

## **I. INTRODUCTION**

Network Environmental, Inc. was retained by TransAlta Corporation to conduct compliance emission testing at Ada Cogeneration LLC, in Ada, Michigan on their existing gas turbine. The purpose of the study was to determine compliance with ROP# MI-ROP-N1784-2020b for Oxides of Nitrogen (NO<sub>x</sub>) and Carbon Monoxide (CO) emission rates under four operating conditions. In addition PM and THC emissions were determined at the High load with the duct burner. The system was tested at 29.4 MW with the turbine and duct burner operating, at 26.4 MW with turbine only, at 16.2 MW with the turbine and duct burner operating, and at 16.2 MW with the turbine only.

The following reference test methods were employed to conduct the sampling:

- Oxides of Nitrogen (NO<sub>x</sub>) - U.S. EPA Method 7E
- Carbon Monoxide (CO) - U.S. EPA Method 10
- Total Hydrocarbons (THC) – U.S. EPA Method 25A
- PM – U.S. EPA Method 5
- Oxygen (O<sub>2</sub>) - U.S. EPA Method 3A
- Carbon Dioxide (CO<sub>2</sub>) – U.S. EPA Method 3A
- Exhaust Gas Parameters – U.S. EPA Methods 1-4

The sampling was conducted from November 2 through 4, 2021 by Stephan K. Byrd, Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc. Mr. Buck Surratt of Ada Cogeneration power facility recorded source operating data and coordinated the source operations during the testing. Ms. Lindsey Wells and Ms. Kaitlyn DeVries of the EGLE, Air Quality Division, were present to observe the testing.

## II. PRESENTATION OF RESULTS

**II.1 TABLE 1  
EMISSION RESULTS  
GAS FIRED TURBINE EXHAUST  
ADA COGENERATION LLC  
ADA, MICHIGAN**

Condition	Sample	Time	NO <sub>x</sub>			CO	
			PPMV <sup>(1)</sup>	#/Hr.	#/MMBTU	#/MMBTU	#/Hr.
29.4 MWs Turbine/Duct Burner November 3, 2021	1	12:05-13:05	40.1	44.90	0.148	0.012	3.63
	2	14:00-15:00	40.4	44.46	0.149	0.012	3.44
	3	15:47-16:47	40.4	45.72	0.149	0.011	3.44
	<b>Average</b>		<b>40.3</b>	<b>45.03</b>	<b>0.149</b>	<b>0.012</b>	<b>3.50</b>
26.4 MWs Turbine only November 4, 2021	1	08:35-09:35	40.3	37.19	0.148	0.025	6.25
	2	09:50-10:50	40.4	37.08	0.149	0.023	5.64
	3	11:07-12:07	41.0	37.79	0.151	0.022	5.50
	<b>Average</b>		<b>40.6</b>	<b>37.35</b>	<b>0.149</b>	<b>0.023</b>	<b>5.80</b>
16.2 MWs Turbine only November 2, 2021	1	09:12-10:12	41.1	28.82	0.152	0.053	10.15
	2	10:32-11:32	41.6	28.75	0.153	0.049	9.11
	3	11:48-12:48	41.1	27.90	0.151	0.050	9.23
	<b>Average</b>		<b>41.3</b>	<b>28.49</b>	<b>0.152</b>	<b>0.051</b>	<b>9.50</b>
16.2 MWs Turbine/Duct Burner November 2, 2021	1	13:20-14:20	39.2	25.08	0.144	0.058	10.11
	2	14:38-15:38	38.7	25.47	0.143	0.060	10.71
	3	16:00-17:00	39.7	25.54	0.146	0.062	10.84
	<b>Average</b>		<b>39.2</b>	<b>25.36</b>	<b>0.144</b>	<b>0.060</b>	<b>10.55</b>
(1) = NO <sub>x</sub> PPM results are corrected to 15% O <sub>2</sub> .							

**II.2 TABLE 2  
PARTICULATE EMISSION RESULTS SUMMARY  
GAS FIRED TURBINE EXHAUST  
ADA COGENERATION LLC  
ADA, MICHIGAN  
NOVEMBER 3, 2021**

Sample	Time	Air Flow Rate	Particulate Emission Rates	
		DSCFM <sup>(1)</sup>	Lbs/Hr <sup>(2)</sup>	Lbs/MMBTU <sup>(3)</sup>
<b>1</b>	12:05-13:12	121,328	0.560	0.0018
<b>2</b>	14:00-15:07	119,433	0.794	0.0027
<b>3</b>	15:47-16:54	122,808	0.560	0.0018
Average		<b>121,190</b>	<b>0.638</b>	<b>0.0021</b>

- (1) DSCFM = Dry Standard Cubic Feet Per Minute (STP = 70 °F & 29.92 in. Hg)  
(2) Lbs/Hr = Pounds Of Particulate Per Hour  
(3) Lbs/MMBTU = Pounds Of Particulate Per Million BTU of Heat Input. Calculated Using The Formula Found In Section 2.1 Of Method 19 For O<sub>2</sub> On A Dry Basis With An F Factor Of 8,710.

**II.3 TABLE 3  
TOTAL HYDROCARBON EMISSION RESULTS SUMMARY  
GAS FIRED TURBINE EXHAUST  
ADA COGENERATION LLC  
ADA, MICHIGAN  
NOVEMBER 3, 2021**

Sample	Time	Air Flow Rate	THC Concentration	THC Emission Rate
		SCFM <sup>(1)</sup>	PPM <sup>(2)</sup>	Lbs/Hr <sup>(3)</sup>
<b>1</b>	12:05-13:05	134,555	0.2	0.18
<b>2</b>	14:00-15:00	132,414	0.1	0.09
<b>3</b>	15:47-16:47	136,656	0.2	0.19
Average		<b>134,542</b>	<b>0.2</b>	<b>0.15</b>

- (1) SCFM = Standard Cubic Feet Per Minute (STP = 70 °F & 29.92 in. Hg)  
(2) PPM = Parts Per Million (v/v) On An Actual (Wet) Basis As Propane  
(3) Lbs/Hr = Pounds Of NMOC Per Hour As Propane

### **III. DISCUSSION OF RESULTS**

The results of the testing are summarized in Table 1-3, Section II.

The NO<sub>x</sub> emissions were calculated as parts per million by volume (PPMV) on a dry basis corrected to 15% O<sub>2</sub>, pounds per hour (#/Hr.) and #/MMBTU.

The CO emissions were calculated in terms of #/MMBTu using Equation 2.1, from U.S. EPA Method 19, with an F Factor of 8,710 DSCF/MMBTu for Natural Gas and pounds per hour (#/Hr.).

PM emissions were calculated in terms of #/MMBTu using Equation 2.1, from U.S. EPA Method 19, with an F Factor of 8,710 DSCF/MMBTu for Natural Gas and pounds per hour (#/Hr.).

THC emissions were calculated in terms of PPM by volume on an actual basis and pounds per hour (#/Hr.). All results were calibration corrected in accordance with Equation 7E-5.

The turbine was operated at two loads during the testing. The loads were High (29.4 MW and 26.4 MW) and Low, 16.2 MW. Testing was performed at each load with the Turbine and Duct Burner operating and with only the Turbine operating.

### **IV. SAMPLING AND ANALYTICAL PROTOCOL**

The sampling for the turbine was performed on the 90-inch I.D. exhaust stack. A diagram of the sampling location can be found in Appendix E. The sampling ports were located approximately four duct diameters downstream from the top of the breaching and greater than two duct diameters from the exit. A stratification test was conducted using three (3) sampling points prior to the testing.

**IV.1 Oxides of Nitrogen** - The NO<sub>x</sub> sampling was conducted in accordance with U.S. EPA Reference Method 7E. A Thermo Environmental Model 42H gas analyzer was used to monitor the exhaust. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the NO<sub>x</sub> concentrations (PPM). The analyzer was operated on the 0-200 ppm scale.

The analyzer was calibrated by direct injection prior to the testing. A span gas of 101.0 PPM was used to establish the initial instrument calibration. Calibration gases of 25.2 PPM and 54.6 PPM were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 54.6 PPM gas to determine the system bias. After each sample, a system zero and system injection of 54.6 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the exhaust. A diagram of the sampling train is shown in Figure 1. Three (3) samples, each sixty (60) minutes in duration, were collected at each of the four conditions.

**IV.2 Carbon Monoxide** - The CO sampling was conducted in accordance with U.S. EPA Reference Method 10. A Thermo Environmental Model 48C gas analyzer was used to monitor the exhaust. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the CO concentrations (PPM). The analyzer was operated on the 0-200 PPM scale.

The analyzer was calibrated by direct injection prior to the testing. A span gas of 92.9 PPM was used to establish the initial instrument calibration. A calibration gas of 51.1 PPM was used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 51.1 PPM gas to determine the system bias. After each sample, a system zero and system injection of 51.1 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the exhaust. A diagram of the sampling train is shown in Figure 1. Three (3) samples, each sixty (60) minutes in duration, were collected at each of the four load conditions.

**IV.3 Oxygen & Carbon Dioxide** - The O<sub>2</sub> & CO<sub>2</sub> sampling was conducted in accordance with U.S. EPA Reference Method 3A. Servomex Series 1400M gas analyzers were used to monitor the exhaust.

A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzers. The analyzers produce instantaneous readouts of the O<sub>2</sub> & CO<sub>2</sub> concentrations (%).

The analyzers were calibrated by direct injection prior to the testing. Span gases of 21.0% O<sub>2</sub> and 21.1% CO<sub>2</sub> were used to establish the initial instrument calibrations. Calibration gases of 12.06% & 5.97% O<sub>2</sub> and 12.1% & 6.01% CO<sub>2</sub> were used to determine the calibration error of the analyzers. The sampling system (from the back of the stack probe to the analyzer) was injected using the 12.06% O<sub>2</sub> & 6.01% CO<sub>2</sub> gas to determine the system bias. After each sample, a system zero and system injection of 12.06% O<sub>2</sub> & 6.01% CO<sub>2</sub> were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzers were calibrated to the output of the data acquisition system (DAS) used to collect the data from the exhaust. A diagram of the sampling train is shown in Figure 1. The O<sub>2</sub> & CO<sub>2</sub> concentrations were monitored during each of the four operating conditions.

**IV.4 Particulate** – The particulate sampling was conducted in accordance with U.S. EPA Method 5. Method 5 is an out-stack filtration method using a heated filter and probe. The samples were collected isokinetically on filters. Three (3) samples were collected from the gas fired turbine exhaust. Each sample was sixty (60) minutes in duration and had a minimum sample volume of thirty (30) dry standard cubic feet. The nozzle/probe rinses and filters were analyzed gravimetrically for particulate in accordance with Method 5. All the quality assurance and quality control procedures listed in the method were incorporated in the sampling and analysis. The particulate sampling train is shown in Figure 2.

**IV.5 Total Hydrocarbon (THC)** – The THC sampling was conducted in accordance with U.S. EPA Method 25A. A J.U.M. Model 3-500 flame ionization detector (FID) analyzer was used to monitor the gas turbine exhaust. Sample gas was extracted through a heated probe. A heated Teflon sample line was used to transport the exhaust gases to the analyzer. The analyzer produces instantaneous readouts of the total VOC concentrations (PPM),

The analyzer was calibrated by system injection (from the back of the stack probe to the analyzer) prior to the testing using propane calibration gases and a methane calibration gas. A span gas of 94.90 PPM propane was used to establish the initial instrument calibration. Calibration gases of

30.2 PPM and 50.6 PPM propane were used to determine the calibration error of the analyzer. After each sample, a system zero and system injections of 30.2 PPM propane was performed to establish system drift and system bias during the test period. All calibration gases used were EPA Protocol Calibration Gases. Three (3) samples were collected from the gas fired turbine exhaust. Each sample was sixty (60) minutes in duration.

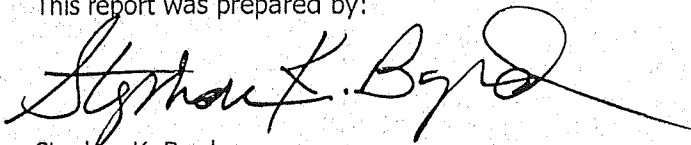
The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the exhaust. The analyzer averages were corrected for calibration error and drift using formula EQ.7E-5 from 40 CFR Part 60, Appendix A, Method 7E. Figure 2 is a diagram of the THC sampling train.

**IV.6 Exhaust Gas Parameters** - The exhaust gas parameters (airflow rate, temperature, moisture, and density) were determined in conjunction with the other sampling by employing U.S. EPA Reference Methods 1 through 4. All the sampling was conducted on the exhaust stack. There were two sampling ports on the exhaust. Test port location was approximately four duct diameters downstream from the nearest disturbance and greater than two diameters from the exit. A twenty-four point traverse was used to perform the sampling.

A moisture train was operated during each operating load. All the quality assurance and quality control procedures listed in the methods were incorporated in the sampling and analysis.

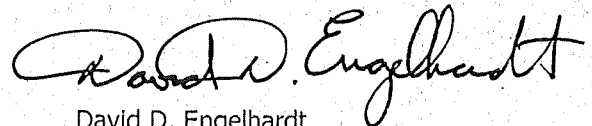
---

This report was prepared by:

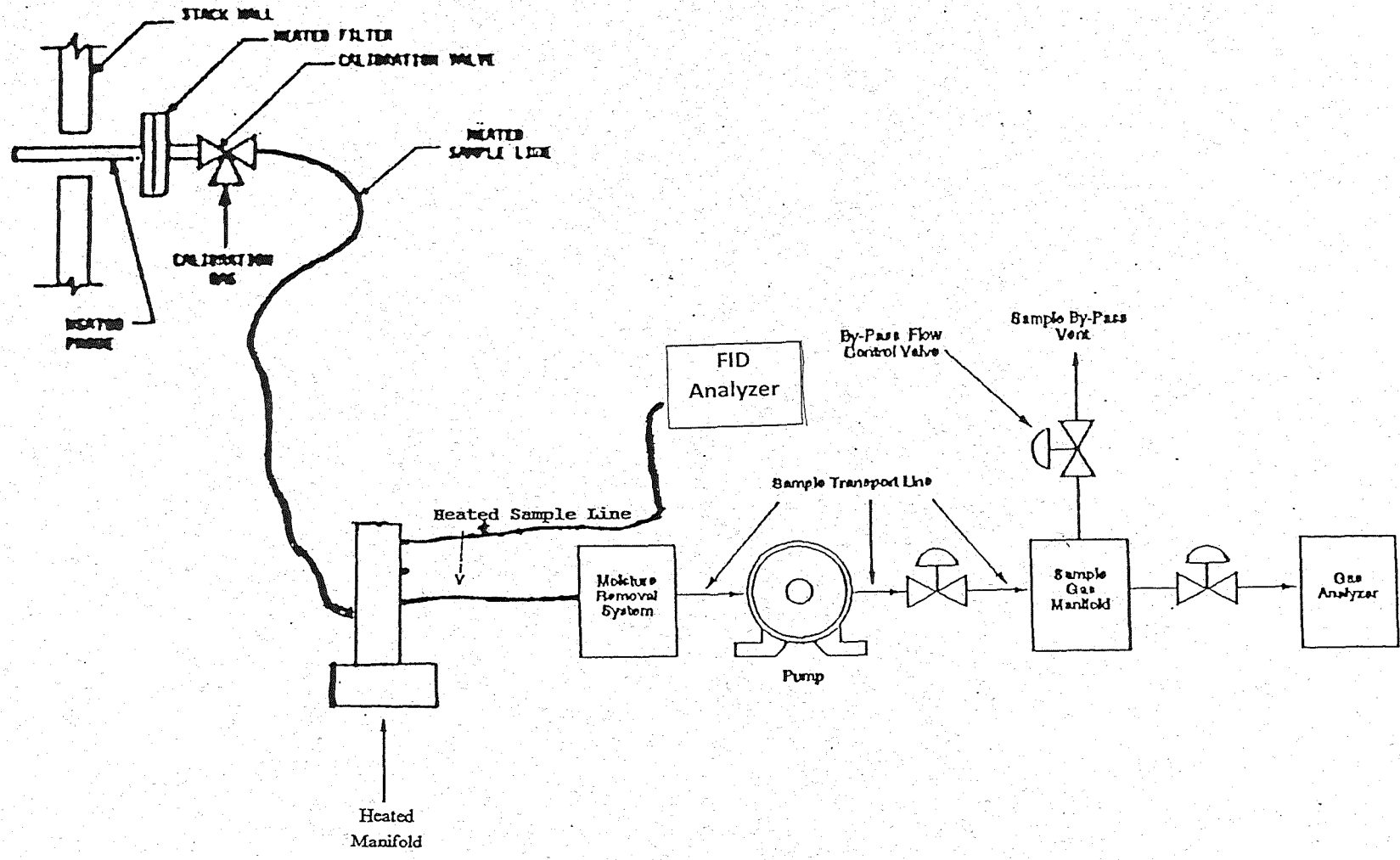


Stephan K. Byrd  
Project Manager

This report was reviewed by:



David D. Engelhardt  
Vice President



**Figure 1**  
**NO<sub>x</sub>, CO, THC, O<sub>2</sub> & CO<sub>2</sub> Sampling Train**



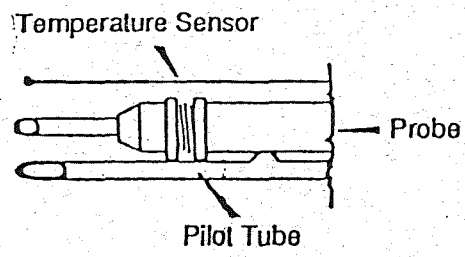
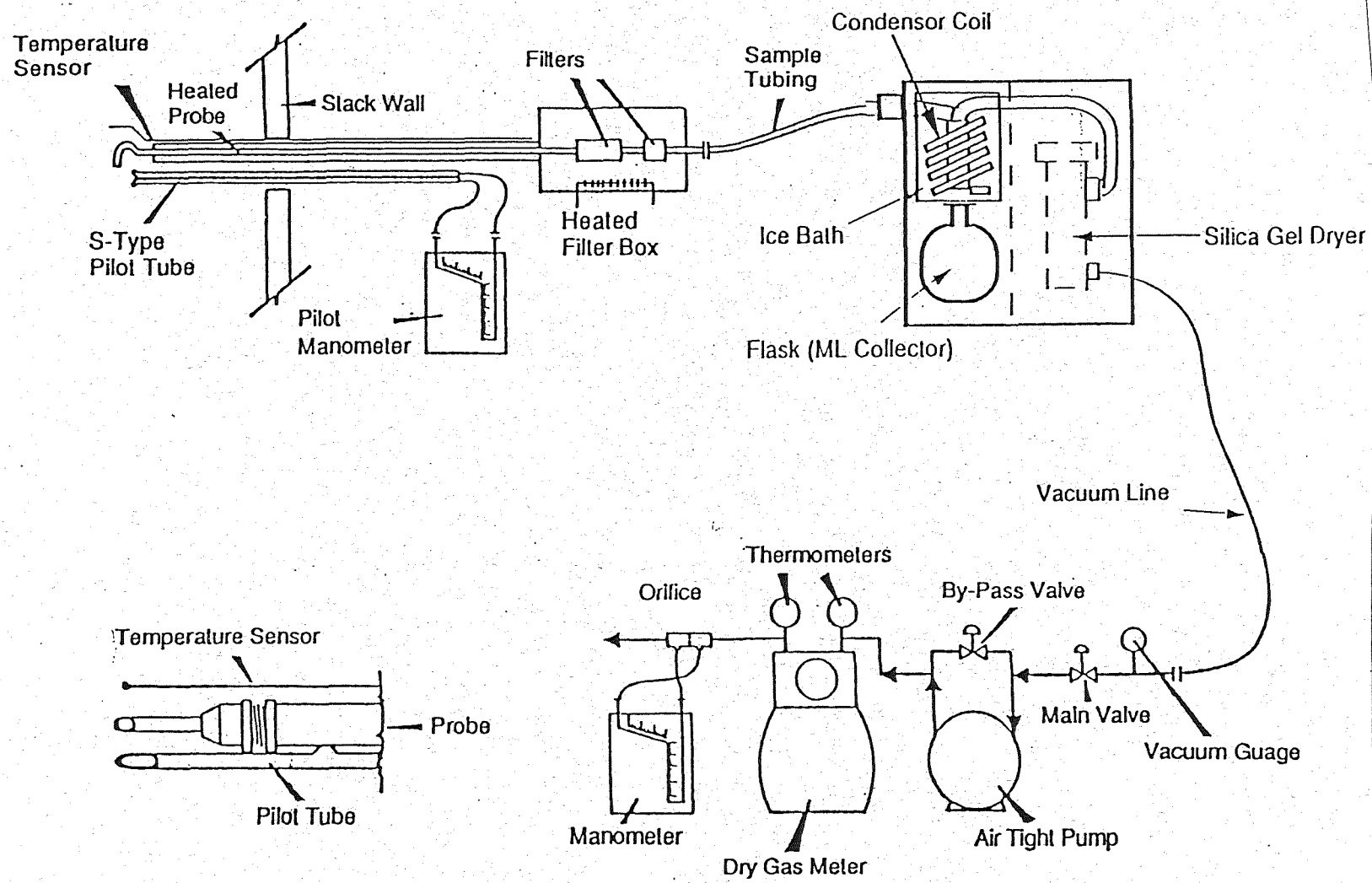


Figure 2  
PM Sampling Train