498	53.9
	RodC3_94.4	181	94.4	2.398	5.9	0.150	930.23	772.2	6602.10	20826.3	9.402	53.4
	RodC3_97.2	182	97.2	2.469	8.7	0.221	980.57	800.1	6726.64	21219.2	8.938	50.8
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1052.07	839.9	7092.91	22374.6	8.607	48.9
Gr-8	RodD5_50	217	50	1.270	3	0.076	780.38	688.9	4649.63	14667.3	8.417	47.8
	RodD5_54.1	218	54.1	1.374	7.1	0.180	803.79	701.9	4831.52	15241.0	8.391	47.7
	RodD5_56.9	219	56.9	1.445	9.9	0.251	843.20	723.8	4956.86	15636.4	8.057	45.8
	RodD5_60	220	60	1.524	13	0.330	866.43	736.7	5095.52	16073.8	7.981	45.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	900.29	755.5	5367.21	16930.9	7.983	45.3
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	770.04	683.2	5535.77	17462.6	10.213	58.0
	RodD5_72.9	223	72.9	1.852	2.02	0.051	845.73	725.2	5668.08	17880.0	9.176	52.1
	RodD5_74.9	224	74.9	1.902	4.02	0.102	886.66	748.0	5756.84	18159.9	8.740	49.6

Table A-49: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	709.19	649.4	4227.54	13335.8	8.786	49.9
	RodB5_52.9	154	52.9	1.344	5.9	0.150	770.76	683.6	4763.60	15026.8	8.777	49.8
	RodB5_55	155	55	1.397	8	0.203	801.39	700.6	4857.80	15323.9	8.472	48.1
	RodB5_57.8	156	57.8	1.468	10.8	0.274	840.42	722.3	4984.52	15723.7	8.139	46.2
	RodB5_64	157	64	1.626	17	0.432	884.66	746.9	5264.10	16605.6	8.016	45.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	862.38	734.5	5710.67	18014.3	9.002	51.1
	RodB5_75.9	159	75.9	1.928	5.02	0.128	894.09	752.1	5800.73	18298.4	8.709	49.5
	RodB5_76.9	160	76.9	1.953	6.02	0.153	906.05	758.7	5845.71	18440.3	8.621	49.0
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	700.01	644.3	4201.38	13253.3	8.901	50.5
	RodF5_53.1	106	53.1	1.349	6.1	0.155	762.50	679.0	4745.21	14968.8	8.878	50.4
	RodF5_55	107	55	1.397	8	0.203	792.16	695.5	4830.99	15239.4	8.563	48.6
	RodF5_57.8	108	57.8	1.468	10.8	0.274	826.36	714.5	4957.82	15639.4	8.286	47.1
	RodF5_64	109	64	1.626	17	0.432	860.89	733.6	5237.24	16520.9	8.275	47.0
	RodF5_73.8	110	73.8	1.875	2.92	0.074	846.59	725.7	5678.77	17913.7	9.180	52.1
	RodF5_75.8	111	75.8	1.925	4.92	0.125	881.64	745.2	5768.86	18197.9	8.826	50.1
	RodF5_76.8	112	76.8	1.951	5.92	0.150	896.01	753.2	5813.98	18340.2	8.703	49.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	708.71	649.1	4220.70	13314.2	8.780	49.9
	RodC2_53.1	58	53.1	1.349	6.1	0.155	823.56	712.9	4765.23	15031.9	8.001	45.4
	RodC2_55	59	55	1.397	8	0.203	838.81	721.4	4851.03	15302.6	7.942	45.1
	RodC2_57.8	60	57.8	1.468	10.8	0.274	864.94	735.9	4977.92	15702.8	7.815	44.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	886.27	747.7	5253.13	16571.0	7.980	45.3
	RodC2_73.8	62	73.8	1.875	2.92	0.074	889.70	749.6	5698.26	17975.2	8.612	48.9
	RodC2_75.8	63	75.8	1.925	4.92	0.125	916.15	764.3	5788.32	18259.2	8.411	47.8
	RodC2_76.8	64	76.8	1.951	5.92	0.150	926.64	770.2	5833.55	18401.9	8.350	47.4
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	706.21	647.7	4200.66	13251.0	8.784	49.9
	RodC6_52.8	138	52.8	1.341	5.8	0.147	820.46	711.2	4759.81	15014.8	8.034	45.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	838.14	721.0	4854.26	15312.8	7.956	45.2
	RodC6_57.8	140	57.8	1.468	10.8	0.274	868.52	737.9	4995.25	15757.5	7.799	44.3
	RodC6_63.8	141	63.8	1.621	16.8	0.427	897.98	754.3	5277.23	16647.0	7.877	44.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	920.49	766.8	5742.24	18113.9	8.292	47.1
	RodC6_75.8	143	75.8	1.925	4.92	0.125	944.17	779.9	5840.81	18424.8	8.156	46.3
	RodC6_76.8	144	76.8	1.951	5.92	0.150	959.97	788.7	5887.89	18573.3	8.044	45.7

Table A-49: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	779.03	688.2	6314.91	19920.4	11.460	65.1
	RodB4_91.3	162	91.3	2.319	2.8	0.071	871.25	739.4	6441.80	20320.7	10.014	56.9
	RodB4_93.3	163	93.3	2.370	4.8	0.122	889.60	749.6	6528.74	20594.9	9.868	56.0
	RodB4_95.1	164	95.1	2.416	6.6	0.168	918.61	765.7	6607.04	20841.9	9.567	54.3
	RodB4_100	165	100	2.540	11.5	0.292	955.04	786.0	6820.15	21514.2	9.381	53.3
	RodB4_106	166	106	2.692	17.5	0.445	1029.56	827.3	7081.48	22338.5	8.835	50.2
	RodB4_109.9	167	109.9	2.791	21.4	0.544	906.36	758.9	6863.24	21650.1	10.117	57.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1002.12	812.1	2663.16	8400.9	3.440	19.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	836.68	720.2	6239.27	19681.8	10.250	58.2
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	808.27	704.4	6361.46	20067.2	10.963	62.3
	RodF4_92.4	100	92.4	2.347	3.9	0.099	918.63	765.7	6536.65	20619.9	9.465	53.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	953.05	784.8	6621.10	20886.3	9.132	51.9
	RodF4_97.2	102	97.2	2.469	8.7	0.221	993.43	807.3	6749.63	21291.7	8.818	50.1
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1051.08	839.3	7127.39	22483.3	8.659	49.2
	RodF4_111	104	111	2.819	-1.75	-0.044	948.16	782.1	6839.51	21575.2	9.497	53.9
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1065.21	847.2	6278.01	19804.0	7.499	42.6
	RodD2_106	66	106	2.692	17.5	0.445	1086.34	858.9	5946.03	18756.8	6.927	39.3
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1107.29	870.5	5495.44	17335.4	6.250	35.5
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1112.67	873.5	4964.80	15661.5	5.612	31.9
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1098.24	865.5	4460.65	14071.1	5.126	29.1
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1094.73	863.6	7050.82	22241.8	8.135	46.2
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1115.28	875.0	7177.26	22640.7	8.089	45.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1023.00	823.7	6583.78	20768.5	8.281	47.0
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1079.26	855.0	7064.95	22286.4	8.299	47.1
	RodD6_106	130	106	2.692	17.5	0.445	1092.70	862.4	7193.53	22692.0	8.319	47.2
	RodD6_112.9	131	112.9	2.868	0.15	0.004	994.96	808.1	6565.03	20709.4	8.560	48.6
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1032.26	828.8	6296.20	19861.4	7.829	44.5
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1056.04	842.1	6041.21	19057.0	7.296	41.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1067.88	848.6	5491.09	17321.6	6.538	37.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1068.46	849.0	4967.57	15670.2	5.911	33.6
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1060.08	844.3	4443.59	14017.3	5.340	30.3

Table A-49: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	765.89	680.9	4665.01	14715.8	8.673	49.3
	RodE2_54	74	54	1.372	7	0.178	827.13	714.9	4842.71	15276.3	8.083	45.9
	RodE2_56.9	75	56.9	1.445	9.9	0.251	857.73	731.9	4974.69	15692.7	7.900	44.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	884.70	746.9	5110.80	16122.0	7.783	44.2
	RodE2_66	77	66	1.676	19	0.483	907.87	759.7	5388.65	16998.5	7.926	45.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	816.14	708.8	5562.07	17545.6	9.457	53.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	878.53	743.4	5702.82	17989.5	8.766	49.8
	RodE2_74.9	80	74.9	1.902	4.02	0.102	908.19	759.9	5794.00	18277.2	8.518	48.4
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	720.67	655.7	4637.65	14629.5	9.413	53.5
	RodB3_54.1	170	54.1	1.374	7.1	0.180	786.86	692.5	4812.37	15180.6	8.611	48.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	823.27	712.7	4938.95	15579.9	8.297	47.1
	RodB3_60.1	172	60.1	1.527	13.1	0.333	819.88	710.9	5083.14	16034.8	8.588	48.8
	RodB3_66.1	173	66.1	1.679	19.1	0.485	869.06	738.2	5354.49	16890.7	8.353	47.4
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	747.12	670.4	5527.34	17436.0	10.648	60.5
	RodB3_73	175	73	1.854	2.12	0.054	825.87	714.2	5664.53	17868.8	9.474	53.8
	RodB3_75	176	75	1.905	4.12	0.105	862.10	734.3	5754.55	18152.7	9.075	51.5
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	741.15	667.1	4638.17	14631.1	9.039	51.3
	RodF3_54	90	54	1.372	7	0.178	806.58	703.5	4816.67	15194.2	8.325	47.3
	RodF3_57	91	57	1.448	10	0.254	842.45	723.4	4954.07	15627.6	8.063	45.8
	RodF3_60	92	60	1.524	13	0.330	867.30	737.2	5091.91	16062.4	7.965	45.2
	RodF3_66.1	93	66.1	1.679	19.1	0.485	886.63	747.9	5373.70	16951.3	8.159	46.3
	RodF3_70	94	70	1.778	-0.88	-0.022	767.36	681.7	5554.23	17520.8	10.298	58.5
	RodF3_73	95	73	1.854	2.12	0.054	866.97	737.0	5691.23	17953.0	8.907	50.6
	RodF3_75	96	75	1.905	4.12	0.105	909.10	760.4	5783.22	18243.2	8.491	48.2
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	750.01	672.0	4635.57	14622.9	8.880	50.4
	RodE6_54.1	122	54.1	1.374	7.1	0.180	805.20	702.7	4809.43	15171.3	8.332	47.3
	RodE6_57	123	57	1.448	10	0.254	833.10	718.2	4938.96	15580.0	8.162	46.4
	RodE6_60.2	124	60.2	1.529	13.2	0.335	853.10	729.3	5082.07	16031.4	8.130	46.2
	RodE6_66.1	125	66.1	1.679	19.1	0.485	880.34	744.4	5344.31	16858.6	8.193	46.5
	RodE6_70	126	70	1.778	-0.88	-0.022	811.19	706.0	5518.68	17408.7	9.463	53.7
	RodE6_73.1	127	73.1	1.857	2.22	0.056	872.28	740.0	5656.74	17844.2	8.780	49.9
	RodE6_75	128	75	1.905	4.12	0.105	901.84	756.4	5741.30	18110.9	8.520	48.4

RBHT Steam Cooling with Droplet Injection Test SCD-4049-G

Matrix Test # 5c

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 24600 - 24900
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 75 kW
Bundle Inlet Reynolds Number: 10000
Bundle Inlet Steam Flow: 181.4 kg/hr (400 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

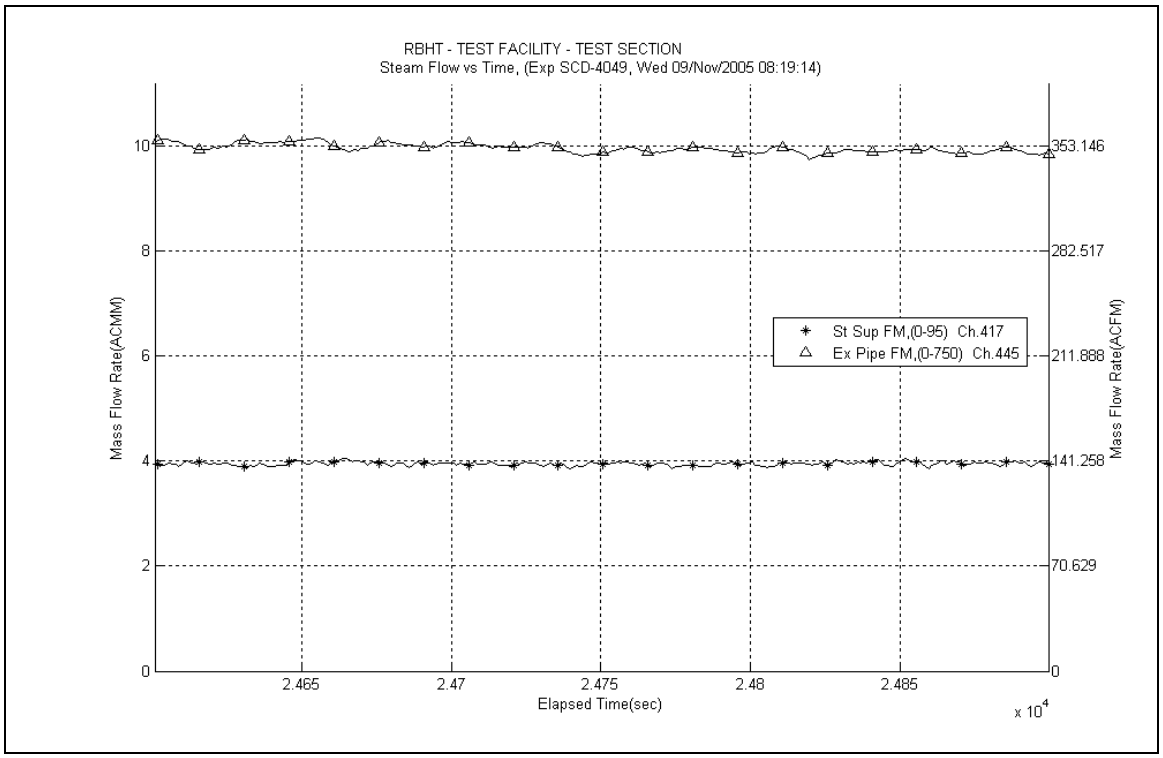

Figure A-184: Inlet and Exhaust Steam Flow Rates for Experiment 4049G

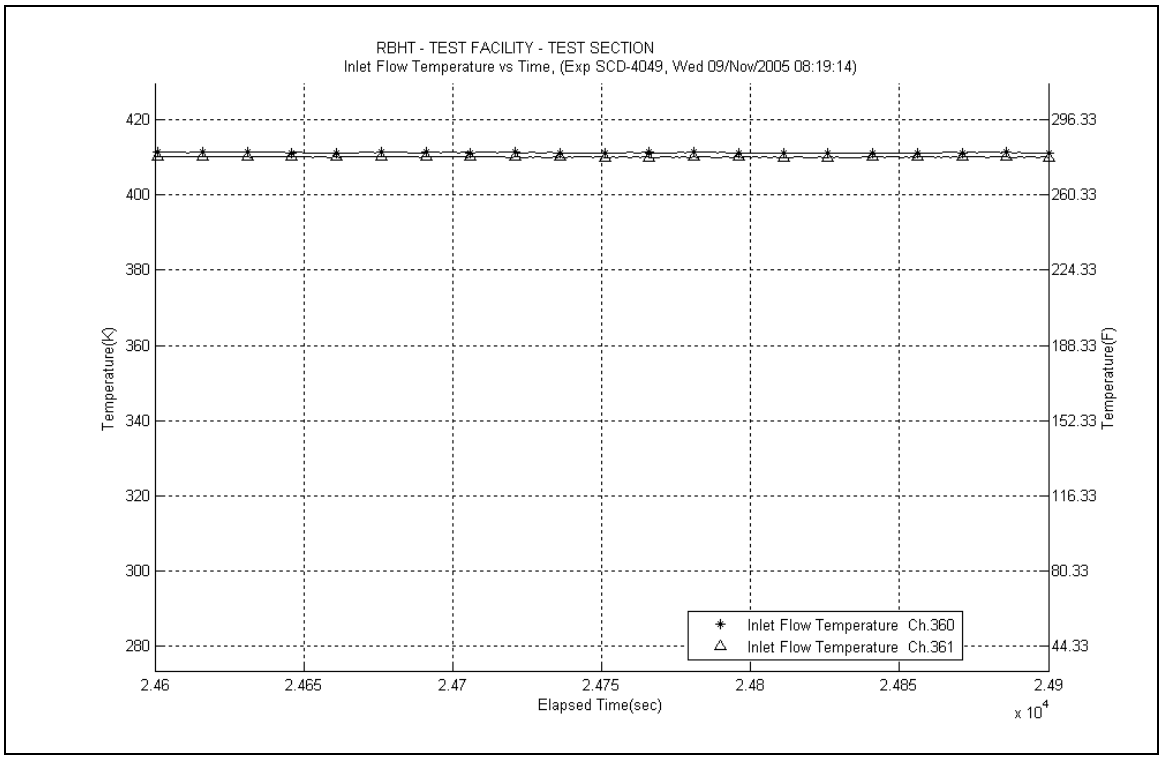

Figure A-185: Inlet Steam Temperature for Experiment 4049G

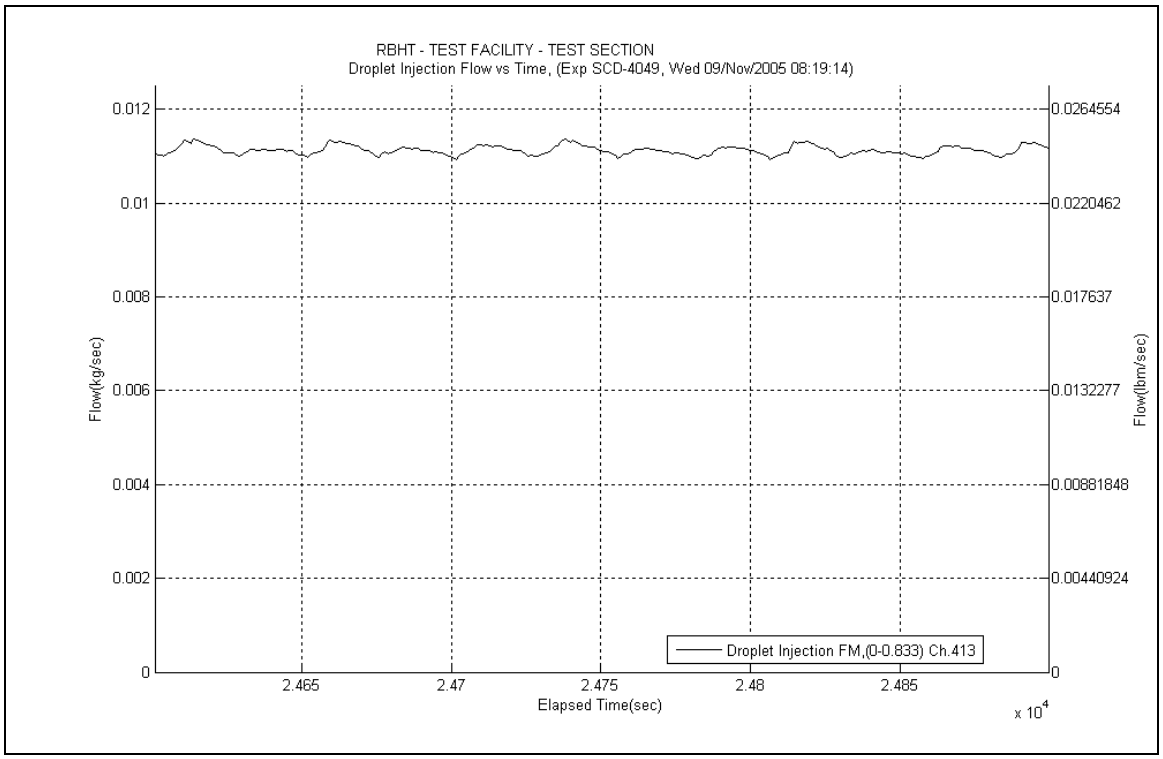

Figure A-186: Droplet Injection Flow Rate for Experiment 4049G

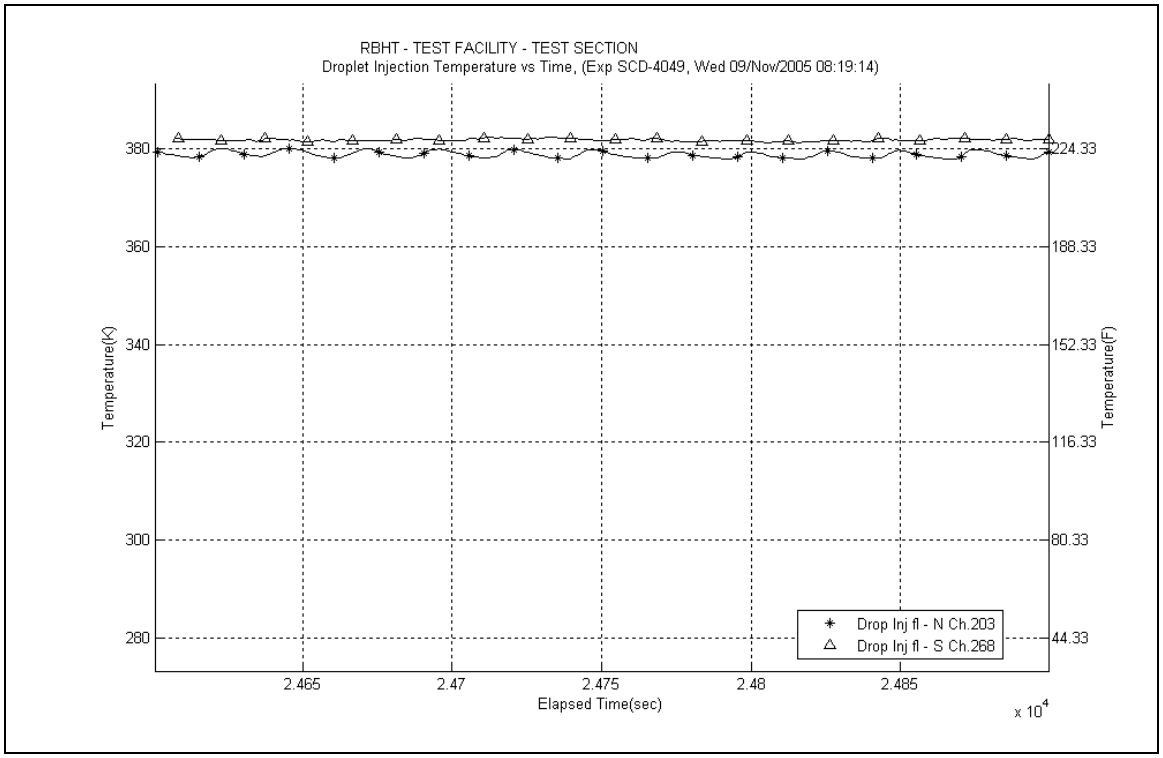

Figure A-187: Droplet Injection Temperature for Experiment 4049G

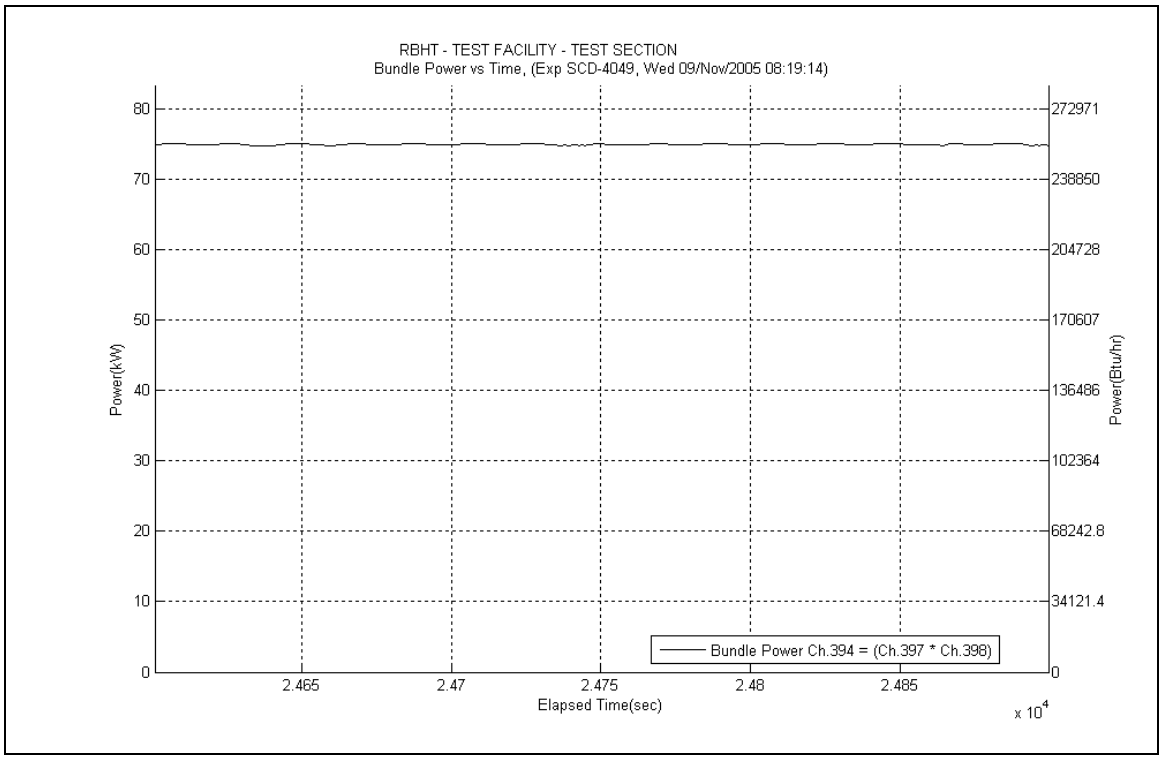

Figure A-188: Bundle Power for Experiment 4049G

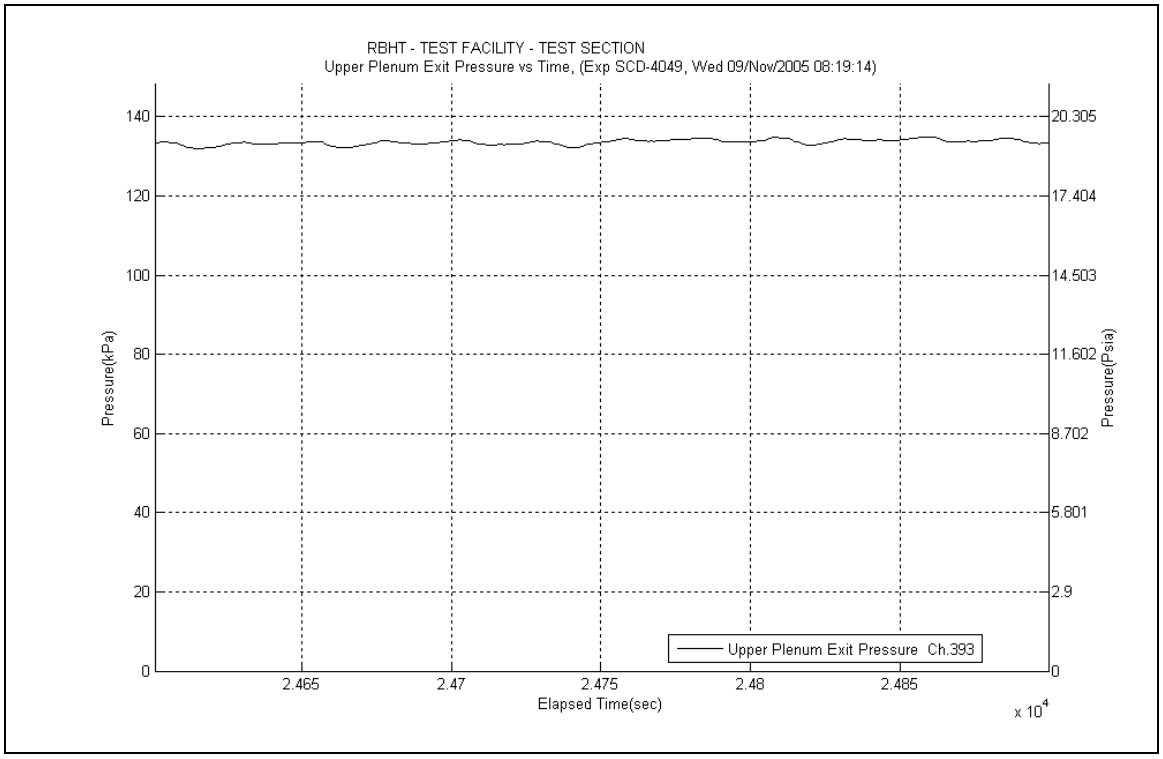

Figure A-189: Upper Plenum Pressure for Experiment 4049G

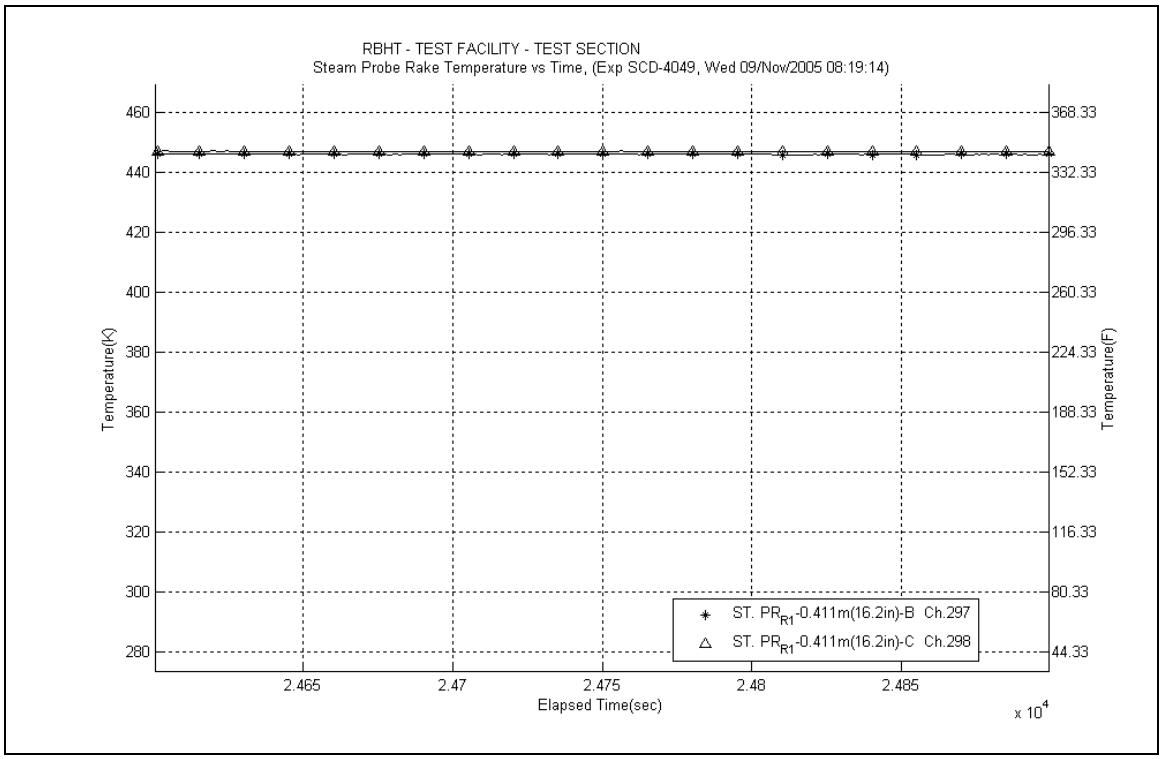

Figure A-190: Steam Probe Rake #1 Temperatures for Experiment 4049G

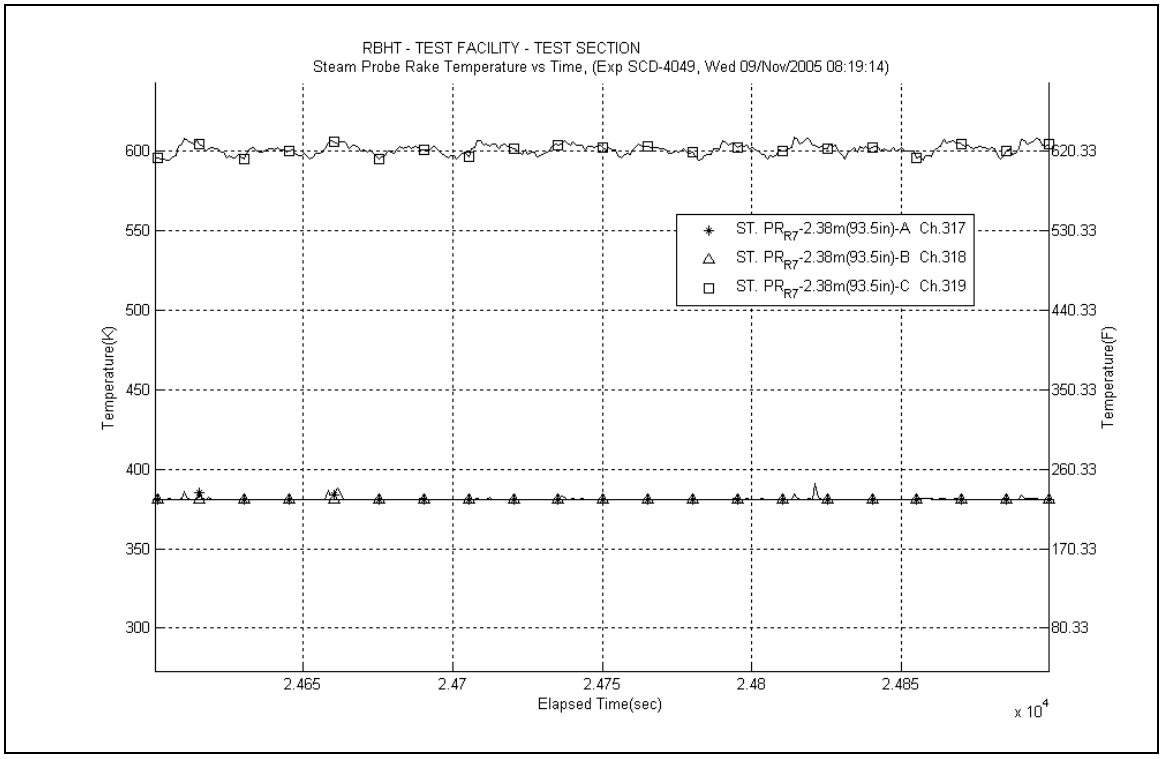

Figure A-191: Steam Probe Rake #7 Temperatures for Experiment 4049G

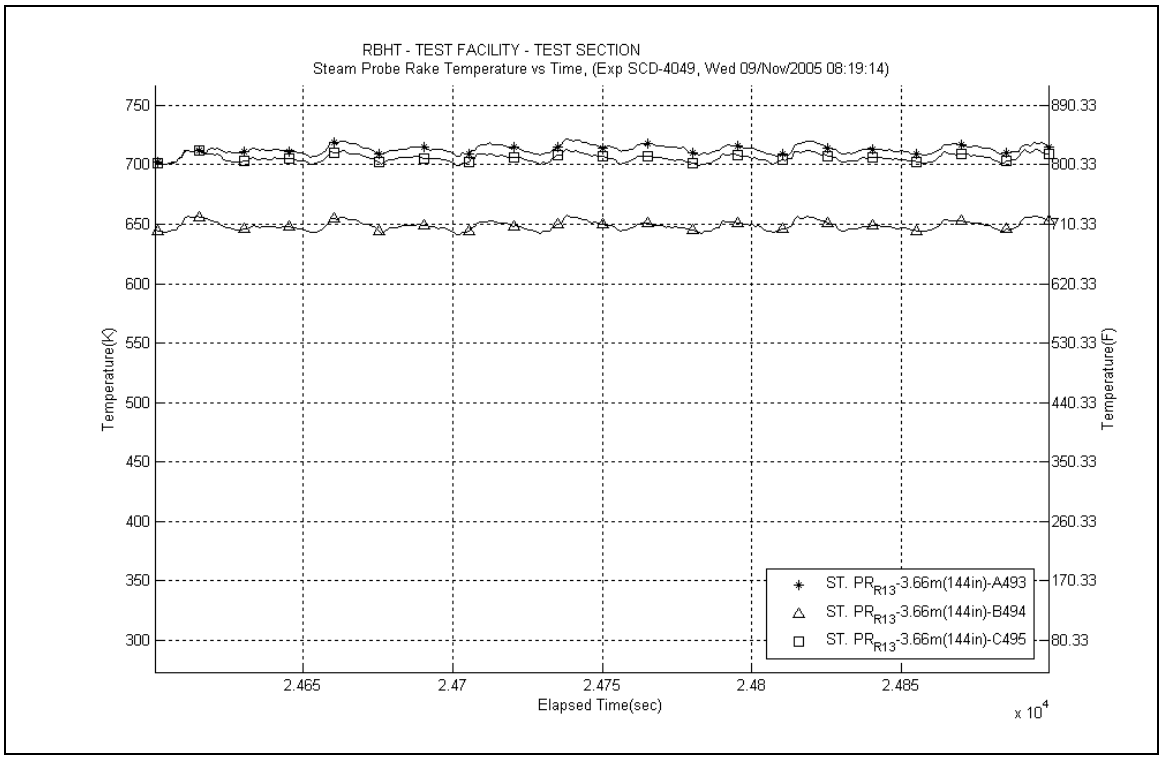

Figure A-192: Steam Probe Rake #13 Temperatures for Experiment 4049G

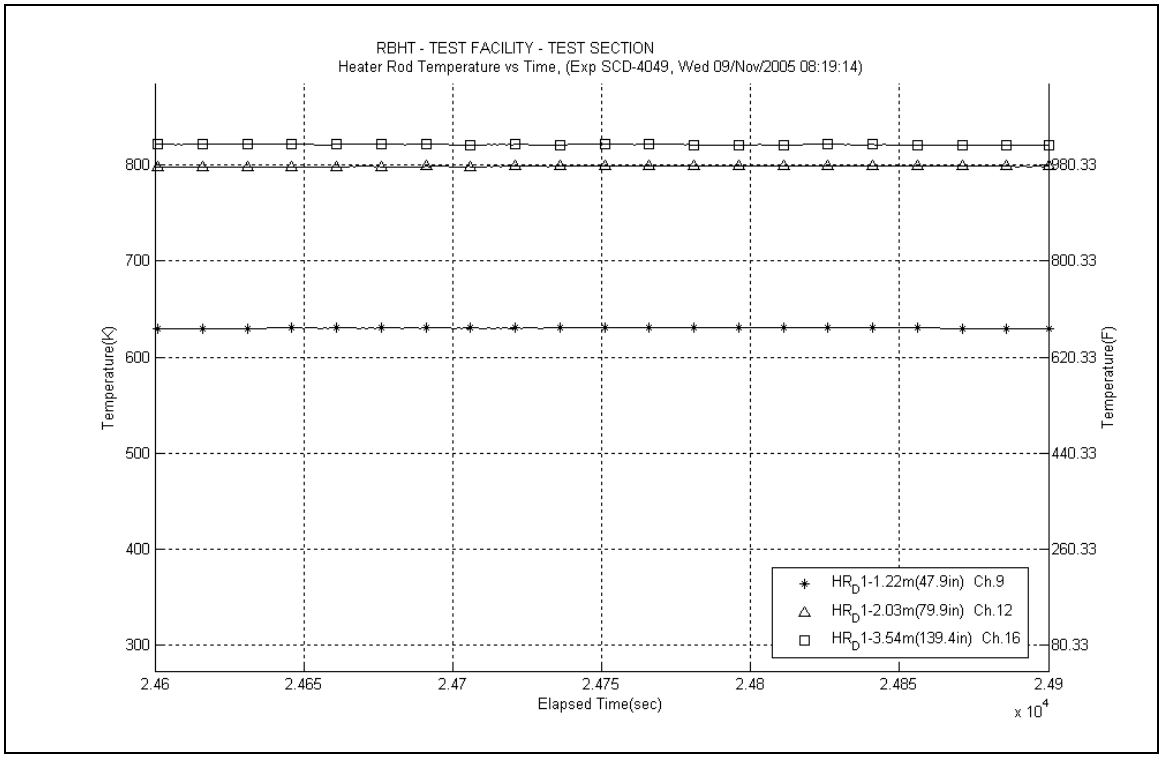

Figure A-193: Heater Rod D1 Temperatures for Experiment 4049G

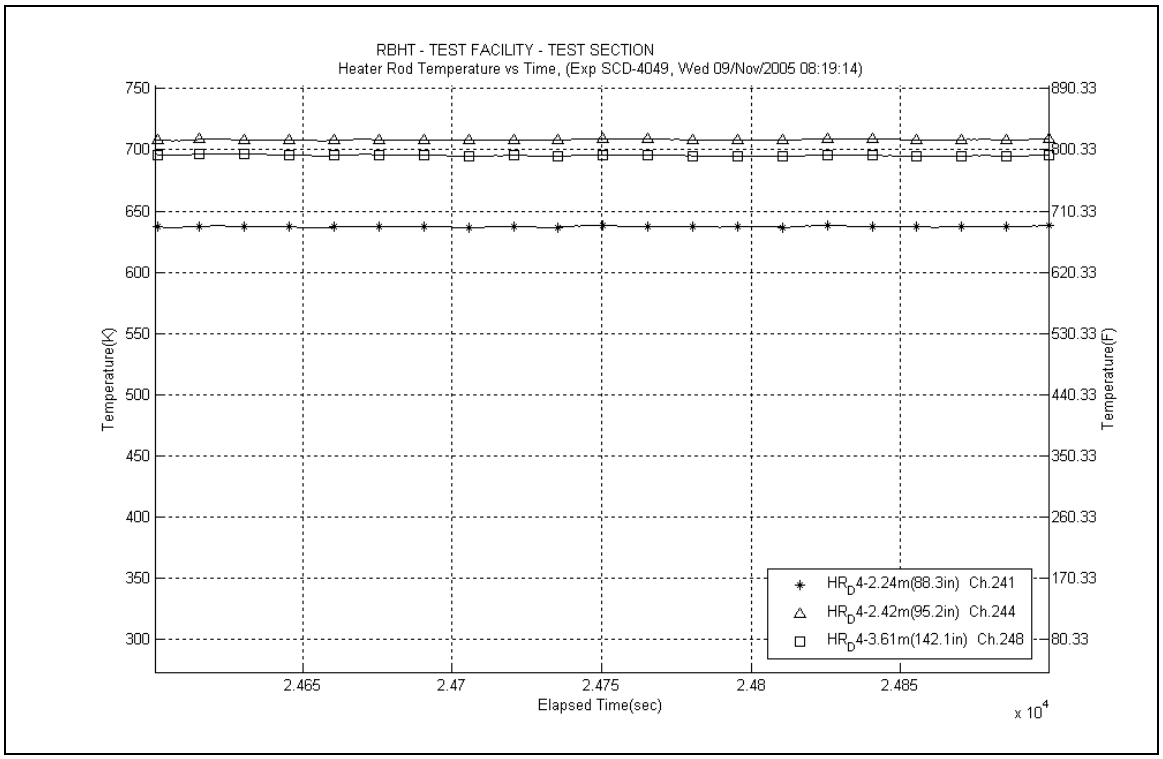

Figure A-194: Heater Rod D4 Temperatures for Experiment 4049G

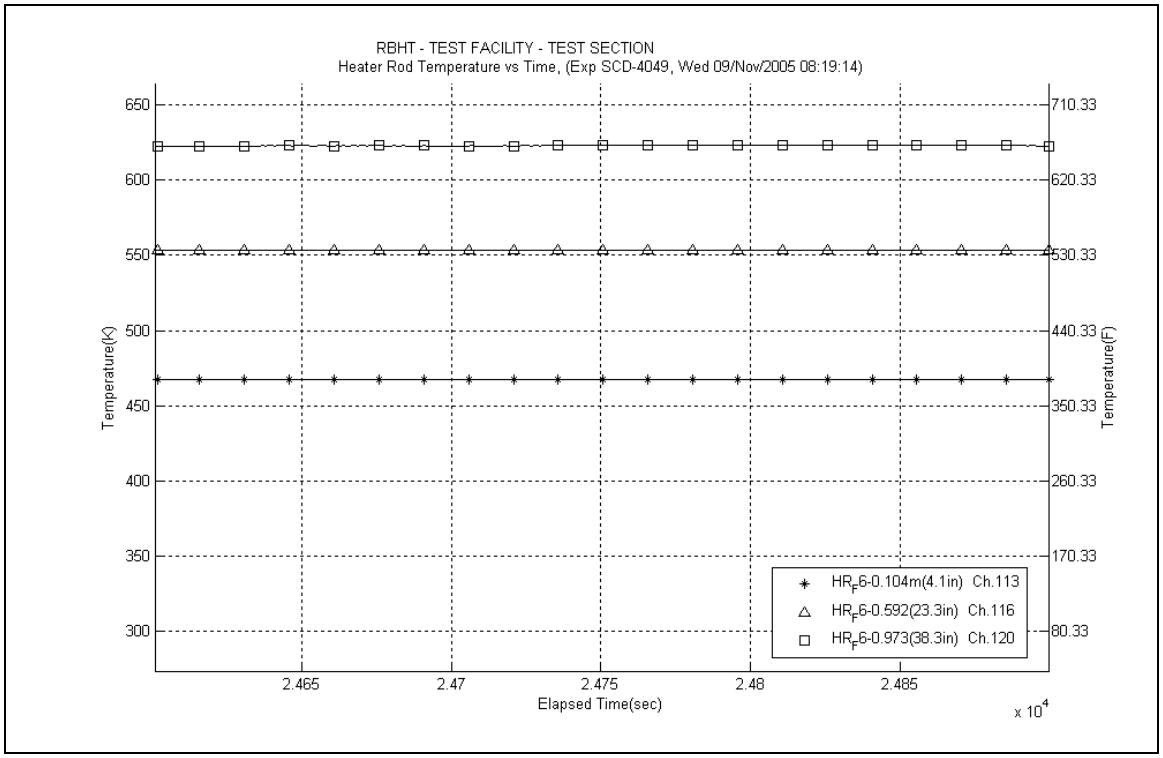

Figure A-195: Heater Rod F6 Temperatures for Experiment 4049G

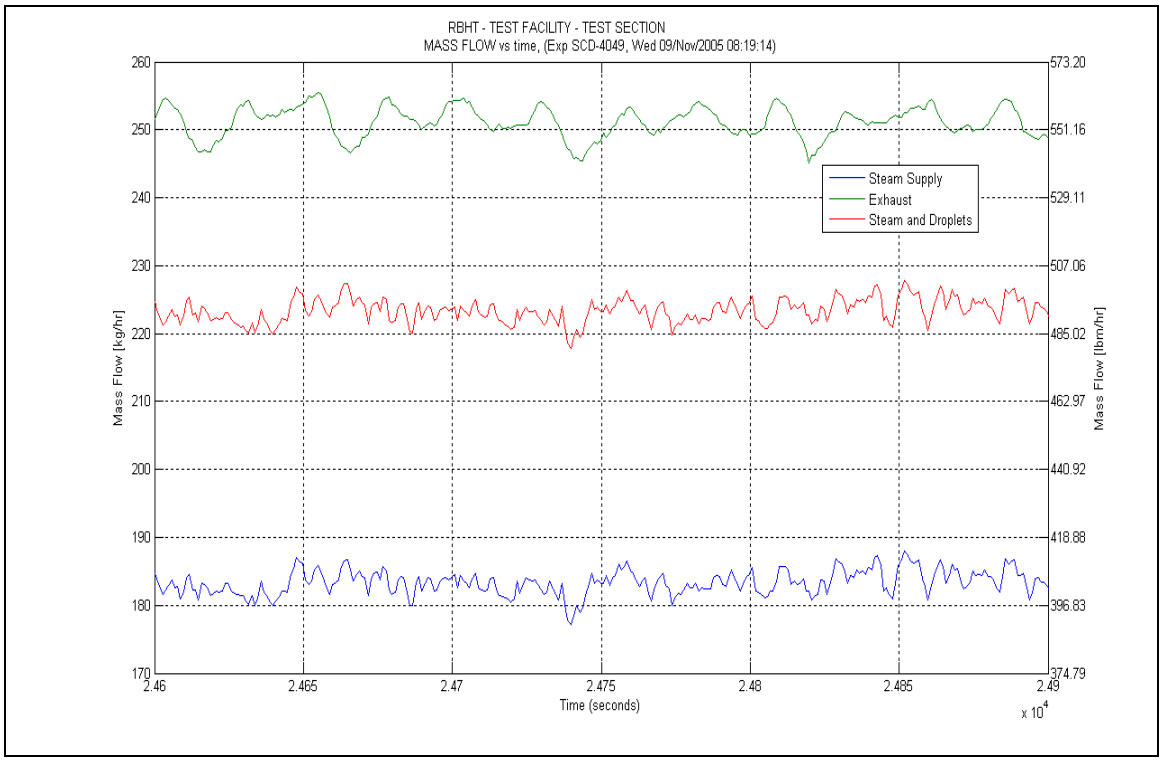

Figure A-196: Mass Flow for Experiment 4049G

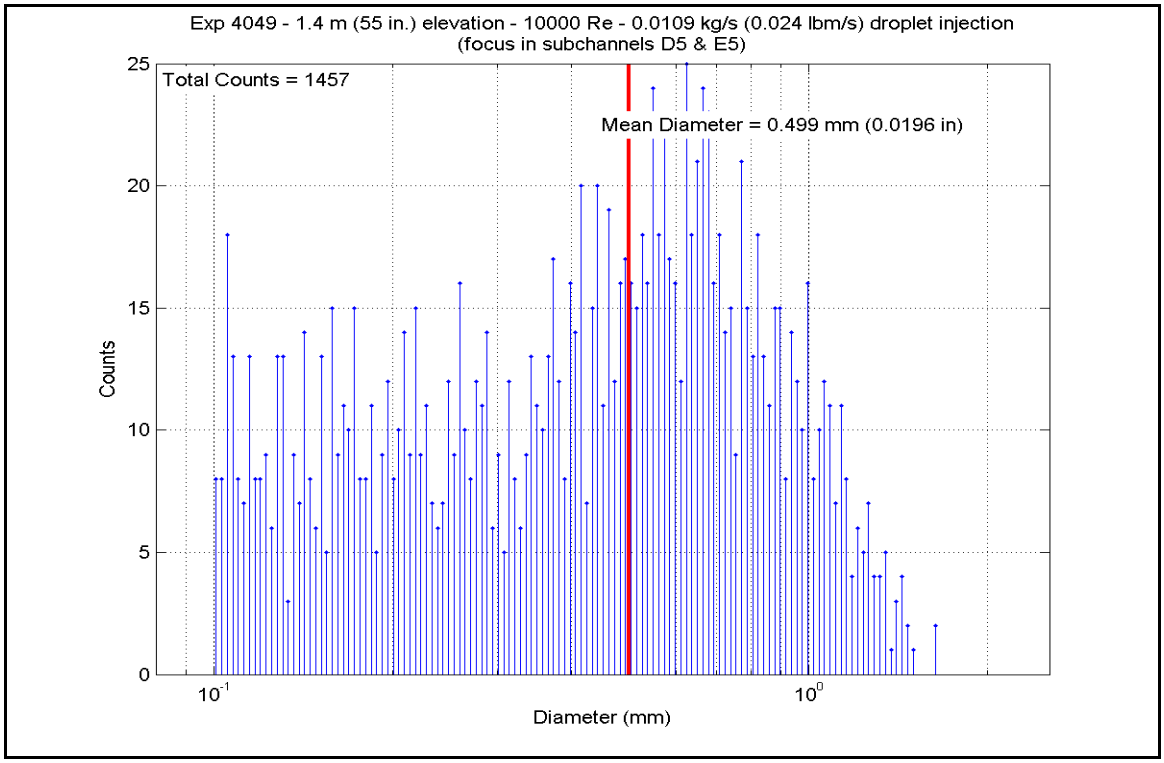

Figure A-197: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049G

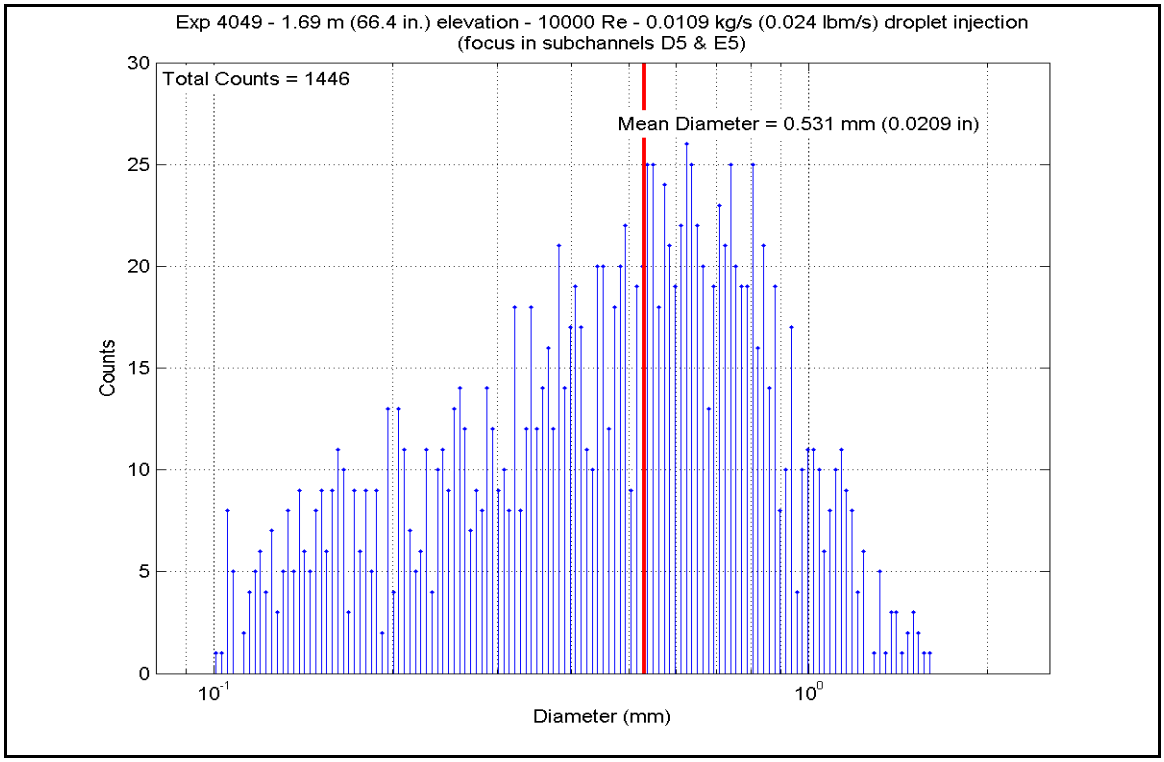

Figure A-198: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049G

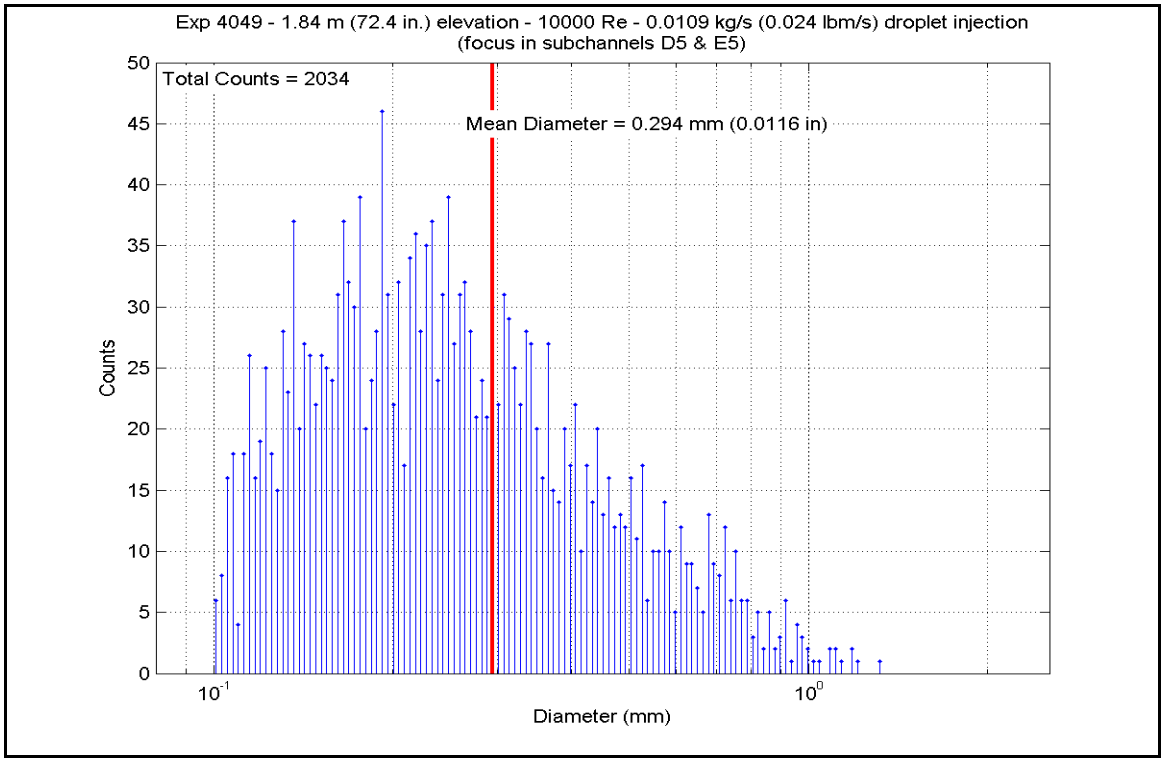

Figure A-199: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049G

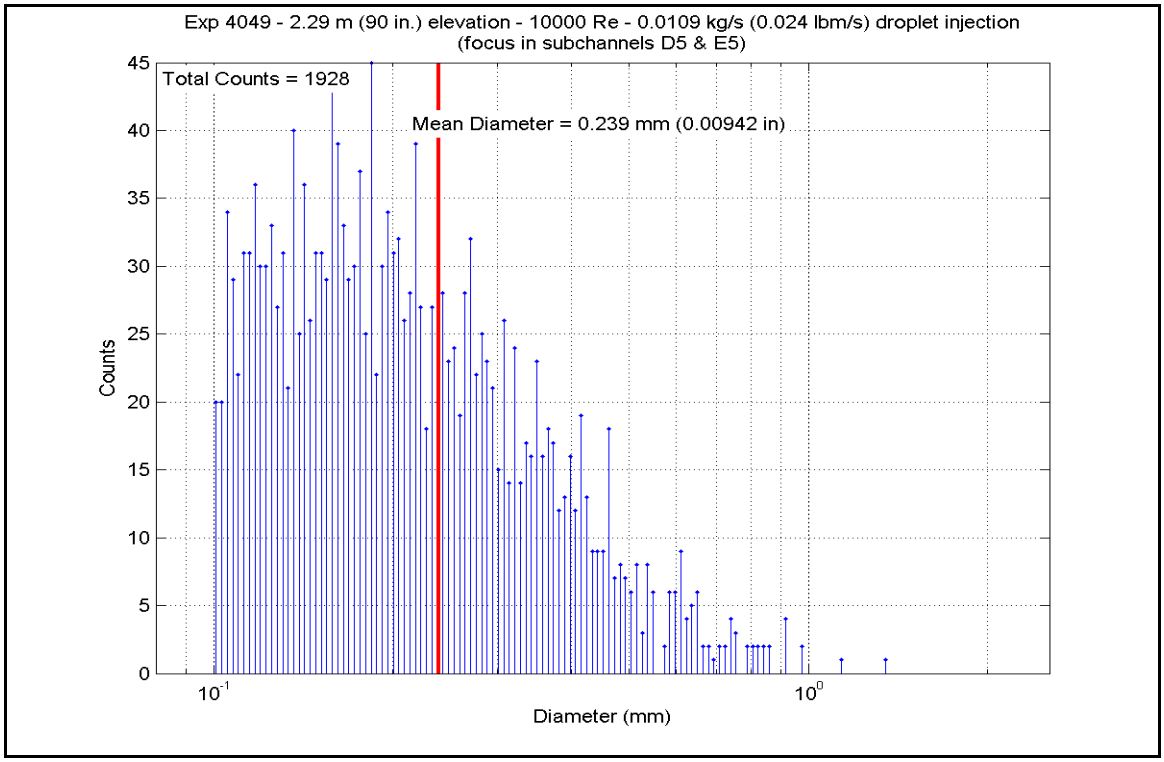

Figure A-200: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049G

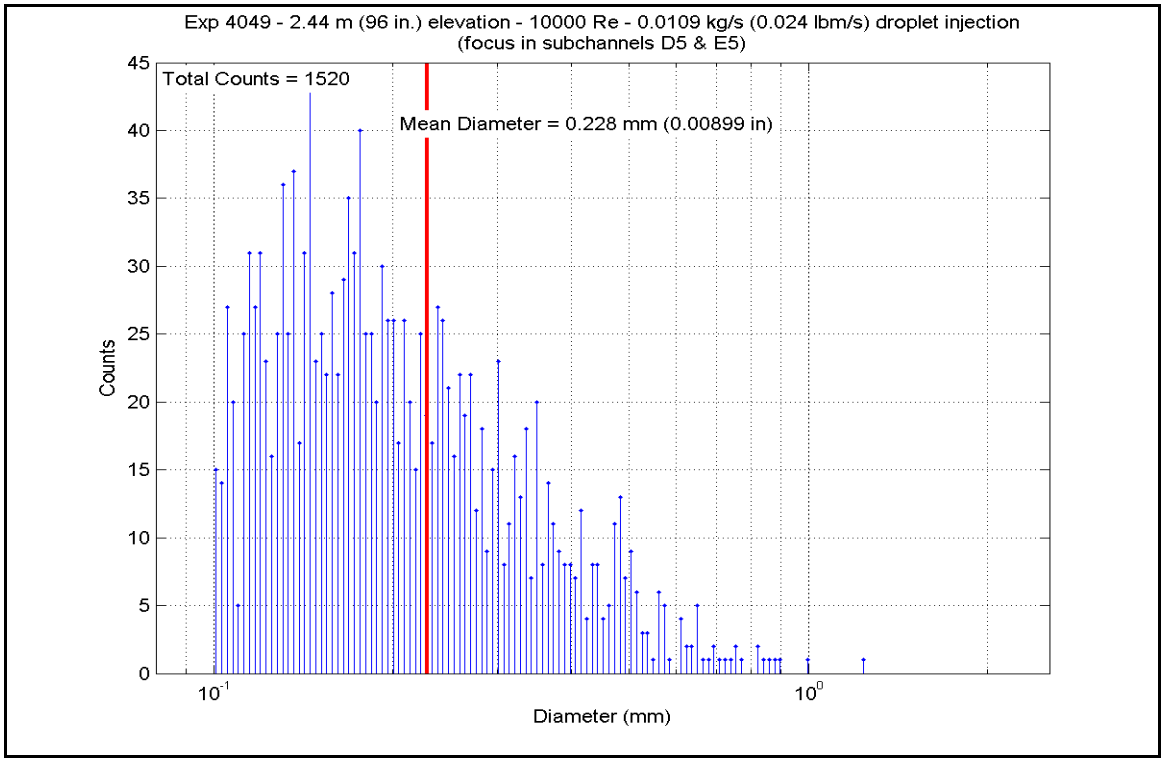

Figure A-201: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049G

Table A-50: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049G

SCD-4049-G	Inlet Reynolds:	10000		
Matrix Test # 5c	UP Pressure:	137.9 kPa	20	psia
Time Window: 24600-24900	Bundle Power:	75.00 kW	255911	Btu/hr
	Steam flow:	0.0504 kg/s	400.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	747.21	670.5	6359.62	20061.4	12.249	69.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	822.65	712.4	6493.56	20483.9	10.920	62.0
	RodD3_93.1	187	93.1	2.365	4.6	0.117	821.02	711.5	6575.07	20741.1	11.088	63.0
	RodD3_95.3	188	95.3	2.421	6.8	0.173	858.44	732.3	6671.72	21046.0	10.583	60.1
	RodD3_100.1	189	100.1	2.543	11.6	0.295	886.34	747.8	6881.64	21708.1	10.453	59.4
	RodD3_106.1	190	106.1	2.695	17.6	0.447	967.03	792.6	7158.56	22581.7	9.686	55.0
	RodD3_110	191	110	2.794	21.5	0.546	817.75	709.7	7065.14	22287.0	11.980	68.0
	RodD3_142.1	192	142.1	3.609	8.6	0.218	887.98	748.7	2479.09	7820.3	3.756	21.3
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	732.70	662.4	6419.09	20249.0	12.719	72.2
	RodC4_91.1	234	91.1	2.314	2.6	0.066	819.08	710.4	6543.54	20641.6	11.071	62.9
	RodC4_93.4	235	93.4	2.372	4.9	0.124	837.86	720.9	6647.68	20970.1	10.900	61.9
	RodC4_95.3	236	95.3	2.421	6.8	0.173	870.84	739.2	6735.54	21247.3	10.478	59.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	898.23	754.4	6952.44	21931.5	10.373	58.9
	RodC4_106.1	238	106.1	2.695	17.6	0.447	960.28	788.9	7230.11	22807.4	9.873	56.1
	RodC4_110	239	110	2.794	21.5	0.546	780.31	688.9	6990.32	22051.0	12.656	71.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	844.82	724.7	2667.00	8413.1	4.324	24.6
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	684.86	635.9	6398.98	20185.6	14.006	79.5
	RodD4_91.3	242	91.3	2.319	2.8	0.071	768.46	682.3	6534.61	20613.4	12.091	68.7
	RodD4_93.2	243	93.2	2.367	4.7	0.119	787.31	692.8	6620.23	20883.5	11.836	67.2
	RodD4_95.2	244	95.2	2.418	6.7	0.170	812.59	706.8	6712.64	21175.0	11.483	65.2
	RodD4_100.1	245	100.1	2.543	11.6	0.295	853.88	729.8	6934.41	21874.6	11.079	62.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	881.20	744.9	7210.17	22744.5	11.038	62.7
	RodD4_142.1	248	142.1	3.609	8.6	0.218	791.09	694.9	2590.10	8170.5	4.600	26.1
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	228.00	382.0	6312.76	19913.6	3135510.743	17806226.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	228.48	382.3	6434.90	20298.9	13414.884	76181.7
	RodE4_95.3	204	95.3	2.421	6.8	0.173	229.65	383.0	6613.78	20863.2	4010.819	22777.0
	RodE4_100.9	205	100.9	2.563	12.4	0.315	230.39	383.4	6860.01	21639.9	2870.616	16301.9

Table A-50: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	889.24	749.4	5214.56	16449.3	7.886	44.8
	RodE3_113.6	194	113.6	2.885	0.85	0.022	901.47	756.2	6431.73	20288.9	9.550	54.2
	RodE3_115.5	195	115.5	2.934	2.75	0.070	930.22	772.2	6202.00	19564.2	8.832	50.2
	RodE3_118.5	196	118.5	3.010	5.75	0.146	944.49	780.1	5822.79	18368.0	8.127	46.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	933.83	774.2	5294.61	16701.9	7.501	42.6
	RodE3_126.5	198	126.5	3.213	13.75	0.349	930.98	772.6	4819.01	15201.6	6.855	38.9
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	860.15	733.2	4160.12	13123.1	6.581	37.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	909.21	760.5	3669.54	11575.6	5.387	30.6
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	869.67	738.5	5117.58	16143.4	7.975	45.3
	RodC5_113.6	226	113.6	2.885	0.85	0.022	832.92	718.1	6264.99	19762.9	10.357	58.8
	RodC5_115.7	227	115.7	2.939	2.95	0.075	879.10	743.8	6015.78	18976.8	9.239	52.5
	RodC5_122.7	229	122.7	3.117	9.95	0.253	912.33	762.2	5181.06	16343.7	7.571	43.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	912.13	762.1	4704.99	14841.9	6.877	39.1
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	782.37	690.0	4098.59	12929.0	7.393	42.0
	RodC5_135.7	232	135.7	3.447	2.2	0.056	822.49	712.3	3619.31	11417.1	6.088	34.6
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	827.44	715.1	5251.95	16567.3	8.761	49.8
	RodE5_113.6	210	113.6	2.885	0.85	0.022	743.27	668.3	6488.06	20466.6	12.591	71.5
	RodE5_115.4	211	115.4	2.931	2.65	0.067	800.45	700.1	6267.11	19769.6	10.948	62.2
	RodE5_118.7	212	118.7	3.015	5.95	0.151	859.04	732.6	5859.51	18483.8	9.286	52.7
	RodE5_122.6	213	122.6	3.114	9.85	0.250	885.97	747.6	5375.90	16958.3	8.170	46.4
	RodE5_126.6	214	126.6	3.216	13.85	0.352	878.74	743.6	4878.73	15390.0	7.497	42.6
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	943.01	779.3	4148.84	13087.5	5.802	33.0
	RodE5_135.6	216	135.6	3.444	2.1	0.053	837.65	720.7	3741.45	11802.4	6.137	34.9
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	872.91	740.3	5941.42	18742.2	9.213	52.3
	RodC3_85.6	178	85.6	2.174	14.72	0.374	698.51	643.4	6204.60	19572.4	13.187	74.9
	RodC3_88.5	179	88.5	2.248	0	0.000	757.19	676.0	6332.14	19974.7	11.966	68.0
	RodC3_92.4	180	92.4	2.347	3.9	0.099	863.78	735.2	6503.80	20516.2	10.230	58.1
	RodC3_94.4	181	94.4	2.398	5.9	0.150	876.32	742.2	6593.05	20797.8	10.169	57.8
	RodC3_97.2	182	97.2	2.469	8.7	0.221	923.49	768.4	6712.11	21173.4	9.651	54.8
	RodC3_108.8	183	108.8	2.764	20.3	0.516	975.78	797.5	7077.26	22325.2	9.464	53.7
Gr-8	RodD5_50	217	50	1.270	3	0.076	778.36	687.8	4632.78	14614.1	8.418	47.8
	RodD5_54.1	218	54.1	1.374	7.1	0.180	770.36	683.3	4792.80	15118.9	8.837	50.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	813.77	707.5	4934.58	15566.1	8.424	47.8
	RodD5_60	220	60	1.524	13	0.330	847.40	726.2	5074.11	16006.3	8.192	46.5
	RodD5_66.1	221	66.1	1.679	19.1	0.485	882.72	745.8	5347.03	16867.2	8.167	46.4
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	733.22	662.7	5512.26	17388.4	10.911	62.0
	RodD5_72.9	223	72.9	1.852	2.02	0.051	802.61	701.3	5648.11	17817.0	9.829	55.8
	RodD5_74.9	224	74.9	1.902	4.02	0.102	841.38	722.8	5738.14	18101.0	9.355	53.1

Table A-50: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	704.41	646.7	4215.52	13297.9	8.848	50.2
	RodB5_52.9	154	52.9	1.344	5.9	0.150	767.95	682.0	4747.57	14976.2	8.793	49.9
	RodB5_55	155	55	1.397	8	0.203	803.97	702.0	4842.31	15275.1	8.407	47.7
	RodB5_57.8	156	57.8	1.468	10.8	0.274	837.01	720.4	4967.66	15670.5	8.157	46.3
	RodB5_64	157	64	1.626	17	0.432	871.57	739.6	5249.34	16559.1	8.157	46.3
	RodB5_73.9	158	73.9	1.877	3.02	0.077	849.00	727.0	5697.56	17973.0	9.175	52.1
	RodB5_75.9	159	75.9	1.928	5.02	0.128	879.81	744.2	5787.92	18258.0	8.880	50.4
	RodB5_76.9	160	76.9	1.953	6.02	0.153	890.62	750.2	5832.64	18399.0	8.802	50.0
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	696.36	642.2	4191.00	13220.5	8.948	50.8
	RodF5_53.1	106	53.1	1.349	6.1	0.155	762.36	678.9	4733.91	14933.1	8.859	50.3
	RodF5_55	107	55	1.397	8	0.203	797.09	698.2	4820.41	15206.0	8.470	48.1
	RodF5_57.8	108	57.8	1.468	10.8	0.274	834.17	718.8	4945.80	15601.5	8.159	46.3
	RodF5_64	109	64	1.626	17	0.432	876.08	742.1	5227.74	16490.9	8.067	45.8
	RodF5_73.8	110	73.8	1.875	2.92	0.074	827.91	715.3	5666.11	17873.7	9.445	53.6
	RodF5_75.8	111	75.8	1.925	4.92	0.125	859.66	733.0	5755.11	18154.5	9.111	51.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	873.30	740.5	5800.48	18297.6	8.989	51.0
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	703.27	646.1	4209.15	13277.8	8.856	50.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	817.66	709.6	4752.35	14991.3	8.059	45.8
	RodC2_55	59	55	1.397	8	0.203	833.11	718.2	4837.89	15261.1	7.995	45.4
	RodC2_57.8	60	57.8	1.468	10.8	0.274	859.89	733.1	4964.14	15659.4	7.856	44.6
	RodC2_63.9	61	63.9	1.623	16.9	0.429	881.05	744.8	5240.26	16530.4	8.024	45.6
	RodC2_73.8	62	73.8	1.875	2.92	0.074	878.03	743.2	5692.64	17957.4	8.757	49.7
	RodC2_75.8	63	75.8	1.925	4.92	0.125	903.45	757.3	5780.71	18235.2	8.558	48.6
	RodC2_76.8	64	76.8	1.951	5.92	0.150	913.67	763.0	5826.18	18378.7	8.497	48.3
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	699.22	643.8	4188.15	13211.5	8.888	50.5
	RodC6_52.8	138	52.8	1.341	5.8	0.147	814.30	707.8	4745.70	14970.3	8.094	46.0
	RodC6_54.8	139	54.8	1.392	7.8	0.198	831.29	717.2	4839.12	15265.0	8.021	45.6
	RodC6_57.8	140	57.8	1.468	10.8	0.274	861.78	734.1	4979.78	15708.7	7.857	44.6
	RodC6_63.8	141	63.8	1.621	16.8	0.427	889.20	749.4	5260.35	16593.8	7.956	45.2
	RodC6_73.7	142	73.7	1.872	2.82	0.072	892.03	750.9	5727.52	18067.5	8.625	49.0
	RodC6_75.8	143	75.8	1.925	4.92	0.125	916.76	764.7	5826.49	18379.7	8.459	48.0
	RodC6_76.8	144	76.8	1.951	5.92	0.150	932.05	773.2	5872.67	18525.3	8.341	47.4

Table A-50: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	749.48	671.8	6300.79	19875.8	12.082	68.6
	RodB4_91.3	162	91.3	2.319	2.8	0.071	836.24	720.0	6427.05	20274.1	10.567	60.0
	RodB4_93.3	163	93.3	2.370	4.8	0.122	851.83	728.6	6514.84	20551.1	10.443	59.3
	RodB4_95.1	164	95.1	2.416	6.6	0.168	879.23	743.8	6593.02	20797.7	10.124	57.5
	RodB4_100	165	100	2.540	11.5	0.292	915.37	763.9	6798.29	21445.2	9.890	56.2
	RodB4_106	166	106	2.692	17.5	0.445	984.63	802.4	7061.51	22275.5	9.333	53.0
	RodB4_109.9	167	109.9	2.791	21.4	0.544	836.97	720.4	6837.96	21570.4	11.229	63.8
	RodB4_142.3	168	142.3	3.614	8.8	0.224	870.98	739.3	2659.94	8390.8	4.137	23.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	787.52	692.9	6226.12	19640.3	11.128	63.2
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	761.24	678.3	6345.85	20018.0	11.901	67.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	846.19	725.5	6520.99	20570.5	10.548	59.9
	RodF4_94.3	101	94.3	2.395	5.8	0.147	872.24	740.0	6606.09	20838.9	10.254	58.2
	RodF4_97.2	102	97.2	2.469	8.7	0.221	901.22	756.1	6734.77	21244.8	10.004	56.8
	RodF4_108.8	103	108.8	2.764	20.3	0.516	940.45	777.8	7119.50	22458.5	9.993	56.7
	RodF4_111	104	111	2.819	-1.75	-0.044	827.68	715.2	6810.49	21483.7	11.357	64.5
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	993.00	807.0	6269.54	19777.3	8.195	46.5
	RodD2_106	66	106	2.692	17.5	0.445	1012.68	818.0	5938.56	18733.2	7.568	43.0
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1022.54	823.5	5487.85	17311.4	6.907	39.2
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1020.37	822.2	4957.36	15638.0	6.256	35.5
	RodD2_117.4	69	117.4	2.982	4.65	0.118	997.60	809.6	4452.48	14045.3	5.785	32.9
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1056.11	842.1	7039.27	22205.4	8.500	48.3
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1074.98	852.6	7164.75	22601.2	8.459	48.0
	RodD2_128.6	72	128.6	3.266	15.85	0.403	953.41	785.0	6572.91	20734.2	9.061	51.5
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1032.59	829.0	7044.81	22222.8	8.756	49.7
	RodD6_106	130	106	2.692	17.5	0.445	1044.33	835.6	7172.70	22626.3	8.787	49.9
	RodD6_112.9	131	112.9	2.868	0.15	0.004	904.08	757.6	6539.88	20630.0	9.673	54.9
	RodD6_114.9	132	114.9	2.918	2.15	0.055	947.58	781.8	6273.64	19790.2	8.718	49.5
	RodD6_116.8	133	116.8	2.967	4.05	0.103	970.99	794.8	6019.00	18986.9	8.101	46.0
	RodD6_120.9	134	120.9	3.071	8.15	0.207	976.94	798.1	5472.70	17263.6	7.307	41.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	974.55	796.8	4951.59	15619.8	6.633	37.7
	RodD6_128.7	136	128.7	3.269	15.95	0.405	964.32	791.1	4428.79	13970.6	6.015	34.2

Table A-50: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	763.40	679.5	4652.45	14676.1	8.690	49.3
	RodE2_54	74	54	1.372	7	0.178	824.33	713.3	4829.53	15234.7	8.099	46.0
	RodE2_56.9	75	56.9	1.445	9.9	0.251	855.40	730.6	4960.70	15648.5	7.907	44.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	882.49	745.6	5095.24	16072.9	7.785	44.2
	RodE2_66	77	66	1.676	19	0.483	904.51	757.9	5372.80	16948.5	7.942	45.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	815.31	708.3	5550.74	17509.8	9.451	53.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	878.98	743.7	5690.39	17950.3	8.741	49.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	908.55	760.1	5781.38	18237.4	8.495	48.2
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	715.82	653.1	4626.37	14593.9	9.484	53.9
	RodB3_54.1	170	54.1	1.374	7.1	0.180	786.53	692.3	4800.50	15143.2	8.595	48.8
	RodB3_56.9	171	56.9	1.445	9.9	0.251	826.43	714.5	4925.61	15537.8	8.231	46.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	822.44	712.3	5068.34	15988.1	8.526	48.4
	RodB3_66.1	173	66.1	1.679	19.1	0.485	869.20	738.3	5338.55	16840.5	8.326	47.3
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	751.35	672.8	5512.55	17389.3	10.533	59.8
	RodB3_73	175	73	1.854	2.12	0.054	820.46	711.2	5652.49	17830.8	9.541	54.2
	RodB3_75	176	75	1.905	4.12	0.105	854.16	729.9	5741.90	18112.8	9.170	52.1
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	735.26	663.8	4631.81	14611.0	9.131	51.9
	RodF3_54	90	54	1.372	7	0.178	803.19	701.6	4808.37	15168.0	8.360	47.5
	RodF3_57	91	57	1.448	10	0.254	846.32	725.6	4946.44	15603.6	8.000	45.4
	RodF3_60	92	60	1.524	13	0.330	876.15	742.1	5084.39	16038.7	7.844	44.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	892.12	751.0	5364.80	16923.3	8.078	45.9
	RodF3_70	94	70	1.778	-0.88	-0.022	795.62	697.4	5568.15	17564.7	9.810	55.7
	RodF3_73	95	73	1.854	2.12	0.054	882.07	745.4	5687.07	17939.9	8.695	49.4
	RodF3_75	96	75	1.905	4.12	0.105	914.02	763.2	5776.66	18222.5	8.421	47.8
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	746.67	670.2	4622.38	14581.3	8.912	50.6
	RodE6_54.1	122	54.1	1.374	7.1	0.180	801.01	700.4	4796.21	15129.6	8.370	47.5
	RodE6_57	123	57	1.448	10	0.254	829.23	716.1	4923.95	15532.6	8.190	46.5
	RodE6_60.2	124	60.2	1.529	13.2	0.335	849.16	727.1	5067.01	15983.9	8.157	46.3
	RodE6_66.1	125	66.1	1.679	19.1	0.485	876.44	742.3	5329.01	16810.4	8.218	46.7
	RodE6_70	126	70	1.778	-0.88	-0.022	801.69	700.8	5505.27	17366.4	9.596	54.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	858.81	732.5	5641.62	17796.5	8.943	50.8
	RodE6_75	128	75	1.905	4.12	0.105	887.13	748.2	5725.51	18061.1	8.686	49.3

RBHT Steam Cooling with Droplet Injection Test SCD-4049-H

Matrix Test # 5d

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 25680 - 25920
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 75 kW
Bundle Inlet Reynolds Number: 10000
Bundle Inlet Steam Flow: 181.4 kg/hr (400 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

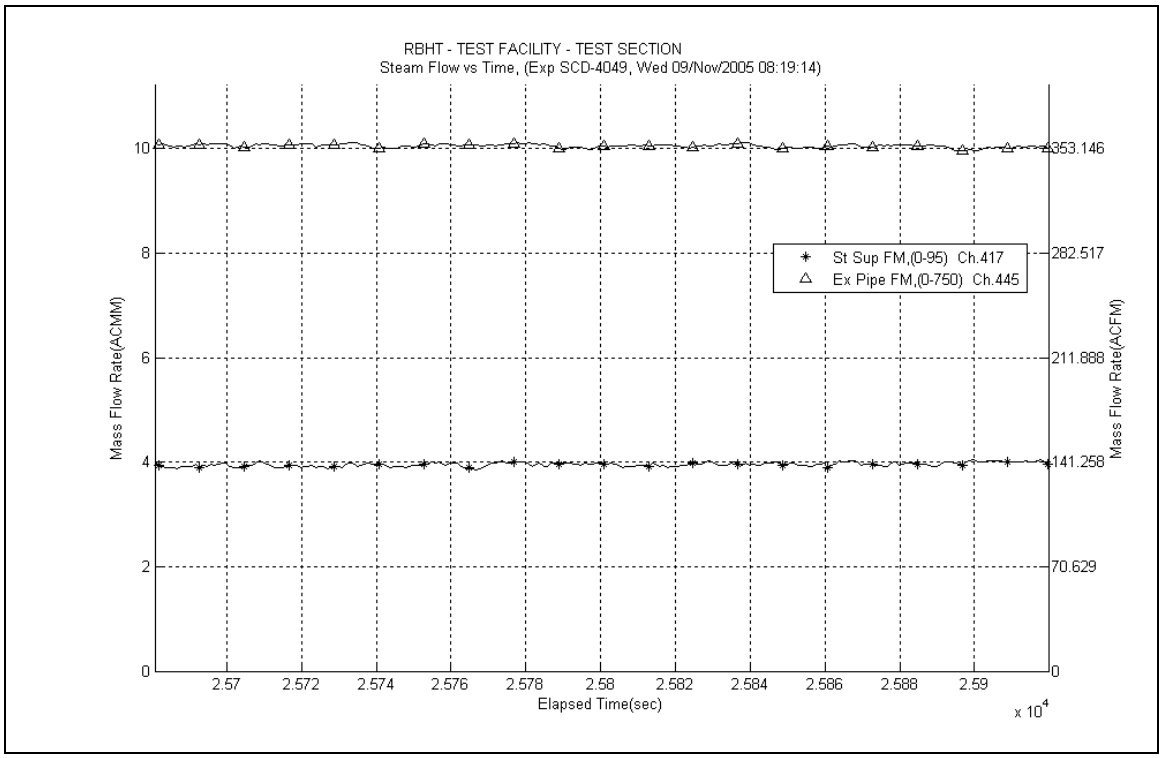

Figure A-202: Inlet and Exhaust Steam Flow Rates for Experiment 4049H

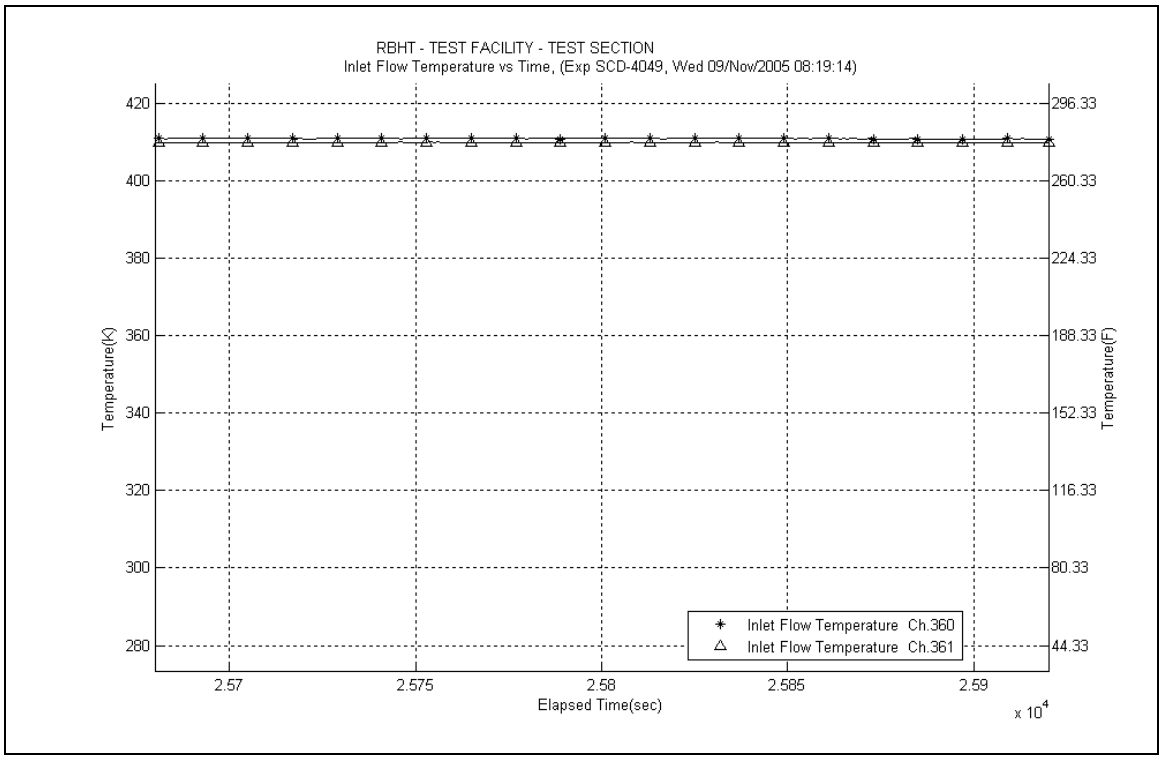

Figure A-203: Inlet Steam Temperature for Experiment 4049H

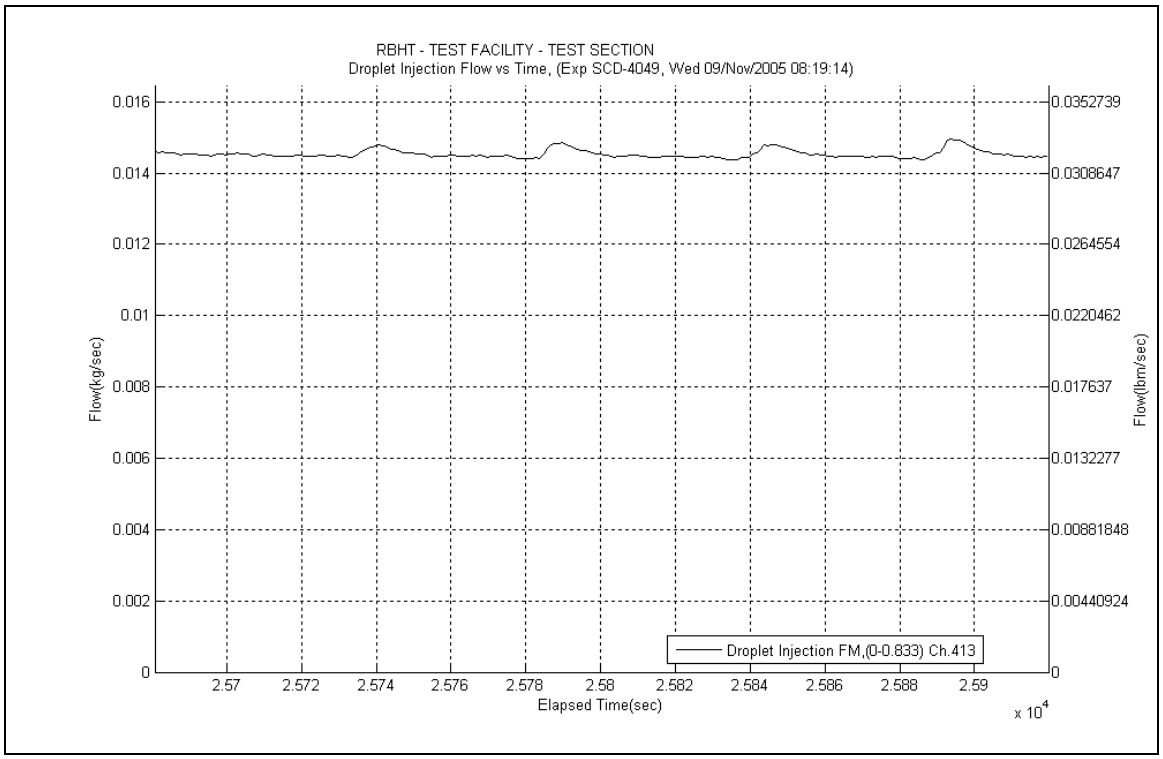

Figure A-204: Droplet Injection Flow Rate for Experiment 4049H

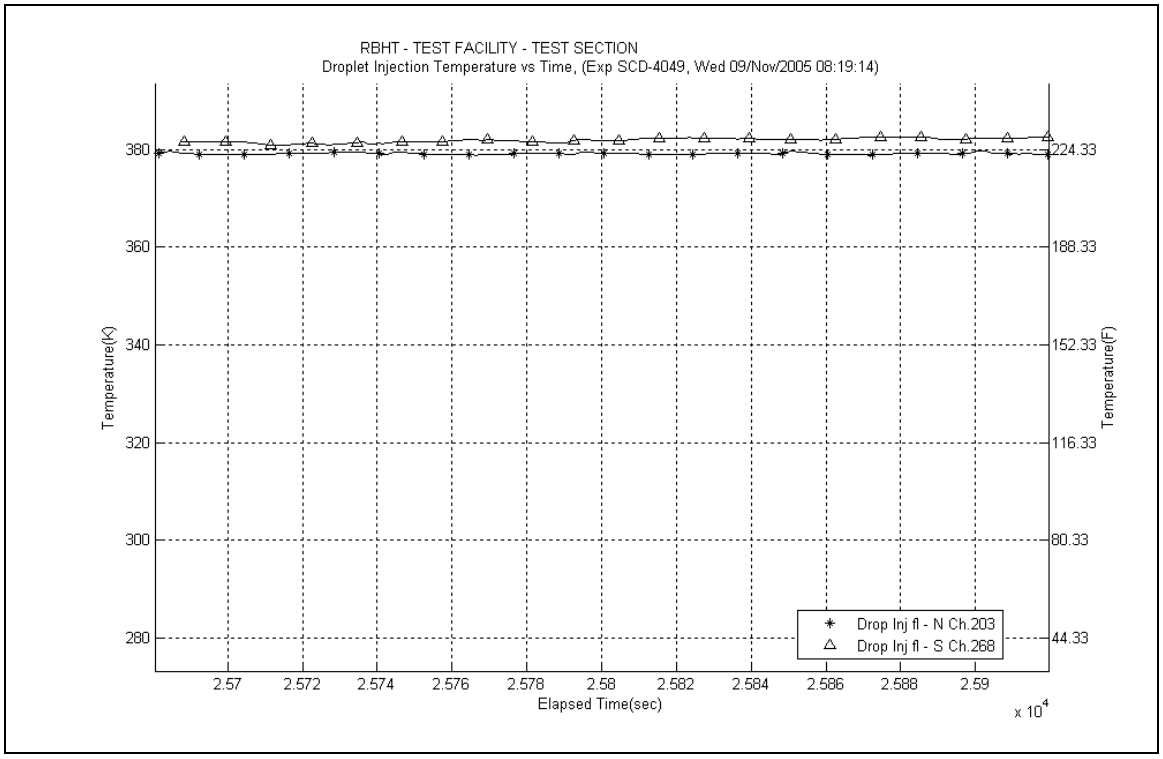

Figure A-205: Droplet Injection Temperature for Experiment 4049H

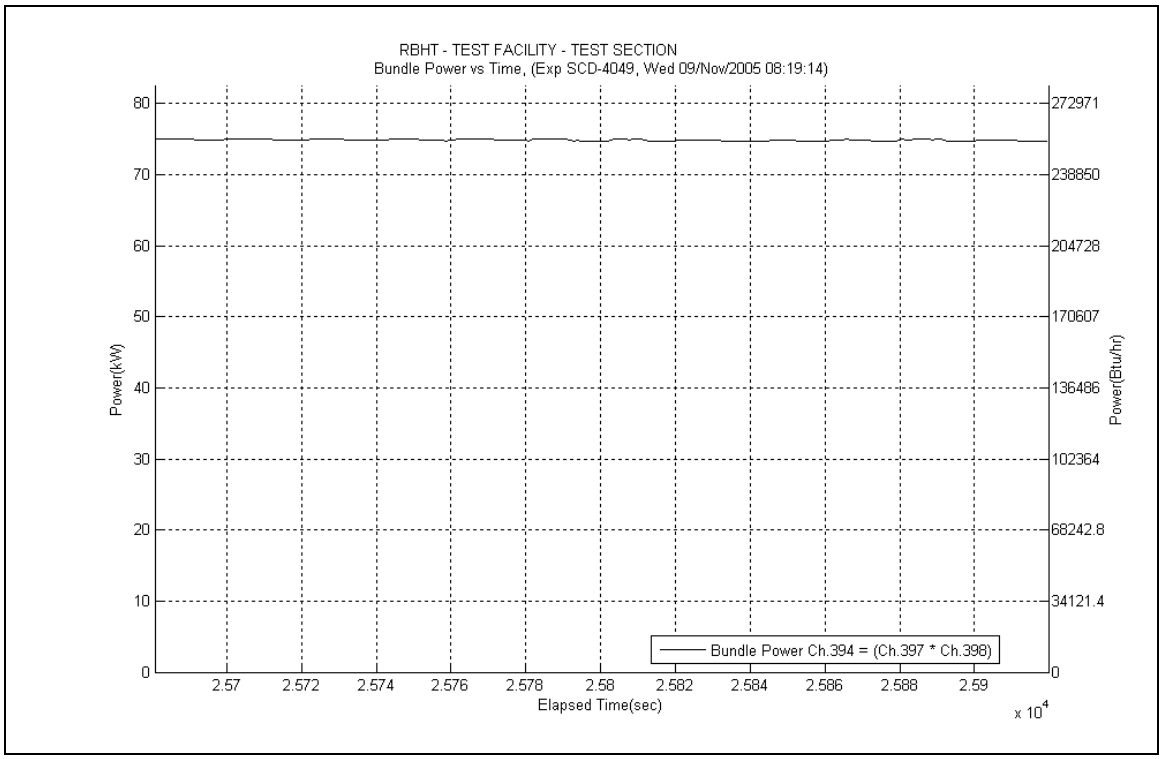

Figure A-206: Bundle Power for Experiment 4049H

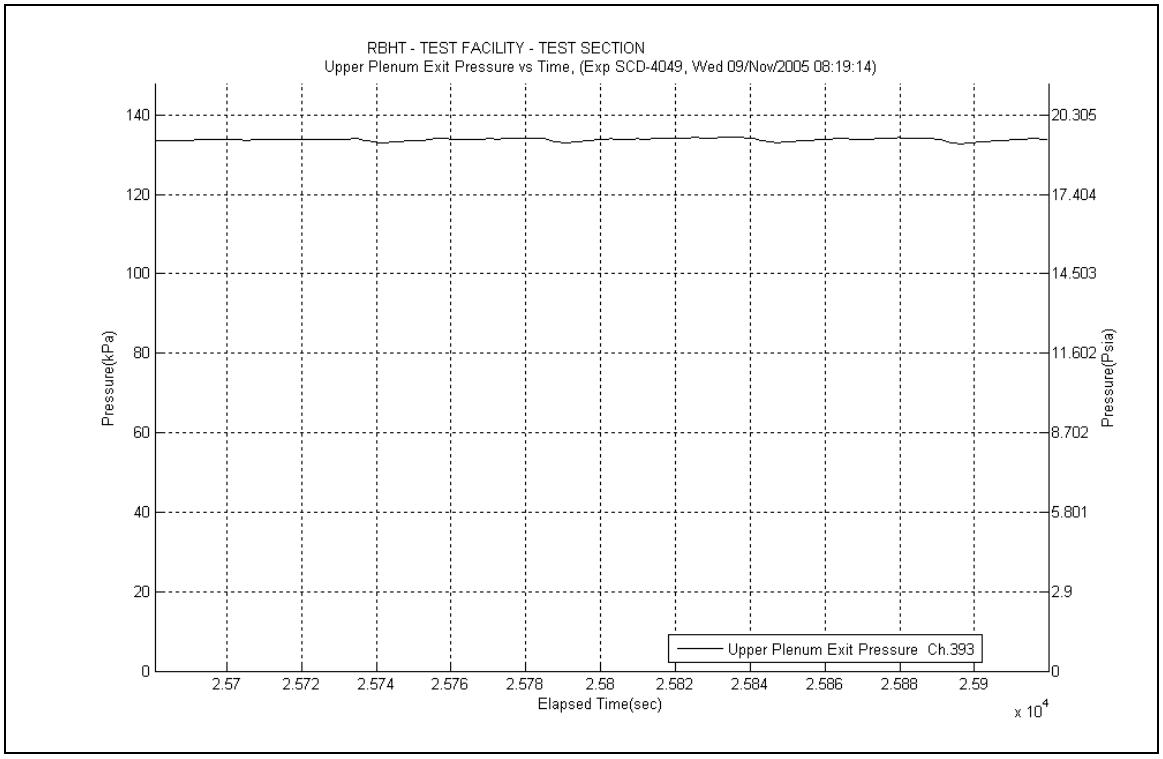

Figure A-207: Upper Plenum Pressure for Experiment 4049H

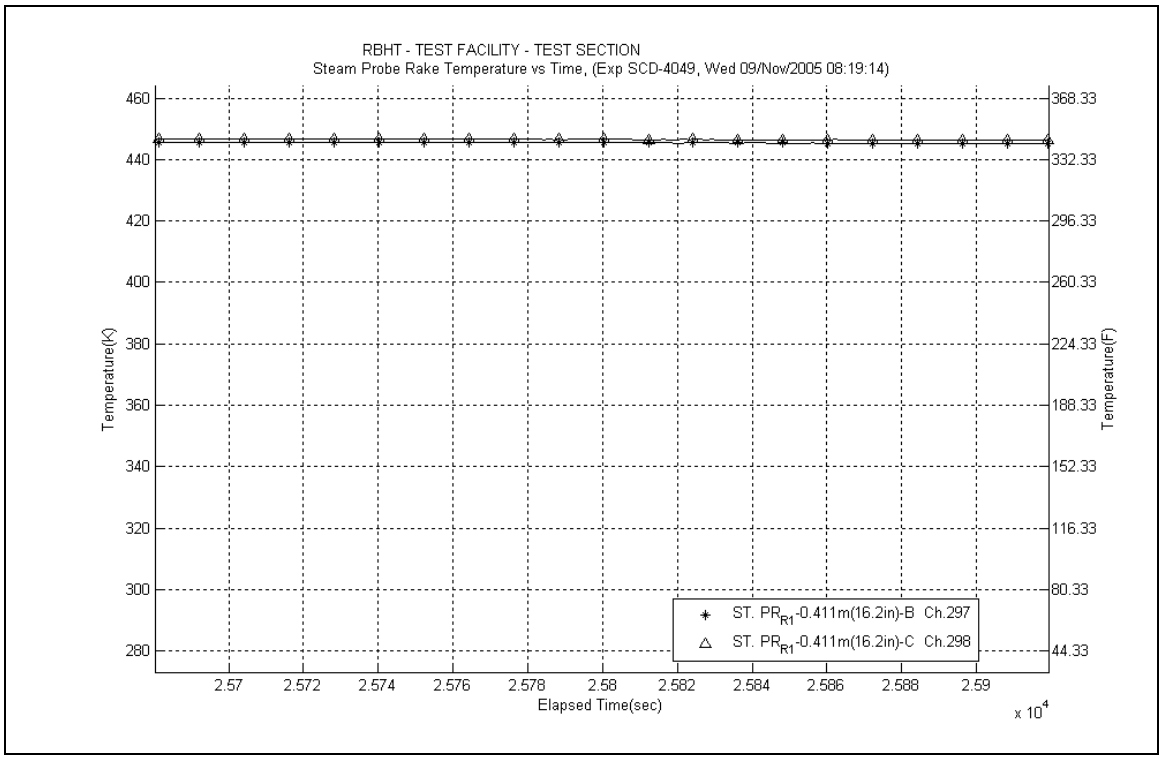

Figure A-208: Steam Probe Rake #1 Temperatures for Experiment 4049H

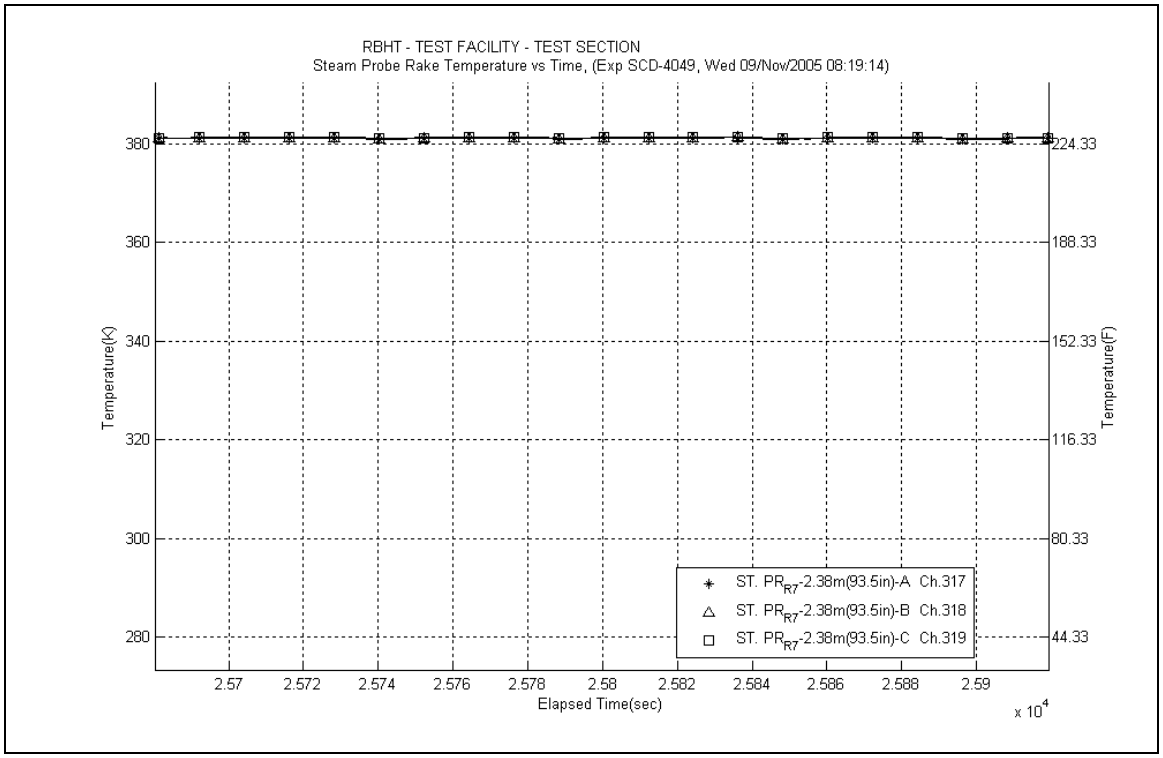

Figure A-209: Steam Probe Rake #7 Temperatures for Experiment 4049H

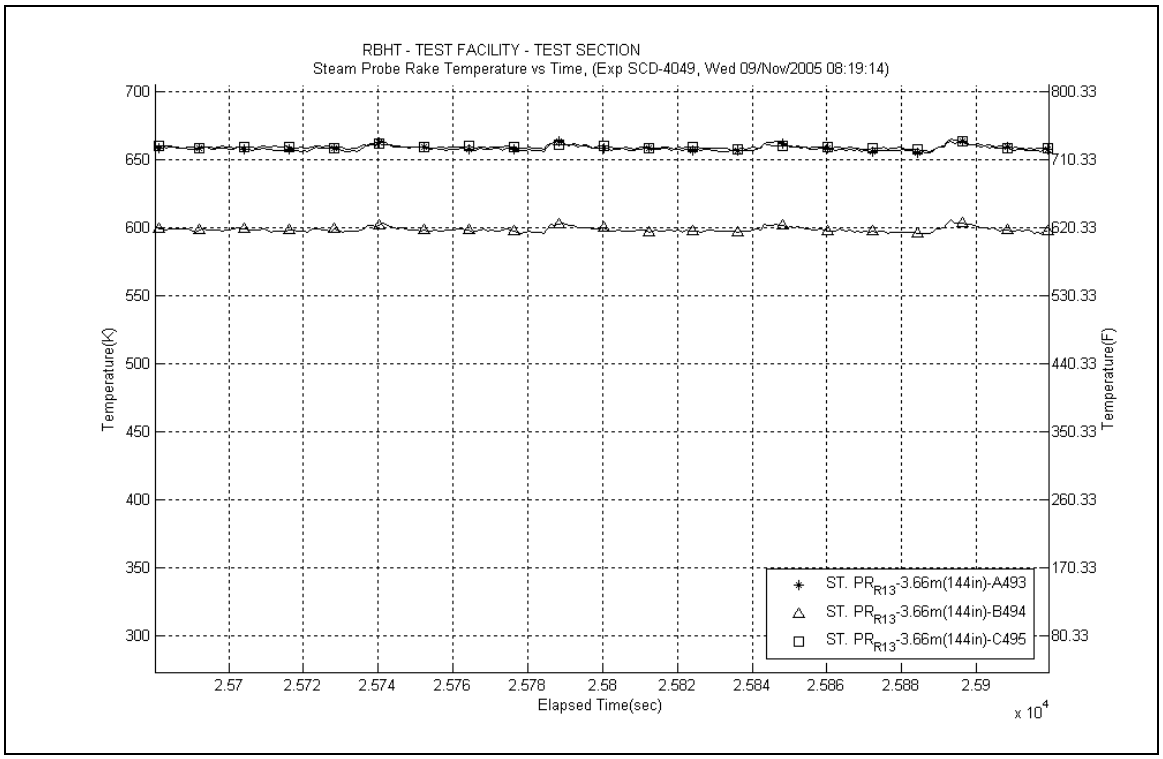

Figure A-210: Steam Probe Rake #13 Temperatures for Experiment 4049H

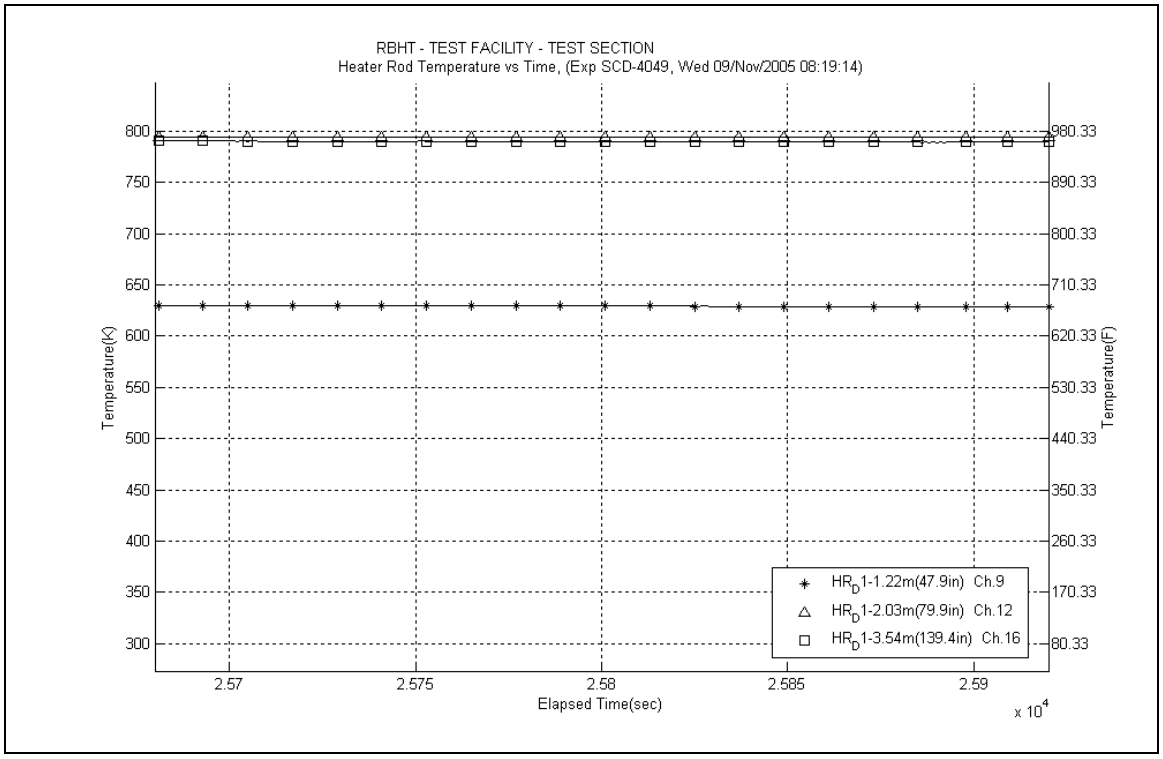

Figure A-211: Heater Rod D1 Temperatures for Experiment 4049H

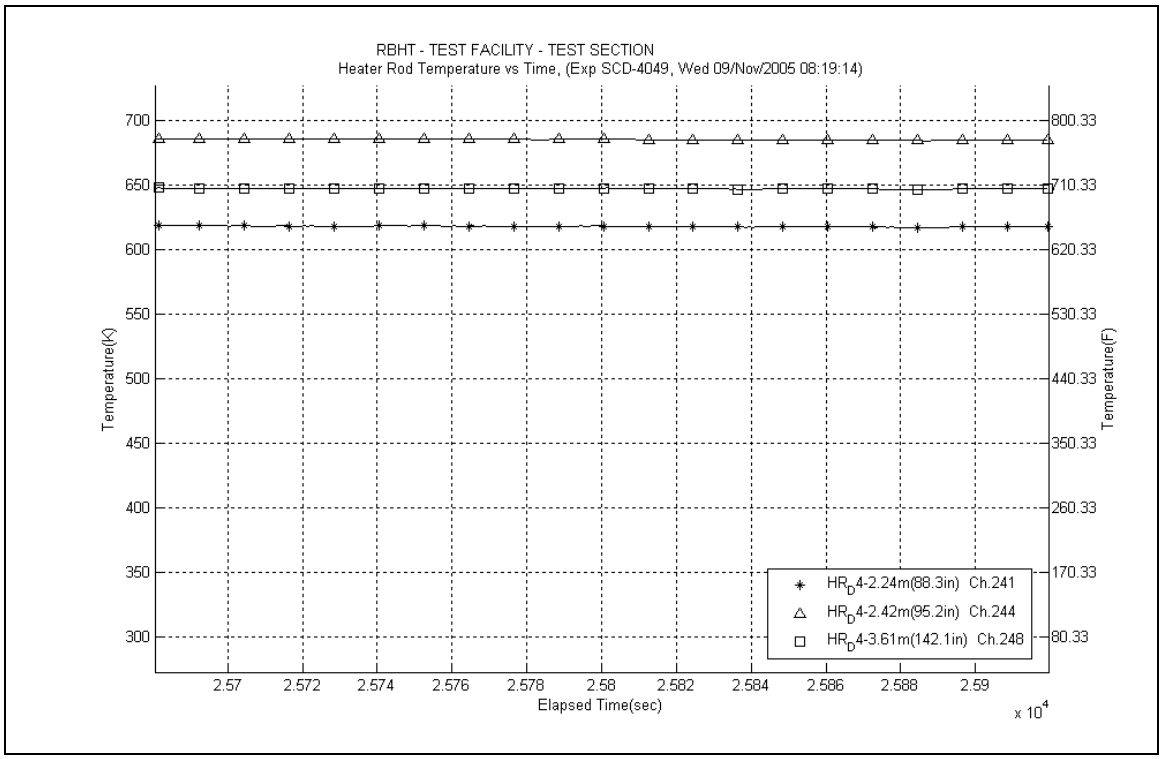

Figure A-212: Heater Rod D4 Temperatures for Experiment 4049H

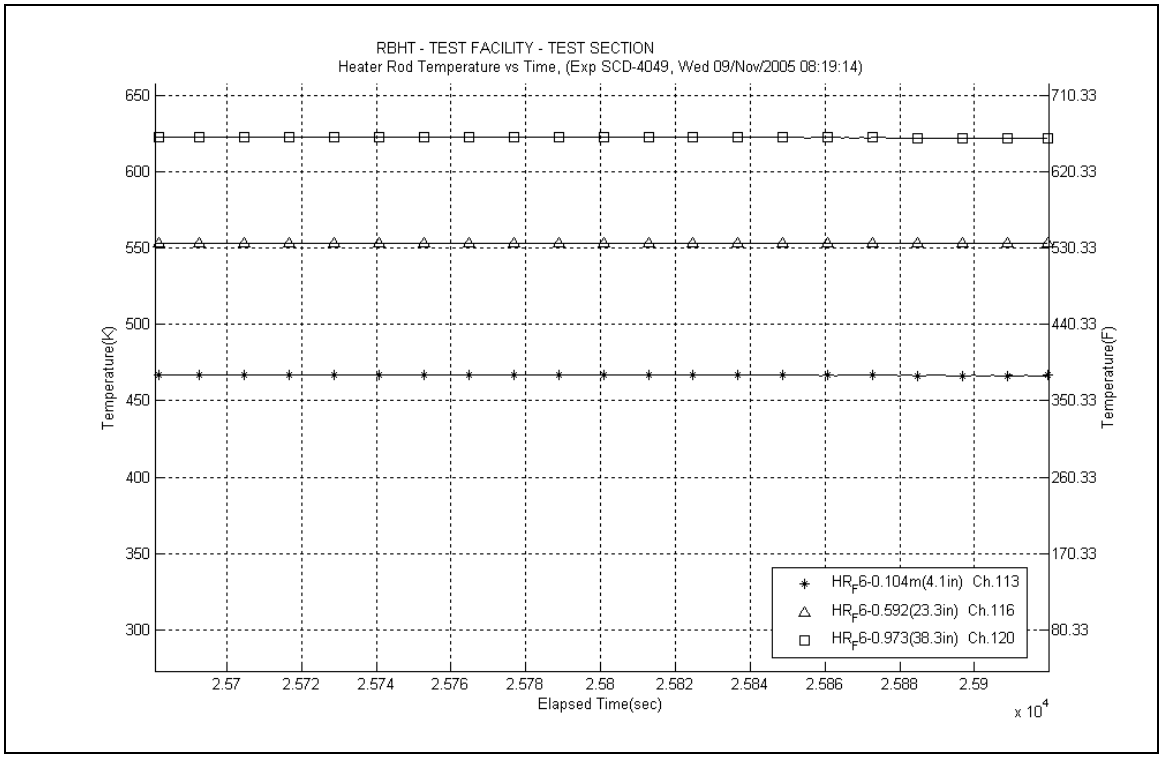

Figure A-213: Heater Rod F6 Temperatures for Experiment 4049H

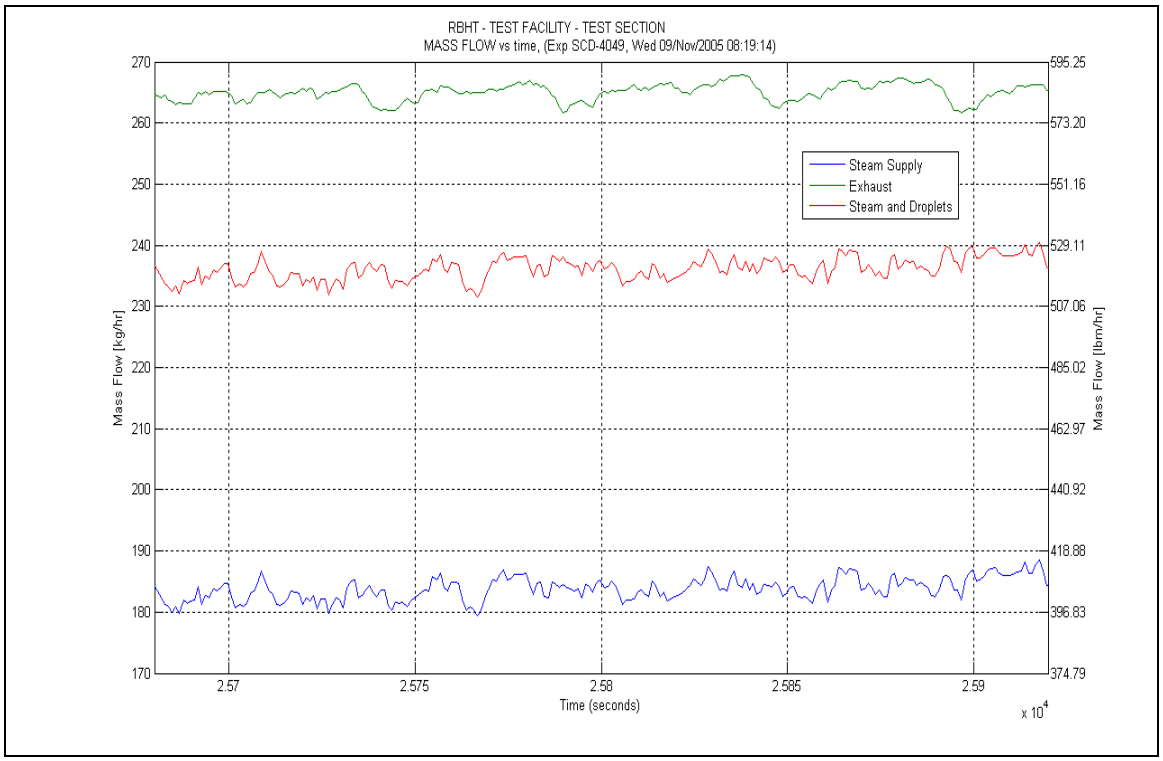

Figure A-214: Mass Flow for Experiment 4049H

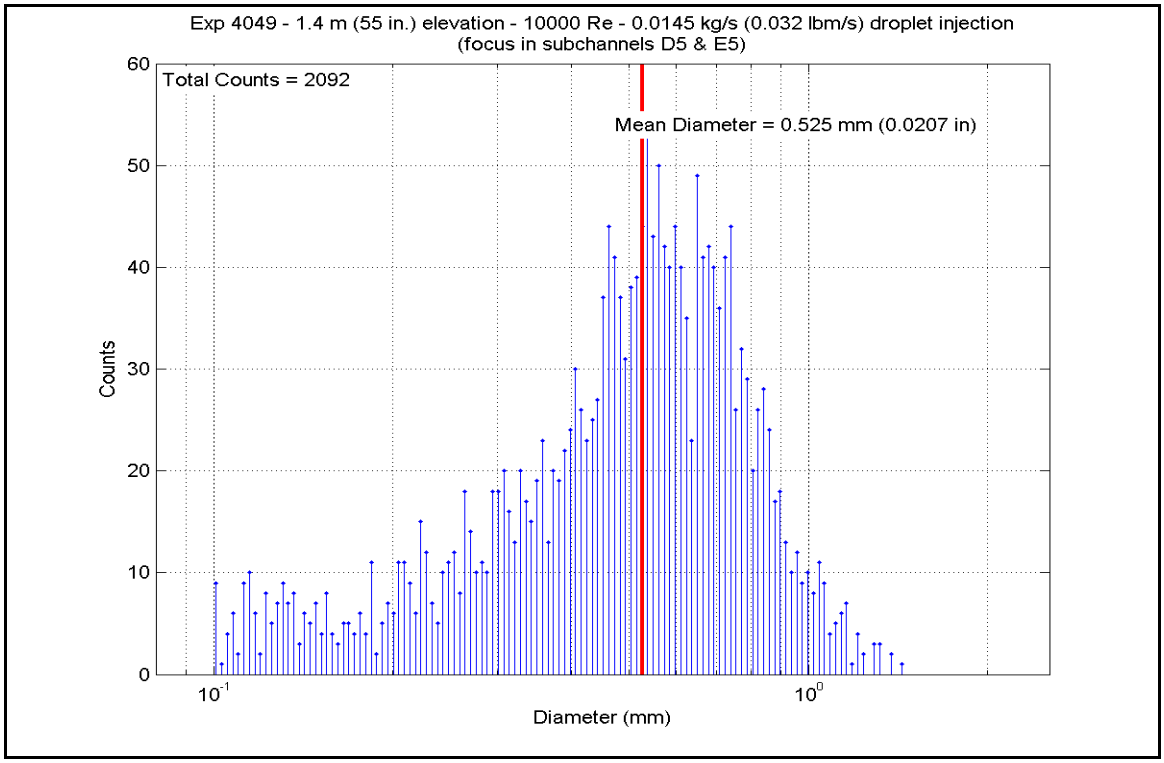

Figure A-215: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049H

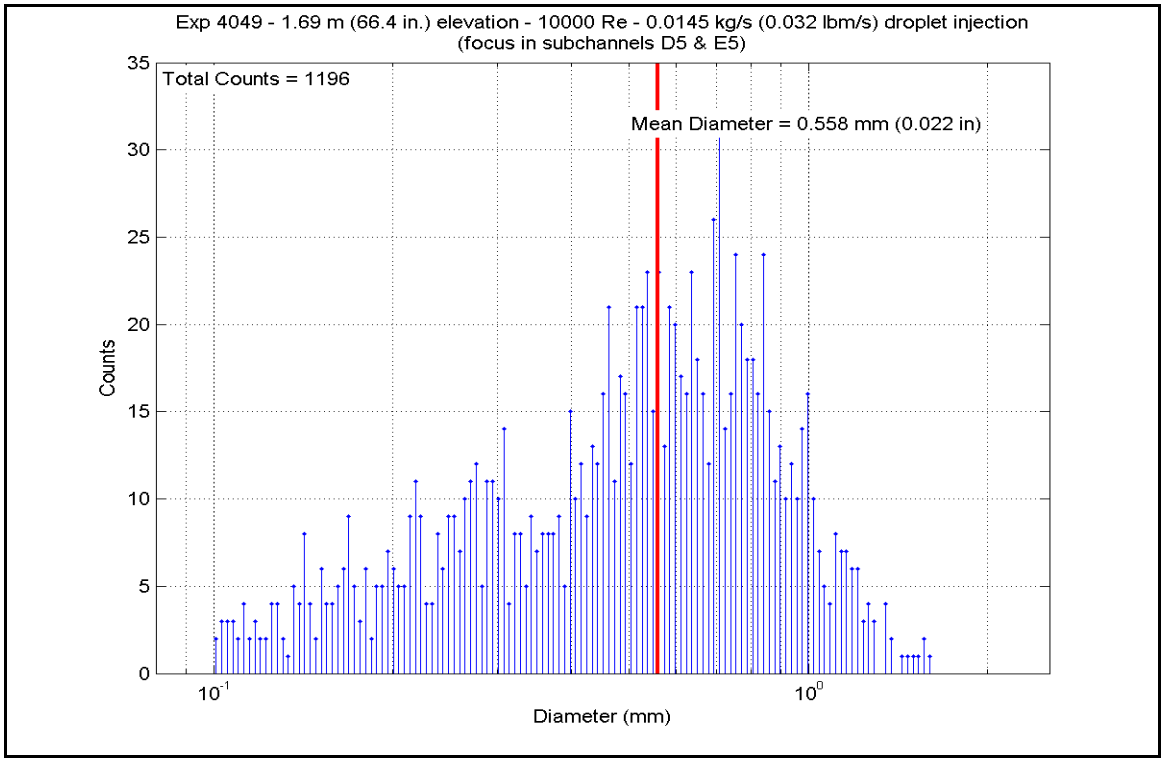

Figure A-216: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049H

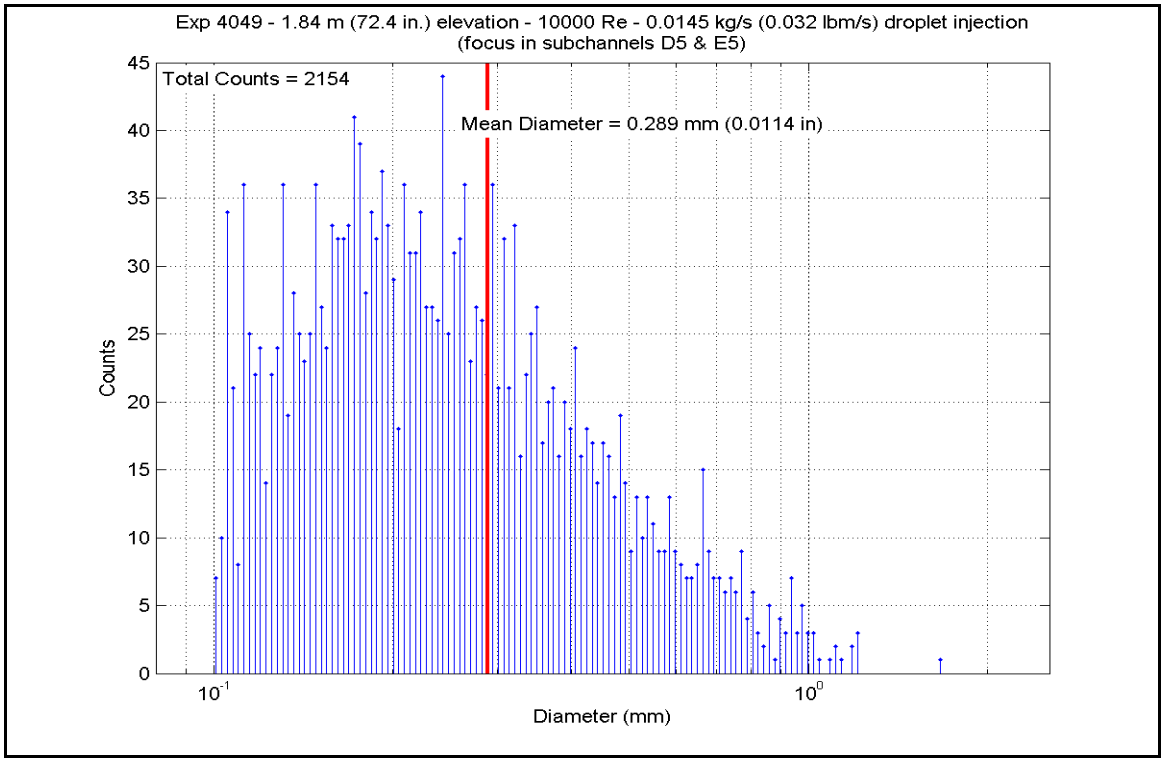

Figure A-217: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049H

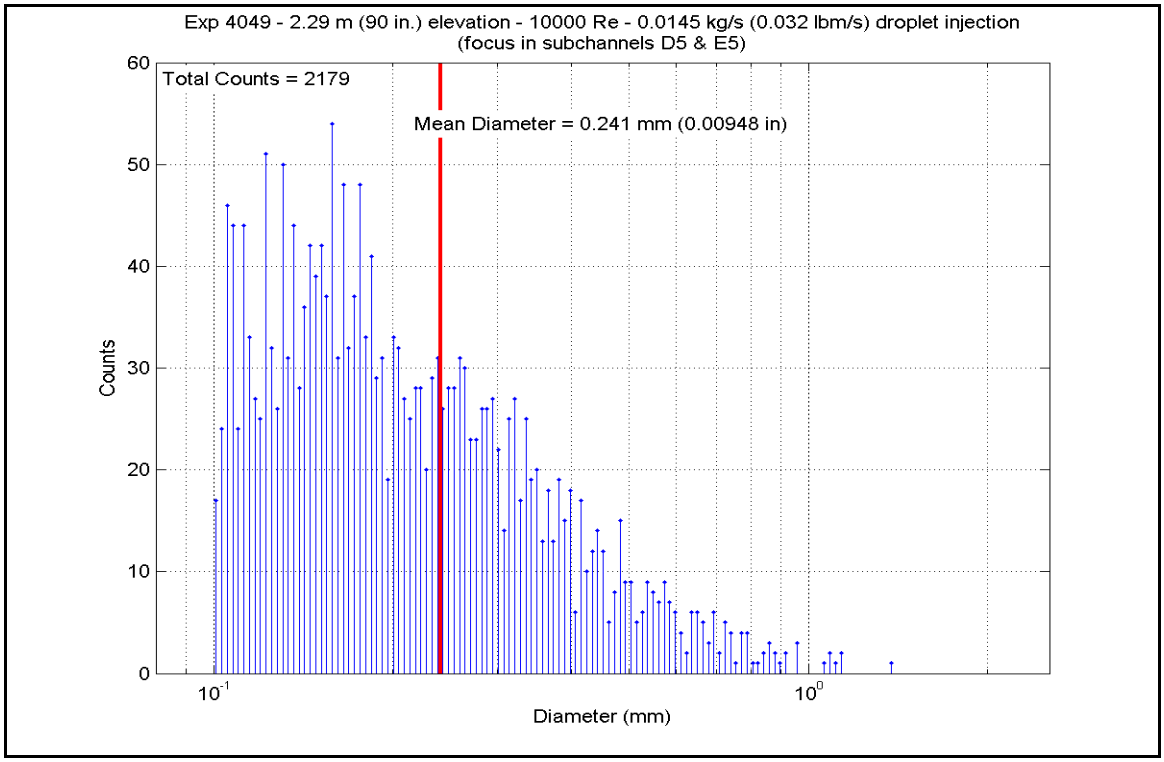

Figure A-218: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049H

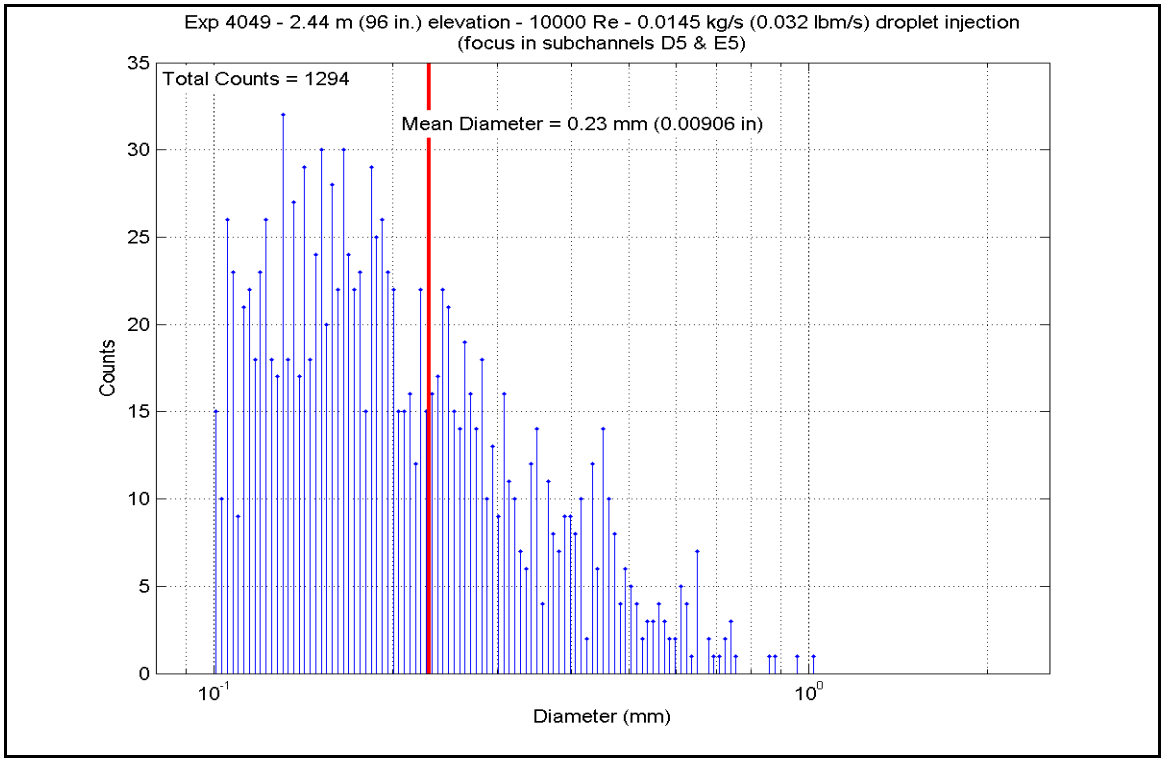

Figure A-219: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049H

Table A-51: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049H

SCD-4049-H		Inlet Reynolds:	10000		
Matrix Test # 5d		UP Pressure:	137.9 kPa	20	psia
Time Window: 25680-25920		Bundle Power:	75.00 kW	255911	Btu/hr
		Steam flow:	0.0504 kg/s	400.0	lbm/hr
		Droplet flow:	0.0145 kg/s	0.032	lbm/s
Inner 3x3					

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	715.47	652.9	6359.92	20062.4	13.047	74.1
	RodD3_91.3	186	91.3	2.319	2.8	0.071	787.21	692.7	6497.60	20496.7	11.619	66.0
	RodD3_93.1	187	93.1	2.365	4.6	0.117	782.94	690.3	6577.28	20748.0	11.852	67.3
	RodD3_95.3	188	95.3	2.421	6.8	0.173	817.56	709.6	6679.71	21071.1	11.330	64.3
	RodD3_100.1	189	100.1	2.543	11.6	0.295	844.17	724.4	6899.80	21765.4	11.198	63.6
	RodD3_106.1	190	106.1	2.695	17.6	0.447	922.06	767.6	7171.06	22621.1	10.332	58.7
	RodD3_110	191	110	2.794	21.5	0.546	760.12	677.7	7083.64	22345.3	13.312	75.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	810.44	705.6	2471.17	7795.3	4.243	24.1
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	684.53	635.7	6430.21	20284.1	14.085	80.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	770.33	683.3	6557.75	20686.4	12.092	68.7
	RodC4_93.4	235	93.4	2.372	4.9	0.124	788.76	693.6	6663.10	21018.7	11.882	67.5
	RodC4_95.3	236	95.3	2.421	6.8	0.173	820.77	711.4	6752.34	21300.3	11.391	64.7
	RodC4_100.1	237	100.1	2.543	11.6	0.295	845.50	725.1	6972.20	21993.8	11.291	64.1
	RodC4_106.1	238	106.1	2.695	17.6	0.447	904.09	757.6	7252.53	22878.1	10.727	60.9
	RodC4_110	239	110	2.794	21.5	0.546	720.29	655.5	7021.81	22150.3	14.264	81.0
	RodC4_142.2	240	142.2	3.612	8.7	0.221	740.31	666.7	2679.22	8451.6	5.230	29.7
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	650.62	616.8	6411.88	20226.3	15.172	86.2
	RodD4_91.3	242	91.3	2.319	2.8	0.071	730.27	661.1	6551.51	20666.7	13.044	74.1
	RodD4_93.2	243	93.2	2.367	4.7	0.119	747.07	670.4	6637.97	20939.5	12.788	72.6
	RodD4_95.2	244	95.2	2.418	6.7	0.170	771.50	684.0	6729.29	21227.5	12.381	70.3
	RodD4_100.1	245	100.1	2.543	11.6	0.295	810.63	705.7	6954.08	21936.7	11.936	67.8
	RodD4_106.1	246	106.1	2.695	17.6	0.447	840.43	722.3	7227.75	22799.9	11.802	67.0
	RodD4_142.1	248	142.1	3.609	8.6	0.218	704.86	647.0	2589.53	8168.7	5.430	30.8
Gr-3	RodE4_91.2	202	91.2	2.316	2.7	0.069	228.43	382.3	6429.50	20281.9	14980.580	85073.1
	RodE4_95.3	204	95.3	2.421	6.8	0.173	229.57	382.9	6609.16	20848.6	4197.318	23836.1
	RodE4_100.9	205	100.9	2.563	12.4	0.315	230.23	383.3	6852.76	21617.0	3071.785	17444.3

Table A-51: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	887.21	748.3	5229.62	16496.8	7.933	45.1
	RodE3_113.6	194	113.6	2.885	0.85	0.022	827.22	714.9	6434.75	20298.4	10.739	61.0
	RodE3_115.5	195	115.5	2.934	2.75	0.070	860.80	733.6	6193.52	19537.5	9.788	55.6
	RodE3_118.5	196	118.5	3.010	5.75	0.146	878.65	743.5	5817.73	18352.0	8.941	50.8
	RodE3_122.7	197	122.7	3.117	9.95	0.253	866.61	736.8	5291.12	16690.8	8.285	47.1
	RodE3_126.5	198	126.5	3.213	13.75	0.349	863.10	734.9	4814.05	15185.9	7.580	43.0
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	781.91	689.8	4146.04	13078.7	7.485	42.5
	RodE3_135.6	200	135.6	3.444	2.1	0.053	836.95	720.3	3667.84	11570.2	6.023	34.2
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	866.67	736.9	5128.72	16178.5	8.030	45.6
	RodC5_113.6	226	113.6	2.885	0.85	0.022	779.17	688.2	6287.59	19834.2	11.408	64.8
	RodC5_115.7	227	115.7	2.939	2.95	0.075	822.26	712.2	6034.69	19036.4	10.155	57.7
	RodC5_122.7	229	122.7	3.117	9.95	0.253	844.18	724.4	5199.84	16402.9	8.439	47.9
	RodC5_126.7	230	126.7	3.218	13.95	0.354	841.67	723.0	4720.72	14891.5	7.693	43.7
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	659.75	621.9	4126.86	13018.2	9.559	54.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	707.80	648.6	3640.19	11483.0	7.587	43.1
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	822.96	712.6	5254.88	16576.5	8.832	50.2
	RodE5_113.6	210	113.6	2.885	0.85	0.022	714.26	652.2	6483.35	20451.7	13.333	75.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	770.75	683.6	6262.94	19756.5	11.539	65.5
	RodE5_118.7	212	118.7	3.015	5.95	0.151	824.64	713.5	5853.27	18464.1	9.810	55.7
	RodE5_122.6	213	122.6	3.114	9.85	0.250	842.68	723.5	5369.91	16939.4	8.736	49.6
	RodE5_126.6	214	126.6	3.216	13.85	0.352	831.22	717.2	4874.23	15375.8	8.080	45.9
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	877.89	743.1	4221.49	13316.7	6.496	36.9
	RodE5_135.6	216	135.6	3.444	2.1	0.053	773.90	685.3	3754.77	11844.4	6.878	39.1
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	842.00	723.2	5939.43	18735.9	9.673	54.9
	RodC3_85.6	178	85.6	2.174	14.72	0.374	664.03	624.3	6201.20	19561.7	14.222	80.8
	RodC3_88.5	179	88.5	2.248	0	0.000	720.03	655.4	6330.95	19971.0	12.867	73.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	821.49	711.8	6507.10	20526.6	10.964	62.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	833.03	718.2	6596.57	20808.9	10.903	61.9
	RodC3_97.2	182	97.2	2.469	8.7	0.221	879.16	743.8	6727.34	21221.4	10.331	58.7
	RodC3_108.8	183	108.8	2.764	20.3	0.516	922.90	768.1	7092.58	22373.6	10.207	58.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	779.34	688.3	4644.00	14649.5	8.423	47.8
	RodD5_54.1	218	54.1	1.374	7.1	0.180	743.34	668.3	4822.63	15213.0	9.358	53.1
	RodD5_56.9	219	56.9	1.445	9.9	0.251	807.03	703.7	4950.89	15617.6	8.550	48.6
	RodD5_60	220	60	1.524	13	0.330	844.69	724.6	5093.82	16068.5	8.260	46.9
	RodD5_66.1	221	66.1	1.679	19.1	0.485	883.69	746.3	5364.17	16921.3	8.181	46.5
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	694.27	641.1	5527.11	17435.3	11.854	67.3
	RodD5_72.9	223	72.9	1.852	2.02	0.051	766.03	680.9	5660.49	17856.0	10.521	59.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	805.73	703.0	5751.16	18142.0	9.955	56.5

Table A-51: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	704.26	646.6	4224.15	13325.1	8.869	50.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	769.30	682.8	4758.27	15010.0	8.790	49.9
	RodB5_55	155	55	1.397	8	0.203	806.05	703.2	4854.06	15312.1	8.397	47.7
	RodB5_57.8	156	57.8	1.468	10.8	0.274	836.09	719.9	4976.87	15699.5	8.184	46.5
	RodB5_64	157	64	1.626	17	0.432	867.90	737.5	5258.50	16587.9	8.218	46.7
	RodB5_73.9	158	73.9	1.877	3.02	0.077	821.69	711.9	5693.62	17960.5	9.590	54.5
	RodB5_75.9	159	75.9	1.928	5.02	0.128	849.79	727.5	5786.34	18253.0	9.306	52.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	859.56	732.9	5831.57	18395.7	9.234	52.4
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	696.22	642.2	4196.50	13237.8	8.963	50.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	762.41	678.9	4740.03	14952.4	8.870	50.4
	RodF5_55	107	55	1.397	8	0.203	799.17	699.4	4825.11	15220.8	8.448	48.0
	RodF5_57.8	108	57.8	1.468	10.8	0.274	837.86	720.8	4950.25	15615.6	8.117	46.1
	RodF5_64	109	64	1.626	17	0.432	877.81	743.0	5228.99	16494.8	8.047	45.7
	RodF5_73.8	110	73.8	1.875	2.92	0.074	814.22	707.7	5667.44	17878.0	9.668	54.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	845.64	725.2	5757.00	18160.5	9.321	52.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	859.25	732.7	5801.30	18300.2	9.190	52.2
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	702.57	645.7	4218.25	13306.5	8.889	50.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	815.51	708.4	4761.76	15021.0	8.105	46.0
	RodC2_55	59	55	1.397	8	0.203	830.85	717.0	4848.49	15294.6	8.043	45.7
	RodC2_57.8	60	57.8	1.468	10.8	0.274	858.02	732.1	4975.84	15696.3	7.898	44.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	877.96	743.1	5252.41	16568.7	8.081	45.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	856.62	731.3	5694.87	17964.5	9.059	51.4
	RodC2_75.8	63	75.8	1.925	4.92	0.125	881.39	745.0	5783.51	18244.1	8.852	50.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	891.53	750.7	5829.54	18389.3	8.786	49.9
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	698.63	643.5	4198.98	13245.7	8.922	50.7
	RodC6_52.8	138	52.8	1.341	5.8	0.147	813.92	707.6	4755.95	15002.6	8.117	46.1
	RodC6_54.8	139	54.8	1.392	7.8	0.198	830.49	716.8	4850.82	15301.9	8.051	45.7
	RodC6_57.8	140	57.8	1.468	10.8	0.274	861.14	733.8	4991.44	15745.5	7.884	44.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	888.74	749.1	5273.80	16636.2	7.982	45.3
	RodC6_73.7	142	73.7	1.872	2.82	0.072	856.51	731.2	5733.01	18084.8	9.122	51.8
	RodC6_75.8	143	75.8	1.925	4.92	0.125	882.44	745.6	5833.65	18402.2	8.914	50.6
	RodC6_76.8	144	76.8	1.951	5.92	0.150	897.12	753.8	5881.07	18551.8	8.789	49.9

Table A-51: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	709.48	649.5	6299.28	19871.1	13.083	74.3
	RodB4_91.3	162	91.3	2.319	2.8	0.071	790.39	694.5	6430.02	20283.5	11.433	64.9
	RodB4_93.3	163	93.3	2.370	4.8	0.122	803.34	701.7	6516.65	20556.8	11.327	64.3
	RodB4_95.1	164	95.1	2.416	6.6	0.168	829.72	716.3	6596.08	20807.3	10.962	62.3
	RodB4_100	165	100	2.540	11.5	0.292	863.44	735.1	6813.75	21494.0	10.723	60.9
	RodB4_106	166	106	2.692	17.5	0.445	930.09	772.1	7076.21	22321.9	10.079	57.2
	RodB4_109.9	167	109.9	2.791	21.4	0.544	746.11	669.9	6853.96	21620.8	13.229	75.1
	RodB4_142.3	168	142.3	3.614	8.8	0.224	763.88	679.8	2656.12	8378.7	4.957	28.1
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	762.10	678.8	6220.77	19623.4	11.647	66.1
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	737.86	665.3	6347.86	20024.3	12.450	70.7
	RodF4_92.4	100	92.4	2.347	3.9	0.099	819.86	710.8	6527.09	20589.7	11.028	62.6
	RodF4_94.3	101	94.3	2.395	5.8	0.147	843.72	724.1	6611.87	20857.1	10.738	61.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	869.94	738.7	6742.46	21269.1	10.503	59.6
	RodF4_108.8	103	108.8	2.764	20.3	0.516	899.05	754.8	7118.28	22454.6	10.608	60.2
	RodF4_111	104	111	2.819	-1.75	-0.044	758.54	676.8	6811.69	21487.5	12.839	72.9
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	932.12	773.2	6279.86	19809.8	8.919	50.6
	RodD2_106	66	106	2.692	17.5	0.445	955.53	786.2	5948.74	18765.3	8.177	46.4
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	968.27	793.3	5497.52	17341.9	7.426	42.2
	RodD2_114.9	68	114.9	2.918	2.15	0.055	964.03	790.9	4967.39	15669.6	6.749	38.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	939.21	777.2	4461.85	14074.9	6.274	35.6
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1015.35	819.5	7055.29	22255.9	8.961	50.9
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1033.52	829.6	7182.37	22656.8	8.916	50.6
	RodD2_128.6	72	128.6	3.266	15.85	0.403	884.72	746.9	6587.79	20781.2	10.031	57.0
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	994.10	807.7	7061.78	22276.4	9.218	52.3
	RodD6_106	130	106	2.692	17.5	0.445	1007.13	814.9	7192.02	22687.2	9.231	52.4
	RodD6_112.9	131	112.9	2.868	0.15	0.004	843.98	724.3	6556.95	20683.9	10.645	60.5
	RodD6_114.9	132	114.9	2.918	2.15	0.055	892.94	751.4	6289.21	19839.3	9.458	53.7
	RodD6_116.8	133	116.8	2.967	4.05	0.103	916.33	764.4	6036.22	19041.2	8.769	49.8
	RodD6_120.9	134	120.9	3.071	8.15	0.207	918.55	765.7	5483.96	17299.2	7.941	45.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	915.09	763.8	4963.25	15656.6	7.224	41.0
	RodD6_128.7	136	128.7	3.269	15.95	0.405	900.93	755.9	4440.58	14007.8	6.599	37.5

Table A-51: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	763.19	679.4	4661.03	14703.2	8.709	49.5
	RodE2_54	74	54	1.372	7	0.178	823.37	712.8	4839.56	15266.4	8.129	46.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	854.69	730.2	4971.71	15683.2	7.933	45.1
	RodE2_59.9	76	59.9	1.521	12.9	0.328	881.95	745.3	5109.09	16116.6	7.813	44.4
	RodE2_66	77	66	1.676	19	0.483	903.50	757.3	5385.57	16988.8	7.973	45.3
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	806.69	703.5	5551.53	17512.3	9.593	54.5
	RodE2_72.9	79	72.9	1.852	2.02	0.051	865.92	736.4	5688.26	17943.6	8.917	50.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	895.56	752.9	5779.29	18230.8	8.657	49.2
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	713.32	651.7	4624.85	14589.1	9.530	54.1
	RodB3_54.1	170	54.1	1.374	7.1	0.180	784.02	690.9	4808.65	15168.9	8.648	49.1
	RodB3_56.9	171	56.9	1.445	9.9	0.251	823.60	712.9	4934.81	15566.9	8.285	47.1
	RodB3_60.1	172	60.1	1.527	13.1	0.333	818.19	709.9	5077.73	16017.7	8.604	48.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	859.30	732.8	5344.49	16859.2	8.466	48.1
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	735.24	663.8	5505.04	17365.6	10.853	61.6
	RodB3_73	175	73	1.854	2.12	0.054	798.39	698.9	5650.53	17824.6	9.906	56.3
	RodB3_75	176	75	1.905	4.12	0.105	829.84	716.4	5744.98	18122.6	9.546	54.2
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	733.67	663.0	4632.20	14612.3	9.161	52.0
	RodF3_54	90	54	1.372	7	0.178	802.22	701.1	4814.91	15188.6	8.385	47.6
	RodF3_57	91	57	1.448	10	0.254	845.21	724.9	4953.05	15624.4	8.025	45.6
	RodF3_60	92	60	1.524	13	0.330	874.53	741.2	5092.19	16063.3	7.876	44.7
	RodF3_66.1	93	66.1	1.679	19.1	0.485	886.74	748.0	5368.01	16933.4	8.149	46.3
	RodF3_70	94	70	1.778	-0.88	-0.022	784.62	691.3	5510.74	17383.6	9.900	56.2
	RodF3_73	95	73	1.854	2.12	0.054	869.95	738.7	5672.19	17892.9	8.836	50.2
	RodF3_75	96	75	1.905	4.12	0.105	902.35	756.7	5769.47	18199.8	8.556	48.6
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	746.84	670.3	4630.03	14605.4	8.924	50.7
	RodE6_54.1	122	54.1	1.374	7.1	0.180	800.68	700.2	4804.00	15154.2	8.389	47.6
	RodE6_57	123	57	1.448	10	0.254	828.79	715.8	4933.84	15563.8	8.212	46.6
	RodE6_60.2	124	60.2	1.529	13.2	0.335	849.06	727.1	5077.84	16018.1	8.176	46.4
	RodE6_66.1	125	66.1	1.679	19.1	0.485	876.34	742.2	5337.79	16838.0	8.233	46.8
	RodE6_70	126	70	1.778	-0.88	-0.022	792.21	695.5	5509.58	17380.0	9.765	55.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	849.14	727.1	5645.91	17810.0	9.090	51.6
	RodE6_75	128	75	1.905	4.12	0.105	876.37	742.2	5734.54	18089.6	8.845	50.2

RBHT Steam Cooling with Droplet Injection Test SCD-4049-I

Matrix Test # 4a

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 26940 - 27360
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 65 kW
Bundle Inlet Reynolds Number: 8000
Bundle Inlet Steam Flow: 144.2 kg/hr (318 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

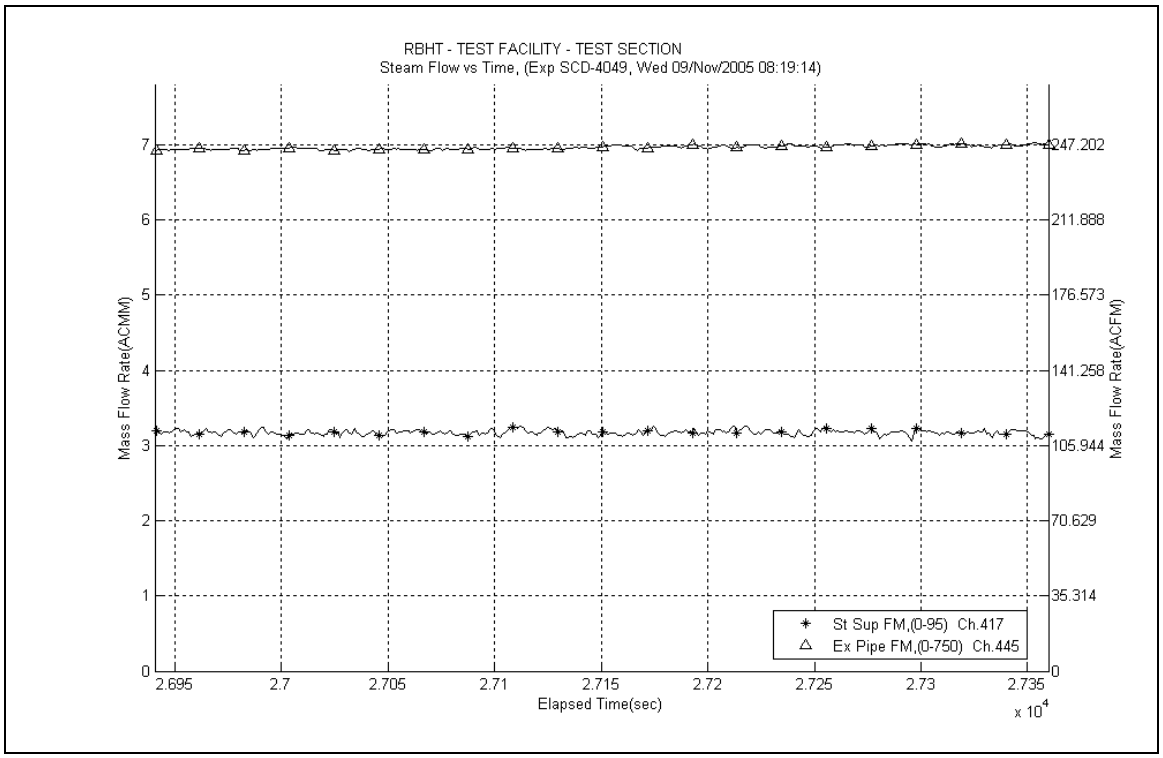

Figure A-220: Inlet and Exhaust Steam Flow Rates for Experiment 4049I

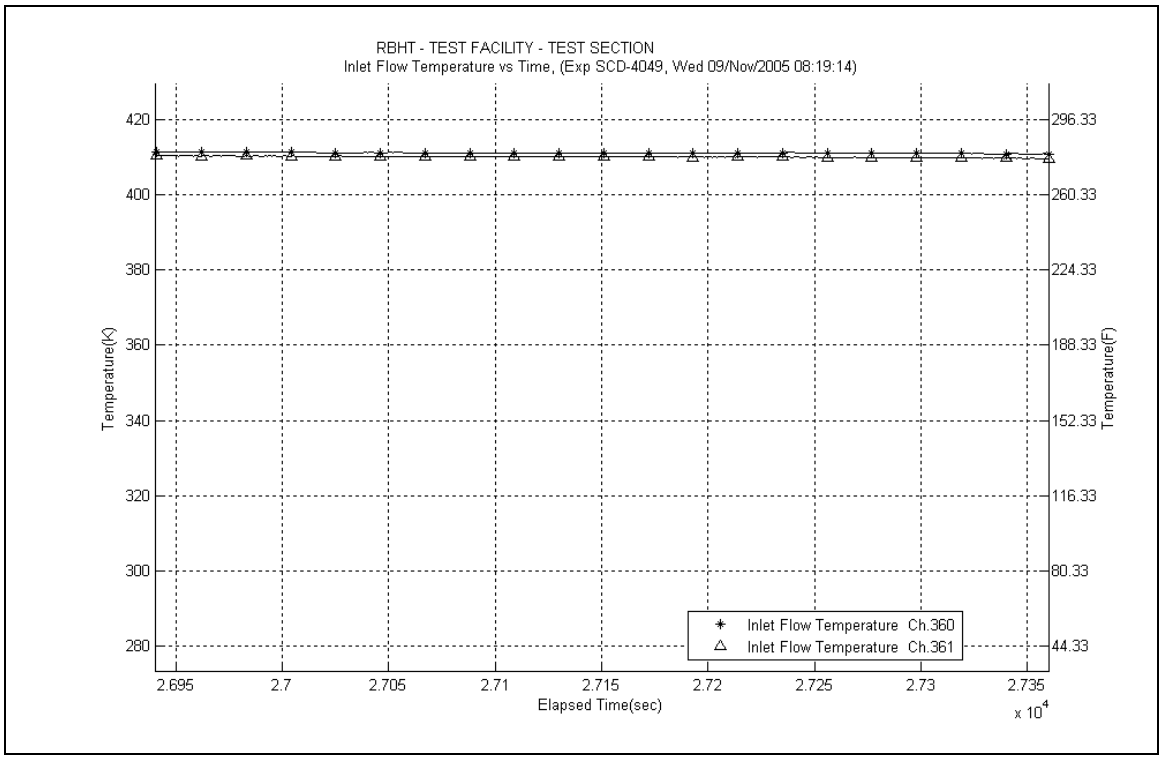

Figure A-221: Inlet Steam Temperature for Experiment 4049I

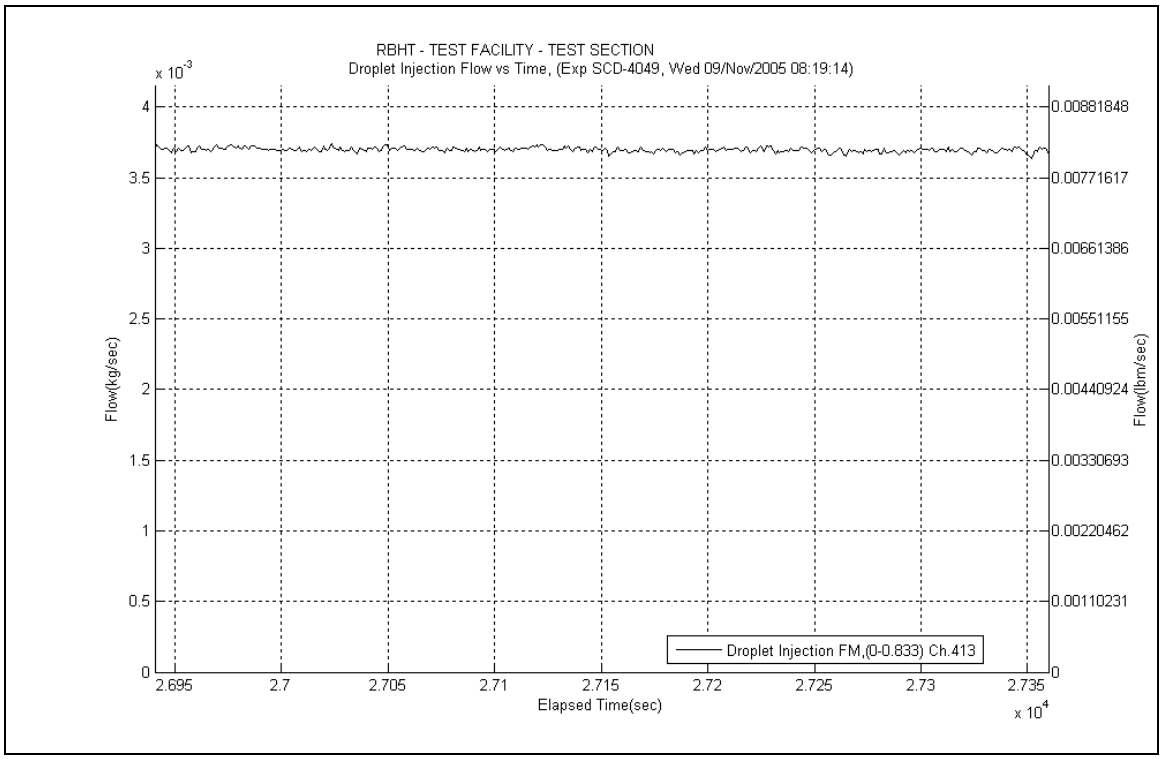

Figure A-222: Droplet Injection Flow Rate for Experiment 4049I

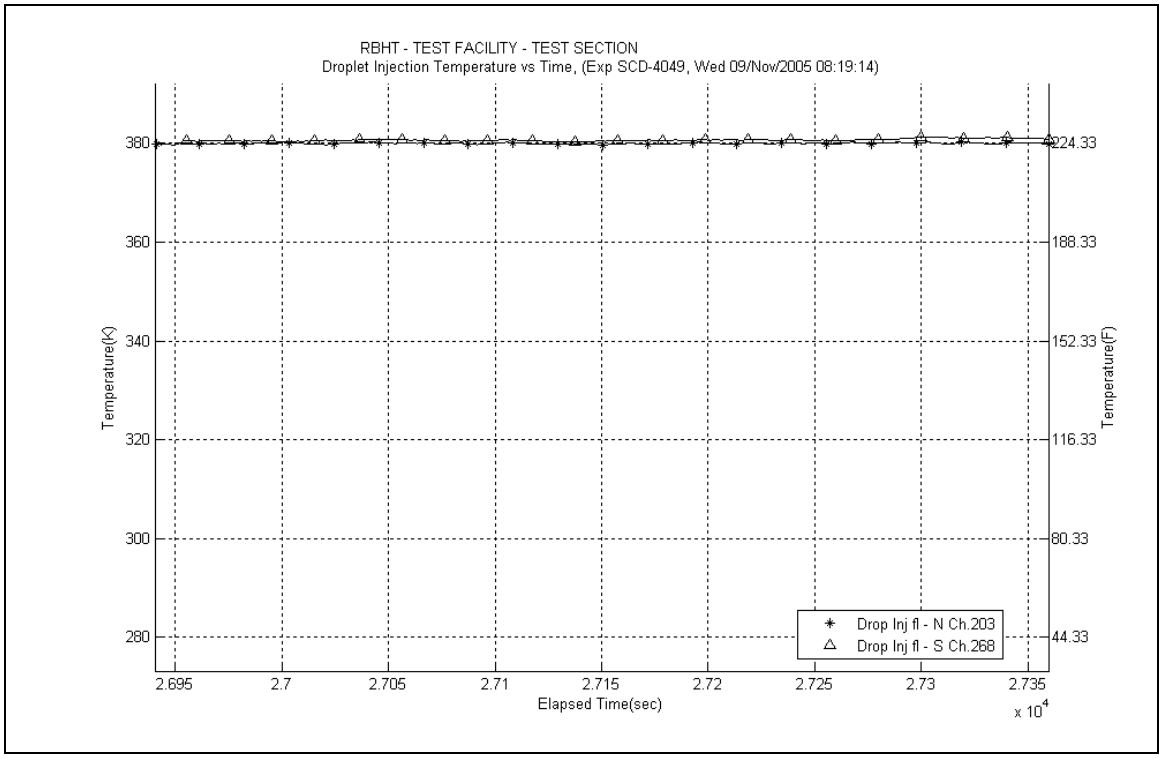

Figure A-223: Droplet Injection Temperature for Experiment 4049I

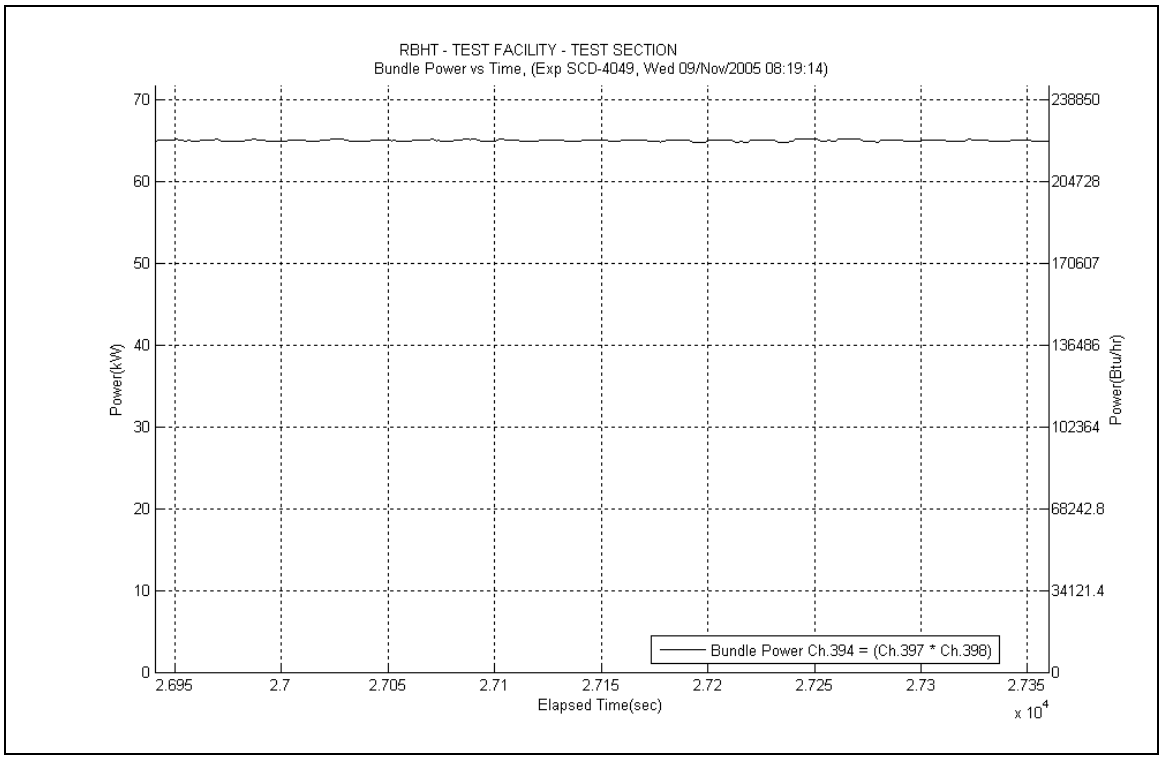

Figure A-224: Bundle Power for Experiment 4049I

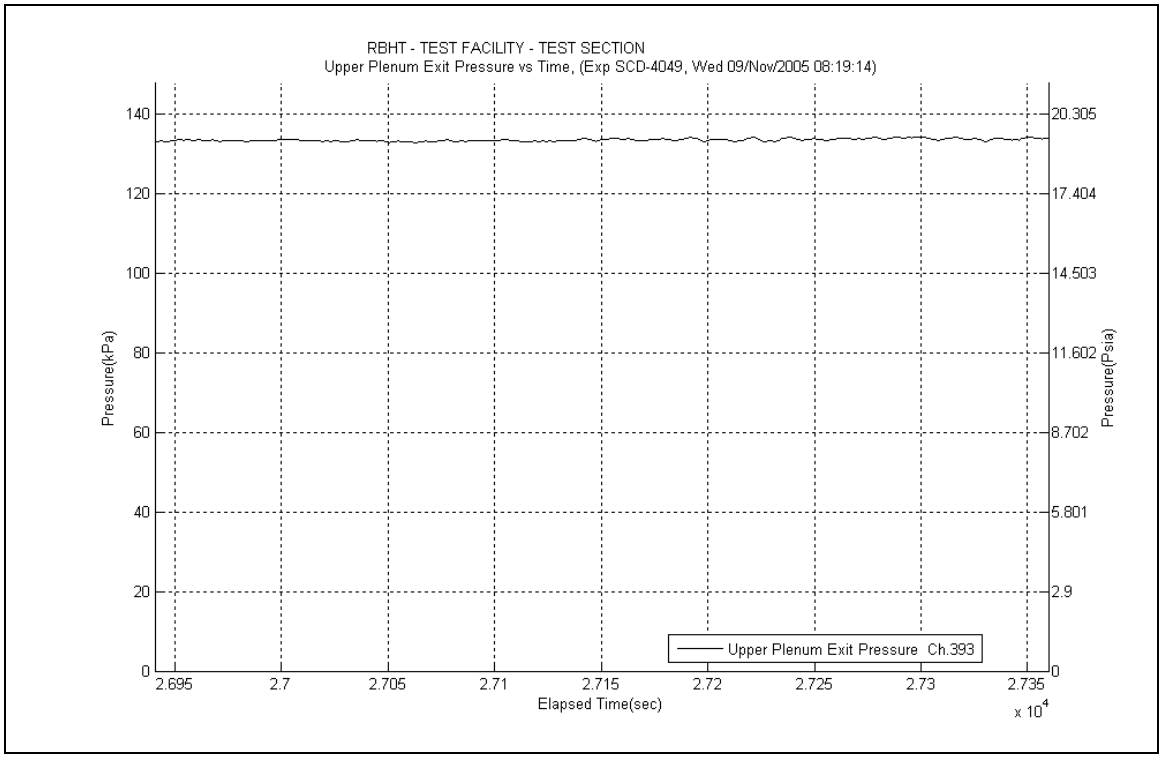

Figure A-225: Upper Plenum Pressure for Experiment 4049I

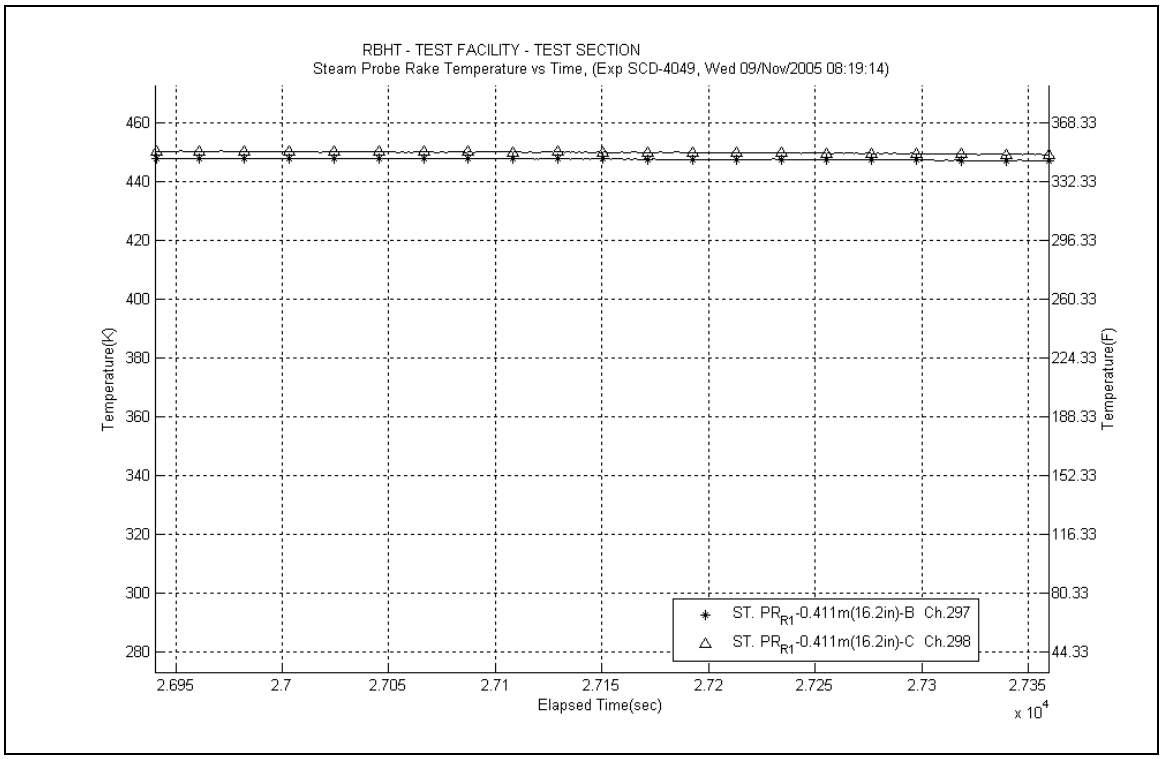

Figure A-226: Steam Probe Rake #1 Temperatures for Experiment 4049I

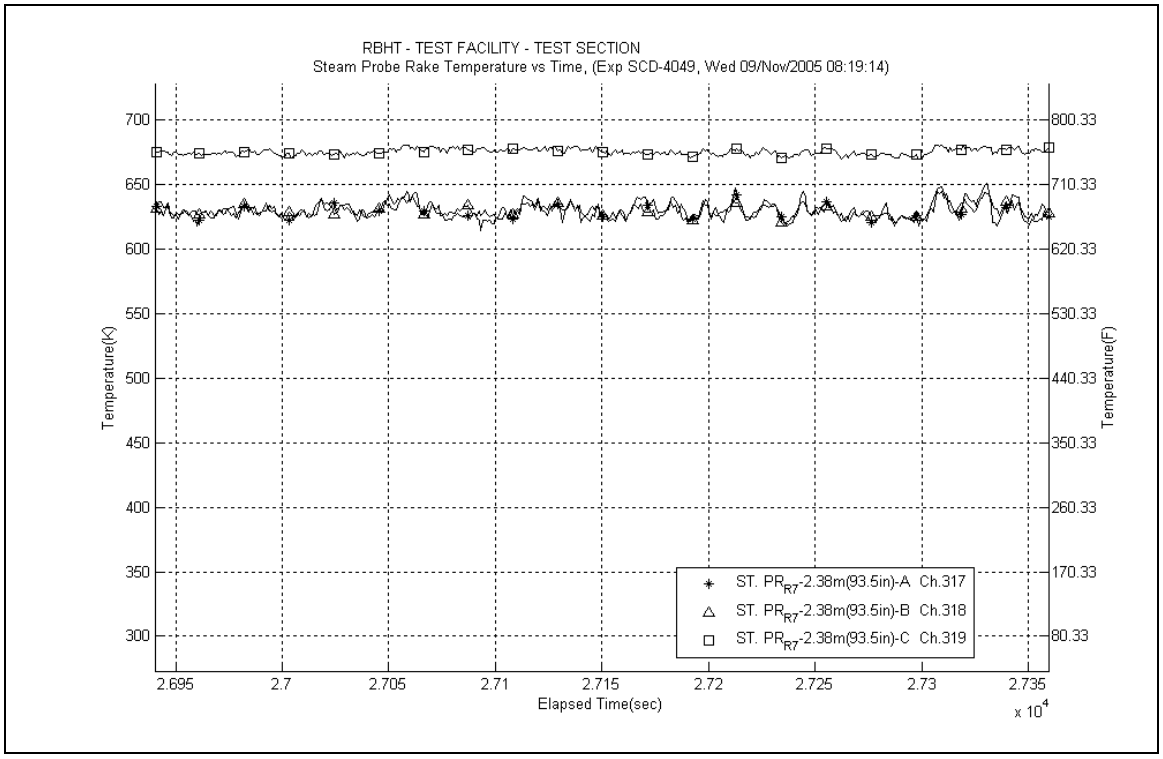

Figure A-227: Steam Probe Rake #7 Temperatures for Experiment 4049I

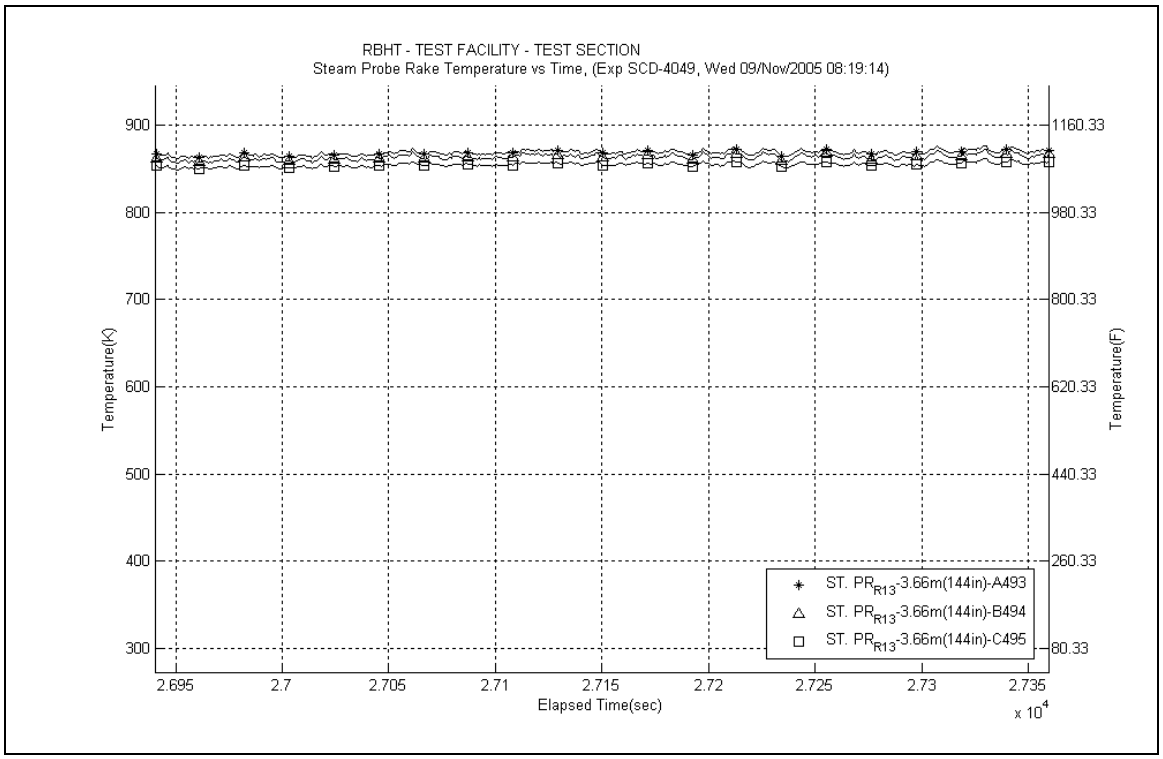

Figure A-228: Steam Probe Rake #13 Temperatures for Experiment 4049I

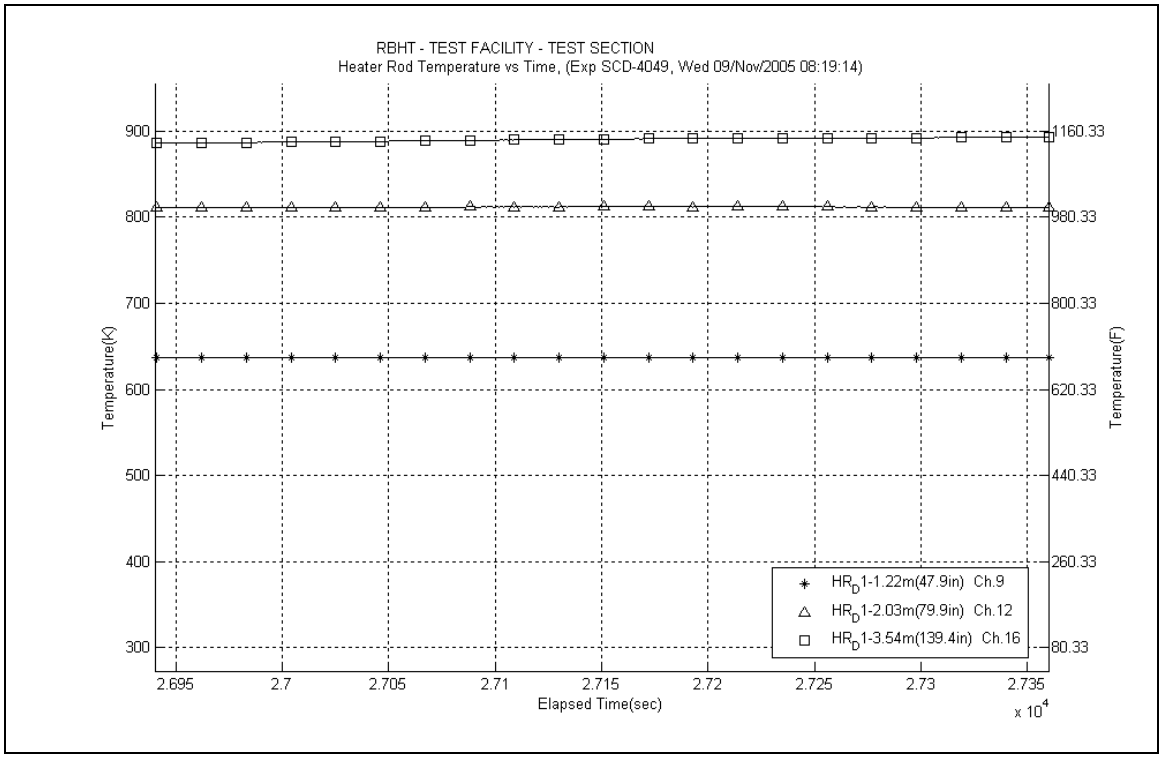

Figure A-229: Heater Rod D1 Temperatures for Experiment 4049I

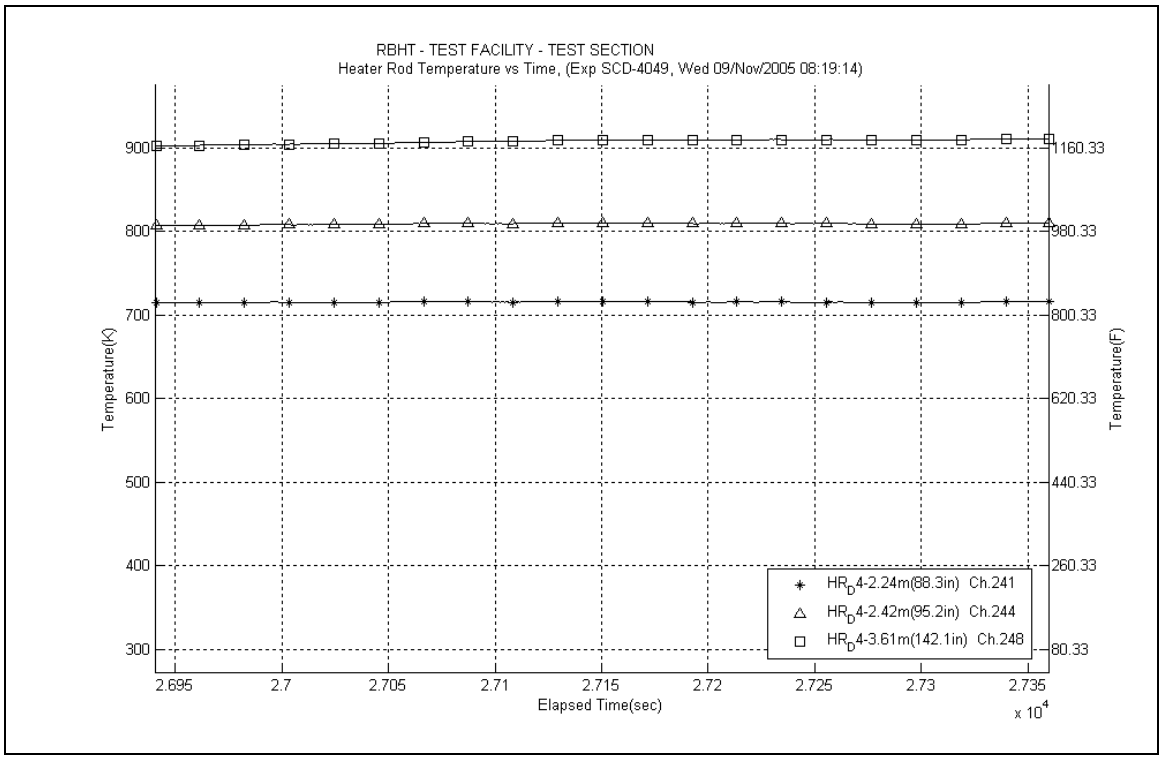

Figure A-230: Heater Rod D4 Temperatures for Experiment 4049I

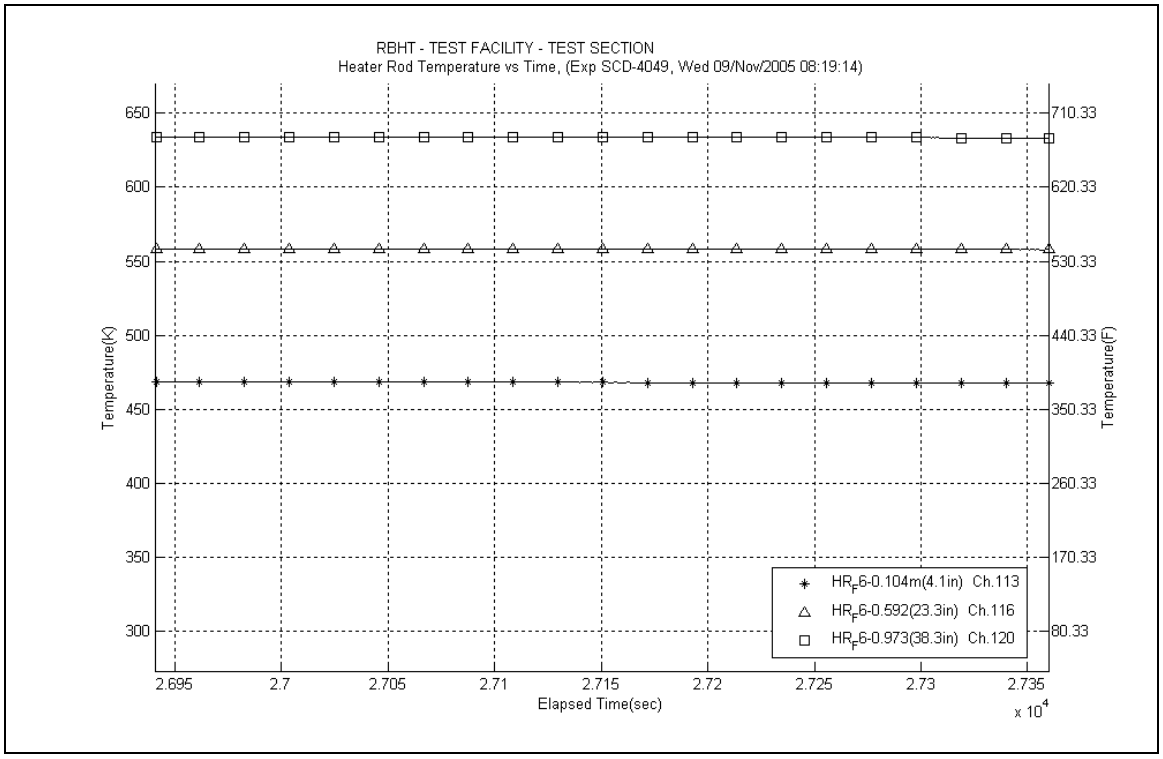

Figure A-231: Heater Rod F6 Temperatures for Experiment 4049I

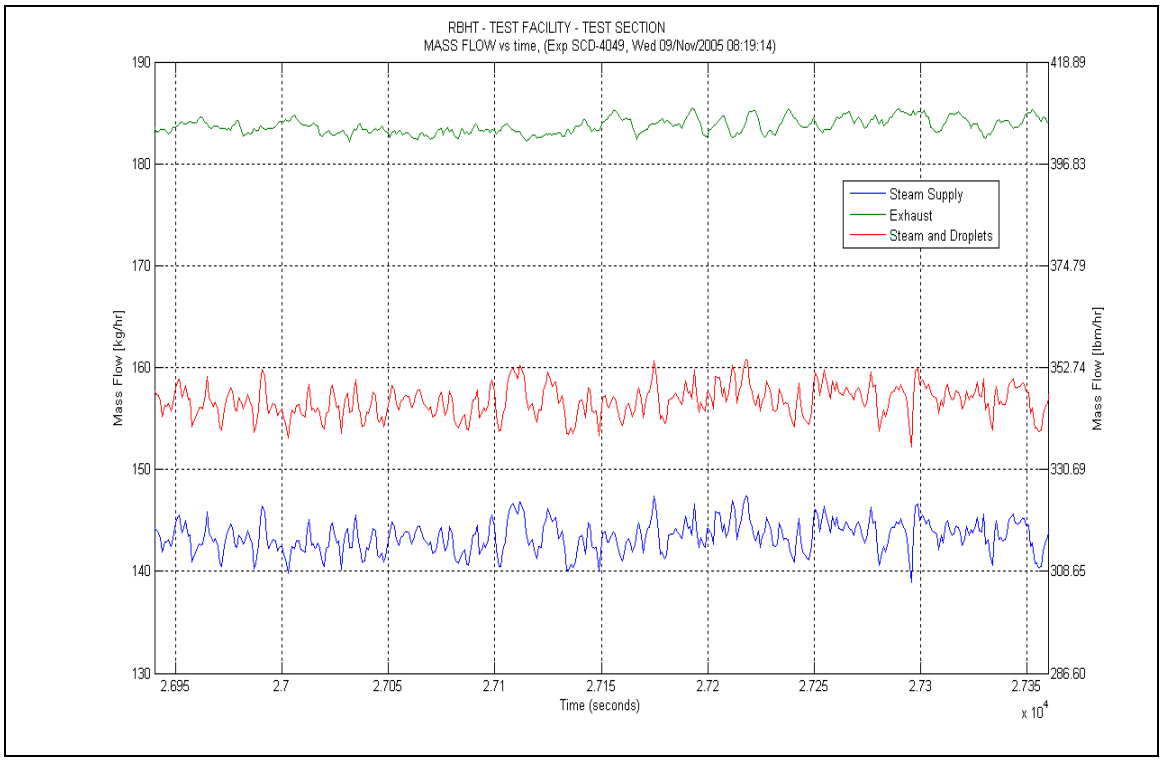

Figure A-232: Mass Flow for Experiment 4049I

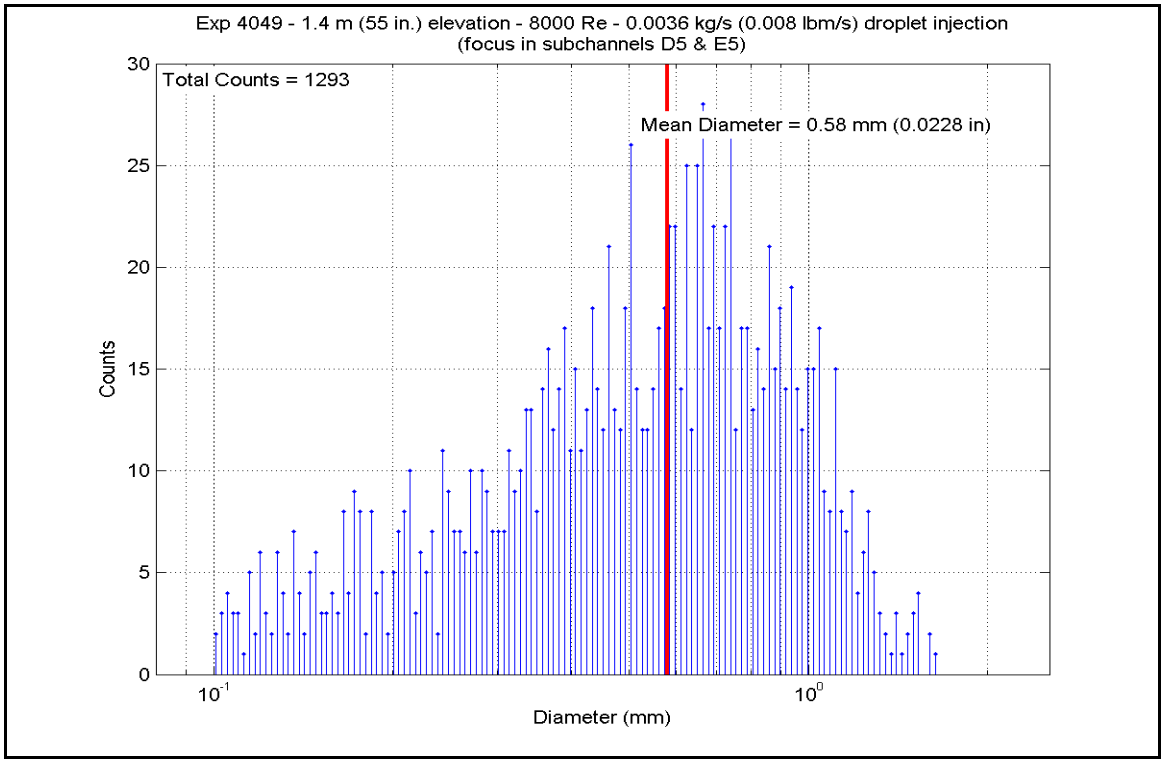

Figure A-233: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049I

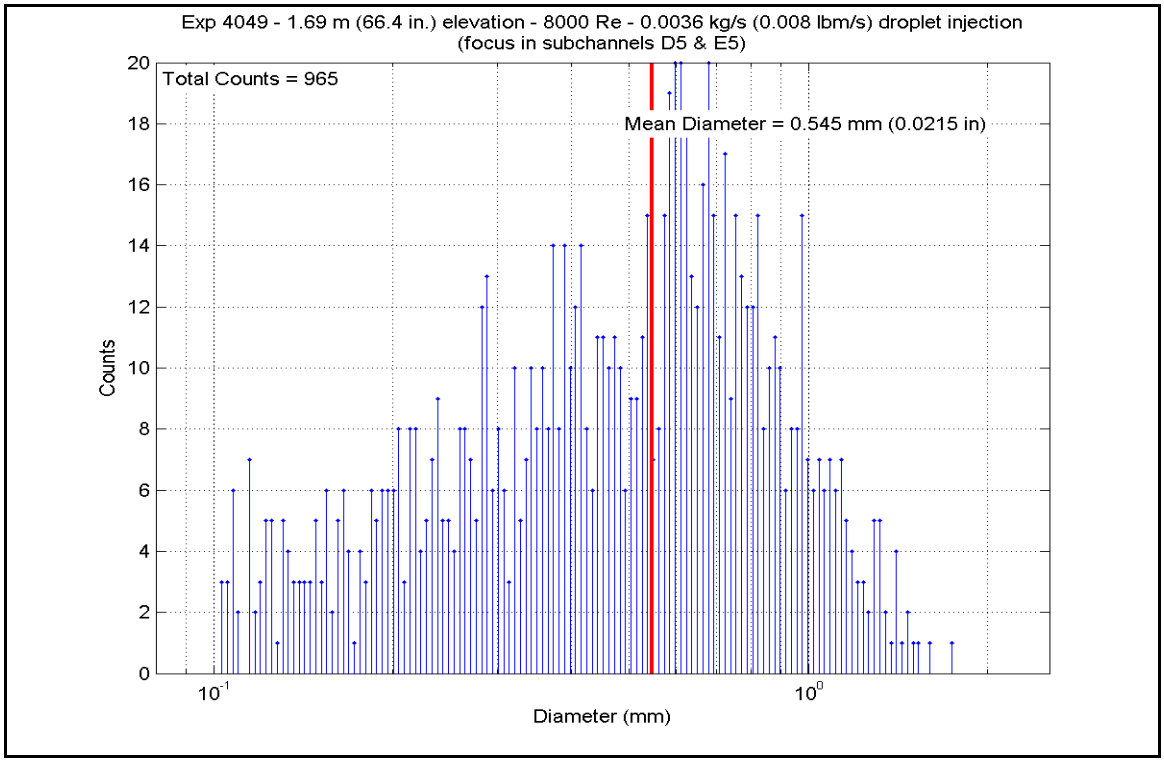

Figure A-234: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049I

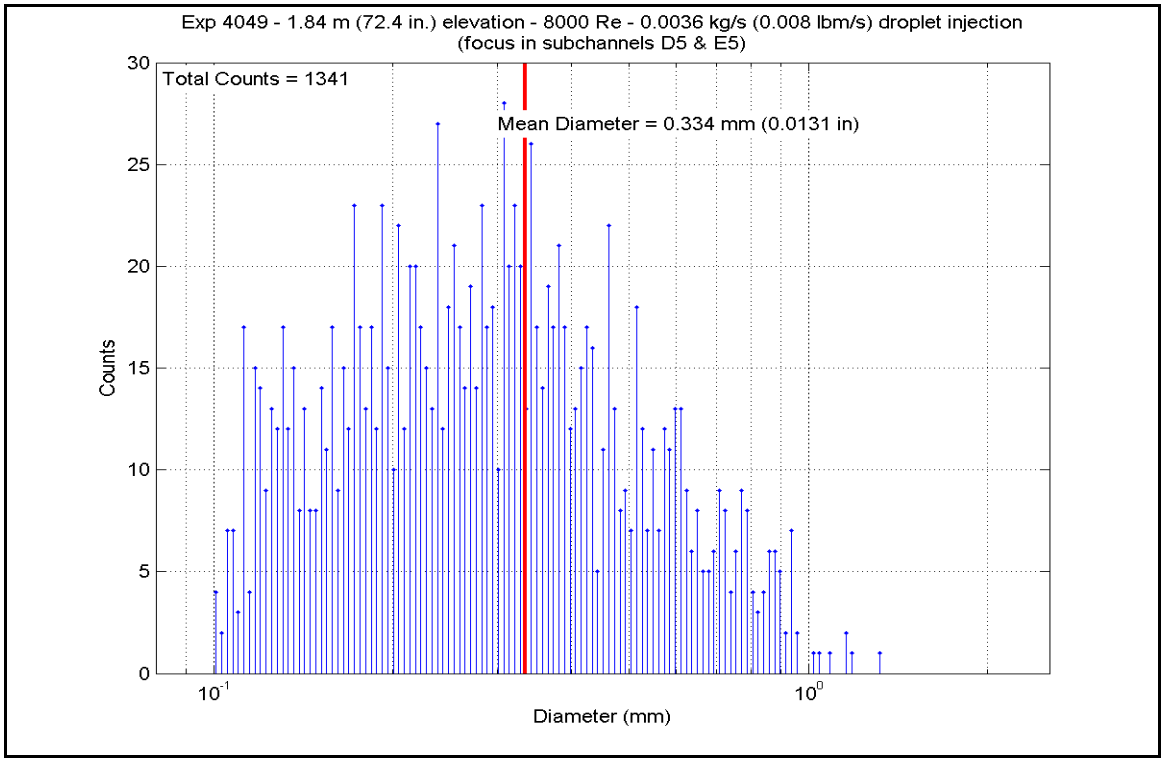

Figure A-235: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049I

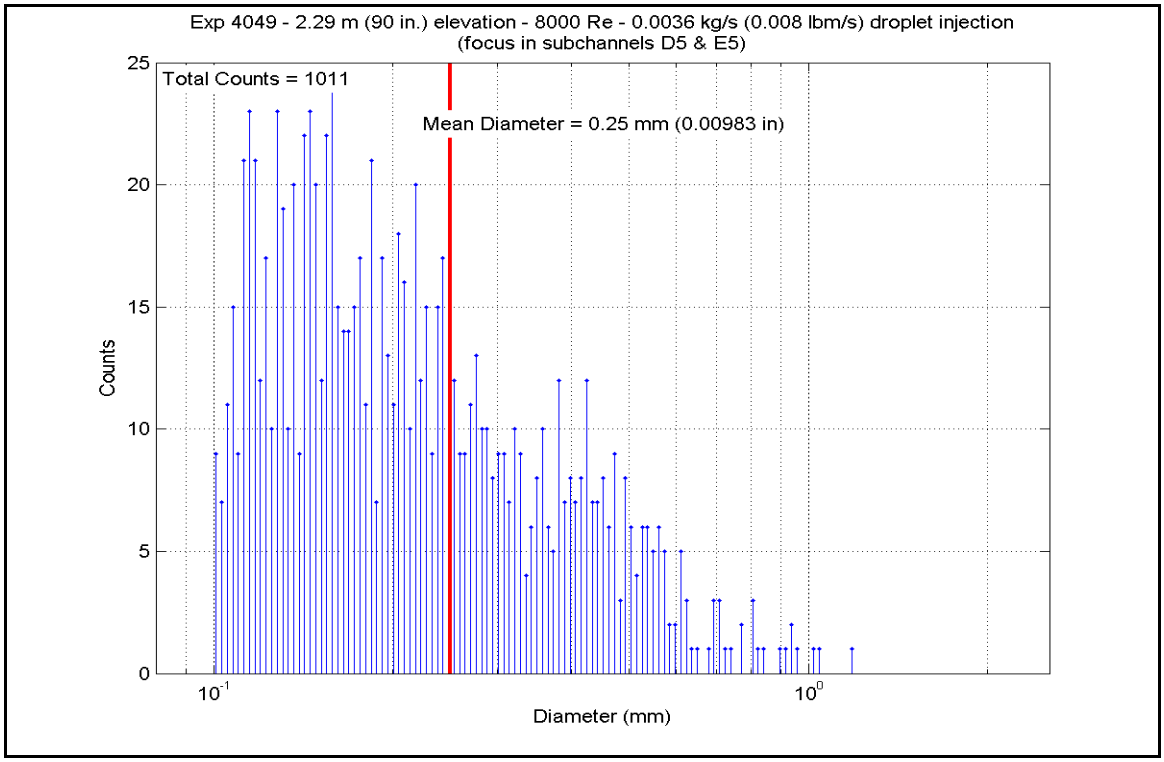

Figure A-236: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049I

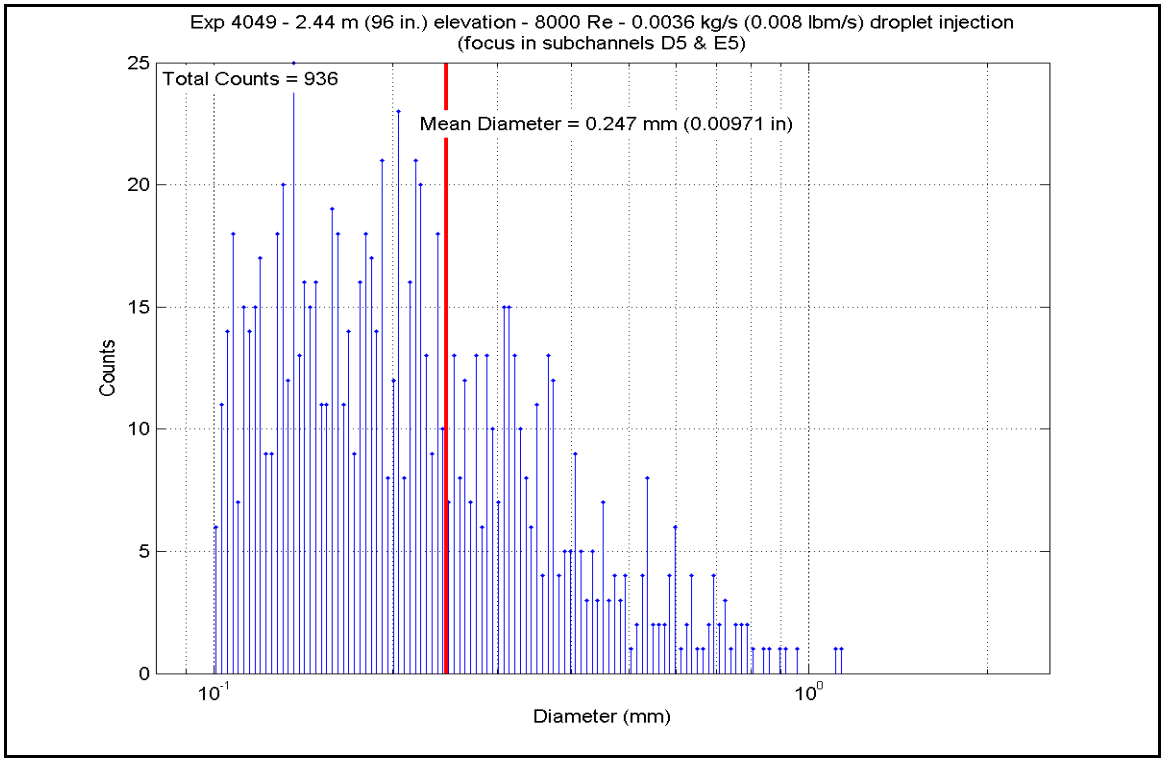

Figure A-237: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049I

Table A-52: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049I

SCD-4049-I	Inlet Reynolds:	8000		
Matrix Test # 4a	UP Pressure:	137.9 kPa	20	psia
Time Window: 26940-27360	Bundle Power:	65.00 kW	221789	Btu/hr
	Steam flow:	0.0401 kg/s	318.0	lbm/hr
	Droplet flow:	0.0036 kg/s	0.008	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	865.34	736.1	5504.88	17365.2	8.637	49.1
	RodD3_91.3	186	91.3	2.319	2.8	0.071	949.08	782.6	5619.37	17726.3	7.793	44.3
	RodD3_93.1	187	93.1	2.365	4.6	0.117	962.74	790.2	5683.04	17927.2	7.735	43.9
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1007.77	815.2	5764.93	18185.5	7.393	42.0
	RodD3_100.1	189	100.1	2.543	11.6	0.295	1067.12	848.2	5946.95	18759.7	7.087	40.2
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1150.03	894.3	6181.20	19498.6	6.704	38.1
	RodD3_110	191	110	2.794	21.5	0.546	1080.39	855.6	6095.15	19227.1	7.151	40.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1177.08	909.3	2073.72	6541.5	2.185	12.4
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	838.73	721.3	5570.16	17571.1	9.121	51.8
	RodC4_91.1	234	91.1	2.314	2.6	0.066	940.48	777.9	5676.78	17907.4	7.968	45.2
	RodC4_93.4	235	93.4	2.372	4.9	0.124	971.09	794.9	5765.07	18185.9	7.758	44.1
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1010.47	816.7	5838.04	18416.1	7.461	42.4
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1066.93	848.1	6021.54	18994.9	7.178	40.8
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1133.83	885.3	6257.90	19740.5	6.908	39.2
	RodC4_110	239	110	2.794	21.5	0.546	1061.47	845.1	6047.86	19078.0	7.256	41.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1169.53	905.1	2259.39	7127.2	2.400	13.6
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	826.29	714.4	5551.44	17512.0	9.279	52.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	927.12	770.4	5662.33	17861.8	8.099	46.0
	RodD4_93.2	243	93.2	2.367	4.7	0.119	957.78	787.5	5731.67	18080.6	7.854	44.6
	RodD4_95.2	244	95.2	2.418	6.7	0.170	994.45	807.8	5805.34	18313.0	7.574	43.0
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1059.86	844.2	5990.76	18897.9	7.202	40.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1129.96	883.1	6223.37	19631.6	6.900	39.2
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1173.61	907.4	2177.24	6868.1	2.302	13.1
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	840.43	722.3	5452.51	17199.9	8.903	50.6
	RodE4_91.2	202	91.2	2.316	2.7	0.069	946.42	781.2	5539.23	17473.5	7.710	43.8
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1024.26	824.4	5682.88	17926.6	7.137	40.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1088.84	860.3	5907.66	18635.7	6.863	39.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1180.52	911.2	2194.24	6921.7	2.304	13.1

Table A-52: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	925.05	769.3	4532.58	14298.0	6.503	36.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1124.38	880.0	5545.22	17492.4	6.186	35.1
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1158.04	898.7	5331.05	16816.8	5.732	32.6
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1186.74	914.7	5001.37	15776.8	5.217	29.6
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1201.91	923.1	4538.63	14317.1	4.660	26.5
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1207.29	926.1	4121.27	13000.5	4.208	23.9
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1138.89	888.1	3542.32	11174.2	3.889	22.1
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1170.12	905.4	3120.30	9843.0	3.312	18.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	924.18	768.8	4447.35	14029.2	6.388	36.3
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1088.14	859.9	5415.17	17082.2	6.296	35.8
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1131.18	883.8	5200.34	16404.5	5.758	32.7
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1186.50	914.5	4467.06	14091.4	4.660	26.5
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1190.40	916.7	4048.63	12771.4	4.207	23.9
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1109.13	871.6	3537.88	11160.2	4.015	22.8
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1144.08	891.0	3102.94	9788.2	3.387	19.2
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	865.92	736.4	4561.85	14390.4	7.151	40.6
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1033.82	829.7	5589.60	17632.4	6.937	39.4
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1085.98	858.7	5395.08	17018.8	6.288	35.7
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1128.85	882.5	5037.49	15890.8	5.592	31.8
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1158.23	898.8	4614.55	14556.6	4.961	28.2
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1171.39	906.1	4180.73	13188.1	4.432	25.2
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1232.56	940.1	3639.29	11480.1	3.623	20.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1169.90	905.3	3203.21	10104.5	3.401	19.3
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	954.10	785.4	5150.58	16247.5	7.094	40.3
	RodC3_85.6	178	85.6	2.174	14.72	0.374	846.39	725.6	5376.48	16960.1	8.694	49.4
	RodC3_88.5	179	88.5	2.248	0	0.000	866.15	736.6	5482.08	17293.2	8.591	48.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	975.12	797.1	5632.92	17769.1	7.539	42.8
	RodC3_94.4	181	94.4	2.398	5.9	0.150	997.31	809.4	5708.59	18007.8	7.420	42.1
	RodC3_97.2	182	97.2	2.469	8.7	0.221	1044.71	835.8	5812.87	18336.7	7.117	40.4
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1141.97	889.8	6119.85	19305.1	6.696	38.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	784.42	691.2	4027.98	12706.3	7.239	41.1
	RodD5_54.1	218	54.1	1.374	7.1	0.180	809.72	705.2	4187.82	13210.5	7.199	40.9
	RodD5_56.9	219	56.9	1.445	9.9	0.251	856.44	731.2	4296.89	13554.5	6.837	38.8
	RodD5_60	220	60	1.524	13	0.330	889.68	749.6	4418.20	13937.2	6.677	37.9
	RodD5_66.1	221	66.1	1.679	19.1	0.485	930.10	772.1	4651.73	14673.9	6.625	37.6
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	811.02	705.9	4799.69	15140.6	8.232	46.8
	RodD5_72.9	223	72.9	1.852	2.02	0.051	881.93	745.3	4911.37	15492.9	7.510	42.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	923.46	768.4	4988.10	15735.0	7.172	40.7

Table A-52: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	718.55	654.6	3665.35	11562.3	7.472	42.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	779.55	688.5	4127.56	13020.4	7.484	42.5
	RodB5_55	155	55	1.397	8	0.203	818.38	710.0	4208.61	13276.1	7.129	40.5
	RodB5_57.8	156	57.8	1.468	10.8	0.274	863.55	735.1	4318.16	13621.6	6.794	38.6
	RodB5_64	157	64	1.626	17	0.432	916.55	764.6	4560.41	14385.8	6.623	37.6
	RodB5_73.9	158	73.9	1.877	3.02	0.077	891.92	750.9	4940.65	15585.3	7.442	42.3
	RodB5_75.9	159	75.9	1.928	5.02	0.128	925.29	769.4	5018.47	15830.8	7.197	40.9
	RodB5_76.9	160	76.9	1.953	6.02	0.153	938.23	776.6	5057.27	15953.2	7.121	40.4
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	717.03	653.7	3639.17	11479.8	7.442	42.3
	RodF5_53.1	106	53.1	1.349	6.1	0.155	770.25	683.3	4111.68	12970.3	7.583	43.1
	RodF5_55	107	55	1.397	8	0.203	803.78	701.9	4185.66	13203.7	7.270	41.3
	RodF5_57.8	108	57.8	1.468	10.8	0.274	841.93	723.1	4295.61	13550.5	6.997	39.7
	RodF5_64	109	64	1.626	17	0.432	886.63	747.9	4535.21	14306.3	6.886	39.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	875.63	741.8	4913.99	15501.2	7.588	43.1
	RodF5_75.8	111	75.8	1.925	4.92	0.125	912.25	762.2	4991.53	15745.8	7.295	41.4
	RodF5_76.8	112	76.8	1.951	5.92	0.150	927.60	770.7	5030.58	15869.0	7.191	40.8
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	718.66	654.6	3657.24	11536.8	7.454	42.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	833.53	718.4	4126.87	13018.2	6.815	38.7
	RodC2_55	59	55	1.397	8	0.203	851.96	728.7	4200.80	13251.4	6.733	38.2
	RodC2_57.8	60	57.8	1.468	10.8	0.274	880.20	744.4	4309.87	13595.5	6.608	37.5
	RodC2_63.9	61	63.9	1.623	16.9	0.429	910.81	761.4	4548.80	14349.2	6.662	37.8
	RodC2_73.8	62	73.8	1.875	2.92	0.074	907.67	759.6	4932.05	15558.2	7.257	41.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	933.46	774.0	5009.51	15802.5	7.101	40.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	943.59	779.6	5048.09	15924.2	7.054	40.1
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	723.96	657.6	3639.84	11481.9	7.339	41.7
	RodC6_52.8	138	52.8	1.341	5.8	0.147	827.65	715.2	4123.21	13006.7	6.876	39.0
	RodC6_54.8	139	54.8	1.392	7.8	0.198	849.13	727.1	4204.29	13262.4	6.769	38.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	879.62	744.1	4325.80	13645.8	6.639	37.7
	RodC6_63.8	141	63.8	1.621	16.8	0.427	918.72	765.8	4569.16	14413.4	6.615	37.6
	RodC6_73.7	142	73.7	1.872	2.82	0.072	943.02	779.3	4965.67	15664.2	6.945	39.4
	RodC6_75.8	143	75.8	1.925	4.92	0.125	966.73	792.4	5051.17	15933.9	6.838	38.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	982.56	801.2	5092.21	16063.4	6.749	38.3

Table A-52: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	829.46	716.2	5447.90	17185.4	9.058	51.4
	RodB4_91.3	162	91.3	2.319	2.8	0.071	927.82	770.8	5562.67	17547.5	7.949	45.1
	RodB4_93.3	163	93.3	2.370	4.8	0.122	952.99	784.8	5636.02	17778.8	7.774	44.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	983.93	802.0	5703.48	17991.6	7.545	42.8
	RodB4_100	165	100	2.540	11.5	0.292	1042.91	834.8	5886.71	18569.6	7.224	41.0
	RodB4_106	166	106	2.692	17.5	0.445	1115.12	874.9	6115.05	19289.9	6.893	39.1
	RodB4_109.9	167	109.9	2.791	21.4	0.544	1047.12	837.1	5913.39	18653.8	7.219	41.0
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1152.79	895.8	2242.54	7074.1	2.425	13.8
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	912.94	762.6	5368.94	16936.3	7.839	44.5
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	886.08	747.6	5488.87	17314.6	8.341	47.4
	RodF4_92.4	100	92.4	2.347	3.9	0.099	992.18	806.6	5641.47	17796.0	7.382	41.9
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1027.43	826.2	5710.81	18014.8	7.144	40.6
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1071.50	850.7	5818.16	18353.4	6.898	39.2
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1143.85	890.8	6139.41	19366.8	6.704	38.1
	RodF4_111	104	111	2.819	-1.75	-0.044	1070.52	850.1	5888.06	18573.9	6.989	39.7
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1149.42	893.9	5411.78	17071.5	5.873	33.4
	RodD2_106	66	106	2.692	17.5	0.445	1171.94	906.4	5121.94	16157.2	5.426	30.8
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1195.47	919.5	4725.44	14906.4	4.884	27.7
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1208.08	926.5	4260.48	13439.7	4.347	24.7
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1201.69	923.0	3819.98	12050.1	3.923	22.3
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1148.44	893.4	6095.76	19229.1	6.623	37.6
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1171.42	906.2	6203.22	19568.1	6.575	37.3
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1103.88	868.6	5679.19	17915.0	6.484	36.8
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1152.70	895.8	6105.51	19259.8	6.603	37.5
	RodD6_106	130	106	2.692	17.5	0.445	1166.86	903.6	6217.20	19612.2	6.622	37.6
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1104.82	869.2	5665.01	17870.3	6.461	36.7
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1141.16	889.4	5429.59	17127.6	5.946	33.8
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1163.59	901.8	5204.72	16418.3	5.563	31.6
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1182.79	912.5	4718.09	14883.2	4.942	28.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1191.67	917.4	4260.63	13440.1	4.421	25.1
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1185.25	913.8	3803.48	11998.1	3.973	22.6

Table A-52: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	773.46	685.1	4043.68	12755.8	7.413	42.1
	RodE2_54	74	54	1.372	7	0.178	835.57	719.6	4196.92	13239.2	6.908	39.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	868.54	737.9	4310.99	13599.0	6.730	38.2
	RodE2_59.9	76	59.9	1.521	12.9	0.328	901.92	756.4	4427.75	13967.3	6.570	37.3
	RodE2_66	77	66	1.676	19	0.483	927.41	770.6	4670.10	14731.8	6.677	37.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	840.81	722.5	4809.27	15170.8	7.848	44.6
	RodE2_72.9	79	72.9	1.852	2.02	0.051	902.87	757.0	4933.02	15561.2	7.310	41.5
	RodE2_74.9	80	74.9	1.902	4.02	0.102	930.69	772.4	5016.29	15823.9	7.139	40.5
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	734.22	663.3	4016.99	12671.6	7.935	45.1
	RodB3_54.1	170	54.1	1.374	7.1	0.180	793.01	695.9	4166.02	13141.7	7.373	41.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	833.66	718.5	4274.33	13483.4	7.057	40.1
	RodB3_60.1	172	60.1	1.527	13.1	0.333	834.98	719.2	4399.15	13877.1	7.248	41.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	878.57	743.5	4635.94	14624.1	7.126	40.5
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	763.08	679.3	4769.14	15044.2	8.913	50.6
	RodB3_73	175	73	1.854	2.12	0.054	845.93	725.3	4899.97	15457.0	7.930	45.0
	RodB3_75	176	75	1.905	4.12	0.105	883.78	746.4	4977.23	15700.7	7.590	43.1
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	750.65	672.4	4024.77	12696.1	7.701	43.7
	RodF3_54	90	54	1.372	7	0.178	806.21	703.3	4176.39	13174.4	7.223	41.0
	RodF3_57	91	57	1.448	10	0.254	845.94	725.3	4291.40	13537.2	6.945	39.4
	RodF3_60	92	60	1.524	13	0.330	878.08	743.2	4408.91	13907.9	6.782	38.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	907.94	759.8	4651.12	14672.0	6.840	38.8
	RodF3_70	94	70	1.778	-0.88	-0.022	794.37	696.7	4793.79	15122.0	8.464	48.1
	RodF3_73	95	73	1.854	2.12	0.054	888.24	748.8	4926.75	15541.4	7.462	42.4
	RodF3_75	96	75	1.905	4.12	0.105	930.80	772.5	5005.76	15790.7	7.123	40.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	756.07	675.4	4015.86	12668.0	7.605	43.2
	RodE6_54.1	122	54.1	1.374	7.1	0.180	815.78	708.6	4166.86	13144.4	7.089	40.3
	RodE6_57	123	57	1.448	10	0.254	845.83	725.3	4279.06	13498.3	6.926	39.3
	RodE6_60.2	124	60.2	1.529	13.2	0.335	874.06	741.0	4403.15	13889.7	6.815	38.7
	RodE6_66.1	125	66.1	1.679	19.1	0.485	898.22	754.4	4630.31	14606.3	6.909	39.2
	RodE6_70	126	70	1.778	-0.88	-0.022	836.50	720.1	4782.86	15087.5	7.860	44.6
	RodE6_73.1	127	73.1	1.857	2.22	0.056	894.29	752.2	4899.52	15455.5	7.353	41.8
	RodE6_75	128	75	1.905	4.12	0.105	923.83	768.6	4971.43	15682.4	7.145	40.6

RBHT Steam Cooling with Droplet Injection Test SCD-4049-J

Matrix Test # 4b

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 28440 - 29760
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 65 kW
Bundle Inlet Reynolds Number: 8000
Bundle Inlet Steam Flow: 144.2 kg/hr (318 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

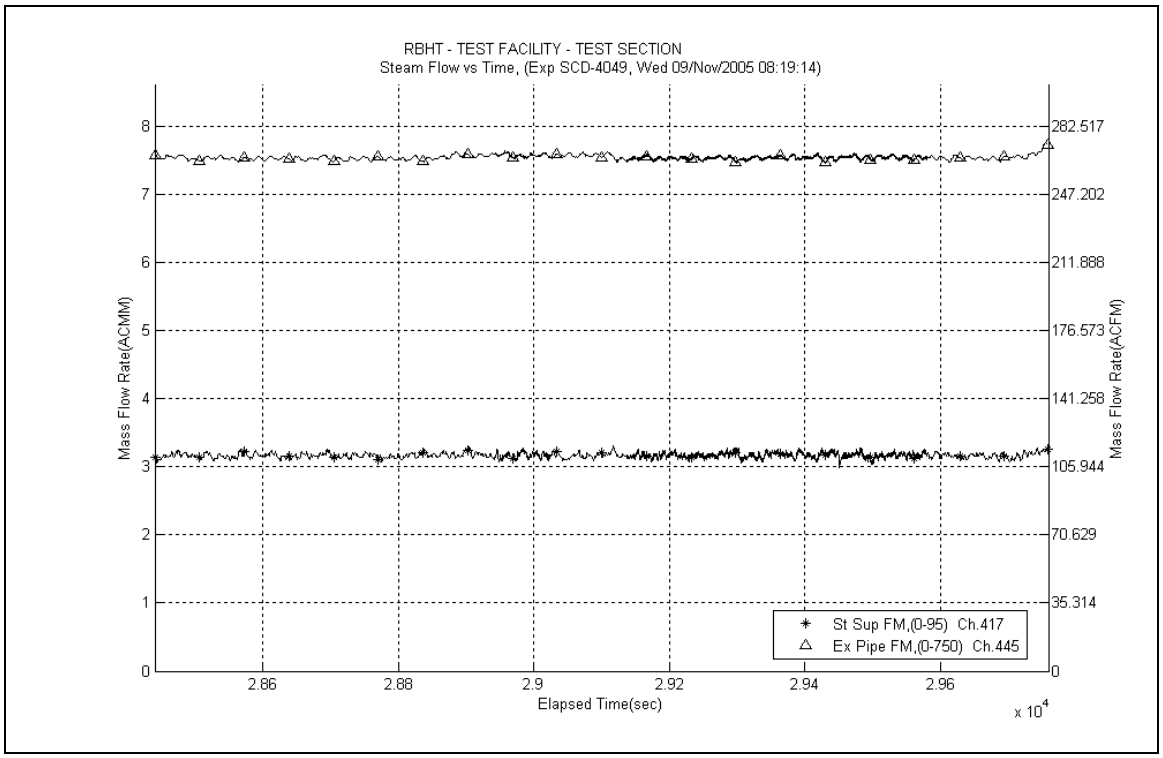

Figure A-238: Inlet and Exhaust Steam Flow Rates for Experiment 4049J

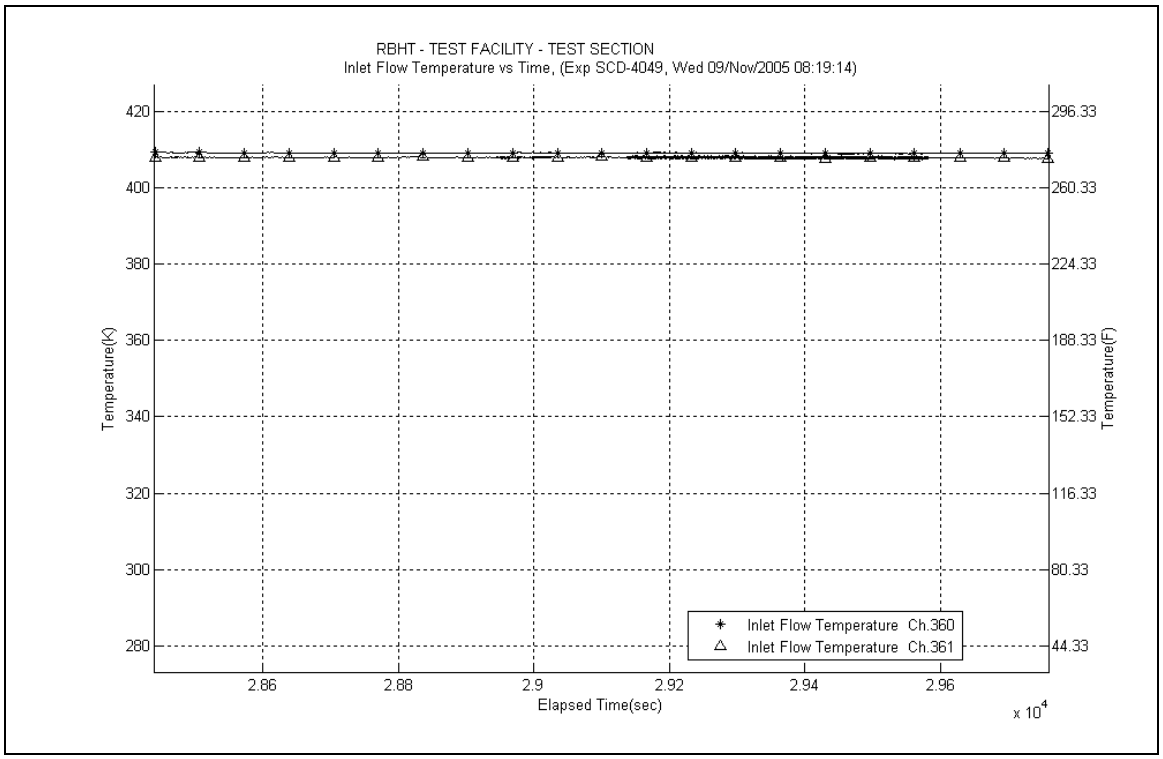

Figure A-239: Inlet Steam Temperature for Experiment 4049J

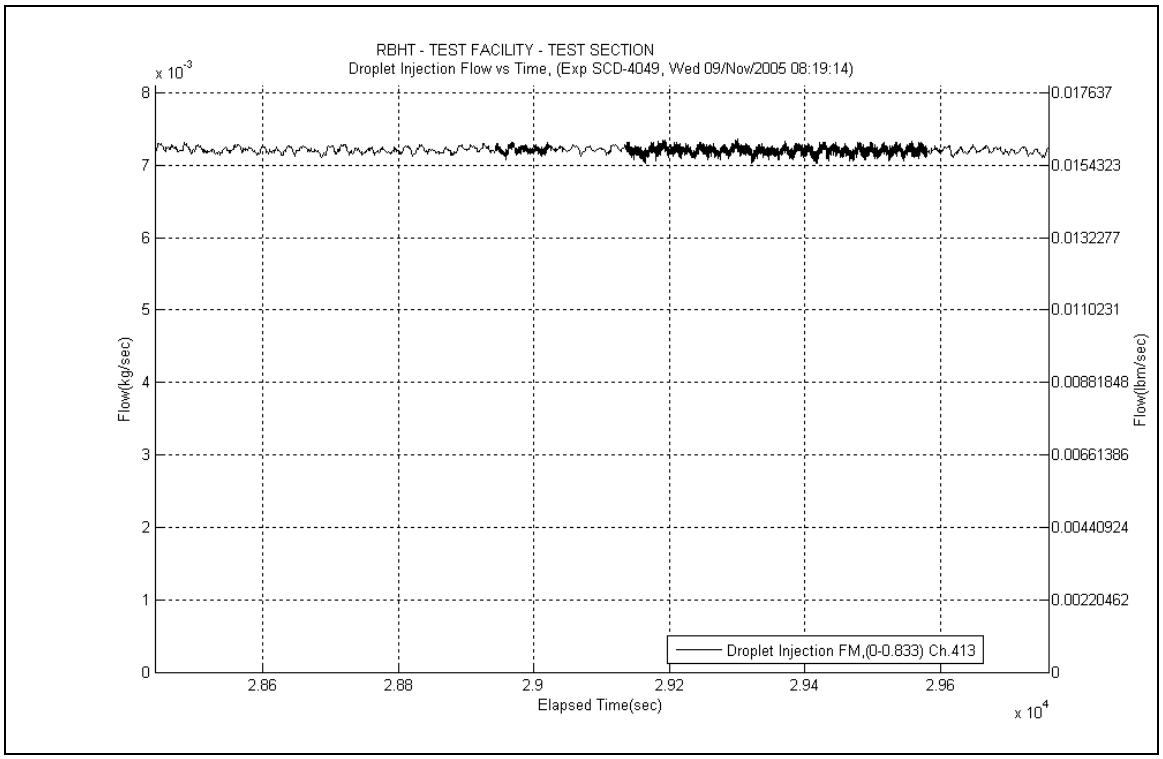

Figure A-240: Droplet Injection Flow Rate for Experiment 4049J

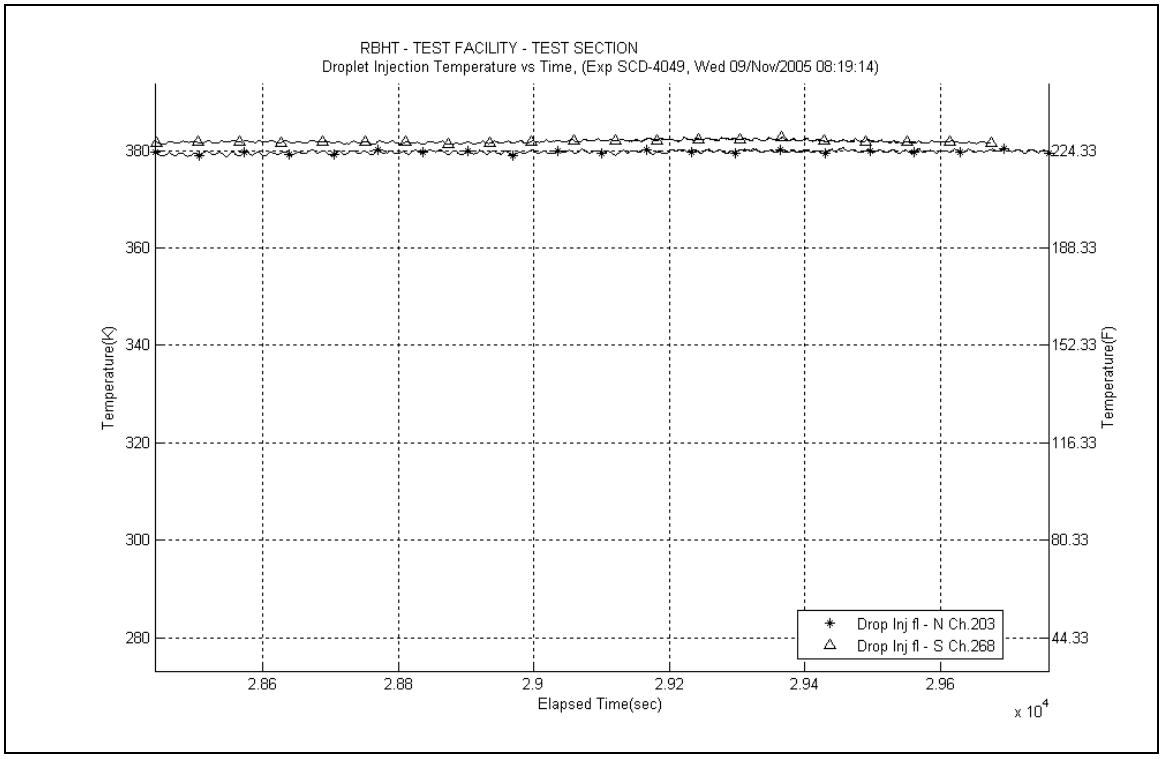

Figure A-241: Droplet Injection Temperature for Experiment 4049J

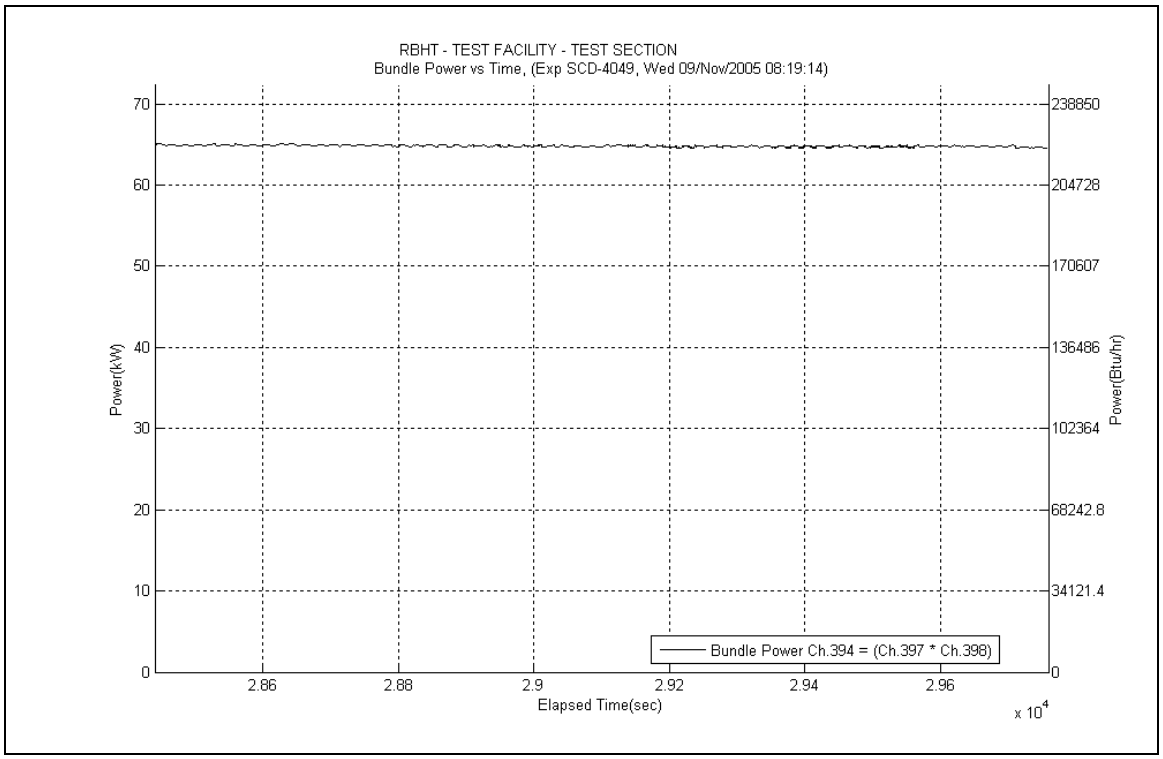

Figure A-242: Bundle Power for Experiment 4049J

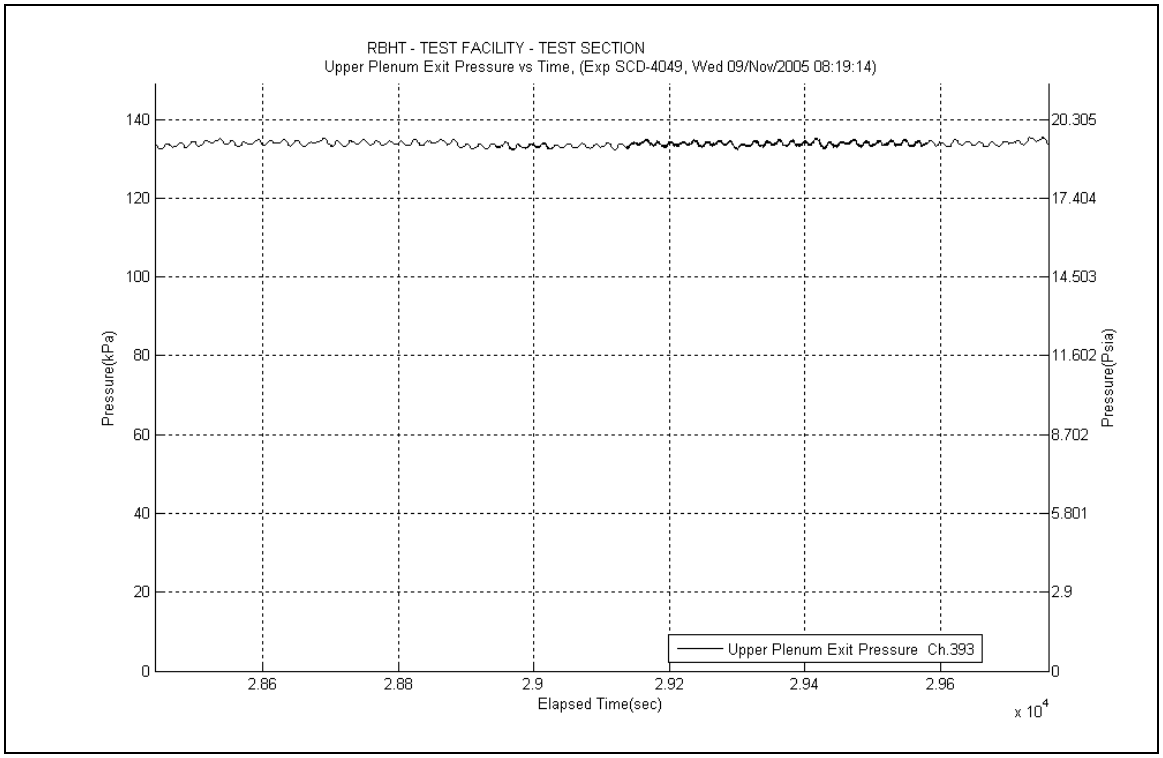

Figure A-243: Upper Plenum Pressure for Experiment 4049J

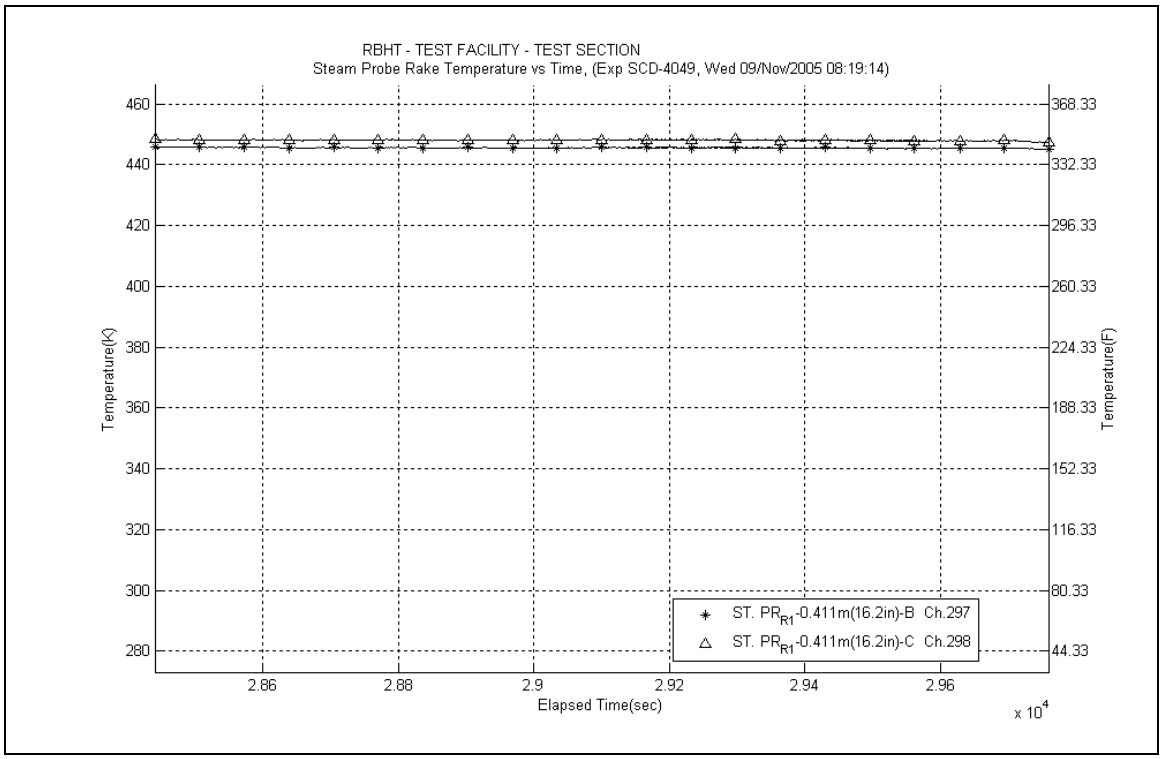

Figure A-244: Steam Probe Rake #1 Temperatures for Experiment 4049J

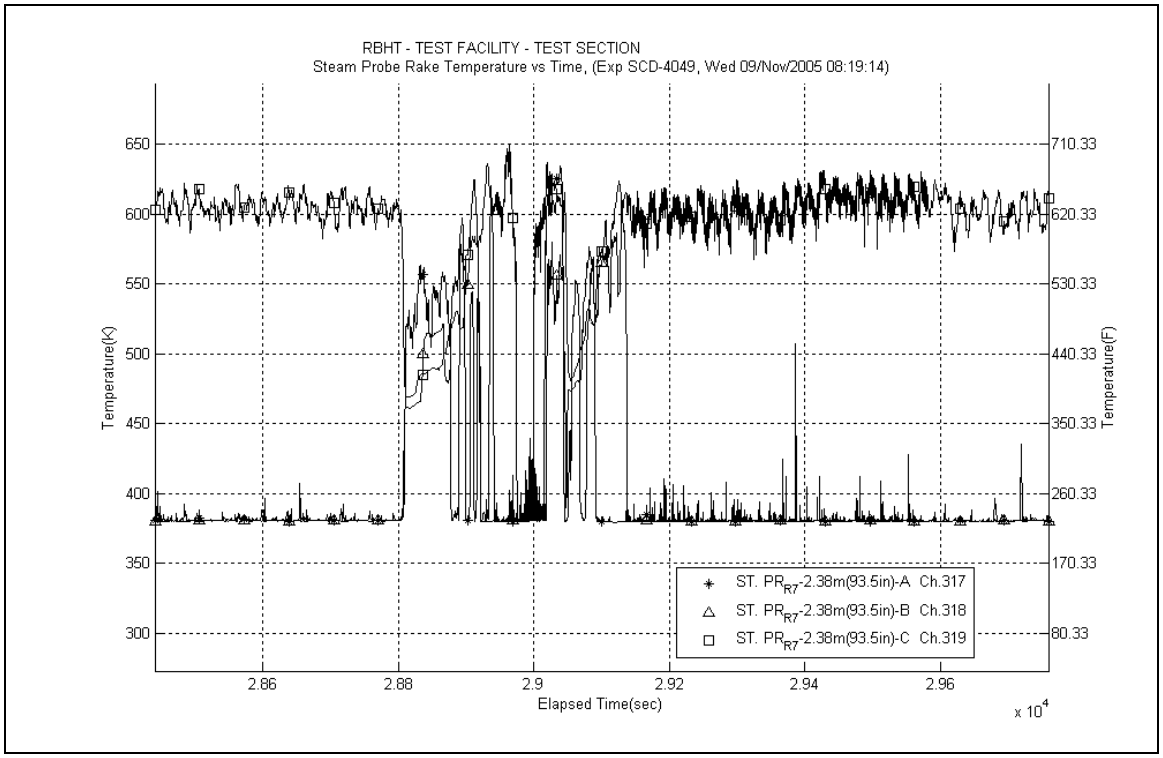

Figure A-245: Steam Probe Rake #7 Temperatures for Experiment 4049J

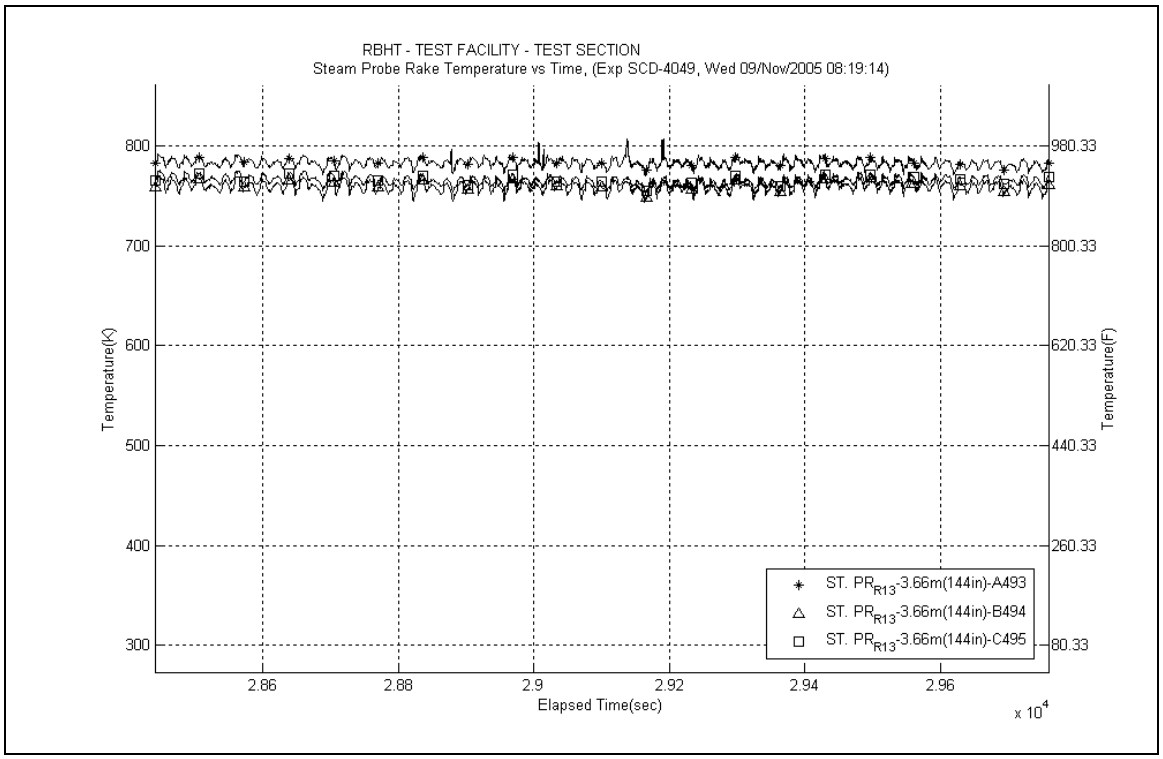

Figure A-246: Steam Probe Rake #13 Temperatures for Experiment 4049J

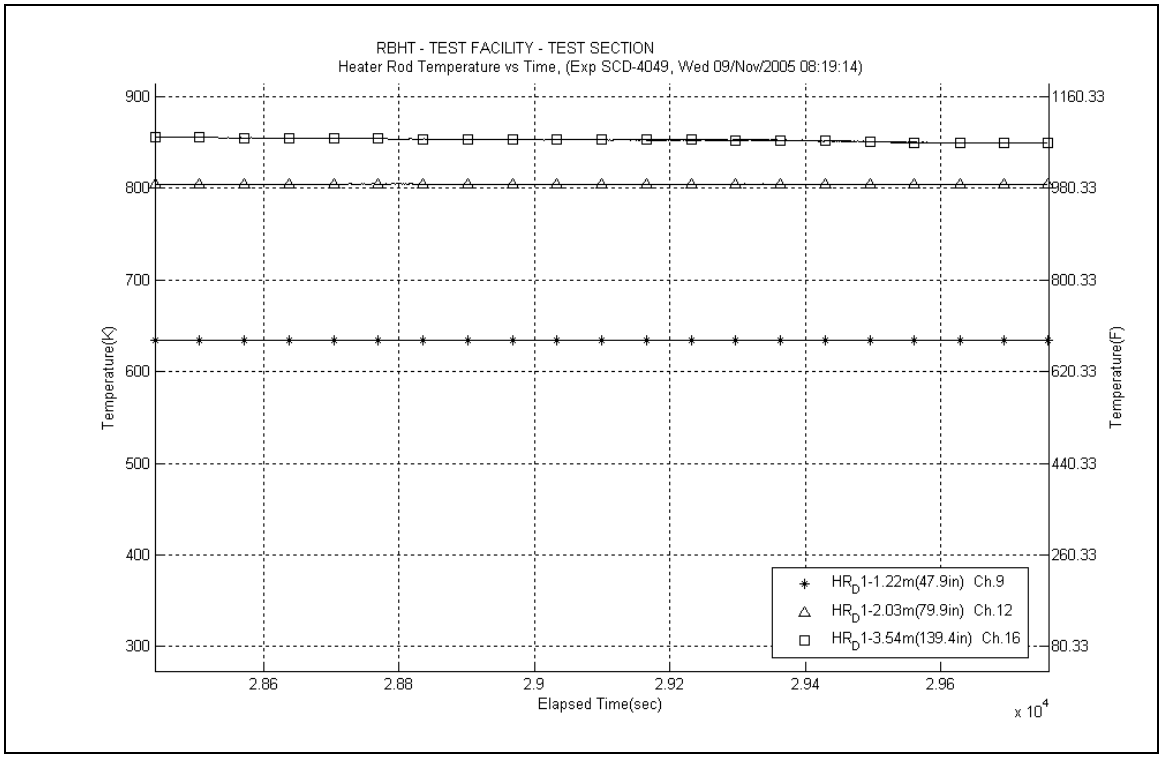

Figure A-247: Heater Rod D1 Temperatures for Experiment 4049J

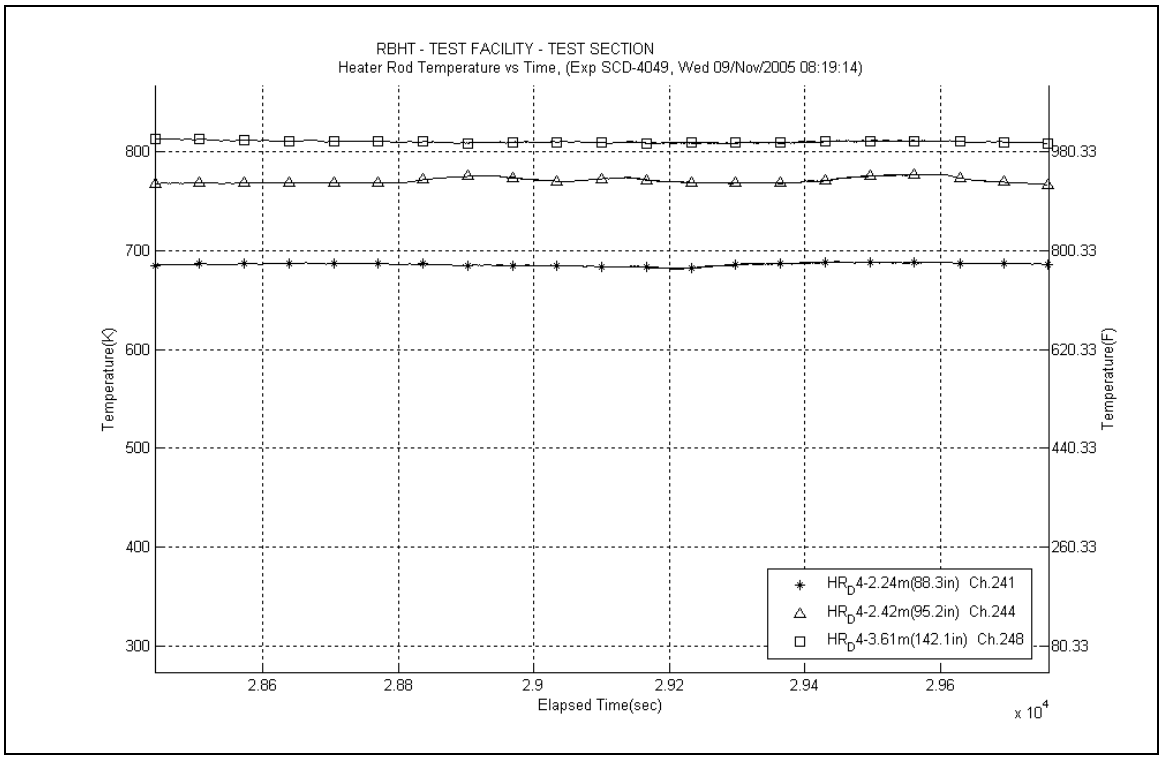

Figure A-248: Heater Rod D4 Temperatures for Experiment 4049J

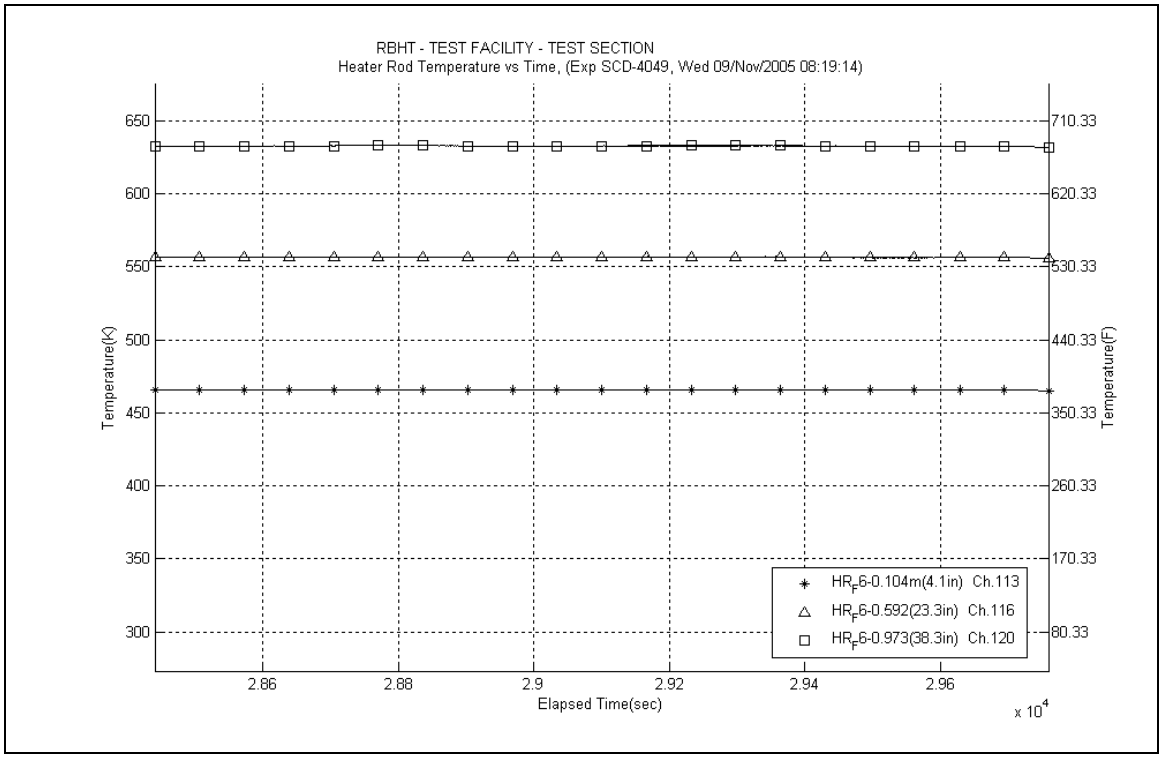

Figure A-249: Heater Rod F6 Temperatures for Experiment 4049J

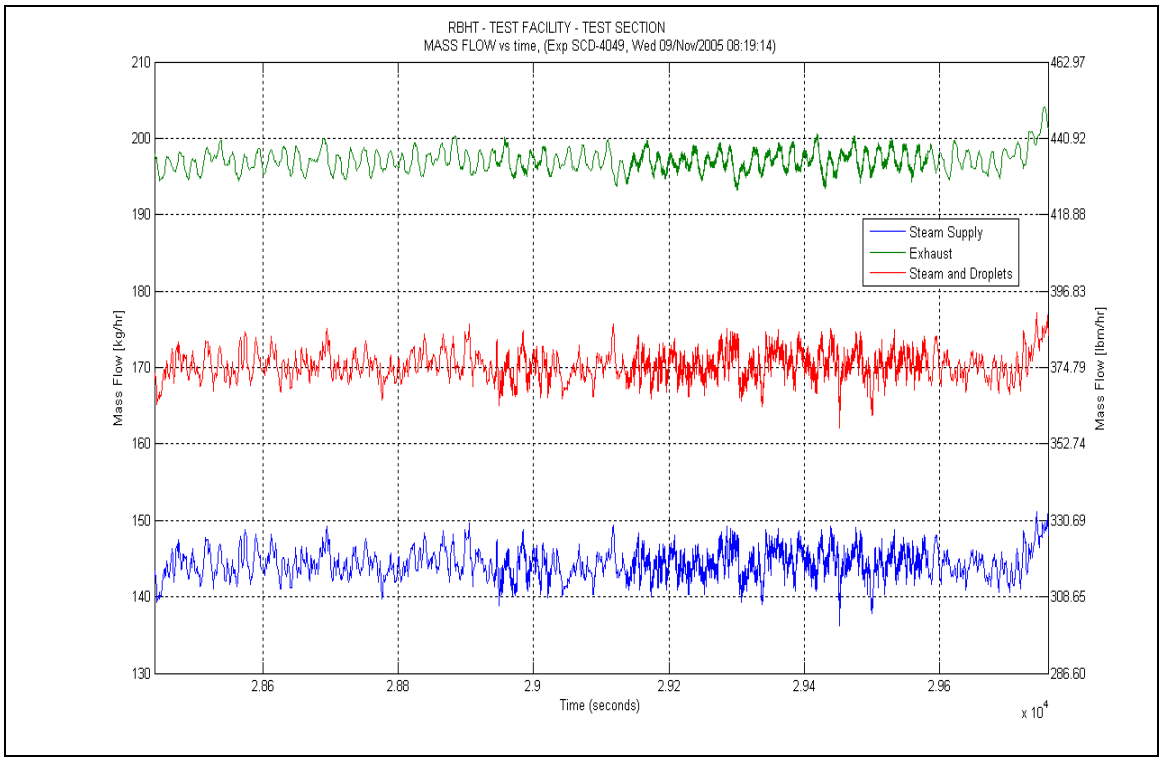

Figure A-250: Mass Flow for Experiment 4049J

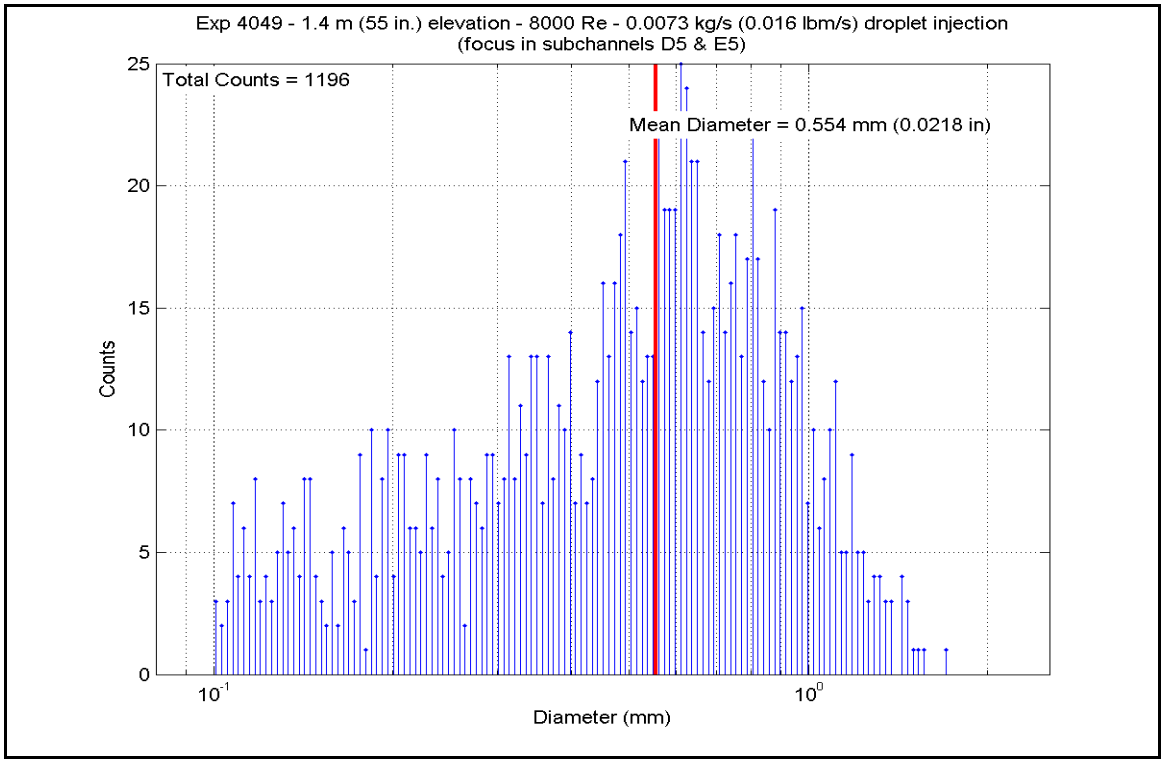

Figure A-251: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049J

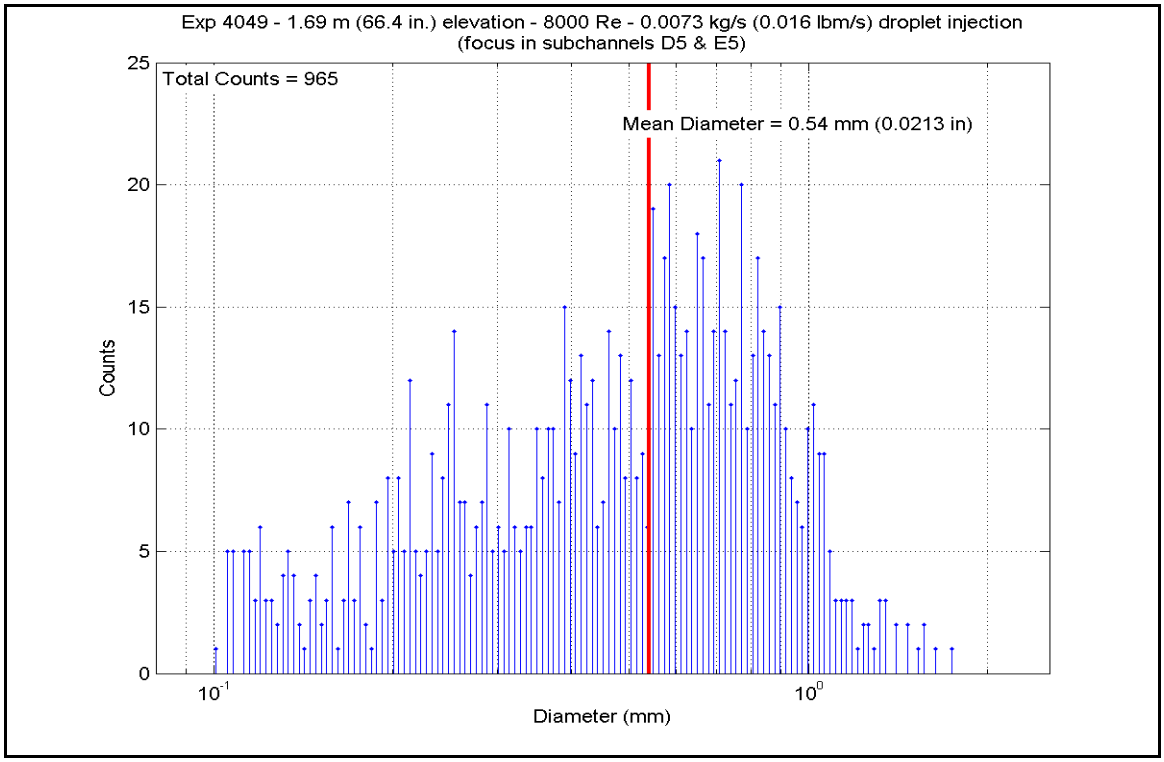

Figure A-252: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049J

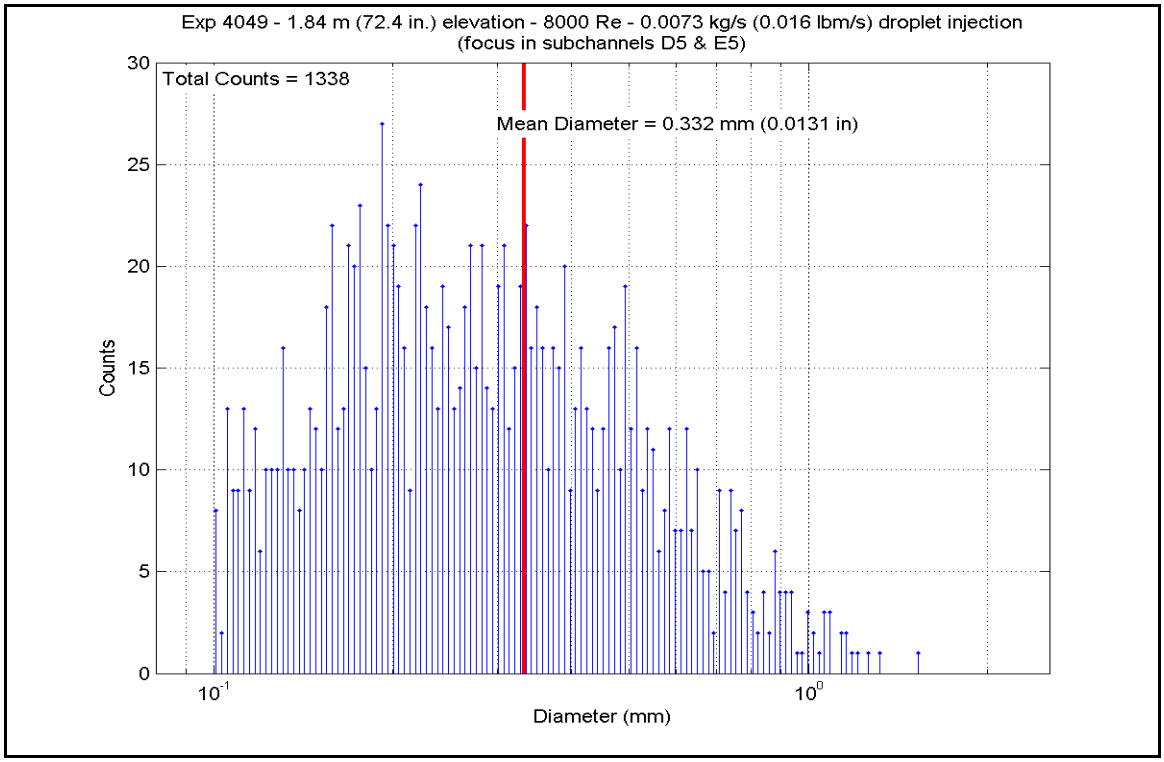

Figure A-253: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049J

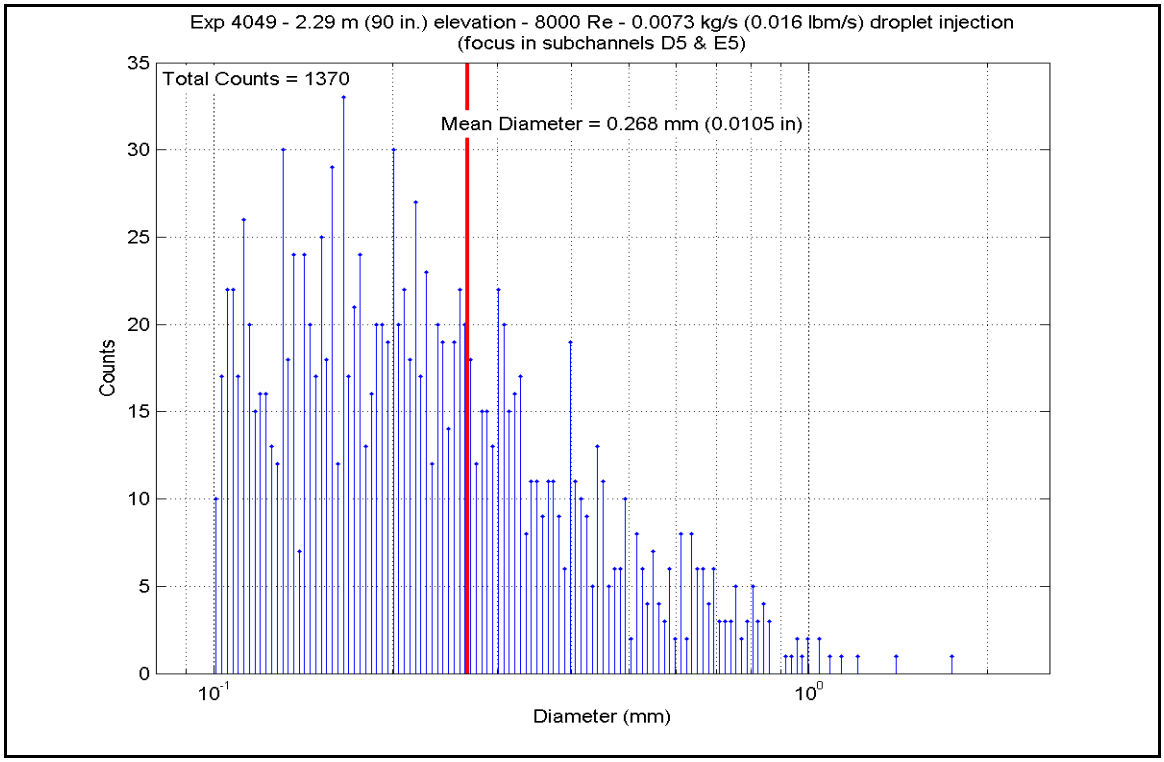

Figure A-254: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049J

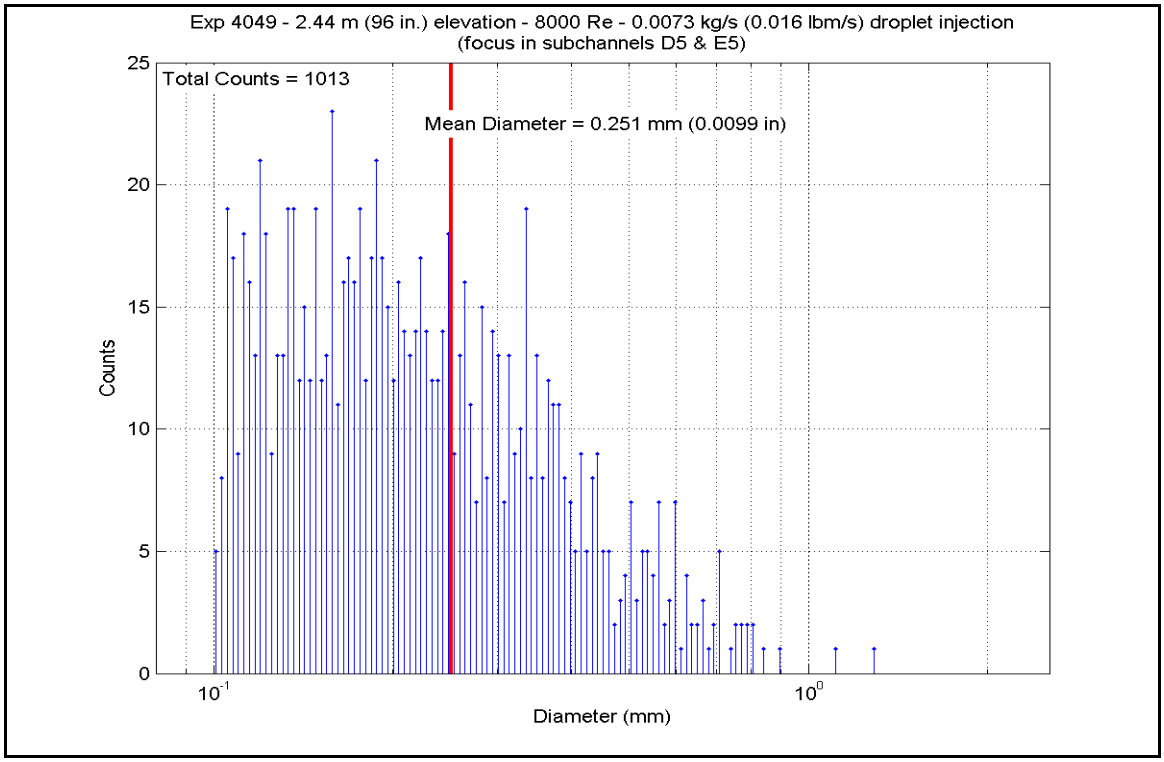

Figure A-255: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049J

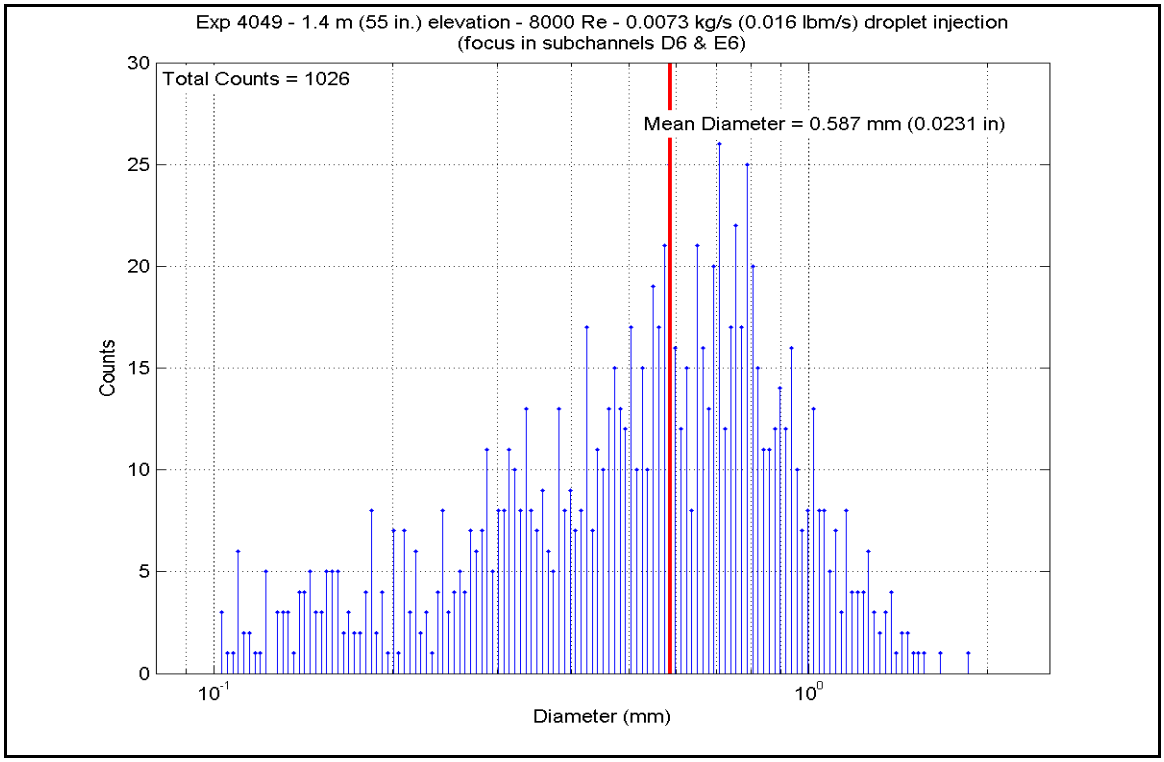

Figure A-256: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049J

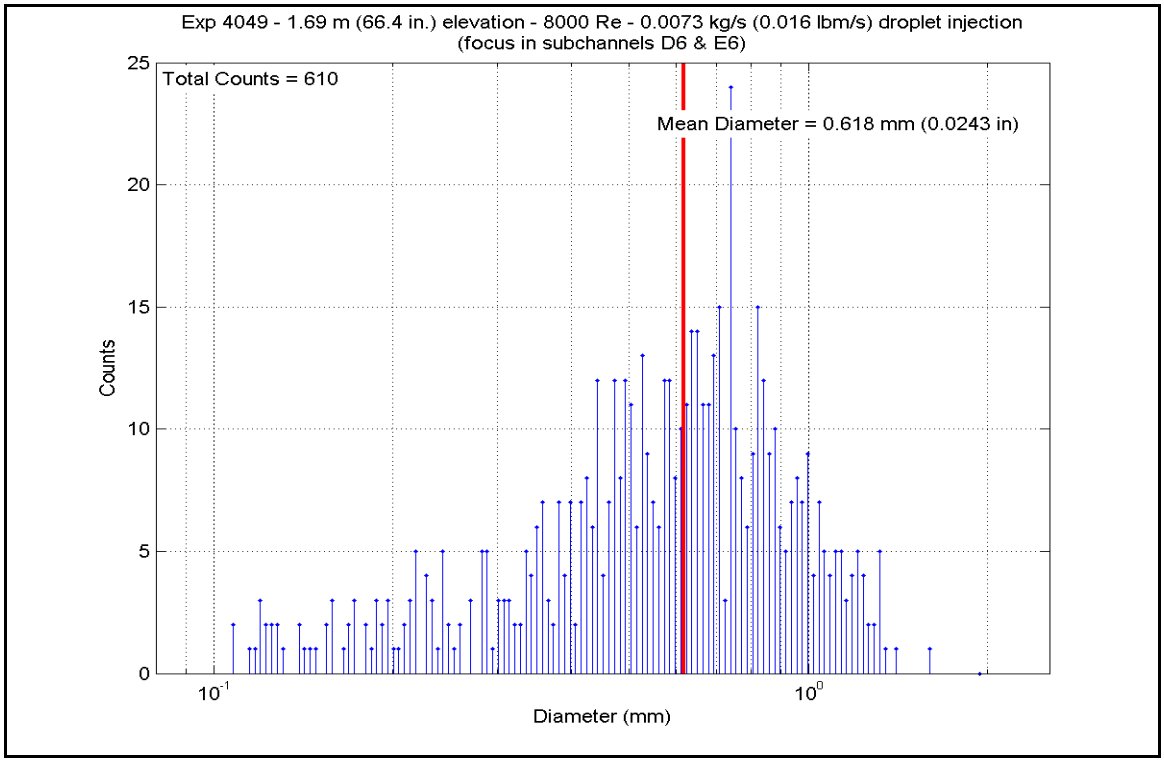

Figure A-257: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049J

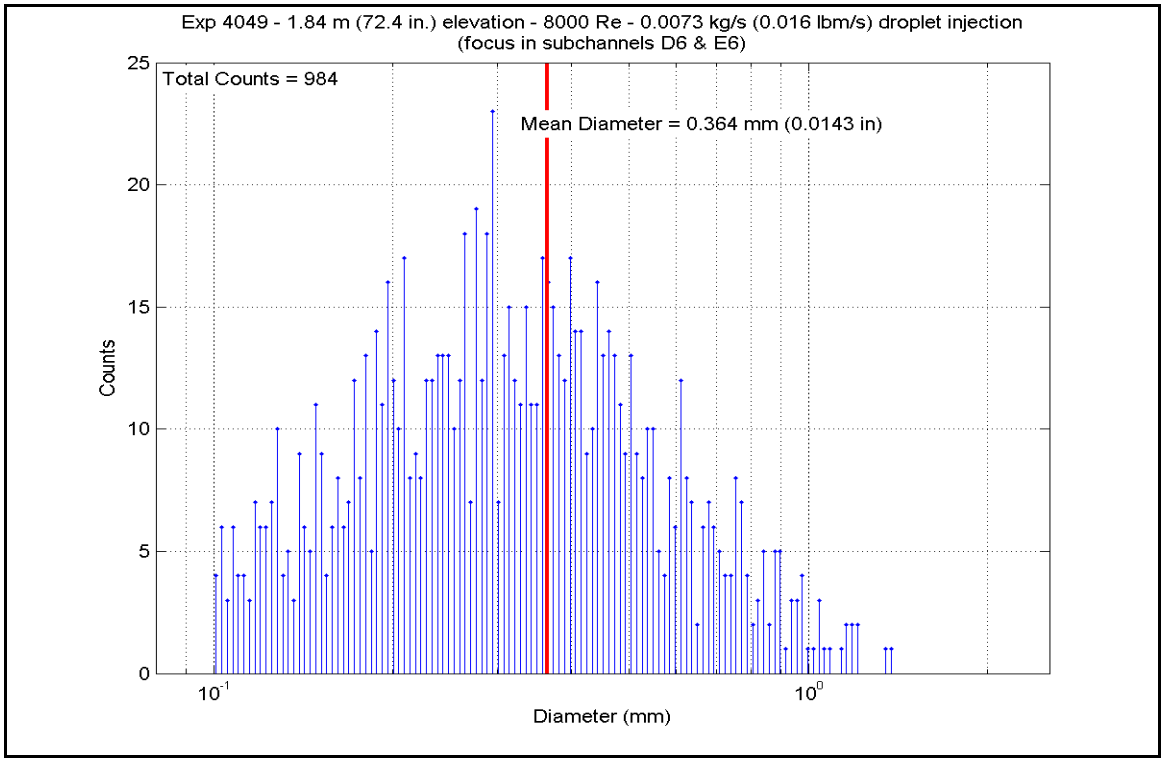

Figure A-258: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049J

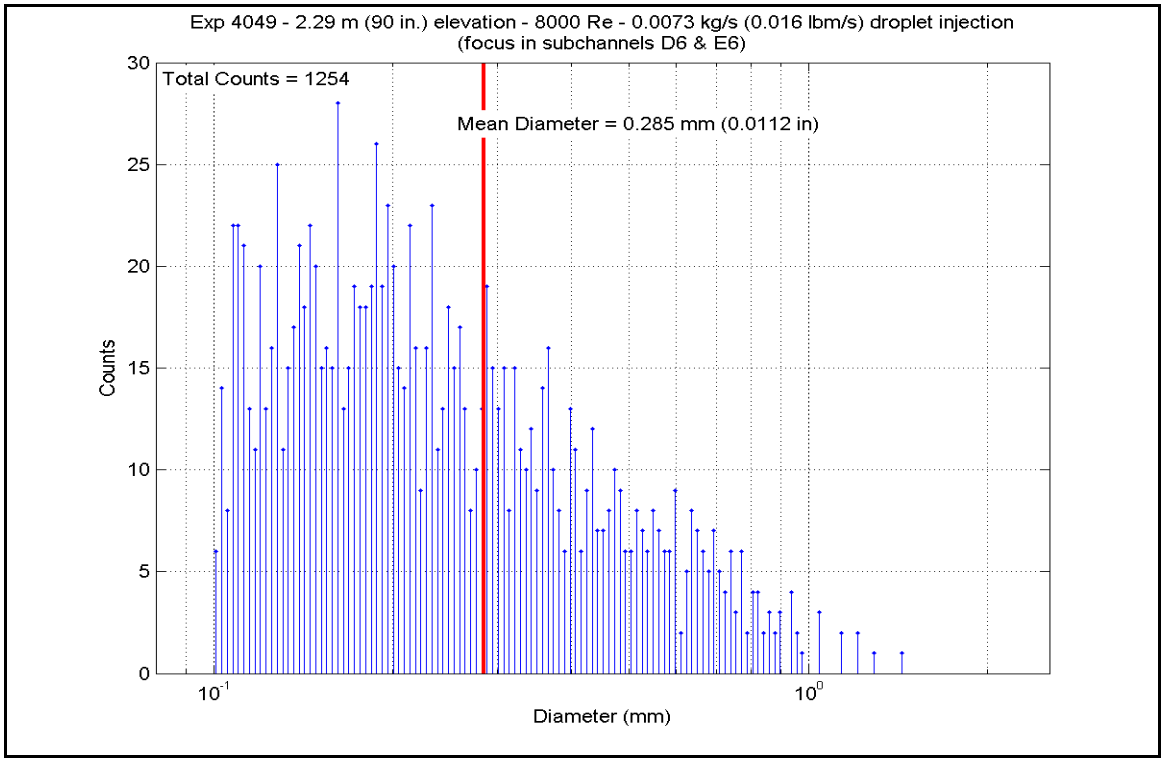

Figure A-259: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049J

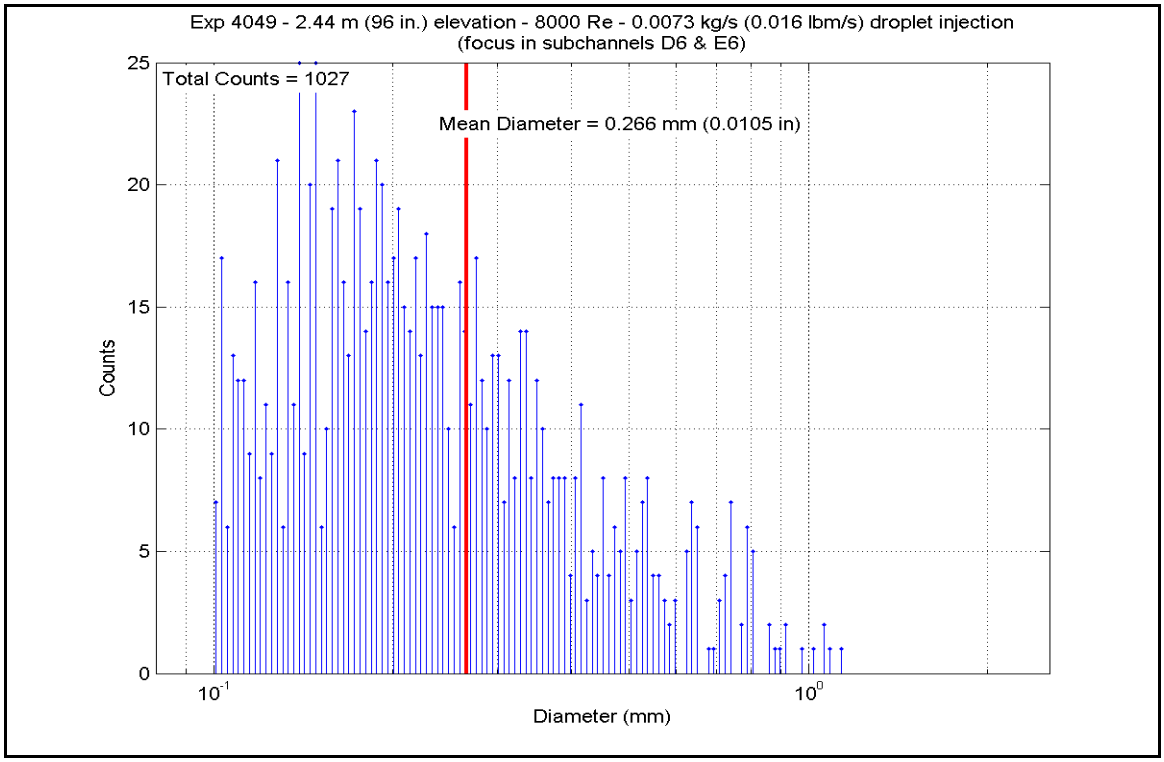

Figure A-260: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049J

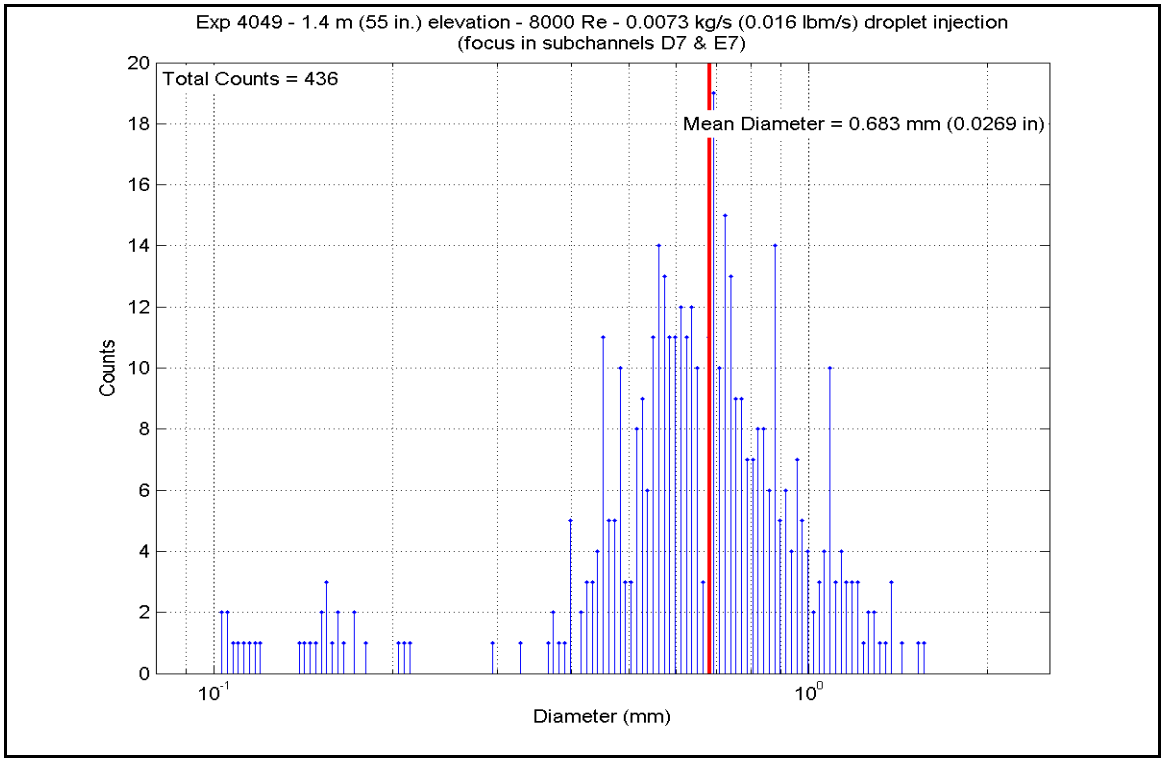

Figure A-261: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049J

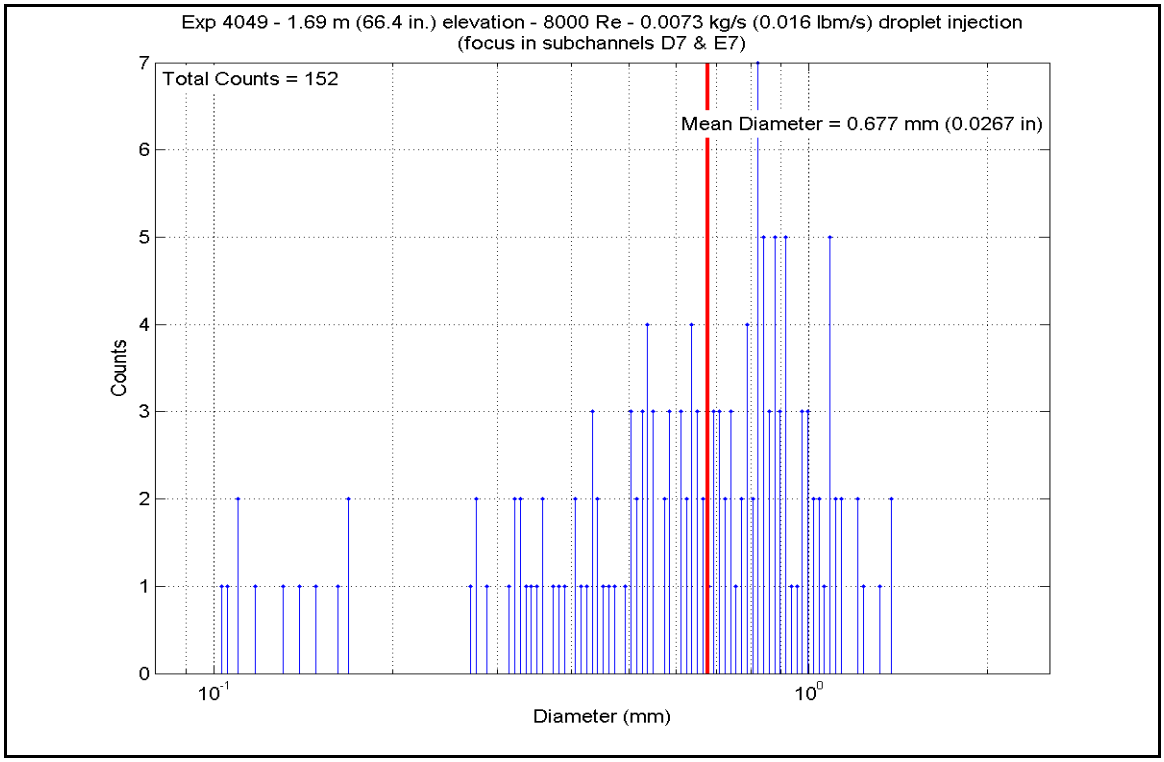

Figure A-262: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049J

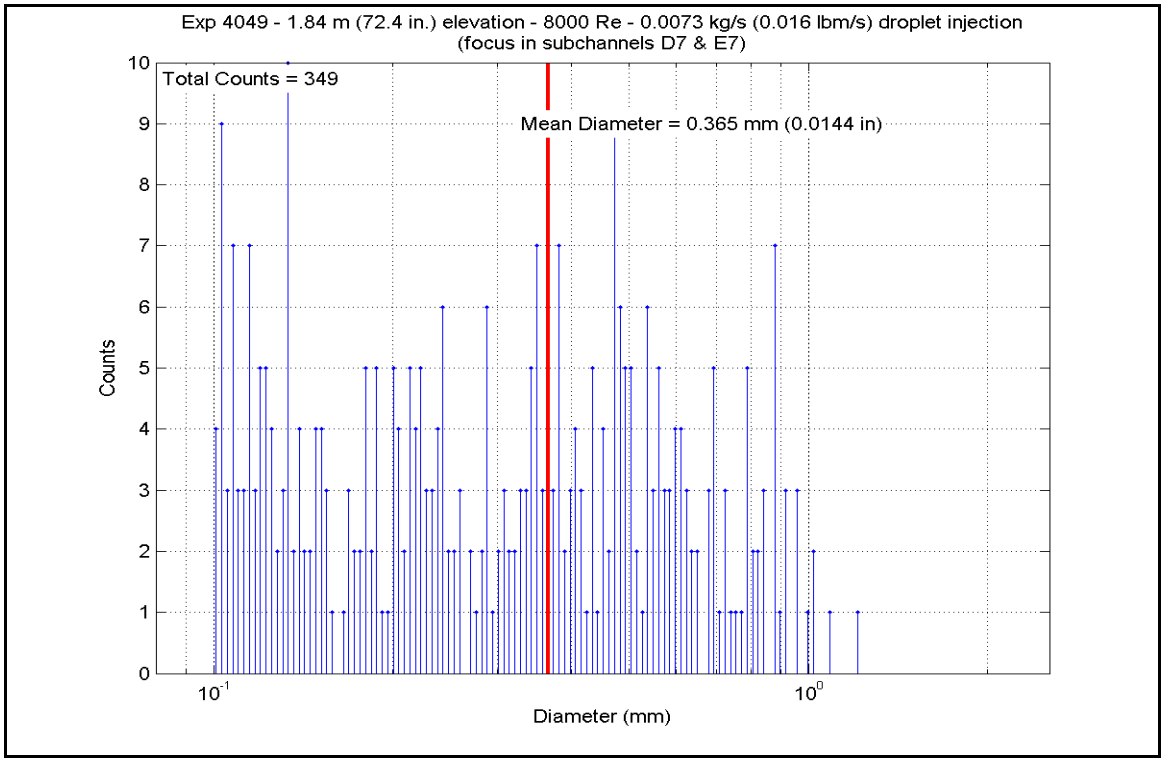

Figure A-263: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049J

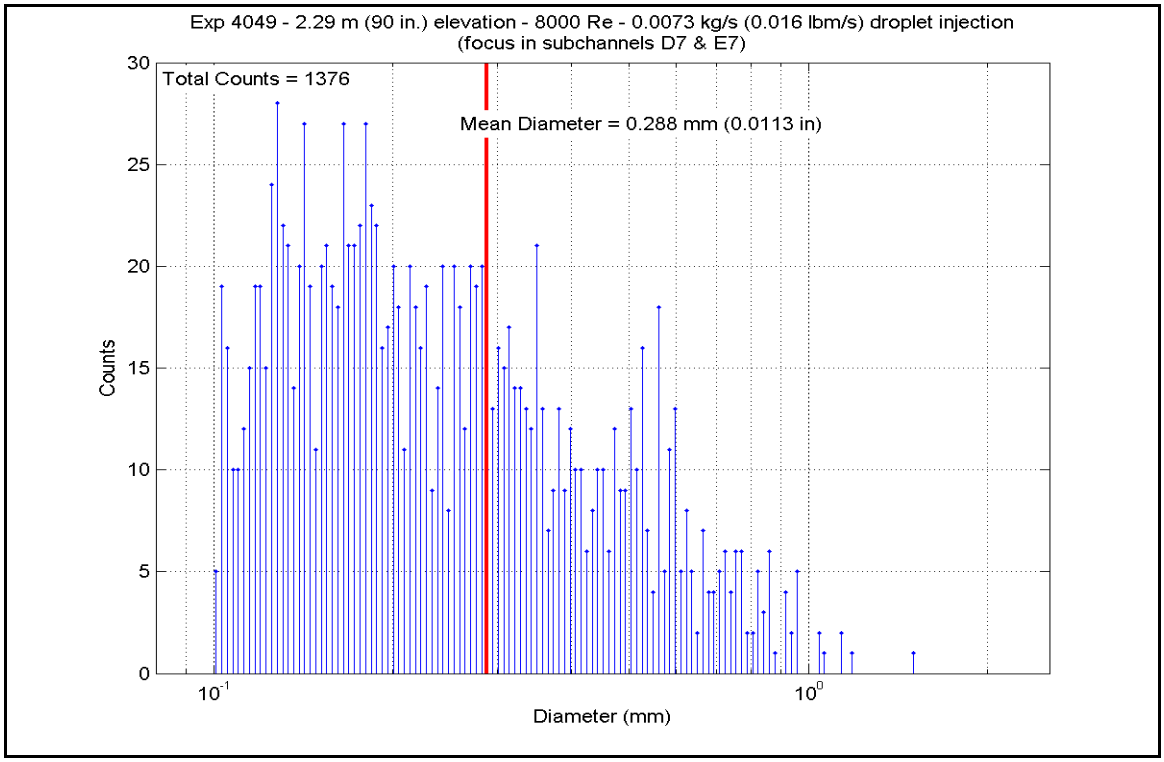

Figure A-264: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049J

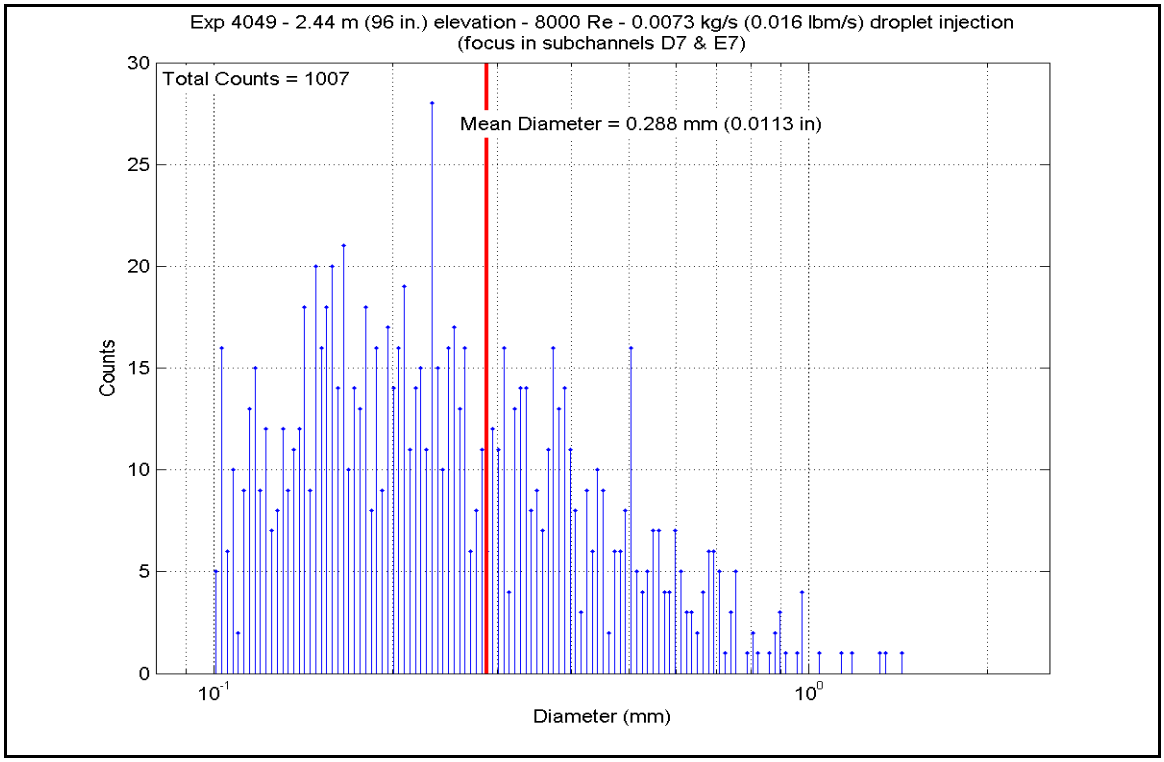

Figure A-265: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049J

Table A-53: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049J

SCD-4049-J	Inlet Reynolds:	8000		
Matrix Test # 4b	UP Pressure:	137.9 kPa	20	psia
Time Window: 28440-29760	Bundle Power:	65.00 kW	221789	Btu/hr
	Steam flow:	0.0401 kg/s	318.0	lbm/hr
	Droplet flow:	0.0073 kg/s	0.016	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	801.93	700.9	5502.84	17358.7	9.588	54.4
	RodD3_91.3	186	91.3	2.319	2.8	0.071	889.17	749.4	5619.66	17727.2	8.500	48.3
	RodD3_93.1	187	93.1	2.365	4.6	0.117	898.35	754.5	5689.65	17948.0	8.488	48.2
	RodD3_95.3	188	95.3	2.421	6.8	0.173	943.14	779.3	5776.38	18221.6	8.077	45.9
	RodD3_100.1	189	100.1	2.543	11.6	0.295	988.32	804.4	5964.57	18815.2	7.845	44.6
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1080.63	855.7	6198.30	19552.5	7.270	41.3
	RodD3_110	191	110	2.794	21.5	0.546	947.91	782.0	6141.29	19372.7	8.531	48.4
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1035.71	830.8	2151.59	6787.2	2.664	15.1
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	782.70	690.2	5566.06	17558.1	10.034	57.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	870.84	739.2	5672.29	17893.3	8.824	50.1
	RodC4_93.4	235	93.4	2.372	4.9	0.124	895.48	752.9	5761.86	18175.8	8.632	49.0
	RodC4_95.3	236	95.3	2.421	6.8	0.173	934.84	774.7	5836.93	18412.6	8.258	46.9
	RodC4_100.1	237	100.1	2.543	11.6	0.295	975.23	797.2	6023.51	19001.2	8.061	45.8
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1045.85	836.4	6268.41	19773.7	7.665	43.5
	RodC4_110	239	110	2.794	21.5	0.546	867.69	737.4	6100.84	19245.1	9.537	54.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	988.00	804.3	2327.94	7343.5	3.063	17.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	773.29	685.0	5539.47	17474.3	10.159	57.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	865.81	736.4	5660.52	17856.1	8.875	50.4
	RodD4_93.2	243	93.2	2.367	4.7	0.119	890.85	750.3	5736.24	18095.0	8.654	49.1
	RodD4_95.2	244	95.2	2.418	6.7	0.170	926.13	769.9	5814.52	18341.9	8.329	47.3
	RodD4_100.1	245	100.1	2.543	11.6	0.295	981.65	800.7	6005.91	18945.6	7.969	45.3
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1047.44	837.3	6245.27	19700.7	7.621	43.3
	RodD4_142.1	248	142.1	3.609	8.6	0.218	998.31	810.0	2247.71	7090.4	2.918	16.6
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	782.99	690.4	5459.98	17223.5	9.838	55.9
	RodE4_91.2	202	91.2	2.316	2.7	0.069	876.10	742.1	5565.72	17557.1	8.588	48.8
	RodE4_95.3	204	95.3	2.421	6.8	0.173	951.55	784.0	5721.50	18048.5	7.908	44.9
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1010.86	817.0	5931.02	18709.4	7.576	43.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1027.13	826.0	2270.79	7163.2	2.842	16.1

Table A-53: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	917.33	765.0	4522.49	14266.2	6.561	37.3
	RodE3_113.6	194	113.6	2.885	0.85	0.022	999.08	810.4	5594.40	17647.5	7.255	41.2
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1034.73	830.2	5390.76	17005.1	6.682	37.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1063.40	846.1	5062.68	15970.2	6.060	34.4
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1075.56	852.9	4603.67	14522.3	5.432	30.8
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1078.39	854.5	4189.25	13215.0	4.926	28.0
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	992.49	806.8	3614.68	11402.5	4.728	26.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1033.75	829.7	3187.43	10054.7	3.956	22.5
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	903.37	757.2	4434.44	13988.5	6.566	37.3
	RodC5_113.6	226	113.6	2.885	0.85	0.022	914.42	763.4	5443.04	17170.1	7.930	45.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	963.61	790.7	5226.70	16487.6	7.105	40.4
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1020.03	822.1	4506.59	14216.0	5.690	32.3
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1020.94	822.6	4093.45	12912.8	5.162	29.3
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	910.87	761.4	3584.82	11308.3	5.250	29.8
	RodC5_135.7	232	135.7	3.447	2.2	0.056	951.45	784.0	3158.20	9962.5	4.365	24.8
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	841.17	722.7	4539.42	14319.6	7.403	42.0
	RodE5_113.6	210	113.6	2.885	0.85	0.022	858.64	732.4	5621.99	17734.6	8.915	50.6
	RodE5_115.4	211	115.4	2.931	2.65	0.067	921.92	767.5	5430.62	17130.9	7.826	44.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	980.80	800.3	5076.69	16014.4	6.744	38.3
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1018.72	821.3	4657.80	14693.0	5.891	33.5
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1031.04	828.2	4229.59	13342.2	5.267	29.9
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1113.77	874.1	3679.33	11606.4	4.154	23.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1009.53	816.2	3251.04	10255.4	4.160	23.6
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	910.19	761.0	5148.13	16239.8	7.547	42.9
	RodC3_85.6	178	85.6	2.174	14.72	0.374	786.48	692.3	5372.98	16949.1	9.621	54.6
	RodC3_88.5	179	88.5	2.248	0	0.000	797.47	698.4	5482.42	17294.3	9.627	54.7
	RodC3_92.4	180	92.4	2.347	3.9	0.099	910.27	761.1	5630.81	17762.4	8.253	46.9
	RodC3_94.4	181	94.4	2.398	5.9	0.150	930.48	772.3	5707.96	18005.8	8.125	46.1
	RodC3_97.2	182	97.2	2.469	8.7	0.221	984.32	802.2	5813.87	18339.9	7.687	43.7
	RodC3_108.8	183	108.8	2.764	20.3	0.516	1056.14	842.1	6135.57	19354.6	7.409	42.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	786.46	692.3	4014.26	12663.0	7.188	40.8
	RodD5_54.1	218	54.1	1.374	7.1	0.180	808.53	704.6	4172.72	13162.9	7.188	40.8
	RodD5_56.9	219	56.9	1.445	9.9	0.251	852.25	728.8	4280.33	13502.3	6.857	38.9
	RodD5_60	220	60	1.524	13	0.330	880.87	744.7	4400.27	13880.6	6.740	38.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	908.47	760.1	4636.08	14624.5	6.813	38.7
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	768.25	682.2	4782.35	15085.9	8.852	50.3
	RodD5_72.9	223	72.9	1.852	2.02	0.051	839.33	721.7	4897.24	15448.3	8.011	45.5
	RodD5_74.9	224	74.9	1.902	4.02	0.102	881.56	745.1	4973.85	15690.0	7.610	43.2

Table A-53: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	715.40	652.8	3651.54	11518.8	7.492	42.5
	RodB5_52.9	154	52.9	1.344	5.9	0.150	774.33	685.6	4115.85	12983.5	7.534	42.8
	RodB5_55	155	55	1.397	8	0.203	805.84	703.1	4195.91	13236.0	7.261	41.2
	RodB5_57.8	156	57.8	1.468	10.8	0.274	847.34	726.1	4306.71	13585.5	6.954	39.5
	RodB5_64	157	64	1.626	17	0.432	894.66	752.4	4547.54	14345.2	6.821	38.7
	RodB5_73.9	158	73.9	1.877	3.02	0.077	852.93	729.2	4934.99	15567.4	7.897	44.8
	RodB5_75.9	159	75.9	1.928	5.02	0.128	887.87	748.6	5013.16	15814.0	7.597	43.1
	RodB5_76.9	160	76.9	1.953	6.02	0.153	901.79	756.4	5052.52	15938.2	7.499	42.6
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	716.82	653.6	3627.46	11442.8	7.421	42.1
	RodF5_53.1	106	53.1	1.349	6.1	0.155	769.04	682.6	4097.24	12924.7	7.573	43.0
	RodF5_55	107	55	1.397	8	0.203	797.83	698.6	4171.13	13157.8	7.320	41.6
	RodF5_57.8	108	57.8	1.468	10.8	0.274	836.57	720.1	4282.15	13508.0	7.036	40.0
	RodF5_64	109	64	1.626	17	0.432	873.10	740.4	4526.07	14277.5	7.016	39.8
	RodF5_73.8	110	73.8	1.875	2.92	0.074	844.79	724.7	4907.09	15479.4	7.956	45.2
	RodF5_75.8	111	75.8	1.925	4.92	0.125	883.11	746.0	4984.57	15723.8	7.609	43.2
	RodF5_76.8	112	76.8	1.951	5.92	0.150	899.22	754.9	5023.51	15846.7	7.484	42.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	716.19	653.3	3643.43	11493.2	7.463	42.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	830.62	716.8	4113.47	12975.9	6.826	38.8
	RodC2_55	59	55	1.397	8	0.203	849.63	727.4	4187.57	13209.7	6.736	38.3
	RodC2_57.8	60	57.8	1.468	10.8	0.274	879.66	744.1	4297.18	13555.5	6.594	37.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	910.92	761.4	4536.16	14309.3	6.642	37.7
	RodC2_73.8	62	73.8	1.875	2.92	0.074	888.74	749.1	4922.74	15528.8	7.450	42.3
	RodC2_75.8	63	75.8	1.925	4.92	0.125	915.58	764.0	5001.22	15776.3	7.274	41.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	926.38	770.0	5040.40	15899.9	7.217	41.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	720.50	655.6	3629.53	11449.4	7.370	41.9
	RodC6_52.8	138	52.8	1.341	5.8	0.147	826.03	714.3	4112.04	12971.4	6.876	39.0
	RodC6_54.8	139	54.8	1.392	7.8	0.198	848.38	726.7	4193.46	13228.3	6.759	38.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	880.15	744.3	4315.53	13613.4	6.617	37.6
	RodC6_63.8	141	63.8	1.621	16.8	0.427	916.74	764.7	4560.09	14384.8	6.621	37.6
	RodC6_73.7	142	73.7	1.872	2.82	0.072	919.58	766.2	4962.16	15653.1	7.175	40.7
	RodC6_75.8	143	75.8	1.925	4.92	0.125	944.20	779.9	5047.90	15923.6	7.048	40.0
	RodC6_76.8	144	76.8	1.951	5.92	0.150	959.84	788.6	5088.75	16052.5	6.953	39.5

Table A-53: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	774.02	685.4	5459.73	17222.7	9.999	56.8
	RodB4_91.3	162	91.3	2.319	2.8	0.071	863.24	735.0	5569.32	17568.4	8.767	49.8
	RodB4_93.3	163	93.3	2.370	4.8	0.122	881.23	744.9	5645.45	17808.6	8.642	49.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	911.33	761.7	5712.08	18018.8	8.359	47.5
	RodB4_100	165	100	2.540	11.5	0.292	955.03	785.9	5893.61	18591.4	8.106	46.0
	RodB4_106	166	106	2.692	17.5	0.445	1027.85	826.4	6118.68	19301.4	7.650	43.4
	RodB4_109.9	167	109.9	2.791	21.4	0.544	853.23	729.4	5954.22	18782.6	9.523	54.1
	RodB4_142.3	168	142.3	3.614	8.8	0.224	979.29	799.4	2317.83	7311.6	3.085	17.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	836.46	720.1	5389.75	17002.0	8.858	50.3
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	803.24	701.6	5494.76	17333.2	9.552	54.2
	RodF4_92.4	100	92.4	2.347	3.9	0.099	913.18	762.7	5646.96	17813.3	8.242	46.8
	RodF4_94.3	101	94.3	2.395	5.8	0.147	948.31	782.2	5720.21	18044.4	7.941	45.1
	RodF4_97.2	102	97.2	2.469	8.7	0.221	991.69	806.3	5832.29	18398.0	7.637	43.4
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1043.26	835.0	6165.35	19448.6	7.562	42.9
	RodF4_111	104	111	2.819	-1.75	-0.044	905.67	758.5	5933.14	18716.1	8.755	49.7
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1065.92	847.6	5440.72	17162.7	6.493	36.9
	RodD2_106	66	106	2.692	17.5	0.445	1085.78	858.6	5154.09	16258.6	6.009	34.1
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1105.37	869.5	4765.65	15033.3	5.432	30.8
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1115.38	875.0	4307.61	13588.4	4.854	27.6
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1100.50	866.8	3872.66	12216.3	4.439	25.2
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1107.29	870.5	6097.15	19233.4	6.934	39.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1130.38	883.4	6207.02	19580.0	6.879	39.1
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1031.10	828.2	5703.41	17991.4	7.102	40.3
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1096.12	864.3	6102.77	19251.2	7.030	39.9
	RodD6_106	130	106	2.692	17.5	0.445	1106.34	870.0	6214.03	19602.2	7.075	40.2
	RodD6_112.9	131	112.9	2.868	0.15	0.004	991.73	806.3	5676.54	17906.7	7.433	42.2
	RodD6_114.9	132	114.9	2.918	2.15	0.055	1028.16	826.6	5445.01	17176.3	6.805	38.6
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1051.87	839.7	5223.56	16477.7	6.340	36.0
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1067.04	848.2	4752.04	14990.3	5.664	32.2
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1070.30	850.0	4300.49	13565.9	5.106	29.0
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1058.65	843.5	3847.39	12136.6	4.632	26.3

Table A-53: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	770.86	683.6	4027.40	12704.4	7.419	42.1
	RodE2_54	74	54	1.372	7	0.178	833.71	718.5	4180.79	13188.3	6.902	39.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	867.20	737.1	4294.85	13548.1	6.719	38.2
	RodE2_59.9	76	59.9	1.521	12.9	0.328	900.26	755.5	4412.65	13919.7	6.564	37.3
	RodE2_66	77	66	1.676	19	0.483	923.06	768.2	4652.47	14676.2	6.694	38.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	827.60	715.2	4801.95	15147.8	8.009	45.5
	RodE2_72.9	79	72.9	1.852	2.02	0.051	886.40	747.8	4924.55	15534.5	7.480	42.5
	RodE2_74.9	80	74.9	1.902	4.02	0.102	913.71	763.0	5004.04	15785.2	7.298	41.4
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	728.82	660.3	4005.88	12636.5	7.999	45.4
	RodB3_54.1	170	54.1	1.374	7.1	0.180	797.51	698.4	4157.46	13114.7	7.300	41.5
	RodB3_56.9	171	56.9	1.445	9.9	0.251	833.66	718.5	4266.50	13458.7	7.044	40.0
	RodB3_60.1	172	60.1	1.527	13.1	0.333	829.11	716.0	4391.79	13853.9	7.306	41.5
	RodB3_66.1	173	66.1	1.679	19.1	0.485	873.00	740.4	4625.94	14592.5	7.172	40.7
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	740.02	666.5	4777.88	15071.8	9.331	53.0
	RodB3_73	175	73	1.854	2.12	0.054	816.51	709.0	4896.49	15446.0	8.320	47.2
	RodB3_75	176	75	1.905	4.12	0.105	852.95	729.2	4974.87	15693.2	7.960	45.2
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	747.86	670.9	4004.21	12631.3	7.702	43.7
	RodF3_54	90	54	1.372	7	0.178	811.26	706.1	4162.78	13131.5	7.137	40.5
	RodF3_57	91	57	1.448	10	0.254	848.96	727.0	4281.68	13506.6	6.895	39.2
	RodF3_60	92	60	1.524	13	0.330	877.22	742.7	4398.65	13875.5	6.775	38.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	897.16	753.8	4636.44	14625.7	6.929	39.3
	RodF3_70	94	70	1.778	-0.88	-0.022	769.91	683.1	4803.09	15151.3	8.863	50.3
	RodF3_73	95	73	1.854	2.12	0.054	863.52	735.1	4920.25	15520.9	7.742	44.0
	RodF3_75	96	75	1.905	4.12	0.105	905.32	758.3	4999.61	15771.3	7.381	41.9
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	756.47	675.6	4002.62	12626.3	7.574	43.0
	RodE6_54.1	122	54.1	1.374	7.1	0.180	815.19	708.3	4152.85	13100.2	7.072	40.2
	RodE6_57	123	57	1.448	10	0.254	846.00	725.4	4264.62	13452.7	6.901	39.2
	RodE6_60.2	124	60.2	1.529	13.2	0.335	873.87	740.9	4388.04	13842.1	6.794	38.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	893.58	751.8	4614.41	14556.2	6.933	39.4
	RodE6_70	126	70	1.778	-0.88	-0.022	821.07	711.5	4765.24	15032.0	8.035	45.6
	RodE6_73.1	127	73.1	1.857	2.22	0.056	879.38	743.9	4884.28	15407.4	7.498	42.6
	RodE6_75	128	75	1.905	4.12	0.105	909.34	760.6	4957.35	15638.0	7.276	41.3

RBHT Steam Cooling with Droplet Injection Test SCD-4049-K

Matrix Test # 4c

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 30420 - 30720
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 65 kW
Bundle Inlet Reynolds Number: 8000
Bundle Inlet Steam Flow: 144.2 kg/hr (318 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

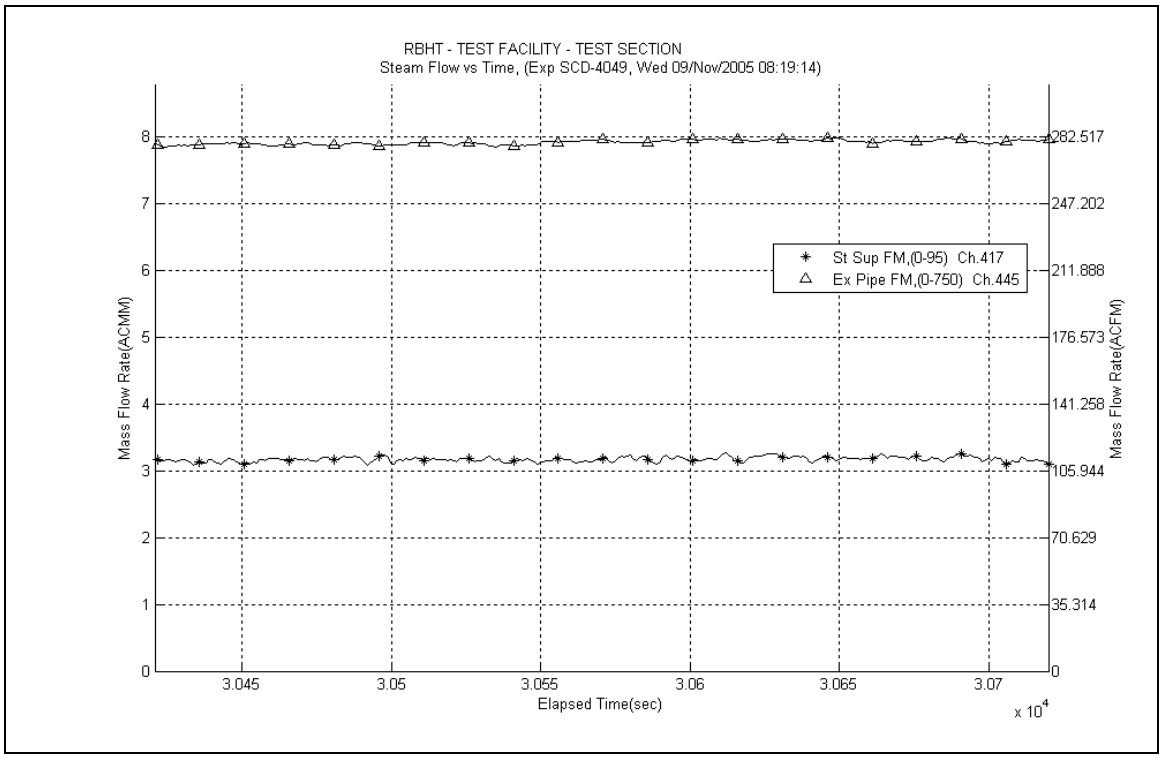

Figure A-266: Inlet and Exhaust Steam Flow Rates for Experiment 4049K

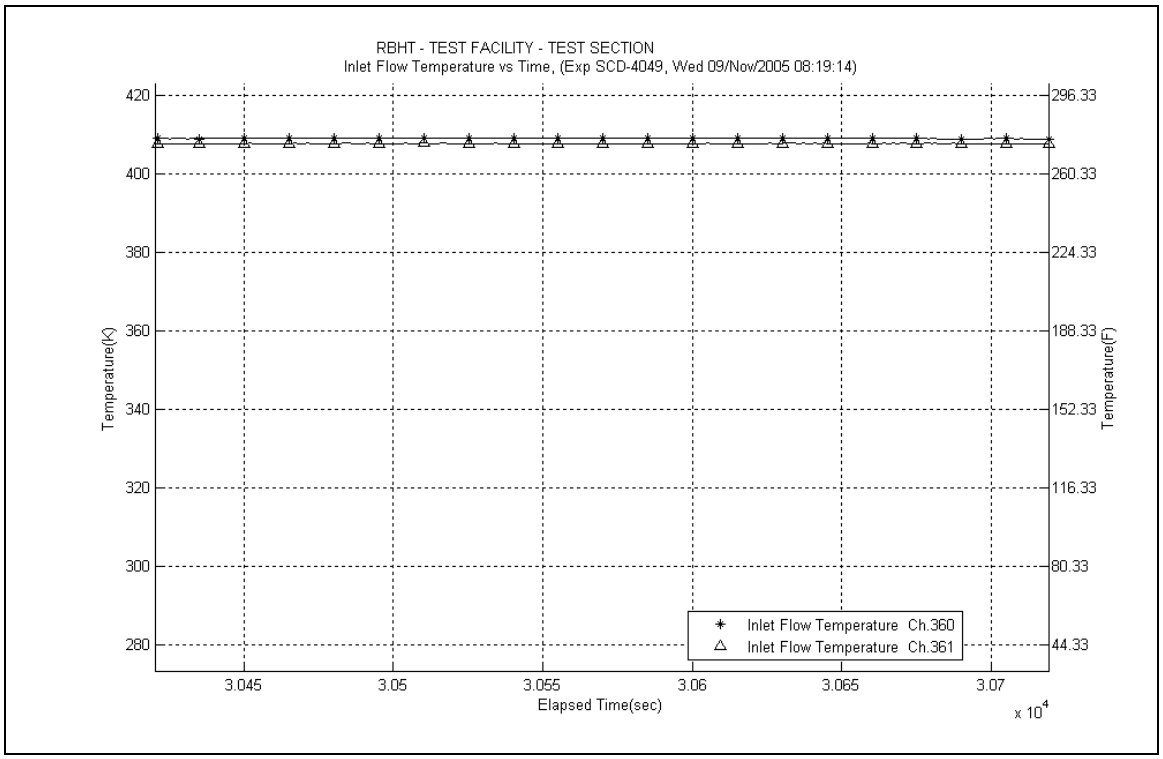

Figure A-267: Inlet Steam Temperature for Experiment 4049K

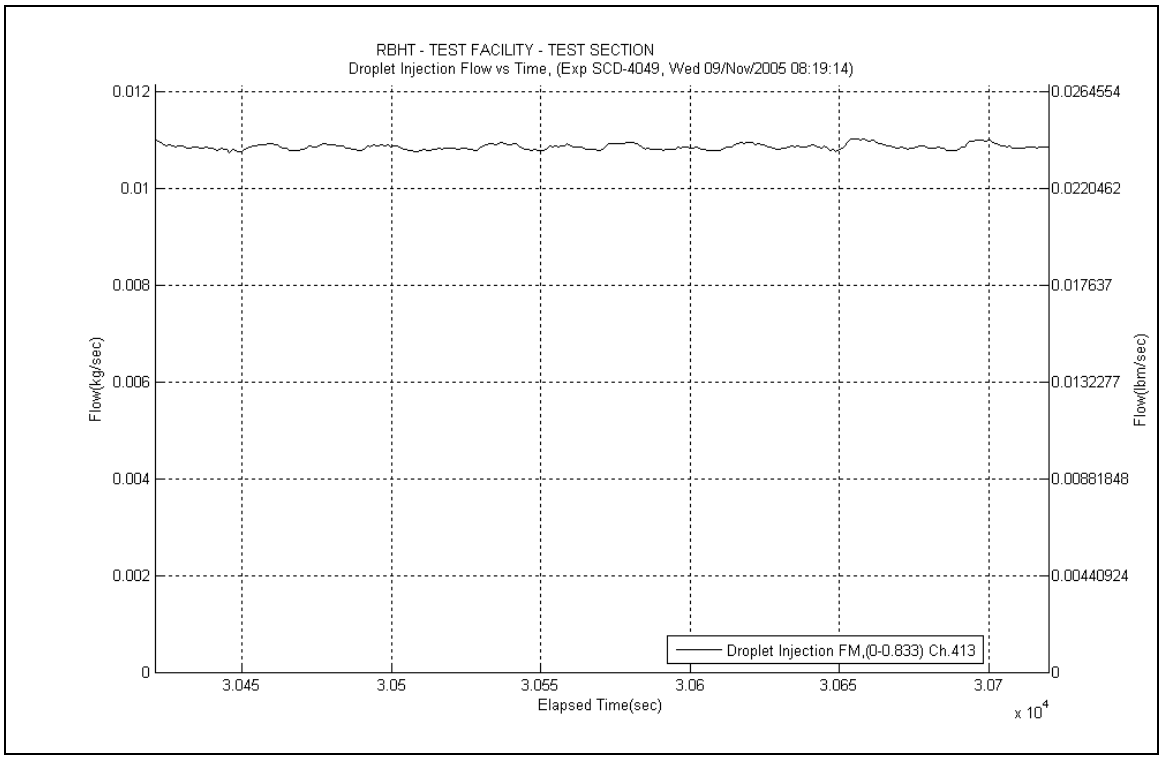

Figure A-268: Droplet Injection Flow Rate for Experiment 4049K

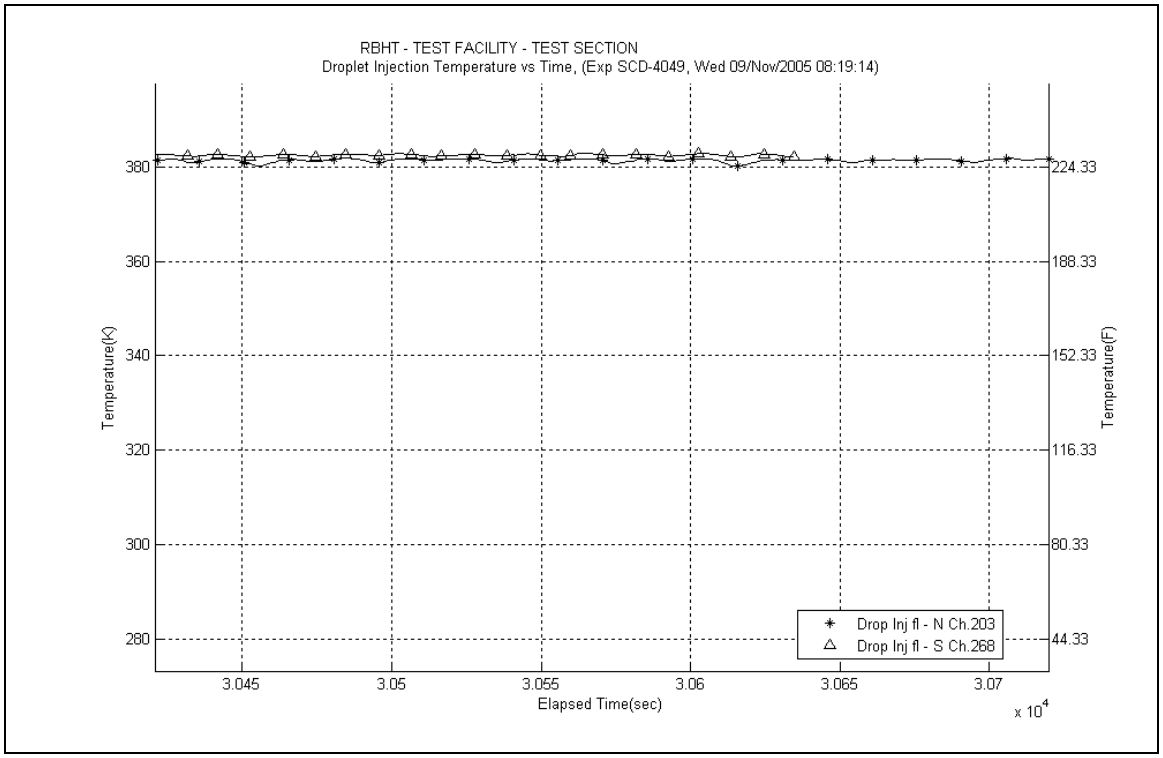

Figure A-269: Droplet Injection Temperature for Experiment 4049K

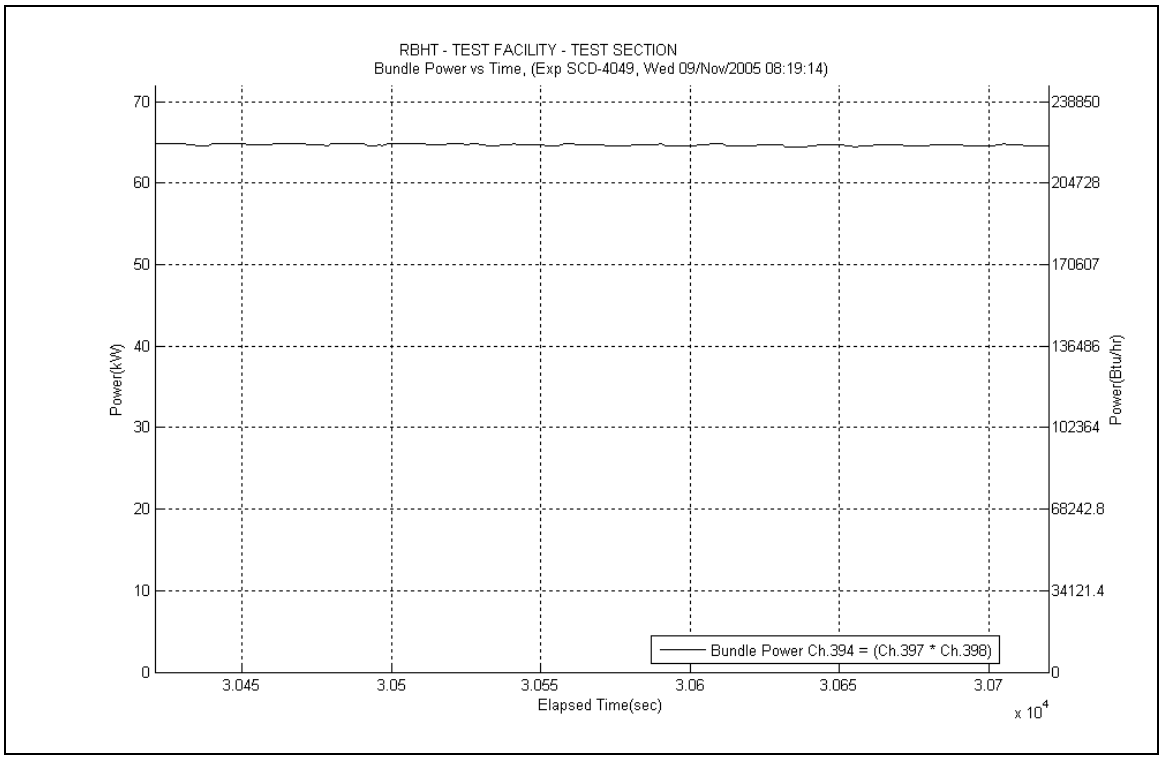

Figure A-270: Bundle Power for Experiment 4049K

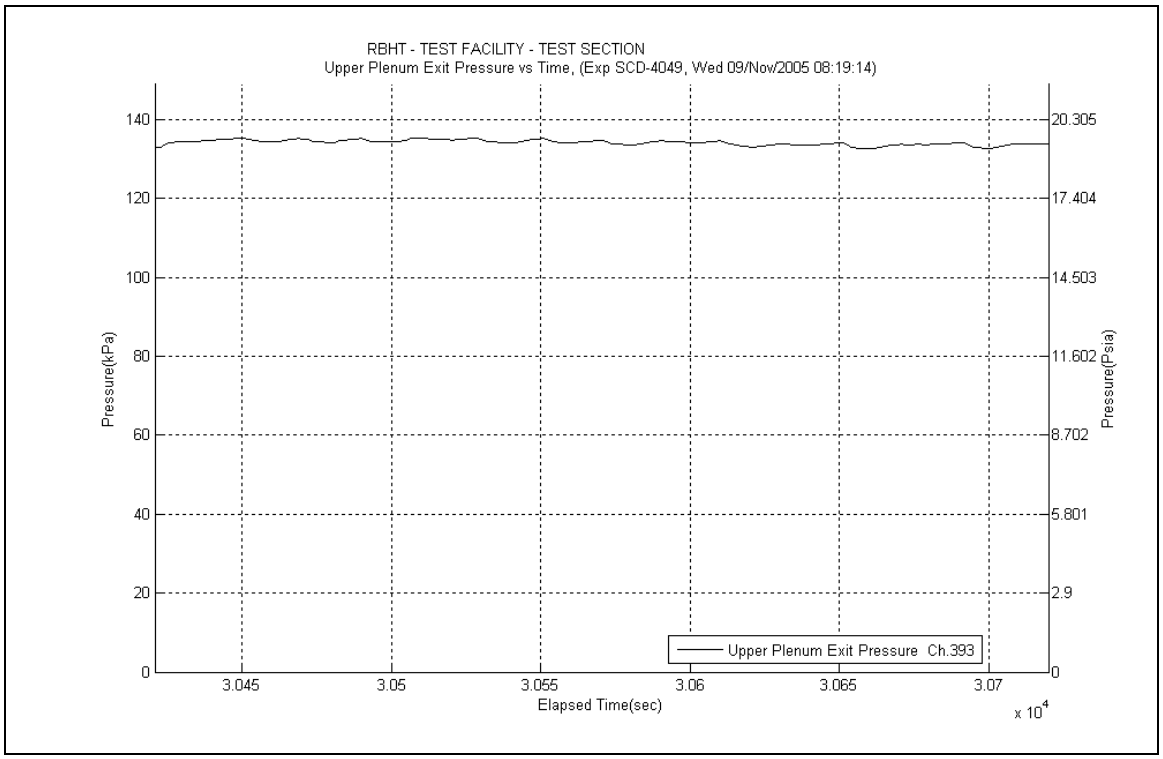

Figure A-271: Upper Plenum Pressure for Experiment 4049K

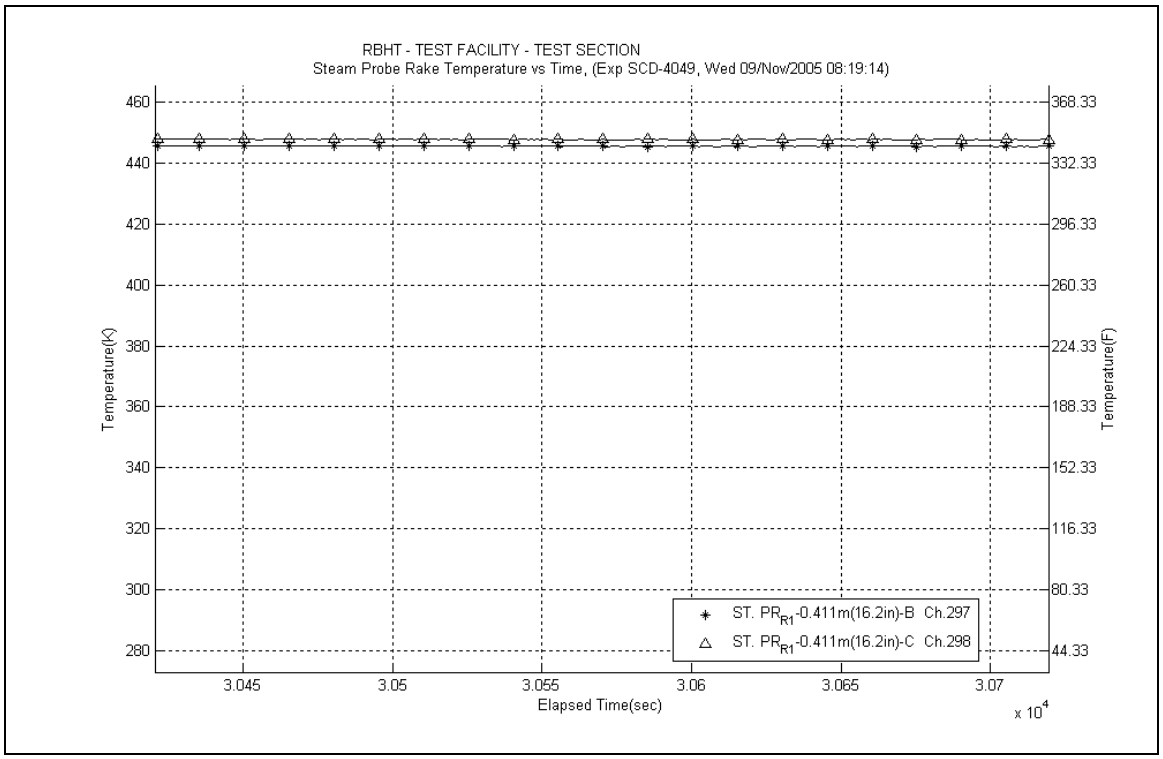

Figure A-272: Steam Probe Rake #1 Temperatures for Experiment 4049K

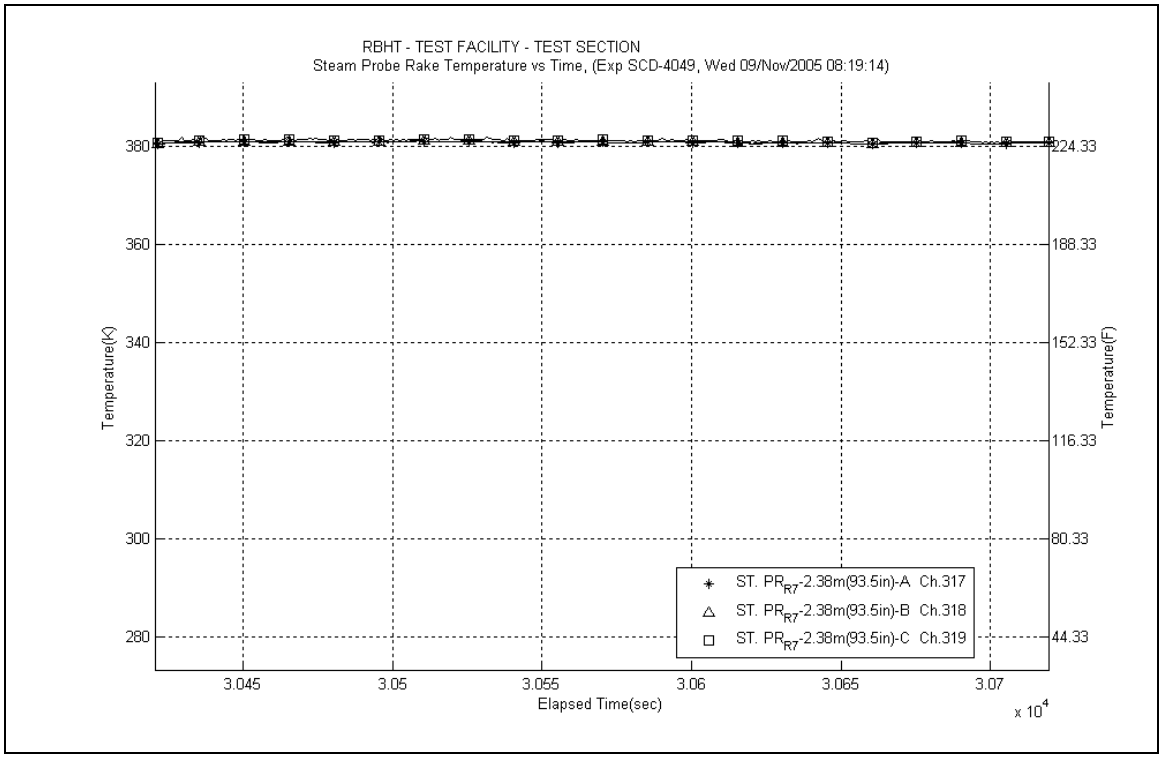

Figure A-273: Steam Probe Rake #7 Temperatures for Experiment 4049K

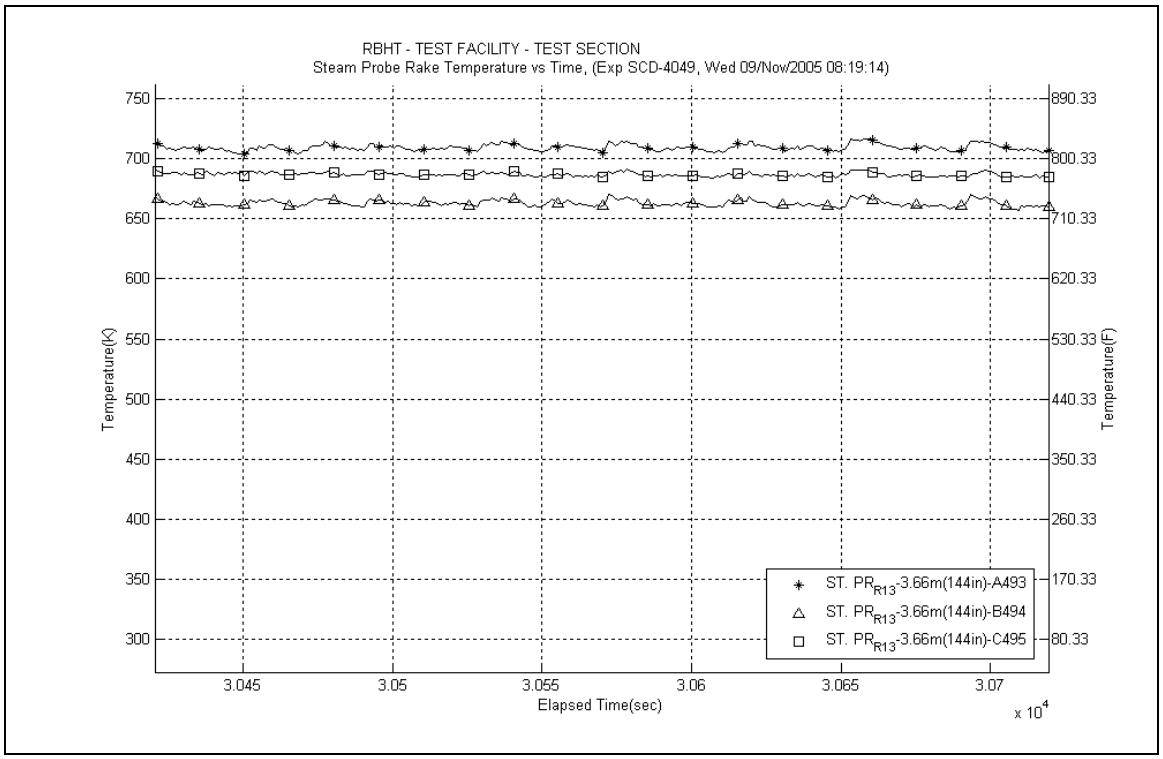

Figure A-274: Steam Probe Rake #13 Temperatures for Experiment 4049K

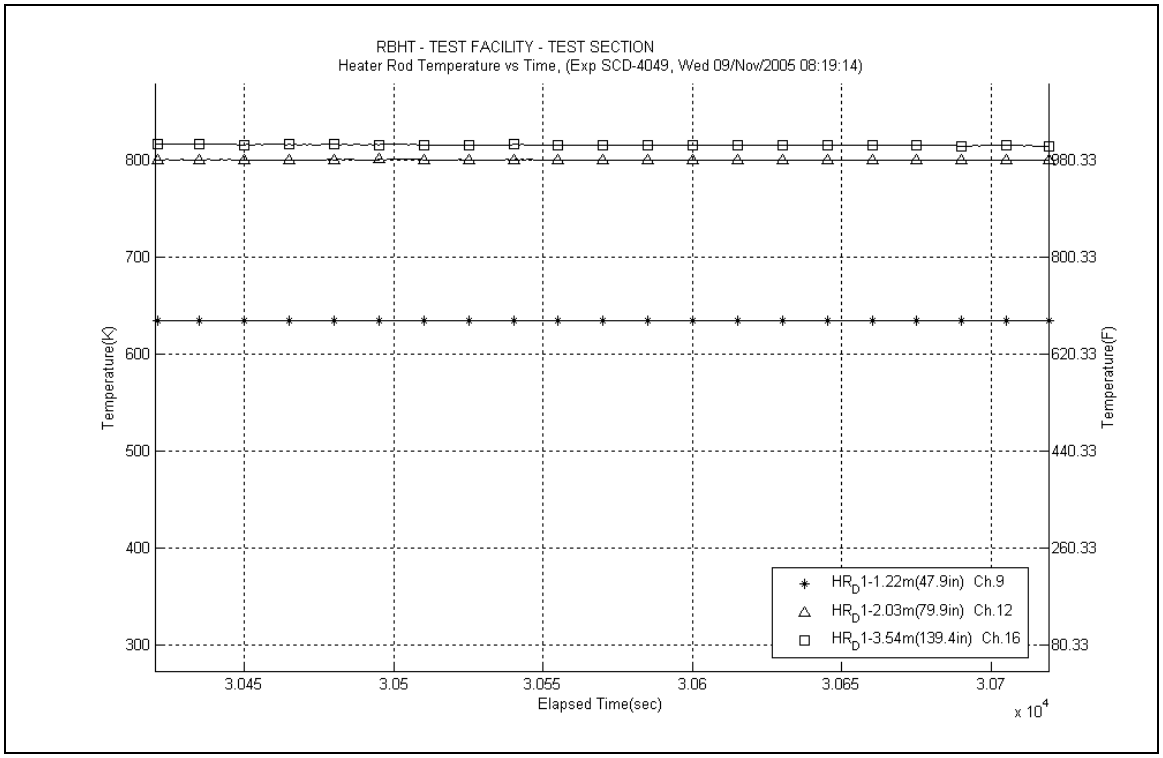

Figure A-275: Heater Rod D1 Temperatures for Experiment 4049K

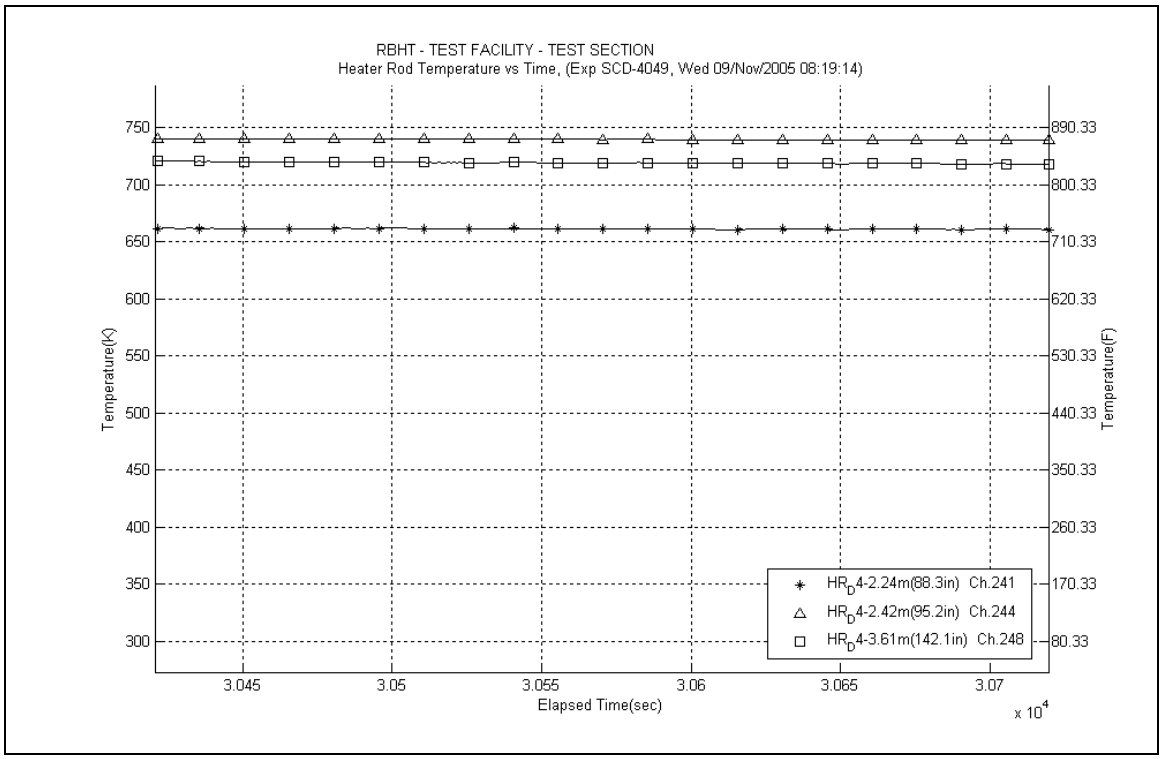

Figure A-276: Heater Rod D4 Temperatures for Experiment 4049K

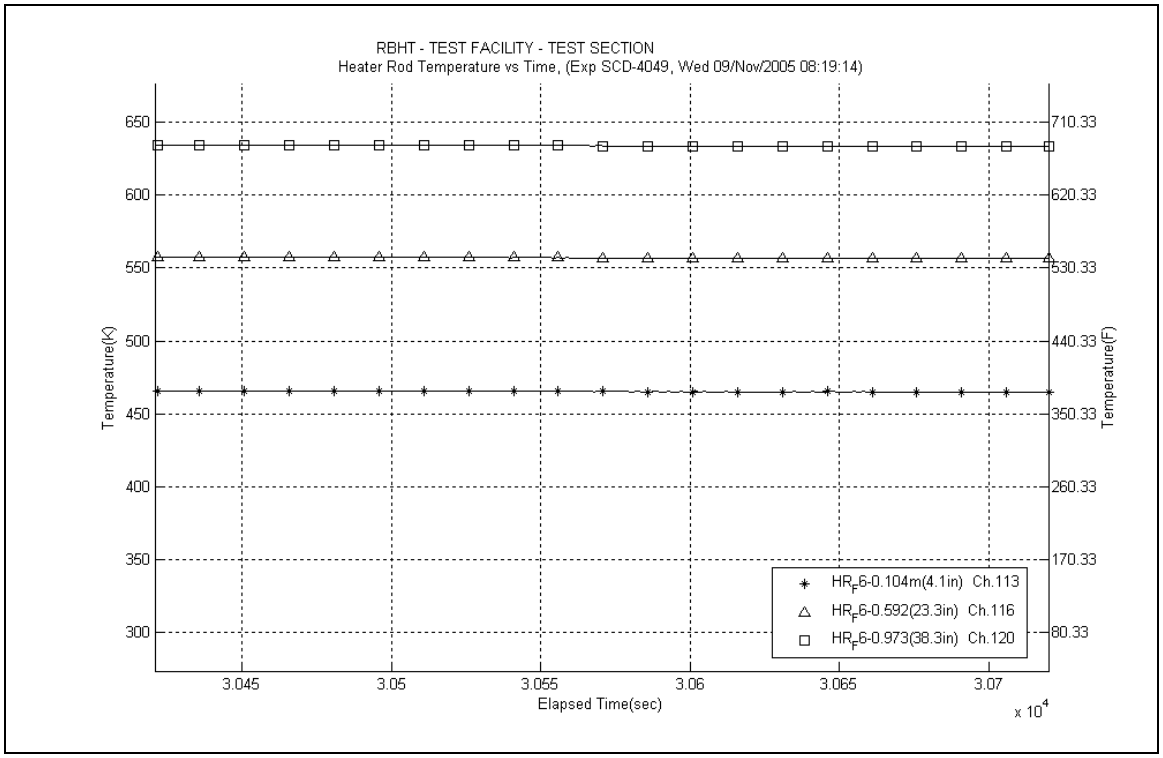

Figure A-277: Heater Rod F6 Temperatures for Experiment 4049K

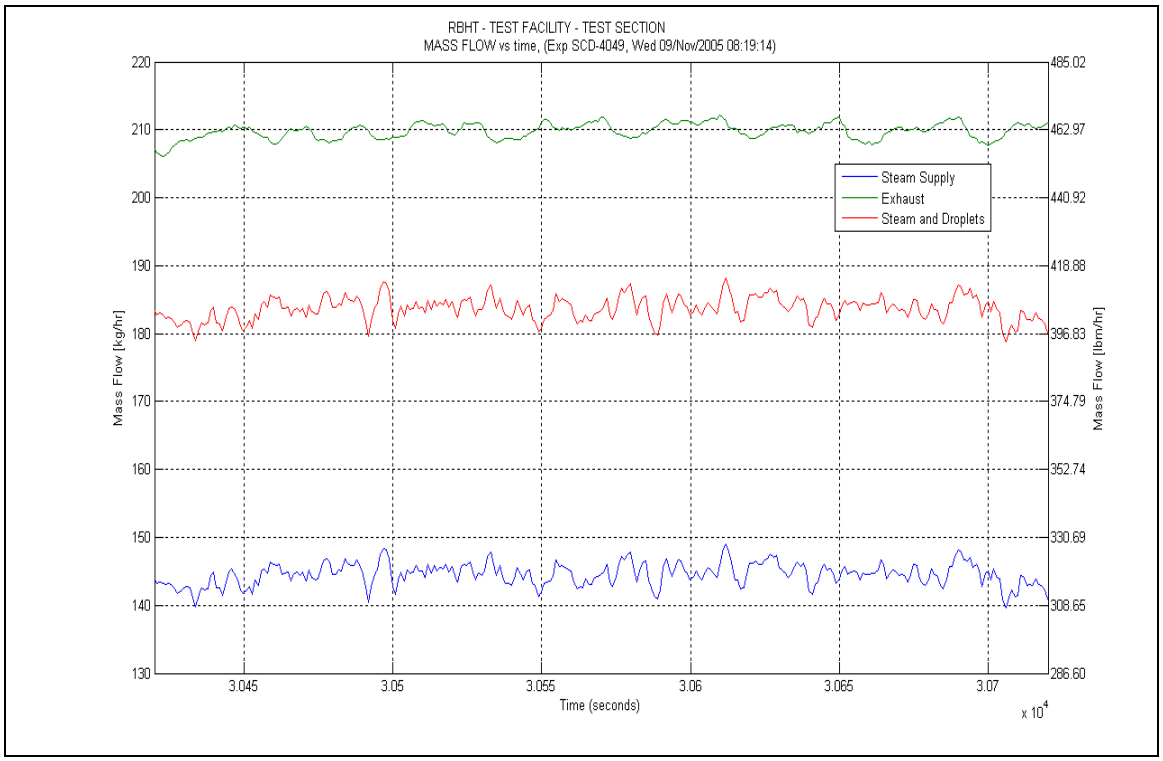

Figure A-278: Mass Flow for Experiment 4049K

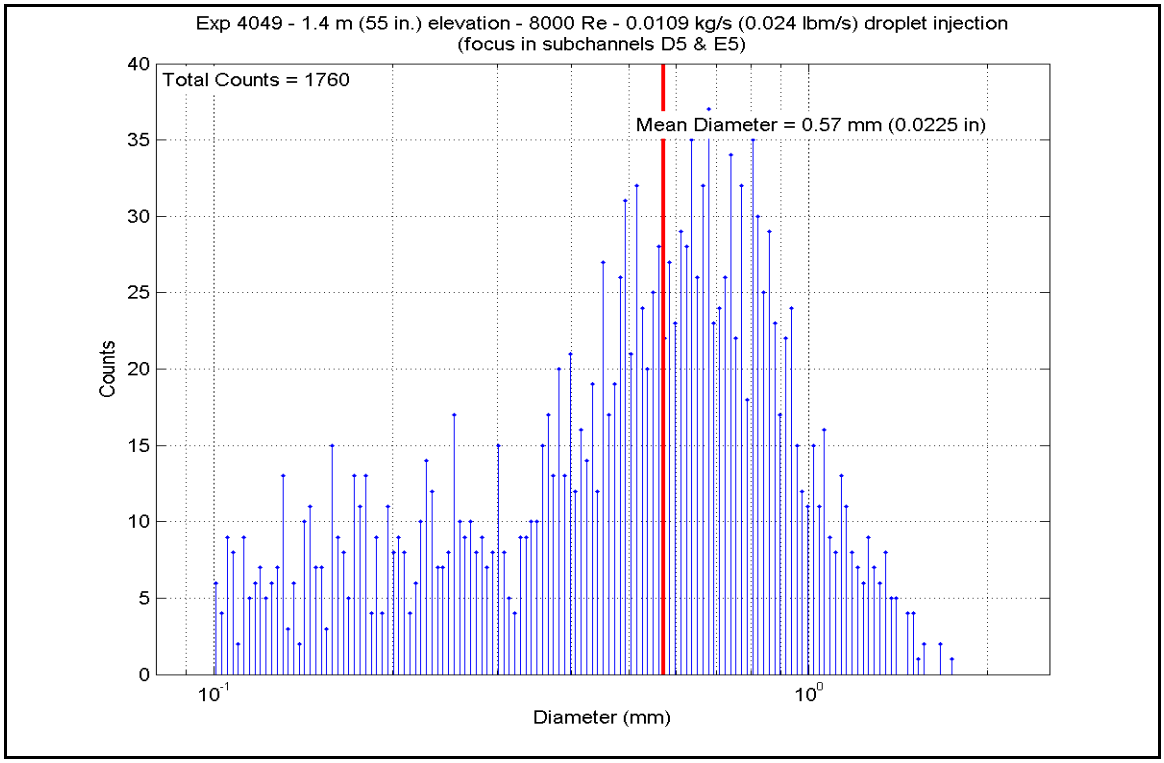

Figure A-279: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049K

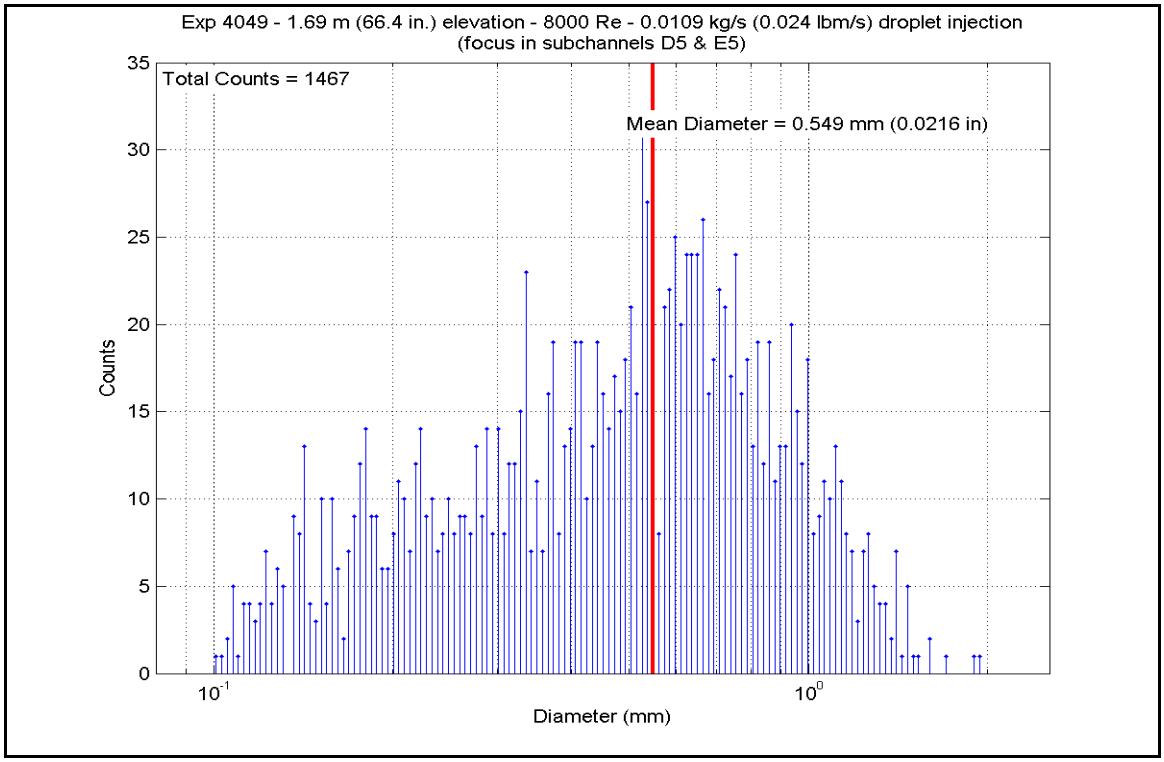

Figure A-280: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049K

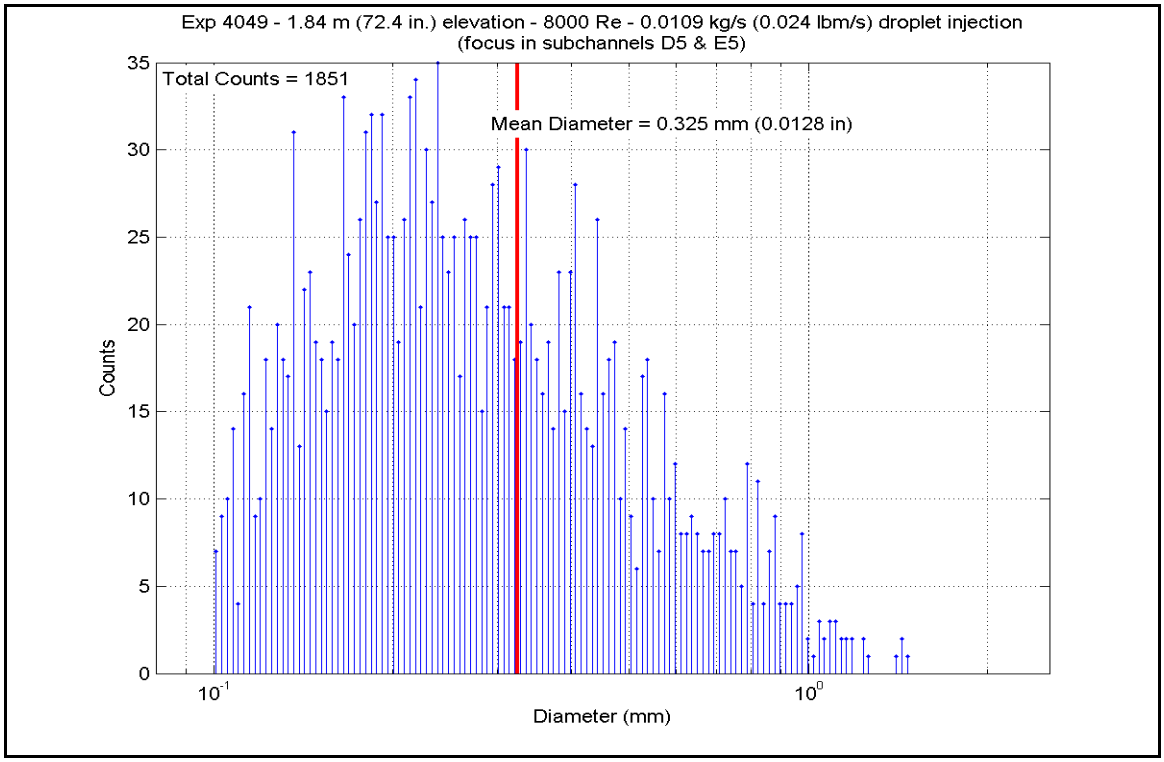

Figure A-281: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049K

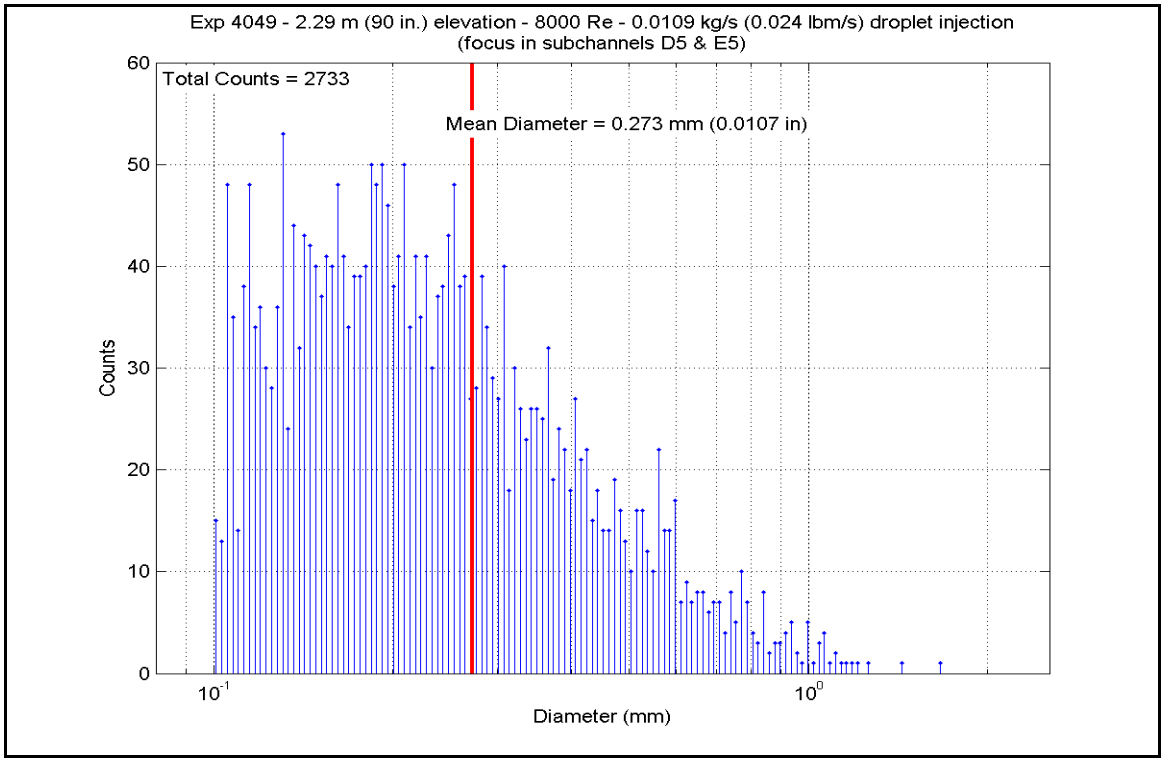

Figure A-282: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049K

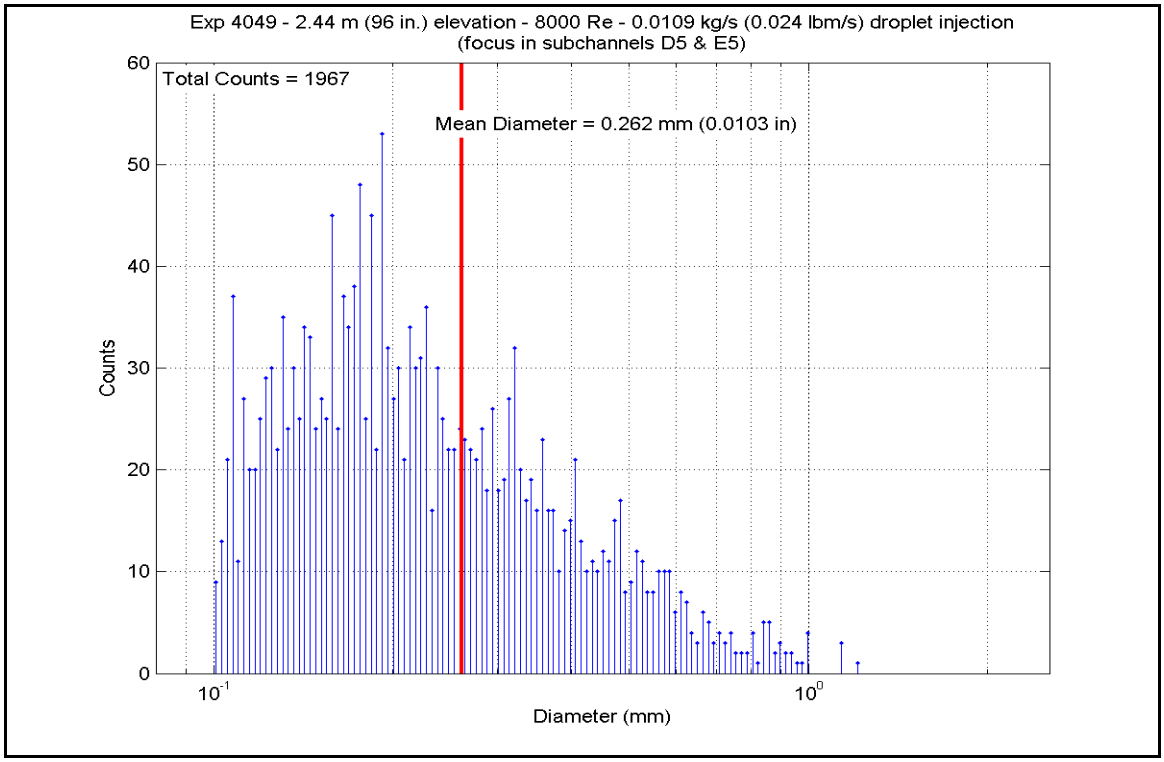

Figure A-283: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049K

Table A-54: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049K

SCD-4049-K	Inlet Reynolds:	8000		
Matrix Test # 4c	UP Pressure:	137.9 kPa	20	psia
Time Window: 30420-30720	Bundle Power:	65.00 kW	221789	Btu/hr
	Steam flow:	0.0401 kg/s	318.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	767.92	682.0	5573.22	17580.7	10.322	58.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	850.81	728.0	5679.48	17915.9	9.119	51.8
	RodD3_93.1	187	93.1	2.365	4.6	0.117	848.93	727.0	5755.58	18156.0	9.269	52.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	893.97	752.0	5838.93	18418.9	8.768	49.8
	RodD3_100.1	189	100.1	2.543	11.6	0.295	939.74	777.5	5962.84	18809.8	8.378	47.6
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1033.49	829.5	6191.28	19530.4	7.686	43.6
	RodD3_110	191	110	2.794	21.5	0.546	806.97	703.7	6127.05	19327.8	10.583	60.1
	RodD3_142.1	192	142.1	3.609	8.6	0.218	903.58	757.4	2241.08	7069.5	3.317	18.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	735.69	664.1	5555.91	17526.1	10.943	62.1
	RodC4_91.1	234	91.1	2.314	2.6	0.066	822.85	712.5	5663.96	17867.0	9.522	54.1
	RodC4_93.4	235	93.4	2.372	4.9	0.124	842.71	723.5	5756.65	18159.4	9.365	53.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	878.45	743.4	5832.60	18398.9	8.967	50.9
	RodC4_100.1	237	100.1	2.543	11.6	0.295	912.89	762.5	6010.90	18961.4	8.776	49.8
	RodC4_106.1	238	106.1	2.695	17.6	0.447	985.98	803.1	6268.05	19772.6	8.269	47.0
	RodC4_110	239	110	2.794	21.5	0.546	782.50	690.1	6096.54	19231.5	10.995	62.4
	RodC4_142.2	240	142.2	3.612	8.7	0.221	815.30	708.3	2340.32	7382.5	3.985	22.6
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	728.75	660.2	5537.27	17467.3	11.058	62.8
	RodD4_91.3	242	91.3	2.319	2.8	0.071	815.25	708.3	5657.27	17845.9	9.633	54.7
	RodD4_93.2	243	93.2	2.367	4.7	0.119	836.17	719.9	5733.47	18086.2	9.427	53.5
	RodD4_95.2	244	95.2	2.418	6.7	0.170	869.70	738.5	5811.75	18333.2	9.057	51.4
	RodD4_100.1	245	100.1	2.543	11.6	0.295	921.83	767.5	6009.51	18957.0	8.661	49.2
	RodD4_106.1	246	106.1	2.695	17.6	0.447	989.00	804.8	6247.49	19707.7	8.210	46.6
	RodD4_142.1	248	142.1	3.609	8.6	0.218	834.18	718.8	2258.05	7123.0	3.725	21.2
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	746.36	670.0	5555.71	17525.5	10.718	60.9
	RodE4_91.2	202	91.2	2.316	2.7	0.069	836.57	720.1	5645.17	17807.7	9.276	52.7
	RodE4_95.3	204	95.3	2.421	6.8	0.173	910.71	761.3	5796.98	18286.6	8.491	48.2
	RodE4_100.9	205	100.9	2.563	12.4	0.315	973.16	796.0	5931.13	18709.8	7.960	45.2
	RodE4_142.3	208	142.3	3.614	8.8	0.224	892.64	751.3	2404.00	7583.4	3.617	20.5

Table A-54: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	920.47	766.7	4544.97	14337.1	6.563	37.3
	RodE3_113.6	194	113.6	2.885	0.85	0.022	894.50	752.3	5573.85	17582.7	8.363	47.5
	RodE3_115.5	195	115.5	2.934	2.75	0.070	932.21	773.3	5459.03	17220.5	7.752	44.0
	RodE3_118.5	196	118.5	3.010	5.75	0.146	964.60	791.3	5129.66	16181.5	6.964	39.5
	RodE3_122.7	197	122.7	3.117	9.95	0.253	975.66	797.4	4681.24	14767.0	6.261	35.6
	RodE3_126.5	198	126.5	3.213	13.75	0.349	978.65	799.1	4269.93	13469.5	5.688	32.3
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	862.70	734.7	3877.31	12231.0	6.109	34.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	914.88	763.6	3353.77	10579.5	4.883	27.7
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	880.95	744.8	4430.25	13975.2	6.785	38.5
	RodC5_113.6	226	113.6	2.885	0.85	0.022	825.89	714.2	5439.69	17159.5	9.098	51.7
	RodC5_115.7	227	115.7	2.939	2.95	0.075	871.65	739.6	5218.96	16463.2	8.108	46.0
	RodC5_122.7	229	122.7	3.117	9.95	0.253	915.30	763.9	4501.68	14200.5	6.550	37.2
	RodC5_126.7	230	126.7	3.218	13.95	0.354	912.58	762.4	4090.58	12903.7	5.975	33.9
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	707.93	648.7	3610.56	11389.5	7.523	42.7
	RodC5_135.7	232	135.7	3.447	2.2	0.056	767.23	681.6	3175.20	10016.2	5.888	33.4
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	822.59	712.4	4546.25	14341.1	7.646	43.4
	RodE5_113.6	210	113.6	2.885	0.85	0.022	766.78	681.4	5623.28	17738.6	10.437	59.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	843.64	724.1	5421.62	17102.5	8.806	50.0
	RodE5_118.7	212	118.7	3.015	5.95	0.151	909.55	760.7	5065.92	15980.4	7.433	42.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	943.18	779.4	4649.43	14666.6	6.501	36.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	949.83	783.1	4224.53	13326.3	5.853	33.2
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1000.43	811.2	3657.55	11537.8	4.735	26.9
	RodE5_135.6	216	135.6	3.444	2.1	0.053	867.77	737.5	3255.02	10268.0	5.088	28.9
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	881.08	744.9	5204.62	16418.0	7.969	45.3
	RodC3_85.6	178	85.6	2.174	14.72	0.374	725.19	658.3	5467.20	17246.3	10.996	62.4
	RodC3_88.5	179	88.5	2.248	0	0.000	762.31	678.9	5551.69	17512.8	10.390	59.0
	RodC3_92.4	180	92.4	2.347	3.9	0.099	870.18	738.8	5702.03	17987.0	8.879	50.4
	RodC3_94.4	181	94.4	2.398	5.9	0.150	885.47	747.3	5781.47	18237.7	8.794	49.9
	RodC3_97.2	182	97.2	2.469	8.7	0.221	939.94	777.6	5808.55	18323.1	8.159	46.3
	RodC3_108.8	183	108.8	2.764	20.3	0.516	997.67	809.6	6126.82	19327.1	7.960	45.2
Gr-8	RodD5_50	217	50	1.270	3	0.076	784.57	691.2	4013.66	12661.1	7.211	41.0
	RodD5_54.1	218	54.1	1.374	7.1	0.180	780.97	689.2	4158.36	13117.5	7.520	42.7
	RodD5_56.9	219	56.9	1.445	9.9	0.251	821.66	711.8	4280.33	13502.3	7.210	40.9
	RodD5_60	220	60	1.524	13	0.330	855.53	730.7	4402.04	13886.2	7.015	39.8
	RodD5_66.1	221	66.1	1.679	19.1	0.485	888.17	748.8	4638.77	14633.0	7.027	39.9
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	720.11	655.4	4781.96	15084.7	9.717	55.2
	RodD5_72.9	223	72.9	1.852	2.02	0.051	792.06	695.4	4894.25	15438.9	8.677	49.3
	RodD5_74.9	224	74.9	1.902	4.02	0.102	834.19	718.8	4971.06	15681.2	8.200	46.6

Table A-54: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	718.03	654.3	3648.92	11510.5	7.446	42.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	779.55	688.5	4109.64	12963.9	7.451	42.3
	RodB5_55	155	55	1.397	8	0.203	814.98	708.1	4183.13	13195.7	7.126	40.5
	RodB5_57.8	156	57.8	1.468	10.8	0.274	850.04	727.6	4325.45	13644.6	6.954	39.5
	RodB5_64	157	64	1.626	17	0.432	887.93	748.7	4549.64	14351.8	6.894	39.2
	RodB5_73.9	158	73.9	1.877	3.02	0.077	838.47	721.2	4993.03	15750.5	8.179	46.4
	RodB5_75.9	159	75.9	1.928	5.02	0.128	871.04	739.3	5068.87	15989.7	7.883	44.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	883.50	746.2	5107.46	16111.5	7.792	44.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	717.83	654.2	3624.83	11434.5	7.400	42.0
	RodF5_53.1	106	53.1	1.349	6.1	0.155	773.36	685.0	4094.35	12915.6	7.508	42.6
	RodF5_55	107	55	1.397	8	0.203	806.30	703.3	4167.46	13146.2	7.206	40.9
	RodF5_57.8	108	57.8	1.468	10.8	0.274	847.19	726.0	4277.11	13492.2	6.908	39.2
	RodF5_64	109	64	1.626	17	0.432	890.47	750.1	4518.17	14252.6	6.820	38.7
	RodF5_73.8	110	73.8	1.875	2.92	0.074	823.78	713.0	4906.32	15477.0	8.235	46.8
	RodF5_75.8	111	75.8	1.925	4.92	0.125	862.38	734.5	4983.14	15719.3	7.855	44.6
	RodF5_76.8	112	76.8	1.951	5.92	0.150	878.63	743.5	5021.60	15840.6	7.718	43.8
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	717.21	653.8	3640.52	11484.0	7.442	42.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	830.60	716.8	4110.21	12965.7	6.821	38.7
	RodC2_55	59	55	1.397	8	0.203	849.14	727.1	4184.32	13199.4	6.736	38.3
	RodC2_57.8	60	57.8	1.468	10.8	0.274	879.86	744.2	4293.56	13544.0	6.587	37.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	911.86	762.0	4532.51	14297.8	6.628	37.6
	RodC2_73.8	62	73.8	1.875	2.92	0.074	876.67	742.4	4910.48	15490.1	7.570	43.0
	RodC2_75.8	63	75.8	1.925	4.92	0.125	905.40	758.4	4992.08	15747.5	7.370	41.9
	RodC2_76.8	64	76.8	1.951	5.92	0.150	917.34	765.0	5030.31	15868.1	7.297	41.4
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	720.30	655.5	3625.16	11435.6	7.364	41.8
	RodC6_52.8	138	52.8	1.341	5.8	0.147	825.60	714.0	4106.12	12952.8	6.871	39.0
	RodC6_54.8	139	54.8	1.392	7.8	0.198	847.35	726.1	4189.11	13214.6	6.764	38.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	879.13	743.8	4311.08	13599.3	6.621	37.6
	RodC6_63.8	141	63.8	1.621	16.8	0.427	911.03	761.5	4548.57	14348.5	6.659	37.8
	RodC6_73.7	142	73.7	1.872	2.82	0.072	884.48	746.8	4971.52	15682.7	7.573	43.0
	RodC6_75.8	143	75.8	1.925	4.92	0.125	911.53	761.8	5058.10	15955.8	7.400	42.0
	RodC6_76.8	144	76.8	1.951	5.92	0.150	927.27	770.5	5099.62	16086.7	7.293	41.4

Table A-54: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	744.53	669.0	5537.66	17468.6	10.721	60.9
	RodB4_91.3	162	91.3	2.319	2.8	0.071	830.55	716.8	5628.09	17753.8	9.340	53.0
	RodB4_93.3	163	93.3	2.370	4.8	0.122	844.42	724.5	5702.36	17988.1	9.251	52.5
	RodB4_95.1	164	95.1	2.416	6.6	0.168	873.75	740.8	5770.79	18204.0	8.937	50.7
	RodB4_100	165	100	2.540	11.5	0.292	917.23	764.9	5892.03	18586.4	8.549	48.5
	RodB4_106	166	106	2.692	17.5	0.445	988.92	804.8	6119.08	19302.6	8.042	45.7
	RodB4_109.9	167	109.9	2.791	21.4	0.544	783.11	690.4	5933.32	18716.7	10.689	60.7
	RodB4_142.3	168	142.3	3.614	8.8	0.224	832.65	718.0	2432.38	7672.9	4.023	22.8
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	813.16	707.1	5392.91	17011.9	9.216	52.3
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	781.15	689.3	5492.93	17327.4	9.930	56.4
	RodF4_92.4	100	92.4	2.347	3.9	0.099	886.40	747.8	5644.00	17804.0	8.572	48.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	920.38	766.7	5716.42	18032.5	8.256	46.9
	RodF4_97.2	102	97.2	2.469	8.7	0.221	962.21	789.9	5827.72	18383.5	7.937	45.1
	RodF4_108.8	103	108.8	2.764	20.3	0.516	993.36	807.2	6162.12	19438.4	8.051	45.7
	RodF4_111	104	111	2.819	-1.75	-0.044	791.21	694.9	5947.24	18760.6	10.559	60.0
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	987.29	803.9	5425.13	17113.6	7.145	40.6
	RodD2_106	66	106	2.692	17.5	0.445	1012.24	817.7	5141.39	16218.5	6.556	37.2
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1034.27	830.0	4752.82	14992.8	5.895	33.5
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1040.49	833.4	4297.06	13555.1	5.289	30.0
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1019.06	821.5	3861.09	12179.8	4.881	27.7
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1076.57	853.5	6085.13	19195.5	7.171	40.7
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1098.46	865.6	6194.59	19540.8	7.116	40.4
	RodD2_128.6	72	128.6	3.266	15.85	0.403	938.75	776.9	5686.11	17936.8	8.000	45.4
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1045.92	836.4	6103.61	19253.8	7.462	42.4
	RodD6_106	130	106	2.692	17.5	0.445	1055.05	841.5	6216.81	19610.9	7.517	42.7
	RodD6_112.9	131	112.9	2.868	0.15	0.004	869.36	738.3	5675.43	17903.1	8.849	50.3
	RodD6_114.9	132	114.9	2.918	2.15	0.055	926.27	770.0	5448.44	17187.1	7.803	44.3
	RodD6_116.8	133	116.8	2.967	4.05	0.103	957.13	787.1	5230.32	16499.0	7.173	40.7
	RodD6_120.9	134	120.9	3.071	8.15	0.207	970.37	794.5	4808.25	15167.6	6.477	36.8
	RodD6_124.8	135	124.8	3.170	12.05	0.306	972.72	795.8	4356.23	13741.7	5.850	33.2
	RodD6_128.7	136	128.7	3.269	15.95	0.405	958.04	787.6	3906.16	12322.0	5.351	30.4

Table A-54: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	772.41	684.5	4023.57	12692.4	7.391	42.0
	RodE2_54	74	54	1.372	7	0.178	834.67	719.1	4176.57	13175.0	6.884	39.1
	RodE2_56.9	75	56.9	1.445	9.9	0.251	867.96	737.6	4291.02	13536.0	6.705	38.1
	RodE2_59.9	76	59.9	1.521	12.9	0.328	901.49	756.2	4408.48	13906.6	6.546	37.2
	RodE2_66	77	66	1.676	19	0.483	923.75	768.6	4648.91	14665.0	6.682	37.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	825.63	714.1	4801.69	15146.9	8.034	45.6
	RodE2_72.9	79	72.9	1.852	2.02	0.051	884.20	746.6	4920.41	15521.4	7.498	42.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	911.46	761.7	4998.60	15768.1	7.314	41.5
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	727.30	659.4	4004.68	12632.8	8.021	45.5
	RodB3_54.1	170	54.1	1.374	7.1	0.180	799.05	699.3	4155.51	13108.5	7.277	41.3
	RodB3_56.9	171	56.9	1.445	9.9	0.251	840.69	722.4	4264.35	13451.9	6.960	39.5
	RodB3_60.1	172	60.1	1.527	13.1	0.333	838.88	721.4	4404.53	13894.1	7.210	40.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	876.15	742.1	4651.52	14673.2	7.177	40.8
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	743.29	668.3	4839.27	15265.5	9.391	53.3
	RodB3_73	175	73	1.854	2.12	0.054	811.67	706.3	4936.44	15572.0	8.458	48.0
	RodB3_75	176	75	1.905	4.12	0.105	847.09	726.0	5012.45	15811.8	8.097	46.0
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	747.47	670.6	4002.18	12624.9	7.704	43.8
	RodF3_54	90	54	1.372	7	0.178	816.76	709.1	4156.35	13111.2	7.059	40.1
	RodF3_57	91	57	1.448	10	0.254	860.71	733.5	4275.43	13486.8	6.757	38.4
	RodF3_60	92	60	1.524	13	0.330	893.34	751.7	4394.45	13862.3	6.605	37.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	910.41	761.2	4639.27	14634.6	6.798	38.6
	RodF3_70	94	70	1.778	-0.88	-0.022	781.39	689.5	4801.78	15147.2	8.677	49.3
	RodF3_73	95	73	1.854	2.12	0.054	875.89	742.0	4910.74	15490.9	7.580	43.0
	RodF3_75	96	75	1.905	4.12	0.105	912.78	762.5	4989.19	15738.4	7.286	41.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	757.79	676.4	3999.70	12617.0	7.550	42.9
	RodE6_54.1	122	54.1	1.374	7.1	0.180	816.03	708.7	4148.77	13087.3	7.055	40.1
	RodE6_57	123	57	1.448	10	0.254	846.66	725.7	4260.46	13439.6	6.887	39.1
	RodE6_60.2	124	60.2	1.529	13.2	0.335	873.63	740.7	4384.32	13830.4	6.791	38.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	892.05	751.0	4611.16	14545.9	6.944	39.4
	RodE6_70	126	70	1.778	-0.88	-0.022	792.64	695.7	4765.21	15031.9	8.439	47.9
	RodE6_73.1	127	73.1	1.857	2.22	0.056	853.64	729.6	4884.63	15408.6	7.807	44.3
	RodE6_75	128	75	1.905	4.12	0.105	884.79	746.9	4956.58	15635.5	7.547	42.9

RBHT Steam Cooling with Droplet Injection Test SCD-4049-L

Matrix Test # 4d

Test Conditions

Test Date – 11/9/2005
Steady State Time Window: 31140 - 31440
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 65 kW
Bundle Inlet Reynolds Number: 8000
Bundle Inlet Steam Flow: 144.2 kg/hr (318 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

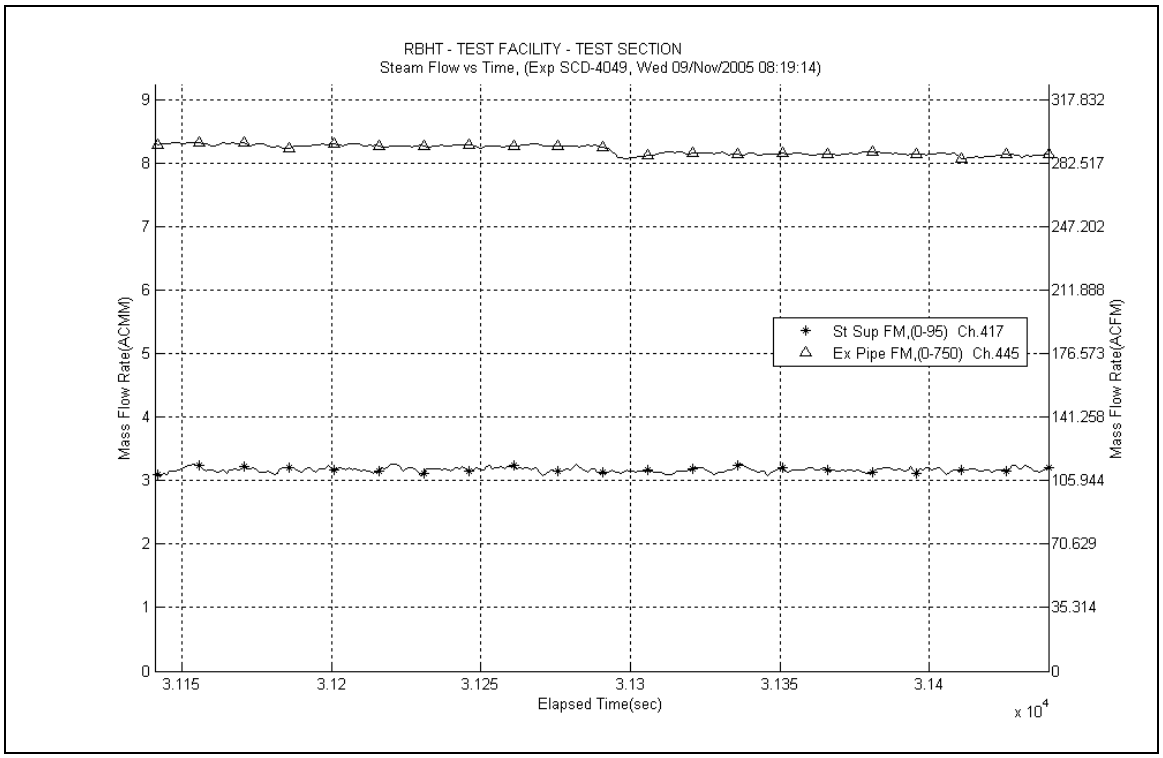

Figure A-284: Inlet and Exhaust Steam Flow Rates for Experiment 4049L

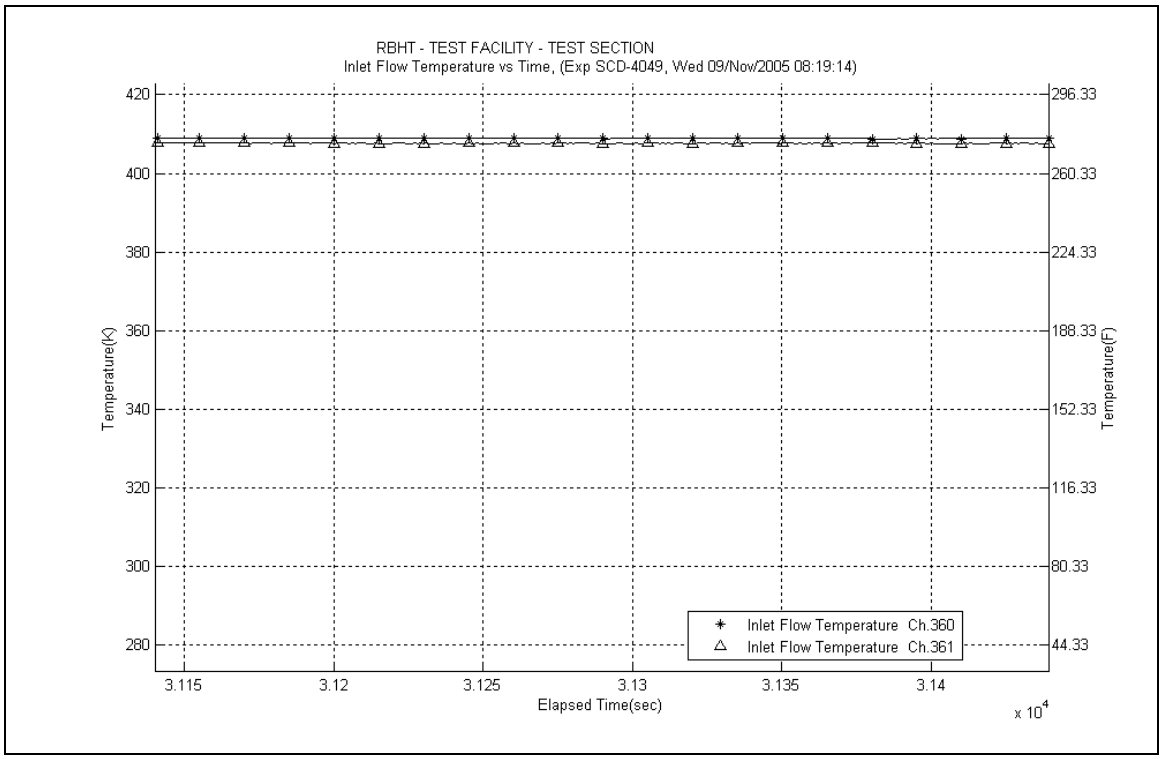

Figure A-285: Inlet Steam Temperature for Experiment 4049L

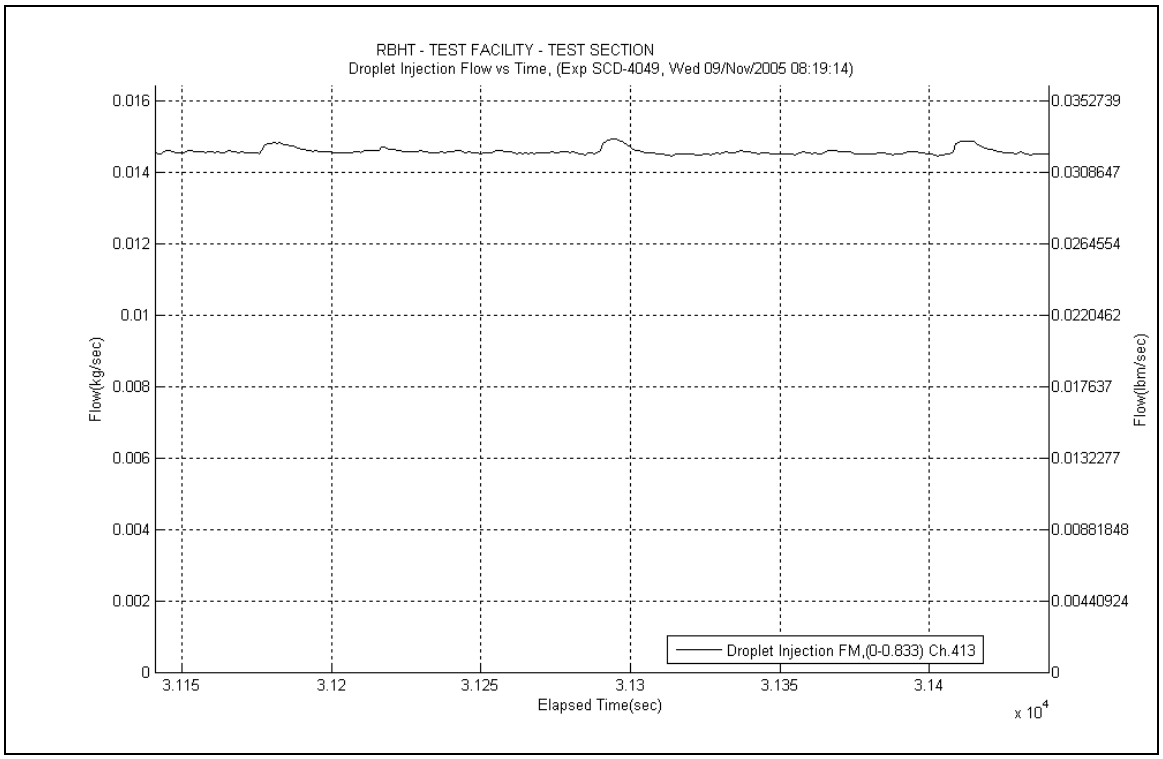

Figure A-286: Droplet Injection Flow Rate for Experiment 4049L

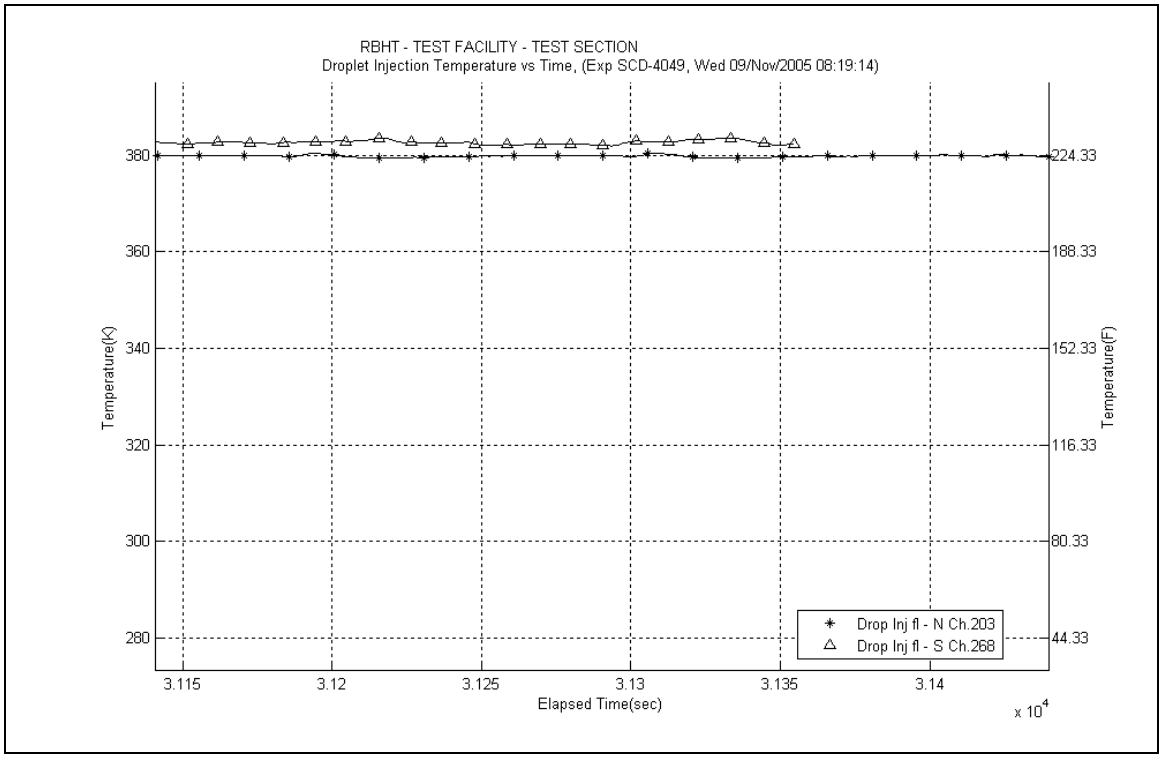

Figure A-287: Droplet Injection Temperature for Experiment 4049L

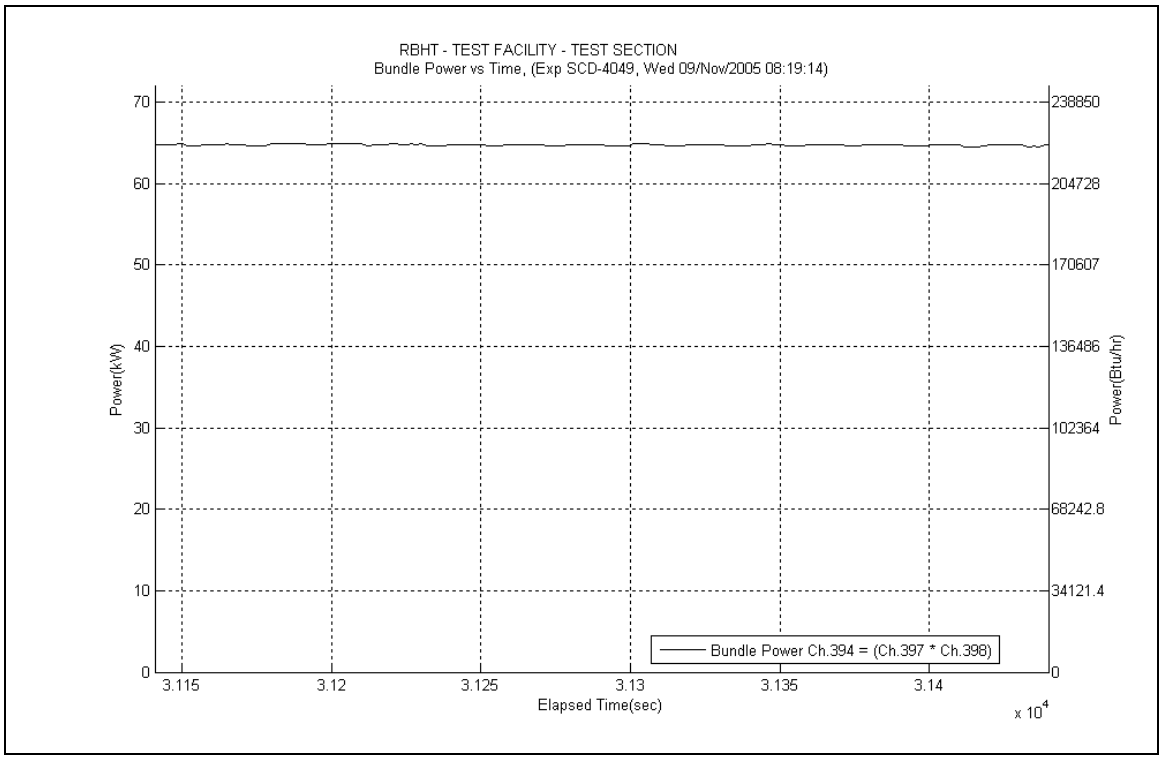

Figure A-288: Bundle Power for Experiment 4049L

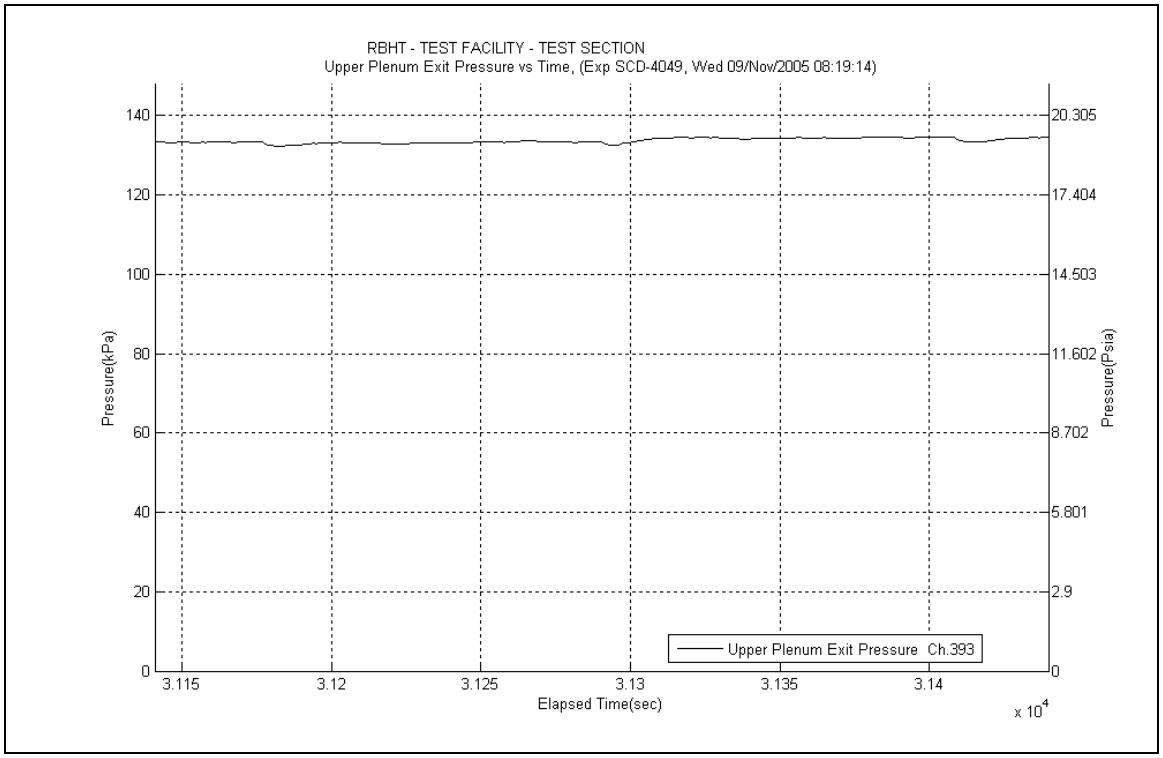

Figure A-289: Upper Plenum Pressure for Experiment 4049L

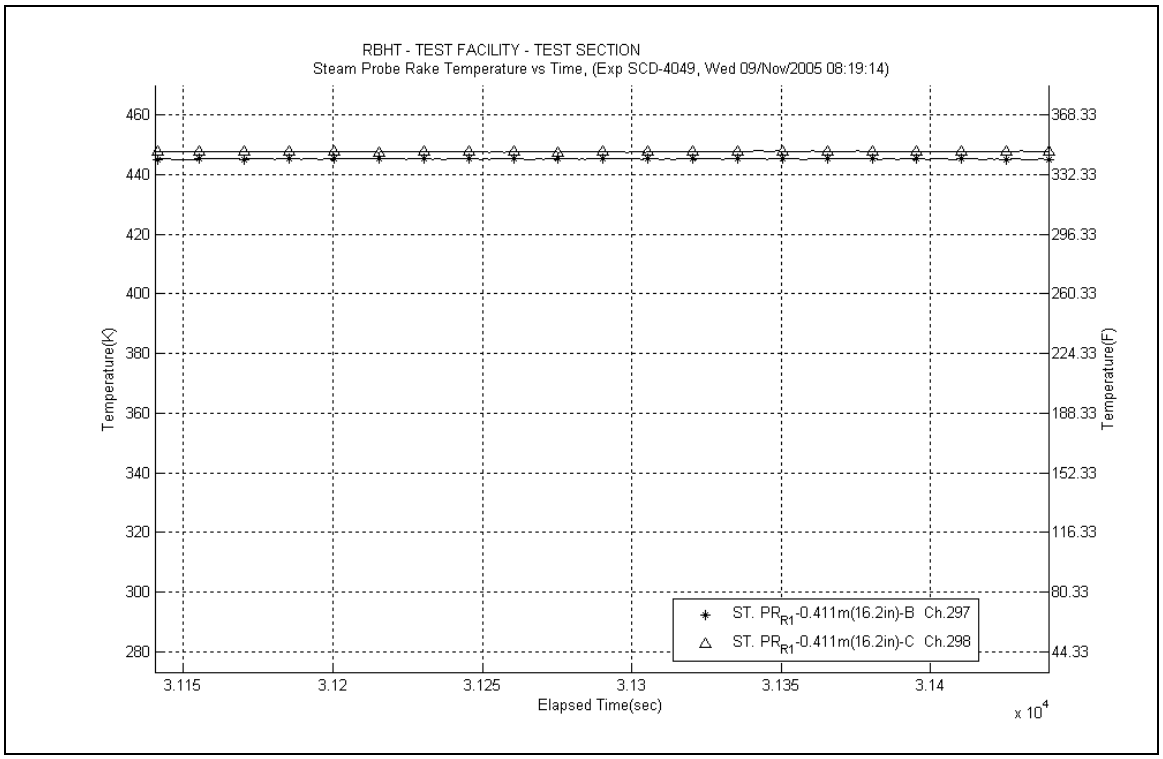

Figure A-290: Steam Probe Rake #1 Temperatures for Experiment 4049L

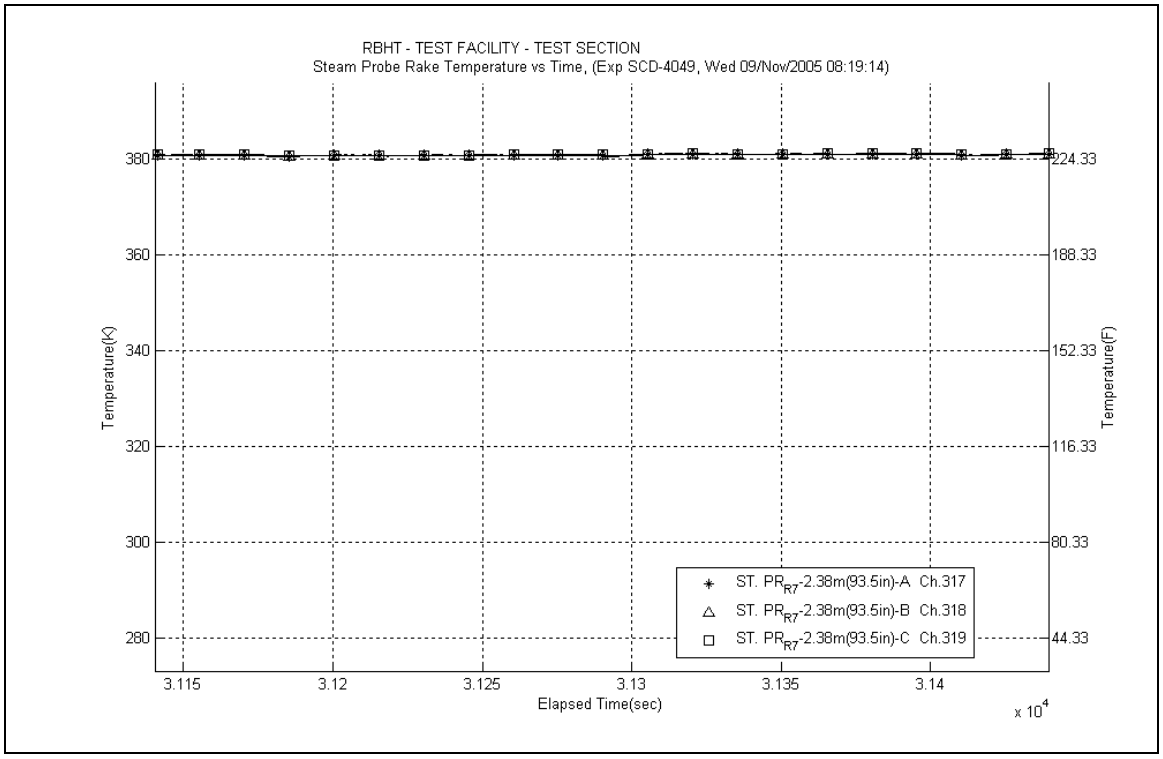

Figure A-291: Steam Probe Rake #7 Temperatures for Experiment 4049L

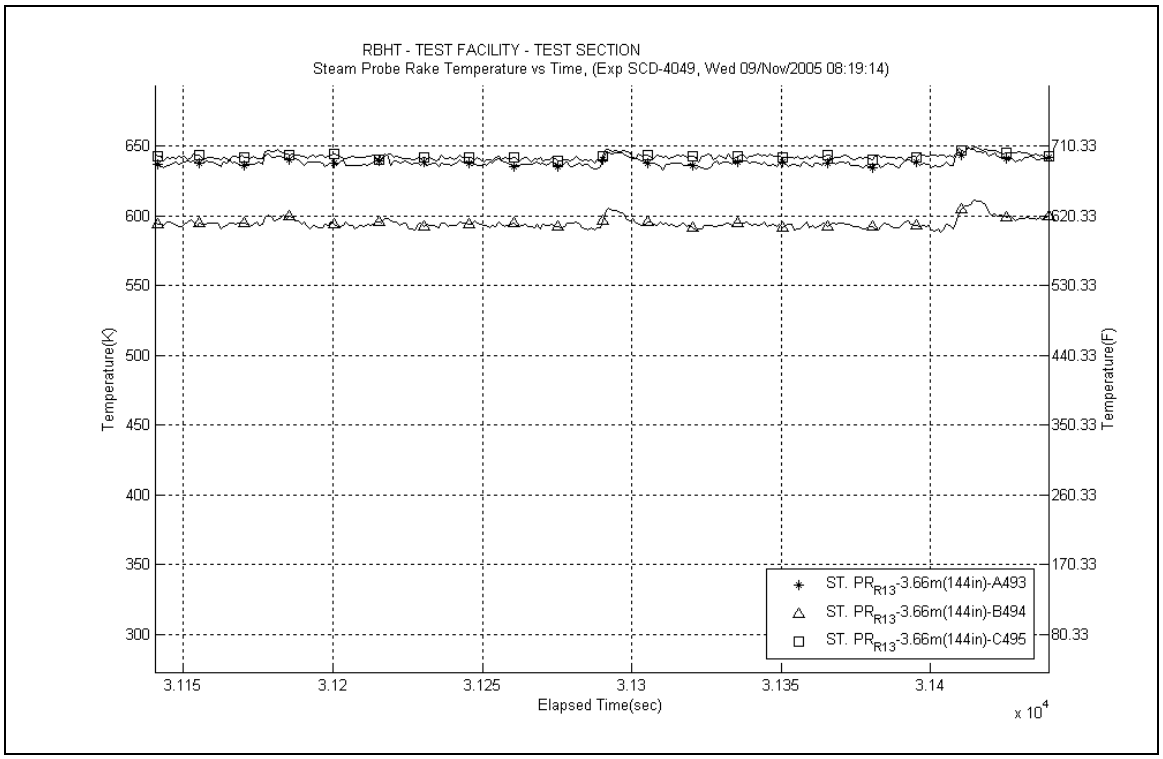

Figure A-292: Steam Probe Rake #13 Temperatures for Experiment 4049L

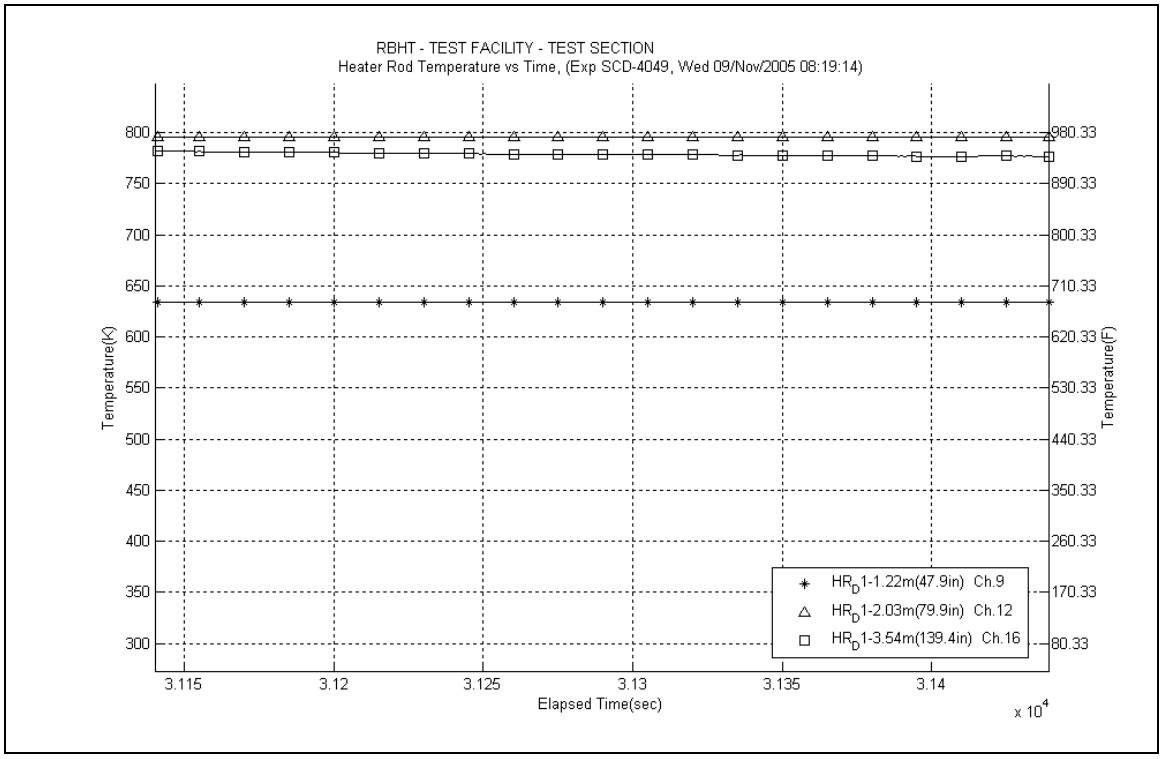

Figure A-293: Heater Rod D1 Temperatures for Experiment 4049L

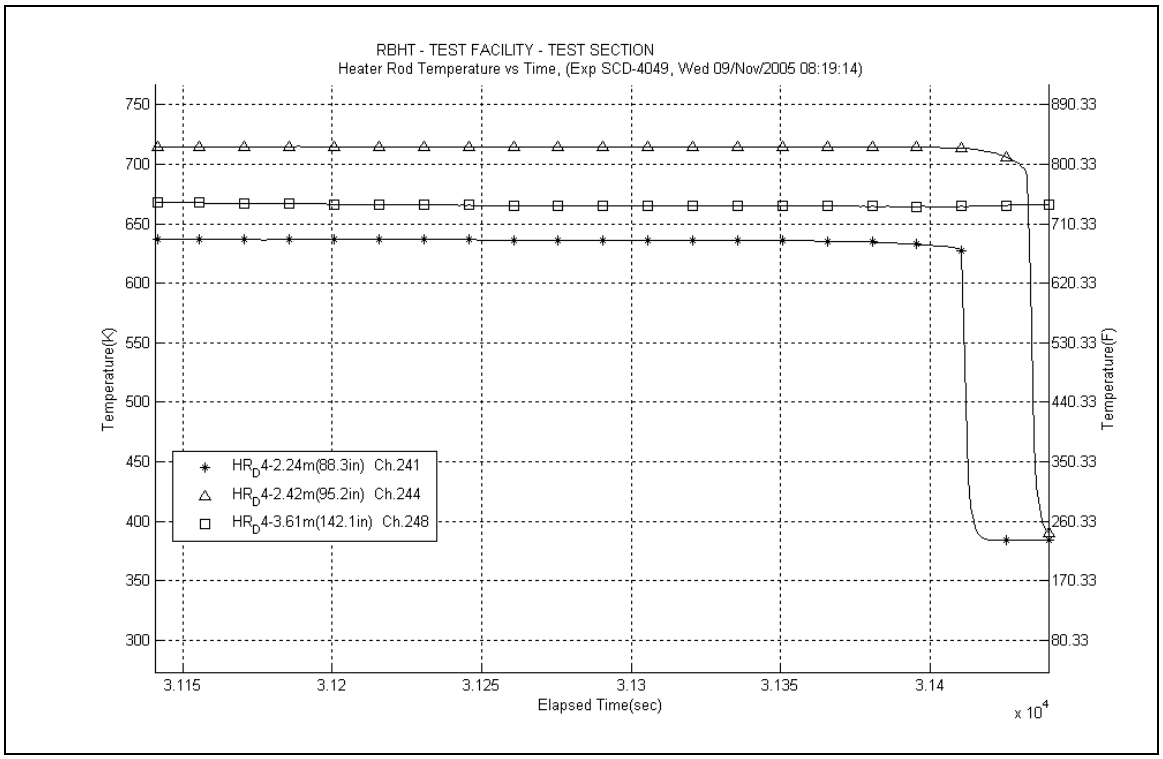

Figure A-294: Heater Rod D4 Temperatures for Experiment 4049L

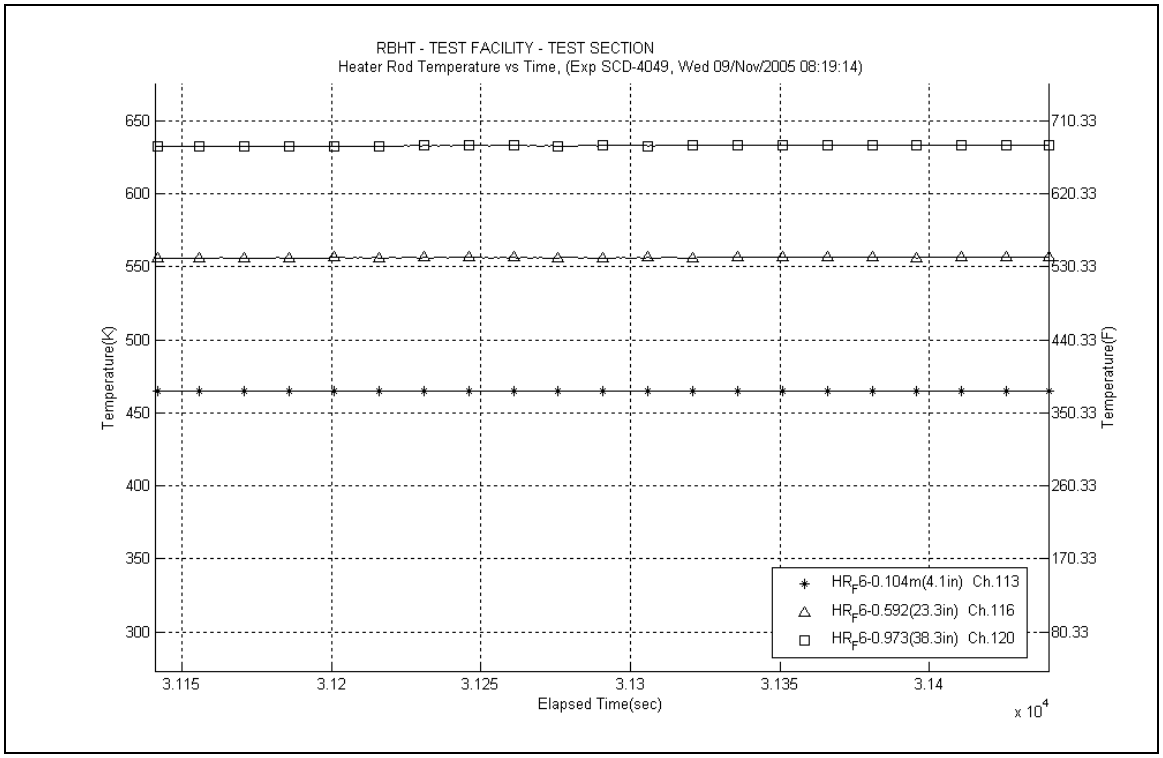

Figure A-295: Heater Rod F6 Temperatures for Experiment 4049L

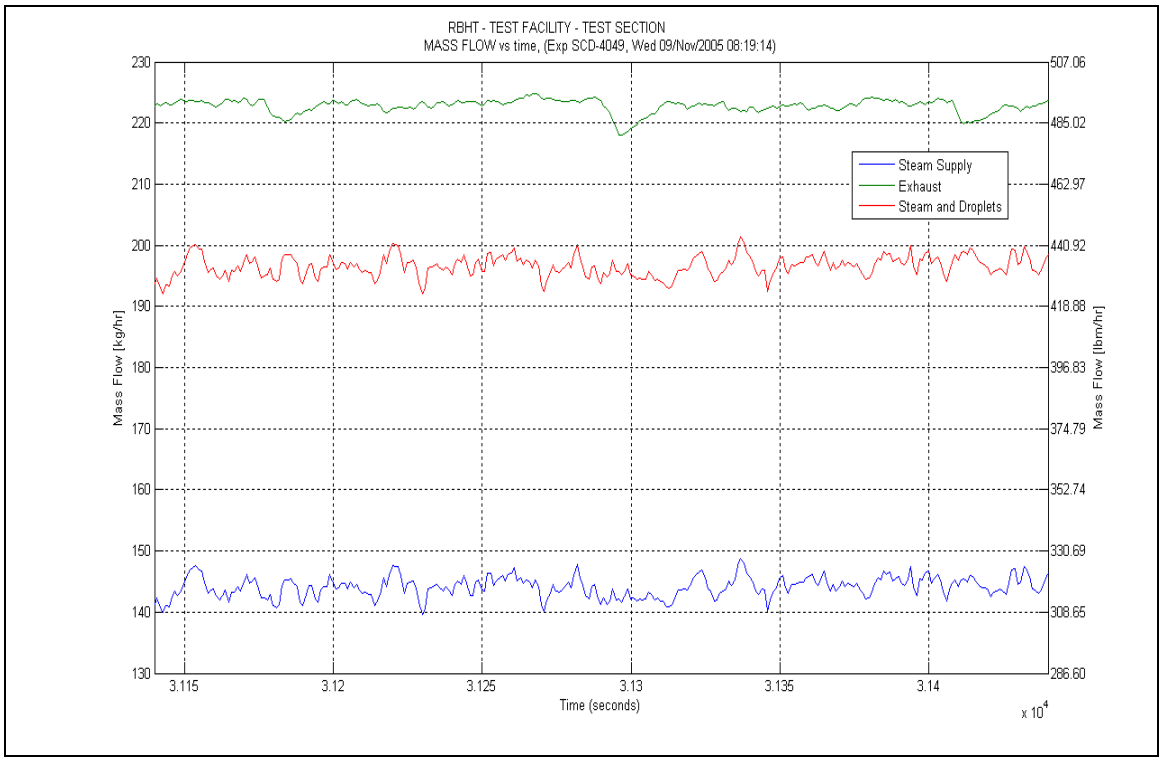

Figure A-296: Mass Flow for Experiment 4049L

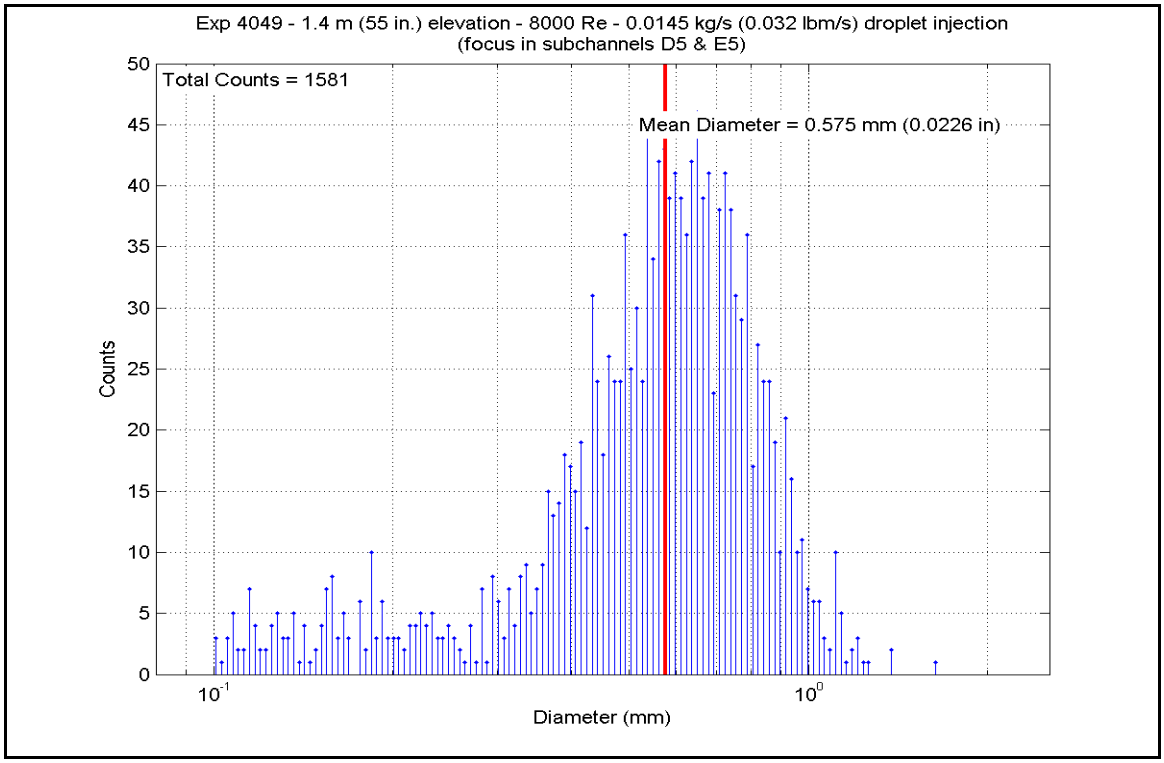

Figure A-297: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4049L

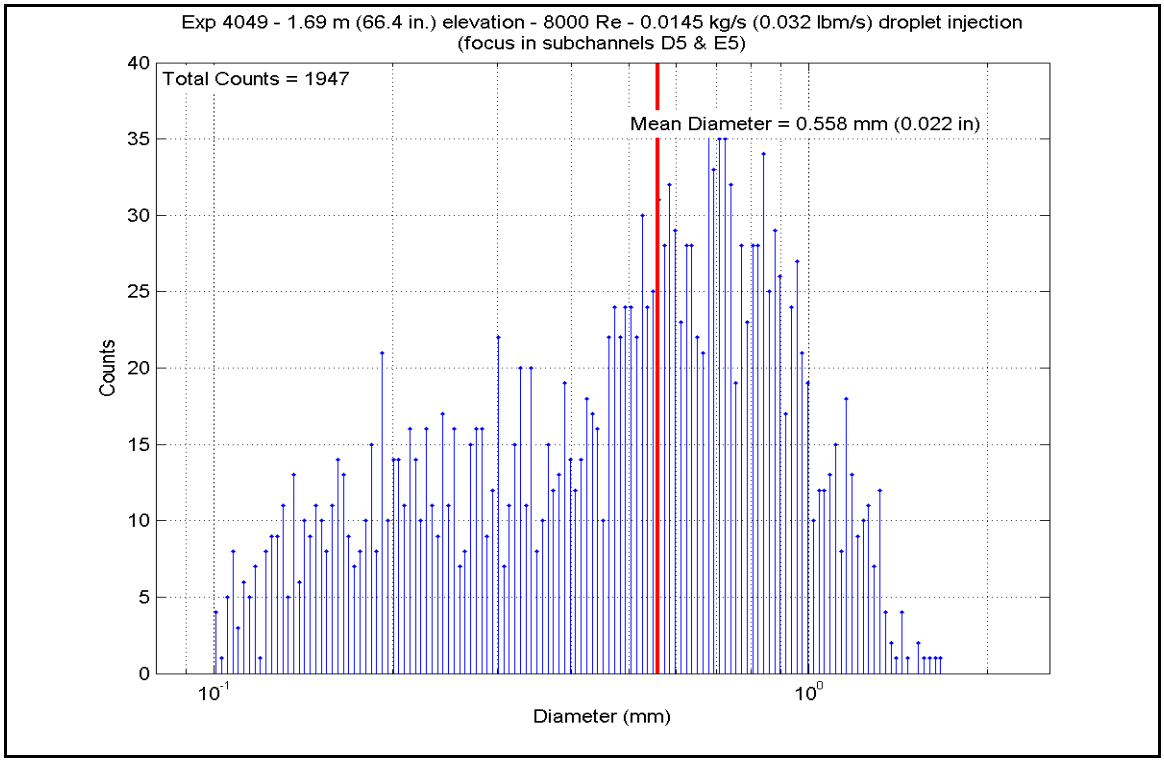

Figure A-298: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4049L

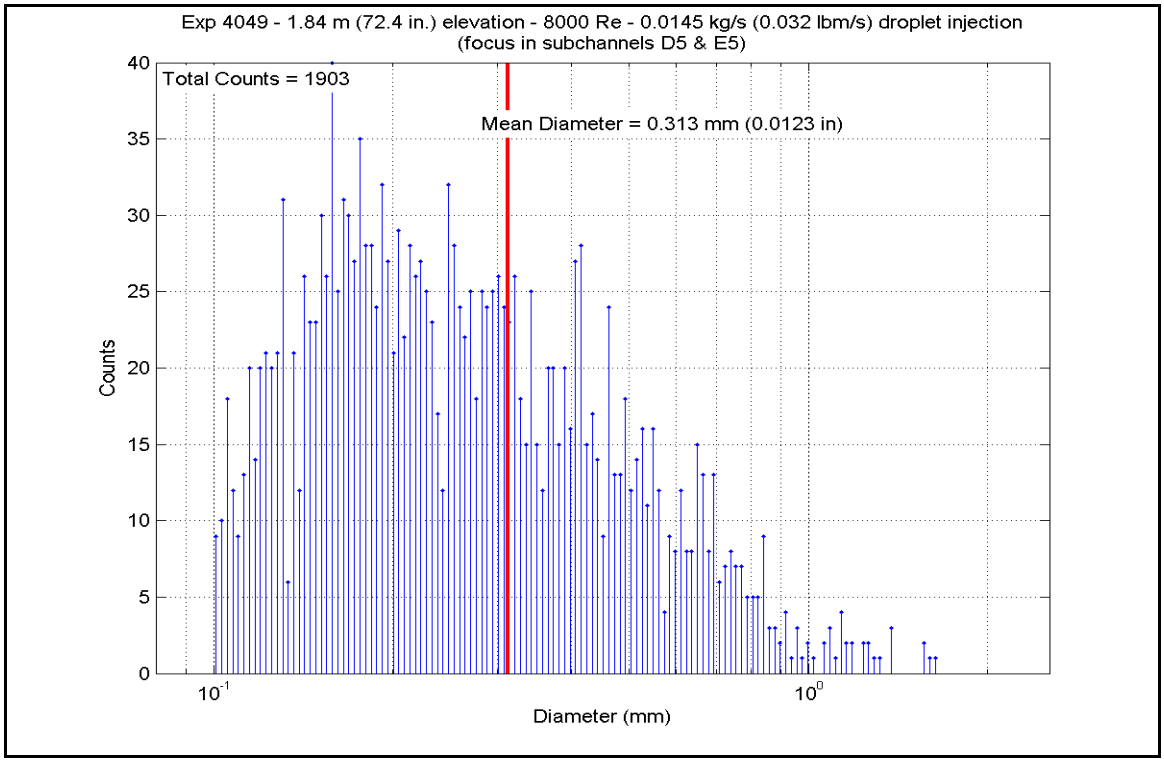

Figure A-299: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4049L

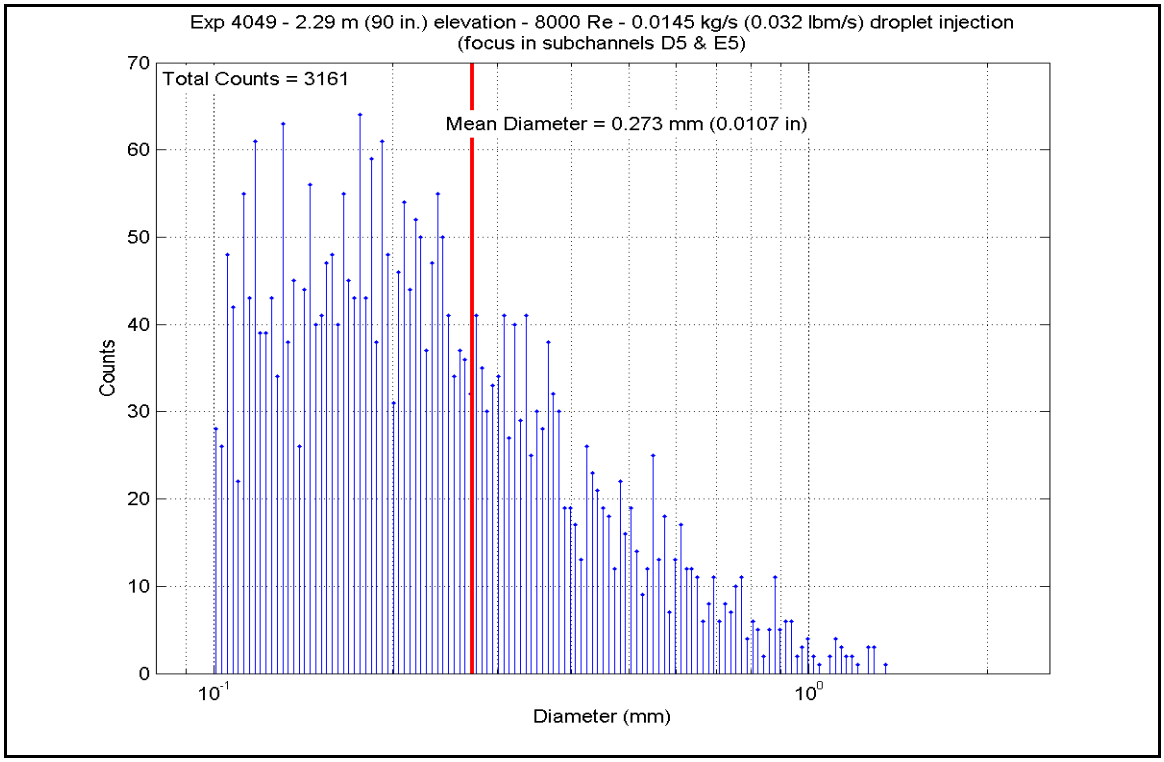

Figure A-300: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4049L

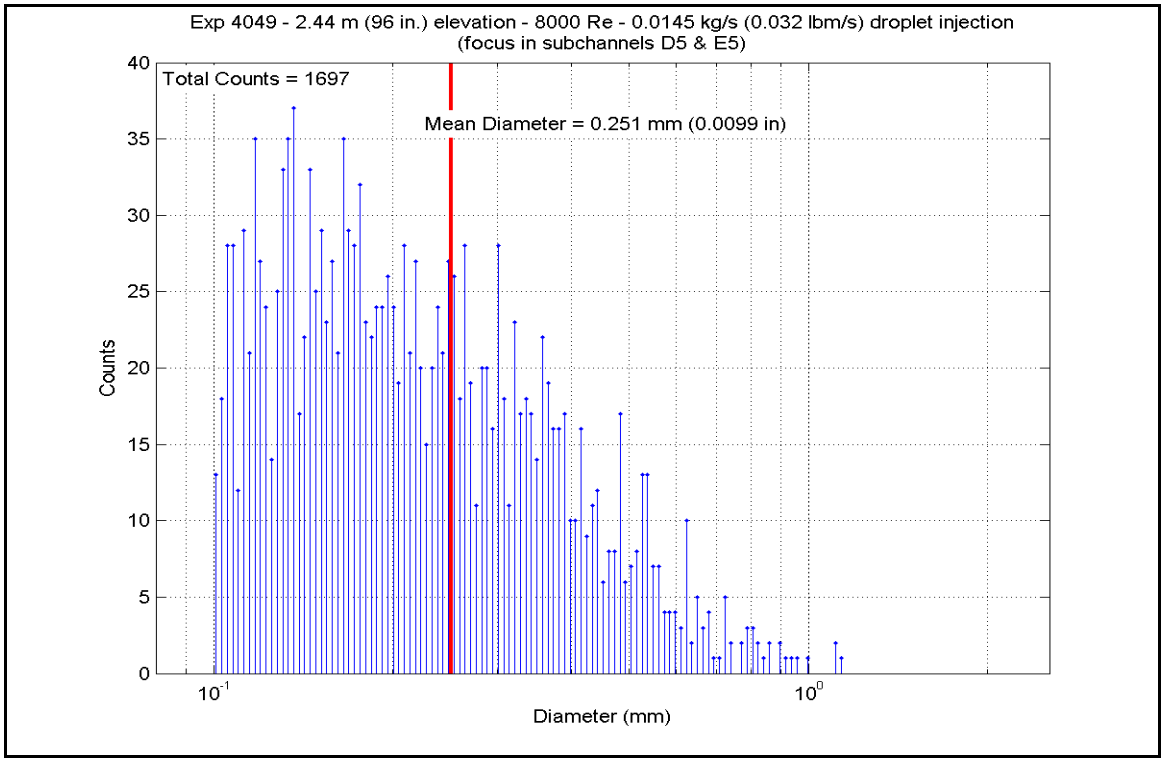

Figure A-301: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4049L

Table A-55: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049L

SCD-4049-L		Inlet Reynolds:	8000		
Matrix Test # 4d		UP Pressure:	137.9 kPa	20	psia
Time Window: 31140-31440		Bundle Power:	65.00 kW	221789	Btu/hr
		Steam flow:	0.0401 kg/s	318.0	lbm/hr
		Droplet flow:	0.0145 kg/s	0.032	lbm/s
Inner 3x3					

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	729.03	660.4	5531.88	17450.3	11.041	62.7
	RodD3_91.3	186	91.3	2.319	2.8	0.071	807.97	704.2	5639.87	17791.0	9.724	55.2
	RodD3_93.1	187	93.1	2.365	4.6	0.117	805.55	702.9	5709.64	18011.1	9.886	56.1
	RodD3_95.3	188	95.3	2.421	6.8	0.173	848.65	726.8	5797.83	18289.3	9.342	53.0
	RodD3_100.1	189	100.1	2.543	11.6	0.295	891.25	750.5	5971.44	18836.9	9.003	51.1
	RodD3_106.1	190	106.1	2.695	17.6	0.447	979.88	799.7	6216.26	19609.2	8.268	47.0
	RodD3_110	191	110	2.794	21.5	0.546	757.00	675.9	6113.35	19284.5	11.556	65.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	816.68	709.1	2213.39	6982.1	3.760	21.4
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	697.90	643.1	5570.24	17571.3	11.854	67.3
	RodC4_91.1	234	91.1	2.314	2.6	0.066	783.95	690.9	5681.58	17922.6	10.220	58.0
	RodC4_93.4	235	93.4	2.372	4.9	0.124	802.71	701.3	5759.50	18168.3	10.021	56.9
	RodC4_95.3	236	95.3	2.421	6.8	0.173	837.90	720.9	5843.76	18434.1	9.581	54.4
	RodC4_100.1	237	100.1	2.543	11.6	0.295	871.18	739.4	6032.50	19029.5	9.379	53.3
	RodC4_106.1	238	106.1	2.695	17.6	0.447	939.29	777.2	6267.38	19770.5	8.811	50.0
	RodC4_110	239	110	2.794	21.5	0.546	732.38	662.3	6021.64	18995.3	11.939	67.8
	RodC4_142.2	240	142.2	3.612	8.7	0.221	734.76	663.6	2407.75	7595.2	4.751	27.0
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	684.34	635.6	5554.10	17520.4	12.171	69.1
	RodD4_91.3	242	91.3	2.319	2.8	0.071	771.46	684.0	5666.25	17874.2	10.426	59.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	792.14	695.5	5742.48	18114.6	10.179	57.8
	RodD4_95.2	244	95.2	2.418	6.7	0.170	824.88	713.6	5829.25	18388.4	9.766	55.5
	RodD4_100.1	245	100.1	2.543	11.6	0.295	874.10	741.0	6014.37	18972.3	9.309	52.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	935.18	774.9	6251.12	19719.2	8.840	50.2
	RodD4_142.1	248	142.1	3.609	8.6	0.218	741.03	667.1	2340.13	7381.9	4.561	25.9
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	702.64	645.7	5484.75	17301.6	11.556	65.6
	RodE4_91.2	202	91.2	2.316	2.7	0.069	791.32	695.0	5574.99	17586.3	9.897	56.2
	RodE4_95.3	204	95.3	2.421	6.8	0.173	862.64	734.6	5740.19	18107.4	9.045	51.4
	RodE4_100.9	205	100.9	2.563	12.4	0.315	922.00	767.6	5929.61	18704.9	8.544	48.5
	RodE4_142.3	208	142.3	3.614	8.8	0.224	784.15	691.0	2330.88	7352.8	4.191	23.8

Table A-55: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	911.48	761.7	4521.31	14262.5	6.615	37.6
	RodE3_113.6	194	113.6	2.885	0.85	0.022	832.56	717.9	5586.87	17623.8	9.241	52.5
	RodE3_115.5	195	115.5	2.934	2.75	0.070	870.20	738.8	5398.43	17029.3	8.406	47.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	900.54	755.7	5070.48	15994.8	7.539	42.8
	RodE3_122.7	197	122.7	3.117	9.95	0.253	906.57	759.0	4625.67	14591.7	6.817	38.7
	RodE3_126.5	198	126.5	3.213	13.75	0.349	906.78	759.1	4215.10	13296.5	6.210	35.3
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	744.37	668.9	3661.83	11551.3	7.091	40.3
	RodE3_135.6	200	135.6	3.444	2.1	0.053	803.35	701.7	3219.39	10155.6	5.596	31.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	877.27	742.7	4432.56	13982.5	6.827	38.8
	RodC5_113.6	226	113.6	2.885	0.85	0.022	780.65	689.1	5446.42	17180.7	9.855	56.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	824.44	713.4	5247.06	16551.8	8.797	50.0
	RodC5_122.7	229	122.7	3.117	9.95	0.253	859.13	732.7	4537.25	14312.8	7.189	40.8
	RodC5_126.7	230	126.7	3.218	13.95	0.354	854.62	730.2	4134.18	13041.3	6.598	37.5
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	643.15	612.7	3616.04	11406.8	8.710	49.5
	RodC5_135.7	232	135.7	3.447	2.2	0.056	693.16	640.5	3217.52	10149.7	6.917	39.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	821.07	711.5	4528.62	14285.5	7.636	43.4
	RodE5_113.6	210	113.6	2.885	0.85	0.022	701.41	645.0	5610.36	17697.9	11.851	67.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	778.43	687.8	5449.76	17191.3	9.901	56.2
	RodE5_118.7	212	118.7	3.015	5.95	0.151	843.63	724.1	5105.32	16104.7	8.293	47.1
	RodE5_122.6	213	122.6	3.114	9.85	0.250	876.84	742.5	4694.79	14809.7	7.236	41.1
	RodE5_126.6	214	126.6	3.216	13.85	0.352	879.94	744.2	4279.85	13500.8	6.565	37.3
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	904.78	758.0	3707.75	11696.1	5.479	31.1
	RodE5_135.6	216	135.6	3.444	2.1	0.053	766.47	681.2	3323.13	10482.8	6.171	35.0
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	849.22	727.2	5150.17	16246.2	8.290	47.1
	RodC3_85.6	178	85.6	2.174	14.72	0.374	699.47	644.0	5335.18	16829.8	11.316	64.3
	RodC3_88.5	179	88.5	2.248	0	0.000	727.06	659.3	5494.87	17333.6	11.011	62.5
	RodC3_92.4	180	92.4	2.347	3.9	0.099	828.32	715.5	5640.45	17792.8	9.396	53.4
	RodC3_94.4	181	94.4	2.398	5.9	0.150	842.30	723.3	5715.56	18029.7	9.304	52.8
	RodC3_97.2	182	97.2	2.469	8.7	0.221	895.39	752.8	5821.15	18362.8	8.722	49.5
	RodC3_108.8	183	108.8	2.764	20.3	0.516	946.79	781.4	6138.10	19362.6	8.539	48.5
Gr-8	RodD5_50	217	50	1.270	3	0.076	782.76	690.2	3997.54	12610.2	7.206	40.9
	RodD5_54.1	218	54.1	1.374	7.1	0.180	728.17	659.9	4115.55	12982.5	8.228	46.7
	RodD5_56.9	219	56.9	1.445	9.9	0.251	805.85	703.1	4248.96	13403.4	7.353	41.8
	RodD5_60	220	60	1.524	13	0.330	851.15	728.2	4366.30	13773.5	7.007	39.8
	RodD5_66.1	221	66.1	1.679	19.1	0.485	887.93	748.7	4599.77	14510.0	6.970	39.6
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	707.04	648.2	4778.42	15073.5	9.975	56.6
	RodD5_72.9	223	72.9	1.852	2.02	0.051	767.09	681.5	4896.50	15446.0	9.083	51.6
	RodD5_74.9	224	74.9	1.902	4.02	0.102	807.12	703.8	4969.15	15675.2	8.581	48.7

Table A-55: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	717.66	654.1	3645.58	11500.0	7.445	42.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	780.56	689.0	4097.19	12924.6	7.415	42.1
	RodB5_55	155	55	1.397	8	0.203	816.88	709.2	4180.27	13186.7	7.099	40.3
	RodB5_57.8	156	57.8	1.468	10.8	0.274	843.59	724.0	4310.60	13597.8	7.002	39.8
	RodB5_64	157	64	1.626	17	0.432	884.85	747.0	4536.20	14309.5	6.906	39.2
	RodB5_73.9	158	73.9	1.877	3.02	0.077	810.30	705.5	4946.86	15604.9	8.495	48.2
	RodB5_75.9	159	75.9	1.928	5.02	0.128	840.55	722.3	5024.98	15851.3	8.203	46.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	852.11	728.8	5065.42	15978.9	8.116	46.1
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	717.09	653.8	3620.18	11419.9	7.402	42.0
	RodF5_53.1	106	53.1	1.349	6.1	0.155	773.28	685.0	4092.52	12909.9	7.505	42.6
	RodF5_55	107	55	1.397	8	0.203	809.52	705.1	4166.61	13143.6	7.165	40.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	851.46	728.4	4274.30	13483.3	6.856	38.9
	RodF5_64	109	64	1.626	17	0.432	887.16	748.2	4504.38	14209.1	6.834	38.8
	RodF5_73.8	110	73.8	1.875	2.92	0.074	808.29	704.4	4869.82	15361.9	8.392	47.7
	RodF5_75.8	111	75.8	1.925	4.92	0.125	846.84	725.8	4960.60	15648.2	8.016	45.5
	RodF5_76.8	112	76.8	1.951	5.92	0.150	862.96	734.8	4999.24	15770.1	7.873	44.7
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	716.44	653.4	3632.48	11458.6	7.437	42.2
	RodC2_53.1	58	53.1	1.349	6.1	0.155	830.05	716.5	4094.64	12916.6	6.801	38.6
	RodC2_55	59	55	1.397	8	0.203	848.27	726.6	4173.75	13166.1	6.729	38.2
	RodC2_57.8	60	57.8	1.468	10.8	0.274	878.45	743.4	4280.74	13503.6	6.581	37.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	907.09	759.3	4526.55	14279.0	6.666	37.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	856.17	731.0	4923.24	15530.4	7.837	44.5
	RodC2_75.8	63	75.8	1.925	4.92	0.125	881.76	745.2	4990.21	15741.6	7.633	43.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	892.70	751.3	5029.73	15866.3	7.567	43.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	719.84	655.3	3618.89	11415.8	7.358	41.8
	RodC6_52.8	138	52.8	1.341	5.8	0.147	825.42	713.9	4097.75	12926.4	6.859	39.0
	RodC6_54.8	139	54.8	1.392	7.8	0.198	846.59	725.7	4183.13	13195.7	6.762	38.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	878.41	743.4	4302.12	13571.0	6.615	37.6
	RodC6_63.8	141	63.8	1.621	16.8	0.427	912.40	762.3	4548.11	14347.0	6.645	37.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	875.37	741.7	4957.08	15637.1	7.657	43.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	901.07	756.0	5037.29	15890.1	7.484	42.5
	RodC6_76.8	144	76.8	1.951	5.92	0.150	915.83	764.2	5080.65	16026.9	7.387	41.9

Table A-55: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	707.14	648.2	5481.46	17291.3	11.440	65.0
	RodB4_91.3	162	91.3	2.319	2.8	0.071	793.73	696.3	5580.21	17602.8	9.864	56.0
	RodB4_93.3	163	93.3	2.370	4.8	0.122	807.92	704.2	5658.45	17849.6	9.757	55.4
	RodB4_95.1	164	95.1	2.416	6.6	0.168	836.20	719.9	5723.75	18055.6	9.411	53.4
	RodB4_100	165	100	2.540	11.5	0.292	875.78	741.9	5893.13	18589.9	9.097	51.7
	RodB4_106	166	106	2.692	17.5	0.445	945.13	780.4	6137.11	19359.5	8.558	48.6
	RodB4_109.9	167	109.9	2.791	21.4	0.544	725.65	658.5	5995.44	18912.6	12.048	68.4
	RodB4_142.3	168	142.3	3.614	8.8	0.224	742.78	668.0	2356.29	7432.9	4.577	26.0
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	783.78	690.8	5362.58	16916.3	9.649	54.8
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	745.05	669.3	5483.01	17296.2	10.604	60.2
	RodF4_92.4	100	92.4	2.347	3.9	0.099	843.96	724.2	5621.98	17734.5	9.127	51.8
	RodF4_94.3	101	94.3	2.395	5.8	0.147	875.60	741.8	5704.54	17995.0	8.809	50.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	914.69	763.5	5832.04	18397.2	8.493	48.2
	RodF4_108.8	103	108.8	2.764	20.3	0.516	931.67	773.0	6190.77	19528.8	8.798	50.0
	RodF4_111	104	111	2.819	-1.75	-0.044	693.50	640.7	5951.35	18773.5	12.785	72.6
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	931.95	773.1	5441.08	17163.9	7.729	43.9
	RodD2_106	66	106	2.692	17.5	0.445	957.69	787.4	5160.13	16277.6	7.072	40.2
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	979.76	799.7	4782.05	15085.0	6.361	36.1
	RodD2_114.9	68	114.9	2.918	2.15	0.055	982.87	801.4	4324.04	13640.2	5.728	32.5
	RodD2_117.4	69	117.4	2.982	4.65	0.118	955.35	786.1	3899.83	12302.0	5.362	30.4
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1031.20	828.3	6107.75	19266.9	7.604	43.2
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1052.28	840.0	6227.06	19643.3	7.555	42.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	879.26	743.9	5711.07	18015.6	8.769	49.8
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1015.01	819.3	6097.20	19233.6	7.747	44.0
	RodD6_106	130	106	2.692	17.5	0.445	1024.71	824.7	6217.42	19612.8	7.804	44.3
	RodD6_112.9	131	112.9	2.868	0.15	0.004	823.61	712.9	5673.85	17898.1	9.526	54.1
	RodD6_114.9	132	114.9	2.918	2.15	0.055	880.37	744.5	5438.96	17157.2	8.337	47.3
	RodD6_116.8	133	116.8	2.967	4.05	0.103	909.68	760.8	5226.94	16488.4	7.668	43.5
	RodD6_120.9	134	120.9	3.071	8.15	0.207	919.66	766.3	4773.12	15056.8	6.901	39.2
	RodD6_124.8	135	124.8	3.170	12.05	0.306	920.22	766.6	4328.71	13654.9	6.253	35.5
	RodD6_128.7	136	128.7	3.269	15.95	0.405	901.65	756.3	3881.96	12245.7	5.763	32.7

Table A-55: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4049, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	771.49	684.0	4024.52	12695.4	7.405	42.1
	RodE2_54	74	54	1.372	7	0.178	832.92	718.1	4179.10	13183.0	6.909	39.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	866.63	736.8	4291.27	13536.8	6.719	38.2
	RodE2_59.9	76	59.9	1.521	12.9	0.328	900.43	755.6	4406.70	13900.9	6.553	37.2
	RodE2_66	77	66	1.676	19	0.483	920.70	766.9	4638.05	14630.7	6.696	38.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	804.80	702.5	4768.13	15041.1	8.267	46.9
	RodE2_72.9	79	72.9	1.852	2.02	0.051	859.90	733.1	4911.49	15493.3	7.773	44.1
	RodE2_74.9	80	74.9	1.902	4.02	0.102	888.73	749.1	4994.12	15753.9	7.559	42.9
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	728.48	660.1	3976.94	12545.3	7.946	45.1
	RodB3_54.1	170	54.1	1.374	7.1	0.180	799.35	699.5	4144.30	13073.2	7.254	41.2
	RodB3_56.9	171	56.9	1.445	9.9	0.251	840.45	722.3	4254.69	13421.4	6.947	39.5
	RodB3_60.1	172	60.1	1.527	13.1	0.333	834.22	718.8	4380.37	13817.9	7.226	41.0
	RodB3_66.1	173	66.1	1.679	19.1	0.485	863.71	735.2	4611.73	14547.7	7.254	41.2
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	723.18	657.1	4766.96	15037.4	9.627	54.7
	RodB3_73	175	73	1.854	2.12	0.054	791.02	694.8	4891.85	15431.3	8.689	49.3
	RodB3_75	176	75	1.905	4.12	0.105	824.01	713.2	4973.32	15688.3	8.344	47.4
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	748.17	671.0	3975.73	12541.4	7.643	43.4
	RodF3_54	90	54	1.372	7	0.178	816.96	709.2	4143.24	13069.8	7.035	39.9
	RodF3_57	91	57	1.448	10	0.254	860.77	733.6	4264.02	13450.9	6.739	38.3
	RodF3_60	92	60	1.524	13	0.330	893.61	751.8	4385.94	13835.4	6.589	37.4
	RodF3_66.1	93	66.1	1.679	19.1	0.485	899.12	754.9	4625.30	14590.5	6.892	39.1
	RodF3_70	94	70	1.778	-0.88	-0.022	723.20	657.2	4803.75	15153.4	9.701	55.1
	RodF3_73	95	73	1.854	2.12	0.054	841.34	722.8	4895.51	15442.9	7.982	45.3
	RodF3_75	96	75	1.905	4.12	0.105	880.97	744.8	4981.39	15713.8	7.629	43.3
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	757.46	676.2	3993.19	12596.5	7.542	42.8
	RodE6_54.1	122	54.1	1.374	7.1	0.180	814.92	708.1	4146.37	13079.7	7.065	40.1
	RodE6_57	123	57	1.448	10	0.254	845.46	725.1	4254.37	13420.4	6.890	39.1
	RodE6_60.2	124	60.2	1.529	13.2	0.335	872.80	740.3	4378.77	13812.8	6.791	38.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	891.53	750.7	4598.33	14505.4	6.930	39.4
	RodE6_70	126	70	1.778	-0.88	-0.022	788.94	693.7	4738.60	14947.9	8.448	48.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	846.90	725.9	4843.76	15279.6	7.826	44.4
	RodE6_75	128	75	1.905	4.12	0.105	875.16	741.6	4923.75	15532.0	7.608	43.2

RBHT Steam Cooling with Droplet Injection Test SCD-4053-A

Matrix Test # 12a

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 11160 - 11820
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 60 kW
Bundle Inlet Reynolds Number: 6000
Bundle Inlet Steam Flow: 122.5 kg/hr (270 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

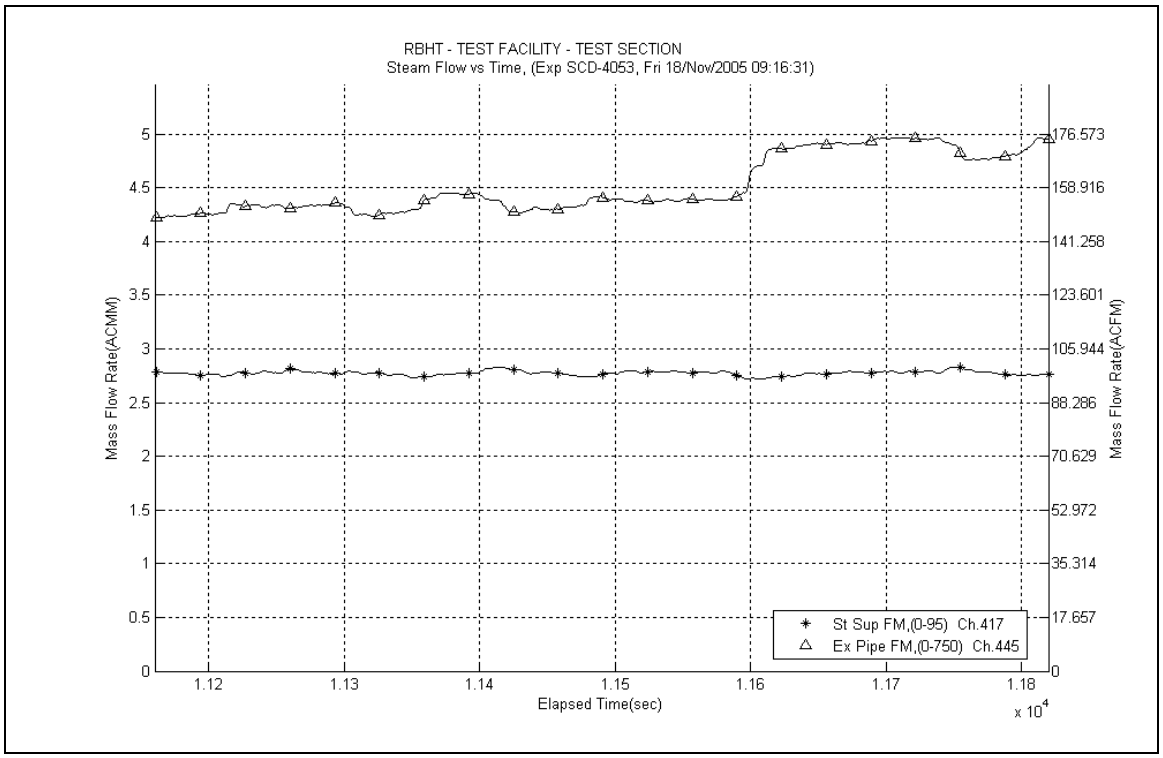

Figure A-302: Inlet and Exhaust Steam Flow Rates for Experiment 4053A

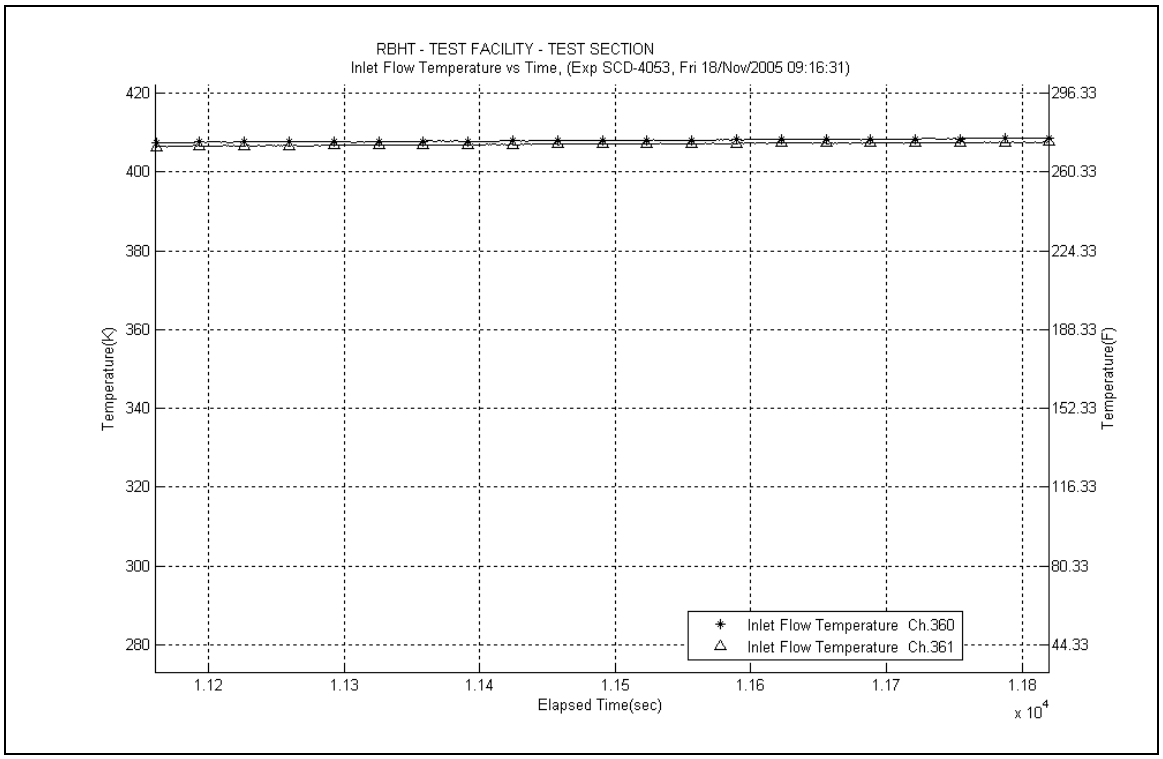

Figure A-303: Inlet Steam Temperature for Experiment 4053A

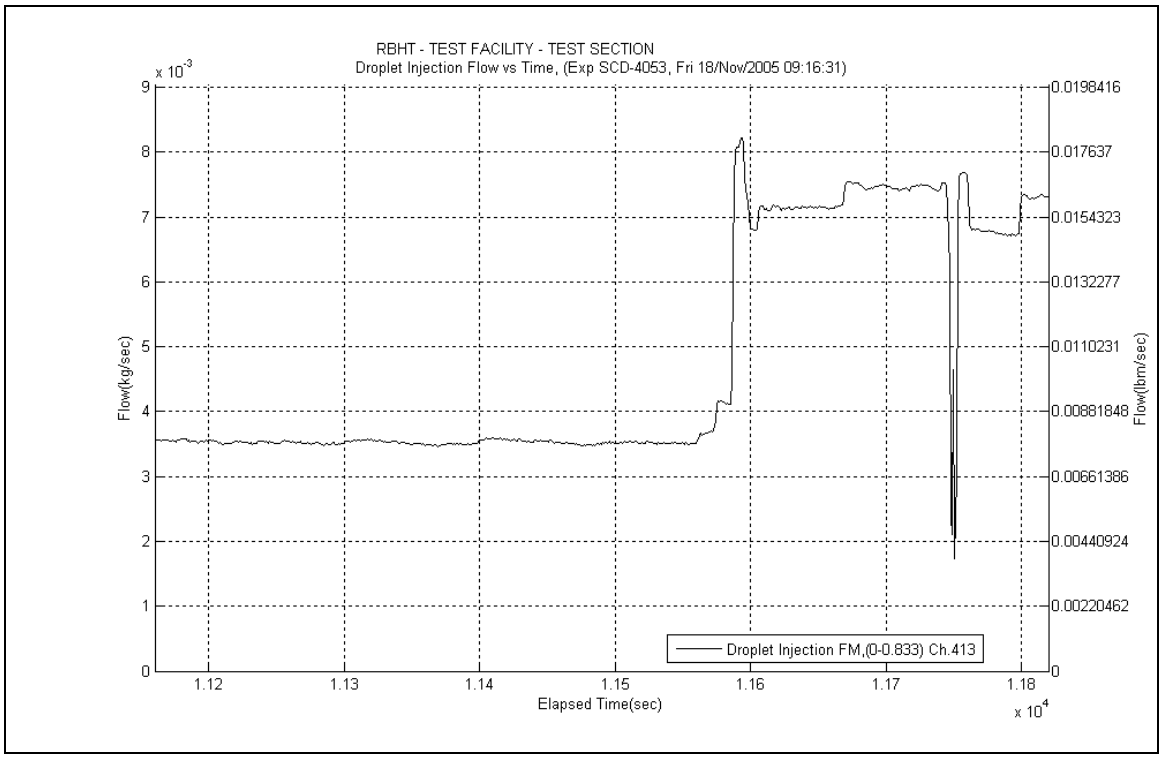

Figure A-304: Droplet Injection Flow Rate for Experiment 4053A

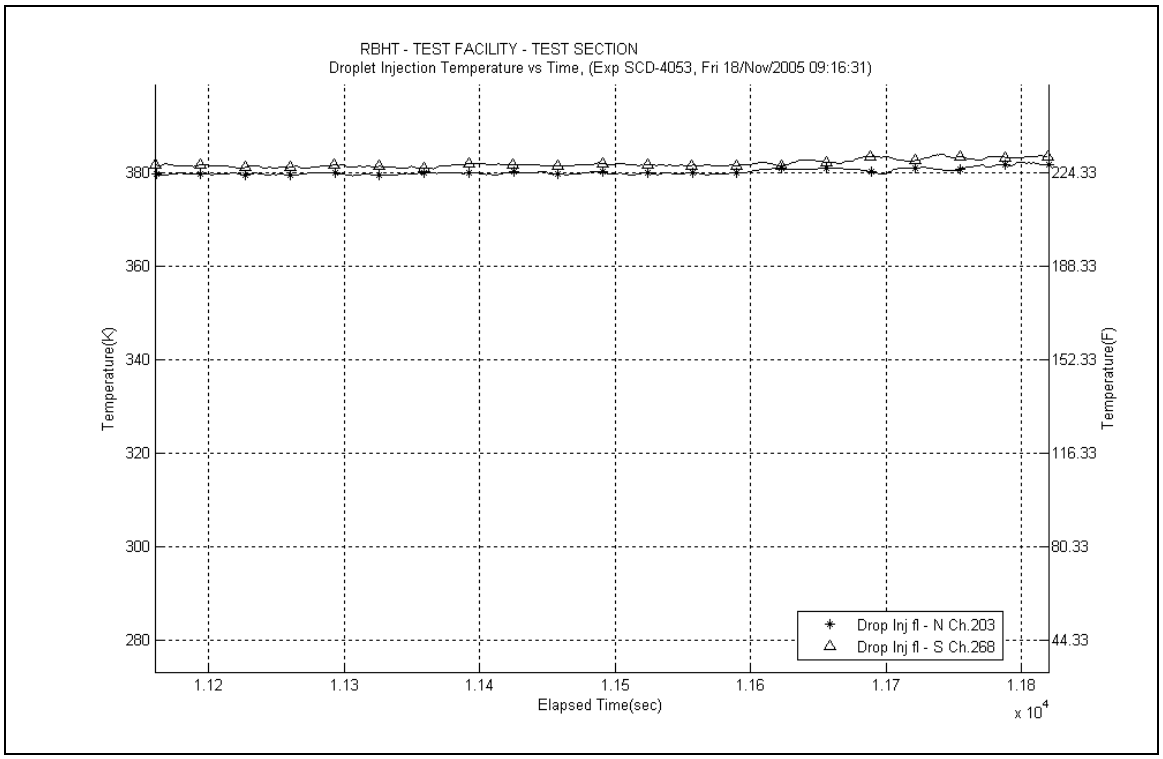

Figure A-305: Droplet Injection Temperature for Experiment 4053A

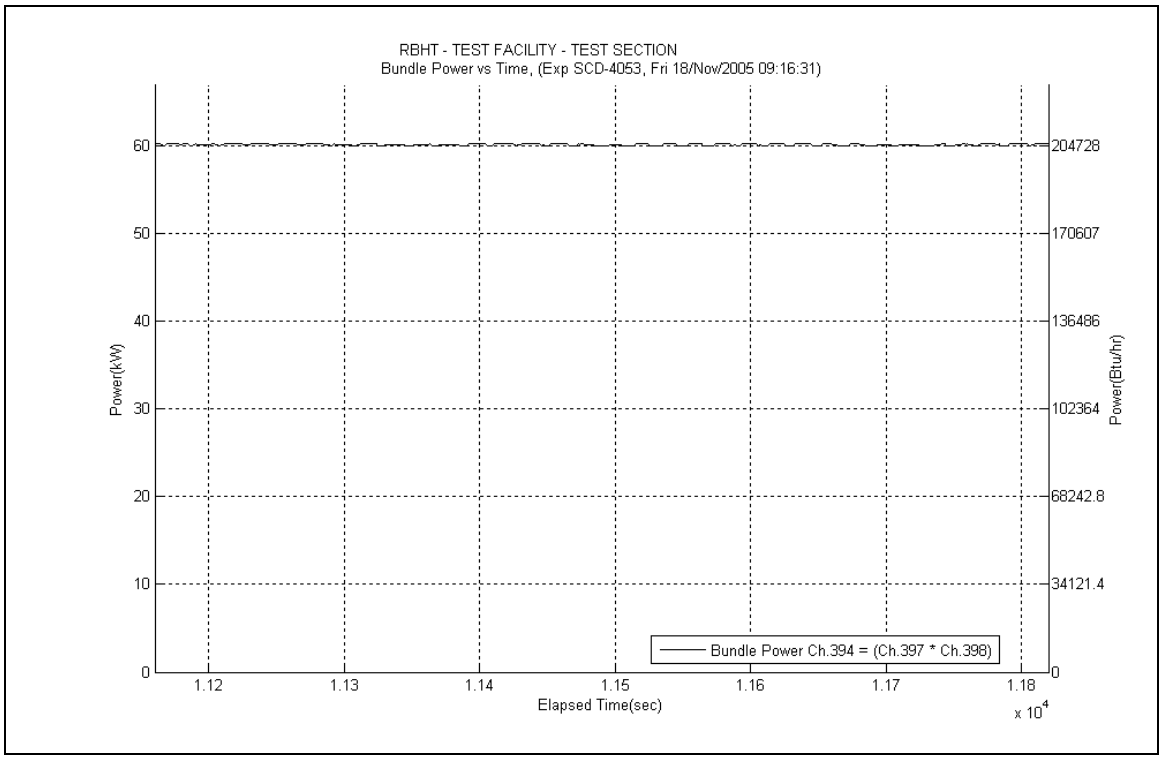

Figure A-306: Bundle Power for Experiment 4053A

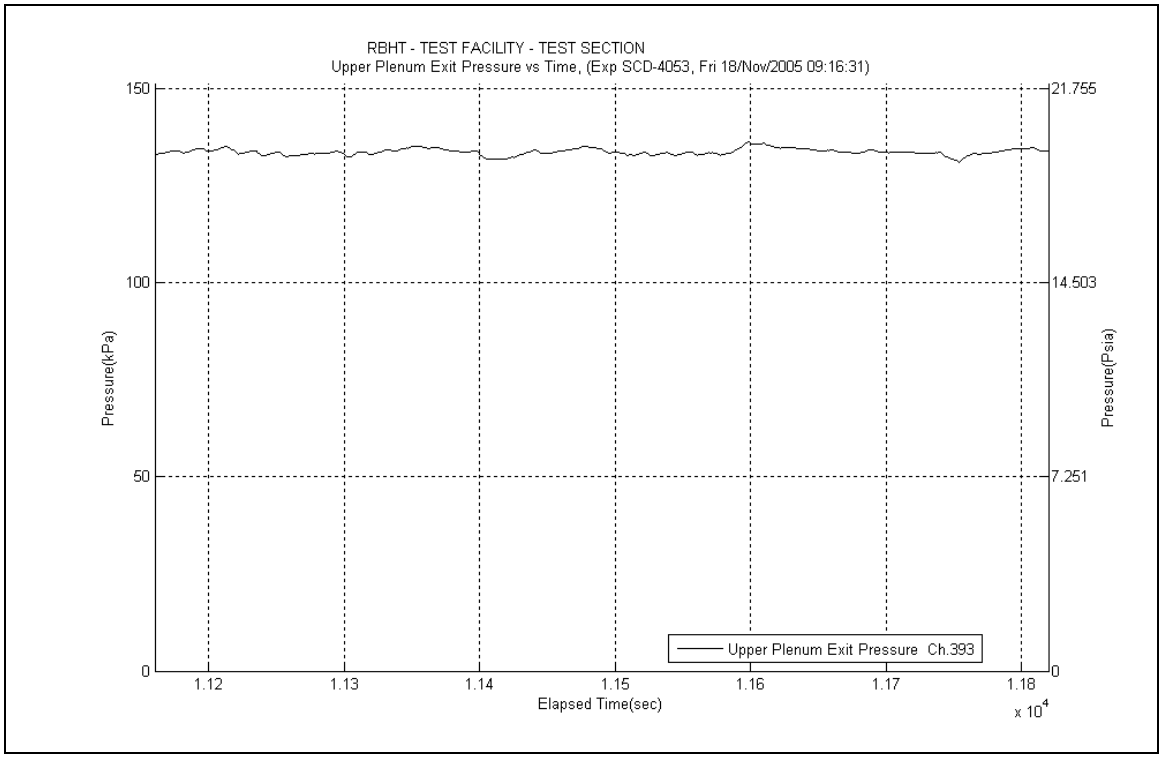

Figure A-307: Upper Plenum Pressure for Experiment 4053A

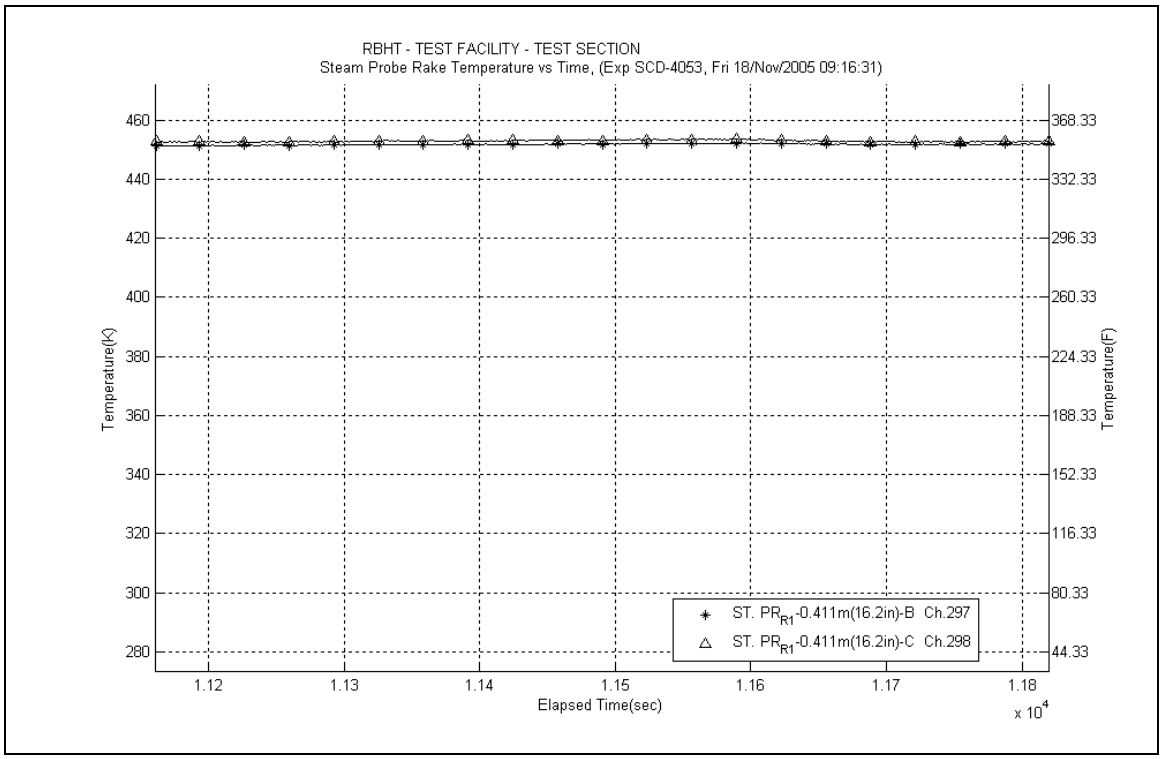

Figure A-308: Steam Probe Rake #1 Temperatures for Experiment 4053A

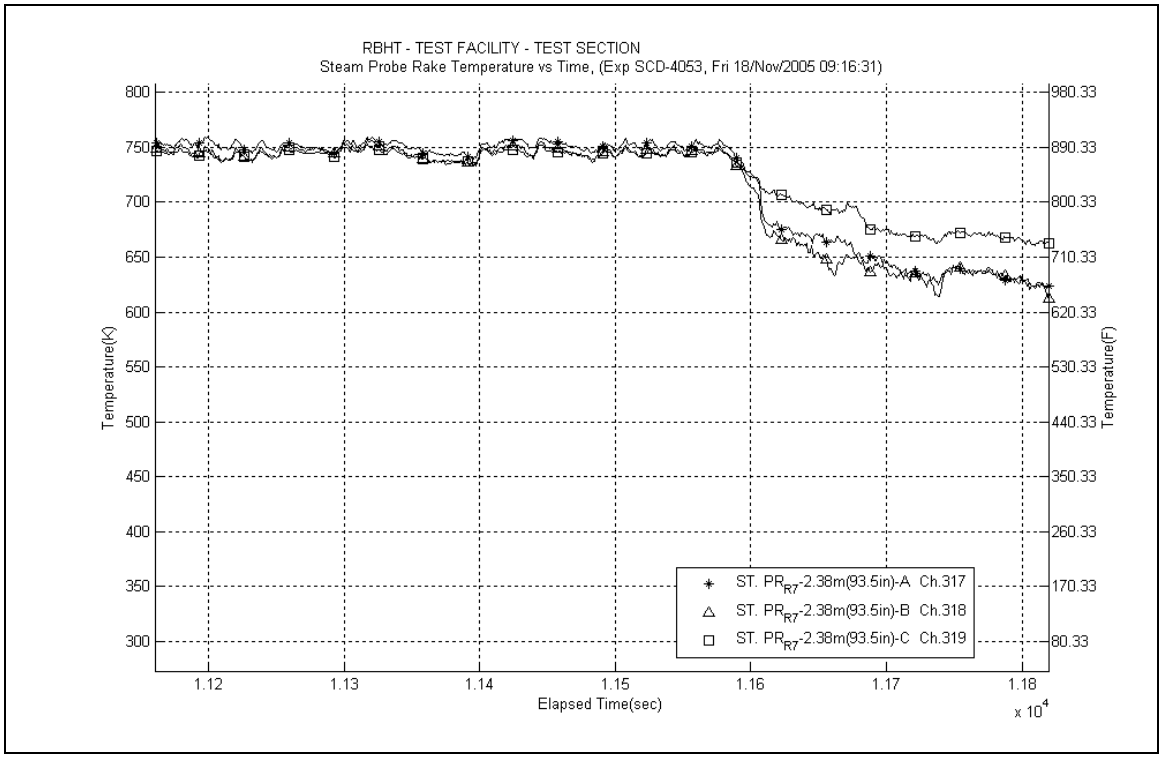

Figure A-309: Steam Probe Rake #7 Temperatures for Experiment 4053A

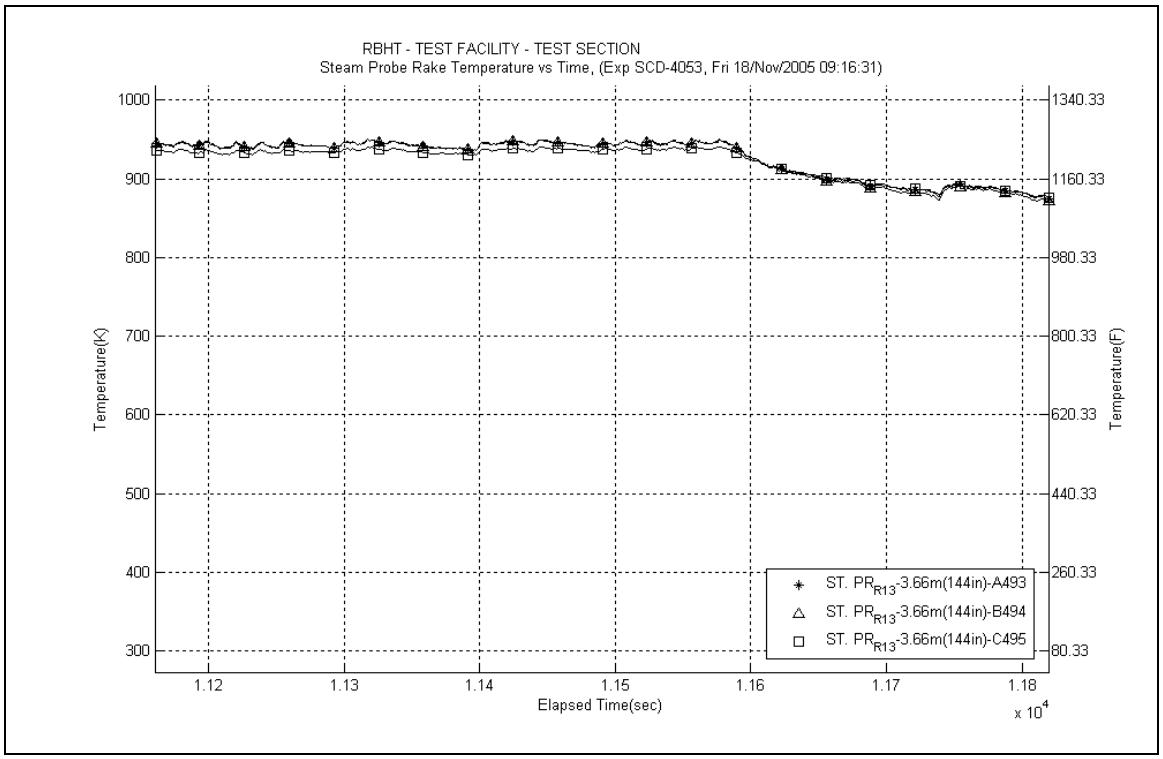

Figure A-310: Steam Probe Rake #13 Temperatures for Experiment 4053A

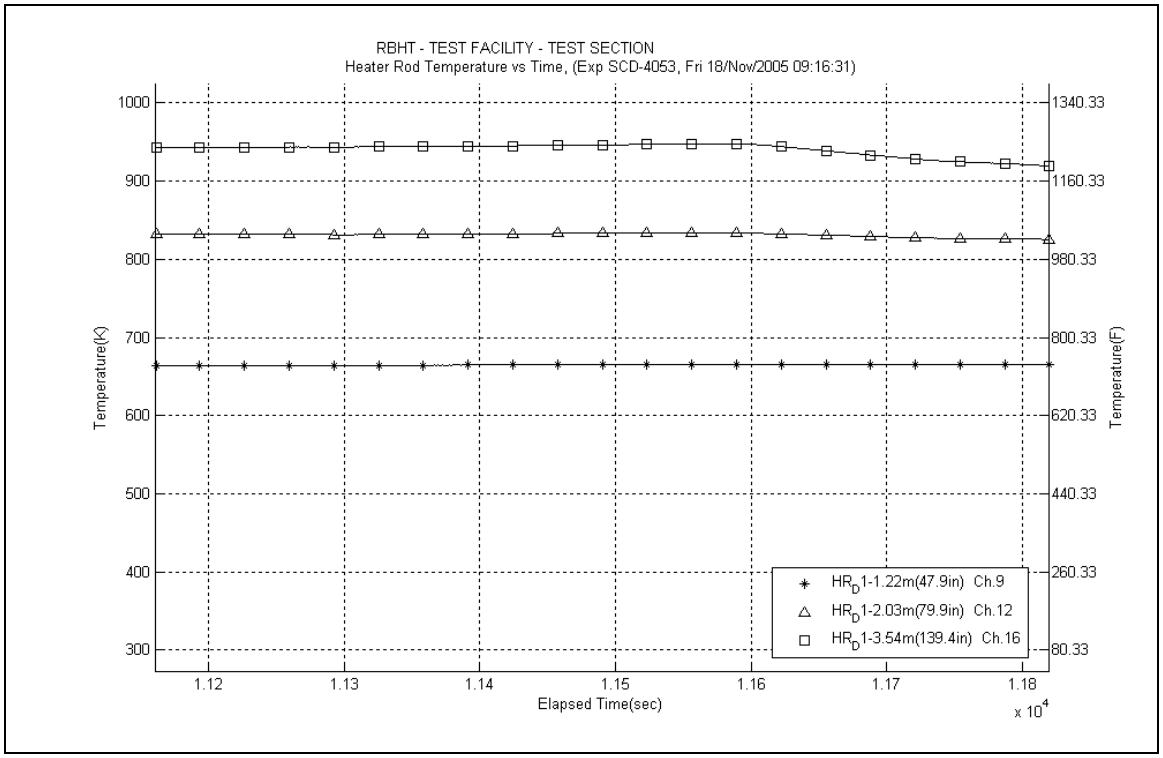

Figure A-311: Heater Rod D1 Temperatures for Experiment 4053A

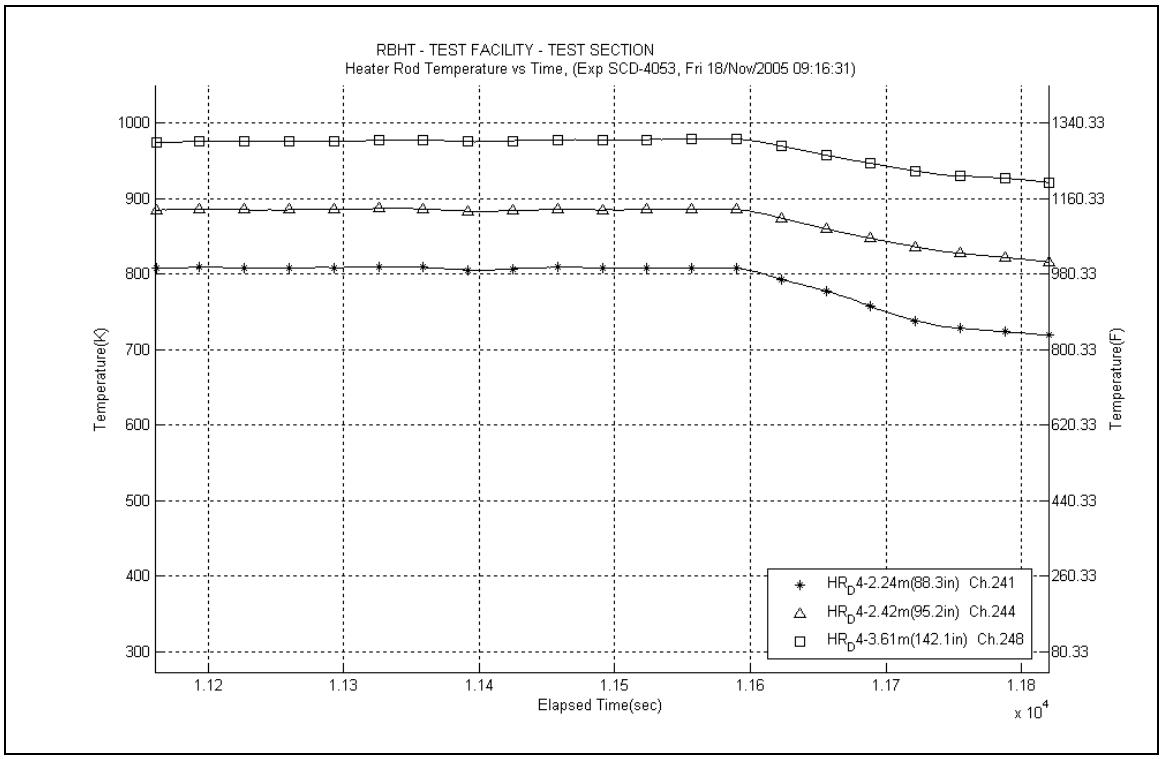

Figure A-312: Heater Rod D4 Temperatures for Experiment 4053A

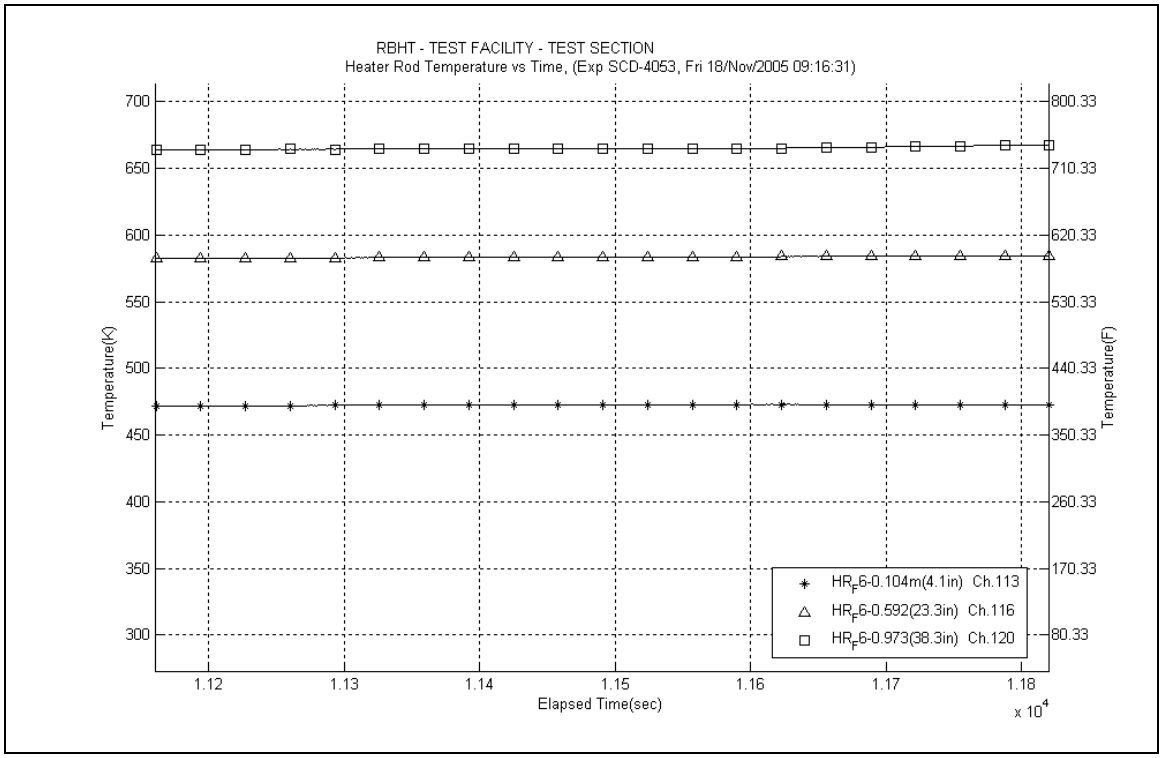

Figure A-313: Heater Rod F6 Temperatures for Experiment 4053A

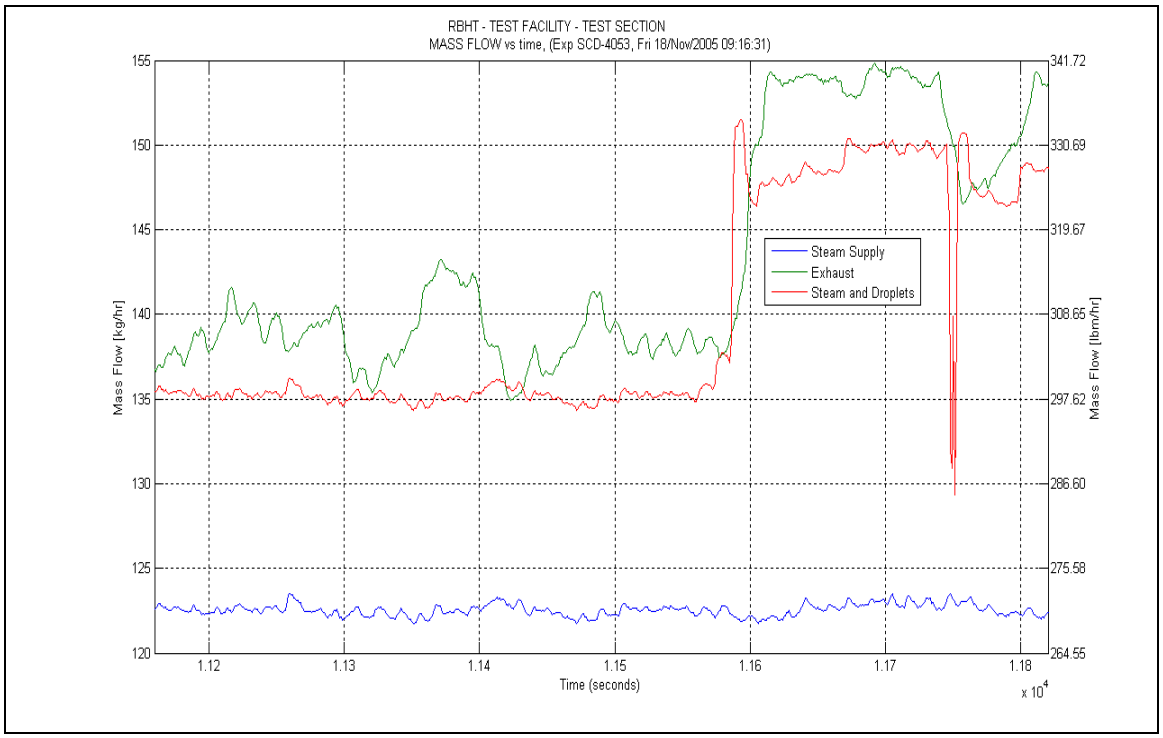

Figure A-314: Mass Flow for Experiment 4053A

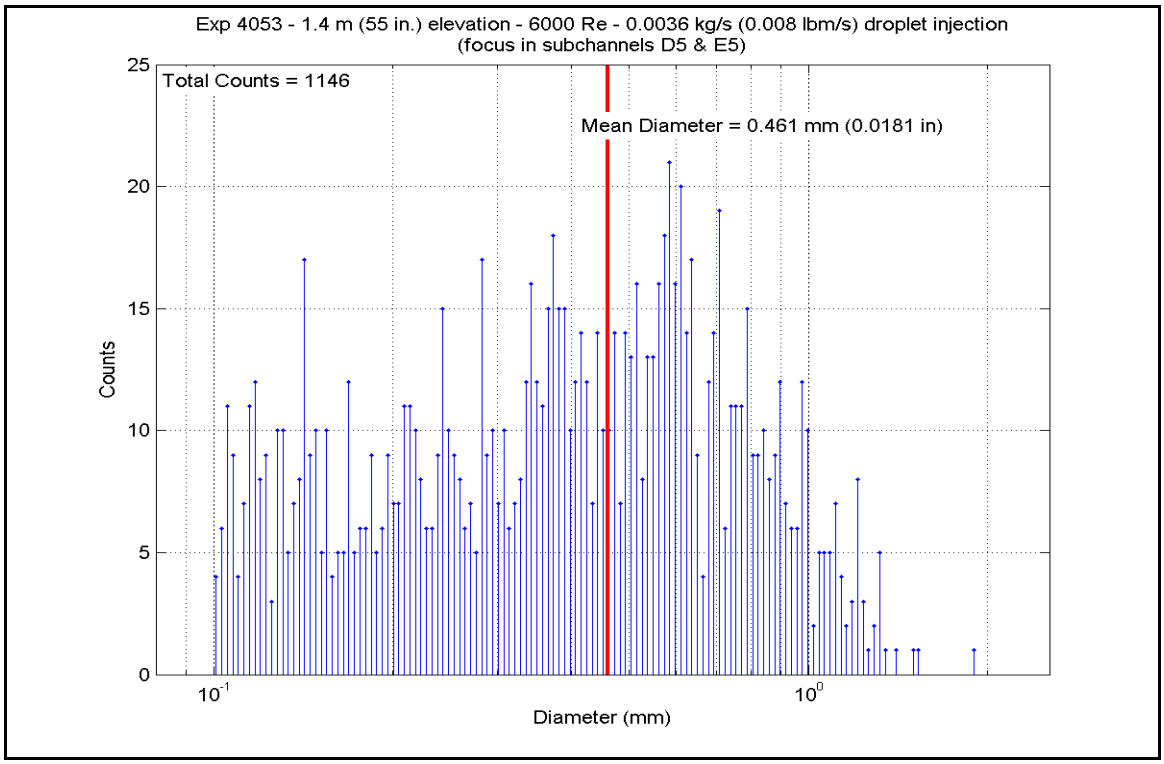

Figure A-315: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053A

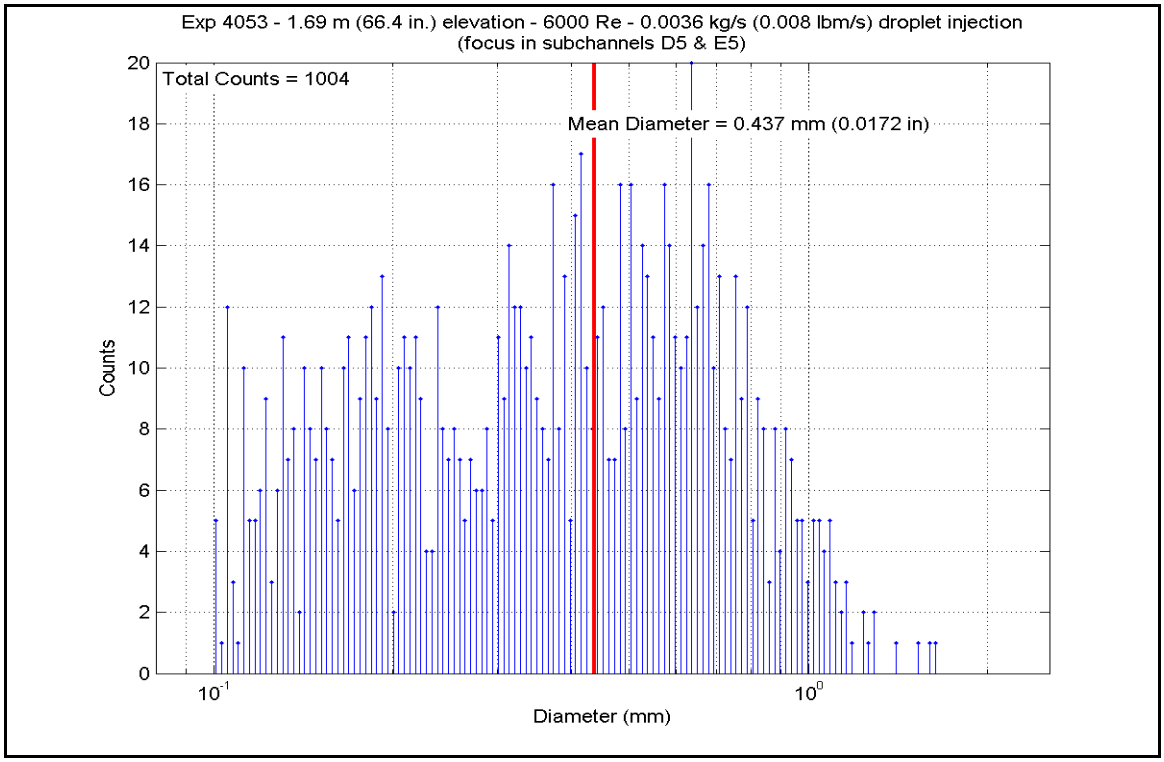

Figure A-316: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053A

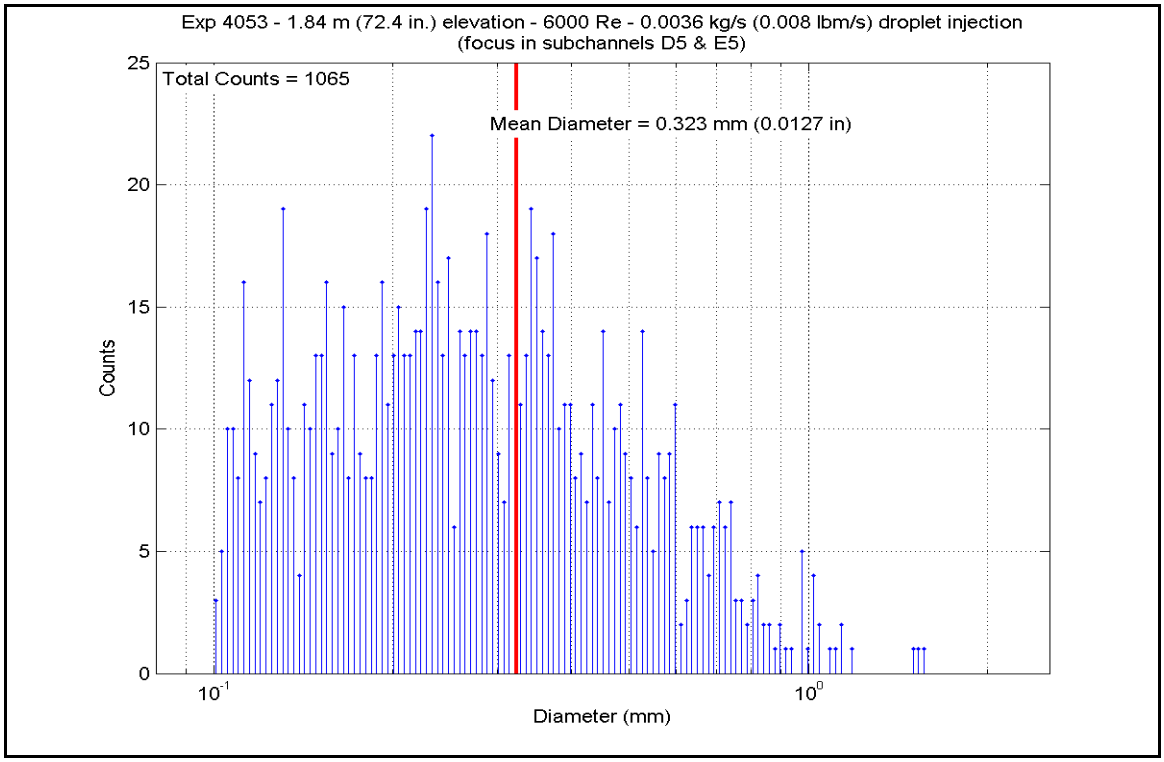

Figure A-317: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053A

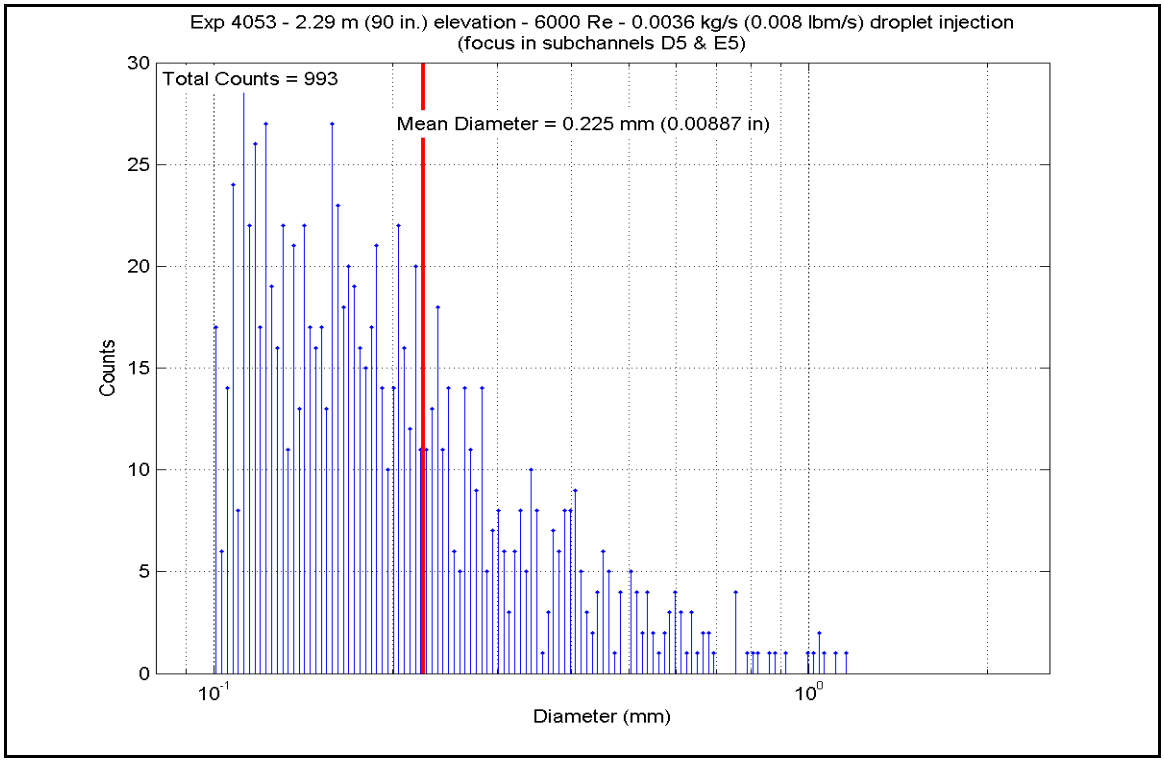

Figure A-318: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053A

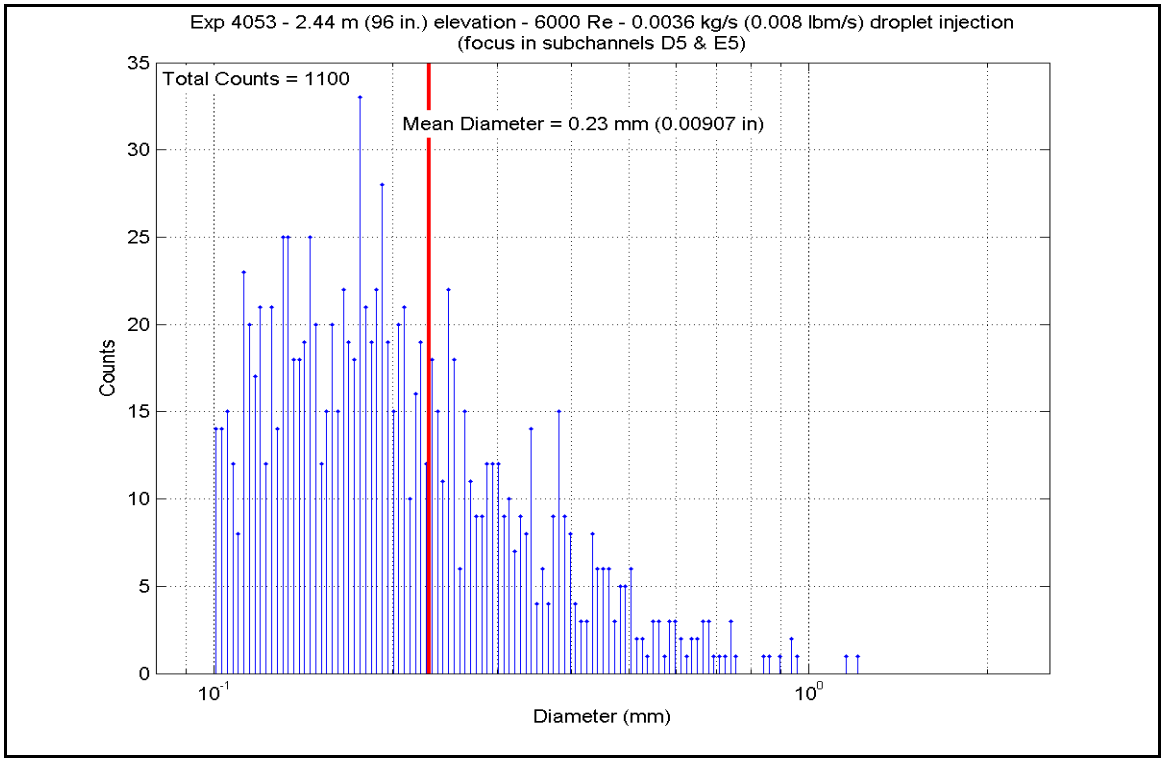

Figure A-319: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053A

Table A-56: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053A

SCD-4053-A	Inlet Reynolds:	6000	
Matrix test # 12a	UP Pressure:	137.9 kPa	20 psia
Time Window: 11160-11820	Bundle Power:	60.00 kW	204728 Btu/hr
	Steam flow:	0.0340 kg/s	270.0 lbm/hr
	Droplet flow:	0.0036 kg/s	0.008 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	980.85	800.3	5461.29	17227.7	7.254	41.2
	RodD3_91.3	186	91.3	2.319	2.8	0.071	1063.36	846.1	5514.58	17395.7	6.601	37.5
	RodD3_93.1	187	93.1	2.365	4.6	0.117	1078.95	854.8	5612.54	17704.8	6.596	37.5
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1125.16	880.5	5661.46	17859.1	6.310	35.8
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1266.15	958.8	5989.33	18893.4	5.769	32.8
	RodD3_110	191	110	2.794	21.5	0.546	1209.13	927.1	5949.67	18768.2	6.064	34.4
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1288.60	971.3	2204.25	6953.3	2.078	11.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	961.32	789.4	5558.75	17535.1	7.580	43.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1043.17	834.9	5596.49	17654.1	6.865	39.0
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1074.82	852.5	5669.96	17885.9	6.696	38.0
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1112.59	873.5	5729.69	18074.3	6.477	36.8
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1177.36	909.5	5881.67	18553.7	6.195	35.2
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1244.85	947.0	6080.50	19180.9	5.980	34.0
	RodC4_110	239	110	2.794	21.5	0.546	1179.91	910.9	5940.41	18739.0	6.240	35.4
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1279.29	966.1	2406.06	7589.9	2.289	13.0
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	961.63	789.6	5546.84	17497.5	7.561	42.9
	RodD4_91.3	242	91.3	2.319	2.8	0.071	1044.09	835.4	5588.05	17627.5	6.847	38.9
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1074.14	852.1	5662.50	17862.4	6.692	38.0
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1108.45	871.2	5720.75	18046.1	6.498	36.9
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1172.96	907.0	5867.54	18509.2	6.209	35.3
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1237.75	943.0	6064.24	19129.7	6.006	34.1
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1279.22	966.0	2346.02	7400.5	2.232	12.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	971.17	794.9	5447.33	17183.6	7.330	41.6
	RodE4_91.2	202	91.2	2.316	2.7	0.069	1054.40	841.2	5478.04	17280.5	6.629	37.6
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1128.40	882.3	5582.31	17609.4	6.200	35.2
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1193.35	918.3	5750.26	18139.2	5.957	33.8
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1280.13	966.6	2342.27	7388.7	2.226	12.6

Table A-56: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_113.6	194	113.6	2.885	0.85	0.022	1237.89	943.1	5432.45	17136.7	5.379	30.5
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1272.11	962.1	5223.89	16478.7	5.003	28.4
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1301.92	978.7	4914.36	15502.4	4.576	26.0
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1321.84	989.7	4484.04	14144.9	4.099	23.3
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1328.93	993.7	4090.77	12904.3	3.716	21.1
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1263.07	957.1	3622.83	11428.2	3.500	19.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1282.68	968.0	3193.57	10074.1	3.028	17.2
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1006.47	814.5	4154.61	13105.7	5.337	30.3
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1181.76	911.9	5373.85	16951.8	5.634	32.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1224.45	935.6	5147.62	16238.2	5.166	29.3
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1279.63	966.3	4457.44	14061.0	4.239	24.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1288.21	971.0	4066.30	12827.1	3.835	21.8
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1203.97	924.2	3684.60	11623.1	3.775	21.4
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1235.31	941.7	3251.55	10257.0	3.228	18.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	922.09	767.6	4244.26	13388.5	6.115	34.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1146.17	892.1	5507.19	17372.4	5.998	34.1
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1183.09	912.6	5288.69	16683.2	5.537	31.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1225.32	936.1	4944.87	15598.6	4.958	28.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1257.01	953.7	4548.71	14348.9	4.420	25.1
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1272.60	962.4	4146.81	13081.1	3.970	22.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1324.07	991.0	3677.53	11600.8	3.355	19.1
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1245.64	947.4	3313.15	10451.3	3.256	18.5
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	1000.18	811.0	4898.58	15452.6	6.344	36.0
	RodC3_85.6	178	85.6	2.174	14.72	0.374	969.28	793.9	5324.10	16794.9	7.182	40.8
	RodC3_88.5	179	88.5	2.248	0	0.000	976.70	798.0	5455.82	17210.4	7.287	41.4
	RodC3_92.4	180	92.4	2.347	3.9	0.099	1081.45	856.2	5502.07	17356.3	6.447	36.6
	RodC3_94.4	181	94.4	2.398	5.9	0.150	1106.41	870.0	5570.66	17572.6	6.342	36.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	848.51	726.8	3716.20	11722.7	5.989	34.0
	RodD5_54.1	218	54.1	1.374	7.1	0.180	869.84	738.6	3908.70	12330.0	6.090	34.6
	RodD5_56.9	219	56.9	1.445	9.9	0.251	921.28	767.2	4015.18	12665.9	5.792	32.9
	RodD5_60	220	60	1.524	13	0.330	968.23	793.3	4123.43	13007.4	5.570	31.6
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1006.51	814.5	4355.29	13738.8	5.594	31.8
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	792.26	695.5	4521.20	14262.1	8.013	45.5
	RodD5_72.9	223	72.9	1.852	2.02	0.051	877.02	742.6	4646.36	14657.0	7.159	40.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	925.95	769.8	4725.16	14905.5	6.770	38.4

Table A-56: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	785.81	691.9	3376.15	10650.1	6.052	34.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	848.25	726.6	3829.08	12078.8	6.173	35.1
	RodB5_55	155	55	1.397	8	0.203	883.55	746.2	3915.95	12352.9	5.974	33.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	937.85	776.4	4022.32	12688.4	5.666	32.2
	RodB5_64	157	64	1.626	17	0.432	1004.34	813.3	4248.52	13401.9	5.473	31.1
	RodB5_73.9	158	73.9	1.877	3.02	0.077	941.21	778.3	4699.57	14824.8	6.589	37.4
	RodB5_75.9	159	75.9	1.928	5.02	0.128	979.67	799.6	4766.04	15034.5	6.341	36.0
	RodB5_76.9	160	76.9	1.953	6.02	0.153	995.03	808.2	4798.96	15138.3	6.257	35.5
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	785.31	691.7	3352.54	10575.6	6.016	34.2
	RodF5_53.1	106	53.1	1.349	6.1	0.155	826.88	714.7	3816.00	12037.6	6.372	36.2
	RodF5_55	107	55	1.397	8	0.203	863.22	734.9	3871.65	12213.1	6.095	34.6
	RodF5_57.8	108	57.8	1.468	10.8	0.274	913.06	762.6	3967.69	12516.1	5.792	32.9
	RodF5_64	109	64	1.626	17	0.432	973.80	796.4	4191.01	13220.5	5.619	31.9
	RodF5_73.8	110	73.8	1.875	2.92	0.074	900.97	755.9	4607.65	14534.8	6.847	38.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	942.59	779.0	4681.92	14769.1	6.552	37.2
	RodF5_76.8	112	76.8	1.951	5.92	0.150	959.52	788.4	4719.87	14888.8	6.452	36.6
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	785.16	691.6	3370.60	10632.6	6.050	34.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	895.81	753.0	3812.00	12025.0	5.708	32.4
	RodC2_55	59	55	1.397	8	0.203	917.74	765.2	3878.88	12235.9	5.624	31.9
	RodC2_57.8	60	57.8	1.468	10.8	0.274	951.82	784.2	3974.36	12537.1	5.491	31.2
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1000.18	811.0	4203.46	13259.8	5.444	30.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	928.58	771.3	4593.60	14490.5	6.557	37.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	962.00	789.8	4672.30	14738.8	6.366	36.1
	RodC2_76.8	64	76.8	1.951	5.92	0.150	976.23	797.7	4709.19	14855.2	6.294	35.7
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	791.00	694.8	3359.25	10596.7	5.967	33.9
	RodC6_52.8	138	52.8	1.341	5.8	0.147	890.13	749.9	3804.63	12001.7	5.746	32.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	916.32	764.4	3886.46	12259.8	5.646	32.1
	RodC6_57.8	140	57.8	1.468	10.8	0.274	943.53	779.6	4023.34	12691.6	5.623	31.9
	RodC6_63.8	141	63.8	1.621	16.8	0.427	993.06	807.1	4264.84	13453.4	5.575	31.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	920.26	766.6	4753.04	14993.5	6.866	39.0
	RodC6_75.8	143	75.8	1.925	4.92	0.125	953.48	785.1	4831.25	15240.2	6.659	37.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	972.42	795.6	4866.59	15351.6	6.537	37.1
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	980.37	800.0	5407.69	17058.6	7.187	40.8
	RodB4_91.3	162	91.3	2.319	2.8	0.071	1064.54	846.8	5464.04	17236.3	6.532	37.1

Table A-56: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	997.87	809.7	5167.73	16301.6	6.712	38.1
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	991.57	806.2	5375.53	16957.1	7.040	40.0
	RodF4_92.4	100	92.4	2.347	3.9	0.099	1087.26	859.4	5494.07	17331.0	6.394	36.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1120.79	878.0	5548.86	17503.9	6.215	35.3
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1246.29	947.8	5240.92	16532.5	5.147	29.2
	RodD2_106	66	106	2.692	17.5	0.445	1268.49	960.1	4970.57	15679.7	4.777	27.1
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1297.46	976.2	4603.33	14521.2	4.304	24.4
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1316.19	986.6	4170.44	13155.7	3.832	21.8
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1314.13	985.4	3771.59	11897.5	3.473	19.7
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1190.03	916.5	5343.27	16855.4	5.554	31.5
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1216.41	931.2	5124.88	16166.4	5.185	29.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1243.43	946.2	4662.97	14709.4	4.592	26.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1255.88	953.1	4230.81	13346.1	4.116	23.4
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1253.77	951.9	3816.77	12040.0	3.721	21.1
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	844.54	724.6	3722.40	11742.3	6.038	34.3
	RodE2_54	74	54	1.372	7	0.178	909.11	760.4	3866.49	12196.9	5.677	32.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	944.36	780.0	3972.14	12530.1	5.545	31.5
	RodE2_59.9	76	59.9	1.521	12.9	0.328	979.90	799.8	4085.33	12887.2	5.433	30.9
	RodE2_66	77	66	1.676	19	0.483	1008.47	815.6	4324.61	13642.0	5.541	31.5
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	833.52	718.4	4507.42	14218.6	7.444	42.3
	RodE2_72.9	79	72.9	1.852	2.02	0.051	919.11	766.0	4615.20	14558.7	6.678	37.9
	RodE2_74.9	80	74.9	1.902	4.02	0.102	957.65	787.4	4686.79	14784.5	6.423	36.5

Table A-56: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	800.60	700.1	3708.03	11697.0	6.476	36.8
	RodB3_54.1	170	54.1	1.374	7.1	0.180	856.92	731.4	3836.93	12103.6	6.101	34.6
	RodB3_56.9	171	56.9	1.445	9.9	0.251	902.43	756.7	3952.83	12469.2	5.861	33.3
	RodB3_60.1	172	60.1	1.527	13.1	0.333	913.64	762.9	4094.81	12917.1	5.972	33.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	961.32	789.4	4341.34	13694.8	5.920	33.6
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	825.35	713.9	3704.19	11684.9	6.201	35.2
	RodF3_54	90	54	1.372	7	0.178	876.00	742.0	3870.13	12208.3	5.972	33.9
	RodF3_57	91	57	1.448	10	0.254	921.49	767.3	3983.60	12566.3	5.744	32.6
	RodF3_60	92	60	1.524	13	0.330	961.50	789.5	4095.97	12920.7	5.584	31.7
	RodF3_66.1	93	66.1	1.679	19.1	0.485	997.78	809.7	4335.30	13675.7	5.632	32.0
	RodF3_70	94	70	1.778	-0.88	-0.022	833.36	718.4	4514.57	14241.2	7.458	42.4
	RodF3_73	95	73	1.854	2.12	0.054	925.76	769.7	4610.64	14544.3	6.608	37.5
	RodF3_75	96	75	1.905	4.12	0.105	969.65	794.1	4687.99	14788.3	6.321	35.9
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	816.65	709.1	3700.58	11673.5	6.287	35.7
	RodE6_54.1	122	54.1	1.374	7.1	0.180	880.37	744.5	3844.78	12128.4	5.894	33.5
	RodE6_57	123	57	1.448	10	0.254	910.55	761.2	3972.68	12531.8	5.820	33.1
	RodE6_60.2	124	60.2	1.529	13.2	0.335	944.73	780.2	4094.55	12916.2	5.713	32.4
	RodE6_66.1	125	66.1	1.679	19.1	0.485	966.30	792.2	4321.87	13633.4	5.854	33.2
	RodE6_70	126	70	1.778	-0.88	-0.022	809.35	705.0	4594.90	14494.6	7.904	44.9
	RodE6_73.1	127	73.1	1.857	2.22	0.056	887.46	748.4	4665.73	14718.1	7.075	40.2
	RodE6_75	128	75	1.905	4.12	0.105	926.30	770.0	4729.85	14920.3	6.773	38.5

RBHT Steam Cooling with Droplet Injection Test SCD-4053-B

Matrix Test # 12b

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 12300 - 13680
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 60 kW
Bundle Inlet Reynolds Number: 6000
Bundle Inlet Steam Flow: 122.5 kg/hr (270 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

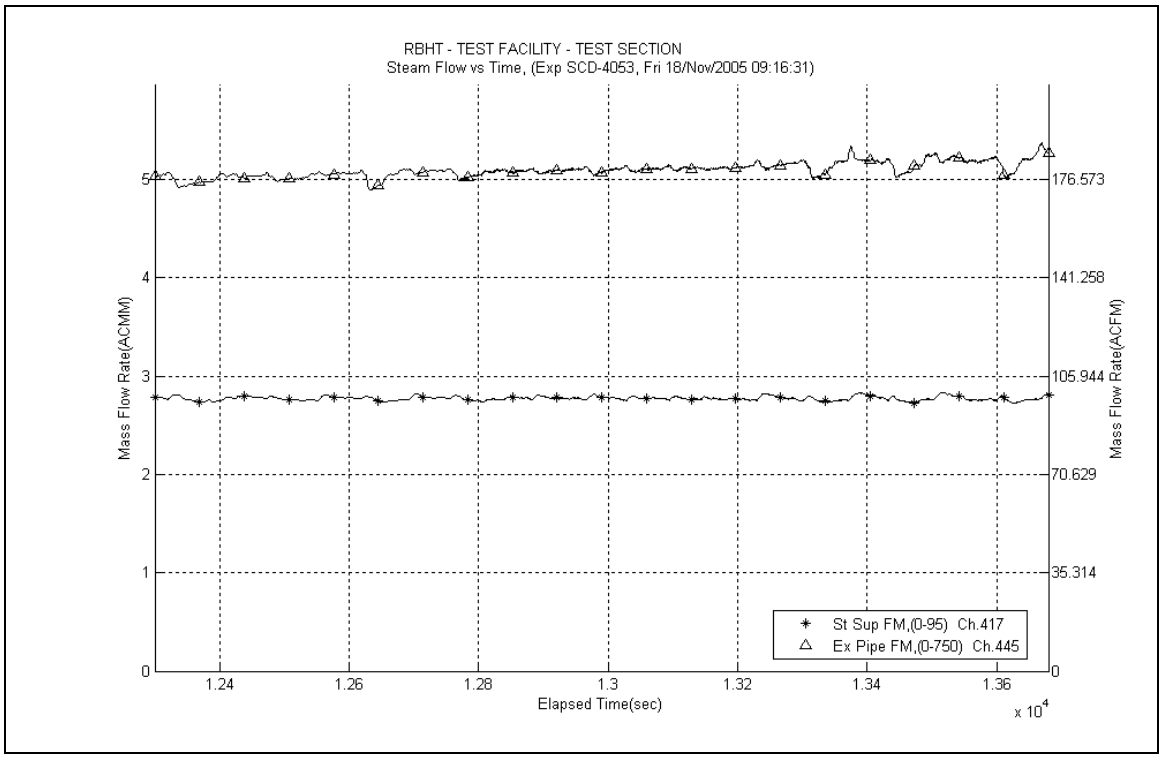

Figure A-320: Inlet and Exhaust Steam Flow Rates for Experiment 4053B

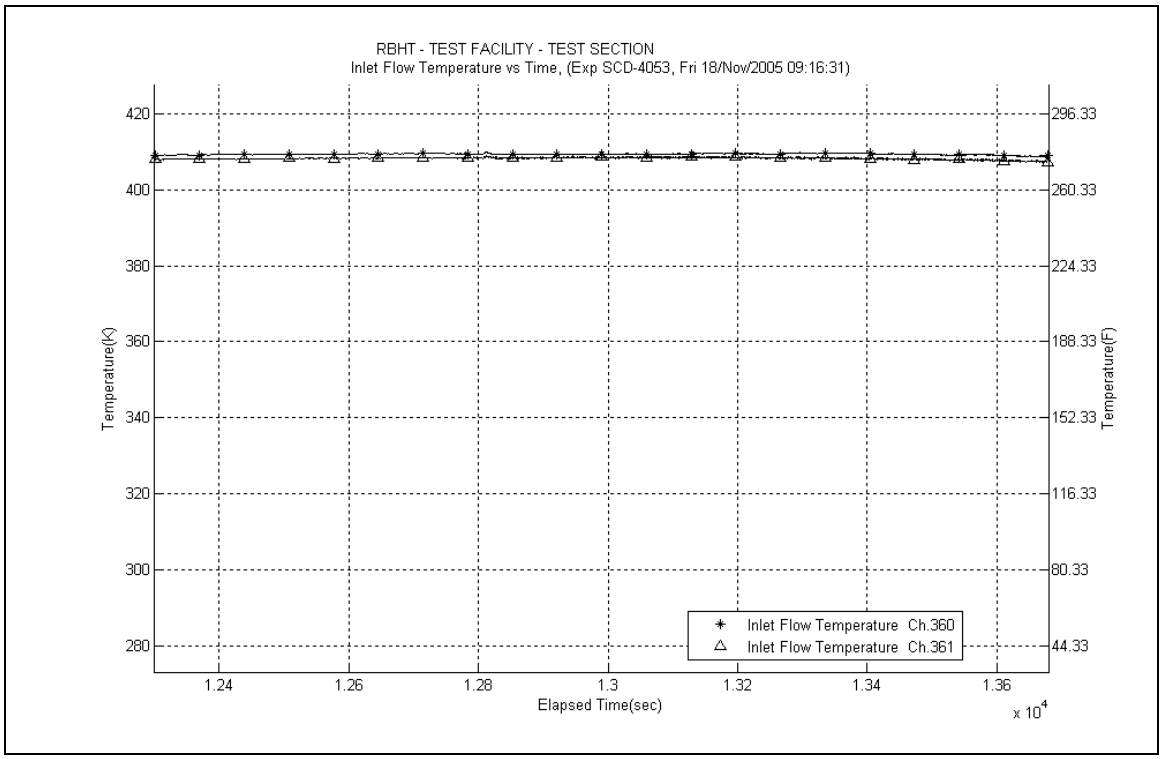

Figure A-321: Inlet Steam Temperature for Experiment 4053B

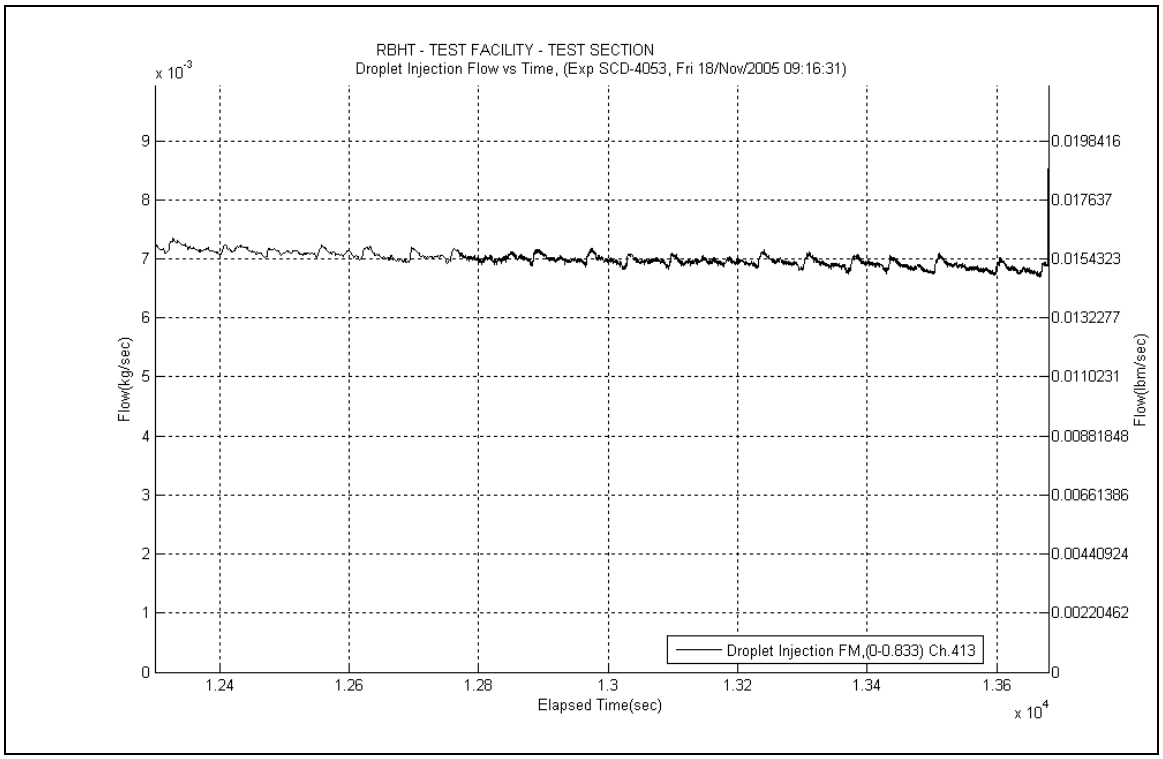

Figure A-322: Droplet Injection Flow Rate for Experiment 4053B

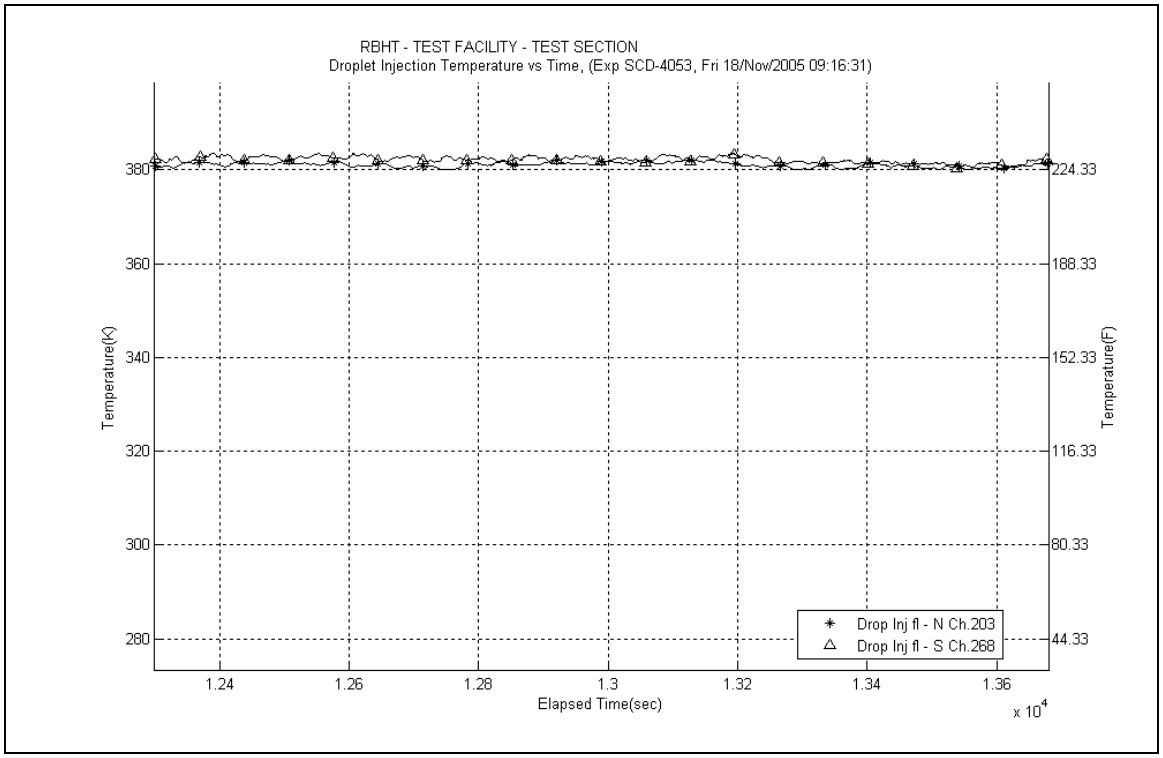

Figure A-323: Droplet Injection Temperature for Experiment 4053B

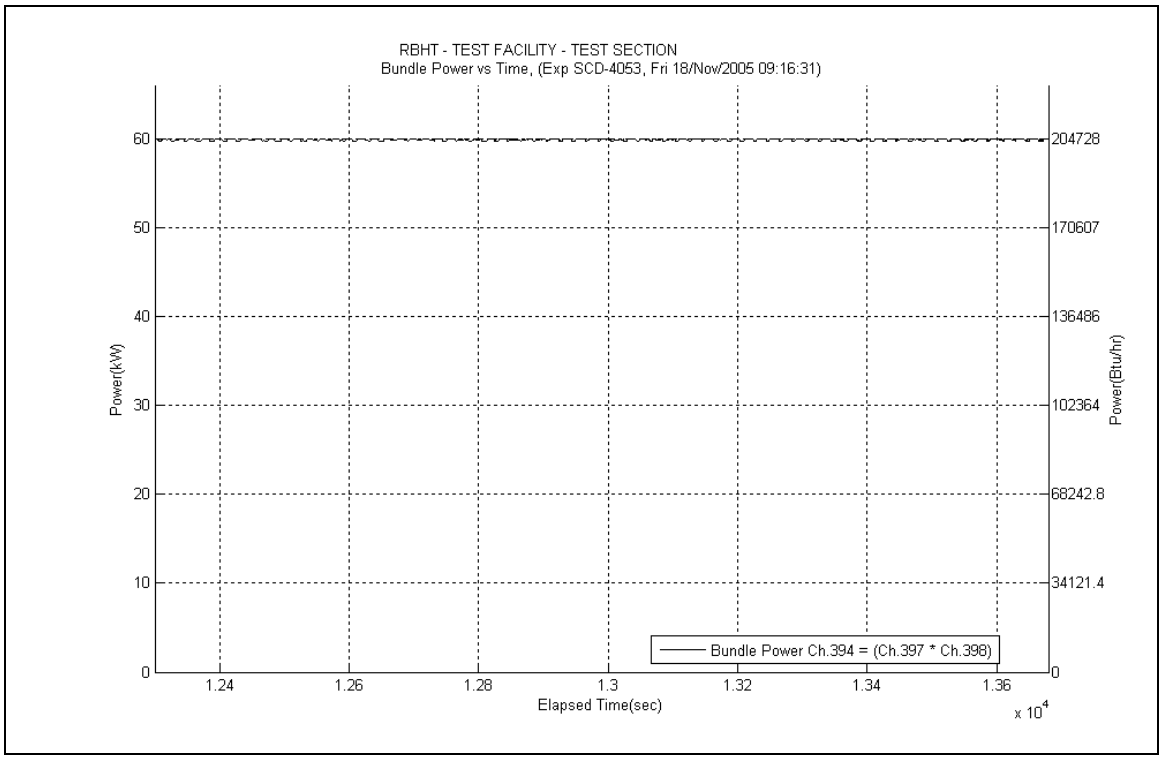

Figure A-324: Bundle Power for Experiment 4053B

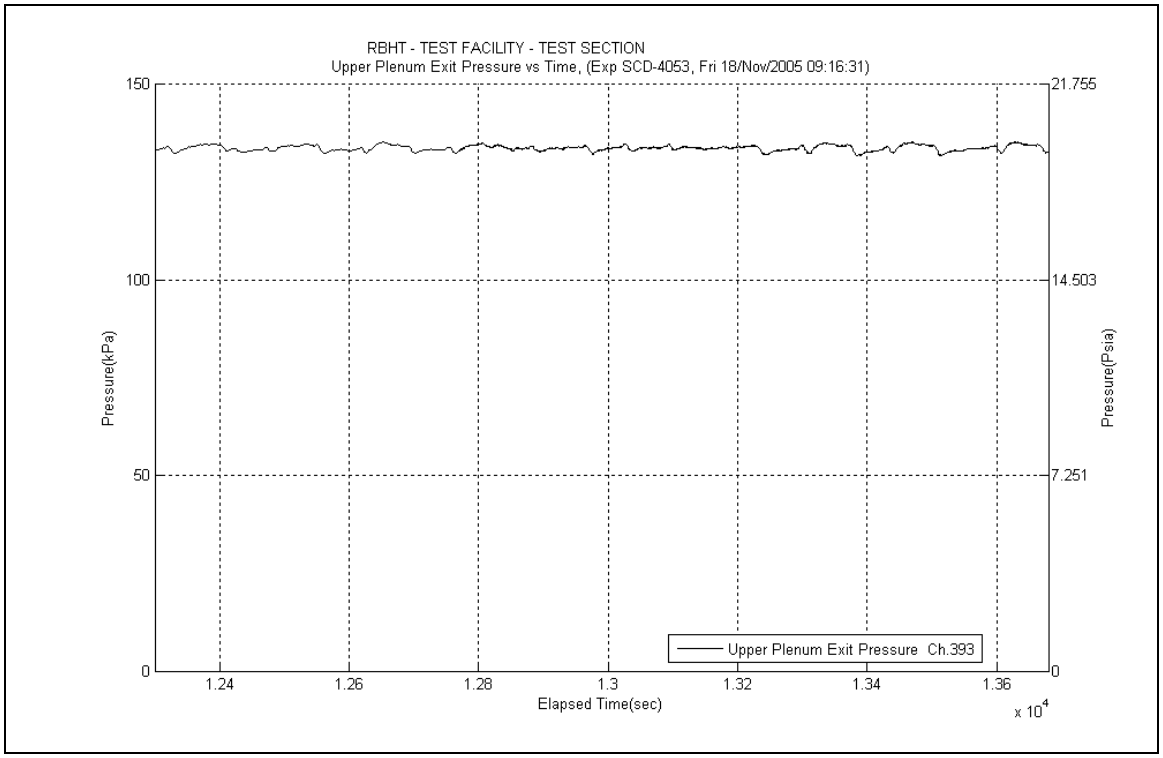

Figure A-325: Upper Plenum Pressure for Experiment 4053B

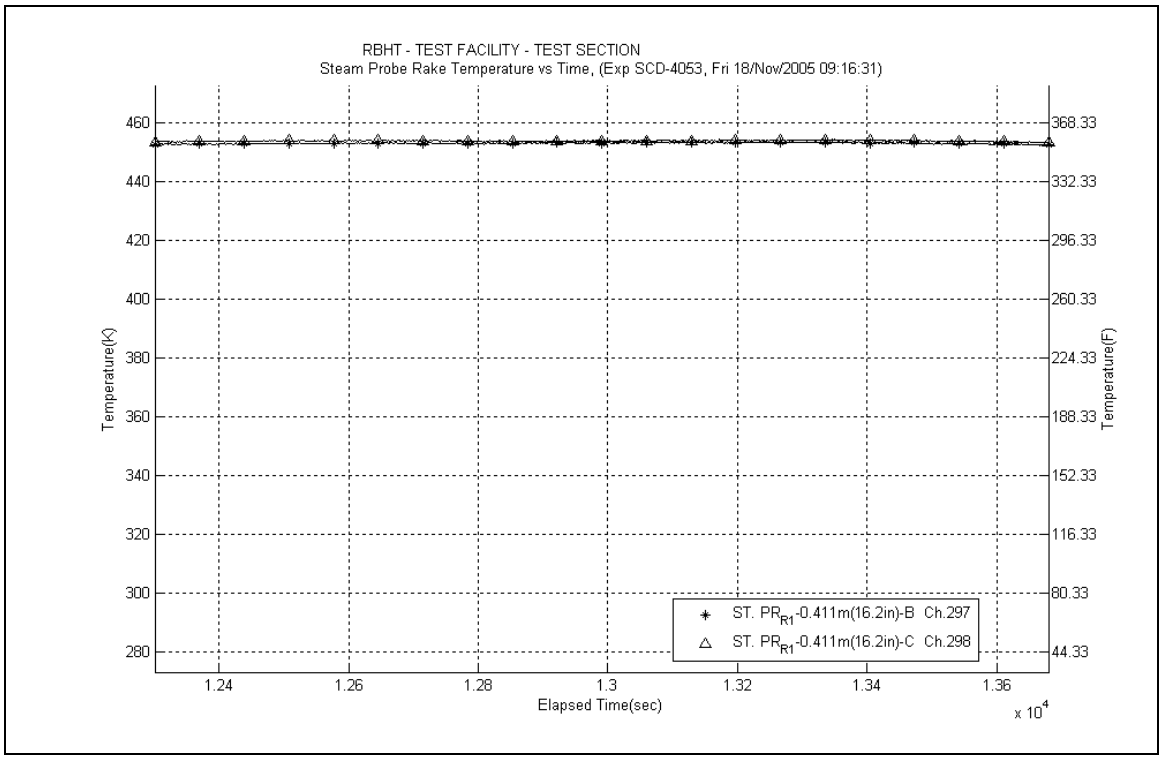

Figure A-326: Steam Probe Rake #1 Temperatures for Experiment 4053B

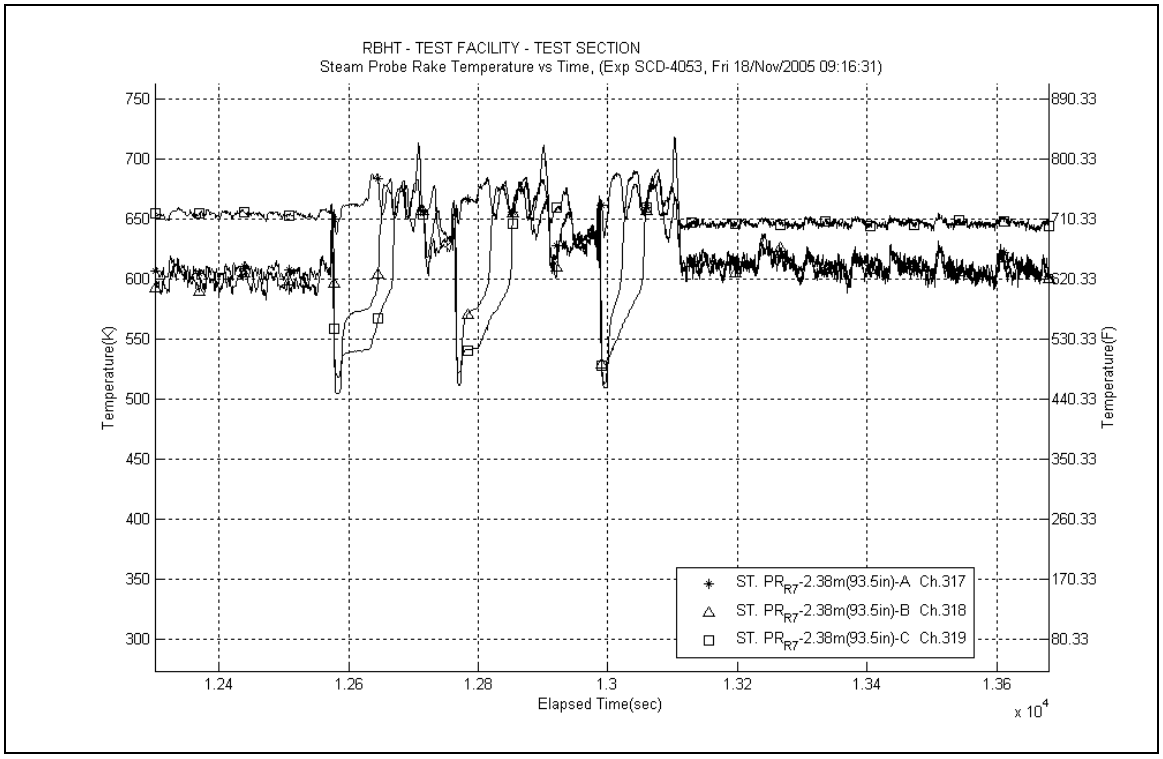

Figure A-327: Steam Probe Rake #7 Temperatures for Experiment 4053B

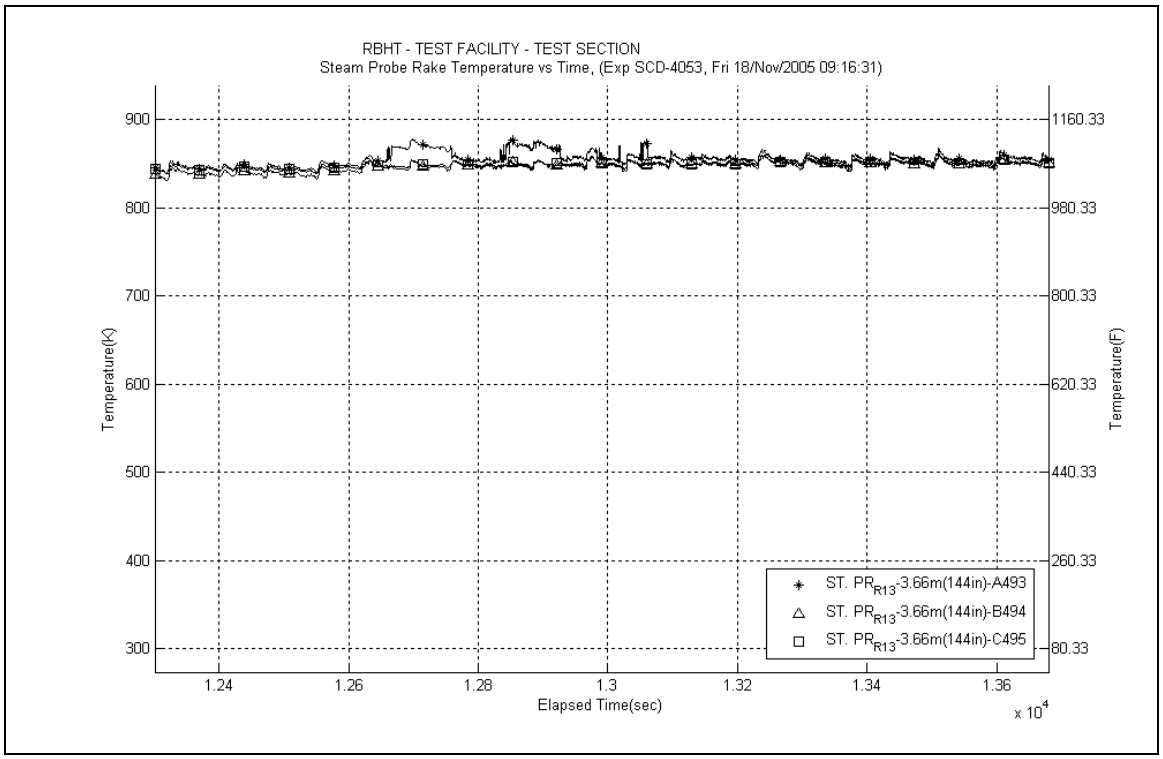

Figure A-328: Steam Probe Rake #13 Temperatures for Experiment 4053B

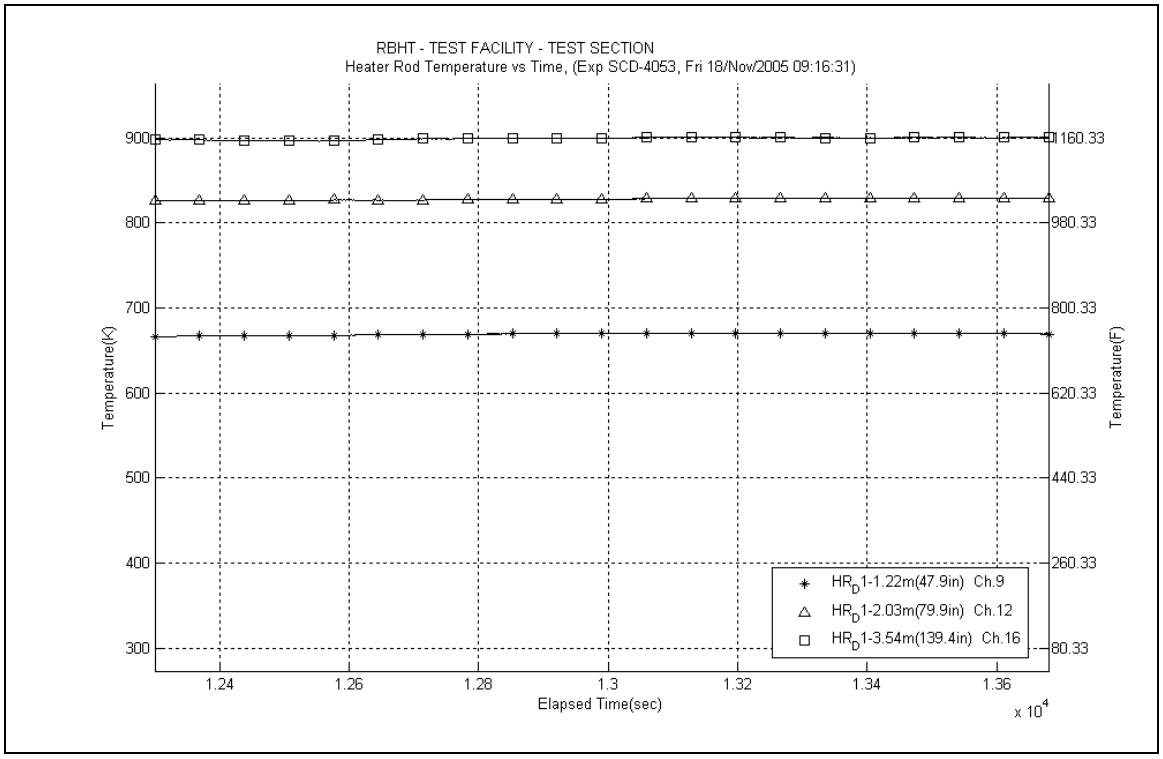

Figure A-329: Heater Rod D1 Temperatures for Experiment 4053B

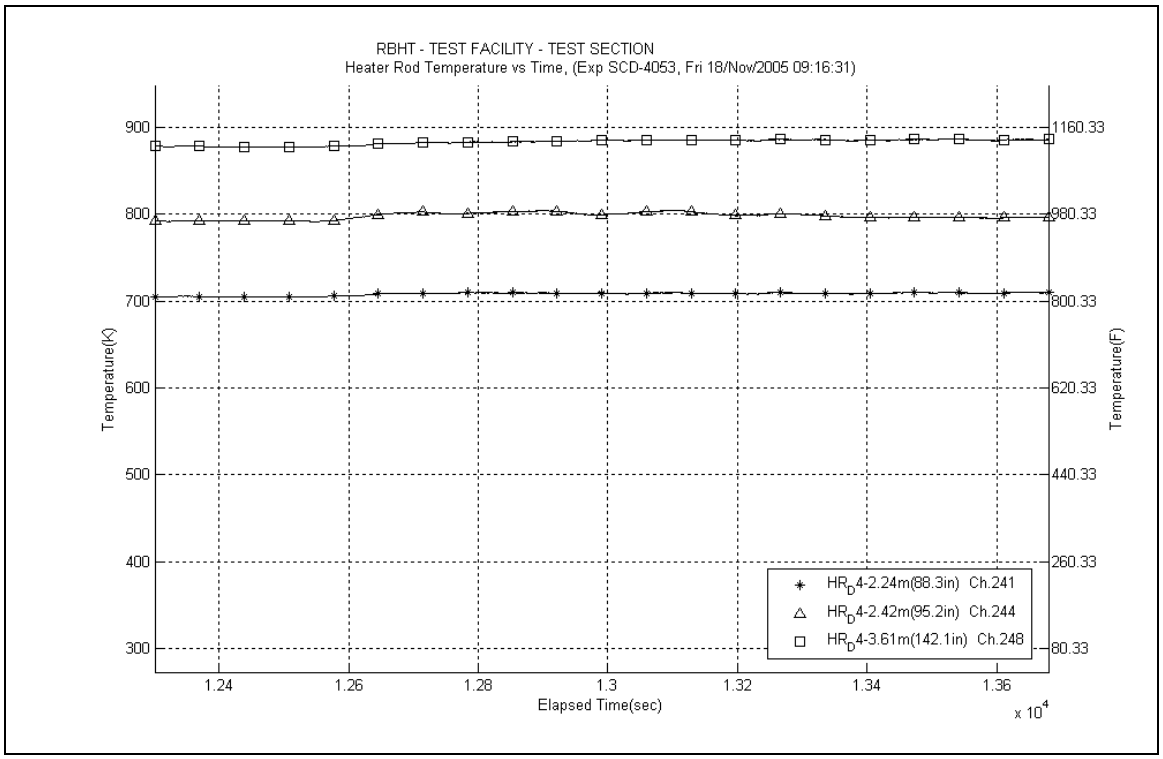

Figure A-330: Heater Rod D4 Temperatures for Experiment 4053B

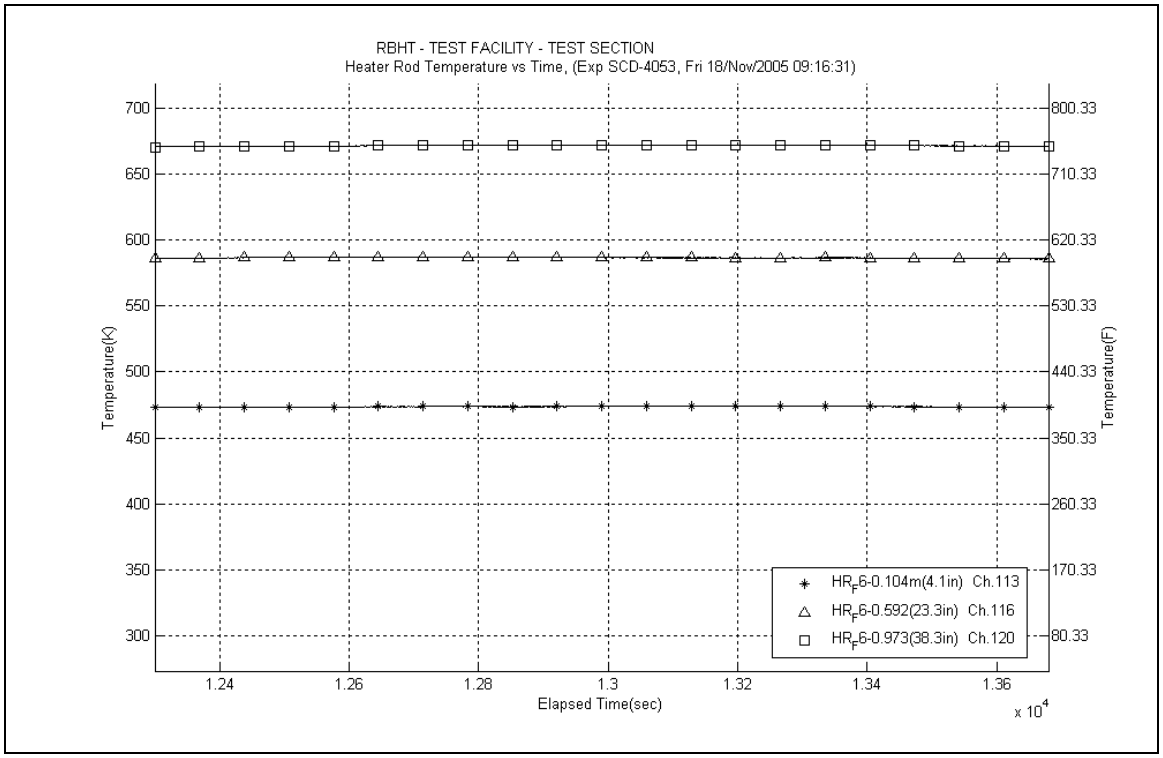

Figure A-331: Heater Rod F6 Temperatures for Experiment 4053B

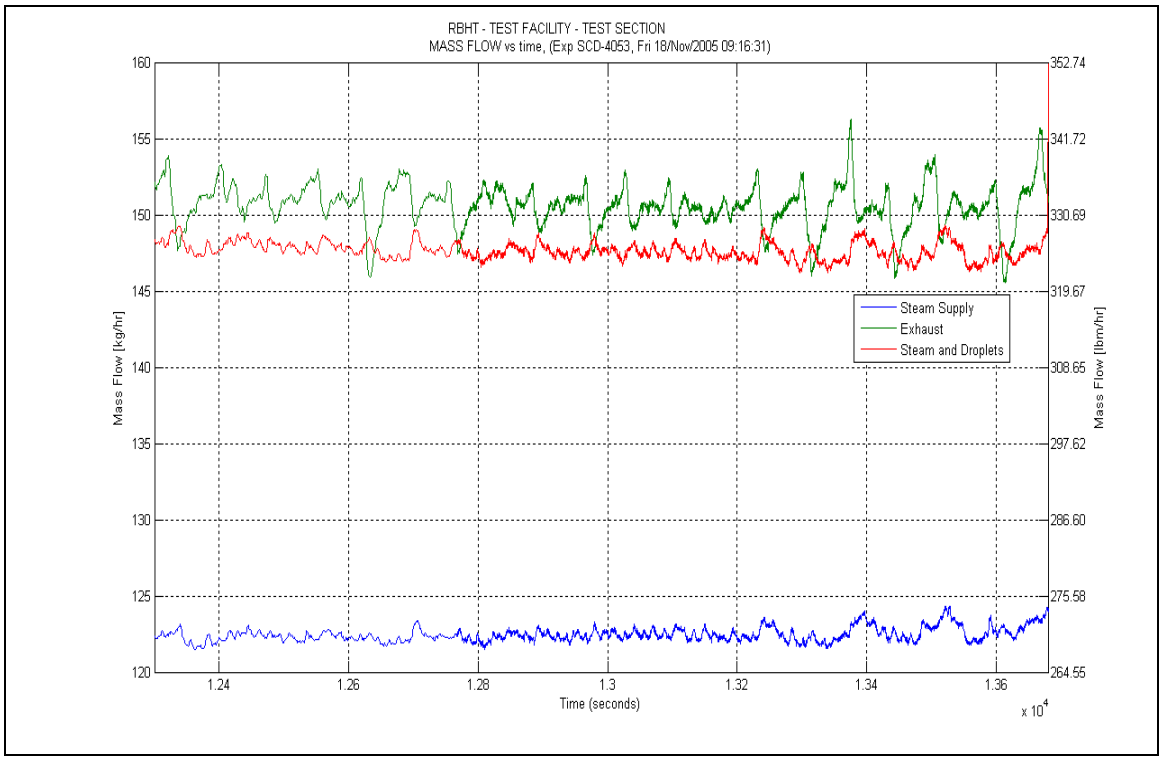

Figure A-332: Mass Flow for Experiment 4053B

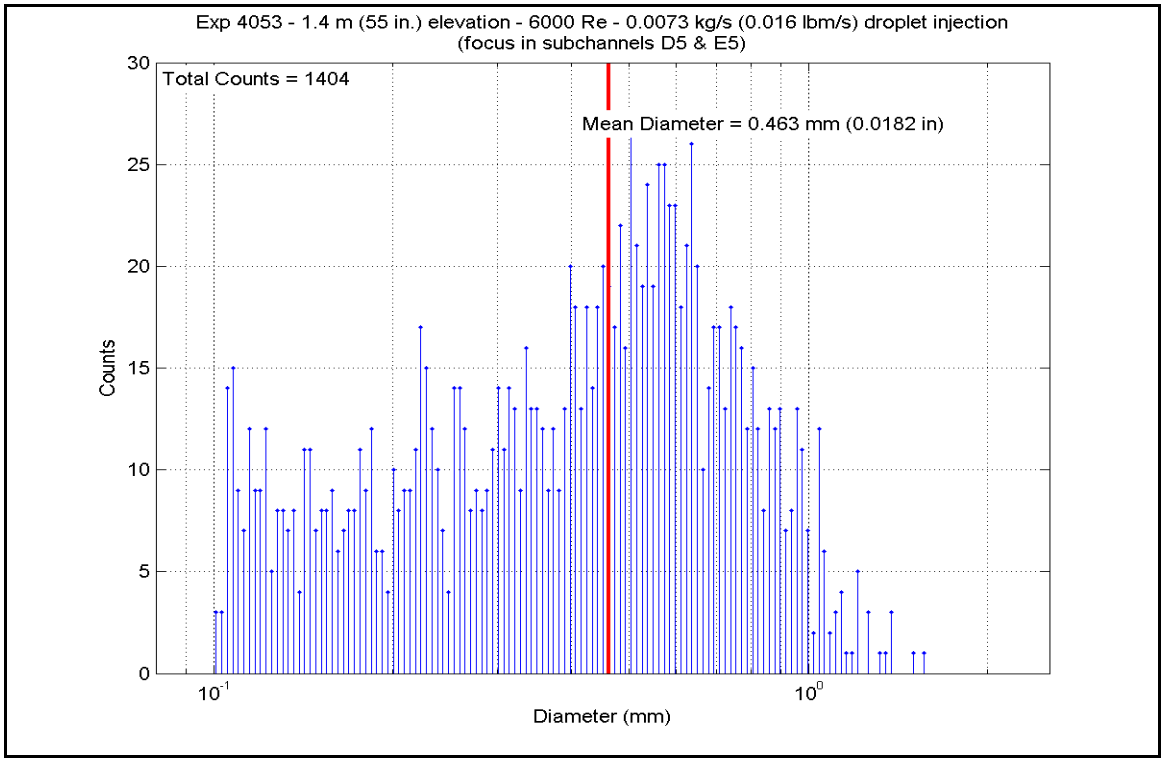

Figure A-333: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053B

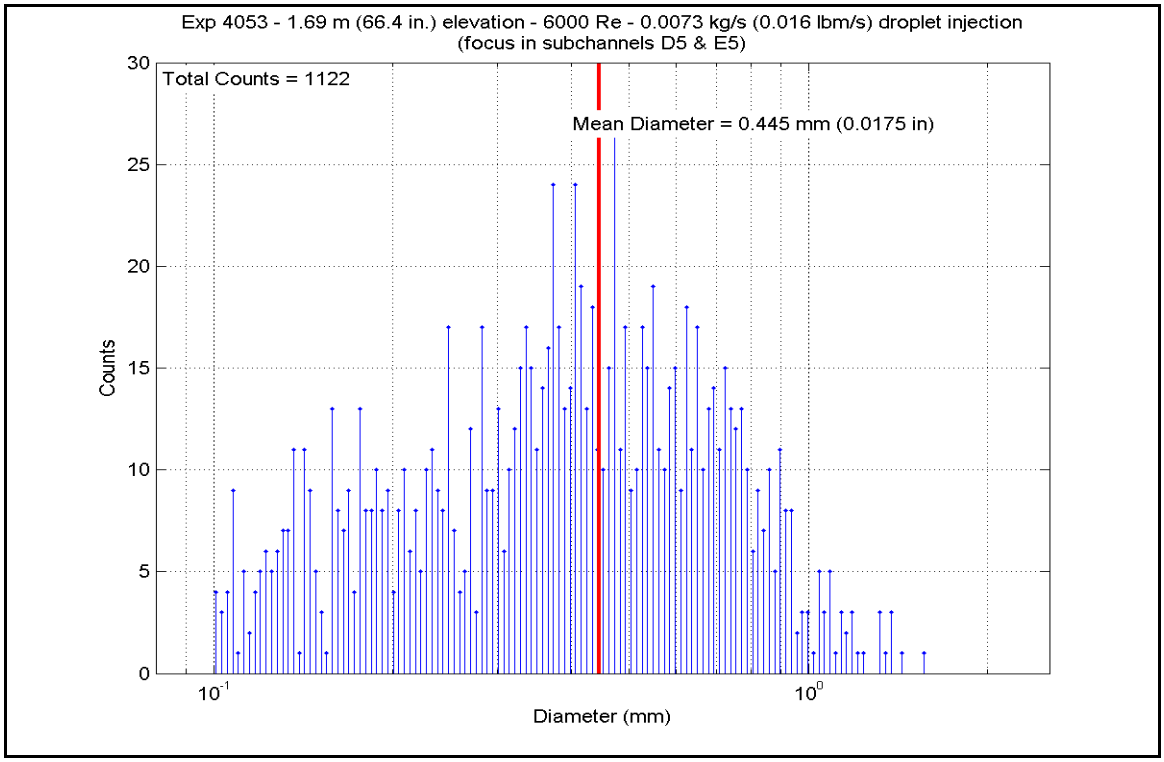

Figure A-334: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053B

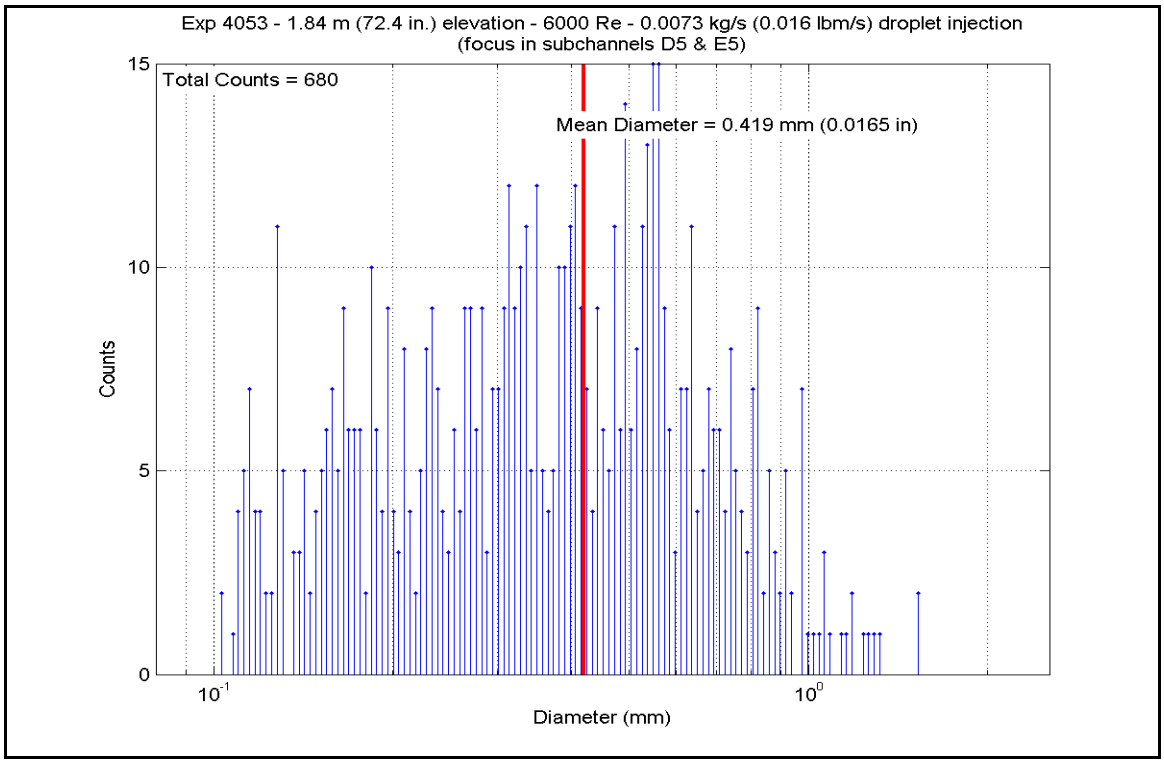

Figure A-335: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053B

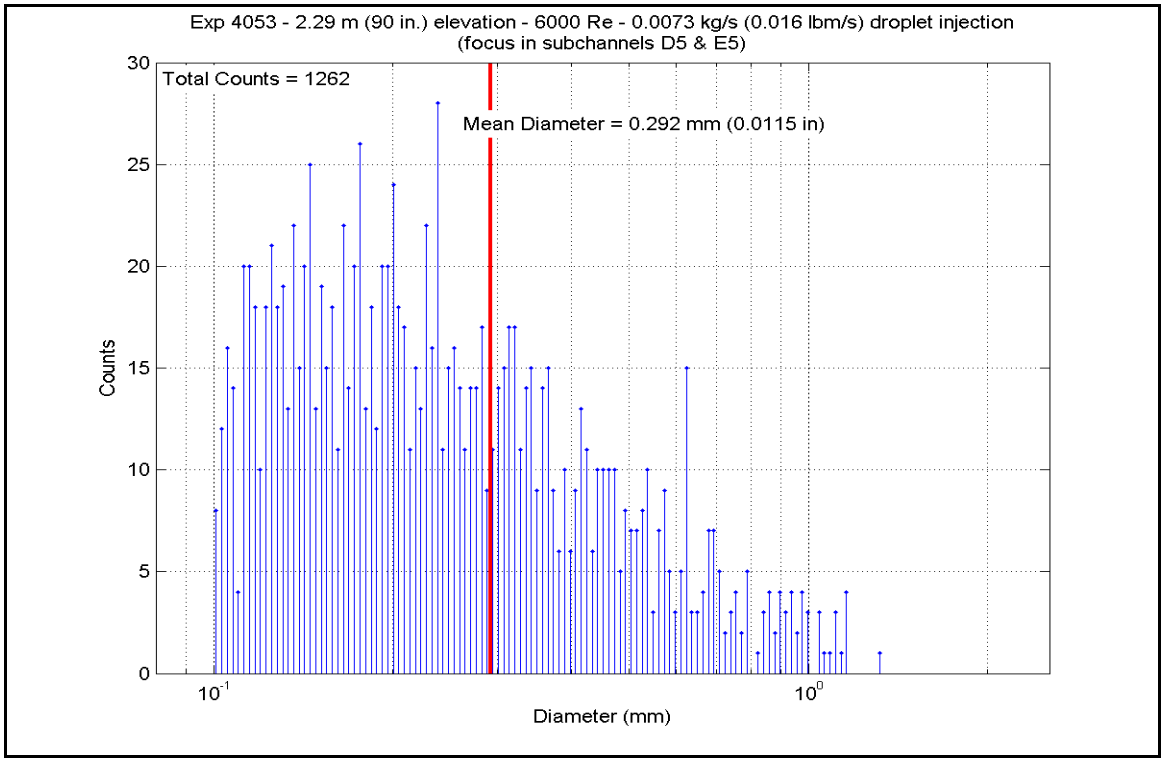

Figure A-336: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053B

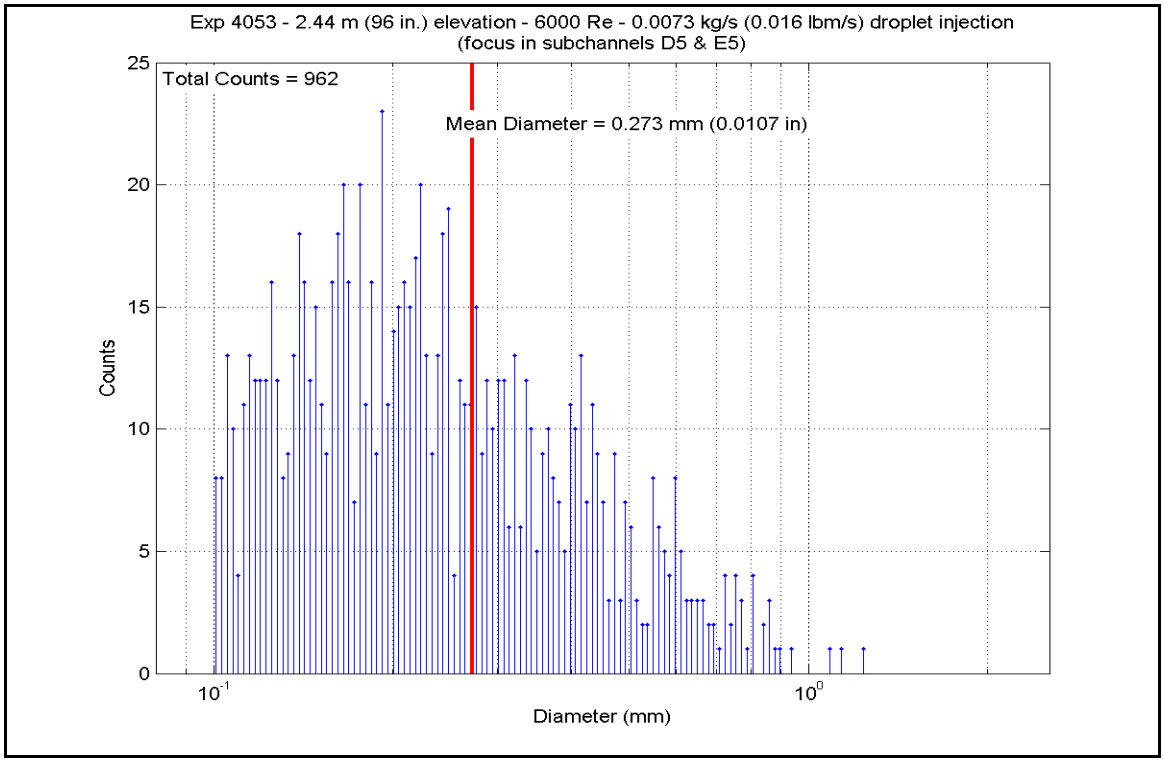

Figure A-337: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053B

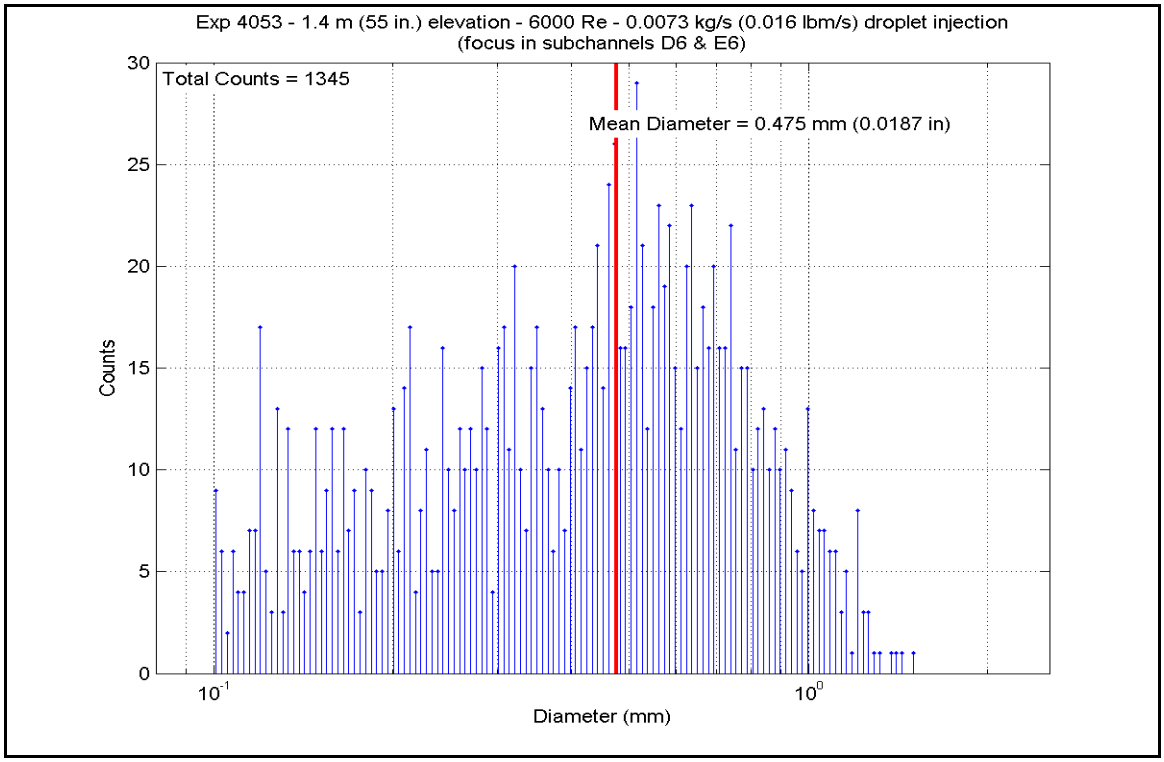

Figure A-338: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053B

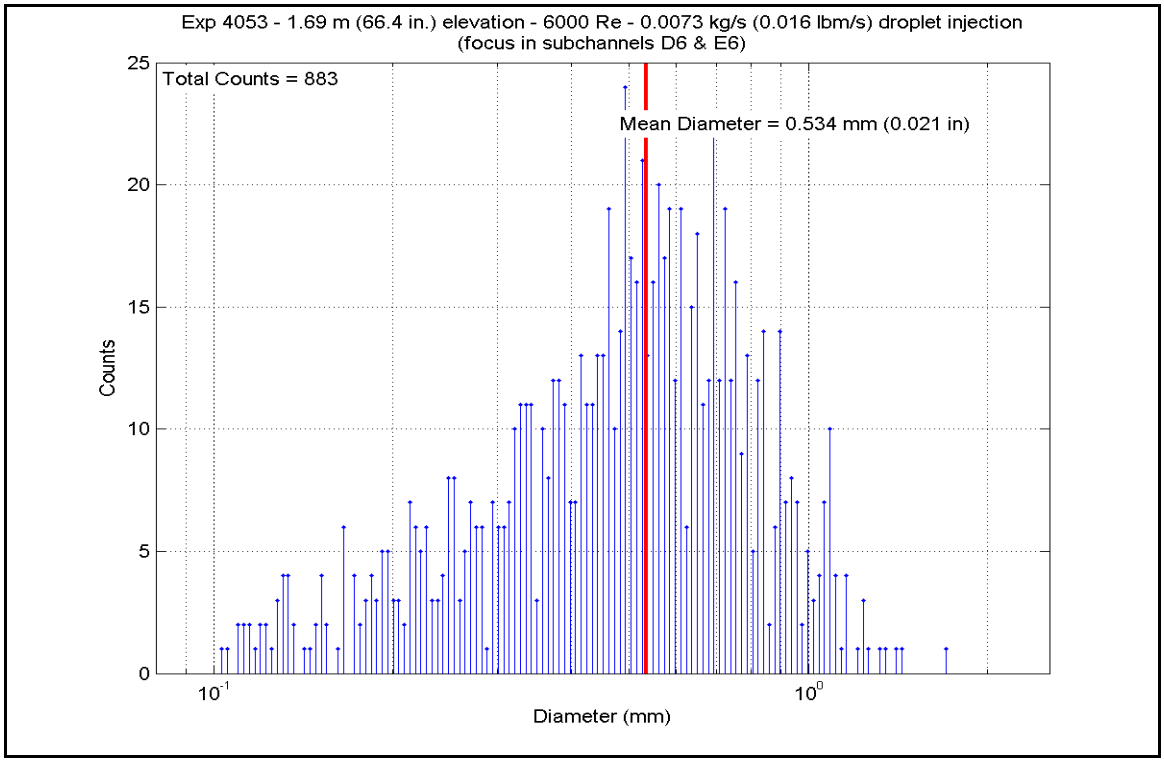

Figure A-339: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053B

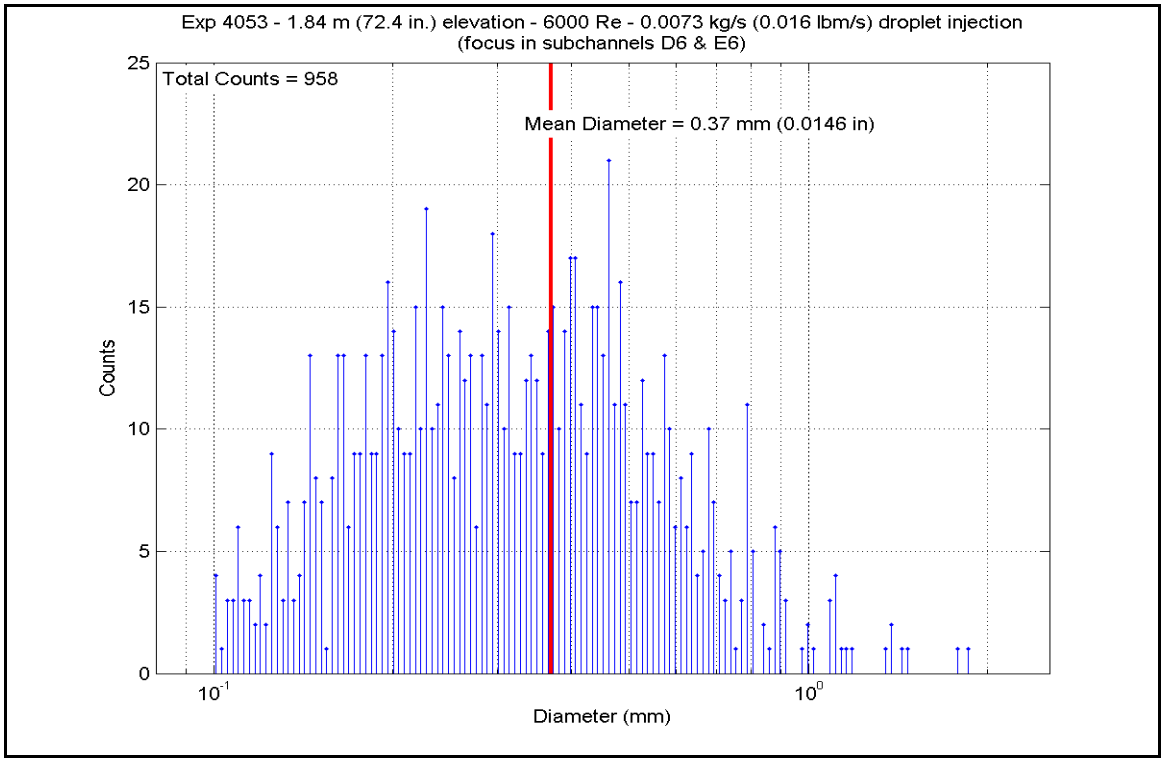

Figure A-340: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053B

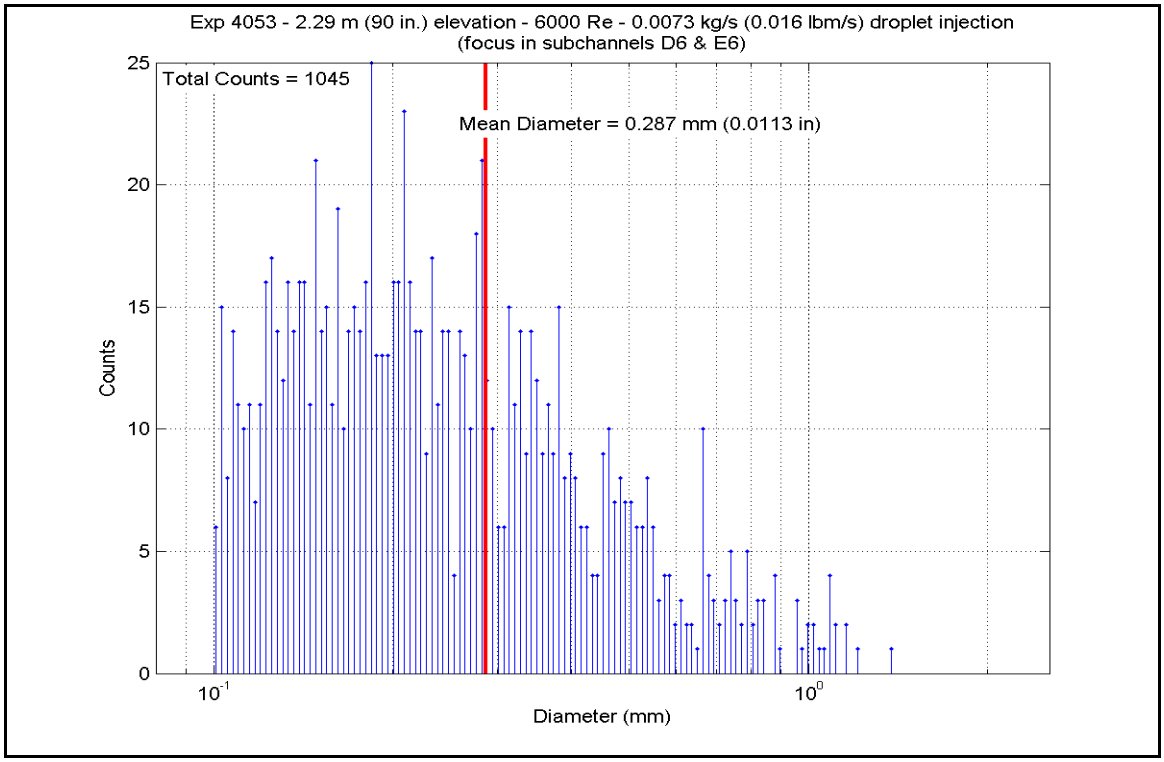

Figure A-341: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053B

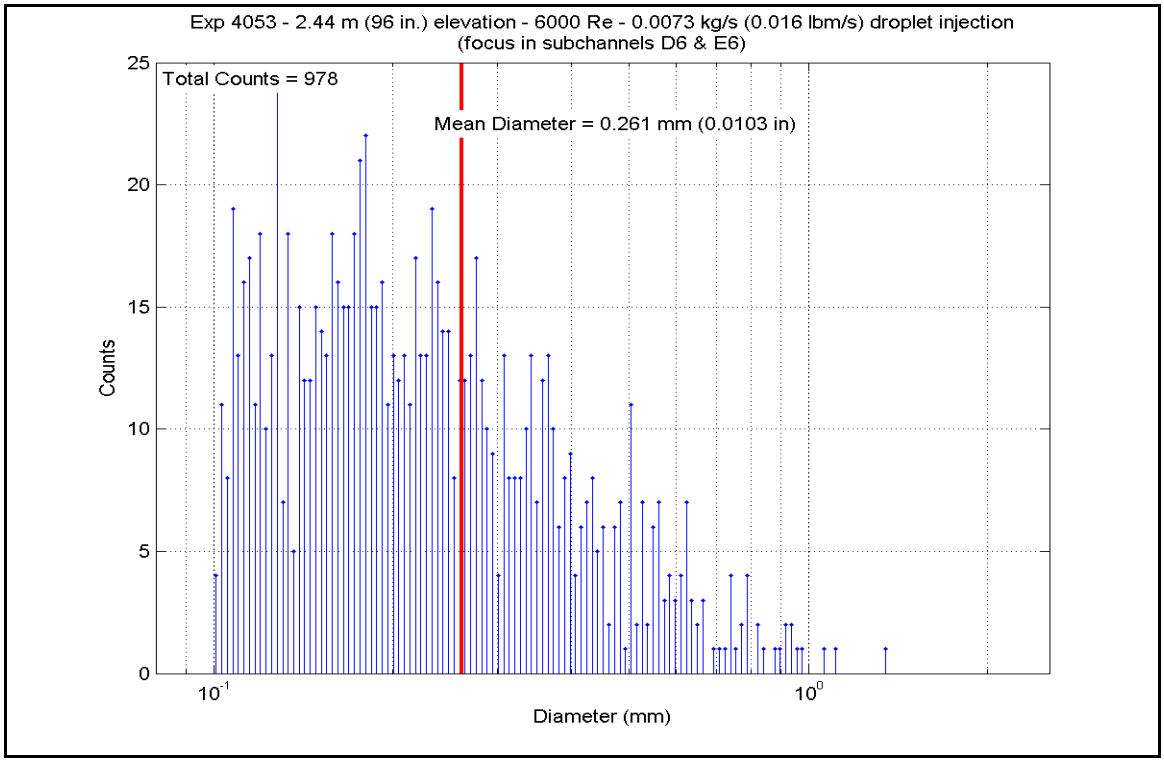

Figure A-342: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053B

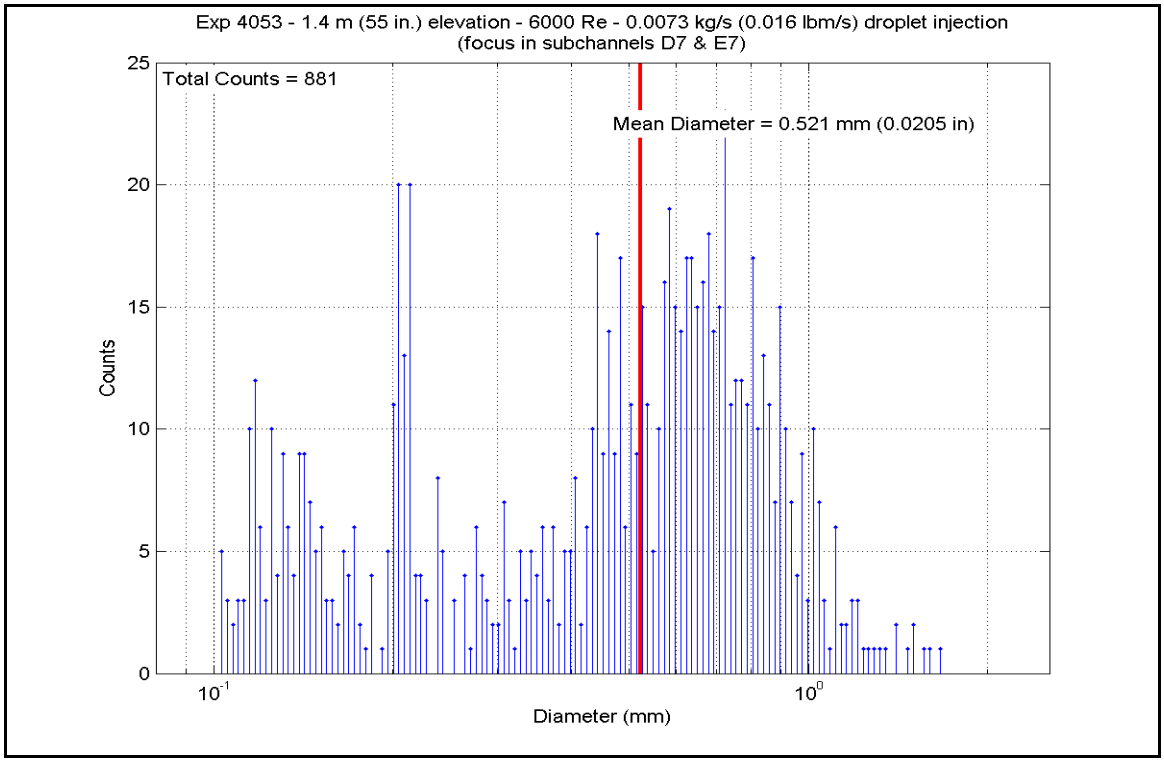

Figure A-343: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053B

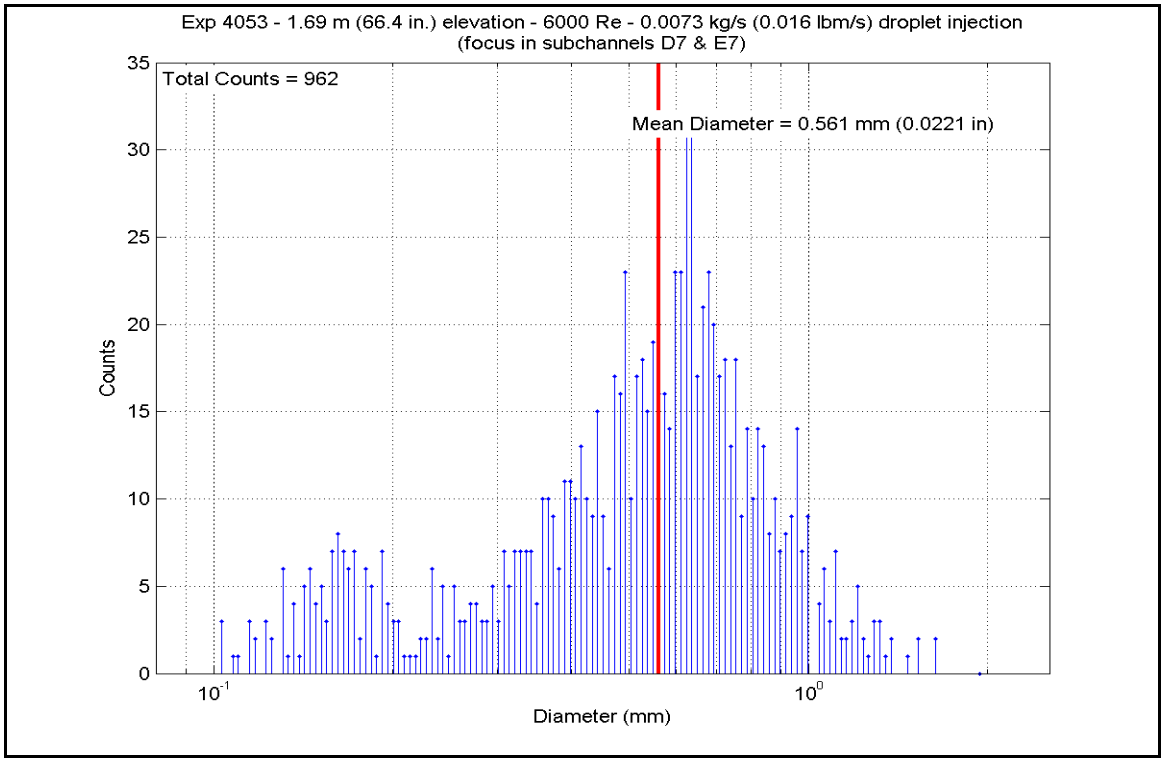

Figure A-344: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053B

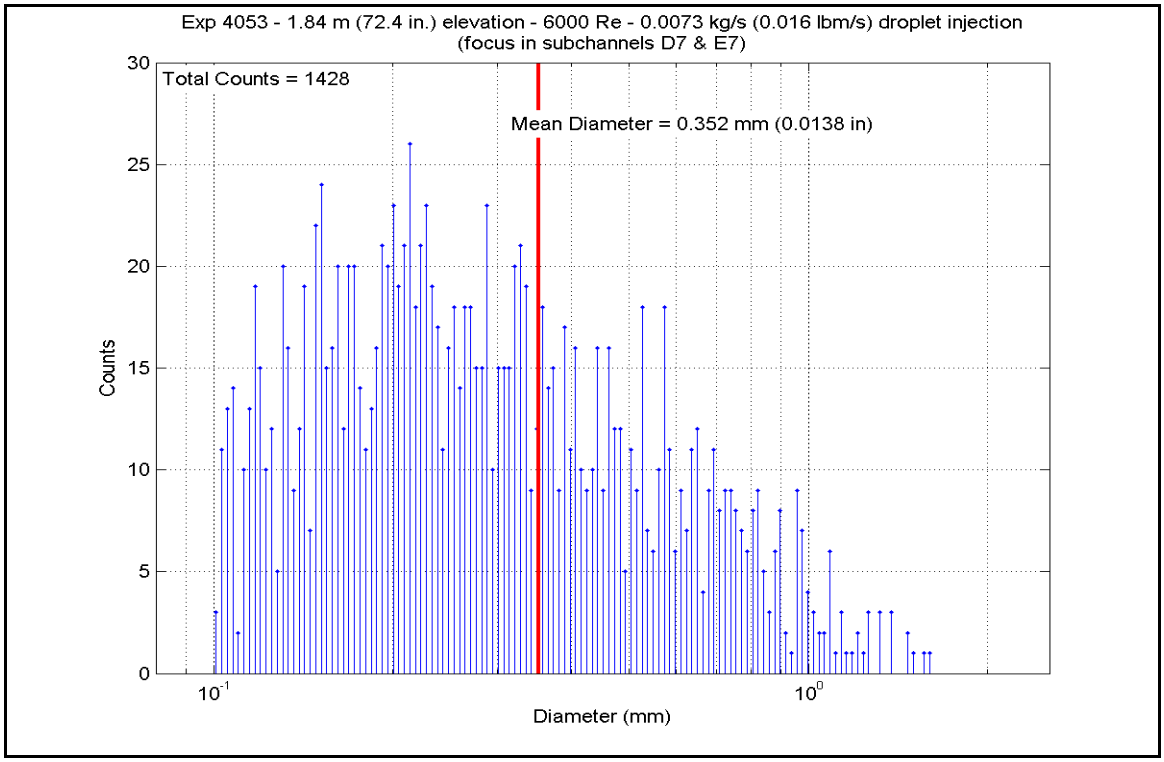

Figure A-345: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053B

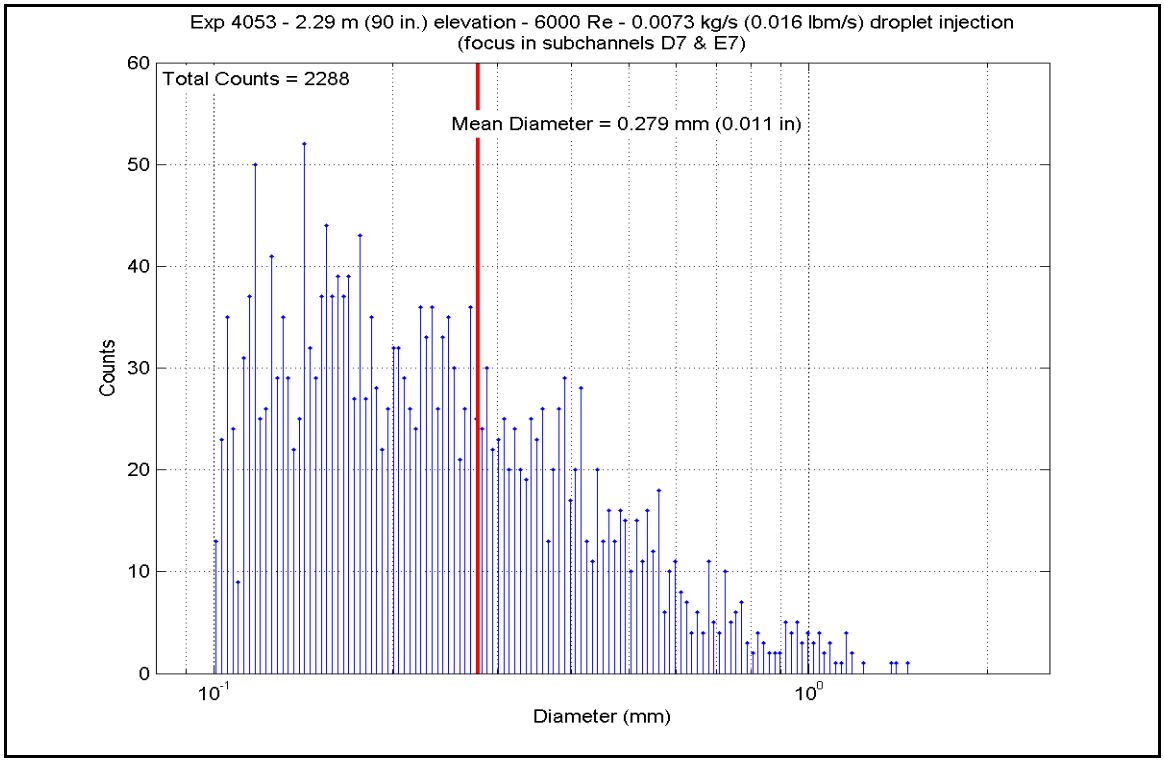

Figure A-346: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053B

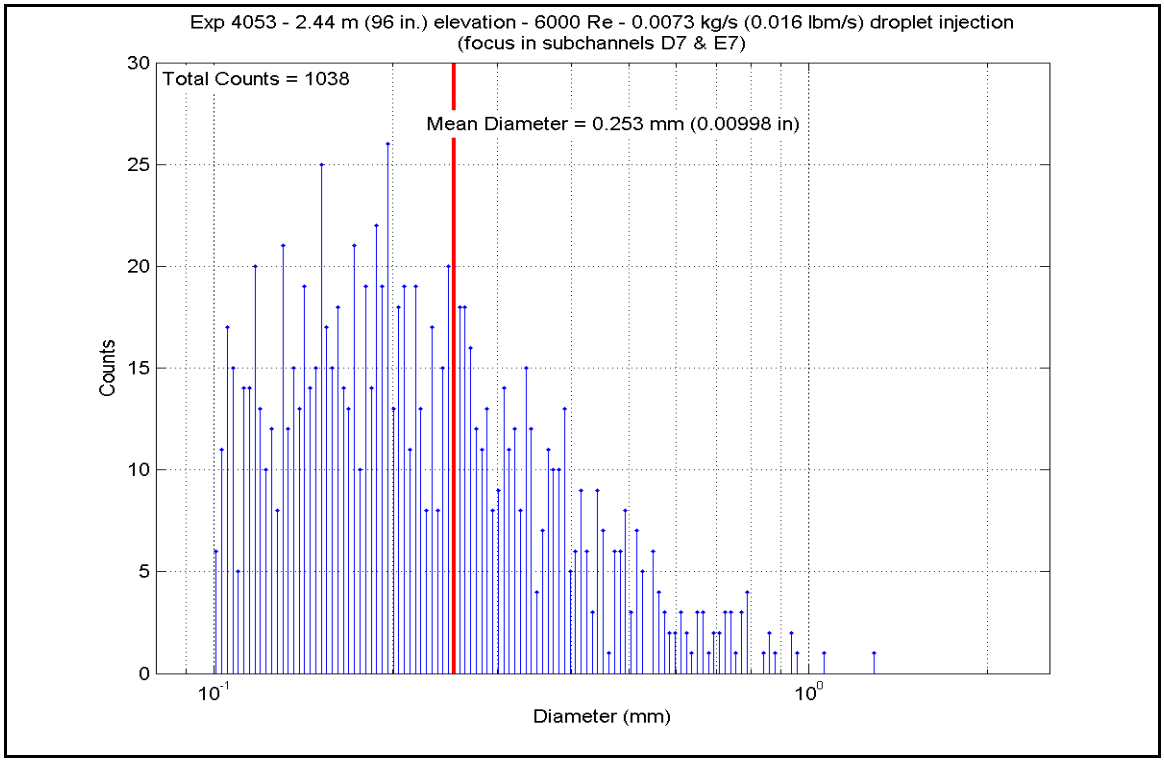

Figure A-347: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053B

Table A-57: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053B

SCD-4053-B	Inlet Reynolds:	6000	
Matrix test # 12b	UP Pressure:	137.9 kPa	20 psia
Time Window: 12300-13680	Bundle Power:	60.00 kW	204728 Btu/hr
	Steam flow:	0.0340 kg/s	270.0 lbm/hr
	Droplet flow:	0.0073 kg/s	0.016 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	844.20	724.4	5076.30	16013.2	8.238	46.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	939.46	777.3	5183.55	16351.5	7.286	41.4
	RodD3_93.1	187	93.1	2.365	4.6	0.117	956.42	786.7	5245.77	16547.8	7.202	40.9
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1005.37	813.9	5328.39	16808.4	6.854	38.9
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1163.19	901.6	5718.55	18039.2	6.115	34.7
	RodD3_110	191	110	2.794	21.5	0.546	1099.58	866.3	5639.68	17790.4	6.471	36.7
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1160.99	900.4	1958.24	6177.3	2.099	11.9
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	816.33	708.9	5139.47	16212.5	8.736	49.6
	RodC4_91.1	234	91.1	2.314	2.6	0.066	906.72	759.1	5240.07	16529.8	7.721	43.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	944.03	779.8	5324.38	16795.7	7.436	42.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	983.75	801.9	5394.75	17017.7	7.138	40.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1055.16	841.6	5568.03	17564.3	6.731	38.2
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1126.76	881.3	5789.82	18264.0	6.442	36.6
	RodC4_110	239	110	2.794	21.5	0.546	1051.59	839.6	5597.85	17658.4	6.797	38.6
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1125.95	880.9	2126.59	6708.3	2.368	13.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	813.08	707.1	5118.27	16145.6	8.748	49.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	906.15	758.8	5227.45	16490.0	7.708	43.8
	RodD4_93.2	243	93.2	2.367	4.7	0.119	936.82	775.8	5297.50	16711.0	7.474	42.4
	RodD4_95.2	244	95.2	2.418	6.7	0.170	974.35	796.7	5369.90	16939.3	7.195	40.9
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1049.38	838.4	5547.83	17500.6	6.754	38.4
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1122.45	879.0	5766.07	18189.1	6.446	36.6
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1128.66	882.4	2053.36	6477.3	2.280	12.9
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	827.97	715.4	5042.55	15906.7	8.405	47.7
	RodE4_91.2	202	91.2	2.316	2.7	0.069	923.20	768.3	5139.40	16212.2	7.393	42.0
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1006.75	814.7	5281.42	16660.2	6.782	38.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1082.19	856.6	5476.24	17274.8	6.411	36.4
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1144.10	891.0	2080.26	6562.2	2.271	12.9

Table A-57: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	990.87	805.9	4185.64	13203.6	5.487	31.2
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1135.94	886.5	5141.15	16217.8	5.662	32.2
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1168.70	904.7	4949.58	15613.4	5.262	29.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1197.35	920.6	4647.71	14661.2	4.795	27.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1215.02	930.4	4224.70	13326.8	4.280	24.3
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1221.03	933.7	3842.86	12122.3	3.870	22.0
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1142.78	890.3	3311.61	10446.5	3.620	20.6
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1164.80	902.5	2922.15	9217.9	3.119	17.7
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	992.77	806.9	4098.39	12928.4	5.359	30.4
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1040.73	833.6	5018.78	15831.8	6.175	35.1
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1081.69	856.3	4818.54	15200.1	5.644	32.1
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1134.20	885.5	4150.35	13092.3	4.580	26.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1139.25	888.3	3767.90	11885.9	4.135	23.5
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1032.18	828.8	3289.93	10378.1	4.091	23.2
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1067.26	848.3	2897.33	9139.6	3.452	19.6
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	914.59	763.5	4192.69	13225.8	6.107	34.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1025.26	825.0	5181.37	16344.6	6.499	36.9
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1061.23	844.9	5003.98	15785.1	6.006	34.1
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1103.73	868.6	4679.69	14762.1	5.344	30.3
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1134.25	885.5	4294.95	13548.4	4.739	26.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1147.96	893.1	3899.11	12299.8	4.238	24.1
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1210.66	928.0	3382.67	10670.6	3.442	19.5
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1107.89	870.9	2988.62	9427.6	3.397	19.3
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	948.34	782.2	4744.58	14966.8	6.587	37.4
	RodC3_85.6	178	85.6	2.174	14.72	0.374	843.97	724.2	4953.80	15626.8	8.042	45.7
	RodC3_88.5	179	88.5	2.248	0	0.000	835.25	719.4	5057.02	15952.4	8.328	47.3
	RodC3_92.4	180	92.4	2.347	3.9	0.099	964.07	791.0	5193.70	16383.5	7.056	40.1
	RodC3_94.4	181	94.4	2.398	5.9	0.150	993.18	807.1	5264.51	16606.9	6.880	39.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	850.15	727.7	3714.62	11717.8	5.971	33.9
	RodD5_54.1	218	54.1	1.374	7.1	0.180	861.19	733.8	3854.90	12160.3	6.088	34.6
	RodD5_56.9	219	56.9	1.445	9.9	0.251	906.70	759.1	3959.11	12489.0	5.833	33.1
	RodD5_60	220	60	1.524	13	0.330	952.66	784.6	4071.40	12843.2	5.618	31.9
	RodD5_66.1	221	66.1	1.679	19.1	0.485	983.13	801.6	4288.77	13528.9	5.680	32.3
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	752.66	673.5	4426.11	13962.2	8.436	47.9
	RodD5_72.9	223	72.9	1.852	2.02	0.051	832.02	717.6	4529.40	14288.0	7.499	42.6
	RodD5_74.9	224	74.9	1.902	4.02	0.102	876.14	742.1	4599.48	14509.1	7.096	40.3

Table A-57: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	798.24	698.8	3372.08	10637.2	5.913	33.6
	RodB5_52.9	154	52.9	1.344	5.9	0.150	850.84	728.1	3802.50	11995.0	6.105	34.7
	RodB5_55	155	55	1.397	8	0.203	881.61	745.2	3878.97	12236.2	5.935	33.7
	RodB5_57.8	156	57.8	1.468	10.8	0.274	932.68	773.5	3977.03	12545.5	5.644	32.1
	RodB5_64	157	64	1.626	17	0.432	997.68	809.6	4199.40	13247.0	5.456	31.0
	RodB5_73.9	158	73.9	1.877	3.02	0.077	900.04	755.4	4561.11	14388.0	6.787	38.5
	RodB5_75.9	159	75.9	1.928	5.02	0.128	937.81	776.4	4632.68	14613.8	6.527	37.1
	RodB5_76.9	160	76.9	1.953	6.02	0.153	953.23	784.9	4668.17	14725.8	6.437	36.6
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	794.60	696.8	3353.36	10578.2	5.918	33.6
	RodF5_53.1	106	53.1	1.349	6.1	0.155	828.59	715.7	3787.97	11949.1	6.307	35.8
	RodF5_55	107	55	1.397	8	0.203	869.53	738.4	3856.68	12165.9	6.012	34.1
	RodF5_57.8	108	57.8	1.468	10.8	0.274	923.05	768.2	3953.77	12472.2	5.689	32.3
	RodF5_64	109	64	1.626	17	0.432	980.83	800.3	4179.99	13185.8	5.552	31.5
	RodF5_73.8	110	73.8	1.875	2.92	0.074	877.36	742.8	4521.84	14264.1	6.964	39.5
	RodF5_75.8	111	75.8	1.925	4.92	0.125	916.65	764.6	4595.14	14495.4	6.673	37.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	932.70	773.5	4631.45	14609.9	6.572	37.3
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	794.01	696.5	3366.28	10618.9	5.947	33.8
	RodC2_53.1	58	53.1	1.349	6.1	0.155	899.11	754.9	3800.70	11989.3	5.663	32.2
	RodC2_55	59	55	1.397	8	0.203	921.46	767.3	3869.11	12205.1	5.579	31.7
	RodC2_57.8	60	57.8	1.468	10.8	0.274	958.38	787.8	3970.12	12523.7	5.436	30.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1004.88	813.6	4190.72	13219.6	5.394	30.6
	RodC2_73.8	62	73.8	1.875	2.92	0.074	918.21	765.5	4544.77	14336.5	6.585	37.4
	RodC2_75.8	63	75.8	1.925	4.92	0.125	948.65	782.4	4618.53	14569.2	6.409	36.4
	RodC2_76.8	64	76.8	1.951	5.92	0.150	961.97	789.8	4655.59	14686.0	6.343	36.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	796.35	697.8	3350.45	10569.0	5.895	33.5
	RodC6_52.8	138	52.8	1.341	5.8	0.147	896.61	753.5	3797.49	11979.2	5.680	32.3
	RodC6_54.8	139	54.8	1.392	7.8	0.198	920.66	766.8	3872.05	12214.4	5.590	31.7
	RodC6_57.8	140	57.8	1.468	10.8	0.274	941.53	778.4	3979.69	12553.9	5.577	31.7
	RodC6_63.8	141	63.8	1.621	16.8	0.427	980.96	800.3	4209.39	13278.5	5.590	31.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	862.11	734.3	4584.96	14463.3	7.231	41.1
	RodC6_75.8	143	75.8	1.925	4.92	0.125	892.96	751.5	4663.68	14711.6	7.013	39.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	911.39	761.7	4700.97	14829.2	6.879	39.1

Table A-57: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	831.80	717.5	5044.57	15913.1	8.355	47.4
	RodB4_91.3	162	91.3	2.319	2.8	0.071	926.40	770.0	5145.58	16231.7	7.368	41.8
	RodB4_93.3	163	93.3	2.370	4.8	0.122	957.32	787.2	5212.93	16444.2	7.148	40.6
	RodB4_95.1	164	95.1	2.416	6.6	0.168	990.19	805.5	5275.26	16640.8	6.921	39.3
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1121.64	878.5	2117.94	6681.1	2.370	13.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	933.19	773.8	4971.23	15681.7	7.049	40.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	884.77	746.9	5073.12	16003.2	7.724	43.9
	RodF4_92.4	100	92.4	2.347	3.9	0.099	981.71	800.8	5216.51	16455.5	6.921	39.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1017.34	820.6	5284.31	16669.4	6.695	38.0
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1159.59	899.6	5004.52	15786.7	5.372	30.5
	RodD2_106	66	106	2.692	17.5	0.445	1181.56	911.8	4738.83	14948.6	4.970	28.2
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1208.88	927.0	4377.97	13810.3	4.463	25.3
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1226.05	936.5	3954.11	12473.2	3.962	22.5
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1219.09	932.6	3549.74	11197.6	3.582	20.3
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1053.58	840.7	5027.86	15860.4	6.090	34.6
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1080.96	855.9	4824.99	15220.4	5.657	32.1
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1104.96	869.2	4385.99	13835.6	5.001	28.4
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1117.57	876.2	3968.10	12517.4	4.461	25.3
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1110.65	872.4	3548.98	11195.3	4.021	22.8

Table A-57: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	851.29	728.3	3724.67	11749.5	5.976	33.9
	RodE2_54	74	54	1.372	7	0.178	916.02	764.3	3866.06	12195.5	5.619	31.9
	RodE2_56.9	75	56.9	1.445	9.9	0.251	952.00	784.3	3971.38	12527.7	5.485	31.2
	RodE2_59.9	76	59.9	1.521	12.9	0.328	987.03	803.7	4081.96	12876.5	5.378	30.5
	RodE2_66	77	66	1.676	19	0.483	1009.93	816.4	4305.87	13582.9	5.507	31.3
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	832.68	718.0	4448.13	14031.6	7.356	41.8
	RodE2_72.9	79	72.9	1.852	2.02	0.051	914.55	763.5	4557.93	14378.0	6.639	37.7
	RodE2_74.9	80	74.9	1.902	4.02	0.102	951.45	784.0	4629.58	14604.0	6.399	36.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	805.29	702.8	3701.75	11677.2	6.412	36.4
	RodB3_54.1	170	54.1	1.374	7.1	0.180	862.29	734.4	3845.50	12130.6	6.063	34.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	903.72	757.4	3944.68	12443.5	5.838	33.2
	RodB3_60.1	172	60.1	1.527	13.1	0.333	905.39	758.4	4063.26	12817.6	5.998	34.1
	RodB3_66.1	173	66.1	1.679	19.1	0.485	942.79	779.1	4280.00	13501.3	5.988	34.0
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	760.66	678.0	4421.44	13947.4	8.301	47.1
	RodB3_73	175	73	1.854	2.12	0.054	849.69	727.4	4526.31	14278.2	7.281	41.3
	RodB3_75	176	75	1.905	4.12	0.105	892.59	751.3	4597.18	14501.8	6.917	39.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	835.56	719.6	3702.58	11679.8	6.094	34.6
	RodF3_54	90	54	1.372	7	0.178	876.97	742.6	3848.37	12139.7	5.930	33.7
	RodF3_57	91	57	1.448	10	0.254	922.17	767.7	3957.61	12484.3	5.701	32.4
	RodF3_60	92	60	1.524	13	0.330	959.43	788.4	4070.26	12839.7	5.565	31.6
	RodF3_66.1	93	66.1	1.679	19.1	0.485	989.64	805.2	4298.27	13558.9	5.643	32.0
	RodF3_70	94	70	1.778	-0.88	-0.022	798.66	699.1	4440.56	14007.8	7.781	44.2
	RodF3_73	95	73	1.854	2.12	0.054	901.58	756.3	4545.27	14338.1	6.748	38.3
	RodF3_75	96	75	1.905	4.12	0.105	946.95	781.5	4618.51	14569.1	6.424	36.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	823.07	712.6	3700.72	11673.9	6.219	35.3
	RodE6_54.1	122	54.1	1.374	7.1	0.180	884.83	746.9	3839.52	12111.8	5.846	33.2
	RodE6_57	123	57	1.448	10	0.254	905.91	758.7	3943.77	12440.6	5.818	33.0
	RodE6_60.2	124	60.2	1.529	13.2	0.335	934.53	774.6	4059.64	12806.1	5.746	32.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	950.35	783.3	4270.12	13470.1	5.911	33.6
	RodE6_70	126	70	1.778	-0.88	-0.022	749.07	671.5	4406.41	13900.0	8.456	48.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	827.18	714.9	4522.26	14265.5	7.547	42.9
	RodE6_75	128	75	1.905	4.12	0.105	864.06	735.4	4590.02	14479.2	7.216	41.0

RBHT Steam Cooling with Droplet Injection Test SCD-4053-C

Matrix Test # 12c

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 14400 - 14880
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 60 kW
Bundle Inlet Reynolds Number: 6000
Bundle Inlet Steam Flow: 122.5 kg/hr (270 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

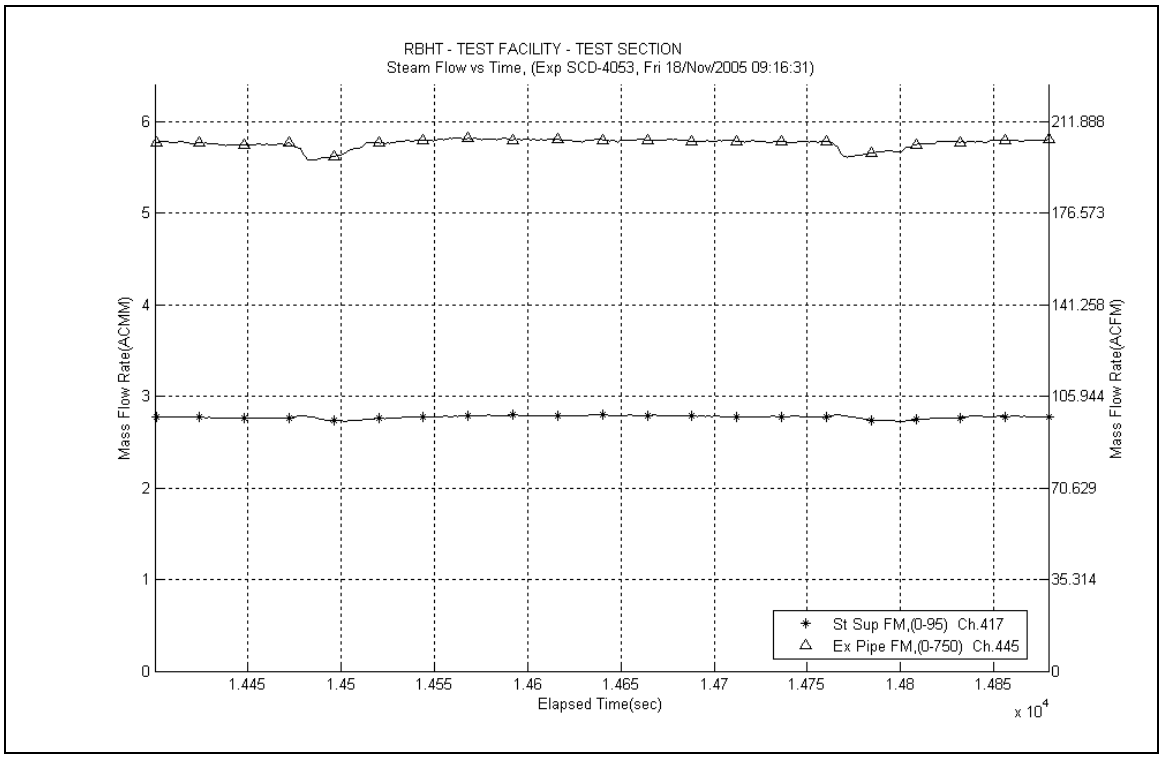

Figure A-348: Inlet and Exhaust Steam Flow Rates for Experiment 4053C

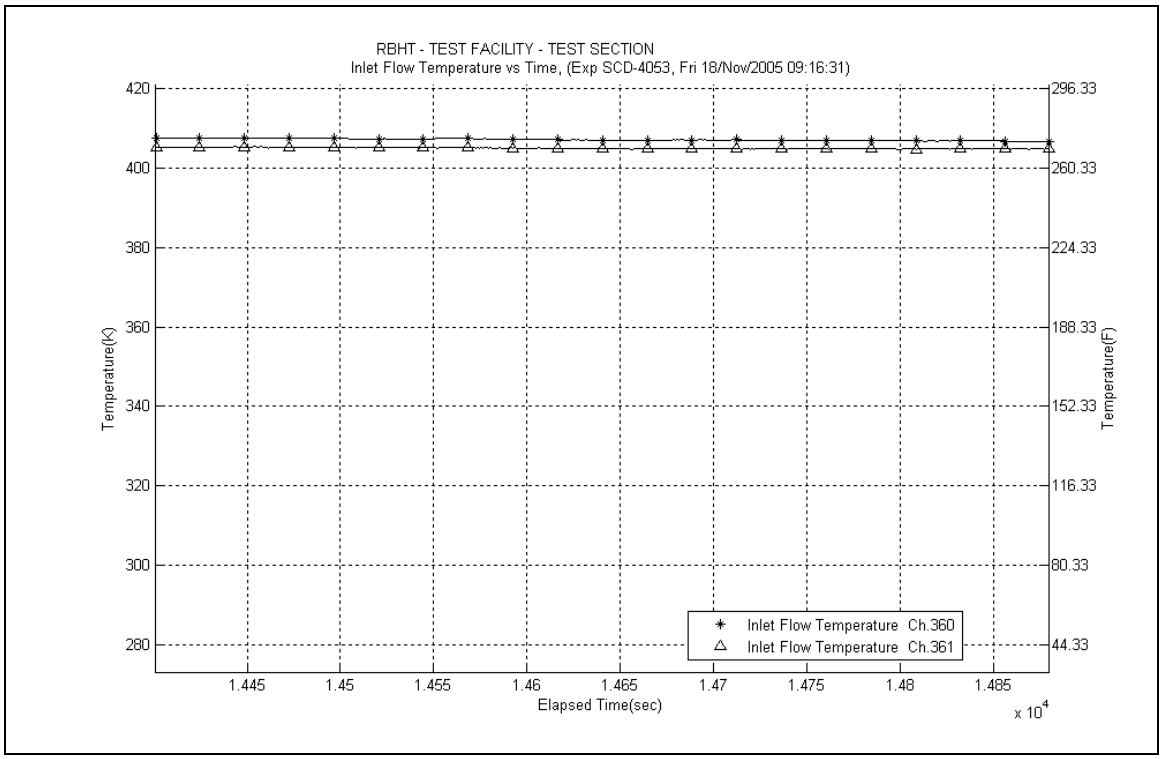

Figure A-349: Inlet Steam Temperature for Experiment 4053C

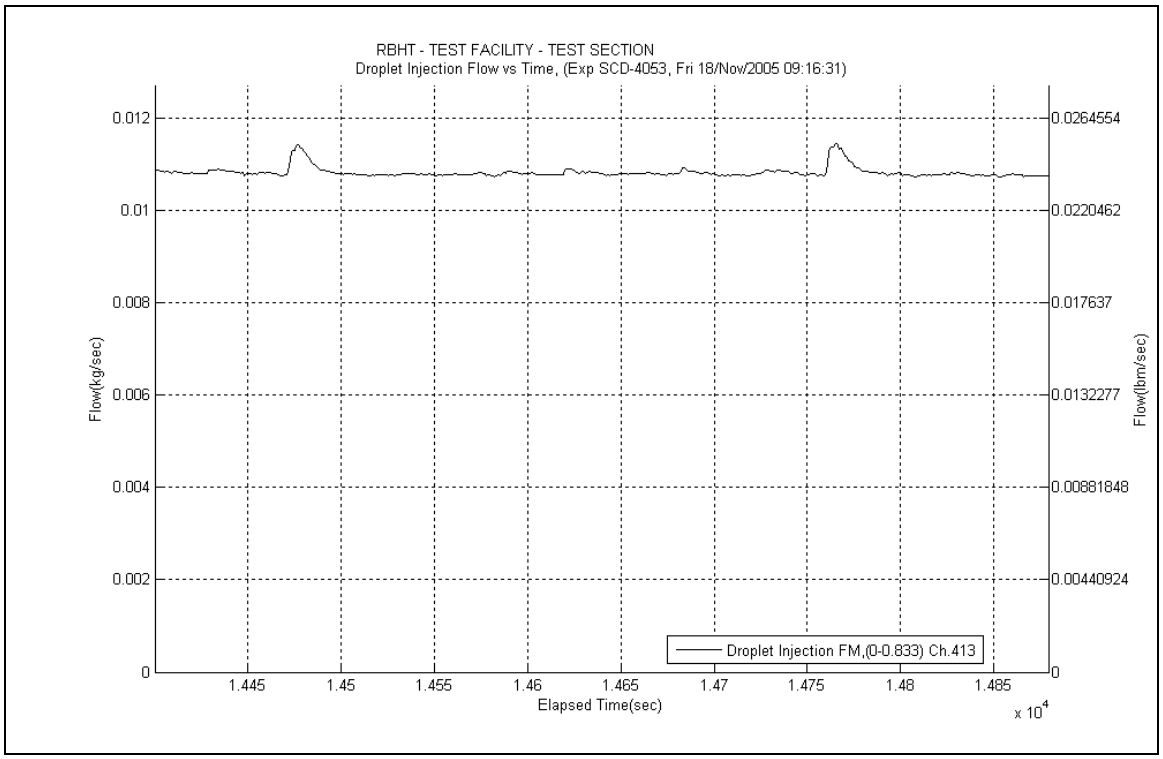

Figure A-350: Droplet Injection Flow Rate for Experiment 4053C

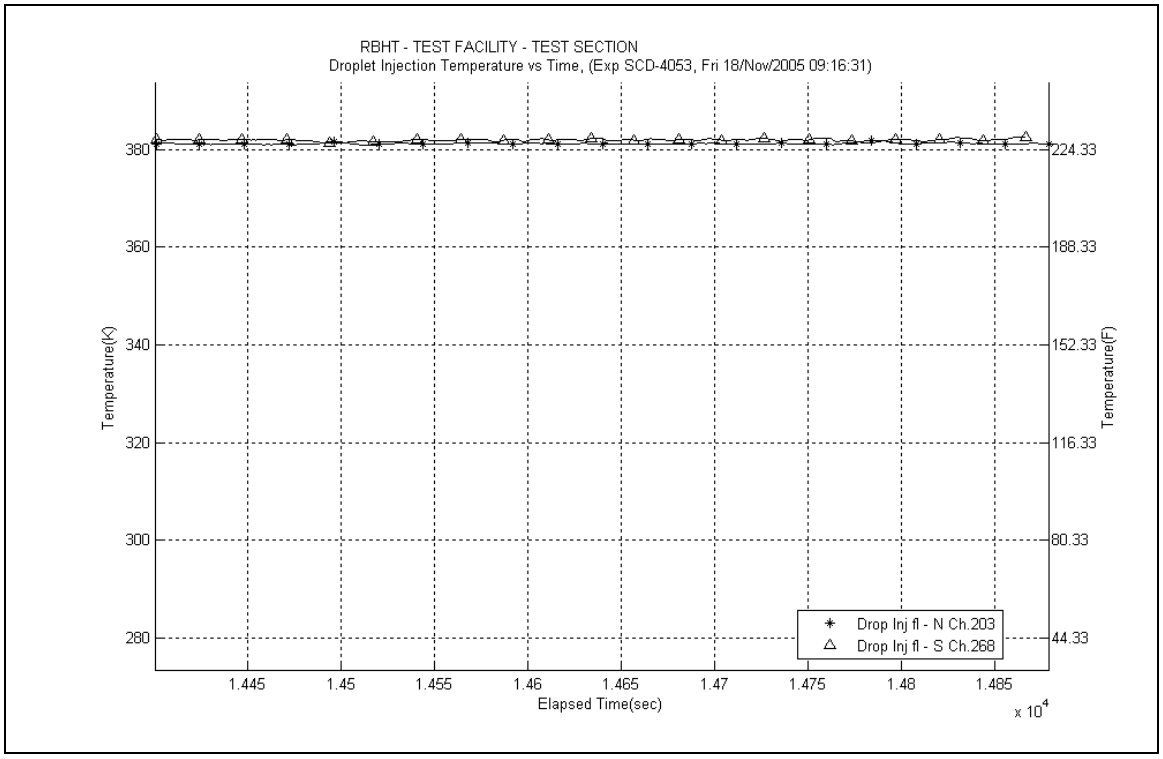

Figure A-351: Droplet Injection Temperature for Experiment 4053C

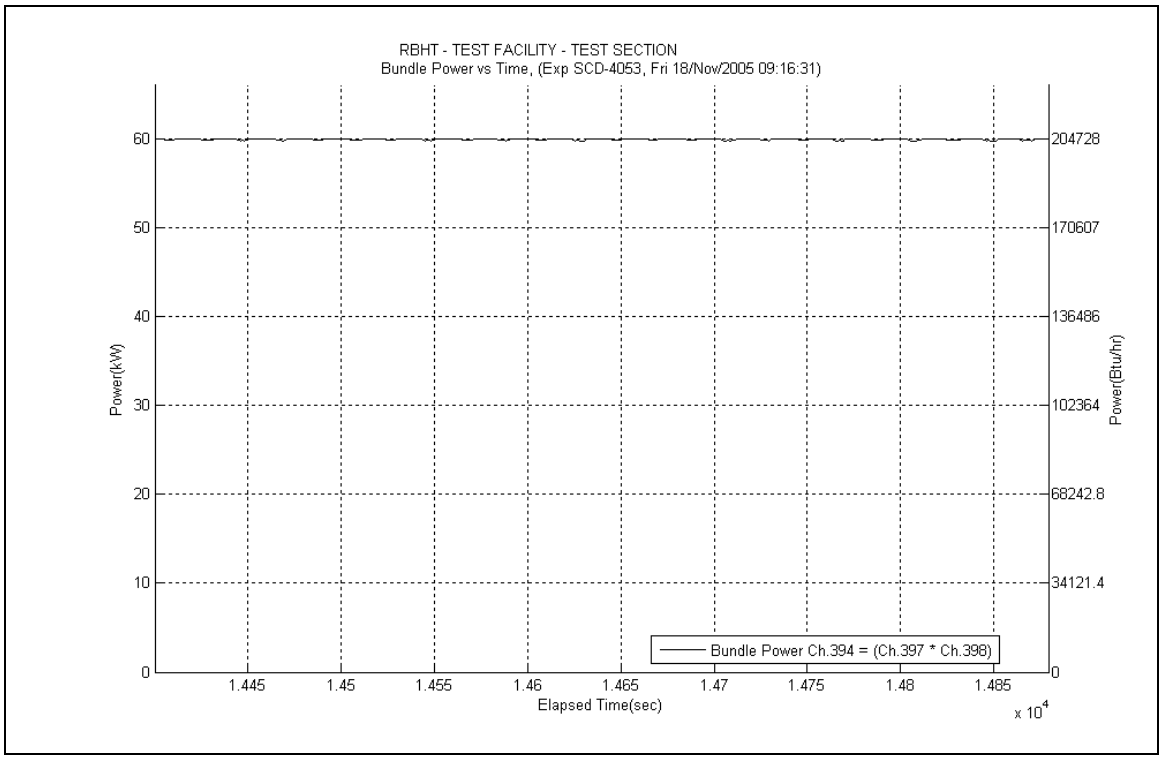

Figure A-352: Bundle Power for Experiment 4053C

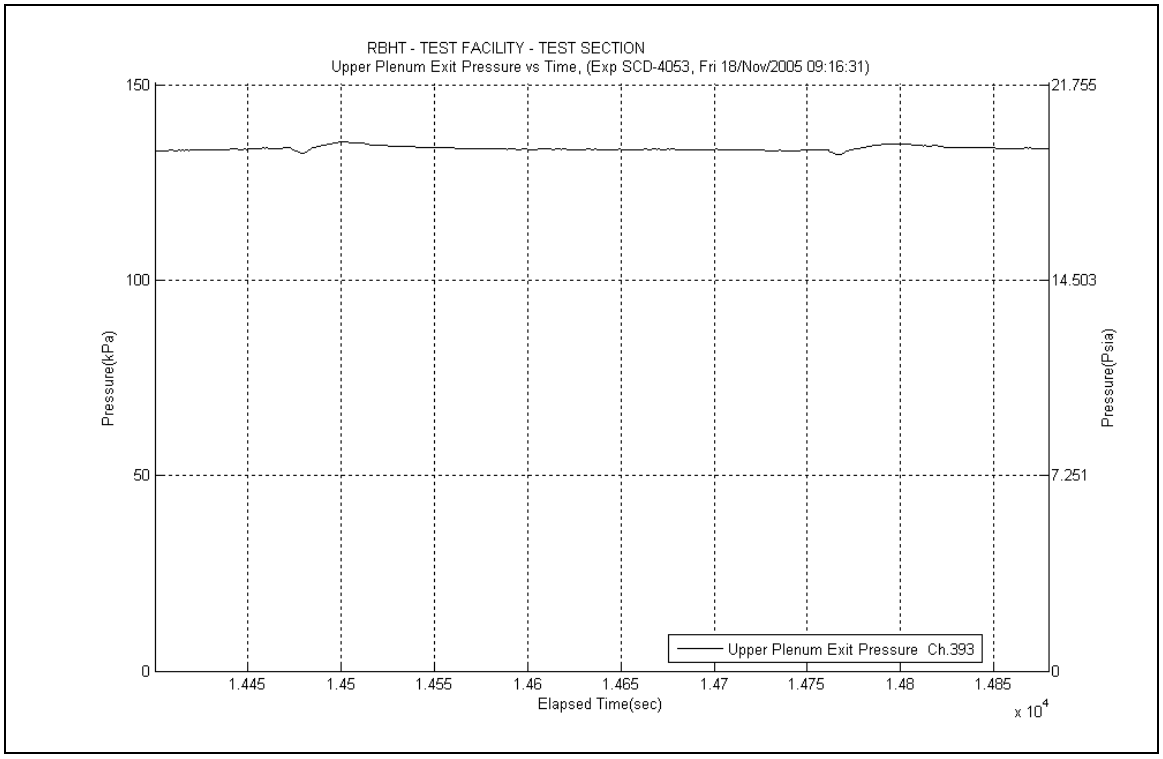

Figure A-353: Upper Plenum Pressure for Experiment 4053C

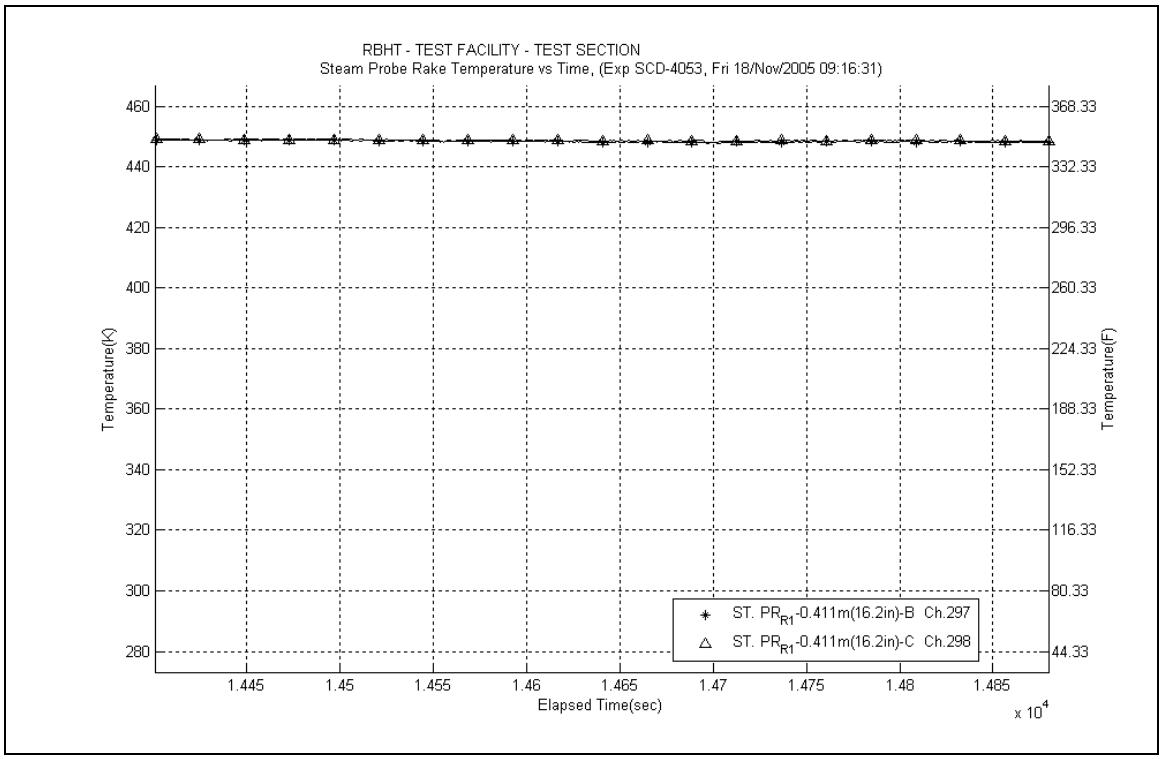

Figure A-354: Steam Probe Rake #1 Temperatures for Experiment 4053C

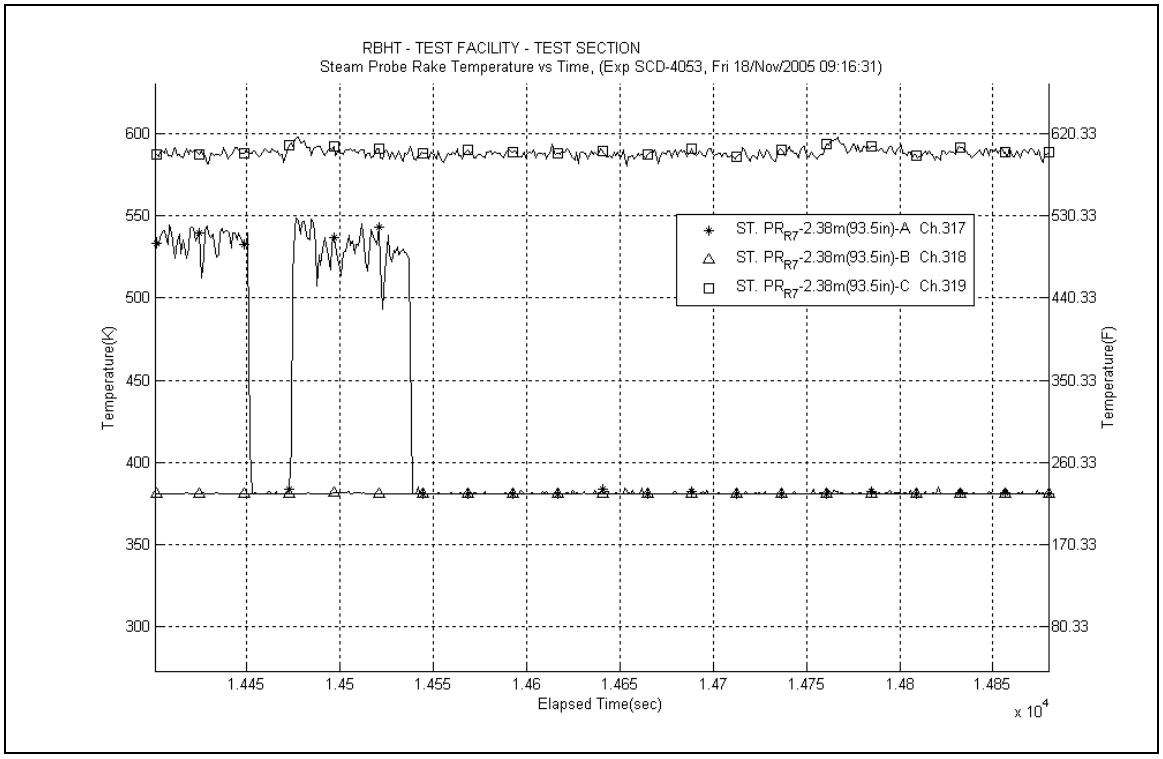

Figure A-355: Steam Probe Rake #7 Temperatures for Experiment 4053C

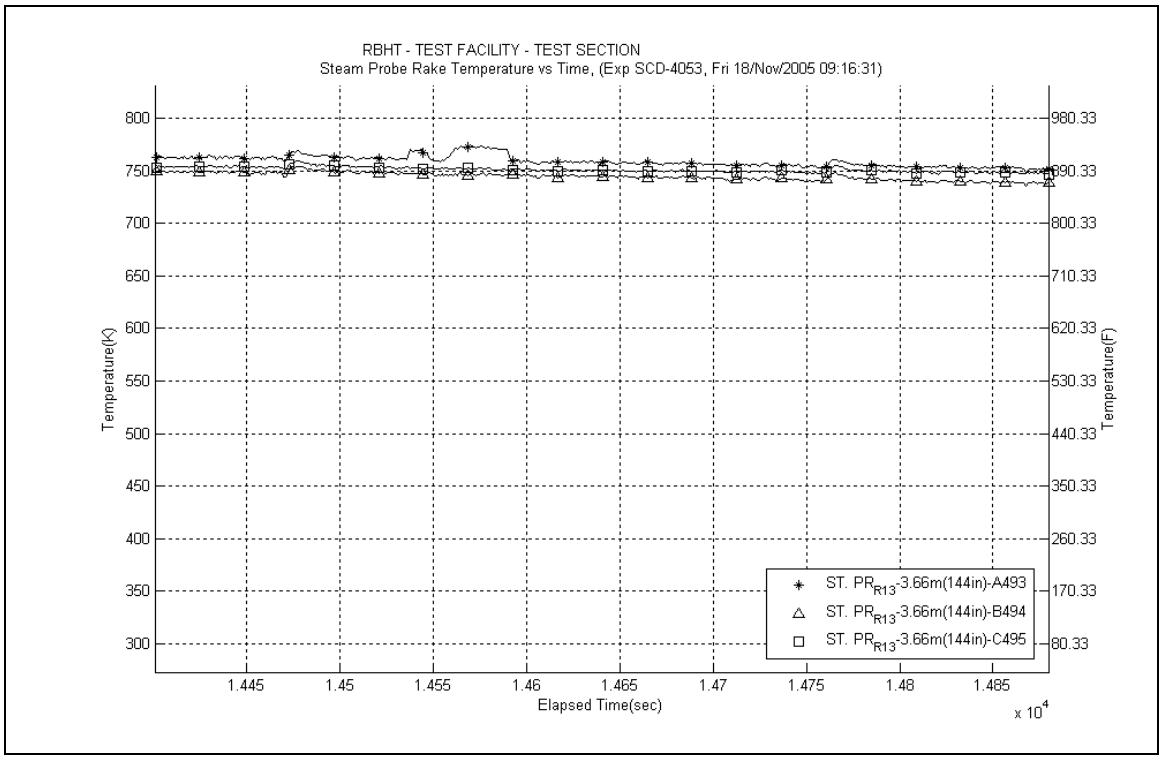

Figure A-356: Steam Probe Rake #13 Temperatures for Experiment 4053C

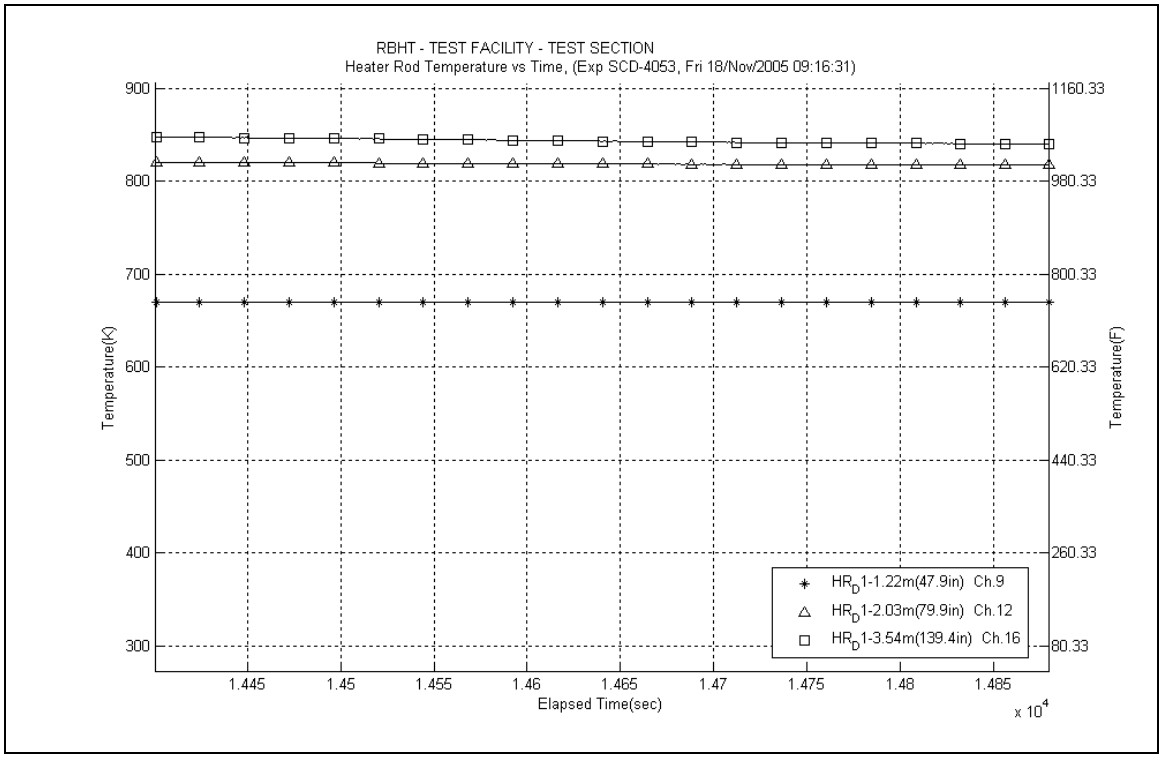

Figure A-357: Heater Rod D1 Temperatures for Experiment 4053C

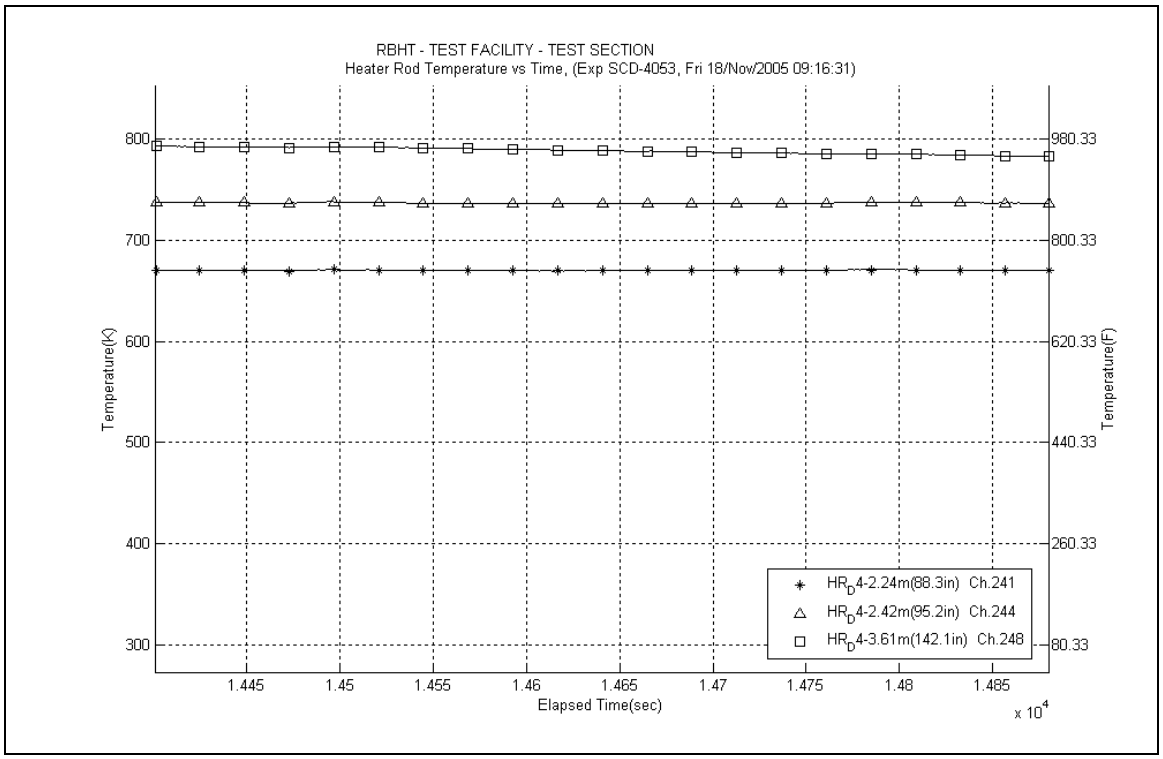

Figure A-358: Heater Rod D4 Temperatures for Experiment 4053C

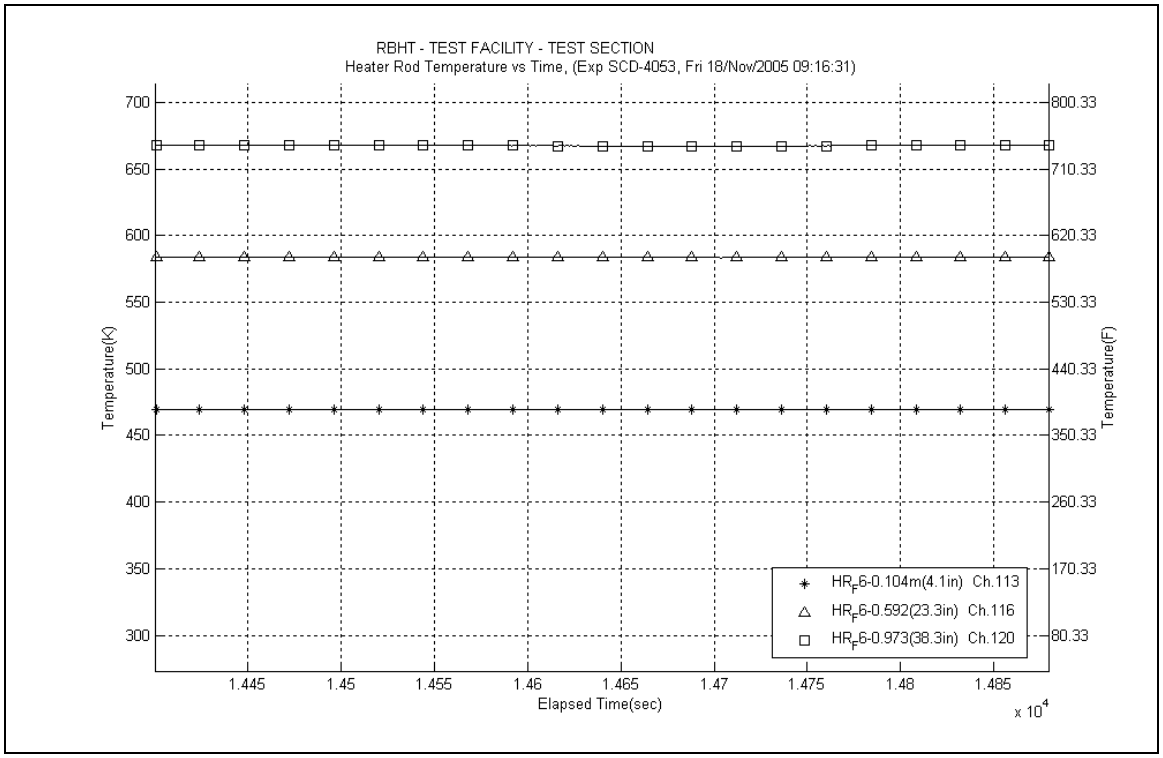

Figure A-359: Heater Rod F6 Temperatures for Experiment 4053C

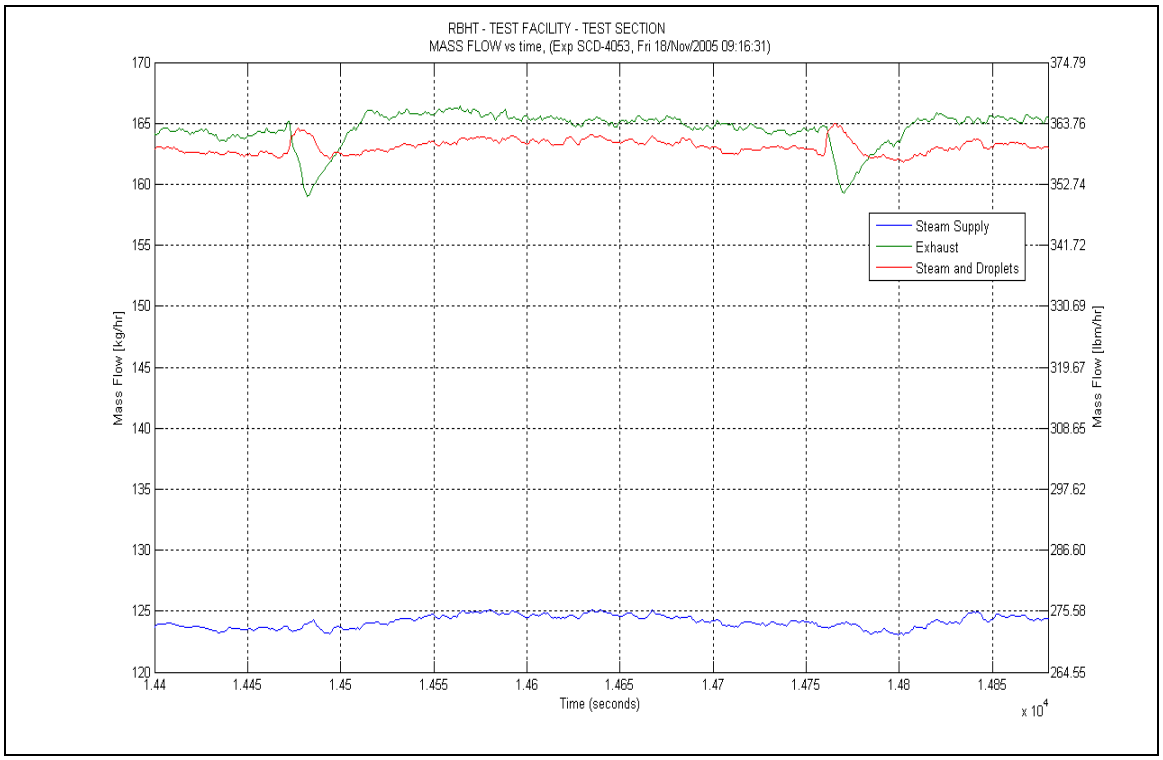

Figure A-360: Mass Flow for Experiment 4053C

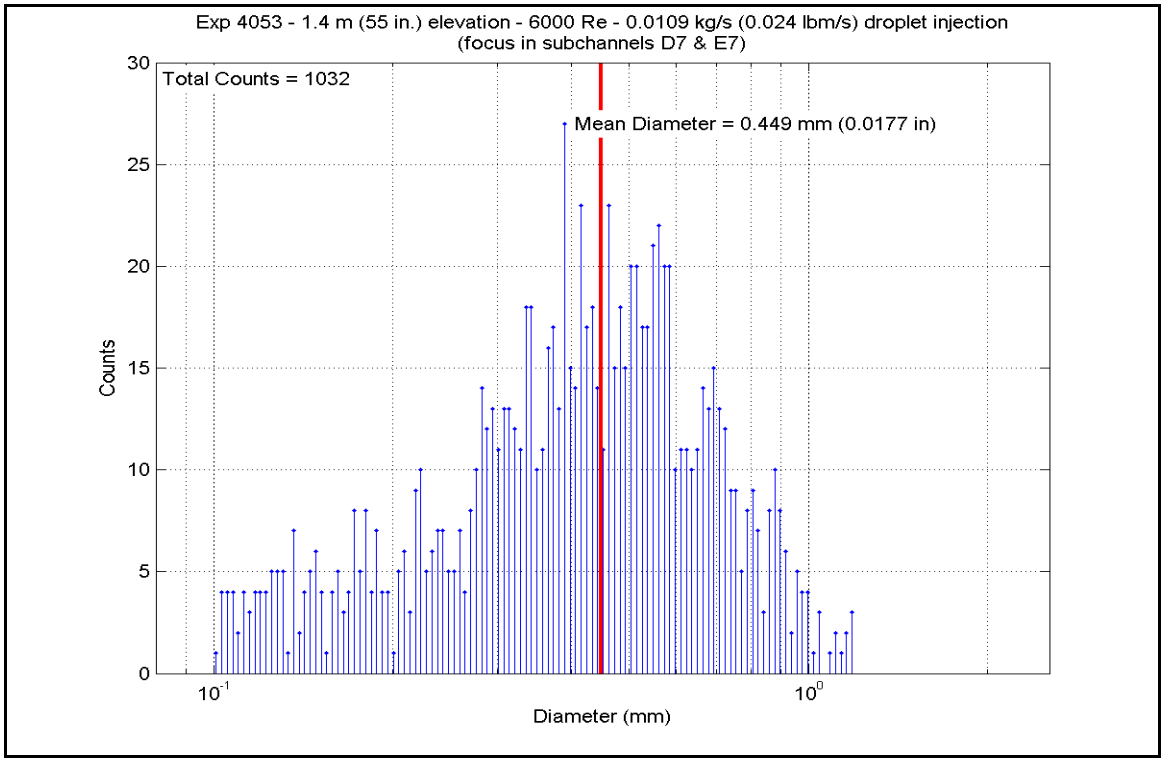

Figure A-361: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053C

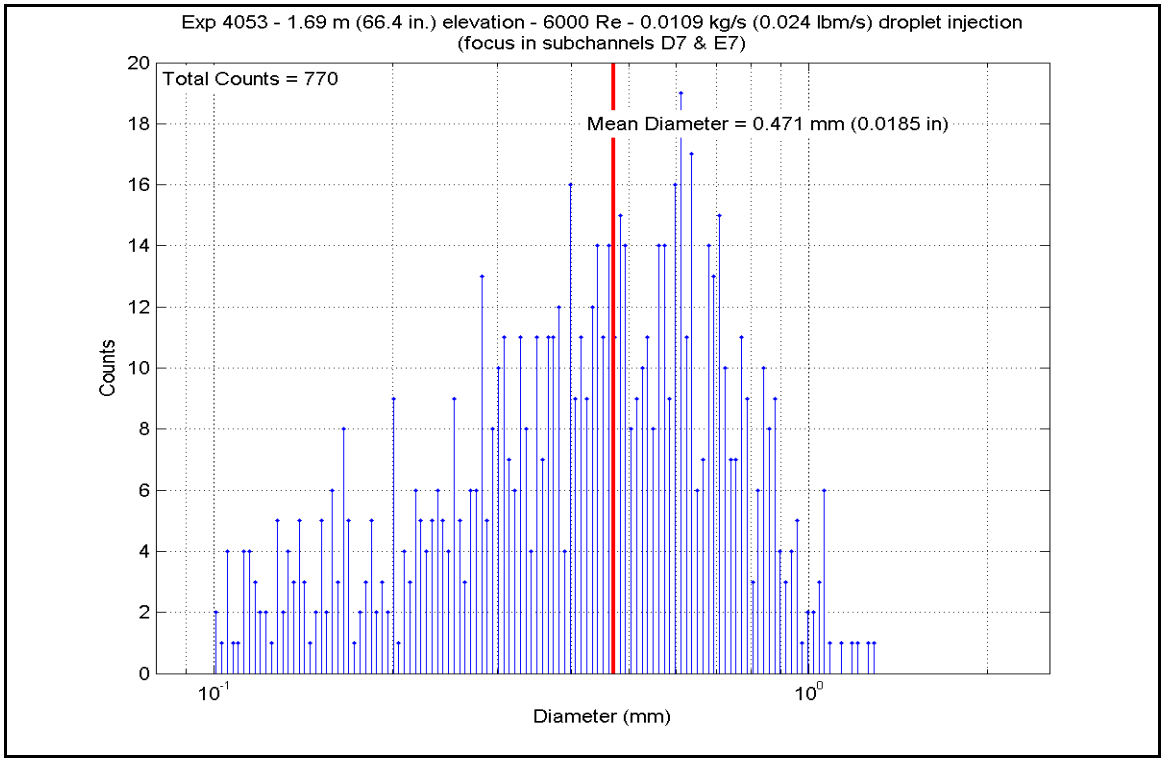

Figure A-362: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053C

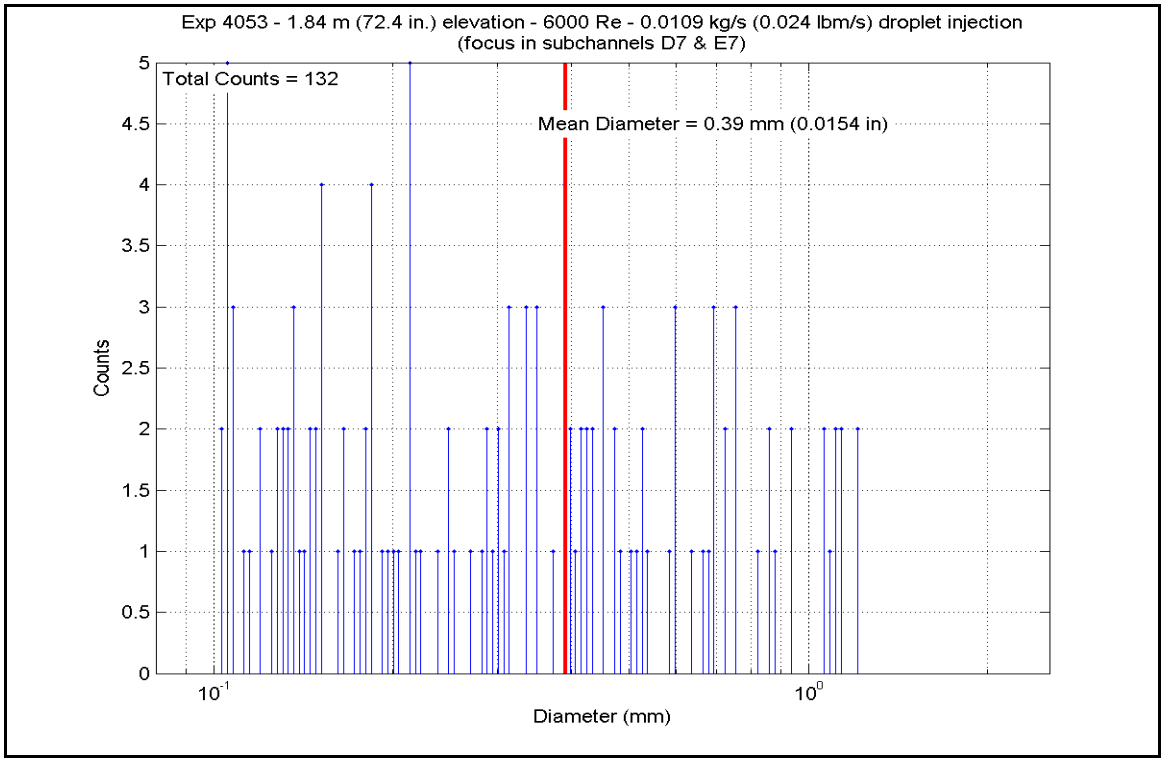

Figure A-363: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053C

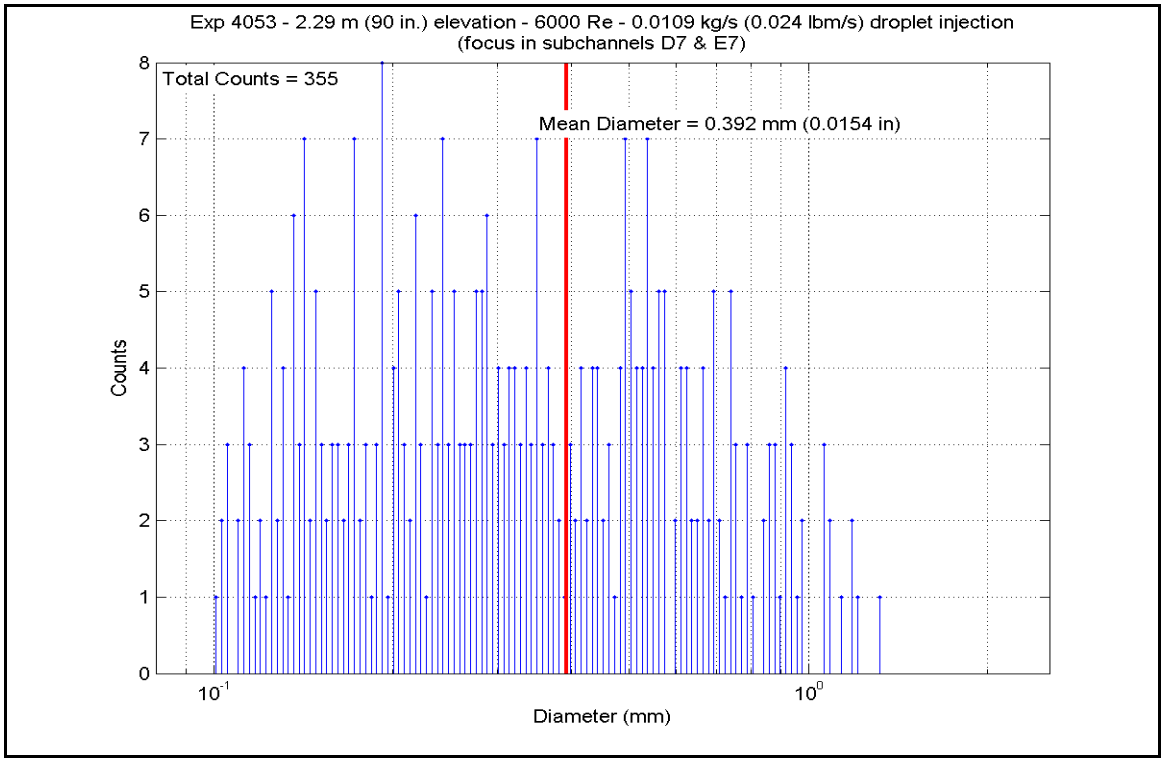

Figure A-364: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053C

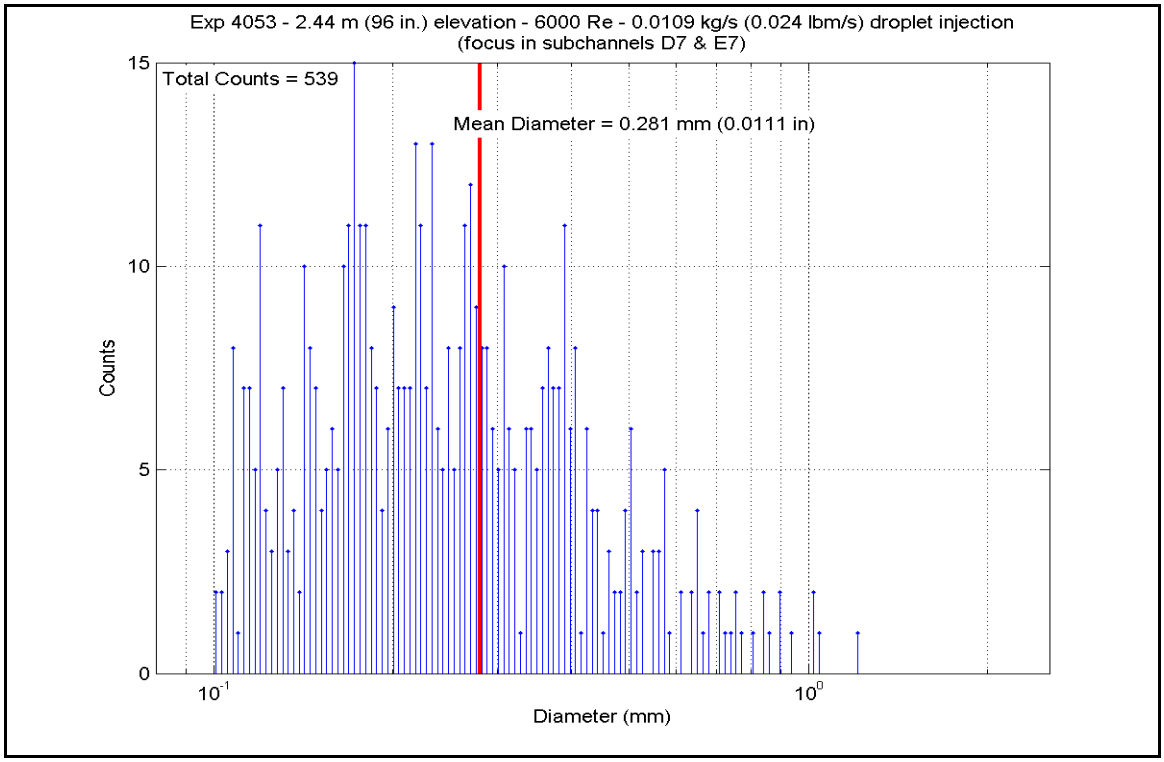

Figure A-365: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053C

Table A-58: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053C

SCD-4053-C	Inlet Reynolds:	6000	
Matrix test # 12c	UP Pressure:	137.9 kPa	20 psia
Time Window: 14400-14880	Bundle Power:	60.00 kW	204728 Btu/hr
	Steam flow:	0.0340 kg/s	270.0 lbm/hr
	Droplet flow:	0.0109 kg/s	0.024 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	782.60	690.1	5113.22	16129.6	9.220	52.4
	RodD3_91.3	186	91.3	2.319	2.8	0.071	869.87	738.6	5212.24	16442.0	8.120	46.1
	RodD3_93.1	187	93.1	2.365	4.6	0.117	872.57	740.1	5275.61	16641.9	8.185	46.5
	RodD3_95.3	188	95.3	2.421	6.8	0.173	916.38	764.5	5357.04	16898.8	7.782	44.2
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1068.36	848.9	5762.81	18178.8	6.858	38.9
	RodD3_110	191	110	2.794	21.5	0.546	884.30	746.6	5700.13	17981.1	8.685	49.3
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1007.55	815.1	2036.35	6423.7	2.612	14.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	747.83	670.8	5145.08	16230.2	9.898	56.2
	RodC4_91.1	234	91.1	2.314	2.6	0.066	827.99	715.4	5248.92	16557.7	8.748	49.7
	RodC4_93.4	235	93.4	2.372	4.9	0.124	852.09	728.8	5332.58	16821.6	8.545	48.5
	RodC4_95.3	236	95.3	2.421	6.8	0.173	887.16	748.2	5405.17	17050.6	8.200	46.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	938.61	776.8	5585.53	17619.5	7.860	44.6
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1021.44	822.8	5823.58	18370.5	7.340	41.7
	RodC4_110	239	110	2.794	21.5	0.546	852.52	729.0	5639.58	17790.1	9.030	51.3
	RodC4_142.2	240	142.2	3.612	8.7	0.221	947.39	781.7	2200.76	6942.3	3.059	17.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	744.70	669.1	5128.28	16177.1	9.925	56.4
	RodD4_91.3	242	91.3	2.319	2.8	0.071	818.85	710.3	5239.26	16527.2	8.867	50.4
	RodD4_93.2	243	93.2	2.367	4.7	0.119	835.13	719.3	5308.94	16747.0	8.744	49.7
	RodD4_95.2	244	95.2	2.418	6.7	0.170	864.84	735.8	5384.86	16986.5	8.456	48.0
	RodD4_100.1	245	100.1	2.543	11.6	0.295	927.29	770.5	5576.07	17589.7	7.974	45.3
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1006.32	814.4	5846.06	18441.4	7.511	42.7
	RodD4_142.1	248	142.1	3.609	8.6	0.218	959.35	788.3	2136.22	6738.7	2.921	16.6
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	763.51	679.5	5052.95	15939.5	9.436	53.6
	RodE4_91.2	202	91.2	2.316	2.7	0.069	818.50	710.1	5147.10	16236.5	8.717	49.5
	RodE4_95.3	204	95.3	2.421	6.8	0.173	865.63	736.3	5290.11	16687.7	8.296	47.1
	RodE4_100.9	205	100.9	2.563	12.4	0.315	951.14	783.8	5502.14	17356.5	7.609	43.2
	RodE4_142.3	208	142.3	3.614	8.8	0.224	992.96	807.0	2154.93	6797.7	2.817	16.0

Table A-58: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	970.18	794.4	4181.34	13190.0	5.634	32.0
	RodE3_113.6	194	113.6	2.885	0.85	0.022	985.89	803.1	5194.92	16387.4	6.854	38.9
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1019.02	821.5	5008.05	15797.9	6.331	36.0
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1049.95	838.7	4705.68	14844.1	5.725	32.5
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1069.06	849.3	4287.63	13525.3	5.098	29.0
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1077.12	853.8	3906.56	12323.2	4.601	26.1
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	989.30	805.0	3370.14	10631.1	4.427	25.1
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1022.03	823.2	2981.01	9403.6	3.754	21.3
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	954.65	785.7	4103.70	12945.1	5.647	32.1
	RodC5_113.6	226	113.6	2.885	0.85	0.022	828.85	715.8	5071.22	15997.1	8.440	47.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	874.93	741.4	4883.89	15406.2	7.549	42.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	933.96	774.2	4235.94	13362.3	6.000	34.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	935.93	775.3	3864.41	12190.3	5.459	31.0
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	827.84	715.3	3386.85	10683.8	5.646	32.1
	RodC5_135.7	232	135.7	3.447	2.2	0.056	874.46	741.2	2990.79	9434.4	4.626	26.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	916.93	764.8	4198.30	13243.5	6.094	34.6
	RodE5_113.6	210	113.6	2.885	0.85	0.022	529.95	549.8	6841.67	21582.1	22.658	128.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	640.18	611.0	6954.22	21937.1	16.872	95.8
	RodE5_118.7	212	118.7	3.015	5.95	0.151	855.78	730.8	6801.11	21454.1	10.834	61.5
	RodE5_122.6	213	122.6	3.114	9.85	0.250	940.29	777.8	4631.34	14609.6	6.502	36.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	960.18	788.8	4162.57	13130.8	5.685	32.3
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1073.30	851.7	3616.07	11406.9	4.278	24.3
	RodE5_135.6	216	135.6	3.444	2.1	0.053	951.88	784.2	3116.94	9832.4	4.306	24.5
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	884.48	746.8	4778.12	15072.6	7.278	41.3
	RodC3_85.6	178	85.6	2.174	14.72	0.374	778.67	688.0	4928.05	15545.5	8.949	50.8
	RodC3_88.5	179	88.5	2.248	0	0.000	766.74	681.3	5058.91	15958.3	9.390	53.3
	RodC3_92.4	180	92.4	2.347	3.9	0.099	882.52	745.7	5218.82	16462.8	7.974	45.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	899.81	755.3	5293.59	16698.6	7.880	44.7
Gr-8	RodD5_50	217	50	1.270	3	0.076	839.54	721.8	3715.71	11721.2	6.076	34.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	838.92	721.4	3861.44	12180.9	6.321	35.9
	RodD5_56.9	219	56.9	1.445	9.9	0.251	881.86	745.3	3975.94	12542.1	6.081	34.5
	RodD5_60	220	60	1.524	13	0.330	910.05	761.0	4079.66	12869.3	5.982	34.0
	RodD5_66.1	221	66.1	1.679	19.1	0.485	936.49	775.6	4296.74	13554.1	6.065	34.4
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	702.33	645.6	4420.65	13944.9	9.320	52.9
	RodD5_72.9	223	72.9	1.852	2.02	0.051	778.20	687.7	4527.51	14282.0	8.229	46.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	817.73	709.7	4599.22	14508.2	7.799	44.3

Table A-58: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	796.65	698.0	3382.36	10669.7	5.948	33.8
	RodB5_52.9	154	52.9	1.344	5.9	0.150	846.48	725.6	3813.12	12028.5	6.165	35.0
	RodB5_55	155	55	1.397	8	0.203	877.77	743.0	3884.22	12252.8	5.978	33.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	911.29	761.6	3986.50	12575.4	5.834	33.1
	RodB5_64	157	64	1.626	17	0.432	975.30	797.2	4205.24	13265.4	5.627	32.0
	RodB5_73.9	158	73.9	1.877	3.02	0.077	847.34	726.1	4566.14	14403.9	7.373	41.9
	RodB5_75.9	159	75.9	1.928	5.02	0.128	879.53	744.0	4638.97	14633.6	7.120	40.4
	RodB5_76.9	160	76.9	1.953	6.02	0.153	893.09	751.5	4674.11	14744.5	7.028	39.9
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	792.53	695.7	3369.93	10630.4	5.969	33.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	821.29	711.6	3804.10	12000.0	6.412	36.4
	RodF5_55	107	55	1.397	8	0.203	863.23	734.9	3867.13	12198.9	6.088	34.6
	RodF5_57.8	108	57.8	1.468	10.8	0.274	916.31	764.4	3960.18	12492.4	5.754	32.7
	RodF5_64	109	64	1.626	17	0.432	967.87	793.1	4178.90	13182.3	5.648	32.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	853.06	729.3	4550.24	14353.7	7.280	41.3
	RodF5_75.8	111	75.8	1.925	4.92	0.125	890.56	750.1	4629.93	14605.1	6.988	39.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	905.66	758.5	4667.86	14724.8	6.888	39.1
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	789.93	694.2	3379.50	10660.6	6.014	34.2
	RodC2_53.1	58	53.1	1.349	6.1	0.155	893.61	751.8	3807.29	12010.1	5.720	32.5
	RodC2_55	59	55	1.397	8	0.203	916.36	764.5	3877.41	12231.3	5.633	32.0
	RodC2_57.8	60	57.8	1.468	10.8	0.274	953.11	784.9	3981.31	12559.0	5.491	31.2
	RodC2_63.9	61	63.9	1.623	16.9	0.429	992.88	807.0	4202.17	13255.7	5.494	31.2
	RodC2_73.8	62	73.8	1.875	2.92	0.074	887.02	748.2	4574.86	14431.4	6.942	39.4
	RodC2_75.8	63	75.8	1.925	4.92	0.125	915.97	764.2	4646.12	14656.2	6.753	38.4
	RodC2_76.8	64	76.8	1.951	5.92	0.150	929.33	771.7	4681.64	14768.2	6.675	37.9
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	790.04	694.3	3353.69	10579.2	5.967	33.9
	RodC6_52.8	138	52.8	1.341	5.8	0.147	885.77	747.5	3804.58	12001.6	5.784	32.8
	RodC6_54.8	139	54.8	1.392	7.8	0.198	905.87	758.6	3878.49	12234.7	5.722	32.5
	RodC6_57.8	140	57.8	1.468	10.8	0.274	920.53	766.8	3995.22	12602.9	5.769	32.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	930.62	772.4	4212.07	13287.0	5.995	34.0
	RodC6_73.7	142	73.7	1.872	2.82	0.072	809.27	705.0	4595.20	14495.6	7.905	44.9
	RodC6_75.8	143	75.8	1.925	4.92	0.125	836.87	720.3	4675.91	14750.2	7.680	43.6
	RodC6_76.8	144	76.8	1.951	5.92	0.150	852.54	729.0	4714.66	14872.4	7.549	42.9

Table A-58: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	761.34	678.3	5050.88	15933.0	9.470	53.8
	RodB4_91.3	162	91.3	2.319	2.8	0.071	846.10	725.4	5155.00	16261.4	8.340	47.4
	RodB4_93.3	163	93.3	2.370	4.8	0.122	865.91	736.4	5224.46	16480.6	8.190	46.5
	RodB4_95.1	164	95.1	2.416	6.6	0.168	895.85	753.1	5287.10	16678.1	7.917	45.0
	RodB4_142.3	168	142.3	3.614	8.8	0.224	947.72	781.9	2181.01	6880.0	3.030	17.2
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	892.62	751.3	4913.49	15499.6	7.393	42.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	822.02	712.1	5034.57	15881.5	8.475	48.1
	RodF4_92.4	100	92.4	2.347	3.9	0.099	902.90	757.0	5203.71	16415.1	7.710	43.8
	RodF4_94.3	101	94.3	2.395	5.8	0.147	930.47	772.3	5277.85	16649.0	7.513	42.7
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1033.83	829.7	5057.28	15953.2	6.276	35.6
	RodD2_106	66	106	2.692	17.5	0.445	1057.74	843.0	4794.20	15123.3	5.778	32.8
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1085.43	858.4	4436.95	13996.4	5.175	29.4
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1100.84	867.0	4018.18	12675.3	4.604	26.1
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1085.70	858.5	3616.48	11408.2	4.216	23.9
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	837.13	720.4	5155.70	16263.7	8.464	48.1
	RodD6_116.8	133	116.8	2.967	4.05	0.103	876.98	742.6	4946.01	15602.2	7.621	43.3
	RodD6_120.9	134	120.9	3.071	8.15	0.207	903.77	757.5	4505.55	14212.8	6.667	37.9
	RodD6_124.8	135	124.8	3.170	12.05	0.306	909.68	760.8	4102.09	12940.1	6.018	34.2
	RodD6_128.7	136	128.7	3.269	15.95	0.405	902.03	756.5	3694.07	11652.9	5.481	31.1

Table A-58: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	843.25	723.8	3729.71	11765.4	6.062	34.4
	RodE2_54	74	54	1.372	7	0.178	908.23	759.9	3872.09	12214.5	5.692	32.3
	RodE2_56.9	75	56.9	1.445	9.9	0.251	944.15	779.9	3977.93	12548.4	5.555	31.5
	RodE2_59.9	76	59.9	1.521	12.9	0.328	979.60	799.6	4086.41	12890.6	5.437	30.9
	RodE2_66	77	66	1.676	19	0.483	1004.75	813.6	4306.91	13586.2	5.545	31.5
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	820.35	711.1	4475.21	14117.1	7.555	42.9
	RodE2_72.9	79	72.9	1.852	2.02	0.051	900.40	755.6	4571.00	14419.2	6.798	38.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	937.50	776.2	4639.75	14636.1	6.539	37.1
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	797.96	698.7	3710.03	11703.3	6.509	37.0
	RodB3_54.1	170	54.1	1.374	7.1	0.180	869.17	738.2	3851.62	12149.9	6.007	34.1
	RodB3_56.9	171	56.9	1.445	9.9	0.251	896.02	753.2	3960.20	12492.4	5.928	33.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	854.75	730.2	4067.27	12830.2	6.489	36.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	887.35	748.3	4276.42	13490.0	6.486	36.8
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	706.90	648.1	4413.41	13922.1	9.216	52.3
	RodB3_73	175	73	1.854	2.12	0.054	793.15	696.0	4527.90	14283.3	8.012	45.5
	RodB3_75	176	75	1.905	4.12	0.105	834.14	718.8	4605.27	14527.3	7.598	43.1
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	828.31	715.5	3705.40	11688.7	6.172	35.1
	RodF3_54	90	54	1.372	7	0.178	888.56	749.0	3852.99	12154.3	5.833	33.1
	RodF3_57	91	57	1.448	10	0.254	931.47	772.9	3965.24	12508.3	5.637	32.0
	RodF3_60	92	60	1.524	13	0.330	963.84	790.8	4075.72	12856.9	5.539	31.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	986.53	803.4	4289.60	13531.6	5.655	32.1
	RodF3_70	94	70	1.778	-0.88	-0.022	816.28	708.9	4417.62	13935.4	7.509	42.6
	RodF3_73	95	73	1.854	2.12	0.054	906.00	758.7	4536.85	14311.5	6.691	38.0
	RodF3_75	96	75	1.905	4.12	0.105	945.65	780.7	4611.56	14547.2	6.426	36.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	813.36	707.2	3714.83	11718.4	6.346	36.0
	RodE6_54.1	122	54.1	1.374	7.1	0.180	872.10	739.9	3852.27	12152.0	5.981	34.0
	RodE6_57	123	57	1.448	10	0.254	873.13	740.4	3957.89	12485.2	6.135	34.8
	RodE6_60.2	124	60.2	1.529	13.2	0.335	906.62	759.0	4073.78	12850.7	6.003	34.1
	RodE6_66.1	125	66.1	1.679	19.1	0.485	919.02	765.9	4286.61	13522.1	6.203	35.2
	RodE6_70	126	70	1.778	-0.88	-0.022	715.74	653.0	4425.63	13960.6	9.074	51.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	790.03	694.3	4527.48	14282.0	8.056	45.7
	RodE6_75	128	75	1.905	4.12	0.105	824.77	713.6	4596.56	14499.8	7.702	43.7

RBHT Steam Cooling with Droplet Injection Test SCD-4053-D

Matrix Test # 12d

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 15780 - 18120
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 60 kW
Bundle Inlet Reynolds Number: 6000
Bundle Inlet Steam Flow: 122.5 kg/hr (270 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

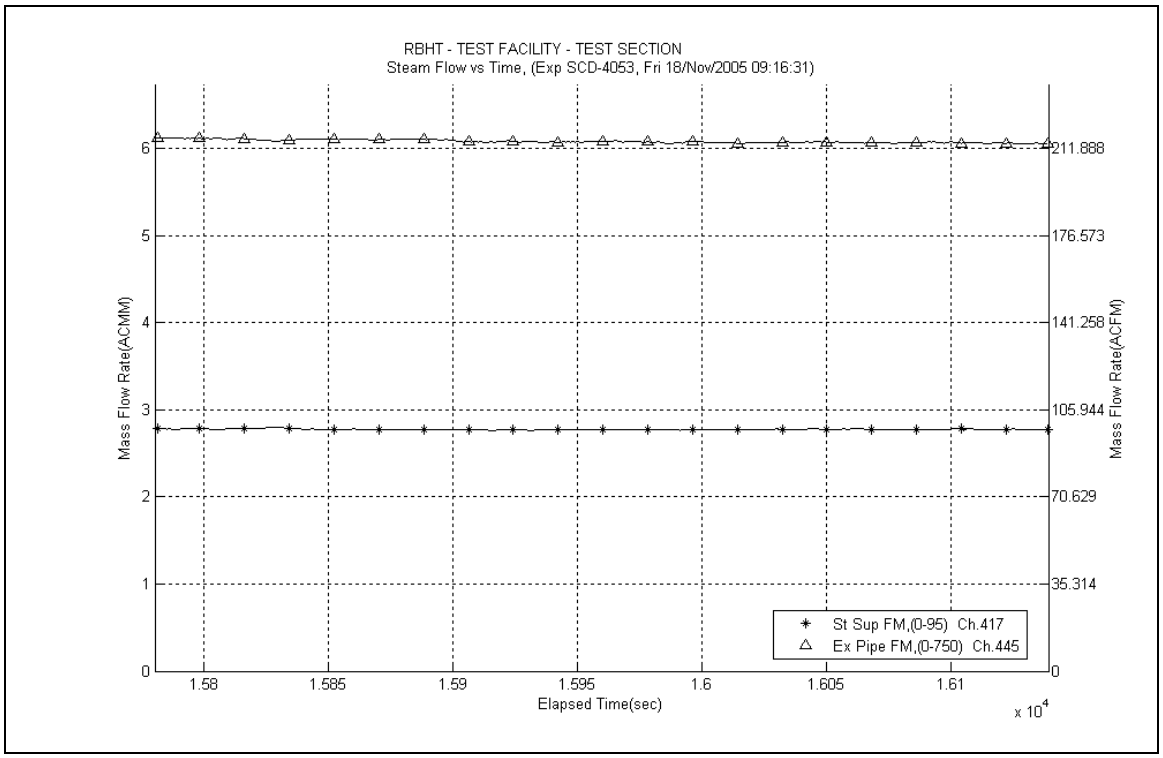

Figure A-366: Inlet and Exhaust Steam Flow Rates for Experiment 4053D

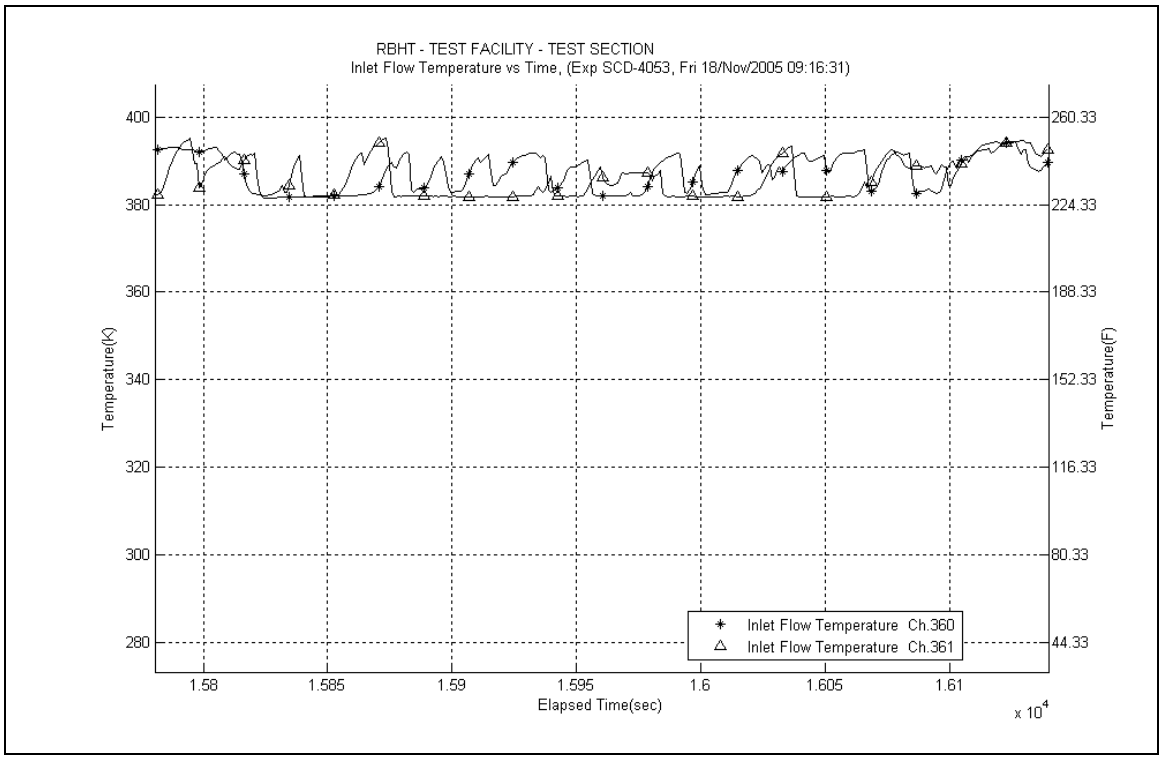

Figure A-367: Inlet Steam Temperature for Experiment 4053D

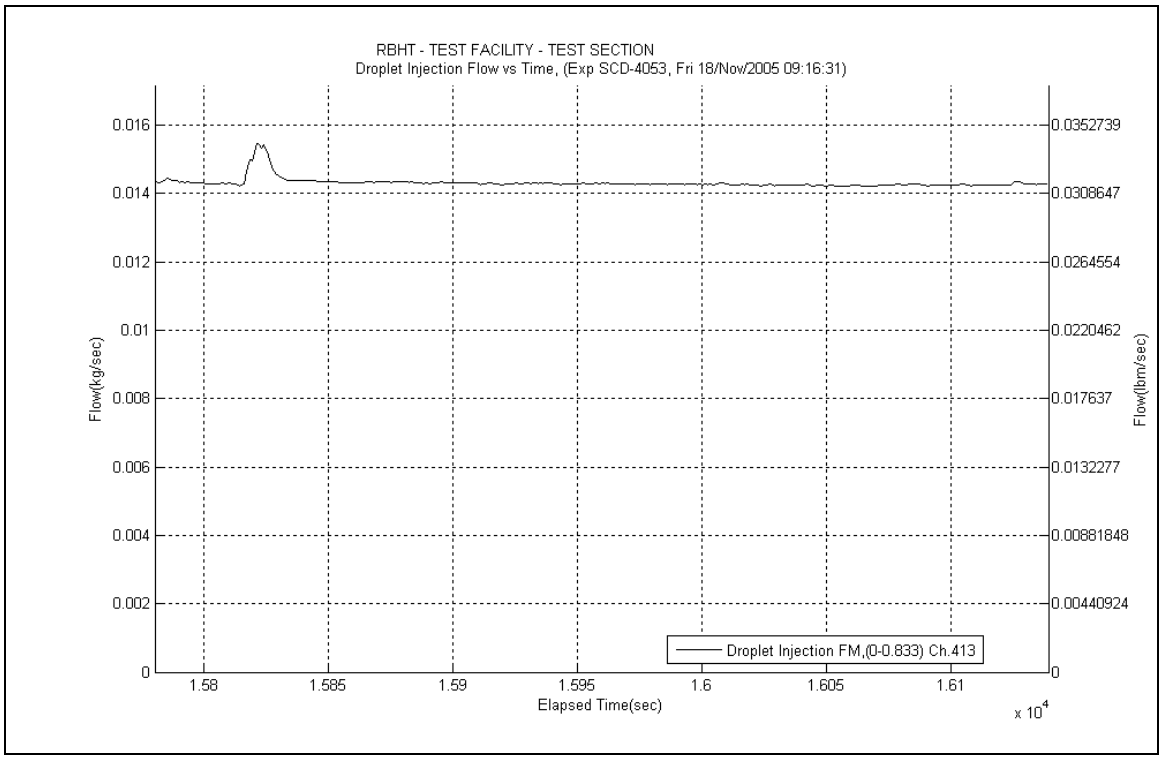

Figure A-368: Droplet Injection Flow Rate for Experiment 4053D

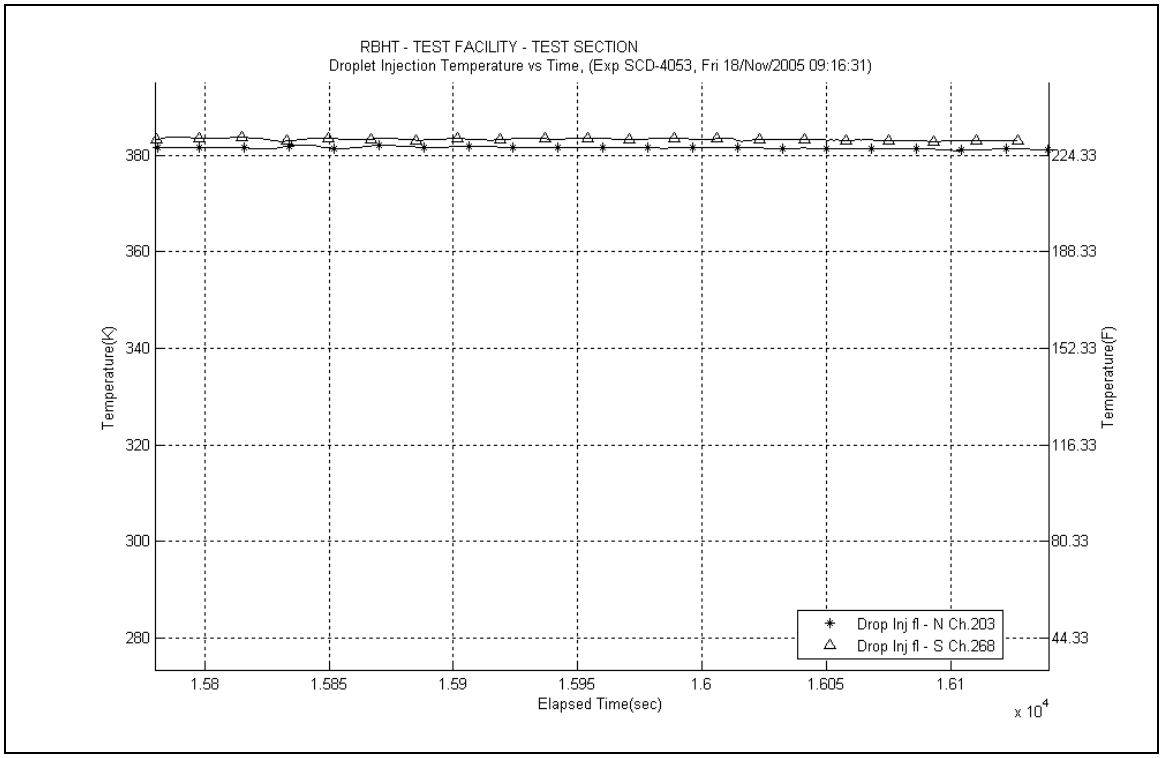

Figure A-369: Droplet Injection Temperature for Experiment 4053D

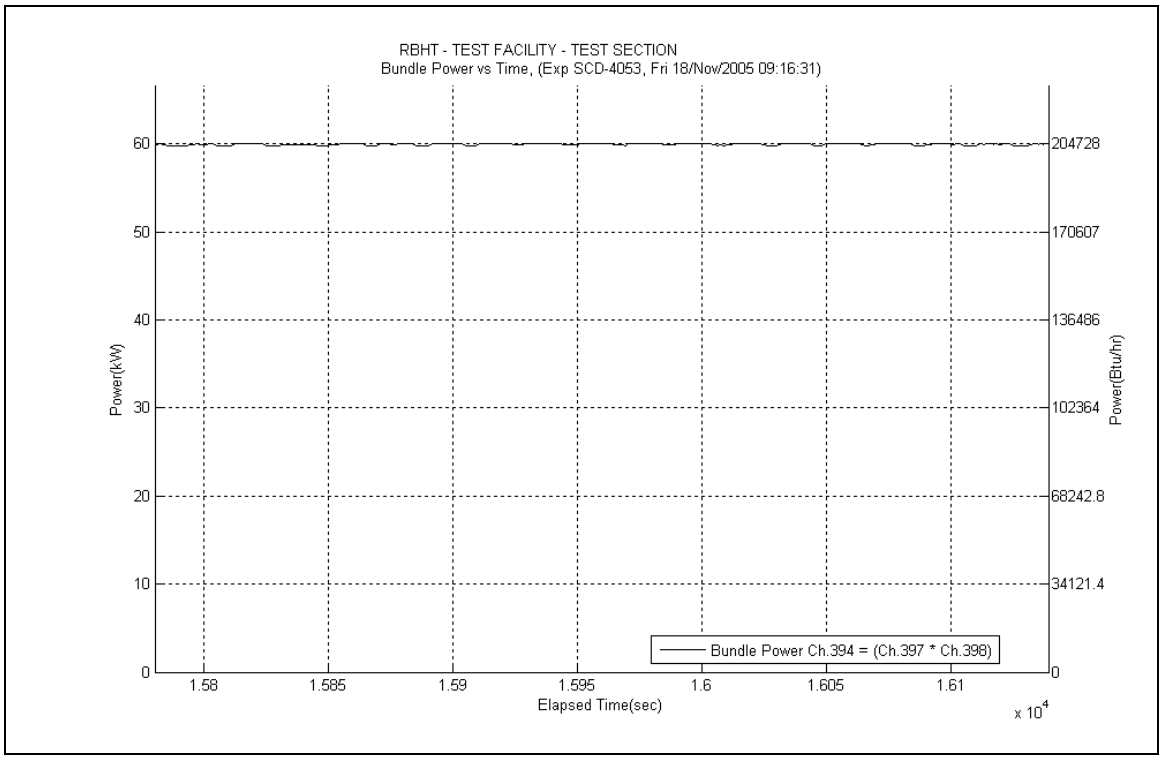

Figure A-370: Bundle Power for Experiment 4053D

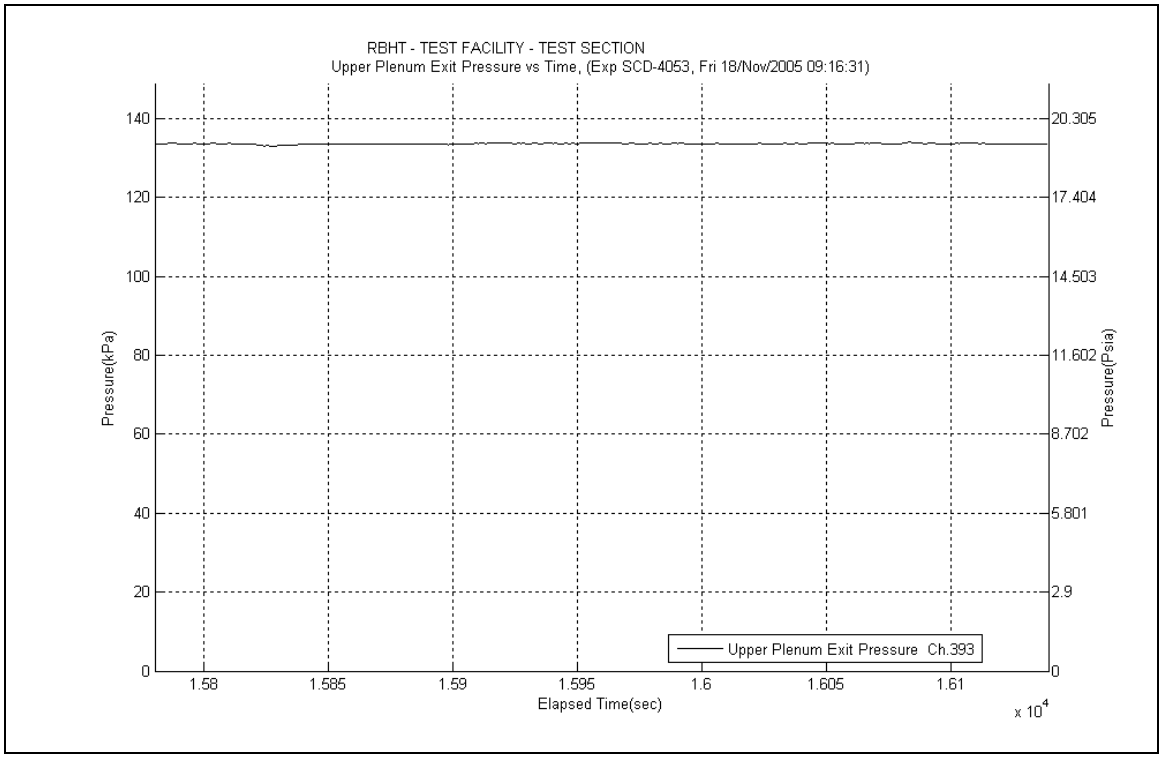

Figure A-371: Upper Plenum Pressure for Experiment 4053D

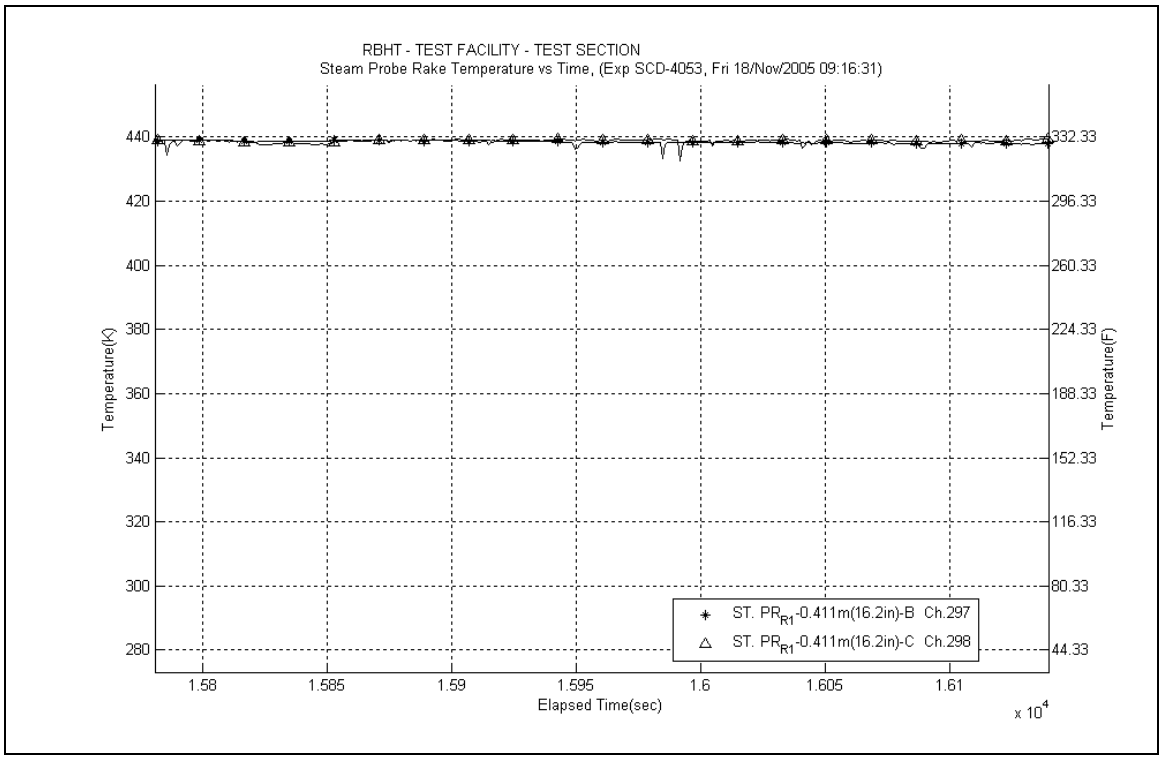

Figure A-372: Steam Probe Rake #1 Temperatures for Experiment 4053D

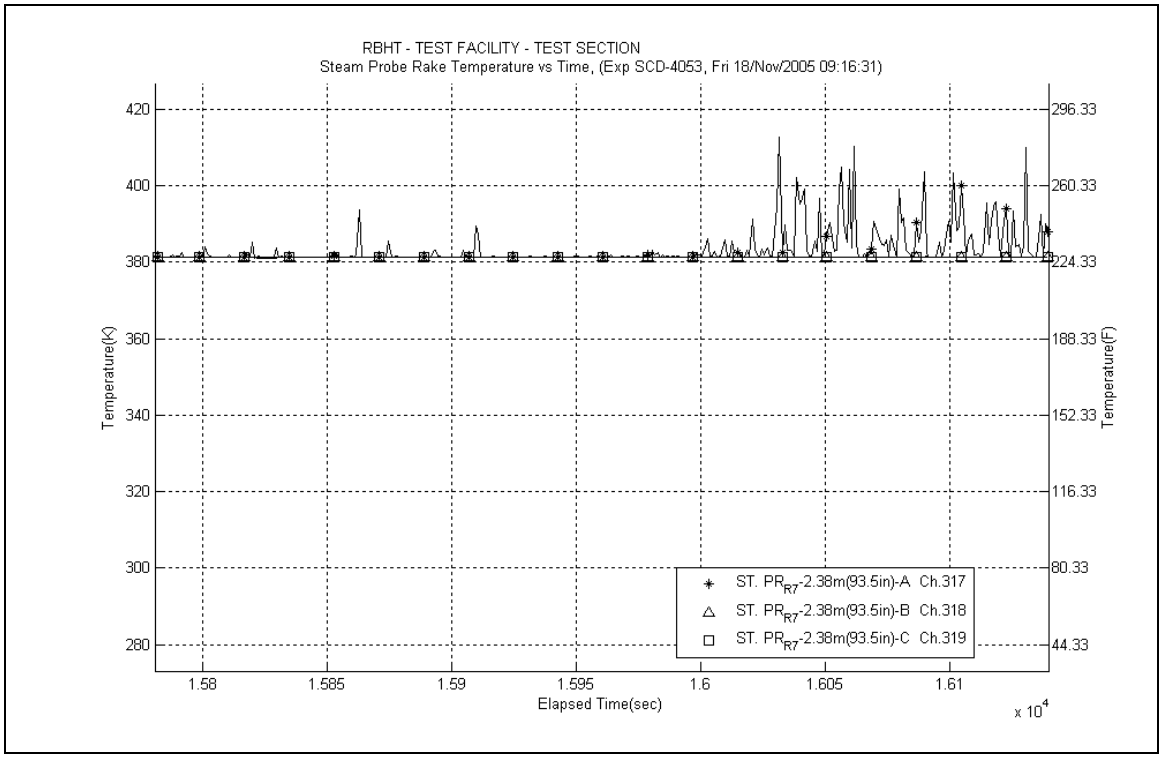

Figure A-373: Steam Probe Rake #7 Temperatures for Experiment 4053D

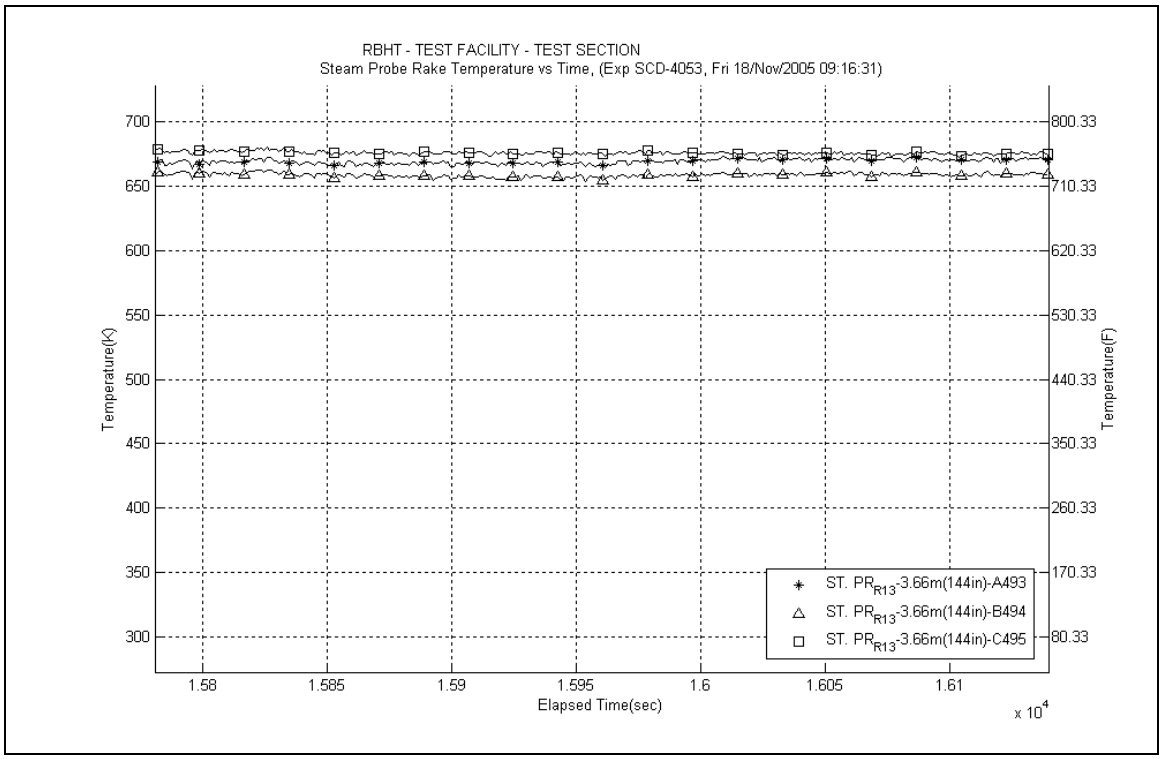

Figure A-374: Steam Probe Rake#13 Temperatures for Experiment 4053D

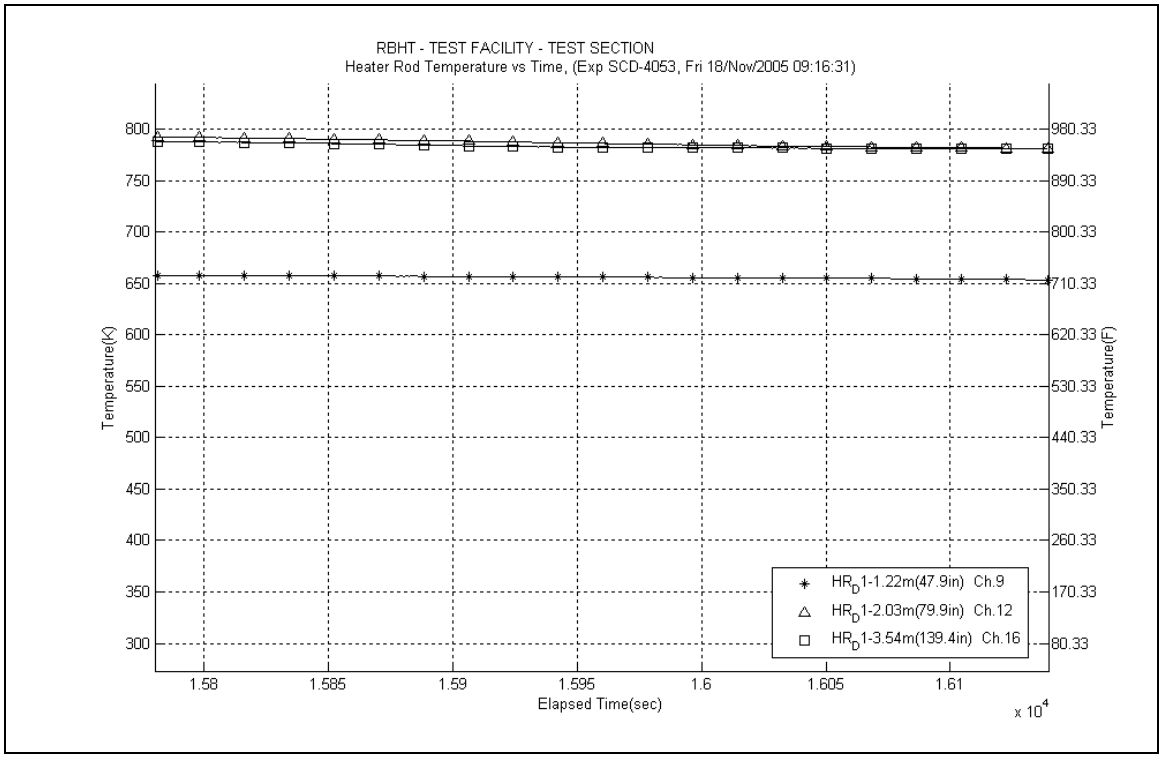

Figure A-375: Heater Rod D1 Temperatures for Experiment 4053D

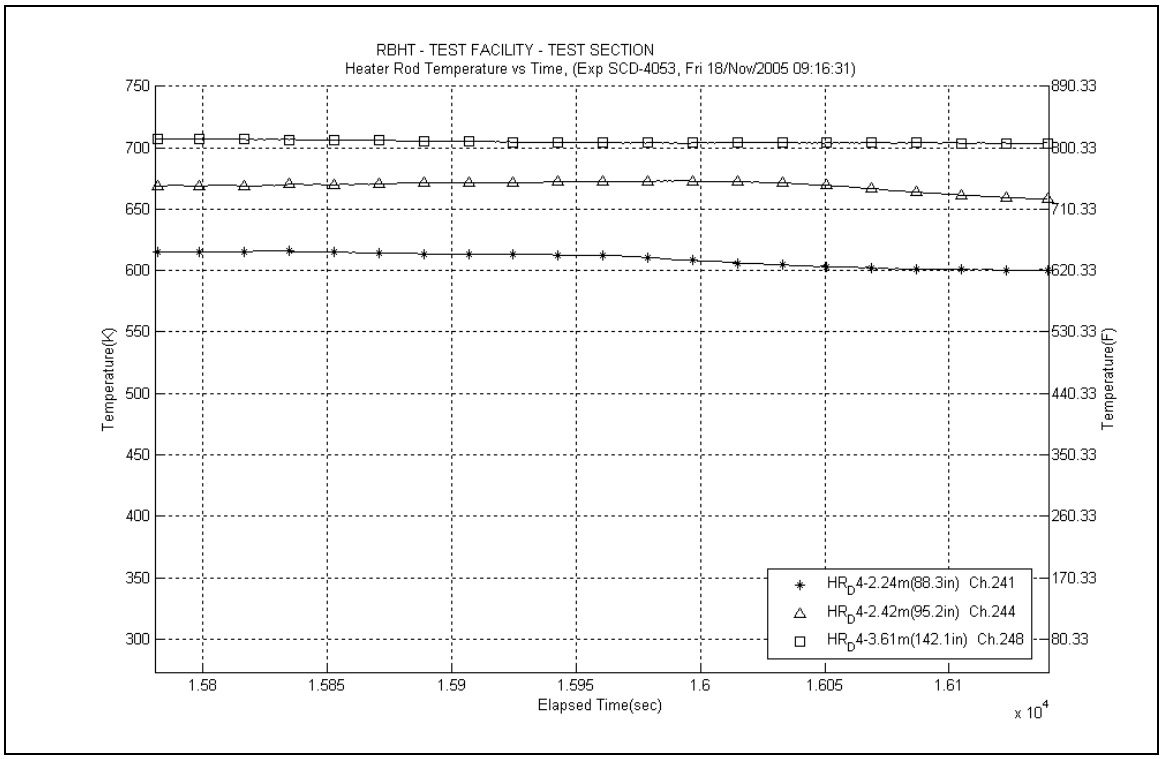

Figure A-376: Heater Rod D4 Temperatures for Experiment 4053D

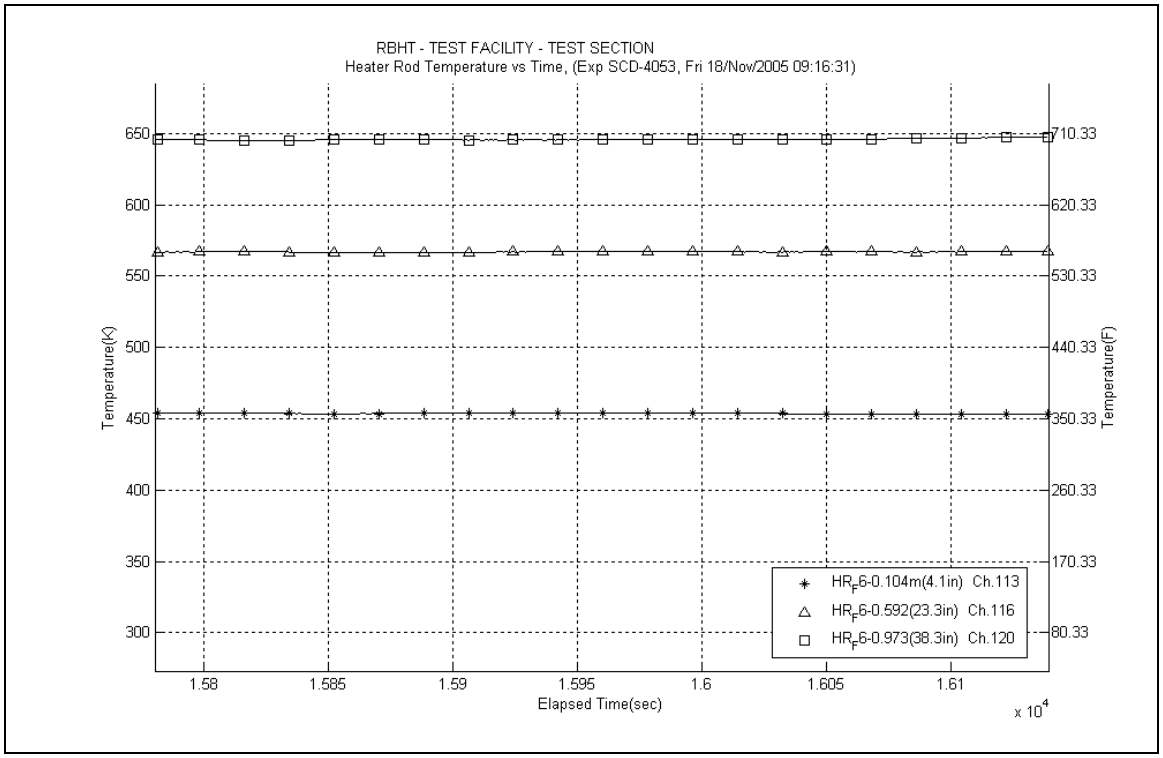

Figure A-377: Heater Rod F6 Temperatures for Experiment 4053D

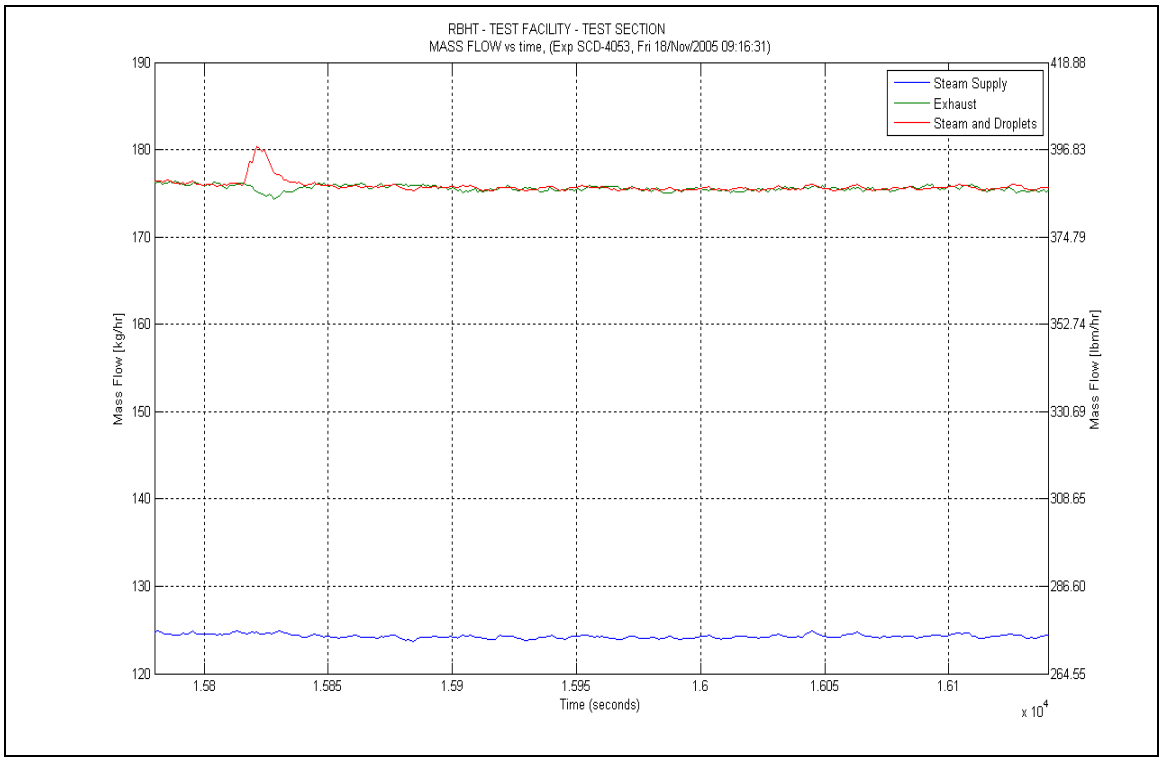

Figure A-378: Mass Flow for Experiment 4053D

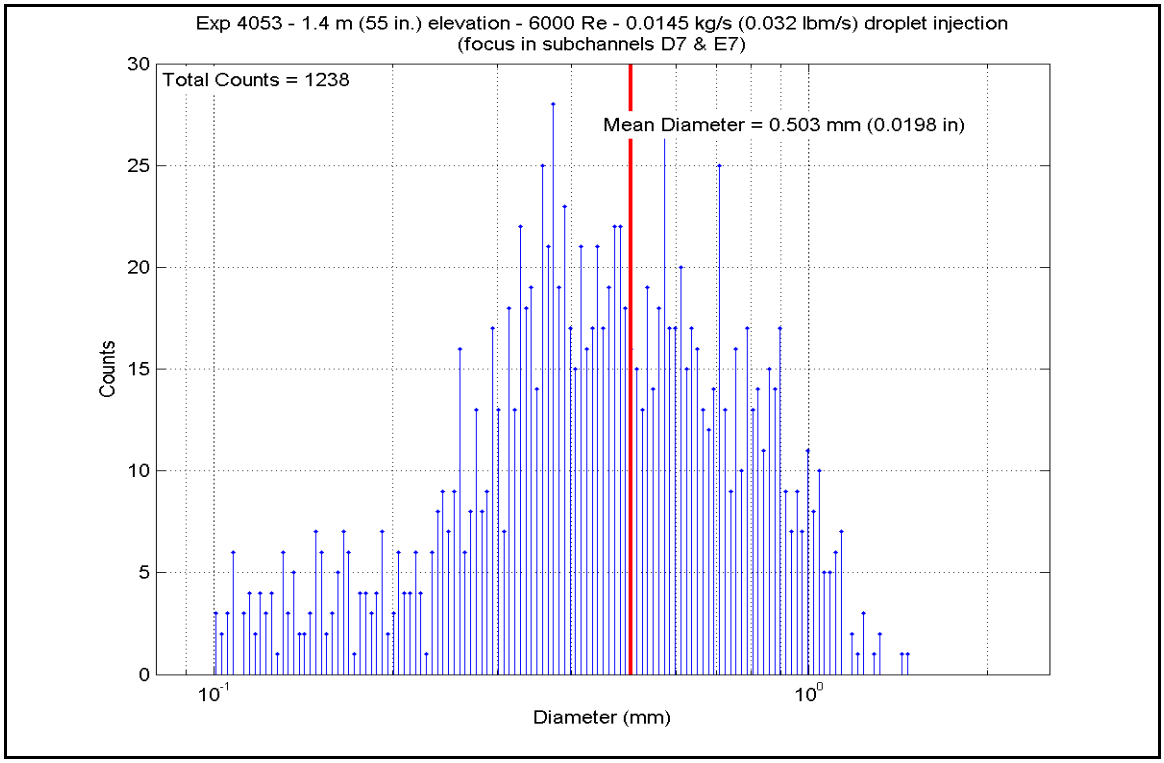

Figure A-379: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053D

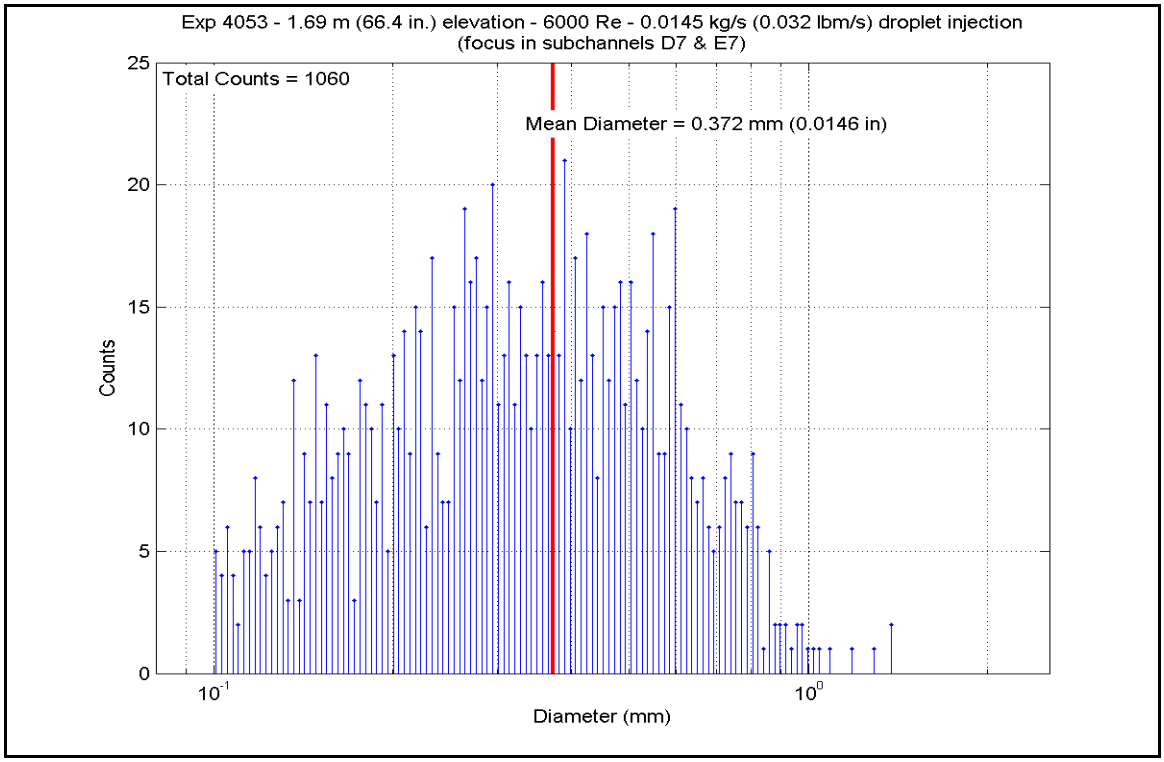

Figure A-380: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053D

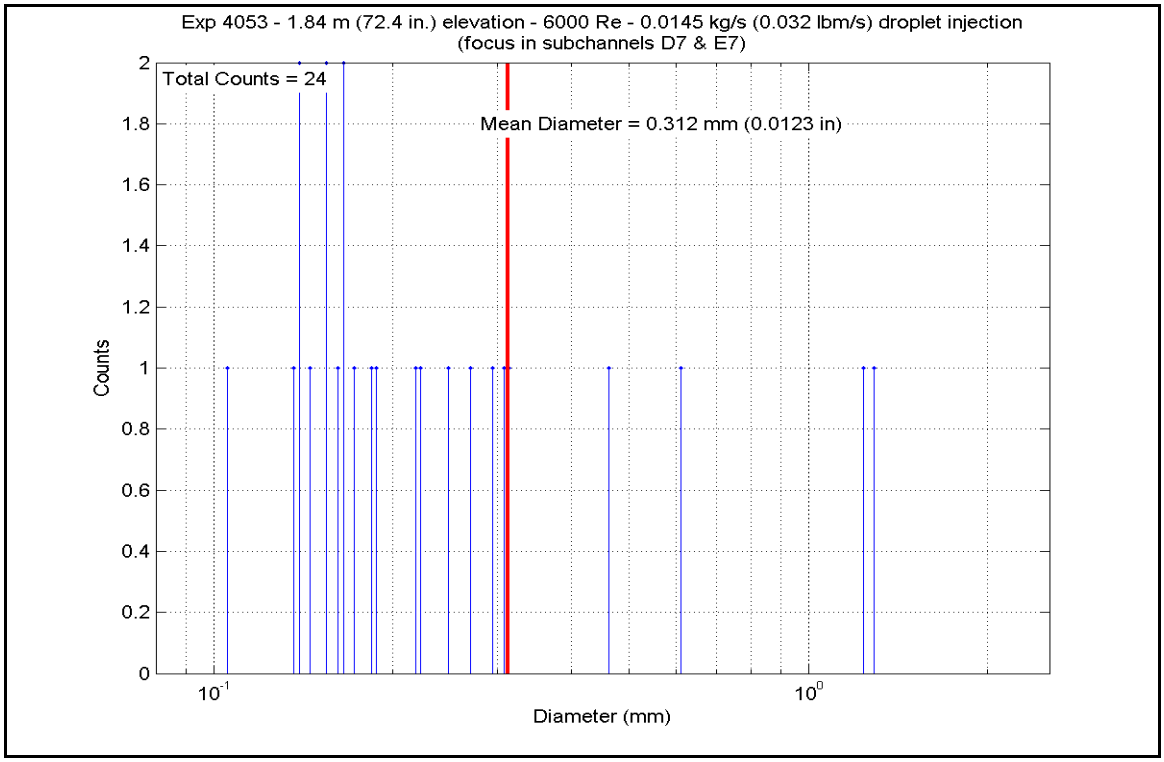

Figure A-381: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053D

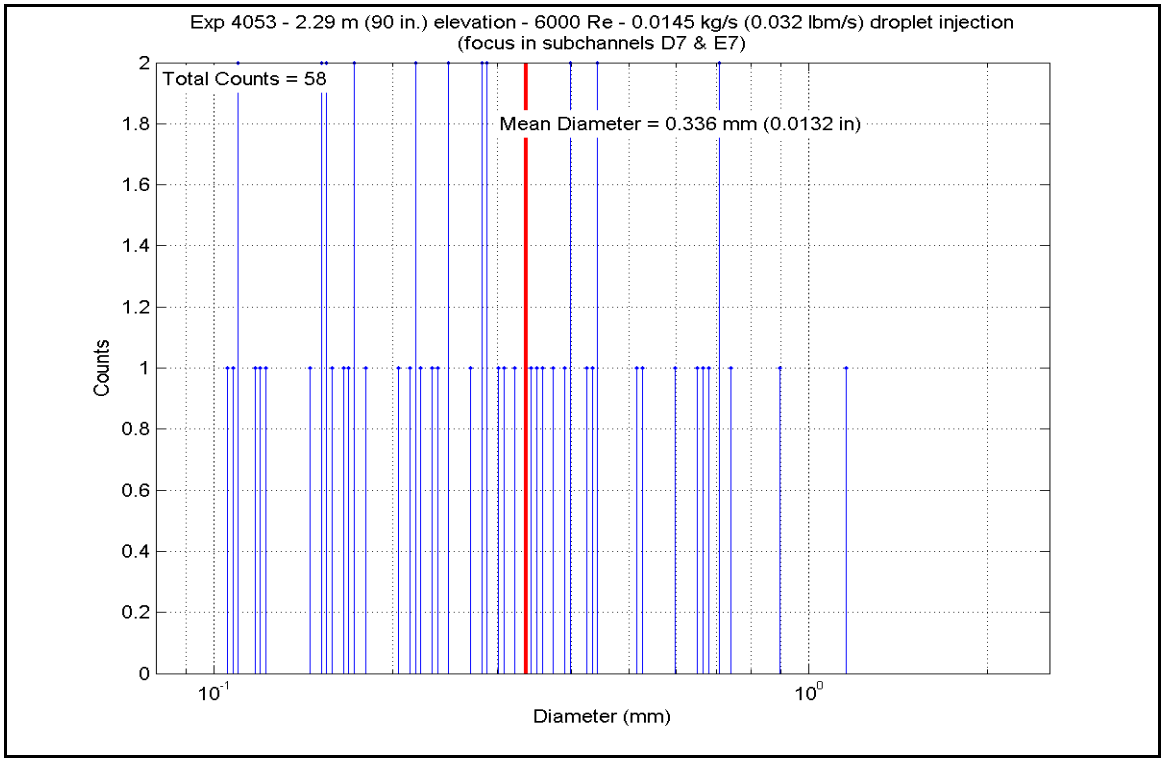

Figure A-382: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053D

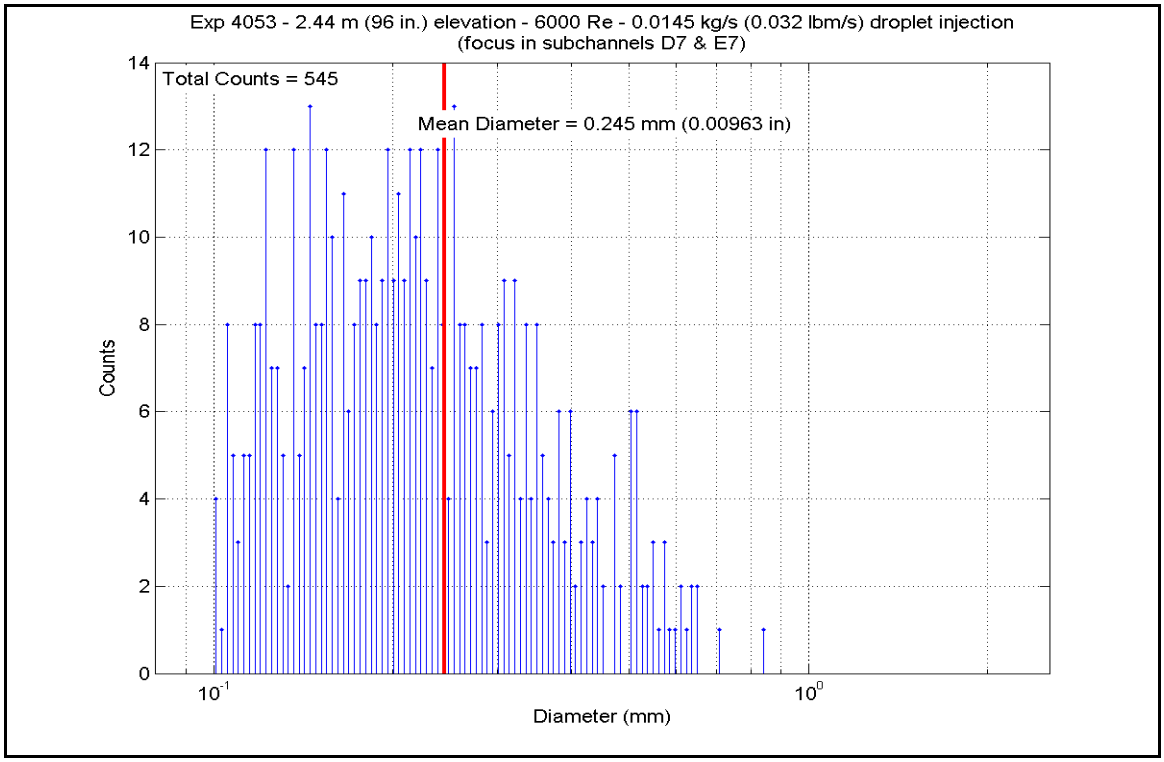

Figure A-383: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053D

Table A-59: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053D

SCD-4053-D	Inlet Reynolds:	6000		
Matrix test # 12d	UP Pressure:	137.9 kPa	20	psia
Time Window: 15780-16140	Bundle Power:	60.00 kW	204728	Btu/hr
	Steam flow:	0.0340 kg/s	270.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	1047.05	837.1	4237.49	13367.2	5.174	29.4
	RodD3_91.3	186	91.3	2.319	2.8	0.071	1120.91	878.1	4327.79	13652.0	4.847	27.5
	RodD3_93.1	187	93.1	2.365	4.6	0.117	1155.90	897.5	4381.10	13820.2	4.722	26.8
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1203.69	924.1	4445.64	14023.8	4.556	25.9
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1338.62	999.0	4771.43	15051.5	4.296	24.4
	RodD3_110	191	110	2.794	21.5	0.546	1316.57	986.8	4706.41	14846.4	4.323	24.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1403.58	1035.1	1625.33	5127.1	1.383	7.9
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1048.33	837.8	4289.16	13530.2	5.229	29.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1115.91	875.3	4370.54	13786.9	4.922	28.0
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1154.46	896.7	4441.40	14010.4	4.794	27.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1192.06	917.6	4499.93	14195.0	4.668	26.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1271.69	961.9	4643.59	14648.2	4.449	25.3
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1325.32	991.7	4828.27	15230.8	4.400	25.0
	RodC4_110	239	110	2.794	21.5	0.546	1296.94	975.9	4671.13	14735.1	4.370	24.8
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1403.50	1035.1	1766.65	5572.9	1.503	8.5
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	1061.32	845.0	4268.93	13466.4	5.123	29.1
	RodD4_91.3	242	91.3	2.319	2.8	0.071	1126.72	881.3	4362.47	13761.4	4.854	27.6
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1164.09	902.1	4420.01	13942.9	4.722	26.8
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1202.38	923.4	4479.36	14130.1	4.597	26.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1275.20	963.8	4626.35	14593.8	4.418	25.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1328.44	993.4	4808.26	15167.6	4.369	24.8
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1413.68	1040.8	1706.51	5383.2	1.439	8.2
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	1048.65	838.0	4200.99	13252.0	5.119	29.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	1118.04	876.5	4283.86	13513.4	4.813	27.3
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1195.80	919.7	4402.16	13886.6	4.549	25.8
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1271.28	961.6	4565.32	14401.3	4.376	24.9
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1406.09	1036.5	1718.36	5420.6	1.459	8.3

Table A-59: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1067.10	848.2	3470.09	10946.4	4.135	23.5
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1337.56	998.5	4289.38	13530.9	3.866	22.0
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1366.32	1014.4	4129.68	13027.1	3.628	20.6
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1394.80	1030.3	3877.28	12230.9	3.323	18.9
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1416.01	1042.0	3523.27	11114.2	2.966	16.8
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1421.92	1045.3	3203.11	10104.2	2.683	15.2
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1394.16	1029.9	2758.90	8702.9	2.366	13.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1399.83	1033.1	2428.96	7662.1	2.073	11.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1065.56	847.3	3428.74	10816.0	4.094	23.2
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1309.07	982.6	4188.46	13212.5	3.874	22.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1343.58	1001.8	4022.48	12688.9	3.606	20.5
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1390.41	1027.8	3462.86	10923.6	2.979	16.9
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1399.56	1032.9	3143.50	9916.2	2.683	15.2
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1372.64	1017.9	2748.67	8670.7	2.401	13.6
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1388.71	1026.9	2413.67	7613.9	2.079	11.8
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1000.41	811.2	3496.08	11028.4	4.526	25.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1234.04	940.9	4301.96	13570.5	4.276	24.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1272.93	962.6	4155.25	13107.8	3.977	22.6
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1314.66	985.7	3882.98	12248.9	3.573	20.3
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1345.98	1003.1	3560.89	11232.8	3.185	18.1
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1362.28	1012.2	3231.31	10193.2	2.849	16.2
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1512.06	1095.4	2781.14	8773.1	2.166	12.3
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1397.30	1031.7	2473.51	7802.7	2.115	12.0
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	1011.76	817.5	3958.77	12488.0	5.051	28.7
	RodC3_85.6	178	85.6	2.174	14.72	0.374	1022.75	823.6	4128.90	13024.6	5.195	29.5
	RodC3_88.5	179	88.5	2.248	0	0.000	1032.33	828.9	4217.62	13304.5	5.244	29.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	1118.54	876.8	4334.53	13673.3	4.867	27.6
	RodC3_94.4	181	94.4	2.398	5.9	0.150	1153.82	896.4	4394.55	13862.6	4.747	27.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	900.84	755.8	3092.06	9753.9	4.596	26.1
	RodD5_54.1	218	54.1	1.374	7.1	0.180	932.29	773.3	3212.83	10134.9	4.562	25.9
	RodD5_56.9	219	56.9	1.445	9.9	0.251	988.90	804.8	3297.20	10401.0	4.333	24.6
	RodD5_60	220	60	1.524	13	0.330	1035.10	830.4	3394.17	10706.9	4.205	23.9
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1076.53	853.4	3578.29	11287.7	4.217	23.9
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	810.60	705.7	3693.88	11652.4	6.340	36.0
	RodD5_72.9	223	72.9	1.852	2.02	0.051	899.45	755.1	3778.34	11918.8	5.627	32.0
	RodD5_74.9	224	74.9	1.902	4.02	0.102	947.76	781.9	3837.65	12105.9	5.332	30.3

Table A-59: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	835.02	719.3	2815.88	8882.7	4.639	26.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	909.41	760.6	3160.89	9971.0	4.639	26.3
	RodB5_55	155	55	1.397	8	0.203	946.98	781.5	3237.96	10214.1	4.504	25.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	1001.06	811.5	3318.67	10468.8	4.293	24.4
	RodB5_64	157	64	1.626	17	0.432	1063.89	846.4	3503.75	11052.6	4.192	23.8
	RodB5_73.9	158	73.9	1.877	3.02	0.077	924.62	769.0	3805.71	12005.1	5.463	31.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	964.80	791.4	3865.40	12193.4	5.246	29.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	981.51	800.7	3895.10	12287.1	5.169	29.4
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	821.41	711.7	2796.00	8820.0	4.712	26.8
	RodF5_53.1	106	53.1	1.349	6.1	0.155	880.40	744.5	3149.70	9935.7	4.828	27.4
	RodF5_55	107	55	1.397	8	0.203	922.30	767.8	3208.02	10119.7	4.621	26.2
	RodF5_57.8	108	57.8	1.468	10.8	0.274	969.18	793.8	3293.41	10389.1	4.443	25.2
	RodF5_64	109	64	1.626	17	0.432	1028.21	826.6	3480.99	10980.8	4.350	24.7
	RodF5_73.8	110	73.8	1.875	2.92	0.074	891.60	750.7	3765.86	11879.4	5.675	32.2
	RodF5_75.8	111	75.8	1.925	4.92	0.125	929.82	771.9	3825.90	12068.8	5.451	31.0
	RodF5_76.8	112	76.8	1.951	5.92	0.150	946.05	781.0	3856.32	12164.8	5.371	30.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	832.59	717.9	2802.12	8839.3	4.635	26.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	929.00	771.5	3151.41	9941.1	4.496	25.5
	RodC2_55	59	55	1.397	8	0.203	950.95	783.7	3207.13	10116.9	4.436	25.2
	RodC2_57.8	60	57.8	1.468	10.8	0.274	985.56	802.9	3291.42	10382.8	4.345	24.7
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1037.37	831.7	3477.83	10970.8	4.297	24.4
	RodC2_73.8	62	73.8	1.875	2.92	0.074	889.57	749.6	3790.29	11956.5	5.729	32.5
	RodC2_75.8	63	75.8	1.925	4.92	0.125	924.29	768.9	3852.53	12152.8	5.533	31.4
	RodC2_76.8	64	76.8	1.951	5.92	0.150	939.56	777.4	3883.77	12251.3	5.458	31.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	833.64	718.5	2790.11	8801.4	4.607	26.2
	RodC6_52.8	138	52.8	1.341	5.8	0.147	938.16	776.6	3161.01	9971.4	4.451	25.3
	RodC6_54.8	139	54.8	1.392	7.8	0.198	962.24	789.9	3228.82	10185.3	4.398	25.0
	RodC6_57.8	140	57.8	1.468	10.8	0.274	983.61	801.8	3338.05	10529.9	4.418	25.1
	RodC6_63.8	141	63.8	1.621	16.8	0.427	1034.51	830.1	3529.23	11133.0	4.376	24.9
	RodC6_73.7	142	73.7	1.872	2.82	0.072	903.01	757.0	3834.01	12094.4	5.680	32.3
	RodC6_75.8	143	75.8	1.925	4.92	0.125	937.89	776.4	3898.81	12298.8	5.492	31.2
	RodC6_76.8	144	76.8	1.951	5.92	0.150	957.70	787.4	3929.87	12396.8	5.386	30.6

Table A-59: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	1031.79	828.6	4203.45	13259.8	5.230	29.7
	RodB4_91.3	162	91.3	2.319	2.8	0.071	1097.40	865.0	4289.36	13530.8	4.934	28.0
	RodB4_93.3	163	93.3	2.370	4.8	0.122	1126.74	881.3	4345.49	13707.8	4.835	27.5
	RodB4_95.1	164	95.1	2.416	6.6	0.168	1154.20	896.6	4398.82	13876.1	4.749	27.0
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1369.83	1016.4	1753.60	5531.7	1.536	8.7
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	1024.59	824.6	4141.52	13064.4	5.199	29.5
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	1032.06	828.7	4225.99	13330.9	5.256	29.8
	RodF4_92.4	100	92.4	2.347	3.9	0.099	1124.73	880.2	4348.31	13716.7	4.849	27.5
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1158.67	899.1	4404.86	13895.1	4.733	26.9
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1318.93	988.1	4177.58	13178.2	3.829	21.7
	RodD2_106	66	106	2.692	17.5	0.445	1341.60	1000.7	3955.30	12477.0	3.552	20.2
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1373.73	1018.6	3653.33	11524.4	3.189	18.1
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1393.23	1029.4	3299.07	10406.9	2.831	16.1
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1397.70	1031.9	2961.04	9340.6	2.531	14.4
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1301.01	978.2	4185.73	13203.9	3.901	22.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1319.89	988.6	4015.23	12666.0	3.677	20.9
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1343.55	1001.8	3647.45	11505.9	3.270	18.6
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1353.93	1007.6	3297.32	10401.4	2.929	16.6
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1361.49	1011.8	2946.32	9294.2	2.599	14.8

Table A-59: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	885.60	747.4	3105.82	9797.3	4.723	26.8
	RodE2_54	74	54	1.372	7	0.178	942.47	779.0	3222.50	10165.4	4.510	25.6
	RodE2_56.9	75	56.9	1.445	9.9	0.251	981.96	800.9	3307.70	10434.2	4.387	24.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	1021.88	823.1	3394.97	10709.4	4.276	24.3
	RodE2_66	77	66	1.676	19	0.483	1039.39	832.8	3584.35	11306.8	4.418	25.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	780.26	688.9	3719.41	11732.9	6.735	38.2
	RodE2_72.9	79	72.9	1.852	2.02	0.051	877.59	742.9	3825.37	12067.1	5.889	33.4
	RodE2_74.9	80	74.9	1.902	4.02	0.102	918.52	765.7	3886.06	12258.6	5.628	32.0
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	851.29	728.3	3059.15	9650.1	4.908	27.9
	RodB3_54.1	170	54.1	1.374	7.1	0.180	896.55	753.5	3168.27	9994.3	4.739	26.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	945.10	780.4	3252.88	10261.2	4.536	25.8
	RodB3_60.1	172	60.1	1.527	13.1	0.333	982.67	801.3	3358.12	10593.2	4.450	25.3
	RodB3_66.1	173	66.1	1.679	19.1	0.485	1005.43	813.9	3553.47	11209.4	4.571	26.0
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	781.19	689.4	3665.36	11562.4	6.626	37.6
	RodB3_73	175	73	1.854	2.12	0.054	874.66	741.3	3759.97	11860.8	5.814	33.0
	RodB3_75	176	75	1.905	4.12	0.105	918.66	765.7	3821.97	12056.4	5.534	31.4
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	883.71	746.3	3078.62	9711.5	4.695	26.7
	RodF3_54	90	54	1.372	7	0.178	933.52	774.0	3193.34	10073.4	4.526	25.7
	RodF3_57	91	57	1.448	10	0.254	979.75	799.7	3291.73	10383.8	4.379	24.9
	RodF3_60	92	60	1.524	13	0.330	1017.18	820.5	3383.08	10671.9	4.287	24.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	1046.67	836.9	3570.08	11261.8	4.361	24.8
	RodF3_70	94	70	1.778	-0.88	-0.022	811.88	706.4	3700.74	11674.0	6.338	36.0
	RodF3_73	95	73	1.854	2.12	0.054	897.73	754.1	3789.98	11955.5	5.659	32.1
	RodF3_75	96	75	1.905	4.12	0.105	941.06	778.2	3853.60	12156.2	5.404	30.7
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	864.55	735.7	3086.42	9736.1	4.849	27.5
	RodE6_54.1	122	54.1	1.374	7.1	0.180	918.49	765.6	3202.37	10101.9	4.638	26.3
	RodE6_57	123	57	1.448	10	0.254	949.91	783.1	3291.10	10381.8	4.559	25.9
	RodE6_60.2	124	60.2	1.529	13.2	0.335	988.86	804.7	3386.70	10683.3	4.451	25.3
	RodE6_66.1	125	66.1	1.679	19.1	0.485	1006.97	814.8	3564.14	11243.1	4.575	26.0
	RodE6_70	126	70	1.778	-0.88	-0.022	782.59	690.1	3683.44	11619.4	6.642	37.7
	RodE6_73.1	127	73.1	1.857	2.22	0.056	869.24	738.3	3763.62	11872.4	5.869	33.3
	RodE6_75	128	75	1.905	4.12	0.105	909.28	760.5	3817.37	12041.9	5.603	31.8

RBHT Steam Cooling with Droplet Injection Test SCD-4053-E

Matrix Test # 11a

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 18120 - 18900
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

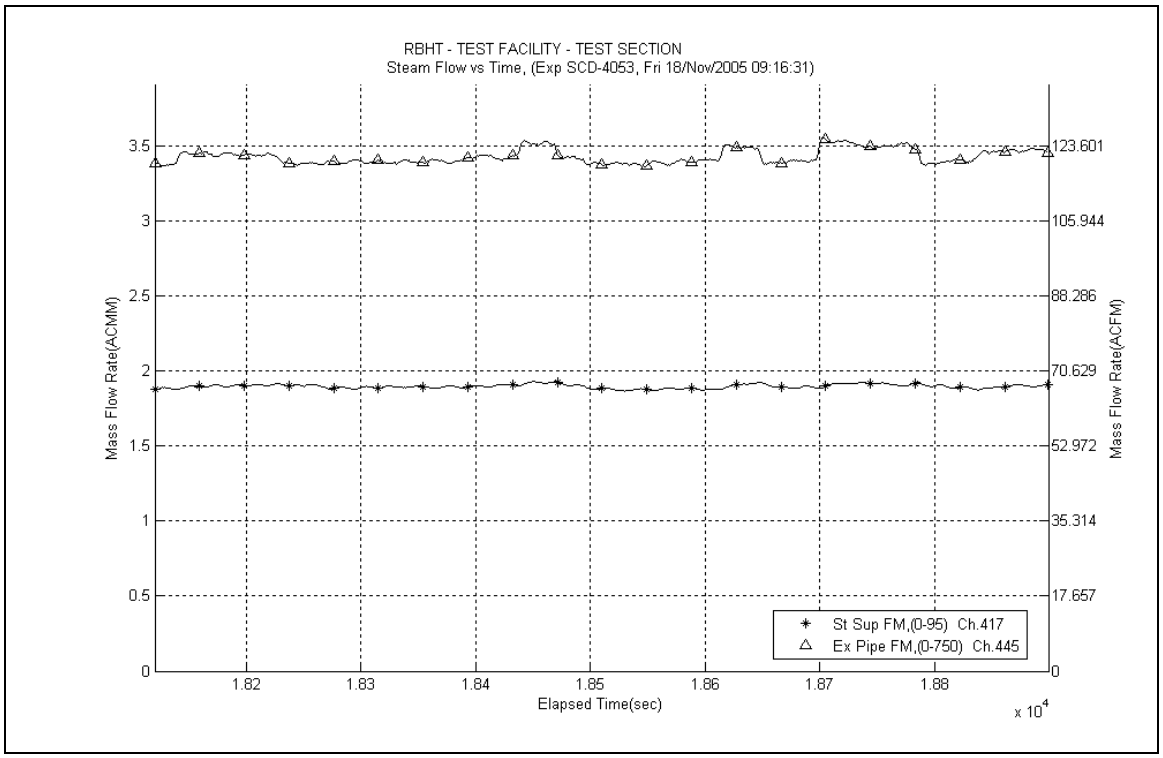

Figure A-384: Inlet and Exhaust Steam Flow Rates for Experiment 4053E

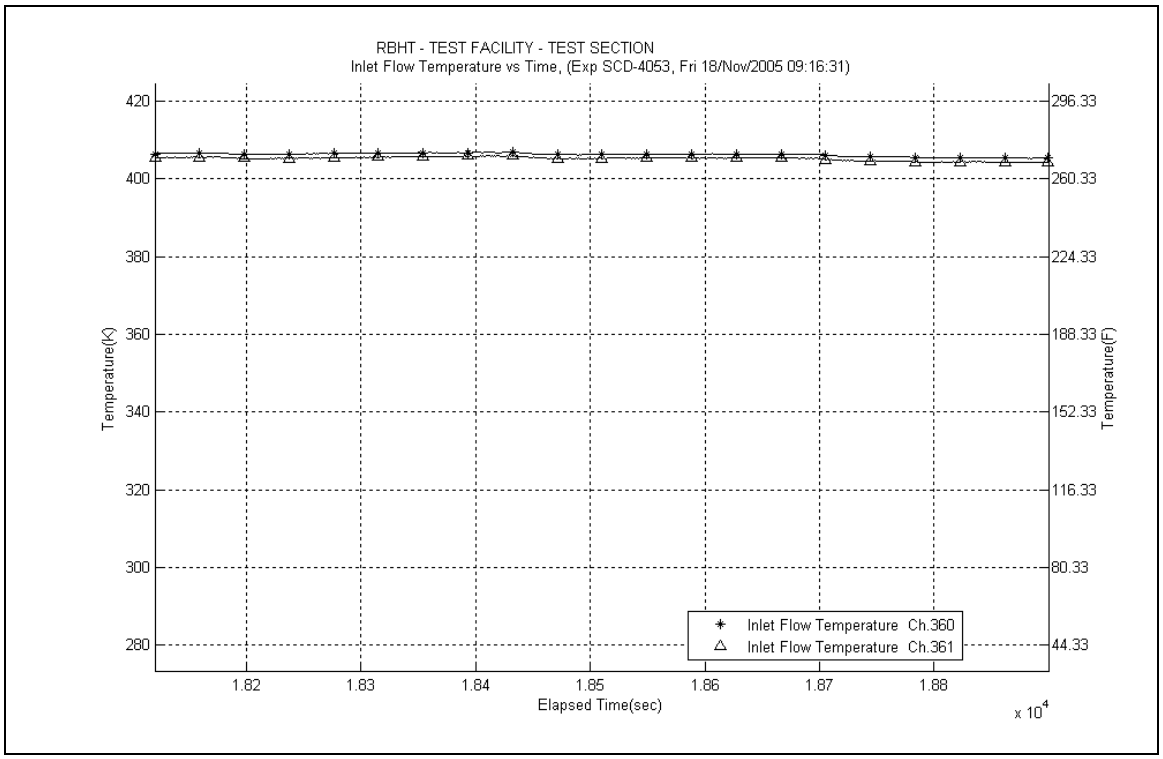

Figure A-385: Inlet Steam Temperature for Experiment 4053E

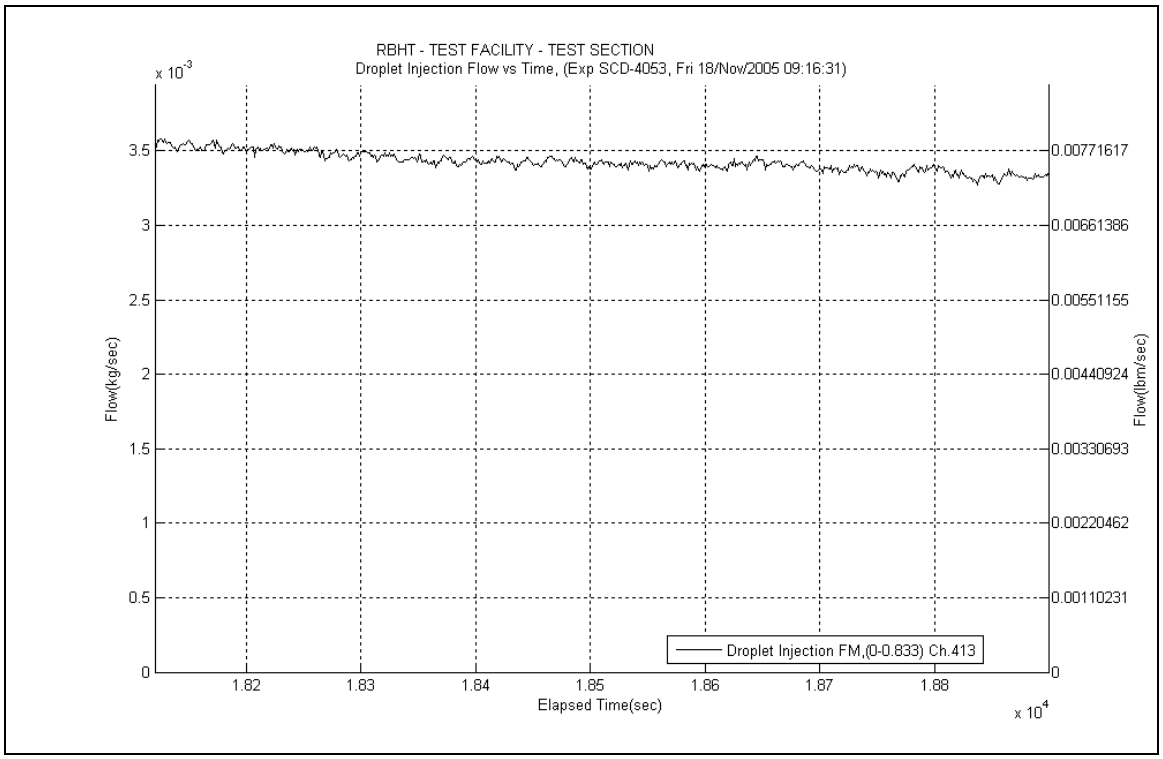

Figure A-386: Droplet Injection Flow Rate for Experiment 4053E

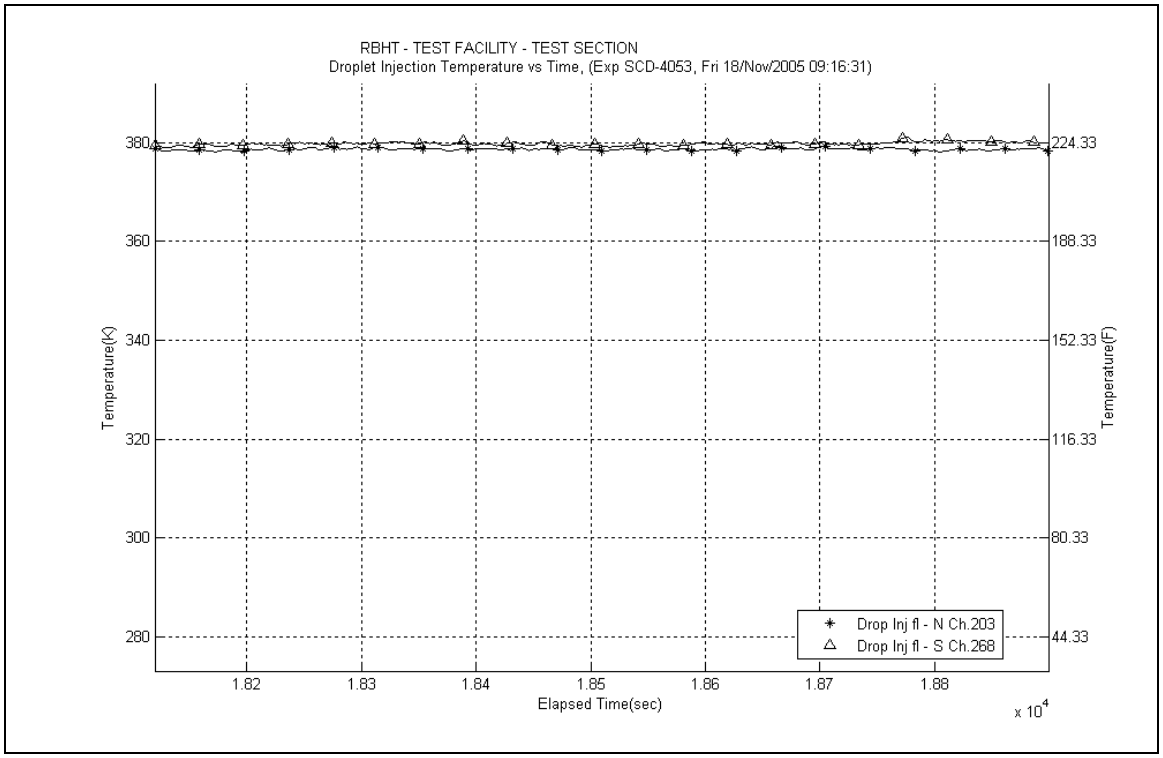

Figure A-387: Droplet Injection Temperature for Experiment 4053E

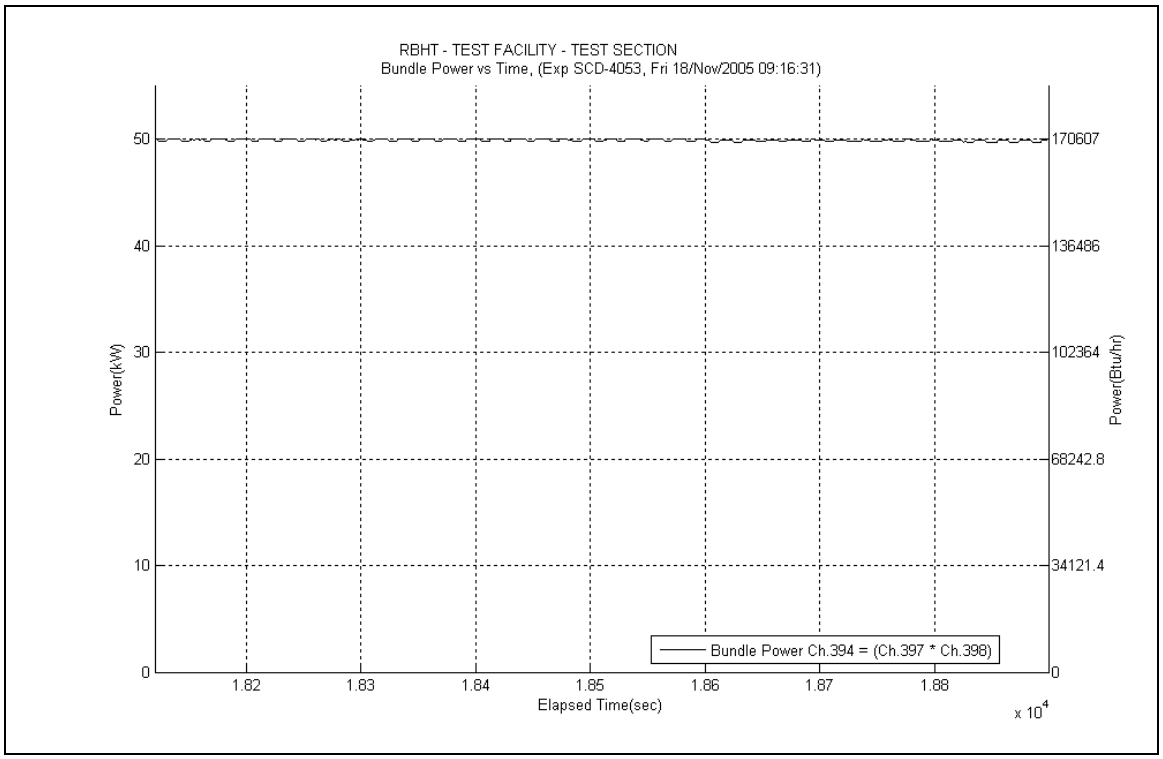

Figure A-388: Bundle Power for Experiment 4053E

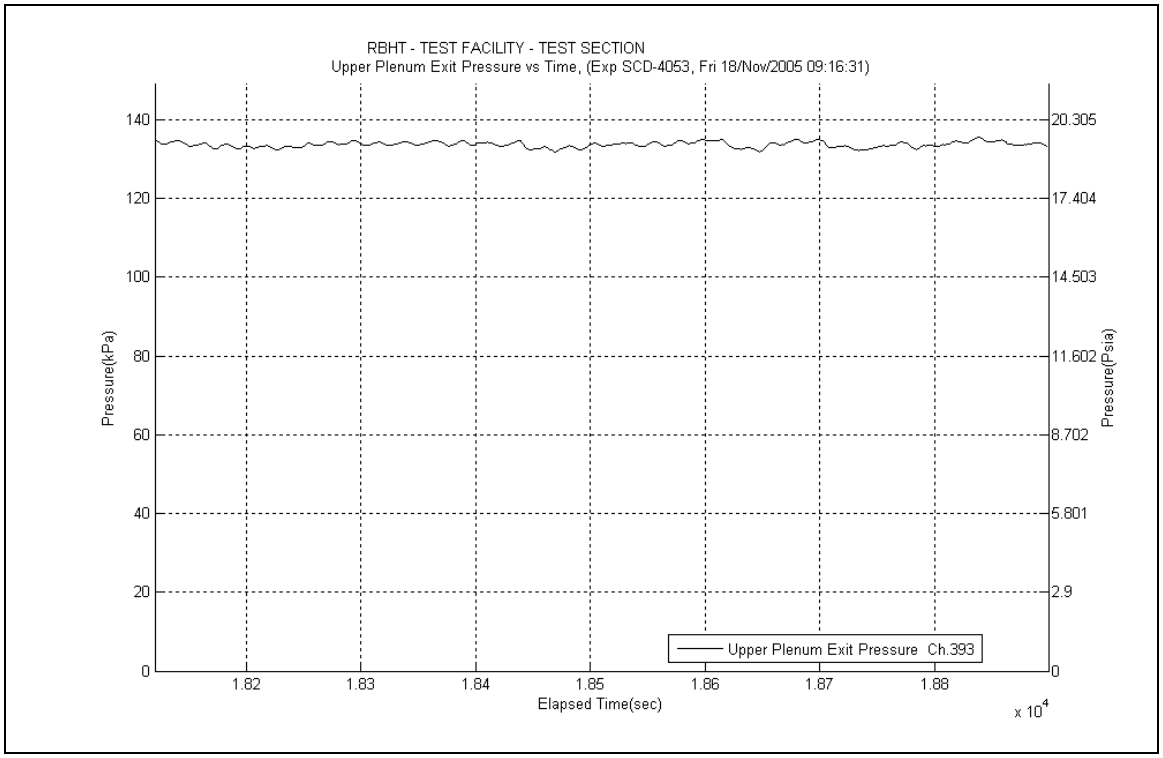

Figure A-389: Upper Plenum Pressure for Experiment 4053E

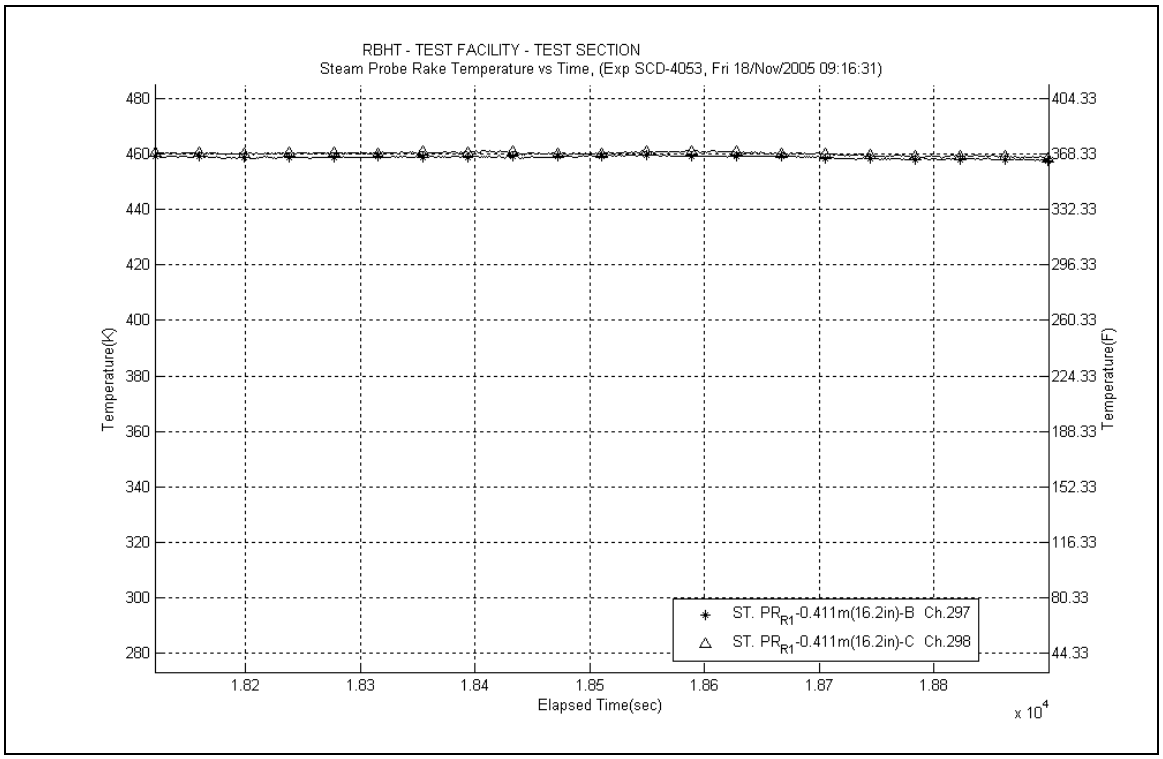

Figure A-390: Steam Probe Rake #1 Temperatures for Experiment 4053E

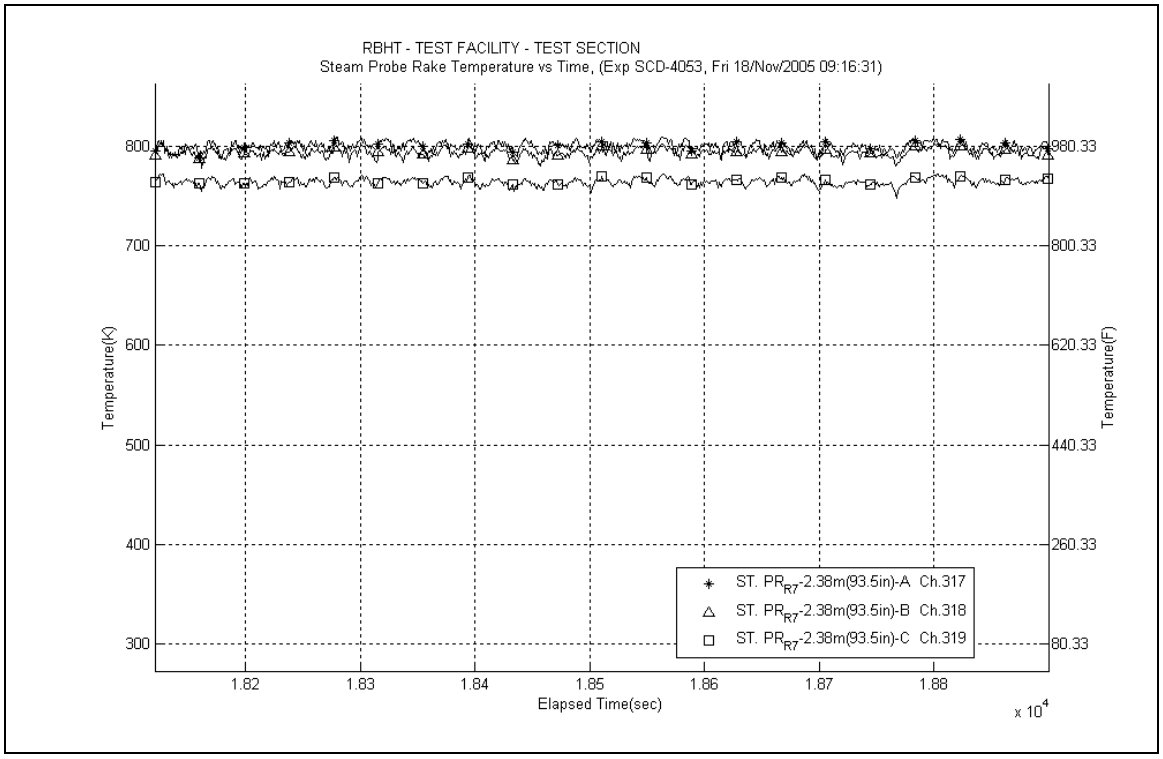

Figure A-391: Steam Probe Rake #7 Temperatures for Experiment 4053E

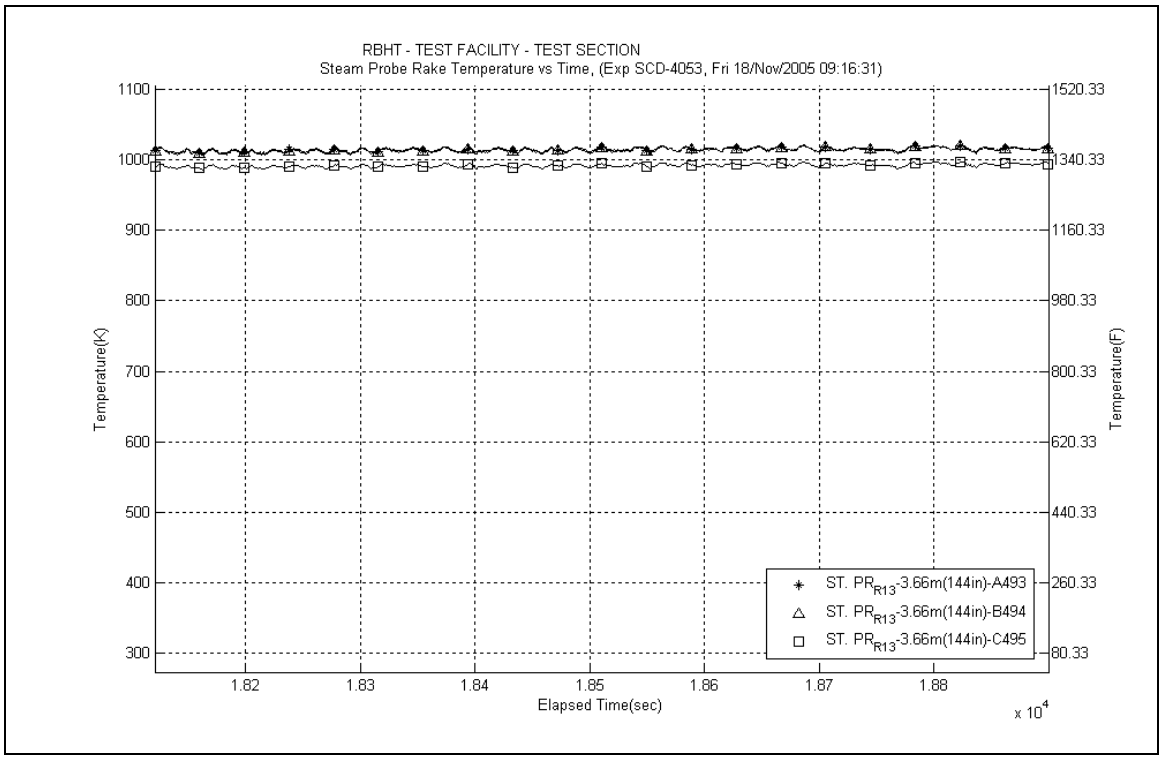

Figure A-392: Steam Probe Rake #13 Temperatures for Experiment 4053E

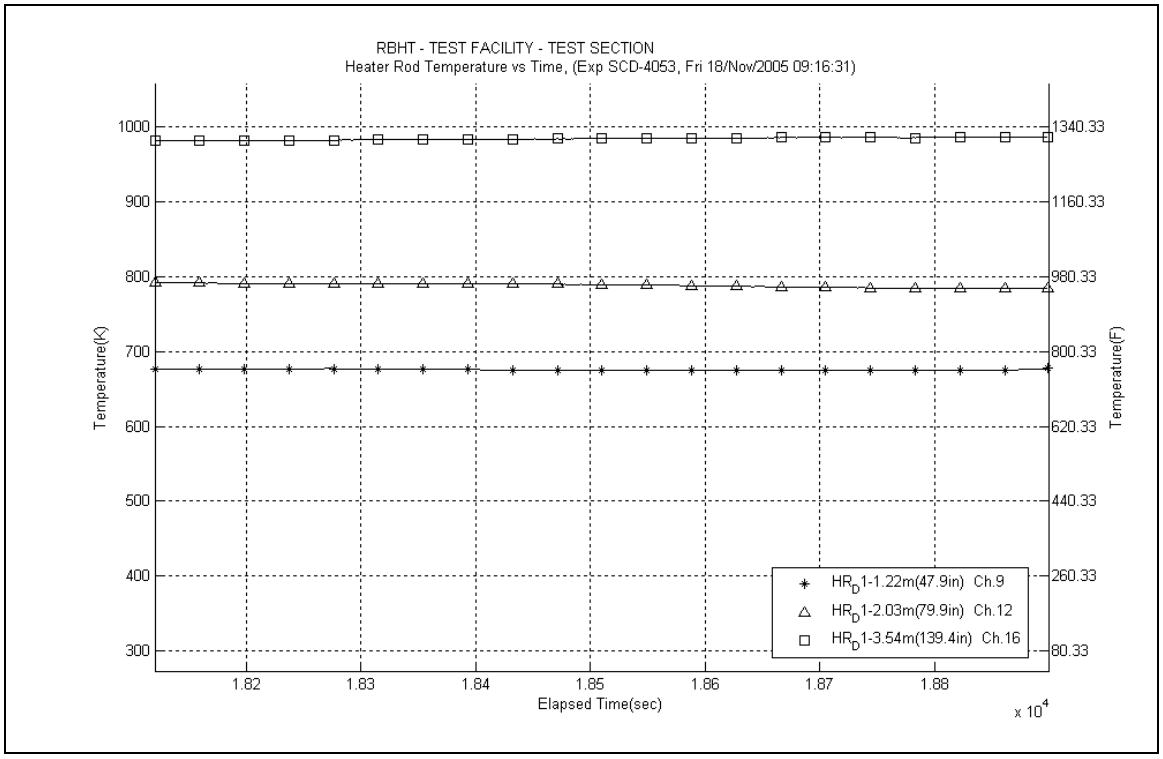

Figure A-393: Heater Rod D1 Temperatures for Experiment 4053E

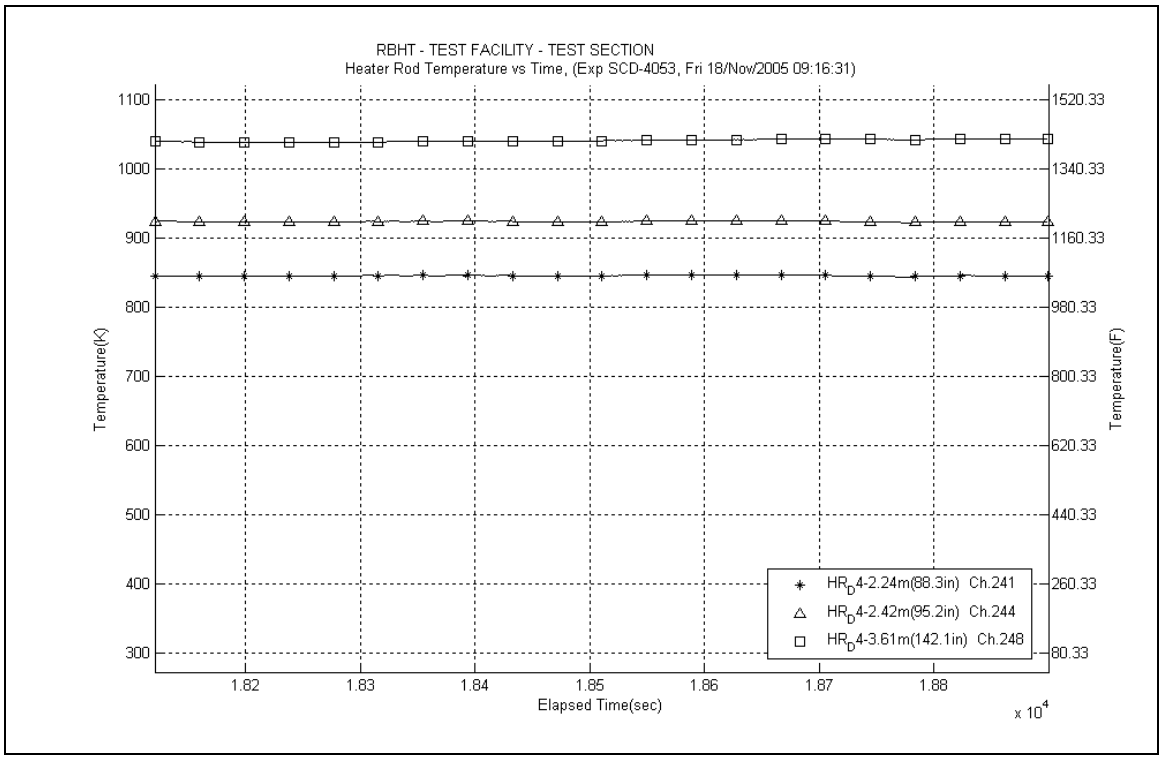

Figure A-394: Heater Rod D4 Temperatures for Experiment 4053E

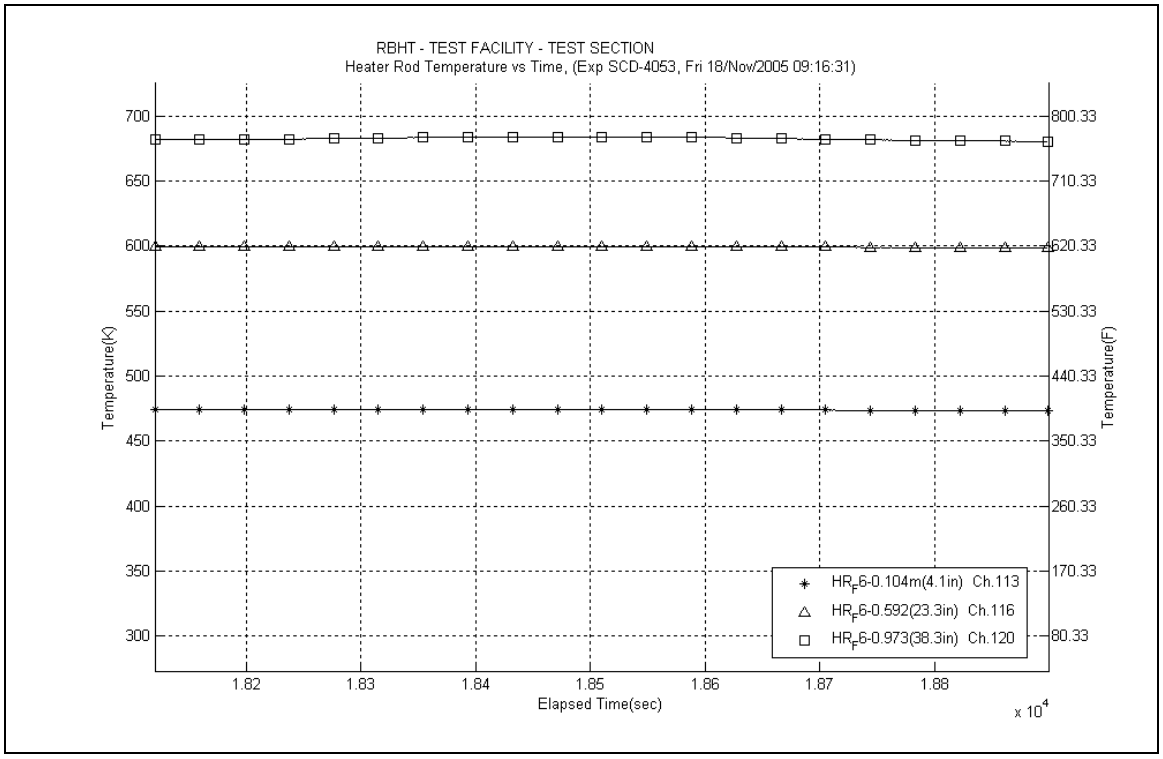

Figure A-395: Heater Rod F6 Temperatures for Experiment 4053E

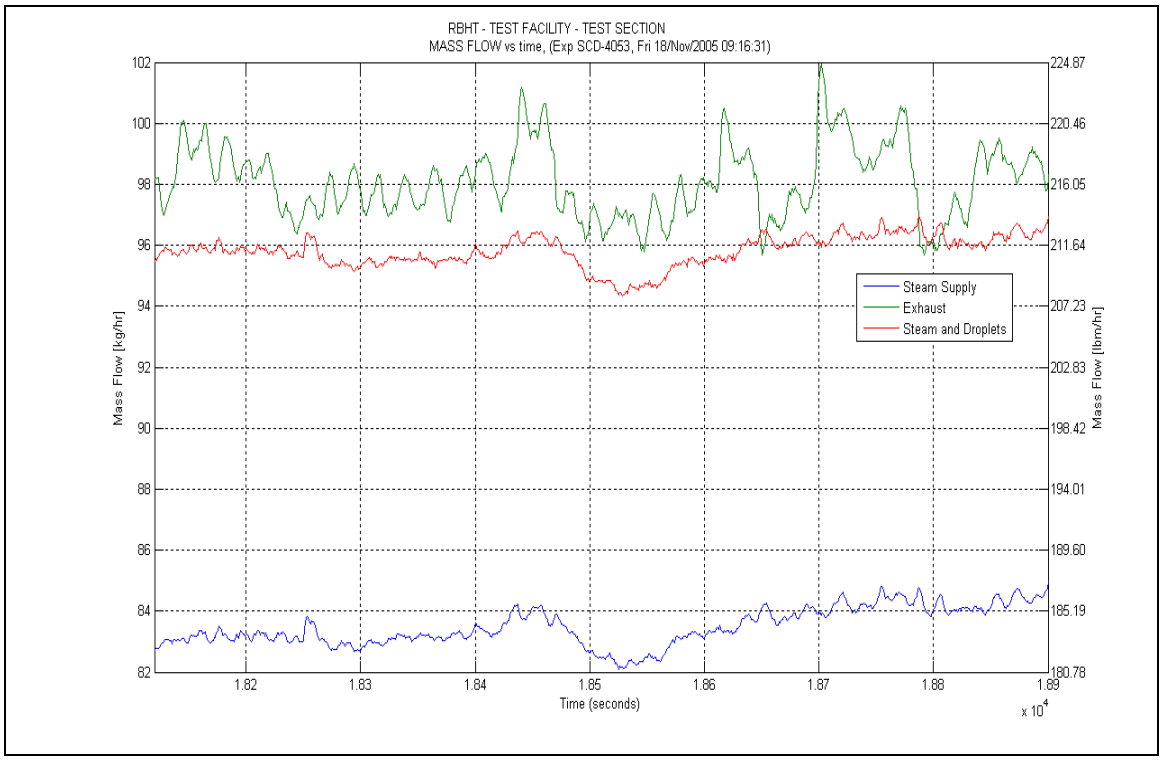

Figure A-396: Mass Flow for Experiment 4053E

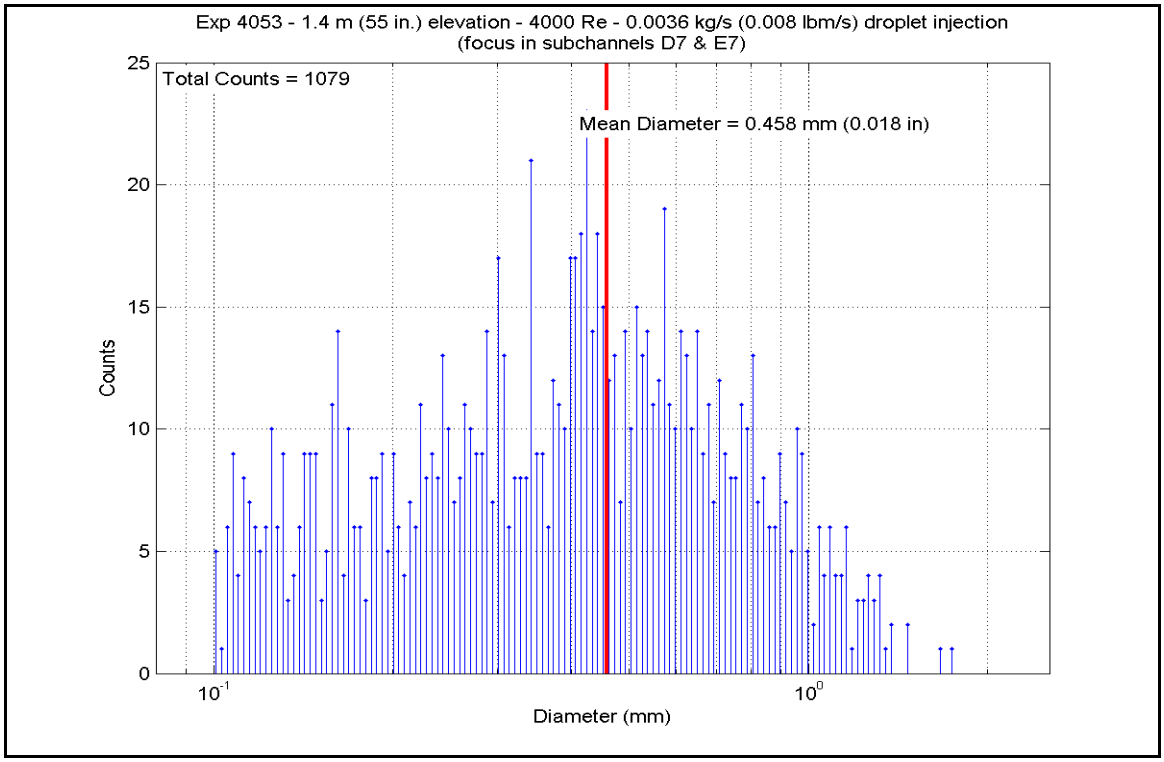

Figure A-397: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053E

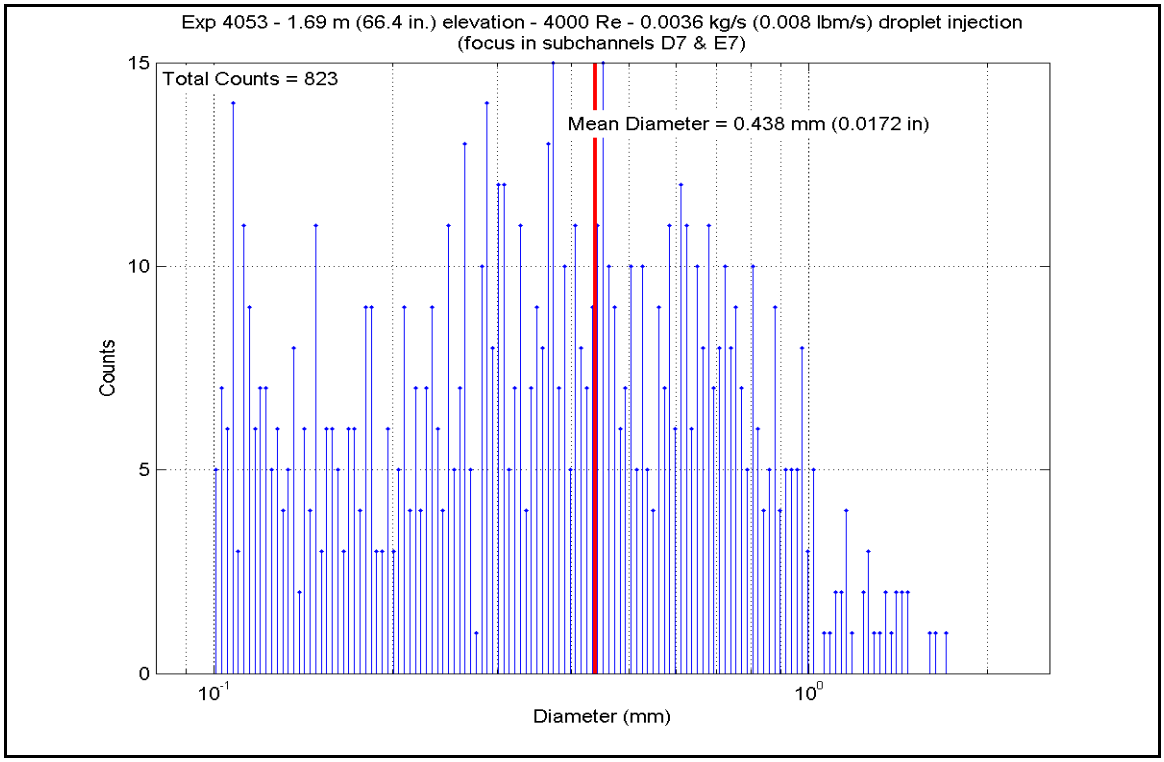

Figure A-398: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053E

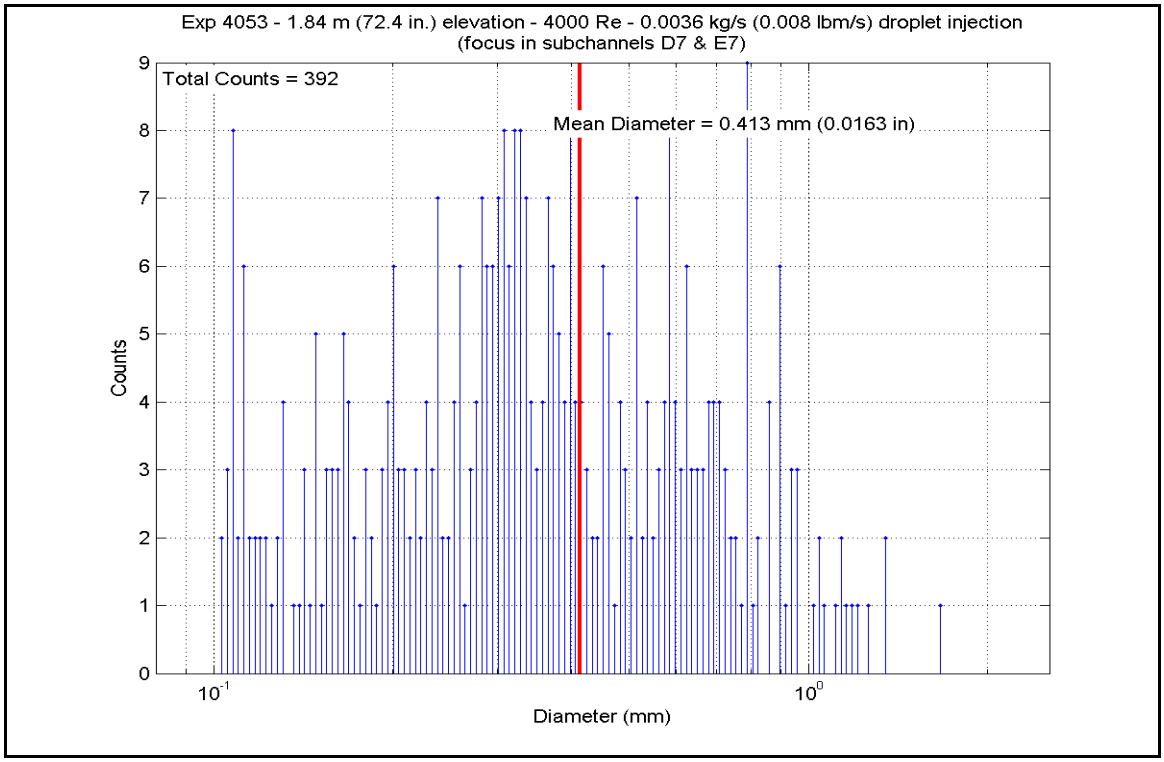

Figure A-399: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053E

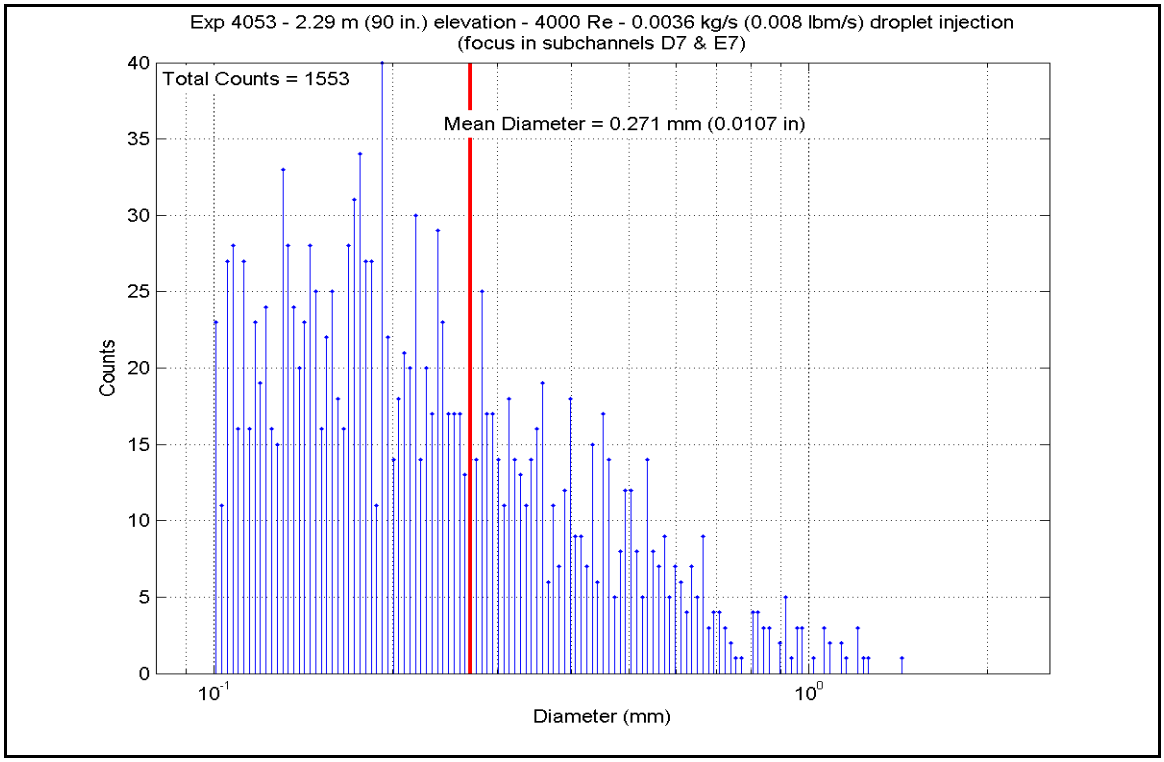

Figure A-400: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053E

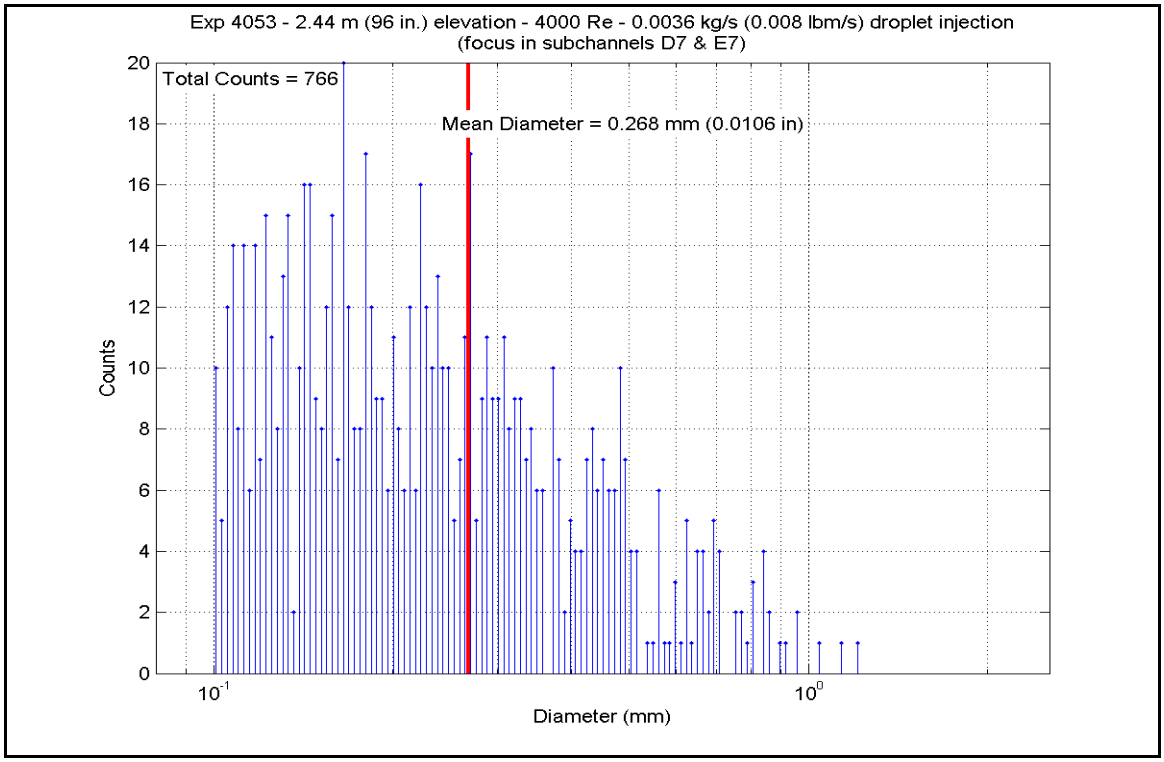

Figure A-401: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053E

Table A-60: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053E

SCD-4053-E	Inlet Reynolds:	4000		
Matrix test # 11a	UP Pressure:	137.9 kPa	20	psia
Time Window: 18120-18900	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0036 kg/s	0.008	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	803.86	702.0	4236.46	13363.9	7.357	41.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	898.79	754.7	4321.86	13633.3	6.443	36.6
	RodD3_93.1	187	93.1	2.365	4.6	0.117	927.73	770.8	4346.41	13710.8	6.212	35.3
	RodD3_95.3	188	95.3	2.421	6.8	0.173	977.74	798.6	4418.86	13939.3	5.894	33.5
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1137.10	887.1	4766.96	15037.4	5.244	29.8
	RodD3_110	191	110	2.794	21.5	0.546	1098.50	865.6	4706.58	14846.9	5.407	30.7
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1195.67	919.6	1666.01	5255.4	1.722	9.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	799.66	699.6	4284.63	13515.9	7.495	42.6
	RodC4_91.1	234	91.1	2.314	2.6	0.066	889.55	749.6	4363.30	13764.0	6.596	37.5
	RodC4_93.4	235	93.4	2.372	4.9	0.124	929.11	771.5	4405.26	13896.4	6.283	35.7
	RodC4_95.3	236	95.3	2.421	6.8	0.173	970.94	794.8	4477.57	14124.5	6.027	34.2
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1065.32	847.2	4649.91	14668.1	5.553	31.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1126.09	881.0	4832.76	15244.9	5.381	30.6
	RodC4_110	239	110	2.794	21.5	0.546	1083.23	857.2	4672.96	14740.9	5.464	31.0
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1186.12	914.3	1797.48	5670.2	1.876	10.7
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	787.47	692.9	4268.34	13464.5	7.629	43.3
	RodD4_91.3	242	91.3	2.319	2.8	0.071	886.71	748.0	4354.59	13736.6	6.611	37.5
	RodD4_93.2	243	93.2	2.367	4.7	0.119	922.87	768.1	4390.02	13848.3	6.318	35.9
	RodD4_95.2	244	95.2	2.418	6.7	0.170	964.70	791.3	4453.72	14049.3	6.045	34.3
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1057.17	842.7	4631.30	14609.4	5.585	31.7
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1112.30	873.3	4808.41	15168.1	5.438	30.9
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1186.85	914.7	1734.02	5470.0	1.808	10.3
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	792.84	695.8	4206.13	13268.3	7.447	42.3
	RodE4_91.2	202	91.2	2.316	2.7	0.069	886.70	748.0	4284.70	13516.1	6.505	36.9
	RodE4_95.3	204	95.3	2.421	6.8	0.173	973.04	795.9	4398.65	13875.6	5.904	33.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1056.88	842.5	4564.52	14398.8	5.507	31.3
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1181.39	911.7	1756.92	5542.2	1.843	10.5

Table A-60: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1013.70	818.5	3480.23	10978.4	4.429	25.2
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1122.08	878.7	4297.35	13556.0	4.806	27.3
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1156.34	897.8	4139.69	13058.6	4.459	25.3
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1189.37	916.1	3889.70	12270.1	4.046	23.0
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1213.30	929.4	3539.40	11165.0	3.592	20.4
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1221.04	933.7	3223.46	10168.4	3.246	18.4
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1176.16	908.8	2781.93	8775.6	2.934	16.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1190.79	916.9	2462.23	7767.1	2.557	14.5
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1013.72	818.6	3418.48	10783.6	4.351	24.7
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1076.39	853.4	4180.93	13188.7	4.928	28.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1117.12	876.0	4015.31	12666.3	4.516	25.6
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1173.30	907.2	3461.29	10918.6	3.662	20.8
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1181.75	911.9	3143.29	9915.5	3.296	18.7
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1127.17	881.6	2741.17	8647.0	3.049	17.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1148.95	893.7	2422.71	7642.4	2.631	14.9
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	946.56	781.2	3501.40	11045.2	4.873	27.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	984.56	802.3	4310.75	13598.3	5.698	32.4
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1032.24	828.8	4166.88	13144.4	5.181	29.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1075.09	852.6	3900.88	12305.3	4.605	26.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1107.36	870.6	3582.73	11301.7	4.074	23.1
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1127.73	881.9	3255.27	10268.8	3.618	20.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1290.86	972.5	2851.55	8995.2	2.683	15.2
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1152.58	895.7	2501.38	7890.6	2.705	15.4
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	918.72	765.8	3963.64	12503.3	5.738	32.6
	RodC3_85.6	178	85.6	2.174	14.72	0.374	840.70	722.4	4140.08	13059.9	6.757	38.4
	RodC3_88.5	179	88.5	2.248	0	0.000	799.39	699.5	4217.04	13302.7	7.380	41.9
	RodC3_92.4	180	92.4	2.347	3.9	0.099	910.73	761.3	4327.20	13650.1	6.338	36.0
	RodC3_94.4	181	94.4	2.398	5.9	0.150	943.87	779.7	4365.84	13772.0	6.099	34.6
Gr-8	RodD5_50	217	50	1.270	3	0.076	892.49	751.2	3096.78	9768.8	4.660	26.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	899.39	755.0	3225.83	10175.9	4.805	27.3
	RodD5_56.9	219	56.9	1.445	9.9	0.251	939.18	777.1	3304.83	10425.1	4.647	26.4
	RodD5_60	220	60	1.524	13	0.330	980.03	799.8	3394.67	10708.5	4.514	25.6
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1002.22	812.2	3576.70	11282.7	4.620	26.2
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	755.42	675.0	3684.31	11622.2	6.986	39.7
	RodD5_72.9	223	72.9	1.852	2.02	0.051	828.61	715.7	3772.46	11900.2	6.281	35.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	874.37	741.1	3831.69	12087.1	5.928	33.7

Table A-60: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	821.75	711.9	2811.10	8867.6	4.735	26.9
	RodB5_52.9	154	52.9	1.344	5.9	0.150	894.05	752.1	3168.70	9995.7	4.757	27.0
	RodB5_55	155	55	1.397	8	0.203	920.15	766.6	3230.59	10190.9	4.667	26.5
	RodB5_57.8	156	57.8	1.468	10.8	0.274	962.36	790.0	3314.60	10455.9	4.514	25.6
	RodB5_64	157	64	1.626	17	0.432	1015.74	819.7	3501.59	11045.8	4.445	25.2
	RodB5_73.9	158	73.9	1.877	3.02	0.077	864.87	735.9	3804.40	12001.0	5.974	33.9
	RodB5_75.9	159	75.9	1.928	5.02	0.128	901.85	756.4	3864.77	12191.4	5.735	32.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	916.60	764.6	3894.57	12285.4	5.656	32.1
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	801.63	700.7	2794.95	8816.7	4.872	27.7
	RodF5_53.1	106	53.1	1.349	6.1	0.155	853.24	729.4	3154.44	9950.7	5.045	28.7
	RodF5_55	107	55	1.397	8	0.203	884.85	747.0	3217.01	10148.1	4.898	27.8
	RodF5_57.8	108	57.8	1.468	10.8	0.274	932.95	773.7	3301.74	10415.3	4.684	26.6
	RodF5_64	109	64	1.626	17	0.432	987.79	804.1	3485.41	10994.7	4.587	26.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	842.26	723.3	3773.18	11902.5	6.143	34.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	878.48	743.4	3832.86	12090.8	5.892	33.5
	RodF5_76.8	112	76.8	1.951	5.92	0.150	893.47	751.7	3862.88	12185.5	5.805	33.0
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	823.02	712.6	2806.81	8854.1	4.717	26.8
	RodC2_53.1	58	53.1	1.349	6.1	0.155	934.79	774.7	3168.08	9993.7	4.482	25.5
	RodC2_55	59	55	1.397	8	0.203	953.66	785.2	3226.40	10177.7	4.446	25.2
	RodC2_57.8	60	57.8	1.468	10.8	0.274	983.70	801.9	3311.95	10447.5	4.383	24.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1022.31	823.3	3495.22	11025.7	4.400	25.0
	RodC2_73.8	62	73.8	1.875	2.92	0.074	852.34	728.9	3799.41	11985.2	6.085	34.6
	RodC2_75.8	63	75.8	1.925	4.92	0.125	887.72	748.6	3859.65	12175.3	5.850	33.2
	RodC2_76.8	64	76.8	1.951	5.92	0.150	903.24	757.2	3890.10	12271.3	5.761	32.7
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	821.65	711.8	2798.95	8829.3	4.715	26.8
	RodC6_52.8	138	52.8	1.341	5.8	0.147	926.54	770.1	3170.10	10000.1	4.538	25.8
	RodC6_54.8	139	54.8	1.392	7.8	0.198	944.94	780.3	3231.75	10194.6	4.508	25.6
	RodC6_57.8	140	57.8	1.468	10.8	0.274	956.84	786.9	3328.30	10499.1	4.567	25.9
	RodC6_63.8	141	63.8	1.621	16.8	0.427	991.40	806.2	3514.52	11086.6	4.604	26.1
	RodC6_73.7	142	73.7	1.872	2.82	0.072	856.08	731.0	3821.87	12056.1	6.085	34.6
	RodC6_75.8	143	75.8	1.925	4.92	0.125	888.98	749.3	3887.15	12262.0	5.881	33.4
	RodC6_76.8	144	76.8	1.951	5.92	0.150	907.29	759.4	3918.40	12360.6	5.768	32.8

Table A-60: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	798.85	699.2	4205.88	13267.5	7.368	41.8
	RodB4_91.3	162	91.3	2.319	2.8	0.071	887.53	748.4	4288.97	13529.6	6.503	36.9
	RodB4_93.3	163	93.3	2.370	4.8	0.122	916.29	764.4	4327.92	13652.4	6.288	35.7
	RodB4_95.1	164	95.1	2.416	6.6	0.168	949.32	782.8	4386.21	13836.3	6.081	34.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1168.56	904.6	1791.80	5652.2	1.905	10.8
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	868.76	738.0	4160.67	13124.8	6.493	36.9
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	801.13	700.4	4235.89	13362.1	7.391	42.0
	RodF4_92.4	100	92.4	2.347	3.9	0.099	909.41	760.6	4350.21	13722.7	6.384	36.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	946.25	781.1	4407.10	13902.2	6.136	34.8
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1125.58	880.7	4188.83	13213.7	4.667	26.5
	RodD2_106	66	106	2.692	17.5	0.445	1150.96	894.8	3970.43	12524.7	4.302	24.4
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1186.00	914.3	3674.93	11592.6	3.836	21.8
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1205.62	925.2	3325.54	10490.4	3.402	19.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1208.38	926.7	2989.54	9430.5	3.049	17.3
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1067.92	848.7	4192.14	13224.1	4.991	28.3
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1094.26	863.3	4023.88	12693.3	4.645	26.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1119.82	877.5	3658.68	11541.3	4.102	23.3
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1130.91	883.7	3311.98	10447.6	3.668	20.8
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1133.84	885.3	2962.92	9346.5	3.271	18.6

Table A-60: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	885.56	747.4	3108.15	9804.6	4.727	26.8
	RodE2_54	74	54	1.372	7	0.178	950.29	783.3	3224.12	10170.5	4.464	25.3
	RodE2_56.9	75	56.9	1.445	9.9	0.251	984.91	802.5	3312.51	10449.3	4.376	24.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	1015.37	819.5	3403.84	10737.4	4.323	24.6
	RodE2_66	77	66	1.676	19	0.483	1016.47	820.1	3593.79	11336.6	4.558	25.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	759.65	677.4	3713.20	11713.3	6.984	39.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	853.43	729.5	3801.06	11990.5	6.078	34.5
	RodE2_74.9	80	74.9	1.902	4.02	0.102	891.12	750.4	3862.12	12183.0	5.824	33.1
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	839.46	721.7	3082.77	9724.6	5.042	28.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	892.63	751.3	3204.25	10107.8	4.821	27.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	928.84	771.4	3288.12	10372.4	4.692	26.6
	RodB3_60.1	172	60.1	1.527	13.1	0.333	922.51	767.9	3380.15	10662.7	4.867	27.6
	RodB3_66.1	173	66.1	1.679	19.1	0.485	953.83	785.3	3570.22	11262.3	4.919	27.9
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	733.87	663.1	3684.66	11623.3	7.284	41.4
	RodB3_73	175	73	1.854	2.12	0.054	805.78	703.0	3774.36	11906.2	6.533	37.1
	RodB3_75	176	75	1.905	4.12	0.105	844.46	724.5	3835.69	12099.7	6.222	35.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	864.68	735.7	3089.48	9745.8	4.853	27.6
	RodF3_54	90	54	1.372	7	0.178	927.45	770.6	3209.68	10124.9	4.589	26.1
	RodF3_57	91	57	1.448	10	0.254	966.34	792.2	3302.89	10419.0	4.473	25.4
	RodF3_60	92	60	1.524	13	0.330	996.80	809.2	3394.82	10709.0	4.416	25.1
	RodF3_66.1	93	66.1	1.679	19.1	0.485	1017.84	820.8	3584.04	11305.8	4.538	25.8
	RodF3_70	94	70	1.778	-0.88	-0.022	794.36	696.7	3693.65	11651.6	6.522	37.0
	RodF3_73	95	73	1.854	2.12	0.054	868.15	737.7	3788.24	11950.0	5.918	33.6
	RodF3_75	96	75	1.905	4.12	0.105	906.20	758.8	3848.85	12141.2	5.675	32.2
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	841.81	723.0	3085.02	9731.7	5.026	28.5
	RodE6_54.1	122	54.1	1.374	7.1	0.180	896.55	753.5	3199.75	10093.6	4.786	27.2
	RodE6_57	123	57	1.448	10	0.254	909.07	760.4	3281.27	10350.8	4.818	27.4
	RodE6_60.2	124	60.2	1.529	13.2	0.335	935.65	775.2	3371.48	10635.3	4.764	27.1
	RodE6_66.1	125	66.1	1.679	19.1	0.485	945.25	780.5	3547.33	11190.0	4.946	28.1
	RodE6_70	126	70	1.778	-0.88	-0.022	736.84	664.7	3664.93	11561.0	7.202	40.9
	RodE6_73.1	127	73.1	1.857	2.22	0.056	810.97	705.9	3756.69	11850.5	6.444	36.6
	RodE6_75	128	75	1.905	4.12	0.105	849.10	727.1	3813.73	12030.4	6.140	34.9

RBHT Steam Cooling with Droplet Injection Test SCD-4053-F

Matrix Test # 11b

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 20100 - 21540
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

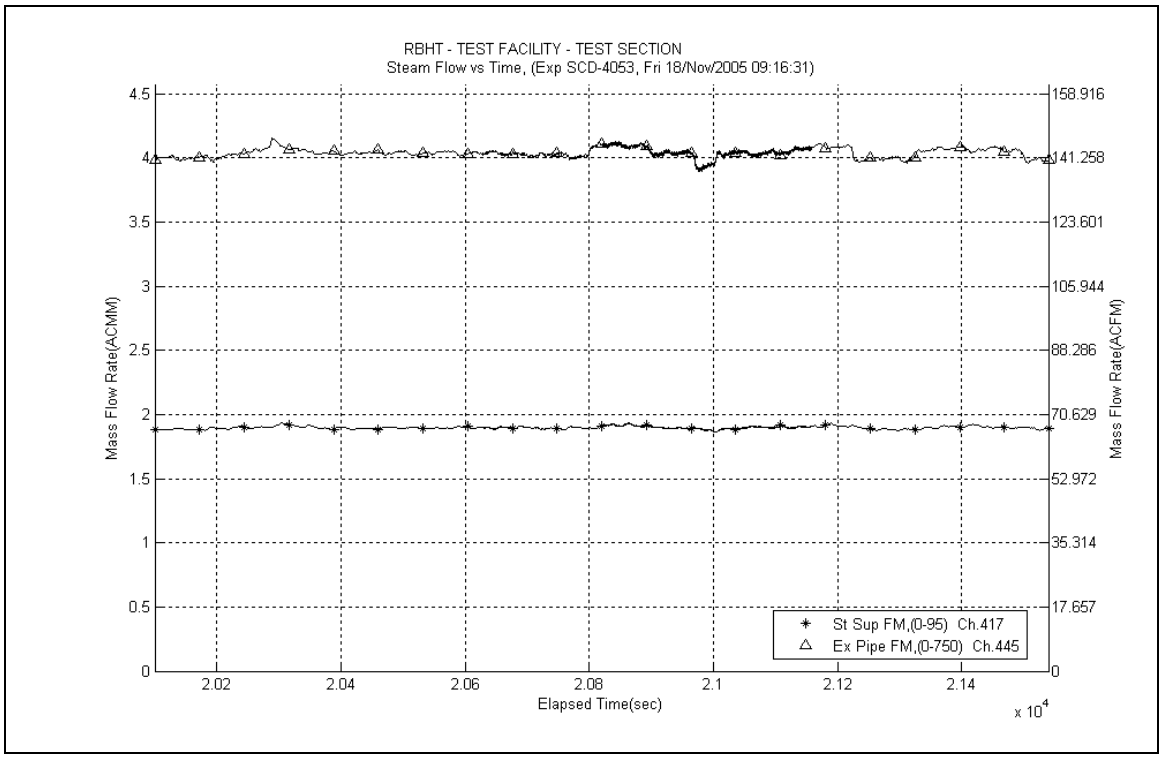

Figure A-402: Inlet and Exhaust Steam Flow Rates for Experiment 4053F

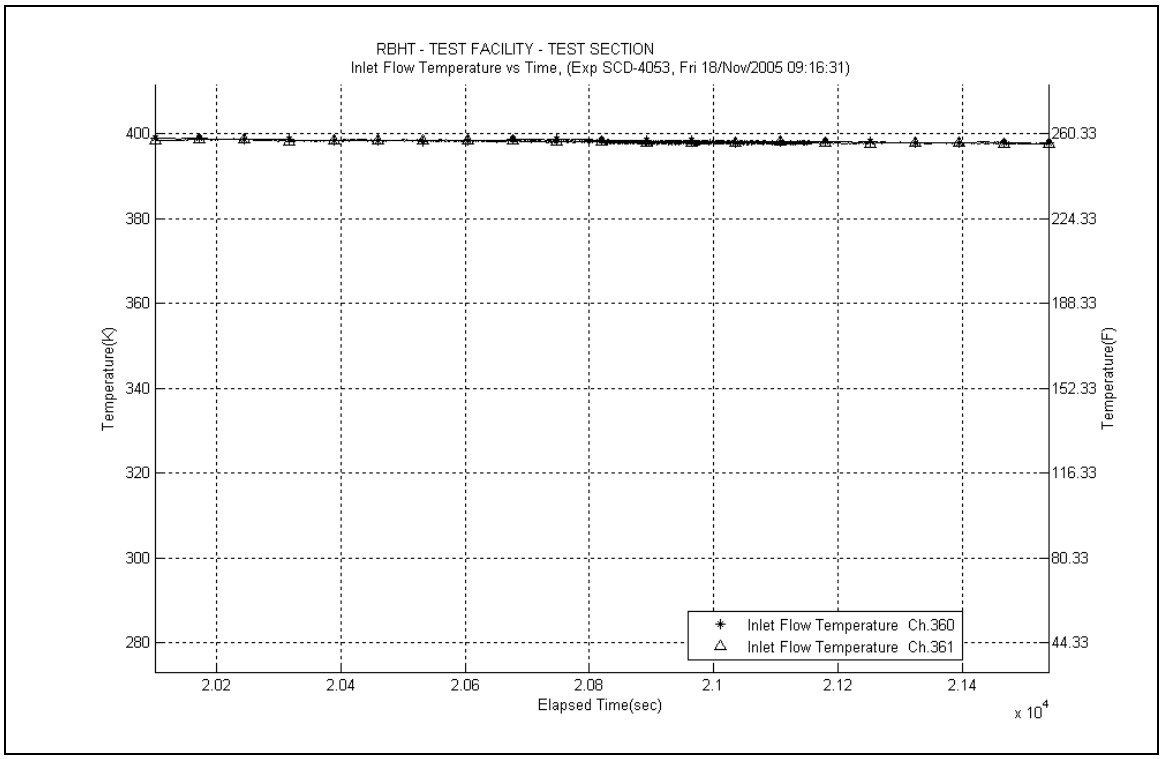

Figure A-403: Inlet Steam Temperature for Experiment 4053F

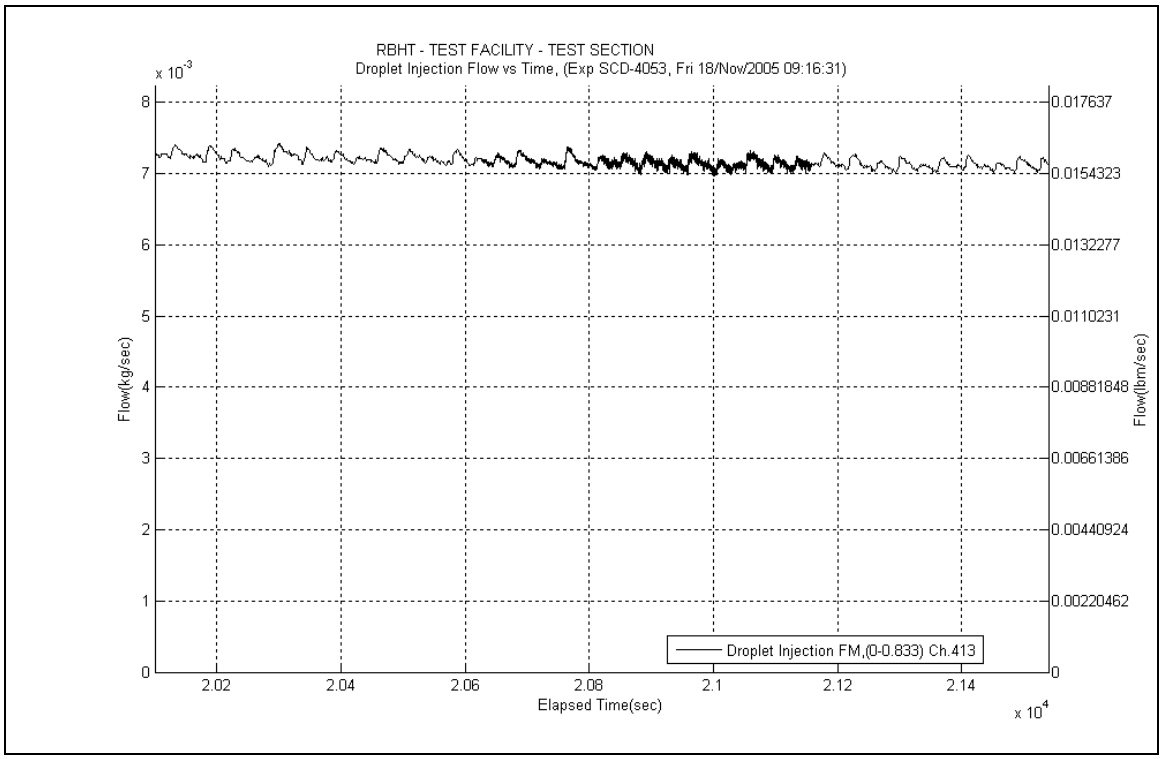

Figure A-404: Droplet Injection Flow Rate for Experiment 4053F

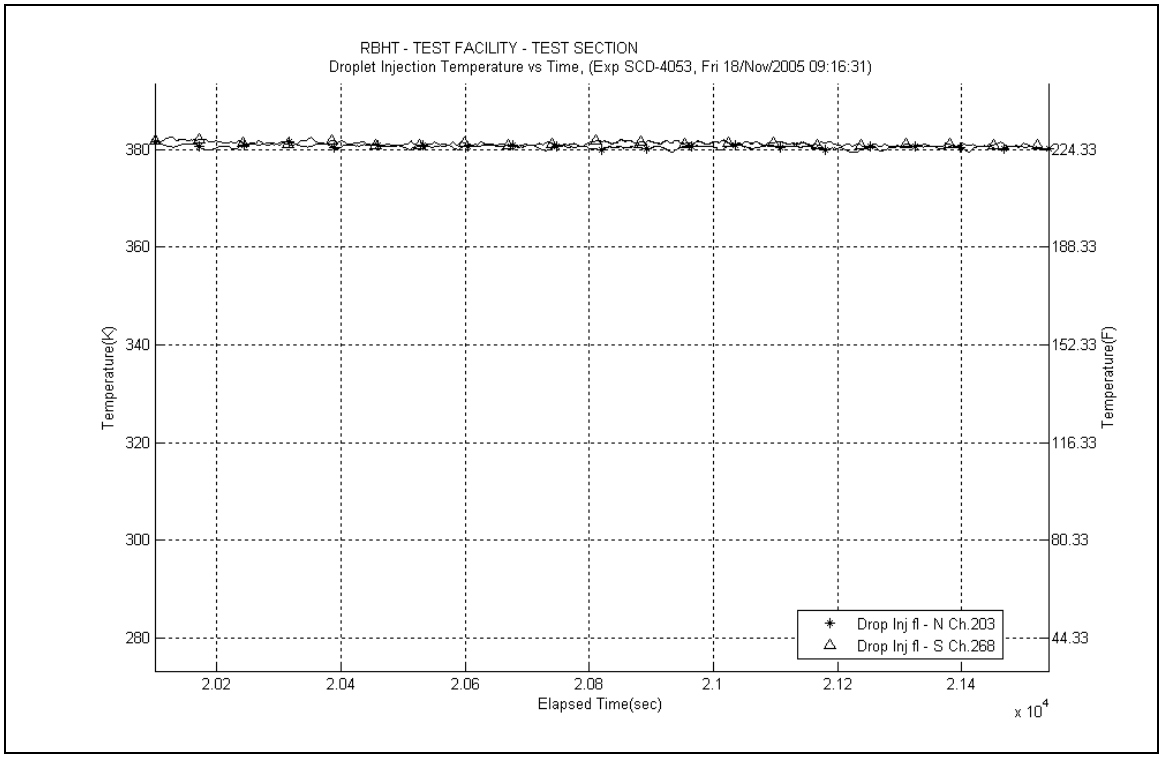

Figure A-405: Droplet Injection Temperature for Experiment 4053F

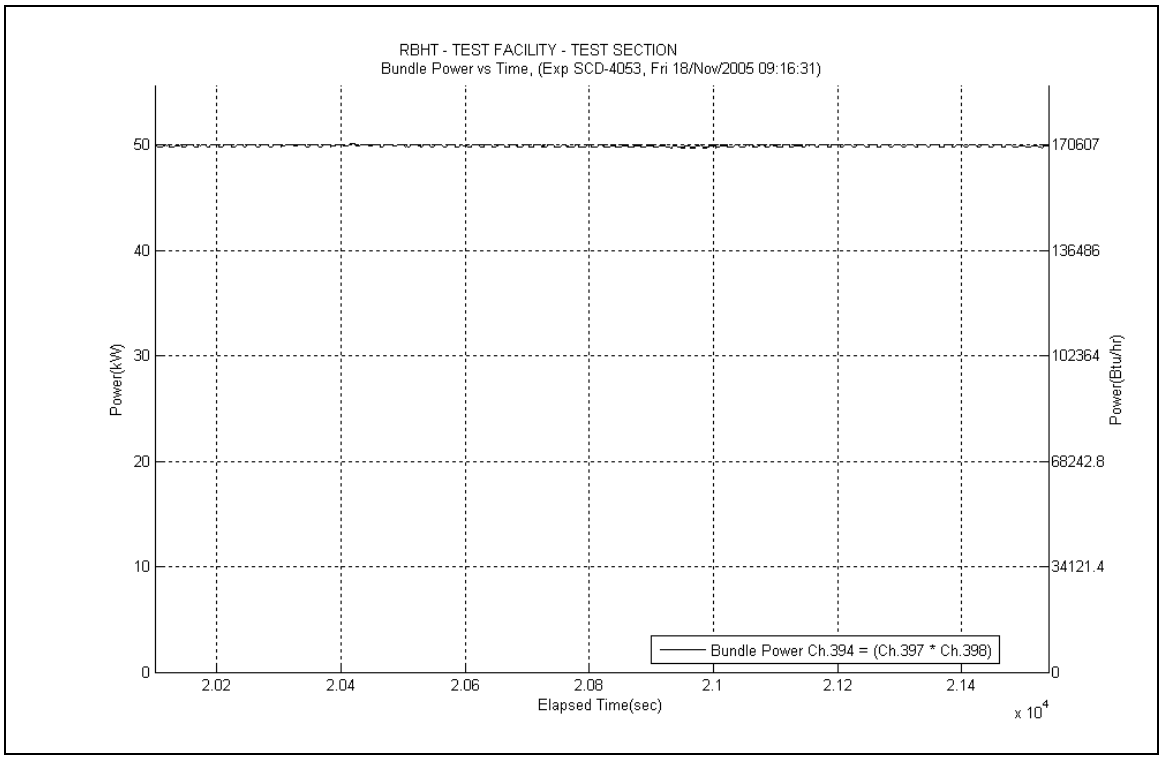

Figure A-406: Bundle Power for Experiment 4053F

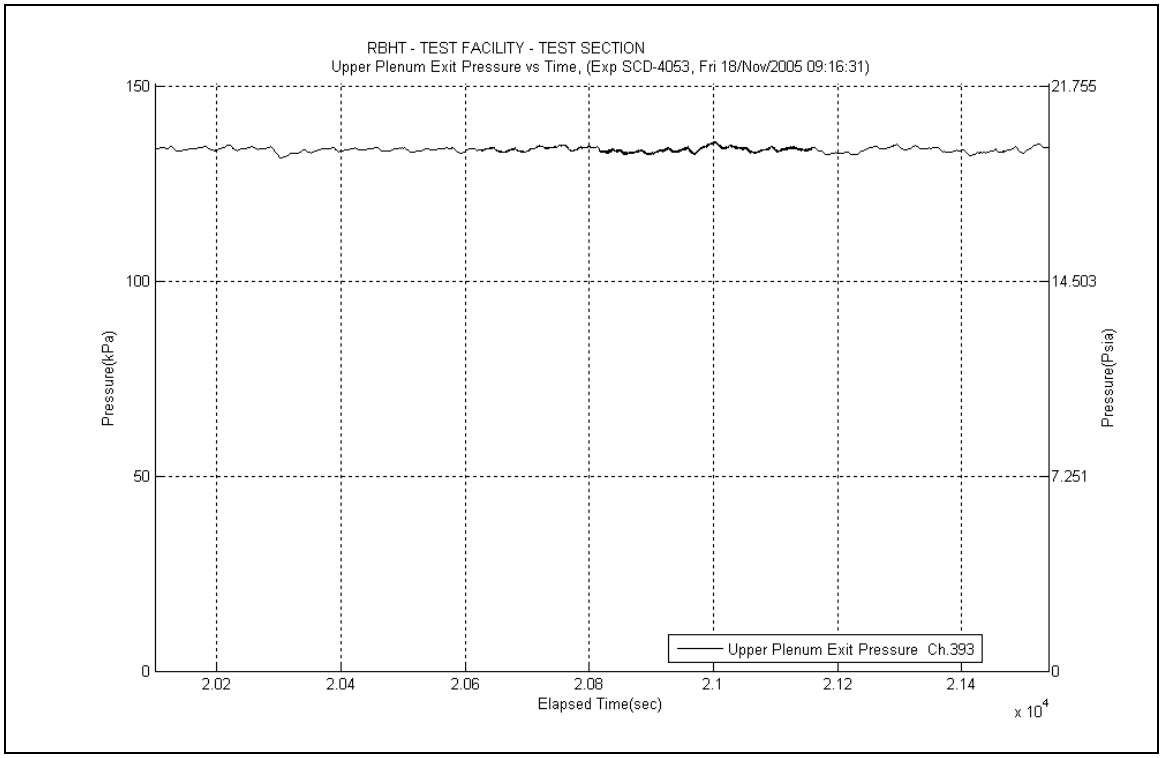

Figure A-407: Upper Plenum Pressure for Experiment 4053F

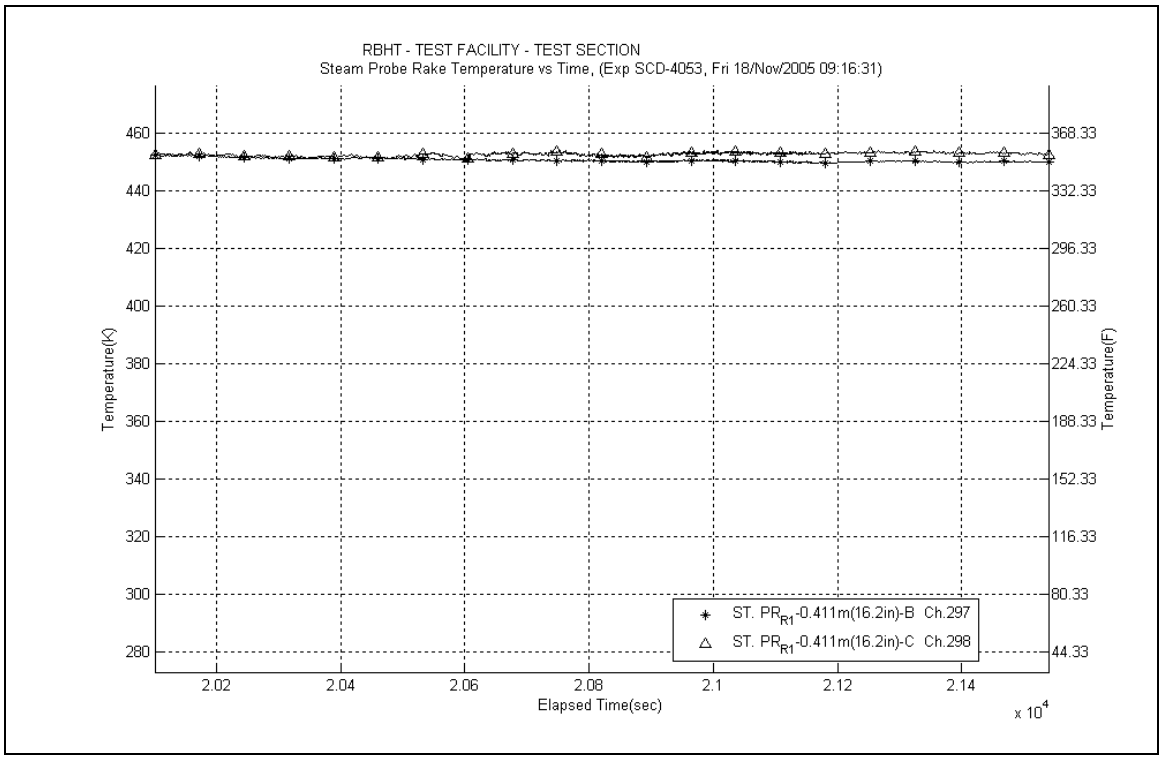

Figure A-408: Steam Probe Rake #1 Temperatures for Experiment 4053F

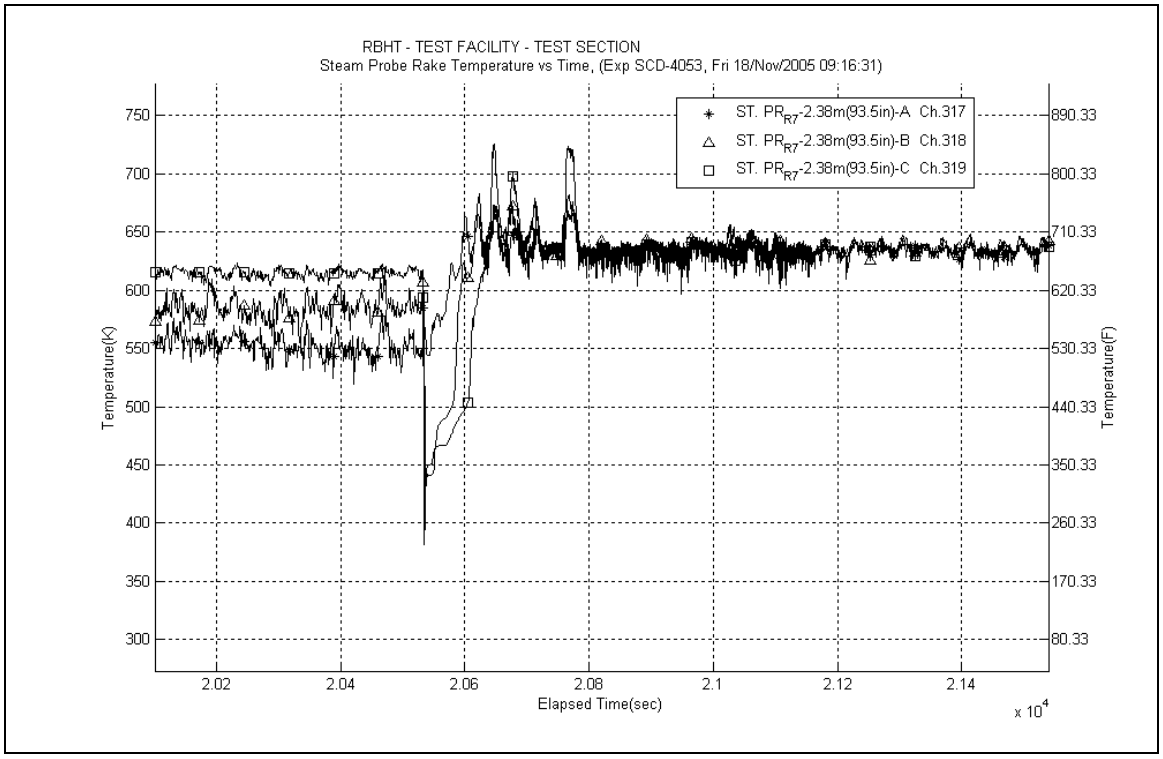

Figure A-409: Steam Probe Rake #7 Temperatures for Experiment 4053F

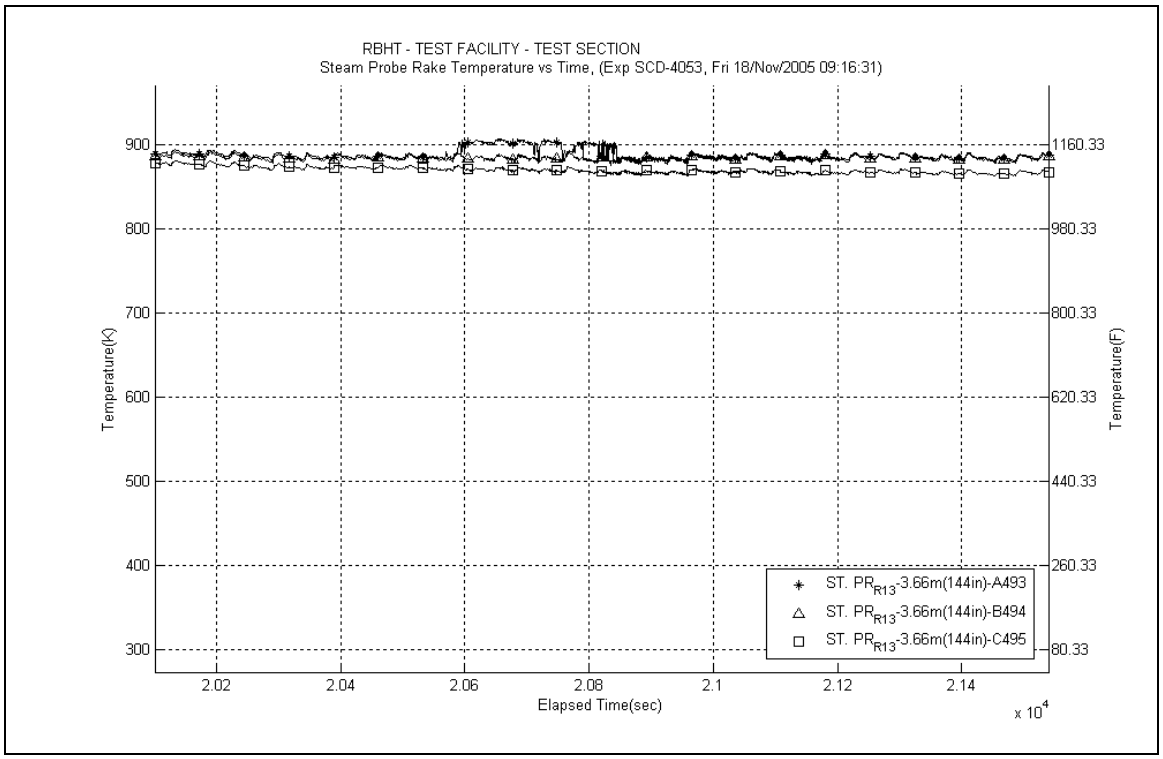

Figure A-410: Steam Probe Rake #13 Temperatures for Experiment 4053F

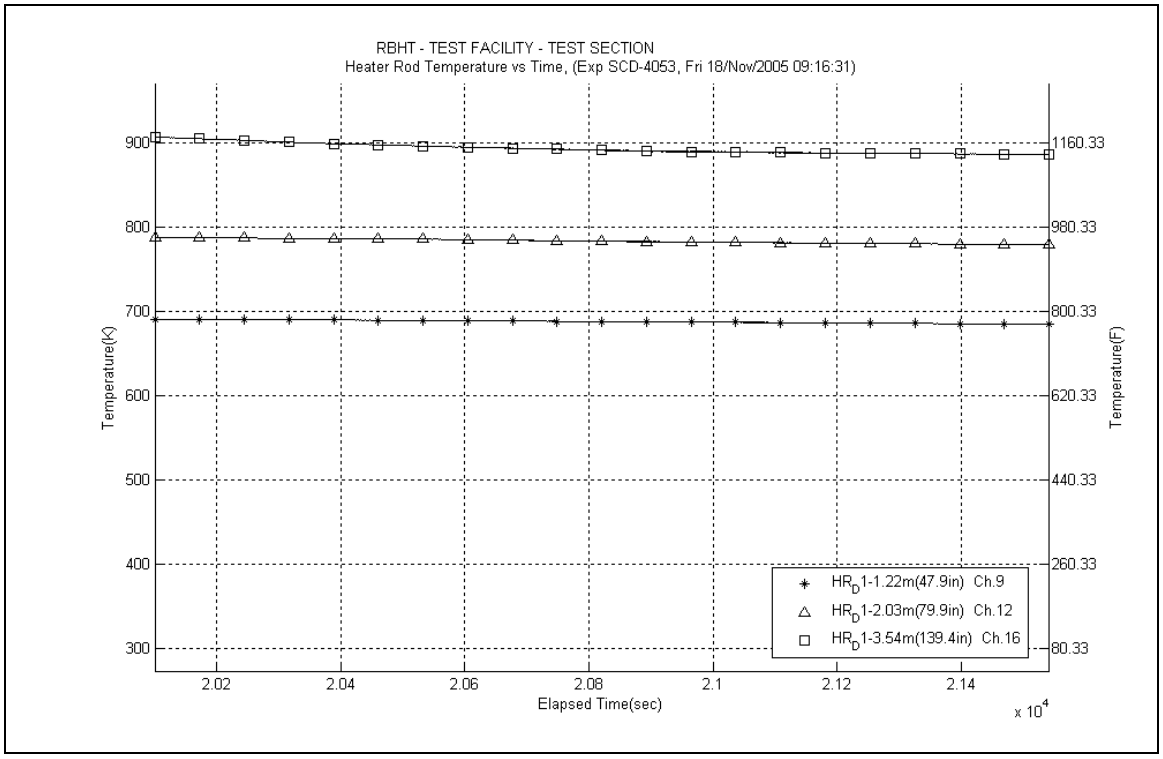

Figure A-411: Heater Rod D1 Temperatures for Experiment 4053F

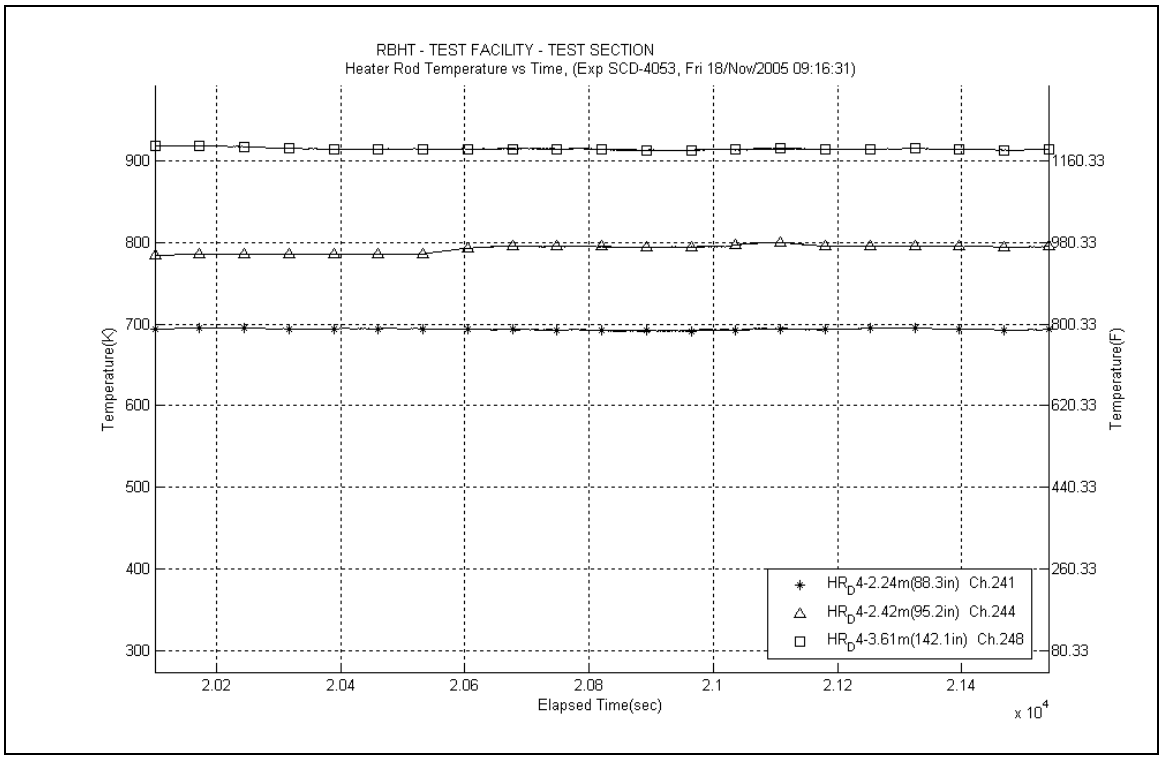

Figure A-412: Heater Rod D4 Temperatures for Experiment 4053F

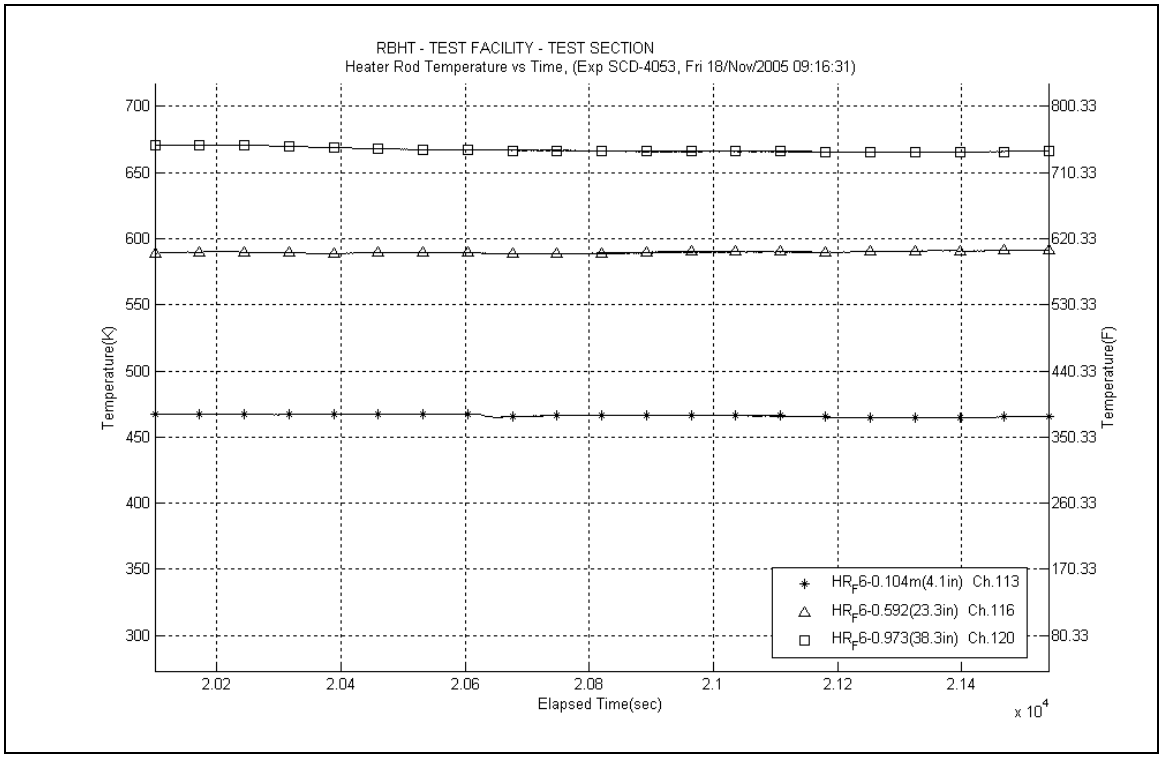

Figure A-413: Heater Rod F6 Temperatures for Experiment 4053F

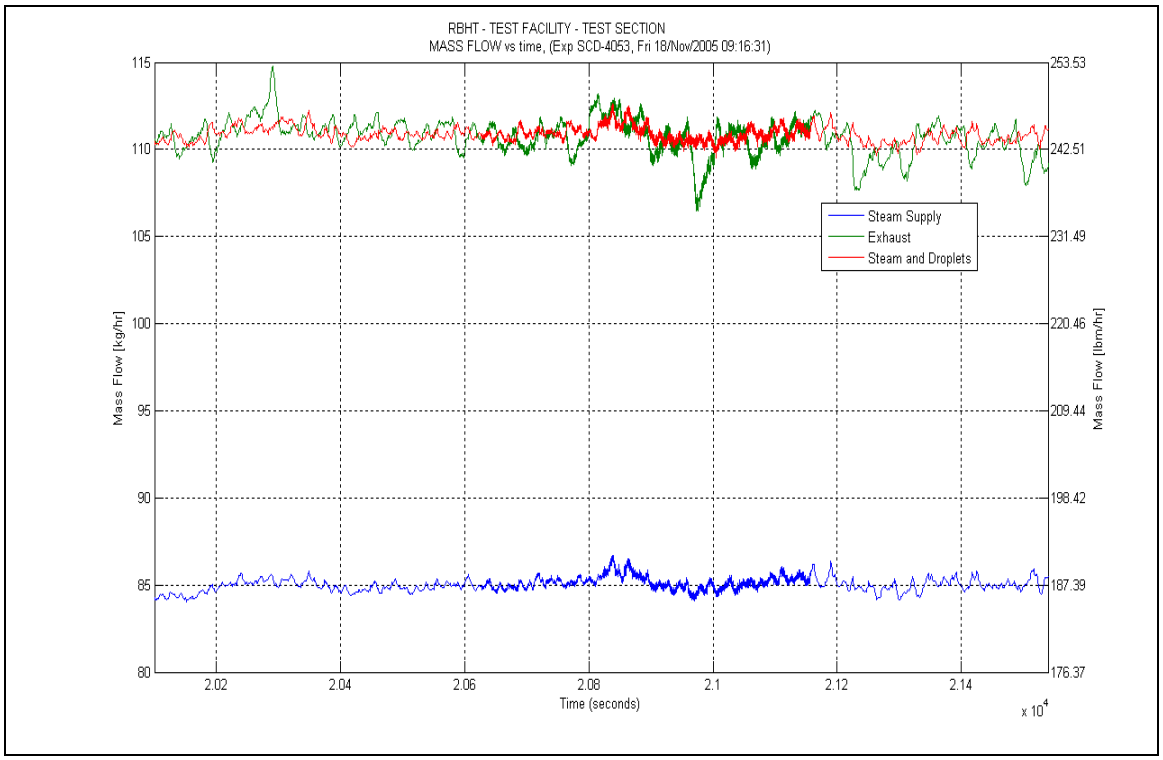

Figure A-414: Mass Flow for Experiment 4053F

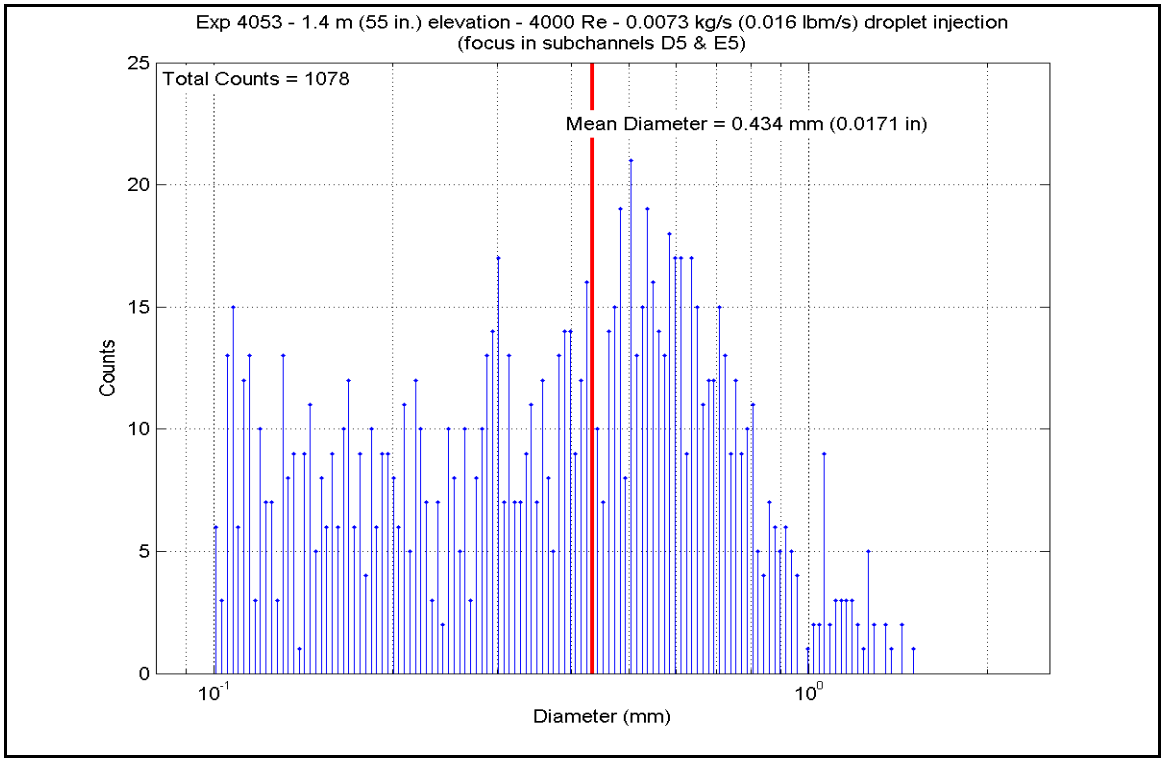

Figure A-415: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053F

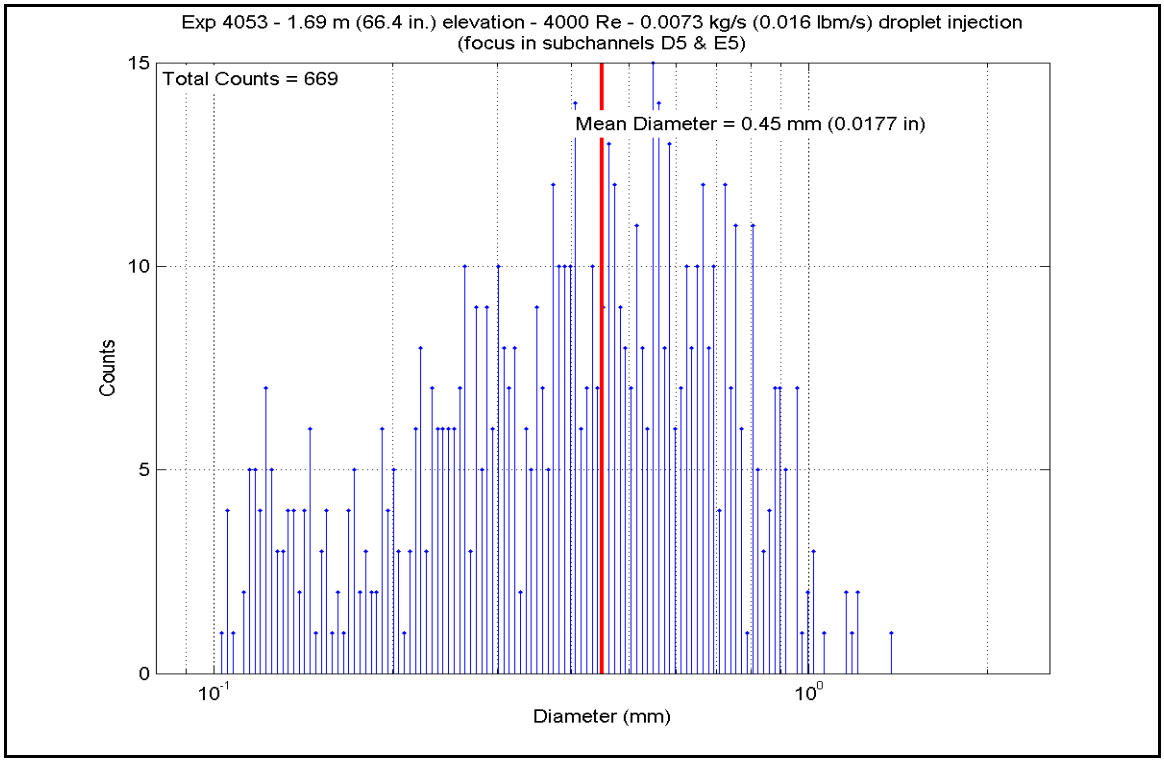

Figure A-416: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053F

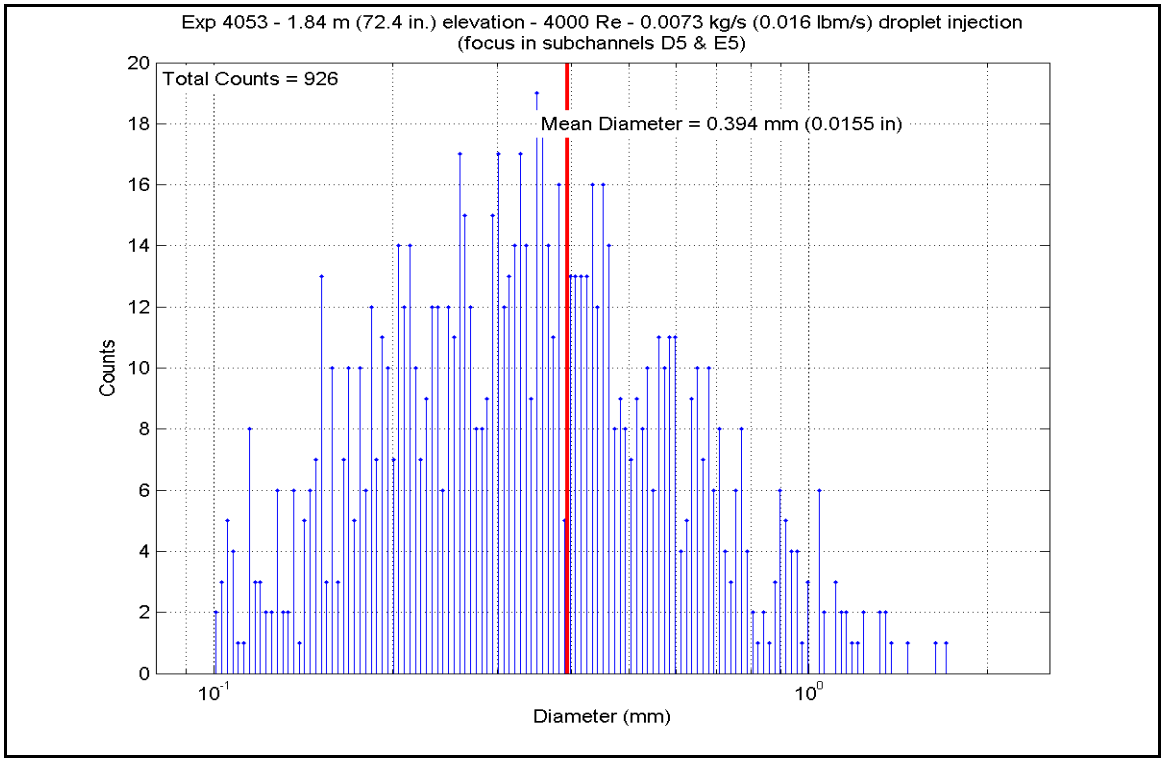

Figure A-417: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053F

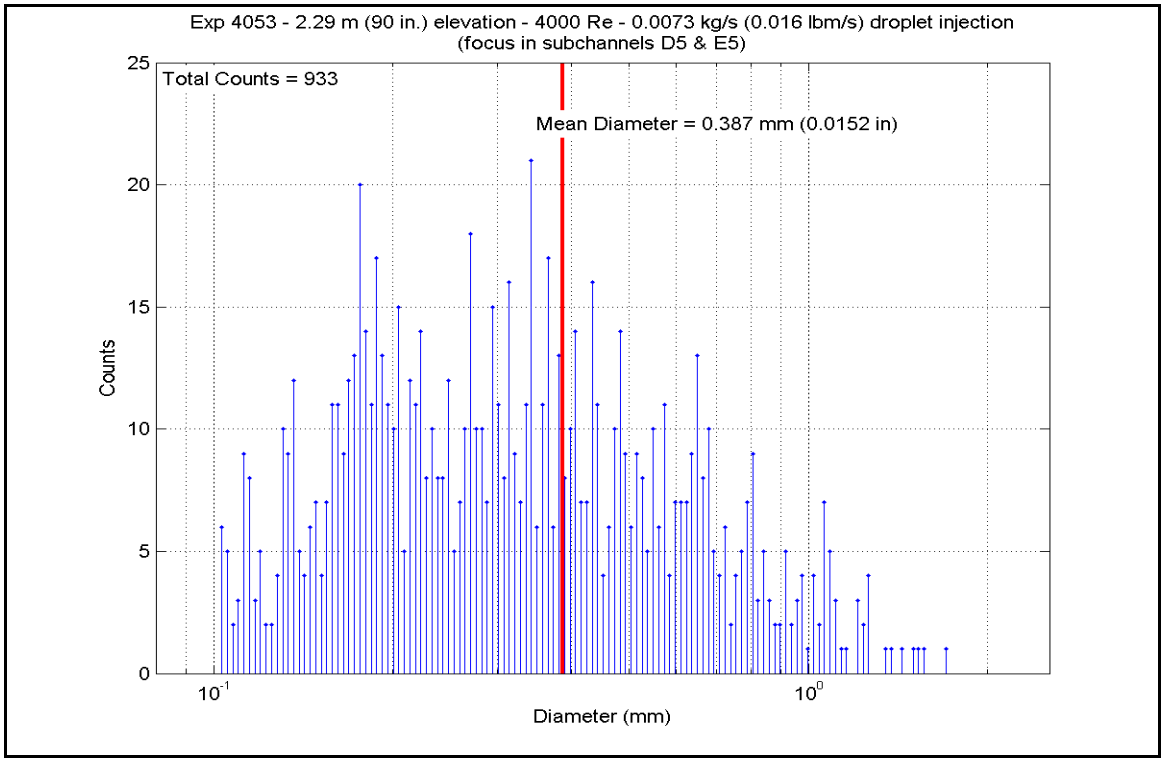

Figure A-418: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053F

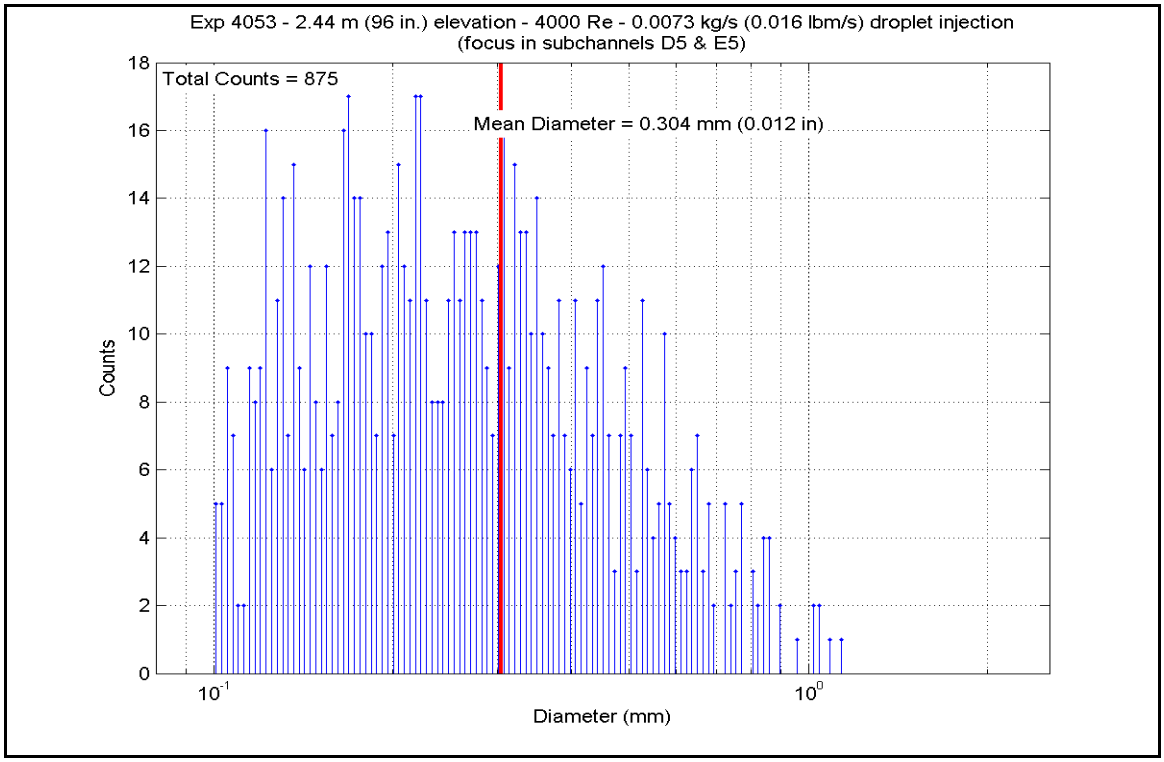

Figure A-419: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053F

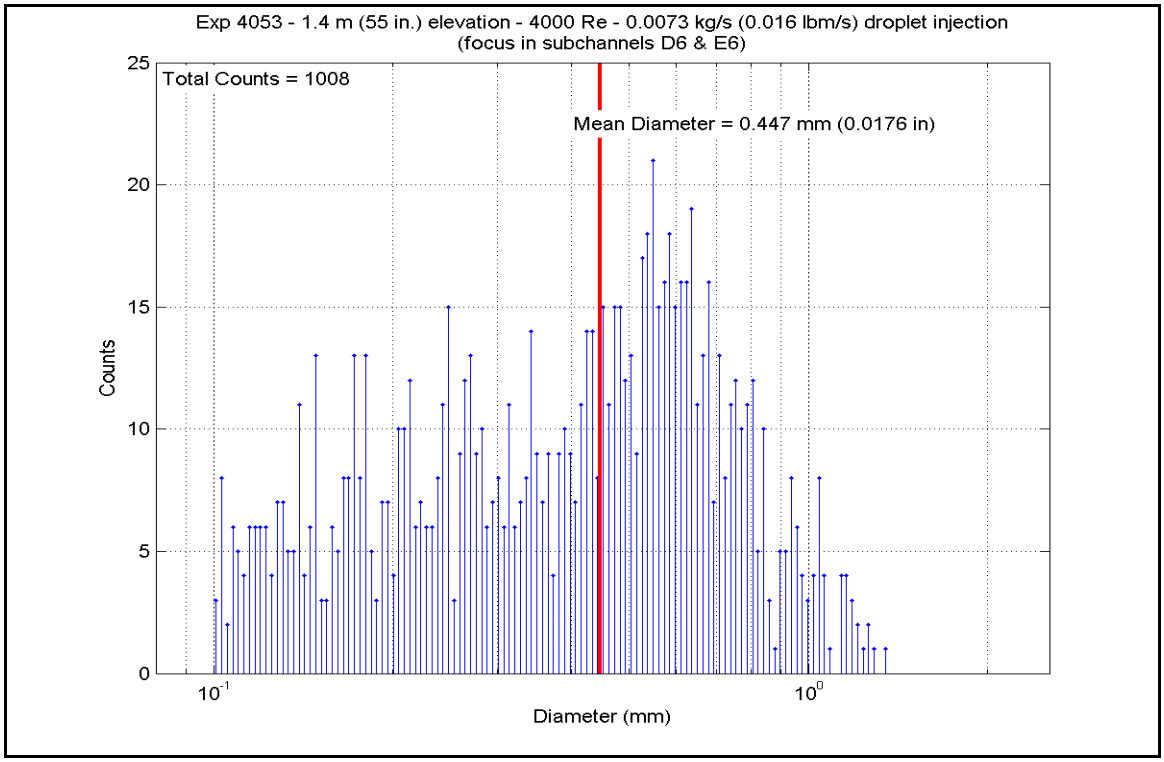

Figure A-420: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053F

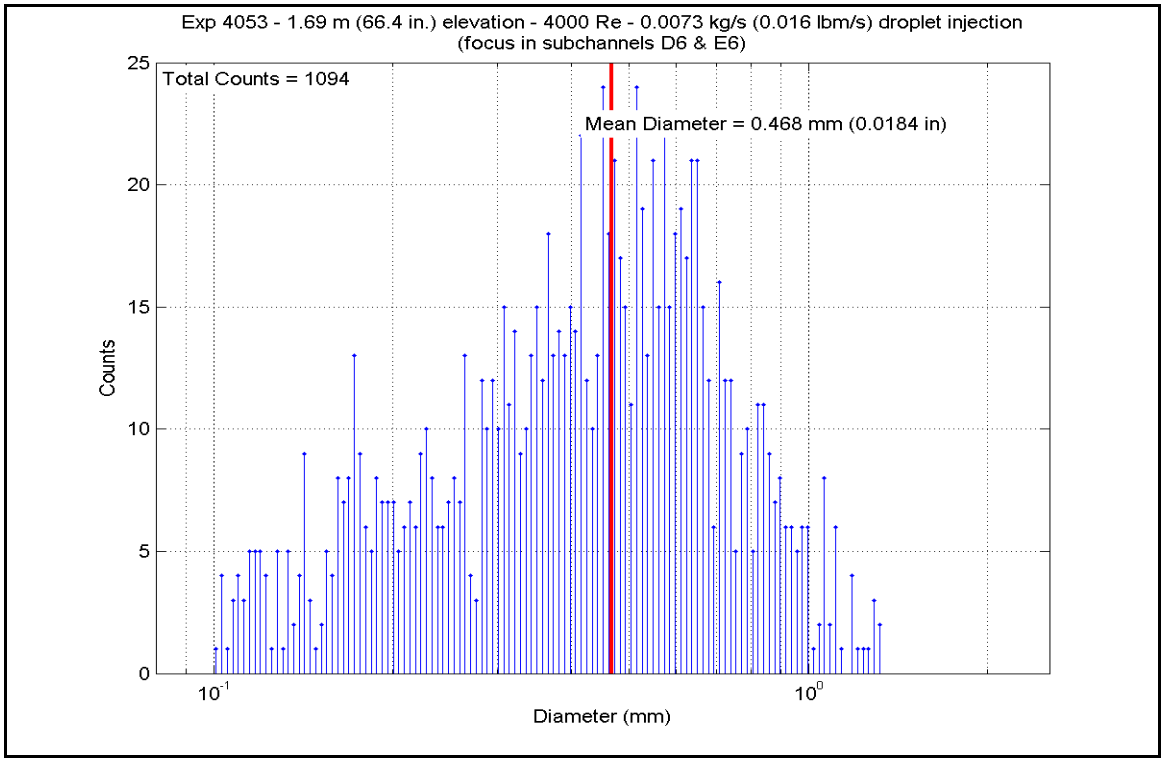

Figure A-421: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053F

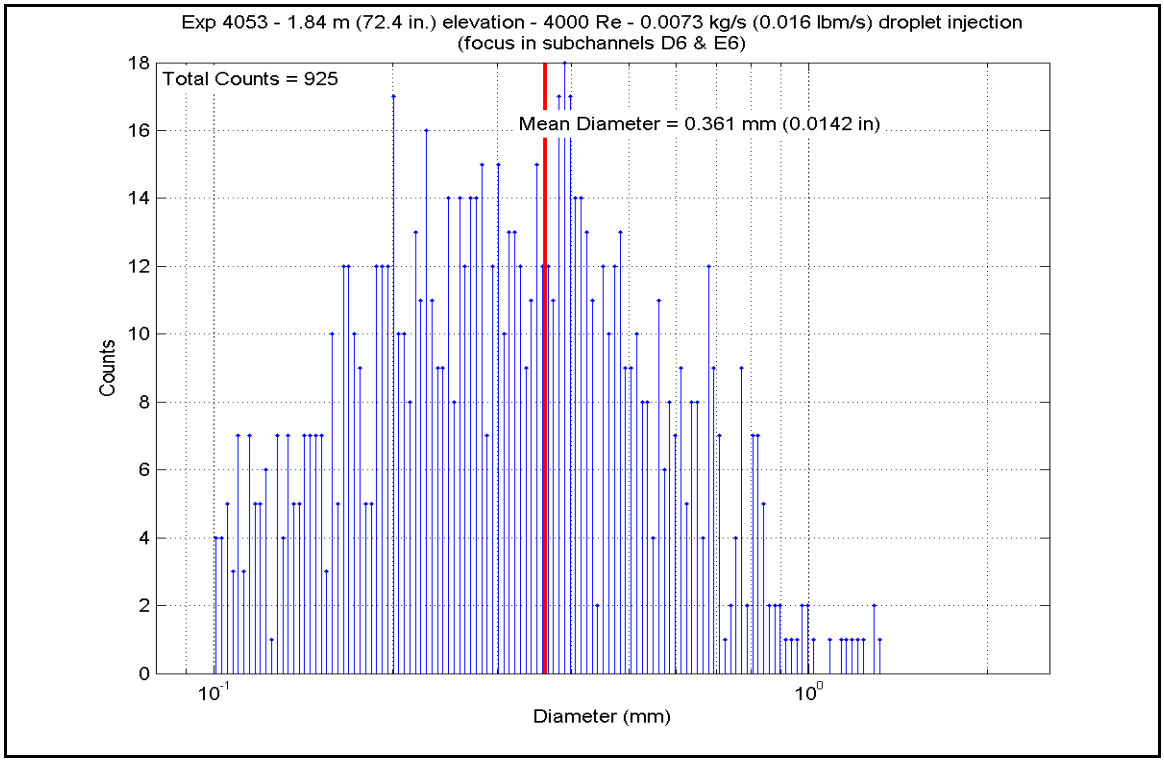

Figure A-422: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053F

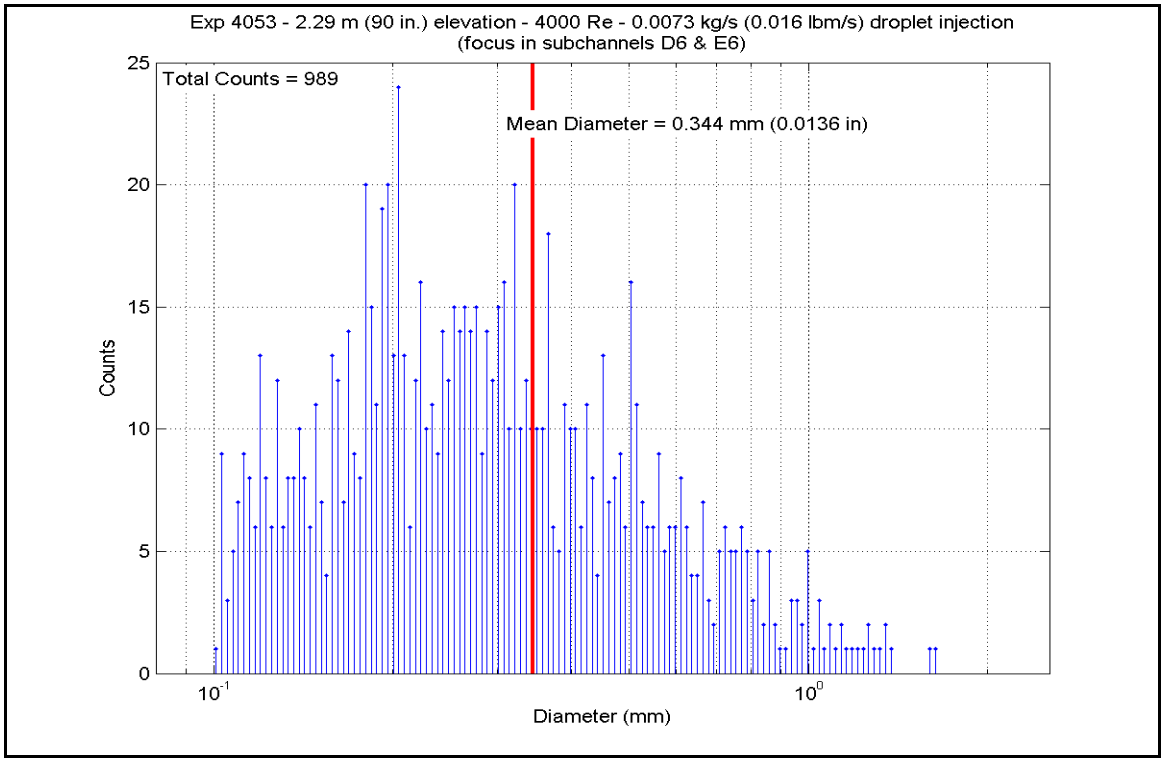

Figure A-423: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053F

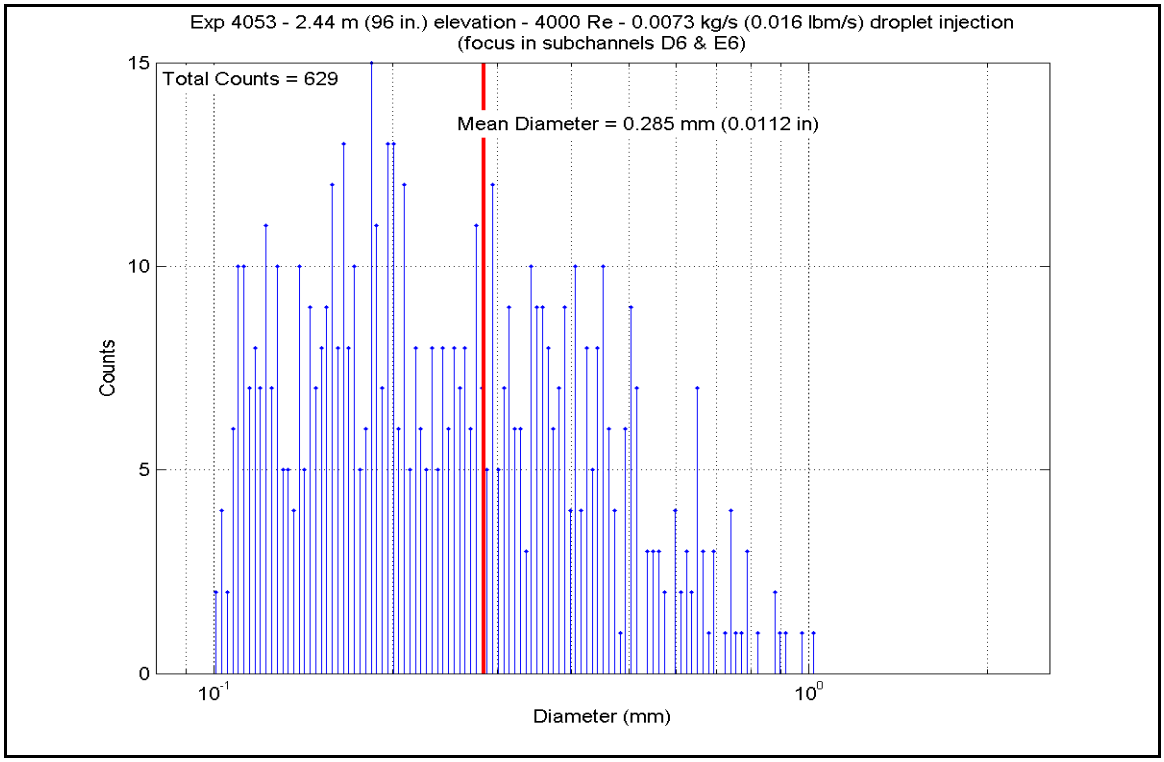

Figure A-424: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053F

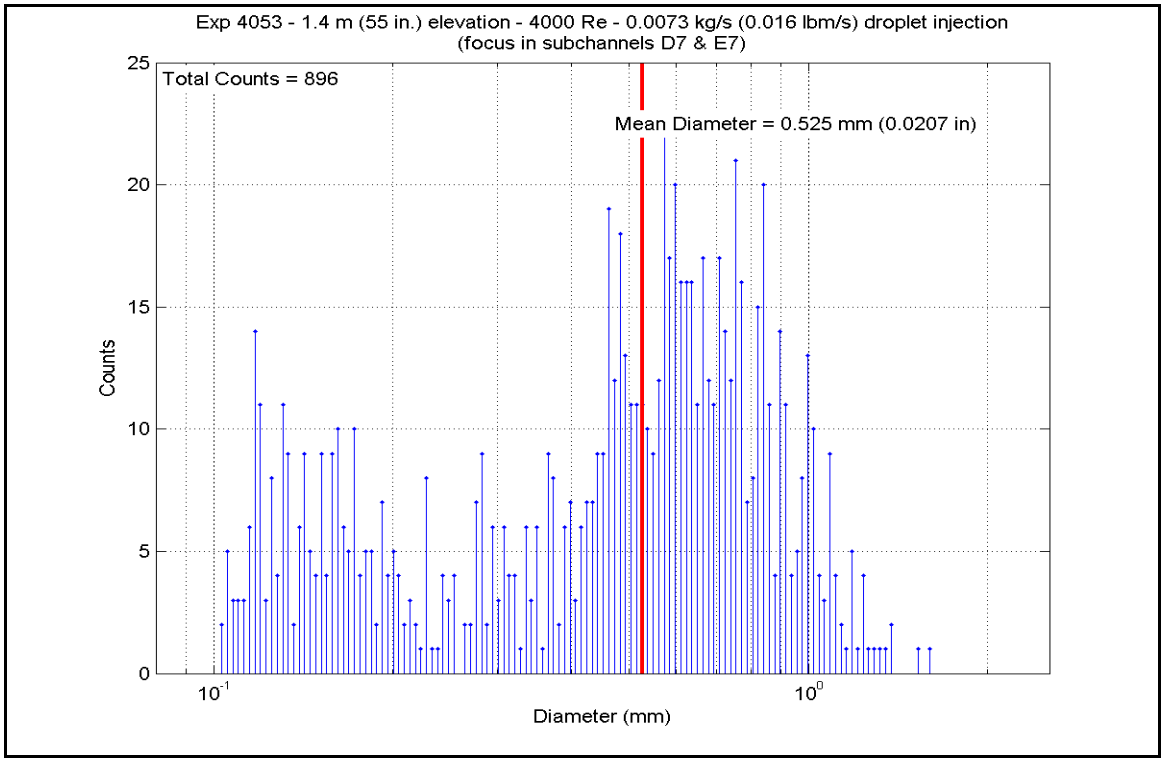

Figure A-425: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053F

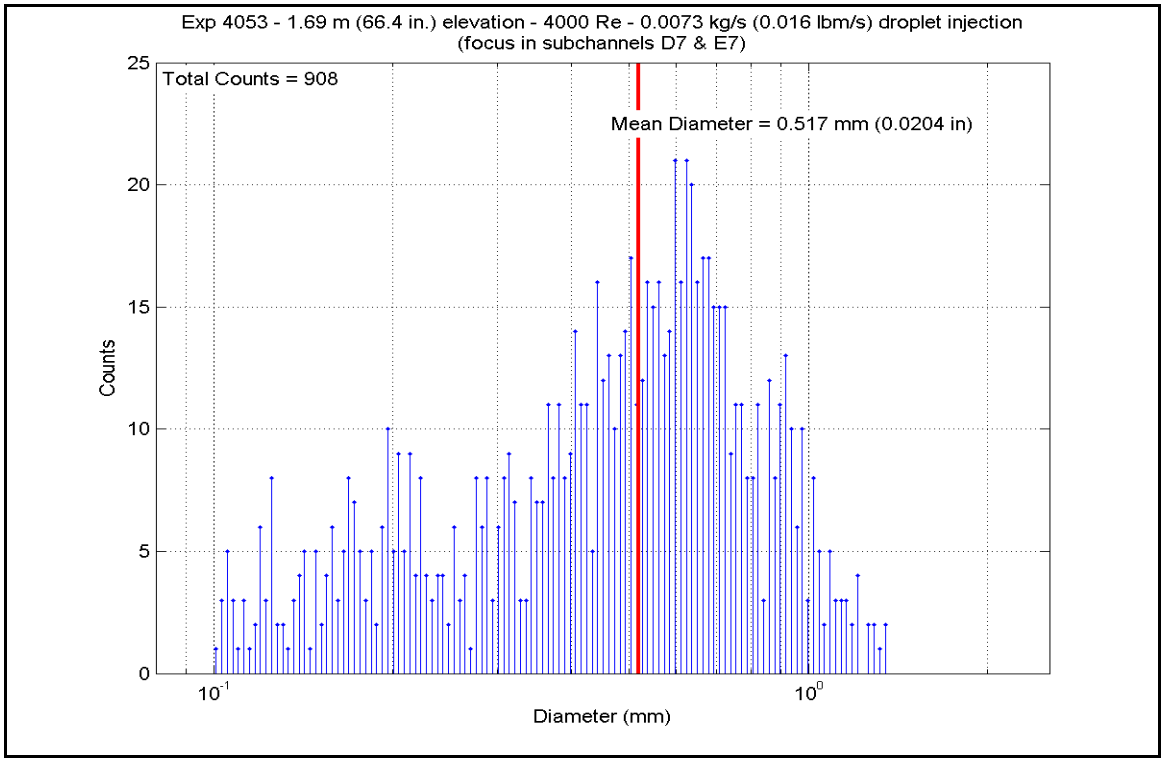

Figure A-426: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053F

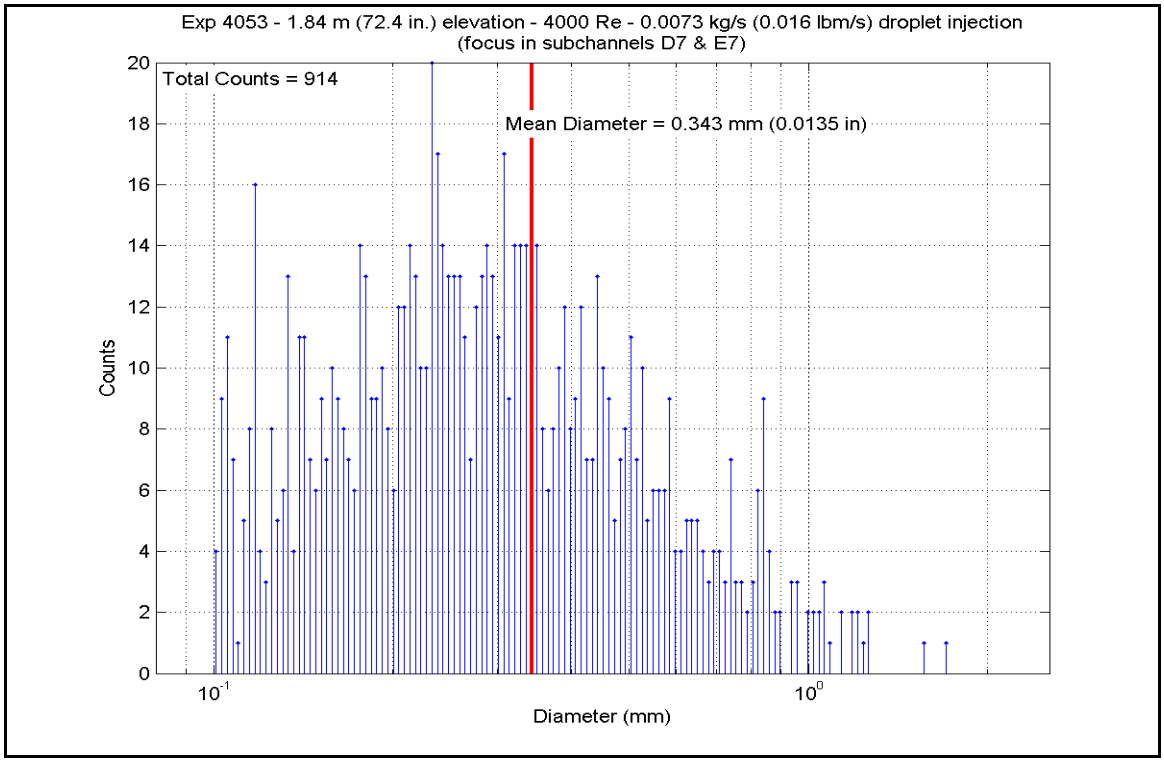

Figure A-427: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053F

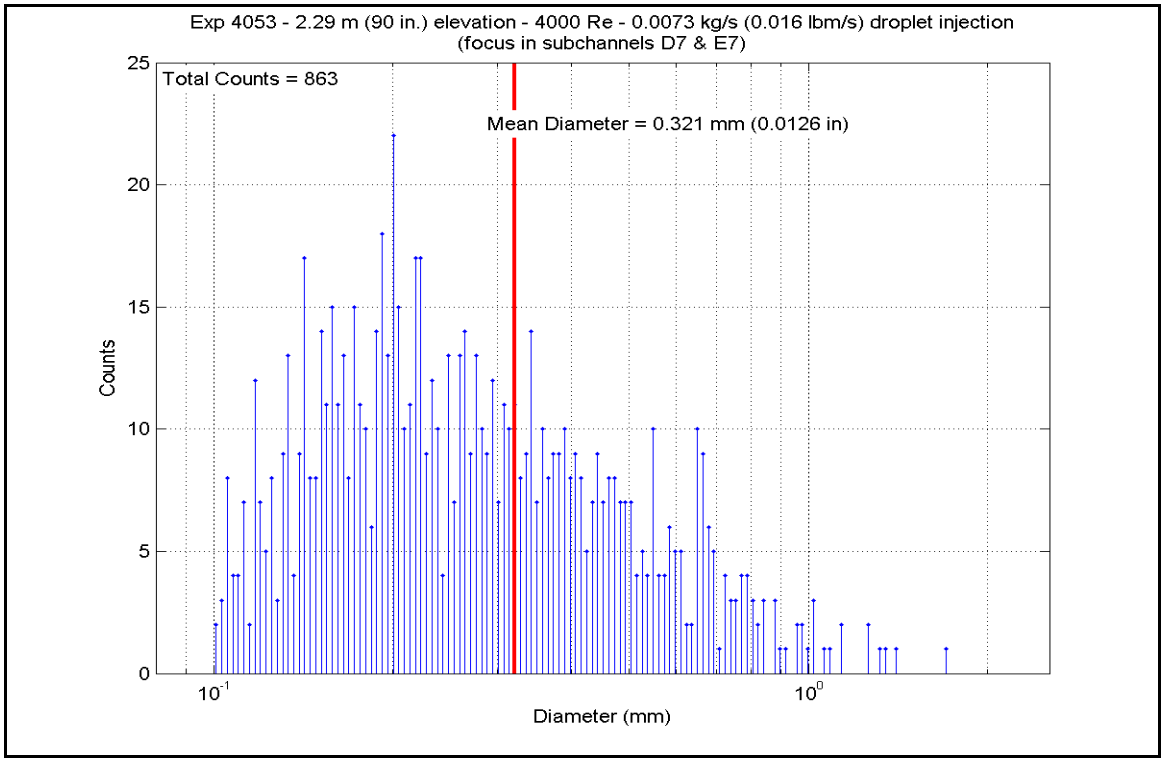

Figure A-428: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053F

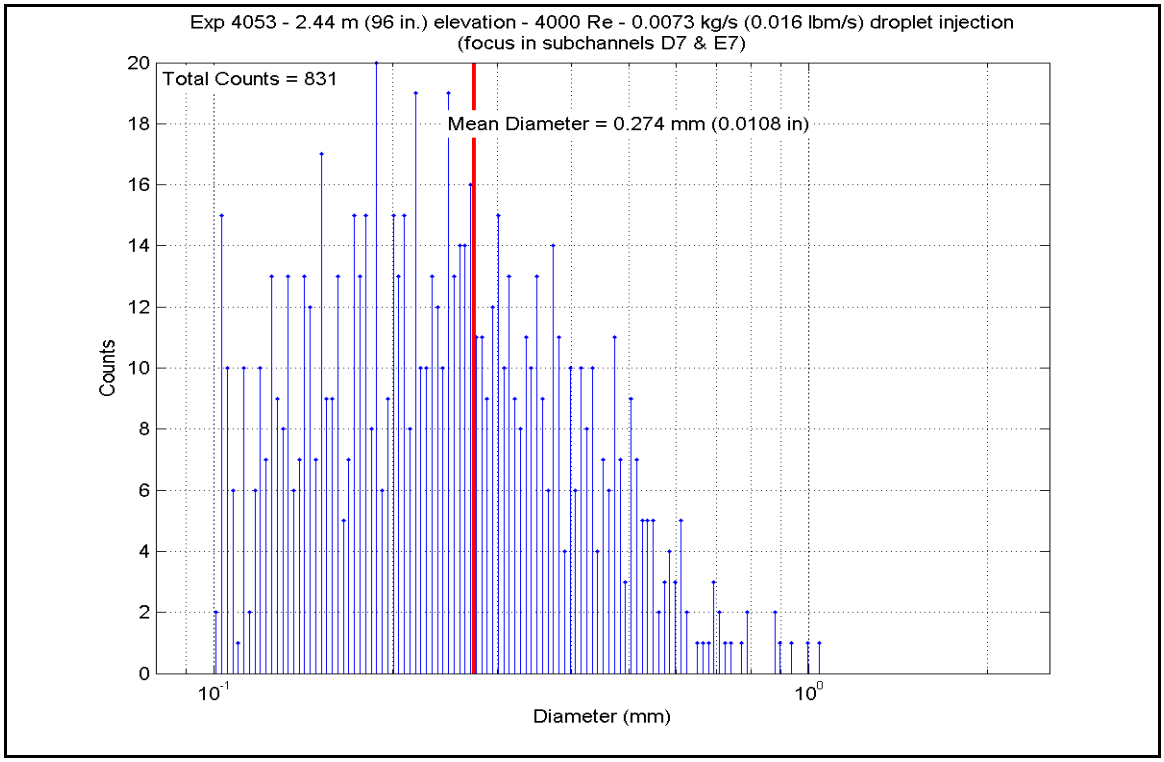

Figure A-429: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053F

Table A-61: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053F

SCD-4053-F	Inlet Reynolds:	4000		
Matrix test # 11b	UP Pressure:	137.9 kPa	20	psia
Time Window: 20100-21540	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0073 kg/s	0.016	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	731.33	661.7	4252.30	13413.9	8.448	48.0
	RodD3_91.3	186	91.3	2.319	2.8	0.071	819.09	710.4	4355.27	13738.7	7.368	41.8
	RodD3_93.1	187	93.1	2.365	4.6	0.117	823.28	712.7	4416.96	13933.3	7.420	42.1
	RodD3_95.3	188	95.3	2.421	6.8	0.173	879.26	743.8	4487.19	14154.8	6.890	39.1
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1049.55	838.5	4818.79	15200.9	5.866	33.3
	RodD3_110	191	110	2.794	21.5	0.546	817.21	709.4	4784.58	15093.0	8.120	46.1
	RodD3_142.1	192	142.1	3.609	8.6	0.218	993.14	807.1	1719.42	5423.9	2.247	12.8
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	708.31	648.9	4328.65	13654.7	9.012	51.2
	RodC4_91.1	234	91.1	2.314	2.6	0.066	790.54	694.6	4434.55	13988.8	7.883	44.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	811.12	706.0	4510.28	14227.7	7.735	43.9
	RodC4_95.3	236	95.3	2.421	6.8	0.173	858.34	732.2	4571.05	14419.4	7.252	41.2
	RodC4_100.1	237	100.1	2.543	11.6	0.295	963.53	790.7	4735.14	14937.0	6.438	36.6
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1022.53	823.4	4922.41	15527.7	6.195	35.2
	RodC4_110	239	110	2.794	21.5	0.546	845.47	725.1	4770.25	15047.8	7.725	43.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	974.09	796.5	1851.40	5840.2	2.481	14.1
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	681.14	633.8	4346.13	13709.9	9.591	54.5
	RodD4_91.3	242	91.3	2.319	2.8	0.071	773.78	685.2	4458.35	14063.8	8.169	46.4
	RodD4_93.2	243	93.2	2.367	4.7	0.119	794.47	696.7	4519.15	14255.7	7.978	45.3
	RodD4_95.2	244	95.2	2.418	6.7	0.170	836.22	719.9	4583.80	14459.6	7.536	42.8
	RodD4_100.1	245	100.1	2.543	11.6	0.295	947.91	782.0	4748.93	14980.5	6.597	37.5
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1000.78	811.4	4915.42	15505.7	6.361	36.1
	RodD4_142.1	248	142.1	3.609	8.6	0.218	981.70	800.8	1783.74	5626.8	2.367	13.4
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	699.64	644.1	4231.81	13349.2	8.973	51.0
	RodE4_91.2	202	91.2	2.316	2.7	0.069	783.76	690.8	4327.80	13652.0	7.787	44.2
	RodE4_95.3	204	95.3	2.421	6.8	0.173	856.61	731.3	4454.09	14050.4	7.086	40.2
	RodE4_100.9	205	100.9	2.563	12.4	0.315	950.79	783.6	4631.90	14611.3	6.408	36.4
	RodE4_142.3	208	142.3	3.614	8.8	0.224	992.98	807.0	1801.38	5682.5	2.355	13.4

Table A-61: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	990.55	805.7	3476.65	10967.1	4.559	25.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	881.22	744.9	4325.42	13644.5	6.622	37.6
	RodE3_115.5	195	115.5	2.934	2.75	0.070	925.86	769.7	4168.05	13148.1	5.973	33.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	967.79	793.0	3919.00	12362.5	5.297	30.1
	RodE3_122.7	197	122.7	3.117	9.95	0.253	999.93	810.9	3574.64	11276.2	4.631	26.3
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1012.98	818.1	3262.45	10291.4	4.156	23.6
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	958.08	787.6	2821.27	8899.7	3.864	21.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	988.44	804.5	2501.19	7890.0	3.289	18.7
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	979.23	799.4	3380.64	10664.2	4.500	25.6
	RodC5_113.6	226	113.6	2.885	0.85	0.022	827.52	715.1	4238.06	13369.0	7.069	40.1
	RodC5_115.7	227	115.7	2.939	2.95	0.075	875.01	741.5	4069.29	12836.6	6.289	35.7
	RodC5_122.7	229	122.7	3.117	9.95	0.253	947.16	781.6	3514.68	11087.1	4.887	27.8
	RodC5_126.7	230	126.7	3.218	13.95	0.354	960.87	789.2	3199.74	10093.6	4.366	24.8
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	899.12	754.9	2793.06	8810.7	4.162	23.6
	RodC5_135.7	232	135.7	3.447	2.2	0.056	931.34	772.8	2468.04	7785.4	3.509	19.9
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	920.09	766.5	3504.57	11055.2	5.064	28.8
	RodE5_113.6	210	113.6	2.885	0.85	0.022	712.94	651.4	4382.05	13823.2	9.036	51.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	791.30	695.0	4223.44	13322.8	7.498	42.6
	RodE5_118.7	212	118.7	3.015	5.95	0.151	857.26	731.6	3950.33	12461.3	6.278	35.7
	RodE5_122.6	213	122.6	3.114	9.85	0.250	898.74	754.7	3631.74	11456.3	5.414	30.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	922.60	767.9	3301.84	10415.6	4.754	27.0
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1116.79	875.8	2862.93	9031.1	3.221	18.3
	RodE5_135.6	216	135.6	3.444	2.1	0.053	963.37	790.6	2548.95	8040.7	3.466	19.7
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	849.55	727.3	3971.46	12528.0	6.390	36.3
	RodC3_85.6	178	85.6	2.174	14.72	0.374	765.35	680.6	4162.34	13130.1	7.746	44.0
	RodC3_88.5	179	88.5	2.248	0	0.000	727.82	659.7	4234.61	13358.1	8.472	48.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	826.12	714.3	4366.00	13772.5	7.300	41.5
	RodC3_94.4	181	94.4	2.398	5.9	0.150	844.09	724.3	4429.84	13973.9	7.190	40.8
Gr-8	RodD5_50	217	50	1.270	3	0.076	894.86	752.5	3075.64	9702.1	4.612	26.2
	RodD5_54.1	218	54.1	1.374	7.1	0.180	874.37	741.1	3199.06	10091.4	4.949	28.1
	RodD5_56.9	219	56.9	1.445	9.9	0.251	927.61	770.7	3275.70	10333.2	4.682	26.6
	RodD5_60	220	60	1.524	13	0.330	941.50	778.4	3362.38	10606.6	4.713	26.8
	RodD5_66.1	221	66.1	1.679	19.1	0.485	937.86	776.4	3574.07	11274.4	5.035	28.6

Table A-61: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	818.23	709.9	2805.18	8848.9	4.753	27.0
	RodB5_52.9	154	52.9	1.344	5.9	0.150	886.28	747.7	3153.38	9947.3	4.790	27.2
	RodB5_55	155	55	1.397	8	0.203	912.41	762.3	3216.10	10145.2	4.699	26.7
	RodB5_57.8	156	57.8	1.468	10.8	0.274	940.99	778.1	3296.66	10399.3	4.624	26.3
	RodB5_64	157	64	1.626	17	0.432	991.55	806.2	3468.70	10942.0	4.543	25.8
	RodB5_73.9	158	73.9	1.877	3.02	0.077	800.62	700.2	3815.30	12035.4	6.663	37.8
	RodB5_75.9	159	75.9	1.928	5.02	0.128	829.97	716.5	3885.42	12256.6	6.455	36.7
	RodB5_76.9	160	76.9	1.953	6.02	0.153	842.67	723.5	3918.36	12360.5	6.375	36.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	797.02	698.2	2788.62	8796.7	4.901	27.8
	RodF5_53.1	106	53.1	1.349	6.1	0.155	850.29	727.8	3162.63	9976.5	5.082	28.9
	RodF5_55	107	55	1.397	8	0.203	888.17	748.8	3223.44	10168.4	4.883	27.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	931.06	772.6	3304.85	10425.2	4.701	26.7
	RodF5_64	109	64	1.626	17	0.432	978.29	798.9	3483.60	10989.0	4.643	26.4
	RodF5_73.8	110	73.8	1.875	2.92	0.074	806.27	703.3	3787.21	11946.8	6.549	37.2
	RodF5_75.8	111	75.8	1.925	4.92	0.125	840.28	722.2	3852.87	12153.9	6.293	35.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	854.82	730.3	3883.50	12250.5	6.196	35.2
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	813.97	707.6	2796.83	8822.6	4.773	27.1
	RodC2_53.1	58	53.1	1.349	6.1	0.155	921.67	767.4	3158.60	9963.8	4.553	25.9
	RodC2_55	59	55	1.397	8	0.203	940.17	777.7	3216.59	10146.7	4.517	25.6
	RodC2_57.8	60	57.8	1.468	10.8	0.274	967.05	792.6	3304.42	10423.8	4.471	25.4
	RodC2_63.9	61	63.9	1.623	16.9	0.429	998.93	810.3	3489.82	11008.6	4.527	25.7
	RodC2_73.8	62	73.8	1.875	2.92	0.074	812.42	706.7	3787.63	11948.1	6.481	36.8
	RodC2_75.8	63	75.8	1.925	4.92	0.125	843.63	724.1	3847.97	12138.4	6.250	35.5
	RodC2_76.8	64	76.8	1.951	5.92	0.150	857.95	732.0	3878.59	12235.0	6.157	35.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	817.64	709.6	2776.01	8756.9	4.708	26.7
	RodC6_52.8	138	52.8	1.341	5.8	0.147	924.60	769.0	3153.87	9948.9	4.527	25.7
	RodC6_54.8	139	54.8	1.392	7.8	0.198	942.67	779.1	3212.39	10133.5	4.495	25.5
	RodC6_57.8	140	57.8	1.468	10.8	0.274	955.81	786.4	3302.26	10417.0	4.537	25.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	966.06	792.1	3489.88	11008.8	4.728	26.9
	RodC6_73.7	142	73.7	1.872	2.82	0.072	791.65	695.2	3824.71	12065.0	6.786	38.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	817.26	709.4	3894.84	12286.3	6.610	37.5
	RodC6_76.8	144	76.8	1.951	5.92	0.150	831.12	717.1	3928.95	12393.9	6.514	37.0

Table A-61: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	694.34	641.1	4246.27	13394.9	9.106	51.7
	RodB4_91.3	162	91.3	2.319	2.8	0.071	781.50	689.5	4326.63	13648.4	7.817	44.4
	RodB4_93.3	163	93.3	2.370	4.8	0.122	798.82	699.2	4389.27	13846.0	7.689	43.7
	RodB4_95.1	164	95.1	2.416	6.6	0.168	837.23	720.5	4447.93	14031.0	7.301	41.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	962.41	790.0	1845.76	5822.5	2.513	14.3
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	794.94	697.0	4134.11	13041.1	7.292	41.4
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	729.85	660.8	4220.22	13312.7	8.409	47.8
	RodF4_92.4	100	92.4	2.347	3.9	0.099	832.50	717.9	4353.16	13732.1	7.201	40.9
	RodF4_94.3	101	94.3	2.395	5.8	0.147	868.13	737.7	4411.99	13917.6	6.892	39.1
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	898.67	754.6	4218.44	13307.1	6.290	35.7
	RodD2_106	66	106	2.692	17.5	0.445	929.65	771.8	4006.16	12637.4	5.710	32.4
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	973.54	796.2	3716.26	11722.9	4.985	28.3
	RodD2_114.9	68	114.9	2.918	2.15	0.055	998.19	809.9	3369.53	10629.2	4.375	24.8
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1000.73	811.3	3035.22	9574.6	3.928	22.3
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	844.75	724.7	4227.62	13336.0	6.855	38.9
	RodD6_116.8	133	116.8	2.967	4.05	0.103	881.72	745.2	4052.93	12785.0	6.200	35.2
	RodD6_120.9	134	120.9	3.071	8.15	0.207	913.86	763.1	3689.20	11637.6	5.379	30.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	932.73	773.6	3345.91	10554.7	4.748	27.0
	RodD6_128.7	136	128.7	3.269	15.95	0.405	933.86	774.2	2997.66	9456.1	4.247	24.1

Table A-61: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	873.76	740.8	3081.55	9720.8	4.772	27.1
	RodE2_54	74	54	1.372	7	0.178	938.84	777.0	3199.37	10092.4	4.501	25.6
	RodE2_56.9	75	56.9	1.445	9.9	0.251	974.30	796.6	3290.28	10379.2	4.409	25.0
	RodE2_59.9	76	59.9	1.521	12.9	0.328	1007.55	815.1	3382.09	10668.8	4.339	24.6
	RodE2_66	77	66	1.676	19	0.483	1010.42	816.7	3566.52	11250.6	4.558	25.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	750.39	672.3	3673.39	11587.7	7.032	39.9
	RodE2_72.9	79	72.9	1.852	2.02	0.051	830.10	716.5	3777.65	11916.6	6.274	35.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	863.97	735.4	3839.00	12110.1	6.036	34.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	833.19	718.3	3073.52	9695.4	5.079	28.8
	RodB3_54.1	170	54.1	1.374	7.1	0.180	894.58	752.4	3198.13	10088.5	4.798	27.2
	RodB3_56.9	171	56.9	1.445	9.9	0.251	915.43	763.9	3297.17	10400.9	4.796	27.2
	RodB3_60.1	172	60.1	1.527	13.1	0.333	870.64	739.1	3395.33	10710.6	5.283	30.0
	RodB3_66.1	173	66.1	1.679	19.1	0.485	886.36	747.8	3581.40	11297.5	5.440	30.9
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	677.12	631.5	3725.88	11753.3	8.296	47.1
	RodB3_73	175	73	1.854	2.12	0.054	751.58	672.9	3782.18	11930.9	7.224	41.0
	RodB3_75	176	75	1.905	4.12	0.105	788.29	693.3	3841.89	12119.3	6.857	38.9
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	854.30	730.0	3087.44	9739.3	4.930	28.0
	RodF3_54	90	54	1.372	7	0.178	921.07	767.1	3206.29	10114.2	4.626	26.3
	RodF3_57	91	57	1.448	10	0.254	959.65	788.5	3300.78	10412.3	4.511	25.6
	RodF3_60	92	60	1.524	13	0.330	989.14	804.9	3390.63	10695.7	4.455	25.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	997.78	809.7	3587.41	11316.5	4.660	26.5
	RodF3_70	94	70	1.778	-0.88	-0.022	771.48	684.0	3697.20	11662.8	6.803	38.6
	RodF3_73	95	73	1.854	2.12	0.054	837.55	720.7	3789.82	11955.0	6.217	35.3
	RodF3_75	96	75	1.905	4.12	0.105	871.56	739.6	3852.20	12151.8	5.986	34.0
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	842.08	723.2	3081.49	9720.6	5.018	28.5
	RodE6_54.1	122	54.1	1.374	7.1	0.180	891.83	750.8	3195.11	10079.0	4.813	27.3
	RodE6_57	123	57	1.448	10	0.254	890.85	750.3	3272.65	10323.6	4.937	28.0
	RodE6_60.2	124	60.2	1.529	13.2	0.335	927.60	770.7	3362.93	10608.4	4.807	27.3
	RodE6_66.1	125	66.1	1.679	19.1	0.485	938.65	776.8	3546.39	11187.1	4.990	28.3
	RodE6_70	126	70	1.778	-0.88	-0.022	705.31	647.2	3664.38	11559.3	7.677	43.6
	RodE6_73.1	127	73.1	1.857	2.22	0.056	765.35	680.6	3763.14	11870.8	7.003	39.8
	RodE6_75	128	75	1.905	4.12	0.105	798.74	699.1	3822.98	12059.6	6.698	38.0

RBHT Steam Cooling with Droplet Injection Test SCD-4053-G

Matrix Test # 11c

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 22380 - 22920
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

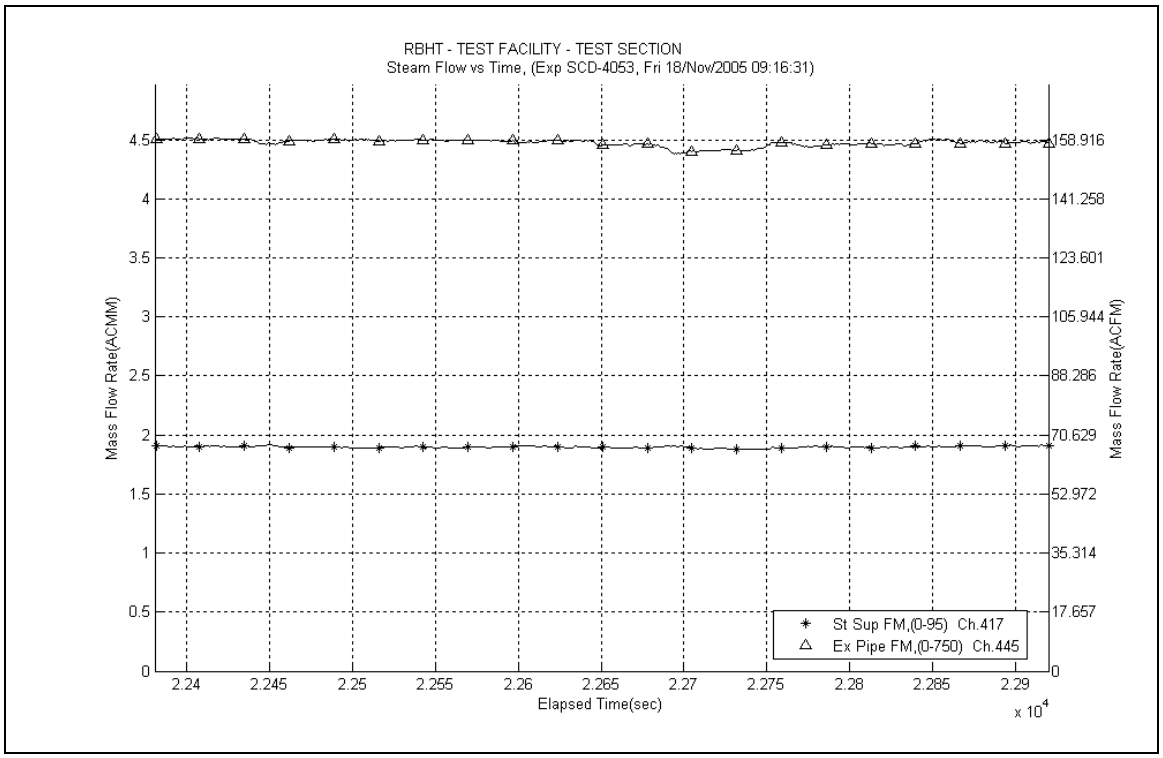

Figure A-430: Inlet and Exhaust Steam Flow Rates for Experiment 4053G

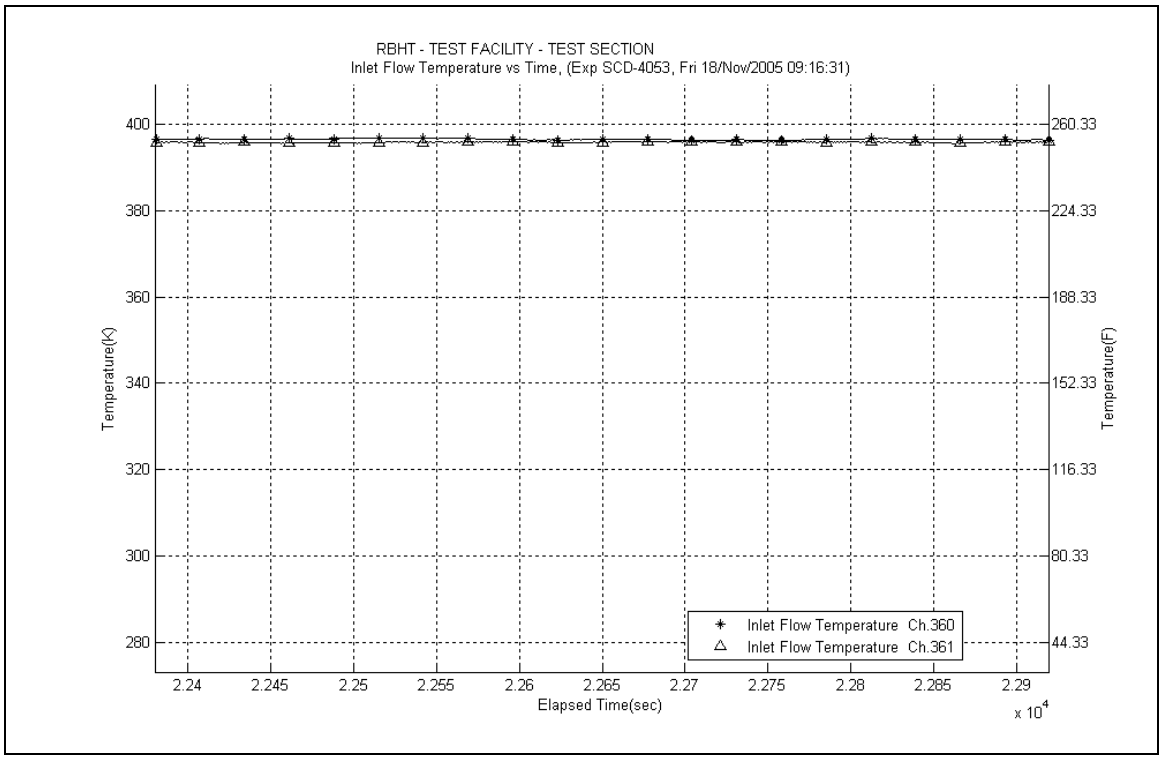

Figure A-431: Inlet Steam Temperature for Experiment 4053G

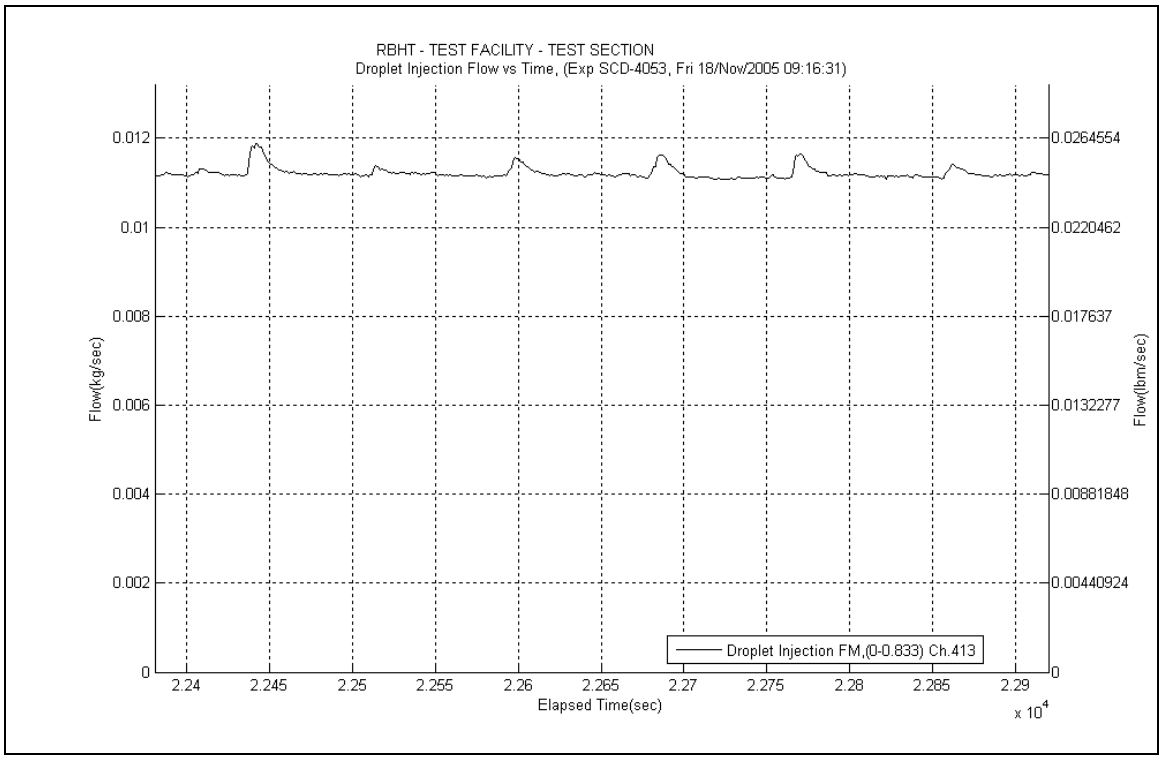

Figure A-432: Droplet Injection Flow Rate for Experiment 4053G

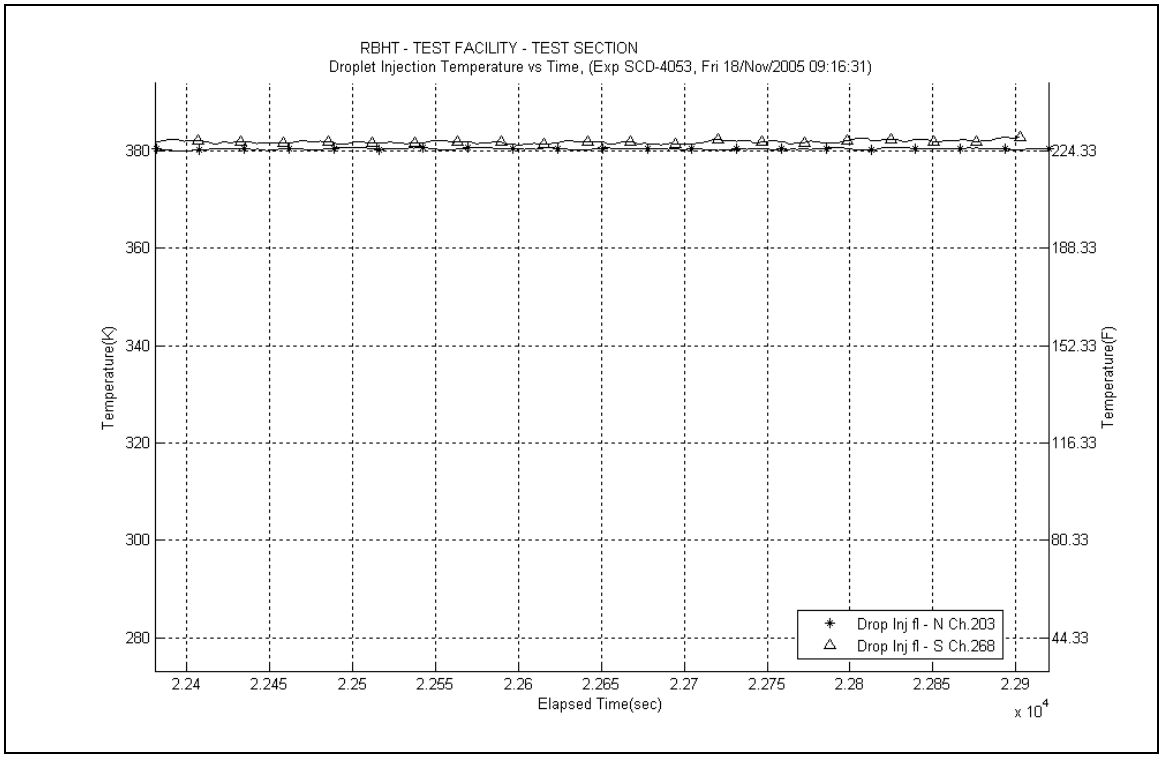

Figure A-433: Droplet Injection Temperature for Experiment 4053G

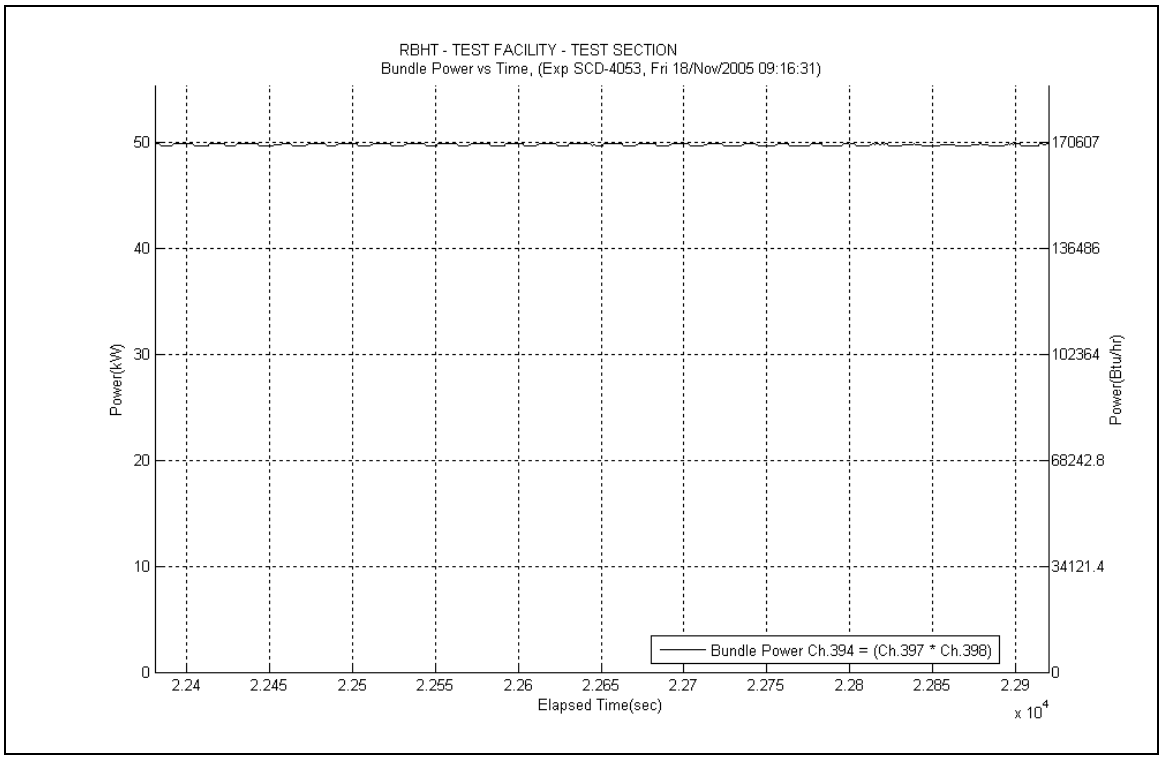

Figure A-434: Bundle Power for Experiment 4053G

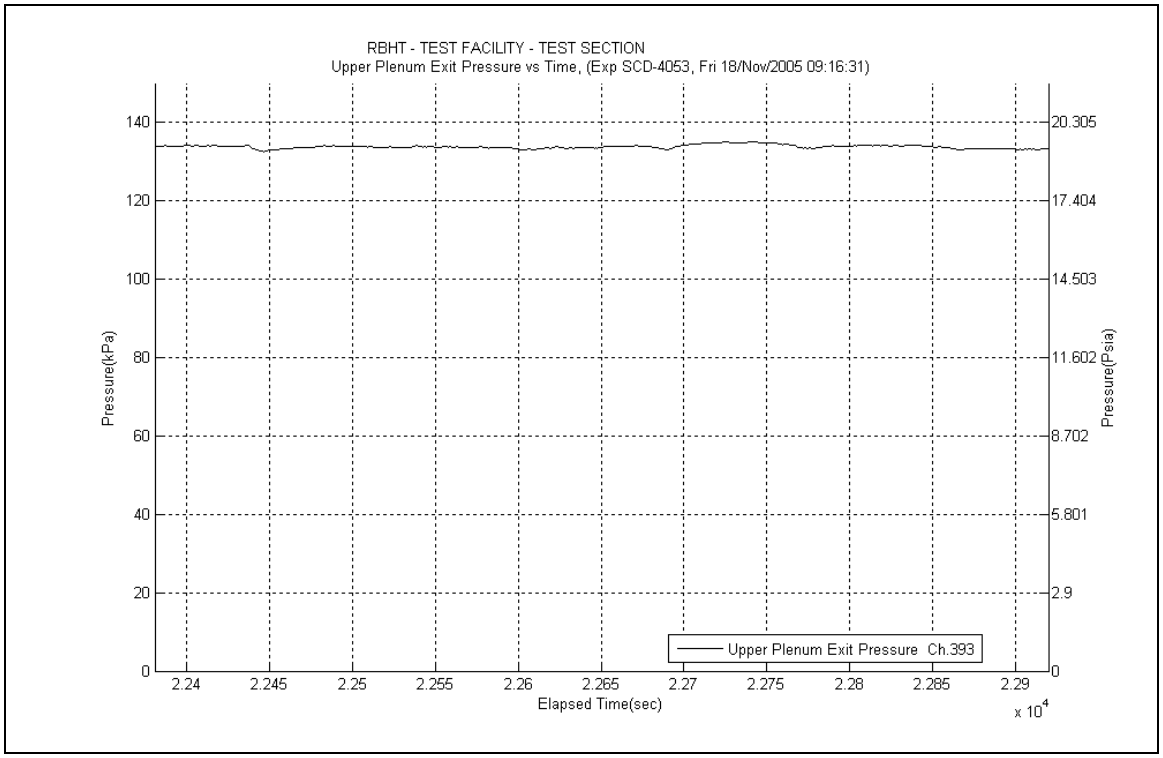

Figure A-435: Upper Plenum Pressure for Experiment 4053G

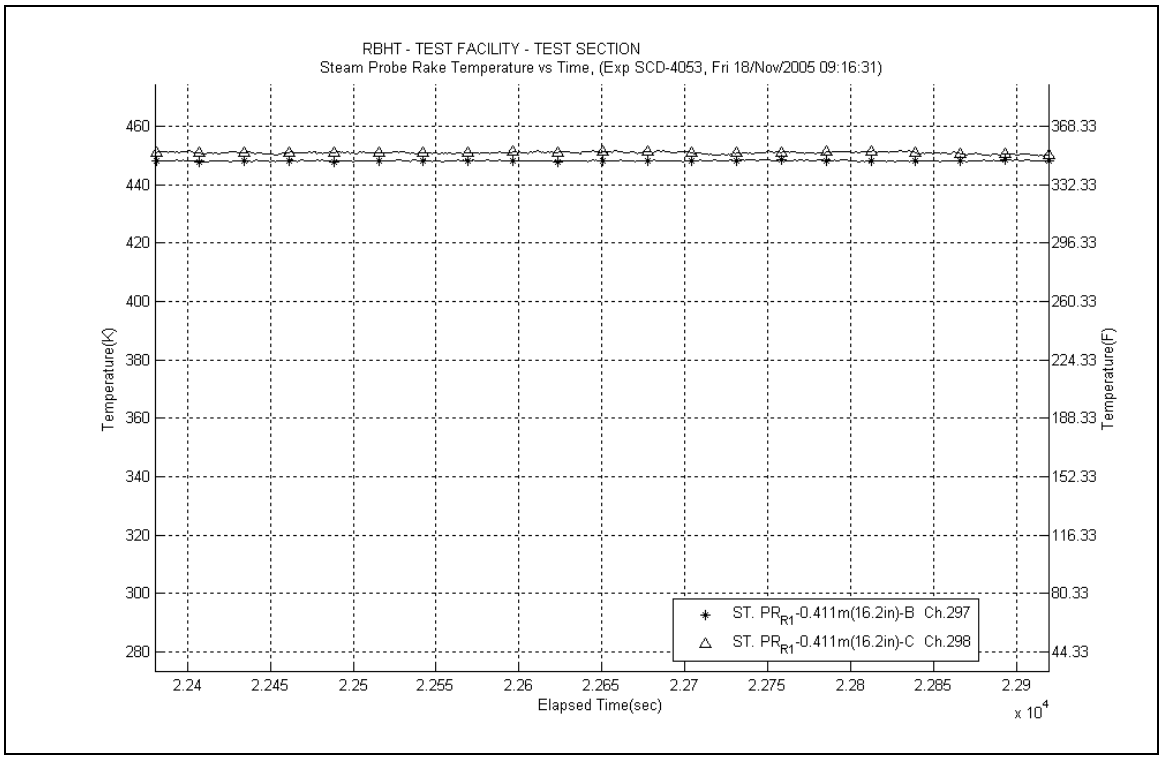

Figure A-436: Steam Probe Rake #1 Temperatures for Experiment 4053G

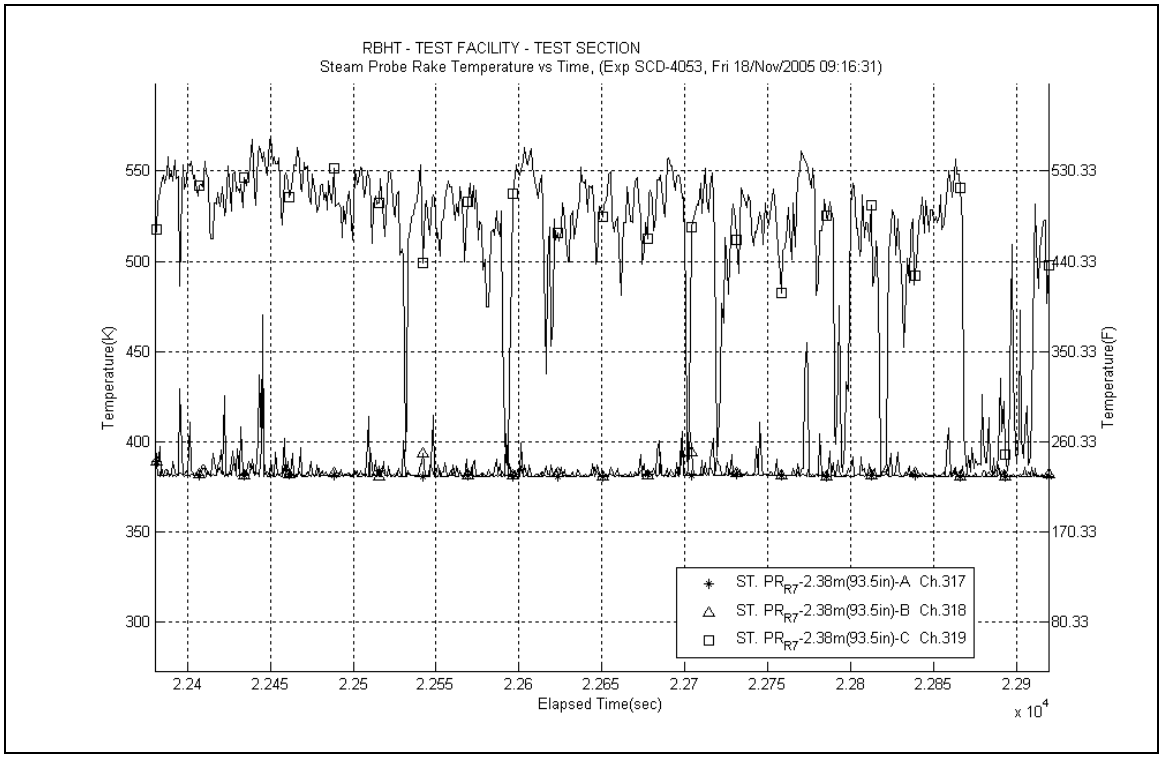

Figure A-437: Steam Probe Rake #7 Temperatures for Experiment 4053G

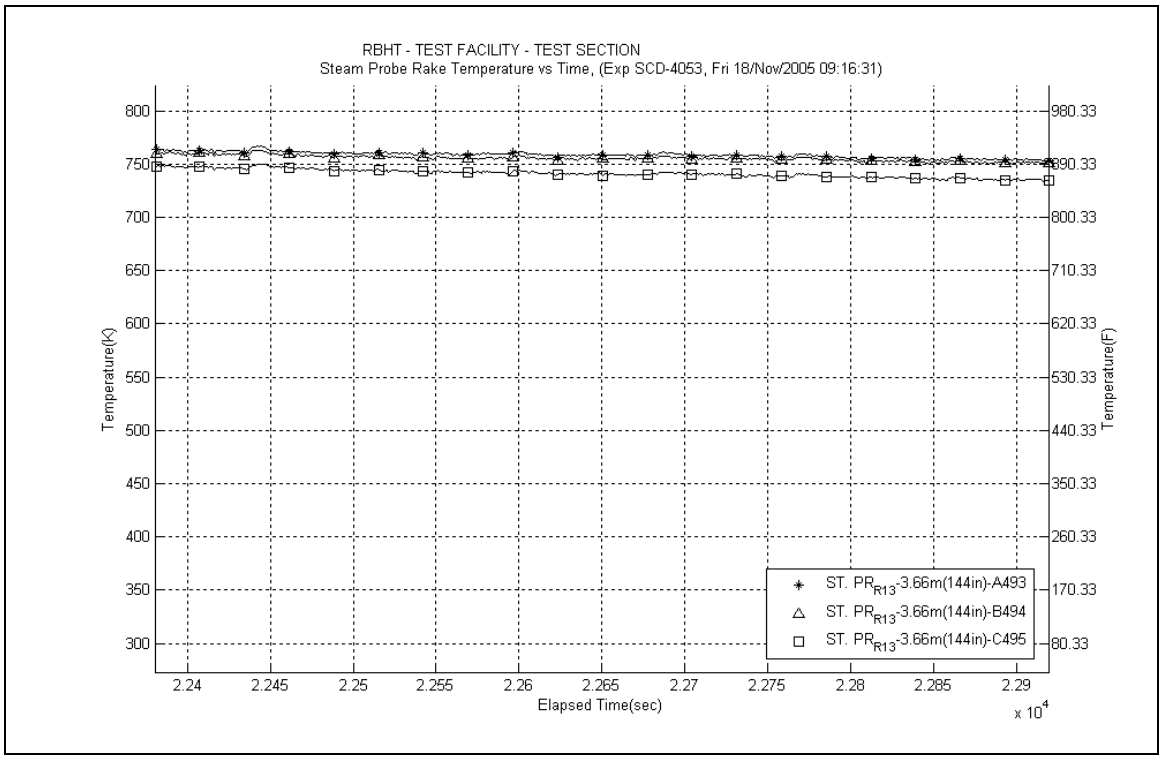

Figure A-438: Steam Probe Rake #13 Temperatures for Experiment 4053G

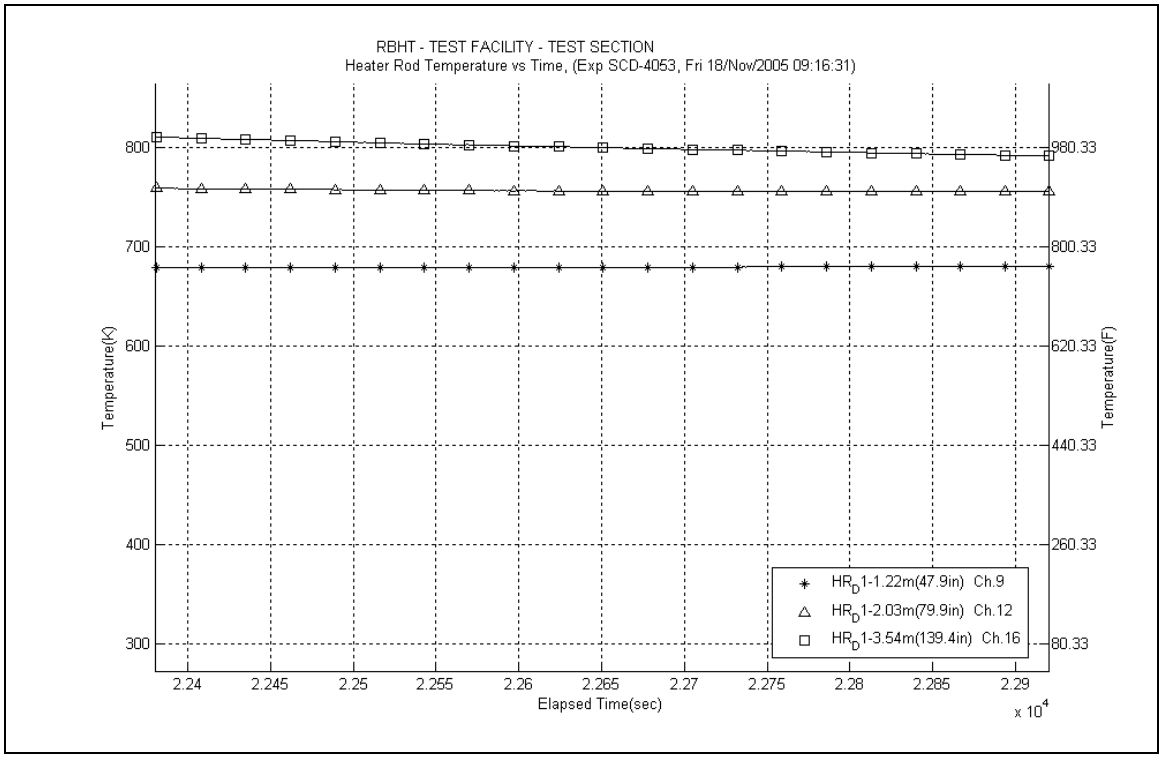

Figure A-439: Heater Rod D1 Temperatures for Experiment 4053G

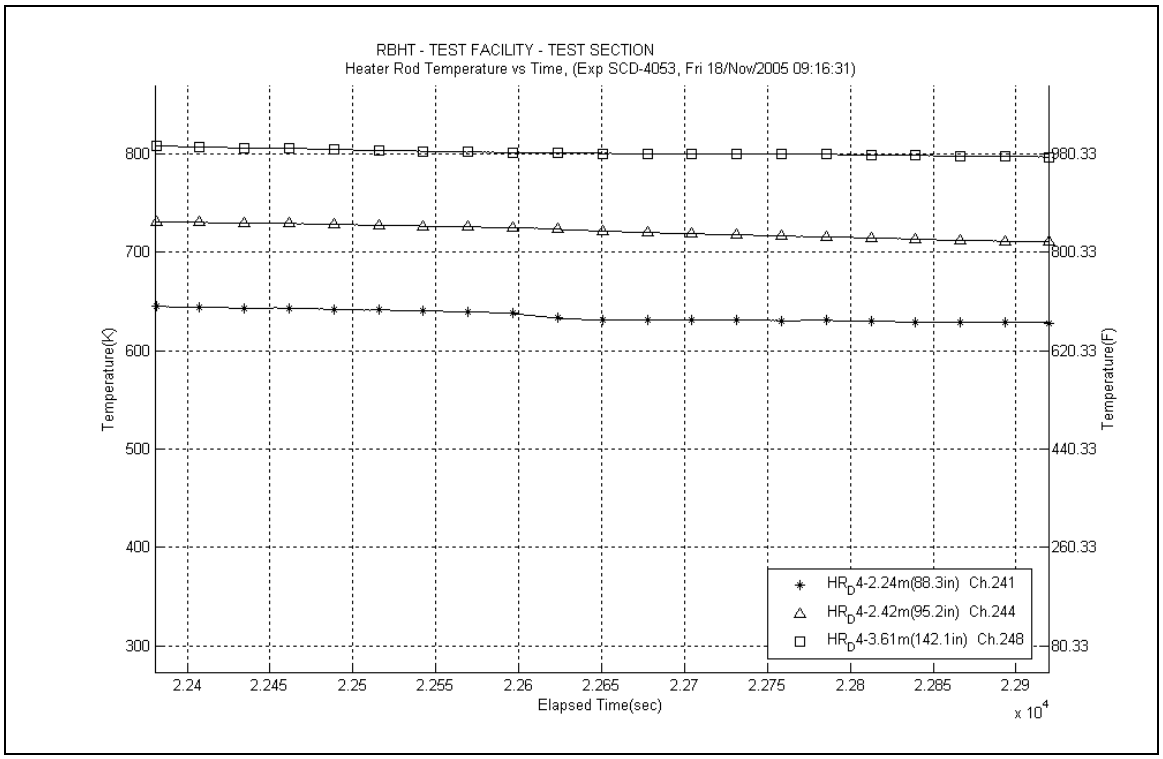

Figure A-440: Heater Rod D4 Temperatures for Experiment 4053G

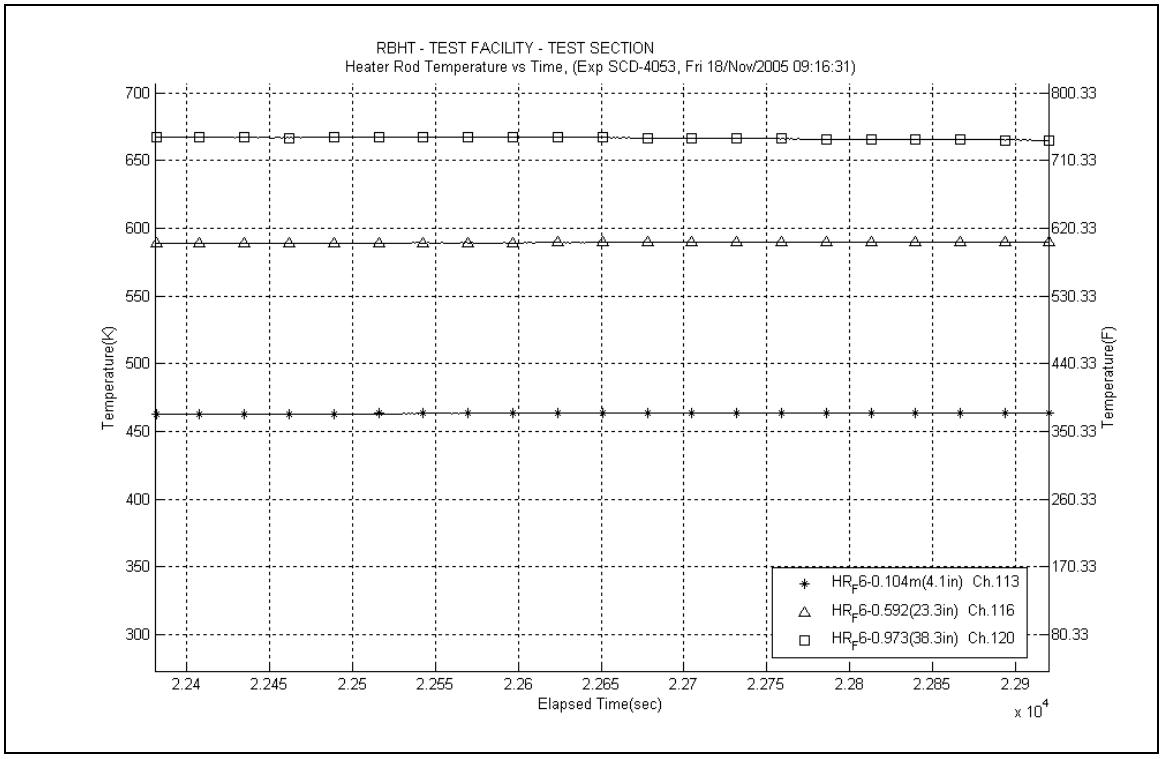

Figure A-441: Heater Rod F6 Temperatures for Experiment 4053G

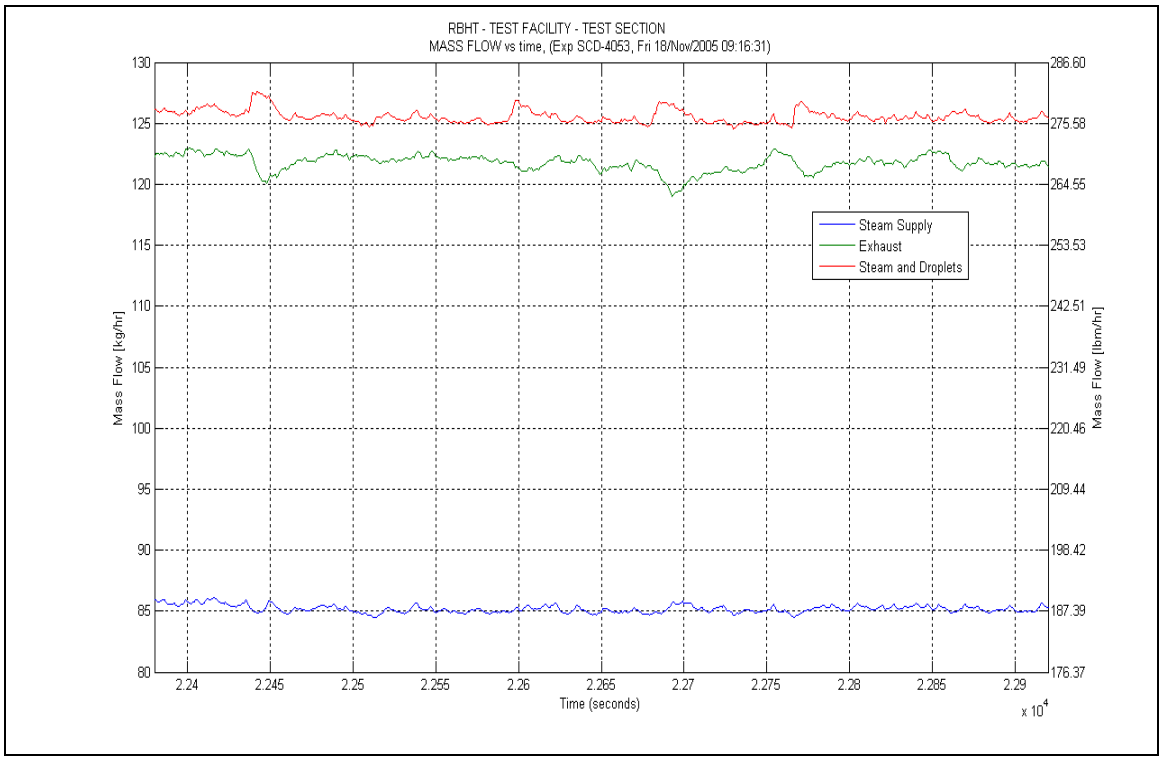

Figure A-442: Mass Flow for Experiment 4053G

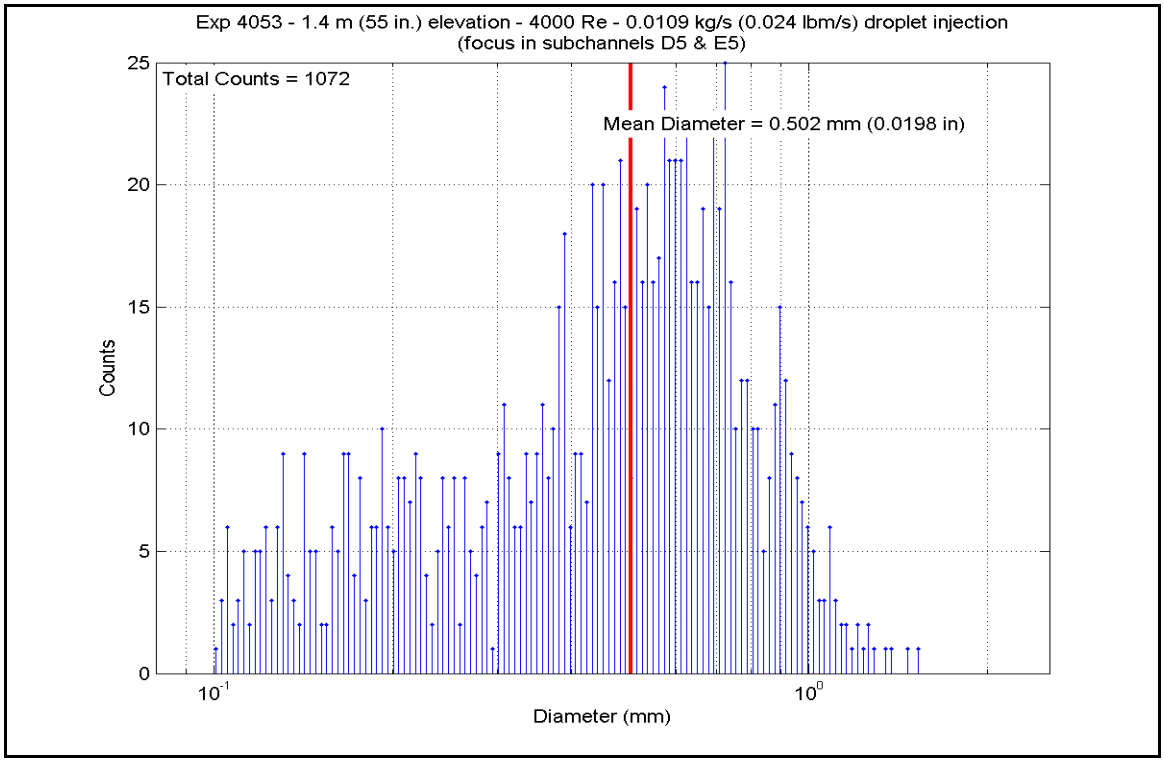

Figure A-443: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053G

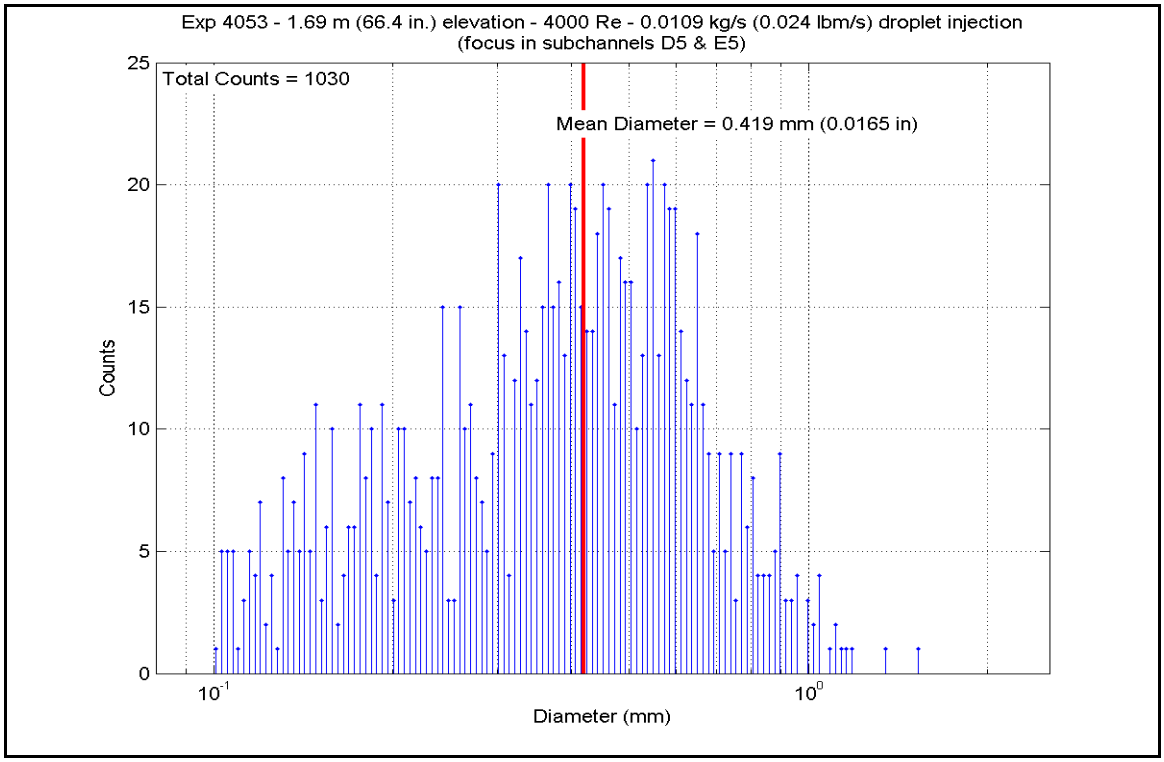

Figure A-444: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053G

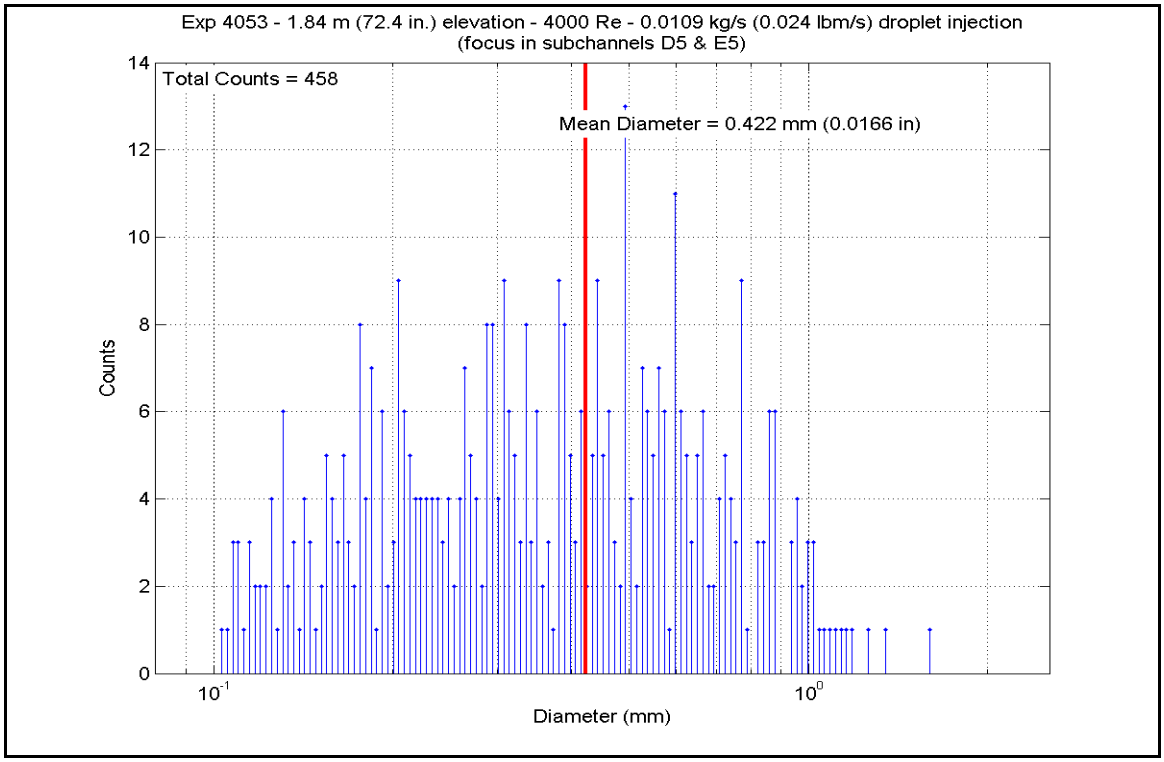

Figure A-445: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053G

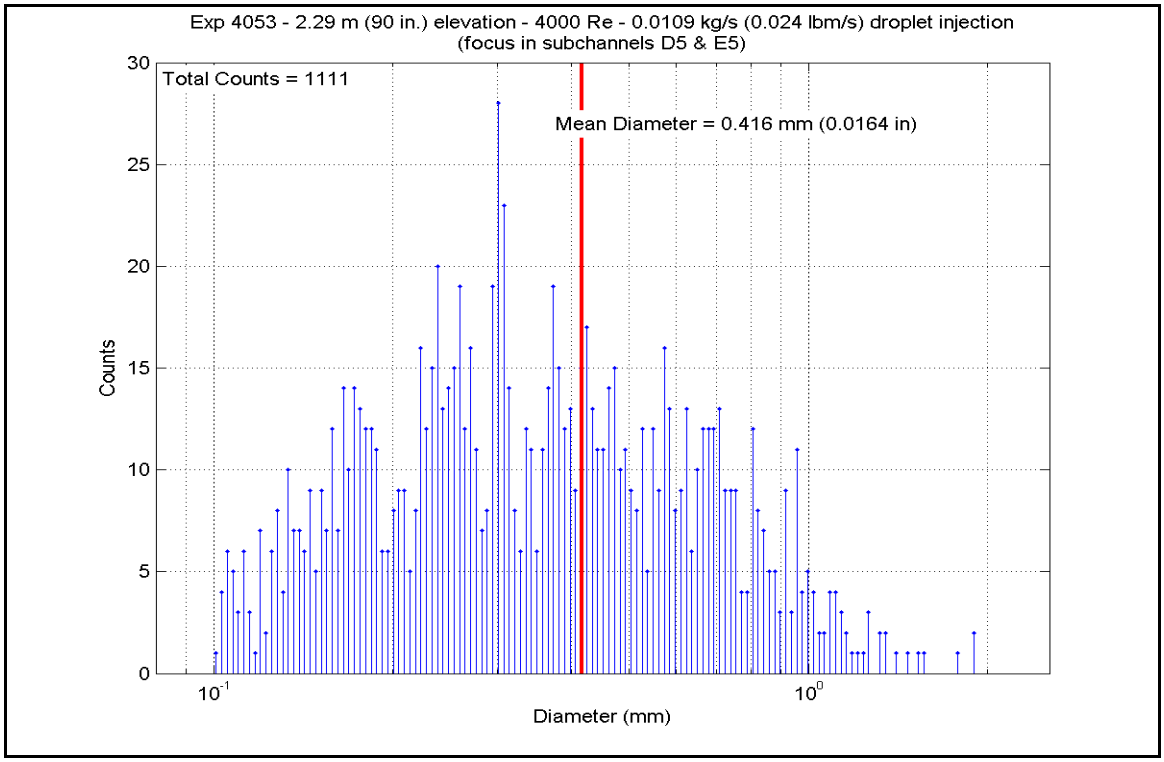

Figure A-446: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053G

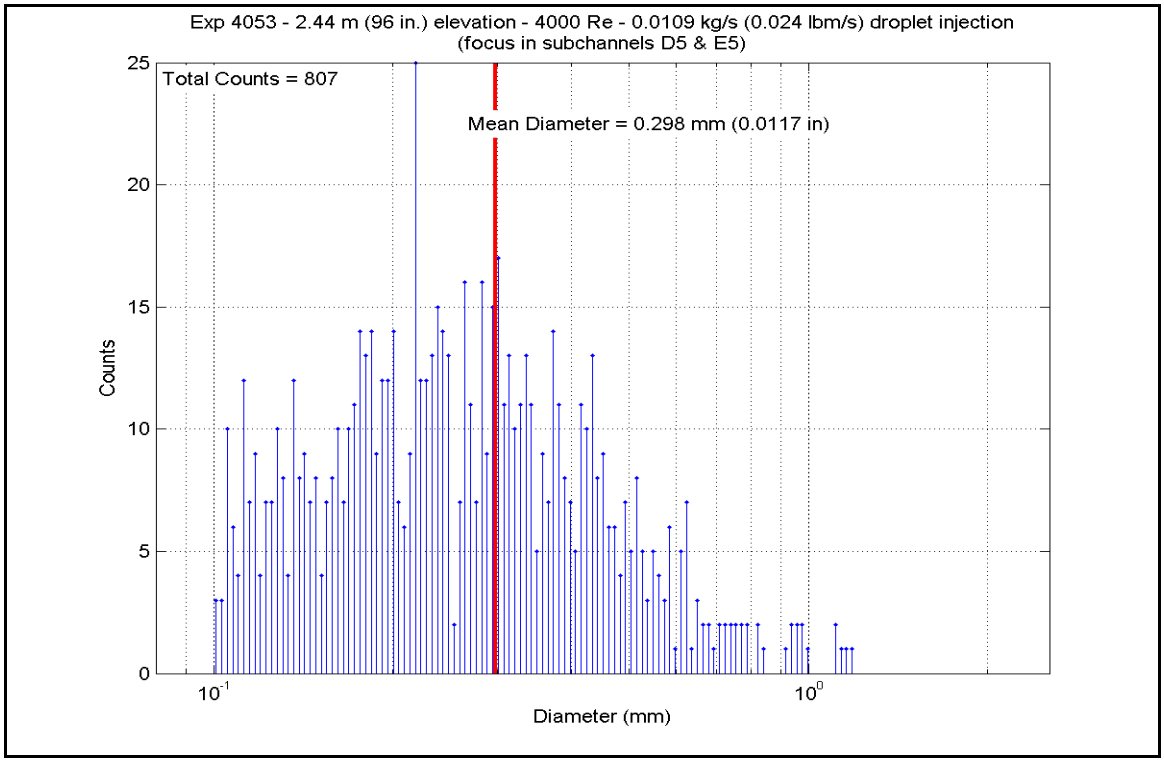

Figure A-447: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053G

Table A-62: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053G

SCD-4053-G	Inlet Reynolds:	4000		
Matrix test # 11c	UP Pressure:	137.9 kPa	20	psia
Time Window: 22380-22920	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	469.08	516.0	5250.24	16561.9	21.778	123.7
	RodD3_91.3	186	91.3	2.319	2.8	0.071	644.97	613.7	4905.19	15473.4	11.764	66.8
	RodD3_93.1	187	93.1	2.365	4.6	0.117	676.01	630.9	4539.22	14319.0	10.132	57.5
	RodD3_95.3	188	95.3	2.421	6.8	0.173	720.54	655.7	4551.03	14356.2	9.240	52.5
	RodD3_106.1	190	106.1	2.695	17.6	0.447	915.01	763.7	4850.98	15302.4	7.061	40.1
	RodD3_110	191	110	2.794	21.5	0.546	751.62	672.9	4481.98	14138.4	8.560	48.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	929.32	771.7	1526.30	4814.7	2.176	12.4
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	581.33	578.3	4287.30	13524.3	12.134	68.9
	RodC4_91.1	234	91.1	2.314	2.6	0.066	658.05	621.0	4374.10	13798.1	10.171	57.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	687.62	637.4	4438.40	14000.9	9.657	54.8
	RodC4_95.3	236	95.3	2.421	6.8	0.173	713.53	651.8	4494.08	14176.6	9.256	52.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	780.39	688.9	4637.82	14630.0	8.396	47.7
	RodC4_106.1	238	106.1	2.695	17.6	0.447	878.33	743.3	4835.08	15252.3	7.435	42.2
	RodC4_110	239	110	2.794	21.5	0.546	722.21	656.6	4619.93	14573.6	9.348	53.1
	RodC4_142.2	240	142.2	3.612	8.7	0.221	907.69	759.6	1725.56	5443.3	2.539	14.4
Gr-3	RodD4_95.2	244	95.2	2.418	6.7	0.170	277.34	409.4	3850.13	12145.2	78.033	443.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	733.24	662.7	4579.36	14445.6	9.064	51.5
	RodD4_106.1	246	106.1	2.695	17.6	0.447	847.10	726.0	4800.14	15142.0	7.753	44.0
	RodD4_142.1	248	142.1	3.609	8.6	0.218	915.81	764.2	1660.25	5237.3	2.414	13.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	589.26	582.7	4150.09	13091.5	11.488	65.2
	RodE4_91.2	202	91.2	2.316	2.7	0.069	650.16	616.6	4259.86	13437.7	10.091	57.3
	RodE4_95.3	204	95.3	2.421	6.8	0.173	720.48	655.6	4384.12	13829.7	8.902	50.6
	RodE4_100.9	205	100.9	2.563	12.4	0.315	806.18	703.2	4594.20	14492.4	7.946	45.1
	RodE4_142.3	208	142.3	3.614	8.8	0.224	919.94	766.4	1656.27	5224.7	2.394	13.6

Table A-62: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	818.02	709.8	3538.61	11162.5	5.997	34.1
	RodE3_113.6	194	113.6	2.885	0.85	0.022	812.18	706.6	4116.19	12984.5	7.046	40.0
	RodE3_115.5	195	115.5	2.934	2.75	0.070	858.57	732.4	3908.80	12330.3	6.199	35.2
	RodE3_118.5	196	118.5	3.010	5.75	0.146	899.48	755.1	3678.56	11604.0	5.478	31.1
	RodE3_122.7	197	122.7	3.117	9.95	0.253	928.30	771.1	3342.88	10545.1	4.774	27.1
	RodE3_126.5	198	126.5	3.213	13.75	0.349	939.56	777.4	3040.93	9592.6	4.274	24.3
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	890.87	750.3	2574.08	8119.9	3.883	22.1
	RodE3_135.6	200	135.6	3.444	2.1	0.053	921.53	767.3	2298.28	7249.9	3.314	18.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	832.85	718.1	3506.63	11061.7	5.798	32.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	747.22	670.5	4167.94	13147.8	8.027	45.6
	RodC5_115.7	227	115.7	2.939	2.95	0.075	796.41	697.8	3997.49	12610.1	7.033	39.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	868.21	737.7	3444.41	10865.4	5.380	30.6
	RodC5_126.7	230	126.7	3.218	13.95	0.354	879.96	744.2	3130.36	9874.7	4.801	27.3
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	817.57	709.6	2721.72	8585.7	4.616	26.2
	RodC5_135.7	232	135.7	3.447	2.2	0.056	855.36	730.6	2391.49	7544.0	3.812	21.6
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	764.89	680.3	3641.21	11486.2	6.782	38.5
	RodE5_113.6	210	113.6	2.885	0.85	0.022	622.42	601.2	4241.93	13381.2	10.755	61.1
	RodE5_115.4	211	115.4	2.931	2.65	0.067	700.26	644.4	4097.43	12925.3	8.676	49.3
	RodE5_118.7	212	118.7	3.015	5.95	0.151	769.55	682.9	3821.86	12056.1	7.057	40.1
	RodE5_122.6	213	122.6	3.114	9.85	0.250	812.23	706.6	3498.36	11035.6	5.988	34.0
	RodE5_126.6	214	126.6	3.216	13.85	0.352	835.91	719.8	3173.55	10011.0	5.220	29.6
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1027.68	826.3	2982.54	9408.4	3.730	21.2
	RodE5_135.6	216	135.6	3.444	2.1	0.053	885.34	747.2	2455.86	7747.0	3.736	21.2
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	729.57	660.7	4029.51	12711.1	8.034	45.6
	RodC3_85.6	178	85.6	2.174	14.72	0.374	606.44	592.3	4255.59	13424.3	11.245	63.9
	RodC3_88.5	179	88.5	2.248	0	0.000	601.09	589.3	4271.56	13474.7	11.449	65.0
	RodC3_92.4	180	92.4	2.347	3.9	0.099	694.02	640.9	4372.99	13794.6	9.384	53.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	721.54	656.2	4411.03	13914.6	8.938	50.8
Gr-8	RodD5_50	217	50	1.270	3	0.076	689.96	638.7	3195.21	10079.3	6.917	39.3
	RodD5_54.1	218	54.1	1.374	7.1	0.180	672.95	629.2	3303.67	10421.4	7.425	42.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	731.89	662.0	3410.22	10757.5	6.768	38.4
	RodD5_60	220	60	1.524	13	0.330	770.16	683.2	3467.21	10937.3	6.395	36.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	669.11	627.1	3655.72	11532.0	8.288	47.1

Table A-62: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	785.75	691.9	2887.76	9109.4	5.177	29.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	747.36	670.6	3222.53	10165.5	6.205	35.2
	RodB5_55	155	55	1.397	8	0.203	781.24	689.4	3298.37	10404.7	5.962	33.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	810.59	705.7	3353.24	10577.8	5.756	32.7
	RodB5_64	157	64	1.626	17	0.432	866.02	736.5	3548.56	11193.9	5.562	31.6
	RodB5_73.9	158	73.9	1.877	3.02	0.077	675.11	630.4	3792.37	11963.0	8.482	48.2
	RodB5_75.9	159	75.9	1.928	5.02	0.128	700.48	644.5	3867.22	12199.1	8.185	46.5
	RodB5_76.9	160	76.9	1.953	6.02	0.153	711.65	650.7	3902.46	12310.3	8.069	45.8
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	772.87	684.7	2864.11	9034.8	5.256	29.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	716.71	653.5	3296.41	10398.5	6.745	38.3
	RodF5_55	107	55	1.397	8	0.203	764.93	680.3	3370.34	10631.7	6.277	35.6
	RodF5_57.8	108	57.8	1.468	10.8	0.274	816.75	709.1	3462.17	10921.4	5.881	33.4
	RodF5_64	109	64	1.626	17	0.432	870.07	738.7	3656.97	11535.9	5.696	32.3
	RodF5_73.8	110	73.8	1.875	2.92	0.074	725.53	658.4	3894.96	12286.7	7.829	44.5
	RodF5_75.8	111	75.8	1.925	4.92	0.125	759.27	677.2	3955.19	12476.6	7.445	42.3
	RodF5_76.8	112	76.8	1.951	5.92	0.150	773.47	685.1	3984.33	12568.6	7.304	41.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	784.15	691.0	2892.28	9123.7	5.201	29.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	793.50	696.2	3279.89	10346.4	5.800	32.9
	RodC2_55	59	55	1.397	8	0.203	814.15	707.7	3343.58	10547.3	5.704	32.4
	RodC2_57.8	60	57.8	1.468	10.8	0.274	845.57	725.1	3432.66	10828.3	5.558	31.6
	RodC2_63.9	61	63.9	1.623	16.9	0.429	876.83	742.5	3621.64	11424.5	5.582	31.7
	RodC2_73.8	62	73.8	1.875	2.92	0.074	712.44	651.2	3952.48	12468.1	8.159	46.3
	RodC2_75.8	63	75.8	1.925	4.92	0.125	743.85	668.6	4028.01	12706.4	7.808	44.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	757.82	676.4	4066.80	12828.7	7.676	43.6
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	785.16	691.6	2869.53	9051.9	5.150	29.2
	RodC6_52.8	138	52.8	1.341	5.8	0.147	791.31	695.0	3241.80	10226.3	5.755	32.7
	RodC6_54.8	139	54.8	1.392	7.8	0.198	807.23	703.8	3305.14	10426.1	5.706	32.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	824.14	713.2	3403.12	10735.1	5.709	32.4
	RodC6_63.8	141	63.8	1.621	16.8	0.427	839.95	722.0	3551.50	11203.2	5.804	33.0
	RodC6_73.7	142	73.7	1.872	2.82	0.072	700.93	644.8	3803.96	11999.6	8.043	45.7
	RodC6_75.8	143	75.8	1.925	4.92	0.125	726.50	659.0	3869.93	12207.7	7.763	44.1
	RodC6_76.8	144	76.8	1.951	5.92	0.150	740.39	666.7	3902.19	12309.5	7.616	43.2

Table A-62: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	581.91	578.7	4153.27	13101.5	11.735	66.6
	RodB4_91.3	162	91.3	2.319	2.8	0.071	654.56	619.0	4244.58	13389.5	9.951	56.5
	RodB4_93.3	163	93.3	2.370	4.8	0.122	674.27	630.0	4275.56	13487.2	9.581	54.4
	RodB4_95.1	164	95.1	2.416	6.6	0.168	704.48	646.7	4331.79	13664.6	9.091	51.6
	RodB4_142.3	168	142.3	3.614	8.8	0.224	894.18	752.1	1719.16	5423.1	2.581	14.7
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	577.65	576.3	4222.65	13320.4	12.077	68.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	262.68	401.3	4021.30	12685.2	115.949	658.5
	RodF4_94.3	101	94.3	2.395	5.8	0.147	571.78	573.0	4423.01	13952.4	12.866	73.1
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	865.51	736.2	3970.70	12525.6	6.228	35.4
	RodD2_106	66	106	2.692	17.5	0.445	893.62	751.8	3765.53	11878.4	5.657	32.1
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	927.49	770.6	3493.13	11019.1	4.994	28.4
	RodD2_114.9	68	114.9	2.918	2.15	0.055	945.60	780.7	3145.69	9923.1	4.384	24.9
	RodD2_117.4	69	117.4	2.982	4.65	0.118	941.60	778.5	2815.93	8882.8	3.946	22.4
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	770.94	683.7	4196.52	13237.9	7.729	43.9
	RodD6_116.8	133	116.8	2.967	4.05	0.103	808.97	704.8	4029.61	12711.4	6.936	39.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	842.46	723.4	3611.42	11392.2	5.877	33.4
	RodD6_124.8	135	124.8	3.170	12.05	0.306	859.74	733.0	3272.58	10323.3	5.180	29.4
	RodD6_128.7	136	128.7	3.269	15.95	0.405	857.85	732.0	2921.88	9217.1	4.639	26.3

Table A-62: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	737.42	665.0	3215.17	10142.2	6.311	35.8
	RodE2_54	74	54	1.372	7	0.178	801.20	700.5	3352.53	10575.6	5.849	33.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	833.25	718.3	3448.45	10878.1	5.698	32.4
	RodE2_59.9	76	59.9	1.521	12.9	0.328	868.98	738.1	3545.85	11185.4	5.532	31.4
	RodE2_66	77	66	1.676	19	0.483	881.10	744.9	3745.33	11814.7	5.735	32.6
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	638.13	609.9	3941.20	12432.5	9.610	54.6
	RodE2_72.9	79	72.9	1.852	2.02	0.051	712.01	650.9	4028.74	12708.7	8.324	47.3
	RodE2_74.9	80	74.9	1.902	4.02	0.102	748.67	671.3	4096.79	12923.3	7.868	44.7
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	711.42	650.6	3139.41	9903.3	6.494	36.9
	RodB3_54.1	170	54.1	1.374	7.1	0.180	784.05	691.0	3286.14	10366.1	5.910	33.6
	RodB3_56.9	171	56.9	1.445	9.9	0.251	818.02	709.8	3369.88	10630.3	5.712	32.4
	RodB3_60.1	172	60.1	1.527	13.1	0.333	766.09	681.0	3401.84	10731.1	6.322	35.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	646.34	614.5	3543.62	11178.3	8.471	48.1
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	718.67	654.6	3183.50	10042.3	6.488	36.8
	RodF3_54	90	54	1.372	7	0.178	790.25	694.4	3316.35	10461.4	5.898	33.5
	RodF3_57	91	57	1.448	10	0.254	835.59	719.6	3419.76	10787.6	5.628	32.0
	RodF3_60	92	60	1.524	13	0.330	870.09	738.8	3520.08	11104.1	5.482	31.1
	RodF3_66.1	93	66.1	1.679	19.1	0.485	861.72	734.1	3822.35	12057.6	6.032	34.3
	RodF3_70	94	70	1.778	-0.88	-0.022	343.77	446.4	5027.64	15859.7	43.426	246.6
	RodF3_73	95	73	1.854	2.12	0.054	424.46	491.2	5562.72	17547.6	28.314	160.8
	RodF3_75	96	75	1.905	4.12	0.105	494.67	530.2	5757.68	18162.6	21.591	122.6
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	707.26	648.3	3254.19	10265.3	6.790	38.6
	RodE6_54.1	122	54.1	1.374	7.1	0.180	768.84	682.5	3375.29	10647.3	6.241	35.4
	RodE6_57	123	57	1.448	10	0.254	780.92	689.2	3500.34	11041.8	6.331	36.0
	RodE6_60.2	124	60.2	1.529	13.2	0.335	804.23	702.2	3586.72	11314.3	6.224	35.3
	RodE6_66.1	125	66.1	1.679	19.1	0.485	813.78	707.5	3746.15	11817.2	6.395	36.3
	RodE6_70	126	70	1.778	-0.88	-0.022	629.22	604.9	3781.71	11929.4	9.425	53.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	686.85	637.0	3853.15	12154.8	8.397	47.7
	RodE6_75	128	75	1.905	4.12	0.105	722.43	656.7	3906.74	12323.8	7.901	44.9

RBHT Steam Cooling with Droplet Injection Test SCD-4053-H

Matrix Test # 11d

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 23940 - 24360
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 55 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

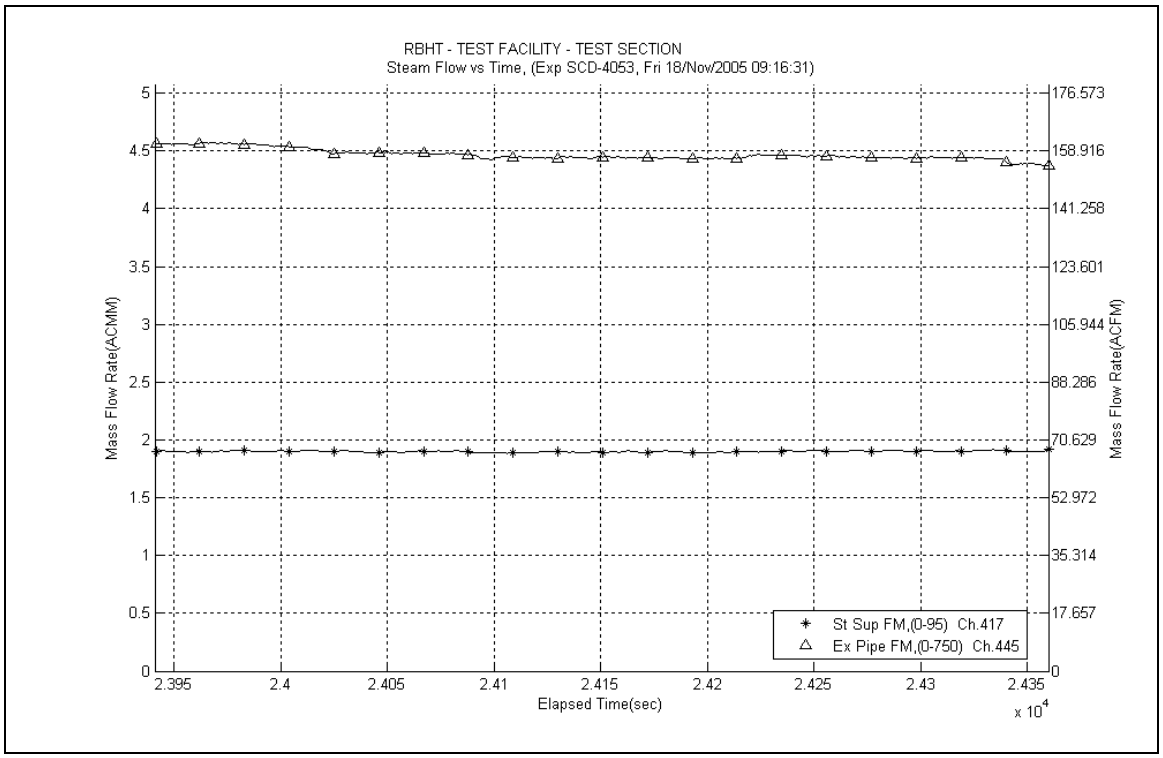

Figure A-448: Inlet and Exhaust Steam Flow Rates for Experiment 4053H

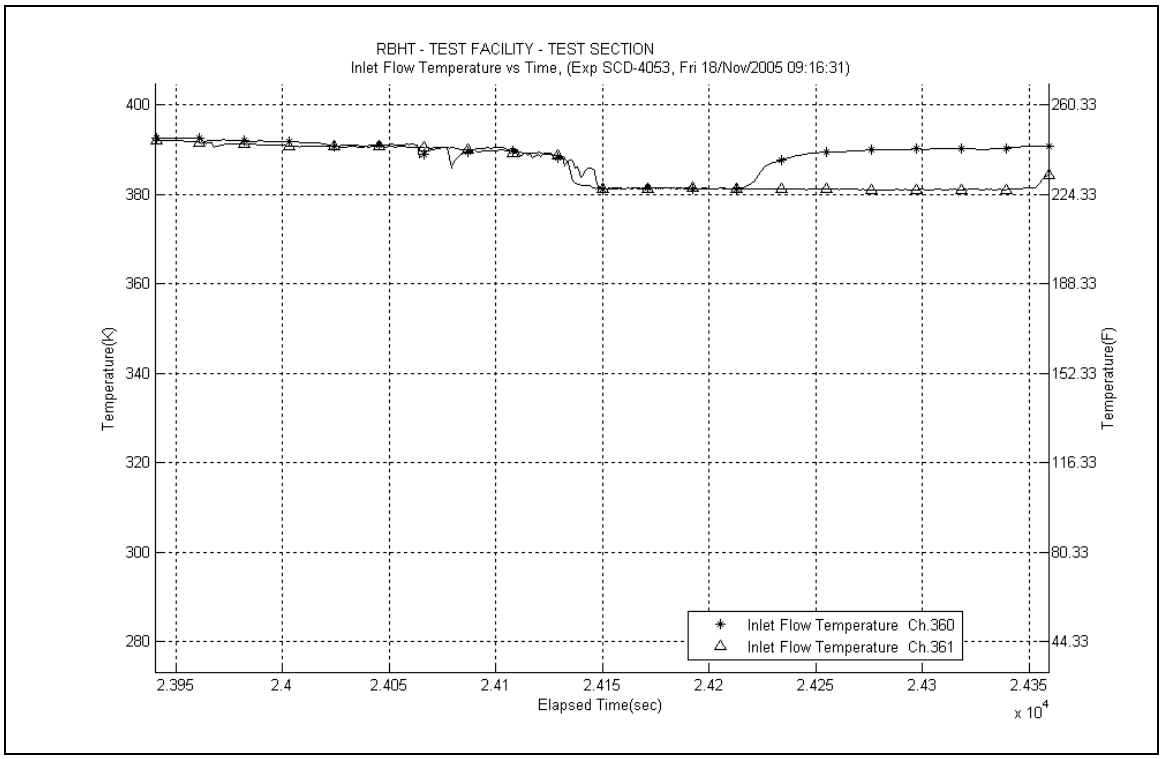

Figure A-449: Inlet Steam Temperature for Experiment 4053H

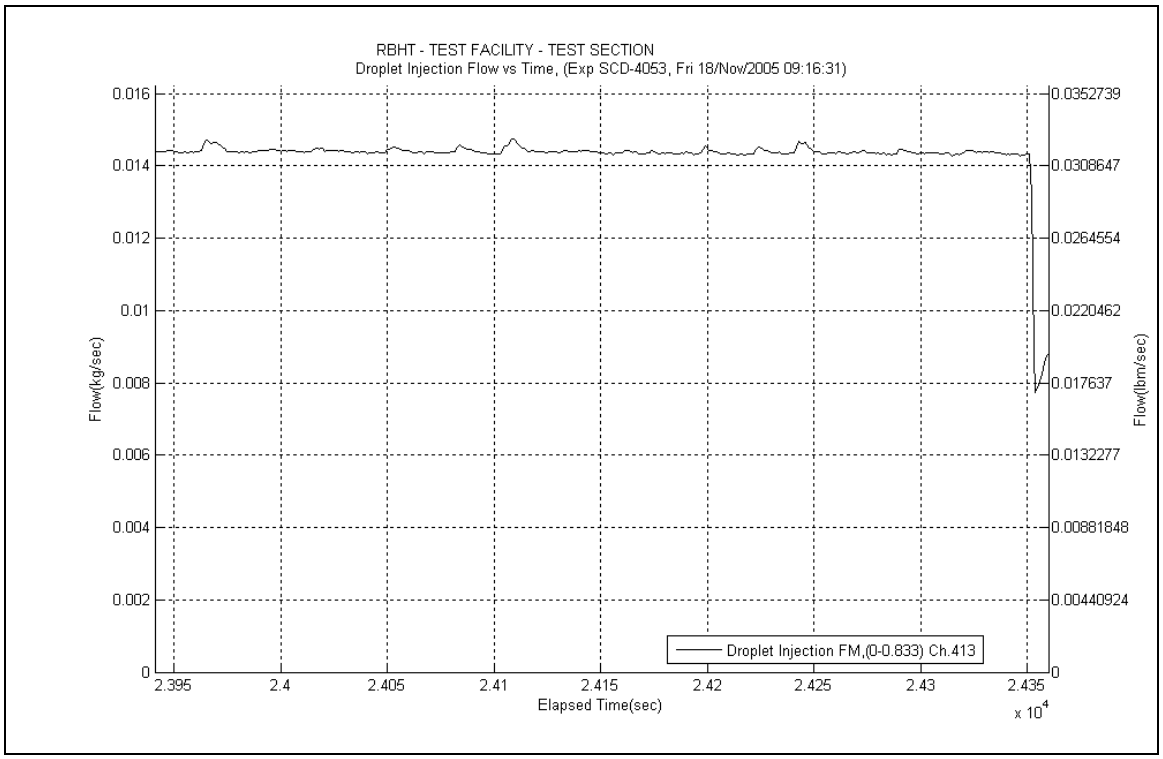

Figure A-450: Droplet Injection Flow Rate for Experiment 4053H

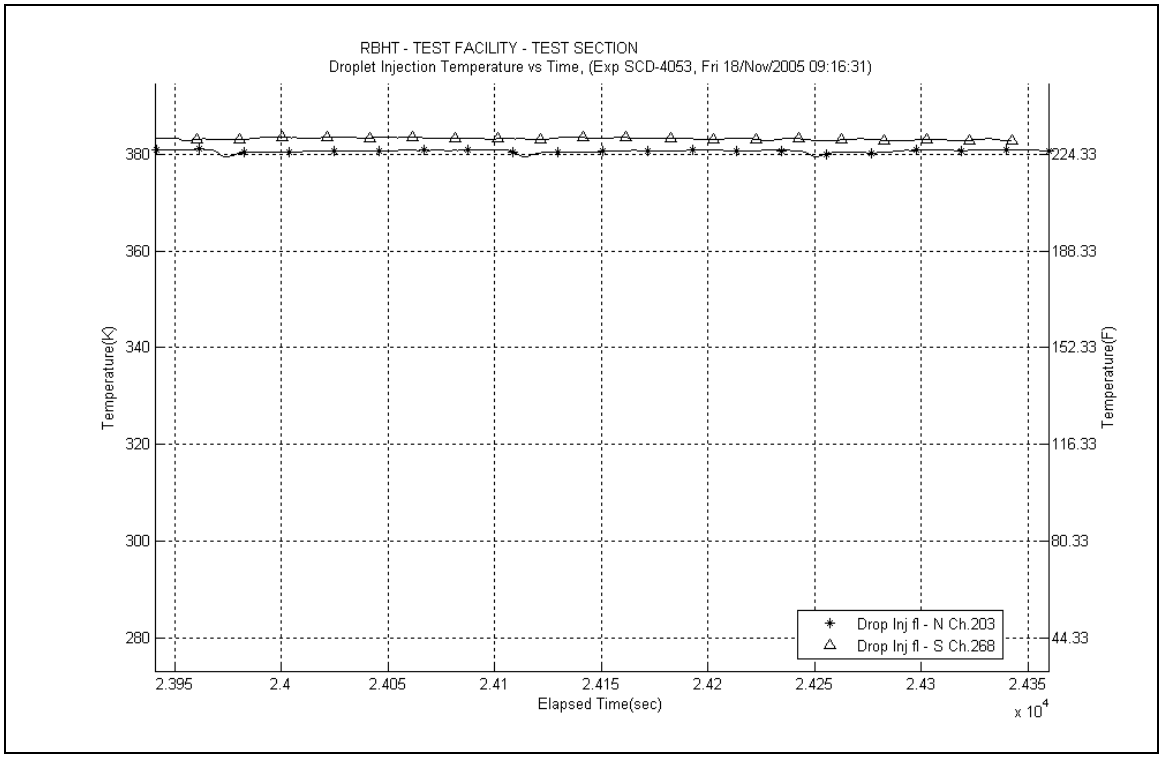

Figure A-451: Droplet Injection Temperature for Experiment 4053H

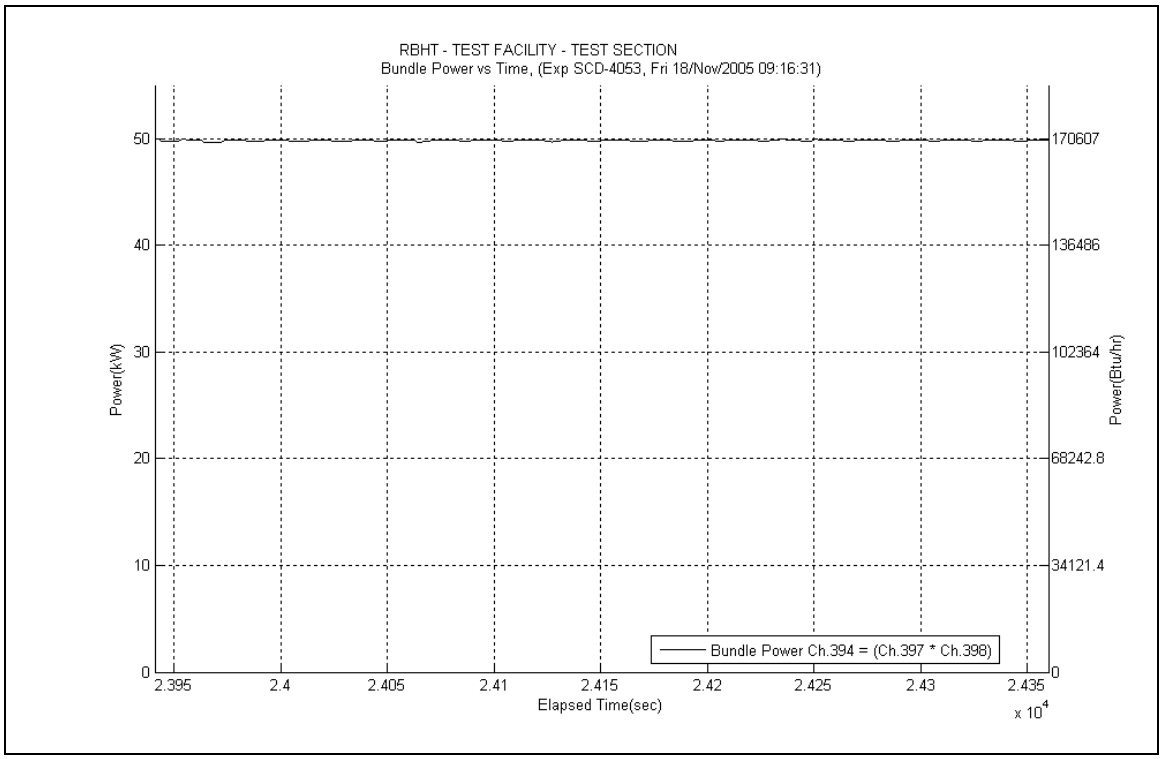

Figure A-452: Bundle Power for Experiment 4053H

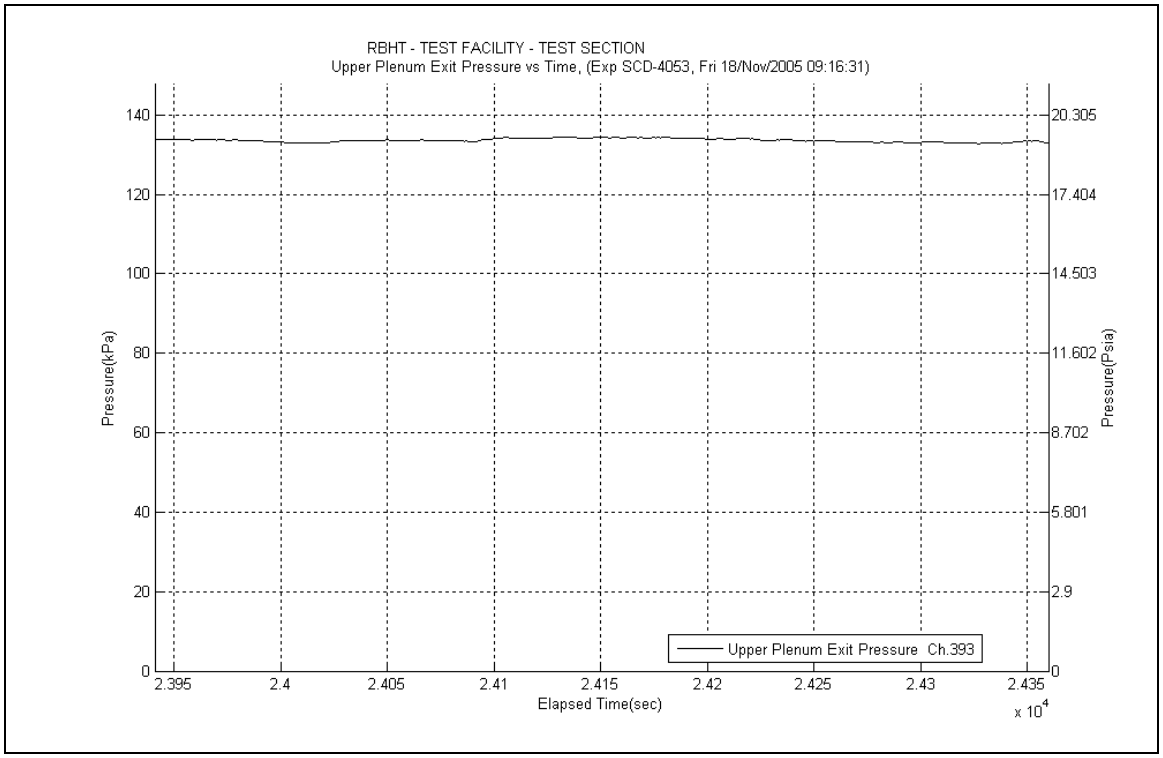

Figure A-453: Upper Plenum Pressure for Experiment 4053H

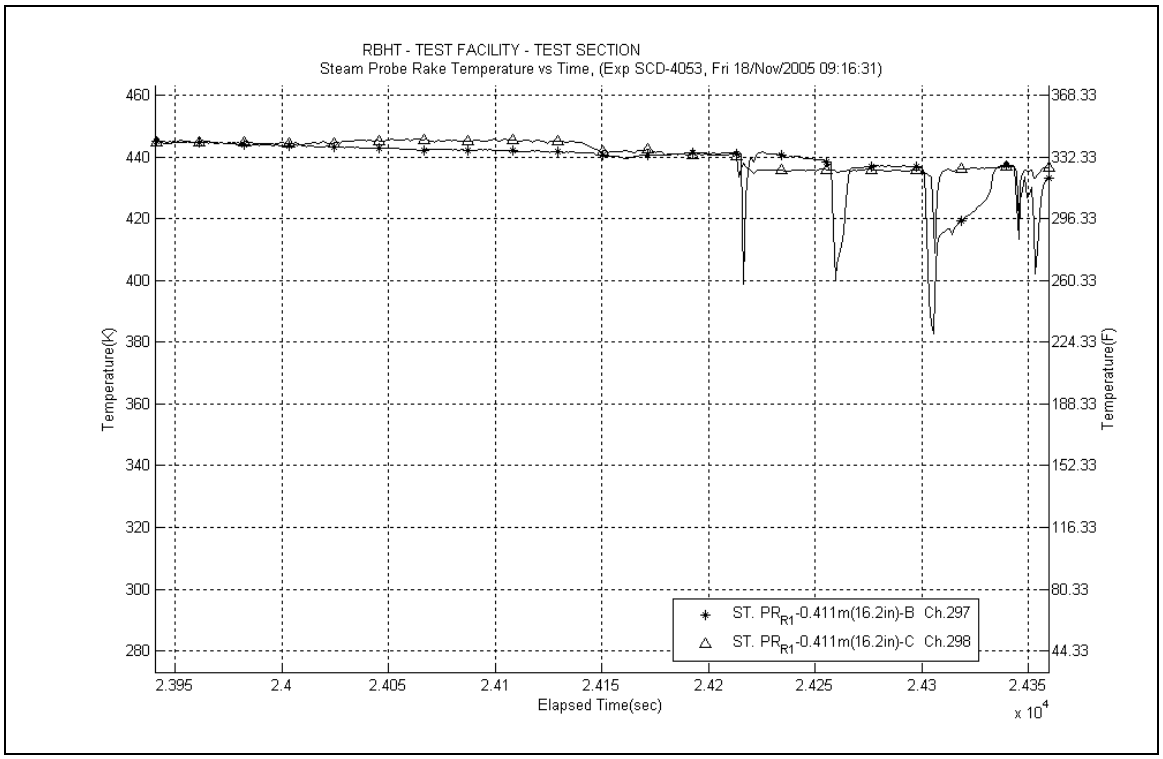

Figure A-454: Steam Probe Rake #1 Temperatures for Experiment 4053H

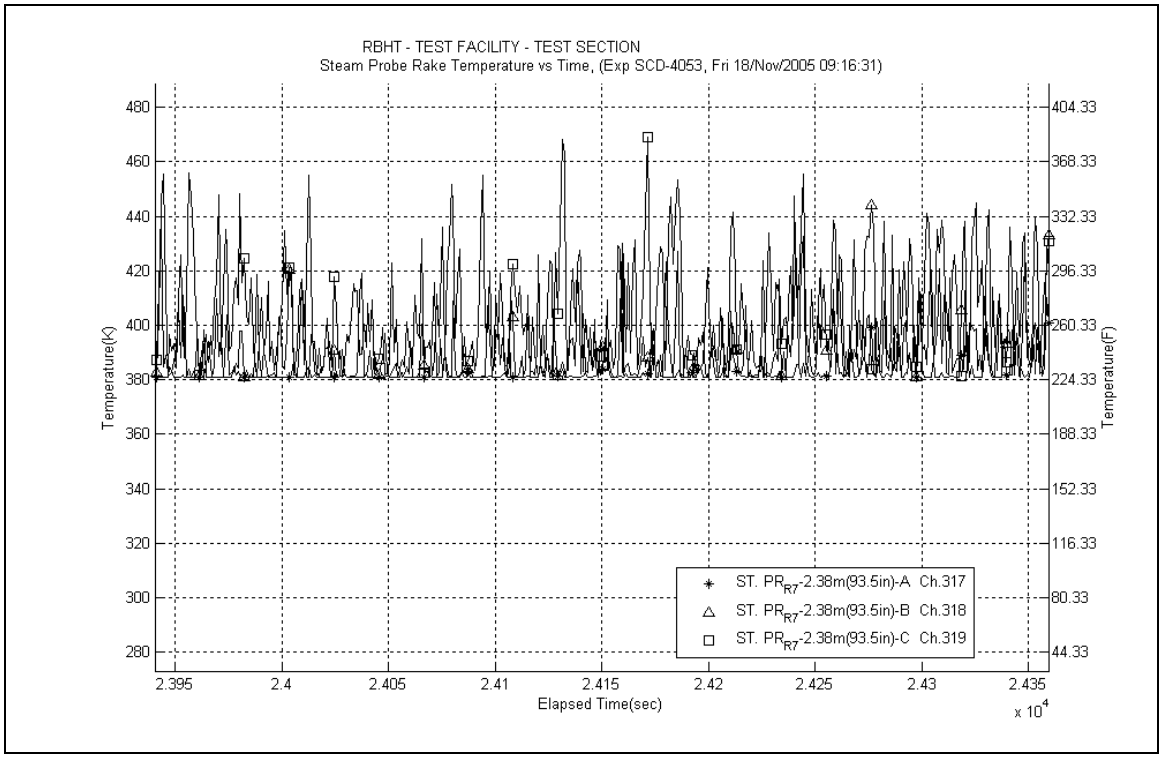

Figure A-455: Steam Probe Rake #7 Temperatures for Experiment 4053H

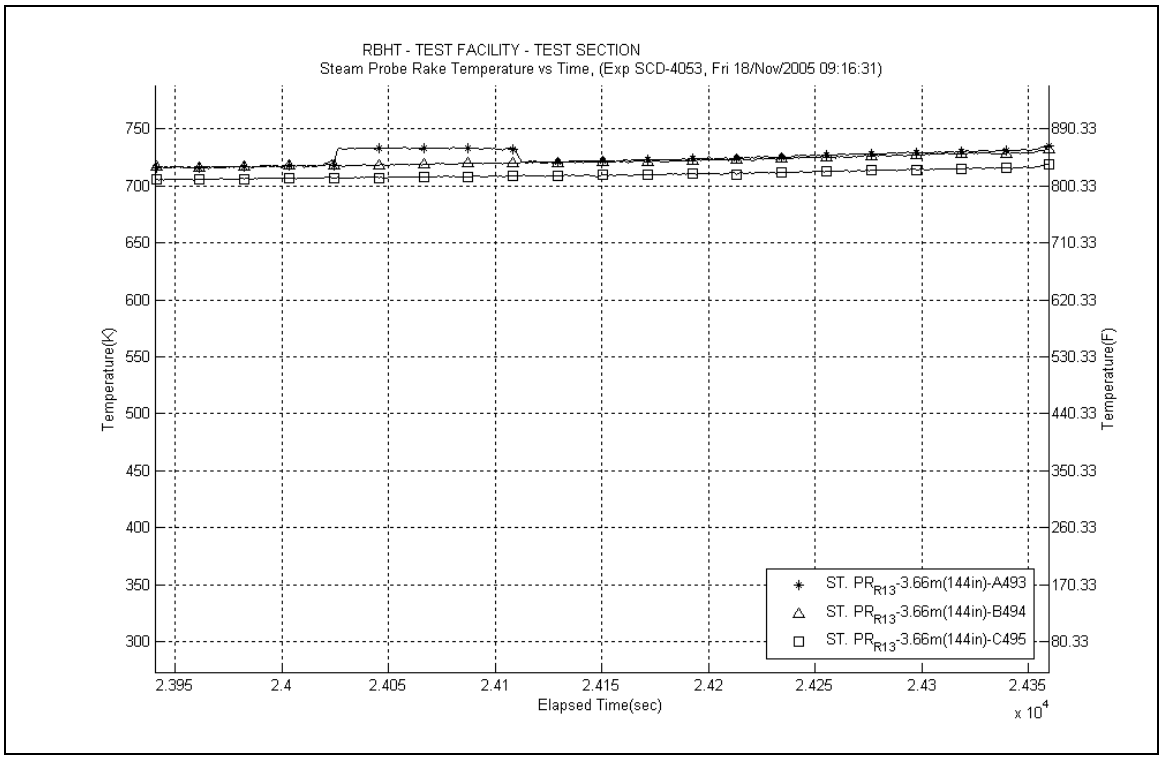

Figure A-456: Steam Probe Rake #13 Temperatures for Experiment 4053H

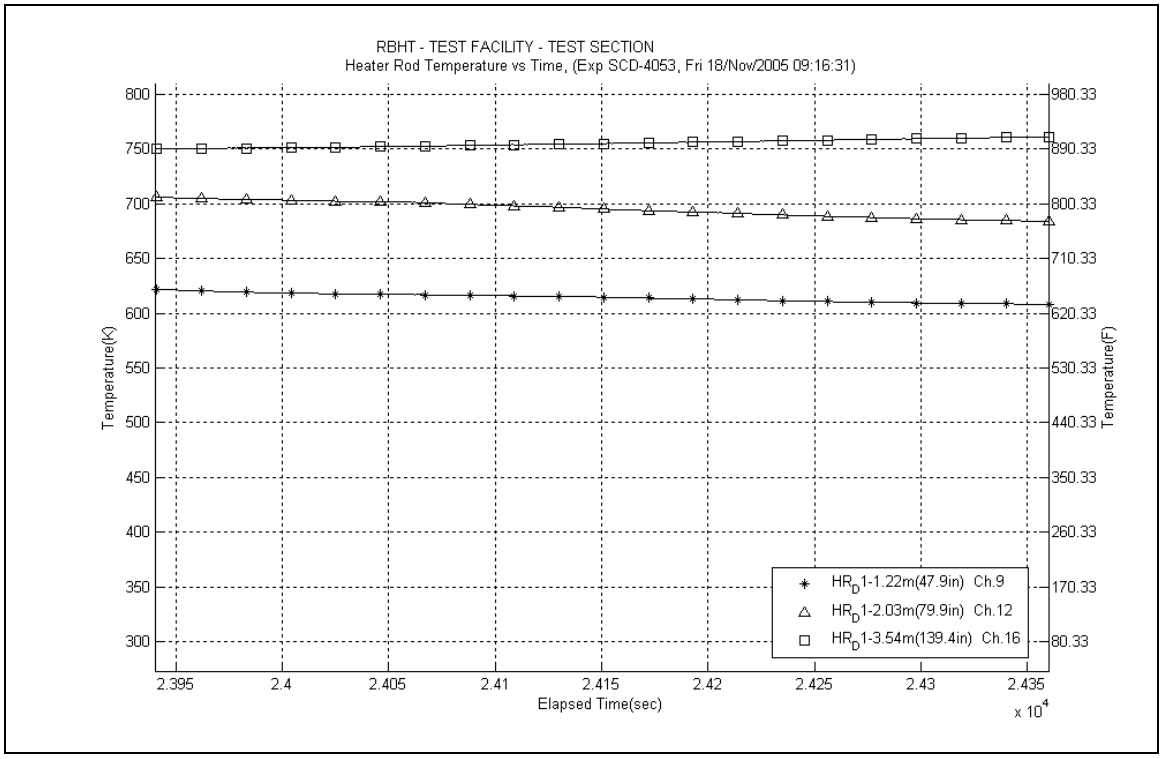

Figure A-457: Heater Rod D1 Temperatures for Experiment 4053H

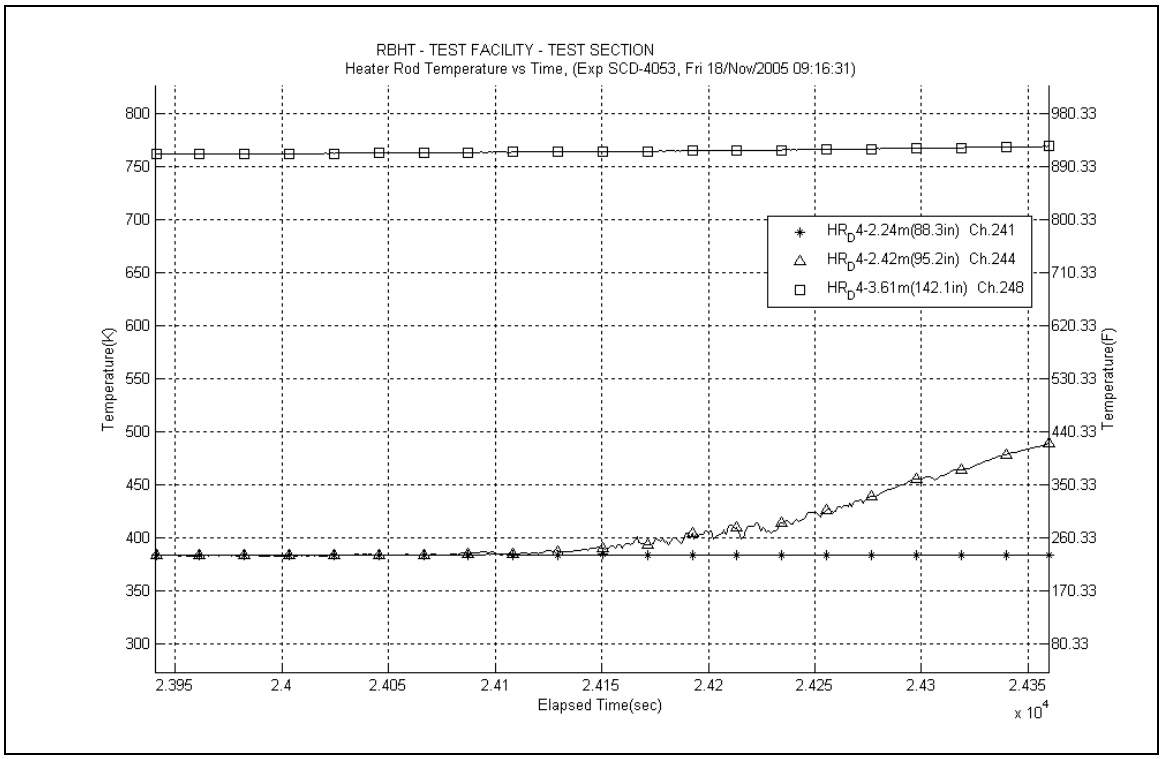

Figure A-458: Heater Rod D4 Temperatures for Experiment 4053H

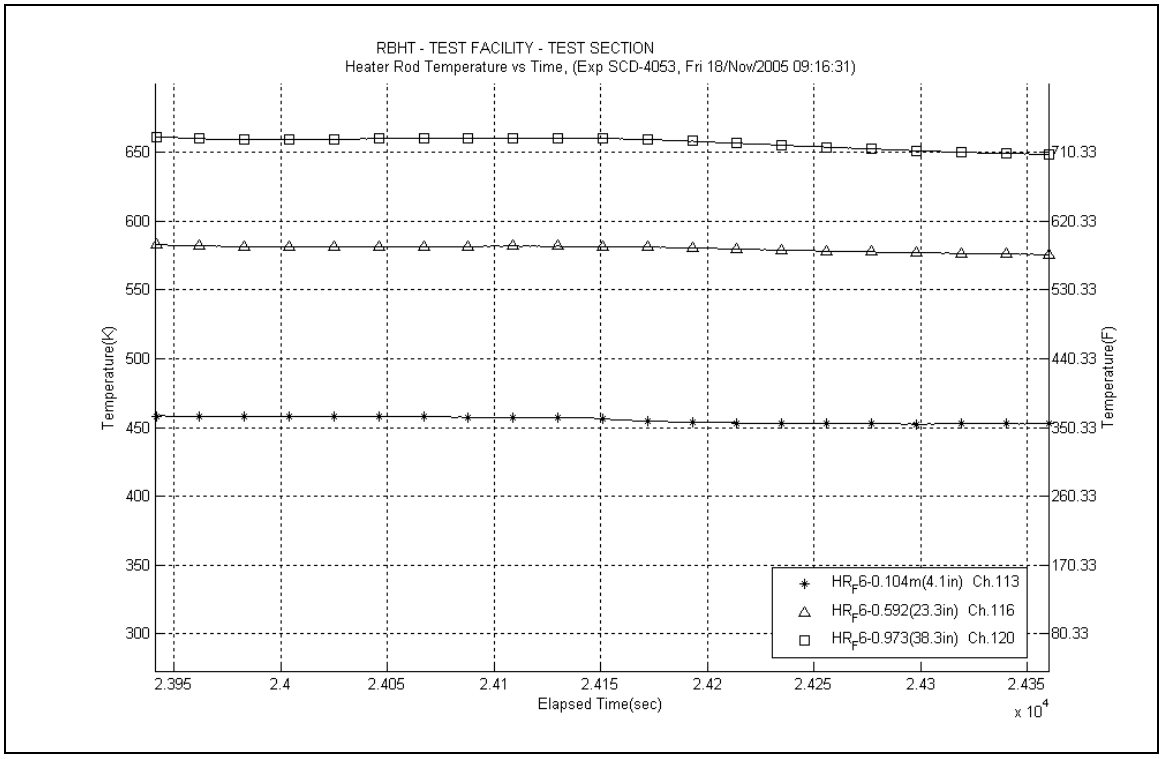

Figure A-459: Heater Rod F6 Temperatures for Experiment 4053H

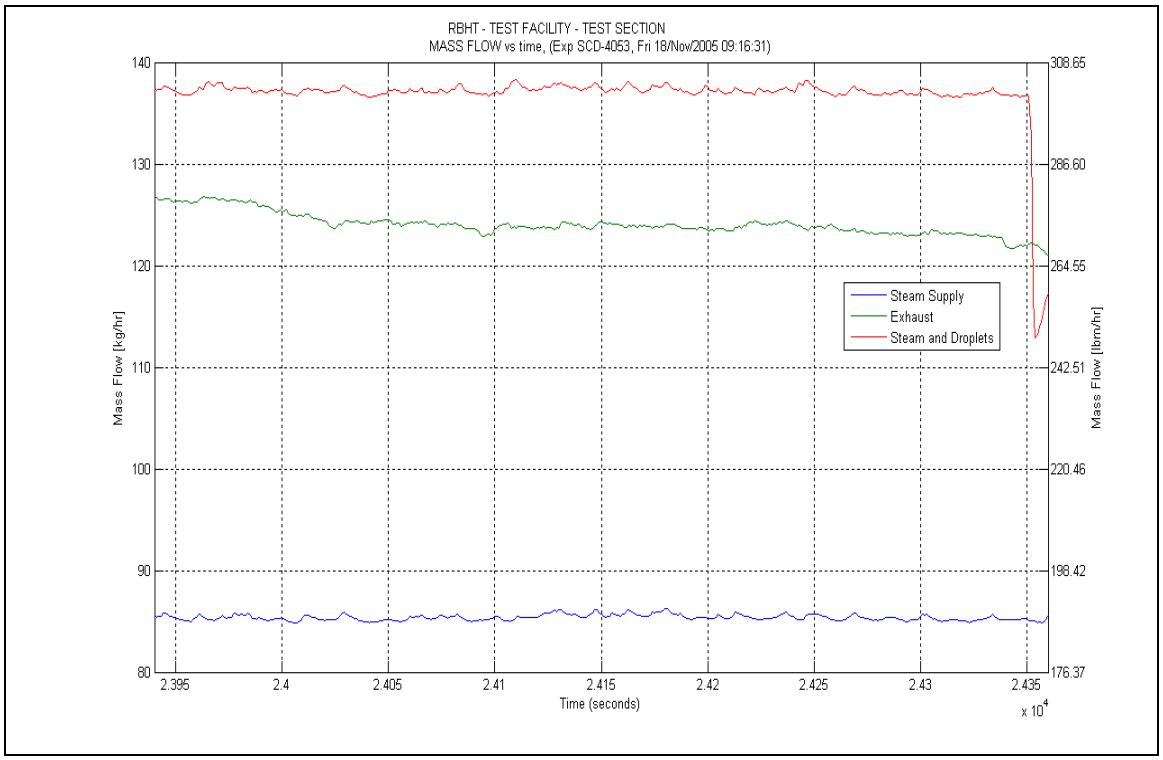

Figure A-460: Mass Flow for Experiment 4053H

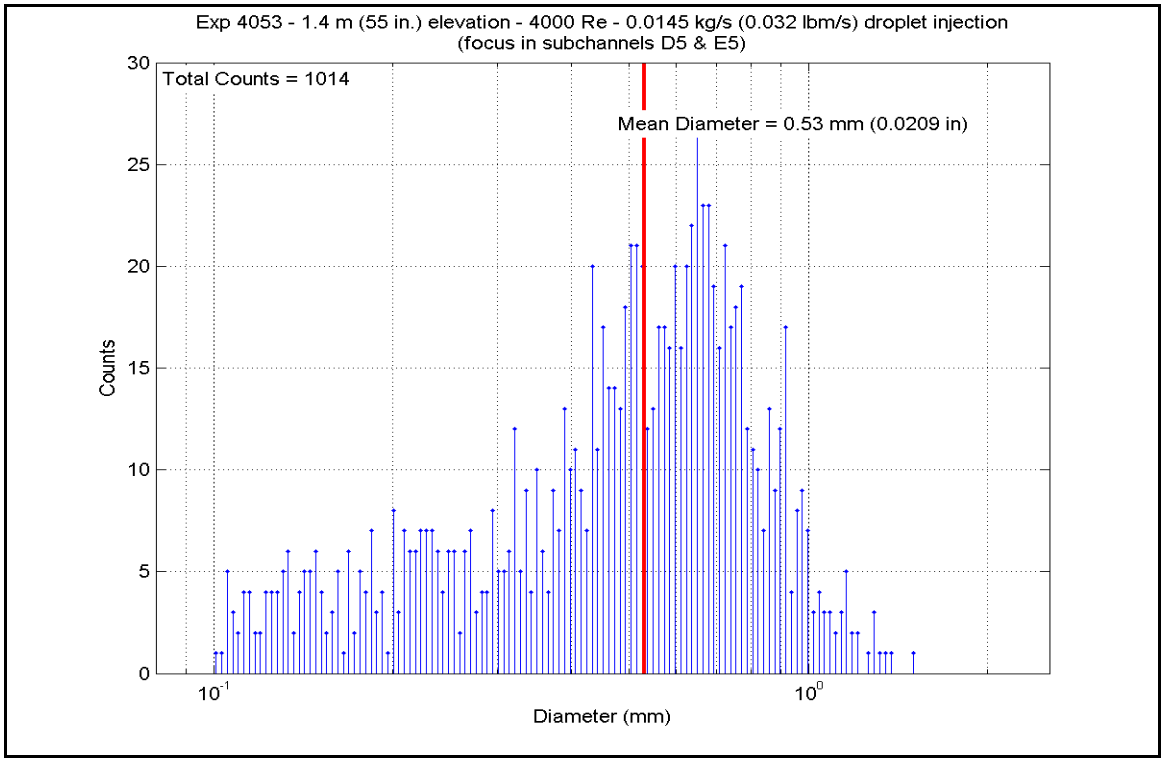

Figure A-461: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053H

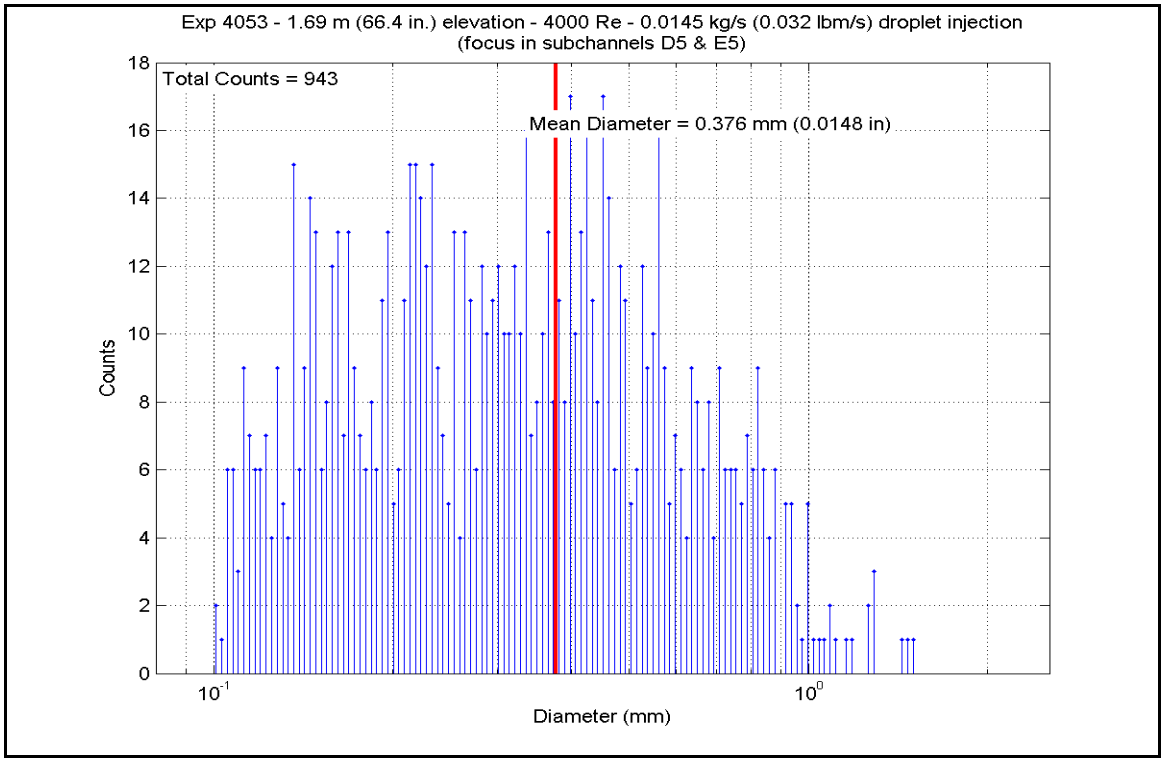

Figure A-462: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053H

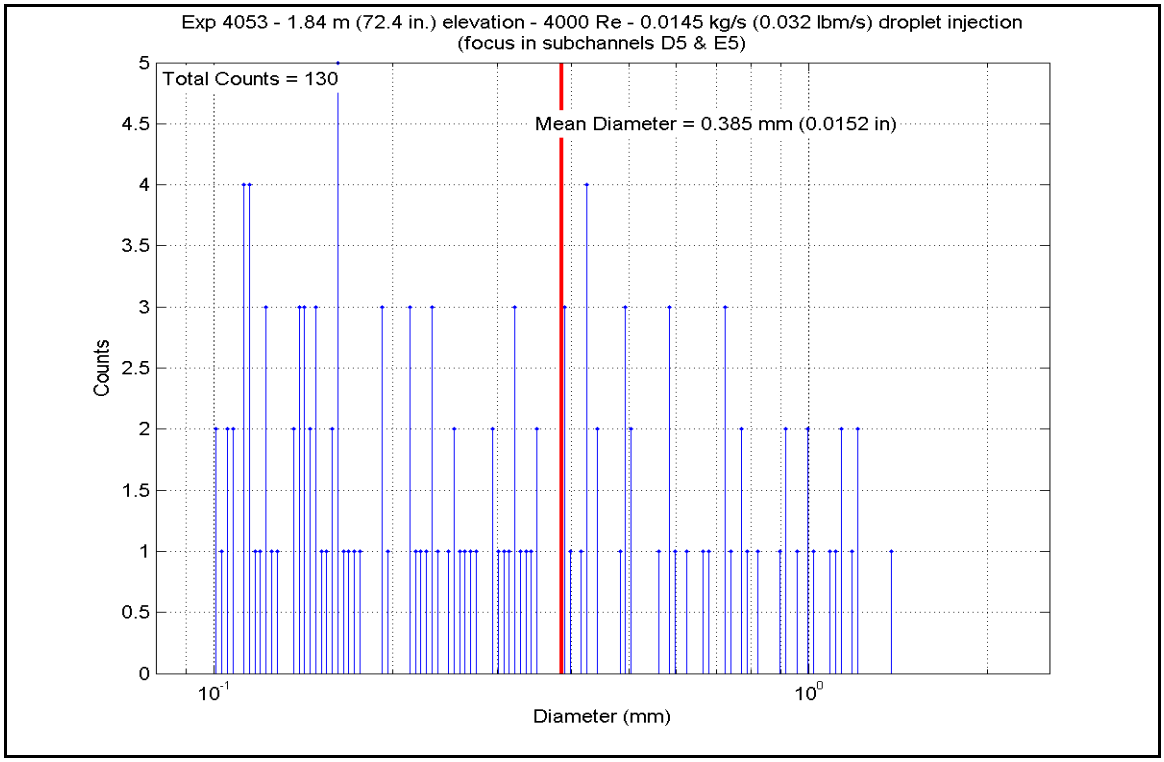

Figure A-463: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053H

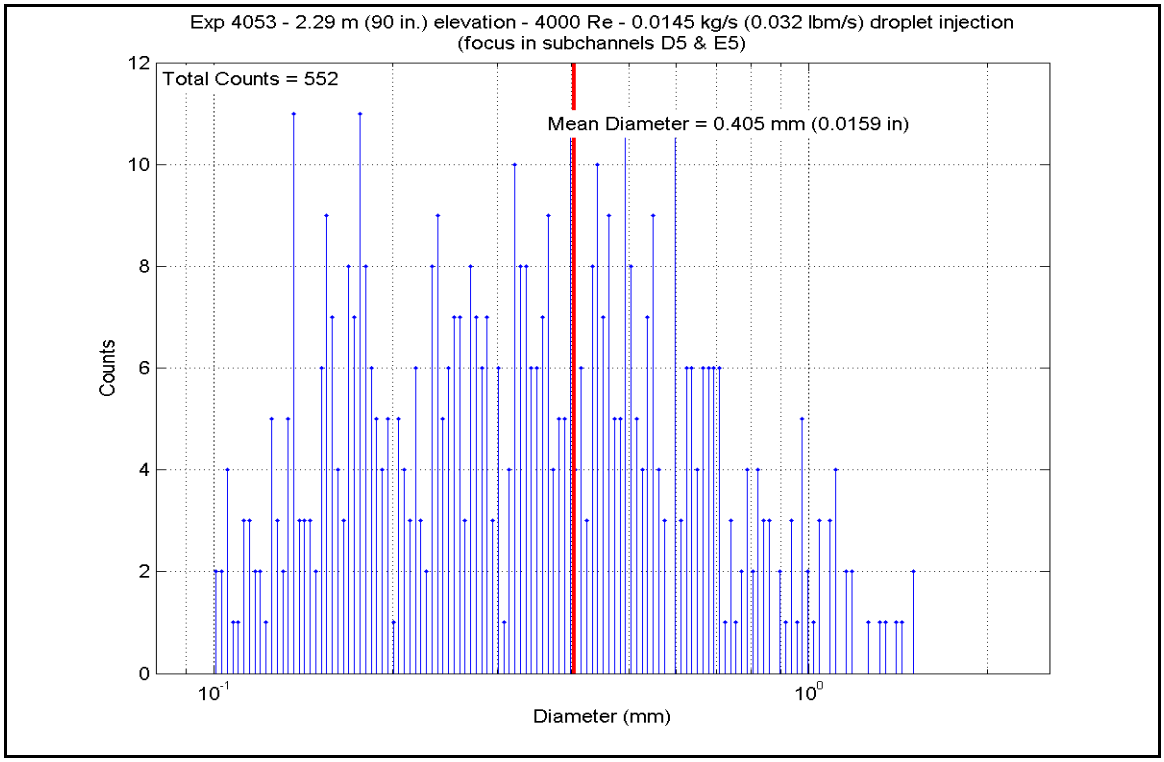

Figure A-464: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053H

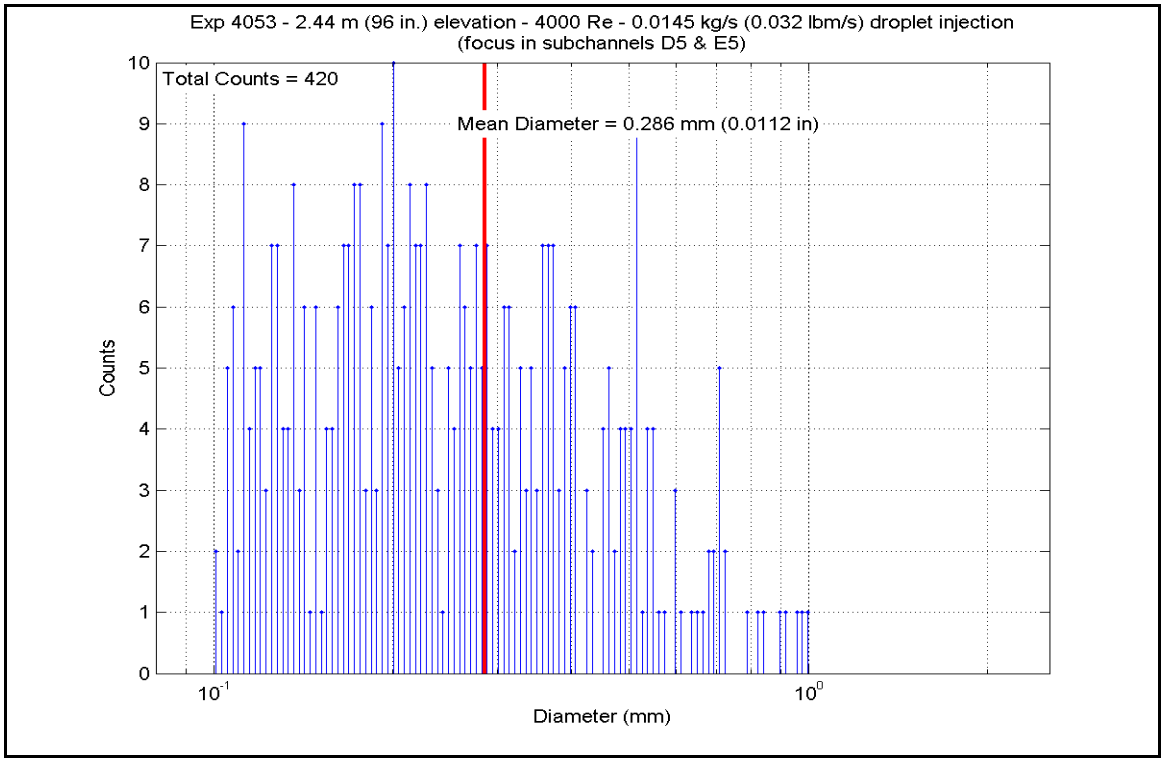

Figure A-465: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053H

Table A-63: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053H

SCD-4053-H	Inlet Reynolds:	4000		
Matrix test # 11d	UP Pressure:	137.9 kPa	20	psia
Time Window: 23940-24360	Bundle Power:	55.00 kW	187668	Btu/hr
	Steam flow:	0.0227 kg/s	180.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	898.40	754.5	2768.28	8732.5	4.129	23.4
	RodD3_91.3	186	91.3	2.319	2.8	0.071	965.26	791.6	2784.60	8784.0	3.777	21.4
	RodD3_93.1	187	93.1	2.365	4.6	0.117	1007.75	815.2	2814.11	8877.1	3.609	20.5
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1057.25	842.7	2836.55	8947.9	3.421	19.4
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1187.44	915.1	2969.26	9366.5	3.095	17.6
	RodD3_110	191	110	2.794	21.5	0.546	1194.35	918.9	2977.27	9391.8	3.081	17.5
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1280.09	966.5	933.59	2945.0	0.887	5.0
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	917.36	765.0	2758.83	8702.7	4.002	22.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	972.94	795.9	2779.54	8768.1	3.731	21.2
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1017.53	820.7	2811.06	8867.5	3.560	20.2
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1059.82	844.2	2835.35	8944.1	3.409	19.4
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1142.10	889.9	2896.14	9135.9	3.168	18.0
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1179.51	910.7	2985.49	9417.7	3.138	17.8
	RodC4_110	239	110	2.794	21.5	0.546	1177.80	909.7	2929.92	9242.4	3.085	17.5
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1278.27	965.5	975.34	3076.7	0.929	5.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	921.06	767.1	2784.85	8784.8	4.018	22.8
	RodD4_91.3	242	91.3	2.319	2.8	0.071	981.93	800.9	2794.43	8815.0	3.706	21.0
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1024.21	824.4	2815.25	8880.7	3.536	20.1
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1065.78	847.5	2836.58	8948.0	3.386	19.2
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1148.09	893.2	2894.20	9129.7	3.146	17.9
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1188.85	915.8	2991.09	9435.4	3.113	17.7
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1298.40	976.7	968.98	3056.6	0.905	5.1
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	905.38	758.4	2744.19	8656.5	4.051	23.0
	RodE4_91.2	202	91.2	2.316	2.7	0.069	961.73	789.7	2767.89	8731.3	3.772	21.4
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1039.79	833.0	2817.59	8888.1	3.471	19.7
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1121.14	878.2	2872.60	9061.6	3.216	18.3
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1288.73	971.3	995.78	3141.2	0.939	5.3

Table A-63: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	921.533187	767.3	2298.279429	7249.9	3.314	18.8
	RodE3_113.6	194	113.6	2.885	0.85	0.022	747.221998	670.5	4167.938169	13147.8	8.027	45.6
	RodE3_115.5	195	115.5	2.934	2.75	0.070	818.022901	709.8	3538.605232	11162.5	5.997	34.1
	RodE3_118.5	196	118.5	3.010	5.75	0.146	858.570523	732.4	3908.802616	12330.3	6.199	35.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	899.482818	755.1	3678.558859	11604.0	5.478	31.1
	RodE3_126.5	198	126.5	3.213	13.75	0.349	928.297646	771.1	3342.883472	10545.1	4.774	27.1
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	939.561177	777.4	3040.927467	9592.6	4.274	24.3
	RodE3_135.6	200	135.6	3.444	2.1	0.053	890.869762	750.3	2574.079667	8119.9	3.883	22.1
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	770.159822	683.2	3467.210464	10937.3	6.395	36.3
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1027.67971	826.3	2982.538644	9408.4	3.730	21.2
	RodC5_122.7	229	122.7	3.117	9.95	0.253	885.335482	747.2	2455.864447	7747.0	3.736	21.2
	RodC5_126.7	230	126.7	3.218	13.95	0.354	689.956468	638.7	3195.208086	10079.3	6.917	39.3
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	672.953543	629.2	3303.665874	10421.4	7.425	42.2
	RodC5_135.7	232	135.7	3.447	2.2	0.056	731.890107	662.0	3410.216409	10757.5	6.768	38.4
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	915.812985	764.2	1660.25327	5237.3	2.414	13.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	878.325006	743.3	4835.082045	15252.3	7.435	42.2
	RodE5_115.4	211	115.4	2.931	2.65	0.067	713.526076	651.8	4494.078478	14176.6	9.256	52.6
	RodE5_118.7	212	118.7	3.015	5.95	0.151	907.692295	759.6	1725.557669	5443.3	2.539	14.4
	RodE5_122.6	213	122.6	3.114	9.85	0.250	229.102889	382.7	4268.206897	13464.1	3870.023	21977.4
	RodE5_126.6	214	126.6	3.216	13.85	0.352	227.08673	381.5	4357.203329	13744.8	-4770.992	-27093.9
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	226.712473	381.3	4395.823424	13866.6	-3414.161	-19388.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	277.33956	409.4	3850.12604	12145.2	78.033	443.1
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	674.265422	630.0	4275.557669	13487.2	9.581	54.4
	RodC3_85.6	178	85.6	2.174	14.72	0.374	704.478823	646.7	4331.787158	13664.6	9.091	51.6
	RodC3_88.5	179	88.5	2.248	0	0.000	894.176706	752.1	1719.159334	5423.1	2.581	14.7
	RodC3_92.4	180	92.4	2.347	3.9	0.099	711.415838	650.6	3139.410226	9903.3	6.494	36.9
	RodC3_94.4	181	94.4	2.398	5.9	0.150	784.049168	691.0	3286.140309	10366.1	5.910	33.6
Gr-8	RodD5_50	217	50	1.270	3	0.076	816.713151	709.1	3051.770511	9626.8	5.184	29.4
	RodD5_54.1	218	54.1	1.374	7.1	0.180	868.206706	737.7	3444.412604	10865.4	5.380	30.6
	RodD5_56.9	219	56.9	1.445	9.9	0.251	879.956754	744.2	3130.356718	9874.7	4.801	27.3
	RodD5_60	220	60	1.524	13	0.330	817.572747	709.6	2721.717004	8585.7	4.616	26.2
	RodD5_66.1	221	66.1	1.679	19.1	0.485	855.36025	730.6	2391.489893	7544.0	3.812	21.6
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	581.325291	578.3	4287.30321	13524.3	12.134	68.9
	RodD5_72.9	223	72.9	1.852	2.02	0.051	658.050273	621.0	4374.10107	13798.1	10.171	57.8
	RodD5_74.9	224	74.9	1.902	4.02	0.102	687.621189	637.4	4438.400713	14000.9	9.657	54.8

Table A-63: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	389.580654	471.8	1034.446968	3263.2	6.402	36.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	402.673888	479.1	1103.756243	3481.8	6.319	35.9
	RodB5_55	155	55	1.397	8	0.203	410.546076	483.5	1160.077408	3659.5	6.355	36.1
	RodB5_57.8	156	57.8	1.468	10.8	0.274	433.877527	496.4	1083.352794	3417.4	5.262	29.9
	RodB5_64	157	64	1.626	17	0.432	442.720369	501.3	1070.80321	3377.8	4.987	28.3
	RodB5_73.9	158	73.9	1.877	3.02	0.077	452.618823	506.8	1067.877527	3368.6	4.754	27.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	785.754851	691.9	2887.757432	9109.4	5.177	29.4
	RodB5_76.9	160	76.9	1.953	6.02	0.153	747.359548	670.6	3222.526754	10165.5	6.205	35.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	392.646302	473.5	1010.806421	3188.6	6.139	34.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	408.199108	482.1	1094.839477	3453.7	6.076	34.5
	RodF5_55	107	55	1.397	8	0.203	416.376635	486.7	1192.8956	3763.0	6.333	36.0
	RodF5_57.8	108	57.8	1.468	10.8	0.274	445.034542	502.6	1109.646183	3500.4	5.113	29.0
	RodF5_64	109	64	1.626	17	0.432	453.78887	507.5	1100.689671	3472.1	4.875	27.7
	RodF5_73.8	110	73.8	1.875	2.92	0.074	466.337872	514.4	1097.299762	3461.4	4.604	26.1
	RodF5_75.8	111	75.8	1.925	4.92	0.125	707.258787	648.3	3254.189061	10265.3	6.790	38.6
	RodF5_76.8	112	76.8	1.951	5.92	0.150	768.839346	682.5	3375.288942	10647.3	6.241	35.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	461.560143	511.8	104.1539998	328.6	0.446	2.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	456.306017	508.9	1478.078954	4662.6	6.474	36.8
	RodC2_55	59	55	1.397	8	0.203	558.878609	565.9	1579.321998	4982.0	4.773	27.1
	RodC2_57.8	60	57.8	1.468	10.8	0.274	591.12893	583.8	1807.203805	5700.8	4.977	28.3
	RodC2_63.9	61	63.9	1.623	16.9	0.429	583.337241	579.4	1491.895482	4706.2	4.199	23.8
	RodC2_73.8	62	73.8	1.875	2.92	0.074	525.210713	547.2	869.8209275	2743.9	2.927	16.6
	RodC2_75.8	63	75.8	1.925	4.92	0.125	743.852699	668.6	4028.010702	12706.4	7.808	44.3
	RodC2_76.8	64	76.8	1.951	5.92	0.150	757.82409	676.4	4066.79786	12828.7	7.676	43.6
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	818.015268	709.8	3369.882283	10630.3	5.712	32.4
	RodC6_52.8	138	52.8	1.341	5.8	0.147	766.092545	681.0	3401.841855	10731.1	6.322	35.9
	RodC6_54.8	139	54.8	1.392	7.8	0.198	646.341914	614.5	3543.619501	11178.3	8.471	48.1
	RodC6_75.8	143	75.8	1.925	4.92	0.125	729.573401	660.7	4029.505351	12711.1	8.034	45.6
	RodC6_76.8	144	76.8	1.951	5.92	0.150	606.440464	592.3	4255.592949	13424.3	11.245	63.9

Table A-63: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	726.50157	659.0	3869.928656	12207.7	7.763	44.1
	RodB4_91.3	162	91.3	2.319	2.8	0.071	740.385386	666.7	3902.192628	12309.5	7.616	43.2
	RodB4_93.3	163	93.3	2.370	4.8	0.122	314.419132	430.0	1159.074792	3656.3	13.412	76.2
	RodB4_95.1	164	95.1	2.416	6.6	0.168	362.613341	456.8	1065.217955	3360.2	7.913	44.9
	RodB4_142.3	168	142.3	3.614	8.8	0.224	700.931867	644.8	3803.96195	11999.6	8.043	45.7
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	759.267872	677.2	3955.186683	12476.6	7.445	42.3
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	773.472866	685.1	3984.331748	12568.6	7.304	41.5
	RodF4_92.4	100	92.4	2.347	3.9	0.099	317.267717	431.6	1137.860523	3589.4	12.747	72.4
	RodF4_94.3	101	94.3	2.395	5.8	0.147	366.374257	458.9	1040.552081	3282.4	7.520	42.7
	RodF4_97.2	102	97.2	2.469	8.7	0.221	847.101153	726.0	4800.136742	15142.0	7.753	44.0
	RodF4_108.8	103	108.8	2.764	20.3	0.516	722.209667	656.6	4619.926278	14573.6	9.348	53.1
	RodF4_111	104	111	2.819	-1.75	-0.044	733.238288	662.7	4579.357907	14445.6	9.064	51.5
Gr-6	RodD2_114.9	68	114.9	2.918	2.15	0.055	865.505636	736.2	3970.697979	12525.6	6.228	35.4
	RodD2_117.4	69	117.4	2.982	4.65	0.118	893.622331	751.8	3765.532699	11878.4	5.657	32.1
	RodD2_120.8	70	120.8	3.068	8.05	0.204	927.491367	770.6	3493.128419	11019.1	4.994	28.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	945.602782	780.7	3145.693222	9923.1	4.384	24.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	941.600583	778.5	2815.928656	8882.8	3.946	22.4
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	812.184471	706.6	4116.19025	12984.5	7.046	40.0
	RodD6_106	130	106	2.692	17.5	0.445	806.1761	703.2	4594.204518	14492.4	7.946	45.1
	RodD6_112.9	131	112.9	2.868	0.15	0.004	622.418288	601.2	4241.933413	13381.2	10.755	61.1
	RodD6_114.9	132	114.9	2.918	2.15	0.055	737.417717	665.0	3215.165279	10142.2	6.311	35.8
	RodD6_116.8	133	116.8	2.967	4.05	0.103	801.1983	700.5	3352.532699	10575.6	5.849	33.2
	RodD6_120.9	134	120.9	3.071	8.15	0.207	676.014269	630.9	4539.224732	14319.0	10.132	57.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	720.540202	655.7	4551.034483	14356.2	9.240	52.5
	RodD6_128.7	136	128.7	3.269	15.95	0.405	929.317467	771.7	1526.301665	4814.7	2.176	12.4

Table A-63: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	833.25113	718.3	3448.454221	10878.1	5.698	32.4
	RodE2_54	74	54	1.372	7	0.178	868.978252	738.1	3545.851367	11185.4	5.532	31.4
	RodE2_56.9	75	56.9	1.445	9.9	0.251	881.095398	744.9	3745.332937	11814.7	5.735	32.6
	RodE2_59.9	76	59.9	1.521	12.9	0.328	638.125089	609.9	3941.198573	12432.5	9.610	54.6
	RodE2_66	77	66	1.676	19	0.483	712.006302	650.9	4028.744352	12708.7	8.324	47.3
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	748.673603	671.3	4096.789536	12923.3	7.868	44.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	281.110321	411.5	1094.088527	3451.3	20.600	117.0
	RodE2_74.9	80	74.9	1.902	4.02	0.102	353.304245	451.7	959.7972533	3027.7	7.660	43.5
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	842.463698	723.4	3611.423306	11392.2	5.877	33.4
	RodB3_54.1	170	54.1	1.374	7.1	0.180	859.73786	733.0	3272.577883	10323.3	5.180	29.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	857.84962	732.0	2921.883472	9217.1	4.639	26.3
	RodB3_60.1	172	60.1	1.527	13.1	0.333	785.163056	691.6	2869.530321	9051.9	5.150	29.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	791.31396	695.0	3241.799049	10226.3	5.755	32.7
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	807.233365	703.8	3305.142687	10426.1	5.706	32.4
	RodB3_73	175	73	1.854	2.12	0.054	824.139108	713.2	3403.120095	10735.1	5.709	32.4
	RodB3_75	176	75	1.905	4.12	0.105	839.953817	722.0	3551.501784	11203.2	5.804	33.0
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	262.68176	401.3	4021.29888	12685.2	115.949	658.5
	RodF3_54	90	54	1.372	7	0.178	571.775767	573.0	4423.007134	13952.4	12.866	73.1
	RodF3_57	91	57	1.448	10	0.254	772.874637	684.7	2864.108205	9034.8	5.256	29.9
	RodF3_60	92	60	1.524	13	0.330	716.70918	653.5	3296.411415	10398.5	6.745	38.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	764.926742	680.3	3370.336504	10631.7	6.277	35.6
	RodF3_70	94	70	1.778	-0.88	-0.022	816.749191	709.1	3462.173603	10921.4	5.881	33.4
	RodF3_73	95	73	1.854	2.12	0.054	870.067967	738.7	3656.973841	11535.9	5.696	32.3
	RodF3_75	96	75	1.905	4.12	0.105	725.525541	658.4	3894.960761	12286.7	7.829	44.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	375.335351	463.9	922.1229489	2908.8	6.259	35.5
	RodE6_54.1	122	54.1	1.374	7.1	0.180	386.860547	470.3	1014.415696	3200.0	6.386	36.3
	RodE6_57	123	57	1.448	10	0.254	382.558347	467.9	1123.735231	3544.8	7.271	41.3
	RodE6_60.2	124	60.2	1.529	13.2	0.335	392.414043	473.4	1078.42329	3401.9	6.559	37.2
	RodE6_66.1	125	66.1	1.679	19.1	0.485	397.109227	476.0	1083.804435	3418.9	6.409	36.4
	RodE6_70	126	70	1.778	-0.88	-0.022	403.20761	479.4	1094.040654	3451.2	6.244	35.5
	RodE6_73.1	127	73.1	1.857	2.22	0.056	718.668383	654.6	3183.495838	10042.3	6.488	36.8
	RodE6_75	128	75	1.905	4.12	0.105	790.249191	694.4	3316.346017	10461.4	5.898	33.5

RBHT Steam Cooling with Droplet Injection Test SCD-4053-I

Matrix Test # 10a

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 25320 - 25920
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 29 kW
Bundle Inlet Reynolds Number: 2000
Bundle Inlet Steam Flow: 40.82 kg/hr (90 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

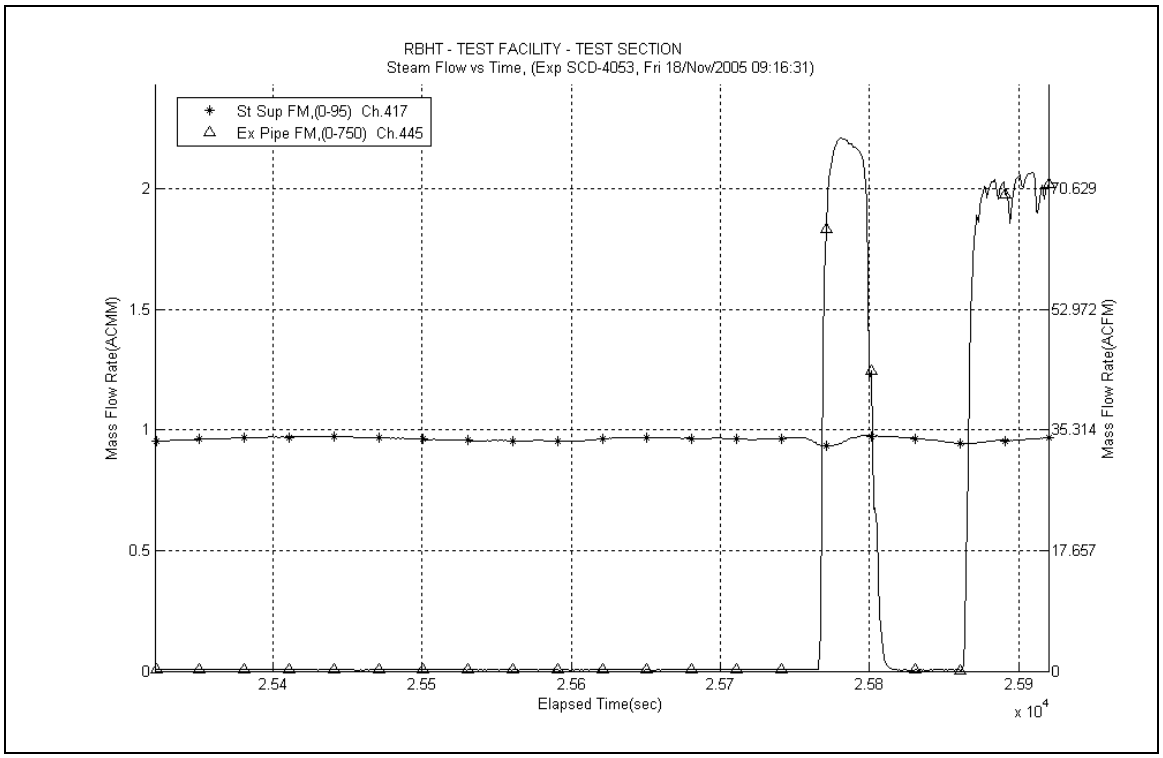

Figure A-466: Inlet and Exhaust Steam Flow Rates for Experiment 4053I

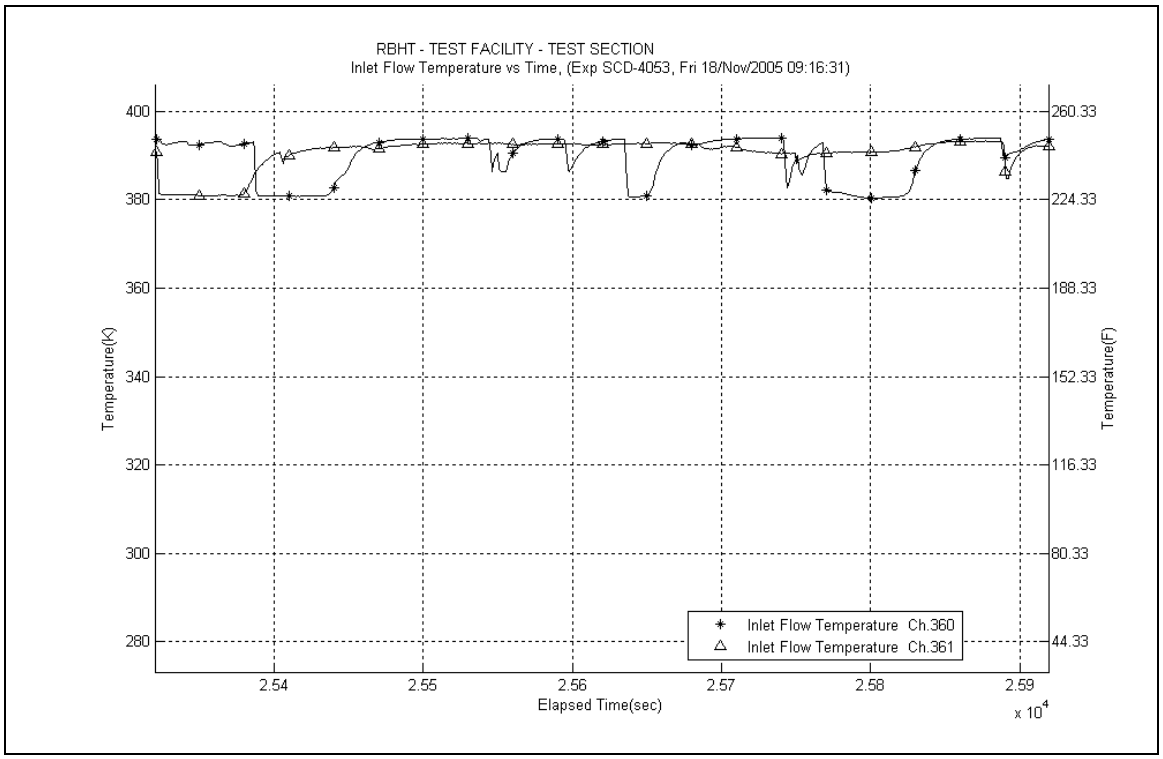

Figure A-467: Inlet Steam Temperature for Experiment 4053I

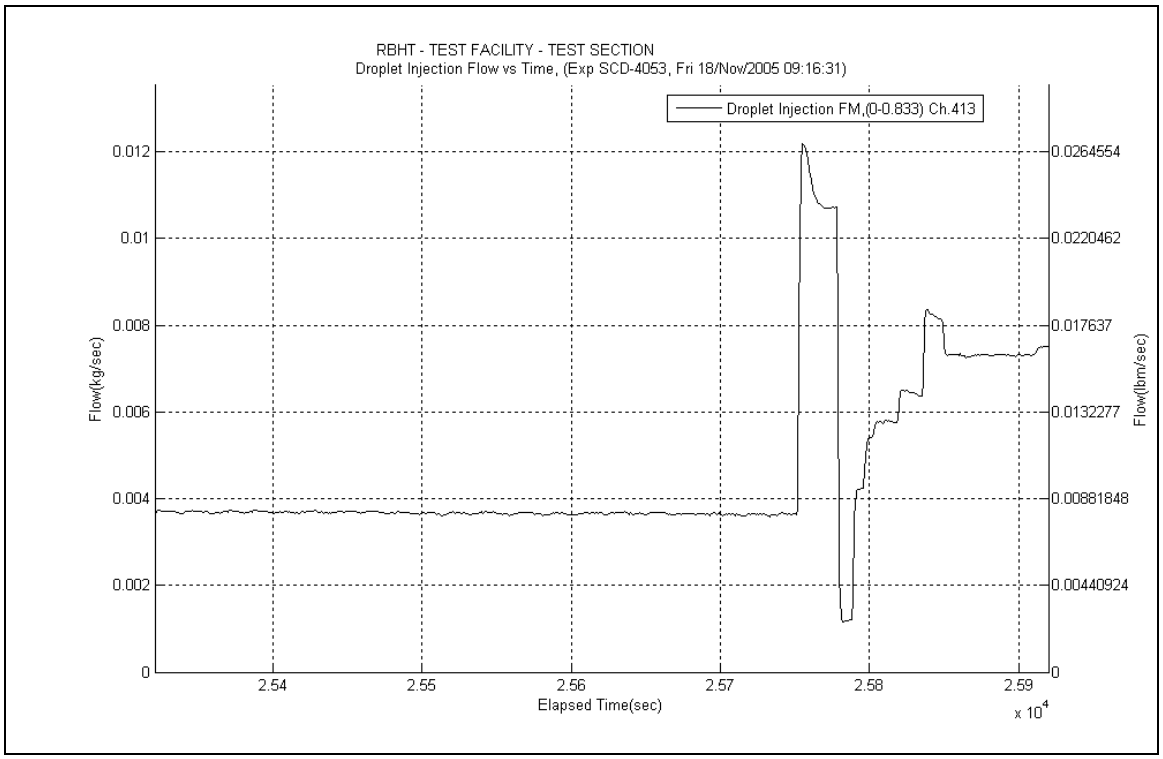

Figure A-468: Droplet Injection Flow Rate for Experiment 4053I

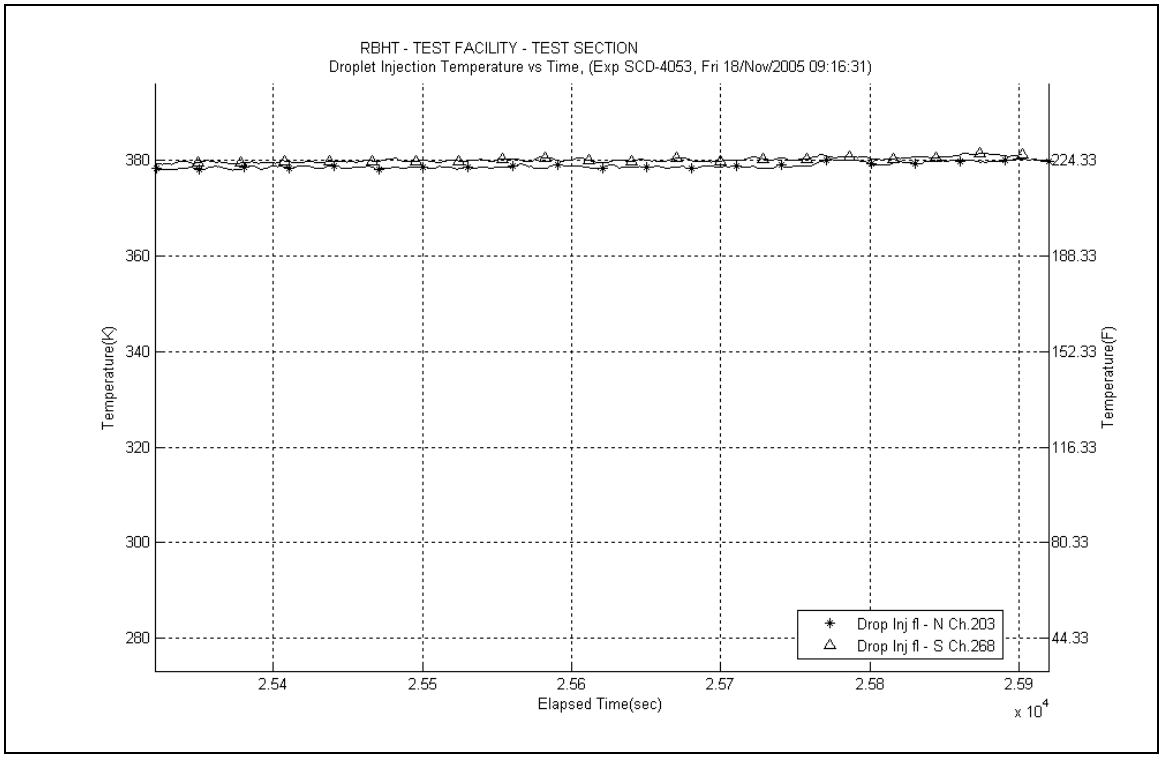

Figure A-469: Droplet Injection Temperature for Experiment 4053I

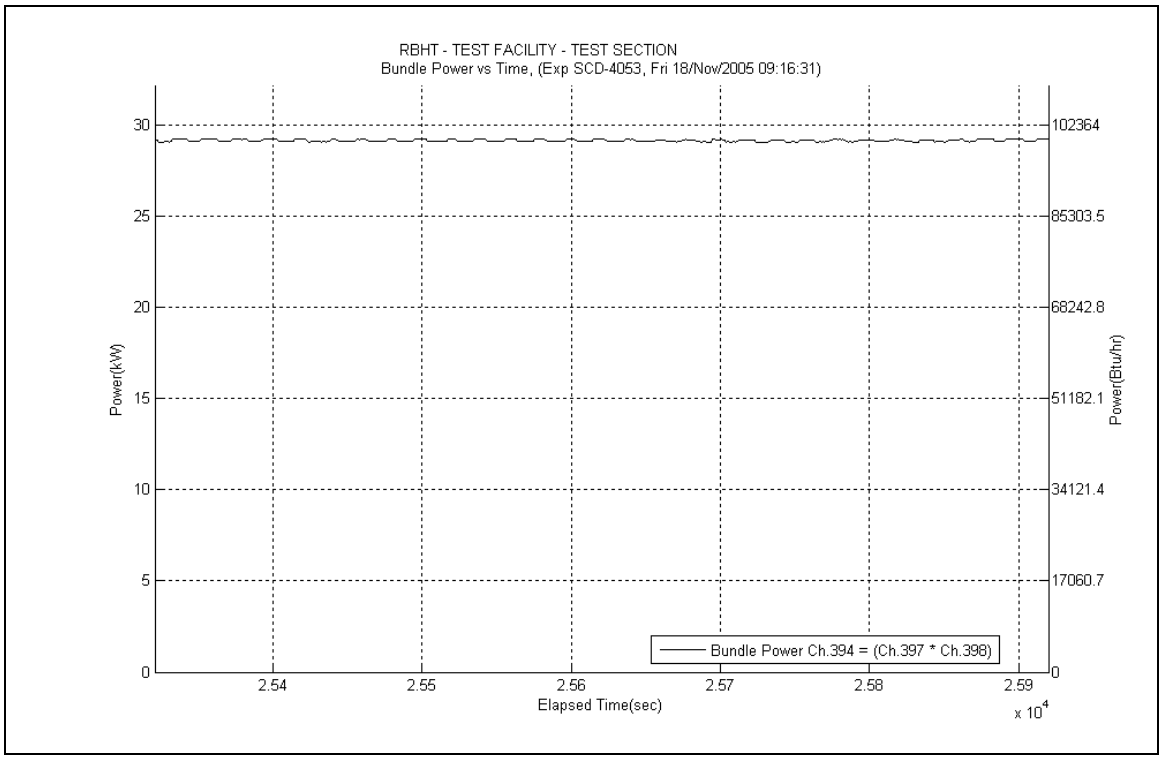

Figure A-470: Bundle Power for Experiment 4053I

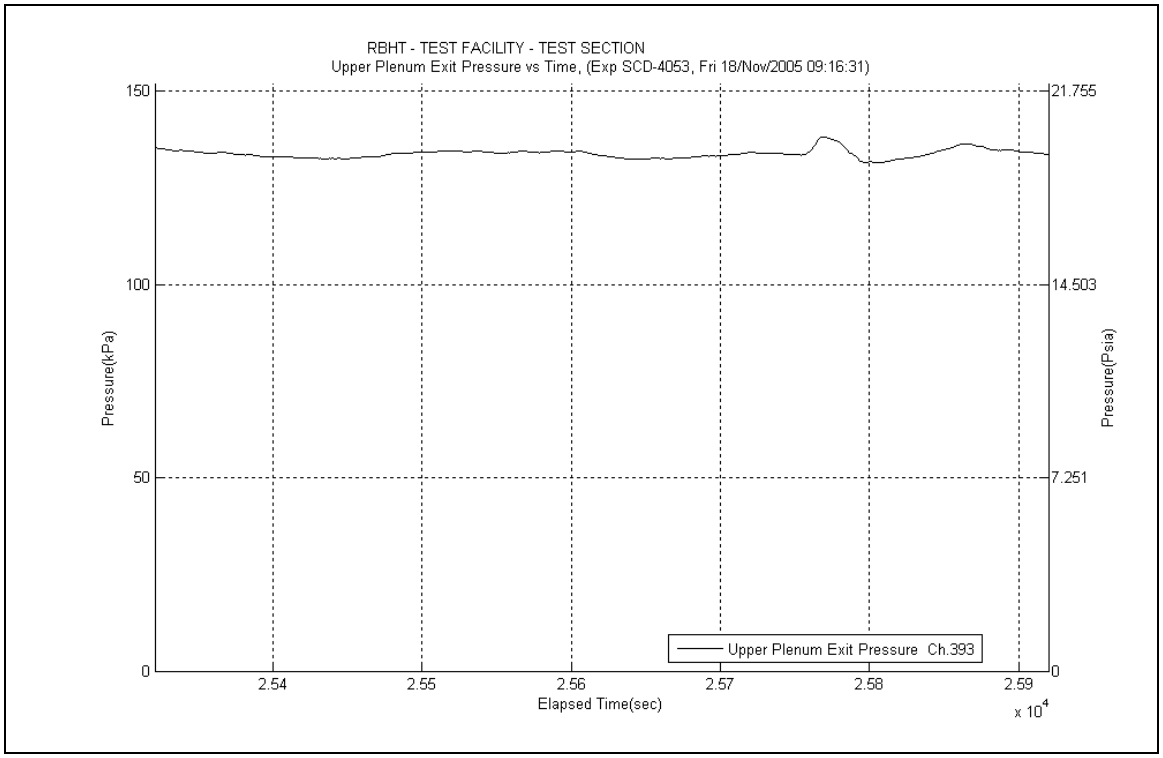

Figure A-471: Upper Plenum Pressure for Experiment 4053I

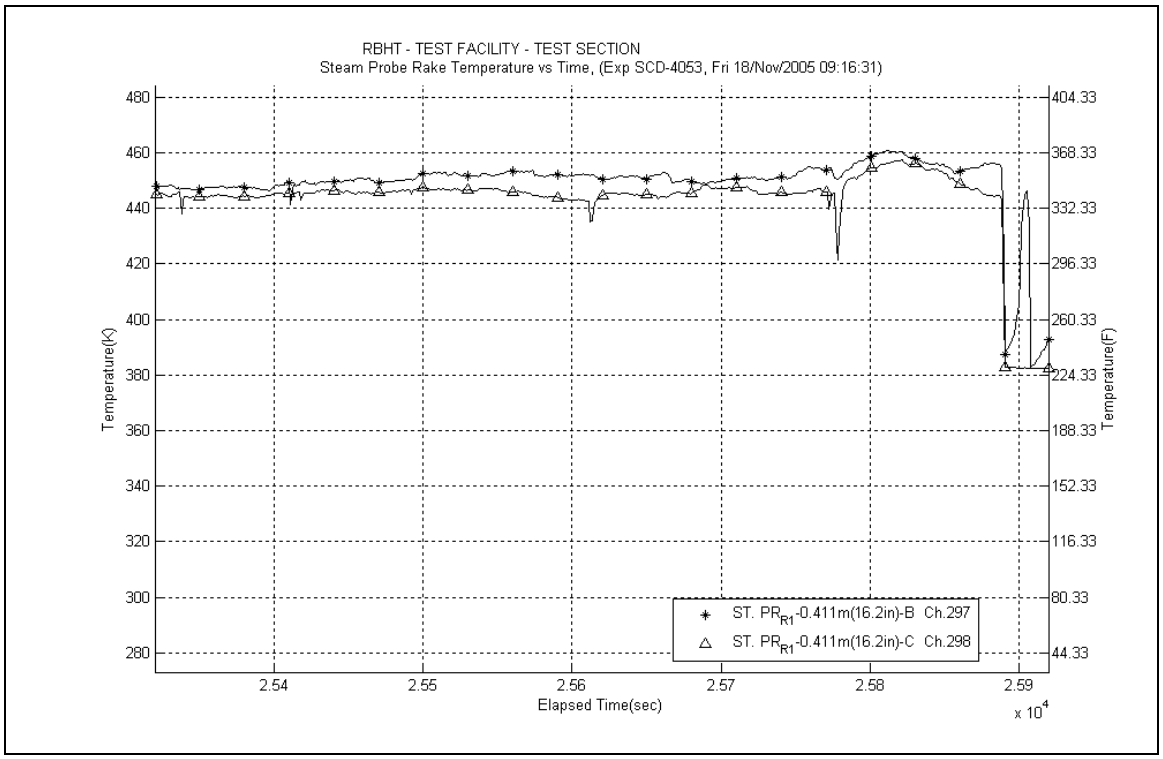

Figure A-472: Steam Probe Rake #1 Temperatures for Experiment 4053I

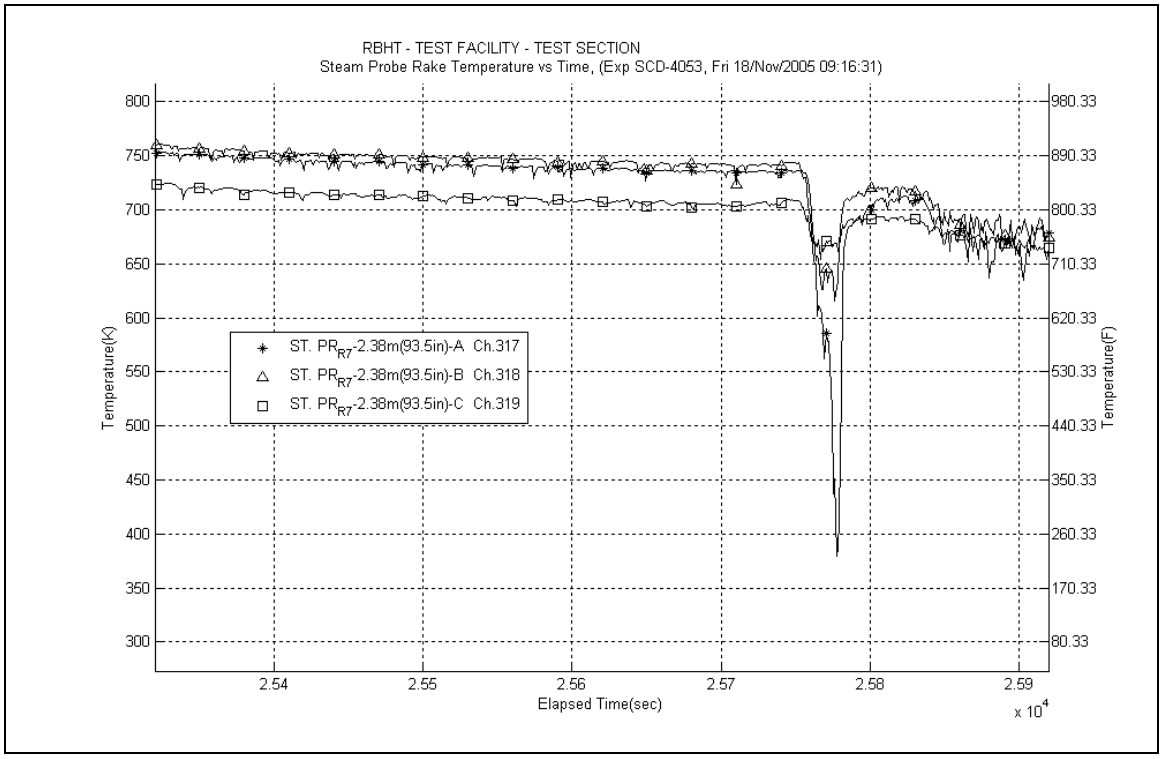

Figure A-473: Steam Probe Rake #7 Temperatures for Experiment 4053I

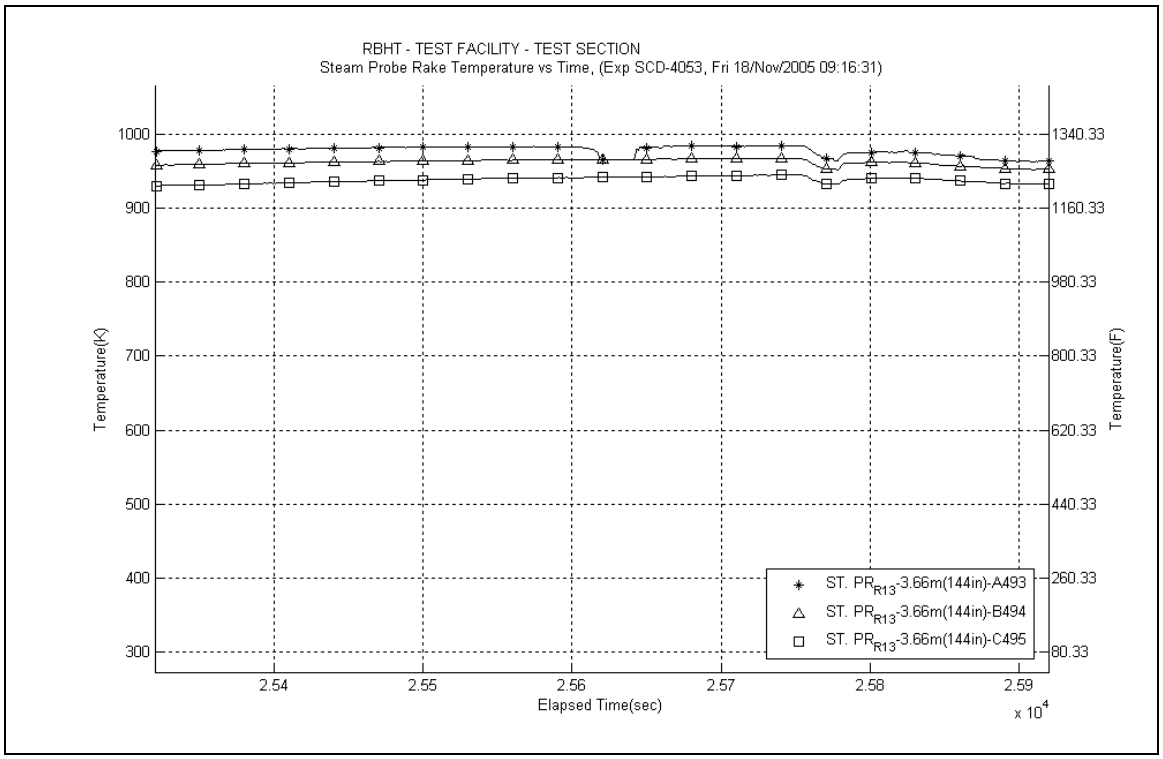

Figure A-474: Steam Probe Rake #13 Temperatures for Experiment 4053I

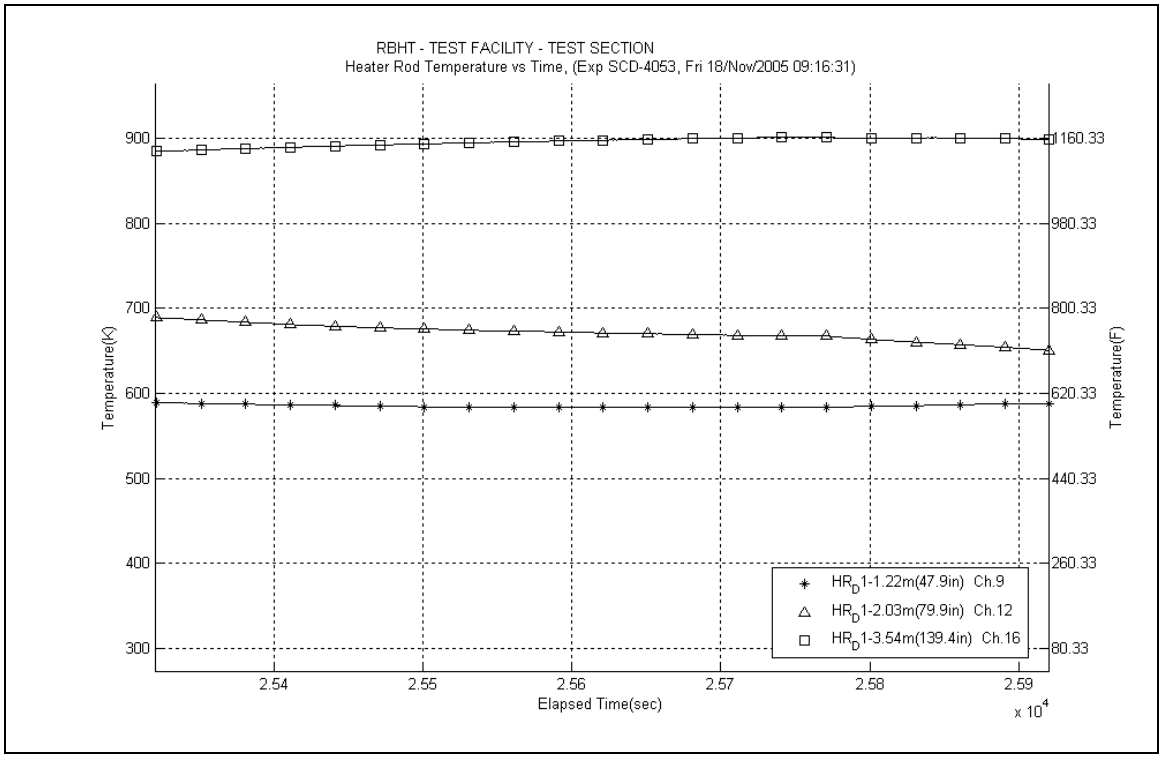

Figure A-475: Heater Rod D1 Temperatures for Experiment 4053I

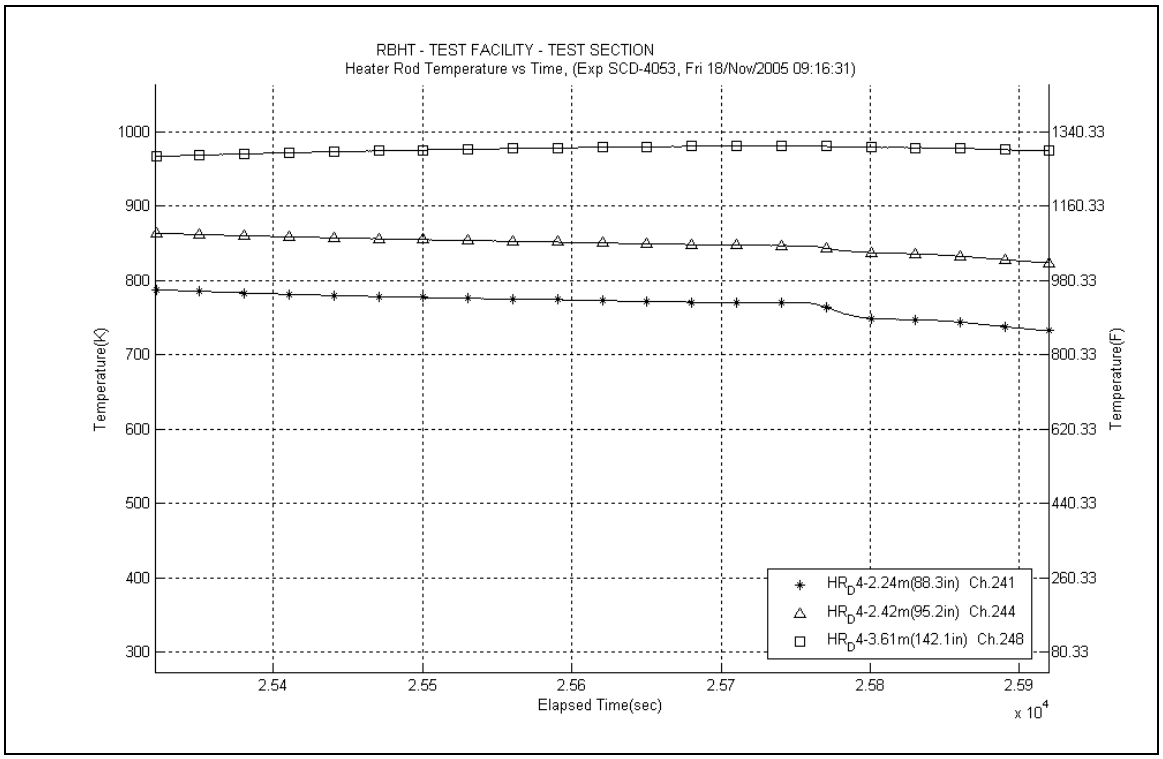

Figure A-476: Heater Rod D4 Temperatures for Experiment 4053I

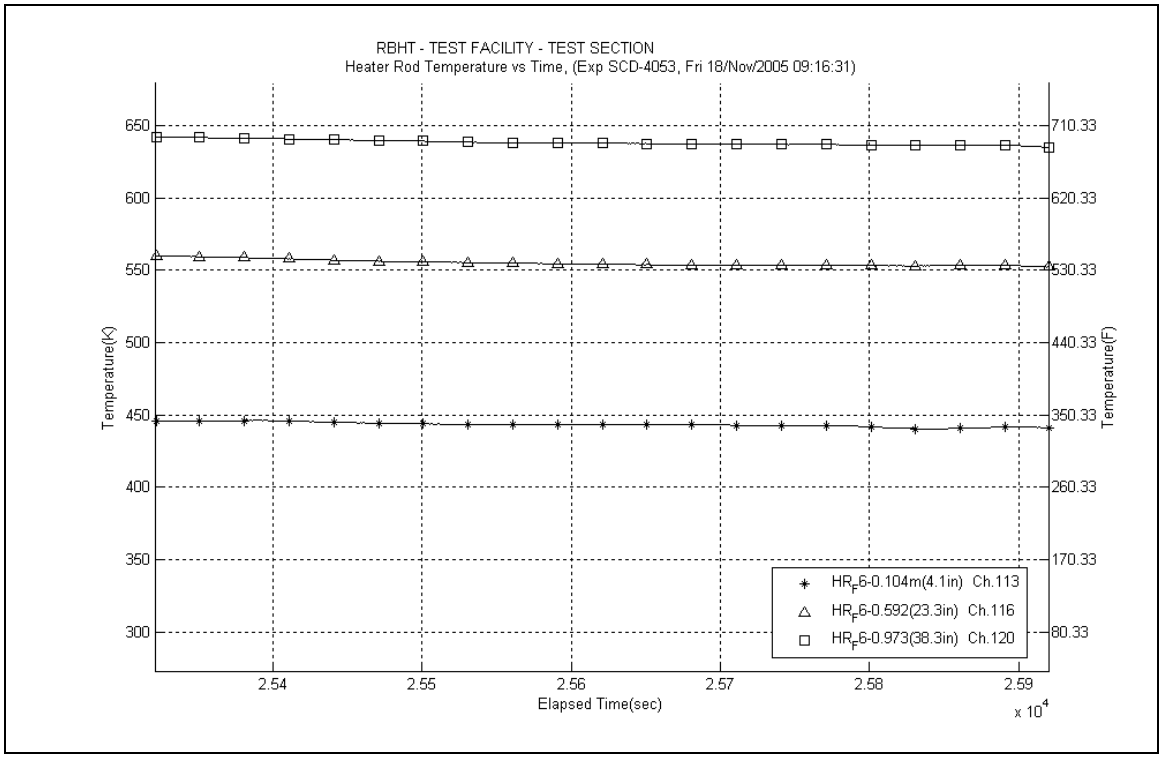

Figure A-477: Heater Rod F6 Temperatures for Experiment 4053I

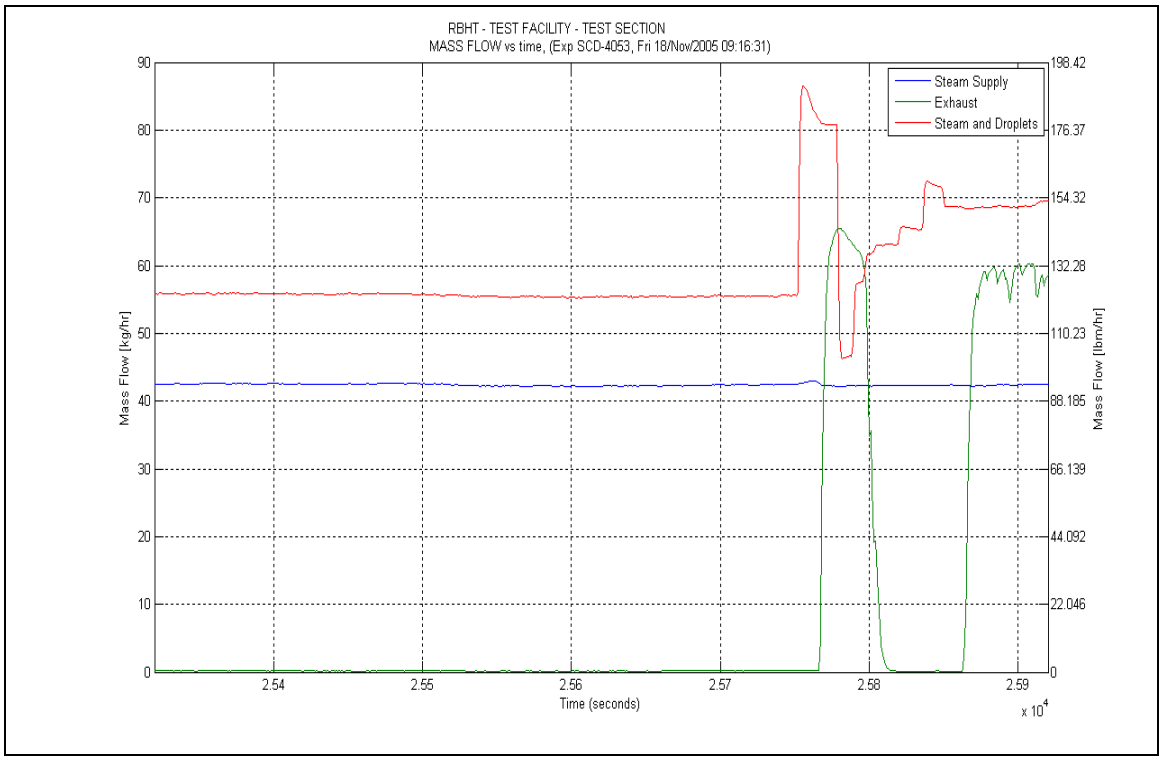

Figure A-478: Mass Flow for Experiment 4053I

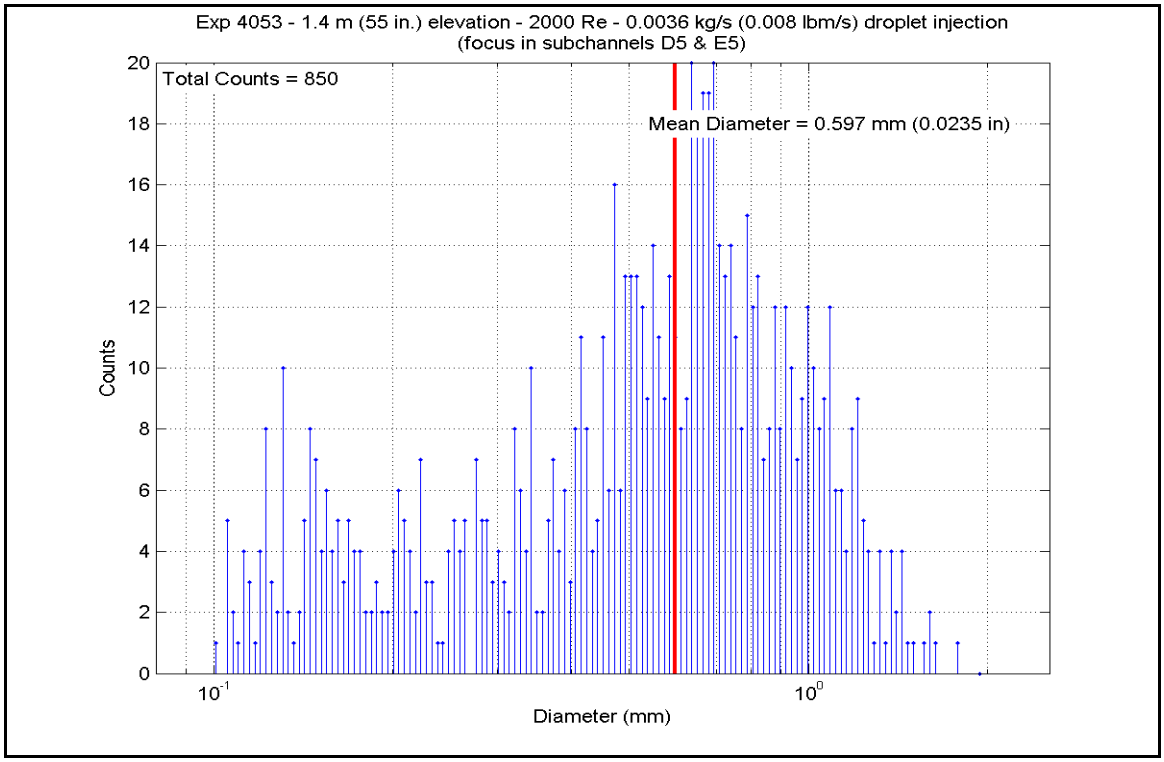

Figure A-479: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053I

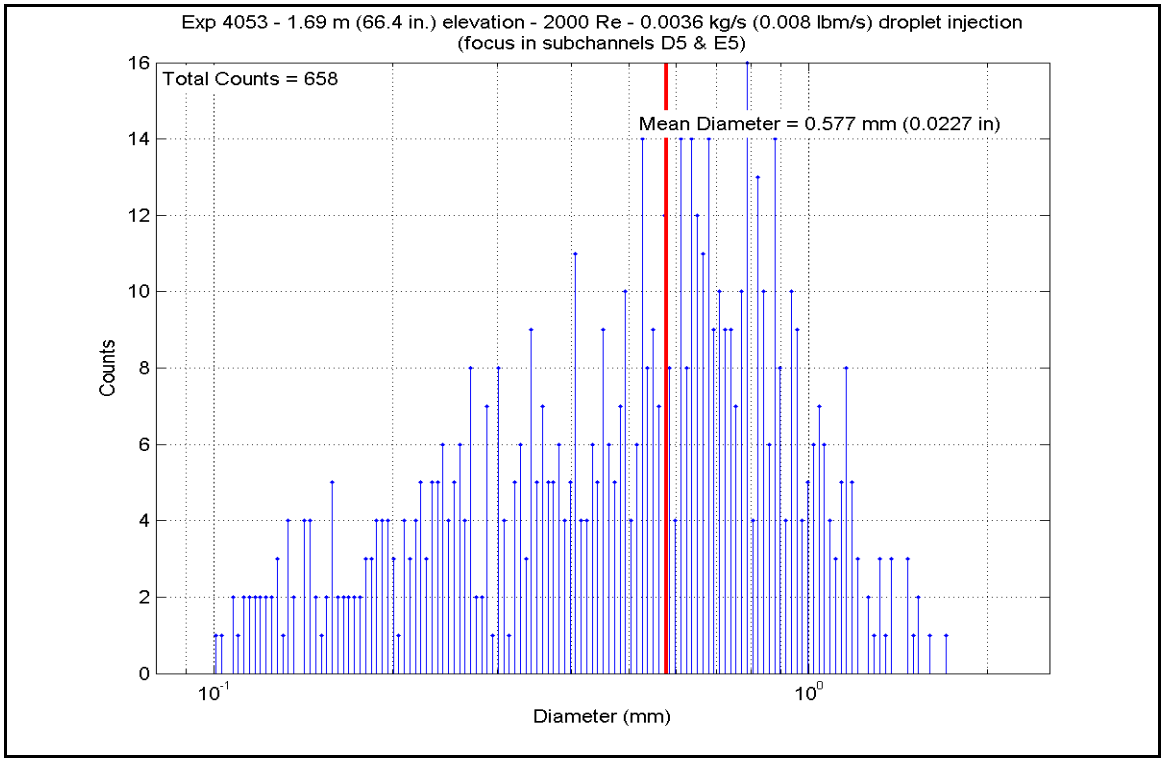

Figure A-480: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053I

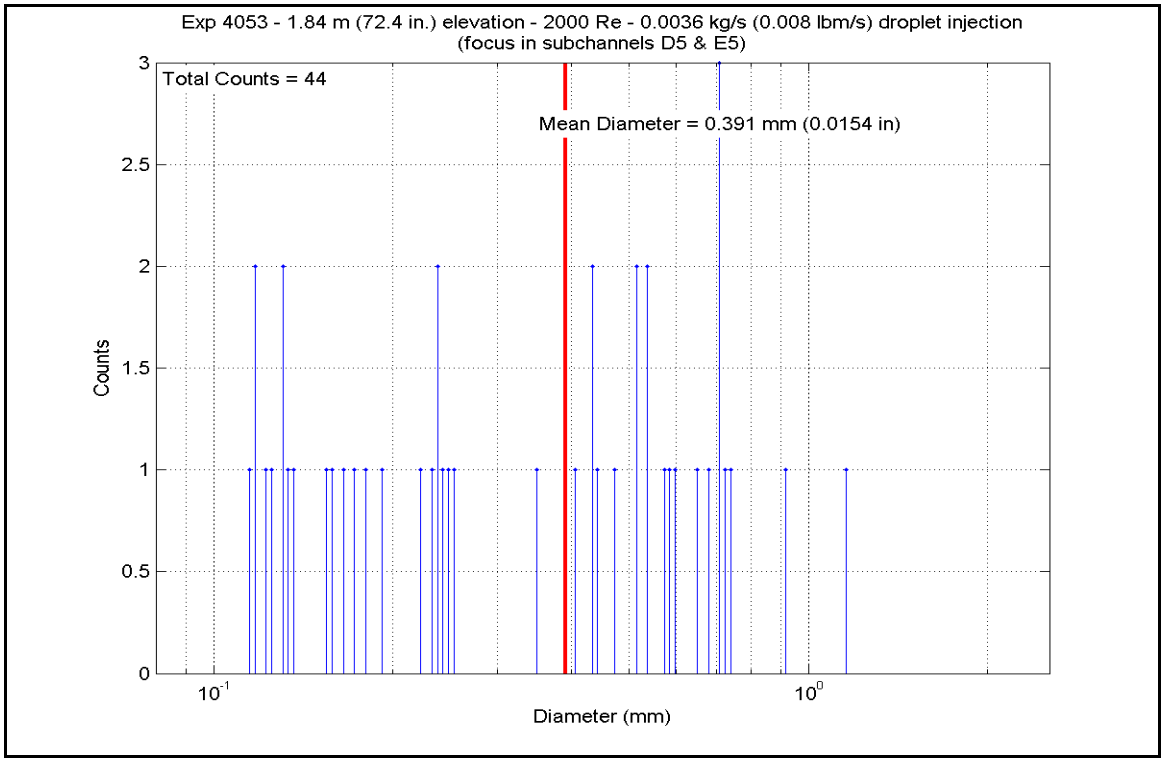

Figure A-481: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053I

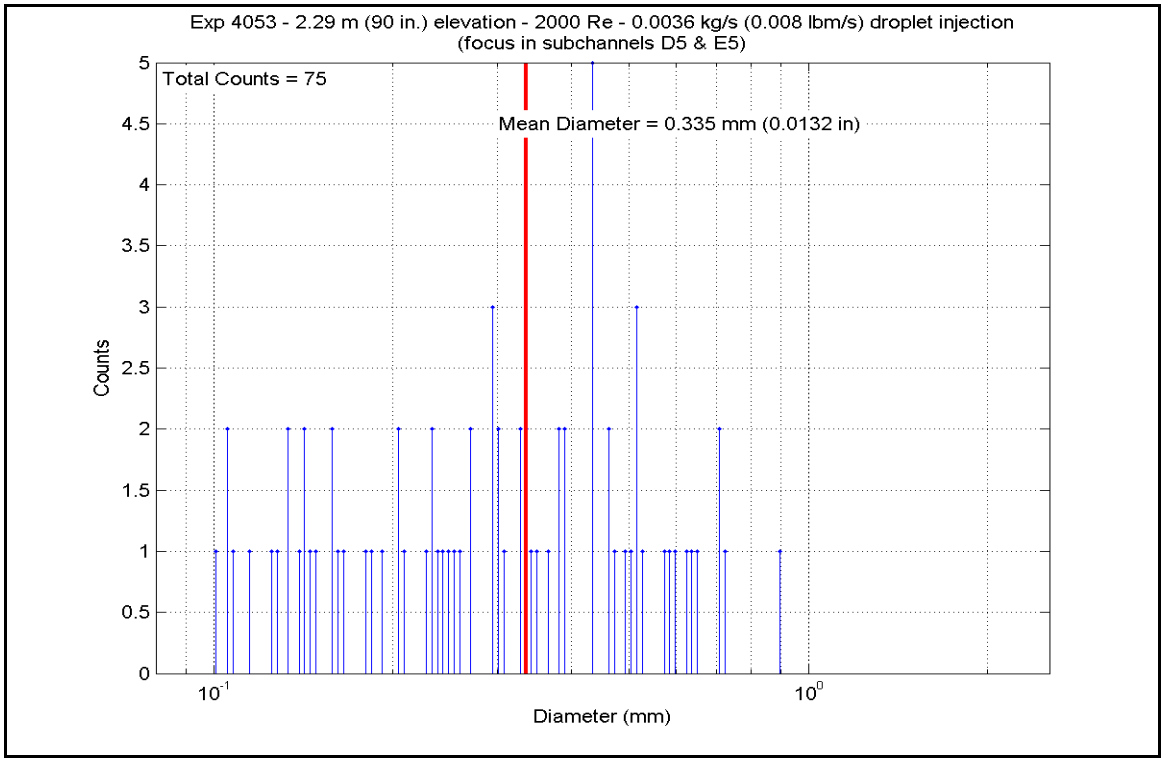

Figure A-482: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053I

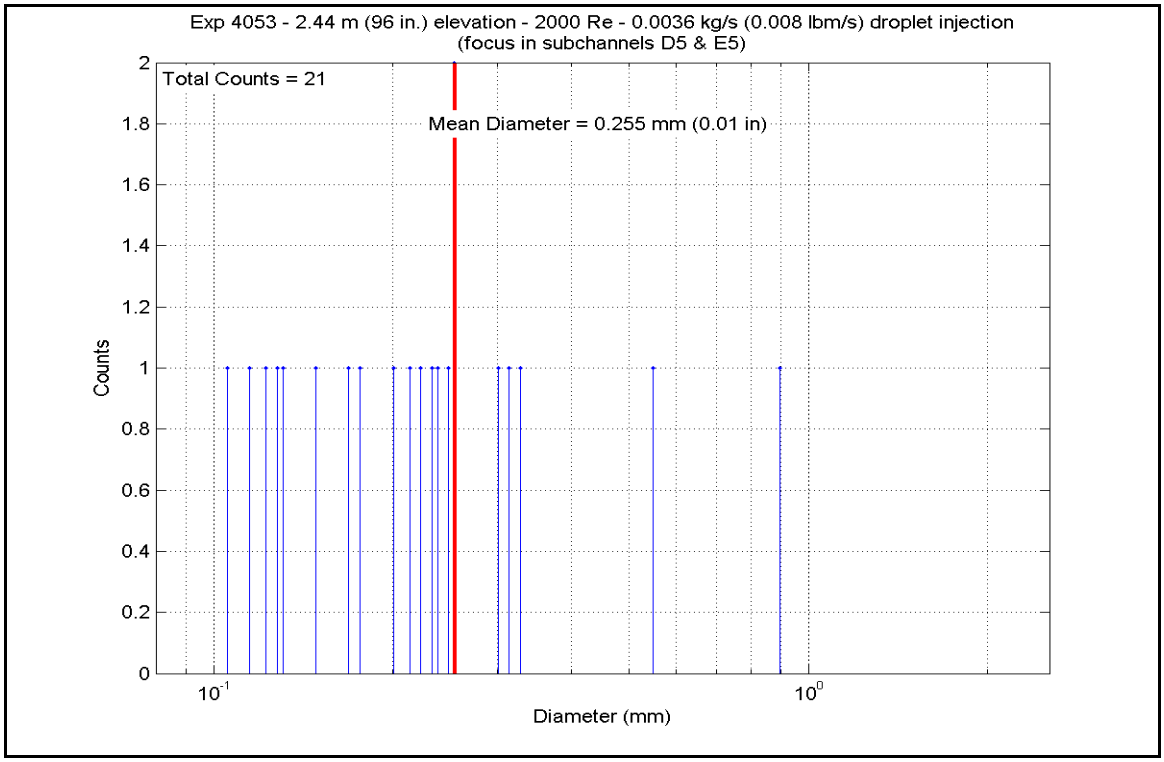

Figure A-483: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053I

Table A-64: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053I

Test 4053-I	Inlet Reynolds:	2000		
Matrix test # 10a	UP Pressure:	137.9 kPa	20	psia
Time Window: 25320-25920	Bundle Power:	29.00 kW	98952	Btu/hr
	Steam flow:	0.0113 kg/s	90.0	lbm/hr
	Droplet flow:	0.0036 kg/s	0.008	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	974.742057	796.9	2762.961699	8715.8	3.700	21.0
	RodD3_91.3	186	91.3	2.319	2.8	0.071	1015.62815	819.6	2795.006661	8816.8	3.549	20.2
	RodD3_93.1	187	93.1	2.365	4.6	0.117	898.398859	754.5	2768.278102	8732.5	4.129	23.4
	RodD3_95.3	188	95.3	2.421	6.8	0.173	965.258251	791.6	2784.601998	8784.0	3.777	21.4
	RodD3_142.1	192	142.1	3.609	8.6	0.218	894.26154	752.2	2722.534555	8588.2	4.086	23.2
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1180.99443	911.5	2623.509575	8275.9	2.753	15.6
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1214.54285	930.1	2421.305579	7638.0	2.454	13.9
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1241.66893	945.2	2205.563697	6957.5	2.176	12.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1254.5245	952.3	1989.646128	6276.3	1.938	11.0
	RodC4_142.2	240	142.2	3.612	8.7	0.221	756.67154	675.7	2141.745212	6756.1	4.051	23.0
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	731.564405	661.8	2370.617818	7478.1	4.708	26.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	778.279384	687.7	2404.874271	7586.2	4.370	24.8
	RodD4_93.2	243	93.2	2.367	4.7	0.119	816.371391	708.9	2234.53622	7048.8	3.798	21.6
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1233.02973	940.4	2503.318901	7896.7	2.491	14.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1187.43927	915.1	2969.263114	9366.5	3.095	17.6
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1194.34885	918.9	2977.26811	9391.8	3.081	17.5
	RodD4_142.1	248	142.1	3.609	8.6	0.218	663.233281	623.8	2389.159867	7536.6	5.489	31.2
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	961.731349	789.7	2767.894255	8731.3	3.772	21.4
	RodE4_91.2	202	91.2	2.316	2.7	0.069	1039.79325	833.0	2817.589509	8888.1	3.471	19.7
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1288.72715	971.3	995.7774355	3141.2	0.939	5.3
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1142.09759	889.9	2896.139883	9135.9	3.168	18.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	905.37836	758.4	2744.186511	8656.5	4.051	23.0

Table A-64: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1283.55049	968.5	1471.935054	4643.2	1.394	7.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1210.33325	927.8	2612.668609	8241.7	2.660	15.1
	RodE3_115.5	195	115.5	2.934	2.75	0.070	800.685454	700.2	2231.729392	7040.0	3.897	22.1
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1242.75896	945.8	2608.914238	8229.8	2.571	14.6
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1264.2325	957.7	2428.385512	7660.3	2.343	13.3
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1281.81028	967.5	2186.506245	6897.3	2.075	11.8
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1287.0773	970.4	1976.395504	6234.5	1.866	10.6
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1285.86803	969.7	1729.004163	5454.1	1.634	9.3
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	784.920849	691.4	2094.07577	6605.8	3.760	21.4
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1390.98794	1028.1	1767.270608	5574.9	1.520	8.6
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1313.2901	985.0	1529.104913	4823.6	1.409	8.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	679.295787	632.8	1819.875937	5740.8	4.033	22.9
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	708.792781	649.1	1958.488759	6178.1	4.073	23.1
	RodC5_135.7	232	135.7	3.447	2.2	0.056	747.836894	670.8	2011.706078	6345.9	3.870	22.0
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1298.3982	976.7	968.9755204	3056.6	0.905	5.1
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1179.50729	910.7	2985.494588	9417.7	3.138	17.8
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1059.81782	844.2	2835.351374	8944.1	3.409	19.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1278.27126	965.5	975.3408826	3076.7	0.929	5.3
	RodE5_122.6	213	122.6	3.114	9.85	0.250	921.05602	767.1	2784.846794	8784.8	4.018	22.8
	RodE5_126.6	214	126.6	3.216	13.85	0.352	981.928851	800.9	2794.432973	8815.0	3.706	21.0
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1024.20868	824.4	2815.247294	8880.7	3.536	20.1
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1065.78339	847.5	2836.578684	8948.0	3.386	19.2
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	980.888451	800.3	2743.625312	8654.8	3.644	20.7
	RodC3_85.6	178	85.6	2.174	14.72	0.374	1010.64037	816.8	2765.121565	8722.6	3.533	20.1
	RodC3_88.5	179	88.5	2.248	0	0.000	1231.21975	939.4	951.4086595	3001.2	0.948	5.4
	RodC3_92.4	180	92.4	2.347	3.9	0.099	643.153372	612.7	1862.074105	5873.9	4.485	25.5
	RodC3_94.4	181	94.4	2.398	5.9	0.150	688.066478	637.6	1960.066611	6183.0	4.260	24.2
Gr-8	RodD5_50	217	50	1.270	3	0.076	1155.72177	897.4	1752.815987	5529.3	1.889	10.7
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1269.53383	960.7	2113.597835	6667.3	2.029	11.5
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1279.83464	966.4	1899.957535	5993.4	1.806	10.3
	RodD5_60	220	60	1.524	13	0.330	1286.16161	969.9	1685.612823	5317.3	1.593	9.0
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1292.39475	973.4	1429.288343	4508.7	1.343	7.6
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	917.358185	765.0	2758.832639	8702.7	4.002	22.7
	RodD5_72.9	223	72.9	1.852	2.02	0.051	972.939376	795.9	2779.544546	8768.1	3.731	21.2
	RodD5_74.9	224	74.9	1.902	4.02	0.102	1017.532	820.7	2811.064946	8867.5	3.560	20.2

Table A-64: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	547.069567	559.3	2473.472939	7802.6	7.752	44.0
	RodB5_52.9	154	52.9	1.344	5.9	0.150	603.341274	590.6	2733.796003	8623.8	7.283	41.4
	RodB5_55	155	55	1.397	8	0.203	620.763414	600.2	2943.215654	9284.4	7.494	42.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	693.34796	640.6	3085.260616	9732.5	6.630	37.7
	RodB5_64	157	64	1.626	17	0.432	723.200117	657.2	3156.143214	9956.1	6.373	36.2
	RodB5_73.9	158	73.9	1.877	3.02	0.077	765.62806	680.7	3265.821815	10302.0	6.075	34.5
	RodB5_75.9	159	75.9	1.928	5.02	0.128	751.192315	672.7	1730.642798	5459.3	3.308	18.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	704.704621	646.9	1978.044963	6239.7	4.149	23.6
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	545.932556	558.7	2482.818485	7832.1	7.809	44.3
	RodF5_53.1	106	53.1	1.349	6.1	0.155	595.64358	586.3	2730.367194	8612.9	7.427	42.2
	RodF5_55	107	55	1.397	8	0.203	603.799292	590.8	2932.352206	9250.1	7.803	44.3
	RodF5_57.8	108	57.8	1.468	10.8	0.274	680.605412	633.5	3072.636137	9692.6	6.789	38.6
	RodF5_64	109	64	1.626	17	0.432	706.942231	648.1	3144.444629	9919.2	6.565	37.3
	RodF5_73.8	110	73.8	1.875	2.92	0.074	744.162689	668.8	3249.13239	10249.4	6.295	35.7
	RodF5_75.8	111	75.8	1.925	4.92	0.125	665.373497	625.0	1816.253122	5729.4	4.153	23.6
	RodF5_76.8	112	76.8	1.951	5.92	0.150	706.79806	648.0	1904.550375	6007.9	3.978	22.6
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1157.28009	898.3	2213.661116	6983.0	2.382	13.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	733.77353	663.0	3646.464613	11502.8	7.210	40.9
	RodC2_55	59	55	1.397	8	0.203	1008.02918	815.4	4728.775187	14916.9	6.062	34.4
	RodC2_57.8	60	57.8	1.468	10.8	0.274	1098.91658	865.9	5354.849292	16891.9	6.149	34.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1166.41738	903.4	4940.716903	15585.5	5.265	29.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1196.48597	920.1	3709.793505	11702.5	3.831	21.8
	RodC2_75.8	63	75.8	1.925	4.92	0.125	743.424188	668.4	2418.14821	7628.0	4.692	26.6
	RodC2_76.8	64	76.8	1.951	5.92	0.150	757.299042	676.1	2433.958368	7677.9	4.598	26.1
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	726.885387	659.2	2022.457952	6379.8	4.054	23.0
	RodC6_52.8	138	52.8	1.341	5.8	0.147	747.450408	670.6	2125.889259	6706.1	4.093	23.2
	RodC6_54.8	139	54.8	1.392	7.8	0.198	776.443589	686.7	2332.886761	7359.1	4.254	24.2
	RodC6_57.8	140	57.8	1.468	10.8	0.274	641.094946	611.5	2410.31557	7603.3	5.835	33.1
	RodC6_63.8	141	63.8	1.621	16.8	0.427	717.557244	654.0	2443.865945	7709.2	4.992	28.3
	RodC6_73.7	142	73.7	1.872	2.82	0.072	758.463672	676.7	2473.696919	7803.3	4.663	26.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	839.69194	721.9	2564.680266	8090.3	4.193	23.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	863.895454	735.3	2662.353039	8398.4	4.187	23.8

Table A-64: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	776.737627	686.9	2428.228976	7659.8	4.425	25.1
	RodB4_91.3	162	91.3	2.319	2.8	0.071	794.806503	696.9	2445.630308	7714.7	4.315	24.5
	RodB4_93.3	163	93.3	2.370	4.8	0.122	383.672082	468.5	2043.605329	6446.6	13.128	74.6
	RodB4_95.1	164	95.1	2.416	6.6	0.168	476.003689	519.8	2294.549542	7238.2	9.252	52.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	743.366595	668.4	2397.916736	7564.2	4.653	26.4
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	769.400458	682.8	2384.904246	7523.2	4.405	25.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	786.306353	692.2	2405.364696	7587.7	4.308	24.5
	RodF4_92.4	100	92.4	2.347	3.9	0.099	385.761357	469.7	2049.530391	6465.2	12.991	73.8
	RodF4_94.3	101	94.3	2.395	5.8	0.147	476.908351	520.3	2298.209825	7249.7	9.233	52.4
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1188.84699	915.8	2991.092423	9435.4	3.113	17.7
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1177.80251	909.7	2929.92423	9242.4	3.085	17.5
	RodF4_111	104	111	2.819	-1.75	-0.044	1148.0915	893.2	2894.196503	9129.7	3.146	17.9
Gr-6	RodD2_114.9	68	114.9	2.918	2.15	0.055	1199.6299	921.8	2574.993339	8122.8	2.650	15.1
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1218.01236	932.0	2424.689425	7648.7	2.449	13.9
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1242.44288	945.6	2212.179017	6978.3	2.181	12.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1255.96769	953.1	1976.794338	6235.8	1.923	10.9
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1261.74221	956.3	1766.129059	5571.3	1.708	9.7
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1224.06595	935.4	2702.449625	8524.9	2.713	15.4
	RodD6_106	130	106	2.692	17.5	0.445	1121.14216	878.2	2872.5995	9061.6	3.216	18.3
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1153.55197	896.2	2743.064113	8653.0	2.964	16.8
	RodD6_114.9	132	114.9	2.918	2.15	0.055	658.449284	621.2	2878.808493	9081.2	6.688	38.0
	RodD6_116.8	133	116.8	2.967	4.05	0.103	691.907094	639.8	3089.186511	9744.8	6.659	37.8
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1007.75454	815.2	2814.109076	8877.1	3.609	20.5
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1057.2526	842.7	2836.547877	8947.9	3.421	19.4
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1280.08981	966.5	933.5900916	2945.0	0.887	5.0

Table A-64: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	700.767552	644.7	3196.174022	10082.3	6.761	38.4
	RodE2_54	74	54	1.372	7	0.178	715.184371	652.7	3365.4005	10616.2	6.908	39.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	679.483647	632.9	3493.112406	11019.0	7.737	43.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	527.261166	548.3	3040.334513	9590.7	10.159	57.7
	RodE2_66	77	66	1.676	19	0.483	679.405221	632.8	2486.973356	7845.2	5.509	31.3
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	726.781307	659.1	2476.120733	7810.9	4.964	28.2
	RodE2_72.9	79	72.9	1.852	2.02	0.051	397.202714	476.0	2012.960866	6349.9	11.897	67.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	484.047252	524.3	2277.671107	7184.9	8.896	50.5
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1223.40634	935.0	2245.405495	7083.1	2.256	12.8
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1231.95313	939.8	2012.429642	6348.2	2.005	11.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1246.53303	947.9	1798.035803	5671.9	1.765	10.0
	RodB3_60.1	172	60.1	1.527	13.1	0.333	751.224363	672.7	1677.334721	5291.2	3.206	18.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	727.118118	659.3	1894.155704	5975.1	3.795	21.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	736.829634	664.7	1930.294754	6089.1	3.794	21.5
	RodB3_73	175	73	1.854	2.12	0.054	750.495562	672.3	2016.458784	6360.9	3.859	21.9
	RodB3_75	176	75	1.905	4.12	0.105	805.980949	703.1	2186.301415	6896.7	3.783	21.5
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	979.566028	799.6	2750.548709	8676.6	3.660	20.8
	RodF3_54	90	54	1.372	7	0.178	1013.13161	818.2	2775.756037	8756.1	3.535	20.1
	RodF3_57	91	57	1.448	10	0.254	733.011399	662.6	1657.708576	5229.2	3.283	18.6
	RodF3_60	92	60	1.524	13	0.330	686.511857	636.8	1903.109076	6003.4	4.151	23.6
	RodF3_66.1	93	66.1	1.679	19.1	0.485	716.065112	653.2	1930.260616	6089.0	3.955	22.5
	RodF3_70	94	70	1.778	-0.88	-0.022	752.861415	673.6	1986.910075	6267.7	3.786	21.5
	RodF3_73	95	73	1.854	2.12	0.054	804.837402	702.5	2137.568693	6743.0	3.706	21.0
	RodF3_75	96	75	1.905	4.12	0.105	731.213239	661.6	2344.127394	7394.5	4.658	26.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	552.39169	562.3	2467.781016	7784.6	7.607	43.2
	RodE6_54.1	122	54.1	1.374	7.1	0.180	604.488701	591.2	2733.782681	8623.7	7.261	41.2
	RodE6_57	123	57	1.448	10	0.254	613.688276	596.3	2940.248959	9275.0	7.623	43.3
	RodE6_60.2	124	60.2	1.529	13.2	0.335	688.262481	637.7	3089.52373	9745.9	6.713	38.1
	RodE6_66.1	125	66.1	1.679	19.1	0.485	715.508851	652.9	3163.322231	9978.7	6.489	36.8
	RodE6_70	126	70	1.778	-0.88	-0.022	754.105312	674.3	3272.429642	10322.9	6.220	35.3
	RodE6_73.1	127	73.1	1.857	2.22	0.056	661.933947	623.1	1823.753539	5753.0	4.203	23.9
	RodE6_75	128	75	1.905	4.12	0.105	717.039517	653.7	1963.027477	6192.4	4.014	22.8

RBHT Steam Cooling with Droplet Injection Test SCD-4053-J

Matrix Test # 10b

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 26400 - 27600
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 29 kW
Bundle Inlet Reynolds Number: 2000
Bundle Inlet Steam Flow: 40.82 kg/hr (90 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

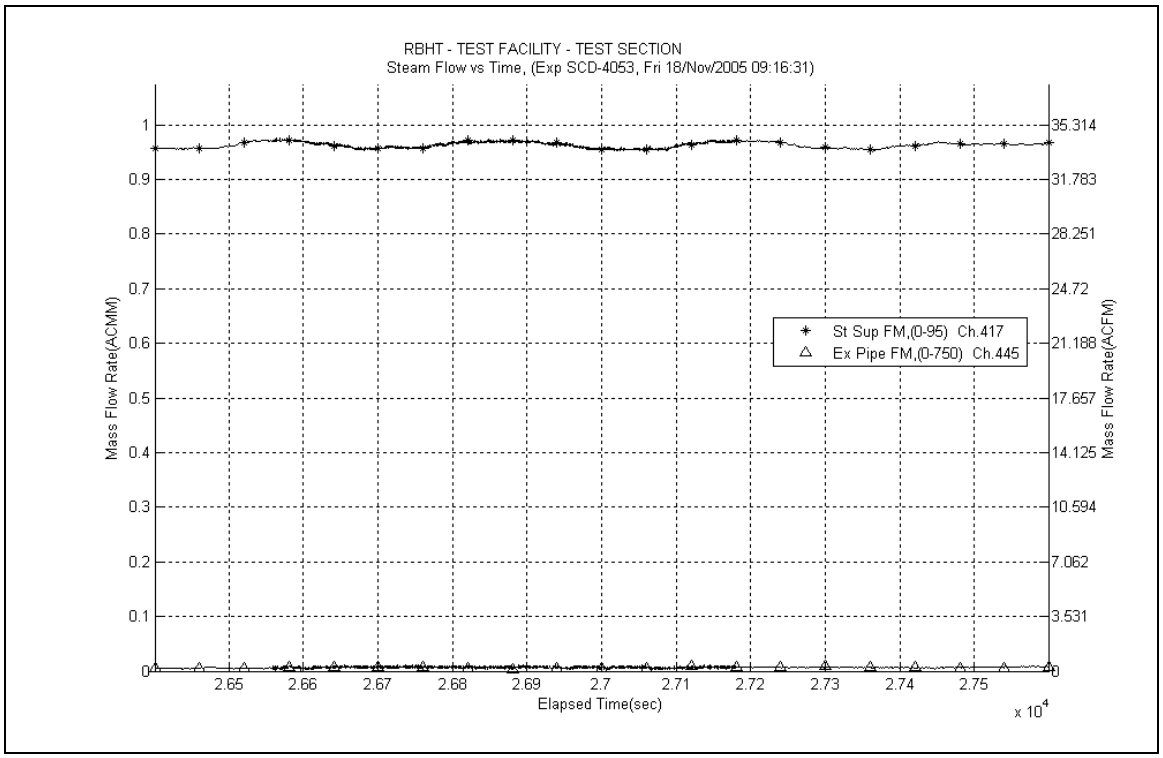

Figure A-484: Inlet and Exhaust Steam Flow Rates for Experiment 4053J

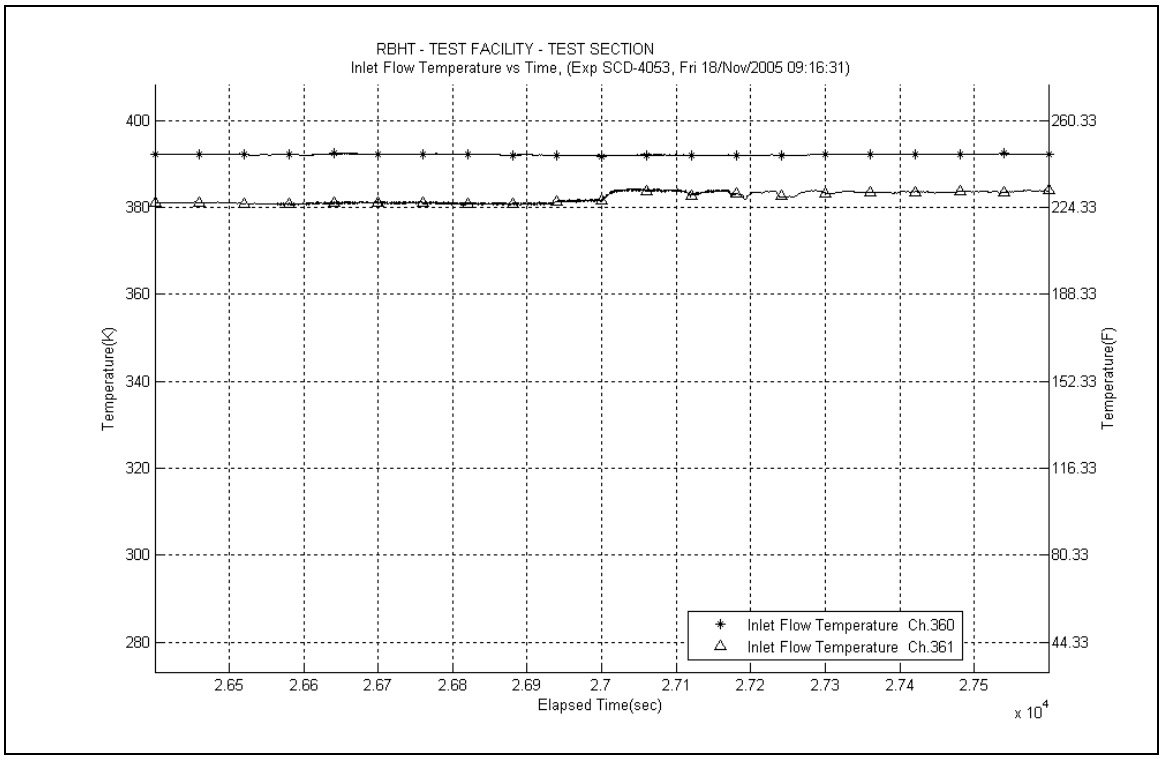

Figure A-485: Inlet Steam Temperature for Experiment 4053J

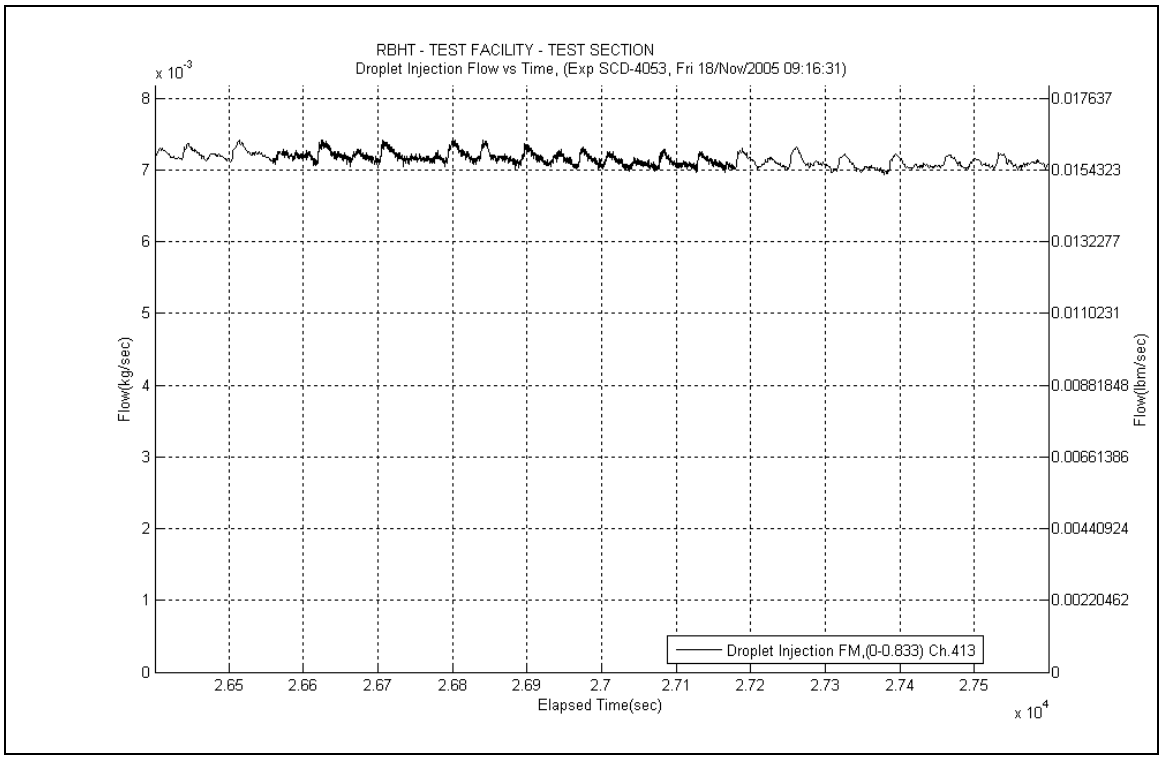

Figure A-486: Droplet Injection Flow Rate for Experiment 4053J

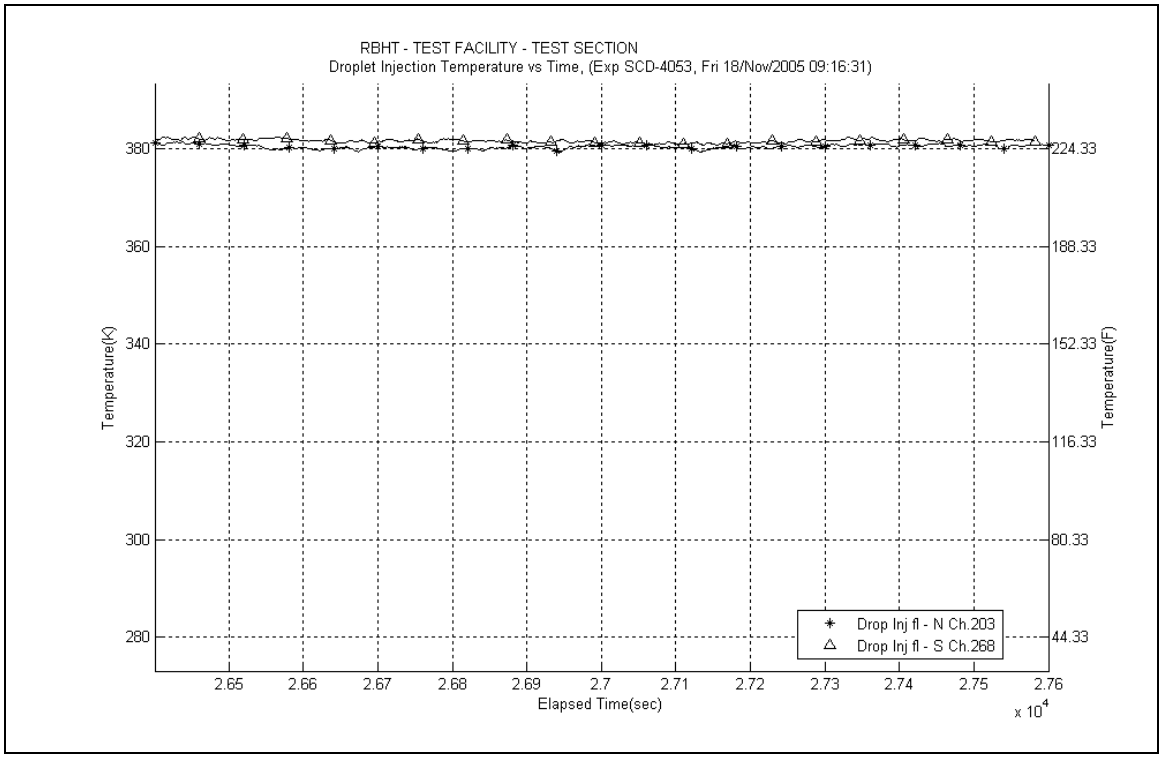

Figure A-487: Droplet Injection Temperature for Experiment 4053J

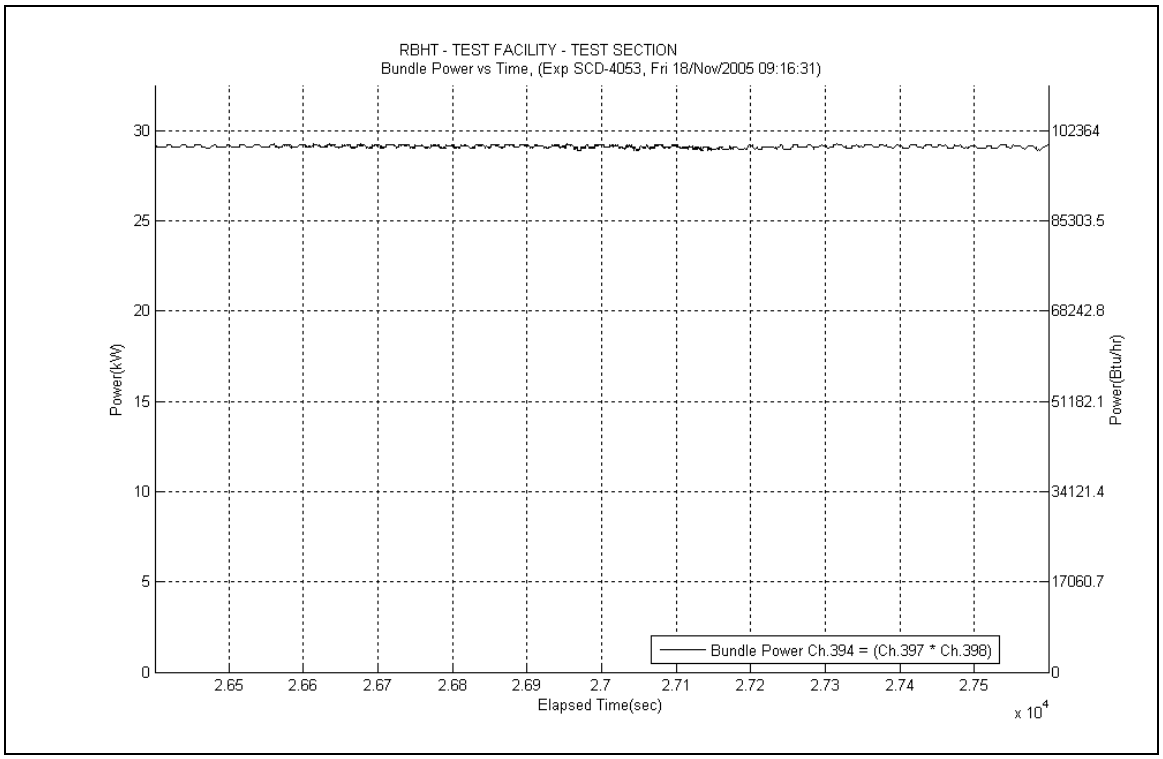

Figure A-488: Bundle Power for Experiment 4053J

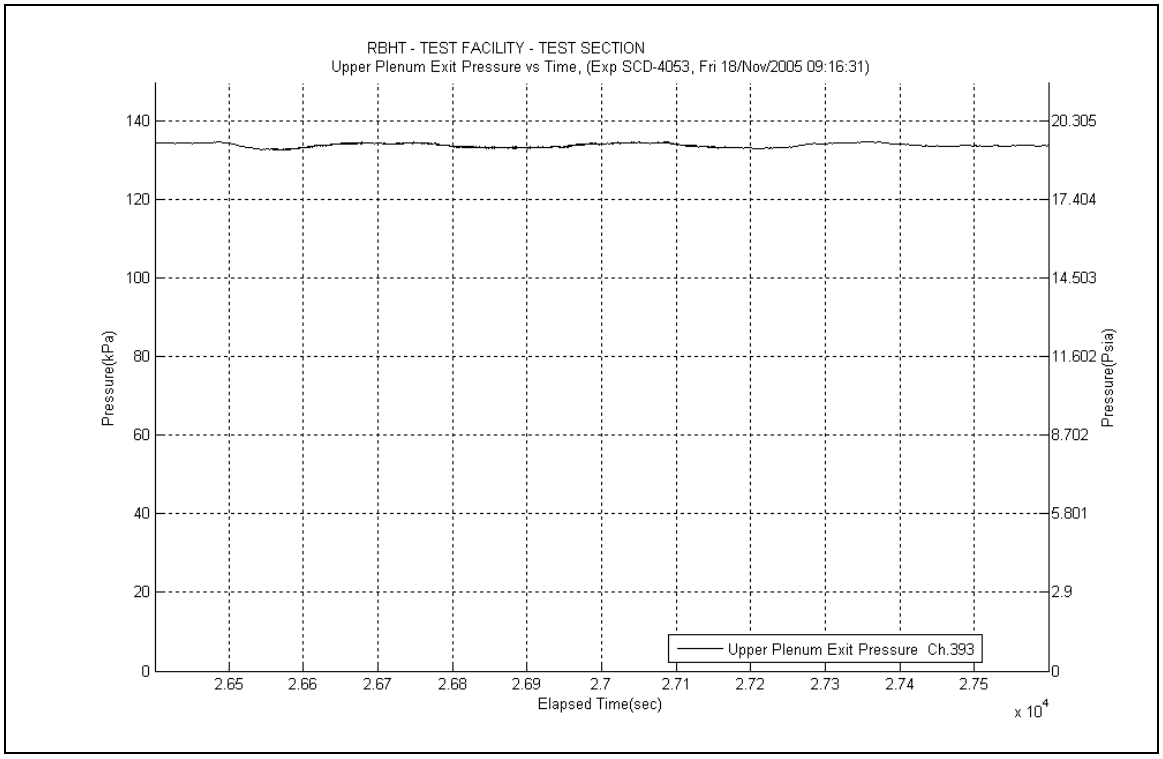

Figure A-489: Upper Plenum Pressure for Experiment 4053J

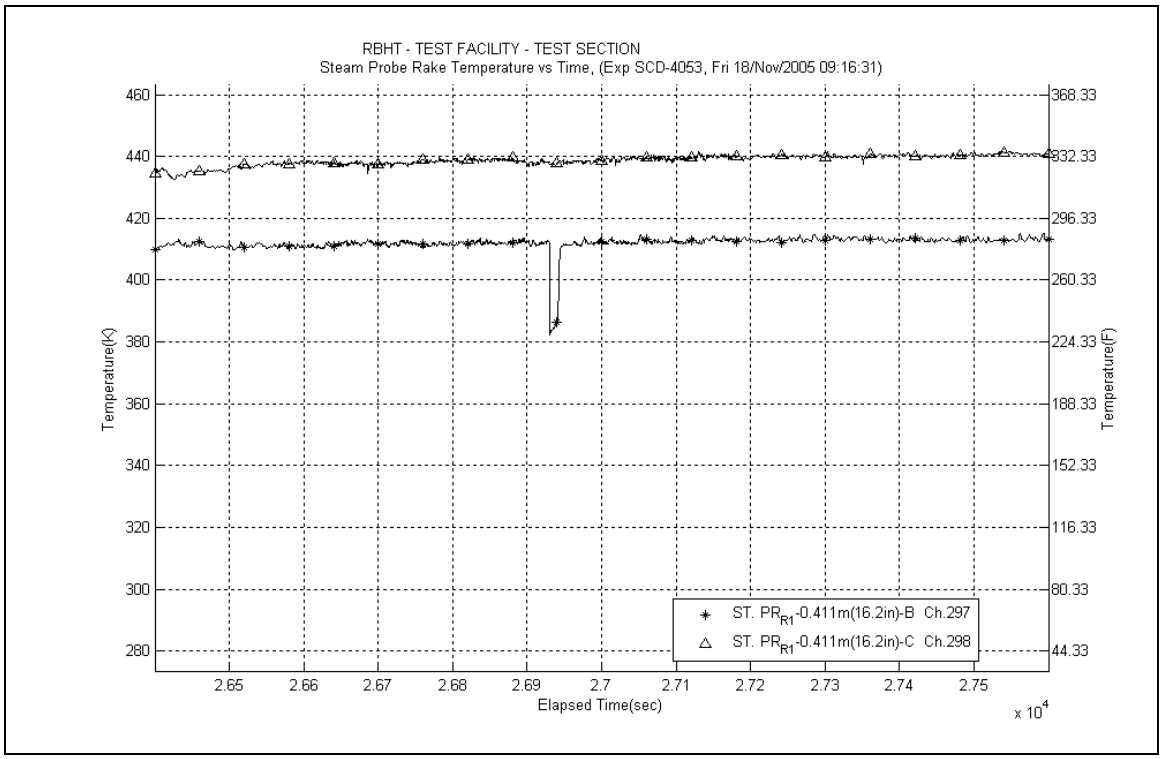

Figure A-490: Steam Probe Rake #1 Temperatures for Experiment 4053J

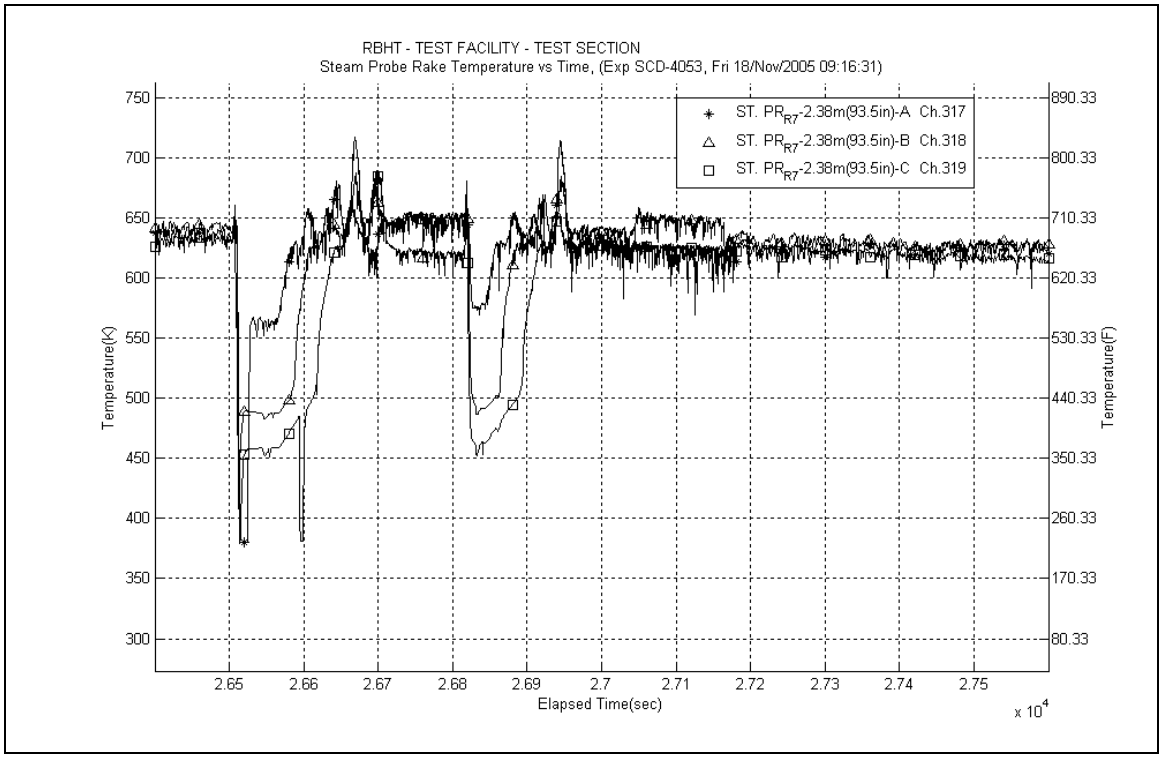

Figure A-491: Steam Probe Rake #7 Temperatures for Experiment 4053J

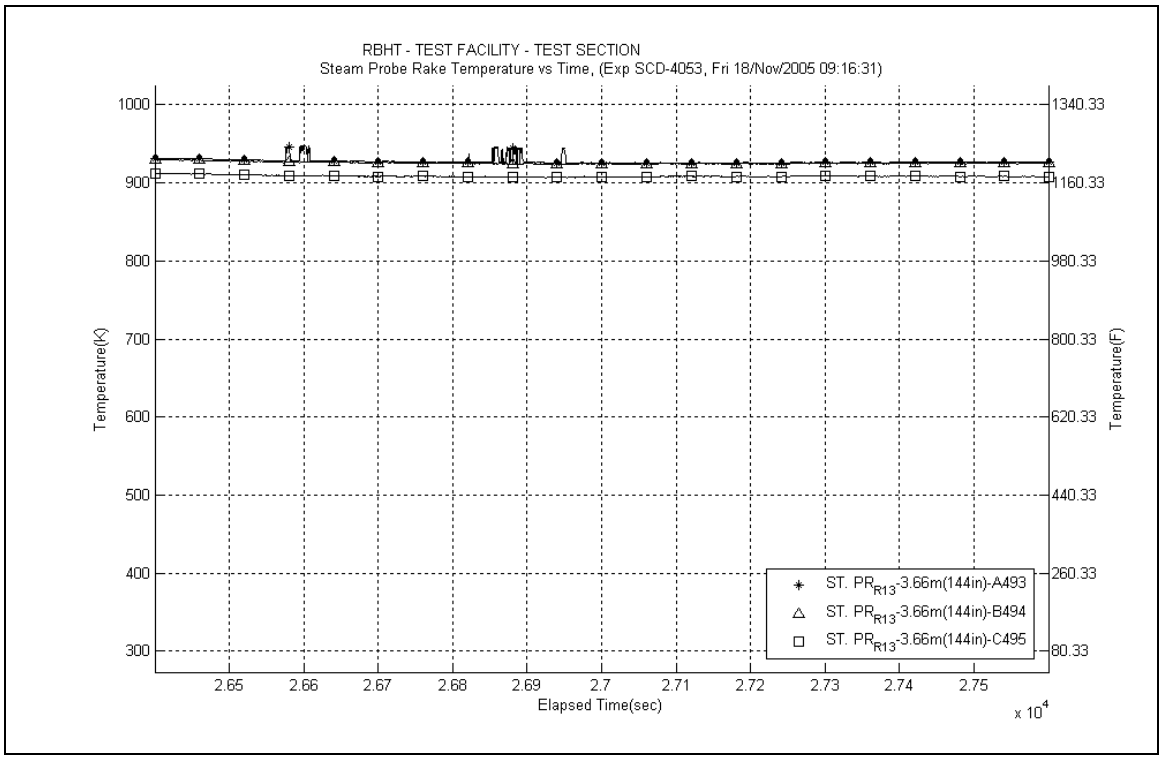

Figure A-492: Steam Probe Rake #13 Temperatures for Experiment 4053J

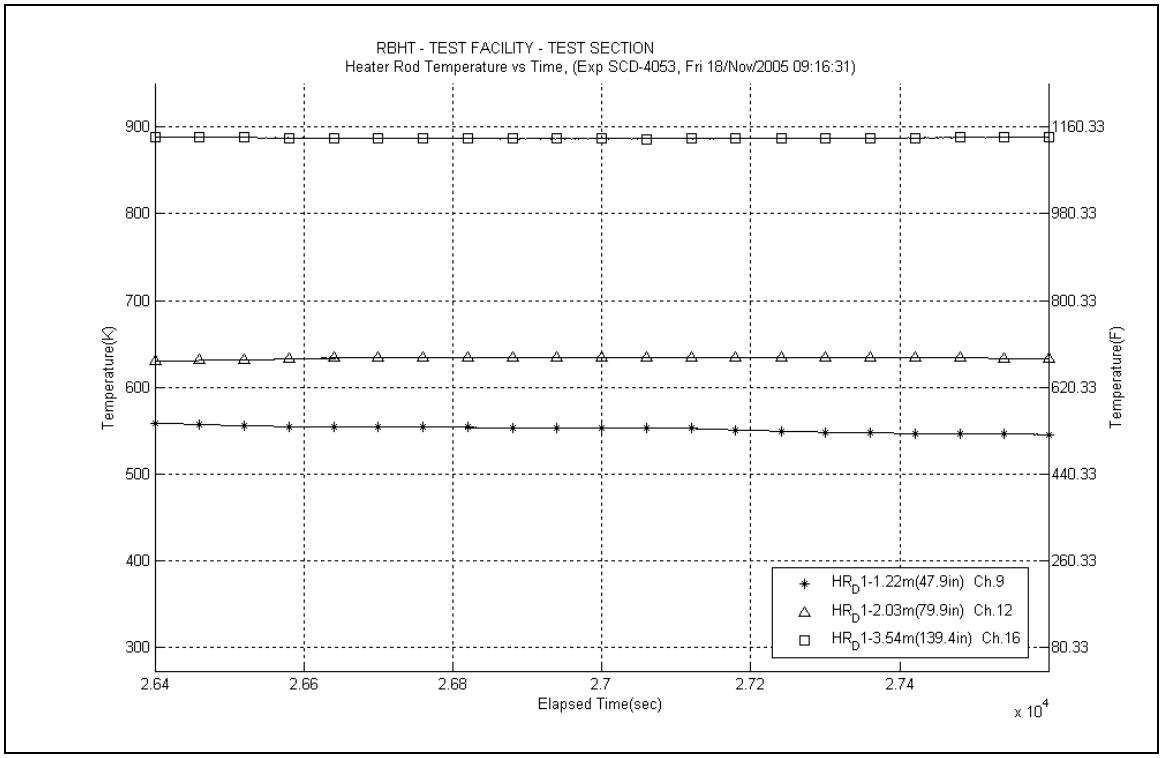

Figure A-493: Heater Rod D1 Temperatures for Experiment 4053J

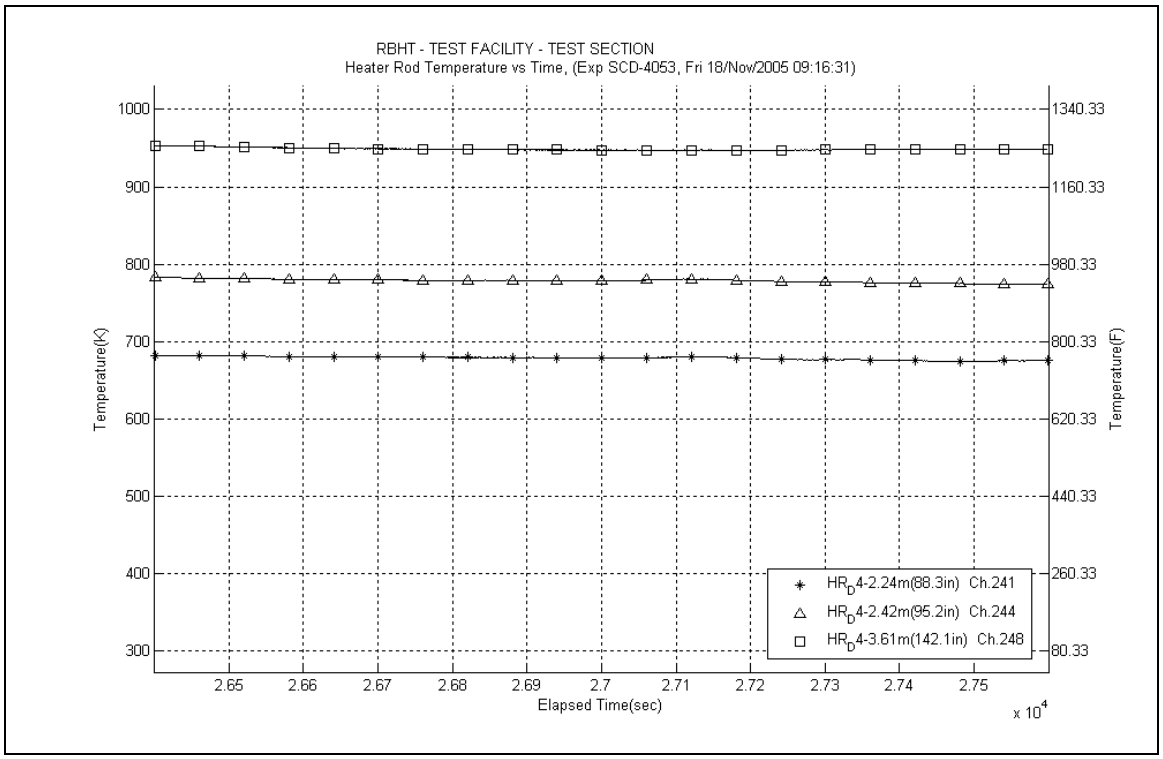

Figure A-494: Heater Rod D4 Temperatures for Experiment 4053J

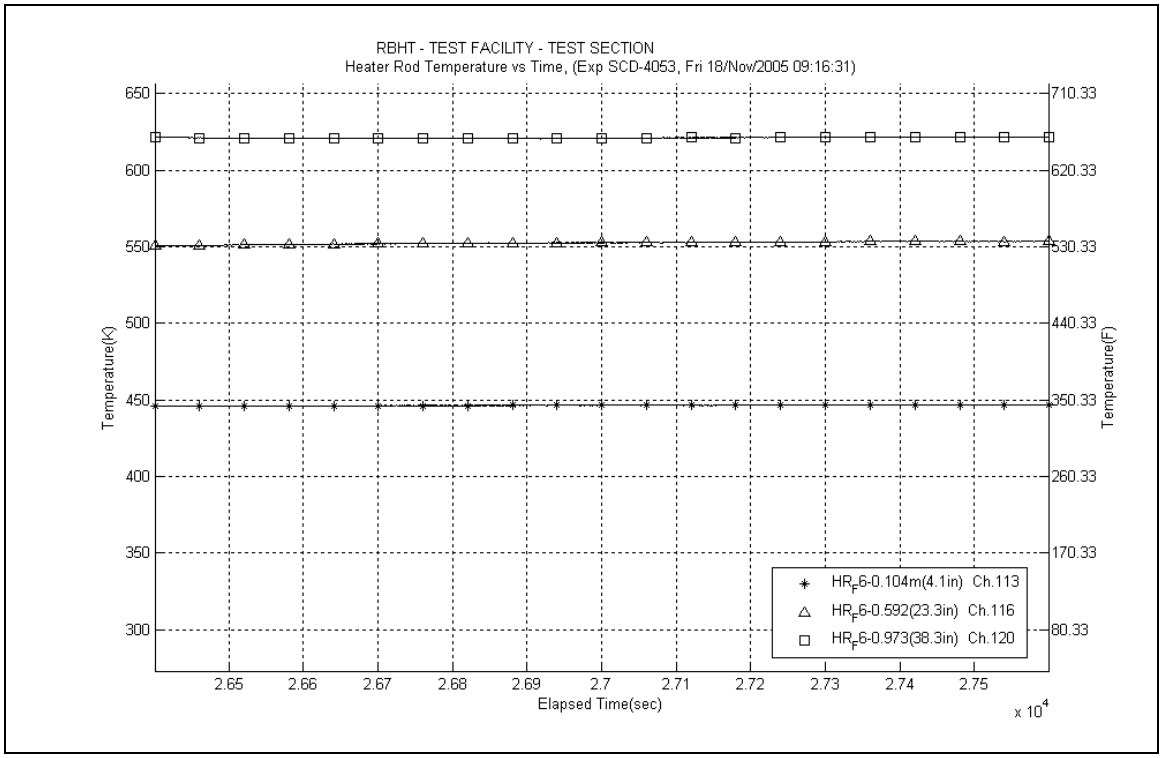

Figure A-495: Heater Rod F6 Temperatures for Experiment 4053J

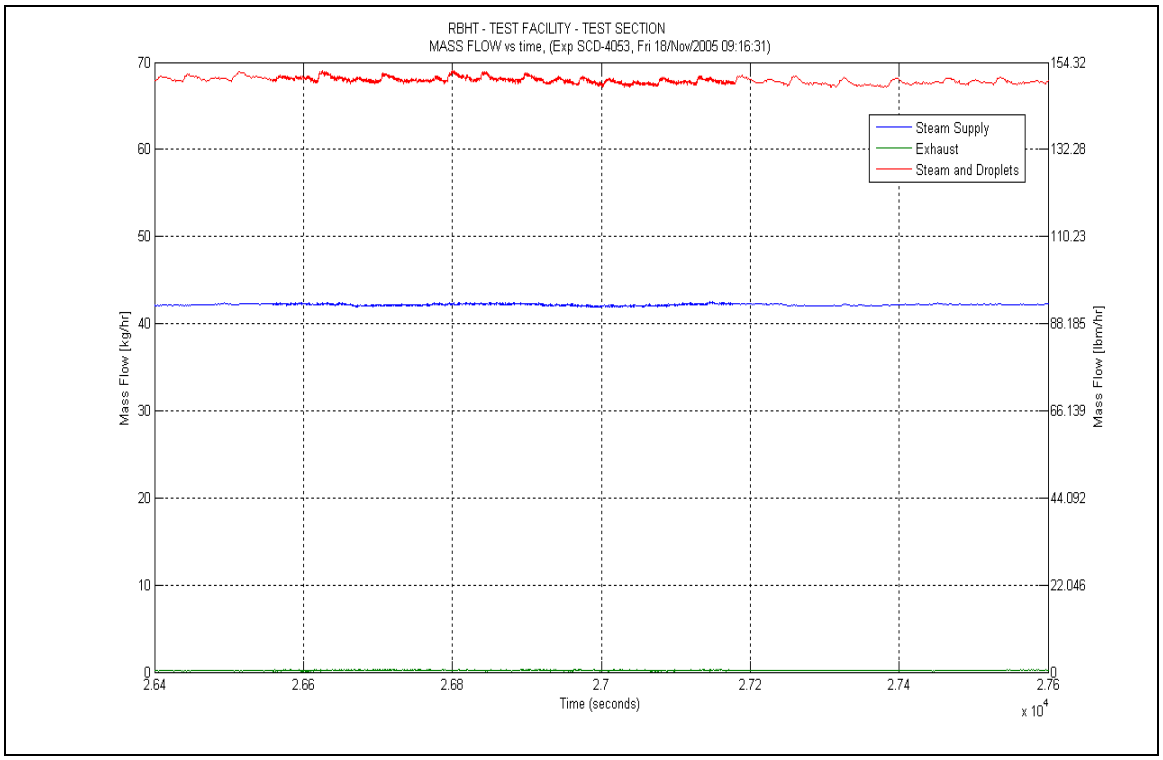

Figure A-496: Mass Flow for Experiment 4053J

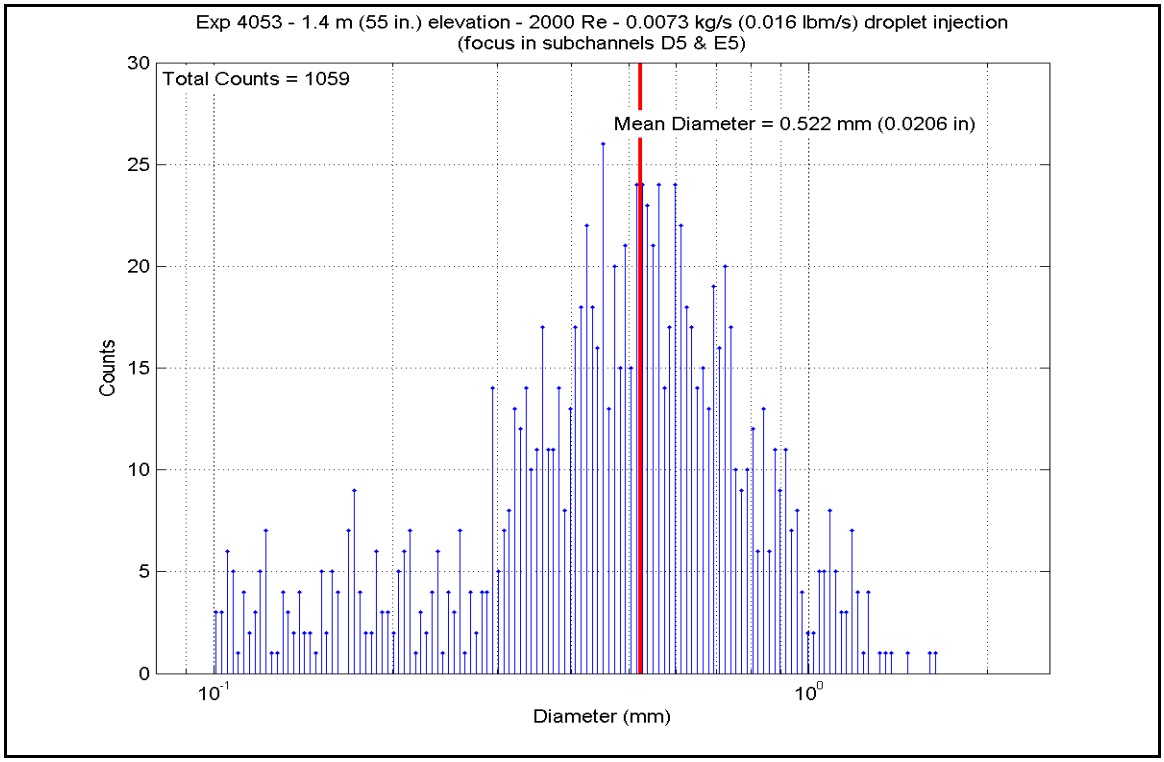

Figure A-497: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053J

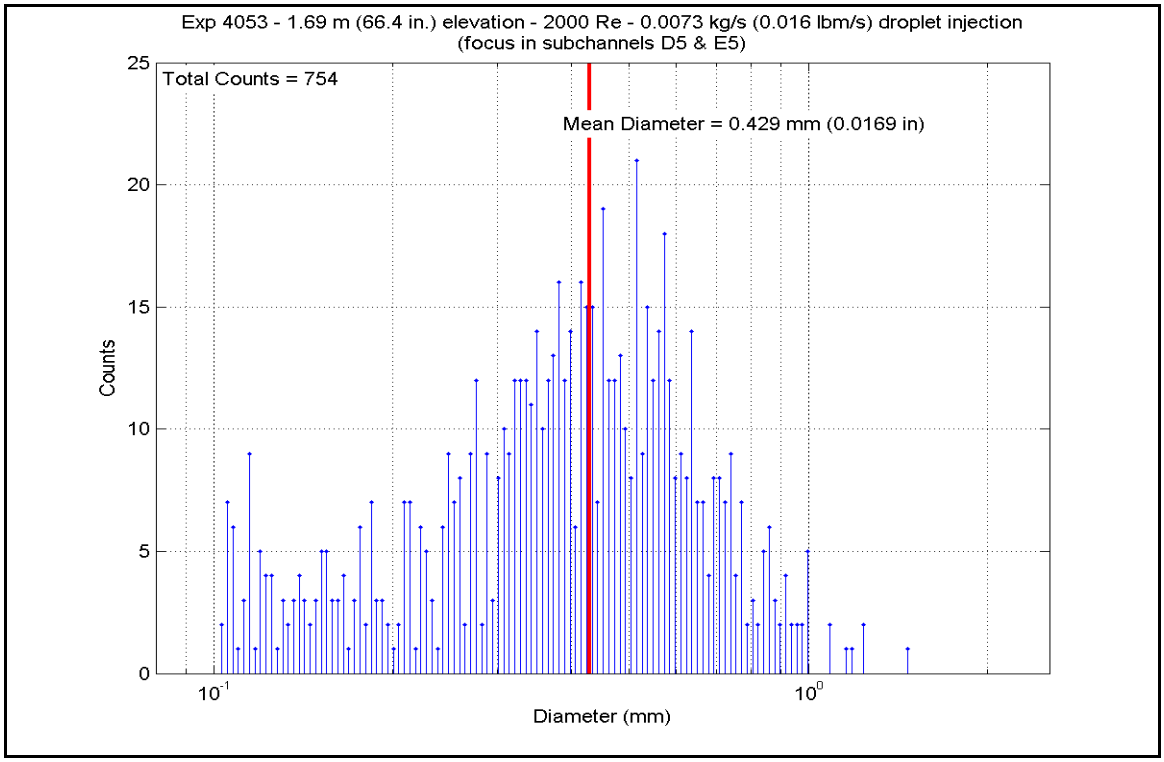

Figure A-498: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053J

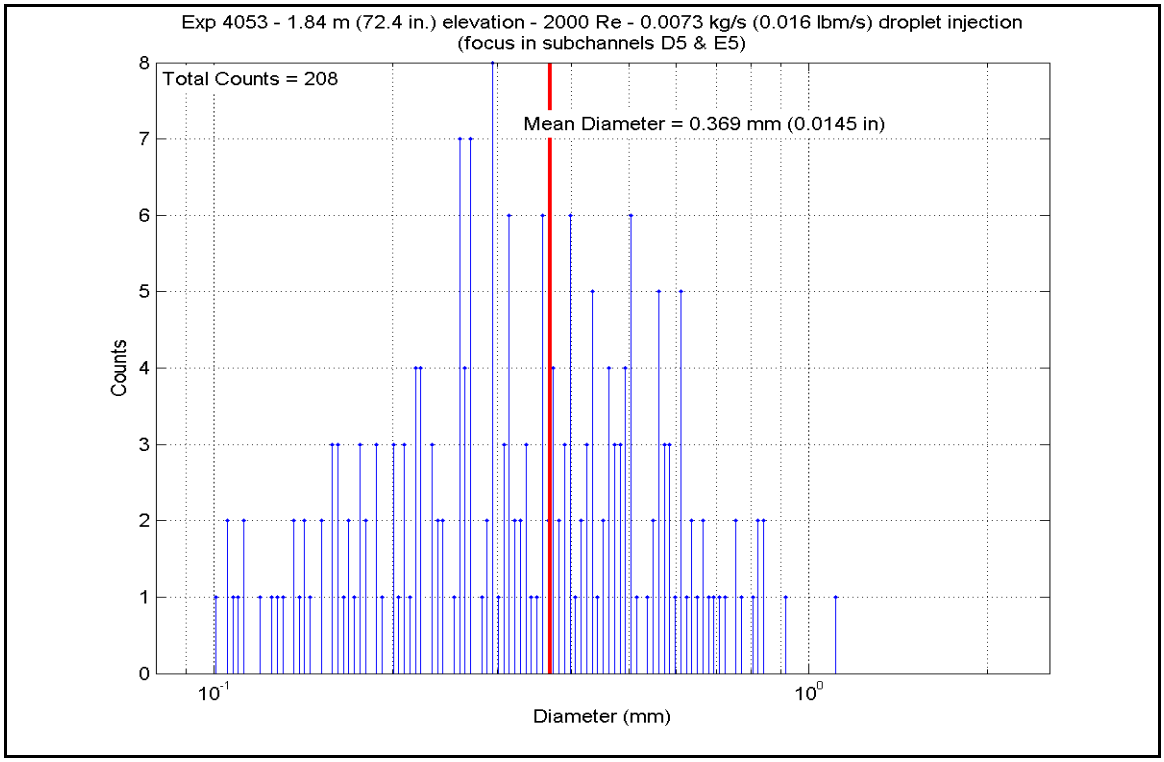

Figure A-499: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053J

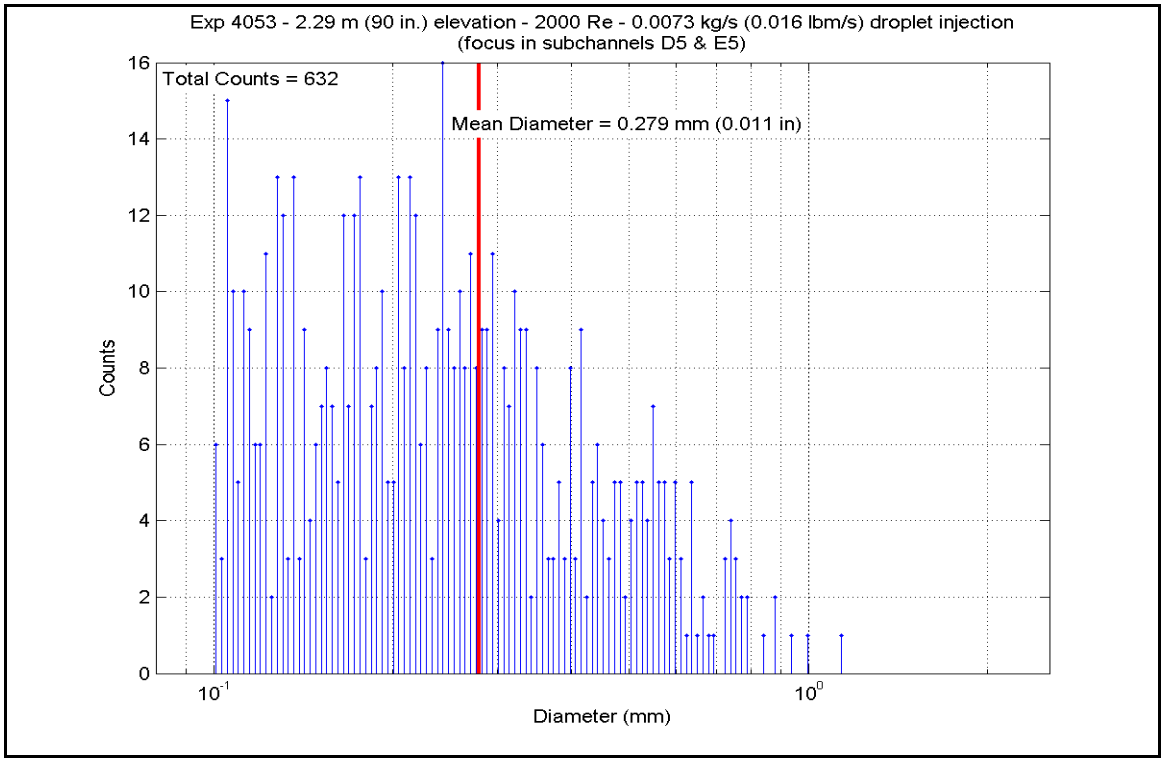

Figure A-500: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053J

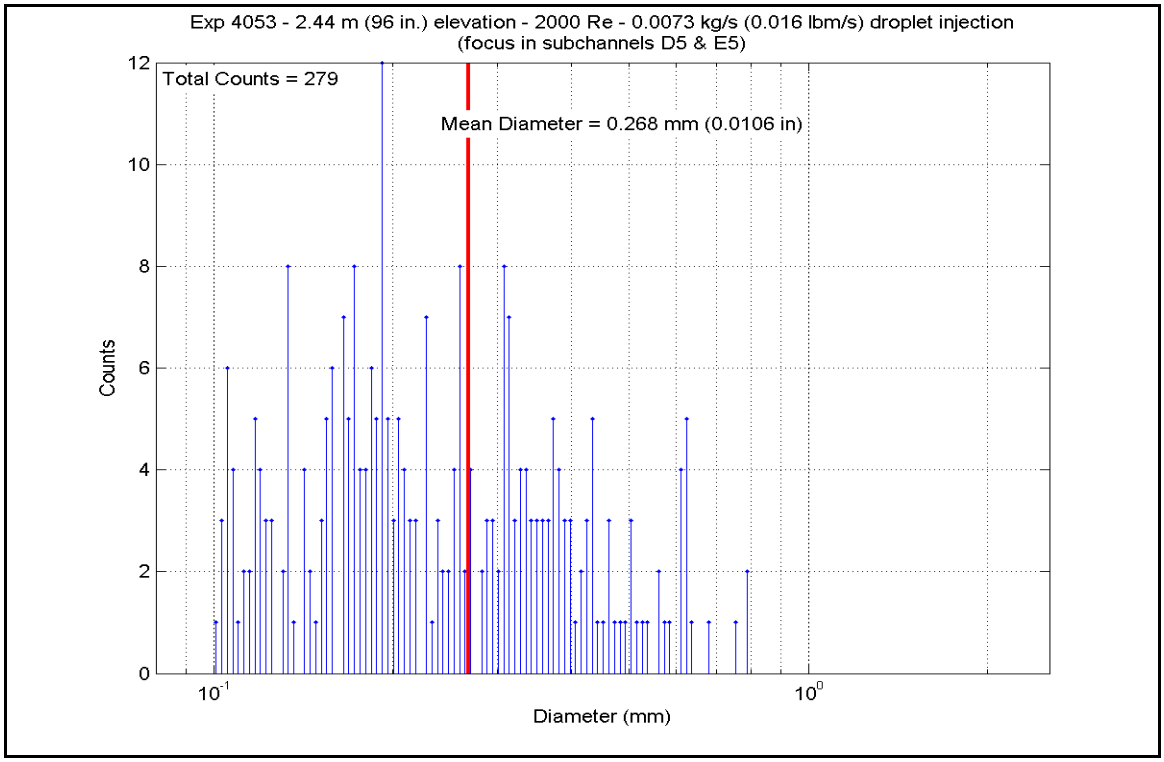

Figure A-501: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053J

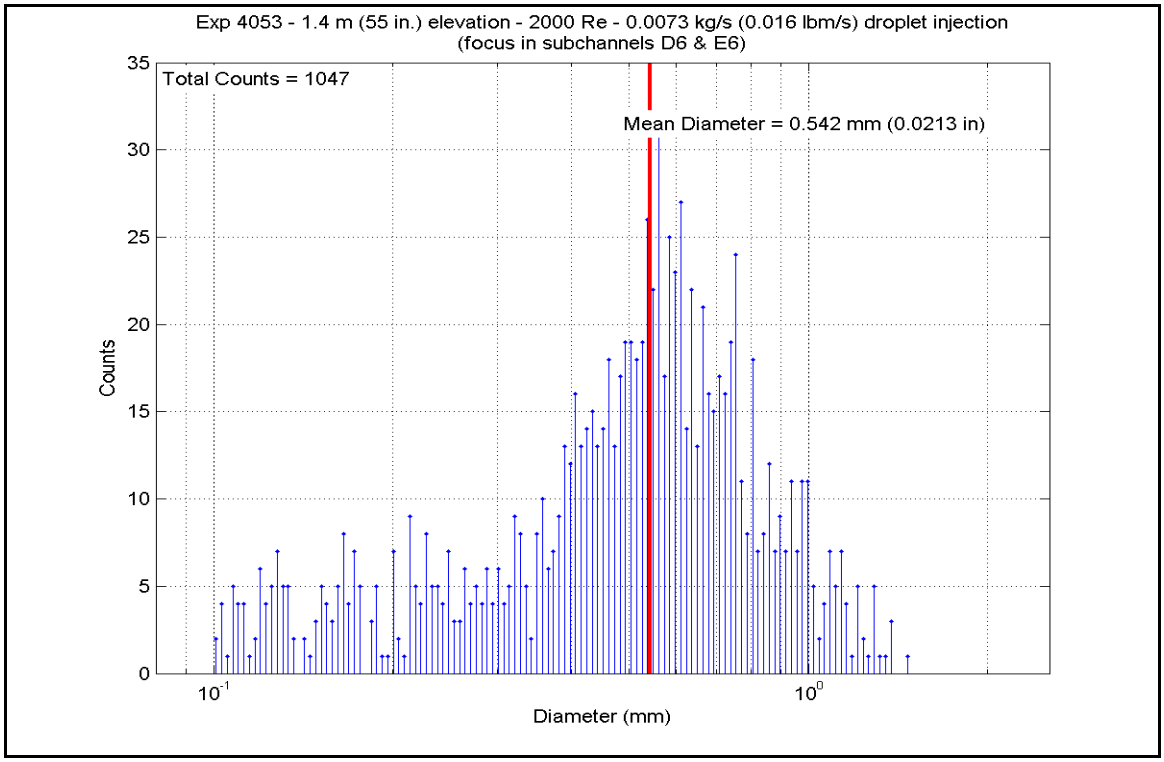

Figure A-502: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053J

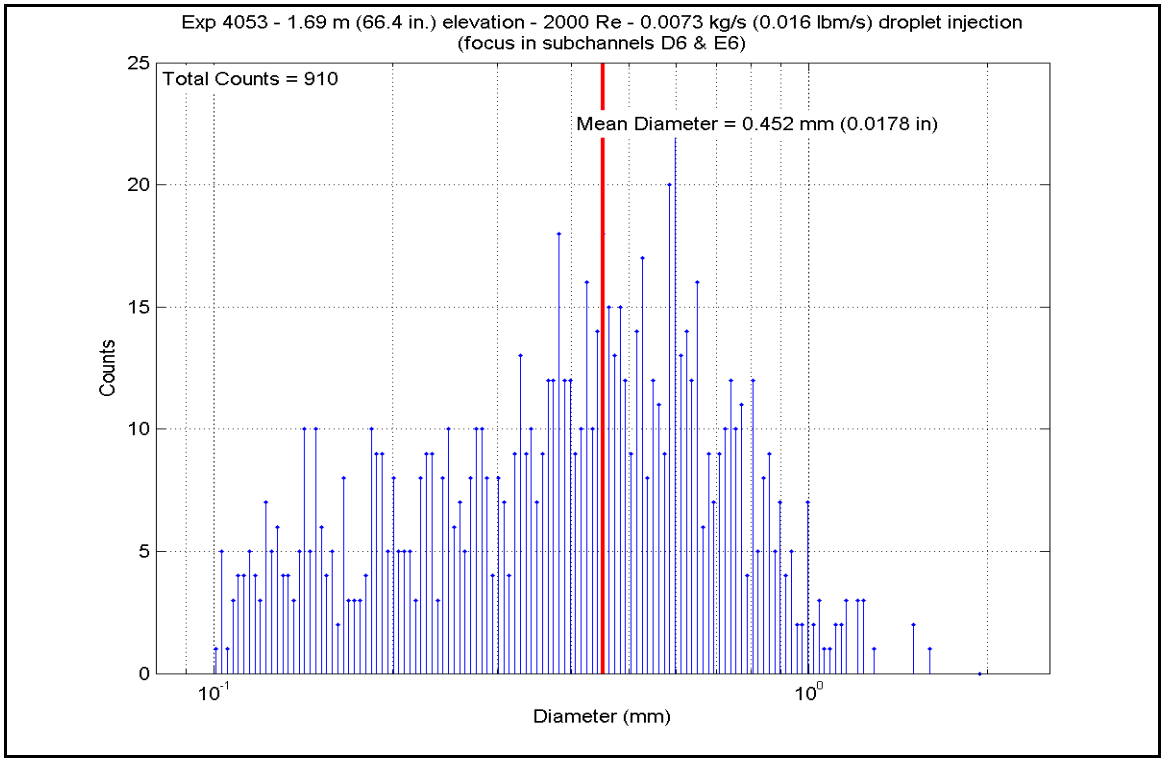

Figure A-503: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053J

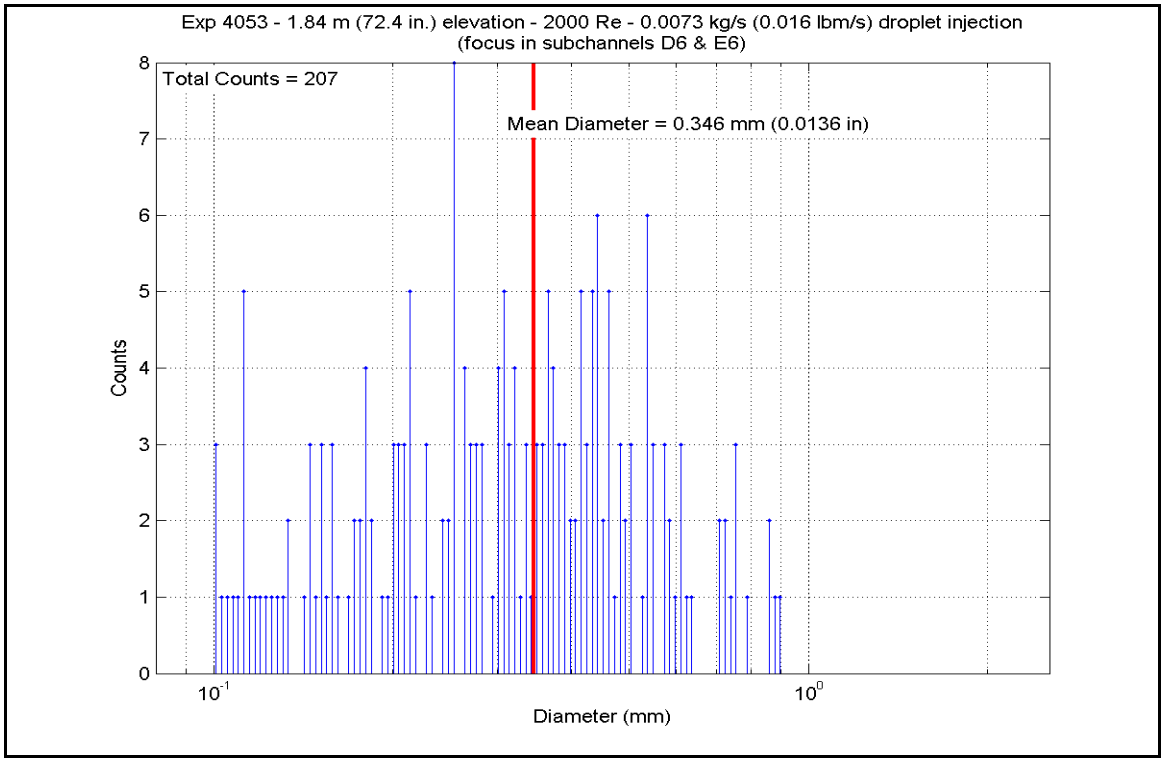

Figure A-504: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053J

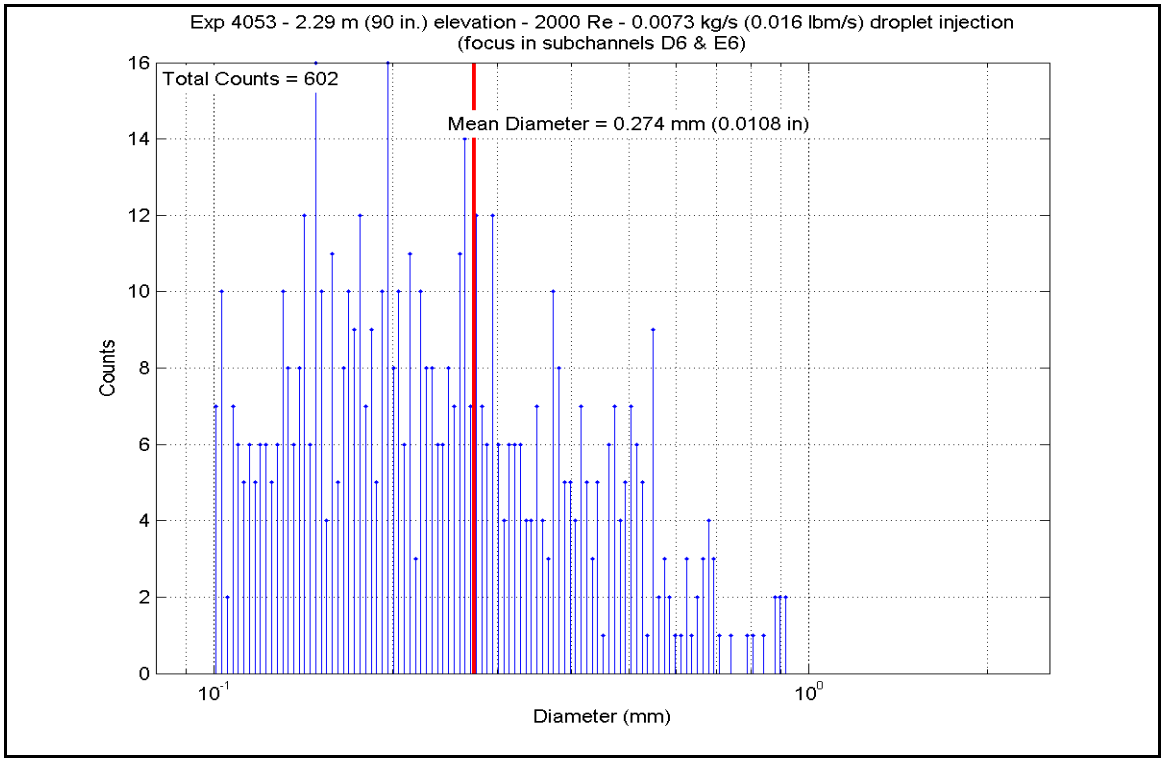

Figure A-505: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053J

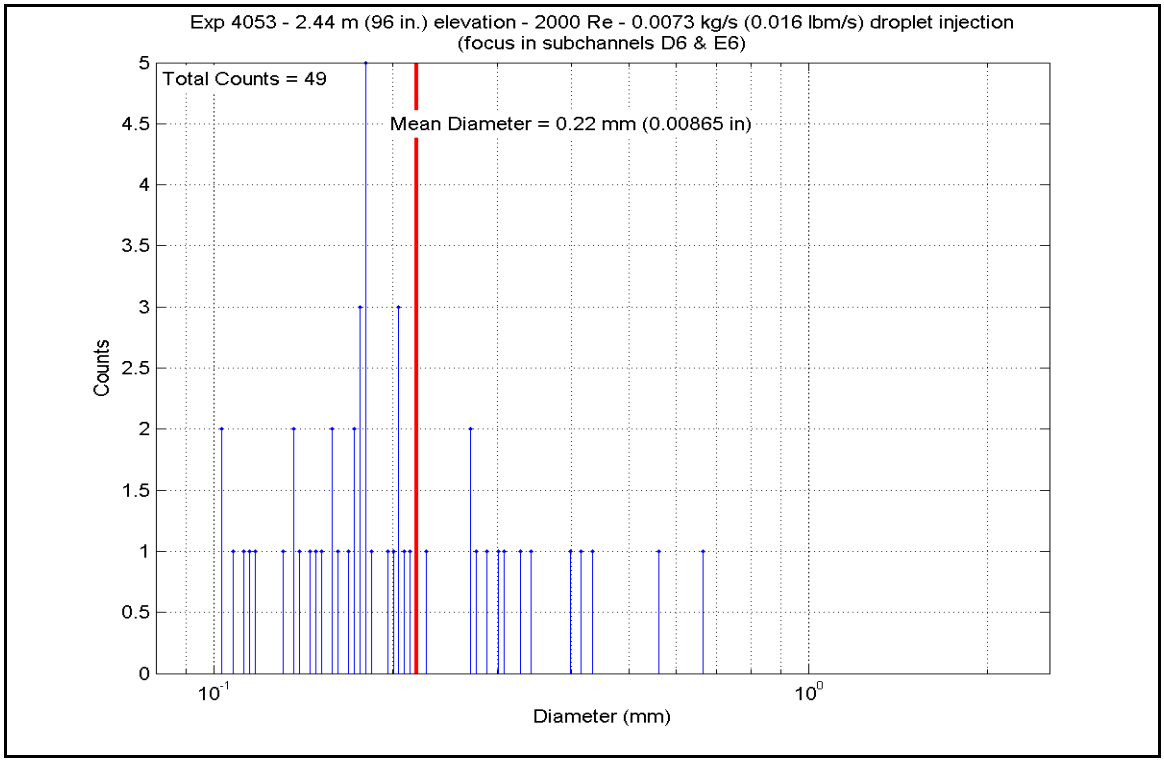

Figure A-506: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053J

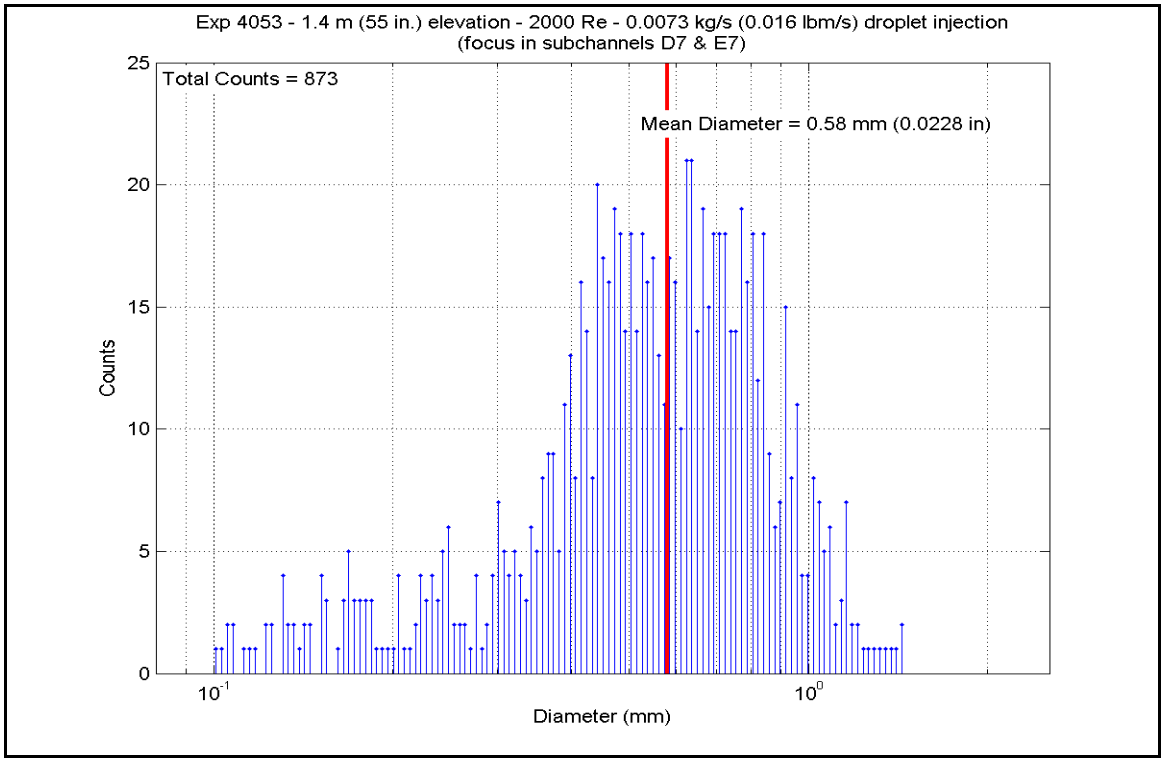

Figure A-507: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053J

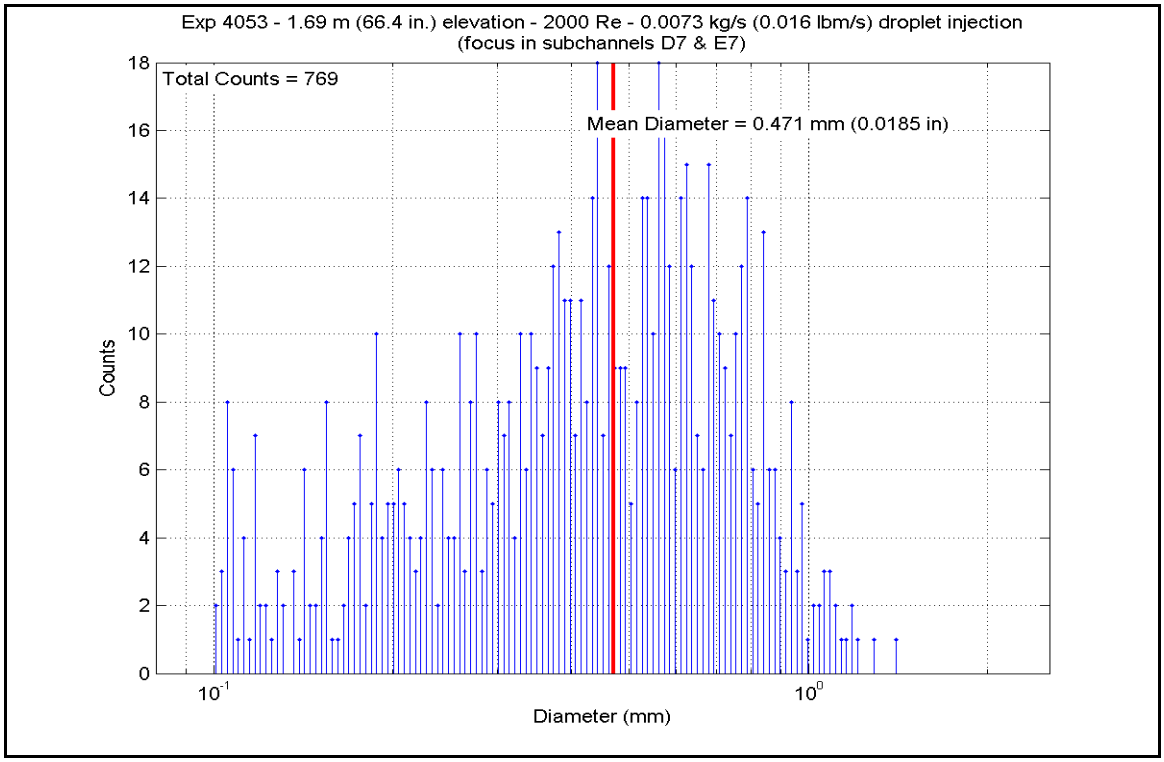

Figure A-508: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053J

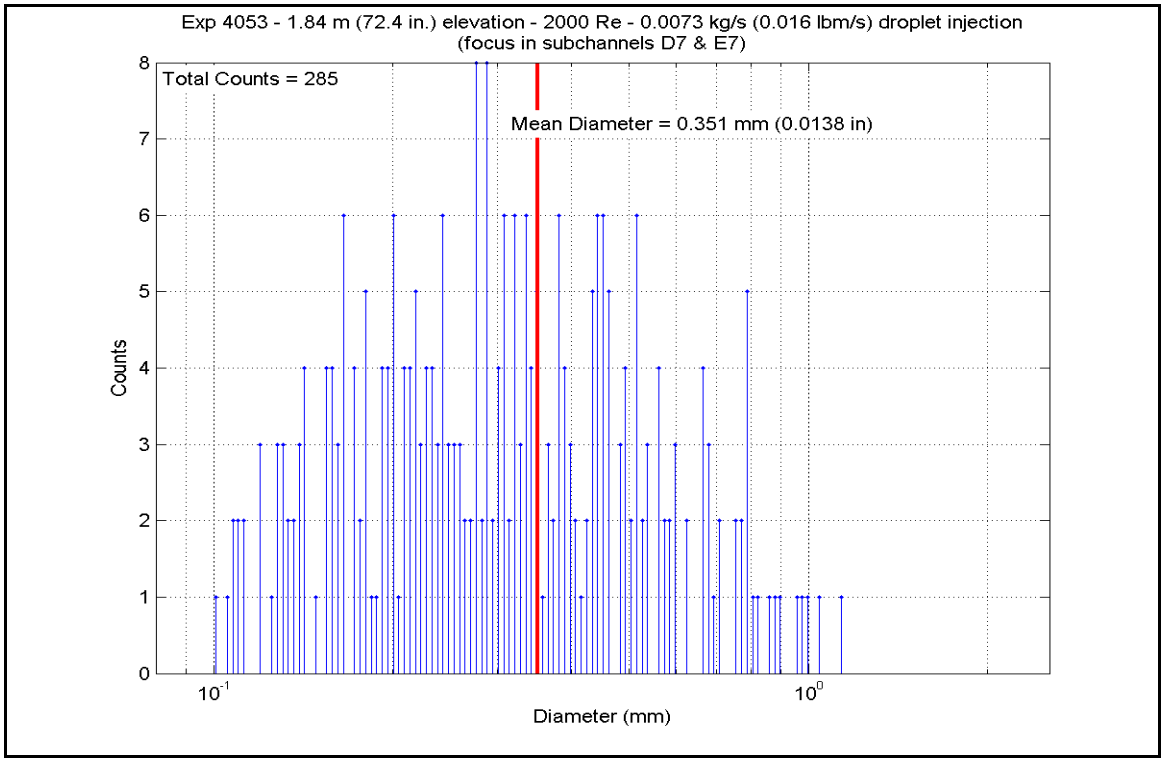

Figure A-509: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053J

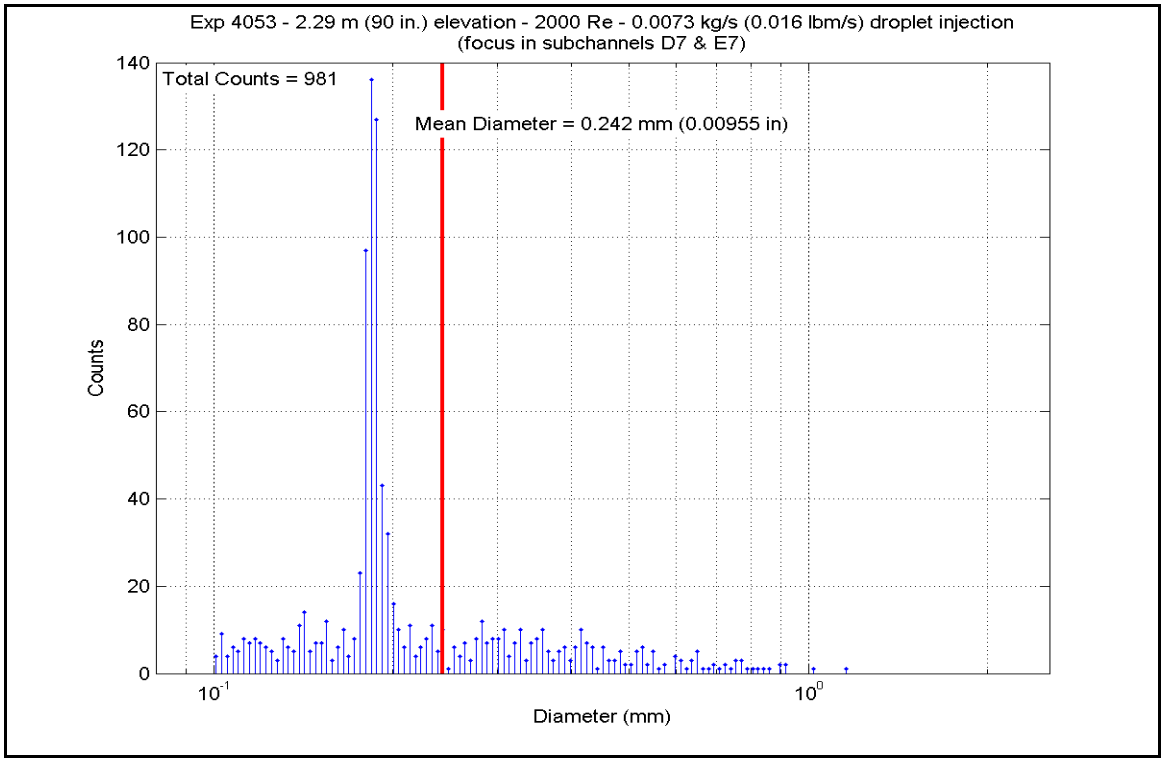

Figure A-510: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053J

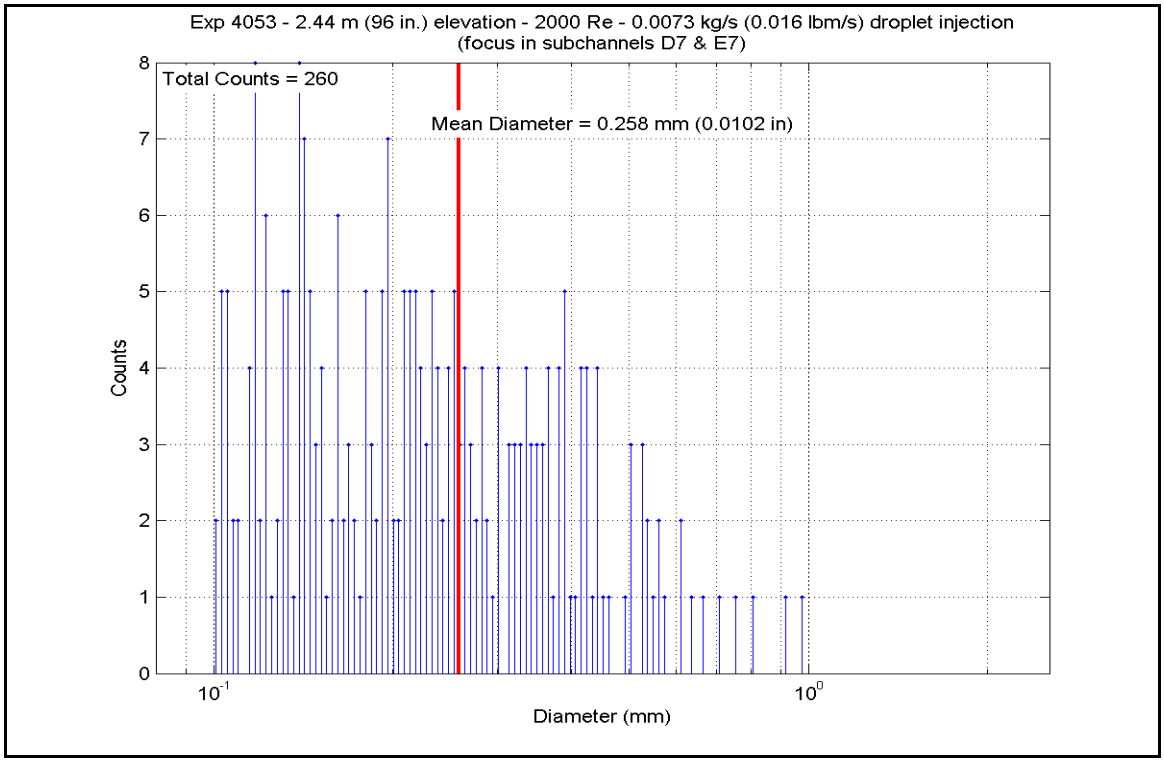

Figure A-511: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053J

Table A-65: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053J

Test 4053-J	Inlet Reynolds:	2000	
Matrix test # 10b	UP Pressure:	137.9 kPa	20 psia
Time Window: 26400-27600	Bundle Power:	29.00 kW	98952 Btu/hr
	Steam flow:	0.0113 kg/s	90.0 lbm/hr
	Droplet flow:	0.0073 kg/s	0.016 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	845.215989	724.9	2565.195752	8091.9	4.156	23.6
	RodD3_91.3	186	91.3	2.319	2.8	0.071	889.519325	749.5	2595.034152	8186.0	3.923	22.3
	RodD3_93.1	187	93.1	2.365	4.6	0.117	736.246756	664.4	2500.022491	7886.3	4.919	27.9
	RodD3_95.3	188	95.3	2.421	6.8	0.173	822.966302	712.6	2550.865056	8046.7	4.287	24.3
	RodD3_142.1	192	142.1	3.609	8.6	0.218	743.968038	668.7	2505.43107	7903.4	4.856	27.6
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1090.15138	861.0	2429.379009	7663.5	2.818	16.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1130.04643	883.2	2271.666389	7166.0	2.518	14.3
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1162.10033	901.0	2085.581424	6579.0	2.233	12.7
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1179.19731	910.5	1894.936693	5977.6	1.992	11.3
	RodC4_142.2	240	142.2	3.612	8.7	0.221	726.653403	659.1	2045.299459	6451.9	4.102	23.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	663.212328	623.8	2200.164515	6940.4	5.055	28.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	702.864977	645.9	2234.660975	7049.2	4.706	26.7
	RodD4_93.2	243	93.2	2.367	4.7	0.119	765.178009	680.5	1985.049979	6261.8	3.695	21.0
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1135.96459	886.5	2349.499375	7411.5	2.588	14.7
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1079.76958	855.2	2805.842149	8851.0	3.294	18.7
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1080.33668	855.6	2771.276968	8742.0	3.251	18.5
	RodD4_142.1	248	142.1	3.609	8.6	0.218	614.887609	597.0	2151.085798	6785.6	5.560	31.6
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	839.013578	721.5	2508.164098	7912.0	4.105	23.3
	RodE4_91.2	202	91.2	2.316	2.7	0.069	927.434002	770.6	2579.972511	8138.5	3.689	20.9
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1243.78641	946.4	1026.612495	3238.4	1.011	5.7
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1028.75511	826.9	2731.32778	8616.0	3.411	19.4
	RodE4_142.3	208	142.3	3.614	8.8	0.224	776.408401	686.7	2457.930029	7753.5	4.482	25.5

Table A-65: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1226.44504	936.7	1439.4803	4540.8	1.442	8.2
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1108.04485	871.0	2447.478134	7720.6	2.781	15.8
	RodE3_115.5	195	115.5	2.934	2.75	0.070	226.155198	381.0	2031.54519	6408.5	-1101.227	-6253.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1148.7503	893.6	2425.689296	7651.8	2.634	15.0
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1178.82726	910.3	2277.690129	7185.0	2.395	13.6
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1204.89213	924.8	2071.645564	6535.0	2.121	12.0
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1215.54006	930.7	1885.700958	5948.4	1.909	10.8
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1214.73136	930.2	1631.853811	5147.7	1.654	9.4
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	753.059046	673.7	1995.875469	6296.0	3.801	21.6
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1319.64395	988.5	1663.79925	5248.5	1.524	8.7
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1245.34974	947.2	1464.289088	4619.1	1.439	8.2
	RodC5_126.7	230	126.7	3.218	13.95	0.354	654.997613	619.3	1831.518117	5777.5	4.289	24.4
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	676.652149	631.3	1898.897126	5990.1	4.232	24.0
	RodC5_135.7	232	135.7	3.447	2.2	0.056	719.103349	654.9	1944.650146	6134.4	3.960	22.5
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1247.61929	948.5	1019.549479	3216.2	1.000	5.7
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1077.87239	854.2	2832.992087	8936.7	3.333	18.9
	RodE5_115.4	211	115.4	2.931	2.65	0.067	941.818042	778.6	2642.869221	8336.9	3.702	21.0
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1234.55813	941.2	1055.308413	3329.0	1.048	6.0
	RodE5_122.6	213	122.6	3.114	9.85	0.250	761.085489	678.2	2505.060808	7902.2	4.699	26.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	841.862345	723.1	2561.0404	8078.8	4.172	23.7
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	892.062899	751.0	2597.144107	8192.7	3.911	22.2
	RodE5_135.6	216	135.6	3.444	2.1	0.053	940.929588	778.1	2633.19242	8306.4	3.693	21.0
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	874.737489	741.3	2552.657643	8052.4	3.947	22.4
	RodC3_85.6	178	85.6	2.174	14.72	0.374	906.559279	759.0	2581.397751	8143.0	3.804	21.6
	RodC3_88.5	179	88.5	2.248	0	0.000	1198.18895	921.0	1044.68701	3295.5	1.077	6.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	624.285702	602.2	1827.216993	5764.0	4.611	26.2
	RodC3_94.4	181	94.4	2.398	5.9	0.150	666.634123	625.7	1891.710121	5967.4	4.313	24.5
Gr-8	RodD5_50	217	50	1.270	3	0.076	1112.37429	873.4	1748.440233	5515.5	1.977	11.2
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1187.58531	915.1	2027.060808	6394.4	2.112	12.0
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1203.65392	924.1	1842.396085	5811.8	1.888	10.7
	RodD5_60	220	60	1.524	13	0.330	1204.52312	924.6	1615.069971	5094.7	1.654	9.4
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1225.96648	936.5	1425.876676	4497.9	1.429	8.1
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	777.250941	687.2	2522.14369	7956.1	4.592	26.1
	RodD5_72.9	223	72.9	1.852	2.02	0.051	847.817788	726.4	2568.709288	8103.0	4.144	23.5
	RodD5_74.9	224	74.9	1.902	4.02	0.102	897.306972	753.9	2609.196168	8230.7	3.898	22.1

Table A-65: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	542.035231	556.5	2467.732611	7784.5	7.858	44.6
	RodB5_52.9	154	52.9	1.344	5.9	0.150	592.095023	584.3	2720.92045	8583.1	7.473	42.4
	RodB5_55	155	55	1.397	8	0.203	613.006601	595.9	2934.807997	9257.9	7.623	43.3
	RodB5_57.8	156	57.8	1.468	10.8	0.274	682.56494	634.6	3077.635985	9708.4	6.771	38.4
	RodB5_64	157	64	1.626	17	0.432	710.829729	650.3	3149.059975	9933.7	6.522	37.0
	RodB5_73.9	158	73.9	1.877	3.02	0.077	750.572174	672.4	3260.667638	10285.8	6.240	35.4
	RodB5_75.9	159	75.9	1.928	5.02	0.128	695.09157	641.5	1646.186589	5192.9	3.524	20.0
	RodB5_76.9	160	76.9	1.953	6.02	0.153	697.268372	642.7	1843.910037	5816.6	3.929	22.3
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	541.886252	556.4	2471.084965	7795.0	7.873	44.7
	RodF5_53.1	106	53.1	1.349	6.1	0.155	587.33369	581.7	2718.339025	8575.0	7.565	43.0
	RodF5_55	107	55	1.397	8	0.203	599.503736	588.4	2930.697209	9244.9	7.889	44.8
	RodF5_57.8	108	57.8	1.468	10.8	0.274	673.374357	629.5	3071.180342	9688.0	6.896	39.2
	RodF5_64	109	64	1.626	17	0.432	698.097601	643.2	3141.44898	9909.7	6.683	37.9
	RodF5_73.8	110	73.8	1.875	2.92	0.074	733.651324	663.0	3247.036651	10242.8	6.421	36.5
	RodF5_75.8	111	75.8	1.925	4.92	0.125	716.478255	653.4	1805.586839	5695.7	3.696	21.0
	RodF5_76.8	112	76.8	1.951	5.92	0.150	756.742895	675.8	1870.689713	5901.1	3.538	20.1
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1179.08506	910.4	2329.000416	7346.8	2.449	13.9
	RodC2_53.1	58	53.1	1.349	6.1	0.155	720.15419	655.5	3650.526447	11515.6	7.417	42.1
	RodC2_55	59	55	1.397	8	0.203	1013.68781	818.5	4772.260725	15054.1	6.074	34.5
	RodC2_57.8	60	57.8	1.468	10.8	0.274	1111.2536	872.7	5397.838817	17027.5	6.111	34.7
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1181.75696	911.9	5020.36693	15836.7	5.264	29.9
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1224.04066	935.4	3822.148688	12057.0	3.837	21.8
	RodC2_75.8	63	75.8	1.925	4.92	0.125	636.647818	609.1	2306.257393	7275.1	5.644	32.0
	RodC2_76.8	64	76.8	1.951	5.92	0.150	653.943253	618.7	2316.863807	7308.5	5.439	30.9
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	701.347776	645.0	1944.2399	6133.1	4.107	23.3
	RodC6_52.8	138	52.8	1.341	5.8	0.147	709.081637	649.3	1998.197834	6303.3	4.154	23.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	697.313332	642.8	2103.456476	6635.4	4.482	25.5
	RodC6_57.8	140	57.8	1.468	10.8	0.274	556.522632	564.6	2181.913369	6882.8	6.642	37.7
	RodC6_63.8	141	63.8	1.621	16.8	0.427	623.069983	601.5	2238.331112	7060.8	5.666	32.2
	RodC6_73.7	142	73.7	1.872	2.82	0.072	661.760845	623.0	2273.279883	7171.1	5.241	29.8
	RodC6_75.8	143	75.8	1.925	4.92	0.125	688.136372	637.7	2360.930446	7447.6	5.131	29.1
	RodC6_76.8	144	76.8	1.951	5.92	0.150	714.690533	652.4	2455.876718	7747.1	5.046	28.7

Table A-65: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	742.177151	667.7	2254.462307	7111.7	4.385	24.9
	RodB4_91.3	162	91.3	2.319	2.8	0.071	758.272411	676.6	2272.534361	7168.7	4.286	24.3
	RodB4_93.3	163	93.3	2.370	4.8	0.122	386.646547	470.2	2036.780092	6425.0	12.838	72.9
	RodB4_95.1	164	95.1	2.416	6.6	0.168	475.509263	519.5	2289.500625	7222.2	9.250	52.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	710.74479	650.2	2216.855477	6993.1	4.592	26.1
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	728.464594	660.1	2227.596002	7027.0	4.451	25.3
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	744.416585	668.9	2245.490629	7083.4	4.348	24.7
	RodF4_92.4	100	92.4	2.347	3.9	0.099	388.663861	471.3	2042.868388	6444.2	12.715	72.2
	RodF4_94.3	101	94.3	2.395	5.8	0.147	478.125718	521.0	2292.138692	7230.6	9.164	52.0
	RodF4_97.2	102	97.2	2.469	8.7	0.221	1082.57468	856.8	2820.858392	8898.4	3.301	18.7
	RodF4_108.8	103	108.8	2.764	20.3	0.516	1068.81833	849.2	2737.891712	8636.7	3.256	18.5
	RodF4_111	104	111	2.819	-1.75	-0.044	1032.34247	828.9	2721.203665	8584.0	3.383	19.2
Gr-6	RodD2_114.9	68	114.9	2.918	2.15	0.055	1103.84313	868.6	2455.018742	7744.4	2.803	15.9
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1127.39935	881.7	2325.707622	7336.4	2.586	14.7
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1162.21604	901.0	2150.18284	6782.8	2.302	13.1
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1183.63361	912.9	1943.790087	6131.7	2.034	11.6
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1193.11393	918.2	1747.24444	5511.7	1.810	10.3
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1122.03434	878.7	2520.108288	7949.7	2.819	16.0
	RodD6_106	130	106	2.692	17.5	0.445	1017.06706	820.4	2675.458559	8439.7	3.391	19.3
	RodD6_112.9	131	112.9	2.868	0.15	0.004	1056.13541	842.1	2515.703457	7935.8	3.038	17.3
	RodD6_114.9	132	114.9	2.918	2.15	0.055	397.460262	476.2	1588.850521	5012.0	9.376	53.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	322.722137	434.7	1532.63571	4834.7	16.180	91.9
	RodD6_120.9	134	120.9	3.071	8.15	0.207	871.936272	739.8	2584.22324	8151.9	4.013	22.8
	RodD6_124.8	135	124.8	3.170	12.05	0.306	927.158322	770.5	2622.856726	8273.8	3.751	21.3
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1235.67222	941.9	972.8987089	3069.0	0.965	5.5

Table A-65: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	314.08237	429.9	1548.809293	4885.7	17.992	102.2
	RodE2_54	74	54	1.372	7	0.178	478.137022	521.0	1756.415389	5540.6	7.022	39.9
	RodE2_56.9	75	56.9	1.445	9.9	0.251	499.864252	533.1	1996.81591	6299.0	7.345	41.7
	RodE2_59.9	76	59.9	1.521	12.9	0.328	328.247472	437.7	2150.875202	6784.9	21.456	121.8
	RodE2_66	77	66	1.676	19	0.483	531.162228	550.5	2192.284048	6915.6	7.231	41.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	591.562074	584.0	2230.341941	7035.6	6.135	34.8
	RodE2_72.9	79	72.9	1.852	2.02	0.051	398.55097	476.8	2007.637651	6333.1	11.771	66.8
	RodE2_74.9	80	74.9	1.902	4.02	0.102	482.699717	523.5	2267.994169	7154.4	8.905	50.6
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1150.28761	894.4	2128.032903	6712.9	2.307	13.1
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1164.24406	902.2	1926.984173	6078.7	2.058	11.7
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1179.45077	910.6	1725.326531	5442.5	1.813	10.3
	RodB3_60.1	172	60.1	1.527	13.1	0.333	706.037697	647.6	1635.261974	5158.4	3.421	19.4
	RodB3_66.1	173	66.1	1.679	19.1	0.485	760.934336	678.1	1849.806331	5835.2	3.471	19.7
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	778.724323	688.0	1886.455643	5950.8	3.425	19.5
	RodB3_73	175	73	1.854	2.12	0.054	784.590416	691.3	1935.07247	6104.2	3.477	19.7
	RodB3_75	176	75	1.905	4.12	0.105	811.162774	706.0	2040.537276	6436.9	3.499	19.9
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	883.162828	746.0	2533.918367	7993.2	3.868	22.0
	RodF3_54	90	54	1.372	7	0.178	917.296855	765.0	2569.244481	8104.7	3.727	21.2
	RodF3_57	91	57	1.448	10	0.254	690.627813	639.1	1643.191962	5183.4	3.552	20.2
	RodF3_60	92	60	1.524	13	0.330	703.838409	646.4	1851.835485	5841.6	3.892	22.1
	RodF3_66.1	93	66.1	1.679	19.1	0.485	735.062774	663.7	1873.571429	5910.2	3.695	21.0
	RodF3_70	94	70	1.778	-0.88	-0.022	768.955156	682.6	1918.12828	6050.7	3.546	20.1
	RodF3_73	95	73	1.854	2.12	0.054	802.908963	701.4	2019.535194	6370.6	3.513	19.9
	RodF3_75	96	75	1.905	4.12	0.105	691.257847	639.4	2192.160766	6915.2	4.732	26.9
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	546.349667	558.9	2451.718034	7733.9	7.701	43.7
	RodE6_54.1	122	54.1	1.374	7.1	0.180	593.891095	585.3	2712.930029	8557.9	7.415	42.1
	RodE6_57	123	57	1.448	10	0.254	606.778284	592.5	2930.466056	9244.2	7.737	43.9
	RodE6_60.2	124	60.2	1.529	13.2	0.335	678.803907	632.5	3081.313203	9720.0	6.835	38.8
	RodE6_66.1	125	66.1	1.679	19.1	0.485	705.011787	647.0	3154.717201	9951.6	6.613	37.6
	RodE6_70	126	70	1.778	-0.88	-0.022	742.244411	667.7	3265.116618	10299.8	6.349	36.1
	RodE6_73.1	127	73.1	1.857	2.22	0.056	607.604286	592.9	1819.518117	5739.7	4.793	27.2
	RodE6_75	128	75	1.905	4.12	0.105	651.845964	617.5	1882.735527	5939.1	4.442	25.2

RBHT Steam Cooling with Droplet Injection Test SCD-4053-K

Matrix Test # 10c

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 28200 - 28560
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 29 kW
Bundle Inlet Reynolds Number: 2000
Bundle Inlet Steam Flow: 40.82 kg/hr (90 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

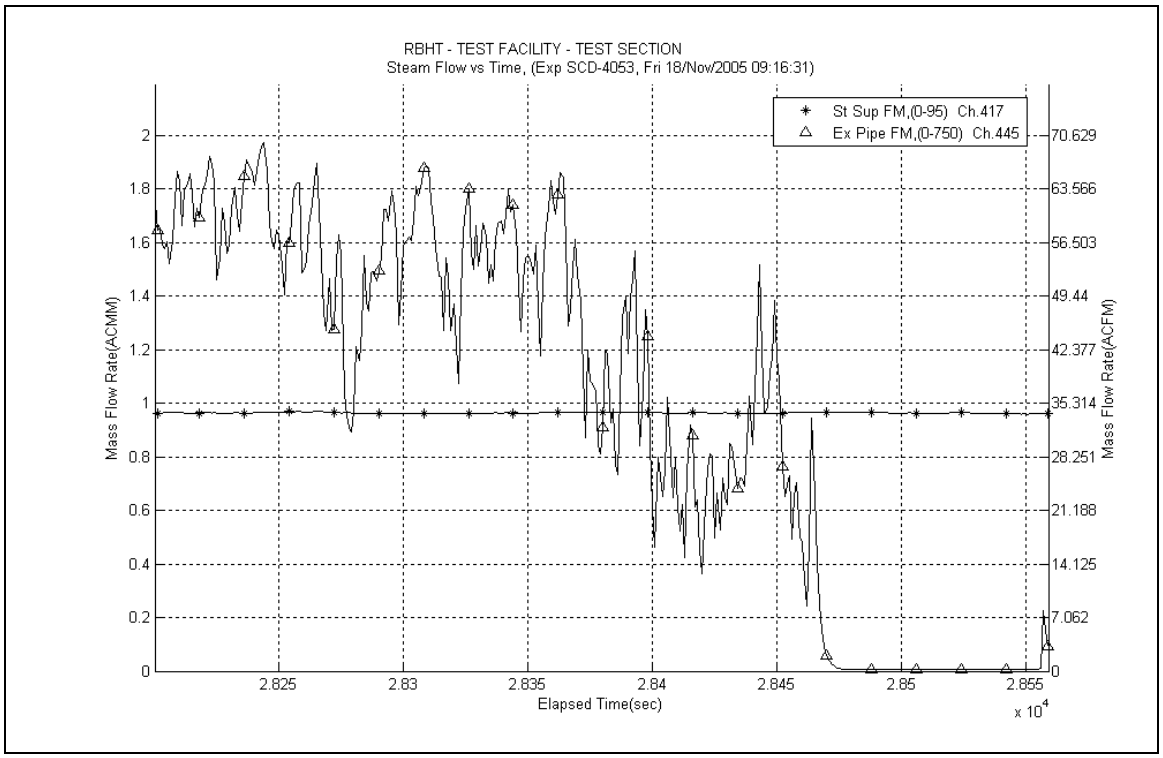

Figure A-512: Inlet and Exhaust Steam Flow Rates for Experiment 4053K

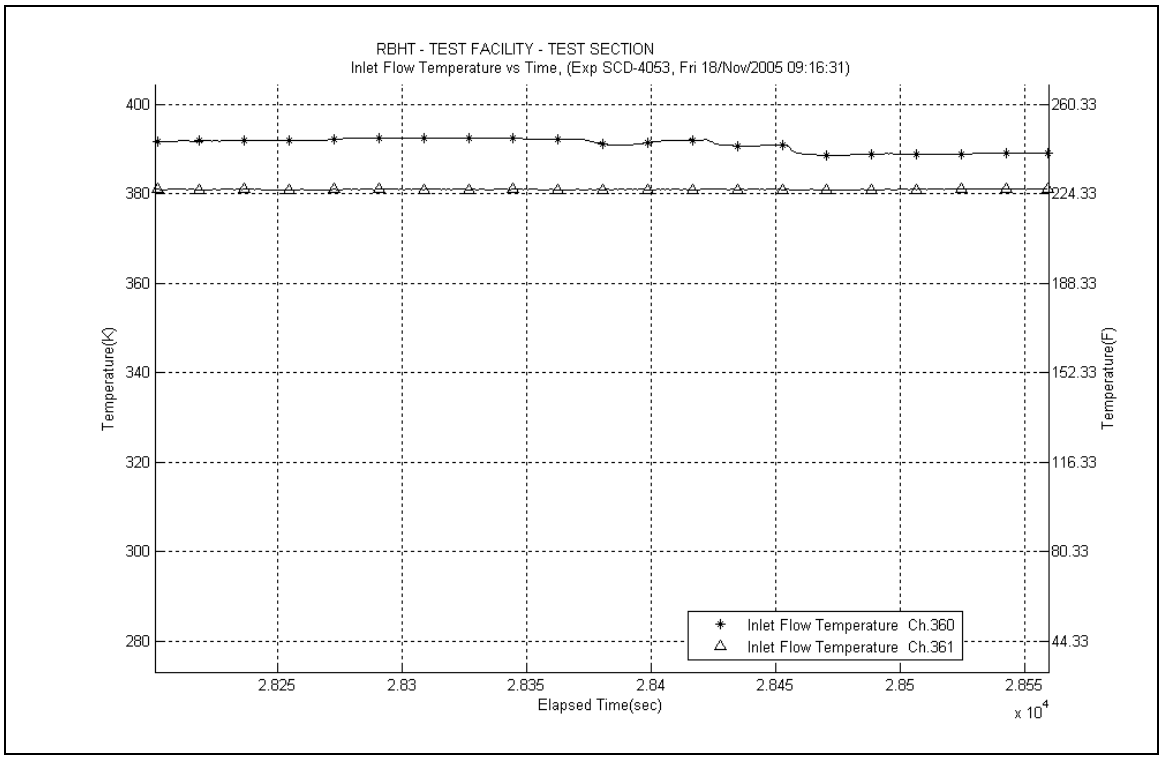

Figure A-513: Inlet Steam Temperature for Experiment 4053K

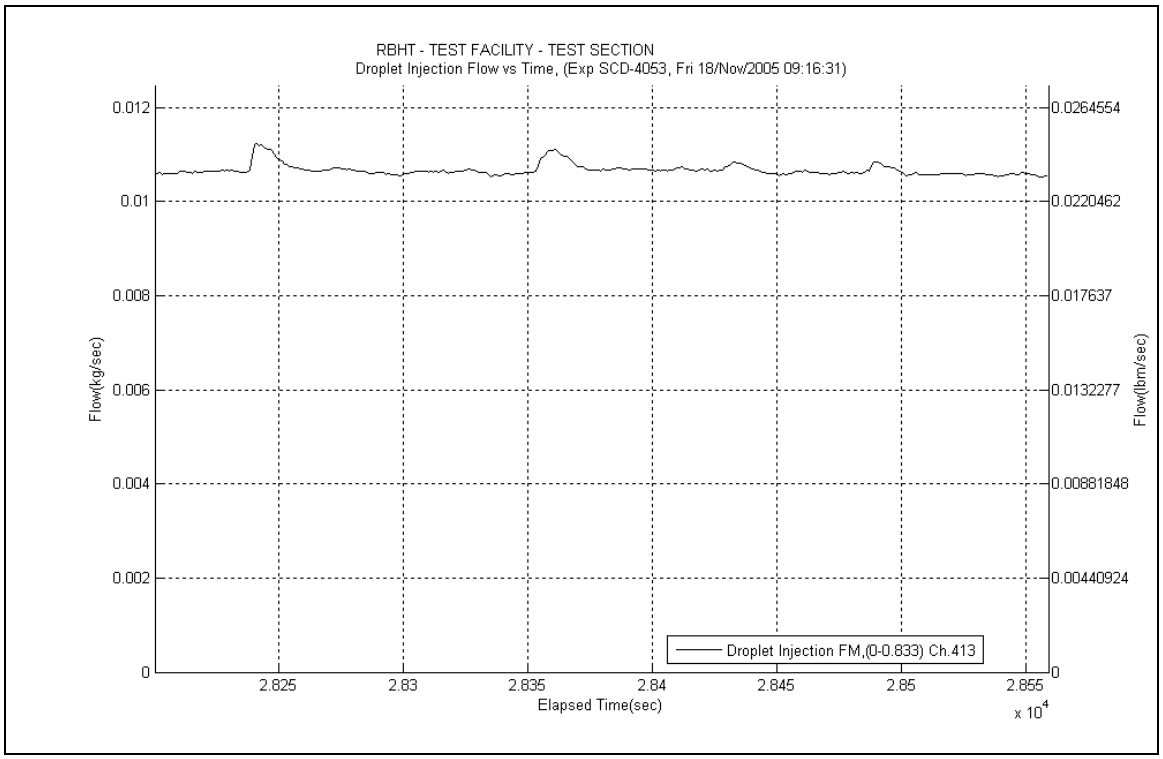

Figure A-514: Droplet Injection Flow Rate for Experiment 4053K

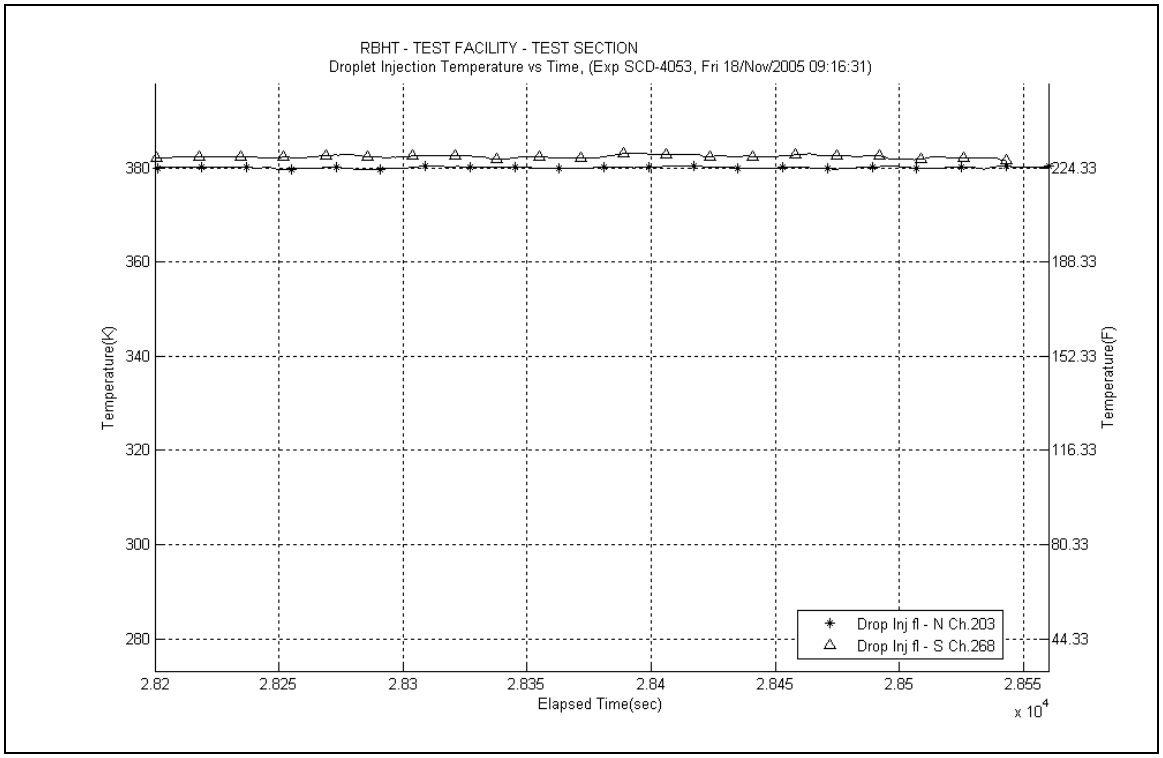

Figure A-515: Droplet Injection Temperature for Experiment 4053K

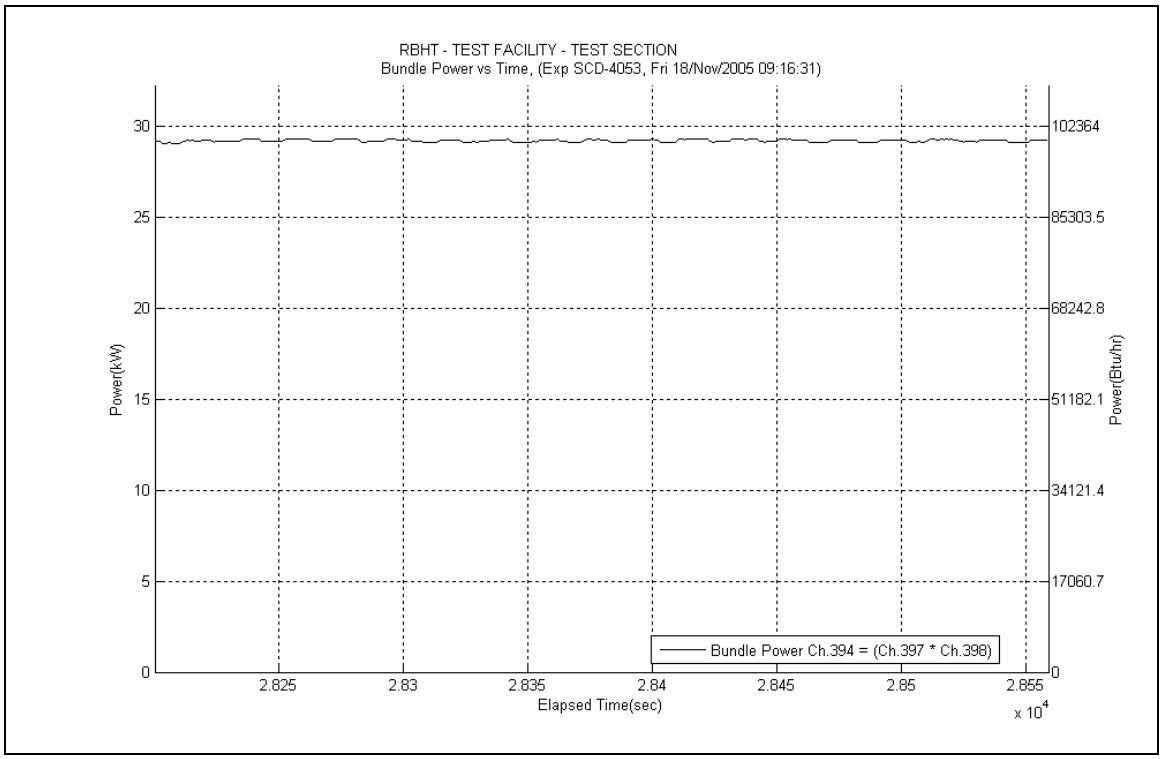

Figure A-516: Bundle Power for Experiment 4053K

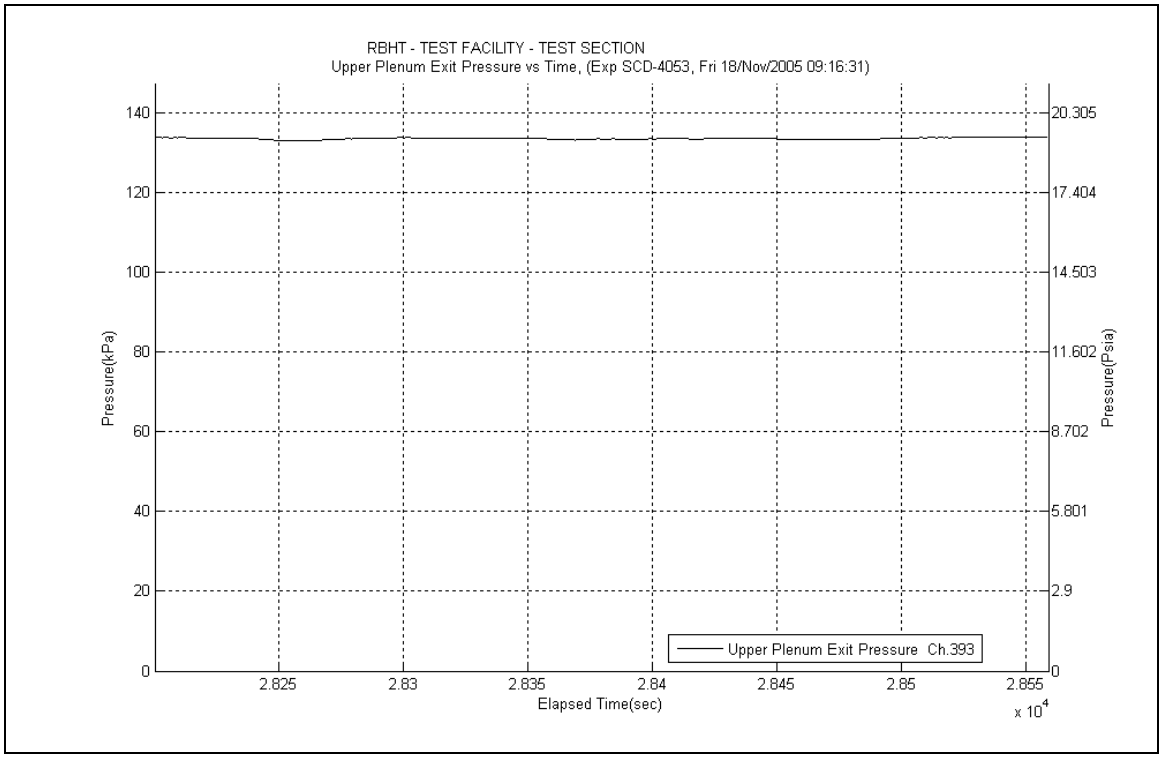

Figure A-517: Upper Plenum Pressure for Experiment 4053K

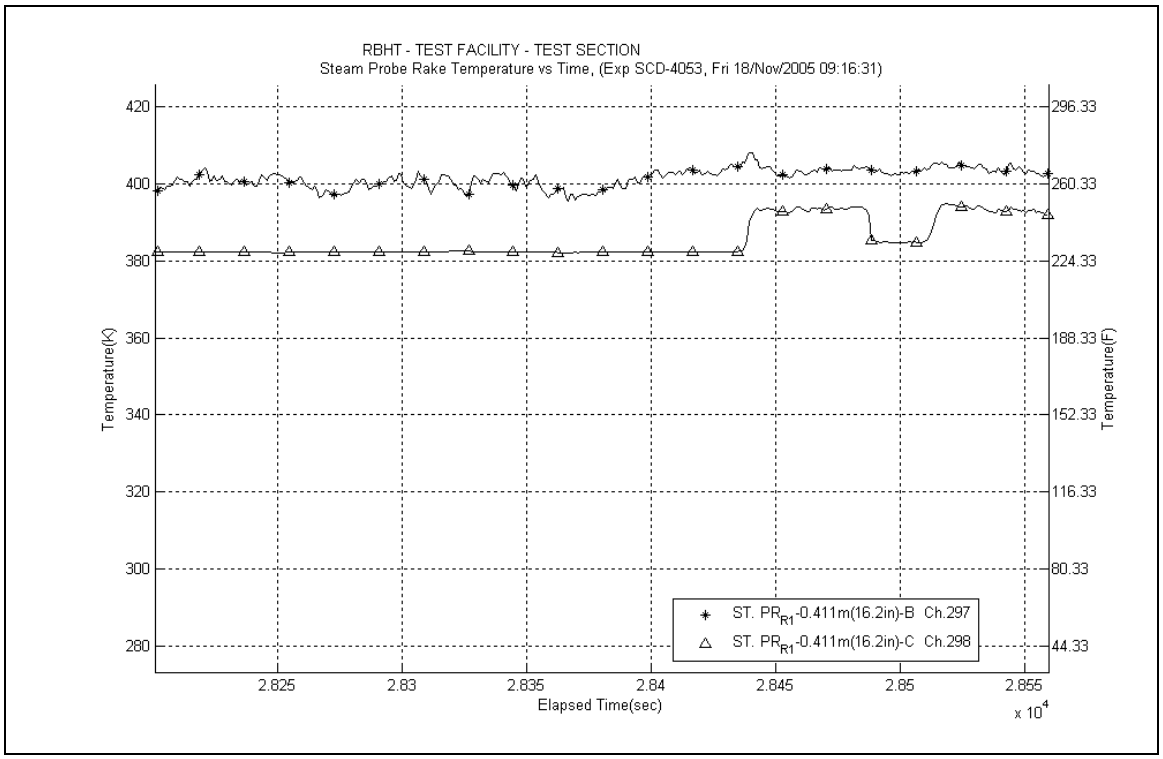

Figure A-518: Steam Probe Rake #1 Temperatures for Experiment 4053K

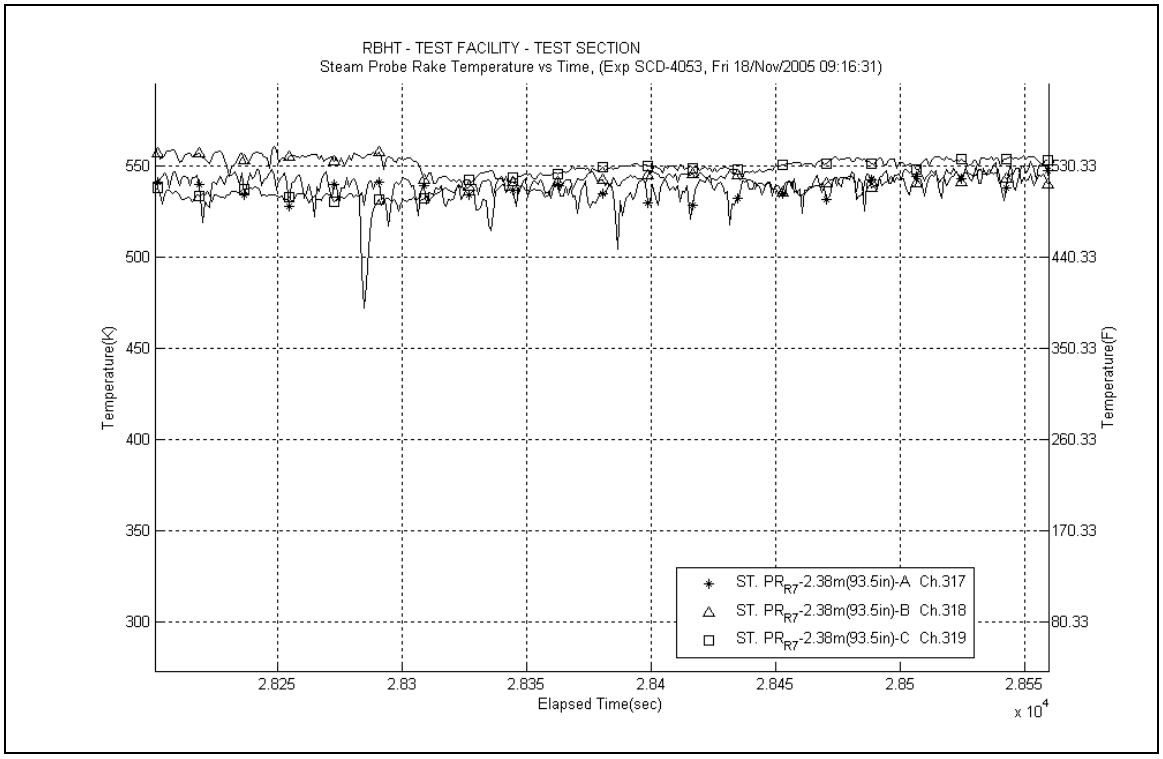

Figure A-519: Steam Probe Rake #7 Temperatures for Experiment 4053K

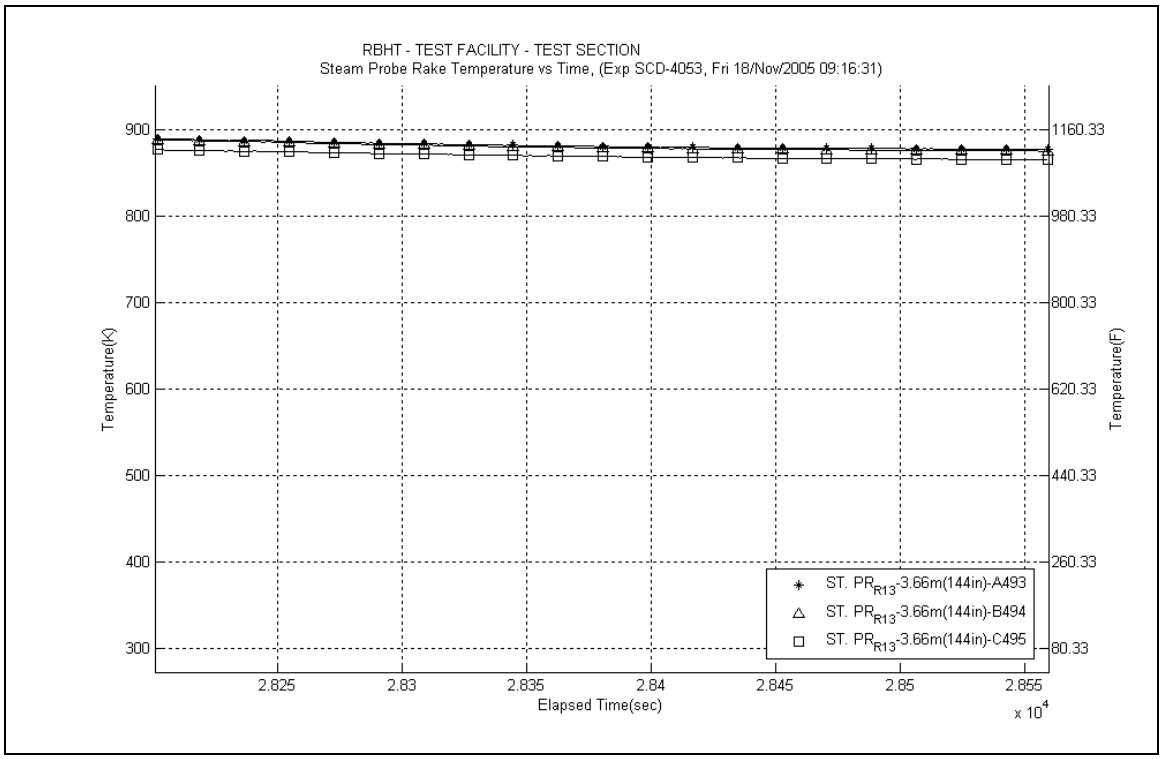

Figure A-520: Steam Probe Rake #13 Temperatures for Experiment 4053K

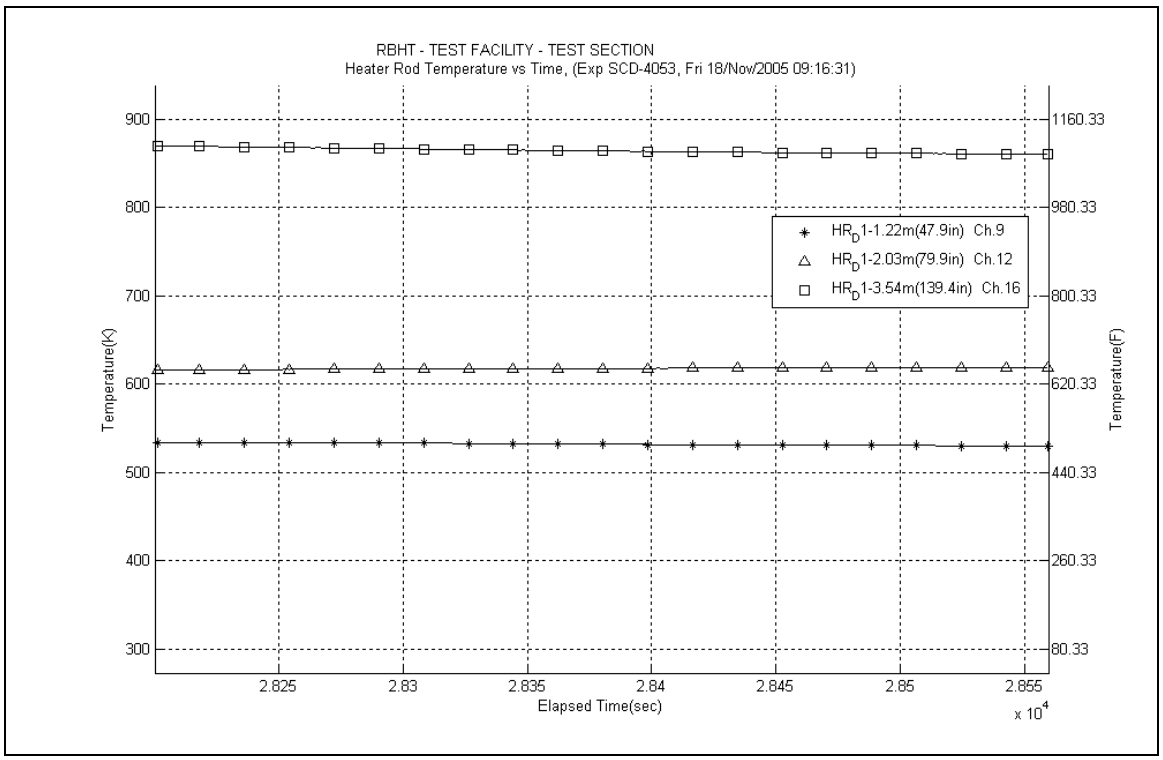

Figure A-521: Heater Rod D1 Temperatures for Experiment 4053K

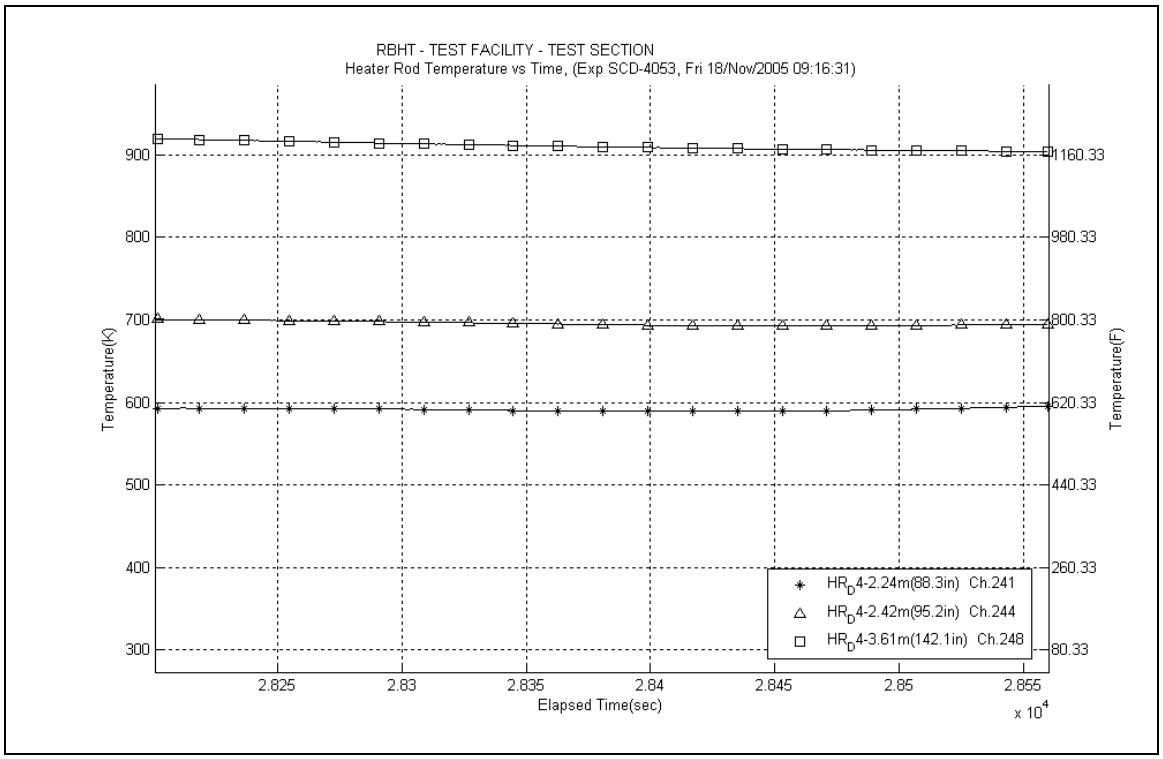

Figure A-522: Heater Rod D4 Temperatures for Experiment 4053K

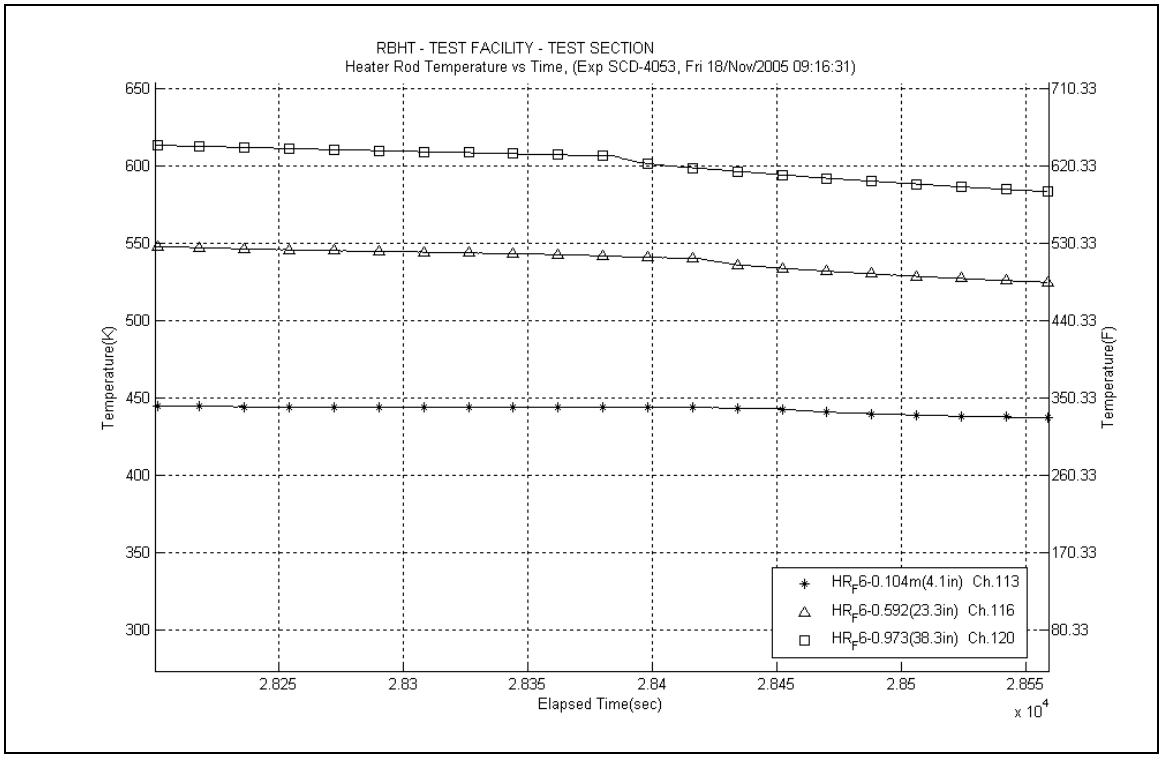

Figure A-523: Heater Rod F6 Temperatures for Experiment 4053K

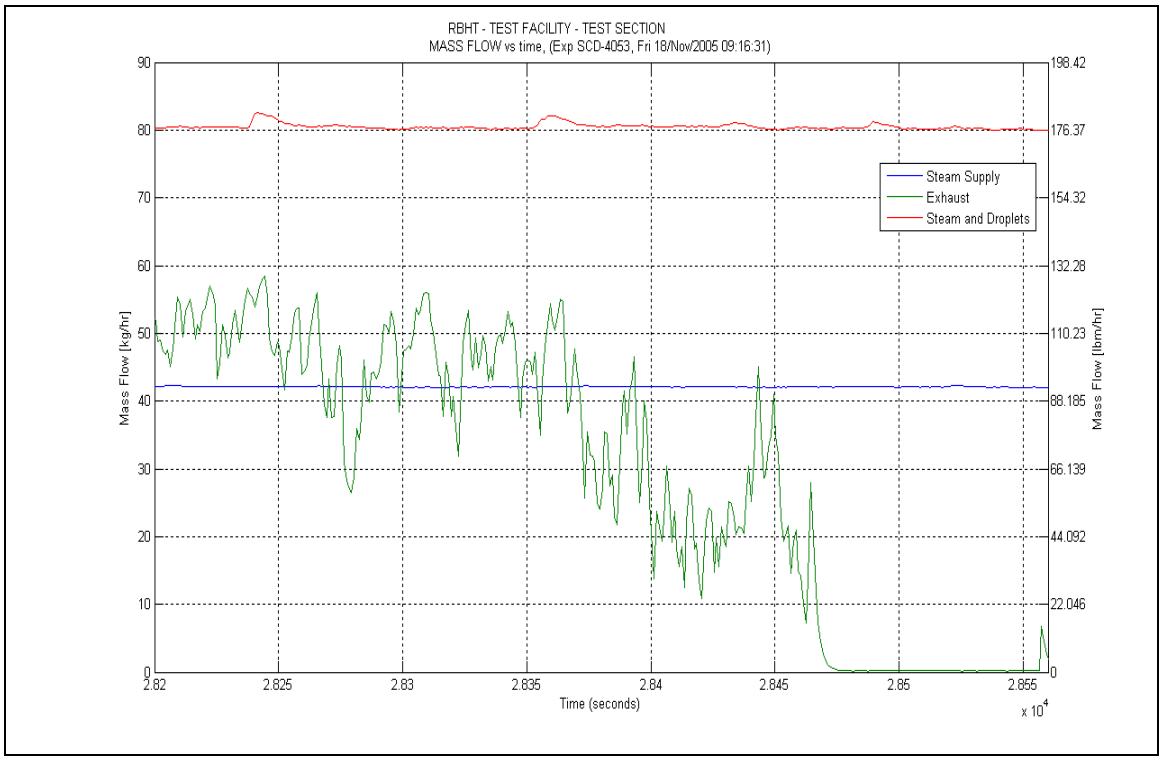

Figure A-524: Mass Flow for Experiment 4053K

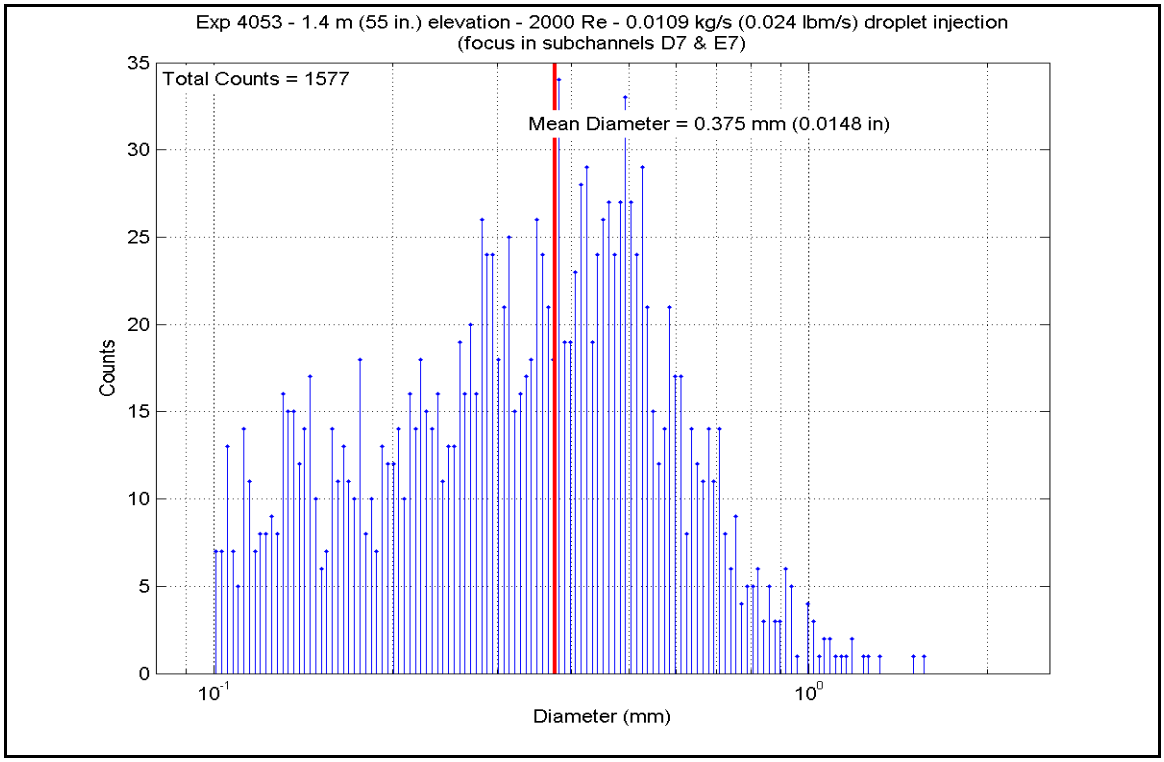

Figure A-525: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053K

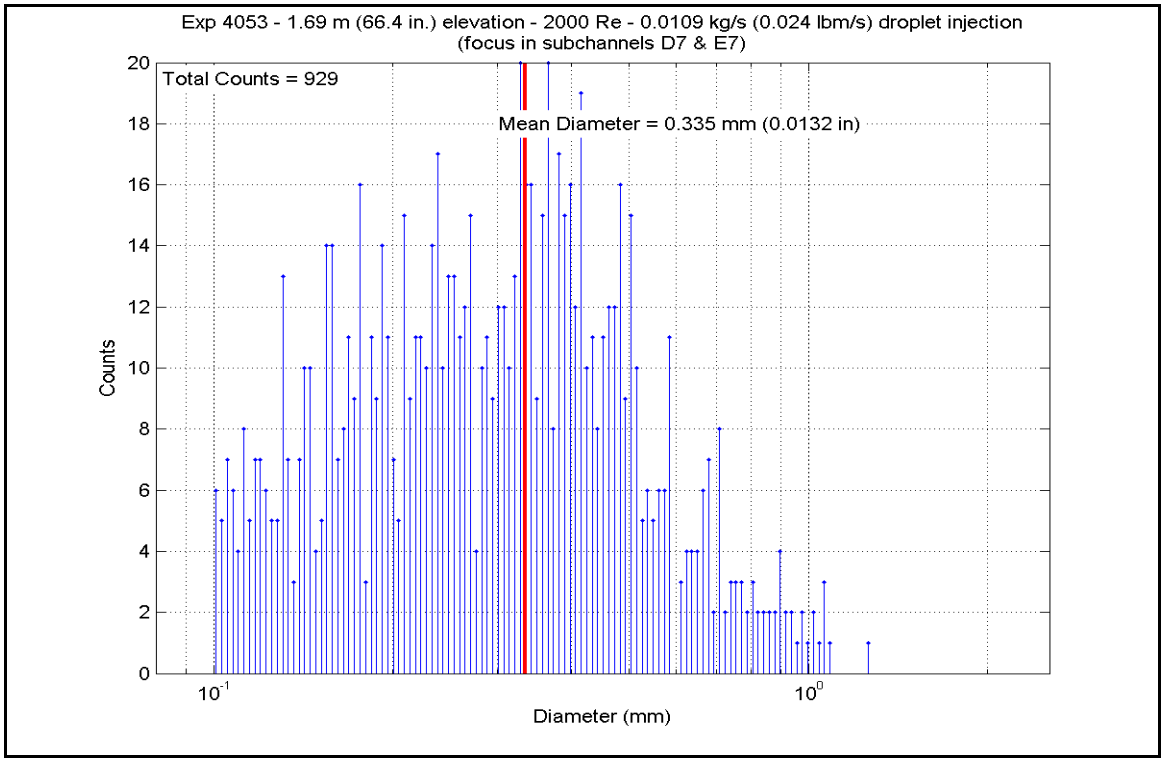

Figure A-526: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053K

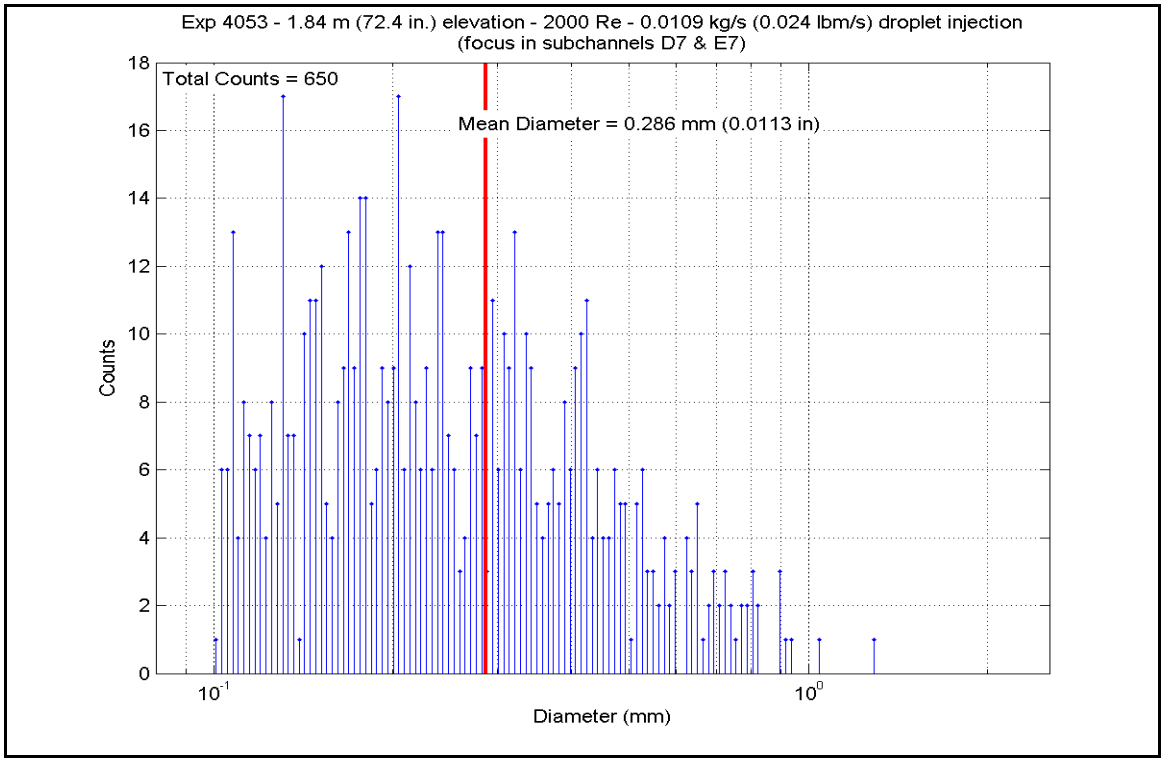

Figure A-527: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053K

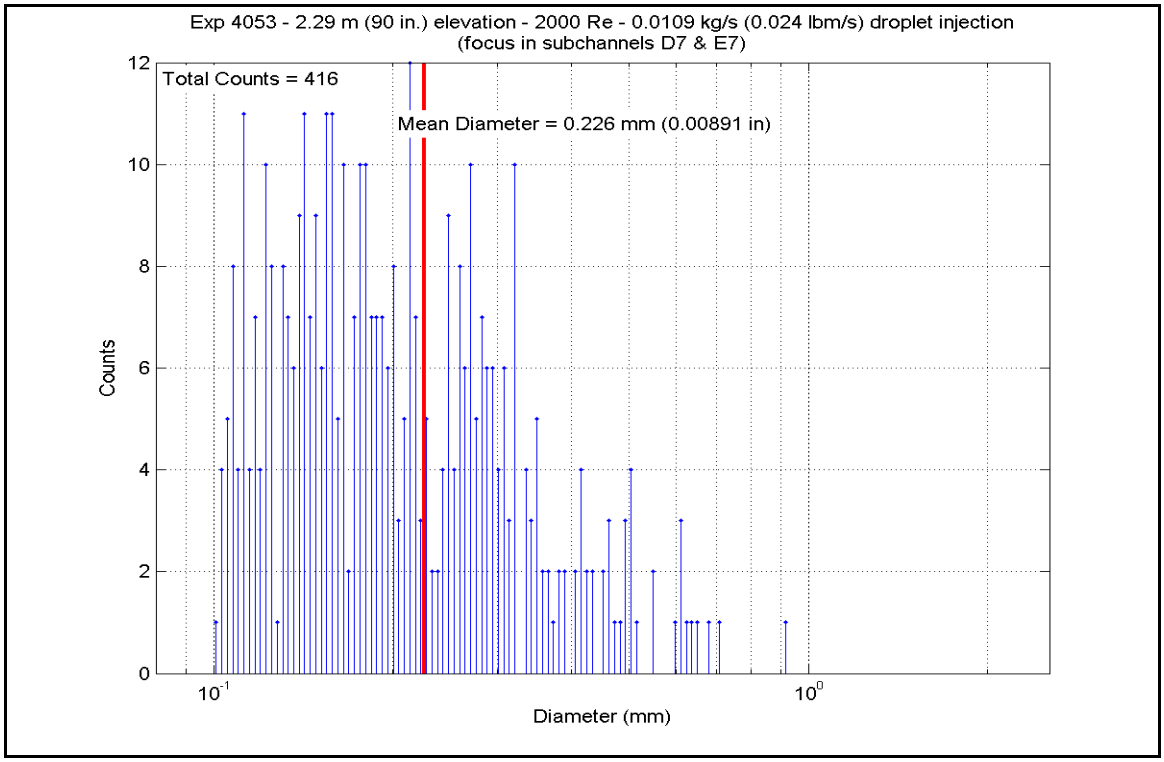

Figure A-528: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053K

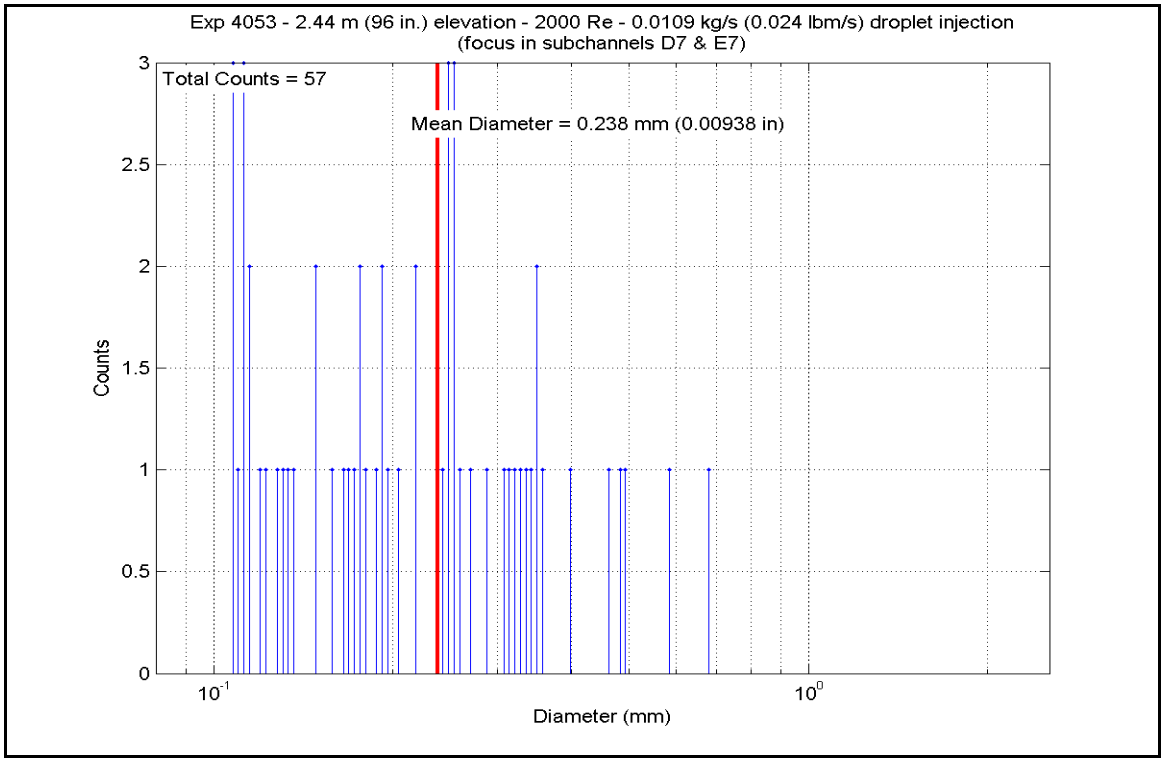

Figure A-529: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053K

Table A-66: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053K

Test 4053-K	Inlet Reynolds:	2000		
Matrix test # 10c	UP Pressure:	137.9 kPa	20	psia
Time Window: 28200-28560	Bundle Power:	29.00 kW	98952	Btu/hr
	Steam flow:	0.0113 kg/s	90.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	722.789986	656.9	2511.165049	7921.5	5.075	28.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	771.043994	683.7	2577.281553	8130.0	4.746	27.0
	RodD3_93.1	187	93.1	2.365	4.6	0.117	600.990055	589.3	2395.435506	7556.4	6.422	36.5
	RodD3_95.3	188	95.3	2.421	6.8	0.173	692.234078	639.9	2490.252427	7855.5	5.364	30.5
	RodD3_142.1	192	142.1	3.609	8.6	0.218	605.735908	591.9	2369.829404	7475.6	6.274	35.6
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	956.508128	786.8	2467.62552	7784.1	3.387	19.2
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1010.06595	816.5	2351.721221	7418.5	3.007	17.1
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1051.53264	839.6	2189.543689	6906.9	2.659	15.1
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1075.31061	852.8	2010.629681	6342.5	2.373	13.5
	RodC4_142.2	240	142.2	3.612	8.7	0.221	650.791484	616.9	2341.221914	7385.4	5.538	31.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	585.739515	580.8	2284.088766	7205.2	6.385	36.3
	RodD4_91.3	242	91.3	2.319	2.8	0.071	625.193842	602.7	2325.525659	7335.9	5.855	33.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	663.920485	624.2	2180.729542	6879.1	5.003	28.4
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1010.63103	816.8	2449.553398	7727.1	3.130	17.8
	RodD4_100.1	245	100.1	2.543	11.6	0.295	970.766006	794.7	2848.490985	8985.6	3.835	21.8
	RodD4_106.1	246	106.1	2.695	17.6	0.447	966.104008	792.1	2806.097087	8851.8	3.802	21.6
	RodD4_142.1	248	142.1	3.609	8.6	0.218	538.272538	554.4	2208.303745	6966.1	7.117	40.4
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	702.991179	645.9	2431.019417	7668.7	5.118	29.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	795.034008	697.1	2553.026352	8053.5	4.502	25.6
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1174.28888	907.8	1147.457004	3619.7	1.213	6.9
	RodE4_100.9	205	100.9	2.563	12.4	0.315	897.016865	753.7	2807.557559	8856.4	4.197	23.8
	RodE4_142.3	208	142.3	3.614	8.8	0.224	624.355354	602.2	2303.346741	7265.9	5.811	33.0

Table A-66: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1152.51029	895.7	1542.653259	4866.3	1.669	9.5
	RodE3_113.6	194	113.6	2.885	0.85	0.022	971.223925	794.9	2535.163662	7997.2	3.411	19.4
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1043.63771	835.2	2465.468793	7777.3	3.023	17.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1081.71336	856.3	2337.68932	7374.2	2.738	15.6
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1115.62466	875.2	2149.809986	6781.6	2.422	13.8
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1130.78728	883.6	1972.869626	6223.4	2.185	12.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1129.22393	882.7	1719.488211	5424.1	1.908	10.8
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	662.514189	623.4	2142.901526	6759.8	4.932	28.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1214.73427	930.2	1712.71706	5402.8	1.736	9.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1149.71828	894.1	1568.585298	4948.1	1.702	9.7
	RodC5_126.7	230	126.7	3.218	13.95	0.354	593.109085	584.9	1998.385576	6303.9	5.473	31.1
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	602.918141	590.3	2069.67129	6528.8	5.520	31.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	628.039043	604.3	2066.446602	6518.6	5.166	29.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1178.37026	910.0	1149.520111	3626.2	1.210	6.9
	RodE5_113.6	210	113.6	2.885	0.85	0.022	955.438128	786.2	2911.513176	9184.4	4.002	22.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	795.443356	697.3	2674.396671	8436.4	4.713	26.8
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1173.547	907.3	1179.274619	3720.0	1.247	7.1
	RodE5_122.6	213	122.6	3.114	9.85	0.250	603.924133	590.9	2469.797503	7791.0	6.570	37.3
	RodE5_126.6	214	126.6	3.216	13.85	0.352	691.397878	639.5	2546.072122	8031.6	5.494	31.2
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	739.474716	666.2	2588.572816	8165.7	5.061	28.7
	RodE5_135.6	216	135.6	3.444	2.1	0.053	791.244466	695.0	2657.330097	8382.5	4.718	26.8
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	747.657379	670.7	2568.553398	8102.5	4.943	28.1
	RodC3_85.6	178	85.6	2.174	14.72	0.374	786.617337	692.4	2616.373093	8253.3	4.684	26.6
	RodC3_88.5	179	88.5	2.248	0	0.000	1146.5848	892.4	1155.499029	3645.0	1.258	7.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	1042.32648	834.4	1886.601942	5951.3	2.317	13.2
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1085.51481	858.4	2149.380028	6780.2	2.507	14.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1108.44798	871.2	1970.367545	6215.5	2.238	12.7
	RodD5_60	220	60	1.524	13	0.330	1106.18664	869.9	1739.647712	5487.7	1.981	11.2
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1141.43502	889.5	1553.855756	4901.6	1.701	9.7
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	603.799764	590.8	2474.409154	7805.5	6.584	37.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	691.629528	639.6	2560.707351	8077.8	5.523	31.4
	RodD5_74.9	224	74.9	1.902	4.02	0.102	747.794189	670.8	2626.750347	8286.1	5.053	28.7

Table A-66: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	547.281845	559.4	2464.047157	7772.8	7.717	43.8
	RodB5_52.9	154	52.9	1.344	5.9	0.150	595.655714	586.3	2714.828017	8563.9	7.384	41.9
	RodB5_55	155	55	1.397	8	0.203	619.224535	599.4	2928.489598	9237.9	7.485	42.5
	RodB5_57.8	156	57.8	1.468	10.8	0.274	689.23147	638.3	3069.558946	9682.9	6.655	37.8
	RodB5_64	157	64	1.626	17	0.432	717.061442	653.7	3139.597781	9903.9	6.420	36.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	755.761817	675.2	3248.432732	10247.2	6.155	35.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	581.828988	578.6	1789.650485	5645.5	5.058	28.7
	RodB5_76.9	160	76.9	1.953	6.02	0.153	543.006352	557.0	2027.363384	6395.3	6.436	36.5
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	548.143786	559.9	2468.672677	7787.4	7.711	43.8
	RodF5_53.1	106	53.1	1.349	6.1	0.155	595.013883	585.9	2713.726768	8560.5	7.394	42.0
	RodF5_55	107	55	1.397	8	0.203	607.301498	592.8	2925.82663	9229.5	7.714	43.8
	RodF5_57.8	108	57.8	1.468	10.8	0.274	682.349612	634.5	3065.739251	9670.9	6.748	38.3
	RodF5_64	109	64	1.626	17	0.432	708.365978	648.9	3136.343967	9893.6	6.529	37.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	747.020902	670.4	3241.854369	10226.4	6.246	35.5
	RodF5_75.8	111	75.8	1.925	4.92	0.125	431.807753	495.3	3581.29681	11297.2	17.572	99.8
	RodF5_76.8	112	76.8	1.951	5.92	0.150	427.512247	492.9	3769.489598	11890.9	18.894	107.3
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1032.10352	828.8	2341.628294	7386.7	2.912	16.5
	RodC2_53.1	58	53.1	1.349	6.1	0.155	725.26104	658.3	3629.790569	11450.2	7.300	41.5
	RodC2_55	59	55	1.397	8	0.203	989.373107	805.0	4762.496533	15023.3	6.255	35.5
	RodC2_57.8	60	57.8	1.468	10.8	0.274	1033.67999	829.6	5392.654646	17011.1	6.693	38.0
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1076.001	853.2	5003.115118	15782.3	5.900	33.5
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1113.87282	874.2	3840.361997	12114.4	4.335	24.6
	RodC2_75.8	63	75.8	1.925	4.92	0.125	576.993523	575.9	2223.316227	7013.5	6.371	36.2
	RodC2_76.8	64	76.8	1.951	5.92	0.150	597.109903	587.1	2241.617198	7071.2	6.073	34.5
Gr-2	RodC6_57.8	140	57.8	1.468	10.8	0.274	247.403135	392.8	2164.435506	6827.7	111.551	633.5
	RodC6_63.8	141	63.8	1.621	16.8	0.427	457.40172	509.5	2194.761442	6923.4	9.567	54.3
	RodC6_73.7	142	73.7	1.872	2.82	0.072	528.055659	548.7	2239.09154	7063.2	7.462	42.4
	RodC6_75.8	143	75.8	1.925	4.92	0.125	592.420763	584.5	2314.203883	7300.2	6.350	36.1
	RodC6_76.8	144	76.8	1.951	5.92	0.150	579.70344	577.4	2269.020804	7157.6	6.452	36.6

Table A-66: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	634.836685	608.1	2382.402219	7515.3	5.856	33.3
	RodB4_91.3	162	91.3	2.319	2.8	0.071	652.680624	618.0	2401.228849	7574.7	5.654	32.1
	RodB4_93.3	163	93.3	2.370	4.8	0.122	387.669279	470.7	2035.227462	6420.1	12.747	72.4
	RodB4_95.1	164	95.1	2.416	6.6	0.168	480.89939	522.5	2287.241331	7215.1	9.044	51.4
	RodB4_142.3	168	142.3	3.614	8.8	0.224	601.08	589.3	2342.854369	7390.5	6.280	35.7
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	686.433981	636.7	2303.839112	7267.5	5.025	28.5
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	701.767268	645.2	2323.271845	7328.8	4.904	27.8
	RodF4_92.4	100	92.4	2.347	3.9	0.099	391.610402	472.9	2041.743412	6440.7	12.479	70.9
	RodF4_94.3	101	94.3	2.395	5.8	0.147	482.666727	523.5	2290.435506	7225.2	8.994	51.1
	RodF4_97.2	102	97.2	2.469	8.7	0.221	953.515645	785.1	2883.23301	9095.2	3.974	22.6
	RodF4_108.8	103	108.8	2.764	20.3	0.516	941.369626	778.4	2804.355062	8846.3	3.931	22.3
	RodF4_111	104	111	2.819	-1.75	-0.044	896.305229	753.3	2804.359223	8846.4	4.196	23.8
Gr-6	RodD2_114.9	68	114.9	2.918	2.15	0.055	1014.18298	818.8	2506.694868	7907.4	3.188	18.1
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1042.18311	834.4	2390.71706	7541.5	2.936	16.7
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1084.31419	857.8	2231.970874	7040.8	2.606	14.8
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1110.75541	872.5	2034.300971	6417.2	2.304	13.1
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1122.07675	878.7	1844.464632	5818.4	2.063	11.7
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1012.19276	817.7	2559.636616	8074.4	3.264	18.5
	RodD6_106	130	106	2.692	17.5	0.445	890.127864	749.9	2699.988904	8517.1	4.078	23.2
	RodD6_112.9	131	112.9	2.868	0.15	0.004	913.474993	762.9	2528.411928	7975.9	3.689	20.9
	RodD6_114.9	132	114.9	2.918	2.15	0.055	507.036879	537.1	1840.926491	5807.2	6.597	37.5
	RodD6_116.8	133	116.8	2.967	4.05	0.103	562.972219	568.1	1920.434119	6058.0	5.733	32.6
	RodD6_120.9	134	120.9	3.071	8.15	0.207	739.603953	666.3	2544.694868	8027.2	4.974	28.2
	RodD6_124.8	135	124.8	3.170	12.05	0.306	799.603856	699.6	2626.162275	8284.2	4.594	26.1
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1172.40391	906.7	1084.514286	3421.1	1.148	6.5

Table A-66: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	557.9038	565.3	2016.52982	6361.1	6.112	34.7
	RodE2_54	74	54	1.372	7	0.178	339.697004	444.1	2769.251731	8735.6	24.793	140.8
	RodE2_59.9	76	59.9	1.521	12.9	0.328	229.216089	382.7	2149.319417	6780.0	1767.403	10036.9
	RodE2_66	77	66	1.676	19	0.483	461.888266	512.0	2139.918169	6750.4	9.149	52.0
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	540.383051	555.6	2195.21914	6924.8	7.027	39.9
	RodE2_72.9	79	72.9	1.852	2.02	0.051	401.174605	478.2	2007.285714	6332.0	11.591	65.8
	RodE2_74.9	80	74.9	1.902	4.02	0.102	483.963148	524.2	2270.793343	7163.2	8.872	50.4
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1044.11458	835.4	2244.68932	7080.9	2.750	15.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1066.2129	847.7	2049.818308	6466.2	2.445	13.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1083.64282	857.4	1845.973648	5823.1	2.157	12.3
	RodB3_60.1	172	60.1	1.527	13.1	0.333	603.975492	590.9	1817.865465	5734.5	4.835	27.5
	RodB3_66.1	173	66.1	1.679	19.1	0.485	627.238183	603.8	2080.088766	6561.6	5.210	29.6
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	637.008183	609.3	2099.037448	6621.4	5.132	29.1
	RodB3_73	175	73	1.854	2.12	0.054	651.124882	617.1	2150.364771	6783.3	5.082	28.9
	RodB3_75	176	75	1.905	4.12	0.105	665.504064	625.1	2290.087379	7224.1	5.234	29.7
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	758.396644	676.7	2475.841886	7810.0	4.668	26.5
	RodF3_54	90	54	1.372	7	0.178	795.108169	697.1	2543.87656	8024.7	4.486	25.5
	RodF3_57	91	57	1.448	10	0.254	668.255617	626.6	1780.034674	5615.1	4.043	23.0
	RodF3_60	92	60	1.524	13	0.330	680.487226	633.4	1935.661581	6106.0	4.278	24.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	706.090638	647.6	1989.998613	6277.5	4.162	23.6
	RodF3_70	94	70	1.778	-0.88	-0.022	737.422607	665.1	2053.008322	6476.2	4.030	22.9
	RodF3_73	95	73	1.854	2.12	0.054	766.362386	681.1	2157.446602	6805.7	4.007	22.8
	RodF3_75	96	75	1.905	4.12	0.105	650.213384	616.6	2260.367545	7130.3	5.354	30.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	546.572538	559.0	2456.023578	7747.5	7.709	43.8
	RodE6_54.1	122	54.1	1.374	7.1	0.180	594.70846	585.8	2717.142857	8571.2	7.410	42.1
	RodE6_57	123	57	1.448	10	0.254	609.332025	593.9	2930.852982	9245.4	7.686	43.6
	RodE6_60.2	124	60.2	1.529	13.2	0.335	681.812164	634.2	3080.786408	9718.3	6.789	38.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	708.536796	649.0	3153.893204	9949.0	6.563	37.3
	RodE6_70	126	70	1.778	-0.88	-0.022	746.566644	670.1	3263.443828	10294.5	6.293	35.7
	RodE6_73.1	127	73.1	1.857	2.22	0.056	594.551262	585.7	1813.183079	5719.7	4.947	28.1
	RodE6_75	128	75	1.905	4.12	0.105	644.950874	613.7	1873.916782	5911.3	4.494	25.5

RBHT Steam Cooling with Droplet Injection Test SCD-4053-L

Matrix Test # 10d

Test Conditions

Test Date – 11/18/2005
Steady State Time Window: 28800 - 29280
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 29 kW
Bundle Inlet Reynolds Number: 2000
Bundle Inlet Steam Flow: 40.82 kg/hr (90 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- No steam probes were traversed in this steady state window.

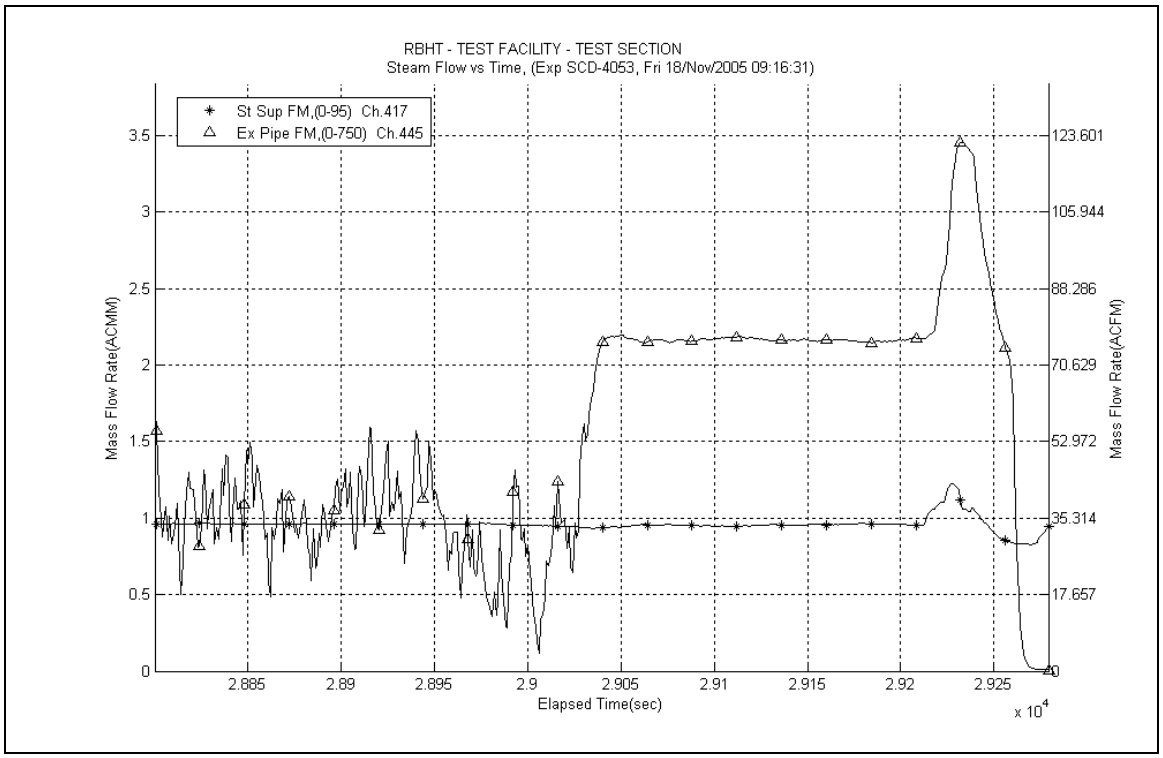

Figure A-530: Inlet and Exhaust Steam Flow Rates for Experiment 4053L

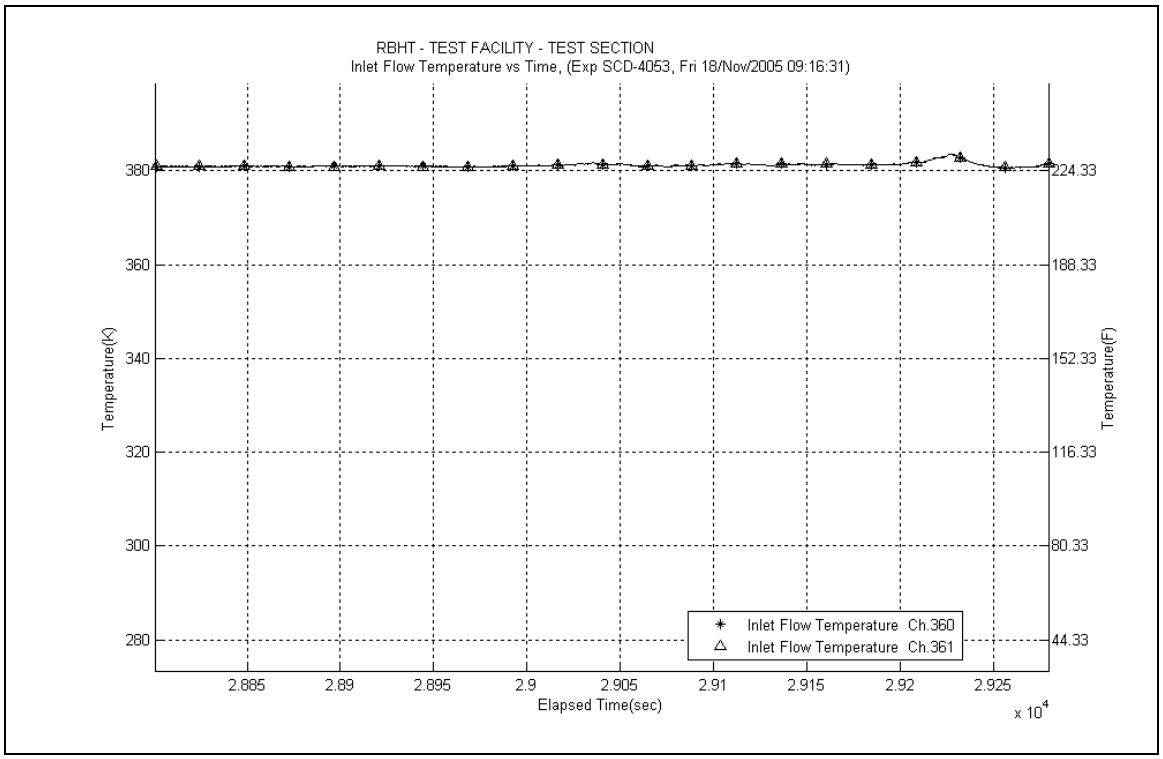

Figure A-531: Inlet Steam Temperature for Experiment 4053L

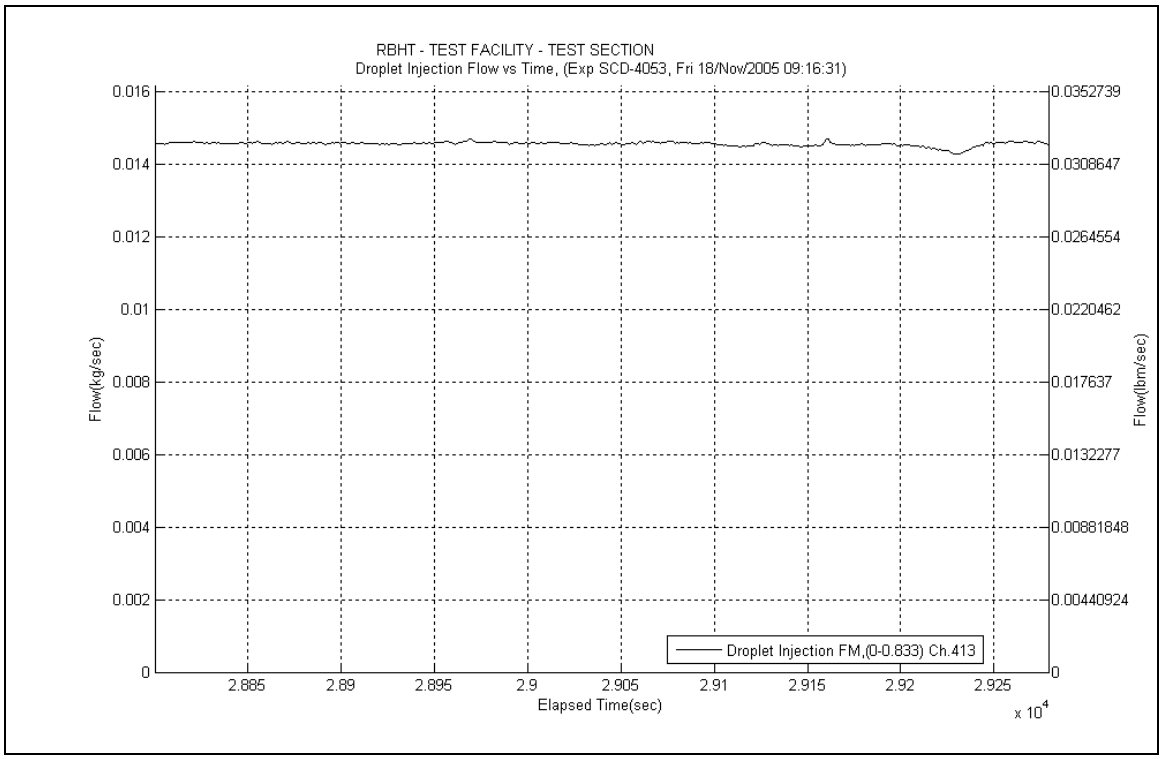

Figure A-532: Droplet Injection Flow Rate for Experiment 4053L

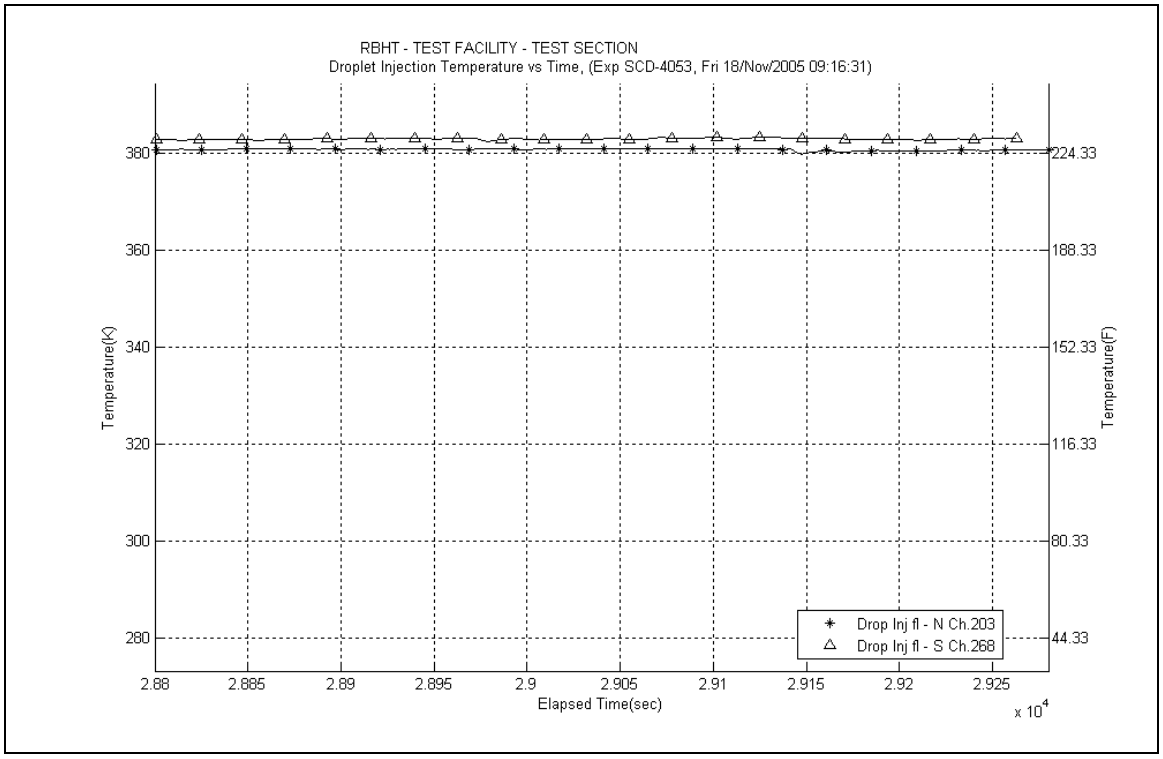

Figure A-533: Droplet Injection Temperature for Experiment 4053L

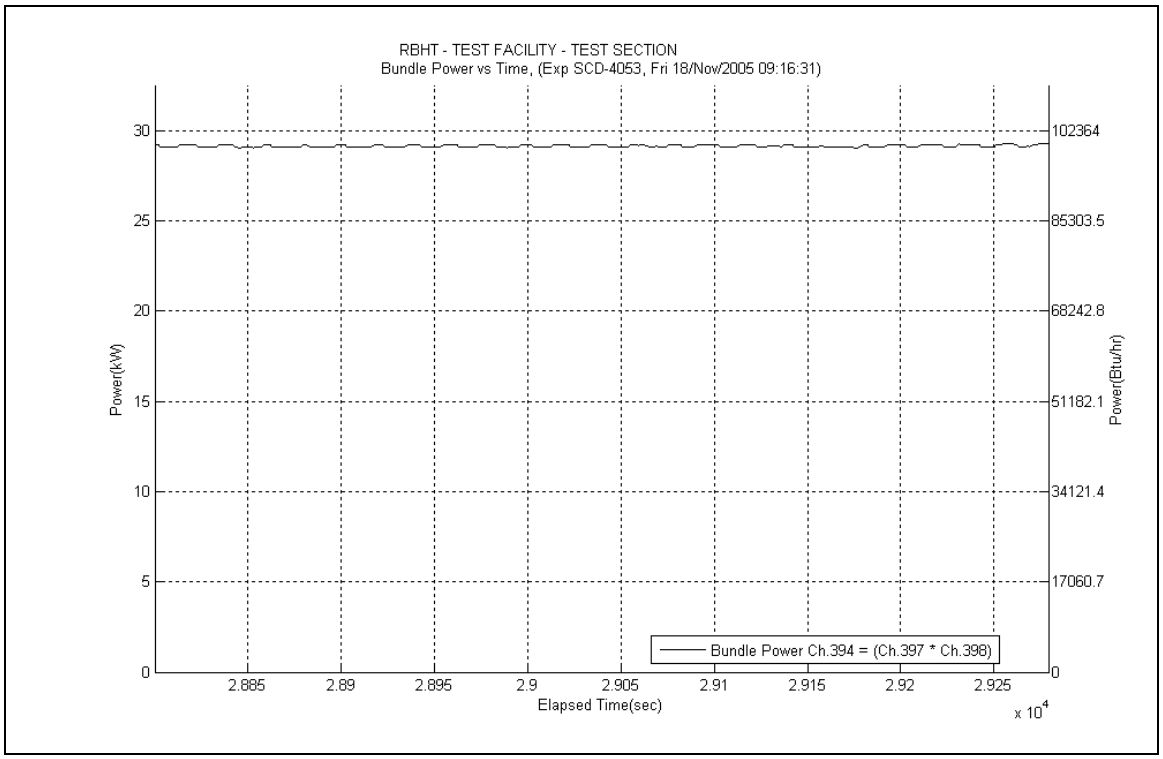

Figure A-534: Bundle Power for Experiment 4053L

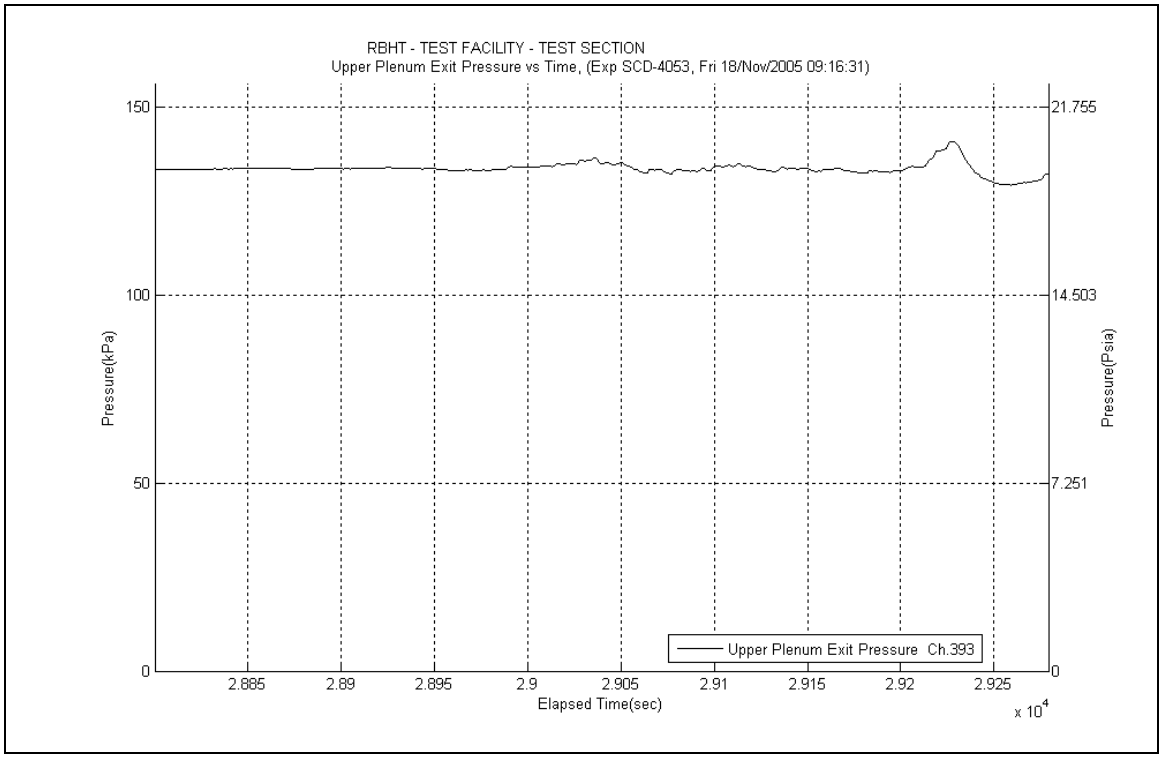

Figure A-535: Upper Plenum Pressure for Experiment 4053L

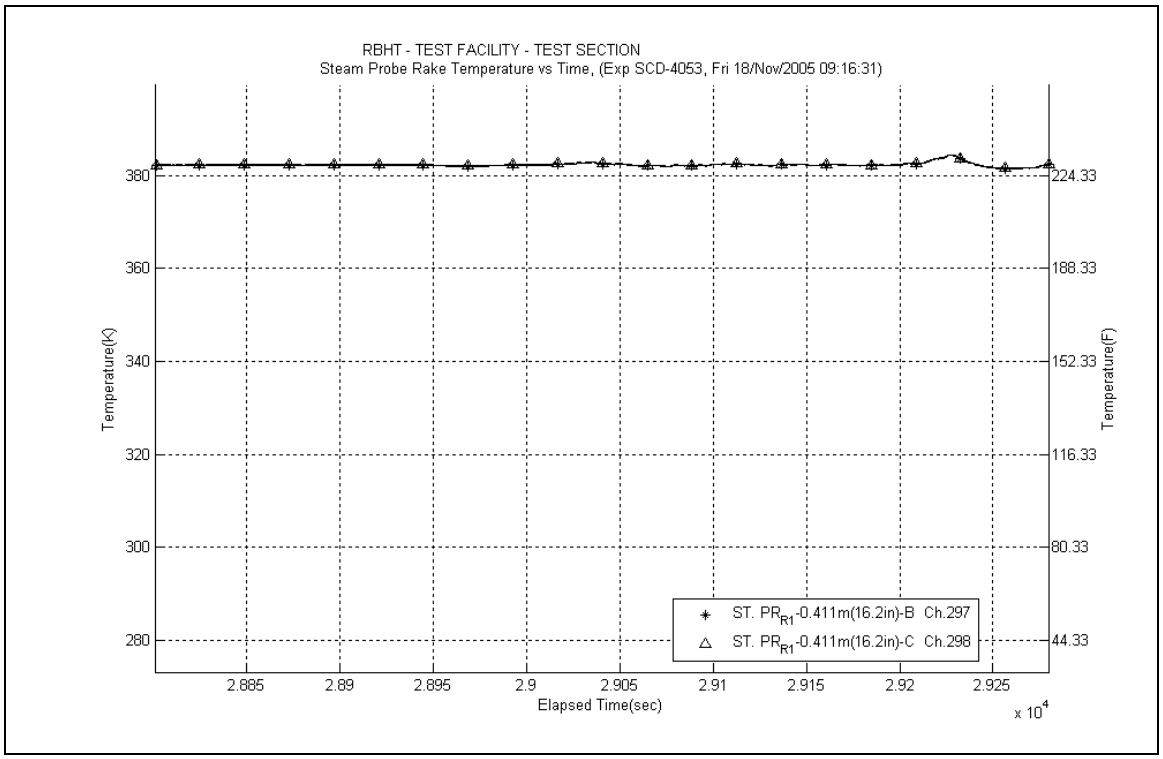

Figure A-536: Steam Probe Rake #1 Temperatures for Experiment 4053L

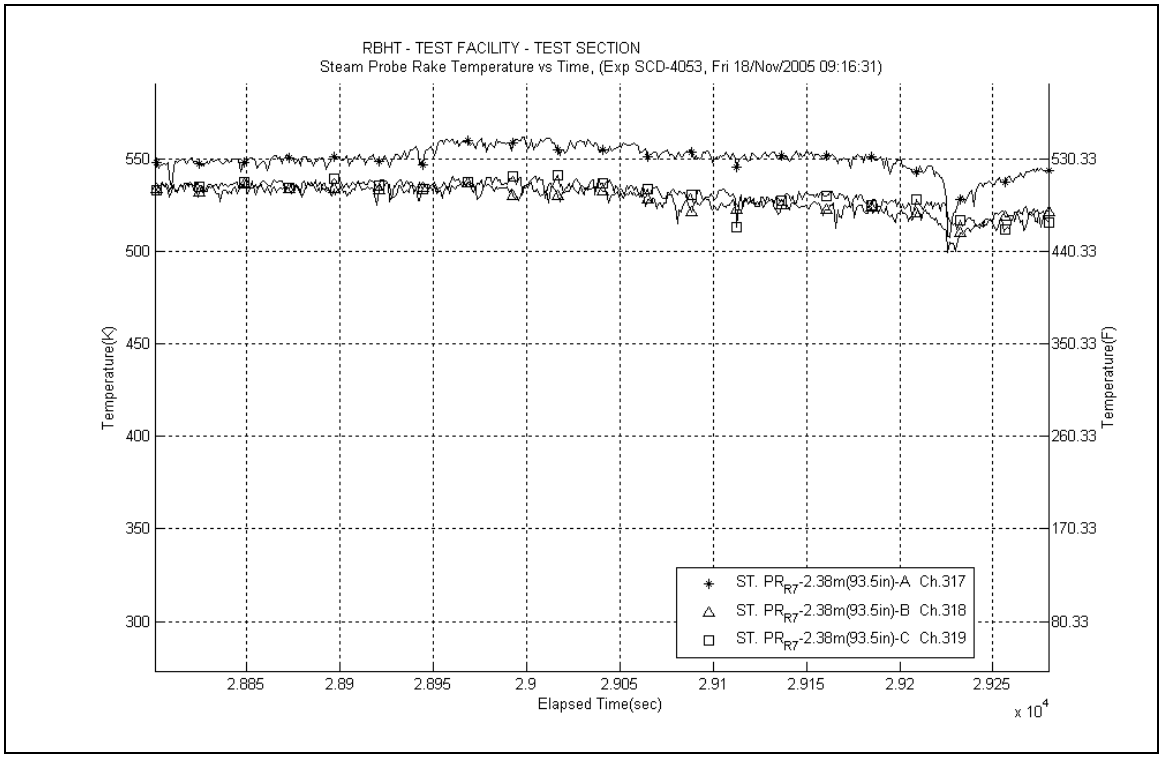

Figure A-537: Steam Probe Rake #7 Temperatures for Experiment 4053L

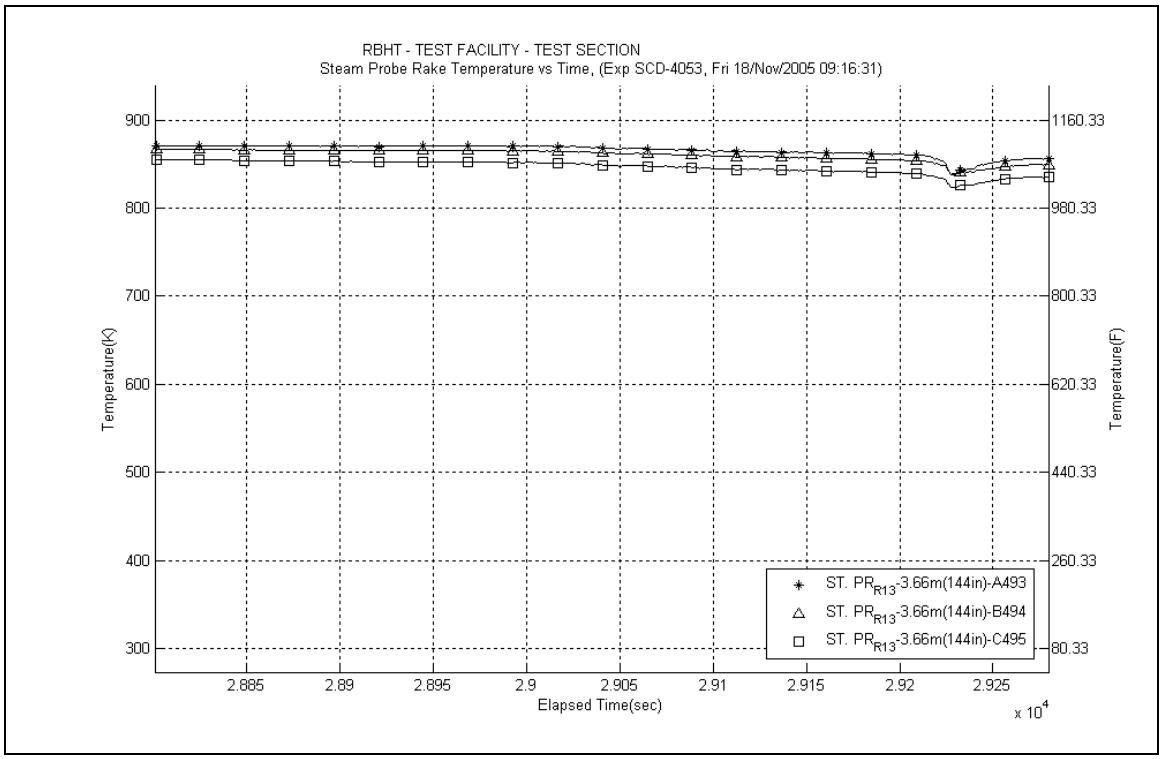

Figure A-538: Steam Probe Rake #13 Temperatures for Experiment 4053L

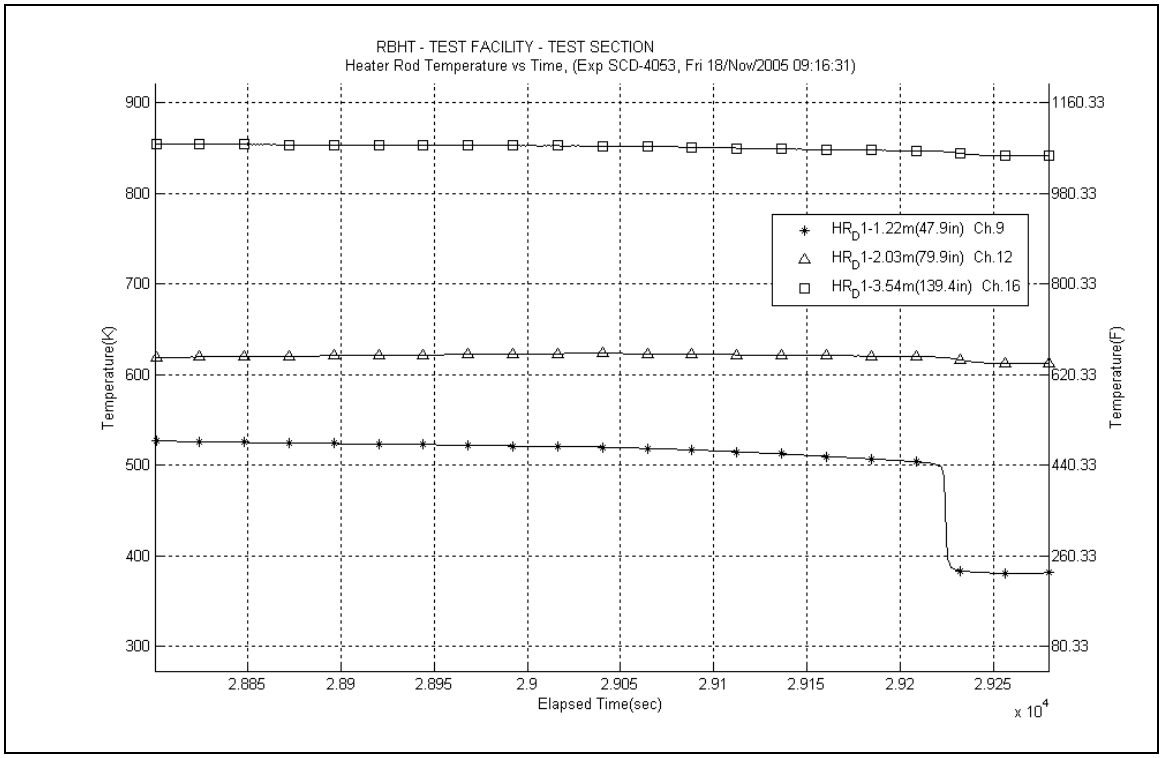

Figure A-539: Heater Rod D1 Temperatures for Experiment 4053L

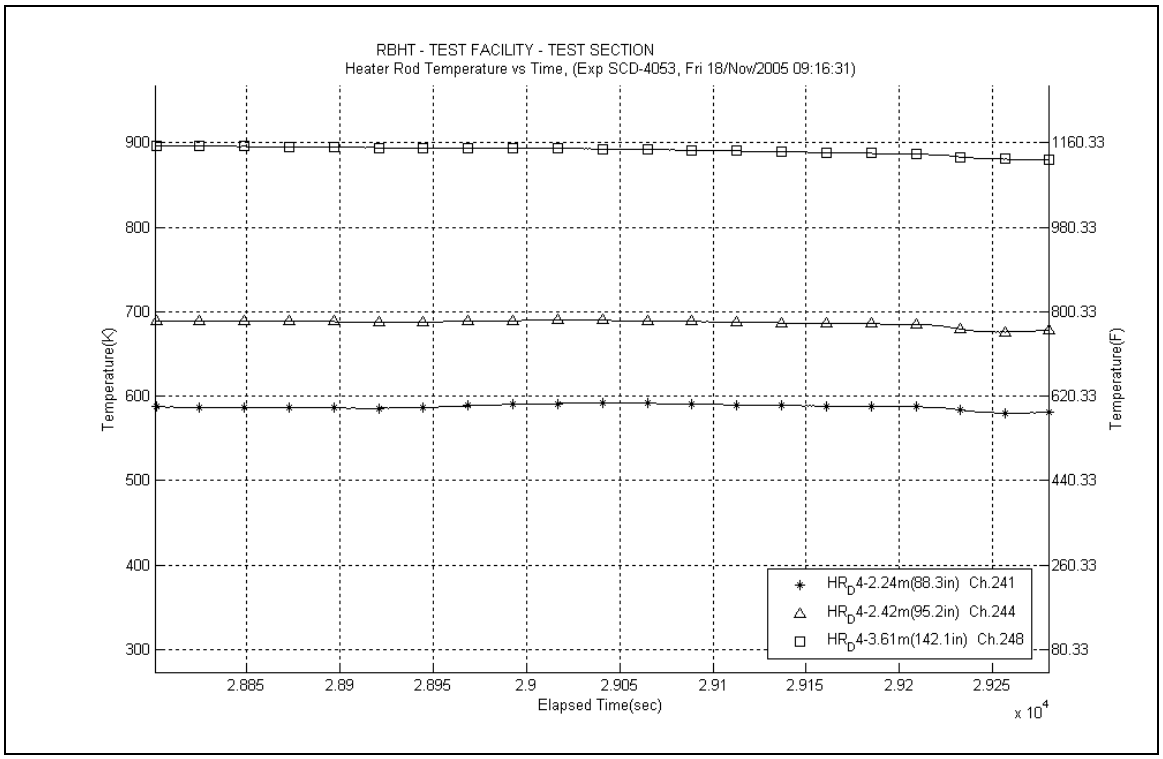

Figure A-540: Heater Rod D4 Temperatures for Experiment 4053L

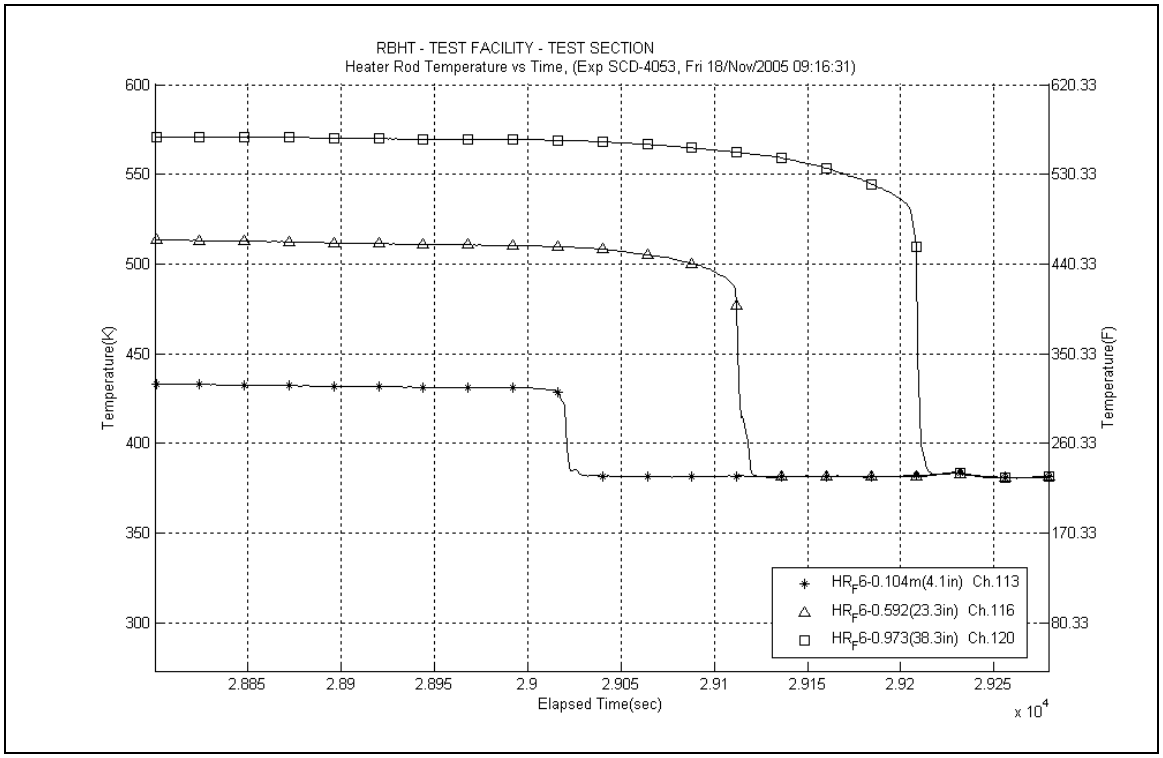

Figure A-541: Heater Rod F6 Temperatures for Experiment 4053L

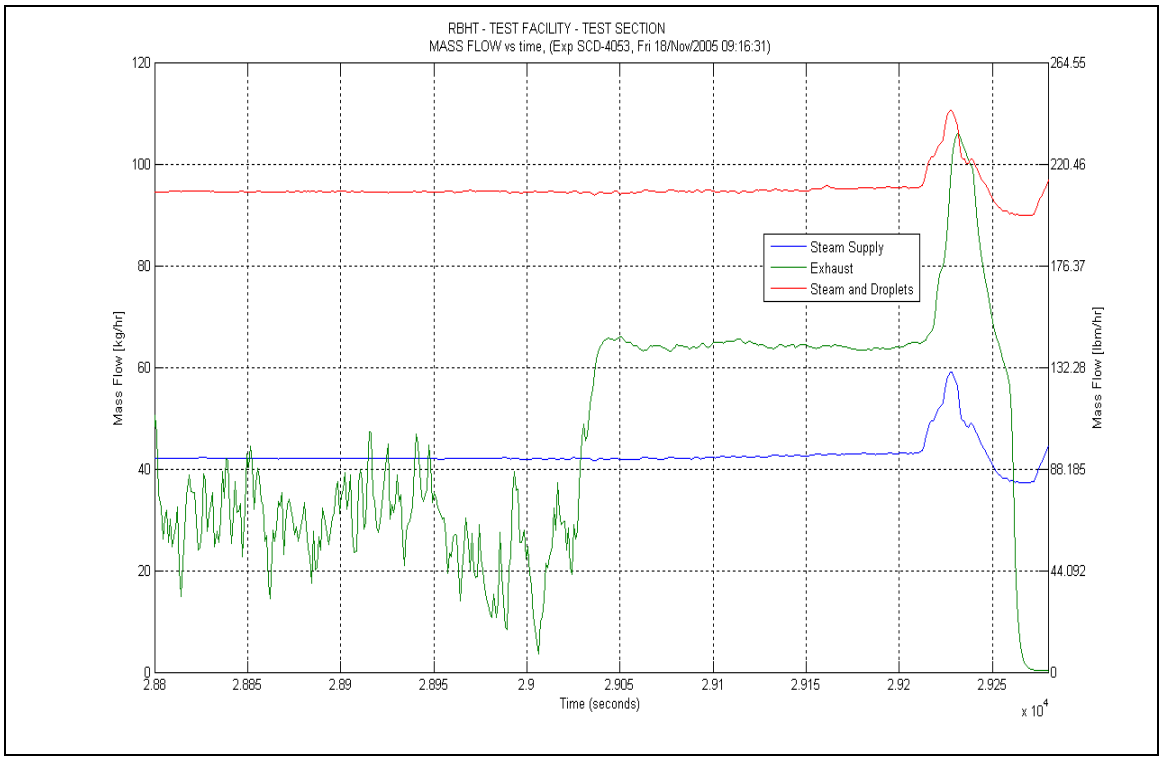

Figure A-542: Mass Flow for Experiment 4053L

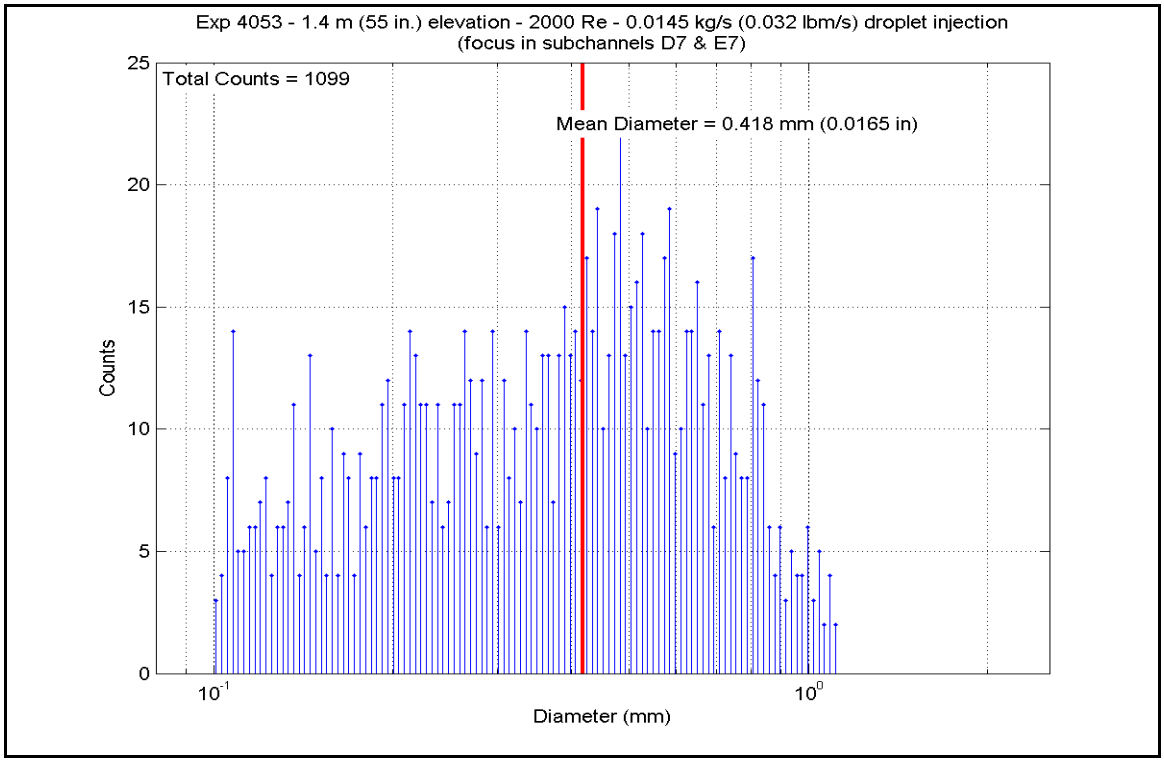

Figure A-543: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4053L

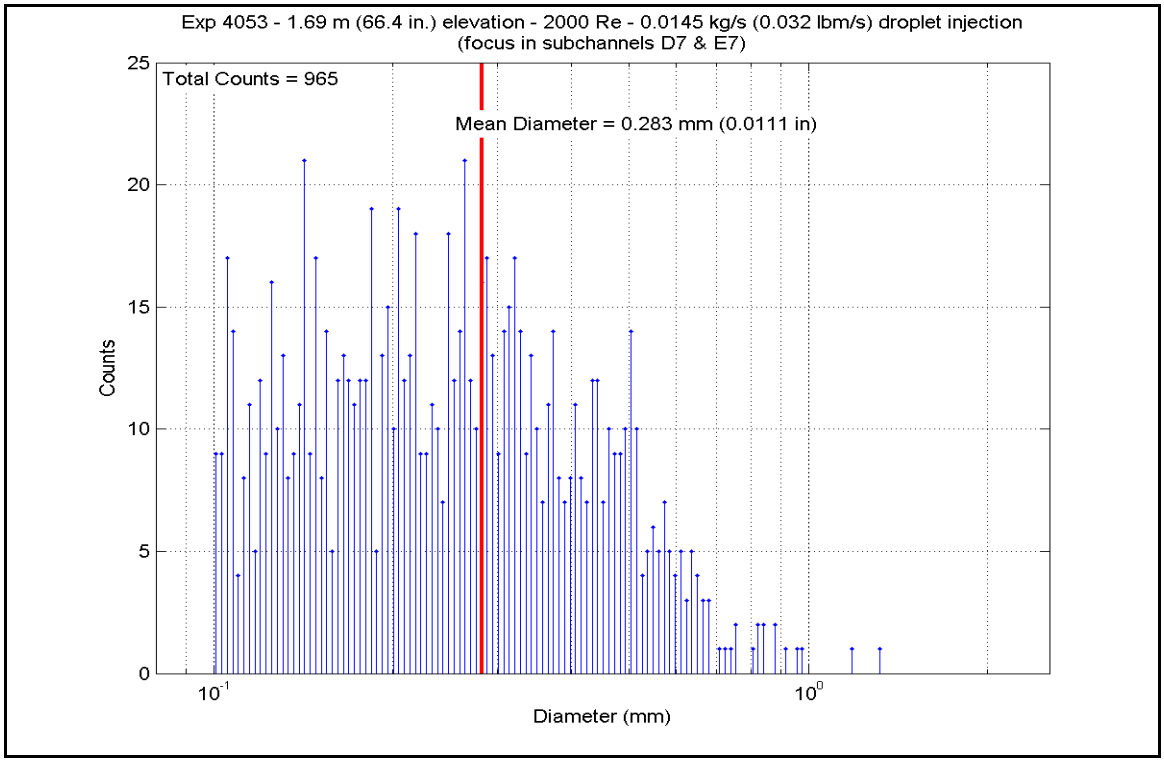

Figure A-544: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4053L

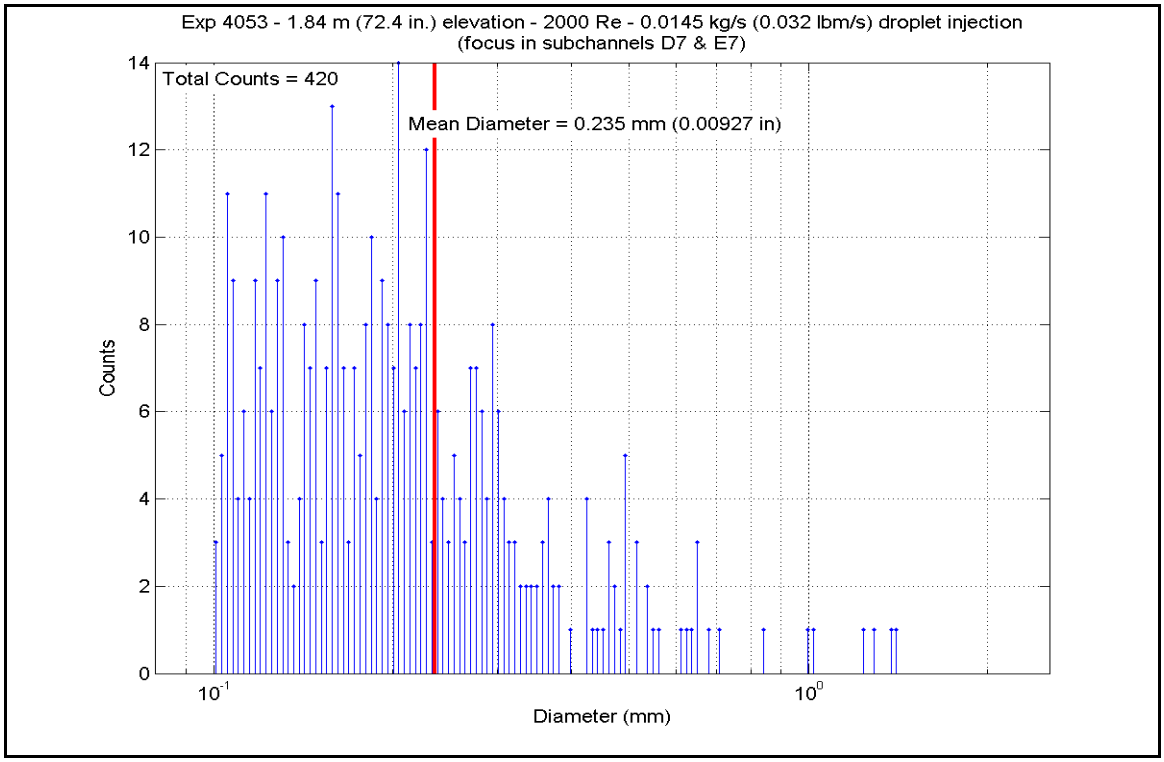

Figure A-545: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4053L

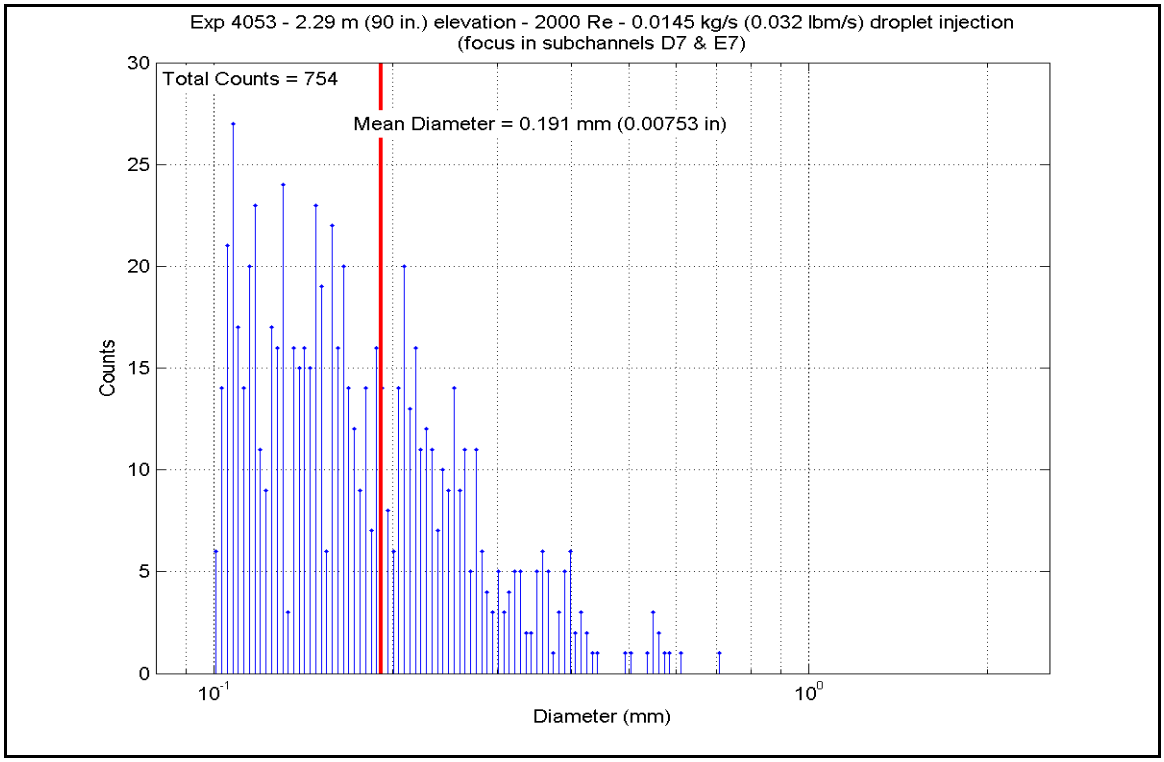

Figure A-546: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4053L

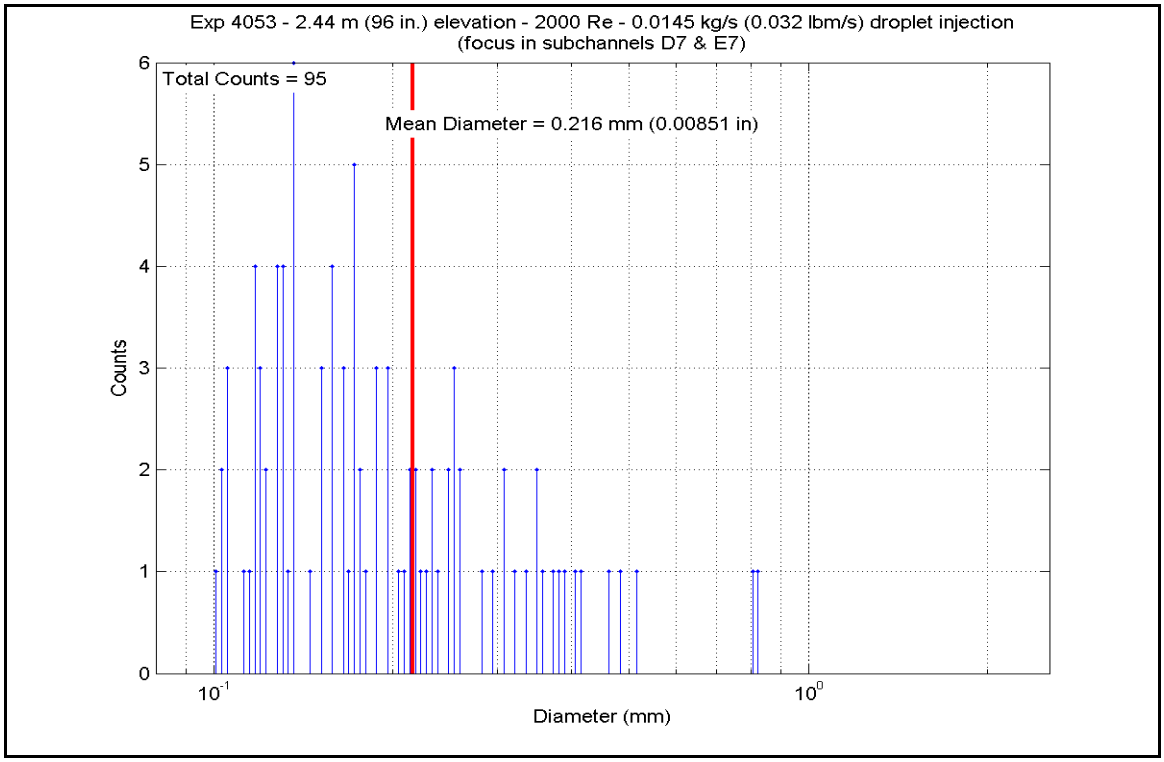

Figure A-547: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4053L

Table A-67: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053L

Test 4053-L	Inlet Reynolds:	2000		
Matrix test # 10d	UP Pressure:	137.9 kPa	20	psia
Time Window: 28800-29280	Bundle Power:	29.00 kW	98952	Btu/hr
	Steam flow:	0.0113 kg/s	90.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	720.245455	655.5	2500.287879	7887.2	5.079	28.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	763.659167	679.6	2555.169192	8060.3	4.770	27.1
	RodD3_93.1	187	93.1	2.365	4.6	0.117	616.485025	597.9	2301.151515	7259.0	5.923	33.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	694.682551	641.3	2451.603535	7733.6	5.253	29.8
	RodD3_142.1	192	142.1	3.609	8.6	0.218	608.194646	593.3	2355.141414	7429.3	6.195	35.2
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	958.151515	787.7	2377.861111	7501.0	3.257	18.5
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1005.52717	814.0	2245.414141	7083.2	2.888	16.4
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1042.24601	834.4	2072.287879	6537.0	2.545	14.5
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1061.0577	844.8	1890.840909	5964.7	2.270	12.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	314.683763	430.2	3884.505051	12253.7	44.812	254.5
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	522.55452	545.7	2316.64899	7307.9	7.865	44.7
	RodD4_91.3	242	91.3	2.319	2.8	0.071	564.969141	569.2	2361.641414	7449.8	7.008	39.8
	RodD4_93.2	243	93.2	2.367	4.7	0.119	572.620758	573.5	2322.070707	7325.0	6.738	38.3
	RodD4_95.2	244	95.2	2.418	6.7	0.170	975.123182	797.1	2381.126263	7511.3	3.187	18.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	962.481338	790.1	2753.704545	8686.6	3.749	21.3
	RodD4_106.1	246	106.1	2.695	17.6	0.447	958.673333	788.0	2703.535354	8528.3	3.700	21.0
	RodD4_142.1	248	142.1	3.609	8.6	0.218	468.591237	515.7	2269.141414	7158.0	9.432	53.6
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	715.090278	652.6	2390.911616	7542.1	4.909	27.9
	RodE4_91.2	202	91.2	2.316	2.7	0.069	802.741212	701.3	2478.65404	7818.9	4.313	24.5
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1150.26485	894.4	1040.392424	3281.9	1.128	6.4
	RodE4_100.9	205	100.9	2.563	12.4	0.315	870.079672	738.7	2736.868687	8633.5	4.263	24.2
	RodE4_142.3	208	142.3	3.614	8.8	0.224	637.957273	609.8	2290.914141	7226.7	5.588	31.7

Table A-67: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1135.13048	886.0	1429.371212	4509.0	1.576	8.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	933.559318	774.0	2472.265152	7798.8	3.504	19.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1040.2775	833.3	2365.671717	7462.5	2.912	16.5
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1075.58066	852.9	2231.123737	7038.1	2.632	14.9
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1105.94836	869.8	2039.366162	6433.2	2.323	13.2
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1118.94705	877.0	1860.088384	5867.6	2.088	11.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1116.11197	875.4	1603.477273	5058.2	1.805	10.3
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	549.842904	560.8	2258.957071	7125.9	7.019	39.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1204.2546	924.4	1564.75	4936.0	1.603	9.1
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1131.86386	884.2	1442.270202	4549.6	1.596	9.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	501.935152	534.2	2033.962121	6416.1	7.425	42.2
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	491.124015	528.2	2110.575758	6657.8	8.021	45.6
	RodC5_135.7	232	135.7	3.447	2.2	0.056	519.24452	543.8	2177.732323	6869.7	7.477	42.5
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	1150.145	894.3	1056.330808	3332.2	1.146	6.5
	RodE5_113.6	210	113.6	2.885	0.85	0.022	927.807828	770.8	2852.856061	8999.3	4.077	23.2
	RodE5_115.4	211	115.4	2.931	2.65	0.067	772.234116	684.4	2655.815657	8377.8	4.880	27.7
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1141.85795	889.7	1109.204798	3499.0	1.214	6.9
	RodE5_122.6	213	122.6	3.114	9.85	0.250	596.077854	586.5	2436.881313	7687.1	6.621	37.6
	RodE5_126.6	214	126.6	3.216	13.85	0.352	682.122449	634.3	2541.712121	8017.8	5.597	31.8
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	729.449672	660.6	2567.568182	8099.4	5.120	29.1
	RodE5_135.6	216	135.6	3.444	2.1	0.053	778.585631	687.9	2602.444444	8209.4	4.727	26.8
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	716.718359	653.5	2612.35101	8240.7	5.345	30.4
	RodC3_85.6	178	85.6	2.174	14.72	0.374	754.978232	674.8	2646.89899	8349.6	5.023	28.5
	RodC3_88.5	179	88.5	2.248	0	0.000	1115.295	875.0	1111.643182	3506.7	1.253	7.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	1003.65558	813.0	1824.441919	5755.2	2.352	13.4
	RodD5_54.1	218	54.1	1.374	7.1	0.180	1050.17318	838.8	2074.858586	6545.1	2.524	14.3
	RodD5_56.9	219	56.9	1.445	9.9	0.251	1072.16028	851.0	1894.583333	5976.5	2.244	12.7
	RodD5_60	220	60	1.524	13	0.330	1068.3552	848.9	1647.292929	5196.4	1.960	11.1
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1105.45798	869.5	1466.265152	4625.3	1.671	9.5
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	582.682854	579.1	2529.416667	7979.0	7.131	40.5
	RodD5_72.9	223	72.9	1.852	2.02	0.051	671.382576	628.4	2590.30303	8171.1	5.842	33.2
	RodD5_74.9	224	74.9	1.902	4.02	0.102	726.542172	659.0	2630.689394	8298.5	5.277	30.0

Table A-67: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	548.675808	560.2	2467.411616	7783.4	7.694	43.7
	RodB5_52.9	154	52.9	1.344	5.9	0.150	596.807601	586.9	2721.994949	8586.5	7.381	41.9
	RodB5_55	155	55	1.397	8	0.203	620.417247	600.0	2936.535354	9263.3	7.483	42.5
	RodB5_57.8	156	57.8	1.468	10.8	0.274	690.877904	639.2	3078.434343	9710.9	6.651	37.8
	RodB5_64	157	64	1.626	17	0.432	718.440606	654.5	3150.29798	9937.6	6.423	36.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	756.833333	675.8	3260.661616	10285.8	6.166	35.0
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	548.207399	559.9	2479.285354	7820.9	7.743	44.0
	RodF5_53.1	106	53.1	1.349	6.1	0.155	595.605657	586.3	2726.719697	8601.4	7.418	42.1
	RodF5_55	107	55	1.397	8	0.203	608.109242	593.2	2934.333333	9256.4	7.720	43.8
	RodF5_57.8	108	57.8	1.468	10.8	0.274	683.226995	634.9	3075.510101	9701.7	6.756	38.4
	RodF5_64	109	64	1.626	17	0.432	709.584116	649.6	3146.583333	9925.9	6.534	37.1
	RodF5_73.8	110	73.8	1.875	2.92	0.074	748.500328	671.2	3250.166667	10252.7	6.244	35.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	1023.07253	823.7	2294.494949	7238.0	2.886	16.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	727.694066	659.6	3647.29798	11505.4	7.299	41.5
	RodC2_55	59	55	1.397	8	0.203	984.017727	802.0	4763.729798	15027.2	6.301	35.8
	RodC2_57.8	60	57.8	1.468	10.8	0.274	1027.22409	826.1	5389.833333	17002.2	6.744	38.3
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1067.15902	848.2	4994.085859	15753.8	5.951	33.8
	RodC2_73.8	62	73.8	1.875	2.92	0.074	1103.51949	868.4	3827.126263	12072.7	4.371	24.8
	RodC2_75.8	63	75.8	1.925	4.92	0.125	580.367449	577.8	2210.843434	6974.1	6.274	35.6
	RodC2_76.8	64	76.8	1.951	5.92	0.150	600.069848	588.7	2232.613636	7042.8	6.001	34.1
Gr-2	RodC6_57.8	140	57.8	1.468	10.8	0.274	229.493106	382.9	2134.729798	6734.0	1429.724	8119.2
	RodC6_63.8	141	63.8	1.621	16.8	0.427	425.065556	491.5	2129.255051	6716.7	10.805	61.4
	RodC6_73.7	142	73.7	1.872	2.82	0.072	507.199975	537.1	2220.356061	7004.1	7.953	45.2
	RodC6_75.8	143	75.8	1.925	4.92	0.125	584.120278	579.9	2285.378788	7209.2	6.417	36.4
	RodC6_76.8	144	76.8	1.951	5.92	0.150	580.367551	577.8	2322.005051	7324.8	6.590	37.4

Table A-67: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	566.687702	570.2	2446.830808	7718.5	7.224	41.0
	RodB4_91.3	162	91.3	2.319	2.8	0.071	587.001086	581.5	2440.472222	7698.5	6.798	38.6
	RodB4_93.3	163	93.3	2.370	4.8	0.122	388.355884	471.1	2037.088384	6426.0	12.704	72.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	482.093586	523.2	2289.143939	7221.1	9.009	51.2
	RodB4_142.3	168	142.3	3.614	8.8	0.224	524.125379	546.6	2540.136364	8012.9	8.578	48.7
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	658.018232	620.9	2283.527778	7203.4	5.310	30.2
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	674.180379	629.9	2297.44697	7247.3	5.149	29.2
	RodF4_92.4	100	92.4	2.347	3.9	0.099	392.221237	473.3	2042.790404	6444.0	12.439	70.6
	RodF4_94.3	101	94.3	2.395	5.8	0.147	483.209747	523.8	2295.151515	7240.1	8.993	51.1
	RodF4_97.2	102	97.2	2.469	8.7	0.221	941.745227	778.6	2761.686869	8711.7	3.869	22.0
	RodF4_108.8	103	108.8	2.764	20.3	0.516	910.55048	761.2	2749.055556	8671.9	4.028	22.9
	RodF4_111	104	111	2.819	-1.75	-0.044	877.507551	742.9	2682.868687	8463.1	4.131	23.5
Gr-6	RodD2_114.9	68	114.9	2.918	2.15	0.055	1004.77851	813.6	2417.623737	7626.4	3.112	17.7
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1030.74477	828.0	2300.840909	7258.0	2.866	16.3
	RodD2_120.8	70	120.8	3.068	8.05	0.204	1069.23636	849.4	2139.323232	6748.5	2.543	14.4
	RodD2_124.8	71	124.8	3.170	12.05	0.306	1093.48301	862.9	1941.040404	6123.0	2.243	12.7
	RodD2_128.6	72	128.6	3.266	15.85	0.403	1103.42581	868.4	1748.838384	5516.7	1.998	11.3
Gr-6	RodD6_103.1	129	103.1	2.619	14.6	0.371	1010.60242	816.8	2441.19697	7700.8	3.119	17.7
	RodD6_106	130	106	2.692	17.5	0.445	890.588838	750.1	2602.315657	8209.0	3.927	22.3
	RodD6_112.9	131	112.9	2.868	0.15	0.004	919.114545	766.0	2449.368687	7726.5	3.544	20.1
	RodD6_114.9	132	114.9	2.918	2.15	0.055	502.086995	534.3	1838.661616	5800.1	6.708	38.1
	RodD6_116.8	133	116.8	2.967	4.05	0.103	558.504596	565.7	1888.522727	5957.3	5.714	32.4
	RodD6_120.9	134	120.9	3.071	8.15	0.207	738.315177	665.5	2506.282828	7906.1	4.911	27.9
	RodD6_124.8	135	124.8	3.170	12.05	0.306	794.185732	696.6	2565.45202	8092.7	4.531	25.7
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1147.57275	892.9	998.1113636	3148.5	1.085	6.2

Table A-67: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4053, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q'' (Btu/hr-ft2)	H.R. q'' (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	574.49202	574.5	1801.69697	5683.5	5.200	29.5
	RodE2_54	74	54	1.372	7	0.178	568.984949	571.5	1384.907828	4368.7	4.061	23.1
	RodE2_56.9	75	56.9	1.445	9.9	0.251	466.534369	514.6	1478.942172	4665.3	6.200	35.2
	RodE2_59.9	76	59.9	1.521	12.9	0.328	325.694141	436.3	2079.209596	6558.9	21.283	120.9
	RodE2_66	77	66	1.676	19	0.483	504.116465	535.4	2095.063131	6608.9	7.588	43.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	560.881818	567.0	2153.308081	6792.6	6.469	36.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	401.561591	478.5	2007.406566	6332.4	11.566	65.7
	RodE2_74.9	80	74.9	1.902	4.02	0.102	484.116944	524.3	2270.070707	7160.9	8.863	50.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	1013.30818	818.3	2153.931818	6794.6	2.743	15.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	1033.68275	829.6	1953.378788	6161.9	2.425	13.8
	RodB3_56.9	171	56.9	1.445	9.9	0.251	1051.27278	839.4	1751.818182	5526.1	2.128	12.1
	RodB3_60.1	172	60.1	1.527	13.1	0.333	456.950455	509.2	3919.015152	12362.5	17.117	97.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	416.763864	486.9	4226.270202	13331.8	22.389	127.1
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	414.017828	485.4	4335.05303	13674.9	23.305	132.3
	RodB3_73	175	73	1.854	2.12	0.054	404.820025	480.3	4451.030303	14040.8	25.173	143.0
	RodB3_75	176	75	1.905	4.12	0.105	358.724596	454.7	4451.712626	14042.9	34.054	193.4
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	782.605808	690.2	2459.535354	7758.6	4.435	25.2
	RodF3_54	90	54	1.372	7	0.178	815.949672	708.7	2496.517677	7875.3	4.246	24.1
	RodF3_57	91	57	1.448	10	0.254	607.364318	592.8	1755.661616	5538.2	4.628	26.3
	RodF3_60	92	60	1.524	13	0.330	619.861591	599.7	2020.032828	6372.2	5.155	29.3
	RodF3_66.1	93	66.1	1.679	19.1	0.485	644.83601	613.6	1980.90404	6248.8	4.752	27.0
	RodF3_70	94	70	1.778	-0.88	-0.022	673.130404	629.3	1982.830808	6254.8	4.454	25.3
	RodF3_73	95	73	1.854	2.12	0.054	707.555101	648.5	2097.856061	6617.7	4.375	24.8
	RodF3_75	96	75	1.905	4.12	0.105	620.318258	600.0	2243.239899	7076.3	5.718	32.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	546.455556	559.0	2453.979798	7741.1	7.706	43.8
	RodE6_54.1	122	54.1	1.374	7.1	0.180	594.234874	585.5	2716.482323	8569.1	7.417	42.1
	RodE6_57	123	57	1.448	10	0.254	609.269722	593.9	2935.15404	9258.9	7.698	43.7
	RodE6_60.2	124	60.2	1.529	13.2	0.335	681.902626	634.2	3085.979798	9734.7	6.799	38.6
	RodE6_66.1	125	66.1	1.679	19.1	0.485	708.556768	649.0	3158.936869	9964.9	6.573	37.3
	RodE6_70	126	70	1.778	-0.88	-0.022	746.396136	670.0	3269.785354	10314.5	6.308	35.8
	RodE6_73.1	127	73.1	1.857	2.22	0.056	564.612753	569.0	1923.457071	6067.5	5.714	32.5
	RodE6_75	128	75	1.905	4.12	0.105	620.116616	599.9	1979.295455	6243.7	5.048	28.7

RBHT Steam Cooling with Droplet Injection Test SCD-4055-A

Matrix Test # 13b

Test Conditions

Test Date – 11/23/2005
Steady State Time Window: 13980 - 15660
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

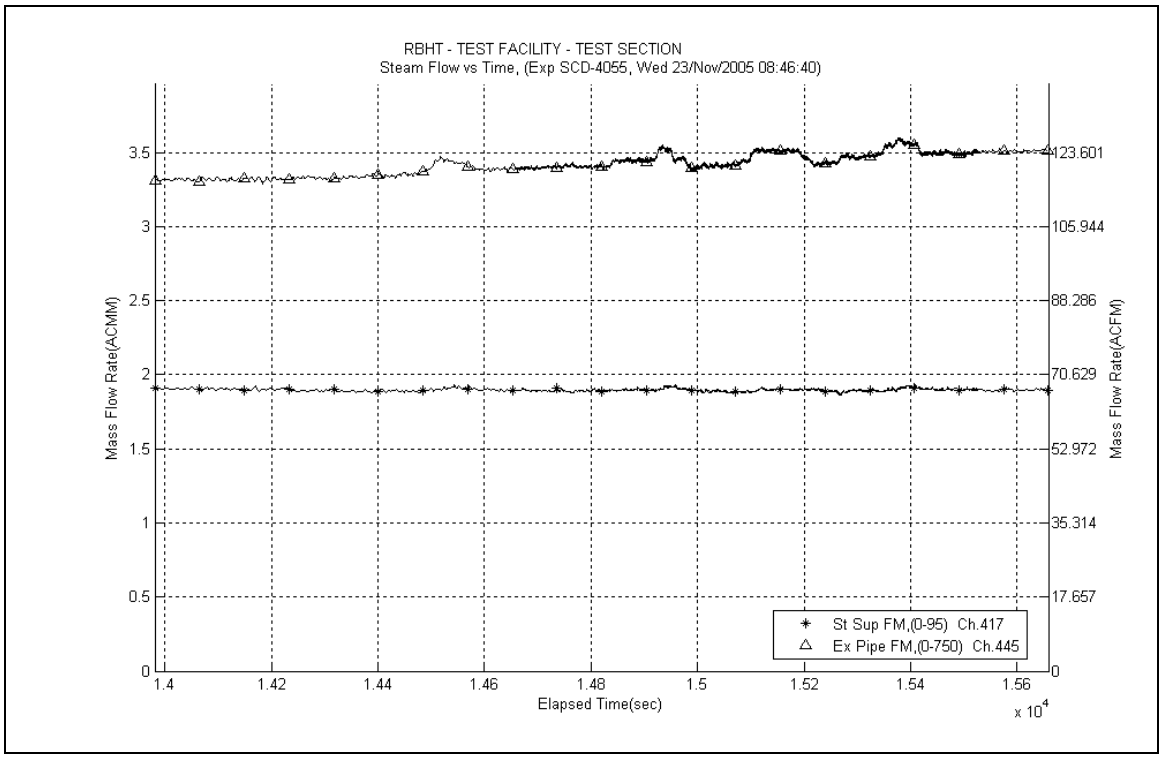

Figure A-548: Inlet and Exhaust Steam Flow Rates for Experiment 4055A

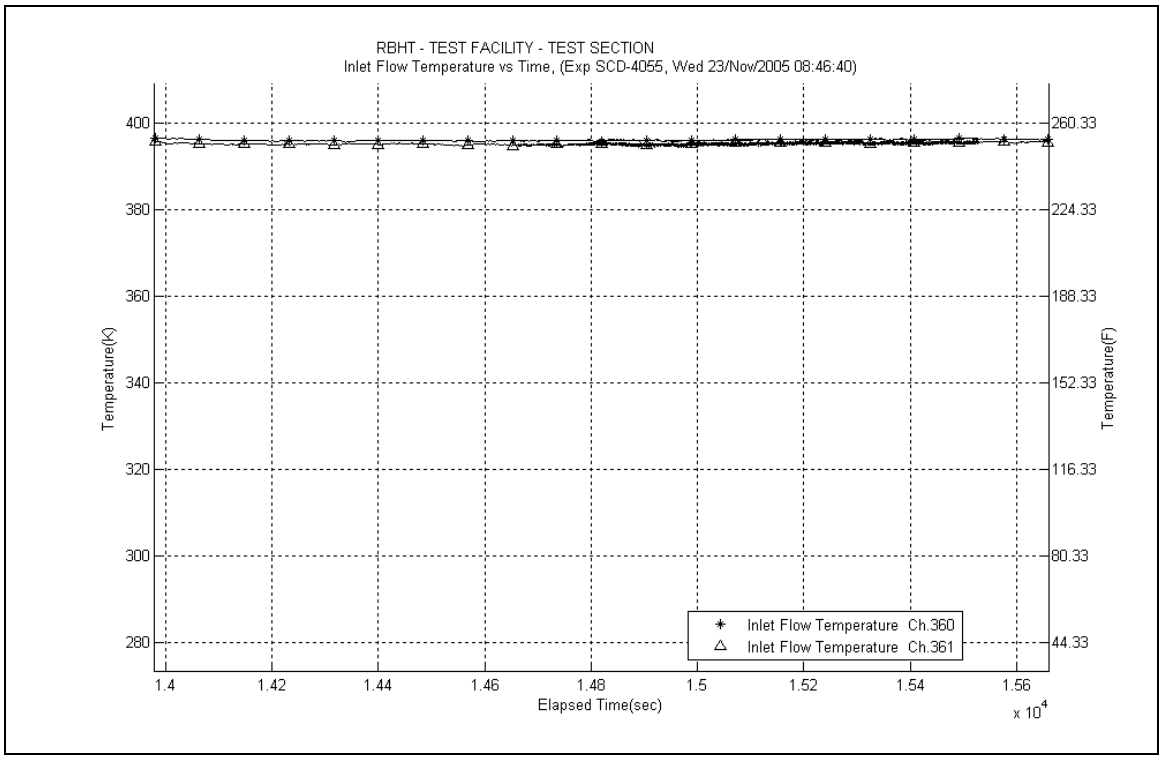

Figure A-549: Inlet Steam Temperature for Experiment 4055A

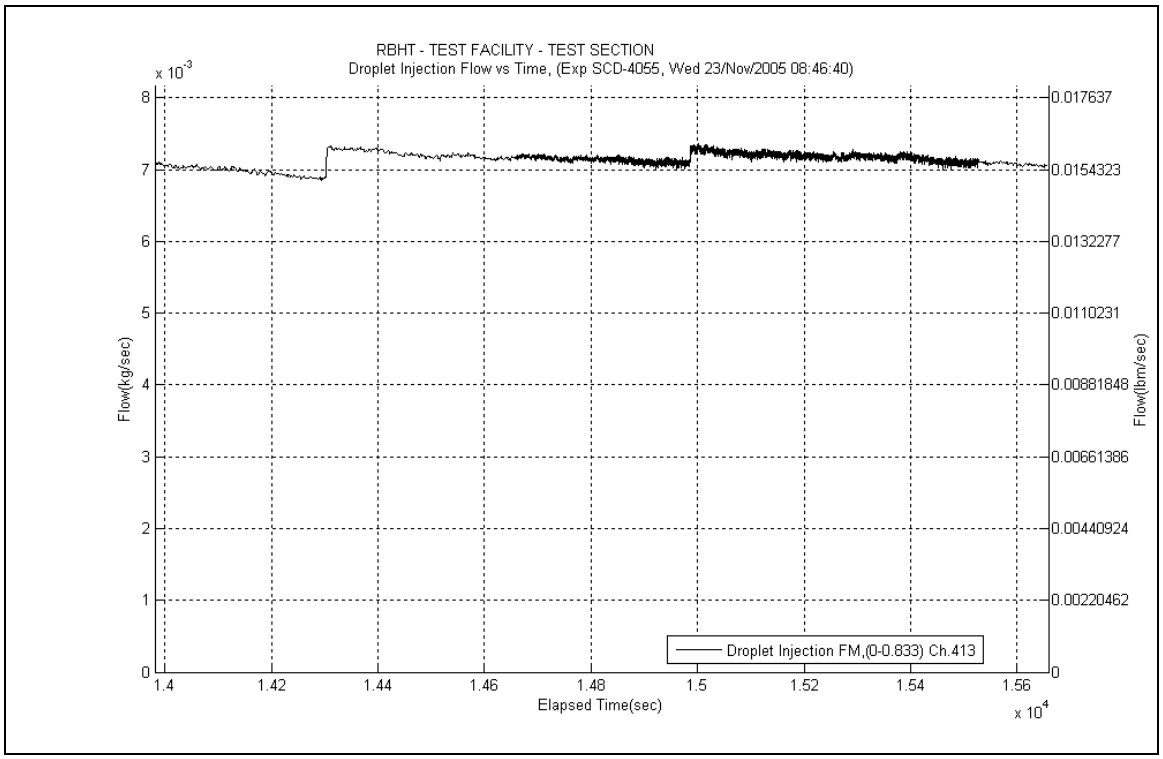

Figure A-550: Droplet Injection Flow Rate for Experiment 4055A

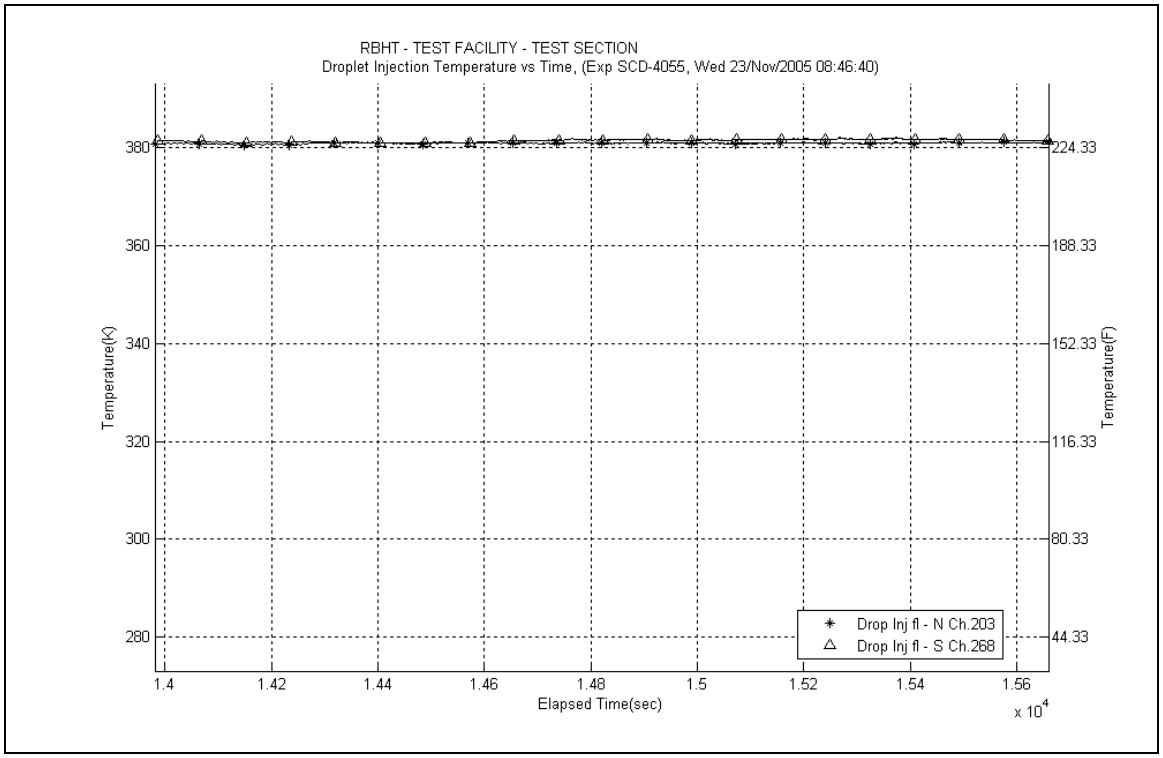

Figure A-551: Droplet Injection Temperature for Experiment 4055A

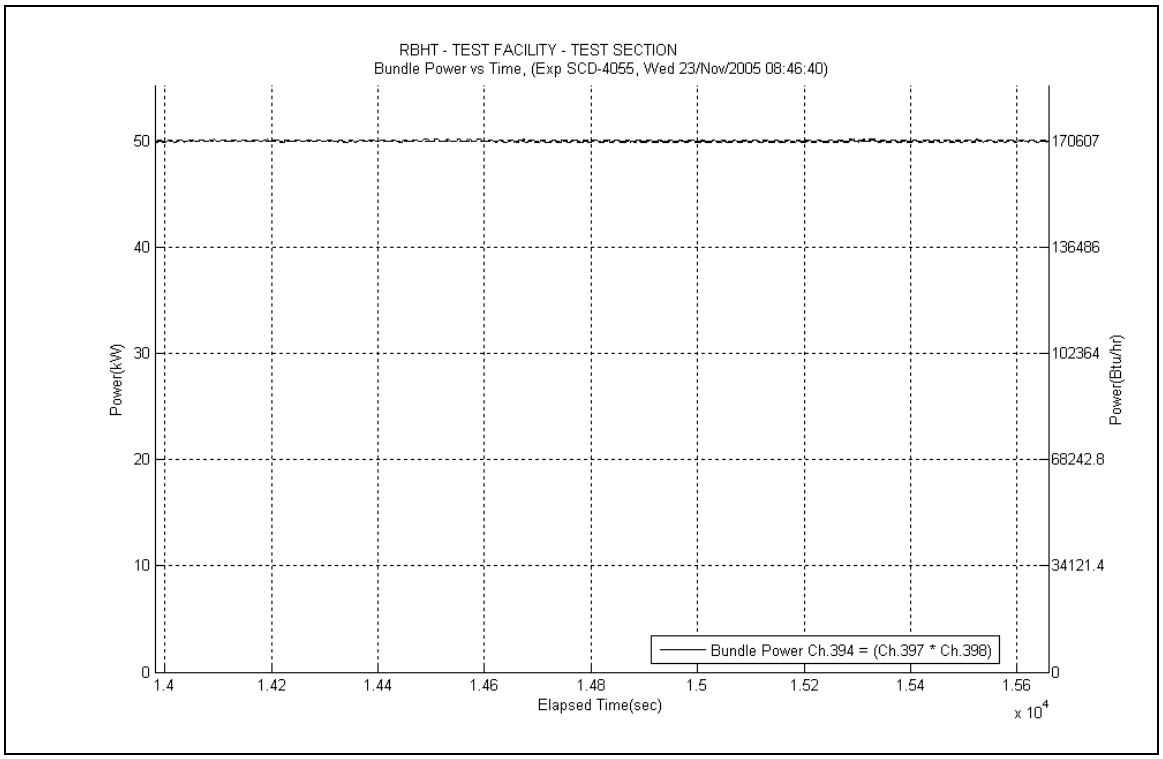

Figure A-552: Bundle Power for Experiment 4055A

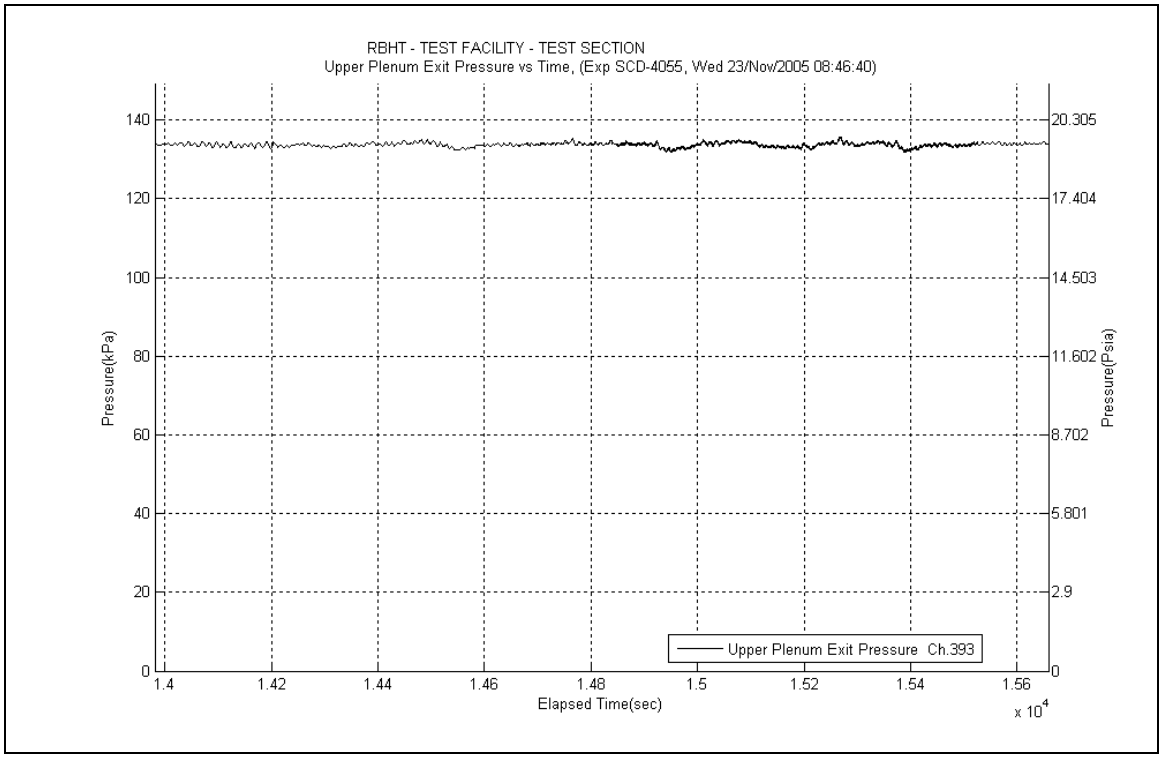

Figure A-553: Upper Plenum Pressure for Experiment 4055A

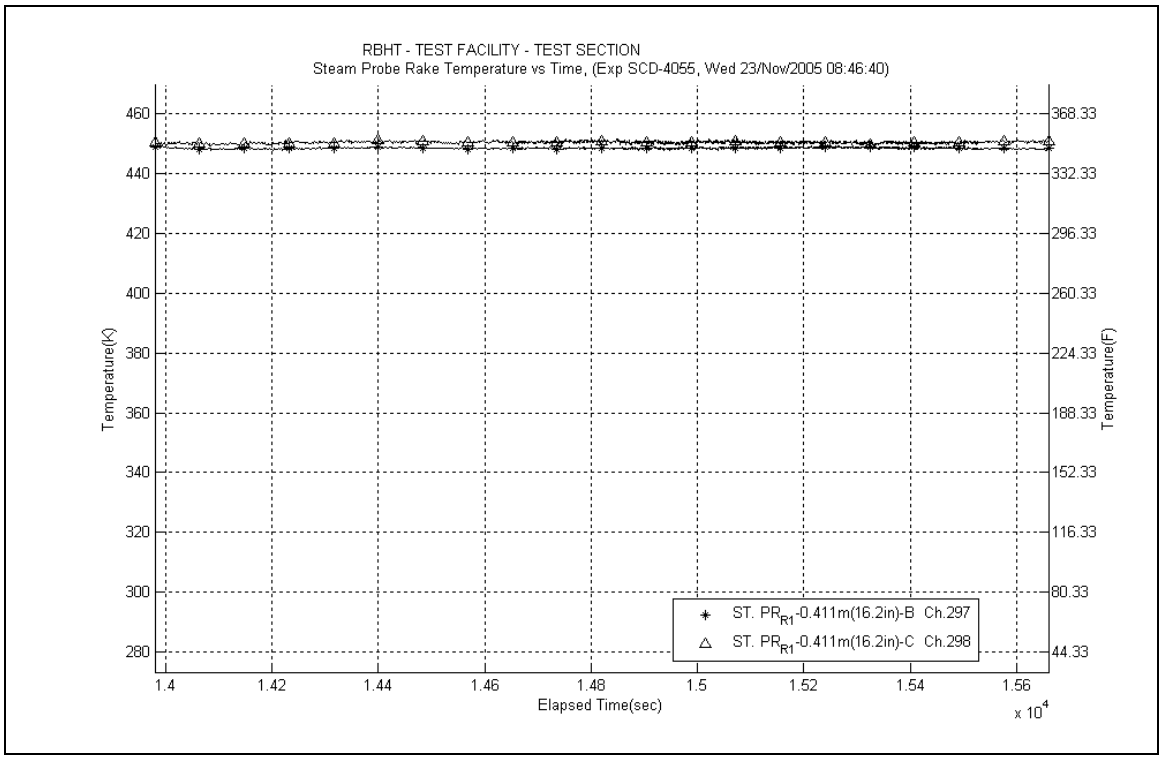

Figure A-554: Steam Probe Rake #1 Temperatures for Experiment 4055A

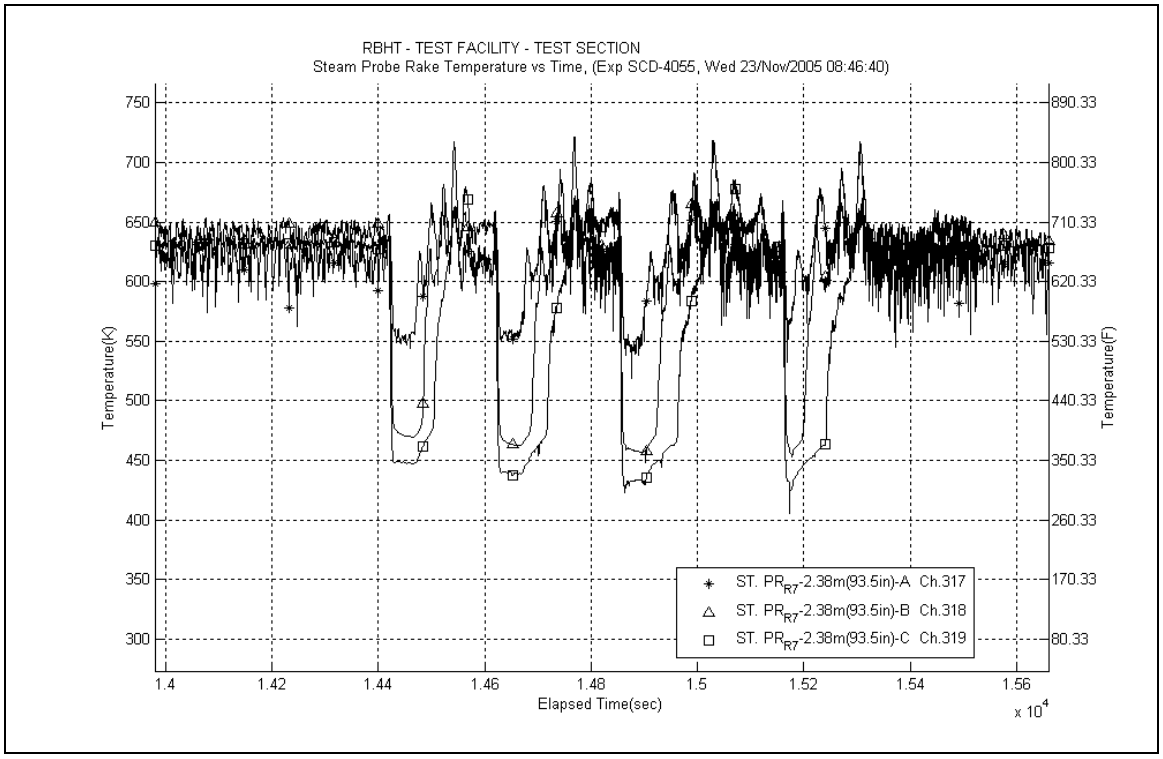

Figure A-555: Steam Probe Rake #7 Temperatures for Experiment 4055A

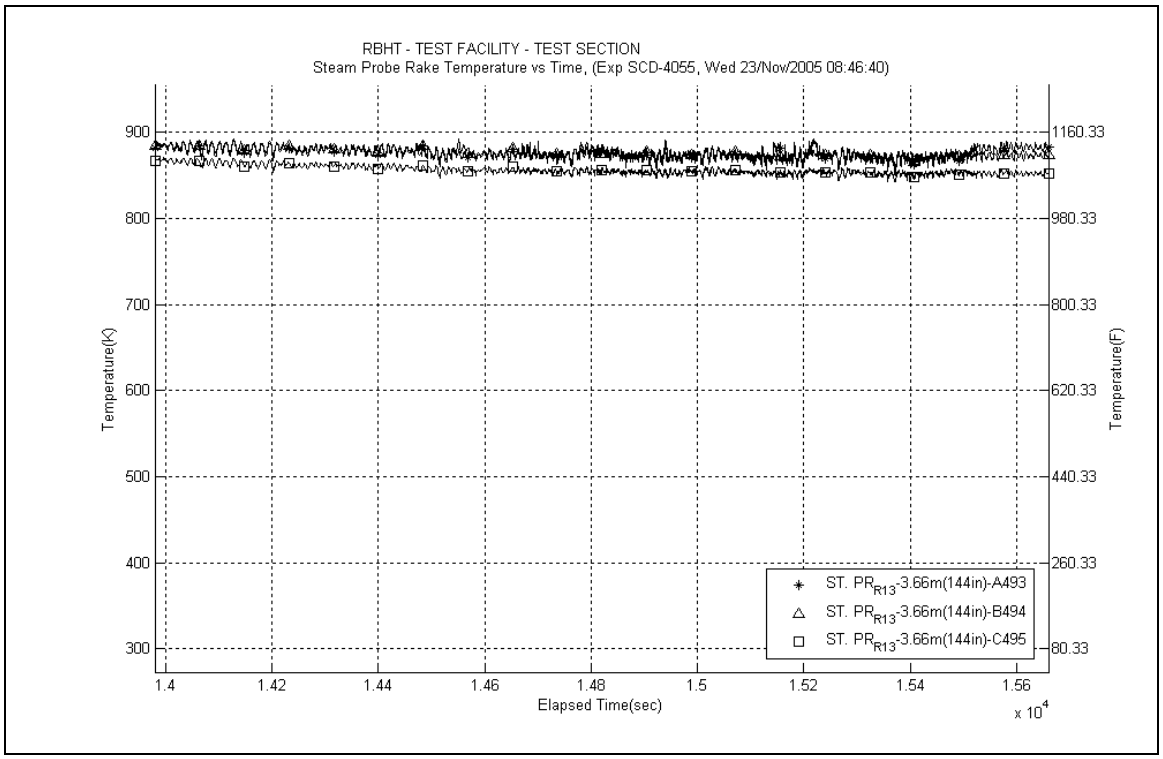

Figure A-556: Steam Probe Rake #13 Temperatures for Experiment 4055A

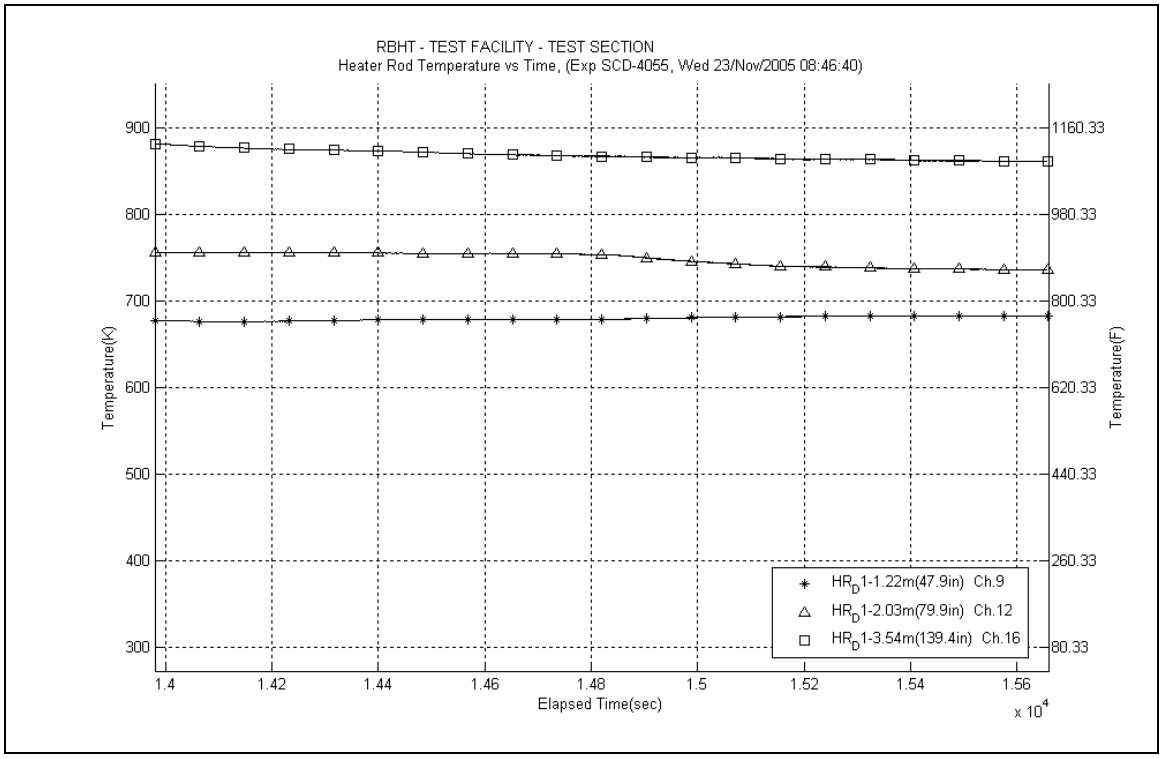

Figure A-557: Heater Rod D1 Temperatures for Experiment 4055A

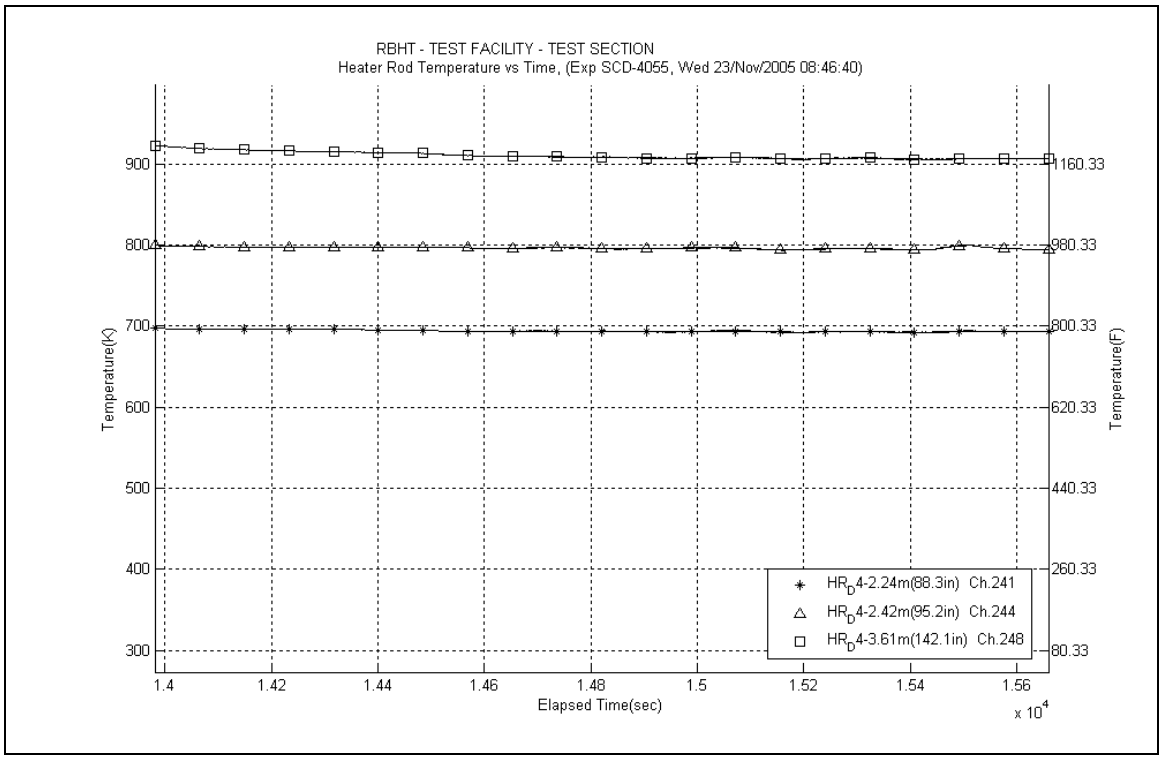

Figure A-558: Heater Rod D4 Temperatures for Experiment 4055A

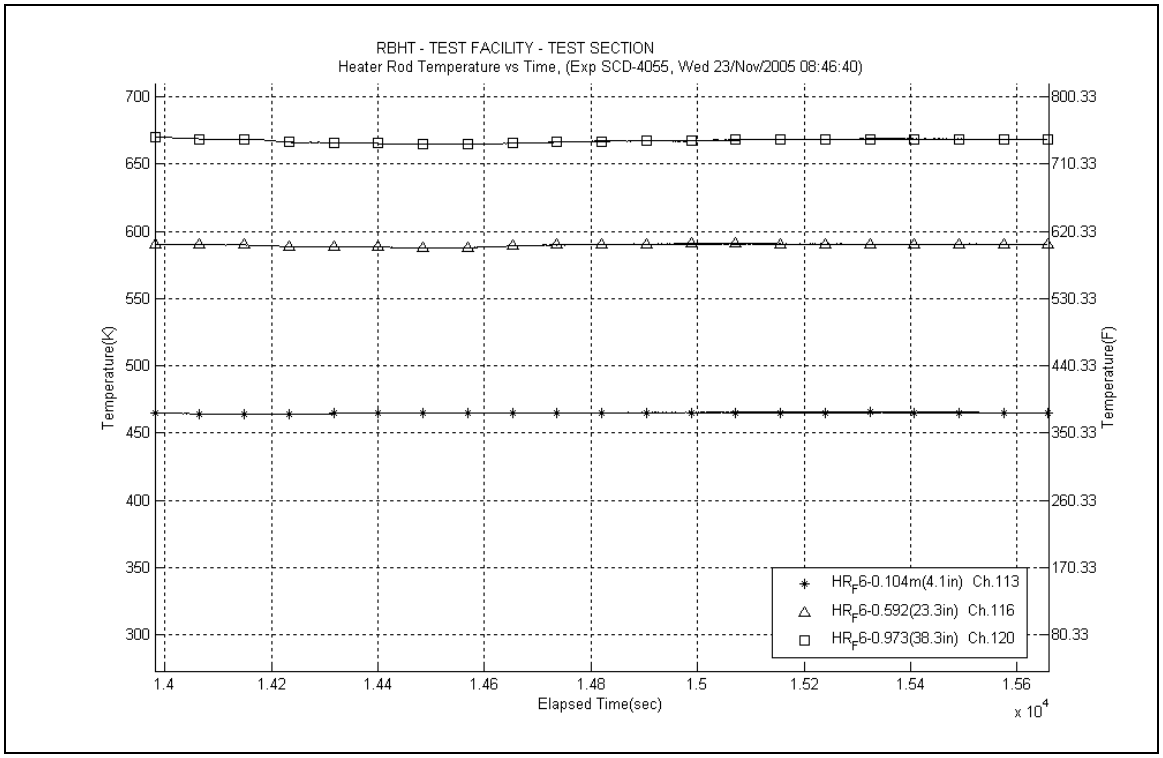

Figure A-559: Heater Rod F6 Temperatures for Experiment 4055A

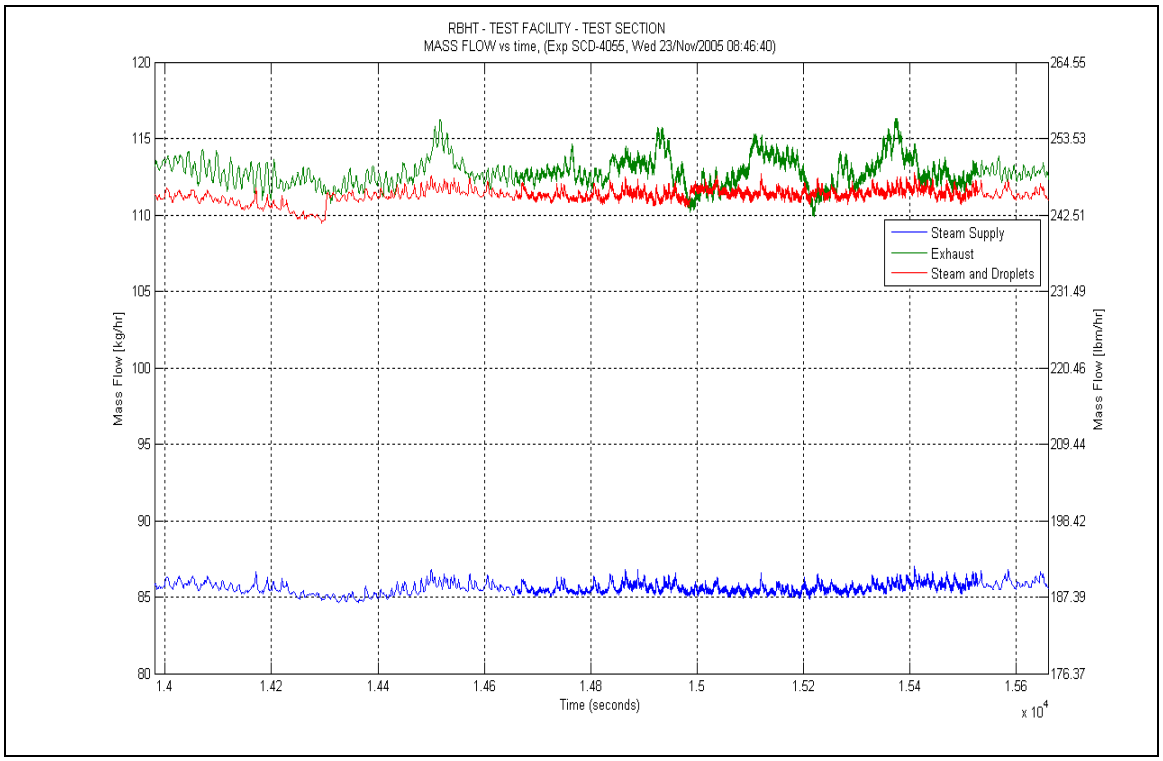

Figure A-560: Mass Flow for Experiment 4055A

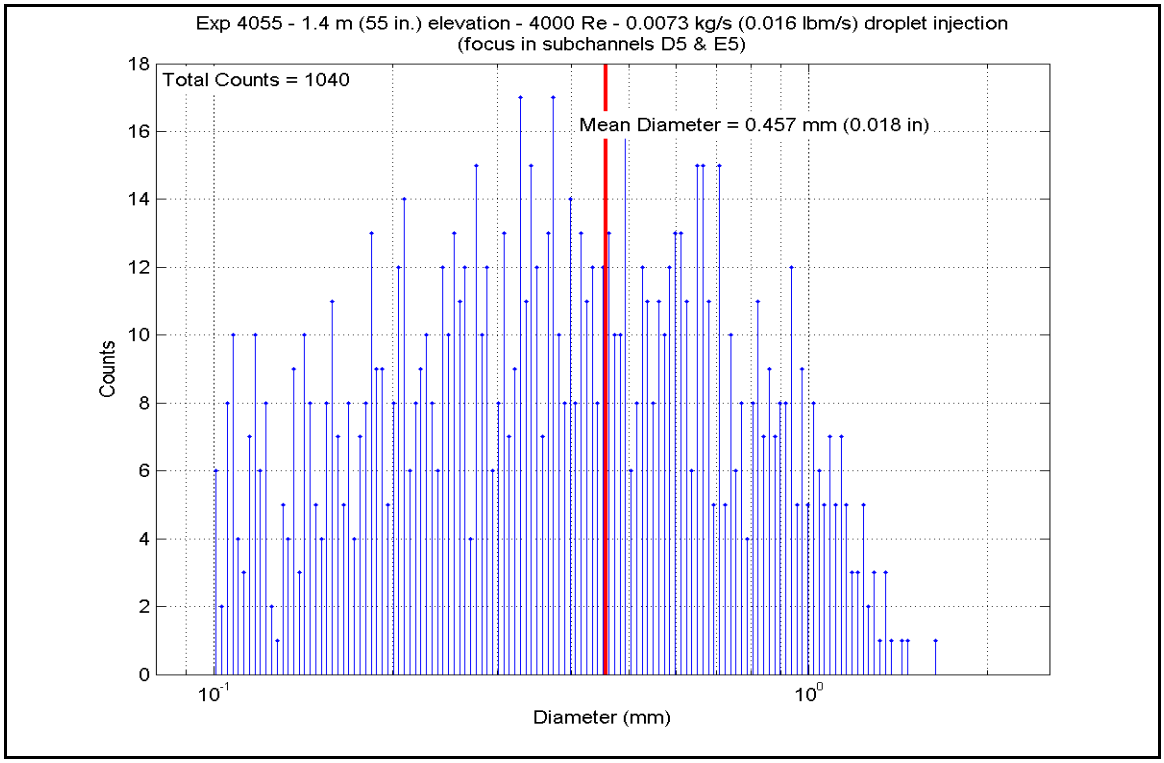

Figure A-561: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055A

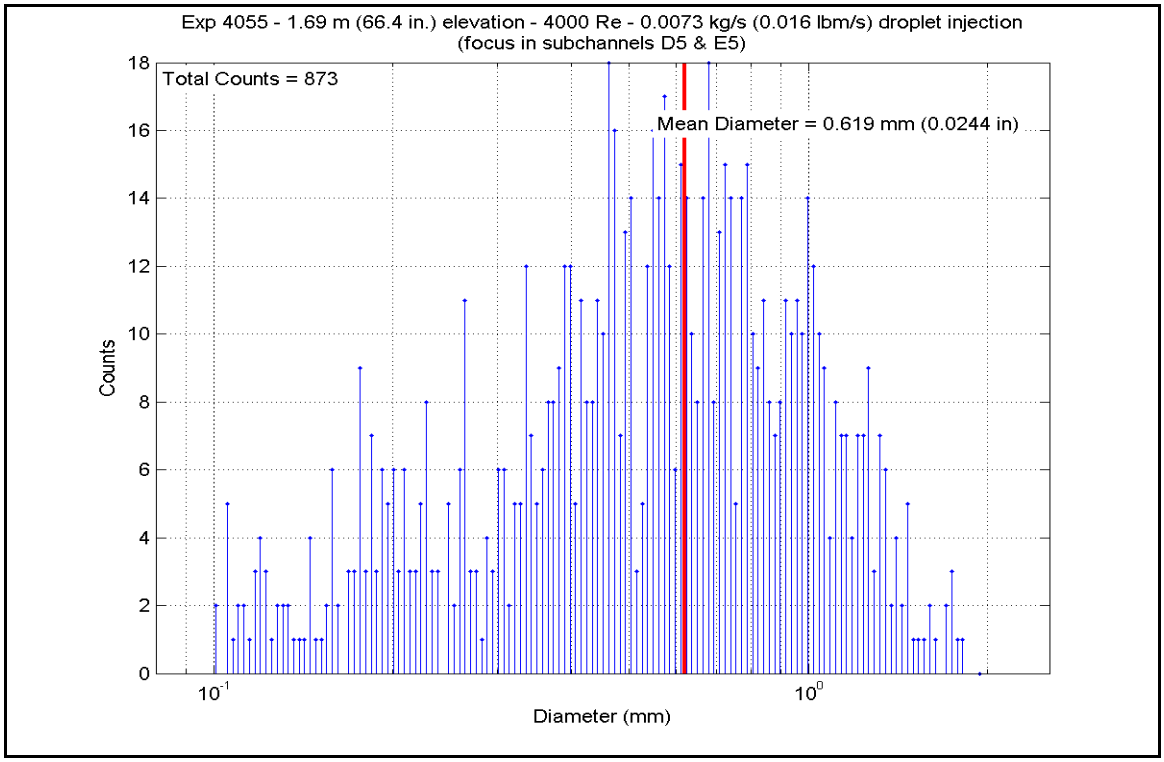

Figure A-562: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055A

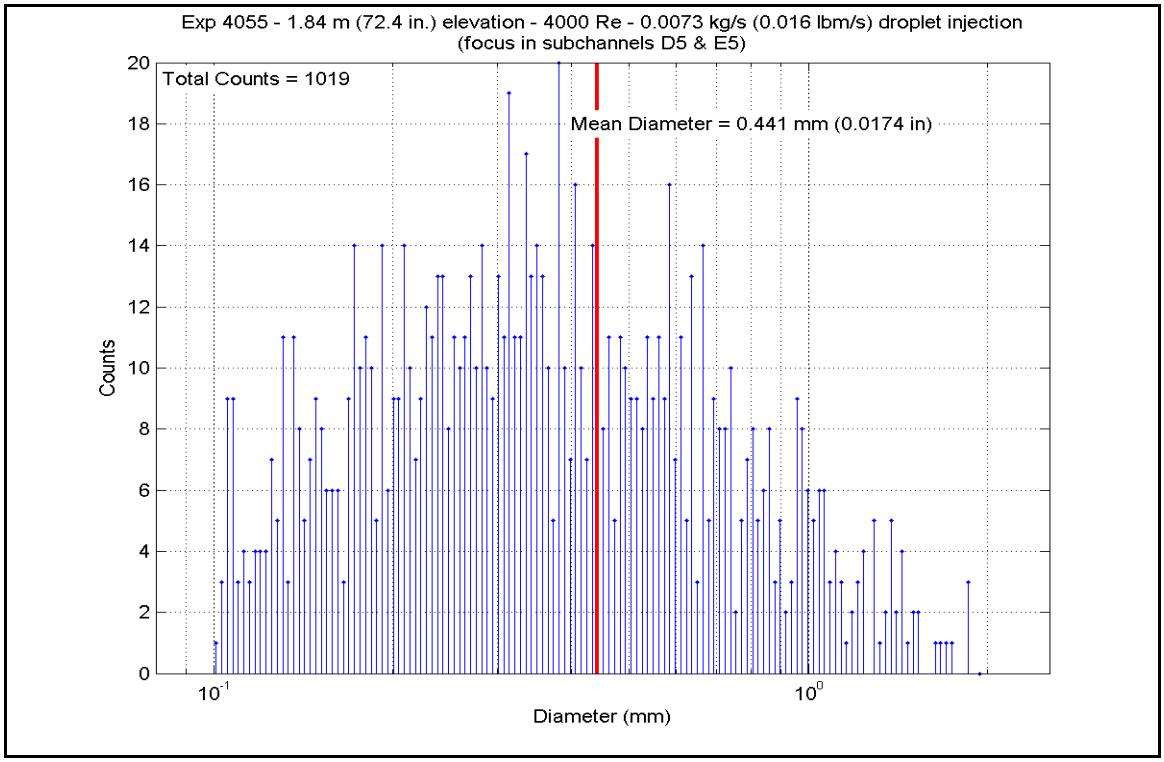

Figure A-563: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055A

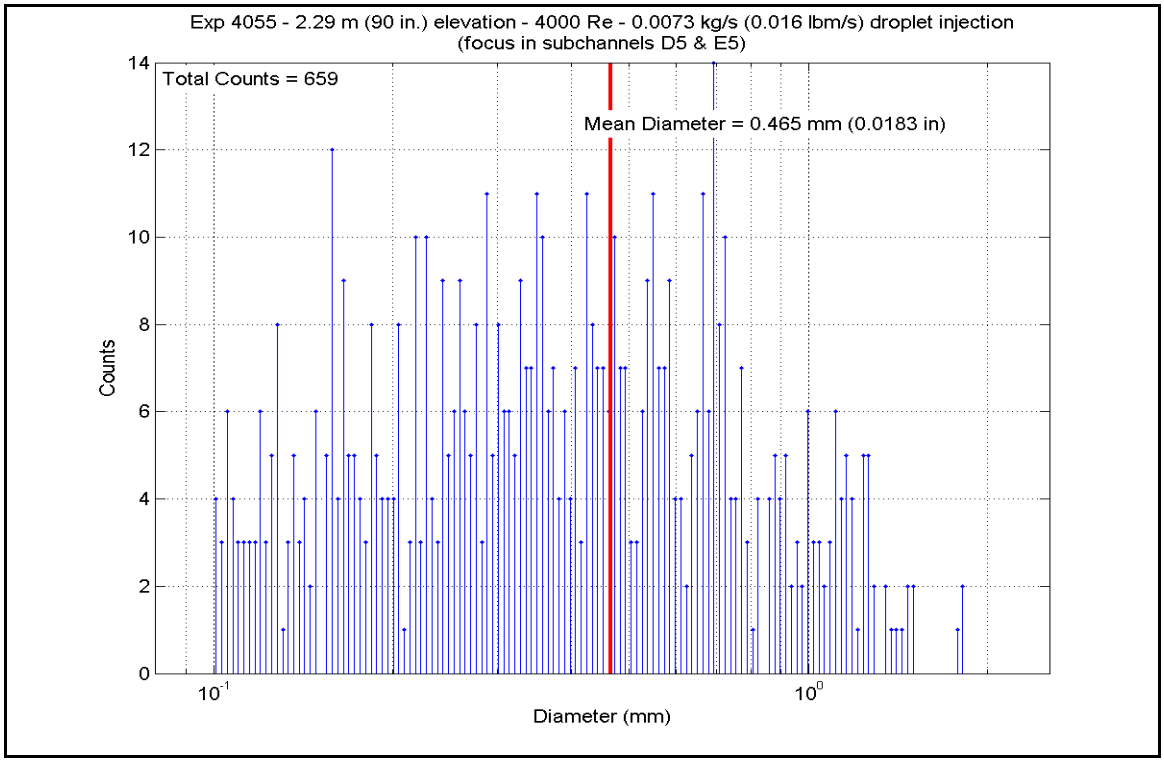

Figure A-564: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055A

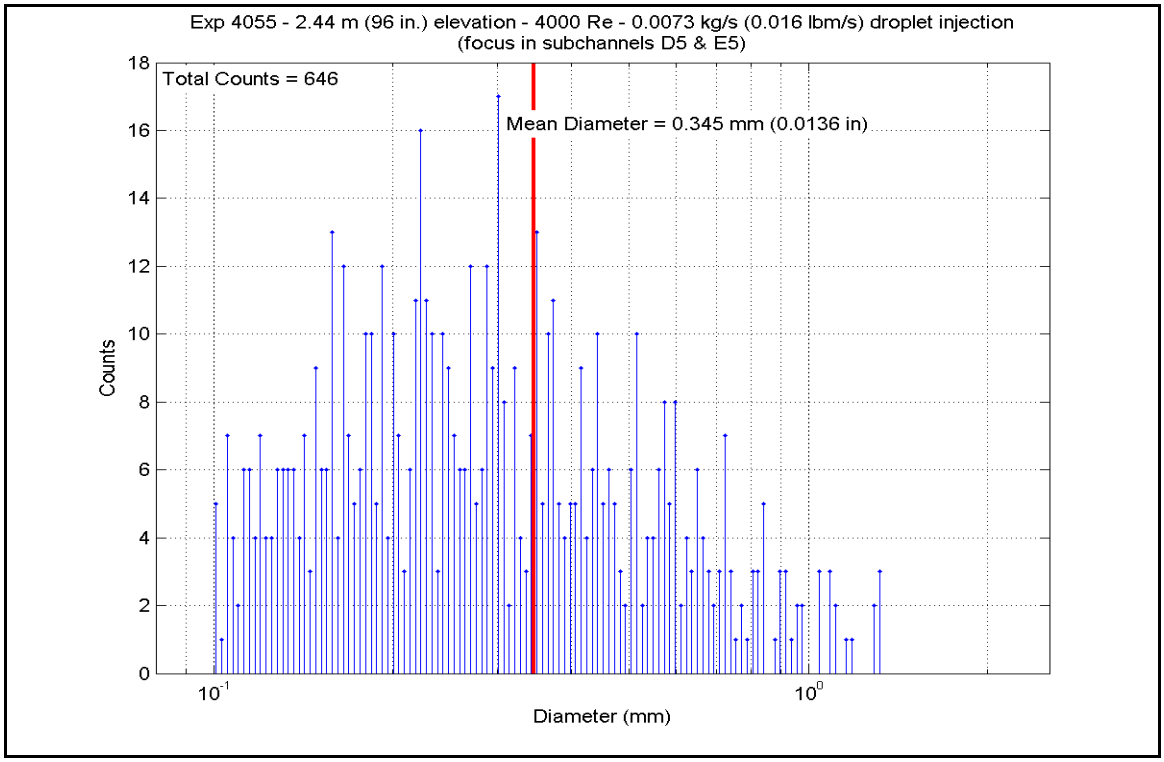

Figure A-565: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055A

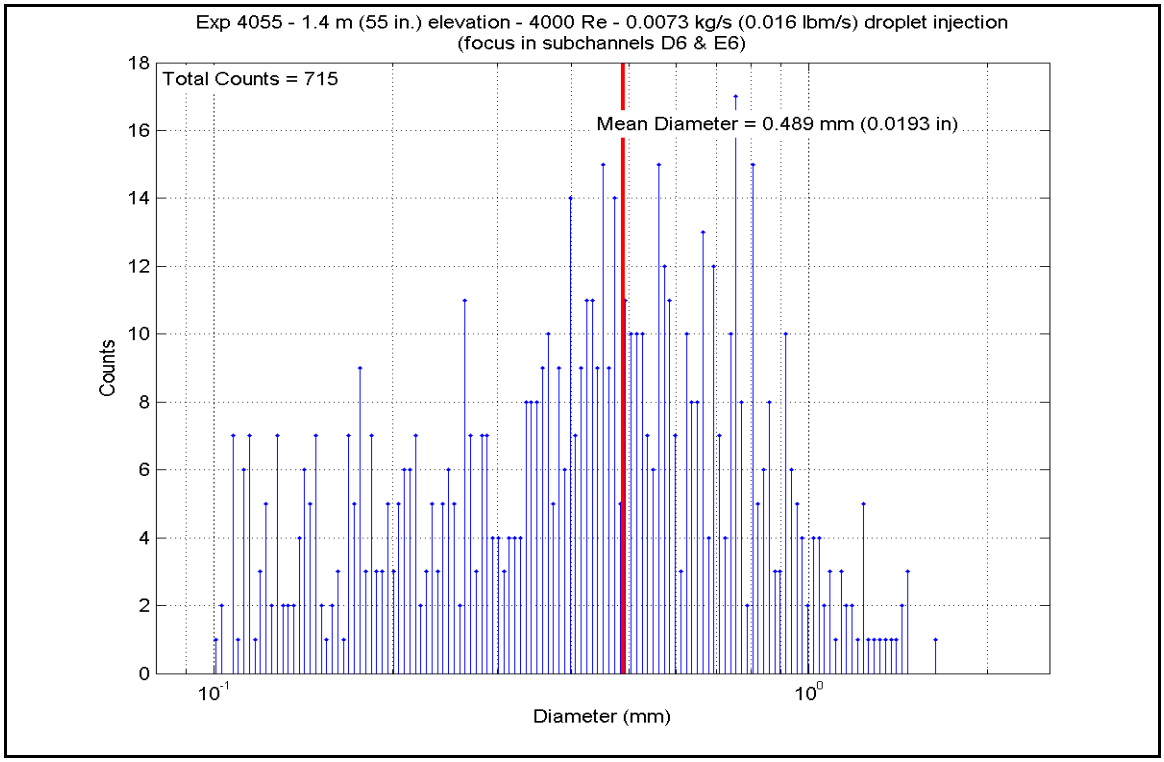

Figure A-566: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055A

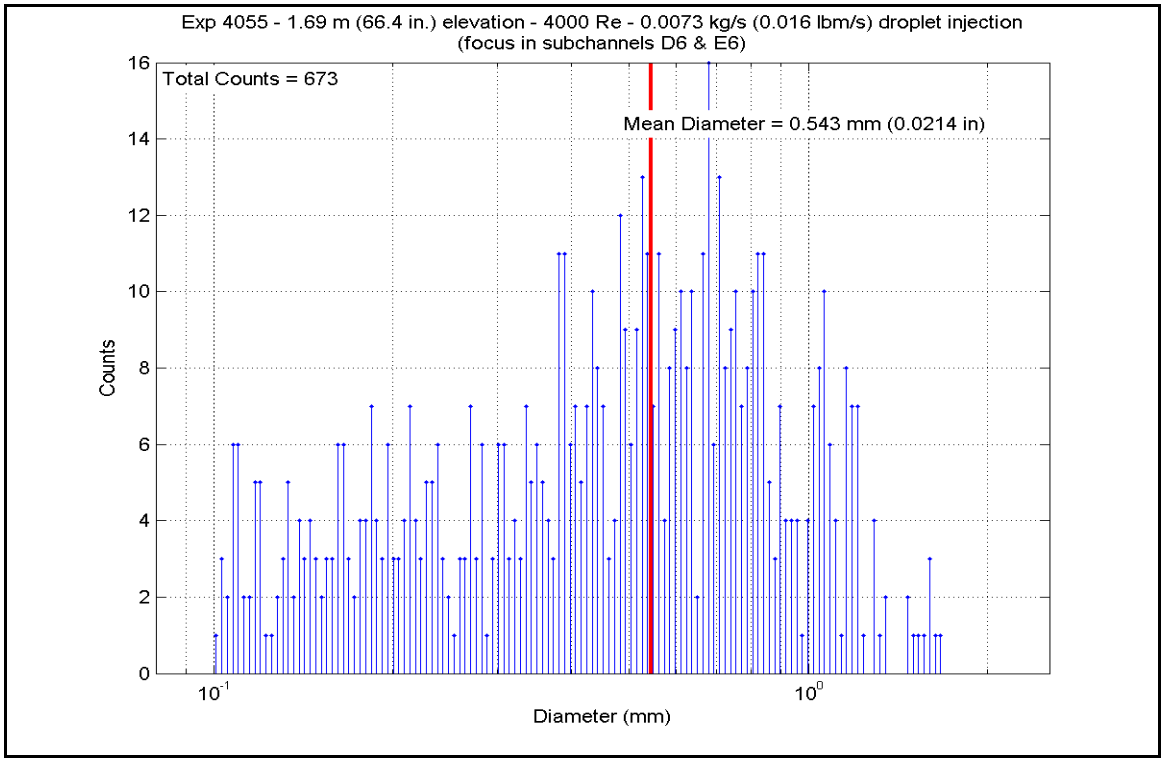

Figure A-567: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055A

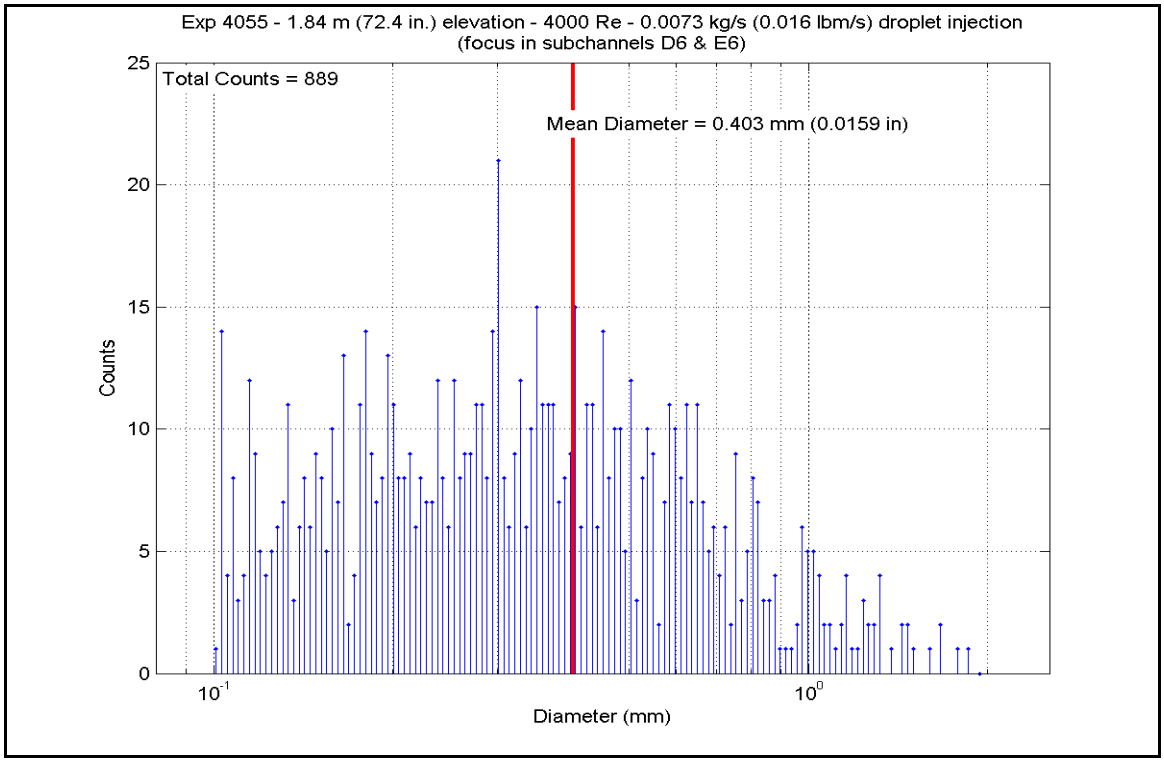

Figure A-568: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055A

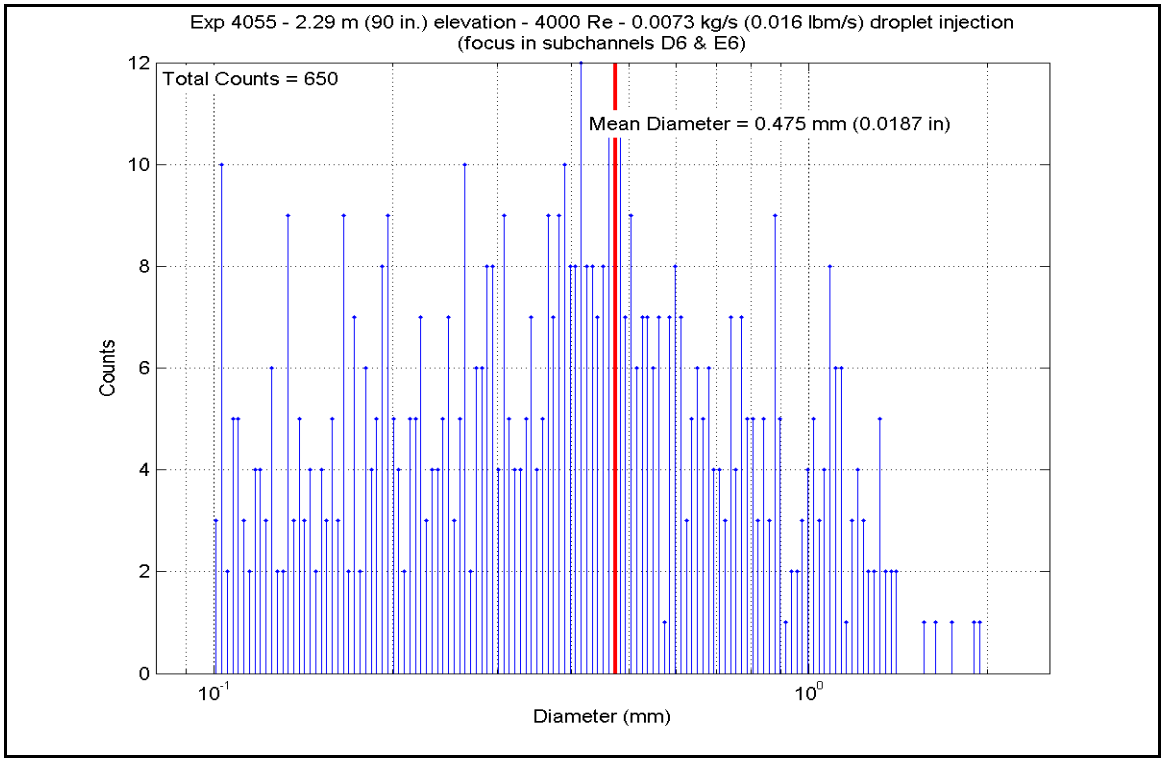

Figure A-569: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055A

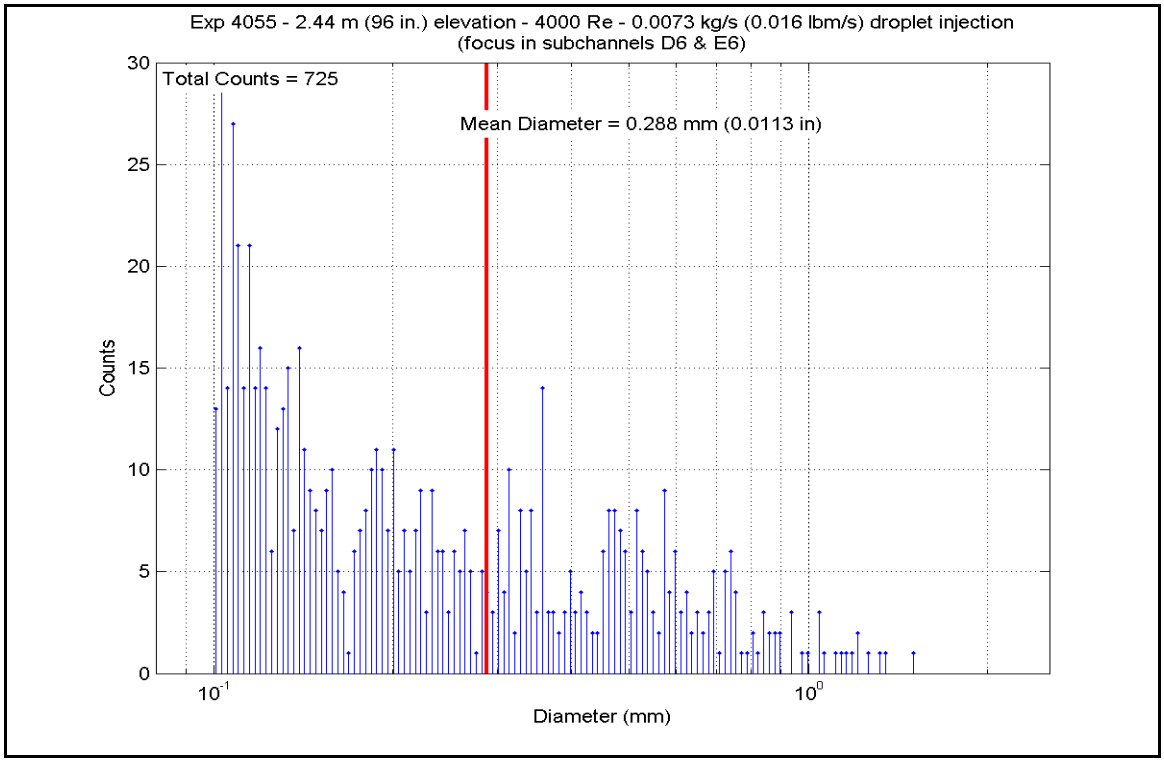

Figure A-570: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055A

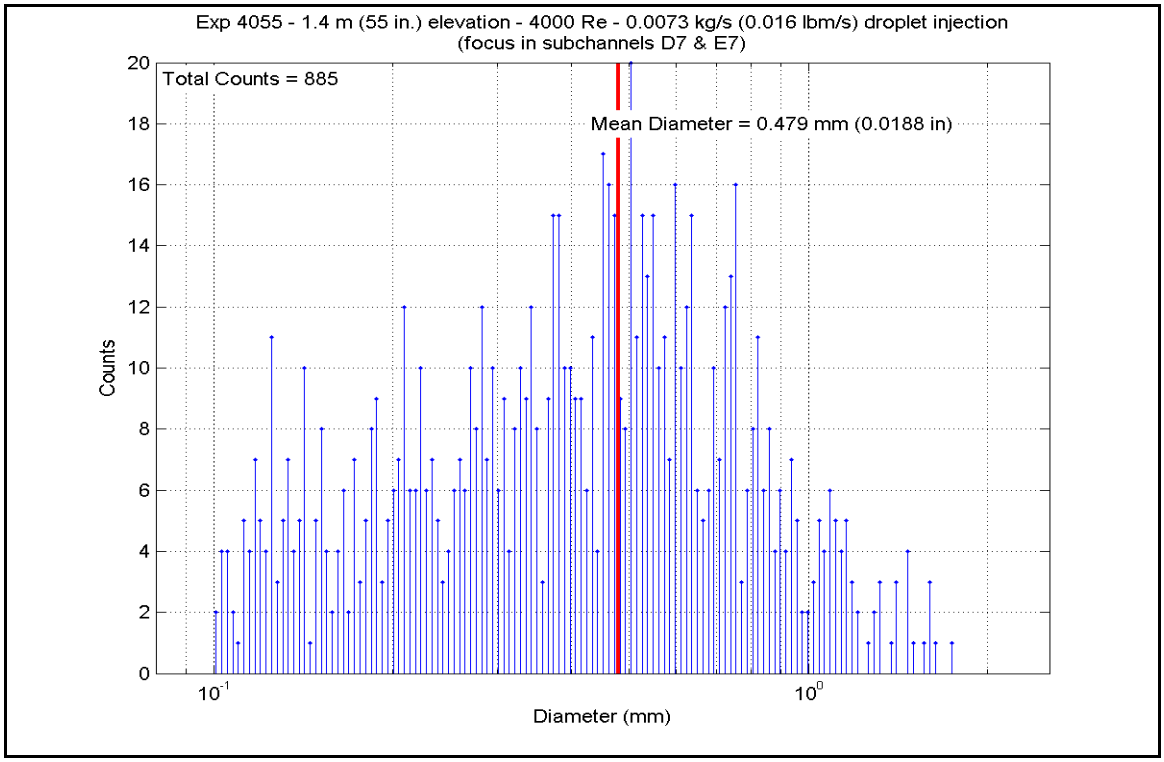

Figure A-571: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055A

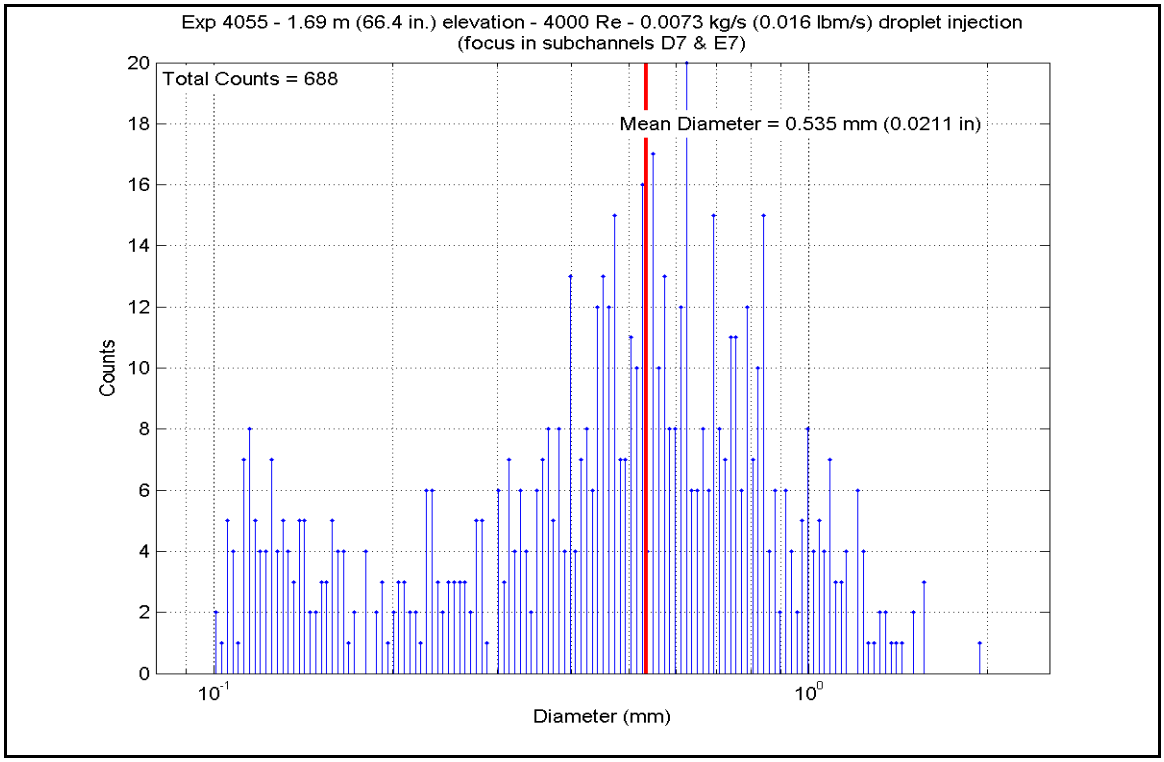

Figure A-572: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055A

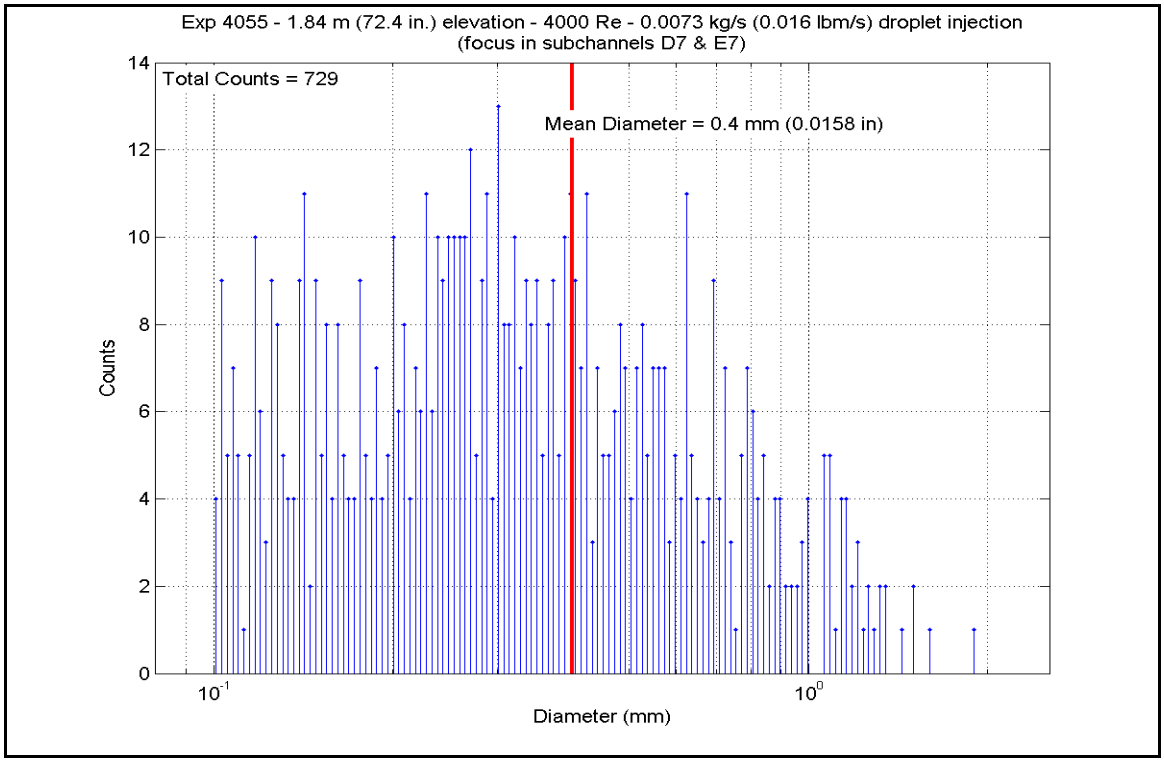

Figure A-573: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055A

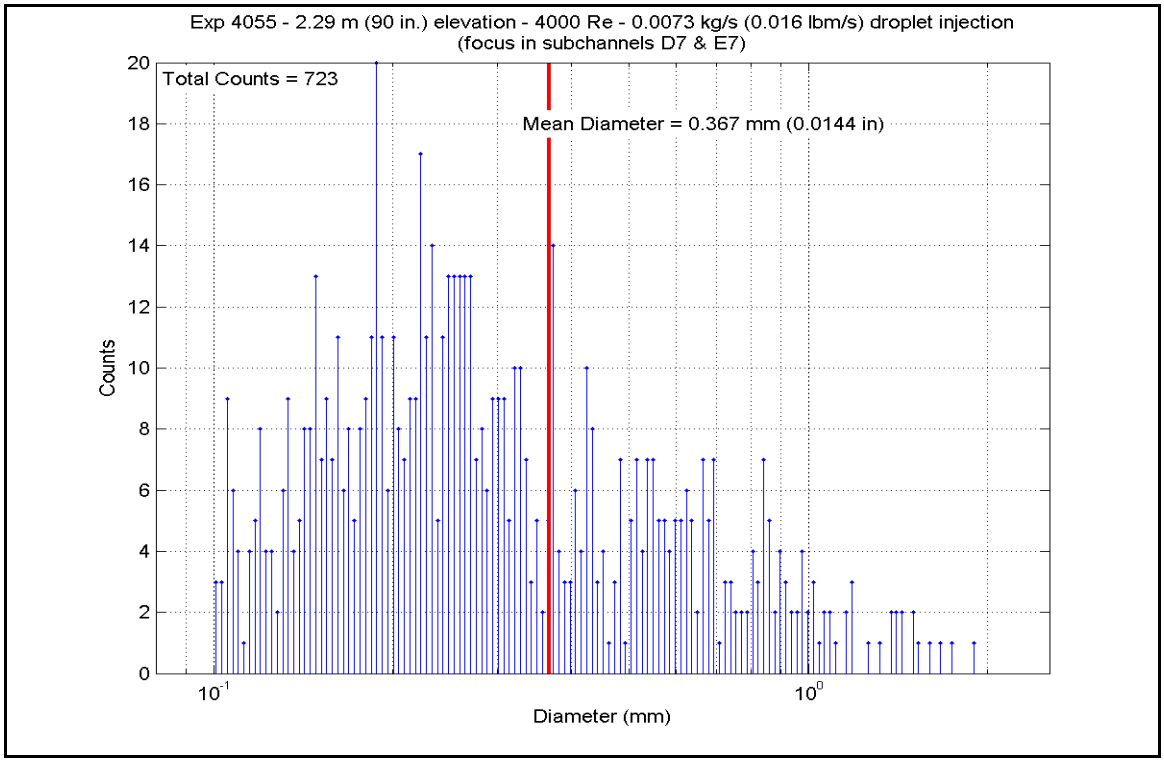

Figure A-574: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055A

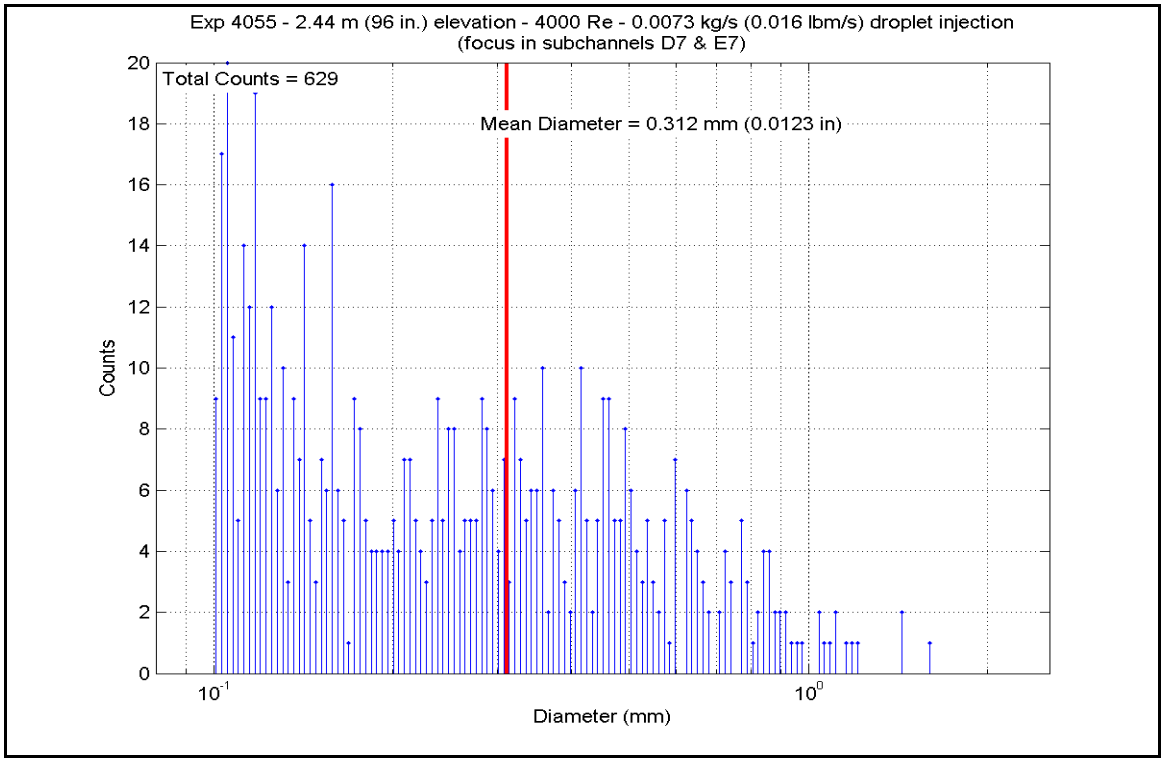

Figure A-575: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055A

Table A-68: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055A

SCD-4055-A	Inlet Reynolds:	4000	
Matrix test # 13b	UP Pressure:	137.9 kPa	20 psia
Time Window 13980-15660	Bundle Power:	50.00 kW	170607 Btu/hr
	Steam flow:	0.0227 kg/s	180.0 lbm/hr
	Droplet flow:	0.0073 kg/s	0.016 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	789.78	694.1	4255.34	13423.5	7.575	43.0
	RodD3_91.3	186	91.3	2.319	2.8	0.071	887.26	748.3	4343.75	13702.4	6.589	37.4
	RodD3_93.1	187	93.1	2.365	4.6	0.117	928.96	771.5	4398.61	13875.4	6.275	35.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	979.08	799.3	4464.34	14082.7	5.944	33.8
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1132.31	884.4	4790.64	15112.1	5.298	30.1
	RodD3_110	191	110	2.794	21.5	0.546	1092.32	862.2	4731.15	14924.4	5.474	31.1
	RodD3_142.1	192	142.1	3.609	53.6	1.361	1175.71	908.5	1680.91	5302.4	1.774	10.1
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	799.82	699.7	4296.71	13554.0	7.514	42.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	886.74	748.0	4381.30	13820.8	6.651	37.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	933.00	773.7	4453.73	14049.3	6.317	35.9
	RodC4_95.3	236	95.3	2.421	6.8	0.173	973.53	796.2	4512.47	14234.6	6.053	34.4
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1061.96	845.3	4662.48	14707.8	5.591	31.7
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1122.52	879.0	4845.05	15283.7	5.416	30.8
	RodC4_110	239	110	2.794	21.5	0.546	1081.10	856.0	4687.13	14785.6	5.494	31.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1175.24	908.3	1817.24	5732.5	1.918	10.9
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	788.02	693.2	4280.42	13502.6	7.643	43.4
	RodD4_91.3	242	91.3	2.319	2.8	0.071	886.22	747.7	4373.07	13794.8	6.644	37.7
	RodD4_93.2	243	93.2	2.367	4.7	0.119	929.46	771.7	4432.08	13981.0	6.318	35.9
	RodD4_95.2	244	95.2	2.418	6.7	0.170	971.98	795.4	4493.41	14174.5	6.040	34.3
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1058.81	843.6	4644.53	14651.2	5.590	31.7
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1112.31	873.3	4824.86	15220.0	5.456	31.0
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1178.17	909.9	1756.36	5540.4	1.848	10.5
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	784.89	691.4	4217.32	13303.5	7.573	43.0
	RodE4_91.2	202	91.2	2.316	2.7	0.069	879.58	744.0	4299.05	13561.3	6.598	37.5
	RodE4_95.3	204	95.3	2.421	6.8	0.173	968.28	793.3	4418.12	13937.0	5.968	33.9
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1050.25	838.8	4581.95	14453.8	5.572	31.6
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1167.85	904.2	1777.00	5605.6	1.891	10.7

Table A-68: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	987.51	804.0	3491.35	11013.5	4.597	26.1
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1113.34	873.9	4316.67	13616.9	4.876	27.7
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1146.98	892.6	4158.39	13117.6	4.525	25.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1179.61	910.7	3908.68	12329.9	4.107	23.3
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1202.65	923.5	3558.83	11226.3	3.651	20.7
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1209.48	927.3	3241.89	10226.5	3.303	18.8
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1160.97	900.4	2803.61	8844.0	3.005	17.1
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1171.81	906.4	2480.30	7824.1	2.628	14.9
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	991.54	806.2	3426.50	10808.9	4.488	25.5
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1083.14	857.1	4202.56	13257.0	4.914	27.9
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1122.69	879.1	4036.98	12734.6	4.512	25.6
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1177.36	909.5	3485.30	10994.4	3.671	20.8
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1185.16	913.8	3167.67	9992.4	3.309	18.8
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1132.95	884.8	2774.58	8752.4	3.066	17.4
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1150.93	894.8	2452.04	7735.0	2.657	15.1
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	940.92	778.1	3497.22	11032.0	4.905	27.9
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1001.72	811.9	4331.25	13662.9	5.598	31.8
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1046.55	836.8	4182.73	13194.4	5.110	29.0
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1089.59	860.7	3913.77	12346.0	4.542	25.8
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1121.64	878.5	3594.98	11340.4	4.023	22.8
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1140.20	888.8	3266.92	10305.5	3.581	20.3
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1182.84	912.5	2870.04	9053.5	3.006	17.1
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1156.81	898.0	2526.61	7970.2	2.720	15.4
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	910.66	761.3	3972.83	12532.3	5.820	33.0
	RodC3_85.6	178	85.6	2.174	14.72	0.374	842.87	723.6	4144.73	13074.6	6.741	38.3
	RodC3_88.5	179	88.5	2.248	0	0.000	793.99	696.5	4233.01	13353.0	7.479	42.5
	RodC3_92.4	180	92.4	2.347	3.9	0.099	904.63	757.9	4353.00	13731.5	6.433	36.5
	RodC3_94.4	181	94.4	2.398	5.9	0.150	942.50	779.0	4414.19	13924.5	6.178	35.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	868.40	737.8	3101.57	9783.9	4.843	27.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	882.08	745.4	3221.46	10162.1	4.925	28.0
	RodD5_56.9	219	56.9	1.445	9.9	0.251	924.54	769.0	3304.24	10423.2	4.744	26.9
	RodD5_60	220	60	1.524	13	0.330	959.86	788.6	3396.63	10714.7	4.641	26.4
	RodD5_66.1	221	66.1	1.679	19.1	0.485	977.91	798.7	3575.98	11280.4	4.769	27.1
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	738.49	665.6	3690.02	11640.2	7.228	41.0
	RodD5_72.9	223	72.9	1.852	2.02	0.051	821.26	711.6	3781.54	11928.9	6.374	36.2
	RodD5_74.9	224	74.9	1.902	4.02	0.102	867.97	737.6	3841.72	12118.7	6.003	34.1

Table A-68: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	816.03	708.7	2819.01	8892.6	4.794	27.2
	RodB5_52.9	154	52.9	1.344	5.9	0.150	859.85	733.1	3175.08	10015.8	5.025	28.5
	RodB5_55	155	55	1.397	8	0.203	899.67	755.2	3238.38	10215.5	4.821	27.4
	RodB5_57.8	156	57.8	1.468	10.8	0.274	946.66	781.3	3322.21	10479.9	4.623	26.3
	RodB5_64	157	64	1.626	17	0.432	997.33	809.4	3509.49	11070.7	4.562	25.9
	RodB5_73.9	158	73.9	1.877	3.02	0.077	850.82	728.1	3809.76	12017.9	6.117	34.7
	RodB5_75.9	159	75.9	1.928	5.02	0.128	888.30	748.9	3871.71	12213.3	5.864	33.3
	RodB5_76.9	160	76.9	1.953	6.02	0.153	904.04	757.6	3902.83	12311.5	5.773	32.8
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	798.95	699.2	2800.46	8834.1	4.905	27.9
	RodF5_53.1	106	53.1	1.349	6.1	0.155	843.70	724.1	3161.49	9972.9	5.135	29.2
	RodF5_55	107	55	1.397	8	0.203	882.18	745.5	3218.50	10152.8	4.920	27.9
	RodF5_57.8	108	57.8	1.468	10.8	0.274	928.42	771.2	3302.02	10416.2	4.714	26.8
	RodF5_64	109	64	1.626	17	0.432	983.78	801.9	3487.85	11002.4	4.615	26.2
	RodF5_73.8	110	73.8	1.875	2.92	0.074	837.62	720.7	3782.60	11932.2	6.205	35.2
	RodF5_75.8	111	75.8	1.925	4.92	0.125	874.89	741.4	3842.20	12120.2	5.940	33.7
	RodF5_76.8	112	76.8	1.951	5.92	0.150	890.46	750.1	3872.15	12214.7	5.845	33.2
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	821.29	711.6	2806.47	8853.0	4.730	26.9
	RodC2_53.1	58	53.1	1.349	6.1	0.155	885.45	747.3	3171.20	10003.5	4.823	27.4
	RodC2_55	59	55	1.397	8	0.203	913.16	762.7	3227.15	10180.1	4.710	26.7
	RodC2_57.8	60	57.8	1.468	10.8	0.274	952.47	784.5	3310.05	10441.5	4.569	25.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	988.26	804.4	3491.85	11015.0	4.593	26.1
	RodC2_73.8	62	73.8	1.875	2.92	0.074	824.73	713.6	3799.33	11985.0	6.367	36.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	857.29	731.6	3861.76	12181.9	6.137	34.8
	RodC2_76.8	64	76.8	1.951	5.92	0.150	872.21	739.9	3893.31	12281.4	6.044	34.3
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	809.12	704.9	2802.74	8841.2	4.823	27.4
	RodC6_52.8	138	52.8	1.341	5.8	0.147	881.72	745.2	3172.48	10007.6	4.853	27.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	908.38	760.0	3234.57	10203.4	4.754	27.0
	RodC6_57.8	140	57.8	1.468	10.8	0.274	936.07	775.4	3329.78	10503.8	4.703	26.7
	RodC6_63.8	141	63.8	1.621	16.8	0.427	982.99	801.5	3518.53	11099.2	4.660	26.5
	RodC6_73.7	142	73.7	1.872	2.82	0.072	848.24	726.6	3828.02	12075.5	6.172	35.0
	RodC6_75.8	143	75.8	1.925	4.92	0.125	880.90	744.8	3893.29	12281.4	5.963	33.9
	RodC6_76.8	144	76.8	1.951	5.92	0.150	899.50	755.1	3924.85	12380.9	5.845	33.2

Table A-68: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	795.72	697.4	4218.12	13306.1	7.430	42.2
	RodB4_91.3	162	91.3	2.319	2.8	0.071	882.26	745.5	4304.65	13579.0	6.579	37.4
	RodB4_93.3	163	93.3	2.370	4.8	0.122	914.24	763.3	4363.70	13765.3	6.359	36.1
	RodB4_95.1	164	95.1	2.416	6.6	0.168	944.76	780.2	4416.75	13932.6	6.162	35.0
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1150.97	894.8	1808.40	5704.6	1.959	11.1
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	865.18	736.0	4157.94	13116.2	6.526	37.1
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	793.45	696.2	4240.89	13377.9	7.500	42.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	904.07	757.6	4360.26	13754.4	6.449	36.6
	RodF4_94.3	101	94.3	2.395	5.8	0.147	941.68	778.5	4417.44	13934.8	6.190	35.2
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1105.25	869.4	4202.73	13257.5	4.791	27.2
	RodD2_106	66	106	2.692	17.5	0.445	1130.46	883.4	3982.83	12563.9	4.413	25.1
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1165.25	902.7	3685.47	11625.8	3.932	22.3
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1184.45	913.4	3334.37	10518.3	3.486	19.8
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1188.03	915.4	2999.01	9460.4	3.124	17.7
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1079.87	855.3	4206.63	13269.8	4.938	28.0
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1102.98	868.1	4039.11	12741.4	4.616	26.2
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1126.28	881.1	3674.12	11590.0	4.090	23.2
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1135.53	886.2	3328.35	10499.3	3.667	20.8
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1138.24	887.7	2981.20	9404.2	3.275	18.6

Table A-68: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	878.50	743.4	3102.10	9785.6	4.769	27.1
	RodE2_54	74	54	1.372	7	0.178	902.19	756.6	3220.78	10159.9	4.777	27.1
	RodE2_56.9	75	56.9	1.445	9.9	0.251	942.63	779.1	3307.93	10434.9	4.629	26.3
	RodE2_59.9	76	59.9	1.521	12.9	0.328	975.97	797.6	3398.41	10720.3	4.544	25.8
	RodE2_66	77	66	1.676	19	0.483	985.28	802.8	3583.65	11304.6	4.732	26.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	732.61	662.4	3710.80	11705.7	7.354	41.8
	RodE2_72.9	79	72.9	1.852	2.02	0.051	821.35	711.7	3805.60	12004.8	6.414	36.4
	RodE2_74.9	80	74.9	1.902	4.02	0.102	859.46	732.9	3867.67	12200.6	6.125	34.8
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	823.54	712.9	3088.03	9741.2	5.185	29.4
	RodB3_54.1	170	54.1	1.374	7.1	0.180	850.40	727.8	3201.92	10100.5	5.145	29.2
	RodB3_56.9	171	56.9	1.445	9.9	0.251	902.18	756.6	3285.83	10365.1	4.874	27.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	899.96	755.3	3378.74	10658.2	5.028	28.6
	RodB3_66.1	173	66.1	1.679	19.1	0.485	950.58	783.5	3563.39	11240.7	4.931	28.0
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	740.07	666.5	3681.77	11614.2	7.190	40.8
	RodB3_73	175	73	1.854	2.12	0.054	794.55	696.8	3774.44	11906.5	6.662	37.8
	RodB3_75	176	75	1.905	4.12	0.105	831.28	717.2	3838.01	12107.0	6.362	36.1
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	859.14	732.7	3090.90	9750.2	4.897	27.8
	RodF3_54	90	54	1.372	7	0.178	885.23	747.2	3209.38	10124.0	4.883	27.7
	RodF3_57	91	57	1.448	10	0.254	933.88	774.2	3300.11	10410.2	4.675	26.5
	RodF3_60	92	60	1.524	13	0.330	971.22	794.9	3391.80	10699.4	4.564	25.9
	RodF3_66.1	93	66.1	1.679	19.1	0.485	989.72	805.2	3579.48	11291.5	4.699	26.7
	RodF3_70	94	70	1.778	-0.88	-0.022	769.11	682.7	3698.35	11666.5	6.835	38.8
	RodF3_73	95	73	1.854	2.12	0.054	844.00	724.3	3791.33	11959.7	6.155	35.0
	RodF3_75	96	75	1.905	4.12	0.105	883.46	746.2	3852.09	12151.4	5.877	33.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	828.02	715.4	3089.45	9745.7	5.149	29.2
	RodE6_54.1	122	54.1	1.374	7.1	0.180	871.43	739.5	3203.52	10105.5	4.979	28.3
	RodE6_57	123	57	1.448	10	0.254	904.11	757.7	3289.27	10376.0	4.865	27.6
	RodE6_60.2	124	60.2	1.529	13.2	0.335	941.76	778.6	3384.14	10675.3	4.741	26.9
	RodE6_66.1	125	66.1	1.679	19.1	0.485	955.10	786.0	3558.66	11225.8	4.894	27.8
	RodE6_70	126	70	1.778	-0.88	-0.022	750.44	672.3	3679.76	11607.8	7.043	40.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	822.16	712.1	3767.40	11884.3	6.341	36.0
	RodE6_75	128	75	1.905	4.12	0.105	859.46	732.9	3823.78	12062.1	6.055	34.4

RBHT Steam Cooling with Droplet Injection Test SCD-4055-B

Matrix Test # 13c

Test Conditions

Test Date – 11/23/2005
Steady State Time Window: 16800 - 17880
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

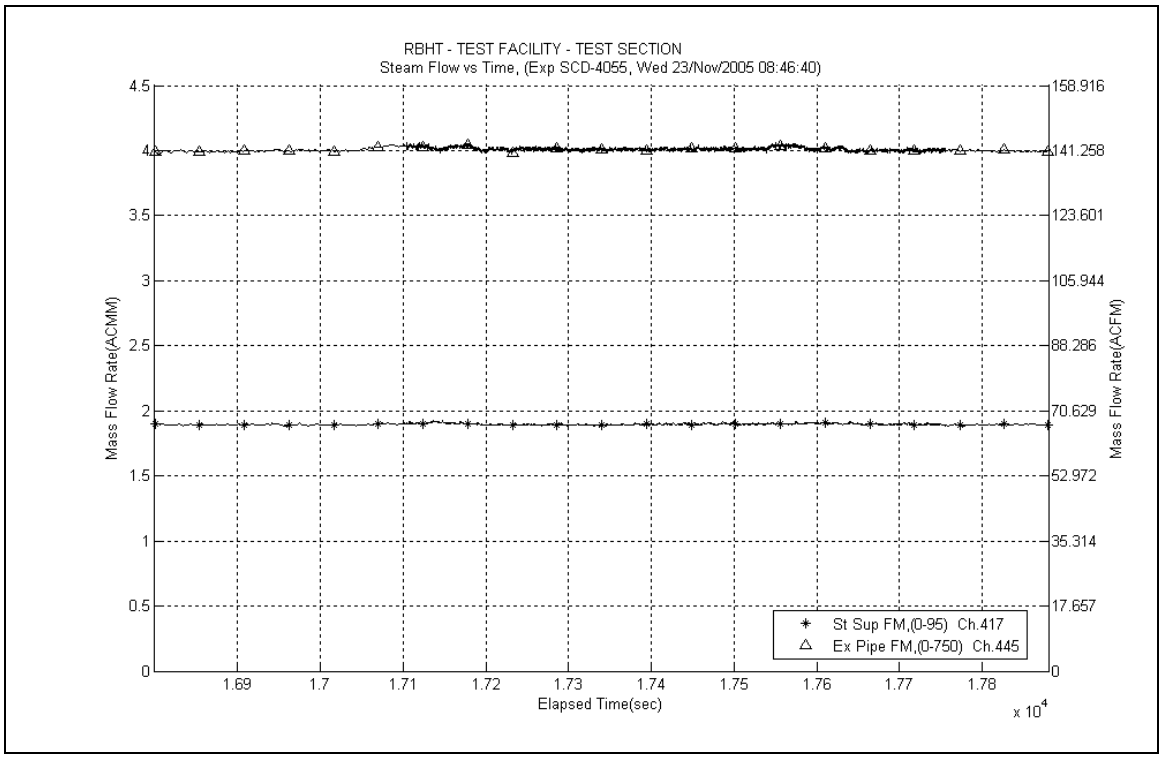

Figure A-576: Inlet and Exhaust Steam Flow Rates for Experiment 4055B

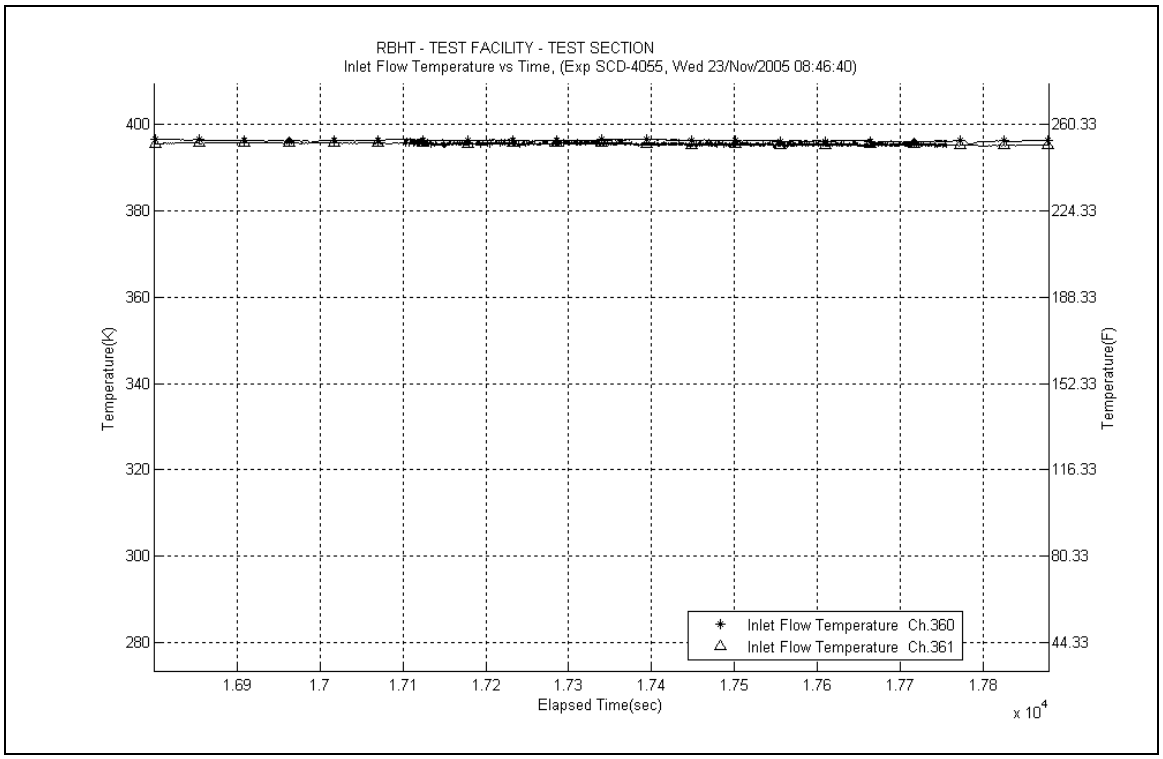

Figure A-577: Inlet Steam Temperature for Experiment 4055B

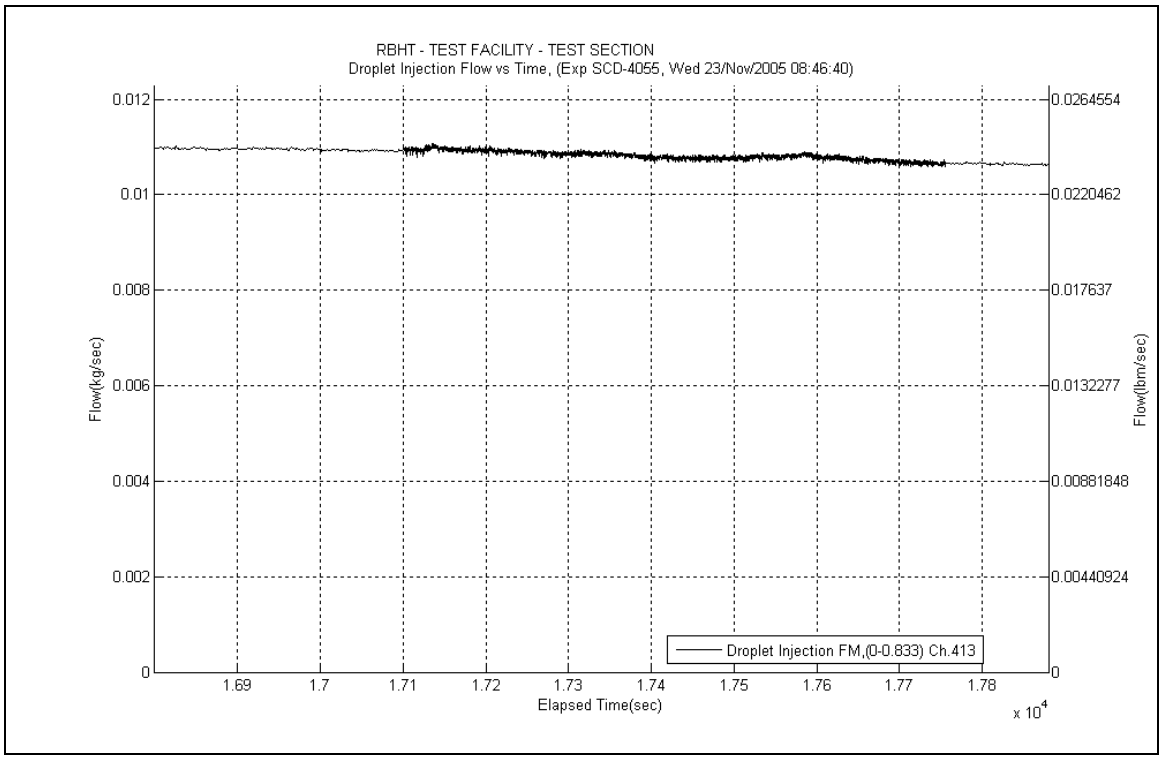

Figure A-578: Droplet Injection Flow Rate for Experiment 4055B

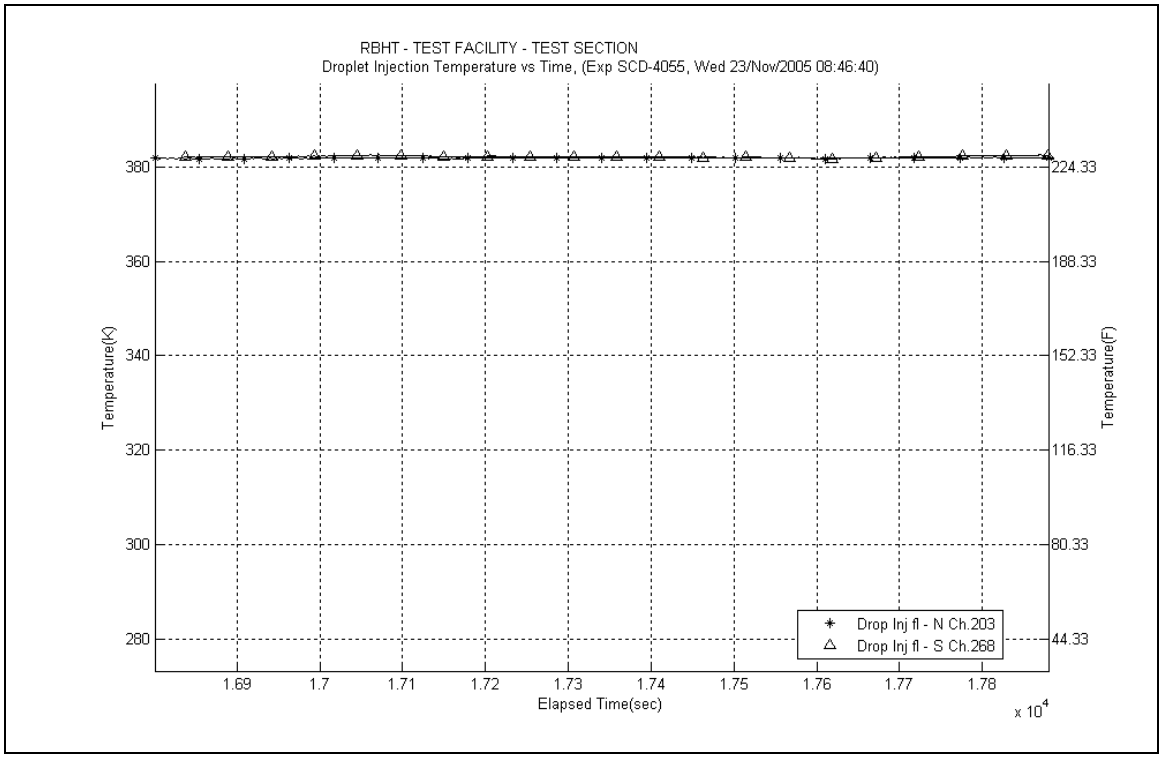

Figure A-579: Droplet Injection Temperature for Experiment 4055B

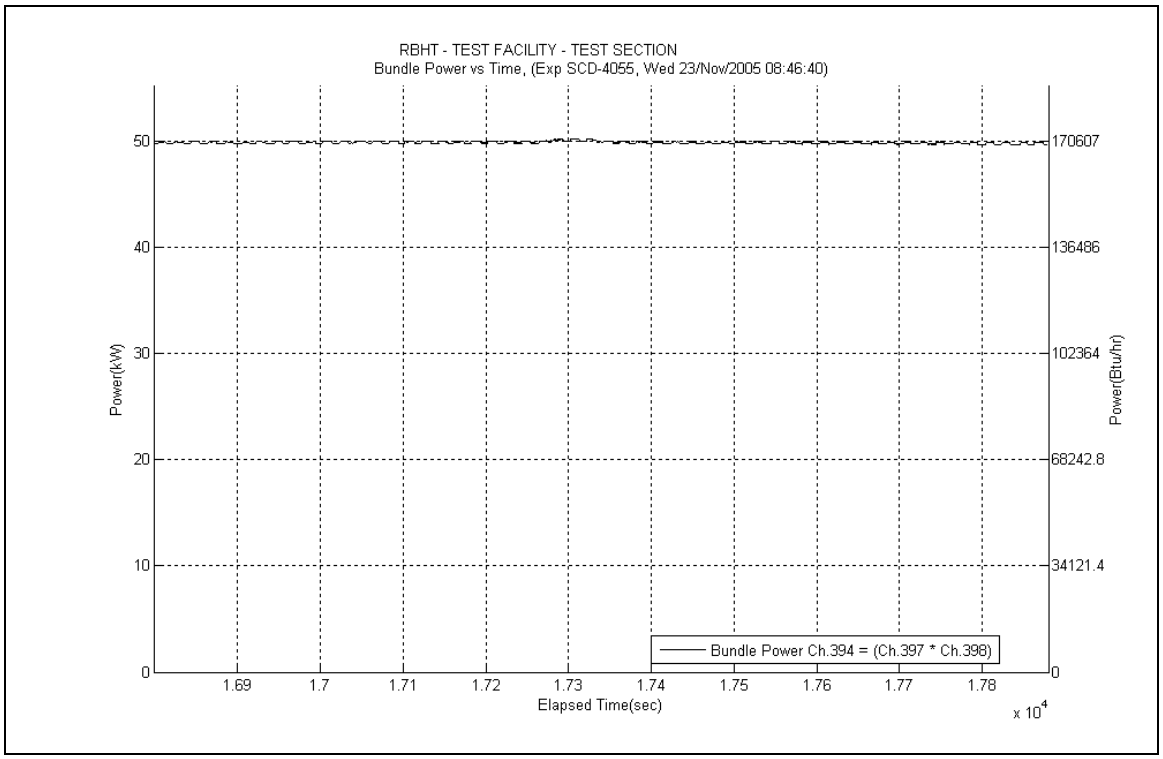

Figure A-580: Bundle Power for Experiment 4055B

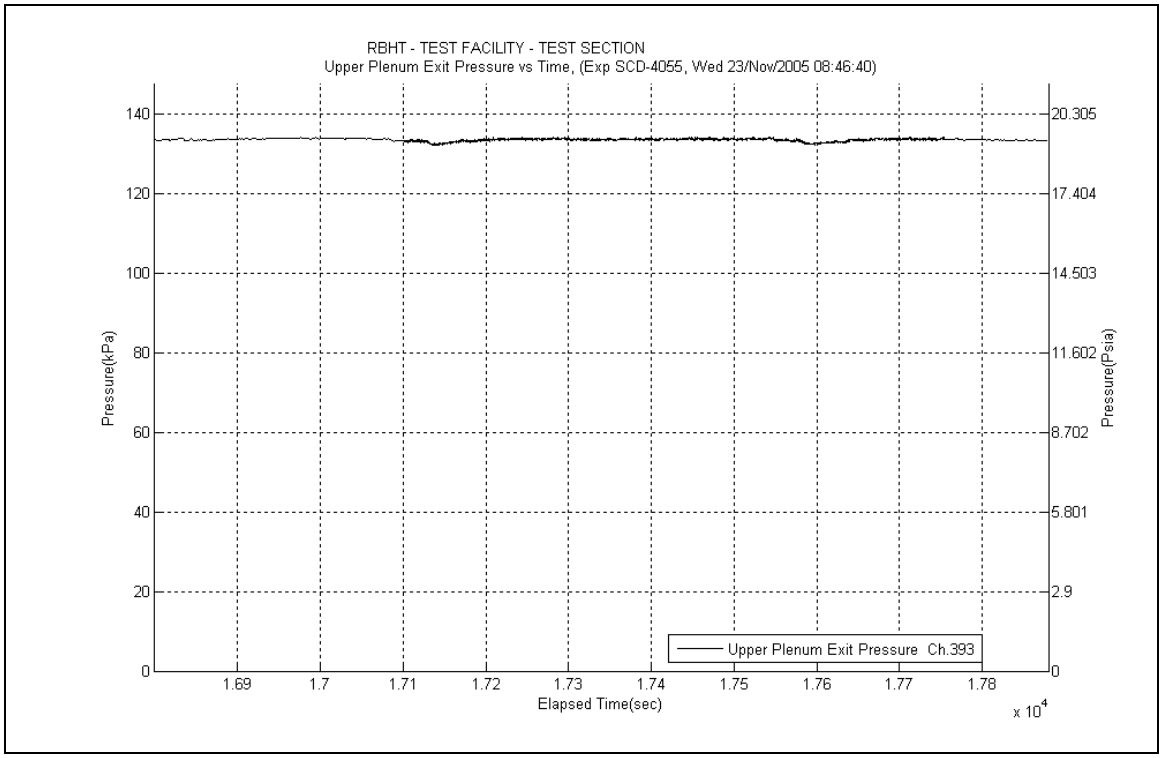

Figure A-581: Upper Plenum Pressure for Experiment 4055B

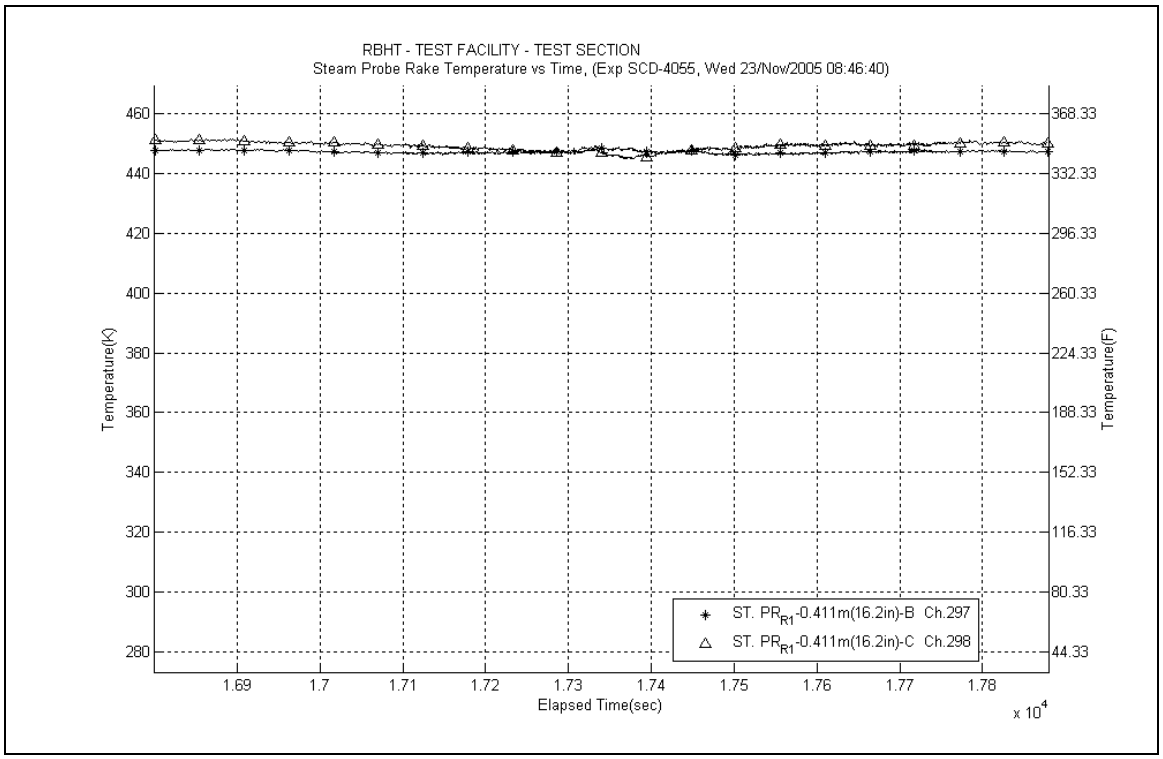

Figure A-582: Steam Probe Rake #1 Temperatures for Experiment 4055B

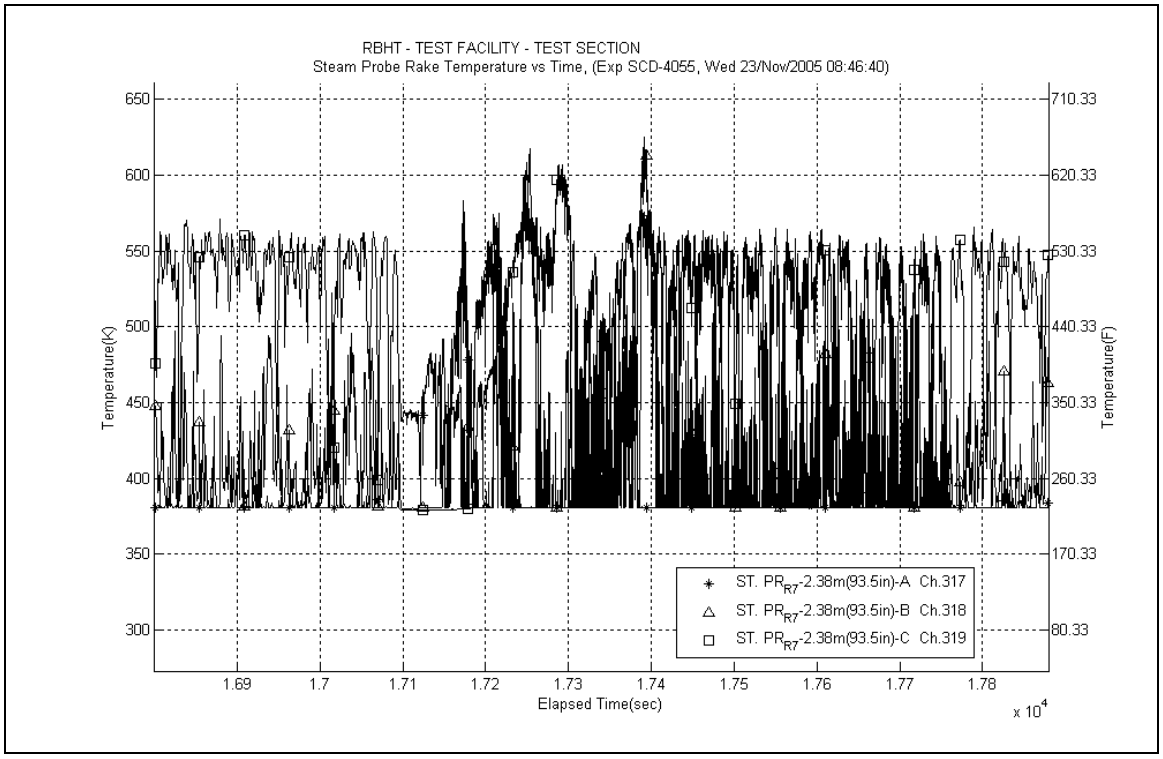

Figure A-583: Steam Probe Rake #7 Temperatures for Experiment 4055B

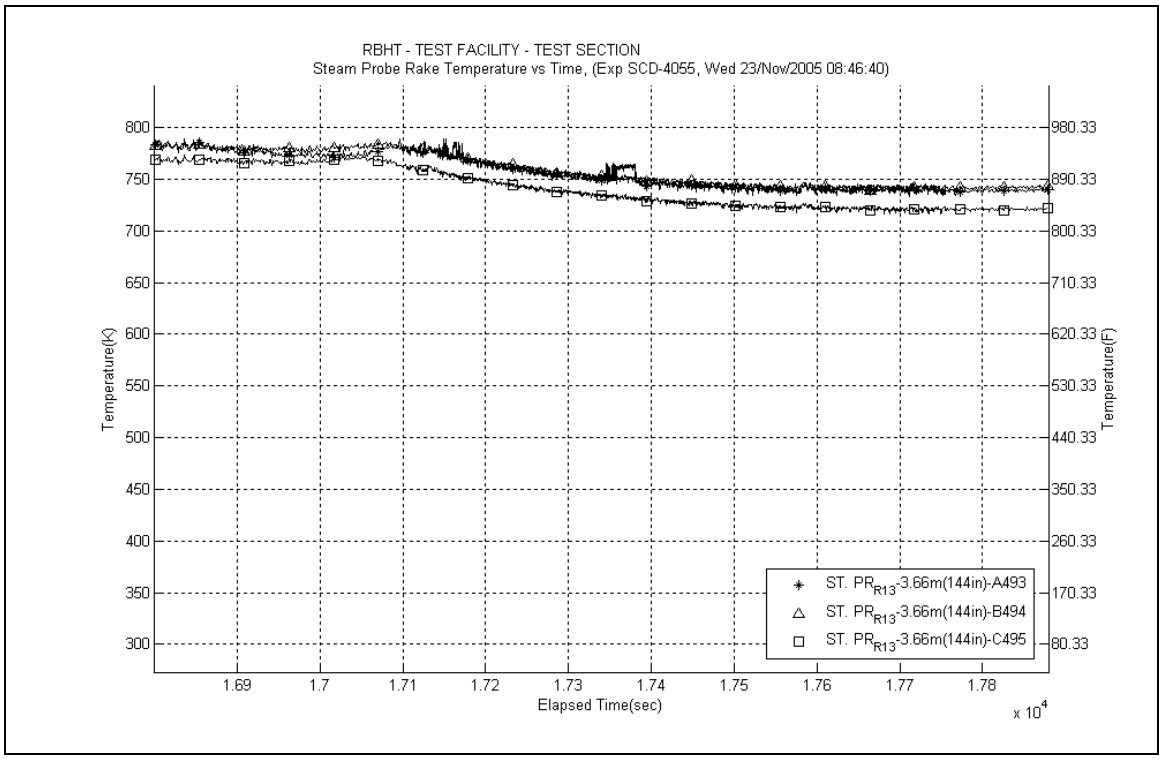

Figure A-584: Steam Probe Rake #13 Temperatures for Experiment 4055B

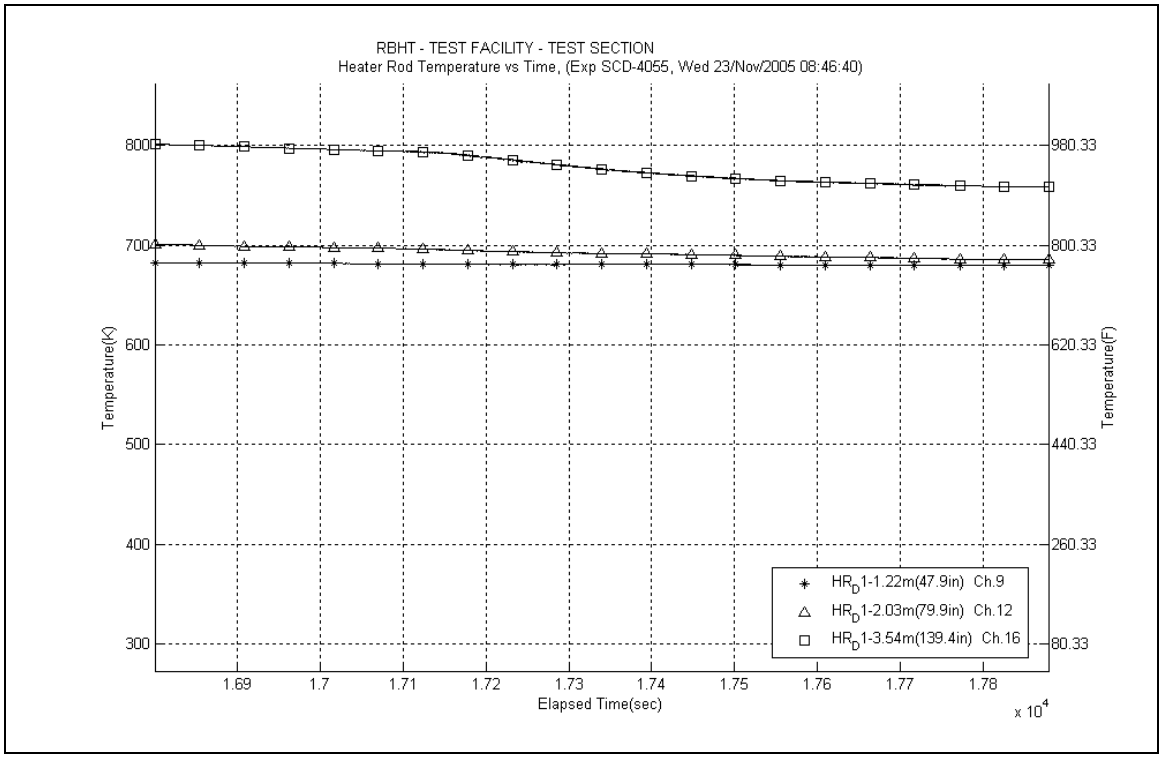

Figure A-585: Heater Rod D1 Temperatures for Experiment 4055B

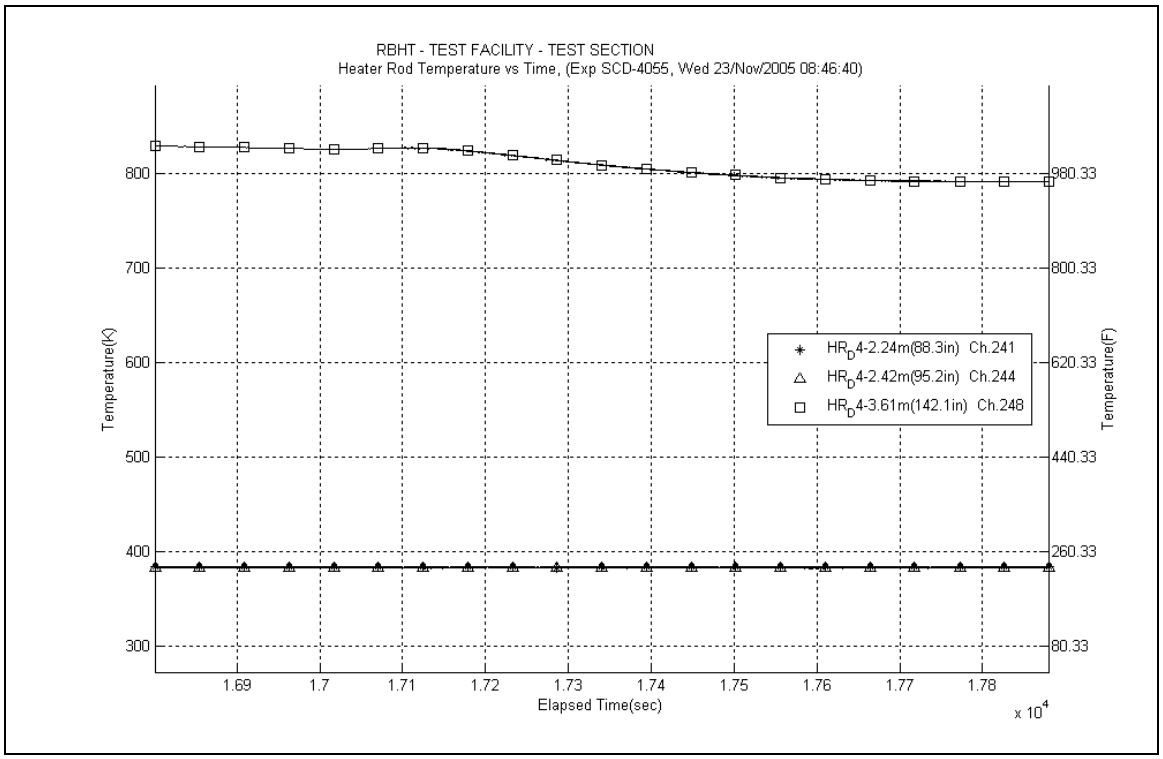

Figure A-586: Heater Rod D4 Temperatures for Experiment 4055B

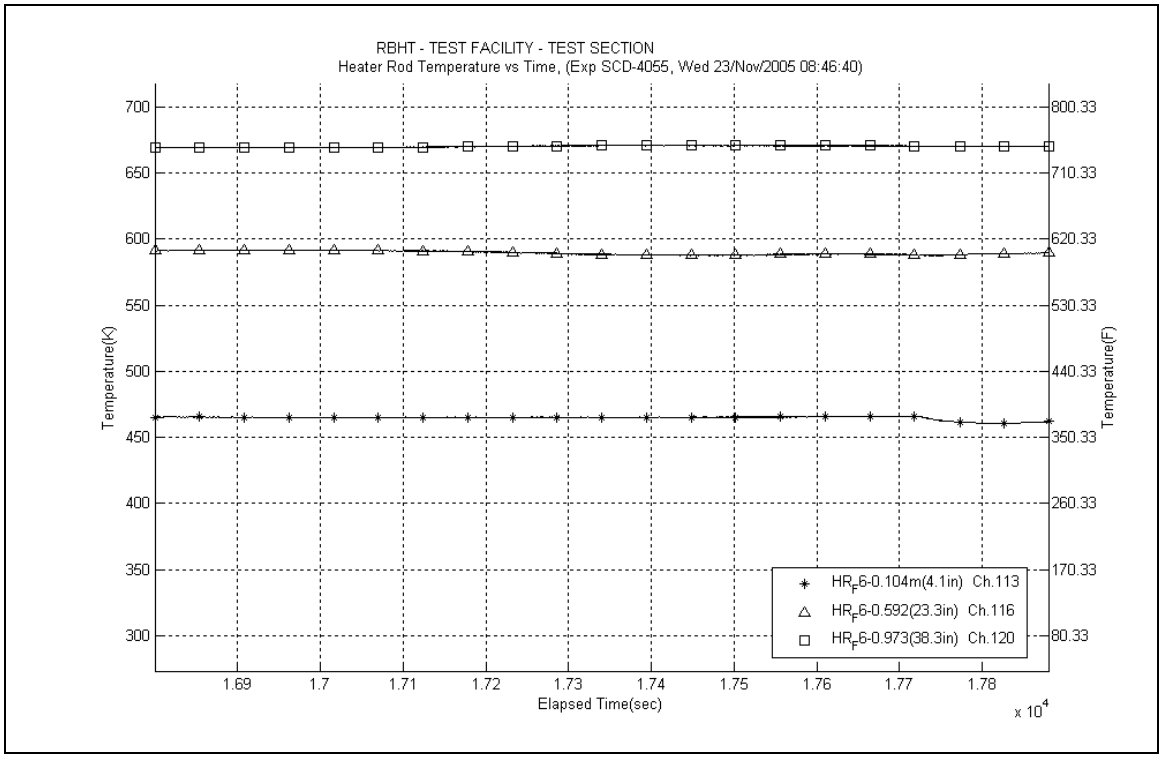

Figure A-587: Heater Rod F6 Temperatures for Experiment 4055B

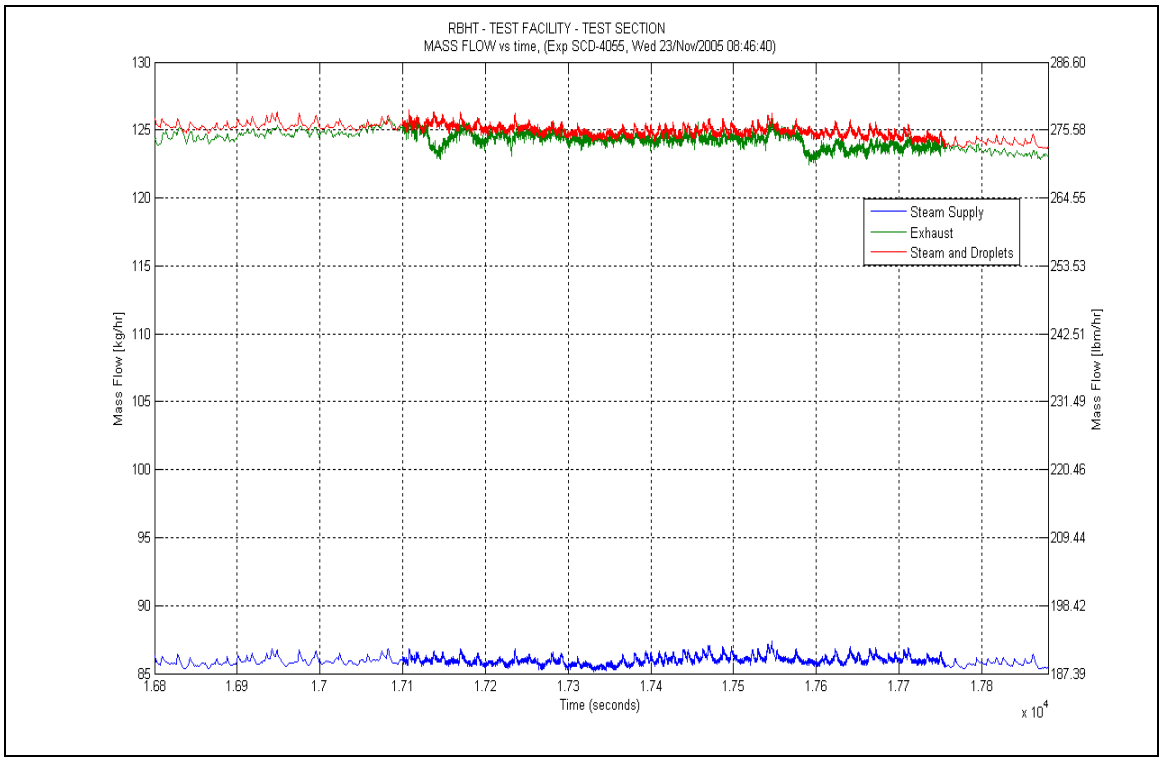

Figure A-588: Mass Flow for Experiment 4055B

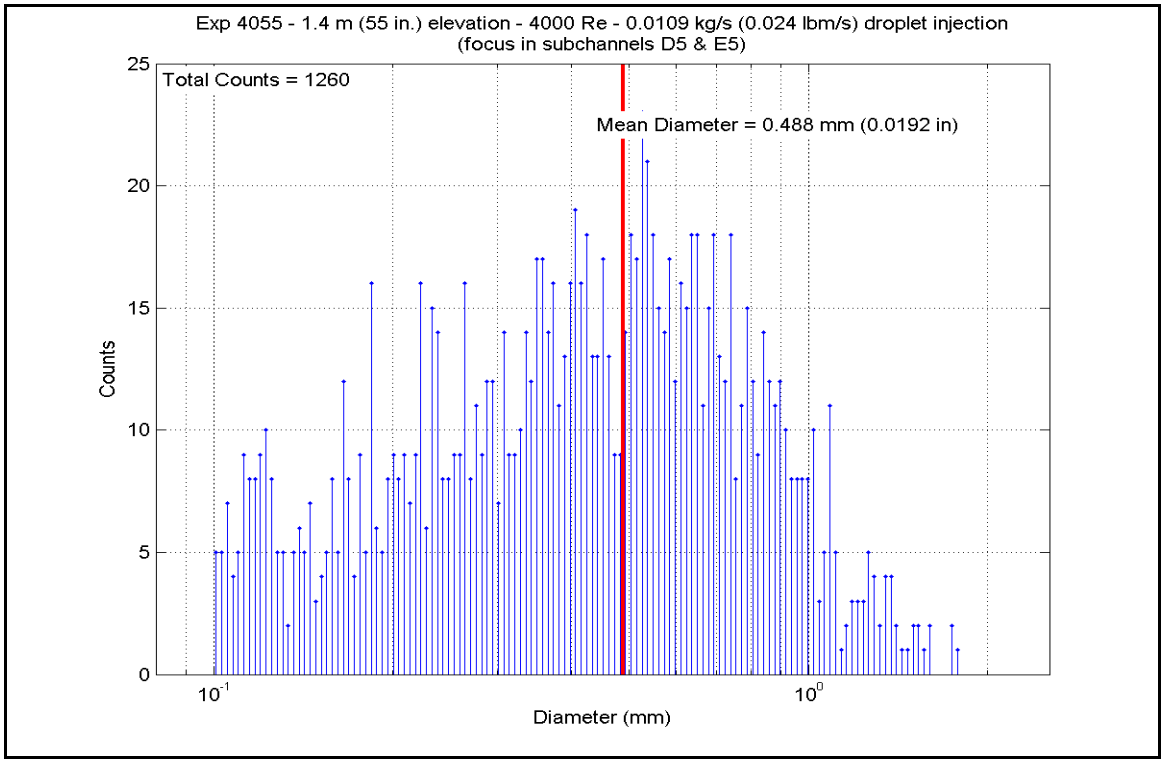

Figure A-589: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055B

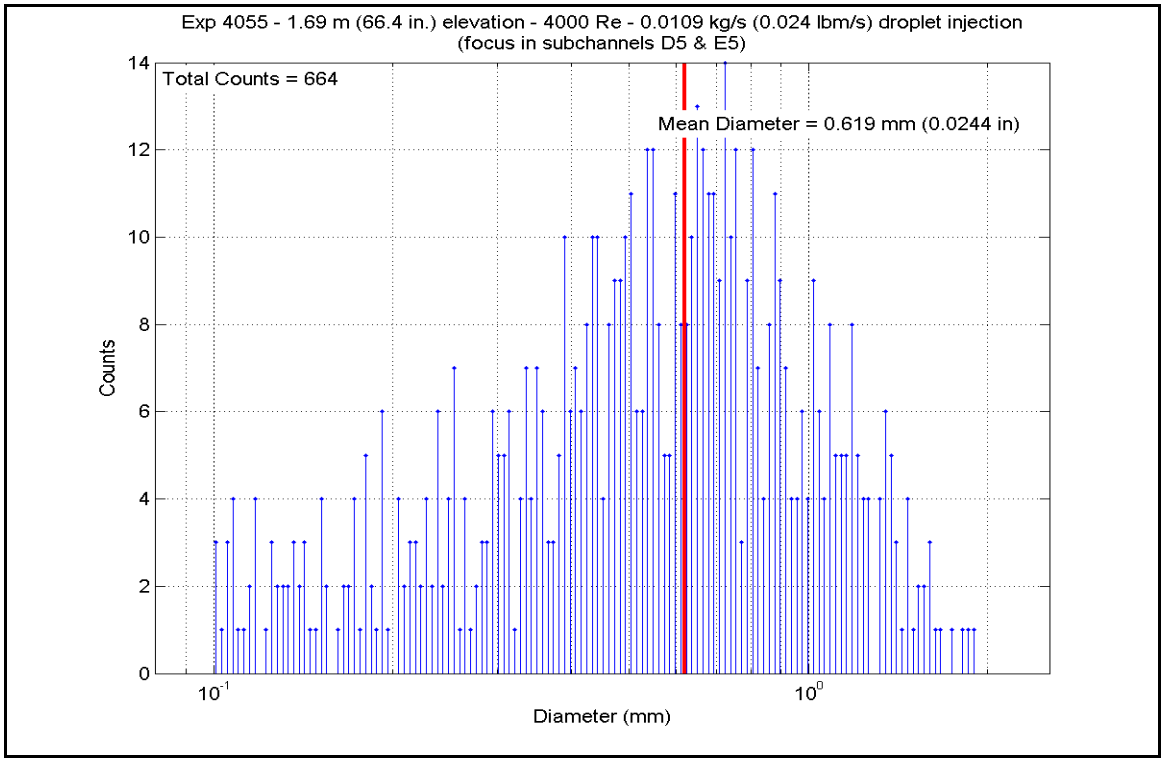

Figure A-590: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055B

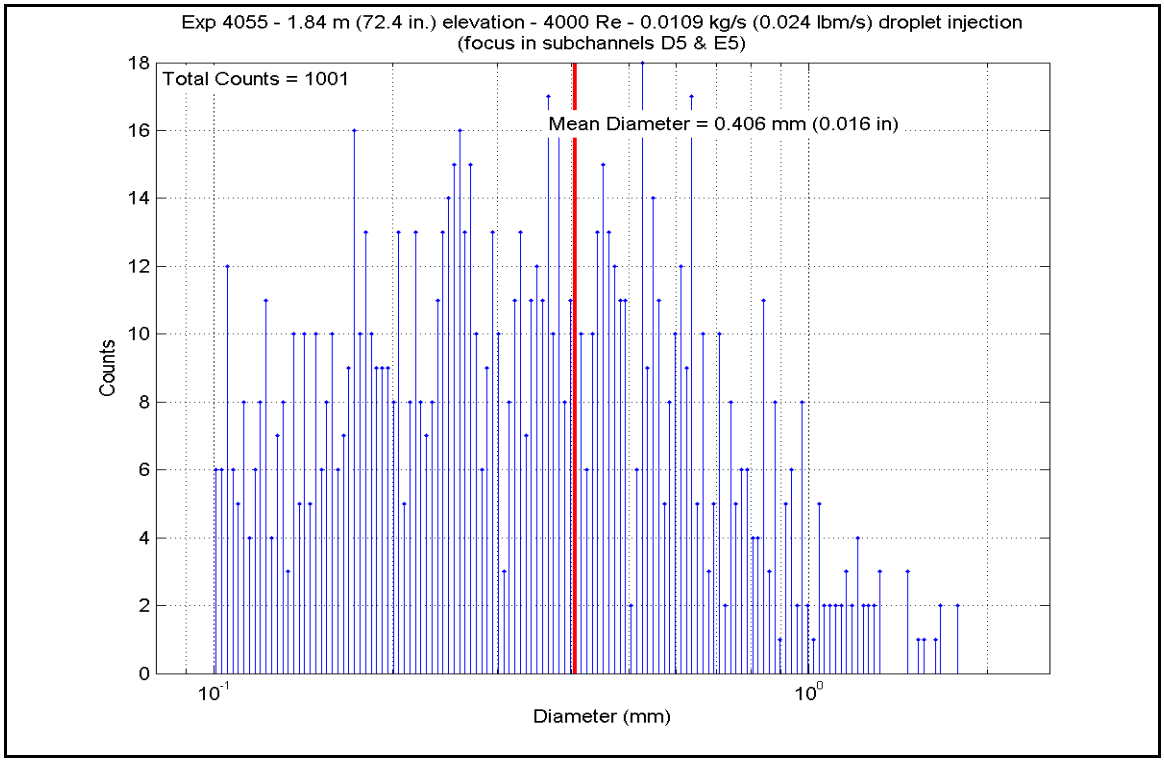

Figure A-591: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055B

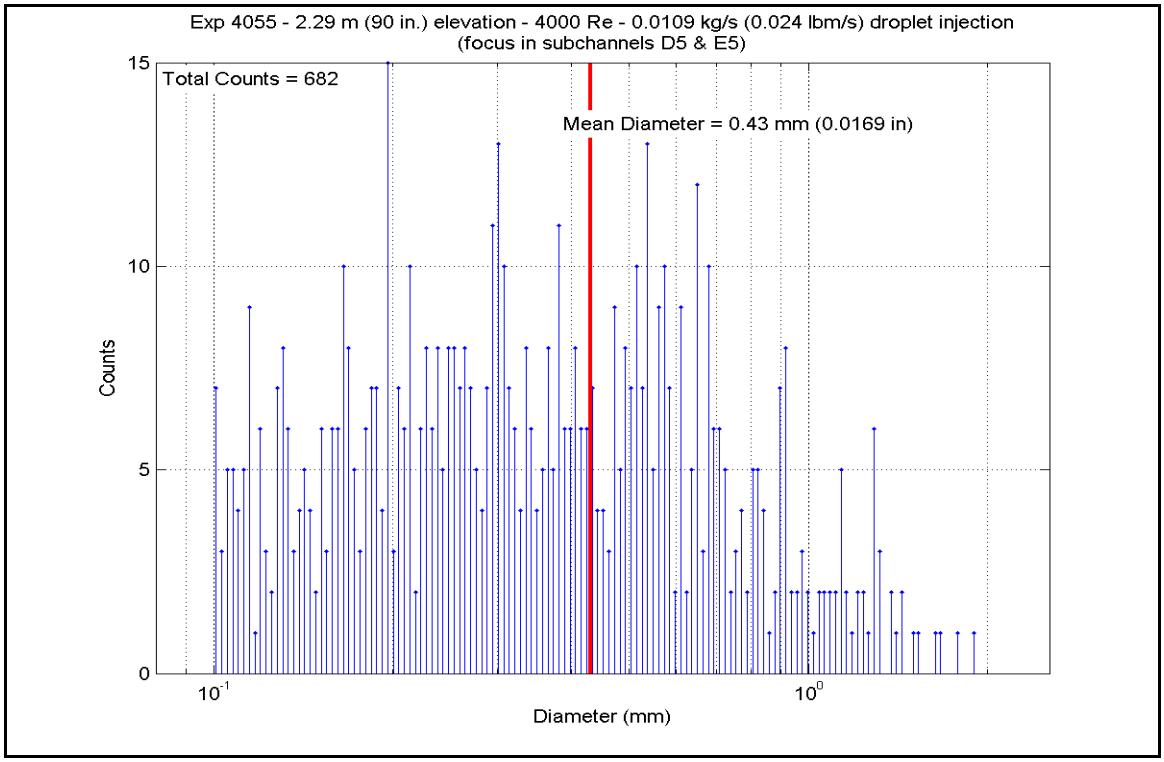

Figure A-592: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055B

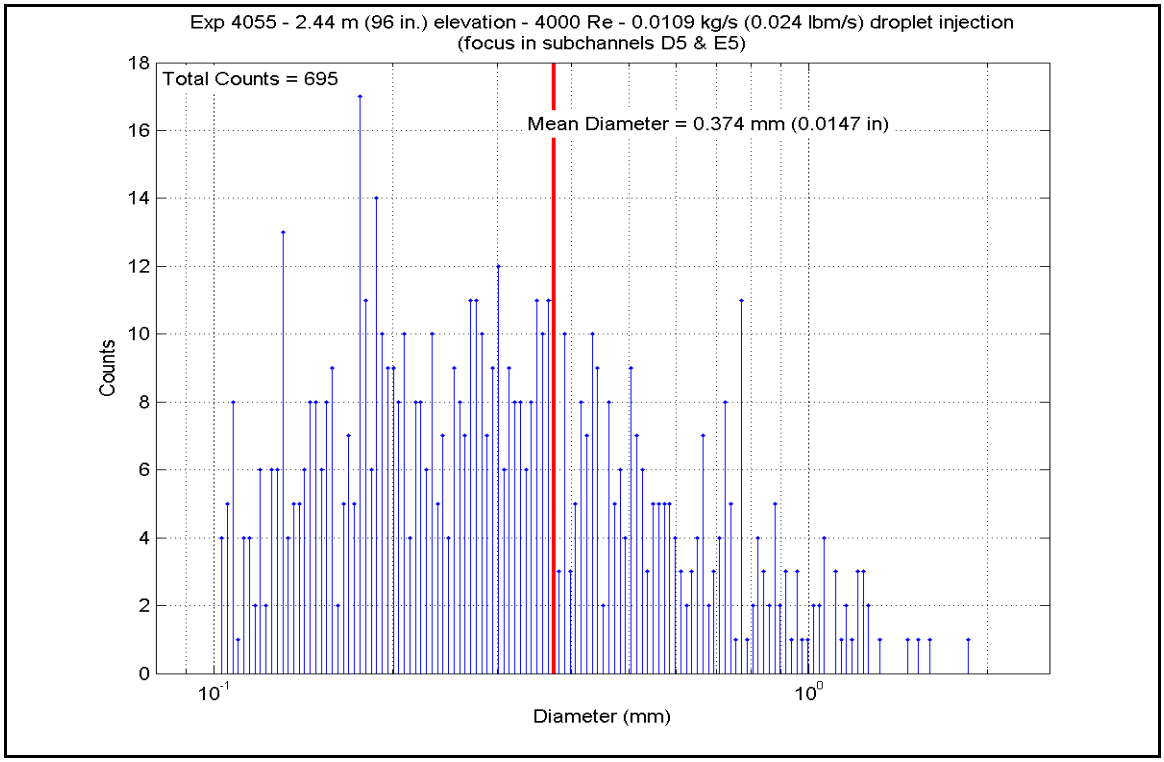

Figure A-593: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055B

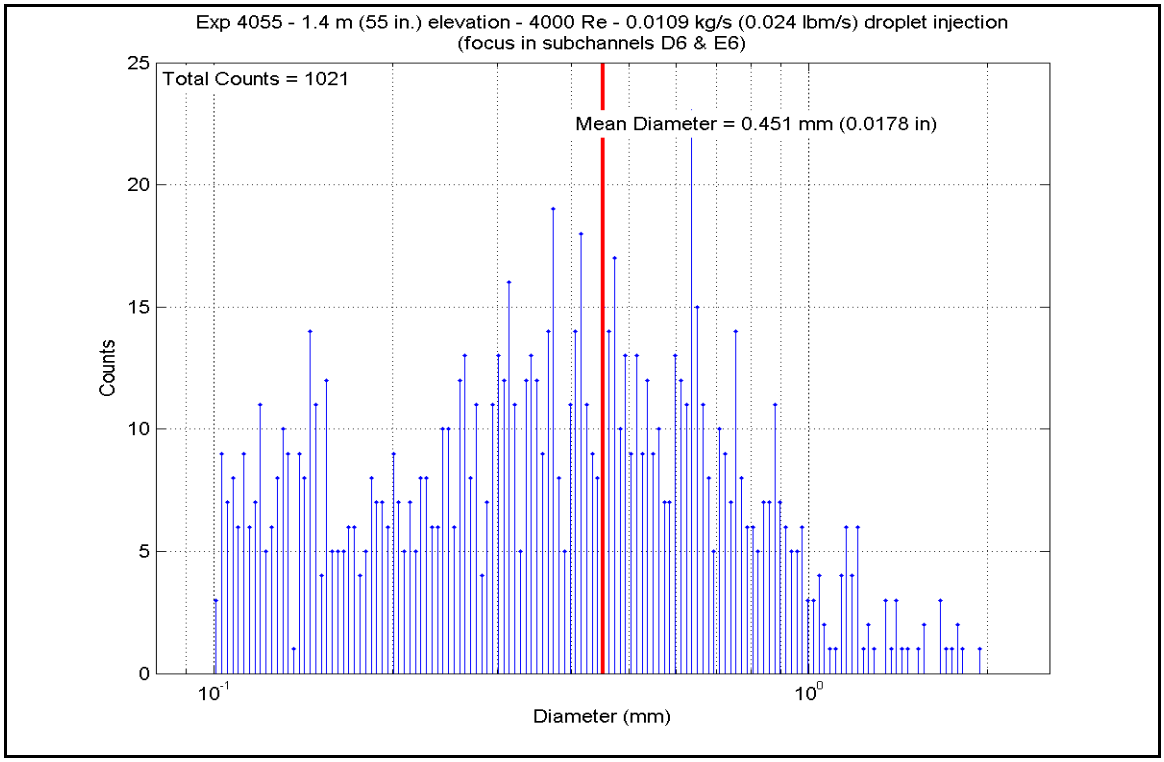

Figure A-594: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055B

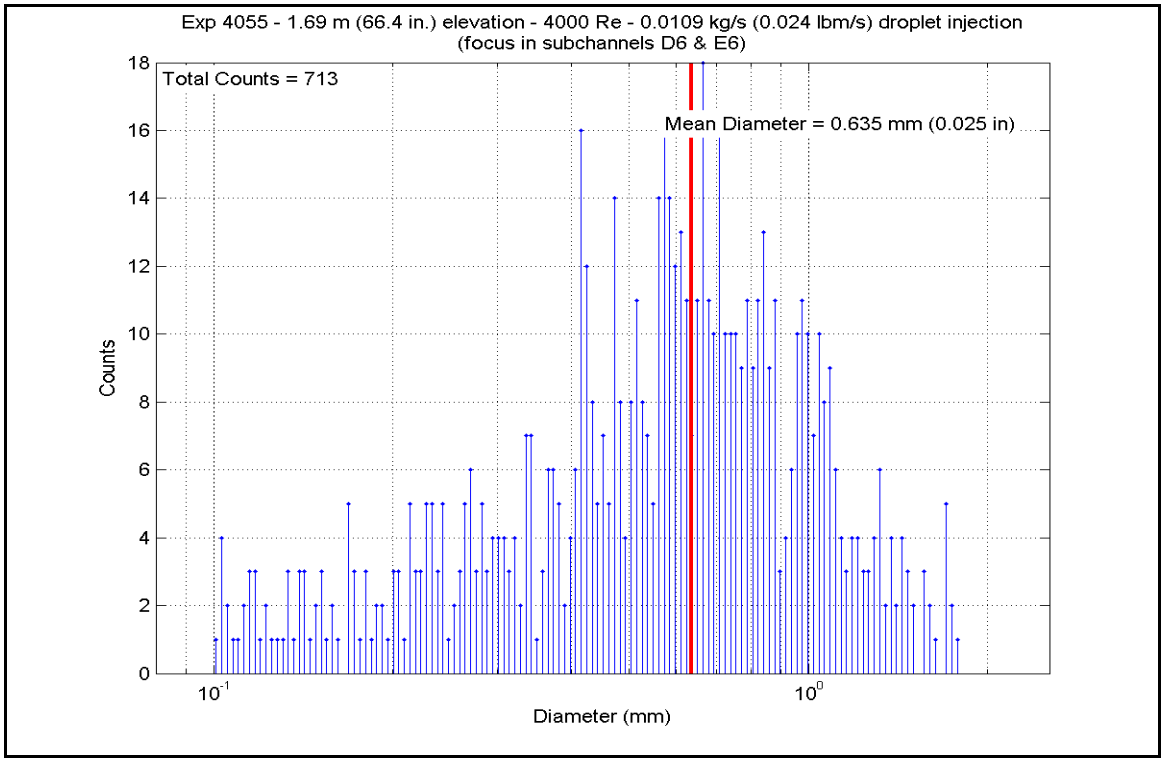

Figure A-595: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055B

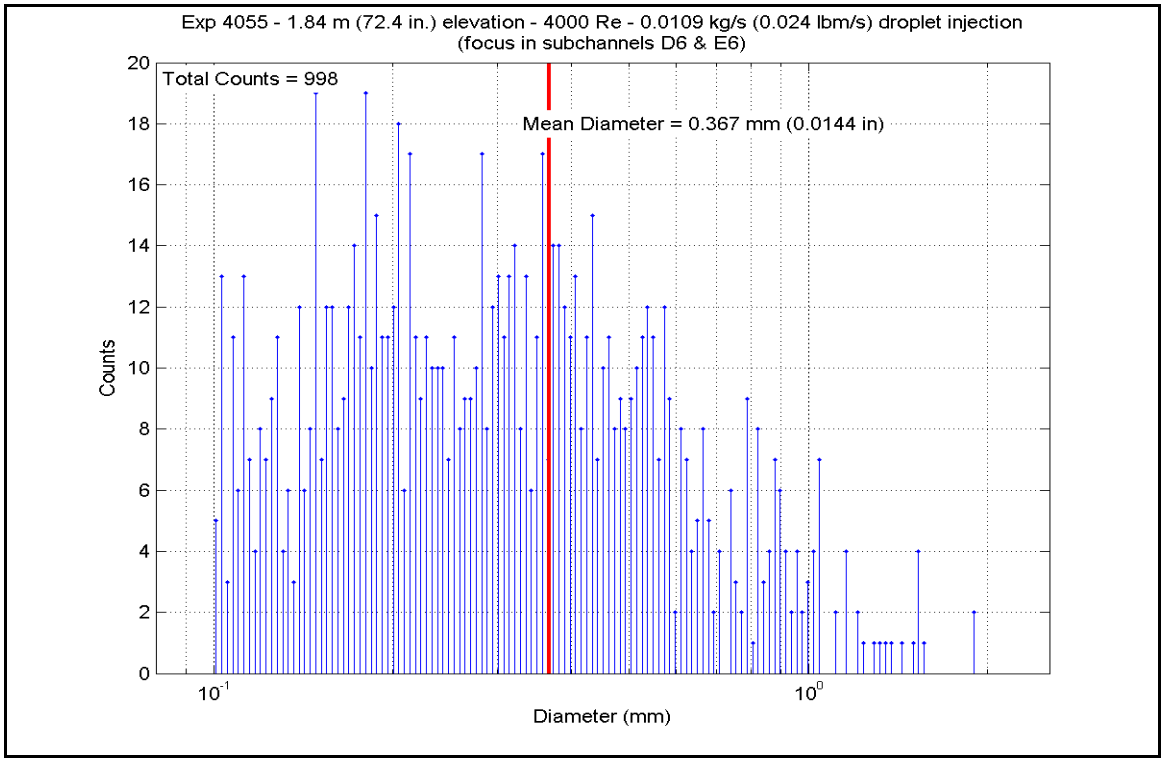

Figure A-596: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055B

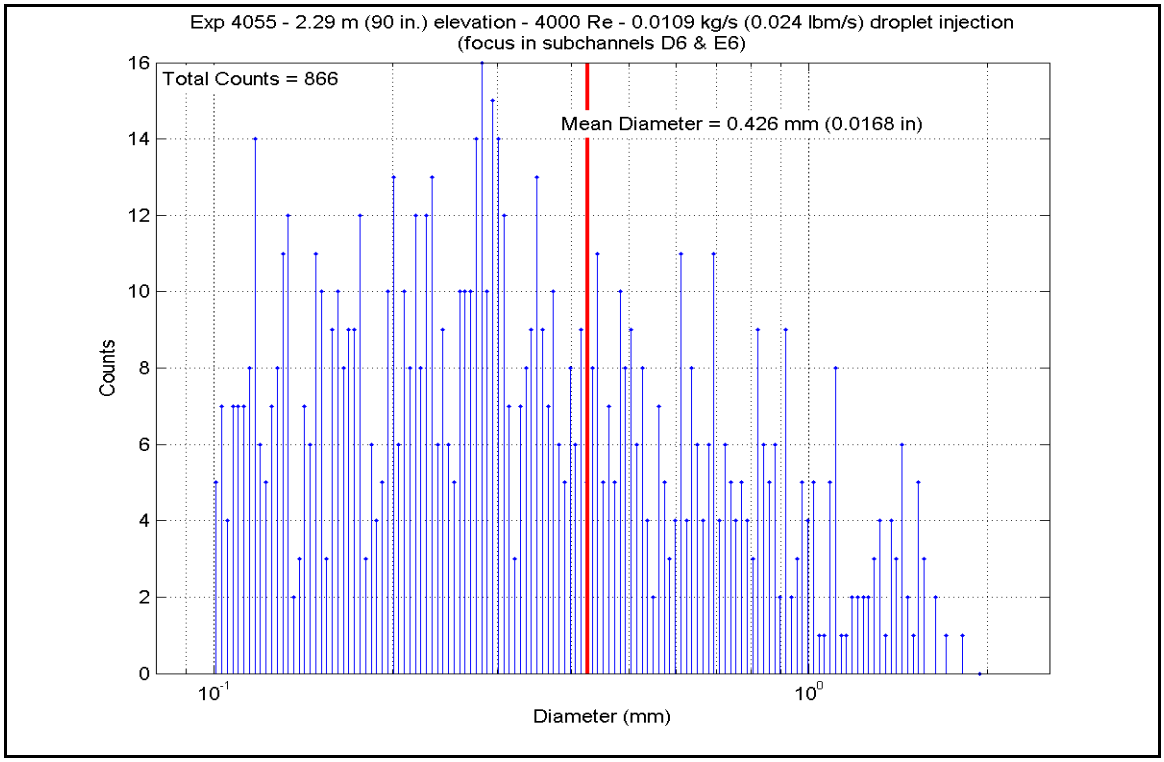

Figure A-597: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055B

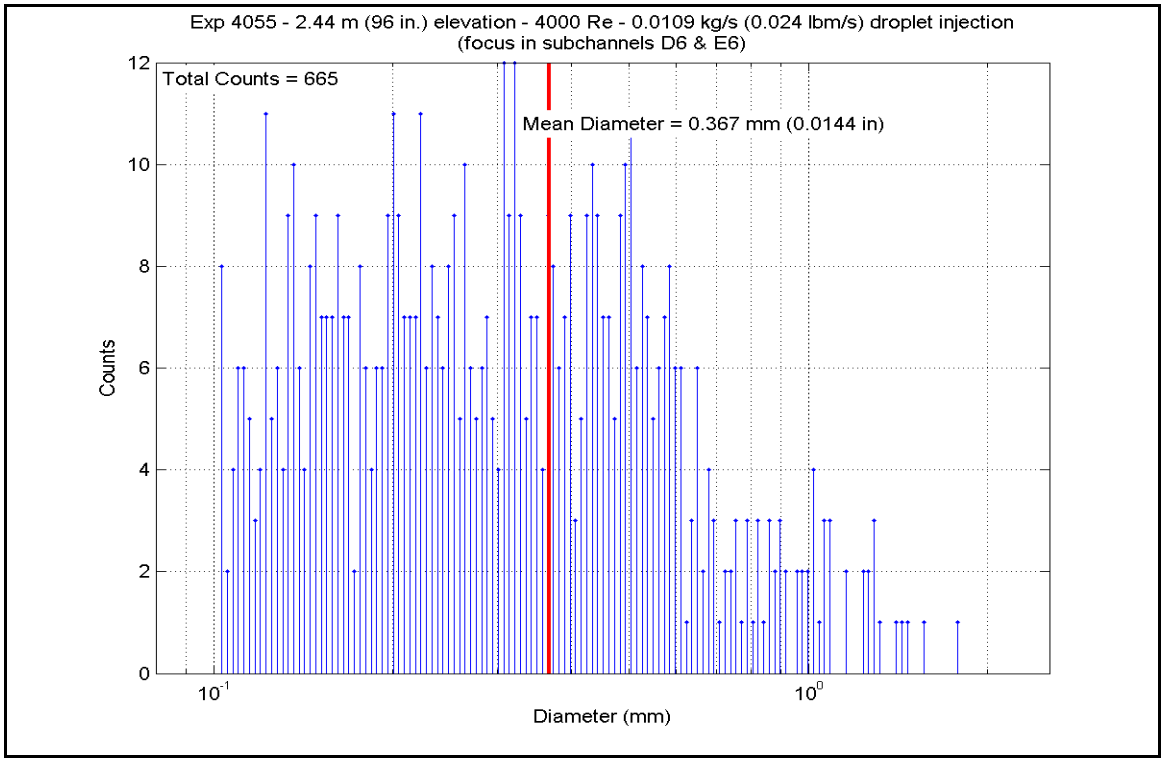

Figure A-598: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055B

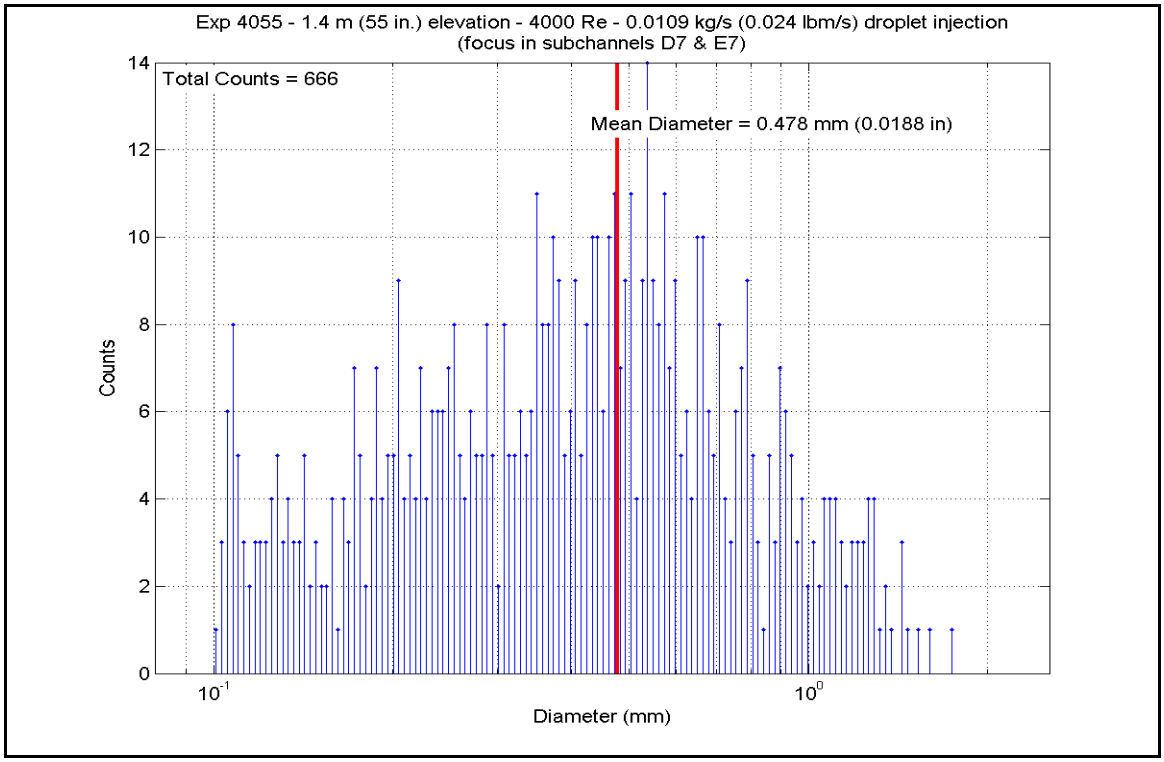

Figure A-599: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055B

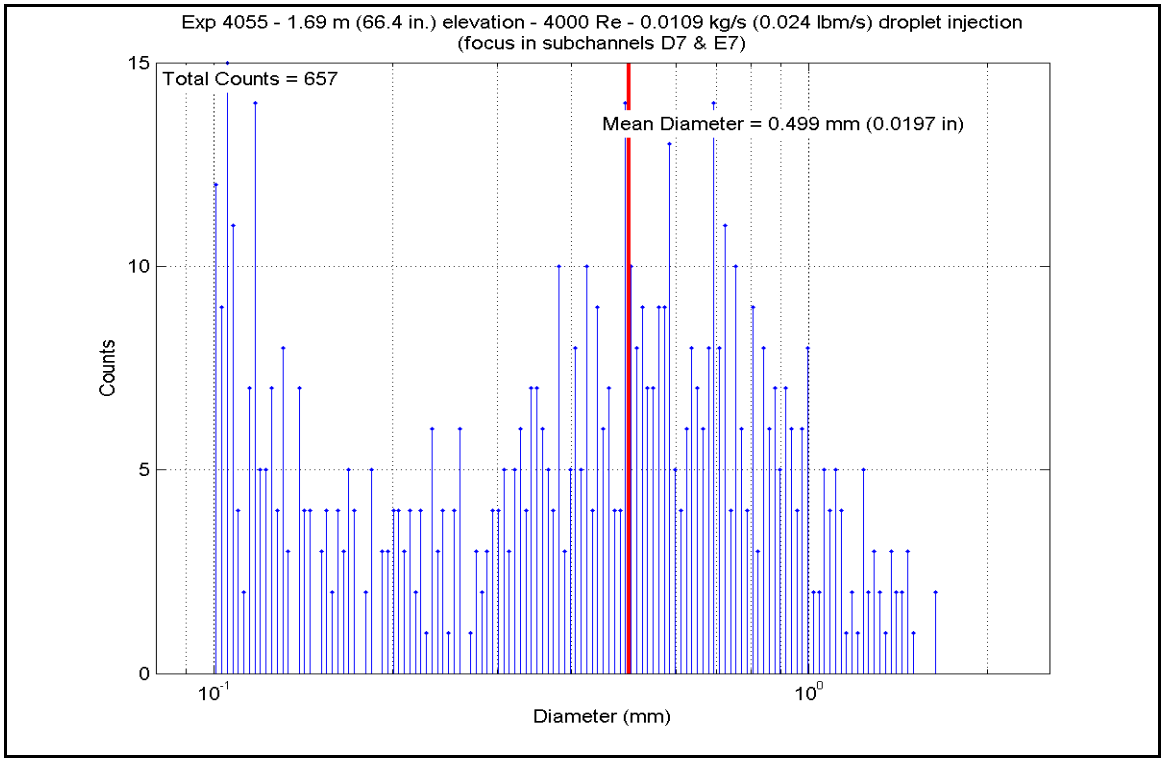

Figure A-600: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055B

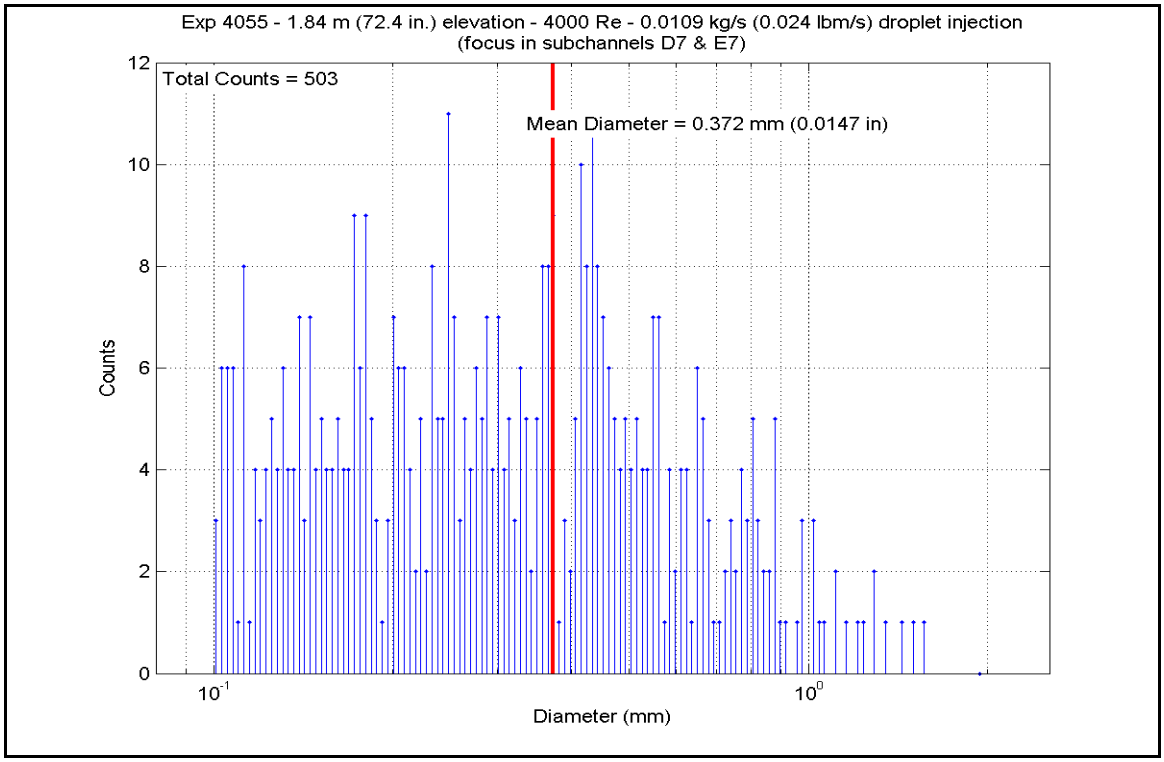

Figure A-601: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055B

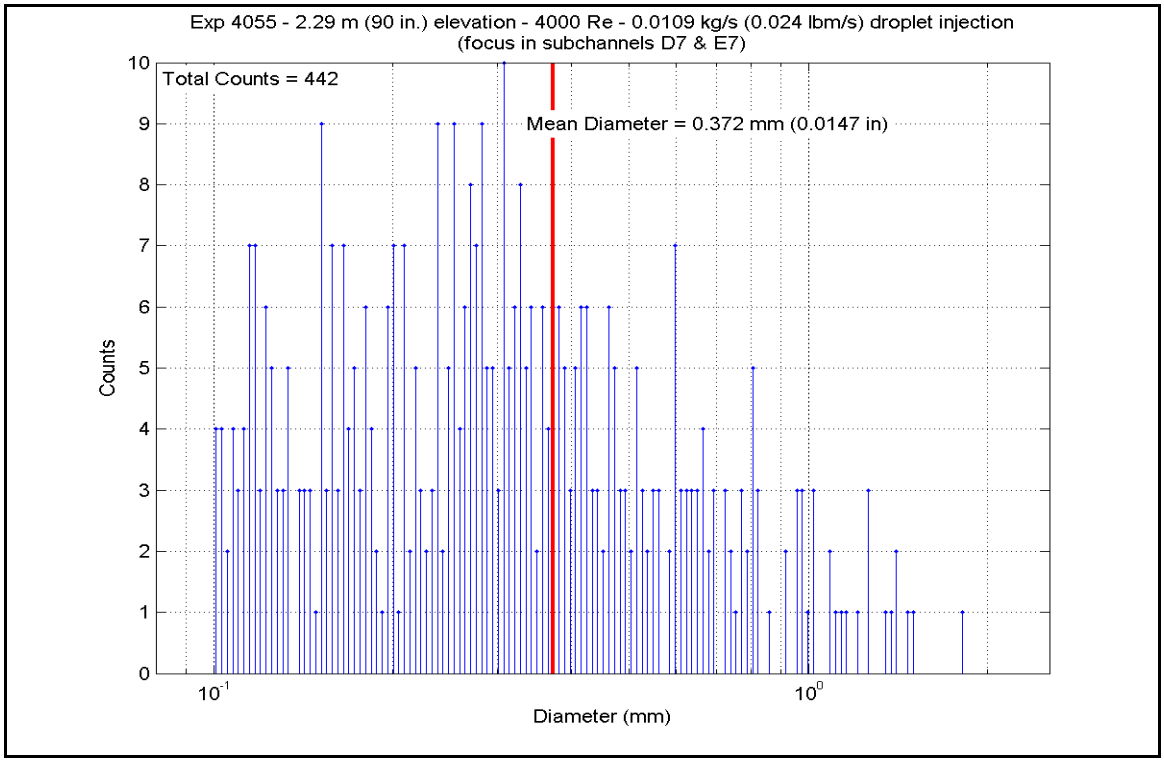

Figure A-602: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055B

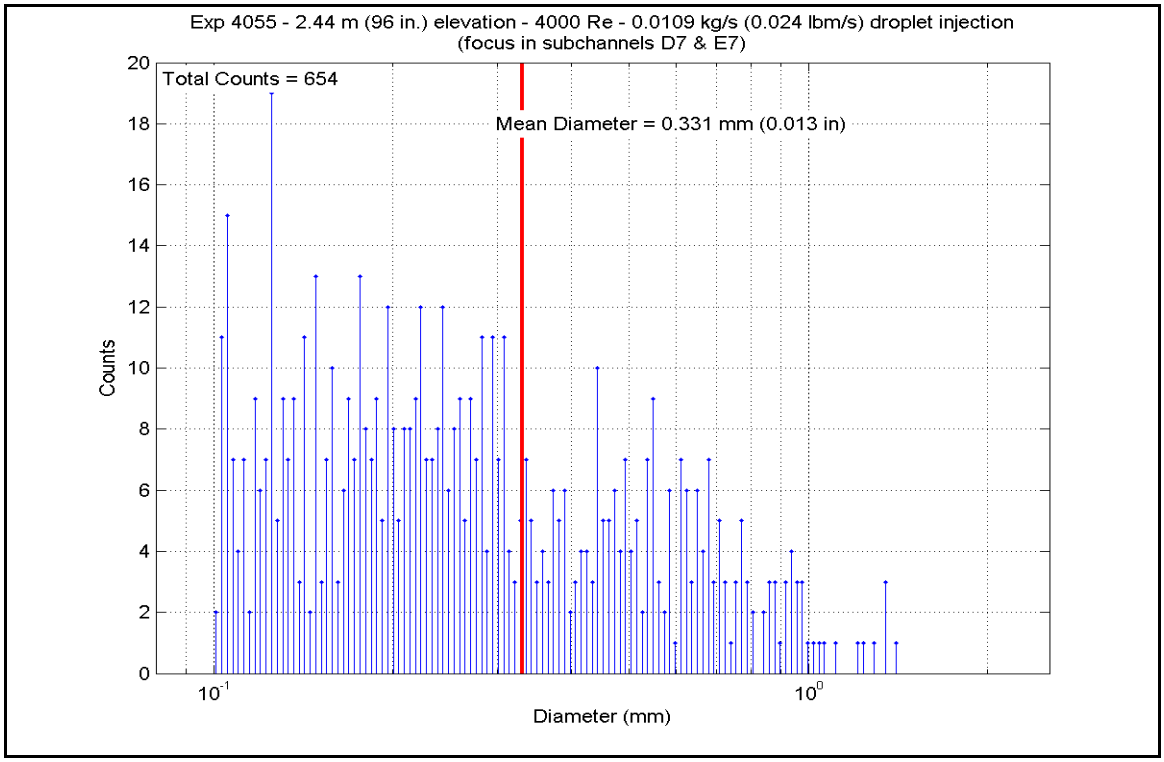

Figure A-603: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055B

Table A-69: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055B

SCD-4055-B	Inlet Reynolds:	4000	
Matrix test # 13c	UP Pressure:	137.9 kPa	20 psia
Time Window: 16800-17880	Bundle Power:	50.00 kW	170607 Btu/hr
	Steam flow:	0.0227 kg/s	180.0 lbm/hr
	Droplet flow:	0.0109 kg/s	0.024 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	701.10	644.9	4241.17	13378.8	8.965	50.9
	RodD3_91.3	186	91.3	2.319	2.8	0.071	776.01	686.5	4327.91	13652.4	7.898	44.8
	RodD3_93.1	187	93.1	2.365	4.6	0.117	785.32	691.7	4381.18	13820.4	7.861	44.6
	RodD3_95.3	188	95.3	2.421	6.8	0.173	820.83	711.4	4445.40	14023.0	7.499	42.6
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1008.49	815.6	4783.14	15088.4	6.128	34.8
	RodD3_110	191	110	2.794	21.5	0.546	868.60	737.9	4913.88	15500.8	7.671	43.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	990.65	805.7	1759.68	5550.9	2.307	13.1
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	714.39	652.3	4318.08	13621.4	8.878	50.4
	RodC4_91.1	234	91.1	2.314	2.6	0.066	788.41	693.4	4393.22	13858.4	7.839	44.5
	RodC4_93.4	235	93.4	2.372	4.9	0.124	811.95	706.5	4459.62	14067.9	7.637	43.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	834.78	719.1	4517.12	14249.2	7.444	42.3
	RodC4_100.1	237	100.1	2.543	11.6	0.295	913.32	762.8	4656.07	14687.6	6.794	38.6
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1000.39	811.1	4842.88	15276.9	6.270	35.6
	RodC4_110	239	110	2.794	21.5	0.546	862.38	734.5	4877.58	15386.3	7.689	43.7
	RodC4_142.2	240	142.2	3.612	8.7	0.221	989.46	805.1	1916.92	6046.9	2.517	14.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	229.91	383.1	4266.82	13459.7	2231.527	12672.6
	RodD4_91.3	242	91.3	2.319	2.8	0.071	228.02	382.0	4357.35	13745.3	267203.121	1517417.6
	RodD4_100.1	245	100.1	2.543	11.6	0.295	796.28	697.7	4710.33	14858.7	8.289	47.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	979.85	799.7	4824.88	15220.1	6.417	36.4
	RodD4_142.1	248	142.1	3.609	8.6	0.218	995.42	808.4	1850.25	5836.6	2.411	13.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	707.63	648.5	4194.15	13230.4	8.744	49.7
	RodE4_91.2	202	91.2	2.316	2.7	0.069	781.12	689.3	4282.25	13508.3	7.742	44.0
	RodE4_95.3	204	95.3	2.421	6.8	0.173	851.74	728.6	4408.45	13906.4	7.068	40.1
	RodE4_100.9	205	100.9	2.563	12.4	0.315	940.42	777.8	4577.62	14440.1	6.425	36.5
	RodE4_142.3	208	142.3	3.614	8.8	0.224	994.00	807.6	1848.79	5832.0	2.414	13.7

Table A-69: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	942.85	779.2	3476.75	10967.4	4.864	27.6
	RodE3_113.6	194	113.6	2.885	0.85	0.022	891.85	750.8	4515.07	14242.8	6.801	38.6
	RodE3_115.5	195	115.5	2.934	2.75	0.070	933.37	773.9	4347.87	13715.3	6.164	35.0
	RodE3_118.5	196	118.5	3.010	5.75	0.146	974.11	796.5	4086.97	12892.3	5.478	31.1
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1003.39	812.8	3725.14	11751.0	4.804	27.3
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1016.60	820.1	3395.95	10712.5	4.306	24.5
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	954.90	785.9	2927.61	9235.1	4.028	22.9
	RodE3_135.6	200	135.6	3.444	2.1	0.053	981.10	800.4	2578.19	8132.9	3.423	19.4
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	954.33	785.6	3416.11	10776.1	4.703	26.7
	RodC5_113.6	226	113.6	2.885	0.85	0.022	872.35	740.0	4401.33	13884.0	6.831	38.8
	RodC5_115.7	227	115.7	2.939	2.95	0.075	917.54	765.1	4238.87	13371.5	6.147	34.9
	RodC5_122.7	229	122.7	3.117	9.95	0.253	988.49	804.5	3666.26	11565.2	4.821	27.4
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1001.98	812.0	3341.64	10541.2	4.317	24.5
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	935.92	775.3	2929.98	9242.6	4.139	23.5
	RodC5_135.7	232	135.7	3.447	2.2	0.056	961.04	789.3	2574.98	8122.8	3.513	19.9
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	913.43	762.8	3508.77	11068.4	5.119	29.1
	RodE5_113.6	210	113.6	2.885	0.85	0.022	787.65	693.0	4584.20	14460.8	8.191	46.5
	RodE5_115.4	211	115.4	2.931	2.65	0.067	853.38	729.5	4419.78	13942.2	7.067	40.1
	RodE5_118.7	212	118.7	3.015	5.95	0.151	912.87	762.5	4124.37	13010.3	6.022	34.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	952.29	784.4	3787.50	11947.7	5.229	29.7
	RodE5_126.6	214	126.6	3.216	13.85	0.352	975.73	797.4	3442.91	10860.7	4.604	26.1
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1011.87	817.5	2984.22	9413.7	3.807	21.6
	RodE5_135.6	216	135.6	3.444	2.1	0.053	989.51	805.1	2645.83	8346.3	3.474	19.7
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	850.25	727.7	3967.92	12516.8	6.377	36.2
	RodC3_85.6	178	85.6	2.174	14.72	0.374	764.27	680.0	4185.01	13201.6	7.804	44.3
	RodC3_88.5	179	88.5	2.248	0	0.000	718.25	654.4	4236.90	13365.3	8.642	49.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	810.94	705.9	4346.99	13712.6	7.457	42.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	834.67	719.1	4407.89	13904.7	7.266	41.3
Gr-8	RodD5_50	217	50	1.270	3	0.076	859.38	732.8	3079.11	9713.0	4.877	27.7
	RodD5_54.1	218	54.1	1.374	7.1	0.180	856.85	731.4	3216.00	10144.9	5.114	29.0
	RodD5_56.9	219	56.9	1.445	9.9	0.251	896.40	753.4	3295.90	10396.9	4.931	28.0
	RodD5_60	220	60	1.524	13	0.330	931.95	773.1	3388.49	10689.0	4.814	27.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	942.58	779.0	3575.51	11278.9	5.004	28.4
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	712.34	651.1	3686.91	11630.4	7.612	43.2
	RodD5_72.9	223	72.9	1.852	2.02	0.051	787.34	692.8	3777.47	11916.0	6.753	38.4
	RodD5_74.9	224	74.9	1.902	4.02	0.102	831.53	717.3	3837.10	12104.1	6.358	36.1

Table A-69: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	814.02	707.6	2812.64	8872.5	4.800	27.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	851.30	728.3	3170.19	10000.4	5.086	28.9
	RodB5_55	155	55	1.397	8	0.203	885.06	747.1	3235.63	10206.8	4.924	28.0
	RodB5_57.8	156	57.8	1.468	10.8	0.274	927.62	770.7	3320.75	10475.3	4.747	27.0
	RodB5_64	157	64	1.626	17	0.432	969.83	794.2	3510.22	11073.0	4.732	26.9
	RodB5_73.9	158	73.9	1.877	3.02	0.077	810.30	705.5	3797.88	11980.4	6.522	37.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	843.20	723.8	3859.48	12174.7	6.274	35.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	857.24	731.6	3889.15	12268.3	6.181	35.1
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	803.44	701.7	2783.88	8781.7	4.838	27.5
	RodF5_53.1	106	53.1	1.349	6.1	0.155	839.76	721.9	3153.24	9946.9	5.154	29.3
	RodF5_55	107	55	1.397	8	0.203	873.30	740.5	3210.27	10126.8	4.975	28.3
	RodF5_57.8	108	57.8	1.468	10.8	0.274	914.94	763.7	3292.19	10385.2	4.793	27.2
	RodF5_64	109	64	1.626	17	0.432	966.35	792.2	3475.75	10964.3	4.707	26.7
	RodF5_73.8	110	73.8	1.875	2.92	0.074	812.75	706.9	3775.40	11909.5	6.456	36.7
	RodF5_75.8	111	75.8	1.925	4.92	0.125	848.45	726.7	3837.95	12106.8	6.186	35.1
	RodF5_76.8	112	76.8	1.951	5.92	0.150	863.78	735.2	3869.16	12205.3	6.086	34.6
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	821.31	711.7	2806.66	8853.6	4.730	26.9
	RodC2_53.1	58	53.1	1.349	6.1	0.155	887.48	748.4	3169.67	9998.7	4.806	27.3
	RodC2_55	59	55	1.397	8	0.203	914.46	763.4	3229.34	10187.0	4.704	26.7
	RodC2_57.8	60	57.8	1.468	10.8	0.274	951.70	784.1	3316.24	10461.1	4.582	26.0
	RodC2_63.9	61	63.9	1.623	16.9	0.429	981.48	800.6	3504.04	11053.5	4.650	26.4
	RodC2_73.8	62	73.8	1.875	2.92	0.074	789.88	694.2	3806.34	12007.1	6.774	38.5
	RodC2_75.8	63	75.8	1.925	4.92	0.125	820.18	711.0	3865.07	12192.4	6.527	37.1
	RodC2_76.8	64	76.8	1.951	5.92	0.150	832.99	718.1	3894.49	12285.2	6.437	36.6
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	805.22	702.7	2790.46	8802.5	4.834	27.5
	RodC6_52.8	138	52.8	1.341	5.8	0.147	877.59	742.9	3158.96	9964.9	4.863	27.6
	RodC6_54.8	139	54.8	1.392	7.8	0.198	902.58	756.8	3221.60	10162.5	4.776	27.1
	RodC6_57.8	140	57.8	1.468	10.8	0.274	929.86	772.0	3313.90	10453.7	4.722	26.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	972.24	795.5	3500.98	11043.8	4.704	26.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	826.16	714.3	3818.26	12044.7	6.383	36.3
	RodC6_75.8	143	75.8	1.925	4.92	0.125	855.19	730.5	3885.56	12257.0	6.195	35.2
	RodC6_76.8	144	76.8	1.951	5.92	0.150	871.04	739.3	3917.60	12358.1	6.092	34.6

Table A-69: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	704.29	646.6	4211.64	13285.6	8.843	50.2
	RodB4_91.3	162	91.3	2.319	2.8	0.071	783.06	690.4	4296.42	13553.0	7.740	44.0
	RodB4_93.3	163	93.3	2.370	4.8	0.122	802.57	701.2	4353.58	13733.4	7.577	43.0
	RodB4_95.1	164	95.1	2.416	6.6	0.168	830.83	716.9	4405.06	13895.8	7.307	41.5
	RodB4_142.3	168	142.3	3.614	8.8	0.224	974.69	796.9	1899.70	5992.6	2.544	14.4
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	814.66	708.0	4173.63	13165.7	7.114	40.4
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	711.53	650.7	4248.03	13400.4	8.786	49.9
	RodF4_92.4	100	92.4	2.347	3.9	0.099	803.48	701.7	4384.11	13829.7	7.618	43.3
	RodF4_94.3	101	94.3	2.395	5.8	0.147	838.17	721.0	4448.26	14032.0	7.290	41.4
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	909.51	760.7	4386.88	13838.4	6.437	36.6
	RodD2_106	66	106	2.692	17.5	0.445	937.31	776.1	4163.20	13132.8	5.869	33.3
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	977.38	798.4	3849.47	12143.1	5.137	29.2
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1001.04	811.5	3487.83	11002.4	4.512	25.6
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1003.75	813.0	3145.09	9921.2	4.054	23.0
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	908.22	759.9	4399.01	13876.7	6.467	36.7
	RodD6_116.8	133	116.8	2.967	4.05	0.103	939.57	777.4	4214.25	13293.8	5.922	33.6
	RodD6_120.9	134	120.9	3.071	8.15	0.207	968.15	793.2	3835.46	12098.9	5.182	29.4
	RodD6_124.8	135	124.8	3.170	12.05	0.306	983.74	801.9	3475.43	10963.2	4.599	26.1
	RodD6_128.7	136	128.7	3.269	15.95	0.405	983.88	802.0	3120.57	9843.8	4.128	23.4

Table A-69: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	874.12	741.0	3094.98	9763.1	4.790	27.2
	RodE2_54	74	54	1.372	7	0.178	899.61	755.2	3213.51	10137.0	4.785	27.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	937.11	776.0	3302.29	10417.1	4.657	26.4
	RodE2_59.9	76	59.9	1.521	12.9	0.328	965.70	791.9	3393.88	10706.0	4.601	26.1
	RodE2_66	77	66	1.676	19	0.483	958.56	787.9	3585.86	11311.6	4.908	27.9
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	675.06	630.4	3734.21	11779.6	8.353	47.4
	RodE2_72.9	79	72.9	1.852	2.02	0.051	751.68	673.0	3810.15	12019.1	7.276	41.3
	RodE2_74.9	80	74.9	1.902	4.02	0.102	788.06	693.2	3874.68	12222.7	6.918	39.3
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	821.82	711.9	3093.03	9757.0	5.209	29.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	838.92	721.4	3210.84	10128.6	5.256	29.8
	RodB3_56.9	171	56.9	1.445	9.9	0.251	878.92	743.7	3293.13	10388.2	5.059	28.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	873.39	740.6	3384.74	10677.2	5.244	29.8
	RodB3_66.1	173	66.1	1.679	19.1	0.485	903.13	757.1	3573.96	11274.1	5.294	30.1
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	686.32	636.7	3692.96	11649.4	8.058	45.8
	RodB3_73	175	73	1.854	2.12	0.054	739.67	666.3	3793.54	11966.7	7.414	42.1
	RodB3_75	176	75	1.905	4.12	0.105	771.78	684.1	3856.07	12164.0	7.091	40.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	854.41	730.0	3078.25	9710.4	4.914	27.9
	RodF3_54	90	54	1.372	7	0.178	870.17	738.8	3196.65	10083.8	4.978	28.3
	RodF3_57	91	57	1.448	10	0.254	911.61	761.8	3289.28	10376.0	4.812	27.3
	RodF3_60	92	60	1.524	13	0.330	941.80	778.6	3380.54	10663.9	4.736	26.9
	RodF3_66.1	93	66.1	1.679	19.1	0.485	954.63	785.7	3568.38	11256.5	4.911	27.9
	RodF3_70	94	70	1.778	-0.88	-0.022	741.04	667.1	3690.85	11642.8	7.194	40.9
	RodF3_73	95	73	1.854	2.12	0.054	808.92	704.8	3787.66	11948.2	6.520	37.0
	RodF3_75	96	75	1.905	4.12	0.105	846.47	725.6	3852.48	12152.7	6.229	35.4
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	833.58	718.5	3074.89	9699.7	5.078	28.8
	RodE6_54.1	122	54.1	1.374	7.1	0.180	875.22	741.6	3193.14	10072.8	4.934	28.0
	RodE6_57	123	57	1.448	10	0.254	908.87	760.3	3278.01	10340.5	4.814	27.3
	RodE6_60.2	124	60.2	1.529	13.2	0.335	944.48	780.1	3372.83	10639.6	4.707	26.7
	RodE6_66.1	125	66.1	1.679	19.1	0.485	950.33	783.3	3550.81	11201.0	4.916	27.9
	RodE6_70	126	70	1.778	-0.88	-0.022	740.09	666.5	3660.39	11546.7	7.148	40.6
	RodE6_73.1	127	73.1	1.857	2.22	0.056	801.88	700.9	3761.16	11864.6	6.554	37.2
	RodE6_75	128	75	1.905	4.12	0.105	835.99	719.8	3820.24	12050.9	6.283	35.7

RBHT Steam Cooling with Droplet Injection Test SCD-4055-C

Matrix Test # 13d

Test Conditions

Test Date – 11/23/2005
Steady State Time Window: 19260 - 20280
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

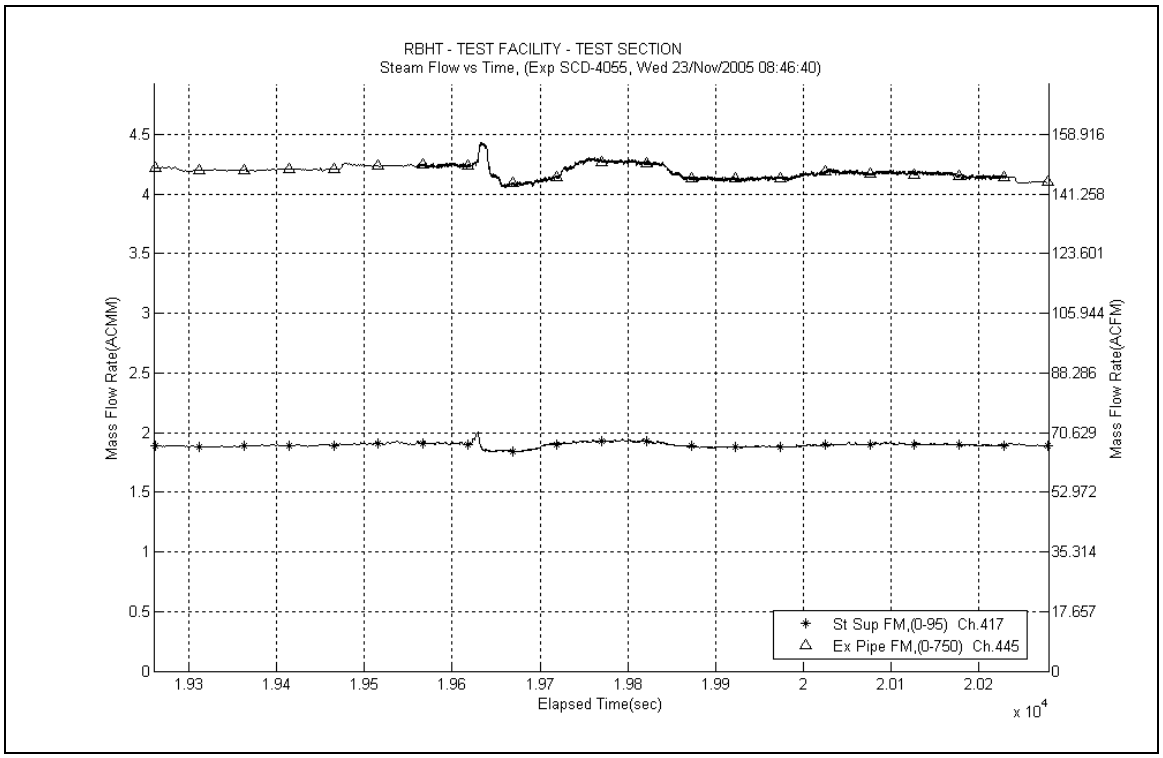

Figure A-604: Inlet and Exhaust Steam Flow Rates for Experiment 4055C

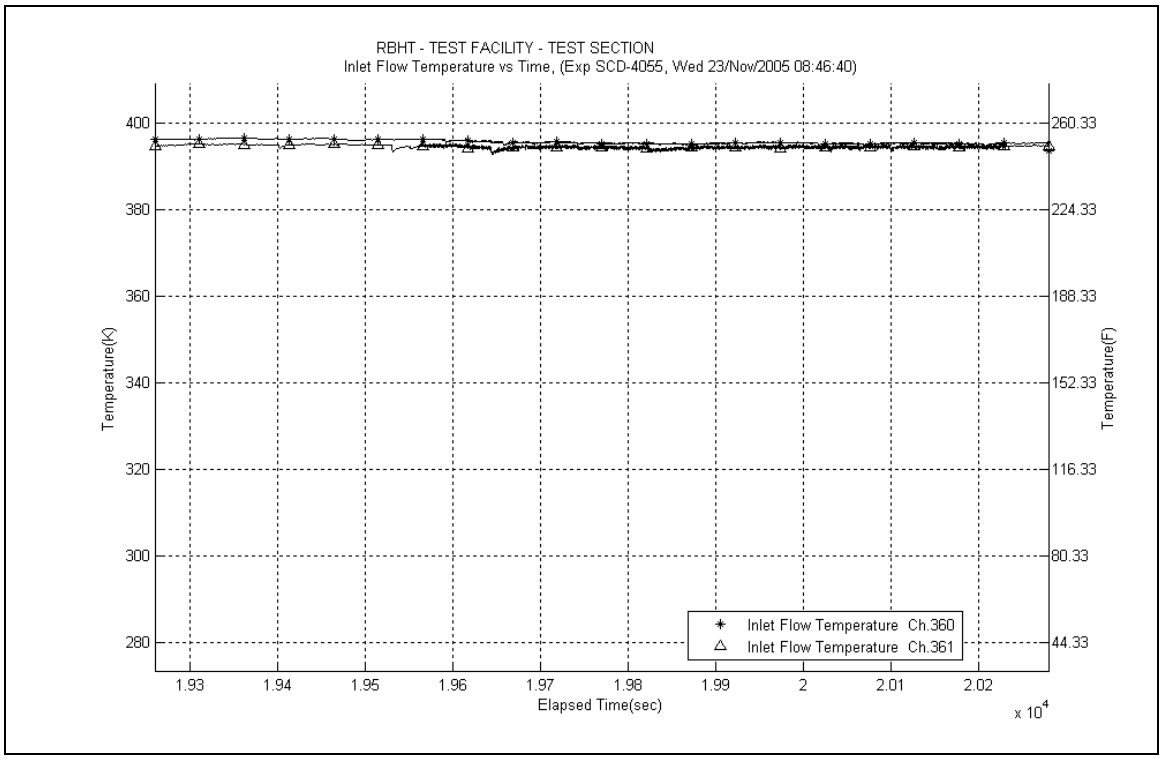

Figure A-605: Inlet Steam Temperature for Experiment 4055C

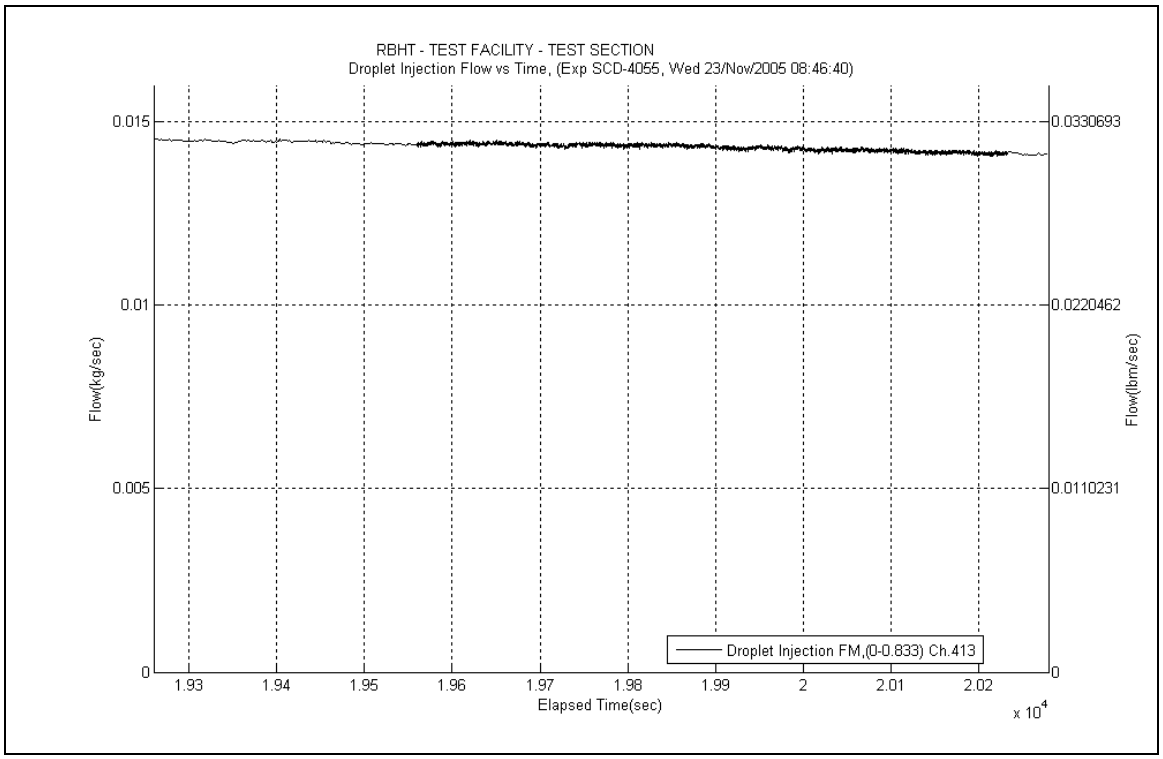

Figure A-606: Droplet Injection Flow Rate for Experiment 4055C

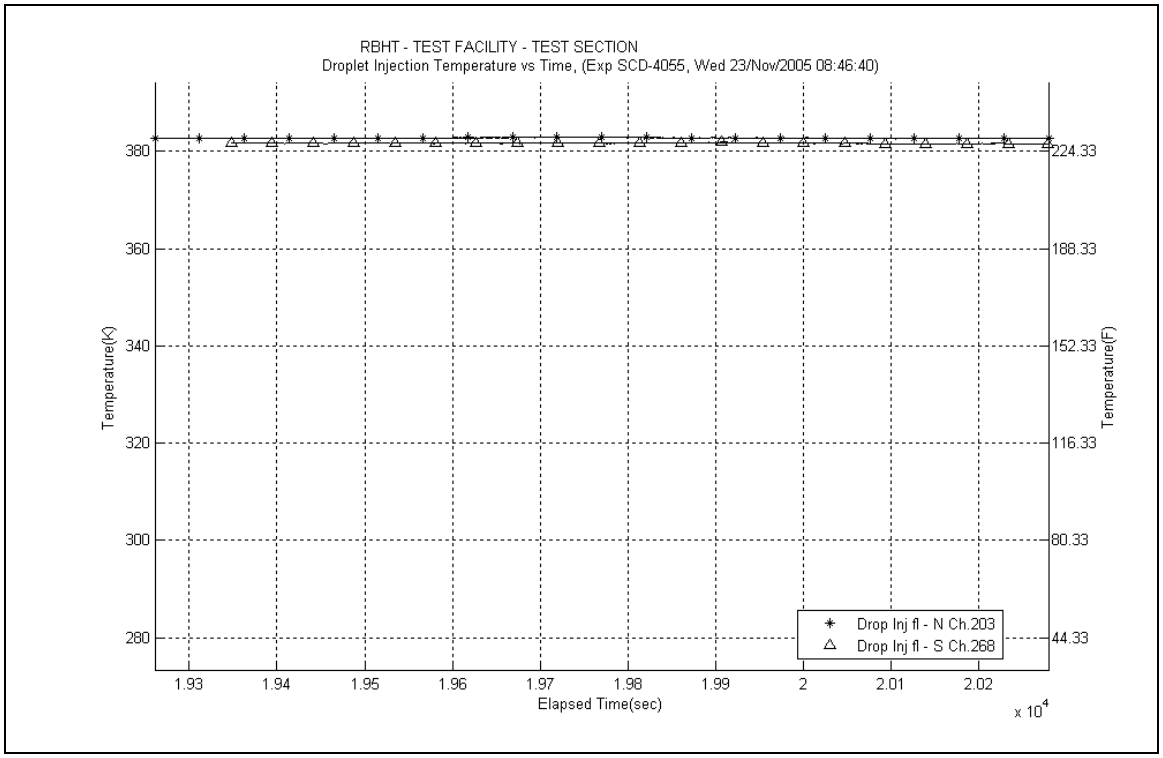

Figure A-607: Droplet Injection Temperature for Experiment 4055C

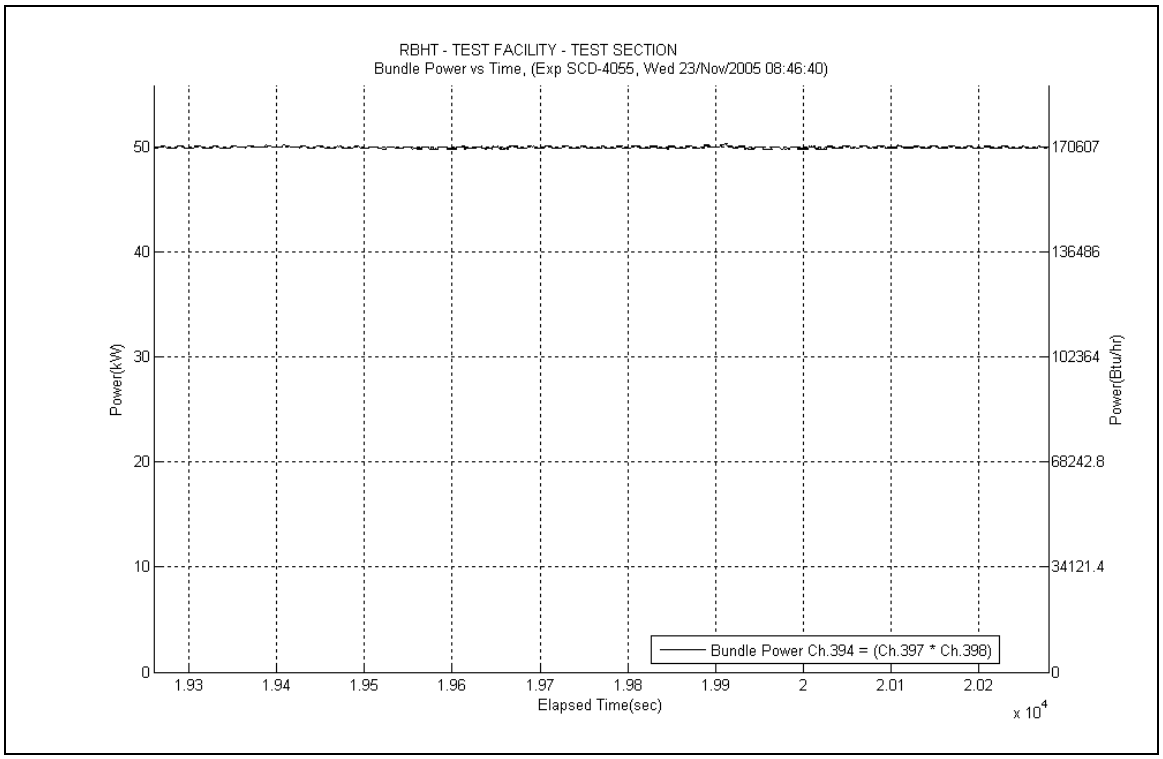

Figure A-608: Bundle Power for Experiment 4055C

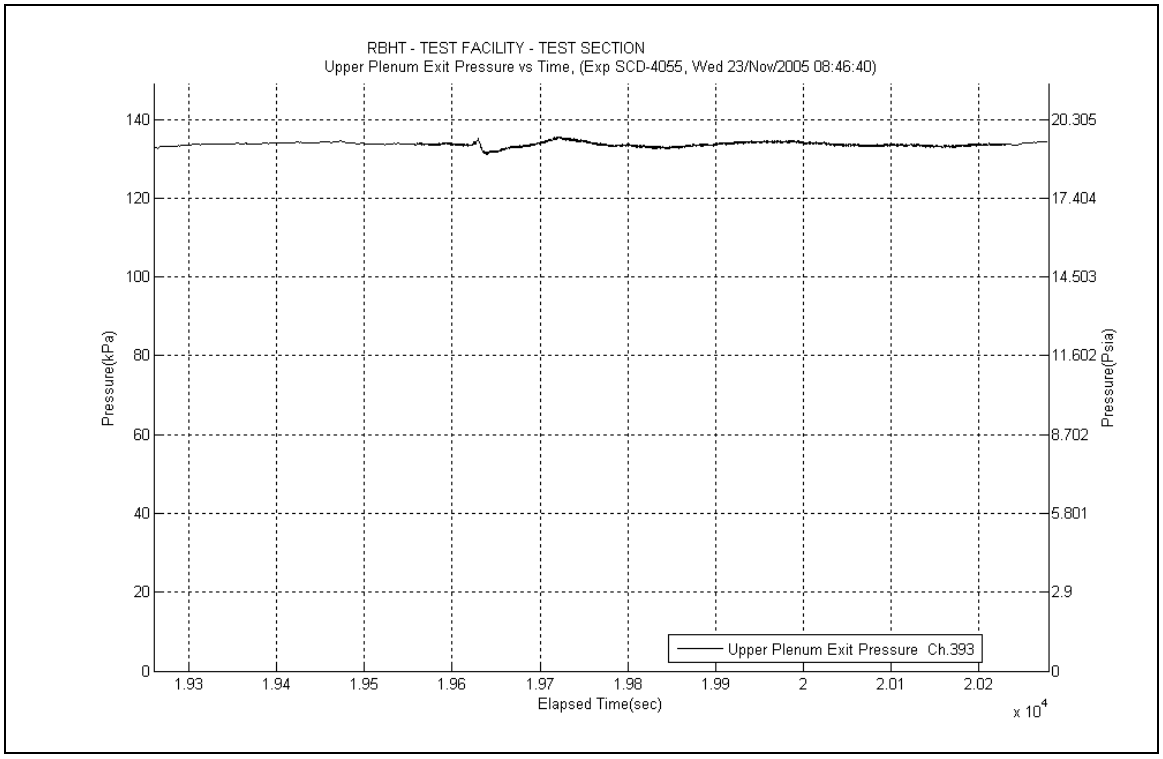

Figure A-609: Upper Plenum Pressure for Experiment 4055C

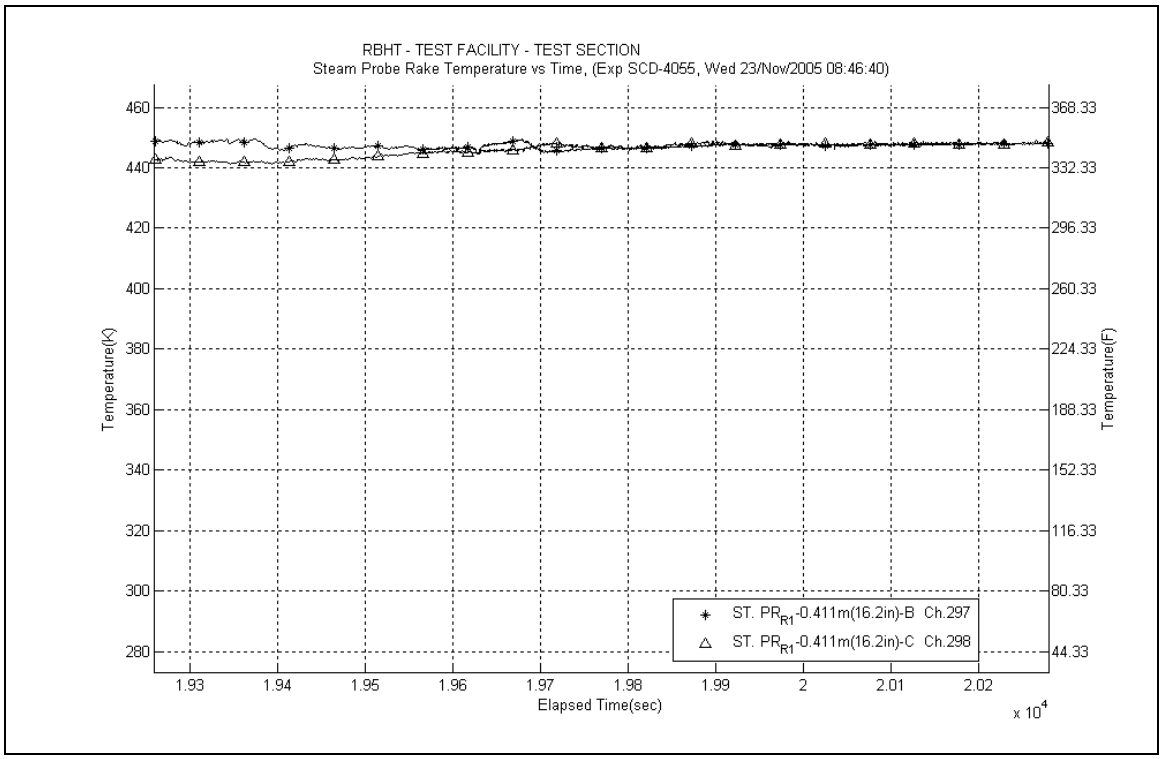

Figure A-610: Steam Probe Rake #1 Temperatures for Experiment 4055C

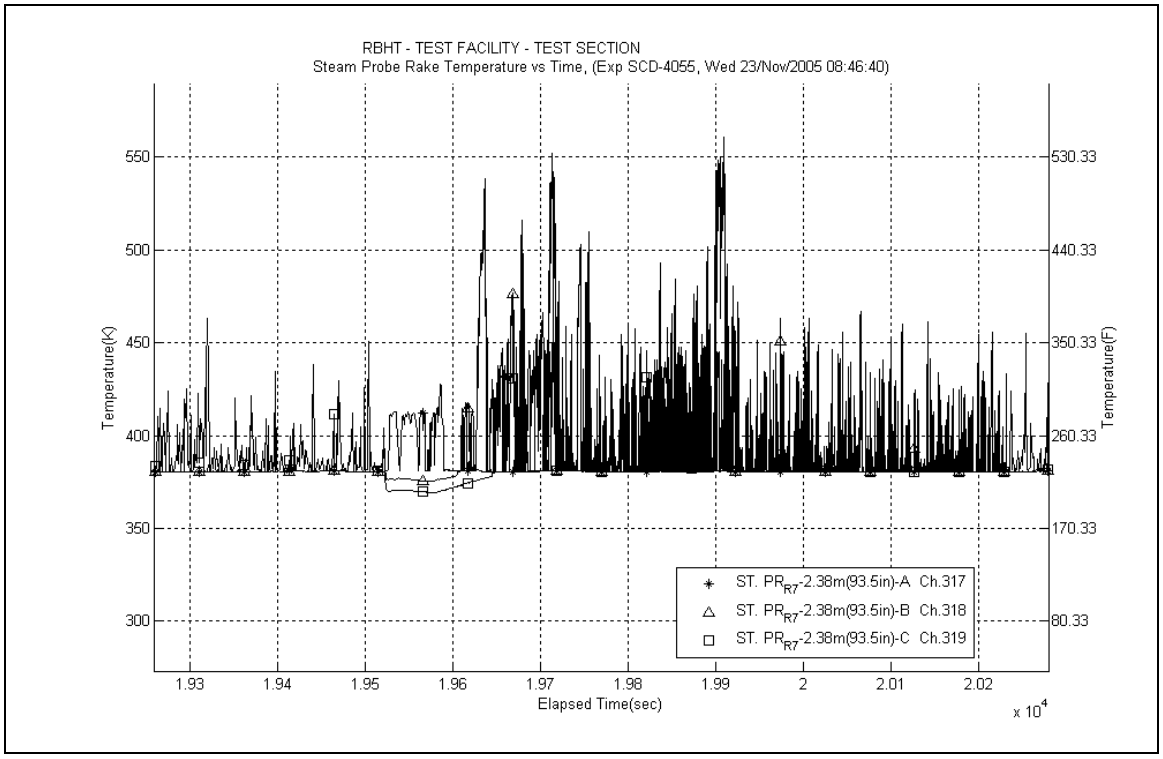

Figure A-611: Steam Probe Rake #7 Temperatures for Experiment 4055C

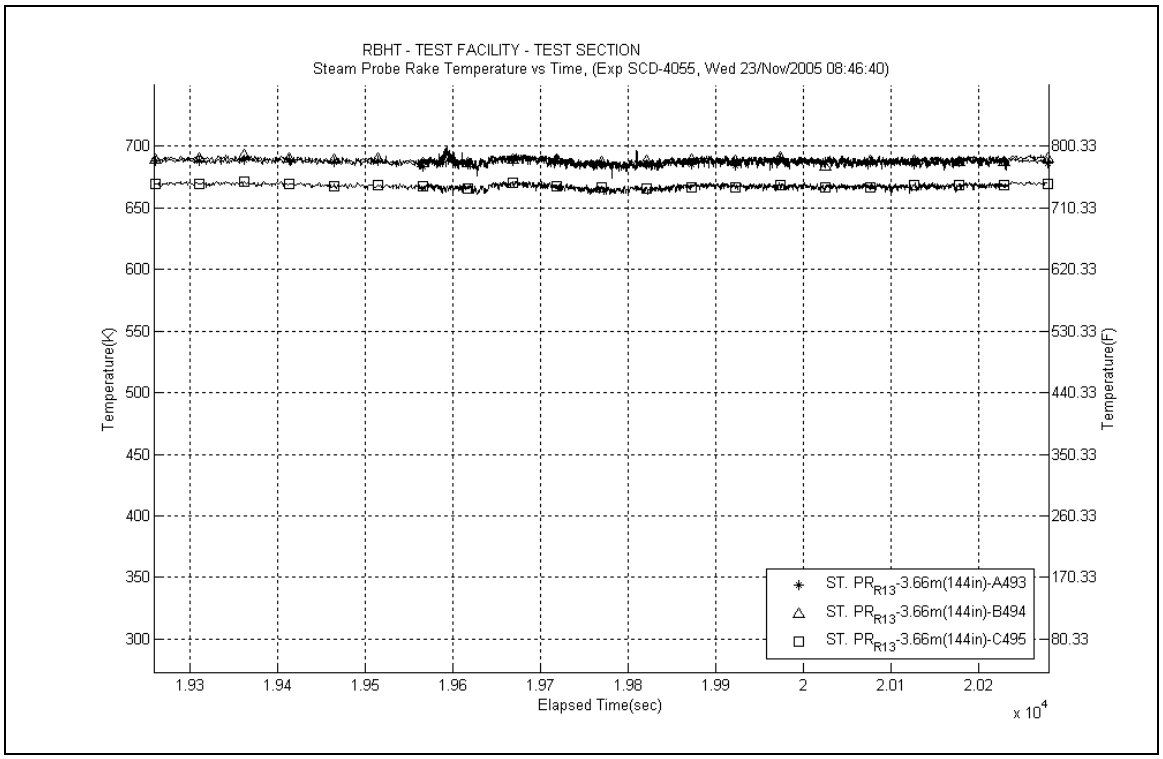

Figure A-612: Steam Probe Rake #13 Temperatures for Experiment 4055C

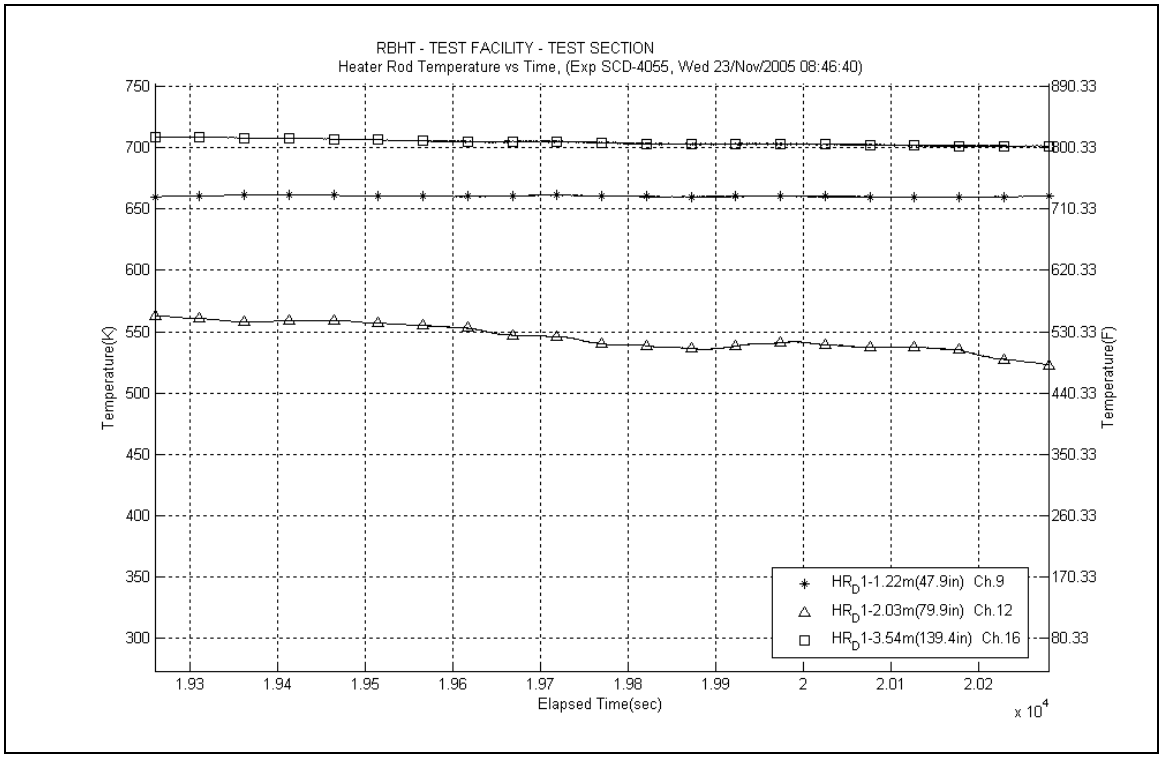

Figure A-613: Heater Rod D1 for Experiment 4055C

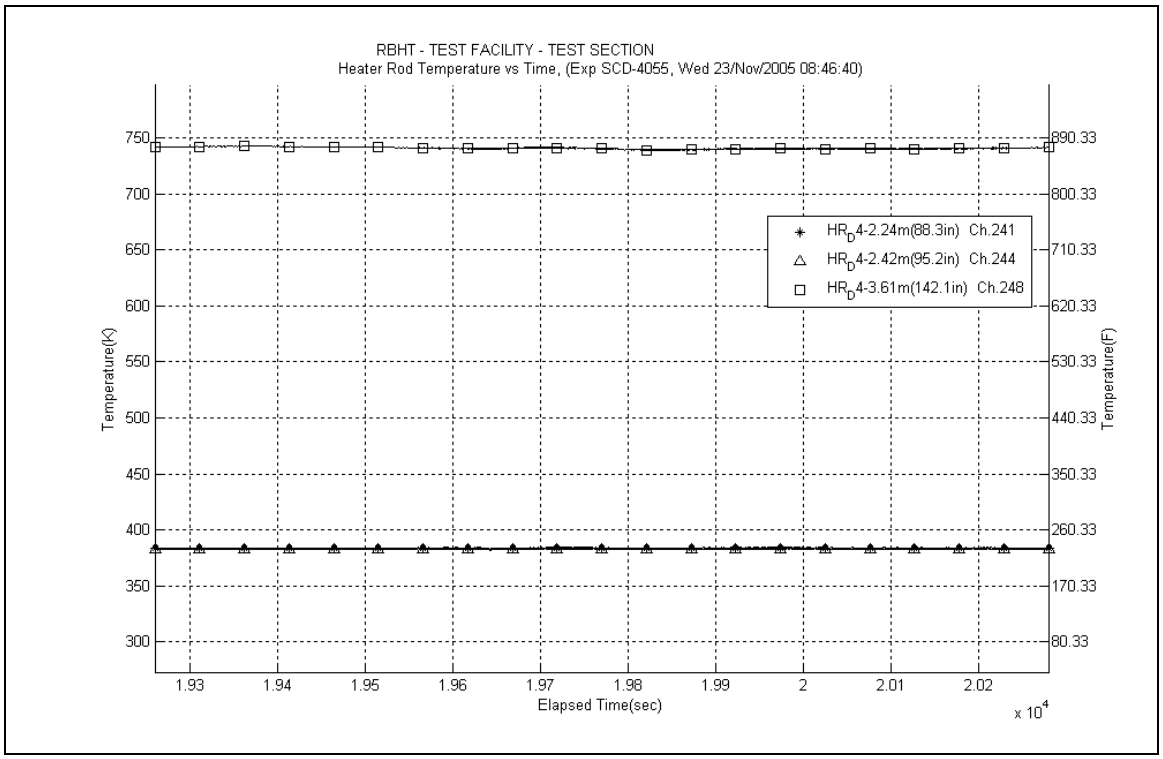

Figure A-614: Heater Rod D4 Temperatures for Experiment 4055C

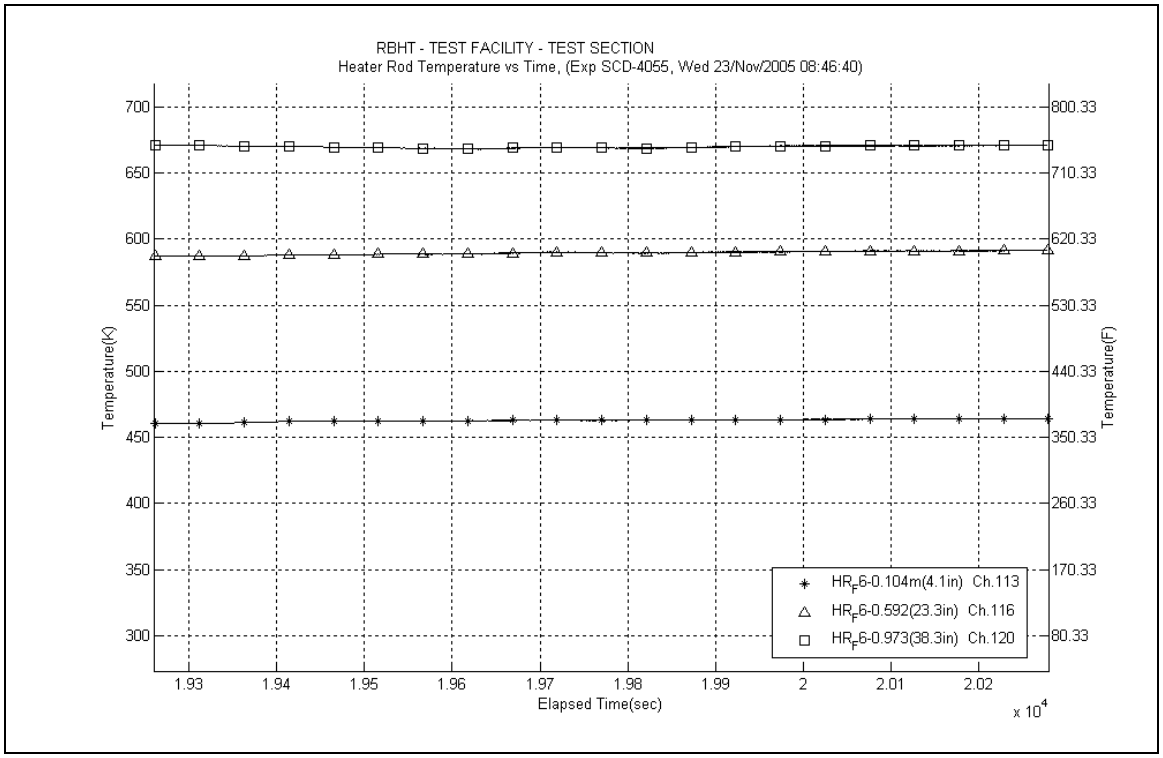

Figure A-615: Heater Rod F6 Temperatures for Experiment 4055C

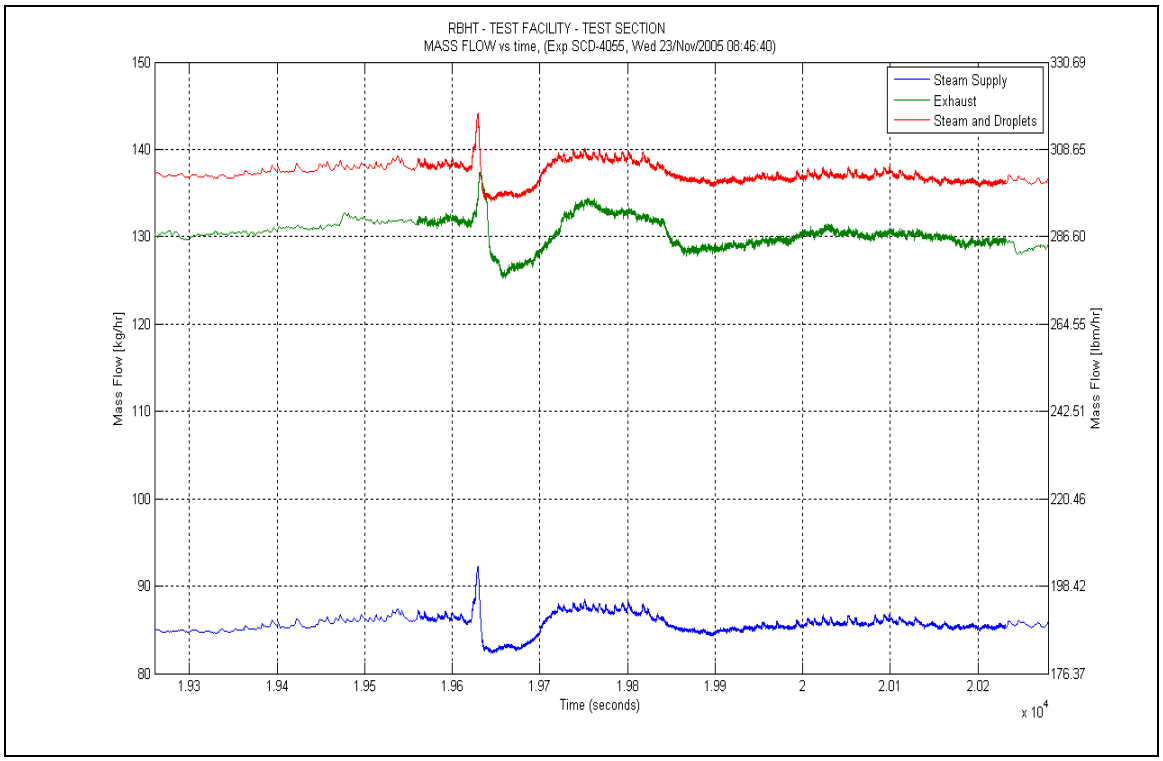

Figure A-616: Mass Flow for Experiment 4055C

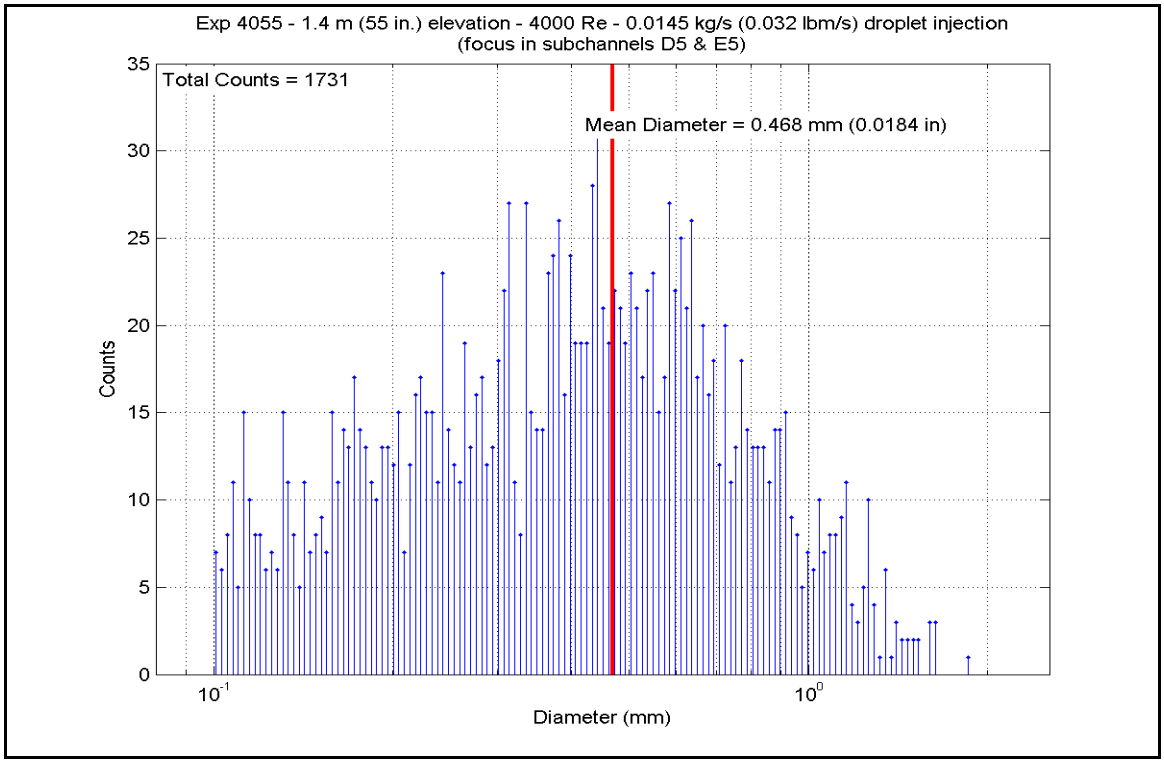

Figure A-617: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055C

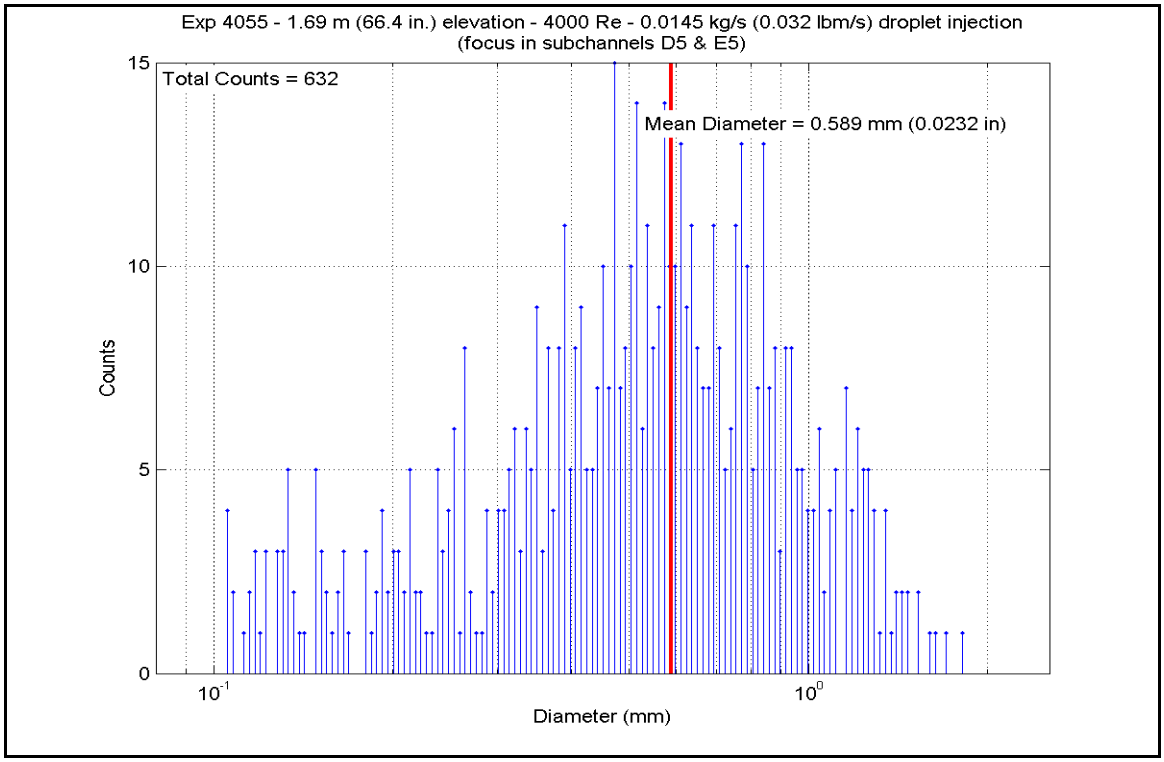

Figure A-618: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055C

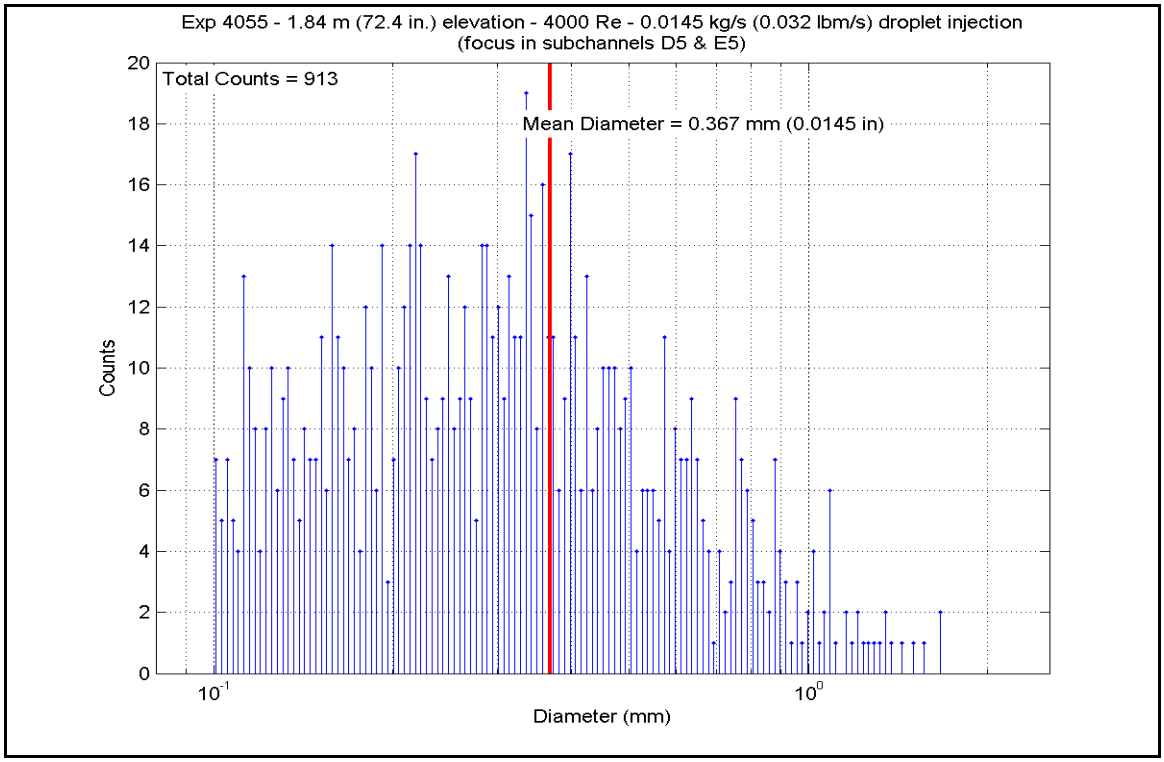

Figure A-619: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055C

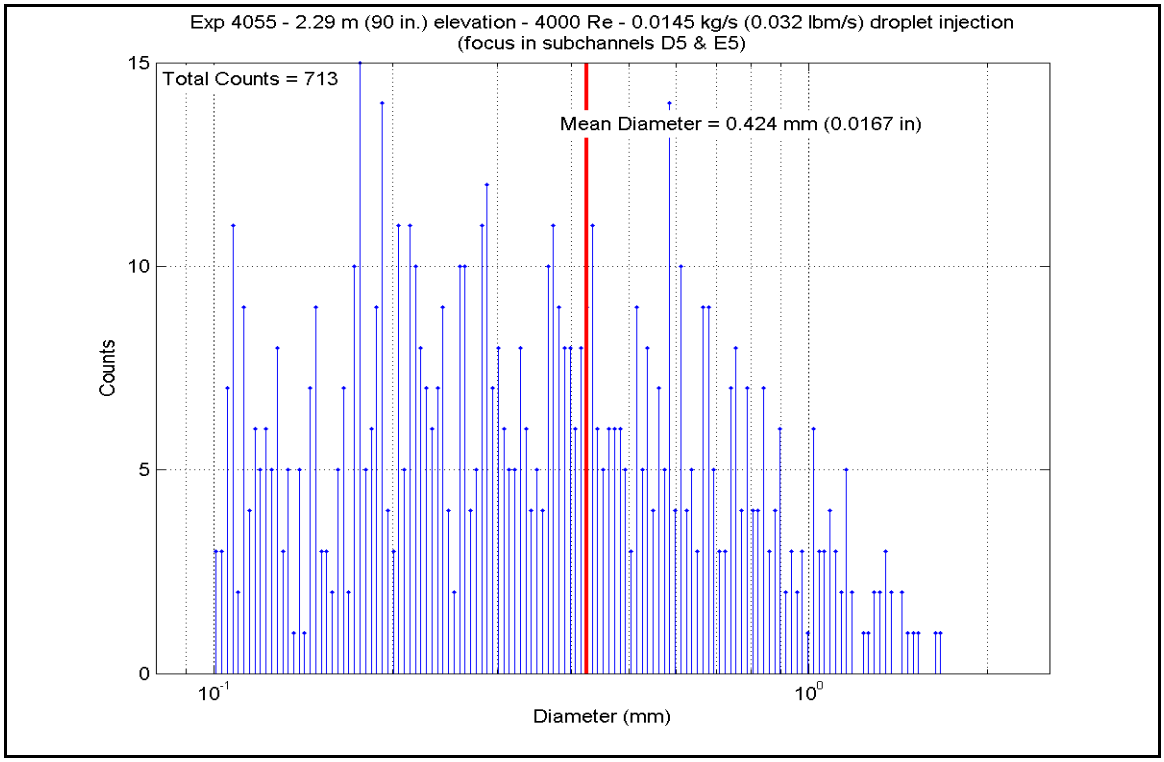

Figure A-620: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055C

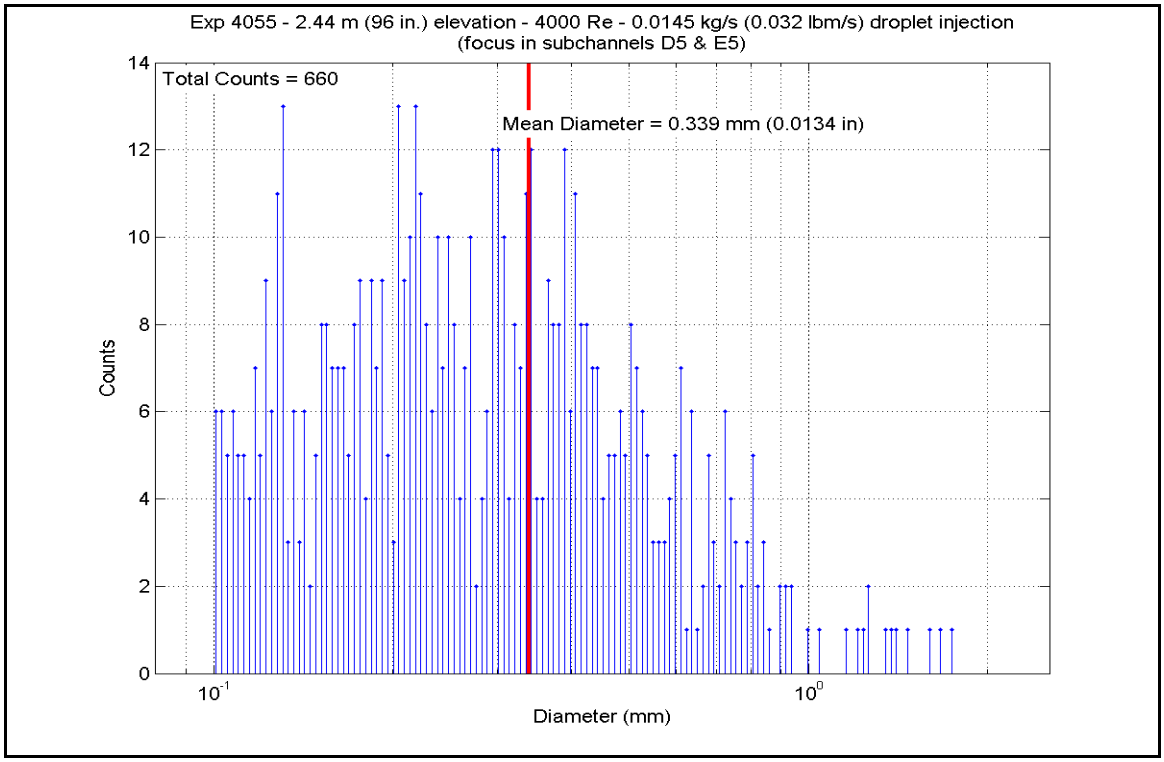

Figure A-621: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055C

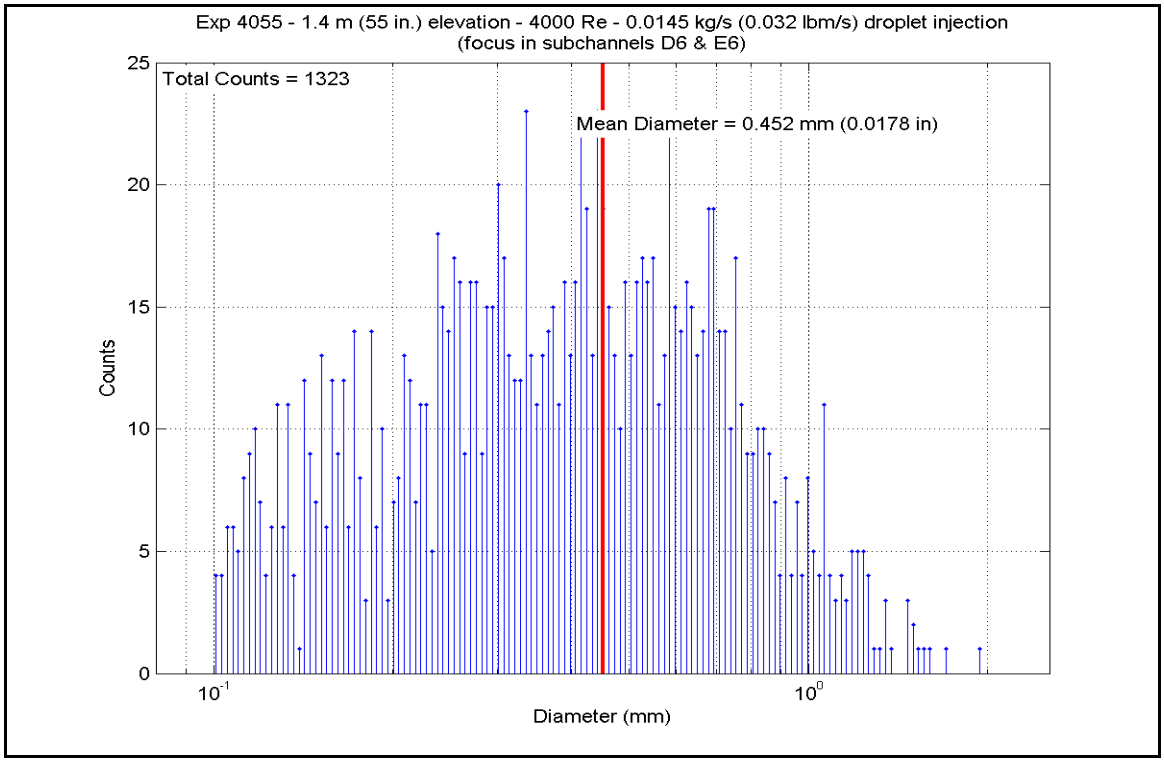

Figure A-622: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055C

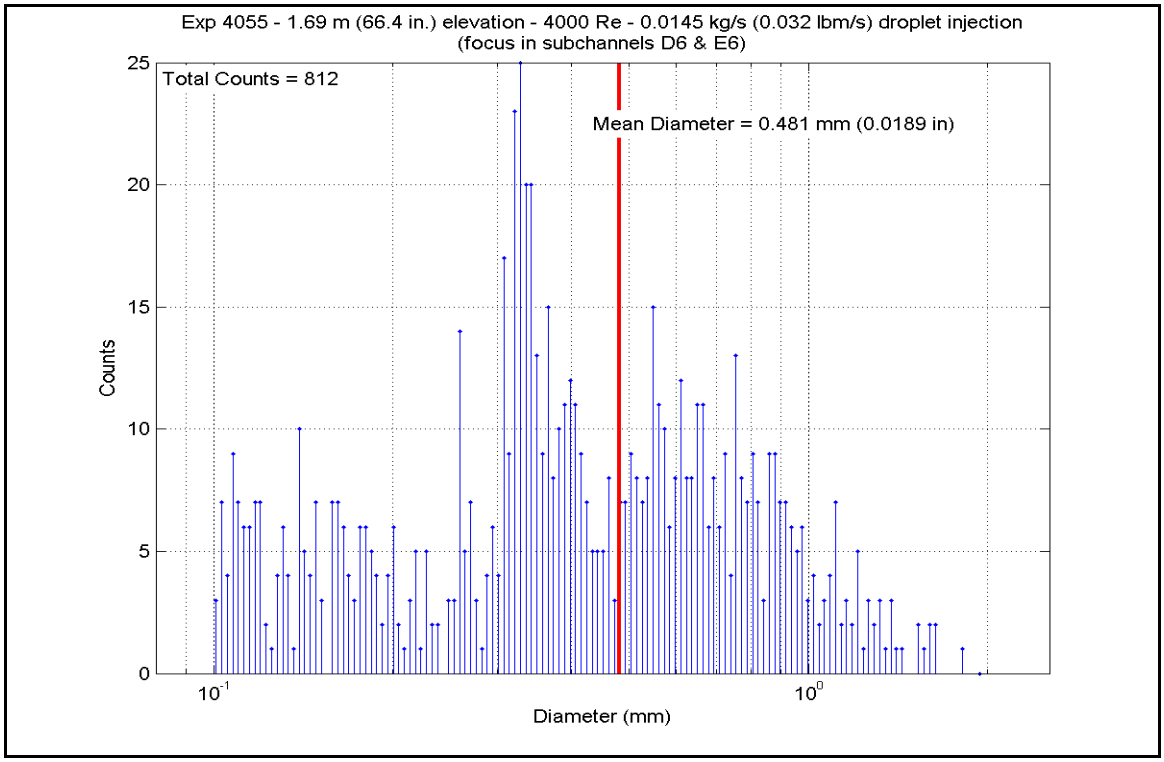

Figure A-623: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055C

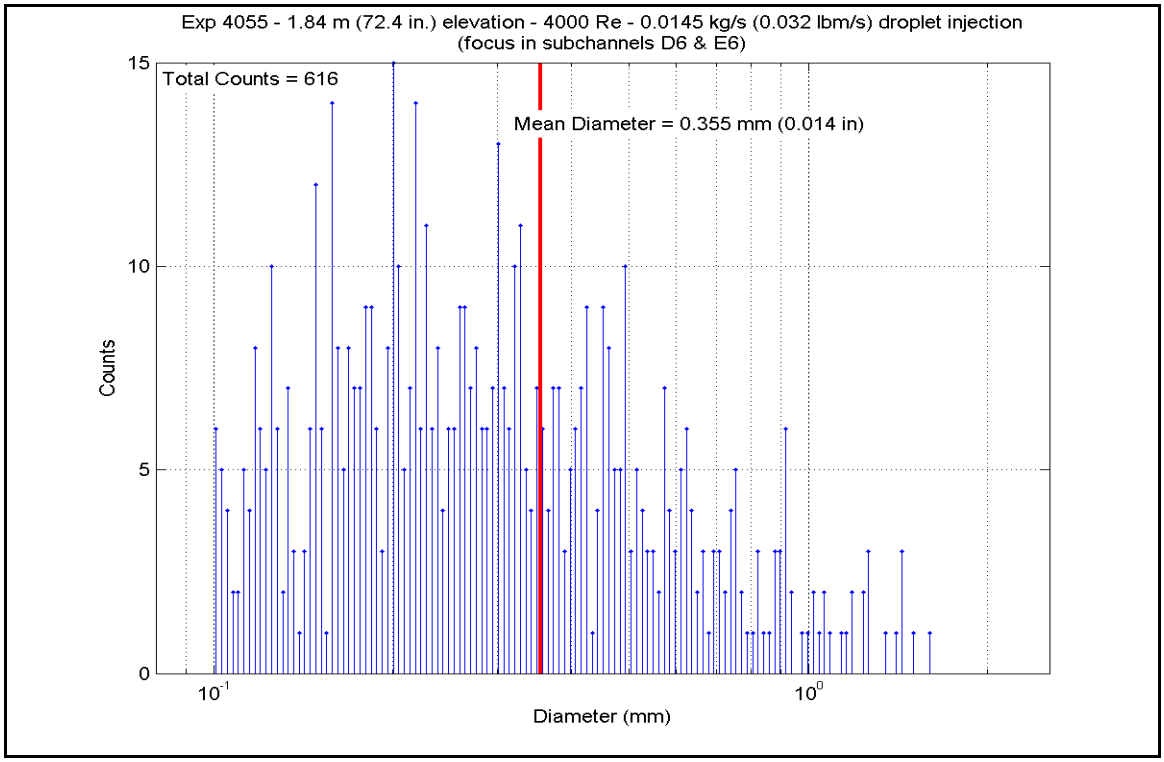

Figure A-624: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055C

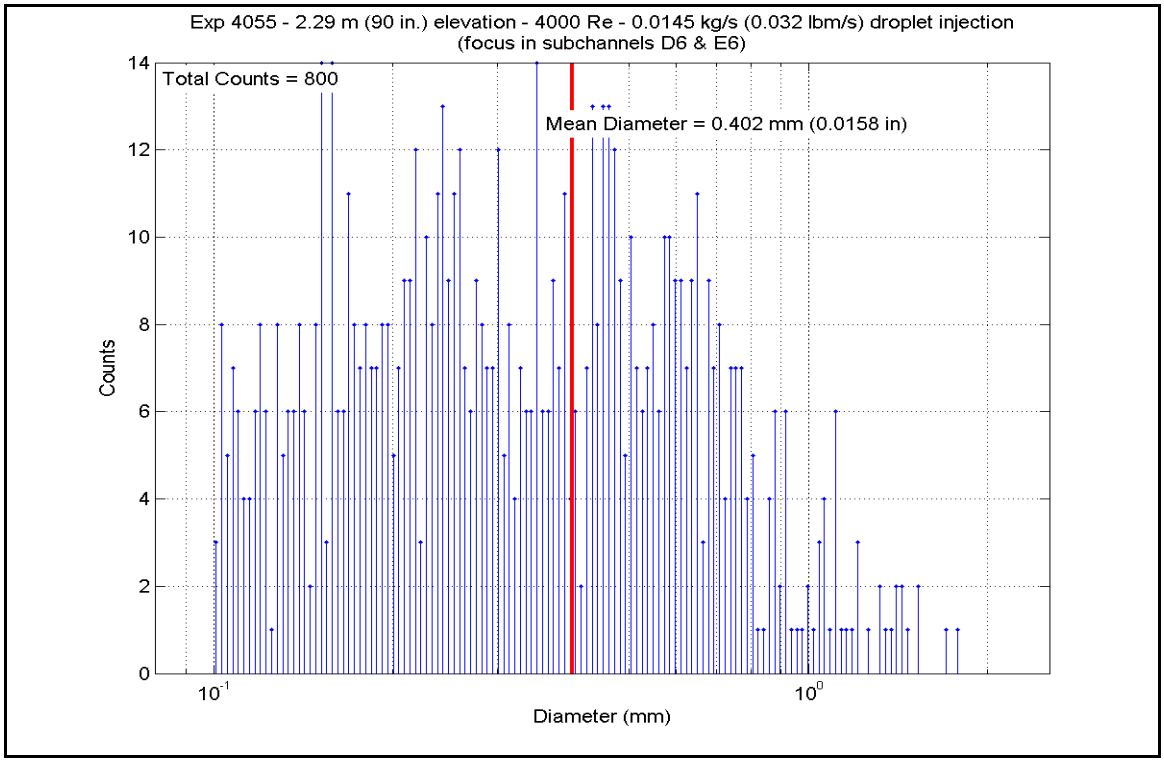

Figure A-625: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055C

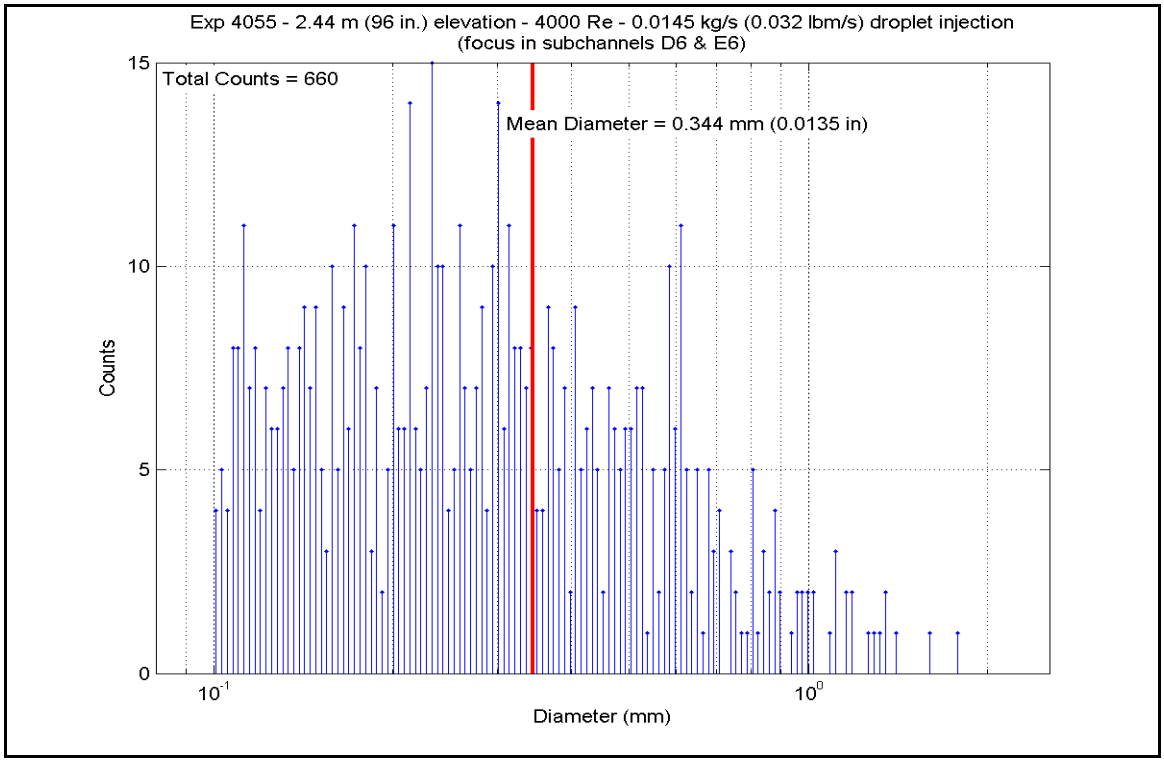

Figure A-626: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055C

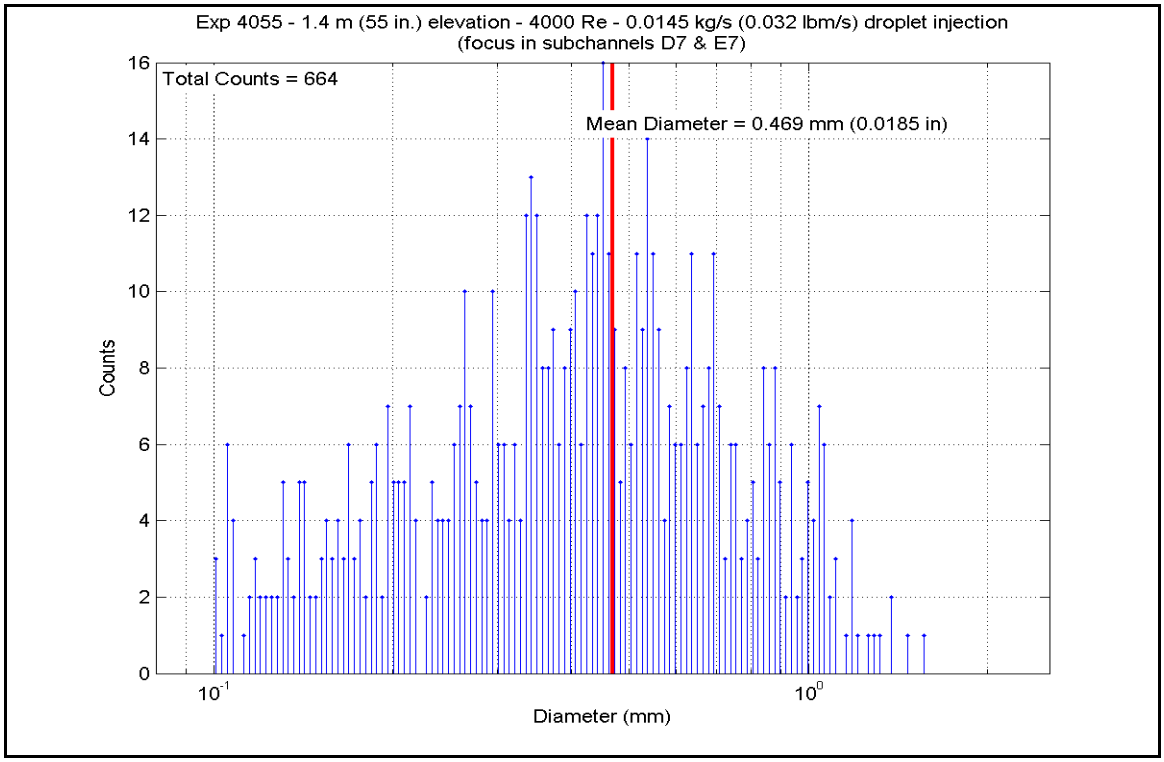

Figure A-627: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055C

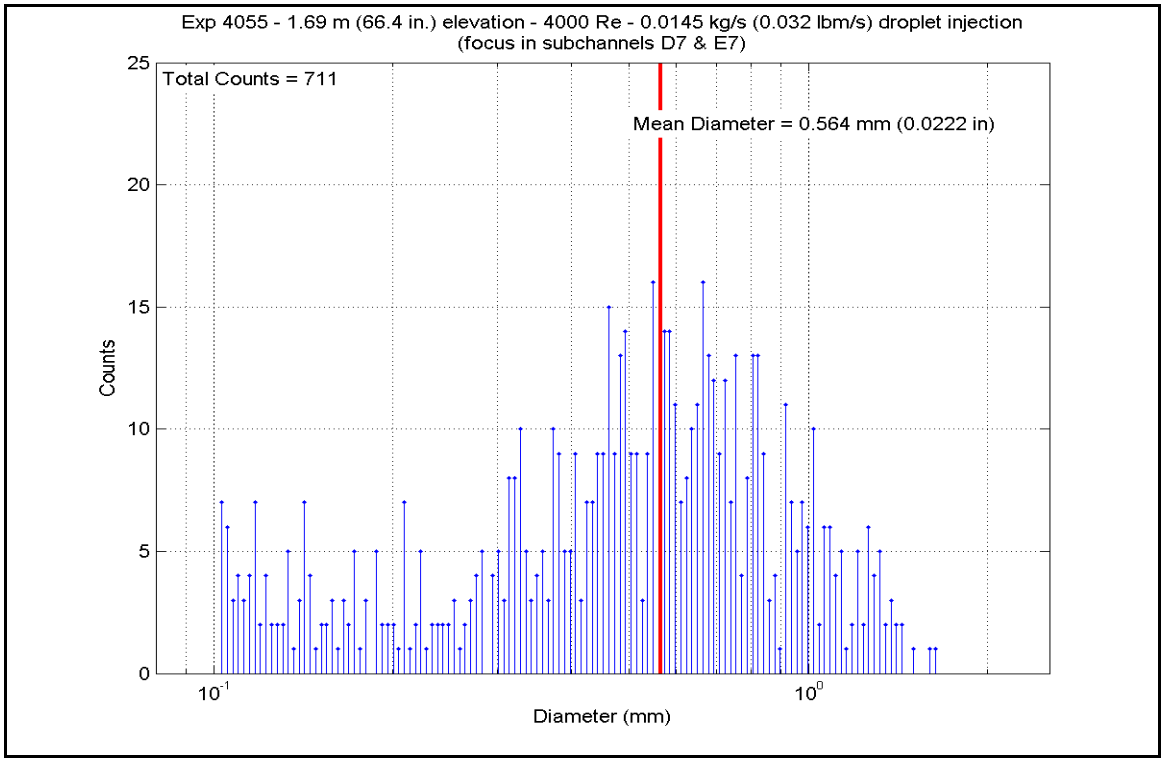

Figure A-628: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055C

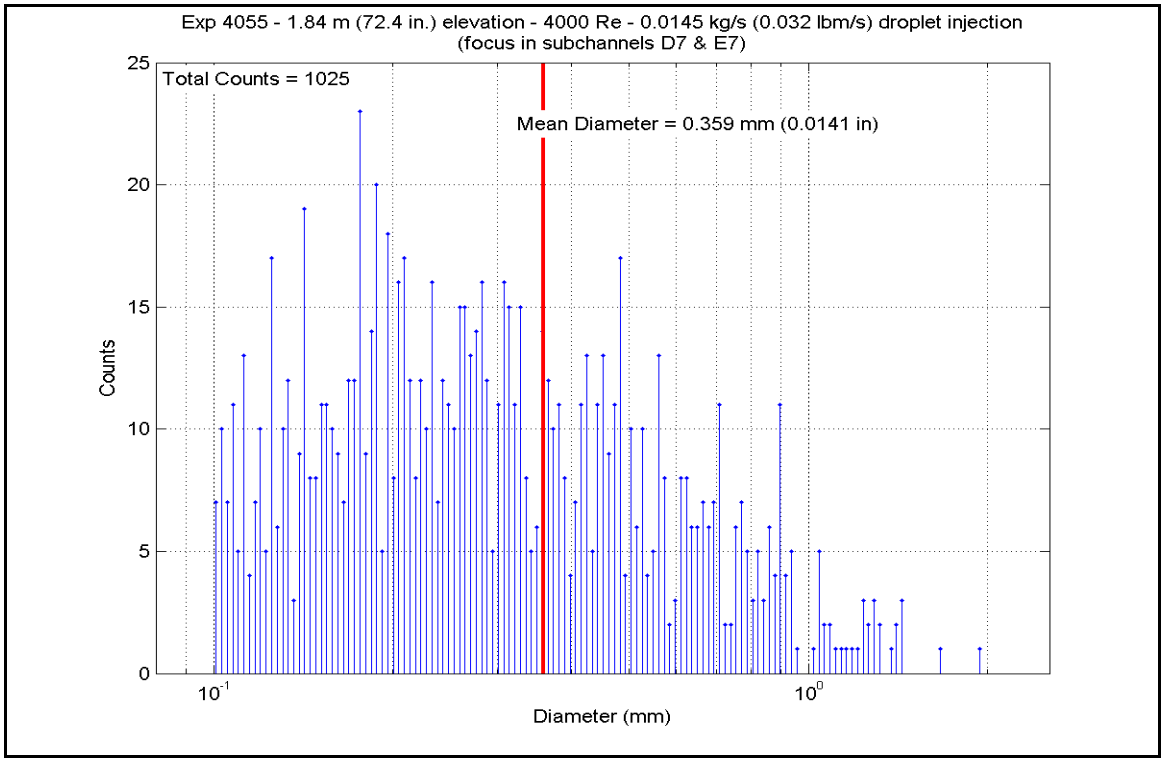

Figure A-629: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055C

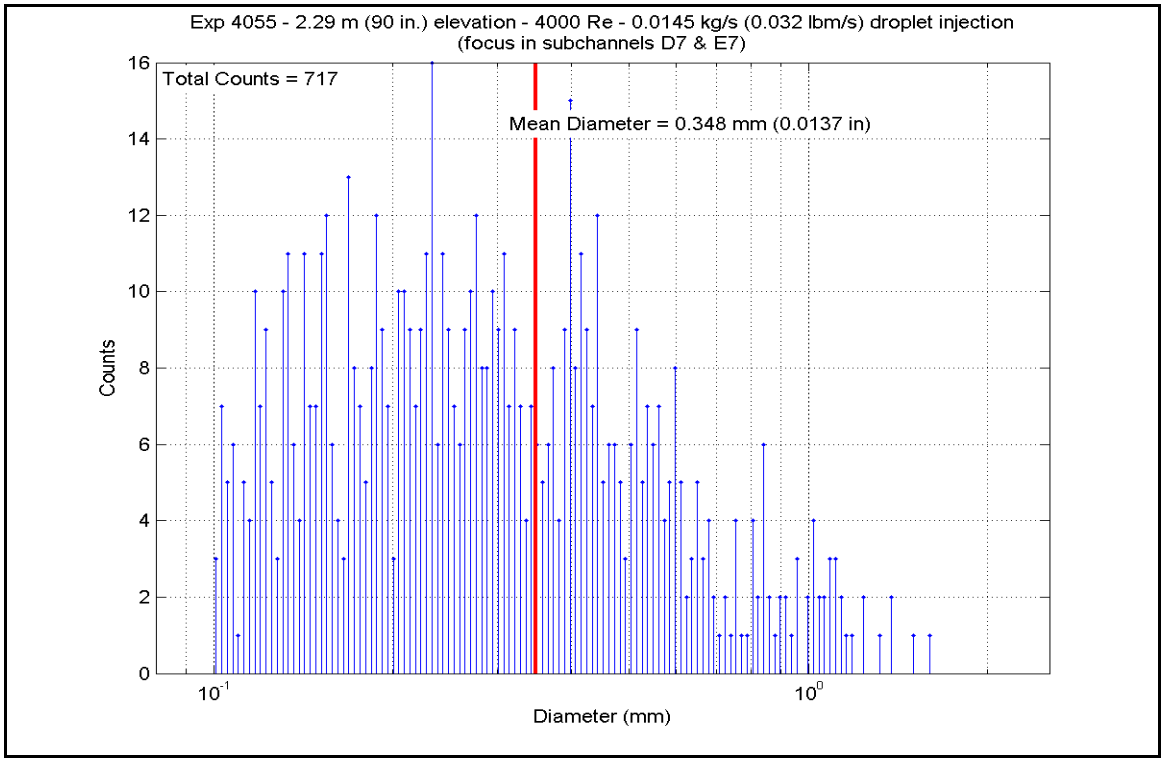

Figure A-630: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055C

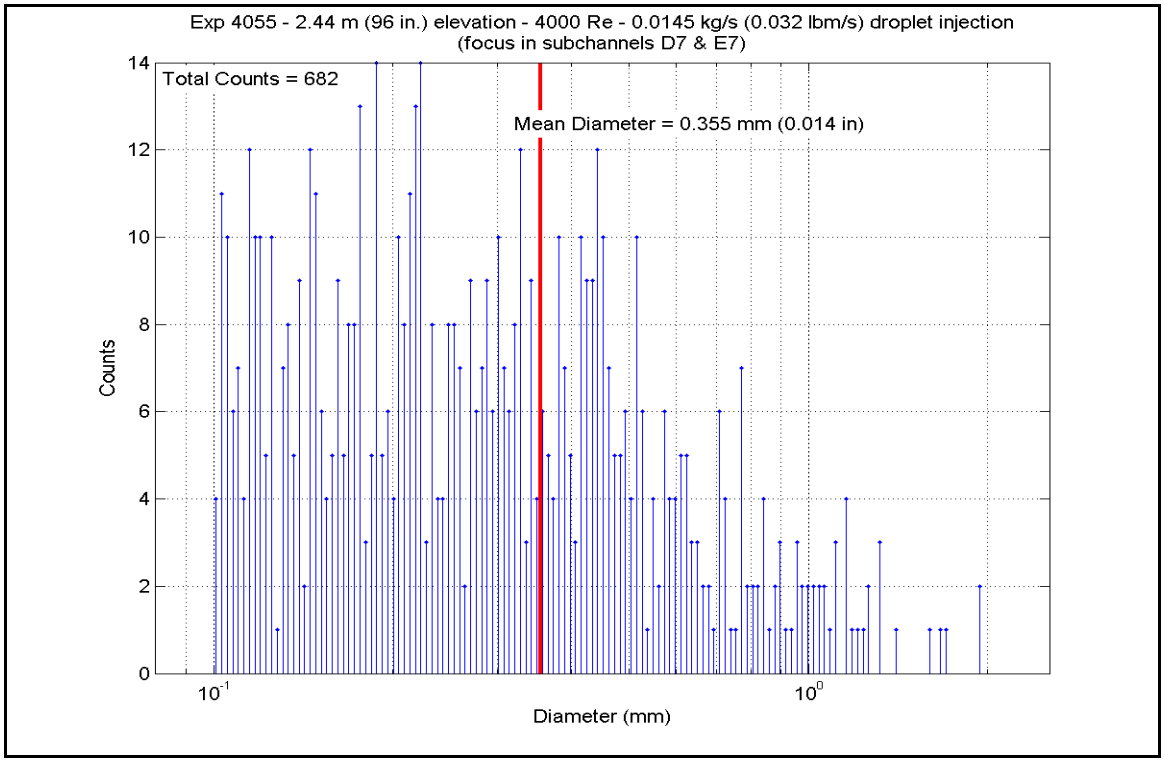

Figure A-631: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055C

Table A-70: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055C

SCD-4055-C	Inlet Reynolds:	4000	
Matrix test # 13d	UP Pressure:	137.9 kPa	20 psia
Time Window 19260-20280	Bundle Power:	50.00 kW	170607 Btu/hr
	Steam flow:	0.0227 kg/s	180.0 lbm/hr
	Droplet flow:	0.0145 kg/s	0.032 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	643.19	612.7	4247.65	13399.2	10.231	58.1
	RodD3_91.3	186	91.3	2.319	2.8	0.071	715.21	652.7	4338.70	13686.4	8.905	50.6
	RodD3_93.1	187	93.1	2.365	4.6	0.117	727.25	659.4	4391.77	13853.8	8.797	50.0
	RodD3_95.3	188	95.3	2.421	6.8	0.173	763.46	679.5	4459.99	14069.0	8.329	47.3
	RodD3_106.1	190	106.1	2.695	17.6	0.447	914.30	763.3	4784.29	15092.0	6.971	39.6
	RodD3_110	191	110	2.794	21.5	0.546	738.19	665.5	4710.63	14859.7	9.233	52.4
	RodD3_142.1	192	142.1	3.609	8.6	0.218	867.33	737.2	1650.20	5205.6	2.581	14.7
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	653.63	618.5	4149.09	13088.3	9.748	55.4
	RodC4_91.1	234	91.1	2.314	2.6	0.066	726.34	658.9	4273.51	13480.8	8.575	48.7
	RodC4_93.4	235	93.4	2.372	4.9	0.124	747.23	670.5	4338.12	13684.6	8.355	47.4
	RodC4_95.3	236	95.3	2.421	6.8	0.173	766.75	681.3	4393.94	13860.7	8.156	46.3
	RodC4_100.1	237	100.1	2.543	11.6	0.295	807.48	704.0	4667.67	14724.2	8.055	45.7
	RodC4_106.1	238	106.1	2.695	17.6	0.447	902.22	756.6	4847.77	15292.3	7.190	40.8
	RodC4_110	239	110	2.794	21.5	0.546	750.55	672.3	4712.84	14866.6	9.019	51.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	866.35	736.7	1731.87	5463.2	2.713	15.4
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	238.20	387.7	3867.15	12198.9	378.964	2152.1
	RodD4_91.3	242	91.3	2.319	2.8	0.071	236.40	386.7	3990.43	12587.8	475.002	2697.5
	RodD4_93.2	243	93.2	2.367	4.7	0.119	236.68	386.9	4034.14	12725.7	464.762	2639.3
	RodD4_95.2	244	95.2	2.418	6.7	0.170	237.86	387.5	4072.07	12845.3	413.101	2346.0
	RodD4_106.1	246	106.1	2.695	17.6	0.447	796.55	697.9	4855.28	15316.0	8.540	48.5
	RodD4_142.1	248	142.1	3.609	8.6	0.218	874.05	741.0	1669.63	5266.9	2.584	14.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	628.07	604.3	4237.21	13366.3	10.591	60.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	692.09	639.9	4326.22	13647.1	9.322	52.9
	RodE4_95.3	204	95.3	2.421	6.8	0.173	754.46	674.5	4445.21	14022.4	8.444	48.0
	RodE4_100.9	205	100.9	2.563	12.4	0.315	823.20	712.7	4617.39	14565.6	7.758	44.1
	RodE4_142.3	208	142.3	3.614	8.8	0.224	873.31	740.5	1749.37	5518.4	2.711	15.4

Table A-70: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	914.04	763.2	3482.87	10986.7	5.077	28.8
	RodE3_113.6	194	113.6	2.885	0.85	0.022	777.13	687.1	4306.49	13584.8	7.842	44.5
	RodE3_115.5	195	115.5	2.934	2.75	0.070	818.38	710.0	4146.38	13079.8	7.023	39.9
	RodE3_118.5	196	118.5	3.010	5.75	0.146	857.10	731.5	3895.01	12286.8	6.191	35.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	882.73	745.8	3542.85	11175.9	5.411	30.7
	RodE3_126.5	198	126.5	3.213	13.75	0.349	895.95	753.1	3225.09	10173.5	4.828	27.4
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	836.15	719.9	2782.90	8778.6	4.576	26.0
	RodE3_135.6	200	135.6	3.444	2.1	0.053	865.55	736.2	2453.96	7741.0	3.849	21.9
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	936.12	775.4	3354.11	10580.5	4.737	26.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	772.79	684.7	4205.72	13266.9	7.720	43.8
	RodC5_115.7	227	115.7	2.939	2.95	0.075	819.45	710.6	3907.16	12325.1	6.606	37.5
	RodC5_122.7	229	122.7	3.117	9.95	0.253	883.31	746.1	3384.53	10676.5	5.165	29.3
	RodC5_126.7	230	126.7	3.218	13.95	0.354	892.14	751.0	3078.50	9711.1	4.635	26.3
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	820.91	711.4	2641.22	8331.7	4.455	25.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	840.05	722.1	2348.34	7407.8	3.837	21.8
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	885.28	747.2	3440.50	10853.1	5.234	29.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	238.19	387.7	3591.44	11329.2	352.424	2001.4
	RodE5_118.7	212	118.7	3.015	5.95	0.151	645.61	614.0	3671.37	11581.3	8.791	49.9
	RodE5_122.6	213	122.6	3.114	9.85	0.250	777.45	687.3	3466.33	10934.5	6.309	35.8
	RodE5_126.6	214	126.6	3.216	13.85	0.352	816.30	708.9	3159.40	9966.3	5.370	30.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	893.29	751.6	2752.91	8684.1	4.138	23.5
	RodE5_135.6	216	135.6	3.444	2.1	0.053	872.71	740.2	2411.86	7608.2	3.741	21.2
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	797.84	698.6	3966.40	12512.0	6.961	39.5
	RodC3_85.6	178	85.6	2.174	14.72	0.374	685.98	636.5	4129.14	13025.4	9.016	51.2
	RodC3_88.5	179	88.5	2.248	0	0.000	642.75	612.5	4224.52	13326.3	10.186	57.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	726.28	658.9	4344.59	13705.0	8.719	49.5
	RodC3_94.4	181	94.4	2.398	5.9	0.150	743.26	668.3	4404.83	13895.0	8.549	48.5
Gr-8	RodD5_50	217	50	1.270	3	0.076	865.44	736.2	3083.96	9728.3	4.838	27.5
	RodD5_54.1	218	54.1	1.374	7.1	0.180	835.26	719.4	3153.71	9948.4	5.193	29.5
	RodD5_56.9	219	56.9	1.445	9.9	0.251	873.89	740.9	3240.14	10221.0	5.017	28.5
	RodD5_60	220	60	1.524	13	0.330	909.11	760.4	3336.45	10524.8	4.899	27.8
	RodD5_66.1	221	66.1	1.679	19.1	0.485	918.56	765.7	3506.68	11061.8	5.078	28.8
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	699.12	643.8	3611.76	11393.3	7.666	43.5
	RodD5_72.9	223	72.9	1.852	2.02	0.051	761.05	678.2	3706.37	11691.7	6.953	39.5
	RodD5_74.9	224	74.9	1.902	4.02	0.102	801.74	700.8	3767.48	11884.5	6.567	37.3

Table A-70: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	806.33	703.3	2803.83	8844.7	4.848	27.5
	RodB5_52.9	154	52.9	1.344	5.9	0.150	832.69	718.0	3159.29	9966.0	5.225	29.7
	RodB5_55	155	55	1.397	8	0.203	867.69	737.4	3221.70	10162.8	5.036	28.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	909.09	760.4	3305.96	10428.6	4.854	27.6
	RodB5_64	157	64	1.626	17	0.432	953.54	785.1	3491.13	11012.8	4.812	27.3
	RodB5_73.9	158	73.9	1.877	3.02	0.077	786.97	692.6	3802.53	11995.1	6.803	38.6
	RodB5_75.9	159	75.9	1.928	5.02	0.128	817.79	709.7	3862.77	12185.1	6.549	37.2
	RodB5_76.9	160	76.9	1.953	6.02	0.153	830.52	716.8	3892.53	12279.0	6.460	36.7
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	803.02	701.5	2789.00	8797.9	4.850	27.5
	RodF5_53.1	106	53.1	1.349	6.1	0.155	835.60	719.6	3158.79	9964.4	5.199	29.5
	RodF5_55	107	55	1.397	8	0.203	863.93	735.3	3219.46	10155.8	5.063	28.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	894.86	752.5	3308.61	10437.0	4.962	28.2
	RodF5_64	109	64	1.626	17	0.432	941.24	778.3	3506.56	11061.4	4.916	27.9
	RodF5_73.8	110	73.8	1.875	2.92	0.074	780.99	689.3	3792.57	11963.7	6.858	38.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	814.26	707.7	3854.68	12159.6	6.575	37.3
	RodF5_76.8	112	76.8	1.951	5.92	0.150	828.12	715.4	3885.60	12257.1	6.475	36.8
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	815.73	708.6	2809.27	8861.8	4.780	27.1
	RodC2_53.1	58	53.1	1.349	6.1	0.155	874.04	741.0	3165.67	9986.1	4.900	27.8
	RodC2_55	59	55	1.397	8	0.203	893.65	751.8	3224.78	10172.6	4.845	27.5
	RodC2_57.8	60	57.8	1.468	10.8	0.274	923.27	768.3	3312.11	10448.1	4.764	27.1
	RodC2_63.9	61	63.9	1.623	16.9	0.429	946.30	781.1	3495.78	11027.4	4.867	27.6
	RodC2_73.8	62	73.8	1.875	2.92	0.074	728.59	660.1	3798.49	11982.3	7.588	43.1
	RodC2_75.8	63	75.8	1.925	4.92	0.125	754.11	674.3	3860.04	12176.5	7.337	41.7
	RodC2_76.8	64	76.8	1.951	5.92	0.150	764.40	680.0	3890.97	12274.1	7.254	41.2
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	805.95	703.1	2785.61	8787.2	4.820	27.4
	RodC6_52.8	138	52.8	1.341	5.8	0.147	875.96	742.0	3161.10	9971.7	4.879	27.7
	RodC6_54.8	139	54.8	1.392	7.8	0.198	899.64	755.2	3222.64	10165.8	4.798	27.2
	RodC6_57.8	140	57.8	1.468	10.8	0.274	924.41	768.9	3317.02	10463.5	4.763	27.0
	RodC6_63.8	141	63.8	1.621	16.8	0.427	963.53	790.7	3504.70	11055.6	4.765	27.1
	RodC6_73.7	142	73.7	1.872	2.82	0.072	806.86	703.6	3821.04	12053.5	6.601	37.5
	RodC6_75.8	143	75.8	1.925	4.92	0.125	833.14	718.2	3886.76	12260.8	6.423	36.5
	RodC6_76.8	144	76.8	1.951	5.92	0.150	847.74	726.3	3917.97	12359.2	6.322	35.9

Table A-70: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	618.64	599.1	4208.96	13277.2	10.774	61.2
	RodB4_91.3	162	91.3	2.319	2.8	0.071	686.71	636.9	4296.36	13552.9	9.366	53.2
	RodB4_93.3	163	93.3	2.370	4.8	0.122	689.81	638.6	4355.85	13740.5	9.432	53.6
	RodB4_95.1	164	95.1	2.416	6.6	0.168	719.86	655.3	4407.86	13904.6	8.962	50.9
	RodB4_142.3	168	142.3	3.614	8.8	0.224	850.21	727.7	1779.93	5614.8	2.861	16.2
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	633.36	607.2	4364.09	13766.5	10.766	61.1
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	315.15	430.5	4811.90	15179.1	55.214	313.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	432.16	495.5	5057.97	15955.4	24.774	140.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	643.37	612.8	4782.41	15086.1	11.514	65.4
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	801.95	700.9	4189.96	13217.2	7.300	41.5
	RodD2_106	66	106	2.692	17.5	0.445	828.22	715.5	3969.27	12521.1	6.613	37.6
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	866.22	736.6	3669.69	11576.0	5.750	32.7
	RodD2_114.9	68	114.9	2.918	2.15	0.055	886.70	748.0	3317.02	10463.6	5.036	28.6
	RodD2_117.4	69	117.4	2.982	4.65	0.118	885.37	747.2	2980.97	9403.5	4.535	25.8
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	789.97	694.2	4217.05	13302.7	7.504	42.6
	RodD6_116.8	133	116.8	2.967	4.05	0.103	822.37	712.2	4046.27	12764.0	6.808	38.7
	RodD6_120.9	134	120.9	3.071	8.15	0.207	850.09	727.6	3681.79	11614.2	5.918	33.6
	RodD6_124.8	135	124.8	3.170	12.05	0.306	862.72	734.7	3334.09	10517.4	5.253	29.8
	RodD6_128.7	136	128.7	3.269	15.95	0.405	855.87	730.9	2985.12	9416.6	4.754	27.0

Table A-70: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	857.91	732.0	3109.23	9808.1	4.936	28.0
	RodE2_54	74	54	1.372	7	0.178	883.72	746.3	3225.53	10174.9	4.919	27.9
	RodE2_56.9	75	56.9	1.445	9.9	0.251	915.57	764.0	3315.32	10458.2	4.822	27.4
	RodE2_59.9	76	59.9	1.521	12.9	0.328	940.05	777.6	3408.58	10752.4	4.787	27.2
	RodE2_66	77	66	1.676	19	0.483	924.53	769.0	3589.35	11322.6	5.153	29.3
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	632.64	606.8	3703.54	11682.8	9.153	52.0
	RodE2_72.9	79	72.9	1.852	2.02	0.051	698.69	643.5	3800.35	11988.2	8.074	45.9
	RodE2_74.9	80	74.9	1.902	4.02	0.102	727.07	659.3	3864.97	12192.0	7.744	44.0
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	808.80	704.7	3072.03	9690.7	5.289	30.0
	RodB3_54.1	170	54.1	1.374	7.1	0.180	826.90	714.8	3200.92	10097.3	5.345	30.4
	RodB3_56.9	171	56.9	1.445	9.9	0.251	855.30	730.5	3284.31	10360.3	5.236	29.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	846.45	725.6	3380.50	10663.8	5.466	31.0
	RodB3_66.1	173	66.1	1.679	19.1	0.485	871.38	739.5	3559.88	11229.6	5.533	31.4
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	658.10	621.0	3676.31	11596.9	8.548	48.5
	RodB3_73	175	73	1.854	2.12	0.054	702.16	645.5	3771.55	11897.4	7.954	45.2
	RodB3_75	176	75	1.905	4.12	0.105	730.90	661.4	3833.89	12094.0	7.624	43.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	854.14	729.9	3087.02	9738.0	4.930	28.0
	RodF3_54	90	54	1.372	7	0.178	859.38	732.8	3210.14	10126.4	5.084	28.9
	RodF3_57	91	57	1.448	10	0.254	892.02	750.9	3300.95	10412.9	4.971	28.2
	RodF3_60	92	60	1.524	13	0.330	916.12	764.3	3393.41	10704.5	4.931	28.0
	RodF3_66.1	93	66.1	1.679	19.1	0.485	895.05	752.6	3587.95	11318.2	5.379	30.5
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	831.95	717.6	3079.18	9713.3	5.098	29.0
	RodE6_54.1	122	54.1	1.374	7.1	0.180	874.53	741.2	3196.70	10084.0	4.944	28.1
	RodE6_57	123	57	1.448	10	0.254	905.29	758.3	3283.21	10356.9	4.848	27.5
	RodE6_60.2	124	60.2	1.529	13.2	0.335	938.13	776.6	3378.86	10658.6	4.758	27.0
	RodE6_66.1	125	66.1	1.679	19.1	0.485	941.64	778.5	3556.70	11219.6	4.984	28.3
	RodE6_70	126	70	1.778	-0.88	-0.022	732.56	662.3	3673.59	11588.4	7.281	41.3
	RodE6_73.1	127	73.1	1.857	2.22	0.056	784.19	691.0	3765.82	11879.3	6.771	38.5
	RodE6_75	128	75	1.905	4.12	0.105	816.06	708.7	3823.75	12062.0	6.502	36.9

RBHT Steam Cooling with Droplet Injection Test SCD-4055-D

Matrix Test # 13a

Test Conditions

Test Date – 11/23/2005
Steady State Time Window: 21600 - 23700
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

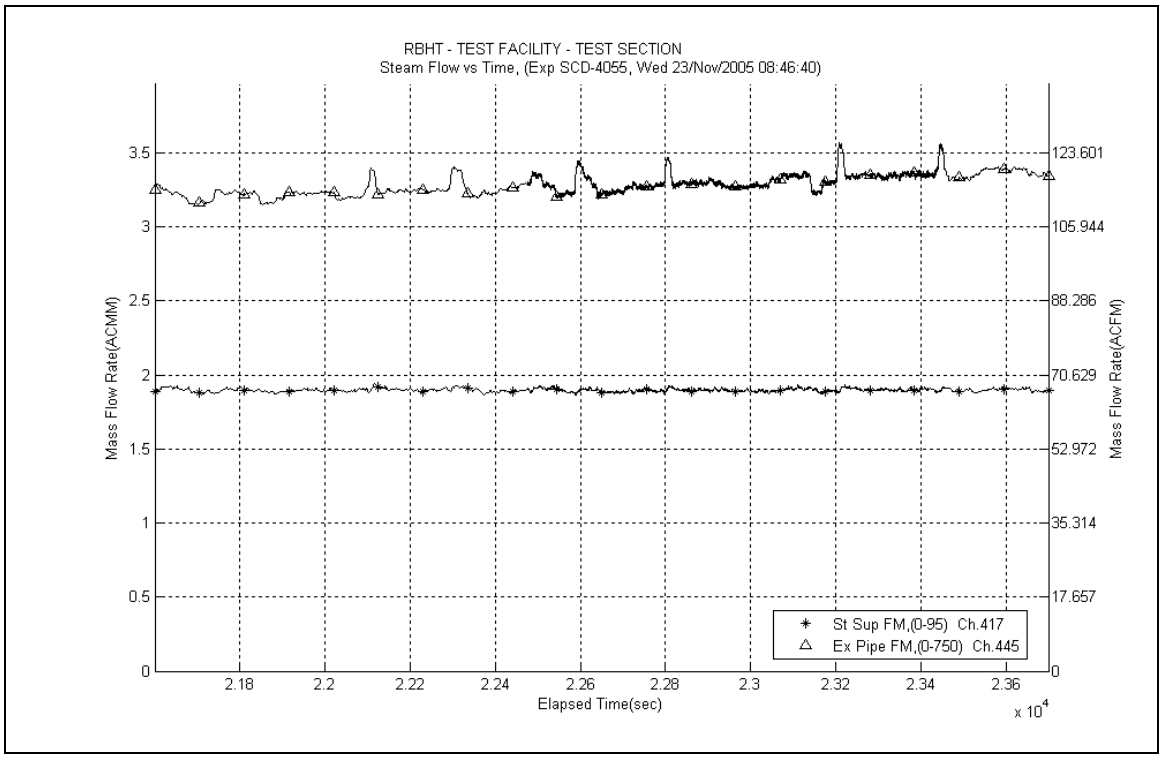

Figure A-632: Inlet and Exhaust Steam Flow Rates for Experiment 4055D

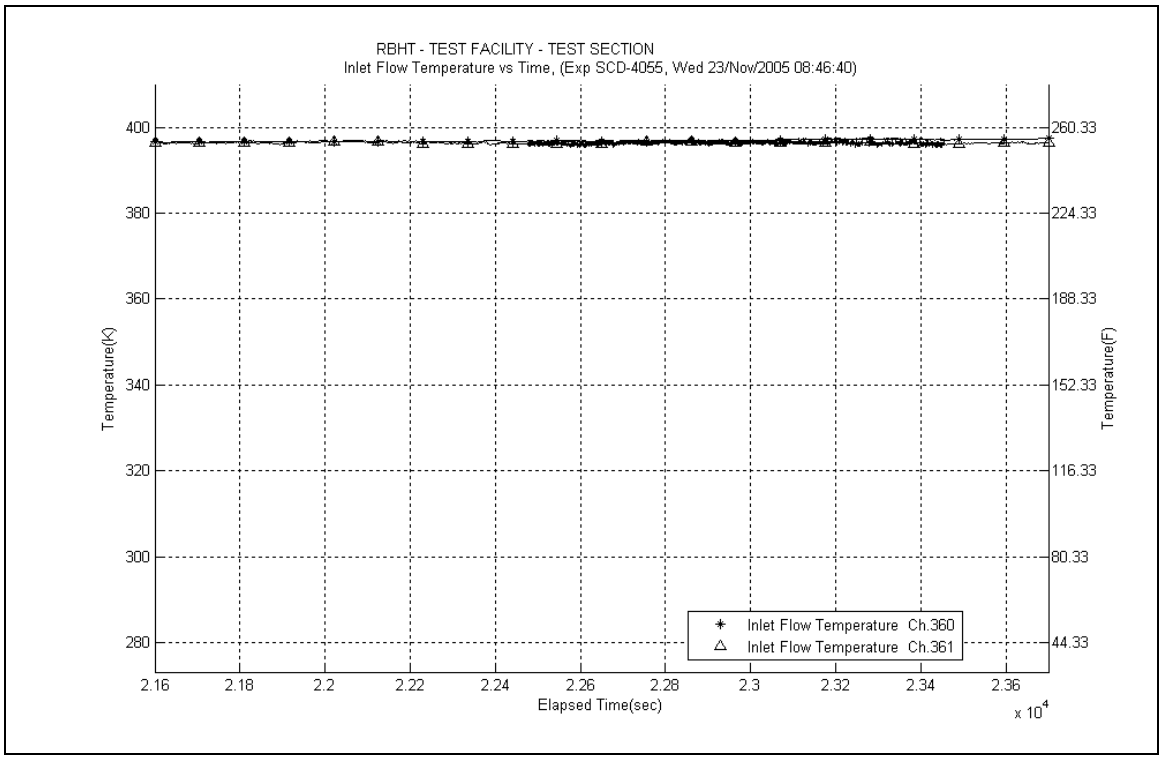

Figure A-633: Inlet Steam Temperature for Experiment 4055D

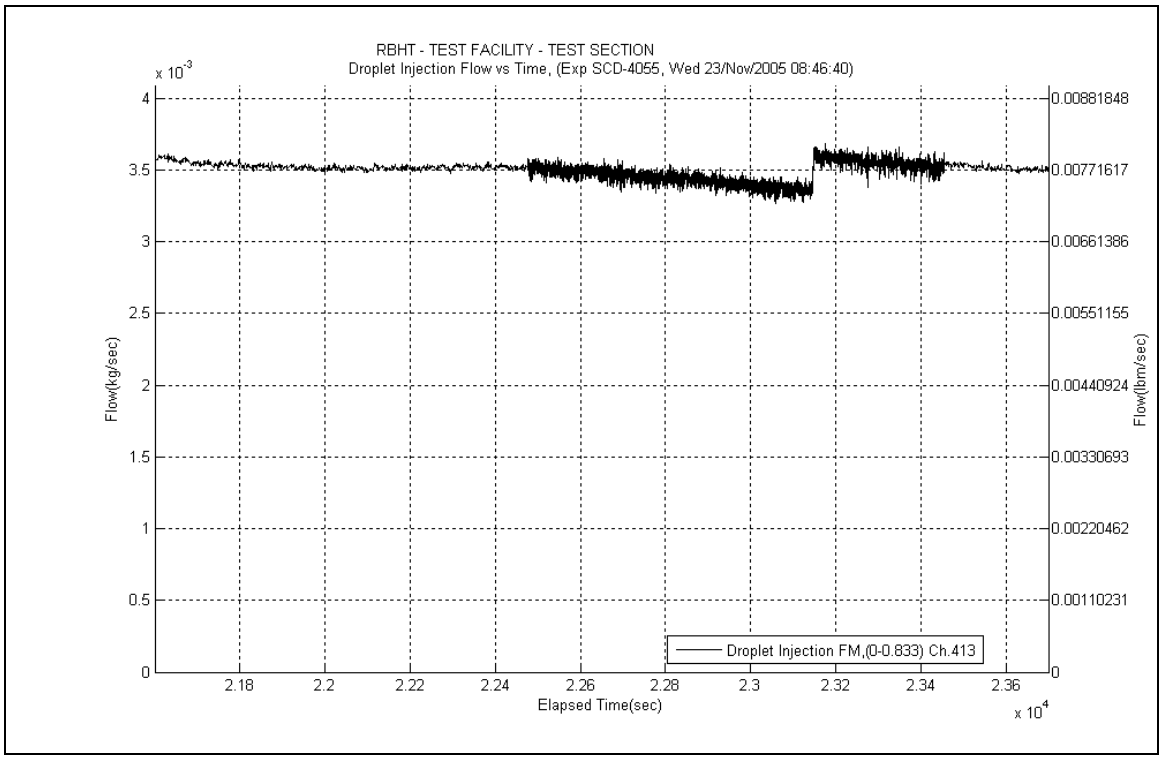

Figure A-634: Droplet Injection Flow Rate for Experiment 4055D

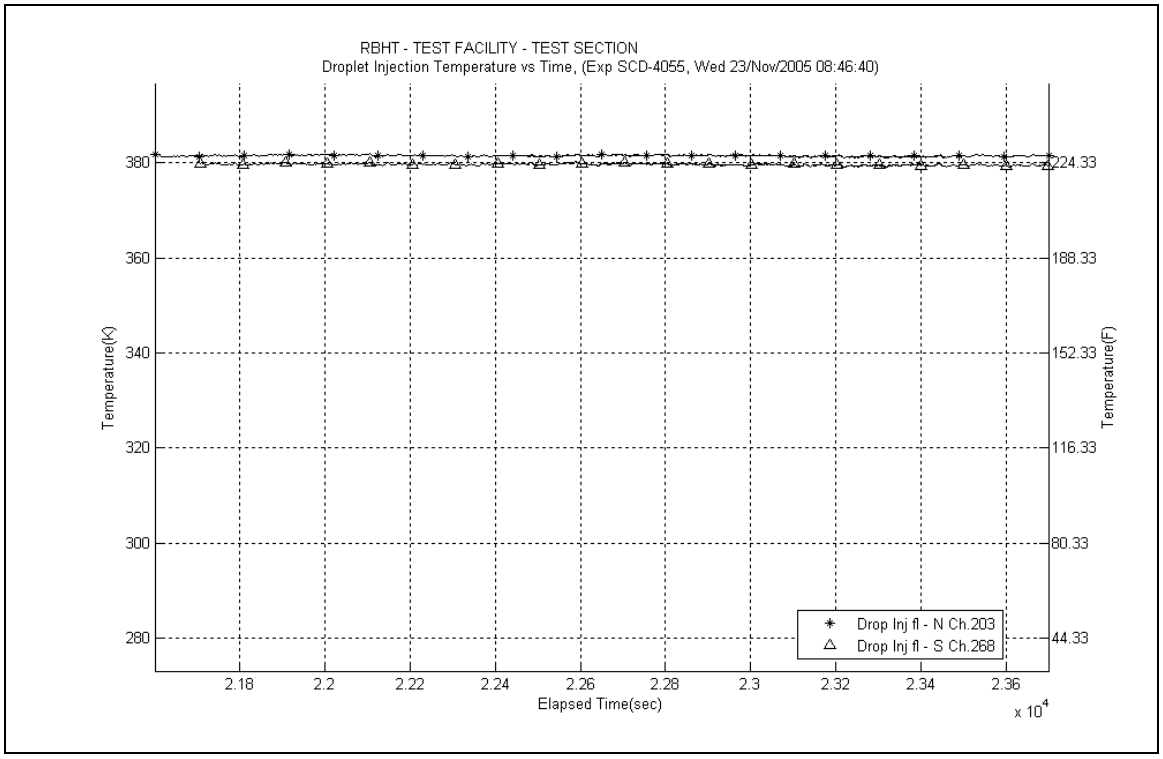

Figure A-635: Droplet Injection Temperature for Experiment 4055D

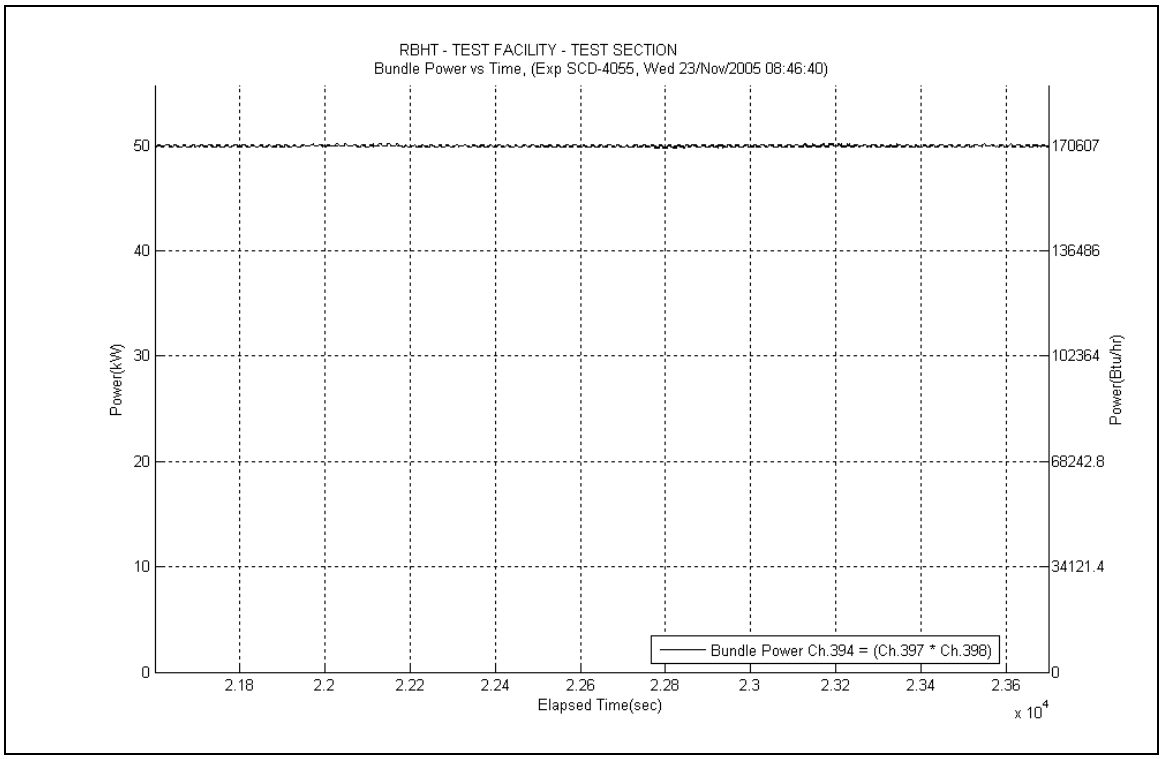

Figure A-636: Bundle Power for Experiment 4055D

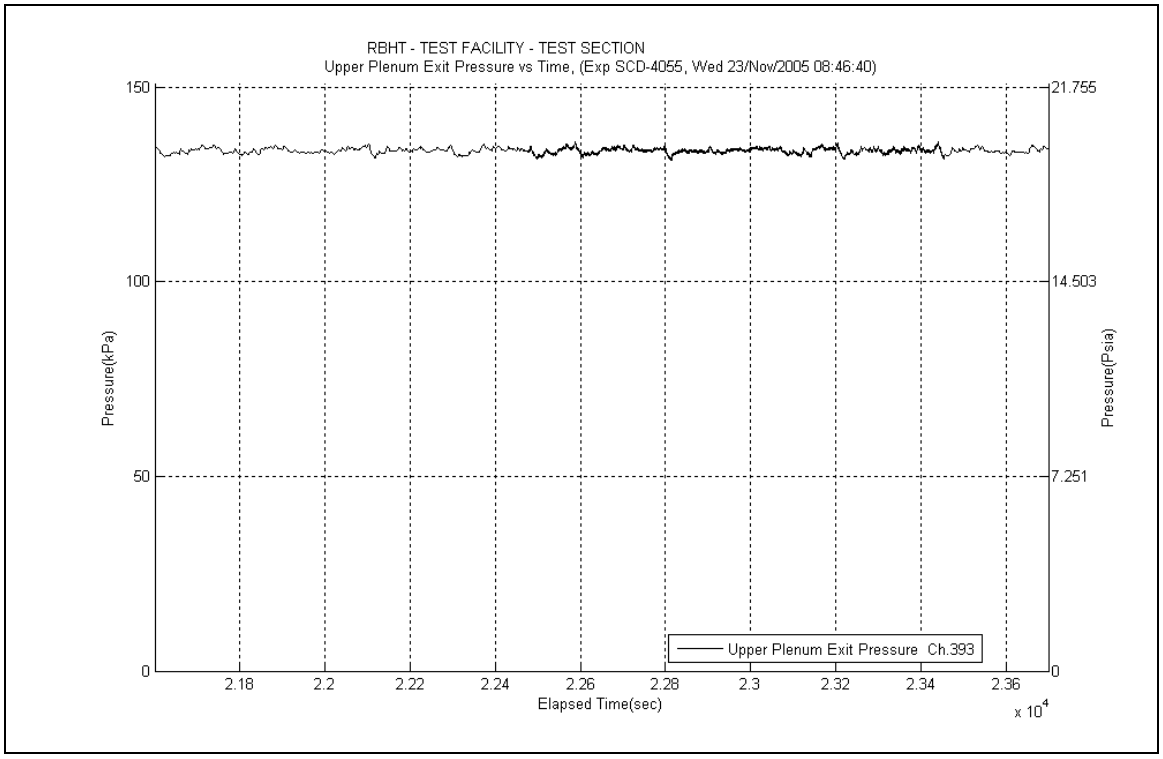

Figure A-637: Upper Plenum Pressure for Experiment 4055D

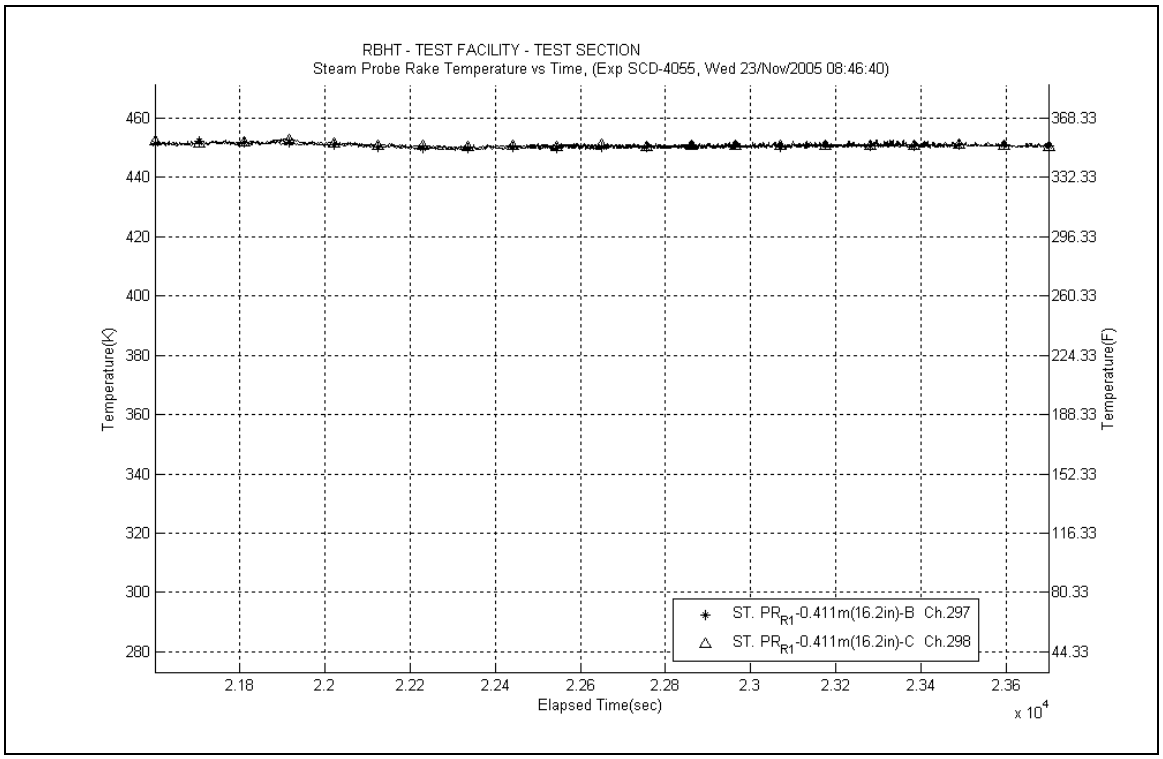

Figure A-638: Steam Probe Rake #1 Temperatures for Experiment 4055D

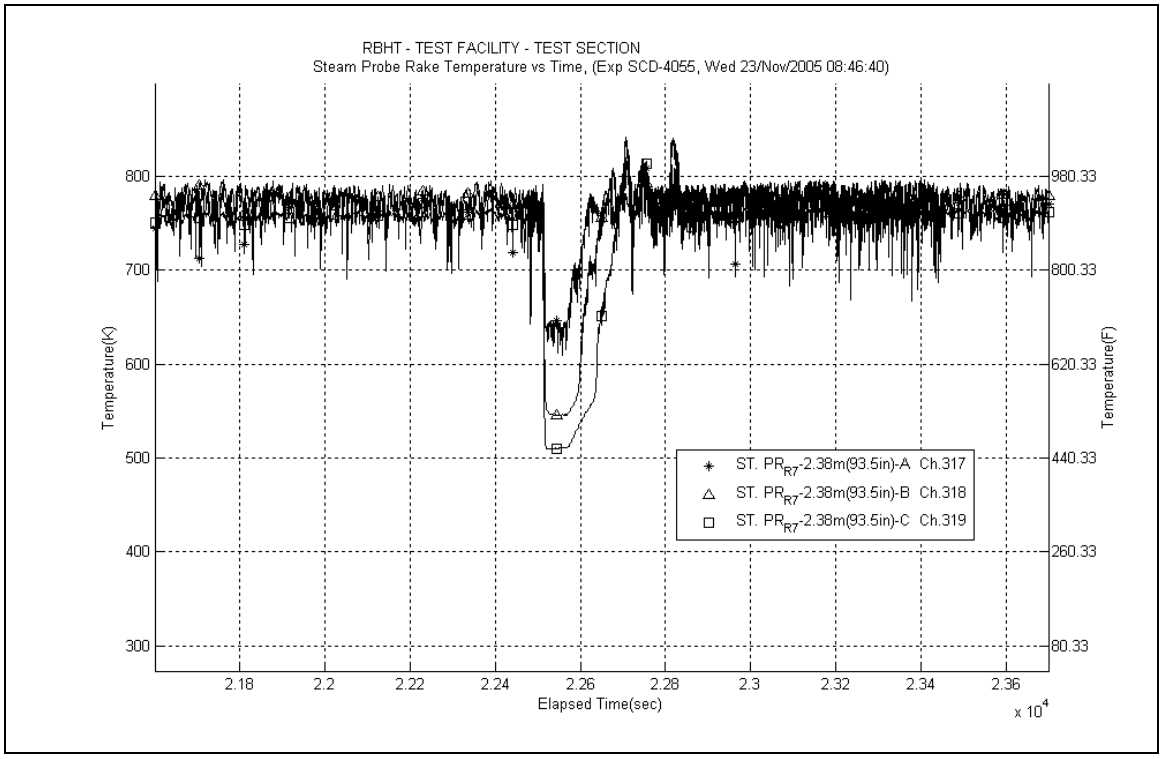

Figure A-639: Steam Probe Rake #7 Temperatures for Experiment 4055D

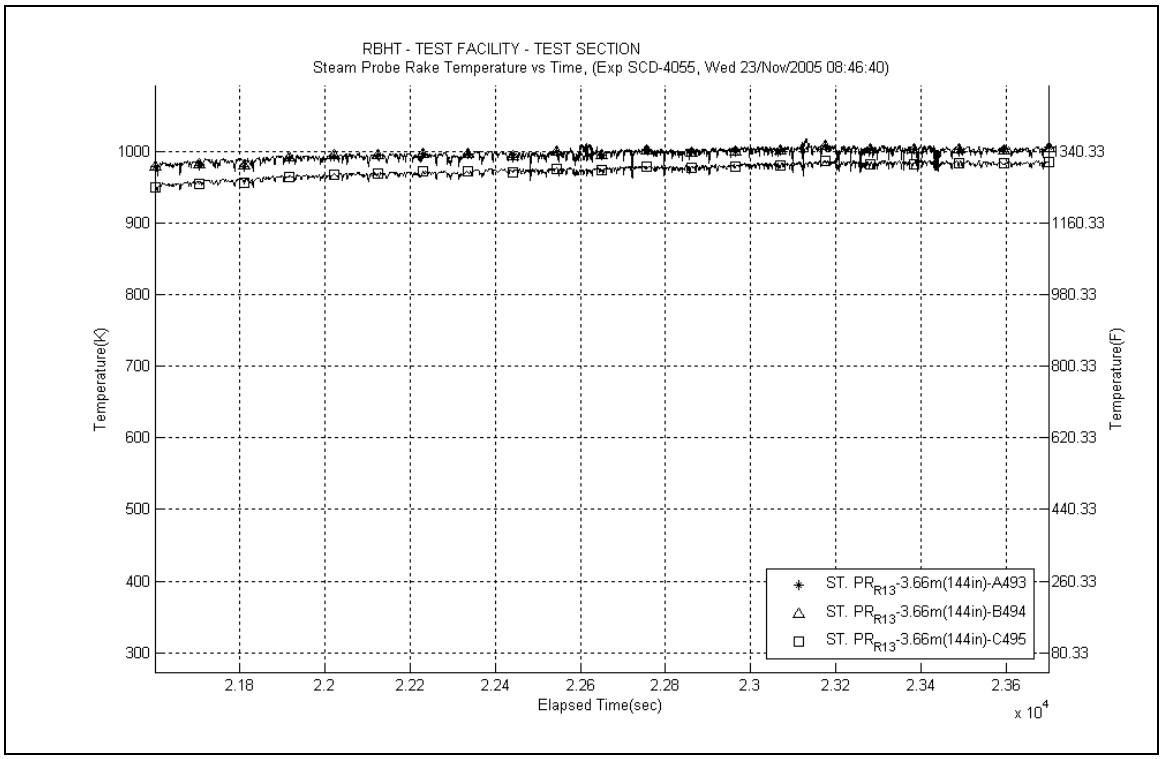

Figure A-640: Steam Probe Rake #13 Temperatures for Experiment 4055D

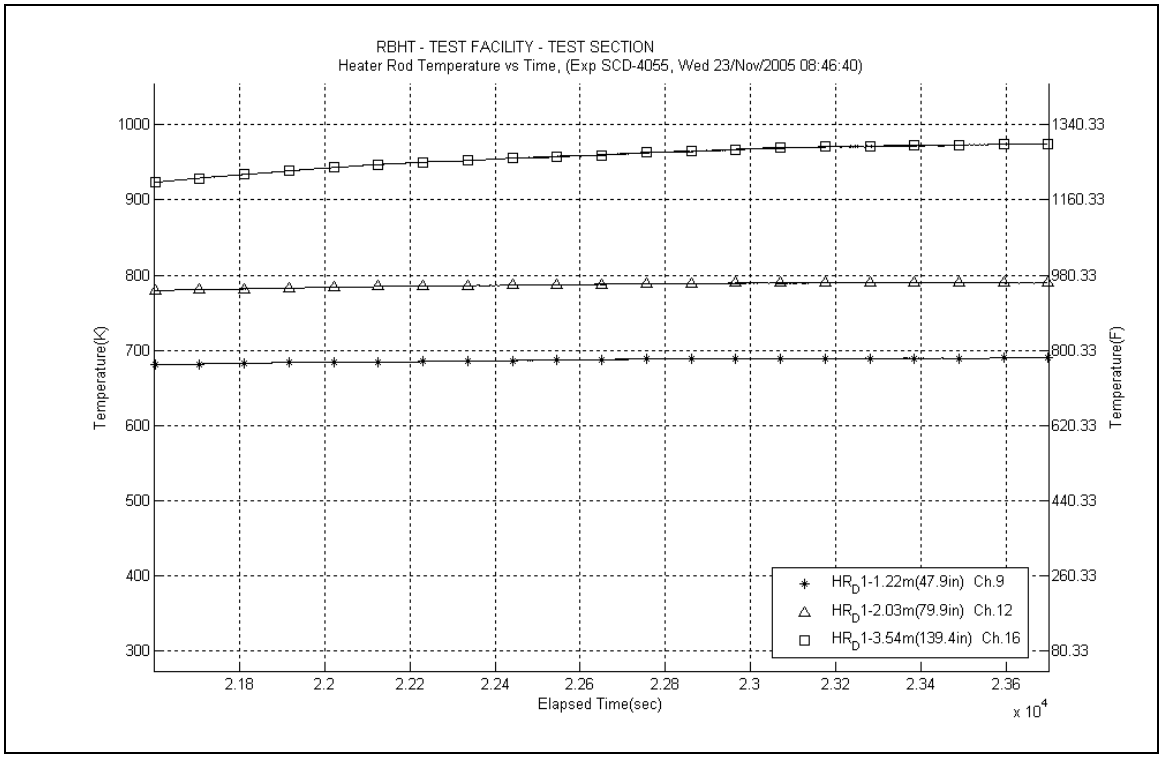

Figure A-641: Heater Rod D1 Temperatures for Experiment 4055D

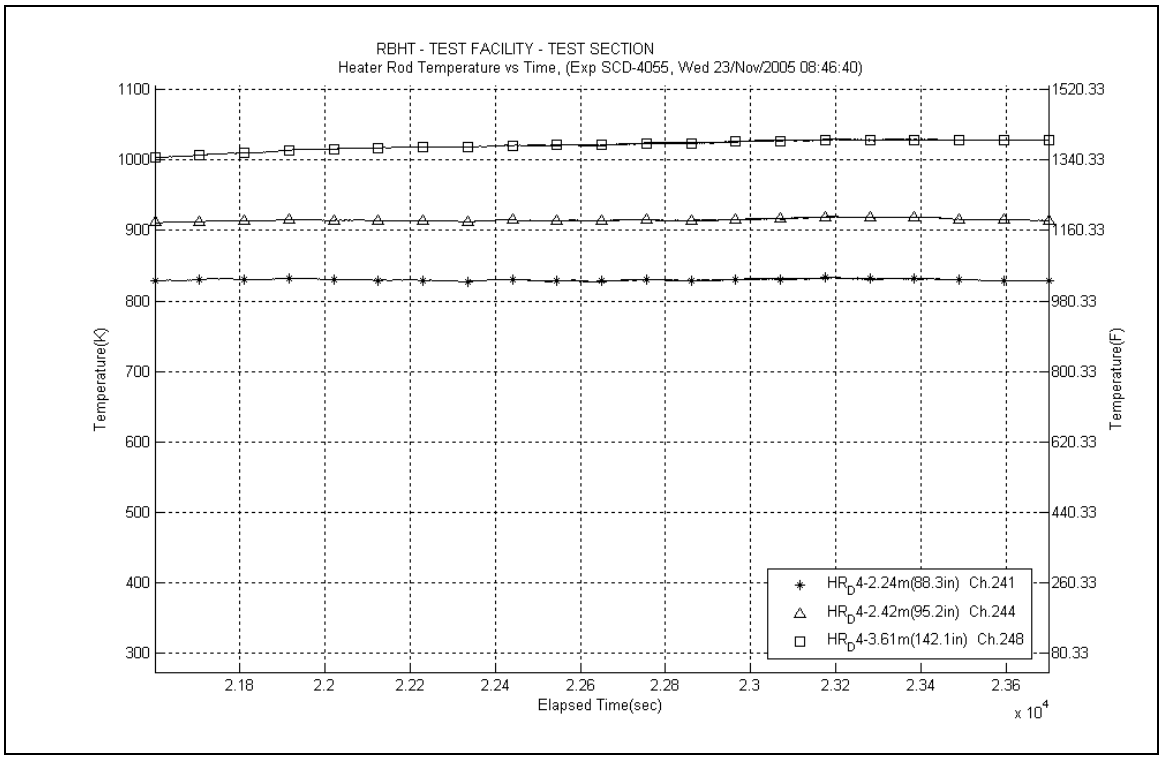

Figure A-642: Heater Rod D4 Temperatures for Experiment 4055D

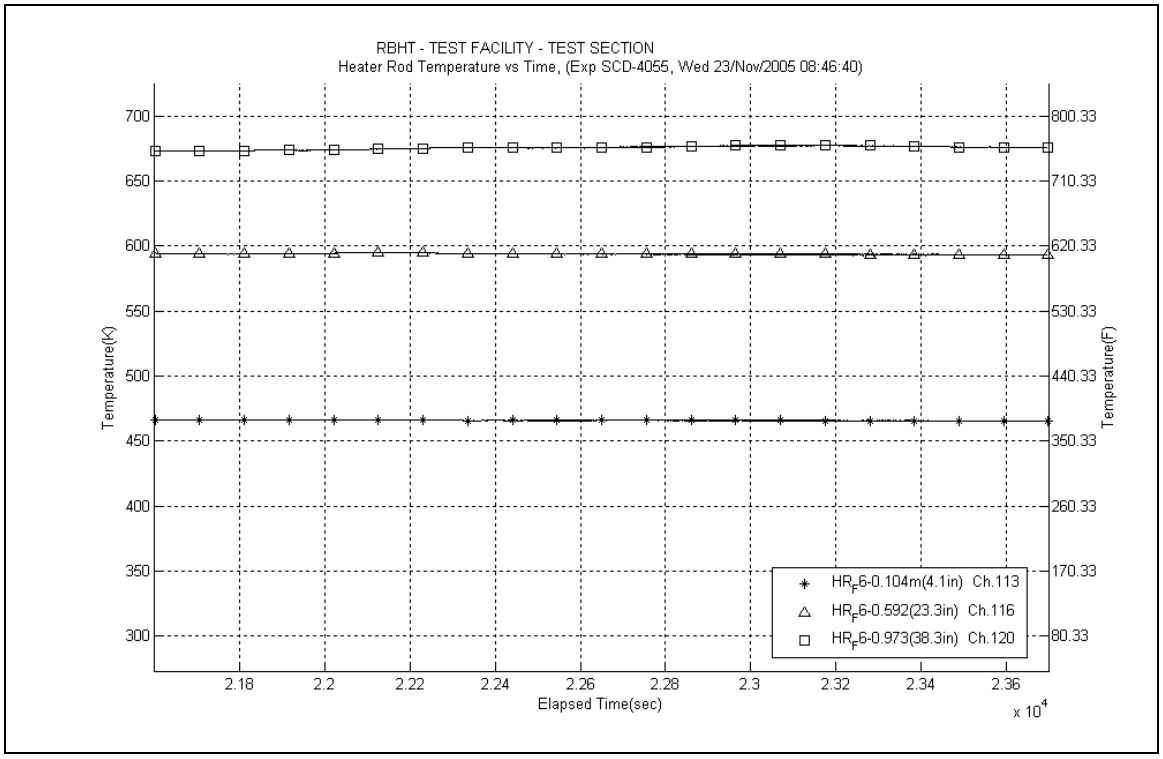

Figure A-643: Heater Rod F6 Temperatures for Experiment 4055D

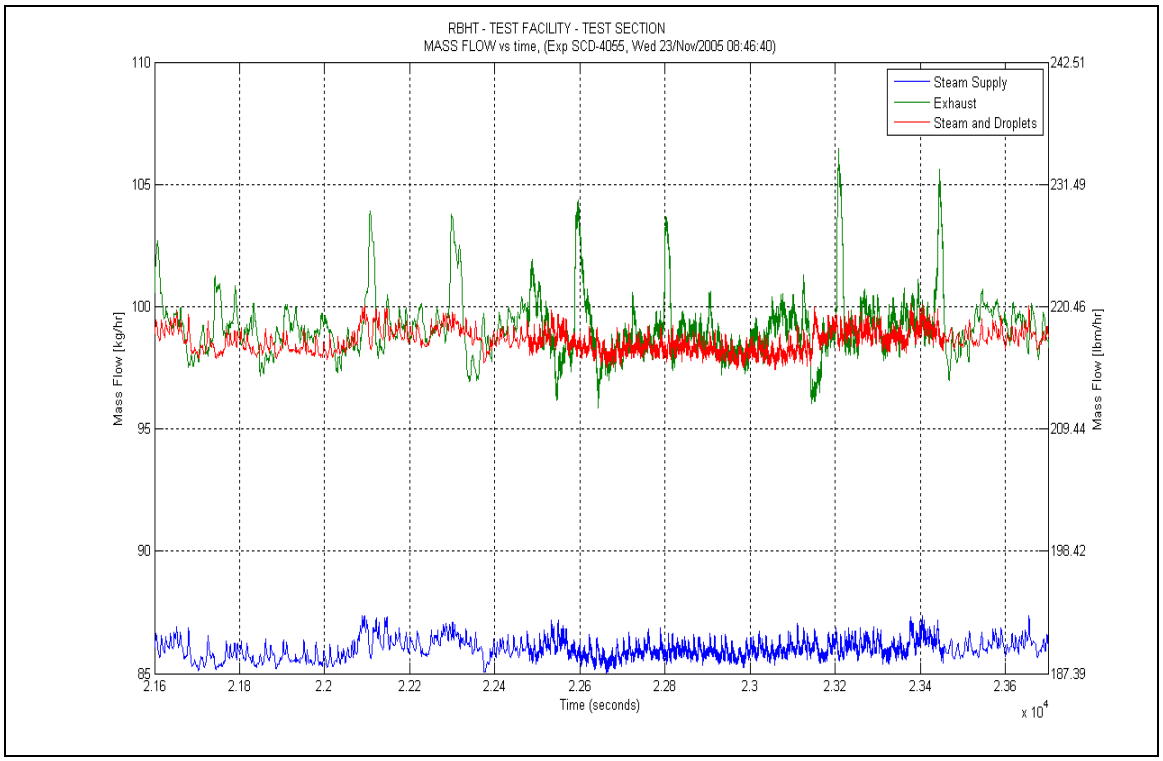

Figure A-644: Mass Flow for Experiment 4055D

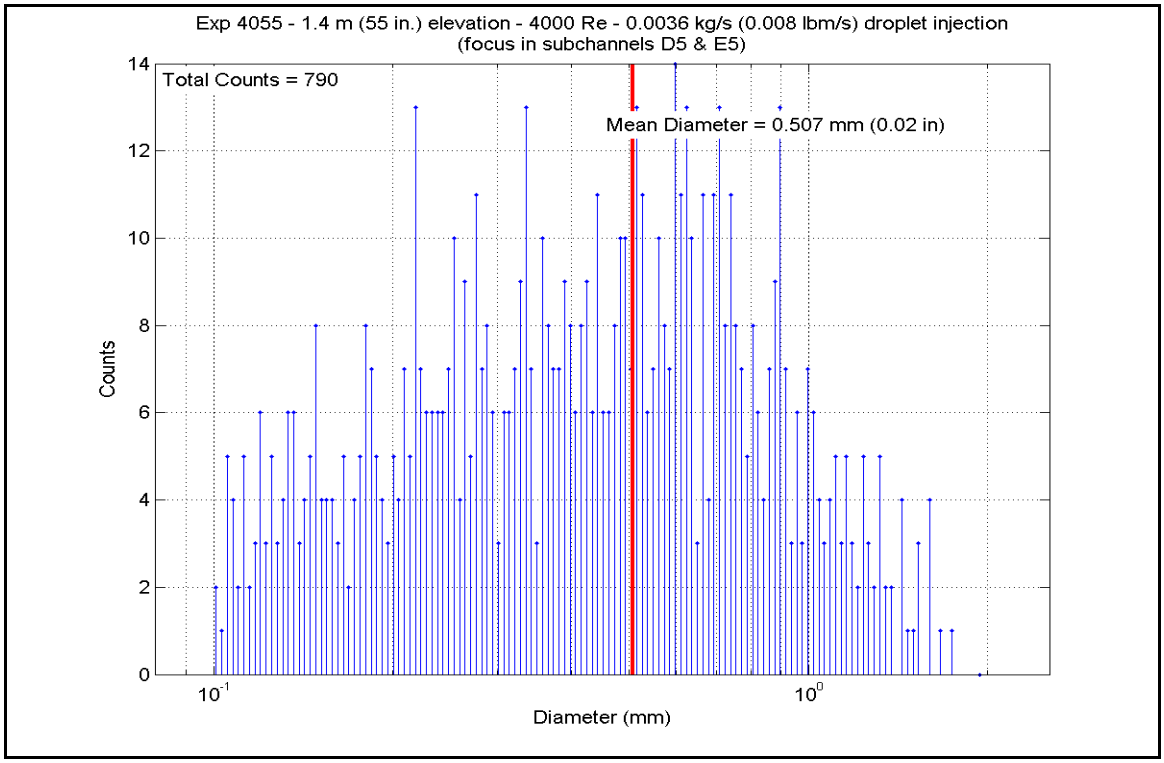

Figure A-645: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055D

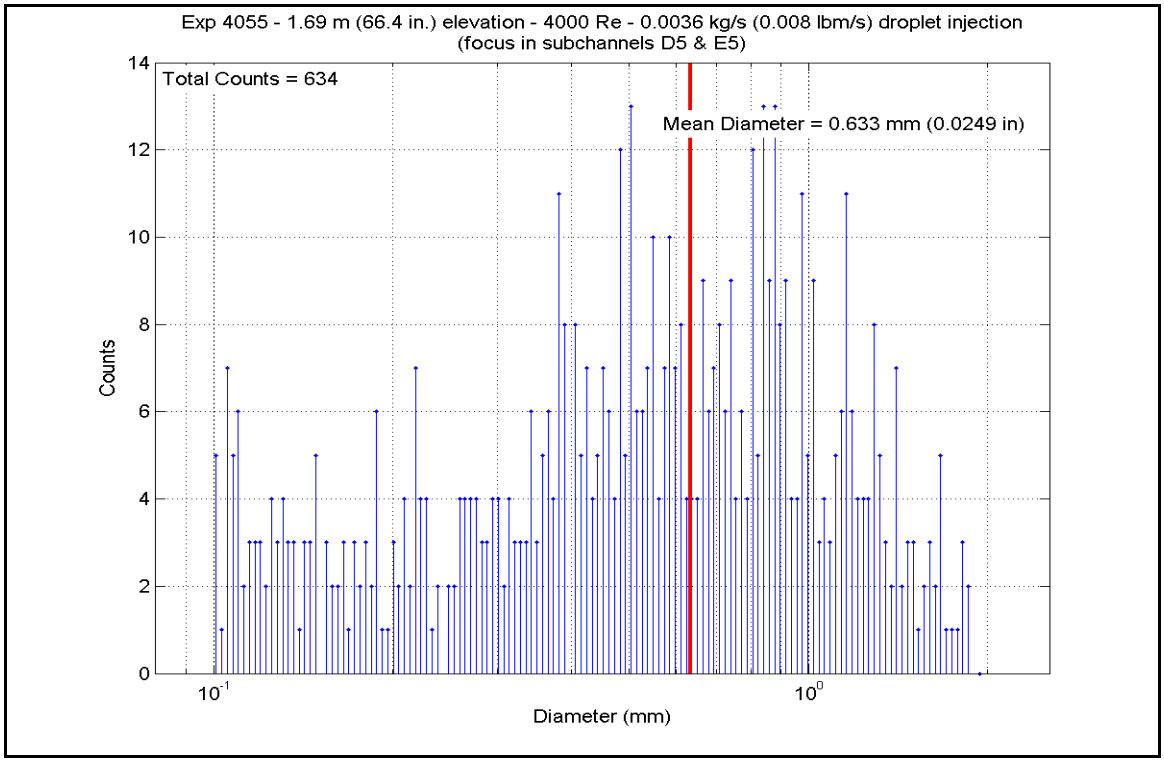

Figure A-646: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055D

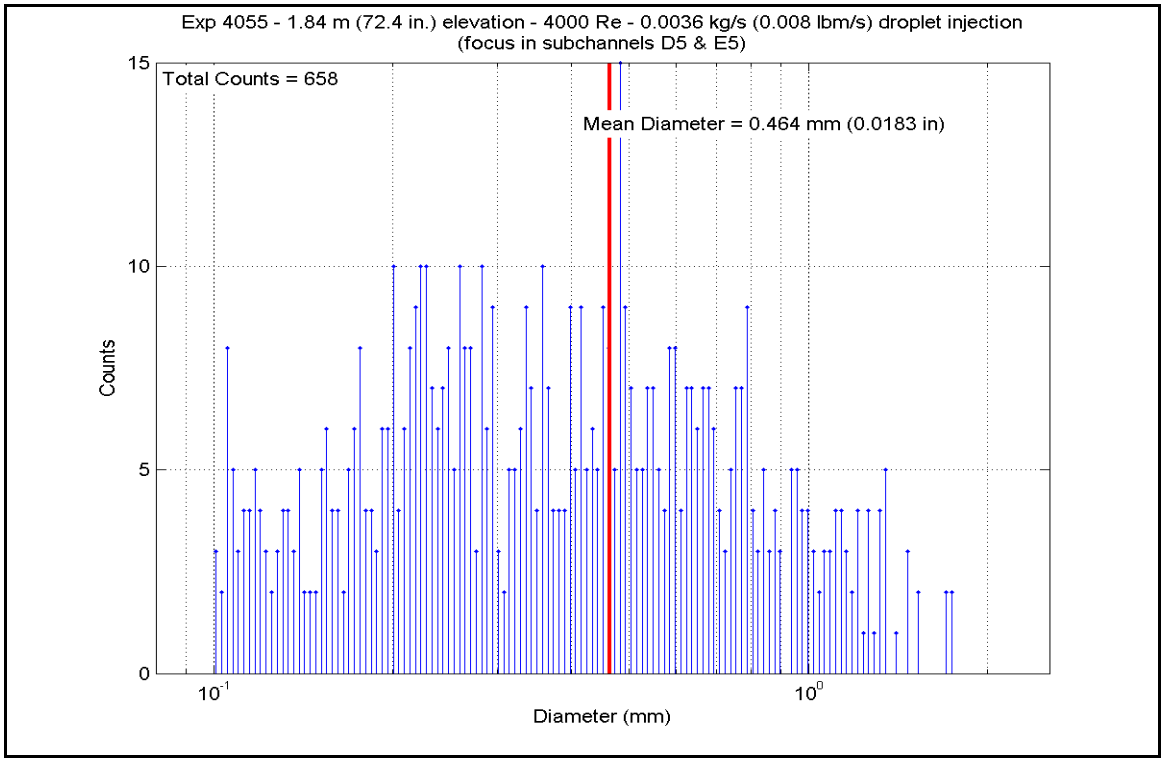

Figure A-647: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055D

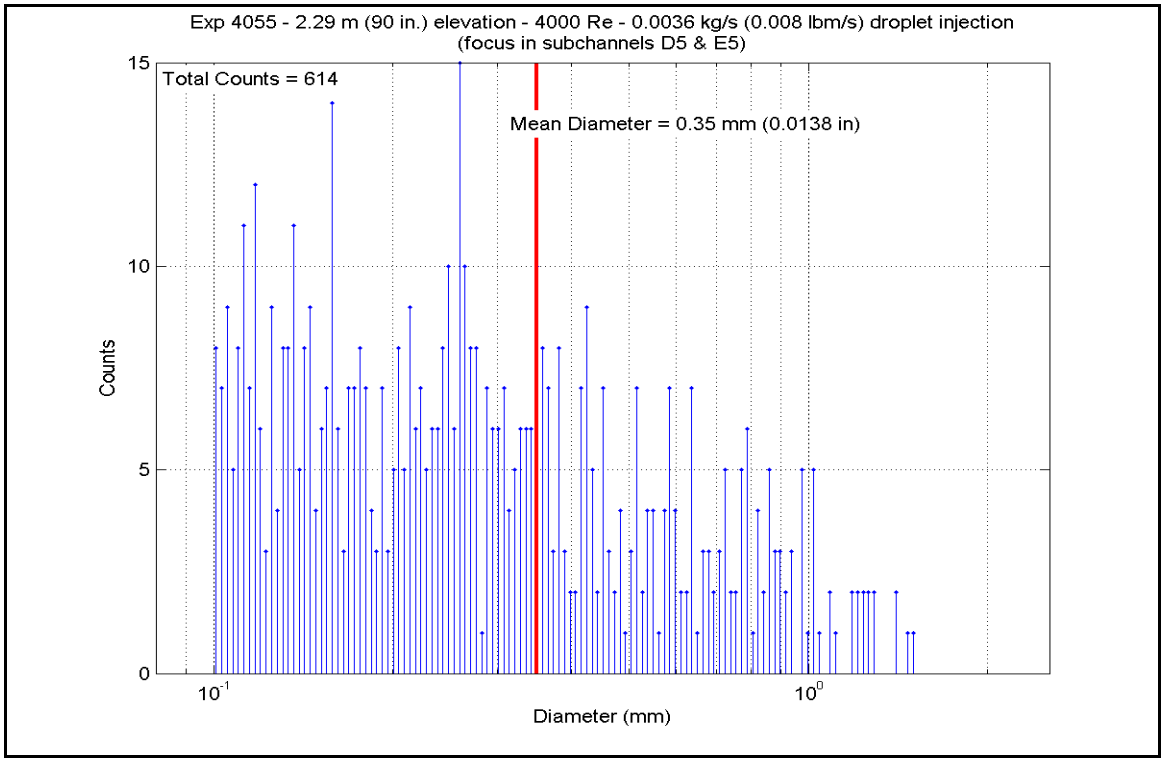

Figure A-648: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055D

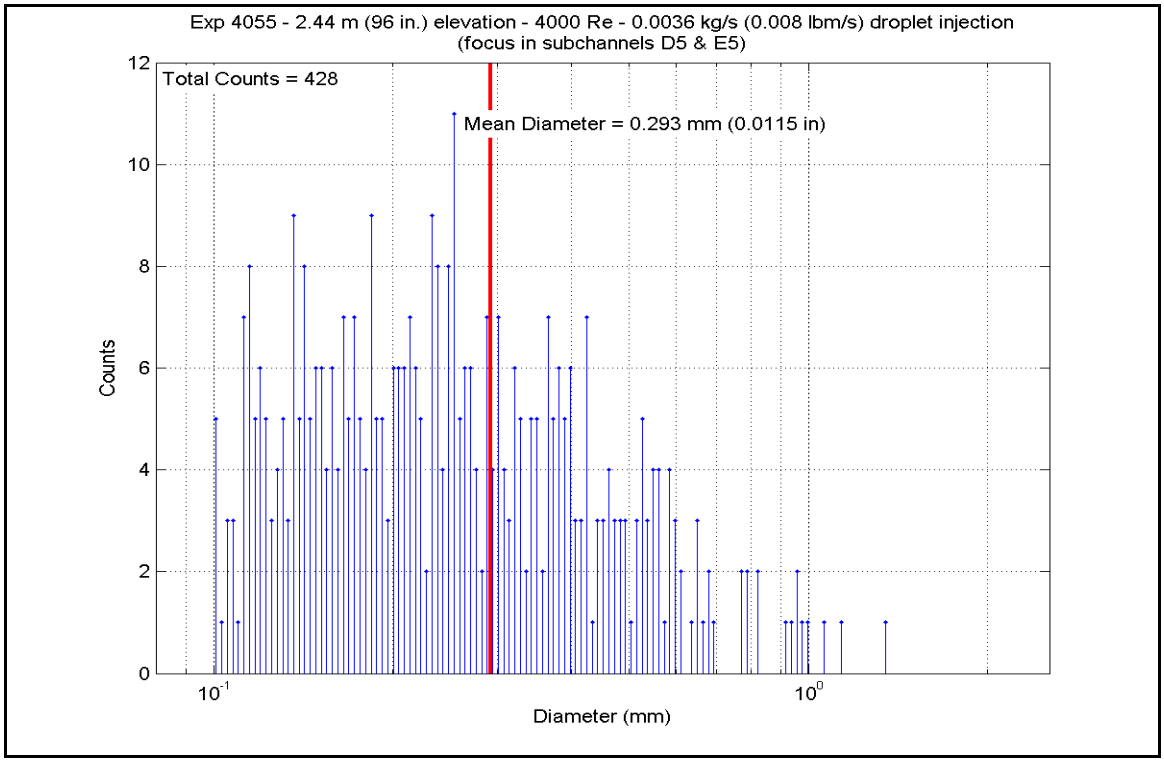

Figure A-649: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055D

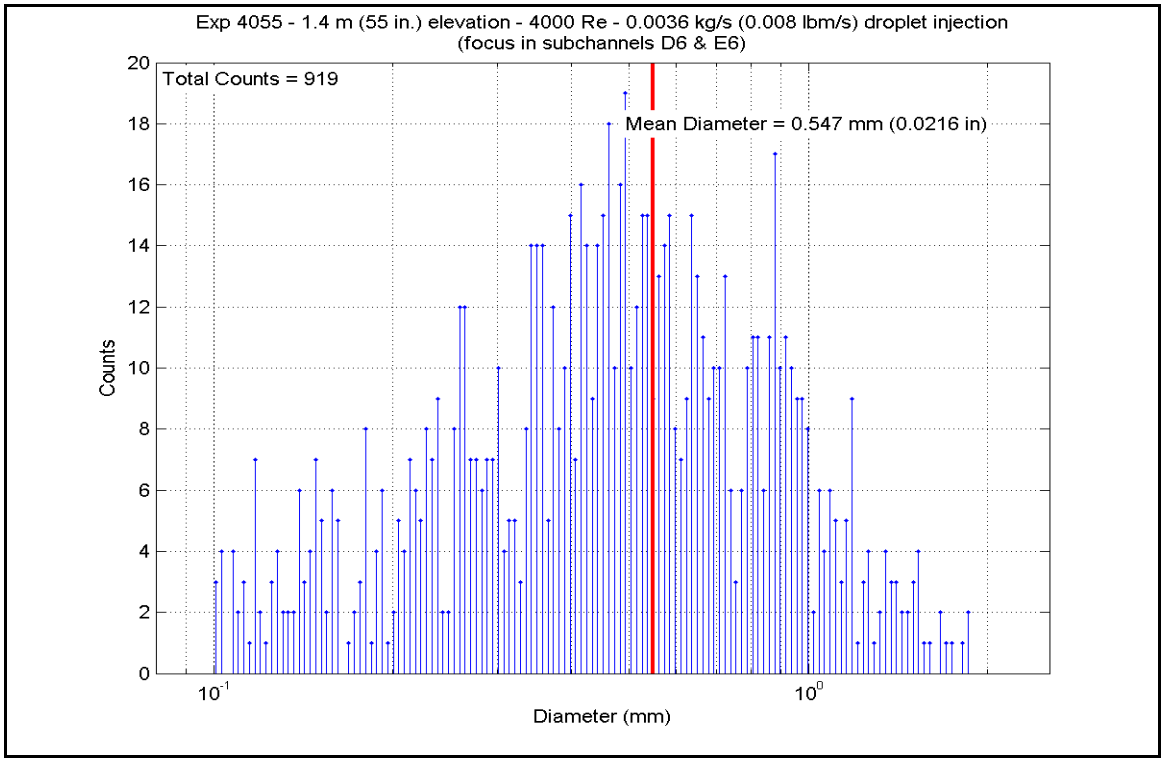

Figure A-650: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055D

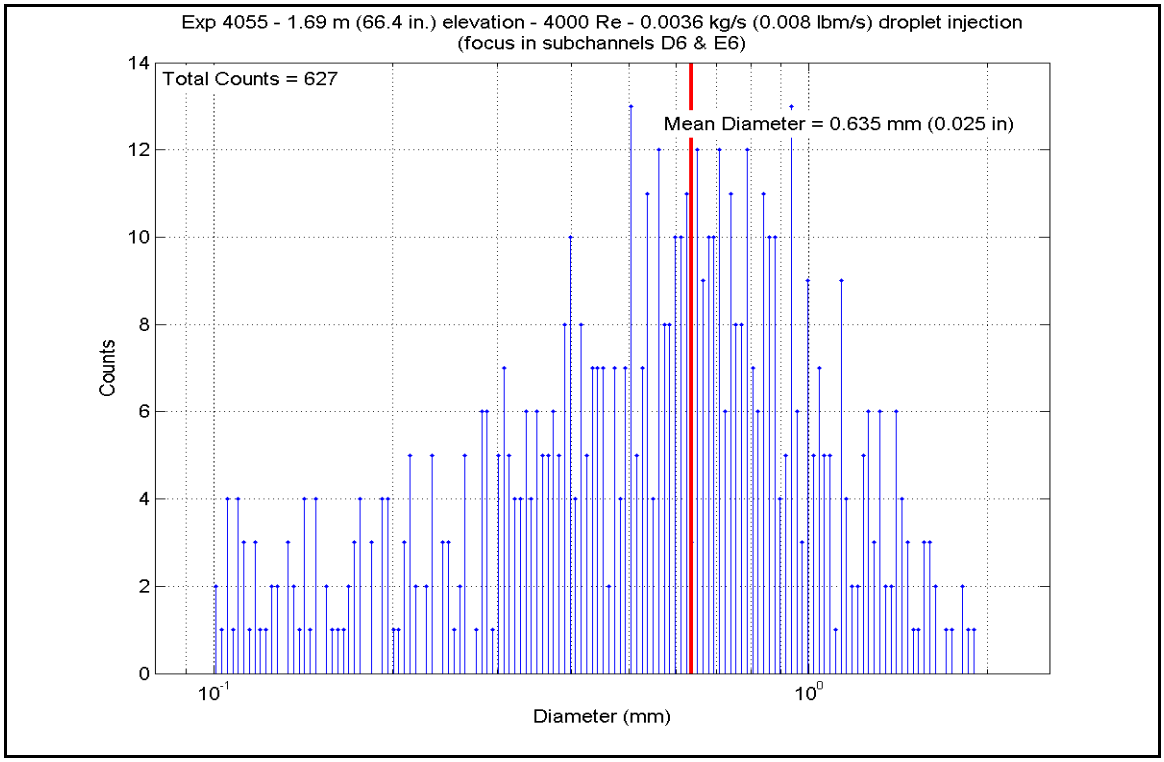

Figure A-651: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055D

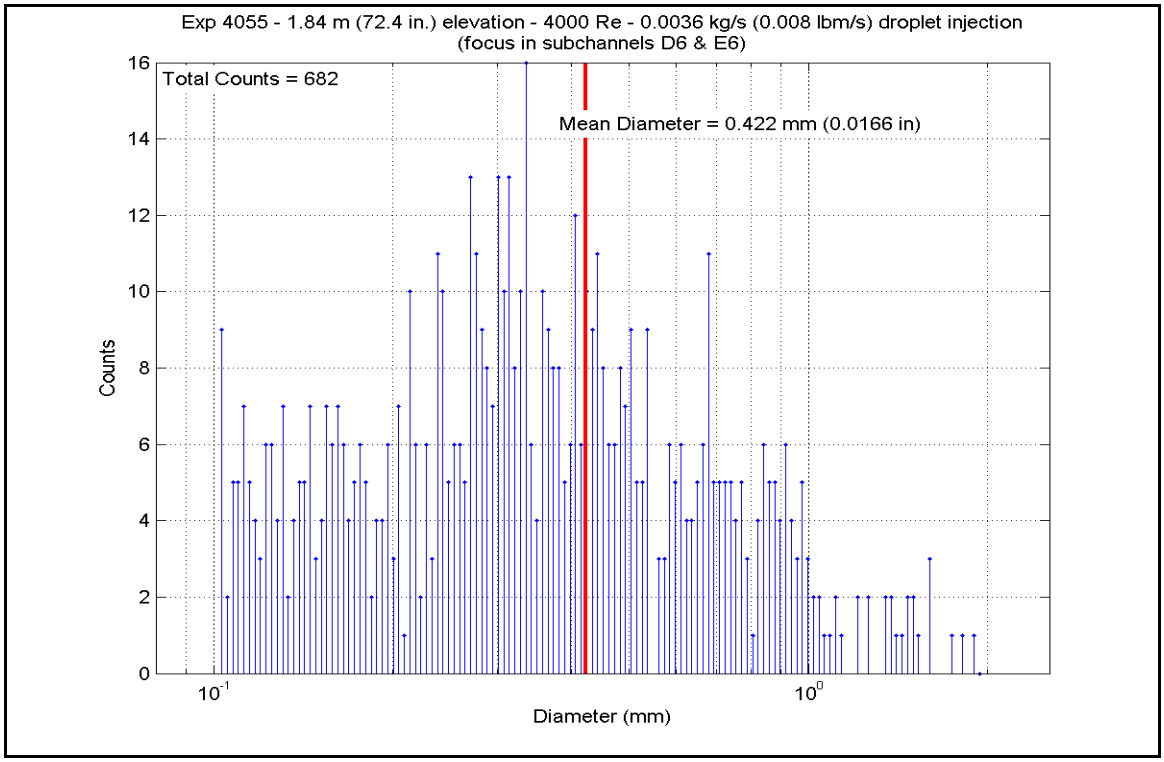

Figure A-652: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055D

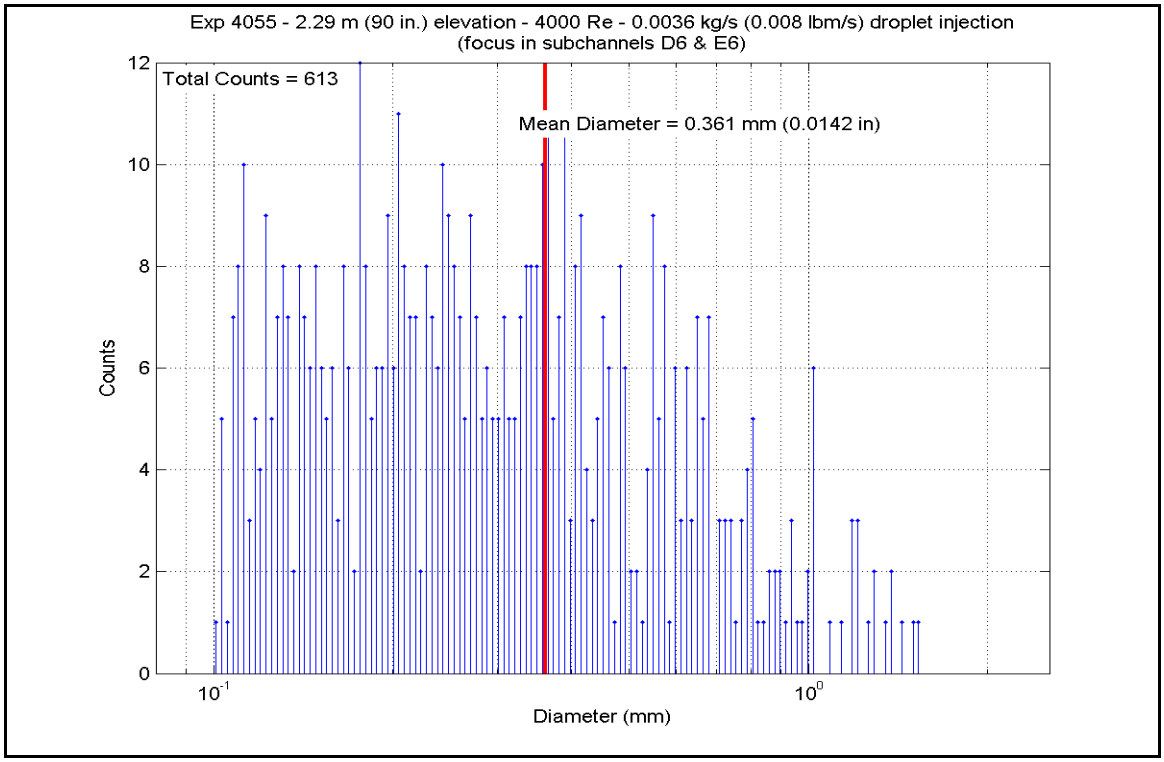

Figure A-653: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055D

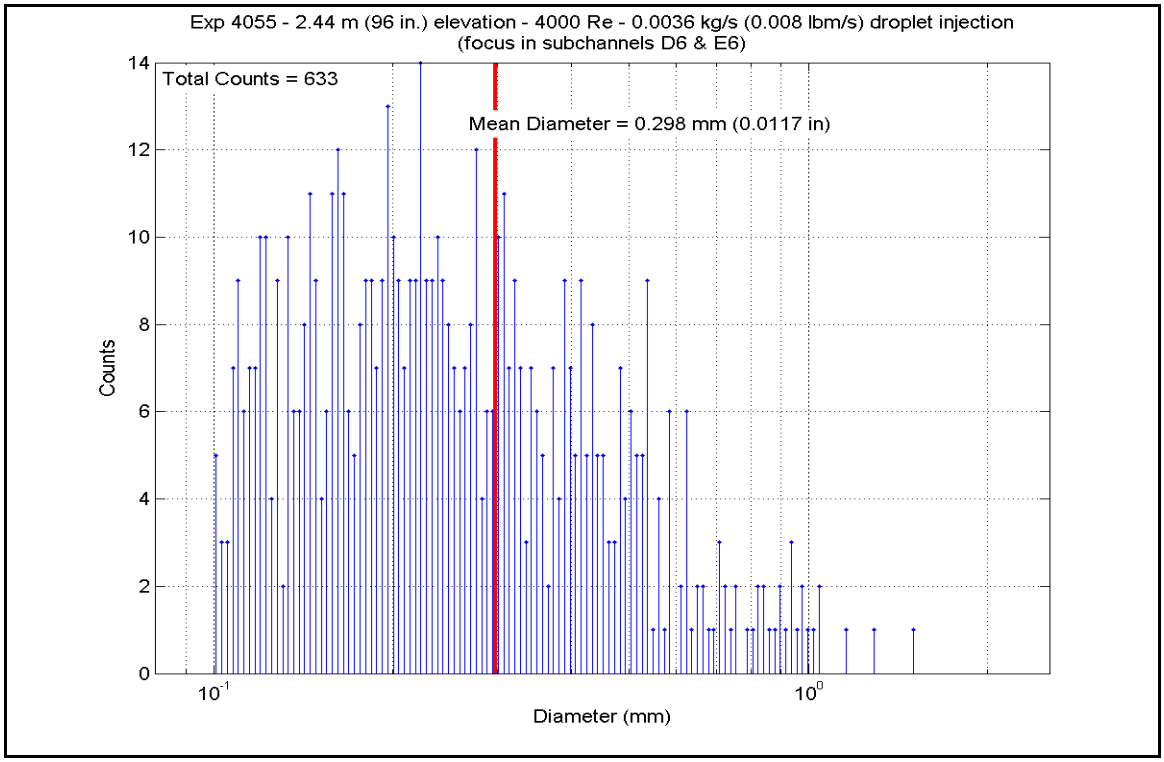

Figure A-654: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055D

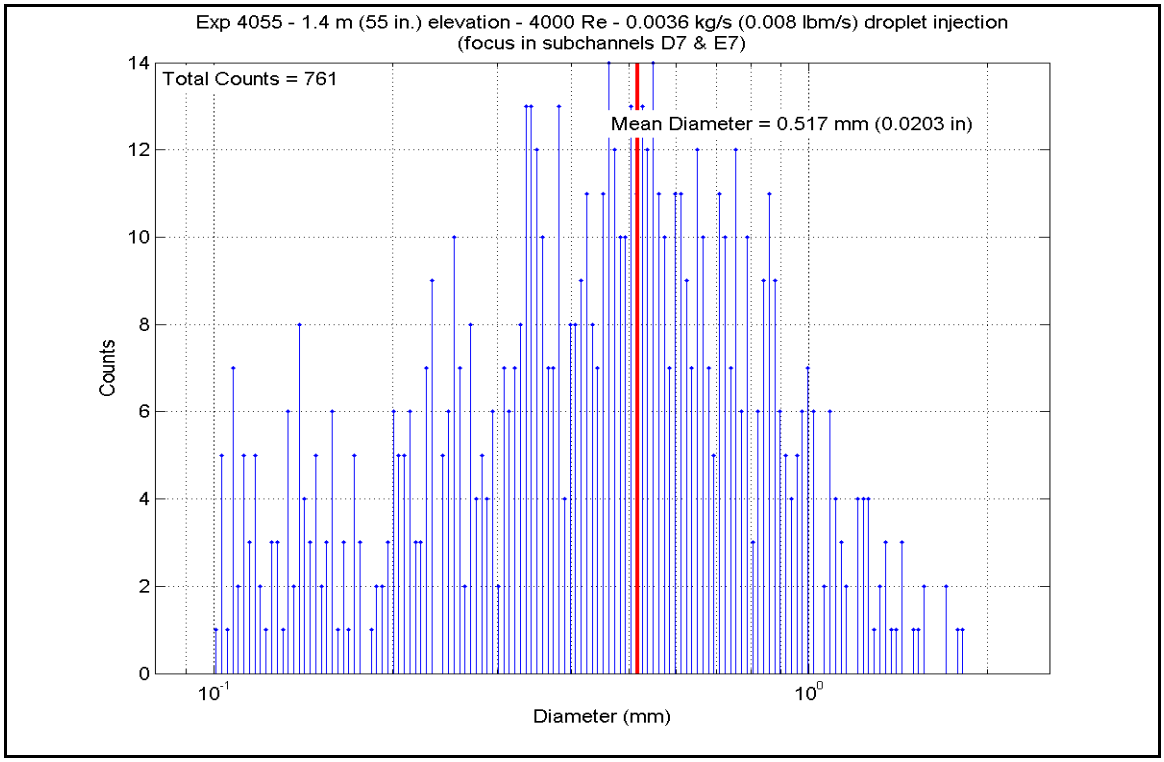

Figure A-655: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4055D

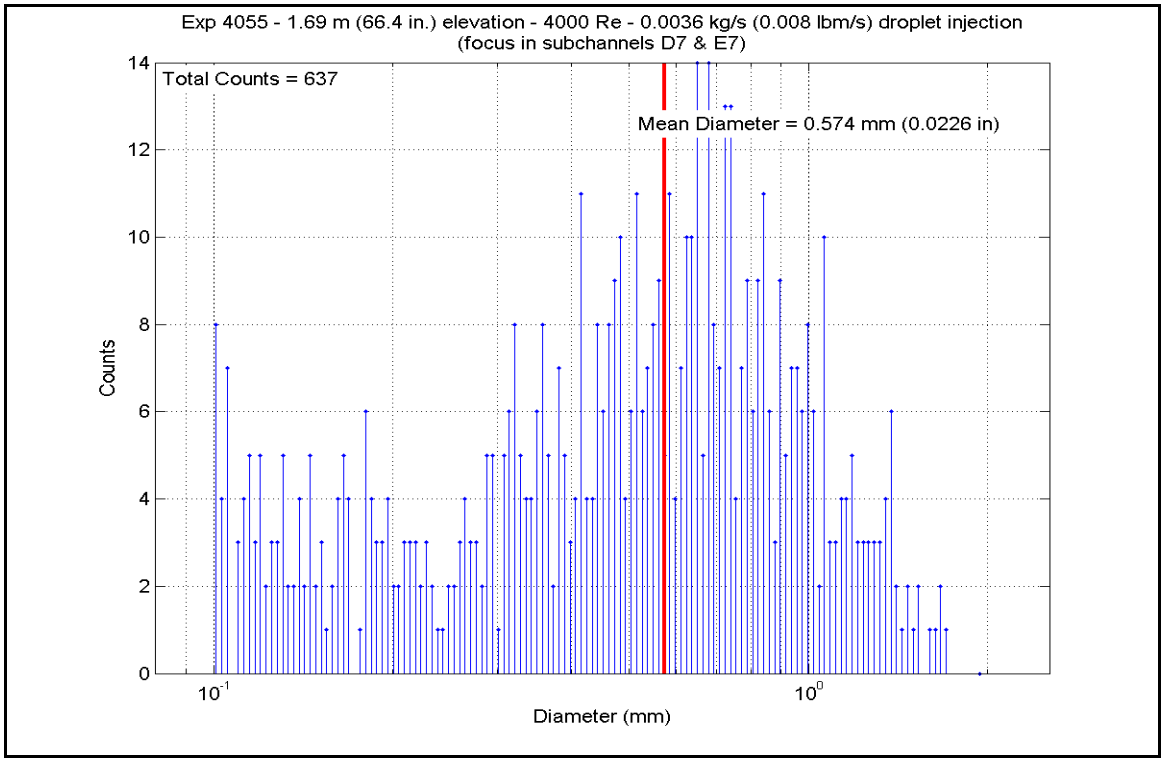

Figure A-656: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4055D

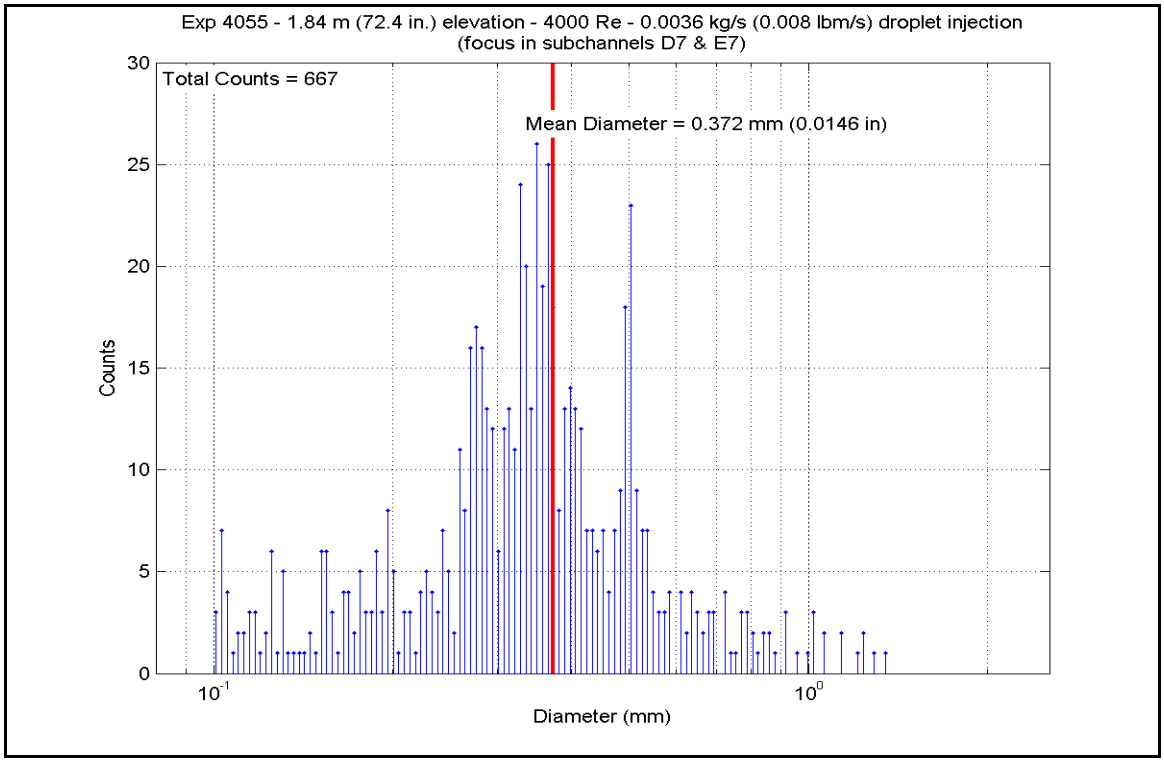

Figure A-657: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4055D

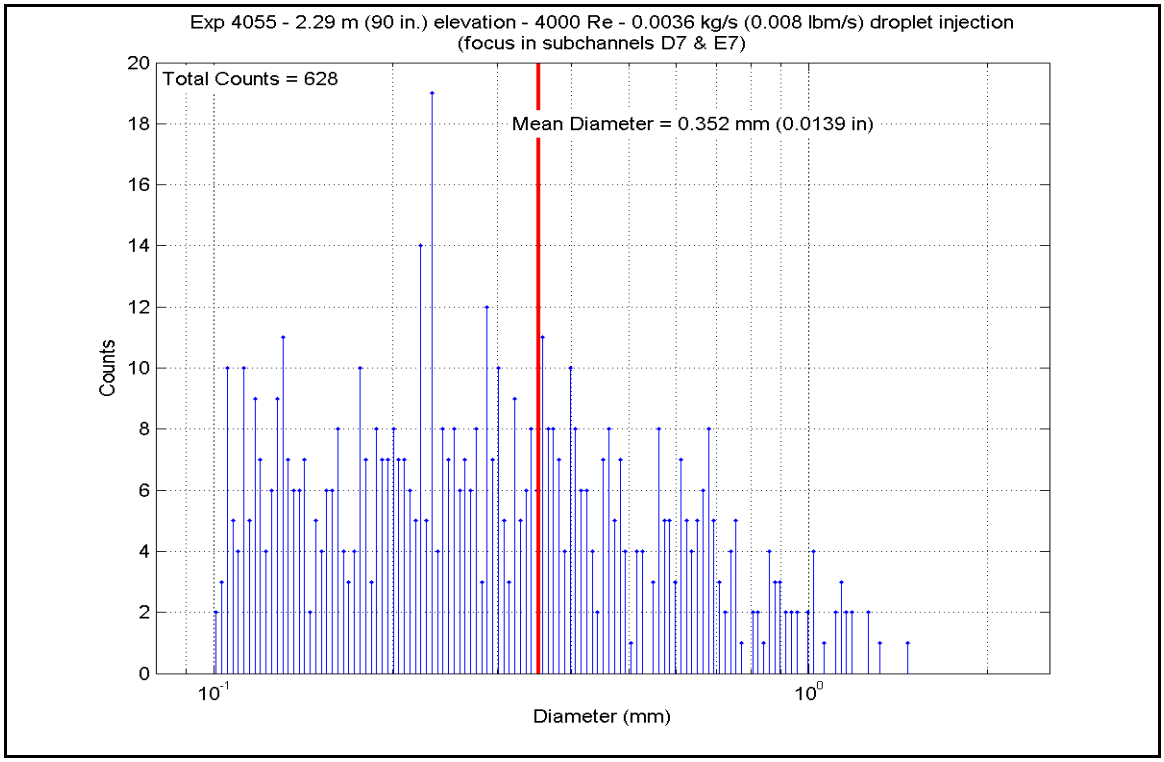

Figure A-658: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4055D

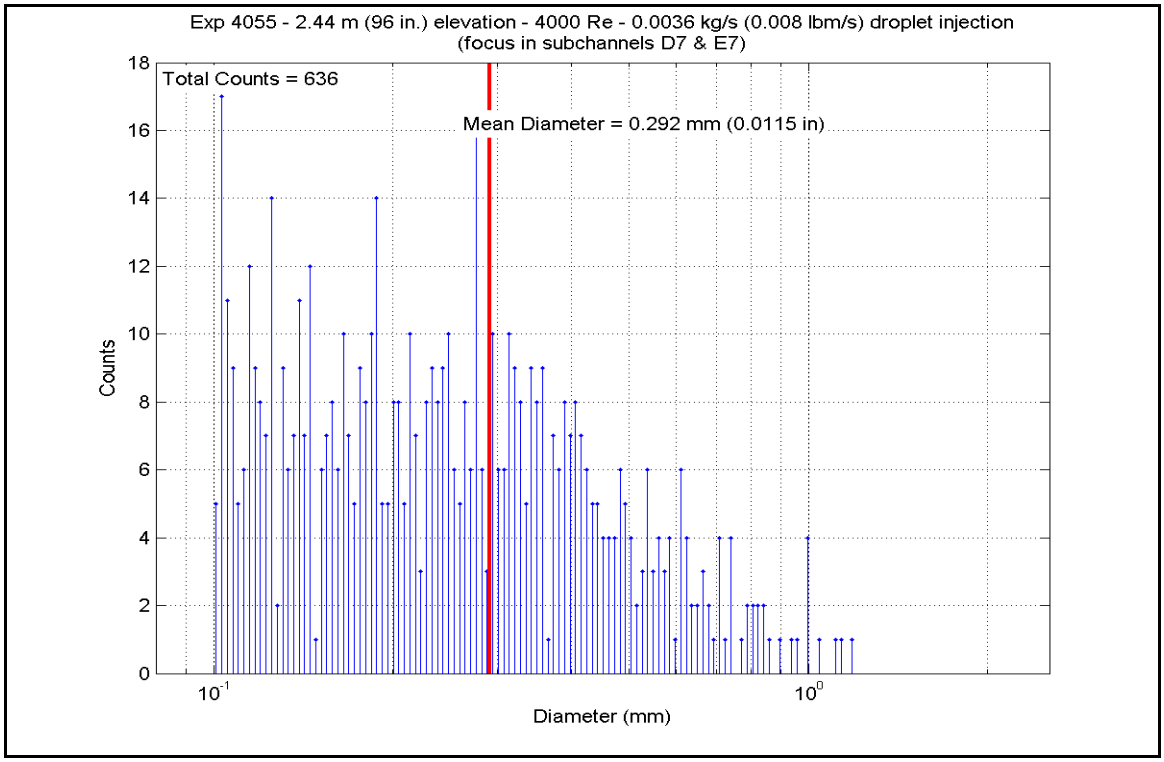

Figure A-659: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4055D

Table A-71: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055D

SCD-4055-D	Inlet Reynolds:	4000	
Matrix test # 13a	UP Pressure:	137.9 kPa	20 psia
Time Window 21600-23700	Bundle Power:	50.00 kW	170607 Btu/hr
	Steam flow:	0.0227 kg/s	180.0 lbm/hr
	Droplet flow:	0.0036 kg/s	0.008 lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	1023.36	823.9	4234.73	13358.4	5.324	30.2
	RodD3_91.3	186	91.3	2.319	2.8	0.071	1098.37	865.6	4323.22	13637.6	4.967	28.2
	RodD3_93.1	187	93.1	2.365	4.6	0.117	1134.78	885.8	4378.43	13811.8	4.829	27.4
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1181.89	912.0	4442.70	14014.5	4.657	26.4
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1317.39	987.3	4757.65	15008.0	4.367	24.8
	RodD3_110	191	110	2.794	21.5	0.546	1291.23	972.7	4700.20	14826.8	4.421	25.1
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1369.81	1016.4	1590.31	5016.6	1.393	7.9
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	1026.80	825.8	4288.22	13527.2	5.368	30.5
	RodC4_91.1	234	91.1	2.314	2.6	0.066	1095.81	864.2	4368.04	13779.0	5.033	28.6
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1137.81	887.5	4437.09	13996.8	4.877	27.7
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1180.90	911.4	4493.58	14175.0	4.716	26.8
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1260.29	955.5	4634.74	14620.3	4.490	25.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1306.26	981.1	4812.58	15181.3	4.463	25.3
	RodC4_110	239	110	2.794	21.5	0.546	1276.54	964.6	4658.09	14694.0	4.442	25.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1370.35	1016.7	1738.96	5485.6	1.522	8.6
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	1033.11	829.3	4274.54	13484.0	5.309	30.2
	RodD4_91.3	242	91.3	2.319	2.8	0.071	1106.01	869.8	4360.86	13756.3	4.967	28.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	1146.53	892.3	4417.77	13935.9	4.810	27.3
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1186.31	914.4	4477.06	14122.9	4.672	26.5
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1259.25	955.0	4620.96	14576.8	4.481	25.4
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1304.74	980.2	4798.21	15136.0	4.456	25.3
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1379.25	1021.6	1682.84	5308.5	1.462	8.3
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	1021.84	823.1	4201.42	13253.4	5.293	30.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	1091.68	861.9	4281.10	13504.7	4.957	28.1
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1169.00	904.8	4398.43	13874.8	4.674	26.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1239.29	943.9	4558.87	14381.0	4.508	25.6
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1365.35	1013.9	1691.16	5334.8	1.487	8.4

Table A-71: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	1034.07	829.9	3482.57	10985.8	4.320	24.5
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1310.73	983.6	4273.24	13479.9	3.947	22.4
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1339.61	999.6	4112.59	12973.2	3.700	21.0
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1367.28	1015.0	3857.11	12167.3	3.386	19.2
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1386.74	1025.8	3499.73	11039.9	3.020	17.2
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1391.27	1028.3	3176.74	10021.0	2.731	15.5
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1361.93	1012.0	2740.58	8645.2	2.417	13.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1365.76	1014.1	2402.22	7577.8	2.111	12.0
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	1029.15	827.1	3426.41	10808.6	4.277	24.3
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1279.89	966.4	4168.68	13150.1	3.963	22.5
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1312.88	984.7	4011.79	12655.2	3.698	21.0
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1359.96	1010.9	3445.82	10869.8	3.044	17.3
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1368.15	1015.5	3123.76	9853.9	2.740	15.6
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1339.91	999.8	2736.84	8633.4	2.461	14.0
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1355.21	1008.3	2396.64	7560.2	2.126	12.1
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	976.54	797.9	3498.94	11037.4	4.674	26.5
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1209.68	927.4	4307.99	13589.6	4.388	24.9
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1249.32	949.4	4162.20	13129.7	4.075	23.1
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1291.02	972.6	3885.54	12256.9	3.655	20.8
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1321.22	989.4	3559.15	11227.3	3.256	18.5
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1336.01	997.6	3225.68	10175.4	2.911	16.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1371.76	1017.5	2803.43	8843.4	2.451	13.9
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1367.64	1015.2	2473.56	7802.8	2.170	12.3
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	992.40	806.7	3958.11	12485.8	5.178	29.4
	RodC3_85.6	178	85.6	2.174	14.72	0.374	1006.19	814.4	4129.68	13027.1	5.307	30.1
	RodC3_88.5	179	88.5	2.248	0	0.000	1019.15	821.6	4213.04	13290.0	5.325	30.2
	RodC3_92.4	180	92.4	2.347	3.9	0.099	1107.10	870.4	4329.38	13657.0	4.925	28.0
	RodC3_94.4	181	94.4	2.398	5.9	0.150	1141.52	889.6	4389.11	13845.4	4.805	27.3
Gr-8	RodD5_50	217	50	1.270	3	0.076	872.88	740.3	3089.99	9747.4	4.792	27.2
	RodD5_54.1	218	54.1	1.374	7.1	0.180	900.11	755.4	3206.44	10114.7	4.771	27.1
	RodD5_56.9	219	56.9	1.445	9.9	0.251	949.34	782.8	3295.63	10396.1	4.569	25.9
	RodD5_60	220	60	1.524	13	0.330	989.77	805.2	3391.79	10699.4	4.453	25.3
	RodD5_66.1	221	66.1	1.679	19.1	0.485	1020.85	822.5	3583.89	11305.4	4.520	25.7
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	775.86	686.4	3705.36	11688.6	6.763	38.4
	RodD5_72.9	223	72.9	1.852	2.02	0.051	865.45	736.2	3781.02	11927.2	5.931	33.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	914.46	763.4	3838.21	12107.6	5.591	31.8

Table A-71: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	821.24	711.6	2811.20	8867.9	4.739	26.9
	RodB5_52.9	154	52.9	1.344	5.9	0.150	872.77	740.2	3159.43	9966.4	4.900	27.8
	RodB5_55	155	55	1.397	8	0.203	917.94	765.3	3226.56	10178.2	4.677	26.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	970.04	794.3	3312.63	10449.7	4.464	25.4
	RodB5_64	157	64	1.626	17	0.432	1029.44	827.3	3502.20	11047.7	4.370	24.8
	RodB5_73.9	158	73.9	1.877	3.02	0.077	876.35	742.2	3797.53	11979.3	5.857	33.3
	RodB5_75.9	159	75.9	1.928	5.02	0.128	918.92	765.9	3856.82	12166.4	5.582	31.7
	RodB5_76.9	160	76.9	1.953	6.02	0.153	935.83	775.3	3886.22	12259.1	5.490	31.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	807.66	704.1	2789.83	8800.5	4.813	27.3
	RodF5_53.1	106	53.1	1.349	6.1	0.155	853.00	729.3	3151.41	9941.1	5.042	28.6
	RodF5_55	107	55	1.397	8	0.203	896.04	753.2	3207.10	10116.8	4.801	27.3
	RodF5_57.8	108	57.8	1.468	10.8	0.274	948.15	782.1	3290.76	10380.7	4.570	26.0
	RodF5_64	109	64	1.626	17	0.432	1012.22	817.7	3476.74	10967.4	4.433	25.2
	RodF5_73.8	110	73.8	1.875	2.92	0.074	871.80	739.7	3774.72	11907.4	5.863	33.3
	RodF5_75.8	111	75.8	1.925	4.92	0.125	910.04	760.9	3832.94	12091.0	5.620	31.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	925.80	769.7	3862.31	12183.7	5.535	31.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	826.34	714.5	2804.89	8848.0	4.688	26.6
	RodC2_53.1	58	53.1	1.349	6.1	0.155	903.77	757.5	3169.31	9997.6	4.690	26.6
	RodC2_55	59	55	1.397	8	0.203	932.69	773.5	3225.86	10176.0	4.578	26.0
	RodC2_57.8	60	57.8	1.468	10.8	0.274	976.24	797.7	3308.69	10437.3	4.422	25.1
	RodC2_63.9	61	63.9	1.623	16.9	0.429	1028.02	826.5	3489.81	11008.6	4.362	24.8
	RodC2_73.8	62	73.8	1.875	2.92	0.074	880.61	744.6	3787.04	11946.2	5.803	33.0
	RodC2_75.8	63	75.8	1.925	4.92	0.125	915.69	764.1	3845.32	12130.1	5.592	31.8
	RodC2_76.8	64	76.8	1.951	5.92	0.150	931.64	772.9	3874.70	12222.7	5.507	31.3
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	822.25	712.2	2792.60	8809.3	4.699	26.7
	RodC6_52.8	138	52.8	1.341	5.8	0.147	890.29	750.0	3157.46	9960.2	4.768	27.1
	RodC6_54.8	139	54.8	1.392	7.8	0.198	920.43	766.7	3223.48	10168.5	4.655	26.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	953.00	784.8	3318.62	10468.6	4.577	26.0
	RodC6_63.8	141	63.8	1.621	16.8	0.427	1008.21	815.5	3510.65	11074.3	4.500	25.6
	RodC6_73.7	142	73.7	1.872	2.82	0.072	878.82	743.6	3820.41	12051.5	5.870	33.3
	RodC6_75.8	143	75.8	1.925	4.92	0.125	912.47	762.3	3883.80	12251.5	5.674	32.2
	RodC6_76.8	144	76.8	1.951	5.92	0.150	931.75	773.0	3914.48	12348.2	5.562	31.6

Table A-71: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	1008.28	815.5	4196.32	13237.3	5.378	30.5
	RodB4_91.3	162	91.3	2.319	2.8	0.071	1079.39	855.0	4280.89	13504.1	5.028	28.6
	RodB4_93.3	163	93.3	2.370	4.8	0.122	1109.11	871.5	4336.51	13679.5	4.922	27.9
	RodB4_95.1	164	95.1	2.416	6.6	0.168	1136.25	886.6	4386.03	13835.7	4.829	27.4
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1330.86	994.7	1709.55	5392.8	1.550	8.8
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	1006.86	814.7	4140.36	13060.8	5.316	30.2
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	1007.05	814.8	4220.31	13313.0	5.417	30.8
	RodF4_92.4	100	92.4	2.347	3.9	0.099	1101.65	867.4	4334.74	13673.9	4.962	28.2
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1134.95	885.9	4389.88	13847.9	4.840	27.5
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1300.40	977.8	4151.18	13094.9	3.871	22.0
	RodD2_106	66	106	2.692	17.5	0.445	1322.82	990.3	3926.34	12385.6	3.586	20.4
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1350.88	1005.9	3619.34	11417.2	3.223	18.3
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1365.80	1014.1	3259.24	10281.3	2.865	16.3
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1367.40	1015.0	2921.42	9215.6	2.564	14.6
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1265.87	958.6	4168.86	13150.7	4.017	22.8
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1282.16	967.7	3995.04	12602.4	3.790	21.5
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1304.48	980.1	3629.64	11449.7	3.372	19.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1312.99	984.8	3277.44	10338.7	3.021	17.2
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1319.29	988.3	2925.30	9227.9	2.681	15.2

Table A-71: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4055, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	879.86	744.2	3098.42	9774.0	4.753	27.0
	RodE2_54	74	54	1.372	7	0.178	912.23	762.2	3217.83	10150.6	4.703	26.7
	RodE2_56.9	75	56.9	1.445	9.9	0.251	960.71	789.1	3304.32	10423.5	4.510	25.6
	RodE2_59.9	76	59.9	1.521	12.9	0.328	1003.72	813.0	3393.95	10706.2	4.375	24.8
	RodE2_66	77	66	1.676	19	0.483	1026.97	825.9	3581.84	11298.9	4.483	25.5
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	773.15	684.9	3716.08	11722.4	6.817	38.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	869.03	738.2	3790.88	11958.3	5.914	33.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	907.76	759.7	3848.78	12141.0	5.662	32.2
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	839.76	721.9	3085.33	9732.7	5.043	28.6
	RodB3_54.1	170	54.1	1.374	7.1	0.180	874.28	741.1	3194.23	10076.2	4.943	28.1
	RodB3_56.9	171	56.9	1.445	9.9	0.251	934.12	774.3	3277.32	10338.3	4.641	26.4
	RodB3_60.1	172	60.1	1.527	13.1	0.333	936.65	775.7	3372.06	10637.2	4.758	27.0
	RodB3_66.1	173	66.1	1.679	19.1	0.485	995.99	808.7	3550.55	11200.2	4.623	26.3
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	785.20	691.6	3666.91	11567.3	6.581	37.4
	RodB3_73	175	73	1.854	2.12	0.054	841.79	723.0	3762.65	11869.3	6.130	34.8
	RodB3_75	176	75	1.905	4.12	0.105	880.13	744.3	3821.62	12055.3	5.860	33.3
Gr-8	RodF3_50.1	89	50.1	1.273	3.1	0.079	869.48	738.4	3081.02	9719.1	4.803	27.3
	RodF3_54	90	54	1.372	7	0.178	899.93	755.3	3197.23	10085.7	4.758	27.0
	RodF3_57	91	57	1.448	10	0.254	955.70	786.3	3288.19	10372.6	4.519	25.7
	RodF3_60	92	60	1.524	13	0.330	1000.54	811.2	3379.71	10661.3	4.375	24.8
	RodF3_66.1	93	66.1	1.679	19.1	0.485	1031.08	828.2	3568.89	11258.1	4.444	25.2
	RodF3_70	94	70	1.778	-0.88	-0.022	814.02	707.6	3697.57	11664.0	6.310	35.8
	RodF3_73	95	73	1.854	2.12	0.054	885.96	747.6	3782.11	11930.7	5.748	32.6
	RodF3_75	96	75	1.905	4.12	0.105	925.47	769.5	3840.39	12114.5	5.506	31.3
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	838.37	721.1	3085.14	9732.1	5.055	28.7
	RodE6_54.1	122	54.1	1.374	7.1	0.180	881.58	745.1	3197.41	10086.2	4.892	27.8
	RodE6_57	123	57	1.448	10	0.254	918.92	765.9	3282.36	10354.2	4.751	27.0
	RodE6_60.2	124	60.2	1.529	13.2	0.335	959.59	788.5	3377.94	10655.7	4.617	26.2
	RodE6_66.1	125	66.1	1.679	19.1	0.485	977.39	798.4	3551.84	11204.3	4.740	26.9
	RodE6_70	126	70	1.778	-0.88	-0.022	762.96	679.2	3670.15	11577.5	6.861	39.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	839.85	722.0	3760.75	11863.3	6.147	34.9
	RodE6_75	128	75	1.905	4.12	0.105	879.57	744.0	3816.54	12039.3	5.857	33.3

RBHT Steam Cooling with Droplet Injection Test SCD-4076-A

Matrix Test # 14a

Test Conditions

Test Date – 12/13/2005
Steady State Time Window: 12120 - 18300
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0036 kg/s (0.008 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

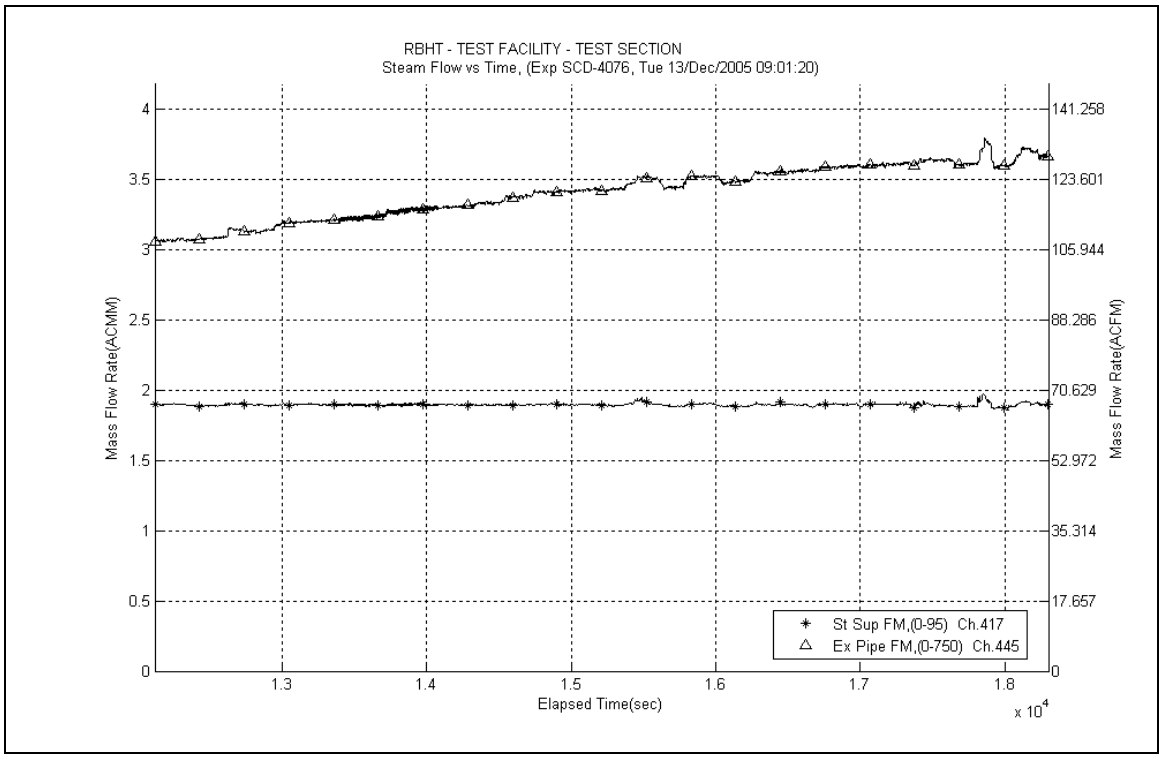

Figure A-660: Inlet and Exhaust Steam Flow Rates for Experiment 4076A

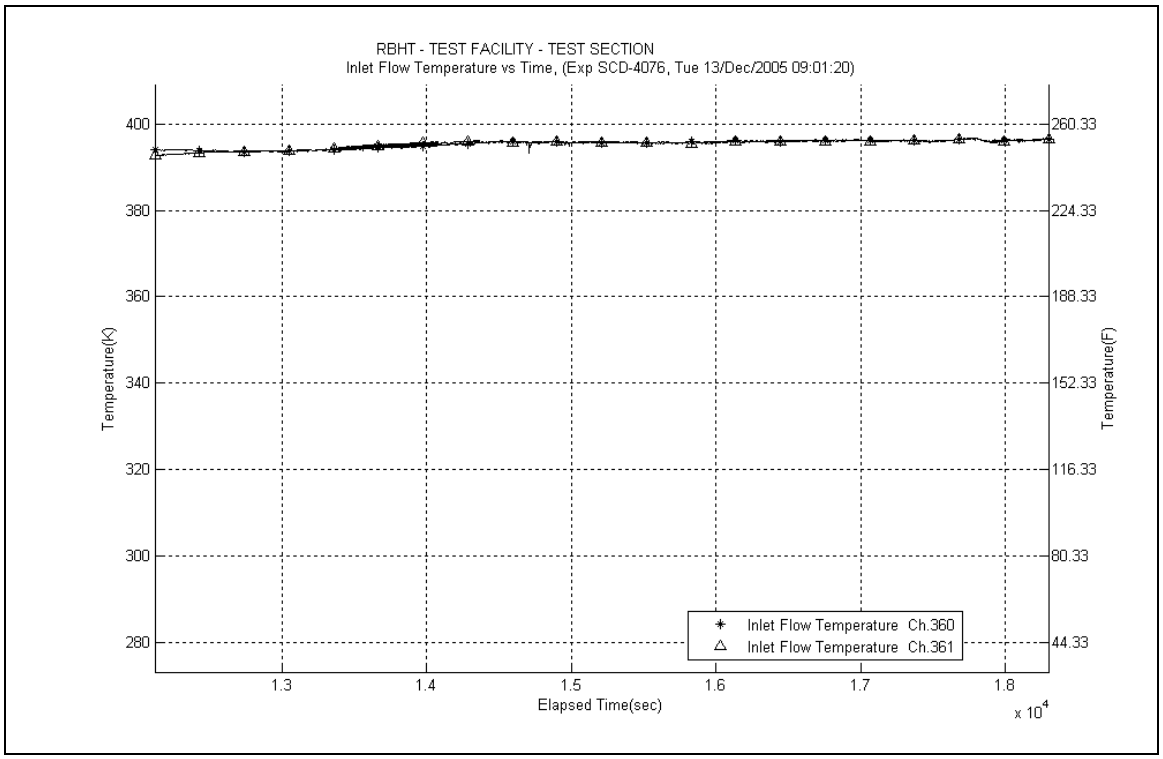

Figure A-661: Inlet Steam Temperature for Experiment 4076A

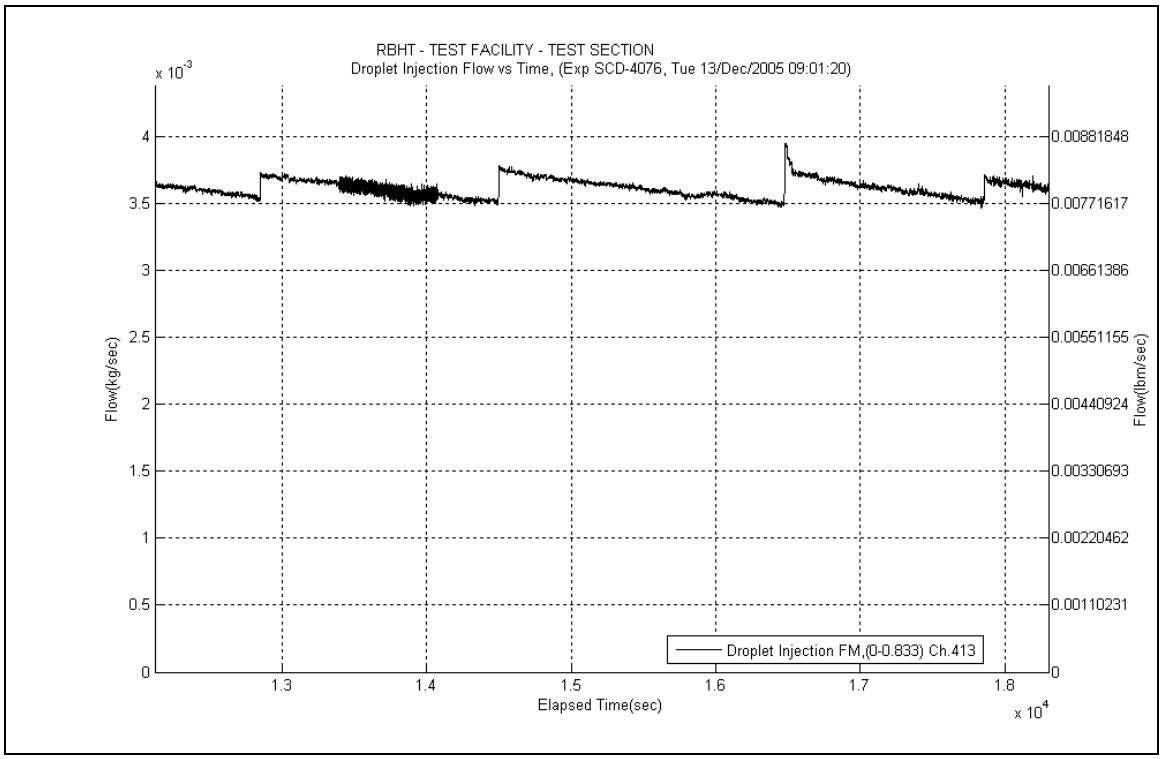

Figure A-662: Droplet Injection Flow Rate for Experiment 4076A

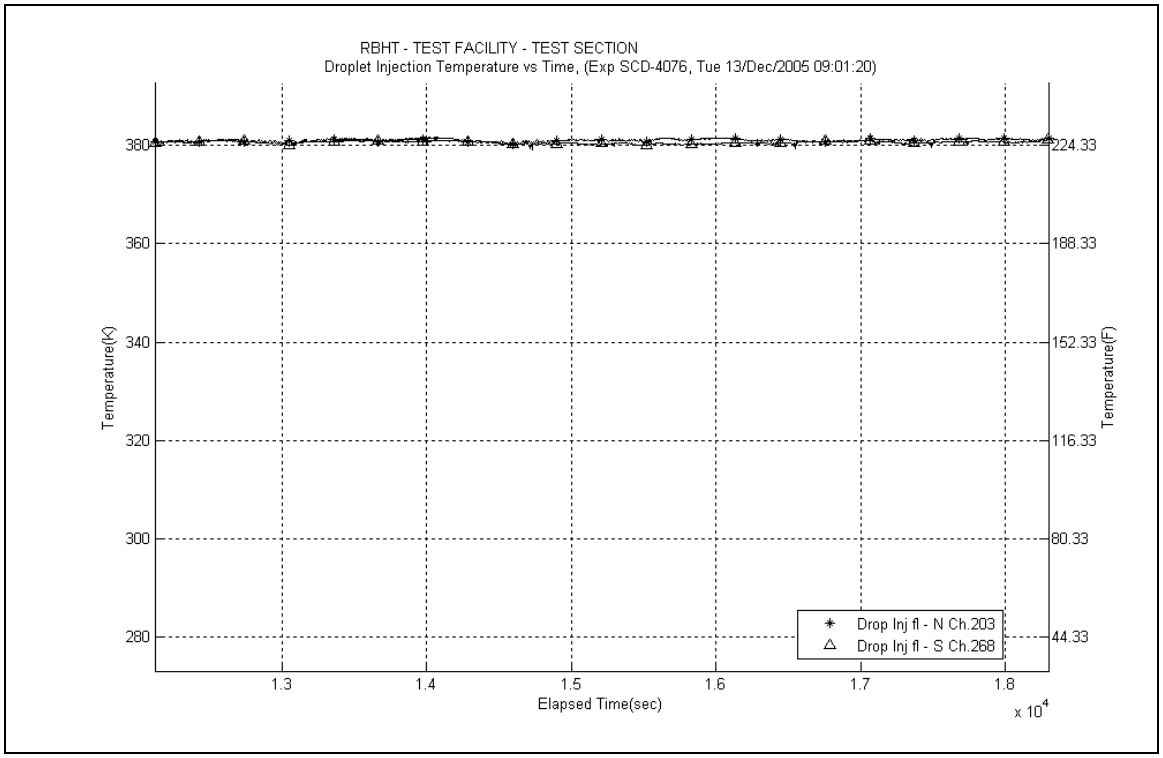

Figure A-663: Droplet Injection Temperature for Experiment 4076A

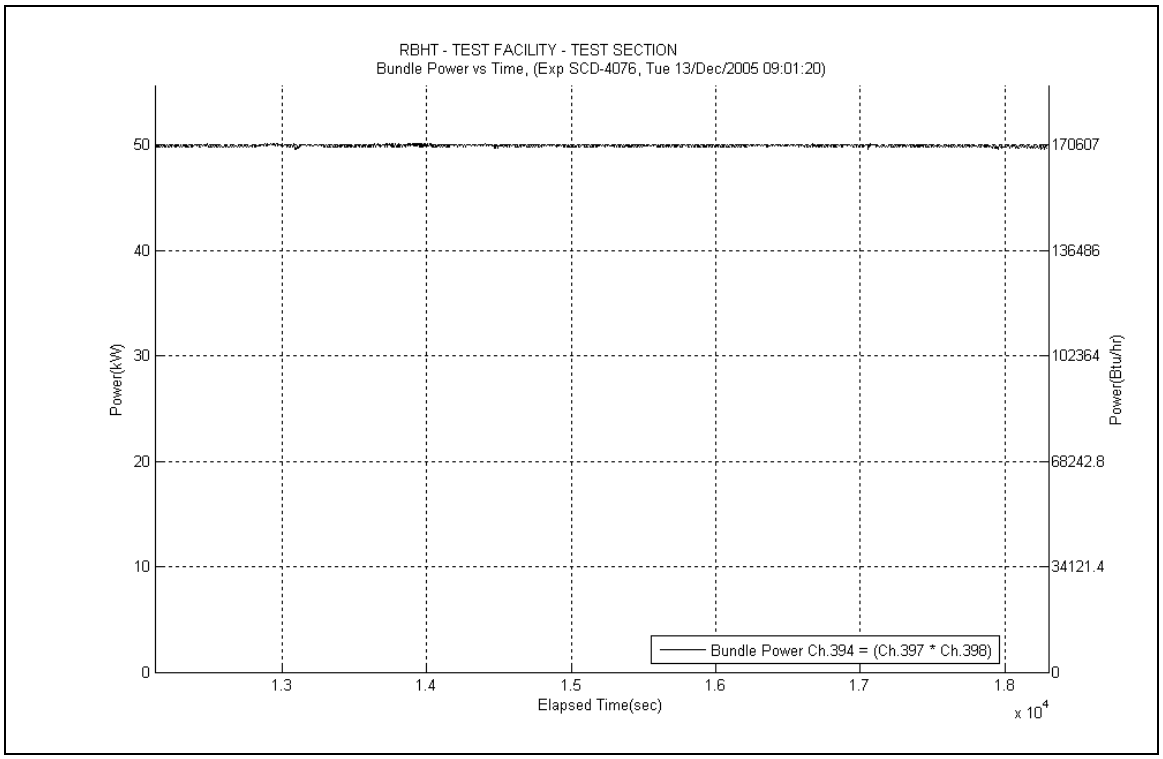

Figure A-664: Bundle Power for Experiment 4076A

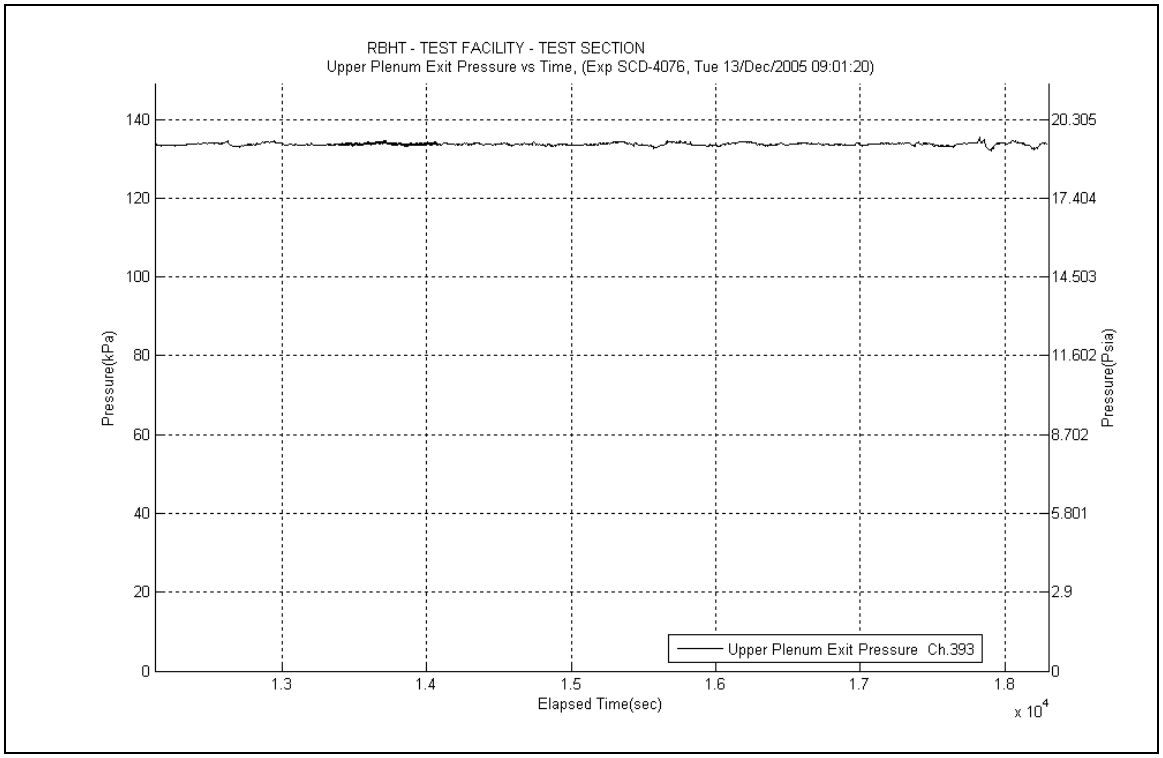

Figure A-665: Upper Plenum Pressure for Experiment 4076A

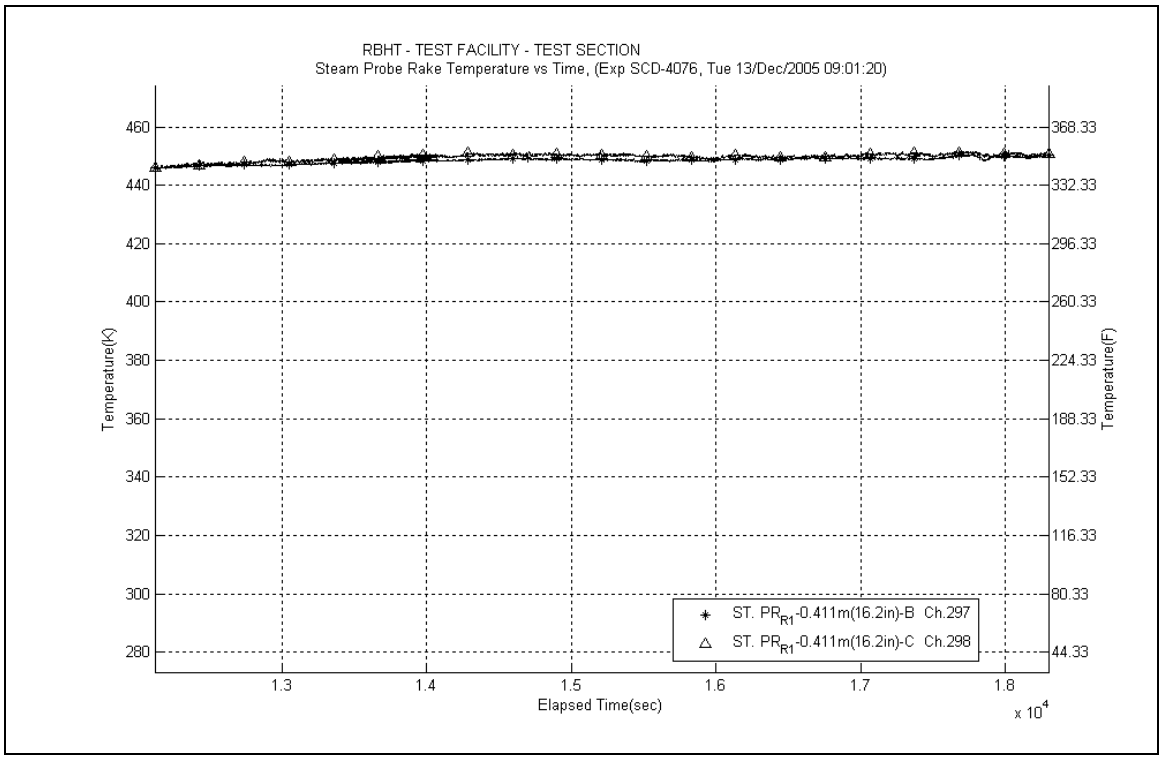

Figure A-666: Steam Probe Rake #1 Temperatures for Experiment 4076A

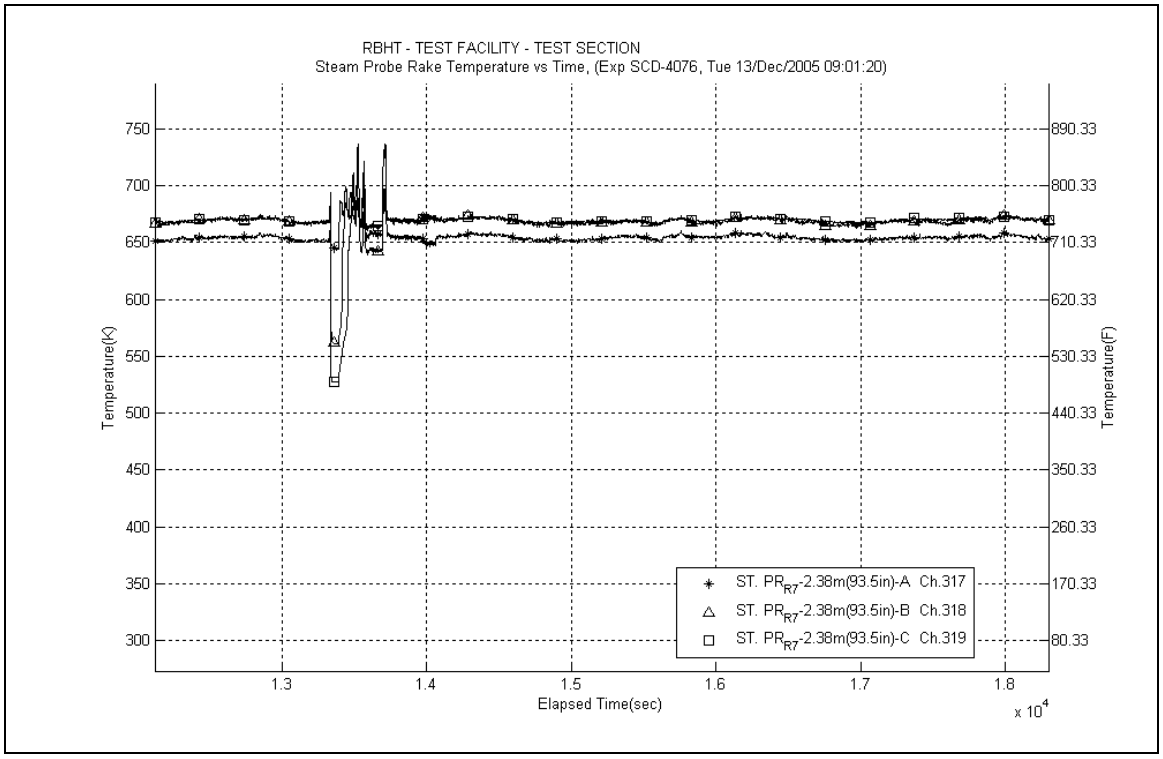

Figure A-667: Steam Probe Rake #7 Temperatures for Experiment 4076A

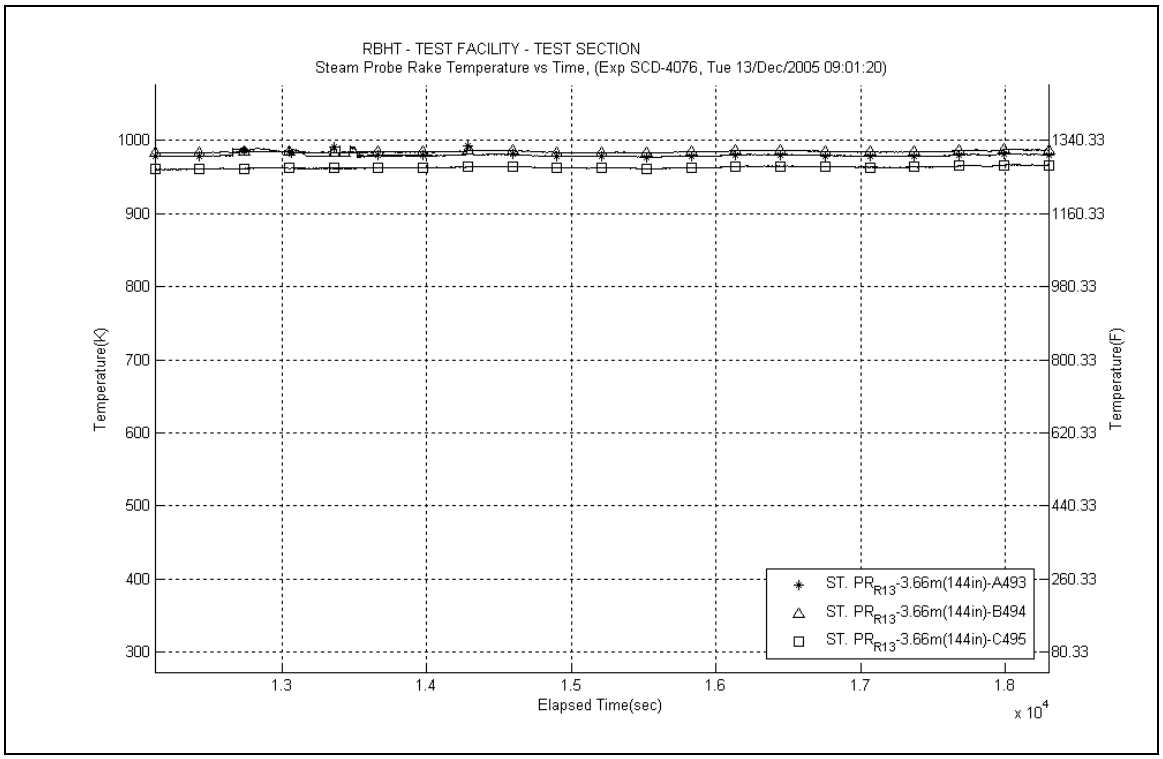

Figure A-668: Steam Probe Rake #13 Temperatures for Experiment 4076A

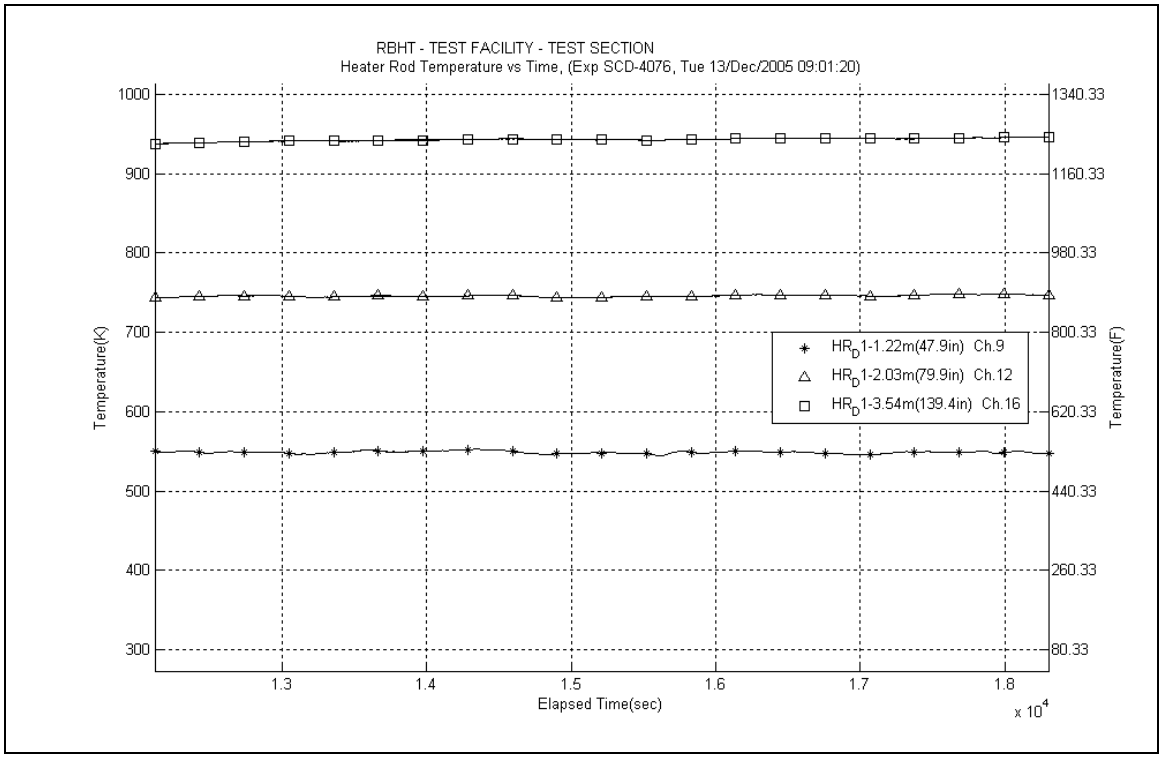

Figure A-669: Heater Rod D1 Temperatures for Experiment 4076A

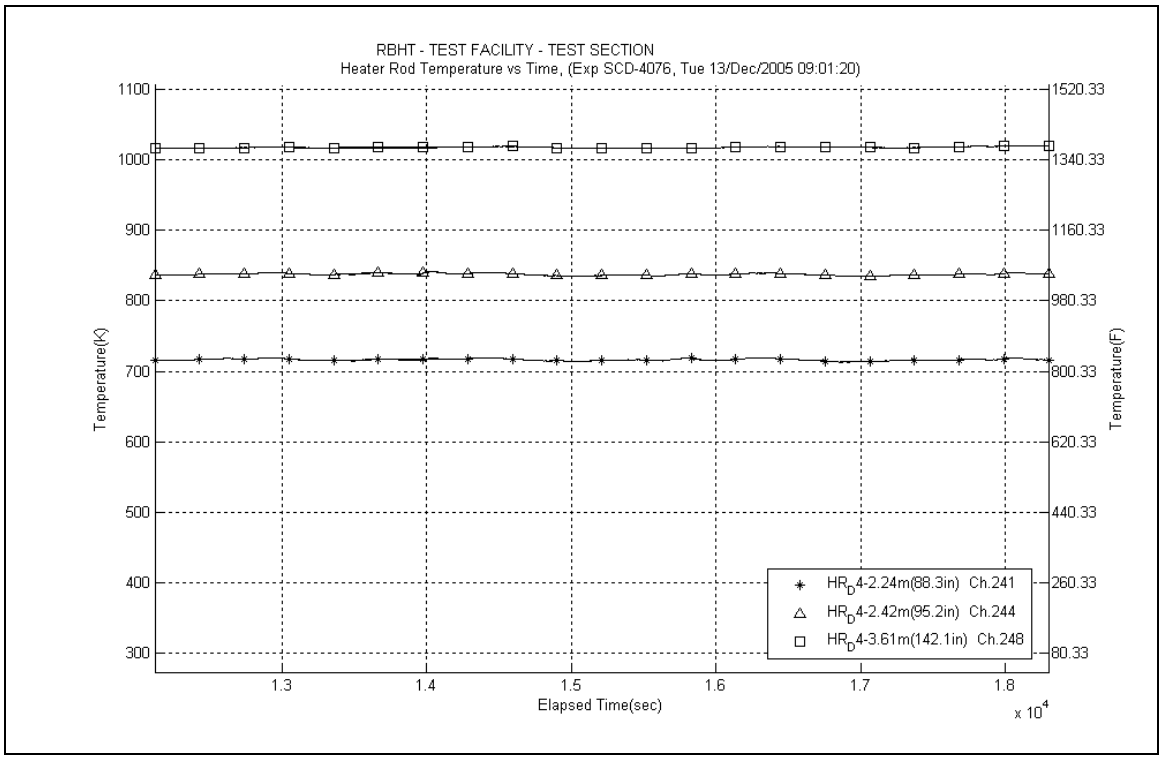

Figure A-670: Heater Rod D4 Temperatures for Experiment 4076A

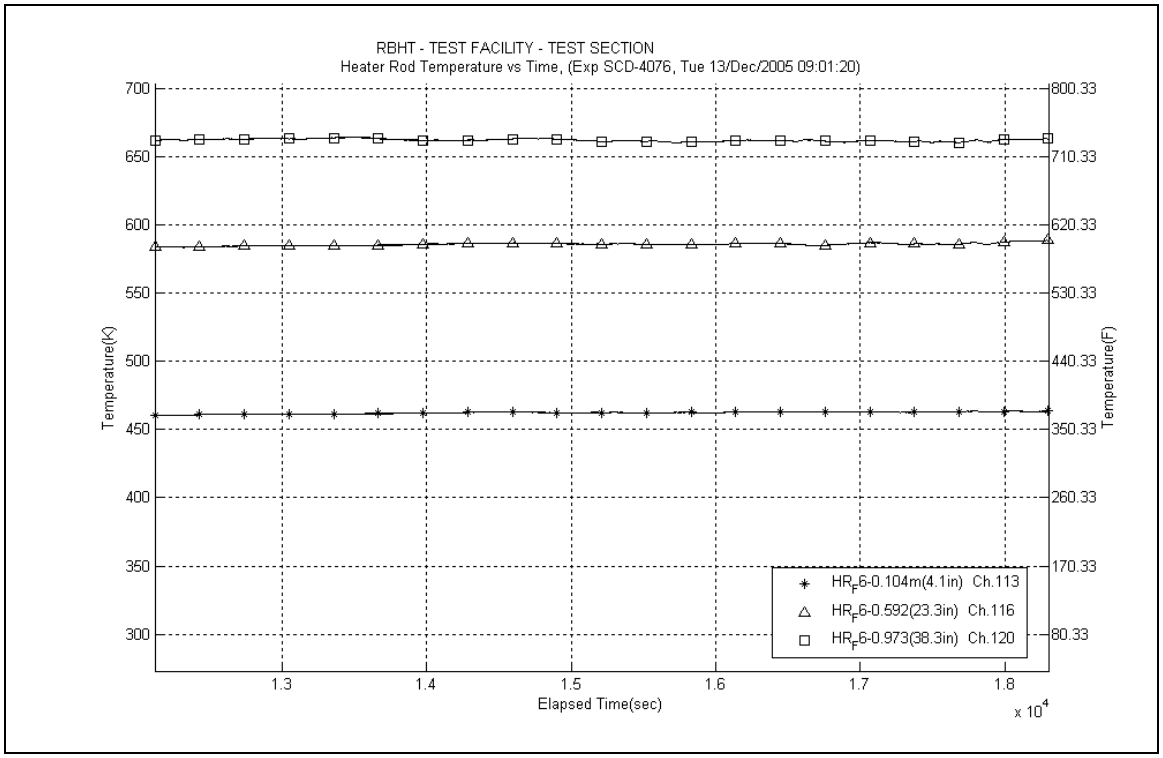

Figure A-671: Heater Rod F6 Temperatures for Experiment 4076A

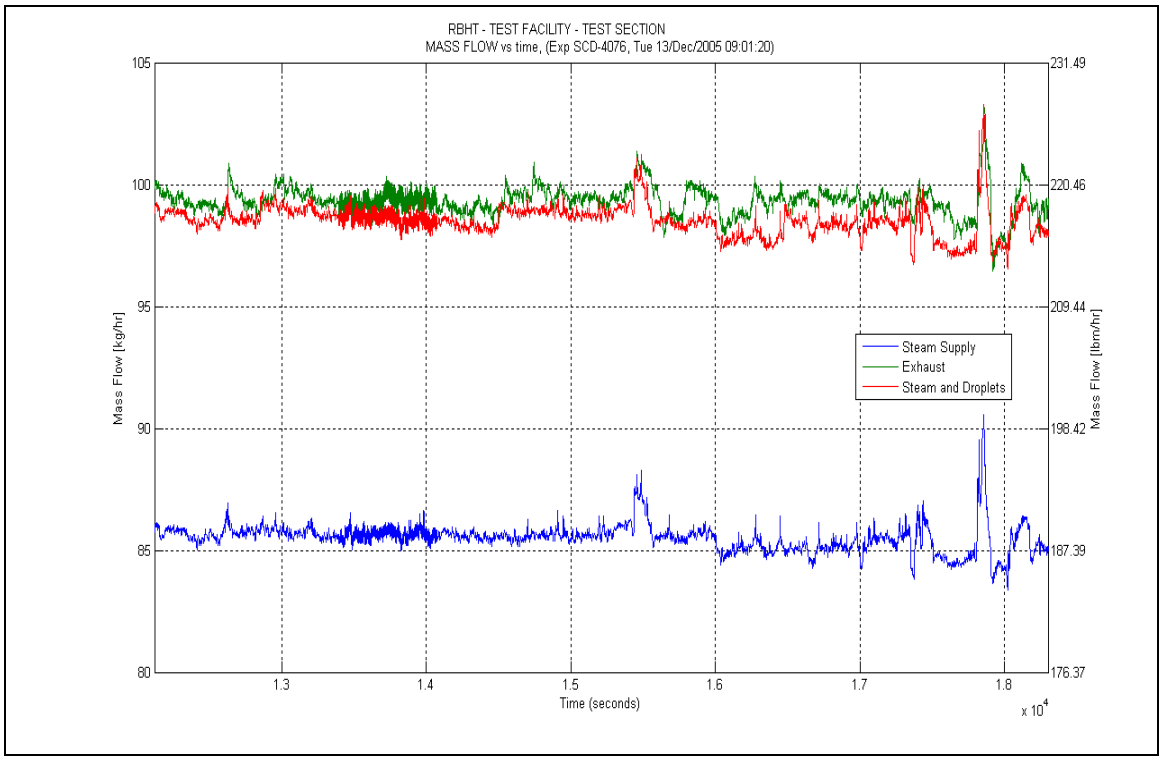

Figure A-672: Mass Flow for Experiment 4076A

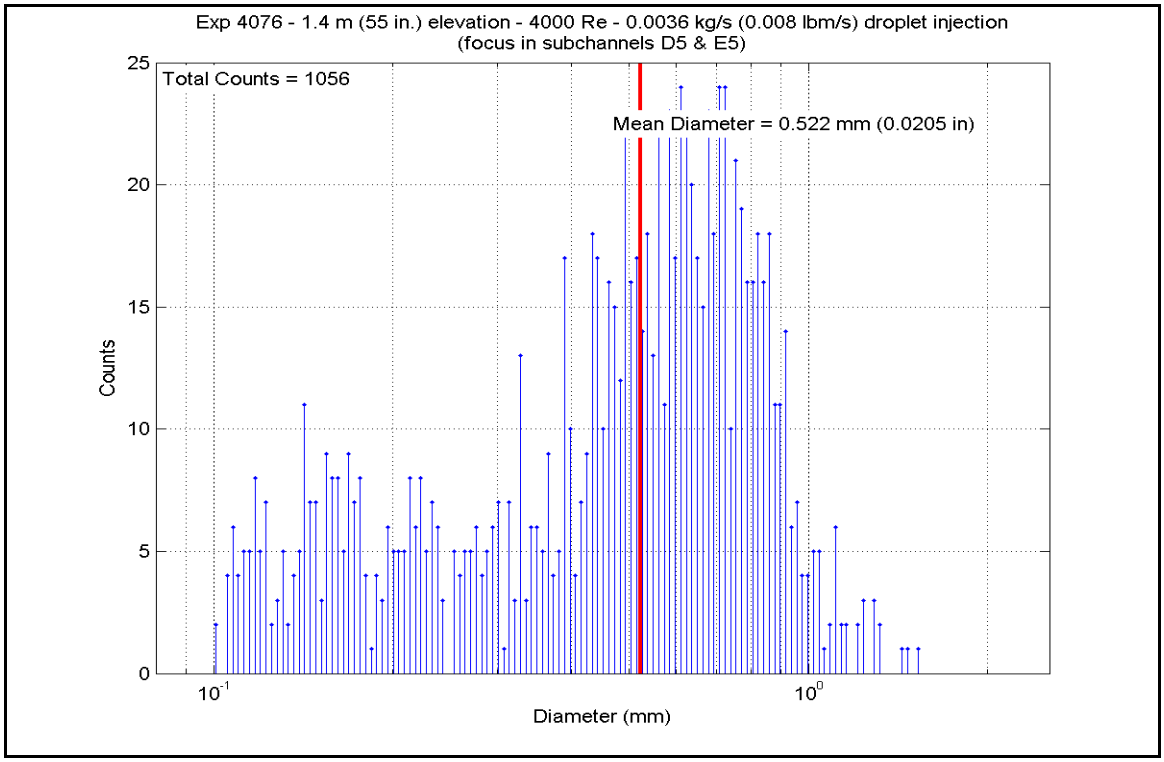

Figure A-673: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076A

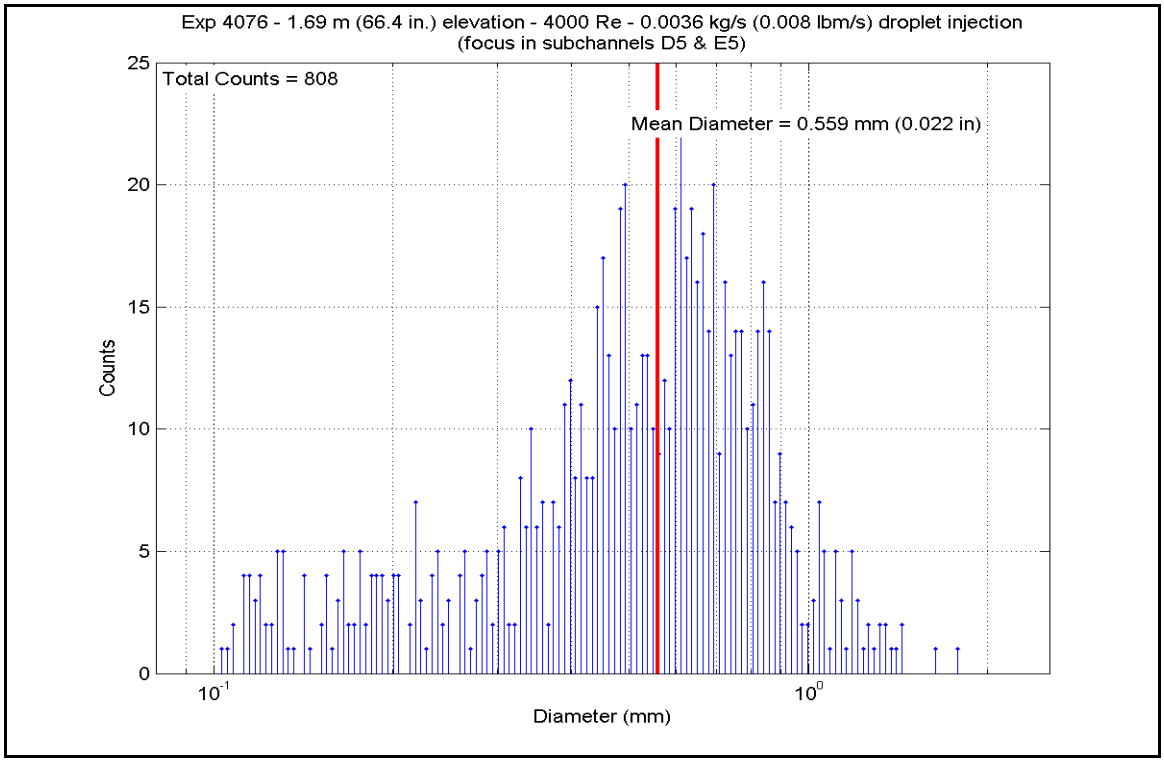

Figure A-674: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076A

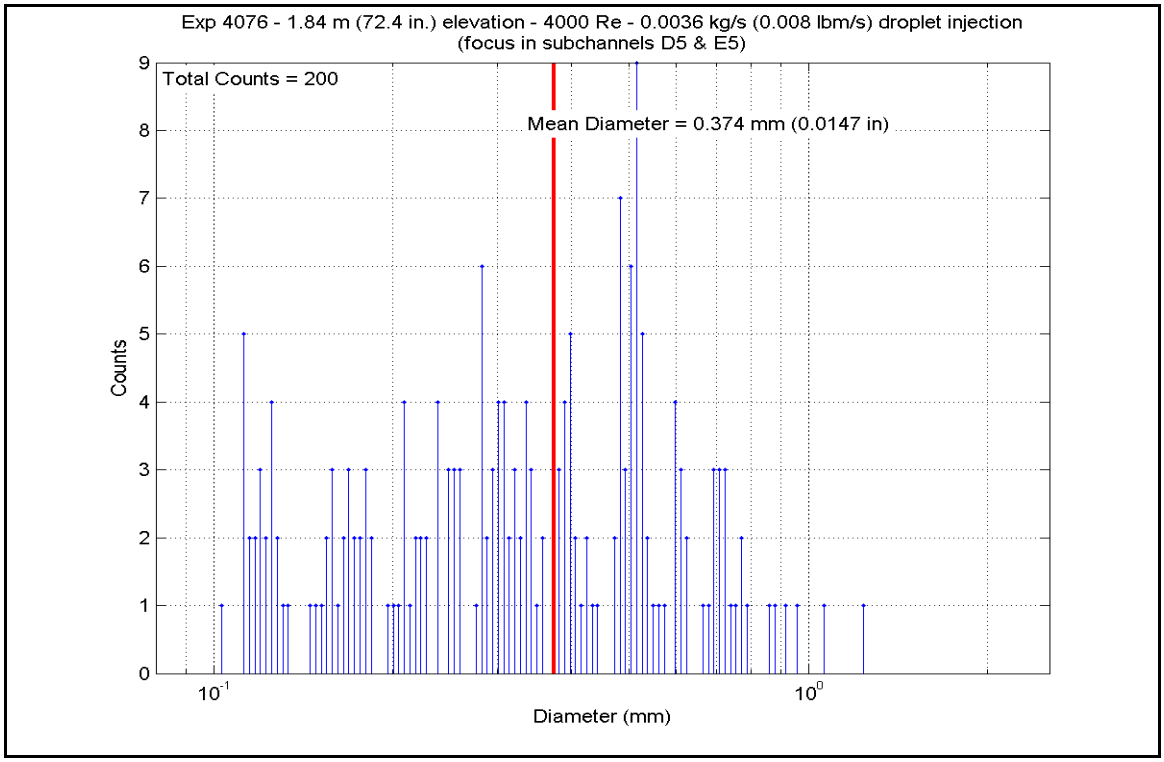

Figure A-675: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076A

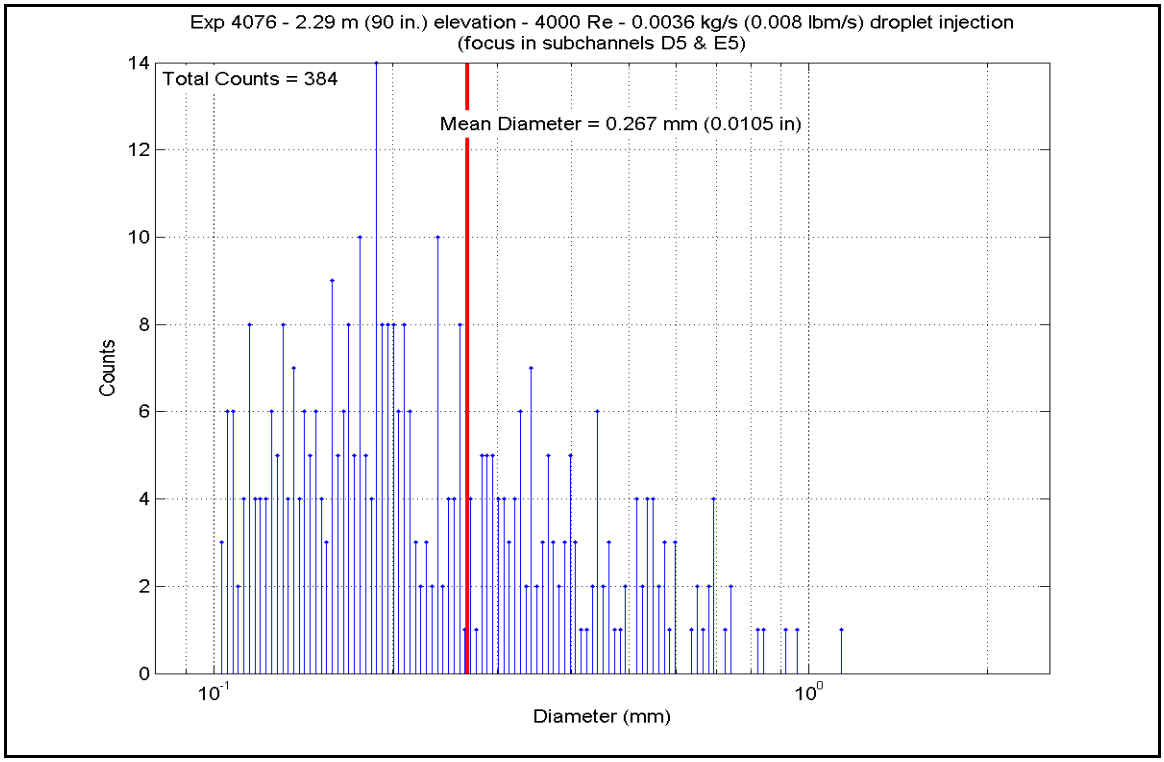

Figure A-676: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076A

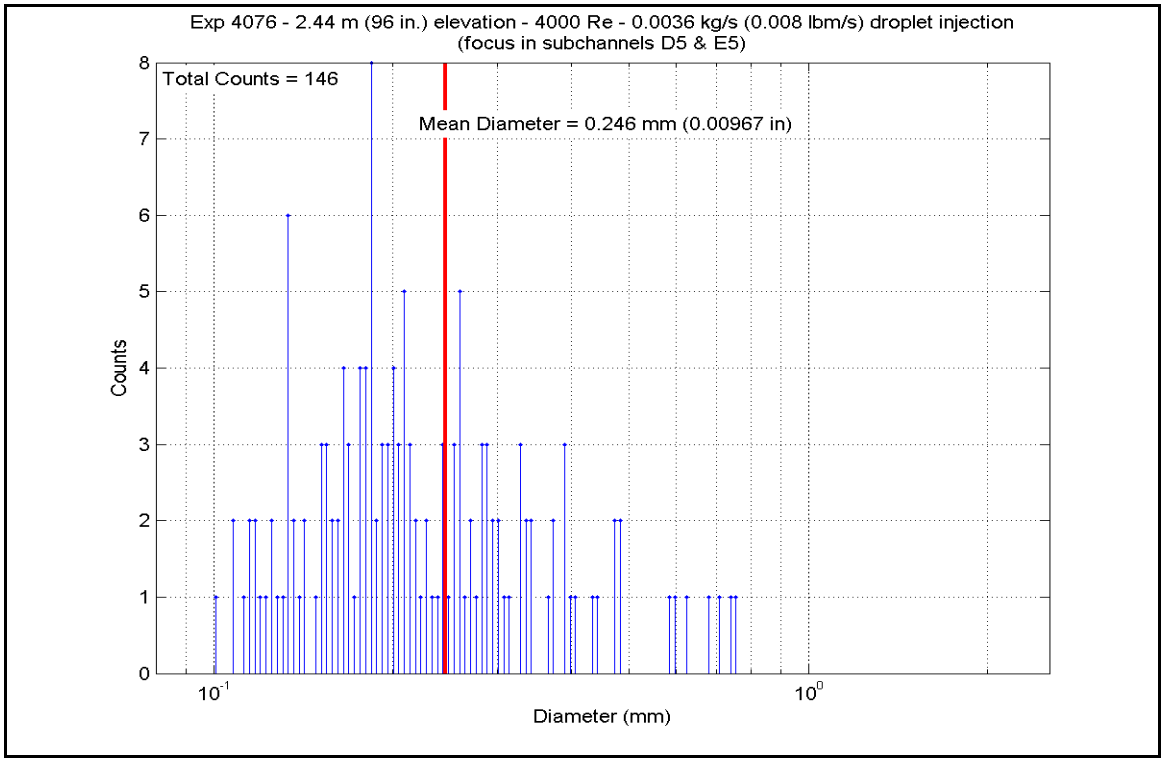

Figure A-677: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076A

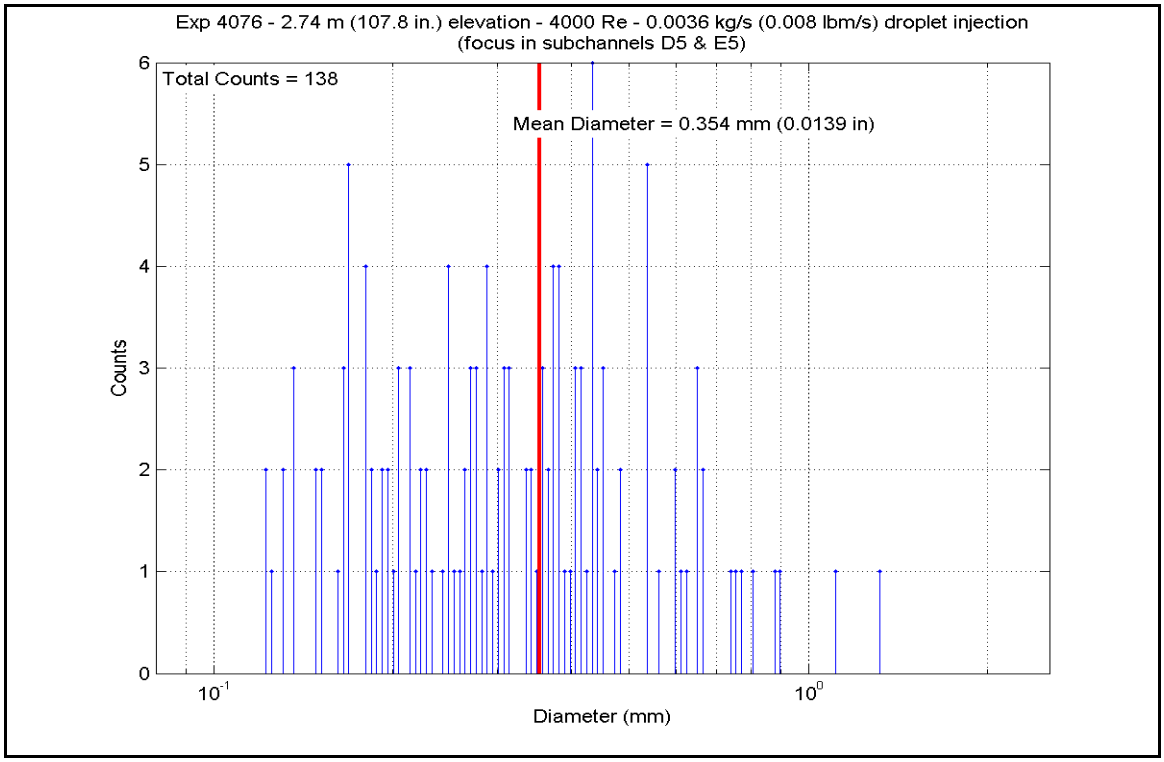

Figure A-678: Droplet Measurements at 2.738m (113.8 in.) Elevation for Experiment 4076A

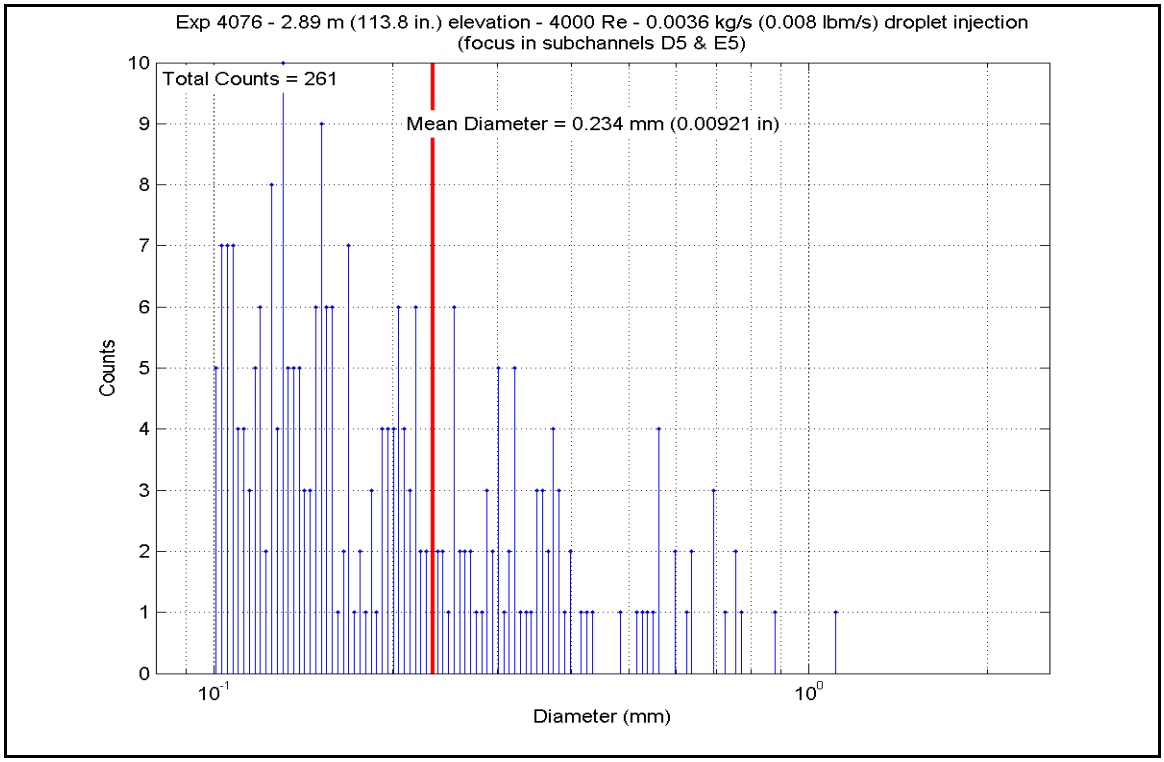

Figure A-679: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076A

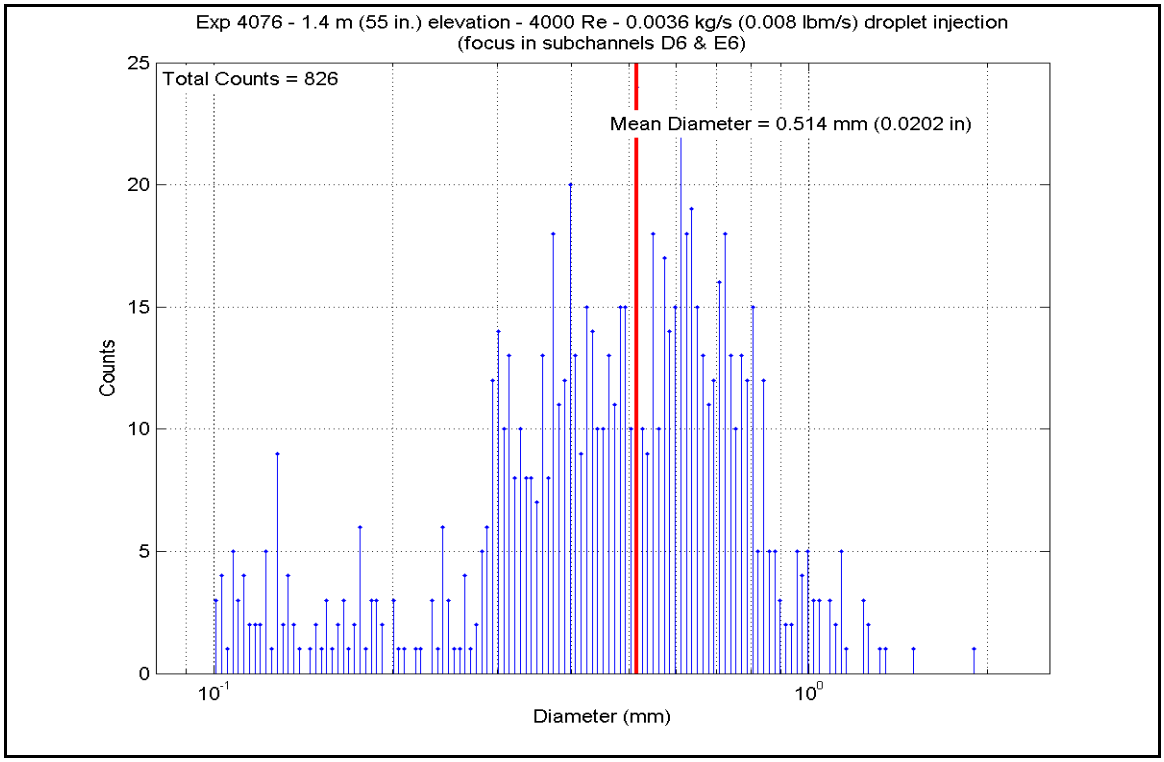

Figure A-680: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076A

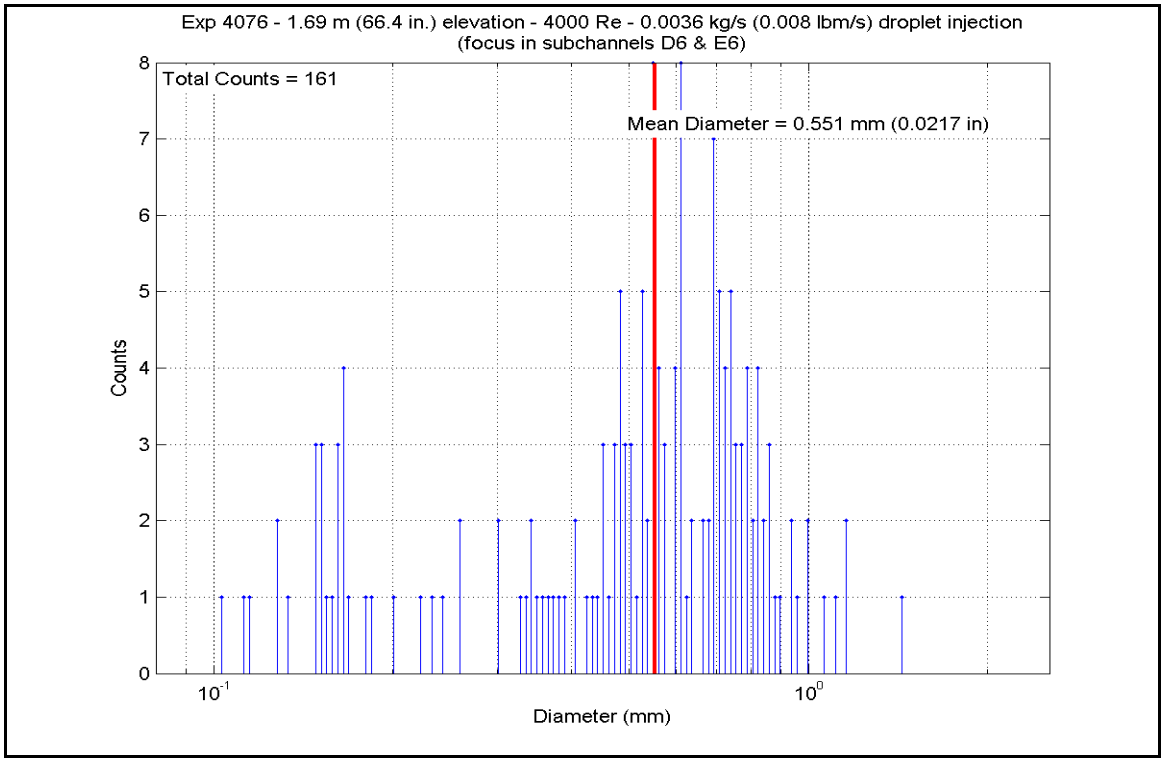

Figure A-681: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076A

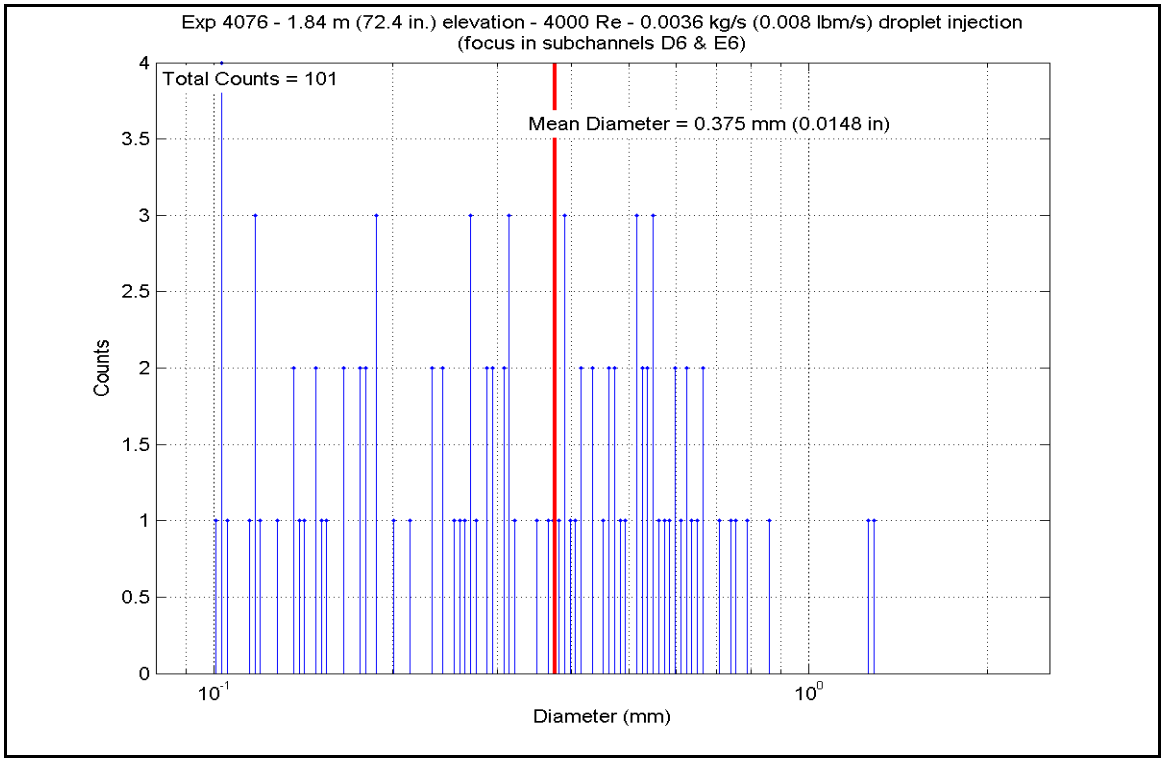

Figure A-682: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076A

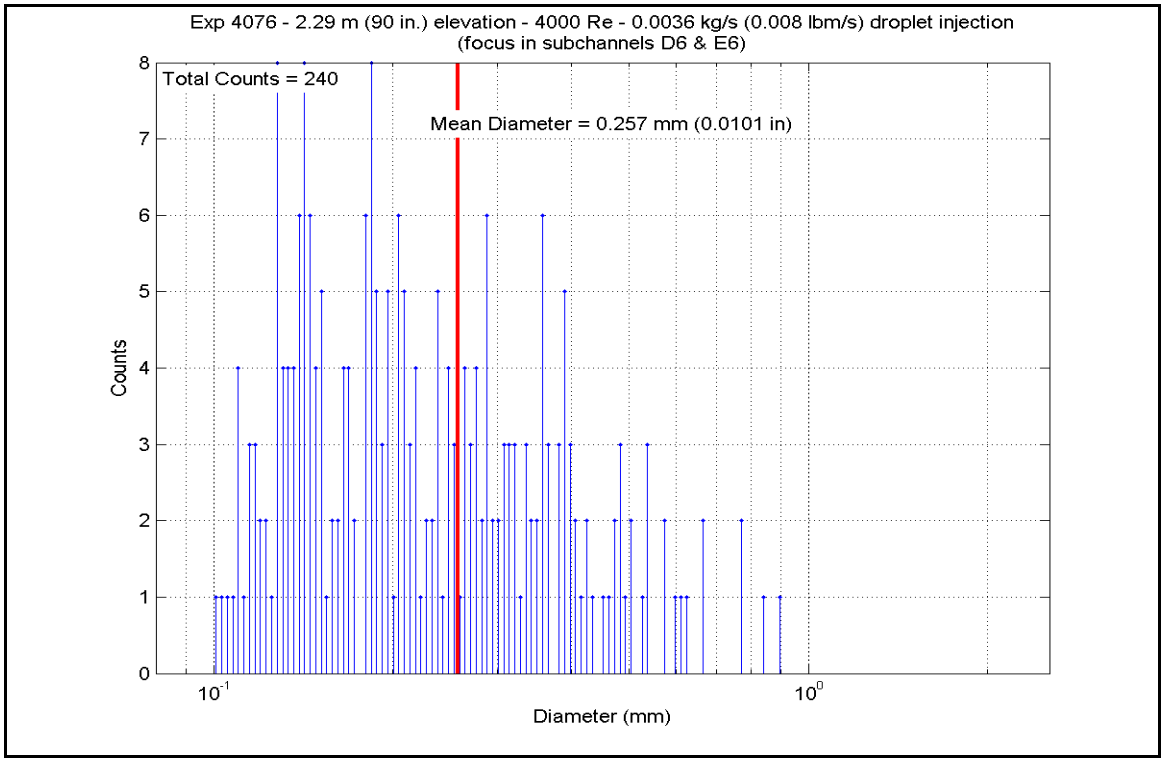

Figure A-683: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076A

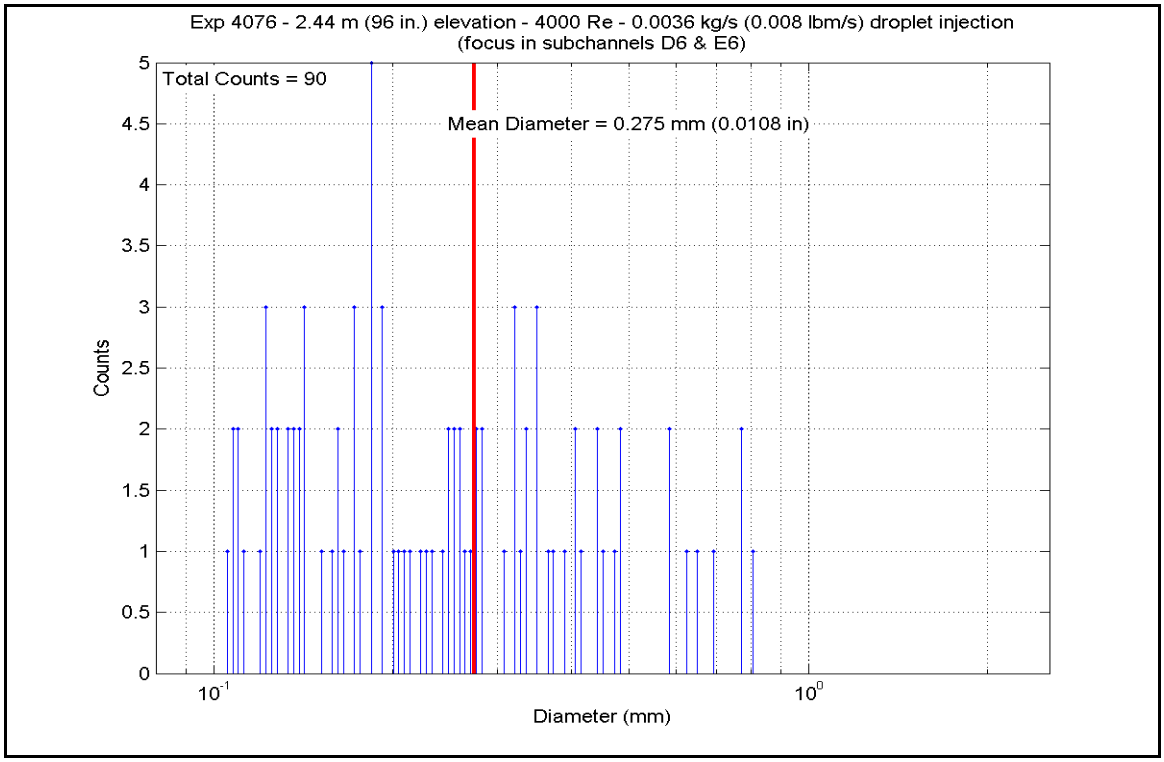

Figure A-684: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076A

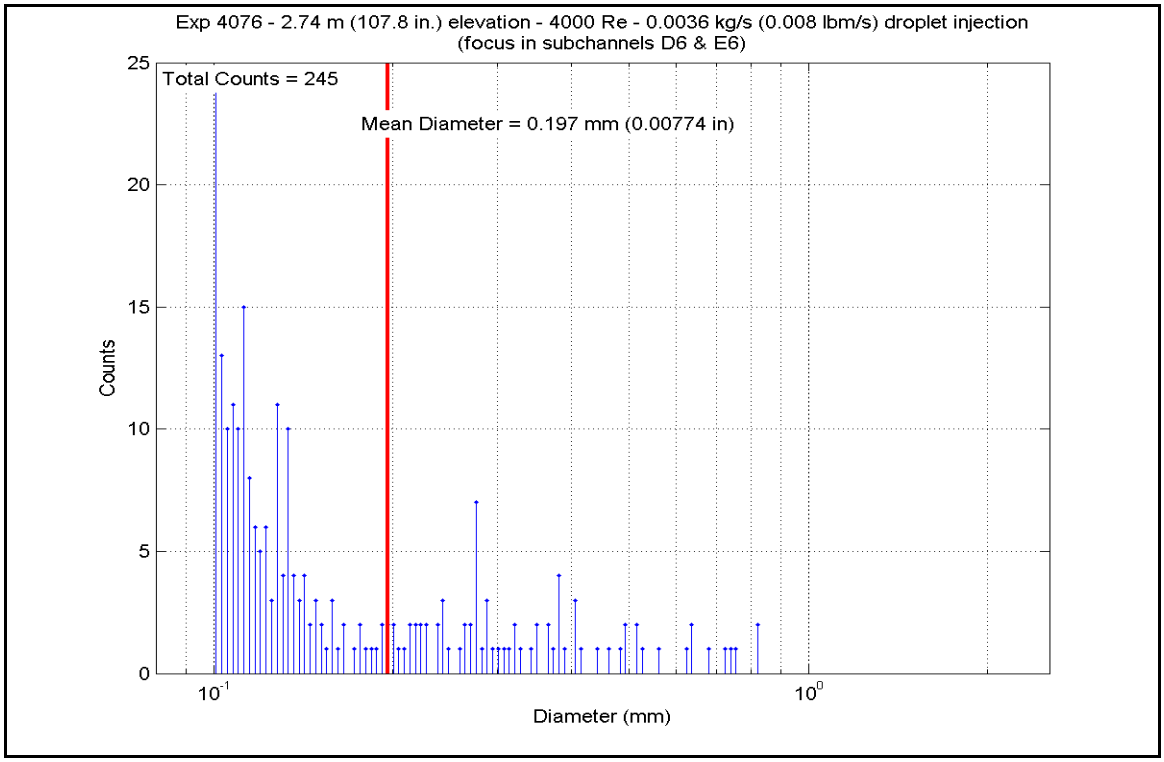

Figure A-685: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076A

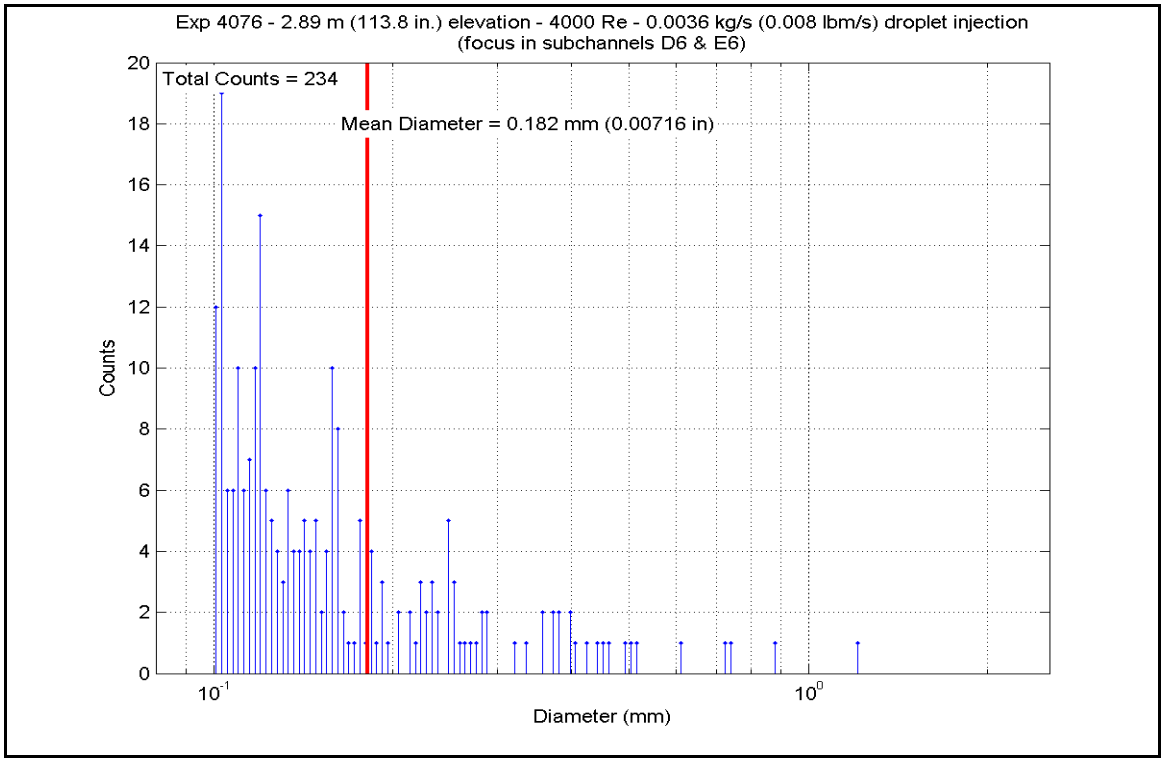

Figure A-686: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076A

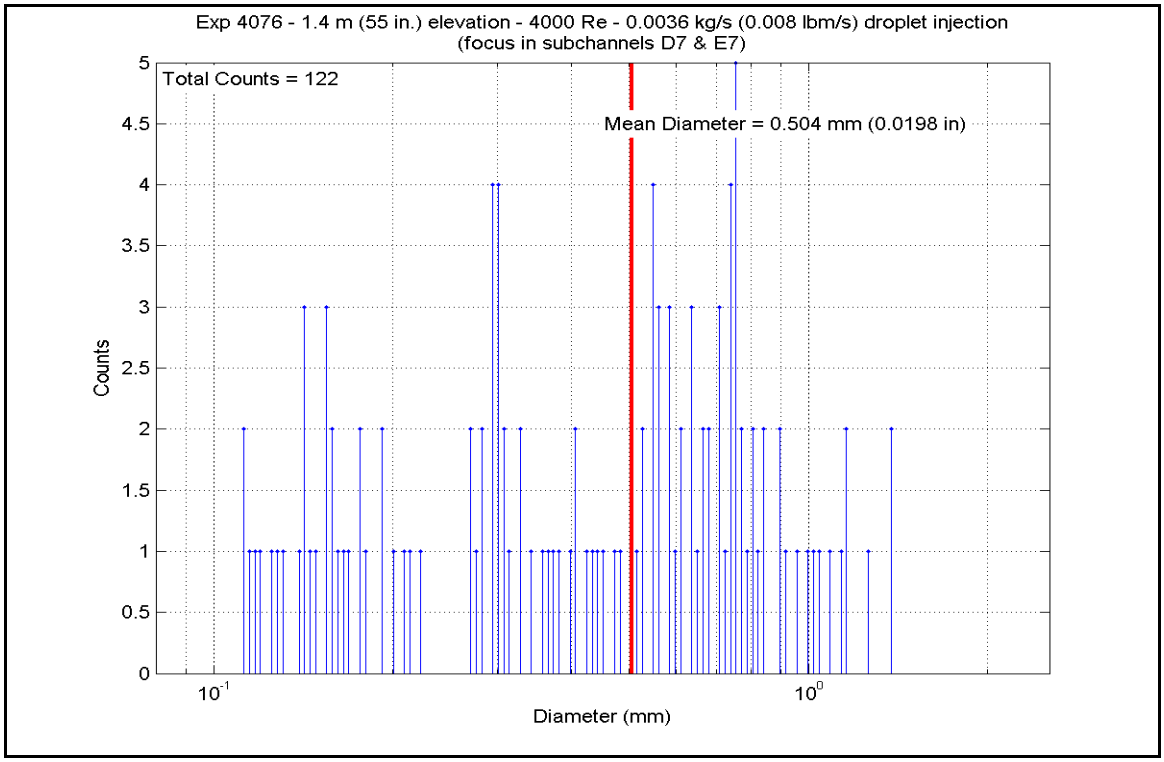

Figure A-687: Droplet Measurements at 1.397m (55 in.) Elevation for Experiment 4076A

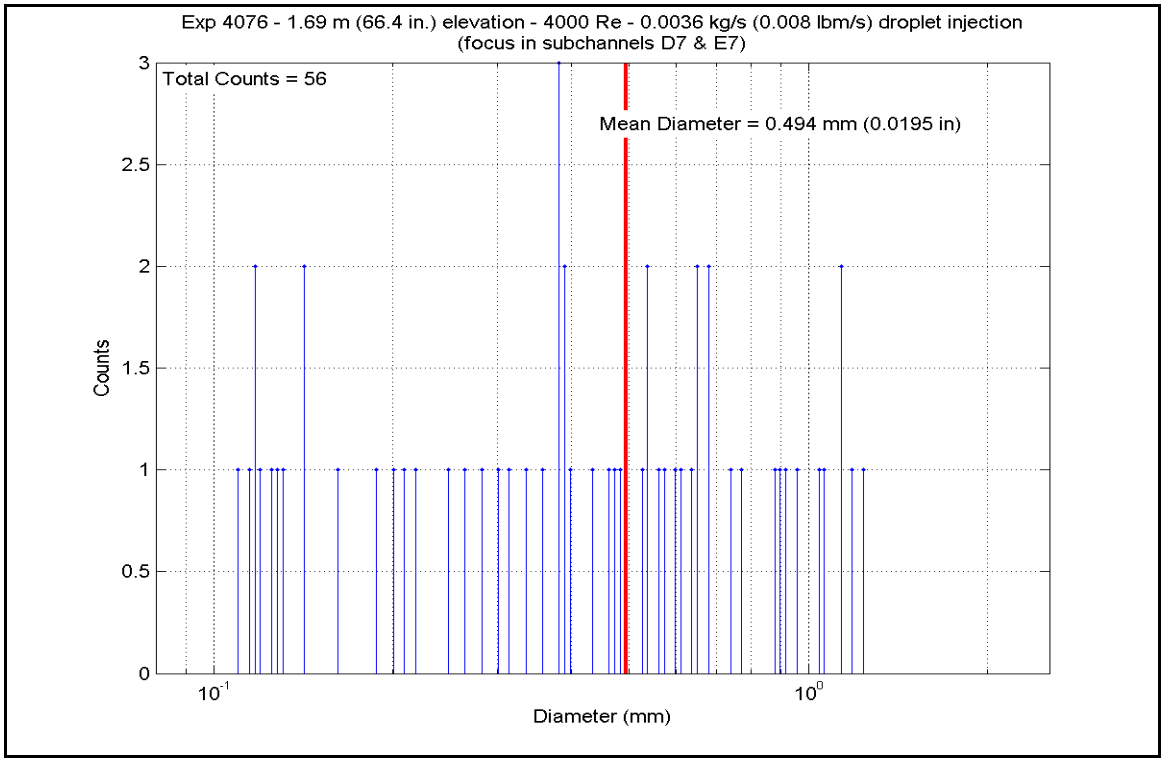

Figure A-688: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076A

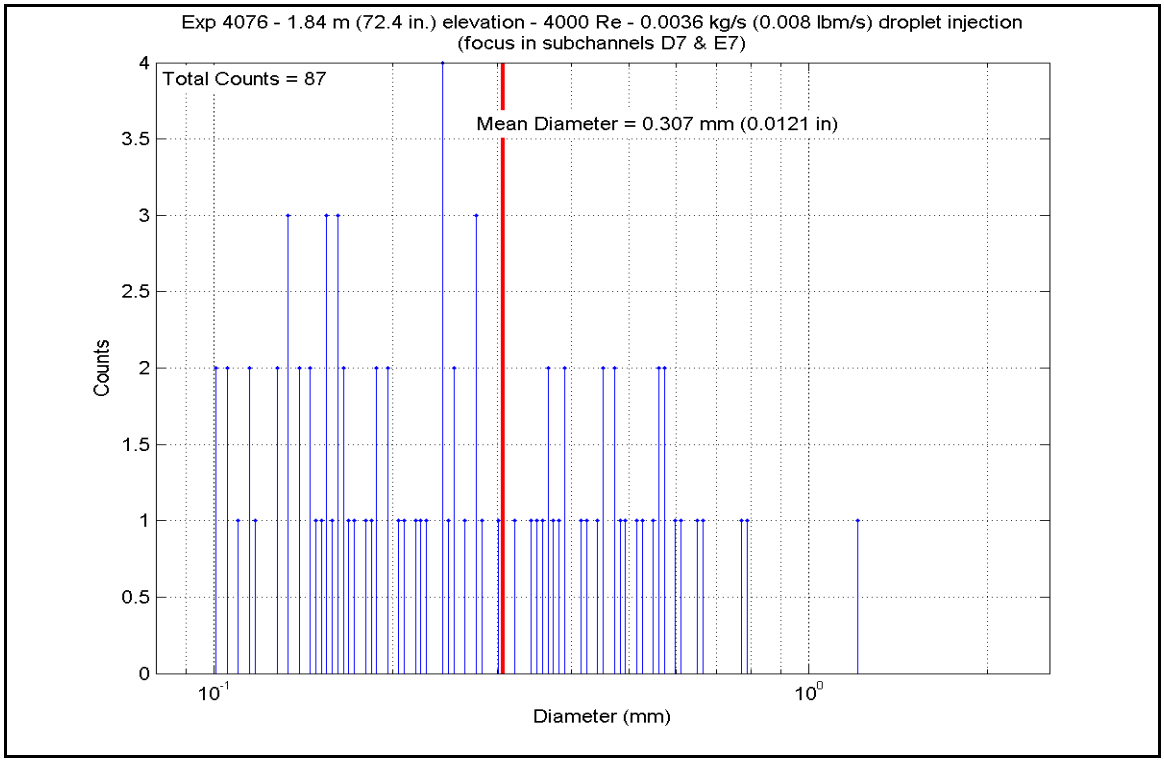

Figure A-689: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076A

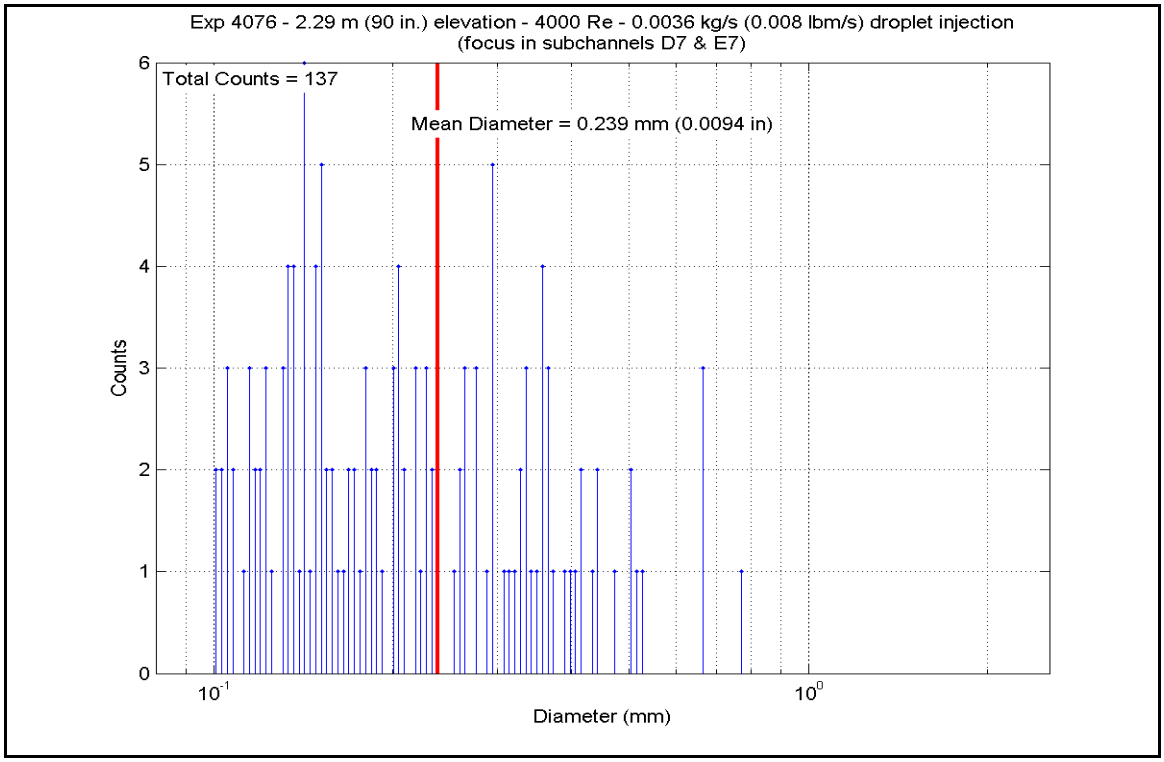

Figure A-690: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076A

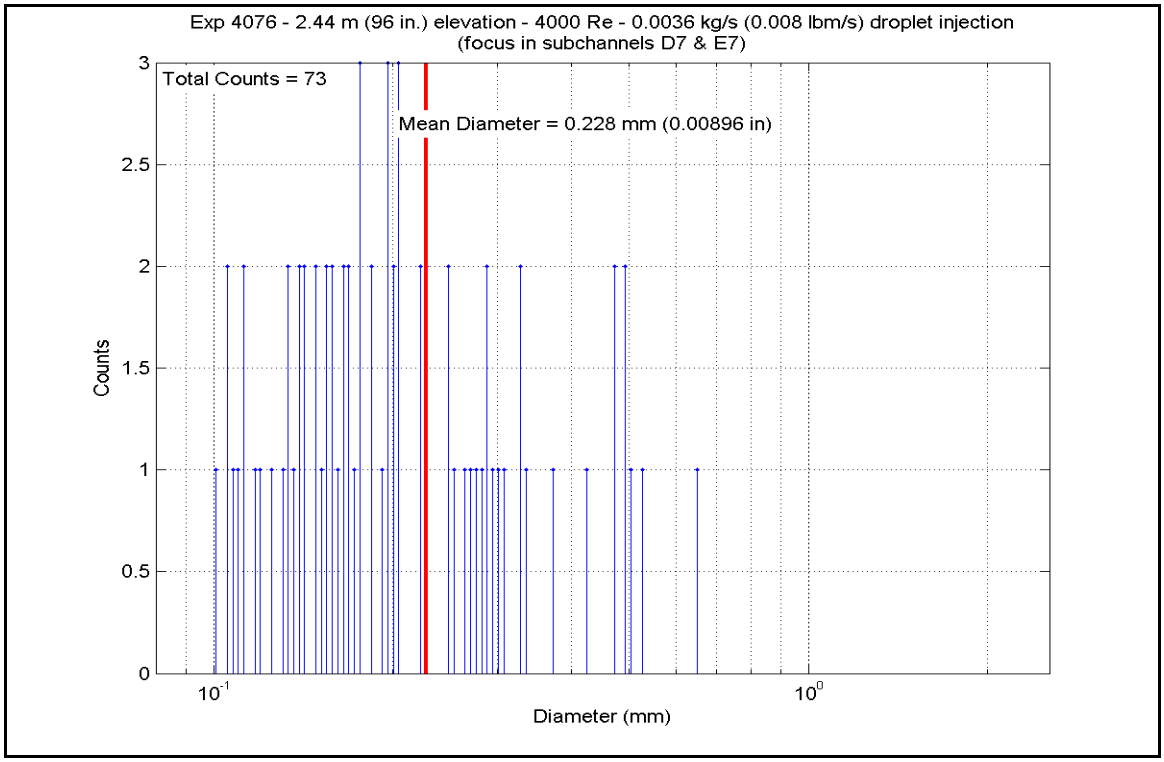

Figure A-691: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076A

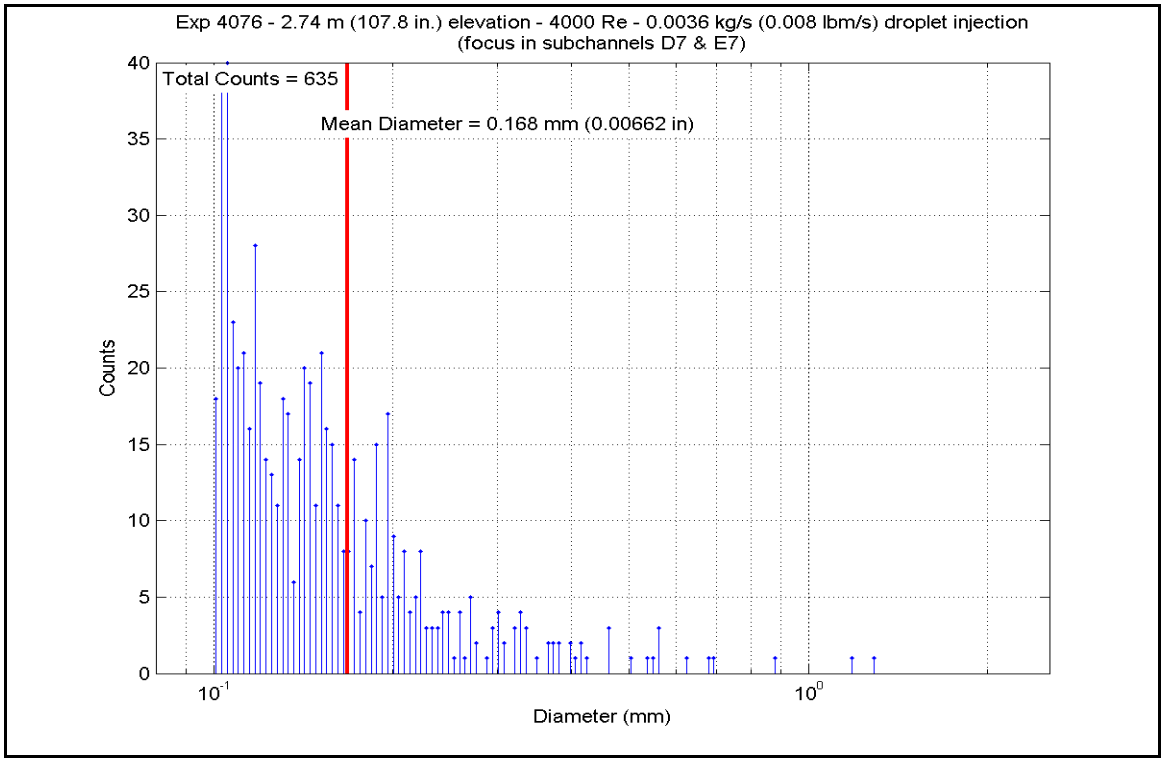

Figure A-692: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076A

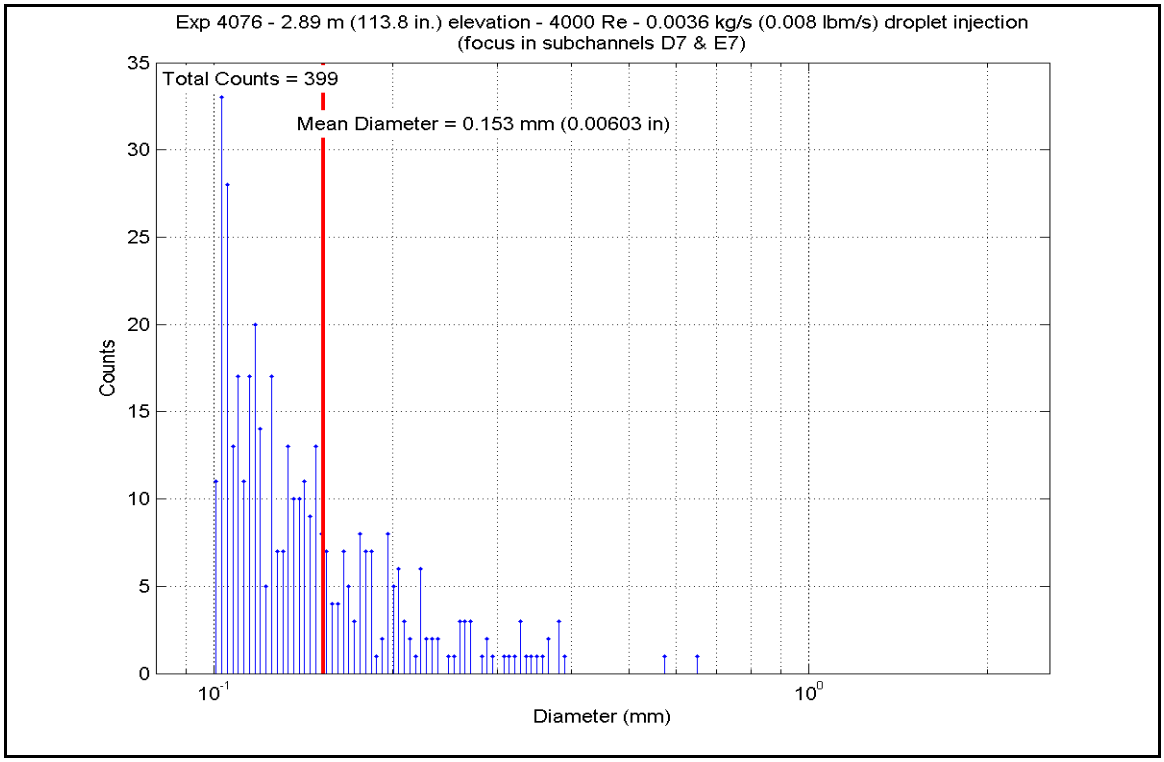

Figure A-693: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076A

Table A-72: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076A

SCD-4076-A	Inlet Reynolds:	4000		
Matrix test # 14a	UP Pressure:	137.9 kPa	20	psia
Time Window: 12120-18300	Bundle Power:	50.00 kW	170607	Btu/hr
	Steam flow:	0.0237 kg/s	188.0	lbm/hr
	Droplet flow:	0.0036 kg/s	0.008	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	816.26	708.9	4236.14	13362.9	7.201	40.9
	RodD3_91.3	186	91.3	2.319	2.8	0.071	923.19	768.3	4325.82	13645.8	6.223	35.3
	RodD3_93.1	187	93.1	2.365	4.6	0.117	966.11	792.1	4379.70	13815.8	5.934	33.7
	RodD3_95.3	188	95.3	2.421	6.8	0.173	1023.14	823.8	4445.09	14022.0	5.590	31.7
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1202.81	923.6	4769.40	15045.1	4.893	27.8
	RodD3_110	191	110	2.794	21.5	0.546	1183.53	912.9	4709.94	14857.5	4.929	28.0
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1348.71	1004.7	1642.12	5180.1	1.465	8.3
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	870.22	738.8	4284.41	13515.2	6.671	37.9
	RodC4_91.1	234	91.1	2.314	2.6	0.066	969.65	794.1	4366.47	13774.0	5.887	33.4
	RodC4_93.4	235	93.4	2.372	4.9	0.124	1013.98	818.7	4436.61	13995.3	5.645	32.1
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1061.40	845.0	4495.24	14180.2	5.394	30.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1153.19	896.0	4642.79	14645.7	5.018	28.5
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1219.63	932.9	4827.43	15228.1	4.868	27.6
	RodC4_110	239	110	2.794	21.5	0.546	1198.40	921.1	4671.69	14736.8	4.814	27.3
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1363.83	1013.1	1780.47	5616.5	1.568	8.9
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	828.22	715.5	4269.25	13467.4	7.113	40.4
	RodD4_91.3	242	91.3	2.319	2.8	0.071	944.87	780.3	4359.77	13752.9	6.082	34.5
	RodD4_93.2	243	93.2	2.367	4.7	0.119	996.30	808.9	4417.18	13934.0	5.749	32.6
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1046.51	836.8	4477.69	14124.9	5.471	31.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1139.25	888.3	4626.11	14593.1	5.077	28.8
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1205.31	925.0	4808.50	15168.4	4.920	27.9
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1371.74	1017.4	1721.28	5429.8	1.505	8.5
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	822.83	712.5	4205.09	13265.0	7.069	40.1
	RodE4_91.2	202	91.2	2.316	2.7	0.069	925.48	769.5	4286.45	13521.6	6.146	34.9
	RodE4_95.3	204	95.3	2.421	6.8	0.173	1022.85	823.6	4405.10	13895.9	5.542	31.5
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1114.95	874.8	4567.20	14407.2	5.149	29.2
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1357.95	1009.8	1739.97	5488.8	1.540	8.7

Table A-72: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	226.72	381.3	3484.03	10990.4	-2719.874	-15445.9
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1221.28	933.9	4292.13	13539.5	4.321	24.5
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1259.95	955.3	4132.46	13035.9	4.005	22.7
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1297.09	976.0	3880.65	12241.5	3.630	20.6
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1327.35	992.8	3527.90	11128.8	3.209	18.2
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1336.13	997.7	3208.83	10122.3	2.896	16.4
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1309.67	983.0	2772.69	8746.5	2.563	14.6
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1327.64	992.9	2445.21	7713.4	2.224	12.6
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	795.44	697.3	3415.81	10775.2	6.020	34.2
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1237.52	942.9	4185.84	13204.2	4.146	23.5
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1279.06	966.0	4017.80	12674.2	3.823	21.7
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1342.80	1001.4	3459.81	10914.0	3.104	17.6
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1354.55	1007.9	3140.94	9908.1	2.788	15.8
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1336.42	997.8	2749.77	8674.1	2.481	14.1
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1354.84	1008.1	2422.53	7641.9	2.150	12.2
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	704.33	646.7	3503.80	11052.7	7.356	41.8
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1183.11	912.7	4318.43	13622.5	4.521	25.7
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1227.61	937.4	4168.49	13149.5	4.170	23.7
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1279.63	966.3	3895.44	12288.2	3.704	21.0
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1319.07	988.2	3572.85	11270.6	3.275	18.6
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1336.08	997.6	3242.32	10227.9	2.926	16.6
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1381.18	1022.7	2833.34	8937.8	2.457	14.0
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1355.76	1008.6	2500.17	7886.8	2.217	12.6
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	803.72	701.9	3960.14	12492.3	6.879	39.1
	RodC3_85.6	178	85.6	2.174	14.72	0.374	804.70	702.4	4133.68	13039.7	7.168	40.7
	RodC3_88.5	179	88.5	2.248	0	0.000	829.44	716.2	4218.89	13308.5	7.015	39.8
	RodC3_92.4	180	92.4	2.347	3.9	0.099	960.61	789.0	4334.24	13672.4	5.916	33.6
	RodC3_94.4	181	94.4	2.398	5.9	0.150	1005.70	814.1	4393.87	13860.5	5.650	32.1
Gr-8	RodD5_50	217	50	1.270	3	0.076	602.50	590.1	3091.84	9753.2	8.256	46.9
	RodD5_54.1	218	54.1	1.374	7.1	0.180	642.51	612.3	3214.24	10139.3	7.754	44.0
	RodD5_56.9	219	56.9	1.445	9.9	0.251	701.26	645.0	3298.18	10404.1	6.969	39.6
	RodD5_60	220	60	1.524	13	0.330	755.15	674.9	3390.68	10695.9	6.432	36.5
	RodD5_66.1	221	66.1	1.679	19.1	0.485	809.09	704.9	3571.15	11265.2	6.146	34.9
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	701.56	645.1	3680.16	11609.1	7.771	44.1
	RodD5_72.9	223	72.9	1.852	2.02	0.051	774.33	685.6	3772.05	11898.9	6.904	39.2
	RodD5_74.9	224	74.9	1.902	4.02	0.102	823.78	713.0	3831.80	12087.4	6.432	36.5

Table A-72: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	790.96	694.8	2808.66	8859.9	4.989	28.3
	RodB5_52.9	154	52.9	1.344	5.9	0.150	622.55	601.2	3167.64	9992.3	8.029	45.6
	RodB5_55	155	55	1.397	8	0.203	668.69	626.9	3230.44	10190.4	7.330	41.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	729.02	660.4	3314.08	10454.3	6.615	37.6
	RodB5_64	157	64	1.626	17	0.432	817.83	709.7	3499.65	11039.6	5.933	33.7
	RodB5_73.9	158	73.9	1.877	3.02	0.077	816.28	708.9	3793.98	11968.1	6.449	36.6
	RodB5_75.9	159	75.9	1.928	5.02	0.128	856.18	731.0	3854.04	12157.6	6.135	34.8
	RodB5_76.9	160	76.9	1.953	6.02	0.153	873.53	740.7	3884.18	12252.6	6.017	34.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	786.36	692.2	2793.03	8810.6	5.002	28.4
	RodF5_53.1	106	53.1	1.349	6.1	0.155	642.67	612.4	3159.53	9966.7	7.619	43.3
	RodF5_55	107	55	1.397	8	0.203	684.41	635.6	3217.07	10148.2	7.049	40.0
	RodF5_57.8	108	57.8	1.468	10.8	0.274	733.83	663.1	3301.71	10415.2	6.527	37.1
	RodF5_64	109	64	1.626	17	0.432	800.76	700.2	3488.15	11003.4	6.090	34.6
	RodF5_73.8	110	73.8	1.875	2.92	0.074	788.46	693.4	3779.56	11922.6	6.744	38.3
	RodF5_75.8	111	75.8	1.925	4.92	0.125	835.75	719.7	3839.38	12111.3	6.317	35.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	856.63	731.3	3869.35	12205.9	6.155	35.0
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	753.93	674.2	2805.34	8849.4	5.334	30.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	639.47	610.6	3170.24	10000.5	7.705	43.8
	RodC2_55	59	55	1.397	8	0.203	665.84	625.3	3227.11	10179.9	7.371	41.9
	RodC2_57.8	60	57.8	1.468	10.8	0.274	708.64	649.1	3311.13	10445.0	6.889	39.1
	RodC2_63.9	61	63.9	1.623	16.9	0.429	771.10	683.8	3494.17	11022.4	6.434	36.5
	RodC2_73.8	62	73.8	1.875	2.92	0.074	746.11	669.9	3789.22	11953.1	7.313	41.5
	RodC2_75.8	63	75.8	1.925	4.92	0.125	788.68	693.5	3848.64	12140.5	6.864	39.0
	RodC2_76.8	64	76.8	1.951	5.92	0.150	806.72	703.6	3878.70	12235.4	6.702	38.1
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	803.72	701.9	2791.35	8805.3	4.848	27.5
	RodC6_52.8	138	52.8	1.341	5.8	0.147	724.54	657.9	3164.02	9980.9	6.372	36.2
	RodC6_54.8	139	54.8	1.392	7.8	0.198	755.52	675.1	3226.79	10178.9	6.117	34.7
	RodC6_57.8	140	57.8	1.468	10.8	0.274	800.29	700.0	3321.11	10476.4	5.803	33.0
	RodC6_63.8	141	63.8	1.621	16.8	0.427	876.62	742.4	3509.06	11069.3	5.410	30.7
	RodC6_73.7	142	73.7	1.872	2.82	0.072	889.69	749.6	3818.23	12044.6	5.770	32.8
	RodC6_75.8	143	75.8	1.925	4.92	0.125	920.95	767.0	3883.99	12252.0	5.605	31.8
	RodC6_76.8	144	76.8	1.951	5.92	0.150	938.51	776.8	3915.43	12351.2	5.511	31.3

Table A-72: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	872.24	739.9	4201.16	13252.6	6.521	37.0
	RodB4_91.3	162	91.3	2.319	2.8	0.071	971.82	795.3	4285.44	13518.4	5.761	32.7
	RodB4_93.3	163	93.3	2.370	4.8	0.122	1008.35	815.6	4343.26	13700.8	5.566	31.6
	RodB4_95.1	164	95.1	2.416	6.6	0.168	1042.73	834.7	4395.30	13865.0	5.395	30.6
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1336.74	998.0	1767.92	5576.9	1.595	9.1
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	838.68	721.3	4146.53	13080.2	6.790	38.6
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	845.04	724.8	4230.09	13343.8	6.855	38.9
	RodF4_92.4	100	92.4	2.347	3.9	0.099	964.22	791.1	4348.63	13717.8	5.907	33.5
	RodF4_94.3	101	94.3	2.395	5.8	0.147	1007.60	815.1	4404.83	13895.0	5.650	32.1
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1210.09	927.6	4177.53	13178.0	4.254	24.2
	RodD2_106	66	106	2.692	17.5	0.445	1235.29	941.6	3956.38	12480.4	3.928	22.3
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1277.46	965.1	3655.37	11530.9	3.483	19.8
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1297.34	976.1	3301.50	10414.6	3.087	17.5
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1302.89	979.2	2965.27	9354.0	2.759	15.7
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1251.41	950.6	4187.21	13208.6	4.091	23.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1275.70	964.1	4017.12	12672.0	3.834	21.8
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1303.30	979.4	3650.69	11516.1	3.395	19.3
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1314.35	985.6	3302.18	10416.7	3.040	17.3
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1322.58	990.1	2953.36	9316.4	2.698	15.3

Table A-72: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	587.50	581.8	3104.26	9792.4	8.635	49.0
	RodE2_54	74	54	1.372	7	0.178	652.50	617.9	3221.94	10163.6	7.590	43.1
	RodE2_56.9	75	56.9	1.445	9.9	0.251	688.66	638.0	3309.79	10440.7	7.185	40.8
	RodE2_59.9	76	59.9	1.521	12.9	0.328	729.34	660.6	3401.08	10728.7	6.784	38.5
	RodE2_66	77	66	1.676	19	0.483	674.20	629.9	3586.92	11314.9	8.039	45.7
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	408.89	482.5	3686.67	11629.6	20.381	115.7
	RodE2_72.9	79	72.9	1.852	2.02	0.051	680.30	633.3	3793.70	11967.2	8.388	47.6
	RodE2_74.9	80	74.9	1.902	4.02	0.102	742.45	667.8	3855.00	12160.6	7.493	42.6
Gr-8	RodB3_54.1	170	54.1	1.374	7.1	0.180	408.14	482.1	3210.68	10128.1	17.824	101.2
	RodB3_56.9	171	56.9	1.445	9.9	0.251	619.16	599.3	3289.36	10376.3	8.409	47.8
	RodB3_60.1	172	60.1	1.527	13.1	0.333	687.91	637.5	3382.90	10671.3	7.356	41.8
	RodB3_66.1	173	66.1	1.679	19.1	0.485	650.42	616.7	3563.15	11240.0	8.435	47.9
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	425.57	491.8	3661.32	11549.6	18.532	105.2
	RodB3_73	175	73	1.854	2.12	0.054	679.19	632.7	3767.64	11885.0	8.351	47.4
	RodB3_75	176	75	1.905	4.12	0.105	744.85	669.2	3827.80	12074.8	7.406	42.1
Gr-8	RodF3_54	90	54	1.372	7	0.178	281.36	411.7	3213.15	10135.9	60.216	342.0
	RodF3_57	91	57	1.448	10	0.254	565.19	569.4	3302.09	10416.4	9.793	55.6
	RodF3_60	92	60	1.524	13	0.330	661.02	622.6	3390.98	10696.8	7.831	44.5
	RodF3_66.1	93	66.1	1.679	19.1	0.485	716.96	653.7	3576.95	11283.5	7.315	41.5
	RodF3_70	94	70	1.778	-0.88	-0.022	600.21	588.8	3694.48	11654.2	9.926	56.4
	RodF3_73	95	73	1.854	2.12	0.054	698.28	643.3	3786.25	11943.7	8.051	45.7
	RodF3_75	96	75	1.905	4.12	0.105	749.67	671.9	3847.54	12137.1	7.375	41.9
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	662.32	623.3	3086.41	9736.1	7.106	40.4
	RodE6_54.1	122	54.1	1.374	7.1	0.180	724.24	657.7	3202.60	10102.6	6.454	36.6
	RodE6_57	123	57	1.448	10	0.254	762.92	679.2	3288.69	10374.2	6.148	34.9
	RodE6_60.2	124	60.2	1.529	13.2	0.335	812.93	707.0	3383.32	10672.7	5.784	32.8
	RodE6_66.1	125	66.1	1.679	19.1	0.485	858.37	732.2	3558.12	11224.1	5.644	32.1
	RodE6_70	126	70	1.778	-0.88	-0.022	788.89	693.6	3673.03	11586.6	6.549	37.2
	RodE6_73.1	127	73.1	1.857	2.22	0.056	853.76	729.7	3764.12	11873.9	6.015	34.2
	RodE6_75	128	75	1.905	4.12	0.105	891.70	750.8	3820.25	12051.0	5.756	32.7

RBHT Steam Cooling with Droplet Injection Test SCD-4076-B

Matrix Test # 14b

Test Conditions

Test Date – 12/13/2005
Steady State Time Window: 19500 - 23700
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0072 kg/s (0.016 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

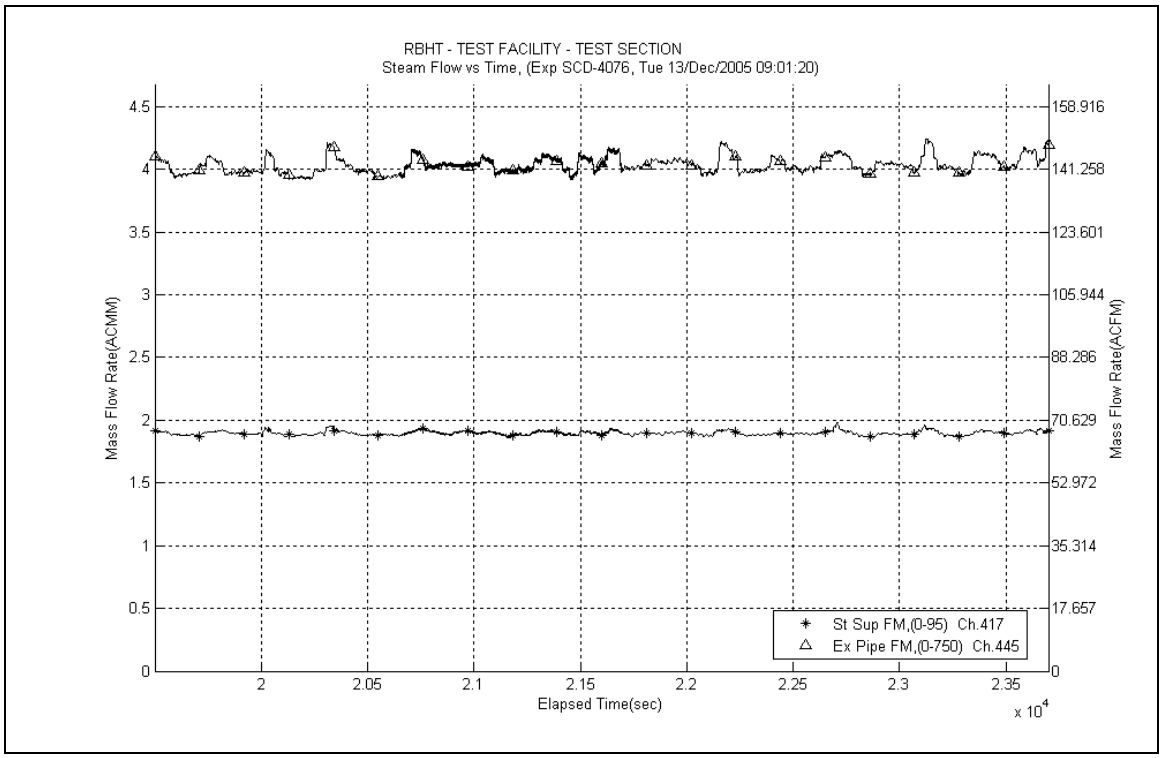

Figure A-694: Inlet and Exhaust Steam Flow Rates for Experiment 4076B

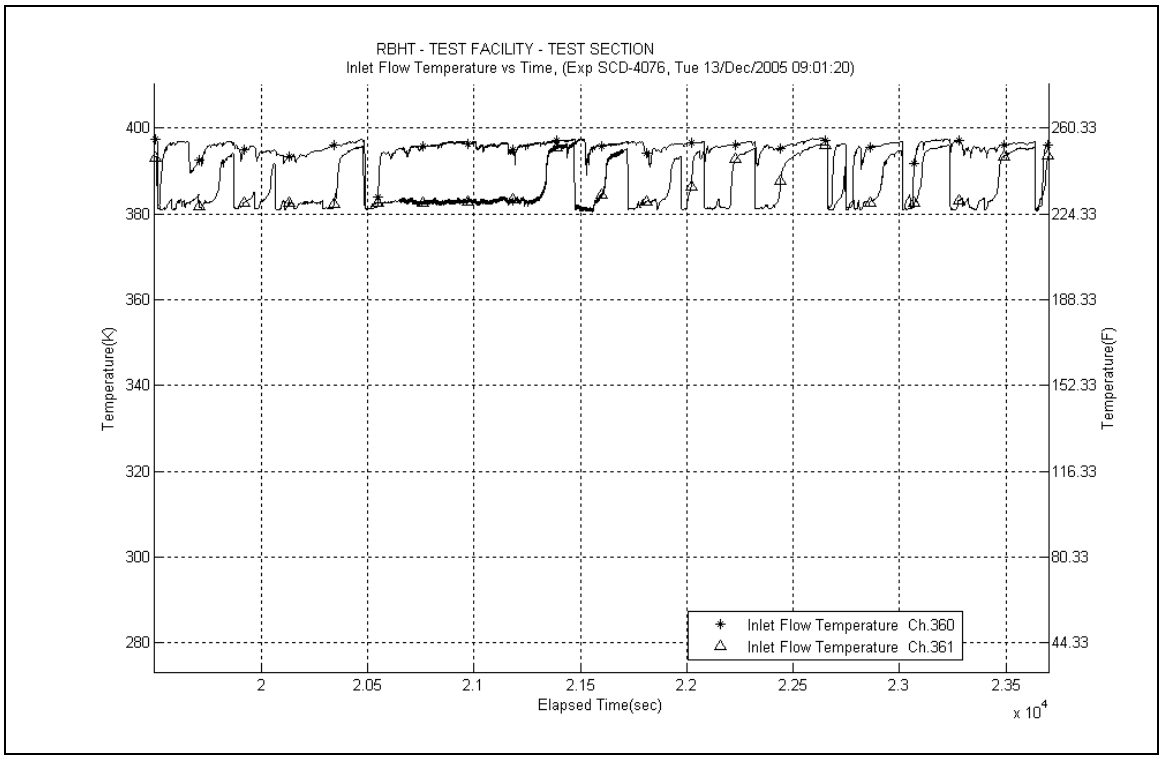

Figure A-695: Inlet Steam Temperature for Experiment 4076B

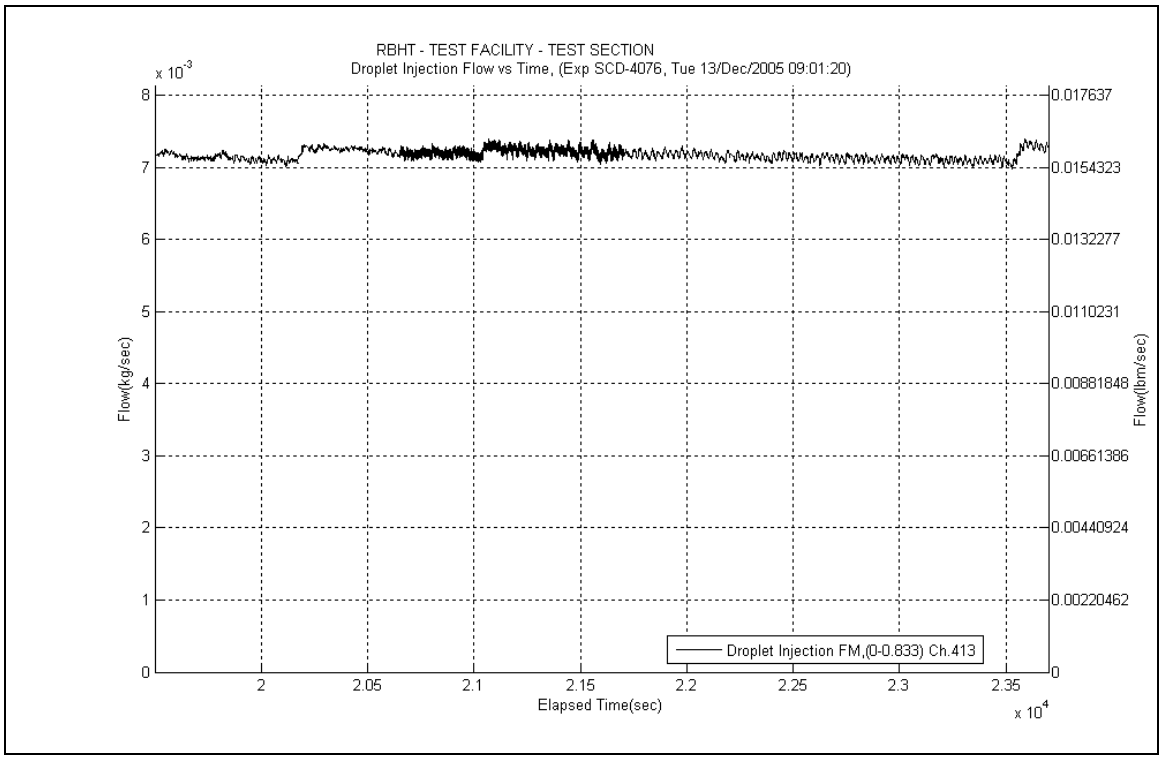

Figure A-696: Droplet Injection Flow Rate for Experiment 4076B

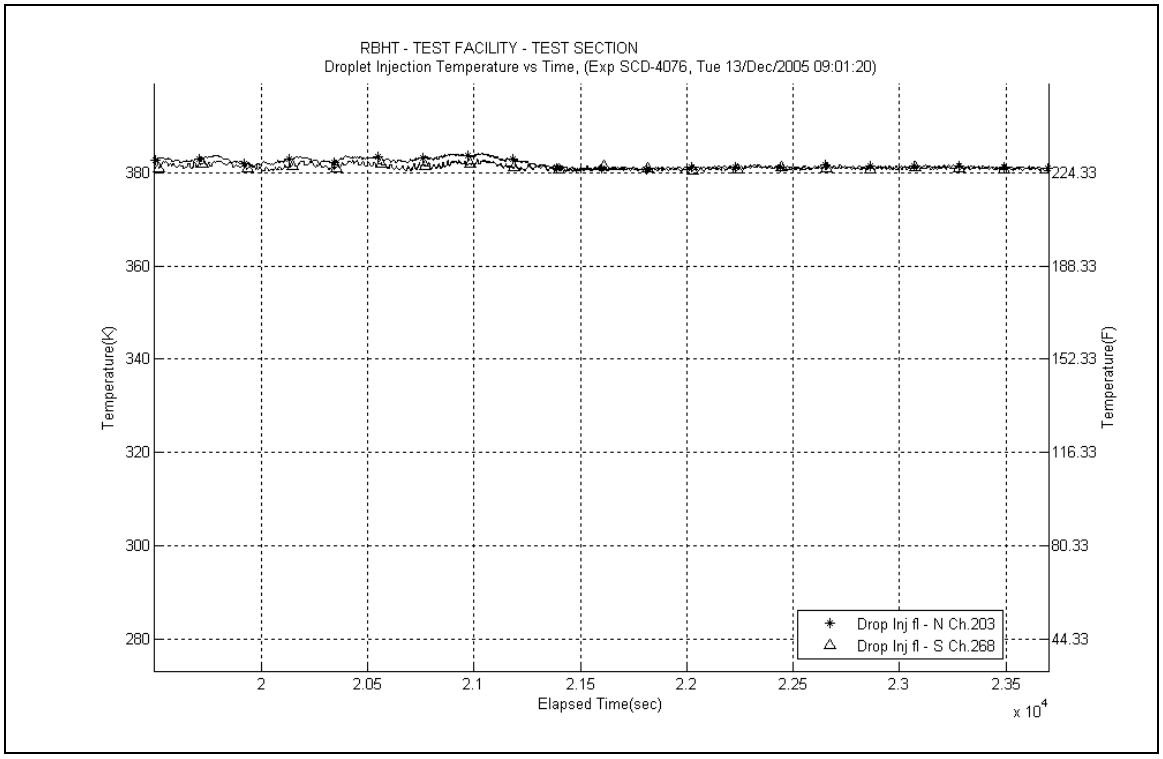

Figure A-697: Droplet Injection Temperature for Experiment 4076B

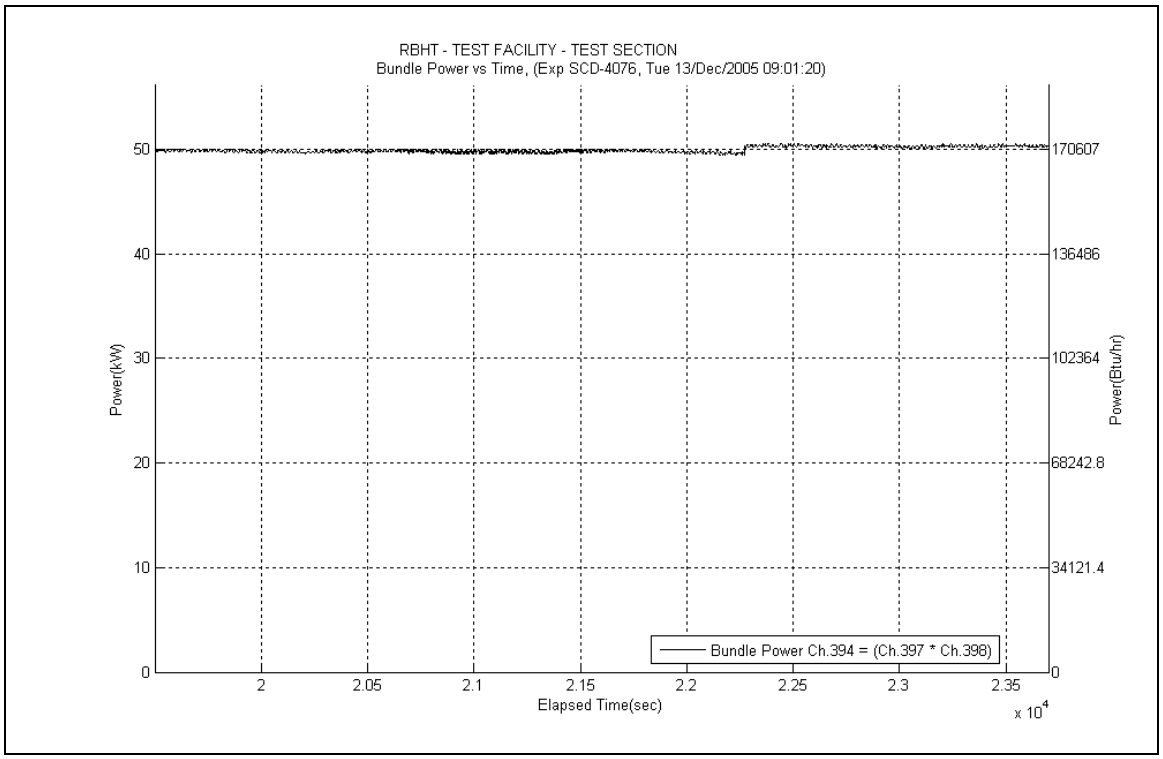

Figure A-698: Bundle Power for Experiment 4076B

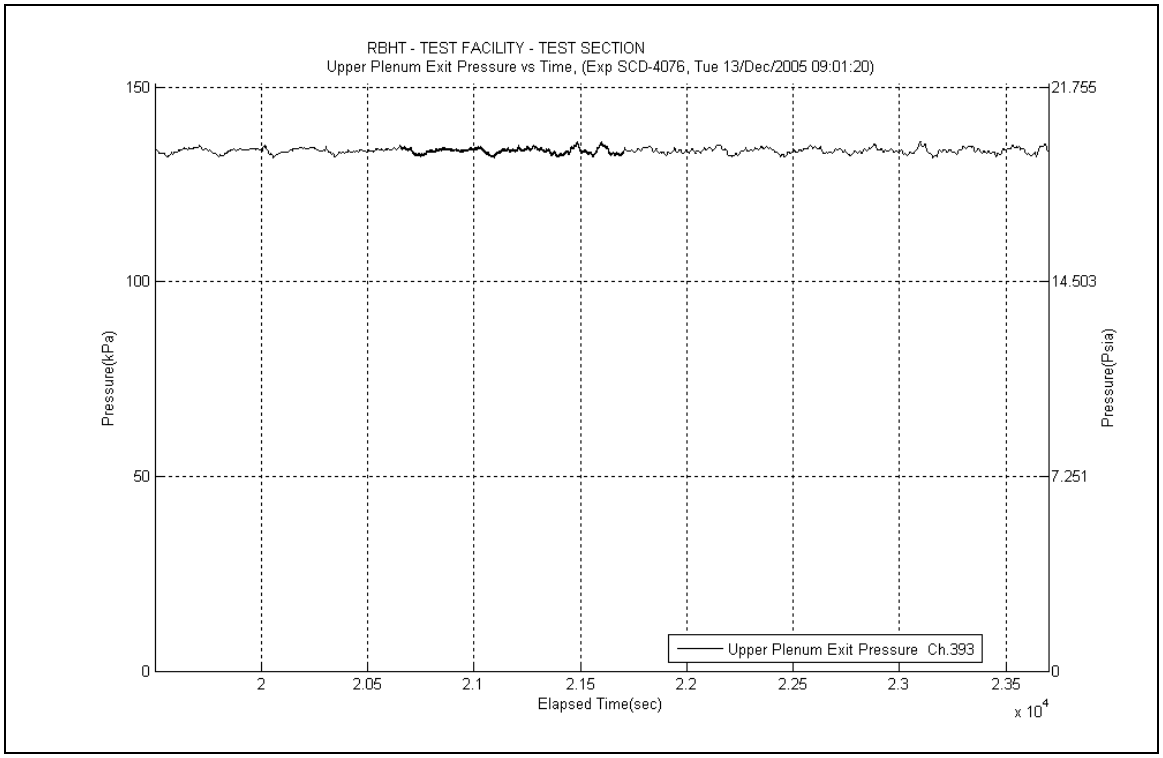

Figure A-699: Upper Plenum Pressure for Experiment 4076B

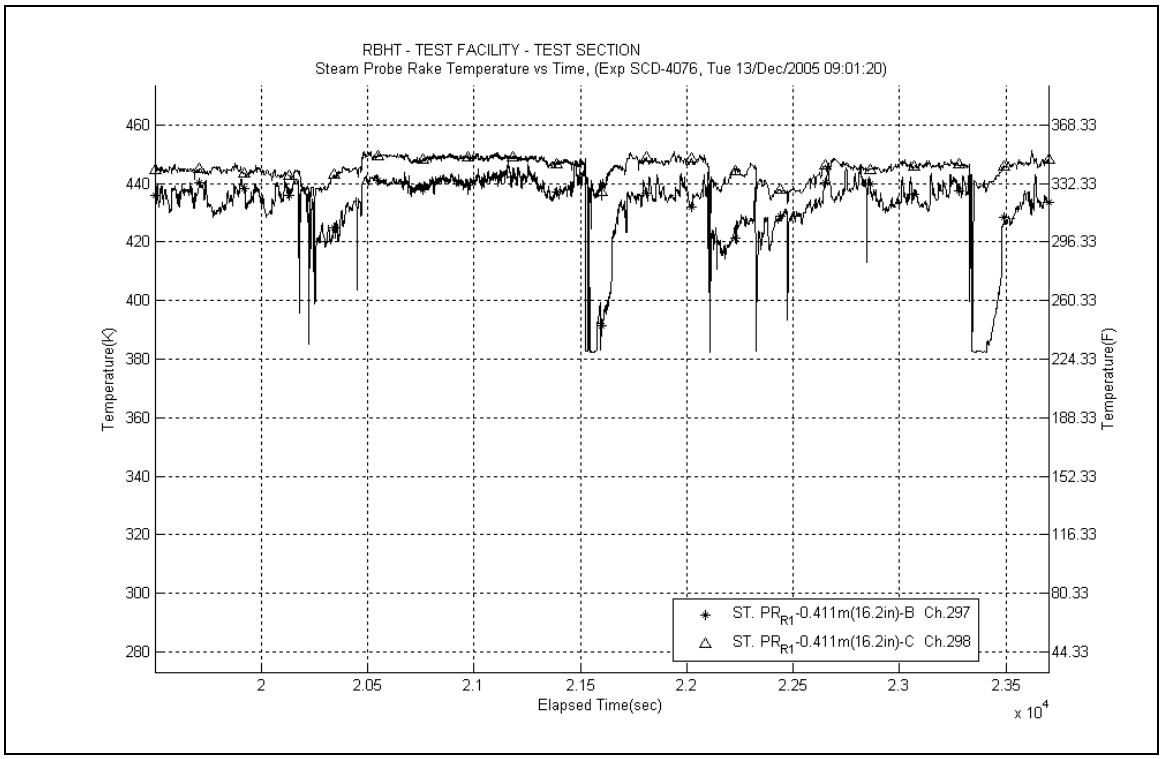

Figure A-700: Steam Probe Rake #1 Temperatures for Experiment 4076B

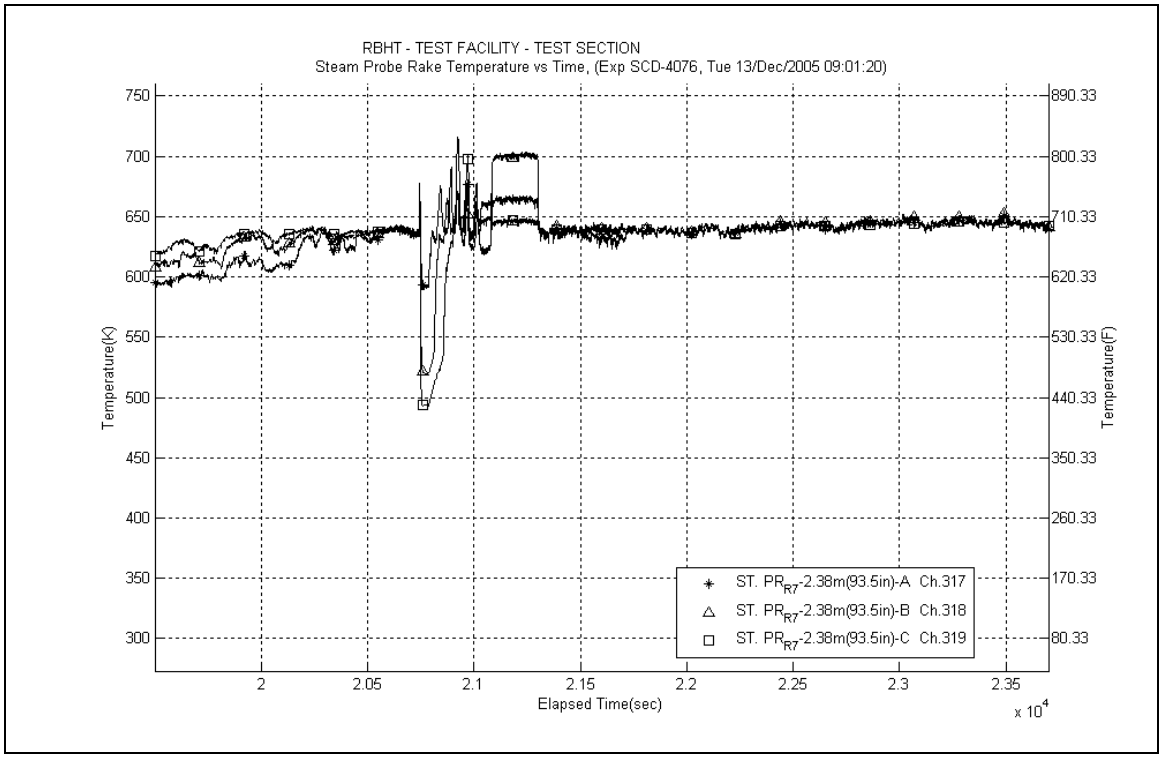

Figure A-701: Steam Probe Rake #7 Temperatures for Experiment 4076B

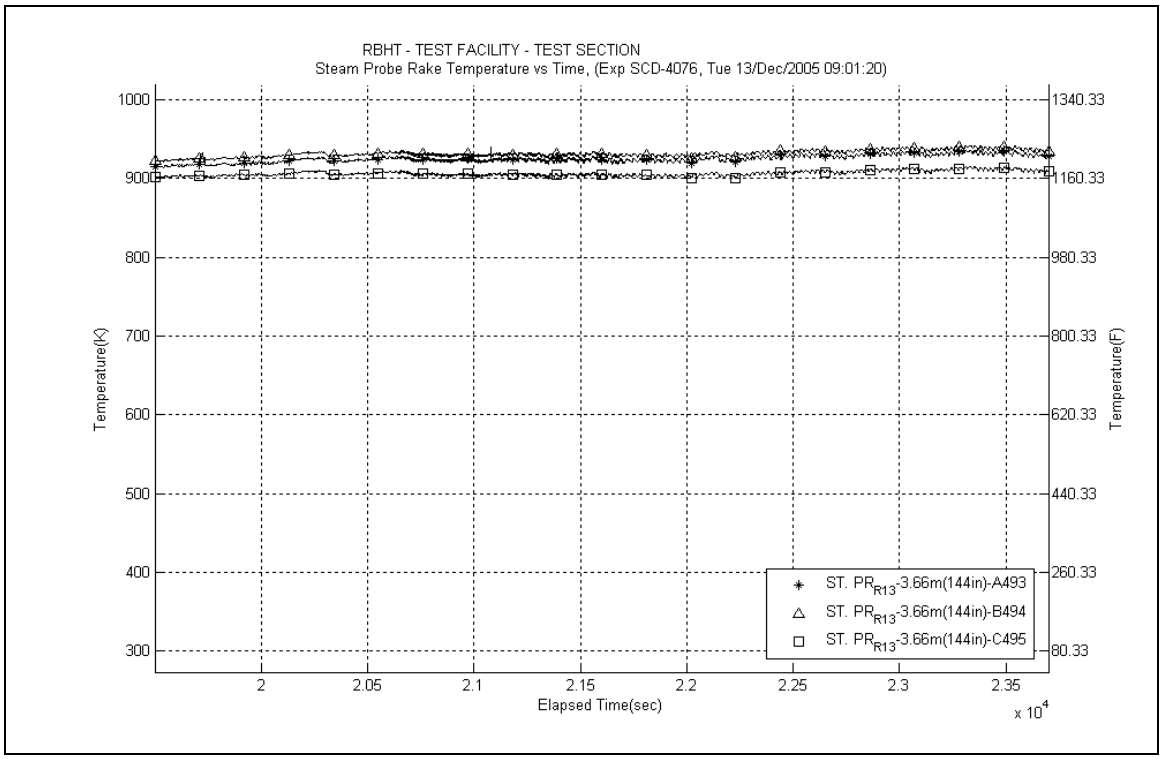

Figure A-702: Steam Probe Rake #13 Temperatures for Experiment 4076B

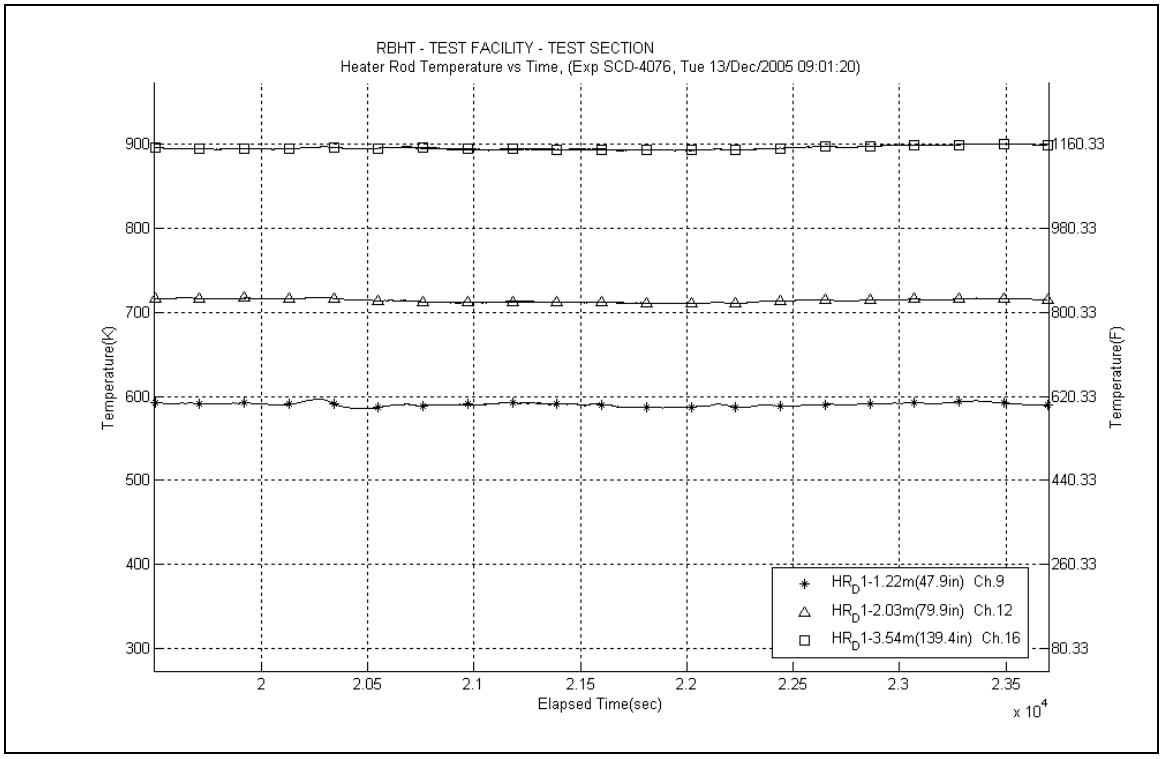

Figure A-703: Heater Rod D1 Temperatures for Experiment 4076B

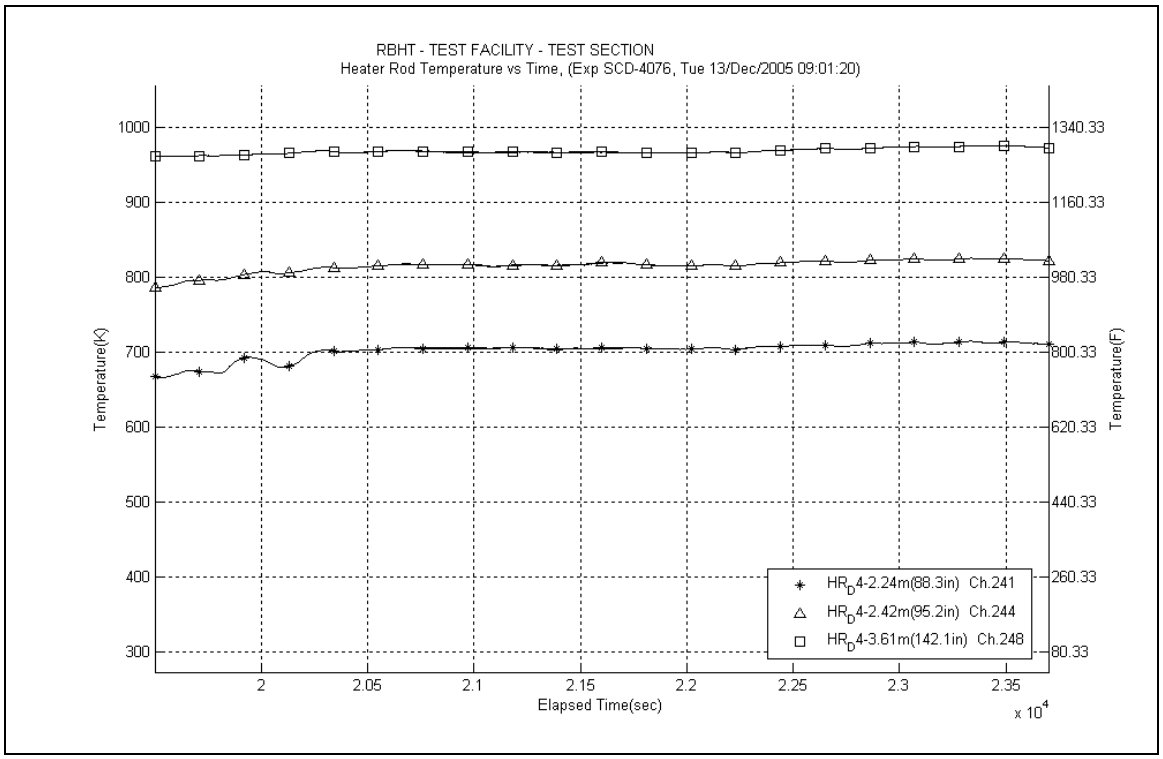

Figure A-704: Heater Rod D4 Temperatures for Experiment 4076B

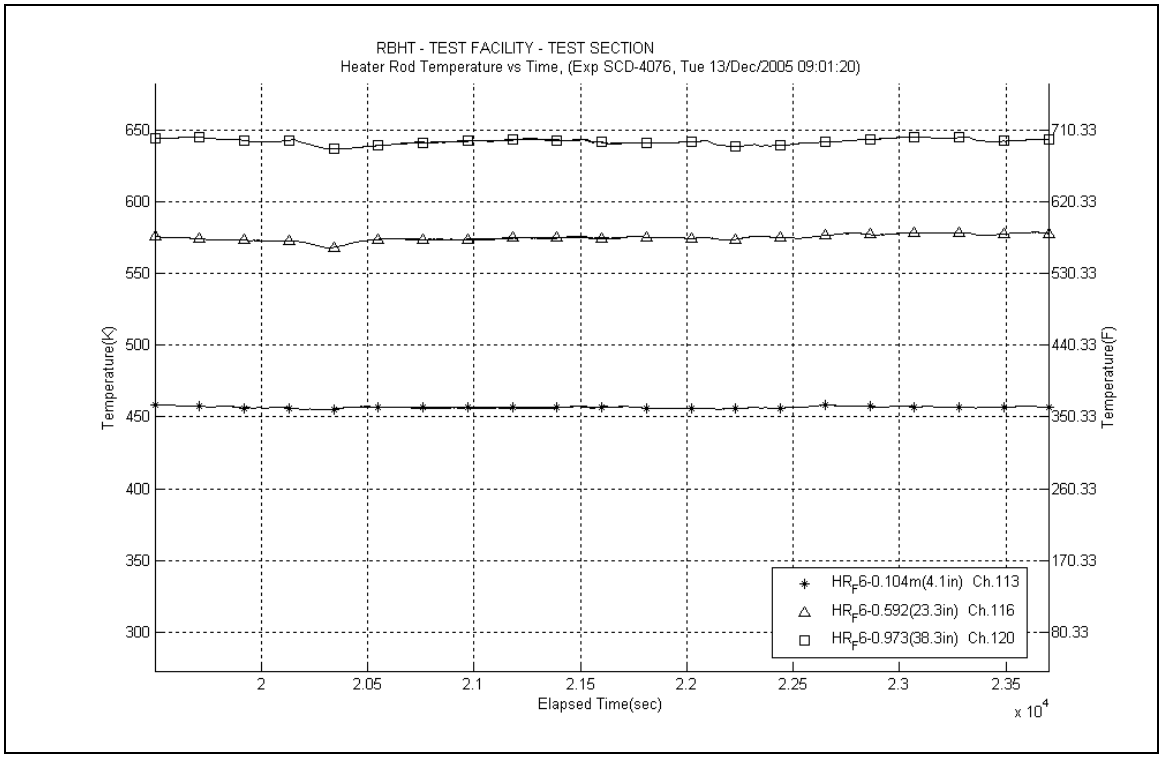

Figure A-705: Heater Rod F6 Temperatures for Experiment 4076B

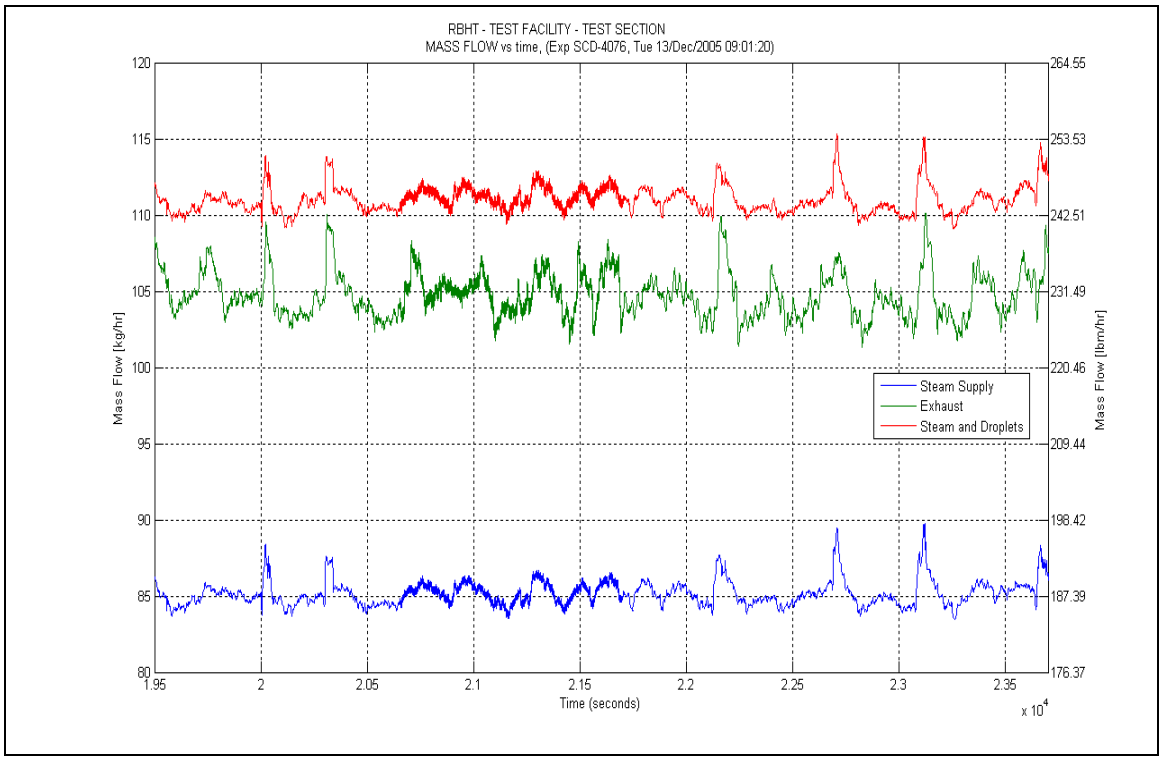

Figure A-706: Mass Flow for Experiment 4076B

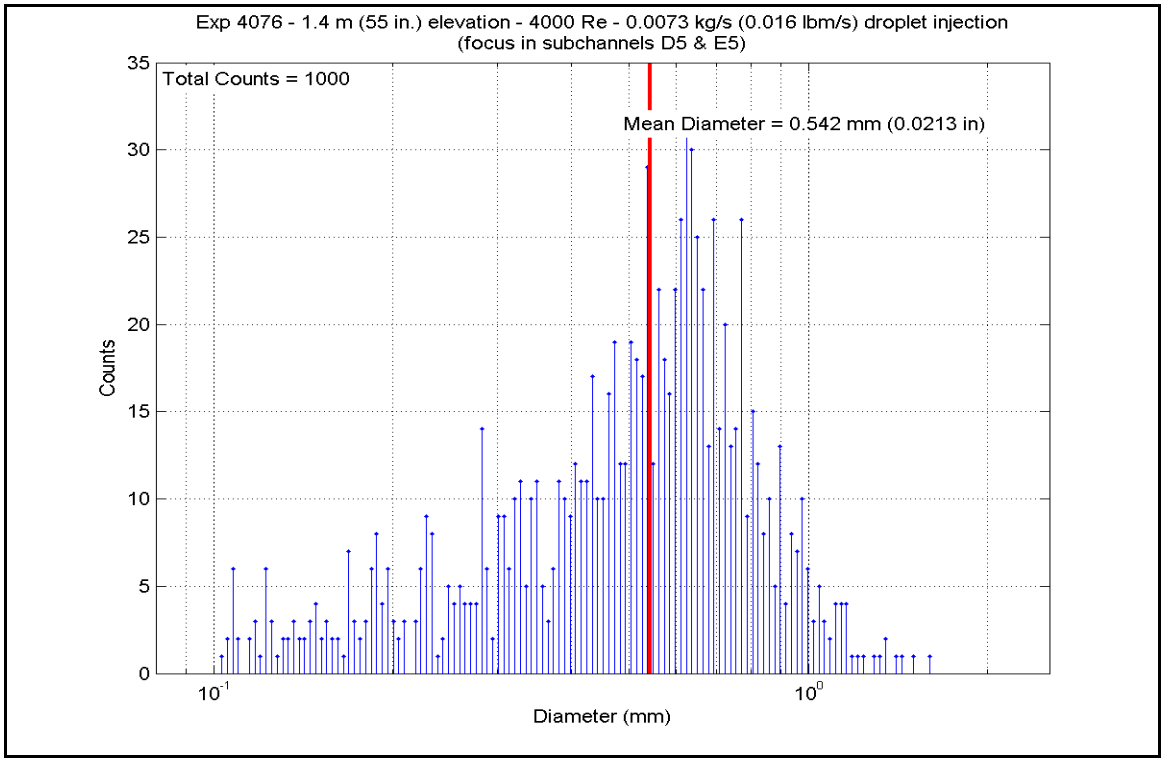

Figure A-707: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076B

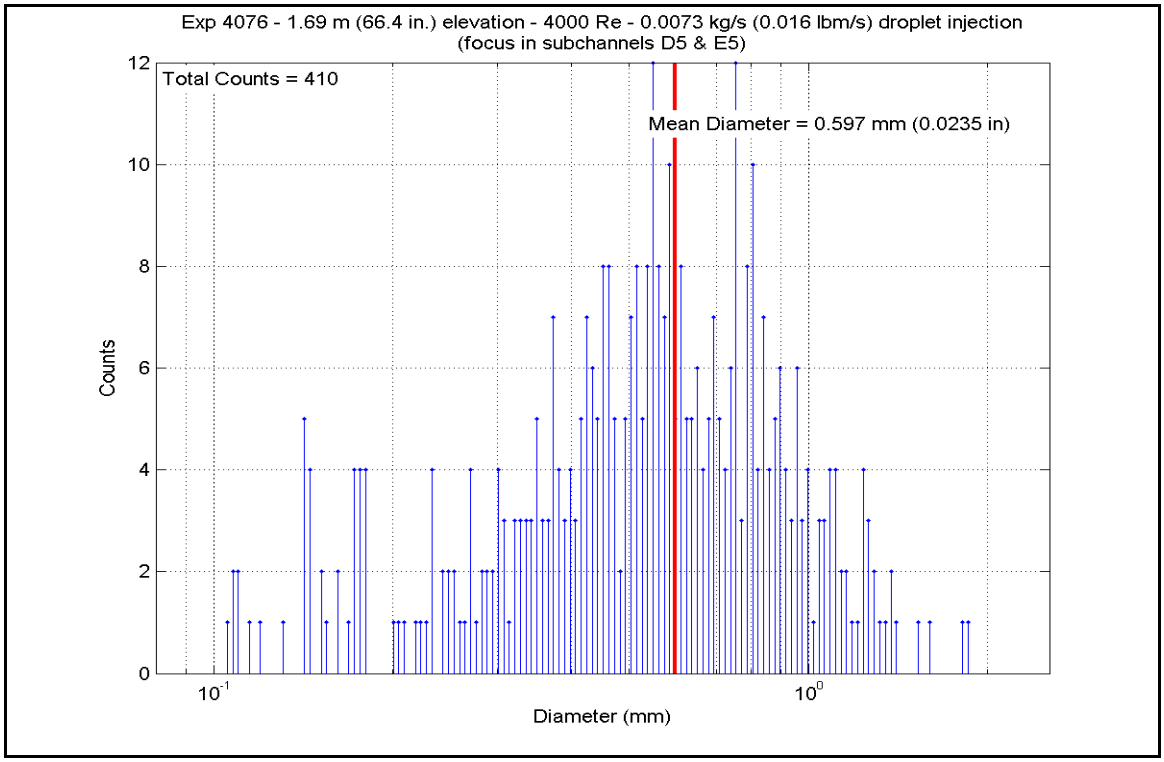

Figure A-708: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076B

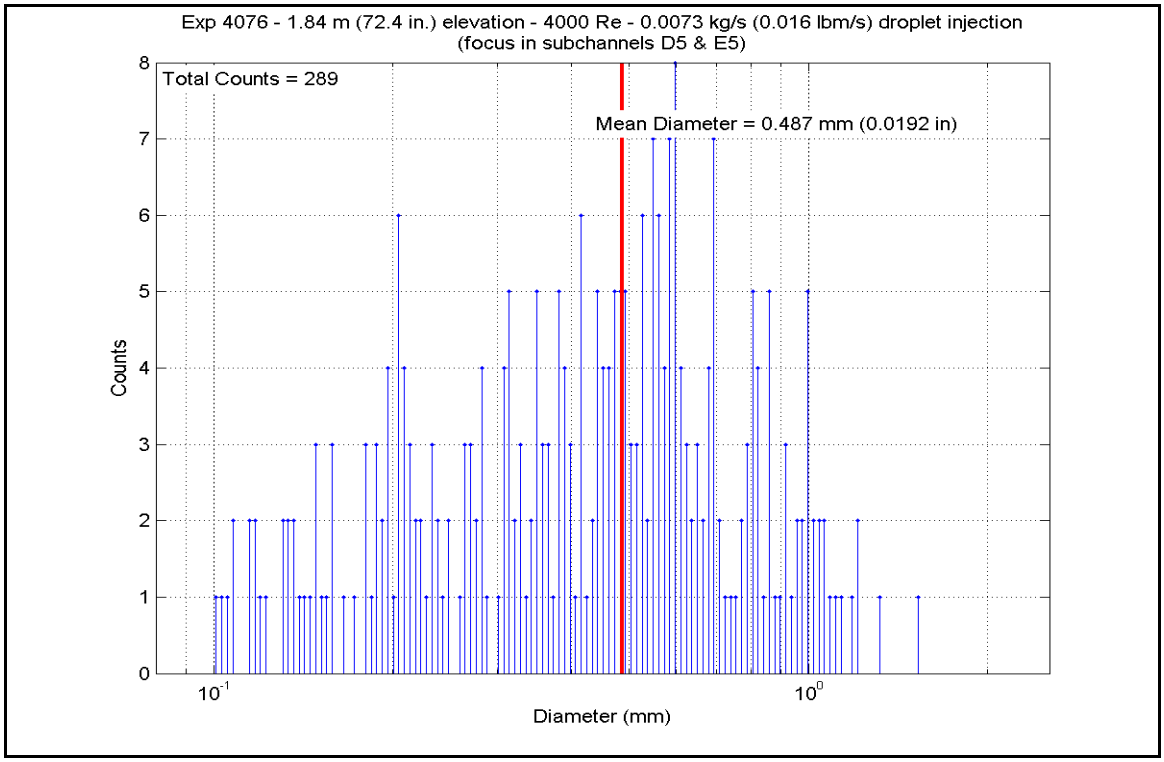

Figure A-709: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076B

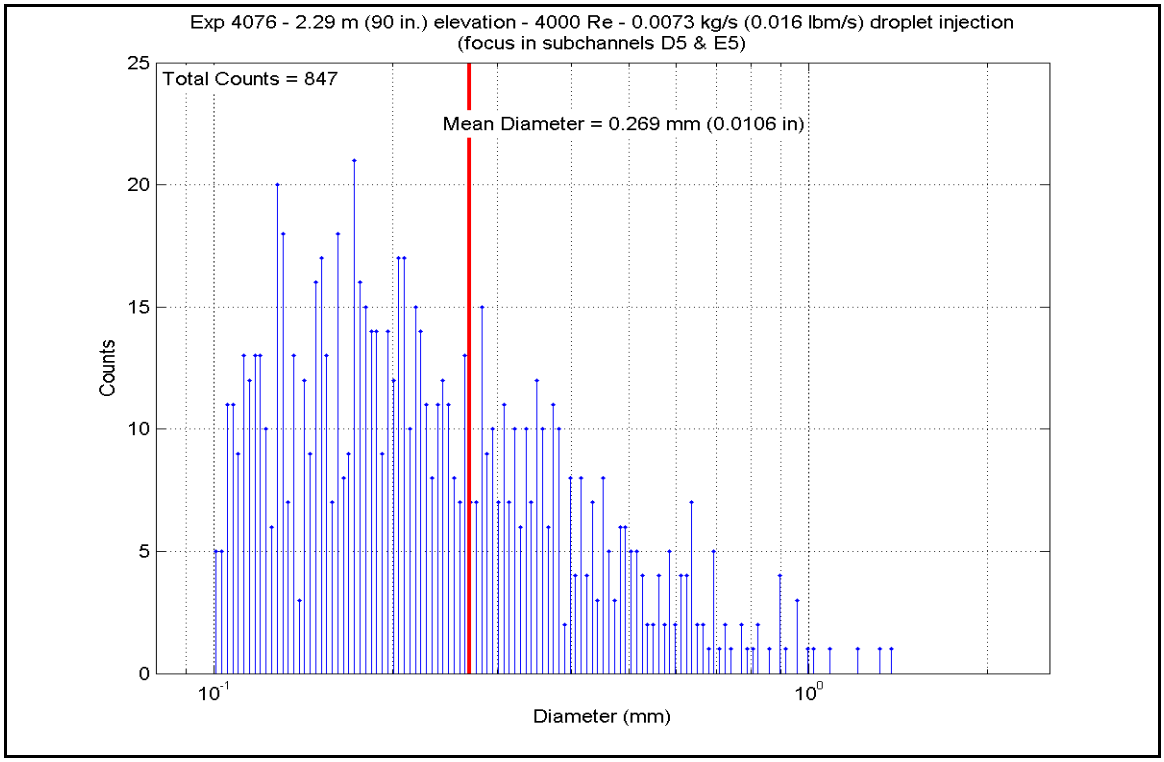

Figure A-710: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076B

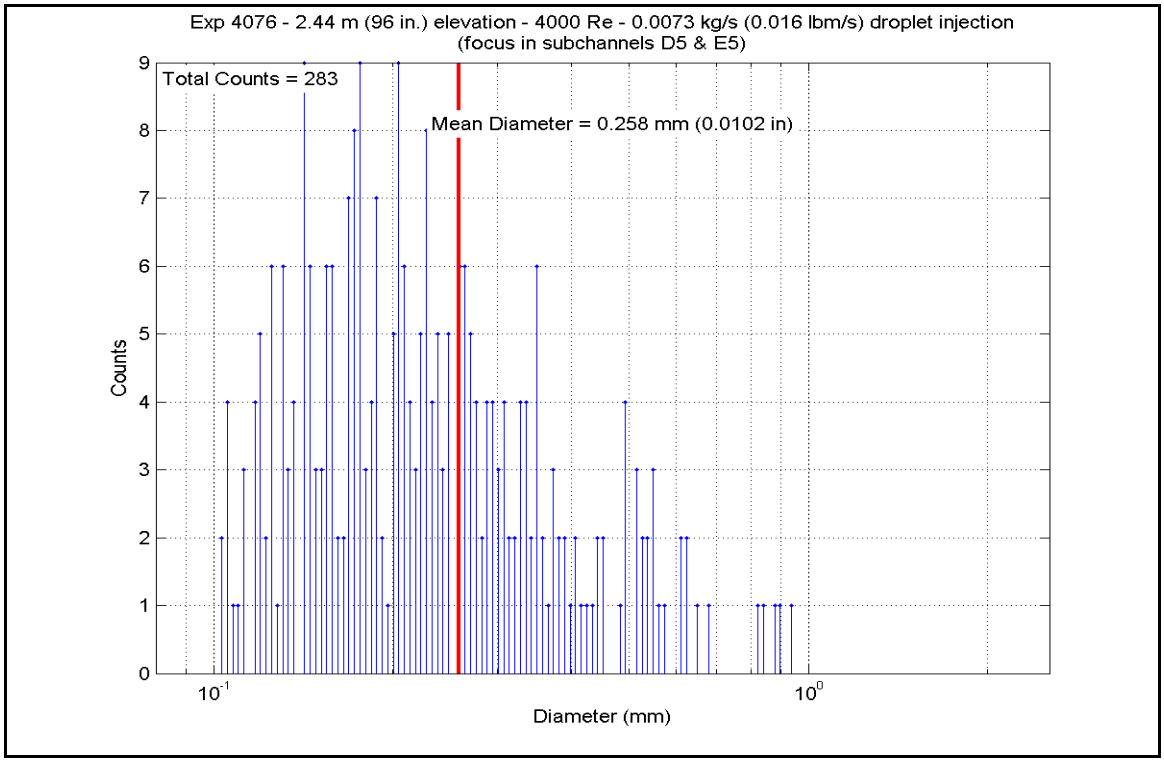

Figure A-711: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076B

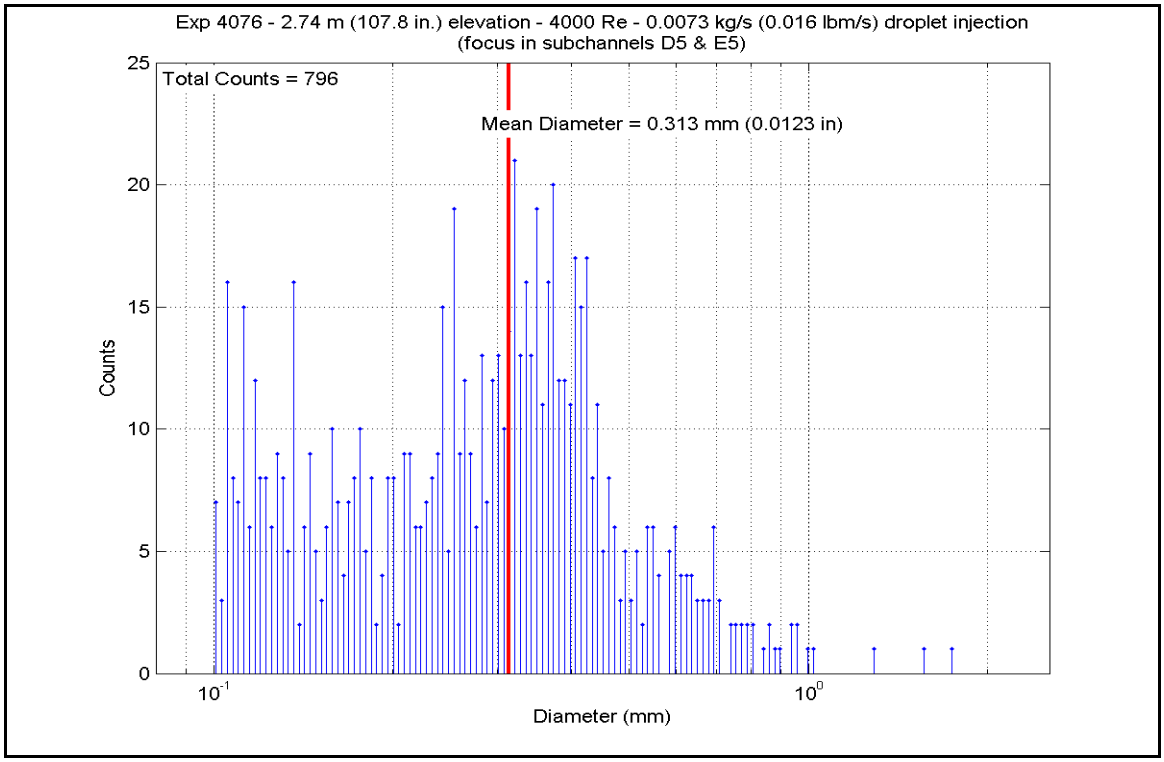

Figure A-712: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076B

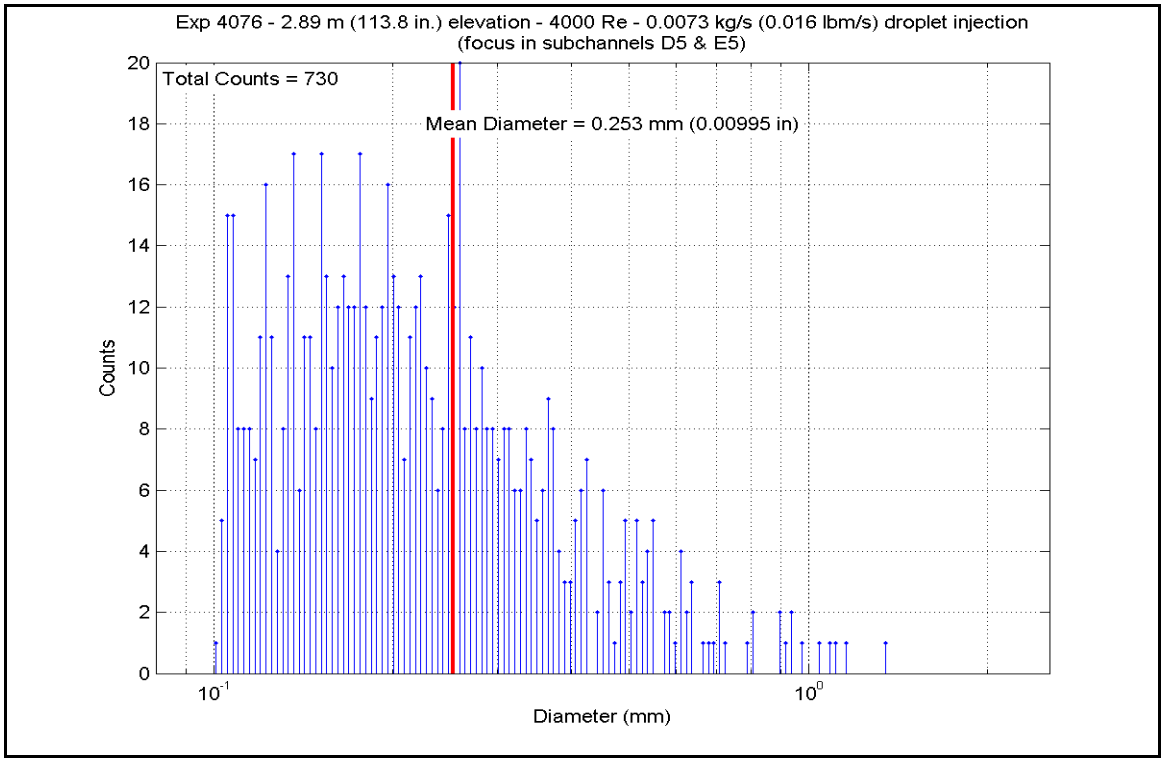

Figure A-713: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076B

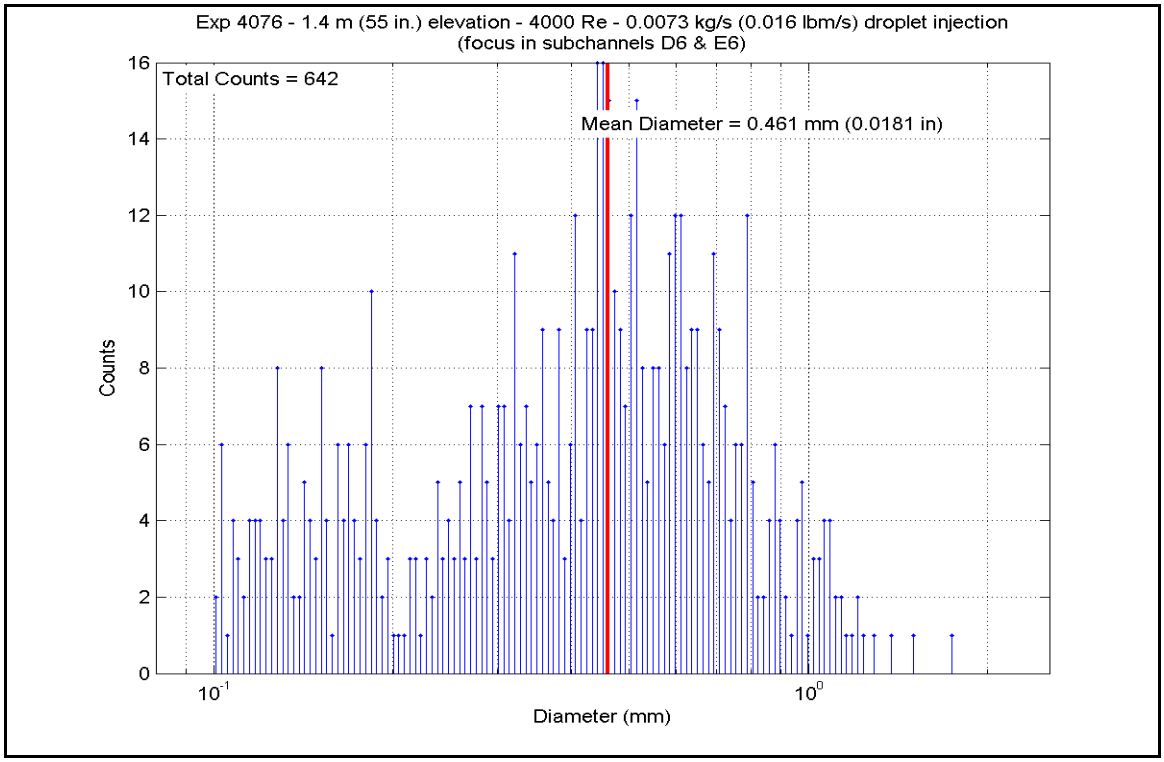

Figure A-714: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076B

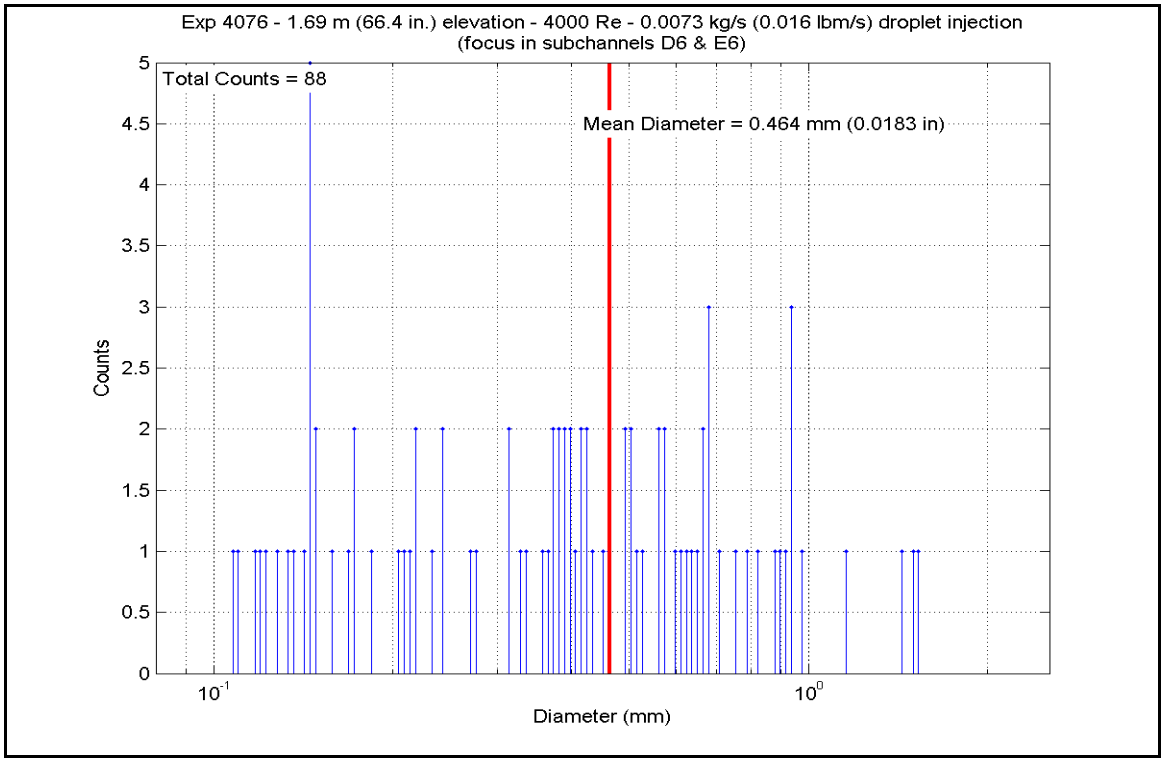

Figure A-715: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076B

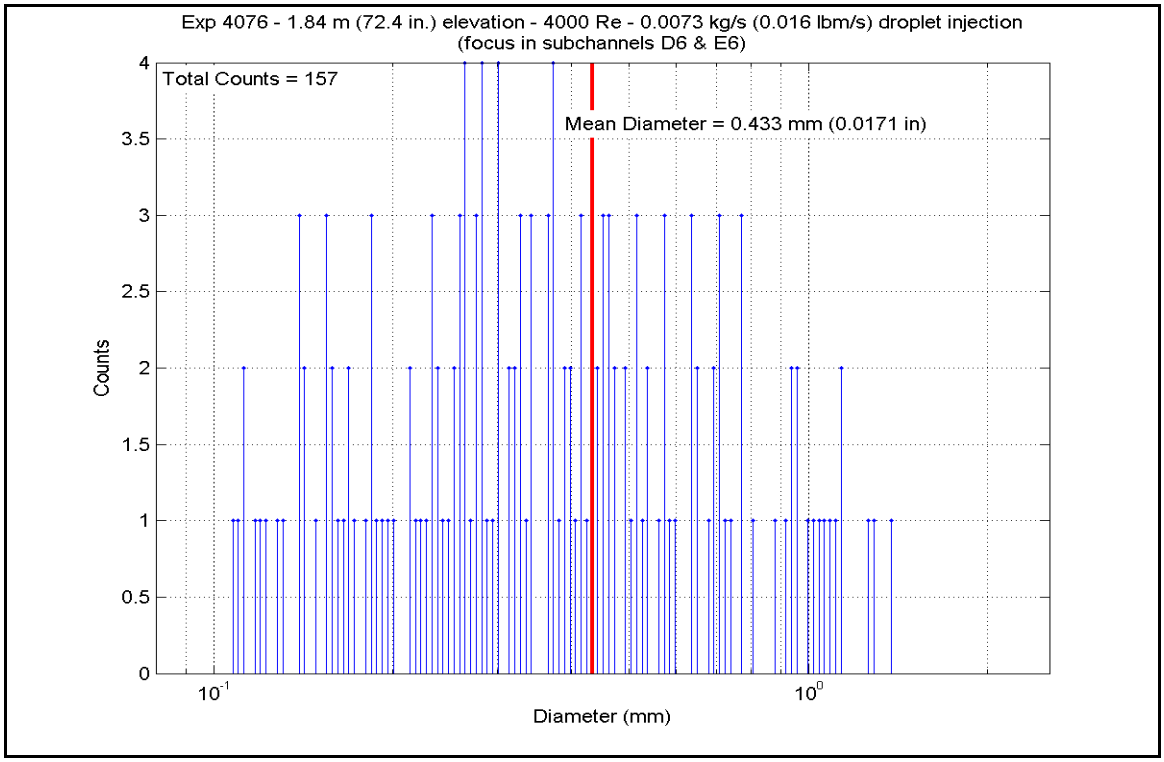

Figure A-716: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076B

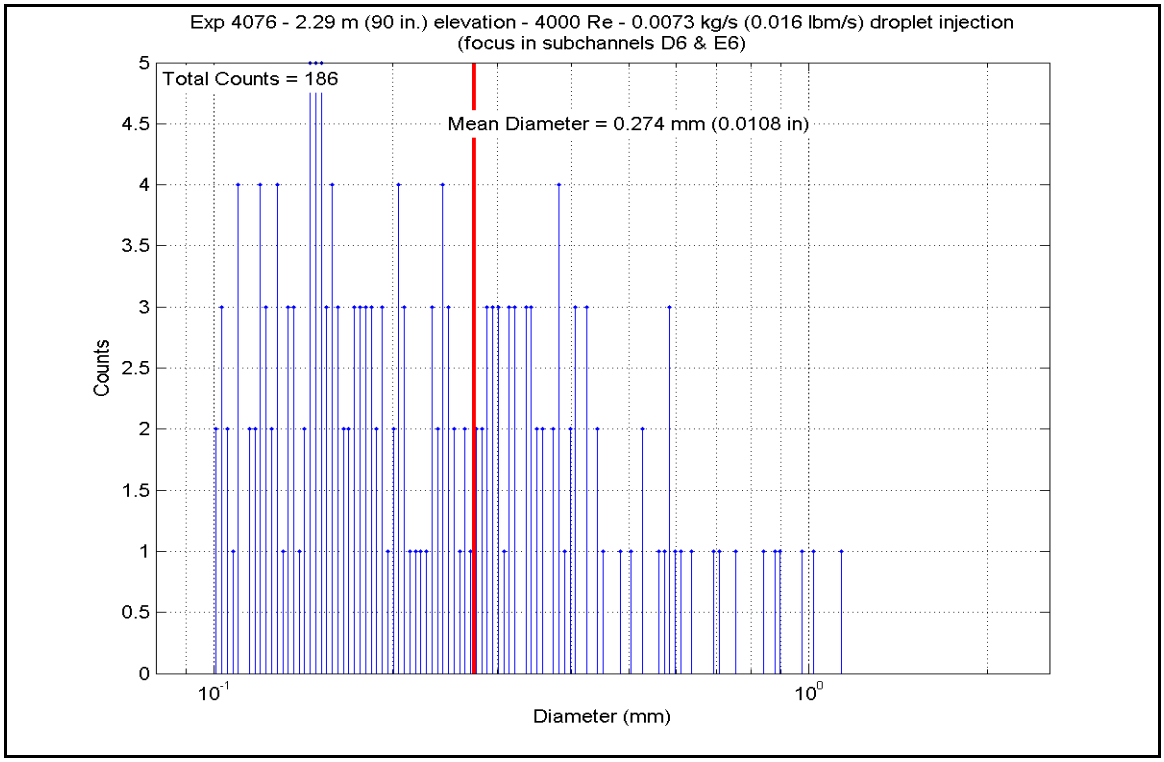

Figure A-717: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076B

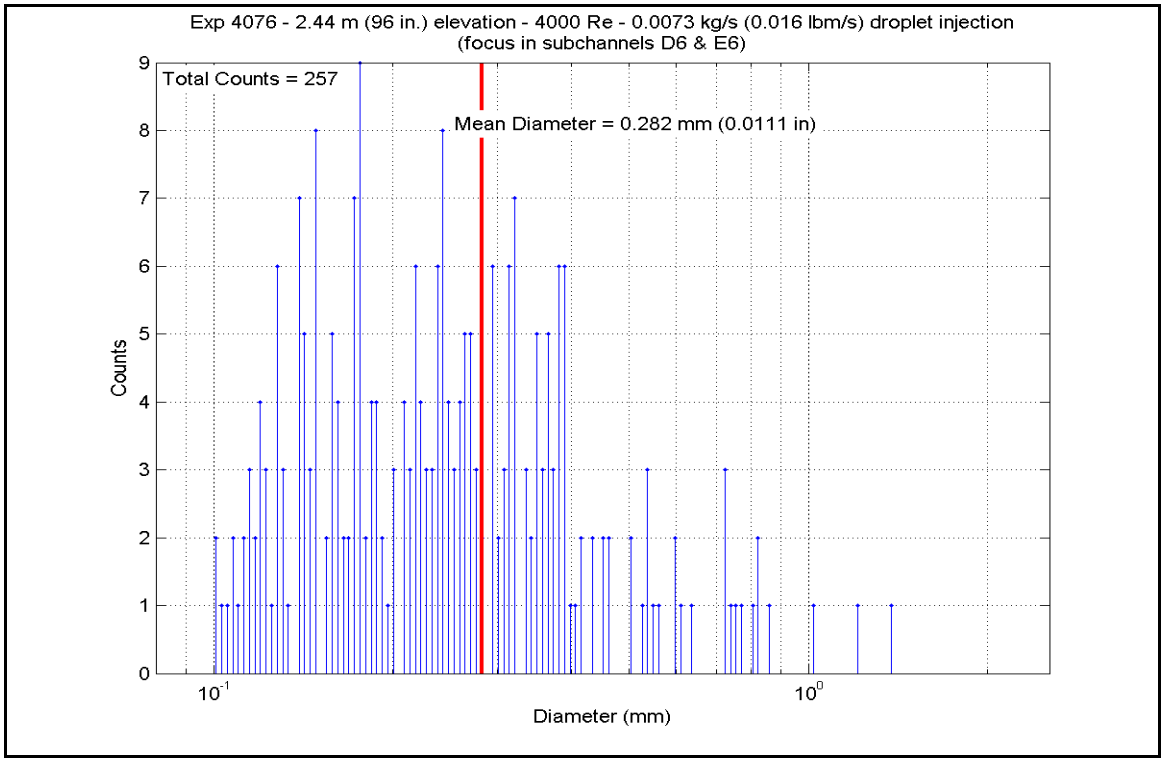

Figure A-718: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076B

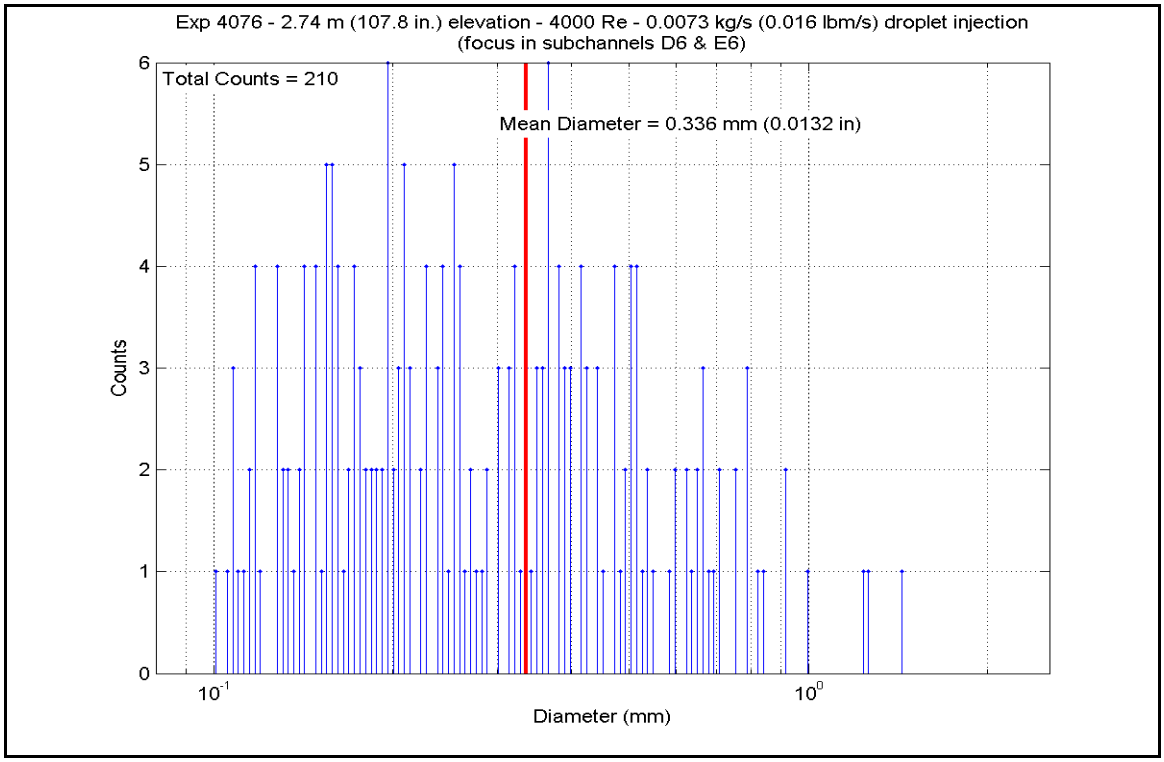

Figure A-719: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076B

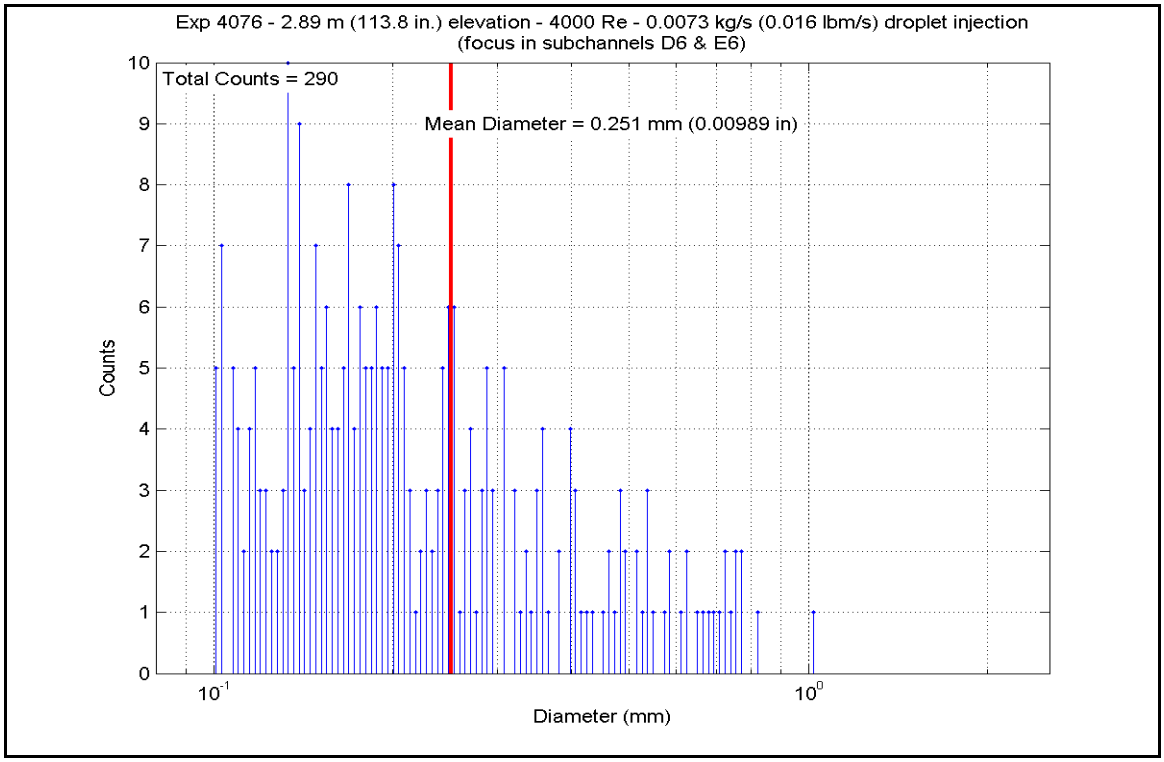

Figure A-720: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076B

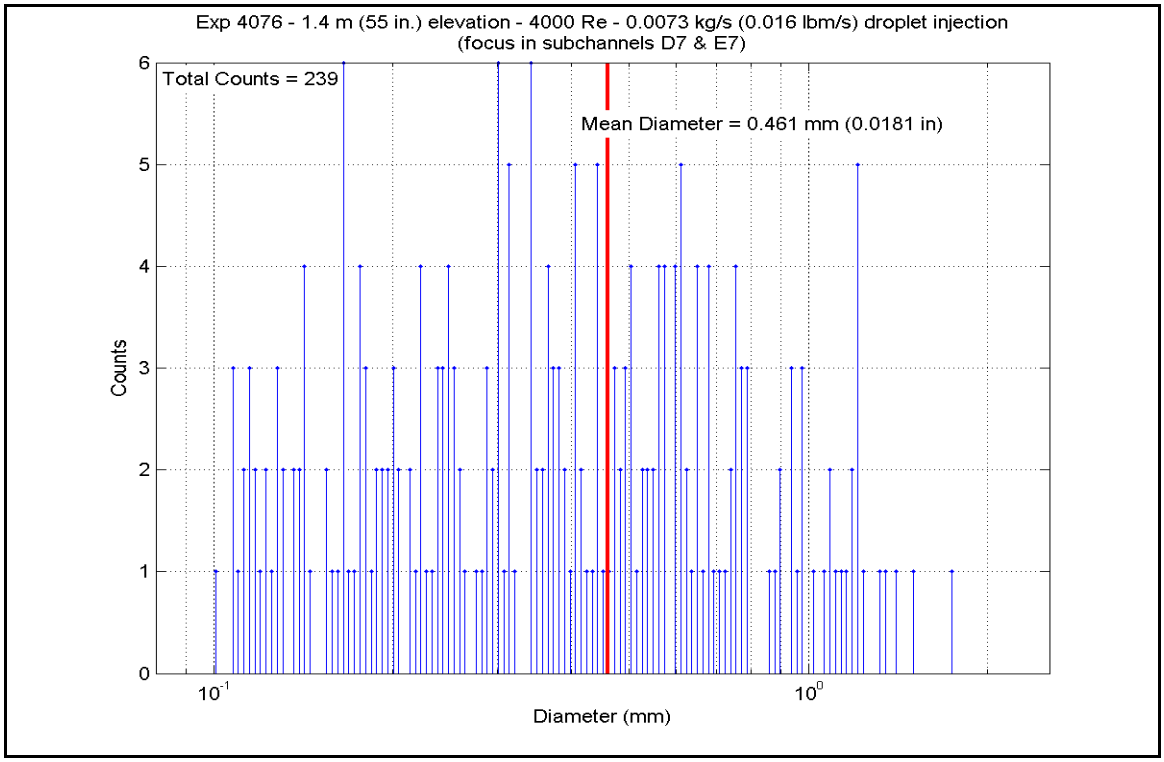

Figure A-721: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076B

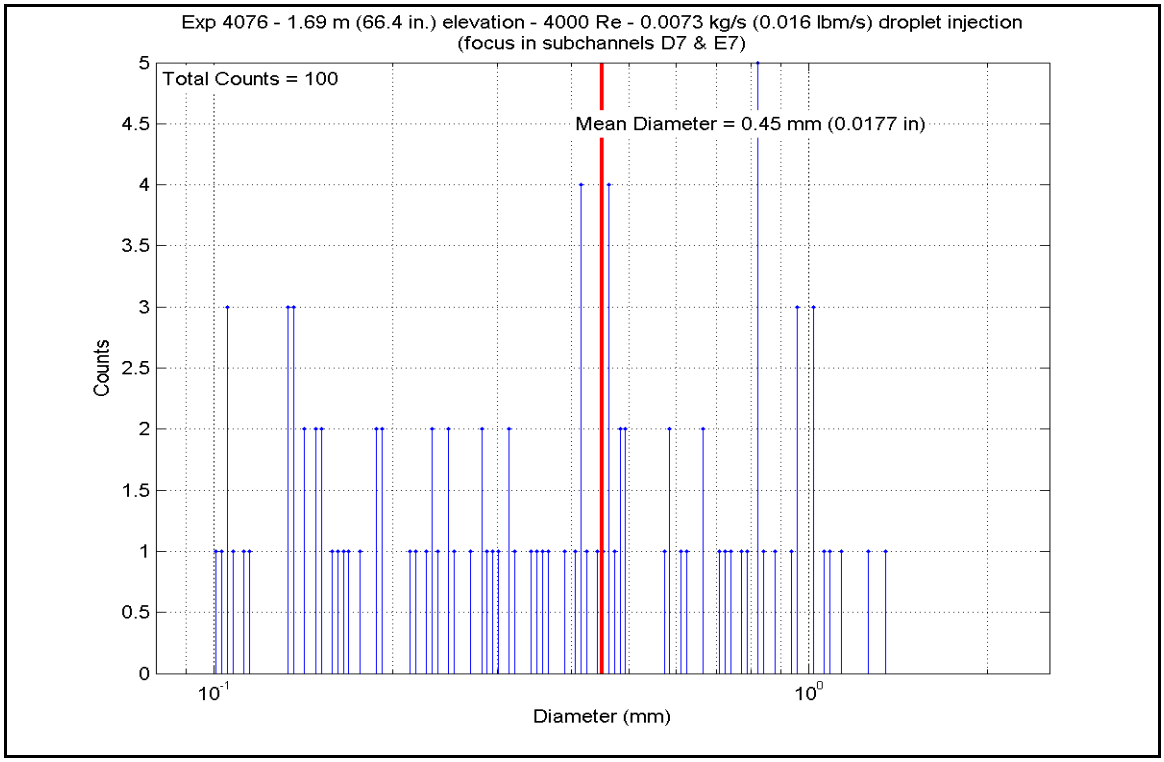

Figure A-722: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076B

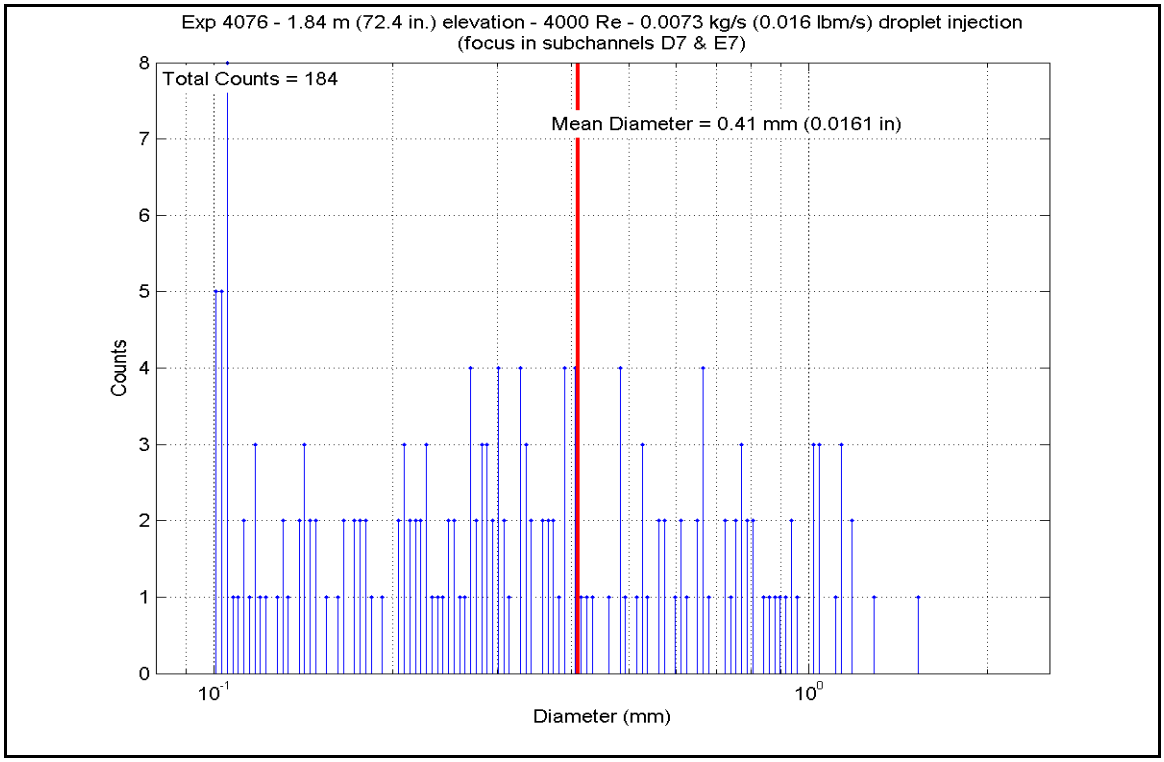

Figure A-723: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076B

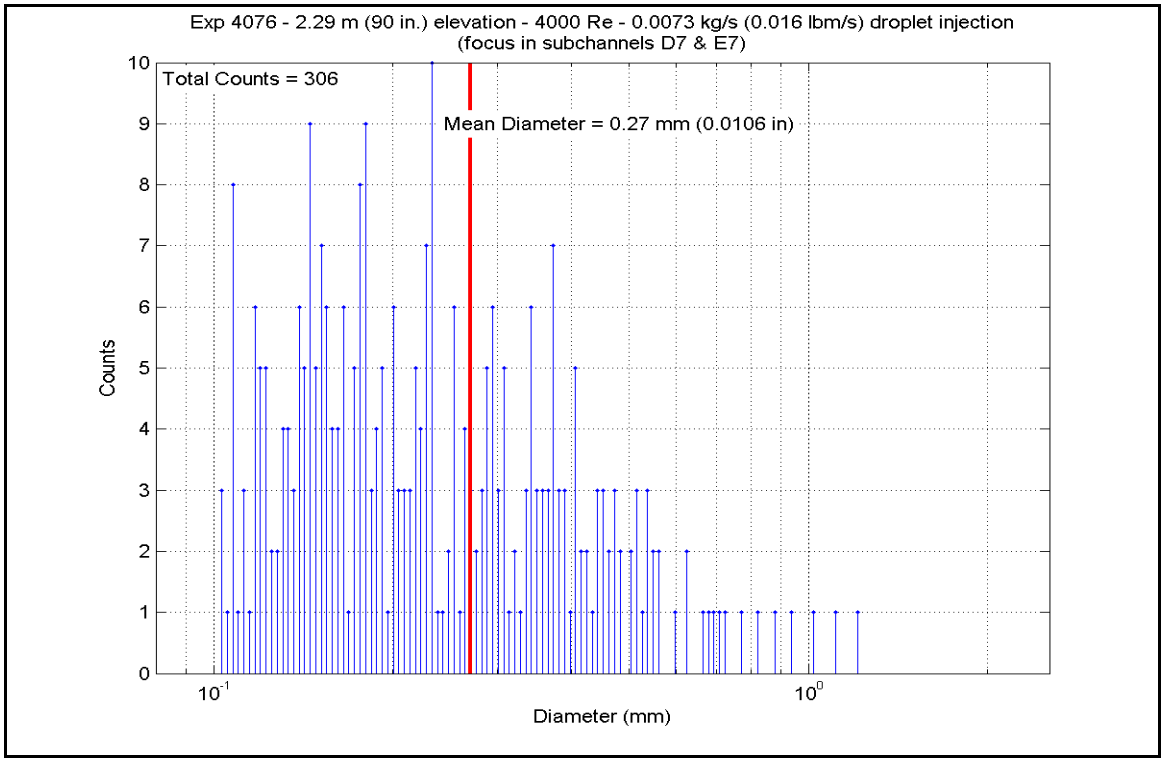

Figure A-724: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076B

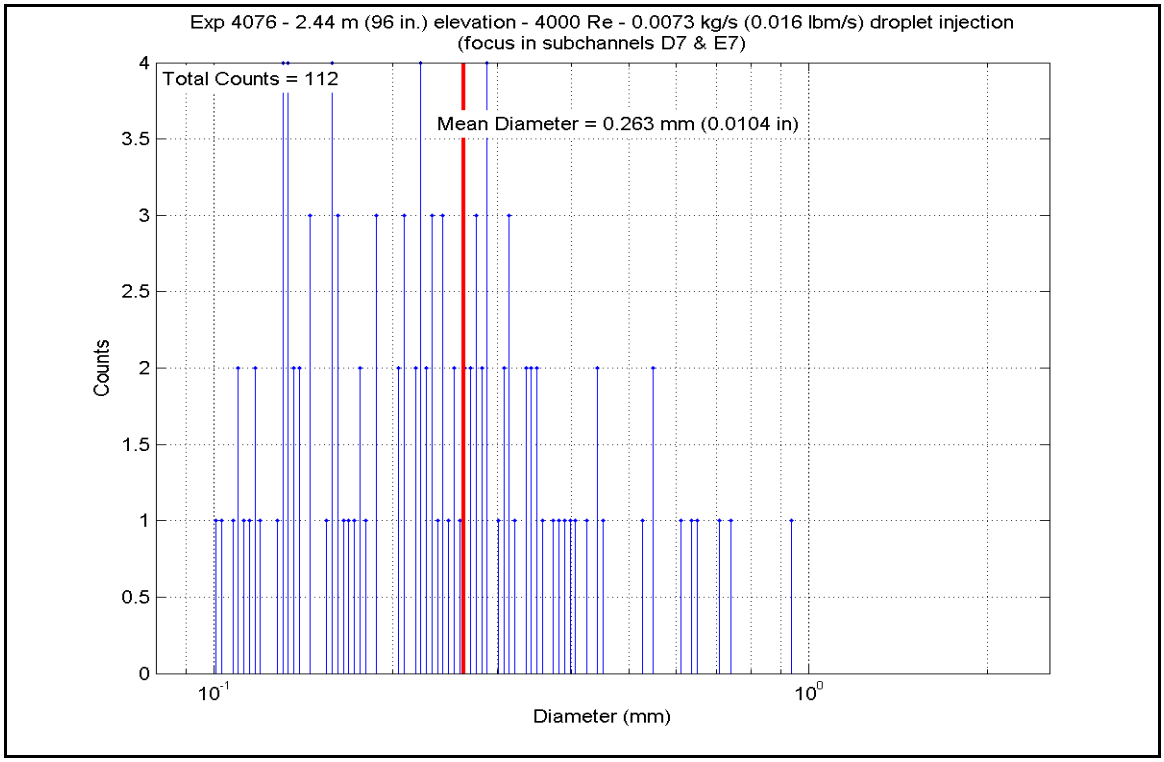

Figure A-725: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076B

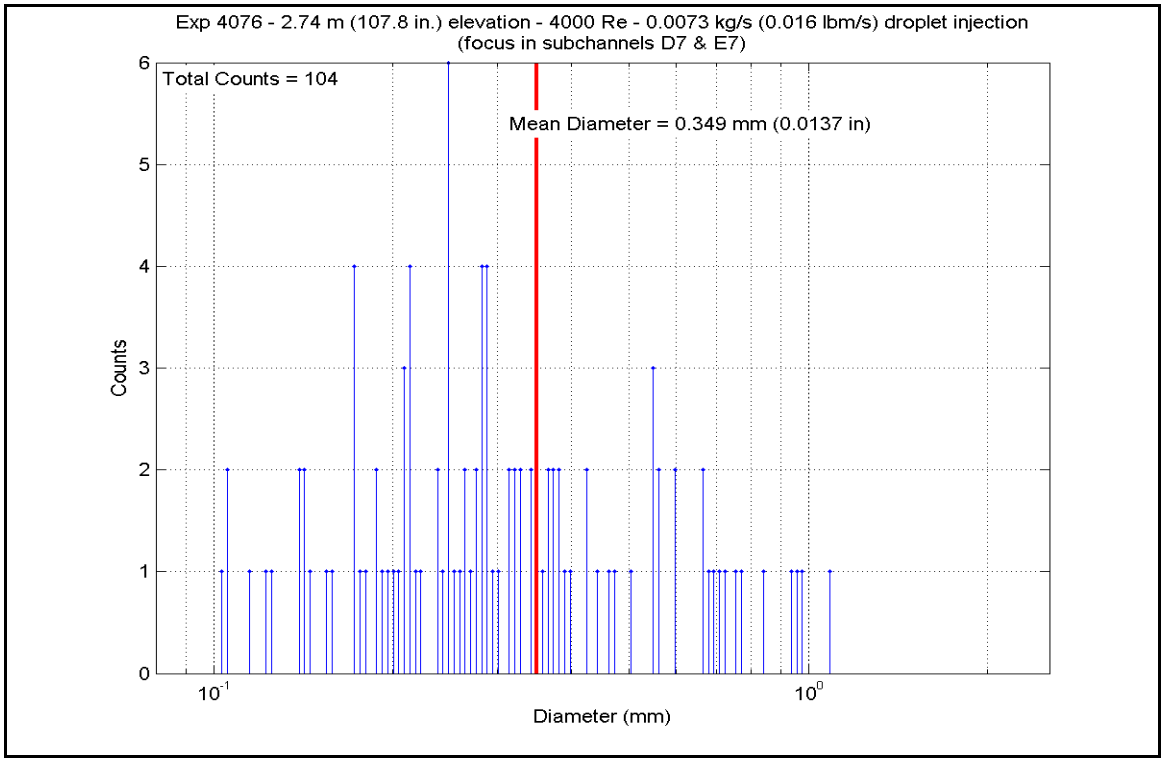

Figure A-726: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076B

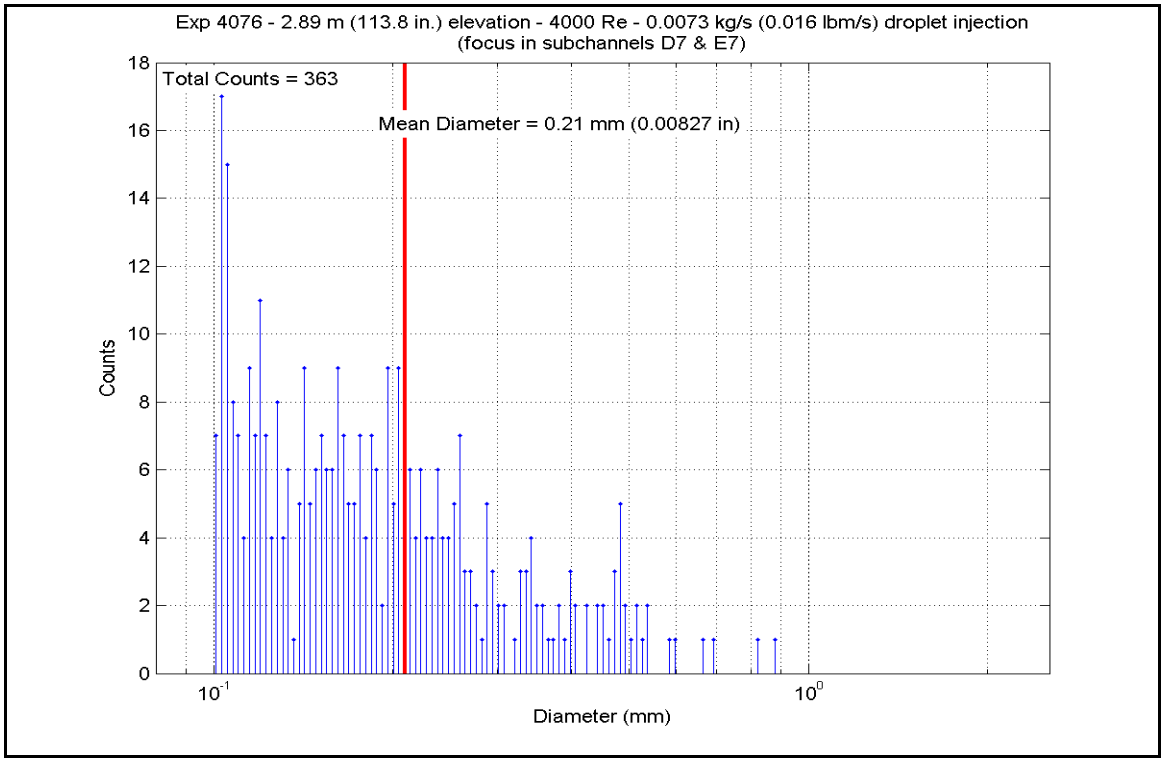

Figure A-727: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076B

Table A-73: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076B

SCD-4076-B	Inlet Reynolds:	4000		
Matrix test # 14b	UP Pressure:	137.9 kPa	20	psia
Time Window: 19500-23700	Bundle Power:	50.00 kW	170607	Btu/hr
	Steam flow:	0.0237 kg/s	188.0	lbm/hr
	Droplet flow:	0.0073 kg/s	0.016	lbm/s
Inner 3x3				

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	773.94	685.3	4213.49	13291.5	7.718	43.8
	RodD3_91.3	186	91.3	2.319	2.8	0.071	885.51	747.3	4304.30	13577.9	6.546	37.2
	RodD3_93.1	187	93.1	2.365	4.6	0.117	929.20	771.6	4357.97	13747.2	6.215	35.3
	RodD3_95.3	188	95.3	2.421	6.8	0.173	987.11	803.8	4422.24	13949.9	5.826	33.1
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1158.84	899.2	4748.84	14980.2	5.102	29.0
	RodD3_110	191	110	2.794	21.5	0.546	1135.01	885.9	4687.78	14787.6	5.168	29.4
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1261.30	956.1	1637.40	5165.2	1.585	9.0
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	818.33	710.0	4265.45	13455.4	7.226	41.0
	RodC4_91.1	234	91.1	2.314	2.6	0.066	918.02	765.4	4350.96	13725.1	6.306	35.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	963.89	790.9	4421.66	13948.1	6.009	34.1
	RodC4_95.3	236	95.3	2.421	6.8	0.173	1009.35	816.1	4479.47	14130.5	5.733	32.6
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1095.85	864.2	4624.56	14588.2	5.329	30.3
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1159.93	899.8	4810.55	15174.9	5.162	29.3
	RodC4_110	239	110	2.794	21.5	0.546	1132.83	884.7	4655.09	14684.5	5.145	29.2
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1271.53	961.8	1776.82	5605.0	1.703	9.7
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	804.71	702.4	4241.22	13378.9	7.354	41.8
	RodD4_91.3	242	91.3	2.319	2.8	0.071	911.02	761.5	4336.24	13678.7	6.349	36.1
	RodD4_93.2	243	93.2	2.367	4.7	0.119	960.16	788.8	4394.08	13861.1	6.002	34.1
	RodD4_95.2	244	95.2	2.418	6.7	0.170	1007.44	815.1	4454.35	14051.3	5.715	32.5
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1095.30	863.9	4601.84	14516.5	5.306	30.1
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1161.18	900.5	4784.88	15093.9	5.127	29.1
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1283.24	968.3	1715.48	5411.5	1.626	9.2
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	803.62	701.8	4177.81	13178.9	7.258	41.2
	RodE4_91.2	202	91.2	2.316	2.7	0.069	897.21	753.8	4262.84	13447.1	6.370	36.2
	RodE4_95.3	204	95.3	2.421	6.8	0.173	990.50	805.6	4382.47	13824.5	5.748	32.6
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1074.07	852.1	4546.35	14341.5	5.373	30.5
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1268.95	960.3	1734.41	5471.2	1.666	9.5

Table A-73: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_63.4	193	63.4	1.610	16.4	0.417	224.19	379.9	3484.70	10992.5	-915.221	-5197.4
	RodE3_113.6	194	113.6	2.885	0.85	0.022	1160.57	900.1	4272.85	13478.7	4.582	26.0
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1197.68	920.8	4115.68	12982.9	4.244	24.1
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1231.13	939.3	3864.61	12190.9	3.853	21.9
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1258.08	954.3	3513.42	11083.1	3.411	19.4
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1265.47	958.4	3195.33	10079.7	3.080	17.5
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1226.23	936.6	2761.14	8710.0	2.766	15.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1242.14	945.4	2436.54	7686.1	2.403	13.6
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	817.40	709.5	3412.56	10764.9	5.790	32.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1156.79	898.0	4172.03	13160.7	4.492	25.5
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1199.26	921.6	4006.19	12637.5	4.125	23.4
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1259.28	955.0	3449.87	10882.6	3.345	19.0
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1269.17	960.5	3131.36	9877.9	3.008	17.1
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1241.44	945.1	2741.00	8646.5	2.705	15.4
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1258.82	954.7	2416.53	7622.9	2.344	13.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	734.03	663.2	3499.51	11039.2	6.916	39.3
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1098.03	865.4	4299.64	13563.2	4.942	28.1
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1144.30	891.1	4153.59	13102.5	4.533	25.7
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1195.01	919.3	3881.58	12244.4	4.014	22.8
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1232.45	940.1	3559.94	11229.8	3.544	20.1
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1249.29	949.4	3230.09	10189.3	3.163	18.0
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1310.32	983.3	2829.05	8924.3	2.614	14.8
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1264.19	957.7	2492.32	7862.0	2.405	13.7
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	714.10	652.1	3958.47	12487.0	8.143	46.2
	RodC3_85.6	178	85.6	2.174	14.72	0.374	747.64	670.7	4117.66	12989.2	7.924	45.0
	RodC3_88.5	179	88.5	2.248	0	0.000	782.13	689.9	4202.48	13256.7	7.584	43.1
	RodC3_92.4	180	92.4	2.347	3.9	0.099	913.79	763.0	4319.43	13625.6	6.298	35.8
	RodC3_94.4	181	94.4	2.398	5.9	0.150	958.40	787.8	4378.30	13811.3	5.994	34.0
Gr-8	RodD5_50	217	50	1.270	3	0.076	617.87	598.6	3091.72	9752.8	7.930	45.0
	RodD5_54.1	218	54.1	1.374	7.1	0.180	660.36	622.2	3213.81	10138.0	7.433	42.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	718.27	654.4	3296.03	10397.3	6.723	38.2
	RodD5_60	220	60	1.524	13	0.330	768.41	682.3	3386.90	10684.0	6.267	35.6
	RodD5_66.1	221	66.1	1.679	19.1	0.485	812.67	706.9	3564.75	11245.0	6.097	34.6
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	656.73	620.2	3680.74	11610.9	8.585	48.8
	RodD5_72.9	223	72.9	1.852	2.02	0.051	741.26	667.2	3770.80	11895.0	7.347	41.7
	RodD5_74.9	224	74.9	1.902	4.02	0.102	788.94	693.7	3830.40	12083.0	6.829	38.8

Table A-73: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	759.81	677.5	2807.04	8854.8	5.278	30.0
	RodB5_52.9	154	52.9	1.344	5.9	0.150	659.34	621.7	3166.55	9988.9	7.341	41.7
	RodB5_55	155	55	1.397	8	0.203	703.52	646.2	3229.67	10188.0	6.792	38.6
	RodB5_57.8	156	57.8	1.468	10.8	0.274	755.99	675.4	3313.37	10452.0	6.275	35.6
	RodB5_64	157	64	1.626	17	0.432	820.35	711.1	3499.20	11038.2	5.907	33.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	756.14	675.4	3798.18	11981.4	7.192	40.8
	RodB5_75.9	159	75.9	1.928	5.02	0.128	795.84	697.5	3857.82	12169.5	6.794	38.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	812.55	706.8	3887.71	12263.8	6.651	37.8
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	743.62	668.5	2796.93	8822.9	5.424	30.8
	RodF5_53.1	106	53.1	1.349	6.1	0.155	685.64	636.3	3157.79	9961.3	6.900	39.2
	RodF5_55	107	55	1.397	8	0.203	725.28	658.3	3214.97	10141.6	6.465	36.7
	RodF5_57.8	108	57.8	1.468	10.8	0.274	770.00	683.1	3298.52	10405.2	6.086	34.6
	RodF5_64	109	64	1.626	17	0.432	832.01	717.6	3484.27	10991.1	5.769	32.8
	RodF5_73.8	110	73.8	1.875	2.92	0.074	757.23	676.1	3779.11	11921.2	7.141	40.6
	RodF5_75.8	111	75.8	1.925	4.92	0.125	798.41	698.9	3839.01	12110.2	6.730	38.2
	RodF5_76.8	112	76.8	1.951	5.92	0.150	816.19	708.8	3869.02	12204.8	6.578	37.4
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	736.44	664.5	2810.77	8866.6	5.528	31.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	681.11	633.8	3171.54	10004.6	6.999	39.7
	RodC2_55	59	55	1.397	8	0.203	707.45	648.4	3228.28	10183.6	6.733	38.2
	RodC2_57.8	60	57.8	1.468	10.8	0.274	745.43	669.5	3311.96	10447.6	6.401	36.3
	RodC2_63.9	61	63.9	1.623	16.9	0.429	789.01	693.7	3494.90	11024.7	6.230	35.4
	RodC2_73.8	62	73.8	1.875	2.92	0.074	696.79	642.5	3790.66	11957.6	8.086	45.9
	RodC2_75.8	63	75.8	1.925	4.92	0.125	743.48	668.4	3850.63	12146.8	7.470	42.4
	RodC2_76.8	64	76.8	1.951	5.92	0.150	762.72	679.1	3880.68	12241.6	7.257	41.2
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	756.82	675.8	2792.87	8810.1	5.281	30.0
	RodC6_52.8	138	52.8	1.341	5.8	0.147	737.81	665.3	3165.49	9985.5	6.209	35.3
	RodC6_54.8	139	54.8	1.392	7.8	0.198	760.55	677.9	3228.31	10183.7	6.062	34.4
	RodC6_57.8	140	57.8	1.468	10.8	0.274	797.86	698.6	3322.56	10481.0	5.831	33.1
	RodC6_63.8	141	63.8	1.621	16.8	0.427	868.55	737.9	3511.13	11075.8	5.481	31.1
	RodC6_73.7	142	73.7	1.872	2.82	0.072	793.53	696.2	3821.21	12054.0	6.757	38.4
	RodC6_75.8	143	75.8	1.925	4.92	0.125	824.26	713.3	3886.80	12260.9	6.519	37.0
	RodC6_76.8	144	76.8	1.951	5.92	0.150	841.99	723.1	3918.01	12359.4	6.381	36.2

Table A-73: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	810.72	705.8	4192.77	13226.1	7.195	40.9
	RodB4_91.3	162	91.3	2.319	2.8	0.071	910.66	761.3	4276.14	13489.1	6.264	35.6
	RodB4_93.3	163	93.3	2.370	4.8	0.122	947.87	782.0	4333.91	13671.3	6.020	34.2
	RodB4_95.1	164	95.1	2.416	6.6	0.168	980.22	799.9	4385.65	13834.5	5.830	33.1
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1243.18	946.0	1767.15	5574.5	1.741	9.9
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	852.72	729.1	4135.18	13044.4	6.619	37.6
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	835.29	719.4	4215.11	13296.6	6.941	39.4
	RodF4_92.4	100	92.4	2.347	3.9	0.099	937.71	776.3	4336.16	13678.4	6.110	34.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	976.77	798.0	4392.47	13856.1	5.866	33.3
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1143.44	890.6	4165.99	13141.6	4.551	25.8
	RodD2_106	66	106	2.692	17.5	0.445	1166.72	903.5	3945.90	12447.3	4.204	23.9
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1207.03	925.9	3646.69	11503.5	3.725	21.2
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1224.76	935.8	3293.66	10389.8	3.304	18.8
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1227.50	937.3	2957.79	9330.4	2.959	16.8
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1170.87	905.9	4178.91	13182.4	4.432	25.2
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1193.04	918.2	4010.51	12651.1	4.156	23.6
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1218.43	932.3	3644.40	11496.3	3.680	20.9
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1227.08	937.1	3296.44	10398.6	3.299	18.7
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1233.37	940.6	2948.03	9299.5	2.932	16.7

Table A-73: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	618.80	599.1	3104.63	9793.6	7.944	45.1
	RodE2_54	74	54	1.372	7	0.178	666.53	625.7	3222.69	10166.0	7.349	41.7
	RodE2_56.9	75	56.9	1.445	9.9	0.251	698.69	643.5	3310.74	10443.7	7.034	39.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	732.25	662.2	3401.70	10730.6	6.746	38.3
	RodE2_66	77	66	1.676	19	0.483	749.21	671.6	3585.96	11311.9	6.880	39.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	577.78	576.4	3706.92	11693.5	10.598	60.2
	RodE2_72.9	79	72.9	1.852	2.02	0.051	667.68	626.3	3802.85	11996.1	8.649	49.1
	RodE2_74.9	80	74.9	1.902	4.02	0.102	715.92	653.1	3862.82	12185.3	7.917	45.0
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	596.74	586.9	3084.03	9728.6	8.364	47.5
	RodB3_54.1	170	54.1	1.374	7.1	0.180	643.44	612.8	3201.59	10099.4	7.706	43.8
	RodB3_56.9	171	56.9	1.445	9.9	0.251	685.62	636.3	3285.89	10365.3	7.180	40.8
	RodB3_60.1	172	60.1	1.527	13.1	0.333	683.33	635.0	3382.46	10670.0	7.429	42.2
	RodB3_66.1	173	66.1	1.679	19.1	0.485	720.80	655.8	3562.59	11238.2	7.229	41.1
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	584.20	579.9	3676.67	11598.1	10.322	58.6
	RodB3_73	175	73	1.854	2.12	0.054	662.39	623.4	3768.33	11887.2	8.675	49.3
	RodB3_75	176	75	1.905	4.12	0.105	705.68	647.4	3827.94	12075.2	8.014	45.5
Gr-8	RodF3_60	92	60	1.524	13	0.330	421.52	489.5	3343.25	10546.3	17.276	98.1
	RodF3_66.1	93	66.1	1.679	19.1	0.485	691.95	639.8	3572.13	11268.3	7.699	43.7
	RodF3_70	94	70	1.778	-0.88	-0.022	594.37	585.6	3698.07	11665.6	10.094	57.3
	RodF3_73	95	73	1.854	2.12	0.054	697.17	642.7	3792.23	11962.6	8.083	45.9
	RodF3_75	96	75	1.905	4.12	0.105	748.09	671.0	3852.58	12153.0	7.407	42.1
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	677.11	631.5	3083.12	9725.7	6.865	39.0
	RodE6_54.1	122	54.1	1.374	7.1	0.180	740.81	666.9	3199.82	10093.8	6.240	35.4
	RodE6_57	123	57	1.448	10	0.254	775.12	686.0	3286.65	10367.7	6.007	34.1
	RodE6_60.2	124	60.2	1.529	13.2	0.335	818.33	710.0	3381.61	10667.3	5.728	32.5
	RodE6_66.1	125	66.1	1.679	19.1	0.485	849.89	727.5	3556.24	11218.2	5.718	32.5
	RodE6_70	126	70	1.778	-0.88	-0.022	694.57	641.2	3672.61	11585.3	7.871	44.7
	RodE6_73.1	127	73.1	1.857	2.22	0.056	765.76	680.8	3764.16	11874.0	7.000	39.8
	RodE6_75	128	75	1.905	4.12	0.105	803.84	702.0	3820.45	12051.6	6.635	37.7

RBHT Steam Cooling with Droplet Injection Test SCD-4076-C

Matrix Test # 14c

Test Conditions

Test Date – 12/13/2005
Steady State Time Window: 24420 - 27600
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0108 kg/s (0.024 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

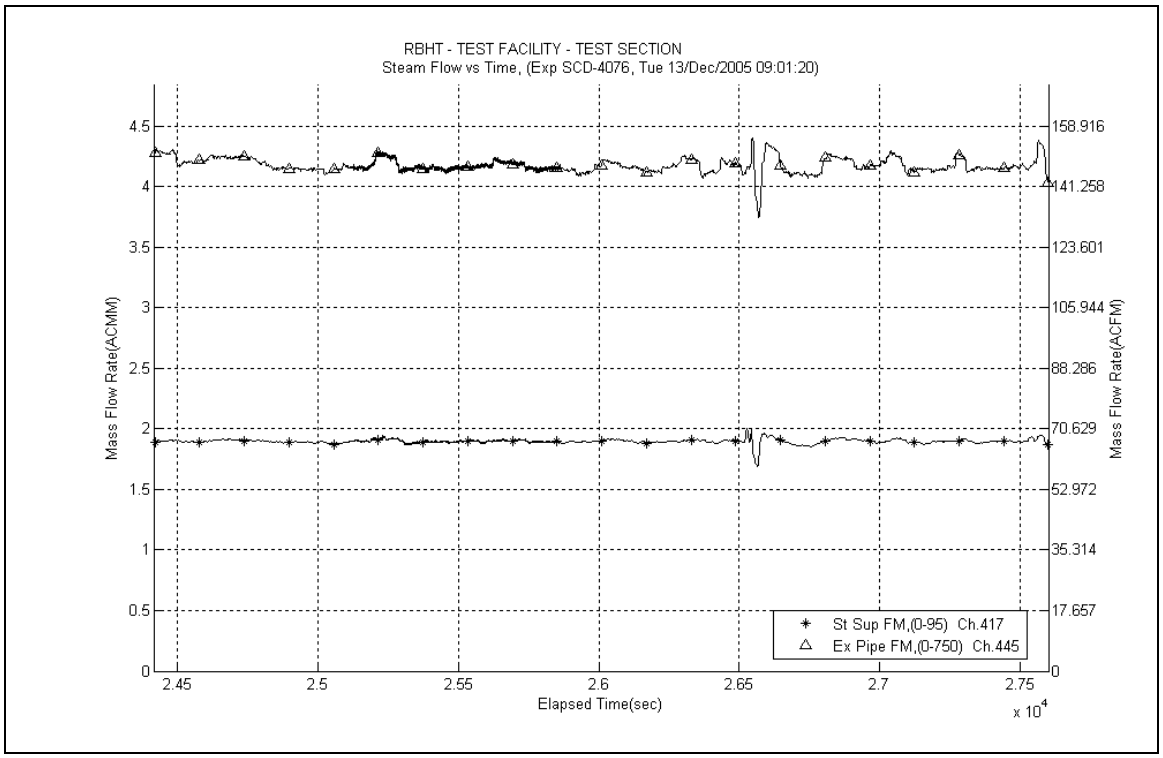

Figure A-728: Inlet and Exhaust Steam Flow Rates for Experiment 4076C

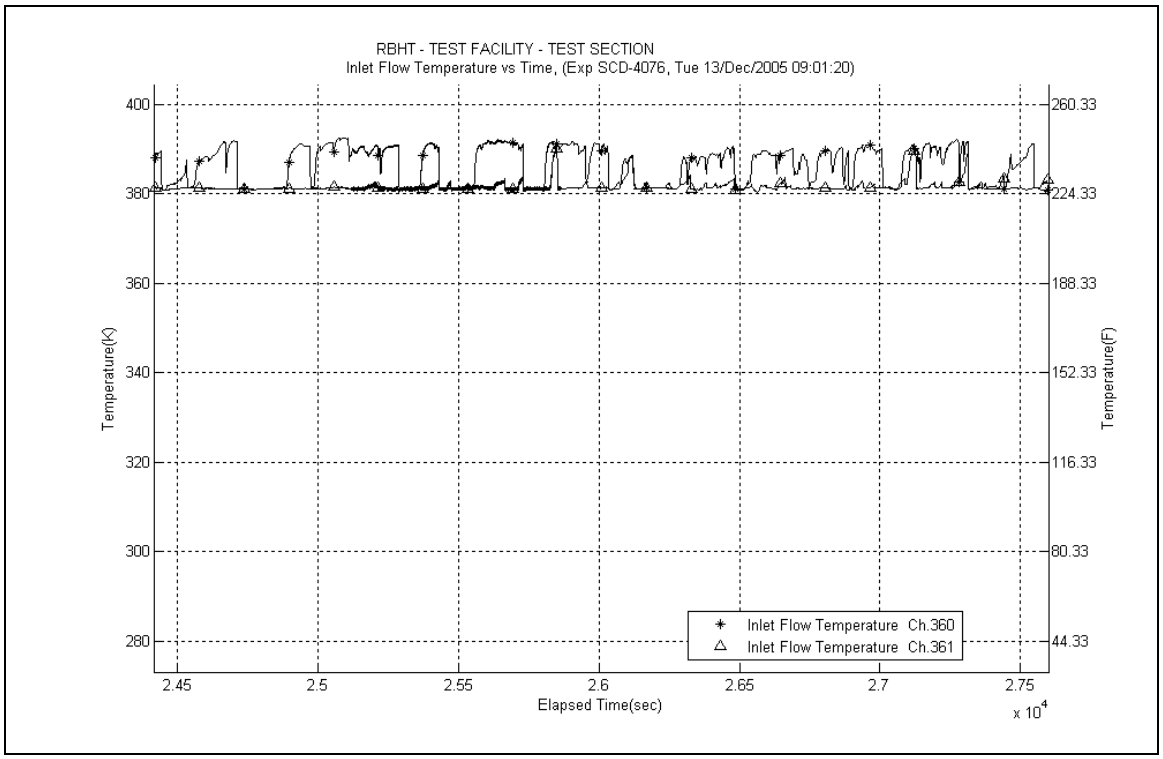

Figure A-729: Inlet Steam Temperature for Experiment 4076C

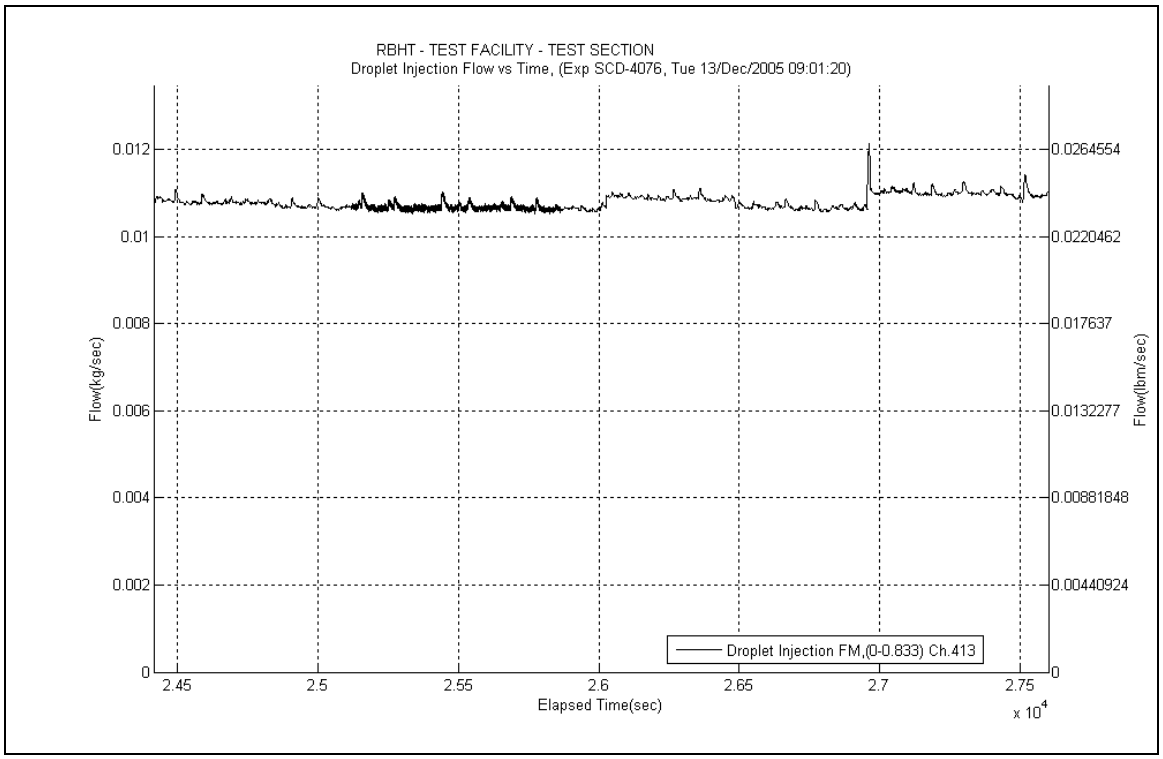

Figure A-730: Droplet Injection Flow Rate for Experiment 4076C

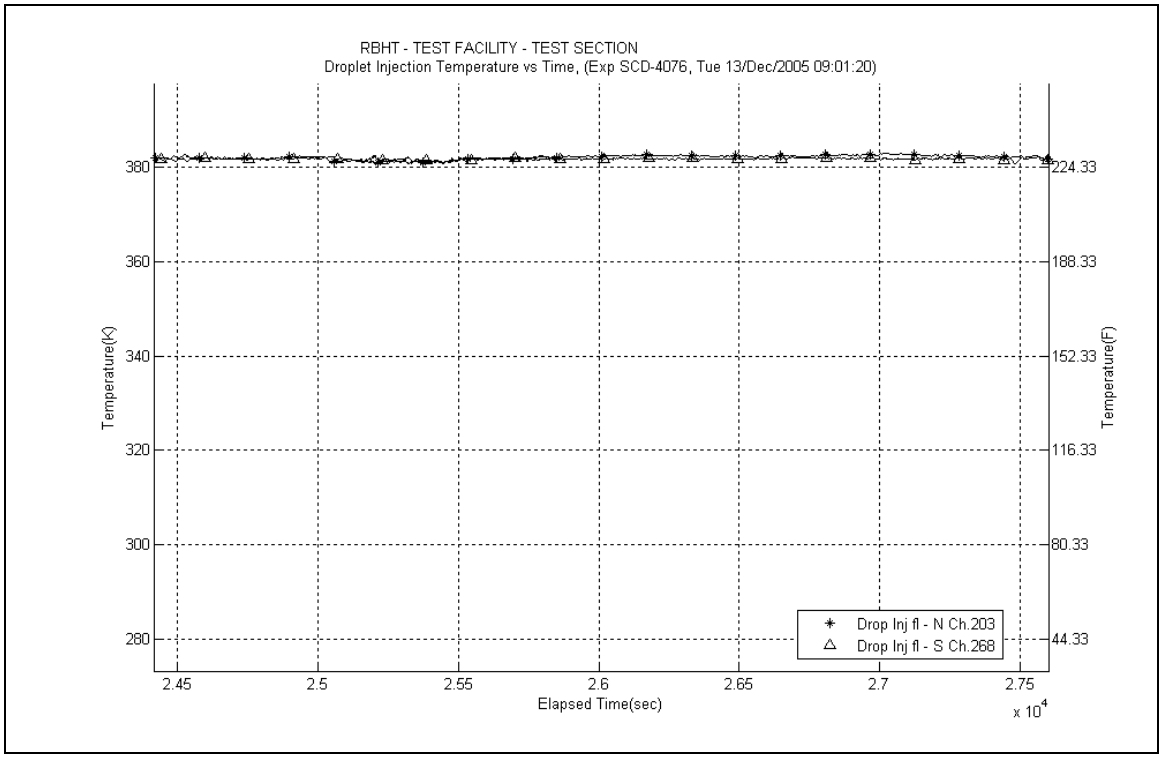

Figure A-731: Droplet Injection Temperature for Experiment 4076C

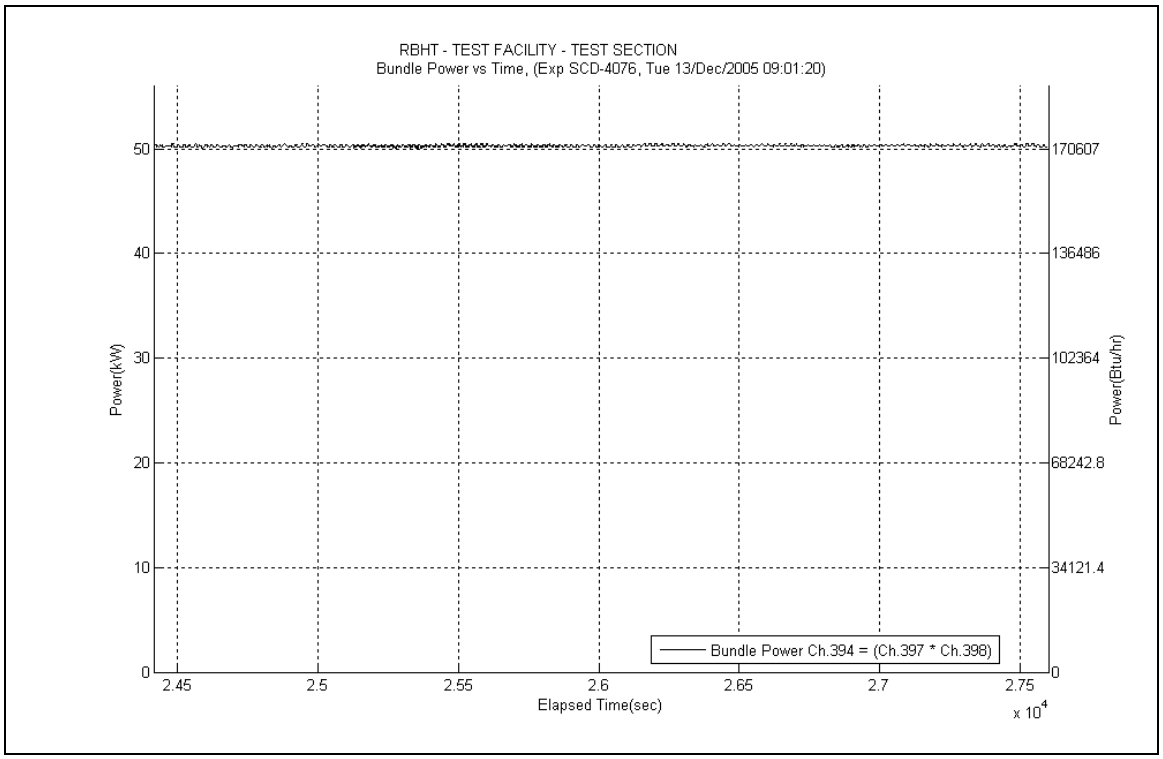

Figure A-732: Bundle Power for Experiment 4076C

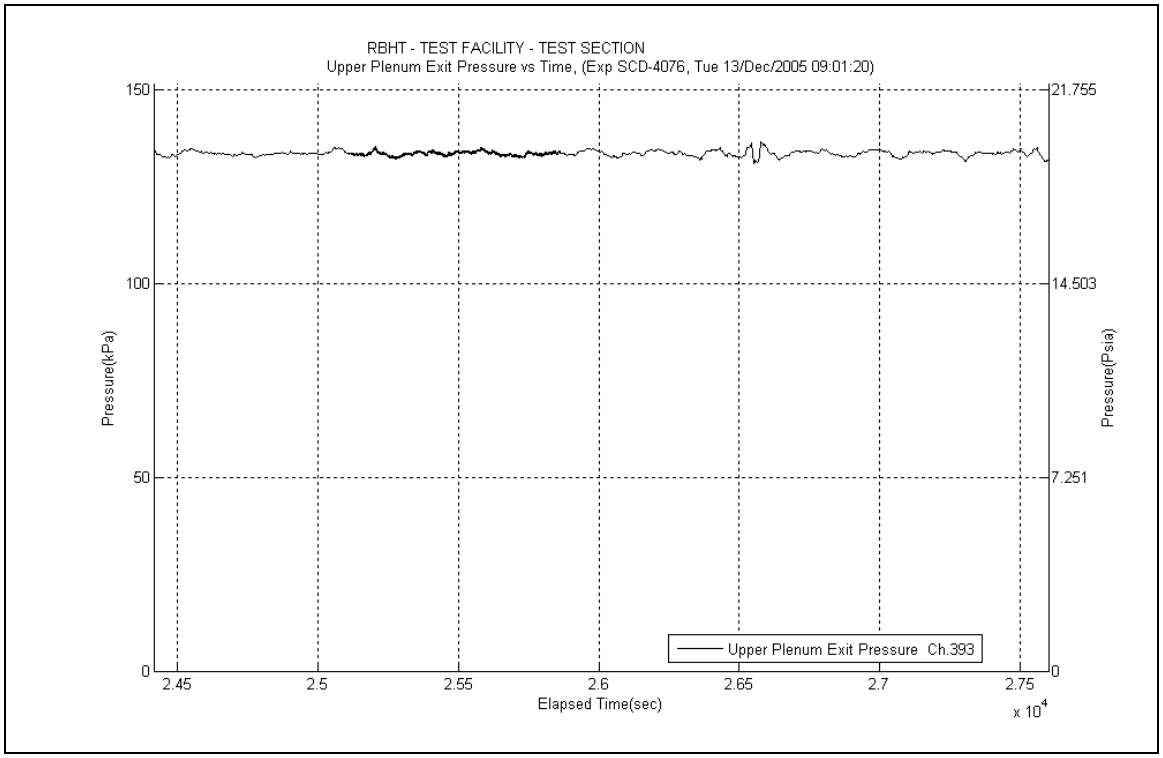

Figure A-733: Upper Plenum Pressure for Experiment 4076C

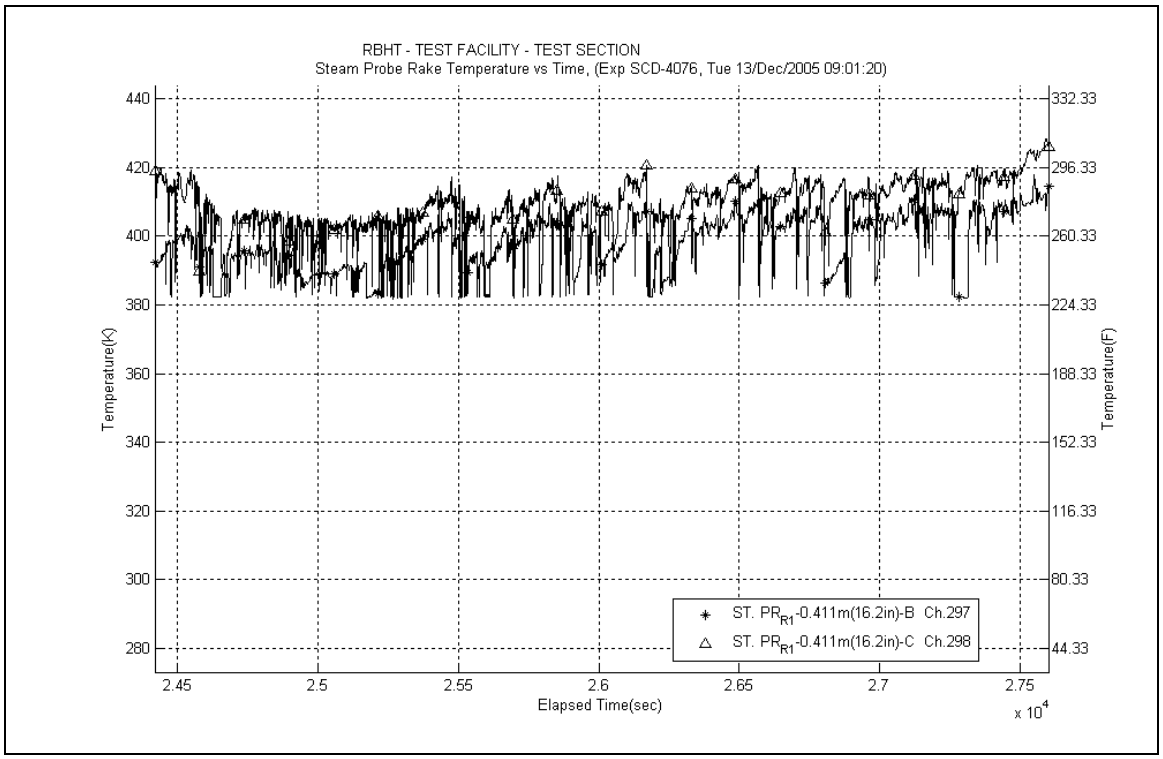

Figure A-734: Steam Probe Rake #1 Temperatures for Experiment 4076C

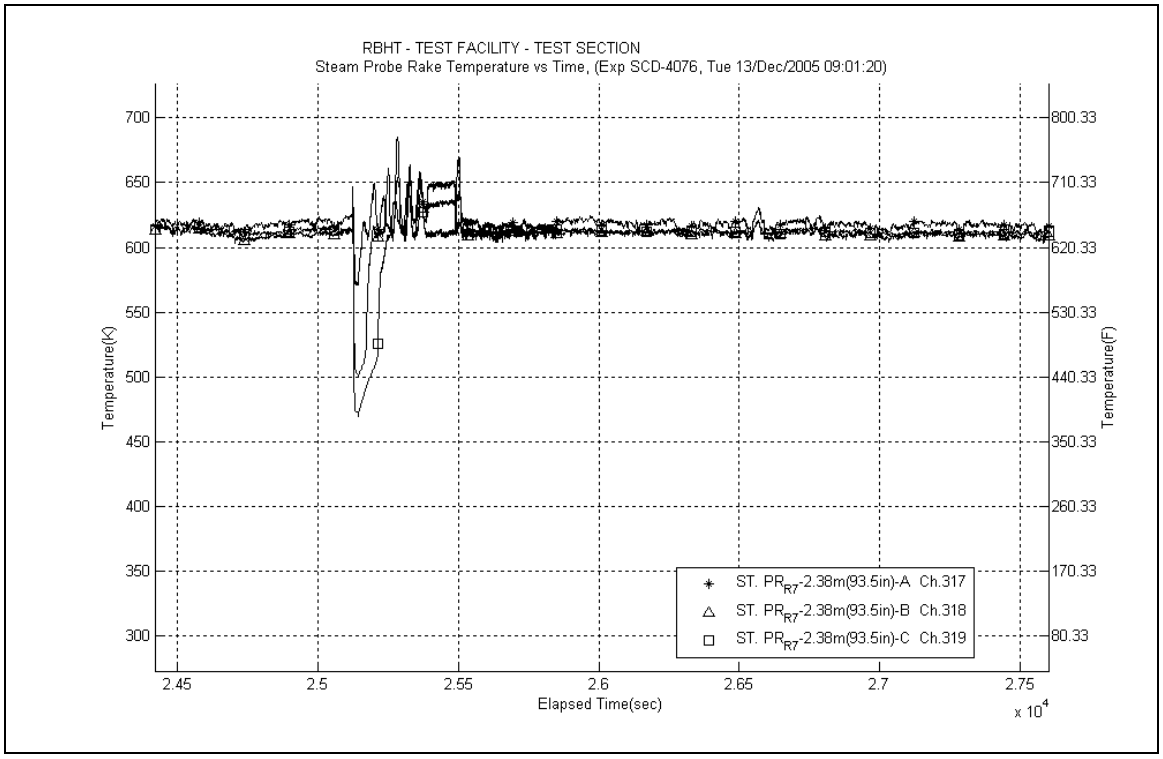

Figure A-735: Steam Probe Rake #7 Temperatures for Experiment 4076C

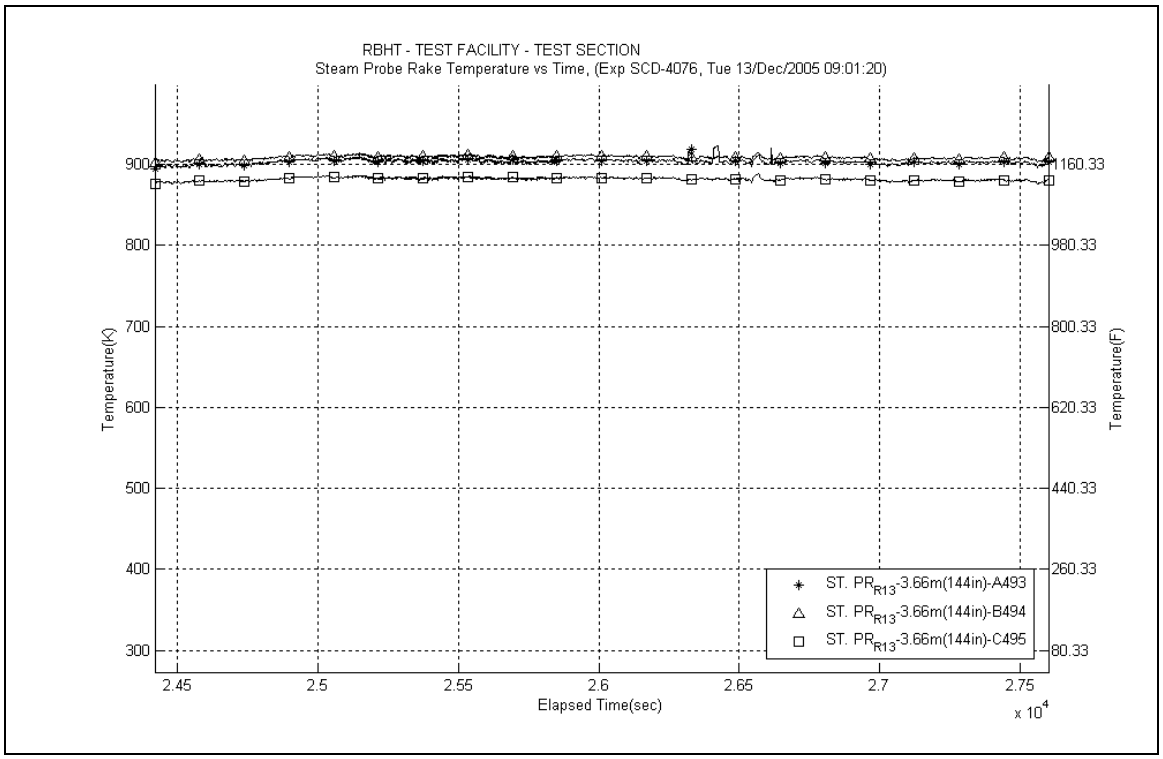

Figure A-736: Steam Probe Rake #13 Temperatures for Experiment 4076C

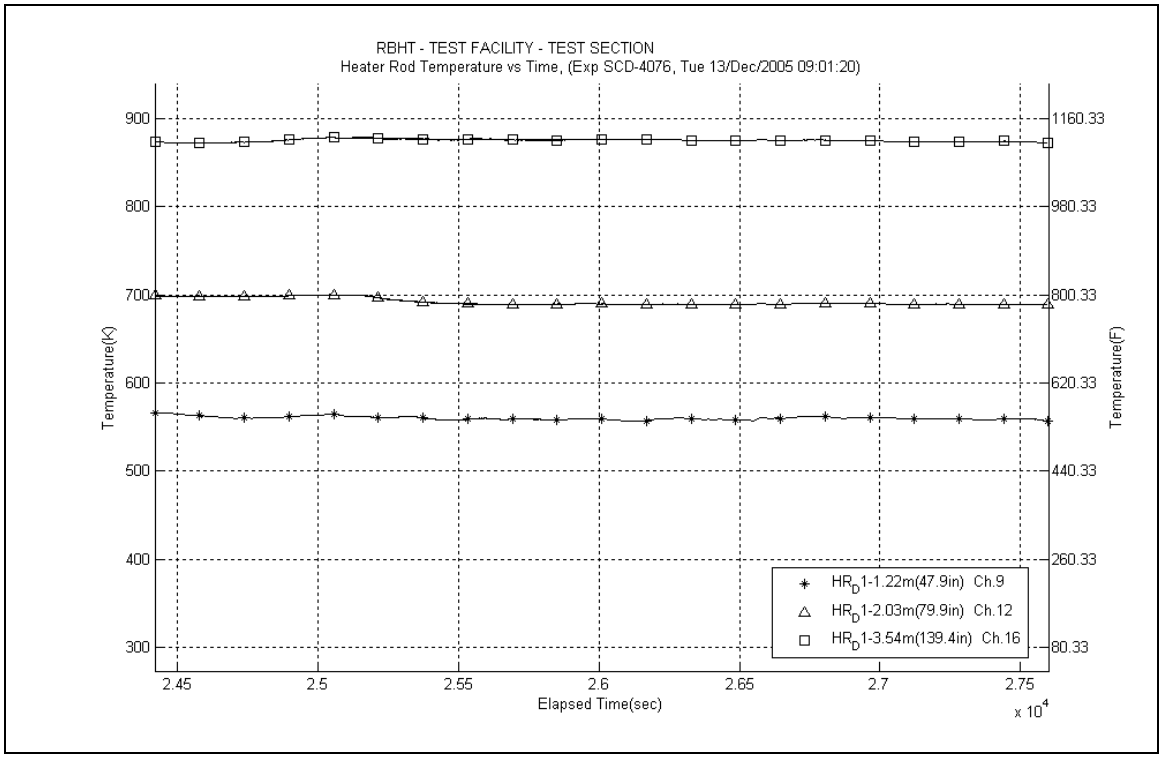

Figure A-737: Heater Rod D1 Temperatures for Experiment 4076C

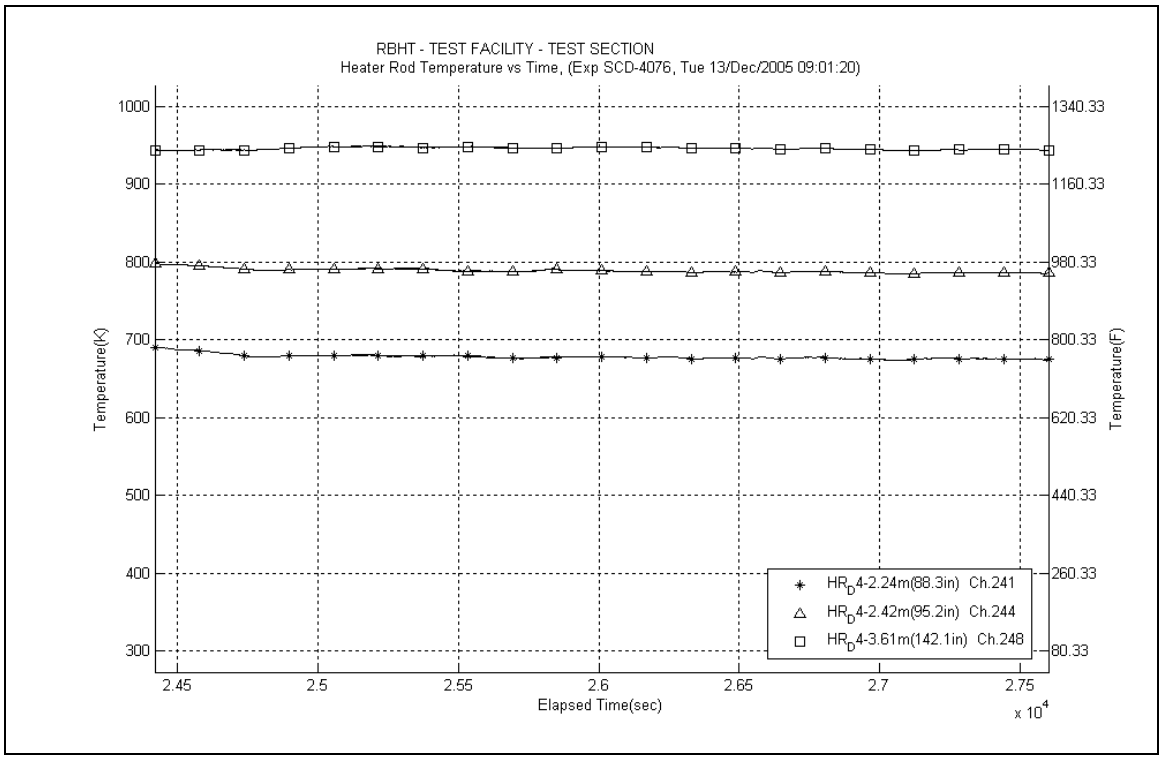

Figure A-738: Heater Rod D4 Temperatures for Experiment 4076C

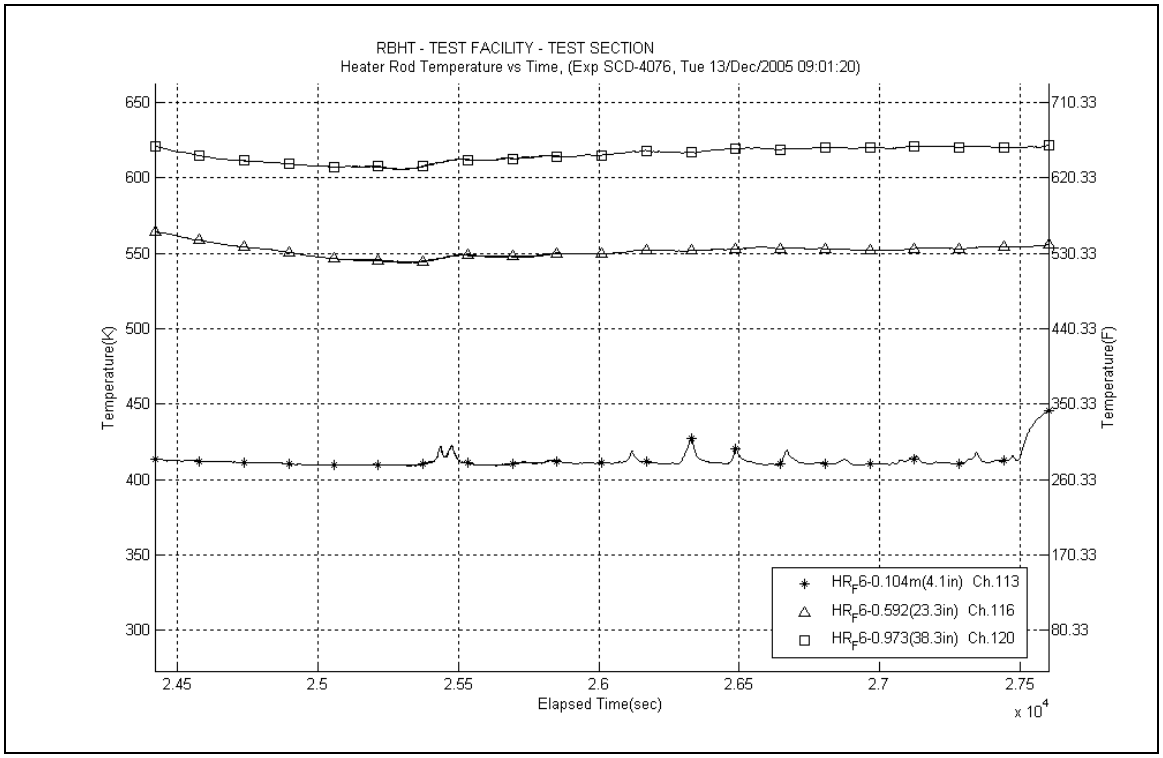

Figure A-739: Heater Rod F6 Temperatures for Experiment 4076C

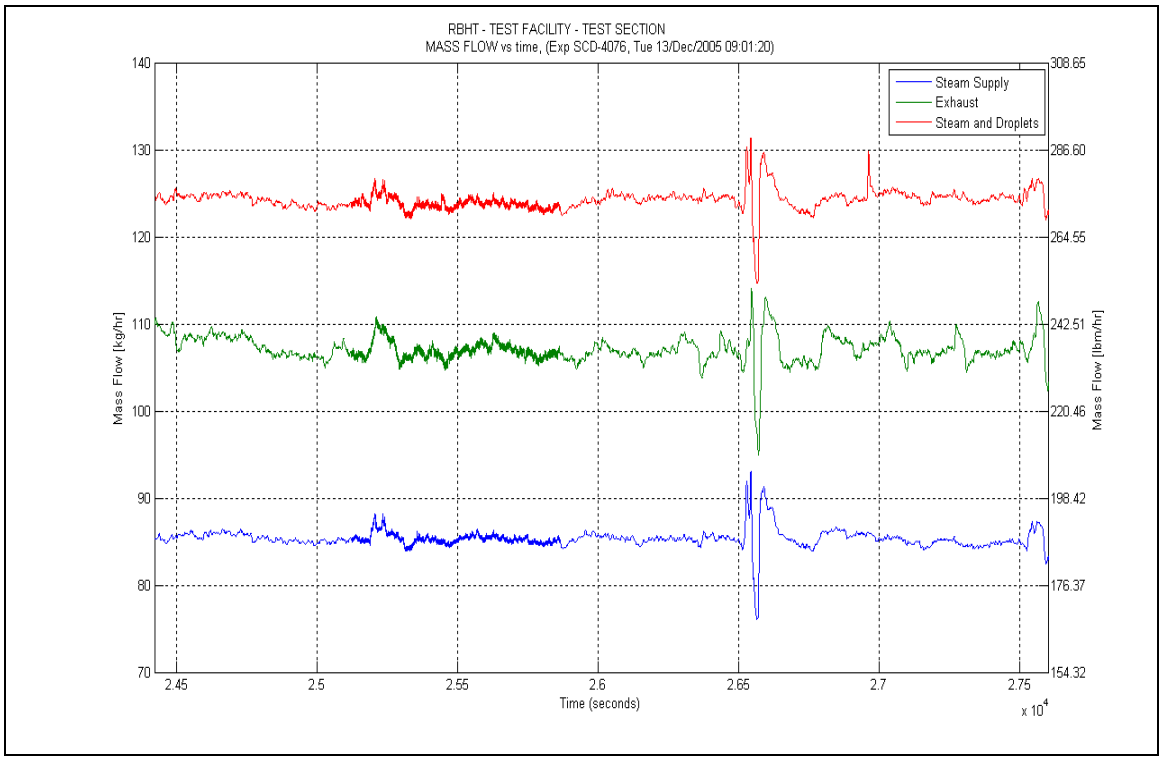

Figure A-740: Mass Flow for Experiment 4076C

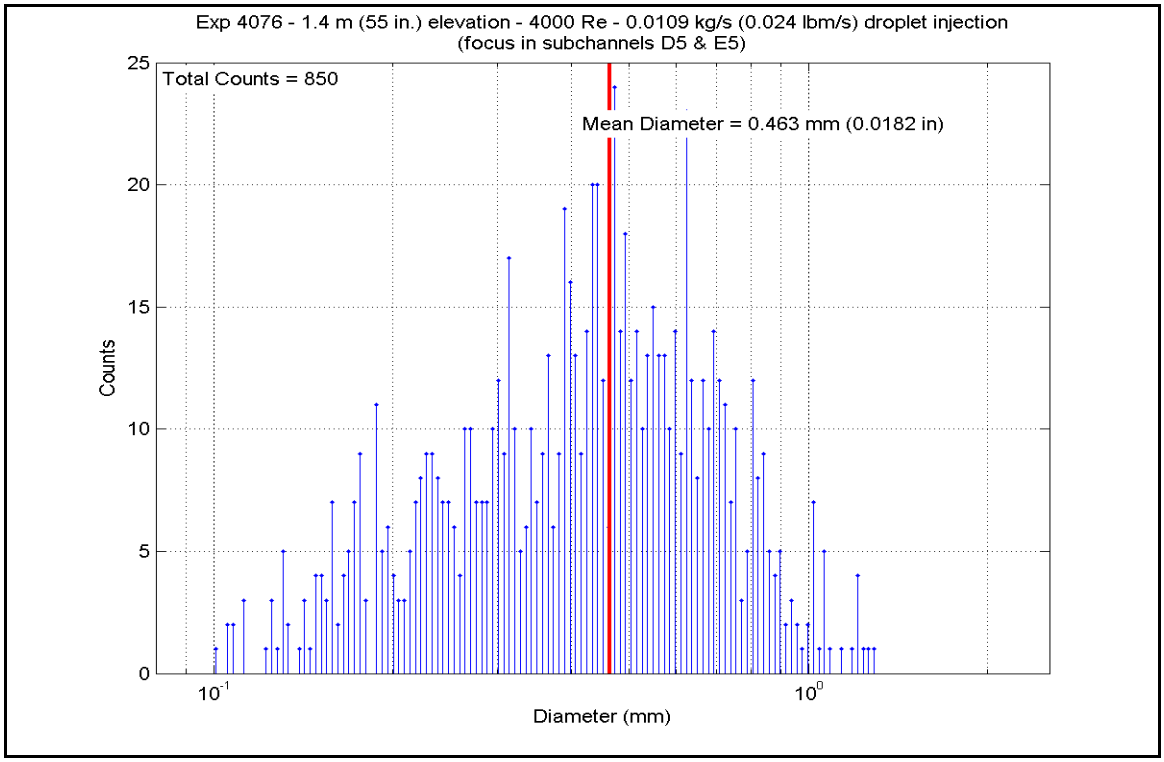

Figure A-741: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076C

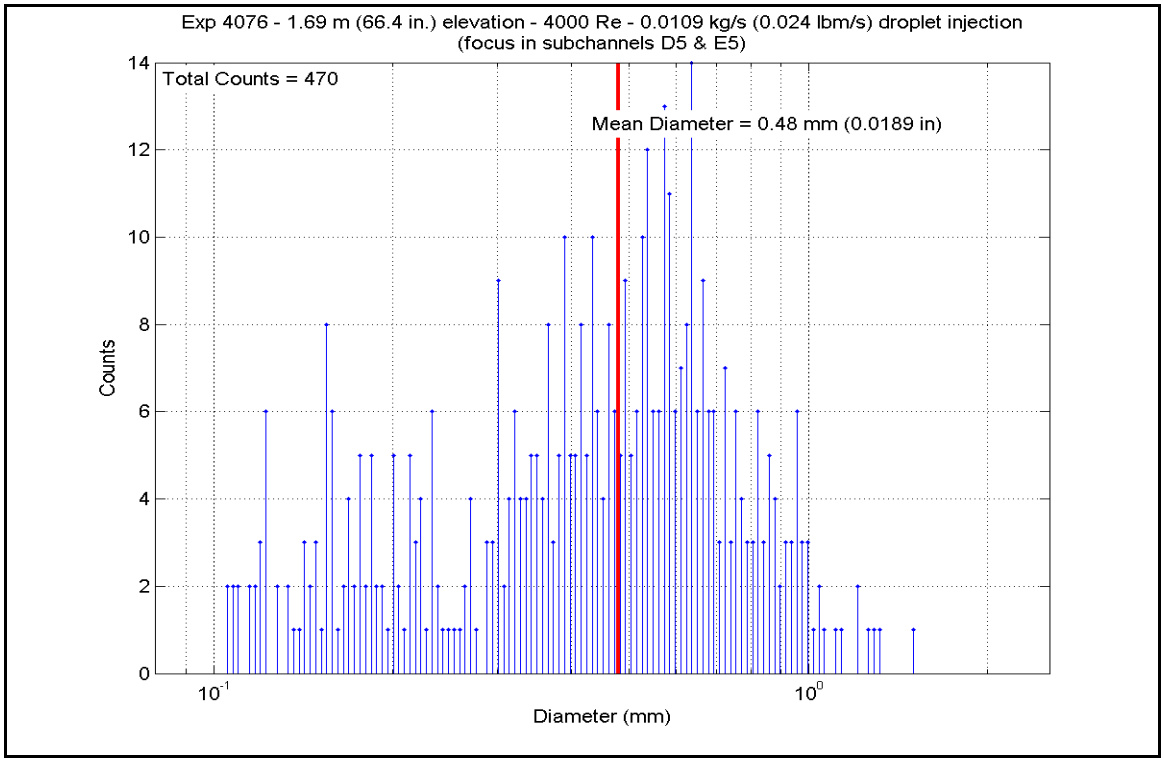

Figure A-742: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076C

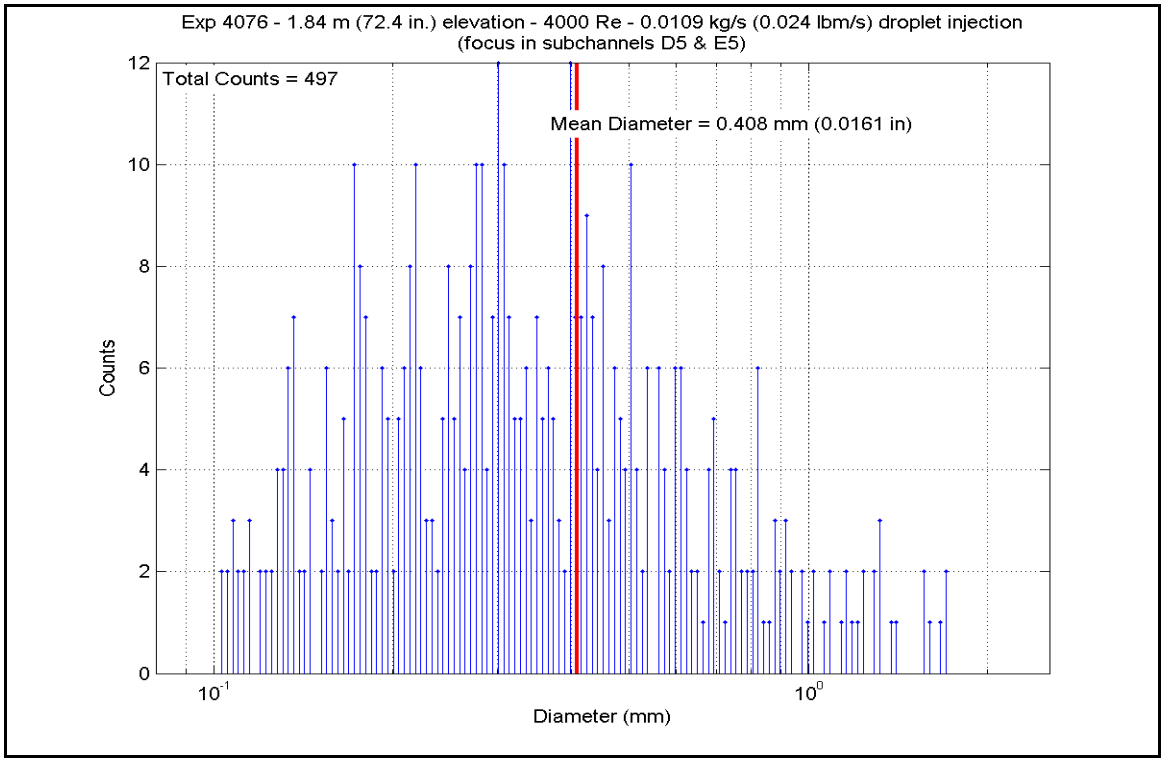

Figure A-743: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076C

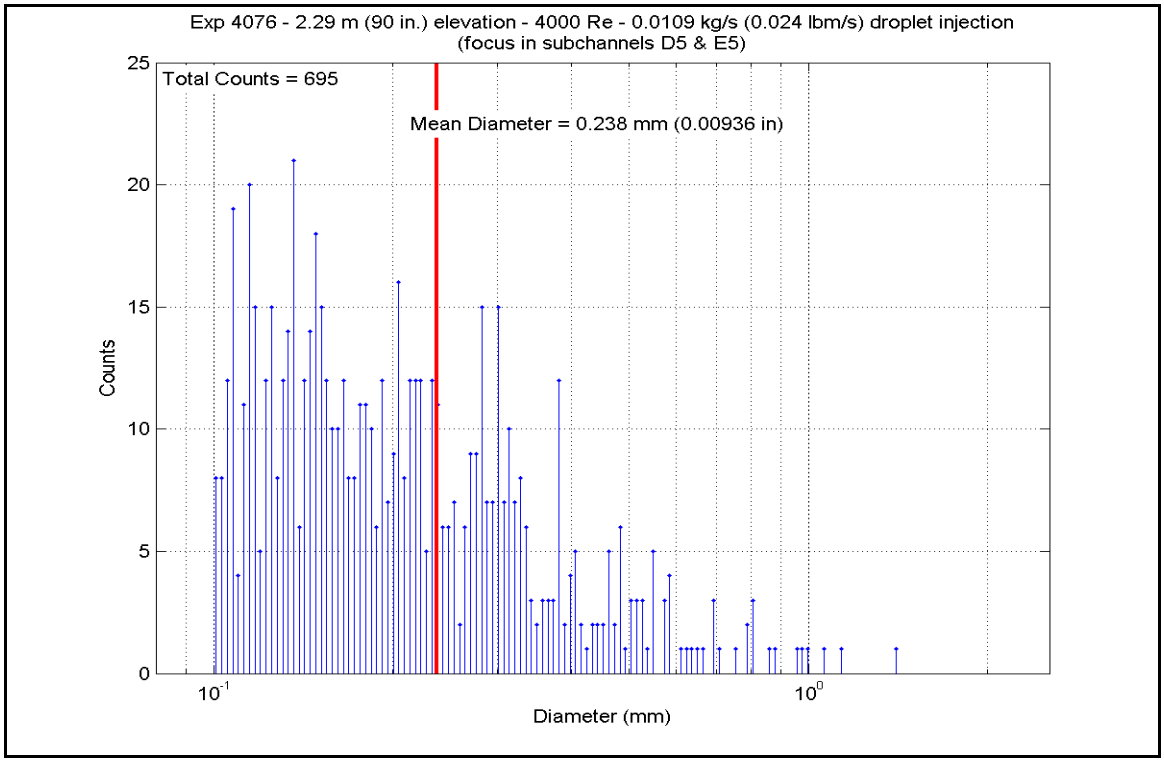

Figure A-744: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076C

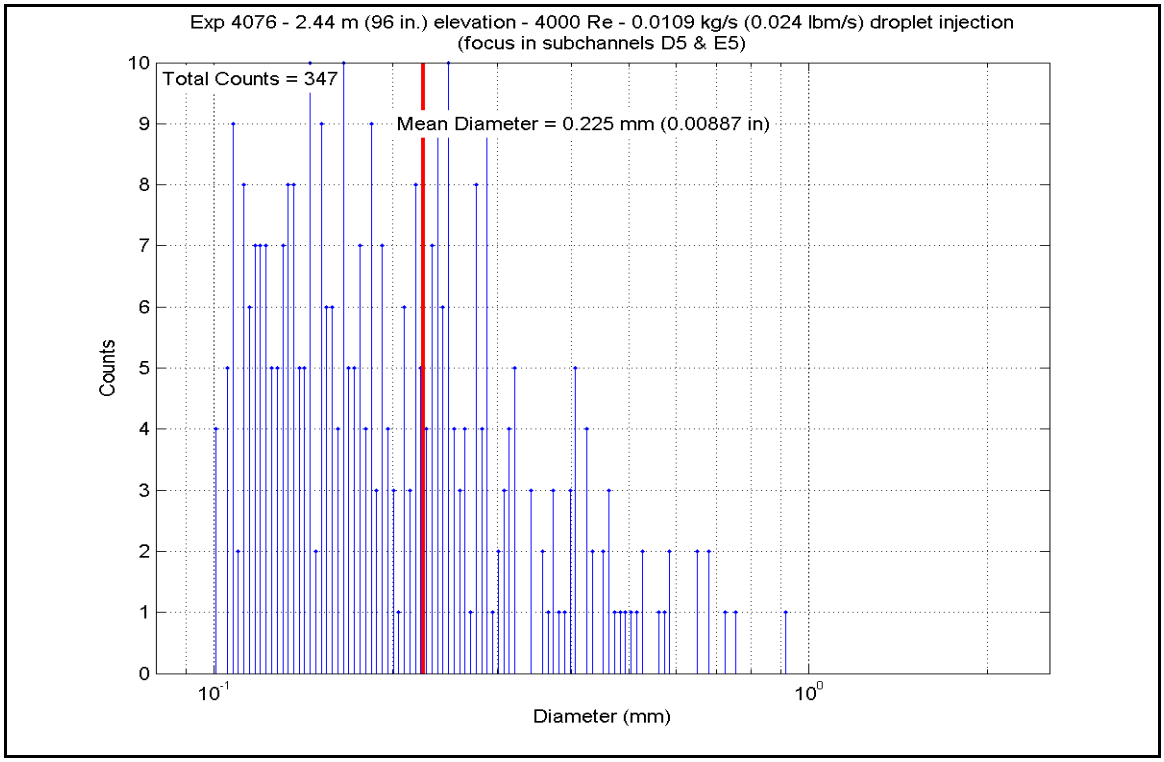

Figure A-745: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076C

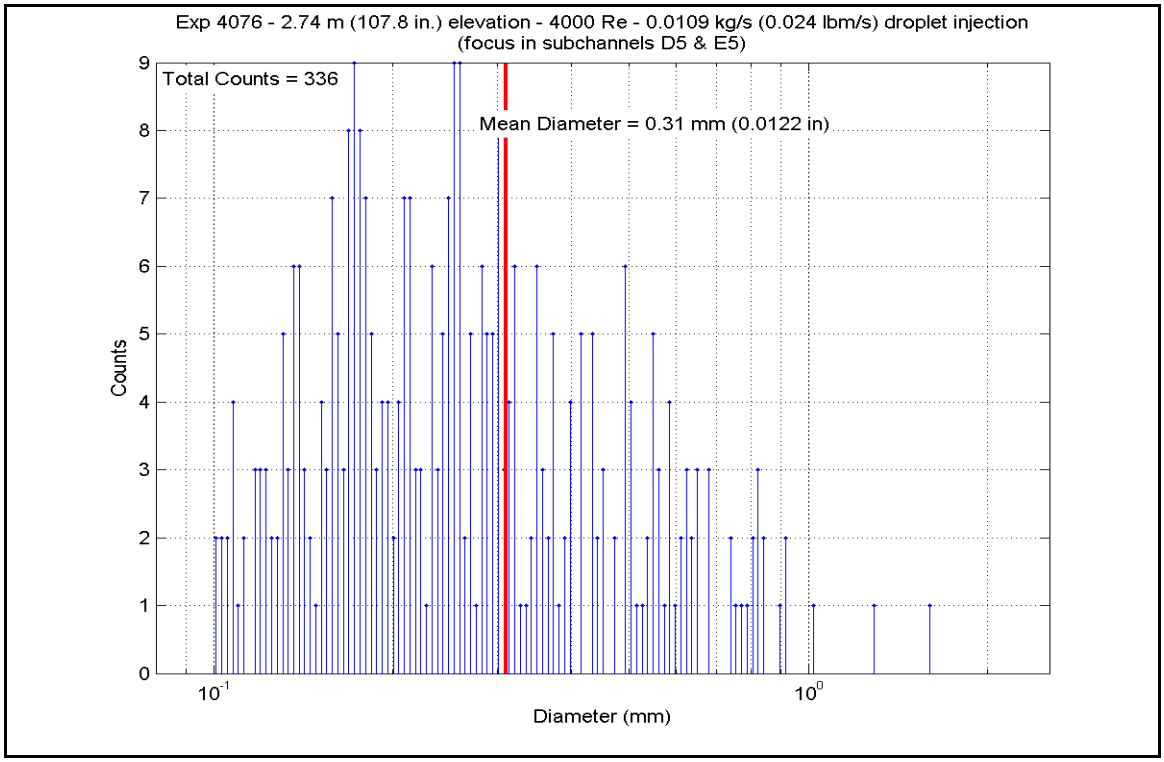

Figure A-746: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076C

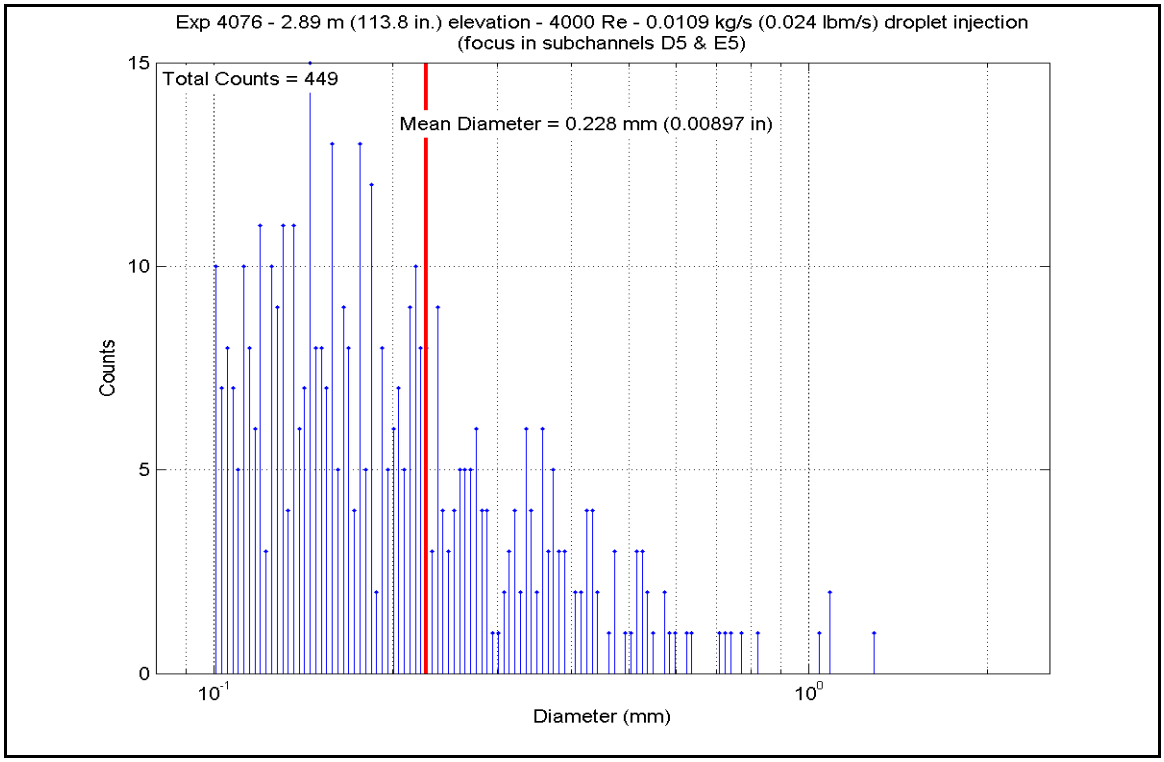

Figure A-747: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076C

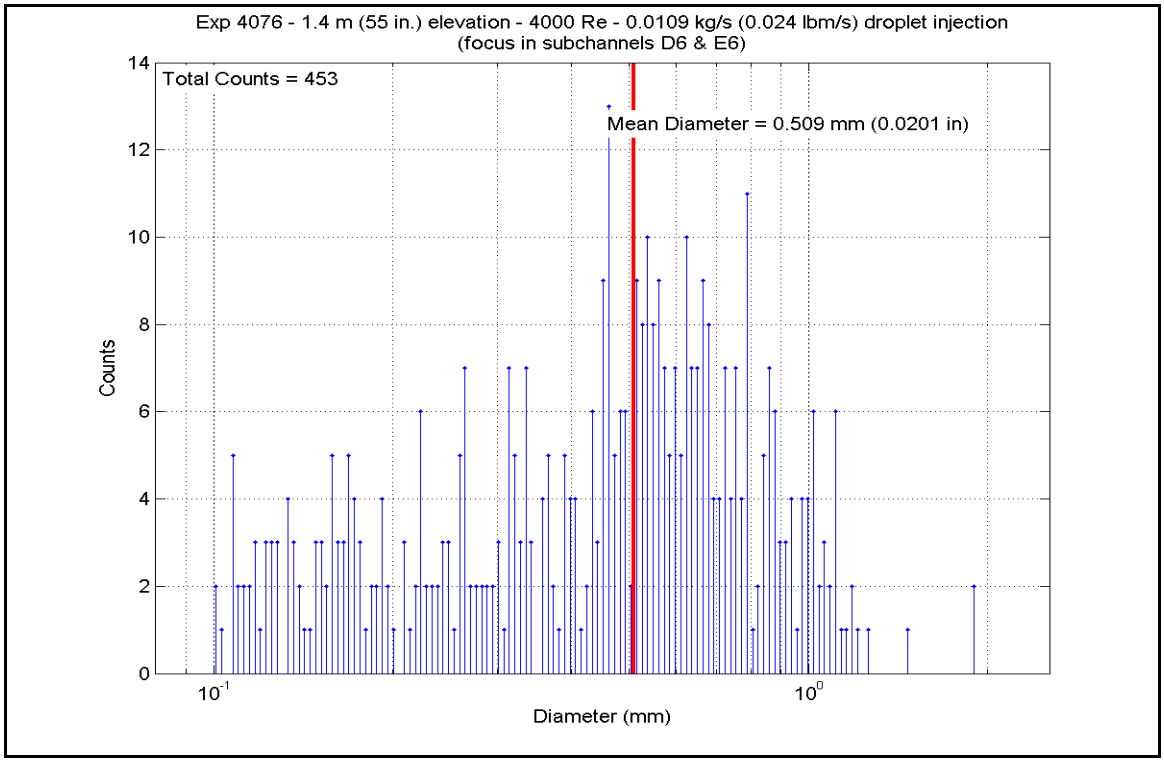

Figure A-748: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076C

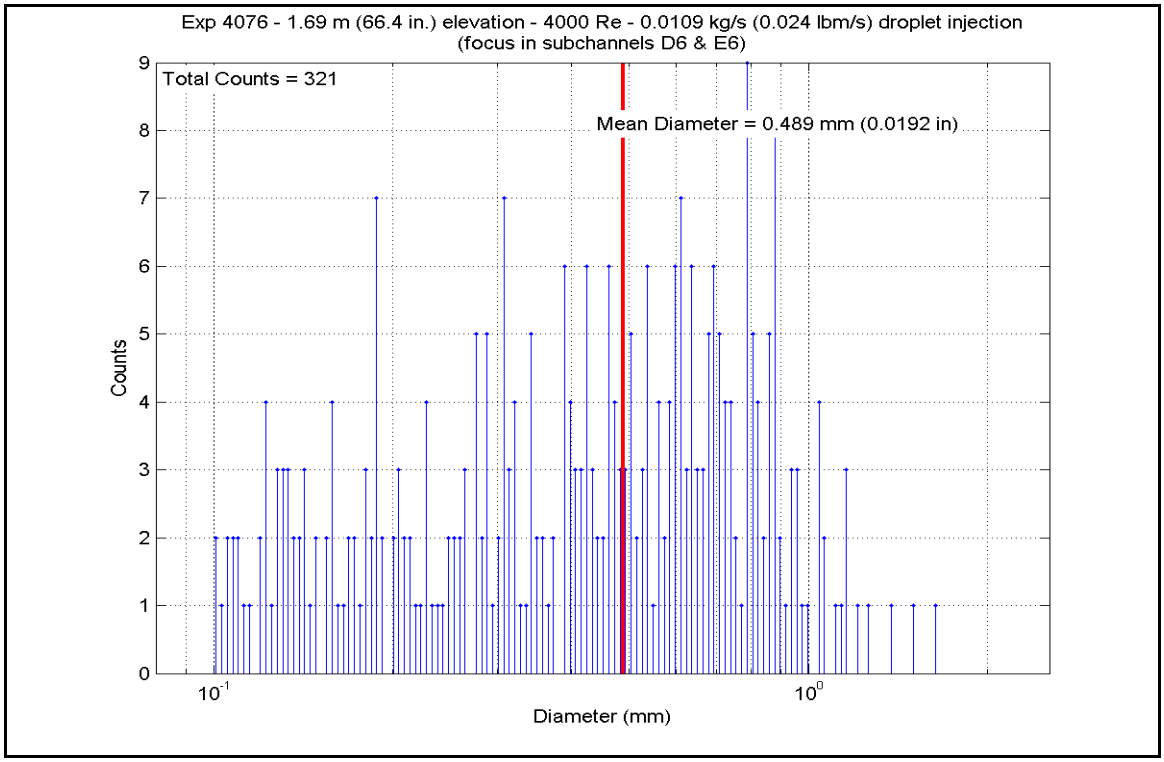

Figure A-749: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076C

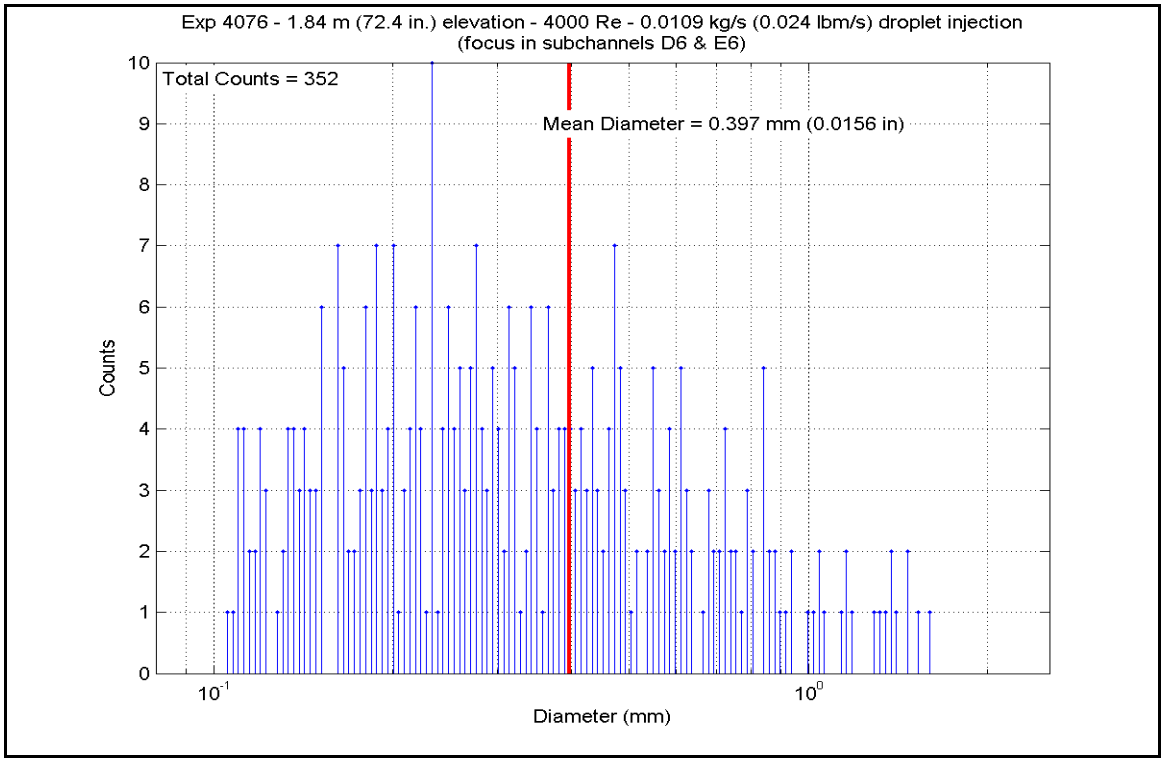

Figure A-750: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076C

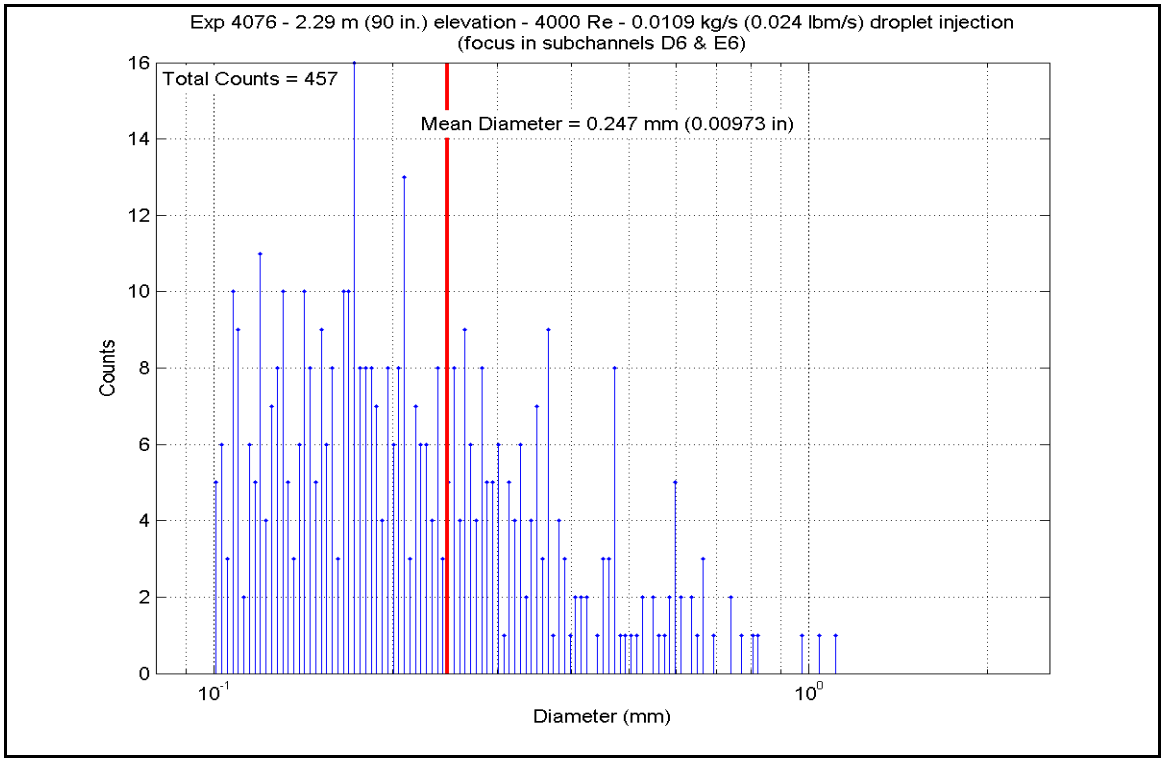

Figure A-751: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076C

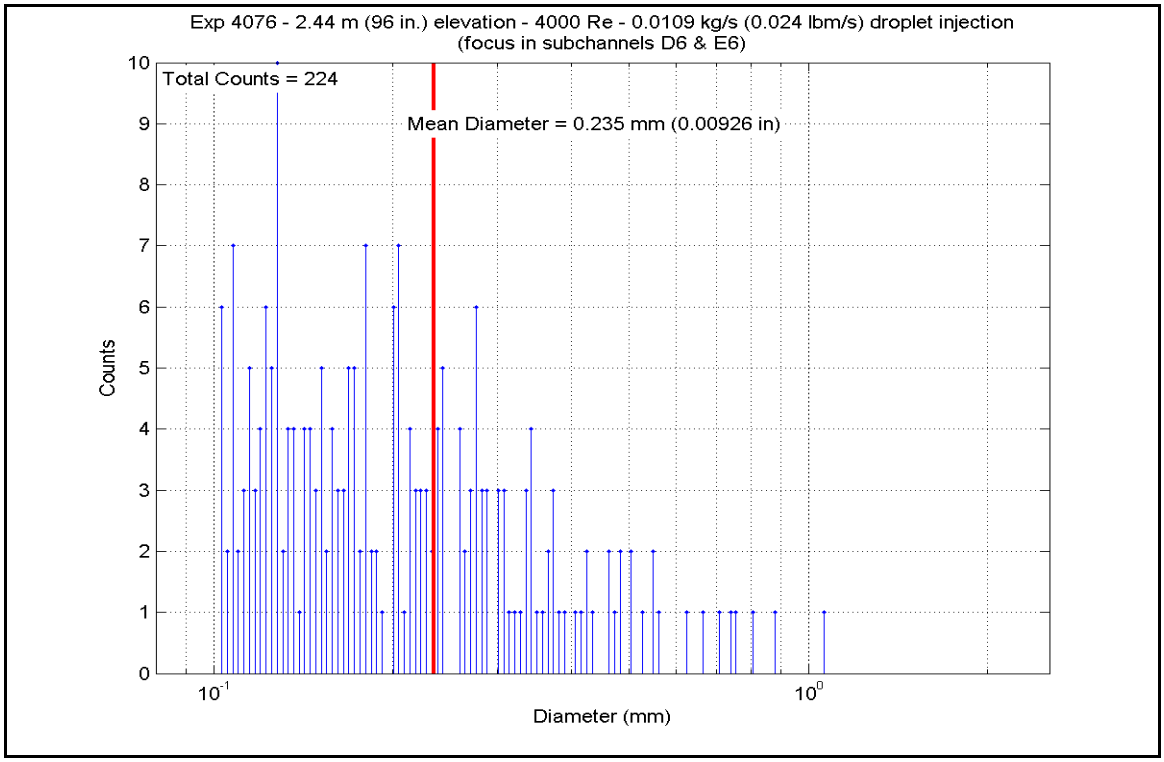

Figure A-752: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076C

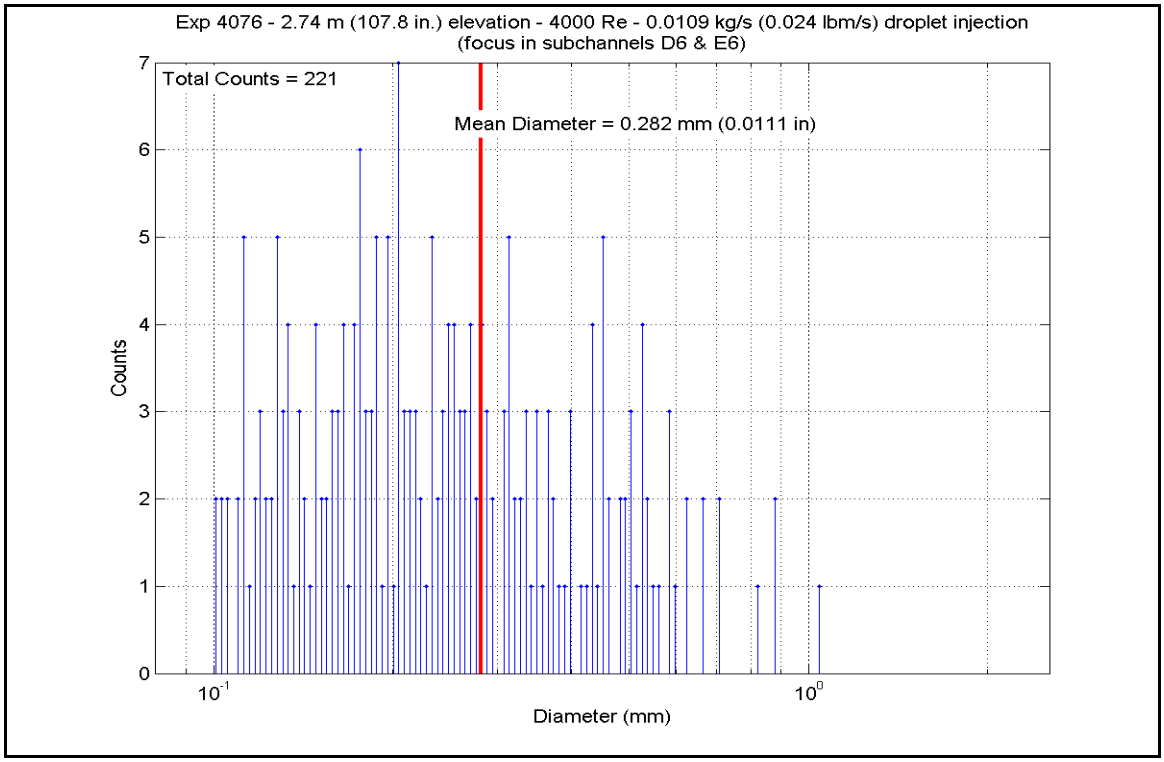

Figure A-753: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076C

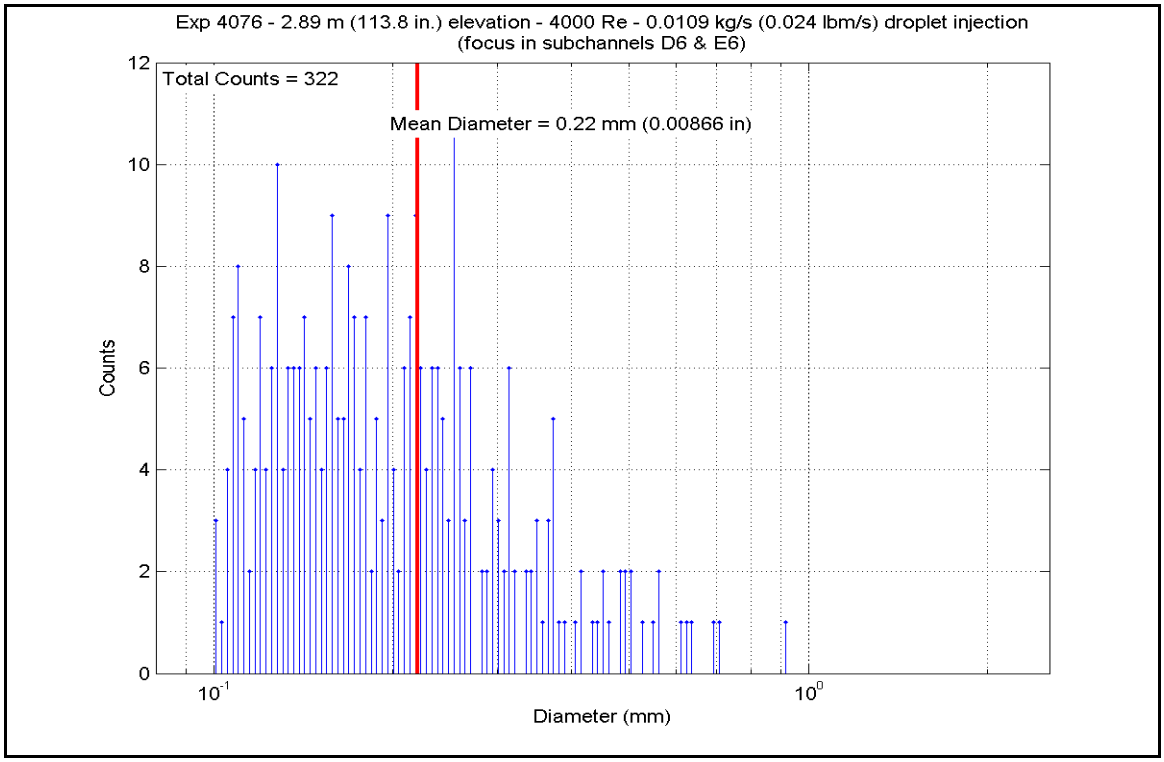

Figure A-754: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076C

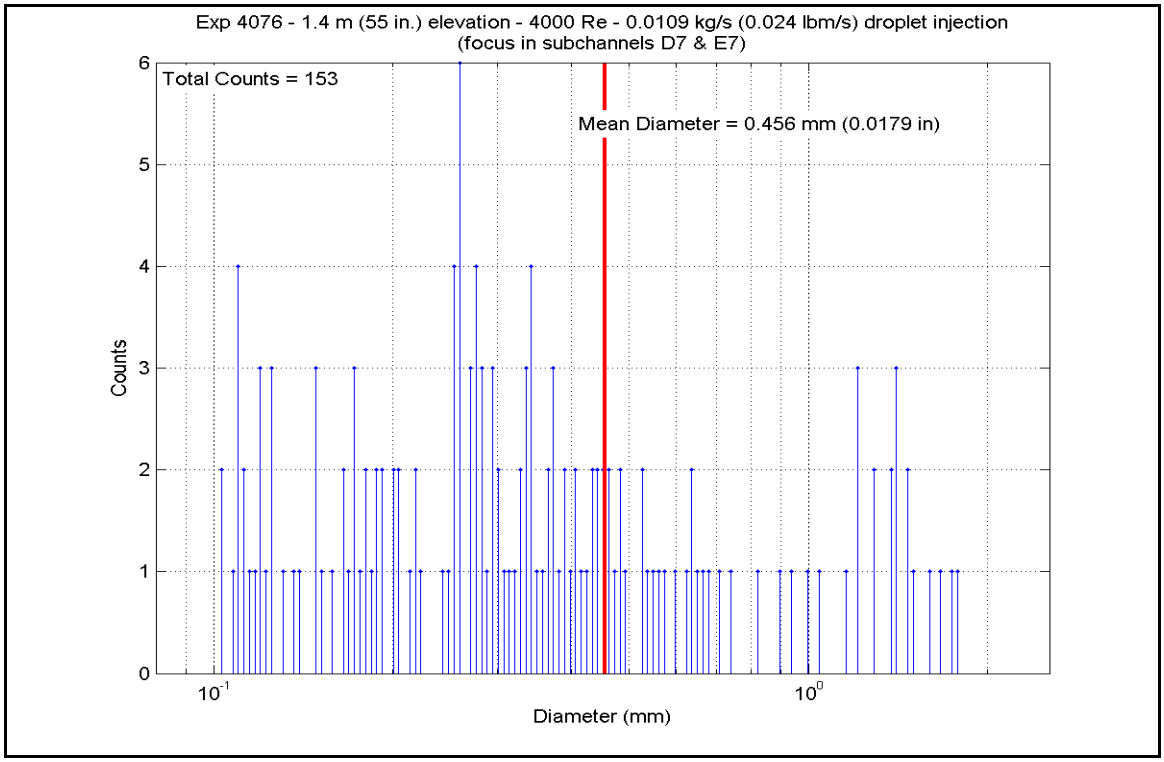

Figure A-755: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076C

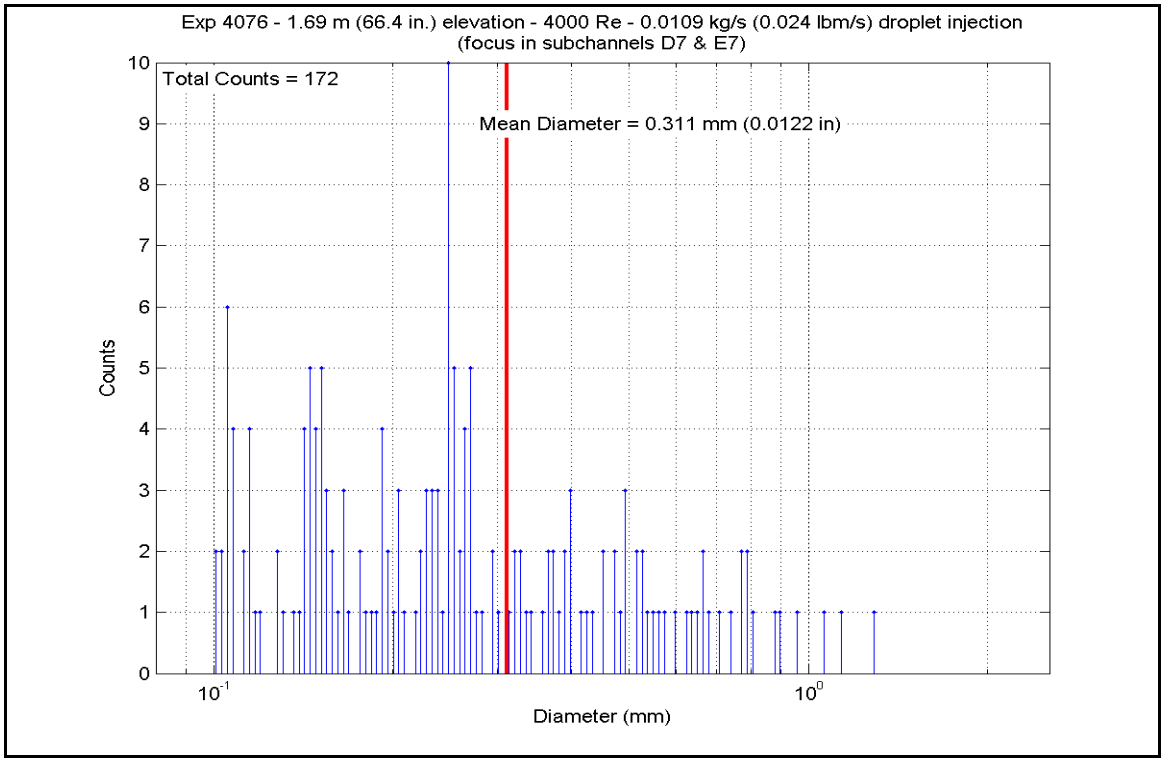

Figure A-756: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076C

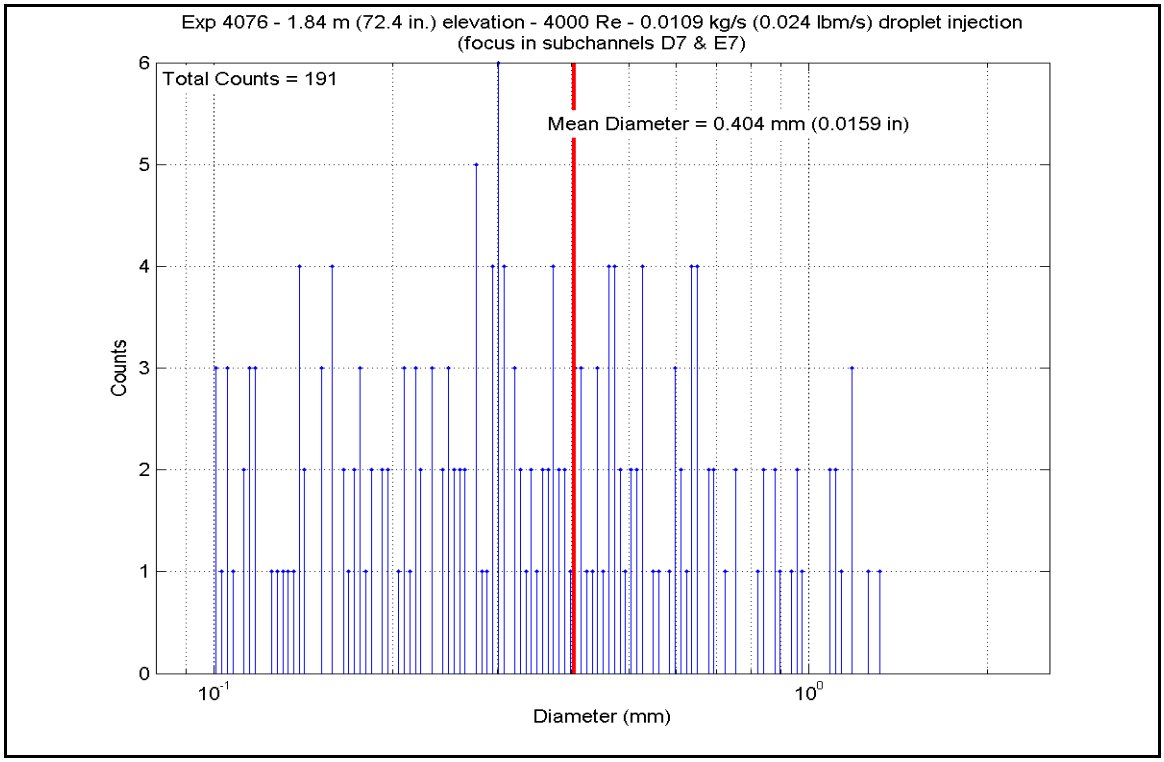

Figure A-757: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076C

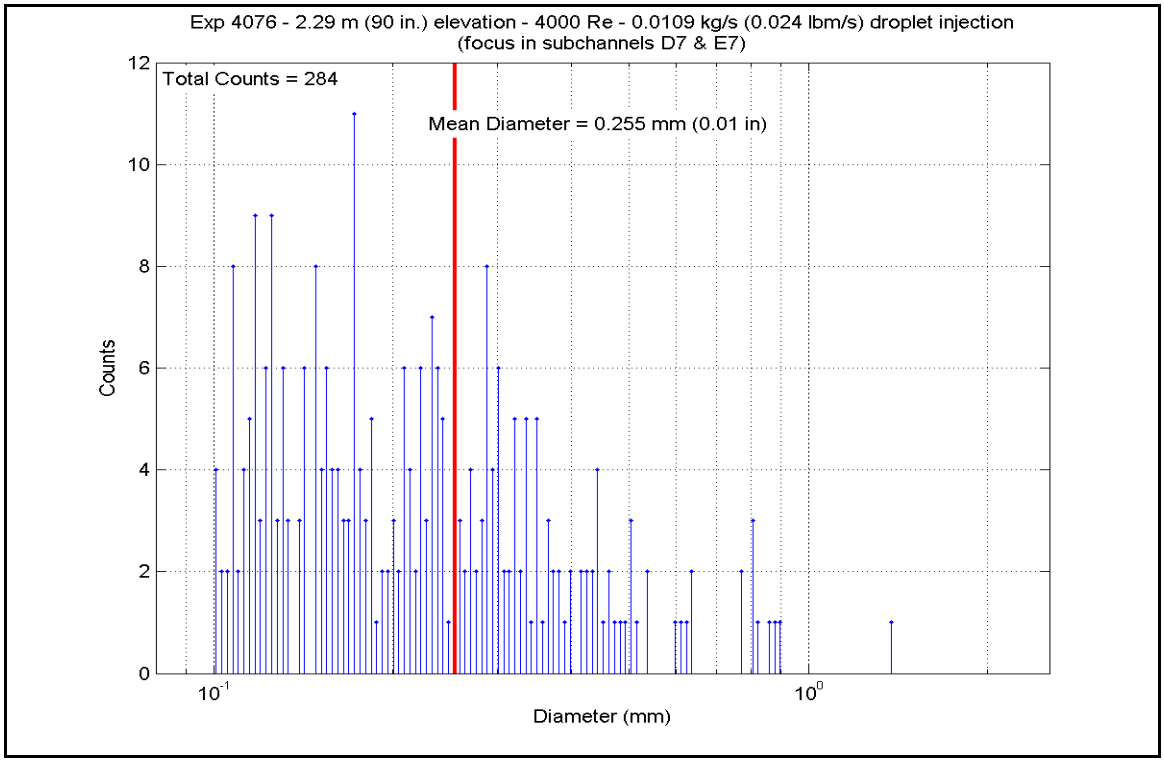

Figure A-758: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076C

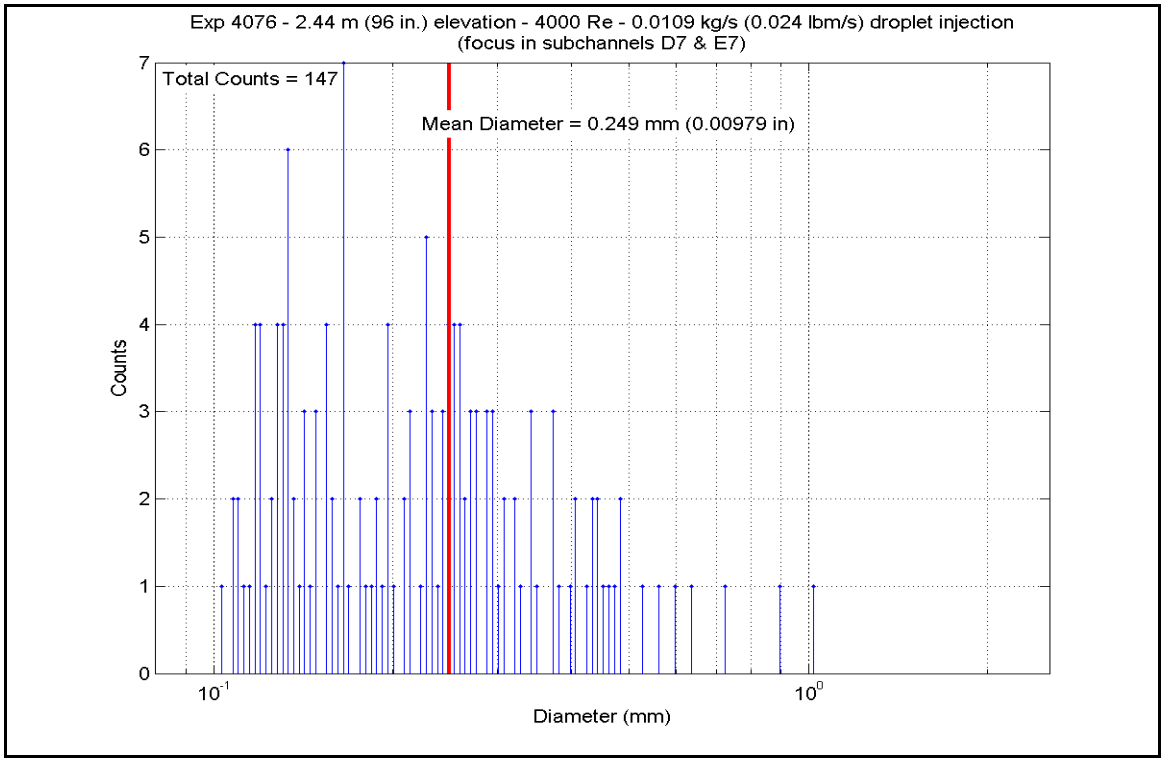

Figure A-759: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076C

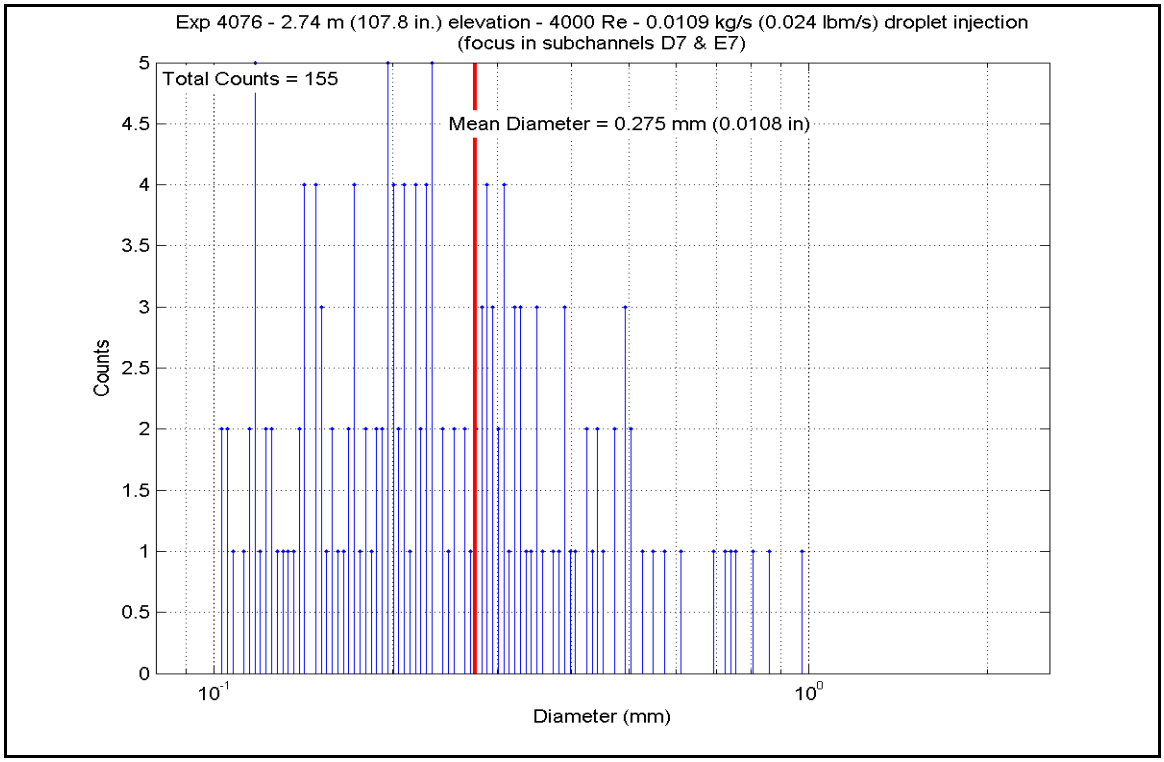

Figure A-760: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076C

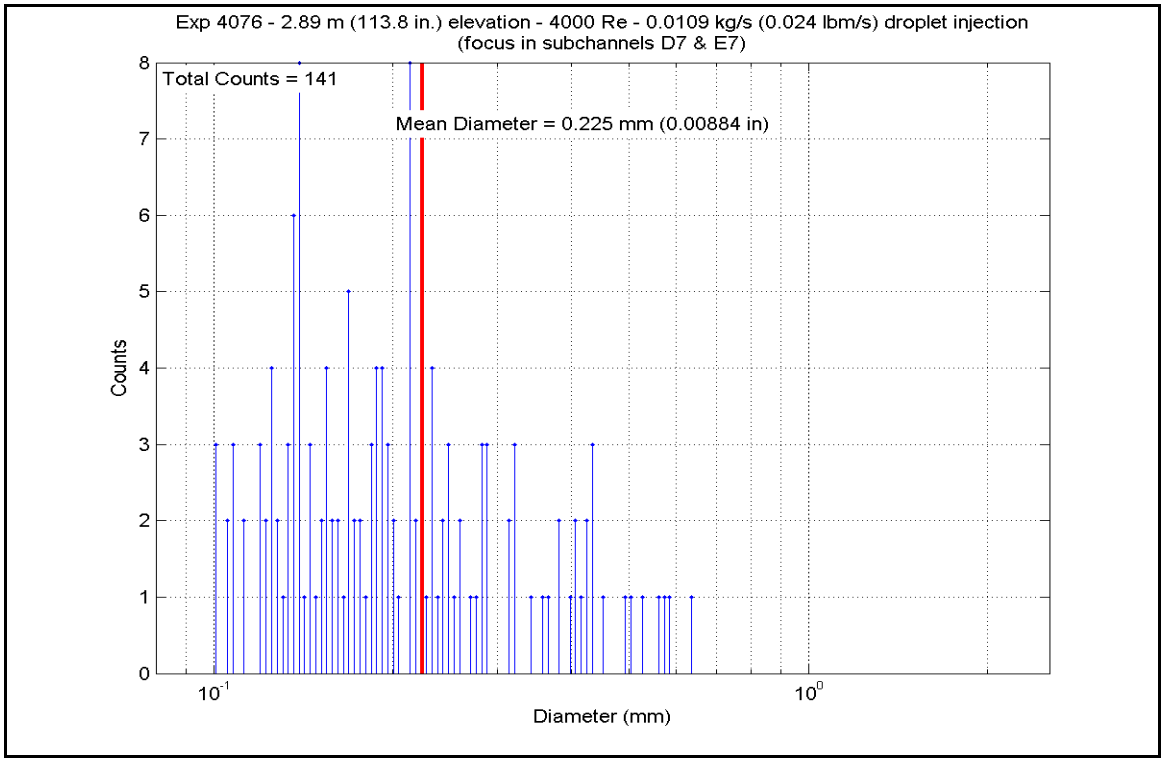

Figure A-761: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076C

Table A-74: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076C

SCD-4076-C	Inlet Reynolds:	4000		
Matrix test # 14 c	UP Pressure:	137.9 kPa	20	psia
Time Window: 24420-27600	Bundle Power:	50.00 kW	170607	Btu/hr
	Steam flow:	0.0237 kg/s	188.0	lbm/hr
	Droplet flow:	0.0109 kg/s	0.024	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	753.62	674.0	4266.17	13457.6	8.117	46.1
	RodD3_91.3	186	91.3	2.319	2.8	0.071	859.75	733.0	4358.63	13749.3	6.899	39.2
	RodD3_93.1	187	93.1	2.365	4.6	0.117	899.00	754.8	4413.78	13923.3	6.578	37.4
	RodD3_95.3	188	95.3	2.421	6.8	0.173	954.75	785.8	4480.12	14132.5	6.165	35.0
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1127.28	881.6	4809.66	15172.1	5.348	30.4
	RodD3_110	191	110	2.794	21.5	0.546	1101.92	867.6	4748.67	14979.7	5.434	30.9
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1223.36	935.0	1652.00	5211.2	1.660	9.4
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	760.07	677.6	4327.27	13650.4	8.133	46.2
	RodC4_91.1	234	91.1	2.314	2.6	0.066	863.62	735.2	4410.17	13911.9	6.938	39.4
	RodC4_93.4	235	93.4	2.372	4.9	0.124	910.56	761.2	4480.40	14133.4	6.564	37.3
	RodC4_95.3	236	95.3	2.421	6.8	0.173	958.74	788.0	4538.32	14316.1	6.211	35.3
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1050.62	839.1	4688.37	14789.5	5.699	32.4
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1121.88	878.6	4872.41	15370.0	5.451	31.0
	RodC4_110	239	110	2.794	21.5	0.546	1090.46	861.2	4715.11	14873.8	5.467	31.0
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1233.82	940.8	1793.24	5656.8	1.783	10.1
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	758.91	677.0	4310.00	13595.9	8.118	46.1
	RodD4_91.3	242	91.3	2.319	2.8	0.071	864.96	735.9	4400.89	13882.6	6.909	39.2
	RodD4_93.2	243	93.2	2.367	4.7	0.119	912.65	762.4	4458.46	14064.2	6.512	37.0
	RodD4_95.2	244	95.2	2.418	6.7	0.170	958.26	787.7	4519.48	14256.7	6.189	35.1
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1047.94	837.6	4671.91	14737.5	5.698	32.4
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1120.58	877.9	4853.60	15310.7	5.438	30.9
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1242.84	945.8	1733.09	5467.0	1.708	9.7
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	775.81	686.4	4240.59	13376.9	7.741	44.0
	RodE4_91.2	202	91.2	2.316	2.7	0.069	868.24	737.7	4322.09	13634.0	6.751	38.3
	RodE4_95.3	204	95.3	2.421	6.8	0.173	961.19	789.4	4441.29	14010.0	6.058	34.4
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1045.19	836.0	4608.43	14537.3	5.639	32.0
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1232.66	940.2	1751.46	5525.0	1.743	9.9

Table A-74: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_113.6	194	113.6	2.885	0.85	0.022	1130.14	883.2	4326.61	13648.3	4.796	27.2
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1166.44	903.4	4161.03	13126.0	4.434	25.2
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1200.35	922.2	3907.92	12327.5	4.019	22.8
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1228.44	937.8	3552.49	11206.3	3.551	20.2
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1236.09	942.1	3231.33	10193.2	3.205	18.2
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1194.45	919.0	2788.31	8795.7	2.885	16.4
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1210.88	928.1	2459.60	7758.8	2.502	14.2
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	707.05	648.2	3466.55	10935.2	7.236	41.1
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1105.80	869.7	4227.28	13335.0	4.816	27.3
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1149.99	894.3	4053.28	12786.1	4.396	25.0
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1213.58	929.6	3489.63	11008.0	3.541	20.1
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1223.23	934.9	3168.07	9993.7	3.183	18.1
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1191.65	917.4	2771.34	8742.2	2.876	16.3
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1213.77	929.7	2441.61	7702.1	2.477	14.1
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	609.05	593.7	3552.71	11207.0	9.323	52.9
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1046.34	836.7	4363.37	13764.2	5.332	30.3
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1096.42	864.5	4206.87	13270.6	4.844	27.5
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1149.29	893.9	3931.10	12400.7	4.267	24.2
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1188.03	915.4	3605.95	11375.0	3.756	21.3
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1206.02	925.4	3272.89	10324.3	3.346	19.0
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1268.99	960.4	2849.32	8988.2	2.737	15.5
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1218.17	932.1	2518.98	7946.1	2.544	14.4
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	699.75	644.1	3975.89	12542.0	8.428	47.9
	RodC3_85.6	178	85.6	2.174	14.72	0.374	730.32	661.1	4159.60	13121.5	8.281	47.0
	RodC3_88.5	179	88.5	2.248	0	0.000	756.85	675.8	4249.68	13405.6	8.036	45.6
	RodC3_92.4	180	92.4	2.347	3.9	0.099	881.07	744.9	4368.96	13781.9	6.690	38.0
	RodC3_94.4	181	94.4	2.398	5.9	0.150	923.46	768.4	4428.95	13971.1	6.368	36.2
Gr-8	RodD5_54.1	218	54.1	1.374	7.1	0.180	442.61	501.3	3253.98	10264.7	15.162	86.1
	RodD5_56.9	219	56.9	1.445	9.9	0.251	581.65	578.5	3348.31	10562.2	9.468	53.8
	RodD5_60	220	60	1.524	13	0.330	649.38	616.1	3441.70	10856.9	8.168	46.4
	RodD5_66.1	221	66.1	1.679	19.1	0.485	704.35	646.7	3629.01	11447.7	7.618	43.3
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	570.65	572.4	3729.70	11765.3	10.885	61.8
	RodD5_72.9	223	72.9	1.852	2.02	0.051	669.63	627.4	3817.14	12041.2	8.643	49.1
	RodD5_74.9	224	74.9	1.902	4.02	0.102	722.15	656.6	3876.04	12227.0	7.844	44.5

Table A-74: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	696.22	642.2	2834.77	8942.3	6.054	34.4
	RodB5_52.9	154	52.9	1.344	5.9	0.150	583.15	579.3	3201.10	10097.9	9.013	51.2
	RodB5_55	155	55	1.397	8	0.203	623.38	601.7	3266.44	10304.0	8.262	46.9
	RodB5_57.8	156	57.8	1.468	10.8	0.274	672.07	628.7	3353.71	10579.3	7.552	42.9
	RodB5_64	157	64	1.626	17	0.432	737.32	665.0	3544.09	11179.8	6.958	39.5
	RodB5_73.9	158	73.9	1.877	3.02	0.077	687.46	637.3	3840.55	12115.0	8.359	47.5
	RodB5_75.9	159	75.9	1.928	5.02	0.128	727.81	659.7	3902.05	12309.0	7.807	44.3
	RodB5_76.9	160	76.9	1.953	6.02	0.153	745.39	669.5	3932.38	12404.7	7.600	43.2
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	669.64	627.4	2806.96	8854.6	6.356	36.1
	RodF5_53.1	106	53.1	1.349	6.1	0.155	595.95	586.5	3185.82	10049.7	8.658	49.2
	RodF5_55	107	55	1.397	8	0.203	634.47	607.9	3244.76	10235.6	7.983	45.3
	RodF5_57.8	108	57.8	1.468	10.8	0.274	676.16	631.0	3331.06	10507.8	7.433	42.2
	RodF5_64	109	64	1.626	17	0.432	745.98	669.8	3521.28	11107.9	6.798	38.6
	RodF5_73.8	110	73.8	1.875	2.92	0.074	703.17	646.0	3812.74	12027.3	8.024	45.6
	RodF5_75.8	111	75.8	1.925	4.92	0.125	746.05	669.8	3873.21	12218.0	7.477	42.5
	RodF5_76.8	112	76.8	1.951	5.92	0.150	764.54	680.1	3903.33	12313.0	7.275	41.3
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	679.66	633.0	2815.79	8882.4	6.234	35.4
	RodC2_53.1	58	53.1	1.349	6.1	0.155	625.52	602.9	3198.03	10088.2	8.045	45.7
	RodC2_55	59	55	1.397	8	0.203	651.83	617.5	3255.69	10270.1	7.682	43.6
	RodC2_57.8	60	57.8	1.468	10.8	0.274	691.90	639.8	3339.78	10535.3	7.199	40.9
	RodC2_63.9	61	63.9	1.623	16.9	0.429	741.12	667.1	3523.39	11114.5	6.867	39.0
	RodC2_73.8	62	73.8	1.875	2.92	0.074	676.32	631.1	3818.65	12045.9	8.518	48.4
	RodC2_75.8	63	75.8	1.925	4.92	0.125	722.56	656.8	3879.11	12236.7	7.844	44.5
	RodC2_76.8	64	76.8	1.951	5.92	0.150	741.88	667.5	3909.32	12332.0	7.607	43.2
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	703.71	646.3	2817.07	8886.4	5.922	33.6
	RodC6_52.8	138	52.8	1.341	5.8	0.147	626.15	603.2	3217.66	10150.1	8.082	45.9
	RodC6_54.8	139	54.8	1.392	7.8	0.198	651.87	617.5	3281.54	10351.6	7.742	44.0
	RodC6_57.8	140	57.8	1.468	10.8	0.274	697.25	642.7	3375.40	10647.7	7.193	40.8
	RodC6_63.8	141	63.8	1.621	16.8	0.427	771.88	684.2	3564.83	11245.2	6.554	37.2
	RodC6_73.7	142	73.7	1.872	2.82	0.072	730.20	661.0	3862.71	12184.9	7.692	43.7
	RodC6_75.8	143	75.8	1.925	4.92	0.125	764.59	680.1	3928.89	12393.7	7.322	41.6
	RodC6_76.8	144	76.8	1.951	5.92	0.150	783.36	690.6	3960.41	12493.1	7.131	40.5

Table A-74: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	759.39	677.3	4241.29	13379.1	7.981	45.3
	RodB4_91.3	162	91.3	2.319	2.8	0.071	861.68	734.1	4326.22	13647.1	6.827	38.8
	RodB4_93.3	163	93.3	2.370	4.8	0.122	901.23	756.1	4383.32	13827.2	6.511	37.0
	RodB4_95.1	164	95.1	2.416	6.6	0.168	935.54	775.1	4435.46	13991.7	6.269	35.6
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1203.28	923.9	1783.98	5627.6	1.829	10.4
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	808.00	704.3	4182.82	13194.7	7.212	41.0
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	796.04	697.6	4265.35	13455.0	7.509	42.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	905.92	758.7	4384.71	13831.6	6.468	36.7
	RodF4_94.3	101	94.3	2.395	5.8	0.147	946.67	781.3	4441.33	14010.2	6.180	35.1
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1108.49	871.2	4205.50	13266.2	4.776	27.1
	RodD2_106	66	106	2.692	17.5	0.445	1131.28	883.9	3982.62	12563.2	4.409	25.0
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1171.72	906.3	3679.95	11608.4	3.899	22.1
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1189.76	916.4	3324.24	10486.3	3.456	19.6
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1192.79	918.0	2986.23	9420.1	3.095	17.6
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1121.78	878.6	4227.35	13335.2	4.730	26.9
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1146.25	892.2	4055.48	12793.0	4.417	25.1
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1173.08	907.1	3684.94	11624.2	3.899	22.1
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1181.55	911.8	3333.31	10514.9	3.496	19.9
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1187.81	915.3	2981.99	9406.7	3.107	17.6

Table A-74: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	554.97	563.7	3130.97	9876.7	9.576	54.4
	RodE2_54	74	54	1.372	7	0.178	610.65	594.6	3250.41	10253.4	8.495	48.2
	RodE2_56.9	75	56.9	1.445	9.9	0.251	643.96	613.1	3339.42	10534.2	8.028	45.6
	RodE2_59.9	76	59.9	1.521	12.9	0.328	677.75	631.9	3430.99	10823.0	7.629	43.3
	RodE2_66	77	66	1.676	19	0.483	703.54	646.2	3617.39	11411.1	7.607	43.2
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	538.74	554.7	3734.74	11781.2	12.019	68.3
	RodE2_72.9	79	72.9	1.852	2.02	0.051	623.32	601.7	3830.51	12083.4	9.690	55.0
	RodE2_74.9	80	74.9	1.902	4.02	0.102	672.02	628.7	3891.66	12276.2	8.765	49.8
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	545.15	558.2	3108.45	9805.6	9.801	55.7
	RodB3_54.1	170	54.1	1.374	7.1	0.180	604.18	591.0	3227.09	10179.8	8.578	48.7
	RodB3_56.9	171	56.9	1.445	9.9	0.251	648.31	615.5	3311.59	10446.4	7.879	44.7
	RodB3_60.1	172	60.1	1.527	13.1	0.333	648.79	615.8	3407.34	10748.5	8.097	46.0
	RodB3_66.1	173	66.1	1.679	19.1	0.485	687.26	637.2	3589.35	11322.6	7.816	44.4
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	558.93	565.9	3703.75	11683.5	11.192	63.6
	RodB3_73	175	73	1.854	2.12	0.054	636.54	609.0	3795.11	11971.7	9.289	52.8
	RodB3_75	176	75	1.905	4.12	0.105	683.64	635.2	3853.39	12155.5	8.457	48.0
gr-8	RodF3_66.1	93	66.1	1.679	19.1	0.485	578.13	576.6	3604.80	11371.3	10.296	58.5
	RodF3_70	94	70	1.778	-0.88	-0.022	550.32	561.1	3722.19	11741.7	11.548	65.6
	RodF3_73	95	73	1.854	2.12	0.054	662.28	623.3	3815.58	12036.2	8.786	49.9
	RodF3_75	96	75	1.905	4.12	0.105	714.41	652.3	3877.74	12232.3	7.972	45.3
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	566.41	570.0	3119.93	9841.8	9.219	52.4
	RodE6_54.1	122	54.1	1.374	7.1	0.180	626.12	603.2	3238.89	10217.1	8.136	46.2
	RodE6_57	123	57	1.448	10	0.254	666.31	625.5	3325.84	10491.4	7.588	43.1
	RodE6_60.2	124	60.2	1.529	13.2	0.335	715.78	653.0	3423.14	10798.3	7.018	39.9
	RodE6_66.1	125	66.1	1.679	19.1	0.485	754.09	674.3	3602.98	11365.6	6.849	38.9
	RodE6_70	126	70	1.778	-0.88	-0.022	625.75	603.0	3712.21	11710.2	9.333	53.0
	RodE6_73.1	127	73.1	1.857	2.22	0.056	707.15	648.2	3803.82	11999.1	7.939	45.1
	RodE6_75	128	75	1.905	4.12	0.105	748.54	671.2	3859.78	12175.7	7.415	42.1

RBHT Steam Cooling with Droplet Injection Test SCD-4076-D

Matrix Test # 14d

Test Conditions

Test Date – 12/13/2005
Steady State Time Window: 28200 - 31620
Upper Plenum Pressure: 1.38 bar (20 psia)
Bundle Power: 50 kW
Bundle Inlet Reynolds Number: 4000
Bundle Inlet Steam Flow: 81.65 kg/hr (180 lbm/hr)
Droplet Injection Flow: 0.0144 kg/s (0.032 lbm/s)
Droplet Injection Hole Diameter: 0.254 mm (.010 in)
Droplet Injection Elevation: 1.295 m (51 in)
Bundle Flow Area: 4.656×10^{-3} m^2 (5.012×10^{-2} ft^2)

Test Notes

- Steam probes at 237.57 cm and 254.0 cm (93.53 in. and 100 in.) were traversed in this steady state window.
- Camera focal length was varied in this steady state window

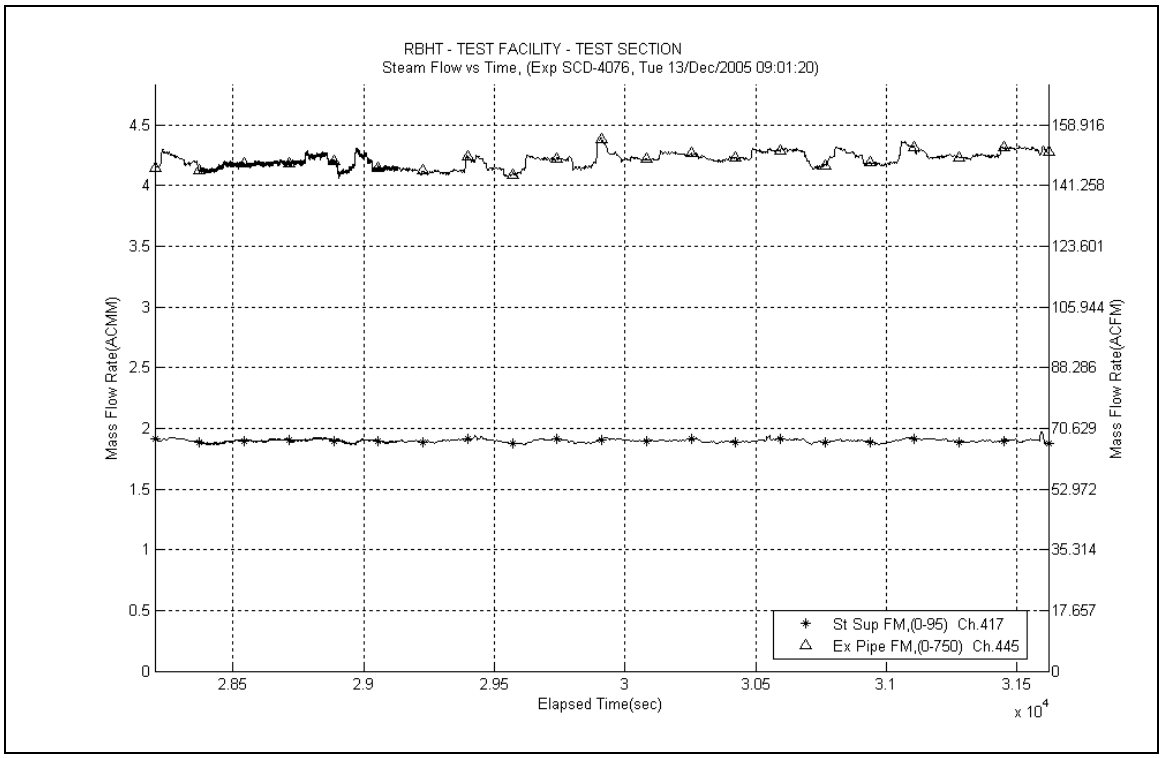

Figure A-762: Inlet and Exhaust Steam Flow Rates for Experiment 4076D

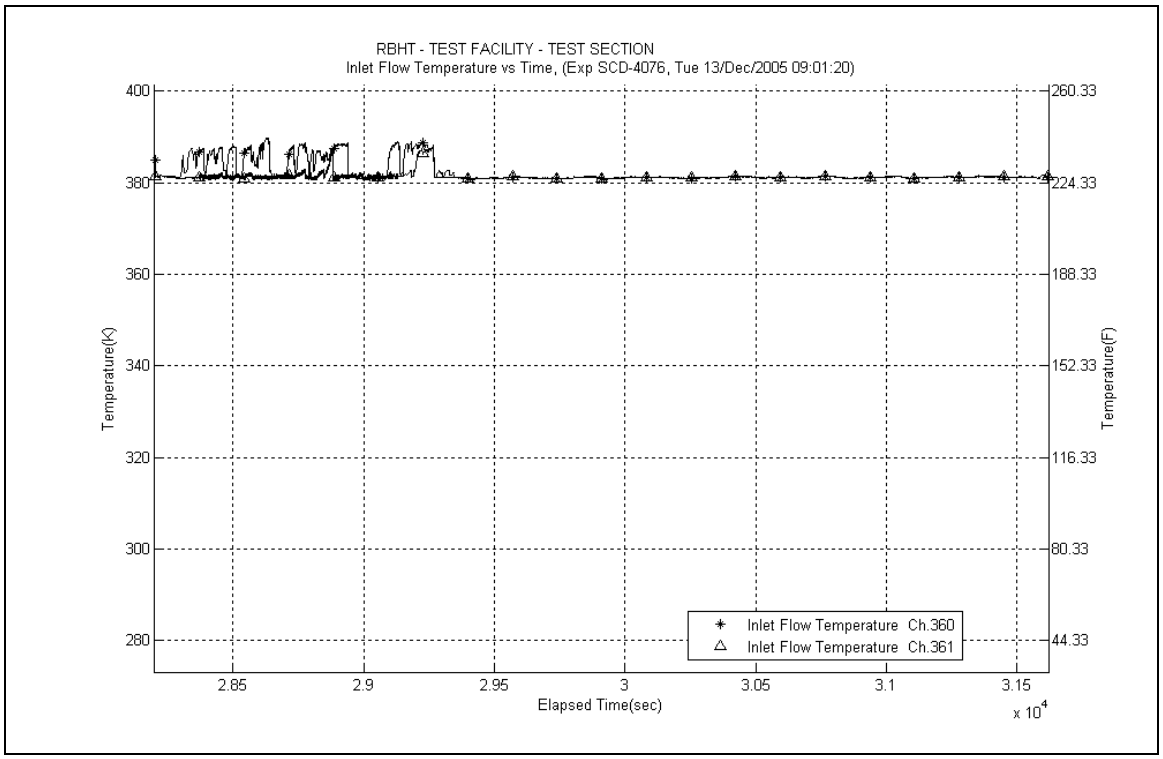

Figure A-763: Inlet Steam Temperature for Experiment 4076D

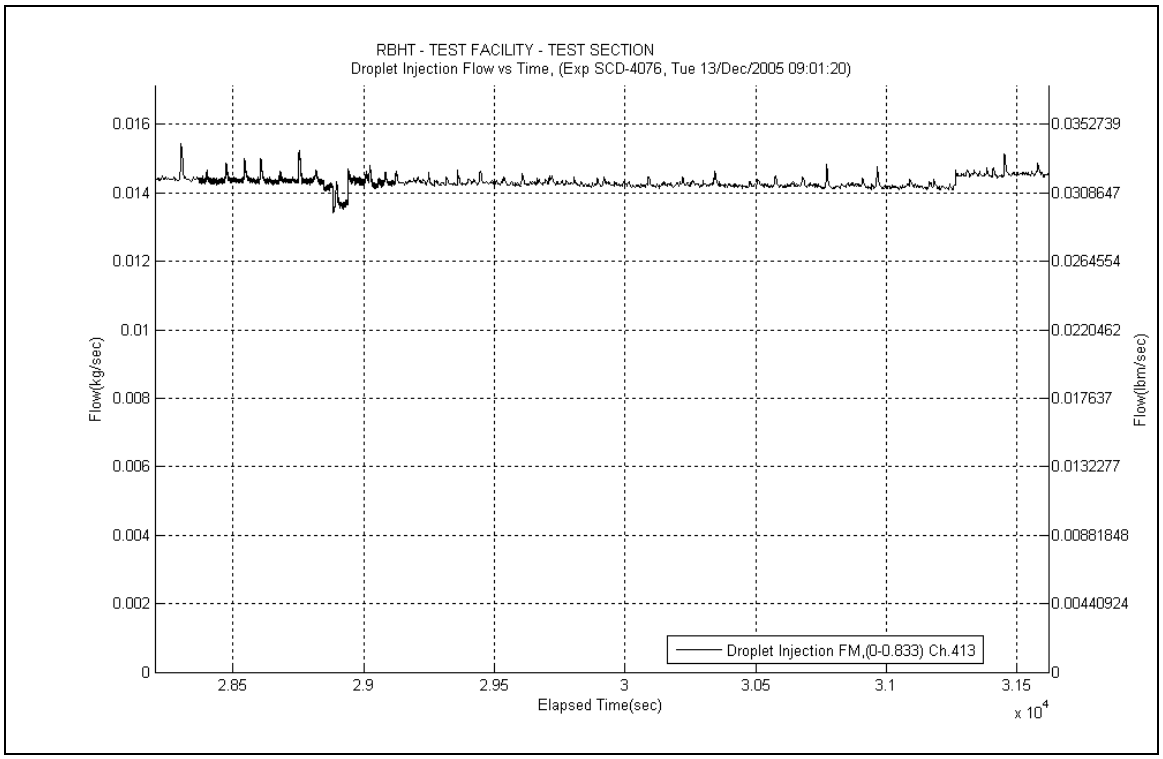

Figure A-764: Droplet Injection Flow Rate for Experiment 4076D

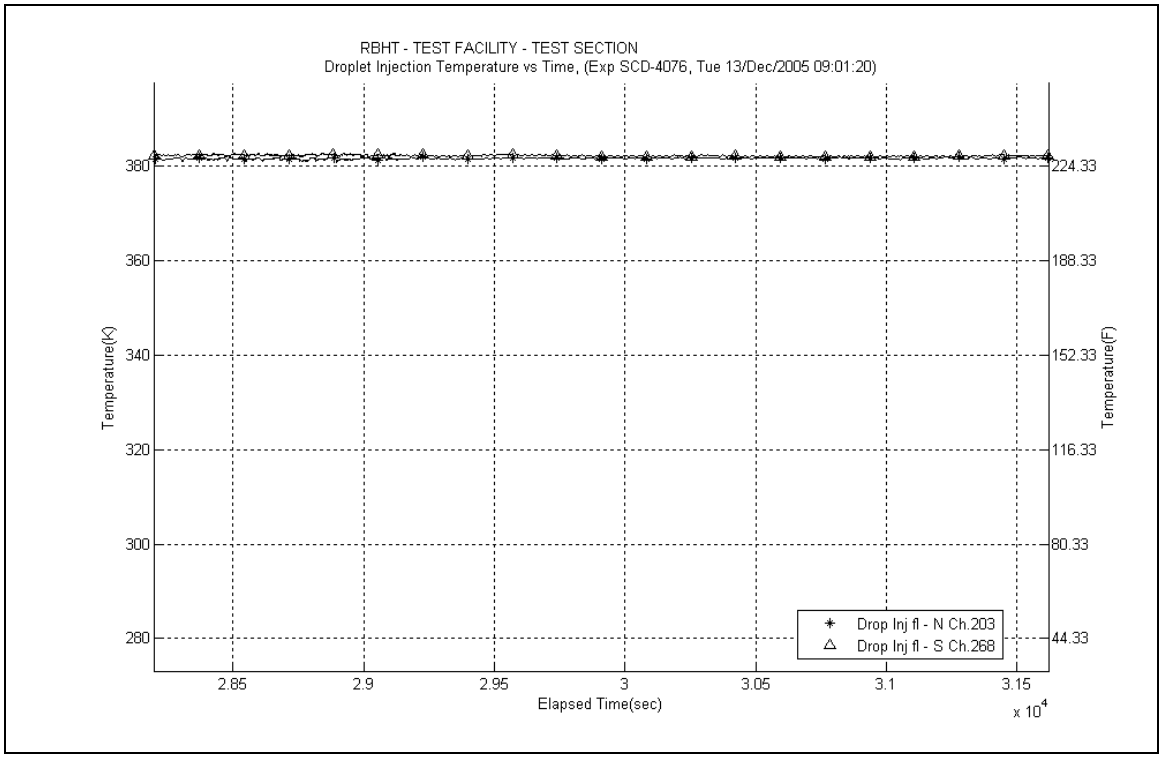

Figure A-765: Droplet Injection Temperature for Experiment 4076D

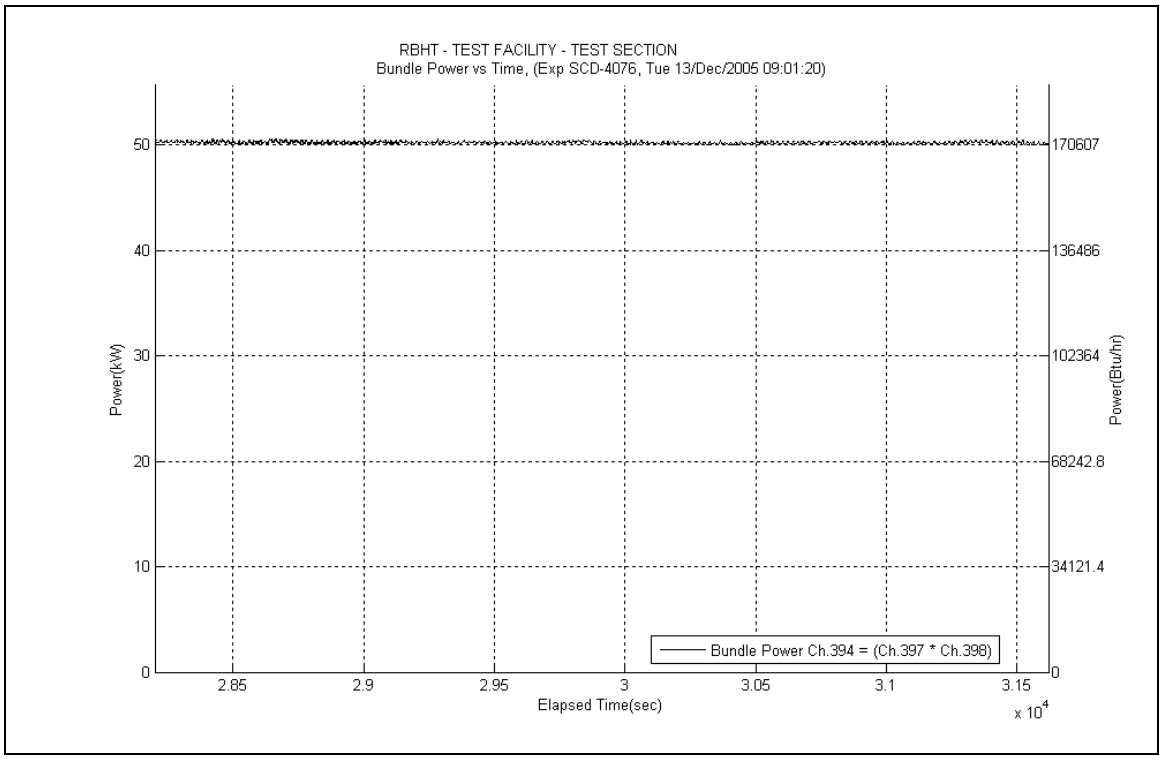

Figure A-766: Bundle Power for Experiment 4076D

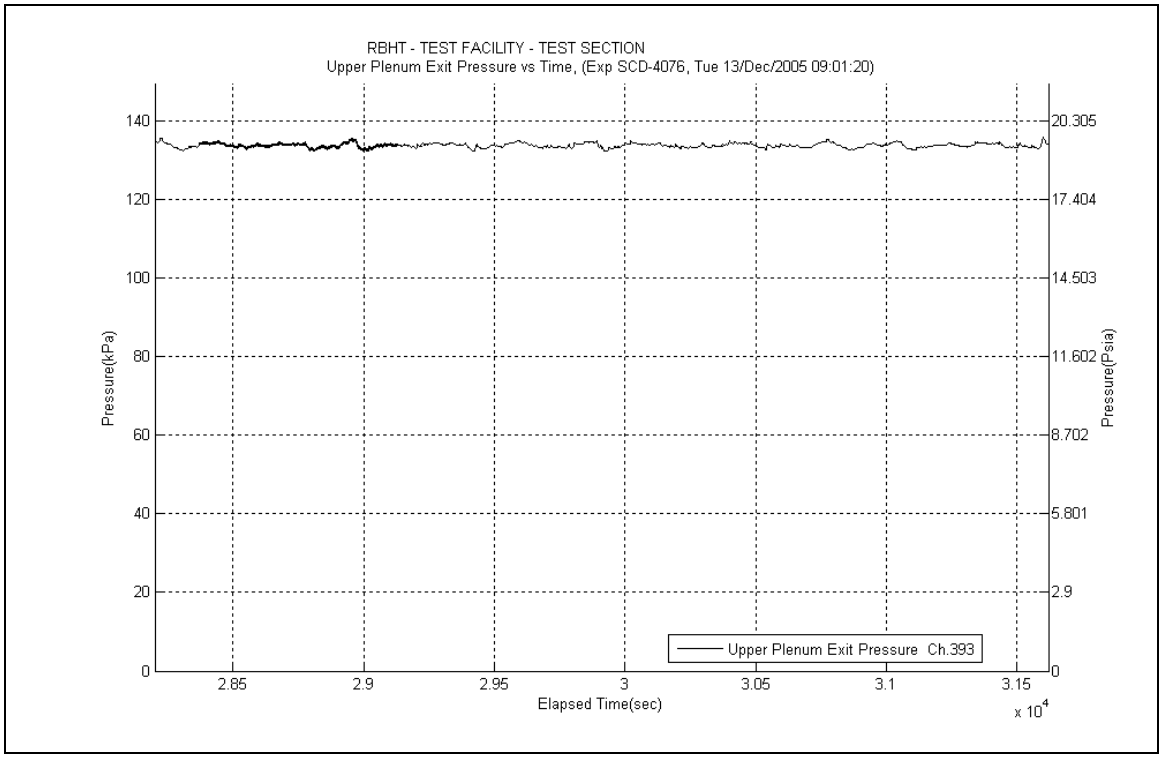

Figure A-767: Upper Plenum Pressure for Experiment 4076D

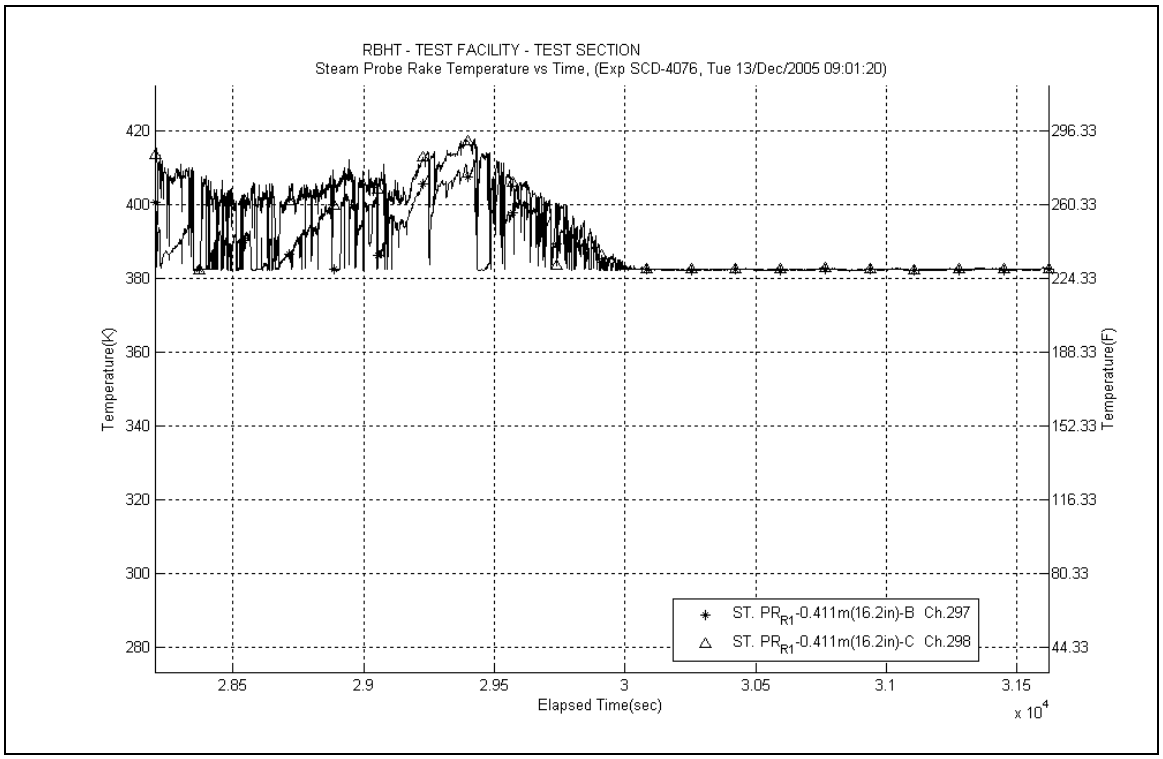

Figure A-768: Steam Probe Rake #1 Temperatures for Experiment 4076D

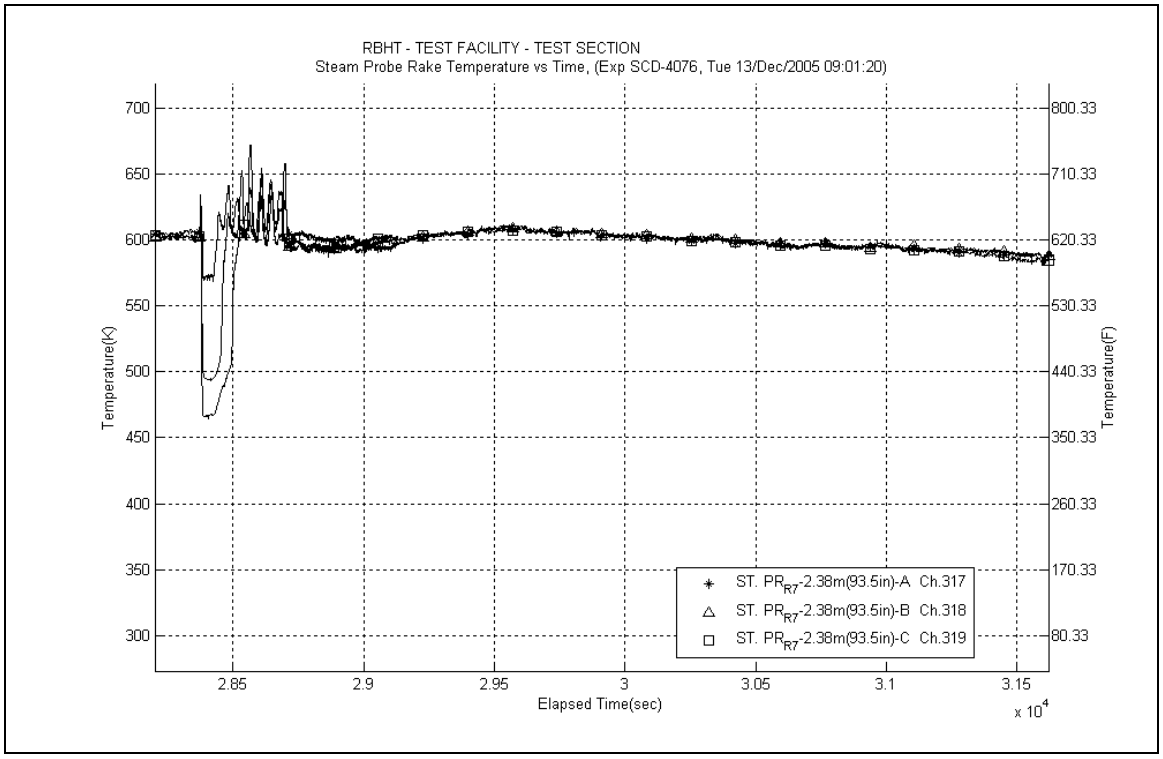

Figure A-769: Steam Probe Rake #7 Temperatures for Experiment 4076D

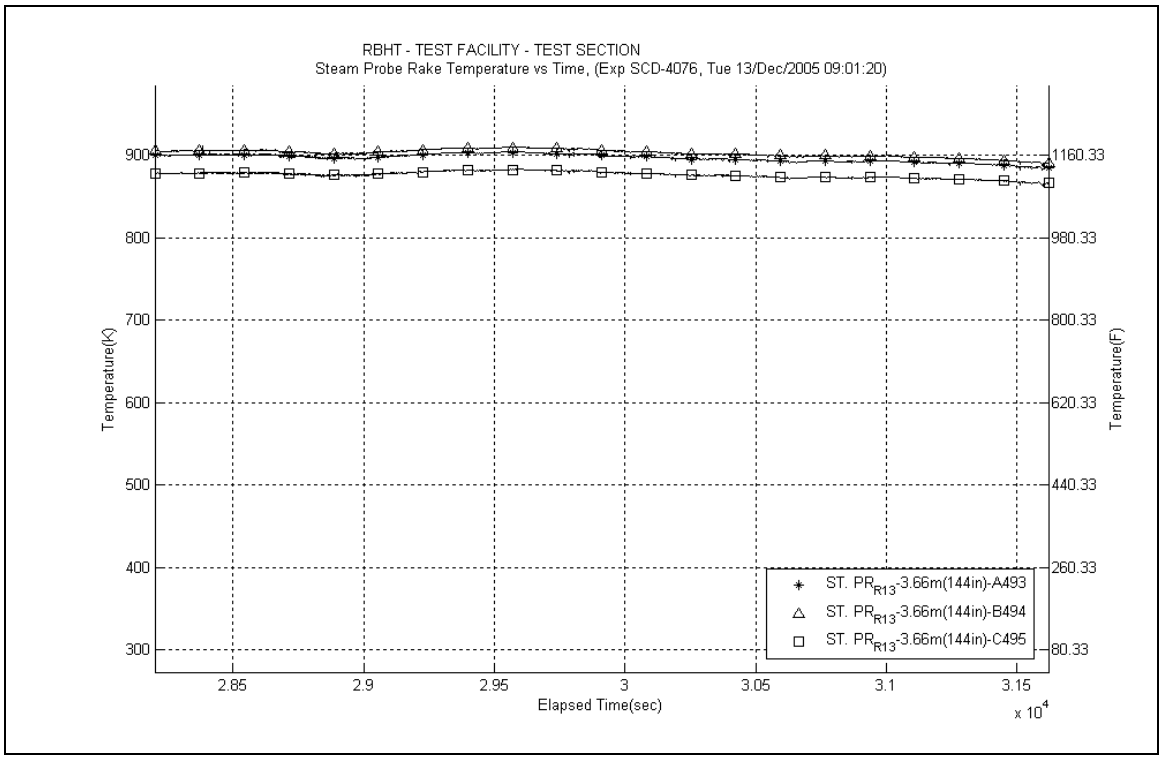

Figure A-770: Steam Probe Rake #13 Temperatures for Experiment 4076D

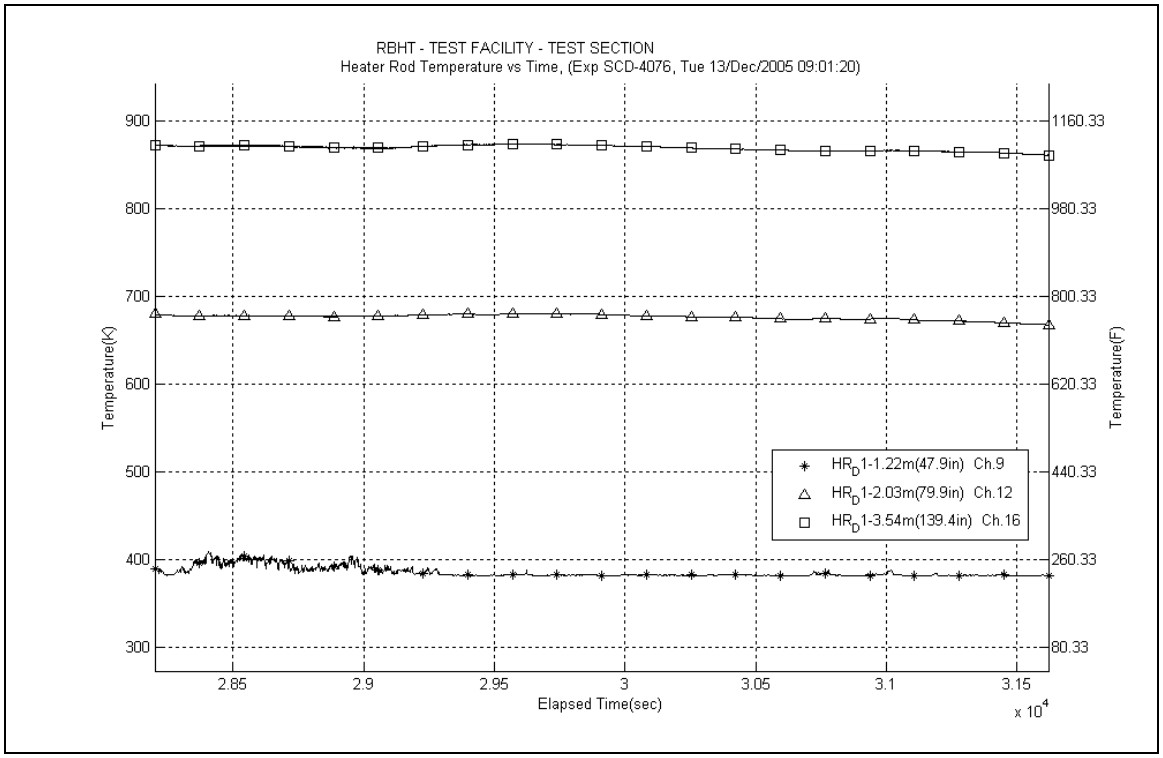

Figure A-771: Heater Rod D1 Temperatures for Experiment 4076D

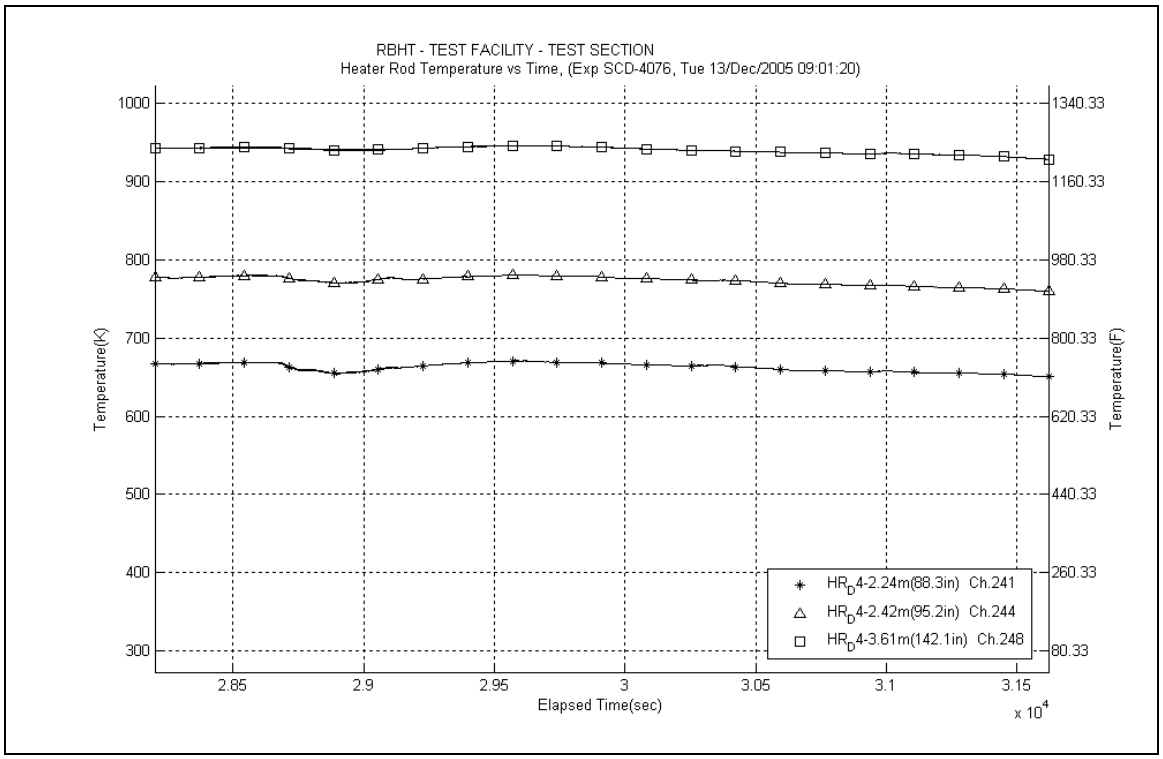

Figure A-772: Heater Rod D4 Temperatures for Experiment 4076D

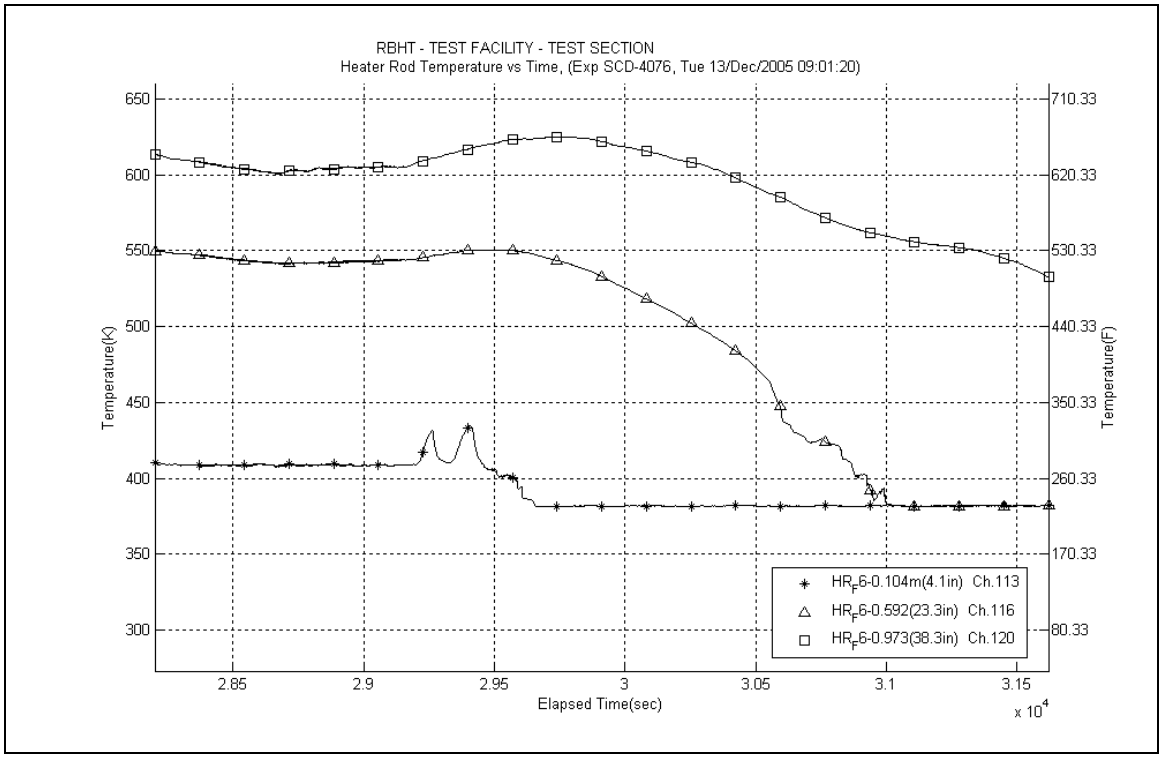

Figure A-773: Heater Rod F6 Temperatures for Experiment 4076D

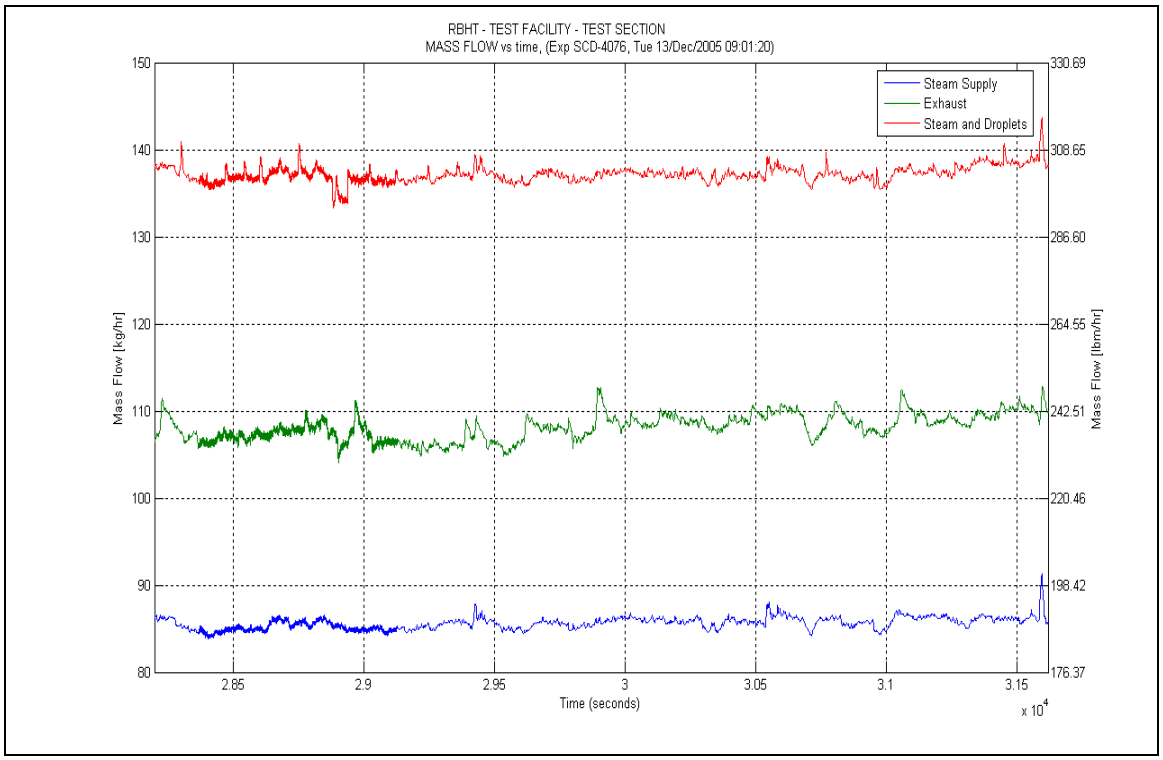

Figure A-774: Mass Flow for Experiment 4076D

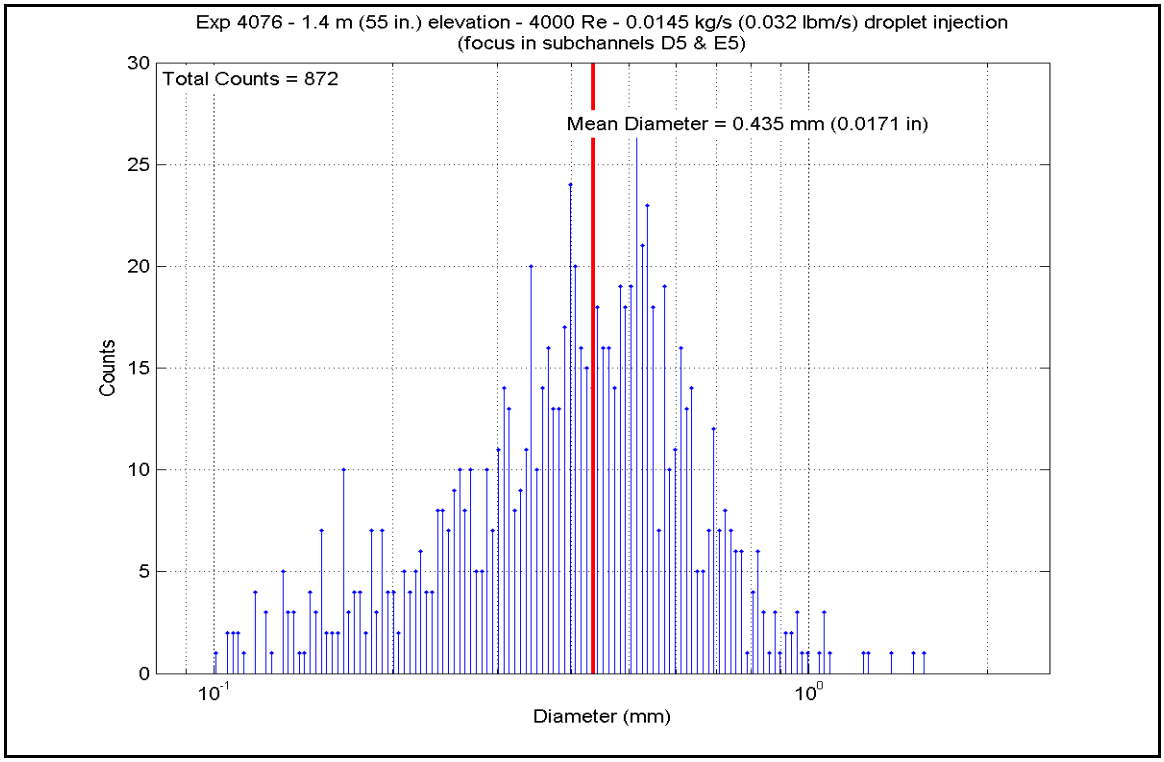

Figure A-775: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076D

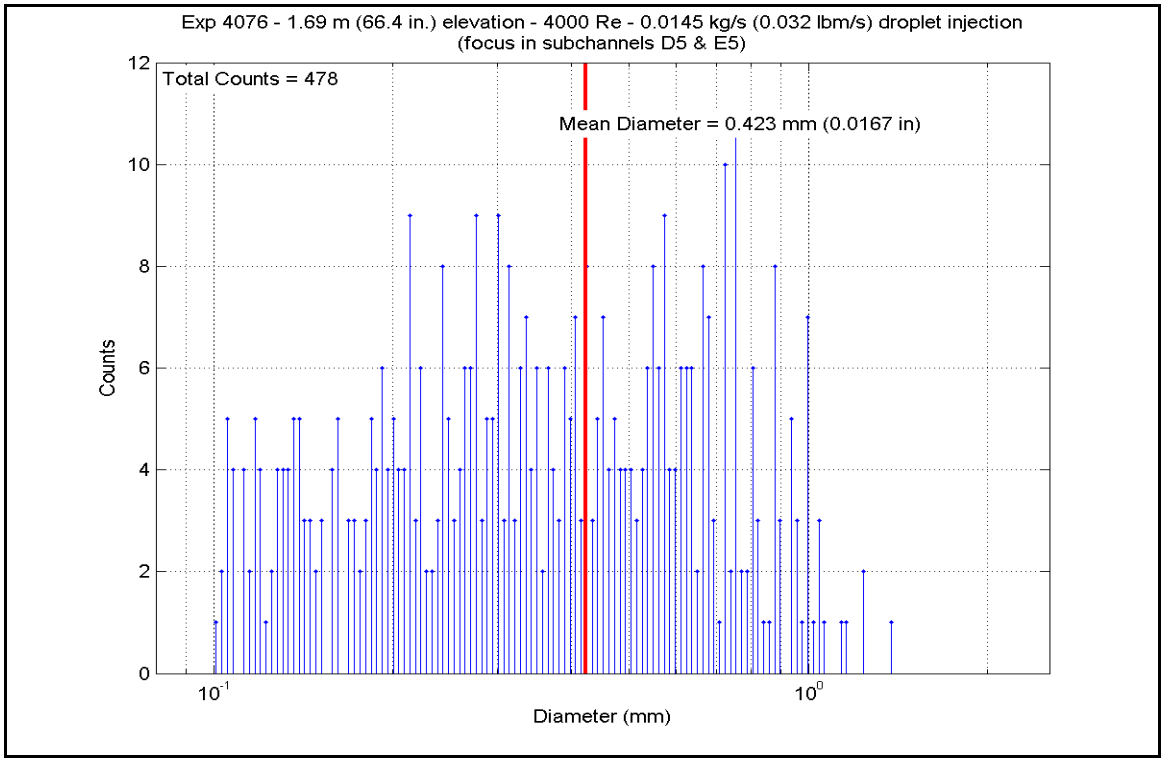

Figure A-776: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076D

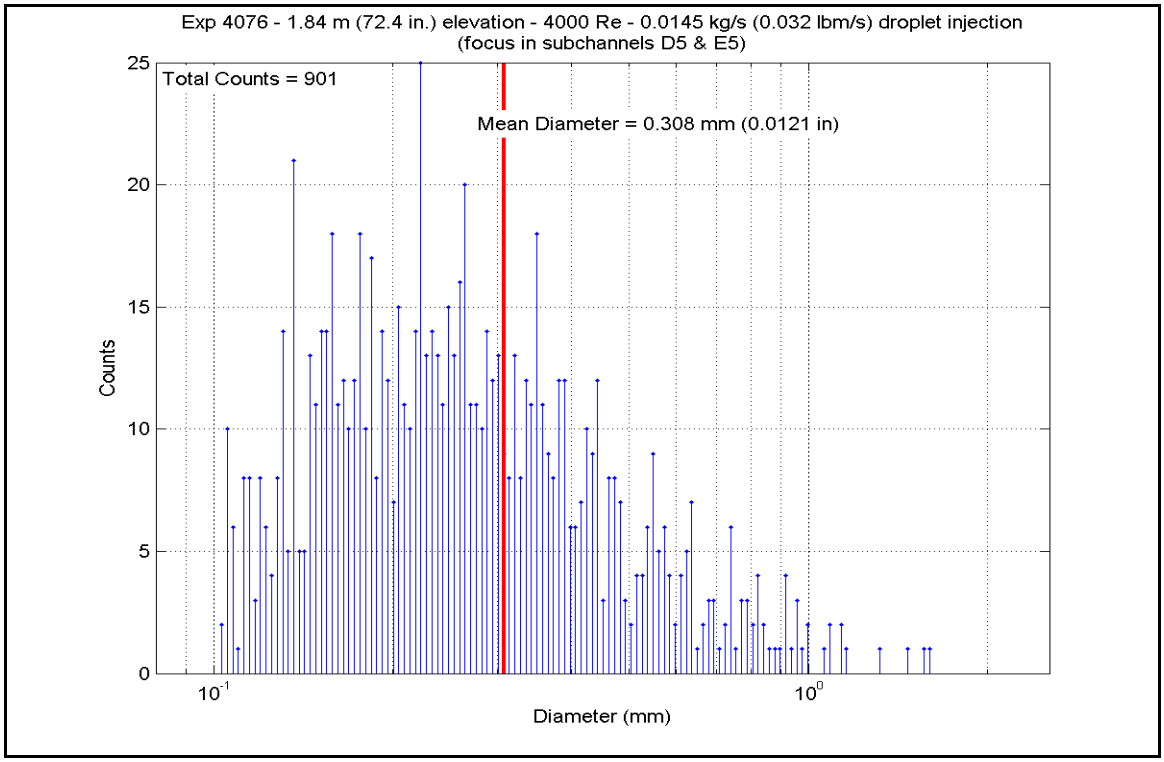

Figure A-777: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076D

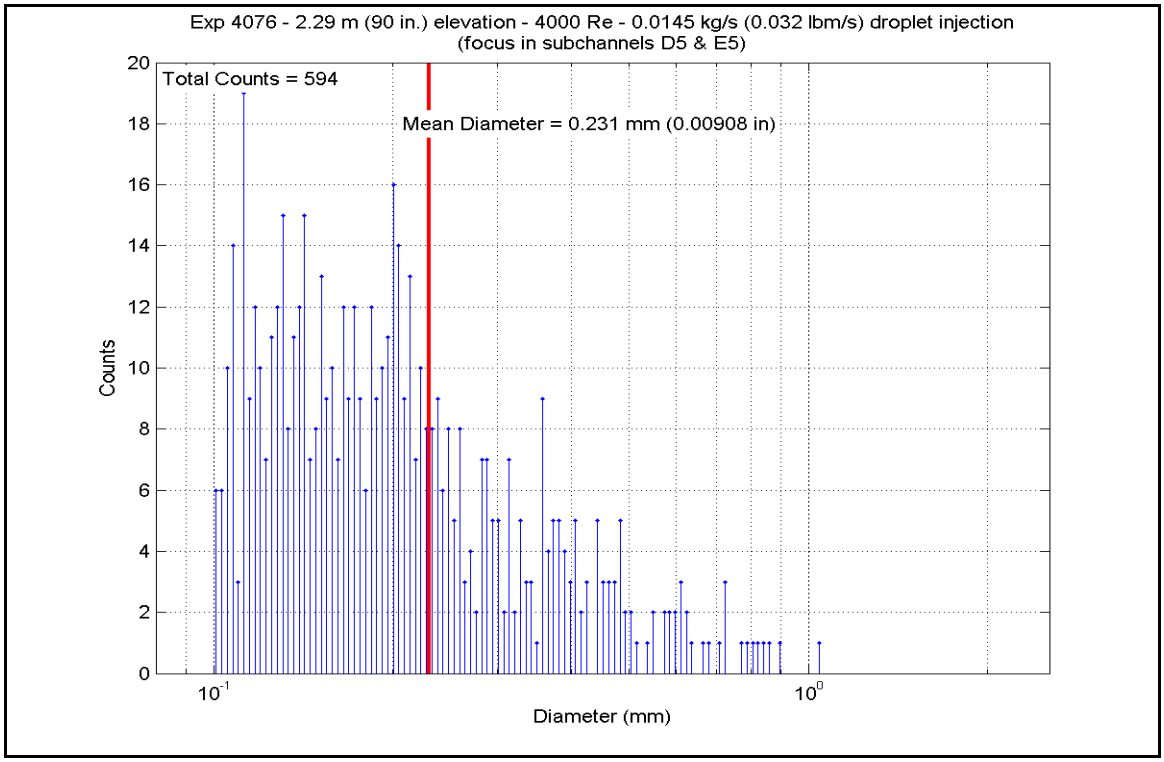

Figure A-778: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076D

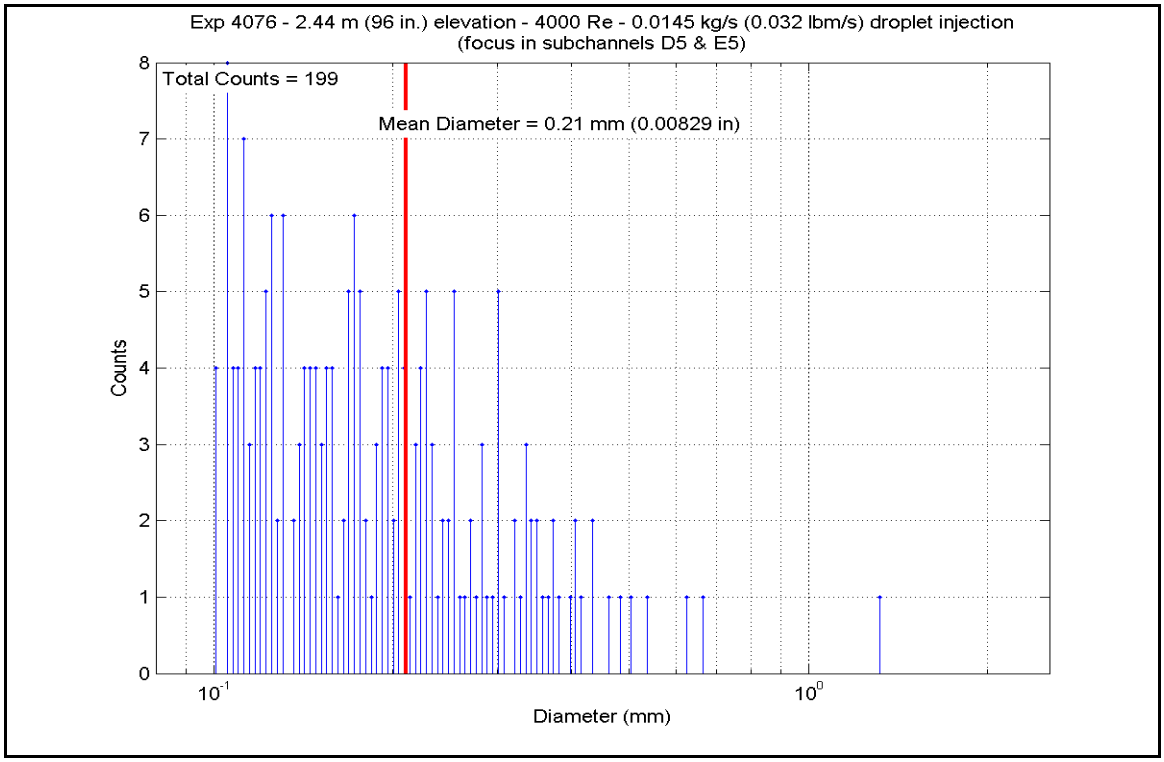

Figure A-779: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076D

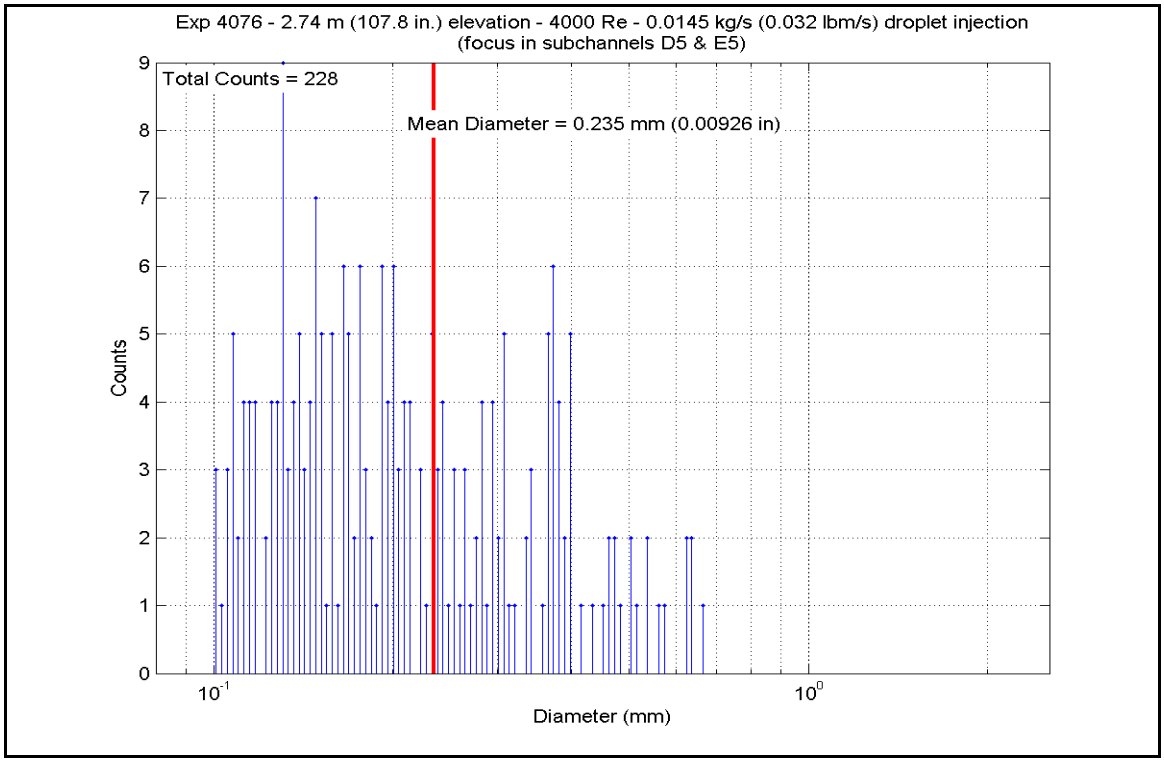

Figure A-780: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076D

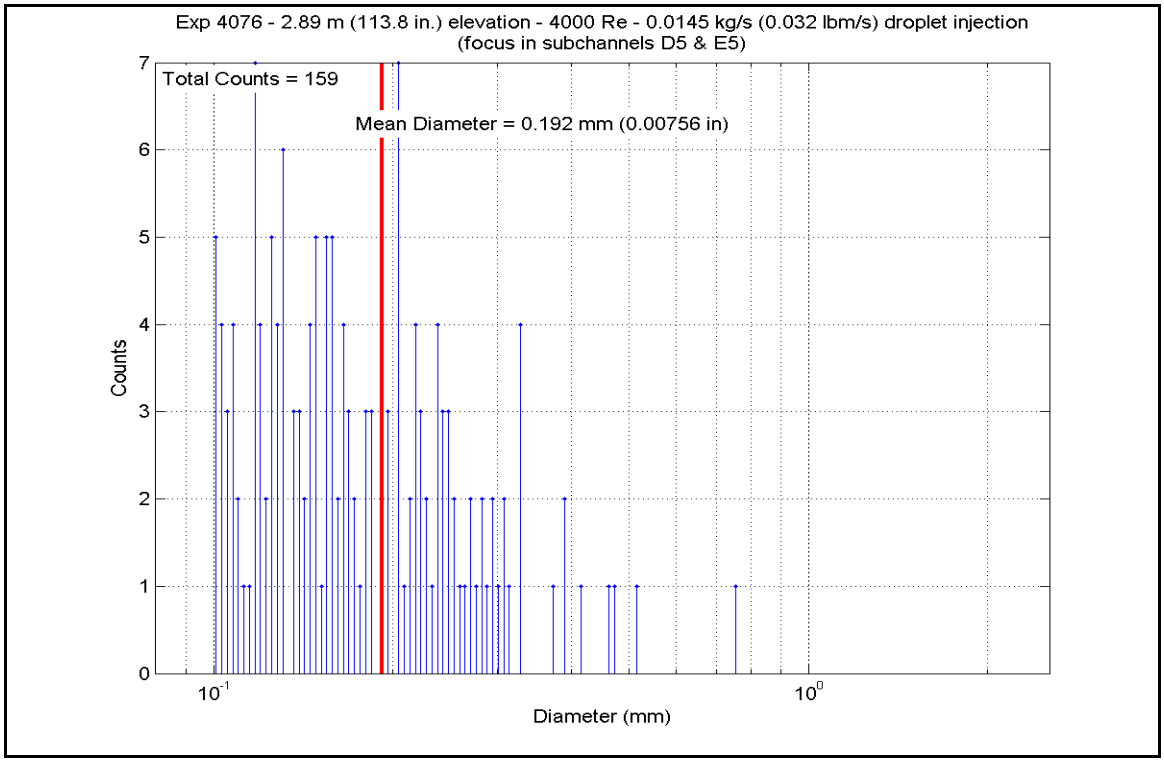

Figure A-781: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076D

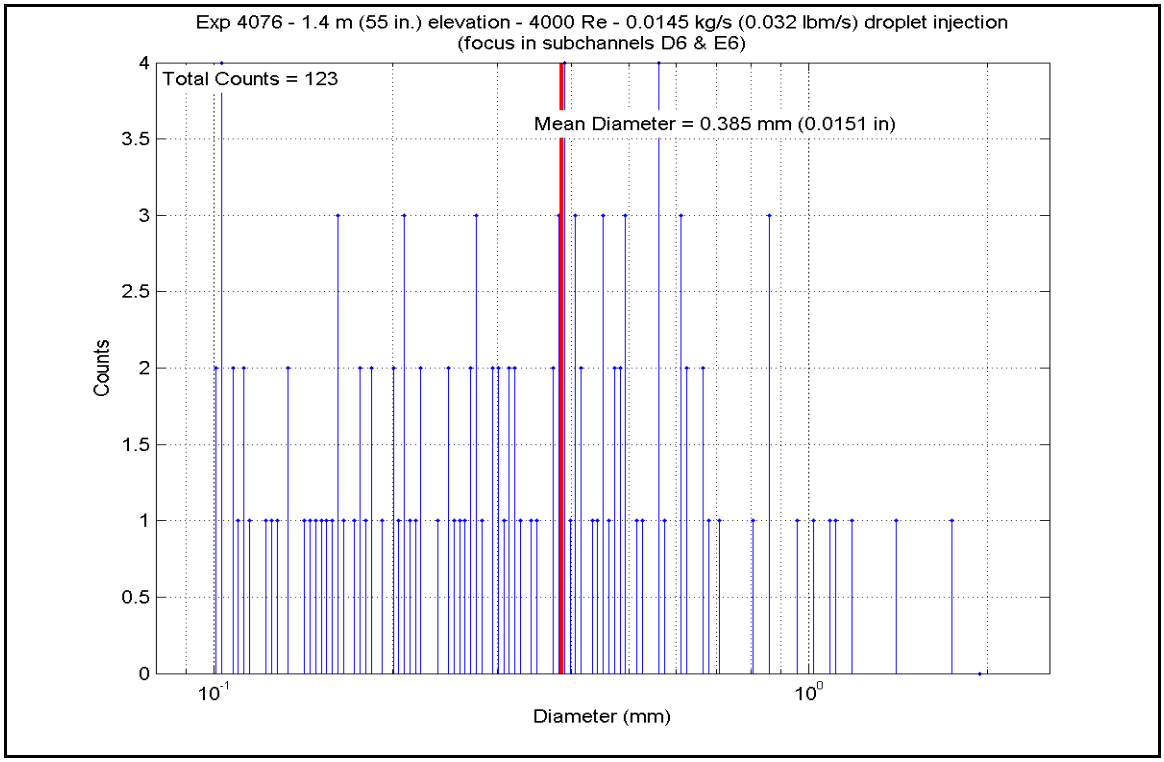

Figure A-782: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076D

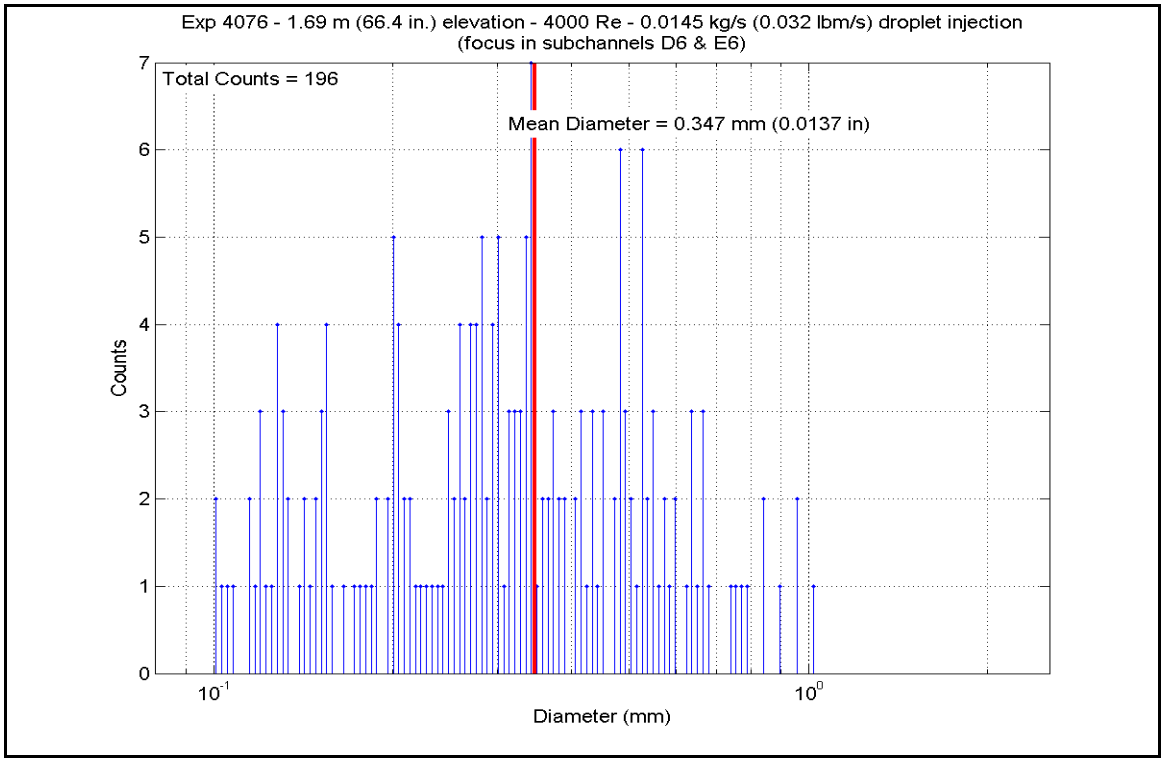

Figure A-783: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076D

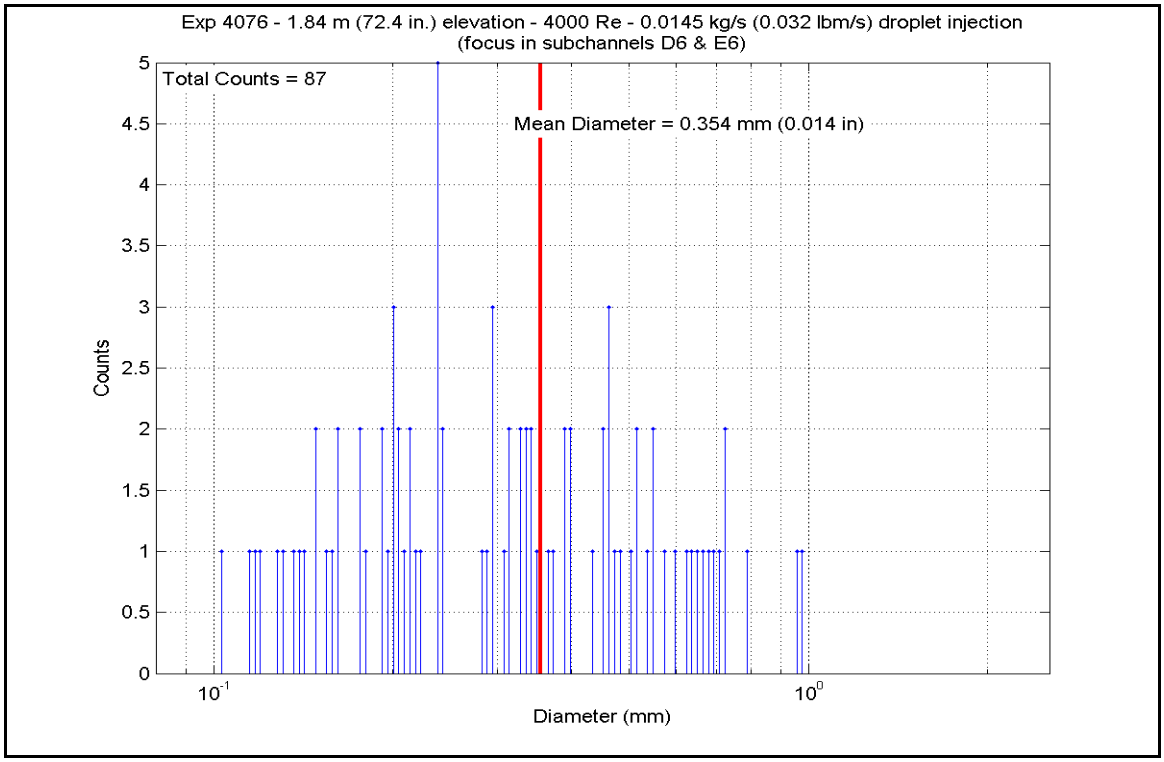

Figure A-784: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076D

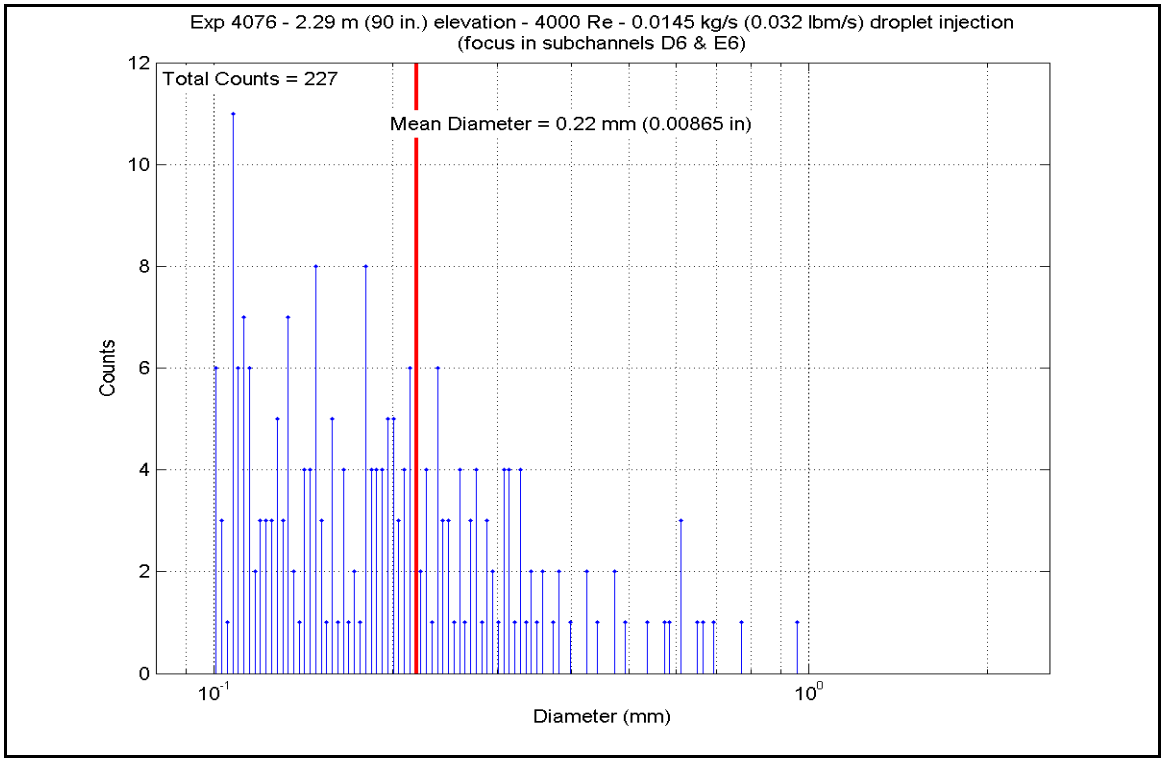

Figure A-785: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076D

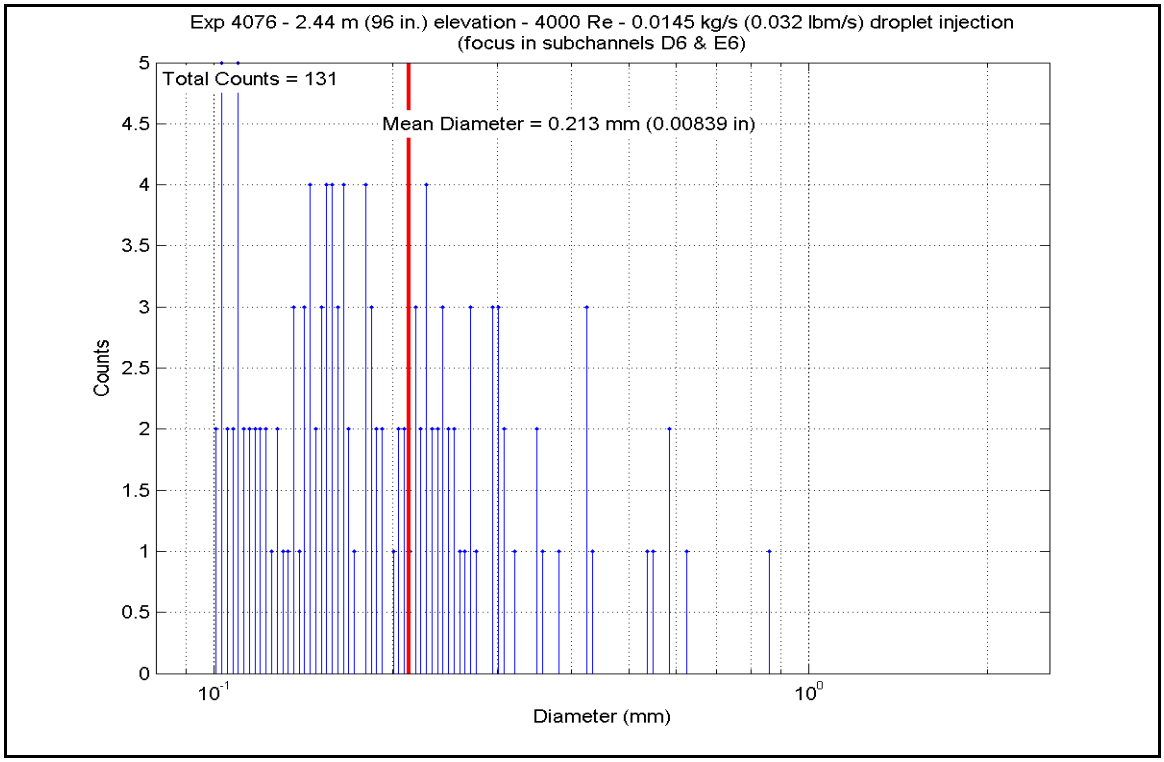

Figure A-786: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076D

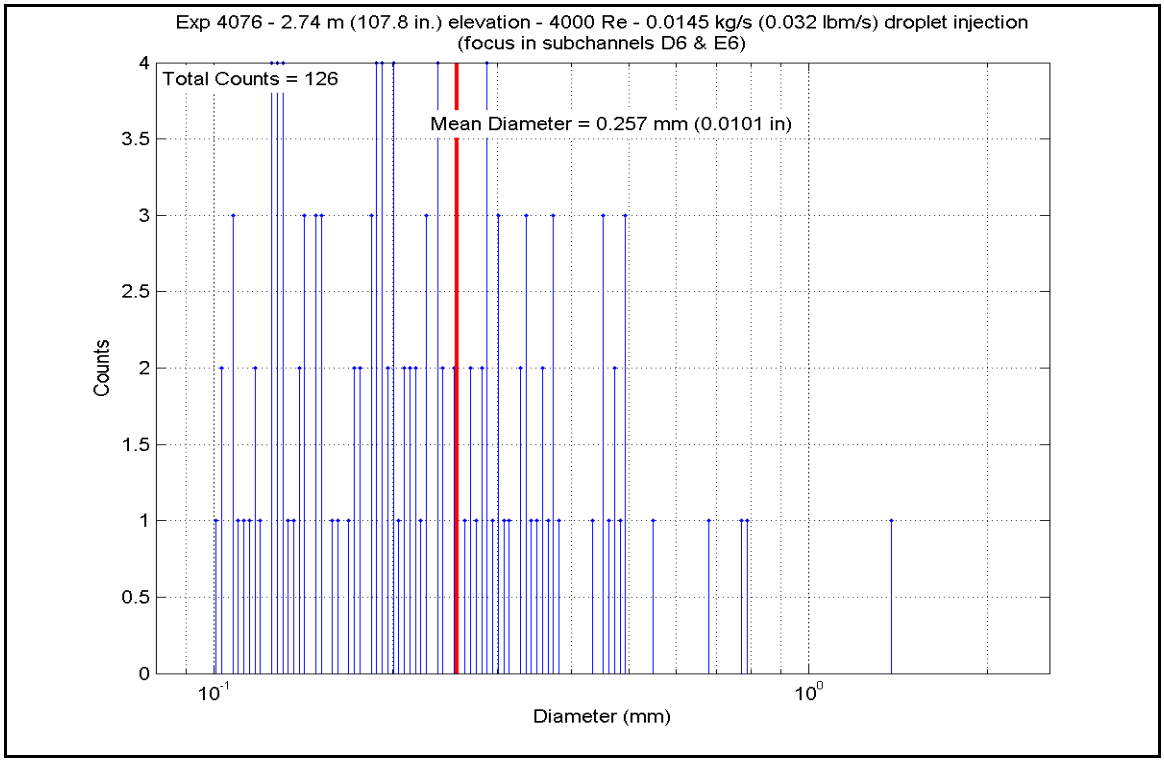

Figure A-787: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076D

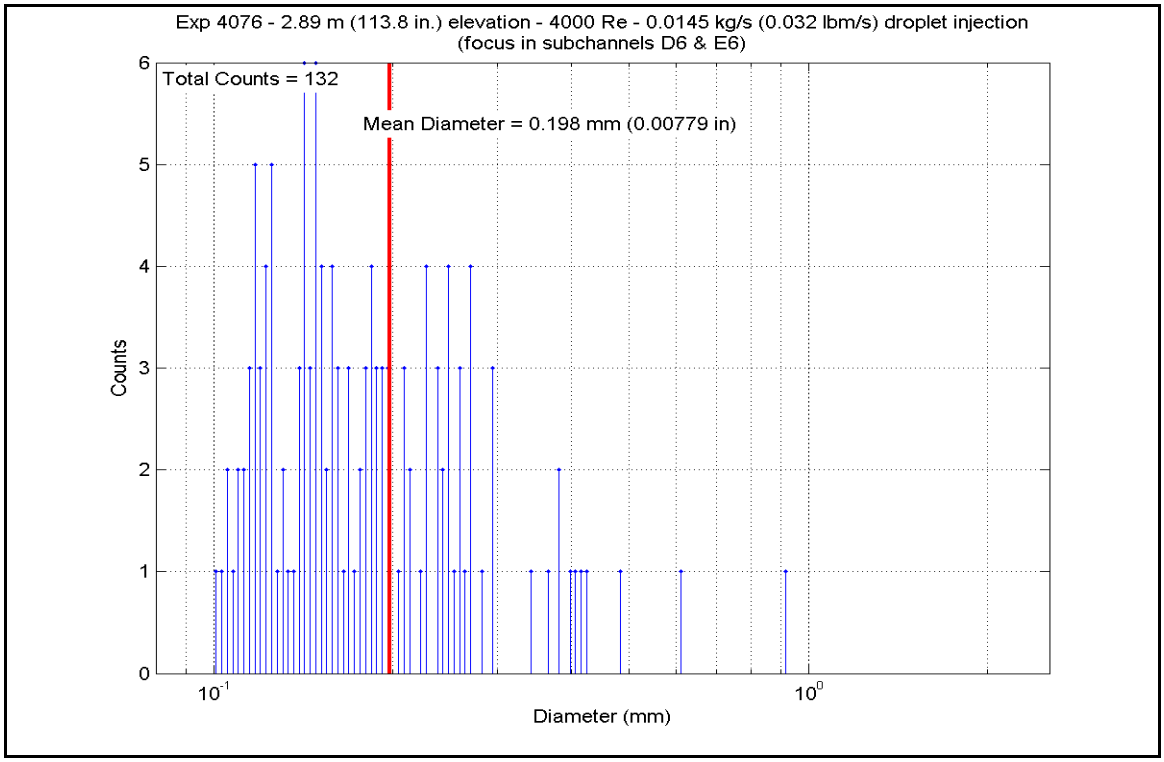

Figure A-788: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076D

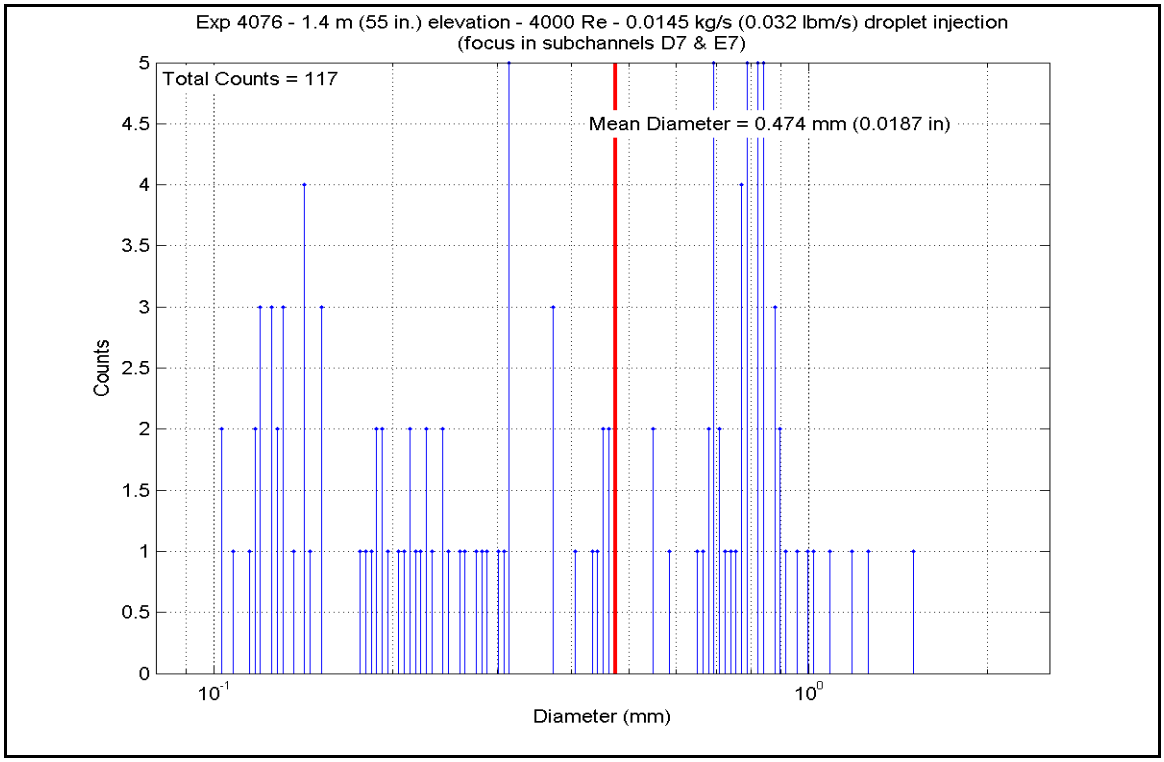

Figure A-789: Droplet Measurements at 1.397 m (55 in.) Elevation for Experiment 4076D

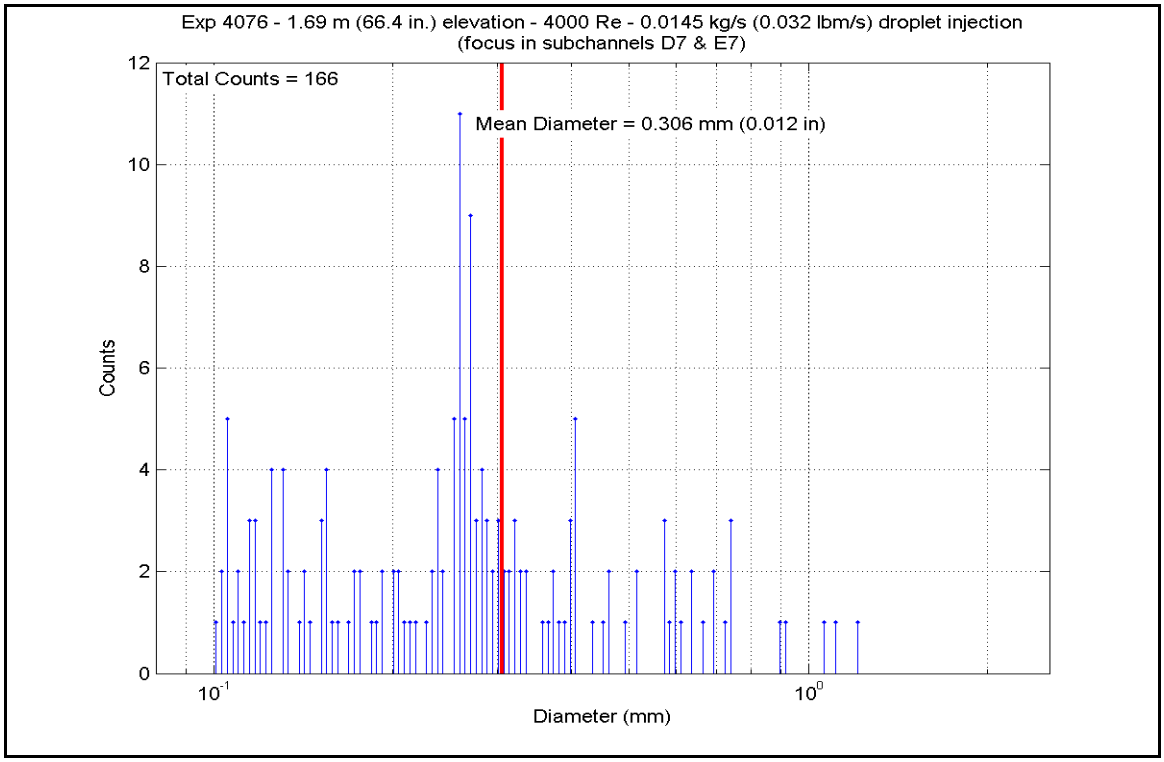

Figure A-790: Droplet Measurements at 1.687 m (66.4 in.) Elevation for Experiment 4076D

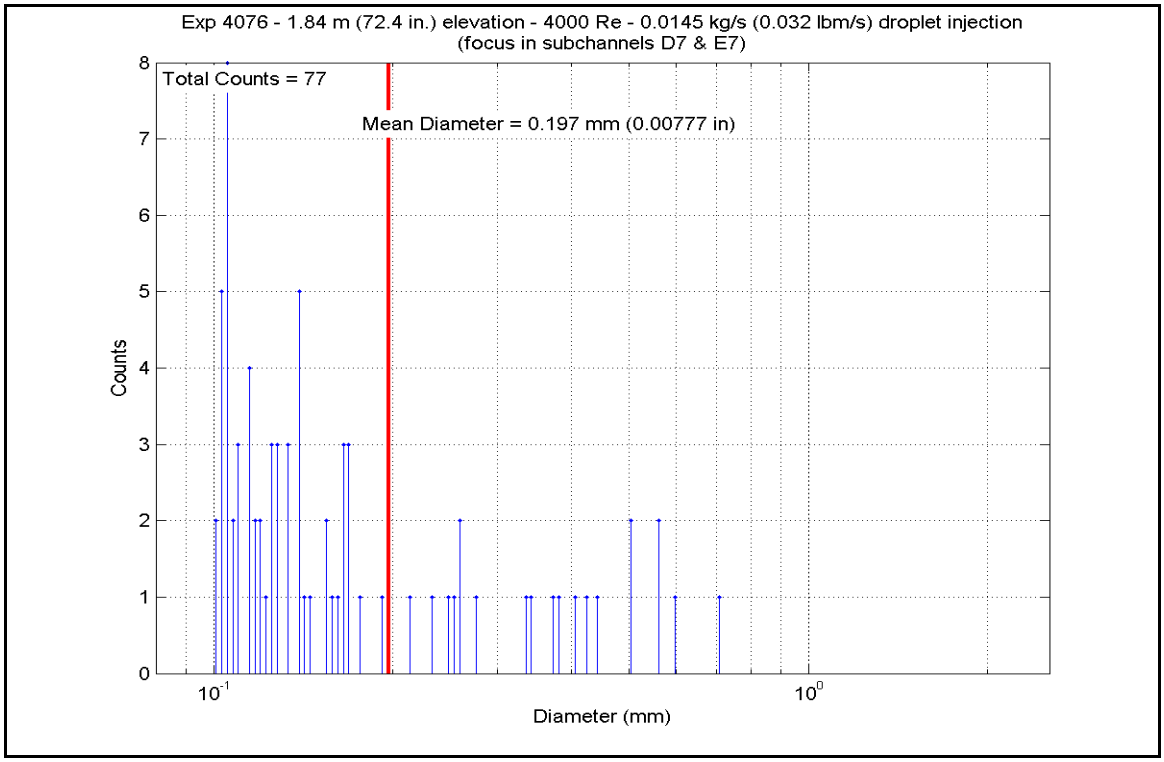

Figure A-791: Droplet Measurements at 1.839 m (72.4 in.) Elevation for Experiment 4076D

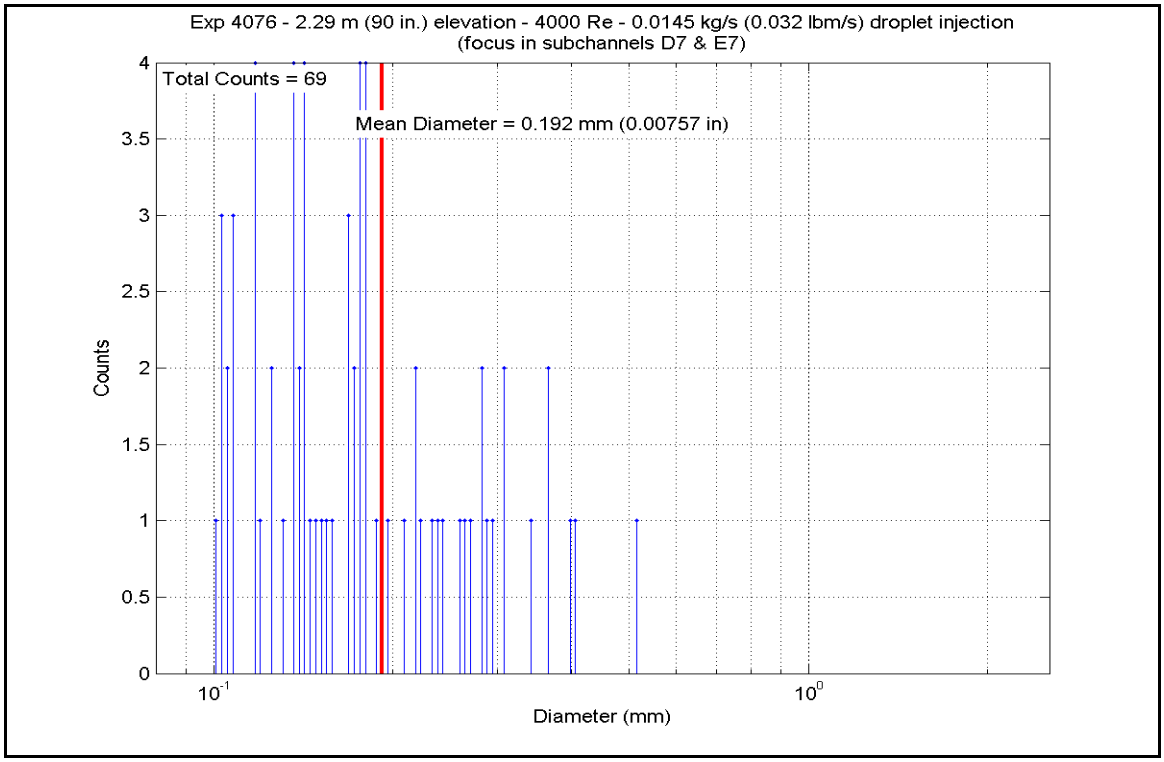

Figure A-792: Droplet Measurements at 2.286 m (90 in.) Elevation for Experiment 4076D

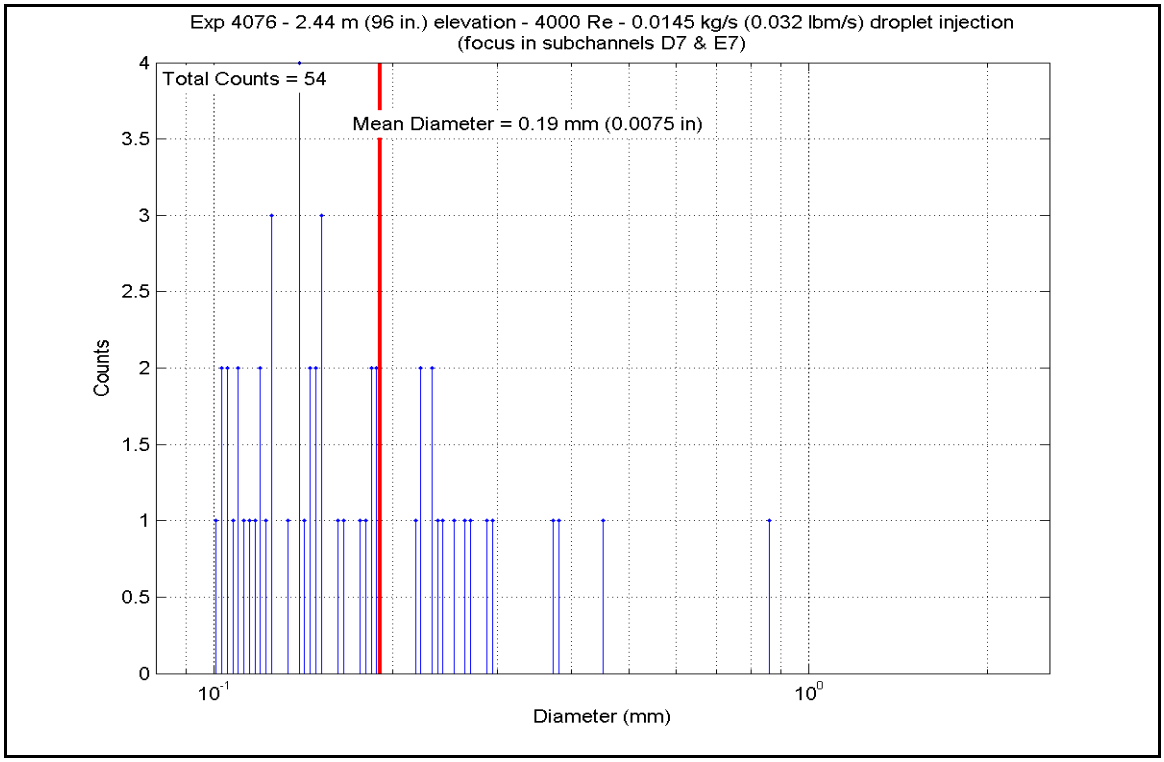

Figure A-793: Droplet Measurements at 2.438 m (96 in.) Elevation for Experiment 4076D

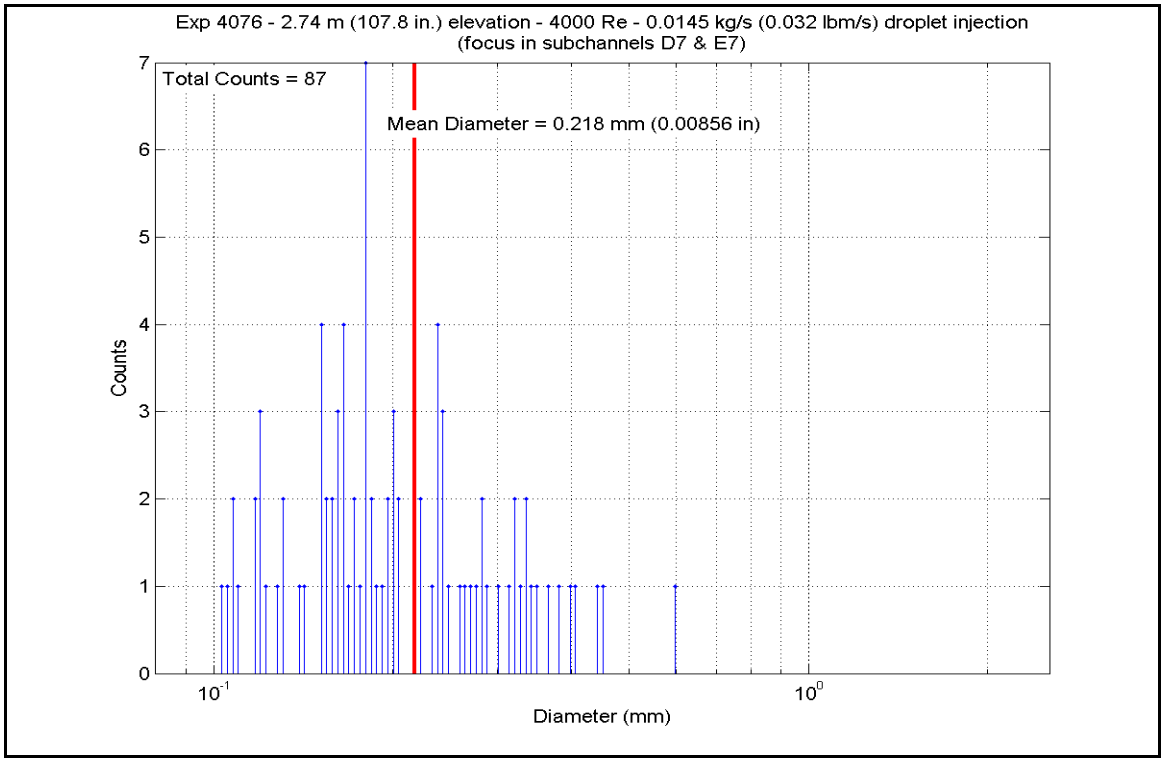

Figure A-794: Droplet Measurements at 2.738m (107.8 in.) Elevation for Experiment 4076D

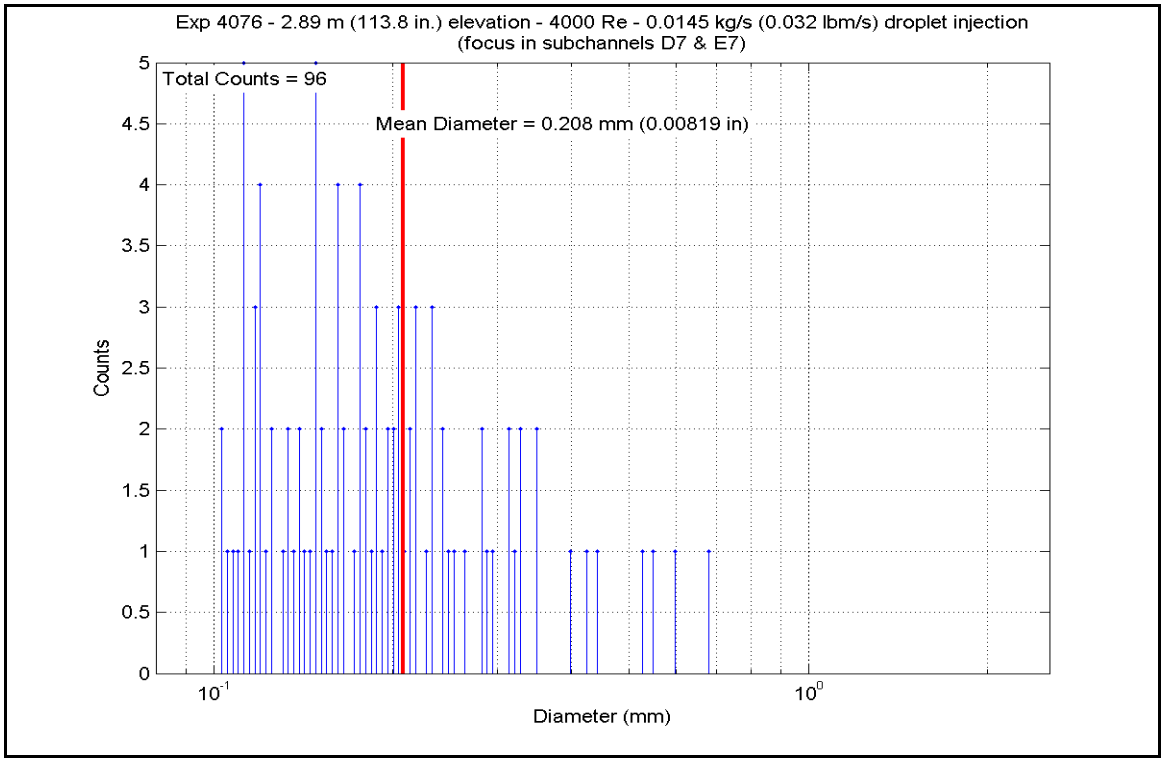

Figure A-795: Droplet Measurements at 2.891m (113.8 in.) Elevation for Experiment 4076D

Table A-75: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076D

SCD-4076-D	Inlet Reynolds:	4000		
Matrix test # 14d	UP Pressure:	137.9 kPa	20	psia
Time Window: 28200-31620	Bundle Power:	50.00 kW	170607	Btu/hr
	Steam flow:	0.0237 kg/s	188.0	lbm/hr
	Droplet flow:	0.0145 kg/s	0.032	lbm/s

Inner 3x3

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodD3_88.3	185	88.3	2.243	-0.2	-0.005	730.41	661.2	4270.43	13471.1	8.500	48.3
	RodD3_91.3	186	91.3	2.319	2.8	0.071	836.24	719.9	4362.13	13760.3	7.172	40.7
	RodD3_93.1	187	93.1	2.365	4.6	0.117	875.78	741.9	4417.28	13934.3	6.819	38.7
	RodD3_95.3	188	95.3	2.421	6.8	0.173	930.78	772.5	4484.19	14145.4	6.381	36.2
	RodD3_106.1	190	106.1	2.695	17.6	0.447	1106.15	869.9	4810.24	15173.9	5.478	31.1
	RodD3_110	191	110	2.794	21.5	0.546	1080.79	855.8	4751.29	14988.0	5.571	31.6
	RodD3_142.1	192	142.1	3.609	8.6	0.218	1213.44	929.5	1665.32	5253.2	1.690	9.6
Gr-3	RodC4_88.4	233	88.4	2.245	-0.1	-0.003	742.85	668.1	4322.84	13636.4	8.396	47.7
	RodC4_91.1	234	91.1	2.314	2.6	0.066	840.86	722.5	4408.18	13905.6	7.193	40.8
	RodC4_93.4	235	93.4	2.372	4.9	0.124	887.24	748.3	4479.67	14131.1	6.795	38.6
	RodC4_95.3	236	95.3	2.421	6.8	0.173	934.39	774.5	4537.93	14314.9	6.424	36.5
	RodC4_100.1	237	100.1	2.543	11.6	0.295	1024.12	824.3	4684.45	14777.1	5.884	33.4
	RodC4_106.1	238	106.1	2.695	17.6	0.447	1097.49	865.1	4869.64	15361.3	5.601	31.8
	RodC4_110	239	110	2.794	21.5	0.546	1067.38	848.4	4713.68	14869.3	5.616	31.9
	RodC4_142.2	240	142.2	3.612	8.7	0.221	1223.04	934.8	1806.13	5697.4	1.815	10.3
Gr-3	RodD4_88.3	241	88.3	2.243	-0.2	-0.005	731.46	661.7	4307.78	13588.9	8.556	48.6
	RodD4_91.3	242	91.3	2.319	2.8	0.071	837.68	720.7	4400.36	13880.9	7.218	41.0
	RodD4_93.2	243	93.2	2.367	4.7	0.119	885.14	747.1	4459.30	14066.9	6.786	38.5
	RodD4_95.2	244	95.2	2.418	6.7	0.170	930.47	772.3	4520.21	14259.0	6.435	36.5
	RodD4_100.1	245	100.1	2.543	11.6	0.295	1019.08	821.5	4668.99	14728.3	5.902	33.5
	RodD4_106.1	246	106.1	2.695	17.6	0.447	1093.66	863.0	4852.80	15308.2	5.606	31.8
	RodD4_142.1	248	142.1	3.609	8.6	0.218	1231.58	939.6	1747.34	5512.0	1.741	9.9
Gr-3	RodE4_88.4	201	88.4	2.245	-0.1	-0.003	741.60	667.4	4245.03	13391.0	8.265	46.9
	RodE4_91.2	202	91.2	2.316	2.7	0.069	836.06	719.9	4326.69	13648.6	7.116	40.4
	RodE4_95.3	204	95.3	2.421	6.8	0.173	930.39	772.3	4446.67	14027.0	6.331	36.0
	RodE4_100.9	205	100.9	2.563	12.4	0.315	1015.37	819.5	4610.37	14543.4	5.855	33.3
	RodE4_142.3	208	142.3	3.614	8.8	0.224	1220.12	933.2	1764.49	5566.1	1.779	10.1

Table A-75: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

Inner 3x3

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-4	RodE3_113.6	194	113.6	2.885	0.85	0.022	1110.30	872.2	4332.10	13665.6	4.910	27.9
	RodE3_115.5	195	115.5	2.934	2.75	0.070	1147.02	892.6	4171.32	13158.4	4.539	25.8
	RodE3_118.5	196	118.5	3.010	5.75	0.146	1182.00	912.0	3917.68	12358.3	4.107	23.3
	RodE3_122.7	197	122.7	3.117	9.95	0.253	1210.96	928.1	3563.04	11239.6	3.625	20.6
	RodE3_126.5	198	126.5	3.213	13.75	0.349	1219.25	932.7	3241.96	10226.8	3.271	18.6
	RodE3_131.7	199	131.7	3.345	-1.8	-0.046	1179.99	910.9	2803.59	8843.9	2.945	16.7
	RodE3_135.6	200	135.6	3.444	2.1	0.053	1198.71	921.3	2473.38	7802.3	2.548	14.5
Gr-4	RodC5_63.7	225	63.7	1.618	16.7	0.424	665.27	625.0	3460.31	10915.5	7.913	44.9
	RodC5_113.6	226	113.6	2.885	0.85	0.022	1085.53	858.4	4224.50	13326.2	4.926	28.0
	RodC5_115.7	227	115.7	2.939	2.95	0.075	1129.95	883.1	4059.57	12805.9	4.501	25.6
	RodC5_122.7	229	122.7	3.117	9.95	0.253	1196.18	919.9	3497.12	11031.7	3.612	20.5
	RodC5_126.7	230	126.7	3.218	13.95	0.354	1206.33	925.6	3176.03	10018.8	3.246	18.4
	RodC5_131.6	231	131.6	3.343	-1.9	-0.048	1175.59	908.5	2784.77	8784.5	2.939	16.7
	RodC5_135.7	232	135.7	3.447	2.2	0.056	1200.35	922.2	2454.14	7741.6	2.524	14.3
Gr-4	RodE5_63.6	209	63.6	1.615	16.6	0.422	556.09	564.3	3550.47	11200.0	10.821	61.5
	RodE5_113.6	210	113.6	2.885	0.85	0.022	1014.82	819.2	4363.06	13763.3	5.545	31.5
	RodE5_115.4	211	115.4	2.931	2.65	0.067	1067.95	848.7	4214.85	13295.7	5.018	28.5
	RodE5_118.7	212	118.7	3.015	5.95	0.151	1123.38	879.5	3939.94	12428.5	4.400	25.0
	RodE5_122.6	213	122.6	3.114	9.85	0.250	1163.92	902.0	3615.35	11404.6	3.863	21.9
	RodE5_126.6	214	126.6	3.216	13.85	0.352	1183.36	912.8	3282.08	10353.3	3.435	19.5
	RodE5_131.6	215	131.6	3.343	-1.9	-0.048	1254.09	952.1	2867.28	9044.8	2.794	15.9
	RodE5_135.6	216	135.6	3.444	2.1	0.053	1200.83	922.5	2533.48	7991.9	2.604	14.8
Gr-5	RodC3_79.8	177	79.8	2.027	8.92	0.227	695.60	641.8	3997.43	12609.9	8.549	48.5
	RodC3_85.6	178	85.6	2.174	14.72	0.374	711.34	650.6	4165.56	13140.3	8.618	48.9
	RodC3_88.5	179	88.5	2.248	0	0.000	734.84	663.6	4252.90	13415.8	8.391	47.7
	RodC3_92.4	180	92.4	2.347	3.9	0.099	860.34	733.3	4370.55	13786.9	6.912	39.3
	RodC3_94.4	181	94.4	2.398	5.9	0.150	903.75	757.5	4429.95	13974.3	6.556	37.2
Gr-8	RodD5_54.1	218	54.1	1.374	7.1	0.180	407.13	481.6	3255.77	10270.3	18.176	103.2
	RodD5_56.9	219	56.9	1.445	9.9	0.251	544.63	557.9	3339.38	10534.1	10.547	59.9
	RodD5_60	220	60	1.524	13	0.330	607.38	592.8	3433.45	10830.8	9.050	51.4
	RodD5_66.1	221	66.1	1.679	19.1	0.485	661.95	623.1	3614.37	11401.5	8.329	47.3
	RodD5_69.9	222	69.9	1.775	-0.98	-0.025	542.62	556.8	3724.24	11748.1	11.837	67.2
	RodD5_72.9	223	72.9	1.852	2.02	0.051	632.58	606.8	3815.62	12036.4	9.431	53.6
	RodD5_74.9	224	74.9	1.902	4.02	0.102	683.62	635.2	3875.66	12225.8	8.506	48.3

Table A-75: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

H.R. ID	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-2	RodB5_41	153	41	1.041	13.5	0.343	641.52	611.8	2892.75	9125.2	6.995	39.7
	RodB5_52.9	154	52.9	1.344	5.9	0.150	508.19	537.7	3224.93	10173.0	11.510	65.4
	RodB5_55	155	55	1.397	8	0.203	560.91	567.0	3283.78	10358.7	9.864	56.0
	RodB5_57.8	156	57.8	1.468	10.8	0.274	616.42	597.8	3364.79	10614.2	8.663	49.2
	RodB5_64	157	64	1.626	17	0.432	685.38	636.1	3551.30	11202.6	7.764	44.1
	RodB5_73.9	158	73.9	1.877	3.02	0.077	672.55	629.0	3837.06	12104.0	8.631	49.0
	RodB5_75.9	159	75.9	1.928	5.02	0.128	713.16	651.6	3896.61	12291.8	8.032	45.6
	RodB5_76.9	160	76.9	1.953	6.02	0.153	731.10	661.5	3926.39	12385.8	7.804	44.3
Gr-2	RodF5_41	105	41	1.041	13.5	0.343	632.18	606.6	2867.69	9046.1	7.095	40.3
	RodF5_53.1	106	53.1	1.349	6.1	0.155	495.62	530.7	3223.21	10167.6	12.044	68.4
	RodF5_55	107	55	1.397	8	0.203	553.55	562.9	3273.24	10325.4	10.054	57.1
	RodF5_57.8	108	57.8	1.468	10.8	0.274	612.82	595.8	3354.31	10581.2	8.716	49.5
	RodF5_64	109	64	1.626	17	0.432	682.21	634.4	3543.35	11177.5	7.801	44.3
	RodF5_73.8	110	73.8	1.875	2.92	0.074	663.07	623.7	3823.18	12060.2	8.788	49.9
	RodF5_75.8	111	75.8	1.925	4.92	0.125	707.94	648.7	3883.03	12249.0	8.091	45.9
	RodF5_76.8	112	76.8	1.951	5.92	0.150	727.49	659.5	3913.04	12343.7	7.834	44.5
Gr-2	RodC2_41	57	41	1.041	13.5	0.343	603.49	590.6	2865.48	9039.2	7.631	43.3
	RodC2_53.1	58	53.1	1.349	6.1	0.155	516.13	542.1	3167.66	9992.4	10.994	62.4
	RodC2_55	59	55	1.397	8	0.203	561.43	567.3	3249.23	10249.7	9.745	55.3
	RodC2_57.8	60	57.8	1.468	10.8	0.274	607.34	592.8	3345.74	10554.1	8.820	50.1
	RodC2_63.9	61	63.9	1.623	16.9	0.429	661.93	623.1	3537.70	11159.7	8.153	46.3
	RodC2_73.8	62	73.8	1.875	2.92	0.074	644.00	613.1	3824.91	12065.7	9.195	52.2
	RodC2_75.8	63	75.8	1.925	4.92	0.125	691.25	639.4	3886.38	12259.6	8.389	47.6
	RodC2_76.8	64	76.8	1.951	5.92	0.150	711.13	650.4	3916.67	12355.2	8.107	46.0
Gr-2	RodC6_40.9	137	40.9	1.039	13.4	0.340	655.49	619.5	2879.46	9083.3	6.736	38.3
	RodC6_52.8	138	52.8	1.341	5.8	0.147	563.15	568.2	3230.30	10190.0	9.638	54.7
	RodC6_54.8	139	54.8	1.392	7.8	0.198	592.36	584.5	3287.62	10370.8	9.023	51.2
	RodC6_57.8	140	57.8	1.468	10.8	0.274	640.63	611.3	3380.81	10664.8	8.193	46.5
	RodC6_63.8	141	63.8	1.621	16.8	0.427	719.32	655.0	3568.05	11255.4	7.262	41.2
	RodC6_73.7	142	73.7	1.872	2.82	0.072	702.97	645.9	3867.91	12201.3	8.143	46.2
	RodC6_75.8	143	75.8	1.925	4.92	0.125	739.00	665.9	3932.99	12406.6	7.697	43.7
	RodC6_76.8	144	76.8	1.951	5.92	0.150	758.30	676.6	3963.92	12504.2	7.475	42.4

Table A-75: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-3	RodB4_88.4	161	88.4	2.245	-0.1	-0.003	752.56	673.5	4237.52	13367.2	8.078	45.9
	RodB4_91.3	162	91.3	2.319	2.8	0.071	850.62	727.9	4322.34	13634.8	6.942	39.4
	RodB4_93.3	163	93.3	2.370	4.8	0.122	888.36	748.9	4381.09	13820.2	6.634	37.7
	RodB4_95.1	164	95.1	2.416	6.6	0.168	922.07	767.6	4433.99	13987.0	6.388	36.3
	RodB4_142.3	168	142.3	3.614	8.8	0.224	1194.40	918.9	1790.11	5646.9	1.852	10.5
Gr-5	RodF4_85.6	98	85.6	2.174	14.72	0.374	762.75	679.1	4193.04	13226.9	7.841	44.5
	RodF4_88.4	99	88.4	2.245	-0.1	-0.003	760.89	678.1	4275.40	13486.7	8.023	45.6
	RodF4_92.4	100	92.4	2.347	3.9	0.099	875.40	741.7	4391.80	13853.9	6.784	38.5
	RodF4_94.3	101	94.3	2.395	5.8	0.147	917.95	765.3	4448.13	14031.6	6.447	36.6
Gr-6	RodD2_103.2	65	103.2	2.621	14.7	0.373	1090.39	861.1	4215.32	13297.2	4.888	27.8
	RodD2_106	66	106	2.692	17.5	0.445	1114.29	874.4	3992.90	12595.6	4.505	25.6
	RodD2_112.6	67	112.6	2.860	-0.15	-0.004	1157.02	898.2	3689.91	11639.8	3.972	22.6
	RodD2_114.9	68	114.9	2.918	2.15	0.055	1175.56	908.5	3333.85	10516.6	3.518	20.0
	RodD2_117.4	69	117.4	2.982	4.65	0.118	1178.35	910.0	2995.92	9450.6	3.152	17.9
Gr-6	RodD6_114.9	132	114.9	2.918	2.15	0.055	1097.84	865.3	4230.94	13346.5	4.864	27.6
	RodD6_116.8	133	116.8	2.967	4.05	0.103	1124.59	880.1	4059.04	12804.2	4.527	25.7
	RodD6_120.9	134	120.9	3.071	8.15	0.207	1152.75	895.8	3689.75	11639.3	3.990	22.7
	RodD6_124.8	135	124.8	3.170	12.05	0.306	1161.73	900.8	3338.75	10532.1	3.576	20.3
	RodD6_128.7	136	128.7	3.269	15.95	0.405	1168.18	904.4	2988.07	9425.9	3.178	18.0

Table A-75: Summary of Steam Cooling Heat Transfer Reduced Data for Experiment 4076, continued

5x5 periphery

	H.R. Location	Channel Number	Elevation (in)	Elevation (m)	Zgrid (in)	Zgrid (m)	H.R. Tw (°F)	H.R.Tw (K)	H.R. q" (Btu/hr-ft2)	H.R. q" (W/m2)	h_{sat} (z) (Btu/hr-ft2-F)	h_{sat} (z) (W/m2-K)
Gr-8	RodE2_50.1	73	50.1	1.273	3.1	0.079	379.06	466.0	3128.75	9869.6	20.712	117.6
	RodE2_54	74	54	1.372	7	0.178	532.25	551.1	3252.74	10260.8	10.691	60.7
	RodE2_56.9	75	56.9	1.445	9.9	0.251	580.43	577.8	3343.40	10546.8	9.487	53.9
	RodE2_59.9	76	59.9	1.521	12.9	0.328	619.20	599.4	3436.43	10840.2	8.784	49.9
	RodE2_66	77	66	1.676	19	0.483	646.81	614.7	3622.23	11426.3	8.649	49.1
	RodE2_69.8	78	69.8	1.773	-1.08	-0.027	509.71	538.5	3731.55	11771.2	13.246	75.2
	RodE2_72.9	79	72.9	1.852	2.02	0.051	597.91	587.5	3825.14	12066.4	10.341	58.7
	RodE2_74.9	80	74.9	1.902	4.02	0.102	646.14	614.3	3886.37	12259.6	9.294	52.8
Gr-8	RodB3_50.2	169	50.2	1.275	3.2	0.081	309.48	427.3	3221.50	10162.2	39.535	224.5
	RodB3_54.1	170	54.1	1.374	7.1	0.180	527.38	548.4	3263.18	10293.7	10.900	61.9
	RodB3_56.9	171	56.9	1.445	9.9	0.251	589.76	583.0	3340.36	10537.2	9.234	52.4
	RodB3_60.1	172	60.1	1.527	13.1	0.333	603.53	590.7	3434.43	10833.9	9.145	51.9
	RodB3_66.1	173	66.1	1.679	19.1	0.485	648.03	615.4	3612.97	11397.1	8.602	48.8
	RodB3_69.9	174	69.9	1.775	-0.98	-0.025	540.80	555.8	3717.22	11726.0	11.884	67.5
	RodB3_73	175	73	1.854	2.12	0.054	623.77	601.9	3808.50	12013.9	9.623	54.6
	RodB3_75	176	75	1.905	4.12	0.105	669.39	627.3	3869.17	12205.3	8.766	49.8
Gr-8	RodF3_60	92	60	1.524	13	0.330	228.35	382.2	3408.53	10752.2	9809.823	55708.9
	RodF3_66.1	93	66.1	1.679	19.1	0.485	572.98	573.7	3595.49	11342.0	10.422	59.2
	RodF3_70	94	70	1.778	-0.88	-0.022	524.68	546.9	3727.66	11758.9	12.565	71.4
	RodF3_73	95	73	1.854	2.12	0.054	633.59	607.4	3823.82	12062.2	9.428	53.5
	RodF3_75	96	75	1.905	4.12	0.105	684.89	635.9	3886.16	12258.9	8.506	48.3
Gr-8	RodE6_50.2	121	50.2	1.275	3.2	0.081	462.32	512.2	3187.42	10054.7	13.603	77.2
	RodE6_54.1	122	54.1	1.374	7.1	0.180	566.19	569.9	3258.69	10279.6	9.636	54.7
	RodE6_57	123	57	1.448	10	0.254	613.68	596.3	3339.52	10534.5	8.659	49.2
	RodE6_60.2	124	60.2	1.529	13.2	0.335	662.24	623.3	3434.35	10833.7	7.909	44.9
	RodE6_66.1	125	66.1	1.679	19.1	0.485	706.07	647.6	3608.14	11381.9	7.547	42.9
	RodE6_70	126	70	1.778	-0.88	-0.022	593.22	584.9	3715.00	11719.0	10.172	57.8
	RodE6_73.1	127	73.1	1.857	2.22	0.056	678.23	632.2	3805.30	12003.8	8.452	48.0
	RodE6_75	128	75	1.905	4.12	0.105	721.30	656.1	3861.49	12181.1	7.828	44.5

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 next 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:

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

where,

ρ = 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:

$$\rho = \sqrt{E_d^2 + E_c^2} \tag{B-2}$$

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,

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

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 an equation of the form

$$Y = (x_1)(x_2)(x_3) \tag{B-4}$$

then

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

and

$$E_c = \sqrt{\sigma_y^2} \tag{B-6}$$

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 Heat Transfer Coefficient Uncertainty Analysis

The purpose of this uncertainty analysis was to estimate the confidence limits in the heat transfer coefficients calculated for heater rods in the Rod Bundle Heat Transfer Facility (RBHT) bundle test series using the uncertainty analysis performed on the FLECHT-SEASET heater rods. It is believed that the uncertainty geometry analysis performed on the FLECHT-SEASET heater rods is applicable to the RBHT heater rods since the construction and materials are the same or very similar.

The uncertainty analysis used the FLECHT-SEASET heat transfer coefficients calculated from test data, using DATARH. The sensitivity of the heat transfer coefficient to variations in the test data and heater rod design was also calculated by the code. This code solves an inverse heat conduction problem using a finite-difference technique.

The uncertainty analysis used standard statistical treatment of independent uncertainty components to establish 1σ and 2σ confidence intervals on the total uncertainty in the heat transfer coefficient. Individual uncertainty components were obtained from either heater rod inspection data, physical informational, or professional experience and judgment. Each component of the total uncertainty was assumed to be independent, and of known variance.

The FLECHT SEASET unblocked bundle test series utilized stainless steel clad, boron nitride filled heater rods with coiled Kanthal wire heating elements (Figure B-1). For the RBHT the cladding was Inconel not stainless steel but the remaining of the heater rod design was the same. The other properties were the same. In the instrumented heated rods, thermocouples were located at several different axial locations on the inside wall of the cladding. The thermocouple output was used in the DATARH code to compute the heat transfer coefficient. The code input requires density, specific heat, and thermal conductivity for the heater rod materials and geometric details of the heater coil.

The heater rod geometric input included clad inside and outside diameters and thermocouple radial location. Code input from the FLECHT SEASET bundle test instruments included thermocouple temperature, bundle pressure, and SCR power output.

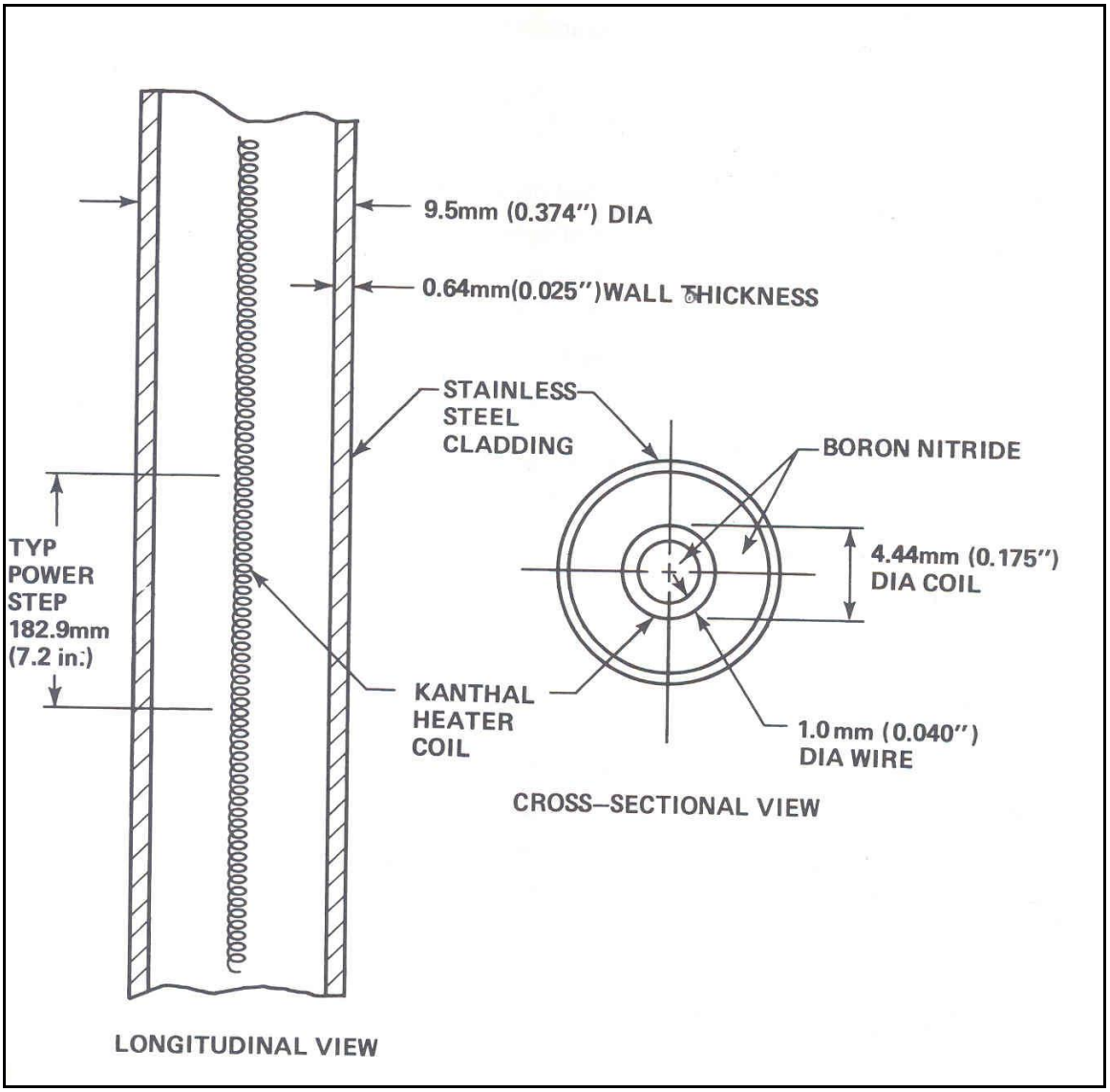

Figure B-1: Heater Rod Design

The heat transfer coefficient may be expressed as

$$h = h[x_1, x_2, ...x_n] \tag{B-7}$$

where x_i (i = 1, 2, . . . n) are the individual parameters that affect the heat transfer coefficient h. The statistical variation of calculated h about its expected value may be expressed by expanding the function $h[x_1,x_2,.....x_n]$ in a multivariable Taylor series.

Including only first-order terms, the result is

$$h[x_1, x_2, ...x_n] - E[h] = \sum_{i=1}^{n} \left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}} \{x_i - E[x_i]\} \tag{B-8}$$

or

$$\Delta h = \sum_{i=1}^{n} \left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}} \Delta x_i \tag{B-9}$$

where the derivatives are evaluated using the means of all the random variables x_i (denoted by $\bar{x}$). E[h] is the expected or mean value of the function h, that is, h evaluated at the means of the random variables x_i. Each $(\partial h / \partial x_i)_{\bar{x}} \Delta x_i$ term also is a random variable with a mean of zero and a variance given by

$$\mathrm{var}\left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}} \Delta x_i = \left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}}^2 \sigma_{x_i}^2 = \sigma_{\Delta h_i}^2 \tag{B-10}$$

where $(\partial h / \partial x_i)_{\bar{x}}$ is constant for given $\bar{x}$.

Assuming the $(\partial h / \partial x_i)_{\bar{x}} \Delta x_i$ terms are independent, the mean of Δh becomes

$$E[\Delta h] = \sum_{i=1}^{n} \left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}} E[\Delta x_i] = 0 \tag{B-11}$$

and the variance of □h is

$$\sigma_{\Delta h}^2 = \sum_{i=1}^{n} \sigma_{\Delta h_i}^2 = \sum_{i=1}^{n} \left(\frac{\partial h}{\partial x_i} \right)_{\bar{x}}^2 \sigma_{x_i}^2 \tag{B-12}$$

Approximating the $(\partial h / \partial x_i)_x$ terms by $(\Delta h / \Delta x_i)_x$, the variance becomes

$$\sigma_{\Delta h}^2 = \sum_{i=1}^{n} \left(\frac{\Delta h_i}{\Delta x_i} \right)_{\bar{x}}^2 \sigma_{x_i}^2 \tag{B-13}$$

A consequence of the central limit theorem in statistics is that the distribution of the uncertainty calculated above approaches a normal distribution. With a known distribution function, the confidence interval of the uncertainty can be calculated from the variance. The 1σ (70 percent) and 2σ (95 percent) confidence intervals are reported in this evaluation.

These values were obtained by individually perturbing each parameter x_i from its expected value by its estimated standard deviation in numerous runs of the DATARH code. Each perturbation resulted in a new value of calculated h, from which the nominal or expected value was subtracted to provide a Δh_i. Since in these perturbations Δx_i was assumed to be equal to σ_{x_i}, the variance can be evaluated by simply summing the squares of the resultant Δh_i terms:

$$\sigma^2_{\Delta_h} = \sum_{i=1}^{n} \Delta^2_{h_i} \tag{B-14}$$

Positive and negative Δh_i terms $(\Delta h_i^+, \Delta h_i^-)$ were obtained by perturbing each x_i both above and below its expected value. They are indicative of the heat transfer coefficient's sensitivity to uncertainty in each parameter, and were statistically combined to provide bother upper and lower uncertainty bands on calculated h. Differences for each Δh_i^+ and Δh_i^- are due to nonlinearities in the function h $[x_1, x_2, \ldots x_n]$.

Uncertainty in the heat transfer coefficient, h, calculated by the DATARH code stems from the following factors:

- Uncertainty in the measured test parameters input to the program
- Uncertainty due to manufacturing tolerances on heater rod dimensions and instrumentation location
- Material property uncertainties

Measured test parameters that are input to DATARH are bundle power, pressure, and clad inside temperature.

The uncertainty in the measured parameters is combined with other sources of uncertainty by summing the variance of each uncertainty component. For the test instruments, the instrument uncertainty was assumed to be uniformly distributed over the uncertainty interval. The variance of a uniformly distributed random variable over the interval $-\alpha < x < \alpha$ is $\alpha^2/_3$. The total instrument uncertainty consists of uncertainty in the sensor, in signal conditioning equipment, and in recording the signal. The variance of each of these components was calculated as described above and summed to get the total variance of the instrument uncertainty. Transducer uncertainty is normally dominant, and thus total uncertainty and transducer uncertainty will be very similar.

The standard deviation (that is, the positive square root of the variance) and maximum uncertainty for each data path are shown in Table B-1 through Table B-5. The maximum uncertainty was calculated by summing the maximum uncertainty of all contributors to the total instrument uncertainty.

Manufacturing tolerances on rod dimensions and instrumentation location also contribute to uncertainty in the calculated heat transfer coefficient h. Heater coil dimensions, clad inside and outside diameters, and thermocouple locations are incorporated in the DATARH geometric heater rod model, because they are possible contributors to uncertainty in h. Uncertainty in the

thermocouple radial location was estimated from X-ray inspection of actual heater rods. Clad outside diameter uncertainty was obtained from the rod inspection data. Uncertainty in clad inside diameter was estimated by combining the uncertainty in clad outside diameter with the uncertainty in clad thickness.

Axial power is also a factor. In FLECHT SEASET heater rods, the number of heater coil turns per inch (coil spacing) is variable (Figure B-1); this changes the length of heater wire per unit length of heater rod. From the X-ray radiographs of the heater rods, the geometry of the axial power steps was determined. Similar approach has been used for the RBHT heater rods.

The rod inspection data do not reflect any variation in the diameter of the Kanthal heater wire. The wire diameter was nominally 0.10 cm (0.040 in.), and small variations in diameter were beyond the resolution of the radiograph. To estimate the uncertainty due to wire diameter variation, the assumption was made that the local variation in wire resistance due to the wire cross-sectional area variation could be approximated from the variation in heater rod resistance between rods.

Uncertainty in the physical properties of the material in the heater rods was based largely on engineering judgment. The boron nitride density uncertainty was based on a sample of five measurements from sections of heater rods that were destructively analyzed.

The input parameters for power factor ($P_{local}/P_{average}$) determination are local step length, total heated length, local step length coil resistance, and total heated length coil resistance. An analysis identical to that discussed was performed for this calculation, varying the input parameters by the estimated standard deviations. Estimated power factor parameter uncertainties are show in Table B-6, and the power factor uncertainty analysis in Table B-7.

Table B-6: Uncertainty of Power

ESTIMATED UNCERTAINTY OF POWER FACTOR CALCULATION

Parameter	Estimated Uncertainty[a]	Best-Estimated Value	Reference/ Comments
Step length	±0.06 in.	14.52 in.	Rod inspection data
Step resistance	±0.03%	3.595 Ω	Rod inspection data
Total length	±0.06 in.	144.48 in.	Rod inspection data
Total resistance	±0.03%	21.60 Ω	Rod inspection data

a. All uncertainties are listed at the 1 σ level.

Table B-7 summarizes the certainties of all the parameters used by DATARH to calculate the FLECHT SEASET heat transfer coefficient. These uncertainties were evaluated at the 1Φ level. The uncertainties in Table B-8 for the heater rod material properties are expected to be similar as the same uncertainties used for the RBHT heater rods since the design and materials are similar.

Other sources of uncertainties that could lead to increased uncertainty in the value of h were reviewed; however, for the most part, they were of relatively minor importance and their absence in this analysis would not be significant. Those other factors were as follows:

- Induction and skin effects - These effects of high-frequency components of the chopped ac power were neglected.

- Wire effective length - Analytically, the effective length for a tightly coiled wire is less than the length based on the helix mean radius (which is used in DATARH). However, this source of uncertainty is the same for each wire and will cancel out in the relative power calculation. Therefore, such a correction was not required.

- Electrical resistivity variation with temperature at rod quench - Changes in rod temperature distribution will affect the local. P/P_{avg}. For example, if half the rod is quenched, resistivity in the upper half could be as much as 4 percent greater than that in the lower half, and power would be redistributed within the rod. Since there was no method by which this could be accounted for proportionately, this effect was ignored.

- Kanthal heater helix position - The heater coil may be slightly off center in the rod. This effect was analyzed by varying the coil diameter; however, no coil displacement was examined.

- Thermocouple axial location - The thermocouples were located well within a given power step. Axial conduction in the heater rod in the vicinity of the thermocouples was assumed to be small and axial conduction effects were ignored.

Table B-7: Thermocouple Power Factor Uncertainty Analysis

THERMOCOUPLE POWER FACTOR UNCERTAINTY ANALYSIS

Parameter	Calculated P/P_{avg} (a)	$\Delta(P/P_{avg})^{+}$ (b)	$\Delta(P/P_{avg})^{-}$
Nominal case	1.6561		
Step length + 0.06 in.	1.6493		-0.0068
Step length - 0.06 in.	1.6630	0.0069	
Step resistance + 0.03%	1.6566	0.0005	
Step resistance - 0.03%	1.6556		-0.0005
Total length + 0.06 in.	1.6568	0.0007	
Total length - 0.06 in.	1.6554		-0.0007
Total resistance + 0.03%	1.6556		-0.0005
Total resistance - 0.03%	1.6566	0.0005	

Using values for $\Delta(P/P_{avg})^{+}$:

$$\sigma_{P/P_{avg}} = (0.0069^2 + 0.0005^2 + 0.0007^2 + 0.0005^2)^{1/2} = 0.0070 \text{ (absolute)}$$
$$= 0.42 \text{ (\%)}$$

Using values for $\Delta(P/P_{avg})^{-}$:

$$\sigma_{P/P_{avg}} = (0.0068^2 + 0.0005^2 + 0.0007^2 + 0.0005^2)^{1/2} = 0.0069 \text{ (absolute)}$$
$$= 0.42 \text{ (\%)}$$

a. $\dfrac{P}{P_{avg}} = \left(\dfrac{\text{step resistance}}{\text{step length}}\right)\left(\dfrac{\text{total length}}{\text{total resistance}}\right)$

b. $\Delta(P/P_{avg}) = P/P_{avg} - (P/P_{avg})_{nominal}$

Table B-8: Uncertainties Effecting the Heat Transfer Coefficient Calculations

ESTIMATED UNCERTAINTY OF PARAMETERS AFFECTING CALCULATED HEAT TRANSFER COEFFICIENT

Parameter	Estimated Uncertainty(σ)[a]	Reference/Comments
Measured power	$\pm$2.14 kw	Table B-5
Measured temperature	At T < 277°C (530°F), $\pm$ 1.39°C ($\pm$ 2.51°F) At 277°C < T < 1316°C (530°F < T < 2400°F), $\pm [1.539 + (0.00217T)^2]^{1/2}$ °C $\{\pm [4.986 + (0.00217T)^2]^{1/2}$ °F$\}$	Table B-1 $\sigma^2_{temp} = 1/3\ (\sigma^2_{sensor} + \sigma^2_{cond} + \sigma^2_{readout}$
Measured pressure	$\pm$ 2.66 kPa ($\pm$ 0.386 psi)	Table B-2
Thermocouple radial location	-0.05 mm (-0.002 in.)	X-ray inspection data. T/C location assumed at clad inside surface. Radial position can only be in boron nitride; thus there is only negative uncertainty.
Rod OD	$\pm$ 0.012 mm ($\pm$ 0.00049 in.)	Heater rod inspection data
Clad ID	$\pm$ 0.012 mm ($\pm$ 0.00049 in.)	Estimate based on rod OD and clad thickness inspection data

a. All errors or uncertainties are listed at the 1σ level.

Table B-8: Uncertainties Effecting the Heat Transfer Coefficient Calculations, continued

ESTIMATED UNCERTAINTY OF PARAMETERS AFFECTING CALCULATED HEAT TRANSFER COEFFICIENT

Parameter	Estimated Uncertainty(σ)[a]	Reference/Comments
Power step factor	±0.42%	Table B -5
Boron nitride properties		
Density	±3%	Heater rod inspection data
Thermal conductivity	±10%	Watlow Electric estimate
Specific heat	±5%	Touloukian,[b] engineering judgment
Kanthal properties		
Density	±2%	Engineering estimate
Thermal conductivity	±5%	Engineering estimate
Specific heat	±5%	Engineering estimate
Stainless steel 347 properties		
Density	±1%	Touloukian,[b] engineering judgment
Thermal conductivity	±3%	
Specific heat	±3%	

a. All errors or uncertainties are listed at the 1σ level.

b. Touloukian, Y. S., Thermophysical Properties of High Temperature Solid Materials, Macmillan, New York, 1967.

The uncertainty analysis was performed for FLECHT-SEASET test 31504 with the following nominal initial conditions:

-	Pressure	0.28 Mpa (40 psia)
-	Initial clad temperature	871 ^{o}C (1600 ^{o}F)
-	Rod peak power	2.3 kw/m (0.7 kw/ft)
-	Flooding rate	25 mm/sec (1.0 in./sec)
-	□T subcooling	60 ^{o}C (140 ^{o}F)
-	Radial power	Uniform
-	Housing temperature	T_{sat}

These test conditions are similar to the low flooding rate RBHT tests.

The analysis was performed on the heat transfer coefficient calculated for the hot rod 8K at the 1.98 m (78 in) elevation. The calculated value of the heat transfer coefficient from rod 8K was obtained with the best-estimate values of all the parameters in Table B-8. Both positive and negative values of Δh_i were obtained from subsequent DATARH calculations for which the parameters given in Table B-8 were varied. The calculated positive and negative values of Δh_i are listed in Table B-9 as a function of time. They are indicative of the heat transfer coefficient sensitivity for each parameter. The various values of Δh_i^+ and Δh_i^- are statistically combined in Table B-10 and the resulting calculated h values with the estimated 95 percent confidence bands (2σ) are shown in Table B-11.

Examination of the Δh_i values in Table B-9 shows that the measured power, rod outside diameter, clad thickness, and power step factor had the largest effects on the calculated heat transfer coefficient. Other parameters such as the rod properties (except the boron nitride density), rod temperature, and system pressure clearly had second-order effects on the accuracy of the calculated heat transfer.

The method used in this analysis presupposes that the process is linear; higher-order terms in the Taylor series expansion [Equation (B-6)] were neglected. If the method is linear, then the Δh_i values would be of equal magnitude but opposite sign. However, as the Δh_i values listed in Table B-9 indicate, the inverse conduction scheme is not a linear equation and Δh_i values can have different magnitudes if the deviation is taken in either the positive or negative direction from the normal value. Therefore, when the upper and lower bands are calculated as in Table B-10, these bands will not have the same magnitude. One method of compensating for the effect of nonlinearity is to simply average each deviation, both positive and negative values, and obtain an averaged deviation at each time step. This will result in a centered confidence band about the estimated heat transfer coefficient data. The calculations for this approach are given in Table B-11.

Figure B-2, which shows the calculated heat transfer coefficient (h) with the 95 percent confidence limits, indicates that the largest uncertainty in h is early in the transient, particularly at the beginning of reflood. Figure B-3 shows the relative uncertainty for the upper 95 percent confidence band as plotted from Table B-10; it indicates that the relative uncertainty quickly decreased to approximately 10 percent by 30 seconds for this test.

Table B-9: Sensitivities

PARAMETER SENSITIVITIES[a]

Time (sec)	Base Case	Measured Power ±2.14		Measured Temperature		Measured Pressure		Thermocouple Radial Location		Rod OD	
		Δh_1^+	Δh_1^-	Δh_2^+	Δh_2^-	Δh_3^+	Δh_3^-	Δh_4^+	Δh_4^-	Δh_5^+	Δh_5^-
0	1.3773	0.1603	-0.1602	0.0424	-0.0415	0.0007	-0.0006	0.0000	-0.0201	0.0594	-0.0592
1	0.9133	0.1585	-0.1584	0.0380	-0.0372	0.0004	-0.0004	0.0000	-0.0105	0.0585	-0.0584
2	1.0165	0.1568	-0.1568	0.0376	-0.0368	0.0005	-0.0005	0.0000	-0.0087	0.0575	-0.0574
3	1.1095	0.1553	-0.1553	0.0373	-0.0367	0.0005	-0.0006	0.0000	-0.0093	0.0567	-0.0567
4	1.2058	0.1538	-0.1537	0.0406	-0.0428	0.0006	-0.0005	0.0000	-0.0101	0.0561	-0.0559
5	1.1835	0.1523	-0.1522	0.0444	-0.0480	0.0006	-0.0005	0.0000	-0.0098	0.0554	-0.0552
10	1.3702	0.1450	-0.1450	0.0615	-0.0633	0.0006	-0.0006	0.0000	-0.0084	0.0516	-0.0515
20	3.5014	0.1340	-0.1339	0.0680	-0.0670	0.0014	-0.0013	0.0000	-0.0024	0.0413	-0.0412
30	4.7009	0.1276	-0.1268	0.0648	-0.0641	0.0017	-0.0018	0.0000	-0.0056	0.0354	-0.0353
40	7.1790	0.1219	-0.1219	0.0667	-0.0659	0.0026	-0.0025	0.0000	-0.0035	0.0278	-0.0277
50	7.1358	0.1183	-0.1182	0.0631	-0.0622	0.0025	-0.0024	0.0000	-0.0048	0.0258	-0.0257
60	8.0461	0.1157	-0.1154	0.0626	-0.0617	0.0028	-0.0026	0.0000	-0.0049	0.0225	-0.0222
70	7.9255	0.1133	-0.1133	0.0600	-0.0592	0.0026	-0.0026	0.0000	-0.0022	0.0209	-0.0209
80	8.0829	0.1116	-0.1115	0.0584	-0.0576	0.0027	-0.0026	0.0000	-0.0058	0.0198	-0.0196
90	8.2738	0.1100	-0.1100	0.0571	-0.0564	0.0027	-0.0027	0.0000	-0.0047	0.0180	-0.0180
100	9.0284	0.1091	-0.1089	0.0576	-0.0567	0.0030	-0.0028	0.0000	-0.0025	0.0156	-0.0154
120	9.9713	0.1085	-0.1084	0.0580	-0.0571	0.0032	-0.0031	0.0000	-0.0034	0.0126	-0.0124
140	10.9637	0.1091	-0.1088	0.0595	-0.0585	0.0036	-0.0034	0.0000	-0.0011	0.0097	-0.0094
160	11.8892	0.1116	-0.1116	0.0622	-0.0615	0.0039	-0.0039	0.0000	-0.0040	0.0080	-0.0080
180	15.2355	0.1165	-0.1164	0.0724	-0.0714	0.0052	-0.0052	0.0000	-0.0010	0.0020	-0.0018
200	15.5146	0.1235	-0.1233	0.0775	-0.0765	0.0057	-0.0055	0.0000	-0.0018	0.0029	-0.0026
220	17.2969	0.1318	-0.1317	0.0875	-0.0876	0.0067	-0.0039	0.0000	-0.0008	0.0009	-0.0008
240	18.8704	0.143	-0.1427	0.1001	-0.0985	0.0080	-0.0078	0.0000	-0.0033	0.0006	-0.0003
260	21.1816	0.1573	-0.1571	0.1400	-0.1378	0.0098	-0.0097	0.0000	-0.0029	0.0005	-0.0002
280	22.9392	0.1755	-0.1751	0.1558	-0.1577	0.0119	-0.0116	0.0006	0.0000	0.0011	-0.0006
300	28.0444	0.2007	-0.2005	0.1576	-0.1546	0.0164	-0.0164	0.0000	-0.0010	0.0038	-0.0036
320	49.1724	0.2500	-0.2500	0.3565	-0.3495	0.0364	-0.0366	0.1164	0.0000	0.0516	-0.0515
325	812.0703	2.3737	-2.3609	26.5086	-22.8027	7.4468	-7.2825	6.3471	0.0000	3.6697	-3.6360

a. $\Delta h_i = \left(\frac{\partial h}{\partial x_i}\right)_{\bar{x}} \sigma_{x_i}$

b. Values of h are given in Btu/hr-ft^2-^{o}F. To convert to w/m^2-^{o}C, multiply by 5.678.

Table B-9: Sensitivities, continued

PARAMETER SENSITIVITIES[a]

Time (sec)	Clad ID		Power Step Factor Axial Power		Boron Nitride Density		Boron Nitride Specific Heat		Boron Nitride Thermal Conductivity		Kanthal Density	
	Δh_6^+	Δh_6^-	Δh_7^+	Δh_7^-	Δh_8^+	Δh_8^-	Δh_9^+	Δh_9^-	Δh_{10}^+	Δh_{10}^-	Δh_{11}^+	Δh_{11}^-
0	0.0138	-0.0137	0.0810	-0.0842	0.3231	-0.3228	0.5440	-0.5436	0.0128	-0.0112	0.0389	-0.0380
1	0.0127	-0.0126	0.0798	-0.0830	0.3359	-0.3295	0.5550	-0.5547	0.0064	-0.0052	0.0390	-0.0382
2	0.0122	-0.0122	0.0786	-0.0818	0.3240	-0.3239	0.5456	-0.5454	0.0048	-0.0039	0.0373	-0.0364
3	0.0121	-0.0122	0.0774	-0.0807	0.3182	-0.3182	0.5358	-0.5358	0.0050	-0.0042	0.0354	-0.0347
4	0.0121	-0.0120	0.0763	-0.0794	0.3123	-0.3122	0.5258	-0.5256	0.0051	-0.0041	0.0337	-0.0329
5	0.0120	-0.0119	0.0752	-0.0782	0.3084	-0.3083	0.5192	-0.5191	0.0044	-0.0036	0.0326	-0.0318
10	0.0111	-0.0111	0.0699	-0.0727	0.2840	-0.2840	0.4782	-0.4782	0.0017	-0.0013	0.0274	-0.0268
20	0.0079	-0.0078	0.0619	-0.0644	0.2114	-0.2114	0.3559	-0.3560	0.0033	-0.0040	0.0204	-0.0199
30	0.0066	-0.0067	0.0566	-0.0590	0.1647	-0.1648	0.2774	-0.2774	0.0009	-0.0007	0.0156	-0.0153
40	0.0040	-0.0040	0.0530	-0.0552	0.1044	-0.1044	0.1757	-0.1757	0.0007	-0.0008	0.0100	-0.0098
50	0.0038	-0.0037	0.0501	-0.0521	0.0918	-0.0918	0.1546	-0.1545	0.0006	-0.0004	0.0088	-0.0085
60	0.0029	-0.0027	0.0481	-0.0498	0.0657	-0.0654	0.1105	-0.1103	0.0018	-0.0012	0.0063	-0.0060
70	0.0022	-0.0022	0.0461	-0.0480	0.0602	-0.0602	0.1013	-0.1014	0.0007	-0.0007	0.0059	-0.0057
80	0.0023	-0.0022	0.0445	-0.0462	0.0491	-0.0490	0.0827	-0.0825	0.0029	-0.0023	0.0046	-0.0044
90	0.0017	-0.0017	0.0430	-0.0447	0.0395	-0.0395	0.0666	-0.0665	0.0017	-0.0014	0.0038	-0.0036
100	0.0007	-0.0005	0.0420	-0.0435	0.0217	-0.0215	0.0364	-0.0363	0.0002	0.0000	0.0022	-0.0020
120	0.0004	-0.0003	0.0404	-0.0419	0.0028	-0.0026	0.0046	-0.0045	0.0016	-0.0012	0.0003	-0.0001
140	0.0018	-0.0015	0.0395	-0.0408	0.0243	-0.0241	0.0408	-0.0406	0.0004	0.0000	0.0023	-0.0020
160	0.0020	-0.0020	0.0393	-0.0409	0.0418	-0.0418	0.0704	-0.0704	0.0030	-0.0026	0.0039	-0.0040
180	0.0049	-0.0048	0.0402	-0.0372	0.0982	-0.0981	0.1652	-0.1652	0.0013	-0.0011	0.0090	-0.0091
200	0.0047	-0.0044	0.0418	-0.0433	0.0973	-0.0971	0.1638	-0.1635	0.0038	-0.0028	0.0091	-0.0091
220	0.0056	-0.0055	0.0436	-0.0453	0.1210	-0.1209	0.2036	-0.2036	0.0017	-0.0014	0.0112	-0.0113
240	0.0059	-0.0056	0.0466	-0.0482	0.1382	-0.1379	0.2325	-0.2322	0.0051	-0.0040	0.0130	-0.0130
260	0.0066	-0.0065	0.0504	-0.0523	0.1618	-0.1616	0.2724	-0.2721	0.0044	-0.0035	0.0174	-0.0176
280	0.0074	-0.0070	0.0554	-0.0573	0.1660	-0.1656	0.2794	-0.2790	0.0025	-0.0017	0.0238	-0.0240
300	0.0095	-0.0094	0.0624	-0.0648	0.2317	-0.2315	0.3901	-0.3899	0.0142	-0.0116	0.0288	-0.0292
320	0.0457	-0.0457	0.0765	-0.0797	0.5322	-0.5330	0.8957	-0.8979	0.0619	-0.0694	0.0464	-0.0475
325	2.3341	-2.3172	0.7236	-0.7473	22.1188	-21.5054	37.6067	-35.8766	24.5470	-16.6868	2.7891	-2.8425

Table B-9: Sensitivities, continued

PARAMETER SENSITIVITIES[a]

Time (sec)	Kanthal Thermal Conductivity		Kanthal Specific Heat		Stainless Steel Density		Stainless Steel Thermal Conductivity		Stainless Steel Specific Heat	
	Δh_{12}^{+}	Δh_{12}^{-}	Δh_{13}^{+}	Δh_{13}^{-}	Δh_{14}^{+}	Δh_{14}^{-}	Δh_{15}^{+}	Δh_{15}^{-}	Δh_{16}^{+}	Δh_{16}^{-}
0	0.0006	-0.0004	0.0975	-0.0974	0.0541	-0.0540	0.0006	-0.0006	0.1635	-0.1634
1	0.0004	-0.0003	0.0978	-0.0979	0.0541	-0.0541	0.0001	0.0000	0.1635	-0.1634
2	0.0004	-0.0003	0.0934	-0.0934	0.0530	-0.0530	0.0002	-0.0001	0.1602	-0.1602
3	0.0000	-0.0003	0.0887	-0.0888	0.0521	-0.0522	0.0001	-0.0001	0.1576	-0.1577
4	0.0004	-0.0003	0.0844	-0.0844	0.0514	-0.0513	0.0000	0.0000	0.1552	-0.1552
5	0.0003	-0.0002	0.0816	-0.0815	0.0508	-0.0507	0.0000	0.0000	0.1535	-0.1534
10	0.0002	-0.0001	0.0687	-0.0687	0.0470	-0.0469	0.0001	0.0000	0.1419	-0.1418
20	0.0001	0.0000	0.0510	-0.0510	0.0348	-0.0347	0.0003	-0.0003	0.1049	-0.1049
30	0.0000	-0.0001	0.0395	-0.0393	0.0276	-0.0276	0.0002	-0.0001	0.0834	-0.0834
40	0.0000	0.0000	0.0251	-0.0251	0.0174	-0.0174	0.0003	-0.0002	0.0526	-0.0525
50	0.0001	0.0000	0.0219	-0.0219	0.0156	-0.0155	0.0002	-0.0001	0.0469	-0.0469
60	0.0002	0.0000	0.0157	-0.0155	0.0113	-0.0111	0.0002	-0.0001	0.0339	-0.0337
70	0.0000	0.0000	0.0146	-0.0146	0.0100	-0.0100	0.0003	-0.0003	0.0302	-0.0302
80	0.0002	0.0000	0.0116	-0.0114	0.0086	-0.0085	0.0002	0.0000	0.0259	-0.0258
90	0.0001	0.0000	0.0094	-0.0094	0.0068	-0.0068	0.0002	-0.0001	0.0206	-0.0206
100	0.0001	0.0000	0.0055	-0.0052	0.0036	-0.0034	0.0003	-0.0002	0.0108	-0.0105
120	0.0001	0.0000	0.0006	-0.0005	0.0006	-0.0005	0.0003	-0.0002	0.0017	-0.0015
140	0.0002	0.0000	0.0056	-0.0053	0.0046	-0.0043	0.0005	-0.0003	0.0136	-0.0133
160	0.0001	-0.0001	0.0100	-0.0100	0.0071	-0.0071	0.0003	-0.0002	0.0215	-0.0215
180	0.0001	0.0000	0.0231	-0.0230	0.0170	-0.0169	0.0007	-0.0005	0.0512	-0.0511
200	0.0002	0.0000	0.0232	-0.0229	0.0166	-0.0164	0.0007	-0.0006	0.0499	-0.0497
220	0.0001	0.0000	0.0285	-0.0284	0.0205	-0.0204	0.0009	-0.0007	0.0618	-0.0617
240	0.0002	0.0000	0.0332	-0.0329	0.0229	-0.0226	0.0009	-0.0006	0.0688	-0.0686
260	0.0001	0.0000	0.0444	-0.0442	0.0264	-0.0262	0.0012	-0.0010	0.0796	-0.0814
280	0.0003	0.0000	0.0608	-0.0604	0.0274	-0.0270	0.0018	-0.0014	0.0824	-0.0820
300	0.0005	-0.0003	0.0736	-0.0734	0.0377	-0.0375	0.0027	-0.0025	0.1136	-0.1135
320	0.0022	-0.0023	0.1188	-0.1191	0.1024	-0.1024	0.0260	-0.0244	0.3095	-0.3093
325	0.3265	-0.3061	7.1965	-7.0988	2.1869	-2.1797	8.3582	-7.6746	6.6077	-6.5858

Table B-10: Standard Deviations

UPPER, LOWER, AND AVERAGE STANDARD DEVIATIONS ON CALCULATED HEAT TRANSFER COEFFICIENTS[a]

Time (sec)	σ_h^+	$2\sigma_h^+$	σ_h	$2\sigma_h^-$	$(\sigma_h)_{avg}$
0	0.6921	1.3842	0.6921	1.3842	0.6921
1	0.7034	1.4068	0.7029	1.4058	0.7031
2	0.6906	1.3812	0.6907	1.3814	0.6906
3	0.6781	1.3562	0.6845	1.3690	0.6813
4	0.6659	1.3318	0.6662	1.3324	0.6660
5	0.6577	1.3154	0.6581	1.3162	0.6579
10	0.6080	1.2160	0.6085	1.2170	0.6082
20	0.4634	0.9268	0.4637	0.9274	0.4635
30	0.3720	0.1384	0.3723	0.1393	0.3721
40	0.2617	0.5234	0.2619	0.5238	0.2618
50	0.2377	0.4754	0.2378	0.4756	0.2377
60	0.1955	0.3910	0.1952	0.3904	0.1953
70	0.1848	0.3696	0.1851	0.3702	0.1849
80	0.1685	0.3370	0.1686	0.3372	0.1685
90	0.1553	0.3106	0.1555	0.3110	0.1554
100	0.1386	0.2772	0.1384	0.2768	0.1385
120	0.1303	0.2606	0.1303	0.2606	0.1303
140	0.1400	0.2800	0.1396	0.2796	0.1398
160	0.1590	0.3180	0.1592	0.3184	0.1591
180	0.2469	0.4938	0.2460	0.4920	0.2464
200	0.2505	0.5010	0.2499	0.4998	0.2502
220	0.2971	0.5942	0.2969	0.5938	0.2970
240	0.3353	0.6706	0.3346	0.6692	0.3349
260	0.3959	0.7918	0.3954	0.7908	0.3956
280	0.4193	0.8386	0.4195	0.8390	0.4194
300	0.5441	1.0882	0.5431	1.0862	0.5436
320	1.2007	2.4014	1.1897	2.3794	1.1952
325	58.0459	116.0198	52.8334	105.6668	55.439

a. $\sigma_h^+ = [\sum_i (\Delta h_i^+)^2]^{1/2}$

$\sigma_h^+ = [\sum_i (\Delta h_i^-)^2]^{1/2}$

$(\sigma_h)_{avg} = \dfrac{\sigma_h^+ + \sigma_h^-}{2}$

Table B-11: Calculated h and 95- Percent Confidence Limits Verses Time

Time (Sec)	Calculated $h^{(a)}$	Upper 95% Confidence Limit[a] Absolute $(h + 2\sigma_h^+)$	Upper 95% Confidence Limit[a] Percent Error $\left(\frac{2\sigma_h^+}{h} \times 100\right)$	Lower 95% Confident Limit Absolute $(h - 2\sigma_h^-)$	Lower 95% Confident Limit Percent Error $\left(\frac{2\sigma_h^-}{h} \times 100\right)$
0	1.3773	2.7615	100.50	-0.0069	100.50
1	0.9133	2.3201	154.03	-0.4925	153.93
2	1.0165	2.3977	135.88	-0.3649	135.90
3	1.1095	2.4657	122.24	-0.2595	123.39
4	1.2058	2.5376	110.45	-0.1260	110.50
5	1.1835	2.3670	111.14	-0.1309	111.21
10	1.3702	2.5862	88.75	0.1532	88.82
20	3.5014	4.4282	26.47	2.5740	26.49
30	4.7009	4.8393	2.94	4.5616	2.96
40	7.1790	7.7024	7.29	6.6552	7.29
50	7.1358	7.6112	6.50	6.6602	6.66
60	8.0461	8.4371	4.86	7.6557	4.85
70	7.9255	8.2951	4.66	7.5553	4.67
80	8.0829	8.4199	4.17	7.7457	4.17
90	8.2738	8.5844	3.75	7.9628	3.75
100	9.0284	9.3056	3.07	8.7516	3.06
120	9.9713	10.2319	2.61	9.7107	2.61
140	10.9637	11.2437	2.55	10.6841	2.55
160	11.8892	12.2072	2.67	11.5708	2.68
180	15.2355	15.7293	3.24	14.7435	3.23
200	15.5146	16.0156	3.23	15.0148	3.22
220	17.2969	17.8911	3.44	16.7031	3.43
240	18.8704	19.5410	3.55	18.2012	3.54
260	21.1816	21.9734	3.74	20.3908	3.73
280	22.9392	23.7778	3.66	22.1002	3.66
300	28.0440	29.1322	3.88	26.9578	3.87
320	49.1724	51.5738	4.88	46.7930	4.84
325	812.0703	928.0901	14.29	706.4035	13.01

a. Values of h are given in Btu/hr-ft^2-^{o}F. To convert to w/m^2-^{o}C, multiply by 5.678.

Table B-11: Calculated h and 95- Percent Confidence Limits Verses Time, continued

CALCULATED h AND 95-PERCENT CONFIDENCE LIMITS VERSUS TIME

USING $(\sigma_h)_{avg}$ VALUES

Time (sec)	Calculated h[a]	$(\sigma_h)_{avg}$	$2(\sigma_h)_{avg}$	Upper 95% Confidence Limit $h + 2(\sigma_h)_{avg}$	Lower 95% Confidence Limit $h - 2(\sigma_h)_{avg}$	Percent Error $\frac{2(\sigma_h)_{avg}}{h} \times 100$
0	1.3773	0.6921	1.3842	2.7615	-0.0069	100.5009
1	0.9133	1.4063	2.8126	3.7259	-1.8993	307.9601
2	1.0165	1.3813	2.7626	3.7791	-1.7461	271.7757
3	1.1095	1.3626	2.7252	3.8347	-1.6157	245.6241
4	1.2058	1.3321	2.6642	3.8700	-1.4584	220.9487
5	1.1835	1.3158	2.6316	3.8151	-1.4481	222.3574
10	1.3702	1.2165	2.4330	3.8032	-1.0628	177.5653
20	3.5014	0.9271	1.8542	5.3556	1.6490	52.9560
30	4.7009	0.1389	0.2778	4.9787	4.4231	5.9095
40	7.1790	0.5236	1.0472	8.2262	6.1318	14.5870
50	7.1358	0.4755	0.9510	8.0868	6.1848	13.3271
60	8.0461	0.3907	0.7814	8.8275	7.2647	9.7115
70	7.9255	0.3699	0.7398	8.6653	7.1867	9.3344
80	8.0829	0.3371	0.6742	8.7571	7.4087	8.3410
90	8.2738	0.3108	0.6216	8.8954	7.6522	7.5129
100	9.0284	0.2770	0.5540	9.5824	8.4744	6.1362
120	9.9713	0.2606	0.5212	10.4925	9.4501	5.2270
140	10.9637	0.2798	0.5596	11.5233	10.4041	5.1041
160	11.8892	0.3182	0.6364	12.5256	11.2528	5.3528
180	15.2355	0.4929	0.9858	16.2213	14.2497	6.4704
200	15.5146	0.5004	1.0008	16.5154	14.5138	6.4507
220	17.2969	0.5940	1.1880	18.4849	16.1089	6.8683
240	18.8704	0.6699	1.3398	20.2102	17.5306	7.1000
260	21.1816	0.7913	1.5826	22.7642	19.5990	7.4716
280	22.9392	0.8388	1.6776	24.6168	21.2616	7.3132
300	28.0440	1.0872	2.1744	30.2184	25.8696	7.7535
320	49.1724	2.3904	4.7808	53.9532	44.3916	9.7225
325	812.0703	110.8433	221.6866	1033.7569	590.3837	27.2989

a. Values of h are given in Btu/hr-ft^2-^{o}F. To convert to w/m^2-^{o}C, multiply by 5.678.

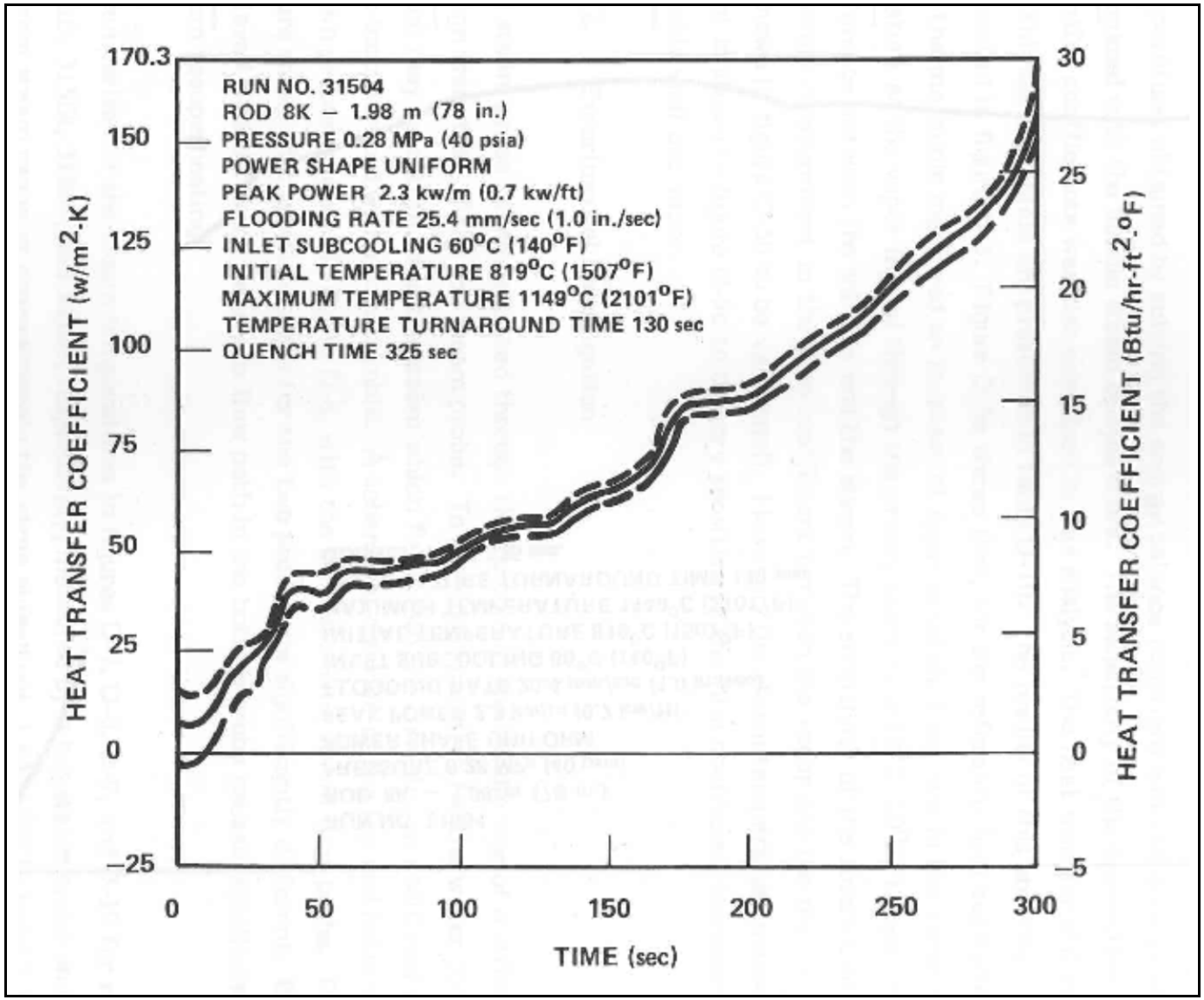

Figure B-2: Rod Heat Transfer Coefficient as a Functioning Time (95% Confidence Limits)

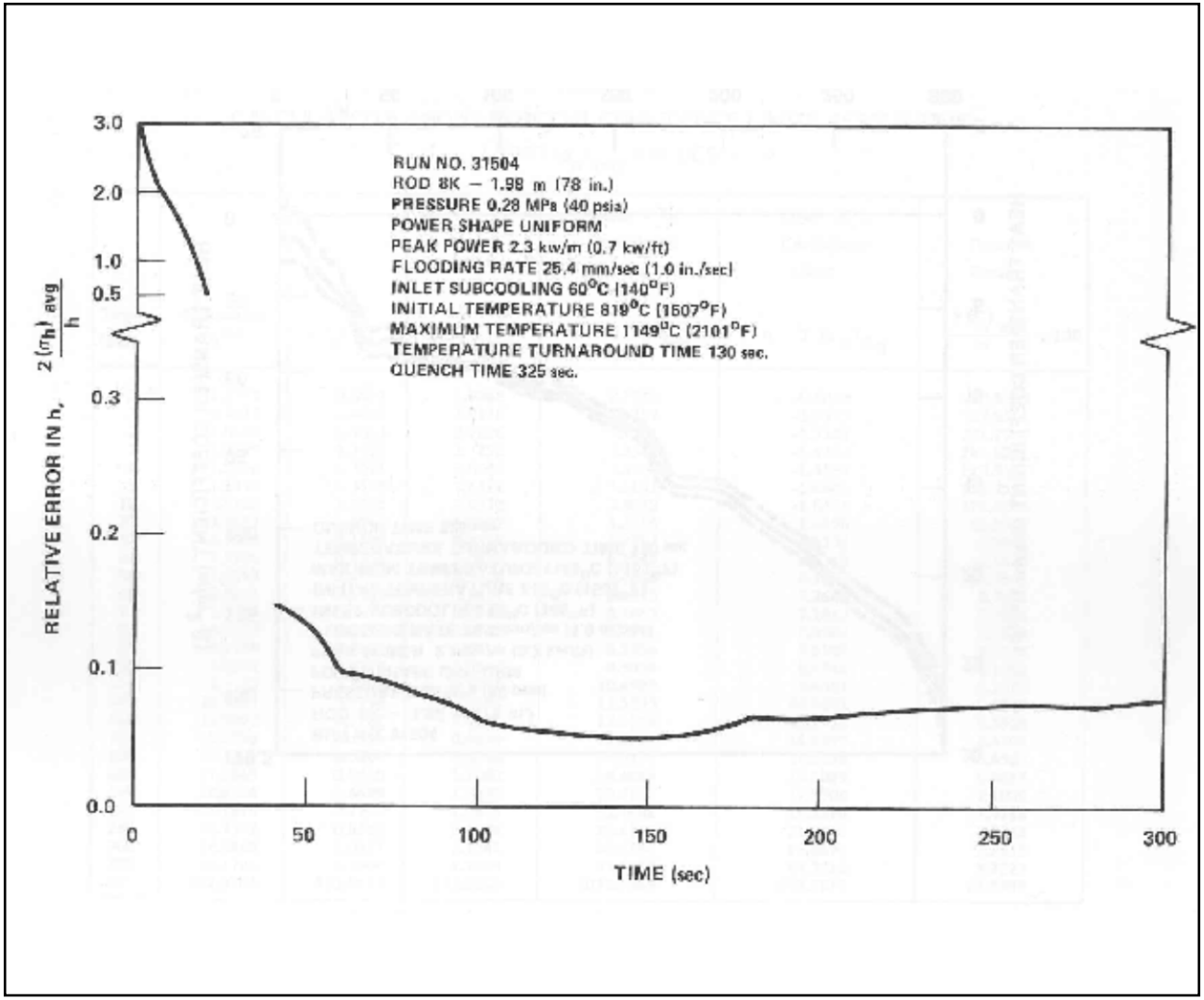

Figure B-3: Relative Uncertainty in Heat Transfer Coefficient as a Function of Time

B.3 Droplet Measurement Uncertainty

This section details testing of the VisiSizer software as completed by Todd at Penn State [4]. A systematic series of tests were performed to characterize the diameter measurement uncertainties and biases of the system. A set of small circles were used in the testing to create images of a known size and location within the optical probe length for VisiSizer to analyze. A set of generalized uncertainties was developed that show the accuracy of VisiSizer along with a method for correcting the measurement bias using a polynomial equation. The effects of calibration bias and changes in operating conditions were also investigated as well as a method for correcting the bias which results from the optical probe length effect.

B.3.1 Testing Methodology

The testing methodology was designed to develop an understanding of system characteristics, and separate the biases and uncertainties for study. The first step involves determining the size of the probe volume with different focus settings. Once this was complete, the uncertainties and biases were investigated. These investigations were broken into five segments, each building upon the previous:

1. Direct droplet measurement uncertainty
2. Calibration bias determination and correction
3. Measurement bias determination and correction
4. Optical probe length effect on measured diameter
5. Effect of optical viewing conditions

Each segment of testing was studied in depth to understand the cause of the uncertainty or bias. Once understood, a generalized uncertainty relation was developed that can apply to all measurements, and bias corrections were developed that remove the effects from the VisiSizer data. These corrections apply when the camera is 66 cm (26 in.) from the optical probe volume.

B.3.2 Test Description

The components of VisiSizer were set up to the desired conditions for testing. However, instead of water droplets – small circles were studied. The circles were studied because the diameter and exact location of each circle in the optical probe was known using a carefully developed experimental procedure. The focus parameter settings and laser pulse duration were each studied as part of the characterization.

B.3.2.1 Calibration Circles

Two sets of circles have been analyzed to determine the diametrical uncertainty of measurements with VisiSizer, where the diameter of each circle was known. The first set of circles was called Patterson graticule circles and these circles were highly accurate coatings on the surface of a microscope reticle. The Patterson graticule circles are typically used to calibrate the optics of a microscope. The second set of circles were attached to a clear polycarbonate

slide. These circles were larger than the graticule circles and were actually screw heads that were inserted into the clear slide. The size of each circle is listed in Table B-12.

Table B-12: Calibration Circle Diameters

Circle no.	diameter [microns (mils)]
1	19.11 (0.7524)
2	35.49 (1.3972)
4	70.98 (2.7945)
6	106.47 (4.1917)
8	144.69 (5.6965)
10	177.45 (6.9862)
12.5	223.86 (8.8134)
15	270.27 (10.6406)
20	360.36 (14.1874)
25	450.45 (17.7343)
A	2383 (93.8)
B	3967 (156.2)

The Patterson graticule circles have numerical labels while the larger set of circles are labeled with letters. The diameter of each Patterson graticule circle was accurate to 0.01 microns ($4.x10^{-04}$ mils) and the circles on the slide were accurate to ± 10 microns (0.4 mils). No suitable objects were available for study in the range of sizes between 450 microns and 2383 microns. The miniscule size of such objects makes them hard to locate and almost impossible to attach to a slide for analysis.

B.3.2.2 Distance from the Camera to Probe Location

The traversing table of a horizontal milling machine was used to hold the reticle and slide during each set of collection sequences. The mill was located in the basement of the Radiation Science and Engineering Center (RSEC) at Penn State and was used because it can accurately move in three dimensions over a very large distance. The x-axis, which was the primary axis used in this investigation, has a range of movement of 122 cm (48 in.).

The procedure for fixing the distance from the camera to the probe location (A) involved moving the circles to the desired location from the camera using the mill traverse handles. Once at the appropriate distance, the camera was carefully focused on the circles. This procedure centered the circles in the optical probe (measurement volume of the system) at the desired distance from the camera. Once set, the camera was not focused again unless the location from camera to the optical probe volume was changed. Typically the digital output on the milling machine was zeroed once the system set-up was complete. The mill then indicated zero when a circle was located in the center of the optical probe.

B.3.2.3 Measurement of Location within the Optical Probe

The milling machine table could be moved when a collection sequence of the circles was desired at a location other than the center of the optical probe. Traversing the mill in the x-direction changes the location of the circles in the probe and the location in the probe was found by reading the digital display of the mill. This reading was referenced to the reading when the center of the optical probe was fixed. The difference between the readings represented the location of the circles within the probe for a collection sequence – where a negative distance indicated the circles had approached the camera.

B.3.2.4 Milling Machine Location Measurement Uncertainty

Under normal circumstances the milling machine table could move in three dimensions with an accuracy of 12.7 microns (0.5 mils). However, a minor problem with the mill table was noted during the testing process. Because of age and heavy use, the traversing measurements were found to have an increased uncertainty in the exact measurement of the table location, which resulted in some erroneous distance measurements. The uncertainty was limited in most cases – but in a few select cases it was noted to be as much as 51 microns (2 mils). When possible, these cases were identified and removed from analysis.

B.3.3 Optical Probe Length Measurement

The dimensions of the optical probe volume were of vital importance when making number and volume flux estimates with VisiSizer for a given experiment. The software reported the height and width of the optical viewing area, but the depth of a frame was not readily known. The depth of a frame was called the optical probe length (OPL), and was the distance towards and away from the camera in which VisiSizer can measure an object. This section investigates the size of the OPL when VisiSizer was in diameter measurement mode with the laser in single pulse mode.

If VisiSizer was focused on a circle and the circle was moved away from the center of the optical probe, there was a finite distance for which the object was in focus for the camera. The optical probe length was a function of the object size, illumination intensity, lens quality, lens configuration (combination of extension tubes, magnification tubes, laser line filter, etc.), and distance from the object to the camera. Finally, the user supplied a focus parameter that instructed VisiSizer on how to discriminate between “in" and "out" of focus images – which directly affected the probe length. A stringent focal test created a very short probe length, while a no focus test allowed circles that were out of focus to be measured by VisiSizer. The reasoning for a focal test was because the out of focus image of a circle appeared smaller than the same circle when it was in focus. Figure B-4 illustrates this point.

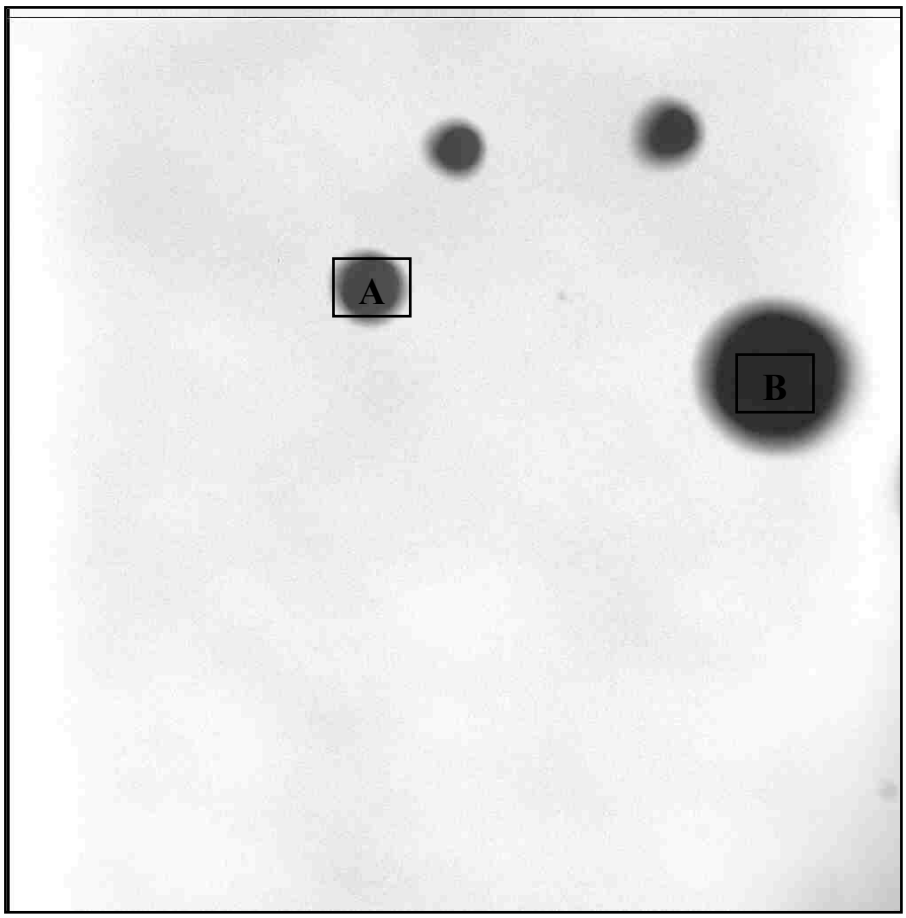

Figure B-4: Sample Frame With Out of Focus Images

Illustrated in this figure is the slide that holds circles A and B. The frame was collected when the images were approximately minus 10 mm (0.39 in.) from the center of the optical probe. The four out of focus images appear fuzzy around the periphery, the fuzziness results in diminished apparent image size when measured by VisiSizer and compared to the same images if they were in focus. This was because VisiSizer assumed some of the pixels in the fuzzy region were not a part of the image.

A selection of circles and focus discrimination settings were investigated to determine the optical probe length for a fixed lens combination, camera distance, and illumination intensity. The circles were moved across the optical probe of the camera by traversing the table. Since the actual size and location of the circles creating each of the images was known, the dependence of circle size and focal parameter could be described for the probe length.

The probe length was determined for each circle size by traversing the mill table across the x-axis. The front and back of the OPL was determined by recording the location of the table where VisiSizer reports about 1 to 2 in focus images of 30 frames captured - with the remainder of the images rejected for focus. The laser pulse duration was set at 7 with the upper threshold set at 200. The threshold differential setting was 30. The results for the optical probe length for each diameter were tabulated in Table B-13 with a range of focus discrimination settings. All data was taken with the camera located 66.0 cm (26.0 in.) from the center of the optical probe.

Table B-13: Optical Probe Length at 66.0 cm (26.0 in) from Camera

Focus Parameter	Optical Probe Length [mm] by Circle Number							
	6	8	10	12.5	15	20	25	A
10								51.0
15		11.2		16.0		18.6	20.3	33.2
20								25.9
25		11.5		12.0		13.1	13.7	19.0
35		9.4		10.1		10.1	9.9	
45		8.9					9.2	8.6
50	3.4	5.0	5.1	5.1	5.4	5.3	5.5	
65	2.8	4.0	3.6	4.0	4.3	4.4	4.6	6.2
75	2.6	3.3	3.4	3.7	4.0	4.0	4.3	
85	1.8	2.7	3.0	3.2	3.4	3.5	3.8	3.5

These measurements were very difficult to perform as they depend upon the ability of the experimenter to locate the region of space in the optical probe where the count rate of in-focus images was small, but not zero. Many competing effects can cause erroneous measurements of the probe length. For instance, the image of a large circle appeared small to VisiSizer when the circle was out of focus. Depending on optical properties and VisiSizer settings, the software may have decided the image was a small in-focus image instead of a large out of focus image. The effect depended on the behavior of the image halo. The data listed in Table B-13 has been carefully screened to remove any overtly erroneous data. A portion of the data in Table B-13 is plotted in Figure B-5. The data for each focus parameter (F) was fit with a logarithmic best-fit line that accurately describes the behavior of the optical probe length vs. circle diameter.

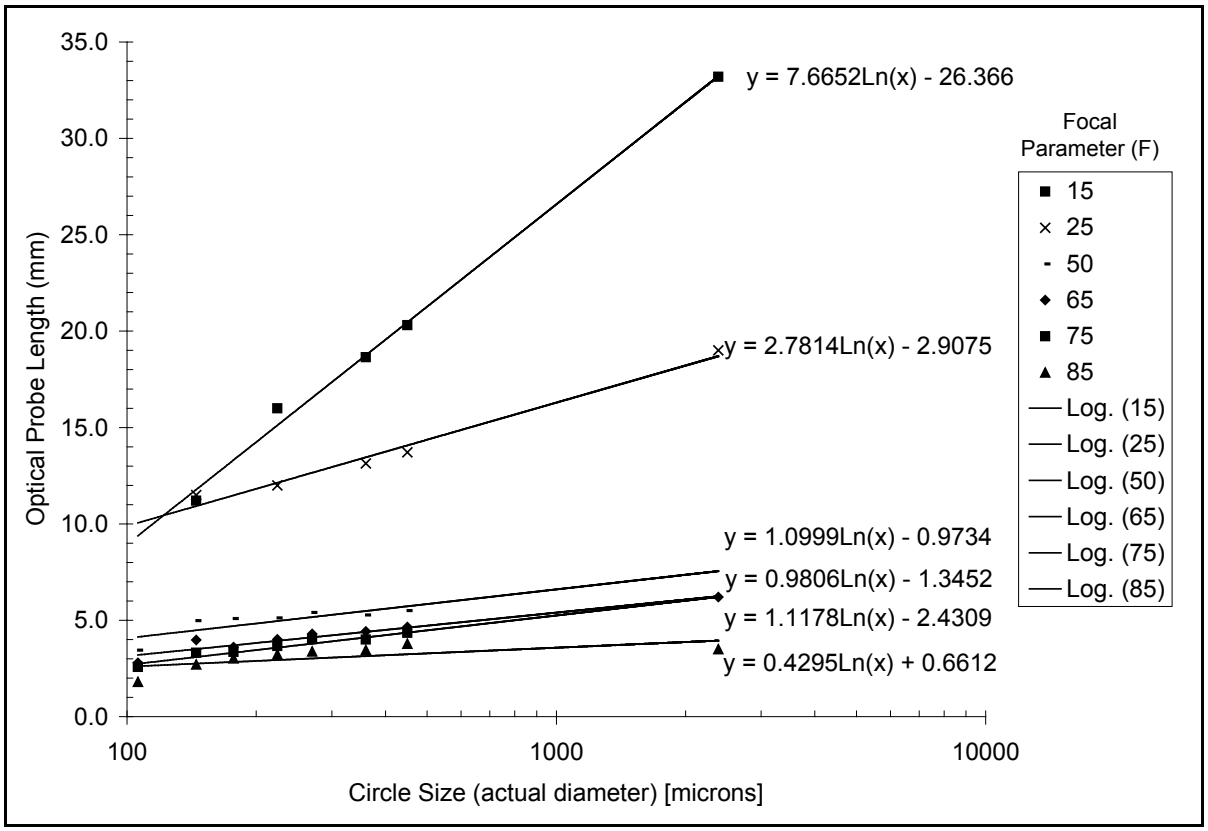

Figure B-5: Plot of the Optical Probe Length vs. Circle Size

The logarithmic best fit for each of the focal parameters was used to describe the behavior of the probe length for each circle size and focus parameter setting. The fits only apply at 66.0 cm (26.0 in.) from the center of the optical probe to the camera. From previous experience, the focal parameter of 25 was known to be the most suitable setting for measuring the velocity of droplets in a reflood experiment because a large probe volume was desired, which enabled the largest amount of information to be captured. The equation for the probe length at a focus parameter of 25 was:

$$OPL_i = 2.7814 \ln(d_i) - 2.9075 \tag{B-15}$$

where:

OPL_i optical probe length for size d_i droplet [mm]

d_i diameter of droplet [microns]

The diameter d_i was the actual diameter of the image that was being measured. Therefore, it was necessary to correct all biases in the measurements prior to finding the optical probe length for a given diameter. Once the probe length was known for a focal discrimination setting, the optical probe volume could be found. Knowing the optical probe volume, estimates of the number and volume flux could be made for a given experiment.

B.3.4 Measurement Bias and Uncertainty

The precision and accuracy of VisiSizer has been investigated using the reticle circles to ascertain the accuracy of the system when used to measure droplet sizes in the RBHT facility. Since each droplet can only be sampled once during a test, VisiSizer must be able to accurately record the droplet diameter with a minimal measurement uncertainty applied to the size of the droplet. Determination of the measurement uncertainty was broken into five portions:

1. direct droplet measurement uncertainty
2. calibration bias
3. measurement bias
4. uncertainty of the location in the optical probe length
5. optical viewing conditions

The direct measurement uncertainty (i.e. measurement precision) was similar to measuring the length of a string many times; fluctuations in the environment, changes in lighting, and dust in the air are all examples of changes that can affect a particular measurement. For VisiSizer, the uncertainty was seen as a variation in the pixel area that the system determines to be in an image. By sampling the number of pixels in an object a large number of times, an estimate of the uncertainty could be made.

Special care must be taken when calibrating VisiSizer. The calibration method involves capturing a frame and inputting the diameter of the largest image in the frame. Typically circle 25 (450 microns) of the reticle was used for calibration and since the direct measurement uncertainty applied to any image that was captured, an uncertainty applied to the image used for calibration. A method was developed to determine what the calibration bias was, and the means to correct the calibration ratio.

Comparisons between the VisiSizer diametrical measurement of a circle and the actual diameter of the circle were made to illustrate the inherent measurement bias of the system that was caused by the optics. Once the bias was characterized, a method for removing it was formulated and was applied to images smaller than 19.5 pixels in diameter.

The optical probe of VisiSizer has a finite measurement volume, of which the optical probe length is the axis along which a droplet moves towards or away from the digital camera, but is still visible. The exact location of a droplet in that length is unknown for a given experiment. Measurement uncertainty results because the apparent diameter of a droplet image that is not in the center of the optical probe length is smaller than the same image if located in the center of the optical probe length. The change in apparent size is a function of the distance of the probe volume from the camera (A) and the location in the optical probe length. A method to correct captured data for this effect was developed for a droplet population that was evenly distributed across the optical probe length.

Finally, the uncertainty from changes in optical viewing conditions was investigated. Optical viewing conditions are related to the intensity of the laser light which exposes the camera CCD. The intensity may vary during a reflood experiment as the conditions inside the test section change. As the experiment progresses the density of the two-phase mixture may vary, resulting in increased or decreased laser absorption in the fluid. To quantify this effect, measurements of the circles were made where the amount of illumination was varied by changing the laser pulse duration, which simulated the possible effect of absorption of laser light

in the two phase flow. The effect was shown to be very small and the same linear effect occurred for all size circles.

B.3.4.1 Direct Measurement Uncertainty

VisiSizer reports all diametrical size measurements in units of microns. But the measurement uncertainty is actually a function of the resolution of a given image, i.e. the number of pixels that are determined to be within the image. VisiSizer can be operated at different distances from the area of study to trade off between good resolution of small droplets and a large optical probe volume with increased counting rates. In order to develop a generalized measurement uncertainty that could apply to all resolutions; the uncertainty was developed using the non-dimensional pixel as a measure of size. The use of pixels enables the user to assume all images with a given pixel area have the same direct measurement uncertainty. This is true no matter the camera location from the probe volume, even though the actual size of the object being imaged is not the same at different camera locations. In the following sections, an integer number of pixels is used to represent the area of a given image, while the equivalent diameter is reported as a real number of pixels that are equivalent to the diameter of the image. The size of a pixel in microns is determined by the calibration ratio. Dividing the area in microns, that is output from VisiSizer, by the calibration ratio (R) squared converts a measurement from microns to pixels, or vise versa.

B.3.4.1.1 Distribution of Individual Measurements

To quantify the direct measurement uncertainty, the image size of each circle is measured a large number of times (>500 times). Each individual measurement is recorded as the number of pixels that are within the image of the circle. As noted before, the measured number of pixels can vary between frames because of random fluctuations. The variations are analyzed to determine the direct measurement uncertainty of the area of each circle. The uncertainty of a large group of measurements for a given circle size should be Gaussian in nature. To illustrate this data from a collection sequence is analyzed to determine the frequency distribution and relative change in pixel area of circle measurements. The analyzed sequence includes eight of the circles on the reticle and the calibration ratio (R) is 20.013 microns (0.8 mils) per pixel for these measurements. The frequency for each of the measurements is plotted in Figures 3-3 and 3-4 for each of the circle sizes. The most probable measured area is assumed to be the center of the distribution and the other measurements are scattered about the most probable size by the relative change in relation to the most probable size.

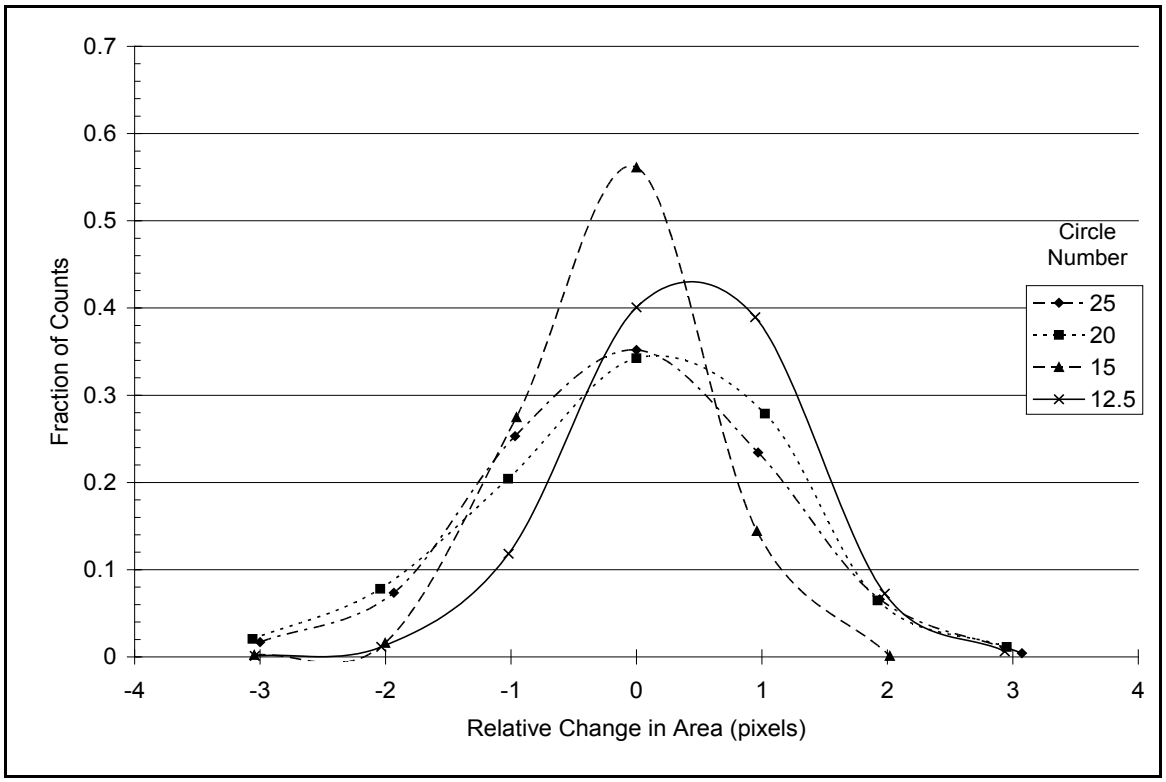

Figure B-6: Distribution of Large Circle Measurements

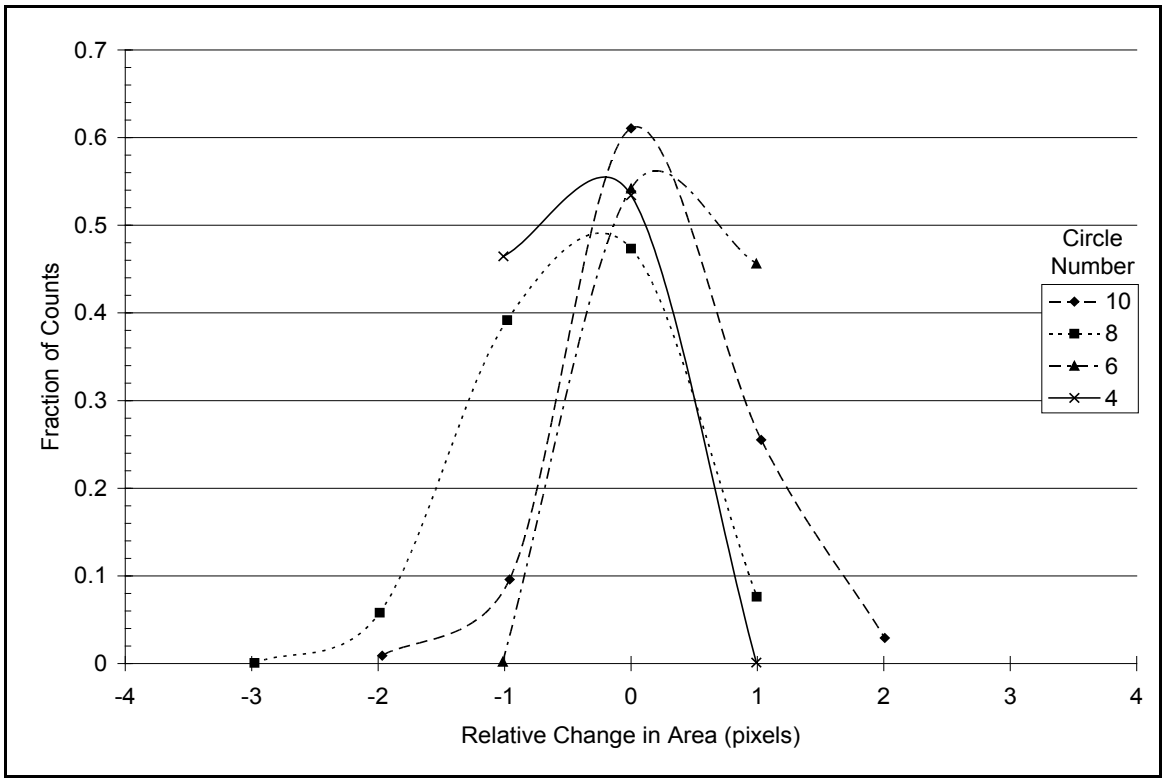

Figure B-7: Distribution of Small Circle Measurements

Figure B-6 and Figure B-7 show that the distribution of measurements for each of the circles is Gaussian in nature, where the percent change for circle 25 (450 microns) is 8.9% from zero to plus two pixels in size. Since the pixel area of each measurement is an integer value, the relative change from the most probable measured size is an integer value. Since the small circles only have about 3-4 pixels of uncertainty, very little data is available to fully illustrate the Gaussian-like distribution function. For the sake of uncertainty analysis, the uncertainty of VisiSizer measurements is assumed Gaussian. The mean area and two sided 95% confidence levels (1.96 σ) for each of the circles are listed in Table B-14, where the method for calculating the mean and 95% confidence are given in Young [8].

Table B-14: Direct Uncertainty of a Sequence of Circle Measurements

Circle Number	Measured Mean Area and 95% Confidence (pixels)
4	2.61 ± 1.09
6	13.47 ± 0.98
8	30.58 ± 1.40
10	51.20 ± 1.34
12.5	87.42 ± 1.67
15	128.84 ± 1.32
20	230.03 ± 2.30
25	365.91 ± 2.13

The 95% confidence has a slight increase in size with increase in pixel area. Reasoning for this behavior can be seen when examining Figure B-6 and Figure B-7 closely. As the actual circle size increases, the width of the measured distribution increases, which results in a larger deviation.

B.3.4.1.2 Investigation of the Effect of Area Variation

Investigating the effect of the variation of an individual measurement from the mean measured value leads to the conclusion that small images are affected more by a variation in the measured area than large images. Figure B-8 is a plot of the pixel area and the percent change that results from increasing the pixel area of an image by one pixel (i.e. a 100% increase in size when increasing from one to two pixels in an image). Also noted on the figure is diameter of two images in microns for comparison, assuming a value of 20.0 microns (0.8 mils) per pixel for the calibration ratio.

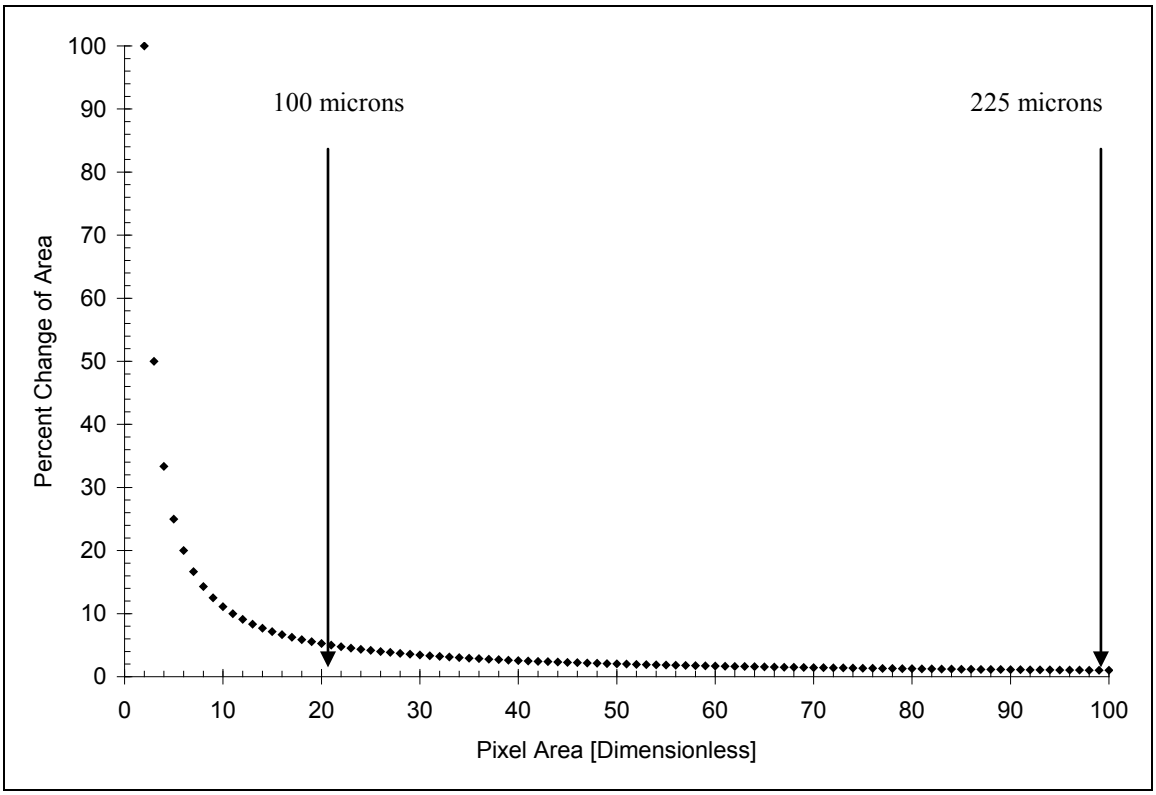

Figure B-8: Effects of Pixel Area Variation

As seen in Figure B-8, the percent change in area is greater than 5% for an area below 21 pixels. The significance of the percent change can be seen in Table B-14 where the measured area of circle number 6 (13.5 pixels in area) has a 95% confidence of one pixel in area. This means the area deviates more than ±5% of the total area of the image. The effect will be more apparent in later sections when the measurement uncertainty is investigated in terms of diametrical uncertainty.

B.3.4.1.3 Generalization of the Uncertainty

The calculated 95% area confidence levels for 228 collection sequences made throughout the testing have been analyzed in order to create a generalized measurement uncertainty for each size of image. Data for each sequence is listed in Appendix A, where each sequence has more than 500 individual circle measurements. The plot of the confidence level vs. image area is seen in Figure B-9, where the data is fit with a logarithmic best fit. A generalized confidence that characterizes all measurements is developed using the deviation about the best fit that bounds 95% of the data using to a one sided Gaussian distribution. See Young [8] for a detailed description of the method.

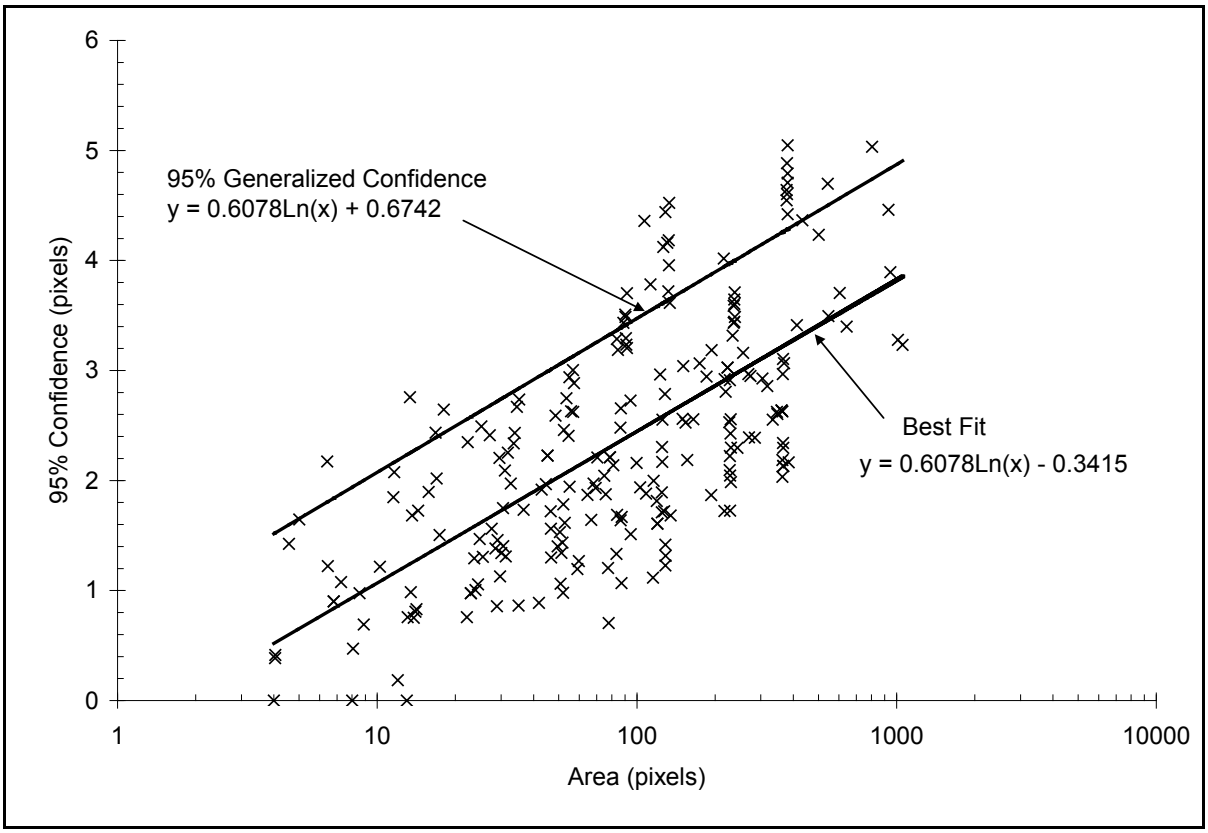

Figure B-9: Generalized 95% Confidence of 228 Measurements

The maximum pixel area of data in Figure B-9 is 1000 pixels. The equivalent diameter is 714 microns (28.56 mils), assuming a calibration ratio of 20.0 microns (0.8 mils) per pixel. Data is not included above this size because the overall percent change in area is miniscule above this size.

The generalized 95% confidence curve in Figure B-9 has the same slope as the best fit line but the magnitude is increased by 1.0157 pixels. Knowing the pixel area of a single droplet measurement in the RBHT Facility, the curve can be used to determine the 95% confidence of that measurement without having to take a large number of samples of the same droplet to create a statistical base. In simple words, there is a 95% chance the mean of a large number of measurements of the same droplet will be within the measured size of the droplet ± the generalized 95% confidence. The best-fit and 95% confidence curves are presented in equation form:

$$\begin{aligned} &best - fit\ deviation \\ &\sigma_{GA-B} = 0.6078\ln(A) - 0.3415 \end{aligned} \tag{B-16}$$

$$\begin{aligned} &generalized\ 95\%\ confidence: \\ &\sigma_{GA-95\%} = 0.6078\ln(A) + 0.6742 \end{aligned} \tag{B-17}$$

where:

σ_{GA-B}	best fit of 228 - 95% confidence data points [pixels]
$\sigma_{GA-95\%}$	generalized 95% confidence of an area measurement [pixels]
A	integer number of pixels in an area measurement [pixels]

These relationships can be extrapolated to 10,000 pixels in area with a high degree of confidence. The direct uncertainty of a droplet measurement in the RBHT Facility can now be addressed using the generalized confidence. For the measurement of any droplet the direct measurement uncertainty of the area of the droplet image is ± the generalized confidence, as determined for that particular area. The generalized confidence and best-fit deviation are calculated for a 200 pixel image:

Given a droplet area in pixels from VisiSizer:
A = 200 pixels in area

The uncertainty is calculated from Equation B-16 and B-17:

$$\sigma_{GA-B} = 0.6078\ln(200) - 0.3415 = 2.879 \text{ pixels} \tag{B-18}$$

$$\sigma_{GA-95\%} = 0.6078\ln(200) + 0.6742 = 3.895 \text{ pixels} \tag{B-19}$$

Therefore the size of the image with 95% confidence is:

A=200 ± 3.895 pixels

The increasing trend in area confidence noted previously is insignificant when studied in terms of percent deviation of the area. Two extreme cases illustrate the change in percent deviation using the generalized 95% confidence. The first case has an image area of 500 pixels and the second case has an area of 4 pixels (which will later be chosen as the minimum pixel area).

$$\text{percent deviation} = \frac{\sigma_{GA-95\%}}{A} \times 100\% \tag{B-20}$$

large image:

$$\frac{4.45\,pixels}{500\,pixels} \times 100\% = 0.890\% \tag{B-21}$$

small image:

$$\frac{1.52\,pixels}{4\,pixels} \times 100\% = 38.00\% \tag{B-22}$$

There is a significant change in the percent deviation between the cases, with the larger image resulting in less percent change in area.

B.3.4.1.4 Conversion to Diameter

Data from VisiSizer is typically used in terms of the equivalent diameter of a circle. For this reason, the area measurement deviation is revisited in terms of diameter. First, the effect of increasing the size of an area measurement by one pixel has been shown to be more significant for small images than for large images. Fortunately, the increase in area has a less significant effect upon the equivalent diameter of an image than upon the area measurement of the same image. This is seen by converting the area of an image into the equivalent diameter of a circle, and finding the percent change in diameter if the area is increased by one pixel. A 41.42% change in measured diameter occurs when the area of the image is increased from one to two pixels as can be seen in Table B-15.

Table B-15: Effect of Increasing Pixel Area

Pixel Area	% Change in Area	Equivalent Pixel Diameter	% Change in Diameter
1		1.1284	
2	100.0	1.5958	41.42
3	50.0	1.9544	22.47
4	33.3	2.2568	15.47
5	25.0	2.5231	11.80
6	20.0	2.7640	9.54
7	16.7	2.9854	8.01
8	14.3	3.1915	6.90
9	12.5	3.3851	6.07
10	11.1	3.5682	5.41
11	10.0	3.7424	4.88
12	9.1	3.9088	4.45

The percent change is significantly reduced from the 100% effect upon an area measurement as shown in Figure B-8 in the previous section. Table B-15 illustrates the need to use caution when including images that are smaller than 11 pixels in area or 3.74 pixels in diameter in the analyzed data. The reason is because if the same droplet is imaged twice and the two measurements deviate by one pixel in area, the deviation in diameter is greater than 5% between the two measurements. However, since these small droplets are of great interest in a reflood experiment, the large uncertainty is accepted for all images with four or more pixels in area or 2.26 equivalent pixels in diameter. Discrimination of the small images is performed by VisiSizer using the minimum pixel area setting.

VisiSizer reports the equivalent diameter of each droplet, not the area, so the generalized confidence must be reworked for diametrical measurements. The relationship between the area and diametrical uncertainty are derived and manipulated to make use of the 95% generalized confidence that was previously derived for area measurements. The following relationships are used to develop the diametrical uncertainty for both the 95% and best-fit uncertainties:

basic relationship:

$$\mathrm{A}+\sigma_{GA} = \frac{\pi}{4}\left(d+\sigma_{Gd}\right)^2 \qquad \text{(B-23)}$$

rearranging, where only real positive roots are meaningful:

$$\sigma_{Gd} = \sqrt{d^2 + \frac{4}{\pi}\sigma_{GA}} - d \tag{B-24}$$

NOTE: the term σ_{Gd}^2 cannot be neglected in the derivation because it is at least 10% of the diameter for the smallest sizes.

knowing the best fit area equation and rearranging:

$$\sigma_{Gd-B} = \sqrt{d^2 + 0.7739\ln(d^2) - 0.6218} - d \tag{B-25}$$

knowing the 95% generalized area confidence and rearranging:

$$\sigma_{Gd-95\%} = \sqrt{d^2 + 0.7739\ln(d^2) + 0.6715} - d \tag{B-26}$$

where:

σ_{Gd-B}	best fit diametrical confidence [linear pixels]
$\sigma_{Gd-95\%}$	generalized 95% diametrical confidence [linear pixels]
d	equivalent diameter of an image in pixels

To illustrate the generalized diametrical confidence, the same data in Figure B-9 is plotted in Figure B-10. This new figure shows each of the 228 measured 95% diametrical deviations which are bounded by the generalized 95% diametrical confidence. The best-fit curve from Figure B-9 is also included in Figure B-10 for comparison.

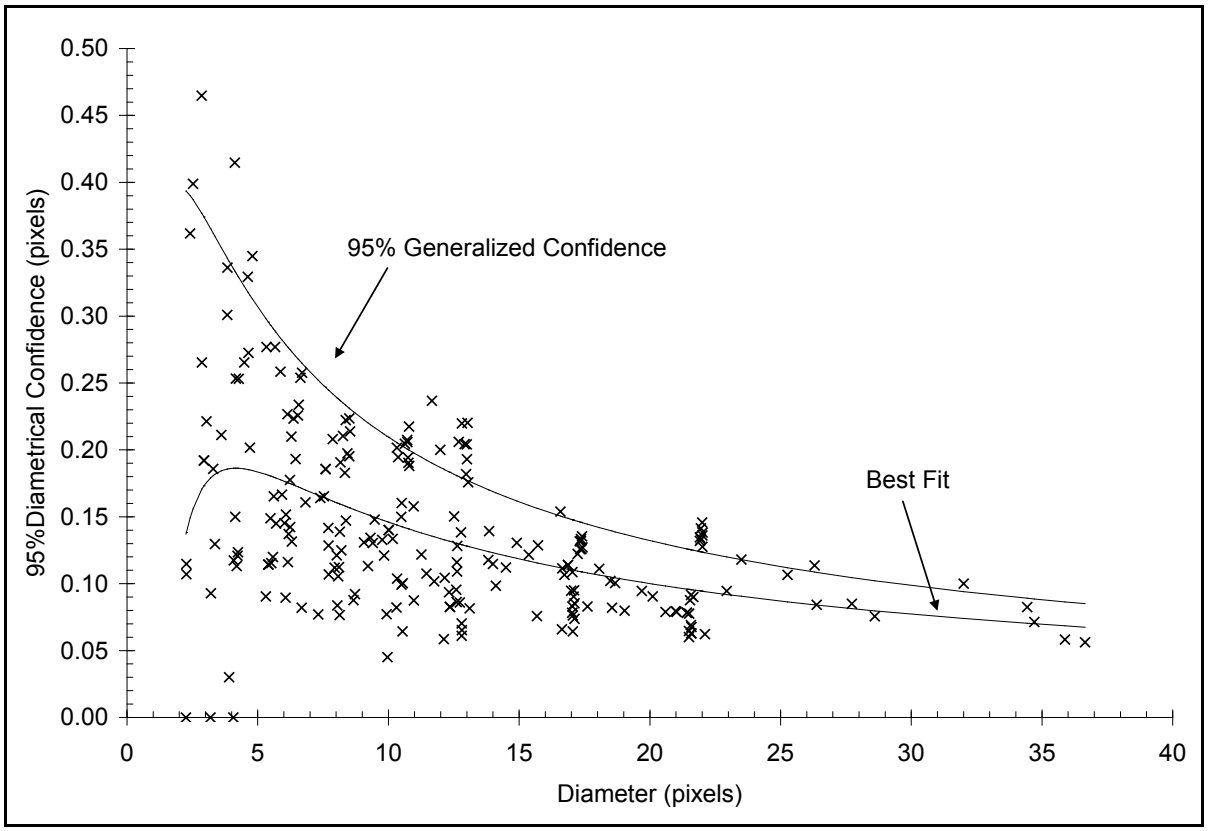

Figure B-10: Diametrical Uncertainty of 228 Data Points

The uncertainty of a measurement decays with increasing diameter. The reason is the fluctuation of one pixel in area has less and less of an effect on the diameter as the diameter increases, and this is because area is related by the square of the diameter. Using Equations B-25 and B-26, the generalized 95% diametrical deviation and the best-fit diametrical uncertainty are calculated for the 200 pixel-area image.

Given a droplet diameter in pixels from VisiSizer:

200 pixel area =15.958 pixels in diameter

The best fit uncertainty is calculated from Equation B-25:

$$\sigma_{Gd-B} = \sqrt{(15.958)^2 + 0.7739\ln((15.958)^2) - 0.6218} - 15.958 = 0.114 \text{ pixels} \qquad \text{(B-27)}$$

The generalized 95% confidence is calculated from Equation B-26:

$$\sigma_{Gd-95\%} = \sqrt{(15.958)^2 + 0.7739\ln((15.958)^2) + 0.6715} - 15.958 = 0.155 \text{ pixels} \qquad \text{(B-28)}$$

Therefore the diameter of the image with 95% confidence is:

$$d = 15.958 \pm 0.155 \text{ pixels}$$

where:

d = diameter of the image [pixels]

Revisiting the percent deviation from Equation B-20, converting the area of the images to diameter and finding the generalized 95% diametrical deviation:

large image (500 pixel area):

$$\frac{0.112\,pixels}{25.231\,pixels}\times 100\% = 0.444\% \tag{B-29}$$

small image (4 pixel area):

$$\frac{0.394\,pixels}{2.257\,pixels}\times 100\% = 17.457\% \tag{B-30}$$

After conversion to diameter, the percent deviation of the large image decreases from 0.89% to 0.44%, while the effect on the small image is even greater, 38% for the area deviation versus 17% for the same image using the diameter deviation. The Sauter Mean Diameter from FLECHT-SEASET [5] was about 1 mm (0.39 in.) and this size has approximately 0.13% deviation.

B.3.4.1.5 Direct Uncertainty Conclusions

The generalized 95% diametrical confidence is necessary because repeated sampling of a droplet is not possible during an experiment. With the generalized deviation of each measurement, the average deviation of the entire population can be found through statistical combination. The generalized 95% confidence is applied to a droplet measurement prior to any other statistical treatment because this uncertainty is directly related to the apparent diameter seen by the camera, not actual diameter of the droplet. When analyzing data in a “class” type structure, the generalized uncertainty for the entire class is determined using the lower class bounds as a conservative approximation.

B.3.4.2 Calibration Bias

VisiSizer measures the area of the image in pixels, calculates the equivalent diameter and determines a ratio (R) that relates the pixel size to the input calibration size of the object. The ratio (R) is in microns per pixel and remains constant while the camera focus remains unchanged. As described in the previous section, there is a direct measurement uncertainty of the size of each individual image measurement, and this includes the image of the object used for calibration.

A large sequence of data is collected of the calibration circle once VisiSizer is satisfactorily calibrated. A diametrical mean is calculated from the sequence, where the mean represents the best estimate of the size of the circle. The mean is then used to remove any remaining calibration bias. The calibration bias is propagated by the calibration ratio (R), where

the ratio can fluctuate proportionally with the uncertainty of the calibration image. The bias only affects data that is listed in microns, not data listed in pixels. The bias correction is developed as follows:

the ratio is found:

$$d_C \sqrt{\frac{4}{\pi} A_C} \tag{B-31}$$

$$R = \frac{d_{CI}}{d_C} \tag{B-32}$$

but the calibration bias is as follows:

$$\Delta d = \frac{\overline{d}}{R} - d_C = \frac{\overline{d} - d_{CI}}{R} \tag{B-33}$$

so the corrected ratio is:

$$R_C = \frac{d_{CI}}{d_C - \Delta d} \tag{B-34}$$

Substituting:

$$R_C = \frac{d_{CI} R}{\overline{d}} \tag{B-35}$$

where:

A_C	integer pixel area of calibration image
d_C	measured calibration image diameter [pixels]
d_{CI}	input calibration image diameter [microns]
R	calculated microns per pixel ratio
Δd	difference between measured calibration size and mean diameter of sequence [pixels]
$\overline{d}$	mean diameter of calibration image sequence [microns]
R_C	corrected microns per pixel ratio

The corrected ratio (R_c) is the ratio that VisiSizer would use if it were exactly calibrated on the mean size of the circle image. The work performed in the previous sections to determine the direct measurement uncertainty was non-dimensionalized into pixels by using the uncorrected ratio (R). But once all corrections are finished, the results will be re-dimensionalized using the corrected ratio (R_c) to remove the calibration bias.

B.3.4.3 Measurement Bias

To determine if any measurement biases are present in a VisiSizer measurement, several sets of data are plotted as actual diameter vs. measured diameter in pixels. These cases are prototypical - the illumination, location in the optical probe length, and distance from the camera to the optical probe are all kept constant. The data is acquired by imaging eight of the reticle circles simultaneously and plotting the circle data for each sequence. Figure B-11 is the resulting plot used to determine the measurement bias.

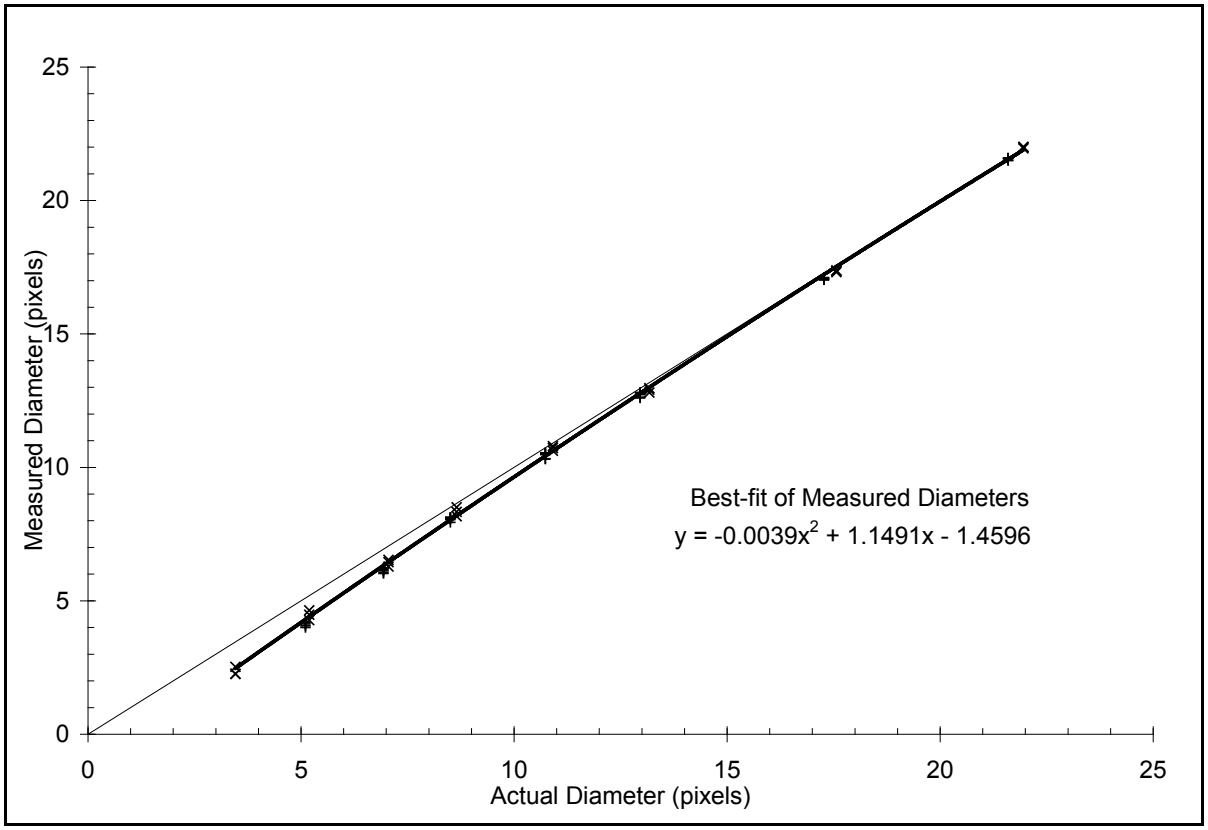

Figure B-11: Actual Versus Measured Diameters to Determine Bias

A measurement bias is present in the VisiSizer system. The trend of small circles to appear smaller than the actual circle size is apparent where the small circles deviate from the 45° perfect agreement line. The data points are fit with a second order polynomial, which will be used later to develop a bias correction.

The pixel diameter is found by dividing the measured diameter by the uncorrected ratio (R). This is because the equivalent pixel diameter in an image is the reported diameter in microns divided by the uncorrected ratio – not the corrected ratio. The actual diameter of a circle is converted to pixels by dividing by the corrected ratio. By calculating the actual diameter in this way, the difference between actual and measured diameter for the 450 micron circle is essentially zero since it is the circle used for calibration. A typical value for the uncorrected ratio is 20.0 microns (0.8 mils) per pixel.

The bias is a result of laser light diffracting around the circles. The effect of laser diffraction is more profound with decreasing size, resulting in a seemingly exponential decay in the difference between actual and measured size as seen in Figure B-12. (In other words, as the size decreases, the difference between the actual and measured diameters increases – a phenomenon seen in Figure B-11.)

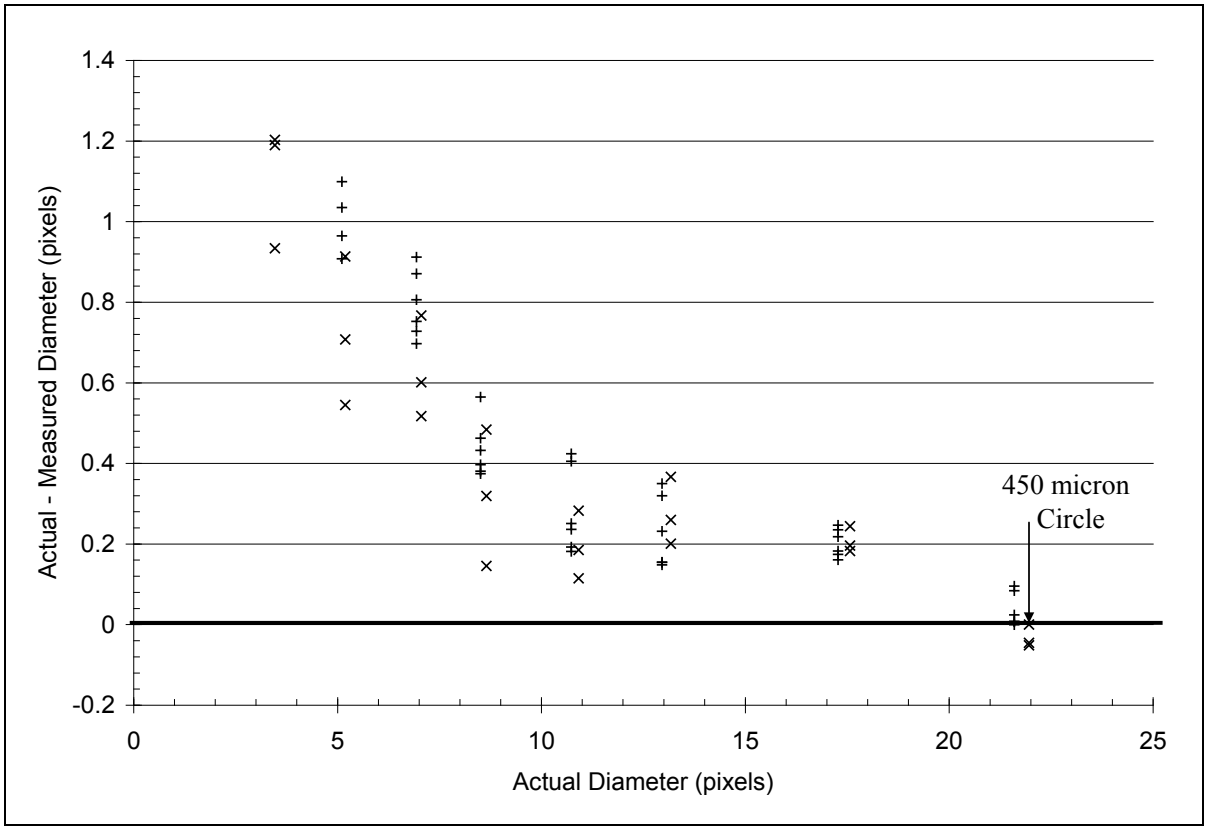

Figure B-12: Comparison of Actual and Measured Diameter

To eliminate the bias, the best fit polynomial found in Figure B-11 is inverted so the measured diameter is input as d_m and the result is the corrected diameter d_N which compensates for the measurement bias. The bias correction is given as

$$d_N = 0.0034 d_m^2 + 0.8678 d_m + 1.3091 \tag{B-36}$$

where:

d_N = corrected diameter of an image [pixels]

d_m = measured diameter output by VisiSizer [pixels]

The data used for Figure B-11 and Figure B-12 is corrected using the bias correction and the resulting diameters (d_N) are plotted in Figure B-13.

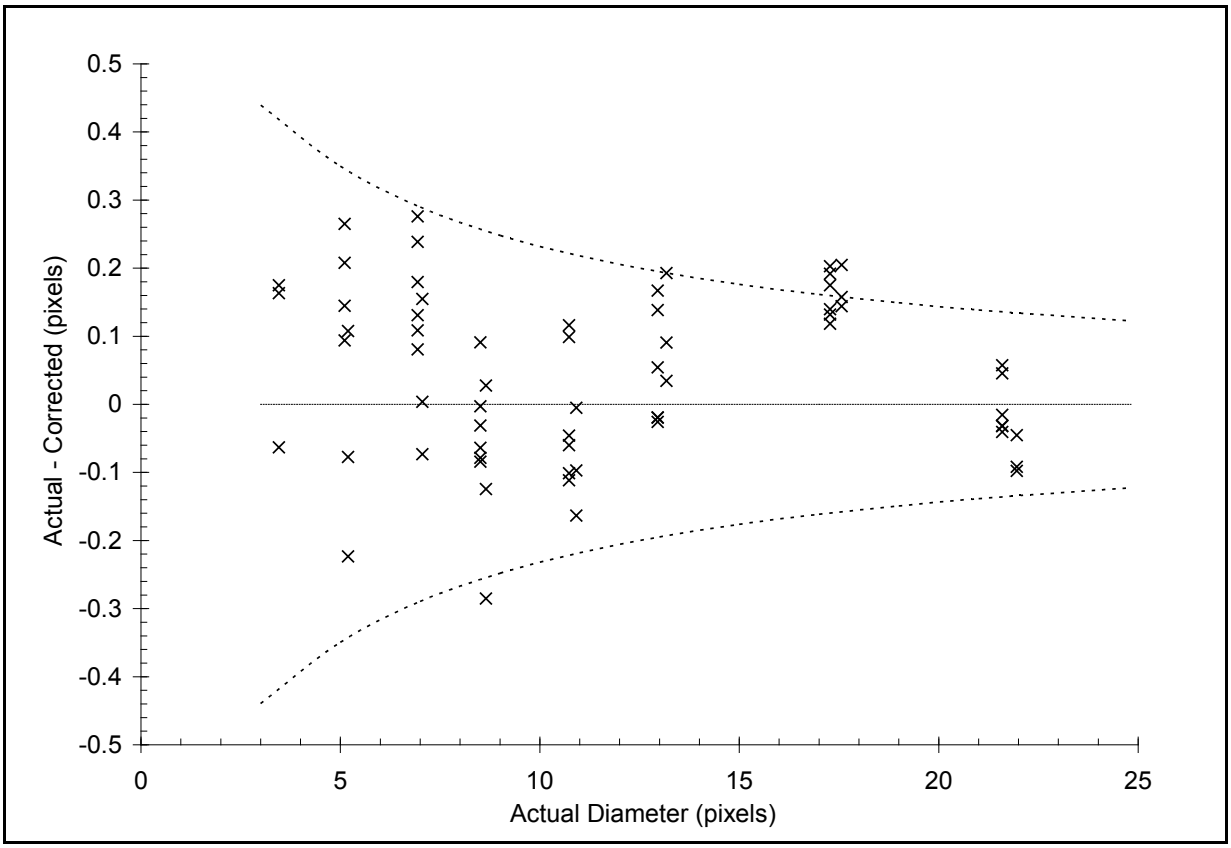

Figure B-13: Data after Bias Correction

The data now falls nicely around zero, indicating no bias. Also included in the figure is the generalized 95% diametrical confidence curve for the range of diameters. Notice nearly all the data falls within the 95% confidence. It must be noted however that this particular correction applies only to the case where the laser is 114 cm (45 in.) ± 5 cm (2 in.) away from the area of study. Also, the laser pulse duration must be set so eight of the ten reticle circles are visible so as to not over or under expose each frame. These limitations are in place because the effect of diffraction changes as the location and intensity of the laser changes. The effects of laser intensity are discussed later.

The bias correction is only applicable for diametrical sizes below 19.5 pixels (390 pixels with R=20.0 microns per pixel). Images larger than 19.5 pixels do not show the bias seen in the smaller images. This is confirmed by maintaining calibration from the reticle to the slide – where VisiSizer is calibrated with the 450 micron (22.5 pixel) circle, and the 3967 micron (198.2 pixel) circle is imaged. The resulting measurement is 3960 microns (197.9 pixels) in diameter. The slight variation in size is reasoned to result from minor variations in experimental conditions caused by the use of the slide versus the reticle.

B.3.4.4 Variation of Diameter in Probe Length

If a droplet is at the front of the optical probe (close to the camera) it should appear to be larger than if at the back of the optical probe. This is intuitively obvious – an object viewed at a close proximity should always appear larger than the same object when viewed farther away. However, another effect competes with the apparent change in size to determine the effect of location within the probe. As the droplet moves from the center of the optical probe it becomes out of focus, resulting in a decrease in apparent size.

Since VisiSizer cannot determine the location of the droplet within the probe, no correction for the size can be made directly by the system. Also, no predictive models for droplet location within a sub-channel are available for a reflood test - so a correction cannot be developed with a known droplet location distribution. The result is that the effect of droplet location in the probe must be studied using an assumed distribution.

B.3.4.4.1 Apparent Change in Diameter

Initially, the uncertainty of a diameter measurement can be quantified by investigating the change in apparent diameter for a given object that is varying within the optical probe length. The location uncertainty is quantified by calculational techniques assuming no effects resulting from the image being out of focus. Knowing the distance from the camera (A), the optical probe length (L), and the diameter of an object (D), the apparent change in diameter can be calculated for objects as they vary in the probe length:

Known:

A	Distance from Camera to Center of Optical Probe
D	Diameter of Object at Distance A
L(A,D)	Optical Probe Length, Function of A and D
l	Distance from Center of Optical Probe to Location of Object

Find:

D_1	Diameter of Object at Distance A-l
D_2	Diameter of Object at Distance A+ e

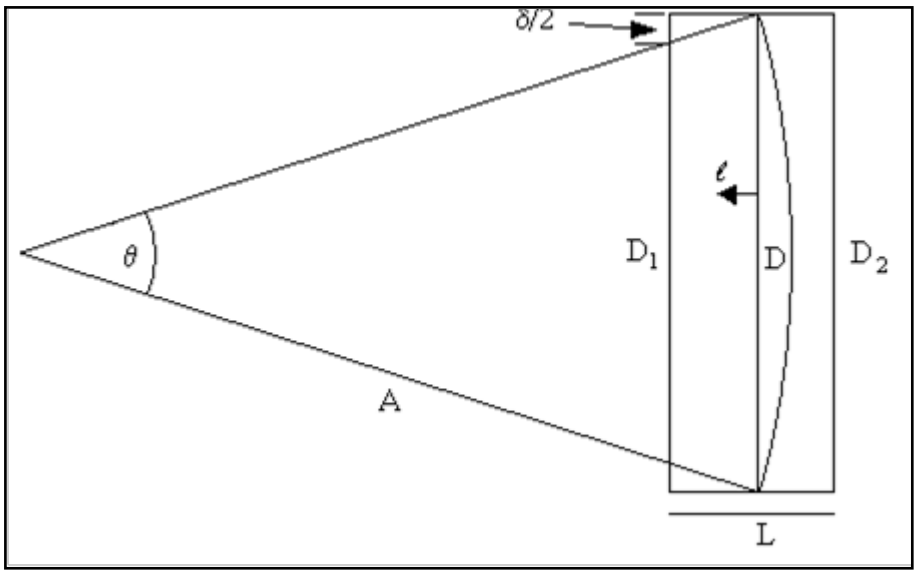

Figure B-14: Schematic of OPL effect

Assume:

A>>D so no curvature of d

$D_1 = D + \delta$

Identity:

$$d = A \cdot \theta \tag{B-37}$$

where:

θ is the angle in radians

So:

$$D_1 = (A-l) \cdot \theta \tag{B-38}$$

$$\frac{D}{A} = \frac{D-\delta}{A-l} \tag{B-39}$$

Rearranging:

$$\delta = l \cdot \frac{D}{A} \tag{B-40}$$

Maximum where l is L/2

$$\delta = \frac{L}{2} \times \frac{d}{A} \tag{B-41}$$

Where δ represents the apparent change in diameter of an object of size D that approaches the camera location by a distance of *l*. The effect of the change in location within the optical probe length is shown below, where Equation B-41 is investigated for a 450 micron circle at the extremes of the optical probe length listed in Table B-13 for a focus parameter of 25.

Using the values

D = 450.45 microns
A = 660 mm (26 in.)
F =15

From Table B-13:

L =13.7 mm

using Equation B-41 (above):

$$\delta = \frac{13.7mm}{2} \cdot \frac{450.45microns}{660mm} = 4.68 \text{ microns} \tag{B-42}$$

At the extreme near and far sides of the optical probe length:

D = 450.45 ± 4.68 microns

This calculation illustrates the intuitive variation with location, but it does not entirely represent the change in size within the probe length. However, it does indicate a small (about 1%) change for a 450 micron circle.

B.3.4.4.2 Effect of Focus on Diameter

If an object moves from the center of the probe length, it appears out of focus to the camera. As an image becomes out of focus it begins to diminish in apparent size because less pixels are determined to be in the image as measured by VisiSizer. When considering a case where the apparent diameter does not change as described in Equation B-41, the effect of moving from the center of the optical probe is a decrease in size. The decrease occurs as the object moves towards and away from the camera in relation to the center of the probe because the image goes out of focus.

B.3.4.4.3 Investigation of VisiSizer Data

The change in measured diameter resulting from moving the reticle circles along the optical probe length is seen in data sequences collected by VisiSizer. Table B-16 lists the corrected diameter of each circle measured at several locations along the optical probe length. The information is collected at 66.0 cm (26 in.) from the camera.

Table B-16: Effect of Traversing OPL on Corrected Diameter [pixels]

Circle Number	Location in OPL (mm)							
	-7.87	**-4.98**	**-2.07**	**0.83**	**3.72**	**6.63**	**9.46**	**12.43**
6			4.523	4.482	3.285			
8		4.864	6.702	6.654	5.881			
10	3.285	7.522	8.563	8.553	8.229	6.219		
12.5	6.540	10.009	10.785	10.935	10.666	9.348	5.034	
15	10.462	12.610	13.106	13.141	12.814	11.973	9.851	
20	16.282	17.298	17.656	17.387	17.295	16.828	15.900	13.417
25	21.397	22.015	22.143	21.872	21.798	21.681	20.956	19.681

The information in Table B-16 has been corrected to remove the measurement bias. The center of the probe is at zero millimeters and the measured diameter decreases for each circle as it moves away from the center of the optical probe length (OPL), where negative distances denote movement towards the camera. Initially the measured size of each circle does not decrease as quickly as when approaching the camera as when it moves away from the camera. This is a result of the two competing effects discussed earlier; the apparent change in size and the effect of being out of focus. The effect can clearly be seen in Figure B-15, where the information in Table B-16 is plotted as the diameter at the center of the OPL minus the local diametrical measurement.

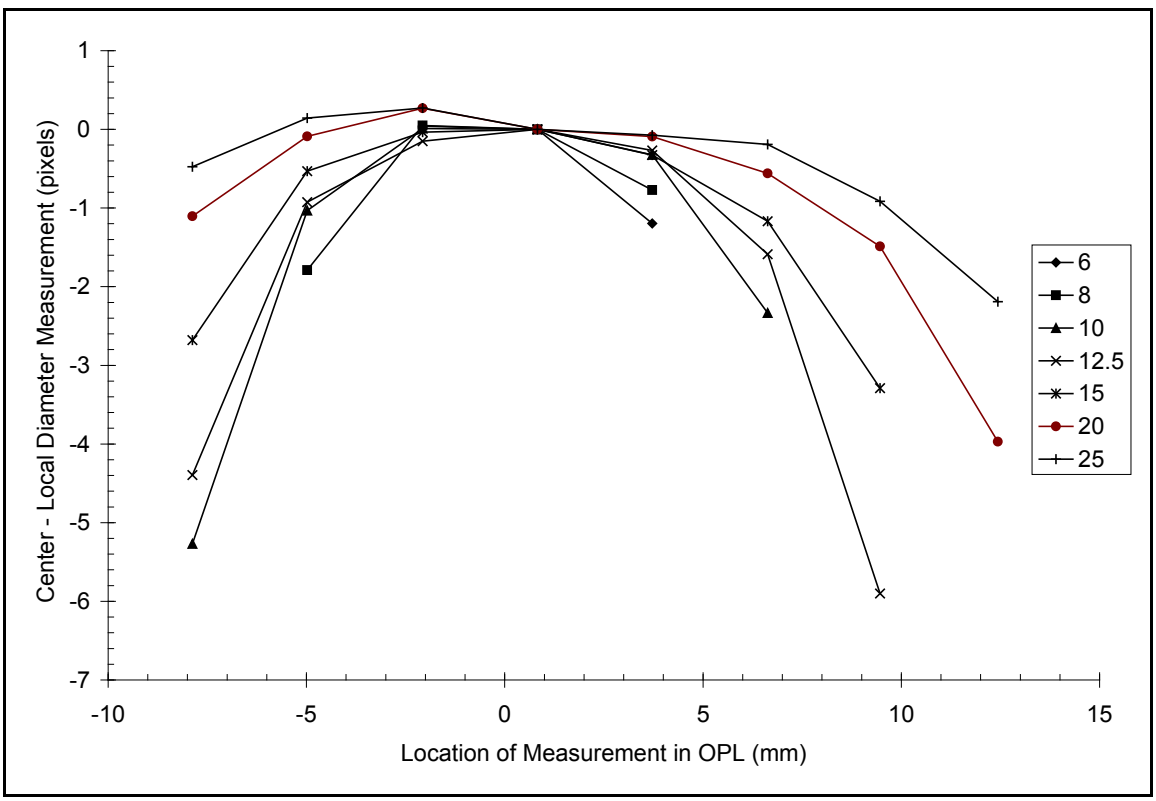

Figure B-15: Difference of Corrected Local Diameter from Diameter at the Center of the OPL

A polynomial best fit of each of the curves in Figure B-15 is developed to characterize the change in size with change in the optical probe location. The curves are listed in Equations B-43 to B-49.

Circle Number:	Equation:	
6	$\Delta d\left(d_6, x\right) = -0.056377x^2 - 0.117970x$	(B-43)
8	$\Delta d\left(d_8, x\right) = -0.044400x^2 - 0.016817x$	(B-44)
10	$\Delta d\left(d_{10}, x\right) = -0.001091x^4 + 0.001048x^3 - 0.01047x^2 - 0.010368x$	(B-45)
12.5	$\Delta d\left(d_{12.5}, x\right) = -0.0007470x^4 + 0.001485x^3 - 0.01295x^2 - 0.001366x$	(B-46)
15	$\Delta d\left(d_{15}, x\right) = -0.0003621x^4 + 0.001465x^3 - 0.01410x^2 - 0.03925x$	(B-47)
20	$\Delta d\left(d_{20}, x\right) = -0.0002179x^4 + 0.001154x^3 - 0.002066x^2 - 0.05398x$	(B-48)
25	$\Delta d\left(d_{25}, x\right) = -0.0001000x^4 + 0.0009038x^3 + 0.002046x^2 - 0.05530x$	(B-49)

where:

$\Delta d\left(d_i, x\right)$ difference of local diameter at x from the diameter at center of circle number i [pixels]

x location in OPL referenced to the center of OPL [mm]

The data shown in Figure B-15 and represented by the polynomial Equations B-43 to B-49 illustrates a bias that results from using a low setting for the focus parameter setting (F). A low setting allows a large optical probe, and the size of droplet images in the probe undergo a decrease in measured diameter as they move away from the center of the probe.

To illustrate the bias, a simple case of data with mono-sized droplets evenly distributed across the OPL is considered. A distribution of droplet sizes is present where the change in size is a result of the location of each droplet in the OPL, assuming no measurement error. The variation in size is more pronounced for sequences which use a low focus parameter (F). A high setting would result in a measured size distribution that is essentially mono-sized, which is the true size of the droplets.

B.3.4.4.4 Bias Correction of OPL Effect

A correction is developed to account for the size of a droplet image decreasing as the image deviates from the center of the OPL. To do this, a probability function $p(d_i, x)$ is defined that describes the probability that a droplet of diameter d_i is found at location x in the OPL. Once the function is defined a correction can be developed where the change of diameter with x is known from Equations B-43 to B-49 and the length of the optical probe is known from Equation B-15. The correction effectively assumes a population of mono-sized droplets and is developed as follows:

known:

$\Delta d\left(d_i, x\right)$ (from Equations B-43 to B-49)

$p\left(d_i, x\right)$ (given)

$L_i = 2.7814 \cdot \ln(d_i) - 2.9075$ (from Equation B-15)

averaging:

$$\Delta \overline{d}_i = \frac{1}{L_i} \int \Delta d\left(d_i, x\right) p\left(d_i, x\right) dx \tag{B-50}$$

integrating from: $-L_i/2$ to $L_i/2$

and:

$$d_{OPLi} = d\left(d_i, 0\right) - \overline{d}_i \tag{B-51}$$

where:

$\Delta \overline{d}_i$ the average deviation from measured diameter at center of OPL [pixels]

$d\left(d_i, 0\right)$ measured diameter at the center of the OPL for size class i

d_{OPLi} corrected diameter which accounts for variaton along the OPL [pixels]

Since Equations B-43 to B-49 are developed from the reticle circles, the assumption of a mono-sized population is accurate. Another assumption is necessary to simplify the analysis. Evaluation of the integral is performed assuming the largest measured diameter occurs in the center of the optical probe length. The assumption is not entirely accurate as can be seen in Figure B-15. The result of using the bias correction for a given measurement sequence of mono-sized droplets with a known distribution results in shifting the mean measured diameter upwards. Once corrected, the mean measured diameter corresponds with the diameter measured at the center of the probe, which is the location of calibration as mentioned in a previous section.

As was discussed previously, no predictions for the probability function $p(d_i, x)$ are available. However, the function can be over-estimated as unity for all d_i and all x. This allows the development of a generalized correction that can be applied to all sizes of droplets. The average deviation can now be found for each of the circles by integrating Equations B-43 to B-49 and finding the average across the probe for each size using the roots in Table B-17:

General Form of Equations

$$\Delta d\left(d_i, x\right) = -A_i \cdot x^4 + B_i \cdot x^3 - C_i \cdot x^2 + D_i \cdot x \tag{B-52}$$

Averaging from -L/2 to L/2 and simplifying

$$\Delta \overline{d}_i = \frac{1}{L}\left[\frac{-2A_i}{5}\left(\frac{L}{2}\right)^5 - \frac{2C_i}{3}\left(\frac{L}{2}\right)^3\right] = \frac{-A_i}{80}L^4 - \frac{C_i}{12}L^2 \tag{B-53}$$

where:

A_i and C_i are found from Table B-17 for circle size i

Table B-17: Calibration Circle Diameters

Circle no.	diameter [microns]	A_i	C_i
6	106.47		-0.056377
8	144.69		-0.044400
10	177.45	-0.0010910	- 0.010470
12.5	223.86	-0.0007470	- 0.012950
15	270.27	-0.0003621	- 0.014100
20	360.36	-0.0002179	- 0.002066
25	450.45	-0.0001000	+0.002046

The data in Figure B-16 is found from Equation B-53 for each circle size to determine the average deviation for that circle.

The data has been fit with a line to define a generalized bias correction. The best fit equation in Figure B-16 is listed, along with the bounds for the equation:

Range: 0 to 24.6 pixels

$$\Delta \overline{d}_i = 0.024267 \cdot d_i - 0.597671 \tag{B-54}$$

Above 24.6 pixels in diameter (492 microns (19.68 mils), assuming R=20 microns (0.8 mils) per pixel) the effect of location variation within the OPL is not significant. This is because the reduction in measured size that results in the bias is insignificant along the optical probe length of large images. The best-fit equation can be used to correct data from a sequence of mono-sized, evenly distributed droplet measurements when the diameter of the droplets is known in pixels at the center of the optical probe length. To correct the population, subtract the average deviation found from Equation B-54 for the diameter from the measured mean size of the sequence.

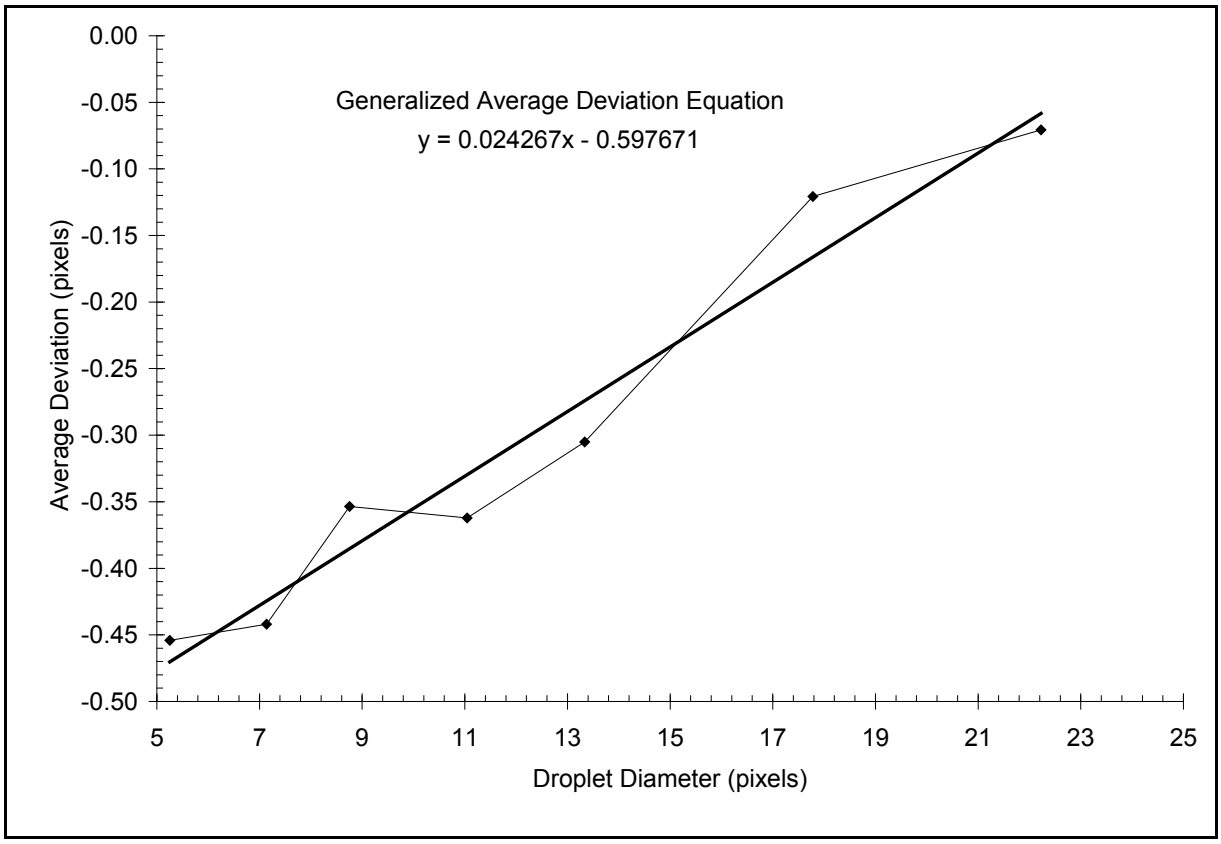

Figure B-16: Average Deviation of Randomly Distributed Population from Actual

The bias correction has been developed for a limited case with mono-sized droplets and a fixed–random distribution of the droplets in the optical probe. Without knowledge of the exact size and location of droplets in a reflood experiment, no bias correction is possible. However, the bias has been shown to only affect droplets smaller than 24.6 pixels in diameter. Assuming a 20.0 microns (0.8 mils) per pixel conversion ratio, the largest droplet affected by the variation in the optical probe length is a 500 micron (20 mils) droplet. Therefore, the effect is not significant for most of the droplet sizes expected in the RBHT facility and can be neglected.

B.3.4.5 Variation of Illumination Intensity

A series of sequences have been collected in which the laser illumination is varied to simulate absorption of the laser light in steam flow during a reflood experiment in the RBHT facility. Under steady state conditions the effect of laser absorption is inconsequential because it can be removed with careful calibration. Since the vapor phase undergoes significant temperature changes during a reflood experiment however, the vapor density, thus laser absorption, changes. The effect of changes in laser intensity are investigated to determine the overall effect on the accuracy of VisiSizer results.

This investigation bounds the expected conditions within the RBHT facility during an experiment, but exact information on the illumination intensity is not available. Figure B-17 shows the measured diameter in pixels for a range of pulse duration settings. The data has been corrected to remove the measurement bias.

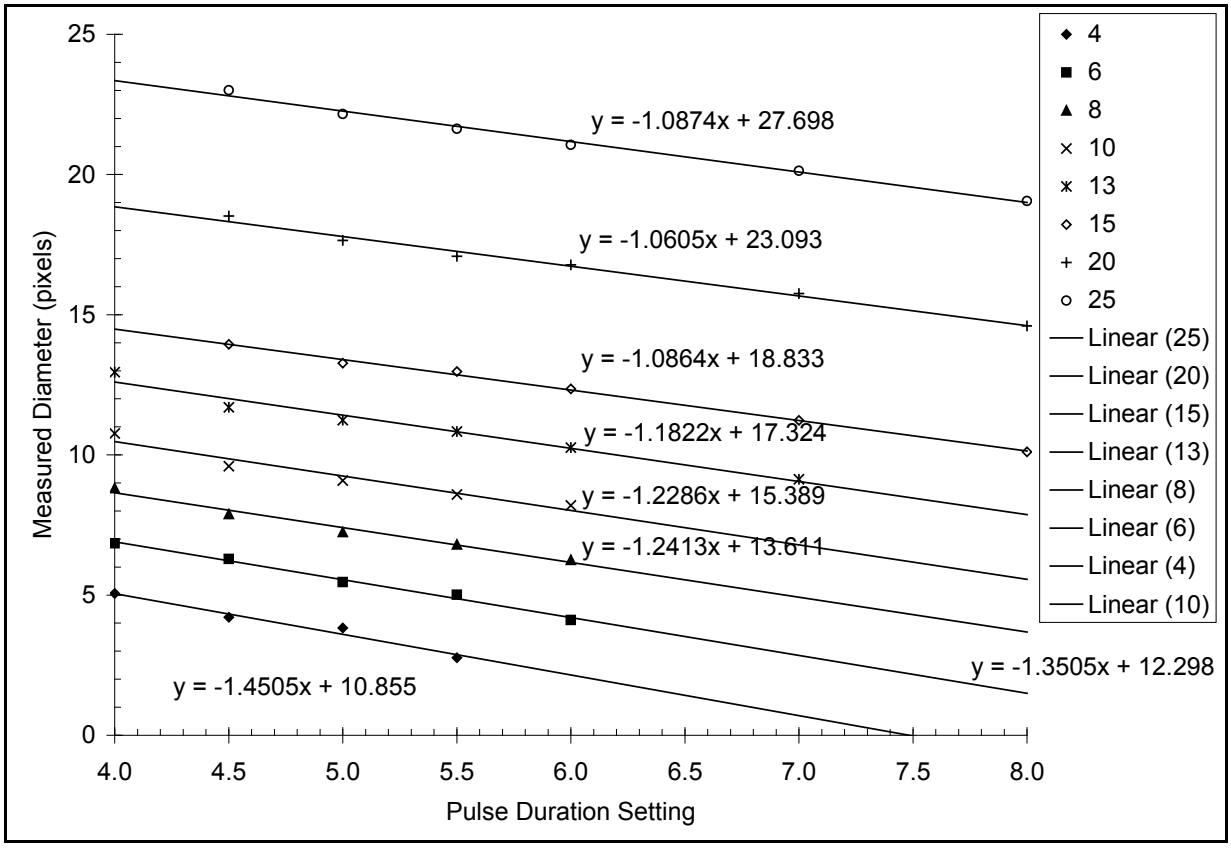

Figure B-17: Effect of Laser Intensity on Diameter Measurement

The diameter change is linear with changes in illumination intensity. This is a significant finding because any changes that affect the illumination intensity during a reflood experiment will not affect the overall distribution of droplet measurements in relation to one another. The distribution will only have an overall increase or decrease in size with respect to the initial calibration.

Currently no method is available to measure the illumination intensity or the relative change in intensity from frame to frame with VisiSizer. A simple bias correction can be developed for frames of data if a method becomes available to measure the change in illumination intensity from the calibration frame.

The results presented in Figure B-17 are collected using the reticle circles and are not entirely prototypical of what occurs with water droplets. Water droplets are semi-transparent and suffer from an over-exposure effect that the opaque circles do not undergo.

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11. ABSTRACT (200 words or less)
As part of the Nuclear Regulatory Commission safety analysis computer code development efforts, the Rod Bundle Heat Transfer (RBHT) test facility has been designed and constructed at The Pennsylvania State University. The test series described in this report is the steam cooling tests with droplet injection. A total of 85 steady-state steam cooling experiments with prescribed droplet injection was performed in the RBHT. The purpose of the experiments was to examine steady-state dispersed flow film boiling in prototypical rod bundle geometry for computer code model development and validation. The Rod Bundle Heat Transfer facility is a full length, 3.66 m (12 ft.), 7 by 7 rod array with typical Pressurized Water Reactor rod diameters of 9.49 mm (0.374 in.) and a rod pitch of 12.59 mm (0.496 in.). The heater rods have a top skewed power shape with a peak to average power of 1.5 at the 2.74 m (9 ft.) elevation. The RBHT facility has been designed using prototypical mixing vane spacer grids. The bundle inlet steam Reynolds number ranged from 2000 to 15,000 with most of the experiments at the lower Reynolds number range. The droplets were injected upward in the center of the sub-channels at the 1.295 m (51 in.) elevation using two or four injection tubes. The injection tubes used a single row, linear hole pattern of four holes per sub-channel and four sub-channels per tube in the center of the bundle. One additional hole was located at the center of the rod gap location to minimize the chance of local

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