AP42 Section:	10.5
Reference:	14
Title:	*Emission Test Report--Champion International Lebanon Plant, Lebanon, Oregon*, EMB Report 81-PLY-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1982. 1997 supplement

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EMB Report 81-PLY-2
May 1982

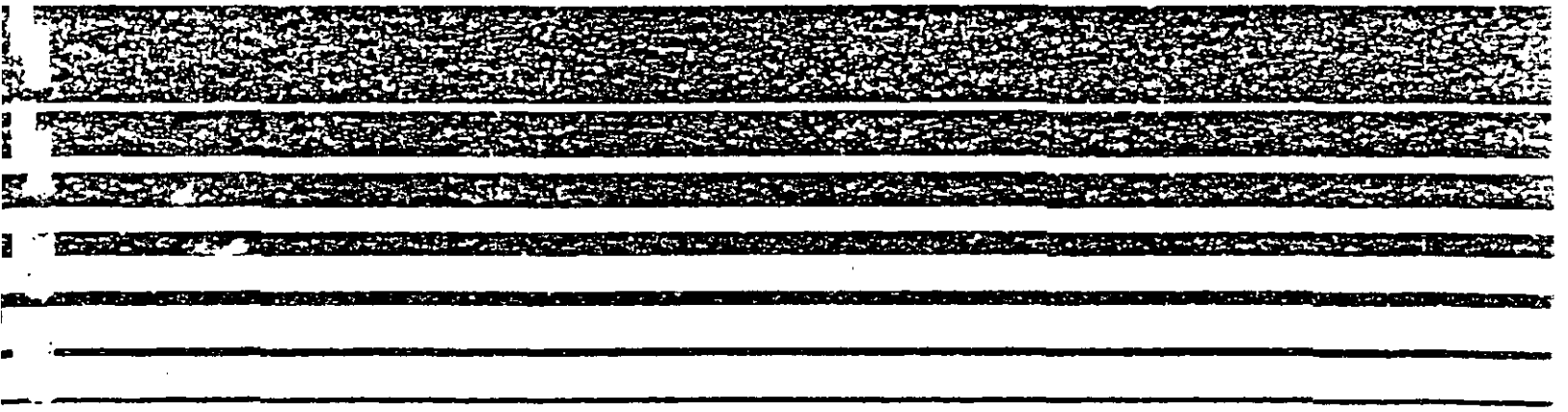
Air

EPA

Plywood/Veneer

(14)

Emission Test Report
Champion International
Lebanon Plant
Lebanon, Oregon



STANDARDS DEVELOPMENT TESTING
PERFORMED AT THE
CHAMPION PLYWOOD PLANT
LEBANON, OREGON
SEPTEMBER 1981

Environmental Consultants, Inc.

EMB Report 81-PLY-2
ESED Project 80/02
EPA Contract No. 68-02-3543
Work Assignment No. 1
TRC Project No. 1460-E80-51

Prepared for:
C.E. Riley, EPA/EMB
Task Manager

Prepared by:
Peter W. Kalika P.E.
Program Manager
Eugene A. Brackbill P.E.
Work Assignment Manager
John H. Powell
Project Scientist
Eric A. Pearson
Project Scientist
S. Dexter Peirce
Environmental Engineer

May 1982

800 Connecticut Blvd.
East Hartford, CT 06108
(203) 289-8631

This report has been reviewed by the Emission Standards and Engineering Division, Office of Air Quality Planning and Standards, Office of Air, Noise and Radiation, Environmental Protection Agency, and approved for publication. Mention of company or product names does not constitute endorsement by EPA. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - as supplies permit - from the Library Services Office, MD-35, Environmental Protection Agency, Research Triangle Park, NC 27711.

Order: EMB Report 81-PLY-2

PREFACE

The work described herein was conducted by personnel from TRC - Environmental Consultants, Inc., Research Triangle Institute (RTI), Del Green Associates (DGA), CH_2MHill, Engineers, Planners, Economists and Scientists; the Champion International Corporation in Lebanon, Oregon; the National Council of the Paper Industry for Air and Stream Improvement (NCASI) and the United States Environmental Protection Agency (EPA) Emission Measurement Branch (EMB).

The scope of work was issued under EPA Contract 68-02-3543, Work Assignment 1. The work was performed under the supervision of Eugene A. Brackbill, P.E., TRC work assignment manager, and John H. Powell, TRC field team leader.

Robert L. Chessin of RTI monitored process operations and was assisted by Paul Willhite of DGA. RTI was responsible for preparing Section 3 and Appendix I of this report, both of which deal with process descriptions and operations. Mark S. Boedigheimer supervised Method 5X analyses performed by CH_2MHill. Victor Dallons supervised NCASI sampling and analysis activities as well as providing helpful suggestions and comments in support of the test program. Jack Hayes, plant engineer for Champion, provided invaluable assistance and guidance to TRC, EPA, and RTI in the performance of the test program. Clyde E. Riley, Office of Air Quality Planning and Standards (OAQPS), Emission Measurement Branch, EPA, served as task manager and was responsible for coordinating the test program.

Edwin J. Vincent, Office of Air Quality Planning and Standards, Chemical and Petroleum Branch, EPA, served as project lead engineer. Mr. Vincent was also responsible for coordinating and directing the process operations monitoring.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES

1.0 INTRODUCTION

1.1 Background

Section 111 of the Clean Air Act of 1970 charges the administrator of the United States Environmental Protection Agency with the responsibility of establishing Federal Standards of Performance for New Stationary Sources (SPNSS) that may significantly contribute to air pollution. When promulgated, these standards of performance for new stationary sources are to reflect the degree of emission limitation achievable through application of the best demonstrated emission control technology. Emission data collected from controlled sources in the plywood industry will provide a portion of the data base used by EPA to develop SPNSS.

EPA's Office of Air Quality Planning and Standards selected the Champion plywood plant in Lebanon, Oregon, as a site for an emission test program because it is considered to employ process and emission control technology representative of modern plywood manufacturing plants.

The test program was designed to determine the emission rate of particulate, condensible and noncondensible organic material emitted from the veneer drying operation. A second objective was to measure the destruction efficiency of wastewood-fired boilers as incinerators for condensible and noncondensible organic emissions.

TRC - Environmental Consultants, Inc. was retained by the EPA Emissions Measurement Branch (EMB) to perform emission measurements at the Champion plywood plant in Lebanon, Oregon. Testing was performed on the veneer dryer emissions and their pollution control system which consists of two wastewood-fired boilers used as incinerators. This report has been prepared in accordance with EPA Contract No. 68-02-3543 under the provisions of Work Assignment No. 1.

The Research Triangle Institute (RTI), the New Source Standard (NSS) contractor, was responsible for coordinating the overall test program with Champion personnel and for assuring that process and control equipment operating conditions were suitable for testing. Related process data were monitored and recorded by RTI. Fugitive emissions from the veneer dryers, ambient air temperature and relative humidity were monitored and recorded by RTI and their subcontractor, Del Green Associates (DGA).

Additional testing for total organic compounds was performed by the National Council of the Paper Industry for Air and Stream Improvement (NCASI) simultaneously with the TRC test program. This testing was performed at the request of the American Plywood Association (APA) for research purposes and to provide an additional measure of quality assurance.

1.2 Summary of Process and Emissions

The Champion-Lebanon plywood plant is part of a large complex including veneer peeling, drying, plywood layup and finishing processes as well as a hardboard plant. Approximately 870,000 square feet (3/8-inch basis) of veneer is dried per day (24 hours/3 shifts). A diagram of the total veneer dryer exhaust system is presented in Figure 1-1.

Champion's Lebanon plant has seven veneer dryers. Dryer 7 is heated by hot gases from an Advanced Combustion Systems Fuel Cell, and is not included in this program. The remaining six dryers, installed in the late 1940s, are steam-heated by two Combustion Engineering water tube boilers.

The veneer drying operation begins after the veneer has been peeled from the log at the lathe operation. The veneer then proceeds to the drying operation. Here, the veneer is continuously hand-fed onto the dryer feed conveyor and into the dryer. The purpose of the operation is to thermally drive the moisture out of the veneer in preparation for the layup and laminating opera-

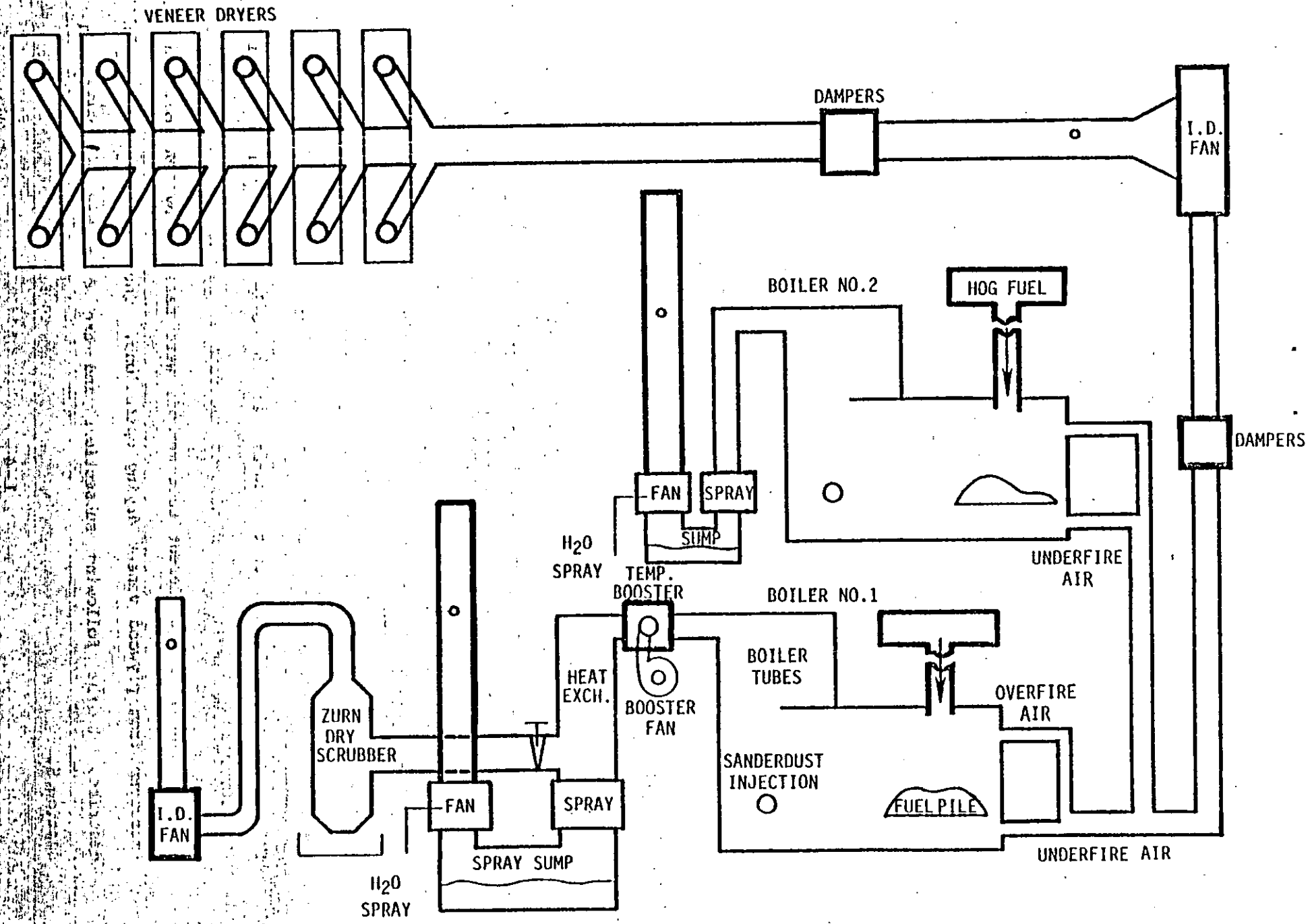


Figure 1-1. Veneer dryer exhaust system at Champion plywood plant, Lebanon, Oregon.

tions which follow. During the drying operation, organic compounds are also driven out of the veneer. These organic compounds are the emissions of interest.

Each dryer has two exhaust ducts. Atop each duct is an abort damper for emergency use only (a source of fugitive emissions). All 12 exhaust ducts converge to a common 48-inch inside diameter (i.d.) duct which carries the effluent through a set of dampers to an induced draft (I.D.) fan. The dryer exhaust is then ducted through another set of dampers and fed into two wastewood-fired boilers as overfire and underfire air.

The exhaust from each boiler is ducted to wet I.D. fans which were originally installed as spark arresters rather than pollution controls. The exhaust is then ducted to the atmosphere.

1.3 Applicability of EPA Reference Test Methods

EPA is required to publish a national reference test method for each regulated source category and pollutant for which a New Source Performance Standard (NSPS) is established. Reference test methods are usually specified by a State regulatory agency during the State Implementation Planning process and may be different from national reference test methods.

The purpose of establishing a national reference test method is to ensure that emission data collected from a specific source is representative of that source and comparable to data collected at other designated sources. The primary purpose of this test program was to collect emission data using standardized test methods which allowed the data to be evaluated to develop a national SPNSS. Two different test methods were selected by EPA to measure emissions from plywood veneer drying operations. These methods are briefly described in the following subsections and are described in detail in Section 5.

1.3.1 EPA Method 5X (Provisional)

Provisional Method 5X is similar to the Oregon Department of Environmental Quality (ODEQ) Method 7 used to measure condensible organic emissions. EPA Method 5X measures particulate and condensible organic matter. "Particulate matter" is defined as any finely divided solid or liquid material, other than uncombined water, that condenses at or above the filtration temperature range of 350 $\pm 25^{\circ}F$ (177 $\pm 14^{\circ}C$), and is collected by the probe and filter (front half of the sampling train). "Condensible organic matter" is defined as any material remaining after extraction, filtration and ambient evaporation of the ether-chloroform extract of the impinger portion of the sampling train. Particulate matter and condensible organic matter are quantified gravimetrically and results are expressed as the mass of collected material.

The purpose of the $350^{\circ}F$ filtration temperature is to precondition the Method 25 slipstream sample being withdrawn from the Method 5X sample stream. This temperature was selected on the basis of average veneer dryer operating temperatures throughout the industry. This temperature condition excludes only matter than can condense at or above $350^{\circ}F$ from the Method 25 samples. It does not affect Method 5X results because the remaining sample is caught in the condenser portion of the train.

1.3.2 EPA Method 25

EPA Reference Method 25, as promulgated in the October 3, 1980 Federal Register (volume 145, no. 194, 65959 ff.), applies to the measurement of organic compounds as total gaseous nonmethane organics (TGNMO). Emissions are expressed as equivalent carbon (C_1) mass. Method 25 sample fractions are separated by a gas chromatographic column, oxidized to carbon dioxide (CO_2), and reduced to methane (CH_4) prior to analysis by flame ionization detector (FID). Since all the sample organic compounds are reduced to CH_4, the

problems associated with the variable FID response characteristic for different organic compound structures is eliminated. This allows comparison of emission data on a uniform C_1 basis. Method 25 is discussed in greater detail in Section 5 of this report.

Major procedural modifications to Method 25 were required to measure accurately emissions from plywood veneer drying facilities. An additional condensate trap immersed in water ice was placed in the sampling train ahead of the standard dry ice immersed condensate trap. The purpose of the additional trap is to condense moisture that would freeze in the dry ice immersed trap and cause a premature sample flow stoppage. In this manner gas stream moisture content, which may range from 30 to 60 percent by volume may effectively be reduced to 3 percent or less before entering the dry ice immersed trap.

The use of the Method 5X sampling train as a sample preconditioner also represents a major modification. In addition to the 350°F sample stream temperature, isokinetic sample extraction from the source using Method 5X was also deemed necessary to obtain a representative Method 25 sample. This is particularly the case when moisture-saturated gas streams, such as those following wet scrubbing devices, are being sampled. Entrained water droplets may contain organic materials that would not be collected using the normal Method 25 constant sampling rate procedure.

1.3.3 Comparability of Test Methods

Methods 5X and 25 are not related and measured results may not be compared under any circumstances. Condensation temperatures differ by more than 100°F between the two methods, and consequently different condensible compounds are collected by each method. In addition, it has been demonstrated

that Method 5X has limited collection capabilities for organic compounds with high-vapor pressures. In addition a loss of organic material is experienced during normal sample recovery and drying operations.

1.4 Measurement Program Summary

The measurement program was conducted at the Champion plywood manufacturing facility in Lebanon, Oregon during the week of September 21, 1981. Tests were performed at the veneer dryer exhaust duct and at the outlet of boiler 2, which used veneer dryer exhaust for combustion air.

All emission testing was performed by TRC and NCASI personnel. RTI personnel monitored process operating conditions, while DGA personnel monitored fugitive emissions, ambient temperature and relative humidity. Wet fan operational data and solution samples were taken by TRC personnel.

1.4.1 Veneer Dryer Exhaust

Preliminary Measurements

Preliminary testing was performed on September 21 to determine volumetric flow rate and stack gas moisture content. An integrated gas sample was also taken to determine concentrations of CO_2, O_2 and CO. Stack diameter and the sampling port configuration were confirmed at this time.

Method 5X - Particulate and Condensible Organics Tests

Four Method 5X tests were performed, one each on September 21, 22, 23 and 25, concurrently with tests performed at the boiler 2 outlet.

Method 25 - Total Organic Tests

Sixteen Method 25 samples were taken at this location concurrently with the Method 5X tests performed. Four Method 25 samples were taken concurrently with each Method 5X test.

1.4.2 Boiler 2 Outlet

Preliminary Measurements

Preliminary tests were performed on September 21 to determine volumetric flow rate and stack gas moisture content. An integrated gas sample was

taken to determine the concentration of CO_2, O_2 and CO in the gas stream.

Method 5X - Particulate and Condensible Organics Tests

Four Method 5X tests were performed at this location on September 21, 22, 23, and 25 concurrently with tests performed at the veneer dryer exhaust. Two additional tests were performed on September 24 while no veneer dryer emissions were ducted to the boiler. These two additional tests were boiler background emission tests.

Method 25 - Total Organic Tests

Sixteen Method 25 samples were taken at this location concurrently with the Method 5X samples (four per test run). In addition, four more samples were taken concurrently with each Method 5X boiler background emission test. A total of 24 Method 25 samples were taken at this location.

Method 3 - Determination of CO_2, O_2, and CO

An integrated gas sample was taken simultaneously with each Method 5X sample. A total of six tests were performed.

Method 9 - Visible Emissions

Visible emissions from the boiler 2 outlet were monitored concurrently with each Method 5X test performed at this site.

1.4.3 Boiler 1 Outlet

Two velocity traverses were performed at the boiler 1 outlet during each Method 5X test performed at the boiler 2 outlet. A total of 12 traverses were performed.

1.4.4 Wet Fan - Boiler 2

Pressure Drop Measurement

Pressure drop (ΔP) across the wet fan sump was monitored at 30-minute intervals during each Method 5X test performed at the boiler 2 outlet.

Solution Sampling

Solution samples were taken from both the water supply and drain of the wet fan sump at 30-minute intervals during each Method 5X test performed at the boiler 2 outlet. The samples were composited into two separate samples for each test.

1.4.5 Fugitive Emissions

Fugitive emissions from the veneer dryers were monitored by RTI and DGA during each Method 5X test.

1.4.6 Ambient Air Measurements

Ambient air temperature and relative humidity were monitored and recorded by DGA at the beginning and end of each Method 5X test.

1.4.7 Clean-Up Evaluations and Audit Samples

Prior to any emission testing, two Method 5X sampling trains were prepared and charged, ready to perform a test. The unexposed trains were then cleaned according to the method and samples recovered. The samples were analyzed to establish background and/or contamination levels from the sample collection equipment.

Method 25 audit samples were prepared by RTI and analyzed at the TRC laboratory in Wethersfield, Connecticut and by NCASI in their laboratory in Corvallis, Orgeon. These audit samples were known concentrations of toluene and propylene analyzed to determine the accuracy of Method 25 analysis by the individual laboratories.

1.5 Report Sections

The remaining sections of this report present the Summary and Discussion of Results (Section 2), Process Description and Operations (Section 3), Description of Sampling Locations (Section 4), Sampling and Analytical Procedures (Section 5), and Quality Assurance (Section 6). Descriptions of methods and procedures, field and laboratory data, and calculations are presented in various appendices as noted in the Table of Contents.

2.0 SUMMARY AND DISCUSSION OF RESULTS

A summary of all emission measurements and collected data is presented in this section. Section 2.1 provides a brief background discussion and definitions of measured parameters. Section 2.2 presents Method 5X particulate/condensible organics results with a complete breakdown and discussion of parameters at both sampling sites. Method 25 total organic emission results are described in detail in Section 2.3, which includes a discussion of emissions at both sampling sites as well as a breakdown of major analytical data. Section 2.4 summarizes the visible emissions observations. Section 2.5 compares the volumetric flow rates of the veneer dryer exhaust and the exhaust outlets of boilers 1 and 2. A summary of wet fan (boiler 2 only) operational data is presented in Section 2.6. Fugitive emissions are discussed in Section 2.7. A full discussion of the Method 5X (cleanup) evaluation and results may be found in Section 2.8. Testing was conducted only during drying of Douglas Fir veneer.

2.1 Background and Definitions

The test program was designed to measure particulate, condensible, and noncondensible organic material emitted from veneer dryers, and the destruction efficiency of wastewood-fired boilers as a control for those emissions.

2.1.1 Particulate Emissions

Particulate emissions are defined as any finely divided solid or liquid matter, other than uncombined water, that condenses at or above 350 $\pm 25^{\circ}F$ ($177 \pm 14^{\circ}C$) and is collected in the probe and filter (front half) of the Method 5X sampling train.

2.1.2 Condensible Emissions

Condensible emissions are defined differently in Methods 5X and 25. Although called by the same name, these two sample fractions differ significantly in content and composition and may not under any circumstances be compared.

Method 5X condensibles are collected in glass impingers containing deionized distilled water and immersed in a water ice bath, and on a back-up filter following those impingers. Any material remaining after extraction, filtration and ambient evaporation of the impinger solution, plus any material collected on the desiccated back-up filter, is defined as condensible organic matter. Quantification of this matter is done gravimetrically.

Method 25 condensibles are collected in two stainless-steel traps, one immersed in water ice followed by another packed in dry ice. Material collected in the traps is oxidized, reduced and analyzed by flame ionization. Results are expressed as a concentration of carbon (C_1).

2.1.3 Noncondensible Emissions

Noncondensible emissions are measured by Method 25 only and are those that pass through both ice traps to the evacuated sample tank at the end of the Method 25 train. These samples are oxidized, reduced and analyzed by FID. Results are expressed as concentrations of carbon (C_1).

2.1.4 Total Organic Emissions

Total organic emissions are those collected by the complete Method 25 sampling train drawing a preconditioned sample slipstream from a Method 5X train. These emissions include condensible and noncondensible emissions as defined above.

2.2 Method 5X - Particulate/Condensible Organics Emission Tests

A summary of Method 5X particulate and condensible organics data collected at the veneer dryer exhaust and the boiler 2 outlet is presented in Tables 2-1a (English units) and 2-1b (metric units). These tables include relevant emission data: stack gas temperature, moisture content and volumetric flow rate; veneer drying production rate; and a summary of the total measured particulate/condensible emissions by concentration, mass emission rate, and emission rate per unit production.

Emission data are presented for five of the six test series performed. Tests 1, 3 and 6 were performed concurrently at the veneer dryer exhaust and the boiler 2 outlet. Tests 4 and 5 were boiler background emission tests without veneer dryer exhaust for combustion air and were performed at the boiler 2 outlet only. Test 2 was entirely voided because of a broken filter holder at the boiler 2 outlet discovered at the conclusion of the test.

Emissions from the veneer dryer exhaust duct averaged 33.4 lbs/hr (15.0 kg/hr) or 1.19 lbs/1000 ft^2 veneer on a 3/8-inch basis (5.62 kg/1000 m^2 on 9.5 mm basis) for the three valid tests performed. Emissions from boiler 2 averaged 33.0 lbs/hr for the same three tests. The concentrations of the emissions from the two sources, however, differed markedly. The average veneer dryer exhaust concentration was 0.161 gr/DSCF (0.363 g/NM^3), while the boiler 2 outlet averaged only 0.098 gr/DSCF (0.224 g/NM^3) for the same three tests.

More detailed summaries of this test data are presented in Sections 2.2.1 and 2.2.2 and in Appendix A. Sample equations and calculations are presented in Appendix B. Field data sheets appear in Appendix C. Sampling logs and summaries are shown in Appendix D. Calibration data for the Method 5X

TABLE 2-1a (English Units)

SUMMARY OF METHOD 5X PARTICULATE AND CONDENSIBLE ORGANICS
COLLECTED AT THE VENEER DRYER EXHAUST AND BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1		3		4[a]		5[a]		6		Average[b]	
Date	9/21/81		9/23/81		9/24/81		9/24/81		9/25/81			
Emission Point	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2
Sample Volume (DSCF)[c]	48.5	38.9	46.1	36.6	NA	30.5	NA	32.6	41.8	38.0	45.9	37.8
Stack Gas Flow Rate (DSCFM)[c]	23,900	39,700	25,700	38,500	NA	33,800	NA	32,400	23,300	40,000	24,300	39,400
Stack Temperature (^{o}F)	315	422	320	421	NA	317	NA	338	322	424	319	422
Stack Gas Moisture (% by volume)	15.1	17.4	11.7	19.2	NA	15.2	NA	21.2	11.2	18.3	12.7	18.3
Isokinesis (%)	112	104	99.6	101	NA	95.5	NA	106	99.7	101	104	102
Wet Fan ΔP (Inches H_2O)	NA	0.73	NA	0.50	NA	0.55	NA	0.94	NA	0.55	NA	0.59
Average Opacity (%)	NA	16	NA	8	NA	9	NA	10	NA	9	NA	10
Production Rate (1000 ft^2/hr)[d]	31.7		28.8		NA	NA	NA	NA	24.3		28.3	
Particulate/Condensible Emissions												
gr/DSCF	0.153	0.104	0.175	0.107	NA	0.127	NA	0.150	0.156	0.082	0.161	0.098
pounds/hour	31.4	35.4	37.8	35.4	NA	36.9	NA	41.9	31.1	28.1	33.4	33.0
pounds/1000 ft^2 [d]	0.99	1.12	1.31	1.23	NA	NA	NA	NA	1.28	1.16	1.19	1.17

[a] Boiler background emission test
[b] Average does not include boiler background emission tests
[c] Standard Conditions are 29.92 inches Hg at 68^{o}F
[d] On 3/8 inch basis, includes trim factor; does not account for redry material
NA Not Applicable

TABLE 2-1b (Metric Units)

SUMMARY OF METHOD 5X PARTICULATE AND CONDENSIBLE ORGANICS
COLLECTED AT THE VENEER DRYER EXHAUST AND BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1		3		4[a]		5[a]		6		Average[b]	
Date	9/21/81		9/23/81		9/24/81		9/24/81		9/25/81			
Emission Point	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2	Dryers	Boiler 2
Sample Volume (NM^3)[c]	1.41	1.10	1.31	1.04	NA	0.86	NA	0.92	1.18	1.08	1.30	1.07
Stack Gas Flowrate (NM^3/min)	677	1120	728	1090	NA	957	NA	918	660	1130	688	1120
Stack Temperature (^oC)	157	217	160	216	NA	159	NA	170	159	218	159	217
Stack Gas Moisture (% by volume)	15.1	17.4	11.7	19.2	NA	15.2	NA	21.2	11.2	18.3	12.7	18.3
Isokinesis (%)	112	104	99.6	101	NA	95.5	NA	106	99.7	101	104	102
Wet fan ΔP (mm H_2O)	NA	18.5	NA	12.7	NA	14.0	NA	23.9	NA	14.0	NA	15.0
Average Opacity (%)	NA	16	NA	8	NA	9	NA	10	NA	9	NA	10
Production Rate (1,000 m^2/hr)[d]	2.94		2.68		NA	NA	NA	NA	2.26		2.63	
Particulate/Condensible Emissions												
g/NM^3	0.341	0.238	0.391	0.245	NA	0.291	NA	0.343	0.357	0.188	0.363	0.224
kg/hour	13.9	16.1	17.1	16.1	NA	16.7	NA	18.9	14.1	12.7	15.0	14.9
kg/1,000 m^2	4.73	5.48	6.38	6.01	NA	NA	NA	NA	6.24	5.62	5.78	5.69

[a] Boiler background emission test
[b] Average does not include boiler backrground emission tests
[c] Standard Conditions are 760 mm Hg at 20°C
[d] On 9.5 mm basis, includes trim factor; does not account for redry material
NA - Not Applicable

sampling train is found in Appendix F. Laboratory analysis data are presented in Appendix G.

2.2.1 Veneer Dryer Exhaust

A summary of Method 5X particulate and condensible organics data collected at the veneer dryer exhaust is presented in Table 2-2. Data presented include sample volume; stack gas flow rate, temperature, and moisture content; isokinesis for each test; veneer production rate; front half (particulate) and total (particulate plus condensible) emissions.

Tests 1, 3 and 6 were performed at the veneer dryer exhaust on September 21, 23, and 25, 1981, respectively. Measured particulate emissions ranged from 1.60 to 3.22 lbs/hr (0.06 to 0.13 lbs/1000 ft^2 veneer), averaging 2.38 lbs/hr (0.09 lbs/1000 ft^2 veneer). Total particulate/condensible emissions ranged from 31.1 to 37.8 lbs/hr (0.99 to 1.31 lbs/1000 ft^2 veneer) for an average of 33.4 lbs/hr (1.19 lbs/1000 ft^2 veneer). Particulate matter collected accounted for approximately 7 percent of the total sample weight while the remaining 93 percent of the catch was condensible organics.

Particulate grain loadings measured at the veneer dryer exhaust averaged 0.011 gr/DSCF for tests 1, 3 and 6; ranging from 0.007 to 0.016 gr/DSCF. Total (particulate/condensible) grain loadings ranged from 0.153 to 0.175 gr/DSCF, for a three-test average of 0.161 gr/DSCF. The bulk of the total emission concentration was accounted for by condensible organics (93 percent).

The average stack gas temperature was 319^{o}F with an average moisture content of 12.7 percent. Moisture content varied from 11.1 percent to 15.1 percent over the three tests. The average stack gas flow rate was 24,300 DSCFM and did not vary significantly among the three tests.

TABLE 2-2

SUMMARY OF METHOD 5X PARTICULATE AND CONDENSIBLE ORGANIC MEASUREMENTS AT THE VENEER DRYER EXHAUST

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number Date	1 9/21/81	3 9/23/81	6 9/25/81	Average --
Sample Volume (DSCF)[a]	48.5	46.1	41.8	45.9
Stack Gas Flowrate (DSCFM)[a]	23,900	25,700	23,300	24,300
Stack Temperature (°F)	315	320	322	319
Stack Gas Moisture (% by volume)	15.1	11.7	11.2	12.7
Isokinesis (%)	112	99.6	99.7	104
Production Rate (1,000 ft²/hr)[b]	31.7	28.8	24.3	28.3
Particulate/Condensible Emissions				
Front Half (Probe and Filter)				
mg	35.6	21.7	43.7	33.7
gr/DSCF	0.011	0.007	0.016	0.011
lbs/hr	2.32[c]	1.60	3.22	2.38
lbs/1,000 ft²	0.07	0.06	0.13	0.09
Total				
mg	481	513	422	472
gr/DSCF	0.153	0.175	0.156	0.161
lbs/hr	31.4[c]	37.8	31.1	33.4
lbs/1000 ft²	0.99	1.31	1.28	1.19
Percent Condensible Emissions	92.6	95.8	89.7	92.9

[a] Standard Conditions are 29.92 in. Hg at 68°F
[b] On 3/8 inch basis, includes trim factor; does not account for redry material
[c] Average of concentration and area ratio method calculations (Refer to Table 2-4)

Isokinesis averaged 104 percent for the three valid tests performed. Isokinesis for test 1 was high at 112 percent due to a nomograph calculation error, while tests 3 and 6 were acceptable at 100 ±10 percent. Leak checks were performed at the conclusion of each test and leak rates found acceptable at less than 0.02 cfm.

The mass emission rate for test 1 was recalculated using the area ratio method because of anisokinetic conditions. The results are presented in Table 2-4 and are identical to those obtained from the concentration method, which is the normal approach. This fact is probably due to the small percentage of particulate matter in the gas stream which would escape collection by the sampling nozzle under anisokinetic sampling conditions. An explanation of the area ratio method for calculating mass emission rates is presented in Section 5 of this report.

2.2.2 Boiler 2 Outlet

A summary of Method 5X particulate and condensible organics data collected at the boiler 2 outlet is presented in Table 2-3. Data presented include sample volume; stack gas flow rate, temperature, and moisture content; isokinesis for each test; veneer production rate; front half (particulate) and total (particulate plus condensible) emissions.

Five emission tests were performed at the boiler 2 outlet. Tests 1, 3 and 6 were performed concurrently with tests performed at the veneer dryer exhaust on September 21, 23 and 25, respectively. Tests 4 and 5 were performed on September 24 at the boiler 2 outlet to measure only boiler emissions when veneer dryer exhaust was not used for overfire/underfire air. Tests 4 and 5 were boiler background emission tests.

TABLE 2-3

SUMMARY OF METHOD 5X PARTICULATE AND CONDENSIBLE ORGANIC MEASUREMENTS
AT THE BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1	3	4[c]	5[c]	6	Average[d] (1, 3, 6)	Average[e] (4, 5)
Date	9/21/81	9/23/81	9/24/81	9/24/81	9/25/81	--	9/24/81
Sample Volume (DSCF)[a]	38.9	36.6	30.5	32.6	38.0	37.8	31.6
Stack Gas Flowrate (DSCFM)[a]	39,700	38,500	33,800	32,400	40,000	39,400	33,100
Stack Temperature (^{o}F)	422	421	317	338	424	422	328
Stack Gas Moisture (% by volume)	17.4	19.2	15.2	21.2	18.3	18.3	18.2
Isokinesis (%)	104	101	95.5	106	101	102	101
Production Rate (1,000 ft^{2}/hr)[b]	31.7	28.8	NA	NA	24.3	28.3	NA[f]
Particulate/Condensible Emissions							
Front Half (Probe and Filter)							
mg	237	218	208	298	190	215	253
gr/DSCF	0.094	0.092	0.106	0.141	0.077	0.088	0.124
lbs/hr	32.0	30.4	30.6	39.1	26.4	29.6	34.9
lbs/1,000 ft[b]	1.01	1.06	NA	NA	1.09	1.05	NA[f]
Total							
mg	262	255	252	318	202	240	285
gr/DSCF	0.104	0.107	0.127	0.150	0.082	0.098	0.139
lbs/hr	35.4	35.4	36.9	41.9	28.1	33.0	39.4
lbs/1000 ft^{2}	1.12	1.23	NA	NA	1.16	1.17	NA[f]
Percent Condensible Emissions	9.60	14.1	17.1	6.68	6.05	10.3	11.4

[a] Standard Conditions are 29.92 in. Hg at 68^{o}F
[b] On 3/8 inch basis, includes trim factor; does not account for redry material
[c] Boiler background emission tests
[d] Average does not include boiler background emission tests
[e] Average of boiler background emission tests
[f] Boiler load increased near the end of Run 4 and maintained at increased load during Run 5
NA - Not Applicable

TABLE 2-4

COMPARISON OF VENEER DRYER EXHAUST EMISSIONS
(CONCENTRATION METHOD VS. AREA RATIO METHOD)

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run #5X-1-I (Isokinesis = 112%)

	Pounds Per Hour		
	Concentration Method	Area Ratio[a] Method	Average
Front Half	2.32	2.32	2.32
Back Half	29.1	29.1	29.1
Total	31.4	31.4	31.4

[a] Brenchley, Turley, Yarmac; Industrial Source Sampling, Ann Arbor Science, Publishers, Inc., 1973, pp.173-175

2.2.2.1 Tests 1, 3, and 6

Measured particulate emissions for tests 1, 3 and 6 ranged from 26.4 to 32.0 lbs/hr, averaging 29.6 lbs/hr (1.05 lbs/1000 ft^2 veneer). Total measured emissions (particulate and condensible) ranged from 28.1 lbs/hr for test 6 to 35.4 lbs/hr for both tests 1 and 3. The average total emission rate was 33.0 lbs/hr (1.17 lbs/1000 ft^2 veneer). Particulate material collected during these three tests accounted for approximately 90 percent of the total emissions, while the remaining 10 percent was condensible organics.

Particulate grain loadings measured at the boiler 2 outlet averaged 0.088 gr/DSCF for these tests, ranging from 0.077 gr/DSCF during test 6 to 0.094 gr/DSCF for test 1. Total grain loadings (particulate/condensible) ranged from 0.082 to 0.107 gr/DSCF, averaging 0.098 gr/DSCF for the three tests.

The average stack gas temperature measured during tests 1, 3 and 6 was 422°F and showed little variation among tests. Moisture content of the gas stream averaged 18.3 percent for the three tests with little variation. Stack gas flow rates averaged 39,400 DSCFM without significant variation.

Isokinesis was acceptable for all three tests at 100 ±10 percent and averaged 102 percent. Leak rates were acceptable for tests 1 and 6 at less than 0.02 cfm. The average leak rate for test 3 (from four leak checks) was 0.026 cfm. Additional calculations for excessive leak rate were performed, but the sample volume and emission rate were not significantly effected.

2.2.2.2 Tests 4 and 5 - (Boiler Background Emission Tests)

The measured particulate emission rate for the boiler background emission tests was 30.6 and 39.1 lbs/hr for tests 4 and 5 respectively, averaging 34.9 lbs/hr. The total emission rates measured were 36.9 and 41.9 lbs/hr, averaging 39.4 lbs/hr. Particulate collected during these tests accounted for

approximately 88 percent of the total sample, while the remaining 12 percent was condensible organics.

Particulate grain loadings averaged 0.124 gr/DSCF for the two boiler background emission tests, ranging from 0.106 gr/DSCF for test 4 to 0.141 gr/DSCF for test 5. Total grain loadings (particulate/condensible) ranged from 0.127 to 0.151 gr/DSCF, averaging 0.139 gr/DSCF for the two tests.

In addition to emission rates that were significantly higher than the three tests (1, 3 and 6) discussed previously in this section (almost 20 percent higher on the average), other parameters were quite different. The average stack temperature of 328°F was 96°F lower than tests 1, 3 and 6. This may be due to overfire/underfire air being introduced at ambient temperature (not preheated) into the boiler during the background emission tests while the temperature of overfire/underfire air used during tests 1, 3 and 6 exceeded 300°F. The average stack gas flow rate (33,100 DSCFM), was 16 percent lower than the average of tests 1, 3 and 6. Moisture content of the stack gas was measured to be 15.2 percent and 21.2 percent for tests 4 and 5, respectively, but the average is essentially the same as tests 1, 3 and 6. Steam production from the boiler remained relatively stable for tests 1, 3, 4 and 6, but a significant increase in production occurred during test 5, due to startup of the hardboard plant, and possibly accounting for the higher emission rate.

Although the intent of these tests was to preclude the introduction of veneer dryer exhaust into the boilers, it was observed through the inspection port in the ductwork immediately in front of the boiler that some veneer dryer exhaust was leaking through the upstream isolation damper and entering the boilers.

2.3 Method 25 - Total Organic Tests

A summary of the Method 25 total organic data (condensible and noncondensible) collected at the veneer dryer exhaust and boiler 2 outlet is presented in Tables 2-5a (English units), 2-5b (metric units), 2-6a (English units) and 2-6b (metric units) amd 2-6c, respectively. These tables include TRC and NCASI average emission data: stack gas flow rate, moisture content and temperature; veneer drying production rate, and a summary of the total organic emissions by concentration, mass emission rate, and emission rate per unit production. All emissions are expressed as carbon (C_1). NCASI calculates the emission rate as lbs/hr equivalent methane (CH_4) instead of carbon (C_1). Their data in the tables have been converted to lbs/hr C_1 for comparison and to present the data on a consistent basis, conforming with Method 25.

Emission data are presented for five test series. Tests 1, 3 and 6 were performed concurrently at the veneer dryer exhaust and the boiler 2 outlet. Tests 4 and 5 were boiler background emission tests and were performed at the boiler 2 outlet only. Test 2 was entirely voided because of a Method 5X sampling problem at the boiler 2 outlet.

More detailed summaries of these test data are presented in Sections 2.3.1 and 2.3.2, and in Appendix A. Sample equations and calculations are presented in Appendix B. Field data sheets appear in Appendix C. Sampling logs and summaries are shown in Appendix D. Laboratory analysis data are presented in Appendix G.

2.3.1 Veneer Dryer Exhaust

A summary of Method 25 condensible and noncondensible organics data collected at the veneer dryer exhaust is presented in Tables 2-5a, 2-5b, and 2-7. Table 2-5 shows relevant emission data and presents total organic

VOC

TABLE 2-5a (English Units)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE VENEER DRYER EXHAUST

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1		3		6		Average	
Date	9/21/81		9/23/81		9/25/81			
Stack Gas Flow Rate (DSCFM)[a]	23,900		25,700		23,300		24,300	
Stack Temperature (^{o}F)	315		320		322		319	
Stack Gas Moisture (% by volume)	15.1		11.7		11.2		12.7	
Production Rate (1000 ft^2 /hr)[b]	31.7		28.8		24.3		28.3	
Analysis Laboratory	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI
Total Organic Emissions[c]								
ppm (C_1)	1577	543	734	729	647	726	986	666
gr/DSCF (C_1)	.344	.118	.160	.159	.141	.158	.215	.145
lbs/hr (C_1)	70.5	24.3 (27.7)[d]	35.3	35.0	28.2	31.6	44.8	30.3 (30.4)[d]
lbs/1000 ft^2 (C_1)	2.22	.765	1.22	1.22	1.16	1.30	1.58	1.10

[a] Standard Conditions are 29.92 inches Hg at 68^{o}F
[b] On 3/8 inch basis, includes trim factor; does not account for redry material
[c] Emissions calculated and reported as C_1. Does not include front half results from Method 5X sample
[d] One data point from Test Run 1 not considered representative. Parenthetical values are approximations based on other test runs.

TABLE 2-5b (Metric Units)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE VENEER DRYER EXHAUST

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1		3		6		Average	
Date	9/21/81		9/23/81		9/25/81			
Stack Gas Flow Rate (NM^3/min)[a]	677		728		660		688	
Stack Temperature (^oC)	157		160		159		159	
Stack Gas Moisture (% by volume)	15.1		11.7		11.2		12.7	
Production Rate (1000 m^2/hr)[b]	2.94		2.68		2.26		2.63	
Analysis Laboratory	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI
Total Organic Emissions[c]								
ppm (C_1)	1577	543	734	729	647	726	986	666
g/NM^3 (C_1)	.788	.270	.367	.364	.323	.362	.493	.332
kg/hr (C_1)	32.0 (12.6)[d]	11.0	16.0	16.3	12.8	14.3	20.3 (13.8)[d]	13.9
kg/1000 m^2 (C_1)	10.9	3.74	5.97	6.08	5.66	6.33	22.5	5.38

[a] Standard Conditions are 29.92 inches Hg at 68°F
[b] On 3/8 inch basis, includes trim factor; does not account for redry material
[c] Emissions calculated and reported as C_1. Does not include front half results from Method 5X sample
[d] One data point from Test Run 1 not considered representative. Parenthetical values are approximations based on other test runs.

TABLE 2-6a (English Units)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number Date	1 9/21/81		3 9/23/81		4[a] 9/24/81		5[a] 9/24/81		6 9/25/81		Average[b] (1, 3, 6)		Average[c] (4, 5)	
Stack Gas Flow Rate (DSCFM)[d]	39,700		38,500		33,800		32,400		40,000		39,400		33,100	
Stack Temperature (^{O}F)	422		421		317		338		424		422		328	
Stack Gas Moisture (% by volume)	17.4		19.2		15.2		21.2		18.3		18.3		18.2	
Production Rate (1000 ft^{2}/hr)[e]	31.7		28.8		NA		NA		24.3		28.3		NA	
Analysis Laboratory	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI
Total Organic Emissions[f]														
ppm (C_1)	741	23.3	1175	146	744	173	1425	120	755	71.1	890	80.1	1085	147
gr/DSCF (C_1)	.162	.005	.256	.032	.162	.038	.311	.026	.165	.015	.194	.017	.236	.032
lbs/hr (C_1)	55.0	1.73	84.6	10.5	47.0	10.9	86.3	7.23	56.5	5.31	65.6	5.85	67.2	9.08
lbs/1000 ft^{2} (C_1)	1.74	.055	2.94	.365	NA[g]	NA[g]	NA[g]	NA[g]	2.32	.219	2.32	.213	NA[g]	NA[g]

[a] Boiler Background Emission Test
[b] Average does not include boiler background emission test
[c] Average of boiler background emission tests
[d] Standard Conditions are 29.92 inches Hg at 68^{O}F
[e] On 3/8 inch basis, includes trim factor; does not account for redry material
[f] Results not corrected for CO_2 interference. See Section 5.3.2.5.
[g] Boiler load increased near the end of Run 4 and maintained at increased load during Run 5
NA - Not Applicable

TABLE 2-6b (Metric Units)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1		3		4[a]		5[a]		6		Average[b] (1, 3, 6)		Average[c] (4, 5)	
Date	9/21/81		9/23/81		9/24/81		9/24/81		9/25/81					
Stack Gas Flow Rate (NM^3/min)[d]	1120		1090		957		918		1130		1120		938	
Stack Temperature (^oC)	217		216		159		170		218		217		165	
Stack Gas Moisture (% by volume)	17.4		19.2		15.2		21.2		18.3		18.3		18.2	
Production Rate (1000 m^2/hr)[e]	2.94		2.68		NA		NA		2.26		2.63		NA	
Analysis Laboratory	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI	TRC	NCASI
Total Organic Emissions[f]														
ppm (C_1)	741	23.3	1175	146	744	173	1425	120	755	71.1	890	80.1	1085	147
g/NM^3 (C_1)	.371	.011	.586	.073	.371	.087	.712	.060	.378	.034	.445	.039	.541	.074
kg/hr (C_1)	25.0	.785	38.4	4.77	21.3	4.95	39.2	3.28	25.7	2.41	29.7	2.66	30.3	4.12
kg/1,000 m^2 (C_1)	8.50	.267	14.3	1.78	NA[g]	NA[g]	NA[g]	NA[g]	11.4	1.07	11.4	1.04	NA[g]	NA[g]

[a] Boiler Background Emission Test
[b] Average does not include boiler background emission test
[c] Average of boiler background emission tests
[d] Standard Conditions are 29.92 inches Hg at 68°F
[e] On 3/8 inch basis, includes trim factor; does not account for redry material
[f] Results not corrected for CO_2 interference. See Section 5.3.2.5.
[g] Boiler load increased near the end of Run 4 and maintained at increased load during Run 5
NA - Not Applicable

TABLE 2-6c

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE BOILER 2 OUTLET CORRECTED FOR CO_2 INTERFERENCE

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	1			3			6			Average		
Date	9/21/81			9/23/81			9/25/81					
Production Rate (1000 ft²/hr)[a]	31.7			28.8			24.3			28.3		
Analysis Laboratory	TRC		NCASI[d]	TRC		NCASI[d]	TRC		NCASI[d]	TRC		NCASI
Total Organic Emissions												
	A[b]	B[c]		A[b]	B[c]		A[b]	B[c]		A[b]	B[c]	
ppm (C_1)	725	732	9.3	1158	1166	130	738	746	55	874	881	64.8
gr/DSCF (C_1)	0.158	0.160	0.002	0.252	0.254	0.028	0.161	0.163	0.012	0.191	0.192	0.014
lb/hr (C_1)	53.8	54.3	0.69	83.3	83.9	9.36	55.2	55.7	4.11	64.3	64.6	4.77
lb/1000 ft² (C_1)	1.70	1.71	0.022	2.89	2.90	0.32	2.27	2.29	0.17	2.27	2.30	0.17

[a]On 3/8 inch basis, includes trim factor; does not account for redry material.
[b]Corrected for CO_2 interference using the Pollution Control Science, Inc., method. See Section 5.3.2.5.
[c]Corrected for CO_2 interference using the NCASI method. See Section 5.3.2.5.
[d]NCASI corrections include a trap blank conversion of approximately 7 ppm.

TABLE 2-6c (Continued)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC MEASUREMENTS
AT THE BOILER 2 OUTLET CORRECTED FOR CO_2 INTERFERENCE

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	4[a]			5[a]			Average		
Date	9/24/81			9/24/81					
Analysis Laboratory	TRC		NCASI[d]	TRC		NCASI[d]	TRC		NCASI
Total Organic Emissions	A[b]	B[c]		A[b]	B[c]		A[b]	B[c]	
ppm (C_1)	731	736	157	1392	1406	102	1062	1071	130
gr/DSCF (C_1)	0.159	0.160	0.034	0.303	0.307	0.022	0.231	0.234	0.028
lb/hr (C_1)	46.2	46.5	9.91	84.3	85.2	6.17	65.7	65.9	8.04

[a]Boiler background emission test.
[b]Corrected for CO_2 interference using the Pollution Control Science, Inc., method. See Section 5.3.2.5.
[c]Corrected for CO_2 interference using the NCASI method. See Section 5.3.2.5.
[d]NCASI corrections include a trap blank correction of approximately 7 ppm.

TABLE 2-7

SUMMARY OF METHOD INDIVIDUAL TOTAL ORGANIC TRAP AND TANK MEASUREMENTS
AT THE VENEER DRYER EXHAUST

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	Date	Stack Gas Flow Rate (DSCFM)	Sample I.D. No.	Analysis Laboratory	Condensible Catch[a,b] Traps (ppm)	Non-Condensible Catch[a,b] Sample Tank (ppm)	Total[a] Catch (ppm)	Pair[a] Average (ppm)	Emission[a] Rate (lbs/hr)	Relative Standard Deviation (%)
1	9/21/81	23,900	I-1-25-A	TRC	2293[d] (376)	274	2567 (650)	1577(619)	70.5(27.7)	88.8(7.20)
			I-1-25-B		376	211[c]	587			
			9211	NCASI	551	17.8	569	543	24.3	6.77
			9212		499	18.3	517			
3	9/23/81	25,700	I-3-25-A	TRC	448	n.d.	448	734	35.3	55.1
			I-3-25-B		823	197	1020			
			9231	NCASI	645	55.4	701	729	35.0	5.34
			9232		750	6.3	756			
6	9/25/81	23,300	I-6-25-A	TRC	681	185	866	647	28.1	48.0
			I-6-25-B		144	283	427			
			9251	NCASI	777	22.4	799	726	31.6	14.3
			9252		612	39.7	652			

[a] As C_1
[b] See Sections 2.1.2 and 2.1.3 for the definition of Method 25 condensible and non-condensible catch.
[c] Sample Tank Leaked
[d] Data point not considered representative. Trap contamination is suspected. Parenthetical values are approximations based on the other test runs.
n.d. - none detected

emissions calculated by both TRC and NCASI as concentration, mass emission rate, and emission rate per unit production. Table 2-7 presents a breakdown of the total organic emissions into condensible and noncondensible organics as analyzed by the two laboratories. In addition, individual sample train analyses results are shown. The relative standard deviation between the paired sample trains is also presented.

Emissions of carbon (C_1) from the veneer dryer exhaust as measured by TRC and NCASI showed good overall correlation except for test 1. The TRC condensible trap concentration determined for one sampling train exceeded its mate by a factor of 5. This might be because of contamination in the trap.

The precision of the test data between the sample pairs (relative standard deviation) was considerably better for NCASI data (averaging 8.8 percent) than for TRC data, which averaged 70 percent.

2.3.2 Boiler 2 Outlet

A summary of Method 25 condensible and noncondensible organics data collected at the boiler 2 outlet is presented in Tables 2-6a, 2-6b, 2-6c, and 2-8. Table 2-6 shows relevant emission data and presents total organic emissions calculated by both TRC and NCASI as concentration, mass emission rate, and emission rate per unit production. Table 2-8 presents a breakdown of the total organic emissions into condensible and noncondensible organics as analyzed by the two laboratories. In addition, individual sample train analyses results are shown. The relative standard deviation between paired sample trains is also presented.

Emissions of carbon (C_1) from boiler 2 as measured by TRC and NCASI show poor correlation. The average emissions as calculated by TRC were 9 times greater than those measured by NCASI. There is no readily apparent explanation for this difference.

TABLE 2-8

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC TRAP AND TANK MEASUREMENTS AT BOILER 2 OUTLET[e]

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	Date	Stack Gas Flow Rate (DSCFM)[a]	Sample I.D. No.	Analysis Laboratory	Condensible Catch[e] Traps (ppm)	Non-Condensible Catch[e] Sample Tank (ppm)	Total[e] Catch (ppm)	Pair[e] Average (ppm)	Emission[e] Rate (lbs/hr)	Relative Standard Deviation (%)
1	9/21/81	39,700	0-1-25-A	TRC	571	215	786	741	55.0	8.96
			0-1-25-B		510	185	695			
			9213	NCASI	23.6	n.d.	23.6[f]	23.3	1.73	2.13
			9214		15.2	7.7	22.9[f]			
3	9/23/81	38,500	0-3-25-A	TRC	592	489	1081	1175	84.6	11.3
			0-3-25-B		1048	221	1269			
			9233	NCASI	145	9.3	154	146	10.5	8.26
			9234		131	6.2	137			
4[b]	9/24/81	33,800	0-4-25-A	TRC	597	279	871[g]	744	47.0	24.3
			0-4-25-B		353	263	616			
			9241	NCASI	213	n.d.	213	173	10.9	33.2
			9242		132	n.d.	132			
5[b]	9/24/81	32,400	0-5-25-A	TRC	773	730	1503	1425	86.3	7.74
			0-5-25-B		897	450	1347			
			9243	NCASI	62.6	44.9	108	120	7.23	13.6
			9244		58.0	73.1	131			

TABLE 2-8 (CONT.)

SUMMARY OF METHOD 25 INDIVIDUAL TOTAL ORGANIC TRAP AND TANK MEASUREMENTS AT BOILER 2 OUTLET[e]

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	Date	Stack Gas Flow Rate (DSCFM)[a]	Sample I.D. No.	Analysis Laboratory	Condensible Catch Traps[c,d] (ppm)	Non-Condensible Catch[c,d] Sample Tank (ppm)	Total[c,d] Catch (ppm)	Pair[c,d] Average (ppm)	Emission[c,d] Rate (lbs/hr)	Relative Standard Deviation (%)
6	9/25/81	40,000	0-6-25A	TRC	379	209	607	755	56.5	27.7
			0-6-25B		731	171	902[g]			
			9253	NCASI	29.1	n.d.	29.1[f]	71.1	5.31	83.5
			9254		62.4	50.4	113			

[a] Standard Conditions are 29.92 in Hg at 68°F

[b] Boiler background emission tests

[c] As C_1

[d] See Section 2.1.2 and 2.1.3 for the definition of Method 25 condensible and non-condensible catch.

[e] Results not corrected for CO_2 interference. See Section 5.3.2.5.

[f] Results are below what NCASI considers their lower detection level for these samples. The lower detection limit is estimaed to be 35 ppm when the CO_2 interference is taken into consideration.

[g] Sample tank leaked.

The intralaboratory and interlaboratory comparisons of relative standard deviations between paired samples show good correlation.

2.4 Visible Emissions

A summary of visible emission observations from the boiler 2 outlet is presented in Table 2-9. Average opacities are presented for 6-minute time periods during each test. No opacity data are provided for port change interruptions. The average opacity for tests 1, 3, 4, 5 and 6 was 10 percent, ranging from 8 percent for tests 3 and 5 to 16 percent for test 1. These 6-minute average opacities are presented graphically in Figures 2-1 through 2-5.

During tests 5 and 6 opacity could not be evaluated because of excessive cloud cover obscuring the white plume. The average opacities in these cases were determined by averaging only the unobscured readings. Visible emission field data sheets and the observer certification are contained in Appendix E.

2.5 Boiler 1 Flow Measurements

A summary of volumetric flow measurements taken at the boiler 1 outlet is presented in Table 2-10. This table shows the two volumetric flow rates measured during each test and the average of the two. In addition, the volumetric flow rates at the boiler 2 outlet and veneer dryer exhaust determined during the Method 5X tests are presented for comparative purposes.

Volumetric flow rates from boiler 1 measured during tests 1, 3 and 6 ranged from 38,680 to 42,370 DSCFM, averaging 38,700 DSCFM with an average stack gas temperature of approximately 250°F. The average stack gas flow rate from boiler 2 during these tests was 39,400 DSCFM, while the flow rate measured at the veneer dryer exhaust averaged 24,900 DSCFM. These measurements reveal a total system output of approximately 80,000 DSCFM, while

TABLE 2-9

SUMMARY OF VISIBLE EMISSIONS
FROM BOILER 2 OUTLET

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run 1 (1644 - 1814) 9/21/81		Run 3 (1156 - 1419) 9/23/81		Run 4 (1313 - 1441) 9/24/81		Run 5 (1644 - 1812) 9/24/81		Run 6 (1207 - 1332) 9/25/81	
Six Minute Time Period	Average Opacity (%)	Six Minute Time Period	Average Opacity (%)	Six Minute Time Period	Average Opacity (%)	Six Minute Time Period	Average Opacity (%)	Six Minute Time Period	Average Opacity (%)
1642-1647	14	1151-1156	5	1324-1329	6	1641-1646	3	1203-1208	a
1648-1653	18	1157-1202	5	1330-1335	11	1647-1652	a	1209-1214	a
1700-1705	12	1203-1208	5	1336-1341	17	1653-1658	16	1215-1220	a
1706-1711	19	1209-1214	5	1342-1347	7	1659-1704	a	1221-1226	18
1712-1717	19	1215-1220	8	1348-1353	10	1705-1711	a	1227-1232	a
1718-1725	19	1221-1226	5	Port Change		1712-1717	a	1233-1238	14
Port Change		1227-1232	8	Port Change		1718-1723	a	Port Change	
Port Change		Port Change		1406-1411	5	Port Change		Port Change	
1736-1741	11	Port Change		1412-1417	5	Port Change		1251-1256	7
1742-1747	15	1343-1348	9	1418-1423	6	1736-1741	a	1257-1302	a
1748-1752	15	1349-1354	9	1424-1429	7	1742-1747	a	1303-1308	a
1800-1805	12	1355-1400	4	1430-1435	15	1747-1752	a	1309-1314	8
1806-1811	18	1401-1406	6	1436-1441	5	1753-1758	a	1315-1320	3
1812-1817	14	1407-1412	11			1759-1804	a	1321-1326	1
		1413-1418	18			1805-1810	a		
		1419-1424	18			1811-1816	a		
Average	16	Average	8	Average	9	Average	10	Average	9

n.d. - not detectable, not used in calculation of averages
a Opacity could not be determined due to overcast sky interference.

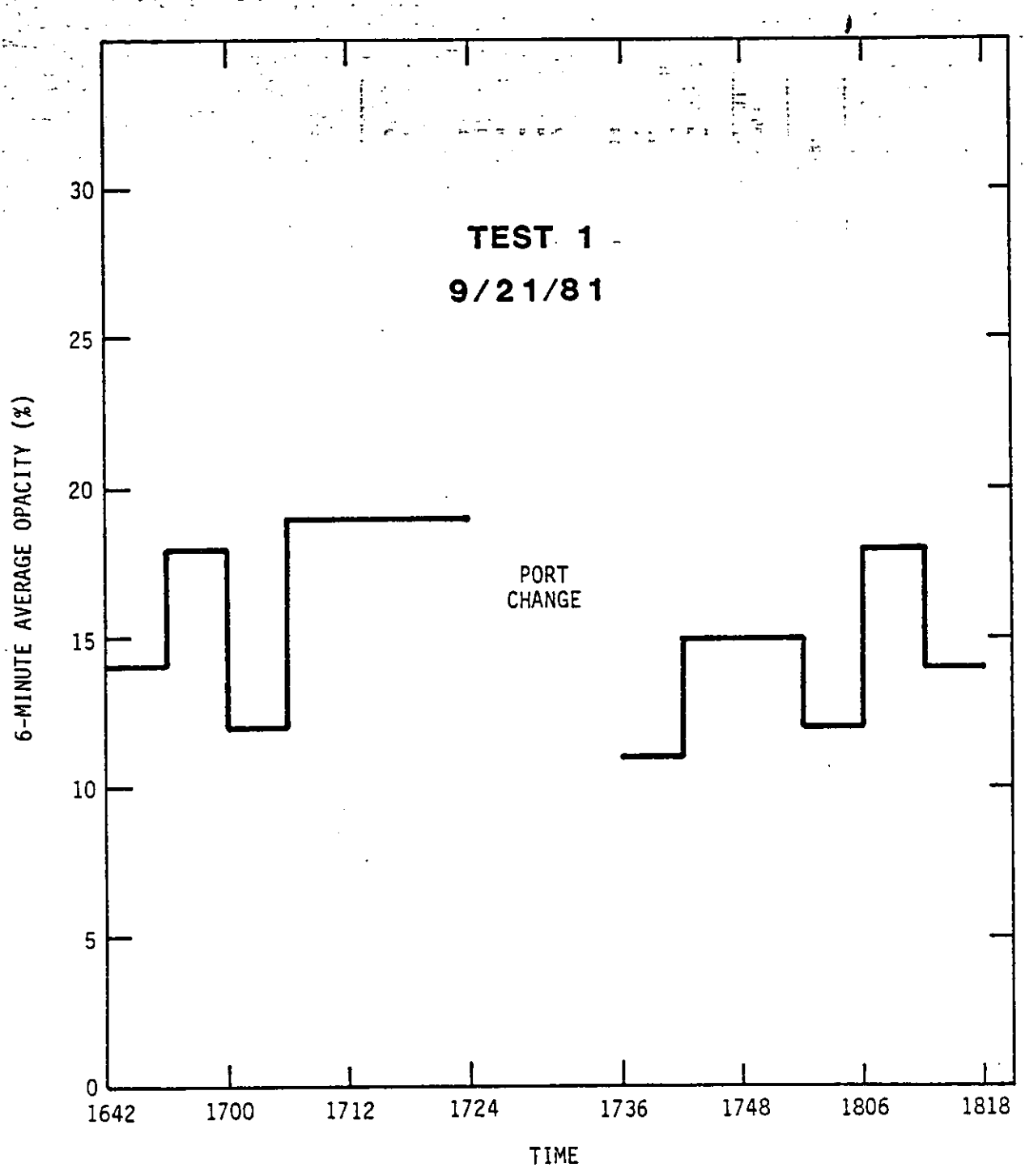


Figure 2-1. Summary of visible emissions from Boiler 2 outlet at Champion plywood plant, Lebanon, Oregon.

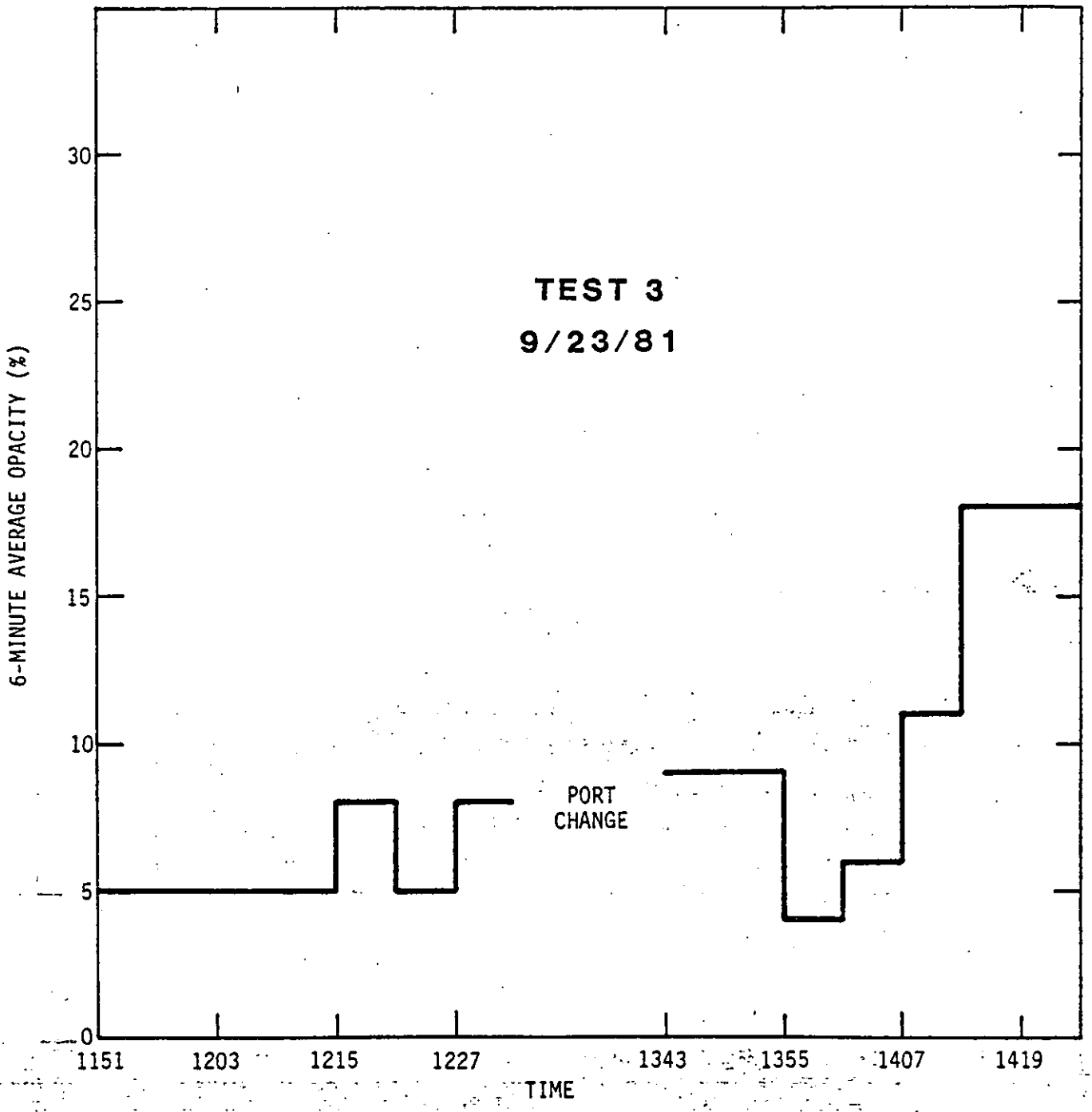


Figure 2-2. Summary of visible emissions from Boiler 2 outlet stack at Champion plywood plant, Lebanon, Oregon.

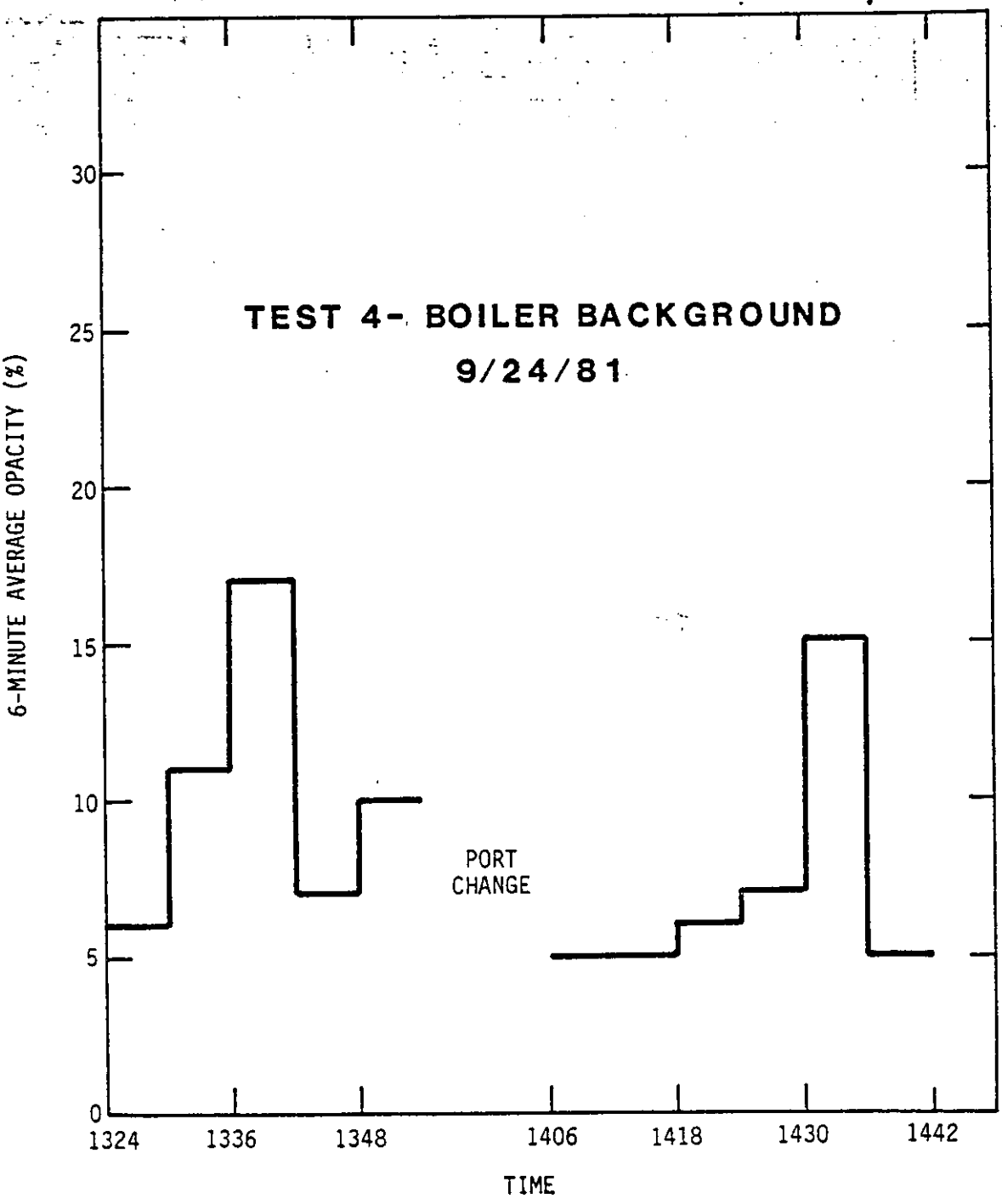


Figure 2-3. Summary of visible emissions from Boiler 2 outlet at Champion plywood plant, Lebanon, Oregon.

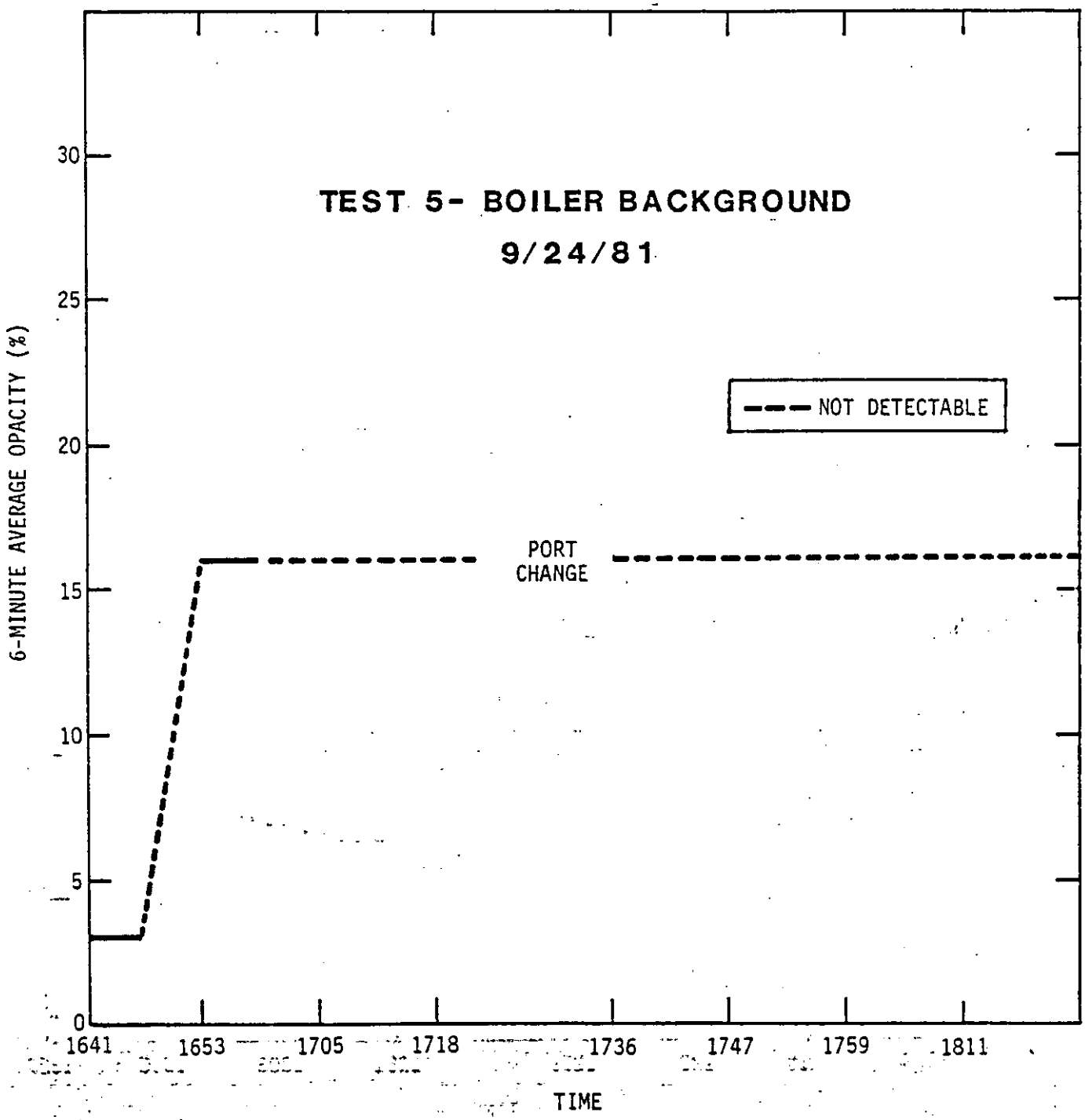


Figure 2-4. Summary of visible emissions from Boiler 2 outlet at Champion plywood plant, Lebanon, Oregon.

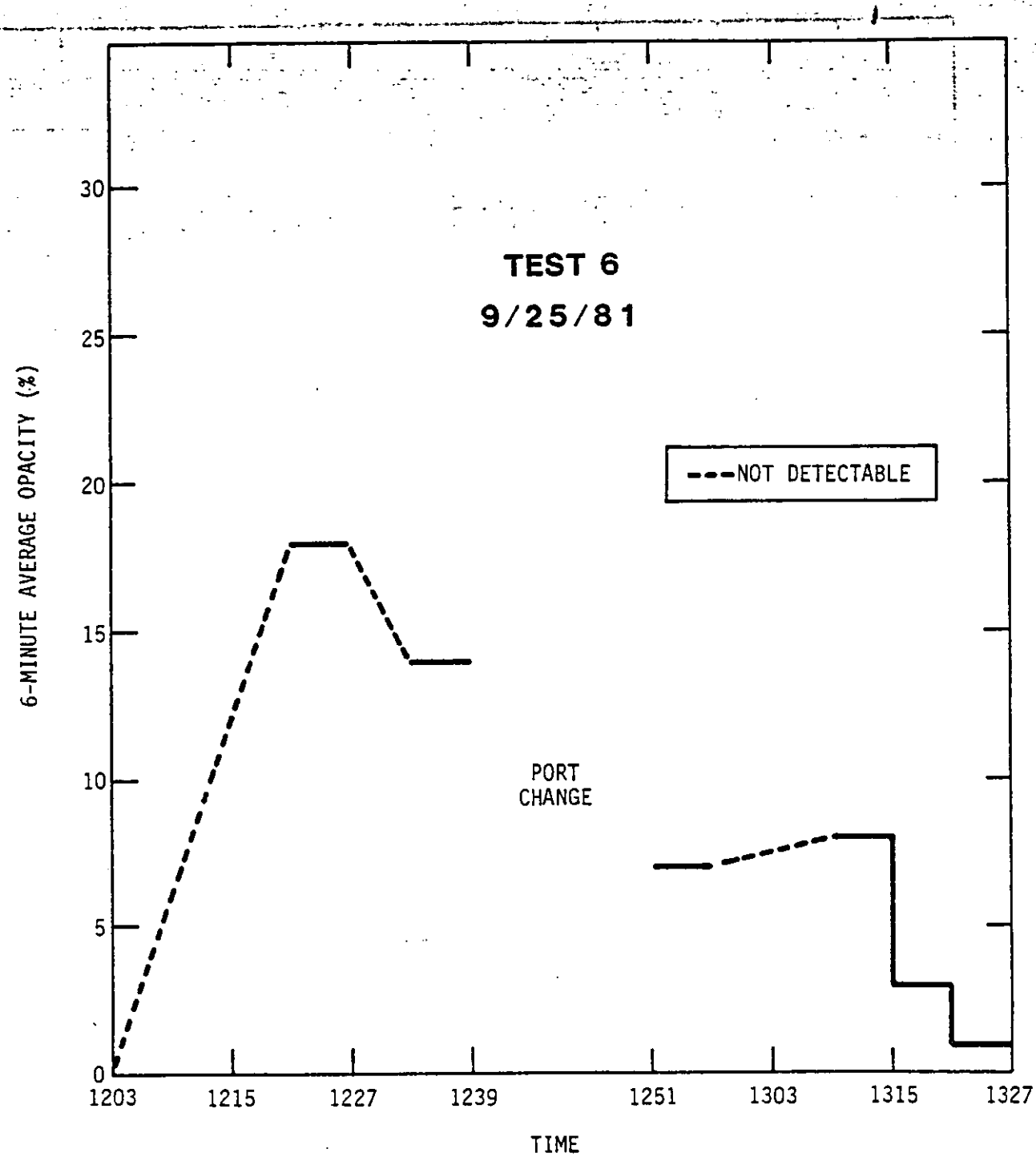


Figure 2-5. Summary of visible emissions from Boiler 2 outlet at Champion plywood plant, Lebanon, Oregon.

TABLE 2-10

SUMMARY OF VOLUMETRIC FLOW MEASUREMENTS AT BOILER 1 OUTLET COMPARED TO BOILER 2 OUTLET AND VENEER DRYER EXHAUST

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run Number	Stack Gas Flow Rates (DSCFM)[a]					
	Boiler 1 Outlet				Boiler 2 Outlet	Veneer Dryer Exhaust
	Date	A	B	Average		
1	9/21/81	42,370	39,340	40,900	39,700	25,700
3	9/23/81	38,680	37,250	38,000	38,500	25,700
4[b]	9/24/81	32,520	34,070	33,300	33,800	NA
5[b]	9/24/81	40,570	40,430	40,500	32,400	NA
6	9/25/81	37,100	37,030	37,100	40,000	23,300
Average[c] (1, 3, 6)	--			38,700	39,400	24,900
Average[d] (4, 5)	9/24/81			36,900	33,100	NA

[a] Standard Conditions are 29.92 in. Hg @ 68°F
[b] Boiler background emission test
[c] Average does not include boiler background emission tests
[d] Average of boiler background emission tests

the input from the veneer dryers was only approximately 25,000 DSCFM. The only other input to this system is a 3000 SCFM fan providing combustion air to the wood-fired temperature booster in the boiler 1 heat exchanger system. The remaining 50,000 DSCFM represents ambient temperature combustion air.

The measured boiler 1 volumetric flow rates for the boiler background emission tests were 33,300 and 40,500 DSCFM for tests 4 and 5, respectively. The stack gas temperature was measured to be 355°F during test 4. This higher temperature was due to the shutdown of the heat exchanger in the boiler 1 exhaust system. The heat exchanger, which supplies hot air to the hardboard plant, was back in operation for test 5 and the stack gas temperature returned to the normal 250°F range.

No measurements of flow from the veneer dryer exhaust were made during the boiler background emission tests. It was, however, observed that small amounts of veneer dryer emissions did enter the boilers during these tests even though all veneer dryer abort dampers were open.

Field data sheets for these measurements may be found in Appendix C. Pitot tube calibration data is presented in Appendix E.

2.6 Wet Fan Operational Data

The pressure drop (ΔP) across the boiler 2 wet fan sump was monitored at 30-minute intervals during each boiler 2 outlet emission test. A summary of these data is presented in Table 2-11.

ΔP measured across the wet fan sump ranged from 0.50 inches H_2O for test 3 to 0.95 inches H_2O for test 5. The average ΔP for the five tests was 0.66 inches H_2O.

TABLE 2-11

SUMMARY OF PRESSURE DROP DATA
ACROSS BOILER 2 WET FAN

CHAMPION PLYWOOD PLANT-LEBANON, OREGON

Run 1 9/21/81		Run 3 9/23/81		Run 4 9/24/81		Run 5 9/24/81		Run 6 9/25/81	
Time	ΔP (in. H_2O)	Time	ΔP (in. H_2O)	Time	ΔP (in. H_2O)	Time	ΔP (in. H_2O)	Time	ΔP (in. H_2O)
1645	0.70	1205	0.45	1320	0.60	1645	1.0	1205	0.60
1715	0.70	1235	0.50	1350	0.60	1715	1.0	1230	0.65
1745	0.75	1315	0.50	1422	0.55	1745	0.75	1305	0.45
1815	0.75	1345	0.50	1450	0.40	1815	1.0	1335	0.50
		1415	0.55						
Average	0.75	Average	0.50	Average	0.55	Average	0.95	Average	0.55

2.7 Summary of Fugitive Emissions

The following is a summary of fugitive emission observations provided by RTI/DGA. The steam-heated veneer dryers all showed fugitive emissions. No estimates were made as to their contribution to total emissions from the dryers but they are not insignificant. Champion has a regular program of dryer maintenance including resealing and replacing skins when the dryers are shut down. Door seals appeared to contribute more to total fugitive emissions than any other single source. There were significant emissions coming from seals around the elephant ears. Leaks did materialize from the green end veneer entrances but were not a major source of fugitive emissions.

The most noticeable change during the week was on Thursday when the abort stacks were opened and no emissions were being incinerated in the boiler. During the morning hours the room air was much clearer around the dryers. In the afternoon there were noticeable fugitive emissions, but probably less than on other test days. Number 4 dryer showed noticeably higher fugitive emissions all week, including Thursday when fugitive emissions were noticed in the afternoon. Dryers 3, 5 and 6 also contributed significant fugitive emissions while dryers 1 and 2 appeared to be somewhat better sealed or dried in such a manner that there were fewer emissions.

As for cooling sections, only dryer number 6 consistently showed organic emissions. The roof vents did reflect the fugitive emissions that were coming off the dryers. Fugitive emission information is included in Table 3-1.

2.8 Ambient Air Measurements

A summary of ambient temperature and relative humidity measurements by RTI/DGA is presented along with process information in Table 3-1. Ambient temperatures ranged from 58 to 69°F, while relative humidity ranged from 46 to 75 percent during the test program.

2.9 Method 5X Clean-up Evaluation

Results of the clean-up evaluations performed on both Method 5X sampling trains are presented in Table 2-12. Front half total residue collected was 1.3 mg and 5.7 mg for the dryer exhaust and boiler 2 sampling trains, respectively. Back half total residue collected was 11.5 mg for each sampling train. Total residue collected during the clean-up evaluation was 12.8 mg for the veneer dryer exhaust sampling train and 17.2 mg for the boiler 2 outlet sampling train.

The average collected residue of 15 mg indicates a lower detection limit in the approximate range of 0.008 gr/DSCF for a Method 5X sample of 30 DSCF.

2.10 Method 25 Audit Sample Analyses

Audit sample analyses were performed by TRC and NCASI in conjunction with the test program. Three audit sample cylinders were provided to each laboratory by RTI. Two of the cylinders contained propylene/nitrogen mixtures and the third contained a toluene/nitrogen mixture. The contents of each tank were analyzed by direct injection of a sample into the TGNMO analyzer. These samples were quantified against the NMO calibration standards.

TRC performed two additional audit sample analyses which were performed by withdrawing samples from the toluene/nitrogen cylinder and into two Method 25 trains configured and operated in a manner indentical to those used for the field sampling program. The samples were then analyzed using the usual Method 25 procedures involving condensible trap purge and recovery, and sample tank analysis. NCASI performed six additional audit sample analyses by withdrawing two samples from each cylinder into two Method 25 trains identical to those used for the field sampling program. These samples were then analyzed using their modified Method 25 procedures.

TRC audit sample analysis results are presented in Tables 2-13a and 2-13b. NCASI results are presented in Tables 2-14a and 2-14b.

TABLE 2-12

SUMMARY OF METHOD 5X CLEAN-UP EVALUATION
CHAMPION PLYWOOD PLANT-LEBANON, OREGON
9/21/81

Sample Fraction	Residue Weight (mg)	
Front Half	5X-I	5X-0
Probe Wash (D. D. H_2O)	1.3	4.4
Probe Wash (acetone)	0	1.2
Front Filter	0	0.1
Front Half Total	1.3	5.7
Back Half		
Organic Extraction	2.9	3.0
Evaporation	0	0
Acetone Rinse	8.4	8.5
Back-up filter	0.2	0
Back Half Total	11.5	11.5
Total Sample	12.8	17.2

TABLE 2-13a

TRC METHOD 25 AUDIT SAMPLE RESULTS
DIRECT INJECTION

Audit Sample Number	Organic Compound	Component Analyzed	RTI Result (ppm C_1)	TRC Result (ppm C_1)	% Error
663	Propylene	C_1	44.4	42.3	-4.73
665	Propylene	C_1	984	1027	+4.37
--	Toluene	C_1	3010	2985	-0.83

TABLE 2-13b

TRC METHOD 25 AUDIT SAMPLE RESULTS
PREPARED SAMPLING TRAINS

Train I.D.	Organic Compound	Component Analyzed	RTI Result (ppm C_1)	TRC Trap (ppm C_1)	TRC Tank (ppm C_1)	TRC Total (ppm C_1)	% Error
A	Toluene	C_1	3010	872	1521	2393	-20.5
B	Toluene	C_1	3010	1190	1157	2347	-22.0

TABLE 2-14a

NCASI METHOD 25 AUDIT SAMPLE RESULTS
DIRECT INJECTION

Audit Sample Number	Organic Compound	Component Analyzed	RTI Result (ppm C_1)	NCASI Result (ppm C_1)	% Error
664	Propylene	C_1	60.9	61.0	+0.16
666	Propylene	C_1	1437	1383	-3.76
675	Toluene	C_1	3409	4002	+17.4

TABLE 2-14b

NCASI METHOD 25 AUDIT SAMPLE RESULTS
PREPARED SAMPLING TRAINS

Audit Sample Number	Organic Compound	Component Analyzed	RTI Result (ppm C_1)	NCASI Trap[a] (ppm C_1)	NCASI Tank[a] (ppm C_1)	NCASI Total[a] (ppm C_1)	% Error
644	Propylene	C_1	60.9	20	52	72	+18.2
666	Propylene	C_1	1437	41	1073	1114	-22.5
675	Toluene	C_1	3409	4451	67	4518	+32.5

[a] Average concentration for two test runs

2.11 Conclusions

Both the Method 5x and Method 25 test results tend to demonstrate that the boiler used as an incinerator achieves a substantial emission reduction. The emissions of concern for this test program were the condensibles only. Despite a number of complicating factors such as the dryer emissions being ducted to two boilers and the increased boiler fuel feed rate during the boiler background tests, examination of the data clearly reveals an emission reduction.

In order to interpret the data properly, it must be assumed that the veneer dryer emissions are equally split between the two boilers. This is necessary since emission data was obtained for only one boiler. The boiler configurations were nearly identical with the exception that the test unit, Boiler No. 1, incorporated a wastewood fired burner and heat exchanger downstream from the boiler, prior to the spray section and induced draft fan. The only effect that this equipment should have on the measured boiler emissions would be to slightly increase the particulates. The measured exhaust flowrates from both boilers were enough to allow the assumption that, using the flowrates as a rough performance indicator, the boilers were operating at similar conditions. Neither of these assumptions is so severe so as to preclude general conclusions being drawn from the data.

The averaged Method 5x data is shown below in Table 2-15a. The veneer dryer data has been divided by two in order to account for the exhaust stream being ducted to both boilers. The condensible emissions from the veneer dryer ducted to <u>each</u> boiler averaged 15.5 lbs/hr while the condensible emissions from the boiler, with the dryer emissions ducted to it, averaged 3.4 lbs/hr. This indicates a condensible emission reduction of approximately 78 percent.

TABLE 2-15a

AVERAGE METHOD 5X MEASURED EMISSIONS

Veneer Dryer Only		Dryer and Boiler		Boiler Only	
Particulate	Condensible	Particulate	Condensible	Particulate	Condensible
1.19 lbs/hr	15.5 lbs/hr	29.6 lbs/hr	3.4 lbs/hr	34.8 lbs/hr	4.5 lbs/hr

The averaged Method 25 results, shown below in Table 2-15b, also tend to support the conclusion of a substantial emission reduction.

TABLE 2-15b

AVERAGE METHOD 25 MEASURED EMISSIONS

Veneer Dryer Only		Dryer and Boiler		Boiler Only	
TRC	NCASI	TRC	NCASI	TRC	NCASI
15.2 lbs/hr	15.1 lbs/hr	65.4 lbs/hr	5.8 lbs/hr	66.6 lbs/hr	9.07 lbs/hr

Applying the same logic as used to interpret the condensible emissions, the NCASI data indicate that the boiler reduces total organic emissions by approximately 67 percent. Although not as apparent in the same way, the TRC data also tend to support the conclusion. The total emission rate of the boiler and dryers operating separately must be higher than the boiler emission rate when the dryers are vented into the boiler. This is clearly evident from the data in the table. Therefore, venting the dryers to the boiler results in an overall emissions reduction for the plant.

A significant difference exists between total organic emissions from the boiler as independently measured by TRC and NCASI. The reason for this is not readily apparent. Examination of the analysis data for the individual sample train components (the trap and tank), reveals that the TRC results are much higher even when the tank components are ignored. Therefore, the discrepancy

may be attributable to the trap samples. Based on reanalyses of the recovered TRC trap samples by RTI, the TRC results appear to be correct. However, based on the audit sample results, the nature of the trap samples, and the ratios of boiler and dryer emissions alone to the combined effluent emissions, it could probably be concluded that the NCASI data are more correct. It may also be concluded that there might have been a real difference between the TRC and NCASI samples at the time of analysis. It is not known, however, whether any such difference would be attributable to contamination, sample loss, or recovery procedures.

3.0 PROCESS DESCRIPTION AND OPERATIONS (Provided by RTI)

This section describes the plywood manufacturing process, specifically the veneer drying process and its emission control, a boiler incineration system. Production and boiler monitoring by RTI as well as process operational conditions during the test program are also discussed.

3.1 Process Equipment

The veneer drying operation begins after the veneer has been peeled from the log at the lathe operation. The veneer then proceeds to the drying operation. Here, the veneer is continuously hand-fed onto the dryer feed conveyor and into the dryer. The purpose of the operation is to thermally drive the moisture out of the veneer in preparation for the layup and laminating operations which follow. During the drying operation, organic compounds are steam-distilled out of the veneer. These organic compounds are the emissions of interest.

The Champion International Lebanon plant is a large wood products complex, plywood being one of the operations. It has a total of seven veneer dryers, six of which are steam-heated and whose emissions are incinerated in the plant boilers. Dryer 7 is heated by hot gases from an Advanced Combustion System Fuel Cell and is not ducted to the boiler system. All steam-heated dryers except number 6 are crossflow conventional dryers of 15-section length, except for dryer number 4 which is 14 sections. Dryers 1, 2, 3 and 5 are three-zone, five-deck models. Dryer 4 is two-zone and five-deck, while dryer 6 is a single-zone, six-deck, longitudinal dryer. Dryer 7 dries white fir (genus Abies) exclusively and the remaining 6 dryers dry Douglas Fir (Pseudotsuga Menziesii) the majority of times. Douglas Fir was the only species dried during the six dryer testing program.

3.2 Emission Control Equipment

Each dryer has two exhaust ducts. Atop each exhaust duct is an abort stack for emergency use only (a source of fugitive emissions). All 12 exhaust ducts converge to a common 48-inch inside diameter (i.d.) duct that carries the effluent through a set of dampers to an I.D. fan. The dryer exhaust is then forced downward in the duct through another set of dampers (fugitive emissions were also observed here) and then fed into the two boilers as overfire/underfire air.

The twin Combustion Engineering water tube boilers are of the dutch oven type. Fuel includes hog fuel (bark and wood), dry trim, veneer clipping and sanderdust from plywood veneer, plus a small amount of hardboard dry waste. Dry fine material is added in a secondary zone. Each boiler has a capacity of 77,000 lb/hr steam at 200 psi, and has a water-cooled grate which is cleaned periodically. A maximum of 10 MWe is produced by steam-driven turbines, but most of the steam is used to heat the veneer dryers and run the hardboard plant adjacent to the plywood facility. The total steam production is about 110,000 lb/hr of which 50,000 lb/hr is required for the veneer dryers. The boiler installation at this test site is not representative of a boiler at a typical plywood plant. When tested with dryer emissions ducted into the boiler, the excess air was over 200 percent. During the test with dryer emissions not going into the boiler, the steam efficiency was presumably higher than when dryer emissions were going to the boiler.

The exhaust from boiler 1 enters a wood-fired temperature booster and a heat exchanger before going through the wet I.D. fan and up a 6-foot i.d. stack. Combustion air for the temperature booster is provided by an I.D. fan rated at 3000 SCFM. Heat generated from the temperature booster and boiler combustion is reclaimed in the heat exchanger for use in the hardboard plant.

An alternate emission control has been installed on boiler 1. This system vents emissions from the heat exchanger to a Zurn dry scrubber (a multiple cyclone unit) through an I.D. fan, and to the atmosphere through a 5-foot i.d. stack. When the Zurn system is on line, the wet fan is shut down. A schematic drawing of the veneer dryer exhaust system is presented in Figure 1-1.

The exhaust from boiler 2 is ducted to a wet I.D. fan which is more of a spark arrester than a pollution control device. Wastewater from the wet fan goes through a canal to a holding pond. The exhaust is then forced to the atmosphere through a 6-foot i.d. steel stack.

3.3 Production and Control Equipment Monitoring

A summary of the production monitoring data collected by RTI is presented in Table 3-1. Boiler operating conditions are provided in Appendix I.

3.4 Process Operating Conditions During Test Program

The operation of each dryer is set according to the size, thickness and kind of wood being dried. The operation of the six steam-heated dryers does vary during most shifts, though as few changes are made as possible. Redry was handled in the morning and testing was not allowed until redry was completed. Douglas Fir was the only species dried in the six dryers during the emission test program.

On September 21, 22 and 23 all six dryers were being operated and only minor upsets occurred on those days. On September 24 dryer 6 was shut down (no monitoring of dryer that day) and dryer 5 was shut down on September 25 for cleaning and maintenance.[1] Dryer production was sufficient to allow testing on all days, including Friday the 25th.

[1] At 1230 hours on September 25, TRC personnel observed that the abort dampers from dryer 5 were open and that a blue haze was emitted.

TABLE 3-1

SUMMARY OF OPERATING CONDITIONS

		Sept. 21	Sept. 23	Sept. 24	Sept. 25
I.	Production* (ft^2 per hour on 3/8" basis)				#5 not in operation
	sapwood	7,018	16,899		11,943
	heartwood (heart-sap mix)	24,655	11,941		12,333
	Total: Douglas Fir Species	31,673	28,840		24,276
II.	Redry rate	9.29%	11.2%		6.9%
III.	Steam Use-- lbs per hour, total plant	98,000-120,000	106,000-110,000 sudden drop at 1:50 in boiler 1	127,000 135,000	106,000-110,000
IV.	Temperatures, dryer	320-360°F	330-355°F		325-355°F
V.	Fugitives				
	1. Abort Stack	#5 green end open, light haze	#5 open, 15%		all closed
	2. Door leaks	all dryers leaked, especially heavy between 3&4	all dryers mod-heavy		Heavy #'s 1,3,4,6
	3. Above dryers	blue haze very evident	mod-heavy		light in morning, mod-heavy in afternoon
	4. Cooling stacks	occasional light haze	#6 mod-heavy		#1, #6 mod
VI.	Weather	61-69°F, 46-68% rel. humidity overcast and sprinkly	58-65°F 60-74% rel. humidity, sunny	58-66°F 55-75% rel. humidity broken clouds	60-64°F, 52-62% rel. humidity sunny, broken clouds

*Does not include dryer #7. Production is on finished plywood basis, not actual throughput of the dryers.

It is normal for small plugups in the feeding and outloading mechanisms to occur and this did happen during the tests. Dryers 1 and 2 also required stops for a couple of minutes when dry end graders required pallet changes. These stops were insufficient cause for cancelling a test.

The boiler operations were monitored each day of testing. Steam load, temperatures and pressures were maintained with minor perturbations. Ten dryer exhausts are vented to the boiler, as was the case on all testing days with the exception of September 24 (Test Runs 4 and 5). The boiler operation is strongly influenced by the volume of air coming from the dryers.

The Lebanon plant's boiler operators have little difficulty in maintaining relatively steady fuel feed rates under this arrangement. On Thursday, September 24, when ambient air was the source of oxygen, the day and evening operators were adjusting fuel feed rates more frequently because they were not as familiar (or had lost familiarity) with how the boilers operated with ambient air being the air supply. However, operator variations had minor affects on boiler performance.

More important were the sudden changes in steam production. Wednesday, September 23, boiler 1 lost its air supply momentarily at 1:50 causing steam production to drop to 35,000 lbs per hour, forcing boiler 2 to increase production to 68,000 lbs per hour. This happened near the end of Test Run 3, but was not felt to greatly affect the sampling on boiler 2 stack. The short rise in steam production for boiler 2 should not have decreased its efficiency in destroying the dryer exhausts. The following day steam production was increased once the first background test run (Run 4) was completed. Air flow from the start during Test Run 5, however, changed little and in fact showed a slight decrease with the increased steam production. The reason for this is not readily apparent from the boiler parameters. Method 5X results show a corresponding increase in total emission with the increase in steam production

and fuel rate for the background tests, not an unexpected result. The increased stream rate and the cold ambient air used instead of hot dryer exhaust for combustion air at least partially explains the increased emissions.

During the week of testing steam loads varied between 62 and 77 percent of full load. Variations in steam production changed minute to minute, but the changes were within a relatively narrow band for most of the tests (See Appendix K for the steam production charts).

Air flow to the boilers was thought to be determined by the dryer exhausts for tests 1, 3, and 6, but additional air was introduced to the boiler process as shown in the higher air flow out of the boiler stacks when compared to dryer exhaust volume. Doors that allow air under the grates provided air for the background tests, 4 and 5, and were closed during the remaining tests, though they still may have been a source of air. It is unclear what the additional sources were for the air.

Production figures provided are not the actual square footage of green veneer dried in the steam-heated dryers but rather a figure that accounts for trim and shrinkage. A full green veneer sheet is approximately 54 inches by 101 inches and will eventually be trimmed to 48 inches by 96 inches following shrinkage in the dryer. The amount of shrinkage depends on the original moisture level. As is the case with all western softwoods, Douglas fir sapwood will shrink more than heartwood. An expected shrinkage loss is 5 to 7 percent. The production figures reported are, therefore, approximately 85 percent of the actual throughput of the dryers. All veneer has been converted to a 3/8-inch basis.

Redry is typically 10 percent of the green veneer rate, but very little (<1 percent) was processed during the testing at Lebanon. Redry contributes nothing to total plywood production, but does add to dryer emissions and steam demand per plywood unit produced. No redry production adjustment is required for the Lebanon data.

4.0 DESCRIPTION OF SAMPLING LOCATIONS

This section presents a description of each sampling location and a summary of the work performed at each site. Figure 4-1 presents a schematic layout of the veneer dryer exhaust system and identifies all sampling locations.

4.1 Veneer Dryer Exhaust

The veneer dryer exhaust was sampled in the 48-inch i.d. duct, 240 inches (5 diameters) downstream of the dampers and 72 inches (1.5 diameters) upstream of the I.D. fan. In accordance with EPA Method 1, sampling was performed at 32 traverse points through two 4-inch sampling ports situated 90° apart and 45° above the horizontal. Figure 4-2 presents the sampling port configuration and a cross section of the duct showing the exact distance of each sampling point from the duct wall.

Method 5X tests performed at this site lasted 64 minutes (2 minutes per traverse point). Method 25 tests were 60 minutes long and were performed concurrently with the Method 5X tests. A total of 3 valid Method 5X and 12 valid Method 25 tests were performed at this location.

4.2 Boiler 2 Outlet

The boiler 2 outlet was sampled in the elliptical steel duct, the axes of which measured 73 inches and 70.5 inches. For calculation purposes the duct was considered to have a 72-inch nominal diameter. Two sampling ports were situated in the duct 90° apart, 480 inches (6.7 diameters) downstream from the top of the wet fan and 300 inches (4 diameters) upstream from the top of the stack. Twenty-four traverse points were sampled at this location in accordance with Method 1. Figure 4-3 presents the sampling port configuration

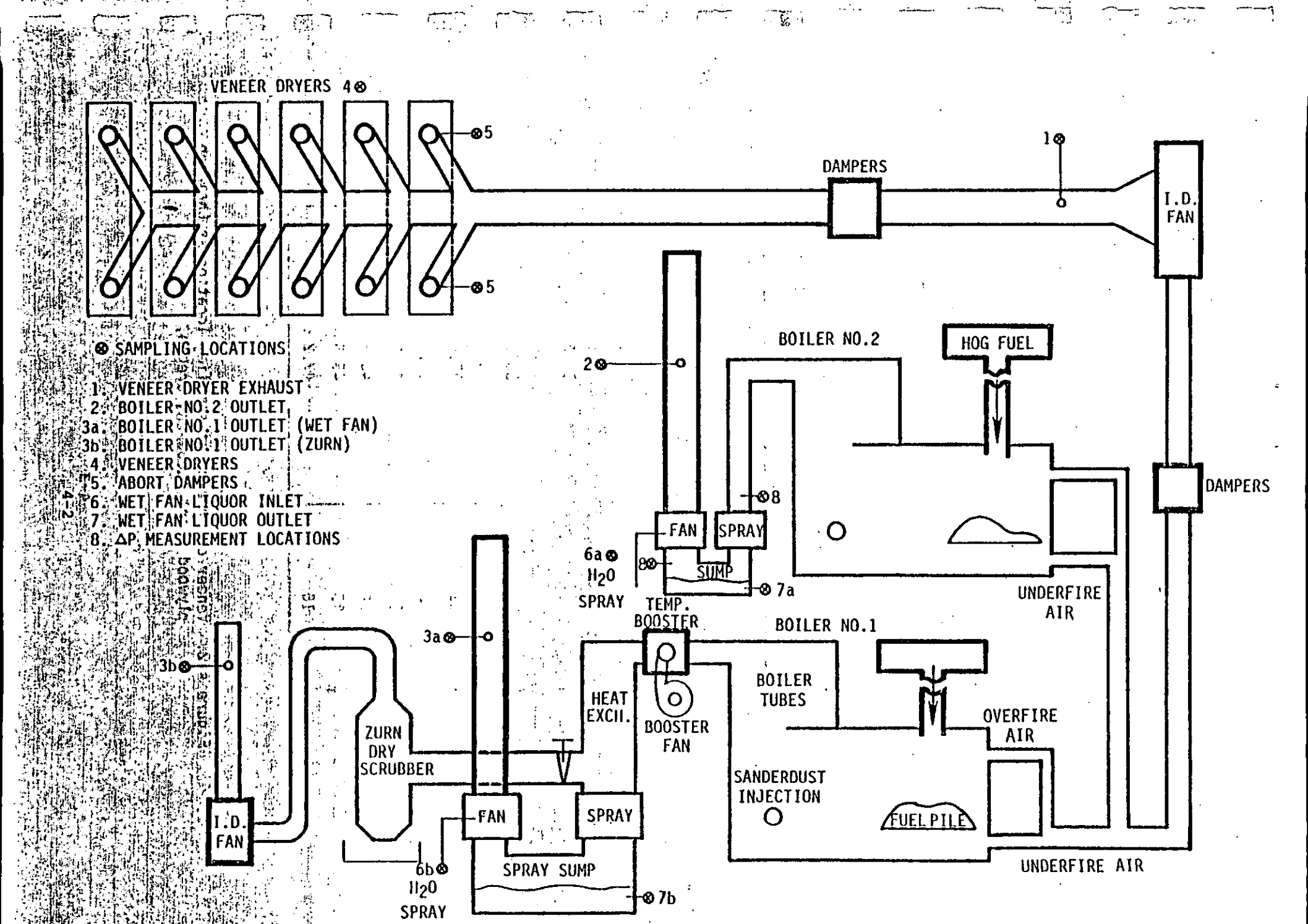
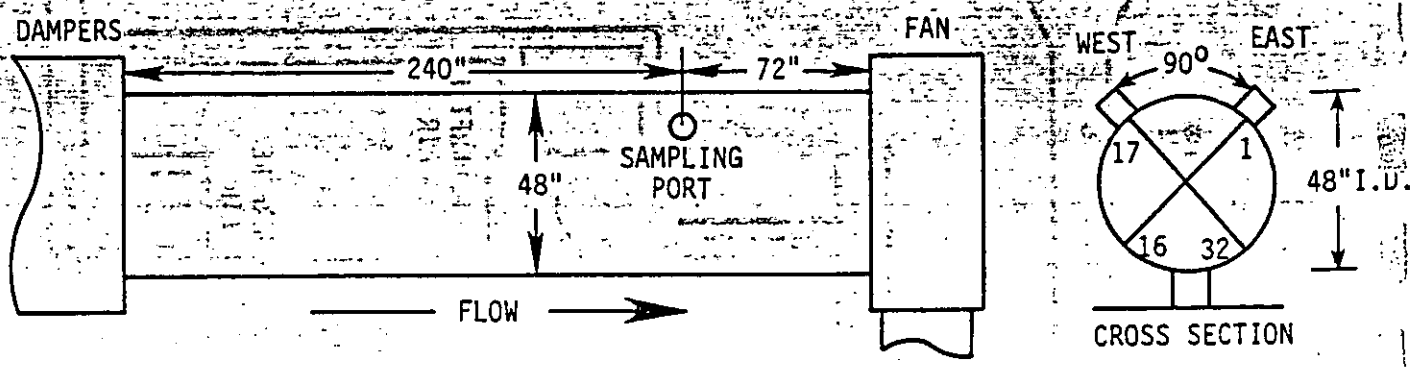


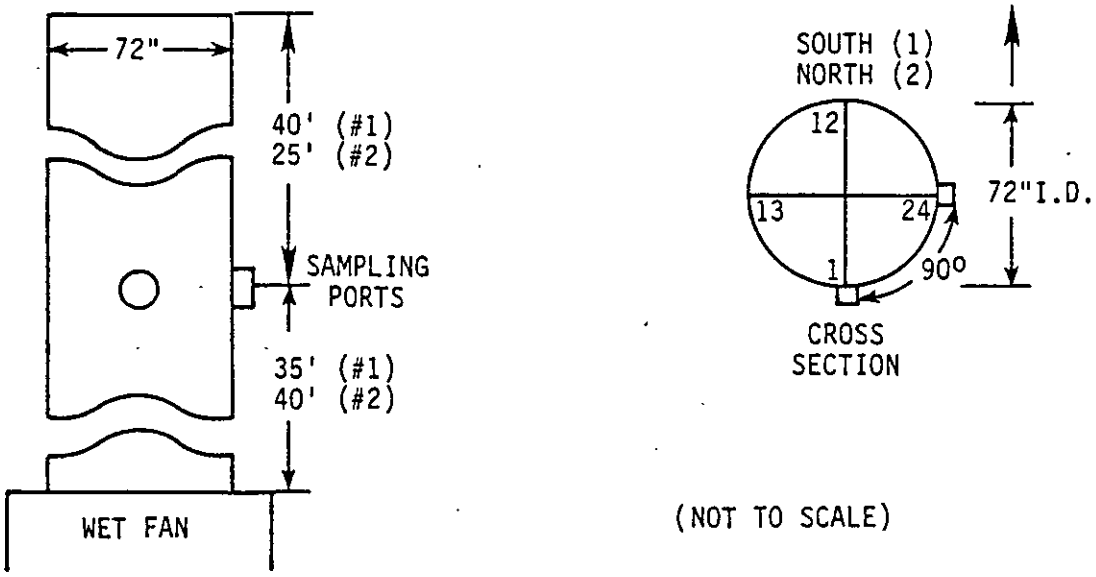
Figure 4-1. Veneer dryer exhaust system at Champion plywood plant, Lebanon, Oregon.



(NOT TO SCALE)

TRAVERSE POINT LOCATIONS	
TRAVERSE POINT NUMBER	TRAVERSE POINT LOCATION (Inches from Inside of Duct)
1	0.75
2	2.4
3	4.1
4	6.0
5	8.1
6	10.6
7	13.6
8	18.0
9	30.0
10	34.4
11	37.4
12	39.9
13	42.0
14	43.9
15	45.6
16	47.2

Figure 4-2. Veneer dryer exhaust sampling location at Champion plywood plant, Lebanon, Oregon.



TRAVERSE POINT LOCATIONS	
TRAVERSE POINT NUMBER	TRAVERSE POINT LOCATION (Inches from Inside of Duct)
1	1.5
2	4.8
3	8.5
4	12.75
5	18.0
6	25.6
7	46.4
8	54.0
9	59.3
10	63.5
11	67.2
12	70.5

Figure 4-3. Boiler outlet (#1 and #2) sampling location at Champion plywood plant, Lebanon, Oregon.

and a cross section of the duct showing the exact distance of each sampling point from the duct wall.

Method 5X tests performed at this location lasted 72 minutes (3 minutes per traverse point). An integrated gas sample was taken in accordance with Method 3 simultaneously with each Method 5X test for Orsat analysis. Method 25 tests were 60 minutes long and were performed concurrently with the Method 5X tests. In addition, visible emission observations were made during each Method 5X test performed at this location.

Three Method 5X tests and 12 Method 25 tests were performed at this location concurrently with similar testing performed at the veneer dryer exhaust. In addition, 2 Method 5X and 8 Method 25 tests were performed at this site as boiler background emission tests.

4.3 Boiler 1 Outlet

The boiler 1 outlet was tested only for velocity and stack gas temperature to determine the volumetric flow rate exiting the stack. Tests were performed in the 72-inch (nominal)[2] steel duct at two ports located 90° apart, 420 inches (5.8 diameters) downstream of the wet fan and 480 inches (6.6 diameters) from the top of the stack. In accordance with EPA Method 1, measurements were made at 24 traverse points. Figure 4-3 presents the sampling port configuration and a cross section of the duct showing the exact distance of each test point from the duct wall.

4.4 Visible Emissions Observation Locations

An overhead view of the Champion boiler house and its immediate environs is presented in Figure 4-4. This figure also shows the two visible emission

[2] This duct was also elliptical, with measured axes of 71 inches and 72 inches.

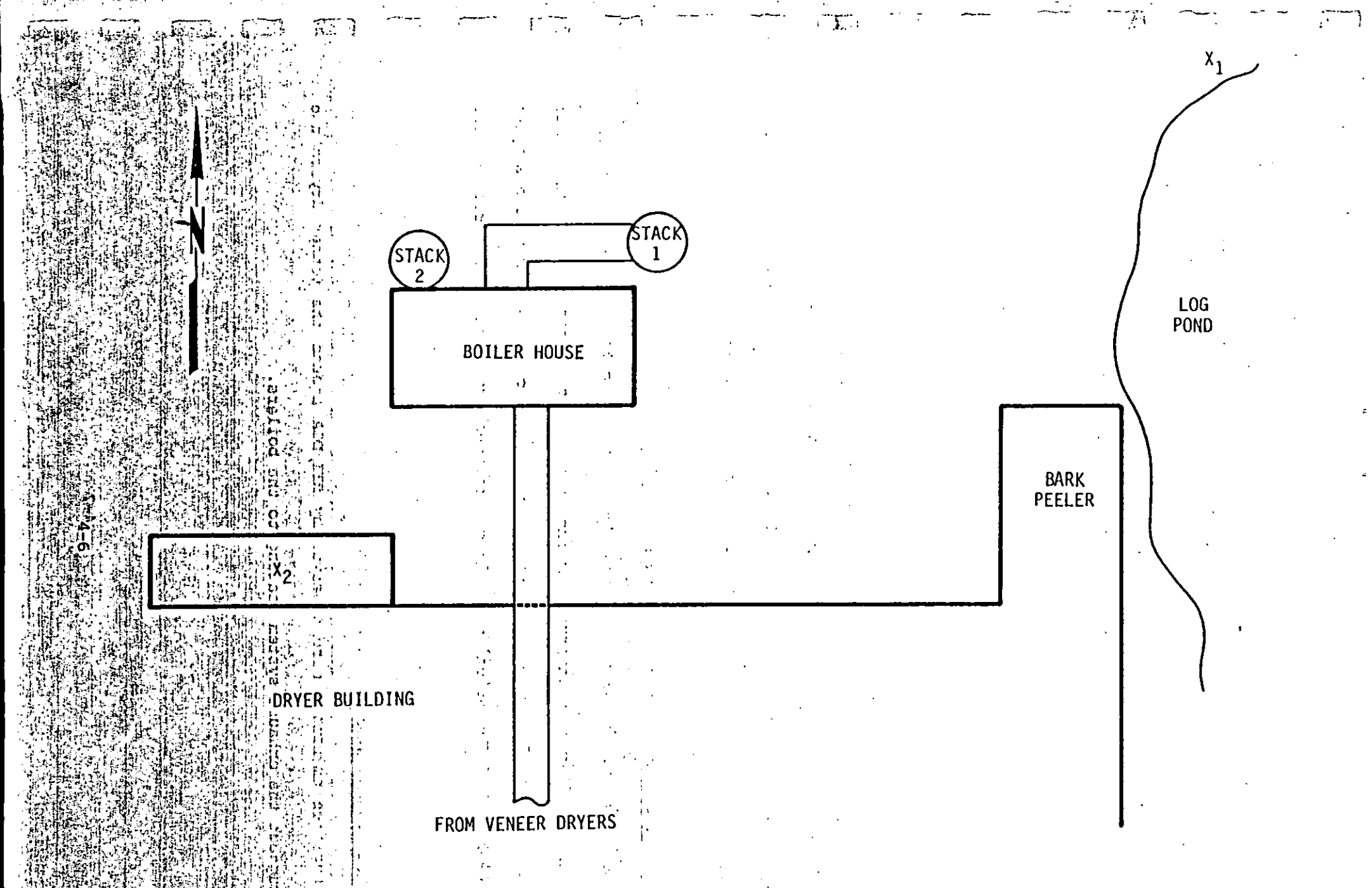


Figure 4-4. Overhead view of visible emission observation locations at Champion plywood plant, Lebanon, Oregon.

observation locations used. Location X_1 was on the bank of the log pond and was used for morning observations. X_2 was atop a shed roof attached to the dryer building and was used for late morning and afternoon observations.

Both observation locations were in accordance with EPA Method 9. The observer was at least one stack height away from the source, with the sun at the observer's back and the plume perpendicular to the observer's line of sight.

4.5 Wet Fan Pressure Drop Measurement Locations

Pressure drop across the boiler 2 wet fan sump was monitored at 30-minute intervals during each Method 5X test using a U-tube water manometer. One side of the manometer was inserted in the duct at the wet spray while the other side was inserted into the duct after the sump just upstream from the fan. These measurement points are shown in Figures 4-1 and 4-5.

4.6 Wet Fan Liquor Sampling Locations

Solution samples were taken from the inlet and outlet of the boiler 2 wet fan sump at 30-minute intervals during each Method 5X test. A 100-ml sample was taken every 30 minutes from each location and composited into two samples for each test. The solution sampling locations are shown in Figures 4-1 and 4-5.

4.7 Fugitive Emissions

Fugitive emissions were observed by RTI/DGA around the veneer dryers and throughout the exhaust system leading to the boilers.

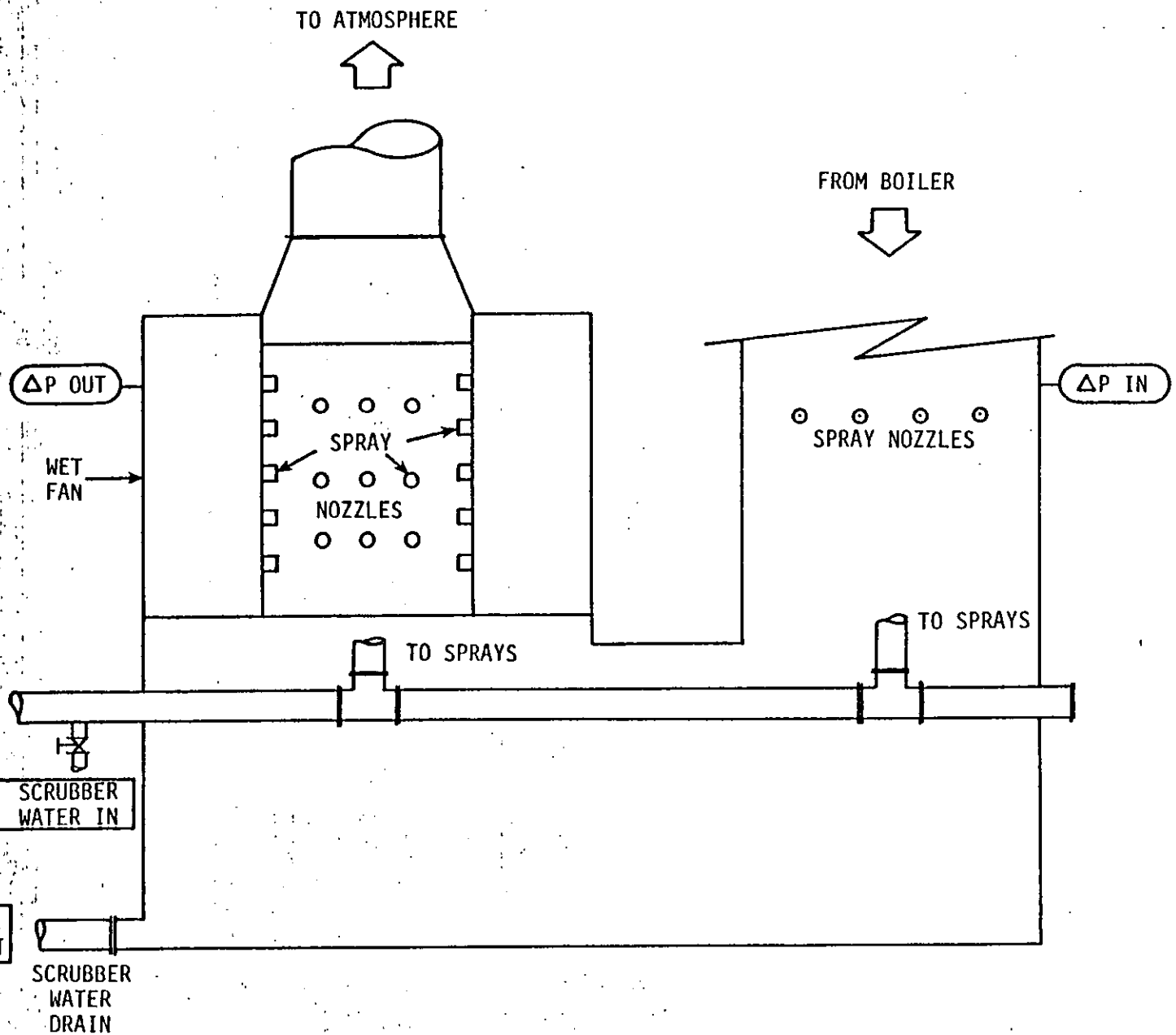


Figure 4-5. Wet fan solution collection points and pressure drop monitoring points at Champion plywood plant, Lebanon, Oregon.

5.0 SAMPLING AND ANALYTICAL METHODS

This section presents descriptions of sampling and analysis procedures employed during the emission testing conducted at the Champion plywood facility in Lebanon, Oregon during the week of September 21, 1981. EPA Methods 1, 2, 3, 4, 5X[3], 9, 22 and 25 were used to measure emissions at the veneer dryer exhaust and from the boiler outlets. These methods are presented in greater detail in Appendix G.

5.1 EPA Reference Methods Used in This Program

The following EPA Reference Methods were used for the testing at the Champion plywood plant. These methods were taken from CFR 40, July 1, 1980, part 60, "Standards of Performance for New Stationary Sources," Appendix A, pp. 183 ff.; and Federal Register, volume 45, no. 194, Friday, October 3, 1980, pp. 65959 ff.

Method 1 - Sample and Velocity Traverses for Stationary Sources

This method specifies the number and location of sampling points within a duct, taking into account duct size and shape and local flow disturbances.

Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate

This method specifies the measurement of gas velocity and flow rate using an S-type pitot tube, manometer, and temperature sensor. The physical dimensions of the pitot tube and its spatial relationship to the temperature sensor and a sampling probe are also specified.

Method 3 - Gas Analysis for CO_2, O_2, Excess Air and Dry Molecular Weight

This method specifies sampling and analytical procedures for the determination of percent CO_2, percent O_2, and percent CO by Orsat analysis, and for the calculation of the molecular weight of the gas stream.

[3] Method 5X will be assigned a reference letter designation when the NSS regulation is proposed in the Federal Register. This method was derived from EPA Method 5 and Oregon Department of Environmental Quality (ODEQ) Method 7.

Method 4 - Determination of Moisture Content in Stack Gases

This method specifies the procedures by which the water vapor content of a gas stream be can determined.

Method 5X - Determination of Particulate and Condensible Organic (Provisional) Emissions from Stationary Sources in the Plywood Industry

This method, based upon EPA Method 5 and Oregon DEQ Method 7, describes procedures for measuring emissions in the context of the following definitions. Particulate matter is material which condenses at or above filtration temperature and is collected by the front half of the sampling train. Condensible organic matter is that material which remains after extraction, filtration, and evaporation of the impinger portion of the train.

Method 9 - Visual Determination of the Opacity of Emissions From Stationary Sources

This method specifies the procedures by which opacity of emissions are measured.

Method 22 - Visual Determination of Fugitive Emissions from Material Processing Sources

This method specifies the procedures for visual determination of the presence and total time of occurence of fugitive process emissions.

Method 25 - Determination of Total Gaseous Nonmethane Organic Emissions as Carbon

This method describes procedures for the sampling and analysis of gaseous nonmethane organic emissions. An emission sample is drawn through a condensate trap and into an evacuated tank. Trap and tank contents are oxidized to carbon dioxide, reduced to methane, and analyzed by a flame ionization detector.

5.2 Preliminary Measurements

Before the start of emission sampling, each location was tested according to EPA Methods 1, 2 and 4 to determine the preliminary stack gas velocity and moisture content within the ducts. In addition, samples were collected at each location according to EPA Method 3 to determine concentrations of CO_2, O_2 and CO in the gas stream.

5.3 Measurements for Particulate, Condensible and Noncondensible Emissions

5.3.1 EPA Reference Method 5X - Particulate and Condensible Organic Compounds

This section presents a summary of procedures followed by TRC during particulate and condensible organic sample collection, recovery and preparation, analysis, and data reduction. Deviations from the specified method are explained in this section. Further details of this method are presented in Appendix G.

5.3.1.1 Method 5X - Sample Collection

The sampling train was a modified EPA Method 5X train as shown in Figure 5-1. This train was designed and built by TRC. A slipstream was drawn from behind the heated Method 5X filter to duplicate TRC and duplicate NCASI Method 25 sampling trains. No vacuum grease was used in the assembly of the Method 5X train prior to the Teflon sample line-impinger train connection. This prevented contamination of the total organic compound samples by the vacuum grease. A minimum amount of grease was used in the impinger train. Leak checks were performed on the complete sampling train (modified 5X train attached to the four Method 25 trains) before and after each test. Field data were recorded on standard EPA Method 5 data sheets which are presented in Appendix C.

The Method 5X sampling train is essentially the same as that described by EPA Method 5 with the following modifications. A flexible Teflon sample line was used to connect the outlet of the 4-1/2 inch glass-fiber Gelman Spectrograde no. 64948 filter to the impinger train. Since the filter was at a higher elevation than the impinger train, condensation in the sample line ran into the first impinger and not back into the filter. The Method 5X impinger train consisted of four impingers and a 2-1/2 inch glass-fiber filter. The

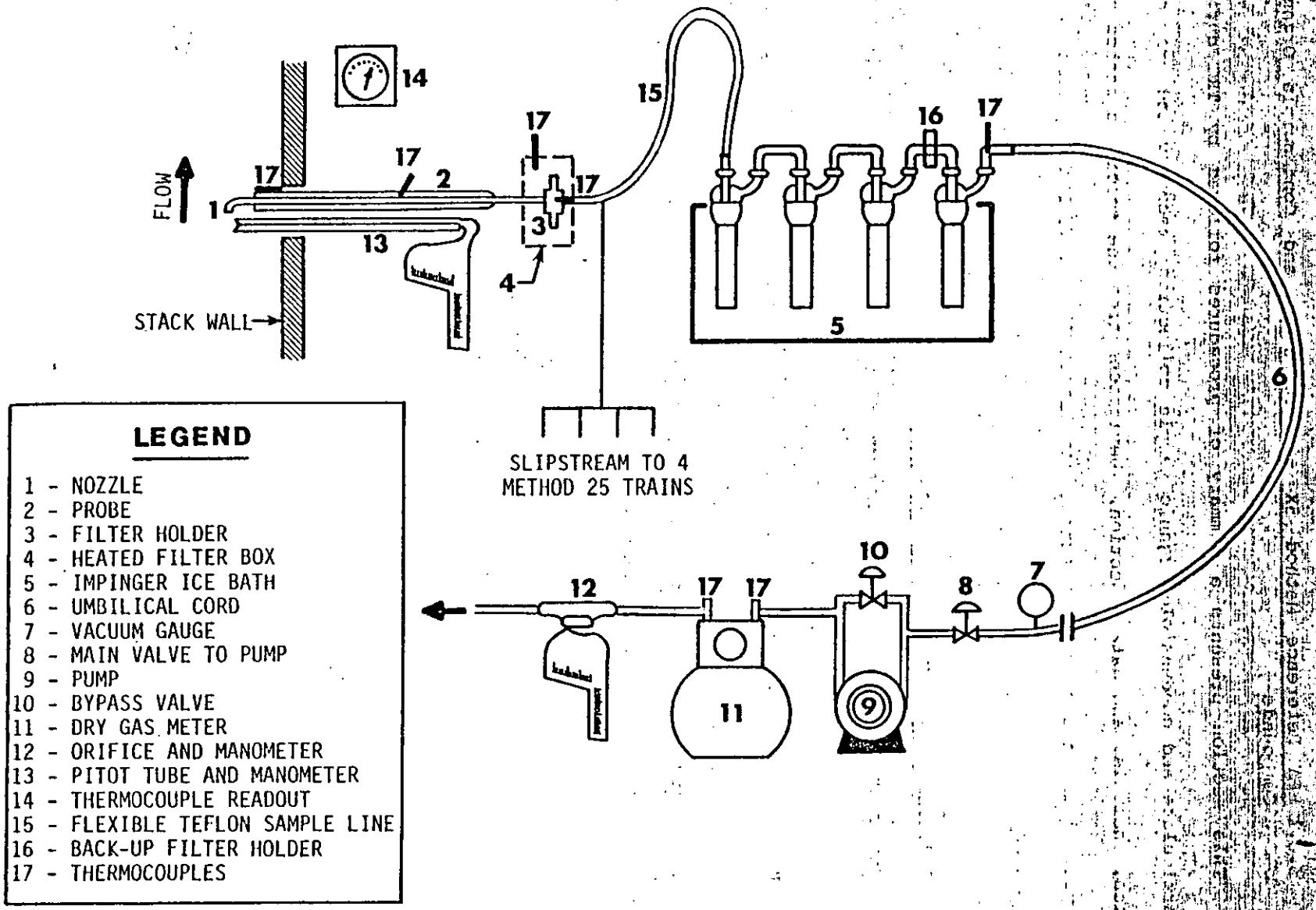


Figure 5-1. Modified EPA particulate and condensible organics sampling train. (August 18, 1977 Federal Register)

first impinger was a modified Greenburg-Smith (impingement plate removed) charged with 100 ml of deionized distilled (D.D.) water. The second impinger was a regular Greenburg-Smith unit also charged with 100 ml of D.D. water. The third was another modified Greenburg-Smith and was empty. The fourth was also a modified Greenburg-Smith type and was charged with 200 grams of silica gel. A 2-1/2 inch glass-fiber filter (similar to the 4-1/2 inch filter) was inserted between the third and fourth impinger to collect any organic material condensed but not collected in the impingers.

Prior to initial field use, all glassware was washed with a chromic acid solution and rinsed with D.D. water and acetone according to Method 5X. To remove any residual vacuum grease Freon 113 (trichlorotrifluoroethane) was used for a final rinse.

Sampling train operations were identical to those of EPA Method 5, with several exceptions. In order to prevent condensation of organic materials in the probe and on the 4-1/2 inch glass-fiber filter, the stainless steel probe and the filter were heated to 350 $\pm 25^{\circ}$F. Thermocouples were inserted into the probe and the filter outlet gas stream to ensure that proper temperatures were maintained. These temperatures were noted on the field data sheet during routine data recording intervals.

5.3.1.2 Method 5X - Sample Recovery and Preparation

Sample recovery was performed in a laboratory on site. This area had a clean and wind-free environment, was well-lighted, and was suited for sample recovery and preparation for shipment.

Sample recovery was performed in accordance with EPA Methods 5 and 5X as presented in Appendix G. At the conclusion of each test run, separate sample fractions were collected from each Method 5X sampling train by a three-person clean-up crew. The liquid samples were placed in glass sample jars with

Teflon-lined lids, and the filters were placed in inert petri dishes and sealed. The sample fractions collected were as follows:

Container 1 - 4-1/2 inch glass-fiber filter.

Container 2 - D.D. H_2O wash of nozzle, probe and front half of the 4-1/2 inch filter holder.

Container 3 - Acetone wash of nozzle, probe and front half of the 4-1/2 inch filter holder.

Container 4 - Exposed impinger solution from impingers 1, 2 and 3 and D.D. H_2O wash of impingers, connectors, Teflon sample line, back half of 4-1/2 inch filter holder and front half of 2-1/2 inch filter holder.

Container 5 - Acetone wash of first three impingers, connectors, Teflon sample line, back half of 4-1/2 inch filter holder, and front half of 2-1/2 inch filter holder.

Container 6 - 2-1/2 inch glass-fiber filter.

The probe and nozzle were brushed and rinsed three times with D.D. H_2O, which was deposited in container 2. The front half of the 4-1/2 inch filter holder was also rinsed with D.D. H_2O, which was deposited in container 2. The probe, nozzle and front half of the 4-1/2 inch filter holder were brushed and rinsed with acetone in the same manner and deposited in container 3.

The Teflon sample line was drained into the impinger train. The Teflon sample line was not brushed because the particulate catch in the sample line is generally considered to be insignificant. Impinger contents were weighed to determine moisture catch and deposited in container 4. The Teflon sample line, impingers, connectors and the back half of the 4-1/2 inch filter holder were rinsed three times with D.D. H_2O into container 4, and then rinsed three times with acetone into container 5.

Both the probe and Teflon sample line were washed with D.D. H_2O after the acetone wash to remove any acetone residue which might contaminate the EPA Method 25 samples. These washes were discarded and the components allowed to dry at ambient conditions before being reassembled.

Both filters were removed from their holders and deposited into their respective petri dishes, containers 1 and 6. Filter residue on the filter holders was scraped and deposited into the same acetone rinse containers as the front halves of their respective filter holders. The stainless steel and glass filter frits used in the filter holders were not rinsed during sample recovery, because any organic material collected on the frits is generally considered to be insignificant. Glass and/or metal particles could become detached and contaminate sample fractions.

Silica gel samples were weighed immediately at the conclusion of each test and the weights recorded by the clean-up crew. All Method 5X samples were packed in locked shock-proof containers and driven to the CH_2MHill laboratory in Corvalis, Oregon for analysis at the conclusion of the test program.

5.3.1.3 Method 5X - Sample Analysis

With the exception of the silica gel samples, all sample fractions were analyzed by CH_2MHill. CH_2MHill was chosen to perform the analytical phase of the Method 5X sampling program because of their extensive experience with Oregon DEQ Method 7, from which EPA Method 5X was derived. All analyses were performed in accordance with EPA Method 5X and as approved by EPA/EMB. The sample fractions were analyzed as follows:

Container 1 - (4-1/2 inch glass-fiber filter) - desiccate and weigh after 24 hours, then weigh to constant weight.

Container 2 - (D.D. H_2O probe rinse) - evaporate, desiccate and weigh after 24 hours.

Container 3 - (acetone probe rinse) - evaporate, desiccate and weigh after 24 hours.

Container 4 - (impinger water solution and D.D. H_2O rinse) - extract, desiccate and weigh.

Container 5 - (impinger acetone wash) - evaporate, desiccate and weigh.

Container 6 - (2-1/2 inch glass-fiber filter) - desiccate and weigh after 24 hours, then weigh to a constant weight.

During this test program experiments were performed to determine if filter sample loss occurred after the initial 24-hour weighing. Filter weights were measured after 24 hours of desiccation and every 12 hours thereafter for another 48 hours. It was discovered that sample loss occurred following the initial weighing and continued throughout the remainder of the 72-hour period. The final version of Method 5X therefore specifies that sample weights be measured after 24 hours of desiccation. The 24-hour weights were used for data calculation in this test program.

Silica gel samples were weighed on site with a triple-beam balance at the conclusion of each test by the Method 5X sample recovery crew. The weight gain of the silica gel was determined to the nearest 0.5 gram and recorded.

All analytical data were recorded on the data sheets as presented in Appendix H. Sample residue remaining after analysis are being retained for at least 90 days after the end of the field program after which they will be discarded.

5.3.1.4 Method 5X Data Reduction

All Method 5X data reduction is performed in a manner identical to procedures described by EPA Method 5. (See Appendix G.) The only variation from these calculations is as follows. Because of the high anisokinetic sampling conditions during test 1 at the veneer dryer exhaust, the particulate mass emission rate (MER) for this run was calculated by two methods: the concentration method (by which calculations are normally done) and the area ratio method. With the former method, the concentration of

particulate matter entering the nozzle is calculated and then multiplied by the volumetric flow rate to obtain the mass emission rate:

$$(m/V) \times Q = MFR \text{ (lbs/hr)} \qquad \text{(Eq. 5-1)}$$

where m = amount of particulate sampled (lbs)
V = volume of sampled gas (DSCF)
Q = volumetric flow rate (DSCF/hr)

If the nozzle sampling velocity is greater than the stack gas velocity (superisokinetic sampling conditions), then the calculated mass emission rate will be less than the true MER. This is because the heavier particles will leave their streamlines (gas streamlines diverted into the nozzle) and will not enter the nozzle, as they would under isokinetic conditions. Since the volume of gas sampled is greater than what would be sampled under isokinetic conditions, the concentration (m/V) will be less than that under isokinetic conditions.

With the area ratio method, the mass of particulate matter collected is divided by the sampling time and then multiplied by the ratio of the stack area to the nozzle area to obtain the mass emission rate:

$$(m/t) \times (A_S/A_n) = MER \text{ (lbs/hr)} \qquad \text{(Eq. 5-2)}$$

where m = amount of particulate sample (lbs)
t = sampling time (hrs)
A_S = area of stack (ft^2)
A_n = area of nozzle (ft^2)

When the nozzle sampling velocity is greater than the stack gas velocity, then the MER calculated by this method will be somewhat greater than the true MER. The lighter particles follow the diverted streamlines into the nozzle; the amount of particulate matter sampled in time (t) is therefore assumed to

Brenchley, D.F., C.D. Turley and R.F. Yarmac, Industrial Source Sampling. Ann Arbor Science Publishers, Inc., 1973, p. 173 ff.

be greater than what should be sampled. The volume of sampled gas is not a factor in this calculation. The average of the two calculated MERs was used as an estimate of the true MER.

5.3.2 EPA Reference Method 25 - Condensible and Noncondensible Organic Compounds

This section presents a summary of procedures followed by TRC during condensible and noncondensible organic sampling equipment preparation, sample collection, field sample recovery, and sample analysis. The TRC Method 25 sampling train is shown in Figure 5-2. Deviations from the method are also explained in this section. NCASI Method 25 procedures are presented in Appendix G. Further details of Method 25 are presented in Appendix G.

5.3.2.1 Method 25 - Sampling Equipment Preparation

This procedure is based on and supplements EPA Method 25, "Determination of Total Gaseous Nonmethane Organic Emissions as Carbon."[5]

Condensate Trap

After being checked for any sign of physical damage, each trap was interconnected to a hydrocarbon (HC)-free air cylinder, flowmeters and CO_2 monitor (nondispersive infrared detector (NDIR)) and inserted in the furnace as shown in Figure 5-3. The trap was then purged with the HC-free air at a 100 ml/min flow rate with the furnace operating at a temperature of 600°C. A propane torch was used to heat those portions of the trap and probe assembly that extend outside the furnace. The purge was performed until the CO_2 monitor indicated a concentration of 10 ppm or less.

[5] Federal Register, volume 45, no. 194, October 3, 1980, pp. 65959-73.

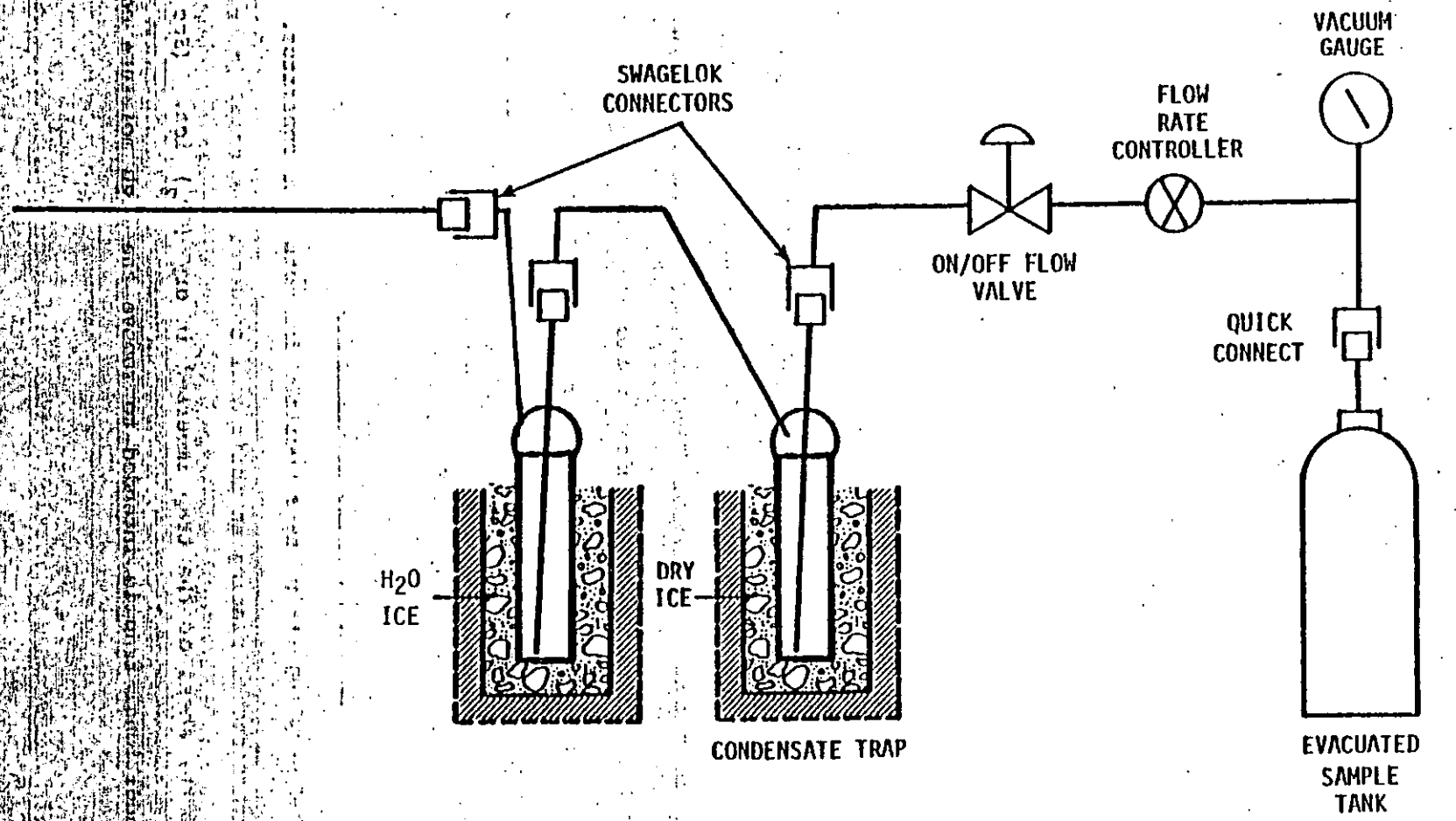


Figure 5-2. Method 25 Sampling Train

Sample Tank

Each sample tank was connected to a cylinder of HC-free air, a vacuum pump, and a mercury manometer as shown in Figure 5-4. The tank was evacuated to 29 inches Hg vacuum after which the three-way valve was switched and the tank pressurized to 10 in Hg with HC-free air. This cycle was repeated three times. After the third pressurization, the tank was connected to the TGNMO analyzer and a sample analysis was performed. If a nonmethane organic concentration greater than 10 ppm was measured, the tank was again subjected to the evacuation-pressurization analysis procedure until accepted. The tank was then evacuated and pressurized to atmospheric conditions with dry nitrogen for shipment to the field.

Flow Control Assembly

The sampling train was assembled as shown in Figure 5-2 and leak-checked. The probe end cap was removed and the probe connected to a flow meter as shown. The sample flow shut-off valve was opened and the flow control valve adjusted to achieve a flow rate of 50 $\pm$5 ml/minute. The flow control adjustment screw was sealed after the flow rate was achieved. The flow control valve number and calibration data were recorded on forms presented in Appendix F.

5.3.2.2 Method 25 - Sample Collection

The sampling train was a modified EPA Method 25 apparatus. The modification consists of placing an additional condensibles trap, immersed in a water ice bath, ahead of the trap immersed in dry (CO_2) ice. (See Figure 5-2.) The additional trap is intended to remove the high moisture content associ-

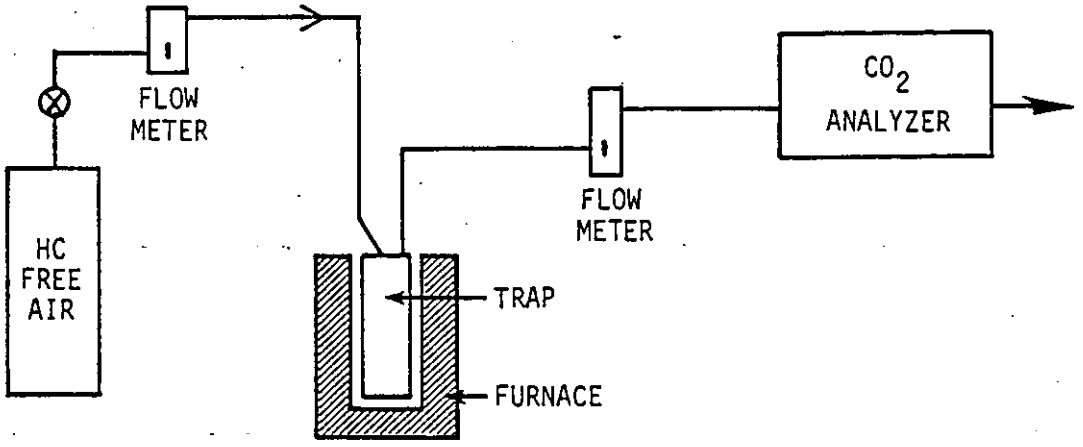


Figure 5-3. Method 25 Trap Preparation

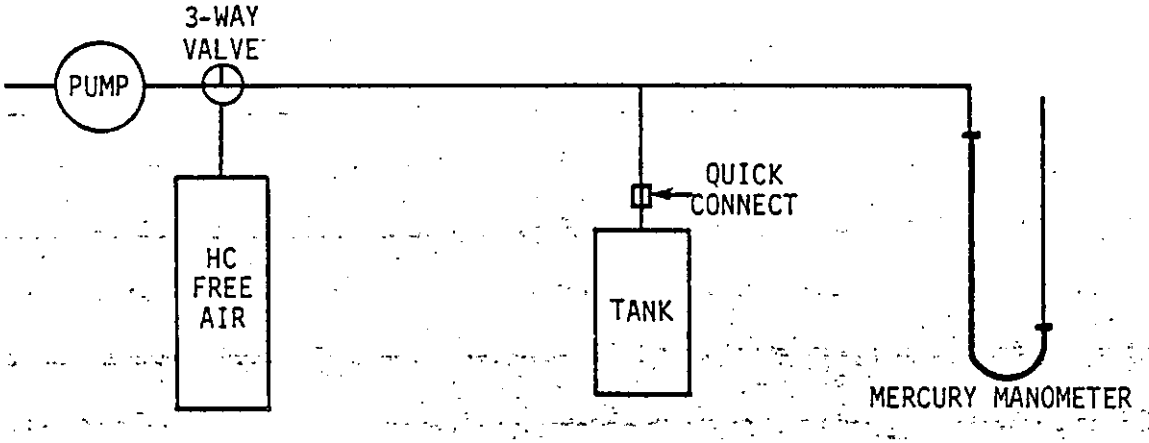


Figure 5-4. Method 25 Tank Purging and Evacuation

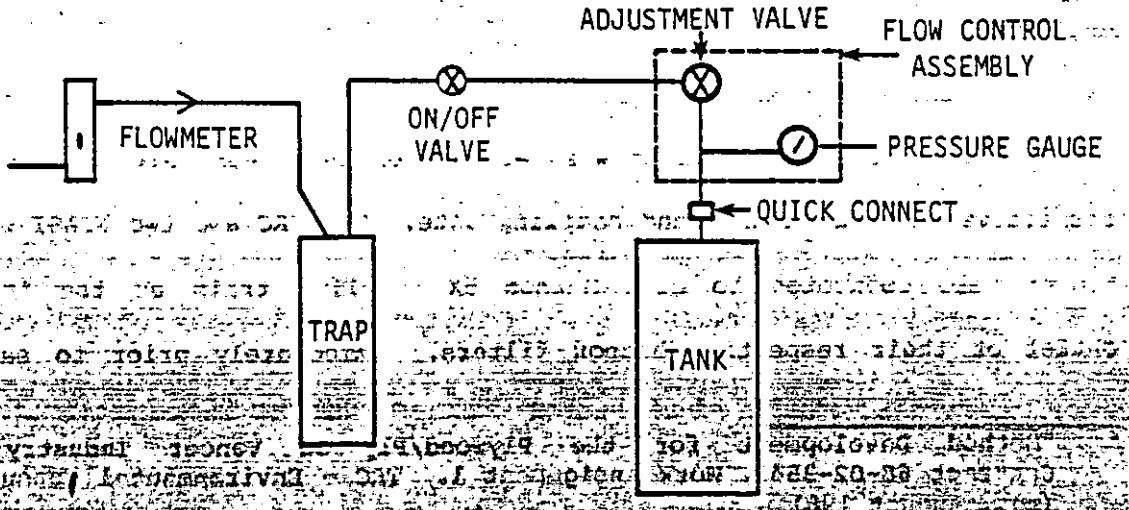


Figure 5-5. Method 25 Flow Control Assembly Adjustment

ated with the process emission streams and prevent freezeup in the dry ice trap which leads to premature sample flow stoppage.[6]

The sample tanks were shipped to the site slightly pressurized with dry nitrogen. Immediately prior to each test, tanks were evacuated. The tank vacuum, ambient temperature and barometric pressure were recorded on the field sampling data sheet. (See Appendix C-2.)

Assuring that the flow shut-off valve was in the closed position, the train was assembled as shown in Figure 5-2. The pretest leak check was then performed. The tank vacuum as indicated by the vacuum gauge was recorded and checked again after a minimum period of 10 minutes. If the indicated vacuum had not changed, the portion of the sampling train behind the shut-off valve did not leak and was considered acceptable. Assuring that the probe tip was tightly capped, the front part of the sampling train was leak checked by opening the flow shut-off valve. After a short period to allow pressure stabilization (not more than 2 minutes), the gauge vacuum indicated was noted. After a minimum period of 10 minutes, the indicated vacuum was again noted. The leak check was considered acceptable if no visible change in vacuum occurred. The pretest leak rate (mmHg/10 minutes) was recorded if observed. At the completion of the leak checks, the sample flow shut-off valve was closed.

After the leak check had been performed, the sample tank number and each trap number of a sampling train was recorded on the field data sheet with the respective test run number and sampling site. Two TRC and two NCASI sampling trains were connected to each Method 5X sampling train at the insulated outlet of their respective hotbox filters. Immediately prior to sampling,

[6] "Method Development for the Plywood/Plywood Veneer Industry," EPA Contract 68-02-3543, Work Assignment 1. TRC - Environmental Consultants, Inc., August 1981.

the gauge vacuum and clock time were noted. The flow shut-off valve was opened and sampling begun. TRC gauge vacuum readings were recorded every 5 minutes during the sampling period. At the end of the sampling period, the flow shut-off valve was closed, the time and final gauge vacuum recorded. After the Method 5X sampling was completed, the Method 25 probe lines were disconnected from the Method 5X interface and tightly capped.

A post-test leak check was performed prior to disassembly of the sampling train. After assuring that the probe had been tightly capped, the flow shut-off valve was opened and the gauge vacuum monitored for a minimum of 10 minutes. The leak check was acceptable if no visible change in tank vacuum occurred. The post-test leak rate (mmHg/10 minutes) was recorded if observed. At the completion of the leak check, the flow shut-off valve was closed.

5.3.2.3 Method 25 - Field Sample Recovery

After the post-test leak check was completed, the TRC sampling train components were disconnected. Both ends of each condensibles trap were tightly sealed. The traps were then packed in dry ice for sample preservation and shipment to the laboratory.

5.3.2.4 Method 25 - Sample Analysis

TRC analyzed two veneer dryer exhaust sampling trains and two boiler 2 outlet sampling trains from each test. The other two dryer exhaust sampling trains and two boiler outlet sampling trains from each test were analyzed by NCASI. The analyses were performed in general accordance with the Method 25 as published. (See Appendix G.)

TRC Analysis Equipment

The analyzer was fabricated by TRC using the following base components:

Varian Model 2800 gas chromatograph with flame ionization detector; and
Hewlett-Packard Model 3390A Reporting Integrator.

These components were interconnected to provide an analyzer scheme very similar to that described in the method. However TRC has made some changes which we believe improve the ease of operation without affecting analyzer performance. Figure 5-6 depicts the analyzer schematic rendering as assembled. A high-grade, HC-free carrier gas is used which eliminates the necessity for the purification furnace.

A six-port valve (Carle Model 5521) was substituted for the two four-port valves in the oxidation catalyst flow scheme. One four-port valve was used instead of two four-port valves in the reduction catalyst flow scheme. In effect the latter valving modification precluded hydrogen venting within the laboratory.

The exit line from the oxidation furnace to the six-port valve was heat traced to avoid condensation. Additionally, all four switching valves incorporated in the analyzer were enclosed in a heated, insulated compartment thermostatically controlled to maintain a constant 100°C temperature.

The separation column used was prepared by Supelco, Inc. It is a 4-1/2 foot long, 1/8-inch diameter stainless steel tube with two packed sections. The injection side section is 3 feet long and contains 10 percent OV-101 (liquid methyl silicone) on 80/100 mesh Supelcoport. The following section is 1-1/2 feet long packed with 60/80 mesh Poropak Q.

The reduction catalyst is a Byron Instruments unit with integral heater. This was mounted within the Varian gas chromatograph oven to ensure constant temperature operation.

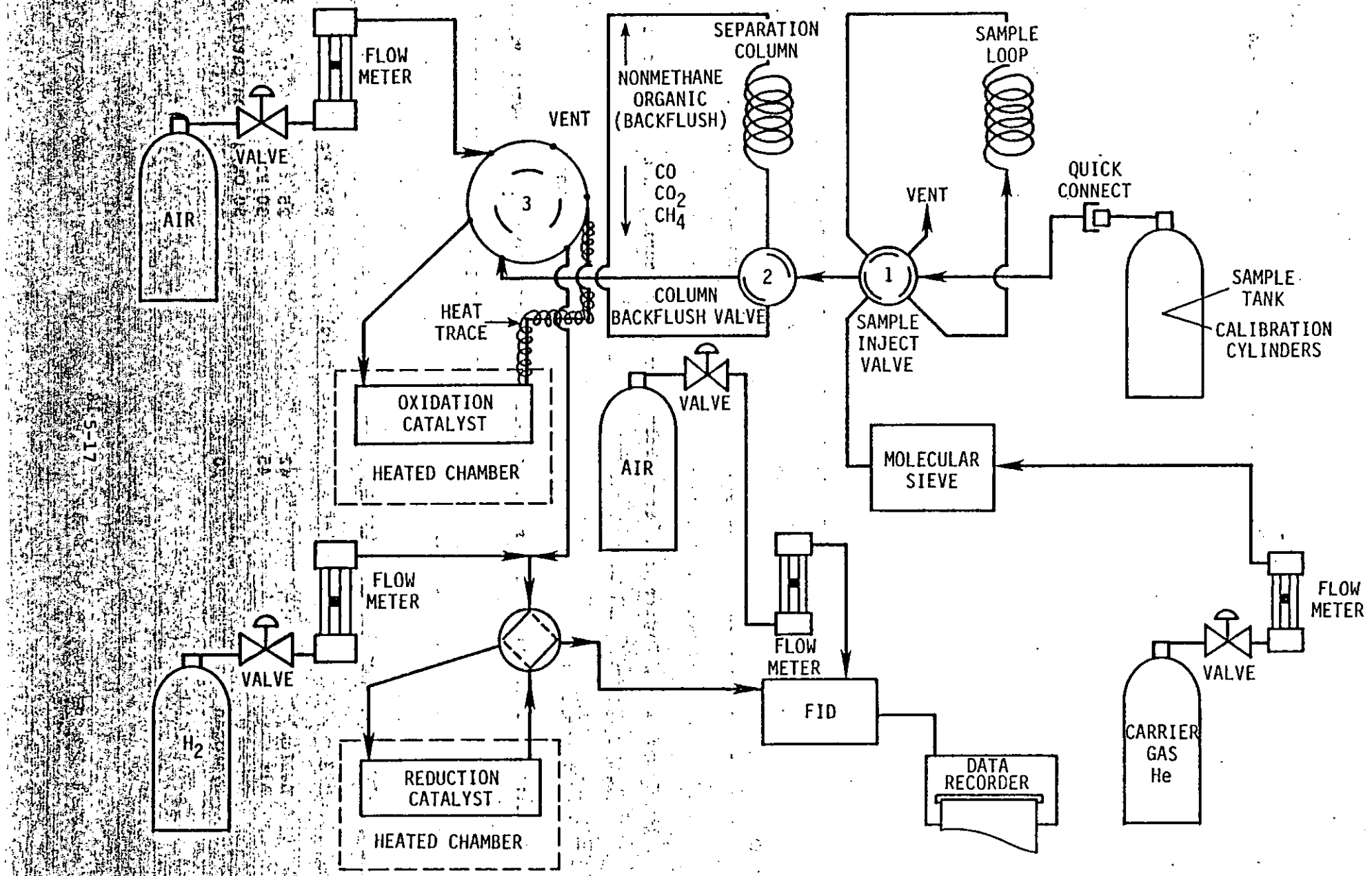


Figure 5-6. TRC Nonmethane Organic Analyzer

Although not clearly shown in Figure 5-6, a single combustion air source services both the oxidation catalyst and the flame ionization detector. Individual metering valves are used after the flow splitter to regulate the supply to each device.

The condensate recovery and conditioning apparatus equipment was assembled by TRC as shown in Figure 5-7 and is essentially the same as the configuration detailed by the method. The NDIR incorporated was an Anarad AR 400, with a range of 10 to 10,000 ppm CO_2.

The TRC arrangement did not incorporate the vacuum pump in a direct link with other equipment. Instead it was located remotely. This was done to avoid contamination by the oil mist vented from the vacuum pump.

A tube furnace is used for volatilization of the condensate trap sample. This provides more even, high temperature heating of the trap. A propane torch is used to heat those parts of the trap, including the probe, which remain outside the furnace during the sample recovery procedure. Valves A, B, C and D in Figure 5-7 and their connecting tubing are enclosed in a thermostatically controlled oven maintained at 180°C to prevent condensation. An oxygen rich carrier gas passes through the condensate trap during heating and oxidizes the organic compounds to CO_2 and water vapor. The flow exits the trap, passes through a water trap and NDIR, and enters the intermediate collection vessel.

Analyzer Operating Conditions:

Gas	Regulator Pressure (psig)	Flow Rate (cc/min)
Helium	42	25
Air	45	30 FID
		50 Oxidation Catalyst
Hydrogen	20	30

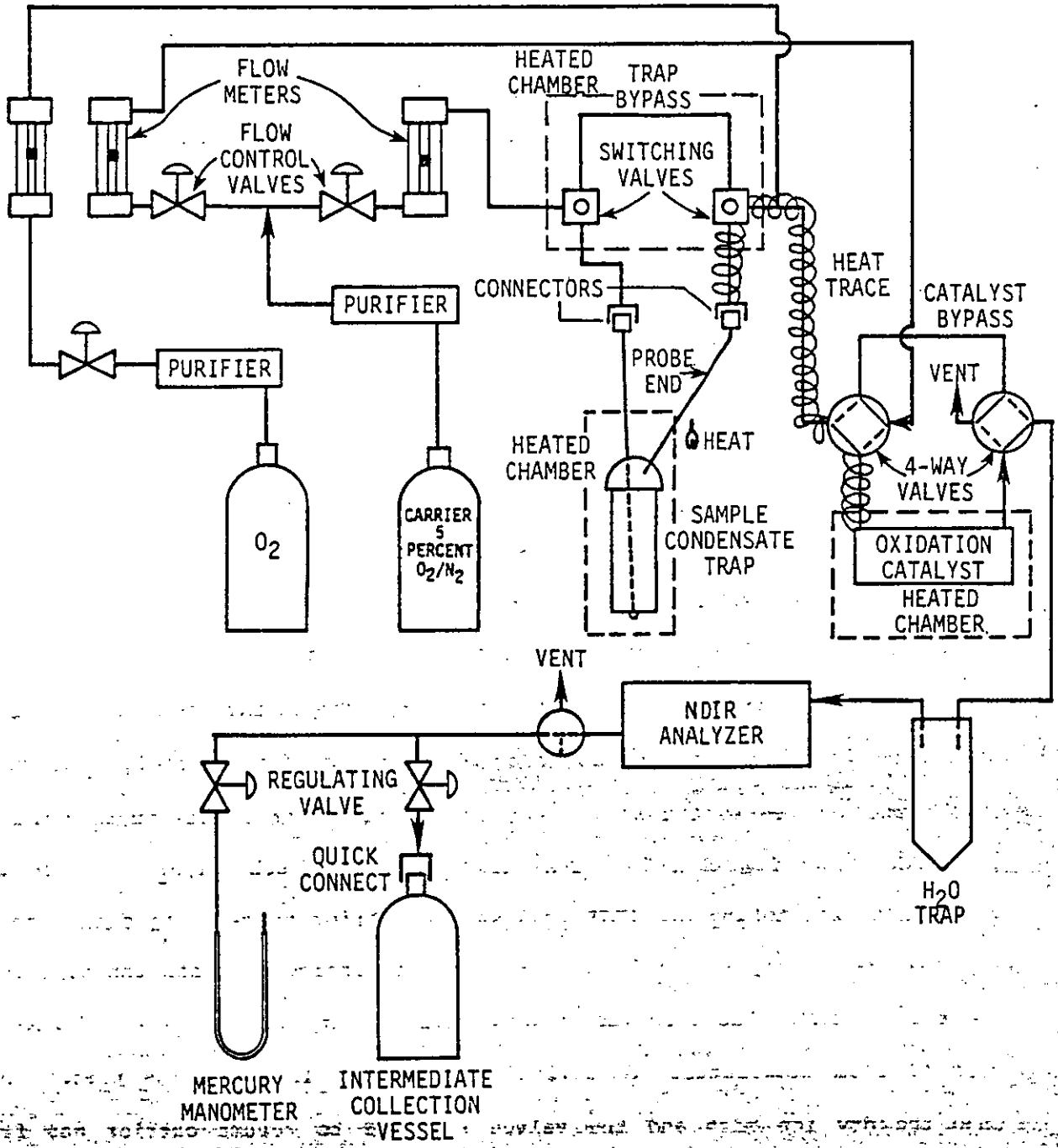


Figure 5-7. TRC Condensate Recovery and Conditioning Apparatus

Separation column normal temperature - 0°C
Separation column backflush temperature - 100°C
Oxidation catalyst temperature - 750°C
Reduction catalyst temperature - 100°C (32 VAC)

Condensate Recovery Conditions:

Gas	Regulator Pressure (psig)	Flow Rate (cc/min)
Oxygen	10	150
Air	15	50

Oxidation catalyst temperature - 850°C

Details of the NCASI analyzer and procedures are presented in Appendix H.

Nonmethane Organic Analysis Procedure

The analysis was performed in accordance with the published procedure. (See Appendix H.) However, the condensate trap carbon dioxide purge (Section A.3.2 of the published procedure) was modified. After briefly purging the trap according to the procedure, the valves were switched so that the trap was bypassed. After the trap had been bypassed, the carrier gas flow continued through the system and into the tank for approximately 5 minutes. It was then vented to the atmosphere through the valve located downstream of the NDIR. (See Figure 5-7.) This time period was sufficient to purge the interconnecting tubing and NDIR cell volume. Prior to resuming flow through the condensate trap, the valve was switched to introduce again the flow into the sample tank. The trap was removed from the dry ice bath and allowed to warm to room temperature (determined by touch). The trap was placed back into the dry ice bath and the valves switched to resume carrier gas flow through the trap after frosting appeared on external trap surfaces. The procedure was then completed as described. This modification to the

procedure is intended to assure the removal of any CO_2 which may be trapped within the ice crystals present in the trap.[7]

5.3.2.5 Method 25 - CO_2 Interference

The existence of potential carbon dioxide interference in the EPA Method 25 analysis procedure has been acknowledged. This interference is believed attributable to the absorption of the inherent gas stream CO_2 by water condensed within the trap and sampling probe, and/or entrapment within ice crystals formed inside the trap. This CO_2 is not completely removed during the trap purge procedure and is later released during the sample recovery procedure. Therefore, the inherent CO_2 is quantified as volatile organic material.

NCASI was the first to raise and experimentally substantiate the CO_2 interference issue and its impact on Method 25 derived sampling data. They performed a laboratory study[8] using a slightly modified Method 25 scheme in conjunction with a sampling program applied to wood-residue-fired boilers. The results indicate that the magnitude of the interference, although random, might be significant. Based upon these findings, NCASI expressed considerable concern regarding the method's applicability in those cases where combustion processes are used as a direct heat source for veneer dryers or are used as a control technique for veneer dryer emissions.

Midwest Research Institute (MRI) performed a CO_2 interference study[9] for EPA that was somewhat limited when compared to that of NCASI. Only one CO_2 challenge concentration, 5 percent by volume, was used with varying

---

7. "Investigation of Carbon Dioxide Interference with Method 25." EPA Contract 68-02-2814, Work Assignment 41. Midwest Research Institute, April 15, 1981, p. 7.

8. "A Study of Wood-Residue Fired Power Boiler Total Gaseous Nonmethane Organic Emissions in the Pacific Northwest." NCASI Air Quality Improvement Technical Bulletin No. 109. September 1980, 19-28.

sample stream moisture contents and flow rates. This study also indicated a randomness for the interference. However, MRI concluded that much of the CO_2 was very likely encapsulated within the ice crystals and could be liberated through a two-step purge procedure incorporating an intermediate warming period. Although based on one sample run, this conclusion contradicted the NCASI study conclusion that ice-encapsulated CO_2 could not be removed effectively by flushing.

After reviewing the MRI findings, NCASI conducted a limited study to evaluate the recommended two-step purge procedure. Their results indicated that the procedure would at best reduce the interference by 50 percent. Additionally, the amount of interference still retained its random character.

Pollution Control Science, Inc. (PCS) performed an independent evaluation of the CO_2 interference based solely upon theoretical absorption-equilibrium chemistry.[10] The results of this evaluation were not intended as a correction but rather as an estimate of the magnitude of the problem.

Both the PCS and NCASI studies present calculation methods for estimating the interference. The PCS equation is:

$$\text{Interference, ppm } C_1 = \frac{P_{CO_2} P_S}{100 - P_s} \times 1303.6$$

where P_{CO_2} = partial pressure CO_2 (atmospheres)

P_s = percent water vapor

1303.6 = 1st approximation conversion factor

The NCASI equation, based upon experimental data is:

$$\text{Interference, ppm } C_1 = \frac{71 + [(9.8 \times \%CO_2) - 6.2] \text{ (ml } H_2O \text{ collected)}}{\text{sample volume}}$$

[9] "Investigation of Carbon Dioxide Interference with Method 25". Final Report. EPA Contract 68-02-2814, Work Assignment 41. Midwest Research Institute, April 15, 1981.

[10] "EPA Method 25 CO_2 Interferences." Measurement of Volatile Organic Compounds by EPA Method 25 Seminar. University of Dayton, September 1981.

The results from this calculation showed a CO_2 interference about twice that calculated for the NCASI samples. The reason this equation showed a higher CO_2 interference when applied to the TRC data is that the NCASI equation contains a factor for trap blanks that was developed from an average of blanks for the NCASI system. Use of this equation with smaller sizes such as gathered by TRC will exaggerate the blank. For comparitive purposes, TRC used a modification of the NCASI equation:

$$\text{Interference, ppm } C_1 = \frac{9.8 \times \%CO_2 \times \text{ml } H_2O \text{ collected}}{\text{sample volume}}$$

NCASI calculated corrections for their data using their equation only.

Table 5-1 presents a summary of the calculated corrections for both the TRC and NCASI data. The gas stream CO_2 and moisture contents used in the equations for the TRC data correspond to those values obtained during the concurrent EPA Method 5X and Method 3 tests. In order to apply the NCASI equation to the TRC data, the milliliters of water collected in the sample trap were calculated from the gas stream moisture content and the Method 25 sample volume employing the EPA Method 4 equation. NCASI used the actual measured liquid volume in their sample trap and the measured CO_2 content in the sample tank for their calculations.

TABLE 5-1

CO_2 INTERFERENCE CORRECTIONS
FOR BOILER 2 OUTLET TOTAL ORGANIC MEASUREMENTS

Run Number	TRC Data PCS Method ppm C_1	TRC Data Modified NCASI Method ppm C_1	NCASI Data ppm C_1
1	16.5	9.4	14.0
3	17.0	9.4	16.5
4	13.3	7.8	16.5
5	33.3	18.9	18.5
6	16.6	9.3	16.5

Comparison of the calculated corrections reveals very good correlation between that obtained using the PCS equation and the NCASI data. However, the corrections obtained applying the modified NCASI equation to the TRC data yield results about 34 percent lower, on the average, than those calculated by NCASI. Considering the basis used for development of the equations, both must overestimate the actual interference because each assume that there is no attempt to purge the CO_2 frozen in the water ice.

5.4 CO_2 and O_2, CO Determination

Concentrations of CO_2 and O_2 were measured in accordance with Method 3 to determine the molecular weight of the gas stream. An integrated gas sample was taken simultaneously with the Method 5X sample through a separate stainless-steel probe that is integral with the Method 5X probe.

The sample was drawn through the probe and a flexible sample line and air-cooled condenser with a Metal Bellows pump at a rate of approximately 0.5 liters per minute. The sample was then pumped into a Tedlar sample bag with an approximate volume of 1 ft^3. Flow rates were recorded simultaneously with the Method 5X data.

Immediately following completion of each Method 3 and 5X test run, the integrated bag sample was analyzed with an Orsat analyzer manufactured by Hayes-Republic. Concentrations of CO_2 and O_2 were determined to the nearest 0.1 percent. Analysis was performed according to the method, using three passes through each absorbing bubbler to ensure complete absorption. Each bag sample was analyzed in triplicate.

EPA Method 3 was to used to determine the molecular weight of the gas stream at boiler outlet during each test. It was determined by a preliminary

Method 3 test that an atmospheric air composition prevailed in the dryer exhaust duct. This was expected since no combustion was taking place in the veneer drying process. No additional Method 3 tests were performed at this location.

5.5 Preliminary Moisture Determination

Preliminary moisture tests were performed at the veneer dryer exhaust and the boiler 2 outlet prior to emission testing. Testing was be performed in accordance with EPA Method 4. Data were recorded on field moisture determination forms as presented in Appendix C.

5.6 Preliminary Velocity Determination

Preliminary velocity measurements were made at the veneer dryer exhaust and boiler 2 outlet prior to emission testing. EPA Methods 1 and 2 were followed in measuring the velocity of the gas stream. Data were recorded on the field data sheets (Traverse Point Location for Circular Ducts and Preliminary Velocity Traverse, Appendix C).

5.7 Visible Emissions

Visible emission observations were conducted concurrently with the particulate/condensible organic tests at the boiler 2 outlet to determine if a relationship exists between measured and visible emissions. Observations were made according to EPA Method 9. Opacity observations were recorded to the nearest 5 percent at 15-second intervals. Opacity was interpreted as the average of a set of 24 consecutive observations for a 6-minute period.

Opacity readings were recorded by a certified observer on the Record of Visible Emissions form as presented in Appendix E. Summaries of visible

emissions were recorded on the Summary Record of Visible Emissions form, also presented in Appendix E.

5.8 Pressure Drop Measurements

Pressure drop (ΔP) across the wet sump prior to the boiler 2 wet I.D. fan (Figures 4-1 and 4-5) was measured to establish the unit operating condition. A U-tube water manometer was used to measure the pressure differential between the spray chamber and the wet I.D. fan at 30-minute intervals during each test.

5.9 Wet Fan Solution Samples

The boiler 2 wet fan solution samples were taken from the supply and drain of the system concurrently with the particulate/condensible organics tests performed at the boiler 2 outlet. These samples are being held for possible future analysis at the direction of EPA.

A 100-ml sample was taken at the wet fan solution supply and drain approximately every 30 minutes during the Method 5X boiler outlet tests. These samples were taken by filling a 100-ml graduated cylinder. Sample numbers and collection times were recorded on the Wet Fan Solution Sample Collection form in Appendix C. The 100-ml aliquots were combined into two composite samples for each test (one supply sample and one drain sample). The size of the composited sample was a function of the actual duration (including interruptions) of the Method 5X test.

The composite samples were packed in locked shock-proof containers and driven to CH_2MHill at the conclusion of the test program.

5.10 Fugitive Emissions

Fugitive emissions are emissions that are not emitted directly from a process stack or duct. These generally include such emissions as those: (1) escaping capture by process equipment exhaust hoods, (2) emitted during material transfer; (3) emitted from buildings which house material processing or handling equipment; and, (4) emitted directly from process equipment.

Guidelines from EPA Method 22, as modified by RTI, were used to determine fugitive emissions from the veneer dryer doors, abort stacks, and dampers in the exhaust system. The method does not require that the opacity of emissions be determined. Instead, the method determines the amount of time that any visible emissions occur during the observation period; that is, the accumulated emission time.

Fugitive emissions from the veneer dryers and the exhaust system were monitored by RTI and DGA. These observations were recorded. Abort stack emissions were also monitored by RTI but the observations were not recorded.

5.11 Ambient Temperature and Relative Humidity

Outdoor ambient temperature and relative humidity were measured at the beginning and end of each test period with a psychrometer provided by TRC. These measurements were made by DGA to determine if a correlation exists between ambient temperature and relative humidity, and the emissions from the veneer dryers. Data were recorded on a form provided by RTI.

6.0 QUALITY ASSURANCE

The TRC quality assurance program is designed to ensure that emission measurement work is performed by qualified people using proper equipment following written procedures in order to provide accurate, defensible data. This program is based upon the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III (EPA-600/4-7-027b).

At the beginning of each day, a meeting was held to orient personnel to the activities scheduled for that day and to discuss results from the previous day, and to determine if any special considerations were appropriate for the day's work.

6.1 Method 5X

TRC's measurement devices, pitot tubes, dry gas meters, thermocouples, probes and nozzles are uniquely identified and calibrated with documented procedures and acceptance criteria before and after each field effort. Records of all calibration data are maintained in TRC files. Samples of these calibration forms are presented in Appendix F.

All Method 5X sampling was 100 ±10 percent isokinetic, except as mentioned in Section 2. Probe and hotbox temperatures were maintained at 350 ±25°F. Deviations from these criteria at the boiler 2 outlet were reported to the EPA/EMB task manager to decide whether a test run should be repeated or continued.

A single clean-up evaluation test was performed on each initial set (collector train) of glassware prior to collecting field samples. The evaluation tests (Method 5X) were performed in the field clean-up laboratory and were observed by the EPA task manager. Necessary changes or modifications to the clean-up procedures were specified by the EPA task manager prior to collecting field samples. The sets of glassware, including the probes,

were prepared and precleaned before conducting the clean-up evaluation tests. The impingers were precharged as specified in the actual test program. Afterward, the sample collectors, including probes, were cleaned and the blank samples recovered and analyzed as specified in the actual test program. Results are presented in Section 2 of this report.

In summary, the evaluation tests were designed to precondition the sample collectors, to establish blank background values, and to educate the clean-up personnel in specific sample recovery procedures.

Acetone was provided by CH_2MHill in glass-lined containers. Both the acetone and D.D. water were analyzed by CH_2MHill prior to field use. Residue data from this preliminary analysis was evaluated by the EPA/EMB task manager with respect to the suitability for use during the test program. These data are presented in Appendix H. In addition, three blank samples of D.D. water, acetone, and both 2-1/2 inch and 4-1/2 inch filters were collected for background analysis. All clean-up evaluation and blank samples were analyzed in conjunction with the actual test samples.

All sample recovery was performed by a three-person clean-up crew. Appropriate sample recovery data were recorded on the sample identification log, sample handling log, chain-of-custody form, and analytical data forms as presented in Appendix D.

Recovered samples were secured in padlocked, shock-proof, steel containers for storage and shipment for analysis.

All preparation and analysis of Method 5X samples were performed by CH_2MHill, which has extensive experience with Oregon DEQ Method 7, from which Method 5X derives. CH_2MHill adhered to the standards of quality assurance set forth in the Quality Assurance Handbook for Air Pollution

Measurement Systems, Volume III (EPA-600/4-7-027b) and the Handbook for Analytical Quality Control in Water and Wastewater Laboratories (EPA-600/4-79-019, March 1979).

6.2 Method 25

Method 25 traps were burned out according to the method prior to testing and spot-checked for contamination. All Method 25 tanks were flushed with nitrogen and checked for contamination prior to field use.

Four sampling trains were used to provide a check on data precision. Two trains were analyzed by TRC and NCASI analyzed the remaining two trains. All tanks and traps have permanently engraved identification numbers.

Analyzers were calibrated over the specified ranges using certified calibration gases. Certification forms are provided in Appendix F.

EPA/EMB provided three audit samples for analysis by TRC and NCASI. These samples were analyzed using procedures described by the method. Results are presented in Section 2.

6.3 Method 3

All Method 3 analyses were performed in triplicate, with three passes being performed through each absorbing bubbler to ensure complete absorption. Each analyzer was leak-checked according to the method prior to any analysis. Samples were analyzed immediately upon completion of the sampling.

6.4 Method 9

The TRC observer had been certified within the past 6 months to perform visible emission evaluations. Documentation verifying the observer's certification is provided in Appendix E.

APPENDIX A

SUMMARY OF EPA METHOD 5X TEST DATA

INLET = DRYER EXHAUST

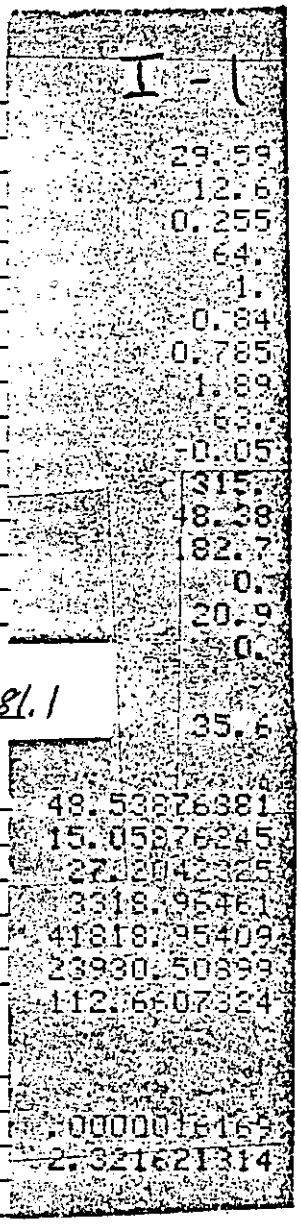
PARTICULATE TEST DATA

TEST 1 TIME 1648-1810

LOCATION Inlet DATE September 21, 1981

FIRM Champion PROJECT NO. 1460-E80

Input A			
P bar	Barometric Pressure - in. Hg	29.59	
As	Stack Area - Ft^2	12.6	
Dn	Nozzle Diameter - in.	0.255	
Time	Total Sampling Time - min.	64	
Y	Calibration Factor	1.00	
Cp	Pitot Coefficient	0.84	
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.785	
ΔH	Average Orifice Pressure Drop - in. H_2O	1.89	
Tm	Average Meter Temperature °F	63	
Pstk	Average Stack Pressure - in. H_2O	-.05	
Tstk	Average Stack Temperature °F	315	
Vm	Meter Volume at Meter Conditions - Ft^3	48.38	
Vl	Total Water Vapor Collected - ml	182.7	
→ CO_2	% CO_2 in Stack Gas (Dry)	0	
O_2	% O_2 in Stack Gas (Dry)	20.9	
→ CO	% CO in Stack Gas (Dry)	0	
Input B			
Mn	Total Particulate Catch - Mg	35.6/445.5/481.1	
Input C			
% H	% Hydrogen in Fuel		
% C	% Carbon in Fuel		
% S	% Sulfur in Fuel		
% N	% Nitrogen in Fuel		
% O	% Oxygen in Fuel		
GCV	Gross Califoric Volume of Fuel - BTU/lb		
Calculated			
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	48.54	
% H_2O	% H_2O Vapor in Stack Gas	15.1	
Mws	Molecular Weight of Stack Gas (Wet)	27.2	
Vs	Average Velocity of Stack Gas - FPM	3320	
Qs	Actual Stack Gas Flowrate - ACFM	4800	
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	23900	
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	117	
Cs	Particulate Concentration-lb/DSCF	0.16 x 10-5/2.02 x 10-5/2.19 x 10-5	
Er	Particulate Emission Rate-lb/hour	2.32 / 29.1 / 31.4	
F	F Factor - DSCF/MM BTU		
E	Particulate Emissions - lbs/MM BTU		



Test Voided.

PARTICULATE TEST DATA

TEST 2 TIME 1353 to 1523

LOCATION Inlet DATE September 22, 1981

FIRM Champion (EPA-Plymouth) PROJECT NO. 1460-E80

Input A		
P bar	Barometric Pressure - in. Hg	29.59
As	Stack Area - Ft^2	12.6
Dn	Nozzle Diameter - in.	0.255
Time	Total Sampling Time - min.	64
Y	Calibration Factor	1.0
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.791
ΔH	Average Orifice Pressure Drop - in. H_2O	1.48
Tm	Average Meter Temperature °F	68
Pstk	Average Stack Pressure - in. H_2O	-.27
Tstk	Average Stack Temperature °F	315
Vm	Meter Volume at Meter Conditions - Ft^3	44.88
Vl	Total Water Vapor Collected - ml	147.8
→ CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
→ CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	24.5/372.1/396.6
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	44.56
% H_2O	% H_2O Vapor in Stack Gas	13.5
Mws	Molecular Weight of Stack Gas (Wet)	27.4
Vs	Average Velocity of Stack Gas - FPM	3330
Qs	Actual Stack Gas Flowrate - ACFM	42000
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	24500
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	101
Cs	Particulate Concentration-lb/DSCF	0.12×10^{-5} / 1.84×10^{-5} / 1.96×10^{-5}
Er	Particulate Emission Rate-lb/hour	1.78 / 24.7 / 28.8
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

SX-2-I

29.59
12.6
0.255
64.
1.
0.84
0.791
1.48
68.
-0.27
315.
44.88
147.8
0.
20.9
0.
396.6
44.55566
13.51277217
27.37175606
3334.994451
42020.93006
24470.35713
101.1342652
.0000196235
28.81166396

PARTICULATE TEST DATA

TEST 3 TIME 1200 to 1416

LOCATION Inlet DATE September 23, 1981

FIRM Champion PROJECT NO. 1460-E80

Input A			
P bar	Barometric Pressure - in. Hg	29.54	29.54
As	Stack Area - Ft^2	12.6	12.6
Dn	Nozzle Diameter - in.	0.255	0.255
Time	Total Sampling Time - min.	64	64.
Y	Calibration Factor	1.0	1.
Cp	Pitot Coefficient	0.84	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.82	0.82
ΔH	Average Orifice Pressure Drop - in. H_2O	1.59	1.59
Tm	Average Meter Temperature °F	67	67.
Pstk	Average Stack Pressure - in. H_2O	0.23	0.23
Tstk	Average Stack Temperature °F	320	320.
Vm	Meter Volume at Meter Conditions - Ft^3	46.45	46.45
Vl	Total Water Vapor Collected - ml	129.4	129.4
CO_2	% CO_2 in Stack Gas (Dry)	0	0.
O_2	% O_2 in Stack Gas (Dry)	20.9	20.9
CO	% CO in Stack Gas (Dry)	0	0.
Input B			
Mn	Total Particulate Catch - Mg	21.7 / 491.0 / 513	21.7
Input C			
% H	% Hydrogen in Fuel		46.1366161
% C	% Carbon in Fuel		11.66873781
% S	% Sulfur in Fuel		27.57157557
% N	% Nitrogen in Fuel		3456.580595
% O	% Oxygen in Fuel		43552.91549
GCV	Gross Califoric Volume of Fuel - BTU/lb		25725.68851
			99.61264706
Calculated			
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	46.1	.0000010369
% H_2O	% H_2O Vapor in Stack Gas	11.7	1.600513005
Mws	Molecular Weight of Stack Gas (Wet)	27.6	
Vs	Average Velocity of Stack Gas - FPM	3460	
Qs	Actual Stack Gas Flowrate - ACFM	43600	
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	25700	
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	99.6	
Cs	Particulate Concentration-lb/DSCF	0.1×10^{-5} / 0.3×10^{-5} / 2.5×10^{-5}	
Er	Particulate Emission Rate-lb/hour	1.6 / 36.2 / 37.8	
F	F Factor - DSCF/MM BTU		
E	Particulate Emissions - lbs/MM BTU		

PARTICULATE TEST DATA

TEST 6 TIME 1212 to 1328

LOCATION Inlet DATE September 25, 1981

FIRM Champion (ELA Plywood) PROJECT NO.

Input A		
P bar	Barometric Pressure - in. Hg	29.56
As	Stack Area - Ft^2	12.6
Dn	Nozzle Diameter - in.	0.255
Time	Total Sampling Time - min.	64
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.74
ΔH	Average Orifice Pressure Drop - in. H_2O	1.33
Tm	Average Meter Temperature °F	72
Pstk	Average Stack Pressure - in. H_2O	−0.05
Tstk	Average Stack Temperature °F	322
Vm	Meter Volume at Meter Conditions - Ft^3	42.49
Vl	Total Water Vapor Collected - ml	111.8
→ CO_2	% CO_2 in Stack Gas (Dry)	0
O_2	% O_2 in Stack Gas (Dry)	20.9
→ CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	43.7/378.4/422.1
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	41.81
% H_2O	% H_2O Vapor in Stack Gas	11.2
Mws	Molecular Weight of Stack Gas (Wet)	27.6
Vs	Average Velocity of Stack Gas - FPM	3120
Qs	Actual Stack Gas Flowrate - ACFM	39300
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	23300
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	99.7
Cs	Particulate Concentration-lb/DSCF	2.3×10^{-5} / 2.00×10^{-5} / 2.23×10^{-5}
Er	Particulate Emission Rate-lb/hour	9.2 / 27.9 / 31.1
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

I-6

29.56
12.6
0.255
64.
1.
0.84
0.74
1.33
72.
-0.05
322.
42.49
111.8
0.
20.9
0.
0.
43.7
41.80793667
11.18624413
27.62285859
3120.423237
39317.33908
23290.50466
99.70487123
0.000023044
3.220178054

PARTICULATE TEST DATA

TEST 5X-1-O TIME 1644 to 1816

LOCATION Boiler 2 Outlet DATE September 21, 1981

FIRM Champion (EPA-Plywood) PROJECT NO. 1460-E80

Input A		
P bar	Barometric Pressure - in. Hg	29.59
As	Stack Area - Ft^2	28.3
Dn	Nozzle Diameter - in.	0.261
Time	Total Sampling Time - min.	72
Y	Calibration Factor	1.0
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.64
ΔH	Average Orifice Pressure Drop - in. H_2O	1.07
Tm	Average Meter Temperature °F	73
Pstk	Average Stack Pressure - in. H_2O	-.05
Tstk	Average Stack Temperature °F	422
Vm	Meter Volume at Meter Conditions - Ft^3	39.56
Vl	Total Water Vapor Collected - ml	174.4
CO_2	% CO_2 in Stack Gas (Dry)	6
O_2	% O_2 in Stack Gas (Dry)	14
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	237.0 / 24.9 / 261.9
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	38.9
% H_2O	% H_2O Vapor in Stack Gas	17.4
Mws	Molecular Weight of Stack Gas (Wet)	27.5
Vs	Average Velocity of Stack Gas - FPM	2870
Qs	Actual Stack Gas Flowrate - ACFM	81200
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	39700
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	104
Cs	Particulate Concentration-lb/DSCF	1.34×10^{-5} / 0.141×10^{-5} / 1.48×10^{-5}
Er	Particulate Emission Rate-lb/hour	32.0 / 3.36 / 35.4
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

5X-1-O

29.59
28.3
0.261
72.
1.
0.84
0.64
1.07
73.
-0.05
422.
39.56
174.4
6.
14.
0.

261.9

38.86618883
17.44724975
27.51007683
2870.573805
81237.23868
39699.03974
103.631741

.0000148556
35.38520765

Test Voided

PARTICULATE TEST DATA

TEST 2 TIME 1349 to 1529

LOCATION Boiler 2 Outlet DATE September 22, 1981

FIRM Champion (EPA-Plywood) PROJECT NO. 1460-E.80

Input A		
P bar	Barometric Pressure - in. Hg	29.63
As	Stack Area - Ft^2	28.3
Dn	Nozzle Diameter - in.	0.261
Time	Total Sampling Time - min.	36
Y	Calibration Factor	1.0
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.661
ΔH	Average Orifice Pressure Drop - in. H_2O	1.08
Tm	Average Meter Temperature °F	76
Pstk	Average Stack Pressure - in. H_2O	-.06
Tstk	Average Stack Temperature °F	431
Vm	Meter Volume at Meter Conditions - Ft^3	20.42
Vl	Total Water Vapor Collected - ml	78
CO_2	% CO_2 in Stack Gas (Dry)	5.1
O_2	% O_2 in Stack Gas (Dry)	14.8
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	114.1 / 18.0 / 132.1
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	19.98
% H_2O	% H_2O Vapor in Stack Gas	15.5
Mws	Molecular Weight of Stack Gas (Wet)	27.6
Vs	Average Velocity of Stack Gas - FPM	2970
Qs	Actual Stack Gas Flowrate - ACFM	84100
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	41700
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	101
Cs	Particulate Concentration-lb/DSCF	$1.26 \times 10^{-5} / 0.20 \times 10^{-5} / 1.46 \times 10^{-5}$
Er	Particulate Emission Rate-lb/hour	31.5 / 5.0 / 36.5
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

5 x 0 = 0
29.63
28.3
0.261
36.
1.
0.84
0.661
1.08
76.
0.05
431.
20.42
78.
5.1
14.8
0.
132.1
19.9769243
15.5335299
27.6359496
2971.05166
84080.7620
41672.7277
101.486024
.000014578
36.450479

PARTICULATE TEST DATA

TEST 3 TIME 1156 to 1232

LOCATION Boiler #2 Outlet DATE September

FIRM Champion (EPA - Plywood) PROJECT NO.

0-3

Input A			
P bar	Barometric Pressure - in. Hg	29.66	29.66
As	Stack Area - Ft^2	28.3	28.3
Dn	Nozzle Diameter - in.	0.261	0.261
Time	Total Sampling Time - min.	72	72.
Y	Calibration Factor	1.0	1.
Cp	Pitot Coefficient	0.84	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.63	0.63
ΔH	Average Orifice Pressure Drop - in. H_2O	0.99	0.99
Tm	Average Meter Temperature °F	78	78.
Pstk	Average Stack Pressure - in. H_2O	-.05	-0.05
Tstk	Average Stack Temperature °F	421	421.
Vm	Meter Volume at Meter Conditions - Ft^3	37.5 V_{mc} = 37.46	37.5
Vl	Total Water Vapor Collected - ml	184.9	184.9
CO_2	% CO_2 in Stack Gas (Dry)	5.5	5.5
O_2	% O_2 in Stack Gas (Dry)	14.7	14.7
CO	% CO in Stack Gas (Dry)	0	0.
Input B			
Mn	Total Particulate Catch - Mg	218.4 / 35.6 / 254.5	218.4
Input C			
% H	% Hydrogen in Fuel		36.5787376
% C	% Carbon in Fuel		19.22997109
% S	% Sulfur in Fuel		27.25270692
% N	% Nitrogen in Fuel		2833.552178
% O	% Oxygen in Fuel		80189.52665
GCV	Gross Califoric Volume of Fuel - BTU/lb		38475.13713
			100.63489
Calculated			
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	36.6	
% H_2O	% H_2O Vapor in Stack Gas	19.2	.0000131629
Mws	Molecular Weight of Stack Gas (Wet)	27.3	30.38656366
Vs	Average Velocity of Stack Gas - FPM	2830	
Qs	Actual Stack Gas Flowrate - ACFM	80200	
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	38500	
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	101	
Cs	Particulate Concentration-lb/DSCF	1.31×10^{-5} / 0.21×10^{-5} / 1.53×10^{-5}	
Er	Particulate Emission Rate-lb/hour	30.4 / 5.0 / 35.4	
F	F Factor - DSCF/MM BTU		
E	Particulate Emissions - lbs/MM BTU		

PARTICULATE TEST DATA

TEST 5X-4-0 TIME 1313 to 1441

LOCATION Boiler 2 outlet DATE Sept. 24, 1981

FIRM Champion PROJECT NO. 1460-E80

Input A		
P bar	Barometric Pressure - in. Hg	29.60
As	Stack Area - Ft^2	28.3
Dn	Nozzle Diameter - in.	0.261
Time	Total Sampling Time - min.	72
Y	Calibration Factor	1.00
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.50
ΔH	Average Orifice Pressure Drop - in. H_2O	0.65
Tm	Average Meter Temperature °F	76
Pstk	Average Stack Pressure - in. H_2O	-.05
Tstk	Average Stack Temperature °F	317
Vm	Meter Volume at Meter Conditions - Ft^3	31.22
Vl	Total Water Vapor Collected - ml	116
CO_2	% CO_2 in Stack Gas (Dry)	5.7
O_2	% O_2 in Stack Gas (Dry)	15.1
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	208.4 / 43.2 / 251.6
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	30.5
% H_2O	% H_2O Vapor in Stack Gas	15.2
Mws	Molecular Weight of Stack Gas (Wet)	27.8
Vs	Average Velocity of Stack Gas - FPM	2090
Qs	Actual Stack Gas Flowrate - ACFM	59300
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	33800
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	95.5
Cs	Particulate Concentration-lb/DSCF	1.51×10^{-5} / $.31 \times 10^{-5}$ / 1.82×10^{-5}
Er	Particulate Emission Rate-lb/hour	30.6 / 6.3 / 36.9
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

0-4

29.6
28.3
0.261
72
1.
0.84
0.5
0.65
76.
-0.05
317.
31.22
116.
5.7
15.1
0.
208.4
30.472931518
15.200270377
27.765477928
2094.859482
59284.52334
33792.54278
95.47348965
.0000150737
30.56269072

PARTICULATE TEST DATA

TEST 5X-5-O TIME 1442 to 1810

LOCATION Boiler 2 Outlet DATE September 24, 1981

FIRM Champion PROJECT NO. 1460-E80

Input A		
P bar	Barometric Pressure - in. Hg	29.6
As	Stack Area - Ft^2	28.3
Dn	Nozzle Diameter - in.	0.261
Time	Total Sampling Time - min.	72.
Y	Calibration Factor	1.0
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.52
ΔH	Average Orifice Pressure Drop - in. H_2O	0.75
Tm	Average Meter Temperature °F	72.
Pstk	Average Stack Pressure - in. H_2O	-.05
Tstk	Average Stack Temperature °F	338
Vm	Meter Volume at Meter Conditions - Ft^3	33.15
Vl	Total Water Vapor Collected - ml	185.9
CO_2	% CO_2 in Stack Gas (Dry)	9.5
O_2	% O_2 in Stack Gas (Dry)	11.2
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	297.6 / 20.6 / 318.2
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	32.6
% H_2O	% H_2O Vapor in Stack Gas	21.2
Mws	Molecular Weight of Stack Gas (Wet)	27.4
Vs	Average Velocity of Stack Gas - FPM	2220
Qs	Actual Stack Gas Flowrate - ACFM	62900
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	32400
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	106
Cs	Particulate Concentration-lb/DSCF	2.01 X 10-5 / 0.14 x 10-5 / 2.15 x 10-5
Er	Particulate Emission Rate-lb/hour	39.1 / 2.7 / 41.9
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

O.S

29.6
28.3
0.261
72.
1.
0.84
0.52
0.75
72.
-0.05
338.
33.15
185.9
9.5
11.2
0
297.6
32.61944813
21.16440081
27.43504451
2221.155302
62858.69504
32433.47586
106.4441162
.0000201161
39.14604488

PARTICULATE TEST DATA

TEST 5X-6-0 TIME 1207 to 1332

LOCATION Boiler #2 Outlet DATE September 25, 1981

FIRM Champion PROJECT NO. 1460-E80

Input A		
P bar	Barometric Pressure - in. Hg	29.66
As	Stack Area - Ft^2	28.3
Dn	Nozzle Diameter - in.	0.261
Time	Total Sampling Time - min.	72
Y	Calibration Factor	1.0
Cp	Pitot Coefficient	0.84
$(\Delta P)^{1/2}$	Average Square Root of Velocity Head (in. H_2O)	0.65
ΔH	Average Orifice Pressure Drop - in. H_2O	0.99
Tm	Average Meter Temperature °F	76
Pstk	Average Stack Pressure - in. H_2O	-.05
Tstk	Average Stack Temperature °F	424
Vm	Meter Volume at Meter Conditions - Ft^3	38.86
Vl	Total Water Vapor Collected - ml	181.4
CO_2	% CO_2 in Stack Gas (Dry)	5.7
O_2	% O_2 in Stack Gas (Dry)	14.1
CO	% CO in Stack Gas (Dry)	0
Input B		
Mn	Total Particulate Catch - Mg	189.6 / 12.5 / 202.1
Input C		
% H	% Hydrogen in Fuel	
% C	% Carbon in Fuel	
% S	% Sulfur in Fuel	
% N	% Nitrogen in Fuel	
% O	% Oxygen in Fuel	
GCV	Gross Califoric Volume of Fuel - BTU/lb	
Calculated		
Vm (std)	Meter Volume at Standard Conditions (Dry)-Ft^3	38.01
% H_2O	% H_2O Vapor in Stack Gas	18.3
Mws	Molecular Weight of Stack Gas (Wet)	27.4
Vs	Average Velocity of Stack Gas - FPM	2920
Qs	Actual Stack Gas Flowrate - ACFM	82700
Qs (std)	Stack Gas Flowrate (0.0% H_2O; STP) - DSCFM	40000
% I	% Isokinetic (Avg. Nozzle Vel/Avg. Stk Vel)	101
Cs	Particulate Concentration-lb/DSCF	1.10×10^{-5} / $.07 \times 10^{-5}$ / 1.17×10^{-5}
Er	Particulate Emission Rate-lb/hour	26.4 / 1.7 / 28.1
F	F Factor - DSCF/MM BTU	
E	Particulate Emissions - lbs/MM BTU	

O-6

29.66
28.
0.26
72.
1.
0.84
0.65
0.99
76.
-0.05
424.
38.86
181.4
5.7
14.1
0.
189.6

38.04682667
18.3302687
27.37150028
2922.653807
82711.10473
39986.95519
100.7160229

.0000109862
26.35824155