AP42 Section:	13.4
Background Chapter	4
Reference:	2a
Title:	Mass Emission Measurements Performed on Kerr McGee Chemic31 Corporations Westend Facility. Kerr McGee Chemical Corporation, Trona, California, December 8, l989. Environmental Systems Corporation (l989).

2a

TIN NO. 89-1183
Issue Date: 10/31/89
Revision 1
Rev. Date: 12/8/89

I. MASS EMISSION MEASUREMENTS PERFORMED ON KERR McGEE CHEMICAL CORPORATIONS WESTEND FACILITY
COOLING TOWER SULFATE 2 (Permit No. B 001923)
COOLING TOWER SULFATE 4 (Permit No. B 001925)
SEPTEMBER 12-14, 1989

Prepared For:

Kerr McGee Chemical Corporation
13200 Main Street
P.O. Box 367
Trona, CA 93562

Prepared By:

Environmental Systems Corporation
200 Tech Center Drive
Knoxville, Tennessee 37912

Reviewed By: Larry W. Smith/KDH Date: 12/8/89

Approved By: Date: 12/8/89

II. CERTIFICATION

Emissions tests were performed by Environmental Systems Corporation (ESC) on selected cells of the Kerr McGee Chemical Corporation Sulfate #2 and #4 cooling towers. Drift testing and particulate emissions tests were conducted consistent with previous testing campaigns (1986 and 1987) by ESC and in general accordance with the test characteristics outlined in the letter from Zenis Walley (Kerr McGee) to Dr. William Kuby (San Bernardino APCD) dated August 30, 1989.

Test team leaders included Mike Mowery of IT Corporation, and Larry Smith of ESC. The supervising manager of the tests is Karl Wilber, Senior Vice President, ESC. Mr. Wilber has been with ESC since 1973 and has been involved with over 50 cooling tower emissions and performance assessments. He has reviewed the test data and procedures contained herein and is familiar with ESC's previous cooling tower emissions testing at the Kerr McGee facility.

Prepared by: Larry Smith and Mike Mowery

Reviewed by: Karl R. Wilber, Senior Vice President

Signature

III. TABLE OF CONTENTS

IV. INTRODUCTION

A.1 General

In the operation of an evaporative cooling tower, circulating water is mechanically broken up, via the fill and water distribution system, to enhance air/water interface and resultant heat transfer. In this process, airflow through the cooling equipment carries smaller droplets with it, presenting the droplets to drift eliminators, which inertially separate a portion of the droplet population from the air stream. That portion which is not collected or is re-entrained in the air is referred to as drift (or carryover) and is exhausted via the cooling fan into the environment. The droplets initially have the same mineral content as the cooling water, but evaporation can result in the droplets becoming more concentrated than the cooling water. Under dry ambient conditions and low water loadings evaporated, dry particulate can be emitted.

A.2 Specific Reason for Test Program

Kerr McGee Chemical Corporation contracted the Cooling Tower Institute (CTI), under Authorization C-89-65, to conduct specific emission measurements on selected cells of Sulfate #2 and Sulfate #4 cooling towers at the Westend Facility in Trona, California. The test program conducted was part of a periodic permit requirement of the County of San Bernardino, Air Pollution Control District. Specific Permit Numbers are B 001923 (Sulfate #2) and B 001925 (Sulfate #4). These tests were performed by Environmental Systems Corporation (ESC) as the official CTI representative. Testing was performed on September 12-14, 1989.

Tower Descriptions and Test Parameters - Testing began on Sulfate #2 cooling tower. This is a two (2) cell, coil shed, counterflow mechanical draft tower. The cell tested was on the north end of the tower. The second tower tested was Sulfate #4. This is a two (2) cell crossflow mechanical draft tower. The south cell was tested on this tower. Tower inspection indicated that there was no particular bias relative to drift emissions in the choice of the test cells.

B.1/2 Test Parameters/Gas Flow Measurements

Test parameters as taken from field measurements are summarized below.

Kerr McGee Sulfate #2 and #4 Cooling Towers Test Results

Parameters	Sulfate #2 North Cell	Sulfate #4 South Cell
Test Date	9/12-13/89	9/13-14/89
Area of Tower (Sq. Ft.)	176.7	252.0
Distance to Atmosphere (Ft.)	0.0	0.0
Ambient Temperature (°F)	93.0	98.0
Barometric Pressure (in/Hg)	28.61	28.52
Static Pressure (in/H_2O)	0.0	0.0
Gas Flow Temperature (°F)	71.0	78.0
Gas Stream Velocity (Ft/Min)	1407.0	1339.0
Gas Stream Flow Rate (ACFM)	248617.0	337428.0

B.3 Pollutant Emission Rate Calculations

Results of Pollutant emissions rates are provided below:

	Sulfate #2	Sulfate #4
Particulate Emissions (lbs/hr)	0.243	0.291
Circulating Water Total Solids	54,650	35,360
Sodium Emissions	0.11	0.12
Drift Fraction (% of circulating water based on sodium analyses)	0.0004	0.0003
Sulfate Emissions (lbs/hr)	0.036	0.040

No particulate were measured on either tower which were greater than 10 μm aerodynamic diameter.

B.4 Production and Operations Information

Production and operations data are provided in the Appendix. Water flow rate on Sulfate #2 was directly measured by ESC via pitot traverse. Flow rate for the test cell was 2117 gpm. Flow rate for the Sulfate #4 tower was estimated at 3500 gpm based on operations records for the 2-cell tower (see signed log of Ralph Alvarado, Kerr McGee).

B.5 Testing Firm

Contractor:
Environmental Systems Corporation
200 Tech Center Drive
Knoxville, Tennessee 37912

(615) 688-7900

Subcontractor:
IT Corporation (Mike Mowery, Source Sampling Manager)
312 Directors Drive
Knoxville, Tennessee 37923

(615) 690-3211

B.6 Other Personnel

Kerr McGee Chemical:

Zenis Walley, Senior Regulatory Affairs, Engineer
Ed Ung, Westend Facility, Plant Engineer

Agency Observer, San Bernardino County:

Jim Lehman

B.7 Other Pertinent Information

Other operations, cooling tower design and test data are provided in the Appendix as well as Section VIII of the report.

V. SUMMARY OF RESULTS

A. Physical Measurements of Test Site

Pertinent physical measurements are summarized below for the Sulfate #2 and Sulfate #4 cooling towers.

	Sulfate #2	Sulfate #4
Fan Stack Diameter (Ft)	15	21
Water Flow Rate (gpm)	2157	3500 (est.)
Local Barometric Pressure (in/Hg)	28.61	28.52

B. Gas Flow Measurements

Velocity (ft/min)	1407	1339
Volumetric Flow (ACFM)	248617	337428
Gas Stream Pressure (in/Hg)	28.61	28.52
Gas Temperature (°F)	71.0	78.0

C. Gas Composition

Moisture (% by Volume)	1.9	2.7

D. Pollutant/Contaminant Emissions

1.	Sulfate Emissions (lbs/hr)	0.036	0.040
2.	Particulate Mass Rate (lbs/hr)*	0.243	0.291
3.	Sodium Emissions (lbs/hr)	0.11	0.12
4.	Drift Fraction (%)**	0.0004	0.0003
5.	Permit Drift Limit (%)	0.002	0.002
6.	Circulating Water TDS	54,650	55,360
7.	Standard Conditions	Pressure	29.92 in/Hg
		Density	0.075 lb/ft^3

*All particulate were PM-10. Note that this may vary with humidity, water loading or cooling tower heat load.

**Note that measured drift fractions for Sulfate #2 and Sulfate #4 towers were 0.017% and 0.0055% respectively, based on ESC's October 1986 testing.

VI. RESULTS DISCUSSIONS

A. Drift Emissions

Using chemical analyses and sampling volumes from the 4 HGBIK exposures, concentrations of exit air sulfate and sodium were calculated. Average procedural blank values for each were subtracted from total collected amounts in each case (See Tables 4.1 a & b, and 4.2 a & b).

Calculations of sodium and sulfate flux were made using average updraft air velocities for each cell. These are calculated using the product of average updraft air velocity and the exit air concentrations of sodium and sulfate. Drift fractions were calculated by ratioing the specific mineral emission rate by the circulating water system "rate" of that same mineral (i.e., water flow rates times elemental concentration). Note that IK backup filter and high volume sampling filter procedural blank levels were considered too high to yield reasonable net collected values. Drift fraction calculations are provided in Tables 4.2 c and d for Sulfate #2 and Sulfate #4 respectively.

Calculation of particulate mass emissions were based on circulating water total solids concentration divided by Na concentration and then multiplied by Na emissions (lbs/hr).

Table 4.1
KERR McGEE CHEMICAL CORPORATION WESTEND FACILITY
HGBIK - Velocity and Flow Data Sulfate #2 - North Cell

(See Table 4.1 a for Summaries Arranged by Diameter)

Diameter 1

Position	Time (Min)	Yaw Angle (Deg)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
1	5	20	1576.20	10.74	1481.14
2	5	20	1801.20	12.94	1692.57
3	5	15	2067.12	15.77	1996.68
4	5	20	2155.76	16.78	2025.75
5	5	45	1204.59	7.50	851.77
6	5	40	1378.46	8.95	1055.96
7	5	45	1668.24	11.62	1179.62
8	5	30	1883.02	13.79	1630.74
9	5	25	1842.43	13.36	1669.81
10	5	5	546.62	2.97	544.54
Average Velocity:			1612.36	11.44	1412.86

Diameter 2

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
11	5	20	1801.2	12.94	1692.57
12	5	20	1975.07	14.76	1855.96
13	5	20	2026.21	15.32	1904.01
14	5	35	2070.53	15.81	1696.08
15	5	50	1272.78	8.06	818.13
16	5	50	1112.54	6.77	715.13
17	5	15	2097.8	16.12	2026.32
18	5	0	1872.8	13.68	1872.80
19	5	0	1436.42	9.46	1436.42
20	5	0	464.8	2.51	464.80
Average Velocity:			1613.02	11.54	1448.22

Diameter 3

Position	Time (Min)	Yaw Angle (Deg)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
21	5	5	597.75	3.26	595.48
22	5	0	1705.74	11.98	1705.74
23	5	10	1903.48	14.00	1874.56
24	5	20	2029.62	15.36	1907.22
25			Negative	0.00	0.00
26	5	10	2053.48	15.62	2022.28
27	5	25	1998.94	15.02	1811.66
28	5	35	1804.61	12.97	1478.25
29	5	40	1058.00	6.35	810.48
30	5	40	526.16	2.85	403.06
Average Velocity:			1367.78	9.74	1260.87

Diameter 4

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
31	5	10	1661.43	11.55	1636.19
32	5	15	1981.89	14.84	1914.36
33	5	20	2012.57	15.17	1891.20
34	5	25	2183.03	17.09	1978.50
35	5	25	781.85	4.41	708.6
36	5	20	2125.08	16.43	1996.92
37	5	25	2067.12	15.77	1873.45
38	5	30	1780.75	12.73	1672.36
39	5	30	1133.00	6.93	981.21
40	5	40	539.80	2.93	413.51
Average Velocity:			1626.65	11.79	1506.73

Table 4.2
KERR McGEE CHEMICAL CORPORATION WESTEND FACILITY
HGBIK - Velocity and Flow Data Sulfate #4 - South Cell

(See Table 4.2 a for Summaries Arranged by Diameter)

Diameter 1

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
1	5	5	1634.15	11.29	1627.93
2	5	5	1923.93	14.22	1916.61
3	5	25	2036.44	15.43	1845.64
4	5	25	2101.21	16.16	1904.34
5	—	—	Negative	0.00	0.00
6	5	15	1153.45	7.09	1114.15
7	5	0	2043.26	15.51	2043.26
8	5	0	1859.16	13.54	1859.16
9	5	5	1381.87	8.98	1376.61
10	5	15	962.54	5.65	929.74
Average Velocity			1509.60	10.79	1461.74

Diameter 2

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
11	5	10	1675.06	11.68	1649.61
12	5	15	1865.98	13.61	1802.40
13	5	25	1985.30	14.88	1799.29
14	5	30	2159.17	16.81	1869.90
15	—	—	Negative	0.00	0.00
16	—	—	Negative	0.00	0.00
17	5	40	1872.80	13.68	1434.65
18	5	10	1883.02	13.79	1854.41
19	5	10	1790.97	12.84	1763.76
20	5	5	1463.69	9.71	1458.12
Average Velocity			1469.60	10.70	1363.21

Diameter 3

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
21	5	15	1156.86	7.12	1117.44
22	5	25	1784.16	12.77	1617.00
23	5	15	1940.98	14.40	1874.84
24	5	30	1702.34	11.95	1474.27
25	—	—	Negative	0.00	0.00
26	—	—	Negative	0.00	0.00
27	5	20	1835.29	13.29	1724.61
28	5	20	1852.34	13.47	1740.63
29	5	15	1627.33	11.22	1571.88
30	5	5	1884.14	13.80	1876.97
Average Velocity			1378.34	9.80	1299.76

Diameter 4

Position	Time (Min)	Yaw Angle (Degrees)	Velocity (FPM)	Flow Setting (CFM)	Vel Times COS (YAW) (FPM)
31	5	40	1184.14	7.33	907.10
32	5	25	1562.56	10.61	1416.16
33	5	30	1930.75	14.29	1672.08
34	5	40	1869.39	13.64	1432.04
35	5	50	1040.95	6.23	669.11
36	—	—	Negative	0.00	0.00
37	5	20	1661.43	11.55	1561.23
38	5	20	1773.93	12.66	1666.95
39	5	15	1934.16	14.33	1868.26
40	5	35	1371.64	8.89	1123.58
Average Velocity			1432.90	9.95	1231.65

TABLE 4.1 a SUMMARY OF TEST DATA
KERR McGEE CHEMICAL CORPORATION
WESTEND SULFATE #2 COOLING TOWER - NORTH CELL

Diameter	IK Tube ID	Fan Stack Velocities Flow (ft/min)	IK System Flow Rate (ft^3/min)
1	#140	1412.86	11.44
2	#171	1448.22	11.54
3	#150	1260.87	9.74
4	#9	1506.73	11.79
	Average	1407.17	11.13

****

TABLE 4.2 a SUMMARY OF TEST DATA
KERR McGEE CHEMICAL CORPORATION
WESTEND SULFATE #4 COOLING TOWER - SOUTH CELL

Diameter	IK Tube ID	Fan Stack Velocities Flow (ft/min)	IK System Flow Rate (ft^3/min)
1	#4859	1461.74	10.79
2	#6	1363.21	10.70
3	#105	1299.76	9.80
4	#14	1231.65	9.95
	Average	1339.09	10.31

B. PM-10 Emissions

PM-10 emissions measurements were made on both towers at a single point collection using an Anderson cascade impactor. Results for the single point tests indicated that all particulate on both towers were less than 10 microns.

Table 4.1b
Kerr McGee Chemical Trona, Calfornia
Sulfate #2 Cooling Tower

IK #	Points	IK Tube Chemical Analyses			
		Na (PPM)	Total (µg)	SO4 (PPM)	Total (µg)
140	1-10	44.9	2245	22.2	1110
171	11-20	42.5	2125	18.0	900
150	21-30	28.2	1410	10.2	510
9	31-40	36.5	1825	13.8	690
	Average (µg)		1901		801
	Procedural Blank (µg)		56		201
	Not Collected (µg)		1845		600

$$\text{Na Concentration} = \left(1845\ \mu g \times \frac{1\ lb}{454 g} \times \frac{1\ g}{10^{6} \mu g}\right) / \left(50\ min \times \frac{11.13\ ft^{3}}{min}\right) = 7.30 \times 10^{-9}\ \frac{lb\ Na}{ft^{3}}$$

$$SO_4\ \text{Concentration} = \left(\frac{600\ \mu g}{50\ min \times 11.13\ ft^{3}/min}\right) \times \frac{1\ lb}{454 g} \times \frac{1\ g}{10^{6} \mu g} = 2.37 \times 10^{-9}\ \frac{lb}{ft^{3}}\ SO_4$$

$$\text{Na Flux} = 7.30 \times 10^{-9}\ \frac{lb}{ft^{3}} \times \frac{1407\ ft}{min} \times \frac{60\ min}{hr} \times \frac{\pi(15\ ft^{2})}{4} = 0.11\ \frac{lbs\ Na}{hr}$$

$$SO_4\ \text{Flux} = 2.37 \times 10^{-9}\ \frac{lb}{ft^{3}} \times 1407\ \frac{ft}{min} \times \frac{60\ min}{hr} \times 176.6\ ft^{2} = \frac{0.035\ lbs\ SO_4}{hr}$$

$$\text{Drift Fraction} = \frac{0.11\ lbs\ Na/hr}{\left(2157\ \frac{gal}{min}\right) \times \left(\frac{8.33\ lbs}{gal}\right) \times \left(\frac{60\ min}{hr}\right) \times \left(\frac{24,764}{10^{6}}\right)\ ppm\ Na} = 0.0004\%$$

Table 4.2b
Kerr McGee Chemical Emissions Summary
Sulfate #4 Cooling Tower

IK #	Points	IK Tube Chemical Analysis Na (PPM)	Total (µg)	SO4 (PPM)	Total (µg)
4589	1-10	15.10	755	5.4	275
6	11-20	22.99	1145	10.5	525
105	21-30	18.1	905	11.4	570
14	31-40	26.6	1330	15.6	780
		Average (µg)	1034		538
		Procedural Blank (µg)	55.7		201
		Not Collected (µg)	978		337

Na Concentration $\left(978\ \mu g \times \frac{1\ lb}{454 g} \times \frac{1\ g}{10^6 \mu g}\right) / 50\ min \times 10.31\ \frac{ft^3}{min} = 4.179 \times 10^{-9}\ \frac{lb}{ft^3}$ Na

Na Flux $\left(4.179 \times 10^{-9}\ \frac{lb}{ft^3}\right) \times \left(1339\ \frac{ft}{min}\right) \times \frac{\pi(21\ ft)^2}{4} \times \frac{60\ min}{hr} = 0.116\ \frac{lb\ Na}{hr}$

SO_4 Concentration $\left(337\ \mu g \times \frac{1\ lb}{454 g} \times \frac{1 g}{10^6 \mu g}\right) / \left(50\ min \times \frac{10.31\ ft^3}{min}\right) = 1.44 \times 10^{-9}\ \frac{lb\ SO_4}{ft^3}$

SO_4 Flux $= 1.44 \times 10^{-9}\ \frac{lb\ SO_4}{ft^3} \times 1339\ \frac{ft}{min} \times \frac{\pi\ (21\ ft)^2}{4} \times \frac{60\ min}{hr} = 0.040\ \frac{lb\ SO_4}{hr}$

Drift Fraction $= \dfrac{0.116\ lb\ Na/hr}{\left(3500\ \frac{gal}{min}\right) \times \left(\frac{8.33\ lb}{gal}\right) \times \left(\frac{60\ min}{hr}\right) \times \left(\frac{22,100}{10^6}\right)\ ppm\ Na} = 0.0003\%$

VII. FACILITY OPERATION RELATIVE TO PROCESS TESTED

Sulfate #2 and #4 Cooling Towers appeared to be operating in general accordance with design.

An inspection of each tower was performed prior to testing. The following were noted during the inspection.

- The water distribution was uniform on Sulfate #2. A random check at eight points of the hot water basin of Sulfate #4 revealed no plugged nozzles and water distribution appeared to be uniform.
- The drift eliminators were well installed with no sizable gaps on either of the two towers.
- The spray zone and drift eliminator level were both free of debris on Sulfate #2. Sulfate #4 also appeared to be free of any debris

Air flow, water rates and heat load were typical of normal tower operation, according to plant records.

Supporting data on plant operations and flows are provided in Appendix C.

VIII. SAMPLING AND ANALYTICAL PROCEDURES

A.1 Overview of Test Effort

ESC traveled to Ridgecrest, California on September 11, 1989 and performed testing at the plant site in Trona on September 12-14 with return travel to Knoxville, Tennessee on September 15, 1989.

A.2 General Test Characteristics

Drift Tests (percent of circulating water flow)

a. One cell each, Westend Sulfate #2 and #4 was tested. See Figure 2.3.1 and Figure 2.3.2.

b. The number of sampling points was 40 per cell, i.e., 4 diameters (every 45 degrees) x 10 equal area points per diameter.

c. The Heated Glass Bead Isokinetic (HGBIK) tubes were backed up by a water trap and filter.

d. Cooling tower inlet air mineral concentrations were measured using Hi Volume samplers.

e. Circulating water samples were taken before and after each diameter to determine the variability in circulating water chemistry.

f. Updraft air velocity was measured including the "yaw" angle at the exit plane and the IK measurement adjusted accordingly.

g. Circulating water flow measurements were made for each test cell.

h. Chemical rinse procedures were performed using triple distilled water and acid rinse for final washing of the IK tubes.

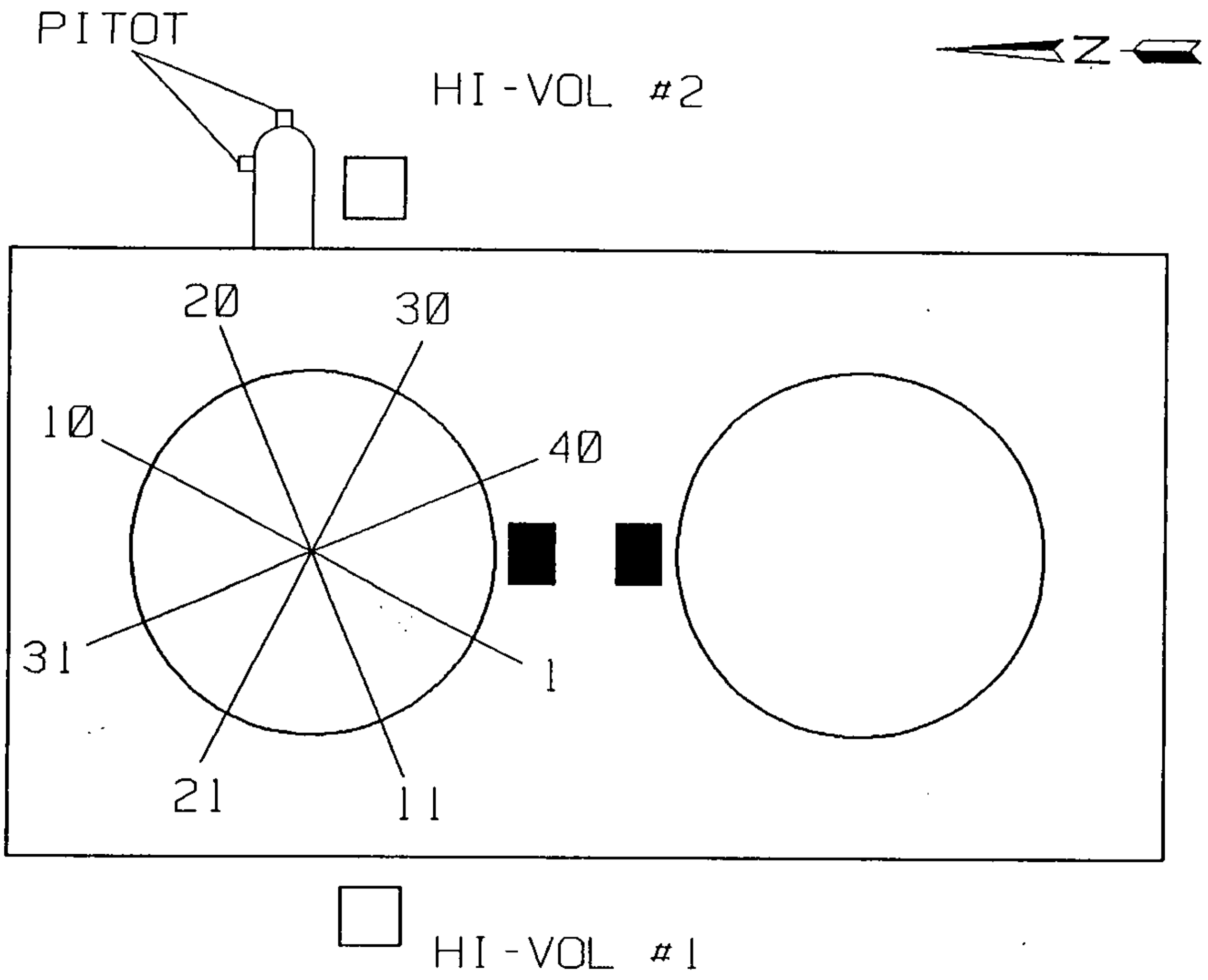


FIGURE 2.3.1

SITE PLAN VIEW

TOWER #2

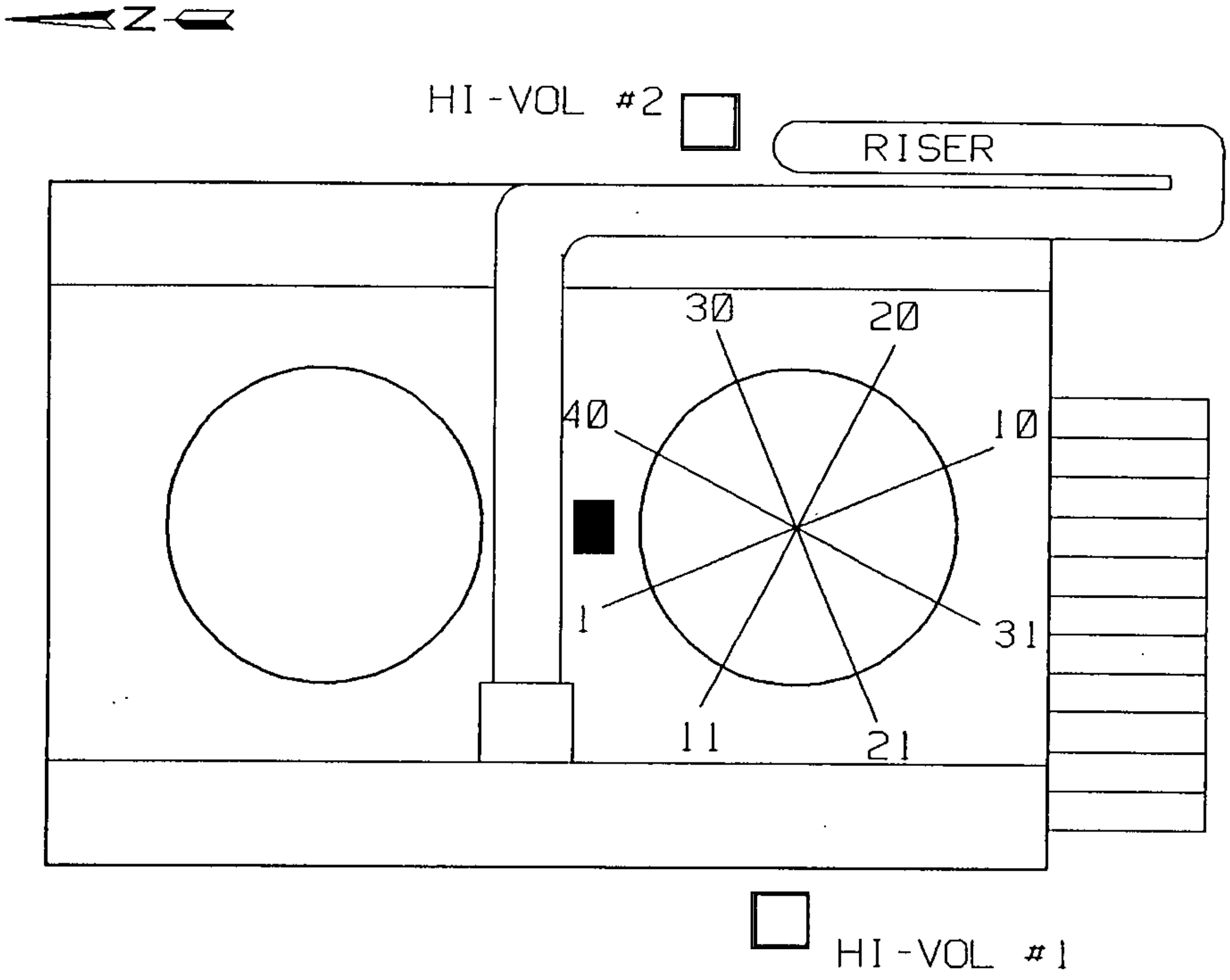


FIGURE 2.3.2

SITE PLAN VIEW

TOWER #4

PM-10 Tests

"PM-10" tests were performed on both towers using an Anderson Cascade Impactor. Single-point measurements were made, consistent with previous protocol, to maintain cut sizes for the impactor.

Meteorological Data

Wind speed and direction measurements were taken during testing. However, because the towers are located in an area surrounded by other buildings, the data collected were felt to be questionable. Observed wind speeds were light and variable throughout the testing period.

Test Preparation and Execution

Tower Inspection - An inspection of each tower was performed prior to testing. The following were noted during the inspection.

- The water distribution was uniform on Tower #2. A random check at eight points of the hot water basin of Tower #4 revealed no plugged nozzles and water distribution appeared to be uniform.
- The drift eliminators were well installed with no sizable gaps on either of the two towers.
- The spray zone and drift eliminator level were both free of debris on Tower #2. Tower #4 also appeared to be free of any debris.

Test Narrative - A chronology of test events is as follows:

9/11/89 - Travel to Ridgecrest, California.

9/12/89 - Safety training and site orientation, inspection of Towers and scaffolding set up. Drive to Ontario, California to pickup test equipment.

9/12/89 - Set up test equipment on Tower #2 and complete PM and PM10 tests, perform two (2) of the four (4) diameters with the ESC Heated Glass Beads IK method. APCD engineer on-site during equipment setup.

9/13/89 - Complete remaining two (2) diameters on Tower #2 with the ESC Heated Glass Beads. Move test equipment to Tower #4 and set up. Completed PM and PM10 tests, perform two (2) of the four (4) diameters with the ESC Heated Glass Beads. Measure waterflow on Tower #2 via pitot traverse.

9/14/89 - Conduct remaining two (2) diameters on Tower #4 with the ESC Heated Glass Beads, tear down and pack equipment for shipment. Measure water flow rate on Tower #4 using plant owned ultra sonic meter. Drive to Ontario, California and ship equipment back to Knoxville, Tennessee.

9/15/89 - Return travel to Knoxville, Tennessee.

B. Calibrations and Sampling Procedures

B.1. Calibrations

Gill Propeller Anemometer - A Gill propeller anemometer was used to measure updraft air velocity at each of the sampling locations. Due to cyclonic flow, a tell-tale was attached to the anemometer to determine the direction and angle of flow. The anemometer was adjusted into the airstream before flow measurements were made. The propeller anemometer (ESC #2) used in this test program was calibrated at the National Oceanic and Atmospheric Administration wind tunnel in Oak Ridge, Tennessee by comparison with a National Bureau of Standards calibrated anemometer.

Heated Glass Bead Isokinetic System - The ESC Heated Glass Bead Isokinetic System measures air flow rate through the sampling train via a bank of Dwyer Rotameters, each of which has a manual flow regulating valve immediately downstream. These rotameters were calibrated over a wide range of air flows. A standard flow meter was connected to the sampling train in series with the system rotameters. Readings of the standard flow meter were recorded over the range of 0 to 2,500 fpm. These corresponded to the readings taken from the system rotameters. The standard meter readings were corrected for barometric pressure and used to back-calculate air velocity at the inlet of the sampling tube. Plots of updraft air velocity versus system flow meter readings are included.

Particle Size Measurement - The Anderson Cascade Impactor train was calibrated in accordance with IT Corporation Quality Assurance Procedures. Data sheets from the calibration are included in Appendix B.

B.2 Sampling Procedures

Drift Measurement Method - ESC Heated Glass Bead System - Initial drift measurements were performed with the ESC Heated Glass Bead Isokinetic (HGBIK) Sampling System. Test protocol and instrumentation were designed to mimic those used in previous test efforts at Kerr McGee's cooling towers (e.g., October 1986, ESC TIN 86-1143) by ESC.

A schematic of the Heated Glass Bead Isokinetic System (HGBIK or IK) is shown in Figure 3.4. Prior to mobilization in the field, each of the sampling tubes (shown in Figure 3.4.1) was washed with warm, 10 percent by volume hydrochloric acid (HCl) and rinsed with distilled water to remove existing deposits. These tubes were then wrapped in plastic to prevent contamination during transport. Before the start of a test, the plastic was removed and the ground glass fitting of the sampling tube was coated with stop cock grease and attached by a clamp to the receptacle which was attached to the vacuum system. After installing the sampling tube, positive and negative electrical leads from a 110 VAC rheostat were connected to the heat tape surrounding the tube. The tube was then affixed to the support structure (Figure 3.4.2) for positioning over the equal area points. IK backup filters were installed along with each IK sampling tube. Once in position, a current of 1.0 to 2.0 amperes was applied to the heat tape, resulting in the heating of the glass beads to a temperature above the boiling point of water. After heating was begun, the vacuum pumps were started and the appropriate flow rate through the rotameters was set using the regulating valve(s), with this flow being a function of the local updraft air velocity. After the sampling duration (5 minutes) for that point was satisfied the sampling tube was moved to the next point. When the last point of each traverse was completed, the power supplies to the heating tape and the vacuum pumps were switched off. The sampling tube was then disconnected from the receptacle and wrapped in plastic for shipment to the laboratory in Knoxville, Tennessee. The associated backup filter was also removed at this time. One IK tube and one backup filter was used for each diameter of the traverse. Two procedural blanks and two backup filters were performed for each of the two test cells. In all respects, these IK tubes and backup filters were handled in the same manner as the others, except that no exhaust air was drawn through them. The collected sample was redissolved by washing the IK tube with 15 ml of a 10 percent solution of nitric acid. This was followed by two 15 ml distilled water rinses. All of the above wash water was collected in a 50 ml volumetric flask and distilled water added to the total volume of 50 ml. The samples were then analyzed for sodium and sulfates by conventional wet chemical and atomic absorption techniques.

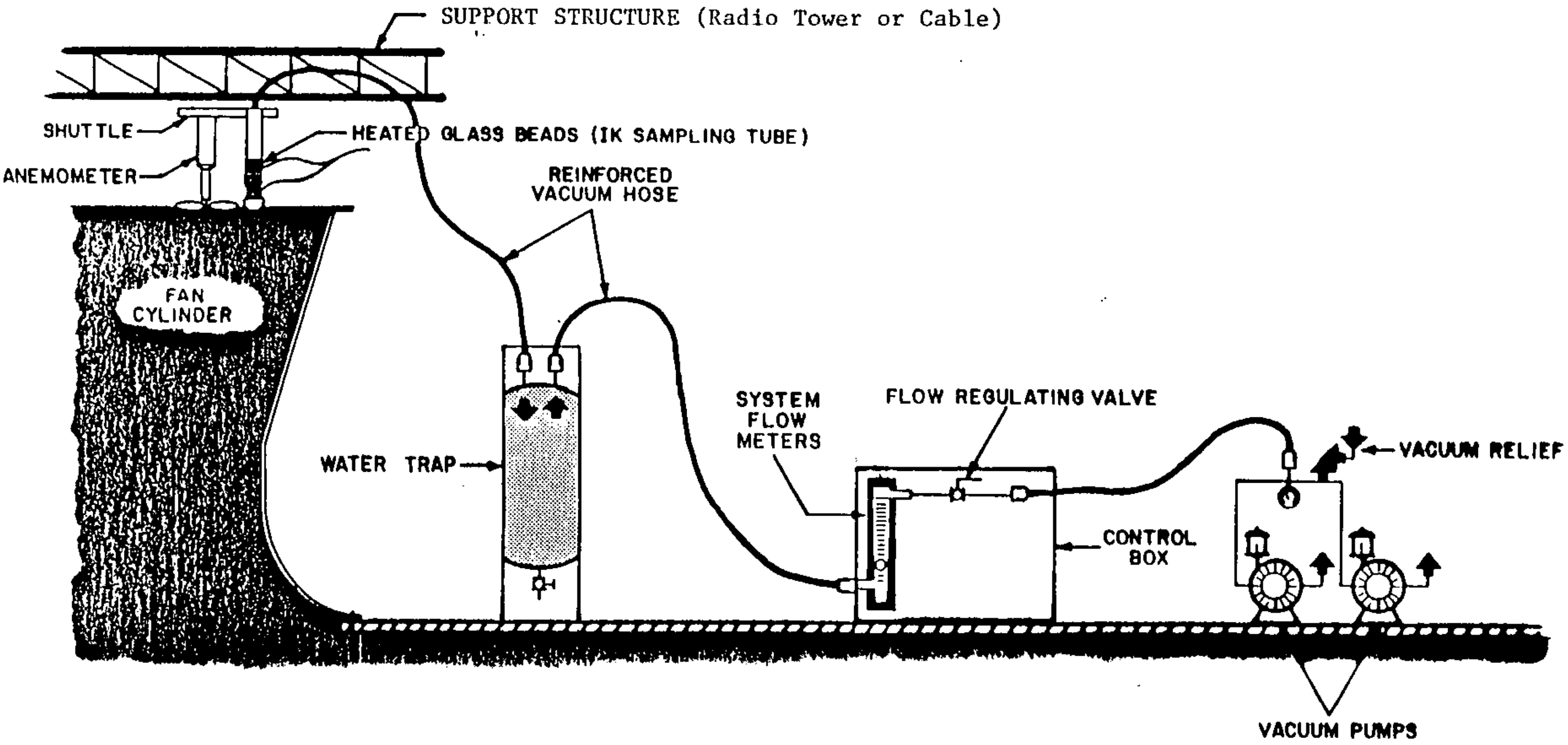


Figure 3.4

ESC HEATED GLASS BEAD SYSTEM

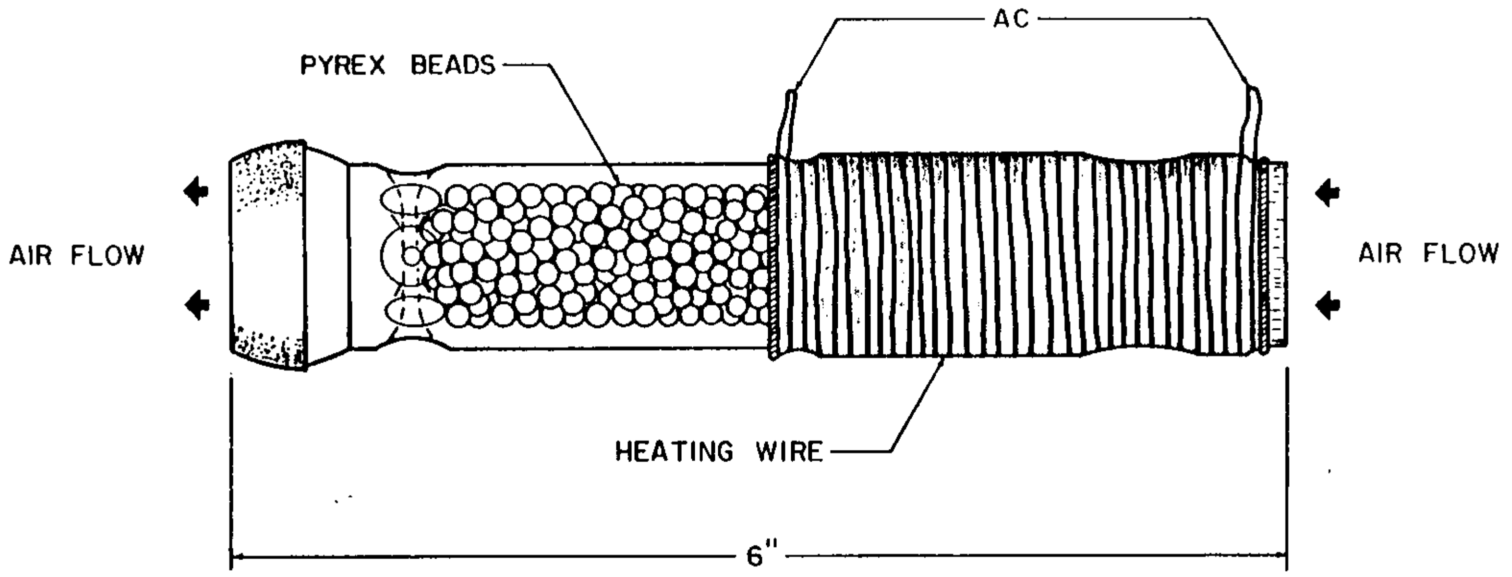


Figure 3.4.1

ESC HEATED GLASS BEAD SAMPLE TUBE

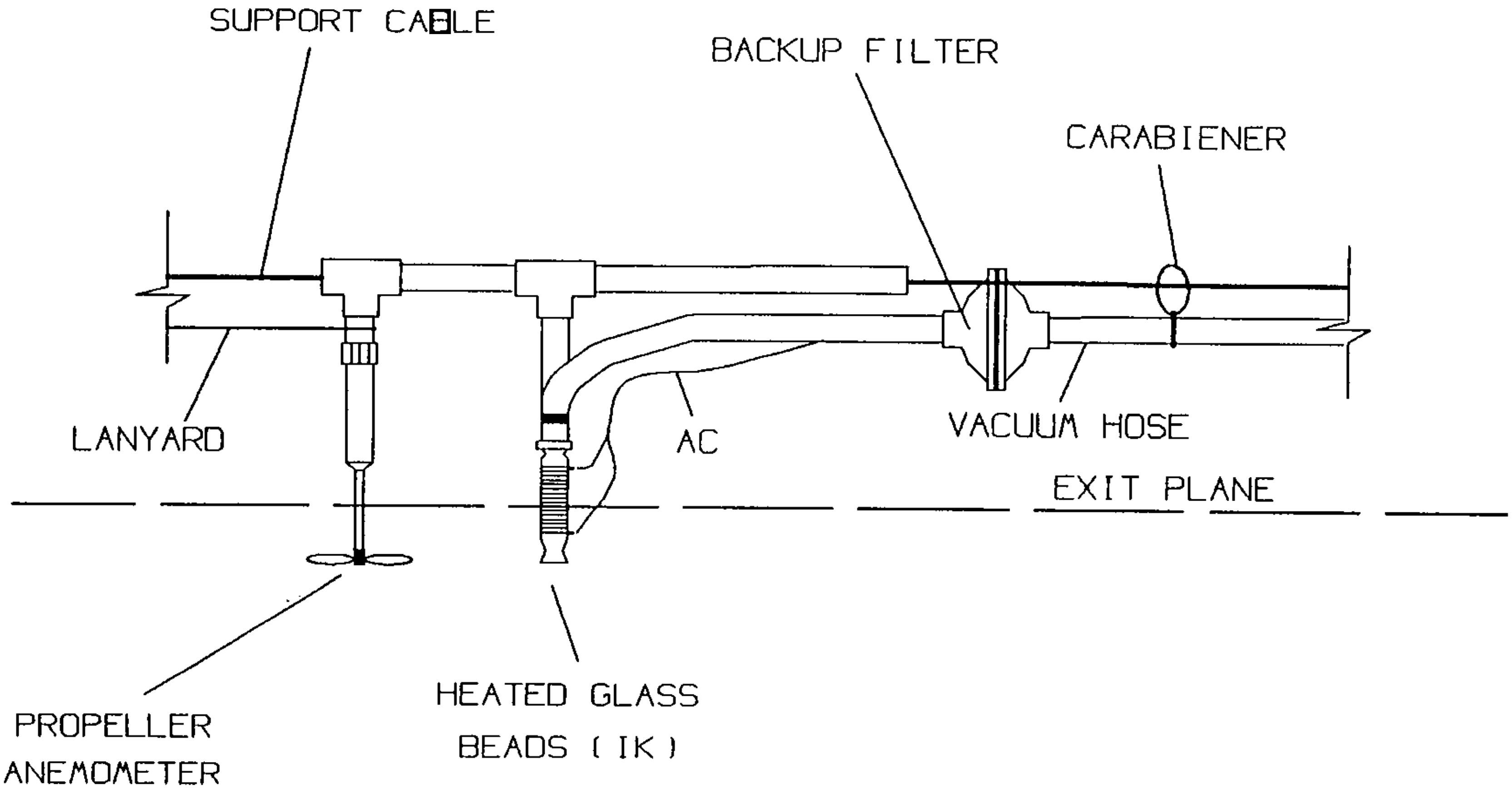


Figure 3.4.2
SAMPLING TRAIN SUPPORT

Sampling and Analytical Procedures - Particle Size - The particle size tests were conducted wit an Anderson Mark III Cascade Impactor. The impactor is a multi-stage impactor for in-stack particulate effluents in moderate grain loading applications. It aerodynamically classifies particles into multiple size ranges and accounts for all their physical properties: namely size, shape, and density. Because of the potential of particles larger than ten microns in the gas stream, a pre-separator was attached to the inlet of the impactor. The Mark III sampler contains eight stages. A glass fiber substrate filter was placed on each stage to collect the particles that accumulated on that plate.

At the conclusion of particle size tests, the filters were removed from their respective plates and placed into a desiccator for 24 hours. The pre-separator was rinsed with acetone into a pre-weighed pan and evaporated to dryness. After desiccation, the filters and washes were then weighed to the nearest 0.12 milligram. The size range of the material on each stage was determined based on the sampling rate during the run using a computer program.

Updraft Air Velocity - In conjunction with the drift data, updraft air velocity was obtained at each data point. This information was used in setting the isokinetic flows and in the computation of the drift flux. The device used to acquire this data was a Gill propeller anemometer (S/N ESC #2), which generates a DC voltage proportional to the air velocity. This voltage was measured with a Fluke Digital volt meter (S/N 47701310). Calibration data for the anemometer and the voltmeter are included in Appendix E.

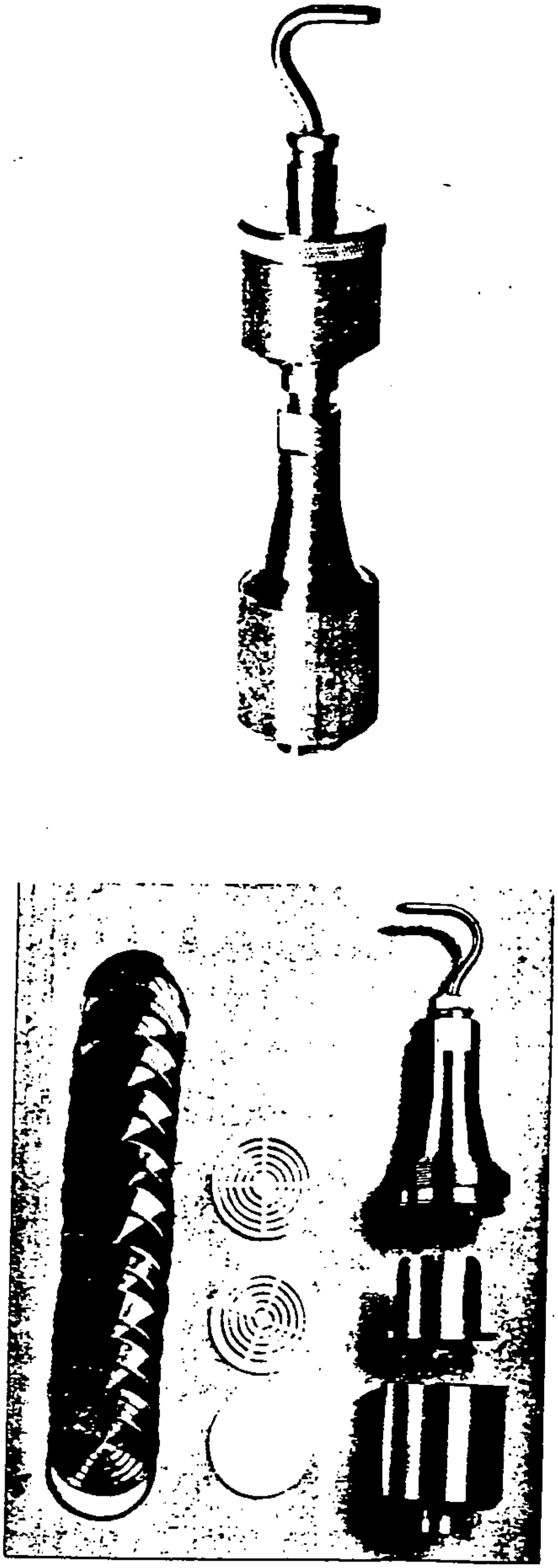


Figure 3.5.1 ANDERSEN MARK III STACK SAMPLER

Circulating Water Samples - Water samples were taken from the cold water basin before and after each traverse diameter. Each water sample bottle was labeled with the date, time and a unique identification number. The water samples were analyzed to determine the concentrations of sodium and sulfates.

Ancillary Data - Ambient particulate measurements, process data (such as system flow rates), and temperatures were also acquired. Beyond the use of water flow rates for drift fraction determination, the ancillary data were not used for any of the emissions assessment calculations. Accordingly, the aforementioned data are included in the Appendix.

APPENDIX A SAMPLE CALCULATIONS & DATA SUMMARIES

Table 4.2b
Kerr McGee Chemical Emissions Summary
Sulfate #4 Cooling Tower

IK #	Points	IK Tube Chemical Analysis			
		Na (PPM)	Total (μg)	SO4 (PPM)	Total (μg)
4589	1-10	15.10	755	5.4	275
6	11-20	22.99	1145	10.5	525
105	21-30	18.1	905	11.4	570
14	31-40	26.6	1330	15.6	780
Average (μg)			1034		538
Procedural Blank (μg)			55.7		201
Not Collected (μg)			978		337

Na Concentration $$\left(978\ \mu g \times \frac{1\ lb}{454g} \times \frac{1\ g}{10^6\ \mu g}\right) / 50\ min \times 10.31 \frac{ft^3}{min} = 4.179 \times 10^{-9} \frac{lb}{ft^3}\ Na$$

Na Flux $$\left(4.179 \times 10^{-9} \frac{lb}{ft^3}\right) \times \left(1339 \frac{ft}{min}\right) \times \frac{\pi(21\ ft)^2}{4} \times \frac{60\ min}{hr} = 0.116 \frac{lb\ Na}{hr}$$

SO_4 Concentration $$\left(337\ \mu g \times \frac{1\ lb}{454g} \times \frac{1g}{10^6 \mu g}\right) / \left(50\ min \times \frac{10.31\ ft^3}{min}\right) = 1.44 \times 10^{-9} \frac{lb\ SO_4}{ft^3}$$

SO_4 Flux $$= 1.44 \times 10^{-9} \frac{lb\ SO_4}{ft^3} \times 1339 \frac{ft}{min} \times \frac{\pi\ (21\ ft)^2}{4} \times \frac{60\ min}{hr} = 0.040 \frac{lb\ SO_4}{hr}$$

Drift Fraction $$= \frac{0.116\ lb\ Na/hr}{\left(3500 \frac{gal}{min}\right) \times \left(\frac{8.33\ lb}{gal}\right) \times \left(\frac{60\ min}{hr}\right) \times \left(\frac{22,100}{10^6}\right) ppm\ Na} = 0.0003\%$$

Table 4.1b
Kerr McGee Chemical Trona, California
Sulfate #2 Cooling Tower

IK #	Points	IK Tube Chemical Analyses Na (PPM)	Total (µg)	SO4 (PPM)	Total (µg)
140	1-10	44.9	2245	22.2	1110
171	11-20	42.5	2125	18.0	900
150	21-30	28.2	1410	10.2	510
9	31-40	36.5	1825	13.8	690
	Average (µg)		1901		801
	Procedural Blank (µg)		56		201
	Not Collected (µg)		1845		600

$$\text{Na Concentration} = \left(1845\ \mu g \times \frac{1\ lb}{454 g} \times \frac{1\ g}{10^{6} \mu g}\right) / \left(50\ min \times \frac{11.13\ ft^{3}}{min}\right) = 7.30 \times 10^{-9}\ \frac{lb\ Na}{ft^{3}}$$

$$SO_4\ \text{Concentration} = \left(\frac{600\ \mu g}{50\ min \times 11.13\ ft^{3}/min}\right) \times \frac{1\ lb}{454 g} \times \frac{1\ g}{10^{6} \mu g} = 2.37 \times 10^{-9}\ \frac{lb}{ft^{3}}\ SO_4$$

$$\text{Na Flux} = 7.30 \times 10^{-9}\ \frac{lb}{ft^{3}} \times \frac{1407\ ft}{min} \times \frac{60\ min}{hr} \times \frac{\pi(15\ ft^{2})}{4} = 0.11\ \frac{lbs\ Na}{hr}$$

$$SO_4\ \text{Flux} = 2.37 \times 10^{-9}\ \frac{lb}{ft^{3}} \times 1407\ \frac{ft}{min} \times \frac{60\ min}{hr} \times 176.6\ ft^{2} = \frac{0.035\ lbs\ SO_4}{hr}$$

$$\text{Drift Fraction} = \frac{0.11\ lbs\ Na/hr}{\left(2157\ \frac{gal}{min}\right) \times \left(\frac{8.33\ lbs}{gal}\right) \times \left(\frac{60\ min}{hr}\right) \times \left(\frac{24{,}764}{10^{6}}\right)\ ppm\ Na} = 0.0004\%$$

KERR MCGEE CHEMICAL CORPORATION
SULFATE #2 - NORTH CELL

IK TUBE ID#	Na (MG)	SO4 (MG)	B-U FILTER ID#
IK-140-A	2.245	0.370	IK-140-BU
IK-140-B *	2.110	---------	IK-140-BU
IK-171-A	2.125	0.300	IK-171-BU
IK-171-B *	1.870	---------	IK-171-BU
IK-150	1.410	0.170	IK-150-BU
IK-9	1.825	0.230	IK-9-BU
IK-1 (BLANK)	0.034	0.064	IK-1-BU
IK-181 (BLANK)	0.077	0.070	IK-181-BU
IK-20-9-89A	0.008	0.049	(RINSE ACID)
IK-20-9-89B	<0.0025	<0.020	(RINSE WATER)

* NO SULFATE ANALYSIS DUE TO LABORATORY MISHAP

CIRCULATING WATER ANALYSIS

SAMPLE ID#	Na MG/LITER	SO4 MG/LITER
CW-2-1A	22,875.00	7,461.00
CW-2-1B	27,600.00	6,800.00
CW-2-2A	23,250.00	6,879.00
CW-2-2B	26,500.00	6,906.00
CW-2-3	27,500.00	6,762.00
CW-2-4	22,875.00	6,606.00
CW-2-5	22,750.00	6,684.00
AVERAGE:	24,764.29	6,871.14

KERR MCGEE CHEMICAL CORPORATION
SULFATE #4 - NORTH CELL

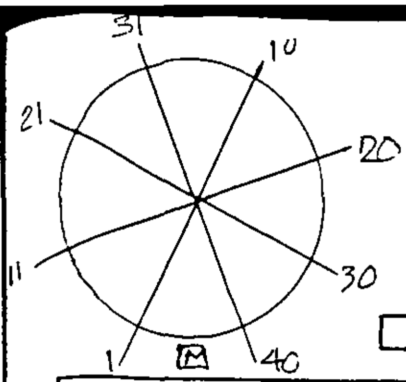
IK TUBE ID#	Na (MG)	S04 (MG)	B-U FILTER ID#
IK-4859-A	0.755	0.090	IK-4859-BU
IK-4859-B *	0.760	----------	IK-4859-BU
IK-6-A	1.145	0.175	IK-6-BU
IK-6-B *	0.900	----------	IK-6-BU
IK-105	0.905	0.190	IK-105-BU
IK-14	1.330	0.260	IK-14-BU
IK-144 (BLANK)	0.025	0.044	IK-144-BU
IK-5 (BLANK)	0.014	0.042	IK-5-BU
IK-20-9-89A	0.008	0.049	(RINSE ACID)
IK-20-9-89B	<0.0025	<0.020	(RINSE WATER)

* NO SULFATE ANALYSIS DUE TO LABORATORY MISHAP

CIRCULATING WATER ANALYSIS

SAMPLE ID#	Na MG/LITER	S04 MG/LITER
CW-4-1A	17,625.00	5,262.00
CW-4-1B	19,800.00	5,200.00
CW-4-2A	22,000.00	5,370.00
CW-4-2B	21,500.00	4,944.00
CW-4-3	21,875.00	5,352.00
CW-4-4	23,750.00	5,790.00
CW-4-5	24,878.00	6,036.00
CW-4-6	25,375.00	6,198.00
AVERAGE:	22,100.38	5,519.00

APPENDIX B FIELD DATA SHEETS



DRIFT DATA SHEET

CUSTOMER KMCC SITE WESTEND DATE 9-12-99

TOWER ID SULFATE #2 CELL ID NORTH STACK DIA. 180"

TRAVERSE ID 1 #2 (DIA) START 4:55 STOP 5:45

POSITION	SAMPLE TIME (MIN)	~~VELOCITY NORMAL TO EXIT PLANE (FPM)~~	YAW ANGLE (DEGREES)	VELOCITY ALONG YAW (FPM)
1	5		20	1576.20
2	5	IK TUBE #140	20	1801.20
3	5		15	2067.12
4	5		20	2155.76
5	5		45	1204.59
6	5		40	1378.46
7	5		45	1668.24
8	5		30	1883.02
9	5		25	1842.43
10	5		5	546.62
		START 6:10		STOP 7:00
11	5		20	1801.20
12	5	IK TUBE #171	20	1975.07
13	5		20	2026.21
14	5		35	2070.53
15	5		50	1272.78
16	5		50	1112.54
17	5		15	2097.80
18	5		0	1872.80
19	5		0	1436.42
20	5		0	464.80

HI-VOLS #1 & #2 START 12:00
STOP 7:20

CHECKED @ ~ 1 HOUR INTERVALS: READ 35 fpm CONSISTANTLY

DRIFT DATA SHEET

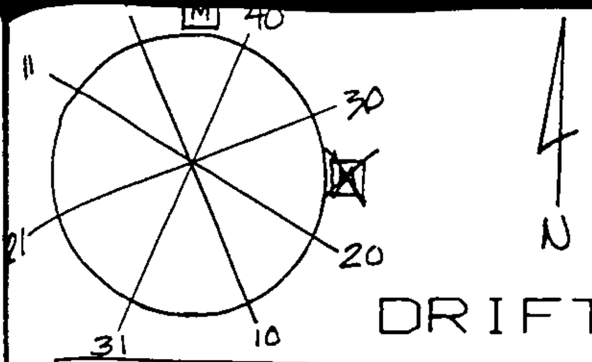
CUSTOMER KMCC SITE WESTEND DATE 9-13-89

TOWER ID SULFATE #2 CELL ID NORTH STACK DIA. 180"

TRAVERSE ID 3RD & 4th (DIA) START 8:35 STOP 9:20

POSITION	SAMPLE TIME (MIN)	~~VELOCITY NORMAL TO EXIT PLANE (FPM)~~	YAW ANGLE (DEGREES)	VELOCITY ALONG YAW (FPM)
21	5		5	597.75
22	5	IK TUBE #150	0	1705.74
23	5		10	1903.48
24	5		20	2029.62
25	—	—	—	NEGATIVE
26	5		10	2053.48
27	5		25	1998.94
28	5		35	1804.61
29	5		40	1058.00
30	5		40	526.16
		START 9:40		STOP @ 10:30
31	5		10	1661.43
32	5		15	1981.89
33	5	IK TUBE #9	20	2012.57
34	5		25	2183.03
35	5		25	781.85
36	5		20	2125.08
37	5		25	2067.12
38	5		20	1780.75
39	5		30	1133.00
40	5		40	539.80

HI-VOLS #1 & #2 START @ 8:16 (35 fpm)
STOP @ 10:50 (35 fpm)



DRIFT DATA SHEET

CUSTOMER KMCC SITE WESTEND DATE 9-13-89

TOWER ID SULFATE #4 CELL ID SOUTH STACK DIA. 21 FT.

TRAVERSE ID 1&2 (DIA) START 3:55 STOP 4:40

POSITION	SAMPLE TIME (MIN)	~~VELOCITY NORMAL TO EXIT PLANE (FPM)~~	YAW ANGLE (DEGREES)	VELOCITY ALONG YAW (FPM)
1	5		5	1634.15
2	5		5	1923.93
3	5	JK TUBE #4859	25	2036.44
4	5		25	2101.21
5	~~5~~			NEGATIVE
6	5		15	1153.45
7	5		0	2043.26
8	5		0	1859.16
9	5		5	1381.87
10	5		15	962.54
		START@ 5:05		STOP@ 5:45
11	5		10	1675.06
12	5	JK TUBE #6	15	1865.98
13	5		25	1985.30
14	5		30	2159.17
15	~~5~~			NEGATIVE
16	~~5~~			NEGATIVE
17	5		40	1872.80
18	5		10	1883.02
19	5		10	1790.97
20	5		5	1463.69

DRIFT DATA SHEET

CUSTOMER KMCC SITE WESTEND DATE 9-14-89
TOWER ID SULFATE #4 CELL ID SOUTH STACK DIA. 21 Ft.
TRAVERSE ID 3 & 4 (DIA.) START 8:35 STOP 9:15

POSITION	SAMPLE TIME (MIN)	VELOCITY NORMAL TO EXIT PLANE (FPM)	YAW ANGLE (DEGREES)	VELOCITY ALONG YAW (FPM)
21	5		15	1156.86
22	5	IK TUBE #105	25	1784.16
23	5		15	1940.98
24	5		30	1702.34
25				NEGATIVE
26				NEGATIVE
27	5		20	1835.29
28	5		20	1852.34
29	5		15	1627.33
30	5		5	1884.14
		START @ 9:55		STOP @ 10:40
31	5		40	1184.14
32	5	IK TUBE #14	25	[illegible] 1562.56
33	5		30	1930.75
34	5		40	1869.39
35	5		50	1040.95
36				NEGATIVE
37	5		20	1661.43
38	5		20	1773.93
39	5		15	1934.16
40	5		35	1371.64

```
            CASCADE IMPACTOR RESULTS

          KERR-MCGEE
          COOLING TOWER #2
          COMPUTER RUN DATE 9/21/89
          COMPUTER OPERATOR SM
          TEST DATE 9/12/89
          PROJ # 406154

          RUN      1
          SAMPLING RATE  0.69 (ACFM) AT  78  DEGREES F
               STAGE 1 INCLUDES PREIMPACTOR
               STAGE 9--BACK-UP FILTER
               PARTICLE DENSITY =  1.00 GRAMS/CM3

STAGE              D50               % MASS              % <=
  #              MICRONS                                  D50
--------------------------------------------------------------------
1.00             10.48                 0.00              %100.00
2.00              7.04                 0.00              %100.00
3.00              4.77                 0.00              %100.00
4.00              3.25                 8.33               91.67
5.00              2.08                 8.33               83.33
6.00              1.04                16.67               66.67
7.00              0.63                25.00               41.67
8.00              0.43                25.00               16.67
9.00                                  16.67
```

CLIENT Kerr-McGee SOURCE Tower #4

RUN NO. 1 Particle size
DATE 9-13-89
OPERATORS MM
METER BOX NO. 5
SAMPLE BOX NO. –
FILTER NO. –
PROBE HEATER SETTING –

BAROMETRIC PRESSURE 28.521
STATIC PRESSURE –
AMBIENT TEMPERATURE 93
PROBE LENGTH 5'
PROBE LINER SS
PORT LENGTH –
PORT DIAMETER –

SCHEMATIC OF STACK
406154

TRAVERSE POINT NUMBER	SAMPLING TIME		VELOCITY HEAD		ORIFICE METER (ΔH) in. H_2O		GAS SAMPLE TEMP. AT DRY GAS METER		PUMP VACUUM GAUGE in. Hg	SAMPLE BOX TEMP. °F	TEMP. OF GAS LEAVING LAST IMPINGER °F	GAS SAMPLE VOLUME (Vm), ft.³	STACK TEMP. (Ts) °F
	CLOCK	SAMPLE	(ΔPs)	(√ΔPs)	ACTUAL	DESIRED	INLET (Tm_{in}) °F	OUTLET (Tm_{out}) °F					
10	4:24	0	.35		1.60	1.60	111	111	6		871.725		78
		10			1.60	1.60	116	112	6		879.00		78
		20			1.60	1.60	120	113	6		883.00		78
		30			1.60.	1.60	124	113	6		891.00		78
		40			1.60	1.600	124	113	6		898.30		78
		50			1.60	1.60	124	114	6		906.00		78
		60			1.60	1.60	124	114	6		911.10		78
		1:10			1.60	1.60	125	114	6		917.50		78
		20			1.60	1.60	125	114	6		926.00		78
		30			1.60	1.60	125	114	6		931.25		78
		40			1.60	1.60	125	114	6		939.400		77
		50			1.60	1.60	125	113	6		944.51		77
	6:24	200									949.25		
TOTAL													
AVERAGE													

STATIC PITOT LEAK-CHECK @ 15 sec.
IMPACT PITOT LEAK-CHECK @ 15 sec.
TRAIN LEAK RATE @ 60 sec: 0 cf @ 10 in.
TRAIN LEAK RATE @ 60 sec: 0 cf @ 8 in.

STACK GAS ANALYSIS

TIME	CO_2	O_2	CO	N_2

NOZZLE CALIBRATION-I.D. NO.

PRETEST		POST-TEST	
DIA. 1	.25	DIA. 1	
DIA. 2	.25	DIA. 2	
DIA. 3	.25	DIA. 3	
AVERAGE	.25	AVERAGE	

INTERNATIONAL TECHNOLOGY CORPORATION

SIGNATURE Michael Mowery
TEST TEAM LEADER

SOURCE SAMPLING CASCADE IMPACTOR TEST LAB DATA SHEET

COMPANY Kerr-McGee DATE 9-13-89

SOURCE Cooling Tower #4 RUN NO. 1

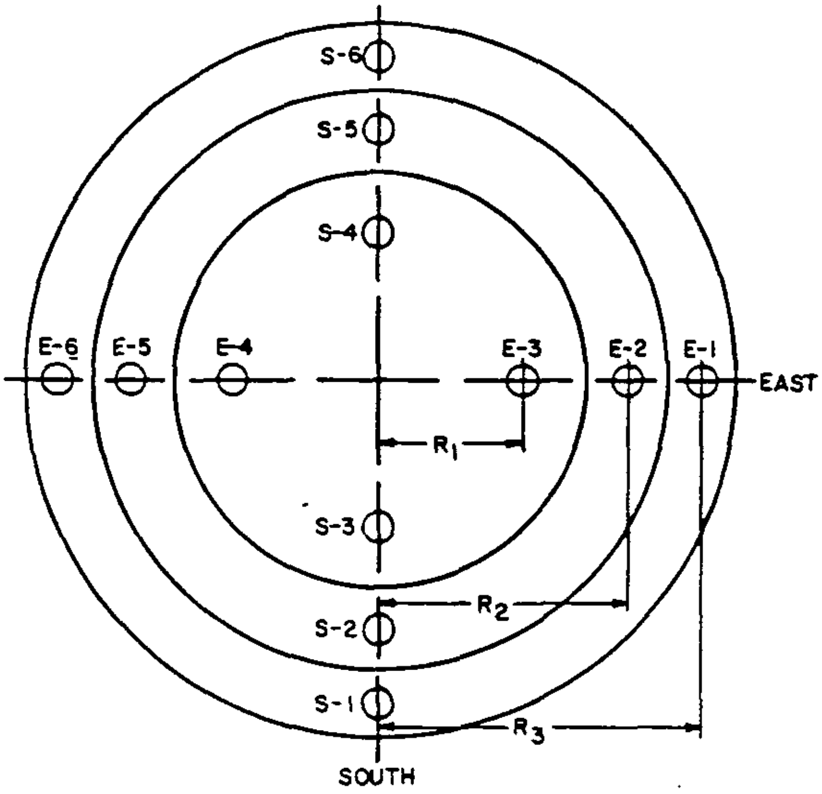
STAGE	FILTER NO.	INITIAL WEIGHT	FINAL WEIGHT	PARTICULATE WEIGHT	% IN SIZE RANGE	SIZE RANGE (Microns)
0	Preseparator	—	—	—		
1	W-1	0.1623	0.1623	0		
2	W-2	0.1456	0.1456	0		
3	W-3	0.1623	0.1623	0		
4	W-4	0.1463	0.1463	0		
5	W-5	0.1601	0.1604	0.0003		
6	W-6	0.1452	0.1455	0.0003		
7	W-7	0.1597	0.1599	0.0002		
8	W-8	0.1449	0.1451	0.0002		
9	W-Final	0.2710	0.2712	0.0002		

TOTAL PARTICULATE COLLECTED 0.0012

1. PROJECT NAME Kerr-McGee
2. SOURCE Cooling Tower #4
3. COMPUTER RUN DATE 9-20-89
4. TEST DATE 9-13-89
5. PROJECT NUMBER 406154
6. RUN I.D. 4-1
7. BAROMETRIC PRESSURE (IN HG.) 28.52
8. STACK GAS GAUGE PRESSURE (IN W.C.) 0.35
9. SAMPLING TIME (MIN.) 120
10. AVERAGE GAS METER TEMP. (F) 118
11. AVERAGE GAS METER PRESSURE (IN W.C.) 1.60
12. AVERAGE STACK GAS TEMP. (F) 78
13. VOLUME OF GAS METERED (CF) 77.525
14. STACK GAS MOISTURE (% VOLUME) 2.7
15. GAS METER CALIBRATION FACTOR (Y) 1.087
16. TOTAL PARTICULATE (g) 0.0012
17. PARTICLE DENSITY (GRAMS/CM^3 — USUALLY 1.0) 1.0

INTERNATIONAL
TECHNOLOGY
CORPORATION

FIG. 2 TRAVERSE POSITIONS IN ROUND FLUES



If the table below does not have enough points, the distance R from the center of the flue to any given test point, n, is calculated by the formula

$$R = d\sqrt{\frac{2n-1}{4N}}$$

d = diameter of flue

N = number of readings across a diameter

n = the n'th point from the center

R = Distance from center of flue to n'th test point, numbered from the center consecutively. In the diagram, n=1 for E-3, E-4, S-3, and S-4

Note: Using compass points to designate stations helps to orient the test locations.

EQUAL AREA ZONES FOR VELOCITY TRAVERSE

% of flue diameter from circumference to test point

180*

	Number of Areas						
POINT NO.	2	3	4	5		6	
1	6.2	4.4	3.23	2.2	3.96	2.0	3.6
2	25.0	14.7	10.47	8.2	14.76	6.7	12.06
3	75.0	29.4	19.38	14:5	26.1	11.8	21.24
4	93.8	70.6	32.32	22.7	40.86	17.7	31.86
5		85.3	67.68	34.4	61.92	25.0	45
6		95.6	80.62	65.6	118.08	35.4	63.72
7			89.53	77.3	139.14	64.6	116.28
8			96.77	85.5	153.9	75.0	135
9				91.8	165.24	82.3	148.14
10				97.8	176.04	88.2	158.76
11						93.3	167.94
12						98.0	176.40

POSITIONS FOR TOWER #2

```
          CASCADE IMPACTOR RESULTS

          KERR-MCGEE
          COOLING TOWER #4
          COMPUTER RUN DATE 9/21/89
          COMPUTER OPERATOR SM
          TEST DATE 9/12/89
          PROJ # 406154

          RUN     1
          SAMPLING RATE  0.67 (ACFM) AT   78  DEGREES F
               STAGE 1 INCLUDES PREIMPACTOR
               STAGE 9--BACK-UP FILTER
               PARTICLE DENSITY =  1.00 GRAMS/CM3

STAGE              D50              % MASS              % <=
  #              MICRONS                                 D50
----------------------------------------------------------------------
 1.00             10.63               0.00             %100.00
 2.00              7.14               0.00             %100.00
 3.00              4.84               0.00             %100.00
 4.00              3.29               0.00             %100.00
 5.00              2.11              25.00              75.00
 6.00              1.06              25.00              50.00
 7.00              0.64              16.67              33.33
 8.00              0.43              16.67              16.67
 9.00                                16.67
```

FOR USE WITH CTI
TEST CODE ATC-105

COOLING TOWER INSTITUTE
ACCEPTANCE TEST PROCEDURE
DATA SHEET "E"
WATER FLOW MEASUREMENT
PITOT TUBE

FILE NO: ______

TEST DATE: 9/13

A N
B S

PITOT TUBE MAKE, MODEL Leo.	SERIAL NO PFA = 1121	PIPE SIZE, INCHES NOM = 12" ID = 12"
DATE CALIBR	TUBE COEFFICIENT c = 0.812	AREA = 005454D², SQ FT A = CA = 0.769

PIPE I D IN				LOCATION DECIMAL INCHES		STA DESC A		B TIME 2:10		STA DESC TIME			
RDG NO	DIA X	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												
5	129												
6	165	1	.026		.3	10 3/4	3.28	10	3.16				
7	204	2	082		1	11.5	3.39	11	3.32				
8	250	3	146		1.75	12	346	11 1/2	3.39				
9	306	4	226		2.75	12 3/4	3.57	11 1/2	3.39				
10	388	5	342		4.1	12 1/2	3.54	11 1/4	3.35				
11	612	6	658		7.9	13 1/4	3.64	9 3/4	3.12				
12	694	7	774		9.288	13 1/4	3.64	8 3/4	2.96				
13	750	8	854		10.25	13 1/4	3.64	8 3/4	2.96				
14	796	9	918		11	11 1/4	3.35	7	2.65				
15	835	10	974		11.7	9	3.00	5	2.24				
16	871												
17	903												
18	933												
19	961												
20	987												

18 IN DIAM AND OVER
UNDER 18 IN DIAM

TOTAL	34.65	TOTAL	30.54	TOTAL		TOTAL	
AVG	3.45	AVG	3.05	AVG		AVG	
TRAVERSE AVG √d			3.26	TRAVERSE AVG √d			

US GPM 2160 ~~2117.66~~

US GPM ______

RDG NO	TIME	d
A		
B		
C		

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

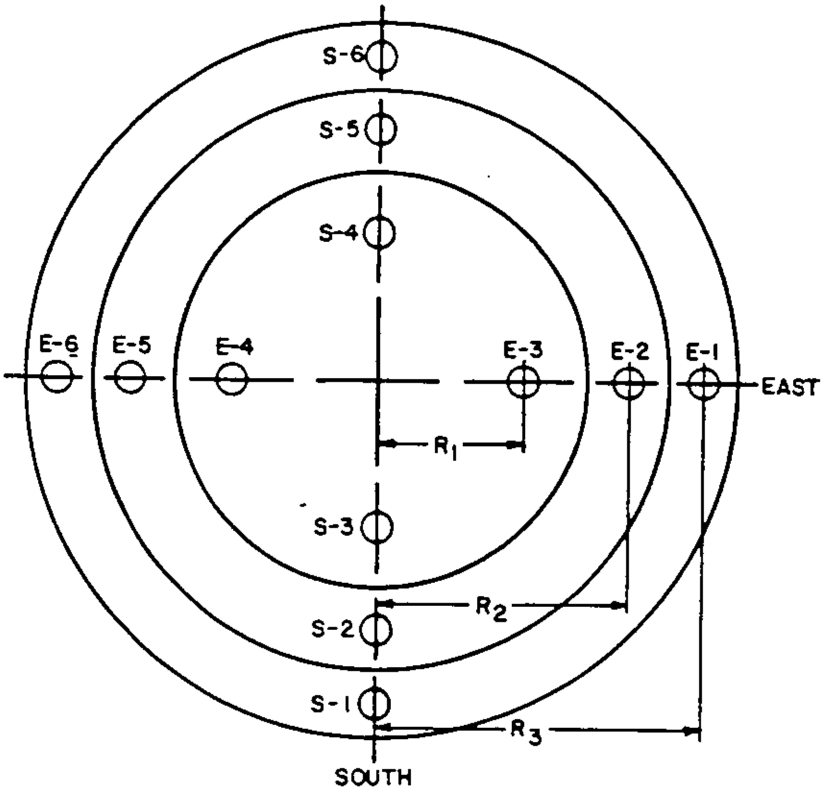
BASIS AIR WATER MANOMETER

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

SULFATE #2 - KERR McGEE

CTI FORM ATC-105 E ______

FIG. 2 TRAVERSE POSITIONS IN ROUND FLUES



If the table below does not have enough points, the distance R from the center of the flue to any given test point, n, is calculated by the formula

$$R = d\sqrt{\frac{2n-1}{4N}}$$

d = diameter of flue

N = number of readings across a diameter

n = the n'th point from the center

R = Distance from center of flue to n'th test point, numbered from the center consecutively. In the diagram, n=1 for E-3, E-4, S-3, and S-4

Note: Using compass points to designate stations helps to orient the test locations.

EQUAL AREA ZONES FOR VELOCITY TRAVERSE

% of flue diameter from circumference to test point

POINT NO.	Number of Areas				
	2	3	4	5	6
1	6.2	4.4	3.23	2.2-5.5	2.0
2	25.0	14.7	10.47	8.2 - 20.6	6.7
3	75.0	29.4	19.38	14:5 -36.5	11.8
4	93.8	70.6	32.32	22.7 57.2	17.7
5		85.3	67.68	34.4 86.7	25.0
6		95.6	80.62	65.6 165.3	35.4
7			89.53	77.3 194.7	64.6
8			96.77	85.5 215.5	75.0
9				91.8 231.3	82.3
10				97.8 246.5	88.2
11					93.3
12					98.0

positions for Tower #4 (in inches)

APPENDIX C OPERATIONAL DATA

9-14-89

Ed,

ANOTHER SET OF READINGS WERE OBTAINED FROM #4 & #2 COOLING TOWERS FOR THE BENEFIT OF MR. LARRY SMITH. THE READINGS AT #4 COOLING TOWER WERE TAKEN AT 3 LOCATIONS (0915-0945 HRS) TO INSURE MORE ACCURATE DATA. THE FLOW RATES WERE AS FOLLOWS:

LOCATION 1. 20" Sched. 30 VERTICAL LINE FROM Xchanger
To Tower. 7.7-7.8 FPS 6810-6899 gpm

LOCATION 2. Upper 16" Sched. 40 HORIZONTAL LINE TO
Xchanger. 6.1 FPS 3363 gpm

Lower 16" Sched. 40 HORIZONTAL LINE TO
Xchanger. 6.1 FPS - 8.0* FPS 3363 - 4410 gp
Combined Rate 6726 - 7773 gp

LOCATION 3. 20" Sched. 30 HORIZONTAL LINE immediately after
Pumps, before ell. 8.0 - 8.4 FPS 7075 - 7429 g

#2 COOLING TOWER FLOW RATE WAS: 9.5 FPS 3317 gpm
(12" Sched. 40 VERTICAL LINE) 1000 HRS

Ed, I've also ATTACHED A CROSS-REFERENCE CHART TO SHOW HOW I CAME UP WITH THE FLOW RATES.

Ralph Alvarado

* THIS HIGH (8.0) SWING WAS Probably due to turbulence. THE 6.1 reading is probably more Accurate.

Dynasonics, Inc.

522 W. 5th Ave. (312) 355-3055
NAPERVILLE, IL 60540

FPS TO GPM CROSS-REFERENCE (Schedule 40)

PIPE DIA.	FPS 1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
1	2.7	4	5.4	6.7	8.1	9.4	10.8	12.1	13.5	14.8	16.1	17.5	18.9	20.2	21.6	22.9	24.3	25.6	27
1¼	4.7	7	9.3	11.6	14	16.3	18.7	21	23.3	25.7	28	30.3	32.7	35	37.3	40	42	44.3	46.6
1½	6.3	9.5	12.7	15.8	19	22.3	25.4	28.6	32	35	38	41.2	44.4	47.6	51	54	57	60	63.4
2	10.5	16	21	26	31	37	42	47	52	58	63	68	73	78	84	89	94	99	105
2½	15	22	30	37	45	52	60	67	74	82	89	97	104	112	119	127	134	142	149
3	23	35	46	58	79	81	92	104	115	127	138	150	161	173	184	196	207	219	231
3½	31	46.3	62	77	92	108	123	139	154	170	185	200	216	231	247	262	277	293	308
4	40	60	69	99	120	139	159	179	199	220	238	258	278	298	318	338	357	377	397
5	62	94	125	156	187	218	250	281	312	343	374	406	437	468	499	530	562	593	624
6	90.1	135	180	225	270	315	360	405	450	496	541	586	631	676	721	766	811	856	901
8	156	234	312	390	468	546	624	702	780	858	936	1014	1092	1170	1248	1326	1404	1482	1560
10	246	369	492	615	738	861	984	1107	1230	1353	1476	1599	1722	1845	1968	2091	2214	2337	2460
12	349	524	698	873	1047	1222	1397	1571	1746	1920	2095	2269	2444	2619	2793	2968	3142	3317	3492
14	422	633	844	1055	1266	1477	1689	1900	2110	2321	2533	2744	2955	3166	3377	3588	3799	4010	4221
16	551	827	1102	1378	1654	1929	2205	2481	2756	3032	3308	3583	3859	4134	4410	4686	4961	5237	5513
18	698	1047	1396	1744	2093	2442	2791	3140	3489	3838	4187	4535	4884	5233	5582	5931	6280	6629	6978
20	867	1301	1734	2168	2602	3035	3469	3902	4336	4770	5203	5637	6071	6504	6938	7371	7805	8239	8673
24	1254	1882	2509	3136	3763	4390	5018	5645	6272	6899	7526	8154	8781	9407	10034	10662	11290	11917	12544

EQUATION TO CONVERT FPS TO GPM GPM = (PIPE I.D.)² x VELOCITY IN FT/SEC. x 2.45

20" sched. 30 $\overset{23.5}{(19)^2}$

9-14-89
0800 - 0820 Hrs

ED,

FLOW RATES FOR TODAY WERE:

2 Cooling TOWER	3317 gpm
4 Cooling TOWER	7442 gpm*
	7075 gpm**

* TOTAL RATE of both 16" LINES.

** RATE of 20" LINE AFTER THE TWO pumps before cell.

9-13-89
1245-1305

Ed,

Today's flow rates were:

# 2 Cooling Tower	2514 gpm
# 4 Cooling Tower	7221 gpm*
	6810 gpm**

* Flows of Two 16" lines Combined

** 20" line after two pumps

Stauffer CHEMICALS

Cooling Tower No. 4

RECEIVED
APR 23 1969
WESTERN PLANT

STAUFFER CHEMICAL COMPANY

Westend, California 93564

South Cell 82 amps

Contract No. 197-139794

Req. No. 3966

Account No. AR 197-140

This Agreement, Made the Eighth Day of April in the year One Thousand Nine Hundred and Sixty-Nine, by and between the Fluor Products Co. Inc.
339 E. San Antonio Drive Long Beach, California 90807

hereinafter called the **Contractor**, and the **Stauffer Chemical Company**, a Delaware corporation, hereinafter called the **Owner.**

Witnesseth: That the **Contractor** and the **Owner** for the consideration hereinafter named, agree as follows:

Article 1. The **Contractor** agrees to provide all of the material, equipment and labor and to perform all of the work to furnish and erect Fluor Model 253-578 2-cell Induced Draft Crossflow Cooling Tower.

as described in the specifications in Article II

and shown on the plans or drawings as prepared by

Architect, Engineer for the erection and completion of same

to be erected at Westend, California

and to do, to the satisfaction of the **Owner** and said **Architect, Engineer,** everything required of the **Contractor** by the drawings and specifications, including the General Conditions thereof, except as herein expressly modified or changed, it being agreed that such drawings and specifications, including the General Conditions thereof, are as fully a part of this Agreement as if hereto attached or herein repeated. It is further agreed that the decision of the **Owner** and **Architect, Engineer** as to the true construction and meaning of said drawings and specifications shall be final.

Article II.

A. Contractor shall furnish all labor, material, tools, equipment and supervision to erect Fluor Model 253-578 2-cell Induced Draft Crossflow Cooling Tower to cool 9360 GPM of water from 88° to 78°F with a 72°F design wet bulb temperature in accordance with your proposal No. LA-CT-8070A dated October 31, 1968 with the following changes:

(1) Fiberglas end wall casing in lieu of the quoted asbestos board.

(2) Stairway in lieu of the quoted ladder.

(3) Two (2) 2-speed TEFC motors in lieu of the quoted 1-speed fan motors (manufacturer: U.S., G.E. or equivalent - no aluminum cases).

(4) Two (2) 20 ft. - 6 bladed Fluor-Aire fiberglas fan assemblies in lieu of the quoted 20 ft - 4 bladed Fluor-Solar assemblies.

(5) Stainless steel structural connectors in lieu of the quoted galvanized-Corten.

Design (6) Two (2) 1.15 service factor 75 HP TEFC motors in lieu of the quoted 1.00 - service factor motors.

B. Work to commence at once upon direction of Owner's Supervising Engineer and completed without undue delay in a workmanlike manner.

END

COOLING TOWER EQUIPMENT
INQUIRY & BID FORM
Mechanical Draft Water-Cooling Tower

Sheet 1 of 3

Customer	Manufacturer
Stauffer Chemical Company Westend, California 93564 By: Frank A. Bela	Fluor Products Co., Inc.
Inquiry No.	Proposal No. LA-CT-3070
Date: Orig. Rev.	Date: Orig. 10-7-68 Rev.

All data set forth herein is in accordance with definitions and standards published by the Cooling Tower Institute.

Symbol * = minimum information to be filled-in by customer, other items may be specified at customer's option.

GENERAL	
Selection	LA-CT-3070
Tower Model	260-568
Type	Induced Draft - Counterflow
DESIGN & OPERATING CONDITIONS	
*Circulating Water Flow, U.S. GPM	9360
*Hot (inlet) Water Temp. F.	88°F
*Cold (outlet) Water Temp. F.	73°F
*Wet Bulb Temp. F., Inlet	
Ambient	72°F
Tower Pump Head, Ft.	29'
Total Fan B.H.P., (Driver Output)	139.2
Drift Loss, % of circulating flow	Less than .2%
Evaporation Loss (at design)	10%
*Design Wind Load, Lbs./sq. ft.	30 lb/sq. ft.
Mi./hr.	0 - 100 mph
*Design Seismic Load, % C	Seismic Zone 3, Sec. 2314, Uniform Bld. code
*Tower Site (ground level, roof, etc.)	Ground Level
*Elevation Above Sea Level, ft.	1600 ft.
*Tower Exposure	East-West-Unobstructed
Heat Load	4.68 x 10^7 Btu/hr.
STRUCTURAL DETAILS	
Number of Cells	2
Fans per Cell	1
Total Number of Fans	2
Nominal Cell Dimen., L x W, ft.	30' x 36'
Overall Tower Dimension, L x W, ft.	60' x 36'
Height—Basin Curb to Fan Deck, ft.	31'
Fan Stack Height, ft.	6' -0"
Overall Tower Height, ft.	37'
Inside Basin Dimensions, ft.	61' x 37'
*Column Extensions, Perimeter, below basin curb, ft.	0' - 11 1/2"
Internal, below curb, ft. (max.)	0' - 11 1/2"
Anchorage	Perimeter Only

COOLING TOWER INSTITUTE
INQUIRY & BID FORM

Sheet 2 of 3
Inquiry No.
Proposal No. LA-CT-307

STRUCTURAL DETAILS (Cont'd.)

Hot Water Inlet—Number	2
Nom. Diameter, in.	16"
Description	125# ASA Flange
Height Inlet Above Basin Curb, ft.	25' - 5"
•Access to Top of Tower	Stairway
Shipping Weight, lbs.	108,000
Operating Weight, lbs.	163,700
Fill Spacing (Vert.)	24" on center
Fill volume (fill only)	43,200 ft^3
Fill Wetted Surface	46,800 ft^2

MATERIALS OF CONSTRUCTION

Framework Members	Douglas Fir
Casing	Fiberglass
Filling	Redwood (1" nominal)
Support	Douglas Fir
Drift Eliminators	Redwood
Spacer	Marine Plywood
Fan Stacks	Redwood
Louvers, Material	Cement Asbestos
Partitions	Redwood
Fan Deck	Douglas Fir
Water Distribution—Type	Enclosed - Low Pressure
Material	Redwood Stave
Lumber Pre-Treatment	Yes
Type of Treatment	Pressure treated, .75#/ft^3 ACC
Items Treated	All wood
Splashers or Spray Nozzles	Polypropylene
Stairway and Handrail	Redwood/Douglas fir
Structural Connectors	Galvanized
Ring Joint Connectors	None used
Bolts, Nuts, Washers	Galvanized
Anchor Connectors	Cast Iron
Nails	Nails-Galvanized
Mechanical Equipment Support	Galvanized Steel
•Anchor Bolts—Material	304 Stainless Steel
Furnished by	Purchaser
•Cold Water Basin—Material	Concrete
Furnished by	Purchaser
•Basin Accessories, by Mfg.	

MECHANICAL EQUIPMENT

Fans

Number	2
Type or Model	Adjustable Pitch Propeller
Manufacturer	Fluor-Solar
Diameter, ft.	16'
Number of Blades	4

COOLING TOWER INSTITUTE
INQUIRY & BID FORM

FLUOR

Sheet 3 of 3
Inquiry No.
Proposal No. LA-CT-807

MECHANICAL EQUIPMENT (Cont'd.)	
Fans	
Fan Speed, RPM	233
Tip Speed, FPM	11,650
BHP per fan, driver output	69.6
Blade Material	Stainless Steel
Hub Material	Galvanized weldment
Total Static Pressure, in. H_2O	.385
Velocity Pressure, in. H_2O	.356
Air Delivery per Fan, ACFM	463,000
Fan Static Efficiency	.40
Speed Reducer	
Number	2
Type	Spiral Bevel
Model	FWD-55
Manufacturer	Fluor-Western
Reduction Ratio	7.62:1
AGMA Mechanical H.P. Rating	80
Service Factor at Rated H.P. of Driver	2.0 minimum
No. of Reductions	Double
Corrosion-proofing	Not recommended
Drive Shaft	
Number	2
Type	Non-lubricated Flexible
Model	5006
Manufacturer	Fluor
Rated H.P.	75
Drive Shaft Material	Epoxy Coated
Coupling Material	Neoprene
Driver	
Number	2
*Kind	Electric Motor
*Type	TEFC
Manufacturer	Major Manufacturer-Fluor Option
Full Load Speed, RPM	1775
*Elec. Char.–phase/cycles/volts	3-60-230/460
Rated H.P.	75
ADDITIONAL DATA	

SANTA FE TANK & TOWER COMPANY, Inc.

= 22 gpm Water

Cooling Tower No. 2

North 34 amps

Proposal No. LA54-223 Date 8-5-54

To West End Chemical Co.

Tower Location Ground

Tower Site West End, California

WARRANTY OF PERFORMANCE

Circulating Water Rate 3,500 GPM

Cooled From 85 °F to 78 °F

Under following conditions:

Wet Bulb 75 °F, Elevation - - ft.

Wind Velocity 0 - 10 MPH.

Tower must be located in unobstructed area.

Max. drift loss 0.2% of circulation.

SPECIFICATIONS

Counterflow Induced Draft Cooling Tower Model 2SF54A-14.4-24x24-2C240

No. of Cells 2 No. Fans Per Cell 1

Each Cell 24 x 24 Arranged side by side

Overall Height (Basin Curb to Fan Deck) 57 Ft.

Overall Base 25' Wide x 49' Long

Approx. Basin Dimensions 26x50 Ft.

DISTRIBUTION SYSTEM

Type Upspray with Header of steel,

Laterals of steel, Nozzles of bronze,

Total Static Pumping Head (Above Basin Curb) 57 Ft.

Centerline Header above Basin Curb 44' 11" Ft.

FANS (Fans has been replaced - March 1989)

Manufacture ~~[illegible]~~

Total No. 2 Dia. 14' ✓ No. Blades per Fan ~~#~~ 6

Fan HP at Motor 27 Fan Speed 242 RPM

Tip Speed 10,640 FPM.

Design ✓

MOTORS

Number 2 HP 30 RPM 1800

Type TEFC Mfgr. GE or equal

Voltage 440 Phase 3 Cycle 60

GEARS

Number 2 Type Spiral bevel

Mfgr. Lufkin Model 90 V.B.

DRIVE SHAFTS

Mfgr. Thomas Model 200 SN

Material Stainless Disc Carbon Steel Shaft

COILSHED

No. of Coil Bays 8 No. of Dist. Systems 2

Height of Coilshed Doors 8' Max. Coil Length 20'

Overall Length 50' Overall Width 26'

PHYSICAL DATA

Bolts, Nuts & Washers Galvanized

Nails Copper

Castings Cast Iron

Type Fan Stack Venturi Redwood

Drift Eliminators 2-pass

Tower Sheathing Double wall Redwood (1" nominal)

Access to Top of Tower Stairway

DESIGN DETAILS

Design Wind Load 30 PSF

CFM/Fan ~~[illegible]~~ 280,000 Static .360

Water Concentration 3.03

MISCELLANEOUS

Anchor Bolts by Purchaser

Anchor Bolt Material - -

Basin by Purchaser

Basin of Concrete

Tower Post Length Below Basin Top 24"

Coil Supports by Purchaser

Coil Supports of - -

Approx. Shipping Wt. 241,000 #

Operating Wt. 313,000 #

FORM WP - 1M - W. P. CO.

```
SERV POINT: [illegible]   SYS LOC:                ACC LOC: 1  WORK CHARGE: 50885   DESC: #1 NH3 COOLING TOWER CIRCULATING PUMP
   MR ASSET:  P1037                                                             GROUP 4:
   ITEM CODE: 0                                                                    MODEL:
   SIGNIF:     1                                                                   TYPE:
   MINOR ACC:                                                                      FRAME:
   MAJOR ACC: 920                                                                  RPM:
   AREA ID:                                                                        HORSEPWR:
   CORP ASSET:                                                                     VOLTS:
GROUP 2:                                                                           PHASE:
   ORIG PO NO:                                                                     AMPS:
   ORIG PO DT:                                                                     SERVICE:
   MFG NAME:                                                                       WEIGHT:
   MFG SERIAL:                                                                     RATIO:
   MANUAL NO:
   MFG DRAW:                                                                    GROUP 5:
   WIRE DIAG:                                                                      SIZE DESC:
   SPEC:                                                                           SIZE/UNIT:
   VENDOR:                                                                         TEMP/UNIT:
GROUP 3:                                                                           CAP/UNIT:
   YEAR MANU:                                                                      PRESS/UNIT:
   INSTALL DATE:                                                                GROUP 6:
   WARRANTY ITD:                                                                   IMPELLER:
   COST:                                                                           ROTATION:
   PARTS GROUP:                                                                    MATERIAL:
GROUP 7:
   REMARKS: I.R. 12X14  10"X 14", 17.125 IMPELLER, 3500 GPM
            BEARINGS:2-7314SKF   426-2700
                     1-2314SKF   426-2720
```

DESIGN: 3,500 GPM
OPERATING: 2,700-3,200 GPM

```
SERV POINT: 09405   SYS LOC:                ACC LOC: 1  WORK CHARGE: 50885   DESC: #2 NH3 COOLING TOWER CIRCULATING PUMP
   MR ASSET:  M1842                                                             GROUP 4:
   ITEM CODE: 0                                                                    MODEL:
   SIGNIF:     1                                                                   TYPE:
   MINOR ACC:                                                                      FRAME:     6324
   MAJOR ACC: 920                                                                  RPM:       880.00
   AREA ID:                                                                        HORSEPWR:  75.00
   CORP ASSET:                                                                     VOLTS:     460
GROUP 2:                                                                           PHASE:
   ORIG PO NO:                                                                     AMPS:
   ORIG PO DT:                                                                     SERVICE:
   MFG NAME:                                                                       WEIGHT:
   MFG SERIAL: SK8092935                                                           RATIO:
   MANUAL NO:
   MFG DRAW:                                                                    GROUP 5:
   WIRE DIAG:                                                                      SIZE DESC:
   SPEC:                                                                           SIZE/UNIT:
   VENDOR:                                                                         TEMP/UNIT:
GROUP 3:                                                                           CAP/UNIT:
   YEAR MANU:                                                                      PRESS/UNIT:
   INSTALL DATE:                                                                GROUP 6:
   WARRANTY ITD:                                                                   IMPELLER:
   COST:                                                                           ROTATION:
   PARTS GROUP:                                                                    MATERIAL:
GROUP 7:
   REMARKS:
```

APPENDIX D LABORATORY ANALYSIS

HARRY W. GALBRAITH, PH.D
CHAIRMAN OF THE BOARD

KENNETH S. WOODS
PRESIDENT

GAIL R. HUTCHENS
EXECUTIVE VICE-PRESIDENT

VELMA M. RUSSELL
SECRETARY TREASURER

GALBRAITH
Laboratories, Inc.

QUANTITATIVE MICROANALYSES
ORGANIC – INORGANIC
615/546-1335

P.O. BOX 51610
KNOXVILLE, TN 37950-1610

2323 SYCAMORE DR.
KNOXVILLE, TN 37921-1750

Mr. Larry W. Smith
Environmental Systems Corporation
200 Tech Center Drive
Knoxville, Tennessee 37912

October 9, 1989

Received: September 22nd
PO#: 22297

Dear Mr. Smith:

Analysis of your compounds gave the following results:

Your #,	Our #,	mg/liter Sodium,	mg/liter SO4 as Sulfur,
IK-1	H-8610	0.68	1.28
IK-5	H-8611	0.28	0.83
IK-6A	H-8612	22.9	3.50
IK-9	H-8613	36.5	4.6
IK-14	H-6614	26.6	5.20
IK-20-9-89A	H-8615	0.15	0.98
IK-20-9-89B	H-8616	< 0.05	< 0.4
IK-105	H-8617	18.1	3.80
IK-140A	H-8618	44.9	7.40
IK-144	H-8619	0.49	0.87
IK-150	H-8620	28.2	3.40
IK-171A	H-8621	42.5	6.00
IK-181	H-8622	1.55	1.40
IK-4859A	H-8623	15.10	1.80
CW-2-1A	H-8624	22,875	2487
CW-2-2A	H-8625	23,250	2293
CW-2-2B	H-8626	26,500	2302

orig: [illegible]
cc: [illegible]

RECEIVED
OCT 10 1989
ENVIRONMENTAL SYSTEMS CORP

Your #,	Our #,	mg/liter Sodium,	mg/liter SO4 as Sulfur,
CW-2-3	H-8627	27,500	2254
CW-2-4	H-8628	22,875	2202
CW-2-5	H-8629	22,750	2228
CW-4-1A	H-8630	17,625	1754
CW-4-2A	H-8631	22,000	1790
CW-4-2B	H-8632	21,500	1648
CW-4-3	H-8633	21,875	1784
CW-4-5	H-8634	24,878	2012
CW-4-6	H-8635	25,375	2066
CW-4-4	H-8636	23,750	1930

Your #,	Our #,	mg Sodium,	µg SO4 as Sulfur,
IK-4859-BU	H-8637	65.6	286
IK-6-BU	H-8638	70.0	786
IK-105-BU	H-8639	78.0	251
IK-14-BU	H-8640	75.6	268
IK-144-BU	H-8641	82.0	309
IK-5-BU	H-8642	69.6	240
IK-140-BU	H-8643	65.6	208
IK-171-BU	H-8644	57.2	235
IK-150-BU	H-8645	70.0	223
IK-9-BU	H-8646	75.6	229
IK-1-BU	H-8647	71.2	228
IK-181-BU	H-8648	69.2	217

Your #,	Our #,	mg Sodium,	mg SO4 as Sulfur,
HV-4-1	H-8649	491.2	21.3
HV-4-2	H-8650	611.2	26.4
HV-4-3	H-8651	339.2	1.76
HV-4-4	H-8652	204.8	1.78
HV-4-5	H-8653	406.4	13.2
HV-4-6	H-8654	608.0	30.1
HV-4-7	H-8655	198.4	1.81
HV-4-8	H-8656	236.8	1.90
HV-2-1	H-8657	1648	30.3
HV-2-2	H-8658	2656	60.9
HV-2-3	H-8659	329.6	1.75
HV-2-4	H-8660	268.8	1.70
HV-2-5	H-8661	508.8	12.6
HV-2-6	H-8662	1469	31.1
HV-2-7	H-8663	374.4	1.72
HV-2-8	H-8664	259.2	1.66

Sincerely yours,

GALBRAITH LABORATORIES, INC.

Gail R Hutchens

Gail R. Hutchens
Exec. Vice-President

GRH:sc

K.M.C.C. DRIFT TESTS - WESTEND
#22-4628

SULFATE #2 - NORTH CELL

IK TUBES	ID FOR LAB ANALYSIS
#140 : POINTS 1-10	IK-140 (A & B)
#171 : POINTS 11-20	IK-171 (A & B)
#150 : POINTS 21-30	IK-150
#9 : POINTS 31-40	IK-9
#1 : BLANK (TAKEN PRE THIRD DIAMETER)	IK-1
#181 : BLANK (TAKEN AFTER TESTING COMPLETED)	K-181
IK BACKUP FILTERS	
IK-140-BU	IK-140-BU
IK-171-BU	IK-171-BU
IK-150-BU	IK-150-BU
IK-9-BU	IK-9-BU
IK-1-BLANK (TAKEN BEFORE 3rd DIA. 9-13-89)	IK-1-BU
IK-181-BLANK (TAKEN AFTER TESTING COMPLETED)	IK-181-BU
HI-VOL FILTERS	
9-12-89 : HI-VOL #1 (7 HOURS, 20 MINUTES @ 35 FPM)	HV-2-1
9-12-89 : HI-VOL #2 (7 HOURS, 20 MINUTES @ 35 FPM)	HV-2-2
9-13-89 : HI-VOL #1 (PRE-TEST BLANK)	HV-2-3
9-13-89 : HI-VOL #2 (PRE-TEST BLANK)	HV-2-4
9-13-89 : HI-VOL #1 (2 HOURS, 34 MINUTES @ 35 FPM)	HV-2-5
9-13-89 : HI-VOL #2 (2 HOURS, 34 MINUTES @ 35 FPM)	HV-2-6
9-13-89 : HI-VOL #1 (POST-TEST BLANK)	HV-2-7
9-13-89 : HI-VOL #2 (POST-TEST BLANK)	HV-2-8
CIRCULATING WATER SAMPLES	
CW-2-1 (PRE-1st DIA. 9-12-89)	CW-2-1 (A & B)
CW-2-2 (BETWEEN 1st & 2nd DIA. 9-12-89)	CW-2-2 (A & B)
CW-2-3 (POST-2nd DIA. 9-12-89)	CW-2-3
CW-2-4 (PRE-3rd DIA. 9-13-89)	CW-2-4
CW-2-5 (BETWEEN 3rd & 4th DIA. 9-13-89)	CW-2-5

* NO MOISTURE WAS CAPTURED IN THE WATER TRAP

SULFATE #4 - SOUTH CELL

IK TUBES	ID FOR LAB ANALYSIS
#4859 : POINTS 1-10	IK-4859 (A & B)
#6 : POINTS 11-20	IK-6 (A & B)
#105 : POINTS 21-30	IK-105
#14 : POINTS 31-40	IK-14
#144 : BLANK (TAKEN BEFORE 3rd DIAMETER)	IK-144
#5 : BLANK (TAKEN AFTER TESTING COMPLETED)	IK-5
IK BACKUP FILTERS	
IK-4859-BU	IK-4859-BU
IK-6-BU	IK-6-BU
IK-105-BU	IK-105-BU
IK-14-BU	IK-14-BU
IK-144-BLANK (TAKEN BEFORE 3rd DIA. 9-13-89)	IK-144-BU
IK-5-BLANK (TAKEN AFTER TESTING COMPLETED)	IK-5-BU
HI-VOL FILTERS	
9-13-89 : HI-VOL #1 (4 HOURS, 50 MINUTES @ 35 FPM)	HV-4-1
9-13-89 : HI-VOL #2 (4 HOURS, 50 MINUTES @ 35 FPM)	HV-4-2
9-13-89 : HI-VOL #1 (POST-TEST BLANK)	HV-4-3
9-13-89 : HI-VOL #2 (POST-TEST BLANK)	HV-4-4
9-14-89 : HI-VOL #1 (3-HOURS, 30 MINUTES @ 35 FPM)	HV-4-5
9-14-89 : HI-VOL #2 (3-HOURS, 30 MINUTES @ 35 FPM)	HV-4-6
9-14-89 : HI-VOL #1 (POST TEST BLANK)	HV-4-7
9-14-89 : HI-VOL #2 (POST TEST BLANK)	HV-4-8
CIRCULATING WATER SAMPLES	
CW-4-1 (PRE-1st DIA. 9-13-89)	CW-4-1 (A & B)
CW-4-2 (BETWEEN 1st & 2nd DIA. 9-13-89)	CW-4-2 (A & B)
CW-4-3 (POST-2nd DIA. 9-13-89)	CW-4-3
CW-4-4 (PRE-3rd DIA. 9-14-89)	CW-4-4
CW-4-5 (BETWEEN 3rd & 4th DIA. 9-14-89)	CW-4-5
CW-4-6 (POST-4th DIA. 9-14-89)	CW-4-6

* NO MOITURE WAS CAPTURED IN THE WATER TRAP

K.M.C.C. DRIFT TESTS - WESTEND
#22-4628

SULFATE #2 - NORTH CELL

IK TUBES	ID FOR LAB ANALYSIS
#140 : POINTS 1-10	IK-140 (A & B)
#171 : POINTS 11-20	IK-171 (A & B)
#150 : POINTS 21-30	IK-150
#9 : POINTS 31-40	IK-9
#1 : BLANK (TAKEN PRE THIRD DIAMETER)	IK-1
#181 : BLANK (TAKEN AFTER TESTING COMPLETED)	K-181

IK BACKUP FILTERS	
IK-140-BU	IK-140-BU
IK-171-BU	IK-171-BU
IK-150-BU	IK-150-BU
IK-9-BU	IK-9-BU
IK-1-BLANK (TAKEN BEFORE 3rd DIA. 9-13-89)	IK-1-BU
IK-181-BLANK (TAKEN AFTER TESTING COMPLETED)	IK-181-BU

HI-VOL FILTERS	
9-12-89 : HI-VOL #1 (7 HOURS, 20 MINUTES @ 35 FPM)	HV-2-1
9-12-89 : HI-VOL #2 (7 HOURS, 20 MINUTES @ 35 FPM)	HV-2-2
9-13-89 : HI-VOL #1 (PRE-TEST BLANK)	HV-2-3
9-13-89 : HI-VOL #2 (PRE-TEST BLANK)	HV-2-4
9-13-89 : HI-VOL #1 (2 HOURS, 34 MINUTES @ 35 FPM)	HV-2-5
9-13-89 : HI-VOL #2 (2 HOURS, 34 MINUTES @ 35 FPM)	HV-2-6
9-13-89 : HI-VOL #1 (POST-TEST BLANK)	HV-2-7
9-13-89 : HI-VOL #2 (POST-TEST BLANK)	HV-2-8

CIRCULATING WATER SAMPLES	
CW-2-1 (PRE-1st DIA. 9-12-89)	CW-2-1 (A & B)
CW-2-2 (BETWEEN 1st & 2nd DIA. 9-12-89)	CW-2-2 (A & B)
CW-2-3 (POST-2nd DIA. 9-12-89)	CW-2-3
CW-2-4 (PRE-3rd DIA. 9-13-89)	CW-2-4
CW-2-5 (BETWEEN 3rd & 4th DIA. 9-13-89)	CW-2-5

* NO MOISTURE WAS CAPTURED IN THE WATER TRAP

SULFATE #4 - SOUTH CELL

IK TUBES	ID FOR LAB ANALYSIS
#4859 : POINTS 1-10	IK-4859 (A & B)
#6 : POINTS 11-20	IK-6 (A & B)
#105 : POINTS 21-30	IK-105
#14 : POINTS 31-40	IK-14
#144 : BLANK (TAKEN BEFORE 3rd DIAMETER)	IK-144
#5 : BLANK (TAKEN AFTER TESTING COMPLETED)	IK-5

IK BACKUP FILTERS

IK-4859-BU	IK-4859-BU
IK-6-BU	IK-6-BU
IK-105-BU	IK-105-BU
IK-14-BU	IK-14-BU
IK-144-BLANK (TAKEN BEFORE 3rd DIA. 9-13-89)	IK-144-BU
IK-5-BLANK (TAKEN AFTER TESTING COMPLETED)	IK-5-BU

HI-VOL FILTERS

9-13-89 : HI-VOL #1 (4 HOURS, 50 MINUTES @ 35 FPM)	HV-4-1
9-13-89 : HI-VOL #2 (4 HOURS, 50 MINUTES @ 35 FPM)	HV-4-2
9-13-89 : HI-VOL #1 (POST-TEST BLANK)	HV-4-3
9-13-89 : HI-VOL #2 (POST-TEST BLANK)	HV-4-4
9-14-89 : HI-VOL #1 (3-HOURS, 30 MINUTES @ 35 FPM)	HV-4-5
9-14-89 : HI-VOL #2 (3-HOURS, 30 MINUTES @ 35 FPM)	HV-4-6
9-14-89 : HI-VOL #1 (POST TEST BLANK)	HV-4-7
9-14-89 : HI-VOL #2 (POST TEST BLANK)	HV-4-8

CIRCULATING WATER SAMPLES

CW-4-1 (PRE-1st DIA. 9-13-89)	CW-4-1 (A & B)
CW-4-2 (BETWEEN 1st & 2nd DIA. 9-13-89)	CW-4-2 (A & B)
CW-4-3 (POST-2nd DIA. 9-13-89)	CW-4-3
CW-4-4 (PRE-3rd DIA. 9-14-89)	CW-4-4
CW-4-5 (BETWEEN 3rd & 4th DIA. 9-14-89)	CW-4-5
CW-4-6 (POST-4th DIA. 9-14-89)	CW-4-6

* NO MOITURE WAS CAPTURED IN THE WATER TRAP

INTERNATIONAL
TECHNOLOGY
CORPORATION

Dear Larry Smith
Company: Environmental Systems
Your samples were received on: 9/22/89
They were logged in under project code: ESC 44202

10-5-89: May Tyler - problems with lab equipment analysis ready 10-13-89

10-18-89: May Tyler - will call back 10-19-89

Your samples were received in good condition unless otherwise indicated below.

If you have any questions please call (615) 588-6401 and reference your project code.

Comments:

Thank you for your business, and we look forward to working with you again.

Beth Monroe

Beth Monroe
Customer Service Representative

IT INTERNATIONAL TECHNOLOGY CORPORATION

ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

Environmental Systems
200 Tech Center Drive
Knoxville, TN 37912
ATTN: Larry Smith

October 11, 1989

Job Number: ESC 44202

P.O. Number: 22298

This is the Certificate of Analysis for the following samples:

Client Project ID: Environmental Systems
Date Received by Lab: 09/22/89
Number of Samples: Six (6)
Sample Type: Water

SODIUM ANALYSIS

Results in mg/liter (ppm)

Lab Sample ID	Client Sample ID	Result
PBWC0695/C0696	Method Blank	0.2 U
JJ6315	CW-2-1B	27,600
JJ6316	CW-4-1B	19,800
JJ6317	IK-6B	18.8
JJ6318	IK-140B	42.2
JJ6319	IK-171B	37.4
JJ6320	IK-4859B	15.2

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

Date Digested: 09/29/89
Date Analyzed: 10/05/89

Reviewed and Approved:

Janice Sterrett
Finance & Computer Services Manager

SULFATE ANALYSIS

Results in mg/liter (ppm)

Sample Matrix: Water

Lab Sample ID	Client Sample ID	Result
P0496/P0500	Method Blank	10 U
JJ6315	CW-2-1B	6,800
JJ6316	CW-4-1B	5,200
JJ6317	IK-6B	17 U*
JJ6318	IK-140B	17 U*
JJ6319	IK-171B	25 U*
JJ6320	IK-4859B	25 U*

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

• - Elevated detection limits due to dilution factors caused by insufficient sample volumes.

Date Analyzed: 10/05/89

INTERNATIONAL TECHNOLOGY CORPORATION

CHAIN-OF-CUSTODY RECORD

R/A Control No. ____________

C/C Control No. A 87321

PROJECT NAME/NUMBER ENVIRONMENTAL SYSTEMS

LAB DESTINATION ____________

SAMPLE TEAM MEMBERS ____________

CARRIER/WAYBILL NO. ____________

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.
1K-171B						
1K-6B						
1K-4859B						
1K-140B						
CW-4-1B						
CW-2-1B						

Special Instructions: ____________

Possible Sample Hazards: ____________

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: monica sternlieb, ESC 9/22 10:06

   Received By: ITAS 9-22-89 1010

2. Relinquished By: ____________

   Received By: ____________

3. Relinquished By: ____________

   Received by: ____________

4. Relinquished By: ____________

   Received By: ____________

WHITE - To accompany samples
YELLOW - Field copy

TECHNOLOGY CORPORATION

REQUEST FOR ANALYSIS

C/C Control No. ______

PROJECT NAME ENVIRONMENTAL SYSTEMS
PROJECT NUMBER 22-1628
PROJECT MANAGER LARRY SMITH
BILL TO ENVIRONMENTAL SYSTEMS,
200 TECH CENTER DRIVE
KNOXVILLE, TN 37912
PURCHASE ORDER NO. 22298

DATE SAMPLES SHIPPED ______
LAB DESTINATION ______
LABORATORY CONTACT ______
SEND LAB REPORT TO ______
DATE REPORT REQUIRED ______
PROJECT CONTACT ______
PROJECT CONTACT PHONE NO. ______

Sample No.	Sample Type	Sample Volume	Preservative	Requested Testing Program	Special Instructions
IK-171B	WATER			SODIUM & SULPHATE	
IK-6B	WATER			"	
IK-4859B	WATER			"	
IK-140B	WATER			"	
CW-1-1B	WATER			"	
CW-2-1B	WATER			SODIUM & SULPHATE	

TURNAROUND TIME REQUIRED: (Rush must be approved by the Project Manager.)

Normal ✓ **Rush** ______ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

Nonhazard ______ **Flammable** ______ **Skin Irritant** ______ **Highly Toxic** ______ **Other** ______ **(Please Specify)**

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping, and disposal.)

Return to Client ✓ **Disposal by Lab** ______

FOR LAB USE ONLY

Received By ______ **Date/Time** ______

WHITE - Original, to accompany samples
YELLOW - Field copy

APPENDIX E CALIBRATIONS

DVM INTERCOMPARISON 9-7-89

LWS

STANDARD USED: FLUKE 8022B S/N 2920259

STANDARD	S/N 47701310 FLUKE 801-KW	B&K 388-HD
0.000	0.000	0.000
0.100	0.100	0.100
0.201	0.200	0.200
0.301	0.300	0.300
0.401	0.400	0.401
0.500	0.500	0.499
0.600	0.600	0.599
0.700	0.701	0.700
0.800	0.800	0.799
0.900	0.900	0.900
1.000	1.000	0.999
2.01	2.010	2.00
5.00	5.00	4.99
10.02	10.02	10.00

TITLE: CALIBRATION OF WS/WD SENSORS

NO. ESC-P1-PPP-

REV. 1

LABORATORY CALIBRATION RECORD

WIND SPEED SENSOR (GENERATOR TYPE)

TIME: 2:11
TEMP: 23.36°C
B.P.: 974.8 mb.

TEST SENSOR

MODEL GILL 27106 S/N ESC #2

STANDARD

MODEL GILL 27100 S/N 5775
BLADE 5775 A CALIB. DATE 12-30-85

TEST EQUIPMENT

ITEM	MODEL	S/N	DATE OF LAST INTERCOMPARISON
FLUKE D.V.M.	8022B	2920259	12-14-88

FAN R.P.M.	STANDARD		TEST SENSOR		
	VELOCITY (M/S)	ACTUAL VELOCITY (M/S)	VOLTS	ERROR	RANGE
89	START	0.57	.025		.000
250	2	1.99	.108		.000
440	4	4.01	.227		.002
609	6	5.97	.337		.003
789	8	7.99	.455		.002
972	10	10.01	.572		.003
1151	12	11.97	.684		.003
1336	14	14.02	.804		.003
1517	16	15.97	.917		.004
	18	16.98	.973		.004
	STOP @	0.28			

PERFORMED BY: Harry O. Smith DATE: 3-14-89

REVIEWED BY: DATE: 4/10/89

ANEMOMETER CALIB. OF #ESC 2

CALIBRATION DATE 3-14-89

VEL(FPM)=3409.2*VOLTS+ 21.6

VOLTS	V(MPS)	V(FPM)	VPRED(FPM)	ERR(%)	CL(FPM)	CL(%)
0.108	1.99	392	390	0.499	5.205	1.335
0.227	4.01	789	795	-0.770	4.279	0.538
0.337	5.97	1175	1170	0.405	3.541	0.303
0.455	7.99	1573	1573	0.008	2.974	0.189
0.572	10.01	1971	1972	-0.055	2.783	0.141
0.684	11.97	2356	2353	0.125	3.013	0.128
0.804	14.02	2760	2763	-0.094	3.618	0.131
0.917	15.97	3144	3148	-0.126	4.396	0.140
0.973	16.98	3343	3339	0.118	4.826	0.145

ANEMOMETER CALIB. OF #ESC 3

CALIBRATION DATE 3-14-89

VEL(FPM)=3407.3*VOLTS+ 24.3

VOLTS	V(MPS)	V(FPM)	VPRED(FPM)	ERR(%)	CL(FPM)	CL(%)
0.108	2.00	394	392	0.363	4.299	1.096
0.224	4.00	787	788	-0.012	3.552	0.451
0.340	6.00	1181	1183	-0.137	2.910	0.246
0.455	8.01	1577	1575	0.141	2.457	0.156
0.569	9.98	1965	1963	0.082	2.299	0.117
0.687	11.99	2360	2365	-0.201	2.499	0.106
0.802	13.99	2754	2757	-0.104	2.981	0.108
0.916	15.97	3144	3145	-0.048	3.627	0.115
0.974	17.01	3349	3343	0.167	3.995	0.120

ANEMOMETER CALIB. OF ESC #5

CALIBRATION DATE 3-14-89

VEL(FPM)=3430.3*VOLTS+ 18.4

VOLTS	V(MPS)	V(FPM)	VPRED(FPM)	ERR(%)	CL(FPM)	CL(%)
0.110	2.00	394	396	-0.524	6.458	1.632
0.222	3.99	785	780	0.699	5.379	0.690
0.340	6.03	1187	1185	0.194	4.397	0.371
0.460	8.06	1587	1596	-0.612	3.696	0.231
0.571	10.06	1980	1977	0.164	3.473	0.176
0.683	12.00	2362	2361	0.041	3.744	0.159
0.800	14.02	2760	2763	-0.099	4.458	0.161
0.913	16.01	3152	3150	0.044	5.408	0.172
0.994	17.42	3429	3428.	0.032	6.181	0.180

CONTROL BOX CALIBRATION SPREADSHEET

ORIFICE MANOMETER SETTING	CALIBRATOR GAS VOLUME (ft3)		CONTROL BOX GAS VOLUME (ft3)	CALIBRATOR TEMP (F)	CONTROL BOX INLET TEMP (F)	CONTROL BOX OUTLET TEMP (F)	CONTROL BOX AVG TEMP (F)	TIME Tenths (min)	GAMMA	DELTA H@	Barometric Pressure(in.Hg)
	Desired	Actual Vw	Vd	Tw	Tdi	Tdo	Td		Y	Delta H @	
0.5	5	4.919	4.452	70	85	79	82	12.14	1.128586	1.731615	29.05
1	5	4.905	4.403	70	90	80	85	8.32	1.121664	1.633474	
2	10	9.776	9.01	70	99	84	91.5	12.3	1.123329	1.784003	
4	10	9.721	9.025	70	104	88	96	8.62	1.118672	1.759165	
									Avg Y 1.123063	Avg Delta H@ 1.727064	

BOX I.D. NUMBER- 5
CALIBRATION STANDARD- SECONDARY
CALIBRATION STANDARD I.D.- DGM1
DATE CALIBRATED- 9-19-89

CALIBRATED BY: GREG FISHBACK
VERIFIED BY: MIKE MOWERY

SIGNATURE:______________

Y - RATIO OF ACCURACY OF PRIMARY SOURCE
TOLERANCE = +/- 0.02

DELTA H@ - ORIFICE PRESSURE DIFFERENTIAL
AT STANDARD CONDITIONS
TOLERANCE = +/- 0.20

CALIBRATION PERFORMED BY: GREG FISHBACK

CONTROL BOX CALIBRATION SPREADSHEET

ORIFICE MANOMETER SETTING	CALIBRATOR GAS VOLUME (ft3)		CONTROL BOX GAS VOLUME (ft3)	CALIBRATOR TEMP (F)	CONTROL BOX INLET TEMP (F)	CONTROL BOX OUTLET TEMP (F)	CONTROL BOX AVG TEMP (F)	TIME Tenths (min)	GAMMA	DELTA H@	Barometric Pressure(in.Hg)
	Desired	Actual Vw	Vd	Tw	Tdi	Tdo	Td		Y	Delta H @	
0.5	5	4.831	4.57	75	103.5	87	95.25	11.6	1.095760	1.645986	29.05
1	5	4.816	4.64	75	107.5	92	99.75	8.47	1.083210	1.750135	
2	10	9.552	9.27	75	115	96	105.5	12.82	1.083645	1.838092	
4	10	9.452	9.2	75	124	101	112.5	8.42	1.088417	1.767130	
									Avg Y 1.087758	Avg Delta H@ 1.750335	

BOX I.D. NUMBER- 5
CALIBRATION STANDARD- SECONDARY
CALIBRATION STANDARD I.D.- DGM1
DATE CALIBRATED- 8-6-89

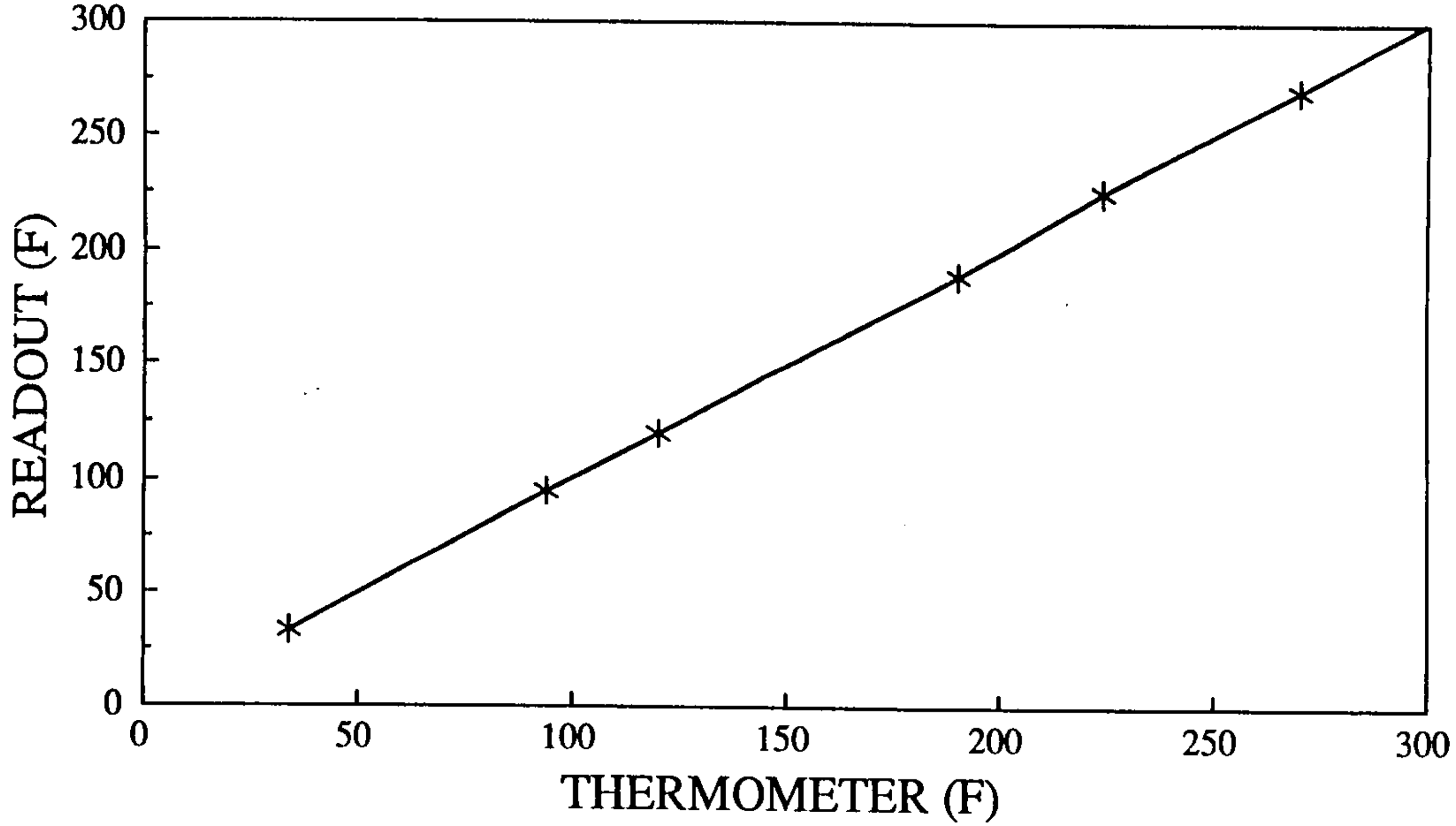
Y - RATIO OF ACCURACY OF PRIMARY SOURCE
TOLERANCE = +/- 0.02

CALIBRATION PERFORMED BY: MIKE MOWERY

DELTA H@ - ORIFICE PRESSURE DIFFERENTIAL
AT STANDARD CONDITIONS
TOLERANCE = +/- 0.20

SIGNATURE: Michael Mowery

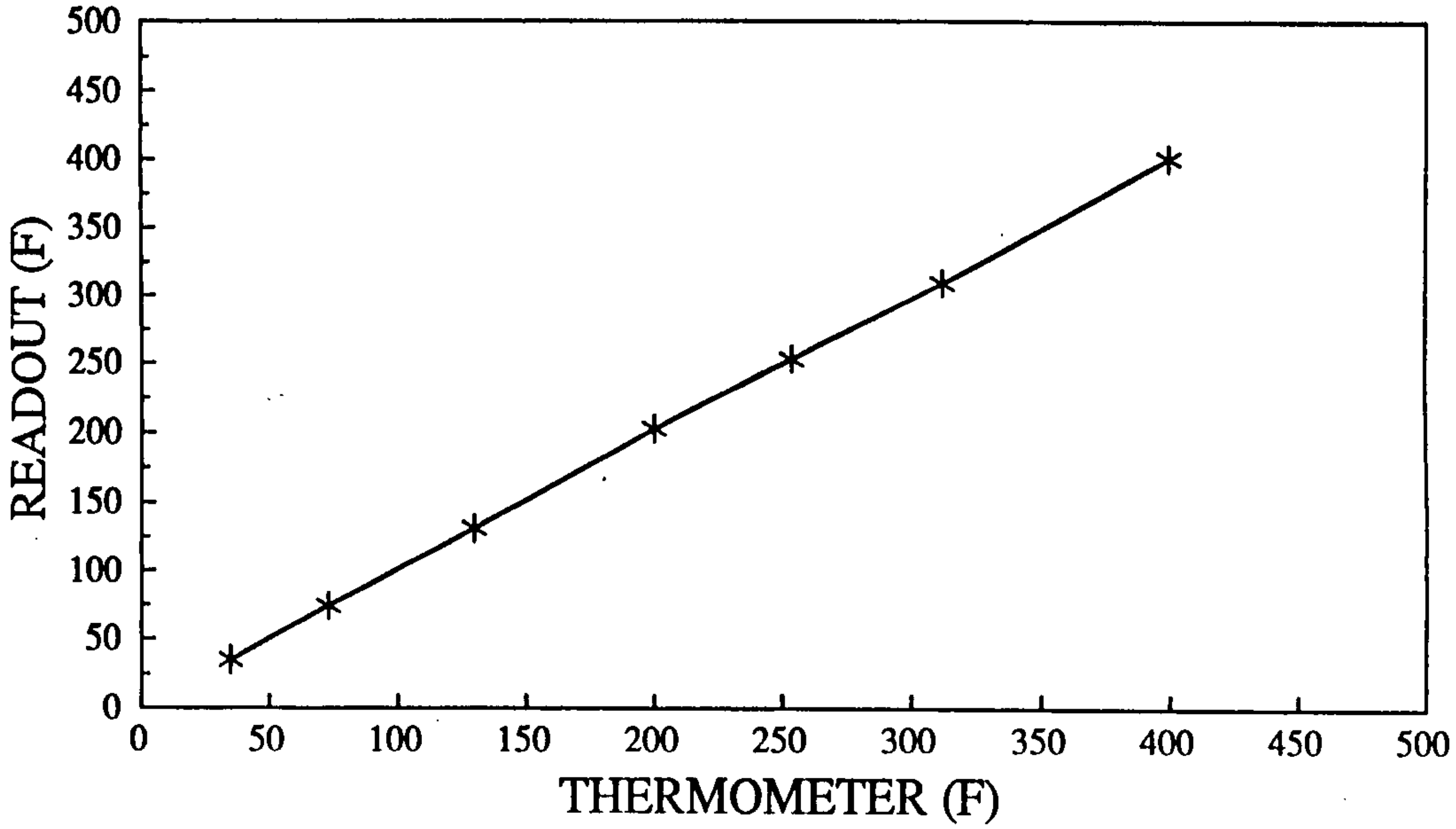
THERMOCOUPLE READOUT CALIBRATION



OMEGA 450 AKT UNIT 1

CALIBRATION DATE 9-20-89
BY: M.S.M.

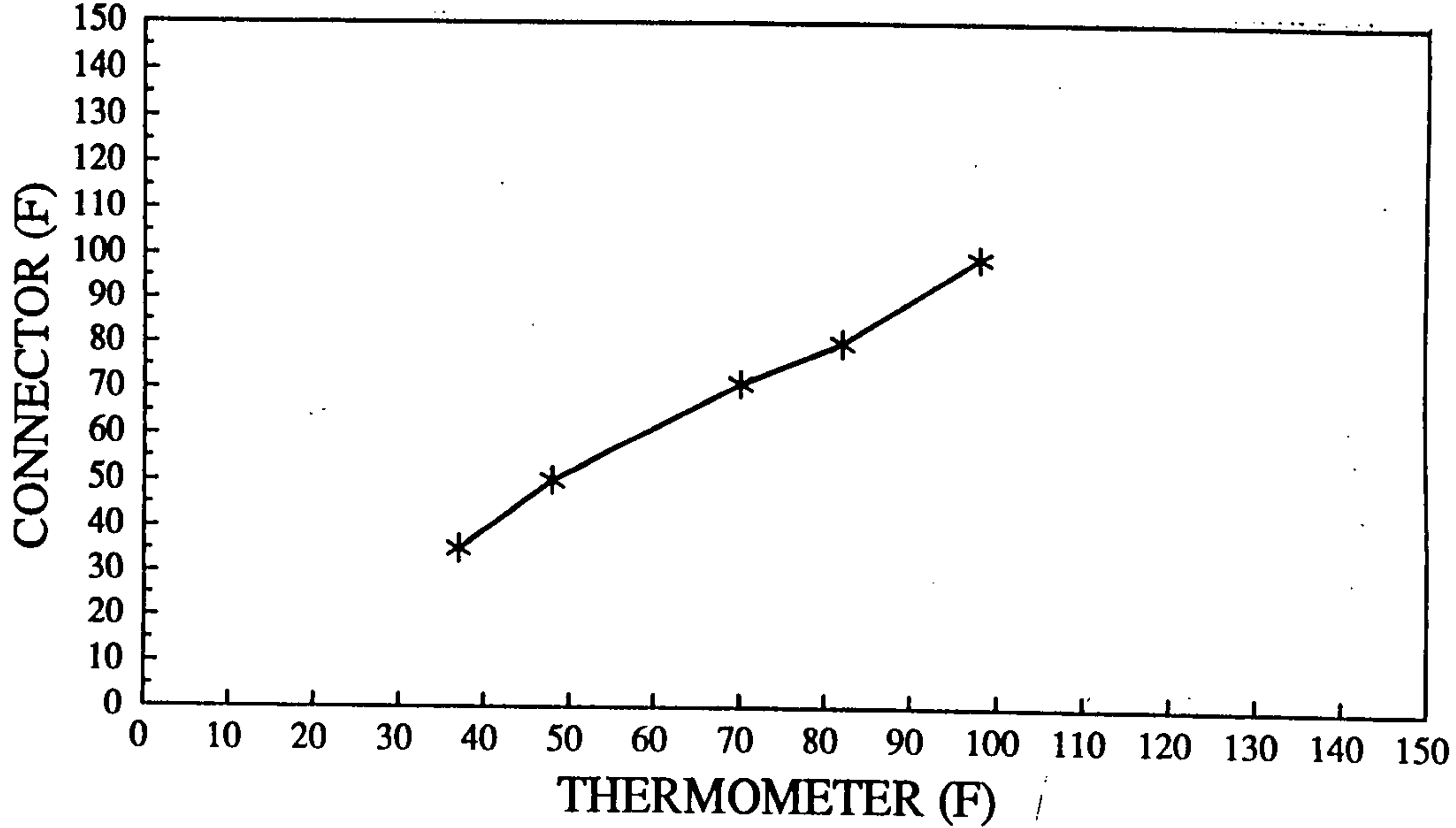
THERMOCOUPLE READOUT CALIBRATION



OMEGA 450 AKT
UNIT NO. 1

CALIBRATION DATE 6-1-89
BY: M.S.M.

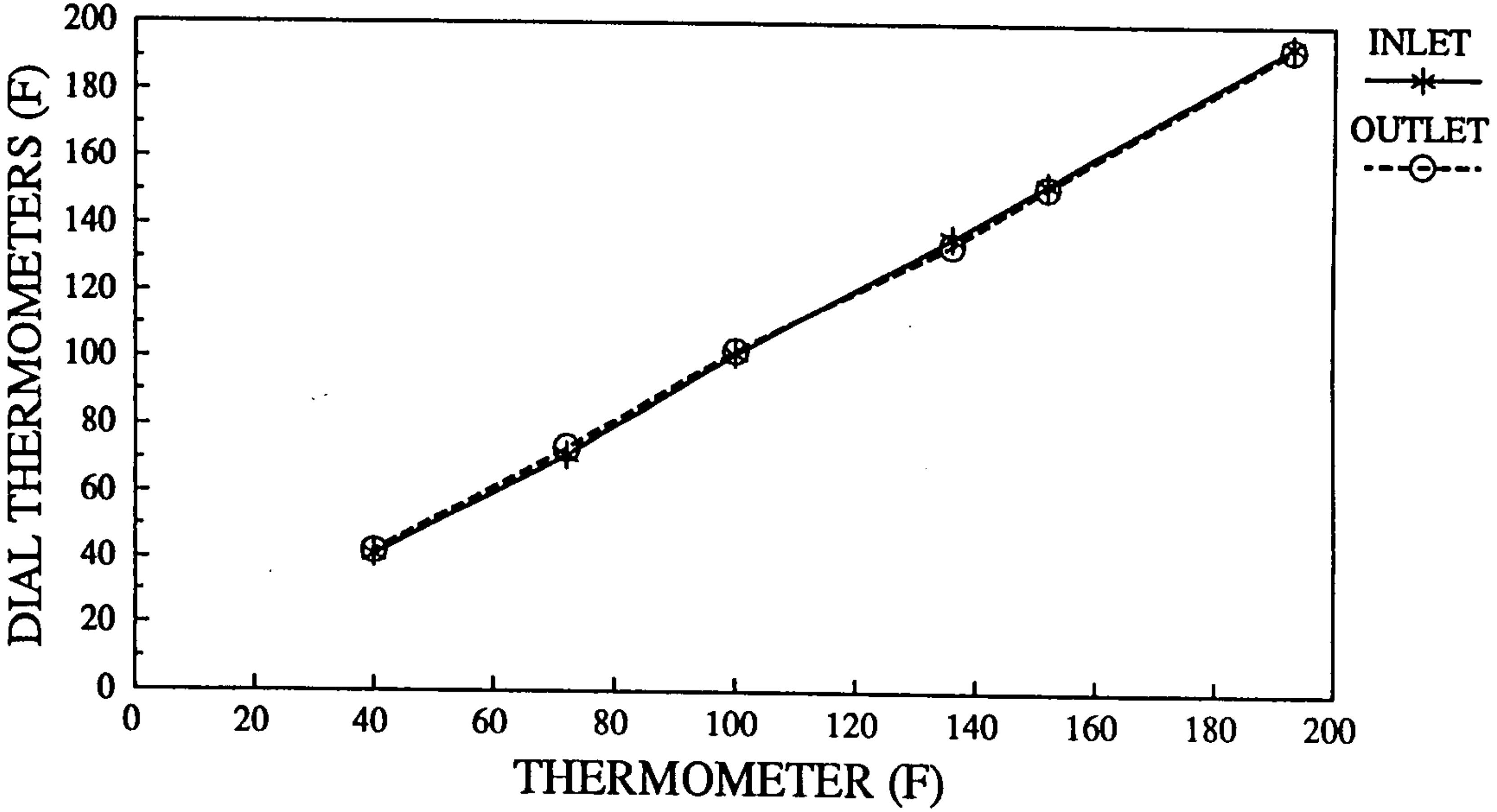
IMPINGER CONNECTOR
THERMOMETER CALIBRATION



CONNECTOR
UNIT NO. 1

CALIBRATION DATE 6-1-89
BY: M.S.M.

CONTROL BOX THERMOMETERS
INLET-OUTLET CALIBRATIONS



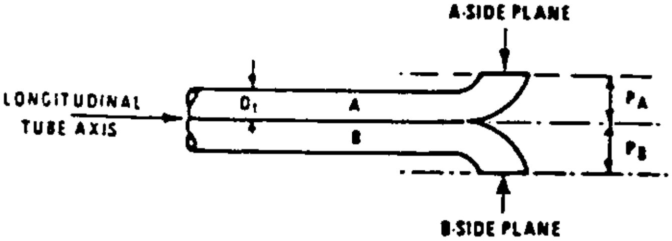
CONTROL BOX NO. 5

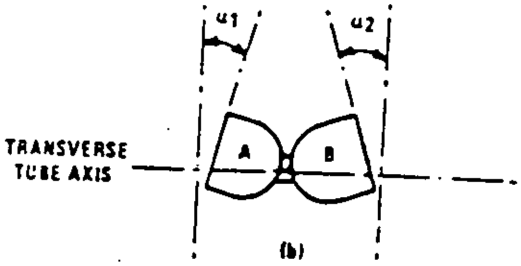
CALIBRATION DATE 6-1-89
BY: M.S.M.

INTERNATIONAL
TECHNOLOGY
CORPORATION

TYPE S PITOT TUBE
CONSTRUCTION CALIBRATIONS

Pitot I.D. No. 6' probe attached Date 9-8-89 Performed By MSM





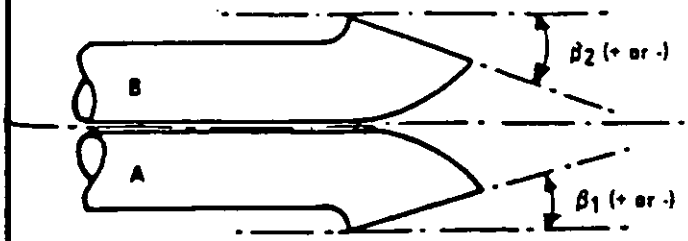
Dt = 0.79 (0.48 to 0.95 cm)

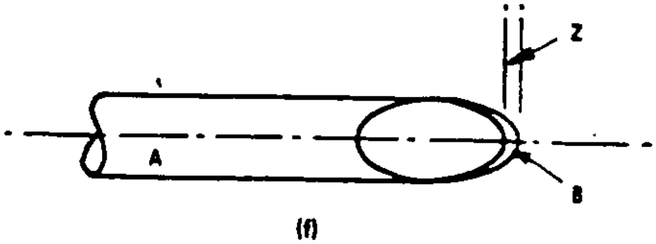
Pa = 1.27 (1.05 Dt≤P≤1.50 Dt)

Pb = 1.27 (1.05 Dt≤P≤1.50 Dt)

a1 = 0 (<10°)

a2 = 0 (<10°)





B1 = 0 (<5°)

B2 = 0 (<5°)

Z = 0 (≤ 0.32cm)

W = 0 (≤ 0.08cm)

INTERNATIONAL TECHNOLOGY CORPORATION

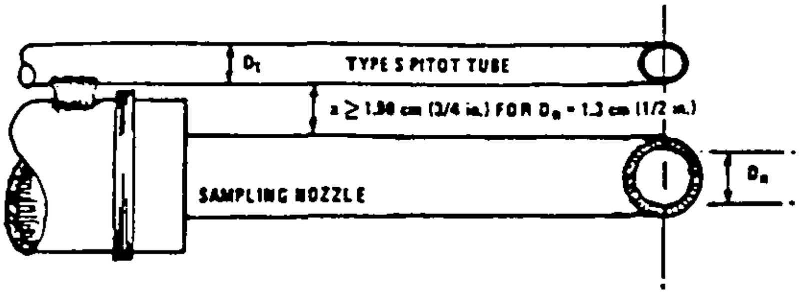
PITOT ALIGNMENT CALIBRATIONS

TYPE S PITOT TUBE

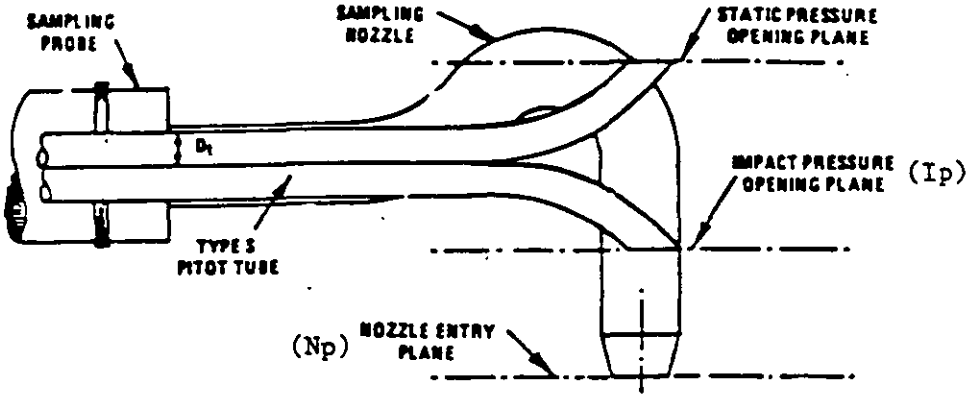
page 1 of 2

Pitot I.D. No. 6' probe attached Date 9-8-89 Performed By MSM

Pitot Alignment Calibrations



X = 1.95 (X≥1.90 cm)



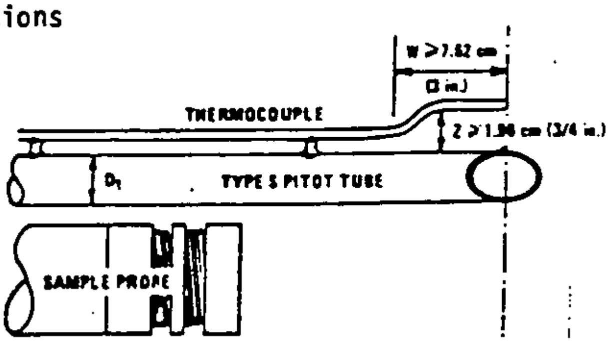
Is Ip higher than Np yes (Ip must be higher than Np)

INTERNATIONAL TECHNOLOGY CORPORATION

PITOT ALIGNMENT CALIBRATIONS
TYPE S PITOT TUBE

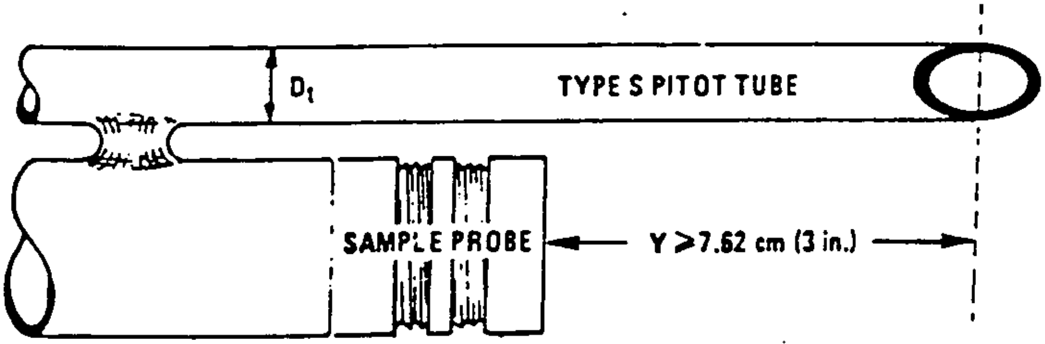
Pitot I.D. No. 6' probe attached Date 9-8-89 Performed BY MSM

Pitot Alignment Calibrations



W = 7.62 (W≥7,62 cm)

Z = 2.20 (Z≥1.90 cm)



Y = 7.62 (Y≥7.62 cm)

Determined Coefficient 0.84

APPENDIX F OPERATIONAL DATA

Evaporation about .7% for 10° Cooling = 22 gpm Water

SANTA FE TANK & TOWER COMPANY, Inc.

Cooling Tower No. 2

North 34 amps

Proposal No. LA54-223 Date 8-5-54

To West End Chemical Co.

Tower Location Ground

Tower Site West End, California

WARRANTY OF PERFORMANCE

Circulating Water Rate 3,500 GPM

Cooled From 85 °F to 78 °F

Under following conditions:

Wet Bulb 75 °F, Elevation - - ft.

Wind Velocity 0 - 10 MPH.

Tower must be located in unobstructed area.

Max. drift loss 0.2% of circulation.

SPECIFICATIONS

Counterflow Induced Draft Cooling Tower Model 2SF54A-14.4-24x24-2C240

No. of Cells 2 No. Fans Per Cell 1

Each Cell 24 x 24 Arranged side by side

Overall Height (Basin Curb to Fan Deck) 57 Ft.

Overall Base 25' Wide x 49' Long

Approx. Basin Dimensions 26x50 Ft.

DISTRIBUTION SYSTEM

Type Upspray with Header of steel,

Laterals of steel, Nozzles of bronze

Total Static Pumping Head (Above Basin Curb) 57 Ft.

Centerline Header above Basin Curb 44' 11" Ft.

FANS (Fans has been replaced - March 1989)

Manufacture ~~[illegible]~~

Total No. 2 Dia. 14' ✓ No. Blades per Fan ~~[illegible]~~ 6

Fan HP at Motor 27 Fan Speed 242 RPM

Tip Speed 10,640 FPM.

Design ✓

MOTORS

Number 2 HP 30 RPM 1800

Type TEFC Mfgr. GE or equal

Voltage 440 Phase 3 Cycle 60

GEARS

Number 2 Type Spiral bevel

Mfgr. Lufkin Model 90 V.B.

DRIVE SHAFTS

Mfgr. Thomas Model 200 SN

Material Stainless Disc Carbon Steel Shaft

COILSHED

No. of Coil Bays 8 No. of Dist. Systems 2

Height of Coilshed Doors 8' Max. Coil Length 20'

Overall Length 50' Overall Width 26'

PHYSICAL DATA

Bolts, Nuts & Washers Galvanized

Nails Copper

Castings Cast Iron

Type Fan Stack Venturi Redwood

Drift Eliminators 2-pass

Tower Sheathing Double wall Redwood (1" nominal)

Access to Top of Tower Stairway

DESIGN DETAILS

Design Wind Load 30 PSF

CFM/Fan ~~227,000~~ 280,000 Static .360

Water Concentration 3.03

MISCELLANEOUS

Anchor Bolts by Purchaser

Anchor Bolt Material - -

Basin by Purchaser

Basin of Concrete

Tower Post Length Below Basin Top 24"

Coil Supports by Purchaser

Coil Supports of - -

Approx. Shipping Wt. 241,000 #

Operating Wt. 313,000 #

```
[illegible]

SER POINT: [illegible]    SYS LOC:              ACC LOC: 1  WORK CHARGE: 5088[illegible]   DESC: #1 NH3 COOLING TOWER CIRCULATING PUMP
   MR ASSET:  M103[illegible]                                                     GROUP 4:
   ITEM CODE: [illegible]                                                            MODEL:
   SIGNIF:    [illegible]                                                            TYPE:
   MINOR ACC:                                                                        FRAME:
   MAJOR ACC: 920                                                                    RPM:
   AREA ID:                                                                          HORSEPWR:
   CORP ASSET:                                                                       VOLTS:
 GROUP 2:                                                                            PHASE:
   ORIG PO NO:                                                                       AMPS:
   ORIG PO DT:                                                                       SERVICE:
   MFG NAME:                                                                         WEIGHT:
   MFG SERIAL:                                                                       RATIO:
   MANUAL NO:
   MFG DRAW:                                                                      GROUP 5:
   WIRE DIAG:                                                                        SIZE DESC:
   SPEC:                                                                             SIZE/UNIT:
   VENDOR:                                                                           TEMP/UNIT:
 GROUP 3:                                                                            CAP/UNIT:
   YEAR MANU:                                                                        PRESS/UNIT:
   INSTALL DATE:                                                                  GROUP 6:
   WARRANTY ITD:                                                                     IMPELLER:
   COST:                                                                             ROTATION:
   PARTS GROUP:                                                                      MATERIAL:
 GROUP 7:
   REMARKS: [illegible] 10⅝ 14", [illegible] IMPELLER, 3500 GPM
            BEARINGS:2-7314BKE   436-2700
                     1-22314KF   436-2720
```

DESIGN: 3500 GPM
OPERATING: 2,700 - 3,200 GPM

```
SER POINT: 09405    SYS LOC:              ACC LOC: 1  WORK CHARGE: 50885   DESC: #2 NH3 COOLING TOWER CIRCULATING PUMP
   MR ASSET:  M1842                                                       GROUP 4:
   ITEM CODE: [illegible]                                                    MODEL:
   SIGNIF:    [illegible]                                                    TYPE:
   MINOR ACC:                                                                FRAME:     6324
   MAJOR ACC: 920                                                            RPM:       880.00
   AREA ID:                                                                  HORSEPWR:  75.00
   CORP ASSET:                                                               VOLTS:     460
 GROUP 2:                                                                    PHASE:
   ORIG PO NO:                                                               AMPS:
   ORIG PO DT:                                                               SERVICE:
   MFG NAME:                                                                 WEIGHT:
   MFG SERIAL: SK8092935                                                     RATIO:
   MANUAL NO:
   MFG DRAW:                                                              GROUP 5:
   WIRE DIAG:                                                                SIZE DESC:
   SPEC:                                                                     SIZE/UNIT:
   VENDOR:                                                                   TEMP/UNIT:
 GROUP 3:                                                                    CAP/UNIT:
   YEAR MANU:                                                                PRESS/UNIT:
   INSTALL DATE:                                                          GROUP 6:
   WARRANTY ITD:                                                             IMPELLER:
   COST:                                                                     ROTATION:
   PARTS GROUP:                                                              MATERIAL:
 GROUP 7:
   REMARKS:
```

9-14-89

Ed,

ANOTHER SET of READINGS WERE OBTAINED FROM #4 & #2 COOLING TOWERS FOR THE BENEFIT of MR. LARRY SMITH. THE READINGS AT #4 COOLING TOWER WERE TAKEN AT 3 LOCATIONS (0915-0945 HRS) TO INSURE MORE ACCURATE DATA. THE FLOW RATES WERE AS FOLLOWS:

LOCATION 1. 20" Sched. 30 VERTICAL LINE FROM Xchanger
To Tower. 7.7-7.8 FPS 6810-6899 gpm

LOCATION 2. Upper 16" Sched. 40 HORIZONTAL LINE To
Xchanger. 6.1 FPS 3363 gpm

Lower 16" Sched. 40 HORIZONTAL LINE To
Xchanger. 6.1 FPS - 8.0* FPS 3363 - 4410 gp.
Combined Rate 6726 - 7773 gp

LOCATION 3. 20" Sched. 30 HORIZONTAL LINE immediately after
Pumps, before ell. 8.0 - 8.4 FPS 7075 - 7429 g

#2 COOLING TOWER FLOW RATE WAS: 9.5 FPS 3317 gpm
(12" Sched. 40 VERTICAL LINE) 1000 HRS

Ed, I've also ATTACHED A CROSS-Reference CHART TO SHOW HOW I CAME UP WITH THE FLOW RATES.

Ralph Alvarado

* THIS HIGH (8.0) SWING WAS Probably due to turbulence. THE 6.1 reading

Dynasonics, Inc.

522 W. 5th Ave. (312) 355-3055
NAPERVILLE, IL 60540

FPS TO GPM CROSS-REFERENCE (Schedule 40)

PIPE DIA.	FPS 1	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
1	2.7	4	5.4	6.7	8.1	9.4	10.8	12.1	13.5	14.8	16.1	17.5	18.9	20.2	21.6	22.9	24.3	25.6	27
1¼	4.7	7	9.3	11.6	14	16.3	18.7	21	23.3	25.7	28	30.3	32.7	35	37.3	40	42	44.3	46.6
1½	6.3	9.5	12.7	15.8	19	22.3	25.4	28.6	32	35	38	41.2	44.4	47.6	51	54	57	60	63.4
2	10.5	16	21	26	31	37	42	47	52	58	63	68	73	78	84	89	94	99	105
2½	15	22	30	37	45	52	60	67	74	82	89	97	104	112	119	127	134	142	149
3	23	35	46	58	79	81	92	104	115	127	138	150	161	173	184	196	207	219	231
3½	31	46.3	62	77	92	108	123	139	154	170	185	200	216	231	247	262	277	293	308
4	40	60	69	99	120	139	159	179	199	220	238	258	278	298	318	338	357	377	397
5	62	94	125	156	187	218	250	281	312	343	374	406	437	468	499	530	562	593	624
6	90.1	135	180	225	270	315	360	405	450	496	541	586	631	676	721	766	811	856	901
8	156	234	312	390	468	546	624	702	780	858	936	1014	1092	1170	1248	1326	1404	1482	1560
10	246	369	492	615	738	861	984	1107	1230	1353	1476	1599	1722	1845	1968	2091	2214	2337	2460
12	349	524	698	873	1047	1222	1397	1571	1746	1920	2095	2269	2444	2619	2793	2968	3142	3317	3492
14	422	633	844	1055	1266	1477	1689	1900	2110	2321	2533	2744	2955	3166	3377	3588	3799	4010	4221
16	551	827	1102	1378	1654	1929	2205	2481	2756	3032	3308	3583	3859	4134	4410	4686	4961	5237	5513
18	698	1047	1398	1744	2093	2442	2791	3140	3489	3838	4187	4535	4884	5233	5582	5931	6280	6629	6978
20	867	1301	1734	2168	2602	3035	3469	3902	4336	4770	5203	5637	6071	6504	6938	7371	7805	8239	8673
24	1254	1882	2509	3136	3763	4390	5018	5645	6272	6899	7526	8154	8781	9407	10034	10662	11290	11917	12544

EQUATION TO CONVERT FPS TO GPM GPM = (PIPE I.D.)² x VELOCITY IN FT/SEC. x 2.45

23.5

20" schd. 30 (19)²

9-14-89
0800 - 0820 Hrs

ED,

FLOW RATES FOR TODAY WERE:

2	Cooling Tower	3317 gpm
4	Cooling Tower	7442 gpm*
		7075 gpm**

* TOTAL RATE OF both 16" LINES.

** RATE OF 20" LINE AFTER THE TWO pumps before cell.

Ralph Edwards

9-13-89
1245-1305

Ed,

Today's flow rates were:

# 2 Cooling Tower	2514 gpm
# 4 Cooling Tower	7221 gpm*
	6810 gpm **

* Flows of Two 16" lines Combined.

** 20" line after two pumps.

Cooling Tower No. 4

STAUFFER CHEMICAL COMPANY
Westend, California 93564

RECEIVED
APR 23 1969
WESTEND PLANT

South Cell 82 amps

I97-139794
Contract No.
3966
Req. No.
AR 197-140
Account No.

This Agreement, Made the Eighth Day of April in the year One Thousand Nine Hundred and Sixty-Nine, by and between the Fluor Products Co. Inc.
339 E. San Antonio Drive, Long Beach, California 90807

hereinafter called the **Contractor**, and the **Stauffer Chemical Company**, a Delaware corporation, hereinafter called the **Owner**.

Witnesseth: That the **Contractor** and the **Owner** for the consideration hereinafter named, agree as follows:

Article 1. The **Contractor** agrees to provide all of the material, equipment and labor and to perform all of the work tofurnish and erect Fluor Model 253-578 2-cell Induced Draft Crossflow Cooling Tower.

as described in the specifications in Article II

and shown on the plans or drawings as prepared by

Architect, Engineer for the erection and completion of same

to be erected at Westend, California

and to do, to the satisfaction of the **Owner** and said **Architect, Engineer,** everything required of the **Contractor** by the drawings and specifications, including the General Conditions thereof, except as herein expressly modified or changed, it being agreed that such drawings and specifications, including the General Conditions thereof, are as fully a part of this Agreement as if hereto attached or herein repeated. It is further agreed that the decision of the **Owner** and **Architect, Engineer** as to the true construction and meaning of said drawings and specifications shall be final.

Article II.

A. Contractor shall furnish all labor, material, tools, equipment and supervision to erect Fluor Model 253-578 2-cell Induced Draft Crossflow Cooling Tower to cool 9360 GPM of water from 88° to 78°F with a 72°F design wet bulb temperature in accordance with your proposal No. LA-CT-8070A dated October 31, 1968 with the following changes:

(1) Fiberglas end wall casing in lieu of the quoted asbestos board.

(2) Stairway in lieu of the quoted ladder.

(3) Two (2) 2-speed TEFC motors in lieu of the quoted 1-speed fan motors (manufacturer: U.S., G.E. or equivalent - no aluminum cases).

(4) Two (2) 20 ft. - 6 bladed Fluor-Aire fiberglas fan assemblies in lieu of the quoted 20 ft - 4 bladed Fluor-Solar assemblies.

(5) Stainless steel structural connectors in lieu of the quoted galvanized-Corten.

Design

(6) Two (2) 1.15 service factor 75 HP TEFC motors in lieu of the quoted 1.00 - service factor motors.

B. Work to commence at once upon direction of Owner's Supervising Engineer and completed without undue delay in a workmanlike manner.

END*

COOLING TOWER INSTITUTE
INQUIRY & BID FORM
Mechanical Draft Water-Cooling Tower

Sheet 1 of 3

Customer
Stauffer Chemical Company
Westend, California 93564
By: Frank A. Bela
Inquiry No.
Date: Orig. Rev.

Manufacturer
Fluor Products Co., Inc.
Proposal No. LA-CT-3070
Date: Orig. 10-7-68 Rev.

All data set forth herein is in accordance with definitions and standards published by the Cooling Tower Institute.

Symbol * = minimum information to be filled-in by customer, other items may be specified at customer's option.

GENERAL	
Selection	LA-CT-3070
Tower Model	260-563
Type	Induced Draft - Counterflow
DESIGN & OPERATING CONDITIONS	
*Circulating Water Flow, U.S. GPM	9360
*Hot (inlet) Water Temp. F.	83°F
*Cold (outlet) Water Temp. F.	73°F
*Wet Bulb Temp. F., Inlet	
Ambient	72°F
Tower Pump Head, Ft.	29'
Total Fan B.H.P., (Driver Output)	139.2
Drift Loss, % of circulating flow	Less than .2%
Evaporation Loss (at design)	10%
*Design Wind Load, Lbs./sq. ft.	30 lb/sq. ft.
Mi./hr.	0 - 100 mph
*Design Seismic Load, % C	Seismic Zone 3, Sec. 2314, Uniform Blc code
*Tower Site (ground level, roof, etc.)	Ground Level
*Elevation Above Sea Level, ft.	1600 ft.
*Tower Exposure	East-West-Unobstructed
Heat Load	4.63 x 10^7 Btu/hr.
STRUCTURAL DETAILS	
Number of Cells	2
Fans per Cell	1
Total Number of Fans	2
Nominal Cell Dimen., L&W, ft.	30' x 36'
Overall Tower Dimension, L&W, ft.	60' x 36'
Height—Basin Curb to Fan Deck, ft.	31'
Fan Stack Height, ft.	6' -0"
Overall Tower Height, ft.	37'
Inside Basin Dimensions, ft.	61' x 37'
*Column Extensions, Perimeter, below basin curb, ft.	0' - 11 1/2"
Internal, below curb, ft. (max.)	0' - 11 1/2"
Anchorage	Perimeter Only

COOLING TOWER INSTITUTE
INQUIRY & BID FORM

Sheet 2 of 3
Inquiry No.
Proposal No. LA-CT-307

STRUCTURAL DETAILS (Cont'd.)	
Hot Water Inlet—Number	2
Nom. Diameter, in.	16"
Description	125# ASA Flange
Height Inlet Above Basin Curb, ft.	25' - 5"
•Access to Top of Tower	Stairway
Shipping Weight, lbs.	103,000
Operating Weight, lbs.	163,700
Fill Spacing (Vert.)	24" on center
Fill volume (fill only)	43,200 ft^3
Fill Wetted Surface	46,800 ft^2
MATERIALS OF CONSTRUCTION	
Framework Members	Douglas Fir
Casing	Fiberglass
Filling	Redwood (1" nominal)
Support	Douglas Fir
Drift Eliminators	Redwood
Spacer	Marine Plywood
Fan Stacks	Redwood
Louvers, Material	Cement Asbestos
Partitions	Redwood
Fan Deck	Douglas Fir
Water Distribution—Type	Enclosed - Low Pressure
Material	Redwood Stave
Lumber Pre-Treatment	Yes
Type of Treatment	Pressure treated, .75#/ft^3 ACC
Items Treated	All wood
Splashers or Spray Nozzles	Polypropylene
Stairway and Handrail	Redwood/Douglas fir
Structural Connectors	Galvanized
Ring Joint Connectors	None used
Bolts, Nuts, Washers	Galvanized
Anchor Connectors	Cast Iron
Nails	Nails-Galvanized
Mechanical Equipment Support	Galvanized Steel
•Anchor Bolts—Material	304 Stainless Steel
Furnished by	Purchaser
•Cold Water Basin—Material	Concrete
Furnished by	Purchaser
•Basin Accessories, by Mfg.	
MECHANICAL EQUIPMENT	
Fans	
Number	2
Type or Model	Adjustable Pitch Propeller
Manufacturer	Fluor-Solar
Diameter, ft.	16'
Number of Blades	4

COOLING TOWER INSTITUTE
INQUIRY & BID FORM

FLUOR

Sheet 3 of 3
Inquiry No.
Proposal No. LA-CT-80

MECHANICAL EQUIPMENT (Cont'd.)	
Fans	
Fan Speed, RPM	233
Tip Speed, FPM	11,650
BHP per fan, driver output	69.6
Blade Material	Stainless Steel
Hub Material	Galvanized weldment
Total Static Pressure, in. H_2O	.385
Velocity Pressure, in. H_2O	.356
Air Delivery per Fan, ACFM	463,000
Fan Static Efficiency	.40
Speed Reducer	
Number	2
Type	Spiral Bevel
Model	FWD-55
Manufacturer	Fluor-Western
Reduction Ratio	7.62:1
AGMA Mechanical H.P. Rating	80
Service Factor at Rated H.P. of Driver	2.0 minimum
No. of Reductions	Double
Corrosion-proofing	Not recommended
Drive Shaft	
Number	2
Type	Non-lubricated Flexible
Model	5006
Manufacturer	Fluor
Rated H.P.	75
Drive Shaft Material	Epoxy Coated
Coupling Material	Neoprene
Driver	
Number	2
•Kind	Electric Motor
•Type	TEFC
Manufacturer	Major Manufacturer-Fluor Option
Full Load Speed, RPM	1775
•Elec. Char.–phase/cycles/volts	3-60-230/460
Rated H.P.	75
ADDITIONAL DATA	

APPENDIX G RELEVANT CORRESPONDENCE

FILE

orig. mso
c: KKus
364

KERR-McGEE CHEMICAL CORPORATION
TRONA, CALIFORNIA 93562

August 30, 1989

RECEIVED
[illegible] 05 1989
[illegible]MENTAL SYSTEMS CORP.

Dr. William Kuby
Air Quality Engineer
San Bernardino County APCD
15505 Civic Drive
Victorville, CA 92392

RE: Westend Cooling Tower Compliance Test Dates. A.C.E. Project.

Dear Dr. Kuby:

Compliance test dates to measure emission rates from the Westend No. 2 and No. 4 cooling towers has been confirmed for the week of September 11, 1989. Environmental Systems Corporation (ESC), the contractor, will arrive on-site on Monday September 11 and will spend the majority of the day receiving safety training and facility orientation. On Tuesday, September 12, deployment of the measurement equipment will be completed and testing begun. On-site testing is expected to be completed by September 15 with a written report delivered to us by October 15, 1989.

Attached is a brief description of test characteristics for drift tests, PM measurement and PM10 tests. The drift test protocol was utilized by ESC during the 1986 baseline test program. The PM/PM10 test protocol is taken directly from the procedures employed by Engineering-Science during the PM/PM10 measurements they conducted as part of the 1986 baseline test program (confirmed by verbal communication with D. Becvar and R. Herbert, August 21-22, 1989). To adhere to the procedures and protocol developed for that program, we are attempting to follow these methodologies as close as possible.

On August 15, Mr. Jim Lehman, via telephone, informed me that he has reviewed the proposed cooling tower test plan and is recommending approval. We have not received written approval as of this date, and trust that in lieu of not receiving written approval, verbal approval will suffice for the record. Since we are proceeding forth with this test plan and schedule, we would appreciate a prompt notice if our understanding is contrary to that held by the District.

Mr. Lehman has been apprised of the test schedule and is planning to visit the site on September 12 at 10 a.m. to discuss the program and witness deployment of the measurement equipment. You are also invited should your schedule permit. Please do not hesitate to contact me at (619) 372-2073 should you have any questions.

Sincerely,

Zenis M. Walley

ZMW/ms
Attachment
cc: T. F. Canning R. B. Chase
A. D. Puri L. S. Trowsdale

ATTACHMENT

GENERAL TEST CHARACTERISTICS

Drift Tests (percent of circulating water rate)

a. One cell per cooling tower, either the north or south cell, from Westend No. 2 and No. 4 will be chosen for testing.

b. The number of sampling points will be 40 per cell.

c. The traverse diameters will be every 45° for a total of four versus the normal two per diameter.

d. The Isokinetic (IK) tubes will be backed up by a water trap and filter, both of which will be chemically analyzed.

e. Cooling tower inlet air mineral concentrations will be measured and compared with exit plane concentrations.

f. Additional circulating water samples will be taken to assess the variability in circulating water chemistry.

g. Updraft air velocity will be quantified as to the angle, off normal, and the IK measurement adjusted accordingly.

h. Circulating waterflow measurement will be made for the test cell.

i. Chemical rinse procedures will be performed using deionized water and will only use acid rinse for final washing of the IK tubes.

PM-10 Measurements

a. One test will be made at a single point on each of the same cells chosen for drift measurements using an Anderson Cascade Impactor. A preseparator will be used, however, no "reference" impactor (see page 11 of Test Plan, point 8) is required.

b. Gravimetric assays will be performed on-site using Kerr-McGee facilities.

Particulate Matter (PM) Tests

a. PM tests will be performed on the same two cells referred to above using an EPA Method 5 type train.

b. One 24 point (i.e. two 12-point diameters) equal area traverse will be made per cell.

APPENDIX H SCHEMATICS

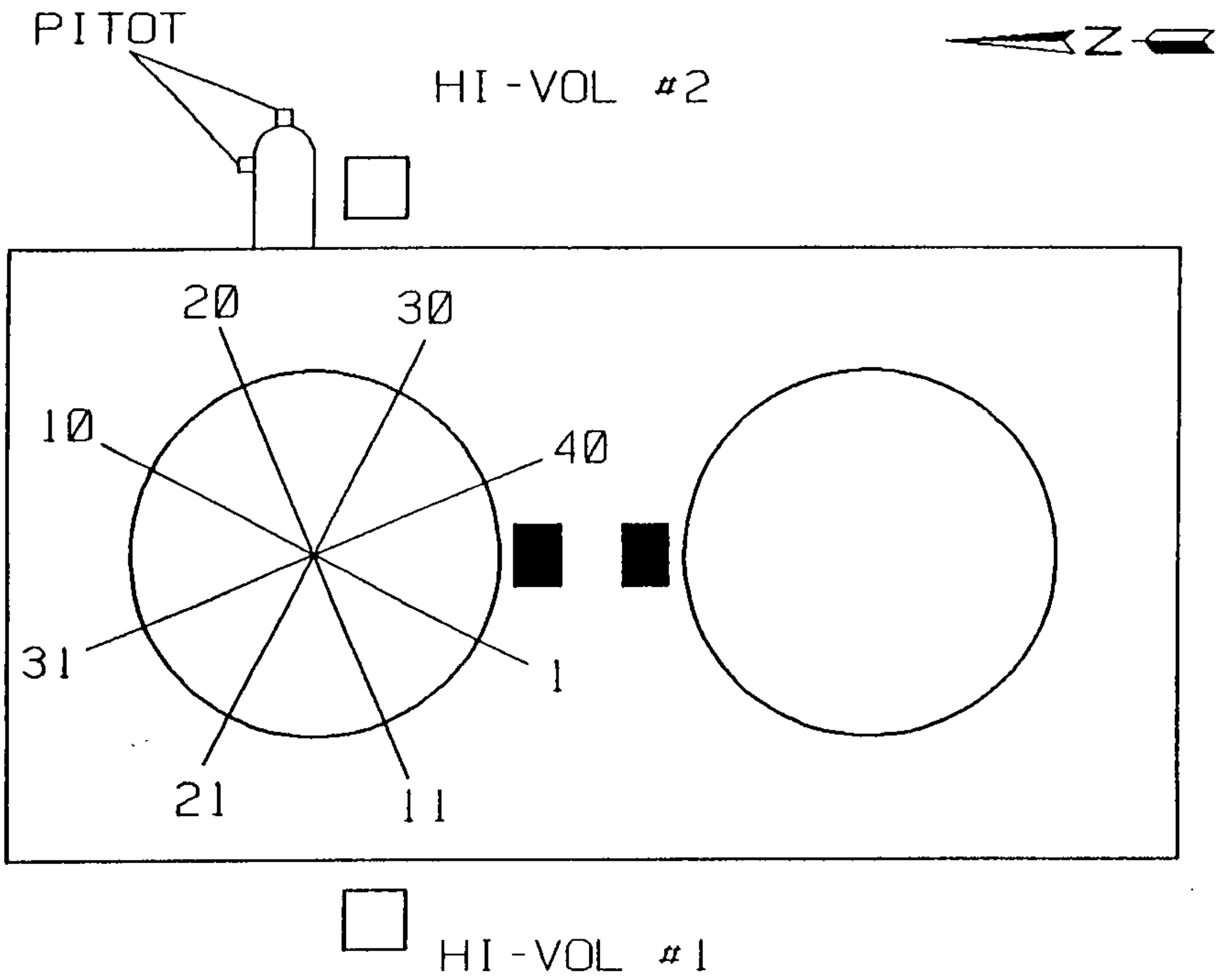


FIGURE 2.3.1

SITE PLAN VIEW

TOWER #2

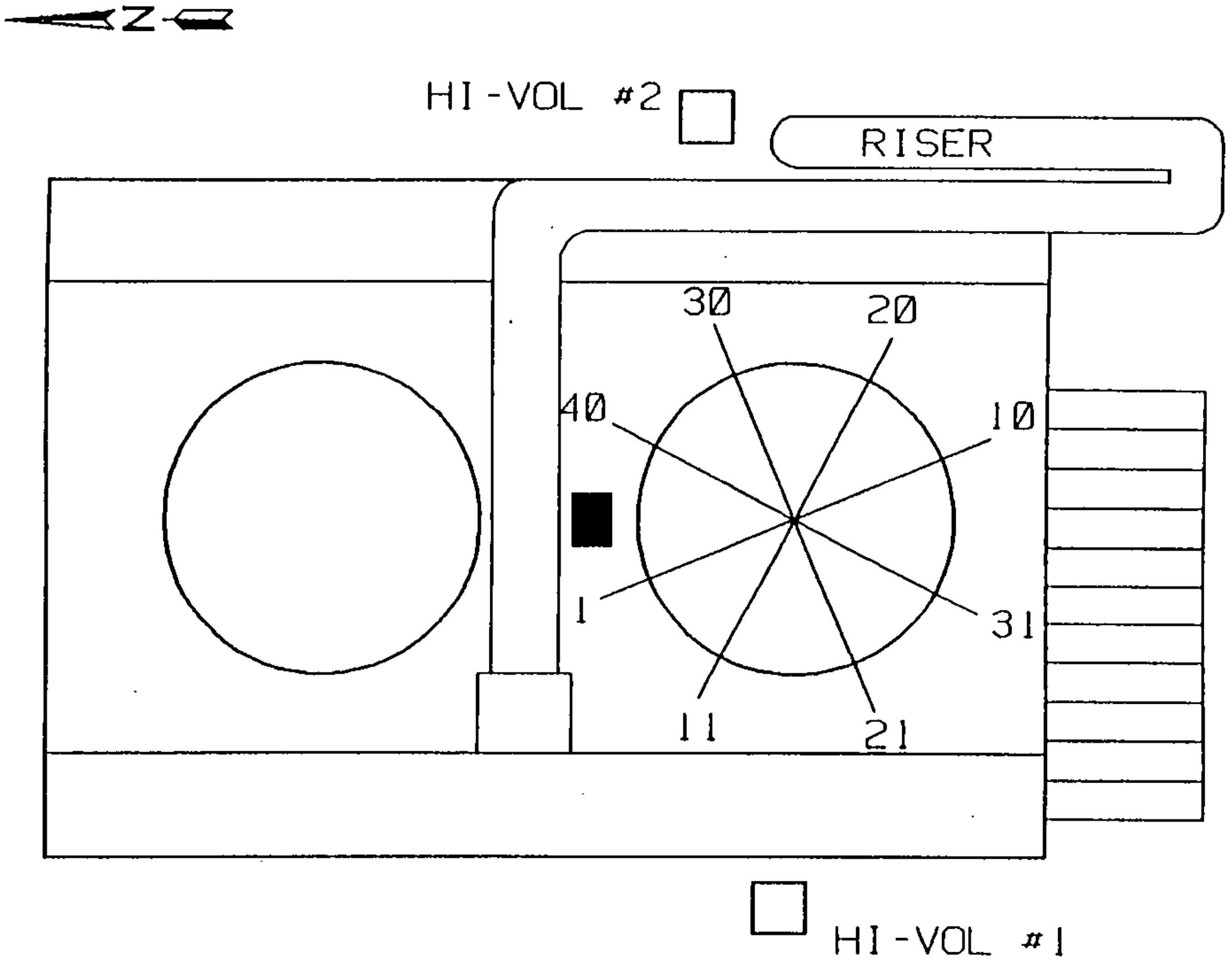


FIGURE 2.3.2

SITE PLAN VIEW

TOWER #4

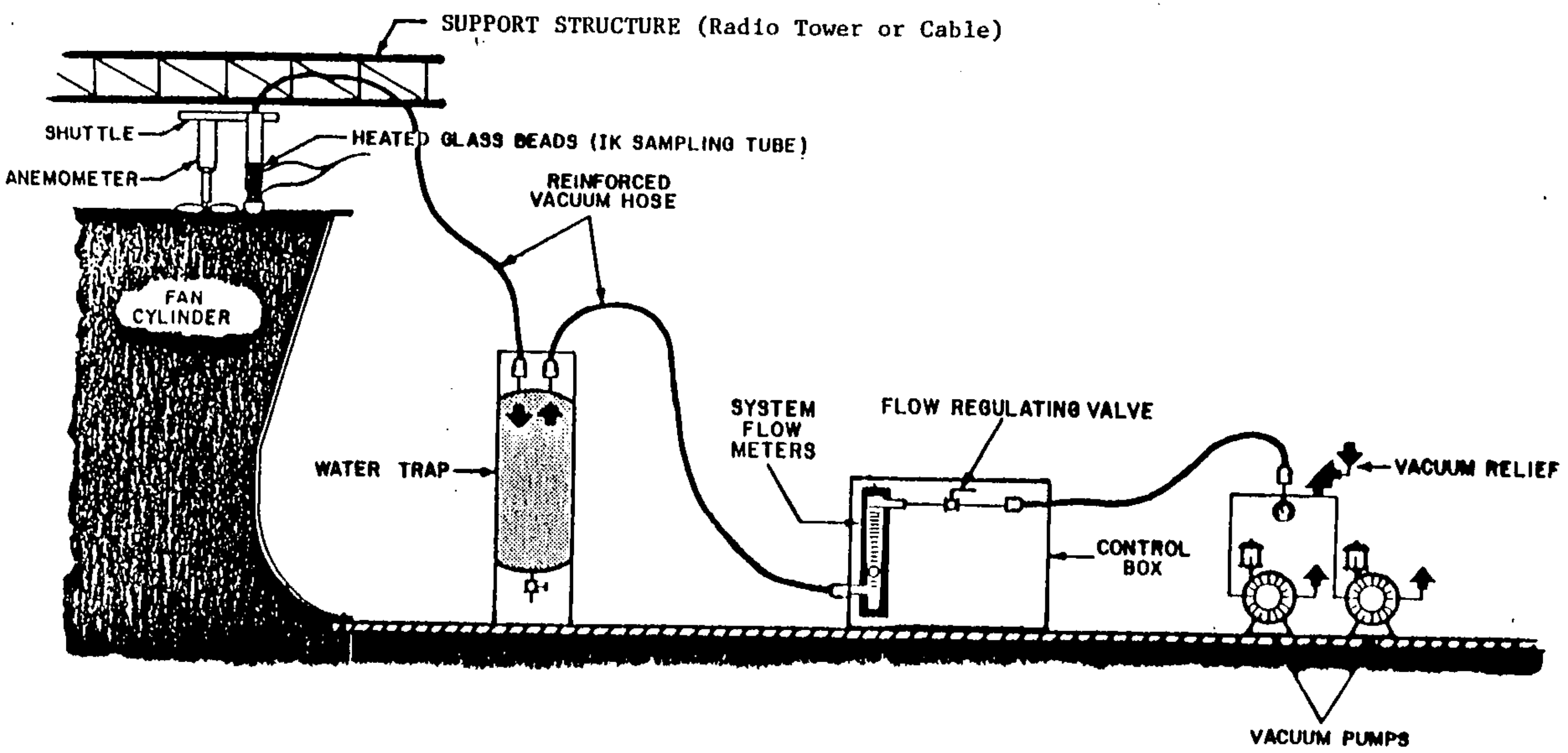


Figure 3.4

ESC HEATED GLASS BEAD SYSTEM

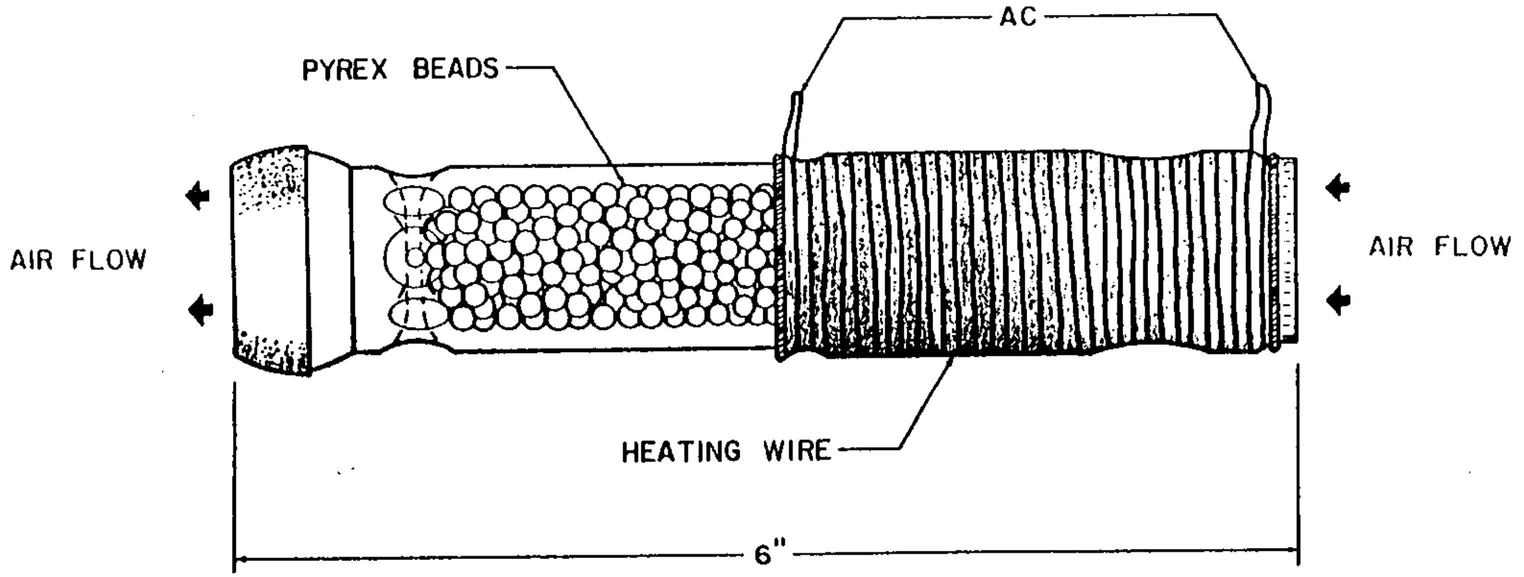


Figure 3.4.1

ESC HEATED GLASS BEAD SAMPLE TUBE

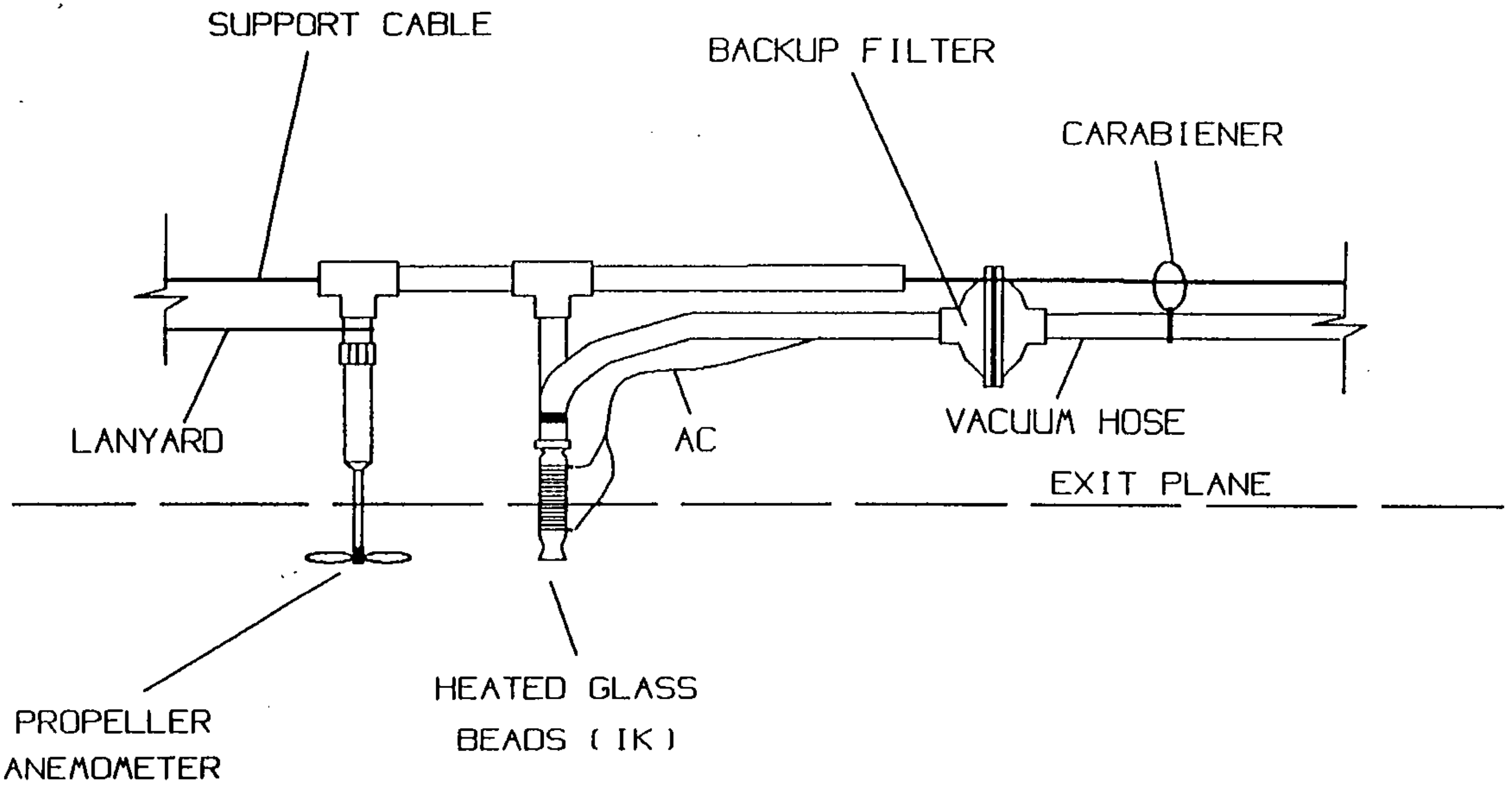


Figure 3.4.2

SAMPLING TRAIN SUPPORT

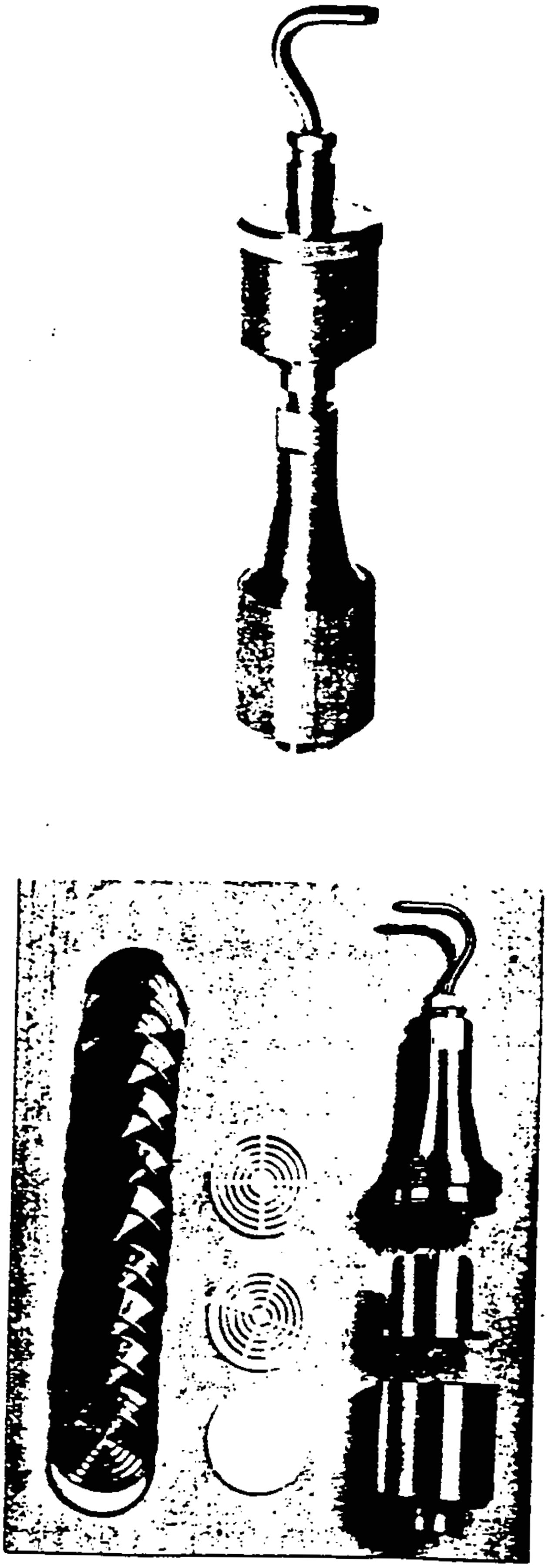


FIGURE 2. ANDERSEN MARK III
STACK SAMPLER

APPENDIX I NOMENCLATURE

NOMECLATURE

- CROSS SECTIONAL AREA OF NOZZLE, SQ. FT.
- CROSS SECTIONAL AREA OF STACK, SQ. FT.
- FRACTION BY VOLUME OF WATER VAPOR IN GAS STREAM.
- PITOT TUBE COEFFICIENT, DIMENSIONLESS.
- CONCENTRATION OF PARTICULATE MATTER IN STACK GAS, GR./DSCF.
- AVERAGE PRESSURE DROP ACROSS THE ORIFICE, INCHES H2O.
- AVERAGE SQ. ROOT VELOCITY HEAD OF STACK GAS, INCHES H2O.
- PERCENT OF ISOKINETIC SAMPLING .
- DRY MOLECULAR WEIGHT OF STACK GAS, LB/LB. MOLE.
- TOTAL AMOUNT OF PARTICULATE MATTER COLLECTED, G.
- MOLECULAR WEIGHT OF STACK GAS (WET BASIS), LB/LB. MOLE.
- BAROMETRIC PRESSURE, INCHES HG.
- ABSOLUTE STACK GAS PRESSURE, INCHES HG.
- PARTICULATE MASS RATE, LBS/HR.
- VOLUMETRIC FLOW RATE, ACTUAL CONDITIONS FT3/MIN.

ID - VOLUMETRIC FLOW RATE AT STANDARD CONDITIONS, (DRY BASIS) FT3/MIN.

- AVERAGE DRY GAS METER TEMPERATURE, *R.
- AVERAGE STACK TEMPERAATURE, *R.

TOTAL SAMPLING TIME, MIN.

- TOTAL VOLUME OF LIQUID COLLECTED IN IMPINGERS AND SILICA GEL, ML.
- VOLUME OF GAS SAMPLE THROUGH THE DRY GAS METER (METER CONDITIONS), CUBIC FT.

TD - VOLUME OF GAS SAMPLE THROUGH THE DRY GAS METER AT STANDARD CONDITONS FT3.

TD - VOLUME OF WATER COLLECTED AT 29.92 IN. HG. AND 70* F CUBIC FT.

- STACK GAS VELOCITY, ACTUAL FT. PER MINUTE.

DRY METER GAS CALIBRATION FACTOR.