

H & H MONITORING, INC.

**DETERMINATION OF VOC
CAPTURE AND DESTRUCTION EFFICIENCY
COATING LINE NOS. 18 AND 19**

PREPARED FOR:

**CURTIS METAL FINISHING COMPANY
STERLING HEIGHTS PLANT
STERLING HEIGHTS, MICHIGAN**

SUBMITTED:

**DECEMBER 11, 2018
HHMI PROJECT NO. 1804-002**

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Title

VOC CAPTURE AND DESTRUCTION EFFICIENCY

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1.0 INTRODUCTION

HHMI conducted a volatile organic compound (VOC) capture and destruction efficiency study on Coating Line Nos. 18 and 19 at the Curtis Metal Finishing Company (Curtis) facility located in Sterling Heights, Michigan. This study was performed in accordance with the MDEQ-approved test plan dated September 6, 2018. Curtis operates two coating lines identified individually as Lines EUDIPSPIN18 and EUDIPSPIN19 which are regulated in the permit together as FGDIPSPINS2. The coating lines are equipped with a regenerative thermal oxidizer (RTO) for VOC emissions control (SV-FGDIPSPINS2RTO). The coating lines and oxidizer are installed in accordance with Permit Application No. 383-00H. The purpose of this testing is to provide capture and destruction efficiency data to demonstrate compliance with conditions of Permit Application No. 383-00H. The abatement system for the coating lines include fume hoods, natural gas-fired curing ovens, ductwork, and fans, which direct the VOC emissions from the coating lines to the RTO.

Messrs. Brad Wallace, Todd Manning and Daniel Hassett on October 18, 2018 performed field services for this project. Messrs. Mark Dziadosz and Adam Bognar with MDEQ Air Quality Division observed the testing and process operations. Additionally, Curtis representatives collected coating samples for analysis.

This report presents the results obtained as well as describes the techniques used in the performance of this testing study. A description of the dip/spin coating processes and the abatement system are presented in Section 2.0. A discussion of sampling and analytical procedures used during the test program is provided in Section 3.0. A discussion of the project results is presented in Section 4.0. A summary of the quality assurance procedures used in the performance of this study is presented in Section 5.0. The Results Table provides detailed summaries of the emissions data. Figures 1 through 4 present information regarding duct dimensions, traverse point locations, and sampling trains. Appendix A presents example calculations for Test Run 1. Appendix B includes quality assurance information. Appendix C presents calculation data spreadsheets and copies of original field data sheets. Appendix D contains copies of analyzer raw concentration charts of data collected in the field. Appendix E contains the laboratory analytical data. Appendix F contains the process and oxidizer operating conditions during the testing. Appendix G contains a copy of the Test Protocol and approval letter from MDEQ-Air Quality Division.

2.0 PROCESS DESCRIPTION

The abatement system controls VOC emissions from Lines EUDIPSPIN18 and EUDIPSPIN19. VOC emitted from the coating lines is controlled by an Anguil Environmental Systems, Inc. RTO. Lines EUDIPSPIN18 and EUDIPSPIN19 each have a part coating area that utilizes a dip/spin system to coat small metal parts. The VOC emissions from these dip/spin lines are controlled separately from the other dip/spin lines at the facility. A known weight of parts is loaded into baskets. The baskets are dipped into the coating vat such that the parts in the baskets are fully submerged in the coating material. The parts are then removed from the coating such that the parts are no longer submerged but remain in the vat. The baskets are then spun to remove excess coating material from the parts. The excess coating material that is spun off the parts remains in the vat for use in subsequent coating cycles. The parts are then placed onto a conveyor line that passes them through a flash-off area and subsequently into a curing oven.

Emissions from Lines EUDIPSPIN18 and EUDIPSPIN19 are captured independently and directed to an exhaust header that leads to the RTO. The RTO operates at a temperature of 1500 °F with a retention time of 0.5 seconds. Material usage data from each dip/spin coating line was recorded along with RTO chamber temperature and fan speed (Hz) which are included in Appendix F.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

Total VOC was measured in the ductwork leading to the exhaust header and the RTO exhaust stack to determine capture and destruction efficiency. Coating material usage and VOC input was measured concurrently with RTO ductwork exhaust gas VOC to determine capture efficiency.

Capture efficiency (CE) was determined using a standard protocol that included using the liquid/gas VOC measurement techniques. Procedures employed for this study were conducted in accordance with the following applicable USEPA reference methodologies:

- Methods 1 and 2 to determine exhaust gas volumetric flow rates.
- Method 3 to determine exhaust gas molecular weights.
- Method 4 to determine exhaust gas moisture content.
- Method 24 to determine volatile materials content in the coating materials, as required by Method 204F.
- Method 25A to determine VOC emissions captured by the abatement system.
- Method 204F to determine VOC analyzer response factors and VOC in the coating materials.

Descriptions of the procedures and methodologies performed to complete this testing project are presented individually in the following sub-sections.

3.1 DESTRUCTION EFFICIENCY

Destruction efficiency (DE) is expressed as the ratio of the difference between the measured inlet and outlet mass VOC emission rates divided by the mass VOC emission rate measured at the inlet.

The RTO DE determination of VOC emissions was conducted in accordance with USEPA Reference Methods. Because the VOC emitted from the RTO was expected to be less than 50 ppm, Method 25A was used. Concurrently with the CE testing, three test runs of approximately 60 minutes were performed, in accordance with compliance testing requirements. A 60-minute block of data was extracted from the CE data during a time which the ovens were completely full. Corresponding exhaust gas volumetric flow rate and

moisture content determinations were made for each test run at the RTO inlet and outlet sampling locations.

HHMI utilized total hydrocarbon analyzers at the RTO inlet and outlet to obtain VOC measurements. Based on these measurements for each test run, the DE was calculated.

3.2 CAPTURE EFFICIENCY

Capture efficiency (CE) is expressed as the captured mass VOC in the captured air stream, determined during the test, divided by the mass VOC measured to be utilized by the coating lines, during the test.

The CE of VOC emissions by the abatement system was conducted in accordance with USEPA Reference Methods. For the purpose of this study, HHMI performed four test runs of approximately 130 minutes each. Sampling for VOC was performed in the main combined exhaust ductwork (captured gas stream) upstream of the RTO. Corresponding exhaust gas volumetric flow rate and moisture content determinations were made at the sampling location.

Coating material usage rates were determined using the weight difference procedure detailed in Method 204F. Vat and coating weights were determined before and after each test run using a calibrated scale. Coating material composition and quantity in the vat were adjusted prior to the sample collection and pre-test weight measurement and immediately following post-test weight measurement and sample collection.

Coating material samples collected during the testing were analyzed to determine VOC content as propane. Data resulting from these analyses were utilized to calculate total VOC input as propane for each test run.

3.2 SAMPLING LOCATIONS

Test ports are installed on the 36-inch diameter combined main exhaust ductwork upstream of the RTO. The ports are located approximately 900 inches (25.0 duct

diameters) downstream from a duct pantleg and approximately 120 inches (3.33 duct diameters) upstream from 45° elbow.

Test ports are installed on the 30-inch diameter exhaust stack from the RTO. The ports are located approximately 258 inches (8.60 duct diameters) downstream from a 90° duct breach and approximately 312 inches (10.40 duct diameters) upstream from the stack exit to atmosphere.

3.3 USEPA TEST METHODS AND PROCEDURES

Testing procedures employed during the performance of this study were conducted in accordance with USEPA Methods 1, 2, 3, 4, 25A, and 204F. A summary of the test procedures is presented below.

Method 1, "*Sample and Velocity Traverses for Stationary Sources*," was used to determine the number of traverse points for flow rate measurement at each sampling location. The number of upstream and downstream stack/duct diameters from the sampling ports to the nearest flow disturbance was determined. Based on these determinations, the appropriate number of traverse points was chosen for the purpose of determining the volumetric flow rate of the flue gas. The sample port locations and the upstream and downstream stack diameters are depicted in Figures 1 and 2.

Method 2, "*Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)*," was used to measure velocity pressures and temperatures at each traverse point. A calibrated Type-S pitot tube equipped with a thermocouple was positioned at each of the traverse points and the exhaust gas temperature and velocity pressure were measured and recorded. The Type-S Pitot tube was calibrated in accordance with the specifications outlined in Method 2. Measurement readings were made on a manometer capable of measuring to the nearest 0.01 inch of water. Temperature readings were made on a calibrated pyrometer.

The average stack gas velocity is a function of average velocity pressure, absolute stack pressure, average stack temperature, molecular weight of the wet stack gas, and Pitot tube coefficient. Determination of average stack gas velocity was performed in accordance with equations presented in Method 2. Actual exhaust gas flow rate was determined from the

average stack gas velocity and stack dimensions. Exhaust gas flow rate data from the stack are presented in Appendix C.

Method 3, (*Gas Analysis for the Determination of Dry Molecular Weight*), was used to determine the molecular weight of the flue gas. Grab samples of the exhaust gas were collected in and analyzed for oxygen (O₂) and carbon dioxide (CO₂) concentrations using a Fyrite Combustion gas analyzer.

The dry molecular weight of the stack gas was calculated based on the assumption that the primary constituents are oxygen, carbon dioxide, and nitrogen (other compounds present have a negligible relative effect on molecular weight). Having measured the oxygen and carbon dioxide concentrations, the percent stack gas was then equal to the sum of each constituent compound's molecular weight (lb/lb-mole) multiplied by its respective concentration.

Method 4, "*Determination of Moisture Content in Stack Gases*," was used to measure the moisture in the exhaust gases at the sampling location. A gas sample was extracted from the stack/duct and moisture present in the gas sample was condensed in a series of impingers. The impingers each contained a known weight of water or silica gel prior to the start of each test run. At the conclusion of each test run, the post-test weights of the impingers were recorded.

The percent of moisture in the exhaust gas was determined based on the volume of gas sampled and water condensed. The percent moisture by volume of the exhaust gas, at standard temperature and pressure (68 degrees Fahrenheit and 29.92 inches of mercury), was determined in accordance with equations presented in Method 4. Moisture data from the source is shown in the Results Tables. A sketch depicting the Method 4 sampling train is presented in Figure 4.

Method 25A, "*Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*," was used to measure VOC emissions concentrations exhaust ductwork. A JUM Engineering, Model VE-7 flame ionization detector (FID) was used to conduct testing exhaust ductwork. Continuous samples were withdrawn from the sample

location through a probe, heated sample line, and pump prior to being subjected to the ionization flame.

The JUM VE-7 directs a portion of the sample through a capillary tube to the FID that ionizes the hydrocarbons to carbon. The detector determines the carbon concentration in terms of parts per million (ppm). The concentration of VOC was then converted to an analog signal (voltage) and recorded on a computerized data acquisition system at 5-second intervals. The data were then averaged over the test period to determine the concentration for VOC reported as equivalent units of the calibration gas (propane). Final results used in determining capture efficiency were converted in accordance with Method 25A and reported in terms of carbon. A sketch depicting the JUM VE-7 measurement train is presented in Figure 3.

Method 204F, *"Volatile Organic Compounds Content in Liquid Input Stream (Distillation Approach)"*, was used to determine the VOC content of the coating material. The material usage volume was calculated based on the diameter of the vat and the difference in liquid levels in the vat from the beginning to the end of each test run.

This study utilized the weight determination procedure to determine the weight of coating material used for each test run by each coating line. Three sets of coating samples were collected, one for Method 24 total volatile matter analyses, one for Method 204F distillation and one as a backup. The coating samples collected from each line were uniquely labeled and logged into a sample custody system. One set of samples was transported to Data Analysis Technology, Inc. (DAT) for distillation. The second set of samples was retained by HHMI for Method 24 volatile matter analysis. The third set was retained by CMFC as backup in the case of a lost or damaged sample.

The distillate from each coating sample was used to generate a known concentration of VOC in a Tedlar bag. Bag generation was accomplished by withdrawing approximately 10 ul of distillate into a syringe. The syringe was weighed; the contents expelled into a volatilization chamber and the gaseous sample was collected in the sample bag along with a known volume of zero air. The syringe was again weighed to obtain the weight of distillate volatilized into the bag. The VOC in the sample bag was then subjected to a FID to measure the VOC content in the sample bag. The known weight of VOC material in the sample bag was then compared to the measured weight of VOC in the sample bag in terms of propane. This ratio

is expressed as the response factor. The amount of VOC introduced to each coating line is calculated based on the weight of the coating material used and its VOC content as propane utilizing the response factor. By utilizing the response factor, the units of VOC measurement for both the VOC in the coating and VOC measured in the exhaust stream, can be expressed in similar terms of propane.

Capture efficiency was then determined as the ratio of mass of VOC measured in the exhaust stream, to the mass of VOC introduced to the coating lines.

4.0 DISCUSSION OF RESULTS

The VOC capture and destruction efficiency, and material usage rates for each test run are shown in the Tables tab in this report. Supplemental information for each test run is provided with the field data and calculation information in Appendix C. Analytical results for coating sample analyses are presented in Appendix D.

Based on the test results of the VOC capture efficiency study, the VOC abatement system installed on Coating Line Nos. 18 and 19 had an average capture efficiency of 59.9%. The RTO VOC destruction efficiency averaged 99.4%.

The applicable capture and destruction efficiency limits stipulated in Permit 383-00H are 85% (by weight) and 95% (by weight) respectively.

5.0 QUALITY ASSURANCE

Quality assurance (QA) objectives required for this study followed applicable criteria detailed by each method used per the facility's test plan dated September 6, 2018, approved by MDEQ. The following sub-sections detail specific QA limitations and this study's compliance with those limitations.

5.1 FIELD EQUIPMENT

Where applicable, reference method QA control procedures were followed to demonstrate creditability of the data developed. Quality assurance information for field equipment is provided in Appendix B. The procedures included, but were not limited to, the following:

- Sampling equipment was calibrated according to procedures contained in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III," EPA 600/4-72-b, September 1994.
- The sample trains were configured according to the appropriate test methods.
- Quality control checks of sample trains were performed on-site, including sample train and Pitot tube leak checks.
- VOC FIDs used for the onsite testing were calibrated in accordance with USEPA Method 25A. Calibration error was within the allowable limit of 5% of calibration gas value. Zero and calibration drift were both within the allowable limit of 3% of analyzer span for all CE test runs. FID response times (0-95% of span) were within the allowable 30 seconds, as required.

Run 3 was shortened by approximately 6 minutes because the second shift operator began production before the oven was empty and baseline concentration of the captured gas stream was achieved.

Calibration data for this study are presented in Appendix B.

5.2 ANALYTICAL DATA

Quality assurance procedures detailed in USEPA Methods 24 and 204F were performed. For Method 24 duplicate samples for volatile matter were analyzed for all samples with results falling within stipulated quality assurance criteria.

For Method 204F, VOC FID was calibrated in accordance with the method. Calibration error was within the allowable limit of 3% of calibration gas value. Zero and calibration drift were both within the allowable limit of 3% of analyzer span for all samples. Zero air was passed through the bag generation apparatus and analyzed to confirm no contamination was present.

5.3 RTO OUTLET AIR FLOW DATA ISSUES

There was significant variability in the RTO outlet air flows measured between Runs 1 (8,413 scfm) and 2 (11,500 scfm, Run 2a). Velocity measurement equipment, including the electronic manometer, pressure lines and pitot tube, were inspected and found to be in proper working order. The variability in flow was pointed out to Mr. Dziadosz with MDEQ. At the request of Mr. Dziadosz, a second oil manometer was installed and used to measure (Run 2b) air flows showing similar results (8,837 scfm) as Run 1. Per Mr. Dziadosz, Runs 2a and 2b were averaged and used to determine the outlet DE for Run 2. Run 3 was within reasonable air flow expectations (9,698 scfm).

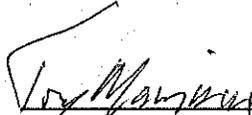
6.0 LIMITATIONS

This report is provided to Curtis Metal Finishing Company in response to a limited assignment. HHMI will not provide any information contained in, or associated with, this report to any unauthorized party without expressed written consent from Curtis Metal Finishing Company, unless required to do so by law or court order. HHMI accepts responsibility for the performance of the work, specified by the limited assignment, which is consistent with others in the industry, but disclaims any consequential damages arising from the information contained in this report.

This report is intended solely for the use of Curtis Metal Finishing Company. The scope of services performed for this assignment may not be appropriate to comply with the requirements of other similar process operations, facilities, or regulatory agencies. Any use of the information or conclusions presented in this report, for purposes other than the defined assignment, is done so at the sole risk of the user.

This emission testing survey was conducted and report developed by the following H & H Monitoring, Inc. personnel:


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Site Leader


Troy Manning
Technician


Daniel L. Hassett
President

TABLES

RESULTS TABLE
VOC CAPTURE AND DESTRUCTION EFFICIENCY
LINES 18 AND 19
CURTIS METAL FINISHING COMPANY
STERLING HEIGHTS, MI
October, 2018

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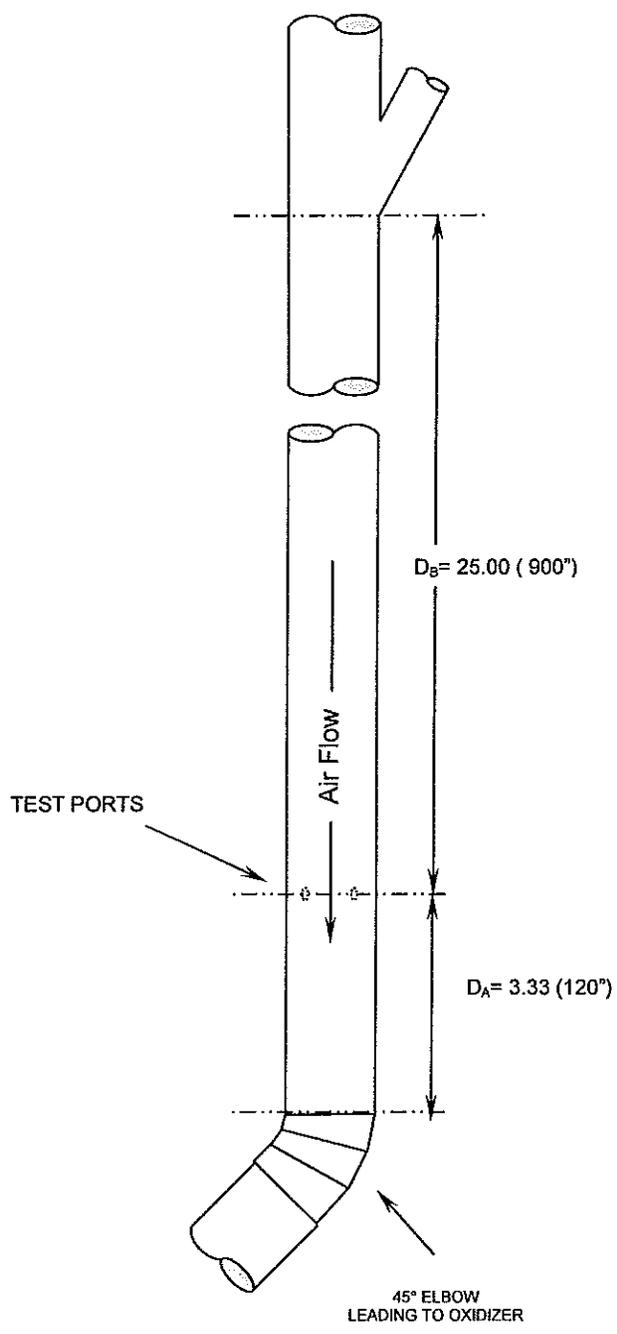
DESTRUCTION EFFICIENCY

| Run No. | 1 | 2 | 3 | Average |
|---|--------------|--------------|--------------|---------------|
| Date | 10/18/2018 | 10/18/2018 | 10/18/2018 | |
| Start Time | 9:05 | 11:59 | 14:32 | |
| Stop Time | 10:05 | 12:59 | 15:32 | |
| Test Duration (minutes) | 60 | 60 | 60 | |
| FLUE GAS FLOWRATES AND VOC | | | | |
| Incinerator Inlet | | | | |
| ACFM | 12,629 | 12,845 | 12,794 | 12,756 |
| SCFM | 10,423 | 10,438 | 10,412 | 10,424 |
| DSCFM | 10,192 | 10,224 | 10,246 | 10,221 |
| VOC concentration (ppm) | 207.9 | 291.7 | 278.6 | 259.40 |
| VOC emission rate (lb/hr) | 14.88 | 20.91 | 19.92 | 18.57 |
| Incinerator Outlet | | | | |
| ACFM | 11,787 | 14,584 | 14,066 | 13,479 |
| SCFM | 8,413 | 10,174 | 9,699 | 9,428 |
| DSCFM | 8,246 | 10,028 | 9,509 | 9,261 |
| VOC concentration (ppm) | 1.94 | 1.65 | 1.86 | 1.82 |
| VOC emission rate (lb/hr) | 0.11 | 0.12 | 0.12 | 0.12 |
| TOTAL VOC DESTRUCTION EFFICIENCY | 99.2% | 99.4% | 99.4% | 99.4% |

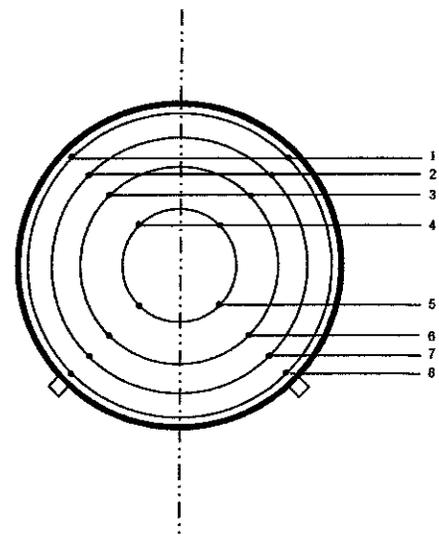
CAPTURE EFFICIENCY

| Run No. | 1 | 2 | 3 | Average |
|--|--------------|--------------|--------------|---------------|
| Date | 10/18/2018 | 10/18/2018 | 10/18/2018 | |
| Start Time | 8:28 | 11:23 | 13:58 | |
| Stop Time | 10:38 | 13:40 | 15:58 | |
| Test Duration (minutes) | 130 | 137 | 120 | |
| CAPTURE EFFICIENCY PARAMETERS | | | | |
| Line 18 VOC input (lbs as propane) | 31.22 | 20.19 | 17.31 | 22.91 |
| Line 19 VOC input (lbs as propane) | 32.79 | 33.96 | 28.28 | 31.68 |
| Total VOC Input (lbs as propane) | 64.00 | 54.16 | 45.59 | 54.58 |
| VOC concentration (ppm as propane) | 161.4 | 221.9 | 234.2 | 205.83 |
| VOC emissions rate (lb/hr as propane) | 11.55 | 15.91 | 16.74 | 14.73 |
| Total VOC Captured (lbs as propane) | 25.03 | 36.32 | 33.49 | 31.61 |
| TOTAL VOC CAPTURE EFFICIENCY | 39.1% | 67.1% | 73.5% | 59.9% |

FIGURES



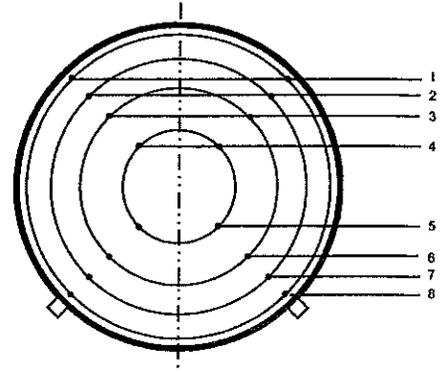
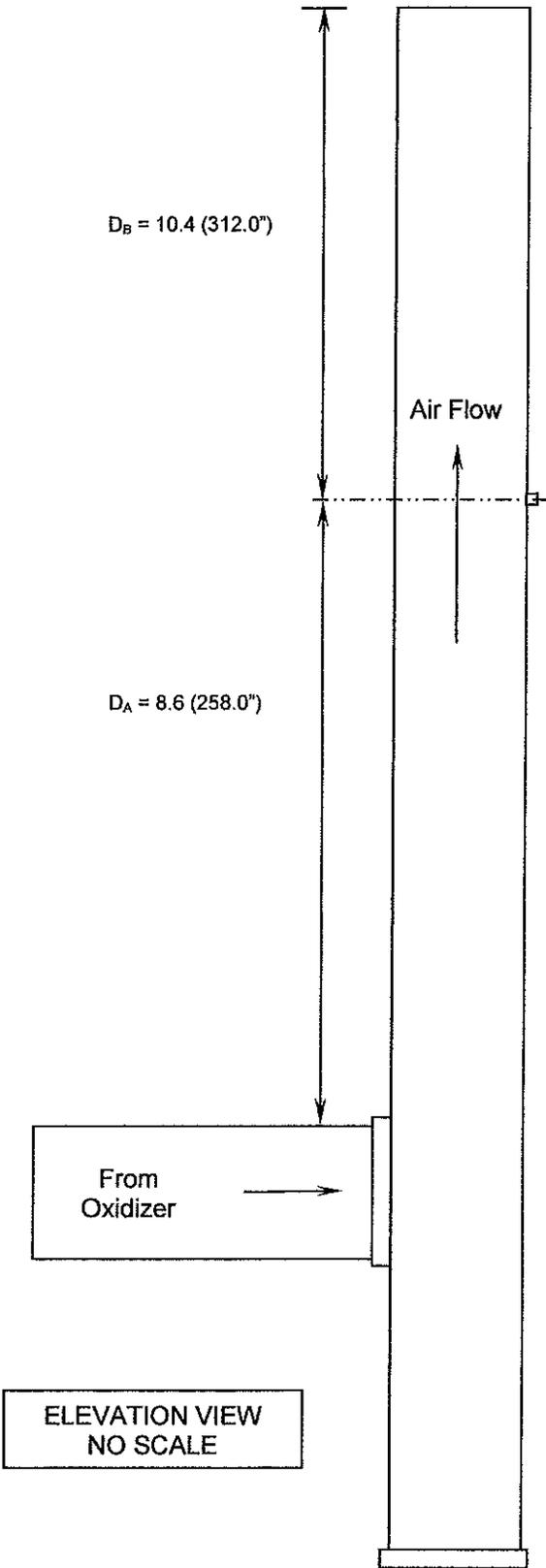
| Traverse Point Locations | |
|--------------------------|--------------------------|
| Stack Dia.: | 36.0" |
| Point # | Distance from Stack wall |
| 1 | 1.15 |
| 2 | 3.78 |
| 3 | 6.98 |
| 4 | 11.63 |
| 5 | 24.37 |
| 6 | 29.02 |
| 7 | 32.22 |
| 8 | 34.85 |



Plan View

NO SCALE

| | |
|--|--|
| <p>FIGURE 1</p> <p>TEST PORT AND TRAVERSE POINT LOCATION RTO INLET</p> | |
| <p>PREPARED FOR</p> <p>CURTIS METAL FINISHING COMPANY STERLING HEIGHTS, MICHIGAN</p> | |
| <p>DRAWN DLH 9/5/18</p> <p>REVISED</p> <p>JOB NO. 1804-002</p> | <p>DRAWING NUMBER</p> <p>1804002-1</p> |
| <p>H & H MONITORING, INC.</p> | |



Traverse Point Matrix

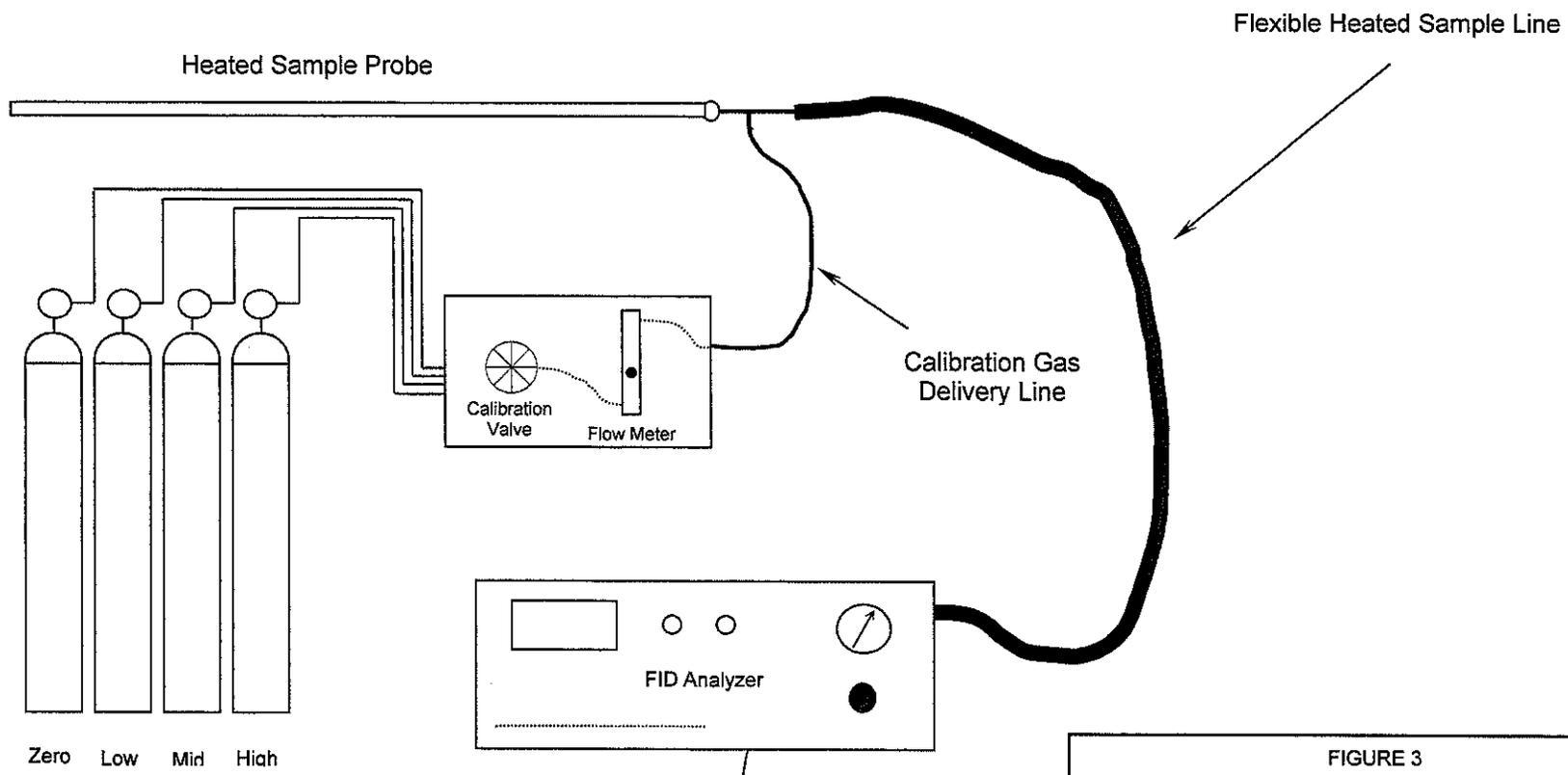
| Traverse Point Locations | |
|--------------------------|--------------------------|
| Stack Diameter | 30.0 |
| Point # | Distance from Stack wall |
| 1 | 0.96 |
| 2 | 3.15 |
| 3 | 5.82 |
| 4 | 9.69 |
| 5 | 20.31 |
| 6 | 24.18 |
| 7 | 26.85 |
| 8 | 29.04 |

FIGURE 2
TEST PORT AND TRAVERSE POINT LOCATION
RTO OUTLET

PREPARED FOR
CURTIS METAL FINISHING COMPANY
STERLING HEIGHTS, MICHIGAN

| | |
|------------------|------------------------------|
| DRAWN DLH 9/4/18 | DRAWING NUMBER 1804002-02 |
| REVISED | |
| JOB NO. 1804-002 | |

H & H MONITORING, INC.



Flexible Heated Sample Line

Heated Sample Probe

Calibration Gas Delivery Line

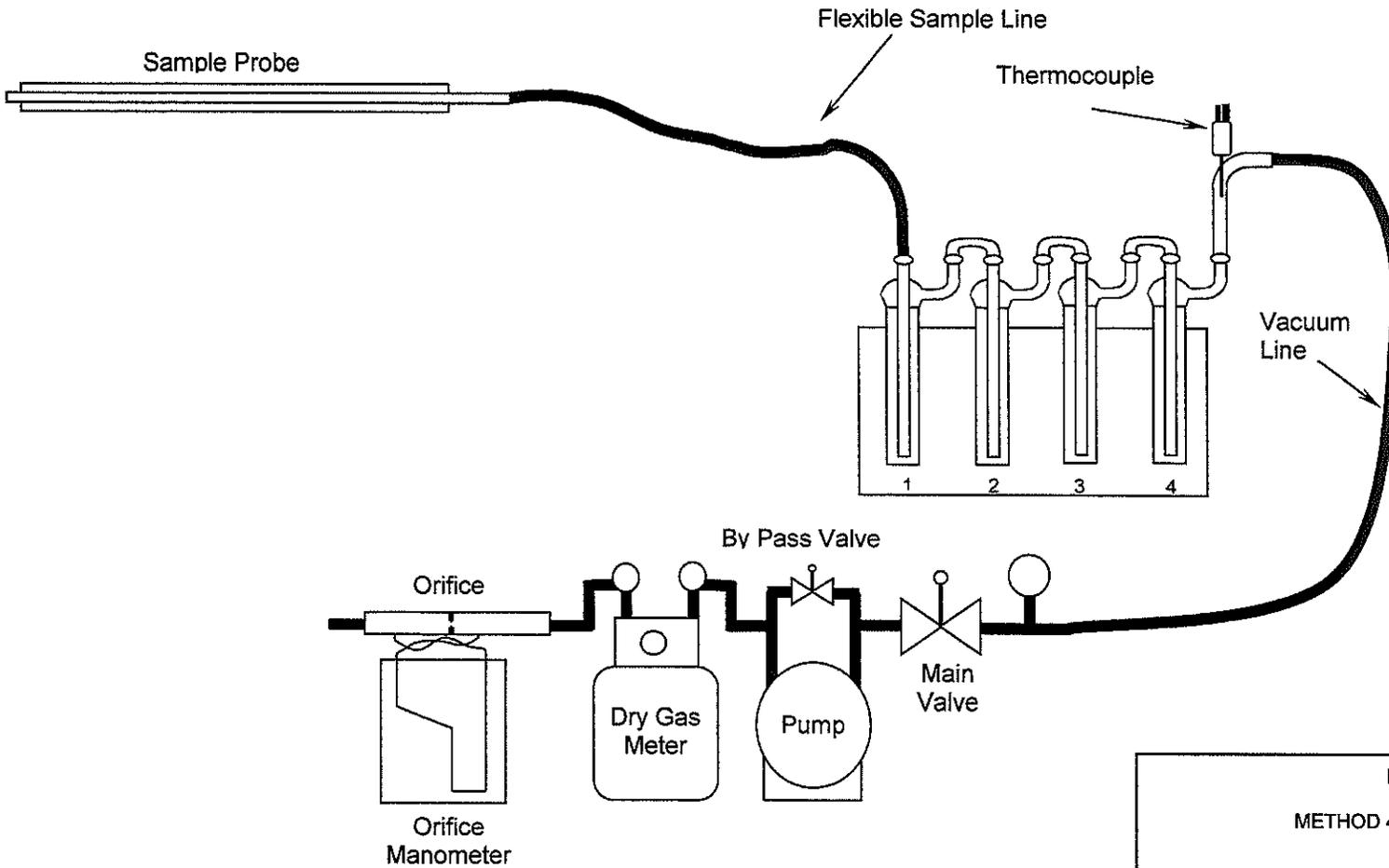
Calibration Valve
Flow Meter

FID Analyzer

Zero Low Mid High

Computer Data Acquisition

| | | |
|--|--------------|----------------------------|
| FIGURE 3 METHOD 25A VOC SAMPLING TRAIN | | |
| PREPARED FOR CURTIS METAL FINISHING COMPANY STERLING HEIGHTS, MICHIGAN | | |
| DRAWN | DLH 12/10/18 | DRAWING NUMBER 180402-3 |
| REVISED | | |
| JOB NO. 1804-002 | | |
| H & H MONITORING, INC. | | |



Impinger #1 : 100 ml H₂O
 Impinger #2 : 100 ml H₂O
 Impinger #3 : Empty
 Impinger #4 : Silica Gel

FIGURE 4
 METHOD 4 SAMPLING TRAIN

PREPARED FOR
 CURTIS METAL FINISHING COMPANY
 STERLING HEIGHTS, MICHIGAN

DRAWN DLH 12/10/18

DRAWING NUMBER
 1804002-4

REVISED

JOB NO. 1804-002

H & H MONITORING, INC.