epe
Pre
Raw mill sets

AP-42 Section 11.6
Reference 53
Report Sect. 4
Reference 58

Source Emissions Compliance Test Report

on the

Kiln Stack

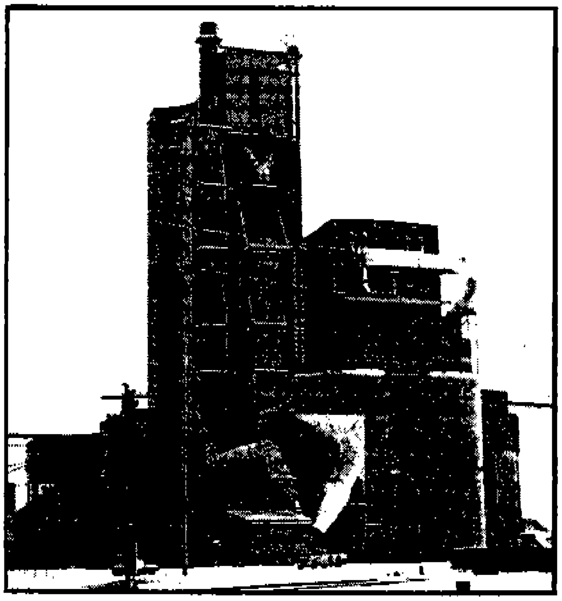
Marquette Cement Manufacturing Company
Cape Girardeau, Missouri

for the

Marquette Company
A Subsidiary of Gulf & Western Industries, Inc.
Natural Resources Group
Nashville, Tennessee

February, 1982

Project No. 82-2-03



GULF+WESTERN INDUSTRIES, INC.

MARQUETTE COMPANY

PERFORMANCE TESTING & CONSULTANTS, INC.

PERFORMANCE TESTING & CONSULTANTS, INC.

P.O. BOX 12516 • 1000 E. 18th AVENUE • N. KANSAS CITY, MISSOURI 64116 • 816/471-1725

February 25, 1982

Mr. John R. Wharrie
Manager of Environmental Control
Marquette Company
One Commerce Place
Nashville, TN 37239

Re: Source Emissions Compliance Test Report on the Kiln Stack

PT&C Project No

Ref 37 Precalciner Kiln
SO_2 values rated as
B by both PSM & MRI
SO_2 only
Note Major error in
SO_2 calculations

Dear Mr. Wharrie:

Attached is the repor urce emissions com-
pliance testing perfor on the Kiln Stack
at the Marquette Cem pe Girardeau, Missouri.

This report includes and after the field
testing along with a analytical procedures,
and the testing and

We wish to thank yo rvice. If there are
any comments, correc report, please advise.

& CONSULTANTS, INC.

Terry L. Shackelford
Vice-President

TLS/cc
Attachments

I, Terry L. Shackelford, hereby certify that the source emissions testing conducted on the Kiln Stack was performed in accordance with the procedures set forth by the U.S. Environmental Protection Agency, and that the data and results submitted within this report are an exact representation of the testing.

Terry L. Shackelford

Terry L. Shackelford
Test Director
PERFORMANCE TESTING & CONSULTANTS, INC.

I, Terry L. Shackelford, hereby attest that all work on this project was performed under my direct supervision and that this report accurately and authentically presents the particulate and sulfur dioxide emission values from the testing performed on the Kiln Stack.

Terry L. Shackelford

Terry L. Shackelford
Project Manager
PERFORMANCE TESTING & CONSULTANTS, INC.

PERFORMANCE TESTING & CONSULTANTS, INC.

P.O. BOX 12516 • 1000 E. 18th AVENUE • N. KANSAS CITY, MISSOURI 64116 • 816/471-1725

January 14, 1982

Mr. John R. Wharrie
Manager of Environmental Control
Marquette Company
One Commerce Place
Nashville, TN 37239

Re: Source Emissions Compliance Test Results - Kiln Stack and Raw Mill Stack - Marquette Cement Manufacturing Company - Cape Girardeau, Missouri

PT&C Project No. 82-2-03

Dear Mr. Wharrie:

In accordance with your authorization, we have completed the source emissions compliance testing on the Kiln Stack and Raw Mill Stack at the Marquette Cement Manufacturing Company located in Cape Girardeau, Missouri.

The testing was performed on Wednesday and Saturday, December 16 and 19, 1981. Three (3) particulate and three (3) sulfur dioxide test repetitions were performed on the Kiln Stack on December 16, and three (3) particulate test repetitions were performed on the Raw Mill Stack on December 19.

The testing was performed in accordance with EPA Reference Methods 1, 2, 3, 5 and 6 as published in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Appendix A.

The results from the testing were as follows:

KILN STACK

AVG. PYRO PROCESS FEED RATE.	237 TPH
AVG. FLUE GAS TEMPERATURE	247 °F 207
AVG. FLUE GAS MOISTURE CONTENT.	17.15 %
AVG. FLUE GAS VELOCITY	51.64 FPS
AVG. FLUE GAS VOLUME	243,367 ACFM
AVG. PARTICULATE EMISSION RATE.	27.79 LB/HR
PERCENT OF ISOKINETIC SAMPLING RANGE.	101-109 %
AVG. SULFUR DIOXIDE EMISSION RATE.	49.46 G/SEC
" " " CONCENTRATION.	266 PPM
MAX. ALLOWABLE PARTICULATE EMISSION RATE (BASED ON 0.30 LB/TON)	71.1 LB/HR[1]
MAX. ALLOWABLE SULFUR DIOXIDE EMISSION RATE.	55.0 G/SEC[2]
" " " " CONCENTRATION.	500 PPM[3]

RAW MILL STACK

AVG. RAW MILL FEED RATE	235 TPH
AVG. PYRO PROCESS FEED RATE	203 TPH
AVG. FLUE GAS TEMPERATURE	222 °F
AVG. FLUE GAS MOISTURE CONTENT	4.49 %
AVG. FLUE GAS VELOCITY	46.53 FPS
AVG. FLUE GAS VOLUME	265,287 ACFM
AVG. PARTICULATE EMISSION RATE	13.72 LB/HR
PERCENT OF ISOKINETIC SAMPLING RANGE	99-104 %
MAX. ALLOWABLE PARTICULATE EMISSION RATE (BASED ON 0.10 LB/TON AND 58.7 LB/HR)	82.2 LB/HR[1,3]

[1] As specified in the July 1, 1981 40 CFR 60, Subpart F.

[2] As required by U.S. EPA, Region VII as part of PSD requirements.

[3] As specified in the State of Missouri Rules of Department of Natural Resources, Chapter 3 - Air Pollution Control Regulations for the Outstate Missouri Area, Title 10 CSR 10-3.050 (Restriction of Emission of Particulate Matter from Industrial Processes)

A cyclonic flow check was performed on the Raw Mill Stack because of the sampling port locations, which had been relocated to meet with minimum EPA requirements. The absolute rotation angle (α) value averaged 6.5°. The maximum allowable is 10° absolute.

If there are any questions or further information is required, please advise.

Respectfully submitted,
PERFORMANCE TESTING & CONSULTANTS, INC.

Terry L. Shackelford, V.P.

TLS/cc

TABLE OF CONTENTS

INTRODUCTION

I. INTRODUCTION

This report presents the results of the source emissions compliance testing performed on the Kiln Stack at the Marquette Cement Manufacturing Company, which is located approximately 1 mile east of Highway 55 on South Sprigg Street in Cape Girardeau, Missouri in Cape Girardeau County.

The purpose of the testing was to determine if the particulate and sulfur dioxide emissions discharged into the atmosphere from the Kiln Stack meet the Missouri Department of Natural Resources and the U.S. Environmental Protection Agency emissions limitations.

The following specific requirements had to be met:

1) all testing equipment calibration performed prior to the test;
2) a minimum of three particulate and three sulfur dioxide testing repetitions performed at the stack sampling location (precipitator outlet) with the pyro process feed system operating at full capacity;
3) a total of 12 traverse points sampled for a minimum of five minutes per point during each particulate testing repetition;
4) one point sampled for 20 minutes per sample, and two samples collected during each sulfur dioxide testing repetition;
5) multi-point integrated gas sampling performed during each testing repetition;
6) the particulate sampling performed in accordance with EPA Reference Method 5 testing procedures;
7) the sulfur dioxide sampling performed in accordance with EPA Reference Method 6 testing procedures;
8) the multi-point integrated gas sampling performed in accordance with EPA Reference Method 3 testing procedures;
9) control room data and precipitator control panel data taken, periodically, during each testing repetition;
10) an average particulate emission rate not in excess of 0.30 lb/ton converted to lb/hr based on the average pyro process feed rate in tons/hr;
11) an average plume opacity of not greater than 20%; and
12) an average sulfur dioxide emission rate not in excess of 55.0 g/sec and an average concentration not in excess of 500 ppm.

The testing was conducted by Performance Testing & Consultants, Inc. PT&C's office is located at 1000 E. 18th Avenue in North Kansas City, Missouri.

The Kiln Stack was tested on Wednesday, December 16, 1981 for particulate and sulfur dioxide emissions. The Kiln Stack was also tested on Thursday, December 17 for particulate only. The additional particulate testing was requested by the Marquette Company to determine if the particulate emission rate would be in excess of the maximum allowable with one of the electrical fields in the electrostatic precipitator out of service. The testing was performed in accordance with EPA Reference Methods 1, 2, 3, 5 and 6 as published in the Thursday, December 23, 1971 Federal Register and subsequent revisions to these methods as published in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Subpart F and Appendix A.

Section II of this report presents a summary of the results from the testing. Section III presents a description of the facility process. Section IV presents a description of the testing equipment and the sampling and analytical procedures used. The calculations, raw field data, laboratory data and other pertinent information are included in the Appendix.

The testing was observed by:

1) Steve Feeler, Environmental Engineer, Missouri Department of Natural Resources - Test Run 1, December 16, 1981; and
2) John Wharrie, Manager of Environmental Control, Marquette Company - Test Runs 1, 2, 3 and 4, December 16 and 17, 1981.

Other parties involved were:

3) Pat Jarrett, Manager of Manufacturing, Marquette Cement Manufacturing Company - December 16 and 17, 1981;
4) Harry Philip, Plant Manager, Marquette Cement Manufacturing Company - December 16 and 17, 1981;
5) Eric Hansen, Manager of Process and Quality Control, Marquette Cement Manufacturing Company - December 16 and 17, 1981;
6) John Walter, Jr., Field Service Representative, General Electric Environmental Services, Inc. (formerly Envirotec Corporation - Buell Division) - December 16 and 17, 1981;
7) Terry Shackelford, Test Director, Performance Testing & Consultants, Inc. - December 16 and 17, 1981;

8) Vinancio Rea, Jr., Engineering Technician, Performance Testing & Consultants, Inc. - December 16 and 17, 1981;

9) Keith Stevenson, Engineering Technician, Performance Testing & Consultants, Inc. - December 16 and 17, 1981; and

10) Louis Raya, Engineering Technician, Performance Testing & Consultants, Inc. - December 16 and 17, 1981.

II. SUMMARY OF TEST RESULTS

953.6

II. SUMMARY OF TEST RESULTS

Based on the results of the particulate and sulfur dioxide testing, the Kiln is operating in compliance with the guidelines set forth by the U.S. Environmental Protection Agency's New Source Performance Standards for Portland Cement Plants and the Missouri Department of Natural Resources' Air Pollution Control Regulations for the Outstate Missouri Area. As shown in the "Particulate Test Summary Data" and "Sulfur Dioxide Test Summary Data", Tables 1. through 3., the process tested as follows:

L01 p.10

.348

.652

TEST RUN NO.	AVERAGE PYRO PROCESS FEED RATE	AVERAGE PARTICULATE EMISSION RATE	MAXIMUM ALLOWABLE PARTICULATE EMISSION RATE[1]
1,2 AND 3	237 TONS/HR	27.79 LB/HR	71.1 LB/HR
4	235 TONS/HR	35.06 LB/HR	70.5 LB/HR
	237	Avg 29.6	Avg 71.0

TEST RUN NO.	AVERAGE SULFUR DIOXIDE EMISSION RATE/CONCENTRATION		MAXIMUM ALLOWABLE SULFUR DIOXIDE EMISSION RATE[2]/CONCENTRATION[3]
1,2 AND 3	49.46 G/SEC - 266 PPM	= 2.54 lb/ton	55.0 G/SEC - 500 PPM
	$\frac{49.46 \times 3600}{7000}$ 25.4 lb/hr		28.2 lb/hr

g is grams not grains

---

[1] Based on the average pyro process feed rate and as specified in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Subpart F, Section 60.62, Paragraph (a)(1).

[2] As required February 1, 1978 by U.S. EPA, Region VII as part of PSD requirements.

[3] As specified in the State of Missouri Rules of Department of Natural Resources, Division 10, Chapter 3, Title 10 CSR 10-3.100, Section (4), Subsection (A).

As indicated, the particulate emission rate for run number 4, during which one of the electrical fields in the electrostatic precipitator was inoperative (intentionally de-energized), also fell well under the calculated maximum allowable.

The plume opacity (visible emissions) limit for the Kiln, as specified in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Subpart F, Section 60.62, Paragraph (a)(2), is 20%. Because the opacity of the plume could not be determined accurately by the State observer, due to the visual interference of the water vapor caused by the high moisture content of the process exhaust gas, no attempt was made to record opacity readings at the stack exit.

The testing was performed in accordance with EPA Reference Methods 1, 2, 3, 5 and 6 as published in Appendix A of Part 60 of the July 1, 1981 40 CFR.

The particulate testing was conducted as specified per the appropriate reference methods. The total elapsed sampling time for each test run was 60 minutes. The minimum required is 60 minutes. The sampled volumes for test runs 1, 2, 3 and 4 were 167.02, 152.25, 156.19 and 154.19 dry standard cubic feet, respectively. The minimum required is 30.0 dscf. The final leak checks for all four test runs fell within the allowable limit of 0.02 cubic feet per minute with 0.001 cfm for run 1, 0.002 cfm for run 2, 0.001 cfm for run 3 and 0.001 cfm for run 4. The isokinetic sampling rates for test runs 1, 2, 3 and 4 were 109%, 102%, 101% and 100%, respectively. The allowable is ±10% of true isokinetic (100%).

The sulfur dioxide testing was also conducted as specified per the appropriate reference methods with the exception of not taking any integrated gas samples for Orsat analysis. The integrated gas samples taken with the particulate testing were the only samples collected for analysis. This procedure was approved by the State observer since the sulfur dioxide and particulate testing were being performed, simultaneously, at the same sampling location.

The average pyro process feed rate during the testing was 236 tons per hour. The process operated steadily and continuously throughout the testing periods.

The testing was performed on two consecutive days with no notable process upsets, test equipment malfunctions or other incidents occurring during the testing.

The gas samples collected in the integrated gas sampling bags for Orsat analysis could not be measured accurately with the standard gas analyzer used due to the high volumes of carbon dioxide and oxygen present in the samples. Because on-site measurements could not be taken, the integrated gas samples were transported to an independent laboratory for gas chromatography analysis, but not until a significant period of time had already lapsed. The gas chromatography analysis indicated that sample leeching had occurred because of the extensive retention time of the samples in the integrated gas sampling bags prior to the analysis, which showed highly erroneous concentrations that could not be considered representative.

Approximately three weeks after the completion of the compliance testing and after having received prior approval from the Missouri Department of Natural Resources, an integrated gas sample was collected from the kiln exhaust stack at the same sampling location with the pyro process operating at conditions equivalent to those when tested previously. The integrated gas sample collected was analyzed with a high volume Orsat at the sampling site. The concentrations of carbon dioxide, oxygen and carbon monoxide measured with the Orsat were used in calculating the particulate and sulfur dioxide emission rates for the compliance testing.

For more detailed information pertaining to the overall field testing, process operation and sample analyses refer to the Appendix of this report.

SO_2

SULFUR DIOXIDE TEST SUMMARY DATA

Table 3.

DESCRIPTION		UNITS	TEST DATA		
Test Date		mo/day/yr	12/16/81	12/16/81	12/16/81
Run Number		–	1	2	3
Sampling Location		–	Kiln Stack	Kiln Stack	Kiln Stack
Average Pyro Process Feed Rate		tons/hr	230	240	240
Total Elapsed Sampling Time		min.	20	20	20
Metered Gas Volume (meter cnd.)	A	ft^3	1.533	0.941	0.748
" " " "	B	"	1.005	0.737	0.960
Barometric Pressure		in.Hg	29.68	29.60	29.41
Average Meter Temperature	A	°F	50	50	48
" " "	B	"	55	55	50
Volume of Barium Chloride Titrant	A	ml	18.4	12.0	10.4
" " " " "	B	"	12.4	7.5	12.2
Blank Volume Titrated	A	ml	0	0	0
" " "	B	"	"	"	"
Normality of Barium Chloride		g-eq/l	0.010246	0.010246	0.010246
Volume of Sample Solution	A	ml	100	100	100
" " " "	B	"	"	"	"
Volume of Sample Aliquot Titrated	A	ml	20	20	20
" " " " "	B	"	"	"	"
Meter Rate Correction Factor		unitless	1.022	0.976	0.976
Flue Gas Volume (std. cnd.)*		dscfh	8,914,998	8,927,010	8,880,146
Metered Gas Volume (std. cnd.)	A	dscf	1.608	0.940	0.746
" " " "	B	"	1.044	0.729	0.953
MEASURED EMISSION RATE .00004408	A	lb/dscf	0.00004138	0.00004616	0.00005046
" " "	B	"	0.00004296	0.00003720	0.00004630
" " "	A	g/sec	46.48	51.92	56.46
" " " 75.4 #/hr 49.5	B	lb/hr "	48.26 375	41.84 372	51.80 430
MEASURED CONCENTRATION 266	A	ppm	249	278	304
" "	B	"	259	224	279
Maximum Allowable Emission Rate 28.3 #/hr		g/sec	55.0	55.0	55.0
Maximum Allowable Concentration		ppm	500	500	500

*Taken from "Particulate Test Summary Data"

1,66 lb/ton feed

III. DESCRIPTION OF FACILITY TESTED

III. DESCRIPTION OF FACILITY TESTED

The Marquette Cement Manufacturing Company in Cape Girardeau, Missouri manufactures portland cement. The Cape Girardeau facility, like several others throughout the U.S., is owned and operated by the Marquette Company which is a subsidiary of Gulf & Western Industries, Inc. See Figure 1.

The Cape Girardeau plant utilizes a roller mill and precalcining process to produce the portland cement. The following describes the manufacturing operation from quarry to finished product storage and distribution:

A. Quarry

The present quarry, which is located at the plant site, contains 54 million tons of rock for proven reserves of over 30 years. The rock from the quarry is transported by vehicle to a 800 horsepower primary crusher which is capable of crushing a capacity of 1,400 tons per hour. The rock is crushed to components less than four inches in size (-4"). The crushed rock is transported by belt conveyor from the crusher to the screening tower and stockpiles. The rock is then proportionally channeled to the four stockpiles based on the chemistry of the rock which varies in chemical characteristics at different levels in the quarry. The supply capacity of the stockpiles is approximately 26 days. This unique capability of screening and separating the rock based on chemistry allows for the utilization of less desirable rock by blending with high quality rock in a controlled manner, which is expected to double the life of the quarry. Screening the rock benefits the chemistry by concentrating the higher alkali portion in the fines. The fines are removed from the rock and transferred to the finish mill where they are mixed with other materials and ground into masonry cement. The screening also eliminates the need for a secondary crusher to crush the -4" rock down to -1" which is required for the finish mill.

See Flow Sheet Dwg. No.'s 1-101-M and 7-101-M for further details.

B. Additives Storage and Reclaim

To make portland cement, the limestone and additives such as; tripoli (a mineral high in silica), flyash and high alumina clay (diaspore) are required. The additives storage and reclaim system provides the means of supplying these additive materials as needed. This system includes a truck unloading station with a crusher that allows the receipt of oversize or mine materials in lieu of precrushed materials. The additive stockpiles are covered to provide for better on-site fugitive dust control.

See Flow Sheet Dwg. No. 1-101-M for further details.

C. Raw Material Storage

All of the materials used to make the portland cement are distributed to the raw material storage silos. The raw materials are proportioned as required and then conveyed to the raw mill. The raw material proportions for the plant are 86% limestone, 6.9% silica, 4.3% flyash and 2.8% diaspore. The raw materials are monitored and the proportions are adjusted approximately every two hours by the plant laboratory to maintain the proper ratios within the desired limits. The constant monitoring and adjusting is required due to the variations in chemical composition of the raw materials. The quick analysis of the raw materials and the resulting blend is accomplished by x-ray analysis. The adjustments for the raw material proportions are computer calculated.

See Flow Sheet Dwg. No.'s 1-101-M and 3-101-M for further details.

D. Raw Milling

The raw materials are transported by belt conveyor and drag conveyor from the proportioning stations at the bottom of the raw material silos to a bucket elevator which discharges the raw materials into the the raw mill pulverizer for crushing, mixing and drying.

The raw mill pulverizer is a 3,000 horsepower roller mill type crusher with a rated capacity of 250 tons per hour. The mill accepts raw materials up to four inches in size and grinds the materials to a fineness of 80%, -200 mesh, which eliminates the need for a secondary crusher.

The raw mill uses hot air from the clinker cooler to dry the raw mix, thereby eliminating the need for a separate dryer. This unique use of hot air from the clinker cooler to dry the raw mix eliminates the variations in chemistry that occur when the preheater off gases are used for drying. Also, the use of the clinker cooler hot air system for drying the raw mix instead of the preheater off gas system leaves the higher grade heat in the preheater gases available for future utilization elsewhere in the heat recovery system.

The dry ground material is pulled out of the raw mill by air flow and carried to the cyclones and the dust collector where the material is separated from the air, which is discharged into the atmosphere through the raw mill exhaust stack, and gravity-fed to the blending silos. The air flow volume requirement for the conveying of the material from the raw mill exceeds the air volume available from the clinker cooler, therefore a certain amount of air is recycled from the raw mill exhaust stack back to the raw mill.

The two, two-stage cyclones preceeding the dust collector are Zurn designs rated at 220,000 ACFM at 400°F and a pressure drop of 3" W.G. The dust collector following the cyclones is a Buell baghouse design rated at 300,000 ACFM at a normal operating temperature of 220°F and a pressure drop of 12" W.G. The dust collector houses 32 fabric filter modules with 56 bags per module. The bag fabric is glass fiber with a silicone/-graphite/Teflon finish. The total cloth area (gross-32 modules) is 173,632 ft^2. The gross air/cloth ratio is 1.73:1. The bags are cleaned by a reverse air system.

See Flow Sheet Dwg. No.'s 3-101-M and 5-101-M and General Arrangement Dwg. No.'s 3-301-M and 3-303-M.

E. Blending Silos

The finely ground and dry raw mix is fed by gravity via airslides and screw conveyors to the four blending silos from the raw mill cyclones and dust collector. The raw mix is distributed evenly to the silos and blended to a chemically uniform mixture and then metered to the kiln feed system.

The four, 6,000 ton capacity blending silos are large enough to provide over 4 days supply of raw mix when full and require less than half the horsepower of conventional blending systems to operate. This system, which is a German design, is the second major installation of its type in the U.S.

See Flow Sheet Dwg. No. 3-101-M for further details.

F. Kiln Feed System (Pyro Process)

The raw blend is transferred by belt conveyor and bucket elevator to the kiln feed bin for distribution to the pyro process.

The pyro process consists of three distinct subprocesses through which the material passes. The first subprocess is preheating or precalcining which occurs in the preheater tower where the material is 90% precalcined in a fast fluid bed type reactor.

The material is heated in the preheater tower to approximately 1,550°F. At this temperature, the calcium carbonate in the material decomposes into calcium oxide and carbon dioxide. Approximately one third of the feed rate (230 tons per hour) is lost out the kiln exhaust stack as gaseous carbon dioxide (80 tons per hour) along with the process combustion gases.

The unique feature of the pyro process is that coal and preheated air as well as raw material are introduced into the preheater tower. The combustion of the fuel takes place in suspension with the dispensed raw material, therefore no actual flame exists.

The fast fluid bed type reactor system and the specific application to cement manufacturing was developed by a Japanese cement manufacturing company and is marketed under the trade name "Reinforced Suspension Preheater". Sixty percent of the total fuel consumed is burned in the RSP.

Another feature of this process is the dual coal mills; one for the kiln and one for the precalciner, which allows the firing of two qualities of fuels. The precalciner can use low quality fuel since a high temperature flame is not required.

This process also allows for easier operation and control. The preheater has a 30 second retention time and the kiln has a 30 minute retention time, therefore, the results of changes made are seen very quickly compared to the 4 hour retention time in conventional processes.

The process is equipped with an alkali by-pass system which allows about 10% of the kiln exhaust gases to bypass the preheater tower. The volatile alkali compounds in the exhaust gases are collected in a dust collector and disposed of. The treated exhaust gas from the by-pass dust collector is fed into the kiln exhaust stack where it is mixed with the treated kiln exhaust gas. Because the sulfur in the coal burned in the preheater becomes tied-up with the alkali, this system allows the use of high sulfur coal.

The raw material fines and the combustion products that become suspended in the kiln exhaust gas stream are removed from the exhaust gas by an electrostatic precipitator prior to being discharged into the atmosphere through the kiln exhaust stack. For the most part, the materials collected by the precipitator are recycled back into the process.

The electrostatic precipitator used to remove the particulate matter contained in the gases emitted from the preheater is a Buell design rated at 247,000 ACFM at a normal operating temperature of 250°F. The precipitator has six electrical fields with 41 gas passages and a total collecting plate surface area of 141,696 ft^2.

The second subprocess is the rotary kiln where the precalcined raw materials are heated to the sintering temperature of 2,800°F. At this temperature, the calcium oxide, silcon dioxide, aluminum compounds, and iron compounds in the raw materials chemically react to form the minerals which are the active components in portland cement. The partially fused product that discharges from the rotary kiln is called clinker.

The third subprocess is the clinker cooler. Its purpose is to recover the heat in the clinker and to cool the clinker to a low enough temperature to be ready for finish grinding. Approximately three pounds of air are required to cool one pound of clinker. About one third of the air placed under the cooler goes to the combustion process at an average temperature of about 1,500°F. The remaining two thirds of the air is excess and must be vented from the cooler. This excess air and the heat it carries passes through the raw mill to dry the raw materials before being vented to the atmosphere.

See Figures 2 and 3, Flow Sheet Dwg. No.'s 3-101-M and 5-101-M and General Arrangement Dwg. No.'s 5-201-M, 5-202-M, 5-203-M, 5-205-M, 5-207-M and 5-202-A.

G. Finish Milling

The clinker from the cooler is transported to the finish mill by drag conveyor and bucket elevator where it is discharged into storage silos and then conveyed to ball mills for final grinding. The partially fused clinker is reduced in size in the ball mills to 95%, -45 micron (325 mesh seive). Approximately 4% calcium sulfate is added in this final processing step. The added calcium sulfate controls the reaction of water with the finely ground cement. This finished product is tested for uniformity and then supplied to customers.

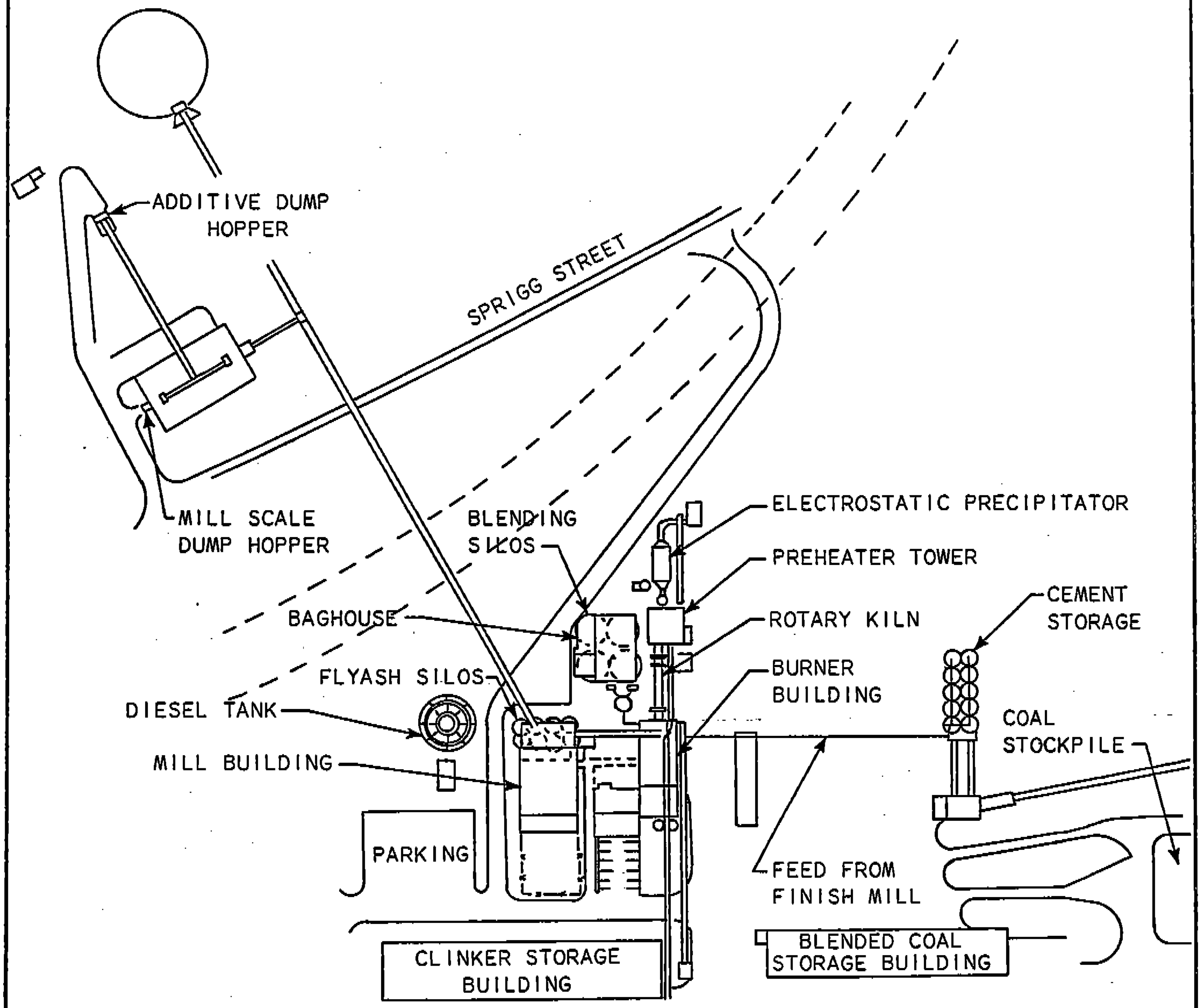
One of the unique features of the finish mill is the special air sweep on the mill (27,000 ACFM) and on the separator (45,000 ACFM) to improve separation of the product from the mill circuit to prevent over grinding. This improves the quality of the final product.

See Flow Sheet Dwg. No.'s 5-101-M and 7-101-M.

H. Final Product Storage and Distribution

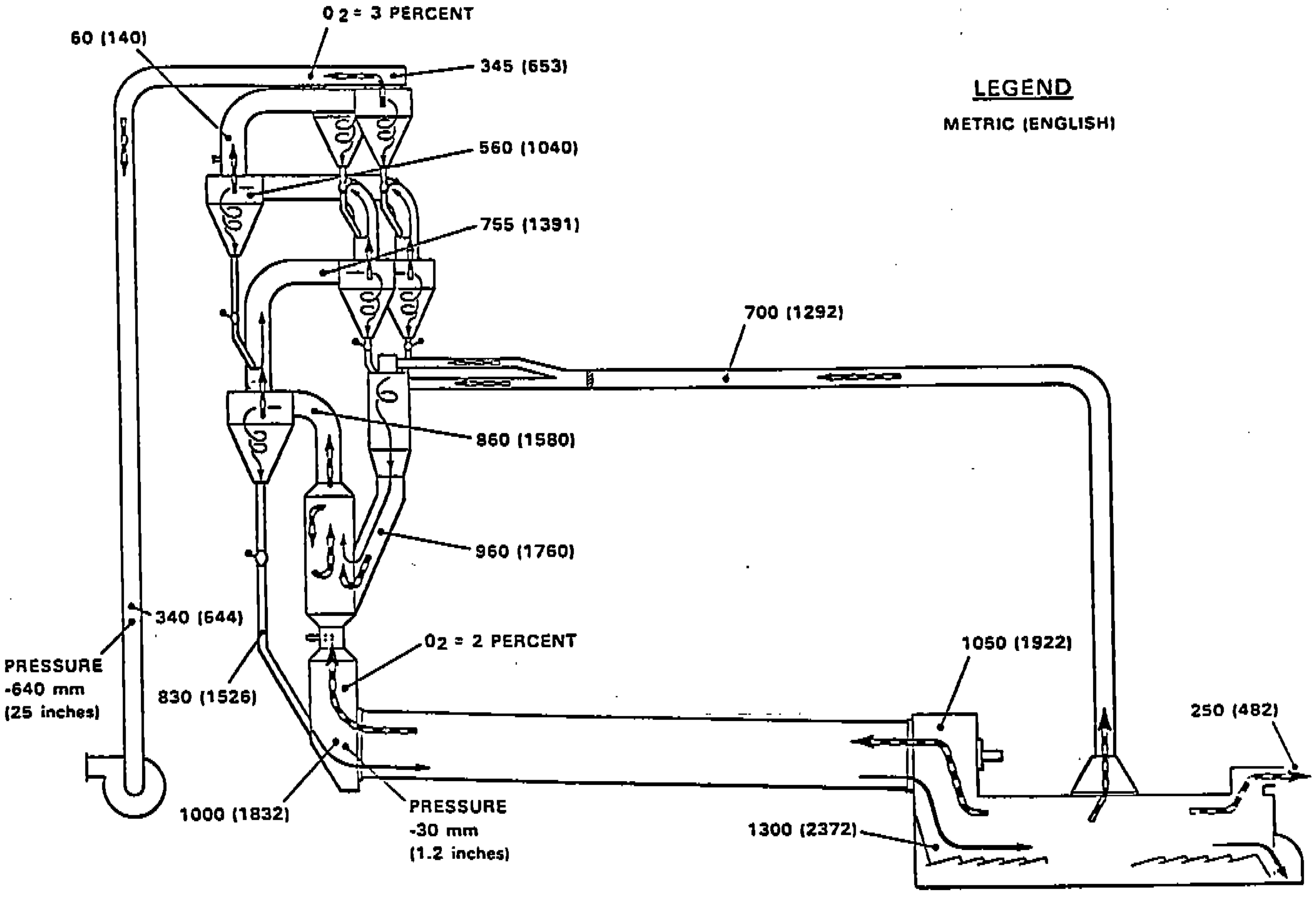
The finished product (cement) is conveyed from the finish mill to the wet plant silos. From the wet plant silos, the cement is either pumped at approximately 100 tons per hour to the dry plant silos for direct distribution (200,000 ton per year) or is transferred to the river silos by conveyor at a rate of up to 800 tons per hour. Barge loading from the river silo is done with a bucket elevator and an air slide rated at 1,000 tons per hour. A typical tow barge with a capacity of 6,000 tons of cement can be loaded in approximately 10 to 12 hours.

See Flow Sheet Dwg. No. 7-101-M for further details.



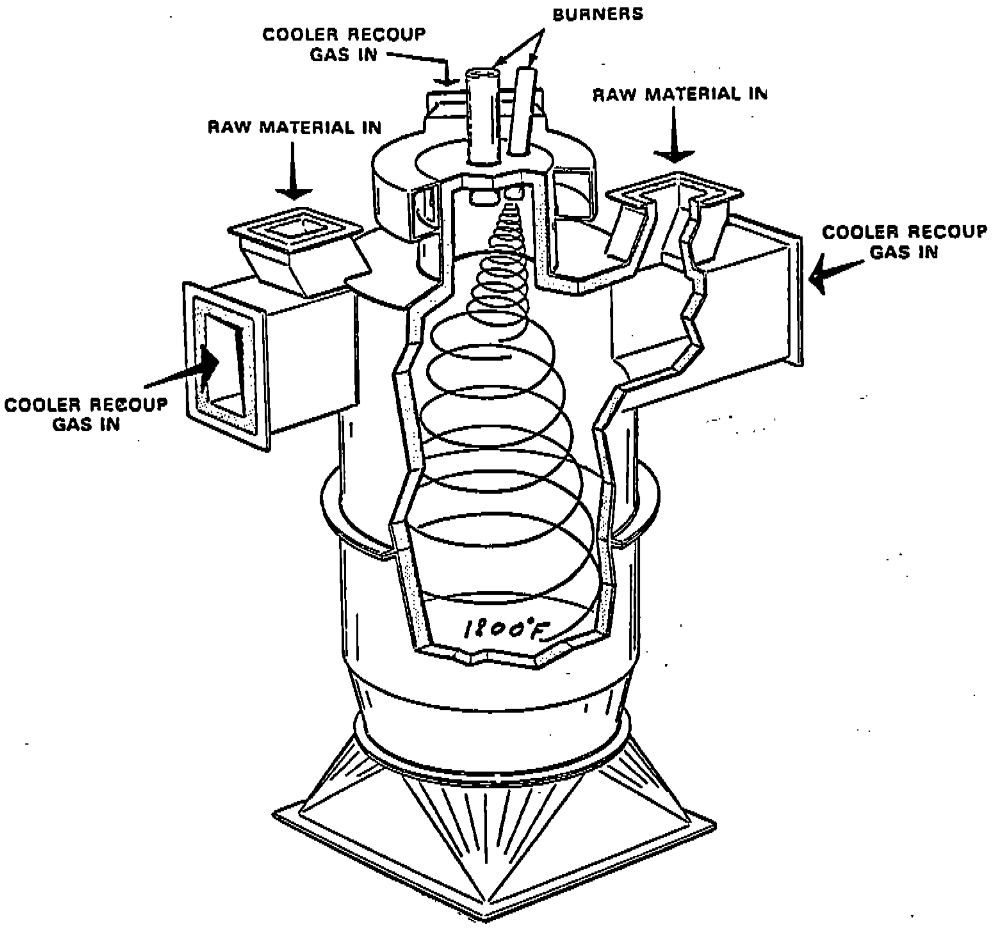
NEW CAPE PLANT LAYOUT

(FIGURE 1.)



TYPICAL TEMPERATURES
COAL FIRED
REINFORCED SUSPENSION PREHEATER

(FIGURE 2.)



SWIRL FURNACE
(COAL DISPERSION)
REINFORCED SUSPENSION PREHEATER
(FIGURE 3.)

Testing Equipment - EPA Reference Method 6 (SO_2)

Sulfur Dioxide Sampling Train:

A Bryan Instruments, Model 700, SO_2 Sampler was used at the sampling location. The SO_2 sampling train consisted of the following components: A heated, 5' effective length stainless-steel probe with a calibrated Type J (Iron/Constantan) thermocouple; a Thermo Electric Minimite potentiometer; a RAC midget impinger unit made-up of one, 30-millimeter glass bubbler, four, 30-milliliter glass impingers, glass balljoint connector tubes, an aluminum support tray and a calibrated Weksler dial thermometer; a control unit with a Thomas 1/20 h.p., sealed-head diaphragm vacuum pump, a calibrated Rockwell dry gas meter, a Dwyer flowmeter, and a calibrated Weksler dial thermometer; an elapse time indicator; a Gast 30 in. Hg vacuum gauge; and Tygon tubing, various interconnecting fittings and valves.

The control unit was used to monitor the dry gas meter temperature, the gas sampling rate and the sampled gas volumes.

Integrated Gas Sampling Train:

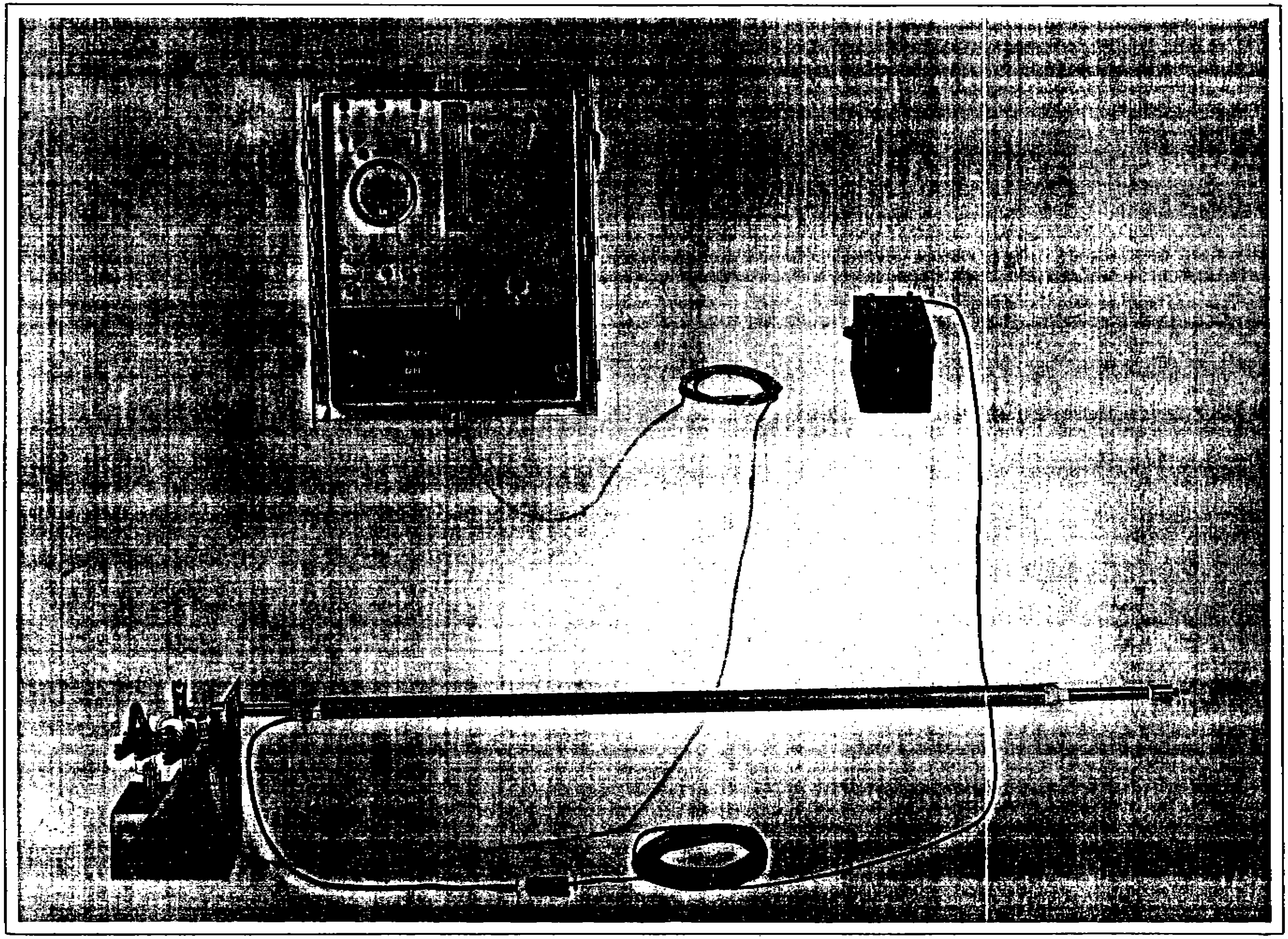
Flue gas was collected at the sampling location with an integrated gas sampling train for determination of carbon dioxide (CO_2), oxygen (O_2) and carbon monoxide (CO) concentrations. The sampling train consisted of the following components: A Drierite, Model A007, gas drying unit; a Thomas, Model 107CA11-TFE, 1/20 h.p., sealed-head diaphragm vacuum pump; a Dwyer, Model RMB 49 SSV, flowmeter; an Ashland, Model P-30, latex bag housed in a protective Nalgene, Model 2210-0130, carboy; and Tygon tubing, and various interconnecting fittings and valves.

Gas Analyzer (Orsat):

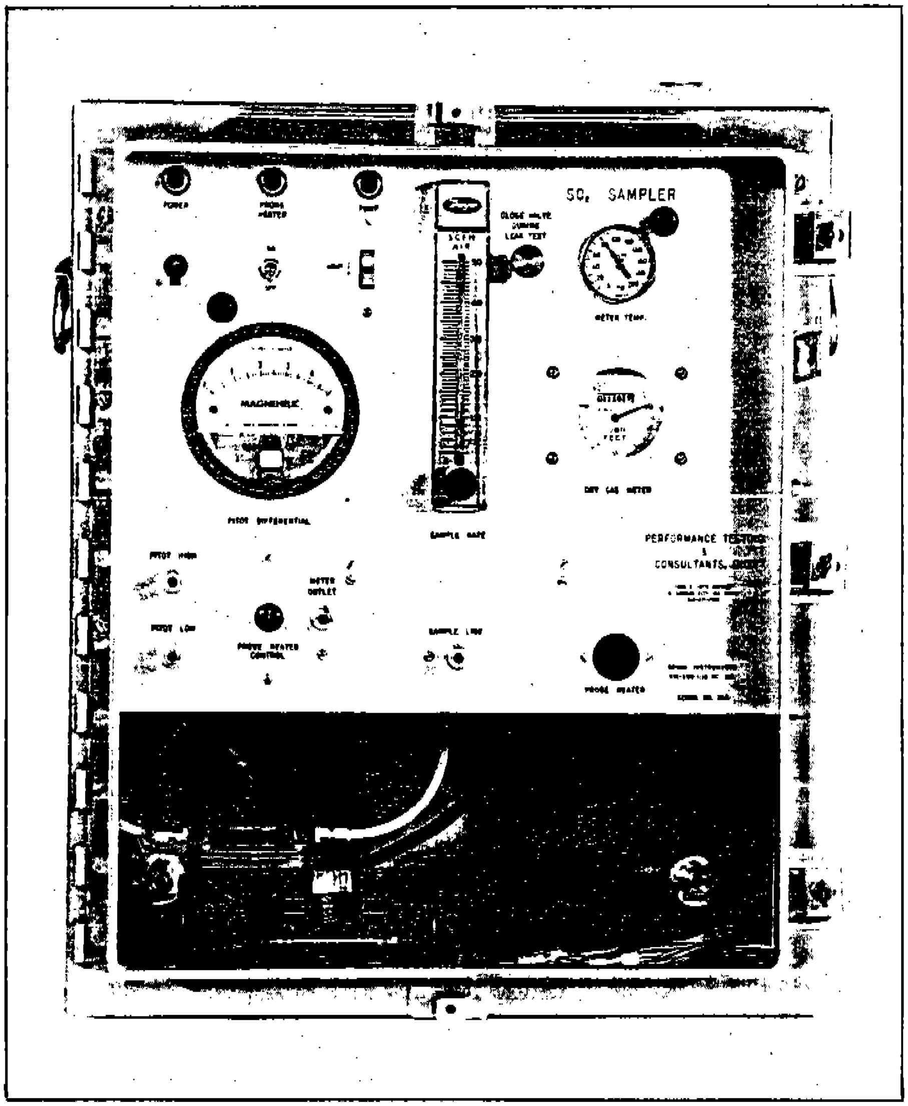
Flue gas concentrations of CO_2, O_2 and CO were determined with a Burrell, Model B, Industro Gas Analyzer (Orsat) which measures these gases in percent by volume to the nearest tenth of a percent.

Barometer:

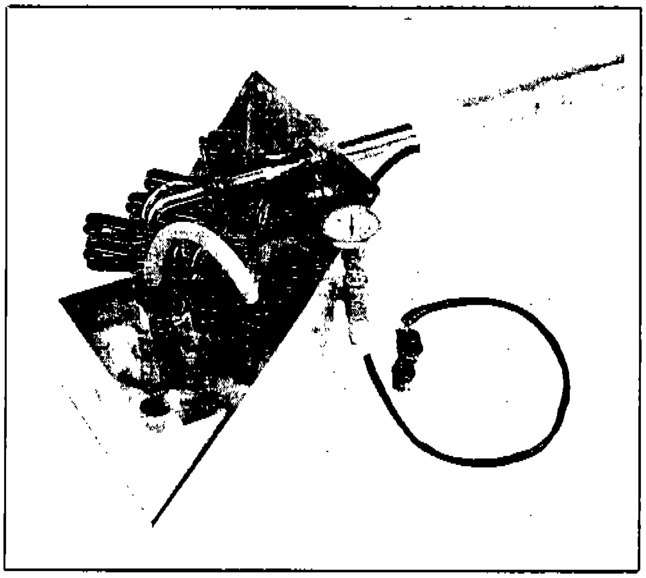
The barometric pressure (actual station pressure) was determined from a calibrated Airguide, Model 211-B, aneroid barometer located at the test site which read directly in inches of mercury to the nearest hundredth of an inch.



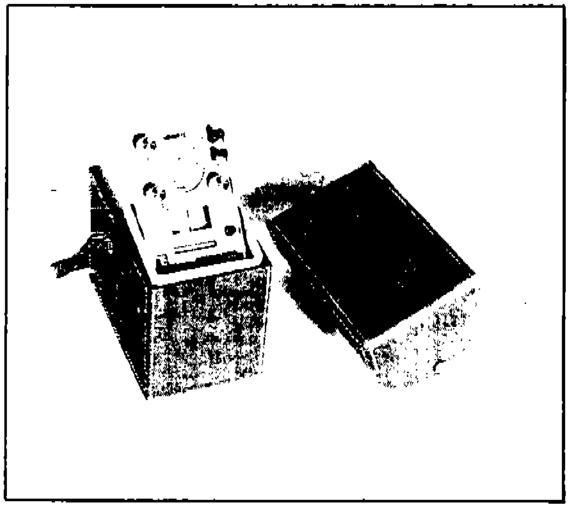
SO$_2$ SAMPLING TRAIN



Control Unit

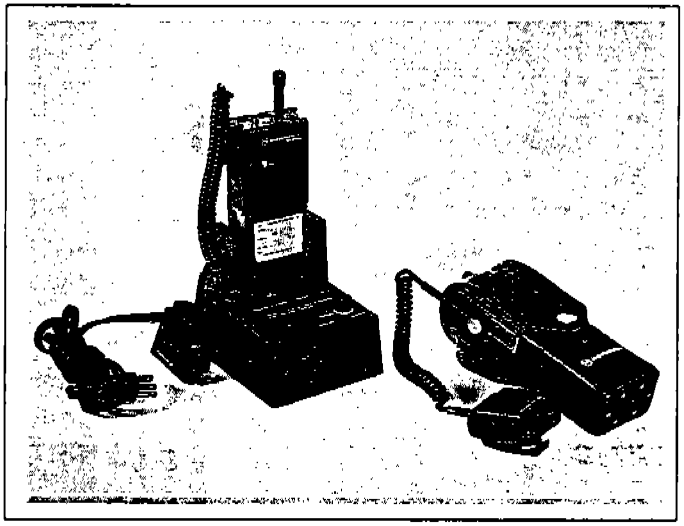


Impinger Unit

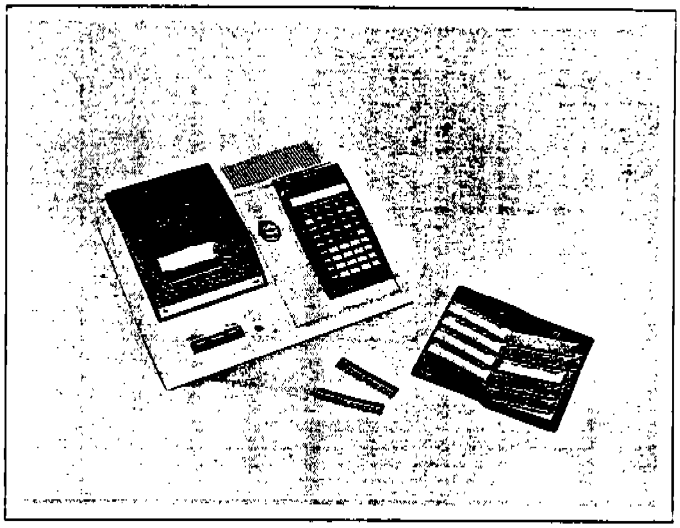


Potentiometer Unit

SO_2 SAMPLING TRAIN



Transceivers



Programmable Calculator

AUXILIARY TEST EQUIPMENT

Sampling Procedures - EPA Reference Method 6 (SO_2)

Prior to the field testing, all instruments were checked and calibrated, and the chemical reagents prepared as follows:

A) Sampling Reagents:
  1) 80% Isopropanol - 400 milliliters of 100% reagent grade isopropanol were mixed with 100 milliliters of deionized, distilled water.
  2) 3% Hydrogen Peroxide - 50 milliliters of 30% reagent grade hydrogen peroixde were mixed with 450 milliliters of deionized, distilled water.

B) Sample Recovery Reagents:
  1) 80% Isopropanol - Prepared prior to sampling. (See A.1.)

C) Analytical Reagents:
  1) Thorin Indicator - 0.20 grams of thorin were dissolved in 100 milliliters of deionized, distilled water.
  2) Barium Chloride - 1.22 grams of solid barium chloride were dissolved in 200 milliliters of deionized, distilled water and diluted to 1 liter with 100% isopropanol. The barium chloride solution was standardized against 25 milliliters of standard sulfuric acid (0.0100 N, ±0.0002 N) to which 100 milliliters of 100% isopropanol had been added.

The sampling procedures were performed in accordance with EPA Reference Method 6 as published in the Thursday, December 23, 1971 Federal Register and subsequent revisions to this method as published in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Appendix A.

A SO_2 sampling train was prepared at the sampling location in the following manner: 15 milliliters of 80% isopropanol were added to the midget bubbler and 15 milliliters of 3% hydrogen peroxide were added to the first and second midget impingers. The third midget impinger was left blank. The fourth midget impinger was partially filled with type 6-16 mesh indicating silica gel. Glass wool was placed in the top of the midget bubbler and in the inlet end of a heated sampling probe. The midget bubbler and impingers were then assembled and placed into an ice bath. Next, a sampling line was connected to the outlet of the impinger unit and the inlet of a control unit vacuum pump.

The entire sampling train was then leak-checked at 10 inches of mercury vacuum for 30 seconds with the sampling probe disconnected and a vacuum gauge installed at the impinger unit inlet. If no vacuum loss occurred during this 30 second period, the leak-check was considered acceptable.

After the SO_2 sampling train was assembled and leak-checked, as previously described, the sampling probe was placed into the flue and connected to the inlet of the impinger unit. The thermocouple from the probe was connected to a potentiometer, the probe heater turned on and the probe heated to approximately 250 degrees Fahrenheit. As soon as the probe temperature stabilized the sulfur dioxide (SO_2) sampling was performed.

One point was sampled at the sampling location from one sampling port. A total of 3 test runs was performed. Each test run consisted of two, 20 minute sampling periods with intervals of at least 30 minutes between periods. The sampling rate was set at a constant flow rate of 1 liter per minute (±10%) to obtain a 20 liter (± 10%) sample per sampling period. The impinger outlet temperature, meter temperature, gas sampling rate and metered gas volume were recorded on a field test form every 5 minutes during each 20-minute sampling period.

After the completion of each 20 minute sampling period the following procedures were performed: The sampling probe was disconnected from the impinger unit and left in the flue with the probe heater on and ready for the next sampling period. A final leak-check was performed at 10 inches of mercury vacuum for 30 seconds and the leakage rate recorded. The impinger unit was then purged with ambient air for a period of at least 15 minutes at the sampling flow rate (1 lpm).

At the end of the purge period, the contents of the midget bubbler and the fourth midget impinger were discarded. The contents of the first, second and third midget impingers were transferred to a leak free polypropylene sample bottle. The three midget impingers and connecting balljoint tubes were rinsed with deionized, distilled water and the rinsings added to the contents of the sample bottle. The sample bottle was sealed, appropriately labeled and the fluid level marked. The bottle was then stored in an ice chest for transporting and for protection against possible sample decomposition until the sulfur dioxide analysis could be performed.

Flue gas concentrations (%CO_2, %O_2 and %CO) were determined by taking several Orsat samples of the gas collected by an integrated gas sampling train during each test run. The flue gas was collected at a predetermined constant flow rate to obtain an adequate sample. The concentrations for each sample were recorded on a field test form. The integrated gas sampling train and gas analyzer (Orsat) were leak-checked prior to sampling.

Control room data and precipitator control panel data were recorded during each test run.

Analytical Procedures - EPA Reference Method 6 (SO_2)

After the field testing was completed, the following procedures were performed: The sulfur dioxide samples and reagent blanks were analyzed by PT&C, Inc. in North Kansas City, Missouri. The analytical procedures were performed in accordance with EPA Reference Method 6 as published in the Thursday, December 23, 1971 Federal Register and subsequent revisions to this method as published in the July 1, 1981 Code of Federal Regulations, Title 40, Part 60, Appendix A.

After the liquid level of a sulfur dioxide sample bottle was visually checked, the sample solution in the bottle was transferred to a volumetric flask and diluted to a known volume with deionized, distilled water as shown on the analysis sheet. Two, 20 milliliter aliquots of the diluted solution were pipetted into two, 250 milliliter Erlenmeyer flasks. Eighty milliliters of 100% isopropanol and two to four drops of thorin indicator were added to each flask. Each of these solutions was then titrated to a pink endpoint using 0.0100 N barium chloride. If the two titrations fell within one percent or 0.2 milliliters, whichever was greater, the average of the volumes was used. If the volumes titrated had a difference greater than 0.2 milliliters the above steps were repeated until the required accuracy was obtained. A 30 milliliter blank of 3% hydrogen peroxide was analyzed with the sulfur dioxide samples. The procedures used in analyzing the samples were also used to analyze the blank.

All test instruments were recalibrated to determine the deviation percentages.

A TI Programmable 59 calculator was used to determine the sulfur dioxide emission rates, concentrations and other pertinent data for each test run.