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Fabric Filter System Study: First Annual Report

Interagency Energy/Environment R&D Program Report

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EPA REVIEW NOTICE

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August 1979

Fabric Filter System Study:
First Annual Report

by

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FIRST ANNUAL REPORT
FABRIC FILTER SYSTEM STUDY

A B S T R A C T

This research program was initiated with the overall objective of characterizing the performance of a fabric filter system installed on a large utility boiler that utilizes low sulfur Western coal.

First year activities included installation of support systems, start-up of fabric filter system and planning for special test programs. Air flow tests were conducted in October, 1978, and the air flow rate was determined to be approximately 1.6 million acfm. Special testing is scheduled to begin in December, 1978, allowing time for the system to reach a more normal operating level.

This report is submitted in fulfillment of Contract No. 68 02 2659 by Southwestern Public Service Company under the sponsorship of the U. S. Environmental Protection Agency. This report covers the period October 1, 1977 to October 15, 1978.

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CONVERSION TABLE

To Convert From	To	Multiply by
Btu/lb	joules/kg	4186.8
^{o}F	^{o}C	$(^{o}F-32)/1.8$
ft	m	0.305
gr/scf	gm/m^3	2.29
in.	cm	2.54
in. W.G.	mm Hg	1.87
lb	gm	454
miles	km	1.609
oz.	grams	28.350
ppm	mg/liter	1.0
Btu	joules	1055
cfm	cubic meters/hr	1.699
ft/sec	centimeters/sec	30.48
sq.ft.	sq. meters	0.093
lbs. of tension	newtons	4.448
stack pressure in Hg	kg/cm^2	0.035
$wscf/10^6$ Btu	wscm/joule	2.6×10^{-11}
$lbs/10^6$	nanogram/joule	433.3
lbs/wscf	$micrograms/m^3$	16.018×10^8
ft^2	$meters^2$	0.093

FABRIC FILTER SYSTEM STUDY

First Annual Report

I. INTRODUCTION & BACKGROUND

Southwestern Public Service Company is an electric utility headquartered in Amarillo, Texas. The Company has a generating capacity of 2740 MW and serves customers in Texas, Oklahoma, New Mexico and a small area of Kansas. Harrington Station, Southwestern's first coal-fired plant, went into operation in July, 1976, with one unit on line.

The basic problem in designing Harrington's second coal-fired unit was the selection of a flue gas treating and control system which would satisfy the Environmental Protection Agency's New Source Performance Standards. Southwestern studied the existing alternatives for controlling coal-fired boiler emissions and an effort was made to select a type of emission control device which would not require scrubbing for particulate removal.

The primary systems initially considered for particulate control were electrostatic precipitators. However, it was determined that numerous utilities were having problems with hot side precipitators being used in association with low sulfur Western coal, so this type of precipitator was not considered.

While obtaining bids and information from suppliers of electrostatic precipitators some mention was made of the use of fabric filters for particulate control. The use of this type of filter system in Southwestern's service area is very common (the carbon black industry) and after observing how fabric filters were applied at Sunbury and NUCLA a decision was made to compare electrostatic precipitators with fabric filter systems. After comparing all parameters (design, operating, maintenance, costs) Southwestern wrote a set of specifications and then negotiated a contract for a fabric filter system to be supplied by Wheelabrator-Frye, Inc.

Only a small amount of information on the performance of fabric filters at other utility installations was available when

Southwestern Public Service was making its evaluation. Because of that, Southwestern and the Environmental Protection Agency agreed to make a comprehensive study of a commercial operating unit. The study will require two years to complete the collection and assessment of one full operating year's worth of data.

Following the testing phase of the program, operational and maintenance data will continue to be recorded until 1982, to determine the long term reliability of the system. Special tests will be conducted through the use of an on-site pilot baghouse.

The objective of the study is to implement an overall program of testing and evaluation design to (1) fully characterize the fabric filter system applied to Harrington Station, Unit #2; (2) study the technical and economic feasibility of the system; and (3) determine the system's optimum operating conditions. This report describes the work that was done during the first year of study and assesses the project's achievements in relation to the objectives previously set forth.

II. EXECUTIVE SUMMARY

Southwestern Public Service Company installed a fabric filter system on Unit #2 of its first coal-fired facility for the collection of particulate from low sulfur Western coal. The installation is a 28-compartment Wheelabrator-Frye, Inc. baghouse, which has several support systems, including an EPA mobile laboratory, a datalogging system and selected instrumentation.

The fabric filter system was started up on June 21, 1978. A start-up plan was implemented by Southwestern to help avoid problems such as dew point and acid point conditions. Two compartments at a time were brought on line and when pressure drop across the baghouse reached 4" wg the cleaning cycle was initiated, along with the fly ash conveying system. Subsequent to the initial start-up, adjustments were made to the cleaning sequence, deflation, pressure and shaker operation to optimize fabric cleaning.

Air flow tests were performed at Harrington Station to determine air flow through the fabric filter system. Southwestern's results indicate that the air flow rate is approximately 1.6 million acfm at full load. During the second year of the study special tests will be conducted by Southwestern Public Service and its subcontractor, GCA, to measure specific parameters simultaneously at five locations so that the effect of the baghouse on these parameters can be determined.

Other areas that are being assessed by the fabric filter study include the corrosiveness of flue gases passing through the baghouse and the performance of different types of fabric filters. Corrosion test coupons have been installed in each of the 28 compartments and will be removed periodically for analysis. Compartments 7 and 22 have been equipped with different types of bags for testing purposes. The test bags will remain in the compartments for the duration of the study. A procedure for testing experimental bags is being developed.

III. DESCRIPTION OF THE SYSTEM

A. Harrington Station

Harrington Station is located approximately five miles northeast of Amarillo, Texas. Unit #2, on which the fabric filter is installed, has a 350 MW turbine with a tangentially-fired steam generator. The Combustion Engineering boiler utilizes low sulfur Wyoming coal to produce 2,688,000 pounds of steam per hour. The average characteristics of the coal are given in Table I.

TABLE I

Average Characteristics of Harrington Station Coal

Moisture	28.26%
Ash	4.74%
Volatile Matter	32.00%
Fixed Carbon	35.00%
Sulphur	0.33%
Calorific value, as rec'd	8,425 Btu/lb

The fly ash laden flue gas from the boiler flows through the preheater directly through the fabric filter system and then out the stack. A diagram of the system is shown in Figure 1.

B. Fabric Filter System

The emission control device selected for Unit #2 is a Wheelabrator Frye, Inc. fabric filter baghouse system. The baghouse is designed to operate at a flue gas flow of 1,650,000 acfm at 313^{o} F. Minimum design efficiency is 98.6%, which would permit 0.1 pounds of particulate/million Btu out the stack. The exterior of the baghouse has 3.5 inches of fiberglass insulation; there is no insulation between plenums and compartments. Other design parameters are summarized in Table II.

The filter bags are suspended from a shaker mechanism by a hook and a J-bolt spring to maintain a design tension. The bags are fastened at the bottom to a thimble with a clamp. Table III gives the fabric characteristics.

FIGURE I. COMBUSTION AIR FLUE GAS FLOW DIAGRAM

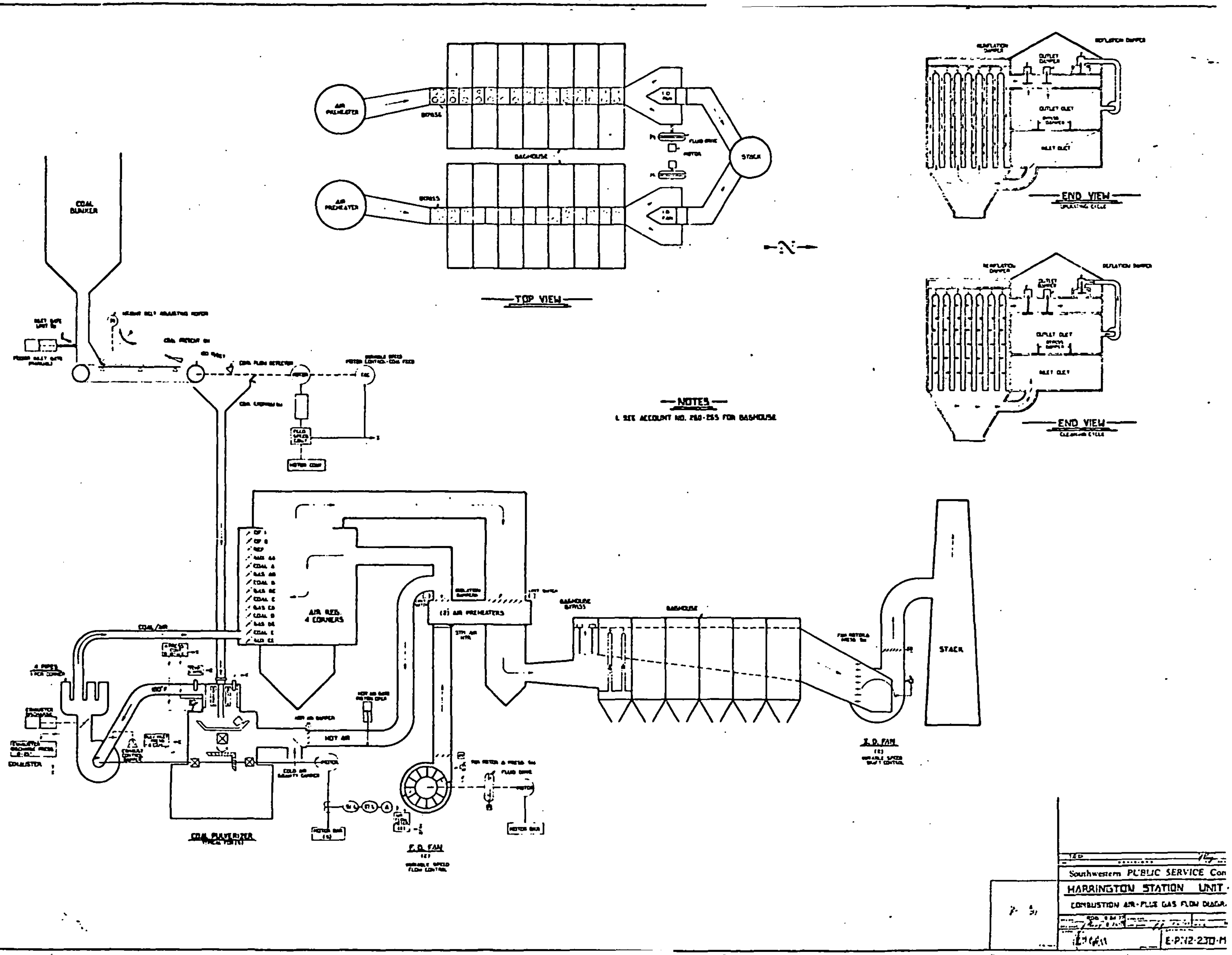


TABLE II

Fabric Filter System Design Parameters

Compartments	28
Bags/compartment	204
Bag manufacturer	W. W. Criswell Divn. Wheelabrator-Frye, Inc.
Model	No. 366, Series 11.5 RS Dustube
Bag diameter	11.5 in.
Bag length	30.5 ft.
Bag spacing, center to center	14.0 in.
Air to cloth ratio, gross	3.16:1
w/1 compartment down	3.27:1
w/2 compartments down	3.40:1
Bag reach	2

TABLE III

Fabric Characteristics

Maximum operating temperature	550° F (288° C)
Thread count	66 x 30
Weight	10.5 ounces/sq. yd.
Permeability at 0.5 in WG	45-65 cfm/ft^2
Cloth material	Fiberglass
Finish	Silicon/Graphite

The baghouse is provided with bypass dampers and start-up, emergency operation and shut down. There are two baghouses on Harrington Unit #2, one designated East and one designated West. Each one has its own operating control system and all bypass dampers are separated for each system. These are poppet type dampers which are 68 inches in diameter; they can be operated independently of each other. For each compartment there are the following dampers.

		Type	Diameter	Operated
1.	Outlet	Poppet	70 in.	motor
2.	Reinflation	Poppet	12 in.	motor
3.	Deflation	Poppet	30 in.	motor
4.	Inlet	Butterfly	60 in.	manually

Bag cleaning is accomplished by a combination of reverse air and gentle shaking. During normal filtering sequence, outlet and reinflation dampers are open and the deflation damper is closed. During cleaning cycles the reinflation and outlet dampers close, leaving only the inlet damper open. After an initial settle period the deflation damper opens, which pressurizes the clean side of the bag. This pressure breaks up the filter cake collected on the dirty side of the bag.

After a settle period the shaker motors are energized briefly to shake off the remaining filter cake. After a final settle period the reinflation and outlet dampers open, putting the compartment back in service.

The Unit #2 fabric filter system has four cleaning cycle modes which were designed to provide maximum flexibility of operation. Mode 1 will clean the West baghouse only and then the control system will reset; Mode 2 will clean the East baghouse and reset; Mode 3 will clean compartments 1 through 28 before the system is reset; Mode 4 will clean the East and West baghouses simultaneously, one compartment at a time on each baghouse.

Maintenance of the baghouse is accomplished periodically by inspecting individual compartments for signs of failure (such as holes or slackness of bags). There have been five bag failures to date and in September a decision was made to retension the bags to maintain 60 pounds. A Fabric Filter System Dustube Failure Log (See Appendix A) is utilized by inspection personnel to record where, when and why failures occur; these forms are kept on file at Harrington Station.

Maintenance inspections also revealed minor problems with the shaker mechanism. These maintenance items were primarily lubrication and adjustment of the shaker mechanism (one or two pins in the linkage were replaced).

It is anticipated that when a method for cooling compartments prior to entry by inspection personnel has been worked out, it will take 2 to 2½ hours to cool down an individual compartment. It is then estimated that 15 or 20 minutes would be required for single bag replacement.

C. Support Systems

1. EPA Trailer: In order to accommodate the extra equipment and personnel required for special testing, it was felt a mobile facility should be made available for use during the testing phase of the project. System Lab personnel surveyed the local market, but were unable to find a trailer that met the requirements for a test facility. In March, 1978, Kenneth Ladd, Project Manager, was informed by EPA that a Government-owned, 30-foot trailer was available for project work. Upon approval by the Project Officer and completion of EPA paper work, the trailer was sent to Amarillo and received by Southwestern Public Service on May 12, 1978.

The trailer was delivered to the System Lab where it was inspected and a list of necessary repairs and refurbishing items was made. Some of the repairs that were made included painting the outside of the trailer and securing paneling on the inside that had come loose. Electrical, plumbing and lighting installations were inspected and determined to be in satisfactory condition.

Upon completion of needed repairs, the mobile lab was moved to Harrington Station and parked underneath the baghouse, north of the control room. This position offers natural protection from the elements and is also easily accessible from the different sample locations. The trailer will remain at this location for the duration of the project (see Figures 2 and 3 for layout of the EPA trailer).

2. Datalogging System: One of the objectives of the fabric filter study is to correlate manual sampling results with operating data to define the performance of the fabric filter system. The parameters listed below are being continuously monitored at five points in the flue gas stream:

SO_2 NO_x O_2 Particulate (grain/cu.ft.)
Flue gas flow (acfm) Temperature (except in stack)
Duct pressure (except in stack).

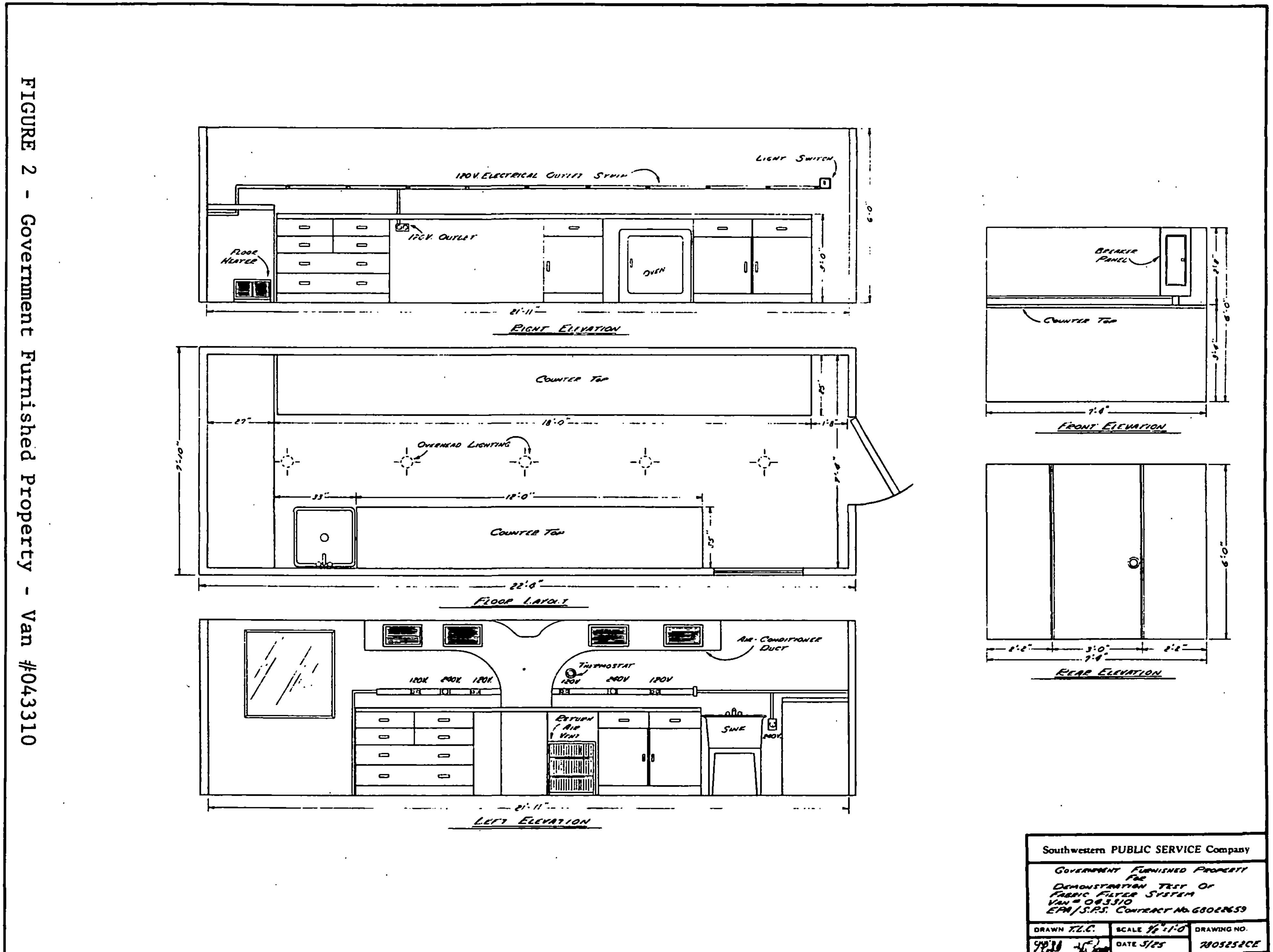


FIGURE 2 - Government Furnished Property - Van #043310

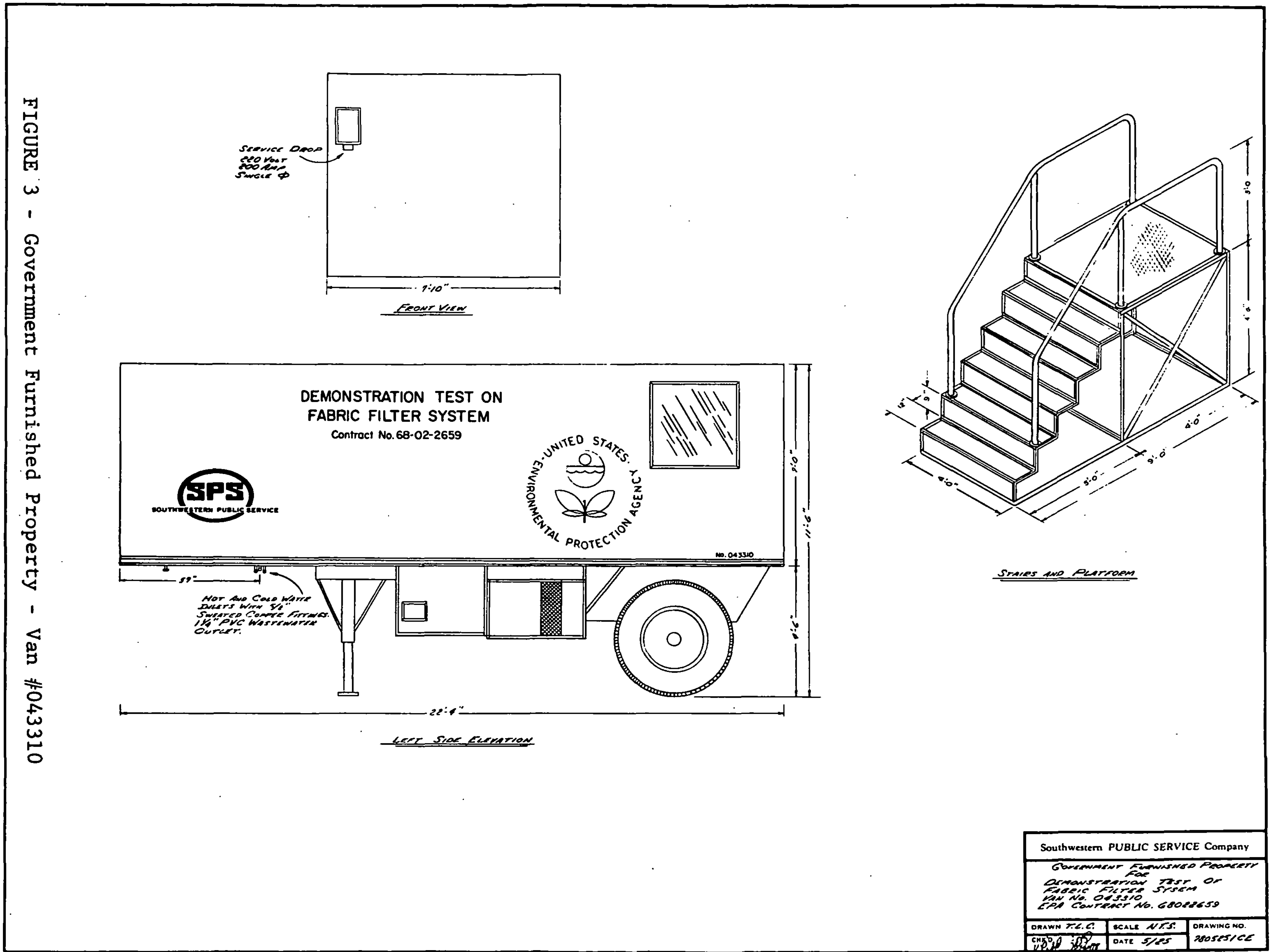


FIGURE 3 - Government Furnished Property - Van #043310

Additional operating parameters being measured or calculated on a continuous basis are pressure drop across the system, power consumption, load on the unit, fuel flow, particulate removal, cleaning mode and frequency, and flue gas flow. This data will not be as specialized as the manual sampling information, but rather will represent every day operation of the fabric filter system.

The Fabric Filter System (FSS) programs are executed under the sublevel processor of the Harrington Station, Unit #2, computer. The plant computer is a Westinghouse Model W2500, 16 bit, real time computer with a one million word disc and 64 K words of core. All contact and analog inputs from the five sampling stations are brought into the computer, which also has access to other performance parameters concerning the plant.

The FSS data collection package is modular in nature (i.e., each program is independent of the others, but accomplishes a specific function necessary for the successful operation of the package). Each program in the package is disc resident and is assigned a unique sublevel number. Table IV lists each program name, sublevel number and general function.

A general software overview is illustrated in Figure 4. On the left of the figure are the inputs to the programs and on the right are outputs. FSS1, the first program to run, monitors the position of the baghouse outlet dampers and the bypass dampers. If an outlet damper is closed for more than 10 minutes out of the hour, a bit in the core resident out-of-service flag (OSV) is set. If a bypass damper is opened once during the hour a corresponding bit is also set in the same flag word. This program also decides when it is time to print the daily baghouse summary log and output to magnetic tape. (Note: The magnetic tape is not operational; parts have been re-ordered and should arrive in approximately four months).

FSS2 is the second program to run and monitors the status of the instrumentation at the five sampling ports. Based on

TABLE IV		
PROGRAM NAME	SUBLEVEL NUMBER	FUNCTION
FSS 1	A013	MONITORS BAGHOUSE COMPARTMENT SERVICE TIME
FSS 2	401F	MONITORS INSTRUMENTATION FAULTS AND CALIBRATIONS
FSS 3	4015	COLLECTS ONE MINUTE SAMPLES AND CALCULATES PARAMETERS
FSS 4	400F	CALCULATES ONE HOUR AVERAGES AND PERFORMANCE PARAMETERS
FSS 5	4009	FABRIC FILTER SUMMARY LOG PART 1
FSS 6	2018	FABRIC FILTER SUMMARY LOG PART 2

TABLE IV - FSS PROGRAM NAME, SUBLEVEL NUMBER, AND FUNCTION

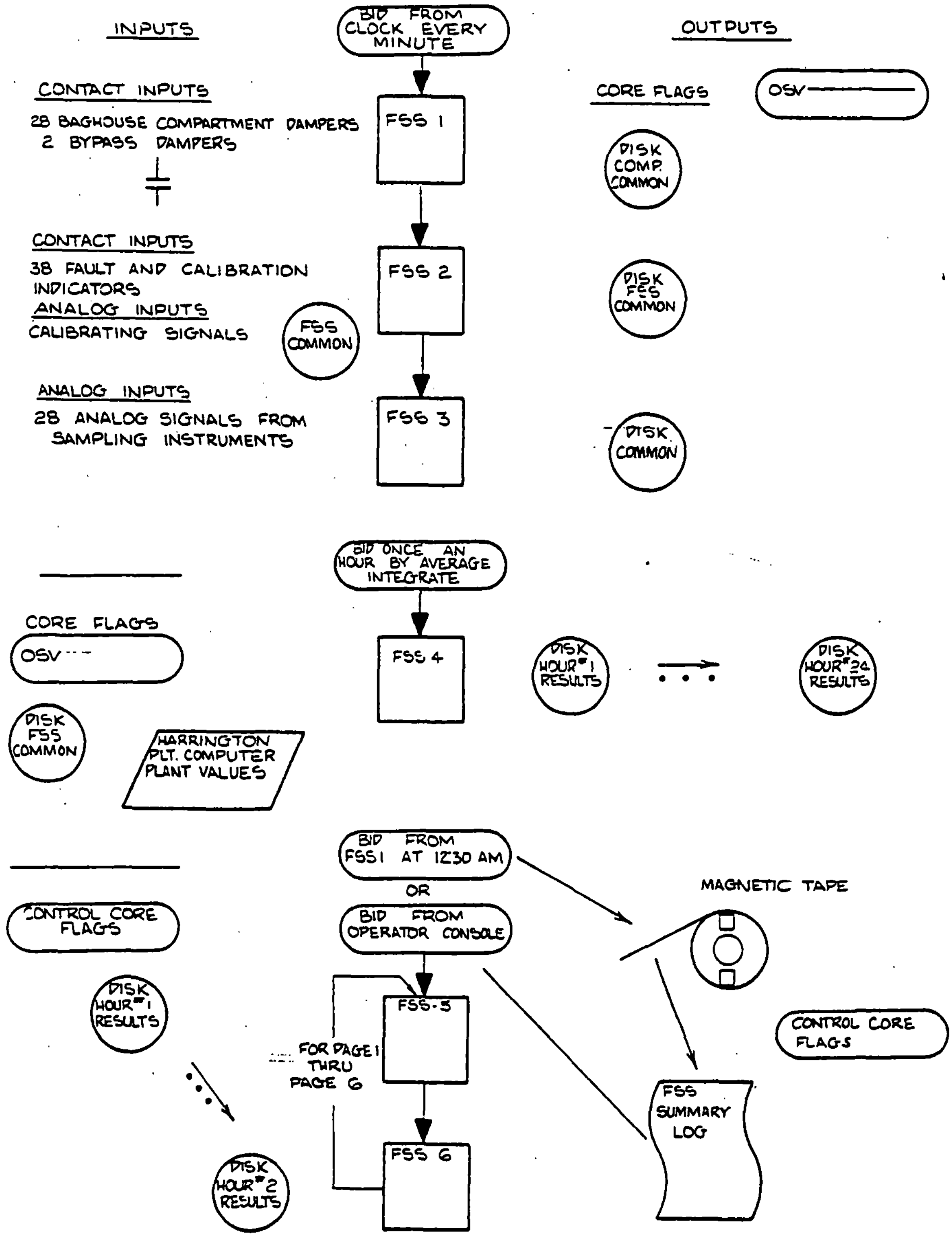


FIGURE 4. INPUT-OUTPUT COMPUTER FLOW

contact closures from the equipment three modes of operation are detected: normal, fault, and calibrating. Some of the devices undergo an automatic daily calibration which is recognized by a contact closure. The program then checks that the zero and span calibration readings are within allowable limits.

If a calibration check shows an instrument to be in error, an alarm is generated on the alarm CRT and all data from the instrument is flagged as questionable. When an instrument is in either the calibration or fault mode the sampling program is inhibited from collecting data from that instrument. The program uses information from the FSS Common to determine what each of the 32 contact inputs represent and stores information in FSS Common regarding the status of the instrumentation. FSS Common is a 100-word sector of disc that serves as a common data pool for all FSS programs.

The third FSS program uses the FSS Common to determine which inputs are to be sampled and which are to be ignored due to a fault condition or a calibration check. FSS4 maintains a running total of every input from the five sampling stations. Since a point may be sampled a different number of times in any hour a sample counter for each input is incremented every time a sample is taken. An averaged value is then determined by dividing the running total by the number of samples. This program also calculates, every minute, a corrected mass flow rate, the energy consumption for both baghouses, and keeps a running total of these quantities.

Every hour, the fourth FSS program is run. FSS4 uses the data collected by FSS3 and stored in FSS Common on disc to calculate hourly averages of the sampled inputs by dividing the running totals by the number of samples taken. This program calculates performance parameters based on these hourly average values. If coal is being fired, particulate loading, pounds of particulate loading, pounds of particulate per million Btu and pounds per million Btu of fuel input of SO_2 and NO_x are calculated.

Removal efficiencies for particulate, SO_2, NO_x, and O_2 and the temperature drop across both baghouses are also calculated by this program. The air-to-cloth ratio of each baghouse is determined by counting the number of compartments out of service for the hour as represented by the core resident out-of-service flags and the uncorrected mass flow rates. The program records various plant performance data that is to be put into the log.

All of the hourly averages, calculated data, and recorded plant parameters are then written to one of 24 hourly result files. Data collected between midnight and 1:00 a.m. will go to the first file (hour #1), data collected between 1:00 a.m. and 2:00 a.m. will go to the second file (hour #2) and so on until the data collected between 11:00 p.m. and midnight will go to the 24th hour (hour #24). Since several other data logs are printed at midnight the FSS summary log is not printed until 00:30 a.m.

The FSS summary log is implemented by use of two programs. The first of these, FSS5, prints the page headers and column titles on each of the six pages of the log. These headers and titles are stored on disc and can be changed by using the utility programs described later. Rather than outputting directly to the printer the FSS summary log programs output data to the Westinghouse Message Writer Program. In this mode data is stored in a disc file until the computer has time to output it to the printer. Additionally, it allows the log to be output to magnetic tape by doing one call.

The second of these log programs, FSS6, prints the actual hourly data and flags values that are questionable because of calibration check failures. After the first page of data has been printed, FSS6 does a time delay of one minute, and then calls FSS5 which will output the page headers and column titles for the second summary log page. FSS5 will then call FSS6 to output the second page of hourly data, and when finished will delay another minute and call FSS5. This process continues until all six pages of the FSS summary log have been printed by the message writer. The one minute time delay allows the message writer to empty its buffer, before the next page of print is loaded into this buffer. After the sixth page is output the program time delays for three minutes and then FSS5 is called which resets the core resident control flags and determines if the log should be output to magnetic tape. The log goes to magnetic tape only if the log programs have been run automatically by FSS1.

The FSS software package provides two means of initiating printing the FSS summary log. The first occurs automatically every day and produces the 24-hour printed data that is also stored on magnetic tape. The second means is a push-button labeled "Baghouse Log" on the control room operator's console. When this button is pushed the hourly results can be output by setting one of the core resident control flags equal to the previous hour. The demand button is inhibited from calling the FSS summary log between 11:15 and 1:05 which avoids the possibility of the log being demanded at a time that would interfere with the automatic daily output of the log. A message is returned to the operator telling him that he cannot demand the log now.

To facilitate modification of the page headers and the column titles, a program was written to allow these titles to be read in from cards and arranged in the proper format and placed in the page header and column title disc files. Complete instructions for using this program are found in the program listing.

3. Instrumentation (select, purchase, install): Specifications for monitoring equipment needed to meet the study's requirements were submitted to bidders in October, 1977 (see Appendix B for typical Bid Request). A review and evaluation of bids was completed in November, 1977. Lear Siegler and IKOR were the vendors selected. The following equipment was purchased.

Four (4) Lear Siegler SM800 SO_2/MO Monitors (see Table V) for specifications). The Lear Siegler SM800 Stack Gas Monitor is an "in situ" measurement system for sulfur dioxide (SO_2) and nitric oxide (NO) concentrations in stack emissions. The SM800 is a second-derivative spectrometer that specifically measures the narrow band absorption of ultraviolet energy in SO_2 and NO molecules. The spectrometer consists of an optical transmitter/receiver (transceiver) unit which is mounted on the side of a stack plus an integral probe that projects into the stack flue gas stream. The light source, monochromator detector, and electronic circuitry are contained in the transmitter unit, while a special retroreflector and gas measurement cavity are housed in the end of the probe.

Outputs from the transceiver are transmitted to the baghouse control room converter unit. In the baghouse control room the signal is monitored and recorded on a backup analog recorder. A second 4-20 ma output is transmitted to the plant computer located in Unit #2 control room.

TABLE V

SO_2/NO_x SPECIFICATIONS STANDARD

Requirements:

1. Monitoring - to meet specifications, continuous output
2. Analyzer Span - SO_2 0-1500 ppm
   NO_x 0-1000 ppm
3. Meet specifications of EPA, CFR Title 40, Part 60, Appendix B, of October 6, 1975 as to accuracy, calibration and operation
4. Recorded on strip chart in control room at plant
5. Zero and span calibration checked daily
6. Location of monitor
   a. $\geq$ 1.0 meters from sides of stack or duct wall (6' long from outside wall)
   b. Monitor representative concentration
   c. In-leakage of air will not change the concentration before emission to atmosphere
7. Required accuracy by EPA

Accuracy	±20% of Ref. $\bar{X}$ value
Cal. Error	$\leq$ 5% of each cal. gas (50%, 90%)
Zero Drift (2 hr)	2% of span
Zero Drift (24 hr)	2% of span
Cali. Drift (2 hr)	2% of span
Cali. Drift (24 hr)	2.5% of span
Response Time	15 minutes (max)
Operational Period	7 days (min)

8. Required Certification - on site operation

Conditioning Period	7 days	
Operational Test	7 days	
NO_x 27 measurements (3/hr)	±20% correlation	Method 7
SO_2 9 measurements (1/hr)	±20% correlation	Method 6

Accuracy same as above (#7)

9. Data Collection - 4 or more readings/hr continuous output to recorder
10. Data Recorded
    a. Hourly averages of SO_2 and NO_x
    b. Heat content of fuel
    c. Percent of each fuel
    d. Integrated MW coal
    e. Any parameters used in calculations
11. Calculations
    a. Conversion to correct units lbs/million Btu

$$E = C \cdot F \frac{(20.9)}{(20.9(1-Bwa)-\%O_2)}$$

where

E = emissions (lbs/10^6 Btu)

F = ratio of dry flue gases to heat constant $\frac{(wscf)}{(10^6\ Btu)}$

C = pollutant concentration (lb/wscf)

Bwa = .027

The last factor will determine the mass flue gas flow attributed to excess air

b. 1 hr averages

c. Excess Emissions (only at stack locations) - alarmed and printed when exceeds equation

$$E_{A_{SO_2}} = \frac{(\%\ Btu\ in\ Coal)\quad(1{:}2)}{(\%\ Btu\ on\ Coal + \%\ Btu\ on\ gas)}$$

$$E_{A_{NO_x}} = \frac{(\%\ Btu\ on\ Coal)(7.0) + (\%Btu\ on\ gas)(.2)}{(\%Btu\ on\ Coal + \%\ Btu\ on\ Gas)}$$

Using hourly average concentration convert to lb/MBtu

Four (4) Lear Siegler CM50 Oxygen Analyzer Control Monitors (see Table VI for specifications). The Lear Siegler CM50 in-stack oxygen analyzer is an in-situ system for the measurement of excess oxygen in combustion process flue gases which includes automatic, unattended calibration checks. During each calibration cycle (once every 24 hours) the calibration gas floods the measurement side of the cell, providing a low-level calibration point. The CM50 measures the excess oxygen in a flue gas using a proprietary, yttria-stabilized, zirconium oxide fuel cell type sensor. The probe is electrically and pneumatically connected to the central unit located near the probe. The partial pressure of oxygen in the flue gas is compared to the reference gas providing an output. The cell output is a function of oxygen content of the flue gas. The control unit performs the signal processing and transmits all information to a remote readout unit located in the baghouse control room.

The excess oxygen percentage is recorded on the baghouse control room's analog recorder. The primary recording of the oxygen levels is done by the plant computer. These oxygen percentages are used for normalizing the sulfur dioxide and nitric oxide emission levels on a wet basis per EPA's alternative monitoring requirements.

TABLE VI
O_2 SPECIFICATIONS

Requirements:

1. Monitoring - continuous output, used to determine the effects of excess air on the flue gas mass flow
2. Analyzer span - 0-10% O_2
3. Meet specifications of EPA CFR Title 40, Part 60, Appendix B, as to accuracy, calibration and operation
4. Recorded on strip chart in control room
5. Zero and span calibration checked daily
6. Location of monitor
   a. $\geq$ 1.0 meter from stack wall (6' long probe from outside of wall)
   b. On stack in location to monitor representative concentration
7. Required Accuracy by EPA:

Zero drift (2 hour)	$\leq$ 0.4% O_2
Zero drift (24 hour)	$\leq$ 0.5% O_2
Calibration drift (2 hour)	$\leq$ 0.4% O_2
Calibration drift (24 hour)	$\leq$ 0.4% O_2
Operational period	7 days (min)

8. Required Certification - on site operation

Conditioning Period	7 days
Operational Period	7 days
(2 hour) Field Test & Span Drift	$\leq$ 0.4% O_2
(24 hour) 15 sets of Data @ 2 hour intervals	$\leq$ 0.5% O_2

9. Data Collection - 4 or more readings/hour, continuous output to recorder
10. Data Recorded - 1 hour averages
11. Calculations - O_2 is used in emission equation
    The hourly average value will be used.

One (1) Lear Siegler Opacity Monitor (see Table VII for specifications): The Lear Siegler RM41 Visible Emission Monitoring System is a transmissometer which measures light transmittence through an optical medium such as smoke or dust. An optical transceiver unit mounted on one side of a stack and a reflector unit on the opposite side comprise the transmissometer. A light source, a detector, and electronic circuitry are all contained in the transceiver and only a special retroreflector is housed in the reflector unit. The dual-beam measurement technique automatically and continuously corrects the measurement for variations in temperature, line voltage, lamp aging and component drift or aging.

Output from the transceiver is transmitted to the baghouse control room converter unit that simultaneously provides an indication of optical density and opacity corrected to stack-exit conditions. The opacity is recorded in the baghouse control room on a back-up analog recorder. A second 4-20 ma output is transmitted to the plant computer, which is the primary recorder.

Four (4) IKOR Continuous Particulate Monitors: The IKOR Model 2710 In-stack Continuous Particulate Monitor System is designed to meet many requirements for in-situ measurements of particulate concentration on a continuous, real-time basis. The in-stack sensor probe, a bullet-shaped sensor manufactured of highly corrosion resistant metals and alloys, is electrically isolated from the wall of the probe by an insulator. The ceramic insulator is isolated from the direct gas and particulate flow by a metal hood. To optimize particle impaction the sensor is faced directly in the air stream.

TABLE VII
STACK FLUE GAS MONITORING SPECIFICATION

OPACITY

Requirements:

1. Monitoring - Transmissometer: continuous output
2. Meet Specifications of EPA CFR Title 40 Part 60 as to measurement, accuracy, calibration, operation
3. Recorded on strip chart in control room
4. Zero and span calibrations checked daily
5. Monitor mounted on stack. It will transverse a diagonal path
6. Required Accuracy by EPA

a.	Spectral Response	Photopic
b.	Angle of view	5^{o}
c.	Angle of projection	5^{o}
d.	Calibration error	$\leq$ 3% opacity
e.	Zero Drift (2 hr)	$\leq$ 2% opacity
f.	Calibration drift (24 hr)	$\leq$ 2% opacity
g.	Response time	10 sec. (max)
h.	Operational period	7 days (test)

7. Data collection — 10 sec. readings, continuous output
8. Calculations

a.	Average (10 sec)	6 min
b.	Average (6 min)	1 hr

9. Data Recorded

a.	6 min. averages	10 logged/hr
b.	Hourly opacity	(average of 6 min averages)
c.	Continuous output to recorder	

10. Alarms

a.	6 min average	$\geq$ 20%

The probe senses a charge transfer which occurs when two dissimilar materials come in physical contact, either by direct impact and/or sliding and rubbing (triboelectricity). Upon collision between particles in the flowing gas stream and the electrically isolated sensing probe, a charge transfer results in the flow of a small electrical current. This current or work function is the difference between the Fermi energy level (maximum quantum energy level) of the particulates and the zero energy level of the metal sensor.

During instantaneous contact, the equilibrium state requires that the Fermi levels coincide with the surface having the higher energy level equal to the lower energy level. This gives rise to a contact potential difference. When contact is suddenly broken (as in a continuous flow condition) the body having the lower work function becomes negatively charged. In this way, a metal sensor subject to collision by a particulate cloud can give an electrical current as a signal due to redistribution of charges from particle impact.

The current output from the sensor probe connects to an electronics module attached to the external end of the probe and is transmitted to the 2710 control unit located in the baghouse control room. In this system a signal is produced equal in magnitude to the current generated by charge transfer. This signal is amplified and converted into an output related to the particulate charge transfer. In the compliance monitoring mode the electronic signal is recorded on an analog recorder in the baghouse control room and integrated over a finite period of time. This integrated output is scanned by the plant computer.

The specifications of the IKOR 2710 are:

a.	Recommended particle size	1 μm to 10 μm
b.	Gravimetric weight gain to electronics signal	One sigma standard deviation: $\geq \pm 10\%$

One (1) Ellison Instruments' Annubar: The annubar Type 86 Flow Sensor is an annubar averaging velocity head sensor for the natural measurement of flow through a duct or stack. The sensor is comprised of four computer-located, upstream ports to provide an average upstream pressure and one downstream or static pressure port. The annubar sensors do not clog in flows with normal amounts of dirt and debris. The high pressure center created by the flow forms a buffer, which keeps the pressure sensing ports clean.

The differential pressure between the upstream and downstream ports is proportional to the square of the fluid velocity. The sensor is connected to a differential pressure device for data transmission to the baghouse control room's analog recorder and to the plant computer.

The following specifications are for the annubar Type 86 Sensor:

a. Extra heavy duty insert-type sensor (2.375" o.d. probe)

b. Supported on both sides of duct

c. 5/8" diameter sensing ports

d. Designed for stack handling gases up to 1200° F for large size stack and ducts

e. 316 stainless steel construction material

f. Accuracy: ± 2.3% of actual flow

g. Approved by U. S. Government GSA PBE-4-1590

Twenty (20) Leeds and Northrup recorders for recording other operating parameters.

In addition, miscellaneous support equipment, thermocouples, and flow transmitters were purchased and a software program was developed. Delivery of the equipment began in February, 1978, and continued through April. Mounting, piping and wiring of the instruments took place in May and June and during July and August of 1978 the Lear Siegler monitors were checked out, started up and calibrated (Southwestern notified Lear Siegler of bad components before equipment could be started up under warranty). The Lear Siegler SM800 probes had to be sent back to the factory and were not returned to Southwestern until July, 1978.

Start-up of IKOR instrumentation began in July, 1978. The IKOR field man requested the IKOR probes be returned to the factory for modification and they were sent back to Southwestern in August. The IKOR instruments still do not operate properly. A summary of some of the problems remaining to be resolved can be reviewed in Appendix C. Numerous efforts by Southwestern and IKOR engineers have failed to produce recordable data. It is anticipated that early in November Southwestern will advise IKOR of a deadline for repairing the equipment. A report on the IKOR situation is presently being prepared to determine what steps to take to get the equipment to function properly.

By September, 1978, the Lear Siegler equipment was installed and most of the initial installation problems had been resolved. The equipment (with the exception of the IKOR monitors) seems to be performing in an acceptable manner. The equipment calibrates itself every 24 hours. These readings are fed into the computer where they are verified within EPA limits. If one parameter is out of the accepted range, the computer will sound an alarm and the problem is identified and corrected. A record of each problem is maintained at the plant that indicates the date, time, how it was repaired and when the items went back into service. Strip charts are also filed at the plant after they have been changed.

The maintenance record indicated the following problems have been experienced since the start of the Lear Siegler equipment but they have all been resolved by Southwestern personnel.

1. UV lamps on SO_2 monitors malfunctioned.
2. Problem encountered with probe alignment (photomultiplier tube).
3. Problem encountered with transceiver card.
4. Replaced a power transformer and power supply card on the O_2 analyzer.

5. Had to make adjustments to the temperature control card.
6. Resolved the problem on percent O_2 card for the O_2 analyzer.
7. Encountered some difficulty in putting in scan gas and other known gases to certify the equipment to be sure it was reading.

Manual sampling equipment was purchased from Lear Siegler and Accurex. Four sampling probes were designed by Olon Plunk and Steve Jones (Southwestern employees) and were built at Harrington Station by instrumentation personnel (the fifth probe was already on hand)(see Figures 5 and 6, Manual Sampling Probe). Probe liners were purchased from Accurex. Two PM100 Consoles were purchased from Lear Siegler but because they did not meet specifications were sent back. Two manual sampling control units to be used on the outlet were then designed and built by Southwestern's System Lab. In addition, four vacuum pumps for NO_x testing were purchased from Fisher Scientific. The manual sampling equipment remains to be certified but will be certified in time for special testing.

The majority of the glassware required for the testing program was purchased from Ace Glassware.

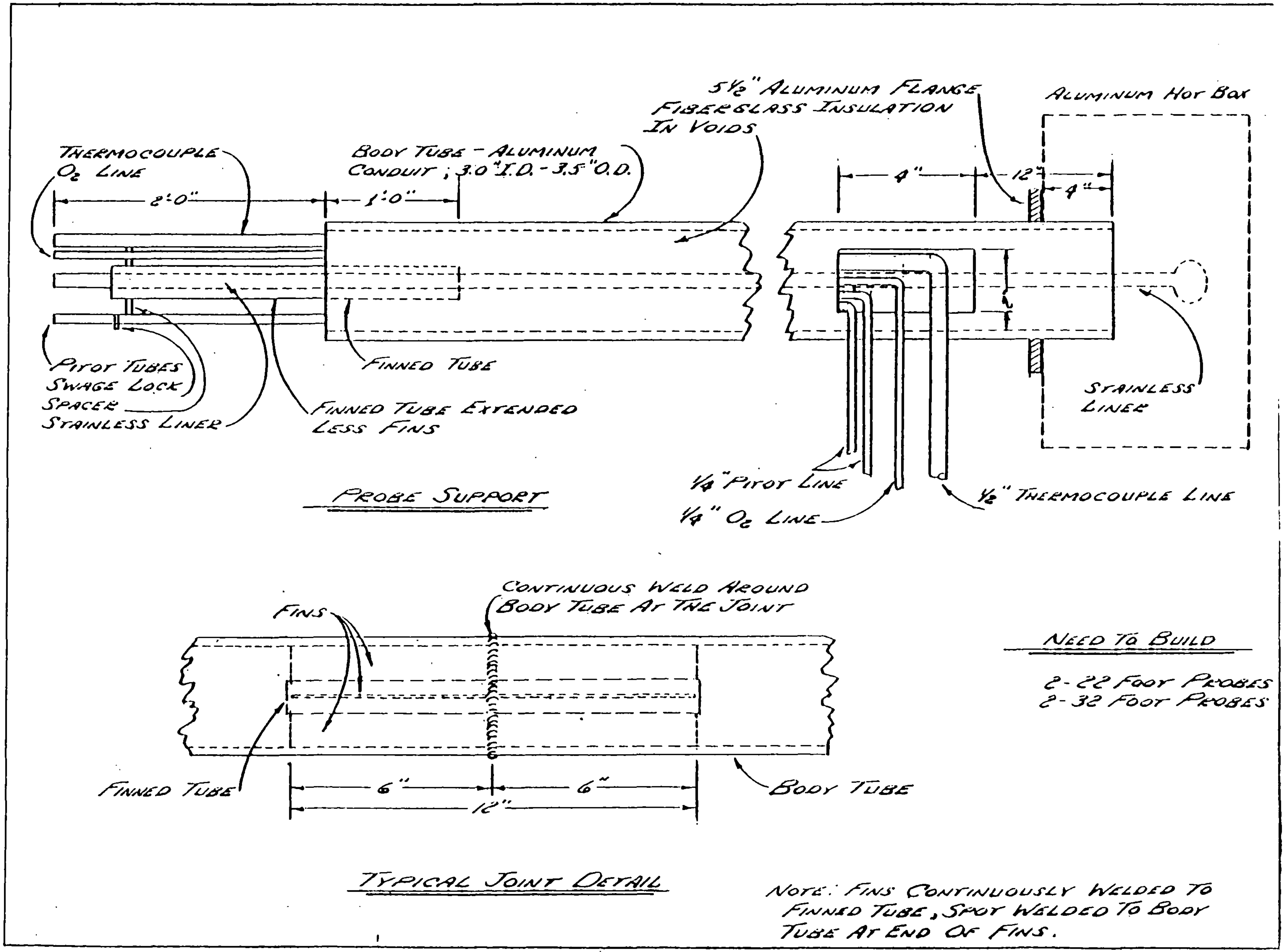


FIGURE 5. MANUAL SAMPLING PROBES FOR FABRIC FILTER STUDY

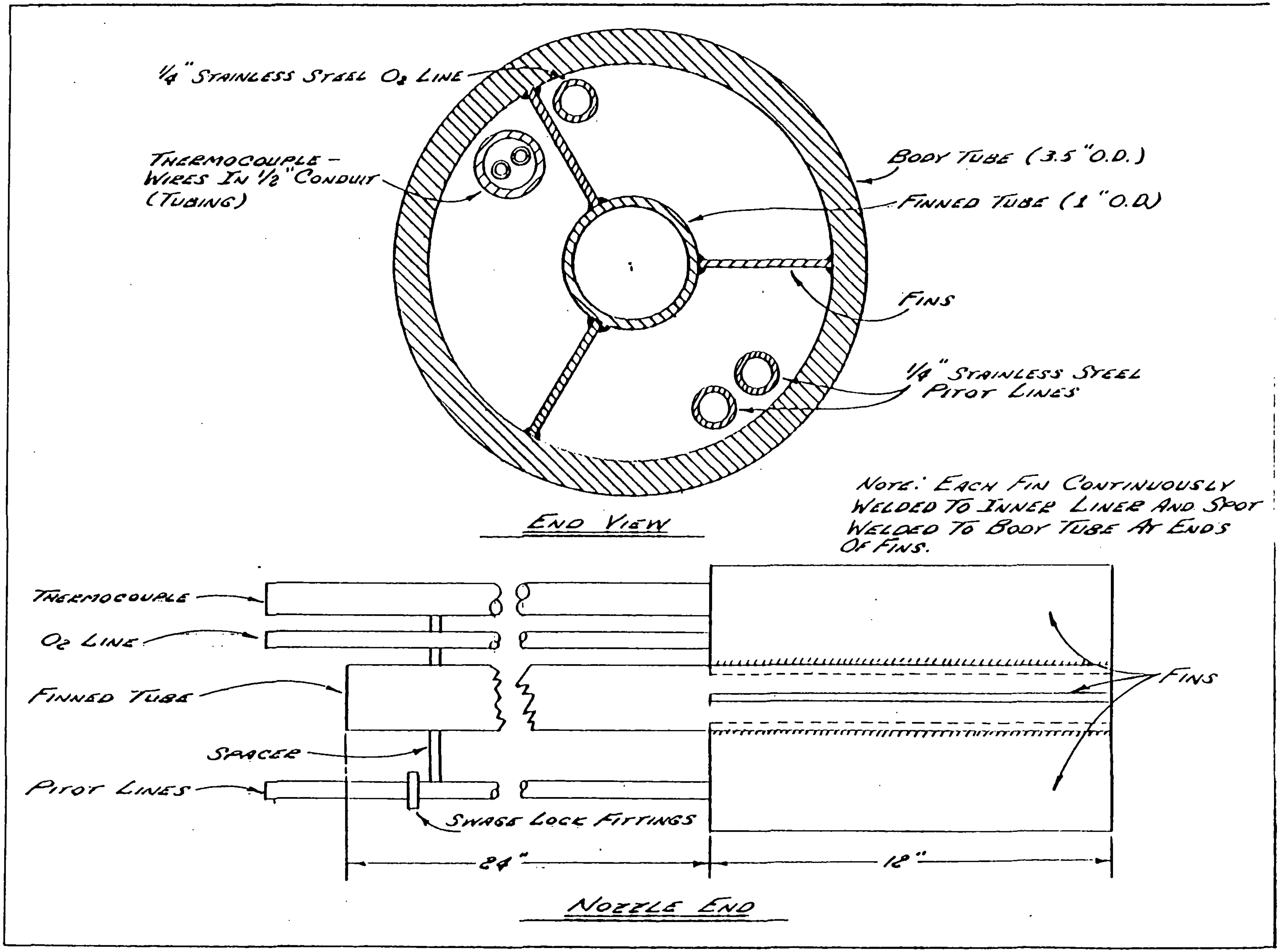


FIGURE 6. MANUAL SAMPLING PROBES FOR FABRIC FILTER STUDY

IV. START-UP OF FABRIC FILTER SYSTEM

A. Start-up Plan

Before a start-up plan was formulated for Harrington Station baghouse, an investigation was made of other fabric filter system start-ups. Southwestern personnel visited with other utilities which have baghouses in operation and sought the advice of start-up personnel at various locations (particularly at Kramer and Sunbury Stations). Individuals known to have expertise in the start-up of these systems, such as Rowan Perkins, Dupont, and Fred Cox, Menardi Southern, were consulted. Additionally, a literature survey was made and the recommendations of various manufacturers were studied and discussed with the Wheelabrator-Frye representatives.

The following considerations were used to plan the start-up procedures so that minimum difficulties would be encountered.

1. Orient operators.
2. Check out equipment.
3. Avoid dew point and acid point conditions.
4. Preheat compartments.
5. Condition and precoat the fabric.
6. Start up with natural gas through the boiler.
7. Change from natural gas to coal with flue gas going through the baghouse as quickly as possible.
8. Designate specific sequence for compartments to be brought on-line.
9. Add additional compartments as load increases.
10. Monitor required operating parameters during start-up and the first cleaning sequence, such as inlet, outlet temperatures; baghouse ΔP and opacity.

B. Actual Start-up Procedures

Because Harrington Station, Unit #2, was capable of start-up on natural gas, the baghouse was bypassed for several weeks before it was started. During this phase all dampers were closed in order to completely isolate the baghouse and to prevent condensation of flue gas in the baghouse. Because no dampers are

100% leakproof, however, all compartment doors were left open in order to pull fresh air into the baghouse and to prevent any leakage of wet flue gas into the compartments.

With all baghouse compartments still isolated from the flue gas, all hopper heaters were energized for two or three days prior to start-up in order to help preheat the compartments. Since the unit was on-line but not firing coal, all bypass dampers were open and the unit had approximately 200 MW load on the boiler.

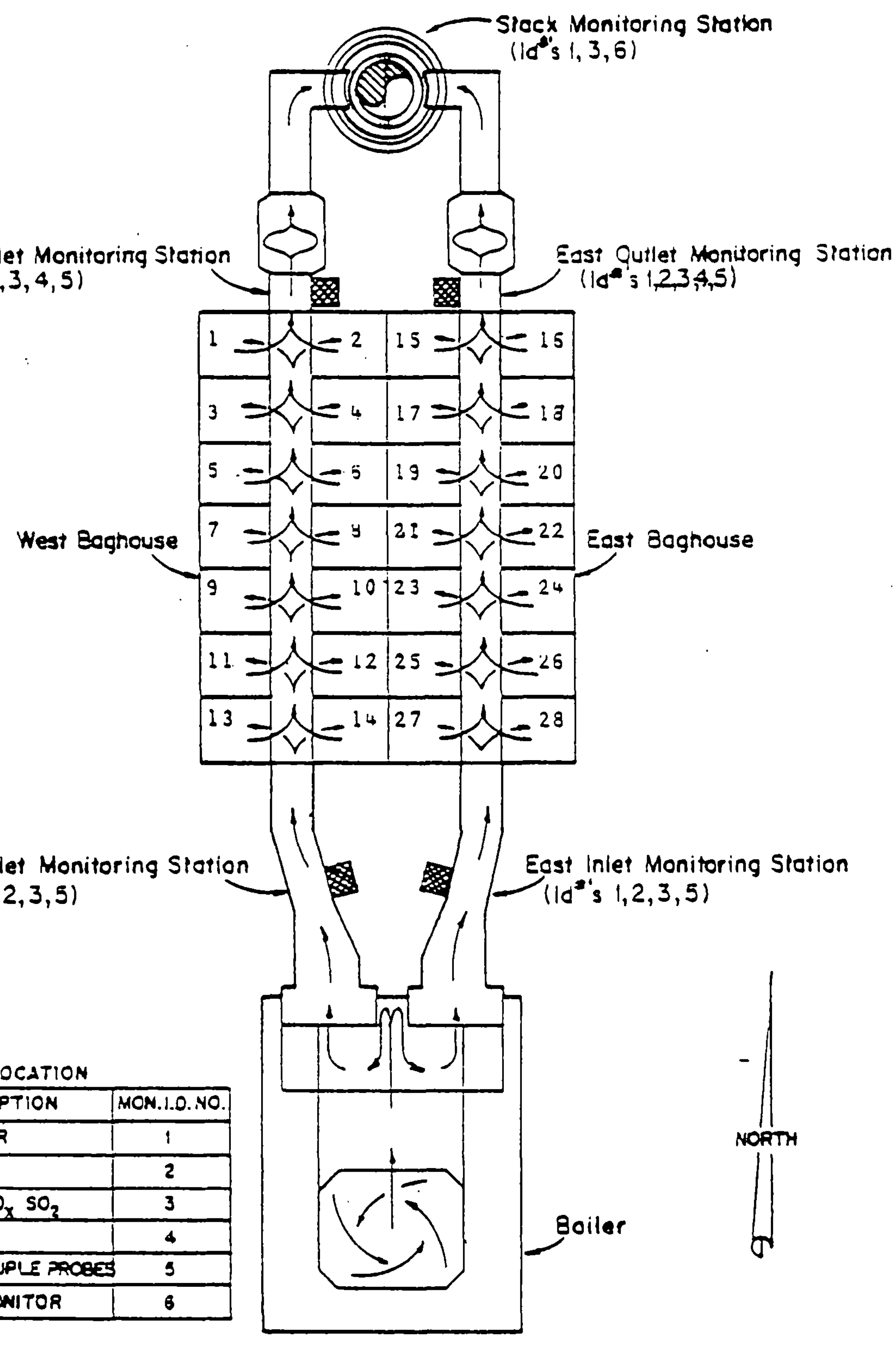
The planned start-up consisted of maintaining a consistent 200 MW load, increasing coal flow and decreasing natural gas flow to the boiler; a minimum condition of at least 50% gas firing was desired. Once the air preheater gas-out temperature was at least 300° F on the East and West sides, the baghouse was ready for start-up.

It was planned to bring two compartments on line at a time until half of them were in service, because the unit would be at half load (see Figure 7). The following procedure was selected:

Bring in Service:	Close:
Compartments 1 and 3	1st bypass damper on West
Compartments 16 and 18	1st bypass damper on East
Compartments 5 and 7	2nd bypass damper on West
Compartments 20 and 22	2nd bypass damper on East
Begin closing bypass dampers slowly	
Compartments 9 and 11	3rd bypass damper on West
Compartments 24 and 26	3rd bypass damper on East
Compartments 13 and 2	4th bypass damper on West
Compartments 28 and 15	4th bypass damper on East

Once these steps were completed the baghouse would be in service with the ash laden flue gas passing through the fabric filter system.

At this point it should be noted that, as with all start-ups, not everything proceeded as planned. The following events actually took place during the start-up.



MONITOR LOCATION

QUAN.	DESCRIPTION	MON. I.D. NO.
5	O_2 MONITOR	1
4	IKOR	2
5	SM 800 NO_x SO_2	3
2	ANNUBAR	4
8	THERMOCOUPLE PROBES	5
1	OPACITY MONITOR	6

FIGURE 7. HARRINGTON NO. 2 FLUE GAS MONITORING STATION

Compartments 1 and 3 were initially brought into service and the first bypass damper on the West side was closed. Compartments 16 and 18 (East) were brought into service and the first bypass damper on the East side was closed. At this point the Wheelabrator-Frye service engineer felt that the ΔP across the bags was too high (approximately 0.9" WG). He felt that a ΔP around 0.7" WG and 0.8" WG would be better; therefore, another compartment was brought into service on each side. During this time the initial compartments put in service were developing fly ash cake and the ΔP was still slowly increasing. Because of the sufficiently high inlet and outlet temperatures through the baghouse and the bag ΔP it was decided to bring into service an additional four compartments on each side before closing another bypass damper. After a total of seven compartments were in service on each baghouse the second bypass damper was closed. The remaining compartments on both East and West baghouses were brought into service with only two bypass dampers on each baghouse in closed position. Thus, all 28 compartments were in service. At this point the remaining two bypass dampers on each baghouse were ready to be closed. These bypass dampers were closed slowly and the effects on opacity can be seen in Figure 8, which shows a marked decrease in opacity only after the last bypass damper on each side was closed. At this point the baghouse was completely in service with the fabric being conditioned. The elapsed time, between first compartment being brought into service and the last bypass damper closed was 3 hours and 50 minutes.

Boiler load was maintained at 200 MW with primary fuel stabilized as coal and only the igniter natural gas in service. The baghouse ΔP was approximately 1.2" WG. The bag coating was expected to require approximately 20 hours before reaching a pressure drop of 4" WG. When pressure drop across the baghouse approached 4" WG, which took approximately 32 hours at 200 MW, the timing circuit control power was turned on and the

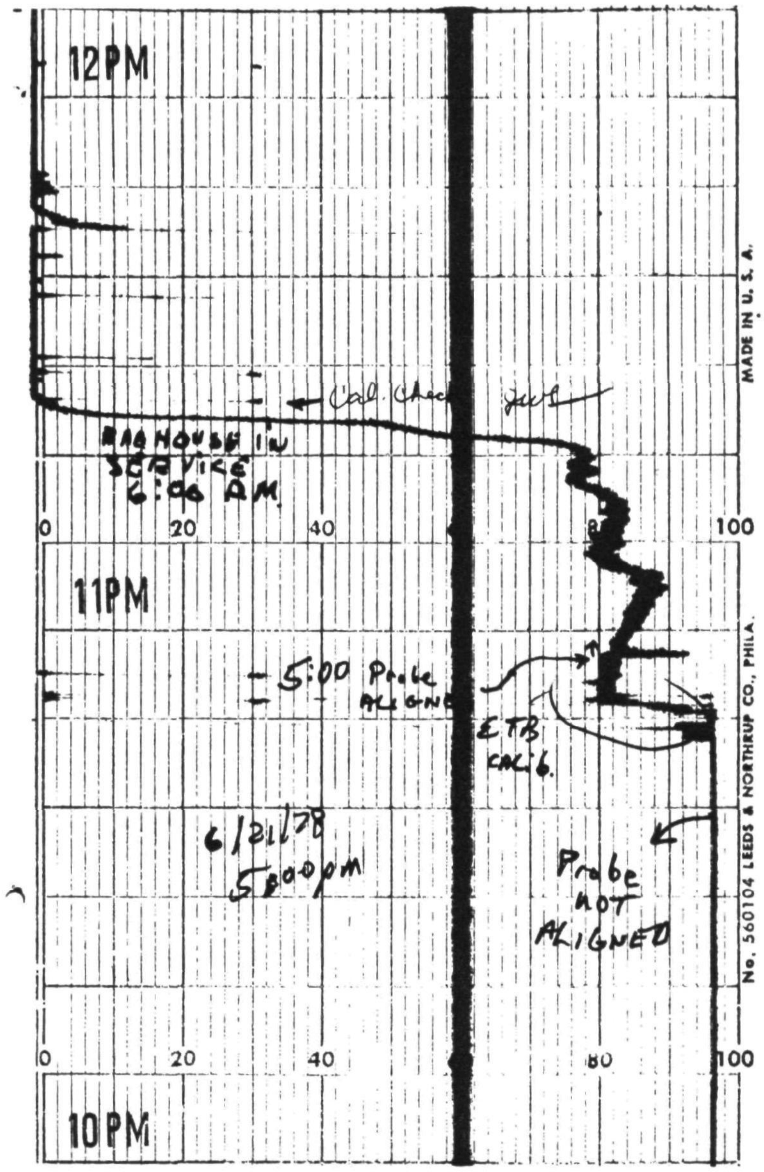


FIGURE 8. STRIP CHART, BAGHOUSE START-UP

cleaning mode selector was placed in Mode 3, which allowed the system to clean one compartment at a time.

The deflation fan was started for the Mode 3 operation. When the pressure drop reached 4" WG the cleaning cycle was initiated, along with the fly ash conveying system.

C. Problems Encountered/Resolved

Approximately three weeks after the fabric filter system was initially started, Southwestern was able to operate Harrington Station, Unit #2, at full load (362 MW) with only coal in service. The unit has operated at loads consistently above 200 MW and during the peak periods it has had 350 MW.

Adjustments have been made to the cleaning sequence, deflation, pressure and shaker operation to optimize fabric cleaning. At this point it is felt that bag life is a major factor in overall performance and in the coming months, Southwestern plans to continue to evaluate very carefully the cost of operating expenses due to fabric replacement and the ΔP power requirements.

The procedure for making adjustments in the cleaning sequence is to change only one of the settings at a time. Figure 9 shows adjustments made in the initial timing sequences. The baghouse is then allowed to operate several days in a cleaning sequence and an evaluation of the effects is made. Efforts have been made to shorten the interval times and settling times, and increase the shake time. The variation for shake time has been changed from 5 to 30 seconds; for one adjustment the deflation sequence was set so that no deflation pressure occurred. Over a period of several days the baghouse ΔP began to increase, at which time the deflation pressure was readjusted to be maintained below 0.3" WG. The fabric began to clean again with a 2.0" WG improvement within two hours after the readjustment.

Initially the deflation ΔP across the fabric was specified to be 0.6" to 0.8" WG. As load was varied with a manually controlled damper on the deflation fans, the deflation ΔP was not

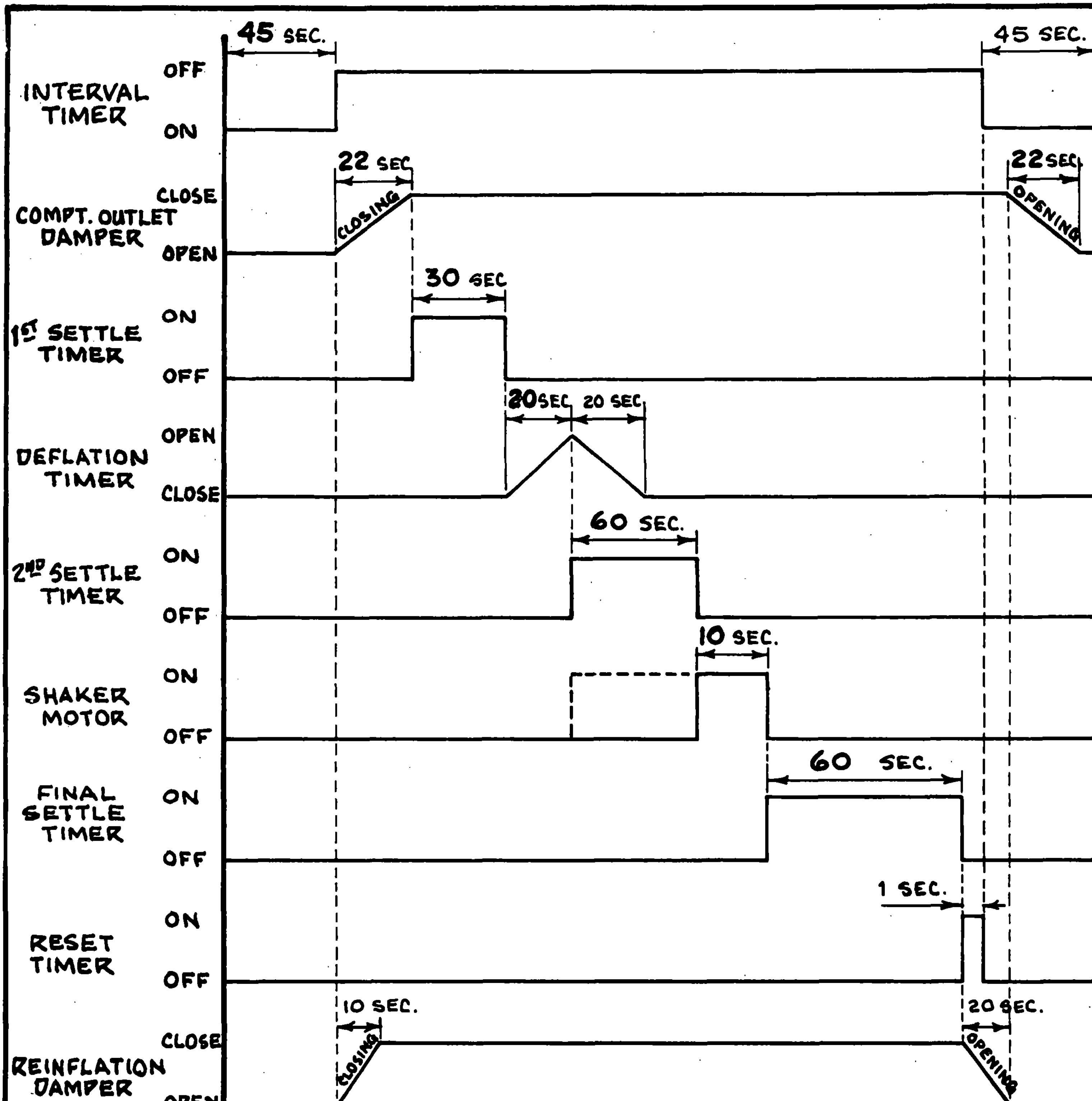


FIGURE 9

TYPICAL TIMING SEQUENCE OF FABRIC CLEANING

SETTINGS AT INITIAL START-UP

consistent; therefore, some "pancaking" of the bags occurred due to over-deflation. Manual control of the deflation ΔP is difficult to impossible to control with load change.

The bags were initially installed with 40 to 45 pounds of tension. The daily inspections indicate that during the deflation cycle of the cleaning sequence a double fold of the fabric results just above the thimble. Lab tests performed by the vendor indicate that a bag tension of 60 pounds removes the double fold.

The baghouse was to have operated with a ΔP of 5" WG flange to flange with a 3.4:1 air-to-cloth ratio. Higher ΔP readings than 5" have been experienced; therefore, an investigation was undertaken to determine the mass flow of flue gas. This test was inconclusive, and later pitot transverses along with stochiometric calculations seemed to indicate the unit runs at design gas flow at full load. More transverses, however, will be conducted in the near future.

A pitot tube and air flow monitoring check was made at the 3.4:1 air-to-cloth ratio. The ΔP across the system is still running in excess of the predicted 5" WG; therefore, additional cleaning cycle schedules are being planned and made to optimize the ΔP and the cleaning sequence relative to bag life versus operating pressure differential.

Recent decisions have been made on additional changes which would help the fabric filter operate more effectively. These changes include:

1. Bags were retensioned to a setting of approximately 60 pounds on September 21.
2. Continue to work on cleaning sequence in order to have optimum cleaning and bag life.
3. Install deflation automatic ΔP control system.
4. Install additional manometer reading ports across the outlet valve of six compartments to investigate individual compartment flow characteristics. Taps for manometer connection were installed on September 19, 1978.

5. Continue to visually inspect each compartment every day (five bags have been found with pencil-size hole leaks since start-up).
6. Addition of a ventilation system to aid in cooling the top compartments for inspection and maintenance.

V. TESTING

A. Description of Testing Done to Date

1. Method: In October air flow tests were conducted on the Harrington Station fabric filter system to determine the exact air flow. The primary reason for measuring the air flow was to see if it was causing high ΔP readings. Tests were run at two inlet locations and one point on the stack.

During previous tests a large amount of turbulence was encountered at the inlet, causing the test results to disagree with air flow measurements from stoichiometric combustion calculations. This discrepancy between calculated and measured values prompted a velocity traverse from the stack. The stack was selected because it met criteria specified in EPA Reference Method 2 ("eight stack diameters downstream from the disturbance").

2. Equipment: The following equipment was used to conduct the air flow tests:

Two 20-foot pitot tubes.

One manometer.

One EPA Reference Method 4 Moisture Sampling Train.

One EPA Reference Method 3 Orsat Apparatus.

B. Test Results

The October air flow test results are summarized in Table VIII.

TABLE VIII

Air Flow Test Results

Traverse	O_2 %	CO_2 %	H_2O %	T_s °F	Mol. wt lb/lb mole	Stack Press. in Hg	Avg. $\sqrt{\Delta P}$	Velo-city ft/sec	Duct Area sq.ft.	Inlet Gas Flow ACFM*	Inlet Gas Flow ACFM**	Stack Gas Flow ACFM
SPS S Type Pitot Tube	4.8	14	9.5	335°	29.05	2647	1.123	77.99	339.8	1,618,212	1,615,813	1,575,999
WBF Std Pitot Tube	4.8	14	9.5	335°	29.05	2647	0.895	77.79	339.8	1,628,372	-	1,585,894

* Corrected to Baghouse inlet conditions at 25.66" Hg and 345° F and 4.55% O_2.

** Stoichiometric calculation.

C. Special Testing

1. Field Sampling and Analysis: The approach to the field testing program shall encompass the determination of two sets of parameters, each of which will be measured at separate times. The stipulation of simultaneous sampling will be met within each set of parameters, but not all parameters will be measured simultaneously. The intent is to measure specific parameters at all five locations simultaneously so that the effect of the baghouse on these parameters can be determined. In keeping with sound engineering judgement and, equally important, reasonable manpower and cost considerations, selected combinations of parameters shall be measured concurrently and simultaneously at the five locations and other measurements can also be measured simultaneously, but at different times.

Table IX lists the parameters to be tested, the test method and the collection set to which each parameter is assigned (A or B). The gas phase compounds (NO_x, SO_2, SO_3, SO_4, C_7-C_{12} organics plus opacity, total mass flow, ash samples and coal samples collected on all days) will be collected simultaneously but on an alternate day other than the particulate samples.

Specific procedures presented in Table IX are described as follows:

Particulate Emissions - EPA Method 5 shall be utilized. The five sample locations will be sampled simultaneously using five trains. Southwestern Public Service Company will provide the appropriate support systems to allow transversing of the sampling trains.

Particle Size Distribution - The three particle size distribution measurement techniques to be utilized shall include: (1) in-stack impactors (0.5 to 20 μm); (2) Condensation Nuclei Counters with (0.0025 to 0.3 μm) Diffusion Denuders; (3) Electro-Optical Dust Counters (0.3 to 10 μm).

Five in-stack impactors will be used to collect simultaneous samples at the five locations. The outlet samples

TABLE IX

SUMMARY OF FIELD COLLECTION/ANALYSIS PROCEDURES

Parameter - Procedure	Two Inlet Sampling Points	Two Outlet Sampling Points	Stack Ports	Coal Sampler	Hopper Samples	Collection Time
Particulate emission EPA Method 5	x	x	x			A
Particulate Size Distribution in-stack impactor	x	x	x			A
Particulate Size Distribution-CNA/DD	x	x	x			A
Particulate Size Distribution - Electro-optical DC	x	x	x			A
Flue Gas Opacity - Lear Siegler		x	x			A&B
NO_x - EPA Method 7	x	x	x			B
SO_2 SO_3 SO_4 EPA Methods 6 & 8	x	x	x			A&B
O_2.. CO CO_2 N_2 G.C.	x	x	x			A&B
Total Mass Flow in conjunction with EPA Method 5	x	x	x			A&B
Moisture Content in conjunction with EPA Method 5	x	x	x			A
Organics - C_1-C_6 Integrated bag sample, on-site G.C. Analysis	x	x	x			A
Organics C_7-C_{12} XAD Sorbent, Lab Analysis						B
Ash: Grab Samples/Cone and Quarter					x	A&B
Coal: Ultimate Samples by SW Public Serv. Co.				x		A&B

should run several hours (6 to 12) in order to collect enough particulate matter. The inlet samples should be run only for a few minutes (5 to 15) to avoid overloading. Several inlet samples should be taken during the outlet sampling period to ensure representative inlet conditions. Two complete small particle measurement systems shall be used during the tests. The small particle measurement systems consist of the condensation nuclei counter with diffusion denuder, the electro-optical particle counter and associated dilution systems, recorders, etc. One system will be used to take measurements at the inlet, alternating between two sample locations, and the other system will be used at the three outlet locations.

Flue Gas Opacity - Opacity measurements must be adequate to characterize baghouse efficiency. Opacity measurements shall be taken at the outlet of each baghouse.

NO_x - To determine the concentration of NO_x before and after the baghouse, EPA Method 7 will be performed simultaneously at the five sample stations. Each test shall consist of three runs, with each run consisting of four samples, collected at fifteen minute intervals. The average of the four samples will constitute a run.

SO_2, SO_3, SO_4 - Tests shall be performed using EPA Method 6 for SO_2 and EPA Method 8 for SO_3 and SO_4. John Nader, EPA, Research Triangle Park, North Carolina, may be able to provide additional information for the SO_3 testing.

O_2, CO, CO_2, N_2 - Fixed gas analysis will be accomplished with a gas chromotograph utilizing a thermal conductivity detector. The bag sampler (Tedlar or Teflon) used to collect the fixed gases (as well as volatile hydrocarbons) shall represent five integrated samples collected simultaneously in conjunction with the EPA Method 5 run. Orsat analyzers will be available in the field as back-up equipment.

Total Mass Flow - Preliminary traverse will be conducted at each sampling location to determine proper sampling conditions. The reported mass flow rates will be those determined from the pitot tube readings obtained with the EPA Method 5 equipment. The pitot tubes will be calibrated in the GCA wind tunnel, prior to each test series.

Moisture Content - The moisture content will be determined in conjunction with the EPA Method 5 runs.

Organics - The volatile organics (C_1-C_6) will be vapor phase components and will be analyzed on site with a gas chromatograph column at 150° C. GCA shall use both AID and Carle gas chromatographs with integrating recorders for this purpose. The samples for C_1-C_6 analysis are to be collected in the integrated bag samples discussed above for O_2, CO, CO_2 and N_2 collection. The non-volatile organics (greater than C_6) must be captured by a sorbent material and returned to the laboratory for subsequent solvent extraction and G.C. analysis. To collect these organic species, the Method 5 train will be modified by placing a gas adsorbent column between the filter and the impinger.

Ash - Ash samples will be collected on all days that sampling takes place. These samples shall be collected from the silo or hoppers, as appropriate, with several samples taken each day. At the end of a day's sampling, the collected ash will be coned and quartered a sufficient number of times to reduce the representative sample to 1 kilogram.

Coal - Coal samples will be provided by Southwestern Public Service Company.

2. Laboratory Analyses

(a) Elemental Analyses: The program will include selected elemental analyses on coal feed, hopper ash and sampling train particulate catches. Specifically, GCA will analyze 18 coal samples, 18 ash samples, 45 sampling train particulate catches and 9 quality control samples. Each of these samples will be analyzed for the 19 elements specified in Table X. There will be a total of 1620 determinations. The analytical procedures to be followed are described below and are designed to encompass the analysis of the raw fuel, the ash collected by the baghouse and particulate from the sampling train cyclones (if used) as well as sampling train particulate filters. The basic technique to be employed for all elemental analyses is Atomic Absorption Spectrometry (AAS). Three different spectrometer configurations shall be employed, in order to achieve desired instrumental sensitivities. The preparation procedures utilized shall depend on both the sample type and element of interest. For analytical procedure for each of the elements see Table X.

Two preparative techniques must be used in order to analyze the ash samples for the broad spectrum of parameters listed

TABLE X

ELEMENTAL ANALYSES BY ATOMIC ABSORPTION SPECTROMETRY

Element	Sample Preparation[a]	Analytical Conditions: Wavelength (nm)	Analytical Conditions: Flame	Solution Sensitivity (μg/mℓ)	Expected Sample Concentration
Al	Fusion[b]	309.3	N_2O/C_2H_2	1	major
As	aqua regia/ hydride generation[c]	193.7	ArH_2	0.001	trace
B	aqua regia	249.7	N_2O/C_2H_2	15	minor
Ba	aqua regia	553.6	N_2O/C_2H_2	0.4	minor
Be	aqua regia/ fusion[d]	234.9	N_2O/C_2H_2	0.025	trace
Ca	aqua regia	422.7	Air/C_2H_2	0.08	major
Cd	aqua regia	228.8	Air/C_2H_2	0.025	trace
Co	aqua regia	240.7	Air/C_2H_2	0.15	trace
Cr	aqua regia/ fusion[d]	357.9	Air/C_2H_2	0.1	trace
Fe	aqua regia	248.3	Air/C_2H_2	0.12	major
Hg	aqua regia	253.7	Flameless Cold Vapor	0.001	nitra-trace
K	aqua regia	166.5	Air/C_2H_2	0.04	minor-major
Mg	aqua regia	285.2	N_2O/C_2H_2	0.025	minor-major
Mn	aqua regia	279.5	Air/C_2H_2	0.055	trace
Pb	aqua regia	283.3	Air/C_2H_2	0.5	trace
Se	aqua regia/ hydride generation[c]	196.0	Ar/H_2	0.001	trace
Si	fusion[b]	251.6	N_2O/C_2H_2	1.8	major
Ti	aqua regia	365.3	N_2O/C_2H_2	1.9	trace-minor
V	aqua regia	318.3	N_2O/C_2H_2	1.7	trace-minor
Zn	aqua regia	213.9	Air/C_2H_2	0.018	trace-minor

[a]Preparation methods applicable only to ash samples.

[b]Dry ashing of the sample followed by sodium carbonate fusion

[c]Aqua regia digestion followed by hydride generation.

[d]Analysis will be performed on samples prepared by both methods.

(see Table X). The majority of these elements will be extracted from ash or particulate samples (regardless of compound form) by an acid (aqua regia) reflux. The more refractive species shall be prepared by a basic fusion. In particular, silica (SiO_2) and the oxides alumina (Al_2O_3), chromium sesquioxide (Cr_2O_3) and beryllium oxide (BeO) are not adequately extracted by the acid reflux; therefore, for the latter elements (Cr, Al, Be), an AAS analysis will be carried out on solutions obtained from both preparative procedures. All coal samples will be prepared for analysis by a Paar Oxygen bomb combustion procedure.

The specific AAS instrumental configuration indicated in Table X is geared toward achieving the desired sensitivity for each element and is based on the expected concentration (major, trace, etc.); therefore, the majority of the parameters shall be determined by standard aspiration techniques using either an air/acetylene or an air/nitrous oxide flame. Exceptions to the standard flame procedure are the arsenic, selenium and mercury determinations. Because of the short wavelengths of the characteristic absorption lines of As and Se, the Hydride generation method shall be the preferred configuration. The desired analytical sensitivity for the Hg determination shall be obtained by a reduction of the Hg in the prepared solution to its elemental form followed by a measurement of the absorbance produced by the evolved Hg vapor.

(b) Specific Inorganic Compound Analysis: The program shall also include some specific compound analyses for the major constituents of the ash samples. This analysis will include the crystalline phases of SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O and TiO_2, which are anticipated to be the major constituents of the ash samples. The preferred method for the identification of these specific crystalline phases present in the samples is X-ray Diffraction Analysis (XRD); therefore, the analysis of the crystalline phase (using XRD) shall be performed and the results shall provide an accurate determination of mineralogical quantitative data.

For this analysis, GCA shall use a Phillips (Norelco) water-cooled Xray generator with a 114.6 mm Debye-Scherrer camera (Charles Supper Col). Powder patterns shall be measured with a precision of about 0.03 mm. Following the conversion of the data to "d-spacings" using the Bragg equation, tables (such as the Powder Diffraction File published by the Joint Committee on Powder Diffraction Standards and ASTM file) shall be used to identify the phases present. GCA will also make use of its in-house data file on airborne particulates and fly ash constituents.

(c) C_7-C_{12} Analysis: Organic emissions boiling in the C_7-C_{12} hydrocarbon range shall be collected on XAD-2 resin. Organic material will be extracted from the 45 resin samples by methylene chloride for 24 hours in a Soxhlet extractor. After extraction the methylene chloride solution will be transferred to a Kuderna-Danish evaporator where it will be concentrated to a volume of 5 ml.

To determine the individual C_7-C_{12} hydrocarbon equivalent (by boiling point) emission rates, a 1 ml aliquot of concentrate shall be analyzed by gas chromatography with flame ionization detection. By using boiling point-retention time and response amount calibration curves, the data (peak retention times and peak areas) shall be interpreted by summing peak areas in ranges obtained from the boiling point-retention time calibration. The area sums shall also be converted, using the response-amount calibration curve, to amounts of material in each boiling point range as follows:

C_7	90 to 110^o C
C_8	110 to 140^o C
C_9	140 to 160^o C
C_{10}	160 to 180^o C
C_{11}	180 to 200^o C
C_{12}	200 to 220^o C

This analysis shall be performed on Tracor gas chromatograph equipped with dual columns, dual flame ionization detectors and a linear temperature program. Peak areas and retention times shall be recorded on Hewlett-Packard integrator. Columns shall be 10% OV-101 on 100/120 mesh Supelcoport. The GC shall be programmed for five minutes isothermal at 50° C/min from 50° C to 220° C. Retention-time and per area calibrated curves shall be derived using this program for a mixture of n-heptane, n-octane, n-nonane, n-detane, n-undecane, and n-dodocane.

(d) Coal and Ash Analysis: Coal and hopper ash samples shall be submitted to Gilbert Associates. Coal samples shall be tested for ultimate, proximate and Btu. Ash samples shall be tested for loss on ignition and carbon.

D. Plans for Special Testing

1. Schedule for special testing calls for Southwestern to begin its tests in December, 1978. The subcontractor (GCA Corporation) will conduct its first series of tests in January, 1979. The original schedule called for testing to start in October, 1978, but it was decided to postpone any special sampling until the fabric filter system's performance reached a more normal operating level.

A consultant contract was executed by Southwestern Public Service Company on August 31, 1978 with GCA Corporation, Bedford, Massachusetts. The other two consultant firms which submitted proposals for the special testing program were Southern Research Institute and Meteorological Research Institute. Selection of the consultant was based on technical evaluations of the proposal and costs for the proposed programs.

2. Corrosion testing: The interaction of a metal with its environment is the corrosion process which is particularly prevalent in many pollution control installations. There are three primary causes of corrosion in a fabric filter* and these are:

*Fabric Filter Manual
Chapter VII, Sec. 2.131, Pg 85.5

1. Chemical attack on the base metal due to gas and for solid particulate incompatability with the materials of construction.
2. Electrolytic corrosion caused by use of dissimilar materials of construction.
3. Operating near or below the water or acid dew point which allows condensation and subsequent corrosion.

Southwestern, in an effort to assess the corrosiveness of the flue gases passing through the fabric filter system at Harrington Station, has placed low carbon steel coupons in the baghouse structure. Each of the 28 compartments have a coupon just inside the entrance door on the clean air side seven feet from the floor. Both inlet ducts and outlet ducts also have a coupon in each (see Appendix D for related drawings).

All coupons are insulated from any baghouse structural metal. The coupons are thoroughly cleaned and weighed before installation. They will be cleaned and weighed again when removed in order to determine weight loss, if any.

The present plan is to remove every other coupon after 120 days to check corrosion and then remove the remaining coupons after one year exposure. No coupons will be removed from the inlet or outlet ducts until the Unit #2's first year inspection. Compartment coupons will be removed in the following order:

1	2	15	16
2	4	17	18
5	6	19	20
7	8	21	22
9	10	23	24
11	12	25	26
13	14	27	28

3. Test Bags: Two test compartments have been equipped with different types of fabric filters for testing purposes. In Compartment 22 there are 34 Acid Flex and 33 Tri-Temp bags installed (supplied by Fabric Filters). In Compartment 7 there are three Nomex bags and twelve Cris-O-Flex bags installed. These bags were given to Southwestern by W. W. Criswell for evaluation purposes. The test bags will remain in the compartments for the duration of the study and periodically some will be removed for testing (see Appendix E for first test results). After initial evaluations have been completed, it is anticipated that Nomex bags may be installed in one entire compartment for a more definitive evaluation.

APPENDIX A

FABRIC FILTER SYSTEM DUSTUBE LOG

Page ______ of ______

HARRINGTON STATION
FABRIC FILTER SYSTEM
DUSTUBE FAILURE LOG

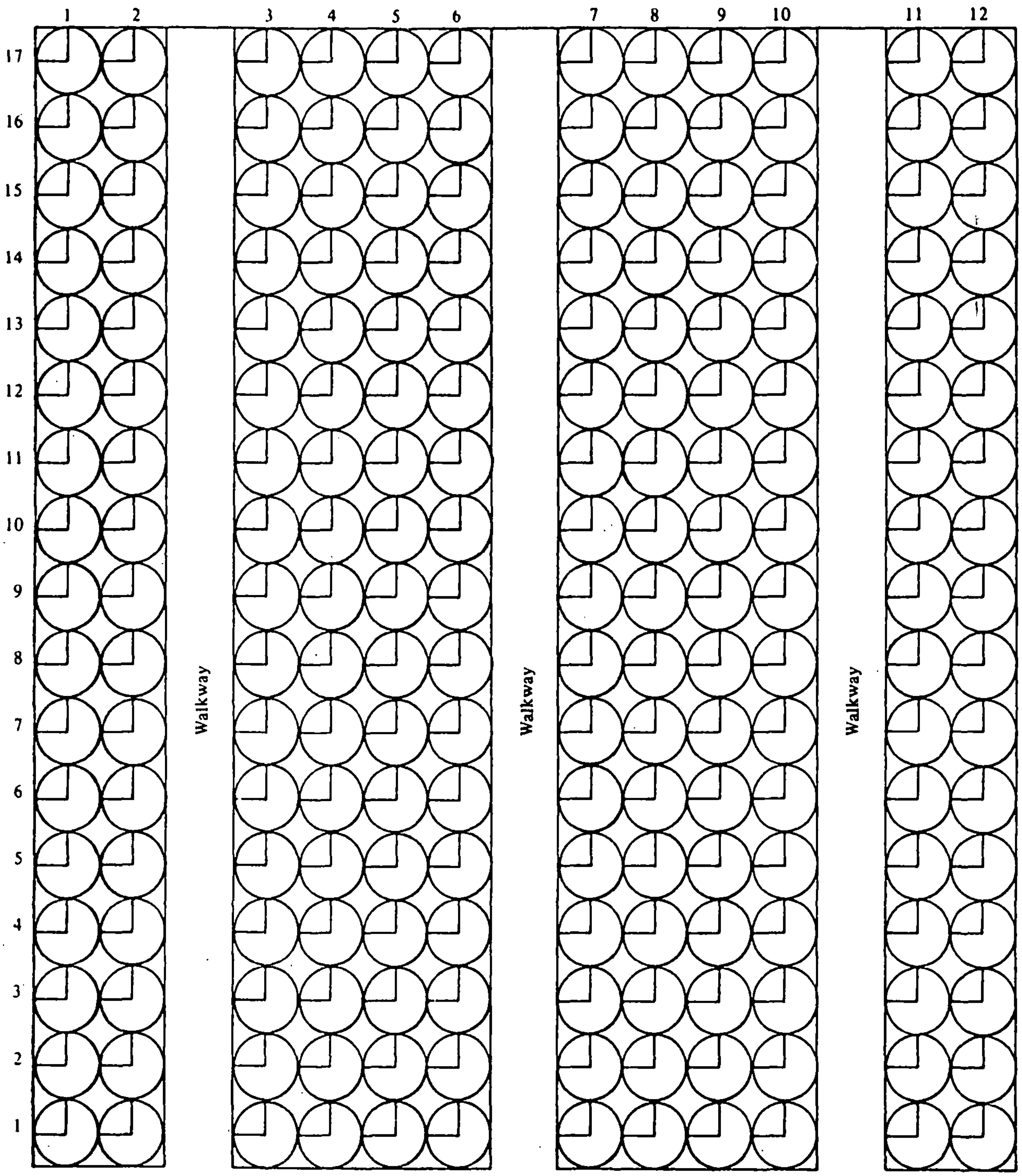
Unit No. ______

Compartment No. ______

No. Faulty Dustubes

Date of Inspection ______

Inspector ______



Walkway Door Walkway

CODE FOR LOCATION OF DUSTUBE FAILURE

Compartment No. ______________

1. Lower cuff
2. Seam
3. Upper cuff
4. Lower 1/3 fabric
5. Middle 1/3 fabric
6. Upper 1/3 fabric

Shaded Red – bag has been tied off

ADDITIONAL INFORMATION

DATE	BAG NO.	REMARKS

BAG INSPECTION - INSTRUCTIONS

December 14, 1977

1. One compartment will be inspected during every working day to insure that every 28 working days the baghouse compartments have all been inspected.

2. A copy of the baghouse inspection form will be turned in to George Faulkner or Rick Traywick.

3. A bag is located by a number designating the row and then the bag number. For example, bag 717 is located in the 7th row and is the 17th bag.

4. The upper left quadrant is used to record a code number which represents a failure as designated on the back page of the bag failure inspection sheet.

5. Remarks under additional information should be as detailed as necessary to identify the failure.

6. Bags that are replaced should be noted on the Dustube Replacement Log by shading the bag location green and recording the date.

7. Manhours required to inspect, tie-off, or replace bags should be recorded on the appropriate forms.

APPENDIX B

TYPICAL BID REQUEST

Southwestern Public Service Company

P. O. BOX 1261 • AMARILLO, TEXAS 79170

July 7, 1977

KVB Equipment Corporation
17332 Irvine Blvd.
Tustin, California 92680

Subject: Stack Monitoring Equipment Harrington #2

Gentlemen:

In order to meet Federal and State Emission Monitoring Laws, the following items will need to be installed on our Harrington Unit #2 electric generating station. Please send itemized quote for the following:

I. Opacity Analyzer - visible emissions monitoring system using a transmissometer Span 0-100%.

II. SO_2/NO_x stack gas analyzer system.-	Span	SO_2	0 - 1500 ppm
		NO_x	0 - 1000 ppm
III. Oxygen Analyzer System.	Span	O_2	0 - 10%

Each of these systems should include the following:

A. Factory certification to meet E.P.A.'s CFR Title 40 Part 60, Appendix B as to measurement, accuracy, calibration and operation.

B. Output to drive strip chart and computer input 4-20 ma and/or 0-10 volts.

C. Strip chart recorder for continuous monitoring.

D. Stack mounting in outdoor environment.

E. Three (3) additional sets of the following:
1. Instruction Manuals.
2. Wiring and interconnection diagrams
3. Installation drawings.

F. Calibration Contact - To disable analyzer output while in self calibration.

G. Fault Indication/Contact - To indicate failure of unit.

H. Large field termination area in junction box capable of handling #14 awg multi-conductor cable.

I. Any probe to be at least 6' long measured from outside mounting on stack.

J. Span to be set at the factory.

Options:

1. Protective weather enclosure for probe/analyzer assemble.
2. Maintenance kit - bulbs, filters, etc.
3. 480 volt A.C. motors, relays, solenoids.

This generating station consists of the following:

350 mw turbine-generator.
C.E. tangentially fired boiler.
Copes-Vulcan soot blowers.
Wheelabrator-Frye baghouse.

Equipment delivery must be on or before January 1978. Please send quotes within three weeks to:

Southwestern Public Service Company
P. O. Box 1261
Amarillo, Texas 79170
Attention: Eddie Barron (806) 378-2443
Olon Plunk (806) 378-2194

Sincerely,

Eddie Barron

EB:vm

APPENDIX C
STATUS OF IKOR INSTRUMENTATION
as of 10/5/78

10/15/78

Pete,

IKOR Status:

Outlets

WEST - no modifications - currently reads about 4% x 100 scale; signal usually stable until what appears to be welding in the area - pegs the signal out on all scales.

EAST - No modifications - was reading about the same as West until about 1 week ago. Signal is currently pegged out on all scales. Technician's brief survey did not turn up anything obvious - unit turned off while working, same noise problem affected it.

Inlet

WEST/EAST - Modified with resistors provided by IKOR (2 days for 1 engineer & 1 tech). At times will get a 30-40%. Fairly stable signal on lowest (x.1) scale. Other scales still peg out. Most of the time signal is pegged out or varying between 0-100% wildly. Signal varies with time/megawatt loading and sun position. No correlation has been drawn between wild readings and what's actually happening. Blowing preheater soot blowers has no effect on readings.

Generally

No signals to recorders are usable as they vary too much. Signals have not been compared to a hand sample. Plant computer readout is likewise useless.

James Lower, John Yost and Sol have tried to stabilize the signal and/or noise unsuccessfully. Problems/Answers beyond our current ability and time schedules.

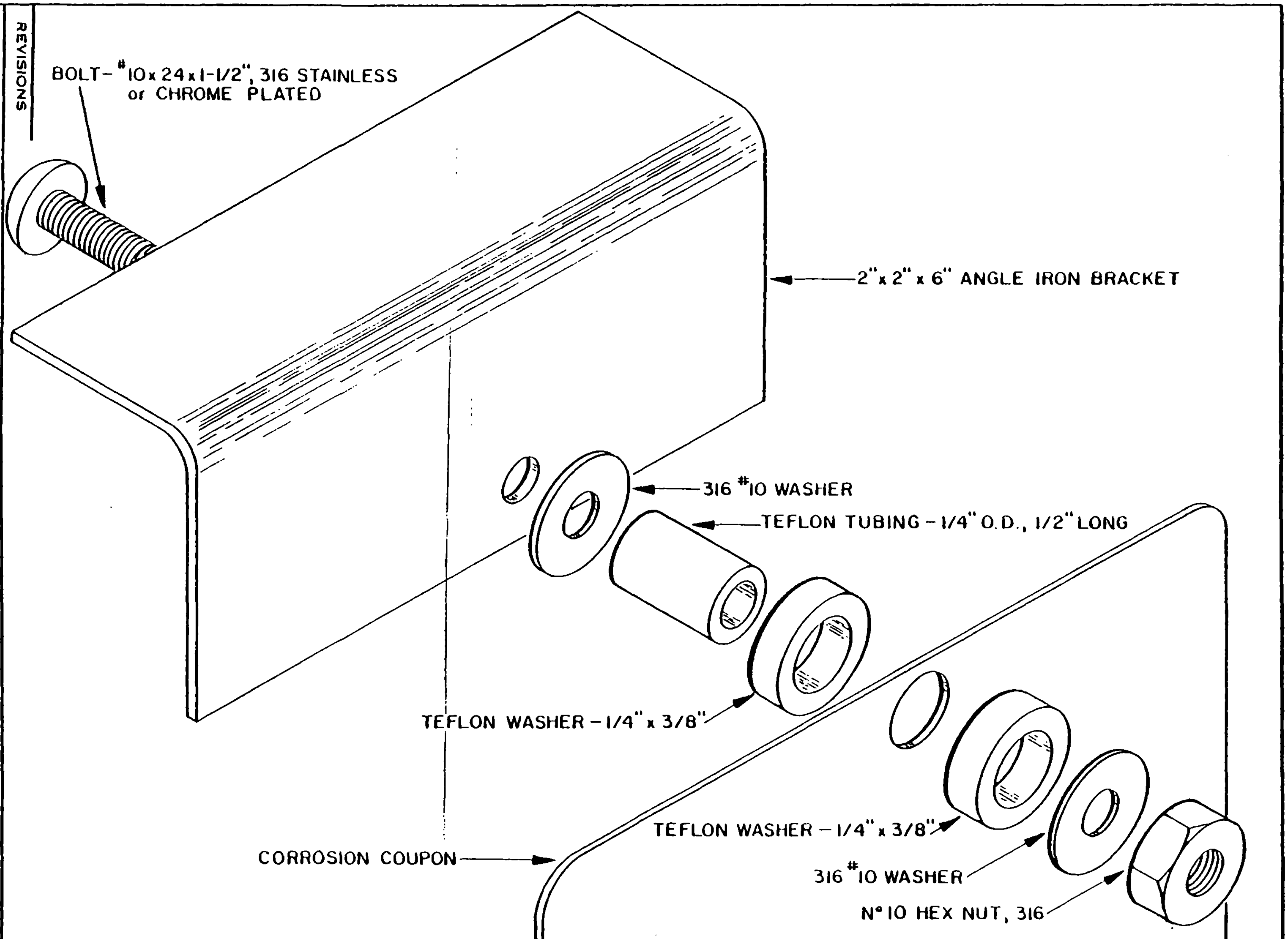
Suggestions

Have IKOR send in "expert" with field experience to modify equipment/installation to suit our needs.

Thanks ETR

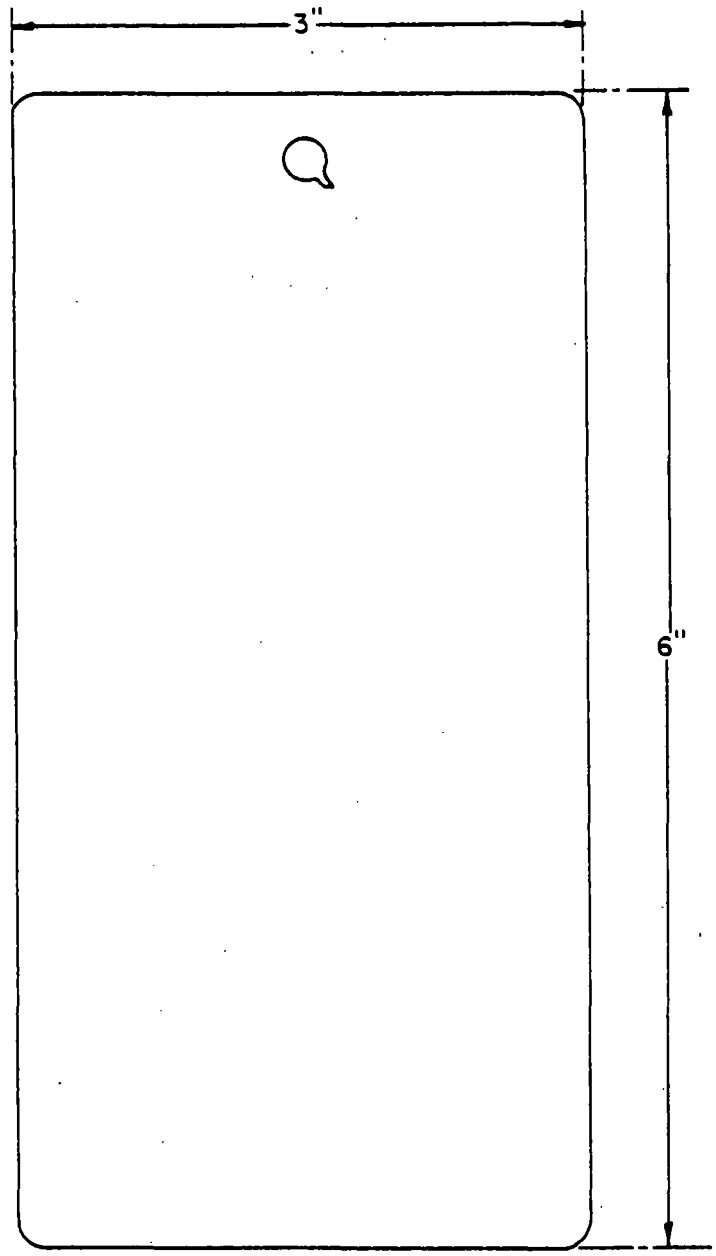
APPENDIX D

CORROSION COUPON ASSEMBLY
DRAWINGS



HARRINGTON STATION UNIT N° 2 - BAGHOUSE-CORROSION COUPON ASSEMBLY

CORROSION TEST COUPON

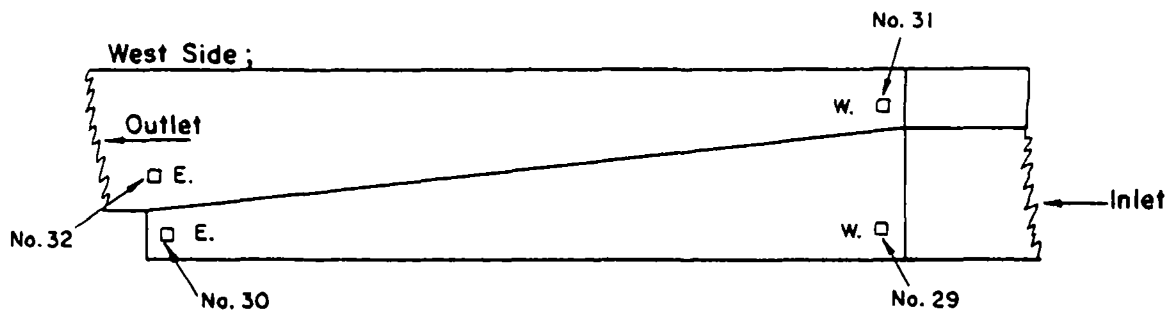


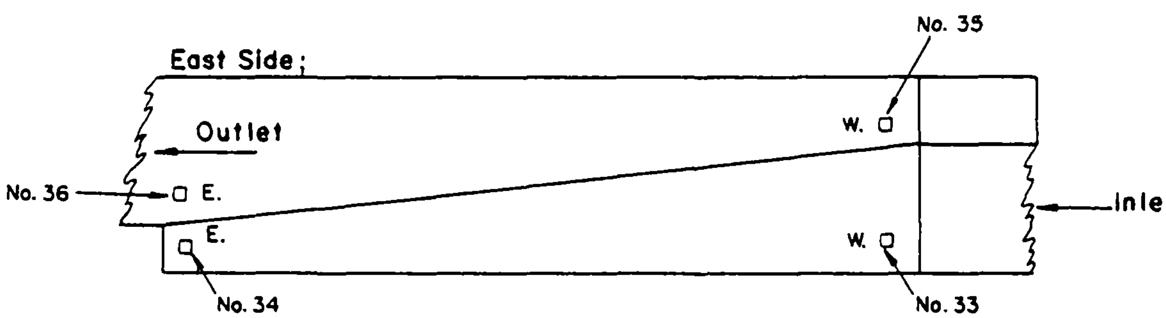
Area_____________36 Sq. Inches
Average Weight________74.5 Grams
Average Thickness______0.0315"

LOCATION OF CORROSION COUPONS

One coupon per compartment, numbers on coupons to match numbering of compartments. (No. 1 thru No. 28)

Inlet and Outlet Ducts:



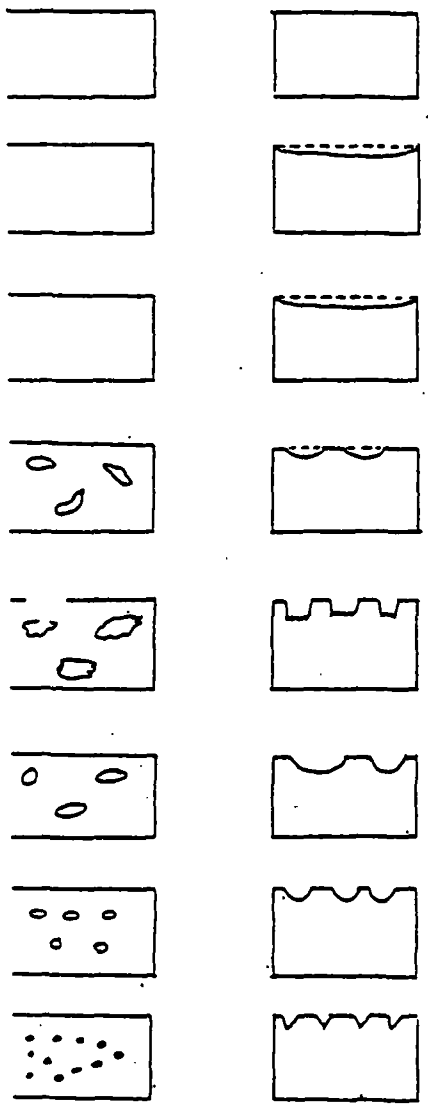


Total: 36

SPECIAL TESTING PROCEDURES

CORROSION

CORROSION DESCRIPTION



0	0.01-0.50MPY	0.51-3.00MPY	3.00-20MPY	>20 MPY
None Visible (a)	---	---	---	---
---	Negligible (b)	Slight even general (C 1)	Moderate even general (D 1)	Severe even general (E 1)
---	Negligible (b)	Slight uneven general (C 2)	Moderate uneven general (D 2)	Severe uneven general (E 2)
---	Negligible (b)	Slight even localized (C 3)	Moderate even localized (D 3)	Severe even localized (E 3)
---	Negligible (b)	Slight uneven localized (C 4)	Moderate uneven localized (D 4)	Severe uneven localized (E 4)
---	Wide pits (F)	---	---	---
---	Medium pits (G)	---	---	---
---	Narrow pits (E)	---	---	---

1. Before cleaning strip testers will be photographed if they appear unusual in any respect. i.e. partly eaten away, heavy deposit, etc.
2. All strip testers will be photographed after cleaning.
   If there is negligible (or no) corrosion any staining or other unusual appearance will be repeated.
4. Large pits will be measured (depth) and reported.

CORROSION COUPON WEIGHTS
for
HARRINGTON STATION BAGHOUSE UNIT #2

February 28, 1978

(weight to nearest million)

1.	72.1150	21.	71.1887
2.	71.4471	22.	71.4255
3.	72.4578	23.	71.2358
4.	71.4497	24.	75.8967
5.	71.3295	25.	75.8130
6.	71.0409	26.	72.4751
7.	71.4606	27.	75.9499
8.	71.5762	28.	75.5271
9.	71.1310	29.	75.6703
10.	71.3176	30.	76.3859
11.	71.3980	31.	68.1900
12.	71.1820	32.	77.8147
13.	71.5155	33.	78.2758
14.	71.7493	34.	78.3320
15.	71.7500	35.	78.2010
16.	76.3133	36.	76.9453
17.	74.1110	37.	76.7273
18.	74.3495	38.	77.4247
19.	73.1115	39.	68.2680
20	73.9455	40.	68.1907
		41.	68.1615

Q Panel Type S, 3" x 6" x .032"

SAE 1010 low carbon steel

ASTM D-609 Specks

Acid cleaned and dried as in standard corrosion coupon procedure before weighing

Prepared by Mario Tinajero

APPENDIX E

EVALUATION OF FILTER BAG PERFORMANCE
(10/13/78)

Copy for George Faulkner
Bag-Fabric Testing
Program-File

ENVIRONMENTAL CONSULTANT
COMPANY

AUG 29 1978

August 27, 1978

Southwestern Public Service Company
P. O. Box 1261
Amarillo, Texas 79170

Attn: Mr. Kenneth L. Ladd, Jr.

Dear Ken:

In accordance to our recent telephone conversation and your letter of August 21, 1978, Environmental Consultant Company is pleased to quote for your testing requirements.

The cost per set of three (3) filter bags for tests one (1) through six (6), is projected to be $375.00 not to exceed a maximum cost of $400.00 for the three (3) bags. The maximum charge is necessary as very often in fabric testing, confirmation of data through re-testing is necessary.

I would like to suggest further testing to ensure proper evaluation and performance levels of the fabric as per the attached laboratory data sheet. Recommended testing is indicated by an X.

Fabric count and yarn systems are important factors in fabric evaluation as well as breaking strengths.

As you know Ken, glass yarns have singles versions as well as a variety of yarn structures of texturized yarns in today's filter fabric. The exact yarn designation and the construction (count) should be determined in each evaluation.

Environmental Consultant Co. would be pleased to perform all the tests as indicated on the data sheet to include any necessary photographs to demonstrate a particular situation, for a maximum charge of $450.00 for the three (3) filter bags ($150.00 per filter bag).

Microphotographs can be accomplished at a charge of $500.00 per sample.

Thank you Ken for allowing Environmental Consultant Co. to quote on your testing requirements. You may rest assured the sincere interest in meeting Southwestern Public Service's testing needs and if I may be of any further service, please do not hesitate to contact me.

Very truly yours,

Win Budrow

Winston F. Budrow
Consultant-Chemist

WFB:jb

P. O. Box 9936 · Phoenix, Az. 85068 · Telephone 602-997-7795 – Laboratory: 11423 N. Cave Creek Rd. · Phoenix, Az. 85020
Filtration Fabric Consulting and Testing

ENVIRONMENTAL CONSULTANT COMPANY
P. O. Box 9936
Phoenix, Arizona 85068

PREPARED FOR SOUTHWESTERN PUBLIC SERVICE COMPANY — DATE
P. O. BOX 1261 — TLN
AMARILLO, TEXAS 79170 — PAGE

Identification		X			
Fiber Content					
Weight	As received	X			
Oz/sq. yd.	Cleaned (Vacuum)	X			
	Cleaned (Washed)	X			
Thickness (inches)		X			
Count		X			
Weave		X			
Yarn	Warp/Length	X			
System	Filing/Width	X			
Permeability	As received	X			
CFM/sq ft @ .5" H_2O	Cleaned (Vacuum)	X			
	Cleaned (Washed)	X			
Breaking					
Strength	Warp/Length	X			
lbs/inch	Filling/Width	X			
Breaking					
Strength	Warp/Length	X			
% Loss	Filling/Width	X			
Mullen Burst (lbs/sq inch)		X			
Mullen Burst % Loss		X			
Flex Cycles (MIT Method)		X			
Flex Cycles (% Loss)		X			
% Extractable	Solvent				
Matter	Water				
Acid/Alkaline (PH)					
% Ignition Loss (LOI)		X			
Treatment Physical Type					
Treatment Chemical Type		X			
% Elongation	Warp/Length				
	Filling/Width				
Fabrication	Seaming				
	Cuffing				
	Ring Cover				
Hardware Type					
Length (inches) Tension ________					
Diameter (inches) Tension ________					
Fabrication Rating					
Other Testing					
Visual inspection					
~~[illegible]~~	Rate of Wetout				

Filtration Fabric Consulting and Testing

ENVIRONMENTAL CONSULTANT
COMPANY

P.O. 1273-060F
Acct No. 571-6600.0380

October 13, 1978
TLN 1065
Page 1

REPORT

SOUTHWESTERN PUBLIC SERVICE COMPANY

AMARILLO, TEXAS

Six filter bags were submitted for evaluation on a continuing filter bag performance program. Three filter bags were new and identified as Acid Flex FF, Tri Temp FF, and Criswell which represents the base original fabric data. These original fabric samples will remain in storage for any future use deemed necessary.

The remaining three bags were received used, securely protected in plastic bags. The bags were labeled Acid Flex FF, Tri Temp FF, and Criswell, all removed 20 September 1978. These bags were reported to be in a dirty state after completion of the cleaning cycle.

Attached is the technical data received from the evaluation.

All bags were fully layed out for general observations.

The fabrication on all bags is rated as good. All bag seams contained from 1.8" to 2" of fabric in the feld lock seam configuration referred to as a wide folded seam.

Seaming contained the triple row chain lock type stitch, sewing with E glass 4 ply sewing yarn with a Teflon coating. The cuffing was a lock type stitch utilizing the same yarn.

All filter bags were properly sewn with the texturized surface inside, filament surface to the outside.

Cuff ropes contained in Fabric Filters bags (acid flex and tri temp) are 3 ply glass rope, whereas the Criswell bags contained 18 ply asbestos rope. Both types are of comparable quality and will adequately serve the purpose.

The Fabric Filter material was heat cleaned (coronized), whereas the Criswell fabric is not heat cleaned (greige goods).

The used and new bags were weighed in the as received condition prior to testing. In general, all three used bags weighed nearly the same (@ 24 lbs). This normally would not be significant, however, when the new bag weight is compared, the two bags from Fabric Filters contained about 145% over the original weight (dust loading), whereas the Criswell bag was over 200% the original weight (dust loading). The difference in loading could be due to the cleaning cycle differences, or the fact that the Criswell bag is accepting a higher dust air flow through the fabric.

Results of the weight and permeability readings strongly indicate a severe plugged condition. It was noted that the Criswell fabric has a higher as received permeability, while carrying a higher dust loading. Microscopic examination of the used fabric surfaces revealed the Criswell fabric to have a more porus filter cake. This is no doubt due to the higher level of texturized glass yarns in comparison to the Fabric Filters surfaces. This would suggest that the Criswell fabric is filtering at a higher rate, causing a higher level of physical breakdown of the glass filaments, accounting for the greater percent loss of strengths.

The low MIT flex values are common values received on used fabrics. It is nearly impossible to remove all the abrassive embedded particulate matter from used fabric, hence low values are usually received in the MIT value. To interpret this data is near impossible with only the one test for comparison. The next set of used bags tested will become significant as any further decline in MIT flex values strongly indicates that the glass filaments are becomming fatigued, and is a measure of fabric life. Glass filter fabric failure usually occurs at MIT values from 20 to 40 cycles with the .03 jaw and a load of 4 lbs.

It was noted that the dust cake on the fabric was difficult to remove, however, when exposed to high humidity the cake did discharge at an easier rate. This indicates that the dust is suceptable to electrostatic charge build-up. It may be that the low sulfur, high resistivity of the dust may contain an electrostatic charge. The glass bags being a non conducting media would not allow the electrostatic charge to disipate and thereby making dust cake discharge difficult. As a possible trial, the injection of higher humidity in the flue gases would reduce the electrostatic charge build up, and may prove advantageous for cake discharge.

ENVIRONMENTAL CONSULTANT
COMPANY
P. O. Box 9936
Phoenix, Arizona 85068

PREPARED FOR SOUTHWESTERN PUBLIC SERVICE COMPANY
AMARILLO, TEXAS

DATE October 13, 1978
TLN 1065
PAGE 3

Identification	NEW BAGS	Acid Flex FF	TT	Criswell	
Fiber Content		Glass	Glass	Glass	
Weight	As received	-	-	-	
Oz/sq. yd.	Cleaned (Vacuum)	-	-	-	
	Cleaned (Washed)	13.65	13.08	10.98	
Thickness (inches)		.018	.016	.017	
Count		44 x 24	45 x 24	65 x 32	
Weave		3 x 1TW	3 x 1TW	3 x 1TW	
Yarn	Warp/Length	37 1/0 F	37 1/0 F	150 1/2 F	
System	Filing/Width	75 1/2 T 75.1/0 F	75 1/2 T 75 1/0 F	75 1/2 T	
Permeability	As received				
CFM/sq ft @ .5" H_2O	Cleaned (Vacuum)				
	Cleaned (Washed)	57.5	61.0	58.6	
Breaking					
Strength	Warp/Length	643	561	389	
lbs/inch	Filling/Width	307	287	146	
Breaking					
Strength	Warp/Length	-	-	-	
% Loss	Filling/Width	-	-	-	
Mullen Burst (lbs/sq inch)		710	538	498	
Mullen Burst % Loss					
Flex Cycles (MIT Method)	.03 Jaw / 4 lb. load	10,745	3785	4698	
Flex Cycles (% Loss)					
% Extractable	Solvent				
Matter	Water				
Acid/Alkaline (PH)					
% Ignition Loss (LOI)		4.36	2.56	2.95	
Treatment Physical Type					
Treatment Chemical Type					
% Elongation	Warp/Length				
	Filling/Width				
Fabrication	Seaming				
	Cuffing				
	Ring Cover				
Hardware Type					
Length (inches) Tension ______					
Diameter (inches) Tension ______					
Fabrication Rating					
Other Testing	% Loss on ignition @ 500°F (LOI)	less .1%	Less .1%	1.87%	

Filtration Fabric Consulting and Testing

ENVIRONMENTAL CONSULTANT COMPANY
P. O. Box 9936
Phoenix, Arizona 85068

PREPARED FOR SOUTHWESTERN PUBLIC SERVICE COMPANY

DATE October 13, 1978
TLN 1065
PAGE A

Identification	USED BAGS	Acid Flex FF	TT	Criswell	
Fiber Content		Glass	Glass	Glass	
Weight Oz/sq. yd.	As received	22.98	20.23	19.22	
	Cleaned (Vacuum)	14.73	14.12	11.38	
	Cleaned (Washed)	13.81	13.17	10.93	
Thickness (inches)		.019	.018	.017	
Count		44 x 23	44 x 24	65 x 31	
Weave		3 x 1TW	3 x 1TW	3 x 1TW	
Yarn System	Warp/Length	37 1/0F	37 1/0 F	150 1/2 F	
	Filing/Width	75 ½T 75 ⅙F	75 ½T 75 ⅙F	75 1/2 T	
Permeability CFM/sq ft @ .5" H_2O	As received	1.30	2.15	1.28	
	Cleaned (Vacuum)	38.0	43.0	39.2	
	Cleaned (Washed)	56.2	58.4	59.6	
Breaking Strength lbs/inch					
	Warp/Length	518	403	265	
	Filling/Width	262	226	118	
Breaking Strength % Loss					
	Warp/Length	19.4%	28%	32%	
	Filling/Width	14.6%	21.3%	19.1%	
Mullen Burst (lbs/sq inch)		541	298	250	
Mullen Burst % Loss		23.6 %	44.6 %	49.8 %	
Flex Cycles (MIT Method)	.03 Jaw / 4 lb. load	5231	2175	292	
Flex Cycles (% Loss)		51.3%	42.5%	93.7%	
% Extractable Matter	Solvent				
	Water				
Acid/Alkaline (PH)					
% Ignition Loss (LOI)		4.12	2.34	1.53	
Treatment Physical Type					
Treatment Chemical Type					
% Elongation	Warp/Length				
	Filling/Width				
Fabrication	Seaming Triple row	Chain lock	Chain lock	Chain lock	
	Cuffing	lock	lock	lock	
	Ring Cover	-	-	-	
Hardware Type					
Length (inches) Tension ________					
Diameter (inches) Tension ________					
Fabrication Rating		Good	Good	Good	
Other Testing					
New Bag Total Weight (lbs.)		9.5	9.7	7.8	
Used Bag Total Weight (lbs.)		23.7	23.5	24.1	

Filtration Fabric Consulting and Testing

WATER DROP MIGRATION
TEXTURIZED SIDE TESTED

Sample (original)	Wet Out Time
Acid Flex FF	Indefinate (10 min. +)
Tri Temp FF	Indefinate (10 min. +)
Criswell	7 Seconds

Sample (2hrs. @ 500^{o}F)	Wet Out Time
Acid Flex FF	Indefinate (15 min. +)
Tri Temp FF	Indefinate (15 min. +)
Criswell	Indefinate (15 min. +)

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/7-79-183	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Fabric Filter System Study: First Annual Report		5. REPORT DATE August 1979
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) K. L. Ladd, G. R. Faulkner, and S. L. Kunka		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Southwestern Public Service Company P.O. Box 1261 Amarillo, Texas 79105		10. PROGRAM ELEMENT NO. EHE624A
		11. CONTRACT/GRANT NO. 68-02-2659
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development Industrial Environmental Research Laboratory Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Annual; 10/77 - 10/78
		14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP project officer is Dale L. Harmon, Mail Drop 61, 919/541-2925.

16. ABSTRACT The report describes first-year activities of a comprehensive EPA-funded study of a commercial fabric filter unit on a 350-MW low-sulfur-coal-fired unit at Southwestern Public Service Company's Harrington Station at Amarillo, Texas. Two years will be required to complete collection and assessment of 1 full operating year's worth of data. Following the testing phase of the program, operational and maintenance data will continue to be recorded until 1982 to determine the long-term reliability of the system. Special tests will be conducted through the use of an on-site pilot baghouse. First-year activities include installation of support systems, startup of the full-scale fabric filter system, and planning for special test programs. Special testing on the full-scale system began in February 1979. Results will be included in the next annual report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B
Fabrics	Stationary Sources	11E
Gas Filters	Fabric Filters	13K
Coal	Particulate	21D
Combustion		21B
Dust		11G

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 79
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

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