# H & H MONITORING, INC.

## DETERMINATION OF VOC CAPTURE AND DESTRUCTION EFFICIENCY COATING LINES MODEL 24, STC1 AND STC2

**PREPARED FOR:**

**DEPOR INDUSTRIES, INC.**
**SHELBY TOWNSHIP, MICHIGAN**

**SUBMITTED:**

**JANUARY 17, 2020**

**HHMI PROJECT NO. 1909-001**

**PREPARED BY:**

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## EXECUTIVE SUMMARY

H & H Monitoring, Inc. (HHMI) was retained by Depor Industries, Inc. (Depor) to perform an emissions evaluation on the volatile organic compounds (VOC) emissions abatement system at their Shelby Township, Michigan facility. This study was performed in accordance with the approved test plan dated October 17, 2019. The purpose of the study was to provide VOC capture and destruction efficiency data to demonstrate compliance with special conditions stipulated in Permit 44-99G.

HHMI personnel performed the field services for the study on November 19 and 20, 2019. Michigan Environmental Great Lakes and Energy (EGLE) personnel were present during the testing to observe sampling and operational procedures.

## SUMMARY OF RESULTS

| **ABATEMENT SYSTEM CAPTURE EFFICIENCY** | **Run 1** | **Run 2** | **Run 3** | **Average** |
|---|---|---|---|---|
| VOC Input via Coating Material Usage (lbs/test) | 48.4 | 47.5 | 61.8 | **56.8** |
| VOC captured by the Abatement System (lbs/test) | 45.2 | 44.0 | 56.8 | **53.3** |
| **VOC Capture Efficiency (% by weight)** | 93.4% | 92.6% | 91.9% | **92.6%** |
| **OXIDIZER DESTRUCTION EFFICIENCY** | | | | |
| VOC Entering the Abatement System (lbs/hr) | 24.2 | 22.8 | 30.3 | **25.8** |
| VOC Exiting the Abatement System (lbs/hr) | 0.10 | 0.10 | 0.08 | 0.09 |
| **VOC Destruction Efficiency (% by weight)** | 99.6% | 99.5% | 99.7% | **99.6%** |

## 1.0 INTRODUCTION

HHMI conducted a volatile organic compounds (VOC) capture and destruction efficiency study on the abatement system for the dip/spin coating lines at the Depor Industries, Inc. (Depor) facility located in Shelby Township, Michigan. This study was performed in accordance with the approved test plan dated October 17, 2019. Depor operates three (3) dip/spin coating lines, identified as Lines Model 24. STC1 and STC2 (EUDUAL24, EUDIPSPINSTC1, EUDIPSPINSTC2), at the Shelby Township, Michigan facility. In accordance with the conditions of Permit 44-99G, Depor was required to demonstrate, by testing, that the capture and destruction efficiency of the VOC abatement system follows stipulated permit requirements. The abatement system includes fume hoods, curing ovens, duct work, and fans, which direct the VOC emissions from the dip/spin coating lines to a rotary Regenerative Thermal Oxidizer (RTO).

Messrs. Daniel Hassett, Brad Wallace and Troy Manning, with HHMI, performed the field services for the study on November 19 and 20, 2019. Additionally, Depor representatives provided documentation of coating material usage and collected coating samples for analysis. Observation of the field activities was performed by Ms. Regina Angellotti, Lindsey Wells and Matthew Karl, with Michigan Environment, Great Lakes and Energy (EGLE), Air Quality Division (AQD).

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 lines 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 exhaust 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 concentration field data. Appendix E contains copies of analytical data. Appendix F contains the coating material usage data. Appendix G includes a copy of the EGLE approved Test Plan and approval letter.

## 2.0 PROCESS DESCRIPTION

VOC emitted from the coating lines are controlled by a Durr Systems rotary RTO. The coating lines each have a parts coating area that utilizes a dip/spin system to coat small metal parts. Each dip/spin line operates independently from the other coating lines at the facility, but according to the same sequence of events. Known quantities of parts are loaded into a basket. The basket is held steady as the dip tank or vat is raised such that the parts in the basket are fully submerged in the coating material. The vat is then partially lowered such that the parts are no longer submerged but remain in the vat. The basket is then spun to remove excess coating material from the parts. The excess coating material that is spun from the parts remains in the vat and reused. The parts are then placed onto a conveyor that transfers them into a curing oven.

Exhaust hoods independently capture emissions from the coating lines and direct them to a main exhaust header, which leads to the RTO. The RTO operates at a temperature of 1550 $^{o}$F with a retention time of 0.5 seconds. The RTO has a rated capacity of 45,000 scfm airflow, however, it has been dialed back to operate at 18,000 scfm. The rated destruction efficiency is 95 percent on a mass basis. Material usage data from each dip/spin coating line was recorded along with RTO chamber temperature, which are included in Appendix F.

## 3.0 SAMPLING AND ANALYTICAL PROCEDURES

Total VOC emission was measured in the inlet ductwork and outlet exhaust stack of the RTO to determine destruction efficiency. Coating material usage and VOC input was measured concurrently with RTO inlet duct work exhaust gases to determine capture efficiency. A 60-minute segment of VOC data was extracted from the capture efficiency data during a time when the lines were all completely full. This data was used to determine VOC destruction efficiency.

Capture efficiency was determined using a standard protocol stipulated by USEPA Method 204 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 in the exhaust gases during both capture and destruction efficiency testing.
- 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.
Corresponding exhaust gas volumetric flow rate determinations were made for each test run at the RTO inlet and outlet sampling locations. The wet bulb procedure described in USEPA Method 4 was performed during each test run to determine moisture content at the inlet test location, and a moisture train was used to determine moisture during each test run at the outlet test location on both November 19 and 20, 2019.

HHMI utilized total hydrocarbon analyzers (JUM VE-7 and JUM 109A) 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 mass of VOC in the captured gas stream, determined during the test, divided by the total mass of VOC input 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 three test runs of approximately 170 minutes each, which constitutes one complete cycle of the coating process without the need to make coating viscosity adjustments. Method 25A was used to determine VOC ppm at the inlet (captured gas stream) sampling location in the ductwork prior to the RTO.

Corresponding exhaust gas volumetric flow rate and moisture content determinations were made for each test run at the RTO inlet sampling location. Measurements were made to obtain the appropriate data to make these determinations.

Coating material usage rates were determined using the weight measurement procedure detailed in Method 204F. Measuring the weight of the vat and coating prior to each test run and immediately following each test run determined the net weight of coating material used. 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. There were no coating material adjustments for viscosity during any of the three runs performed.

Pre-test and post-test samples were collected for each test run. 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 for each test run.

## 3.3 SAMPLING LOCATIONS

The inlet ports are installed on the 48-inch diameter duct, inside of the south building wall 432 inches (9.00 duct diameters) downstream from a duct expansion and 96 inches (2.00 duct diameters) upstream from a 90° elbow.

Test ports are installed on the 36-inch by 78-inch rectangular exhaust stack from the RTO. The ports are located 147 inches (2.98 equivalent duct diameters) downstream from a duct elbow and 108 inches (2.19 equivalent duct diameters) upstream from the stack exit to atmosphere.

## 3.4 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 2 and 3.

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 and analyzed for oxygen ($O_2$) and carbon dioxide ($CO_2$) 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 RTO inlet and outlet locations. The wet-bulb procedure was used at the inlet sampling location. For the outlet, 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 summary sheets in Appendix C. 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 at the inlet and outlet of the RTO. JUM Engineering, Model VE-7, flame ionization detectors (FID) were used to conduct testing at the inlet and outlet locations of the RTO, respectively. Continuous samples were withdrawn from the sample locations 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 DE 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 weight was calculated based on the difference in weight of the vat from the beginning

to the end of each test run.

This study utilized the weight measurement approach to determine the quantity of coating material used for each test run by each dip/spin coating line. The coating samples collected from each line were uniquely labeled and transported to the HHMI laboratory for analyses. Duplicate samples were collected for each sample. One sample was analyzed for VOC content using USEPA Method 24. This result was used in the determination of the total mass of VOC content of the coating material used during each test run, assuming that it is all released during the curing process.

The second sample was for vacuum distillation to extract the VOC material from the coating material. The VOC extract was then used to generate a known concentration of VOC in a Tedlar bag. This was accomplished by withdrawing a small amount of the VOC material into a syringe. The syringe was weighed; the contents expelled into a volatilization chamber and collected in the sample bag with a known volume of zero grade air. The VOC in the sample bag was then subjected to an FID to measure the VOC content in the sample bag. The known weight of VOC-containing 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 dip/spin coating line is calculated based on the net 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 (as 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 dip/spin coating lines.

## 4.0 DISCUSSION OF RESULTS

The VOC capture and destruction efficiencies, and coating material usage rates for each test run are shown in the Results Table included 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.

The results of this VOC capture and destruction study, show the VOC abatement system has an average capture efficiency of 92.6% and the VOC destruction efficiency across the RTO was 99.6%.

## 5.0 QUALITY ASSURANCE

Quality assurance (QA) objectives required for this study followed applicable criteria detailed by each method used and approved by the facility's test plan dated October 17, 2019. It should be noted that following completion of the first test run, the HHMI data acquisition system failed to retain the VOC data recorded during the test. Since there was no data to report from this test run, HHMI immediately began the second test run, labeling that run Run 1. Corresponding coating samples for the analyzer data were labeled Run 2 with the following runs labeled Runs 3 and 4 for samples and Runs 2 and 3 for the analyzer data.

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 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 test runs. FID response times (0-95% of span) were within the allowable 30 seconds, as required.

- Test run analyzer data was drift corrected using the correction procedure detailed in USEPA Method 7E.

Calibration data for this study are summarized in the table entitled Field Equipment Calibration, which is presented in Appendix B. This table presents confirmation of field equipment calibrations being within stipulated allowable variances.

## 5.2 COATING MATERIAL MEASUREMENT

For each test run, the coating material for each line was measured. This procedure was performed by Depor by preparing the coating material in an appropriate vat for each line. After coating preparation, a sample was collected, and the initial weight of the vat and coating material was recorded using a scale with and accuracy of ±0.5 lb. Following each test run on each line, each vat was weighed again to obtain the final weight of the vat and coating material. A post-test coating sample was collected after the weight of the vat and coating was obtained. The difference of these weights yielded the net coating weight that was used during the test run. Before use, each vat was weighted empty to obtain the tare weight.

## 5.3 ANALYTICAL DATA

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

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 and a known organic solvent were analyzed as control samples using the sample bag generation system.

Coating sample distillate preparation was performed in accordance with specified procedures detailed in USEPA Method 204F. Duplicate bag samples were prepared and analyzed for each distillate sample. All sample response factors of the duplicate samples agreed to within 1.5% of the average response factor for the two duplicate samples.

The response factor data sheet is presented in Appendix E.

## 6.0 LIMITATIONS

This report is provided to Depor Industries, Inc. 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 Depor Industries, Inc., 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 Depor Industries, Inc. 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:

| Brad Wallace | Troy Manning | Daniel L. Hassett |
|---|---|---|
| Site Leader | Technician | President |

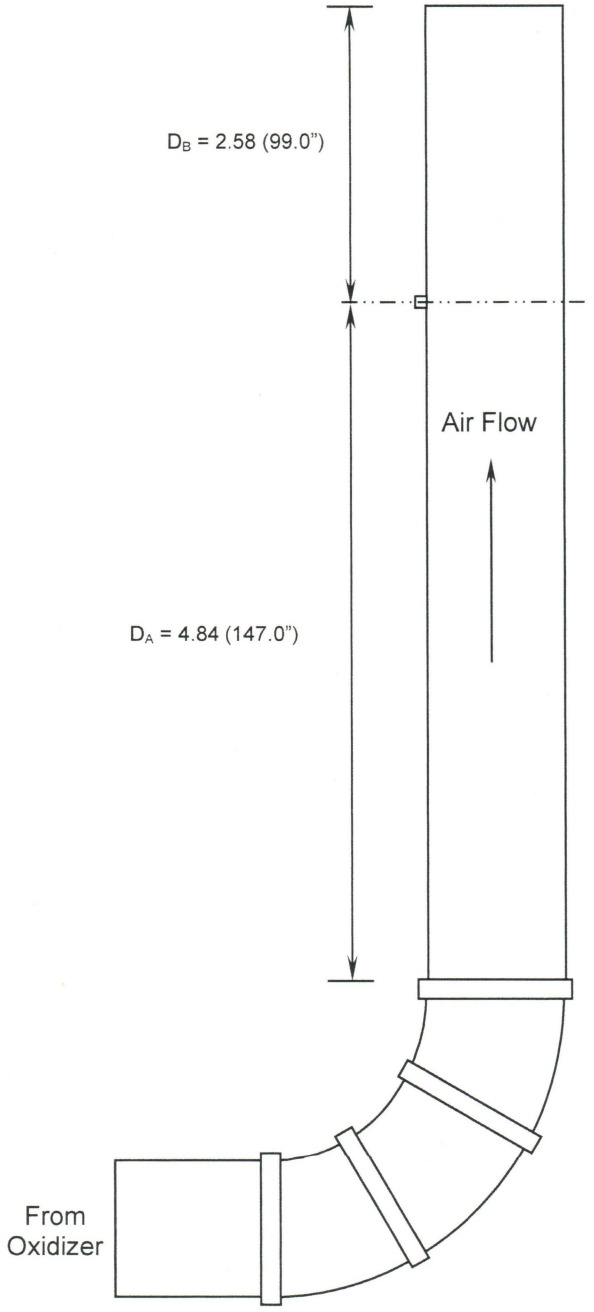
# RESULTS TABLE
## VOC CAPTURE AND DESTRUCTION EFFICIENCY
## COATING LINES 24, STC1 AND STC2
## DEPOR INDUSTRIES
## SHELBY TWP, MICHIGAN
## November 2019

**DESTRUCTION EFFICIENCY**

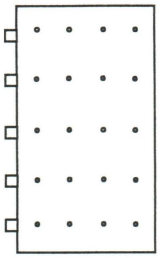
| Run No. | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| Date | 11/19/2019 | 11/19/2019 | 11/20/2019 | |
| Start Time | 12:48 | 15:48 | 8:14 | |
| Stop Time | 13:48 | 16:48 | 9:14 | |
| | | | | |
| **FLUE GAS FLOWRATES AND VOC** | | | | |
| **Incinerator Inlet** | | | | |
| ACFM | 21,705 | 20,625 | 20,268 | **20,866** |
| SCFM | 17,539 | 16,825 | 16,491 | **16,952** |
| DSCFM | 17,163 | 16,433 | 16,161 | **16,586** |
| VOC concentration (ppm) | 201.0 | 197.6 | 267.4 | **222.00** |
| **VOC emission rate (lb/hr)** | **24.21** | **22.83** | **30.28** | **25.77** |
| **Incinerator Outlet** | | | | |
| ACFM | 27,471 | 27,842 | 26,356 | **27,223** |
| SCFM | 18,958 | 19,337 | 18,417 | **18,904** |
| DSCFM | 18,579 | 18,968 | 18,064 | **18,537** |
| VOC concentration (ppm) | 0.75 | 0.78 | 0.63 | **0.72** |
| **VOC emission rate (lb/hr)** | **0.10** | **0.10** | **0.08** | **0.09** |
| | | | | |
| **TOTAL VOC DESTRUCTION EFFICIENCY** | **99.6%** | **99.5%** | **99.7%** | **99.6%** |

**CAPTURE EFFICIENCY**

| Run No. | 1 | 2 | 3 | Average |
|---|---|---|---|---|
| Date | 11/19/2019 | 11/19/2019 | 11/20/2019 | |
| Start Time | 11:58 | 15:00 | 7:25 | |
| Stop Time | 14:49 | 17:50 | 10:17 | |
| Test Duration (minutes) | 171 | 170 | 172 | |
| | | | | |
| **CAPTURE EFFICIENCY PARAMETERS** | | | | |
| Line 24 | 17.68 | 12.08 | 15.42 | **15.06** |
| Line STC1 | 18.48 | 21.02 | 31.09 | **23.53** |
| Line STC2 | 12.28 | 14.35 | 15.29 | **13.98** |
| **Total VOC Input (lbs)** | **48.44** | **47.45** | **61.81** | **52.57** |
| | | | | |
| VOC concentration (ppm) | 131.8 | 134.3 | 174.9 | **147.00** |
| VOC emissions rate (lb/hr) | **15.87** | **15.52** | **19.81** | 17.07 |
| **Total VOC Captured (lbs)** | **45.24** | **43.96** | **56.78** | **48.66** |
| | | | | |
| **TOTAL VOC CAPTURE EFFICIENCY** | **93.39%** | **92.64%** | **91.86%** | **92.63%** |




ELEVATION VIEW
NO SCALE



Traverse Point Matrix

| Traverse Point Locations | |
|---|---|
| Stack Dimensions.: | 36.0 X 78.0 |
| Point # | Distance from Stack wall |
| 1 | 4.50 |
| 2 | 13.50 |
| 3 | 22.50 |
| 4 | 31.50 |

FIGURE 1

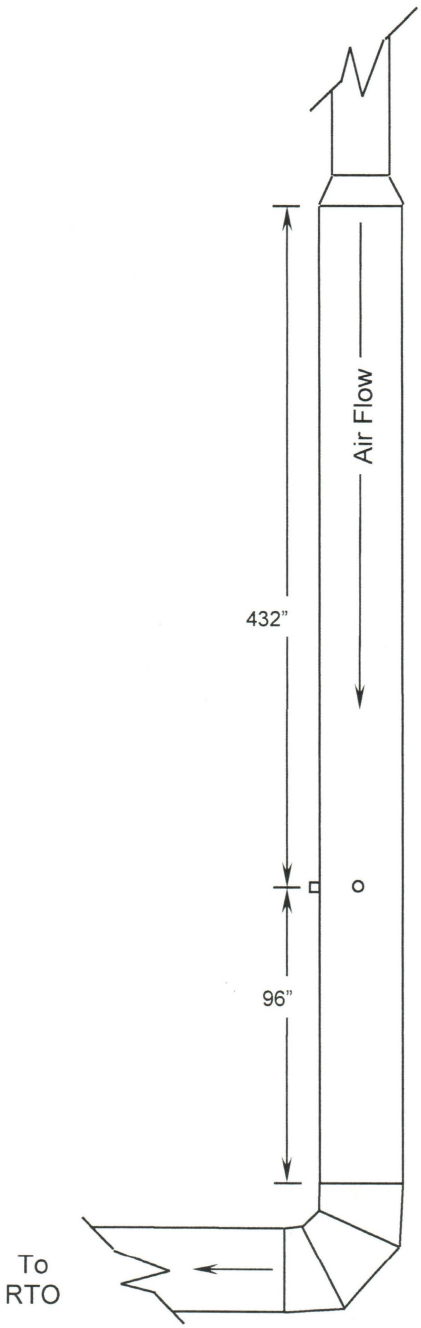
TEST PORT AND TRAVERSE POINT LOCATION
RTO OUTLET

PREPARED FOR

DEPOR INDUSTRIES, INC.
SHELBY TWP, MICHIGAN

| | |
|---|---|
| DRAWN DLH 10/4/19 | DRAWING NUMBER 1909001-03 |
| REVISED DLH 1/16/20 | |
| JOB NO. 1909-001 | |

H & H MONITORING, INC.




Plan View

| Traverse Point Locations | |
|---|---|
| Stack Dia.: | 48" |
| Point # | Distance from Stack wall |
| 1 | 1.54 |
| 2 | 5.04 |
| 3 | 9.31 |
| 4 | 15.50 |
| 5 | 32.50 |
| 6 | 38.69 |
| 7 | 42.96 |
| 8 | 46.46 |

FIGURE 2

TEST PORT AND TRAVERSE POINT LOCATION
RTO SYSTEM INLET

PREPARED FOR

DEPOR INDUSTRIES, INC.
SHELBY TOWNSHIP, MICHIGAN

| | |
|---|---|
| DRAWN DLH 10/4/19 | DRAWING NUMBER 1909001-2 |
| REVISED | |

JOB NO. 1909-001

H & H MONITORING, INC.

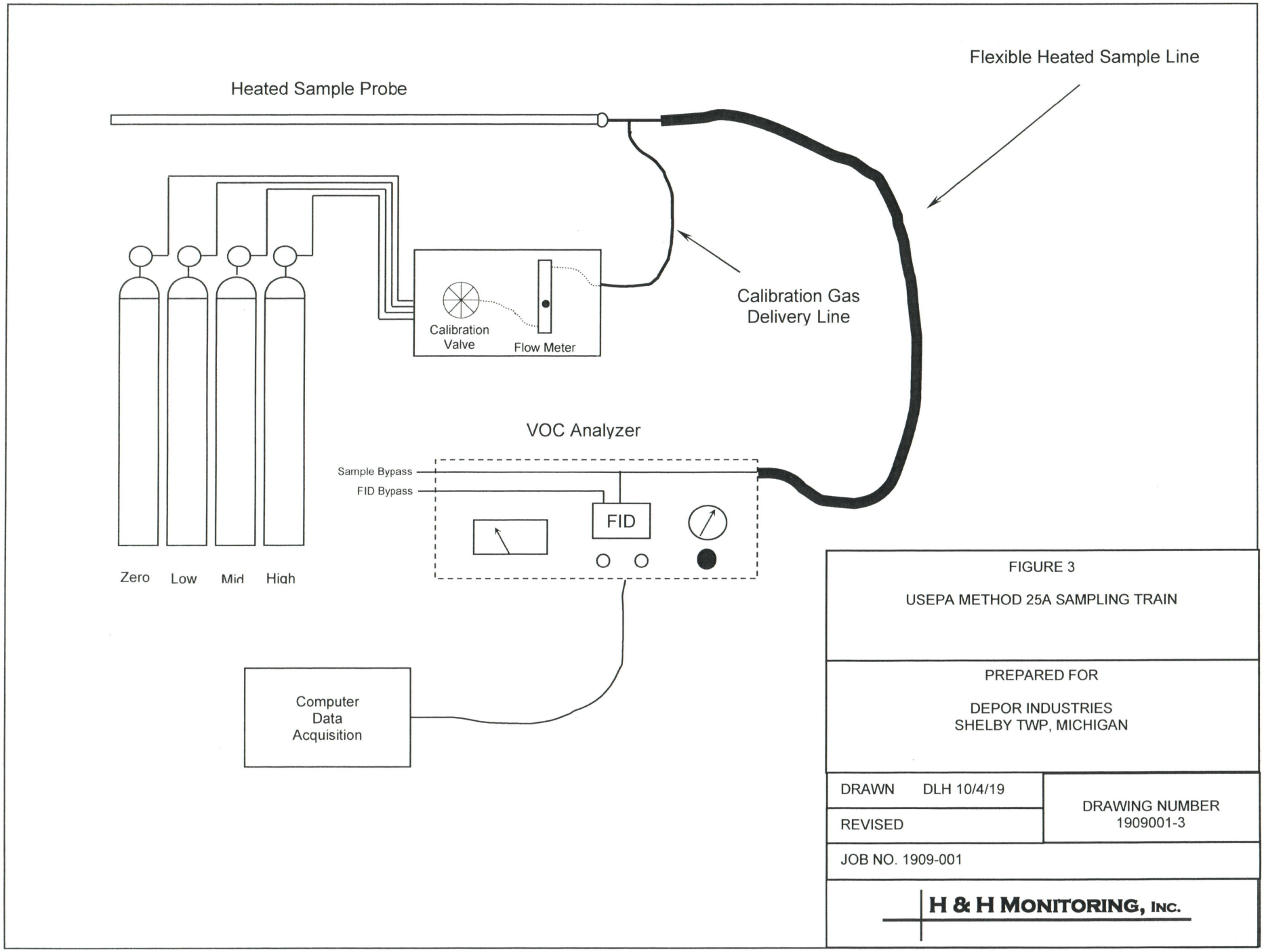



FIGURE 3

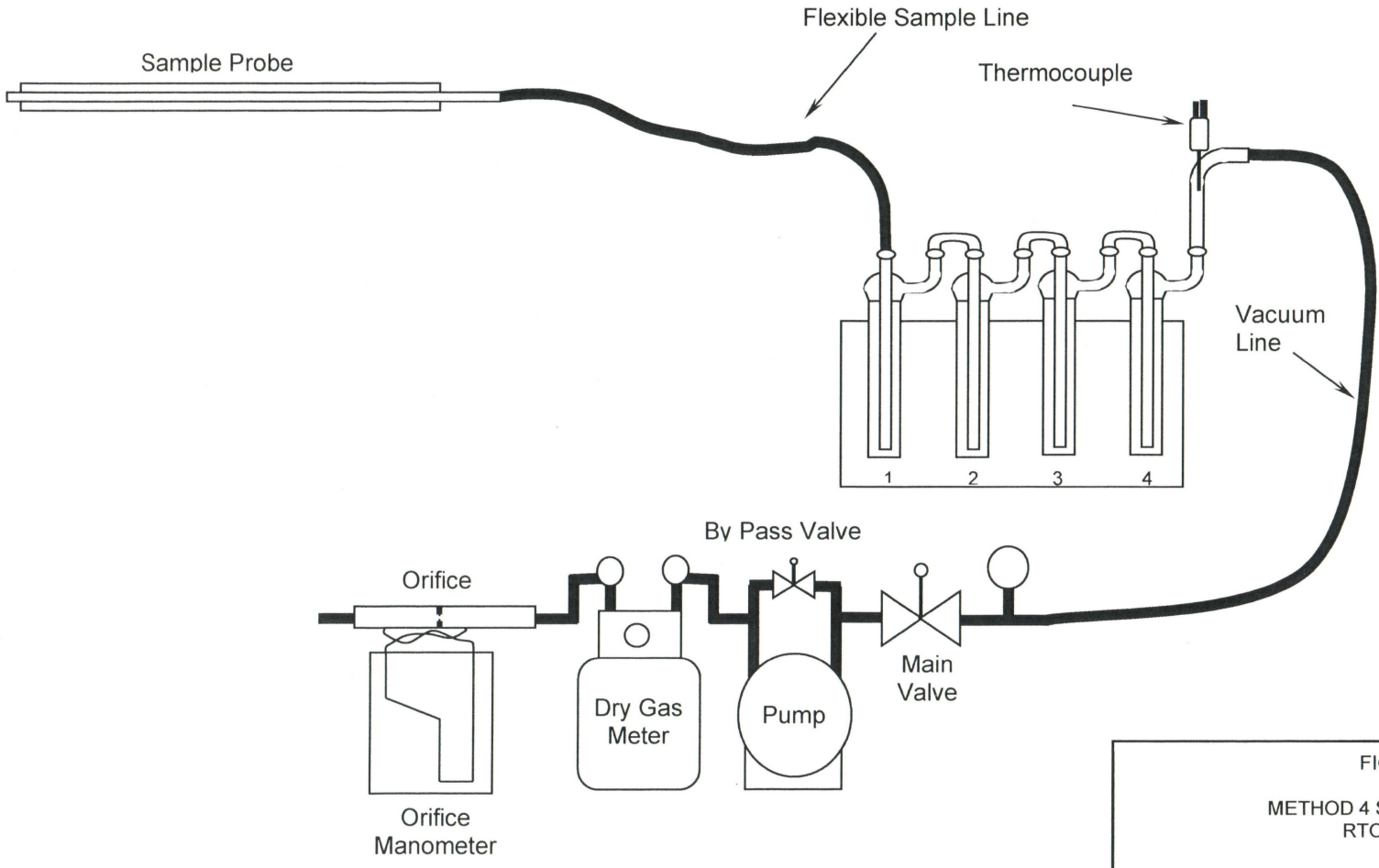
USEPA METHOD 25A SAMPLING TRAIN

PREPARED FOR

DEPOR INDUSTRIES
SHELBY TWP, MICHIGAN

| | |
|---|---|
| DRAWN DLH 10/4/19 | DRAWING NUMBER 1909001-3 |
| REVISED | |
| JOB NO. 1909-001 | |

H & H MONITORING, INC.




Impinger #1 : 100 ml $H_2O$
Impinger #2 : 100 lm $H_2O$
Impinger #3 : Empty
Impinger #4 : Silica Gel

FIGURE 4

METHOD 4 SAMPLING TRAIN
RTO OUTLET

PREPARED FOR

DEPOR INDUSTRIES, INC.
SHELBY TOWNSHIP, MICHIGAN

| | |
|---|---|
| DRAWN DLH 1/16/20 | DRAWING NUMBER 1909001-4 |
| REVISED | |

JOB NO. 1909-001

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