Prepared for:

Shell Oil Products US
17 Junction Drive
PMB#299
Glen Carbon, Illinois  62034

Regenerative Thermal Oxidizer Performance Testing Work Plan
Roxana, Illinois

Prepared by:

Geosyntec consultants

engineers | scientists | innovators
924 Anacapa Street, Suite 4A
Santa Barbara, CA 93101

Project Number: SB0659

June 14, 2013
SVE Regenerative Thermal Oxidizer
Performance Testing Work Plan

Roxana, Illinois

Prepared for:
Shell Oil Products US

Kate Graf
Senior Consultant

Robert Ettinger
Principal
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Attachment B: Pace Test Protocol
1.0 INTRODUCTION

Geosyntec Consultants (Geosyntec) has been retained by Shell Oil Products US (SOPUS) to arrange for and oversee stack testing required by the Illinois Environmental Protection Agency (IEPA). SOPUS operates a soil vapor extraction (SVE) system at a corrective action site located in the Village of Roxana, in Madison County, Illinois. The SVE system uses a blower to extract soil gas from the ground where it is passed through a knockout tank which extracts the condensate from the gas stream. The gas stream is then conveyed to a natural gas fired regenerative thermal oxidizer (RTO) to destroy hydrocarbon constituents prior to emissions. The RTO operates under an IEPA permit number 11060036 issued on July 14, 2011.

In a letter dated April 12, 2013, the IEPA requested SOPUS conduct emission testing to measure benzene and volatile organic matter (VOM) emissions at the inlet and outlet of the RTO during operation of the SVE. The testing will be conducted at a range of combustion chamber temperatures based on minimum, normal, and maximum combustion chamber temperatures for the RTO since operation began. The testing will include operating the RTO at three (3) set points to vary the combustion chamber temperatures. The set points to be tested include 1500°F, 1550°F, and 1650°F. Per IEPA, the testing is being conducted to establish the minimum acceptable temperature for the combustion chamber that will ensure compliance with the permitted emission limits, applicable emission standards, and regulatory requirements.
2.0 RTO DESCRIPTION

The RTO is located on the southwestern boundary of the Phillips 66 Wood River Refinery North Property, near the corner of Chaffer Street and 8th Street in the Village of Roxana. The RTO is an Anguil Environmental system designed to treat 10,000 standard cubic feet per minute (SCFM). The hydrocarbon mass loading rate for the inlet to the RTO is expected to be 75 to 100 lb/hr, with an outlet hydrocarbon emission rate of 2 to 5 lb/hr. The general arrangement drawing for the RTO is provided in the Attachment A.
3.0 PERFORMANCE TEST PROCEDURES

The testing will include three (3) operating scenarios (maximum temperature, normal operating temperature, and minimum temperature). During testing the SVE system will be operating. The testing shall be conducted at the inlet and outlet locations simultaneously. During testing parametric monitoring will be conducted to monitor inlet and outlet temperature. Testing at each location will be conducted in accordance with the following United States Environmental Protection Agency (USEPA) Reference Methods:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Method</th>
<th>Procedure</th>
<th>Number of Runs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traverse Points</td>
<td>USEPA Method 1</td>
<td>Linear Measurements</td>
<td>1</td>
</tr>
<tr>
<td>Volumetric Airflow</td>
<td>USEPA Method 2</td>
<td>Pitot Tube</td>
<td>3</td>
</tr>
<tr>
<td>Gas Composition O₂ and CO₂</td>
<td>USEPA Method 3A</td>
<td>Instrumental Analyzer</td>
<td>3</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>USEPA Method 4</td>
<td>Impinger Condensate</td>
<td>3</td>
</tr>
<tr>
<td>Benzene</td>
<td>USEPA Method 18</td>
<td>Tedlar Bag and GC/MS</td>
<td>3</td>
</tr>
<tr>
<td>Total Hydrocarbons</td>
<td>USEPA Method 25A</td>
<td>Instrumental Analyzer - FID</td>
<td>3</td>
</tr>
</tbody>
</table>

Stack testing will be performed by Pace Analytical Field Services Division (Pace). Pace adheres to the ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies and has an interim accreditation with the Source Testing Accreditation Council. The attached test protocol from Pace provides additional information on Pace’s experience and details of the planned stack testing.
4.0 REPORTING

Within 60 days of completion of the RTO performance test, Geosyntec will submit a test report to IEPA. The test report will include a summary table of test results and the identification, location, and description of the emission units tested, as well as the names of the testing firm, personnel performing testing, and agency personnel observing testing. The report will provide a description of test procedures utilized in testing, description of the sampling locations, map of sample points, and details of the testing and analysis equipment used. The SVE operating conditions, RTO operating conditions, raw data sheets, laboratory analysis, calculations, equipment calibration information, quality control evaluation data, and an explanation of any discrepancies or anomalies in the test data will be included in the test report.
5.0 SCHEDULE

The proposed schedule for the testing and submittal of a test report to the IEPA is as follows:

- Five (5) Days Prior to Testing: Confirm the exact date and time of the testing with IEPA to enable IEPA representatives to witness the test.

- Week of June 17, 2013: Conduct Emission Testing (within 90 days from receipt of letter requesting testing). We anticipate 2 – 3 days are necessary to conduct the field activities associated with the emission testing.

- Within 30 Days of the Test Date: Obtain test results from stack testing firm

- Within 60 Days of the Test Date: Submit test results to IEPA

Geosyntec would like to conduct the performance test the week of 24 June 2013. The testing dates are dependent on (i) written approval from the Compliance Section Manager (ii) coordination with Phillips 66 refinery, and (iii) confirmation of availability with the stack testing firm.
APPENDIX A

INLET AND OUTLET SAMPLING LOCATION DETAILS
Inlet Sampling Location

Inlet Duct
RTO Inlet Sample Port Location

Dimensions:
- 65.6 in.
- 42 in.
- 21.0 in.
- 21.1 in.
- 5.53 in.
Outlet Sampling Location

Ports constructed of 1/8 inch stainless steel tubing.

Sample Port

Pitot Tube/Differential Pressure Port
APPENDIX B

PACE TEST PROTOCOL
Total Hydrocarbons and Benzene Emissions Testing Protocol

Plant Name: Conoco Phillips
Wood River Refinery
Protocol Date: May 31, 2013
Revision Date: June 14, 2013
Testing Dates: June 25-26, 2013

Client Test Coordinator:
Kate Graf
Geosyntec Consultants
1787 Sentry Parkway West
Building 18, Suite 120
Blue Bell, PA  19422
Telephone No.: (267) 419-3103
Facsimile No.: (267) 401-1554
E-mail Address: kgraf@geosyntec.com

Testing Firm Coordinator:
Paul Robinson
Pace Analytical Services, Inc.
1700 Elm Street, Suite 200
Minneapolis, MN  55414
Telephone No.: (612) 607-6432
Facsimile No.: (612) 607-6388
E-mail Address: paul.robinson@pacelabs.com

Subject Facility:
Conoco Phillips
Wood River Refinery
900 South Central Avenue
Roxana, IL  62084

Regulatory Permit No.: 

Subject Emission Sources:
Vapor Extraction System

Test Locations:
RTO Inlet
RTO Outlet
Plant/Source Information

Subject Facility: Conoco Phillips
Wood River Refinery
900 South Central Avenue
Roxana, IL 62084

Plant Contact: Kate Graf
Company Affiliation: Geosyntec Consultants/Conoco Phillips
Office Address: 900 South Central Avenue
Roxana, IL 62084

Telephone Number: (267) 419-3103
Facsimile Number: (267) 401-1554
E-mail Address: kgraf@geosyntec.com

Reason for Test: Emissions Permit Requirement

Testing Firm Information

Project Contact: Paul Robinson
Testing Firm: Pace Analytical Services, Inc.
Office Location: 1700 Elm Street, Suite 200
Minneapolis, MN 55414
Telephone Number: (612) 607-6432
Facsimile Number: (612) 607-6388
E-mail Address paul.robinson@pacelabs.com

Subcontractors: Enthalpy Analytical

Regulatory Contact Information

Regulatory Agency: Illinois Environmental Protection Agency
Testing Contact:
Office Location: 1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794
Telephone Number: (217) 782-3397
Facsimile Number:
E-mail Address
Note: Chart based on anticipated participants at the time of protocol development and is subject to change.
Target Operating Conditions: Minimum, Normal, Maximum Temperature Conditions

The confidential client operates a soil vapor extraction system (SVE) which uses a blower to extract soil gas from the ground where it is passed through a knockout tank to extracts the condensate from the gas stream. The gas stream is conveyed to a natural gas fired regenerative thermal oxidizer (RTO) to destroy hydrocarbon constituents. The RTO manufacturer is Anguil Environmental and designed to treat 10,000 standard cubic feet per minute (SCFM). The hydrocarbon emission rate on the inlet to the RTO is expected to be 75 to 100 lb/hr, with an outlet hydrocarbon emission rate of 2 to 5 lb/hr.

For this test event three (3) operating scenarios (maximum temperature, normal operating temperature, and minimum temperature) will be set on the RTO to establish the minimum acceptable temperature for the RTO. The RTO combustion temperature set points for this test event will be:

- Test 1 – 1500F
- Test 2 – 1550F
- Test 3 – 1650F

Operation data will be collected during the test event and included in the test report.

Testing Schedule

Plant operations will begin preparing the process for the target operating conditions in the early morning of Tuesday, June 25th, 2013. At approximately 0800 hours, the test team will contact the plant coordinator to verify operation at target conditions. If the plant processes and test equipment are ready, sampling will commence shortly thereafter.

Testing is presently planned for the following schedule:

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel</td>
<td>Set up/Test</td>
<td>Test</td>
<td>Contingency</td>
<td></td>
</tr>
</tbody>
</table>

The final test report will be submitted to the Illinois Environmental Protection Agency within 60 days of the completion of testing. In cases where multiple sources are tested during a single mobilization, the last day of testing will dictate the start of the 60 days. All sources evaluated during a mobilization will be summarized in a single report.
### Emissions Testing Constituents

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Source Identification</th>
<th>Regulated Constituents</th>
<th>Applicable Rules or Regulations</th>
<th>Emission Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTO Inlet</td>
<td>Total Hydrocarbons</td>
<td>NA</td>
<td>To be determined</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
<td>NA</td>
<td>To be determined</td>
<td></td>
</tr>
</tbody>
</table>

### Process Monitoring Parameters

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Process Parameter</th>
<th>Monitoring Method</th>
<th>Target Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature</td>
<td>Continuous monitoring</td>
<td>To be determined</td>
</tr>
</tbody>
</table>

### Emissions Testing Methods

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Method</th>
<th>No. of Runs</th>
<th>Length of Run</th>
<th>Sample Vol/Rate</th>
<th>Report Units</th>
<th>Detection Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate Test Ports &amp; Trvs Point</td>
<td>EPA Method 1 (details below)</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Volumetric Airflow</td>
<td>EPA Method 2</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>ACFM DSCFM</td>
<td>4 Ft./Sec.</td>
</tr>
<tr>
<td>Gas Composition Instrumental</td>
<td>EPA Method 3A</td>
<td>3</td>
<td>1 Hour</td>
<td>1 LPM</td>
<td>% v/v</td>
<td>0.1 % v/v</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>EPA Method 4</td>
<td>3</td>
<td>1 Hour</td>
<td>0.5 CFM</td>
<td>% v/v Mole. Wt.</td>
<td>0.3 % v/v</td>
</tr>
<tr>
<td>Benzene</td>
<td>EPA Method 18</td>
<td>3</td>
<td>1 Hour</td>
<td>6 Liters</td>
<td>PPM v/v LB/HR</td>
<td>1 PPB v/v</td>
</tr>
<tr>
<td>Total Gaseous Organic Compounds</td>
<td>EPA Method 25A</td>
<td>3</td>
<td>1 Hour</td>
<td>1 LPM</td>
<td>PPM v/v LB/HR</td>
<td>2 PPM v/v</td>
</tr>
</tbody>
</table>

**Test Location Details:** Test site details are not currently available. All airflow measurements will be conducted at test locations that meet Method 1 requirements and documented in the final report.

**Special Considerations:**
1) Absence of cyclonic flow will be verified at all airflow test locations per procedures outlined in Section 11.4 of EPA Method 1.
2) Airflow measurements will be conducted twice during each test run per EPA Method 2 requirements.
### Emissions Testing Constituents

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Source Identification</th>
<th>Regulated Constituents</th>
<th>Applicable Rules or Regulations</th>
<th>Emission Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTO Outlet</td>
<td>Total Hydrocarbons</td>
<td>Permit Condition 3a</td>
<td>To be determined</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benzene</td>
<td>Permit Condition 3b</td>
<td>To be determined</td>
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</table>

### Process Monitoring Parameters

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Process Parameter</th>
<th>Monitoring Method</th>
<th>Target Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature</td>
<td>Continuous monitoring</td>
<td>To be determined</td>
</tr>
<tr>
<td></td>
<td>Total Maximum Firing Rate</td>
<td>To be determined</td>
<td>As stipulated in Permit Condition 3c</td>
</tr>
</tbody>
</table>

### Emissions Testing Methods

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Method</th>
<th>No. of Runs</th>
<th>Length of Run</th>
<th>Sample Vol/Rate</th>
<th>Report Units</th>
<th>Detection Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate Test Ports &amp; Trvs Point</td>
<td>EPA Method 1</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Volumetric Airflow</td>
<td>EPA Method 2</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>ACFM DSCFM</td>
<td>4 Ft./Sec.</td>
</tr>
<tr>
<td>Gas Composition Instrumental</td>
<td>EPA Method 3A</td>
<td>3</td>
<td>1 Hour</td>
<td>1 LPM</td>
<td>% v/v</td>
<td>0.1 % v/v</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>EPA Method 4</td>
<td>3</td>
<td>1 Hour</td>
<td>0.5 CFM</td>
<td>% v/v</td>
<td>0.3 % v/v</td>
</tr>
<tr>
<td>Benzene</td>
<td>EPA Method 18</td>
<td>3</td>
<td>1 Hour</td>
<td>6 Liters</td>
<td>PPM v/v LB/HR</td>
<td>1 PPB v/v</td>
</tr>
<tr>
<td>Total Gaseous Organic Compounds</td>
<td>EPA Method 25A</td>
<td>3</td>
<td>1 Hour</td>
<td>1 LPM</td>
<td>PPM v/v LB/HR</td>
<td>2 PPM v/v</td>
</tr>
</tbody>
</table>

Test Location Details: Test site details are not currently available. All airflow measurements will be conducted at test locations that meet Method 1 requirements and documented in the final report.

Special Considerations: 1) Absence of cyclonic flow will be verified at all airflow test locations per procedures outlined in Section 11.4 of EPA Method 1.
2) Airflow measurements will be conducted twice during each test run per EPA Method 2 requirements.
A final test report will be compiled by Pace Analytical at the completion of testing. The report will be submitted to the client within 30 days of the last day of sampling. The client will be responsible for submitting report copies as required by regulatory agencies. Two electronic copies of the test report on CD-ROM will be included with hardbound copies of the report. The final test report will include the following information:

- Name and location of emission facility.
- Identification of emission unit.
- Date of tests.
- Name and address of testing company.
- Certification of project information (client signatures also required).
- Reasons and constituents for test.
- Names of observers and witnesses.
- Emission results expressed in the units of the emission limitation criteria.
- Process descriptions as provided by the client.
- Process rate information as provided by the client.
- Descriptions of maintenance activities as provided by the client.
- Discussions of problems or errors encountered.
- Sampling and analytical procedures.
- Analytical results of fuels or process samples as appropriate.
- Dimensioned drawing of sampling location.
- Copies of raw field data.
- Copies of laboratory analytical reports.
- Calculation equations.
- Sampling train calibration data.
- Laboratory quality assurance information as appropriate.
- Copy of this test plan and other pertinent pretest correspondence.
Safety Considerations

Safety is an important aspect of sampling programs, especially when test teams and observers are in unfamiliar plant surroundings. Plants are required to provide test ports, safe test platforms and access routes. The test firm is required to follow plant safety protocols and rules as well as their own safety program. Attention must be given to special considerations related to testing such as overhead work, solvent usage, compressed gases, flammable materials, open ports and electrical appliances. Observers and regulatory witnesses must comply with both plant and test firm safety protocols. Pace cannot provide PPE for visitors and observers. The following protocols and Personal Protection Equipment (PPE) will be required for this site.

<table>
<thead>
<tr>
<th>Safety Requirements</th>
<th>Pace Protocol</th>
<th>Plant Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Smoking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Safety Shoes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Metatarsal Guards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESD Shoes or Strap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard Hat</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Safety Glasses</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Full-Face Shield</td>
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<td></td>
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<tr>
<td>Chemical Resistant Gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abrasion Resistant Gloves</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Temperature Insulating Gloves</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Full Length Trousers (Waist to Ankle)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Long-Sleeved Shirt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Retardant Clothing</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Chemical Resistant Suit/Clothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Facial Hair</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dust Respirator</td>
<td></td>
<td></td>
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<tr>
<td>Half-Face Air Purifying Respirator</td>
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</tr>
<tr>
<td>Full-Face Air Purifying Respirator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self Contained Breathing Apparatus</td>
<td></td>
<td></td>
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<tr>
<td>Supplied Air Respirator</td>
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<td></td>
</tr>
<tr>
<td>Plant Security Log In</td>
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<td></td>
</tr>
<tr>
<td>Plant Safety Training</td>
<td>X</td>
<td></td>
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<tr>
<td>Plant Escort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spark Permit/Protocols</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Electronic Device Restrictions</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Designated Break/Smoking Areas</td>
<td>X</td>
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<tr>
<td>Safety Climb System</td>
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</tr>
<tr>
<td>Fall Protection (Harness/Tie-off)</td>
<td>X</td>
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<tr>
<td>Attachment 1</td>
<td>Test Location Schematic(s)</td>
<td></td>
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<tr>
<td>-------------</td>
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<td></td>
</tr>
<tr>
<td>Attachment 2</td>
<td>Abbreviations, Symbols, and Nomenclature</td>
<td></td>
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<tr>
<td>Attachment 3</td>
<td>Calculation Equations</td>
<td></td>
</tr>
<tr>
<td>Attachment 4</td>
<td>Method Summaries</td>
<td></td>
</tr>
<tr>
<td>Attachment 5</td>
<td>Quality Statement</td>
<td></td>
</tr>
</tbody>
</table>
Attachment 1
Test Location Schematic(s)

To be included in test report.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Hg</td>
<td>Inches of Mercury (pressure)</td>
</tr>
<tr>
<td>&quot;WC</td>
<td>Inches Water Column (pressure)</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees Centigrade or Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Degrees Fahrenheit</td>
</tr>
<tr>
<td>°K</td>
<td>Degrees Kelvin (absolute)</td>
</tr>
<tr>
<td>°R</td>
<td>Degrees Rankin (absolute)</td>
</tr>
<tr>
<td>% v/v</td>
<td>Percent by volume</td>
</tr>
<tr>
<td>% w/w</td>
<td>Percent by weight</td>
</tr>
<tr>
<td>ACFM</td>
<td>Actual Cubic Feet per Minute</td>
</tr>
<tr>
<td>AP-42</td>
<td>Compilation of Air Pollutant Emission Factors, Volume I, Stationary Point and Area Sources.</td>
</tr>
<tr>
<td>BACT</td>
<td>Best Available Control Technology</td>
</tr>
<tr>
<td>BH</td>
<td>Baghouse</td>
</tr>
<tr>
<td>BHP</td>
<td>Brake Horsepower</td>
</tr>
<tr>
<td>BTU</td>
<td>British Thermal Unit</td>
</tr>
<tr>
<td>c</td>
<td>Centimeter</td>
</tr>
<tr>
<td>c³</td>
<td>Cubic Centimeter</td>
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<tr>
<td>cc</td>
<td>Cubic Centimeter</td>
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<tr>
<td>CAA</td>
<td>Clean Air Act</td>
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<tr>
<td>CAAA</td>
<td>Clean Air Act Amendments</td>
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<td>CE</td>
<td>Control Equipment (in Reg. ID Nos.)</td>
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<tr>
<td>CE</td>
<td>Control Efficiency</td>
</tr>
<tr>
<td>CEM</td>
<td>Continuous Emissions Monitor</td>
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<td>FT³</td>
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<td>Nitrogen Oxides (quantified as NO₂)</td>
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<td>Particulate Matter with and aerodynamic diameter equal to or less than 10 microns</td>
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<td>Description</td>
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<tr>
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<td>Particulate Matter with an aerodynamic diameter equal to or less than 2.5 microns</td>
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<td>Parts Per Million</td>
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<td>Part Per Million by volume</td>
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<td>PPMv-dry</td>
<td>Parts Per Million by volume, dry basis</td>
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<tr>
<td>PPMv-wet</td>
<td>Parts Per Million by volume, wet basis</td>
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<tr>
<td>PPMw</td>
<td>Parts Per Million by Weight (mg/l)</td>
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<tr>
<td>PSIA</td>
<td>Pounds per Square Inch, Absolute</td>
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<tr>
<td>PSIG</td>
<td>Pounds per Square Inch, Gauge</td>
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<td>PTE</td>
<td>Permanent Total Enclosure</td>
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<tr>
<td>RA</td>
<td>Relative Accuracy</td>
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<td>RATA</td>
<td>Relative Accuracy Test Audit</td>
</tr>
<tr>
<td>rH</td>
<td>Relative Humidity</td>
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<tr>
<td>RTO</td>
<td>Regenerative Thermal Oxidizer or Recuperative Thermal Oxidizer</td>
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<tr>
<td>SCF</td>
<td>Standard Cubic Feet</td>
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<tr>
<td>SCFM</td>
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</tr>
<tr>
<td>scm</td>
<td>Standard Cubic Meter</td>
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<tr>
<td>scmm</td>
<td>Standard Cubic Meter per Minute</td>
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<td>Scr.</td>
<td>Scrubber</td>
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<td>Standard Industrial Classification</td>
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<td>SO$_2$</td>
<td>Sulfur Dioxide</td>
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<tr>
<td>SO$_x$</td>
<td>Sulfur Oxides</td>
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<td>Square Feet</td>
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<td>Thermal Conductivity Detector</td>
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<td>TO</td>
<td>Thermal Oxidizer</td>
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<tr>
<td>TPD</td>
<td>Tons Per Day</td>
</tr>
<tr>
<td>TPH</td>
<td>Tons Per Hour</td>
</tr>
<tr>
<td>TPY</td>
<td>Tons per year</td>
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<tr>
<td>TRS</td>
<td>Total Reduced Sulfur</td>
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<tr>
<td>TSP</td>
<td>Total Suspended Particulate Matter</td>
</tr>
<tr>
<td>TTE</td>
<td>Temporary Total Enclosure</td>
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<td>USEPA</td>
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<tr>
<td>VHAP</td>
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<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
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<td>VOCs</td>
<td>Volatile Organic Compounds</td>
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<td>WC</td>
<td>Water Column</td>
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<td>WDGS</td>
<td>Wet Distiller’s Grains with Solubles</td>
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### State Environmental Agency Acronyms

<table>
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<tr>
<th>Acronym</th>
<th>State and Agency Name</th>
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<tr>
<td>ADEM</td>
<td>Alabama Department of Environmental Management</td>
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<tr>
<td>ADEC</td>
<td>Alaska Department of Environmental Conservation</td>
</tr>
<tr>
<td>ADEQ</td>
<td>Arizona Department of Environmental Quality</td>
</tr>
<tr>
<td>ADEQ</td>
<td>Arkansas Department of Environmental Quality</td>
</tr>
<tr>
<td>CARB</td>
<td>California Air Resources Board</td>
</tr>
<tr>
<td>CDPHE</td>
<td>Colorado Department of Public Health &amp; Environment</td>
</tr>
<tr>
<td>CDEP</td>
<td>Connecticut Department of Environmental Protection</td>
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<tr>
<td>DNREC</td>
<td>Delaware Natural Resources &amp; Environmental Control</td>
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<tr>
<td>FDEP</td>
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<tr>
<td>GEPA</td>
<td>Georgia Environmental Protection Agency</td>
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<td>Illinois Environmental Protection Agency</td>
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<td>IDEM</td>
<td>Indiana Department of Environmental Management</td>
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<td>IDNR</td>
<td>Iowa Department of Natural Resources</td>
</tr>
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<td>KDHE</td>
<td>Kansas Department of Health &amp; Environment</td>
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<td>Kentucky Department for Environmental Protection</td>
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<td>Louisiana Department of Environmental Quality</td>
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<td>Massachusetts Department of Environmental Protection</td>
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<td>Nebraska Department of Environmental Quality</td>
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<td>New Hampshire Department of Environmental Services</td>
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<td>New Jersey Department of Environmental Protection</td>
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<td>New Mexico Environment Department</td>
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<td>NYSDEC</td>
<td>New York State Department of Environmental Conservation</td>
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<td>NCDENR</td>
<td>North Carolina Department of Environment &amp; Natural Resources</td>
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<td>OEPA</td>
<td>Ohio Environmental Protection Agency</td>
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<td>Oklahoma Department of Environmental Quality</td>
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<td>Oregon Department of Environmental Quality</td>
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<td>South Dakota Department of Environment &amp; Natural Resources</td>
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<tr>
<td>WDNSR</td>
<td>Wisconsin Department of Natural Resources</td>
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</table>
EPA Method 2 Calculations

Flue Gas Linear Velocity

\[
V_s = 85.49 \times C_p \times \sqrt{\Delta P} \times \sqrt{\frac{T_s}{P_s \times M_s}}
\]

Volumetric Flow Rates - ACFM, SCFM & DSCFM

\[
Q = 60 \times v_s \times A
\]

\[
Q_s = Q \times \left( \frac{528}{T_s} \right) \times \left( \frac{P_s}{29.92} \right) = Q \times 17.647 \times \left( \frac{P_s}{T_s} \right)
\]

\[
Q_{sd} = Q_s \times (1 - B_{ws})
\]

Mass Flow Rate of Wet Flue Gas

\[
m_g = \frac{4.995 \times Q_{sd} \times G_d}{1 - B_{ws}}
\]

Actual Gas Density

\[
\rho = \frac{0.04585 \times P_s \times M_s}{T_s}
\]

Where:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Cross-sectional area of duct at sample point (sq. ft.).</td>
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<tr>
<td>B_{ws}</td>
<td>Water vapor in gas stream (proportion by volume).</td>
</tr>
<tr>
<td>C_p</td>
<td>Pitot tube calibration coefficient.</td>
</tr>
<tr>
<td>G_d</td>
<td>Flue gas specific gravity relative to air, dimensionless.</td>
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<tr>
<td>m_g</td>
<td>Mass flow rate of wet flue gas (LB/HR).</td>
</tr>
<tr>
<td>M_s</td>
<td>Molecular weight of wet flue gas (LB/LB-mole).</td>
</tr>
<tr>
<td>P_s</td>
<td>Absolute gas pressure of duct (Inches Hg).</td>
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<tr>
<td>\Delta P</td>
<td>Velocity pressure measured by pitot tube (Inches WC).</td>
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<tr>
<td>Q</td>
<td>Actual flue gas volumetric flow rate (ACFM).</td>
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<tr>
<td>Q_s</td>
<td>Volumetric gas flow at standard conditions (SCFM).</td>
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<tr>
<td>Q_{sd}</td>
<td>Dry standard volumetric gas flow rate (DSCFM).</td>
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<tr>
<td>T_s</td>
<td>Flue gas temperature (°R).</td>
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<tr>
<td>V_s</td>
<td>Flue gas linear velocity (feet per second).</td>
</tr>
<tr>
<td>\rho</td>
<td>Actual flue gas density (LB/CF).</td>
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</table>
EPA Method 3 Calculations

Dry Molecular Weight of Flue Gas

\[ M_d = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + (0.28 \times (\%N_2 + \%CO)) \]

Wet Molecular Weight of Flue Gas

\[ M_s = M_d \times (1 - B_{wS}) + (18 \times B_{wS}) \]

Percent Excess Air

\[ \%EA = 100 \times \left( \frac{\%O_2 - (0.05 \times \%CO)}{(0.264 \times \%N_2) - \%O_2 + (0.5 \times \%CO)} \right) \]

Fuel F-factor (for comparison)

\[ F_0 = \frac{20.9 - \%O_2}{\%CO_2} \]

Where:

- \( B_{wS} \) = Water vapor in gas stream (proportion by volume).
- \( \%CO \) = Carbon monoxide in gas stream (percent).
- \( \%CO_2 \) = Carbon dioxide in gas stream (percent).
- \( \%EA \) = Excess air for combustion (percent).
- \( F_0 \) = Fuel F-factor for results comparison.
- \( M_d \) = Molecular weight of dry flue gas (LB/LB-mole).
- \( M_s \) = Molecular weight of wet flue gas (LB/LB-mole).
- \( \%N_2 \) = Nitrogen in gas stream (percent).
- \( \%O_2 \) = Oxygen in gas stream (percent).
**EPA Method 4 Calculations**

**Sample Volume, Standard Conditions**

\[
V_{std} = 17.647 \times V_m \times Y \times \left(\frac{P_b + \Delta H}{13.6} \right) \div T_m
\]

**Volume of Water Vapor Sampled**

\[
V_w = 0.047070 \times V_{lc}
\]

**Proportion of Water Vapor in Sampled Gas**

\[
B_{ws} = \frac{V_w}{V_w + V_{std}}
\]

**Moisture Content of Sampled Gas**

\[
MC = B_{ws} \times 100
\]

Where:

- \(B_{ws}\) = Water vapor in gas stream (proportion by volume).
- \(\Delta H\) = Orifice meter differential pressure (Inches WC).
- \(MC\) = Moisture Content, % v/v
- \(P_b\) = Barometric pressure (Inches Hg).
- \(T_m\) = Sampling train meter temperature (°R).
- \(V_{lc}\) = Total volume of liquid collected in sampling train (mls).
- \(V_m\) = Volume of gas sample measured by gas meter (CF).
- \(V_{std}\) = Gas volume corrected to standard conditions (DSCF).
- \(V_w\) = Volume of water vapor in gas sample (SCF).
- \(Y\) = Dry gas meter calibration coefficient.
Psychometric Moisture Content

Saturated Water Vapor Pressure

\[ V_{P_s} = \text{Value indexed from Vapor Pressure of Water Table (29.92" Hg)} \]

Source Gas Water Vapor Pressure

\[ V_{P_a} = V_{P_s} - (0.000367 \times P_s \times (T_{db} - T_{wb}) \times (1 + ((T_{wb} - 32) / 1571))) \]

Moisture Content

\[ MC\% = 100 \times V_{P_a} / P_s \]

Where:

- \( MC\% \) = Moisture content of stack gas, percent by volume.
- \( P_s \) = Absolute pressure of stack gas, inches Hg.
- \( T_{db} \) = Dry bulb temperature measurement, °F.
- \( T_{wb} \) = Wet bulb temperature measurement, °F.
- \( V_{P_a} \) = Vapor pressure of stack gas, inches Hg.
- \( V_{P_s} \) = Saturated vapor pressure at wet bulb temperature and 29.92 inches Hg.

### VAPOR PRESSURE OF WATER ("Hg)

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<th>3</th>
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<td>27.82</td>
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<td>19.47</td>
<td>22.13</td>
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Volatile Organic Compound Calculations

Weight/Volume Concentration

\[ C_{VOC} = \frac{m_{VOC}}{V_{std}} \]

Volume/Volume Concentration

\[ C_{PPM} = \frac{C_{voc} \times 24.04}{MW_{VOC}} \]

VOC Emission Rate

\[ E_{VOC} = (6.242 \times 10^{-8}) \times 60 \times C_{VOC} \times DSCFM \]

Where:
- \( C_{VOC} \) = Volatile organic compound (VOC) concentration, mg/dscm
- \( C_{PPM} \) = Volatile organic compound (VOC) concentration, PPM v/v
- DSCFM = Volumetric airflow, Dry Standard Cubic Feet per Minute
- \( E_{VOC} \) = Volatile organic compound (VOC) emission rate, LB/HR
- \( M_{VOC} \) = Mass of volatile organic compound collected, µg
- \( MW_{VOC} \) = Molecular weight of volatile organic compound
- \( V_{std} \) = Standard volume of air sample, liters
- \( 60 \) = Conversion from minutes to hours
- \( (6.242 \times 10^{-8}) \) = Conversion from mg/dscm to LB/DSCF
Control Efficiency Calculations

Capture Efficiency of Volatile Organic Compounds

\[ E_C = \frac{MR_{VOC_{in}}}{MR_{VOC_{in}}} \times 100 \]

Destruction/Reduction Efficiency of Volatile Organic Compounds

\[ E_{DR} = \frac{MR_{VOC_{in}} - MR_{VOC_{out}}}{MR_{VOC_{in}}} \times 100 \]

Control Efficiency of Volatile Organic Compounds

\[ E_T = \frac{E_C \times E_{DR}}{100} \]

Where:
- \( E_C \) = Capture Efficiency, percentage of VOC captured by exhaust versus VOC released based on carbon (percent).
- \( E_{DR} \) = Destruction/Removal Efficiency of pollution control device (percent).
- \( E_T \) = Total control or reduction efficiency based capture and destruction/removal efficiencies (percent).
- \( MR_{VOC_{Rls}} \) = Mass Rate of VOC released from process based on VOC usage and volatile carbon analyses of formulations (LB/HR_{carbon}).
- \( MR_{VOC_{in}} \) = Mass Rate of VOC measured at pollution control device inlet (LB/HR_{carbon}).
- \( MR_{VOC_{Out}} \) = Mass Rate of VOC measured at pollution control device outlet (LB/HR_{carbon}).
Instrumental Analyzer Calculations
EPA Methods 3A, 6C, 7E and 10

Analyzer Calibration Error

\[ A_E = \frac{C_{AR} - C_{Cyl}}{S_{FS}} \times 100 \]

System Calibration Bias

\[ B_{Sys} = \frac{C_{SR} - C_{AR}}{S_{FS}} \times 100 \]

System Drift

\[ D_{Sys} = \frac{C_{SRf} - C_{SRi}}{S_{FS}} \times 100 \]

Gas Concentration Corrected for System Bias

\[ C_{PPM} = \left( \bar{C} - C_{0_{SR}} \right) \frac{C_{Cyl}}{\left( \frac{C_{SRf} + C_{SRi}}{2} \right)} - C_{0_{SR}} \]

Conversion to Weight/Volume Units

\[ C_{mg/dscm} = C_{PPM} \times \frac{M_{Gas}}{24.04} \]

Emission Rate Calculation

\[ E_R = 6.243 \times 10^{-8} \times C_{mg/dscm} \times DSCFM \times 60 \]

Where:

- \( A_E \) = Analyzer calibration error, percent of span.
- \( B_{Sys} \) = System calibration bias, percent of span.
- \( D_{Sys} \) = System calibration drift, percent of span.
- \( \bar{C} \) = Average gas concentration response from analyzer, PPM (or %).
- \( C_{0_{SR}} \) = Average of initial and final system calibration bias check responses for the zero gas, PPM (or %).
- \( C_{AR} \) = Analyzer direct calibration response, PPM (or %).
- \( C_{Cyl} \) = Actual concentration of calibration gas, PPM (or %).
- \( C_{SR} \) = System calibration response, PPM (or %).
- \( C_{SRi} \) = Initial system calibration response, PPM (or %).
- \( C_{SRf} \) = Final system calibration response, PPM (or %).
- \( C_{PPM} \) = Concentration adjusted for system bias, PPM (or %).
- \( C_{mg/dscm} \) = Constituent concentration converted to mg/dscm.
- \( M_{Gas} \) = Molecular weight of target constituent, lb/lb-mole.
- \( E_R \) = Emission rate of constituent, LB/HR.
- \( S_{FS} \) = System measurement span, full scale.
- \( DSCFM \) = Dry standard cubic feet per minute.
- \( 6.243 \times 10^{-8} \) = Conversion factor, mg/cm to LB/CF.
- \( 60 \) = Conversion factor, minutes to hours.
Gas Concentration Calculations

**Weight/Volume Concentration**

\[ C_{mg/cm} = \frac{m}{V_{std}} \]

**Volume/Volume Concentration**

\[ C_{ppm} = \frac{C_{mg/cm} \times 24.04}{MW} \]

**Emission Rate**

\[ E_{Gas} = \left(6.242 \times 10^{-8}\right) \times 60 \times C_{mg/cm} \times DSCFM \]

Where:

- \( C_{mg/cm} \) = Compound Concentration, mg/cubic meter.
- \( C_{ppm} \) = Compound Concentration, PPM v/v.
- \( DSCFM \) = Volumetric Airflow, dry standard cubic feet per minute.
- \( E_{Gas} \) = Compound Emission Rate, LB/HR.
- \( m \) = Mass of Compound Collected, µg.
- \( MW \) = Molecular Weight of Compound.
- \( V_{std} \) = Standard Volume of Air Sample, liters.
- \( 6.242 \times 10^{-8} \) = Conversion From mg/dscm To LB/CF.
- 60 = Conversion From Minutes to Hours.
Moisture Correction Calculations

Wet to Dry Concentration Correction

$$C_{dry} = \frac{C_{wet}}{1 - \frac{MC_{source}}{100}}$$

Dry to Wet Concentration Correction

$$C_{wet} = C_{dry} \times \left(1 - \frac{MC_{source}}{100}\right)$$

Wet Analytical Basis to Wet Stack Basis

$$C_{wet-s} = \frac{C_{wet-a}}{1 - \frac{MC_{analyses}}{100}} \times \left(1 - \frac{MC_{source}}{100}\right)$$

Note: Changes in temperature and pressure from the source to analysis affect the moisture capacity of the gas sample. 100% rH at laboratory conditions, or 2.5% v/v, is assumed for the analysis moisture content. If another value is used, it will be noted in the Results Summary. Care must be taken to ensure that analytes of interest are not soluble in the resulting condensate.

Where:

- \(C_{dry}\) = Compound Concentration, dry basis, not unit specific.
- \(C_{wet}\) = Compound Concentration, wet basis, not unit specific.
- \(C_{wet-a}\) = Compound Concentration, wet basis, at analysis.
- \(C_{wet-s}\) = Compound Concentration, wet basis, in source gas.
- \(MC_{analyses}\) = Moisture content of gas at analytical conditions.
- \(MC_{source}\) = Moisture content of gas at source conditions.
Volatile Organic Compound Calculations
EPA Method 25A

Convert Analyzer Response to Carbon Basis

\[ C_{\text{ppm-C}_1} = C_{\text{propane}} \times 3 \]

Methane Corrected Concentration (as carbon)

\[ C_{\text{ppm-(C1-CH4)}} = C_{\text{ppm-C}_1} - C_{\text{ppm-CH}_4} \]

Weight/Volume Concentration (as carbon)

\[ C_{\text{VOC-C}_1} = \frac{C_{\text{ppm-C}_1} \times 12.01}{24.04} = C_{\text{ppm-C}_1} \times 0.5 \text{ or } C_{\text{ppm-(C1-CH4)}} \times 0.5 \]

Emission Rate (as carbon)

\[ E_{\text{VOC-C}_1} = (6.242 \times 10^{-8}) \times 60 \times C_{\text{VOC-C}_1} \times \text{SCFM} \]

Where:
- \( C_{\text{VOC-C}_1} \) = VOC Concentration as Carbon, mg/scm.
- \( C_{\text{ppm-C}_1} \) = VOC Concentration as Carbon, PPM v/v.
- \( C_{\text{ppm-(C1-CH4)}} \) = Methane Corrected Concentration as Carbon, PPM v/v.
- \( C_{\text{ppm-CH}_4} \) = Methane Concentration, PPM v/v.
- \( C_{\text{propane}} \) = Average THC Analyzer Concentration, PPM as propane.
- \( \text{SCFM} \) = Volumetric Airflow, Standard Cubic Feet Per Minute.
- \( E_{\text{VOC-C}_1} \) = VOC Emission Rate as Carbon, LB/HR.
- 12.01 = Molecular Weight of Carbon.
- \((6.242 \times 10^{-8})\) = Conversion From mg/scm To LB/SCF.
- 60 = Conversion from Minutes to Hours.
**EPA Method 1** specifies test location acceptability criteria and defines the minimum number of traverse points for representative sampling. Linear measurements from upstream and downstream flow disturbances and the duct equivalent diameter are compared and the distances related to number of diameters. A flow disturbance can be defined as anything that changes or upsets the direction of flow within the duct including bends, dampers, fans, shape or size transitions, and open flames. Method 1 stipulates that test ports should be located at least eight diameters downstream and two diameters upstream of any flow disturbance. The minimum acceptable criteria are two diameters downstream and 0.5 diameters upstream of flow disturbances. The test location must also be free of cyclonic or multidirectional flow. Once the distances have been determined, the values are used to select the minimum number of traverse points for representative sampling. Shorter distances require a greater number of traverse points. The test site configuration and measurement details will be included in test report.

Pace FSD conducts the method as written with no routine deviations. Project situational deviations are fully documented at the time of the test.

**EPA Method 2** defines procedures used to measure linear velocity and volumetric flow rate of a confined gas stream. Using traverse points determined by EPA Method 1, multiple differential pressure measurements (pitot impact opening versus static pressure) are made using a pitot tube and differential pressure gauge. The individual measurements are averaged and combined with the gas density to calculate the average gas velocity. The velocity and duct cross-sectional area are used to calculate the volumetric flow rate. The volumetric flow rate is expressed as actual cubic feet per minute (ACFM), standard cubic feet per minute (SCFM), and dry standard cubic feet per minute (DSCFM). The technician maintains comprehensive test records on EPA Method 2 Field Data Sheet. Details of the equipment used to measure gas velocity include:

- **Pitot Tube:** S-Type
- **Differential Pressure Gauge:** Oil or Electronic Digital Manometer
- **Temperature Device:** Type K Thermocouple
- **Barometer Type:** Electronic Digital Barometer
- **Gas Density Determination:** EPA Method 3
- **Gas Moisture Determination:** EPA Method 4

Quality Control: Sampling equipment calibrations ensure accurate measurement of stack gas flow-rate and sample volume.

Pace FSD conducts the method as written with no routine deviations. Project situational deviations are fully documented at the time of the test.

**EPA Method 3A** defines procedures to measure carbon dioxide (CO2) and oxygen (O2) concentrations from stationary sources. A stainless steel sampling probe and a sampling line draw a sample of the gas stream from the duct to a thermo-electric gas conditioner to remove moisture. The conditioned gas stream is delivered to an infrared gas analyzer to quantify CO2 concentrations and paramagnetic gas analyzer quantifies O2 concentrations. Zero grade cylinder air or a zero gas generator provides zero gas.
Span gases include varying concentrations of EPA Protocol 1 CO2/O2 mixed standards specific to the target calibration range. A computerized data acquisition system logs CO2/O2 concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with standardized spreadsheets in Microsoft Excel. The operator also maintains comprehensive test records on the Gas Monitoring Field Data Sheet. Equipment used for CO2/O2 testing includes:

- **Probe Material:** Stainless Steel
- **Moisture Removal:** Thermo-electric
- **Transfer Line:** Teflon™
- **Analytical Technique:** Non-dispersive Infrared Detector (CO2) Paramagnetic Detector (O2)
- **Calibration Gas:** EPA Protocol 1

Quality control procedures are defined in Section 9.0 of EPA Method 7E, which include:

- NO2-NO Conversion Efficiency is $\geq 90\%$ of certified gas concentration
- Gases have traceability protocol (G1, G2)
- High-level gas is equal to the calibration span
- Mid-level gas is 40-60% of calibration span
- Low-level gas is 20% of calibration span
- Analyzer is documented to show interference effects are $\leq 2.5\%$ of the calibration span
- Analyzer and calibration gas performance equals the analyzer calibration error or the 3-point system calibration error for dilution system and within $\pm 2.0\%$ of calibration span of the analyzer for low, mid, and high level calibration gases (with alternative specifications equaling 0.5 ppmv absolute difference)
- System response time determines minimum sampling time per point
- Drift equals 3.0% of calibration span for low, mid, high level gases (with alternate specifications at 0.5 ppmv absolute difference)
- Purge time equals $\geq 2$ times the system response time; stratification test is used for sample point selection

Pace FSD conducts the method as written with no routine deviations. Project situational deviations are fully documented at the time of testing.

**EPA Method 4** defines procedures to measure the moisture content of emission gas streams from stationary sources. A stainless steel sampling probe draws a sample of the gas stream from the duct to a series of impingers to condense the water vapor. The first two impingers initially contain deionized water and a third impinger is dry. A desiccant packed drying column follows the impingers to quantitatively collect the remaining moisture. An ice bath maintains the impinger train temperature (outlet) at 68°F or less. Collected water condensate is measured and discarded. Method 4 equations convert the condensed liquid volume to a gas volume. The water vapor volume compared with the dry standard gas volume collected through the isokinetic train determines the moisture content of the emissions gas stream and is reported in percent by volume. The operator
maintains comprehensive test records on EPA Method 4 Field Data Sheet, Constant Rate Moisture Sampling.

- **Probe Material:** Stainless Steel
- **Impinger Train Material:** Borosilicate Glass
- **Desiccant:** Drierite
- **Condensate Measure:** Graduated Cylinder or Electronic Scale
- **Desiccant Measure:** Electronic Scale

Pace FSD conducted this method as written with no deviations.

**EPA Method 18** defines procedures to measure gaseous organics emitted from industrial sources. Depending on flame hazards and source conditions, samples are collected using one of five procedures: Integrated Bag Sampling, Impinger, Sorbent Tube Sampling, Direct Interface Sampling, Dilution Interface Sampling. Through pretest screening or previous information on the source gas, the identity and approximate concentration of the compounds are determined in order to prepare the required spikes and calibration standards.

Integrated Bag Sampling: a gas sample is collected into a flexible bag made of Tedlar™, Teflon™, or Mylar™. An inert sampling probe and Teflon™ transfer line extract a sample of the gas stream at a constant rate and deliver it to the bag. An evacuation vessel or inert pump facilitates sample flow. The flow rate is set so the final volume of the sample is approximately 80% of the bag capacity. The collected sample is protected from sunlight and steep temperature gradients. A test protocol document outlines target parameters, sampling handling protocols, and analytical strategies.

The major components of the sample are separated by gas chromatography (GC) and individually quantified with flame ionization. Prior to analysis, the system is calibrated with appropriate zero and span gases. After sampling, recovery studies and response factors are performed and must meet method requirements. The train operator maintains comprehensive test records on the Midget Train Sampling Field Data Sheet. Details of testing are outlined below:

- **Probe:** Stainless Steel
- **Sample Lines:** Teflon™
- **Collection Procedure:** Tedlar™ Bags, Evacuation Chamber

Quality Control: Recovery study for bag sampling demonstrates that proper sampling/analysis procedures were selected. Calibration gas standards for each target compound to be analyzed are commercial cylinder gases certified by the manufacturer to be accurate to 1% or 2% of the certified label value are allowed.

Pace FSD conducts the method as written with no routine deviations. Project situational deviations are fully documented at the time of testing.
EPA Method 25A defines procedures used to measure total hydrocarbons from stationary sources. A stainless steel sampling probe and heat-traced Teflon™ sampling line draw a sample of the gas stream from the duct directly to the analytical system. A total hydrocarbon monitor utilizing a flame ionization detector (FID) quantifies total hydrocarbon concentrations. Zero grade cylinder air or a zero gas generator provides zero gas. Span gases include varying concentrations of EPA Protocol propane (C3H8) standards specific to the target calibration range. A computerized data acquisition system logs THC concentrations for one-minute averages. The logged results are integrated to test periods and tabulated with standardized spreadsheets in Microsoft Excel. The analyzer results are multiplied by 3 to report results as carbon (C1). The operator also maintains comprehensive test records on the Gas Monitoring Field Data Sheet. Equipment used for THC testing includes:

- **Probe Material:** Stainless Steel
- **Transfer Line:** Teflon™, (heated)
- **Analytical Technique:** Flame Ionization Detector (FID)
- **Calibration Gas:** EPA Protocol 1

Quality Control: Zero and calibration drift tests ensure bias introduced by drift in the measurement system output during the run is $\leq 3\%$ of span. Zero Drift is less than $\pm 3\%$ of the span value. Calibration Drift is less than $\pm 3\%$ of span value. Calibration Error is less than $\pm 5\%$ of the calibration gas value.

Pace FSD conducts the method as written with no routine deviations. Project situational deviations are fully documented at the time of testing.
Pace Analytical strives to produce data that are complete, representative, and of known precision and accuracy. To meet these objectives, Pace Analytical uses method specific data sheets and forms which clearly identify the process tested, the date, time, test location, and sampling personnel. Observations are recorded in indelible ink unless conditions do not allow. If any corrections are needed, the old data is lined out and new data is initialed and dated. All data is checked for completeness and accuracy. Our use of proper equipment, rigorous maintenance, and timely calibrations are extremely important to stack testing integrity and client service. We design and build much of our own test equipment and employ full time staff dedicated to implementing maintenance and calibration schedules. Equipment is calibrated on a schedule that meets or exceeds the method requirements. High quality traceable standards and reagents are used and are positively identified and tracked with a unique number. Any samples collected are secured and properly preserved to prevent degradation and tampering. Chain of custody is maintained from sample collection through laboratory analysis.

To ensure testing integrity and data quality, Pace Analytical observes the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems for the development of training programs, Standard Operating Procedures and Procedure Manuals. Pace Analytical has implemented a rigorous Quality Program documented in a Field Services specific Quality Assurance Manual that outlines our quality policies. Pace Analytical uses a custom, computerized Learning Management System to facilitate and track employee training. Controlled copies of all relevant procedures are available to personnel where work is being performed. Equipment is maintained and calibrated by trained personnel on a frequency that meets or exceeds method requirements. Any equipment found to not meet the required specifications is removed from service until it can be repaired and verified to be functioning properly. Pace Analytical uses matrix spikes, duplicate analysis, internal standards, blanks, and linearity and drift checks where required and appropriate. Procedures are in place to assure the accurate transfer of raw data and accuracy of calculations. The Pace Analytical Quality Assurance Program includes procedures for preventative action, corrective action, internal audits and management reviews. Pace Analytical has an internal proficiency testing program and participates in third party proficiency testing programs where available. Pace Analytical field team leaders are certified Qualified Source Testing Individuals (QSTI). The Pace quality program complies with ASTM D7036 - 04 Standard Practice for Competence of Air Emission Testing Bodies.

By this test protocol, the regulatory agency is notified of the testing event and invited to observe any and all testing activities. Documentation of the Pace Analytical Quality Assurance Program will be available on-site.