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Emission Test Report

National Institute of Standards and Technology
Gaithersburg, Maryland

EMISSION TEST REPORT

FOR

MINERAL DRIFT EMISSIONS TESTING OF A COOLING TOWER CHROMIUM NESHAPS DEVELOPMENT

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
STEAM AND WATER CHILL PLANT
GAITHERSBURG, MARYLAND

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1.0 INTRODUCTION

During the week of July 13 to 19, 1990, Entropy Environmentalists, Inc. (Entropy) conducted an emission measurement program on a comfort cooling tower at the National Institute of Standards and Technology (NIST, formerly NBS) in Gaithersburg, Maryland. The testing program was conducted under contract to the U. S. Environmental Protection Agency's (EPA) Emission Measurement Branch (EMB) (Contract No. 68D90055, Work Assignment No. 25).

The emission test program at NIST included testing to: (1) determine the accuracy and the precision of the EPA's draft Cooling Tower Drift Emission Test Method[1] (CT Drift Method) and (2) provide supporting data for a possible chromium National Emission Standard for Hazardous Air Pollutants (NESHAP). The draft CT Drift Method involves the isokinetic collection of cooling tower drift. Cooling tower drift emissions are expressed as the percent of water flow through the tower that exits the fan cell in the form of water droplets and aerosols. These drift emissions are collected in an acidic impinger solution which is analyzed for elements (minerals) present and detectable by inductively-coupled argon plasma spectroscopy (ICAP). The draft CT Drift Method assumes that the relative mineral concentrations present in the cooling water are the same as for the cooling tower drift captured using the draft method. By identifying several common indicator minerals present in the cooling tower drift, the other minerals and their relative concentrations can be extrapolated from the results of a cooling water sample analysis. When these calculated values are linked to water flow rates, mineral emission rates can be determined for any cooling water constituent of interest.

The Marley-designed, comfort cooling tower used primarily for air conditioning was chosen for testing because it is outfitted with Munters D-15 high-efficiency drift eliminators (HEDE's). The tower tested was in good condition and operating under design load. In addition, the tower design allowed easy access to the fan cell outlets and the testing personnel were able to make unobstructed cell traverses. The tower is located near Building 302 of the NIST steam and water chill plant. A more detailed description of the cooling tower is presented in Section 2.0 of this report.

Coordinating the testing program were the following key personnel: Mr. Bill Kirk, the Entropy Project Manager; Mr. Dan Bivins of the U.S. EPA,

Emission Measurement Branch (EMB), Project Officer; Mr. Ron Myers of the U.S. EPA, Industrial Studies Branch (ISB), Project Officer; and Mr. Allen Federline, Site Manager, National Institute of Standards and Technology. Other testing program participants are listed in Appendix F.

This interim report covers the first of three similar testing programs to be conducted to characterize cooling tower emissions. Subsequent testing will be similarly reported. At the conclusion of all the testing programs, a final report will summarize the data collected, and the findings will be used to prepare a draft method for quantifying cooling tower mineral drift emissions.

The test results are reported and discussed in Section 3.0. Section 4.0 outlines the sampling procedures and the testing locations. Data assessment is discussed in Section 5.0, followed by Quality Assurance and Quality Control in Section 6.0. Appendix A to this document contains the test results and example calculations. Appendix B contains the field and analytical data. Appendix C presents the sampling and analytical procedures used. Calibration and quality assurance data are contained in Appendix D. Process data are found in Appendix E, and the test participants and observers are presented in Appendix F.

2.0 PROCESS AND CONTROL EQUIPMENT OPERATING PARAMETERS

The National Institute of Standards and Technology (NIST) operates a Marley-designed comfort cooling tower built by the Foster Wheeler Company at their facility in Gaithersburg, Maryland. The cooling tower provides comfort cooling as well as cooling for laboratory ovens, lasers, etc. The cooling tower consists of four crossflow sections, all equipped with Munters D-15 high-efficiency drift eliminators. Each section includes a 30-foot diameter fan cell stack with a fan driven by a separate motor. The fan motors can be set at either a high or low speed. The motors on the cells being tested were set at the high speed throughout the testing program.

The cooling water flow rate to each section during testing was approximately 7930 gallons-per-minute (gpm). The water is pumped through a single riser to a distribution manifold, and gravity fed to a covered water trough under the cooling tower decking. The evaporation rate for the cooling tower was approximately 0.25 million gallons per day (mgd).

The tower was built in 1966. Recently, new decking, fans, stacks, windwalls, and mist eliminators have been installed. Access to the top of the tower is by stairs, and electrical power is accessible on the top of the cooling tower deck. The specific dimensions and other pertinent information for the cooling tower are listed below:

Height to top of tower, feet:	32.0
Height from top of tower to top of fan stack, feet:	6.0
Number of riser cells:	4
Number of fan cells:	4
Dimension of tower (width x length), feet:	44 x 66
Diameter of cell stacks, feet:	22.0
Airflow capacity of each fan, cfm (highest speed):	≈1,500,000
Recirculating water flow rate, each cell, mgd:	12.67

The cooling tower water reservoir holds approximately 360,000 gallons, with approximately 250,000 gallons of makeup water added each day. The cooling water treatment program involves using a biocide solution containing disodium cyanodithioimdocarbonate (7.35%) and potassium methyldithiocarbonate (10.15%)

added at a rate of 6.5 gallons per week. Molybdates and polyacrylates are also used to treat the cooling water. Nutmeg Chemical Company in New Haven, Connecticut supplies the water treatment chemicals and services the cooling tower. Figure 2-1 is a schematic of the NIST cooling tower.

The cooling tower operating parameters were monitored during the emission testing by Mr. Ron Myers of ISB, and Mr. Dan Bivins of EMB, U. S. EPA. Recirculating water flow rate in the riser pipes, airflow, inlet and outlet water temperatures, blowdown, and makeup water flow rates were monitored by plant technicians and logged using a process computer. These two resources provided the database for the process parameters used in the final drift calculations. Meteorological data collected included ambient wet bulb and dry bulb temperatures, ambient humidity, wind speed, and wind direction. The general guidelines for Cooling Tower Institute thermal efficiency and drift testing were followed whenever possible (see Appendix C).

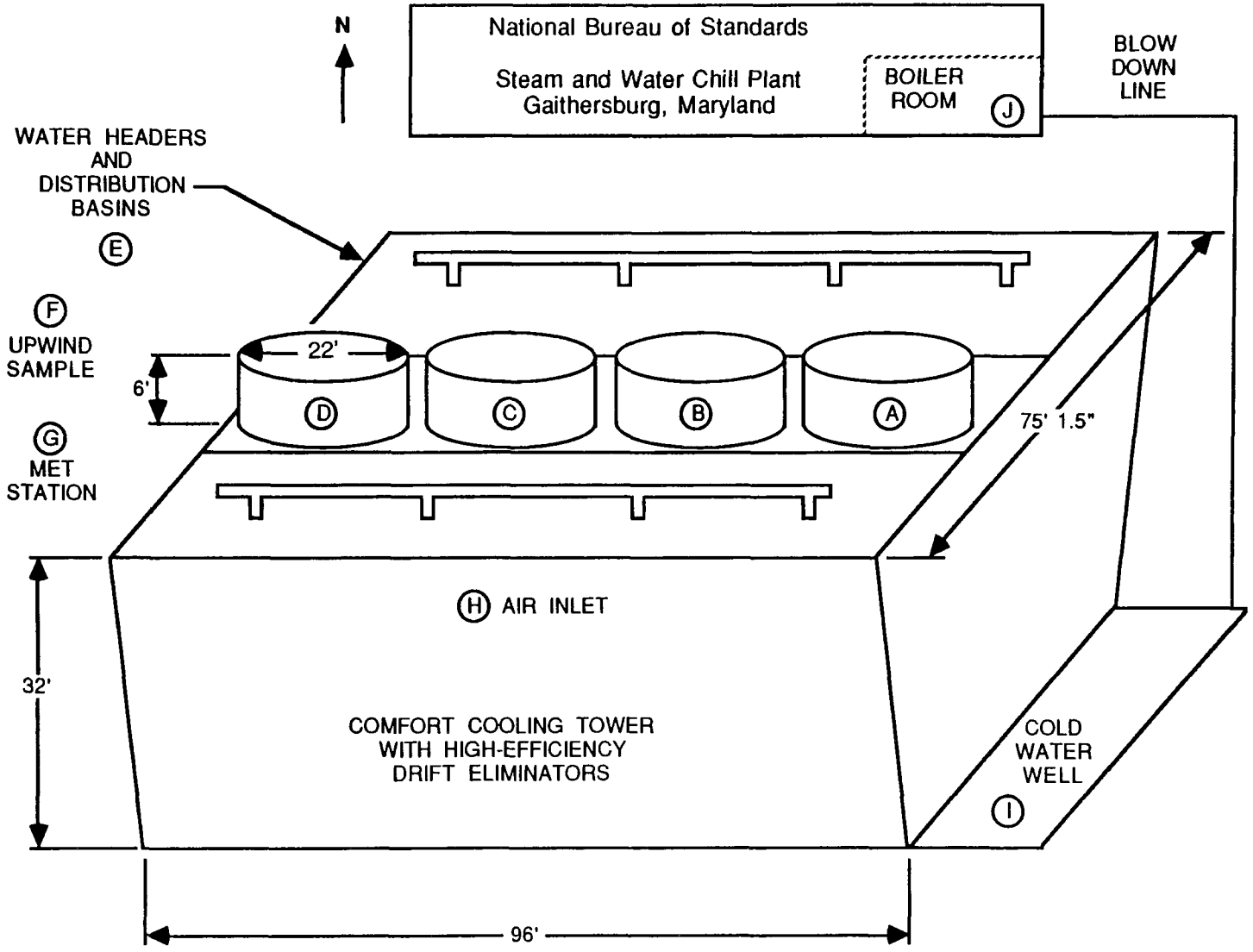


Figure 2-1. Schematic of Marley Comfort cooling tower with Munters D-15 high efficiency drift eliminators.

3.0 RESULTS AND DISCUSSION

A field testing program was conducted to determine the mass emission rates, and drift rates in percent, of thirty-two elements (minerals) from four fan cells with high-efficiency drift eliminators on a steam and chill plant cooling tower. The EPA's Draft CT Drift Method was used to determine the emission rates. This method uses a modified EPA Method 13B-type impinger train, with a back-up filter, attached to a high-volume sampling system. Table 3-1 presents the test schedule.

Twelve of the thirty-two target elements were detected in both the cooling water and in the emission samples: calcium (Ca), magnesium (Mg), sodium (Na), strontium (Sr), titanium (Ti), manganese (Mn), aluminum (Al), zinc (Zn), chromium (Cr), iron (Fe), copper (Cu) and boron (B). The first four elements Ca, Mg, Na, Sr - are commonly used to measure emission rates of cooling towers.[2,3] The average percent mineral drift calculated for these four elements, 0.007 percent, was consistent with previous test data for cooling towers equipped with high-efficiency drift eliminators (see Section 3.3).[2,3,4,5]

Sampling was conducted using both high-volume and low-volume metering systems to collect the emission samples. The drift rates determined by using the two systems were not statistically different (see Section 3.6).

When conducting isokinetic sampling at cooling towers, an S-type pitot is typically used to align the sampling nozzle under cyclonic flow conditions. During this field test, a tell-tail, a narrow pennant used to indicate wind direction at the top of a sailboat mast, was attached near the nozzle to visually align the sampling nozzle prior to final adjustment using the pitot-tube. Nozzle angles determined by using the two techniques were not statistically different (see Section 3.7).

3.1 PERCENT MINERAL DRIFT

Percent mineral drift is a widely accepted unit used for characterizing cooling tower emissions. It is determined by analyzing both the stack emissions and cooling water for one or more elements. Percent mineral drift is defined as the percent of elements or contaminants in the cooling tower water that exit the cooling tower in the form of air emissions:

TABLE 3.1. TESTING SCHEDULE FOR NIST COOLING TOWER

Date (1990)	Sample Type	Fan Cell 1		Fan Cell 2		Fan Cell 3		Fan Cell 4	
		Run No.	Test Time	Run No.	Test Time	Run No.	Test Time	Run No.	Test Time
7/09	CTD* Hi Vol CTD Lo Vol			C2-CTD-1* C2-CTD-2	1452-2036 1450-2034	C3-CTD-1 C3-CTD-2	1454-2028 1452-2025		
7/10	CTD Hi Vol CTD Lo Vol	C1-CTD-1 C1-CTD-2	0932-1904 0930-1904	C2-CTD-3 C2-CTD-4	0927-1902 0925-1900				
7/11	CTD Hi Vol CTD Lo Vol			C2-CTD-5 C2-CTD-6	0937-1629 0935-1637	C3-CTD-3 C3-CTD-4	0934-1535 0932-1540		
7/12	CTD Hi Vol CTD Lo Vol			C2-CTD-7 C2-CTD-8	0917-1541 0915-1939			C4-CTD-1 C4-CTD-2	0919-1627 0918-1626

*CTD is the abbreviation for the CT Drift Method.

$$\text{Percent Drift} = \frac{\text{Emission Conc. (mg/dscm) x fan cell flow (dscm/hr)}}{\text{Water Conc. (mg/L) x water flow (L/hr)}} \times 100$$

Assuming that the relative concentrations present in the cooling water are the same as for the drift emissions, the percent drift for one element can be used to calculate mass emission rates for all elements present in the cooling water.

Emission concentrations were determined by isokinetically sampling the emissions at the exit stack of the cooling tower. Two sample portions were collected: (1) the impinger reagent and rinses of the impinger train and sampling probe and (2) the backup filter placed prior to the silica gel impinger. Analysis of these two portions yielded a total catch for each element, which was divided by the volume of the gas sampled.

Concentrations of the target elements were determined for a composite sample of cooling tower water consisting of periodic grab samples collected while isokinetic sampling was in progress. Stack flow rates were determined using the pitot tube pressures and alignment angles recorded for the sampling traverse of the fan cell stack. Water flow rates were determined from readings taken by the cooling tower personnel, and included corrections for auxiliary flows such as blowdown rates and makeup water.

3.2 ELEMENTS AND SAMPLES USED FOR THE ANALYSIS OF PERCENT DRIFT

Thirty-two target elements were selected for analysis in the cooling tower water and drift emission samples (see Table 3.2). These target elements were analyzed using inductively-coupled argon plasmography (ICAP) by two separate laboratories, Research Triangle Institute (RTI) and University of Missouri (U of MO). The analytical results reported by the University of Missouri were consistently higher (averaging 12% higher) than those reported by the Research Triangle Institute (see results in Appendix A). The same trend was seen for analysis of audit samples, with U of MO reporting values 1 percent to 5 percent higher than those of RTI, but closer to the actual audit values (see Appendix A and Section 6.2). With few exceptions, however, the differences in the data were not significant.

TABLE 3.2. STATUS OF ELEMENTS USED FOR DETERMINATION OF COOLING TOWER DRIFT

Thirty-two Target Elements	Elements Not Detected	Elements Within 5X of Det. Limit	Elements Used for Analysis	(Concentration in excess of 5X the detection limit)
Silver	Silver	Barium	Calcium	
Aluminum	Arsenic	Potassium	Magnesium	Alkali and
Arsenic	Beryllium	Molybdenum	Sodium	Alkali Earth
Boron	Bismuth	Phosphorous	Strontium	Metals
Barium	Cadmium			
Beryllium	Cobalt		Titanium	
Bismuth	Tungsten		Manganese	
Calcium	Lithium		Aluminum	
Cadmium	Antimony		Zinc	Transition
Cobalt	Lead		Chromium	Metals
Chromium	Nickel		Iron	
Copper	Selenium		Copper	
Iron	Silicon			
Potassium	Tin		Boron	Semimetal
Tungsten	Thallium			
Lithium	Vanadium			
Antimony				
Magnesium				
Manganese				
Sodium				
Molybdenum				
Phosphorous				
Lead				
Nickel				
Selenium				
Silicon				
Tin				
Strontium				
Titanium				
Thallium				
Vanadium				
Zinc				

Of the 32 elements analyzed, 16 were not detectable by ICAP (see Table 3.2). Four elements yielded inconclusive results because their concentration levels were less than five times the analytical detection limit. The remaining 12 elements were used to establish drift rates, emission concentrations, and for statistical comparisons: calcium, magnesium, sodium, strontium, titanium, manganese, aluminum, zinc, chromium, iron, copper and boron (see Tables 3.3 and 3.4). The results of the cooling water analyses conducted by U of MO (see Table 3.5) were used to calculate the drift rates presented. Calcium, magnesium, sodium, and strontium, are highly-reactive, alkali and alkali earth metals and are the elements commonly used to determine cooling tower emission rates.[2,3] Transition metals have valence electrons in more than one shell and are noted for their variability in oxidation state; the transition and semimetals (see Table 3.4) have undergone only limited study in relation to cooling tower emissions testing.[2]

During the last two days of the field test (Runs 3 and 4), the sample lines in the CT Drift trains used to sample Fan Cell 2 were changed from Teflon to PVC. Samples from these trains showed consistently higher concentrations, ranging from 50 percent to 400 percent higher, for many of the target elements. These data were eliminated from subsequent statistical analysis and were not used in establishing drift rates.

3.3 DRIFT RATES BASED ON THE ALKALI AND ALKALI EARTH METALS

The alkali and alkali earth metals have been commonly used as indicator elements to calculate cooling tower drift emissions because of their relatively high concentration in both the cooling water and drift emissions. The drift rates calculated using the four alkali/alkali earth elements detected for this field test ranged from 0.001 percent to 0.026 percent, with an average over all samples of 0.007 percent (see Figure 3-1).

This drift rate compared favorably with previously reported cooling tower drift values, which ranged from 0.002 percent to 0.01 percent for the same elements emitted from cooling towers using high-efficiency drift eliminators.[2] The data from the current test are improved, however, in relation to the variability expressed in terms of the relative standard deviation (RSD). Past attempts to establish drift rates for cooling towers have yielded RSD's over

Table 3.3. Summary of percent Drift Results, Alkali/Alkali Earth Metals

Fan No.	Type	Run No.	Date	Percent Drift								
				Calcium		Magnesium		Sodium		Strontium		Boron
				UoM	RTI	UoM	RTI	UoM	RTI	UoM	RTI	RTI
2	CTI/HI	1	7/09/90	0.006	0.001	0.007	0.007	0.016	0.002	0.010	0.009	0.005
2	CTI/LO	2			0.002		0.002		0.002		0.012	0.007
3	CTI/HI	1		0.009	0.002	0.011	0.010	0.021	0.003	0.012	0.011	0.011
3	CTI/LO	2		0.010		0.009		0.026		0.014		
2	CTI/HI	3	7/10/90	0.005	0.001	0.006	0.005	0.011	0.002	0.009	0.006	0.007
2	CTI/LO	4			0.001		0.007		0.002		0.007	
1	CTI/HI	1		0.005	0.002	0.005	0.008	0.008	0.001	0.004	0.005	0.010
1	CTI/LO	2		0.007		0.008		0.014		0.010		
2	CTI/HI	5	7/11/90	0.006	0.002	0.004	0.004	0.005	0.001	0.006	0.005	0.005
2	CTI/LO	6			0.001		0.010		0.001		0.009	0.013
3	CTI/HI	3*										
3	CTI/LO	4*										
2	CTI/HI	7	7/12/90	0.006	0.001	0.007	0.006	0.008	0.001	0.006	0.005	0.004
2	CTI/LO	8			0.002		0.011		0.002		0.012	0.011
4	CTI/HI	1*										
4	CTI/LO	2*										
	Average			0.007	0.002	0.007	0.007	0.014	0.002	0.009	0.008	0.008
	Rel. Std. Dev.			27%	28%	31%	41%	52%	42%	36%	34%	41%

Average Overall Percent Drift 0.007

*NOTE: Contamination was apparent in some elements of these runs: instead of selective use of numbers, all the data from these sample trains were note used in this report.

Table 3.3. Summary of Percent Drift Results, Transition Elements

Fan No.	Type	Run No.	Date	Percent Drift							
				Aluminum		Chromium		Copper		Iron	
				UoM	RTI	UoM	RTI	UoM	RTI	UoM	RTI
2	CTI/HI	1	7/09/90	6.213	2.574	7.610	1.998	1.079	0.817	1.668	1.032
2	CTI/LO	2			1.780		2.318		1.020		1.067
3	CTI/HI	1		2.086	3.081	4.922	2.372	1.078	0.989	1.419	1.448
3	CTI/LO	2		6.587		3.564		1.325		1.353	
2	CTI/HI	3	7/10/90	6.870	7.424	4.902	5.957	0.424	0.346	1.807	2.159
2	CTI/LO	4			6.505		5.188		0.465		2.062
1	CTI/HI	1		5.087	3.252	1.268	2.374	0.272	0.341	1.228	1.884
1	CTI/LO	2		4.485		5.465		0.749		5.382	
2	CTI/HI	5	7/11/90	13.385	8.626	13.515	3.872	1.394	0.500	6.129	2.666
2	CTI/LO	6			16.480		3.983		0.683		8.673
3	CTI/HI	3									
3	CTI/LO	4									
2	CTI/HI	7	7/12/90	5.041	5.098		6.576	1.506	0.780		6.792
2	CTI/LO	8							0.808		
4	CTI/HI	1									
4	CTI/LO	2									
	Average			6.219	6.091	5.892	3.848	0.978	0.675	2.712	3.087
	Rel. Std. Dev.			53%	75%	66%	45%	47%	37%	77%	88%

Table 3.3. Summary of Percent Drift Results, Transition Elements

Fan No.	Type	Run No.	Date	Percent Drift					
				Manganese		Titanium		Zinc	
				UoM	RTI	UoM	RTI	UoM	RTI
2	CTI/HI	1	7/09/90	2.492	2.068	1.179	1.108	2.768	2.764
2	CTI/LO	2					0.598		2.901
3	CTI/HI	1		2.089	1.544			4.232	3.254
3	CTI/LO	2		15.865		0.484		4.790	
2	CTI/HI	3	7/10/90	4.085	3.158	0.494	0.579	1.251	1.002
2	CTI/LO	4			0.644		1.299		3.295
1	CTI/HI	1		6.113	9.257	0.571	0.782	1.267	0.724
1	CTI/LO	2		1.613				0.642	
2	CTI/HI	5	7/11/90	2.016	1.670	0.179	0.256		
2	CTI/LO	6			0.711		0.532		12.205
3	CTI/HI	3							
3	CTI/LO	4							
2	CTI/HI	7	7/12/90	6.711	1.406	0.517	0.394	6.688	5.118
2	CTI/LO	8			0.989		3.083		10.078
4	CTI/HI	1							
4	CTI/LO	2							
	Average			5.123	2.383	0.571	0.959	3.091	4.593
	Rel. Std. Dev.			93%	113%	58%	90%	72%	86%

Table 3.4. Summary of Emission Concentration Results, Alkali/Alkali Earth Metals

Fan No.	Type	Run No.	Date	Concentration (ug/DSCM) Calcium UoM	Calcium RTI	Magnesium UoM	Magnesium RTI	Sodium UoM	Sodium RTI	Strontium UoM	Strontium RTI	Boron RTI
2	CTI/HI	1	7/09/90	18.81	3.60	6.11	5.77	27.22	2.54	0.16	0.15	0.37
2	CTI/LO	2			4.83		1.74		3.98		0.19	0.51
3	CTI/HI	1		23.14	6.45	8.83	7.95	31.43	4.54	0.18	0.16	0.74
3	CTI/LO	2		26.71		7.54		39.05		0.20		
2	CTI/HI	3	7/10/90	10.79	3.32	4.25	3.59	14.34	2.13	0.11	0.08	0.49
2	CTI/LO	4			2.62		5.02		2.72		0.09	
1	CTI/HI	1		10.95	4.25	3.06	4.79	9.60	1.73	0.05	0.06	0.66
1	CTI/LO	2		15.42		5.41		16.92		0.12		
2	CTI/HI	5	7/11/90	11.05	3.12	2.72	2.14	6.33	1.04	0.07	0.06	0.33
2	CTI/LO	6			2.70		6.12		1.60		0.11	0.88
3	CTI/HI	3*										
3	CTI/LO	4*										
2	CTI/HI	7	7/12/90	13.81	2.29	5.02	4.11	10.68	0.89	0.08	0.06	0.28
2	CTI/LO	8			4.20		7.34		1.95		0.15	0.86
4	CTI/HI	1*										
4	CTI/LO	2*										
	Average			16.34	3.74	5.37	4.86	19.45	2.31	0.12	0.11	0.57
	Rel. Std. Dev.			37%	33%	39%	42%	60%	51%	45%	43%	40%

*NOTE: Contamination was apparent in some elements of these runs: instead of selective use of numbers, all the data from these sample trains were not used in this report.

Table 3.4. Summary of Emission Concentration Results, Transition Elements

Fan No.	Type	Run No.	Date	Concentration (ug/DSCM) Aluminum UoM	Aluminum RTI	Chromium UoM	Chromium RTI	Copper UoM	Copper RTI	Iron UoM	Iron RTI
2	CTI/HI	1	7/09/90	10.27	4.26	1.05	0.28	0.91	0.69	5.91	3.66
2	CTI/LO	2			2.94		0.32		0.86		3.78
3	CTI/HI	1		3.12	4.61	0.62	0.30	0.83	0.76	4.55	4.65
3	CTI/LO	2		9.83		0.45		1.01		4.32	
2	CTI/HI	3	7/10/90	4.18	4.52	0.21	0.26	0.17	0.14	2.03	2.43
2	CTI/LO	4			3.96		0.23		0.18		2.32
1	CTI/HI	1		2.82	1.80	0.05	0.09	0.10	0.12	1.26	1.93
1	CTI/LO	2		2.49		0.22		0.27		5.51	
2	CTI/HI	5	7/11/90	5.45	3.51	0.70	0.20	0.30	0.11	3.98	1.71
2	CTI/LO	6			6.71		0.21		0.15		5.57
3	CTI/HI	3									
3	CTI/LO	4									
2	CTI/HI	7	7/12/90	1.70	1.72		0.21	0.38	0.20		2.68
2	CTI/LO	8					0.29		0.20		6.35
4	CTI/HI	1									
4	CTI/LO	2									
	Average			4.98	3.78	0.47	0.24	0.50	0.34	3.94	3.51
	Rel. Std. Dev.			67%	41%	73%	28%	73%	88%	44%	45%

Table 3.4. Summary of Emission Concentration Results, Transition Elements

Fan No.	Type	Run No.	Date	Concentration (ug/DSCM) Manganese UoM	Manganese RTI	Titanium UoM	Titanium RTI	Zinc UoM	Zinc RTI
2	CTI/HI	1	7/09/90	0.81	0.67	0.65	0.61	2.61	2.61
2	CTI/LO	2					0.33		2.74
3	CTI/HI	1		0.62	0.46			3.62	2.78
3	CTI/LO	2				0.24		4.08	
2	CTI/HI	3	7/10/90	0.61	0.47	0.21	0.25	0.64	0.52
2	CTI/LO	4			0.10		0.56		1.70
1	CTI/HI	1		0.83	1.26	0.22	0.31	0.60	0.34
1	CTI/LO	2		0.22		2.71		0.30	
2	CTI/HI	5	7/11/90	0.25	0.21	0.07	0.10	2.24	1.69
2	CTI/LO	6			0.09		0.20		1.05
3	CTI/HI	3							
3	CTI/LO	4							
2	CTI/HI	7	7/12/90	0.88	0.18	0.21	0.16	0.63	0.48
2	CTI/LO	8			0.13		1.27		0.95
4	CTI/HI	1							
4	CTI/LO	2							
	Average			0.60	0.40	0.62	0.42	1.84	1.49
	Rel. Std. Dev.			45%	96%	153%	86%	82%	65%

TABLE 3.5. SUMMARY OF RESULTS FOR COOLING WATER ANALYSIS

Run No.*	Calcium Conc. (ppm)	Calcium % in Filtrate	Magnesium Conc. (ppm)	Magnesium % in Filtrate	Sodium Conc. (ppm)	Sodium % in Filtrate	Strontium Conc. (ppm)	Strontium % in Filtrate
Run 1	369.27	99.8	109.29	99.7	205.32	99.8	2.03	99.0
Run 2	378.28	99.7	113.13	99.9	213.20	99.9	2.09	99.7
Run 3	357.97	99.7	108.18	99.8	203.33	99.8	1.99	99.8
Run 4	370.80	99.8	111.14	99.9	211.32	99.8	2.08	99.8

Run No.*	Aluminum Conc. (ppm)	Aluminum % in Filtrate	Boron Conc. (ppm)	Boron % in Filtrate	Chromium Conc. (ppm)	Chromium % in Filtrate	Copper Conc. (ppm)	Copper % in Filtrate
Run 1	0.203	0.0	9.333	99.6	0.017	0.0	0.104	85.0
Run 2	0.098	0.0	11.498	99.1	0.007	0.0	0.064	92.0
Run 3	0.071	0.0	12.256	98.7	0.009	0.0	0.038	78.5
Run 4	0.054	0.0	12.000	98.3	0.005	0.0	0.040	86.9

Run No.*	Iron Conc. (ppm)	Iron % in Filtrate	Manganese Conc. (ppm)	Manganese % in Filtrate	Titanium Conc. (ppm)	Titanium % in Filtrate	Zinc Conc. (ppm)	Zinc % in Filtrate
Run 1	0.435	21.2	0.040	74.3	0.068	81.3	0.116	42.4
Run 2	0.181	33.1	0.024	85.0	0.069	84.3	0.083	48.3
Run 3	0.112	26.8	0.022	91.4	0.066	83.2	0.015	0.0
Run 4	0.063	0.0	0.021	96.4	0.066	92.9	0.015	0.0

*In the case of cooling tower water samples, the run number reflects the test day the sample was collected.

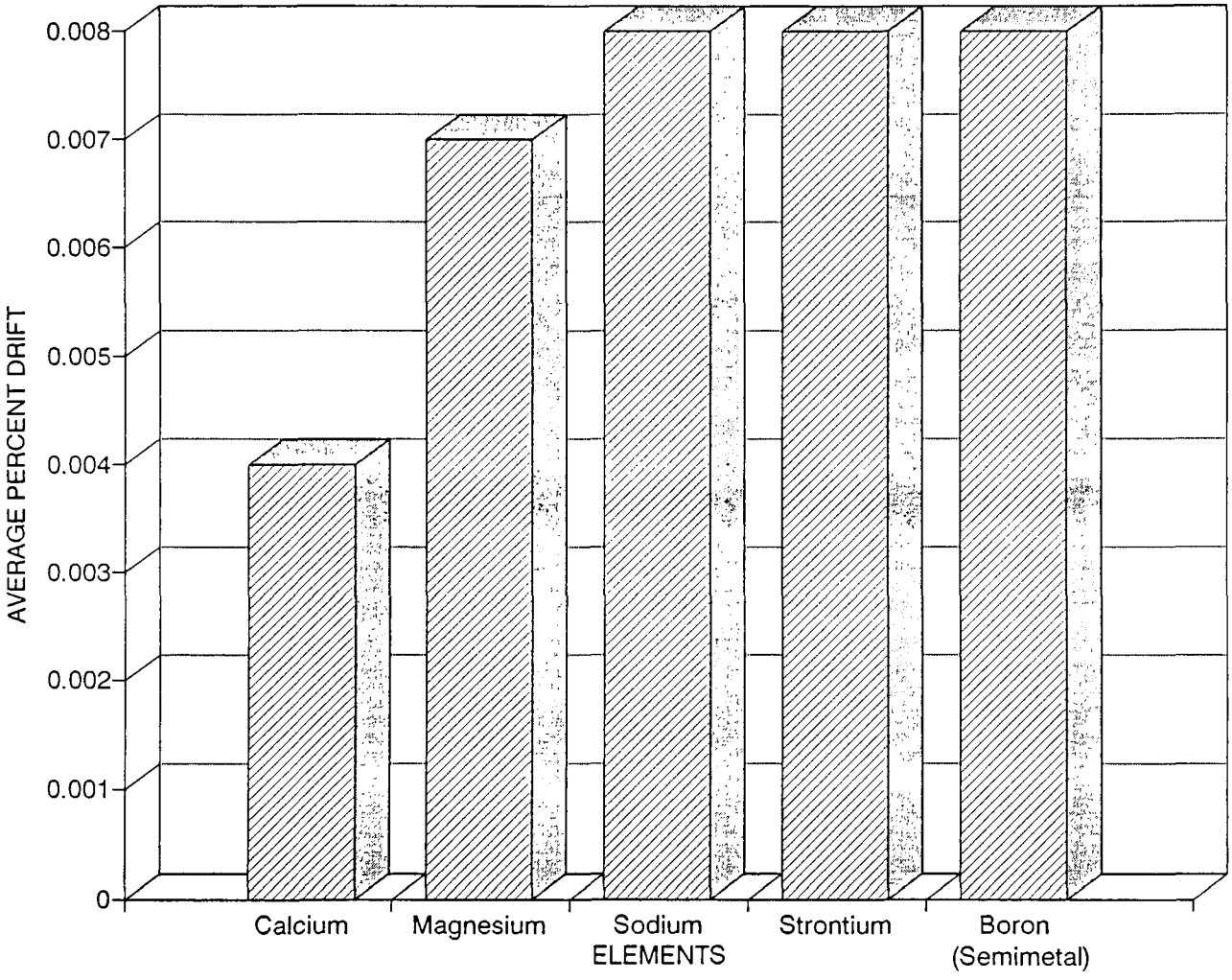


Figure 3-1. Average percent drift for alkali/alkali earth elements.

200 percent. The RSD's calculated for the alkali/alkali earth elements for this study ranged from 27 percent to 52 percent. As depicted in Figure 3-2, the day-to-day (or run-to-run) differences were usually within one standard deviation of the average.

Figure 3-3 provides a graphical view of the cell effects. Fan Cell 2 was tested during all four runs. Data from Fan Cell 3, collected on day 1, and data from Fan Cell 1, collected on day 2, were not statistically different from data collected on Fan Cell 2 during those same days.

3.4 DRIFT RATES OF TRANSITION METALS

Figure 3-4 presents drift rates based on the twelve elements analyzed. The average drift rate for the seven transition metals, 3.3 percent, is approximately 500 times greater than that for the four alkali metals, which is 0.007 percent. Limited data from previous cooling tower drift tests indicate that this trend has been noted before.[2] However, because previous efforts included only one or two of these elements, the high drift rates were often eliminated as outliers.[2]

The data and experimental procedures were reexamined to determine if there is some inherent reason for this difference. After eliminating data from filters that had high blank values, and correcting for ambient air concentrations of the relevant elements, drift rates based on the transition metals are still significantly higher than those based on the alkali metals. No reason for this difference can be postulated. The relative standard deviations calculated for the transition elements were slightly higher than for the alkali and alkali earth elements, averaging about 63%.

3.5 DRIFT RATES BASED ON SOLUBILITY

There is a strong inverse correlation between the solubility of the elements detected in the cooling water and the drift rate calculated from their concentration in the emission samples. Figure 3-5 graphically displays the average percent mineral concentration in the filtrate (solubility), from Table 3.5, with the average percent drift results presented in Table 3.3. The relationship between percent drift and solubility demonstrates that as the solubility of an element increases, the contribution it makes to the cooling

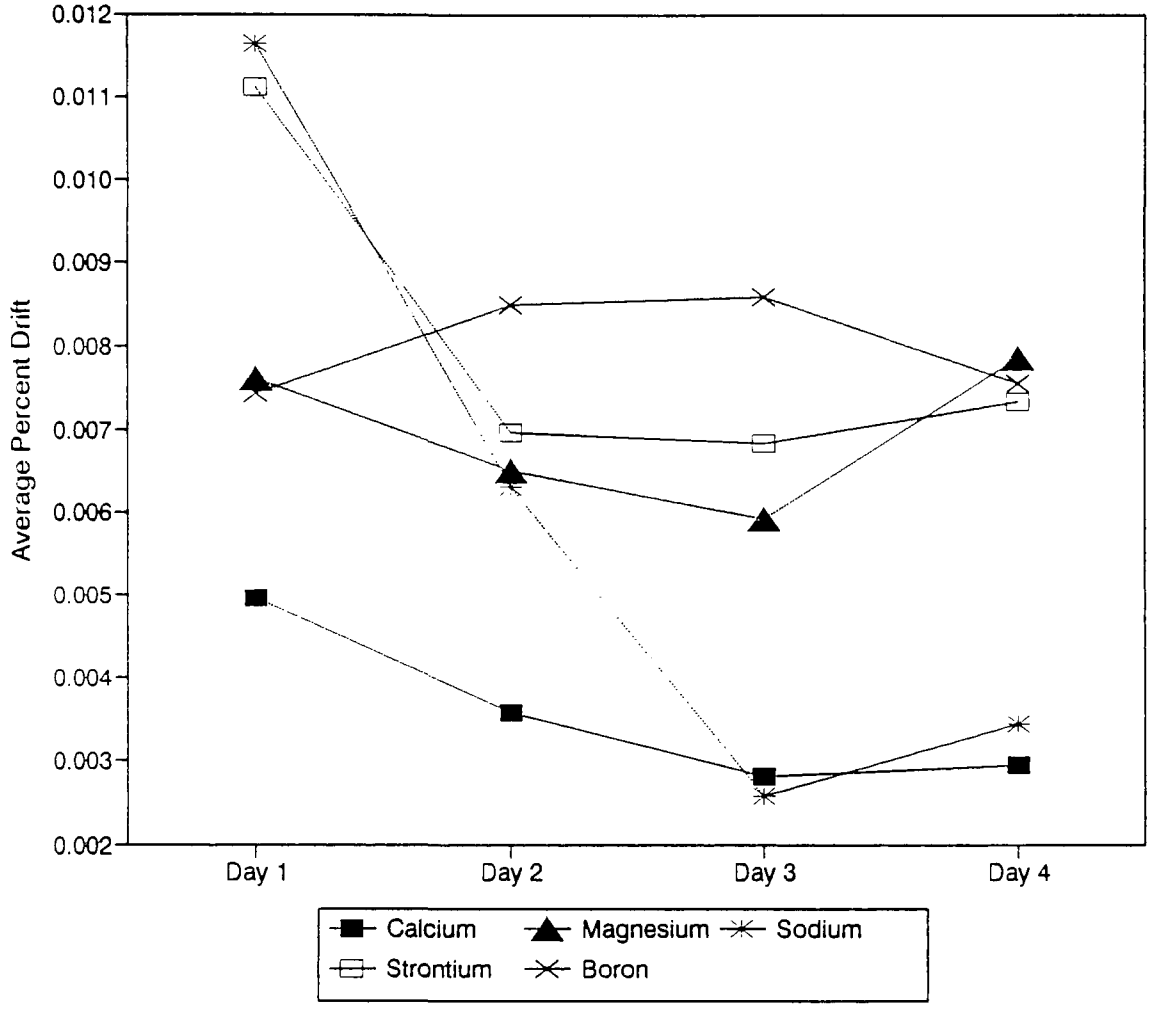


Figure 3-2. Day-to-day effects on percent drift.

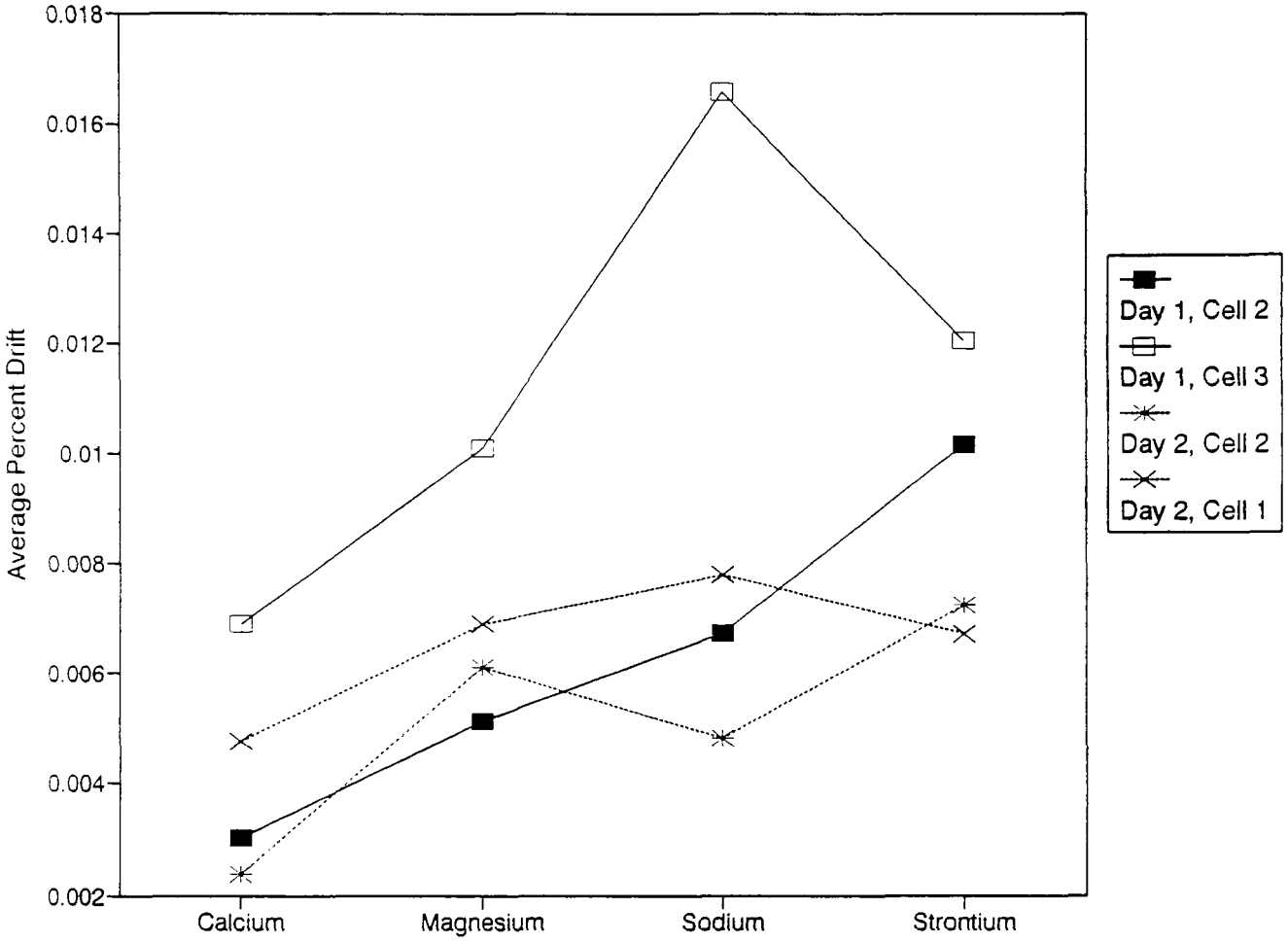


Figure 3-3. Cell effects on percent drift.

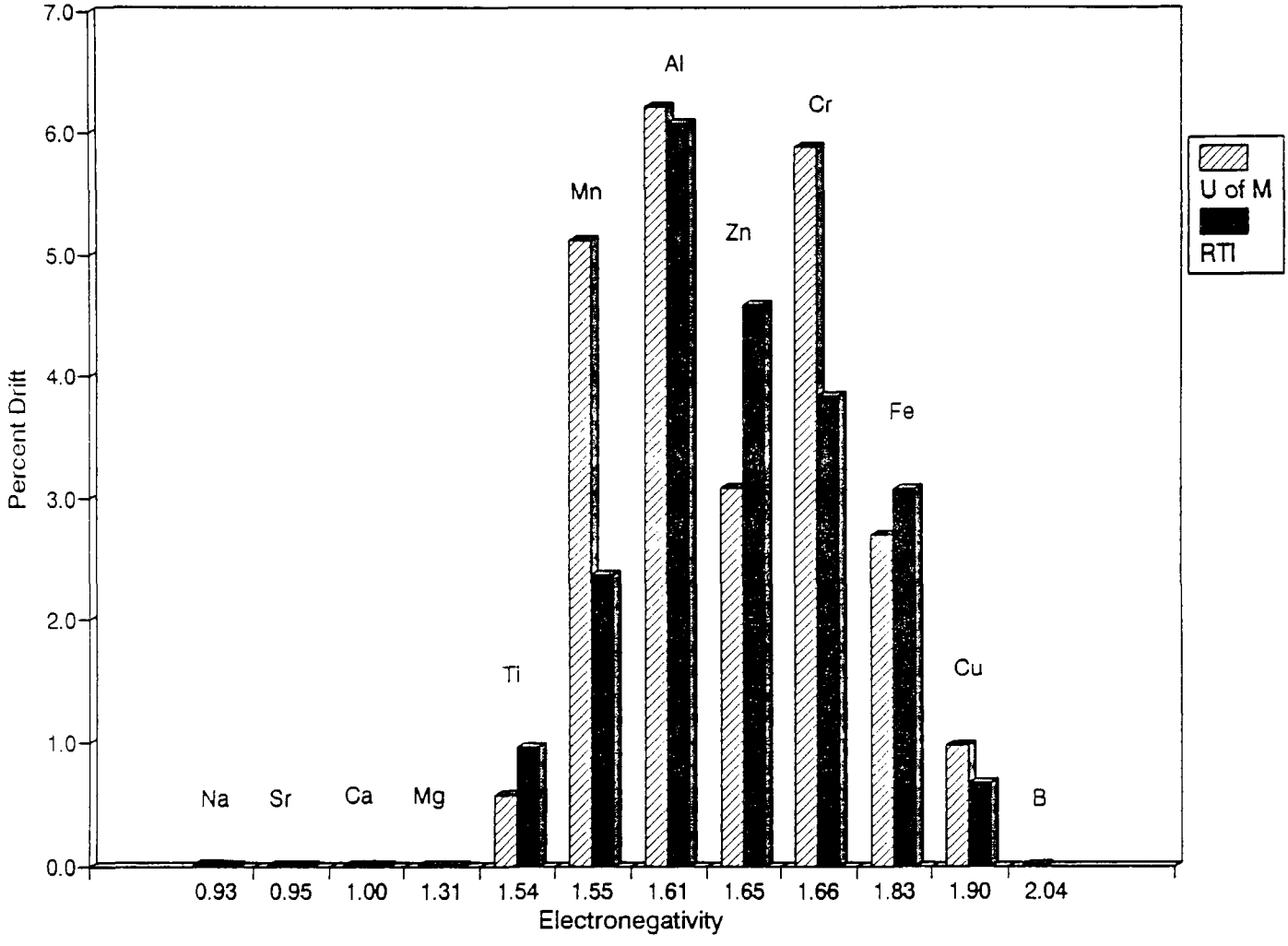


Figure 3-4. Comparison of percent drift of alkali/alkali earth elements and transition elements.

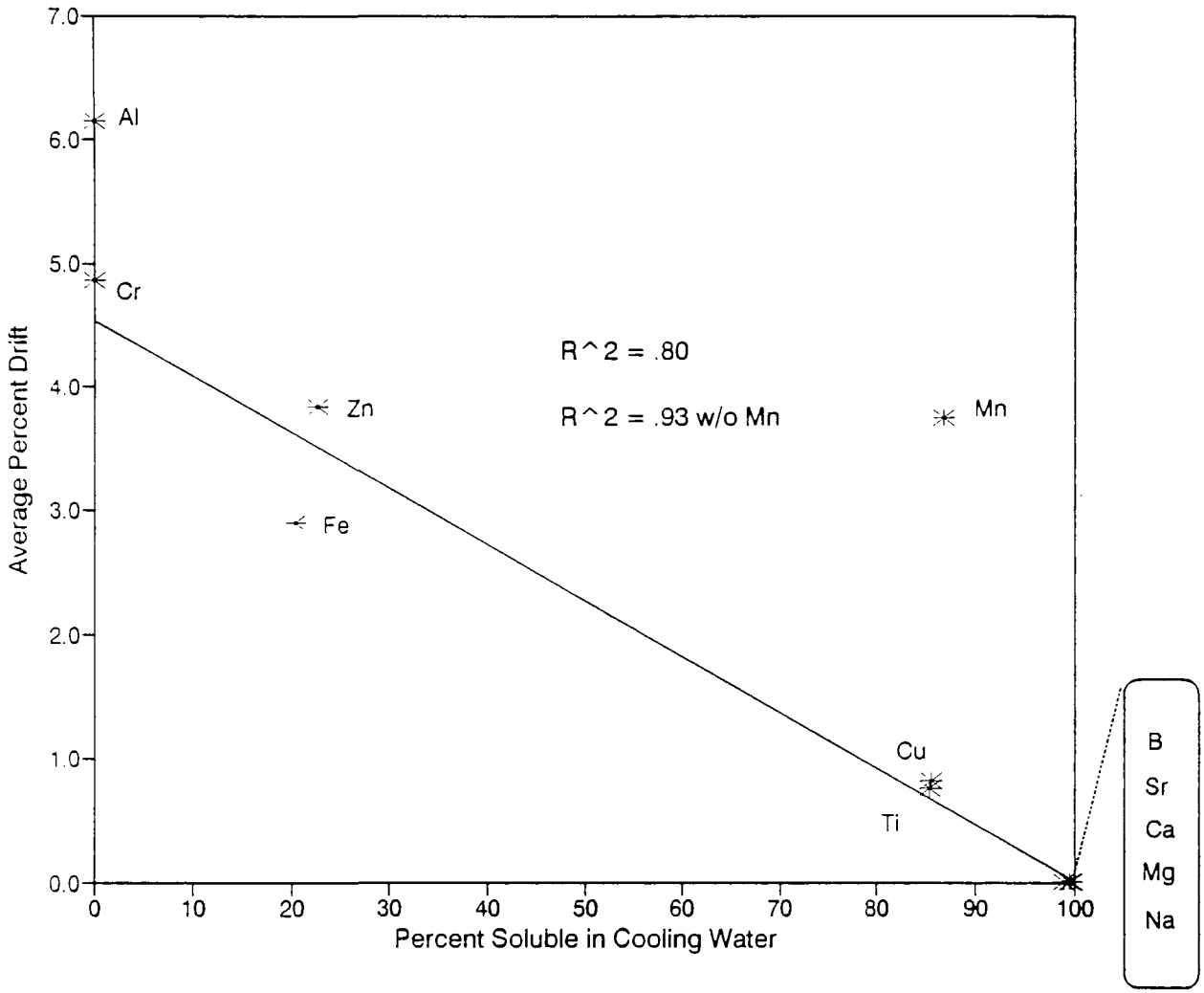


Figure 3-5. Percent drift versus solubility.

tower drift decreases. The strong inverse relationship between solubility and tower drift demonstrated by these data suggests that solubility must be considered in the selection of indicator or surrogate elements.

Previous testing programs have assumed a one-to-one relationship between concentration of the chemical species contained in the cooling water and in the cooling tower drift emissions and have not considered the relationship of solubility to drift emissions.[5] In the test reported in Reference 4, the recirculating water was spiked with lithium bromide (LiBr) as a surrogate indicator for use in determining the cooling tower drift rate. During the testing, the LiBr levels in the cooling water were monitored using a specific ion electrode. Calculated drift rates from this test of 0.005 percent are consistent with drift rates from the NIST testing presented in Section 3.3 of this report.[5] If the earlier data were plotted on Figure 3-5, the high solubility of the LiBr and the drift rate of 0.005 percent would be in agreement with current results. Subsequent testing programs will further investigate this relationship and the results will be included in the final summary report.

3.6 HIGH-VOLUME VS. LOW-VOLUME METERING SYSTEMS

The CT Drift draft method, because of the relatively low concentrations of emissions from cooling towers, specifies use of a high-volume sample metering system. The high-volume metering system is capable of sampling at four times the rate of a standard Method 5 metering system.

For this test program, paired CT Drift trains were operated, one with the required high-volume metering system and one with a typical Method 5 (low-volume) metering system. In this way, the feasibility of substituting the more readily available low-volume system could be assessed.

Table 3.6 presents a side-by-side comparison of drift emission results obtained using the high- and low-volume systems to sample the alkali metals. The differences in percent drift are well within the standard deviation of all the data, and no trends were observed in either the percent drift or the relative standard deviation of the data.

TABLE 3.6. COMPARISON OF HIGH AND LOW-VOLUME SAMPLING SYSTEMS

Element	Avg. Percent Drift	
	High-Volume System	Low-Volume System
Calcium	0.00237	0.00201
Magnesium	0.00383	0.00436
Sodium	0.00493	0.00437
Strontium	0.00424	0.00565

3.7 TELL TAIL VS. S-TYPE PITOT TUBE FOR NOZZLE ALIGNMENT IN CYCLONIC FLOW

The draft CT Drift method specifies alignment of the sampling nozzle into the cyclonic flow commonly found in cooling tower exit stacks. The CT Drift method, like other sampling methods where the nozzle is aligned with the flow, uses an S-type pitot with one of the two inlets parallel to the nozzle inlet to determine the direction of the cyclonic flow. The sampling nozzle is aligned to the cyclonic flow by rotating the nozzle/pitot assembly until the pressure across the S-type pitot is zero. Because the gas flow is not completely vertical (perpendicular to the exit plane of the stack), sampling times must be adjusted to reflect the vertical gas-flow component. The sampling time for each traverse point is normally calculated by dividing the total sampling time by the total number of points used to sample points. In cyclonic flows, this sampling time for each point is adjusted by multiplying the time component by the cosine of the angle of the nozzle alignment. For example, if the nozzle is adjusted 15° from perpendicular to account for the cyclonic flow, and the sampling time per point is 20 minutes, then 20 minutes is multiplied by the cosine of 15°, to yield a adjusted sampling time of 19 1/3 minutes.

In addition to the specified pitot assembly, this field test incorporated a tell-tail, or ribbon, placed on or near the nozzle to determine the direction of cyclonic flow. The sampling nozzle was aligned by sighting the tell-tail, and rotating the nozzle opening 180° to the tell-tail. The tell-tail was used to make the initial adjustment of the sampling nozzle. The pitot tube was then used to make any final adjustment in the sampling nozzle angle. As Table 3.7 shows, the difference between the angle indicated by the tell-tail and that by

the S-type pitot was relatively small, about 3.5 degrees, with a standard deviation of approximately 2.5 degrees.

A systematic error of 2.5 to 5.0 degrees over the course of a field test could affect sampling times as much as 10%. However, because of the length of the field test (six hours per run), and the inherent imprecision of the isokinetic sampling of cooling towers, about twice of that of typical Method 5-type isokinetic sampling, this type of error would not significantly alter the overall results.

3.8 AMBIENT AIR MINERAL CONCENTRATIONS

Ambient air sampling was done using a Method 5-type sampling system, with the exclusion of a probe. Ambient air was drawn through a filter by the metering system. The filter was later analyzed by ICAP for the requisite thirty-two elements. The results are displayed as Table 3.8.

3.9 METEOROLOGICAL DATA

Meteorological data were obtained through the National Weather Service (NWS) at Dulles International Airport, 15 miles Southwest of the sampling site. Though the data were indicative of the area, the sampling team's instruments showed small variances in barometric pressure and temperature from Dulles' records. A summary of the NWS meteorological data is displayed in Table 3.9.

3.10 CONCLUSIONS AND RECOMMENDATIONS

Drift Calculations

The results indicate that a single percent drift rate can be established for a particular cooling tower. The percent drift rate is determined by isokinetic sampling using a modified CT Drift impinger train, and analysis for two or three of the alkali or alkali earth metals of the collected emission samples along with a representative sample of cooling water. This drift rate can then be used to estimate mass emission rates for other contaminants detected in the cooling water.

TABLE 3.7. TELL TAIL VS. PITOT TUBE FOR NOZZLE ALIGNMENT

Run No. 3			Run No. 4		
Angle (degrees) Tell-Tail	Pitot Tube	Difference (degrees)	Angle (degrees) Tell-Tail	Pitot Tube	Difference (degrees)
45	45	0	20	24	4
14	19	5	15	21	6
9	14	5	15	17	2
18	21	3	19	24	5
20	22	2	21	23	2
50	52	2	69	61	8
26	29	3	42	39	3
20	21	1	26	26	0
28	24	4	24	24	0
29	23	6	18	23	5
20	24	4	21	27	6
50	46	4	65	68	3
35	33	2	22	25	4
28	25	3	21	18	3
22	22	0	20	17	3
26	22	4	16	20	4
18	22	4	26	24	2
62	68	6	77	86	9
23	18	5	49	52	3
18	15	3	30	32	2
21	16	5	20	21	1
25	24	1	16	18	2
29	18	11	16	20	4
65	59	6	50	53	3
Average Difference:		3.7			3.50
Standard Deviation:		2.37			2.21

TABLE 3.8. AMBIENT AIR MINERAL CONCENTRATION - JULY 10-12, 1990*

Date	July 10			July 11			July 12				
Element	ppm	Total Catch	ug/acf	ppm	Total Catch	ug/acf	ppm	Total Catch	ug/acf	Filter Blank	Average ug/acf
Al	2.500	70.00	0.166	2.600	80.00	0.167	2.300	50.00	0.100	1.800	0.144
B		0.00	0.000		0.00	0.000		0.00	0.000		0.000
Ca	1.100	30.00	0.071	1.000	20.00	0.042	1.000	20.00	0.040	0.800	0.051
Cr	0.000	-2.00	0.000	0.000	0.00	0.000	0.050	3.00	0.006	0.020	0.002
Cu	0.170	16.02	0.038	0.078	6.82	0.014	0.120	11.02	0.022	0.010	0.025
Fe	0.320	15.00	0.036	0.330	16.00	0.033	0.510	34.00	0.068	0.170	0.046
Mg	0.190	4.90	0.012	0.190	4.90	0.010	0.240	9.90	0.020	0.141	0.014
Mn	0.020	1.23	0.003	0.020	1.23	0.003	0.020	1.23	0.002	0.008	0.003
Na	0.890	28.00	0.066	0.890	28.00	0.058	0.900	29.00	0.058	0.610	0.061
Sr	0.022	0.40	0.001	0.023	0.50	0.001	0.022	0.40	0.001	0.018	0.001
Ti	0.057	1.90	0.005	0.037	0.00	0.000	0.096	5.80	0.012	0.038	0.005
Zn	0.020	2.00	0.005	0.064	6.40	0.013	0.020	2.00	0.004	0.000	0.007
ACF	421.5			479.4			501.3				

ug/acfm = [(ppm - filter blank) * 100 ml] / ACF; 100 mls is volume of filter digestion solution.

*NOTE: Ambient samples could not be collected on July 9, 1991.

TABLE 3.9. METEROLOGICAL CONDITIONS FOR DULLES INTERNATIONAL AIRPORT; JULY 9 -12, 1991

Date	Time	Station Pressure	Temperature (Dry Bulb, °F)	Humidity (%)	Wind Direction	Wind Speed (kts)	Comments
July 9, 91	1450 - 2030	29.61 - 29.62	98 - 78	46 - 84	S by SW	11 - 7	Hazy
July 10, 91	0930 - 1900	29.67 - 29.59	80 - 88	74 - 63	NW by SW	7 - 10	P. Cloudy
July 11, 91	0930 - 1630	29.67 - 29.67	85 - 71	59 - 87	W	7 - 6	P. Cloudy
July 12, 91	0900 - 1630	29.61 - 29.56	73 - 72	94 - 94	SW	5 - 5	Cloudy

NOTE: All conditions are shown as a range of conditions experienced during that time period as reported by the National Weather Service. Measurements taken by sampling team will vary slightly.

Tell-Tail vs. Pitot Tube for Nozzle Alignment into Cyclonic Flow

The experiments indicated that there was no significant difference between using a tell-tail or S-type pitot for nozzle alignment. Therefore, a tell-tail may be used for nozzle alignment in cyclonic flow.

Cooling Water Analysis

It is recommended that ICAP analysis of the cooling water samples include a preconcentration step (a complexation/coprecipitation reaction). This change in the analysis procedure is inexpensive (between $10 and $20 per sample) and would insure that elements expected to be absent or at low concentrations in the cooling water, such as lead or nickel, are actually absent or at very low levels. It would further eliminate some imprecision in the analysis of elements at concentrations close to the ICAP detection limits and would require less extensive "boil down" procedures.

Modifications to the CT Drift Sampling Method

As discussed previously, no appreciable difference existed between the high-and low-volume sampling methods. Therefore, isokinetic sampling for cooling tower emissions may use a standard Method 5 metering system.

The current CT Drift method requires 0.1 N nitric acid for the impinger reagent and 2.0 N nitric acid to be used for rinses of the sampling system. It is recommended that an experiment be conducted during the next cooling tower test program to assess the suitability of using 1.0 N nitric acid for both the impinger and rinse reagent, and thereby eliminating confusion in sample train preparation and recovery, and allowing the same "lot" of reagent to be analyzed for the blank values. It also is recommended that at least three of the CT Drift trains in the next test program include an extra impinger to assess collection efficiency. Analysis of the backup filters for the next field test should provide additional collection efficiency data. These data may eliminate the necessity for use of an efficiency filter for future tests. In addition, a search should be conducted for an "ultra-low" blank value filter to improve detection limits for these samples.

Ambient Air Sample Collection

Ambient air samples should be taken during each test run. These samples should be collected using the same type of impinger train used to collect samples from the cooling tower. Results for the ambient sampling should not be used to adjust mass emission rates or percent drift values, but may be used to assess levels of elements present in the ambient air.

4.0 SAMPLING AND ANALYTICAL PROCEDURES AND TEST LOCATIONS

This section describes the particular sampling locations (see Figure 2-1) and the sampling and analytical procedures used to determine the drift emissions from the comfort cooling tower at the National Institute of Standards and Technology facility in Gaithersburg, Maryland.

4.1 COOLING TOWER CELL STACK SAMPLING LOCATIONS (SAMPLING LOCATIONS A, B, C, AND D)

Six sampling systems were operated simultaneously on two of the four fan cells of the cooling tower (see Figure 4-1). One fan cell was tested using paired high-volume/low-volume CT Drift sampling trains; the other cell was tested simultaneously using the same paired CT Drift sampling trains. The schedule for the 16 runs conducted over a 4-day period, the sampling methods, and the testing locations is presented in Table 4.1.

The Number 2 fan cell on the tower was sampled during all four runs; the Number 3 cell was sampled during two of the four runs. The Number 1 and 4 cells were each sampled once. There were no observable internal leaks in any of the four fan cells. Table 4.1 presents the test schedule for Fan Cells 1 through 4.

Figures 2-1, 4-2, and 4-3 identify the sampling locations and show the physical layout of the process cooling tower. Figure 2-1 presents the overall dimensions of the cooling tower. Figure 4-2 is a cutaway view of a fan cell stack showing the sample nozzle plane and the testing equipment location. Figure 4-3 represents the top view of a fan cell showing the equal area zones, the traverse points, and the sampling axes.

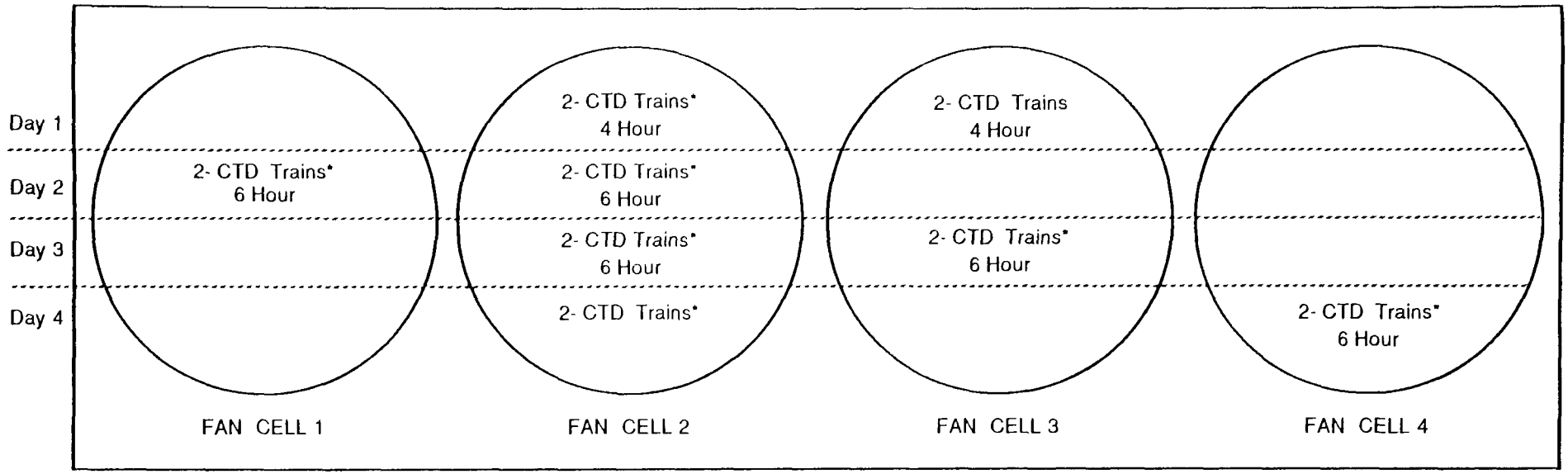
4.2 RECIRCULATING WATER PIPE (SAMPLING LOCATION E)

Recirculating water flow rates to the fan cell distribution basins were determined from flow readings taken by the plant technicians (see Appendix E) and from a process computer that monitored the four condenser flow rates. Chiller water is combined and is then returned to the tower through a single 42-inch riser pipe. Upon exiting the riser, the flow is split into four branches, one for each of the four fan cells. Flow rates through the riser were determined from the process computer and from data supplied by the plant process

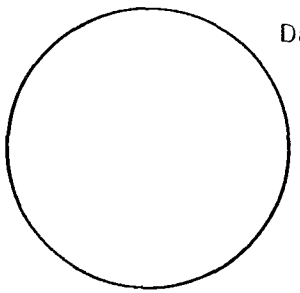
TABLE 4.1. SCHEDULE OF SAMPLING METHODS AND LOCATIONS

Day	Type of Test	Fan Cell 1	Fan Cell 2	Fan Cell 3	Fan Cell 4	Cell No.	Sample Matrix***
1	Two CTD Trains*		4-hr			2	(A & B)
	Two CTD Trains*			4-hr		3	(C & D)
	Ambient Train ****						(G)
	Grab Sample (Cooling Water)		**				(J)
2	Two CTD Trains*		6-hr			2	(A & B)
	Two CTD Trains*	6-hr				1	(C & D)
	Ambient Train						(G)
	Grab Sample (Cooling Water)		**				(J)
3	Two CTD Trains*		6-hr			2	(A & B)
	Two CTD Trains*			6-hr		3	(C & D)
	Ambient Train						(G)
	Grab Sample (Cooling Water)		**				(J)
4	Two CTD Trains*		6-hr			2	(A & B)
	Two CTD Trains*				6-hr	4	(C & D)
	Ambient Train						(G)
	Grab Sample (Cooling Water)		**				(J)

*One CTD (CT Drift) train was operated using a high-volume metering console and the other using a Method 5-type metering console.
**One cooling water grab sample was taken at the beginning of the run, two in the middle, and one at the end of the run.
***From Figures 6, 7, 8, and 10, which are schematics of the sample preparation and analysis.
****The ambient sampling train could not be used on the first day.



Control Room and Turbines: Grab Samples** and Process Data, Days 1-4



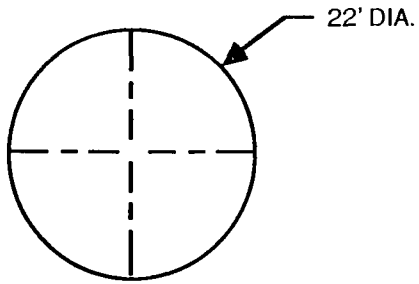
*One CTD train will be operated using a high volume metering console and the other using an EPA Method 5 metering console.

**One cooling water sample will be taken at the beginning of the run, two in the middle, and one at the end of the run.

Figure 4-1. Schedule of sampling methods and locations.

TRAVERSE POINTS

2 AXES
12 POINTS / AXIS
24 TOTAL POINTS



TOP VIEW OF FAN CELL

POINT	% OF DIAMETER	DISTANCE FROM INSIDE WALL (INCHES)*
1	2.1	6.05
2	6.7	19.30
3	11.8	34.00
4	17.7	51.00
5	25.0	72.00
6	35.6	102.53

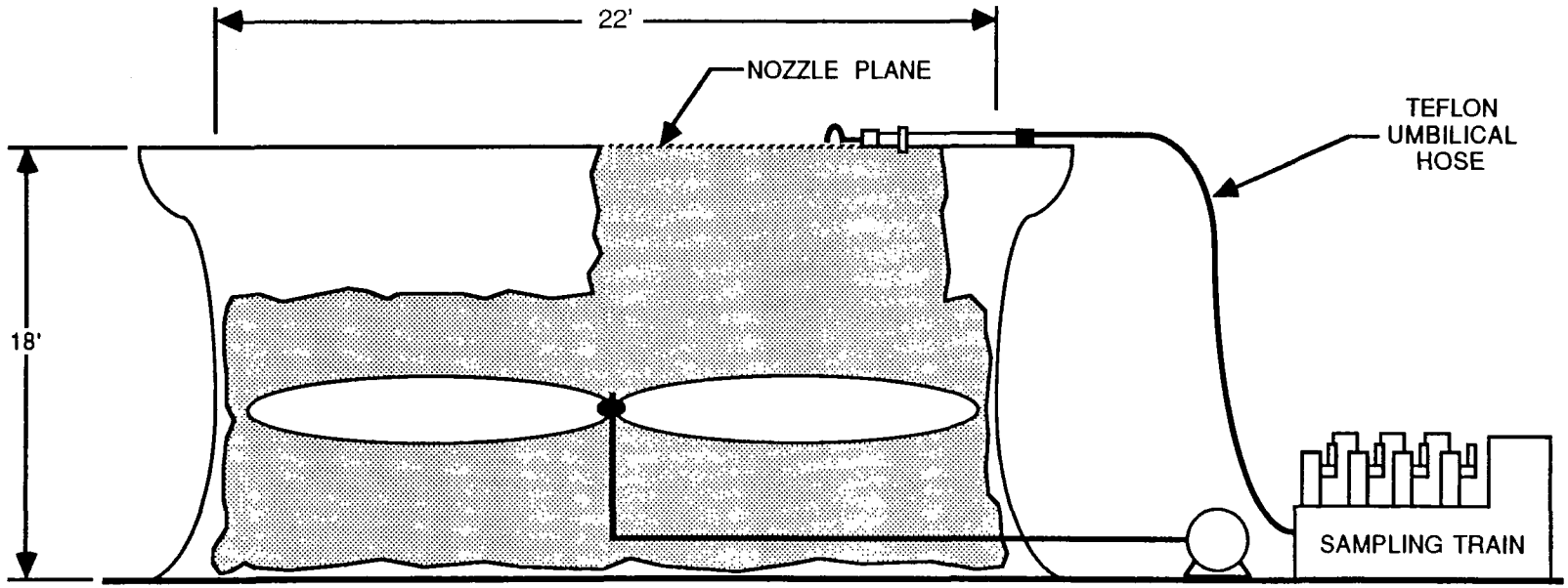
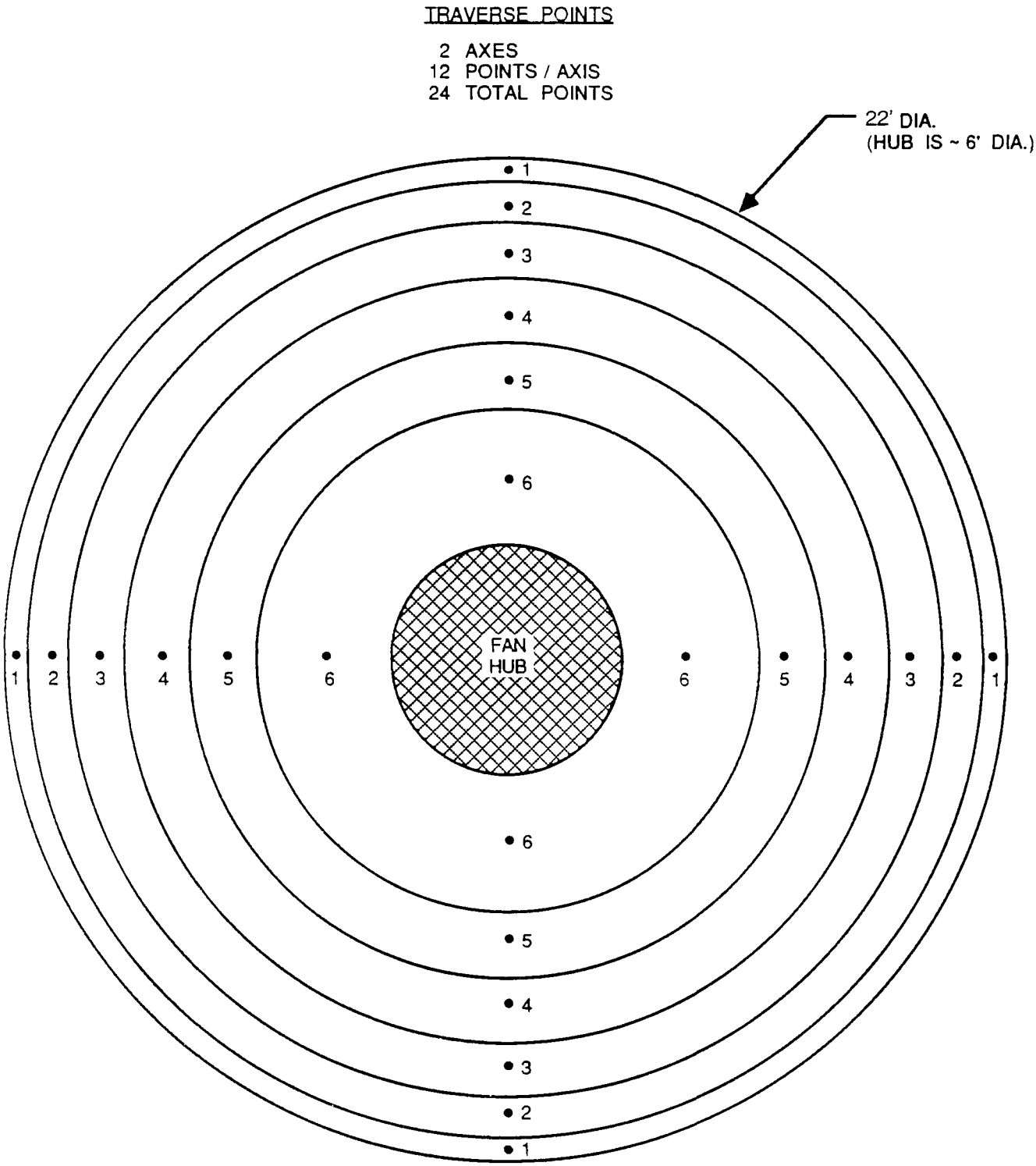


Figure 4-2. Cutaway view of a fan cell stack on the cooling tower at NIST, showing the equipment locations and the nozzle traverse planes.



Points 1 to 6 represent the distance from the inside wall to the center of the equal area zone.

Figure 4-3. Top view of a fan cell showing the sampling axes and traverse points.

technicians. To obtain the flow rate to each individual cell, the measured water flow rate for the one riser water pipe was divided by four, assuming equal distribution to each cell.

4.3 MINERAL CONCENTRATION OF AMBIENT AND COOLING TOWER INLET AIR (SAMPLING LOCATION F)

The mineral content of the ambient air entering the cooling tower was determined using an EPA Method 5-type train. This train was operated continuously at a constant sampling rate during each day of testing, upwind of the cooling tower. The Method 5 train was modified to eliminate the nozzle/probe assembly and the impinger assembly with the front half of the filter holder serving as the air inlet.

The direction of dissipation of the four fan cell plumes was observed to confirm minimal air recirculation between the fan cells.

4.4 AMBIENT AIR METEOROLOGICAL STATION (SAMPLING LOCATION G)

Ambient air meteorological data were obtained from the plant's process data monitoring system for a location upwind of the cooling tower. The system measured local weather conditions, including the ambient wet bulb and dry bulb temperatures, ambient humidity, wind speed, and wind direction.

4.5 DETERMINATION OF VOLUMETRIC AIR FLOW RATES

An alignment procedure was used to determine the volumetric air flow rates for the cooling tower fan cells. This procedure is part of the CT Drift method and involves directing the nozzle of the sampling train directly into the cyclonic flow of the cooling tower fan cell during sampling using pitot tube pressure measurements to determine the correct flow angle. For this test series, when the sampling train was moved to a new traverse point, the flow angle was initially determined using a tell-tail attached to the sampling probe. The exact flow angles were then determined using the S-type pitot attached to the probe. The angles determined using the tell-tail were compared to those determined using the pitot tube.

4.6 COOLING TOWER INSTITUTE DRAFT EMISSION MEASUREMENT METHOD

A copy of the CT Drift draft emission measurement method or CTD method used to measure the drift emissions is presented in Appendix C. Figure 4-4 shows the CT Drift sampling train. The nozzle of the train is aligned directly into the sample gas during sampling. The sample gas flow angle was initially determined using a tell-tail attached to the sampling probe. The exact flow angles were determined using the S-type pitot tubes attached to the probe.

The CTD draft emission measurement method for measuring drift from cooling towers is similar to EPA Method 5 with four major differences: (1) a high-volume metering system is used which draws about 2 to 3 times the sample volume of the Method 5 metering console, (2) a 15- to 20-foot length of Teflon tubing connects the probe exit to the inlet of the first impinger, (3) the nozzle is aligned into the direction of the cyclonic flow with the sampling time adjusted to compensate for this misalignment (see Appendix C, CT Drift Method), and (4) 0.1 N nitric acid is used in the impingers for sample collection and 2 N nitric acid is used for sample recovery.

The high-volume metering consoles specified by the CTD method are not included in any of the EPA test methods. One of the paired CTD trains on each fan cell was operated using a Method 5-type (low-volume) metering console and one using a high-volume metering console to compare the two systems as they sampled the same point simultaneously. If no significant difference is found between drift results using the two systems, consideration will be given to specifying the more readily available Method 5-type equipment in the resulting draft method.

4.7 CT DRIFT SAMPLE ANALYSIS

The CTD method relies on the determination of the mineral content of the cooling tower drift collected by the sampling system. The initial step in the analysis of the collected samples is the reduction of the sample volume to provide measurable analyte concentrations. Because the high-volume metering system drew about twice the sample volume of the standard Method 5 metering system, the total volume of each high-volume impinger sample was reduced to 40 ml while the samples produced using the standard Method 5 system were reduced to 20 ml. Two 10-ml aliquots of each concentrated sample were sent for

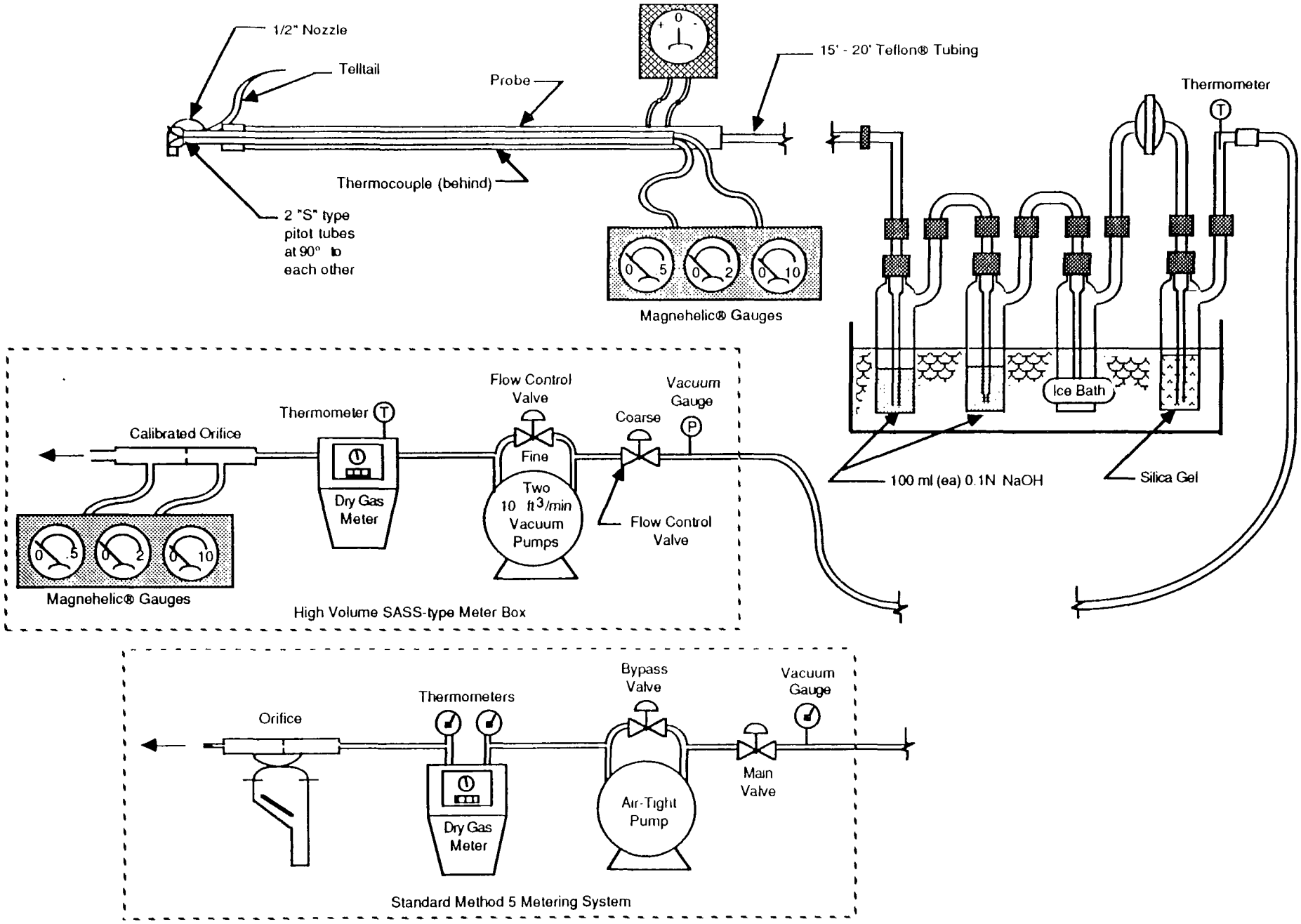


Figure 4-4. Schematic of CTD draft method sampling train.

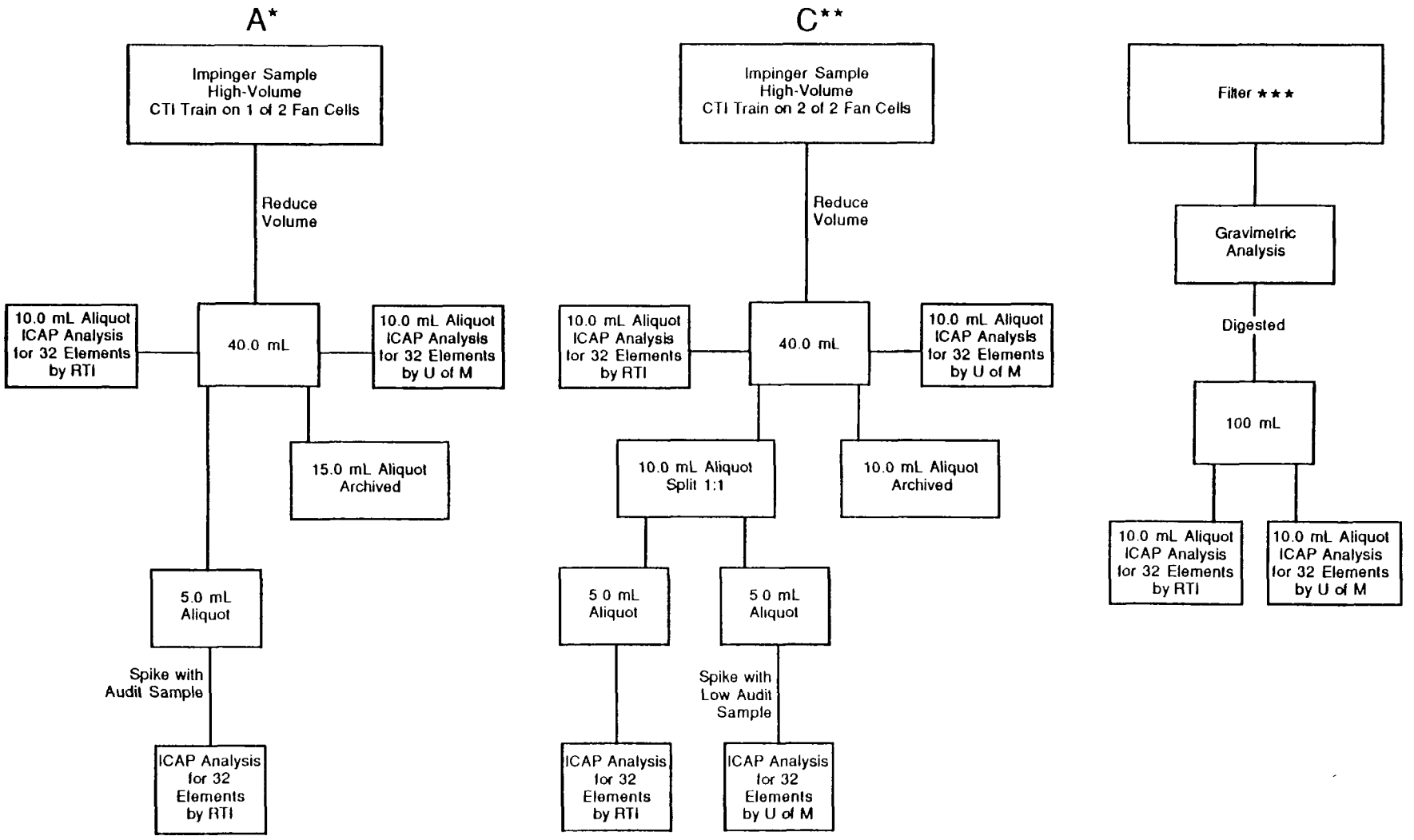
analysis, one to the University of Missouri (U of MO), and the other to Research Triangle Institute (RTI) (see Figure 4-5). The sample analysis was performed by ICAP for 32 elements: Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, K, W, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, V, and Zn. The back-half filters were weighed and then digested using a hydrofluoric-nitric acid solution and then heating the sample solution in a microwave oven. Two 10-ml aliquots were taken from this 100-ml solution. One 10-ml aliquot was sent to RTI and the other to U of MO for ICAP analysis for 32 elements.

Liquid samples from the two low-volume CT Drift trains were reduced to a volume of 20 ml (see Figure 4-6). One 10-ml aliquot was temporarily archived for the same purpose as described previously for the high-volume CT Drift train samples (see Figure 4-6). The other aliquots went to RTI or U of MO for ICAP analysis of the 32 elements of interest. A discussion of data interpretation for the high- and low-volume CT Drift train samples is presented in Section 5.0.

To determine the analytical precision and accuracy, one 10-ml aliquot of sample from the high-volume trains was split into two 5-ml aliquots. One of these 5-ml aliquots was spiked with 5 ml of the cooling water sample collected during that run and the other was spiked with 5 ml of an audit sample, and each pair of aliquots was submitted to one of the two labs for analysis. Since each day's testing included two high-volume sample runs (one on each fan cell), one pair of 5-ml aliquots was analyzed by U of MO and the other pair was analyzed by RTI (see Figure 4-5). The remaining 10-ml from each high-volume run was archived (see Figure 4-5). The results from the minerals analysis were used to calculate the drift emissions in terms of: ul of drift/dscm; ml of drift/hour; and, drift as a percent of water flow.

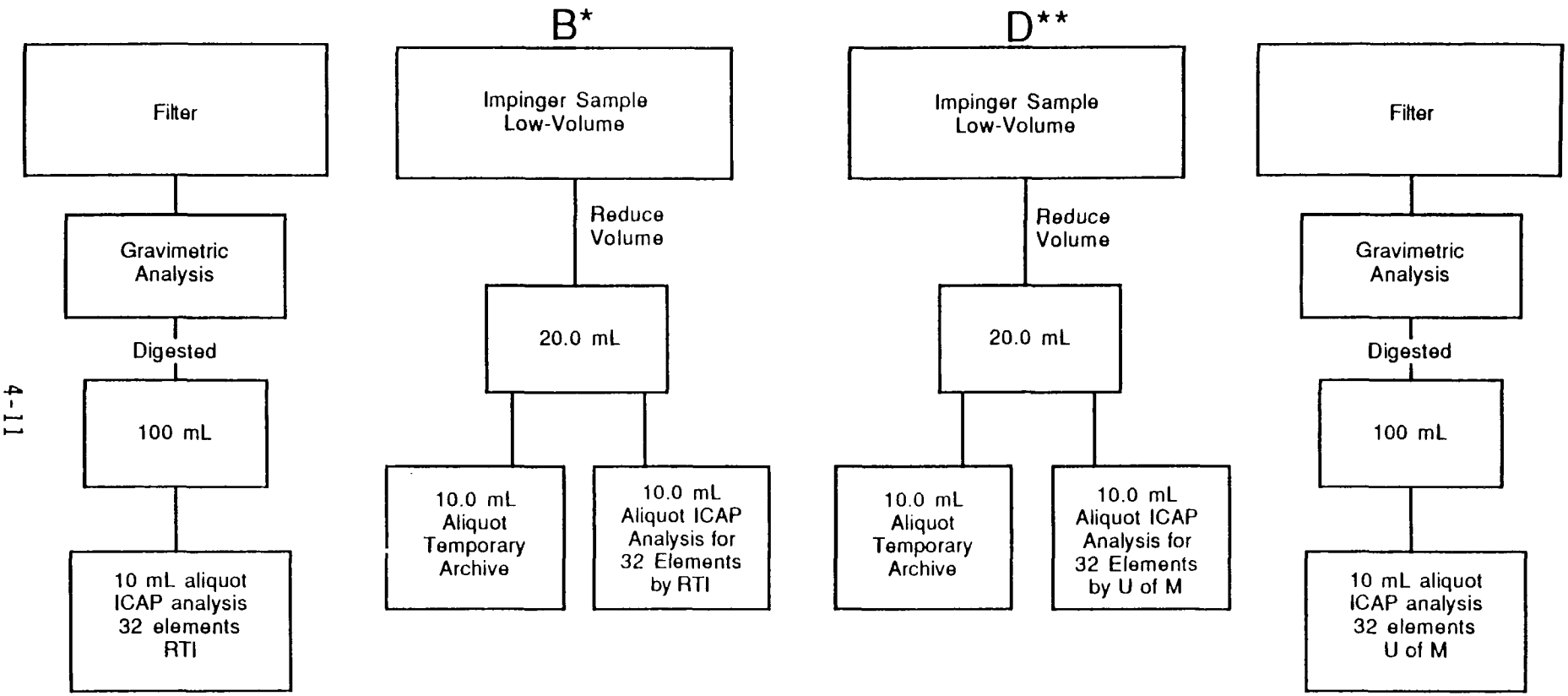
4.8 CT DRIFT COOLING WATER SAMPLING AND ANALYSIS (SAMPLING LOCATION J)

During each sampling run, four recirculating water samples were taken from a sample line installed in the riser pipe supply line. This sampling station was located inside Building 302 and is routinely used to monitor the Ph of the recirculating water. One sample was taken at the beginning of the run, two during the middle of the run, and one at the end of the run. These samples were taken by hand in uniquely labeled, EPA-approved, precleaned plastic bottles. At



* Impinger samples A and B will be run together on the same cell
** Impinger samples C and D will be run together on the same cell.
*** Filter analysis was the same for A and C.

Figure 4-5. Schematic of sample preparation and analysis for high-volume CTD train.



* Impinger samples A and B will be run together on the same cell
** Impinger samples C and D will be run together on the same cell.

Figure 4-6. Schematic of sample preparation and analysis for low-volume CTD train.

the conclusion of the run, the samples were combined and filtered to separate the suspended solids from the dissolved solids. The filtrate was stored in a labeled sample bottle and the filter was returned to its numbered container.

These daily samples were analyzed for the 32 elements by U of MO and RTI using ICAP analysis. Sample calculations are presented in Appendix A and data reduction is discussed in Section 5.0. Figure 4-7 shows the scheme for the cooling water sample preparation and analysis.

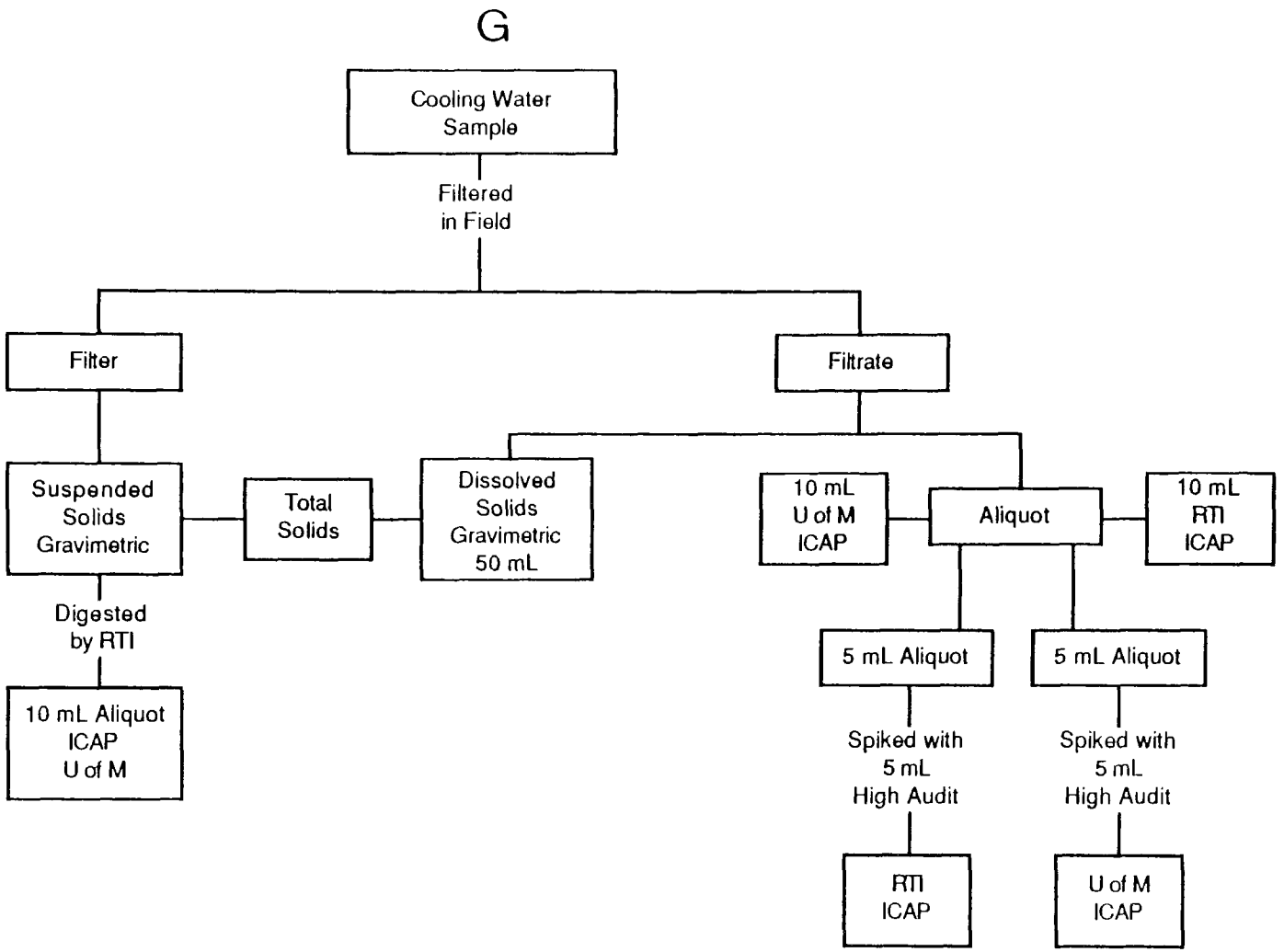


Figure 4-7. Schematic of sample preparation and analysis for cooling water samples.

5.0 DATA ASSESSMENT

Samples were collected from three different sources at the test site: the cooling tower water, ambient air, and the cooling tower emissions. All were analyzed to determine concentrations of the 32 target elements. Preparation of the elemental data for the statistical evaluations included:

(1) Eliminate consideration of those elements yielding non-detect values for any of the samples.

(2) Eliminate consideration of data resulting from obviously contaminated samples (values at levels 500 percent above the remaining data were determined to indicate contamination);

(3) Separation of data sets with values that were less than five times the detection limit from those with values that were equal to or greater than five times the detection limit; and

(4) Application of a standard T-test at a 95 percent confidence level, to eliminate outliers.

5.1 COOLING TOWER WATER

The cooling tower water was collected from a spigot site inside the chill plant. It was collected in four aliquots over each test run (six hours) to yield a single representative sample of about one liter. The sample was filtered on the test site to differentiate between suspended and dissolved solids. The filter was placed in one sample container, and the filtrate was volumed and placed in another container. The filter was subsequently digested with a concentrated acid, and this sample was diluted to 100 ml.

To determine a percent drift value, the concentration of the various elements in the cooling tower water was first determined. The total concentration of each target element in the cooling water was calculated from the concentrations measured in the filtrate and in the filter digestion solution:

$$\text{Total Conc. of Element in Cooling Water} = \frac{(\text{Filter Dig. Soln. Conc.} - \text{Blank Conc.}) \times 100 \text{ ml}}{\text{Final Volume of Filtrate (ml)}} + \text{Filtrate Conc}$$

The dissolved or soluble solids were compared to the suspended solids in the cooling water by dividing the filtrate concentration by the total concentration. Because Research Triangle Institute did not analyze the filter digestion solution, only the University of Missouri data were used in calculating values for the cooling tower water.

5.2 AMBIENT AIR

Ambient air samples were collected approximately 100 meters upwind of the cooling tower. They were obtained by using a Method 5-type collection system located two meters off the ground, sampling for the duration of each test run (six hours). The concentrations of minerals and elements in the ambient air were not used in calculating percent drift, but were measured to assess the background levels of the target elements.

5.3 EMISSION SAMPLES

Once the concentrations of elements in the cooling tower water samples were determined, the results were combined with the cooling tower emission concentrations, the cooling tower water flow rates, and the cooling tower air flow rates to calculate the percent drift values for each element for each run (see Section 3.1 for equation). As mentioned above, the percent drift values were subjected to a standard T-test to eliminate outliers (see Appendix A for T-test values). The resulting percent drift values for each run were analyzed to determine:

(1) The average percent drift and the relative standard deviation of percent drift for each of the alkali/alkali earth metals (calcium, magnesium, sodium, and strontium) and an average percent drift value for these elements as a whole. Boron, a semimetal, was subsequently added to this group, as its percent drift was in the same range of values. An average of percent drift was first calculated for each lab facility used, then these two values were combined to give one average percent drift for each element (see Appendix A).

(2) The same parameters as (1) for the transition metals.

(3) The effect of using the high-volume versus the low-volume sampling system. The system effects were compared for each alkali/alkali earth metal by averaging high-volume train results and comparing them to the average of the low-volume trains.

(4) Cell-to-cell and day-to-day variations analyzed in a manner similar to (3).

(5) Sampling and analytical precision, and a comparison of the analytical results presented by both laboratories, utilizing the drift and cooling water data and the results of the audit and spiked emission samples.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Entropy performed a number of quality assurance/quality control (QA/QC) activities to ensure and quantify the quality of the data collected.

To ensure test program continuity and organization, informal meetings were held throughout the field testing phase of the project. At the meetings, results from the testing conducted on the previous day were reviewed. Questions were addressed and any problems or misunderstandings resolved. Responsibilities for each member of the test team were clearly delineated, particularly in situations where more than one person performed similar activities.

Specific quality control and quality assurance activities performed for the sampling and analytical phases are presented below.

6.1 SAMPLING QA/QC

Prior to and at the completion of the field test all sampling equipment, including nozzles, pitot tubes, dry gas meters, orifices, and thermocouples were calibrated in accordance with documented procedures and acceptance criteria in the Quality Assurance Handbook, Volume III, EPA-600/4-77-027b.

Standardized data sheets were used to record all field equipment calibration and the pertinent run data collected during the field evaluation testing. Applicable QC procedures and criteria from Section 3.4 of the Handbook (EPA Method 5) were also conducted (see Appendix D).

An on-site audit of the meterbox calibrations was conducted. The results of this audit are presented in Table 6.1. All audit values were within the acceptable range of 5%.

TABLE 6.1. METER BOX CALIBRATION AUDIT

Meter Box Number	Pre-Audit Value	Allowable Error	Calculated Y_c	Acceptable
EN-1	0.9597	0.9072<Y<1.0077	0.9539	Yes
EN-2	1.0031	0.9529<Y<1.0533	0.9604	Yes
RAC-1	1.0400	0.9880<Y<1.0920	1.0437	Yes
RAC-3	1.1358	1.0790<Y<1.1926	1.0327	Yes

6.2 ANALYTICAL QA/QC

ICAP analyses were conducted following the standard operating procedures of the respective laboratories (U of MO and RTI). The precision and accuracy of the analyses were based on the results of the spiked 5-ml aliquots from the standard-volume CT Drift train samples (see Appendix B).

Flaws in a data acquisition program caused RTI's results for the audit samples to be off by a factor of 10 from predicted values. As a result, duplicate analyses were conducted, and the results of the cooling tower water analyses conducted by the University of Missouri were used to calculate the percent drift results.

6.2.1 Blank Results

Blanks were collected for all sampling reagents, filters, DI water, and nitric acid. Each lab analyzed these blanks for all 32 target elements. The DI water and nitric acid blanks were insignificant compared to the sample values.

The Pallflex quartz filters used in the CT Drift train have low enough blank values to be used in most trace element emission sampling applications. However, when used as a backup filter to sample cooling tower emissions, their blank levels constituted as much as 80% of total catch on the filter. Large variances between the filter results reported by the two laboratories can be traced to this problem.

6.2.2 Duplicate Analysis

The University of Missouri conducts random duplicate analyses as part of its overall QA/QC procedures. All duplicate values reported were within 10% of the original sample value. The raw lab results are not included in this report, but are available for review.

6.2.3 Audit Sample Results

The "low" and "high" audit sample concentrations were 5.0 ppm and 50.0 ppm, respectively, for the twelve elements used in the drift calculations (Section 3.2), with the exception of Ca and Sr, at low and high levels of 0.5 ppm and 5.0 ppm, respectively, and Ti, at 0.0 ppm and 0.0 ppm, respectively.

As mentioned above, RTI's data acquisition program caused readily apparent errors in reporting of the audit concentrations.

With the exception of calcium, the audit results for both laboratories were typically within 15% of the predicted audit values. The audit values for calcium were 0.5 and 5.0 ppm, respectively; U of MO reported values of 0.89 ppm and 4.90 ppm, respectively; and RTI reported values of 0.11 ppm and 0.81 ppm, respectively. There is no apparent reason for the difference. The samples values for calcium for both labs had standard deviations of about 25%, considered good for cooling tower sampling. The audit results for both laboratories are shown at the bottom of the tables in Appendix A.

7.0 REFERENCES

1. The EPA Cooling Tower Drift Emissions Test draft emission measurement method (CT Drift Method) is a modified method of the Cooling Tower Institute (CTI) draft emission measurement method.

2. Memo from Rick Marinshaw, Midwest Research Institute, Cary, North Carolina, to Al Vervaert, U. S. Environmental Protection Agency, Industrial Studies Branch, Research Triangle Park, North Carolina. "Drift Test Data from Tom Weast, Industrial Process Cooling Tower NESHAP," November 8, 1989.

3. Wilber, K. and K. Vercauteren, "Comprehensive Drift Measurements on a Circular Mechanical Draft Cooling Tower," Technical Paper No. TP-86-1 presented at 1986 Cooling Tower Institute Annual Meeting, Houston, Texas, January 1986.

4. "Emission Test Report: National Bureau of Standards Steam and Chill Plant, Gaithersburg, Maryland," EMB Report No. 86-CCT-4, ESED Project No. 85/02, prepared by Entropy Environmentalists, Inc. for U. S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, North Carolina, under Contract No. 68-02-4336, Work Assignment Nos. 3 and 5, October 1986.

5. "Method Development and Evaluation for Chromium Air Emissions from Cooling Towers: Munters Corporation, Fort Myers, Florida," EMB Report, ESED Project No. 85/2b, prepared by Entropy Environmentalists, Inc. for U. S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, North Carolina, under Contract No. 68-02-4336, Work Assignment No. 3, May 1986.

APPENDIX A

FIELD TEST RESULTS
AND
DRIFT RATE CALCULATION TABLES

FIELD DATA AND RESULTS TABULATION

PLANT: EMB Site #2 - Gaithersburg, MD

RUN #	DATE	SAMPLING LOCATION	OPERATOR
C1-CTI-1	7/10/90	Fan Cell #1	Matt Hamilton
C1-CTI-2	7/10/90	Fan Cell #1	Matt Hamilton

		C1-CTI-1	C1-CTI-2
	Run Start Time	932	930
	Run Finish Time	1904	1904
	Net Traversing Points	24	24
Theta	Net Run Time, Minutes	342.50	342.50
Dia	Nozzle Diameter, Inches	0.369	0.275
Cp	Pitot Tube Coefficient	0.840	0.840
Y	Dry Gas Meter Calibration Factor	0.9821	1.1360
Pbar	Barometric Pressure, Inches Hg	30.00	30.00
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.43	2.28
Vm	Volume Of Metered Gas Sample, Dry ACF	583.130	282.581
tm	Dry Gas Meter Temperature, Degrees F	95	97
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	547.983	306.695
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	508.1	280.0
Vwstd	Volume of Water Vapor, SCF*	23.916	13.180
%H_2O	Moisture Content, Percent by Volume	4.2	4.1
Mfd	Dry Mole Fraction	0.958	0.959
Md	Gas Molecular Weight, lb/lb-Mole, Dry	28.84	28.84
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.38	28.40
Pg	Flue Gas Static Pressure, Inches H_2O	0.0	0.0
Ps	Absolute Flue Gas Pressure, Inches Hg	30.00	30.00
ts	Flue Gas Temperature, Degrees F	90	90
Delta-p	Average Velocity Head, Inches H_2O	0.4377	0.4377
vs	Flue Gas Velocity, Feet/Second	38.19	38.17
A	Stack/Duct Area, Square Inches	97,314	97,314
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,427,941	1,428,683
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	40,439	40,460
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,548,509	1,547,698
%I	Isokinetic Sampling Rate, Percent	102.0	102.7

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

FIELD DATA AND RESULTS TABULATION

PLANT: EMB Site #2 Gaithersburg, MD

RUN #	DATE	SAMPLING LOCATION	OPERATOR
C2-CTI-1	7/09/90	Fan Cell #2	BARRY RUDD
C2-CTI-2	7/09/90	Fan Cell #2	BARRY RUDD
C2-CTI-3	7/10/90	Fan Cell #2	Barry Rudd
C2-CTI-4	7/10/90	Fan Cell #2	BARRY RUDD

		C2-CTI-1	C2-CTI-2	C2-CTI-3	C2-CTI-4
	Run Start Time	1452	1450	927	92
	Run Finish Time	2036	2034	1902	190
	Net Traversing Points	24	24	24	2
Theta	Net Run Time, Minutes	254.25	254.25	345.78	345.7
Dia	Nozzle Diameter, Inches	0.370	0.275	0.370	0.27
Cp	Pitot Tube Coefficient	0.840	0.840	0.840	0.84
Y	Dry Gas Meter Calibration Factor	1.0220	1.0400	1.0220	1.040
Pbar	Barometric Pressure, Inches Hg	29.40	29.40	30.00	30.0
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.04	2.20	1.05	2.2
Vm	Volume Of Metered Gas Sample, Dry ACF	397.703	215.163	537.894	299.48
tm	Dry Gas Meter Temperature, Degrees F	103	104	97	10
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	375.384	206.895	523.635	294.34
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	380.7	213.7	515.5	285.
Vwstd	Volume of Water Vapor, SCF*	17.920	10.059	24.265	13.43
$\%H_2O$	Moisture Content, Percent by Volume	4.6	4.6	4.4	4.
Mfd	Dry Mole Fraction	0.954	0.954	0.956	0.95
Md	Gas Molecular Weight, lb/lb-Mole, Dry	28.84	28.84	28.84	28.8
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.34	28.34	28.36	28.3
Pg	Flue Gas Static Pressure, Inches H_2O	0.0	0.0	0.0	0.
Ps	Absolute Flue Gas Pressure, Inches Hg	29.40	29.40	30.00	30.0
ts	Flue Gas Temperature, Degrees F	92	92	92	9
Delta-p	Average Velocity Head, Inches H_2O	0.3722	0.3722	0.3664	0.366
vs	Flue Gas Velocity, Feet/Second	35.66	35.66	35.01	35.0
A	Stack/Duct Area, Square Inches	97,314	97,314	97,314	97,31
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,296,506	1,296,506	1,301,573	1,301,57
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	36,717	36,717	36,861	36,86
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,445,924	1,445,924	1,419,568	1,419,56
%I	Isokinetic Sampling Rate, Percent	103.1	102.8	105.3	107.

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

FIELD DATA AND RESULTS TABULATION

PLANT: EMB Site #2 - Gaithersburg, MD

RUN #	DATE	SAMPLING LOCATION	OPERATOR
C2-CTI-5	7/11/90	Fan Cell #2	BARRY RUDD
C2-CTI-6	7/11/90	Fan Cell #2	BARRY RUDD
C2-CTI-7	7/12/90	Fan Cell #2	BARRY RUDD
C2-CTI-8	7/12/90	Fan Cell #2	BARRY RUDD

		C2-CTI-5	C2-CTI-6	C2-CTI-7	C2-CTI-8
	Run Start Time	937	935	917	915
	Run Finish Time	1629	1637	1541	1539
	Net Traversing Points	24	24	24	24
Theta	Net Run Time, Minutes	369.25	369.25	351.25	351.25
Dia	Nozzle Diameter, Inches	0.370	0.275	0.370	0.275
Cp	Pitot Tube Coefficient	0.840	0.840	0.840	0.840
Y	Dry Gas Meter Calibration Factor	1.0220	1.0400	1.0220	1.0400
Pbar	Barometric Pressure, Inches Hg	30.00	30.00	29.20	29.20
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.15	2.47	2.13	2.34
Vm	Volume Of Metered Gas Sample, Dry ACF	588.396	325.298	763.483	306.083
tm	Dry Gas Meter Temperature, Degrees F	87	98	87	103
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	583.412	322.791	738.699	292.952
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	420.0	239.0	620.5	266.2
Vwstd	Volume of Water Vapor, SCF*	19.769	11.250	29.207	12.530
%H_2O	Moisture Content, Percent by Volume	3.3	3.4	3.8	4.1
Mfd	Dry Mole Fraction	0.967	0.966	0.962	0.959
Md	Gas Molecular Weight, lb/lb-Mole, Dry	28.84	28.84	28.84	28.84
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.48	28.47	28.43	28.40
Pg	Flue Gas Static Pressure, Inches H_2O	0.0	0.0	0.0	0.0
Ps	Absolute Flue Gas Pressure, Inches Hg	30.00	30.00	29.20	29.20
ts	Flue Gas Temperature, Degrees F	85	85	85	85
Delta-p	Average Velocity Head, Inches H_2O	0.4100	0.4100	0.3721	0.3721
vs	Flue Gas Velocity, Feet/Second	36.72	36.73	35.49	35.51
A	Stack/Duct Area, Square Inches	97,314	97,314	97,314	97,314
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,398,590	1,397,524	1,308,892	1,305,546
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	39,608	39,578	37,068	36,973
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,488,904	1,489,310	1,439,031	1,439,842
%I	Isokinetic Sampling Rate, Percent	102.2	102.5	145.4	104.7

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

FIELD DATA AND RESULTS TABULATION

PLANT: EMB Site #2 - Gaithersburg, MD

RUN #	DATE	SAMPLING LOCATION	OPERATOR
C3-CTI-1	7/09/90	Fan Cell #3	Matt Hamilton
C3-CTI-2	7/09/90	Fan Cell #3	Matt Hamilton
C3-CTI-3	7/11/90	Fan Cell #3	Matt Hamilton
C3-CTI-4	7/11/90	Fan Cell #3	Matt Hamilton

		C3-CTI-1	C3-CTI-2	C3-CTI-3	C3-CTI-4
	Run Start Time	1454	1452	934	93
	Run Finish Time	2028	2025	1535	154
	Net Traversing Points	24	24	24	2
Theta	Net Run Time, Minutes	235.75	235.75	317.50	325.0
Dia	Nozzle Diameter, Inches	0.376	0.275	0.369	0.27
Cp	Pitot Tube Coefficient	0.840	0.840	0.840	0.84
Y	Dry Gas Meter Calibration Factor	0.9821	1.1360	0.9821	1.136
Pbar	Barometric Pressure, Inches Hg	29.40	29.40	30.00	30.0
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	1.59	2.74	1.55	2.4
Vm	Volume Of Metered Gas Sample, Dry ACF	418.450	210.078	558.442	276.70
tm	Dry Gas Meter Temperature, Degrees F	103	101	88	9
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	380.067	222.130	531.643	303.71
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	404.8	224.0	376.5	220.
Vwstd	Volume of Water Vapor, SCF*	19.054	10.544	17.722	10.39
$\%H_2O$	Moisture Content, Percent by Volume	4.8	4.5	3.2	3.
Mfd	Dry Mole Fraction	0.952	0.955	0.968	0.96
Md	Gas Molecular Weight, lb/lb-Mole, Dry	28.84	28.84	28.84	28.8
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.32	28.35	28.49	28.4
Pg	Flue Gas Static Pressure, Inches H_2O	0.0	0.0	0.0	0.
Ps	Absolute Flue Gas Pressure, Inches Hg	29.40	29.40	30.00	30.0
ts	Flue Gas Temperature, Degrees F	94	94	84	8
Delta-p	Average Velocity Head, Inches H_2O	0.4583	0.4583	0.4702	0.470
vs	Flue Gas Velocity, Feet/Second	39.66	39.63	39.29	39.3
A	Stack/Duct Area, Square Inches	97,314	97,314	97,314	97,31
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,433,718	1,437,148	1,500,777	1,500,37
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	40,603	40,700	42,502	42,49
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,608,114	1,606,897	1,593,111	1,594,32
%I	Isokinetic Sampling Rate, Percent	98.5	107.4	101.5	102.

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

FIELD DATA AND RESULTS TABULATION

PLANT: EMB Site #2 Gaithersburg, MD

RUN #	DATE	SAMPLING LOCATION	OPERATOR
C4-CTI-1	7/12/90	Fan Cell #4	Matt Hamilton
C4-CTI-2	7/12/90	Fan Cell #4	Matt Hamilton

		C4-CTI-1	C4-CTI-2
	Run Start Time	919	918
	Run Finish Time	1627	1626
	Net Traversing Points	24	24
Theta	Net Run Time, Minutes	385.00	385.00
Dia	Nozzle Diameter, Inches	0.369	0.275
Cp	Pitot Tube Coefficient	0.840	0.840
Y	Dry Gas Meter Calibration Factor	0.9821	1.1360
Pbar	Barometric Pressure, Inches Hg	29.20	29.20
Delta-H	Avg. Pressure Differential of Orifice Meter, Inches H_2O	3.30	2.63
Vm	Volume Of Metered Gas Sample, Dry ACF	1001.288	336.112
tm	Dry Gas Meter Temperature, Degrees F	88	92
Vmstd	Volume Of Metered Gas Sample, Dry SCF*	931.986	358.650
Vlc	Total Volume of Liquid Collected in Impingers & Silica Gel, ml	730.3	296.7
Vwstd	Volume of Water Vapor, SCF*	34.375	13.966
$\%H_2O$	Moisture Content, Percent by Volume	3.6	3.7
Mfd	Dry Mole Fraction	0.964	0.963
Md	Gas Molecular Weight, lb/lb-Mole, Dry	28.84	28.84
Ms	Gas Molecular Weight, lb/lb-Mole, Wet	28.45	28.44
Pg	Flue Gas Static Pressure, Inches H_2O	0.0	0.0
Ps	Absolute Flue Gas Pressure, Inches Hg	29.20	29.20
ts	Flue Gas Temperature, Degrees F	83	83
Delta-p	Average Velocity Head, Inches H_2O	0.4889	0.4889
vs	Flue Gas Velocity, Feet/Second	40.59	40.60
A	Stack/Duct Area, Square Inches	97,314	97,314
Qsd	Volumetric Air Flow Rate, Dry SCFM*	1,505,621	1,504,429
Qmsd	Volumetric Air Flow Rate, Dry SCMM*	42,639	42,605
Qaw	Volumetric Air Flow Rate, Wet ACFM	1,645,823	1,646,229
%I	Isokinetic Sampling Rate, Percent	146.3	101.5

* 68° F (20° C) -- 29.92 Inches of Mercury (Hg)

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS			ALUMINUM (ppm)	Percent Drift	Percent Drift (T-test)	BORON (ppm)	Percent Drift	Percent Drift (T-test)
DI Water			0.42			ND		
Nitric Acid			0.24			ND		
Filter, 47mm qtz			0.31			ND		
Filter, Whatman 41			ND			ND		
Filter, Pflex qtz			1.38			ND		
Fan No.	Type	Run No.	Matrix					
C2	CTI/HI	1	F	1.64	2.5740	2.5740	0.03	0.0048	0.0048
C2	CTI/HI	1	N	0.72			0.01		
C2	CTI/LO	2	F	1.41	1.7797	1.7797	0.01	0.0067	0.0067
C2	CTI/LO	2	N	0.96			0.08		
C3	CTI/HI	1	F	1.72	3.0811	3.0811	0.07	0.0108	0.0108
C3	CTI/HI	1	N	0.63			0.02		
C2	CTI/HI	3	F	2.05	7.4235	7.4235	0.06	0.0069	0.0069
C2	CTI/HI	3	N	0.23			0.04		
C2	CTI/LO	4	F	1.71	6.5045	6.5045	0.15	0.0254	
C2	CTI/LO	4	N	0.20			0.03		
C1	CTI/HI	1	F	1.66	3.2519	3.2519	0.10	0.0101	0.0101
C1	CTI/HI	1	N	0.20			ND		
C2	CTI/HI	5	F	1.96	8.6256	8.6256	0.05	0.0047	0.0047
C2	CTI/HI	5	N	0.24			0.02		
C2	CTI/LO	6	F	1.93	16.4804	16.4804	0.07	0.0125	0.0125
C2	CTI/LO	6	N	0.56			0.04		
C3	CTI/HI	3	F	1.78			0.05		
C3	CTI/HI	3	N	0.69			0.04		
C2	CTI/HI	7	F	1.74	5.0977	5.0977	0.05	0.0037	0.0037
C2	CTI/HI	7	N	0.16			0.02		
C2	CTI/LO	8	F	2.06	29.5461		0.06	0.0114	0.0114
C2	CTI/LO	8	N	0.99			0.04		
C4	CTI/HI	1	F	1.61			0.05		
C4	CTI/HI	1	N	0.36			0.03		
	Average				8.436	6.091		0.010	0.008
	Rel. Std. Dev.					75%			41%
COOLING WATER (ppm)									
	Run 1			0.20			9.33		
	Run 2			0.10			11.50		
	Run 3			0.07			12.26		
	Run 4			0.05			12.00		
AUDITS (ppm)									
	Low			4.49			ND		
	High			44.80			ND		
DETECTION LIMIT				0.14			0.01		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS				CALCIUM (ppm)	Percent Drift	Percent Drift (T-test)	CHROMIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				0.00			ND		
Nitric Acid				-			0.01		
Filter, 47mm qtz				0.02			ND		
Filter, Whatman 41				ND			ND		
Filter, Pflex qtz				0.11			0.01		
Fan No.	Type	Run No.	Matri						
C2	CTI/HI	1	F	0.13	0.0012	0.0012	0.02	1.9975	1.9975
C2	CTI/HI	1	N	0.89			0.07		
C2	CTI/LO	2	F	0.16	0.0016	0.0016	0.01	2.3175	2.3175
C2	CTI/LO	2	N	1.14			0.10		
C3	CTI/HI	1	F	0.13	0.0024	0.0024	0.02	2.3718	2.3718
C3	CTI/HI	1	N	1.67			0.08		
C2	CTI/HI	3	F	0.14	0.0014	0.0014	0.03	5.9566	5.9566
C2	CTI/HI	3	N	1.15			0.07		
C2	CTI/LO	4	F	0.16	0.0011	0.0011	0.02	5.1879	5.1879
C2	CTI/LO	4	N	0.84			0.07		
C1	CTI/HI	1	F	0.15	0.0020	0.0020	0.02	2.3739	2.3739
C1	CTI/HI	1	N	1.55			0.03		
C2	CTI/HI	5	F	0.13	0.0015	0.0015	0.02	3.8716	3.8716
C2	CTI/HI	5	N	1.23			0.07		
C2	CTI/LO	6	F	0.13	0.0013	0.0013	0.02	3.9834	3.9834
C2	CTI/LO	6	N	1.11			0.05		
C3	CTI/HI	3	F	0.14			0.02		
C3	CTI/HI	3	N	0.68			0.06		
C2	CTI/HI	7	F	0.13	0.0010	0.0010	0.03	6.5760	6.5760
C2	CTI/HI	7	N	1.13			0.07		
C2	CTI/LO	8	F	0.12	0.0018	0.0018	0.02	9.3083	
C2	CTI/LO	8	N	1.66			0.11		
C4	CTI/HI	1	F	0.13			0.02		
C4	CTI/HI	1	N	1.54			0.06		
	Average				0.002	0.002		4.394	3.848
	Rel. Std.					28%			45%
COOLING WATER (ppm)									
	Run 1			369.27			0.02		
	Run 2			378.28			0.01		
	Run 3			357.97			0.01		
	Run 4			370.80			0.01		
AUDITS (ppm)									
	Low			0.11			5.05		
	High			0.81			47.40		
DETECTION LIMIT				0.00			0.01		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS				COPPER (ppm)	Percent Drift	Percent Drift (T-test)	IRON (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				ND			0.20		
Nitric Acid				ND			0.22		
Filter, 47mm qtz				ND			0.06		
Filter, Whatman 41				ND			ND		
Filter, Pflex qtz				ND			0.15		
Fan No.	Type	Run No.	Matri						
C2	CTI/HI	1	F	ND	0.8174	0.8174	0.22	1.0323	1.0323
C2	CTI/HI	1	N	0.18			1.01		
C2	CTI/LO	2	F	ND	1.0196	1.0196	0.22	1.0666	1.0666
C2	CTI/LO	2	N	0.25			1.01		
C3	CTI/HI	1	F	ND	0.9886	0.9886	0.26	1.4477	1.4477
C3	CTI/HI	1	N	0.20			1.21		
C2	CTI/HI	3	F	ND	0.3461	0.3461	0.34	2.1585	2.1585
C2	CTI/HI	3	N	0.05			0.65		
C2	CTI/LO	4	F	ND	0.4648	0.4648	0.26	2.0618	2.0618
C2	CTI/LO	4	N	0.08			0.62		
C1	CTI/HI	1	F	ND	0.3414	0.3414	0.27	1.8839	1.8839
C1	CTI/HI	1	N	0.05			0.68		
C2	CTI/HI	5	F	ND	0.5002	0.5002	0.28	2.6661	2.6661
C2	CTI/HI	5	N	0.05			0.61		
C2	CTI/LO	6	F	ND	0.6825	0.6825	0.46	8.6732	8.6732
C2	CTI/LO	6	N	0.07			1.23		
C3	CTI/HI	3	F	ND			0.28		
C3	CTI/HI	3	N	0.54			3.60		
C2	CTI/HI	7	F	ND	0.7799	0.7799	0.50	6.7921	6.7921
C2	CTI/HI	7	N	0.10			0.75		
C2	CTI/LO	8	F	ND	0.8077	0.8077	0.30	16.0999	
C2	CTI/LO	8	N	0.08			2.12		
C4	CTI/HI	1	F	ND			0.31		
C4	CTI/HI	1	N	0.04			0.93		
	Average				0.675	0.675		4.388	3.087
	Rel. Std.					37%			88%
COOLING WATER (ppm)									
	Run 1			0.10			0.44		
	Run 2			0.06			0.18		
	Run 3			0.04			0.11		
	Run 4			0.04			0.06		
AUDITS (ppm)									
	Low			5.17			5.19		
	High			49.20			50.00		
DETECTION LIMIT				0.03			0.02		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS				MAGNESIUM (ppm)	Percent Drift	Percent Drift (T-test)	MANGANESE (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				0.02			ND		
Nitric Acid				0.12			0.01		
Filter, 47mm qtz				0.06			0.00		
Filter, Whatman 41				0.02			ND		
Filter, Pflex qtz				0.14			0.01		
Fan No.	Type	Run No.	Matri						
C2	CTI/HI	1	F	0.16	0.0065	0.0065	0.01	2.0675	2.0675
C2	CTI/HI	1	N	1.59			0.18		
C2	CTI/LO	2	F	0.24	0.0020	0.0020	0.01	12.3641	
C2	CTI/LO	2	N	0.04			1.17		
C3	CTI/HI	1	F	0.19	0.0099	0.0099	0.01	1.5435	1.5435
C3	CTI/HI	1	N	2.12			0.13		
C2	CTI/HI	3	F	0.15	0.0051	0.0051	0.01	3.1580	3.1580
C2	CTI/HI	3	N	1.43			0.18		
C2	CTI/LO	4	F	0.19	0.0072	0.0072	0.01	0.6439	0.6439
C2	CTI/LO	4	N	1.94			0.04		
C1	CTI/HI	1	F	0.20	0.0075	0.0075	0.01	9.2571	9.2571
C1	CTI/HI	1	N	1.82			0.49		
C2	CTI/HI	5	F	0.16	0.0035	0.0035	0.01	1.6702	1.6702
C2	CTI/HI	5	N	0.96			0.09		
C2	CTI/LO	6	F	0.19	0.0099	0.0099	0.01	0.7108	0.7108
C2	CTI/LO	6	N	2.67			0.03		
C3	CTI/HI	3	F	0.19			0.01		
C3	CTI/HI	3	N	1.46			0.12		
C2	CTI/HI	7	F	0.17	0.0059	0.0059	0.01	1.4055	1.4055
C2	CTI/HI	7	N	2.18			0.09		
C2	CTI/LO	8	F	0.13	0.0105	0.0105	0.01	0.9891	0.9891
C2	CTI/LO	8	N	3.16			0.05		
C4	CTI/HI	1	F	0.16			0.01		
C4	CTI/HI	1	N	1.24			0.09		
	Average				0.007	0.007		3.381	2.383
	Rel. Std.					42%			113%
COOLING WATER (ppm)									
	Run 1			109.29			0.04		
	Run 2			113.13			0.02		
	Run 3			108.18			0.02		
	Run 4			111.14			0.02		
AUDITS (ppm)									
	Low			4.79			4.76		
	High			46.40			46.40		
DETECTION LIMIT				0.00			0.00		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS				SODIUM (ppm)	Percent Drift	Percent Drift (T-test)	STRONTIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				ND			ND		
Nitric Acid				-			ND		
Filter, 47mm qtz				0.05			0.01		
Filter, Whatman 41				ND			0.00		
Filter, Pflex qtz				0.07			0.02		
Fan No.	Type	Run No.	Matri						
C2	CTI/HI	1	F	0.09	0.0015	0.0015	0.02	0.0091	0.0091
C2	CTI/HI	1	N	0.63			0.04		
C2	CTI/LO	2	F	0.14	0.0024	0.0024	0.02	0.0116	0.0116
C2	CTI/LO	2	N	0.82			0.04		
C3	CTI/HI	1	F	0.10	0.0030		0.02	0.0108	0.0108
C3	CTI/HI	1	N	1.15			0.04		
C2	CTI/HI	3	F	0.07	0.0016	0.0016	0.02	0.0062	0.0062
C2	CTI/HI	3	N	0.79			0.02		
C2	CTI/LO	4	F	0.14	0.0021	0.0021	0.02	0.0070	0.0070
C2	CTI/LO	4	N	0.77			0.02		
C1	CTI/HI	1	F	0.11	0.0014	0.0014	0.02	0.0054	0.0054
C1	CTI/HI	1	N	0.57			0.03		
C2	CTI/HI	5	F	0.09	0.0009	0.0009	0.02	0.0051	0.0051
C2	CTI/HI	5	N	0.36			0.01		
C2	CTI/LO	6	F	0.11	0.0014	0.0014	0.02	0.0094	0.0094
C2	CTI/LO	6	N	0.51			0.03		
C3	CTI/HI	3	F	0.09			0.02		
C3	CTI/HI	3	N	0.29			0.07		
C2	CTI/HI	7	F	0.06	0.0007	0.0007	0.02	0.0046	0.0046
C2	CTI/HI	7	N	0.47			0.03		
C2	CTI/LO	8	F	0.05	0.0015	0.0015	0.02	0.0115	0.0115
C2	CTI/LO	8	N	0.81			0.05		
C4	CTI/HI	1	F	0.07			0.02		
C4	CTI/HI	1	N	0.21			0.02		
	Average				0.002	0.001		0.008	0.008
	Rel. Std.					35%			34%
COOLING WATER (ppm)									
	Run 1			205.32			2.03		
	Run 2			213.20			2.09		
	Run 3			203.33			1.99		
	Run 4			211.32			2.08		
AUDITS (ppm)									
	Low			0.49			0.51		
	High			5.41			5.05		
DETECTION LIMIT				0.03			0.00		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (RTI Analysis)

BLANKS	TITANIUM (ppm)	Percent Drift	Percent Drift (T-test)	ZINC (ppm)	Percent Drift	Percent Drift (T-test)
DI Water	ND			0.04		
Nitric Acid	-			0.21		
Filter, 47mm qtz	0.49			0.01		
Filter, Whatman 41	0.02			0.01		
Filter, Pflex qtz	0.03			0.02		

Fan No.	Type	Run No.	Matri						
C2	CTI/HI	1	F	0.09	1.1075	1.1075	0.04	2.7641	2.7641
C2	CTI/HI	1	N	0.02			0.86		
C2	CTI/LO	2	F	0.05	0.5979	0.5979	0.05	2.9013	2.9013
C2	CTI/LO	2	N	0.02			0.87		
C3	CTI/HI	1	F	0.59	10.6285		0.02	3.2543	3.2543
C3	CTI/HI	1	N	0.05			0.95		
C2	CTI/HI	3	F	0.06	0.5791	0.5791	0.03	1.0021	1.0021
C2	CTI/HI	3	N	0.02			0.39		
C2	CTI/LO	4	F	0.08	1.2990	1.2990	0.09	3.2954	3.2954
C2	CTI/LO	4	N	0.01			0.57		
C1	CTI/HI	1	F	0.07	0.7819	0.7819	0.03	0.7240	0.7240
C1	CTI/HI	1	N	0.02			0.32		
C2	CTI/HI	5	F	0.03	0.2560	0.2560	0.03	19.6817	
C2	CTI/HI	5	N	0.04			0.90		
C2	CTI/LO	6	F	0.04	0.5316	0.5316	0.08	12.2045	12.2045
C2	CTI/LO	6	N	0.06			0.37		
C3	CTI/HI	3	F	0.07			0.02		
C3	CTI/HI	3	N	0.07			1.00		
C2	CTI/HI	7	F	0.07	0.3939	0.3939	0.04	5.1181	5.1181
C2	CTI/HI	7	N	ND			0.41		
C2	CTI/LO	8	F	0.13	3.0829	3.0829	0.04	10.0776	10.0776
C2	CTI/LO	8	N	0.07			0.52		
C4	CTI/HI	1	F	0.05			0.03		
C4	CTI/HI	1	N	0.02			6.35		
	Average				1.926	0.959		6.102	4.593
	Rel. Std.					90%			86%

COOLING WATER (ppm)				
Run 1	0.07		0.12	
Run 2	0.07		0.08	
Run 3	0.07		0.02	
Run 4	0.07		0.02	

AUDITS (ppm)				
Low	ND		4.96	
High	0.01		48.50	

DETECTION LIMIT	0.01		0.01	

Cooling Tower Test
EEI #3644

Analysis and Drift Data (UoM Analysis)

BLANKS	ALUMINUM (ppm)	Percent Drift	Percent Drift (T-test)	CALCIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water	0.06			0.25		
Nitric Acid	0.41			1.50		
Filter, 47mm qtz	0.77			0.03		
Filter, Whatman 41	ND			0.06		
Filter, Pflex qtz	1.80			0.80		

Fan No.	Type	Run No.	Matrix					
C2	CTI/HI	1	F	2.10	6.2132	6.2132	1.00	0.0063	0.0063
C2	CTI/HI	1	N	2.39			6.00		
C3	CTI/HI	1	F	1.90	2.0855	2.0855	0.97	0.0085	0.0085
C3	CTI/HI	1	N	1.00			7.30		
C3	CTI/LO	2	F	2.20	6.5868	6.5868	1.00	0.0098	0.0098
C3	CTI/LO	2	N	1.50			8.90		
C2	CTI/HI	3	F	2.40	6.8695	6.8695	0.96	0.0046	0.0046
C2	CTI/HI	3	N	0.46			5.10		
C1	CTI/HI	1	F	2.00	5.0869	5.0869	1.30	0.0051	0.0051
C1	CTI/HI	1	N	1.60			7.50		
C1	CTI/LO	2	F	1.90	4.4845	4.4845	1.10	0.0072	0.0072
C1	CTI/LO	2	N	0.70			4.10		
C2	CTI/HI	5	F	2.60	13.3845	13.3845	0.98	0.0056	0.0056
C2	CTI/HI	5	N	0.66			5.80		
C3	CTI/HI	3	F	2.50			1.10		
C3	CTI/HI	3	N	1.10			4.90		
C3	CTI/LO	4	F	2.80			1.40		
C3	CTI/LO	4	N	1.10			10.00		
C2	CTI/HI	7	F	2.10	5.0411	5.0411	0.93	0.0060	0.0060
C2	CTI/HI	7	N	0.55			8.40		
C4	CTI/HI	1	F	3.10			1.30		
C4	CTI/HI	1	N	0.69			11.00		
C4	CTI/LO	2	F	2.50			1.40		
C4	CTI/LO	2	N	1.50			16.00		
	Average				6.219	6.219		0.007	0.007
	Rel. Std. Dev.					53%			27%

COOLING WATER (ppm)		
Run 1	0.20	369.27
Run 2	0.10	378.28
Run 3	0.07	357.97
Run 4	0.05	370.80

AUDITS (ppm)		
Low	5.10	0.89
High	49.70	4.90

DETECTION LIMIT	0.10	2.00

Cooling Tower Test
EEI #3644

Analysis and Drift Data (UoM Analysis)

BLANKS				CHROMIUM (ppm)	Percent Drift	Percent Drift (T-test)	COPPER (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				ND			ND		
Nitric Acid				ND			0.01		
Filter, 47mm qtz				ND			ND		
Filter, Whatman 41				ND			ND		
Filter, Pflex qtz				0.02			0.01		
Fan No.	Type	Run No.	Matrix						
C2	CTI/HI	1	F	0.00	7.6095	7.6095	0.03	1.0790	1.0790
C2	CTI/HI	1	N	0.28			0.20		
C3	CTI/HI	1	F	0.05	4.9214	4.9214	0.00	1.0778	1.0778
C3	CTI/HI	1	N	0.09			0.23		
C3	CTI/LO	2	F	0.00	3.5636	3.5636	0.00	1.3248	1.3248
C3	CTI/LO	2	N	0.14			0.33		
C2	CTI/HI	3	F	0.00	4.9017	4.9017	0.00	0.4235	0.4235
C2	CTI/HI	3	N	0.08			0.07		
C1	CTI/HI	1	F	0.00	1.2682	1.2682	0.01	0.2717	0.2717
C1	CTI/HI	1	N	0.04			0.08		
C1	CTI/LO	2	F	0.00	5.4645	5.4645	0.01	0.7490	0.7490
C1	CTI/LO	2	N	0.05			0.07		
C2	CTI/HI	5	F	0.10	13.5153	13.5153	0.04	1.3938	1.3938
C2	CTI/HI	5	N	0.09			0.06		
C3	CTI/HI	3	F	0.34			0.03		
C3	CTI/HI	3	N	0.07			0.62		
C3	CTI/LO	4	F	0.68			0.03		
C3	CTI/LO	4	N	0.09			0.06		
C2	CTI/HI	7	F	0.76	118.1238		0.06	1.5056	1.5056
C2	CTI/HI	7	N	0.08			0.08		
C4	CTI/HI	1	F	3.40			0.38		
C4	CTI/HI	1	N	0.07			0.06		
C4	CTI/LO	2	F	9.70			0.58		
C4	CTI/LO	2	N	0.10			0.23		
	Average				19.921	5.892		0.978	0.978
	Rel. Std. D					66%			47%
COOLING WATER (ppm)									
	Run 1			0.02			0.10		
	Run 2			0.01			0.06		
	Run 3			0.01			0.04		
	Run 4			0.01			0.04		
AUDITS (ppm)									
	Low			5.20			5.18		
	High			49.10			50.20		
DETECTION LIMIT				0.05			0.01		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (UoM Analysis)

BLANKS			IRON (ppm)	Percent Drift	Percent Drift (T-test)	MAGNESIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water			0.02			0.02		
Nitric Acid			0.16			0.12		
Filter, 47mm qtz			0.09			0.06		
Filter, Whatman 41			0.02			0.01		
Filter, Pflex qtz			0.17			0.14		
Fan No.	Type	Run No. Matrix						
C2	CTI/HI	1 F	0.23	1.6675	1.6675	0.16	0.0069	0.0069
C2	CTI/HI	1 N	1.58			1.70		
C3	CTI/HI	1 F	0.18	1.4193	1.4193	0.18	0.0110	0.0110
C3	CTI/HI	1 N	1.36			2.40		
C3	CTI/LO	2 F	0.22	1.3529	1.3529	0.18	0.0094	0.0094
C3	CTI/LO	2 N	1.27			2.30		
C2	CTI/HI	3 F	0.24	1.8069	1.8069	0.13	0.0061	0.0061
C2	CTI/HI	3 N	0.74			1.70		
C1	CTI/HI	1 F	0.23	1.2275	1.2275	0.20	0.0048	0.0048
C1	CTI/HI	1 N	0.84			2.20		
C1	CTI/LO	2 F	0.47	5.3823	5.3823	0.18	0.0084	0.0084
C1	CTI/LO	2 N	0.61			1.20		
C2	CTI/HI	5 F	0.60	6.1920	6.1920	0.16	0.0044	0.0044
C2	CTI/HI	5 N	0.73			1.20		
C3	CTI/HI	3 F	1.40			0.19		
C3	CTI/HI	3 N	4.09			1.60		
C3	CTI/LO	4 F	2.60			0.36		
C3	CTI/LO	4 N	1.06			3.32		
C2	CTI/HI	7 F	3.26	40.9709		0.20	0.0072	0.0072
C2	CTI/HI	7 N	0.87			2.60		
C4	CTI/HI	1 F	13.90			0.24		
C4	CTI/HI	1 N	1.01			1.40		
C4	CTI/LO	2 F	43.10			0.26		
C4	CTI/LO	2 N	2.39			5.92		
	Average			7.502	2.721		0.007	0.007
	Rel. Std. D				78%			31%
COOLING WATER (ppm)								
	Run 1		0.44			109.29		
	Run 2		0.18			113.13		
	Run 3		0.11			108.18		
	Run 4		0.06			111.14		
AUDITS (ppm)								
	Low		5.37			5.20		
	High		51.10			49.70		
DETECTION LIMIT			0.03			0.08		

Cooling Tower Test
EEI #3644

Analysis and Drift Data (UoM Analysis)

BLANKS	MANGANESE (ppm)	Percent Drift	Percent Drift (T-test)	SODIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water	ND			0.17		
Nitric Acid	0.01			0.48		
Filter, 47mm qtz	0.00			0.40		
Filter, Whatman 41	ND			0.10		
Filter, Pflex qtz	0.01			0.61		

Fan No.	Type	Run No.	Matrix						
C2	CTI/HI	1	F	0.02	2.4919	2.4919	1.10	0.0163	0.0163
C2	CTI/HI	1	N	0.19			6.49		
C3	CTI/HI	1	F	0.02	2.0885	2.0885	0.98	0.0208	0.0208
C3	CTI/HI	1	N	0.14			8.01		
C3	CTI/LO	2	F	0.02	15.8648	15.8648	1.20	0.0259	0.0259
C3	CTI/LO	2	N	1.41			9.81		
C2	CTI/HI	3	F	0.02	4.0854	4.0854	0.76	0.0108	0.0108
C2	CTI/HI	3	N	0.20			5.42		
C1	CTI/HI	1	F	0.02	6.1129	6.1129	1.30	0.0080	0.0080
C1	CTI/HI	1	N	0.59			4.48		
C1	CTI/LO	2	F	0.02	1.6192	1.6192	1.00	0.0140	0.0140
C1	CTI/LO	2	N	0.02			3.18		
C2	CTI/HI	5	F	0.00	2.0158	2.0158	0.82	0.0054	0.0054
C2	CTI/HI	5	N	0.11			2.57		
C3	CTI/HI	3	F	0.05			0.91		
C3	CTI/HI	3	N	0.13			3.36		
C3	CTI/LO	4	F	0.14			1.30		
C3	CTI/LO	4	N	0.04			6.16		
C2	CTI/HI	7	F	0.15	6.7108	6.7108	0.80	0.0081	0.0081
C2	CTI/HI	7	N	0.11			5.59		
C4	CTI/HI	1	F	3.07			1.10		
C4	CTI/HI	1	N	0.09			2.70		
C4	CTI/LO	2	F	4.86			1.20		
C4	CTI/LO	2	N	0.06			10.70		
	Average				5.124	5.124		0.014	0.014
	Rel. Std. D					93%			51%

COOLING WATER (ppm)		
Run 1	0.04	205.32
Run 2	0.02	213.20
Run 3	0.02	203.33
Run 4	0.02	211.32

AUDITS (ppm)		
Low	5.13	5.60
High	49.00	52.30

DETECTION LIMIT	0.01	0.05

Cooling Tower Test
EEI #3644

Analysis and Drift Data (UoM Analysis)

BLANKS				STRONTIUM (ppm)	Percent Drift	Percent Drift (T-test)	TITANIUM (ppm)	Percent Drift	Percent Drift (T-test)
DI Water				0.00			ND		
Nitric Acid				0.00			0.01		
Filter, 47mm qtz				0.01			0.44		
Filter, Whatman 41				0.00			0.06		
Filter, Pflex qtz				0.02			0.04		
Fan No.	Type	Run No.	Matrix						
C2	CTI/HI	1	F	0.02	0.0098	0.0098	0.10	1.1788	1.1788
C2	CTI/HI	1	N	0.04			0.03		
C3	CTI/HI	1	F	0.02	0.0119	0.0119	0.54	9.5019	
C3	CTI/HI	1	N	0.04			0.03		
C3	CTI/LO	2	F	0.02	0.0135	0.0135	0.05	0.4836	0.4836
C3	CTI/LO	2	N	0.06			0.03		
C2	CTI/HI	3	F	0.03	0.0085	0.0085	0.07	0.4941	0.4941
C2	CTI/HI	3	N	0.03			0.02		
C1	CTI/HI	1	F	0.02	0.0043	0.0043	0.07	0.5707	0.5707
C1	CTI/HI	1	N	0.03			0.02		
C1	CTI/LO	2	F	0.02	0.0104	0.0104	0.27	6.9473	
C1	CTI/LO	2	N	0.02			0.01		
C2	CTI/HI	5	F	0.02	0.0060	0.0060	0.04	0.1792	0.1792
C2	CTI/HI	5	N	0.02			0.03		
C3	CTI/HI	3	F	0.02			0.08		
C3	CTI/HI	3	N	0.08			0.08		
C3	CTI/LO	4	F	0.02			0.04		
C3	CTI/LO	4	N	0.05			0.02		
C2	CTI/HI	7	F	0.02	0.0059	0.0059	0.08	0.5167	0.5167
C2	CTI/HI	7	N	0.04			0.01		
C4	CTI/HI	1	F	0.02			0.06		
C4	CTI/HI	1	N	0.02			0.03		
C4	CTI/LO	2	F	0.02			0.04		
C4	CTI/LO	2	N	0.08			0.08		
	Average				0.009	0.009		2.484	0.571
	Rel. Std. D					36%			58%
COOLING WATER (ppm)									
	Run 1			2.03			0.07		
	Run 2			2.09			0.07		
	Run 3			1.99			0.07		
	Run 4			2.08			0.07		
AUDITS (ppm)									
	Low			0.58			0.00		
	High			5.58			0.00		
DETECTION LIMIT				0.00			0.01		

Cooling Tower Test
EEI #3644 Analysis and Drift Data (UoM Analysis)

BLANKS	ZINC (ppm)	Percent Drift	Percent Drift (T-test)
DI Water	0.05		
Nitric Acid	0.25		
Filter, 47mm qtz	0.02		
Filter, Whatman 41	0.01		
Filter, Pflex qtz	ND		

Fan No.	Type	Run No.	Matrix			
C2	CTI/HI	1	F	0.00	2.7680	2.7680
C2	CTI/HI	1	N	0.94		
C3	CTI/HI	1	F	0.02	4.2319	4.2319
C3	CTI/HI	1	N	1.17		
C3	CTI/LO	2	F	0.06	4.7898	4.7898
C3	CTI/LO	2	N	1.25		
C2	CTI/HI	3	F	0.00	1.2507	1.2507
C2	CTI/HI	3	N	0.49		
C1	CTI/HI	1	F	0.02	1.2671	1.2671
C1	CTI/HI	1	N	0.43		
C1	CTI/LO	2	F	0.00	0.6423	0.6423
C1	CTI/LO	2	N	0.38		
C2	CTI/HI	5	F	0.00	26.0170	
C2	CTI/HI	5	N	1.17		
C3	CTI/HI	3	F	0.04		
C3	CTI/HI	3	N	1.17		
C3	CTI/LO	4	F	0.02		
C3	CTI/LO	4	N	0.71		
C2	CTI/HI	7	F	0.04	6.6882	6.6882
C2	CTI/HI	7	N	0.47		
C4	CTI/HI	1	F	0.38		
C4	CTI/HI	1	N	7.28		
C4	CTI/LO	2	F	0.58		
C4	CTI/LO	2	N	1.11		
	Average				5.957	3.091
	Rel. Std. D					72%

COOLING WATER (ppm)	
Run 1	0.12
Run 2	0.08
Run 3	0.02
Run 4	0.02

AUDITS (ppm)	
Low	5.23
High	48.90

DETECTION LIMIT	0.02

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (UoM Analysis)

BLANKS				ALUMINU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	CALCIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	CHROMIU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	COPPER ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM												
C2	CTI/HI	1	10.63	109.20	10.2728	10.2728	200.00	18.8147	18.8147	11.20	1.0536	1.0536	9.72	0.9140	0.9140
C3	CTI/HI	1	10.76	33.60	3.1227	3.1227	249.00	23.1413	23.1413	6.64	0.6171	0.6171	8.90	0.8268	0.8268
C3	CTI/LO	2	6.29	61.80	9.8251	9.8251	168.00	26.7091	26.7091	2.80	0.4452	0.4452	6.37	1.0124	1.0124
C2	CTI/HI	3	14.83	62.00	4.1807	4.1807	160.00	10.7889	10.7889	3.16	0.2131	0.2131	2.50	0.1683	0.1683
C1	CTI/HI	1	15.52	43.80	2.8222	2.8222	170.00	10.9536	10.9536	0.78	0.0503	0.0503	1.53	0.0985	0.0985
C1	CTI/LO	2	8.69	21.60	2.4856	2.4856	134.00	15.4200	15.4200	1.88	0.2163	0.2163	2.36	0.2711	0.2711
C2	CTI/HI	5	16.52	90.00	5.4479	5.4479	190.00	11.5012	11.5012	11.52	0.6973	0.6973	5.02	0.3036	0.3036
C3	CTI/HI	3	15.06	83.80			98.00			33.30			14.31		
C3	CTI/LO	4	8.60	127.60			400.00			69.76			4.34		
C2	CTI/HI	7	20.92	35.60	1.7017	1.7017	289.00	13.8145	13.8145	77.24	3.6922		7.88	0.3765	0.3765
C4	CTI/HI	1	26.39	135.60			240.00			339.40			38.11		
C4	CTI/LO	2	10.16	113.60			640.00			971.84			65.88		
	Average				4.982	4.982		16.393	16.393		0.873	0.470		0.496	0.496
	Rel. Std. Dev.					67%			36%			74%			73%
COOLING WATER (ppm)															
	Run 1			0.20			369.27			0.02			0.10		
	Run 2			0.10			378.28			0.01			0.06		
	Run 3			0.07			357.97			0.01			0.04		
	Run 4			0.05			370.80			0.01			0.04		
AUDITS (ppm)															
	Low			5.10			0.89			5.20			5.18		
	High			49.70			4.90			49.10			50.20		
DETECTION LIMIT				0.10			2.00			0.05			0.01		

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (UoM Analysis)

BLANKS				IRON ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	MAGNESIU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	MANGANE ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	SODIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM												
C2	CTI/HI	1	10.63	62.80	5.9078	5.9078	64.98	6.1129	6.1129	8.63	0.8119	0.8119	289.40	27.2248	27.2248
C3	CTI/HI	1	10.76	49.00	4.5539	4.5539	94.98	8.8271	8.8271	6.63	0.6162	0.6162	338.20	31.4312	31.4312
C3	CTI/LO	2	6.29	27.20	4.3243	4.3243	47.44	7.5421	7.5421	29.33	4.6630		245.60	39.0461	39.0461
C2	CTI/HI	3	14.83	30.12	2.0310	2.0310	63.08	4.2535	4.2535	9.03	0.6089	0.6089	212.60	14.3358	14.3358
C1	CTI/HI	1	15.52	19.52	1.2577	1.2577	47.44	3.0567	3.0567	12.89	0.8305	0.8305	149.00	9.6005	9.6005
C1	CTI/LO	2	8.69	47.88	5.5098	5.5098	46.98	5.4062	5.4062	1.91	0.2198	0.2198	147.00	16.9160	16.9160
C2	CTI/HI	5	16.52	65.68	3.9758	3.9758	44.98	2.7228	2.7228	4.20	0.2542	0.2542	104.60	6.3317	6.3317
C3	CTI/HI	3	15.06	201.60			34.44			7.03			87.60		
C3	CTI/LO	4	8.60	279.00			149.28			14.75			296.20		
C2	CTI/HI	7	20.92	337.56	16.1358		104.98	5.0182	5.0182	18.43	0.8810	0.8810	223.40	10.6788	10.6788
C4	CTI/HI	1	26.39	1390.00			35.44			307.93			93.40		
C4	CTI/LO	2	10.16	4382.20			243.68			487.55			467.80		
	Average				5.462	3.937		5.367	5.367		1.111	0.603		19.446	19.446
	Rel. Std. Dev					44%			39%			45%			60%
COOLING WATER (ppm)															
	Run 1			0.44			109.29			0.04			205.32		
	Run 2			0.18			113.13			0.02			213.20		
	Run 3			0.11			108.18			0.02			203.33		
	Run 4			0.06			111.14			0.02			211.32		
AUDITS (ppm)															
	Low			5.37			5.20			5.13			5.60		
	High			51.10			49.70			49.00			52.30		
DETECTION LIMIT				0.03			0.08			0.01			0.05		

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (UoM Analysis)

BLANKS				STRONTIU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	TITANIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	ZINC ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM									
C2	CTI/HI	1	10.63	1.72	0.1622	0.1622	6.94	0.6529	0.6529	27.80	2.6152	2.6152
C3	CTI/HI	1	10.76	1.92	0.1788	0.1788	51.28	4.7658		38.96	3.6208	3.6208
C3	CTI/LO	2	6.29	1.26	0.2006	0.2006	1.52	0.2417	0.2417	25.68	4.0827	4.0827
C2	CTI/HI	3	14.83	1.64	0.1109	0.1109	3.14	0.2117	0.2117	9.56	0.6446	0.6446
C1	CTI/HI	1	15.52	0.79	0.0510	0.0510	3.46	0.2229	0.2229	9.24	0.5954	0.5954
C1	CTI/LO	2	8.69	1.06	0.1224	0.1224	23.56	2.7112	2.7112	2.62	0.3015	0.3015
C2	CTI/HI	5	16.52	1.12	0.0680	0.0680	1.12	0.0678	0.0678	36.96	2.2373	2.2373
C3	CTI/HI	3	15.06	1.88			5.38			40.96		
C3	CTI/LO	4	8.60	2.36			0.88			11.36		
C2	CTI/HI	7	20.92	1.60	0.0767	0.0767	4.46	0.2132	0.2132	13.12	0.6272	0.6272
C4	CTI/HI	1	26.39	0.73			2.96			319.36		
C4	CTI/LO	2	10.16	3.40			3.30			75.28		
		Average			0.121	0.121		1.136	0.617		1.841	1.841
		Rel. Std. Dev				45%			152%			82%
COOLING WATER (ppm)												
		Run 1		2.03			0.07			0.12		
		Run 2		2.09			0.07			0.08		
		Run 3		1.99			0.07			0.02		
		Run 4		2.08			0.07			0.02		
AUDITS (ppm)												
		Low		0.58			0.00			5.23		
		High		5.58			0.00			48.90		
DETECTION LIMIT				0.00			0.01			0.02		

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (RTI Analysis)

BLANKS				ALUMINU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	BORON ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	CALCIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	CHROMIU ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM												
C2	CTI/HI	1	10.63	45.24	4.2559	4.2559	3.88	0.3650	0.3650	38.30	3.6030	3.6030	2.94	0.2766	0.2766
C2	CTI/LO	2	5.86	17.24	2.9420	2.9420	2.98	0.5085	0.5085	28.30	4.8294	4.8294	1.88	0.3208	0.3208
C3	CTI/HI	1	10.76	49.64	4.6134	4.6134	7.98	0.7416	0.7416	69.40	6.4498	6.4498	3.20	0.2974	0.2974
C2	CTI/HI	3	14.83	67.00	4.5179	4.5179	7.28	0.4909	0.4909	49.30	3.3243	3.3243	3.84	0.2589	0.2589
C2	CTI/LO	4	8.34	33.00	3.9568	3.9568	15.10	1.8106		21.86	2.6211	2.6211	1.88	0.2254	0.2254
C1	CTI/HI	1	15.52	28.00	1.8041	1.8041	10.20	0.6572	0.6572	66.00	4.2526	4.2526	1.46	0.0941	0.0941
C2	CTI/HI	5	16.52	58.00	3.5109	3.5109	5.44	0.3293	0.3293	51.50	3.1174	3.1174	3.30	0.1998	0.1998
C2	CTI/LO	6	9.14	61.36	6.7133	6.7133	8.06	0.8818	0.8818	24.70	2.7024	2.7024	1.88	0.2057	0.2057
C3	CTI/HI	3	15.06	58.00			6.70			30.00			2.10		
C2	CTI/HI	7	20.92	36.00	1.7208	1.7208	5.88	0.2811	0.2811	47.90	2.2897	2.2897	4.30	0.2055	0.2055
C2	CTI/LO	8	8.30	82.96	9.9952		7.12	0.8578	0.8578	34.90	4.2048	4.2048	2.42	0.2916	0.2916
C4	CTI/HI	1	26.39	27.84			5.80			64.20			3.04		
		Average			4.403	3.782		0.692	0.568		3.739	3.739		0.238	0.238
		Rel. Std. Dev.				41%			40%			33%			28%
COOLING WATER (ppm)															
		Run 1		0.20			9.33			369.27			0.02		
		Run 2		0.10			11.50			378.28			0.01		
		Run 3		0.07			12.26			357.97			0.01		
		Run 4		0.05			12.00			370.80			0.01		
AUDITS (ppm)															
		Low		4.49			ND			0.11			5.05		
		High		44.80			ND			0.81			47.40		
DETECTION LIMIT				0.14			0.01			0.00			0.01		

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (RTI Analysis)

BLANKS				COPPER ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	IRON ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	MAGNESI ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	MANGAN ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM												
C2	CTI/HI	1	10.63	7.36	0.6924	0.6924	38.88	3.6576	3.6576	61.30	5.7667	5.7667	7.16	0.6736	0.6736
C2	CTI/LO	2	5.86	5.06	0.8635	0.8635	22.14	3.7782	3.7782	10.20	1.7406	1.7406	23.60	4.0273	
C3	CTI/HI	1	10.76	8.16	0.7584	0.7584	49.98	4.6450	4.6450	85.50	7.9461	7.9461	4.90	0.4554	0.4554
C2	CTI/HI	3	14.83	2.04	0.1376	0.1376	35.98	2.4262	2.4262	53.30	3.5941	3.5941	6.98	0.4707	0.4707
C2	CTI/LO	4	8.34	1.54	0.1847	0.1847	19.32	2.3165	2.3165	41.90	5.0240	5.0240	0.80	0.0959	0.0959
C1	CTI/HI	1	15.52	1.92	0.1237	0.1237	29.96	1.9304	1.9304	74.40	4.7938	4.7938	19.52	1.2577	1.2577
C2	CTI/HI	5	16.52	1.80	0.1090	0.1090	28.28	1.7119	1.7119	35.40	2.1429	2.1429	3.48	0.2107	0.2107
C2	CTI/LO	6	9.14	1.36	0.1488	0.1488	50.94	5.5733	5.5733	55.90	6.1160	6.1160	0.82	0.0897	0.0897
C3	CTI/HI	3	15.06	21.64			147.68			58.40			4.56		
C2	CTI/HI	7	20.92	4.08	0.1950	0.1950	55.96	2.6750	2.6750	85.90	4.1061	4.1061	3.86	0.1845	0.1845
C2	CTI/LO	8	8.30	1.68	0.2024	0.2024	52.74	6.3542	6.3542	60.90	7.3373	7.3373	1.08	0.1301	0.1301
C4	CTI/HI	1	26.39	1.56			44.40			46.70			3.78		
		Average			0.342	0.342		3.507	3.507		4.857	4.857		0.760	0.396
		Rel. Std. Dev.				88%			45%			42%			96%
COOLING WATER (ppm)															
		Run 1		0.10			0.44			109.29			0.04		
		Run 2		0.06			0.18			113.13			0.02		
		Run 3		0.04			0.11			108.18			0.02		
		Run 4		0.04			0.06			111.14			0.02		
AUDITS (ppm)															
		Low		5.17			5.19			4.79			4.76		
		High		49.20			50.00			46.40			46.40		
DETECTION LIMIT				0.03			0.02			0.00			0.00		

Cooling Tower Test
EEI #3644

Analysis and Concentration Data (RTI Analysis)

BLANKS				SODIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	STRONTI ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	TITANIUM ug	Conc. ug/dscm	Conc. ug/dscm (T-test)	ZINC ug	Conc. ug/dscm	Conc. ug/dscm (T-test)
Fan No.	Type	Run No.	DSCM												
C2	CTI/HI	1	10.63	27.00	2.5400	2.5400	1.60	0.1505	0.1505	6.52	0.6134	0.6134	27.76	2.6115	2.6115
C2	CTI/LO	2	5.86	23.30	3.9761	3.9761	1.12	0.1911	0.1911	1.94	0.3311	0.3311	16.06	2.7406	2.7406
C3	CTI/HI	1	10.76	48.80	4.5353	4.5353	1.74	0.1617	0.1617	57.36	5.3309		29.96	2.7844	2.7844
C2	CTI/HI	3	14.83	31.56	2.1281	2.1281	1.20	0.0809	0.0809	3.68	0.2481	0.2481	7.66	0.5165	0.5165
C2	CTI/LO	4	8.34	22.72	2.7242	2.7242	0.76	0.0911	0.0911	4.64	0.5564	0.5564	14.16	1.6978	1.6978
C1	CTI/HI	1	15.52	26.78	1.7255	1.7255	1.00	0.0644	0.0644	4.74	0.3054	0.3054	5.28	0.3402	0.3402
C2	CTI/HI	5	16.52	17.12	1.0363	1.0363	0.96	0.0581	0.0581	1.60	0.0969	0.0969	27.96	1.6925	1.6925
C2	CTI/LO	6	9.14	14.60	1.5974	1.5974	0.98	0.1072	0.1072	1.84	0.2013	0.2013	9.60	1.0503	1.0503
C3	CTI/HI	3	15.06	13.96			3.02			6.64			32.02		
C2	CTI/HI	7	20.92	18.72	0.8948	0.8948	1.24	0.0593	0.0593	3.40	0.1625	0.1625	10.04	0.4799	0.4799
C2	CTI/LO	8	8.30	16.16	1.9470	1.9470	1.24	0.1494	0.1494	10.58	1.2747	1.2747	7.86	0.9470	0.9470
C4	CTI/HI	1	26.39	8.34			0.60			2.66			246.62		
		Average			2.310	2.310		0.111	0.111		0.912	0.421		1.486	1.486
		Rel. Std. Dev.				51%			43%			86%			65%
COOLING WATER (ppm)															
		Run 1		205.32			2.03			0.07			0.12		
		Run 2		213.20			2.09			0.07			0.08		
		Run 3		203.33			1.99			0.07			0.02		
		Run 4		211.32			2.08			0.07			0.02		
AUDITS (ppm)															
		Low		0.49			0.51			ND			4.96		
		High		5.41			5.05			0.01			48.50		
DETECTION LIMIT				0.03			0.00			0.01			0.01		

APPENDIX B

FIELD AND ANALYTICAL DATA

NOTE: Sample custody teams and isokinetic sampling teams used different numbers to refer to samples. Below is a list of references to associate sample analysis numbers to the run numbers reported earlier in the report:

Date	Sampling Run Number			Analysis Run Number
July 9	C2	CTD/HI	1	2-CTI/HI-1A
	C2	CTD/LO	2	2-CTI/LO-1B
	C3	CTD/HI	1	3-CTI/HI-1C
	C3	CTD/LO	2	3-CTI/LO-1D
July 10	C2	CTD/HI	3	2-CTI/HI-2A
	C2	CTD/LO	4	2-CTI/LO-2B
	C1	CTD/HI	1	1-CTI/HI-2C
	C1	CTD/LO	2	1-CTI/LO-2D
July 11	C2	CTD/HI	5	2-CTI/HI-3A
	C2	CTD/LO	6	2-CTI/LO-3B
	C3	CTD/HI	3	3-CTI/HI-3C
	C3	CTD/LO	4	3-CTI/LO-3D
July 12	C2	CTD/HI	7	2-CTI/HI-4A
	C2	CTD/LO	8	2-CTI/LO-4B
	C4	CTD/HI	1	4-CTI/HI-4C
	C4	CTD/LO	2	4-CTI/LO-4D

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER ~~1~~ 1-2-C
ADDRESS (High Volume) — TIME START 9:32
SAMPLING LOCATION Cooling Tower cell #1 — TIME FINISH 19:04
DATE 7-1 .5 — TEAM LEADER M.H — TECHNICIANS W.K
BAROMETRIC PRESSURE. IN. HG 30.02 — STATIC PRESSURE IN. H_2O ~ 0
TRAIN LEAK CHECK VACUUM IN. HG 15 10 — — — — —
TRAIN LEAK RATE, CU.FT/MIN .21 .1 — — — — —

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 95 PRE
- ✓ THERMOCOUPLE @ 92 POST

IDENTIFICATION NUMBERS .369

REAGENT BOX ___ NOZZLE ___ DIAMETER ~~.376~~
METER BOX HV-2 .9821 T/C READOUT R+A-
UMBILICAL ___ T/C PROBE R-133
SAMPLE BOX ___ ORSAT PUMP ___
PROBE 11-2-4 PITOT 39 TEDLAR BAG ___

LEAK CHECK READINGS

	B	E
1		
2		
3		
4		
5		
6		

FILTER #	TARE

DELTA $H_@$	.3031			
METER TEMP	100			
EST. $\%H_2O$	4.5			
C FACTOR	.171			
STACK TEMP	95			
REF DELTA P	.583			
K-FACTOR	3.154			

FYRITE

C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	C-1	0	844.631	.20	.63	.63	85	4	N/A	N/A	89	
2	-2	4	454.41	.20	1.32	1.32	86	5			90	
3	-3	25	879.17	.63	1.99	1.99	91	6			90	
4	-4	40½	910.47	.58	1.83	1.83	92	6			86	
5	-5	54¾	937.63	.56	1.76	1.76	93	5			84	
6	-6	68¾	963.82	.27	.85	.85	93	4			83	
7	B-1	81¼	979.402	.38	1.20	1.20	90	5			86	
8	-2	9	993.45	.50	1.54	1.58	90	5			86	
9	-3	22½	17.70	.56	1.77	1.77	91	6			88	
10	-4	35¾	42.18	.58	1.83	1.83	94	6			92	
11	-5	51½	72.05	.59	.86	1.86	95	6			90	
12	-6	67¾	102.9	.21	.66	.66	97	3			89	
13	D-1	77¾	114.038	.35	1.10	1.10	95	4			94	
14	-2	13½	134.92	.46	1.45	1.45	98	5			95	
15	-3	29¼	163.00	.40	1.26	1.26	99	5			94	
16	-4	43½	185.68	.55	1.73	1.73	99	6			92	
17	-5	59½	214.98	.60	1.89	1.89	99	6			91	
18	-6	75¾	247.12	.22	.69	.69	100	3			89	
19	A-1	89¼	260.450	.41	1.29	1.29	101	5			94	
20	-2	17	287.07	.50	1.58	1.58	99	6			94	
21	-3	34½	315.93	.58	1.83	1.83	98	6			93	
22	-4	52¼	354.080	.64	2.02	2.02	100	6			93	
23	-5	17¾	390.33	.62	1.96	1.96	101	6			91	
24	-6	35½	424.65	.10	.32	.32	100	3			90	
25		42	1427.761									

342.5	583.130	0.4377	1.433	95	90
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010-3
12/89
p1

A1-CTT-1

ISOKINETIC TYPE FIELD DATA SHEET

1-2D

COMPANY NAME Site #2 RUN NUMBER ~~1-A-B~~

ADDRESS [redacted] (low-volume) TIME START 7:50

SAMPLING LOCATION cooling tower cell #1 TIME FINISH 19:07

DATE 7-10-90 TEAM LEADER MLH TECHNICIANS WK

BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O ~0

TRAIN LEAK CHECK VACUUM IN. HG 15 8

TRAIN LEAK RATE, CU.FT/MIN .002 .003

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 95 PRE
- ✓ THERMOCOUPLE @ 95 POST

IDENTIFICATION NUMBERS

REAGENT BOX ____ NOZZLE ____ DIAMETER .275

METER BOX RAI-3 Y L136 T/C READOUT K-4

UMBILICAL ____ T/C PROBE K-33

SAMPLE BOX ____ ORSAT PUMP N/A

PROBE K-24 PITOT 39 TEDLAR BAG ____

LEAK CHECK READINGS

	B	E
1		
2		
3		
4		
5		
6		

FILTER #	TARE

DELTA $H_@$	1.564				FYRITE
METER TEMP	100				
EST. $\%H_2O$	4.5				
C FACTOR	.885				
STACK TEMP	95				
REF DELTA P	.367				
K-FACTOR	5.020				C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	C-1	0	592.627	.20	1.00	1.00	80	3	N/A	N/A	89	
2	-2	9	597.40	.42	2.11	2.11	84	4			90	
3	-3	25	608.97	.63	3.16	3.16	87	5			93	
4	-4	40½	623.041	.54	2.91	2.91	92	5			95	
5	-5	54¾	636.36	.56	2.81	2.81	94	5			94	
6	-6	68¾	648.97	.27	1.35	1.35	95	3			83	
7	B-1	81¼	657.937	.38	1.91	1.91	96	4			86	
8	-2	9	663.65	.50	2.51	2.51	92	4			85	
9	-3	22½	675.08	.56	2.81	2.81	94	5			88	
10	-4	35¾	687.05	.58	2.91	2.91	104	5			92	
11	-5	51½	700.65	.59	2.96	2.96	106	5			90	
12	-6	67¾	716.98	.21	1.05	1.05	106	3			89	
13	D-1	77¾	722.714	.35	1.76	1.76	100	4			94	
14	-2	13½	732.28	.46	2.31	2.31	100	5			95	
15	-3	29¼	745.25	.40	2.01	2.01	101	5			94	
16	-4	43½	756.33	.55	2.76	2.76	103	5			92	
17	-5	57½	770.90	.60	3.01	3.01	107	5			91	
18	-6	75¾	785.98	.22	1.10	1.10	108	3			89	
19	A-1	89¼	794.123	.41	2.06	2.06	96	5			94	
20	-2	L7	807.00	.50	2.51	2.51	98	5			94	
21	-3	34½	821.94	.58	2.91	2.91	101	5			93	
22	-4	52¼	838.433	.64	3.21	3.21	99	5			93	
23	-5	17¾	855.60	.62	3.11	3.11	100	5			91	
24	-6	35½	872.58	.10	.50	.50	102	2			90	
25		42	875.208									

342.5	282.581	0.4377	2.281	97	90
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010-3
12/89
p1

C1-CTI-2

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site # 2 - EMB #3625 RUN NUMBER 2-2A
ADDRESS TIME START 0927
SAMPLING LOCATION FAN Cell #2 TIME FINISH 1902
DATE 07.10.90 TEAM LEADER B. Rudd TECHNICIANS T. Brozell
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 5
TRAIN LEAK RATE, CU.FT/MIN 0.008 0.005

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ___ PITOTS, POSTTEST
- ___ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 95 PRE
- ___ THERMOCOUPLE @ ___ POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.370
METER BOX HV-1 Y 1.022 T/C READOUT F.28
UMBILICAL A T/C PROBE R.189
SAMPLE BOX A ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B 1	
E	
B 2	
E	
B 3	
E	
B 4	
E	
B 5	
E	
B 6	
E	

FILTER #	TARE

DELTA $H_@$	0.2597			
METER TEMP	100			
EST. $\%H_2O$	4.5			
C FACTOR	0.147			
STACK TEMP	95			
REF DELTA P	0.074			
K-FACTOR	2.732			

FYRITE
C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK
1	C 1	0/0	143.611	0.38	1.04	1.04	85	2	N/A	N/A	79	
2	2	16 1/2	168.25	0.49	1.32	1.32	89	2			90	
3	3	33 3/4	197.22	0.53	1.43	1.43	92	2			91	
4	4	51 1/2	227.83	0.56	1.53	1.53	93	4			88	
5	5	68 1/2	258.26	0.51	1.40	1.40	94	4			85	
6	6	86	288.33	0.13	0.36	0.36	93	2			86	
7	B 1	93 1/2 0	295.274	0.23	0.63	0.63	90	2			87	
8	2	12 1/4	310.22	0.46	1.26	1.26	93	3			88	
9	3	28 1/2	336.45	0.48	1.32	1.32	101	4			92	
10	4	45	363.90	0.50	1.36	1.36	102	4			98	
11	5	62	392.69	0.53	1.46	1.46	103	4			91	
12	6	78 1/4	421.87	0.25	0.68	0.68	104	2			98	
13	D - 1	88 1/4 0	434.511	0.29	0.78	0.78	100	3			100	
14	2	12	450.22	0.32	0.88	0.88	100	3			91	
15	3	26 1/2	470.39	0.39	1.06	1.06	101	3			96	
16	4	42 1/2	494.75	0.46	1.25	1.25	101	4			96	
17	5	58 3/4	521.37	0.46	1.26	1.26	101	4			95	
18	6	75	548.43	0.08	0.22	0.22	100	1			96	
19	A - 1	76 1/4 0	550.838	0.22	0.60	0.60	98	2			92	
20	2	13 3/4	566.02	0.37	1.01	1.01	97	3			94	
21	3	29 3/4	589.68	0.53	1.43	1.43	100	5			99	
22	4	47 1/4	620.21	0.50	1.36	1.36	101	5			95	
23	5	64 1/4	648.90	0.46	1.26	1.26	101	4			91	
24	6	80 3/4	675.89	0.10	0.27	0.27	100	2			92	
25		87 1/2	681.505									

345.75	537.894	0.3664	1.049	97		92
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm		ts

F1010
12/89
p1

C2-CTI-3

ISOKINETIC TEE FIELD DATA SHEET

COMPANY NAME Site # 2 - EMB #3625 RUN NUMBER 2-2B
ADDRESS TIME START 0925
SAMPLING LOCATION Fan Cell #2 TIME FINISH 1900
DATE 07-10-90 TEAM LEADER B Rudd TECHNICIANS T. Brozell
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 5
TRAIN LEAK RATE, CU.FT/MIN 0.003 0.004

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ___ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ ~~75~~ PRE
- ___ THERMOCOUPLE @ ___ POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.275
METER BOX RAC-1 Y 1.040 T/C READOUT E28
UMBILICAL 6 T/C PROBE R-189
SAMPLE BOX B ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

~~LEAK CHECK READINGS~~
STOP 1132
RESTART 1420

FILTER #	TARE

DELTA $H_@$	1.78			
METER TEMP	100			
EST. $\%H_2O$	4.5			
C FACTOR	1.017			
STACK TEMP	95			
REF DELTA P	0.319			
K-FACTOR	5.772			

FYRITE
C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	B-1	0/0	27.103	0.38	2.19	2.19	85	2	N/A	N/A	79	
2	2	16½	40.29	0.49	2.84	2.84	100	3			90	
3	3	17¼	56.95	0.53	3.07	3.07	101	3			91	
4	4	17¾	74.44	0.56	3.27	3.27	103	3			88	
5	5	17	91.81	0.51	3.00	3.00	104	3			85	
6	6	17½	109.02	0.13	0.76	0.76	103	2			86	
7	B-1	7½/0	113.067	0.23	1.33	1.33	92	2			87	
8	2	12¼	121.03	0.46	2.67	2.67	98	3			88	1
9	3	16¼	135.44	0.48	2.77	2.77	101	3			92	
10	4	16½	151.04	0.50	2.89	2.87	103	3			98	
11	5	17	167.39	0.53	3.08	3.08	104	3			91	
12	6	16½	183.57	0.25	1.44	1.44	107	2			98	
13	A-1	0/0	190.692	0.29	1.63	1.63	92	2			100	
14	2	12	199.53	0.32	1.87	1.87	104	3			91	
15	3	14½	210.18	0.39	2.26	2.26	106	3			96	
16	4	16	223.53	0.46	2.67	2.67	107	3			96	
17	5	16¼	238.27	0.46	2.68	2.68	108	4			95	
18	6	16¼	253.43	0.08	0.47	0.47	109	1			96	
19	A-1	~~16½~~	254.786	0.22	1.27	1.27	99	2			92	
20	2	13¾	263.48	0.37	2.15	2.15	104	3			94	
21	3	16	276.39	0.53	3.05	3.05	106	3			~~93~~	
22	4	17½	293.68	0.50	2.31	2.31	108	3			95	
23	5	17	308.08	0.46	2.70	2.70	109	3			91	
24	6	16½	323.23	0.10	0.59	0.59	109	2			92	
25		6¾	326.586									

345.75	299.483	0.3664	2.20	103	92
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

C2-CTI-4

TEST LOG

Plant Name: Site #2 Date: 7-10-90

Sampling Location: cooling tower cell 1 Initials: MCH

1-2C

~~1-1A~~ - high volume .05 leak thru pumps (valves off

14:32 - 10:50

plant went down: power outage 11:09 - 11:33

14:08 - 15:04

noticed filter shut on backward h/2 thru 3rd port 15:27 - 16:56

change out silgel. 17:18 - 18:10

18:20 - 19:04

~~1-1B~~ good run 9:30 - 10:52

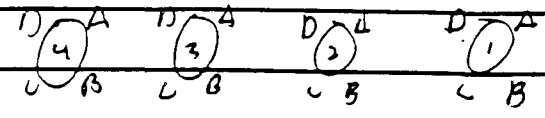
1-20 run at same time as 1-1-A 11:11 - 11:33

14:08 - 15:06

15:25 - 16:56

18:20 - 19:04

17:16 - 18:08



ENTROPY ENVIRONMENTALISTS, INC.

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: Cooling Tower -1 EBI Ref# 3625

Sampling Location: Out, Fan 2

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	2A CTI/HI	2B CTI/LO	
Run Date:	7/10/90	7/10/90	/ /90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (.1 M HNO_3)			
Final Weight, g.	739.0	477.1	
Tared Weight, g.	355.1	257.9	
Water Catch, g.	383.9	219.2	
Reagent 2 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, g.	383.9	219.2	
Silica Gel:			
Final Weight, g.	1381.6	466.2	
Tared Weight, g.	1250.0	400.0	
Absorbed Water, g.	131.6	66.2	
TOTAL WATER COLLECTED, g.	515.5	285.4	

(circle one)

Triple beam or Electronic

Balance # 10

NOTES:

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: COOLING TOWER - 1 EEI Ref# 3625

Sampling Location: OUT FAN 1

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	2C CTI/HI	2D CTI/LO	
Run Date:	7/10/90	7/10/90	/ /90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (_____)			
Final Weight, g.	730.3	470.5	
Tared Weight, g.	357.2	256.0	
Water Catch, g.	373.1	214.5	
Reagent 2 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 (Sil Gel eff)			
Final Weight, g.		208.5	
Tared Weight, g.		200.0	
Water Catch, g.		8.5	
CONDENSED WATER, g.			
Silica Gel:			
Final Weight, g.	1385.0	457.0	
Tared Weight, g.	1250.0	400.0	
Absorbed Water, g.	135.0	57.0	
TOTAL WATER COLLECTED, g.	508.1	280.0	

(circle one)

Triple beam or Electronic

Balance # 10

NOTES:

ISOKINETIC TEE FIELD DATA SHEET

COMPANY NAME _____ RUN NUMBER 2-3A
ADDRESS _____ TIME START 0937
SAMPLING LOCATION FAN CELL # 2 TIME FINISH 1629
DATE 07.11.90 TEAM LEADER B. RUDD TECHNICIANS T. BRODELL
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 5 ___ ___ ___ ___ ___
TRAIN LEAK RATE, CU.FT/MIN 0.004 0.004 ___ ___ ___ ___ ___

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 90 PRE
- ✓ THERMOCOUPLE @ 85 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.376
METER BOX HV-1 Y 1.022 T/C READOUT E28
UMBILICAL A T/C PROBE R-189
SAMPLE BOX A ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B 1	
B 2	
B 3	
B 4	
B 5	
B 6	

FILTER #	TARE

DELTA $H_@$	0.2597	0.2597			FYRITE
METER TEMP	100	90			
EST. $\%H_2O$	4.5	4.5			
C FACTOR	0.147	0.147			
STACK TEMP	95	85			
REF DELTA P	0.674	0.686			
K-FACTOR	2.7732	2.683			C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	~~GAS TEMPERATURES~~ ~~FILTER BOX~~ °F TELE-TAIL	~~GAS TEMPERATURES~~ ~~IMPINGER EXIT~~ °F	STACK TEMP. °F	LK CHK #
1	A-1	0/0	682.275	0.35	0.95	0.95	83	2	45	45	83	
2	2	12 3/4	700.37	0.41	1.11	1.11	86	3			87	
3	3	29 3/4	725.99	0.52	1.40	1.40	87	4			88	
4	4	47 1/4	755.88	0.51	1.37	1.37	88	4			89	
5	5	64	784.78	0.49	1.32	1.32	88	4			89	
6	6	80 3/4	812.36	0.18	0.48	0.48	87	2			90	
7	B-1	92/0	824.874	0.42	1.14	1.14	88	4			84	
8	2	15 3/4	849.62	0.47	1.27	1.27	87	4			87	
9	3	32 1/2	877.47	0.57	1.55	1.55	88	4			85	
10	4	49	907.03	0.57	1.55	1.55	89	4			85	
11	5	65 1/2	937.02	0.56	1.52	1.52	89	4			84	CHANGE
12	6	82	966.37	0.20	0.55	0.55	88	2			77	✓ NC
13	D-1	94 1/2/0	980.569	0.36	0.98	0.98	88	3			84	
14	2	15	1001.97	0.42	1.13	1.13	87	3			90	
15	3	31 1/4	1027.27	0.47	1.27	1.27	87	4			86	
16	4	48	1054.89	0.48	1.29	1.29	87	4			88	
17	5	64 3/4	1082.92	0.45	1.23	1.23	86	4			80	
18	6	81 1/2	1110.34	0.12	0.33	0.33	86	2			80	
19	C-1	98 1/4/0	1116.906	0.48	1.31	1.31	86	4			82	
20	2	17	1145.49	0.47	1.27	1.27	86	4			86	
21	3	34 1/2	1174.76	0.52	1.41	1.41	85	4			81	
22	4	51 3/4	1204.47	0.58	1.57	1.57	85	5			82	
23	5	68 1/4	1234.46	0.45	1.22	1.22	85	4			83	
24	6	85 1/4	1261.93	0.13	0.35	0.35	85	2			81	
25		94 1/2	1270.671									

369.25	588.396	0.4100	1.149	87	85
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

C2-CTI-5

ISOKINETIC FIELD DATA SHEET

COMPANY NAME SITE # 2 - EMB #3625 RUN NUMBER 2-3B
ADDRESS TIME START 0935
SAMPLING LOCATION FAN CELL # 2 TIME FINISH 1627
DATE 07-11-90 TEAM LEADER B. RUDD TECHNICIANS T. BROZEK
BAROMETRIC PRESSURE. IN. HG 30.0 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 5
TRAIN LEAK RATE, CU.FT/MIN 0.007 0.008

EQUIPMENT CHECKS
- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 90 PRE
- ✓ THERMOCOUPLE @ 85 POST

IDENTIFICATION NUMBERS
REAGENT BOX ___ NOZZLE ___ DIAMETER 0.275
METER BOX RAC-1 Y 1.040 T/C READOUT F28
UMBILICAL B T/C PROBE K-189
SAMPLE BOX B ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

LEAK CHEC READINGS

FILTER #	TARE

DELTA $H_@$	1.798	1.798		
METER TEMP	100	100		
EST. $\%H_2O$	4.5	4.5		
C FACTOR	1.017	1.017		
STACK TEMP	95	85		
REF DELTA P	0.319	0.313		
K-FACTOR	5.772	5.877		

FYRITE
C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	
1	A-1	0/0	328.305	0.35	2.01	2.01	84	2	45	45	83	
2	2	12 3/4	337.71	0.41	2.37	2.37	95	3	14	19	87	
17 3/4 3	3	23 3/4	351.94	0.52	3.01	3.01	97	4	9	14	88	
17 1/2 4	4	47 1/4	368.77	0.51	2.95	2.95	99	4	18	21	89	
16 3/4 5	5	64	385.38	0.49	2.84	2.84	100	4	20	22	89	
16 3/4 6	6	80 3/4	400.76	0.18	1.04	1.04	101	3	50	52	90	
11 1/4 7	B-1	92/0	407.763	0.42	2.42	2.42	90	3	26	29	84	
8	2	15 3/4	422.15	0.47	2.74	2.74	100	3	20	21	87	
16 3/4 9	3	32 1/2	436.29	0.57	3.34	3.34	102	4	28	24	85	
16 1/2 10	4	49	453.07	0.57	3.34	3.34	102	4	29	23	85	
16 1/2 11	5	65 1/2	469.54	0.56	3.28	3.28	102	4	20	24	84	
16 1/2 12	6	82	485.98	0.20	1.19	1.19	103	2	50	46	77	
12 1/2 13	D-1	94 1/2/0	494.039	0.36	2.07	2.07	89	3	35	33	84	
14	2	15	505.56	0.42	2.43	2.43	98	3	28	25	90	
16 1/2 15	3	31 1/4	519.09	0.47	2.74	2.74	100	4	22	22	86	
16 3/4 16	4	48	534.34	0.48	2.78	2.78	99	4	26	22	88	
16 3/4 17	5	64 3/4	550.00	0.45	2.65	2.65	99	4	48	22	80	
16 3/4 18	6	81 1/2	564.85	0.12	0.71	0.71	100	2	62	68	80	
6 3/4 19	C-1	88 1/4/0	568.364	0.48	2.77	2.77	88	4	23	18	82	
20	2	17	583.96	0.47	2.73	2.73	99	4	18	15	86	
17 1/2 21	3	34 1/2	600.04	0.52	3.06	3.06	101	4	21	16	81	
17 1/4 22	4	51 3/4	616.73	0.58	3.40	3.40	100	4	25	24	82	
16 1/2 23	5	68 1/4	633.43	0.45	2.63	2.63	100	4	29	18	83	
17 24	6	85 1/4	648.78	0.13	0.76	0.76	99	2	65	59	81	
9 1/4 25		94 1/2	653.603									
		369.25	325.298	0.4100		2.469	98				85	
		minutes	Vm	$(\sqrt{\Delta p})^2$		ΔH	tm				ts	

F1010
12/89
p1

C2-CTI-6

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER 3-3 C
ADDRESS High Volume — TIME START 9:34
SAMPLING LOCATION Cooling Tower Cell #3 — TIME FINISH 15:35
DATE 7-11-90 — TEAM LEADER MCH — TECHNICIANS WKK
BAROMETRIC PRESSURE. IN. HG 30.10 — STATIC PRESSURE IN. H_2O ~0
TRAIN LEAK CHECK VACUUM IN. HG 14 20
TRAIN LEAK RATE, CU.FT/MIN .115 .165

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 90 PRE
- ✓ THERMOCOUPLE @ 85 POST

IDENTIFICATION NUMBERS

REAGENT BOX ____ NOZZLE ____ DIAMETER .369
METER BOX HV-2 Y 19821 T/C READOUT R+A
UMBILICAL ____ T/C PROBE R133
SAMPLE BOX ____ ORSAT PUMP ____
PROBE 11-24 PITOT 34 TEDLAR BAG N/A

LEAK CHECK READINGS

B 1 E	9:3	11:
B 2 E	11:3	13:
B 3 E	13	15
B 4 E	15	15
B 5 E		
B 6 E		

FILTER #	TARE

						FYRITE
DELTA $H_@$	.3031					
METER TEMP	100					
EST. $\%H_2O$	4.5					
C FACTOR	.171					
STACK TEMP	90					
REF DELTA P	.578					
K-FACTOR	3.183					C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	428.928	.25	.79	.79	81	3	N/A	N/A	88	
2	-2	17 1/4	450.02	.55	1.75	1.75	86	5			89	
3	-3	35 1/4	471.08	.60	1.91	1.91	88	6			86	
4	-4	53	516.31	.59	1.83	1.88	89	6			85	
5	-5	71	550.93	.56	1.78	1.78	90	6			85	
6	-6	88 1/2	543.86	.20	.64	.64	10	3			81	
7	B-1	101 1/4	598.490	.36	1.15	1.15	88	4			89	
8	-2	16 3/4	624.07	.56	1.78	1.78	89	7			88	
9	-3	34 1/2	657.84	.53	1.69	1.69	89	7			86	
10	-4	52	511.05	.61	1.94	1.94	90	7			84	
11	-5	70	727.07	.54	1.45	1.45	88	7			82	
12	-6	88	761.40	.32	1.02	1.02	88	4			80	
13	C-1	103 3/4	783.237	.38	1.21	1.21	87	4			83	
14	-2	113/4	810.16	.61	1.94	1.94	89	7			83	
15	-3	35 1/2	845.26	.62	1.97	1.97	90	7			82	
16	-4	53 1/4	880.38	.69	2.20	2.20	90	7			81	
17	-5	71	917.21	.61	1.94	1.94	89	7			78	
18	-6	89	955.00	.12	.38	.38	88	2			76	
19	D 1	94 1/2	957.886	.44	1.56	1.56	87	8			85	
20	-2	16	984.02	.50	1.59	1.57	87	21			85	
21	-3	~~53 1/2~~	987.370									
22	-4		18 finished		vacuum		above 20 in					
23	-5											
24	-6											
25												

5						
317 1/2	558.442	0.9702	1.549	88		R4
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm		ts

F1010-3
12/89
p1

C3-CT2-3

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER 3-3-D
ADDRESS Low Volume — TIME START 9:32
SAMPLING LOCATION Colme Tower Cell #3 — TIME FINISH 15:46
DATE 7-11-90 — TEAM LEADER A. H — TECHNICIANS WKK
BAROMETRIC PRESSURE. IN. HG 30.0 — STATIC PRESSURE IN. H_2O ~0
TRAIN LEAK CHECK VACUUM IN. HG 15 8
TRAIN LEAK RATE, CU.FT/MIN .003 .000

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 90 PRE
- ✓ THERMOCOUPLE @ 92 POST

IDENTIFICATION NUMBERS

REAGENT BOX R — NOZZLE ___ — DIAMETER .275
METER BOX RAI-3 1.136 — T/C READOUT R+A
UMBILICAL ___ — T/C PROBE K133
SAMPLE BOX ___ — ORSAT PUMP ___
PROBE 11-2-4 — PITOT 37 — TEDLAR BAG ___

LEAK CHECK READINGS

B 1 E
B 2 E
B 3 E
B 4 E
B 5 E
B 6 E

FILTER #	TARE

DELTA $H_@$	1.564			
METER TEMP	100			
EST. $\%H_2O$	4.5			
C FACTOR	.885			
STACK TEMP	90			
REF DELTA P	.363			
K-FACTOR	5.066			

FYRITE ___

C_p .84

A

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	875450	.25	1.27	1.27	78	3	N/A	N/A	88	
2	-2	11¼	885.55	.55	2.78	2.78	~	5			89	
3	-3	25¼	901.34	.60	3.04	3.04	90	5			86	
4	-4	53	917.80	.59	2.99	2.94	95	5			85	
5	-5	71	934.48	.56	2.84	2.84	90	5			85	
6	-6	88½	951.24	.20	1.01	1.01	90	3			81	
7	D-1	101¼	957.219	.36	1.82	1.82	86	4			89	
8	2	169/4	969.47	.56	2.84	2.84	88	5			88	
9	-3	34 1/4	985.34	.53	2.68	2.68	91	5			86	
10	-4	52	0.95	.61	3.09	3.09	93	5			84	
11	5	70	17.86	.58	2.94	2.94	93	5			82	
12	-6	88	34.45	.32	1.62	1.62	91	4			80	
13	C-1	102¾	45.977	.38	1.93	1.93	87	4			83	
14	-2	173/4	58.57	.61	3.09	3.09	89	5			83	
15	-3	35½	75.24	.62	3.14	3.14	93	5			82	
16	-4	53¼	92.15	.69	3.50	3.55	95	6			87	
17	-5	71	109.93	.61	3.09	3.09	97	5			78	
18	-6	89	127.78	.12	.61	.61	96	2			76	
19	B 1	94½	130347	.45	2.44	2.46	92	5			85	
20	2	16	144.00	.50	2.53	2.53	92	5			85	
21	~~B/G~~	~~0~~	~~3~~									
22			finish because High Volume train shutdown									
23			~~vacuum~~									
24		25½	1152.150									
25												

~~minutes~~ 325 — ~~276.700~~ Vm — ~~0.4702~~ $(\sqrt{\Delta p})^2$ — ~~2.465~~ ΔH — ~~91~~ ts — ~~84~~ ts

F1010-3 12/89 p1

C3-CTI-4

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: Cooling Tower - 1 EEI Ref# 3625

Sampling Location: Out, Fan 2

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	CT/HI 3A	CT/LO 3B	
Run Date:	7/11/90	7/11/90	/90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (0.1 M HNO_3)

Final Weight, g.	662.3	430.9	
Tared Weight, g.	359.0	259.7	
Water Catch, g.	303.3	171.2	

Reagent 2 (_____)

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

Reagent 3 (_____)

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

CONDENSED WATER, g.	303.3	171.2	
Silica Gel:			
Final Weight, g.	1367.2	678	
Tared Weight, g.	1250.5	600.0	
Absorbed Water, g.	116.7	78	
TOTAL WATER COLLECTED, g.	420.0	239.0	

(circle one)

(Triple beam) or Electronic

Balance # 10

NOTES:

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: Cooling Tower - 1 EEI Ref# 3625

Sampling Location: Out, Fan 3

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	CTI/HI 3C	CTI/LO 3D	
Run Date:	7/11 /90	7/11 /90	/ /90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (0.1 M HNO_3)

Final Weight, g.	625.7	417.0	
Tared Weight, g.	357.2	259.8	
Water Catch, g.	268.5	157.2	

Reagent 2 ( )

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

Reagent 3 ( )

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

CONDENSED WATER, g.	268.5	157.2	
Silica Gel:			
Final Weight, g.	1359.0	663.6	
Tared Weight, g.	1251.0	600.0	
Absorbed Water, g.	108.0	63.6	
TOTAL WATER COLLECTED, g.	376.5	220.8	

(circle one)

Triple beam or Electronic

Balance # 10

NOTES:

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME S.te #2 — RUN NUMBER 3-1-C
ADDRESS — TIME START 14:54
SAMPLING LOCATION Cooling tower CM #3 — TIME FINISH 20:28
DATE 7-9-90 — TEAM LEADER MCH — TECHNICIANS WK
BAROMETRIC PRESSURE. IN. HG 29.4 — STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 12
TRAIN LEAK RATE, CU.FT/MIN .04 .035

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ___ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 100 PRE
- ✓ THERMOCOUPLE @ 100 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER .376
METER BOX ~~3-03H~~ Y .9821 T/C READOUT 4770174
UMBILICAL HV-2 T/C PROBE K-133
SAMPLE BOX ___ ORSAT PUMP ___
PROBE 11-24 PITOT 339 TEDLAR BAG ___

LEAK CHECK READINGS

B 1 E
B 2 E
B 3 E
B 4 E
B 5 E
B 6 E

FILTER #	TARE

DELTA $H_@$	.3031		FYRITE
METER TEMP	100		
EST. $\%H_2O$	5		
C FACTOR	.170		
STACK TEMP	95		
REF DELTA P	.546		
K-FACTOR	3.371		C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H_2O IDEAL	ORIFICE SETTING IN. H_2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A 3	0	425.213	.57	1.92	1.92	103	7	NA	NA	96	
2	4	11:45	447.98	.60	2.02	2.02	102	7			96	
3	5	23:30	469.545	.52	1.75	1.75	103	7			95	
4	6	35:15	490.77	.55	1.85	1.85	106	7			94	
5	2	47:00	512.64	.49	1.65	1.65	106	7			96	
6	1	55:45	535.21	1.23	1.11	1.11	106	7			95	
7	B 1	69:30	550.918	.37	1.05	1.05	109	6			95	
8	2	11:30	564.08	.60	2.02	2.02	104	7			95	
9	3	23:15	591.57	.57	1.92	1.92	107	8			95	
10	4	35:00	613.94	.61	2.05	2.05	108	8			92	
11	5	45:45	637.75	.50	1.69	1.69	110	8			93	
12	6	57:00	654.47	.17	.57	.57	110	8			88	
13	C 1	63:30	661.678	.30	1.01	1.01	102	4			93	
14	2	9:15	674.69	.41	1.38	1.38	101	5			94	
15	3	19:30	692.00	.50	1.69	1.69	101	7			94	
16	4	29:45	711.56	.58	1.96	1.96	101	8			94	
17	5	41:00	734.42	.50	1.69	1.69	100	8			94	
18	6	50:15	751.98	.19	.64	.64	100	8			95	
19	D 1	56:45	758.976	.28	.94	.94	96	5			93	
20	2	11:30	774.03	.56	1.88	1.88	95	7			93	
21	3	23:00	796.03	.62	2.09	2.09	96	8			92	
22	4	34:30	820.15	.62	2.02	2.02	97	8			92	
23		46:00	843.663									
24												
25												
		235.75 minutes	418.450 Vm	0.4563 $(\sqrt{\Delta p})^2$		1.586 ΔH	103 tm				94 ts	

F1010.3
12/89
p1

C3-CTI-1

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER 3-1 B
ADDRESS Worcester MS — TIME START 14:52
SAMPLING LOCATION Cooling Tower Cell #3 — TIME FINISH 20:25
DATE 7-9-90 — TEAM LEADER MH — TECHNICIANS WK
BAROMETRIC PRESSURE. IN. HG 29.4 — STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 15 10
TRAIN LEAK RATE, CU.FT/MIN .001 .002 .002

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- ___ M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 100 PRE
- ✓ THERMOCOUPLE @ 160 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER .275 ~~.270~~
METER BOX Nu-1 .9886 T/C READOUT RTA-2
UMBILICAL RAC-3 T/C PROBE R-133
SAMPLE BOX ___ ORSAT PUMP ___
PROBE 11-2-4 PITOT 39 TEDLAR BAG ___

LEAK CHECK READINGS

B 1: 785,248
E 1: 786,08
B 2:
E 2:
B 3:
E 3:
B 4:
E 4:
B 5:
E 5:
B 6:
E 6:

FILTER #	TARE

DELTA $H_@$	1.873	~~1.956~~ 1.956	1.564			FYRITE
METER TEMP	100	100	120			
EST. %H_2O	5	5	5			
C FACTOR	1.075	1.07	1.01			
STACK TEMP	90	95	95			
REF DELTA P	~~.266~~ .295	.80	.32			
K-FACTOR	6.237		5.15			C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A 3	0	757.240	.57	3.56	3.56	95	16	N/A	N/A	96	
2	4	11:45	769.75	.60	3.74	3.74	97	19			96	
3	5	23:30	780.248	.52	3.29	3.29	99	05			95	✓
4	6	35:15	416.32	.55	3.16	3.16	98	5			94	
5	2	47:00	427.30	.49	2.81	2.81	99	5			96	
6	1	58:45	437.75	.33	1.90	1.90	100	4			95	
7	B 1	69:30	445.902	.31	1.78	1.78	101	4			95	
8	2	81:15	454.25	.60	3.45	3.45	102	5			95	
9	3	23:15	465.45	.57	3.28	3.28	102	5			95	
10	4	35:00	476.890	.61	3.51	3.51	101	5			97	
11	5	45:45	487.83	.50	2.88	2.88	102	5			93	
12	6	55:00	497.17	.17	.98	.98	102	3			88	
13	C 1	63:30	502.134	.30	1.72	1.72	100	4			93	
14	2	9:15	508.67	.41	2.36	2.36	98	5			94	
15	3	19:30	517.13	.50	2.88	2.88	98	5			94	
16	4	29:45	526.51	.58	3.34	3.34	99	5			94	
17	5	41:00	537.71	.50	2.88	2.88	100	5			94	
18	6	50:15	546.24	.19	1.09	1.09	102	3			95	
19	D 1	56:45	550.098	.28	1.61	1.61	100	4			93	
20	2	11:30	558.18	.56	3.22	3.22	103	6			93	
21	3	23:00	569.00	.62	3.57	3.57	108	6			92	
22	4	34:30	580.81	.60	3.45	3.45	110	6			92	
23		46:00	592.512									
24												
25												

235.75	210.078	0.9588	2.739	101	94
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010-3
12/89
p1

C3-CTI-2

FIELD TEST LOG

Plant Name Site #2 Job No. 3625

Sampling Location cell #3

Start	Stop	Comments/Problems*	Run No. 3-1-BD
14:52	15:14	Zero vacuum stop to fix	Date 7-9-90
15:38 ~~15:15~~	16:23	shook out glass mat in sil-gel tmp	
16:43	17:46	Pump froze when went to restart (Blew 4 fuses	
18:28	19:25	new box line 3 wrong hose - line 4	
19:39	20:25	stop after Low Volume Cell #3 pt. 4 sil-gel spent	

Sampling Team Initials MLH (Team Leader) WK (Others)

Posttest Leak Rate .002 at 10 Sample Appearance

Good Run (check)? ✓ YES ___ NO (if NO, explain in "Comments/Problems")

Start	Stop	Comments/Problems*	Run No. ~~0~~ 3-1-AC
14:54	15:16	High Volume cell #3	Date 7-9-90
15:40 ~~15:09~~	16:25	run ~~stop~~ same time as above test	
16:45	17:48		
18:30	19:27		
19:42	20:28		

Sampling Team Initials MLH (Team Leader) WK (Others)

Posttest Leak Rate .035 at 12 Sample Appearance

Good Run (check)? ✓ YES ___ NO (if NO, explain in "Comments/Problems")

Start	Stop	Comments/Problems* Woods (clear)	Run No.
		1 2 3 4	Date
		○ ○ ○ ○ B D A	
		~~B C D~~	

Sampling Team Initials ___ (Team Leader) ___ (Others)

Posttest Leak Rate ___ Sample Appearance ___

Good Run (check)? ___ YES ___ NO (if NO, explain in "Comments/Problems")

* USE REVERSE SIDE IF MORE SPACE REQUIRED.

ISOKINETIC TEE FIELD DATA SHEET

COMPANY NAME SITE #2 - EMB #3625 RUN NUMBER 2-1A (High)
ADDRESS TIME START 1458
SAMPLING LOCATION FAN CELL #2 TIME FINISH 2036
DATE 07.09.96 TEAM LEADER B. RUDD TECHNICIANS T. BROZELL
BAROMETRIC PRESSURE. IN. HG 29.4 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 15
TRAIN LEAK RATE, CU.FT/MIN 0.011 0.009

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 95 PRE
- ✓ THERMOCOUPLE @ 92 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.370
METER BOX HV-1 Y 1.023 T/C READOUT F28
UMBILICAL A T/C PROBE R-189
SAMPLE BOX A ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B1 R ___ B2 R ___ B3 R ___ B4 R ___ B5 R ___ B6 R ___

FILTER #	TARE

DELTA $H_@$	0.2597			
METER TEMP	100			
EST. $\%H_2O$	5			
C FACTOR	0.146			
STACK TEMP	95			
REF DELTA P	0.679			
K-FACTOR	2.709			

FYRITE ___ ___ ___ ___ ___ ___

C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK
1	A-1	0/0	743.632	0.42	1.14	1.14	103	10	N/A	N/A	94	
2	2	10 1/4	760.84	0.43	1.16	1.16	102	10			93	
3	3	21 3/4	779.61	0.51	1.38	1.38	103	11			93	
4	4	33 1/4	798.48	0.49	1.33	1.33	106	11			93	
5	5	45	819.09	0.48	1.30	1.30	106	11			92	
6	6	56 1/4	839.01	0.14	0.38	0.38	106	10			90	
7	A-1	57 1/2	840.656	0.21	0.57	0.57	109	6			97	
8	2	11 1/4	854.38	0.27	0.73	0.73	109	6			95	
9	3	22 3/4	869.63	0.49	1.33	1.33	107	9			95	
10	4	34 3/4	890.29	0.51	1.38	1.38	108	11			94	
11	5	46 1/4	910.98	0.51	1.38	1.38	110	11			94	
12	6	57 3/4	931.34	0.14	0.38	0.38	110	5			91	
13	B-1	66 1/2	940.675	0.33	0.89	0.89	102	8			93	
14	2	11	956.54	0.35	0.95	0.95	101	8			90	
15	3	21 3/4	972.37	0.42	1.14	1.14	101	9			92	
16	4	33 1/2	990.73	0.49	1.33	1.33	101	10			92	
17	5	45 1/2	1011.11	0.51	1.38	1.38	100	12			91	
18	6	57 1/4	31.88	0.24	0.65	0.65	100	6			90	
19	C-1	66 1/2	42.710	0.31	0.84	0.84	96	7			92	
20	2	11 1/4	58.36	0.43	1.16	1.16	95	10			92	
21	3	23	77.22	0.52	1.41	1.41	96	13			91	
22	4	34 3/4	97.99	0.47	1.27	1.27	97	13			91	
23	5	46 1/4	1117.55	0.28	0.76	0.76	97	7			90	
24	6	55 1/4	1129.63	0.26	0.70	0.70	96	6			89	
25		64 1/4	1141.335									

2542.5	397.703	0.3722	1.039	103	92
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

C2-CTI-1

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME SITE 2 - EMB #3625 RUN NUMBER 2-1R (Low)
ADDRESS _____ TIME START 1450
SAMPLING LOCATION CELL #2 TIME FINISH 2034
DATE 07.09.90 TEAM LEADER B. REDD TECHNICIANS T. BROZELL
BAROMETRIC PRESSURE. IN. HG 29.4 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 5
TRAIN LEAK RATE, CU.FT/MIN 0.006 0.003

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 95 PRE
- ✓ THERMOCOUPLE @ 92 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.275
METER BOX RAC-1 Y 1.040 T/C READOUT F28
UMBILICAL B T/C PROBE K-189
SAMPLE BOX B ORSAT PUMP N/A
PROBE 11.9 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B 1 R B 2 R B 3 R B 4 R B 5 R B 6 R

FILTER #	TARE

DELTA $H_@$	1.798			
METER TEMP	100			
EST. $\%H_2O$	5			
C FACTOR	1.008			
STACK TEMP	95			
REF DELTA P	0.322			
K-FACTOR	5.722			

FYRITE ___ C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0/0	811.501	0.42	2.40	2.40	94	2	N/A	N/A	94	
2	2	10 1/4	820.14	0.43	2.46	2.46	101	2			93	
21 3/4 3	3	11 1/2	830.01	0.51	2.92	2.92	103	2			95	
33 1/4 4	4	11 1/2	840.88	0.49	2.80	2.80	106	2			93	
45 5	5	11 3/4	851.87	0.48	2.75	2.75	107	3			92	
56 1/4 6	6	11 1/4	863.60	0.14	0.80	0.80	109	2			90	
57 1/2 7	B-1	1 1/4	863.908	0.21	1.20	1.20	100	2			97	
8	2	11 1/4	871.13	0.27	1.54	1.54	105	2			95	
22 3/4 9	3	11 1/2	878.67	0.49	2.80	2.80	105	3			95	
34 3/4 10	4	12	889.96	0.51	2.92	2.92	108	3			94	
46 1/4 11	5	11 1/2	901.29	0.51	2.92	2.92	110	3			94	
57 3/4 12	6	11 1/2	912.11	0.14	0.80	0.80	111	3			91	
66 1/2 13	B-1	8 3/4	917.031	0.33	1.89	1.89	96	2			93	
14	2	11	925.26	0.35	2.00	2.00	98	2			90	
21 3/4 15	3	10 3/4	933.51	0.42	2.40	2.40	102	3			92	
33 1/2 16	4	11 3/4	943.80	0.49	2.80	2.80	106	3			92	
45 1/2 17	5	12	955.28	0.51	2.92	2.92	108	3			91	
57 1/4 18	6	11 3/4	966.63	0.24	1.37	1.37	109	3			90	
66 19	C-1	8 3/4	973.903	0.31	1.77	1.77	96	2			92	
20	2	11 1/4	981.68	0.43	2.46	2.46	102	3			92	
23 21	3	11 3/4	992.28	0.52	2.98	2.98	103	3			91	
34 3/4 22	4	11 3/4	1003.71	0.47	2.69	2.69	106	3			91	
46 1/4 23	5	11 1/2	14.34	0.28	1.60	1.60	108	3			90	
55 1/4 24	6	9	20.68	0.26	1.49	1.49	108	2			89	
64 1/4 25		9	1026.664									

254.25	215.163	0.3722	2.195	104	92
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
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p1

C2-GTI-2

RESULTS OF ON-SITE MOISTURE ANALYSIS

BD 80
BK 12

Plant Name: Cooling Tower - 1 EEI Ref# 3625

Sampling Location: OUT - FAN Cell #2

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	1A CTI-HI	1B CTI-CO	
Run Date:	7/9/90	7/9/90	/90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (.1 M HNO_3)

Final Weight, g.	647.2	419.1	
Tared Weight, g.	359.2	258.9	
Water Catch, g.	288.0	160.2	

Reagent 2 (_____)

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

Reagent 3 (_____)

Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			

CONDENSED WATER, g.	288.0	160.2	
Silica Gel:			
Final Weight, g.	1342.7	453.5	
Tared Weight, g.	1250	400	
Absorbed Water, g.	92.7	53.5	
TOTAL WATER COLLECTED, g.	380.7	213.7	

(circle one)

(Triple beam) or Electronic

Balance # 10

NOTES: 4.6% moisture

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: COOLING TOWER # ~~3~~ 1 BEI Ref# 3625

Sampling Location: OUT - FAN CELL # 3

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	1C CTI-HI	1D CTI-LO	
Run Date:	7/9/90	7/9/90	/90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (.1 M HNO_3)			
Final Weight, g.	662.0	431.3	
Tared Weight, g.	359.6	259.6	
Water Catch, g.	302.4	171.7	
Reagent 2 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, g.	302.4	171.7	
Silica Gel:			
Final Weight, g.	1352.4	452.3	
Tared Weight, g.	1250.0	400	
Absorbed Water, g.	102.4	52.3	
TOTAL WATER COLLECTED, g.	404.8	224.0	

(circle one)

Triple beam or Electronic

Balance # 10

NOTES:

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2- EMB #3625 RUN NUMBER 2-4A
ADDRESS TIME START 0917
SAMPLING LOCATION FAN CELL #2 TIME FINISH 1541
DATE 07.12.90 TEAM LEADER B. RUDD TECHNICIANS T. BROZELL
BAROMETRIC PRESSURE. IN. HG 29.2 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 10
TRAIN LEAK RATE, CU.FT/MIN 0.003 0.0

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 78 PRE
- ✓ THERMOCOUPLE @ 95 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.370
METER BOX HV.1 Y 1.022 T/C READOUT F28
UMBILICAL A T/C PROBE R-189
SAMPLE BOX A ORSAT PUMP N/A
PROBE 11-9 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B 1 | R B 2 | R B 3 | R B 4 | R B 5 | R B 6 | R

FILTER #	TARE

DELTA $H_@$	0.2597	0.2597 → ① CHANGED			FYRITE
METER TEMP	80	80	80 NOMO		
EST. $\%H_2O$	4.0	4.0	3		
C FACTOR	0.142	0.143	0.145		
STACK TEMP	80	80	80		
REF DELTA P	0.680	0.674	0.663		
K-FACTOR	2.707	2.731	2.777		C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK
1	C-1	0/0	276.819	0.36	0.984	1.97	76	5	N/A	N/A	74	✓
2	2	16½	310.02	0.41	1.121	1.68	77	5			75	
3	3	33¼	341.79	0.49	1.332	2.66	79	8			80	
4	4	50½	381.90	0.53	1.472	2.44	81	9			79	①
5	5	67	422.77	0.45	1.252	2.50	83	8			80	
6	6	83½	460.11	0.13	0.363	0.73	84	6			80	
7	D-1	92¼/0	471.547	0.33	0.924	1.85	84	6			79	
8	2	14	499.05	0.39	1.087	2.17	83	6			80	
9	3	30¼	533.54	0.50	1.385	2.77	84	8			84	
10	4	46¾	572.78	0.55	1.531	3.06	85	9			82	
11	5	63¼	613.96	0.53	1.483	2.97	87	9			81	
12	6	79¼	653.76	0.10	0.281	0.56	88	5			80	
13	A-1	86/0	662.347	0.34	0.951	1.90	87	7			83	
14	2	16¼	694.52	0.44	1.228	2.46	87	8			83	
15	3	33¼	732.58	0.48	1.331	2.66	88	9			87	
16	4	50½	773.72	0.53	1.459	2.92	90	9			93	
17	5	67½	814.66	0.47	1.301	2.60	91	9			91	
18	6	84	853.79	0.11	0.307	0.61	92	4			88	
19	B-1	85¼/0	855.321	0.16	0.449	0.90	92	3			86	
20	2	11	870.78	0.36	1.004	2.01	92	7			89	
21	3	26¼	902.08	0.45	1.247	2.49	93	8			93	
22	4	43	940.17	0.50	1.384	2.77	95	9			95	
23	5	60	980.98	0.50	1.386	2.77	95	9			94	
24	6	77	1022.27	0.23	0.637	1.27	96	4			96	
25		87¾	1040.302									

351.25	763.483	0.3721	2.134	87	85
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

C2-CTI-78

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 - EMB #3625 RUN NUMBER 2-4B
ADDRESS TIME START 0915
SAMPLING LOCATION Fan Cell #2 TIME FINISH 1539
DATE 07-12-90 TEAM LEADER B. Rudd TECHNICIANS T. Brozell
BAROMETRIC PRESSURE. IN. HG 29.2 STATIC PRESSURE IN. H_2O 0
TRAIN LEAK CHECK VACUUM IN. HG 15 8
TRAIN LEAK RATE, CU.FT/MIN 0.006 0.004

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 78 PRE
- ✓ THERMOCOUPLE @ 95 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER 0.275
METER BOX MAC-1 Y 1.040 T/C READOUT F.78
UMBILICAL B T/C PROBE K.189
SAMPLE BOX B ORSAT PUMP N/A
PROBE 169 PITOT ___ TEDLAR BAG N/A

LEAK CHECK READINGS

B 1 B 2 B 3 B 4 B 5 B 6 B

FILTER #	TARE

DELTA $H_@$	1.798	1.798		
METER TEMP	90	90		
EST. $\%H_2O$	4	3		
C FACTOR	1.007	1.025		
STACK TEMP	80	80		
REF DELTA P	0.313	0.308		
K-FACTOR	5.876	5.976		

FYRITE
C_p 0.84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX TAIL	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	C 1	0/0	654.108	0.36	2.10	2.10	80	3	20	24	74	
2	2	16½	666.82	0.41	2.42	2.42	91	3	15	21	75	
3	3	33¼	680.89	0.49	2.94	2.94	104	4	15	17	80	CHAN
4	4	50½	697.61	0.53	3.22	3.22	103	5	19	24	79	
5	5	67	713.98	0.45	2.73	2.73	103	4	21	23	80	
6	6	83½	729.23	0.13	0.79	0.79	102	2	69	61	80	
7	D 1	92¼/0	733.866	0.33	1.98	1.98	91	3	42	39	79	
8	2	14	744.49	0.39	2.36	2.36	100	3	26	26	80	
9	3	30¼	757.88	0.50	3.00	3.00	100	4	24	24	84	
10	4	46¾	773.68	0.55	3.33	3.33	104	5	18	23	82	
11	5	63¼	790.18	0.53	3.23	3.23	106	4	21	27	81	
12	6	79¼	806.29	0.10	0.61	0.61	107	2	65	68	80	
13	A 1	86/0	809.699	0.34	2.02	2.02	90	3	22	26	83	
14	2	16¼	821.97	0.44	2.64	2.64	97	4	21	18	83	
15	3	33¼	837.30	0.48	2.90	2.90	107	4	20	17	87	
16	4	50½	853.44	0.53	3.18	3.18	110	4	16	20	93	
17	5	67½	870.24	0.47	2.83	2.83	110	4	26	24	91	
18	6	84	885.86	0.11	0.67	0.67	111	2	77	86	88	
19	B 1	85¼/0	886.557	0.16	0.96	0.96	99	2	49	52	86	
20	2	11	892.69	0.36	2.17	2.17	106	3	30	32	89	
21	3	26¼	904.73	0.45	2.70	2.70	108	3	20	21	93	
22	4	43	919.99	0.50	3.00	3.00	112	4	16	18	95	
23	5	60	936.48	0.50	3.01	3.01	113	4	16	20	94	
24	6	77	952.95	0.23	1.38	1.38	114	3	50	53	96	
25		87¾	960.191									

351.25	306.083	0.3721	2.340	103	85
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010
12/89
p1

C2-CTI-8

TEST LOG

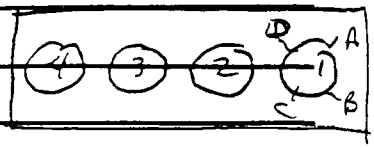
Plant Name: SITE #2 - EMB #3625 Date: 07.09-13.90

Sampling Location: FAN CELL #2 Initials: BFR

07.09.90

2-1A HIGH VOLUME TRAIN - NO PROBLEMS

2-1B LOW VOLUME TRAIN - NO PROBLEMS



07.10.90

2-2A REALIGNED ANGLE FINDER BY INCREASING ANGLE READING

2-2B BY ABOUT 8° AFTER 1ST "PORT" (C)

1132 PLANT LOST POWER - WE STOPPED THE TESTS UNTIL RESTART @ 1420. CELLS 1, 2 & 3 WERE BACK ON LINE. GOOD RUNS

07.11.90

2-3A GOOD RUNS

2 3B

07.12.90

2-4A WE DECIDED TO DOUBLE THE DESIRED ΔH TO CATCH 1½ TIMES THE CFM FROM THE PREVIOUS RUNS.

2-4B - NO CHANGES ON LOW VOLUME TRAIN

BOTH RUNS WERE GOOD

ENTROPY ENVIRONMENTALISTS, INC.

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER Cell dry 4-4-C
ADDRESS ~~S~~ High Volume — TIME START 9:19
SAMPLING LOCATION Cell #4 Cooling Tower — TIME FINISH 16:27
DATE 7-12-90 — TEAM LEADER MLH — TECHNICIANS WKK
BAROMETRIC PRESSURE. IN. HG 29.2 — STATIC PRESSURE IN. H_2O ____
TRAIN LEAK CHECK VACUUM IN. HG 15 ~~14~~ 14
TRAIN LEAK RATE, CU.FT/MIN .055 ~~.00~~ .055

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/A M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 40 PRE
- ✓ THERMOCOUPLE @ 85 POST

IDENTIFICATION NUMBERS .369 .877

REAGENT BOX ____ NOZZLE ____ DIAMETER ~~.369~~
METER BOX HV-2 .9821 T/C READOUT RKA
UMBILICAL ____ T/C PROBE K-133
SAMPLE BOX ____ ORSAT PUMP ____
PROBE 1-2-4 PITOT 39 TEDLAR BAG N/A

LEAK CHECK READINGS

B 1	
E	
B 2	
E	
B 3	
E	
B 4	
E	
B 5	
E	
B 6	
E	

FILTER #	TARE

					FYRITE
DELTA $H_@$	3031				
METER TEMP	90				
EST. $\%H_2O$	~~4.8~~				
C FACTOR	.170				
STACK TEMP	80				
REF DELTA P	.573				
K-FACTOR	3.211 × 2 =	6.422			C_p .87

LINE	SAMPLE POINT	CLOCK TIME MINUTES	DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL (3.08)	ORIFICE SETTING IN. H2O ACTUAL (3.04)	GAS METER TEMP °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	988.692	.48	~~1.51~~	~~1.54~~	75	8	N/A	N/A	83	
2	-2	16 3/4	029.907	.60	3.85	3.85	79	9			82	
3	-3	33 3/4	76.95	.65	4.17	4.17	81	11			82	
4	-4	51 1/2	127.88	.67	4.30	4.30	83	12			82	
5	-5	69 1/4	180.05	.63	4.05	4.05	84	11			79	
6	-6	87	230.84	.10	.64	.64	84	3			78	
7	B-1	93 1/2	238.125	.32	2.06	2.06	83	7			78	
8	-2	17 1/4	273.98	.48	3.08	3.08	84	9			85	
9	-3	33 1/2	314.95	.63	4.05	4.05	85	11			77	
10	-4	50 1/2	363.75	.61	3.92	3.92	86	11			81	
11	-5	68 1/4	413.69	.55	3.53	3.53	88	10			79	
12	-6	84	456.94	.20	1.28	1.28	89	4			79	
13	C-1	97 1/4	478.155	.21	1.35	1.35	87	5			86	
14	-2	16 1/4	585.18	.53	3.40	3.40	88	10			87	
15	-3	32 1/2	548.47	.74	~~4.75~~	4.75	89	12			87	
16	-4	49 1/2	600.91	.74	4.75	4.75	90	12			84	
17	-5	~~64~~ 67 1/2	656.33	.68	4.37	4.37	92	12			83	
18	-6	~~84~~ 84 3/4	706.74	.15	.96	.96	95	5			82	
19	D-1	96 1/2	723.890	.55	3.53	3.53	95	10			88	
20	2	14 3/4	763.43	.58	3.72	3.72	96	11			87	
21	-3	32 1/2	812.50	.59	3.79	3.79	96	11			88	
22	-4	48 3/4	857.84	.71	4.56	4.56	97	14			88	
23	-5	66 1/2	911.86	.68	4.37	4.37	97	13			86	
24	-6	83 1/4	962.09	.25	1.61	1.61	97	5			85	
25		98	1989.980									

385 minutes — 1001.288 Vm — 0.4889 $(\sqrt{\Delta p})^2$ — 3.299 ΔH — 88 tm — 83 ts

F1010 12/89 p1

C4-CTI-1

ISOKINETIC TYPE FIELD DATA SHEET

COMPANY NAME Site #2 — RUN NUMBER 4-4-BD
ADDRESS Low Volume — TIME START 9:18
SAMPLING LOCATION Cooling tower cell #4 — TIME FINISH 16:26
DATE 7-12-90 — TEAM LEADER MLH — TECHNICIANS WKK
BAROMETRIC PRESSURE. IN. HG 29.27 — STATIC PRESSURE IN. H_2O ~0
TRAIN LEAK CHECK VACUUM IN. HG 15 7 — — — — —
TRAIN LEAK RATE, CU.FT/MIN .001 .001 — — — — —

EQUIPMENT CHECKS

- ✓ PITOTS, PRETEST
- ✓ PITOTS, POSTTEST
- N/L M3 SAMPLING SYS/TED BAG
- ✓ THERMOCOUPLE @ 87 PRE
- ✓ THERMOCOUPLE @ 85 POST

IDENTIFICATION NUMBERS

REAGENT BOX ___ NOZZLE ___ DIAMETER .275
METER BOX RAC3 Y 1.136 T/C READOUT R+A
UMBILICAL ___ T/C PROBE R-132
SAMPLE BOX ___ ORSAT PUMP ___
PROBE 1-2-4 PITOT 39 TEDLAR BAG N/A

LEAK CHECK READINGS

B 1 E
B 2 E
B 3 E
B 4 E
B 5 E
B 6 E

FILTER #	TARE

DELTA $H_@$	1.564			
METER TEMP	96			
EST. $\%H_2O$	4.0			
C FACTOR	.876			
STACK TEMP	80			
REF DELTA P	.360			
K-FACTOR	5.111			

FYRITE — C_p .84

LINE	SAMPLE POINT	CLOCK TIME MINUTES	152.363 DRY GAS METER READINGS CUBIC FEET	PITOT READING IN. H_2O	ORIFICE SETTING IN. H2O IDEAL	ORIFICE SETTING IN. H2O ACTUAL	GAS METER TEMP. °F	VACUUM IN. HG GAUGE	GAS TEMPERATURES FILTER BOX °F	GAS TEMPERATURES IMPINGER EXIT °F	STACK TEMP. °F	LK CHK #
1	A-1	0	152.363	.48	2.45	2.45	74	4	N/L	N/A	83	
2	-2	16 3/4	165.996	.60	3.07	3.07	78	5			82	
3	-3	23 3/4	181.79	.65	3.32	3.32	84	5			82	
4	-4	51 1/2	199.22	.67	3.42	3.42	88	5			82	
5	-5	69 1/4	216.59	.63	3.22	3.22	90	5			79	
6	-6	87	233.541	.10	.51	.51	90	2			78	
7	B-1	93 1/2	236.124	.32	1.684	1.64	84	3			78	
8	-2	17 1/4	248.02	.48	2.45	2.45	85	4			85	
9	-3	33 1/2	261.80	.63	3.22	3.22	86	5			77	
10	-4	50 1/2	277.82	.61	3.12	3.12	88	5			81	
11	-5	68 1/4	294.59	.55	2.81	2.81	90	5			79	
12	-6	84	308.74	.20	1.02	1.02	89	3			79	
13	C-1	97 1/4	315.997	.21	1.07	1.07	87	3			86	
14	-2	16 1/4	325.05	.53	2.71	2.71	88	5			87	
15	-3	32 1/2	335.17	.74	3.78	3.78	91	6			87	
16	-4	49 1/2	346.92	.74	3.78	3.78	93	6			84	
17	-5	67 1/2	357.56	.68	3.48	3.48	93	6			83	
18	-6	84 1/4	372.64	.15	.77	.77	100	3			82	
19	D-1	96 1/4	378.554	.55	2.81	2.81	99	5			88	
20	-2	113 3/4	411.81	.58	2.96	2.96	102	5			87	
21	-3	32 1/2	428.38	.59	3.02	3.02	106	5			88	
22	-4	48 3/4	443.67	.71	3.63	3.63	107	6			88	
23	-5	66 1/2	462.05	.68	3.48	3.48	108	6			86	
24	-6	83 1/4	479.08	.25	1.28	1.28	107	3			85	
25		98	488.475									

385	336.112	0.4889	2.626	92	83
minutes	Vm	$(\sqrt{\Delta p})^2$	ΔH	tm	ts

F1010.3 12/89 p1

C4-CTI-2

TEST LOG

Plant Name: Site #2 3625 Date: 7-11-90

Sampling Location: Cooling tower cell #3 Initials: MLH

3-3-C
~~3-2-A~~ High Volume 9:34-15:35 Start 9:34-11
vacuum went up above 20 in : had to stop test 11:32-13:
with 3 pts left on last port 13:29-15:
sample times per pt = 60 x 18 min 15:17-15:
High leak rate .055 with pump on - valve off
.165 final leak ✓. Start 9:32-H

~~3-2-B~~ low volume run simultaneously with 3-2-A 11:30-13:
3-3-D 9:32-15:40 had to stop early because of High 13:27-15:
Volume train had to stop final leak ✓ - dead-stop 15:15-15:
- Both nomographs estimate stack temp + motor temp a little High (5°-10°) 15

4-4-C used .877 nozzle 1st pt backtrack to .369
High Volm double K factor 200% ISO Start 9:19-
final leaker .055 (Best one all week). 9:44-1
11:10-1
9:19-16:27 12:59-14
14:50-1

4-4-D 9:18-16:26 good run 9:18-
final leak .001 at 7-4 9:43-1
11:09-12
12:58-14:
14:49-1

run out of new state test logs

ENTROPY ENVIRONMENTALISTS, INC.

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: COOLING TOWER-1 EEI Ref# 3625

Sampling Location: OUT, FAN 2

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	CTI/HI 4A	CTI/LO 4B	
Run Date:	7/12/90	7/12/90	/90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (0.1 M HNO_3)			
Final Weight, g.	806.7	455.1	
Tared Weight, g.	355.7	257.1	
Water Catch, g.	451.0	198.0	
Reagent 2 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, g.	451.0	198.0	
Silica Gel:			
Final Weight, g.	1419.5	668.2	
Tared Weight, g.	1250.0	600.0	
Absorbed Water, g.	169.5	68.2	
TOTAL WATER COLLECTED, g.	620.5	266.2	

(circle one)

Triple beam or Electronic

Balance # 10

NOTES:

RESULTS OF ON-SITE MOISTURE ANALYSIS

Plant Name: Cooling Tower - 1 EEI Ref# 3625

Sampling Location: out, fan 4

Date Received: Date Analyzed: Reagent Box(es):

Run Number:	CTI/HI 4C	CTI/LO 4D	
Run Date:	7/12/90	7/12/90	/90

ANALYSIS OF MOISTURE CATCH

Reagent 1 (0.1 M HNO_3)			
Final Weight, g.	880.5	469.2	
Tared Weight, g.	357.1	258.4	
Water Catch, g.	523.4	210.8	
Reagent 2 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
Reagent 3 (_____)			
Final Weight, g.			
Tared Weight, g.			
Water Catch, g.			
CONDENSED WATER, g.	523.4	210.8	
Silica Gel:			
Final Weight, g.	1456.9	685.9	
Tared Weight, g.	1250.0	600.0	
Absorbed Water, g.	206.9	85.9	
TOTAL WATER COLLECTED, g.	730.3	296.7	

(circle one)

(Triple beam) or Electronic

Balance # 10

NOTES:

RESEARCH TRIANGLE INSTITUTE

Center for Environmental Measurements

August 28, 1990

Mr. Bill Kirk
CEM/ Engineering Division
Entropy Environmentalists, Inc.
P.O. Box 12291
Research Triangle Park, NC 27709-2291

Dear Bill,

Enclosed are the ICAP results for the digested samples received on 8-14-1990 for the project entitled, "Method Development and Testing for Industrial Cooling Towers," EPA Contract No. 68D90055, RTI Project No. 4441-025.

Due to the insufficient supply of sample, no duplicate analyses and replicate analyses of questionable samples were performed.

If you have any questions, please call me at 541-6569 or Peter Grohse at 541-6897.

Sincerely,

Kate Luk

Kate K. Luk, Ph.D.

Ref: 4441-025
cc: W. Gutknecht
P. Grohse
J. Merricks

Post Office Box 12194 Research Triangle Park, North Carolina 27709-2194 Telephone 919 541-6000
FAX: 919 541-5929

RTI Project No : 4441-025

Samples : Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 1. Digested Sample Analysis Results, ug/mL

Sample	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd
1	ND	0.423	ND	ND	ND	ND	ND	0.00200	ND
2	ND	0.243	-	ND	ND	ND	-	-	0.00300
3	ND	0.305	0.221	ND	0.0220	ND	ND	0.02000	0.00800
4	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	1.38	ND	ND	0.0400	ND	ND	0.105	ND
6	ND	1.64	0.176	0.0340	0.0590	ND	ND	0.132	ND
7	ND	1.41	ND	0.0130	0.0460	ND	ND	0.160	ND
8	ND	1.72	ND	0.0730	0.0430	ND	ND	0.131	ND
10	ND	0.361	ND	ND	0.0160	ND	ND	0.046	ND
11	0.0310	2.05	ND	0.0560	0.0390	ND	ND	0.138	ND
12	ND	1.71	ND	0.145	0.106	ND	ND	0.155	ND
13	ND	1.66	ND	0.102	0.0340	ND	ND	0.145	ND
15	ND	0.364	ND	ND	0.0120	ND	ND	0.0530	ND
16	ND	1.96	ND	0.0460	0.0440	ND	ND	0.128	ND
17	ND	1.93	ND	0.0720	0.0440	ND	ND	0.130	ND
18	ND	1.78	ND	0.0510	0.0400	ND	ND	0.135	ND
20	0.0390	0.285	ND	0.0210	0.0180	ND	ND	0.0440	ND
21	0.0320	1.74	ND	0.0500	0.0320	ND	ND	0.132	ND
22	ND	2.06	ND	0.0630	0.0440	ND	ND	0.122	ND
23	ND	1.61	ND	0.0460	0.0340	ND	ND	0.131	ND
25	ND	0.377	ND	0.0150	0.0180	ND	ND	0.0430	ND
26	0.0400	0.955	ND	0.0840	0.0310	ND	ND	1.14	0.0110
28	0.0580	0.198	ND	0.0300	ND	ND	ND	0.843	0.0120
30	0.0770	0.561	ND	0.0430	0.0190	ND	ND	1.11	0.00900
32	0.0620	0.991	ND	0.0410	0.0250	ND	ND	1.66	0.0150
34	0.0950	0.724	ND	0.0120	0.0180	ND	ND	0.890	0.00900
36	0.225	2.51	4.87	0.0120	0.246	ND	ND	0.461	2.36
37	0.149	0.634	ND	0.0170	0.0260	ND	ND	1.67	0.0210
40	ND	0.227	ND	0.0420	0.0150	ND	ND	1.15	0.00400
42	0.164	2.25	5.00	0.0240	0.263	0.240	ND	0.616	2.37
43	0.0310	0.197	ND	ND	0.0160	ND	ND	1.55	0.0340
46	0.0390	0.243	ND	0.0210	0.0130	ND	ND	1.23	0.0370
48	0.195	2.21	3.92	0.0190	0.253	0.230	ND	0.412	2.37
49	0.721	0.693	0.719	0.0400	0.071	0.00100	ND	0.675	0.0100
52	ND	0.163	ND	0.0220	0.0160	ND	ND	1.13	0.0230
54	0.204	2.07	3.78	0.0220	0.231	0.224	ND	0.583	2.35
55	0.0330	0.364	ND	0.0300	0.0220	ND	ND	1.54	0.0100
65	0.337	ND	ND	ND	0.229	ND	ND	335	ND
66	ND	ND	ND	0.340	0.238	ND	ND	325	ND
67	0.0330	ND	ND	0.309	0.213	ND	ND	307	ND
68	ND	ND	ND	0.298	0.230	ND	ND	316	ND
69	0.108	22.3	50.0	0.137	2.53	2.31	ND	155	23.6
70	0.117	22.6	50.6	0.151	2.45	2.36	ND	156	24.1
71	0.112	21.7	49.5	0.133	2.41	2.26	ND	157	23.4
72	0.0980	22.6	49.4	0.141	2.38	2.28	ND	162	24.0
73	0.0510	4.49	9.33	ND	0.532	0.481	ND	0.106	4.88
74	0.0780	44.8	106	ND	5.23	4.53	ND	0.814	47.1
Detection Limit	0.027	0.14	0.16	0.012	0.012	0.0010	0.38	0.0010	0.0030

- : Insufficient Sample

RTI Project No : 4441-025

Samples : Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 1. Digested Sample Analysis Results, ug/mL

Sample	Co	Cr	Cu	Fe	K	W	Li	Mg	Mn
1	ND	ND	ND	0.198	ND	ND	ND	0.0210	ND
2	ND	0.00700	ND	0.218	-	-	-	0.115	0.00500
3	ND	ND	ND	0.0610	ND	ND	ND	0.0600	0.00300
4	ND	ND	ND	ND	ND	ND	ND	0.0160	ND
5	ND	0.0140	ND	0.152	ND	ND	ND	0.139	0.00800
6	ND	0.0190	ND	0.224	ND	ND	ND	0.162	0.0100
7	ND	0.0130	ND	0.215	ND	ND	ND	0.241	0.0110
8	ND	0.0160	ND	0.255	0.0890	ND	ND	0.192	0.00900
10	ND	0.0100	ND	0.120	0.0920	ND	ND	0.106	0.00300
11	ND	0.0280	ND	0.341	0.125	ND	ND	0.146	0.00900
12	ND	0.0210	ND	0.264	ND	ND	ND	0.193	0.0100
13	ND	0.0190	ND	0.268	0.0970	ND	ND	0.201	0.00800
15	ND	0.0080	ND	0.298	ND	ND	ND	0.216	0.00500
16	ND	0.0210	ND	0.280	0.0560	ND	ND	0.155	0.01000
17	ND	0.0240	ND	0.459	ND	ND	ND	0.187	0.0110
18	ND	0.0150	ND	0.276	ND	ND	ND	0.185	0.00800
20	ND	0.00800	ND	0.106	ND	ND	ND	0.128	0.00300
21	ND	0.0330	ND	0.498	0.0680	ND	ND	0.172	0.0110
22	ND	0.0170	ND	0.299	ND	ND	ND	0.130	0.00900
23	ND	0.0240	ND	0.312	ND	ND	ND	0.156	0.0130
25	ND	0.0070	ND	0.103	ND	ND	ND	0.0910	0.00400
26	ND	0.101	0.253	1.01	ND	ND	ND	0.0380	1.17
28	ND	0.0660	0.0770	0.624	0.102	ND	ND	1.94	0.0350
30	ND	0.0510	0.0680	1.23	0.078	ND	ND	2.67	0.0310
32	ND	0.113	0.0840	2.12	0.133	0.0110	0.0490	3.16	0.0540
34	ND	0.0680	0.184	1.01	ND	ND	ND	1.59	0.179
36	2.46	2.42	2.38	2.95	0.755	ND	0.0490	3.08	2.43
37	ND	0.0820	0.204	1.21	0.112	ND	ND	2.12	0.125
40	ND	0.0680	0.0510	0.645	0.109	ND	ND	1.43	0.177
42	2.48	2.34	2.44	2.66	0.750	ND	ND	2.93	2.39
43	ND	0.0310	0.0480	0.677	0.0680	ND	ND	1.82	0.493
46	0.0430	0.0720	0.0450	0.605	ND	0.0110	ND	0.960	0.0870
48	2.37	2.32	2.46	2.69	0.678	ND	ND	2.54	2.31
49	0.504	0.0570	0.541	3.60	0.133	ND	ND	1.46	0.119
52	ND	0.0670	0.102	0.752	0.0820	ND	ND	2.18	0.0940
54	2.32	2.32	2.22	2.68	0.673	ND	ND	3.36	2.38
55	0.0540	0.0580	0.0390	0.928	ND	ND	ND	1.24	0.0870
65	ND	0.00700	0.0510	ND	2.63	0.0110	ND	108	0.0140
66	ND	ND	0.0420	ND	2.64	0.0100	0.0870	114	0.0140
67	ND	ND	ND	ND	2.59	ND	0.0660	110	0.0130
68	ND	ND	0.0490	ND	2.73	ND	ND	115	0.0130
69	23.0	23.3	22.9	24.1	9.28	0.0330	0.0530	75.7	24.3
70	23.9	24.1	23.1	24.9	9.13	0.0310	ND	77.3	24.8
71	23.6	22.9	21.6	23.3	8.71	0.0320	ND	77.2	23.2
72	23.5	23.0	22.9	23.4	8.80	0.0320	13.3	77.8	23.8
73	4.67	5.05	5.17	5.19	1.46	0.0160	ND	4.79	4.76
74	46.9	47.4	49.2	50.0	16.0	0.0700	ND	46.4	46.4
Detection Limit	0.018	0.006	0.027	0.018	0.062	0.0093	0.049	0.0030	0.0010

- : Insufficient Sample

RTI Project No : 4441-025

Samples : Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 1. Digested Sample Analysis Results, ug/mL

Sample	Mo	Na	Ni	P	Pb	Sb	Se	Si	Sn
1	ND	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	-	0.0620	-	ND	ND	-	-	ND
3	0.0640	0.0460	ND	ND	ND	ND	ND	27.0	ND
4	ND	ND	ND	ND	ND	ND	0.282	ND	ND
5	0.159	0.0680	ND	ND	ND	ND	ND	86.9	ND
6	0.184	0.0880	0.0120	ND	ND	ND	ND	100	ND
7	0.204	0.137	ND	ND	ND	ND	ND	85.9	ND
8	0.200	0.0960	ND	ND	ND	ND	ND	86.4	ND
10	ND	0.0450	ND	ND	ND	ND	0.416	26.1	ND
11	0.219	0.0650	0.0140	ND	ND	ND	0.402	108	ND
12	0.183	0.141	ND	ND	ND	ND	0.333	90.9	ND
13	0.171	0.107	ND	ND	ND	ND	ND	84.7	ND
15	0.0560	0.0440	ND	ND	ND	ND	ND	26.2	ND
16	0.191	0.0940	ND	ND	ND	ND	ND	114	ND
17	0.192	0.112	0.0180	ND	ND	ND	ND	102	ND
18	0.171	0.0900	ND	ND	ND	ND	ND	99.3	ND
20	0.0450	0.0290	ND	ND	ND	ND	ND	26.0	ND
21	0.167	0.0590	ND	ND	ND	ND	ND	48.3	ND
22	0.217	0.0540	0.0140	ND	ND	ND	ND	55.2	ND
23	0.186	0.0690	0.0240	ND	ND	ND	ND	45.2	ND
25	0.0610	0.0270	ND	ND	ND	ND	ND	14.7	ND
26	ND	0.82	0.0410	0.410	ND	ND	ND	ND	ND
28	ND	0.771	0.0340	0.317	ND	ND	0.224	ND	ND
30	ND	0.510	0.0320	ND	ND	ND	ND	ND	ND
32	ND	0.808	0.0470	0.388	ND	ND	ND	ND	ND
34	ND	0.625	0.0610	0.454	ND	ND	0.222	ND	ND
36	ND	0.528	2.75	ND	2.43	ND	11.8	ND	ND
37	ND	1.15	0.0340	0.606	ND	ND	0.278	ND	ND
40	0.0310	0.789	0.0210	0.552	ND	ND	ND	ND	ND
42	ND	0.750	2.44	ND	2.49	ND	11.4	ND	ND
43	ND	0.572	ND	ND	0.125	ND	ND	ND	ND
46	ND	0.363	0.0190	ND	ND	ND	0.222	ND	ND
48	ND	0.336	2.37	ND	2.37	ND	9.76	ND	ND
49	ND	0.294	0.0370	ND	0.583	ND	2.19	ND	ND
52	ND	0.468	0.0390	ND	ND	ND	ND	ND	ND
54	ND	0.458	2.29	ND	2.39	ND	9.78	ND	ND
55	ND	0.206	0.0130	ND	ND	ND	ND	ND	ND
65	0.114	21.4	ND	ND	ND	ND	0.206	ND	ND
66	0.0950	22.0	ND	ND	ND	ND	0.234	ND	ND
67	0.09000	20.8	ND	ND	ND	ND	ND	ND	ND
68	0.0790	21.9	ND	ND	ND	ND	ND	ND	ND
69	ND	12.9	24.1	ND	23.7	ND	108	ND	ND
70	0.0480	13.4	25.0	ND	23.8	ND	109	ND	ND
71	0.0410	12.7	23.3	ND	23.6	ND	107	ND	ND
72	0.0430	13.3	24.5	ND	23.8	ND	108	ND	ND
73	ND	0.491	4.94	ND	4.82	ND	20.4	ND	ND
74	ND	5.41	47.9	ND	48.2	0.590	229	ND	ND
Detection Limit	0.027	0.026	0.012	0.31	0.12	0.43	0.19	0.12	0.14

- : Insufficient Sample

RTI Project No : 4441-025

Samples : Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 1. Digested Sample Analysis Results, ug/mL

Sample	Sr	Ti	Tl	V	Zn
1	ND	ND	ND	ND	0.0350
2	ND	-	-	ND	0.212
3	0.00800	0.485	ND	0.0120	0.0140
4	0.00100	0.0190	ND	ND	0.00800
5	0.0160	0.0330	ND	0.00900	0.0190
6	0.0180	0.0910	ND	ND	0.0370
7	0.0190	0.0480	ND	ND	0.0490
8	0.0190	0.587	ND	ND	0.0230
10	0.00700	0.234	ND	ND	0.0340
11	0.0200	0.0610	ND	ND	0.0260
12	0.0190	0.0770	ND	ND	0.0890
13	0.0160	0.0720	ND	ND	0.0270
15	0.00700	0.0720	ND	ND	0.0260
16	0.0200	0.0280	ND	ND	0.0250
17	0.0190	0.0390	ND	ND	0.0830
18	0.0190	0.0710	ND	ND	0.0240
20	0.00600	0.0530	ND	ND	0.0210
21	0.01600	0.0670	ND	ND	0.0410
22	0.01900	0.125	ND	ND	0.0360
23	0.0160	0.0500	ND	ND	0.0300
25	0.00500	0.0420	ND	ND	0.0170
26	0.0410	0.0220	ND	ND	0.865
28	0.0230	0.0120	ND	ND	0.570
30	0.0340	0.0620	ND	ND	0.372
32	0.0470	0.0690	ND	ND	0.520
34	0.0350	0.0180	ND	ND	0.861
36	0.0170	ND	ND	ND	2.70
37	0.0360	0.0490	ND	ND	0.951
40	0.0200	0.0220	ND	ND	0.386
42	0.235	ND	ND	ND	2.53
43	0.0250	0.0210	ND	ND	0.324
46	0.0140	0.0400	ND	ND	0.896
48	0.231	0.0170	ND	ND	2.68
49	0.0680	0.0710	ND	ND	1.00
52	0.0310	ND	ND	ND	0.408
54	0.237	ND	ND	ND	2.52
55	0.0150	0.0240	ND	ND	6.35
65	1.81	ND	ND	ND	ND
66	1.98	ND	ND	ND	ND
67	1.88	ND	ND	ND	ND
68	1.96	ND	ND	ND	ND
69	3.25	0.0140	ND	ND	22.3
70	3.32	ND	ND	ND	22.8
71	3.18	ND	ND	ND	22.5
72	3.21	ND	ND	ND	23.1
73	0.514	ND	ND	ND	4.96
74	5.05	0.0140	0.085	ND	48.5
Detection Limit	0.001	0.012	0.80	0.0090	0.0060

- : Insufficient Sample

RTI Project No : 4441-025

Samples : QC for Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 2. Calibration Check Sample, ug/mL

Sample	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd
QC	0.475	19.2	8.89	2.09	1.95	1.99	9.81	1.98	2.02
QC	0.381	20.2	9.85	1.94	1.78	1.87	9.99	2.13	1.86
QC	0.289	21.3	9.71	2.11	1.88	2.11	11.7	2.06	2.20
QC	0.400	20.2	10.7	2.19	2.07	2.03	8.37	1.89	2.08
QC	0.380	19.5	8.42	2.02	2.06	1.97	9.30	1.70	2.01
QC	0.436	20.2	10.4	1.98	1.96	2.00	9.60	2.12	1.94
QC Expected	0.408	20.0	10.0	2.02	2.02	2.00	9.92	2.00	2.00

Interference Check, ug/mL

Sample	Ag	Al	As	B	Ba	Be	Bi	Ca	Cd
1000 ppm Al	ND	999	0.962	ND	ND	ND	ND	ND	0.00500
1000 ppm Fe	ND	ND	ND	1.01	ND	ND	ND	ND	0.0150
Detection Limit	0.027	0.14	0.16	0.012	0.012	0.0010	0.38	0.0010	0.0030

RTI Project No : 4441-025

Samples : QC for Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 2. Calibration Check Sample, ug/mL

Sample	Co	Cr	Cu	Fe	K	W	Li	Mg	Mn
QC	2.00	2.03	1.83	20.0	41.4	10.1	8.79	20.8	1.88
QC	1.95	1.82	1.87	19.2	49.0	9.62	9.82	19.1	2.04
QC	2.16	2.25	2.23	21.5	50.7	10.4	11.2	20.8	2.17
QC	2.05	2.07	1.99	20.7	55.8	9.88	10.2	20.7	2.04
QC	2.01	2.02	1.95	20.1	41.8	9.08	8.07	20.6	2.05
QC	1.99	1.99	2.05	20.3	51.7	9.77	9.89	19.6	1.95
QC Expected	2.00	2.00	2.00	20.0	50.0	10.0	10.0	20.0	2.00

Interference Check, ug/mL

Sample	Co	Cr	Cu	Fe	K	W	Li	Mg	Mn
1000 ppm Al	0.0560	ND	ND	0.0310	ND	ND	ND	0.00800	0.00500
1000 ppm Fe	ND	0.0610	ND	1009	ND	ND	ND	ND	0.0330
Detection Limit	0.018	0.006	0.027	0.018	0.062	0.0093	0.049	0.0030	0.0010

RTI Project NO : 4441-025

Samples : QC for Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 2. Calibration Check Sample, ug/mL

Sample	Mo	Na	Ni	P	Pb	Sb	Se	Si	Sn
QC	2.02	9.86	9.86	16.7	10.4	4.27	9.72	10.1	4.12
QC	1.78	9.46	9.41	15.1	9.91	3.92	9.75	9.49	3.75
QC	2.24	13.1	10.9	18.9	10.8	4.14	9.62	9.45	4.28
QC	2.19	9.75	10.7	15.7	10.3	4.17	10.0	7.41	4.00
QC	2.03	8.92	10.1	16.8	10.1	4.22	9.11	8.11	4.04
QC	1.91	10.2	10.0	15.4	10.0	3.80	10.6	10.2	3.72
QC Expected	2.00	10.0	10.0	16.4	10.2	4.00	10.0	10.0	4.00

Interference Check, ug/mL

Sample	Mo	Na	Ni	P	Pb	Sb	Se	Si	Sn
1000 ppm Al	ND	ND	ND	0.557	0.414	ND	ND	ND	ND
1000 ppm Fe	ND	ND	ND	0.369	ND	ND	ND	ND	ND
Detection Limit	0.027	0.026	0.012	0.31	0.12	0.43	0.19	0.12	0.14

RTI Project No : 4441-025

Samples : QC for Digested Samples from Cooling Tower
Company : Entropy
Method of Analysis : ICAP
Sample received : 8-14-90
Report Date : 8-28-90

Table 2. Calibration Check Sample, ug/mL

Sample	Sr	Ti	Tl	V	Zn
QC	1.97	10.2	9.54	2.05	2.03
QC	1.88	10.0	9.73	1.89	1.82
QC	2.24	11.7	9.61	2.22	2.24
QC	1.96	8.40	10.0	1.94	2.11
QC	2.07	8.45	8.54	2.02	2.00
QC	2.01	11.8	9.50	1.91	1.90
QC Expected	2.00	20.0	20.0	2.00	2.00

Interference Check, ug/mL

Sample	Sr	Ti	Tl	V	Zn
1000 ppm Al	ND	ND	ND	ND	0.00600
1000 ppm Fe	ND	ND	ND	ND	0.0710
Detection Limit	0.001	0.012	0.80	0.0090	0.0060

UNIVERSITY OF MISSOURI

Environmental Trace Substances Research Center

Route 3
Columbia, Missouri 65203
Telephone (314) 882-2151

September 10, 1990

Bill Kirk
Entropy
Post Office Box 12291
Research Triangle Park, N.C. 27709

Dear Dr. Kirk:

Enclosed are the ICP results for the 54 samples you sent and a University invoice.

The samples took longer to analyze than projected because we were not informed that there was HF in many of the samples. Because of this, we ended up running many of the samples 2 or 3 times. I also did not report values for Si or B. Ag values may also be suspect as indicated by spike recoveries.

If you send samples in the future, I would suggest removal of the HF by addition of Perchloric acid and evaporation to fumes of $HClO_4$ at least twice then the residue dissolved in acid and diluted to volume.

Let me know if you have any questions.

Sincerely,

Edward J. Hinderberger

Edward J. Hinderberger, Jr.
Group Leader

EH:bm

Enclosure

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Blind QC Report

Project: ENTROPY
Units: MCG/ML
Batch #: B-90080874

Customer ID: WP011 MIN1
Description: EPA WATER-MINERALS
ETSRC ID: 0080934

Elm	Result	Expected Value	+/- STD.DEV.	Estimated Sample Detection Limit
AG	<0.01			0.01
AL	0.04			0.02
AS	<0.04			0.04
BA	0.012			0.0005
BE	<0.001			0.001
BI	<0.04			0.04
CA	4.7	4.80	0.49	0.5
CD	<0.003			0.003
CO	<0.01			0.01
CR	<0.01			0.01
CU	<0.002			0.002
FE	<0.005			0.005
K	1.3			0.3
LI	0.002			0.002
MG	1.3	1.26	0.155	0.03
MN	<0.002			0.002
MO	<0.005			0.005
NA	38.7	33.3	2.08	0.01
NI	<0.01			0.01
P	<0.09			0.09
PB	<0.04			0.04
SB	<0.04			0.04
SE	<0.05			0.05
SN	<0.04			0.04
SR	0.0042			0.0005
TI	<0.002			0.002
TL	<0.06			0.06
V	<0.004			0.004
ZN	<0.003			0.003

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Duplicate Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 6
Description: FAN 2 CTI/HI 1 A FILTER
ETSRC ID: 0080880

Elm	Result	Duplicate	% Deviation	Estimated Sample Detection Limit
AG	<0.05	<0.05	0.0	0.05
AL	2.1	2.1	0.0	0.1
AS	<0.2	<0.2	0.0	0.2
BA	0.060	0.061	1.7	0.003
BE	<0.003	<0.003	0.0	0.003
BI	<0.2	<0.2	0.0	0.2
CA	1.0	1.1	9.5	0.2
CD	<0.01	<0.01	0.0	0.01
CO	<0.05	<0.05	0.0	0.05
CR	<0.05	<0.05	0.0	0.05
CU	0.03	0.03	0.0	0.01
FE	0.23	0.23	0.0	0.03
K	<1.	<1.	0.0	1.
LI	<0.01	<0.01	0.0	0.01
MG	0.16	0.16	0.0	0.002
MN	0.02	0.02	0.0	0.01
MO	0.19	0.19	0.0	0.03
NA	1.1	1.1	0.0	0.07
NI	<0.06	<0.06	0.0	0.06
P	<0.5	<0.5	0.0	0.5
PB	<0.2	<0.2	0.0	0.2
SB	<0.2	<0.2	0.0	0.2
SE	<0.2	<0.2	0.0	0.2
SN	<0.2	<0.2	0.0	0.2
SR	0.021	0.022	4.7	0.002
TI	0.099	0.099	0.0	0.01
TL	<0.2	<0.2	0.0	0.2
V	<0.02	<0.02	0.0	0.02
ZN	<0.01	<0.01	0.0	0.01

Average % Deviation 0.5

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Duplicate Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 16
Description: FAN 2 CTI/HI 3 A FILTER
ETSRC ID: 0080888

Elm	Result	Duplicate	% Deviation	Estimated Sample Detection Limit
AG	<0.05	<0.05	0.0	0.05
AL	2.6	2.6	0.0	0.1
AS	<0.2	<0.2	0.0	0.2
BA	0.045	0.044	2.2	0.002
BE	<0.002	<0.002	0.0	0.002
BI	<0.2	<0.2	0.0	0.2
CA	0.99	0.97	2.0	0.2
CD	<0.01	<0.01	0.0	0.01
CO	<0.05	<0.05	0.0	0.05
CR	0.06	0.17	95.7	0.05
CU	0.047	0.034	32.1	0.01
FE	0.35	0.85	83.3	0.03
K	<1.	<1.	0.0	1.
LI	<0.01	<0.01	0.0	0.01
MG	0.16	0.16	0.0	0.002
MN	<0.01	0.02	***	0.01
MO	0.22	0.21	4.7	0.03
NA	0.82	0.81	1.2	0.05
NI	<0.05	0.1	***	0.05
P	<0.7	<0.7	0.0	0.7
PB	<0.2	<0.2	0.0	0.2
SB	<0.2	<0.2	0.0	0.2
SE	<0.3	<0.3	0.0	0.3
SN	<0.2	<0.2	0.0	0.2
SR	0.023	0.023	0.0	0.002
TI	0.036	0.034	5.7	0.01
TL	<0.2	<0.2	0.0	0.2
V	<0.02	<0.02	0.0	0.02
ZN	<0.01	<0.01	0.0	0.01

Average % Deviation 8.4

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Duplicate Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 29
Description: FAN 1 CTI/LO 2 D NITRIC
ETSRC ID: 0080899

Elm	Result	Duplicate	% Deviation	Estimated Sample Detection Limit
AG	<0.01	<0.01	0.0	0.01
AL	0.68	0.71	4.3	0.02
AS	<0.04	<0.04	0.0	0.04
BA	0.016	0.016	0.0	0.0005
BE	<0.001	<0.001	0.0	0.001
BI	<0.04	<0.04	0.0	0.04
CA	4.0	4.1	2.5	0.5
CD	0.005	0.005	0.0	0.003
CO	<0.01	<0.01	0.0	0.01
CR	0.044	0.050	12.8	0.01
CU	0.066	0.069	4.4	0.002
FE	0.590	0.625	5.8	0.005
K	<0.3	0.4	***	0.3
LI	<0.002	<0.002	0.0	0.002
MG	1.2	1.3	8.0	0.03
MN	0.022	0.023	4.4	0.002
MO	<0.005	<0.005	0.0	0.005
NA	3.16	3.19	0.9	0.01
NI	0.02	0.02	0.0	0.01
P	0.1	0.2	66.7	0.09
PB	0.06	0.06	0.0	0.04
SB	<0.04	<0.04	0.0	0.04
SE	<0.05	<0.05	0.0	0.05
SN	<0.04	<0.04	0.0	0.04
SR	0.024	0.025	4.1	0.0005
TI	0.014	0.014	0.0	0.002
TL	<0.06	<0.06	0.0	0.06
V	<0.004	<0.004	0.0	0.004
ZN	0.360	0.395	9.3	0.003

Average % Deviation 4.4

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Duplicate Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 39
Description: FAN 3 CTI/HI 1 C NITRIC
ETSRC ID: 0080904

Elm	Result	Duplicate	% Deviation	Estimated Sample Detection Limit
AG	0.076	0.27	112.1	0.01
AL	3.10	3.10	0.0	0.02
AS	5.26	5.22	0.8	0.04
BA	0.274	0.274	0.0	0.0005
BE	0.261	0.260	0.4	0.001
BI	<0.04	<0.04	0.0	0.04
CA	3.9	3.8	2.6	0.5
CD	2.71	2.70	0.4	0.004
CO	2.50	2.48	0.8	0.01
CR	2.59	2.58	0.4	0.01
CU	2.69	2.68	0.4	0.002
FE	3.31	3.30	0.3	0.005
K	15.	15.	0.0	0.3
LI	<0.002	<0.002	0.0	0.002
MG	3.77	3.73	1.1	0.03
MN	2.56	2.56	0.0	0.002
MO	<0.005	<0.005	0.0	0.005
NA	6.70	6.72	0.3	0.01
NI	2.70	2.69	0.4	0.01
P	<0.1	<0.1	0.0	0.1
PB	2.6	2.6	0.0	0.04
SB	<0.04	<0.04	0.0	0.04
SE	12.9	12.8	0.8	0.05
SN	<0.04	<0.04	0.0	0.04
SR	0.297	0.296	0.3	0.0005
TI	0.016	0.017	6.1	0.002
TL	<0.06	<0.06	0.0	0.06
V	<0.004	<0.004	0.0	0.004
ZN	3.24	3.22	0.6	0.004

Average % Deviation 4.4

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Spike Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 13
Description: FAN 1 CTI/HI 2 C FILTER
ETSRC ID: 0080885

Elm	Result	MCG Added	Spiked Sample	% Recovery	Estimated Sample Detection Limit
AG	<0.05	2.0	2.9	145.	0.05
AL	2.0	500.0	500.	100.	0.1
AS	<0.2	5.0	4.6	92.	0.3
BA	0.041	1.0	1.06	102.	0.003
BE	<0.003	1.0	0.981	98.	0.003
BI	<0.2	0.0	<0.2	-	0.2
CA	1.3	0.0	1.9	-	0.2
CD	<0.01	2.0	1.97	99.	0.01
CO	<0.05	0.0	<0.05	-	0.05
CR	<0.05	10.0	10.1	101.	0.05
CU	0.01	20.0	19.8	99.	0.01
FE	0.23	500.0	528.	106.	0.04
K	<1.	0.0	<1.	-	1.
LI	<0.01	0.0	<0.01	-	0.01
MG	0.20	100.0	95.6	95.	0.003
MN	0.02	100.0	96.3	96.	0.01
MO	0.17	10.0	10.3	101.	0.04
NA	1.3	0.0	1.1	-	0.07
NI	<0.06	5.0	5.1	102.	0.06
P	<0.5	0.0	<0.9	-	0.7
PB	<0.2	5.0	4.6	92.	0.2
SB	<0.2	0.0	<0.2	-	0.2
SE	<0.2	5.0	4.8	96.	0.3
SN	<0.2	0.0	<0.2	-	0.2
SR	0.020	2.0	2.15	106.	0.003
TI	0.069	0.0	0.076	-	0.01
TL	<0.2	10.0	9.6	96.	0.2
V	<0.02	5.0	4.99	100.	0.02
ZN	0.02	100.0	98.8	99.	0.02

Average % Recovery 101.

- Not Spiked
* Possibly Not Spiked - Not in Average
*** Spike Too Low

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Spike Report
Project: ENTROPY Units: MCG/ML
Batch #: B-90080874

Customer ID: 20
Description: FAN 3 PM10 3 E LEAD FILTER
ETSRC ID: 0080891

Elm	Result	MCG Added	Spiked Sample	% Recovery	Estimated Sample Detection Limit
AG	<0.05	4.0	4.3	108.	0.05
AL	1.4	20.0	22.3	105.	0.1
AS	<0.2	10.0	9.8	98.	0.2
BA	0.024	2.0	2.09	103.	0.003
BE	<0.002	1.0	0.944	94.	0.003
BI	<0.2	0.0	<0.2	-	0.2
CA	3.5	0.0	4.9	-	0.2
CD	<0.01	2.0	2.11	105.	0.01
CO	<0.05	0.0	<0.05	-	0.05
CR	0.52	10.0	10.9	104.	0.05
CU	0.038	20.0	20.2	101.	0.01
FE	2.3	200.0	217.	107.	0.03
K	<1.	0.0	<1.	-	1.
LI	<0.01	0.0	<0.01	-	0.01
MG	0.311	100.0	99.0	99.	0.003
MN	0.094	10.0	10.2	101.	0.01
MO	0.04	10.0	10.3	103.	0.03
NA	0.96	0.0	1.2	-	0.05
NI	1.2	10.0	11.6	104.	0.05
P	<0.7	0.0	<1.	-	0.9
PB	<0.2	10.0	10.	100.	0.2
SB	<0.2	0.0	<0.2	-	0.2
SE	<0.3	10.0	9.8	98.	0.3
SN	<0.2	0.0	<0.2	-	0.2
SR	0.0082	2.0	2.20	110.	0.003
TI	0.057	0.0	0.065	-	0.01
TL	<0.2	10.0	9.9	99.	0.2
V	<0.02	2.0	2.06	103.	0.02
ZN	0.15	40.0	39.9	99.	0.02

Average % Recovery 102.

- Not Spiked
* Possibly Not Spiked - Not in Average
*** Spike Too Low

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Spike Report

Project: ENTROPY
Units: MCG/ML

Batch #: B-90080874

Customer ID: 34
Description: FAN 2 CTI/HI 1 A NITRIC
ETSRC ID: 0080902

Elm	Result	MCG Added	Spiked Sample	% Recovery	Estimated Sample Detection Limit
AG	0.02	0.7	0.80	117.	0.01
AL	2.39	3.3	6.74	131.	0.02
AS	<0.04	1.7	2.0	120.	0.05
BA	0.021	0.3	0.397	114.	0.0005
BE	<0.001	0.2	0.189	111.	0.001
BI	<0.04	0.0	<0.04	-	0.04
CA	6.0	0.0	8.3	-	0.5
CD	0.009	0.3	0.438	130.	0.003
CO	<0.01	0.0	0.01	-	0.01
CR	0.28	1.7	2.24	117.	0.01
CU	0.201	3.3	3.89	111.	0.002
FE	1.58	33.3	40.9	118.	0.005
K	2.7	0.0	2.9	-	0.3
LI	0.003	0.0	0.003	-	0.002
MG	1.7	16.7	21.0	116.	0.03
MN	0.19	1.7	2.08	113.	0.002
MO	<0.005	1.7	1.94	116.	0.007
NA	6.49	0.0	6.37	-	0.01
NI	0.32	1.7	2.34	121.	0.01
P	0.40	0.0	<0.2	-	0.1
PB	0.04	1.7	2.0	117.	0.04
SB	<0.04	0.0	<0.04	-	0.04
SE	<0.05	1.7	1.9	114.	0.06
SN	<0.04	0.0	<0.04	-	0.04
SR	0.038	0.3	0.442	122.	0.0005
TI	0.026	0.0	0.027	-	0.002
TL	<0.06	1.7	1.9	114.	0.06
V	<0.004	0.3	0.39	118.	0.004
ZN	0.941	6.7	9.07	122.	0.003

Average % Recovery 118.

- Not Spiked
* Possibly Not Spiked - Not in Average
*** Spike Too Low

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Spike Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 43
Description: FAN 1 CTI/HI 2 C NITRIC
ETSRC ID: 0080906

Elm	Result	MCG Added	Spiked Sample	% Recovery	Estimated Sample Detection Limit
AG	<0.01	0.7	0.75	112.	0.01
AL	1.6	3.3	5.25	110.	0.02
AS	<0.04	1.7	1.9	114.	0.04
BA	0.019	0.3	0.374	108.	0.0005
BE	0.001	0.2	0.181	106.	0.001
BI	<0.04	0.0	<0.04	-	0.04
CA	7.5	0.0	7.3	-	0.5
CD	0.033	0.3	0.440	123.	0.003
CO	<0.01	0.0	<0.01	-	0.01
CR	0.039	1.7	1.88	110.	0.01
CU	0.084	3.3	3.55	104.	0.002
FE	0.836	33.3	37.8	111.	0.005
K	3.3	0.0	2.9	-	0.3
LI	0.004	0.0	0.004	-	0.002
MG	2.2	16.7	20.3	109.	0.03
MN	0.588	1.7	2.36	106.	0.002
MO	<0.005	1.7	1.83	110.	0.006
NA	4.48	0.0	4.34	-	0.01
NI	0.03	1.7	1.95	115.	0.01
P	0.33	0.0	<0.1	-	0.1
PB	<0.04	1.7	1.9	114.	0.04
SB	<0.04	0.0	<0.04	-	0.04
SE	<0.05	1.7	1.8	108.	0.05
SN	<0.04	0.0	<0.04	-	0.04
SR	0.032	0.3	0.410	115.	0.0005
TI	0.023	0.0	0.023	-	0.002
TL	<0.06	1.7	1.8	108.	0.06
V	<0.004	0.3	0.37	112.	0.004
ZN	0.427	6.7	8.15	116.	0.003

Average % Recovery 111.

- Not Spiked
* Possibly Not Spiked - Not in Average
*** Spike Too Low

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Duplicate Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 64
Description: WATER FILTER RUN 4
ETSRC ID: 0080922

Elm	Result	Duplicate	% Deviation	Estimated Sample Detection Limit
AG	<0.05	<0.05	0.0	0.05
AL	0.81	0.83	2.4	0.1
AS	<0.2	<0.2	0.0	0.2
BA	0.029	0.029	0.0	0.002
BE	<0.002	<0.002	0.0	0.002
BI	<0.2	<0.2	0.0	0.2
CA	7.6	7.6	0.0	2.
CD	<0.01	<0.01	0.0	0.01
CO	<0.05	<0.05	0.0	0.05
CR	0.05	<0.05	***	0.05
CU	0.050	0.050	0.0	0.01
FE	0.66	0.65	1.5	0.03
K	<1.	<1.	0.0	1.
LI	<0.01	<0.01	0.0	0.01
MG	1.37	1.37	0.0	0.002
MN	0.01	0.02	66.7	0.01
MO	0.05	0.05	0.0	0.03
NA	3.1	3.1	0.0	0.05
NI	<0.05	0.06	***	0.05
P	<0.7	<0.7	0.0	0.7
PB	<0.2	<0.2	0.0	0.2
SB	<0.2	<0.2	0.0	0.2
SE	<0.3	<0.3	0.0	0.3
SN	<0.2	<0.2	0.0	0.2
SR	0.044	0.044	0.0	0.002
TI	0.044	0.044	0.0	0.01
TL	<0.2	<0.2	0.0	0.2
V	<0.02	<0.02	0.0	0.02
ZN	0.16	0.16	0.0	0.01

Average % Deviation 2.6

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Spike Report
Project: ENTROPY Units: MCG/ML
Batch #: B-90080874

Customer ID: 70
Description: WATER RUN 2
ETSRC ID: 0080928

Elm	Result	MCG Added	Spiked Sample	% Recovery	Estimated Sample Detection Limit
AG	0.1	2.0	2.5	120.	0.05
AL	25.9	500.0	520.	99.	0.1
AS	50.5	5.0	57.5	***	0.3
BA	2.68	1.0	3.79	***	0.003
BE	2.56	1.0	3.78	***	0.003
BI	<0.2	0.0	<0.2	-	0.2
CA	181.	0.0	191.	-	2.
CD	26.0	2.0	29.3	***	0.02
CO	24.7	0.0	25.7	-	0.05
CR	24.9	10.0	35.5	***	0.05
CU	25.2	20.0	45.8	103.	0.01
FE	26.7	500.0	528.	100.	0.04
K	148.	0.0	155.	-	1.
LI	0.02	0.0	0.03	-	0.01
MG	77.9	100.0	174.	96.	0.08
MN	24.9	100.0	119.	94.	0.01
MO	0.04	10.0	9.61	96.	0.04
NA	127.	0.0	133.	-	0.05
NI	25.7	5.0	31.5	***	0.05
P	<1.	0.0	<1.	-	1.
PB	25.1	5.0	30.9	***	0.2
SB	<0.2	0.0	<0.2	-	0.2
SE	125.	5.0	137.	***	0.4
SN	<0.2	0.0	<0.2	-	0.2
SR	3.70	2.0	5.98	114.	0.003
TI	0.03	0.0	0.037	-	0.01
TL	<0.2	10.0	8.9	89.	0.2
V	<0.02	5.0	4.73	95.	0.02
ZN	25.3	100.0	124.	99.	0.03

Average % Recovery 100.

\- Not Spiked
* Possibly Not Spiked - Not in Average
*** Spike Too Low

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Blind QC Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: ERA9924TM
Description: WATER - TRACE METALS
ETSRC ID: 0080933

Elm	Result	Expected Value	+/- STD.DEV.	Estimated Sample Detection Limit
AG	0.042	0.160	0.040	0.01
AL	0.44	0.366	0.092	0.02
AS	0.07	0.059	0.015	0.04
BA	0.216	0.196	0.049	0.0005
BE	0.057	0.050	0.012	0.001
BI	<0.04			0.04
CA	<0.03			0.03
CD	0.11	0.0874	0.022	0.003
CO	0.13	0.120	0.030	0.01
CR	0.24	0.226	0.057	0.01
CU	0.16	0.133	0.033	0.002
FE	0.20	0.171	0.043	0.005
K	0.4			0.3
LI	<0.002			0.002
MG	0.0019			0.0005
MN	0.18	0.160	0.040	0.002
MO	0.12	0.104	0.026	0.005
NA	0.081			0.01
NI	0.37	0.312	0.078	0.01
P	<0.09			0.09
PB	0.12	0.107	0.027	0.04
SB	0.13	0.124	0.031	0.04
SE	0.09	0.0627	0.016	0.05
SN	<0.04			0.04
SR	0.0006			0.0005
TI	0.12	0.117	0.029	0.002
TL	<0.06	0.0294	0.0075	0.06
V	0.12	0.106	0.026	0.004
ZN	0.15	0.126	0.032	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 1
Description: H20 BLANK
ETSRC ID: 0080875

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.06	0.02
AS	<0.04	0.04
BA	0.0037	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	0.25	0.03
CD	<0.002	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	<0.002	0.002
FE	0.024	0.005
K	1.8	0.3
LI	0.003	0.002
MG	0.019	0.0005
MN	<0.002	0.002
MO	<0.005	0.005
NA	0.17	0.01
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.001	0.0005
TI	<0.002	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	0.045	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 2
Description: NITRIC ACID BLANK
ETSRC ID: 0080876

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.41	0.02
AS	<0.04	0.04
BA	0.0045	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	1.5	0.4
CD	<0.002	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	0.0086	0.002
FE	0.16	0.005
K	1.6	0.3
LI	0.002	0.002
MG	0.123	0.0005
MN	0.005	0.002
MO	<0.005	0.005
NA	0.48	0.01
NI	0.068	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.0024	0.0005
TI	0.005	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	0.246	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 3
Description: FILTER BLANK (94)
ETSRC ID: 0080877

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.77	0.02
AS	<0.04	0.04
BA	0.021	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	0.31	0.03
CD	<0.002	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	<0.002	0.002
FE	0.092	0.006
K	<0.3	0.3
LI	<0.002	0.002
MG	0.0599	0.0005
MN	0.003	0.002
MO	0.055	0.005
NA	0.40	0.01
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.0079	0.0005
TI	0.437	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	0.015	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 4
Description: FILTER BLANK (93)
ETSRC ID: 0080878

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	<0.02	0.02
AS	<0.04	0.04
BA	0.0007	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	0.06	0.03
CD	<0.002	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	<0.002	0.002
FE	0.016	0.005
K	0.4	0.3
LI	<0.002	0.002
MG	0.012	0.0005
MN	<0.002	0.002
MO	<0.005	0.005
NA	0.10	0.01
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.001	0.0005
TI	0.056	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	0.0082	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 5
Description: FILTER BLANK (96)
ETSRC ID: 0080879

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	1.8	0.02
AS	0.04	0.04
BA	0.038	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	0.80	0.03
CD	0.002	0.002
CO	<0.01	0.01
CR	0.02	0.01
CU	0.0098	0.002
FE	0.17	0.007
K	<0.3	0.3
LI	<0.002	0.002
MG	0.141	0.0005
MN	0.0077	0.002
MO	0.17	0.005
NA	0.61	0.01
NI	0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.018	0.0005
TI	0.038	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	<0.003	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY
Units: MCG/ML
Batch #: B-90080874

Customer ID: 6
Description: FAN 2 CTI/HI 1 A FILTER
ETSRC ID: 0080880

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.1	0.1
AS	<0.2	0.2
BA	0.060	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	1.0	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.03	0.01
FE	0.23	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.16	0.002
MN	0.02	0.01
MO	0.19	0.03
NA	1.1	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.021	0.002
TI	0.099	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY
Units: MCG/ML

Batch #: B-90080874

Customer ID: 8
Description: FAN 3 CTI/HI 1 C FILTER
ETSRC ID: 0080881

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	1.9	0.1
AS	<0.2	0.2
BA	0.038	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	0.97	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.05	0.05
CU	<0.01	0.01
FE	0.18	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.18	0.002
MN	0.02	0.01
MO	0.17	0.03
NA	0.98	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.021	0.002
TI	0.54	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.02	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 9
Description: FAN 3 CTI/LO 1 B FILTER
ETSRC ID: 0080882

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.2	0.1
AS	<0.2	0.2
BA	0.060	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	1.0	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	<0.01	0.01
FE	0.22	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.18	0.002
MN	0.02	0.01
MO	0.20	0.03
NA	1.2	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.020	0.002
TI	0.048	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.056	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 10
Description: FAN 2 PM10 1 E LEAD FILTER
ETSRC ID: 0080883

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.64	0.02
AS	<0.04	0.04
BA	0.020	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	0.57	0.03
CD	0.003	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	0.012	0.002
FE	0.12	0.006
K	<0.3	0.3
LI	<0.002	0.002
MG	0.145	0.0005
MN	0.0066	0.002
MO	0.055	0.005
NA	0.62	0.01
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	0.0077	0.0005
TI	0.228	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	0.070	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 11
Description: FAN 2 CTI/HI 2 A FILTER
ETSRC ID: 0080884

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.4	0.1
AS	<0.2	0.2
BA	0.045	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	0.96	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	<0.01	0.01
FE	0.24	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.13	0.002
MN	0.02	0.01
MO	0.21	0.03
NA	0.76	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.025	0.002
TI	0.065	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 13
Description: FAN 1 CTI/HI 2 C FILTER
ETSRC ID: 0080885

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.0	0.1
AS	<0.2	0.2
BA	0.041	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	1.3	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.01	0.01
FE	0.23	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.20	0.002
MN	0.02	0.01
MO	0.17	0.03
NA	1.3	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.020	0.002
TI	0.069	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.02	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 14
Description: FAN 1 CTI/LO 2 D FILTER
ETSRC ID: 0080886

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	1.9	0.1
AS	<0.2	0.2
BA	0.038	0.003
BE	<0.003	0.003
BI	<0.2	0.2
CA	1.1	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.01	0.01
FE	0.47	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.18	0.002
MN	0.02	0.01
MO	0.17	0.03
NA	1.0	0.07
NI	<0.06	0.06
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.020	0.002
TI	0.27	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 15
Description: FAN 1 PM10 2 E LEAD FILTER
ETSRC ID: 0080887

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	0.88	0.1
AS	<0.2	0.2
BA	0.019	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	0.54	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.042	0.01
FE	0.45	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.412	0.002
MN	0.01	0.01
MO	0.05	0.02
NA	0.44	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.006	0.002
TI	0.22	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.03	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY
Units: MCG/ML
Batch #: B-90080874

Customer ID: 16
Description: FAN 2 CTI/HI 3 A FILTER
ETSRC ID: 0080888

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.6	0.1
AS	<0.2	0.2
BA	0.044	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	0.98	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.1	0.05
CU	0.041	0.01
FE	0.60	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.16	0.002
MN	<0.01	0.01
MO	0.21	0.03
NA	0.82	0.05
NI	<0.08	0.08
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.023	0.002
TI	0.035	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 18
Description: FAN 2 CTI/HI 3 C FILTER
ETSRC ID: 0080889

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.5	0.1
AS	<0.2	0.2
BA	0.043	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	1.1	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.34	0.05
CU	0.031	0.01
FE	1.4	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.19	0.002
MN	0.053	0.01
MO	0.18	0.03
NA	0.91	0.05
NI	0.58	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.021	0.002
TI	0.077	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.04	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 19
Description: FAN 2 CTI/LO 3 D FILTER
ETSRC ID: 0080890

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.8	0.1
AS	<0.2	0.2
BA	0.043	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	1.4	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.68	0.05
CU	0.033	0.01
FE	2.6	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.355	0.002
MN	0.14	0.01
MO	0.21	0.03
NA	1.3	0.05
NI	1.7	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.023	0.002
TI	0.040	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.02	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 20
Description: FAN 3 PM10 3 E LEAD FILTER
ETSRC ID: 0080891

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	1.4	0.1
AS	<0.2	0.2
BA	0.024	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	3.5	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.52	0.05
CU	0.038	0.01
FE	2.3	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.311	0.002
MN	0.094	0.01
MO	0.04	0.03
NA	0.96	0.05
NI	1.2	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.0082	0.002
TI	0.057	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.15	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 21
Description: FAN 2 CTI/HI 4 A FILTER
ETSRC ID: 0080892

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.1	0.1
AS	<0.2	0.2
BA	0.036	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	0.93	0.2
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.76	0.05
CU	0.060	0.01
FE	3.26	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.20	0.002
MN	0.15	0.01
MO	0.17	0.03
NA	0.80	0.05
NI	1.9	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.019	0.002
TI	0.079	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.042	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 23
Description: FAN 4 CTI/HI 4 C FILTER
ETSRC ID: 0080893

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	3.1	0.1
AS	<0.2	0.2
BA	0.038	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	1.3	0.2
CD	<0.01	0.01
CO	0.49	0.05
CR	3.4	0.05
CU	0.38	0.01
FE	13.9	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.24	0.002
MN	3.07	0.01
MO	0.18	0.03
NA	1.1	0.05
NI	36.5	0.05
P	<0.8	0.8
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.022	0.002
TI	0.062	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.38	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 24
Description: FAN 4 CTI/LO 4 D FILTER
ETSRC ID: 0080894

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.5	0.1
AS	<0.2	0.2
BA	0.037	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	1.4	0.2
CD	<0.01	0.01
CO	0.80	0.05
CR	9.70	0.05
CU	0.58	0.01
FE	43.1	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.259	0.002
MN	4.86	0.01
MO	0.21	0.03
NA	1.2	0.05
NI	61.3	0.05
P	<0.8	0.8
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.021	0.002
TI	0.041	0.01
TL	<0.3	0.3
V	0.04	0.02
ZN	0.58	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 25
Description: FAN 4 PM10 4 E LEAD FILTER
ETSRC ID: 0080897

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	0.70	0.1
AS	<0.2	0.2
BA	0.020	0.002
BE	<0.005	0.005
BI	<0.2	0.2
CA	0.4	0.2
CD	<0.02	0.02
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.12	0.01
FE	0.11	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.11	0.002
MN	0.01	0.01
MO	0.05	0.02
NA	0.34	0.07
NI	<0.07	0.07
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.0080	0.002
TI	0.048	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 27
Description: FAN 3 CTI/LO 1 D NITRIC
ETSRC ID: 0080898

Elm	Result	Estimated Sample Detection Limit
AG	0.02	0.01
AL	1.5	0.02
AS	<0.04	0.04
BA	0.037	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	8.9	0.5
CD	0.012	0.003
CO	<0.01	0.01
CR	0.14	0.01
CU	0.327	0.002
FE	1.27	0.005
K	4.6	0.3
LI	0.004	0.002
MG	2.3	0.03
MN	1.41	0.002
MO	0.008	0.005
NA	9.81	0.01
NI	0.054	0.01
P	0.82	0.09
PB	0.06	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.0555	0.0005
TI	0.031	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	1.25	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 29
Description: FAN 1 CTI/LO 2 D NITRIC
ETSRC ID: 0080899

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.70	0.02
AS	<0.04	0.04
BA	0.016	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	4.1	0.5
CD	0.005	0.003
CO	<0.01	0.01
CR	0.047	0.01
CU	0.067	0.002
FE	0.607	0.005
K	<0.3	0.3
LI	<0.002	0.002
MG	1.2	0.03
MN	0.022	0.002
MO	<0.005	0.005
NA	3.18	0.01
NI	0.02	0.01
P	0.1	0.09
PB	0.06	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.024	0.0005
TI	0.014	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.377	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 31
Description: FAN 2 CTI.LO 3 D NITRIC
ETSRC ID: 0080900

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	1.1	0.02
AS	<0.04	0.04
BA	0.019	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	10.	0.5
CD	0.014	0.003
CO	<0.01	0.01
CR	0.094	0.01
CU	0.059	0.002
FE	1.06	0.005
K	4.5	0.3
LI	0.005	0.002
MG	3.32	0.03
MN	0.043	0.002
MO	<0.005	0.005
NA	6.16	0.01
NI	0.04	0.01
P	0.30	0.09
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.049	0.0005
TI	0.022	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.714	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 33
Description: FAN 4 CTI/LO 4 D NITRIC
ETSRC ID: 0080901

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	1.5	0.02
AS	<0.04	0.04
BA	0.036	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	16.	0.5
CD	0.023	0.003
CO	<0.01	0.01
CR	0.096	0.01
CU	0.230	0.002
FE	2.39	0.005
K	4.8	0.3
LI	0.005	0.002
MG	5.92	0.03
MN	0.063	0.002
MO	0.006	0.005
NA	10.7	0.01
NI	0.071	0.01
P	0.33	0.09
PB	0.07	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.0800	0.0005
TI	0.083	0.002
TL	<0.06	0.06
V	0.008	0.004
ZN	1.11	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 34
Description: FAN 2 CTI/HI 1 A NITRIC
ETSRC ID: 0080902

Elm	Result	Estimated Sample Detection Limit
AG	0.02	0.01
AL	2.39	0.02
AS	<0.04	0.04
BA	0.021	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	6.0	0.5
CD	0.009	0.003
CO	<0.01	0.01
CR	0.28	0.01
CU	0.201	0.002
FE	1.58	0.005
K	2.7	0.3
LI	0.003	0.002
MG	1.7	0.03
MN	0.19	0.002
MO	<0.005	0.005
NA	6.49	0.01
NI	0.32	0.01
P	0.40	0.09
PB	0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.038	0.0005
TI	0.026	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.941	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 37
Description: FAN 3 CTI/HI 1 C NITRIC
ETSRC ID: 0080903

Elm	Result	Estimated Sample Detection Limit
AG	0.02	0.01
AL	1.0	0.02
AS	<0.04	0.04
BA	0.028	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	7.3	0.5
CD	0.024	0.003
CO	<0.01	0.01
CR	0.091	0.01
CU	0.231	0.002
FE	1.36	0.005
K	3.4	0.3
LI	0.004	0.002
MG	2.4	0.03
MN	0.14	0.002
MO	0.006	0.005
NA	8.01	0.01
NI	0.053	0.01
P	0.64	0.09
PB	0.08	0.04
SB	<0.04	0.04
SE	0.05	0.05
SN	<0.04	0.04
SR	0.043	0.0005
TI	0.032	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	1.17	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 39
Description: FAN 3 CTI/HI 1 C NITRIC
ETSRC ID: 0080904

Elm	Result	Estimated Sample Detection Limit
AG	0.17	0.01
AL	3.10	0.02
AS	5.24	0.04
BA	0.274	0.0005
BE	0.261	0.001
BI	<0.04	0.04
CA	3.8	0.5
CD	2.70	0.004
CO	2.49	0.01
CR	2.58	0.01
CU	2.69	0.002
FE	3.30	0.005
K	15.	0.3
LI	<0.002	0.002
MG	3.75	0.03
MN	2.56	0.002
MO	<0.005	0.005
NA	6.71	0.01
NI	2.70	0.01
P	<0.1	0.1
PB	2.6	0.04
SB	<0.04	0.04
SE	12.9	0.05
SN	<0.04	0.04
SR	0.297	0.0005
TI	0.016	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	3.23	0.004

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 40
Description: FAN 2 CTI/HI 2 A NITRIC
ETSRC ID: 0080905

Elm	Result	Estimated Sample Detection Limit
AG	0.02	0.01
AL	0.46	0.02
AS	<0.04	0.04
BA	0.017	0.0005
BE	<0.001	0.001
BI	<0.04	0.04
CA	5.1	0.5
CD	0.008	0.003
CO	<0.01	0.01
CR	0.079	0.01
CU	0.071	0.002
FE	0.738	0.005
K	3.1	0.3
LI	0.002	0.002
MG	1.7	0.03
MN	0.20	0.002
MO	<0.005	0.005
NA	5.42	0.01
NI	0.04	0.01
P	0.48	0.09
PB	0.05	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.026	0.0005
TI	0.016	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.485	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 43
Description: FAN 1 CTI/HI 2 C NITRIC
ETSRC ID: 0080906

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	1.6	0.02
AS	<0.04	0.04
BA	0.019	0.0005
BE	0.001	0.001
BI	<0.04	0.04
CA	7.5	0.5
CD	0.033	0.003
CO	<0.01	0.01
CR	0.039	0.01
CU	0.084	0.002
FE	0.836	0.005
K	3.3	0.3
LI	0.004	0.002
MG	2.2	0.03
MN	0.588	0.002
MO	<0.005	0.005
NA	4.48	0.01
NI	0.03	0.01
P	0.33	0.09
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.032	0.0005
TI	0.023	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.427	0.003

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Blank Report

Project: ENTROPY
Units: MCG
Batch #: B-90080874

Customer ID: BLANK 1
Description: BLANK
ETSRC ID: 0080874

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	<0.02	0.02
AS	<0.04	0.04
BA	<0.0005	0.0005
BE	<0.0006	0.0006
BI	<0.04	0.04
CA	<0.03	0.03
CD	<0.002	0.002
CO	<0.01	0.01
CR	<0.01	0.01
CU	<0.002	0.002
FE	<0.005	0.005
K	<0.3	0.3
LI	<0.002	0.002
MG	<0.0005	0.0005
MN	<0.002	0.002
MO	<0.005	0.005
NA	<0.01	0.01
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SN	<0.04	0.04
SR	<0.0005	0.0005
TI	<0.002	0.002
TL	<0.05	0.05
V	<0.003	0.003
ZN	<0.002	0.002

Quality Control Report
Environmental Trace Substances Research Center
ICP Scan - Blank Report
Project: ENTROPY Units: MCG
Batch #: B-90080874

Customer ID: BLANK 3
Description: BLANK
ETSRC ID: 0080918

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	<0.1	0.1
AS	<0.2	0.2
BA	<0.002	0.002
BE	<0.005	0.005
BI	<0.2	0.2
CA	<0.2	0.2
CD	<0.02	0.02
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.036	0.01
FE	<0.02	0.02
K	<1.	1.
LI	<0.01	0.01
MG	<0.002	0.002
MN	<0.01	0.01
MO	<0.02	0.02
NA	<0.07	0.07
NI	<0.07	0.07
P	<0.4	0.4
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	<0.002	0.002
TI	<0.01	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 45
Description: FAN 1 CTI/HI 2 C NITRIC
ETSRC ID: 0080907

Elm	Result	Estimated Sample Detection Limit
AG	0.086	0.01
AL	2.88	0.02
AS	5.30	0.04
BA	0.281	0.0005
BE	0.267	0.001
BI	<0.04	0.04
CA	3.8	0.5
CD	2.79	0.004
CO	2.54	0.01
CR	2.61	0.01
CU	2.63	0.002
FE	3.10	0.005
K	15.	0.3
LI	0.002	0.002
MG	3.66	0.03
MN	2.83	0.002
MO	<0.005	0.005
NA	4.91	0.01
NI	2.74	0.01
P	<0.1	0.1
PB	2.7	0.04
SB	<0.04	0.04
SE	13.0	0.05
SN	<0.04	0.04
SR	0.294	0.0005
TI	0.010	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	2.94	0.004

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 46
Description: FAN 2 CTI/HI 3 A NITRIC
ETSRC ID: 0080908

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.66	0.02
AS	<0.04	0.04
BA	0.015	0.0005
BE	0.001	0.001
BI	<0.04	0.04
CA	5.8	0.5
CD	0.051	0.003
CO	0.047	0.01
CR	0.088	0.01
CU	0.056	0.002
FE	0.727	0.005
K	1.6	0.3
LI	0.003	0.002
MG	1.2	0.03
MN	0.11	0.002
MO	<0.005	0.005
NA	2.57	0.01
NI	0.04	0.01
P	0.2	0.09
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.018	0.0005
TI	0.033	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	1.17	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 49
Description: FAN 2 CTI/HI 3 C NITRIC
ETSRC ID: 0080909

Elm	Result	Estimated Sample Detection Limit
AG	0.54	0.01
AL	1.1	0.02
AS	1.2	0.04
BA	0.0800	0.0005
BE	0.002	0.001
BI	<0.04	0.04
CA	4.9	0.5
CD	0.028	0.003
CO	0.55	0.01
CR	0.065	0.01
CU	0.618	0.002
FE	4.09	0.005
K	2.1	0.3
LI	0.003	0.002
MG	1.6	0.03
MN	0.13	0.002
MO	<0.005	0.005
NA	3.36	0.01
NI	0.057	0.01
P	0.2	0.1
PB	0.59	0.04
SB	<0.04	0.04
SE	2.8	0.05
SN	<0.04	0.04
SR	0.0813	0.0005
TI	0.079	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	1.17	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 51
Description: FAN 2 CTI/HI 3 C NITRIC
ETSRC ID: 0080910

Elm	Result	Estimated Sample Detection Limit
AG	0.25	0.01
AL	3.14	0.02
AS	5.68	0.04
BA	0.307	0.0005
BE	0.253	0.0005
BI	<0.04	0.04
CA	3.0	0.3
CD	2.71	0.003
CO	2.79	0.01
CR	2.54	0.01
CU	2.86	0.002
FE	4.83	0.005
K	14.	0.2
LI	<0.002	0.002
MG	3.30	0.02
MN	2.58	0.002
MO	<0.005	0.005
NA	4.50	0.01
NI	2.63	0.01
P	<0.2	0.2
PB	2.9	0.04
SB	<0.04	0.04
SE	14.0	0.06
SN	<0.04	0.04
SR	0.312	0.0005
TI	0.041	0.002
TL	<0.04	0.04
V	<0.004	0.004
ZN	3.29	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 52
Description: FAN 2 CTI/HI 4 A NITRIC
ETSRC ID: 0080911

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.55	0.02
AS	<0.04	0.04
BA	0.019	0.0005
BE	0.001	0.001
BI	<0.04	0.04
CA	8.4	0.5
CD	0.028	0.003
CO	0.01	0.01
CR	0.081	0.01
CU	0.080	0.002
FE	0.874	0.005
K	2.9	0.3
LI	0.003	0.002
MG	2.6	0.03
MN	0.11	0.002
MO	<0.005	0.005
NA	5.59	0.01
NI	0.050	0.01
P	0.45	0.09
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.040	0.0005
TI	0.014	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	0.469	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 55
Description: FAN 4 CTI/HI 4 C NITRIC
ETSRC ID: 0080912

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.69	0.02
AS	<0.04	0.04
BA	0.027	0.0005
BE	0.001	0.001
BI	<0.04	0.04
CA	11.	0.5
CD	0.01	0.003
CO	0.049	0.01
CR	0.070	0.01
CU	0.063	0.002
FE	1.01	0.005
K	1.7	0.3
LI	0.002	0.002
MG	1.4	0.03
MN	0.090	0.002
MO	<0.005	0.005
NA	2.70	0.01
NI	0.03	0.01
P	0.31	0.09
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.05	0.05
SN	<0.04	0.04
SR	0.019	0.0005
TI	0.033	0.002
TL	<0.06	0.06
V	0.004	0.004
ZN	7.28	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 57
Description: FAN 4 CTI/HI 4 C NITRIC
ETSRC ID: 0080913

Elm	Result	Estimated Sample Detection Limit
AG	0.090	0.01
AL	2.88	0.02
AS	5.13	0.04
BA	0.273	0.0005
BE	0.261	0.001
BI	<0.04	0.04
CA	6.0	0.5
CD	2.67	0.004
CO	2.48	0.01
CR	2.54	0.01
CU	2.58	0.002
FE	3.11	0.005
K	14.	0.3
LI	<0.002	0.002
MG	3.2	0.03
MN	2.51	0.002
MO	<0.005	0.005
NA	4.11	0.01
NI	2.67	0.01
P	<0.1	0.1
PB	2.6	0.04
SB	<0.04	0.04
SE	12.7	0.05
SN	<0.04	0.04
SR	0.284	0.0005
TI	0.017	0.002
TL	<0.06	0.06
V	<0.004	0.004
ZN	6.25	0.003

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 58
Description: AMBIENT FILTER RUN 2
ETSRC ID: 0080914

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.5	0.1
AS	<0.2	0.2
BA	0.047	0.002
BE	<0.005	0.005
BI	<0.2	0.2
CA	1.1	0.2
CD	<0.02	0.02
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.17	0.01
FE	0.32	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.19	0.002
MN	0.02	0.01
MO	0.21	0.03
NA	0.89	0.07
NI	<0.07	0.07
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.022	0.002
TI	0.057	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	0.02	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 59
Description: AMBIENT FILTER RUN 3
ETSRC ID: 0080915

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.6	0.1
AS	<0.2	0.2
BA	0.050	0.002
BE	<0.005	0.005
BI	<0.2	0.2
CA	1.0	0.2
CD	<0.02	0.02
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.078	0.01
FE	0.33	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.19	0.002
MN	0.02	0.01
MO	0.22	0.03
NA	0.89	0.07
NI	<0.07	0.07
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.023	0.002
TI	0.037	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	0.064	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 60
Description: AMBIENT FILTER RUN 4
ETSRC ID: 0080916

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.6	0.1
AS	<0.2	0.2
BA	0.050	0.002
BE	<0.005	0.005
BI	<0.2	0.2
CA	1.0	0.2
CD	<0.02	0.02
CO	<0.05	0.05
CR	0.05	0.05
CU	0.12	0.01
FE	0.51	0.03
K	<1.	1.
LI	<0.01	0.01
MG	0.24	0.002
MN	0.02	0.01
MO	0.21	0.03
NA	0.90	0.07
NI	<0.07	0.07
P	<0.5	0.5
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.2	0.2
SN	<0.2	0.2
SR	0.022	0.002
TI	0.096	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	0.02	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 68
Description: WATER RUN #4
ETSRC ID: 0080926

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	<0.1	0.1
AS	<0.2	0.2
BA	0.23	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	370.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.035	0.01
FE	<0.03	0.03
K	40.	1.
LI	0.051	0.01
MG	111.	0.08
MN	0.02	0.01
MO	0.086	0.02
NA	211.	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	2.08	0.003
TI	0.061	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY
Units: MCG/ML
Batch #: B-90080874

Customer ID: 65
Description: WATER RUN #1
ETSRC ID: 0080923

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	<0.1	0.1
AS	<0.2	0.2
BA	0.23	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	365.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.088	0.01
FE	0.092	0.03
K	40.	1.
LI	0.048	0.01
MG	109.	0.08
MN	0.03	0.01
MO	0.086	0.02
NA	205.	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	2.01	0.003
TI	0.055	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.049	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 66
Description: WATER RUN #2
ETSRC ID: 0080924

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	<0.1	0.1
AS	<0.2	0.2
BA	0.23	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	377.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.059	0.01
FE	0.06	0.03
K	41.	1.
LI	0.052	0.01
MG	113.	0.08
MN	0.02	0.01
MO	0.089	0.02
NA	213.	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	2.08	0.003
TI	0.058	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.040	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 67
Description: WATER RUN #3
ETSRC ID: 0080925

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	<0.1	0.1
AS	<0.2	0.2
BA	0.22	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	357.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	<0.05	0.05
CU	0.03	0.01
FE	0.03	0.03
K	40.	1.
LI	0.049	0.01
MG	108.	0.08
MN	0.02	0.01
MO	0.078	0.02
NA	203.	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	1.98	0.003
TI	0.055	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	<0.01	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 61
Description: WATER FILTER RUN 1
ETSRC ID: 0080919

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	2.4	0.1
AS	<0.2	0.2
BA	0.14	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	44.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.17	0.05
CU	0.16	0.01
FE	3.59	0.03
K	<1.	1.
LI	<0.01	0.01
MG	3.04	0.002
MN	0.11	0.01
MO	0.06	0.03
NA	3.3	0.05
NI	0.08	0.05
P	1.	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.21	0.003
TI	0.13	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.70	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 62
Description: WATER FILTER RUN 2
ETSRC ID: 0080920

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	1.3	0.1
AS	<0.2	0.2
BA	0.052	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	13.	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.07	0.05
CU	0.052	0.01
FE	1.3	0.03
K	<1.	1.
LI	<0.01	0.01
MG	1.39	0.002
MN	0.039	0.01
MO	0.05	0.03
NA	2.1	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.066	0.002
TI	0.11	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.45	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 63
Description: WATER FILTER RUN 3
ETSRC ID: 0080921

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	0.94	0.1
AS	<0.2	0.2
BA	0.032	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	8.7	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.08	0.05
CU	0.074	0.01
FE	0.80	0.03
K	<1.	1.
LI	<0.01	0.01
MG	1.64	0.002
MN	0.02	0.01
MO	0.05	0.03
NA	3.0	0.05
NI	<0.05	0.05
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.052	0.002
TI	0.10	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.15	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 64
Description: WATER FILTER RUN 4
ETSRC ID: 0080922

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	0.82	0.1
AS	<0.2	0.2
BA	0.029	0.002
BE	<0.002	0.002
BI	<0.2	0.2
CA	7.6	2.
CD	<0.01	0.01
CO	<0.05	0.05
CR	0.05	0.05
CU	0.050	0.01
FE	0.66	0.03
K	<1.	1.
LI	<0.01	0.01
MG	1.37	0.002
MN	0.01	0.01
MO	0.05	0.03
NA	3.1	0.05
NI	<0.06	0.06
P	<0.7	0.7
PB	<0.2	0.2
SB	<0.2	0.2
SE	<0.3	0.3
SN	<0.2	0.2
SR	0.044	0.002
TI	0.044	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	0.16	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 69
Description: WATER RUN 1
ETSRC ID: 0080927

Elm	Result	Estimated Sample Detection Limit
AG	0.08	0.05
AL	26.3	0.1
AS	51.2	0.2
BA	2.74	0.002
BE	2.59	0.002
BI	<0.2	0.2
CA	184.	2.
CD	26.3	0.02
CO	25.0	0.05
CR	25.2	0.05
CU	25.6	0.01
FE	29.7	0.03
K	150.	1.
LI	0.02	0.01
MG	78.5	0.08
MN	25.3	0.01
MO	0.05	0.03
NA	129.	0.05
NI	26.1	0.05
P	<1.	1.
PB	25.4	0.2
SB	<0.2	0.2
SE	127.	0.3
SN	<0.2	0.2
SR	3.75	0.003
TI	0.03	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	25.6	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 70
Description: WATER RUN 2
ETSRC ID: 0080928

Elm	Result	Estimated Sample Detection Limit
AG	0.1	0.05
AL	25.9	0.1
AS	50.5	0.2
BA	2.68	0.002
BE	2.56	0.002
BI	<0.2	0.2
CA	181.	2.
CD	26.0	0.02
CO	24.7	0.05
CR	24.9	0.05
CU	25.2	0.01
FE	26.7	0.03
K	148.	1.
LI	0.02	0.01
MG	77.9	0.08
MN	24.9	0.01
MO	0.04	0.03
NA	127.	0.05
NI	25.7	0.05
P	<1.	1.
PB	25.1	0.2
SB	<0.2	0.2
SE	125.	0.3
SN	<0.2	0.2
SR	3.70	0.003
TI	0.03	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	25.3	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 71
Description: WATER RUN 3
ETSRC ID: 0080929

Elm	Result	Estimated Sample Detection Limit
AG	0.06	0.05
AL	26.7	0.1
AS	52.2	0.2
BA	2.75	0.002
BE	2.63	0.002
BI	<0.2	0.2
CA	179.	2.
CD	27.1	0.02
CO	25.5	0.05
CR	25.8	0.05
CU	26.1	0.01
FE	27.6	0.03
K	153.	1.
LI	0.02	0.01
MG	77.8	0.08
MN	25.7	0.01
MO	0.04	0.03
NA	128.	0.05
NI	26.5	0.05
P	<1.	1.
PB	26.1	0.2
SB	<0.2	0.2
SE	129.	0.3
SN	<0.2	0.2
SR	3.78	0.003
TI	0.02	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	26.3	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 72
Description: WATER RUN 4
ETSRC ID: 0080930

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	26.9	0.1
AS	52.1	0.2
BA	2.79	0.002
BE	2.65	0.002
BI	<0.2	0.2
CA	184.	2.
CD	27.1	0.02
CO	25.6	0.05
CR	25.8	0.05
CU	26.2	0.01
FE	27.7	0.03
K	154.	1.
LI	0.02	0.01
MG	79.9	0.08
MN	25.8	0.01
MO	0.03	0.03
NA	131.	0.05
NI	26.5	0.05
P	<1.	1.
PB	26.2	0.2
SB	<0.2	0.2
SE	130.	0.3
SN	<0.2	0.2
SR	3.84	0.003
TI	0.02	0.01
TL	<0.2	0.2
V	<0.02	0.02
ZN	26.3	0.02

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 73
Description: LOW AUDIT
ETSRC ID: 0080931

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	5.1	0.1
AS	10.	0.2
BA	0.538	0.002
BE	0.52	0.005
BI	<0.2	0.2
CA	0.89	0.2
CD	5.28	0.02
CO	5.07	0.05
CR	5.20	0.05
CU	5.18	0.01
FE	5.37	0.03
K	29.	1.
LI	<0.01	0.01
MG	5.2	0.2
MN	5.13	0.01
MO	<0.03	0.03
NA	5.6	0.07
NI	5.4	0.07
P	<0.5	0.5
PB	5.2	0.2
SB	<0.2	0.2
SE	25.7	0.2
SN	<0.2	0.2
SR	0.578	0.002
TI	<0.01	0.01
TL	<0.3	0.3
V	<0.02	0.02
ZN	5.23	0.01

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report

Project: ENTROPY Units: MCG/ML

Batch #: B-90080874

Customer ID: 74
Description: HIGH AUDIT
ETSRC ID: 0080932

Elm	Result	Estimated Sample Detection Limit
AG	<0.05	0.05
AL	49.7	0.1
AS	98.9	0.2
BA	5.18	0.002
BE	5.10	0.005
BI	<0.2	0.2
CA	4.9	0.2
CD	50.5	0.03
CO	48.2	0.05
CR	49.1	0.05
CU	50.2	0.01
FE	51.1	0.03
K	262.	1.
LI	<0.01	0.01
MG	49.7	0.2
MN	49.0	0.01
MO	<0.03	0.03
NA	52.3	0.07
NI	51.5	0.07
P	<1.	1.
PB	49.0	0.2
SB	<0.2	0.2
SE	245.	0.3
SN	<0.2	0.2
SR	5.58	0.002
TI	<0.01	0.01
TL	<0.3	0.3
V	<0.03	0.03
ZN	48.9	0.03

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

SEP 19 1991

MEMORANDUM

SUBJECT: Emission Test Request for National Institute of Standards and Technology, Gaithersburg, Maryland

FROM: James U. Crowder, Chief
Industrial Studies Branch, ESD (MD-13)

TO: Gilbert H. Wood, Chief
Emission Measurement Branch, TSD (MD-14)

This is to request that the Emission Measurement Branch conduct emission tests at the National Institute of Standards and Technology located in Gaithersburg, Maryland. Emission tests are to be conducted on one cooling tower that supplies comfort cooling and cooling for laboratory processes (lasers, ovens, etc.). Emission tests are needed to supplement the data on performance of high-efficiency drift eliminators.

Detailed information on the facility to be tested and a discussion of the emission measurements required are presented in the attached source test request prepared by Midwest Research Institute (MRI). Questions regarding this test request should be directed to Ms. Beth Teague or Ms. Carol Athey of MRI.

Attachment

cc: Debbie Stackhouse, SDB
Beth Teague, ISB
Al Vervaert, ISB
Carol Athey, MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513
Telephone (919) 467-5215
FAX (919) 467-8060

Date: September 18, 1989

Subject: Recommendation for Emission Testing at National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland
Chromium Emissions from Cooling Towers NESHAP
EPA Contract No. 68-02-3817; ESD Project 85/02b
MRI Project 7716-K

From: Carol Athey CA

To: Beth Teague
ESD/ISB (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Recommendation

1. Conduct outlet testing of the comfort cooling tower located at Building 302 to determine drift rate based on emissions of native materials (to be determined prior to testing).

2. During the tests, obtain data on airflow, recirculating waterflow, inlet and outlet water temperatures, blowdown, and makeup waterflow rates. Also, obtain data on ambient wet bulb and dry bulb temperatures, ambient humidity, ambient concentrations of materials selected for measurement to determine drift rate, wind speed, and wind direction.

3. Prior to and during the tests, obtain grab samples of the cooling tower basin water for analysis to determine the concentrations of native minerals.

II. Basis of Selection

The cooling tower at this facility was selected for testing for the following reasons:

1. The cooling tower is equipped with Munters D-15 high-efficiency drift eliminators (HEDE's).
2. The cooling tower is located such that the test personnel will have good access to the outlet stacks. The stack design will permit unobstructed sampling traverses.

III. Relationship of Test Data to Development of Performance Standards

These test data are needed to supplement the data on the performance of HEDE's; drift rate will be determined as a percentage of recirculating waterflow.

IV. Description of the Cooling Tower

The NIST is a Federal government research facility near Gaithersburg, Maryland. Comfort cooling and cooling for laboratory processes (lasers, ovens, etc.) are both provided by a 4-cell Marley tower located near the western boundary of the facility. The tower was installed in the early 1960's.

A sketch of the cooling tower system is provided in Figure 1. The tower is a crossflow design with redwood splash fill and one fan per cell. Propeller fans measuring 22 feet (ft) in diameter are located in the stack of each cell. In 1985, the tower was retrofitted with high-efficiency Munters D-15 drift eliminators.

The capacity of the water basin is about 500,000 gallons (gal). Four pumps, each rated for 8,800 gallons per minute, circulate the water to the chillers. The water from the chillers is combined and returned to the tower through a 42-inch riser pipe. Above the tower, the flow is split into four branches and distributed to each of the cells. The water distribution decks are located directly above the fill and are equipped with gravity-flow nozzles. In winter, heated water is sprayed up into the rear of the tower to prevent icing conditions.

A phosphate-based water treatment program is used to inhibit corrosion in the heat exchangers. The tower currently is operating at six cycles of concentration. Conductivity and pH are monitored continuously, and blowdown occurs automatically when the conductivity reaches 1,800 to 2,000 μmhos. Blowdown averages about 60,000 gallons per day (gal/day) in summer and about 2,000 gal/day in winter.

Makeup water is provided by the City of Gaithersburg. The conductivity is generally about 300 μmhos, but after heavy rains and after salt has been applied to the roads in the winter, the conductivity increases. Makeup requirements in summer average about 300,000 gal/day, and in winter average about 55,000 gal/day. Most of the water has first been used for once-through cooling of oil and air compressors.

Biological growth is controlled by manually adding 6.5 gal of a solution containing disodium cyanodithiodocarbonate (7.35 percent) or potassium methyldithiocarbonate (10.15 percent) once a week.

V. Test Methodologies

The test methodologies that are used by EMB should accurately characterize the drift rate based on emissions of native materials contained in the recirculating water. Additionally, accurate determinations of recirculating waterflow rate in the riser pipe and determinations of inlet or ambient concentrations of the native materials used to determine drift rate should be made. Onsite meteorological data that will be needed include ambient wet bulb and dry bulb temperatures, ambient humidity, wind speed, and wind direction. The general guidelines

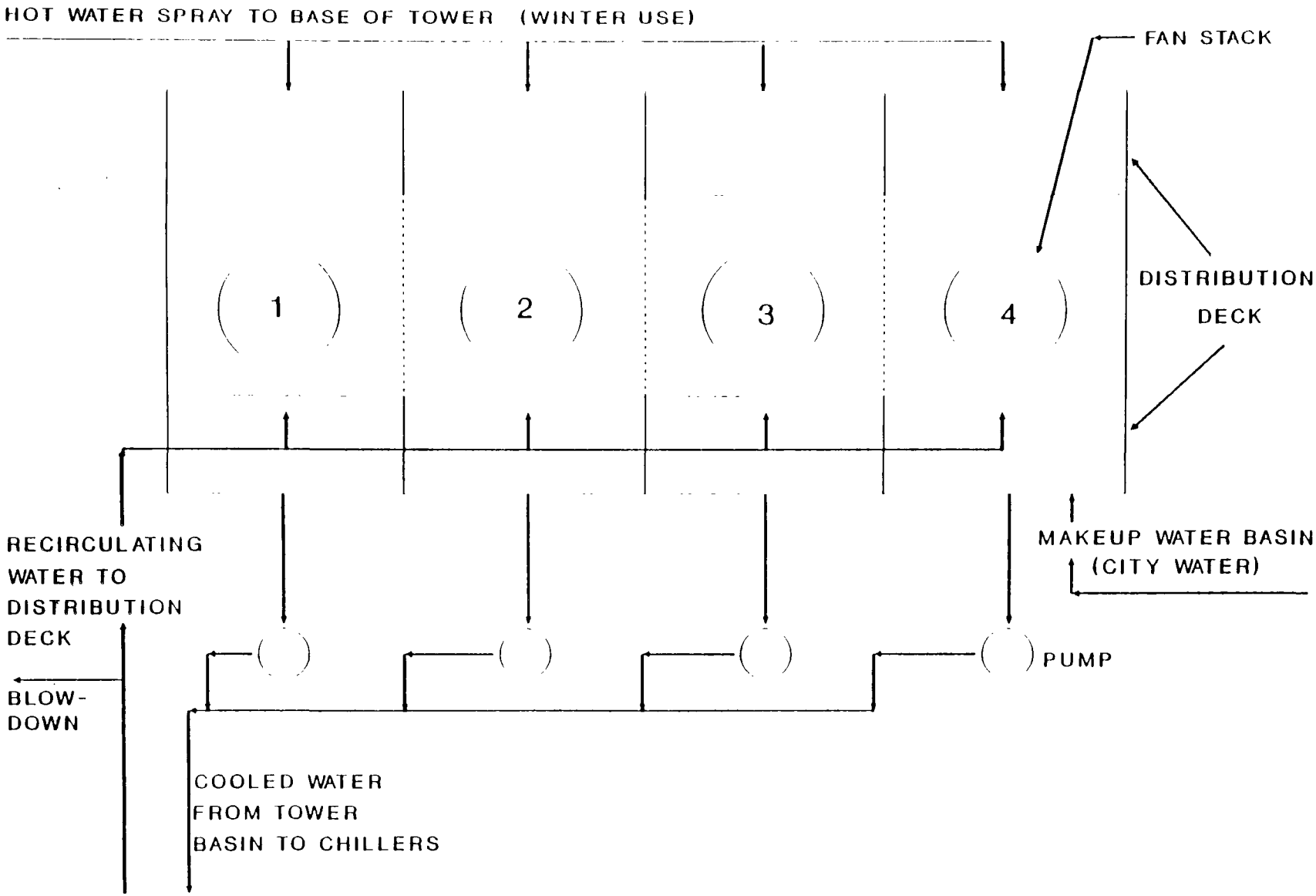


Figure 1. Cooling tower at NIST facility in Gaithersburg, Maryland.

for Cooling Tower Institute thermal efficiency and drift testing should be adhered to when possible (see attached).

Representatives of Midwest Research Institute (MRI) will monitor the cooling tower operating parameters to ensure that the testing conditions are appropriate. These operating parameters include inlet and outlet water temperatures, blowdown rates, makeup water flowrates, fan amperage, and physical condition of the fan cells.

VI. Coordination

Coordination will be needed among the EMB project officer, the ISB project officer, the testing contractor, and MRI to ensure that the testing is performed under the proper conditions. No coordination with other EPA offices is anticipated. In-house EPA test personnel should be used to the maximum extent possible in conducting this test to conserve resources. The contact at NIST is Mr. Alan Federline at (301) 975-6956.

Attachment

1602-21/CTS

SOURCE SAMPLING AND ANALYSIS SCHEDULE[a]

Company Name: National Institute of Standards and Technology

Company Location: Gaithersburg, Maryland

Industry: Industrial cooling tower

Process: Comfort cooling

Control Equipment:

Sampling Point Figure	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By **	Minimum Sampling Time	Minimum Gas Volume Sampled ft^3	Initial Analysis Type	Initial Analysis Method	Initial Analysis By**	Final Analysis Type	Final Analysis Method	Final Analysis By**
Riser cells 1-4		Drift rate										
Basin		Grab										

*Simulaneous Sampling Required

**CIR = Contractor, EPA = Environmental Protection Agency

[d]The sampling methodologies to be used will be selected by EMB.

REMARKS

1. Sampling shall be performed with ±10% isokinetic conditions.
2. Methods are EPA unless indicated otherwise.
3. Impingers and analysis of impinger catch will be per the Federal Register, Volume 36. No. 159, Part II, Tuesday, Aug. 17, 1971, unless specifically changed by the Project Officer.
4. Sampling time and gas volumes are for each sample.

Attachment

FILE COPY

COOLING TOWER INSTITUTE

IT IS GOOD BUSINESS *TO* CONSERVE WATER

March 24, 1986

Ms. Pamela Csik Bellin
Midwest Research Institute
Suite 202
4504 Creedmoor Road
Raleigh, NC 27612

Dear Ms. Bellin:

As a follow-up to our discussions during the January Cooling Tower Institute meeting and in subsequent telephone conversations, I am pleased to provide, on behalf of the CTI, our recommendations for acceptable limits on test conditions for the cooling tower drift measurements that will be performed in the near future by the Environmental Protection Agency. These recommended guidelines, relating to tower operating parameters and ambient environmental conditions, include the following:

1. Ambient Wind Speed: Ideally the average ambient wind speed during the drift measurement should be less than 5 to 6 miles per hour. More realistically the average wind speed, measured in an open and unobstructed location within 100 feet upwind of the tower at a point 5 feet above basin curb elevation should not exceed 10 miles per hour. Wind gusts should not exceed 15 miles per hour and should not exceed 1 minute duration.

2. Heat Load: Drift measurements may be taken with or without heat load (on a mechanical draft cooling tower).

3. Ambient Temperature and Humidity: Drift measurements may be taken at any non-freezing ambient temperature/humidity condition.

4. Stability of Test Conditions: Variations in average ambient air temperatures should not exceed the following limits during the drift measurement period:

   *** Wet-bulb temperature - 2°F per hour
   *** Dry-bulb temperature - 5°F per hour

5. Water Flow: The drift measurements should be taken at normal operating waterflow conditions, i.e., design flow ± 10%.

(713) 350-1000

6. Water Quality: Drift measurements should not be taken during temporary upset conditions in water chemistry, i.e., the cycles of concentration for the circulating water at the time of the drift measurement should be within a reasonable proximity of normal levels.

7. Tracer Element Selection: The tracer element used should be unique to any of the ambient airborne minerals in the environment. The test procedure should provide for analysis of the ambient air to ensure this.

Should you require additional information regarding these test limitations, let me know and I will provide it. The Cooling Tower Institute is certainly interested in the EPA's activities regarding measurement of chromium emissions and drift measurement technology, and we are prepared to support this effort any way that we can.

Very truly yours,

John W. Cooper, Jr., P.E.
Chairman, CTI Drift Measurement
Sub-committee

JWC/mmk

cc: A.F. Brunn
J. Kuharic

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

MEMORANDUM

SUBJECT: Emission Test Request for Allied Fibers, Inc., Moncure, North Carolina

FROM: James U. Crowder, Chief
Industrial Studies Branch, ESD (MD-13)

TO: Gilbert H. Wood, Chief
Emission Measurement Branch, TSD (MD-14)

This is to request that the Emission Measurement Branch conduct emission tests at the Allied Fibers plant located in Moncure, North Carolina. Emissions tests are to be conducted on two industrial process cooling towers. Emission tests are needed to supplement the data on performance of high-efficiency drift eliminators.

Detailed information on the facility to be tested and a discussion of the emission measurements required are presented in the attached source test request prepared by Midwest Research Institute (MRI). Questions regarding this test request should be directed to Ms. Beth Teague or Ms. Carol Athey of MRI.

Attachment

cc: Debbie Stackhouse, SDB
Beth Teague, ISB
Al Vervaert, ISB
Carol Athey, MRI

1603-13/CTS

MIDWEST RESEARCH INSTITUTE
Suite 35
401 Harrison Oaks Boulevard
Cary, North Carolina 275
Telephone (919) 467-52
FAX (919) 467-80

Date: September 14, 1989

Subject: Recommendation for Emission Testing at Allied Fibers Incorporated in Moncure, North Carolina
Chromium Emissions from Cooling Towers NESHAP
EPA Contract No. 68-02-3817; ESD Project 85/02b
MRI Project 7716-K

From: Carol Athey

To: Ronald Myers
ESD/ISB (MD-13)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Recommendation

1. Conduct outlet testing of the Marley industrial process cooling towers (TW-2 and TW-3) to determine drift rate based on emissions of native materials (to be determined prior to testing).

2. During the tests, obtain data on airflow, recirculating waterflow, inlet and outlet water temperatures, blowdown, and makeup waterflow rates. Also, obtain data on ambient wet bulb and dry bulb temperatures, ambient humidity, ambient concentrations of materials selected for measurement to determine drift rate, wind speed, and wind direction.

3. Prior to and during the tests, obtain grab samples of the cooling tower basin water for analysis to determine the concentrations of native minerals.

II. Basis of Selection

The cooling towers at this facility were selected for testing for the following reasons:

1. The cooling towers are Marley towers equipped with Marley XCEL-15 high-efficiency drift eliminators (HEDE's).
2. The cooling towers are located such that the test personnel will have good access to the outlet stacks. All the stacks are at the same elevation with no major obstructions.
3. The cooling towers operate continuously, 24 hours per day. 365 days per year.
4. The facility is located proximate to Research Triangle Park, which eliminates the need for a large expenditure of travel funds for the test crew.

III. Relationship of Test Data to Development of Performance Standards

These test data are needed to supplement the data on the performance of HEDE's; drift rate will be determined as a percentage of recirculating waterflow.

IV. Description of the Cooling Tower

Allied Fibers operates two, identical Marley ICT's associated with the polymer production process. Both towers are crossflow with splash fill. One tower was originally installed in 1973; the second tower was installed in 1975. Both towers were rebuilt in 1988; at that time, Marley XCEL-15 drift eliminators were installed. Access ports for measuring recirculation rate have not been installed on the riser pipes. Recirculating water enters the towers at approximately 104°F and is cooled to about 93°F in the summer (70°F to about 56°F in winter). Specific tower information is presented below.

Dimensions of tower (wxl), ft	23x40
Overall tower height, ft	12.9
Height of fan stack, ft	3.8
Airflow capacity of each fan, acfm	~185×10^3
No. of fan cells per tower	2
Dimensions of cells (wxl), ft	23x20
Recirculating waterflow rate, gal/min	~3,500 (total, both towers)

No corrosion protection chemicals are used in these towers. The towers and associated heat exchangers are cleaned and checked for corrosion approximately every 2 years. Plant personnel report that no corrosion problems have ever been found. A Nalco water treatment program is used for biocide, antifoam, dispersant, and pH control. The pH is maintained between 6 and 7. The total solids content of the recirculating water is 0.86 percent (8,600 ppm). Because the recirculating cooling water is used for direct cooling of the manufacturing process, the solids may include ethylene glycol and short-chain polymers of polyester.

During a plant visit in August 1989, the fire extinguisher system inside one of the towers was observed to be leaking. Plant personnel indicated that the repairs to this tower would probably be scheduled during October or November 1989.

V. Test Methodologies

The test methodologies that are used by EMB should accurately characterize the drift rate based on emissions of native materials contained in the recirculating water. Additionally, accurate determinations of recirculating waterflow rate in the riser pipes and determinations of inlet or ambient concentrations of the native materials used to determine drift rate should be made. Onsite meteorological data that will be needed include ambient wet bulb and dry bulb temperatures, ambient humidity, wind speed, and wind direction. The general guidelines for Cooling Tower Institute thermal efficiency and drift testing should be adhered to when possible (see attached).

Representatives of Midwest Research Institute (MRI) will monitor the cooling tower operating parameters to ensure that the testing conditions are appropriate. These operating parameters include inlet and outlet water temperatures, blowdown rates, makeup water flowrates, fan amperage, and physical condition of the fan cells.

VI. Coordination

Coordination will be needed among the EMB project officer, the ISB project officer, the testing contractor, and MRI to ensure that the testing is performed under the proper conditions. No coordination with other EPA offices is anticipated. In-house EPA test personnel should be used to the maximum extent possible in conducting this test to conserve resources. The contact at Allied Fibers is Mr. Bill Boyer at (919) 542-2200.

Attachment

1602-14/CTS

SOURCE SAMPLING AND ANALYSIS SCHEDULE[a]

Contract No.. | Assignment Number:

Company Name: Allied Fibers, Inc. | Company location: Moncure, North Carolina

Industry: Industrial cooling tower | Process: Polymer production | Control Equipment:

Sampling Point Figure	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By **	Minimum Sampling Time	Minimum Gas Volume, Sampled ft^3	Initial Analysis			Final Analysis		
							Type	Method	By**	Type	Method	By**
Riser cells 1-4		Drift rate										
Basin		Grab										

*Simulaneous Sampling Required
**CIR = Contractor, EPA = Environmental Protection Agency
[a]The sampling methodologies to be used will be selected by EMB.

REMARKS
1. Sampling shall be performed with ±10% isokinetic conditions.
2. Methods are EPA unless indicated otherwise.
3. Impingers and analysis of impinger catch will be per the Federal Register, Volume 36. No. 159, Part II, Tuesday, Aug. 17, 1971, unless specifically changed by the Project Officer.
4. Sampling time and gas volumes are for each sample.

C T I COOLING TOWER INSTITUTE

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March 24, 1986

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Midwest Research Institute
Suite 202
4504 Creedmoor Road
Raleigh, NC 27612

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3. Ambient Temperature and Humidity: Drift measurements may be taken at any non-freezing ambient temperature/humidity condition.

4. Stability of Test Conditions: Variations in average ambient air temperatures should not exceed the following limits during the drift measurement period:

   *** Wet-bulb temperature - 2°F per hour
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5. Water Flow: The drift measurements should be taken at normal operating waterflow conditions, i.e., design flow ± 10%.

Spring, TX 77388-(713) 350-1995

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7. Tracer Element Selection: The tracer element used should be unique to any of the ambient airborne minerals in the environment. The test procedure should provide for analysis of the ambient air to ensure this.

Should you require additional information regarding these test limitations, let me know and I will provide it. The Cooling Tower Institute is certainly interested in the EPA's activities regarding measurement of chromium emissions and drift measurement technology, and we are prepared to support this effort any way that we can.

Very truly yours,

John W. Cooper, Jr., P.E.
Chairman, CTI Drift Measurement
Sub-committee

JWC/mmk

cc: A.F. Brunn
I. Kuharic

MRI

COOLING TOWER DRIFT TEST PROCEEDURES

FOR TOTAL MASS EMISSIONS

USING MODIFIED EPA METHOD 13A

FOR ISOKINETIC SAMPLING

MIDWEST RESEARCH INSTITUTE 425 Volker Boulevard, Kansas City, MO 64110-2299 • (816) 753-7600

SECTION 1

INTRODUCTION

The independent cooling tower testing services of Midwest Research Institute (MRI) are available to conduct drift tests on cooling towers.

Cooling tower drift is defined as the percent of water flow through the tower which exits through the fan in the form of water droplets and aerosols. The amount of drift from the tower is determined by isokinetically sampling a representative fraction of the tower airflow and measuring the amount of droplets and aerosol leaving the stack. The drift sampling proceedures used by MRI are in accordance with a modified EPA method 13A for isokinetic sampling of emissions.

After sample collection, analytical laboratory techniques are then used to measure the concentration of a number of selected trace constituents present in the basin water and water collected from the airflow exiting the fan stack. The trace constituents may be the metals already present in the cooling tower water or from intentionally added materials. Inductively coupled argon plasma spectroscopy (ICP), an extremely sensitive detection technique, is usually used by MRI in tests currently being performed. Other analytical techniques such as flame atomic adsorption (FLAA), graphite furnace atomic adsorption (GFAA), and neutron activation analysis (NNA) may be used if appropriate for the concentration of the trace elements analyzed.

By comparing the measurements of the selected trace constituents in the isokinetic sampling train and the same trace constituents in the basin water, the drift rate can be calculated.

SECTION 2

DRIFT TEST EQUIPMENT

A typical drift sampling system is shown in Figure 1. Since drift is defined as the amount of droplets or aerosols exiting the fan stack, the drift tests must be made at the top of the fan stack. Also the proximity of the sample locations to the fan required that the station locations be adjusted for the hub effect. Sample locations are determined for 10-point radial traverses using the equation for equal annular areas for fan discharge from Chapter 5 of the CTI Manual. Figure 2 shows typical sampling locations. The major equipment components then used to collect the drift samples are described below.

AIR PITOT/DRIFT PROBE:

Since cyclonic flow can bias the drift results, adjustments in the sampling technique must be used to eliminate this bias. A special MRI air pitot-drift probe assembly was developed to allow unbiased sampling. If the sample nozzle is not aligned with the flow, then effective velocity through the nozzle opening is reduced by the cosine of the angle between the flow and stack axis. This results in a sample which is not truly isokinetic and thus the alignment approach[1] must be used for the drift test to eliminate this bias. Since the sample proportionality could be compromised with the alignment approach, proportional sampling needs are then satisfied by adjusting the nominal base sample time by the cosine of the cyclonic flow angle. Airflow, fan discharge temperature and the angle of cyclonic flow were measured with this probe assembly. The air pitot-drift probe assembly was equipped with:

1. S-type primary pitot tips which are connected to a manometer to measure air velocity.

2. Secondary pitot tips which are positioned at 90 degrees from the primary pitot tips. The secondary set of pitot tips are connected to a separate manometer to align the probe and compensate for any cyclonic flow effects.

3. A temperature sensor connected to a digital readout to measure the stack temperature.

---

[1] Peeler, J.W., F.J. Phoenix, and D.J. Grove, "Characterization of Cyclonic Flow and Analysis of Particulate Sampling Approaches at Asphalt Plant," Entropy Environmentalists, Inc.

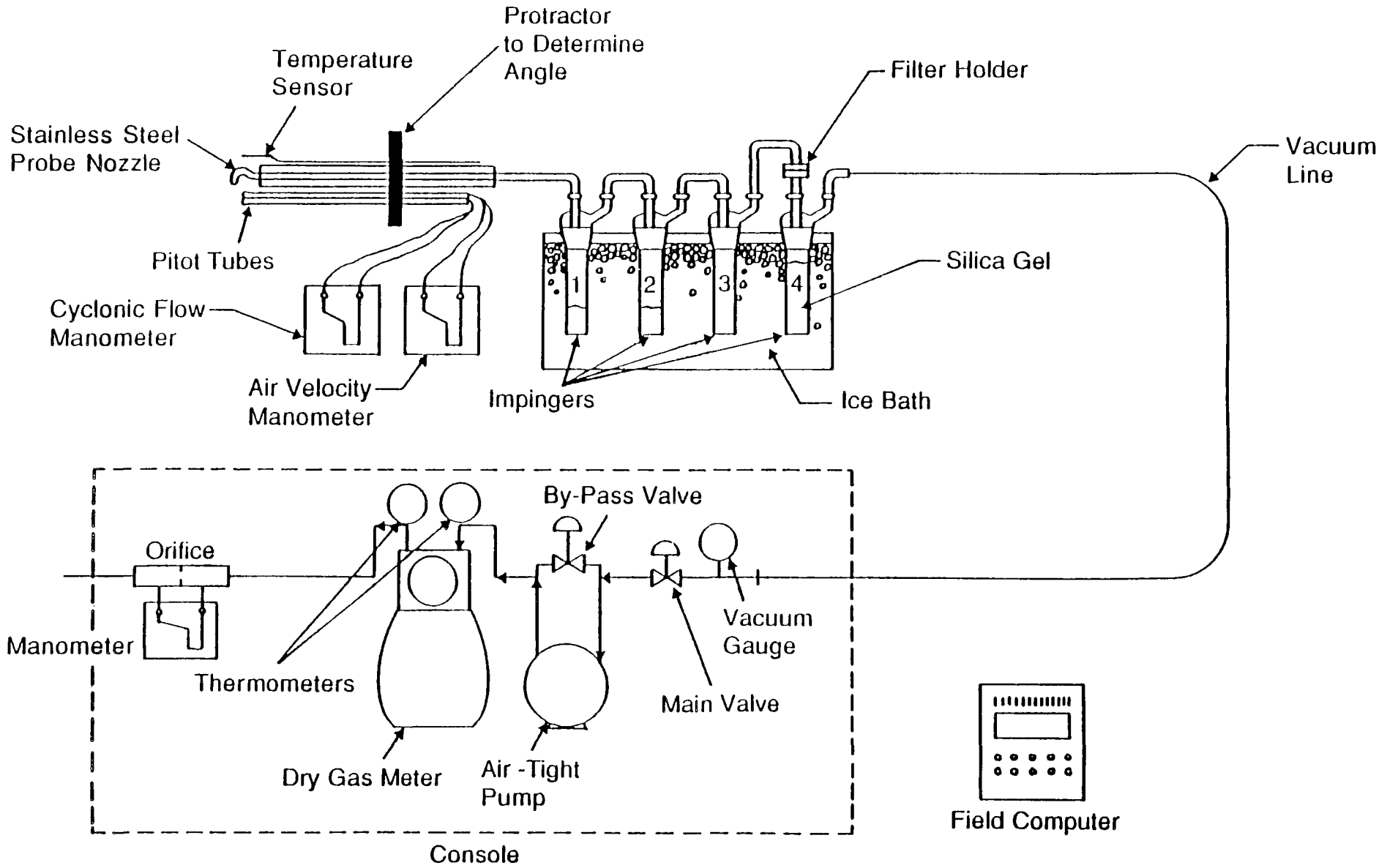

Figure 1. Typical draft collection train.

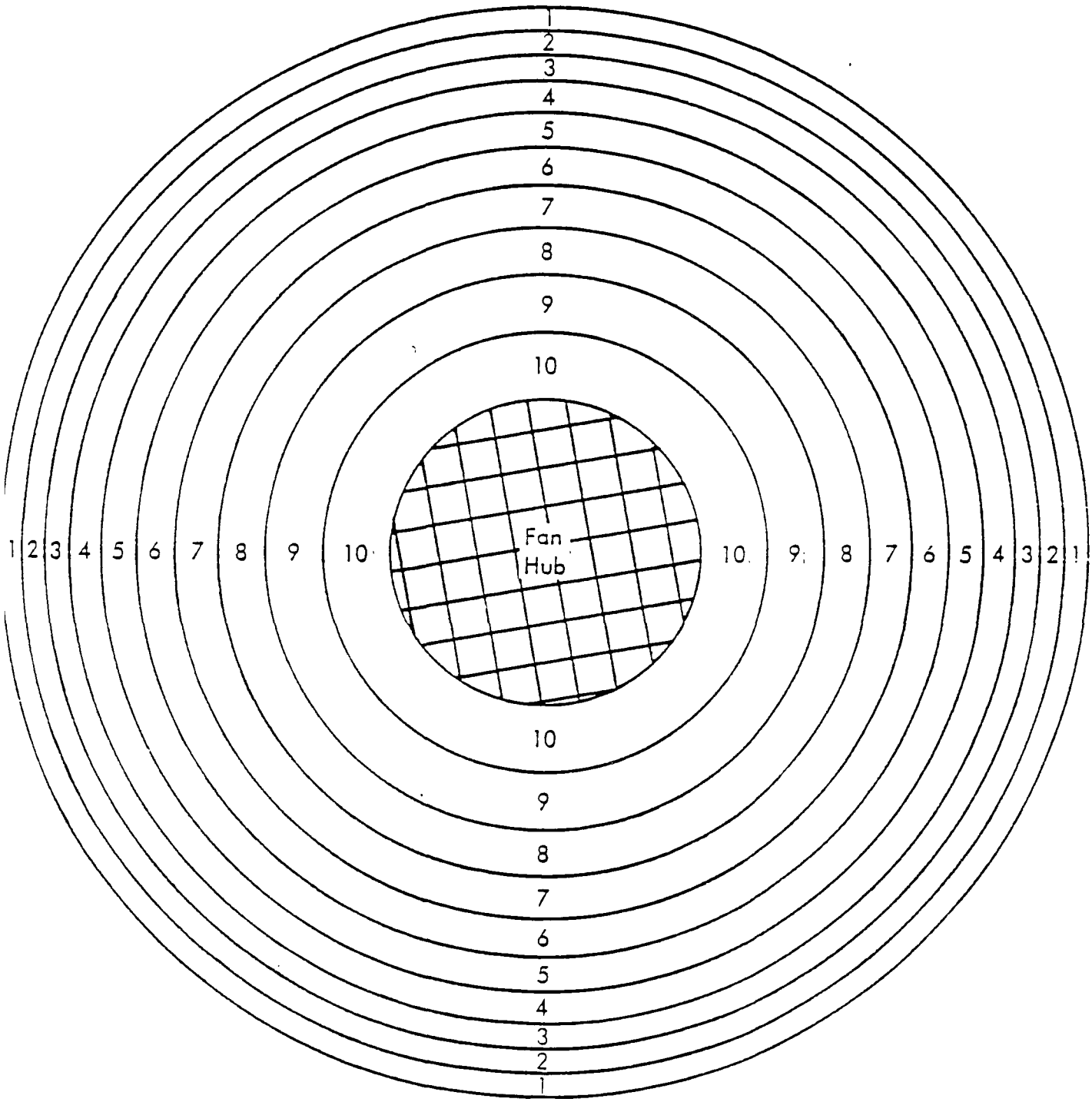

Figure 2 - Sampling Points were Located in the Center of Each of the Equal Area Zones. Numbers 1 to 10 indicate the distances from the fans inside wall to the respective sampling points.

4. A protractor was attached to the probe assembly to determine the angle that the probe was rotated during the cyclonic flow determination.

5. A stainless steel sample nozzle and flexible teflon sample probe which are connected to the drift collection train.

DRIFT COLLECTION TRAIN:

The drift collection train which is shown in Figure 1, consists of four high capacity impingers and a filter assembly. Impingers 1 and 2 contained distilled water and were used to scrub out the aerosols and water droplets. The third impinger is used to collect any water droplets that might be carried over from the previous impingers. The filter was used as the final collection media and was placed between impinger 3 which was dry and impinger 4 which contained silica gel. The sampling train was kept iced during testing to help reduce the water vapor pressure and to further improve collection efficiency.

CONTROL CONSOLE AND PUMP:

The control console and pump used was a High Volume Sampling System (HVSS) consistent with EPA Method 13A requirements. The impinger train is connected to the console via a sample line thru the leak free vacuum pump capable of up to 4 cfm. The modular vacuum pump has two control valves to adjust and maintain the desired sampling rate. The console contains a calibrated dry gas meter, digital temperature readout, manometers and associated controls.

SECTION 3

SAMPLING SEQUENCE

The test sequence for a typical drift test is as follows:

1. Water flow and fan horsepower measurements are conducted and the tower operations monitored.

2. Drift sample and airflow measurement locations are calculated.

3. A basin water sample is collected.

4. Isokinetic drift sampling of the selected fan stack is conducted.

5. A second basin water sample is collected during the middle of the drift test.

6. Isokinetic drift sampling of the fan is completed.

7. A third basin sample is collected at the conclusion of the test. The three basin samples are composited into 1 basin water sample.

8. The drift samples are recovered from the sample collection system.

9. The basin composite, water blank and drift impinger samples are acid stabilized and transported to the laboratory for analysis.

SECTION 4

DRIFT TEST METHODS

The tower operational test data are acquired in accordance with applicable portions of the CTI ATC-105 (1982) or ASME PTC-23 (1986) test code. The drift sampling data are acquired in accardance with applicable portions of EPA Method 13A. The individual parameters are measured as follows:

* Total circulating water flow is measured with two 10- or 20-point pitot traverse of the hot water return lines or risers to the tower. A standard or reinforced Simplex-Leopold type pitot tube, is used to measure the velocity at each point. An air-over-water manometer is used for measuring the differential pressure between the impact and reference orifices of the pitot tube.

* Fan motor power is measured with a clamp on digital kilowatt meter, using the two watt meter method.

* Air velocity is measured with four 10-point radial traverses of the fan stack using the predetermined sampling locations. At each point the MRI air pitot-drift probe assembly is rotated until the pressure difference across the secondary pitot tips is zero. When this zero differential has been obtained the primary probe has been aligned with the flow and the protractor read to determine the cyclonic flow angle. The probe assembly is then used to measure the velocity pressure and temperature at the sample point.

* The isokinetic sample rate and proportional sample duration are determined using an Epson HX-20 computer. The previously determined velocity pressure, stack temperature and cyclonic flow angle are used by a computer program to calculate the required sample volume, isokinetic rate and the adjusted base sample time.

* Sampling at each traverse location is commenced after the proper sample rate is determined by turning on the sample pump and simultaneously activating the variable timer function of the HX-20 computer. When each sample time had ended the pump is shut off, the air pitot-probe assembly is relocated to the next sample location, and the above procedure repeated until all 40 points had been sampled.

* The drift sample recovery is initialed by using distilled deionized water to rinse the stainless steel nozzle and flexible teflon probe into the contents of the first impinger. The impinger train is sealed and then removed from the cooling tower to sample recovery location where the remainder of the sample recovery is performed. The impinger volumes and rinse volumes are measured and recorded. The impinger contents along with all rinse are transferred to sample bottles. A distilled deionized water blank is taken. Both the drift impinger samples and water blank are nitric acid stabilized and then returned to MRI for further analysis.

* Basin water samples are taken at the beginning the midpoint and the conclusion of the drift sample. The basin water sample is usually taken from a thermal well that is installed on the discharge side of the circulating water flow pump. The samples are collected after the thermal well line is purged. The three samples are collected and then combined into one composite basin water sample. The composite basin sample is stabilized with nitric in the same manner as are the impinger and water blank samples. The composite basin water sample is returned to MRI for further analysis.

SECTION 5

SAMPLE ANALYSIS

The samples are returned to MRI where custody of the samples is transferred to the analytical section. Quantative analysis of selected trace elements in both the tower basin water samples and the collected drift samples is then performed by the analytical section. A Jarrell-Ash Model 1155A ICP-AES instrument is usually used to analyze the samples by inductively coupled argon plasma spectroscopy (ICP). The flame or furnace atomic absorption spectroscopy (FLAA and GFAA, respectively) may also be used to analyze for some elements such as chromium on a Perkin-Elmer Model 5000 Zeeman Atomic Absorption Spectrophometer. Several methods can be used to prepare the drift and basin water samples for the analysis using depending on the analysis method to be used and the tracers to be analyzed. The preparation and analysis methods which may be used are described below.

ACIDIFICATION AND DILUTION :

This is the simplist procedure used to prepare surface and ground water samples for analysis by flame atomic absorption spectroscopy (FLAA) or by inductively coupled argon plasma spectroscopy (ICP).

The entire sample is acidified at the time of collection with nitric acid. At the time of analysis the sample is diluted if necessary and acidified with nitric to obtain approximately a 10% nitric acid sample matrix which is then ready for analysis.

METHOD 3005:

Method 3005 is an acid digestion procedure used to prepare surface and ground water samples for analysis by flame atomic absorption spectroscopy (FLAA) or by inductively coupled argon plasma spectroscopy (ICP).

For total recoverable metals the entire sample is acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is filtered and diluted to volume, and is then ready for analysis.

For dissolved metals the sample is filtered through a 0.5 um filter at the time of collection and the liquid phase is then acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is filtered (if necessary) and diluted to volume, and is then ready for analysis.

METHOD 3010:

Method 3010 is a digestion procedure that is used for the preparation of aqueous samples, EP and mobility-procedure extracts, and wastes that contain suspended solids for analysis, by flame atomic absorption spectroscopy (FLAA) or by inductively coupled argon plasma spectroscopy (ICP).

A mixture of nitric acid and the material to be analyzed is refluxed in a covered Griffin beaker. This step is repeated with additional portions of nitric acid until the digestate is light in color or until its color has stabilized. After the digestate has been brought to a low volume, it is refluxed with hydrochloric acid and brought up to volume

METHOD 3050:

Method 3050 is an acid digestion procedure used to prepare sediments, sludges, and soil samples for analysis by flame or furnace atomic absorption spectroscopy (FLAA and GFAA, respectively) or by inductively coupled argon plasma spectroscopy (ICP).

A representative sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Dilute hydrochloric acid is used as the final reflux acid for (1) the ICP analysis of As and Se, and (2) the flame AA or ICP analysis of Al, Ba, Ca, Cd, Cr, Co, Cu, Fe, Mo, Pb, Ni, K, Na, Tl, V, and Zn. Dilute nitric acid is employed as the final dilution acid for the furnace AA analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V.

METHOD 6010:

Method 6010 describes the procedures for inductively coupled argon plasma spectroscopy (ICP) in determining elements including metals in solution. This method is applicable to a large number of metals and wastes. All matrices, including ground water, aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments and other solid wastes, require digestion prior to analysis.

ICP is then used for the simultaneous, or sequential, multielemental determination of elements by measuring the element-emitted light with optical spectrometry. Samples are nebulized and the resulting emission spectra are produced by a radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the lines are monitored by photomultiplier tubes. Background correction is required for trace element determination.

METHOD 7000:

Method 7000 is used for the determination of metals in drinking, surface and saline waters and domestic and industrial wastes by Atomic Absorption. While drinking water free of particulate matter may be analyzed directly, ground water, other aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments, and other solid wastes require digestion prior to analysis by Atomic Absorption using the furnace technique.

In direct-aspiration atomic absorption spectroscopy, a sample is aspirated and atomized in a flame. A light beam from a hollow cathode lamp or an electrodeless discharge lamp is directed through the flame into a monochromator, and onto a detector that measures the amount of absorbed light. Absorption depends upon the presence of free unexcited ground-state atoms in the flame. Because the wavelength of the light beam is characteristic of only the metal being determined, the light energy absorbed by the flame is a measure of the concentration of that metal in the sample. This principle is the basis of atomic absorption.

When using the furnace technique in conjunction with an atomic absorption spectrophotometer, a representative aliquot of the sample is placed in the graphite tube in the furnace, evaporated to dryness, charred, and atomized. As a greater percentage of available analyte atoms is vaporized and dissociated for absorption in the tube rather than the flame, the used of smaller sample volumes or detection of lower concentrations of elements is possible. The principle is essentially the same as with direct aspiration atomic absorption, except that a furnace, rather than a flame is used to atomize the sample.

NEUTRON ACTIVATION ANALYSIS

Neutron activation analysis (NAA) is a highly selective and sensitive analytical method capable of measuring trace amounts of many elements. NAA is performed by first irradiating a sample with neutrons to produce radioactive isotopes of the stable elements present in the sample, then selectively measuring the activated products using techniques such as gamma-ray spectroscopy or specific radiochemical separation proceedures. NAA may be applied to relatively small samples of solids or liquids since it is independent of the chemical form of the elements and requires a minimum of pre-analysis preparation or chemistry, thus minimizing reagent or laboratory contamination. Although MRI doesnot perform NAA, this analysis can be subtracted if needed for a specific test.

SECTION 6

RESULTS AND CONCLUSIONS

The following equation is used by the MRI drift computer program to calculate the drift results:

$$\% \text{ Drift} = 100 * (NFA * NWT) / (NZA * WFR * EQT * BTC)$$

NFA	=	Net Fan Area (square feet)
NWT	=	Net Weight of Tracer (mcg)
NZA	=	Nozzle Area (square feet)
WFR	=	Waterflow Rate (grams per minute)
EQT	=	Equivalent Sample Time (minutes)
BTC	=	Basin Tracer Concentration (mcg/g)

If several tracers are sufficiently concentrated for analysis the results are presented in tabular format for comparison. If any site conditions are observed which may influence the results they are noted in the report which is prepared to document the drift results.

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report
Project: Marley Cooling Tower Co. Units: MCG/ML
Batch #: B-89020001

Customer ID: 4A
Description: AQUEOUS SOLUTION
ETSRC ID: 9020005

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.03	0.02
AS	<0.04	0.04
B	<0.01	0.01
BA	<0.0007	0.0007
BE	<0.0007	0.0007
BI	<0.04	0.04
CA	0.21	0.06
CD	0.016	0.003
CO	<0.01	0.01
CR	0.01	0.01
CU	0.017	0.002
FE	0.25	0.01
K	0.6	0.4
W	<0.01	0.01
LI	0.190	0.001
MG	0.047	0.0009
MN	0.012	0.003
MO	<0.01	0.01
NA	0.21	0.03
NI	0.02	0.01
P	<0.1	0.1
PB	0.09	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SI	0.03	0.01
SN	<0.04	0.04
SR	0.0008	0.0005
TI	<0.002	0.002
TL	<0.06	0.06
V	<0.002	0.002
ZN	0.065	0.002

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report
Project: Marley Cooling Tower Co. Units: MCG/ML
Batch #: B-89020001

Customer ID: 4B
Description: AQUEOUS SOLUTION
ETSRC ID: 9020028

Elm	Result	Estimated Sample Detection Limit
AG	<1.	1.
AL	<2.	2.
AS	<4.	4.
B	2.	1.
BA	0.2	0.07
BE	<0.07	0.07
BI	<4.	4.
CA	300.	5.
CD	<0.3	0.3
CO	<1.	1.
CR	<1.	1.
CU	<0.2	0.2
FE	<1.	1.
K	100.	40.
W	<1.	1.
LI	1550.	0.1
MG	282.	0.09
MN	<0.3	0.3
MO	<1.	1.
NA	1130.	2.
NI	<1.	1.
P	<10.	10.
PB	<4.	4.
SB	<4.	4.
SE	<4.	4.
SI	37.	1.
SN	<4.	4.
SR	3.2	0.05
TI	<0.2	0.2
TL	<6.	6.
V	<0.2	0.2
ZN	<0.2	0.2

Environmental Trace Substances Research Center
ICP Scan - Sample Analysis Report
Project: MARLEY COOLING TOWER CO. Units: MCG/ML
Batch #: B-89020156

Customer ID: 4C
Description: AQUEOUS SOLUTION
ETSRC ID: 9020160

Elm	Result	Estimated Sample Detection Limit
AG	<0.01	0.01
AL	0.05	0.02
AS	<0.04	0.04
B	<0.01	0.01
BA	0.001	0.0005
BE	<0.0005	0.0005
BI	<0.04	0.04
CA	0.2	0.09
CD	<0.003	0.003
CO	<0.005	0.005
CR	<0.008	0.008
CU	0.026	0.002
FE	0.064	0.005
K	<0.3	0.3
W	<0.02	0.02
LI	<0.002	0.002
MG	0.030	0.0006
MN	<0.002	0.002
MO	<0.006	0.006
NA	0.12	0.02
NI	<0.01	0.01
P	<0.1	0.1
PB	<0.04	0.04
SB	<0.04	0.04
SE	<0.04	0.04
SI	0.02	0.01
SN	<0.04	0.04
SR	0.001	0.0006
TI	<0.005	0.005
TL	<0.08	0.08
V	<0.003	0.003
ZN	0.22	0.003

Sample Volume	376	Rinse Volume	151	Filter Sample Volume	50
Water Blank Volume	401	Initial Water Vol.	250	2nd Rinse Volume	207

DESCRIPTION	B	BA	CA	CU	K	LI	MG	NA	SI	SR
Basin Water (ucg/g)	2.0	.2	300.0	NA	100.0	1550.0	282.0	1130.0	37.0	3.2
Impinger (ucg/g)	NA	NA	.2100	.0170	.6000	.1300	.0470	.2100	.0300	.0008
Impg 2nd Rns (ucg/g)	NA	.0010	.2000	.0260	NA	NA	.0300	.1200	.0200	.0010
Filter (ucg/g)	NA	NA	NA	NA	NA	.0300	NA	NA	NA	NA
Water Blank (ucg/g)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Filter Blank (ucg)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CALCULATED VALUES										
Impinger Catch (ucg)	.00	.00	78.96	6.39	225.60	71.44	17.67	78.96	11.28	.30
Impg 2nd Catch (ucg)	.00	.21	41.40	5.38	.00	.00	6.21	24.84	4.14	.21
Filter (ucg)	.00	.00	.00	.00	.00	1.50	.00	.00	.00	.00
Water Blank (ucg)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Filter Blank (ucg)	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
Net Sample (ucg)	.00	.21	120.36	11.77	225.60	72.94	23.88	103.80	15.42	.51

DRIFT TEST RESULTS

TRACER ANALYZED	BASIN CONC. (mcg/g)	TRACER NET WT. (mcg)	DRIFT RATE ml/min	DRIFT % OF GPM	DRIFT % OF DRY AIR
BA	0.2	0.21	126.71	0.01108	0.01289
CA	300.0	120.36	48.42	0.00423	0.00493
K	100.0	225.60	272.25	0.02380	0.02769
LI	1550.0	72.94	5.68	0.00050	0.00058
MG	282.0	23.88	10.22	0.00089	0.00104
NA	1130.0	103.80	11.09	0.00097	0.00113
SI	37.0	15.42	50.29	0.00440	0.00512
SR	3.2	0.51	19.23	0.00168	0.00196

DRIFT TEST RESULTS

TRACER ANALYZED	BASIN CONC. (mcg/g)	TRACER NET WT. (mcg)	DRIFT RATE ml/min	DRIFT % OF GPM	DRIFT % OF DRY AIR
BA	0.1	1.24	24195.66	0.06408	0.11403
CA	563.0	5926.62	21567.70	0.05712	0.10164
CU	2.0	16.38	16696.40	0.04422	0.07869
FE	0.4	12.39	61914.52	0.16398	0.29179
LI	0.3	2.96	23970.45	0.06349	0.11297
MG	112.0	1191.38	21794.02	0.05772	0.10271
MN	0.0	1.23	%126002.79	0.33372	0.59382
MO	0.0	0.74	32258.11	0.08544	0.15203
NA	733.0	7849.25	21939.63	0.05811	0.10340
P	0.7	14.80	45257.64	0.11987	0.21329
SR	4.8	48.83	20973.62	0.05555	0.09884
ZN	1.6	38.25	47785.11	0.12656	0.22520
B	1.2	1.19	2031.75	0.00538	0.00958
CR	0.0	2.76	%188491.98	0.49923	0.88832

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

JAN 25 1990

MEMORANDUM

SUBJECT: Emission Tests For Development Of Cooling Tower Emission Factors

FROM: E. L. Martinez, Chief
Criteria Emissions Section, MRB

THRU: William F. Hunt, Jr.
Chief, Monitoring and Reports Branch

TO: Gilbert Wood, Chief
Emission Measurement Branch

This is to request that the Emission Measurement Branch conduct additional measurements to those already planned at the 2 cooling towers scheduled for testing during 1990 for development of particulate emission factors. I am also requesting that a third cooling tower be tested, arrangements and funds permitting.

We are requesting the following testing:

1) cooling tower water flow rate, at least one per tower

2) particulate measurement (preferably PM_{10}), at least one per tower

3) total suspended and total dissolved solids

4) drift measurement expressed as a percent of the tower water circulation rate

5) a listing of the physical and operating parameters of the cooling towers

6) a copy of any water chemistry analysis you may be planning to do.

After testing is completed and the results analyzed, please provide a copy of the test report to Dennis Shipman of our staff. We plan to turn the test results over to an MRB contractor to develop the emission factors for this source category.

If there are any questions, please direct them to Dennis Shipman at x5477.

cc: D. Bivins
E. McCarley
D. Shipman

APPENDIX D

QA/QC DATA

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 6/14/90 Meter Box # RAC-1

Barometric Pressure 29.56 in. Hg Calibrated by: TTB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Gas Volume Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Dry Gas Meter Inlet	Dry Gas Meter Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	4.976	79.5			84.3	12.22	1.0290	1.712
1.0	5	5.020	80.0			92.8	8.70	1.0337	1.713
1.5	10	10.035	78.0			89.3	14.98	1.0302	1.903
2.0	10	10.079	77.0			97.1	13.12	1.0410	1.910
3.0	10	10.119	78.0			107.5	10.40	1.0517	1.775
4.0	10	10.160	78.0			112.8	9.05	1.0545	1.775
							Average	1.0400	1.798

Gamma of Ref Meter 1.0164

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*(Pb+(Del H/13.6))*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time / Vw} ^2
0.5	0.0368	1.0290	1.7119
1.0	0.0737	1.0337	1.7128
1.5	0.1103	1.0302	1.9031
2.0	0.1471	1.0410	1.9100
3.0	0.2206	1.0517	1.7748
4.0	0.2941	1.0545	1.7755

.02Y =	0.0208
Yi upper limit	1.0608
Yi lower limit	1.0192
Var for del H	0.150
Del H upper limit	1.948
Del H lower limit	1.648

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # RAC-1

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	772.300	Start	79.0	Finish	673.387	Start	81.0
Date	6/14/90	Start	767.300	Finish	80.0	Start	668.411	Finish	87.5
P bar	29.56	Diff	5.000	Average	79.5	Diff	4.976	Average	84.3
Init	TTB	Run-Time min.sec		12.13		Run-Time decimal		12.22	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	778.300	Start	80.0	Finish	679.410	Start	87.5
Date	6/14/90	Start	773.300	Finish	80.0	Start	674.390	Finish	98.0
P bar	29.56	Diff	5.000	Average	80.0	Diff	5.020	Average	92.8
Init	TTB	Run-Time min.sec		8.42		Run-Time decimal		8.70	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	791.300	Start	78.0	Finish	692.450	Start	82.5
Date	6/14/90	Start	781.300	Finish	78.0	Start	682.415	Finish	96.0
P bar	29.56	Diff	10.000	Average	78.0	Diff	10.035	Average	89.3
Init	TTB	Run-Time min.sec		14.59		Run-Time decimal		14.98	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	801.800	Start	77.0	Finish	703.034	Start	89.3
Date	6/14/90	Start	791.800	Finish	77.0	Start	692.955	Finish	105.0
P bar	29.56	Diff	10.000	Average	77.0	Diff	10.079	Average	97.1
Init	TTB	Run-Time min.sec		13.07		Run-Time decimal		13.12	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	812.800	Start	78.0	Finish	714.162	Start	105.0
Date	6/14/90	Start	802.800	Finish	78.0	Start	704.043	Finish	110.0
P bar	29.56	Diff	10.000	Average	78.0	Diff	10.119	Average	107.5
Init	TTB	Run-Time min.sec		10.24		Run-Time decimal		10.40	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	823.400	Start	78.0	Finish	724.942	Start	107.5
Date	6/14/90	Start	813.400	Finish	78.0	Start	714.782	Finish	118.0
P bar	29.56	Diff	10.000	Average	78.0	Diff	10.160	Average	112.8
Init	TTB	Run-Time min.sec		9.03		Run-Time decimal		9.05	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 7/19/90 Meter Box # RAC-1

Barometric Pressure 29.73 in. Hg Calibrated by: [signature]

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Dry Gas Meter Inlet	Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	0.000	0.0			0.0	0.00		
1.0	5	4.900	76.0			88.3	8.47	1.0357	1.619
1.5	10	9.983	76.0			98.0	14.97	1.0336	1.864
2.0	10.1	10.009	76.0			106.3	13.10	1.0553	1.839
3.0	10	10.017	76.0			111.5	10.37	1.0511	1.746
4.0	10	10.088	76.0			112.5	9.07	1.0430	1.778
							Average	1.0437	1.769

Gamma of Ref Meter 0.9948

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*{Pb+(Del H/13.6)}*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time /(Gamma* Vw)} ^2
0.5	0.0368		
1.0	0.0737	1.0357	1.6189
1.5	0.1103	1.0336	1.8639
2.0	0.1471	1.0553	1.8393
3.0	0.2206	1.0511	1.7462
4.0	0.2941	1.0430	1.7779

.02Y =	0.0209
Yi upper limit	1.0646
Yi lower limit	1.0228
Var for del H	0.150
Del H upper limit	1.919
Del H lower limit	1.619

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # **RAC-1**

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac		Volume		Temp		Volume		Temp	
Del H	0.5	Finish		Start		Finish		Start	
Date	7/19/90	Start		Finish		Start		Finish	
P bar	29.73	Diff	0.000	Average	0.0	Diff	0.000	Average	0.0
Init		Run-Time min.sec				Run-Time decimal		0.00	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	428.400	Start	76.0	Finish	976.844	Start	82.5
Date	7/19/90	Start	423.400	Finish	76.0	Start	971.944	Finish	94.0
P bar	29.73	Diff	5.000	Average	76.0	Diff	4.900	Average	88.3
Init	TTB	Run-Time min.sec		8.28		Run-Time decimal		8.47	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	449.500	Start	76.0	Finish	997.759	Start	94.0
Date	7/19/90	Start	439.500	Finish	76.0	Start	987.776	Finish	102.0
P bar	29.73	Diff	10.000	Average	76.0	Diff	9.983	Average	98.0
Init	TTB	Run-Time min.sec		14.58		Run-Time decimal		14.97	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	460.300	Start	76.0	Finish	1008.357	Start	105.5
Date	7/19/90	Start	450.200	Finish	76.0	Start	998.348	Finish	107.0
P bar	29.73	Diff	10.100	Average	76.0	Diff	10.009	Average	106.3
Init	TTB	Run-Time min.sec		13.06		Run-Time decimal		13.10	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	506.000	Start	76.0	Finish	54.003	Start	112.0
Date	7/19/90	Start	496.000	Finish	76.0	Start	43.986	Finish	111.0
P bar	29.73	Diff	10.000	Average	76.0	Diff	10.017	Average	111.5
Init	TTB	Run-Time min.sec		10.22		Run-Time decimal		10.37	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	532.200	Start	76.0	Finish	80.270	Start	111.0
Date	7/19/90	Start	522.200	Finish	76.0	Start	70.182	Finish	114.0
P bar	29.73	Diff	10.000	Average	76.0	Diff	10.088	Average	112.5
Init	TTB	Run-Time min.sec		9.04		Run-Time decimal		9.07	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 5/27/90 Meter Box # RAC-3

Barometric Pressure 29.63 in. Hg Calibrated by: _____

Orifice Manometer Setting (Del H) in. H2O	Gas Volume: Wet test meter (Vm) ft^3	Gas Volume: Dry Gas meter (Vd) ft^3	Temperatures: Wet test meter (tw) deg F	Dry Gas Meter: Inlet	Dry Gas Meter: Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	4.663	74.5			94.5	11.67	1.1160	1.487
1.0	5	4.605	75.0			98.5	8.47	1.1357	1.558
1.5	10	9.367	75.0			103.5	13.95	1.1253	1.572
2.0	10	9.426	75.5			108.3	12.18	1.1253	1.588
3.0	10	9.286	76.0			113.0	9.88	1.1479	1.558
4.0	10	9.123	76.0			112.5	8.55	1.1645	1.556
							Average	1.1358	1.553

Gamma of Ref Meter 1.0045

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*{Pb+(Del H/13.6)}*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time /(Gamma* Vw)} ^2
0.5	0.0368	1.1160	1.4871
1.0	0.0737	1.1357	1.5581
1.5	0.1103	1.1253	1.5721
2.0	0.1471	1.1253	1.5884
3.0	0.2206	1.1479	1.5579
4.0	0.2941	1.1645	1.5559

.02Y =	0.0227
Yi upper limit	1.1585
Yi lower limit	1.1131
Var for del H	0.150
Del H upper limit	1.703
Del H lower limit	1.403

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # RAC-3

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	27.500	Start	74.0	Finish	326.995	Start	93.0
Date	5/27/90	Start	22.500	Finish	75.0	Start	322.332	Finish	96.0
P bar	29.63	Diff	5.000	Average	74.5	Diff	4.663	Average	94.5
Init		Run-Time min.sec		11.40		Run-Time decimal		11.67	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	33.100	Start	75.0	Finish	332.043	Start	96.0
Date	5/27/90	Start	28.100	Finish	75.0	Start	327.438	Finish	101.0
P bar	29.63	Diff	5.000	Average	75.0	Diff	4.605	Average	98.5
Init		Run-Time min.sec		8.28		Run-Time decimal		8.47	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	43.700	Start	75.0	Finish	341.965	Start	101.0
Date	5/27/90	Start	33.700	Finish	75.0	Start	332.598	Finish	106.0
P bar	29.63	Diff	10.000	Average	75.0	Diff	9.367	Average	103.5
Init		Run-Time min.sec		13.57		Run-Time decimal		13.95	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	65.100	Start	75.0	Finish	361.887	Start	107.5
Date	5/27/90	Start	55.100	Finish	76.0	Start	352.461	Finish	109.0
P bar	29.63	Diff	10.000	Average	75.5	Diff	9.426	Average	108.3
Init		Run-Time min.sec		12.11		Run-Time decimal		12.18	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	96.600	Start	76.0	Finish	391.042	Start	113.0
Date	5/27/90	Start	86.600	Finish	76.0	Start	381.756	Finish	113.0
P bar	29.63	Diff	10.000	Average	76.0	Diff	9.286	Average	113.0
Init		Run-Time min.sec		9.53		Run-Time decimal		9.88	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	107.000	Start	76.0	Finish	401.095	Start	113.0
Date	5/27/90	Start	97.500	Finish	76.0	Start	391.972	Finish	112.0
P bar	29.63	Diff	9.500	Average	76.0	Diff	9.123	Average	112.5
Init		Run-Time min.sec		8.33		Run-Time decimal		8.55	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 7/20/90 Meter Box # rac-3

Barometric Pressure 29.62 in. Hg Calibrated by: TTB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume: Wet test meter (Vm) ft^3	Gas Volume: Dry Gas meter (Vd) ft^3	Temperatures: Wet test meter (tw) deg F	Temperatures: Dry Gas Meter Inlet	Temperatures: Dry Gas Meter Outlet	Temperatures: Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	4.532	75.0			80.5	11.72	1.1074	1.572
1.0	5.105	4.663	75.0			93.0	8.65	1.1229	1.607
1.5	10	9.161	75.0			102.5	13.98	1.1375	1.614
2.0	10.1	9.271	75.0			104.0	12.30	1.1369	1.628
3.0	10	9.162	76.0			107.0	9.85	1.1401	1.595
4.0	10	9.091	77.0			110.5	8.50	1.1511	1.580
							Average	1.1327	1.599

Gamma of Ref Meter 0.9948

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*{Pb+(Del H/13.6)}*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time /(Gamma* Vw)} ^2
0.5	0.0368	1.1074	1.5724
1.0	0.0737	1.1229	1.6070
1.5	0.1103	1.1375	1.6140
2.0	0.1471	1.1369	1.6279
3.0	0.2206	1.1401	1.5949
4.0	0.2941	1.1511	1.5798

.02Y =	0.0227
Yi upper limit	1.1553
Yi lower limit	1.1100
Var for del H	0.150
Del H upper limit	1.749
Del H lower limit	1.449

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # rac-3

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	605.000	Start	75.0	Finish	495.477	Start	76.0
Date	7/20/90	Start	600.000	Finish	75.0	Start	490.945	Finish	85.0
P bar	29.62	Diff	5.000	Average	75.0	Diff	4.532	Average	80.5
Init	TTB	Run-Time min.sec		11.43		Run-Time decimal		11.72	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	611.705	Start	75.0	Finish	501.593	Start	85.0
Date	7/20/90	Start	606.600	Finish	75.0	Start	496.930	Finish	101.0
P bar	29.62	Diff	5.105	Average	75.0	Diff	4.663	Average	93.0
Init	TTB	Run-Time min.sec		8.39		Run-Time decimal		8.65	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	622.400	Start	75.0	Finish	511.384	Start	101.0
Date	7/20/90	Start	612.400	Finish	75.0	Start	502.223	Finish	104.0
P bar	29.62	Diff	10.000	Average	75.0	Diff	9.161	Average	102.5
Init	TTB	Run-Time min.sec		13.59		Run-Time decimal		13.98	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	633.200	Start	75.0	Finish	521.293	Start	104.0
Date	7/20/90	Start	623.100	Finish	75.0	Start	512.022	Finish	104.0
P bar	29.62	Diff	10.100	Average	75.0	Diff	9.271	Average	104.0
Init	TTB	Run-Time min.sec		12.18		Run-Time decimal		12.30	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	644.000	Start	76.0	Finish	531.186	Start	104.0
Date	7/20/90	Start	634.000	Finish	76.0	Start	522.024	Finish	110.0
P bar	29.62	Diff	10.000	Average	76.0	Diff	9.162	Average	107.0
Init	TTB	Run-Time min.sec		9.51		Run-Time decimal		9.85	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	655.000	Start	76.0	Finish	541.187	Start	110.0
Date	7/20/90	Start	645.000	Finish	78.0	Start	532.096	Finish	111.0
P bar	29.62	Diff	10.000	Average	77.0	Diff	9.091	Average	110.5
Init	TTB	Run-Time min.sec		8.30		Run-Time decimal		8.50	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 6/12/90 Meter Box # EN-1

Barometric Pressure 29.72 in. Hg Calibrated by: TB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Gas Volume Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Temperatures Dry Gas Meter Inlet	Temperatures Dry Gas Meter Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	5.308	75.0			78.0	12.92	0.9616	1.894
1.0	5	5.410	75.5			89.0	9.37	0.9607	1.955
1.5	10	11.054	76.0			97.5	15.20	0.9528	1.905
2.0	10	11.057	76.0			104.0	13.20	0.9625	1.893
3.0	10	11.119	77.0			108.0	10.90	0.9598	1.930
4.0	10	11.137	77.0			111.0	9.47	0.9609	1.931
							Average	0.9597	1.918

Gamma of Ref Meter 1.0164

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*(Pb+(Del H/13.6))*(tw+460)	Del Hi = (.0317*Del H/Pb*(td+460))* ((tw+460)*time / Vw) ^ 2
0.5	0.0368	0.9616	1.8935
1.0	0.0737	0.9607	1.9552
1.5	0.1103	0.9528	1.9049
2.0	0.1471	0.9625	1.8934
3.0	0.2206	0.9598	1.9301
4.0	0.2941	0.9609	1.9310

.02Y =	0.0192
Yi upper limit	0.9789
Yi lower limit	0.9405
Var for del H	0.150
Del H upper limit	2.068
Del H lower limit	1.768

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # EN-1

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	490.800	Start	75.0	Finish	658.861	Start	73.0
Date	6/12/90	Start	485.800	Finish	75.0	Start	653.553	Finish	83.0
P bar	29.72	Diff	5.000	Average	75.0	Diff	5.308	Average	78.0
Init	TTB	Run-Time min.sec		12.55		Run-Time decimal		12.92	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	496.800	Start	75.0	Finish	565.341	Start	85.0
Date	6/12/90	Start	491.800	Finish	76.0	Start	559.931	Finish	93.0
P bar	29.72	Diff	5.000	Average	75.5	Diff	5.410	Average	89.0
Init	TTB	Run-Time min.sec		9.22		Run-Time decimal		9.37	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	507.500	Start	76.0	Finish	677.155	Start	94.0
Date	6/12/90	Start	497.500	Finish	76.0	Start	666.101	Finish	101.0
P bar	29.72	Diff	10.000	Average	76.0	Diff	11.054	Average	97.5
Init	TTB	Run-Time min.sec		15.12		Run-Time decimal		15.20	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	518.600	Start	76.0	Finish	689.330	Start	102.0
Date	6/12/90	Start	508.600	Finish	76.0	Start	678.273	Finish	106.0
P bar	29.72	Diff	10.000	Average	76.0	Diff	11.057	Average	104.0
Init	TTB	Run-Time min.sec		13.12		Run-Time decimal		13.20	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	529.500	Start	77.0	Finish	701.447	Start	107.0
Date	6/12/90	Start	519.500	Finish	77.0	Start	690.328	Finish	109.0
P bar	29.72	Diff	10.000	Average	77.0	Diff	11.119	Average	108.0
Init	TTB	Run-Time min.sec		10.54		Run-Time decimal		10.90	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	540.300	Start	77.0	Finish	713.473	Start	110.0
Date	6/12/90	Start	530.300	Finish	77.0	Start	702.336	Finish	112.0
P bar	29.72	Diff	10.000	Average	77.0	Diff	11.137	Average	111.0
Init	TTB	Run-Time min.sec		9.28		Run-Time decimal		9.47	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 7/19/90 Meter Box # EN-1

Barometric Pressure 29.73 in. Hg Calibrated by: TTB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Dry Gas Meter Inlet	Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	0.000	0.0			0.0	0.00		
1.0	5	5.521	73.5			95.0	9.42	0.9552	1.877
1.5	10	11.154	74.0			101.0	15.32	0.9538	1.846
2.0	10	11.235	74.5			105.5	13.38	0.9524	1.868
3.0	10	11.255	75.0			108.5	10.95	0.9525	1.869
4.0	10	11.242	75.0			111.0	9.55	0.9555	1.887

Gamma of Ref Meter 1.0164

Average	0.9539	1.870

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*(Pb+(Del H/13.6))*(tw+460)	Del Hi = (.0317*Del H/Pb*(td+460))* ((tw+460)*time /(Gamma* Vw))^2
0.5	0.0368		
1.0	0.0737	0.9552	1.8774
1.5	0.1103	0.9538	1.8462
2.0	0.1471	0.9524	1.8679
3.0	0.2206	0.9525	1.8692
4.0	0.2941	0.9555	1.8874

.02Y =	0.0191
Yi upper limit	0.9730
Yi lower limit	0.9348
Var for del H	0.150
Del H upper limit	2.020
Del H lower limit	1.720

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # **EN-1**

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac		Volume		Temp		Volume		Temp	
Del H	0.5	Finish		Start		Finish		Start	
Date	7/19/90	Start		Finish		Start		Finish	
P bar	29.73	Diff	0.000	Average	0.0	Diff	0.000	Average	0.0
Init		Run-Time min.sec				Run-Time decimal		0.00	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	713.600	Start	73.0	Finish	64.556	Start	92.0
Date	7/19/90	Start	708.600	Finish	74.0	Start	59.035	Finish	98.0
P bar	29.73	Diff	5.000	Average	73.5	Diff	5.521	Average	95.0
Init	TTE	Run-Time min.sec		9.25		Run-Time decimal		9.42	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	724.200	Start	74.0	Finish	76.384	Start	98.0
Date	7/19/90	Start	714.200	Finish	74.0	Start	65.230	Finish	104.0
P bar	29.73	Diff	10.000	Average	74.0	Diff	11.154	Average	101.0
Init	TTE	Run-Time min.sec		15.19		Run-Time decimal		15.32	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	734.500	Start	74.0	Finish	87.950	Start	104.0
Date	7/19/90	Start	724.500	Finish	75.0	Start	76.715	Finish	107.0
P bar	29.73	Diff	10.000	Average	74.5	Diff	11.235	Average	105.5
Init	TTE	Run-Time min.sec		13.23		Run-Time decimal		13.38	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	744.900	Start	75.0	Finish	99.664	Start	107.0
Date	7/19/90	Start	734.900	Finish	75.0	Start	88.409	Finish	110.0
P bar	29.73	Diff	10.000	Average	75.0	Diff	11.255	Average	108.5
Init	TTE	Run-Time min.sec		10.57		Run-Time decimal		10.95	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	755.800	Start	75.0	Finish	111.912	Start	110.0
Date	7/19/90	Start	745.800	Finish	75.0	Start	100.670	Finish	112.0
P bar	29.73	Diff	10.000	Average	75.0	Diff	11.242	Average	111.0
Init	TTE	Run-Time min.sec		9.33		Run-Time decimal		9.55	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 6/14/90 Meter Box # EN-2

Barometric Pressure 29.60 in. Hg Calibrated by: TTB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Dry Gas Meter Inlet	Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	5.128	73.5			82.0	13.13	1.0056	1.940
1.0	5	5.211	75.0			94.0	9.50	1.0074	1.997
1.5	10	10.639	77.0			107.0	15.50	1.0050	1.963
2.0	10	10.729	77.5			111.5	13.62	1.0023	2.008
3.0	10	10.721	79.0			112.5	11.00	0.9995	1.973
4.0	10	10.750	79.0			115.0	9.62	0.9987	2.002
							Average	1.0031	1.980

Gamma of Ref Meter 1.0164

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*{Pb+(Del H/13.6)}*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time / Vw} ^ 2
0.5	0.0368	1.0056	1.9401
1.0	0.0737	1.0074	1.9974
1.5	0.1103	1.0050	1.9629
2.0	0.1471	1.0023	2.0076
3.0	0.2206	0.9995	1.9728
4.0	0.2941	0.9987	2.0016

.02Y =	0.0201
Yi upper limit	1.0231
Yi lower limit	0.9830
Var for del H	0.150
Del H upper limit	2.130
Del H lower limit	1.830

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # EN-2

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	688.700	Start	73.0	Finish	366.935	Start	77.0
Date	6/14/90	Start	683.700	Finish	74.0	Start	361.807	Finish	87.0
P bar	29.60	Diff	5.000	Average	73.5	Diff	5.128	Average	82.0
Init	TTB	Run-Time min.sec		13.08		Run-Time decimal		13.13	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	697.000	Start	75.0	Finish	375.566	Start	91.0
Date	6/14/90	Start	692.000	Finish	75.0	Start	370.355	Finish	97.0
P bar	29.60	Diff	5.000	Average	75.0	Diff	5.211	Average	94.0
Init	TTB	Run-Time min.sec		9.30		Run-Time decimal		9.50	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	721.000	Start	77.0	Finish	401.008	Start	105.0
Date	6/14/90	Start	711.000	Finish	77.0	Start	390.369	Finish	109.0
P bar	29.60	Diff	10.000	Average	77.0	Diff	10.639	Average	107.0
Init	TTB	Run-Time min.sec		15.30		Run-Time decimal		15.50	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	744.800	Start	77.0	Finish	426.485	Start	112.0
Date	6/14/90	Start	734.800	Finish	78.0	Start	415.756	Finish	111.0
P bar	29.60	Diff	10.000	Average	77.5	Diff	10.729	Average	111.5
Init	TTB	Run-Time min.sec		13.37		Run-Time decimal		13.62	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	755.300	Start	79.0	Finish	437.735	Start	111.0
Date	6/14/90	Start	745.300	Finish	79.0	Start	427.014	Finish	114.0
P bar	29.60	Diff	10.000	Average	79.0	Diff	10.721	Average	112.5
Init	TTB	Run-Time min.sec		11.00		Run-Time decimal		11.00	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	765.900	Start	79.0	Finish	449.130	Start	114.0
Date	6/14/90	Start	755.900	Finish	79.0	Start	438.380	Finish	116.0
P bar	29.60	Diff	10.000	Average	79.0	Diff	10.750	Average	115.0
Init	TTB	Run-Time min.sec		9.37		Run-Time decimal		9.62	

METER BOX CALIBRATION DATA AND CALCULATION FORM
(English Units)

Date 7/19/90 Meter Box # EN-2

Barometric Pressure 29.73 in. Hg Calibrated by: TTB

Orifice Manometer Setting (Del H) in. H2O	Gas Volume Wet test meter (Vm) ft^3	Dry Gas meter (Vd) ft^3	Temperatures Wet test meter (tw) deg F	Dry Gas Meter Inlet	Outlet	Avg (td) deg F	Time decimal min	Yi	Del H in. H2O
0.5	5	5.225	75.0			82.0	13.02	0.9632	1.928
1.0	5	5.278	75.5			90.5	9.27	0.9664	1.928
1.5	10	10.700	76.5			98.5	15.55	0.9643	2.014
2.0	10	10.822	77.0			105.0	13.55	0.9624	2.019
3.0	10	10.891	77.0			109.0	11.02	0.9607	1.988
4.0	10	11.092	77.0			111.5	9.47	0.9451	1.949
							Average	0.9604	1.971

Gamma of Ref Meter 0.9948

Del H in. H20	Del H/ 13.6	Yi = Gamma*Vw*Pb*(td+460) / Vd*{Pb+(Del H/13.6)}*(tw+460)	Del Hi = {.0317*Del H/Pb*(td+460)}* {(tw+460)*time /(Gamma* Vw)}^2
0.5	0.0368	0.9632	1.9281
1.0	0.0737	0.9664	1.9278
1.5	0.1103	0.9643	2.0140
2.0	0.1471	0.9624	2.0193
3.0	0.2206	0.9607	1.9882
4.0	0.2941	0.9451	1.9489

.02Y =	0.0192
Yi upper limit	0.9796
Yi lower limit	0.9412
Var for del H	0.150
Del H upper limit	2.121
Del H lower limit	1.821

METHOD 5 METERBOX CALIBRATION WORKSHEET

Meter Box # EN-2

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	0.5	Finish	261.000	Start	75.0	Finish	960.488	Start	77.0
Date	7/19/90	Start	256.000	Finish	75.0	Start	955.263	Finish	87.0
P bar	29.73	Diff	5.000	Average	75.0	Diff	5.225	Average	82.0
Init	TMB	Run-Time min.sec		13.01		Run-Time decimal		13.02	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.0	Finish	266.700	Start	75.0	Finish	966.506	Start	87.0
Date	7/19/90	Start	261.700	Finish	76.0	Start	961.228	Finish	94.0
P bar	29.73	Diff	5.000	Average	75.5	Diff	5.278	Average	90.5
Init	TMB	Run-Time min.sec		9.16		Run-Time decimal		9.27	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	1.5	Finish	277.100	Start	76.0	Finish	977.634	Start	94.0
Date	7/19/90	Start	267.100	Finish	77.0	Start	966.934	Finish	103.0
P bar	29.73	Diff	10.000	Average	76.5	Diff	10.700	Average	98.5
Init	TMB	Run-Time min.sec		15.33		Run-Time decimal		15.55	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	2.0	Finish	287.700	Start	77.0	Finish	989.121	Start	103.0
Date	7/19/90	Start	277.700	Finish	77.0	Start	978.299	Finish	107.0
P bar	29.73	Diff	10.000	Average	77.0	Diff	10.822	Average	105.0
Init	TMB	Run-Time min.sec		13.33		Run-Time decimal		13.55	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	3.0	Finish	298.200	Start	77.0	Finish	1000.559	Start	107.0
Date	7/19/90	Start	288.200	Finish	77.0	Start	989.668	Finish	111.0
P bar	29.73	Diff	10.000	Average	77.0	Diff	10.891	Average	109.0
Init	TMB	Run-Time min.sec		11.01		Run-Time decimal		11.02	

		Standard (Ref) Meter Box				Meter Box (to calibrate)			
Vac	4.0	Volume		Temp		Volume		Temp	
Del H	4.0	Finish	309.100	Start	77.0	Finish	12.641	Start	111.0
Date	7/19/90	Start	299.100	Finish	77.0	Start	1.549	Finish	112.0
P bar	29.73	Diff	10.000	Average	77.0	Diff	11.092	Average	111.5
Init	TMB	Run-Time min.sec		9.28		Run-Time decimal		9.47	

APPENDIX E

PROCESS DATA

Finish	92062400	341513000	125766600
Start	92007000	341446000	125700600
Difference	55,400	67,000	
	TIME		

Condenser flow at Tower

Every 15 min	#1 R.U.	# 2 R.U	#3 R.U.	#4 R U
			GPM	
1230				
1245				
1300				
1315				
1330				
1345				
1400				
1415				
1430				
1445		7275	8237	8025
1500	7517	7335	8445	8019
1515	7497	7297	8459	8042
1530	7532	7295	8045	7990
1545	7524	7312	8060	8062
1600	7510	7285	8107	8017
1615	7480	7290	8027	7992
1630	7549	8017	8010	8025
1645	7512	7300	8037	8019
1700	7552	7282	8052	8007
[illegible]	7507	7625	8019	8042
1730	7552	7317	8052	7990
1745	[illegible]	7220	8019	8000
[illegible]	[illegible]	7227	8037	8012
[illegible]	7530	[illegible]	8077	8010
1830	74917	7275	8102	8050
1945	7549	7302	8075	8035
1900	7487	7320	8040	8017
1915	Secured at 1905	7412	8245	8250
[illegible]	—	7410	8205	8282
1945	—	7450	8142	8240
2000	—	7407	8160	8262
[illegible]	—	7260	8192	8265
2030	—	7402	8177	8145
2045	—	7375	8307	8212
2100	—	7370	8165	8240

Condenser Flow Readings 7-9-90

		#2 R.U.	=3 R.U.	#4 R.U
2115		7405	8202	8235
2130		7380	8142	8254
2145				
2200				
2215				
2230				
2245				
2300				
$\bar{x}$	7518	7370.7	8136.0	8097.8
s	24.0	147.3	120.8	110.2
n	17	28	28	28

7780

15.7

30 mins

		R H	U o C	Dir	Separate table
9.30		52.4	2.3	S W	
10.00		49.27	3.2	West	
10.30		48.27	2.15	west	
11.00		48.85	4	west	
11.30		46.05	5.6	S.W	
12.00					
12.30	N	5	5		
13.00	W	49.0	2.85		
13.30	S	2.28	1.95		
14.00					
14.30					
15.00					
15.30					

2 [illegible]
3
4 [illegible]

E.n

D&F

Condenser Flow at Tower 15 mins

RH - UPC - DIR 30 mins

Time	#1	#2	#3	#4
9.30	OFF	7382	8180	8267
9.45	OFF	7362	8182	8250
10.00	OFF	7435	8137	8265
10.15	OFF	7387	9192	8222
10.30	OFF	7422	8195	8240
10.45	OFF	7385	8182	8295
11.00	OFF	7440	8172	8247
11.15	OFF	7372	8[illegible]	8260
11 30	OFF	7417	8190	8267
11 45 n		9	9	9
12.00 $\bar{x}$		7400.2	9179.7	8257
12.15 s		28.6	17.5	20.6
12.30				
12.45				
13.00				
13.15				
13.30				
13.45				
14.00				
14.15				
14.30				
14.45				
15.00				
15.15				

7946

	#1	#2	#3	#4
9:00		7425	8157	8069
9:15		7422	8185	8050
9:30		7417	8150	8145
9:45		7417	8337	8077
10:00		7472	8167	8065
10:15		7410	8195	8132
10:30		7420	8205	8107
10:45		7420	8205	8142
11:00		7452	8405	8112
11:15		7377	8472	8085
11:30		7430	8195	8112
11:45		7407	8727	8092
12:00		7380	8532	8087
12:15		7445	8375	8090
12:30		7430	8197	8130
12:45		7382	8199	8092
13:00		7442	8170	8120
13:15		7407	8149	8105
13:30		7405	8215	8090
13:45		7395	8222	8080
14:00		7357	8122	8097
14:15		7430	8162	8052
14:30		7395	8152	8105
14:45		7361	8145	8090
15:00		7352	8197	8112
15:15		7417	8174	8087
15:30		7417	8157	8072
15:45		7415	8185	8107
16:00		7440	8199	8057
16:15		7422	8170	8078
16:30		7375	8180	8092
16:45		7415	8212	8105
17:00				
	7918			
n		32	32	32
$\bar{x}$		7412.5	8235.81	8095.7
s		27.0	160.9	229

7-12-90

Time	Flow cfm	RH	Vel	Dir	DB / WB	
8:45	7422	89.37	.4761	S	71.2#	69.1
9:00	7422	86.67	1.576	S.E.	72.66	69.3
9:15	7425	83.42	2.325	S.W	74.44	68.4
9:30	7400	80.47	1.526	W.	75.0	70.04
9:45	7415	75.4	4.126	S.W.	76.11	69.8
10:00	7425	72.17	.7507	S.E	77.0	69.7
10:15	7405	71.07	3.85	S	77.98	70.3
10:30	7400	72.1	3.3	S.W	77.62	76.2
10:45	7410	73.9	.5005	S.E.	76.71	69.8
11:00	7420	75.37	3.226	S.E	76.28	69.9
11:15	7375	76.54	5.026	S	76.11	70.1
11:30	7412	74.52	.5005	S.E.	76.8	70.1
11:45	7442	68.02	.5005	S.W.	79.11	70.6
12:00	7407	67.55	8.0	S	79.38	70.6
12:15	7387	61.17	6.151	S.W	82.37	68.2
12:30	7427	65.65	5.275	S	81.09	68.8
12:45	7422	61.55	.9003	S	82.3	68.3
1:00	7410	58.62	4.176	S.E.	83.29	70.0
1:15	7360	56.62	4.225	S.W.	84.55	68.
1:30	7412	57.17	2.725	W	84.81	68.6
1:45	7437	57.4	.5005	S.W.	84.75	68.7
2:00	7442	57.7	.5005	S.E.	85.25	69.
2:15	7377	57.37	.5005	E.	87.75	75.
2:30	7420	51.57	4.726	S.E.	89.77	70.6
2:45	7415	46.42	.5005	S.E.	91.93	74.9
3:00	7380	47.17	.6256	S.E.	89.88	68.
3:15	7465	53.1	5.075	S.E.	88.34	69.6
3:30		STOP				
3:45						
4:00						
n	27	27	27			
x̄	7412.4	66.6	2.65		80.83	69.9
s	22.8	11.7	2.18		5.67	1.63

7-12-96

Time	COND FLOW	R-	VE-	[illegible]	RB	LWB
7:45	8160	89.37	.4761	S	71.24	69.1
9 00	8170	86.67	1.576	S.E	72.66	69.3
9:15	8174	82.42	2.325	S.W.	74.44	68.
9.30	8220	80.47	1.526	W.	75.0	70.6
9:45	8190	75.4	4.126	S.W	76.11	69.8
10:00	8220	72.17	.750	S.E	77.0	69
10.15	8177	71.07	2.55	S	77.98	70.
10:30	8197	72.1	3.3	S.W	77.62	70.
10:45	8162	73.9	.5005	S.E.	76.71	69
11:00	8120	75.37	3.226	S.E.	76.28	69.
11:15	8174	76.54	5.026	S	76.11	70.
11.30	8174	74.52	.5005	S.E.	76.8	70.
11:45	8220	68.02	.5005	S.W.	79.11	70
12:00	8252	67.55	8.0	S.	79.38	70
12 15	8197	61.17	6.151	S.W	82.37	68.
12 30	8187	65.65	5.275	S	81.09	68.
12:45	8237	61.55	.9003	S	82.3	68.
1:00	8230	58.62	4.176	S.E.	83.29	70.
1.15	8147	56.62	4.225	S.W.	84.55	65.
1 30	8199	57.17	2.725	W	84.81	68.
1.45	8185	57.4	.5005	S.W.	84.75	68.
2.00	8192	57.7	.5005	S.E.	85.25	69.
2 15	8195	57.37	.5005	E.	87.75	75
2 30	8227	51.57	4.726	S.E	89.77	70.
2:45	8215	46.42	.5005	S.E.	91.93	74
3:00	8207	47.17	.6256	S.E.	89.88	68.
3:15	8216	53.1	5.075	S.E.	88.34	69.
3.30						
3.45						
4:00						
n	27	27	27		27	2
$\bar{x}$	8194	66.6	2.65		80.8	69
s	29.5	11.7	2.18		5.67	1.4

STOP

7-12-90

Time	Cond Flow	RH	Vel	Dir	DB	WB
8:45	8117	89.37	.4761	S	71.24	69.1
9:00	8107	86.67	1.576	S.E.	72.66	69.38
9:15	8075	82.42	2.325	S.W.	74.44	68.4
9:30	8042	80.47	1.526	W.	75.0	70.0
9:45	8062	75.4	4.126	S.W	76.11	69.81
10:00	8060	72.17	.750	S.E	77.0	69.7
10:15	8061	71.07	3.50	S	77.98	70.3
10:30	8069	72.1	3.3	S.W	77.62	70.2
10:45	8122	73.9	.5005	S.E.	76.71	69.8
11:00	8042	75.37	3.226	S.E.	76.28	69.9
11:15	8072	76.54	5.026	S	76.11	70.1
11:30	8094	74.52	.5005	S.E.	76.8	70.1
11:45	8080	68.02	.5005	S.W.	79.11	70.0
12:00	8062	67.55	8.0	S	79.38	70.0
12:15	8072	61.17	6.151	S.W.	82.37	68.2
12:30	8040	65.65	5.275	S	81.09	68.8
12:45	8052	61.55	.9003	S	82.3	68.3
1:00	8097	59.62	41.176	S.E	83.29	70.3
1:15	9102	56.62	4.225	S.W	84.55	68.
1:30	8087	57.17	2.725	W	84.81	68.6
1:45	8069	57.4	.5005	S.W.	84.75	68.7
2:00	8127	57.7	.5005	S.E.	85.25	69.2
2:15	8090	57.37	.5005	E.	87.75	75.0
2:30	8072	51.57	4.726	S.E.	89.77	70.9
2:45	8095	46.42	.5005	S.E.	91.93	74.9
3:00	8065	47.17	.6254	S.E.	89.88	68.3
3:15	8094	53.1	5.075	S.E.	88.34	69.6
3:30						
3:45	8078.75					
4:00						

STOP

8079

APPENDIX F

TEST PROGRAM PARTICIPANTS

SAMPLING PROGRAM PARTICIPANTS

Name	Organization	Responsibility
Dan Bivins	EPA, Emission Measurement Branch	EPA Task Manager
Ron Myers	EPA, Industrial Studies Branch	EPA Task Coordinator
Bill Kirk	Entropy Environmentalists, Inc.	Project Coordinator
Barry Rudd	Entropy Environmentalists, Inc.	Sampling Team Leader
Matt Hamilton	Entropy Environmentalists, Inc.	Sampling Technician
Todd Brozell	Entropy Environmentalists, Inc.	Sampling Technician
Greg Blanschan	Entropy Environmentalists, Inc.	Sampling Technician
Sam McClintock	Entropy Environmentalists, Inc.	Train Recovery/Transport
Bill DeWees	DEECO, Inc.	Field Engineer