H & H MONITORING, INC.

DETERMINATION OF NMVOC EMISSION
FOR
DEVELOPMENT OF NMVOC EMISSION FACTORS

BODYCOTE THERMAL PROCESSING, INC.
ROMULUS PLANT
ROMULUS, MICHIGAN

PREPARED FOR:

ASI ENVIRONMENTAL TECHNOLOGIES, INC.
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SUBMITTED:

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HHMI PROJECT NO. 1911-001

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EXECUTIVE SUMMARY

H & H Monitoring, Inc. (HHMI) was retained by ASI Environmental Technologies, Inc. (ASI) to perform an emissions evaluation on the Oil Quench Chamber Stack with Safety Flare and Post-Flame Curtain stack associated with Flexible Group (FG-HEATTREAT) identified in Permit No. 47-19. The testing was performed at the Bodycote Thermal Processing, Inc. facility in Romulus, Michigan. HHMI performed the evaluation to provide NMVOC emissions data to develop NMVOC emission factors for the Heat Treat Furnaces installed at the Bodycote plant in Romulus, Michigan. The testing was performed in accordance with the procedures stipulated in USEPA Reference Methods. HHMI professionals conducted the field services on December 17, 2019. Representatives of ASI and Bodycote coordinated the testing with plant operations. Michigan Department of Environment, Great Lakes and Energy (EGLE) provided observance of the testing activities. Summaries of the results are presented below.

SUMMARY OF RESULTS

Source	Safety Flare		Hood	
Furnace Condition	Non-Quench	Quench	Non-Quench	Quench
Methane Emissions (lb/hr as propane):	0.0409	0.0772	0.1037	0.1489
VOC Emission (lb/hr as propane):	0.0450	0.0893	0.1122	0.1736
NMVOC Emission (lb/hr as propane):	0.0041	0.0121	0.0086	0.0247
NMVOC Emitted During Test (lbs as propane):	0.0396	0.0099	0.0828	0.0202

Emission Factor Determination	Non-Quench	Quench	Total
Total NMVOC Emitted per Condition (lbs)	0.1225	0.0301	0.1526
Weight of Parts Processed Including rack (lbs)	3750	3750	3750
Emission Factor (lbs NMVOC/Ton of Metal)	0.0653	0.0161	0.0814
Annual Emission (Ton NMVOC/year/Furnace)	0.0533	0.0131	0.0664
Annual Emission (Ton NMVOC/year/3Furnaces)	0.1600	0.0393	0.1993

1.0 INTRODUCTION

HHMI performed testing to determine non-methane volatile organic compounds (NMVOC) emissions and NMVOC emission factors conducted at the Bodycote plant in Romulus, Michigan. The testing was performed on the Oil Quench Chamber Stack (SV-002-77F2) with safety flare and the Post-Flame Curtain stack (SV-003-77F2) associated with EU-UBQ-77F2 of Flexible Group (FG-HEATTREAT) identified in Permit to Install No. 47-19.

The purpose of this project is to provide the above described information pursuant to Condition V (1) of Permit No. 47-19. This test report serves as the verification of NMVOC emission rates from the oil quench and endothermic gas injection portions of FG-HEATTREAT.

Messrs. Brad Wallace, Troy Manning and Daniel L. Hassett on December 17, 2019, performed field services for this project. Mr. Dave Warner with ASI and Tom Anderson with Bodycote provided coordination of the testing with production operations and abatement system operations. Mr. Tom Gasloli with ELGE provided observation of the onsite testing activities.

This report presents the results obtained as well as describes the techniques used in the performance of this testing study. A description of the 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 testing data. Figures 1 through 3 present test locations and sampling trains. Appendix A presents example calculations for the test run. Appendix B includes quality assurance information. Appendix C presents calculation data spreadsheets and copies of original field data sheets. Appendix D contains copies of raw analyzer concentration data. Appendix E presents process operating data. Appendix F includes a copy of the test plan and the EGLE test plan acceptance letter.

2.0 PROCESS DESCRIPTION

Bodycote has three natural gas-fired carbonitriding integral oil quench furnaces, each with natural gas-fired burners, endothermic gas injection, anhydrous ammonia injection, safety flare, and flame curtain. Heat treatment is any one of several controlled heating and cooling operations used to bring about a desired change in the physical properties of a metal. FG-HEATTREAT is limited to processing 4,900 tons of metal per year. The furnaces typically operate in batch cycles of approximately 9 hours each, plus the quench cycles. The operating parameters that regulate the process is dependent on specific metal materials and the desired finished properties of the metal. Each furnace utilizes a gas flare to burn off excess gases emitted from the heat treat and oil quench chambers. The furnace has a hooded and vented flame curtain at the furnace loading door where metal parts are introduced to and removed from the furnace. The safety flare on the oil quench chamber stack operates continuously while the flame curtain at the furnace loading door operates by a switch only when the furnace door is opened. Neither the safety flare nor flame curtain has a rated control capacity.

Production data recorded during each series of test runs is provided in Appendix E.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 Site-Specific and Method Deviations

A single test run was conducted in order to cover an entire batch duration. The batch during the test run transpired over a 10-hour, 30-minute period which included 49 minutes of quench time. Three exhaust gas volumetric flow rate and moisture content determinations were made over the duration of the test run.

HHMI utilized two dual detector total hydrocarbon/methane analyzers (JUM 109A) to obtain NMVOC measurements. VOC and methane were measured using total hydrocarbon analyzers equipped for simultaneous methane measurement. The instruments were calibrated using USEPA Protocol 1 propane and methane calibration gas standards.

As requested by Mr. Mark Dziadosz in the acceptance letter, a single test run was performed over the entire duration of the heat treat batch. Pre-test and post-test USEPA Method 25A quality assurance procedures were performed.

3.2 Sampling Locations

Two test locations including the Oil Quench Chamber Stack (SV-002077F2) w/ safety flare and the Post-Flame Curtain stack (SV-003-77F2) were tested simultaneously over the entire duration of the heat treat batch Furnace ID 77-F2 processed batch No. 1338 during the testing.

The Post-Flame Curtain Stack test ports are located in the 22" diameter stack above (downstream) of the flame curtain. The equivalent diameter of the duct is 22." Two test ports are installed approximately 96" (4.36 equivalent diameters) downstream of the fume hood over the furnace loadout door and approximately 22" (1.0 equivalent diameters) upstream of the stack transition into a rain cap.

The Oil Quench Chamber Stack test ports are located in the 12" diameter stack above (downstream) of the safety flare. The equivalent diameter of the duct is 12." Two test ports are installed approximately 60" (5.0 equivalent diameters) downstream of the fume hood over the furnace loadout door and approximately 22" (1.8 diameters) upstream of the stack transition into a rain cap.

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 and 25A. 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 through 6.

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 using 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 for the volumetric flow and VOC testing. 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 each of the sampling locations. The wet-bulb procedure described in the method was used at both sampling locations. A wet-bulb temperature was determined using a moisture wick attached to the tip of a thermocouple. The wick was wetted and placed in the exhaust gas stream until a stable temperature reading was obtained. The difference in this temperature and the actual stack temperature and the stack pressure were used to perform stoichiometric calculation of water vapor pressure at stack gas conditions. Vapor pressures were then converted to percent of water vapor in the exhaust gases.

Method 25A (VOC), "*Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*," was used to measure VOC and methane concentration in the exhaust gas. JUM Engineering flame ionization detectors (FID) were used to conduct testing. Exhaust gas was withdrawn from the sample locations through a probe, heated sample line, and pump prior to being subjected to an ionization flame.

Each instrument 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 2-second intervals over the test period. The concentration of VOC is reported as equivalent units of the calibration gas (propane or methane).

In addition to the methods described above, the instruments also measure methane in the exhaust gases. The amount of methane was continuously measured using procedures similar to USEPA Method 25A. A flame ionization analyzer equipped with a proprietary design Katalyzer® to remove non-methane organic compounds was used to measure methane. The methane results were converted to terms of propane via a response factor and subtracted from the VOC concentration to obtain NMVOC.

4.0 RESULTS

The NMVOC emission results emission factor determination are presented in Tables 1 and 2, respectively, of this report. Supplemental information is provided with the field data and calculation information in Appendix C.

HHMI measured VOC and methane emissions from the Oil Quench Chamber and Post-Flame Curtain Stacks for the entire duration of the 10.5-hour batch cycle. The weight of parts processed, including the rack, was 3,750 pounds.

Two emission factors were calculated for each stack; one for during non-quench operations and one for quench operations. Non-quench operations occurred for the first 581 minutes and quench operations occurred during the final 49 minutes of the batch cycle.

The NMVOC emitted during the non-quench portion of the batch cycle was 0.1225 pound, yielding an emission factor of 0.0653 pound per ton. The NMVOC emitted during the quench portion of the batch cycle was 0.0301 pound, yielding an emission factor of 0.0161 pound per ton.

The total NMVOC emission during the entire batch cycle was 0.1526 pound, yielding an annual emission of 0.0664 ton per year for Furnace 77-F2, based on the process limit of 4900 Ton/year for FG-HEATTREAT (1633.3 T/year each Furnace).

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 November 18, 2019. The following sub-sections detail specific QA limitations and this study's compliance with those limitations.

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.

6.0 LIMITATIONS

This report is provided to Bodycote Thermal Processing, Inc., on behalf of ASI Environmental Technologies, 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 Bodycote Thermal Processing Inc. and ASI Environmental Technologies, 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 Bodycote Thermal Processing, Inc. and ASI Environmental Technologies, 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

TABLES

TABLE 1

NMVOC EMISSION
FURNACE 77-F2
BODYCOTE THERMAL PROCESSING
ROMULUS, MI
December 17, 2019

Source	SAFETY FLARE		HOOD	
Furnace Condition	**Non-Quench**	**Quench**	**Non-Quench**	**Quench**
Start Time	8:45	18:26	8:45	18:26
Stop Time	18:26	19:15	18:26	19:15
Total Time (mins)	581	49	581	49
Air Flow (scfm)	580	629	1,591	1,779
Methane Conc. (drift corrected ppmv)	23.09	40.20	22.58	29.00
Methane Response Factor	2.25	2.25	2.38	2.38
Methane as Propane (ppmv)	10.26	17.87	9.49	12.18
Methane Conc. (lb/scf as propane):	1.17E-06	2.04E-06	1.09E-06	1.39E-06
Methane Emissions (lb/hr as propane):	0.0409	0.0772	0.1037	0.1489
VOC Conc. (drift corrected ppmv as propane):	11.29	20.67	10.27	14.21
VOC Conc. (lb/scf as propane):	1.29E-06	2.37E-06	1.18E-06	1.63E-06
VOC Emission (lb/hr as propane):	0.0450	0.0893	0.1122	0.1736
NMVOC Emission (lb/hr as propane):	0.0041	0.0121	0.0086	0.0247
NMVOC Emitted (lbs as propane):	0.0396	0.0099	0.0828	0.0202

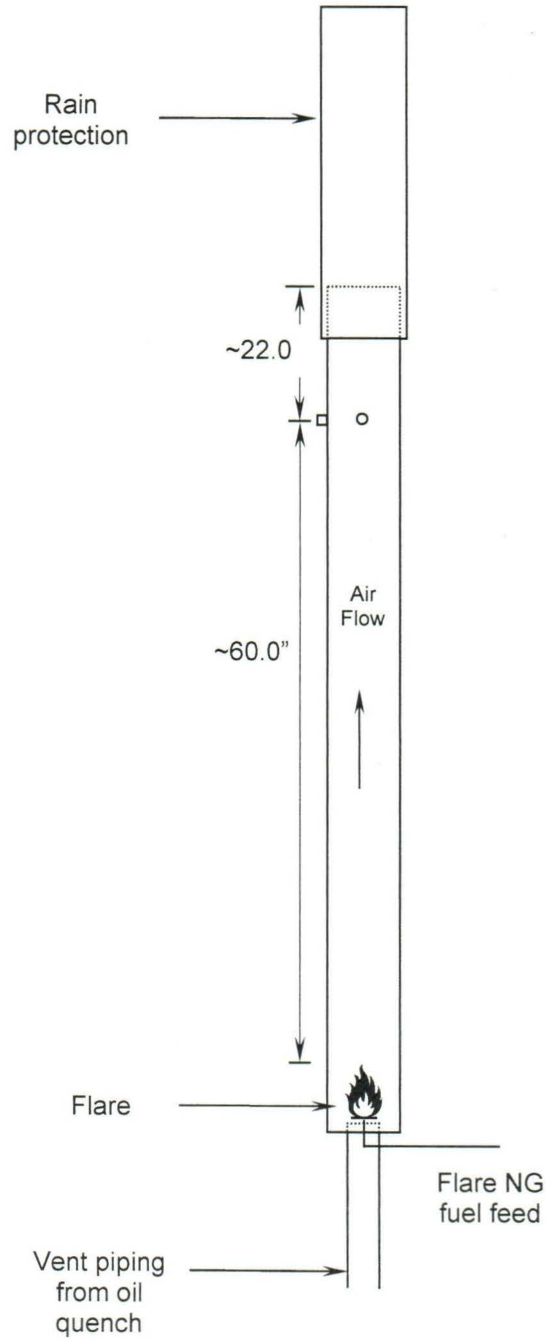
Note: Non-Quench air flow is the average of 3 air flows measured during the test run. The Quench air flow is that air flow measured nearest to the time block of data used in the calculations (1-3).

TABLE 2

NMVOC EMISSION FACTORS
FURNACE 77-F2
BODYCOTE THERMAL PROCESSING
ROMULUS, MI
December 17, 2019

Furnace Condition	Non-Quench	Quench	Total
Start Time	8:45	18:26	
Stop Time	18:26	19:15	
Total Time (mins)	581	49	
Emission Factor Determination			
Operational Limitation (Tons of metal per year per Furnace)		1633.3	
Weight of Parts Processed during test Including rack (lbs)		3750	
NMVOC Emitted (lbs)	0.1225	0.0301	0.1526
Emission Factor (lbs NMVOC/Ton of Metal)	0.0653	0.0161	0.0814
Annual Emission (Ton NMVOC/year/Furnace)	0.0533	0.0131	0.0664
Annual Emission (Ton NMVOC/year/ All 3 Furnaces)	0.1600	0.0393	0.1993

FIGURES



Traverse Point Locations	
Stack Dia.:	12
Point #	Distance from Stack wall
1	0.50
2	1.26
3	2.33
4	3.88
5	8.12
6	9.67
7	10.74
8	11.50

NO SCALE

FIGURE 1

TEST PORT AND TRAVERSE POINT LOCATION
OIL QUENCH CHAMBER STACK WITH SAFETY FLARE

PREPARED FOR

BODYCOTE THERMAL PROCESSING, INC.
ROMULUS, MICHIGAN

DRAWN DLH 11/16/19	DRAWING NUMBER 1911001-1
REVISED	
JOB NO. 1911-001	

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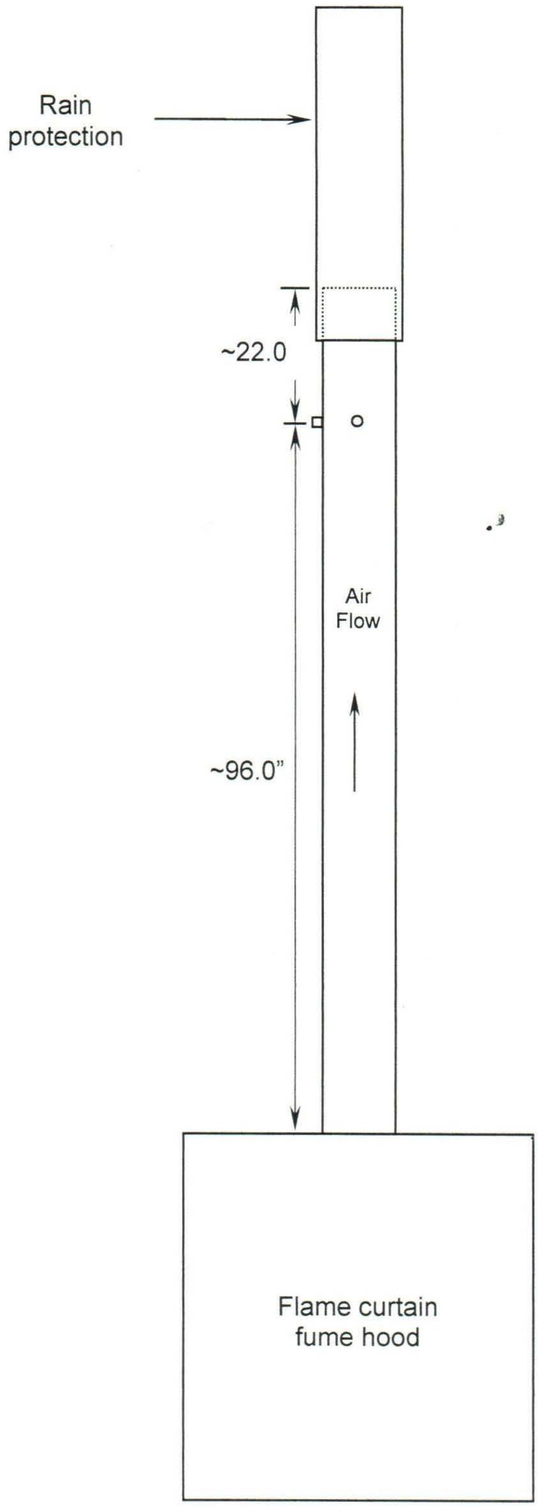

Traverse Point Locations	
Stack Dia.:	22
Point #	Distance from Stack wall
1	0.70
2	2.31
3	4.27
4	7.11
5	14.89
6	17.73
7	19.69
8	21.30

NO SCALE

FIGURE 2

TEST PORT AND TRAVERSE POINT LOCATION
POST-FLAME CURTAIN STACK

PREPARED FOR

BODYCOTE THERMAL PROCESSING, INC.
ROMULUS, MICHIGAN

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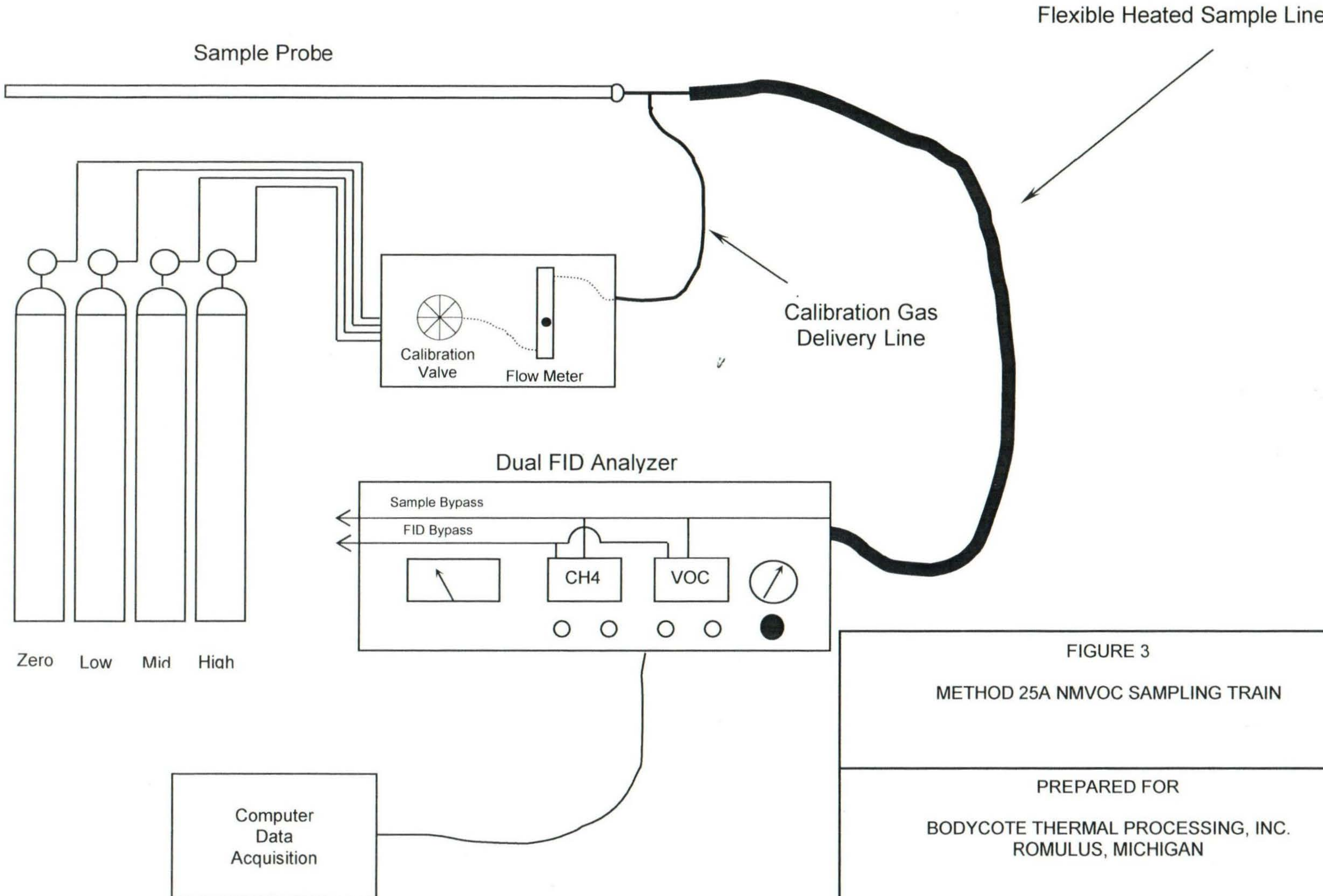

FIGURE 3

METHOD 25A NMVOC SAMPLING TRAIN

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