AP42 Section:	13.4
Background Chapter	4
Reference:	6
Title:	Cooling Tower Drift Test Report for Unnamed Client of the Cooling Tower Institute, Houston, Texas. Midwest Research Institute (I989)

<u>SUMMARY</u>

The testing services of Midwest Research Institute (MRI) were retained by)to conduct drift tests on a \7-cell, mechanical-draft, counter-flow cooling tower located at the The work was performed by MRI as an independent test contractor.

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 was determined by isokinetically sampling a representative fraction of the tower airflow, and measuring the amount of droplets and aerosol leaving the stack. Inductively coupled argon plasma spectroscopy (ICP), an extremely sensitive detection technique, was then used to measure the concentration of three selected trace constituents (Na, Ca, Mg) in the basin water and water collected from the airflow exiting the fan stack. At the plant's request, an additional trace constituent, chromium (Cr), was analyzed. Since the chromium concentration was near the detection limit of (ICP), the drift samples were analyzed using Graphite Furnace Atomic Absorption (GFAA). From the measurements of the selected trace constituents in the isokinetic sampling train and the same trace constituents in the basin water, the drift rate was calculated.

The calculated drift rates were between 0.0188% and 0.0348% for Fan Stack 1, depending on which of the three tracers was used. When the results are averaged for main tracers, a drift rate of 0.027% is obtained for Fan 1. The calculated drift rate for chromium is 0.0077% for Fan 1.

The calculated drift rates were between 0.0107% and 0.0146% for Fan Stack 5, depending on which of the three tracers was used. When the results are averaged for main tracers, a drift rate of 0.013% is obtained for Fan 5. The calculated drift rate for chromium is 0.0063% for Fan 5.

The average drift rate for the three main tracers from Fan Stacks 1 and 5 was 0.020%, and the average chromium (Cr) drift rate from Fan Stacks 1 and 5 was 0.007%. It should be noted that the water circulation rate was 125.5% of design, and that the drift sampling was conducted on two days when the wind speed was very high. This, in combination with low concentration of the tracers, could account for spread or variation from tracer to tracer.

COOLING TOWER TEST REPORT

DRIFT TEST
ON THE

7-CELL, MECHANICAL-DRAFT, COUNTER-FLOW
COOLING TOWER

I. INTRODUCTION

The testing services of Midwest Research Institute (MRI) were retained by the Watson Cogeneration Company to conduct drift tests using EPA Modified Method 5 isokinetic sampling techniques on a mechanical-draft, counter-flow cooling tower. The cooling tower is located at The work was performed by Nicholas M. Stich and Steve Cummins of MRI.

II. TEST SITE DESCRIPTION

The plant is located in The cooling tower provides cooling water to process heat exchangers and steam condensers. The cooling tower is located at

The cooling tower consists of seven mechanical-draft, counter-flow cells in a continuous straight line with a common cold water basin beneath the tower. Each cell is equipped with a 28-ft diameter, six-bladed fan driven by a 100-hp motor. The hub seal was 84 in. in diameter. The fan stack was 336 in. in diameter at the sample plane location and constructed of fiberglass.

One underground ground steel conduit returns hot water from the plant to the cooling tower. The main line then tees off to feed seven individual 18-in-diameter cell risers. Pitot taps for water flow and hot water measurement were located in the 18-in lines.

The cold water from the cooling tower basin is collected in the pump forebay adjacent to the tower where four of the five pumps are used to return cold water to the plant. Taps with temporary standpipes were used for the measurement of cold water temperatures on each of the four pump discharge lines.

III. SAMPLING SEQUENCE

The test sequence for the drift tests were as follows:

1. Water flow and fan horsepower measurements were conducted and the tower operations monitored.
2. Drift sample and airflow measurement locations were calculated.
3. A basin water sample was collected.
4. Isokinetic drift sampling of the selected fan stack was conducted.
5. A second basin water sample was collected during the middle of the drift test.
6. Isokinetic drift sampling of the fan was completed.
7. A third basin sample was collected at the conclusion of the test. The three basin samples were composited into one basin water sample.
8. The drift samples were recovered from the sample collection system.
9. The basin composite, water blank, and drift impinger samples were acid-stabilized and transported to the laboratory for analysis.

IV. DRIFT TEST EQUIPMENT

A. Sample Location

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 were determined for 10-point radial traverses using the equation for equal annular areas for fan discharge from Chapter 5 of the CTI Manual.

B. 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° 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.

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

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

C. Drift Collection Train

The drift collection train 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 was 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.

D. Control Console and Pump

The control console and pump used was a High-Volume Sampling System (HVSS) consistent with EPA Method 5 requirements. The impinger train is connected to the console via a sample line through 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

[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.

adjust and maintain the desired sampling rate. The console contains a calibrated dry gas meter, digital temperature readout, manometers, and associated controls.

V. DRIFT TEST METHODS

Testing was conducted on . The tower's circulating water flow was 125.5% of design, and the fan horsepower was 103.1% of design. The test data were acquired in accordance with applicable portions of the CTI ATC-105 (1982) test code. The individual parameters were measured as follows:

- Total circulating water flow was measured with two 10-point pitot traverses of the seven hot water risers. A 42-in Simplex-Leopold-type pitot tube was used to measure the velocity at each point. An air-over-water manometer was used for measuring the differential pressure between the impact and reference orifices of the pitot tube.

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

- Air velocity was 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 was rotated until the pressure difference across the secondary pitot tips was zero. When this zero differential was obtained, the primary probe had been aligned with the flow and the protractor read to determine the cyclonic flow angle. The probe assembly was then used to measure the velocity pressure and temperature at the sample point.

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

- Sampling at each traverse location was commenced after the proper sample rate was 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 was shut off, the air pitot/probe assembly was relocated to the next sample location, and the above procedure repeated until all 40 points had been sampled.

- The drift sample recovery was initiated 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 was sealed and then removed from the cooling tower to the sample recovery location where the remainder of the sample recovery was recorded. The impinger contents, along with all the rinse, were transferred to sample bottles. A distilled deionized water blank was taken. Both the drift impinger samples and water blank were nitric acid-stabilized and then returned to MRI for further analysis.

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

VI. SAMPLE ANALYSIS

The samples were returned to MRI where custody of the samples was transferred to the analytical section. Quantitative analysis of selected trace elements in both the tower basin water samples and the collected drift samples was then performed by the analytical section. A Jarrell-Ash Model 1155A ICP-AES instrument was used to analyze the samples by inductively coupled argon plasma spectroscopy (ICP) samples. Graphite furnace atomic absorption spectroscopy (GFAA) was used to analyze for chromium on a Perkin-Elmer Model 5000 Zeeman Atomic Absorption Spectrophotometer. The drift and basin water samples were prepared using two different preparation techniques, Method 3050 and the acidification and dilution procedure. The results presented in this report are the averages obtained from the analysis of both preparation techniques for each sample. Method 6010 was used for the analysis of Ca, Na, Mg, and Method 7191 was used for the analysis of Cr. The methods used are described below.

A. Acidification and Dilution

This procedure was used to prepare surface and groundwater 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.

B. 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 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.

C. Method 6010

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

The simultaneous, or sequential, multielemental determination of elements by ICP is measured by element-emitted light by 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.

D. Method 7000 and 7191

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, groundwater, other aqueous samples, EP extracts, industrial wastes, soils, sludges, sediments, and other solid wastes require digestion prior to analysis. Method 7191 is a modification of Method 7000 that is specific for chromium 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 use 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.

VII. RESULTS AND CONCLUSIONS

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

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

where: NFA = Net Fan Area (square feet)
NWT = Net Weight of Tracer (micrograms)
NZA = Nozzle Area (square feet)
WFR = Water Flow Rate (grams per minute)
EQT = Equivalent Sample Time (240 minutes)
BTC = Basin Tracer Concentration (micrograms per grams)

The table below summarizes the results of the laboratory analysis and drift calculations.

FAN STACK 1

Tracer Analyzed	Sample Weight (µg)	Water Blank (µg/g)	Basin Conc. (µg/g)	% Drift
Ca	1354.9	0.0000	170.5	0.0348
Mg	331.6	0.0000	77.1	0.0188
Na	1836.8	0.0000	228.5	0.0279
Cr	14.7	0.0034	8.32	0.0077

FAN STACK 5

Tracer Analyzed	Sample Weight (μg)	Water Blank (μg/g)	Basin Conc. (μg/g)	% Drift
Ca	631.1	0.0000	177.5	0.0146
Mg	207.4	0.0000	80.2	0.0107
Na	956.6	0.0000	295.5	0.0133
Cr	13.3	0.0034	8.7	0.0063

The calculated drift rates were between 0.0188% and 0.0348% for Fan Stack 1, depending on which of the three tracers was used. When the results are averaged for main tracers, a drift rate of 0.027% is obtained for Fan 1. The calculated drift rate for chromium is 0.0077% for Fan 1.

The calculated drift rates were between 0.0107% and 0.0146% for Fan Stack 5, depending on which of the three tracers was used. When the results are averaged for main tracers, a drift rate of 0.013% is obtained for Fan 5. The calculated drift rate for chromium is 0.0063% for Fan 5.

The average drift rate for the three main tracers from Fan Stacks 1 and 5 was 0.020%, and the average chromium (Cr) drift rate from Fan Stacks 1 and 5 was 0.007%. It should be noted the water circulation rate was 125.5% of design, and that the drift sampling was conducted on two days when the wind speed was very high. This in combination with low concentration of the tracers could account for spread or variation from tracer to tracer.

APPENDIX A

SUMMARY OF RESULTS

DRIFT TEST
ON THE

7-CELL, MECHANICAL-DRAFT, COUNTER-FLOW
COOLING TOWER

FILE NAME :	PROGRAM VER.
RUN # : 1	10/01/88 V2.1
LOCATION :	
DATE :	
PROJECT # :	

INITIAL METER VOLUME (CUBIC FEET)=	190.000
FINAL METER VOLUME (CUBIC FEET)=	632.390
METER FACTOR=	0.9857
FINAL LEAK RATE (CU FT/MIN)=	0.000
NET METER VOLUME (CUBIC FEET)=	436.064
GAS VOLUME (DRY STANDARD CUBIC FEET)=	429.883
BAROMETRIC PRESSURE (IN. HG)=	29.95
STATIC PRESSURE (INCHES H20)=	-0.15
PERCENT OXYGEN=	21.0
PERCENT CARBON DIOXIDE=	0.0
MOISTURE COLLECTED (ML)=	0.0
PERCENT WATER=	5.3
DRY MOLECULAR WEIGHT=	28.84
WET MOLECULAR WEIGHT=	28.26
AVERAGE METER TEMPERATURE (F.)=	78.8
AVERAGE DELTA H (IN. H20)=	2.19
AVG.SUM of SQR DELTA P (for % ISOKINETIC)=	0.4433
% ISOKINETIC=	101.0
AVERAGE STACK TEMPERATURE (F.)=	93.7
AVG. SUM of SQR DELTA P * COS of ANGLE (IN. H20)=	0.4125
PITOT COEFFICIENT=	0.84
SAMPLING TIME (MINUTES)=	221.8
NOZZLE DIAMETER (INCHES)=	0.5021
STACK AXIS (INCHES)=	336.0
HUB AXIS (INCHES)=	84.0
NET FREE STACK AREA (SQUARE FEET)=	577.27
STACK VELOCITY (ACTUAL, FEET/MIN)=	1,438
FLOW RATE (ACTUAL, CUBIC FT/MIN)=	829,828
FLOW RATE (STANDARD, WET, CUBIC FT/MIN)=	791,849
FLOW RATE (STANDARD, DRY, CUBIC FT/MIN)=	749,685

------------------- DRIFT ANALYSIS ------------------

TRACER ANALYZED	SAMPLE WEIGHT (mcg)	WATER BLANK (mcg/g)	BASIN CONC. (mcg/g)	% DRIFT
Ca	1354.9	0.0000	170.50	0.0348
Cr	14.7	0.0034	8.32	0.0077
Mg	331.6	0.0000	77.10	0.0188
Na	1836.8	0.0000	288.50	0.0279

FILE NAME :	PROGRAM VER.
RUN # : 1	10/01/88 V2.1
LOCATION :	
DATE :	
PROJECT # :	

* * METRIC UNITS * *

INITIAL METER VOLUME (CUBIC METERS)=	5.380
FINAL METER VOLUME (CUBIC METERS)=	17.907
METER FACTOR=	0.9857
FINAL LEAK RATE (CU M/MIN)=	0.0000
NET METER VOLUME (CUBIC METERS)=	12.348
GAS VOLUME (DRY STANDARD CUBIC METERS)=	12.173
BAROMETRIC PRESSURE (MM HG)=	761
STATIC PRESSURE (MM H20)=	-4
PERCENT OXYGEN=	21.0
PERCENT CARBON DIOXIDE=	0.0
MOISTURE COLLECTED (ML)=	0.0
PERCENT WATER=	5.3
DRY MOLECULAR WEIGHT=	28.84
WET MOLECULAR WEIGHT=	28.26
AVERAGE METER TEMPERATURE (C.)=	26.0
AVERAGE DELTA H (MM H20)=	55.7
AVG. SUM of SQR DELTA P (for % ISOKINETIC)=	2.23
% ISOKINETIC=	101.0
AVERAGE STACK TEMPERATURE (C.)=	34.3
AVG. SUM of SQR DELTA P * COS of ANGLE (MM H20)=	2.08
PITOT COEFFICIENT=	0.84
SAMPLING TIME (MINUTES)=	221.8
NOZZLE DIAMETER (MM)=	12.75
STACK AXIS #1 (METERS)=	8.534
STACK AXIS #2 (METERS)=	2.134
CIRCULAR STACK	
STACK AREA (SQUARE METERS)=	53.630
STACK VELOCITY (ACTUAL, M/MIN)=	438
FLOW RATE (ACTUAL, CUBIC M/MIN)=	23,498
FLOW RATE (STANDARD, WET, CUBIC M/MIN)=	22,423
FLOW RATE (STANDARD, DRY, CUBIC M/MIN)=	21,229

FILE NAME :
RUN # : 1
LOCATION :
DATE :
PROJECT # :

PROGRAM VER.
10/01/88 V2.1

POINT #	DELTA P (IN. H20)	DELTA H (IN. H20)	STACK T (F.)	METER T. IN(F.)	METER T. OUT(F.)	ANGLE (DEG)
1	0.040	0.400	91	80	80	45
2	0.050	0.500	93	79	79	50
3	0.080	0.820	92	80	80	20
4	0.140	1.400	95	80	80	20
5	0.170	1.700	94	79	79	15
6	0.280	2.800	94	79	79	19
7	0.300	3.000	94	80	79	5
8	0.360	3.700	94	82	79	20
9	0.330	3.400	92	82	79	20
10	0.250	2.500	93	81	79	35
11	0.240	2.400	95	75	76	30
12	0.300	3.000	95	77	76	25
13	0.290	2.900	94	78	76	25
14	0.320	3.200	94	80	78	30
15	0.350	3.500	94	81	79	25
16	0.320	3.200	95	81	79	25
17	0.310	3.200	94	83	81	25
18	0.250	2.500	94	84	82	30
19	0.280	2.900	94	83	82	30
20	0.240	2.400	94	82	83	35
21	0.010	0.100	82	79	80	15
22	0.010	0.100	85	80	80	25
23	0.020	0.200	91	80	79	10
24	0.050	0.500	91	80	79	20
25	0.060	0.600	94	80	79	10
26	0.080	0.800	95	81	79	10
27	0.120	1.200	96	81	79	30
28	0.180	1.800	95	81	79	10
29	0.210	2.100	94	82	79	10
30	0.180	1.800	94	82	79	5
31	0.200	2.000	95	77	77	20
32	0.240	2.400	97	77	77	10
33	0.270	2.700	96	77	77	10
34	0.270	2.700	96	76	75	10
35	0.350	3.500	96	77	75	5
36	0.360	3.600	96	77	75	5
37	0.310	3.100	96	76	75	5
38	0.380	3.800	95	75	74	10
39	0.310	3.100	94	75	74	25
40	0.220	2.200	94	75	74	5

DRIFT DATA REDUCTION

RUN # 1

Sample Volume	823
Rinse Volume	245
Initial Water Vol.	250

DESCRIPTION	Ca	Cr	Mg	Na
Water Blank (mcg/g)	0.0000	.0034	0.0000	0.0000
Filter Blank (mcg)	2.8100	.5786	.3030	0.0000
DIGESTED				
Basin Water (mcg/g)	171.00	8.37	77.40	290.00
Impinger (mcg/g)	1.6100	.0168	.3959	2.0700
Filter (mcg)	24.300	.658	8.780	38.200
TOTAL SAMPLE WT(mcg)	1346.5	12.2	334.3	1739.6
ACIDIFIED				
Basin Water (mcg/g)	170.00	8.27	76.80	287.00
Impinger (mcg/g)	1.6600	.0236	.4000	2.3500
Filter (mcg)	24.300	.658	8.780	38.200
TOTAL SAMPLE WT(mcg)	1363.4	17.2	328.9	1934.1
AVERAGE				
Basin Water (mcg/g)	170.50	8.32	77.10	288.50
Impinger (mcg/g)	1.6350	.0202	.3980	2.2100
Filter (mcg)	24.300	.658	8.780	38.200
TOTAL SAMPLE WT(mcg)	1354.9	14.7	331.6	1836.8

FILE NAME	:		PROGRAM VER.
RUN #	: 2		10/01/88 V2.1
LOCATION	:		
DATE	:		
PROJECT #	:		

INITIAL METER VOLUME (CUBIC FEET)=	635.000
FINAL METER VOLUME (CUBIC FEET)=	1086.130
METER FACTOR=	0.9857
FINAL LEAK RATE (CU FT/MIN)=	0.000
NET METER VOLUME (CUBIC FEET)=	444.679
GAS VOLUME (DRY STANDARD CUBIC FEET)=	437.389
BAROMETRIC PRESSURE (IN. HG)=	29.85
STATIC PRESSURE (INCHES H20)=	-0.15
PERCENT OXYGEN=	21.0
PERCENT CARBON DIOXIDE=	0.0
MOISTURE COLLECTED (ML)=	0.0
PERCENT WATER=	4.8
DRY MOLECULAR WEIGHT=	28.84
WET MOLECULAR WEIGHT=	28.32
AVERAGE METER TEMPERATURE (F.)=	78.1
AVERAGE DELTA H (IN. H20)=	2.11
AVG.SUM of SQR DELTA P (for % ISOKINETIC)=	0.4316
% ISOKINETIC=	101.3
AVERAGE STACK TEMPERATURE (F.)=	90.1
AVG. SUM of SQR DELTA P * COS of ANGLE (IN. H20)=	0.4158
PITOT COEFFICIENT=	0.84
SAMPLING TIME (MINUTES)=	229.6
NOZZLE DIAMETER (INCHES)=	0.5021
STACK AXIS (INCHES)=	336.0
HUB AXIS (INCHES)=	84.0
NET FREE STACK AREA (SQUARE FEET)=	577.27
STACK VELOCITY (ACTUAL, FEET/MIN)=	1,445
FLOW RATE (ACTUAL, CUBIC FT/MIN)=	834,219
FLOW RATE (STANDARD, WET, CUBIC FT/MIN)=	798,609
FLOW RATE (STANDARD, DRY, CUBIC FT/MIN)=	760,493

------------------ DRIFT ANALYSIS ------------------

TRACER ANALYZED	SAMPLE WEIGHT (mcg)	WATER BLANK (mcg/g)	BASIN CONC. (mcg/g)	% DRIFT
Ca	631.1	0.0000	177.50	0.0146
Cr	13.3	0.0034	8.70	0.0063
Mg	207.4	0.0000	80.20	0.0107
Na	956.6	0.0000	295.50	0.0133

FILE NAME :
RUN # : 2
LOCATION :
DATE :
PROJECT # :

PROGRAM VER.
10/01/88 V2.1

* * METRIC UNITS * *

INITIAL METER VOLUME (CUBIC METERS)=	17.981
FINAL METER VOLUME (CUBIC METERS)=	30.755
METER FACTOR=	0.9857
FINAL LEAK RATE (CU M/MIN)=	0.0000
NET METER VOLUME (CUBIC METERS)=	12.592
GAS VOLUME (DRY STANDARD CUBIC METERS)=	12.385
BAROMETRIC PRESSURE (MM HG)=	758
STATIC PRESSURE (MM H20)=	-4
PERCENT OXYGEN=	21.0
PERCENT CARBON DIOXIDE=	0.0
MOISTURE COLLECTED (ML)=	0.0
PERCENT WATER=	4.8
DRY MOLECULAR WEIGHT=	28.84
WET MOLECULAR WEIGHT=	28.32
AVERAGE METER TEMPERATURE (C.)=	25.6
AVERAGE DELTA H (MM H20)=	53.6
AVG. SUM of SQR DELTA P (for % ISOKINETIC)=	2.18
% ISOKINETIC=	101.3
AVERAGE STACK TEMPERATURE (C.)=	32.3
AVG. SUM of SQR DELTA P * COS of ANGLE (MM H20)=	2.10
PITOT COEFFICIENT=	0.84
SAMPLING TIME (MINUTES)=	229.6
NOZZLE DIAMETER (MM)=	12.75
STACK AXIS #1 (METERS)=	8.534
STACK AXIS #2 (METERS)=	2.134
CIRCULAR STACK	
STACK AREA (SQUARE METERS)=	53.630
STACK VELOCITY (ACTUAL, M/MIN)=	440
FLOW RATE (ACTUAL, CUBIC M/MIN)=	23,622
FLOW RATE (STANDARD, WET, CUBIC M/MIN)=	22,614
FLOW RATE (STANDARD, DRY, CUBIC M/MIN)=	21,535

FILE NAME :
RUN # : 2
LOCATION :
DATE :
PROJECT # :

PROGRAM VER.
10/01/88 V2.1

POINT #	DELTA P (IN. H20)	DELTA H (IN. H20)	STACK T (F.)	METER T. IN(F.)	METER T. OUT(F.)	ANGLE (DEG)
1	0.130	1.300	81	70	70	35
2	0.090	0.900	81	70	70	40
3	0.130	1.300	80	70	70	15
4	0.210	2.200	80	71	70	15
5	0.110	1.100	81	74	71	0
6	0.240	2.400	80	73	71	10
7	0.280	2.900	80	75	72	5
8	0.320	3.300	80	76	73	10
9	0.250	2.600	80	77	74	20
10	0.200	2.100	80	77	74	15
11	0.080	0.800	84	76	76	0
12	0.260	2.700	96	79	80	5
13	0.250	2.600	95	81	81	5
14	0.210	2.200	94	82	81	5
15	0.290	3.000	94	81	81	5
16	0.260	2.700	94	81	81	5
17	0.330	3.400	92	81	81	10
18	0.310	3.200	92	81	81	10
19	0.280	2.900	91	82	81	10
20	0.210	2.200	92	81	80	10
21	0.010	0.100	86	79	79	10
22	0.010	0.100	91	80	80	0
23	0.030	0.300	90	82	80	30
24	0.020	0.200	91	82	81	25
25	0.050	0.500	94	83	81	20
26	0.100	1.000	90	83	81	10
27	0.110	1.100	94	84	81	10
28	0.250	2.600	94	84	81	5
29	0.160	1.600	94	83	80	15
30	0.170	1.700	95	81	79	25
31	0.180	1.800	96	78	77	30
32	0.210	2.200	97	78	78	20
33	0.290	3.000	97	79	78	15
34	0.360	3.700	96	80	78	10
35	0.340	3.500	95	81	78	15
36	0.350	3.600	96	81	78	15
37	0.340	3.500	96	81	79	15
38	0.330	3.400	94	81	78	15
39	0.290	3.000	94	78	76	15
40	0.170	1.700	95	77	75	25

DRIFT DATA REDUCTION

RUN # 2

Sample Volume 731

Rinse Volume 200

Initial Water Vol. 250

DESCRIPTION	Ca	Cr	Mg	Na
Water Blank (mcg/g)	0.0000	.0034	0.0000	0.0000
Filter Blank (mcg)	2.8100	.5786	.3030	0.0000
DIGESTED				
Basin Water (mcg/g)	179.00	8.78	80.90	298.00
Impinger (mcg/g)	.8440	.0183	.2830	1.1700
Filter (mcg)	15.600	.653	1.680	0.000
TOTAL SAMPLE WT(mcg)	629.8	11.9	208.3	853.2
ACIDIFIED				
Basin Water (mcg/g)	176.00	8.61	79.50	293.00
Impinger (mcg/g)	.8690	.0230	.2830	1.4500
Filter (mcg)	15.600	.653	1.680	.000
TOTAL SAMPLE WT(mcg)	632.4	14.7	206.6	1060.0
AVERAGE				
Basin Water (mcg/g)	177.50	8.70	80.20	295.50
Impinger (mcg/g)	.8565	.0207	.2830	1.3100
Filter (mcg)	15.600	.653	1.680	.000
TOTAL SAMPLE WT(mcg)	631.1	13.3	207.4	956.6

APPENDIX B

FIELD DATA SHEETS

DRIFT TEST
ON THE

7-CELL, MECHANICAL-DRAFT, COUNTER-FLOW
COOLING TOWER

MIDWEST RESEARCH INSTITUTE

FILE NO.: ____________ TEST DATE: ____________

DATA SHEET "C"

MEAS OF: FAN DRIVER INPUT HORSEPOWER — FAN HP — UNIT: HP

INSTRUMENT IDENTIFICATION: Esterline Angus — DATE CALIBR:

TIME. START — END

FAN NO	VOLTS	AMPS	P.F	KW_1	KW_2	KW_T	MOTOR EFF	HP
1	480 / 480	97.9 / 98.7	88.0	24.1	47.1	72.5	.952	
2	480 / 480	97.9 / 97.4	87.9	47.1	24.5	71.4	.952	
3	480 / 481	97.8 / 99.7	88.1	23.9	46.5	71.8	.952	
4	482 / 482	97.2 / 93.5	87.2	24.3	45.2	69.4	.952	
5	481 / 482	93.1 / 93.1	87.5	23.6	45.2	68.8	.952	
6	481 / 481	98.6 / 98.9	87.9	24.4	46.1	72.3	.952	
7	481 / 482	98.5 / 98.6	88.2	25.1	47.2	71.2	.952	
(Avg.)		(97.1)				(71.1)		
TEST AVERAGE INPUT HP				Avg FAN HP (with Line Loss)				89.74

MEAS OF: — UNIT:

INSTRUMENT IDENTIFICATION:

TIME			WIND, MPH	WIND DIREC
TEST AVERAGE:				

MEAS. OF: — UNIT:

INSTRUMENT IDENTIFICATION: — DATE CALIBR.:

RUN	TIME					
1						
2		WirE Size			250 MCM	
3		Wire Length			600 ft	
4						
5		Kilowatts	Loss		= .77	Kw Loss
6		/				
7		HP.	LossED		= .98	Hp Loss
8						
9		Motor	Hp.		=	89.74
10				Avg.		
11						
12						
13						
14						
15						
TEST AVERAGE						

MEAS. OF: Pump Press — UNIT:

INSTRUMENT IDENTIFICATION: — DATE CALIBR.:

RUN	TIME	#1	#2	#3	#4	
1	10:00	70	70	70	70	
2	18:30	70	70	70	70	
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
TEST AVERAGE.						

MIDWEST RESEARCH INSTITUTE

FILE NO.: ______________

DATA SHEET "E"
WATER FLOW MEASUREMENT
PITOT TUBE

TEST DATE: ______________

PITOT TUBE MAKE, MODEL	SERIAL NO.	PIPE SIZE, INCHES
MRI- Simplex	MRI-8842	NOM = 18 I.D. = 17¼
DATE CALIBR. APR 1988	TUBE COEFFICIENT C = .7948	AREA = .00545 ID², SQ FT A = 17¼ = 1.62295 17⅛ = 1.59951

PIPE I.D. IN.				LOCATION DECIMAL INCHES		STA. DESC. Riser #1 TIME				STA. DESC. Riser #2 TIME			
RDG NO. (18 IN. DIAM AND OVER)	DIA. X	RDG NO. (UNDER 18 IN. DIAM)	DIA. X	CALCULATED	CORRECTED*	d, in.	√d	d, in.	√d	d, in.	√d	d, in	√d
1	.013												
2	.039												
3	.067					North TAP		South TAP		North TAP		South TAP	
4	.097					17¼"		17⅛"		17⅛"		17⅛"	
5	.129			17¼"	17⅛"	[illegible]							
6	.165	1	.026	7/16	7/16	50½		48		63		62	
7	.204	2	.082	1 7/16	1 3/8	62		56		71		76	
8	.250	3	.146	2½	2½	78		58		84		82	
9	.306	4	.226	3 7/8	3 7/8	76		64		87		83	
10	.388	5	.342	5 7/8	5 7/8	70		68		86		83	
11	.612	6	.658	11 3/8	11¼	75		87		78		83	
12	.694	7	.774	13 3/8	13¼	72		82		76		77	
13	.750	8	.854	14 3/4	14 5/8	66		76		68		68	
14	.796	9	.918	15 13/16	15 3/4	48		62		62		57	
15	.835	10	.974	16 13/16	16 11/16	35		41		45		46	
16	.871												
17	.903												
18	.933												
19	.961												
20	.987												
						TOTAL	79.01	TOTAL	79.65	TOTAL	84.50	TOTAL	84.3[illegible]
						AVG	7.901	AVG	7.965	AVG	8.450	AVG	8.433
						TRAVERSE AVG √d				TRAVERSE AVG √d			

RDG NO	TIME	d
A		
B		
C		

Riser #1:
North Tap = 10599
South Tap = 10531
Riser #1 Avg = 10565
US GPM ______

Riser #2:
North Tap = 11172
South Tap = 11150
Riser #2 Avg = 11161
US GPM ______

$Q, gpm = \sqrt{d}\,(1040 \times C \times A) = \sqrt{d}\,(\_\_\_\_\_\_)$

BASIS: AIR/WATER MANOMETER

* CALCULATED VALUE DECREASED BY DISTANCE FROM END OF PITOT TUBE TO CENTER LINE OF IMPACT HOLE.

MIDWEST RESEARCH INSTITUTE

FILE NO.: ______________

DATA SHEET "E"
WATER FLOW MEASUREMENT
PITOT TUBE

TEST DATE: ______________

PITOT TUBE MAKE, MODEL	SERIAL NO.	PIPE SIZE, INCHES
MRI- Simplex	MRI- 8842	NOM = 18 I.D =

DATE CALIBR.	TUBE COEFFICIENT	AREA = .00545 ID², SQ FT
APR- 1988	C = .7948	A =

PIPE I.D. RDG NO. (18 IN. DIAM AND OVER)	DIA. X	RDG NO. (UNDER 18 IN. DIAM)	DIA. X	LOCATION DECIMAL INCHES CALCULATED	CORRECTED*	STA. DESC. Riser #3 d, in.	√d	d, in.	√d	STA. DESC. Riser #4 d, in.	√d	d, in.	√d
1	.013												
2	.039												
3	.067			17 1/8"	17 3/16"								
4	.097					North Tap		South Tap		North Tap		South Tap	
5	.129					17 1/8"		17 1/8"		17 1/8		17 3/16"	
6	.165	1	.026	7/16	7/16	71		62		78		62	
7	.204	2	.082	1 3/8	1 3/8	84		70		87		76	
8	.250	3	.146	2 1/2	2 1/2	88		71		92		86	
9	.306	4	.226	3 7/8	3 7/8	88		78		94		86	
10	.388	5	.342	5 7/8	5 7/8	84		80		90		87	
11	.612	6	.658	11 1/4	11 5/16	72		83		78		89	
12	.694	7	.774	13 1/4	13 5/16	69		83		72		87	
13	.750	8	.854	14 5/8	14 11/16	62		80		66		81	
14	.796	9	.918	15 3/4	15 13/16	53		62		56		69	
15	.835	10	.974	16 11/16	16 3/4	33		42		41		42	
16	.871												
17	.903												
18	.933												
19	.961												
20	.987												
						TOTAL	83.20	TOTAL	83.96	TOTAL	86.26	TOTAL	87.01
						AVG	8.320	AVG	8.396	AVG	8.626	AVG	8.701
						TRAVERSE AVG √d				TRAVERSE AVG √d			

RDG NO	TIME	d
A		
B		
C		

Q, gpm $= \sqrt{d}\,(1040 \times C \times A) = \sqrt{d}\,(\_\_\_\_\_\_)$

BASIS: AIR/WATER MANOMETER

Riser #3:
North Tap = 11000
South Tap = 11101
US GPM Riser #3 avg = 11050

Riser #4:
North Tap = 11405
South Tap = 11588
US GPM Riser #4 avg = 11496

* CALCULATED VALUE DECREASED BY DISTANCE FROM END OF PITOT TUBE TO CENTER LINE OF IMPACT HOLE

MIDWEST RESEARCH INSTITUTE

FILE NO.: ____________

DATA SHEET "E"
WATER FLOW MEASUREMENT
PITOT TUBE

TEST DATE: ____________

PITOT TUBE MAKE, MODEL	SERIAL NO.	PIPE SIZE, INCHES
MRI - Simplex	MRI-8842	NOM = 18 I.D. =
DATE CALIBR. APR-1988	TUBE COEFFICIENT c = .7948	AREA = .00545 ID², SQ FT A =

PIPE I.D.	IN.			LOCATION DECIMAL INCHES		STA. DESC. Riser #5		TIME		STA. DESC. Riser #6		TIME	
18 IN. DIAM AND OVER RDG NO.	DIA. X	UNDER 18 IN. DIAM RDG NO.	DIA. X	CALCULATED	CORRECTED*	d, in.	√d	d, in.	√d	d, in.	√d	d, in	√d
1	.013												
2	.039												
3	.067												
4	.097			17 3/16"	17 1/8"	North TAP		South TAP		North TAP		South TAP	
5	.129					17 3/16		17 1/8"		17 3/16"		17 3/16	
6	.165	1	.026	7/16	7/16	66		61		68		58	
7	.204	2	.082	1 3/8	1 3/8	83		76		84		73	
8	.250	3	.146	2 1/2	2 1/2	89		80		92		74	
9	.306	4	.226	3 7/8	3 7/8	91		82		92		76	
10	.388	5	.342	5 7/8	5 7/8	86		83		84		73	
11	.612	6	.658	11 5/16	11 1/4	74		86		72		87	
12	.694	7	.774	13 5/16	13 1/4	68		86		68		91	
13	.750	8	.854	14 11/16	14 5/8	63		78		67		89	
14	.796	9	.918	15 13/16	15 3/4	54		62		57		72	
15	.835	10	.974	16 3/4	16 11/16	38		44		42		48	
16	.871												
17	.903												
18	.933												
19	.961												
20	.987												
						TOTAL	83.78	TOTAL	85.52	TOTAL	84.70	TOTAL	85.73
						AVG	8.378	AVG	8.552	AVG	8.470	AVG	8.573

TRAVERSE AVG √d

RDG NO	TIME	d
A		
B		
C		

North Tap = 11158
South Tap = 11307
US GPM Riser #5 Avg = 11232

North Tap = 11280
South Tap = 11418
US GPM Riser #6 Avg = 11349

Q, gpm = $\sqrt{d}\,(1040 \times C \times A) = \sqrt{d}\,(\_\_\_\_\_\_)$

BASIS: AIR/WATER MANOMETER

* CALCULATED VALUE DECREASED BY DISTANCE FROM END OF PITOT TUBE TO CENTER LINE OF IMPACT HOLE.

MIDWEST RESEARCH INSTITUTE

FILE NO.: ______

DATA SHEET "E"
WATER FLOW MEASUREMENT
PITOT TUBE

TEST DATE: ______

PITOT TUBE MAKE, MODEL	SERIAL NO.	PIPE SIZE, INCHES
MRI - Simplex	MRI - 8842	NOM = 18 I.D. =
DATE CALIBR. APR - 1988	TUBE COEFFICIENT C = .7948	AREA = .00545 ID², SQ FT A =

PIPE I.D. RDG NO. (18 IN. DIAM AND OVER)	DIA. X	RDG NO. (UNDER 18 IN. DIAM)	DIA. X	LOCATION DECIMAL INCHES CALCULATED	CORRECTED*	STA. DESC. Riser # 7 d. in.	√d	TIME d. in.	√d	STA. DESC. By pass d. in.	√d	TIME d. in.	√d
1	.013												
2	.039												
3	.067												
4	.097			17 1/8		North Tap		South Tap		Horz			
5	.129					17 1/8"		17 1/8					
6	.165	1	.026	7/16		68		50		Bypass Shut off			
7	.204	2	.082	1 3/8		82		61		For Thermal Test			
8	.250	3	.146	2 1/2		88		64					
9	.306	4	.226	3 7/8		84		65					
10	.388	5	.342	5 7/8		79		68					
11	.612	6	.658	11 1/4		69		82					
12	.694	7	.774	13 1/4		72		82					
13	.750	8	.854	14 5/8		68		81					
14	.796	9	.918	15 3/4		63		66					
15	.835	10	.974	16 11/16		43		51					
16	.871												
17	.903												
18	.933												
19	.961												
20	.987												

TOTAL 84.26	TOTAL 81.56	TOTAL	TOTAL
AVG 8.426	AVG 8.156	AVG	AVG
TRAVERSE AVG √d		TRAVERSE AVG √d	

North Tap = 11140
South Tap = 10783
US GPM Riser #7 Avg = 10961

US GPM ______

RDG NO	TIME	d
A		
B		
C		

Q, gpm = √d (1040 x C x A) = √d (______)

BASIS: AIR/WATER MANOMETER

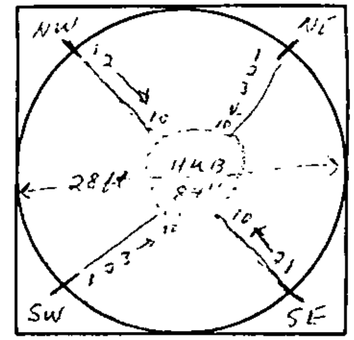
Riser # 1 – 10565
2 – 11161
3 – 11050
4 – 11496
5 – 11232
6 – 11349
7 – 10961

* CALCULATED VALUE DECREASED BY DISTANCE FROM END OF PITOT TUBE TO CENTER LINE OF IMPACT HOLE.

Total Tower Flow = 77814 gpm

FIELD DATA

RUN NO.	# 1	PROBE NO.	Air Pitot - Drift	NOZZLE DIA.	.5021
PROJECT NO.		PROBE LENGTH AND TYPE	14'	ASSUMED MOISTURE %	Sat
PLANT		SAMPLE BOX NO.	Drift	METER ΔH @	.293
DATE		METER BOX NO.	Drift	METER CORRECTION	.9857
SAMPLING LOCATION		TEMP. CONTROLLER NO.	Drift	PITOT NO.	Air Pitot
SAMPLE TYPE	Drift	TEMP. METER NO.	Drift	PITOT COEFFICIENT	.84
OPERATOR	Stich	THERMOCOUPLE I.D. NO.	#1	BAROMETRIC PRESSURE	29.95
FILTER NO.	NA	UMBILICAL CORD I.D. NO.	—	SITE TO BARO. ELEVATION (ft.)	-0-
RECORD DATA EVERY	VAR MIN.	UMBILICAL CORD I.D. NO.	—	CORRECTED B.P. (0.1 in./100 ft.)	29.95
UMBILICAL/SAMPLER HOOKUP	Drift	NOZZLE NO.	8-1	STATIC PRESSURE	-.15



SCHEMATIC OF TRAVERSE POINT LAYOUT

PITOT LEAK CHECK ≥3" H_2O

	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)	11:00					
PASS/FAIL						

PITOT LEAK CHECK ≥3" H_2O

	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)						
PASS/FAIL						

SAMPLE TRAIN LEAK CHECKS

	INITIAL	FINAL	INITIAL	FINAL	INITIAL
TIME (24 hr)	11:00				
VACUUM, In. Hg	≥15"		≥15"		≥15"
CFM	.018				
VOLUMES					
FINAL					
INITIAL					
DIFFERENCE					

SAMPLE TRAIN LEAK CHECKS

	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)					
VACUUM, In. Hg		≥15"		≥15"	
CFM					
VOLUMES					
FINAL					
INITIAL					
DIFFERENCE					

INITIAL VOLUME 190.00

FINAL VOLUME

LEAK CHECK VOLUME

ADJUSTED FINAL VOLUME

COMMENTS

Revision 11/18/86

RUN NO. #1

DATE

SAMPLING LOCATION

PROJECT NO.

p. 1 of 2

OPERATOR Slick / Cummins

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr.) SUM	GAS METER READING (V_m), ft³ INITIAL 190.00 DESIRED	ACTUAL	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ACTUAL	STACK TEMP. (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VAC., in. Hg	IMPINGER TEMP., °F	SAMPLE BOX TEMP., °F	PROBE TEMP., °F	FILTER TEMP., °F	ANGLE	
NE-1	11:45 START	254	193.81	193.84	.04	.40	.40	91	80	80	3	NA	NA	NA	NA	45	
NE 2		485	197.67	197.77	.05	.50	.50	93	79	79	3	—	—	—	—	50	
NE 3		823	204.83	204.94	.08	.82	.82	92	80	80	4	—	—	—	—	20	
NE 4		1161	214.29	214.38	.14	1.4	1.4	95	80	80	5	—	—	—	—	20	
NE 5		1508	224.97	224.86	.17	1.7	1.7	94	79	79	6	—	—	—	—	15	
NE 6		1848	238.40	238.21	.28	2.8	2.8	94	79	79	10	—	—	—	—	[illegible]	19
NE 7		2206	253.05	252.84	.30	3.0	3.0	94	80	79	10	—	—	—	—	5	
NE 8		2544	268.23	268.08	.36	3.7	3.7	94	82	79	12	—	—	—	—	20	
NE 9	STOP	2882	282.80	282.71	.33	3.4	3.4	92	82	79	11	—	—	—	—	20	
NE 10	13:08	3176	293.80	293.70	.25	2.5	2.5	93	81	79	8	—	—	—	—	35	
	CHANGE		of	PORTS													
NW-1	13:15	3487	305.09	305.19	.24	2.4	2.4	95	75	76	8	NA	NA	NA	NA	30	
NW-2		3813	318.35	318.40	.30	3.0	3.0	95	77	76	10	—	—	—	—	25	
NW-3		4137	331.41	331.36	.29	2.9	2.9	94	78	76	10	—	—	—	—	25	
NW-4		4450	344.54	344.16	.32	3.2	3.2	94	80	78	10	—	—	—	—	30	
NW-5		4776	358.97	358.47	.35	3.5	3.5	94	81	79	11	—	—	—	—	25	
NW-6		5102	372.75	372.24	.32	3.2	3.2	95	81	79	11	—	—	—	—	25	
NW-7		5428	386.37	386.15	.31	3.2	3.2	94	83	81	11	—	—	—	—	25	
NW-8		5739	398.07	398.13	.25	2.5	2.5	94	84	82	10	—	—	—	—	30	
NW-9	STOP	6056	410.44	410.52	.28	2.9	2.9	94	83	82	10	—	—	—	—	30	
NW-10	14:30	6344	421.26	421.08	.24	2.4	2.4	94	82	83	9	—	—	—	—	35	
			CHANGE	PORTS													
			Continued	Sheet #2													

COMMENTS

Revision 9-4-86

RUN NO. 1 FAN #1 SAMPLING LOCATION ______ p. 2 of 2

DATE ______ PROJECT NO. ______ OPERATOR Stick / Cummins

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr.)	GAS METER READING (V_m), ft³ INITIAL - NA - DESIRED	ACTUAL	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ACTUAL	STACK TEMP. (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VAC., in. Hg	IMPINGER TEMP., °F	SAMPLE BOX TEMP., °F	PROBE TEMP., °F	FILTER TEMP., °F	ANGLE	
	SUM																
SW-1	6691	Start 14:43	423.88	423.72	.01	.10	.10	82	79	80	1	NA	NA	NA	NA	15	
SW-2	7017		426.34	426.37	.01	.10	.10	85	80	80	1	—	—	—	—	25	
SW-3	7371		430.09	429.85	.02	.20	.20	91	80	79	1	—	—	—	—	10	
SW-4	7709		435.75	435.80	.05	.50	.50	91	80	79	2	—	—	—	—	20	
SW-5	8063		442.23	442.21	.06	.60	.60	94	80	79	3	—	—	—	—	10	
SW-6	8417		449.72	449.73	.08	.80	.80	95	81	79	4	—	—	—	—	10	
SW-7	8728		457.76	468.98	.12	1.2	1.2	96	81	79	5	—	—	—	—	30	
SW-8	9082		468.98	469.10	.18	1.8	1.8	95	81	79	7	—	—	—	—	10	
SW-9	9436	Stop	481.13	481.30	.21	2.1	2.1	94	82	79	8	—	—	—	—	10	
SW-10	7794	16:00	492.50	492.59	.18	1.8	1.8	94	82	79	6	—	—	—	—	5	
			PORT	CHANGE													
		Start															
SE-1	10132	16:11	503.73	503.96	.20	2.0	2.0	95	77	77	8	NA	NA	NA	NA	20	
SE-2	10486		516.60	516.84	.24	2.4	2.4	97	77	77	8	—	—	—	—	10	
SE-3	10840		530.26	530.35	.27	2.7	2.7	96	77	77	10	—	—	—	—	10	
SE-4	11194		543.87	543.86	.27	2.7	2.7	96	76	75	10	—	—	—	—	10	
SE-5	11552		559.57	559.35	.35	3.5	3.5	96	77	75	12	—	—	—	—	5	
SE-6	11910		575.49	575.22	.36	3.6	3.6	96	77	75	14	—	—	—	—	5	
SE-7	12268		590.25	590.13	.31	3.1	3.1	96	76	75	12	—	—	—	—	5	
SE-8	12622		606.39	606.18	.38	3.8	3.8	95	75	74	13	—	—	—	—	10	
SE-9	12948		619.83	619.49	.31	3.1	3.1	94	75	74	11	—	—	—	—	25	
SE-10	13306	Stop	632.26	632.39	.22	2.2	2.2	94	75	74	8	—	—	—	—	[illegible]	5
	Sample Time		221.77	min													

COMMENTS Wind was from the Southwest - Gusting at FAN STACK 10-12 MPH

Revision 9-4-86

MIDWEST RESEARCH INSTITUTE

Drift Sample Recovery

File ______ Date 9-15-88

Run #1

	1st Impinger Probe Rinse	2nd Impinger	3rd Impinger
Final Volume (includes rinses)	430	235	55
Rinse Volume	180	40	25
Initial Volume	150	100	—
Net Volume	100	95	30

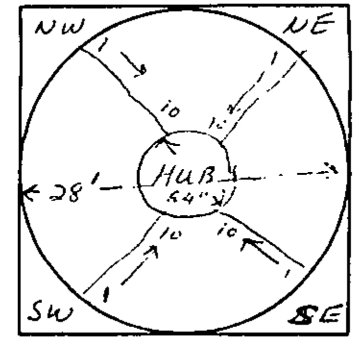
No. of Bottles	Description
1	Basin Composite (No. of Comps. 3)
1	Probe Rinse & 1st Impinger (Vol.= 430 ml)
1	2nd & 3rd Impinger (Sample Vol. = 290 ml)
1	Filter
1	Water Blank use for Both Runs
1	Filter Blank use for Both Runs

FIELD DATA

RUN NO. #2
PROJECT NO. ___
PLANT ___
DATE ___
SAMPLING LOCATION Fan Stack #5
SAMPLE TYPE Drift
OPERATOR Strck
FILTER NO. NA
RECORD DATA EVERY 6 MIN.
UMBILICAL/SAMPLER HOOKUP Drift

PROBE NO. Drift
PROBE LENGTH AND TYPE 12' teflon
SAMPLE BOX NO. Drift
METER BOX NO. Drift
TEMP. CONTROLLER NO. Drift
TEMP. METER NO. Drift
THERMOCOUPLE I.D. NO. Drift
UMBILICAL CORD I.D. NO. NA
UMBILICAL CORD I.D. NO. NA
NOZZLE NO. 8-1

NOZZLE DIA. .0521
ASSUMED MOISTURE % Sat
METER ΔH@ .293
METER CORRECTION .9857
PITOT NO. Air Pitot
PITOT COEFFICIENT .84
BAROMETRIC PRESSURE 29.85
SITE TO BARO. ELEVATION (ft.) -0-
CORRECTED B.P. (0.1 in./100 ft.) 29.85
STATIC PRESSURE -.15



SCHEMATIC OF TRAVERSE POINT LAYOUT

Fan #5

PITOT LEAK CHECK $\geq 3'' H_2O$

	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)	8:45					
PASS/FAIL						

PITOT LEAK CHECK $\geq 3'' H_2O$

	INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)						
PASS/FAIL						

SAMPLE TRAIN LEAK CHECKS

	INITIAL	FINAL	INITIAL	FINAL	INITIAL
TIME (24 hr)	8:45				
VACUUM, In. Hg	≥15"		≥15"		≥15"
CFM	.017				
VOLUMES					
FINAL					
INITIAL					
DIFFERENCE					

SAMPLE TRAIN LEAK CHECKS

	FINAL	INITIAL	FINAL	INITIAL	FINAL
TIME (24 hr)					
VACUUM, In. Hg		≥15"		≥15"	
CFM					
VOLUMES					
FINAL					
INITIAL					
DIFFERENCE					

INITIAL VOLUME 635.00
FINAL VOLUME ___
LEAK CHECK VOLUME ___
ADJUSTED FINAL VOLUME ___

COMMENTS

Revision 11/18/86

RUN NO. # 2 SAMPLING LOCATION — FAN #5 p. 1 of 2

DATE PROJECT NO. OPERATOR Stack / Cum

TRAVERSE POINT NUMBER	SAMPLING TIME, min (SUM SECONDS)	CLOCK TIME (24-hr.)	GAS METER READING (V_m), ft³ INITIAL 635.00 DESIRED	ACTUAL	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ACTUAL	STACK TEMP. (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VAC., in. Hg	IMPINGER TEMP., °F	SAMPLE BOX TEMP., °F	PROBE TEMP., °F	FILTER TEMP., °F	ANGLE	
NE-1	294	start 10:21	642.94	642.65	.13	1.3	1.3	81	70	70	5	NA	NA	NA	NA	35	
NE-2	569		649.13	649.04	.09	.9	.9	81	70	70	5	—	—	—	—	40	
NE-3	916		658.51	658.48	.13	1.3	1.3	80	70	70	5	—	—	—	—	15	
NE-4	1263		670.45	670.31	.21	2.2	2.2	80	71	70	8	—	—	—	—	15	
NE-5	1623		679.44	679.30	.11	1.1	1.1	81	74	71	5	—	—	—	—	0	
NE-6	1977		692.49	692.52	.24	2.4	2.4	80	73	71	9	—	—	—	—	10	
NE-7	2335		706.80	706.59	.28	2.7	2.7	80	75	72	10	—	—	—	—	5	
NE-8	2689		721.94	721.45	.32	3.3	3.3	80	76	73	11	—	—	—	—	10	
NE-9	3027	stop	734.75	734.23	.25	2.6	2.6	80	77	74	9	—	—	—	—	20	
NE-10	3374	11:36	746.51	746.28	.20	2.1	2.1	80	77	74	8	—	—	—	—	15	
	PORT		CHANGE														
NW-1	3734*	11:45	754.21	754.31	.08	.8	.8	84	76	76	4	NA	NA	NA	NA	0	
NW-2	4092**	13:30	767.94	767.71	.26	2.7	2.7	96	79	80	9	—	—	—	—	5	
NW-3	4450		781.46	781.24	.25	2.6	2.6	95	81	81	9	—	—	—	—	5	
NW-4	4808		793.87	793.71	.21	2.2	2.2	94	82	81	8	—	—	—	—	5	
NW-5	5166		808.44	808.32	.29	3.0	3.0	94	81	81	10	—	—	—	—	5	
NW-6	5524		822.24	822.14	.26	2.7	2.7	94	81	81	9	—	—	—	—	5	
NW-7	5878		837.64	837.59	.33	3.4	3.4	92	81	81	11	—	—	—	—	10	
NW-8	6232		852.57	852.53	.31	3.2	3.2	92	81	81	11	—	—	—	—	10	
NW-9	6586	stop	866.78	866.83	.28	2.9	2.9	91	82	81	10	—	—	—	—	10	
NW-10	6940	14:38	879.05	879.25	.21	2.2	2.2	92	81	80	8	—	—	—	—	10	
			PORT	CHANGE													
			Continue	Next	Sheet												

COMMENTS * Had to stop testing at this point Plant Requested we leave Fan stack Deck

** Restarted Sampling After All Clear.

Revision 9-4-86

RUN NO. 2 SAMPLING LOCATION ____ EAST p. 2 of 2

DATE ____ PROJECT NO. ____ OPERATOR Stich / Cummins

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr.)	GAS METER READING (V_m), ft³ DESIRED	GAS METER READING ACTUAL	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMP. (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VAC., in. Hg	IMPINGER TEMP., °F	SAMPLE BOX TEMP., °F	PROBE TEMP., °F	FILTER TEMP., °F	ANGLE
SW-1	7274	Start 14:53	881.74	881.56	.01	.10	.10	86	79	79	2	NA	NA	NA	NA	10
SW-2	7654		884.46	884.52	.01	.10	.10	91	80	80	2	—	—	—	—	0
SW-3	7965		888.55	888.51	.03	.30	.30	90	82	80	2	—	—	—	—	30
SW-4	8291		892.04	891.94	.02	.20	.20	91	82	81	2	—	—	—	—	25
SW-5	8629		897.77	897.55	.05	.50	.50	94	83	81	3	—	—	—	—	20
SW-6	8983		906.27	906.24	.10	1.0	1.0	90	83	81	5	—	—	—	—	10
SW-7	9337		915.17	915.28	.11	1.1	1.1	94	84	81	5	—	—	—	—	10
SW-8	9695		928.74	928.74	.25	2.6	2.6	94	84	81	8	—	—	—	—	5
SW-9	10042	Stop	937.24	939.10	.16	1.6	1.6	94	83	80	6	—	—	—	—	15
SW-10	10368	16:09	949.37	949.15	.17	1.7	1.7	95	81	79	7	—	—	—	—	25
			PORT	CHANGE												
SE-1	10679	Start 16:19	959.27	959.12	.18	1.8	1.8	96	78	77	7	NA	NA	NA	NA	30
SE-2	11017		971.15	971.08	.21	2.2	2.2	97	78	78	8	—	-	-	-	20
SE-3	11364		985.17	985.09	.29	3.0	3.0	97	79	78	10	—	-	—	-	15
SE-4	11718		1001.14	1001.01	.36	3.7	3.7	96	80	78	12	—	-	-	-	10
SE-5	12065		1016.38	1016.10	.34	3.5	3.5	95	81	78	12	—	-	-	-	15
SE-6	12412		1031.82	1031.50	.35	3.6	3.6	96	81	78	12	-	—	—	-	15
SE-7	12759		1047.06	1046.81	.34	3.5	3.5	96	81	79	12	-	—	—	-	15
SE-8	13106		1062.09	1061.88	.33	3.4	3.4	94	81	78	12	-	—	—	-	15
SE-9	13453	Stop	1076.11	1076.01	.29	3.0	3.0	94	78	76	12	-	—	—	—	15
SE-10	13779		1086.16	1086.13	.17	1.7	1.7	95	77	75	7	—	—	—	-	25

COMMENTS

Total Sample Time 229.65

Revision 9-4-85

MIDWEST RESEARCH INSTITUTE

Drift Sample Recovery

File Run # 2

Date 9-16-88

	1st Impinger Probe Rinse	2nd Impinger	3rd Impinger
Final Volume (includes rinses)	450	230	60
Rinse Volume	170	20	10
Initial Volume	150	100	—
Net Volume	130	110	50

No. of Bottles	Description
1	Basin Composite (No. of Comps. 3)
1	Probe Rinse & 1st Impinger (Vol.= 450 ml)
1	2nd & 3rd Impinger (Sample Vol. = 290 ml)
1	Filter
—	Water Blank use Sample from Run # 1
—	Filter Blank use Sample from Run # 1

APPENDIX C

LABORATORY ANALYSIS

DRIFT TEST
ON THE

7-CELL, MECHANICAL-DRAFT, COUNTER-FLOW
COOLING TOWER

INTEROFFICE COMMUNICATION

MIDWEST RESEARCH INSTITUTE

To: T. Weast

From: E. McClendon *EM*

Subject: ICAP Analysis Results for Project

Enclosed are the results of the ICAP analysis performed for drift samples.

I. Introduction and Request for Analysis

These samples were submitted for Project The analytes of interest were Ca, Cr, Mg and Na. Analyses were performed on the Jarrell-Ash Model 1155A ICP-AES and the Perkin-Elmer Model 5000 Zeeman AAS.

II. Submission of Samples for Analysis and Sample Preparation

Eight samples (Impinger contents for run 1 in two containers, a filter for run 1, basin water from run 1, impinger contents for run 2 in two containers, a filter for run 2, basin water from run 2, a blank filter and a conatiner with "blank" water) were received in the Atomic Spectroscopy Facility from D. Cobb. The samples were prepared according to the atomic absorption section of EPA SW-846 Method 3050. Aliquots of the combined impinger contents, basin water and "blank" water were used, while the filters were placed in beakers and digested according to the procedure.

The impinger contents and basin waters were also analyzed without digestion by diluting them with concentrated HNO_3 to make them 10% (v/v) acid and analyzing or diluting them with 10 % HNO_3 if the dilution was sufficient to insure an acid content of 10%.

III. Standard Preparation

Standards for this analysis were prepared at appropriate concentrations from Spex Industries Multielement Custom Plasma Standard Analytical Reference Materials. The standards were prepared in 10% (v/v) nitric acid (Baker Instra-analyzed Lot B04058) and the upper instrumental calibration limits for ICP were 10 mcg/mL for Ca and Cr, 5 mcg/mL for Mg and 150 mcg/mL for Na. The upper calibration limit for the GFAA analysis for Cr was 25 mcg/L. A calibration blank consisting of the stock 10% nitric acid was used in both analyses.

An instrumental check standard was prepared at a 1 mcg/mL level for ICP analysis and at a 100 mcg/L level for GFAA analysis from custom prepared multielement standards from Inorganic Ventures, Inc..

IV. Instrumental Analysis

The samples were analyzed initially on the Jarrell-Ash Model 1155A ICP-AES. The instrumental parameters are recorded on the appropriate sheet in the data packet and the instrument was profiled and standardized according to the manufacturer's instructions.

Subsequent analysis for Cr by GFAA was performed on the Perkin-Elmer Model 5000 Zeeman atomic absorption spectrometer. Instrumental and furnace parameters are recorded on the appropriate sheet in the data packet.

V. Sample Analysis Results and Discussion

The samples were analyzed by EPA SW-846 Methods 6010 and 7191. The tables listed below contain the analytical data for this study.

Table No.	Description
1	Summary of Sample Analysis Results
2	Sample Weighing Data
3	ICAP Sample Raw and Calculated Data
4	Instrumental Check Standard, Duplicate and Spike Data
5	Cr GFAA Sample Raw and Calculated Data

Table 1 contains the analytical results of the analysis. Table 2 contains the sample weighing data generated during the digestion of the samples. Table 3 contains the ICAP sample raw data along with the blank corrected calculated sample data and table 4 instrumental check standard data, the resulting percent instrumental drift and duplicate determination and spike recovery data. Table 5 contains the data generated during the graphite furnace analysis for Cr.

The cell formulas used in these tables are included for completeness.

VI. Internal Quality Control

The detection limit for the ICP analysis was determined by direct output from the Jarrell-Ash Model 1155A ICP-AES. This detection limit was determined from the calibration blank data generated throughout the sample run and is defined as two times the largest standard deviation of the calibration blank data. The detection limit for the GFAA analyses was determined from multiple analyses of a low level standard and is defined as three times the standard deviation of these multiple analyses divided by the slope of the calibration curve.

Analytical quality check samples were prepared from Custom Multielement Plasma Standard Analytical Reference Materials manufactured by Inorganic Ventures, Inc.. The concentration (mcg/mL) found for this solution did not deviate from the stated value by more than 5 percent.

Midpoint instrumental check standards were analyzed throughout the sample analysis run. The percent drift calculated from the instrumental check determinations is appended in the

Instrumental Check Standard, Duplicate and Spike Data Table (Table 4). Instrument drift for all analyses was less than 7 percent, indicating that the instruments were fairly stable throughout the entire sample analyses.

No interference check standard was prepared as the analysis was for what could be considered major components. The duplicate determinations showed percent differences of less than 7 percent. Spike recoveries ranged from 95.2 to 113 percent.

VII. Additional Information

The following raw data accompanies this report. This information is coded by and also contains a part number identifier.

Part Number	Description
1	ICP-AES Data Reporting Sheet
2	Control Table Editor Output
3	DEC Command Files Used
4	ICAP Sample Raw Data
5	Atomic Absorption Data Reporting Sheet
6	Atomic Absorption Worksheet
7	Data Station 10 Output
8	Sample Weighing Sheet - Initial Weights
9	Sample Weighing Sheet - Final Weights
10	Photocopy of MRI Laboratory Generated Sample Inventory
11	Photocopies of Notebook

With the exception of part number 11, the photocopies of the notebook , this file contains the only record of the analysis. This file should therefore be archived as required by the project or as required by MRI policy.

This data has undergone one level of senior review within the Analytical Chemistry Section. The MRI Quality Assurance Unit has not reviewed this data.

Approved,

John Stanley, Head
Analytical Chemistry Section

Table 1. Summary of Sample Analysis Results for Project

Project:
Lotus File:
Jarrell-Ash Data File:
Analyst: M. Greene
Analysis Date:
Data Analyst: E. McClendon
Date:
Sample Matrix: 10% HNO_3
Analytes: Ca, Cr, Mg, Na, Zn

Summary of Sample Analysis Results:

Verified by: E. McClendon

Project Sample Name	ASF Sample Bar Code(s)	Sample Units	Element Ca	Element Cr	Element Mg	Element Na
Digested Samples						
Water Blank	06402	mcg/g	<0.0163	0.00356	<0.00093	<0.0425
Filter Blank	06408	mcg	2.81	0.438	0.303	<2.12
Basin H2O #1	06403/06404	mcg/g	171	8.37	77.4	290
Impingers #1	06406	mcg/g	1.61	0.0169	0.396	2.07
Filter #1	06407	mcg	24.3	0.517	8.78	38.2
Basin H2O #2	06409	mcg/g	179	8.78	80.9	298
Impingers #2	06410	mcg/g	0.844	0.0183	0.283	1.17
Filter #2	06411	mcg	15.6	0.513	1.68	<2.12
Acidified Samples						
Basin H2O #1		mcg/mL	170	8.27	76.8	287
Impingers #1		mcg/mL	1.66	0.0236	0.400	2.35
Basin H2O #2		mcg/mL	176	8.61	79.5	293
Impingers #2		mcg/mL	0.869	0.0230	0.283	1.45

Comments:
The samples were analyzed on a Jarrell-Ash Model 1155A ICP-AES.
The final sample concentrations are as received in the units listed.

Table 2. Sample Weighing Data.

Project:
Lotus File:
Data Analyst: E. McClendon
Date:

Sample Weighing Data:

Verified by: M Cereone

ASF Bar Code	Beaker Wt. (g)	Sample Wt. (g)	Final Wt. (g)	Net Sx Wt. (g)
06401	66.9984		116.0523	49.0539
06402	66.1604	50.3997	116.1306	49.9702
06403	63.5522	50.0650	113.7595	50.2073
06404	67.4168	50.7372	117.0385	49.6217
06405	68.2621	50.8770	118.0460	49.7839
06406	65.0587	50.6041	115.1490	50.0903
06407	64.3116		114.5732	50.2616
06408	62.8706		112.3271	49.4565
06409	64.3986	51.0101	114.0708	49.6722
06410	68.6110	49.6403	118.0961	49.4851
06411	54.6608		104.1387	49.4779

Table 3. ICAP Sample Raw and Calculated Data.

Project:
Lotus File:
Jarrell-Ash Data File:
Analyst: M. Greene
Analysis Date:
Data Analyst: E. McClendon
Date:
Sample Matrix: 10% HNO3
Analytes: Ca, Cr, Mg, Na, Zn

ICAP Sample Raw and Calculated Data:

Verified by: Ed McClendon

ASF Bar Code	Sample Units	Dilution Factor	Element Ca	Element Cr	Element Mg	Element Na
					Raw Data	
06401	mcg/mL	1	0.03024	0.01358	0.00775	0.25158
06402	mcg/mL	1	0.02596	0.01834	0.00455	0.11472
06403	mcg/mL	20	8.7387	0.43208	3.941	14.768
06404	mcg/mL	20	8.5092	0.41349	3.8734	14.575
06405	mcg/mL	40	6.5001	0.35586	3.8907	12.637
06406	mcg/mL	1	1.6533	0.04156	0.40759	2.3417
06407	mcg/mL	1	0.51224	-0.00859	0.18225	1.005
06408	mcg/mL	1	0.08684	-0.00859	0.01382	0.15139
06409	mcg/mL	20	9.1837	0.45077	4.1538	15.295
06410	mcg/mL	1	0.87707	0.03507	0.2917	1.4269
06411	mcg/mL	1	0.34488	-0.00859	0.04171	0.23297
Basin 1	mcg/mL	20	8.4718	0.41043	3.8208	14.293
Basin 1 dup	mcg/mL	20	8.5431	0.41617	3.8545	14.359
Basin 2	mcg/mL	20	8.7884	0.43056	3.9747	14.645
Impingers 1	mcg/mL	1.11	1.4905	0.02124	0.35978	2.1139
Impingers 2	mcg/mL	1.11	0.78206	0.02069	0.2544	1.3067
Detection Limit			0.01646	0.00859	0.00094	0.04289
				Calculated Data		
06401	mcg		1.483389	0.666151	0.380167	12.34098
06402	mcg/g		-0.01631	-0.00851	-0.00093	-0.04252
06403	mcg/g		175.2411	8.663354	79.03643	295.9530
06404	mcg/g		166.4131	8.085211	75.75730	284.8478
06405	mcg/g		254.3886	13.92580	152.2768	494.3771
06406	mcg/g		1.607199	0.038360	0.395939	2.074050
06407	mcg		24.26261	-0.43174	8.780008	38.17192
06408	mcg		2.811412	-0.42483	0.303321	-2.12118
06409	mcg/g		178.8274	8.776187	80.88961	297.6348
06410	mcg/g		0.844445	0.032129	0.283129	1.173830
06411	mcg		15.58054	-0.42501	1.683555	-2.12210
Basin 1	mcg/mL		169.436	8.2086	76.416	285.86
Basin 1 dup	mcg/mL		170.862	8.3234	77.09	287.18
Basin 2	mcg/mL		175.768	8.6112	79.494	292.9
Impingers 1	mcg/mL		1.656111	0.0236	0.399755	2.348777

Table 4. Instrument Check Standard, Duplicate and Spike Data.

Project:
Lotus File:
Jarrell-Ash Data File:
Analyst: M. Greene
Analysis Date:
Data Analyst: E. McClendon
Date:
Sample Matrix: 10% HNO_3
Analytes: Ca, Cr, Mg, Na, Zn

ICS, Duplicate and Spike Data:

Verified by: E. McClendon

	Sample Units	Element Ca	Element Cr	Element Mg	Element Na
Instrument Check Standard Data:					
Initial ICS		4.8552	4.9551	2.4412	74.2460
ICS1		4.7715	4.9484	2.3972	72.35
% Drift 1		1.72	0.14	1.80	2.55
ICS2		4.7853	4.9807	2.4109	72.419
% Drift 2		1.44	0.52	1.24	2.46
ICS3		4.7792	4.9595	2.4043	72.678
% Drift 3		1.57	0.09	1.51	2.11
Duplicate and Spike Calculations:					
06403	mcg/g	175.2411	8.663354	79.03643	295.9530
06404	mcg/g	166.4131	8.085211	75.75730	284.8478
% Difference		5.17	6.90	4.24	3.82
06405	mcg/g	254.3886	13.92580	152.2768	494.3771
Spike Level		78.62098	4.913811	78.62098	196.5524
% Recovery		106	113	95.2	104
Basin 1	mcg/mL	169.436	8.2086	76.416	285.86
Basin 1 dup	mcg/mL	170.862	8.3234	77.09	287.18
% Difference		0.84	1.39	0.88	0.46

Comments:
The samples were analyzed on a Jarrell-Ash Model 1155A ICP-AES.
The final sample concentrations are as received in the units listed.
* Spike level too low.

Table 5. Cr GFAA Analysis Raw and Calculated Data

Project:
Lotus File:
Jarrell-Ash Data File:
Analyst: M. Greene
Analysis Date:
Data Analyst: E. McClendon
Date:
Sample Matrix: 10% HNO3
Analyte: Cr

Sample Analysis Data:

Instrumental Detection Limit: (ug/L, see below)

Verified by: E McClendon

Standard	Absorbance
0 ug/L	0.003
0.25 ug/L	0.004
0.5 ug/L	0.007
1 ug/L	0.016
2.5 ug/L	0.042
5 ug/L	0.079
10 ug/L	0.168
25 ug/L	0.395

Regression Output:

Constant	0.0015987
Std Err of Y Est	0.0038172
R Squared	0.9993215
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	0.0158466
Std Err of Coef.	0.0001686
Correlation Coefficient	0.9996607

	Absorbance	Dilution Factor	Result (ug/L)	Result*DF (ug/L)	Sample Result	Sample Units
NBS 1643b	0.336	1	21.10245	21.10245		
10 mcg/L MRI5	0.163	1	10.18525	10.18525		
Sample ASF Bar Code						
06401	0.047	1	2.865055	2.865055	0.1405421	mcg
06402	0.103	1	6.398946	6.398946	0.0035558	mcg/g
06406	0.316	1	19.84035	19.84035	0.0168616	mcg/g
06407	0.209	1	13.08809	13.08809	0.5172865	mcg
06408	0.187	1	11.69978	11.69978	0.4380881	mcg
06410	0.338	1	21.22866	21.22866	0.0183310	mcg/g
06411	0.211	1	13.21430	13.21430	0.5132740	mcg

Detection Limit Determination:

0.25 ug/L	0.009	
0.25 ug/L	0.005	Detection Limit (ug/L):
0.25 ug/L	0.004	3*Standard Deviation/Slope of Curve =
0.25 ug/L	0.006	0.3257108 ug/L
0.25 ug/L	0.005	

Drift Determination (10 ug/L standard):

		% Drift
Initial ICS	0.168	
ICS1	0.161	4.17
ICS1	0.163	2.98
ICS1	0.157	6.55

Comments:

These samples were analyzed on a Perkin-Elmer Zeeman 5000 with a Cr hollow cathode lamp.

A negative number indicates that the sample was less than the detection limit

Impingers 2	mcg/mL	0.868955	0.022988	0.282666	1.451888

Comments:

The samples were analyzed on a Jarrell-Ash Model 1155A ICP-AES.

The calculated data is blank corrected.

A negative number indicates that the result is less than the detection limi